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Harpoon to Derrick:

Lessons from an American Energy Transition of the 1860s

"Can he who has only discovered the value of whale bone and whale oil be said to have discovered the true uses of the whale?"

-Henry David Thoreau, 1853[1]

The pitched vessel leans hard with the wind as it cuts through the open ocean. The moment is one of sustained tension. Brinksmanship requires one to catch the breeze but never give the vessel to it completely. The majesty of a sailing ship plying the open sea romances the onlooker with its potential for adventure and its simple aesthetic beauty. The vessel seems stretched between sky and sea; in reality it is stretched between human ingenuity and the combined natural forces of the wind and sea. During the Age of Sail (1400-1850), all human marine travel existed within this synergistic, but entirely volatile, relationship. The whaleship, despite its ties to industrial enterprise, evokes a similar connection to the romance of the sea when in the open ocean.

In contrast, the sight of such vessels clumsily maneuvering the ice fields of the Arctic appeared jarring and odd. Similar to the factory smokestack rising from a pastoral countryside, whale ships seemed interlopers when they began Arctic probes in the mid-1800s. Shortly, however, the hunt for bowhead had brought the bulk of the American fleet to the northern most stretches of the earth. Scarcity of whales and competition in their marketplace forced the whalemen to defy the natural occurrences of these icy waters, and in August 1871, storms drove the fleet into a narrow strip of water less than a half-mile wide. In the log of *Taber*, the first mate recorded that, "It looks like a poor show to get out of this season."[2]

Scattered along the coast for twenty miles, the fleet lay in water fourteen to twenty-four feet deep with ice closing in. The whalers' concerns were for their physical survival; in the balance, though, was the very industry and livelihood to which they had committed their lives. The fact that they remained when the waters could freeze is evidence of their desperation to

increase production. Frozen in time, this image of the whale ships locked in ice is one response to the question: What did the energy transition from whale oil to petroleum look like in the nineteenth century in North America? Yet to fully understand this energy transition our view must include multiple sites and moments that led to this Arctic still-life in 1871.

For decades, our guide to understanding energy transitions has been the writer and observer of technological shifts Lewis Mumford, whose essential, organizational boundaries grow from his efforts to chronicle the human interaction with technology in seminal books such as *Technics and Civilization*. "The tool brought man into closer harmony with his environment," Mumford writes, "not merely because it enabled him to reshape it, but because it made him recognize the limits of his capacities."[3] Mumford sees these realizations as "…part of the creation of a third state between nature and humane arts…," that is the use of technology to manipulate the human capacities and possibilities.[4] As a tool that drives and powers other technical processes, energy is the linchpin organizing and enabling Mumford's dynamic paradigm. Humans determine how technology will allow them to "prevail over the raw nature of things," and new systems of energy provide the power to do so.[5] Mumford sees a lust or desire for the machine emerge among developed societies (particularly Europe and the U.S.) after 1750 and energy is a primary tool for compounding these initiatives and re-organizing societies around them.[6] Such an "instrumentalist" view of history has contributed to the inquiry of many sub-disciplines since Mumford wrote *Technics and Civilization* in 1934, including the history of technology and environmental history. Many of us historians, specifically emphasizing energy history, salute Mumford's basic paradigm as the point of departure for our own work.

As we focus our current historical inquiry specifically on energy pasts, transitions become an essential delineation. The inquiry of current scholars in energy history seeks to nuance and complicate our ability to discern and to interpret transitions.[7] My case study here, which is designed to display some of these approaches, focuses on this 1871 moment when previous historians have instructed us that the American whaling fleet met its downfall.[8]

Modeling Energy Transitions

Illuminating the changes that transpire during mid-1800s, marks a primary focus of energy historians and many of us are actively working to construct

a common organizational framework.[9] Periodizing transitions from one energy source to another and also creating demarcations that properly acknowledge more significant shifts provides a common language that allows us to catalogue the ongoing human relationship with energy. Formalizing such distinctions will sharpen our understanding of the differences between energy sources and user societies. In particular, as we study specific energy transitions, we must enable scholars to specifically differentiate among transitions to separate what might be called intrinsic or foundational shifts in energy use, during which the ethic or mode of collection or use marks a severe departure from previous models.

