Frequently Asked Questions about Commercial Fishing Restrictions in the Pacific Marine National Monuments

- ## What marine national monuments have been established in the Pacific under the authority of the Antiquities Act of 1906, and what are the commercial fishing restrictions in the monuments?

Papahānaumokuākea Marine National Monument Established by President George W. Bush on June 15, 2006 around the Northwestern Hawaiian Islands. Initially, the Monument included the lands, waters, and submerged lands to lines of latitude and longitude that lie approximately 50 nautical miles (nm) from the mean low water line of the islands. On August 26, 2016, the seaward boundaries of the Monument were extended by President Barack Obama out to the 200-nm limit of the US Exclusive Economic Zone (EEZ), except for waters surrounding Nihoa.[1,2] The Monument currently covers about 582,578 square miles. Commercial fishing is prohibited in the Monument. See https://www.fisheries.noaa.gov/pacific-islands/habitat-conservation/papahanaumokuakea-marine-national-monument

Pacific Remote Islands Marine National Monument Established by President George W. Bush on January 6, 2009 around seven unincorporated US islands and atolls: Baker, Howland and Jarvis Islands; Johnston, Wake, and Palmyra Atolls; and Kingman Reef. Initially, the Monument included the lands, waters, and submerged lands to lines of latitude and longitude that lie approximately 50 nm from the mean low water line of the islands and atolls. On September 25, 2014, the seaward boundaries of the Monument around Jarvis and Wake Islands and Johnston Atoll were extended by President Barack Obama out to 200 nm. The Monument boundaries around Howland and Baker Islands remained at 50 nm. The Monument currently covers about 370,000 square miles. Commercial fishing is prohibited in the Monument. See https://www.fisheries.noaa.gov/pacific-islands/habitat-conservation/pacific-remote-islands-marine-national-monument

Rose Atoll Marine National Monument Established by President George W. Bush on January 6, 2009 around Rose Atoll in American Samoa. The Monument extends from the mean low water line of Rose Atoll out to 50 nm. The total area of the Monument is approximately 13,451 square miles. Within the Monument all commercial fishing is prohibited. See https://www.fisheries.noaa.gov/pacific-islands/habitat-conservation/rose-atoll-marine-national-monument

Marianas Trench Marine National Monument Established by President George W. Bush on January 6, 2009, the Monument consists of three different areas around the Mariana Archipelago: the Islands Unit, which encompasses the waters and submerged lands around the three northernmost Mariana Islands: Farallon de Pajaros (Uracas), Maug, and Asuncion; the Volcanic Unit, which encompasses the submerged lands within 1 nm of 21 designated volcanic sites; and the Trench Unit, which encompasses the submerged lands extending from the northern limit of the US EEZ around the Commonwealth of the Northern Mariana Islands to the southern limit of the EEZ around the Territory of Guam. The total area of the Monument is approximately 95,216 square miles. Commercial fishing is prohibited in the Islands Unit. Commercial fishing in the waters of the Trench and Volcanic Units is not restricted. See https://www.fisheries.noaa.gov/pacific-islands/habitat-conservation/marianas-trench-marine-national-monument

