WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

Essential Fish Habitat Component Team for Revising Territorial BMUS Lists
A subgroup of the Archipelagic Fishery Ecosystem Plan Team

Draft Report

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Background on EFH Provisions

In 1996, Congress passed the Sustainable Fisheries Act, which amended the Magnuson Stevens Fishery Conservation and Management Act (MSA) and added several new fishery management plan (FMP) provisions. Among the most important of these additions was the requirement to holistically identify and describe essential fish habitat (EFH) and, under the EFH final rule, habitat areas of particular concern (HAPC) for all federally managed species (50 CFR 600.815). The MSA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." HAPC are areas of EFH that meet one or more of the following considerations: (1) ecological function provided by the habitat is important; (2) habitat is sensitive to human-induced environmental degradation; (3) development activities are, or will be, stressing the habitat type; or (4) the habitat type is rare. At the time, the new mandate represented a shift in fishery management to allow regional councils to begin focusing on broader ecosystem-based approaches as opposed to traditional single or multi-species management.

In 1999, NMFS issued guidelines intended to assist Councils in implementing the EFH provision of the MSA and set forth the following four broad tasks:

1. Identify and describe EFH for all species managed under an FMP;
2. Describe adverse impacts to EFH from fishing activities;
3. Describe adverse impacts to EFH from non-fishing activities; and
4. Recommend conservation and enhancement measures to minimize and mitigate the adverse impacts to EFH resulting from fishing and non-fishing-related activities.

Councils also have the authority to comment on federal or state agency actions that would adversely affect the habitat, including EFH, of managed species. Fishery management actions must be evaluated for impacts on all EFH and HAPC in the area of effect and not just the EFH and HAPC for the fishery to which the management action applies.

The EFH guidelines note that a wide range of basic information is needed to identify EFH. This includes data on current and historic stock size, the geographic range of the managed species, the habitat requirements by life history stage, and the distribution and characteristics of those habitats. Since EFH has to be identified for each major life history stage, information about a species' distribution, density, growth, mortality, and production within all of the habitats it occupies, or formerly occupied, is also necessary. According to National Standard 2 guidelines, the stock assessment and fishery evaluation (SAFE) report should summarize the best scientific information available (BSIA) concerning the past, present, and possible future condition of EFH described by the FEPs. The guidelines also state that the quality of available data used to identify EFH should be rated using the following four-level system:

- Level 1: All that is known is where a species occurs based on distribution data for all or part of the geographic range of the species;
- Level 2: Data on habitat-related densities or relative abundance of the species are available;
- Level 3: Data on growth, reproduction, or survival rates within habitats are available; and
- Level 4: Production rates by habitat are available.

The EFH provisions are especially important because of the procedural requirements they impose on both regional councils and federal agencies. First, for each FMP, regional councils must identify adverse impacts to EFH resulting from both fishing and non-fishing activities, and describe measures to minimize these impacts. Second, the provisions allowed regional councils to provide comments and make recommendations to federal or state agencies that propose actions that may affect the habitat, including EFH, of a managed species. In 2002, NMFS revised the guidelines by providing additional clarifications and guidance to ease implementation of the EFH provision by regional councils.

Western Pacific Region

In 1999, the Western Pacific Regional Fishery Management Council (Council) developed and NMFS approved EFH definitions for management unit species (MUS) under the Bottomfish and Seamount Groundfish FMP (Amendment 6), Crustacean FMP (Amendment 10), Pelagic FMP (Amendment 8), and Precious Corals FMP (Amendment 4) (64 FR 19067, April 19, 1999). NMFS approved additional EFH definitions for coral reef ecosystem species in 2004 as part of the implementation of the Coral Reef Ecosystem FMP (69 FR 8336, February 24, 2004). NMFS approved EFH definitions for deep water shrimp through an amendment to the Crustaceans FMP in 2008 (73 FR 70603, November 21, 2008). In 2009, the Council transitioned its five species-based FMPs to five place-based Fishery Ecosystem Plans (FEPs) that carried forward EFH definitions and provisions for all FMP fishery resources into their respective FEPs (75 FR 2198, January 14, 2010). In 2019, Amendment 4 to the American Samoa Archipelago FEP and Amendment 5 to the Mariana Archipelago FEP reclassified some bottomfish, pelagic, crustacean, precious coral, and coral reef ecosystem species as ecosystem component species (ECS) (84 FR 2767, February 8, 2019). These species do not have EFH or HAPC under the MSA, as these habitat categories only apply to MUS. Discussion and analysis of potential effects on EFH and HAPC would only consider these habitat designations for species remaining as bottomfish MUS (BMUS) in these two territories.

