DRAFT

Amendment to the Fishery Ecosystem Plan for the Hawai‘i Archipelago Including a Fishery Impact Statement

Refining Essential Fish Habitat for Main Hawaiian Islands Uku (*Aprion virescens*)

Regulatory Identification Number (RTID) 0648-XXXXX

November 14, 2023

Prepared by:

Western Pacific Fishery Management Council
1164 Bishop St., Suite 1400
Honolulu, HI 96813
and
National Oceanic & Atmospheric Administration
National Marine Fisheries Service
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg. 176
Honolulu, HI 96818

Cover Page

Amendment to the Fishery Ecosystem Plan for the Hawai‘i Archipelago Including a Fishery Impact Statement

Refining Essential Fish Habitat for Main Hawaiian Islands Uku (*Aprion virescens*)

Regulatory Identification Number (RITD) 0648-XXXXX

Responsible Federal Agency and Lead Regional Fishery Management Council	**Contact Information**
Responsible Agency National Oceanic & Atmospheric Administration National Marine Fisheries Service Pacific Islands Regional Office 1845 Wasp Blvd., Bldg. 176 Honolulu, HI 96818	Responsible Official Sarah Malloy Acting Regional Administrator Tel. (808)725-5000 Fax: (808)725-5215
Regional Fishery Management Council Western Pacific Fishery Management Council 1164 Bishop Street, Suite 1400 Honolulu, HI 96813	Council Executive Director Kitty M. Simonds Tel: (808)522-8220 Fax: (808)522-8226

Abstract

The Western Pacific Fishery Management Council (Council) is considering a revision to its essential fish habitat (EFH) for uku, or green jobfish, *Aprion virescens*, in the Fishery Ecosystem Plan (FEP) for the Hawai‘i Archipelago (Hawaii FEP). The Magnuson-Stevens Conservation and Management Act defines EFH as "those waters and substrate that are necessary for fish spawning, breeding, feeding, and growth to maturity" and requires NMFS and the Council to minimize adverse impacts on EFH to the extent practicable while identifying actions to encourage the conservation and enhancement of EFH. The habitat designation is to be reviewed periodically, and regulatory guidelines exist to help regional fishery management councils develop EFH components for their fishery management plans (FMPs) and FEPs. For uku, EFH was initially designated for bottomfish in a 1999 omnibus amendment to the Bottomfish and Seamount Groundfish FMP. This was adopted in the Hawaii FEP, and in 2016, Amendment 4 to the Hawaii FEP refined descriptions of EFH by categorizing bottomfish into three assemblages (i.e., shallow, intermediate, and deep) and identifying EFH and habitat areas of particular concern for four life stages (i.e., egg, post-hatch pelagic, post-settlement, and sub-adult/adult).

Uku was the only remaining management unit species (MUS) in the shallow-water bottomfish assemblage following Amendment 5 to the Hawaii FEP, which reclassified the other MUS as ecosystem component species, but EFH was not revised at this time to be specific to uku. Additionally, two new habitat models for uku went through the Western Pacific Stock Assessment Review process in 2022, were determined to be the best scientific information available, and are now available for management use. The Council preliminarily recommended a

framework amendment to revise main Hawaiian Island sub-adult and adult uku EFH based on this new information to update the text descriptions and representative maps that describe EFH.

The Council, at its 197th meeting, is considering final action to revise EFH for uku in the Hawaii FEP. The Council will consider the following alternatives:

1. No Action;
2. Amend the Hawai‘i FEP to update EFH descriptions and maps for subadult and adult uku in the Main Hawaiian Islands using best scientific information available;
    a. Revise EFH descriptions and maps based on presence/absence model outputs from 0 to 300 m supplemented by information from relevant literature (preliminarily preferred);
    b. Revise EFH description and maps using density model outputs from 0 to 30 m and presence/absence model outputs from 30 to 300 m, supplemented by information from relevant literature.

How to Comment

Instructions on how to comment on this document and the associated proposed rule can be found by searching on RTID 0648-XXXXX at www.regulations.gov or by contacting the responsible official or Council at the above address. Comments are due on the date specified in the instructions.

ABBREVIATIONS

ACL – Annual Catch Limit
ACT – Annual Catch Target
AM – Accountability Measure
APAIS – Access Point Angler Intercept Survey
ASFC – NMFS Alaska Fisheries Science Center
B – Biomass
BMUS – Bottomfish Management Unit Species
BRT – Boosted Regression Tree
BRUV – Baited Remote Underwater Video
BSIA – Best Scientific Information Available
CE – Categorical Exclusion
CIA – Cumulative Impact Analysis
CFR – Code of Federal Regulations
CHTS – Coastal Household Telephone Survey
CML – Commercial Marine License
Council – Western Pacific Fishery Management Council (also WPFMC)
CPUE – Catch Per Unit Effort
CV – Coefficient of Variation
DLNR – Hawai'i Department of Land and Natural Resources
ECS – Ecosystem Component Species
EEZ – Exclusive Economic Zone
EFH – Essential Fish Habitat
F – Fishing Mortality
F_{MSY} – Fishing Mortality at MSY
F_{OFL} – Fishing Mortality used to calculate OFL
FAD – fish aggregating device
FEP – Fishery Ecosystem Plan
FES -- Fishing Effort Survey
FIS – Fishery Impact Statement
FMP – Fishery Management Plan
FR – *Federal Register*
HAPC – Habitat Areas of Particular Concern
HAR -- Hawai'i Administrative Rules
Hawai'i FEP – Fishery Ecosystem Plan for the Hawai'i Archipelago
HDAR – Hawai'i Division of Aquatic Resources
HMRFS – Hawai'i Marine Recreational Fishing Survey
Magnuson-Stevens Act – Magnuson-Stevens Fishery Conservation and Management Act
MHI – Main Hawaiian Islands
MOUSS – Modular Optical Underwater Survey System
MRIP – NMFS Marine Recreational Information Program
MSST – Minimum Stock Size Threshold
MSY – Maximum Sustainable Yield
MUS – Management Unit Species

NCRMP – National Coral Reef Monitoring Program
NEPA – National Environmental Policy Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
NS – National Standard
NWHI – Northwestern Hawaiian Islands
OFL – Overfishing Limit
OTEC – Ocean Thermal Energy Conversion
PIFSC – NMFS Pacific Islands Fisheries Science Center
PIFSC-SAP – NMFS Pacific Islands Fisheries Science Center Stock Assessment Program
PIRO – NMFS Pacific Islands Regional Office
PMNM – Papahānaumokuākea Marine National Monument
RA – NMFS Regional Administrator
SAFE – Stock Assessment and Fishery Evaluation
SDM – Species Distribution Model
SPR – Spawning Potential Ratio
SSC – Scientific and Statistical Committee
SWAC – Seawater Air Conditioning
WPacFIN – Western Pacific Fisheries Information Network
WPFMC – Western Pacific Fishery Management Council (also Council)
WPSAR – Western Pacific Stock Assessment Review

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Background Information

As authorized by the Magnuson-Stevens Fishery Conservation and Management Act Magnuson-Stevens Act), the Western Pacific Regional Fishery Management Council (WPFMC, or the Council) and the National Marine Fisheries Service (NMFS) manage the fisheries for bottomfish in federal waters (the U.S. Exclusive Economic Zone, or EEZ) around the Hawaiian Islands in accordance with the Fishery Ecosystem Plan (FEP) for the Hawai‘i Archipelago (Hawai‘i FEP) and implementing regulations under Title 50 Code of Federal Regulations, Part 665 (50 CFR 665).

The proposed action pertains to the management of uku (green jobfish; *Aprion virescens*), a bottomfish species commonly harvested in Hawai‘i. Currently, the only active fisheries for uku in Hawai‘i occur in the main Hawaiian Islands (MHI), as historical bottomfish fisheries in the Northwestern Hawaiian Islands (NWHI) were closed by NMFS in 2009 in accordance with the provisions of Presidential Proclamation establishing the Papahānaumokuākea Marine National Monument and prohibiting commercial fishing therein (71 FR 51134, August 29, 2006).

1.1.1 Magnuson-Stevens Act Provisions on EFH

The Magnuson-Stevens Act defines essential fish habitat (EFH) as “those waters and substrate that are necessary for fish spawning, breeding, feeding, and growth to maturity.” This includes marine areas and their chemical and biological properties that are utilized by inhabiting organisms. Substrate includes sediment, hard bottom, and other structural relief, including manmade structures, underlying the water column as well as their associated biological communities.

Section 303(a)(7) of the Magnuson-Stevens Act and implementing regulations at 50 CFR 600.805 require that EFH be described and identified for federally managed species listed in FMPs (or FEPs) based on NMFS regulatory guidelines (67 FR 2376, January 17, 2002). As stated previously, the Magnuson-Stevens Act defines EFH and requires NMFS and the Council to minimize adverse fishing impacts on EFH to the extent practicable while identifying other actions to encourage the conservation and enhancement of EFH. Further, the Magnuson-Stevens Act requires federal agencies that authorize, fund, or undertake actions that may adversely affect EFH to consult with NMFS such that NMFS can provide conservation recommendations to federal and state agencies regarding these actions.

In 2002, NMFS published a final rule revising the regulations implementing EFH provisions of the Magnuson-Stevens Act (67 FR 2376, January 17, 2002). Subpart J of 50 CFR part 600 provides regulatory guidelines to assist regional fishery management councils in developing EFH components of their FMPs. Among these guidelines are 10 mandatory contents of FMPs (50 CFR 600.815(a)), which are as follows:

1. Description and identification of EFH;
2. Fishing activities that may adversely affect EFH;
3. Non-Magnuson-Stevens Act fishing activities that may adversely affect EFH;

4. Non-fishing related activities that may adversely affect EFH;
5. Cumulative impacts analysis;
6. Conservation/fishing impact recommendations;
7. Prey species;
8. Identification of habitat areas of particular concern (HAPC);
9. Research needs; and
10. Develop approaches to better integrate goals and objectives into habitat actions.

The NMFS regulatory guidelines also define the four-level system (50 CFR 600.815(a)(1)(iii)) used to organize the information necessary to describe and identify EFH:

- Level 1: Presence/absence data are available for some or all portions of the geographic range of the species.
- Level 2: Habitat-related densities of the species are available.
- Level 3: Growth, reproduction, or survival rates within habitats are available.
- Level 4: Production rates by habitat are available.

Councils should strive to describe habitat based on the highest level of detail, but EFH should not be designated in cases where there is no information available on a given species or life stage and habitat usage cannot be inferred from other means (50 CFR 600.815(a)(1)(iii)(B)).

Further, the NMFS guidelines recommend the Council identify EFH that is especially important to federally managed species as HAPC to help provide additional focus for conservation and management efforts. Identification of HAPC is based on one or more of the following considerations: the importance of the ecological function provided by the habitat; the extent to which the habitat is sensitive to human-induced environmental degradation; whether, and to what extent, development activities are, or will be, stressing the habitat type; and the rarity of the habitat type (50 CFR 600.815(a)(8)).

1.1.2 Current Uku EFH and HAPC in the Hawai‘i FEP

In 1999, the Council developed and NMFS approved Amendment 6 to the Bottomfish and Seamount Groundfish fishery management plan (FMP) (74 FR 19067, April 19, 1999) that defined EFH for Hawai‘i bottomfish, inclusive of uku.

As a part of the 2009 reorganization of the Council’s species-based fishery management plans (FMP) into spatially oriented FEPs (75 FR 2198, January 14, 2010), EFH definitions and provisions were carried forward. The Council also described HAPC in addition to and as a subset of EFH. Descriptions of HAPC were based on whether ecological function of the habitat is important, habitat is sensitive to anthropogenic degradation, development activities are or will stress the habitat, and/or the habitat type is rare.

In 2016, the Council developed and NMFS approved Amendment 4 to the Hawai‘i FEP (81 FR 7494, February 2, 2016), which refined the descriptions of EFH and HAPC for Hawai‘i Archipelago bottomfish management unit species (BMUS) by categorizing them into three assemblages (i.e., shallow, intermediate, and deep) and identifying EFH and HAPC for each group by life stage (WPFMC 2016). This review and revision occurred over seven years ago, and there have been recent studies furthering the foundational knowledge regarding uku habitat in the waters surrounding the Hawai‘i Archipelago (e.g., Franklin 2021; Tanaka et al. 2022). Section 3.2.6 contains the current description of HAPC, and HAPC are not being reviewed as part of this action. Current uku EFH is represented in **Table 1**, Figure 1, and Figure 2.

Table 1. Current EFH for shallow-water bottomfish, inclusive of uku, in the Hawai‘i FEP.

Egg	**Post-Hatch Pelagic**	**Post-Settlement**	**Sub-Adult/Adult**
Water column extending from the baseline to 50 nmi to a depth of 240 m.	Water column extending from the shoreline to the outer boundary of the EEZ to a depth of 240 m.	Water column and bottom habitat extending from the shoreline to a depth of 240 m isobath from the surface to a depth of 240 m.	

Source: WPFMC (2016).

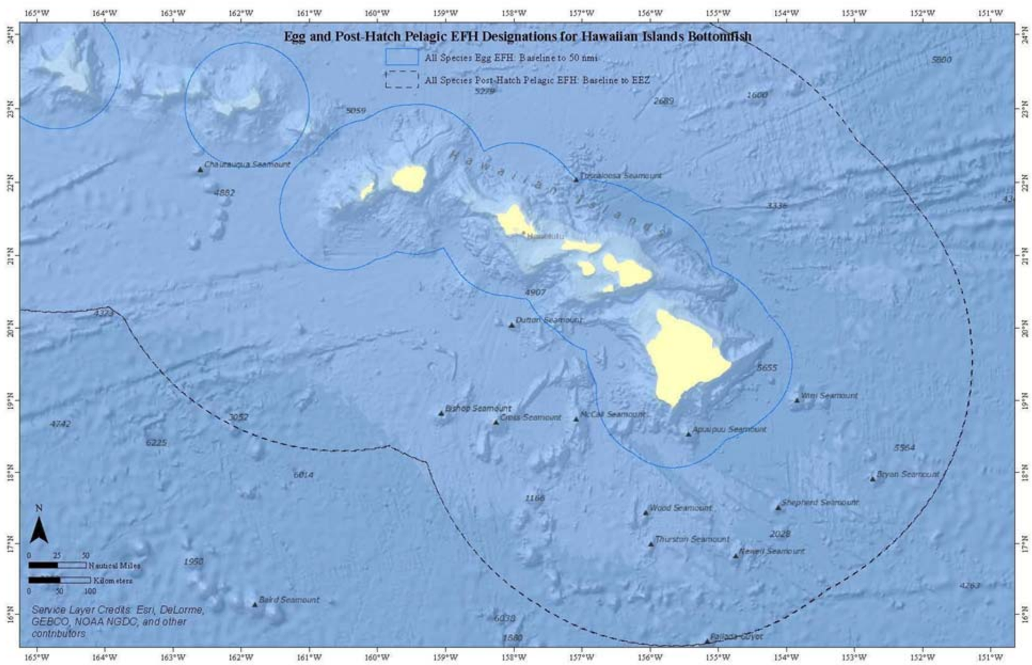

Figure 1. Map of current EFH for egg and post-hatch pelagic phases of MHI bottomfish (Source: WPFMC 2016).