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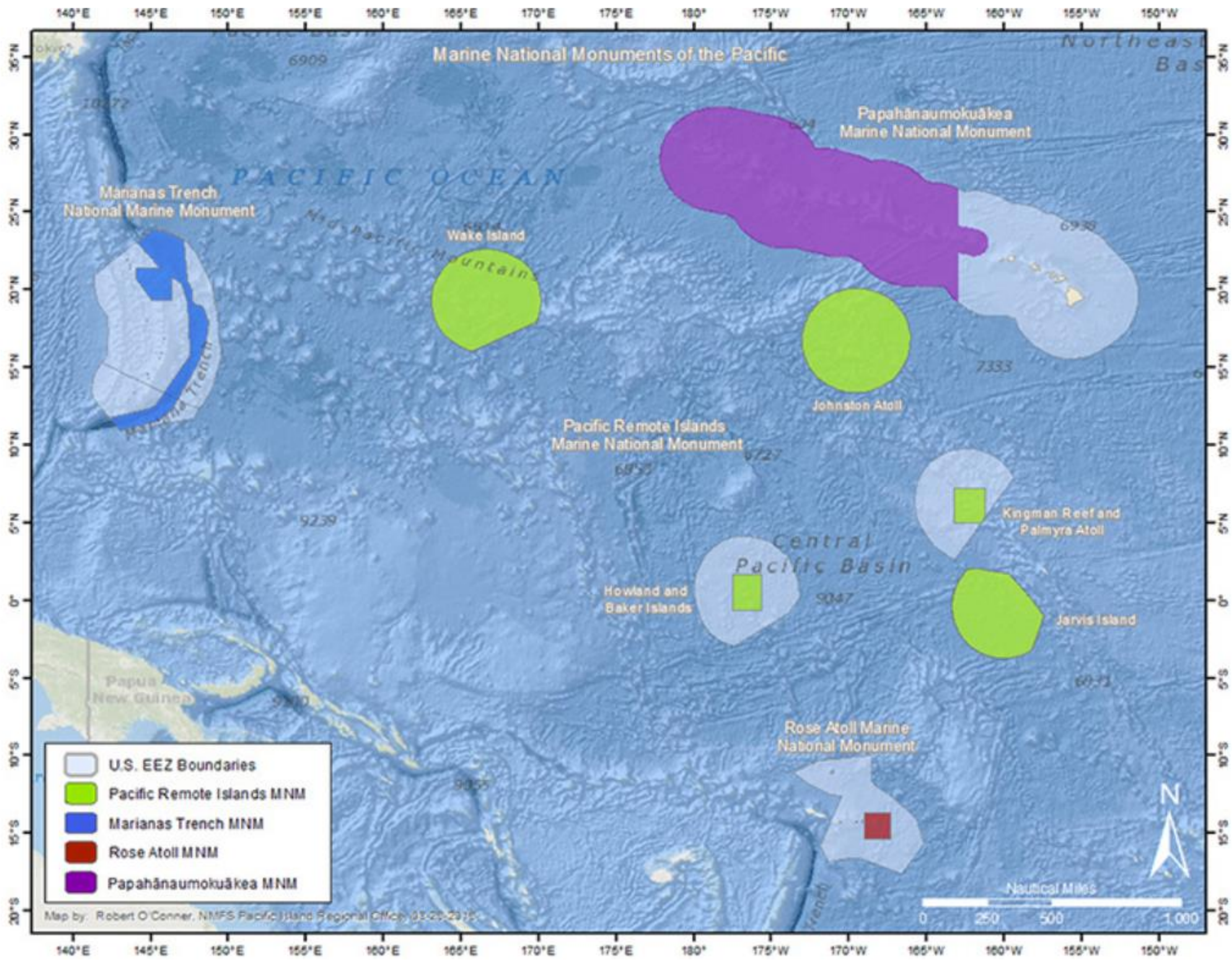
[1] The Exclusive Economic Zone or EEZ refers to the area of coastal water and seabed within 200 nm of a country's coastline, to which a country can claim exclusive rights for fishing, drilling, and other economic activities.

[2] The boundary at the eastern end of the Monument was not extended in order to preserve the important commercial and subsistence bottomfish fishing area around Middle Bank, which is located between the islands of Niʻihau and Nihoa.

The locations of the Pacific marine national monuments are shown in Figure 1 below. Note that distances are not to scale.

Figure 1 Marine National Monuments of the Pacific

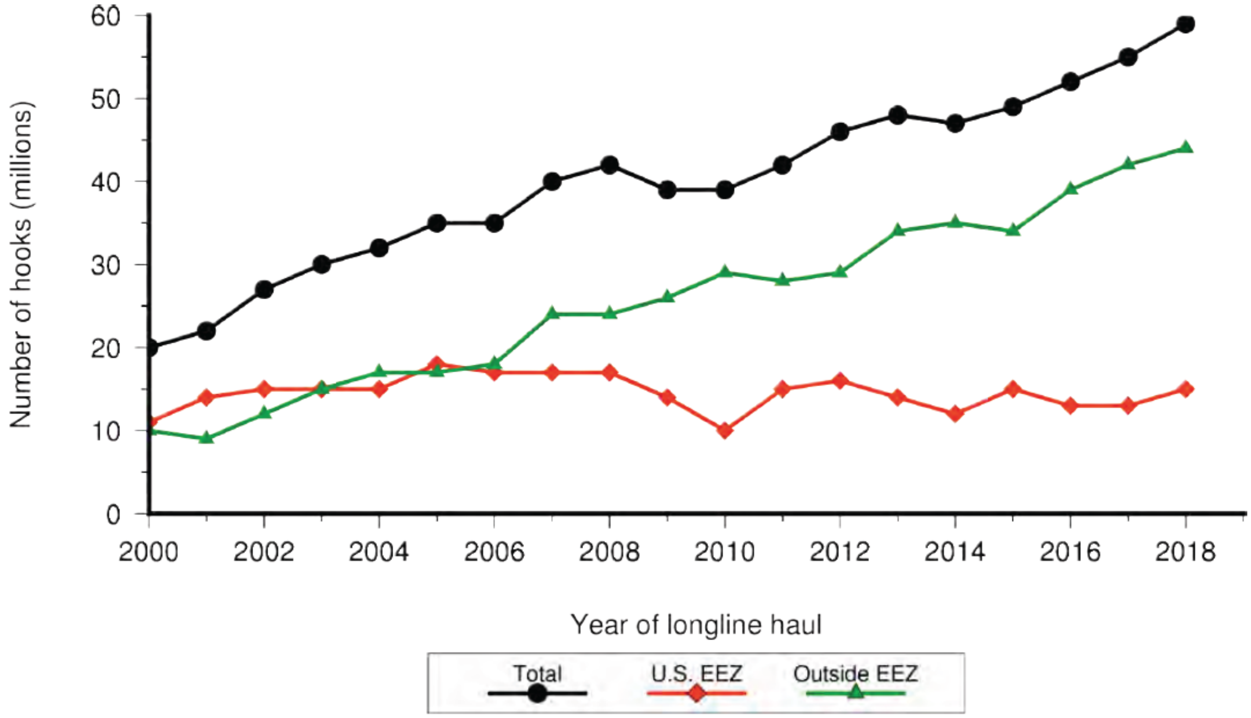


Source: National Marine Fisheries Service (2019a)