The habitat objective of the FEPs is to refine EFH and minimize impacts to EFH, with the following sub-objectives:

- Review EFH and HAPC designations every five years based on the best scientific information available and update such designations based on the best scientific information available , when available; and
- Identify and prioritize research to assess adverse impacts to EFH and HAPC from fishing (including aquaculture) and non-fishing activities, including, but not limited to, activities that introduce land-based pollution into the marine environment.

As stated in the FEPs, none of the fisheries operating under the American Samoa or Mariana Archipelago FEPs are expected to have adverse impacts on EFH or HAPC for species managed under the different fisheries. Continued and future operations of fisheries under these FEPs are not likely to lead to substantial physical, chemical, or biological alterations to the habitat, or result in loss of, or injury to, these species or their prey (WPFMC 2009a; WPFMC 2009b).

Based on the MSA definition of EFH and its associated description in the FEPs, the proposed action to revise the territorial BMUS lists would have little effect on the designation of EFH required to be specified in the FEPs. The bottomfish EFH definitions may need to be slightly revised to better reflect species being added to each territorial BMUS list, and, for example, there may not be data available to describe the depth distribution of newly added species. Moreover, if Etelis boweni *has a different depth distribution than* Etelis carbunculus*, the EFH range would be adjusted. Additionally, shallow-water BMUS that would transition to the territorial Fishery Management Plans would need to have their EFH designations removed.*

Current EFH Designations for Territorial Bottomfish

The Council has used the best scientific information available (BSIA) to describe EFH and provide information on the biological requirements for each life stage (i.e., egg, larvae, juvenile, and adult) for all MUS in American Samoa, Guam, and the CNMI (see Tables 1 and 2).

To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for bottomfish assemblages pursuant to 50 CFR 600.805(b). The species complex designations include deep-slope bottomfish (i.e., shallow-water and deepwater) and are based on the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual BMUS throughout the Western Pacific Region.

At present, there is not enough data on the relative productivity of different habitats to develop EFH designations based on Level 3 or Level 4 data. Given the uncertainty concerning the life histories and habitat requirements of many BMUS, the Council designated EFH for adult and juvenile bottomfish as the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fathoms) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish throughout the Western Pacific Region. This precautionary approach ensures that enough habitats are protected to sustain managed species.

Table 1. EFH and HAPC for American Samoa BMUS (from WPFMC 2022a).

American Samoa BMUS	EFH	HAPC
Aphareus rutilans (red snapper/silvermouth) *Aprion virescens* (gray snapper/jobfish) *Caranx lugubris* (black trevally/jack) *Etelis carbunculus* (red snapper) E. *coruscans* (red snapper) *Lethrinus rubrioperculatus* (redgill emperor) *Lutjanus kasmira* (blueline snapper) *Pristipomoides filamentosus* (pink snapper) *P*. *flavipinnis* (yelloweye snapper) *P*. *zonatus* (snapper) *Variola louti* (lunartail grouper)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20–140 fm)

Table 2. EFH and HAPC for Mariana Archipelago BMUS (from WPFMC 2022b).