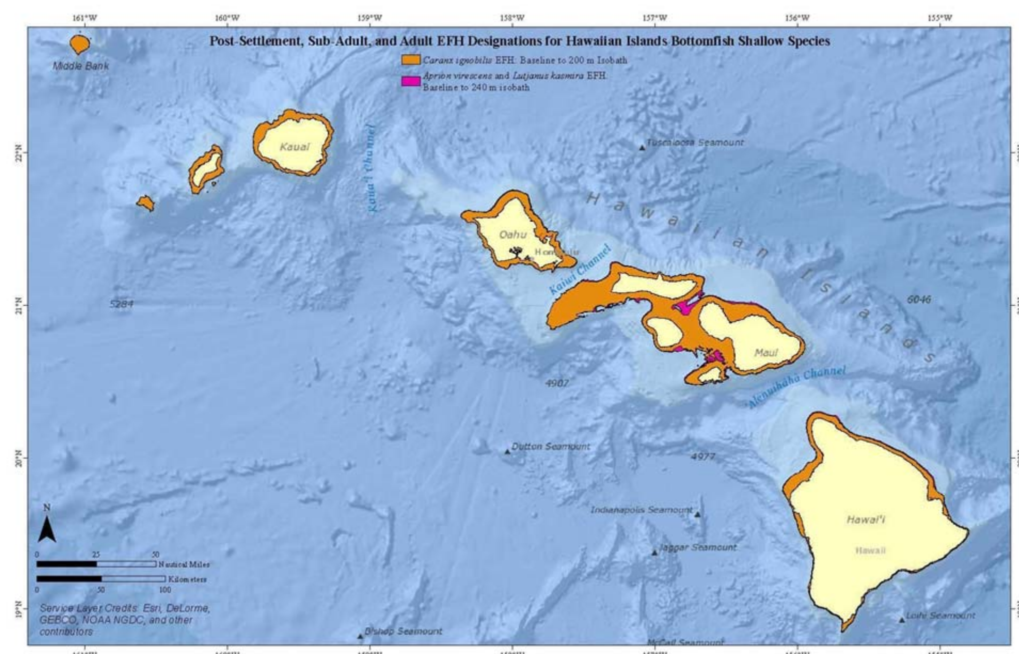

Figure 2. Map of current EFH for post-settlement, sub-adult, and adult life stages of MHI shallow-water bottomfish inclusive of designations for *Caranx ignobilis*, *Lutjanus kasmira*, and *Aprion virescens* (Source: WPFMC 2016).

1.1.3 Description of the fishery

Uku are a popular food fish in Hawaiʻi and are valued by both commercial and non-commercial fishers. As a food fish, uku are similar to some MHI Deep 7 bottomfish species (e.g., ʻopakapaka (*Pristipomoides filamentosus*), onaga (*Etelis coruscans*)) that are sought after for their firm and flavorful white flesh that can be cooked or consumed raw (WPFMC 2023). However, unlike the Deep 7 bottomfish, fishers do not typically harvest uku to fill the seasonal demand for whole fish during the holidays in Hawaiʻi due to the public's preference for red colored fish. Uku are commonly consumed by the hotel and restaurant industries that utilize it as a low-price alternative to Deep 7 bottomfish (WPFMC 2023). The uku fishery was previously managed as a member of the non-Deep 7 BMUS complex, grouped together with the white ulua (*Caranx ignobilis*), black ulua (*Caranx lugubris*), pig-lip ulua (*Pseudocaranx dentex*), and yellowtail kalekale (*Pristipomoides auricilla*) before these four species were reclassified from MUS to ecosystem component species (ECS) in the FEP in 2019 (84 FR 2767, February 8, 2019).

In Hawaiʻi, the uku fishery is important for both beginner and veteran fishers, with many targeting the species opportunistically during good weather, when they have live bait, or via trolling when transiting to and from a fishing ground (Ayers 2022). The MHI uku fishery utilizes several different gear types due to the wide range of depths and habitat types frequented by the species (WPFMC 2023). Uku are both preferentially targeted and caught incidentally by gears including deep-sea handlines, inshore handlines, trolling with bait, spearfishing, shore-based casting, and cast nets, with deep-sea handline being the historically dominant gear and especially in the commercial sector (WPFMC 2023). However, since 1965, catch using deep-sea handline gear has proportionally decreased as other gears have become more commonly reported; this may be indicative of a shift to fishers directly targeting uku with unique gears and/or techniques specifically aimed at the species (WPFMC 2023). Uku are typically targeted and harvested most heavily in May and June of each year during annual spawning aggregations along the Penguin Bank (Nadon et al. 2020), though fishers are still known to catch them year-round in relatively high numbers (WPFMC 2023). Additional information on fishery trends can be found in Section 3.1.2.

1.2 Proposed Action

The Council is considering a regulatory amendment to revise MHI sub-adult and adult uku EFH based on new best scientific information available (BSIA). The Council and NMFS periodically review the EFH provisions of the FEPs and revise or amend EFH provisions as warranted based on BSIA. All MUS must have EFH specified with a text description and representative maps.

At its 195th meeting in June 2023, the Council recommended initial action be taken to revise and update MHI uku EFH for sub-adults and adults based on two new, Western Pacific Stock Assessment Review (WPSAR)-reviewed EFH models. The WPSAR process resulted in both models being designated as BSIA and approved for management use. As a result, the Council may take final action to determine which alternative is most appropriate at this time to describe uku EFH. The alternatives are to retain the current EFH description and maps (Alternative 1), or to amend the Hawaiʻi FEP to update EFH descriptions and maps for subadult and adult uku in the MHI using BSIA (Alternative 2). Two sub-alternatives under Alternative 2 are based on the presence/absence model outputs only (Level 1 data; Franklin 2021) or an overlay of the presence/absence model outputs and the density model outputs (Level 2 data; Tanaka et al. 2022).

1.3 Purpose and Need

The purpose of this action is to amend the FEP to update the EFH descriptions and maps for sub-adult and adult uku in the MHI. The amendment will incorporate the new BSIA information for the EFH description. Doing so will comply with the NMFS regulatory guidelines (67 FR 2376, January 17, 2002) and provisions of the Magnuson-Stevens Act (50 CFR 600 Subpart J).

This action is needed to identify and describe EFH based on BSIA to allow NMFS to effectively conserve and manage habitat in support of sustainable fisheries management. The proposed action is a framework FEP amendment, although it is more administrative in nature; there will be no new regulations or changes to existing regulations.

1.4 Action Area

The action area is the state and federal waters throughout the MHI where fishing for uku occurs. In the MHI, uku primarily occur in waters from the surface down to 300 m deep around each of the islands and banks. Waters around the NWHI are not part of the action area because commercial fishing is prohibited in the Papahānaumokuākea Marine National Monument (50 CFR 404.6), and there is no new information available that would inform a revision of uku EFH in these waters; therefore, NWHI uku EFH will remain the same as described in Amendment 4 to the Hawai‘i FEP.

1.5 Decision(s) to be Made

After Council final action, this non-regulatory amendment and the associated CE will support a decision by the Regional Administrator (RA) of the NMFS Pacific Island Region, on behalf of the Secretary of Commerce, whether to approve, disapprove, or partially approve the Council’s recommendation.

1.6 Public Involvement

NMFS and the Council provided several opportunities to the public to provide input on refining the EFH designations for MHI uku in the Hawai‘i FEP. The scientific review of the habitat models under the WPSAR framework was announced in the *Federal Register*, was open to the public and provided opportunities for public comment. The development of the Council’s recommendations for refining designations of MHI uku EFH in the FEP took place over the course of several meetings of Council advisory bodies, Council Meetings, and the Scientific and Statistical Committee (SSC). Relevant meetings where the Council and its SSC discussed uku EFH are presented in Table 2. These meetings were announced in the *Federal Register* and on the Council’s website, and all meetings were open to the public with time set aside on their agendas for public comment. The public had an opportunity to comment on the proposed EFH for MHI uku at these meetings, and no public comment addressed this action at any of the listed meetings. Initially, an options paper was developed to provide an overview of the multiple combinations of the models under consideration. The options have been revised based on Council and SSC feedback and are now incorporated into the alternatives represented in this document.

Table 2. Meetings of the Council and its SSC during which the Council discussed the proposed action to refine uku EFH allowed the public to submit comments

Meeting	Date(s)	*Federal Register* Notice	Summary of Discussion and Recommendations
WPSAR	July 12-14, 2022	87 FR 38382	The WPSAR panel consisted of two scientists from the Center of Independent Experts and a member of the SSC. Panelists were instructed to review each of the two models presented (Franklin 2021; Tanaka et al. 2022) on their own merits to evaluate whether they provided information useful for management, rather than choose one over the other. Panelists provided critique and recommendations to the lead authors and concluded that each model provided sound scientific information to inform management.
148th SSC	June 14-16, 2023	88 FR 33867	The SSC discussed the methods by which fishery-dependent catch per unit effort CPUE data had been incorporated into an Option that is no longer under consideration. The SSC noted a preference for incorporating data inputs in a unified model with appropriate weighting for different data sources. The SSC discussed the utility of incorporating fishery dependent data, but there was no agreement among SSC members as to whether it was appropriate. The SSC recommended utilizing the model outputs providing Level 1 information (Franklin 2021) to refine uku EFH in the Hawaiʻi FEP, as specified under Option 2. The SSC noted that the Franklin (2021) model provides information encompassing the full range of the stock but also suggested that future approaches utilize the Level 2 model outputs.
195th Council	June 26-30, 2023	88 FR 33867	The Council discussed the regulatory implications of providing EFH sub-areas where there had previously been none, and whether the implementation of these sub-areas could lead to exclusions of nearshore areas that are heavily impacted by human activity, such as harbors. The Council noted their interest in implementing the model outputs for EFH given that they are BSIA. The Council recommended Option 2, which would refine uku EFH utilizing Level 1 data based on outputs of the presence/absence model by Franklin (2021), as its

Meeting	Date(s)	*Federal Register* Notice	Summary of Discussion and Recommendations
			preliminary preferred alternative. Relatedly, the Council directed staff to convene an Action Team to develop the FEP amendment for final action at its 197th meeting in December 2023. The Council also recommended NMFS PIRO to provide clarification on the application of EFH in the Papahānaumokuākea Marine National Monument (PMNM) and directed the Action Team to consider expanding the EFH refinement to the NWHI.

1.7 List of Preparers

Thomas Remington, Fishery Management Specialist, Lynker
Joshua DeMello, Fishery Analyst, Western Pacific Regional Fishery Management Council
Sean Hanser, Resource Management Specialist, NMFS PIRO
Savannah Lewis, Fishery Management Specialist, NMFS PIRO

1.8 List of Reviewers

Kisei Tanaka, Research Marine Biologist, NMFS PIFSC
Justin Suca, Quantitative Fish Ecologist, NMFS PIFSC
Jonathan Whitney, Marine Ecologist, NMFS PIFSC
Brett Schumacher, Fish and Wildlife Administrator, NMFS PIRO

2 DESCRIPTION OF ALTERNATIVES CONSIDERED

2.1 Development of the Alternatives

The alternatives under consideration by the Council were developed in coordination with NMFS PIFSC, NMFS PIRO, and Hawaiʻi Division of Aquatic Resources (HDAR). A review of past EFH descriptions and updates was performed in conjunction with a review of all of the EFH components to determine if and where an update to the current descriptions was needed. New BSIA in the form of ecological models were approved for use through the WPSAR process (WPFMC 2022). Together, the review of information and new BSIA models were used to develop Alternative 2 and its two sub-alternatives; the sub-alternatives represent two different uses of the BSIA models.

2.2 Description of the Alternatives

Three total alternatives were developed to evaluate a range of management options: a baseline of no Federal action (Alternative 1), revising EFH based on presence-absence model information (Alternative 2a), and revising EFH based on an overlay of presence-absence and density model information (Alternatives 2b). These alternatives are described in detail and evaluated below.

2.2.1 Alternative 1: No Action (Status Quo)

Under Alternative 1, the Council would not recommend amending the Hawaiʻi FEP to revise sub-adult and adult uku EFH text descriptions and maps in the MHI. The existing MHI uku EFH designations, as described in Section 1.1.2 and Table 1, were last reviewed in 2016 as part of the shallow-water bottomfish species complex in the Hawaiʻi FEP. The 2016 version would persist with no changes. This designation specifies EFH for sub-adult and adult MHI uku as the water column and bottom habitat extending from the shoreline to the 240 m isobath from the surface to a depth of 240 m.

Expected Outcomes

The status quo alternative would result in no changes to the EFH description for sub-adult and adult uku in the Hawaiʻi FEP management area around the MHI. Federal agencies authorizing or funding activities in this area that may affect uku EFH would still be required to consult with the NMFS Habitat Conservation Division to identify recommended measures, if necessary, to mitigate impacts to EFH that are more than minimal or not temporary. These consultations would be based on uku EFH in the MHI as described in Amendment 4 to the Hawaiʻi FEP (WPFMC 2016). There would be no impacts to the MHI uku stock or the associated fishery, but the quality of EFH consultations may be lessened through the usage of habitat information that is not the BSIA. Uku stocks could be adversely affected by federal actions in the marine environment beyond 240 m deep, because new models used in Alternative 2 suggest uku populations may occasionally inhabit depths up to 300 m. Additionally, this alternative does not utilize BSIA as required under NS2 and 50 CFR 600.815(a).

