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An Ecosystem is Not a Monument, and Other Challenges to Fishing in the 21st Century

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Abstract

The continental shelf of the United States was once the preserve of commercial fishermen. This is no longer the case. The exclusive economic zone is increasingly becoming the focus of other economically powerful, sometimes incompatible uses, including green energy, shipping, communications, mining, military exclusion zones, and conservation regions. These other uses generally have fixed boundaries. The distribution of fished species moves in relation to warming of shelf waters, presenting challenges to both federal regional fishery management councils and industry alike. There is need for continued engagement between user groups with respectful use of guiding science and legal structure to ensure reasoned access for all, and stability for economies that are reliant on ocean shelf resources, including the fishing industry.

"Which of the following is not like the others: (1) a monument, (2) an antiquity [defined as a'relic or monument of ancient times', Webster's International Dictionary of the English Language 66 (1902)], or (3) 5,000 square miles of land beneath the ocean?," wrote Chief Justice John Roberts. "If you answered (3), you are not only correct but also a speaker of ordinary English," he said. "In this case, however, the government has relied on the Antiquities Act of 1906 to designate an area of submerged land about the size of Connecticut as a monument—the Northeast Canyons and Seamounts Marine National Monument."

The harvest of fish from the sea is a human activity as old as recorded history. Transoceanic expeditions to Newfoundland Grand Banks in search of cod began shortly after the European discovery of North America and continued through the 15th and 16th centuries by French, Portuguese and Spanish fleets. Fishermen have long epitomized the image of hardy individuals seeking to make a living in freedom at sea, but this freedom is facing increasing stricture as the continental shelves and exclusive economic zones (EEZ) become the focus of multiple, sometimes incompatible uses. In this complex debate, fishermen and the fishing industry compete with economic giants, a plethora of political and social philosophies, and a diversity of scientific opinion. Fisheries are becoming the minority economic player in this debate. The rules of engagement dictating both survival of the fishing industry as a sustainable biological and economic enterprise, and the broader needs of society served by other ocean users are neither stable nor arguably responsive to the minority (fishing) constituency. The misuse of the Antiquities Act is but a single example. An ecosystem, defined by Merriam Webster as "the complex of a community of organisms and its environment functioning as an ecological unit," is not a monument. There is need for continued engagement between user groups with respectful use of guiding science and legal structure to ensure reasoned access for all, and stability for economies that are reliant on ocean shelf resources, including the fishing industry.

How did we get here? When did oceans become national, rather than international territories? When did we start zoning the ocean? Where will this process end, and who will be winners and losers? A little history provides useful context, and it starts in the North Atlantic as World War II came to an end.

Iceland officially remained neutral throughout World War II, but it was strategically too important to North Atlantic shipping to remain untouched. British forces invaded Iceland on May 10, 1940. The defense of Iceland was transferred from Britain to the United States on July 7, 1941, 5 months before the latter joined the Allied effort. On June 17, 1944, Iceland ended the Act of Union with Denmark, declared independence, and established the Republic of Iceland. The end of World War II and economic support from the Marshall Plan ushered in a period of economic growth for Iceland. Among Iceland's most significant natural resources was its cod fishery, but postwar competition for this resources with the United Kingdom intensified, and the 1948 "Cod Wars" were characterized by fishing vessels accompanied by military escorts and more than one instance of vessels being rammed by counterparts from the opposing side. Iceland began to flex its proverbial muscles with respect to its marine resources, and sequentially extended its maritime jurisdiction from 6 to 12, and subsequently to 200 miles. In doing so, it set the example of a 200-mile EEZ that the world would eventually follow. Little did they realize the implications of this boundary in years to come.