Guam and CNMI BMUS	EFH	HAPC
Lehi (*Aphareus rutilans*) Giant trevally (*Caranx ignobilis*) Black trevally (*Caranx lugubris*) Ehu (*Etelis carbunculus*) Onaga (*E. coruscans*) Redgill emperor (*Lethrinus rubrioperculatus*) Blueline snapper (*Lutjanus kasmira*) Yellowtail snapper (*Pristipomoides auricilla*) Opakapaka (*P. filamentosus*) Yelloweye snapper (*P. flavipinnis*) Kalekale (*P. sieboldii*) Gindai (*P. zonatus*) Lunartail grouper (*Variola louti*)	**Eggs and larvae:** the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). **Juvenile/adults:** the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20–140 fm)

Available Life History Information to Inform EFH

There is regional variation in species composition as well as the relative abundance of the MUS of the deepwater bottomfish complexes in the Western Pacific Region. In American Samoa and the Mariana Archipelago, the bottomfish fishery can be divided into two distinct fisheries: a shallow- and a deep-water bottomfish fishery, based on species and depth. The shallow-water (0 to 100 m) bottomfish complex comprises groupers, snappers, and jacks in the genera *Lethrinus*, *Lutjanus* and, *Aprion*. The deepwater (100–400 m) bottomfish complex comprises snappers in the genera *Pristipomoides*, *Etelis*, and *Aphareus*.

Except for several of the major commercial species, very little is known about the life histories, habitat utilization patterns, food habits, or spawning behavior of most adult shallow- and deep-water bottomfish species in American Samoa and the Mariana Archipelago. Further, very little is known about the distribution and habitat requirements of juvenile bottomfish in these areas.

Generally, the distribution of adult bottomfish in the Western Pacific Region is closely linked to suitable physical habitat. Unlike the U.S. mainland with its continental shelf ecosystems, the Pacific Islands are primarily volcanic peaks with steep drop-offs and relatively limited shelf ecosystems. The BMUS under the Council’s jurisdiction are found concentrated on top of and along the steep slopes of deepwater banks. The 100-fathom (1820-meter) isobath is commonly used as an index of bottomfish habitat.

Eggs and larvae are pelagic with an uncertain pelagic larval duration. Pelagic larval duration (PLD) is assumed to range between 40 to 180 days. A *P. filamentosus* PLD of 60 to 180 days was based on the estimated ages of juveniles from other studies. Evidence suggests that bottomfish larvae may display a vertical migration pattern in which they avoided surface waters during the day. A model of passive pelagic particle connectivity in the MHI, based on a PLD of 45 days, found a median distance for successful settlements around 100 km and that cross-channel dispersal can be common.

The majority of bottomfish species juveniles are thought to settle directly to adult habitats. The exception is *P. filamentosus*, which settles into flat, featureless bottom habitat composed of unconsolidated sediment such as sand, silt, and clay at depths of 70 to 100 m. They stay in this nursery habitat for two years before moving into adult habitat (i.e., deeper, harder bottom). Juvenile *E. carbunculus* were observed in holes and under rocks in adult habitats. Cavities that provide shelter appear to be particularly important to this species and the same is likely true for other species that settle directly to adult habitats.

Adult bottomfish are usually found in habitats characterized by a hard substrate of high structural complexity, although some species are found in less rugous bottom. The total extent and geographic distribution of the preferred habitat of bottomfish are not well known. Bottomfish populations are not evenly distributed within their natural habitat; instead, they are found dispersed in a non-random, patchy fashion. Deepwater snappers tend to aggregate in association with prominent underwater features, such as headlands and promontories. Some species form large benthopelagic schools (e.g., *P. seiboldii, A. rutilans*), whereas others are found tens of meters off the bottom (e.g., *E. coruscans*). Depth range and location on the slope varies by species. Generally deeper species consist of *E. carbunculus* and *E. coruscans*, whereas the majority of *Pristomoides* spp. are found shallower. *P. filamentosus* migrate to shallower water and different habitat at night compared to the daytime.

The eggs and larvae of all BMUS are pelagic, floating at the surface until hatching and subject thereafter to advection by the prevailing ocean currents. There have been few taxonomic studies of these life stages of snappers (lutjanids) and groupers (epinepheline serranids). Presently, few larvae can be identified to the species level. As snapper and grouper larvae are rarely collected in plankton surveys, it is extremely difficult to study their distribution. Given the existing scientific uncertainty about the distribution of eggs and larvae of bottomfish, the Council designated the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 400 meters as EFH for bottomfish eggs and larvae throughout the Western Pacific Region (Tables 1 and 2). Table 3 describes the known life history and EFH information for the BMUS in the proposed revision list for the American Samoa and Mariana Archipelagos.