2.2.2 Alternative 2: Amend the FEP to revise uku EFH in the MHI

Alternative 2 recommends amending the FEP to revise sub-adult and adult uku EFH text descriptions and maps in the MHI and makes some small administrative changes. The two sub-alternatives below use the BSIA models (Franklin 2021 and Tanka et al. 2022) discussed in Section 2.1.1 in two different ways to help designate uku EFH. Under each sub-alternative, all Magnuson-Stevens Act requirements other than those pertaining to EFH would be unchanged, including those associated with HAPC, stock status, fishery and bycatch monitoring, human communities, and annual catch limit and accountability specifications. The EFH designations for egg and post-hatch pelagic (i.e., larval) phases of uku would remain as specified in Amendment 4 to the Hawaiʻi FEP; proposed revisions to uku EFH in the MHI are limited to the subadult and adult life stages for the species.

The proposed revisions under each of the presented sub-alternatives would not remove or add any EFH from the FEP that is not either already covered by uku or other FEP BMUS EFH designations. Additionally, none of the options presented here would identify new HAPC or revise any HAPC currently listed in Section 3.2.6 of the Hawaiʻi FEP.

2.2.2.1 EFH Revisions

To provide an updated and revised description of uku EFH, the team preparing this document reviewed the 2009 FEP (WPFMC 2009); amendments to the Hawaiʻi FEP (WPFMC 2016, 2018); the new distribution models of uku subadults and adults (Franklin in 2021; Tanaka et al.

2022); a recent uku stock assessment (Nadon et al. 2020); literature on uku diet, general snapper ecology, and threats to marine habitat; and ongoing studies on the distribution of various life stages of uku. Relevant information from the review was synthesized to designate uku EFH that considers where the species occurs and habitat that is required to maintain a viable population of uku that can be harvested sustainably. EFH includes habitat that may have indirect effects on uku and could provide important ecological functions such as supporting the persistence of prey, forage, predators, and community structure (Sandlin et al. 2010; Pinnegar et al. 2000) and moderating or causing variability in environmental quality, such as water quality (Colin et al. 2017; Bantilan-Smith et al. 2008) and habitat structuring species (Edmunds & Gray 2014; Ault & Johnson 1998; Harmelin-Vivien 1994).

Revised EFH text is shown in Table 3. A new map for post-settlement uku was created using the original EFH description as described in Amendment 4. The original map (Figure 2) included post-settlement and subadult/adult uku in the same map. To provide all of the EFH descriptions and maps in one location, the original map was recreated and is presented as Figure 3 below. No new information is available at this time for post-settlement uku. Additionally, there is an administrative wording update to change ‘baseline’ to ‘shoreline’ for accuracy and consistency purposes. Additionally, the ‘shallow-water complex’ language will be removed and simply referred to as ‘uku’ due to Amendment 6 to the Hawaiʻi FEP reclassifying all other shallow-water complex species as ECS; ECS species do not have EFH designated for them.

Table 3. Revised EFH text description for uku in the FEP for the MHI.

	Egg	**Post-Hatch Pelagic**	**Post-Settlement**	**Sub-Adult/Adult**
Revised in proposed Amendment?	No	No	No	Yes
Description	Water column extending from the shoreline to 50 nmi to a depth of 240 m.	Water column extending from the shoreline to the outer boundary of the EEZ to a depth of 240 m.	Water column and bottom habitat extending from the shoreline to a depth of 240 m isobath from the surface to a depth of 240 m.	Benthopelagic zone, including all bottom habitats, in depths from the surface to 300 m bounded by the shoreline and the 300 m isobath

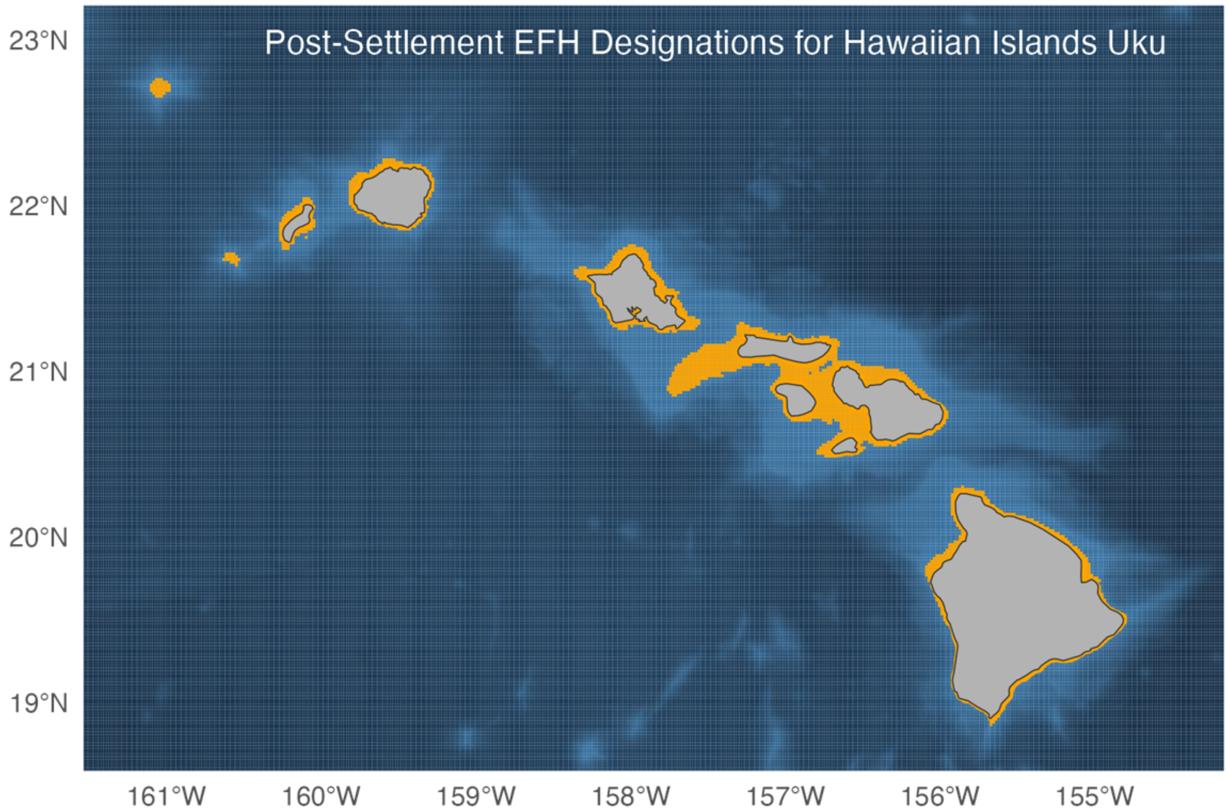

Figure 3. Updated post-settlement map for MHI Uku EFH. No new data was used to generate this map, but the sub-adult and adult overlay was removed. Shallow-water bottomfish ECS were also removed.

2.2.2.2 EFH Models for Sub-Adult and Adult Uku

From July 12-14, 2022, the Council and NMFS convened a peer-review WPSAR process for recently developed Level 1, presence/absence, (Franklin 2021) and Level 2, density, (Tanaka et al. 2022) models to improve the delineation of uku EFH within the MHI (87 FR 38382, June 28, 2022). Neither study examined uku egg or larval abundance, nor post-settlement of uku. Instead, both models focused on EFH for sub-adult, and adult life stages for the species (WPFMC 2022).

The Level 1 EFH model, or presence/absence model, developed by Franklin in 2021, provides estimates of uku relative occupancy using a species distribution model (SDM) based on boosted regression trees (BRT). BRT is a machine learning technique that combines decision trees to classify data and predict complex relationships in datasets. This BRT model utilized fishery-independent presence-absence data from both shallow waters collected through diver surveys in depths less than 30 m and deep waters collected through baited remote underwater video (BRUV) surveys between 45 to >300 m. The BRUV surveys employed specialized underwater video equipment such as the “BotCam” and the Modular Optical Underwater Survey System (MOUSS). By incorporating data from both shallow and deep waters, this approach covers the known vertical habitat range of uku. This model can be integrated with existing published information to enhance the delineation of uku EFH for management purposes. However, it is important to note that there is a challenge due to spatial discontinuity. Two separate BRT models were independently calibrated to estimate uku occurrence in shallow and deep waters (WPFMC 2022). To create the single Level 1 model, these two BRT models were placed side by side to describe the range that the sampling methods covered. The edges of the two models have not been integrated or interpolated.

The Level 2 EFH model, or density model, developed by Tanaka et al. (2022), offers uku relative density estimates based on a statistical generalized additive mixed model. For the EFH density analysis, the fishery-independent diver survey data from 2010 to 2019 was utilized. This data was chosen due to its large spatial coverage and standardized uku density, measured as the number of individuals per 100 m^2. No other data source possesses the same level of spatial coverage and standardization as the diver survey data, thus making it the sole option for the EFH density analysis. However, it is important to note that this model only generates uku density estimates for shallow-water areas ranging from 0 to 30 meters. Consequently, while the EFH density analysis employs a statistically robust method for estimating uku density, the source data does not represent the complete habitat utilization of the species in the MHI, which is crucial for delineating EFH boundaries (WPFMC 2022). However, a major strength of the model is it uses Level 2 data for predicting the spatially and temporally dynamic distribution of uku EFH, enabling the analysis of potential shift, emergence, or disappearance of EFH distribution.

The WPSAR process determined that both the presence-absence and density approach represent a great improvement over existing literature based descriptions of uku EFH (WPFMC 2005; WPFMC 2016; WPFMC 2022). However, it was also noted that the fishery independent data sources utilized for the presence/absence and density modeling approaches generally represent low encounter rates of uku relative to other species and may not necessarily provide estimates at a resolution fine enough to model EFH (WPFMC 2022). In shallow water (0-30 m) where diver surveys are conducted, uku occurrence can be rare, potentially leading to downward bias in observations. These factors result in low probabilities of occurrence being used to designate EFH (see Appendix A for maps and further discussion). In deeper surveys, the deployments are heavily concentrated in waters that are deeper than typical uku distributions and are focused on the bottom (as does the diver survey). This creates an issue for a bentho-pelagic species like uku that may be present at a given location but be missed due to its presence higher in the water column than where the observations are occurring.

At its 145th meeting from September 13-15, 2022 (87 FR 53732), the Council's SSC received a report on the WPSAR external review of the EFH models for MHI uku. The SSC endorsed the WPSAR recommendations and determined both models to be BSIA. Subsequently, at its 192nd meeting from September 20-22, 2022 (87 FR 53732), the Council approved the WPSAR report and directed staff to determine if the models could be used to refine the identification and description of uku EFH in the FEP.

In addition to identifying and describing uku EFH in the MHI using these models, additional thresholds of EFH for the species would be identified (i.e., top 25 percent and 50 percent, EFH hot spots and core EFH, respectively) to better describe ecologically meaningful areas for which mitigation of adverse impacts to uku and its habitat could be prioritized during federal agency consultations. The additional thresholds of EFH were adopted from the NOAA NMFS Alaska

Fisheries Science Center (AFSC). The AFSC offers two distinct definitions of EFH: firstly, as the area inhabited by 95 percent of a species' population, and alternatively, as the area that contains 95 percent of the occupied habitat. More recent species distribution modeling approaches define EFH as the area that encompasses the top 95 percent of the species' predicted occurrences or abundance (Laman et al. 2022; Harris et al. 2022). For the purpose of designating EFH for uku in the MHI, EFH is defined as the spatial domain that contains 95 percent of the predicted uku presence (Level 1) or density (Level 2). However, it is critical to note that these standards were developed in a region where target species are observed at much higher density over a longer survey period than uku are in the MHI. As a result, many regions may qualify as EFH under the 95 percent, 75 percent, and 50 percent thresholds for uku despite models predicting extremely low probability of occurrence. Refinement of EFH classification for rare or poorly surveyed species is needed, though these methods are used at present due to lack of alternative designation pathways.

2.2.2.3 Alternative 2a: Revise uku EFH in the MHI based on only Presence-Absence Information (Preliminarily Preferred)

Under Alternative 2a, the Council would recommend amending the FEP to revise uku EFH in the MHI based on the products of the Level 1, or presence-absence, EFH model developed by Franklin (2021) as shown in Figure 4, and supplemented by additional relevant information from peer-reviewed literature. The existing EFH text-based descriptions and maps, based only on qualitative data, would be revised using the model visualizations of uku EFH in the MHI (Figure 4). EFH is defined as the spatial domain containing 95 percent of predicted uku occurrence (Level 1). Areas with predicted uku occurrence or abundance below the 5 percent quantile were discarded, as these areas are considered to be below the EFH threshold. The model based EFH outputs were plotted with a resolution of 0.01 degrees. Descriptions of EFH for other life stages of uku (i.e., egg, post-hatch pelagic, and post-settlement) would remain exactly as they were approved in the Council's Amendment 4 to the Hawaiʻi FEP in 2016 because there is no new data for these life stages (Table 3). This option would not implement revisions to EFH designations for MHI uku associated with the density modeling products developed by Tanaka et al. (2022), also identified as BSIA.