• Have commercial fishing restrictions in Pacific marine national monuments forced US fishing vessels out of the US EEZ?

There is no evidence that commercial fishing restrictions in Pacific marine national monuments forced US fishing vessels out of the US EEZ. As shown in Figure 2 below, over the years, the area of the ocean outside the US EEZ has accounted for an increasing proportion of the total fishing effort of Hawaiʻi-based longline vessels. However, the figure shows that the start of this increase predates the establishment of the Pacific marine national monuments by several years. In contrast, the fraction of the fleet's effort spent inside the US EEZ has been relatively stable since 2000.

Figure 2 Fishing effort of the Hawai'i-based longline fleet by region



Source: National Marine Fisheries Service (2020a)

With respect to US purse seine vessels operating in the western and central Pacific, Table 1 below shows that the US EEZ accounted for a small fraction of the fleet's catch both before and after expansion of the Pacific marine national monuments. During the 2013–2017 period, the fleet caught about 2% of its total harvest in the US EEZ, 21% on the high seas (i.e., ocean areas outside of any country's EEZ), and 77% in the EEZs of foreign nations.

Table 1 Percent of the US purse seine fleet catch by region

Region	2013	2014	2015	2016	2017
Foreign EEZ	85.6%	85.2%	66.7%	68.9%	85.7%
US EEZ	1.8%	2.2%	0.4%	1.7%	3.1%
High Seas	13.4%	13.1%	32.4%	28.1%	11.2%

Source: Havice et al. (2019)

• Have commercial fishing restrictions in Pacific marine national monuments placed a burden on domestic fishing and decreased production within sustainable fisheries?

There is no evidence that the Hawai'i-based longline fishery overall experienced a significant negative economic impact as a result of the expansion of the Papahānaumokuākea Marine National Monument in 2016. As shown in Table 2 below, a comparison of fisheries data between the five years prior to the expansion (2012-2016) and the two years after the expansion (2017-2018) reveals that the fishery's average annual tuna catch increased by 16% after the expansion, and its catch per unit of fishing effort (calculated by dividing catch by number of hooks set) remained nearly the same (1% decrease).[3] Fleet-wide revenue increased by about 4%. The finding that the economic performance of the Hawaiʻi-based longline fishery was not substantially diminished by the Monument expansion is corroborated by a recent study conducted by Lynham et al. (2020). Based on an analysis that controlled for confounding factors that may have occurred at the same time as the expansion, the researchers concluded that total tuna catch and catch-per-unit-effort in the fishery were higher after the expansion.

While the Hawaiʻi-based longline fleet as a group did not experience a negative impact, Chan (2020) reported that a segment of the fleet (37 of 141 active vessels or about a quarter of the fleet) that relied substantially on the area included in the expansion was forced to relocate to fishing grounds with which they were not familiar, leading to decreased productivity and revenue for those vessels. Annualized losses were estimated to be about $2.6 million, which is less than 3% of the total average annual revenue of the Hawaiʻi-based longline fleet in 2017-2018. In the longer term, when these vessels find productive fishing areas outside the Monument, they are expected to become more efficient, and the negative economic impacts to this segment have the potential to decline (Chan 2020). The segment of the fleet that never used the expansion area (about a quarter of the fleet) also experienced a decline in catch-per-unit-effort after the expansion, but their pounds kept per trip increased significantly (indicating bigger fish caught) and as a result, their revenue per trip increased (Chan 2020). The economic performance of those vessels that occasionally used the expansion area (about half of the active fleet) was not estimated.