Table 3. Relevant life history and habitat information for the various life stages of proposed revised American Samoa and Mariana Archipelago BMUS.

Species	Eggs/Larvae	Juvenile	Adult
Aphareus rutilans	**Eggs:** pelagic, spherical, and small (0.77–0.85 mm). **Larvae:** pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. Larvae remain planktonic to at least 54 mm (Leis 1987; Leis and Lee 1994; Leis and Carson-Ewart 2004)	A single juvenile was collected at 40 m off Kaneohe Bay, Oahu on a shallow sediment flat. (Parrish 1989)	Seamounts and continental slope habitats with a wide depth range (100–300 m) and no apparent bottom habitat preference. In the Mariana Archipelago, it was caught between 119–229 m during surveys. Aggregations of *A. rutilans* were found near areas of prominent relief features such as headlands, showing a preference for habitats with hard substrates. Gonochoristic broadcast spawners that form spawning aggregations that coincide with warmer water temperatures. A large school (>100 individuals) was sighted on a bottom camera in Hawaii. (Allen 1985; Misa et al. 2008; Parrish 1989; Ralston and Williams 1988; Richards pers. comm. 2022)
Etelis boweni	Newly described cryptic species. Habitat is assumed to be similar to *E. carbunculus* due to co-occurrence in catch.		

Species	Eggs/Larvae	Juvenile	Adult
Etelis carbunculus	**Eggs**: pelagic, spherical, and small (0.77–0.85 mm). **Larvae**: pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. Larvae remain planktonic at least to 50 mm. (Leis 1987; Leis and Lee 1994; Leis and Carson-Ewart 2004)	Juveniles settle directly in adult habitats (depth and habitat). Juvenile *E. carbunculus* < 22 cm SL were caught during fishing surveys in depths between 183–313 m depth and 15 cm FL fish were observed during submersible dives off North Oahu and East Oahu at depths of 274–290 m and 300 m, respectively. Juveniles were observed very close to the bottom either solitary or in small groups. Cavities that provide shelter appear to be particularly important to this species. (Parrish 1989; Kelley et al. 1997; Kelley et al. 2006; Ikehara 2006; Weng 2013; WPFMC 2016)	Adults are found on the hard substrate deepwater slopes in areas of high structural complexity. They inhabit seamounts and continental slope habitats with greatest abundance between 200–310 m on hard bottom, low slope habitats and do not exhibit any ontogenetic habitat shifts. Individuals are found solitarily or in small groups. *E. carbunculus* were recorded during 90 BotCam drop camera deployments in the MHI at depths of 192–325 m and in temperatures ranging from 10.70 °C – 19.11 °C and averaging 14.58 °C. Individuals recorded as deep as 515 m from the *Pisces* submersible in Hawaii. Adults require shelter and therefore are rarely observed venturing up into the water column. There is currently no information to suggest that they travel great distances outside a small home range. (Allen 1985; Drazen, unpub. data; Everson 1984; Haight 1989; Misa et al. 2013; Ralston and Polovina 1982; Weng 2013)

Species	Eggs/Larvae	Juvenile	Adult
Etelis coruscans	**Eggs:** pelagic, spherical, and small (0.77–0.85 mm) and larvae hatch at about 1.7–2.2 mm. **Larvae:** pelagic and distributed off the edge of continental shelves and offshore from oceanic islands until at least 22 mm. PLD is assumed to range between 40–180 days. (Leis 1987; Leis and Lee 1994; Leis and Carson-Ewart 2004)	Juveniles are thought to settle directly to adult habitats and were observed very close to the bottom or hiding in cavities. (Ikehara 2006)	Seamounts and continental slope habitats with the greatest abundance between 200–310 m on hard bottom habitats with larger fish occupying relatively higher slope habitats than smaller fish. Adults in Hawaii form benthopelagic schools up to tens of meters off the bottom. In the Mariana Archipelago, it was caught between 155–320 m. Gonochoristic broadcast spawners that form spawning aggregations that coincides with warmer water temperatures. There is currently no information to suggest that they travel great distances outside a small home range. (Allen 1985; Everson et al. 1989; Misa et al. 2013; Weng 2013)
Paracaesio kuskarii	There is no specific information for this species. **Eggs:** All lutjanid eggs are pelagic, small (0.77–0.85 mm diameter) and spherical. **Larvae:** Larvae of lutjanids hatch at about 1.7–2.2 mm, and have a large yolk sac. (Leis 1987; Leis and Carson-Ewart 2004)	There is no specific information for this species.	Occurs over rocky bottoms at depths of 100–310 m. (Allen 1985; Carpenter and Niem 2001)