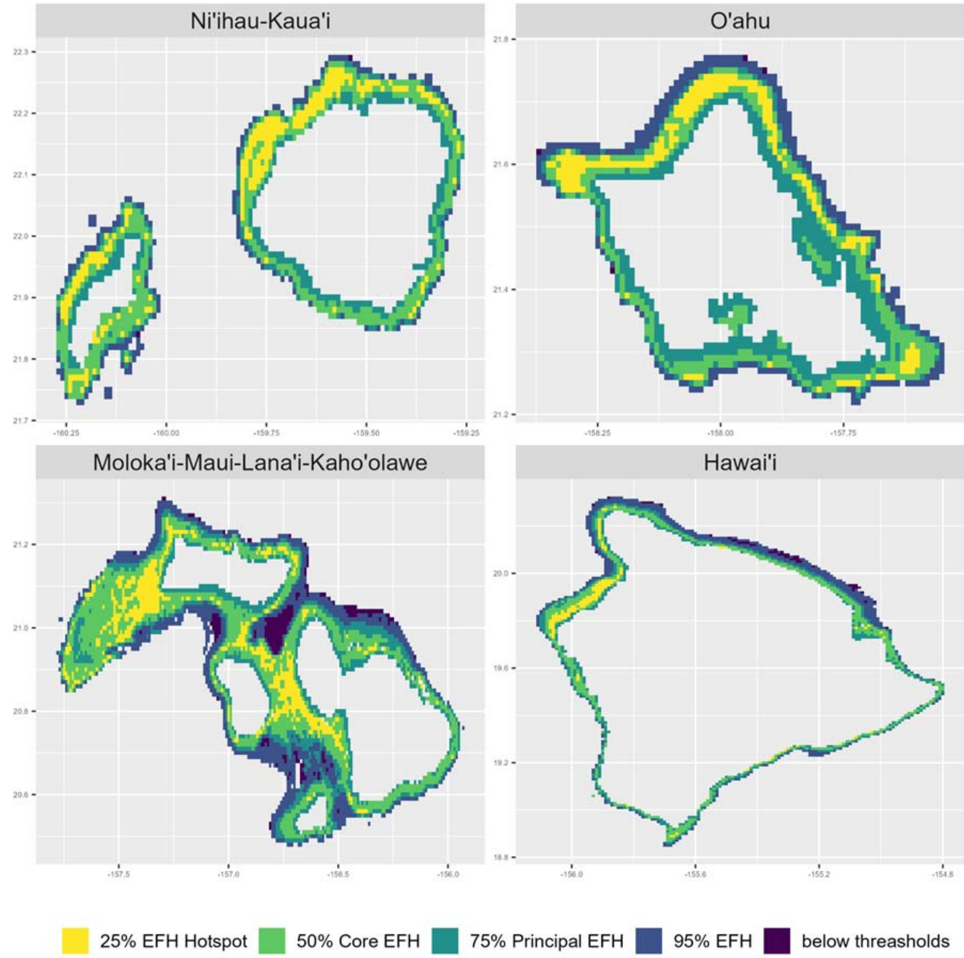

Figure 4. EFH Level 1 map for subadult and adult uku in the main Hawaiian Islands. EFH is defined as the area with model derived presence probabilities greater than 5 percent (i.e., the top 95 percent of occupied habitat) from a boosted regression tree model developed by Franklin (2021). EFH subcategories are also identified as areas of the top 25 percent (EFH hot spots), top 50 percent (core EFH area), and top 75 percent (principal EFH area). EFH classifications are presented with a 0.01-degree decimal resolution.

Expected Fishery Outcomes

Alternative 2a would revise the existing text based EFH descriptions and maps for the species and improve EFH designations based on new data and a model. The use of the presence-absence model products would not result in a reclassification of EFH data under Magnuson-Stevens Act, as the EFH designations for uku are currently considered Level 1, or presence-absence. The proposed revisions to EFH under Alternative 2a would require no regulatory changes, and changes to management resulting from revising uku EFH are not expected.

The total area defined as EFH for uku in the MHI is similar to the current footprint of uku EFH in the MHI with additional spatial delineation to identify ecologically meaningful areas for sub-adult and adult uku. The total change in the EFH footprint would increase by approximately 643 km^2. Because the EFH area for Deep 7 bottomfish around the MHI extends to the 400 m isobath and this alternative only proposes changing uku EFH to extend to the 300 m isobath, the area in which action agencies would need to consult with NMFS on impacts to EFH would not change. Federal agencies that conduct, authorize, or fund activities in the area would still be required to consult with NMFS Habitat Conservation Division to identify recommended conservation measures, if necessary, to mitigate impacts to EFH that are more than minimal or not temporary. The Council does not expect Alternative 2a to result in significant overall impacts.

2.2.2.4 Alternative 2b: Revise uku EFH based on an overlay of Presence-Absence and Density Information

Under Alternative 2b, the Council would recommend amending the FEP to revise uku EFH in the MHI based on an overlay of outputs from both the presence/absence EFH models developed by Franklin (2021) and the density model developed by Tanaka et al. (2022), as shown in Figure 5 and Figure 6, and supplemented by additional relevant information from peer-reviewed literature. EFH is defined as the spatial domain containing 95 percent of predicted uku occurrence (Level 1) or abundance (Level 2). Areas with predicted uku occurrence or abundance below the 5 percent quantile were discarded, as these areas are considered to be below the EFH threshold. The model based EFH outputs were overlaid on top of each other with a resolution of 0.01 degrees. In its EFH designation, the Council would utilize density information where it is available, generally from 0 to 30 m. Where density information is not available, presence-absence information would be employed, generally from 30 to 300 m. In this way, EFH would be based on outputs from each BSIA EFH model using an overlay method rather than combining them (e.g., using a weighted average or similar integration approach).

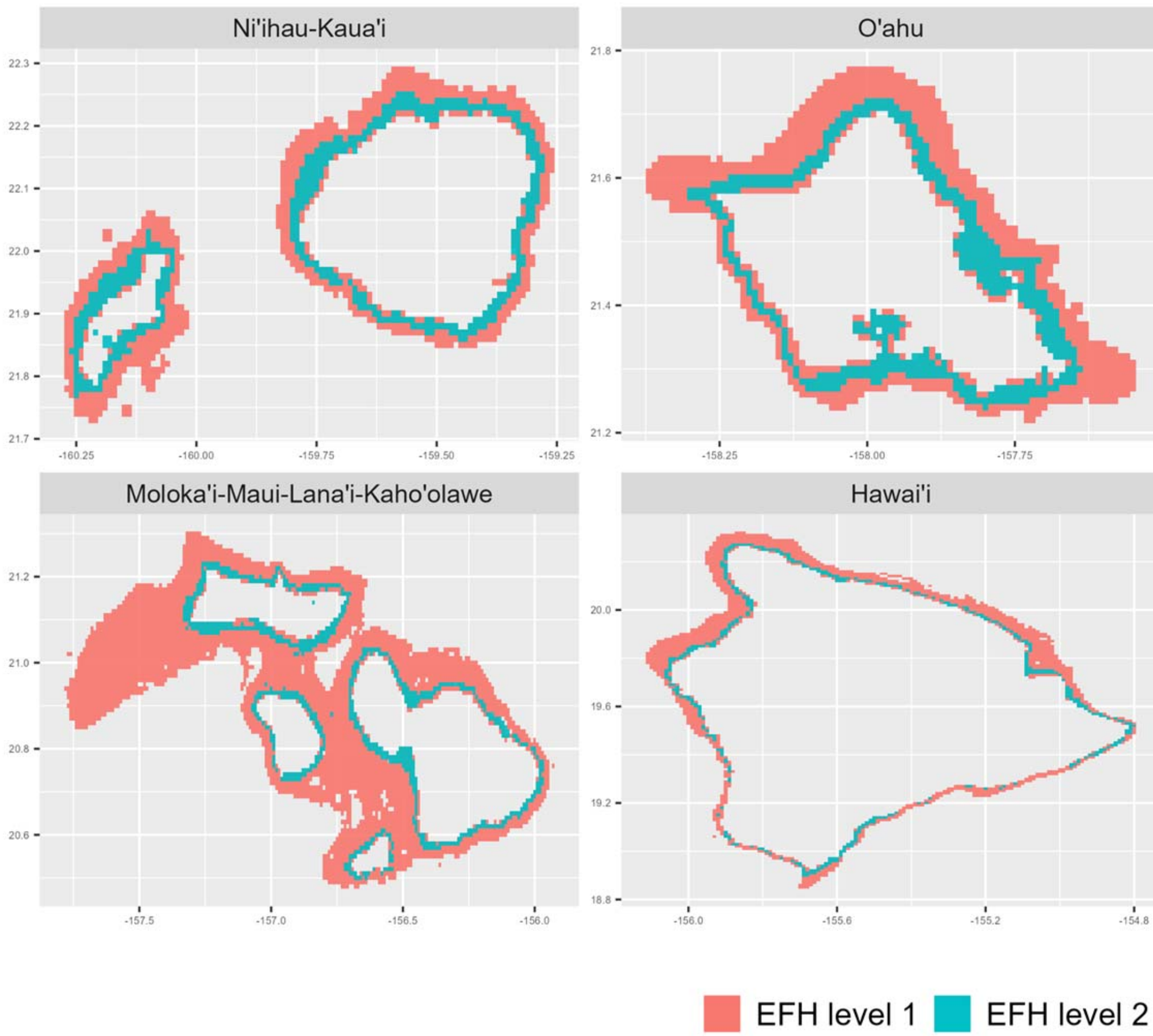

Figure 5. Overlay of spatial extent of EFH from both the presence/absence (Level 1) and density (Level 2) models developed by Franklin (2021) and Tanaka et al. (2022). EFH is defined as the top 95 percent of habitat defined as model estimated occupancy or density greater than 5 percent.

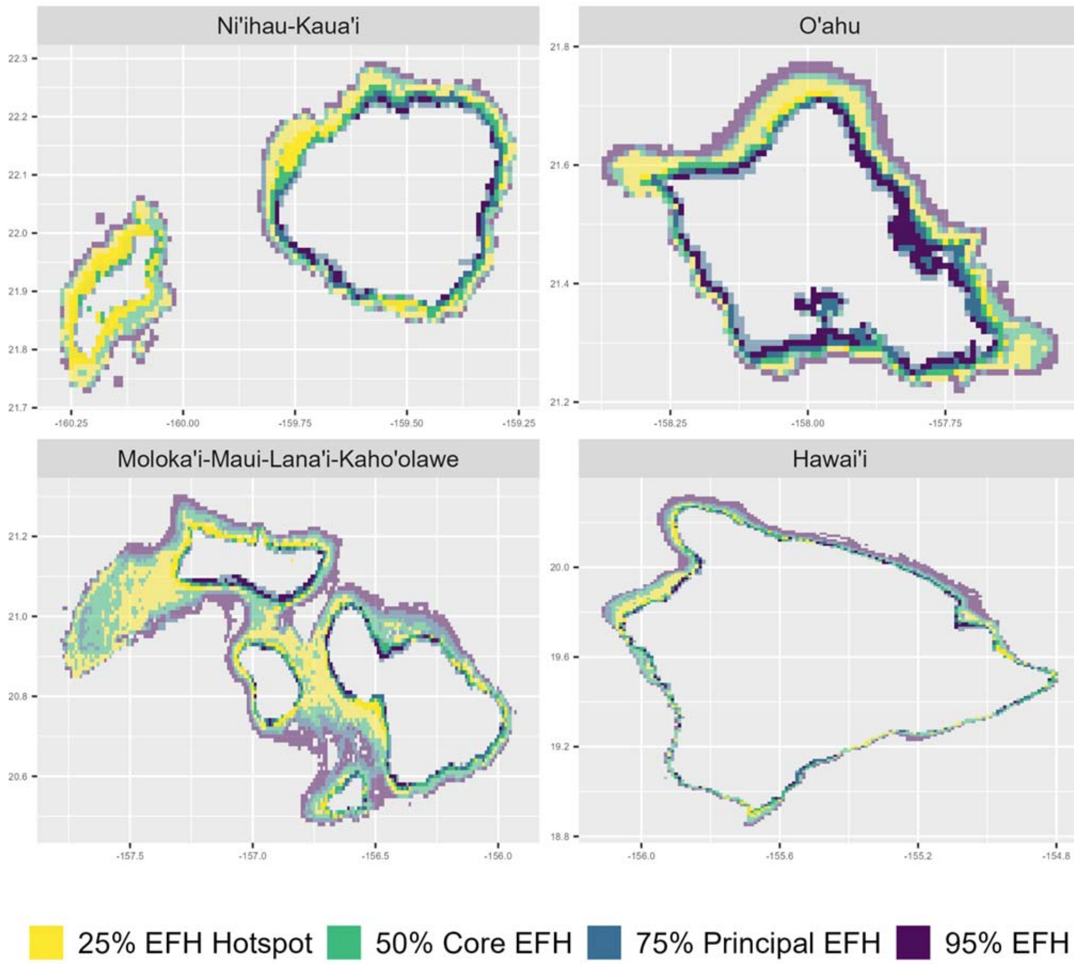

Figure 6. Overlay of model derived EFH subcategories from both the presence/absence EFH models developed by Franklin (2021) (Level 1) and the density model developed by Tanaka et al. (2022) (Level 2).

This alternative would revise the current EFH designation for the sub-adult/adult life stage of MHI uku. Similar to Alternative 2a, the current text descriptions (Table 1) would be replaced with model-based descriptions and visualizations of uku EFH in the MHI (Table 2; Figure 5 and Figure 6). Descriptions of EFH for other life stages of uku (i.e., egg, post-hatch pelagic, and post-settlement) would remain exactly as they were approved in the Council's Amendment 4 to the Hawai‘i FEP in 2016.

Expected Fishery Outcomes

Under Alternative 2b, the Council would amend EFH text descriptions and maps for the sub-adult/adult life stage of MHI uku in the FEP. The maps would preferentially utilize density model products in the spatial domain over which they are available (i.e., typically from the shoreline extending seaward to a depth of 30 m), overlaid by presence-absence products in the offshore areas (i.e., generally 30 to 300 m) as well as in nearshore areas for which density data was not indicative of EFH. These model-based outputs would be supplemented and supported by additional qualitative information from peer-reviewed literature.

The proposed refinements to uku EFH in the MHI would represent an improvement over the current text descriptions and maps of EFH (WPFMC 2016) by implementing descriptions and visualizations of EFH for the species based on a revised literature review and new data and model products. Because the Council would base the EFH designation for MHI uku on presence-absence data from the Franklin (2021) model for areas with depths greater than 30 m, the seaward boundary of the proposed EFH under this alternative would be the same as under Alternative 2a. Thus, the EFH footprint for MHI uku would be relatively similar between Alternatives 2a and 2b. However, the utilization of both model products allows for a more accurate visualization of EFH for uku and uses both BSIA science products.

Because the EFH area for Deep 7 bottomfish around the MHI extends to the 400 m isobath and this alternative only proposes changing uku EFH to extend to the 300 m isobath, the area in which action agencies would need to consult with NMFS on impacts to EFH would not change. The proposed action under Alternative 2b would require no regulatory changes, and the Council does not expect this option to result in significant impacts to the uku stock or fishery.