This is particularly crucial as we make energy studies a vital component of efforts to organize the Anthropocene concept.[10] To properly contextualize the changes in human living during this geological epoch, it is particularly imperative that we distinguish between the transitions in the ethic or mode of harvest. To accomplish this task, historians might utilize principles of physics, which, of course, studies energy and matter in nature. In the recent re-publication of *Energy and Civilization in History*, Vaclav Smil, the well-known philosopher and historian of energy, suggests such a foundation by offering language to help historians distinguish between sources of energy, including:

- efficiency of energy conversions: the effectiveness of technologies employed to harvest or convert raw materials into energy

- Energy returns: which needed to exceed input for a source to be viable and sustainable

- Energy intensity: measures the cost of products, services, and even of aggregate economic output—however, can't necessarily include past costs or inputs. Thus, such calculations are not necessarily cumulative.[11]

With the implications of the Anthropocene in mind, energy transitions of the 19th century are most acute as we trace the uneven adoption of the fossil fuels that will mightily increase the impact of humans on Earth's environment during the 20th century. In *Fossil Capital*, environmental historian Andreas Malm creates a template for connecting these new sources of power to their future impacts when he deems burning of coal, petroleum and other fossil fuels as "…so many invisible missiles aimed at the future."[12] Particularly at critical junctures in our energy past such as the mid-19th century, transitions merit particular importance and should be subject to careful scrutiny.

Informed by the ideas of Smil, scholars must subject sources of energy to questions, including:

o What is required to harvest this energy source?

o Is there an energy investment in its harvest? If so, how does it compare to its output?

o Are there basic ways in which the source is inherently limited in its accessibility, supply or scope?

o Can the energy extracted from this source be applied to other applications as well?

o What are the source's capabilities for expansion and further development?

o Are there significantly different outcomes or waste from this source as opposed to others?

o Regarding transitions, how does this source of power amend or replace another?

o Regarding transitions, in its collection or use, does it represent a significant change from previous sources?[13]

The answers to such a line of questioning aids us in distinguishing each energy source from another and, in so doing, also emphasizes certain transitions as more critical than others. While each energy transition is important, the modular shift reflects much more dramatic implications for human users. In distinguishing the fossil fuel era from those that preceded it, Smil writes:

> The contrast is clear. Preindustrial societies tapped virtually instantaneous solar energy flows, converting only a negligible fraction of practically inexhaustible radiation income. Modern civilization depends on extracting prodigious energy stores, depleting finite fossil fuel deposits that cannot be replenished on time scales order of magnitude longer than the existence of our species.[14]

Once the right questions are being addressed, archival material holds the answer for scholars. If our inquiry emphasizes the strategy of energy and technology put forward by Mumford and others, it provides a rationale and purpose for recording, detailing, and organizing the activities of energy harvest and use.

In the transition suggested by the 1871 episode in the Arctic, the whalers' reaction to this situation may be the high point of the industry's acceptance of limits. Although other whalers in the world would industrialize with new ship technology or the use of explosives, American whalers restrained any technological advancement: they only put more vessels on the water, stayed out longer, and covered more ocean. At this tenuous juncture in the history of American whaling, the whalers stared at the approaching ice, resisted the urge to leave, and then waited for their fate to unfold. The fate of this fleet represents a moment of historical convergence: the meeting of a variety of factors to create a historically-significant moment.[15] Closer scrutiny of American whaling reveals that its role as a primary energy industry was never stable and had come under very clear threat by the mid-1800s. In fact, the market that whalers served was changing significantly. Chomping at the bit to expand and industrialize, Americans wanted a scale and scope of energy that whales could not deliver.