Species	Eggs/Larvae	Juvenile	Adult
Paracaesio stonei	There is no specific information for this species. **Eggs:** All lutjanid eggs are pelagic, small (0.77–0.85 mm diameter) and spherical. **Larvae:** Larvae of lutjanids hatch at about 1.7–2.2 mm, and have a large yolk sac. (Leis 1987; Leis and Carson-Ewart 2004)	There is no specific information for this species.	Bathydemersal; depth range 200–320 m. (Allen 1985; Fry et al. 2006)
Pristipomoides argyrogrammicus	There is no specific information for this species. **Eggs:** All lutjanid eggs are pelagic, small (0.77–0.85 mm diameter) and spherical. **Larvae:** Larvae of lutjanids hatch at about 1.7–2.2 mm, and have a large yolk sac. (Leis 1987; Leis and Carson-Ewart 2004)	There is no specific information for this species.	Occurs over rocky bottoms at depths between about 70–300 m. In the Mariana Archipelago, it was caught between 183–293 m during surveys. (Allen 1985; Ralston and Williams 1988)

Species	Eggs/Larvae	Juvenile	Adult
Pristipomoides auricilla	**Eggs:** pelagic, spherical, and small (0.77–0.85 mm). **Larvae:** pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. Larvae remain planktonic to at least 54 mm. (Leis and Lee 1994; Leis and Carson-Ewart 2004)	There is no specific information for this species.	Seamounts and continental slope habitats and generally occur over rocky reefs and hard bottoms at depths between 90–360 m but are most abundant between 180–270 m. In the Mariana Archipelago, it is frequently caught between 90–270 m. They form small to medium-sized benthopelagic schools that swim relatively close to the bottom. Gonochoristic broadcast spawners that form spawning aggregations that coincides with warmer water temperatures. (Allen 1985; Ralston and Williams 1988)

Species	Eggs/Larvae	Juvenile	Adult
Pristipomoides filamentosus	**Eggs:** pelagic, spherical, and small in size (0.77–0.85 mm). **Larvae:** pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. Larvae remain planktonic to at least 54 mm. A PLD of 60–180 days was suggested which is based on estimated ages of juveniles from other studies. Juveniles first appear in juvenile habitat at 70–100 mm FL. (Moffitt and Parrish 1996; Leis and Lee 1994; Leis and Carson-Ewart 2004).	Juveniles occupy nursery areas consisting of flat, featureless, sandy substrate in shallow water (30 m) for the first two years before moving into adult habitats. (Misa et al. 2013; Parish 1989; Parrish et al. 2015)	Seamounts and continental slope habitats. Adult greatest abundance is between 90–210 m on hard bottom, low slope habitats. In the Mariana Archipelago, it was caught between 110–229 m during surveys. They utilize mostly physical habitats that are abundant and not easily disturbed. Individuals are found in areas of high relief at depths of 100–400 m, and at night, they migrate into shallower flat, shelf areas, where they are found at depths of 30-80 m. Gonochoristic broadcast spawners that form spawning aggregations which coincides with warmer water temperatures. (Allen 1985; Misa et al. 2013; Moffitt and Parrish 1996; Parrish 1989; Parrish et al. 1997; Ralston and Williams 1988; Ziemann and Kelley 2004)
Pristipomoides flavipinnis	**Eggs** are pelagic, spherical, and small (0.77–0.85 mm). **Larvae**: pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. (Leis and Carson-Ewart 2004)	There is no specific information for this species.	Generally occur over rocky reefs and hard bottoms at depths between 90–360 m but are most abundant between 180–270 m. In the Mariana Archipelago, it was caught between 123–274 m during surveys. Gonochoristic broadcast spawners that form spawning aggregations that coincides with warmer water temperatures. (Allen 1985; Ralston and Williams 1988)