United States jurisdiction over fishery resources on continental shelves was codified in 1976 with passage of the Magnuson Stevens Fishery Conservation and Management Act (MSA). To place the gravity of this action in context, the 200-mile EEZ footprint covers approximately 4.42 million sq. miles, exceeding that of the entire U.S. landmass at approximately 3.79 million sq. miles. The MSA contains strong and authoritative wording. Its purpose, taken from 1996 amended reauthorization, is to "*provide for the conservation and management of the fisheries, and for other purposes*," thus:

(1) *to take immediate action to conserve and manage the fishery resources found off the coast of the United States, and the anadromous species and Continental Shelf fishery resources of the United States, by exercising (A) sovereign rights for the purposes of exploring, exploiting, conserving, and managing all fish within the exclusive economic zone established by Presidential Proclamation 5030, dates March 10, 1983, and (B) exclusive fishery management authority beyond the exclusive economic zone over such anadromous species and Continental Shelf fishery resources [, and fishery resources in special areas]..*

Indeed, it was the MSA in part that led to the first seizure of a foreign vessel harvesting fish in U.S. territorial waters. The Soviet trawler Taras Shevchenko arrived in Boston, MA, on April 11, 1977. The MSA thus became a tool of international diplomacy in the Cold War era. Implicit in this inclusion is that fish and fisheries become items to be bartered to obtain larger, national, and international political goals (witness the continuing evolution of selective import quotas and tariffs, not always responsive to home industry or entity needs).

In addition to codifying international boundaries, the MSA proceeded to establish a structure for stewardship, thus:

"establish Regional Fishery Management Councils to exercise sound judgement in the stewardship of fishery resources through the preparation, monitoring, and revision of such plans under circumstances (A) which will enable the States, the fishing industry, consumer and environmental organizations, and other interested persons to participate in, and advise on, the establishment and administration of such plans, and (B) which take into account the social and economic needs of the States.."

Each Council would have three members from each of the represented states, to include both standing memberships plus nominated and then appointed citizen members who serve 3 y terms. Although there is commendable inclusion here for citizen members, the diversity of contributing challenges subsumed in just fishery management alone is daunting, and underscores a continuing and pressing need for communication and listening skills in both council members and affected constituents—not just fishermen, but everyone with social and economic interest in a sustainable coastal zone economy and food security.

I served as an appointed member for the Commonwealth of Virginia on the Mid-Atlantic Fisheries Management Council (MAFMC) from 2016 through 2019. Despite a career as a fisheries biologist, the diversity of challenges that I encountered in this period were considerable, and on more than one occasion, I questioned how much of the information provided by witnesses was useful to the Council. Scientists are trained to test hypotheses, and then deliver facts, rather than opinions, in a specific format with statistically defensible boundaries. They have their own vocabulary replete with exquisite terms, often marginally or completely unintelligible to the layperson. Consider the following as examples. What is essential fish habitat, if not water? What is the difference between overfished and overfishing? What is SSB (spawning stock biomass, but scientists love acronyms)? Should the stock recruit curve be Beverton-Holt or Ricker? Who cares about steepness and why? Should we use parametric or non-parametric approaches, or maybe Bayesian? Is an MPA a Marine Protected Area or a Master of Public Administration (if you Google it there are 144 definitions). What is the difference between weather and climate? Sitting in Council public hearings, I was more than once reminded of Tolkien:

"In one thing you have not changed, dear friend, said Aragorn: you still speak in riddles. What? In riddles? said Gandalf. No! For I was talking aloud to myself. A habit of the old: they choose the wisest person present to speak to; the long explanations needed by the young are wearying."

J. R. R. Tolkien, The Two Towers, Part II: Lord of the Rings.

The collective lack of progressive response of governmental bodies stands as testament to the fact that the scientists, us, are still, at least part of the time, speaking in riddles and need to improve the communication skills.

