Why Petroleum Did Not Save the Whales

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Abstract

Ironically, even though fossil fuels provided substitutes for the main uses of whale oil, the rise of fossil fuel use in the nineteenth century served to increase the intensity of whaling. The connections between fossil fuels and whaling are an example of the unanticipated consequences that frequently come with technological change. I draw on political-economic theory to explain why fossil fuels served to escalate rather than eliminate whaling. The case of whaling highlights the limited potential for technological developments to help overcome environmental problems without concurrent political, economic, and social change that supports conservation.

Keywords

whaling, whale oil, displacement paradox, depletion paradox, tragedy of the commodity

In 1861, the magazine Vanity Fair carried a cartoon with the caption, “Grand Ball Given by the Whales in Honor of the Discovery of the Oil Wells in Pennsylvania,” depicting a group of anthropomorphized sperm whales in celebratory revelry, surrounded by banners with slogans such as “We wail no more for our blubber” and “Oils well that ends well” (Vanity Fair 1861). Since that time, some people have assumed that the rise in the production of petroleum and other fossil fuels was a key factor in ending large-scale whaling and, thereby, saved the whales from extermination. However, as scholars who study the subject have long known, an examination of the history of whaling does not bear out this misconception. In fact, it points to the opposite conclusion: the rising production of petroleum and other fossil fuels played a central role in escalating whaling, so that more whales were killed in the twentieth century than in all previous centuries. Even though there are many reasons why growth in the production of fossil fuels failed to eliminate whaling, despite the fact that fossil fuels provide potential substitutes for the predominant historical uses of whale products, political-economic forces and the complex nature of technological systems stand out as especially important.

In some regards we are in a position today analogous to the one faced by societies in the latter half of the nineteenth century. The continued reliance on a particular natural resource—whales in the nineteenth century and fossil fuels in our time—is becoming increasingly untenable due to the environmental problems associated with use of the resource in question (e.g., the threat of depletion and extinction of whales then and the threat of climate change now). The idea that the development of a new resource will suppress use of a formerly dominant resource is at least as common today as it was in the past—that is, just as some people expected the rise of fossil fuels to suppress whaling in the nineteenth century, the development of nonfossil energy is expect by many to suppress fossil fuel use in the twenty-first. For example, reflecting this widely held expectation, former

1Providing a recent example, Michael Medved (2014), writing for USA Today, reports that whales “owe their very survival to a much-derided 19th century Pennsylvania oil driller named Edwin Drake. His story should reassure present-day pessimists of the near miraculous power of technological advancement and pursuit of profit to save the environment.” Similarly, Peter Applebome (2008) writes in the New York Times, “The birth of the American petroleum industry in 1859 in Titusville, Pa., allowed kerosene to supplant whale oil.” It is not uncommon for even energy economists to assume that fossil fuels saved the whales. For example, Griffin and Steele (1980:3) write, “Kerosene did replace whale oil . . . preserving whales from extinction.” Ruffner (1978) documents several historical and contemporary (as of the time of his writing) examples of the expectation that the rise of fossil fuels and the decline of whaling where closely connected. Ruffner (1978) shows that not only do some people assume that the rise of petroleum saved the whales, as I emphasize here, but also some people assume the decline of whales led to the discovery of petroleum.

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Robert K. Merton (1936) highlighted the fact that social actions and technological developments invariably have a suite of unanticipated consequences. As commonplace as this point has become, the widespread expectation that new technologies will help societies overcome environmental problems reflects the still common assumption that technologies will principally have the consequences intended by those who develop and/or deploy them, or at least will have consequences that seem to follow in a straightforward manner. However, empirical research has shown that technologies that are expected to help conserve resources or solve environmental problems frequently do not help, and sometimes hinder, conservation. For example, research on energy efficiency has shown that improvements in efficiency are sometimes associated with increases in resource consumption (e.g., Polimeni et al. 2008). Similarly, the development of substitutes for a particular resource does not always lead to reductions of use of that resource. For example, the development of electronic storage mediums and e-mail did not lead to dramatic reduction in paper consumption, despite widespread expectations for the emergence of the “paperless office” in the computer era (Sellen and Harper 2002). Likewise, York (2012) showed that in most nations of the world, over the past five decades, the generation of nonfossil fuel energy typically did not effectively displace the use of fossil fuels—nonfossil energy sources were for the most part added to, not used in place of, fossil energy sources.

Why do these types of counterintuitive outcomes of technological change sometimes occur? Part of the explanation is surely due to the unpredictable nature of complex systems, like societies and economies. Due to feedback loops, interactions, and nonlinear relationships, processes do not unfold in an easy-to-follow manner. However, there are also likely systematic structural forces at work. In the modern era, market forces have been dominant in most nations around the world and in the global economy as a whole, where businesses and industries are primarily focused on making profits. Thus, technologies are typically deployed to increase profits, not to conserve resources. Producers work to create markets and expand consumption of their products so as to further the accumulation of wealth. This is one important reason why, for example, improvements in energy efficiency are not reliably converted into reductions in energy use but rather result in expanded production and consumption (York and McGee 2016). Therefore, to understand the rise of modern whaling and the continuation of whaling even after petroleum and other fossil fuels were abundantly available, it is necessary to draw on political-economic theory, which helps us to understand how commodities and markets are shaped by industries. In particular, I draw on the concept of “tragedy of the commodity” developed by Longo and Clausen (2011) to analyze these types of processes and assess how they work in capitalist economies. However, I also consider how production dynamics worked in the Soviet system. In that economy, different structural features led to outcomes similar to those in capitalist economies in that whaling was driven more by a push for increased production than by demand for whale products. Additionally, I briefly discuss the current whaling programs of Japan, Norway, and Iceland, as well as those of indigenous communities, which are driven by a variety of processes.