Table 4. Comparison of Features of the Alternatives

Alt.	EFH Description for sub-adult and adult uku	Model(s) Used	Changes to EFH spatial extent	Total Uku EFH Footprint	Complies with Magnuson-Stevens?
1	Water column and bottom habitat extending from the shoreline to a depth of 240 m isobath from the surface to a depth of 240 m.	None	No change.	9,449 km^2	No. Alt. 1 does not utilize BSIA and, thus, is not consistent with NS2.
2a	Benthopelagic zone, including all bottom habitats, in depths from the surface to 300 m bounded by the shoreline and the 300 m isobath	Presence-Absence Level 1 Model (Franklin 2021)	Larger uku EFH area, with survey data used as model inputs extended to the 300 m isobath. Some small gaps due to strict depth interpretations where EFH had been all encompassing previously	10,092 km^2	Yes. Alt. 2a utilizes BSIA, consistent with NS2. However, it does not describe habitat based on the highest level of detail (i.e., Level 2) where available, inconsistent with implementing regulations at 50 CFR 600.815(a)(1)(iii)(B).

Alt.	EFH Description for sub-adult and adult uku	Model(s) Used	Changes to EFH spatial extent	Total Uku EFH Footprint	Complies with Magnuson-Stevens?
			Recognition of EFH sub-areas (principle, core, and hotspot EFH).		
2b	Benthopelagic zone, including all bottom habitats, in depths from the surface to 300 m bounded by the shoreline and the 300 m isobath	Presence-Absence Level 1 Model (Franklin 2021) and Density Level 2 Model (Tanaka 2022)	Same as above.	Same as above	Yes. Alt. 2b utilizes BSIA, consistent with NS2, and describes habitat based on the highest level of detail where available, consistent with implementing regulations at 50 CFR 600.815(a)(1)(iii)(B).

3 FISHERY IMPACT STATEMENT

The Magnuson-Stevens Act requires that a fishery impact statement (FIS) be prepared for all amendments to FMPs (i.e., FEPs). The FIS contains: 1) background information on the target species and fishery; 2) an assessment of the likely biological/conservation, economic, and social effects of the conservation and management measures on fishery participants and their communities; 3) an assessment of any effects on participants in the fisheries conducted in adjacent areas under the authority of another Fishery Management Council; and 4) the safety of human life at sea. Detailed discussion of the expected effects for all alternatives considered is provided in Section 2.2. Additionally, this FIS contains a review of Magnuson-Stevens Act mandatory EFH components under 50 CFR 600.815 as introduced in Section 1.1.1.

3.1 Background information

3.1.1 Overview of Uku Biology and Habitat

General information regarding the biology and habitat of uku is described in Amendment 4 to the FEP (WPFMC 2016). Uku is in the subfamily Etelinae and is the only species in its genus. Uku are widely distributed throughout the Indian and Pacific oceans from East Africa to Hawaiʻi (Druzhinin 1970; Tinker 1978). Ralston (1979) reported it spawns during the summer months while its spawning season has been reported elsewhere as being from May to October (Everson et al. 1989). The maximum length for the species is 110 cm (Randall 2007) and the Hawaiʻi state record with respect to catch weight is 39.5 lb.[1]

Uku reach sexual maturity at an age of 4-5 years and approximately 42.5-47.5 cm standard length (Everson et al. 1989; Grimes 1987). Egg and larval development in this species are poorly known. Leis and Lee (1994) described identifying characteristics of their larvae which appear to be more similar to *Etelis* than *Aphareus* or *Pristipomoides* larvae. This species lacks a melanophore cluster on the dorsal side of the tail but has a distal melanophore or several in series on the second dorsal spine. Larvae are confirmed to be pelagic to at least 18 mm notochord length and may in fact settle before it reaches 20 mm (Leis and Lee 1994). While early life history information for uku is scarce, larval and juvenile uku have most commonly been observed in the summer, likely coupled with the peak of adult spawning in June, and rarely deeper than 40 m (Schmidt et al. 2023). Meyer et al. (2007) observed that uku movement patterns were generally similar to those previously described for other coral reef fishes, which is associated with a strong diel rhythmicity. This diel rhythm in uku movement may indicate changing between foraging and refuge habitats.

In the Hawaiian Archipelago, most bottomfish species are caught along the steep drop-offs and slopes that surround the islands and banks (Ralston and Polovina 1982). Uku, however, is different in that it is primarily caught on the tops, not the sides or slopes, of these banks, and it can also be caught at or near the surface with a lure (Kramer 1986; Meyer et al. 2007). The adult habitat of uku includes the open waters of deep lagoons, channels, or seaward reefs at depths of 0 -180 m, where individuals or small aggregations are most often observed (Haight et al. 1993; Lieske and Myers 1994). In Guam, uku are found along the outer reef slopes, in deep channels and in shallow lagoons at depths of 3-180 m (Amesbury and Myers 1982). Uku have been reported to be as deep as 274 m (Druzhinin 1970) but are reportedly also abundant in shallow water over coral reefs (Talbot 1960). In the waters around the Hawaiian Islands, the official deepest recorded uku occurrence was 227 m (UH data 2010; WPFMC 2016).

3.1.2 Overview of the Uku Fishery and its Management

Information about the MHI uku fishery is summarized from various sources, including previous EAs for uku (NMFS 2015, NMFS 2020, NMFS 2022a) and the annual Stock Assessment and Fishery Evaluation (SAFE) report (WPFMC 2023). In Hawaiʻi, uku are highly regarded for their firm and flavorful white flesh that is good for either cooking or raw consumption, similar to ʻōpakapaka, onaga, and other Deep-7 bottomfish. However, residents of Hawaiʻi do not typically use uku to fill seasonal demand for whole fish during the holiday season due to consumer preference for red color. Rather, Hawaiian hotel and restaurant industries primarily drive the commercial uku fishery, taking advantage of the species as a low-price alternative to Deep-7 bottomfish (WPFMC 2023).

3.1.2.1 Fishery Operations

The uku fishery occurs in both federal and state waters around the MHI, with approximately two thirds of commercial uku landings originating in federal waters in recent decades (WPFMC

[1] http://www.hawaiifishingnews.com/records.cfm.

2023). However, a 2014 survey of commercial and non-commercial bottomfish fishers indicated that the majority of MHI bottomfish fishing trips (56 percent) are limited to state waters, with the remained occurring in the EEZ seaward of state waters (Chan and Pan 2017); this is similar to the result a 2012 study that reported that the majority of bottomfish trips (66 percent) occur in state waters (Hospital and Beavers 2012). Though fishing for uku takes place throughout the MHI, catches are heavily concentrated in certain areas such as Penguin Bank, which is where roughly 37 percent of commercial harvest occurs. Spawning aggregations of uku on Penguin Bank make it one of the few bottomfish species available in substantial quantities to Hawaiʻi consumers during summer months (NMFS 2022a; WPFMC 2023). While there are areas in which fishers concentrate uku effort, other bottomfishing locations in the MHI tend to vary seasonally according to sea conditions and the availability and price of target species.

Because uku occupy a wide range of habitats from shallow waters nearshore to deeper offshore areas, fishers target the species with a variety of different gear types including shore-based fishing gears, spearfishing, handline, and troll gear (WPFMC 2023). The majority of uku catch comes from deep sea handline, which is also the primary gear that fishers use to target Deep-7 bottomfish, and fishers also commonly harvest the species as incidental catch while targeting other species, such as ʻōpakapaka and onaga, due to the diversity of habitats in which they are found.

When using handlines, fishers employ a vertical hook-and-line method of fishing in which weighted and baited lines are lowered and raised with electric or hydraulic powered reels to the desired fishing depth to target particular species (NMFS 2022a). The main line is typically constructed of Dacron, or 400 to 450-pound test monofilament, with hook leaders of 80 to 120-pound test monofilament. The hooks are circle hooks, generally of the Mustad (conventional scale) sizes 11/0, 12/0, and 13/0, and a typical configuration uses six to eight hooks branching off the main line. The weight is typically 5 to 6 pounds. The hook leaders are typically two to three feet long and separated by about six feet along the main line (NMFS 2022a). Squid is typically used as bait, but hooks may also be baited with fish such as aku (*Katsuwonus pelamis*) or hālalu/akule (*Selar crumenophthalmus*). Some fishers may also suspend a chum bag (palu) containing chopped fish or squid above the highest hook to attract fish (NMFS 2022a). In the commercial bottomfish fleet of the MHI, most vessels are made of fiberglass and measure approximately 23 feet in length, but there are a few larger full-time commercial vessels (Chan and Pan 2017).

In the commercial fishery sector, fishers primarily harvest uku on single-day fishing trips during the summer. Landings peak from April through June and decline as the fishing season for yellowfin tuna (*Thunnus albacares*, or ʻahi) starts, as many fishers shift from targeting bottomfish to targeting tuna (NMFS 2022a). While a large amount of historical catch and effort information comes from the commercial fishery sector, the uku fishery is also known to have a substantial non-commercial component (WPFMC 2023).

Information on the non-commercial uku fishery in the MHI is sourced from the Hawaiʻi Marine Recreational Fishing Survey (HMRFS) and the NOAA Fisheries Marine Recreational Information Program's (MRIP) Fishing Effort Survey (FES) administered in Hawai'i by HDAR. HMRFS was established in 2001 in collaboration with NMFS; NMFS provided oversight of two independent and complementary surveys: the Coastal Household Telephone Survey (CHTS) for fishing effort and the Access Point Angler Intercept Survey (APAIS) for catch rate. Due to steadily decreasing numbers of households with landline phones as well as other factors, the FES was pilot tested in 2017 and eventually replaced the CHTS in 2018. The APAIS focuses on in-person interviews of fishers at publicly accessible locations such as public boat ramps and popular shore fishing sites.

3.1.2.2 Fishery Performance

Following a 1989 peak in commercial uku catch, reportedly due to the sudden appearance of large adult uku, catch quickly decreased to a relative low in 1996 (WPFMC 2023). Uku catch began increasing in 2003 until its peak in 2017 and declined thereafter - notably similar to trends in the Deep-7 bottomfish fishery. Prior to 2009, a large proportion of landed uku were caught in the NWHI, but the closure in 2009 resulted in fishers shifting their effort into the waters of the MHI. Several factors likely contributed to the increase in the uku fishery in the 2000s, including high market demand associated with a decrease in NWHI catch, closures of the Deep-7 bottomfish fishery due to exceedance of the ACL causing fishers to switch targets, increased numbers of fishery entrants associated with the economic recession around 2008, and increased demand from the hotel and restaurant industries. However, similar to Deep-7 bottomfish, MHI uku commercial fishery landings and effort have been in a state of decline following a recent peak in 2017 (Figure 7; WPFMC 2023).

The recent decline in uku catch is likely attributable to several factors. Hotel and restaurant demand was nearly eliminated following the lockdown in March 2020 associated with the COVID-19 pandemic, and some wholesalers limited their purchases drastically to adjust for the low demand (WPFMC 2023). As tourists returned to Hawaiʻi following the easing of travel restrictions in the wake of the pandemic, uku wholesale prices increased; however, the fishery did not show an immediate commensurate response, with landings remaining below pre-pandemic levels. In addition to recent challenges presented by the COVID-19 pandemic, uku fishers have noted that shark depredation and difficult fishing conditions (e.g., unusual current patterns) have been problematic in recent years. Depredation is reportedly especially frequent when uku are directly targeted in high numbers, such as is the case for the fishery at the Penguin Bank. As a result, fishers have noted that some fishery participants have moved away from targeting uku in recent years, perhaps targeting higher value species (WPFMC 2023).

Outside of shark depredation, uku bycatch is thought to be low (i.e., <2 percent), as the only regulation limiting commercial catch is a one-pound minimum size (HAR §13-95 2010) and individuals less than one pound can be retained for personal consumption (unless caught by spear; WPFMC 2023). Additionally, the bottomfish fishing methods employed to harvest uku are relatively target-specific (Kawamoto and Gonzalez 2005). However, bycatch proportions have been generally increasing since 2002, possibly because of the increasing contribution over time of other gear types, such as inshore handline. Compared to other species targeted with similar gears, uku are retained at a slightly higher rate, though this may be associated with commonly released species (e.g., kahala, sharks) being caught with similar gear types (WPFMC 2023).

3.1.2.2 Historical and Current Management

The State of Hawaiʻi Department of Land and Natural Resources (DLNR) HDAR works with NMFS and the Council to manage the uku fishery in the MHI through data sharing and regular communications about fisheries management. This relationship helps prevent overfishing and promotes management of the fishery for long-term sustainability (WPFMC 2023).

Until 2019, NMFS and the Council managed uku under the FEP as a part of the MHI non-Deep 7 bottomfish complex that also included white/giant ulua (*Caranx ignobilis*), gunkan/black ulua (*Caranx lugubris*), butaguchi/pig-lip ulua (*Pseudocaranx dentex*), and yellowtail kalekale (*Pristipomoides auricilla*). Despite being Hawaiʻi BMUS, taʻape (*Lutjanus kasmira*) and kahala (*Seriola dumerili*) were managed within their respective family groups as coral reef ecosystem MUS. In 2019, Amendment 5 to the Hawaiʻi FEP reclassified taʻape, kahala, and all non-Deep 7 bottomfish except uku as ECS; that group of species does not have the same management requirements as MUS (84 FR 2767, February 8, 2019; WPFMC 2018). These reclassifications were based on a quantitative multi-variable analysis as well as expert opinion that evaluated each MUS according to factors provided in NS1 that Councils should consider when determining which species under their jurisdiction require federal conservation and management (81 FR 71858, October 18, 2016).

For the purposes of EFH designations, the Council originally classified BMUS as shallow- or deep-water species complexes in the original 2009 FEP based on the ecological relationships among the individual species and their preferred habitat (WPFMC 2009). The shallow-water species (0-50 fathoms) were consistent with the non-Deep 7 bottomfish complex, inclusive of taʻape and kahala, while the Deep-7 bottomfish comprised the deep-water species (50-200 fathoms). EFH designations in the FEP were identical across both complexes (see Table 5) to reduce the complexity and the number of EFH identifications required for individual species and life stages (WPFMC 2009). The Council intended the designations to encompass the steep drop-offs and high-relief habitats that are important for bottomfish throughout the Western Pacific Region under the assumption that the distribution of adult bottomfish in the region is closely linked to suitable physical habitat.