In the case of whale and sperm oil in 1871, the main application of this energy was illumination. Kerosene, rent from petroleum, could be burned in similar lamps. Consumers needed to do little to accommodate this shift; therefore, the significant transition in this case occurred in the fashion in which suppliers acquired the oil and the scale on which it could be processed into a useable commodity. The urgency of the whalers' 1870s trips deep into the Arctic stemmed from the emergence of petroleum during the 1860s, which promised larger supply with less uncertainty. This new competition in their market place drove them to take risks. The new resource of petroleum exploited fissures in the energy market that grew from significant moments such as the Civil War and also on seemingly insignificant ones, such as the encroaching Arctic ice of 1871.[16]

Energy Drawn from the Sea

At the apex of American whaling in approximately 1820, nearly half of the recorded voyages left from New Bedford, along the coast of Massachusetts.[17] By the mid-19th century, New Bedford's fleet numbered 320 with the next

"competing" port possessing only 65. Unlike a traditional seaport, New Bedford served as much more than entrepot. While the docks and berths allowed large ships to use New Bedford as a port, the town's one-dimensional infrastructure clearly positioned it as a fusion of a site of oil transshipment, such as contemporary Valdez, Alaska and of oil refining, such as locations in the American South and West. Despite maintaining the Seamen's Bethel, counting house, and other hallmarks of maritime society, this infrastructure was less designed around the sailor and more conditioned for industrial workers in whale oil, such as refiners and factory workers.[18]

The industrial seaport needed to continue to change in both size and complexity in order to confront the growing supply. While maps from 1834 demonstrate increased instrumentalization, the original family names are involved in the expansion. Production grew by mid-century and New Bedford became increasingly central to the trade of oils taken from the sea. This growth and expansion is evident by contrasting views from a span of only fifteen years. Whalers' plan exceeded their wildest expectations and by the 1820s the city was, per capita, the world's wealthiest.[19] An energy mecca, controlling an international regime of collection, processing and distributing, New Bedford functioned as this era's Houston, Texas.

Fish Island is one of a few spits of land sprinkled among the wide Acushnet at New Bedford. In a town that prioritized shoreline access, developers had placed whale oil refineries on some of the islands earlier in the 1800s. In its first rendition, the plants on Fish Island combined with the other refineries of New Bedford to complete the task of harvesting raw energy from whale blubber by creating the oil that lit the world during the early 1800s. When whale oil's share of the illumination market dipped in the mid 1800s, a few New Bedford oil works closed, including that on Fish Island. Temporarily, the illumination industry abandoned the spit of sand and grass, little wider than a fair-sized parking lot.

Energy Drawn from Geologic Resources

Pennsylvania oilmen classified efficiently collecting and distributing crude as their most pressing technological quandary. Through this emphasis, the oil fields of the 1860s became a cutting edge of new technologies. Engineers with little training devised the precursors of many contemporary technologies, including off-shore wells, pipelines, tanker rail cars, and increasingly complex refineries. Entrepreneurs quickly identified infrastructural development and

control within the oil industry as the portion of the industry that was most likely to endure—even if Pennsylvania's supply diminished. As the Oil Creek Valley of Pennsylvania, an 11-mile valley stretching from Titusville to Franklin, dominated world petroleum production through 1872, though, diminishment of supply was of little concern.[20]

On the Pennsylvania energy frontier, companies established a new group of "towns of light" as one-dimensional sites, structured around extraction and with little hope for any future after the reserve was depleted. Such an idea of development stood in stark contrast to the involvement of business leaders in New Bedford. A complex set of factors contributed to these distinctions—a primary one being the technology of harvest. However, a basic fact of energy use also significantly contributed to the differences between towns: primarily, each of these illumination industries developed a resource within the larger cultural preferences of its consuming public. Laissez-faire business and comparatively low start-up costs in petroleum meant individual economic opportunity at a time when individuals sought out just such an opportunity. The staid nature and hierarchy of the whaling business quickly made it appear a thing of the past. In short, each industry appealed to be radically different—though chronologically abutting—eras in energy use.