One of my aims here is to explore the unanticipated consequences for whales that came with the rise of fossil fuels. Another aim is to call into question the currently popular view (as noted above) that the way to overcome our reliance on fossil fuels is to develop and deploy alternative energy sources without questioning the political-economic order. As the lesson here about how the rise of fossil fuels did not lead to a reduction in whaling suggests, there is no reason to expect that the expansion of non–fossil fuel energy sources—be they nuclear power, hydroelectric dams, wind turbines, or photovoltaic cells—will necessarily lead to the suppression of fossil fuel use. Preventing the extinction of whales required the suppression of whaling, not per se the development of substitutes for whale products. Likewise, it is likely the case that transitioning to a carbon-free economy will not be accomplished by technological developments alone. Rather, it may require active suppression of fossil fuel use, such as by restricting the amount of fossil fuel that can be extracted (Sinn 2012).

The Emergence of Modern Whaling

“Modern” and “old” commercial whaling can broadly be distinguished by a transition in the complex of technologies used in whaling that began in the 1860s (Tønnessen and
This change in the technologies of whaling was associated with changes in the biology (which species of whales were hunted), the economics (what products were made from whales), the geography (where whales were hunted), and the geopolitics (which nations led whaling efforts) of whaling. A categorical distinction between “modern” and “old” whaling may appear a bit crude, since there are of course continuities across these two categories and substantial variation within each category. However, there is clearly a dramatic shift in virtually all aspects of whaling that occurred in the latter decades of the nineteenth century indicative of a qualitative (and quantitative) transformation of whaling. Although various societies around the world hunted whales for subsistence for perhaps thousands of years, commercial whaling did not emerge until the eleventh century. It began in limited form by Basques in the Bay of Biscay and became widely practiced in Europe only after the sixteenth century, with the establishment of Dutch, English, and German industries (Clapham and Baker 2002; Ellis 1991). Since substantial numbers of whales, particularly, large ones, were not taken until the emergence of commercial whaling, that is where I begin my account.

Old commercial whaling was based on the key technologies of the sail ship, the rowboat, and the hand-thrown harpoon. Whales were chased by rowboats launched from shore or from sail ships, caught by hand-thrown harpoon, and killed by lance or spear. Only a few types of whales could regularly be hunted successfully by these methods. Importantly, fast-swimming whales could not be caught by sail ships and rowboats. Additionally, since whales, once killed, needed to be hauled by the rowboat to shore or to a sail ship, whales that tended to sink once dead were impractical and unsafe to catch. For these reasons, of the baleen whales, the family of right whales (which includes bowheads) was the main target. They were named right whales, in fact, because they are slow moving (obtaining maximum speeds of only seven knots) and typically float after death and are, therefore, the right whales to catch. The sperm whale, a toothed whale, was particularly prized although more challenging to catch. Importantly, the large rorquals, a family of baleen whales that includes the blue and fin whales (the largest animals ever to have lived), could not be captured frequently in the premodern era because they are fast swimming (reaching up to 30 knots for short bursts) and tend to sink once dead.

Although the relative value of various whale products varied across time and place, whale oil stands out as the most important economic driver of commercial whaling over most of the commercial whaling era. Through the nineteenth century, whale oil was primarily used as lamp fuel, as well as to make candles, making it an important energy source. In fact, whale oil was the dominant source for light in many places around the world. Whale oil was also used as an industrial lubricant (especially in textile manufacturing) and to make soap. Baleen (also known as “whalebone” even though it is not bone) was also valuable in the era before plastics. It is strong and pliable, being used, for example, for the ribs in umbrellas and corsets. It garnered particularly high prices in the latter part of the nineteenth century and early part of the twentieth century (Davis, Gallman, and Gleiter 1997). Whale meat for food was a motivation for whaling in some indigenous societies, and whale meat was (and still is) consumed in some industrial societies. However, whale meat was not a major factor in the economics of the global commercial whaling industry, since it never enjoyed a widespread popular market.

There is a variety of other whales that were hunted (e.g., gray whales, narwhals, belugas) in both the premodern and modern eras. However, these species had relatively small populations, and none were major parts of the global whaling industry, although sometimes they were important in some locales. The vast majority of whale products taken during commercial whaling came from the right whales (including bowhead whales), the sperm whale, and in the modern era, the large rorquals (blue, fin, sei, Bryde’s, and humpback whales). In the latter part of the twentieth century, after most other whale populations had been decimated, minke whales, which are small rorquals, were increasingly targeted.

Oil from the spermaceti organ and junk (a mass of tissue and cartilage) in the head of sperm whales was particularly prized, since it makes fine candles, burns cleanly, and is an especially good lubricant (in the twentieth century it was used to lubricate some components in the lunar modules from the Apollo missions and in intercontinental ballistic missiles as well as, more prosaically, automatic transmissions in cars) (Ellis 1991; Gosho, Rice, and Breiwick 1984).

The recent and ongoing whaling (targeting mainly minke whales but also fin whales) by Norwegian, Japanese, and Icelandic whalers is anomalous in that whale meat is one of the main commodities produced for sale. Additionally, in the Soviet whaling industry starting in the 1950s, meat (canned and frozen) from baleen whales became an important product from whaling (Ivashchenko, Clapham, and Brownell 2011). Previously, the meat had been boiled to extract oil, as was done in most other commercial whaling industries, or was simply dumped in the ocean as waste (as was also done at various times in other whaling industries).
whalebone) were sometimes ground into meal and used as crop fertilizer, although this did not provide a substantial source of economic return. Ambergris was a particularly valuable product that came from whales, but it was rarely found in whales and, therefore, was never a driving force behind whaling.  