Despite these not being inconsiderable challenges, the regional Councils endeavor to manage fish stocks in a sustainable manner. How well are they doing in just this task (I will address the large challenges of multiple competing users later in this text)? Each geographic region faces unique challenges. I will focus a few comments on the status of stocks managed by the MAFMC and the New England Fisheries Management Council (NEFMC). It is relevant to start with an overview of the oceanography of the Council jurisdictions. The mid-Atlantic and New England shelf is part of a complex ocean ecosystem integrating physical signals from a yet wider region, given that its source water is the cold Labrador Current (LC). The Labrador Sea has been warming since the early 1800s (Moore et al. 2017). The Gulf of Maine (GOM) is supplied by westward flowing water from the LC across the Scotia Shelf (SS). Water exits the GOM through the Great South Channel to the Georges Bank (GB). In turn, the Mid-Atlantic Bight (MAB) is supplied by continuing southwesterly flow of this water mass. The warming signal from LC source water was recorded in ocean quahog shells for the MAB and GB, and accelerating growth rates continue to this day (Pace et al. 2018). The mid-Atlantic and New England subunits are far from uniform in physics and geology, driving differing responses in biologically exploitable resources. The central GOM is relatively deep and has counterclockwise circulation. The shallow western coastal rim is modest in area. The GB has clockwise circulation, is relatively shallow, and well mixed vertically. The MAB is notable for a very large annual temperature range combined with strong seasonal stratification, and the presence of a unique cold pool (Houghton et al. 1982) that permits southern extensions of the range of boreal (northern) species and structures the cross-shelf distribution of the benthos (Brown et al. 2012).

Returning to the fisheries managed by the MAFMC, the council is responsible for the Atlantic mackerel, chub mackerel bluefish, spiny dogfish, summer flounder, golden and blueline tilefish, surf clam, butterfish, ocean quahog, *Illex* and longfin squids, scup, black sea bass, and monkfish. Of these, only the Atlantic mackerel and bluefish are technically overfished (i.e., the stock is depleted below the overfishing threshold: a stock-specific biological reference point where biomass is less than half that estimated to sustain maximum sustainable yield, Bmsy, where less than ½ Bmsy is overfished), and only the Atlantic mackerel is being overfished (i.e., the fishing mortality rate, F, exceeds the fishing mortality rate commensurate with maximum sustainable yield, Fmsy, so overfishing is a rate where F/Fmsy is > 1.0). The MAFMC manages conservatively, and it has a conservative risk policy where, simply stated, a "buffer" is considered between estimated stock available for harvest and actual quota allowed. The MAFMC manages through single-species assessments, implemented by the Northeast Fisheries Science Center, and reviewed by a Science and Statistical Committee that provides recommendations on overfishing limits. This highly structured process typically involves periodic major assessments every 3 y or

so (sometimes more depending on species) with annual updates from the Northeast Fisheries Science Center and Science and Statistical Committee to guide revision, if required, on overfishing limits and quotas. Although this process has strong attributes—the number of overfished stocks is commendably low—it focuses on short-term projections in an environment, literally and metaphorically, where environmental baselines are no longer stable but driven by warming climate, and the reality that multispecies interactions will always compromise single-species approaches. The NEFMC is, by contrast, challenged by overfished stocks of the Atlantic cod, winter flounder, yellowtail flounder, Atlantic halibut, Atlantic wolffish, witch flounder, windowpane flounder, and ocean pout among the Northeast Multispecies groundfish. Rebuilding plans are in place. The point to make, again, is that the biology of the MAB is different from that of GB and GOM, challenges are species specific, the NEFMC has to address trans-boundary stock management with Canada to the north, and it is also in flux as the GB and GOM warm with climate change. Stock assessment models designed to project stock status in changing environments are in their infancy and the subject of much research, but that does not negate the here- and-now challenges of "simply managing fisheries" because this is not simple.