The devices and techniques employed for the collection of oil serve as the industries' clearest point of contrast. Most important, whaling knew the rises and falls in productivity that were directly applied to the rate of harvest; it did not see boom development. By contrast, the petroleum industry was defined by the feast or famine of sudden surge and diminution of supply that made possible—even necessary—boom and bust development. Ultimately, the culture of boom created a pattern of development on the oil landscape of the 1860s. Initially, groups of speculators located near one another informally became known as towns. With very few ties to local traditions or cultural patterns, the names of these communities often reflected their utilitarian rationale for existence. Early development in Pennsylvania followed a waterway known as Oil Creek, for instance, and towns quickly filled the region with names such as Petroleum Centre and Oil City.[21]

After 1865, and particularly after the conclusion of the Civil War, the attributes that made petroleum a boom commodity—its liquid occurrence, lack of property controls, and scarce available technology— also opened the industry to largescale, investor speculation.[22] This additional capital

and the sprawling infrastructure of rail lines, pipelines, refineries, and distribution rapidly destroyed any hopes of local or even regional control over the petroleum trade.[23]

By contrast, the technology of American whaling reached its peak with the whale ship and remained fairly uncomplicated through the fishery's demise. Powered by the energy of the wind and of men's labor, the ship and its crew composed the vital cogs in the harvest. Investors desiring more production merely, walked up and down Front Street and raised the funding for additional ships and voyages. Petroleum, on the other hand, employed hardware such as derricks and steam engines, each of which demanded a network of labor, energy production, refinement and transportation. Once attached to a supply of crude, however, there was no limit to how much the machines could produce in contrast to the whale industry that faced a decreasing number of whales in the North Atlantic at the end of the nineteenth century. Modern technology used devices and transportation to spread the commodity's use in ways that New Bedford's elite could only imagine. Each town in the Pennsylvania oil fields became a setting for the culture of extraction. Ultimately, details of petroleum's occurrence as well as its remote location generated the oddest collection device of all: the boomtown.[24]

A Historic Transition in Illuminating Oils

From the mastheads of whaling ships such as *Taber* and *Comet* in the Spring of 1871, lookouts could see nothing but ice. The only clear water buoyed each ship and surrounded the hull for a few yards. The Arctic whales pursued by *Taber* and others provided a variety of materials to commercial markets. Baleen whales offered stores of oil for illumination, but also bone for a variety of uses, including the ribs in umbrellas and skirt hoops and other materials used for buggy whips. The oil, however, remained the preeminent product of the Arctic whale hunt. The expansion of the whaling fleet northward, in essence, was the New Bedford financiers bow to changing times; of course, it would turn out that to be competitive, whaling needed more than an expansion of grounds.

On September 1, 1871, the thick ice pressed tighter the 26 whaling vessels. The *Comet* succumbed first. The ice, with a seemingly monstrous strength, squeezed the brig and lifted it half out of the water before simply shattering the stern. The ice seemed to pursue the whale ships and the *Comet* was its

first catch. When other whalemen arrived, they found the *Comet's* crew on the ice scrutinizing their plight. The crew and supplies from the Comet were divided among the rest of the fleet. However, the fleet sealed its fate by ignoring *Comet's* demise. Instead of fleeing south, the remaining vessels continued to pursue whales.

After two more days of whaling, the fleet's fate began to unfold. On September 7, captains of a few of the vessels went in boats and sounded along the edge of the ice to the southward in order to determine where they should proceed. Instead, they found in some places less than nine feet of water. Exit from the area would be impossible. Thirty vessels pooled together to determine their future. With it, they also held the potential of the American whale fishery. On September 8, the log of *Seneca* records: "thirty ships in sight and all crowded into shoal water by the ice, with every prospect of being drove ashore in standing inshore to clear the ice." Captain Kelley of the *Gay Head* wrote, "We felt keenly our responsibility, with three million dollars worth of property and 1,200 lives at stake. Young ice formed nearly every night and the land was covered with snow. There was every indication that winter had set in."[25] Of the forty-two New Bedford whalers in the region, thirty-three would not return. Like the tentacles of a giant sea beast, the ices came faster than expected. Rapidly the bulk of the fleet stood stock-still in the sea, as if suddenly transmuted into a maritime painting adorning a collector's wall.