Radical innovations in the methods of whaling began in the 1860s on the Finnmark coast in northern Norway, led by Sven Foyn, which ultimately transformed the entire industry, marking the emergence of modern whaling. One major change was the switch away from sail to coal-fired steamships (and later to diesel-powered ships). Steamships could go faster than sail, enabling them to keep pace with the large rorquals. Additionally, Foyn developed the harpoon cannon, with explosives in the tip of the harpoon, which could kill even the largest of whales. Importantly, the harpoon cannon was mounted on the bow of the ship, so whales did not need to be chased with rowboats (which, as noted above, could not catch fast-swimming whales). Another significant change was the use of fossil fuel–powered air compressors, which were used to pump whale carcasses full of air so they did not sink. This package of technologies opened vast new opportunities for whalers, making previously uncatchable large rorquals prime prey while also improving the ease with which right and sperm whales could be killed.

Importantly for my assessment here, modern whaling techniques were developed shortly after petroleum, a potential substitute for whale oil, began to be pumped out of the ground in substantial quantities and long after coal became the dominant energy source for industry. In one sense, this is entirely unsurprising since the key technologies of modern whaling depend on fossil fuels. There could not have been modern whaling before fossil fuels were readily available. However, in another sense, it is quite surprising. Counter to the expectations of the anthropomorphic whales we met at the start of this article, whaling does not come to an end after the rise of petroleum but rather undergoes a radical transformation that allows for its acceleration. There is a tension between supply and demand here, where fossil fuels offered the potential to suppress whaling by providing a substitute for whale oil while at the same time allowing for modern whaling techniques to increase the capacity to kill whales.

It is naive to think of substitution happening in a smooth and inevitable manner, as if there were a fixed demand for oil so that a new source of it could simply replace an old source. In fact, a number of well-established alternatives to whale oil were commonly available on the market in the mid-nineteenth century. Even before petroleum became a major source of lamp fuel in the 1860s, by the 1850s kerosene from coal was widely available. Camphene and burning fluid, both plant-based energy sources, were also common and fairly inexpensive. Likewise, fats from domestic animals (e.g., lard and tallow), which can be used as lamp fuel, to make candles, as lubricant, and to make soap, were abundant. In an age of rapid economic and population growth, perhaps it should have been expected that the market could accommodate a wide range of oils. Nonetheless, the dramatic growth of petroleum production in the latter part of the nineteenth century did in principle have the potential to crowd out other fuel sources (and sources of lubricant, etc.). In fact, the demand for and prices of whale oil were lower in the latter part of the nineteenth century than they had been at their midcentury peak. In light of these considerations, it is rather odd that modern whaling techniques were developed right at the time the whaling industry appeared poised to begin a permanent decline. It is even more odd that in the twentieth century, the age of abundant fossil fuels and electric lighting, the slaughter of whales reached a new zenith.

These oddities can be made sense of by understanding the particular context in which modern whaling techniques were developed and the dynamics of commodification and technological innovation in market economies. By the end of the eighteenth century, sperm and right whale populations in the Atlantic were already depleted, so the first half of the nineteenth century saw the expansion of whaling in the Pacific. By the 1860s, sperm and right whale populations in the Pacific, like those in the Atlantic, were depleted, limiting the potential for profit in the whaling industry (Ellis 1991). Nonetheless, this restriction in supply meant prices for whale oil, although reaching their peak in the 1850s, did not plummet despite growing competition from kerosene and petroleum. It was in this context that Sven Foyn, operating on the Finnmark coast, saw an opportunity to make a profit by developing ways to whale more intensively. Norway, particularly Finnmark, was a poor, “backward” locale in the global economy. It had not experienced significant industrialization and lacked access to highly valuable natural resources within national borders (at this time, Norway’s petroleum resources remained undiscovered). Therefore, taking “free” resources, whales, from the oceanic commons was one of the region’s few economic options. Importantly, competition for whales had recently declined.

Through the middle decades of the nineteenth century, the United States was the dominant whaling nation in the world (Davis et al. 1997; Dolin 2007). However, when the United States fell into civil war, its ships were to a large extent taken up for military purposes and not available for whaling. Many of these ships were destroyed in the war, so even after the war’s end, U.S. whalers could not immediately resume whaling at

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7Ambergris is a waxy secretion of the bile ducts in the intestines of sperm whales, which is prized as a fixative by perfumers. Although sometimes found in the digestive tracks of dead sperm whales, it was most commonly collected on beaches around the world, where ocean currents washed it up after it was expelled by the whales (Kemp 2012).

8Camphene is a combination of turpentine and camphor oil, both of which are derived from trees. Burning fluid was a combination of turpentine, camphor oil, and alcohol, which, of course, is distilled from plants, typically grains.
previous levels. In fact, after the war, the U.S. government and industry focused their efforts on expanding westward and exploiting the vast natural resources of the nation. Capital returns on investments and workers’ wages were much higher in agriculture, mining, and manufacturing than in whaling (Davis et al. 1997; Dolin 2007). Due to this, the United States never returned to whaling with much force and, therefore, never developed a significant modern whaling fleet. Norwegian investors and workers lacked the opportunities available to Americans, and therefore, Norwegian whalers had a comparative advantage relative to the United States in that their opportunity costs for focusing on whaling were low (Davis et al. 1997). Also, rising prices for baleen, driven in part by trends in women’s fashions (i.e., the popularity of corsets), helped to make whaling remain profitable in the latter decades of the nineteenth century (Davis et al. 1997). Additionally, modern whaling techniques helped to overcome the limitations on supply stemming from the depletion of whale stocks by making it feasible to catch the previously unexploited populations of large rorquals. For these reasons, over the last four decades of the nineteenth century, the technologies that define modern whaling were developed and refined, even though whale oil was less needed than ever.

**Innovation and Geographic Expansion in the Twentieth Century**

Building on its investments in shipping and trade, fishing, and exploration, the United Kingdom (once Norwegians had developed the key technologies) built a large modern whaling fleet, controlled a major part of the global whaling market, and dominated the industry in the years before the Second World War. Thus, the United Kingdom was at the center of the transformations in the whaling industry and markets that occurred in the first decades of the twentieth century (Burnett 2012). There was a major geographic expansion in whaling, led in part by British exploration of the Antarctic region. Additionally, there were technological innovations that not only allowed for more intensive whaling but also allowed for the development of a variety of new uses for whale oil (see below).