Table 2 Tuna catch and revenue of the Hawaiʻi-based longline fleet

	Total Tuna Catch (number of fish)	Catch-Per-Unit-Effort	Inflation-Adjusted Revenue ($million)
2018	304,446	5.16	$102.3
2017	338,167	6.19	$103.0
2017-2018 Average	**321,307**	**5.68**	**$102.7**
2016	309,685	5.96	$106,2
2015	296,637	6.07	$100.6
2014	267,355	5.67	$89.4
2013	259,330	5.41	$96.4
2012	253,733	5.59	$102.6
2012-2016 Average	**277,348**	**5.74**	**$99.0**

Source: National Marine Fisheries Service (2020a); Western Pacific Regional Fishery Management Council (2019)

The US purse seine fleet operating in the western and central Pacific has experienced economic pressures in recent years that have led to a sharp decline in fleet size. Of particular significance has been the change in

[3] Bigeye tuna is the most important tuna species caught by the Hawaiʻi-based longline fleet. Since 2009, the fleet has been subject to flag-based longline bigeye tuna catch quotas that were imposed by the Western and Central Pacific Fisheries Commission to address potential bigeye overfishing in the Pacific. The US quota is small compared to the quota of other nations, but beginning in 2012, the fleet has compensated for the small quota by purchasing part (up to 1,000 mt) of the 2,000 mt of bigeye tuna that National Marine Fisheries Service allocates annually to each of the US Pacific Islands of American Samoa, Guam and the Northern Mariana Islands—the Commission's quota for the US does not apply to these territories (Ayers et al. 2018; Western Pacific Regional Fishery Management Council 2020). Between 2012 and 2015, bigeye tuna catches by the Hawaiʻi-based longline fleet increased by more than 40% even though the US quota of bigeye tuna was maintained at 3,763 mt from 2012-1014 and reduced to 3,554 mt in 2015 (Western Pacific Regional Fishery Management Council 2019). This growth can be attributed to the territorial quota purchases, together with more active vessels, improved catch efficiency, and increases in bigeye landings in the high seas to the northeast of the main Hawaiian Islands where there is little international competition and high catch rates (Ayers et al. 2018).

fishing access arrangements with the Pacific Island countries. As shown in Table 1 above, most of the fishing effort of the US fleet has occurred in the EEZs of these countries. For more than three decades, the US fleet's fishing access had been facilitated by a multilateral treaty that granted US-flagged purse seine vessels unlimited access to fish in the EEZs of Pacific Island countries in exchange for licensing fees paid by industry and a development assistance package supplied by the US State Department (Havice et al. 2019). However, access conditions under the treaty have changed over the past few years, and US vessel owners now find themselves facing the same increased access costs as other purse seine fleets operating in the region.[4] Moreover, the US fleet regularly reports that the cost of operating under the US flag is relatively higher than under competitor flags. These costs include the need to comply with US Coast Guard requirements, together with high vessel insurance costs (Havice et al. 2019). Limits on the use of fish aggregation devices (FADs) and on the number of fishing days that the US purse seine fleet can spend in the US EEZ and high seas have also had a negative economic impact on the fleet.[5,6]

The restrictions on commercial fishing in the Pacific marine national monuments have constrained the operational flexibility of the US purse seine fleet (National Marine Fisheries Service 2018). However, it is doubtful that these restrictions have contributed significantly to the economic difficulties of the US purse seine fishery. The US EEZ waters of importance to the US purse seine fleet have historically been those around the Pacific Remote Islands Marine National Monument, especially during a strong El Niño, when fishing for skipjack tuna shifts from the western to the central equatorial Pacific in response to physical and biological impacts (Lehodey et al. 1997). As shown in Table 1, the US EEZ accounted for a small percentage of the fleet's catch before any of the Pacific marine national monuments were expanded. In fact, the EEZ percentage reached a five-year high in 2017, three years after the expansion of the Pacific Remote Islands Marine National Monument. Furthermore, the 2014 expansion of that monument did not include the waters around Howland and Baker Islands, which is where most of the fishing effort of the purse seine fleet in the US EEZ has typically occurred (National Marine Fisheries Service 2015).[7]

[4] Five other nations besides the US have major purse seine fleets operating within the the western and central Pacific: Japan, South Korea, Taiwan, China, and the Philippines. In addition, the largest Pacific Island nations countries—Fiji, the Solomon Islands, Papua New Guinea—have developed their own purse seine fleets, generally through joint ventures with foreign companies (The World Bank and Nicholas Institute 2016).

[5] FADs are generally floating objects; they include natural objects as well as anchored and drifting rafts deployed specifically to aggregate tuna. FADs can be a highly effective method to increase tuna catch-per-unit-effort (Holmes et al. 2019). However, the extensive use of drifting FADs in purse seine fisheries has led to increased catches of juvenile bigeye and yellowfin tuna as well as vulnerable bycatch species (e.g., pelagic sharks), raising concerns about the sustainability of these tuna species' populations and the supporting pelagic ecosystem (Leroy et al. 2013; National Marine Fisheries Service 2017; Griffiths et al. 2019). In response to these concerns, the Western and Central Pacific Fisheries Commission requires member countries to implement seasonal prohibitions on purse seine fishing with FADs (Post and Squires 2020). From 2014-2016, about half of the fishing sets made by the US purse seine fleet during periods when FAD setting was allowed were FAD sets (National Marine Fisheries Service 2018).