Species	Eggs/Larvae	Juvenile	Adult
Pristipomoides multidens	There is no specific information for this species. **Eggs:** All lutjanid eggs are pelagic, small (0.77-0.85 mm diameter) and spherical. **Larvae:** Larvae of lutjanids hatch at about 1.7-2.2 mm, and have a large yolk sac. Individuals of Pristipomoides remain pelagic to considerable size. (Leis 1987; Leis and Lee 1994; Leis and Carson-Ewart 2004)	Juveniles were found in flat, featureless, sandy habitats in mixed schools with *Nemipterus* sp. in areas distinctly separate from the adult habitats. (Newman et al. 2016)	A schooling fish that inhabits hard bottom areas with vertical relief and large epibenthos. Depth ranges from 60 to at least 200 m and are concentrated in depths from 80–150 m. (Newman et al. 2000)
Pristipomoides sieboldii	**Eggs**: pelagic, spherical, and small in size (0.77–0.85 mm). **Larvae**: pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. Larvae remain planktonic to at least 54 mm. (Leis and Lee 1994; Leis and Carson-Ewart 2004)	There is no specific information for this species.	Seamounts and continental slope habitats with the greatest abundance between 180–270 m but no affinity to a specific habitat; however, a habitat shift to hard bottom, high slope from other habitat types was observed within the size class of 25–35 cm. In the Mariana Archipelago, it was caught between 146–274 m during surveys. Often observed in large schools. Gonochoristic broadcast spawners that form spawning aggregations that coincides with warmer water temperatures. (Allen 1985; Misa et al. 2013; Ralston and Williams 1988)

Species	Eggs/Larvae	Juvenile	Adult
Pristipomoides zonatus	**Eggs**: pelagic, spherical, and small in size (0.77–0.85 mm). **Larvae**: pelagic and distributed off the edge of continental shelves and offshore from oceanic islands. (Leis and Carson-Ewart 2004)	Juveniles are thought to settle directly in adult habitats and were observed very close to the bottom either solitary or in small groups. (Kelley et al. 1997)	Seamounts and continental slope habitats with a preference for hard substrate and high slopes such as escarpments with high vertical relief. Preferred depth in Hawaii is 200–259 m and at Johnston Atoll 215–250 m. In the Mariana Archipelago, it was caught between 128–293 m during surveys. Gonochoristic broadcast spawners that form spawning aggregations that coincides with warmer water temperatures. (Allen 1985, Misa 2008, Ralston and Williams 1988)

Recent EFH Reviews

There have been no EFH reviews completed by the Council in 2021 or 2022. A review of the biological components of crustacean EFH in Guam and Hawaii was finalized in 2019 (WPFMC 2020). The non-fishing and cumulative impact components of EFH were reviewed in 2016 through 2017 for the region, which can be found in Minton (2017).

Ongoing Projects Relevant to EFH

American Samoa

No field work related to EFH was conducted in American Samoa in 2021.

A Council Scientific and Statistical Committee (SSC) working group and NMFS Pacific Islands Fisheries Science Center (PIFSC), American Samoa Department of Marine and Wildlife Resources (DMWR), and Council staff held two remote data evaluation workshops to improve information used in the bottomfish stock assessment. PIFSC also completed a thorough evaluation of all published reports related to life history and habitat (depth, substrate, feeding) for BMUS species of shallow and deep water snappers found in American Samoa. None of the data summarized in these reports would support changes to the current EFH levels of information for American Samoa bottomfish.