Before the twentieth century, commercial whaling was largely restricted to the northern hemisphere. The North Atlantic fishery was exploited with particular intensity, but even the vast Pacific Ocean saw its population of whales decline over the nineteenth century (Clapham and Baker 2002; Ellis 1991). Thus, Atlantic and Pacific stocks of sperm and right whales had become depleted by the time modern whaling techniques were developed. The biggest geographic shift in the location of whaling occurred early in the twentieth century, when increasing exploration of the oceans of the southern hemisphere, particularly around Antarctica, led to the discovery of huge stocks of blue whales and other rorquals (Burnett 2012). This led to a whaling rush of unprecedented speed and ferocity in the early years of the twentieth century. Whales were in fact so abundant in Antarctic waters that whalers were highly wasteful in the first years of the bonanza. Whalers frequently removed the prime blubber from whales and then dumped the carcasses in the ocean, despite the fact that whale oil can be extracted from flesh and bones by boiling them, and other uses (e.g., as food, as fertilizer) can be made of various parts of whales. This expansion into the Southern Ocean was largely made possible by fossil fuels. Coal- and diesel-powered ships were important for accelerating travel, which allowed for more rapid transportation of whaling ships to the south of the globe and the return of whale products to the north.

At around the same time as the southern expansion of whaling, there were further developments and refinements in the complex of technologies involved in modern whaling. Most notably, the early years of the twentieth century saw the development of the factory ship, which allowed whales to be entirely processed at sea and barrels of whale oil and other products brought back to port ready for sale (Clapham and Baker 2002; Ellis 1991). By the 1920s, the factory ship was becoming the norm. Since the carcasses of whales no longer needed to be brought to shore for processing, pelagic (open-ocean) whaling dramatically expanded. Factory ships, which could remain at sea for months, prowled the world’s oceans, being fed whales by fleets of support vessels and returning to port only when their stores were full. The factory ship and its fleet could not exist without fossil fuels, which powered the whole operation and allowed for long-duration storage of whale products by running freezers (for meat) and processing whale oil so it would not become rancid.

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9 Although whales are mammals, not fish, regional whale hunting industries are nonetheless referred to as fisheries. There was a famous court case in New York in 1818 that addressed whether whale oil counted as fish oil for purposes of inspection and taxation. This was in some ways a pre-Darwinian version of the “Scopes Monkey Trial.” Scientists testified that whales are mammals, not fish, while others argued tradition, common sense, and the Bible tell us that whales are fish. The court ruled that whales are fish for legal purposes. Burnett (2007) provides an engaging history of this trial.

10 Although the ruthless killing of the whales per se and even the rapid depletion of whale populations did not generally raise the ire of the public or of those in government until the latter part of the twentieth century, the sheer wastefulness of the industry did receive criticism in the early twentieth century (Burnett 2012). The expansion of whaling in the southern hemisphere coincided with the emergence of whale science (cetology), with scientists frequently travelling on whaling ships. There was a complex relationship between the cetologists and the whaling industry, where scientists relied on whalers to provide them with dead whales to study and to learn about the locations and movements of whales, but where scientists also started to sound the alarm about the unsustainability of the industry and report on the intelligence and social sophistication of whales. Burnett (2012) provides a well-crafted history of cetology over the twentieth century and how it eventually contributed to whale conservation, despite being born in the blood of whales.
With the southern oceans opened up to whaling and with the rise of the factory fleet, there emerged the potential for oversupply of whales. This potentially could have led to a drop in prices and profits if the market for whale products did not expand. However, this was a period of rapid global industrial expansion, scientific and technological innovations, and the development of new commodities and consumer markets. Perhaps the most important innovation for providing a market for whale oil was the development of the process of hydrogenation in 1905 and the refinement of this process by the 1910s (Burnett 2012; Ellis 1991). This process could convert whale oil into a solid at room temperature and, as importantly, remove its unpleasant odor, making it a major source of margarine. Thus, in the twentieth century whales were killed in huge numbers so they could be eaten on toast, despite the fact that there were many other fat sources that could serve this purpose. The technological innovations did not stop with hydrogenation. The twentieth century saw whale products used in the manufacture of rustproof paints, pharmaceuticals, cosmetics, and a variety of other chemical products. In fact, since glycerin is a side product of soap making, with the appearance of the First World War, whale oil contributed to the manufacture of explosives. Thus, in addition to being used for many of the purposes they had been before modern whaling, such as lubricant, whale products were turned into a variety of new commodities that were sold around the world.

The last phase of the global commercial whaling era unfolded after the Second World War. The huge scale and aggressiveness of whaling that was enabled by the power of fossil fuels and technological innovations in production processes quickly decimated whale populations all around the world (Ellis 1991). By the 1940s it was clear that whaling was approaching its end, if for no other reason than that whale populations could not sustain anywhere near the level of killing that was taking place. Aided by growing understanding of the biology and ecology of whales and interest in developing methods for international cooperation (in the aftermath of the war), the International Whaling Commission (IWC) was formed in 1949. It included most of the major whaling nations in the world (Burnett 2012; Ellis 1991). The IWC had the purpose of regulating whaling so as to prevent the collapse of the industry due to overexploitation. It largely failed in this, since whalers did not want regulations and many member nations were reluctant to commit to strict limits (Ellis 1991).