The whalers had pressed forward, despite Native Alaskan warnings that the weather was going to be unusually poor. The whalemen did not understand much of the native's language and they also had to consider the reaction at New Bedford's counting house if they were to abbreviate their hunt. Indeed, the ices were worse than usual: records kept at the Sea Islands, Port St. Michaels, Norton Sound, and the posts on the Yukon River reveal that the ice floe normally lasted from five to twenty days; in 1871 the floe extended to ninety days.[26] As the ice locked the ships in place, heavy snow also added to the whalers' difficulty, packing them in more solidly than before.

Frozen in time, the ships resisted every effort to free them. Captain William H. Kelley of the *Gay Head* observed, "Within half an hour from the time the ice began to move, we were solidly enclosed."[27] Continuing to take whales and to maneuver the vessels whenever the ice allowed, the fleet emptied each ship as it froze in place and then continued its pursuit. Through early September, the process continued as the remaining whalers filled their stores with oil that would never make it to the market. It was common knowledge that the land offered no relief. "The search for open water," wrote

Kelley, "was in vain." We felt there was no possibility of rescue... we were anxious and meetings of all the captains were held nearly every day and every phase of the situation was thoroughly discussed."[28] The only alternative was to remain at sea on the seaworthy vessels. A small expedition of three whaleboats was sent South to see if a clear passage existed.

The report came back two days later that clear passage had been found. The main body of the fleet, however, would not be able to make the trip. On September 12, 1871, the decision was made official in the log of *Champion*, which reads:

> Know all men by these present that we, the undersigned, masters of whaleships now lying at Point Belcher, after holding a meeting concerning our dreadful situation, have all come to the conclusion that our ships cannot be got out this year and there being no harbor that we can get our vessels into and not having provisions enough to feed our crews to exceed three months and being in a barren country where there is neither food nor fuel to be obtained, we feel ourselves under the painful necessity of abandoning our vessels and trying to work our way south without boats and if possible get on board of ships that are south of the ice.[29]

The grief of the moment is obvious, even in the understated log. Abandoning ship, of course, contradicted maritime culture's tradition. Additionally, the economic considerations of these industrialists were also significant. The masters' obvious pain reflects that of the industry itself at this stage in industrial innovation.

The remaining vessels in the fleet took on the extra crew members and began the somber return to Honolulu. Behind them they left the fleet of thirty-three vessels, fully loaded with their takes of whale oil and the equipment of the trade. No lives were lost, although one boat steerer chose to remain and live on the *Massachusetts.* In the first night away from the ships, this unnamed individual deserted in hopes of keeping all the supplies and gear that had been left behind. The salvage law of the sea would, in fact, entitle him to anything that he found.

In a moment of desperation, the whaler had gambled everything against the very limits under which he worked. The conservative approach that dominated the American whale fishery appears at this point to be overwhelmed by the need for the fleet to return with a solid return. This same incident also demonstrates the whaler's complacency in the face of improving the technology of the hunt. In hindsight, though, the Arctic freeze—entirely

predicated on human agency (the choice to remain)—also demonstrates the value of decision making at the grassroots level of an industry by those who may know it best. The stranded whalers made the wrong decision.

Simultaneously, controlling interests in the petroleum industry made decisions that would steer the nation toward a very different kind of future. The unruly oil spilling from Earth's bowels along the 11-mile stretch of Oil Creek would be tamed—more or less. When it came to Americans as kerosene, petroleum began to meet the new public's expectations by offering light to American citizens at a much lower price than whalers ever had. And, of course, for petroleum, making light was just the beginning of the critical role it would carve for itself in American life. Through innovations in technology and chemistry, petroleum's applications expanded hand-in-glove with the American industrial economy, powering transportation as well as supplying raw materials for plastics and pharmaceuticals. Clearly, it possessed expansive capabilities due to its overwhelming supply by the early 1900s.