[6] National Marine Fisheries Service first implemented purse seine fishing effort limits in 2009 in response to a tuna conservation measure established by the Western and Central Pacific Fisheries Commission. Chan and Squires (2016) estimated that the losses to the combined sectors of the US purse seine vessels, tuna canneries, and vessel support companies when the fishing day limit was reached in 2015 ranged from $11 million to $110 million, depending on the counterfactual period considered. See also Sagapolutele (2018) and Ramsden (2019).

[7] The US EEZ around Howland and Baker has received the most US purse seine fishing effort (about eight fishing days per vessel per year), followed by Jarvis (two days) and Kingman and Palmyra (0.3 days). No purse seine fishing has occurred around Wake Island (National Marine Fisheries Service 2015). In order to better accommodate commercial fishing interests, a 50-nm Monument boundary remains in place around Howland, Baker, Palmyra and Kingman (Western Pacific Regional Fishery Management Council 2014b). These fishing interests include the Hawai'i-based longline fleet as well as the purse seine fleet; the EEZ around Palmyra has accounted for as much as 12 percent of the annual longline catch (Western Pacific Regional Fishery Management Council 2014a). As with the purse seine fishery, longline fishing activity in the waters around the Monument increases during El Niño events (Howell and Kobayashi 2006).

- ## Have commercial fishing restrictions in Pacific marine national monuments exacerbated the economic impacts of the COVID-19 pandemic on the seafood industry?

The COVID-19 pandemic has had a devastating economic impact on Hawaiʻi's seafood industry. However, this impact is not connected in any way to commercial fishing restrictions in the Pacific marine national monuments. In fact, the impact is not due to a lack of fish supply but rather to a precipitous decline in the demand for the fish landed by the Hawaiʻi-based longline fleet. As the National Marine Fisheries Service Pacific Islands Fisheries Science Center recently reported to the Western Pacific Regional Fishery Management Council, "COVID-19 led to nationwide restaurant closures and travel/visitor restrictions, resulting in a historical demand shock causing the Hawaii seafood market to crash" (National Marine Fisheries Service 2020c). Eric Kingma, executive director of The Hawaii Longline Association, has stated that most of the longline fishing vessels that target pelagic fish such as bigeye and yellowfin tuna, swordfish and mahi mahi, were tied up in port due to the lack of demand caused by the pandemic (Reiley 2020). The Association has tried to mitigate the economic losses related to excess supply by partnering with the Hawaii Foodbank (Hawaii Agricultural Foundation 2020).

In contrast, during the COVID-19 pandemic there has been exceptionally high retail demand for canned and pouched products utilizing skipjack and yellowfin tuna caught by US and foreign purse seine fleets (Craymer 2020). However, as discussed above, the US EEZ accounted for a small percentage of the US fleet's catch before any of the Pacific marine national monuments were expanded. Therefore, it is doubtful that fishing restrictions in the monuments have significantly constrained the US purse seine fleet's ability to respond to the increased demand for processed tuna products by catching more fish.

- ## Is there any peer-reviewed literature that demonstrates the conservation benefit of commercial fishing restrictions in large-scale marine protected areas to pelagic species caught by commercial fisheries?

There is considerable peer-reviewed literature on the potential conservation benefits of commercial fishing restrictions in large-scale marine protected areas to pelagic species caught by commercial fisheries. However, additional research is needed to determine whether these benefits are actually being realized in existing marine protected areas.

Much of the literature related to potential conservation benefits has focused on yellowfin tuna, a species targeted by both the Hawaiʻi-based longline fleet and US purse seine fleet. While recent tagging studies in the Main Hawaiian Islands show that some adult yellowfin tuna undertake large-scale movements (Lam et al. 2020), other studies based on tagging (Brill et al. 1999; Holland et al. 1999; Klimley and Holloway 1999; Itano and Holland 2000; Adam et al. 2003); biological sampling (Boehlert and Mundy 1994; Itano 2000), and otolith chemistry data (Wells et al. 2012; Rooker et al. 2016) demonstrate that other yellowfin tuna individuals caught around the Main Hawaiian Islands appeared to be locally spawned and then retained. Many individuals exhibited high fidelity to local banks, seamounts, and FADs.[8] Evidence of some degree of site fidelity for yellowfin tuna has been found elsewhere in the Pacific, including the Federated States of Micronesia (Anderson et al. 2019); northwestern Coral Sea (Hampton and Gunn 1998); Solomon Islands

[8] The State of Hawaii maintains a large network of anchored FADs close to the inhabited islands to enhance small-scale troll and handline fisheries (Itano and Holland 2000).

(Western and Central Pacific Fisheries Commission 2017); northern Tasman Sea and southern Coral Sea (Evans et al. 2011); Palau (Palau International Coral Reef Center and the Stanford Center for Ocean Solutions 2019); and off Baja California, Mexico (Klimley et al. 2003; Schaefer et al. 2007; Jorgensen et al. 2016), although the occurrence of fully discrete, closed populations may be unlikely (Moore et al. 2020). Given the nature of yellowfin tuna biology and behavior, it has been suggested that these tuna, together with other pelagic species that have similar biological and behavioral characteristics, could benefit from the conservation safeguards provided by large-scale marine protected areas (Koldewey et al. 2010; Boerder et al. 2017; O'Leary et al. 2018; Richardson et al. 2018; Boerder et al. 2019; Hernández et al. 2019; Palau International Coral Reef Center and the Stanford Center for Ocean Solutions 2019; Gilman et al. 2020).