In due course the IWC developed a quota system for nations, although this was not highly effective for conservation purposes. One problem was that quotas were set in generic “blue whale units” (BWU) rather than as limits on each population or species of whale. This crude metric lumped all whales together on a single scale in which one blue whale was 1 BWU, one fin whale 0.5 BWU, one humpback 0.4 BWU, and so on. This meant that if whalers focused on a single species, they could dramatically overharvest it even while remaining within the quota. Additionally, the quotas were often ignored (more on this in the next section), some nations did not participate in the IWC, and there were a number of pirate whalers who ignored international regulations (Ellis 1991). As a result, despite the declining populations and IWC regulations, a vast number of whales were killed in the decades after the war. As large rorquals became increasingly scarce, whalers shifted their focus back to sperm whales, with predictable consequences for the sperm whales. Thus, sperm whale catches had two peaks, one in the 1830s in the premodern era and then again in the 1960s, after which their populations collapsed.11 The United Kingdom and several other nations reduced the scale of their whaling industries. However, the Soviet Union and Japan (which I will discuss more in the next section) expanded their whaling fleets, making them the dominant whaling nations after mid-century. Finally, acknowledging that the whaling industry had destroyed the stocks of all the species it targeted so that large-scale whaling was no longer viable, and under pressure from a growing international outcry, in 1982 the IWC passed a moratorium on commercial whaling, which came into full effect in 1986. Although some whaling continued after this time and continues to this day (there are exemptions for scientific research and for some indigenous societies, and some nations either do not participate in the IWC or do not accept the moratorium), after 1986, large-scale commercial whaling was at its end.

The ecological consequences of the commercial whaling era were extraordinary. The populations of all species that were hunted were dramatically depleted. In fact, many became seriously endangered, and a few, such as the northern right whale, were pushed to the very brink of extinction (Ellis 1991). The depletion of whales has had wide-ranging and enduring consequences for marine ecosystems, some of which are still not fully understood. For example, whales play an important role in nutrient cycling that increases primary productivity in coastal waters, and this ecological service has been undermined by the loss of large whale populations (Roman and McCarthy 2010).12 Although the populations of a few species have recovered to a reasonable

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11Remarkably, in light of the fact that they were targeted for centuries, sperm whales managed to survive the commercial whaling era, although the status of their global population is uncertain (Gosho et al. 1984). One reason sperm whales may have fared better than many other species, despite being hunted so intensively, is that, unlike with baleen whales, male sperm whales are larger than female sperm whales, and therefore, mortality from whaling was lower for females. It is a well-established principle of population biology that male mortality is less of a threat to population survival than female mortality.

12Additionally, whales sequester carbon since their bodies usually sink to the bottom of the ocean when they die (Pershing et al. 2010). So, the depletion of whales in a small way influences the global climate.
degree since the moratorium, the global populations of many species, such as the blue whale, are still only a small fraction of what they were before intensive whaling began.

Although the moratorium on whaling in one sense can be seen as a great conservation success, in another sense it is a dispiriting testimony to the difficulty of protecting species, ecosystems, and natural resources before they are destroyed. The simple fact of the matter is that the moratorium was established only after most whale stocks were commercially, if not biologically, extinct or nearly so. Therefore, whaling had already ceased to be an industry with much prospect for profits. Thus, the nations renouncing whaling were not giving up much. Nonetheless, the development of the environmental movement and transformation of how people thought about whales in many of the Western democracies that unfolded over the second half of the twentieth century represent a remarkable social change that perhaps holds out hope for conservation successes in the future (Zelko 2012).

The Commons, Commodities, and Capitalism

In some regards, the depletion of whales is a prime example of the tragedy of the commons (Hardin 1968). As a generally unregulated (until the twentieth century) common resource, whales were overexploited because individual nations and whalers benefited from killing whales but did not reap the long-term rewards of conservation if they practiced restraint, since others continued whaling regardless. The history of the destruction of whales certainly highlights the need for enforceable international agreements to help conserve common resources, since if left unregulated, self-interested actors can undermine the common good. However, the tragedy of the commons has only modest explanatory power, being a rough and unnuanced generalization that fails to take into account contextual factors and structural forces.

Longo and colleagues’ (Longo and Clausen 2011; Longo, Clausen, and Clark 2015) concept of the tragedy of the commodity is perhaps more useful than the tragedy of the commons in helping us to understand how whaling not only continued but escalated after fossil fuels came in to widespread use. They build on the eco-Marxian political-economy tradition to understand how market processes and capital interests lead to overexploitation of natural resources. One of their prime examples focuses on the Sicilian bluefin tuna fishery. This fishery for centuries was managed in a sustainable manner, where fish were harvested as a local food source. However, over the course of the twentieth century, global market forces transformed this fishery. Rather than levels of harvest being determined by local fishers to provide for local demand, they became increasingly driven by a modern fishing industry seeking to maximize profits by selling fish around the world, wherever the best prices could be obtained. Bluefin tuna became particularly prized for sushi on the Japanese market, where the prices paid for tuna reached extraordinary levels. These high prices spurred higher and higher levels of harvest, and since the global market was so much larger than the local one, any level of supply could be sold.

The tragedy-of-the-commodity concept highlights that a common resource is not necessarily overexploited when it is used primarily for meeting local needs and there is not ready access to a global market. This is because there is a limit on how much can be consumed locally and there are not profits to be made from excessive extraction. However, in a capitalist global economy where the fishing industry has the potential to make large profits by extracting a common resource as quickly as possible and selling wherever prices are highest, there is a structural drive toward overexploitation. The key point, then, of Longo and his colleagues is that the commodification of a resource, where it is extracted to sell on a market for profit, rather than common ownership of a resource is typically the primary reason for overexploitation of natural resources in the modern era.

The tragedy-of-the-commodity logic is built on political-economic theorizing that recognizes that elite capitalists, most notably, corporations, have the power to create and manipulate markets rather than simply respond to preexisting demand (Foster, Clark, and York 2010). Although people have some enduring demand for resources to meet their basic needs, such as for food and water, the vast majority of consumption in modern economies is not to meet basic needs (Rivera-Ferre 2009). Before the modern era, there was typically no perception of need for most of the commodities that industrial capitalism would later provide (Dawson 2005). In fact the insatiable consumer desire that is taken for granted in capitalist societies was not even conceived of before consumerism as a way of life was constructed over the past two centuries by the concerted efforts of private industry (Dawson 2005). Recognizing this helps to make sense of why petroleum and other fossil fuels did not lead to an end to whaling.