Conclusion

Seeing the whale hunt as a parable of a changing energy culture demystifies one of the heroic undertakings of the American past. In fact, the whale hunt's depiction as an energy transaction destroys its place in history: The energy harvested from a whale, required a great deal of energy input (albeit of a fairly primitive sense), and, thereby, destined the transaction to be that of a deficit—a loser. This energy cycle clearly placed strict limits on the potential for whale oil to become a regime that could dominate American life, whereas petroleum could be seen as a multiplier of possibilities.[30] During the 1870s, chemists and entrepreneurs worked hard with coal and other sources to create kerosene and other versions of oil that could be burned in lamps. Even the sum of these illuminants, though, could not reach each American as could petroleum-based fuels. Thus, the importance of this energy transition that played out in 1871 lay primarily in a shift to resources that could fulfill the scale and scope of new expectations—sources of power that, unlike whales, were more capable of fueling entire patterns of everyday human life. For this reason, the whalers of 1871 mark an active front in the creation of a new energy regime—their resource and industry was largely unsustainable.

In this transition of the 1870s we clearly find a modular shift in humans' energy futures. Indeed, the transition in illuminants spanned approximately

three decades. Between 1860 and 1890, changes in making light brokered an economic revolution in the U.S. Despite a number of challengers by 1850, whale oil continued to rule the illumination market with $7.8 million worth of production. The efforts of chemists and businessmen moved kerosene into a competitive position and when, during the 1860s, whale oil's share of the market fell precipitously, no viable replacement existed but petroleum. By the end of the 1860s, petroleum possessed greater production than whale oil ever had. The petroleum industry catapulted from non-existence around 1860 to $20 million worth of production in 1870, $44 million in 1880, and $85 million in 1890. During the same period, whale and sperm oil declined from $10 million in 1850, $2 million in 1880, to $1.7 million in 1890. Kerosene, made from petroleum, kept lowering its price during this thirty-year span, while the price of whale and sperm oil shot upward. Census 1870 reflects basic changes in American ways of doing things when it no longer lists whaling as an industry; instead, it is included with hunting and fishing.[31]

As the petroleum industry evolved during the 1860s, Pennsylvania oilmen were grounded in business, not in a maritime version of the volatile hunter/prey relationship. Perfecting the technologies for gathering, storing, transporting, and refining the crude while maintaining profits represented the challenge of the new petroleum industry. Entirely new groups orchestrated this resource harvest: speculators and marketers well-schooled in the nation's energy and illumination needs drove the search for a steady supply of petroleum. Pennsylvania rock oil was a commodity not limited by the amount of fats and oils that could be extracted from a single mammal, however large it might be. Instead, the greatest mystery in rock oil's discovery lay in the amount available beneath Earth's surface. It truly seemed unbounded—if it could first be located and tamed.

The 1860s oil boom in Pennsylvania was defined by rapid, largely disorganized development. Although the region almost single-handedly made kerosene into a viable commodity on the illumination market, its supply could not be relied upon. An effort to organize the industry grew from the interest of a few entrepreneurs in maximizing their own profit. Similar to the whaling scions' decision to develop New Bedford and usher in the demise of Nantucket, business strategy drove the development of petroleum after 1865. A young fruit salesman in Cleveland, Ohio personified this emerging new era. John D. Rockefeller, Sr. viewed petroleum with an eye toward systematic management and expansion. More than any other agency, his Standard Oil Trust defined petroleum supplies that would flow

throughout the American economy.

Studying this juncture from the line of questioning posed above distinguishes it as a particularly meaningful transition in humans' life with energy. While each transition is important, the modular shift reflects much more dramatic implications for human users. The capacity for growth was very likely the most distinct characteristic that distinguished whale and petroleum oils. This capability for expansion grew from the composition of each resource and, in particular, its differing capabilities if burned. In addition, the consuming culture and its surrounding economic marketplace distinguished these energy resource. Whereas whale oil largely created the American illumination market, petroleum entered a diversifying energy economy in addition to an expanding market for lighting. Petroleum possessed flexibility that could be applied to new innovations and uses. In both its supply and inherent capabilities, petroleum possessed a multiplying effect that clearly defines its transition as modular and truly transformed human life.