Moving forward, a collaborative effort between the PIFSC Life History Program and American Samoa will take place in Tutuila and the Manu'a Islands as soon as travel and other research efforts resume. This plan would lead to shore-based bottomfish research by working with fishers to sample their catch to provide life history (e.g., growth rate, size-at-maturity), population dynamics (e.g., mortality rate), and ecological (e.g., how the life history and population dynamics vary over space and time) information for a variety of economical, recreational, and subsistence valued deepwater snappers. Parts of this work would contribute to the understanding of bottomfish habitats in American Samoa.

Mariana Archipelago

The PIFSC Ecosystem Science Division conducted the NOAA's National Coral Reef Monitoring Program (NCRMP) - Pacific Region surveys aboard the NOAA Ship *Rainier*, which provides scientific information to support ecosystem approaches to the management and conservation of coral reefs. Diver-based surveys include fine-scale, rapid ecological assessment (REA) surveys of reef fishes and corals, as well as surveys to monitor nearshore physical and ecological factors associated with ocean acidification and general water quality, including data on water temperature, salinity, and other physical and biological characteristics of the coral reef environment using an assortment of oceanographic sampling and monitoring instruments, including systems deployed from the ship and underwater moored instruments. Survey areas include reef areas around Guam and the Northern Mariana Islands of Rota, Aguijan, Tinian, Saipan, Sarigan, Zealandia Bank, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug, Supply Reef, and Farallon de Pajaros. Since its inception in 2000, NCRMP-Pacific (formally known as Pacific Reef Assessment and Monitoring Program, or RAMP) established baseline ecosystem assessments and conducted long-term monitoring that integrates biological observations with oceanographic data as part of a long-term NOAA effort to monitor the status and trends of U.S. coral reef ecosystems. This cruise was delayed due to COVID, and the cruise departed in March 2022.

Research is ongoing to analyze a synthesized dataset (i.e., federal and jurisdictional data) to look at trends in benthic communities over space in time across the Mariana Archipelago. In 2022, the response of fish communities will be layered on top of this effort. A group of PIFSC staff is analyzing changes in benthic and fish composition across the Pacific Remote Island Area (PRIA). There is particular interest in both of these projects to determine the variance in response to bleaching events.

Ongoing life history research is examining spatial variability along latitudinal gradients in the Mariana Archipelago. The research plans to identify spatial variability in life history parameters across the archipelago and provide insights into how fish may respond to climate change as well as specific extreme thermal events. Creation of multiple individual time series (i.e., chronologies) for a complex of species (e.g., deepwater snappers, coral reef fish, coral). This research is using samples collected by the PIFSC Commercial Fishery Biosampling Programs on Guam and Saipan and research surveys. Continuing research surveys to the northern islands is necessary to advance this research.

Main Hawaiian Islands

PIFSC recently developed a statistical EFH-modeling framework. This EFH modeling framework consists of (1) spatiotemporal predictive-process generalized linear mixed-effects models and (2) an advanced environmental data summary (EDS) tool that can subset, extract, and summarize satellite and other oceanographic-related data from a remote ERDDAP server (e.g., sea surface temperature, chlorophyll-*a*) at various spatial and temporal scales or resolutions. The EFH framework can quantify spatiotemporal changes in target density and biomass (i.e., species or functional group level abundance or biomass) as a function of various environmental drivers. On July 12–14, 2022, these EFH model results underwent review at a WPSAR Review Panel Discussion with external reviewers and public audiences. PIFSC's EFH modeling framework has been approved and recommended by the WPSAR Panel with caveats on input data.

EFH Research and Information Needs

According to the annual SAFE reports (WPFMC 2022a; WPFMC 2022b), the Council identified the following scientific data which are needed to more effectively address the EFH provisions for regional bottomfish fisheries:

- Inventory of marine habitats in the EEZ of the Western Pacific region;
- Data to obtain a better SPR estimate for American Samoa's bottomfish complex;
- Baseline (virgin stock) parameters (CPUE, percent immature) for the CNMI/Guam deep-water and shallow water bottomfish complexes;
- High resolution maps of bottom topography/currents/water masses/primary productivity; and
- Habitat utilization patterns for different life history stages and species.

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