It is known that the MAB, GB, and GOM have been warming for a long time (Saba et al. 2016) and that species footprints are moving inexorably north and east (Kleisner et al. 2017). Species-specific sensitivity to climate change has received much attention (Hare et al. 2016) but future species distributions are not driven by temperature alone. Habitat changes over this range, as does the distribution of both predators on and prey of target species (McHenry et al. 2019). Many species will suffer contraction of their footprint, given changes in bottom geology north of GB. Food web impacts on early life history stages may be particularly vulnerable, given that adult spawning may be cued to temperature, whereas food availability may be driven by seasonal day length resulting. The fact that such a mismatch can result in recruitment failures has been well documented since the early contributions of Johan Hjort (Hjort 1914, 1926). In a recent webinar, Jason Link (Link 2021) suggested cod might be largely absent from the GOM within a decade, with lobsters all moving to Canada within a few decades. Can you imagine Cape Cod with no cod? So, the Councils will be managing species that are not in their designated region; in the case of NEFMC, stocks may have moved across the Hague Line and be outside of U.S. management all together! The overlap of species distributions between Council regions is not new, but wholesale migration of their distributions arguably is new within the time frames of the MSA. Immediate challenges to Council structures are thus emerging in the cross-regional arena: Who acts as lead Council where species move? How can a common strategy on single-species versus ecosystem-based assessments be implemented? How can choke species, that is species for which the available quota is exhausted (long) before the quotas are exhausted of (some of) the other species that are caught together in a (mixed) fishery, be accommodated? What time frames should be considered for adaptation of management structure?

But managing fisheries, with the MAFMC and NEFMC as examples, is no longer about just MSA directions to "*conserve and manage*" as a sustainable resource that serves the "*social and economic needs of the States*." It is about managing fisheries in a changing landscape (seascape?) of competition for ocean shelf resources where the environment is changing faster than in living history and species footprints are moving inexorably north and east. The competition includes marine monuments and sanctuaries, environmental advocacy, communications corridors, mining, national defense, shipping and, the elephant in the room—green energy in the form of wind farms. Who will be the winners and losers in this competition? Over what time frames will winners emerge? How will the fishing industry be represented in this debate? A few examples will be examined.

The Northeast Canyons and Seamounts National Monument referred to by Justice Roberts comprises 4,913 square miles, approximately 130 miles east-southeast of Cape Cod. It was created by President Obama in 2016 by a sweep of the pen using the Antiquities Act of 1906. The Monument is managed cooperatively by NOAA and USFWS employing a bewildering mix of legislation including MSA, the Endangered Species Act, the Marine Mammal Protection Act, the National Wildlife Refuge System Administration Act as amended, the Refuge Recreation Act, Public Law 98–532, and Executive Order 6,166. And then there is the National Marine Sanctuaries Act that, under Commerce, can be used to designate and protect marine areas of national significance, so assigned based on their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities. There are probably a few more relevant pieces of legislation that I have, in my ignorance, left out. This is a plethora of confusing, at least to the inquisitive laymen, federal legislation that both creates forms of exclusion zones to fisheries and appears to lack uniform definitions [e.g., the Coastal and Marine Ecological Classification Standards of 2012 (NOAA 2012) do not appear where Essential Fish Habitat designation is used in delineating Habitat Management Area, for that task NEFMC employs the Swept Area Seabed Impact (NEFMC Habitat Plan Development team 2011) model], and is not clear on how or even if such designations are required to be revisited, even when species move, or clearly state who has precedent over who in the agency and legislative structure. A recent and unquestionably substantial addition to this arsenal is the Biden administration goal of "30% by 2030" of the nation's land, inland waters, and oceans (by that read EEZ) protected as conservation areas (Executive Office of the President 2021). Public polling indicates that 80% of voters nationwide view this as a reasonable goal that will be good for the economy (NRDC 2021). What is "protected" in this context? Is a region protected only at the exclusory level afforded by Monument status, or do the words of MSA directing to "*..conserve and manage the fishery resources*." and *"exercise sound judgement in the stewardship..*" rise to the equivalency of protection? If so, then is not the entire EEZ already protected under MSA? Does 30% need to be set aside in Marine Protected Areas (MPA)? Although MPAs have their support in constituencies arguing for preservation of biodiversity (Lester et al. 2009, Edgar et al 2014) in addition to associated social and economic benefits (Davis et al. 2019), the debates over MPAs as universal positive tools in fishery management are far from resolved (Hilborn et al. 2004). Whereas the sustainability of managed fisheries is regularly stated, bottom trawling has recently been cast as a demonic activity releasing annually approximately 1 billion metric tons of carbon from the seafloor, equivalent to that released by air travel globally, to contribute to acidification of the ocean (Sala et al. 2021).