A report prepared for the International Seafood Sustainability Foundation notes that frequent association with certain habitats has been observed in other pelagic species as well (Davies et al. 2012).[9] The report lists several studies documenting aggregations of pelagic sharks and manta rays around relatively shallow seamounts (i.e., summits less than 800 m deep) and nearshore coastal features. In some instances, these aggregations represent key life stages, such as in the blue shark which spends the first few years of life within nearshore and coastal habitat. Pelagic sharks and manta rays are bycatch species in both the Hawaiʻi-based longline and US purse seine fisheries.[10] Other pelagic species caught by the Hawaiʻi-based longline fishery that aggregate around shallow seamounts include blue marlin, shortbill spearfish, and swordfish (Morato et al. 2010). As shown in Table 3 below, National Marine Fisheries Service catch data for the Hawaiʻi-based longline fishery prior to the expansion of Papahānaumokuākea Marine National Monument indicate that many of the shark and billfish species that have been associated with seamounts and other underwater features were caught by vessels fishing in the US EEZ around the Northwestern Hawaiian Islands. Moreover, these same species have also been caught by the Hawaiʻi-based longline fleet in the US EEZ around the Pacific Remote Islands Marine National Monument, where the fleet has targeted pelagic species concentrated around shallow features (Gilman et al. 2020).

Table 3 Hawaiʻi-based longline fleet catch of selected species in the US EEZ around the Northwestern Hawaiian Islands

	Blue shark [a]	Mako sharks [a]	Silky shark [a,b]	Blue marlin	Shortbill spearfish	Swordfish
			(number of fish caught)			
2012	8,247	233	3	270	1,060	2,259
2013	7,201	281	4	335	1,696	1,526
2014	5,128	192	2	266	1,024	1,495
2015	6,929	330	4	536	1,619	1,865

Source: National Marine Fisheries Service (2020a)

[a] After the federal banning of shark finning in 2000, the majority of sharks caught by the Hawaiʻi-based longline fleet in the EEZ around the Northwestern Hawaiian Islands were released intact, and most released sharks likely survived. However, a recent study concluded that the survival rate of released sharks in longline fisheries depends on whether the sharks are in good condition at release and if trailing gear is minimized (Hutchinson and Bigelow 2019). Moreover, the stainless-steel hooks typically used in the Hawaiʻi-based longline fishery may have a deleterious effect on the long-term survival of released sharks due to their resistance to corrosion and shedding (Begue et al. 2020).

[b] The silky shark is classified by the International Union for Conservation of Nature as a near threatened species in the western and central Pacific, and the Western and Central Pacific Fisheries Management Commission lists the species as highly depleted (Convention on International Trade in Endangered Species 2016).

[9] The International Seafood Sustainability Foundation is a global, non-profit partnership between the tuna industry and scientists whose goal is the long-term conservation and sustainable use of global tuna fisheries https://iss-foundation.org/

[10] Two bycatch species in the Hawaiʻi-based longline and US purse seine fisheries—the oceanic whitetip shark and giant manta ray—were listed as threatened under the Endangered Species Act in 2018.

It is important to note that the pelagic zone within the Papahānaumokuākea Marine National Monument is also habitat for approximately 23 species of whales and dolphins (Carretta et al. 2019). While individuals of many of these species likely spend a limited time in the Monument, others are known to be long-term residents. For example, humpback whales use it as a wintering area; a subpopulation of false killer whales lives largely, but not entirely within the Monument; and the Midway Atoll/Kure stock and Pearl & Hermes Reef stock of spinner dolphins reside entirely within the Monument (Carretta et al. 2019). National Marine Fisheries Service has classified the deep-set component of the Hawaiʻi-based longline fishery as a Category I fishery under the Marine Mammal Protection Act, which means that component results in frequent incidental death or serious injury of marine mammals.[11] The basis for this classification is the deep-set component's interactions with an endangered population of false killer whales. If a certain number of false killer whale mortalities or serious injuries (i.e., an injury that will more likely than not lead to the animal's death) occur as a result of interactions with this component of the longline fishery, National Marine Fisheries Service prohibits these vessels from fishing in the Southern Exclusion Zone, which lies adjacent to the southern boundary of the Papahānaumokuākea Marine National Monument (National Marine Fisheries Service 2019c).[12] The US purse seine fishery in the central and western Pacific Ocean is classified as a Category III fishery, which means there is a remote likelihood of or no known incidental mortality and serious injury of marine mammals in the fishery.[13]

The aforementioned International Seafood Sustainability Foundation report notes that, "Given the challenges facing spatial protection of highly mobile pelagic species, such as tunas, attention is increasingly being directed towards protecting smaller areas where pelagic species spend a disproportionate amount of time, are highly vulnerable to anthropogenic pressures, and/or are associated with particular life-history stages" (Davies et al. 2012). (See also National Research Council 2001.) However, despite the recent proliferation of marine protected areas encompassing pelagic habitats, few studies have assessed the ecological responses in these areas (Gilman et al. 2019). While the quality/quantity of prey resources and highly suitable habitats (e.g., banks, seamounts) in the Pacific marine national monuments are conducive to use by pelagic species, there is uncertainty over the efficacy of the monuments in protecting these species relative to other conservation measures.