In 2016, the Council implemented Amendment 4 to the FEP to revise descriptions and identification of EFH and HAPC for Hawaiʻi Archipelago bottomfish and seamount groundfish MUS (81 FR 7494, February 12, 2016; WPFMC 2016). The original shallow- and deep-water species assemblages of the 2009 FEP were reorganized into three (i.e., shallow, intermediate, and deep) because several species had been recorded together at the same depth as individuals of both the shallow and deep assemblages, while depth ranges for other species had rarely been observed to overlap in this way. The Council included uku in the shallow-water bottomfish species assemblage alongside taʻape and white ulua, designating EFH. However, the overall EFH designation for all life stages of all bottomfish species was retained as the water column and bottom habitat in depths from the surface to 400 m depth throughout the EEZ (WPFMC 2016).

Amendment 5 to the Hawaiʻi FEP in 2019 reclassified taʻape and white ulua from BMUS to ECS, and ECS do not require EFH designations. Thus, currently, uku is the only remaining MUS in the non-Deep 7 bottomfish complex for management purposes as well as the only remaining shallow-water bottomfish species with respect to EFH designated in the 2016 amendment to the Hawai'i FEP.

Table 5. Depth assemblage and EFH descriptions for intermediate and deep Hawai'i BMUS.

Assemblage	EFH (eggs)	EFH (post-hatch pelagic)	EFH (post-settlement)	EFH (sub-adult/adult)
Intermediate Lehi (*Aphareus rutilans*) Hapu'upu'u (*Hyporthodus quernus*) 'Ōpakapaka (*Pristipomoides filamentosus*)	Pelagic zone of the water column in depths from the surface to 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*) extending from the official US baseline to a line on which each point is 50 miles from the baseline	Pelagic zone of the water column in depths from the surface 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*), extending from the officialU.S. baseline to the EEZ boundary	Benthic (*H. quernus* and *A. rutilans*) or benthopelagic (*A. rutilans* and *P. filamentosus)* zones, including all bottom habitats, in depths from the surface to 280 m (*A. rutilans* and *P. filamentosus*) or 320 m (*H. quernus*) bounded by the 40 m isobath and 100 m (*P. filamentosus*), 280 m (*A. rutilans*) or 320 m (*H. quernus*) isobaths	Same as post-settlement
Deep Ehu (*Etelis carbunculus*) Onaga (*E. coruscans*) Kalekale (*P. sieboldii*) Gindai (*P. zonatus*)	Pelagic zone of the water column in depths from the surface to 400 m, extending from the official U.S. baseline to a line on which each point is 50 miles from the baseline	Pelagic zone of the water column in depths from the surface to 400 m, extending from the official U.S. baseline to the EEZ boundary	Benthic zone, including all bottom habitats, in depths from 80 to 400 m bounded by the official U.S. baseline and 400 m isobath	Benthic (*E. carbunculus* and *P. zonatus*) or benthopelagic (*E. coruscansi*) zones, including all bottom habitats, in depths from 80 to 400 m bounded by the official U.S. baseline and 400 m isobaths

3.1.2.2.1 Annual Catch Limits and Annual Catch Targets

The MHI uku fishery has been managed using a framework of annual catch limits (ACL) and accountability measures (AMs) since 2012 when the requirement to implement an ACL and AMs was initially created for non-Deep 7 bottomfish in the FEP. NMFS implemented ACLs and AMs each year from 2012 to 2016 for non-Deep 7 BMUS (Table 6) before implementing individual ACLs and AMs for uku only from 2019 to 2021 (Table 7). NMFS did not implement an ACL for non-Deep 7 bottomfish in 2017 or 2018 because NMFS received new information that required additional environmental analyses to support the Council's ACL recommendations (82 FR 58129, December 11, 2017).

Federal regulations also allow the specification of an annual catch target (ACT) that is less than the ACL, as recommended by the Council, and serves as the basis for invoking AMs (50 CFR 665.4(d)). The implementation of an ACT reduces the likelihood that the ACL will be exceeded. In 2022, NMFS issued a final rule implementing an ACL of 295,419 lb, an ACT of 291,010 lb, and AMs for MHI uku in fishing years 2022 through 2025 (87 FR 17195, March 28, 2022) based on the results of the 2020 stock assessment for the species (Nadon et al. 2020; see Section 3.1.3). For the first time in the uku fishery, these ACLs and ACTs apply to the total combined commercial and non-commercial catch of uku instead of solely the commercial portion of uku catches. As an in-season AM, if NMFS projects that the total catch will reach the ACT in any given fishing year based on Hawaiʻi commercial marine license (CML) and HMRFS data, NMFS will close commercial and non-commercial uku fisheries in federal waters for the remainder of the fishing year. As a post-season AM, if NMFS determines that the most recent three-year average catch exceeds the ACL in a fishing year, NMFS would reduce the ACL and ACT for the following fishing year by the amount of the overage. In 2022, the fishery harvested an estimated 282,241 lb of uku across both commercial and non-commercial sectors, a majority of which came from non-commercial fishing, representing approximately 97 percent of the implemented ACT (see Table 8).

Table 6. Annual Catch Limits and commercial catch for non-Deep 7 bottomfish, inclusive of uku, from 2012 to 2018.

Year	ACL	Non-Deep 7 Catch (lb)	Proportion of ACL	Uku Catch (lb)	Proportion of Total
2012	135,000	138,958	1.03	116,410	0.84
2013	140,000	136,685	0.98	121,476	0.89
2014	140,000	108,888	0.78	97,003	0.89
2015	178,000	112,427	0.63	101,965	0.91
2016	178,000	127,343	0.72	118,597	0.93
2017	N/A	141,936	N/A	132,735	0.94
2018	N/A	84,141	N/A	75,292	0.90

Source: WPacFIN data query; WPFMC (2023); 77 FR 6019 (February 7, 2012); 78 FR 48075 (August 7, 2013); 79 FR 4276 (January 27, 2014); 80 FR 52415 (August 31, 2015); 82 FR 18716 (April 21, 2017).

Table 7. Annual Catch Limits and commercial catch for uku from 2019 to 2021.

Year	ACL (lb)	Uku Catch (lb)	Proportion of ACL
2019	127,205	90,016	0.71
2020	127,205	48,038	0.38
2021	127,205	60,363	0.48

Source: WPFMC (2023); 85 FR 26622 (May 5, 2020).

Table 8. Annual Catch Limit, Annual Catch Target, commercial catch, and estimated non-commercial catch from HMRFS for uku in 2022.

Year	ACL (lb)	ACT (lb)	Commercial Catch (lb)	Estimated Non-Commercial Catch (lb)	Total Estimated Catch (lb)	Proportion of ACT	Proportion of ACL
2022	295,419	291,010	52,966	229,275	282,241	0.97	0.96

Source: WPFMC (2023); 87 FR 17195 (March 28, 2022).

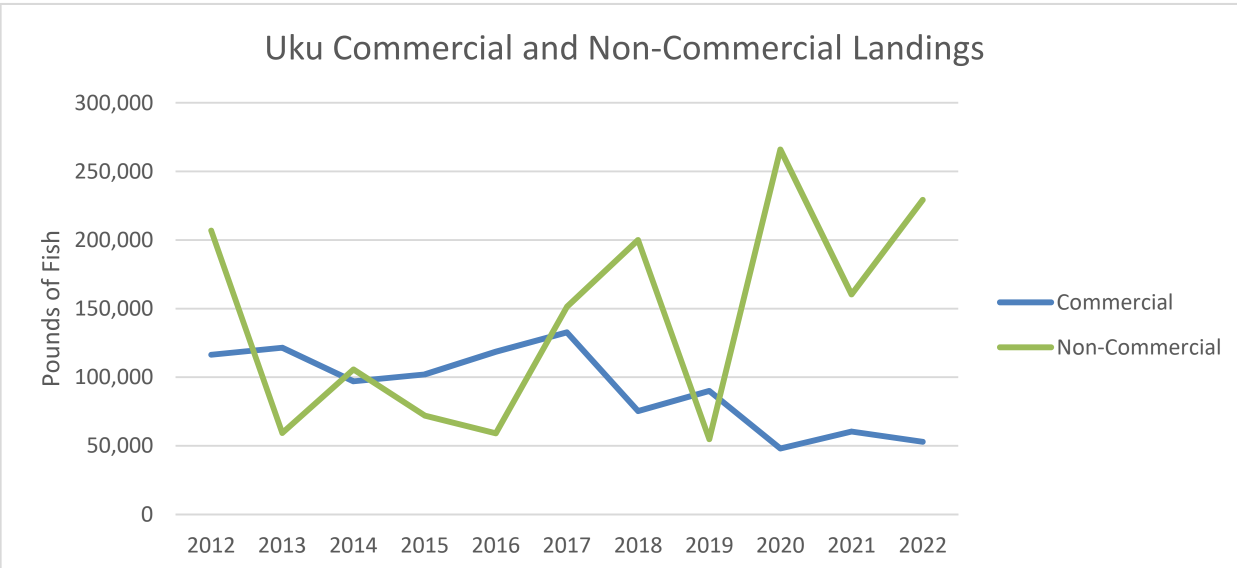

Figure 7. Commercial and estimated non-commercial catch from HMRFS for uku from 2012-2022. (Source WPFMC (2023); Nadon (2020); NMFS MRIP website, accessed 11/01/2023.)

3.1.3 Uku Stock Status

Despite recent decreases in commercial catch, the BSIA indicates that the MHI uku stock is relatively healthy. Unlike its previous stock assessment that was comprised of 27 single-species assessments for reef-associated species around the MHI (Nadon 2017), the most recent stock assessment for uku focused solely on uku (Nadon et al. 2020; Table 9). This assessment built upon the previous assessment efforts and used catch, catch per unit effort (CPUE), diver surveys, and size composition time series in a Stock Synthesis 3.30 modeling framework with a terminal data year of 2018. The 2020 assessment ultimately concluded that MHI uku are not overfished nor experiencing overfishing.

Table 9. Results from 2020 stock assessment for MHI uku.

Parameter	Value	Notes	Status
MSY	93	Units mt	
F_{2018} (age 5-30)	0.08	Units yr^{-1}	
F_{MSY} (age 5-30)	0.14	Units yr^{-1}	
F_{2018}/F_{MSY}	0.57		No overfishing occurring
SSB_{2018}	819	Units mt	
SSB_{MSST}	301	Units mt	
SSB_{2018}/ SSB_{MSST}	2.7		Not overfished

Note: "MSY" is maximum sustainable yield, "F" is fishing mortality, "SSB" is spawning stock biomass, "MSST" is minimum stock size threshold, and "mt" is metric tons. Source: (Nadon et al. 2020).

The 2020 assessment had a lower recent fishing mortality rate of approximately 0.08 versus 0.15 for the 2017 assessment. The 2020 stock assessment also determined a higher overfishing limit (OFL) than the 2017 assessment based on catch-derived biomass, though the spawning potential ratio (SPR)-based F_{MSY} proxy used in the 2017 assessment (F_{30} = 0.16) is close to the F_{MSY} value estimated in the 2020 assessment (0.14). The 2020 assessment underwent peer review from a WPSAR panel in February 2020 (85 FR 5633, January 31, 2020) which determined the assessment to be BSIA for uku. An update to the 2020 assessment will be available in 2024, and a new WPSAR benchmark stock assessment scheduled for completion in 2027[2].

3.1.4 Impacts of the Proposed Action

The proposed action would modify the language in the Hawaiʻi FEP to update the description of EFH based on new BSIA and literature review of EFH for MHI uku. The current amendment would therefore not modify or remove any existing data collection methodologies or reporting requirements and does not recommend any new data collection methodologies to be implemented. The action would also not result in changes to fishing location, timing, effort, or authorized gear types, access to fishery resources, or harvest levels. Due to the limited scope and administrative nature of the amendment, the proposed action is not anticipated to impact (a) participants in the fisheries and fishing communities affected by the plan amendment; (b) participants in the fisheries conducted in adjacent areas under the authority of another Council; nor (c) the safety of human life at sea, including whether and to what extent such measures may affect the safety of participants in the fishery.

Additionally, this action is not anticipated to have impacts on fishery resources, protected resources, habitat, socioeconomic setting, fishery administration or enforcement, and thus qualifies for a categorical exclusion (CE) from NEPA requirements to conduct an Environmental Assessment (EA) or Environmental Impact Statement (EIS).

[2] https://www.fisheries.noaa.gov/pacific-islands/population-assessments/western-pacific-stock-assessment-review-schedule.

3.2 EFH Components Review

As described in Section 1.1.1, implementing regulations of the Magnuson-Stevens Act pertaining to EFH detail 10 aspects of FMPs that Councils must include and review periodically (50 CFR 600.815(a)). Here, we describe and review each of these components for uku, utilizing descriptions from previous FEP amendments as well as more recent literature and information.

3.2.1 Fishing Activities

3.2.1.1 Magnuson-Stevens Act

The Council previously summarized fishing activities under the Magnuson-Stevens Act that have the potential to adversely affect EFH in Amendment 4 to the Hawai‘i FEP (WPFMC 2016). Predominant gear types used for bottomfish fishing cause few fishing-related impacts to habitat utilized by uku. The current management regime prohibits the use of destructive and non-selective gears such as bottom trawls, bottom-set nets, explosives, and poisons. There may be impacts to benthic habitat during bottomfish fishing operations from vessel anchor damage over productive areas (Tuck et al. 2011) and heavy weights and line entanglement from hook and line gear, but surveys in the NWHI found little evidence of physical disturbances by bottomfishing from anchors and fishing gear (Kelley and Ikehara 2006). Hook and line methods of fishing, as typically employed in bottomfish fisheries, are considered low impact and not likely to adversely affect EFH.

In 2022, NMFS published the final programmatic environmental impact statement (PEIS) to support early planning for a future aquaculture management program in the Pacific Islands Region (NMFS 2022b). In the PEIS, NMFS reviewed direct and indirect environmental impacts expected to result from the implementation of the management program, including on habitat, based on five impact criteria: (1) effluents and emissions from marine aquaculture activities, (2) habitat and ecosystem function, (3) local wild fish stocks, (4) other marine wildlife and protected species, and (5) socioeconomic impacts.