Copper communication cables were relegated to the scrapheap of history when satellite communications enabled connectivity world-wide, but the advent of high-speed fiber optics facilitating breathtaking data transmission rates has reinvigorated the use of cables in communication, including undersea communication corridors. An underwater network of electricity cables has been functioning as part of the national grid for many years, mostly in shallower waters, well before wind turbines were considered as a major element of the national energy strategy. Both of these exist as significant economic drivers and are respectfully avoided by fishermen operating mobile gear.

The mid-Atlantic hosts the largest naval base in the world (Norfolk, VA) in addition to other military installations serving all arms of the Department of Defense (DOD). The U.S. Navy operates DOD danger zones and restricted areas where the Atlantic Fleet conducts training exercises and tests. These are modest in area, but deserving of respectful use. Most other operational regions of limited access concerns, such as shock boxes and submarine transit lanes, are in deeper waters than typically occupied by fishing fleets.

Offshore sand mining for beach replenishment to maintain coastal infrastructure and serve tourism is expected to increase along the mid-Atlantic coastline with sea level rise and climate change–driven increases in coastal storm activity. Although these represent modest offshore target zones for dredging source material, they are none the less in depth ranges commensurate with fishing, and represent a vital resource in significant local coastal economies.

The recent stranding (March 23–29, 2021) of the container vessel Ever Given in the Suez Canal has highlighted the fragility of the global supply chain for cargo of all kinds. International trade relies on immediate access of these behemoths to docking facilities with short turnaround times. The specifications of such vessels are impressive. The Ever Given was built in 2018; is 400 m long, about 59 m wide, and 15.7 m deep; can carry a total of 220,940 tons; and has a capacity of 20,388 standard-size 20-foot containers (a TEU). She represents ship design driven by economies of scale in transport costs that have been in progress since 2008. As an example, cost savings per TEU carried between Asia and Northern Europe decreased from ~$1000/TEU for a mid 1990's 8,000 TEU vessel to $700 for a 2013 18,000 TEU vessel. These economies are increasingly offset by rising port costs and port access challenges driven by, among other things, access channel depths (a fully loaded 20,000 TEU vessel draws 16.5 m necessitating dredging at most U.S. east coast ports) and limited clearance under existing bridges, in some instances necessitating raising bridges to facilitate access. The profitability of international megaship–based trade balances on the status of capacity (or overcapacity) for transport, fuel oil prices, and the global economy (Kapoor 2016). Yet this race for ever larger ships continues driving scenarios of safety and access that dictate exclusion zones where and when they operate.

"It's the economy, stupid"—James Carville, 1992, presidential campaign strategist for Bill Clinton.

James Carville's words place the role of fishing in the EEZ in contrast to other uses described earlier. Consider that the MAFMC manages fisheries with a value of approximately 2 billion dollars annually. The port of New York and New Jersey handled 3.77 million inbound TEU in 2019. The Ports of Virginia handled 1.36 million inbound TEU in 2019. If a $15,000 value is assigned to the contents of each TEU, approximating to filling each with potatoes at the average 2020 U.S. retail price of $0.75/pound, the throughput of the Ports of Virginia VA port alone exceeds the value of the fisheries under MAFMC management. The shipping economy dwarfs the fishing economy.