If demand for a commodity, like whale oil, was limited by need, then a potential substitute, like petroleum, could reasonably be expected to push it out of the market. However, demand for resources is not fixed at a “natural” level. Rather, demand can expand as established uses increase in frequency, such as using abundant oil of various types to have more lighting, and as innovation leads to new uses for resources, such as how whale oil came to be used for margarine, in paint, and so forth. In pursuit of profits, capital clearly has it in its interest to work to continually expand consumption and develop new products for sale. Therefore, increasing the supply of new resources, like fossil fuels, does not necessarily displace consumption of other resources. New resources can

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13Hardin’s (1968) argument has many critics. It is important to recognize that common resources are not necessarily overexploited in all or even most circumstances. In fact, there are many examples of effectively managed commons (Bollier 2014).
be added to, rather than used in place of, others in the market as new ways are found to make commodities (and profits) from all available resources.

The desire to make profits in markets is clearly a major incentive that drives technological innovations and applications. As I explained above, part of what kept whaling going through the twentieth century was a suite of new goods that were produced from whale products. The growing supply of whales that came about with the development of modern whaling techniques, especially after the expansion of the whaling industry into the southern hemisphere, provided an abundance of raw material that could be utilized to make marketable products. Perhaps one of the most widely recognized features of the modern era is the ability of private industry to innovate and develop new consumer goods and markets. So, it should not be surprising that despite the rise of fossil fuels, new uses were regularly found for the raw materials provided by whalers. It is not that the whaling industry itself per se developed new uses for whales but, rather, that businesses, markets, and technoscience frequently found ways of generating profits from available resources. In this sense, the abundance of dead whales supplied by whalers helped create consumer products in that it made it worthwhile for various businesses to invest in developing marketable whale-based goods, such as margarine and rustproof paint.

Another process that was at work in accelerating whaling over the twentieth century was, ironically, the anticipation of regulation of whaling (Ellis 1991). In the context of the commons, whalers could take whales in international waters with impunity. However, as it became clear that national and international restrictions on whaling were on the horizon, particularly after the formation of the IWC, whalers, who had fixed capital investments in their whaling ships and other apparatus, had an extra incentive to catch as many whales as possible before laws restricted their capacity to do so. The perverse incentive to further escalate resource depletion in anticipation of environmental laws has been called the “green paradox” by Hans-Werner Sinn (2012). Sinn’s specific argument focuses on the fossil fuel industry in the twenty-first century. Sinn contends that corporations anticipate future restrictions on fossil fuel extraction. They therefore work hard to extract and sell the fossil fuel assets they can access as quickly as possible before they can do so no longer due to regulation. Sinn notes that this incentive makes it so that the supply side, rather than the demand side, drives fossil fuel use. The fossil fuel industry is responding to concerns about its ability to sell its reserves rather than to an inherent demand. The green paradox is a phenomenon that stems from the pursuit of private profits, so it is part of the political-economic processes that lead to environmental exploitation described above.

A related phenomenon occurred in twentieth-century whaling. Perversely, the very fact that whale populations were being driven to the brink of extinction led individual whalers and whaling nations, who were in competition with other whalers and nations, to intensify their efforts to get as many whales for themselves before the whales were gone (Ellis 1991). This is an intensified version of the tragedy of the commons, where the incentive to overexploit a common resource becomes enhanced the closer that resource comes to depletion. This phenomenon could be called the “depletion paradox,” which is much like the green paradox, where the anticipation of depletion, just like the anticipation of regulation, can spur the processes that lead to depletion. There are many examples of this, one being the destruction of the passenger pigeon in North America mainly by market hunters in the latter part of the nineteenth century (Schorger 1955). Although the depletion paradox can apply to noncapitalist economies (as I explain in the next section), it is important to recognize that the driving force that typically leads to it is the ruthless profit seeking of private interests. In this regard, this phenomenon is closely connected with the tragedy of the commodity.

Geopolitical and Cultural Logics

Although profit-seeking behavior by capitalists goes a long way to explaining the overexploitation of whales, other processes also served to drive whaling at various times and places. Commodification of resources in global markets is the most common cause of wanton extraction and is clearly sufficient to lead to resource depletion. However, geopolitical and cultural forces can also drive resource extraction, even in the absence of demand for those resources.

The rapacity of Soviet whaling is not adequately explained by the logic of the tragedy of the commodity. It was spurred more by the tragedy-of-the-commons logic in tandem with geopolitical considerations, not by the commodification of whale products for making profits in markets. The Soviet Union did not make a serious attempt at large-scale modern whaling until the 1930s. However, Soviet whaling was a major cause of the devastation of whaling stocks after the Second World War, rapidly killing vast numbers of whales (Clapham and Ivashchenko 2009; Ellis 1991; Ivashchenko, Clapham, and Brownell 2011). For example, in a few years from the late 1950s until the early 1960s, Soviet whaling virtually destroyed the humpback whale populations around Australia and New Zealand. These populations had been robust before the arrival of the Soviet whaling fleet (Clapham and Ivashchenko 2009). The Soviet Union, in violation of international law, took many more whales than allowed by

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14The protection of coastal redwood forests in northern California provides a clear example of this paradox. When it became clear that the U.S. Congress was going to purchase and protect redwood groves to form Redwood National Park in the late 1960s and expand it in the 1970s, some of the lumber companies that owned land Congress was considering for protection logged intensively to extract timber before the land came under public ownership (Lydon 2001).
the quotas set in international agreements, and it systematically falsified the data it submitted to the Bureau of International Whaling Statistics (Clapham and Ivashchenko 2009; Ivashchenko et al. 2011).