For American consumers, the entire energy scene had begun to shift by the 1850s: new methods for producing, distributing, and using of power changed basic ideas of what was possible. Part of the context, then, for the whaler's journey among the ice bergs in 1871, is the fact that energy transitions often require shifts not just in energy sources, but also in the fashion in which humans do very basic things—such as making light. In addition, transitions can be partly a product of larger cultural shifts—in this case a desire for growth—and the ability of a maturing infrastructure to develop existing sources impossible just years prior.

Just as many consumers today fear the concept of significant changes in their use of energy, Americans of the 19th century faced significant periods of adaptation and adjustment. Energy transitions occur when one prime mover replaces another as dominant. Although it is dangerous to expect technological fixes to deliver us from every bind, it is equally silly to expect that our society and our market-based economy would tolerate a complete return to primitive living. Instead of time to dig in our heels, moments of energy transition present a historic opportunity to improve our living condition for generations; indeed, they are our opportunity to shape the new era. As research reveals new innovations, consumers can fuel such change by influencing market controls, which might be exerted by government or corporations, and ultimately to alter price or availability as producers strive to make a resource or a technology more appealing or economically viable.

Notes

1. Thoreau, Henry David, *JOURNAL 7*, Princeton University Press, 2001.
2. Everett S. Allen, *Children of the Light* (Parnassus, 1983), 242.
3. Lewis Mumford, *Technics and Civilization,* (New York: Harcourt, Brace, 1964), P. 321.
4. Idem., p. 322.
5. Idem., p. 323: "No part of the environment, no social conventions, could be taken for granted, once the machine had shown how far order and system and intelligence might prevail over the raw nature of things."
6, Idem., p. 365.
7. See for instance "FORUM: The Environmental History of Energy Transitions," *Environmental History* Vol. 24, No. 3 ((July 2019).
8. Most histories of whaling are, correctly, based in maritime history. A few early histories of petroleum include discussion of energy from whale oil (including Harold F. Williamson and Arnold R. Daum, *The American Petroleum Industry*). From each of these sources, though, the limited supply of whale oil seems to have defined it with seafaring pursuits instead of with other energy industries, such as coal mining.
9. See for instance "FORUM: The Environmental History of Energy Transitions," *Environmental History* Vol. 24, No. 3 ((July 2019).
10. The reference here is to the discussion by natural scientists and humanists to delineate our current geological epoch as the "Anthropocene," because humans have created significant impacts on the environment that they control Earth's fate. See, for instance, John R. McNeil, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (New York: Norton, 2001). Additionally: J.R. McNeil, *Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge: Harvard University Press, 2016).; Robert Marks, *The Origins of the Modern World: A Global and Environmental Narrative from the Fifteenth to the Twenty-First Century* (Lanham: Rowman & Littlefield Publishers, 2007; and Andreas Malm, Fossil Capital.
11. Vaclav Smil, *Energy and Civilization*, 12-14.
12. Malm, *Fossil Capital* 7-9.
13. Smil.
14. Smill, 295.
15. For a discussion of moments of "historical convergence," see Marks.
16. See Brian Black, *Petrolia.*
17. Lance E. Davis, et al., *In Pursuit of Leviathan,* Table 3D.1, 116. Of 8,292 Nineteenth-Century voyages, 4,094, or 36%, left from New Bedford. Nantucket was next with 1,312 and 11%.
18. For details of early New Bedford, see, for instance, Everett S. Allen, *Children of the Light.*

19. Elmo Hohman, The American Whalemen, 42-3.
20. Black, *Petrolia*.
21. ibdem.
22. idem., 180-1.
23. With tremendous fortune possible by the mid-1860s, outside investors overwhelmed internal development in the Pennsylvania oil regions. ibdem.
24. This terminology had been used to describe a more permanent version of work camps in the American West, particularly related to the rush for gold in California. The link with petroleum mining occurs first in the Pennsylvania fields and is discussed in Black, 140-70. The boomtown functioned to provide the necessary social, economic, and technological support for petroleum development wherever oil was found.
25. Allen, 215-7.
26. ibdem.
27. ibdem.
28. idem, 245-7.
29. idem, 239-40.
30. Discussed most effectively in Davis, et al., PP. 214-18.
31. Idem, pp. 12-14.