The proverbial elephant in this room is green energy in the form of offshore wind farms. The U.S. east coast continental shelf has 1.7 million acres of federal bottom under lease for the development of offshore wind energy (MARCO 2020, Munroe et al. 2021). The Biden administration moved quickly to permit the Vineyard Wind 1 offshore wind farm and is poised to continue its support for additional expansion (White House 2021). Offshore wind farms have a projected life of 50 y. Optimal physical spacing of individual structures restricts access by both commercial vessels towing mobile gear and federal survey vessels. Stock assessment surveys will be compromised, and both fishery footprints and concomitant quotas will be reduced. The modification of local flow fields and sediment transport, with impacts on water column dispersal processes and benthic community composition and productivity, remains subjects of research. Offshore wind farms are not inaccessible to Coast Guard aerial rescue operations, but they do present significant limitations for the use of helicopters. Exclusion zones or setback advisories for transmission cables beyond the wind farm footprint, between farm and shoreline, are of the order of 500 m or three times bottom depth (Best & Kilcher 2019); thus, a 500-m setback results in each kilometer of cable excluding 1 km^2 of bottom. The fishing industry has formed a broad membership–based coalition committed to improving compatibility of offshore development with their businesses (RODA 2021). Whereas the development of offshore wind power remains a dynamic area of technology and public policy, the economic impact estimates for the offshore wind energy economy are enormous and equal in stature to that of shipping.

"According to the U.S. Department of Energy, the Atlantic Coast offshore wind project pipeline is estimated to support up to 86,000 jobs, drive $57 billion in investments, and provide up to $25 billion in economic output by 2030."

"New York expects a $6 billion in-state industry by 2028, and Massachusetts projects up to $80 million in direct economic impacts (Forbes *Magazine* 2018)*...".*

Perhaps the most breathtaking projection is the following:

*"Offshore wind is projected to meet 90% of U.S. energy demand at full build out (*Electrek Green Energy Brief 2021*)"*

The impacts of such an achievement would radically change national energy policy, arguably negating the need for a U.S. fossil annual fuel subsidy approaching $649 billion, a number more than 10 times federal spending on education (Ellsmoor 2019), and this does not include "savings" from reduction in greenhouse gas emissions. The subsidy estimate does not include annual spending of $81 billion on defending oil supplies from the around the world (DiChristopher 2018). Elimination of U.S. dependency on foreign oil would allow not just economic savings but also a major revision of everything from domestic and defense spending through foreign policy on human rights, where the latter would no longer include turning a proverbial blind eye to ongoing abuses in oil-supplying nations. As noted at the beginning of this text, the MSA enabled the inclusion of fisheries access as a tool of international diplomacy in the Cold War era. Wind energy–facilitated independence from foreign oil supply will become yet another addition to this toolbox, but one of far greater economic impact than fishery access. This prompts the question, where does preservation of the fishing industry sit in this pecking order? At the bottom?

Fishery management in support of a sustainable industry that supports coastal communities and contributes to food security faces a growing list of challenges. With respect to just managing the fishery resource, two important questions arise:

1. How difficult is it to quantify response of a target species or species complexes to changing climate and thereby "conserve and manage the fishery resources?"

2. How difficult is it to translate this information in a proactive manner to management plans that serve the "social and economic needs of the States," and by that I include preservation of a sustainable fishing industry?

How much of the "zoned" resource will be accessible to the fishing industry? The EEZ is being zoned with fixed boundaries with respect to wind farms that have projected 50 y operational time frames until decommissioning. Fisheries are based on moving species distributions and do not function well with fixed boundaries. Where will the fish be, and how will a management structure to ensure access be developed? The "space" for fisheries is shrinking. Fisheries will not be the largest economic player as development of the EEZ continues, but they are historically an important part of the economic and social structure of coastal communities. To reiterate one of my opening statements, there is need for continued engagement between user groups with respectful use of guiding science and legal structure to ensure reasoned access for all, and stability for economies that are reliant on ocean shelf resources, including the fishing industry.

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