With respect to considerations for MHI uku and the species’ EFH provided in the aquaculture management PEIS, criteria 1, 2, and 3 are the most pertinent. Under criterion 1, aquaculture facilities could affect water quality by altering physical parameters, nutrients, concentrations of chlorophyll-*a*, and the levels of pollutants in the water column stemming from fish excretions, excess feed, release of veterinary drugs used to treat fish, or release of chemicals used during normal site operation and maintenance. Impacts would be reflective of the total amount of a given substance added to the receiving waters over time relative to normal background levels as well as the carrying capacity of the area. NMFS concluded that impacts to the environment from effluents and emissions to be negligible to minor adverse due to the proposed limited entry system, permit durations, all operations only being permitted to use Food and Drug Administration-approved antibiotics and associated chemicals, and all operations being subject to the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) permit program. Considerations for greenhouse gas emissions would be explored during any siting analysis.

Under criterion 2, the installation of aquaculture-related mooring structures that secure the culture system to the ocean floor could impact geologic features and physical habitat in the MHI. Additionally, aquaculture operations could affect benthic habitats and the organisms that reside in the benthos through nutrient enhancement as described under criterion 1. The presence of aquaculture structures could disrupt continuous habitats or create novel habitat in the pelagic environment. Aquaculture facilities could also act as fish aggregating devices (FADs) that could affect predator-prey relationships, species diversity, and species distributions. NMFS concluded that impacts to habitat and ecosystem function would be negligible to moderate adverse. All moorings would be subject to permitting by the US Army Corps of Engineers, water quality monitoring would be required under an EPA NPDES water quality permit, decommissioning plans would be required, the number of facilities would be based on comprehensive siting analyses, emergency plans would be in place to address gear failure, and the proposed limited entry system as well as permit durations would limit habitat impacts.

Criterion 3 describes potential effects on local fish stocks. The escape of cultured fish may impact local stocks through predation, by competition for resources and habitat, or by interbreeding with wild populations of the same fish. Aquaculture operations could also contribute to the transmission and amplification of naturally occurring pathogens and parasites or the introduction of pathogens or parasites to an area by cultured fish; however, measures to treat and prevent this spread may mitigate some risk. Lastly, and potentially the least likely to lead to impacts to MHI uku or their habitat, would be the use of whole fish for feeding cultured fish, though the use of locally sourced prey species of uku could lead to potential impacts. NMFS concluded that impacts to wild fish stocks would be moderately adverse to minorly beneficial. While pathogen transfer and escapes could happen, management measures would reduce the impact and these impacts would be considered for every operation. Non-native and genetically engineered species are not allowed to be cultured, and area-based management would further reduce impacts to fish stocks.

3.2.1.2 Non-Magnuson Stevens Act

The Council previously summarized fishing activities that are not managed under the Magnuson-Stevens Act and have the potential to adversely affect EFH in Amendment 4 to the FEP (WPFMC 2016). Non-Magnuson Stevens Act fishing activities that may adversely affect EFH include fisheries that are solely regulated by the State of Hawaiʻi, such as the aquarium trade and offshore aquaculture occurring within three nautical miles from shore. Predominant gear types are similar in state and federal waters (WPFMC 2023) and have been deemed not harmful to habitat (see Section 3.2.1.1). While fishing that occurs in state waters may impact EFH, most activities have been studied for their impacts on habitat and the Council concluded that these activities likely have a small impact on EFH because the fishing is done on a small scale (WPFMC 2016).

3.2.2 Non-Fishing Activities

The Council previously summarized non-fishing activities that have the potential to adversely affect EFH in Amendment 4 to the Hawaiʻi FEP (WPFMC 2016), and NMFS previously summarized these activities in several documents. Activities are most likely to directly affect uku in an adverse manner in the life stage that corresponds to the zone and depth at which the activity occurs. Because the uku inhabit nearshore waters and EFH includes the water column, bottom habitat, and manmade structures for various life stages, many activities have the potential to adversely affect EFH. NMFS has produced documents regarding non-fishing related activities in other regions (NMFS 2008; NMFS 2011; Kiffney et al. 2022) and supported assessments of the potential impacts of non-fishing activities on bottomfish habitat in the Pacific Islands Region (Ramirez 2012; Minton 2017).

In Minton (2017), potential stressors on EFH were identified and grouped into broader categories: environmental stressors, biological stressors, physical stressors, pollution stressors, and sea level rise:

1. Environmental stressors are associated with excessive or insufficient physical or chemical conditions within the marine environment, and include: ocean acidification, shifts in productivity, thermal, salinity, irradiance, noise, and hypoxia.
2. Biological stressors are associated with interactions among organisms of the same or different species, and include: invasive species, disease, and FAD effect.
3. Physical stressors are associated with changes in exposure to kinetic energy and include physical damage.
4. Pollution stressors occur when chemicals or other contaminants are present in concentrations large enough to affect organisms and thereby cause biological or ecological change, and include: sediment, chemicals, and nutrient inputs.
5. Sea level rise is a unique marine stressor with important implications in the Western Pacific Region. On casual examination, sea level rise alone might appear to be unimportant to subtidal marine ecosystems, but it is a substantial direct threat to intertidal and mangrove ecosystems and acts indirectly on certain other ecosystems through often synergistic interactions with other stressors, such as changes to water quality.

At any given time and place, organisms may be exposed to a complex regime of interacting stressors at various levels of exposure and duration. The effects of these stressors on EFH will vary broadly by ecosystem type, the organisms affected, and their location. In some cases, little-to-no effect may be observed, but the effects of other stressors on EFH can be significant, resulting in increased mortality, altered abundances and assemblage composition, and disrupted trophic dynamics.

3.2.2.1 Land-Based

As described in Amendment 4 to the Hawaiʻi FEP, land-based activities that have the potential to impact uku EFH include agriculture, landscaping, stormwater and wastewater management, freshwater diversion, and other discharge activities that can lead to nutrient loading, sedimentation, and eutrophication in nearshore waters as well as contribute hazardous substances and thermal pollution. While the water quality characteristics for uku EFH are not defined, the ecosystem impacts from degraded coastal water quality would likely impact the function of the habitat that supports uku (WPFMC 2016).

Minton (2017) describes additional land-based activities and operations that have the potential to impact EFH. Land-based energy projects, including wind turbines, solar, geothermal facilities, and land-based ocean thermal energy conversion (OTEC) and seawater air conditioning

(SWAC), likely have similar impacts to habitat as land-based development and construction projects, which can contribute a wide range of both direct and indirect stressors. However, many of these projects require local and/or federal permits and are likely to be subject to environmental review or other forms of disclosure that involve public and expert review (e.g., NEPA, coastal zone management program, Clean Water Act, etc.). Land-based aquaculture can contribute wastewater effluent into coastal and nearshore environments, where any excess feed, combined with excretory products would be flushed from the ponds and likely result in elevated nutrient levels in the receiving waters. Other terrestrial-derived pollutants include wastewater discharge, sewage effluent, and storm water.

3.2.2.2 Nearshore

Unlike land-based projects, there are water-based projects and processes that occur in or have direct connections to estuarine and marine ecosystems. Dredging, shoreline and manmade structure maintenance, coastal construction, and ballast water pumping are relevant examples of nearshore activities that may adversely affect bottomfish EFH, inclusive of MHI uku, as detailed in Amendment 4 to the Hawaiʻi FEP. Dredge material, construction-related turbidity, and ballast water can negatively impact EFH by making nearshore water conditions inhospitable for the survival of eggs, larvae, and juvenile fish (WPFMC 2016). Shoreline maintenance and coastal construction can impact EFH through physical habitat removal, conversion, and siltation. Overwater structures can impact EFH by changing light conditions, altering energy in the environment, and introducing contaminants (NMFS 2011). The exchange of ballast water in ports may introduce invasive alien species into the marine environment that result in permanent ecosystem changes, however this process is regulated by the US Coast Guard and Hawaiʻi DLNR (WPFMC 2016). Water-based dredging projects involve the direct removal or addition of material into nearshore waters, which can result in a wide range of direct impacts to EFH (Minton 2017; Kiffney et al. 2022).

Human-made structures can provide valuable habitat for managed species directly or indirectly and are considered part of EFH, as defined in the NMFS Final Rule for the *Guidelines for the Description, Identification, Conservation, and Enhancement of Essential Fish Habitat* (67 FR 2343, January 17, 2002). These structures are included in uku EFH. Manmade structures may include shipwrecks, shoreline treatments, and other structures for human use. It is recognized that while some structures are maintained, repaired, and upgraded for human purposes, the benthic species that are attached to the structures and the functions of stabilizing the shoreline and adding complexity and structure to the environment contribute to EFH. The human-made structures can provide valuable habitat because they can perform the same functions that the natural environment performed prior to the establishment of the structures. Mobile and sessile organisms growing on manmade structures perform functions that support or improve EFH including: refuge (Patranella et al. 2017; Breitburg 1999; Hixon and Beets 1993), water filtering (Riisgård and Larsen 2010, 1995), removing contaminants from sediment and water (Karlsson et al. 2017, Crews 2012, Gifford et al. 2005), transferring nutrients (Barbier et al. 2011), and affecting fish assemblages (Roff et al. 2019).

In general, human activity in the water may have an effect on uku distribution and habitat use. Floros et al. (2013) report that uku presence on reefs on the northeast coast of South Africa and southern Mozambique appear to be affected by activities permitted on the reefs. They compared reefs with four different levels of permitted activity: 1) reefs with low scuba diving pressure and unregulated angling and spearfishing, 2) reefs with low scuba diving pressure and regulated angling and spearfishing of only gamefish (including uku), 3) reefs with high-diving pressure but no fishing allowed, and 4) sanctuary reefs where there was no diving or fishing. The greatest dissimilarity between sites was driven by differences in the presence of six important reef predator species that included uku. At reef type 1, uku was entirely absent. At reef type 3, no sexually mature uku were observed. At sanctuary reefs, there was a range of sizes and many more uku than the other three reef areas. Floros et al. (2013) suggested that the low abundance and absence of sexually mature individuals of several species, including uku, on the non-sanctuary reefs may indicate reduced reproductive potential and could have significant ramifications for future generations. These populations may be reliant on juveniles from surrounding no-take zones to replenish stocks.

The Level 2 density model of uku distribution (Tanaka et al. 2022) have noted that the abundance and distribution of uku in the highly populated MHI differs from the NWHI and unpopulated portions of the MHI (e.g., Niʻihau), the former of which is the site of a protected national monument that is relatively uninhabited and experiences low levels of human activity. Uku in the NWHI occur at much higher density in shallow water (0-30m) r than in the MHI (Tanaka pers. obs, see Appendix A). Although uku can be observed and caught in shallow water in the MHI, they tend to occur in greater numbers below 30 m in the MHI (Asher et al. 2017), suggesting that uku may be using deeper waters as refugia from fishing or human activity.

3.2.2.3 Offshore

Most offshore activities that have the potential to impact uku EFH in the MHI are related to energy development and military training activities, as further described below. Minton (2017) describes additional projects and activities that may also contribute to EFH impacts, such as shipping and boating, anchorage sites, ocean mining, development of artificial reefs, recreational and scientific ocean uses, and introduction of marine debris.

3.2.2.3.1 Cable installation, maintenance, and decommissioning

The installation of cables for energy or telecommunication transmission purposes typically involves the dredging and plowing of the seafloor, which may result in the loss of benthic habitat and lead to siltation, sedimentation, and turbidity impacts to habitat (WPFMC 2016; Kiffney et al. 2022). Buried cables likely involve the removal or disturbance of substratum, which could include reefs, through mechanical trenching or directional drilling (Minton 2017). Habitat conversion may occur if cables are not sufficiently buried, and the regular maintenance or decommissioning of these cables may also lead to the release of contaminants (WPFMC 2016). Electromagnetic fields generated by these cables may alter fish behavior (Gill et al. 2005). Cables that are not buried or exposed also have the potential to interact with bottomfish fisheries equipment, especially when they are laid on shallow banks. If snagged or damaged by FAD anchors, cables can damage the substrate.

3.2.2.3.2 Wind farms

Potential impacts to EFH from wind farms include sounds from turbines that may cause behavioral effects in fish; changes in current patterns from wind farm placement that may affect distribution of species within estuaries and bays and migration patterns of fishes; siltation, sedimentation, and turbidity during construction that may affect habitat quality by temporarily disrupting and displacing eggs and larvae; and discharge of contaminants stored at storage platforms may affect water quality (WPFMC 2016; Kiffney et al. 2022). While there are no offshore wind farms currently operating in the offshore waters around the MHI, there have been proposals for such systems in recent years.

3.2.2.3.3 Ocean Thermal Energy Conversion and Sea Water Air Conditioning

Water-based OTEC operations produce energy by using warm surface waters to vaporize a working fluid that turns a turbine. The working fluid is condensed by cold ocean water pumped from deep in the water column and passed through in heat exchangers. OTEC and SWAC plants can be sited fairly close to shore and still have access to deep, cold water, which is piped to the surface for use in condensing working fluids in OTEC and/or distributed to cool buildings in SWAC projects (WPFMC 2016). As a by-product, OTEC produces cold, nutrient-rich water that is generally discharged back into the ocean (Minton 2017). Potential impacts to EFH from OTEC include elevated levels of dissolved inorganic nutrients such as phosphate, nitrate, and silicate; changes to phytoplankton and zooplankton distribution and abundance; promotion of harmful algal blooms; other biotic and abiotic condition changes associated with discharge of cold nutrient-rich return water; and leaching of toxic metals through heat exchangers. There are additional potential adverse impacts from the loss of benthic habitat in the immediate project footprint and adjacent areas from sedimentation (WPFMC 2016). OTEC technology is being tested at the Natural Energy Laboratory of Hawaiʻi Authority on Hawaiʻi Island.

3.2.2.3.4 Wave energy facilities

Wave energy projects can affect the distribution of eggs and larvae by disturbing natural hydrological processes, and associated in-water structures, transmission lines, and anchors also have the potential to impact benthic and water column habitats (WPFMC 2016; Kiffney et al. 2022). There is one Hawaiʻi-based wave energy test site currently situated in Kaneohe Bay; it has berths for testing wave energy conversion devices at moorings located at sites that are 50 m, 60 m, and 80 m deep.