Even if not fitting fully with the tragedy-of-the-commodity model, Soviet whaling otherwise does fit with the general pattern of the modern whaling era in that it was production driven. The Soviet Union had its own version of a “treadmill of production” (Schnaiberg 1980), where political and economic forces generated a growth dynamic spurring extraction of resources (see also Mandel 1992). The Soviet planning system set annual production targets and generously rewarded workers when these were met or exceeded. There was also competition between crews and fleets to catch the most whales, which further escalated the rate of killing. The state also regularly upped the targets if the production quotas were met, with little consideration of the sustainability of the harvests. Since the targets were about the raw mass of whales taken, rather than the actual amount of usable products extracted, even whales that had decomposed too much to be used still counted toward the targets, and therefore, often whales were caught faster than they could be processed and went to waste (Clapham and Ivashchenko 2009).

The frenzied drive to accelerate whaling at all costs is strikingly at odds with the fact that demand for whale products in the Soviet Union was low (Ivashchenko et al. 2011). The main drive stemmed from a nationalistic fervor to get the Soviet Union’s “share” of whales before they were all gone (Ivashchenko et al. 2011), fitting with the depletion paradox I described in the previous section. This desire was heightened by the fact that the Soviet Union started whaling later than many other nations, and Soviet officials recognized that major capitalist nations had already taken a huge number of whales. Additionally, Soviet officials, as part of Cold War posturing, wanted their whaling ships and fleets to be the largest in the world, consistent with their desire to have other technologies and industries exceed in scale those of other nations (Ivashchenko et al. 2011).

In recent years, Japan, Norway, and Iceland are the three nations with the highest levels of whaling, although these levels are much lower than what occurred throughout the era of global commercial whaling. Japan claims its whaling is for scientific research and therefore exempt from the IWC’s moratorium on whaling. However, the Japanese whaling program was found to be in violation of international law in March 2014 by the International Court of Justice. Norway registered an objection to the IWC moratorium on whaling in 1982, so it is not bound by the moratorium. Iceland left the IWC but in the early 2000s rejoined it. However, it claimed a reservation to the ban on whaling and now engages in both commercial whaling and whaling it claims is for scientific purposes.

The industries of Japan and Norway focus on minke whales (although Japan has also hunted several other species of whales in recent years), which are too small to have been of interest to whalers in earlier eras when large whales were still available. Iceland has focused on endangered fin whales, having killed hundreds in the past decade, but also hunts minke whales. Whale meat is the primary commodity produced by these industries, in contrast with most other whaling industries throughout history, where meat was typically processed to extract oil or simply dumped as waste. The ongoing whaling by these nations in some regards defies economic logic. Norway (a major petroleum producer), Iceland, and Japan are three of the wealthiest nations in the world and have advanced economies. In these nations, whaling provides a negligible number of jobs, there is not a high level of demand for whale meat (in fact, much of the meat has gone to waste for lack of finding a market), and, rather than being a substantial source of revenue, whaling is dependent on government subsidies. It is also noteworthy that these three nations resist international pressure to stop whaling in light of the fact that they are otherwise generally supportive of international agreements and domestic policies aimed at fostering environmental protection.

Current Norwegian, Icelandic, and Japanese whaling is not entirely explained by the political-economic forces that...
underlie the tragedy of the commodity. To some degree the commitment of these nations to continued whaling has something in common with that of the Soviet Union, in that it reflects geopolitical posturing aimed at asserting independence from the demands of other nations, although there is obviously nothing like the Cold War maneuvering at work here. Additionally, none of these three nations has a production-centric planned economy like the Soviet Union. A cultural logic also motivates whaling in these nations, where Norwegian, Icelandic, and Japanese peoples each in their own way claim a degree of sociocultural identity with whaling and continue it as a way of maintaining a link to (partially mythical and idealized) past traditions (Kalland 2009; Morikawa 2009).

However, although Norwegian, Icelandic, and Japanese whaling practices are not based on a sensible national-level economic logic, actors pursuing private profits contribute to the perpetuation of whaling in these nations. Bell and York (2010) analyze how industries work to utilize, exploit, and manipulate cultural meanings, images, and ideas to construct economic identities for communities that serve the economic interests of those industries. In particular, Bell and York examine in detail how the coal industry in Appalachia works to maintain and enhance the identification of people in the region with coal production, even though coal provides far fewer jobs than it once did. Similarly, ranchers in the American West make use of the culturally charged cowboy image to help maintain access to vast areas of public lands and government subsidies, even though ranching makes an insignificant contribution to the economy or the job market.

In these cases, some economic actors, even though not necessarily the most powerful ones, can gain economic advantage by utilizing cultural constructions. Something of this sort is going on in Norway, Iceland, and Japan, where those in the whaling industry, following the logic of capitalism, utilize any tools at their disposal to maintain profits, regardless of whether whaling is important for the larger national economy. For example, the Taiji drive-hunts of small cetaceans in Japan are justified as part of local fishing culture, but sales of captured animals to zoos and aquariums generate profits for locals (Kyodo 2016). Similarly, Norway claims it whales since the meat is an important and traditional part of its people’s diet, although the whaling industry exports a large share to Japan and sells whale meat as feed to fur farms (Bale 2016). So, in this sense, economic interests in part still drive contemporary whaling, even though it is economically irrational for nations as a whole.

Ongoing whaling in some indigenous communities (which is of a much smaller scale than commercial whaling endeavors) is also driven by distinct cultural and political logics. Indigenous communities around the world who engaged in subsistence whaling were exempt from the IWC moratorium and given quotas of whales they could catch (Ellis 1991). In most circumstances, market forces were not driving the whaling, since the whales were not sold but rather were consumed by the communities. Therefore, the principle motivation for whaling in many of these communities is one of subsistence economics. However, in some of the communities with exemptions from the moratorium, cultural and political logics are the more important forces driving whaling, in that whale meat is not a significant source of food. Rather, whaling is sometimes practiced as a way of maintaining cultural traditions and as an assertion of sovereignty and resistance to the authority of modern nation-states formed through colonialism (Deutsch 2017). One example of this type of motivation is of the Makah Tribe on the Olympic Peninsula in North America. In 1994, the U.S. government claimed the Makah, who had not engaged in whaling for 70 years, were qualified for an exemption from the IWC moratorium and from U.S. laws protecting whales and allotted them a small quota of gray whales. Despite substantial controversy and public protests, and the fact that tribal members were not in need of whale meat for subsistence purposes, the Makah proceeded with efforts at whaling, taking a gray whale in 1999, claiming that it was important for the maintenance and revival of their cultural traditions (Deutsch 2017; Sullivan 2000). The Makah also asserted that they had a sovereign right to engage in whaling, a right they had retained in the 1855 Treaty of Neah Bay (Deutsch 2017; Sullivan 2000). Thus, this is an example where whaling was driven not by economic forces but by cultural identity construction and a struggle for political independence.