Documenting the responses of pelagic ecosystems to commercial fishing restrictions within the Pacific marine national monuments is likely to be challenging. Conducting comprehensive field studies of pelagic ecosystems in large-scale marine protected areas is expensive because these areas tend to be remote as well as vast, and the elements of pelagic ecosystems are difficult to observe. Modelling offers an alternative to

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[11] The Hawaiʻi-based longline fishery consists of a deep-set component, which targets bigeye tuna, and a shallow-set component, which targets swordfish. The former component is by far the largest. In 2008, for example, 143 deep-set vessels made 20,977 sets, while 11 shallow-set vessels made 420 sets (Western Pacific Regional Fishery Management Council 2019).

[12] The Southern Exclusion Zone is a management area created by the False Killer Whale Take Reduction Plan. Only the Main Hawaiian Islands Insular false killer whale stock, which is listed as an endangered "distinct population segment" under the Endangered Species Act, and the Hawaii Pelagic false killer whale stock are protected under the Take Reduction Plan (National Marine Fisheries Service 2019c).

On July 24, 2018, National Marine Fisheries Service closed the Southern Exclusion Zone to the deep-set component of the Hawaiʻi-based longline fishery due to interactions that resulted in serious injuries to four killer whales. The Southern Exclusion Zone was closed to this component for a second consecutive calendar year on February 22, 2019, due to fishery interactions that resulted in the mortality of one false killer whale and serious injury to another (National Marine Fisheries Service 2020b).

[13] In 2018, US purse seine vessels reported 12 instances of interactions with 59 individual marine mammals, including 29 false killer whales (19 released alive and 10 dead), 15 pantropical spotted dolphins (5 dead and 10 released alive), 7 unidentified dolphins (all released alive), 4 Minke whales (all released alive), 2 sei whales (both released alive), and one baleen whale (released alive) (National Marine Fisheries Service 2019b)

field studies, but the models must be complex to fully identify and quantify the conservation benefits of large-scale marine protected areas (Edwards et al. 2009; Fulton et al. 2015).[14] For example, a recent study conducted by Gilman et al. (2020) that employed a modelling approach using fishery-dependent data found no apparent causal impacts of the expansion areas of the Pacific Remote Islands Marine National Monument on pelagic species diversity, lengths, and trophic level of the catch, perhaps because the expansion areas were too recent, were too small, did not contain critical habitat for specific life-history stages, had been lightly exploited, or experienced "fishing-the-line" effects.[15] However, the authors also note that the study's assessment of ecological responses was limited by using only fishery-dependent data, as this approach can lead to ambiguous conclusions regarding the effects of conservation measures.[16]

Notwithstanding the difficulties of assessing the ecological effects of large-scale marine protected areas, additional studies of pelagic ecosystems within the Pacific marine national monuments are planned for the future. For instance, the Block Lab of Stanford University is preparing to undertake a multiyear tagging study to help determine how tuna and billfish (e.g., blue marlin, shortbill spearfish, striped marlin and swordfish) use Papahānaumokuākea Marine National Monument waters, their residency time in the Monument, what environmental conditions and oceanographic preferences they're using in the Monument, and what areas in state and international waters are providing them with critical habitat. Similar tagging studies recently conducted elsewhere suggest that, with effective enforcement, large-scale marine protected areas potentially offer protection to a variety of species with a range of spatial ecologies (e.g., Carlisle et al. 2019).

Although there is currently scientific uncertainty about the conservation benefits of large-scale marine protected areas, reopening these areas to commercial fishing may not be in the interests of the long-term sustainability and profitability of pelagic fisheries. In an era in which the impact of climate-related stressors to marine ecosystems is growing, a case can be made for making these areas an integral component of a precautionary approach (Alger 2019). A recent report issued by the National Marine Fisheries Service Climate Science Strategy notes that as a result of global warming, Pacific Island waters are expected to experience major changes, including increased temperatures, increased acidity, changes in currents, and lower productivity. The report concludes that these changes will likely impact the ecosystem trophic structure, biomass, and catch for the Hawaiʻi-based longline fishery, with the fishery's yield projected to decline significantly after 2050 (Polovina et al. 2016). Similarly, the US purse seine fishery may be adversely affected by a projected decrease in skipjack tuna abundance in the western and central Pacific after 2060 (Lehodey et al. 2013; Dueri et al. 2014; Erauskin-Extramiana et al. 2019). Large-scale marine protected areas such as the Pacific marine national monuments may promote pelagic ecosystem

[14] Fulton et al. (2015) describe a modelling approach as follows: "A model is an abstraction of reality, a simplified description of certain features or processes of interest. Models can be used to describe, to explain, and ultimately to predict how systems work and how they might respond to human actions." The authors note that many types of models can be used to evaluate marine protected area performance.