The cases of the Soviet Union, Norway, Iceland, and Japan and indigenous whaling illustrate that although, as I argued in the previous section, political-economic forces, particularly the quest for profits under capitalism, were the main drivers behind the destruction of whales, other forces, such as geopolitical interests and cultural logics, were at work too, although these forces were also shaped by political-economic context. Importantly, consistent with economic and technological forces, the cultural and geopolitical forces I identify here show that whaling was driven not by an inherent demand for whale products but rather by forces of production. This point highlights why the appearance of substitutes for whale oil did not lead to a decline of whaling. The supply side of whaling followed its own logics—political-economic, technological, geopolitical, and cultural—that were not driven by preexisting demand.

**Conclusion: Theory from above and below the Waves**

My most basic aim here has been to explain why the discovery of petroleum and growing use of other fossil fuels did not end whaling. Since fossil fuels provide potential substitutes for the main products of whaling—whale oil most notably—rising petroleum production could have ended whaling. However, to the contrary, fossil fuels allowed for the development of modern whaling technologies, which greatly expanded the capacity to kill whales. Additionally, a variety
of other technological innovations, like hydrogenation, allowed for the development of new commodities, such as whale oil–based margarine, that expanded the market for the products of whaling. Due to these changes, most whales that were ever killed were killed in the twentieth century, in the era of plentiful fossil fuels and substitutes for whale products. Tragically, widespread whaling did not end until most whale stocks were driven to commercial extinction and many species to the brink of biological extinction.

Although the history of modern whaling is fascinating in and of itself, in telling this history I have larger theoretical aims revolving around understanding political-economic processes, technological effects on social change, and socio-ecological interactions. This history illustrates the limitations of technological fixes, absent of corresponding economic and political changes, with respect to solving environmental problems. In one sense, the prevalence of unanticipated consequences of technological developments (e.g., petroleum made killing whales easier, which proved more consequential than the fact that it could substitute for many of the uses of whale oil) highlights the basic unpredictability of complex systems, like economies and societies. In another sense, macrostructural forces, particularly the nature of market economies and profit-seeking actions of businesses, contribute to the quite predictable consequence that technological developments are used to increase production so as to increase revenue rather than used for conservation.

The case of whaling shows the error of conceptualizing resource extraction as necessarily driven by inherent demand or societal need for the resources extracted and highlights how the capacity for production and the interests of industry can create demand and drive consumption. In particular, the case of whaling shows some potential explanations for the displacement paradox identified by York (2006, 2012), who demonstrated that the development of non–fossil fuel energy sources in recent decades did not substantially suppress fossil fuel use in most nations. As I have shown happened in the case of modern whaling, the power of industry (especially in the context of capitalism), geopolitical posturing, and/or cultural identity construction can drive the extraction of a resource even when it is not needed. The displacement paradox, in addition to Sinn’s (2011) green paradox (where industries accelerate resource extraction in anticipation of future regulations) and the depletion paradox (where individual economic actors accelerate extraction of a commonly held resource in an attempt to maximize their share of that resource as it approaches exhaustion), suggest the need for addressing the production side of resource exploitation, rather than focusing primarily on the consumption side. Furthermore, these paradoxes suggest that “green” technological fixes, such as developing renewable energy sources, are unlikely to curb environmental degradation unless there are corresponding political and social changes that ensure technologies are applied for the common good, and environmental protection is promoted as a goal in itself.

Finally, the history of whaling highlights the importance of including a consideration of ecology and biology into sociological analyses and a consideration of sociological theory into environmental science and conservation biology. As Longo and Clark (2016) have argued, there is a pressing need to understand the connections between marine environments and social processes. Nonhuman animals clearly have major effects on the material aspects of societies, by shaping ecosystems, providing labor, and serving as sources of materials (Tovey 2003; York and Longo 2015; York and Mancus 2013). The history of whaling and its consequences for humans and whales needs to be understood as an interaction between a suite of social factors (economics, politics, technology, culture) and a suite of ecological and biological factors (the distribution and abundance of whale populations, the behavior and characteristics of particular whale species).

Ryan Tucker Jones (2013), in his history of exploration, transportation, and resource extraction (including whaling) in the North Pacific, emphasizes the importance of telling history from “below the waves.” Human history cannot be properly understood without considering the nature of the ocean and its inhabitants. Of course, we must also look above the waves, since the social processes that led to the devastation of whale populations, and environmental problems more generally, are not as simple and straightforward as many environmental scientists may implicitly assume. One lesson here for environmental scientists is that technological changes do not necessarily have the effects that are often expected. It is likely that many conservation strategies may not work out as expected due to political-economic, cultural, and geopolitical dynamics. This is why conservation biology needs social science. One lesson for social scientists is that thinking of whales as simply a uniform, generic resource to be extracted can lead to a failure to understand the emergence and eventual collapse of modern commercial whaling. More generally, thinking about the environment as merely a stage for human action and a source of raw materials will lead to a misunderstanding of how societies develop and change. Sociology needs to engage with the environmental sciences to develop richer ecosocial theories, and through this engagement, sociology will likely give a number of vital insights to natural scientists working on conserving biodiversity.

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