[15] Fishing-the-line refers to the relocation of fishing effort close to the seaward boundary of a marine protected area in order to capture the spillover of targeted fish at the edge of the area. This concentration of fishing effort has been documented for Hawaiʻi-based longline vessels fishing in the waters around Papahānaumokuākea Marine National Monument after the 2016 expansion (Chan 2020). O'Leary et al. (2018) suggest that fishing-the-line provides evidence that a marine protected area is appropriately located for the target fish species and indicates management effectiveness.

[16] Gilman et al. (2020) state: "Finding few significant statistical effects does not mean there was no impact—it is just that we could not find any strong evidence of impacts for some ecological responses given the available fishery-dependent data. Absence of evidence is not evidence of absence. We suspect that impact evaluations of [marine protected areas] based on such preferentially-sampled observational data will often be inconclusive and uncertain because of the complex social, economic and ecological interactions affecting pelagic fishery catch rates. The study did not assess various ecological responses to the [marine protected areas] that could be explored using both fisheries-independent and fisheries-dependent data, such as changes in attributes (e.g., biomass, size) of non-harvested species, changes from cascading effects through the food web (e.g., effects on seabird populations from changes in prey availability, from subsurface predators driving forage species to the sea surface, and in prey local abundance, in response to reduced localized fishing mortality of apex predators, or changes in functional links between open ocean and coastal pelagic, demersal and benthic systems."

resilience and adaptation to changing environmental conditions resulting from global warming, especially if effective fisheries management tools are applied outside the areas (Game et al. 2009; Hilborn 2016; Roberts et al. 2017; O'Leary et al. 2018; Hernández et al. 2019).[17] Moreover, these areas are large-scale living laboratories that can potentially help scientists better understand climate-related impacts on ocean ecosystems (Hernández et al. 2019). O'Leary et al. (2018) emphasize that large-scale marine protected areas alone will not be able to protect against climate change and other human-induced impacts, particularly those that diffuse across boundaries. The authors argue, however, that these areas can be an important additional tool for ocean resource management during this time of global environmental uncertainty.

Summary

- In general, commercial fishing is prohibited within the boundaries of the Pacific marine national monuments. However, concessions have been made to accommodate commercial fishing interests, including not extending the eastern boundary of the Papahānaumokuākea Marine National Monument in order to preserve commercial bottomfish fishing areas around Middle Bank; excluding the waters around Howland and Baker Islands during the expansion of the Pacific Remote Islands Marine National Monument to avoid areas where the US purse seine and Hawaiʻi-based longline fleets operate; and allowing commercial fishing in the waters of the Trench and Volcanic Units of the Marianas Trench Marine National Monument.

- There is no evidence that commercial fishing restrictions in Pacific marine national monuments forced US fishing vessels out of the US EEZ. Fishing effort by the Hawaiʻi-based longline and US purse seine fleets in the US EEZ was low prior to Pacific marine national monument creation and expansion, and it has remained low.

- There is no evidence that commercial fishing restrictions in Pacific marine national monuments have significantly diminished the economic performance of the Hawaiʻi-based longline fleet as a whole, but a study found that some individual fishing vessels experienced at least temporary economic losses as a result of monument expansion. There is also no evidence that commercial fishing restrictions in Pacific marine national monuments have significantly diminished the economic performance of the US purse seine fleet.

- There is no evidence that the economic impact of the COVID-19 pandemic on Hawaiʻi's seafood industry is connected in any way to commercial fishing restrictions in the Pacific marine national monuments. Rather, it is due to a precipitous decline in the demand for the fish landed by the Hawaiʻi-based longline fleet.

- There is considerable peer-reviewed literature on the potential conservation benefits of large-scale marine protected areas to pelagic species caught by commercial fisheries, but more studies are required to determine whether these benefits are actually being realized. In the meantime, given the uncertainty about the impacts of global climate change, a precautionary approach that maintains commercial fishing

[17] Based on information presented in Roberts et al. (2017), O'Leary et al. (2018) summarize the potential benefits of large-scale marine protected areas as follows: "[They] may encompass range shifts of marine species under climate change, reduce cumulative stressors on ecosystems enabling faster recovery from climatic impacts, promote larger populations more resilient to extinction and with greater genetic diversity, and act as wildlife refugia."

restriction in these areas may be in the interests of the long-term sustainability of fisheries targeting pelagic species as well as the conservation of pelagic ecosystems.

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