3.2.2.3.5 Military activities

The active use of sonar and weapons testing by the military can affect EFH through noise, electromagnetism, physical striking by vessels, explosives and their byproducts, and marine debris; these processes are actively occurring in the MHI (WPFMC 2016; Department of the Navy 2013, 2018). As identified in Minton (2017), military activities, both land-based and ocean-based, can have direct and indirect effects on EFH through other operations such as troop and ship maneuvers, amphibious landings, missile launches, underwater demolitions, and coordinated maneuvers with multinational task forces.

3.2.2.3.6 Other

Minton (2017) identified several other offshore activities that have the potential to impact uku EFH in the MHI, including shipping and boating, anchorage sites, ocean mining, development of artificial reefs, recreational and scientific ocean uses, and introduction of marine debris to the ocean environment. Each of these activities can introduce direct or indirect effects to habitat, such as noise, invasive species, disease, FAD effects, physical damage, sedimentation, as well as introduction of hydrocarbons, metals, or endocrine disruptors.

3.2.3 Climate Change

A rapidly changing global climate is and will continue to have impacts on EFH, adding a layer of complexity to the conservation and management of fish habitat. Impacts on a suite of environmental factors, such as water chemistry, temperature, and precipitation affect EFH directly along with food webs that MUS rely on. Stress from environmental changes, such as increased water temperatures, and natural processes, such as ocean circulation patterns, can cause a cascade of impacts from climate change beyond the direct and observable effects. Complex ecological and environmental modifications that are the result of climate change will interact with both fishing and non-fishing activities, modifying the current understanding of how a species interacts with its environment (Kiffney et al. 2022).

Based on a 2022 Climate Vulnerability Analysis for the Pacific Islands Region (Giddens et al. 2022), uku were found to have high exposure to detrimental changes in physical variables in its environment due to climate change. In a detailed species narrative, four exposure factors that drove a very high score include ocean acidification, sea surface temperature, ocean oxygen, and air temperature (Mukai et al., 2022). The distributional vulnerability classified uku has “high” due to adult mobility, limited early life stage dispersal, and relatively high habitat specialization. This may be negated, however, due to the low biological sensitivity to climate change for factors such as early life history, spawning cycle, and growth rate (Mukai et al., 2022).

3.2.4 Cumulative Impacts Analysis

The 2002 NMFS final rule regarding EFH (67 FR 2343, January 17, 2002) requires a cumulative impact analysis (CIA) to the extent feasible and practicable that evaluates how the cumulative impacts of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale, inclusive of natural stressors (50 CFR 600.815(a)(2)). The Council provided descriptions of cumulative impacts to bottomfish EFH, inclusive of MHI uku, in Amendment 4 to the FEP (WPFMC 2016). Briefly, the Council noted the existence of a wide range of past, present, and future activities that have the potential to affect bottomfish EFH, inclusive of MHI uku, such as aquaculture facilities and operations, inter-island electricity cables, and offshore energy development. The activities that pose the greatest threat to EFH for subadult and adult life stages of uku are those that result in benthic alteration (e.g., laying cables, anchoring energy and aquaculture facilities, etc.).

A description of facets that should be included in a CIA is provided by Minton (2017), which notes that the most substantial impacts may result not from the direct effects of a particular activity, but from the combination of individually “minor” effects of multiple actions concentrated in space and/or time. While it can be challenging to predict the cumulative effect of multiple stressors as well as a species' response to various sets of stressors, recent years have allowed for more attention to be placed on potential interactions between and among multiple stressors. A meta-analysis that reviewed over 200 studies found that cumulative effects of any two stressors were distributed among all interaction types with 26 percent being additive (i.e., no interaction) 36 percent synergistic, and 38 percent antagonistic (Crain et al. 2008).

3.2.5 Conservation and Fishing Impact Recommendations

In Appendix 5 of Amendment 4 to the Hawai'i FEP (WPFMC 2016), the Council identified a wide range of conservation and enhancement recommendations pertaining to non-Magnuson Stevens Act fishing impacts as well as non-fishing impacts to EFH, at times referring to associated NMFS documents and reports (e.g., NMFS 2011).

3.2.6 Prey Species

The Council previously summarized considerations for prey species as they pertain to EFH for MHI uku in Amendment 4 to the Hawai'i FEP (WPFMC 2016). Portions of this description are included here alongside additional information gathered from peer-reviewed literature.

Haight et al. (1993) characterized uku as being in the piscivorous guild of snappers as opposed to the zooplanktivores. The species has a strong overlap in prey type with other snappers including *Etelis carbunculus* and *E. coruscans,* but the exact species uku consume have limited overlap and their feeding niche is separated by depth and diel feeding pattern (Haight 1989; Haight et al. 1993). Uku feed during daytime hours, and the diet of individuals collected from Penguin Bank included fish (88.7 percent), larval fish (5.6 percent), planktonic crustaceans (1.4 percent), shrimp (2.8 percent) and crabs (1.4 percent) (Haight 1989). Unlike the benthic species of deepwater lutjanids, uku has feeding habits that do not seem to be constrained by substrate association (Parrish 1987). This species forages throughout the water column from the surface down to almost 200 m (Ralston 1979; Parrish 1987).

Uku feed on a range of species that come from various habitats (Haight 1989; Haight et al. 1993; Parrish 1987). Coral reef associate fish found in uku stomachs and guts include juvenile barracuda (family Sphyraenidae), goatfish of the genus *Parupeneus*; unicornfish (*Naso* spp., family Acanthuridae); boxfish, puffers, filefish, triggerfish (order Tetraodontiformes); and painted frogfish (*Antennarius pictus*). Uku are also known to consume the Oriental flying gurnard (*Dactyloptena orientalis*), which is a nearshore species found in coastal waters over sandy substrates such as bays and estuaries. Several species of adult mantis shrimp have been documented in uku diet with Haight et al. (1993) specifically identifying *Odontodactylus hanseni*, a species found across a range of depths (Haight et al. 1993; Parrish 1987). Uku also consume deep, demersal, and benthic fish species such as flatheads (family Platycephalidae); sea robins (*Tryglia* spp.); Hawaiian sea moths (*Pegasus papilio*), various eels (order Anguilliformes); as well as shrimp, isopods, juvenile and adult crabs, octopus and squid (Haight et al. 1993). In the water column, uku consume fish larvae; small crustaceans; krill (order Euphausiacea); crab larvae (megalopa); pteropods (pelagic sea snails); coastal pelagic fish such as 'opelu (mackerel scad); and urochordates including tunicates, salps, and pyrosomes. Seki and Callahan (1988) noted that pyrosomes concentrate phytoplankton and microzooplankton when they filter feed. Kashkina (1986) reports that up to 20% of the body weight of salps is comprised of concentrated plankton. Décima et al. (2019) determined that some species of pyrosomes collect and consume particulate organic matter as well. Particulate organic material is diverse in origin and is derived from a variety of plant sources including phytoplankton, attached aquatic vegetation in shallow waters, macroscopic pelagic algae, and waterborne and windborne materials of terrestrial origin (Riley 1970). Uku may benefit from this plankton consumption via secondary consumption from pelagic urochordate predation.

In summary, uku are reliant on diverse prey types originating from a range of habitat types including benthic coral reef-associated fishes and invertebrates, water-column zooplankton, and pelagic urochordates.

3.2.7 Identification of HAPC

The Council provided HAPC designations for bottomfish in Amendment 4 to the Hawaiʻi FEP (WPFMC 2016; see Table 10 and Figure 8). Uku has been observed in the HAPC at Makapuʻu Point, Penguin Bank, Pailolo Channel, and Hilo. The rationale for the Council's endorsement of the seven areas as HAPC for Hawaiʻi bottomfish was based on the considerations specified in the WPSAR Working Group Final Report for Hawaiʻi Bottomfish EFH and HAPC (WPFMC 2011).

Table 10. HAPC designations for Hawaiian Islands bottomfish.

Location	**Latitude**	**Longitude**	**Area (km^2)**
Kaʻena Point	21° 36.0′ N 21° 49.0′ N	158° 11.9′ W 158° 16.0′ W	48
Kāneʻohe	21° 31' 06.00" N 21° 29' 42.28" N 21° 28' 52.61" N 21° 30' 19.10" N	157° 46' 54.42" W 157° 45' 21.06" W 157° 46' 10.64" W 157° 47' 46.14" W	8
Makapuʻu Point	21° 25' 57.54" N 21° 20' 03.85" N 21° 19' 01.38" N 21° 25' 02.09" N	157° 42' 02.74" W 157° 36' 58.45" W 157° 39' 02.76" W 157° 43' 05.72" W	44
Penguin Bank	157° 10' 24.82" W 157° 09' 00.00" W 157° 34' 01.20" W 157° 33' 59.99" W	21° 04' 59.99" N 21° 01' 01.19" N 20° 53' 59.99" N 20° 59' 46.25" N	393
Pailolo Channel	21° 2.0′ N 21° 7.0′ N	156° 37.0′ W 156° 43.0′ W	96
North Kahoʻolawe	21° 35.0′ N 21° 41.5′ N	156° 41.5′ W 156° 45.0′ W	73
Hilo	19° 32.0′ N 19° 54.0′ N	154° 49.0′ W 155° 7.0′ W	845

Source: WPFMC (2016).

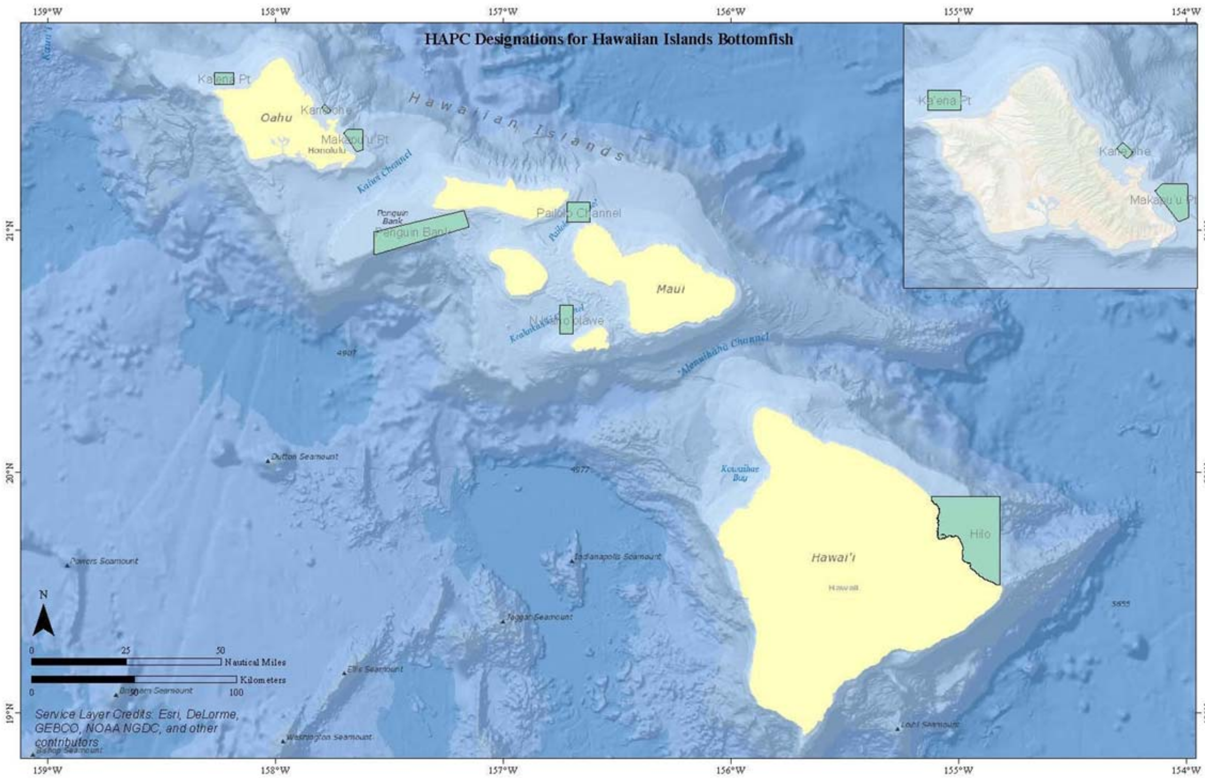

Figure 8. HAPC designations for Hawaiian Islands bottomfish (Source: WPFMC 2016)

3.2.8 Research Needs

The Council previously provided EFH research needs in Amendment 4 to the FEP, which noted that bottomfish are prioritized for habitat assessment (WPFMC 2016), as well as in the Council's Hawaiʻi annual SAFE report (WPFMC 2023). Several identified needs relevant to sub-adult and adult life stages of uku are as follows:

- Spawning locations, patterns, and timing
- Food habits (feeding depth, major prey species, etc.).
- Habitat-related densities for all life history stages.
- Growth, reproduction, and survival rates within habitats.
- Inventory of marine habitats in the US EEZ.
- High resolution maps of bottom topography, currents, water masses, and primary productivity.
- Habitat utilization patterns for different life history stages and species.

The Council also noted that additional research may be necessary to identify and evaluate actual and potential adverse effects on EFH, including, but not limited to, direct physical alteration; impaired habitat quality/functions; indirect adverse effects, such as sea level rise and other climate change concerns; and the cumulative impact of activities (WPFMC 2016). Research and discussions are also needed to decide on EFH thresholds for species with relatively tight habitat affinities, like uku, that result in a low number of observations in surveys. The quantile method adopted from AFSC at present results in extremely low model probabilities of occurrence (<5%) resulting in relatively high cut-offs of EFH, including having EFH designated for waters deeper than where uku have ever been observed and in harbor regions where we lack surveys and uku are generally thought to not inhabit. Recalling that EFH for particular species is more than just where the species occur but acknowledging species presence is the central to designating EFH, future refinements should collaboratively discuss alternative structures for EFH classification for uku and similar rare occurrence species.

3.2.9 Approaches to Better Integrate Goals and Objectives into Habitat Objectives

This document summarized that uku sub-adults and adults can occur across a range of depths, feed on diverse prey originating from a range of habitat types, and may be affected by a suite of stressors that are known to occur in the MHI. At this time, an understanding of sub-adult and adult uku habitat use and seasonal and diel patterns is fragmentary and poorly understood. A relatively fine-scale, seasonal, integrated three-dimensional model of uku occurrence that considers spatial extent and depth of where uku are found could provide information on uku's range, density distribution, high activity sites, and potential for overlap with stressors. Distribution information could be mapped to habitat types, correlated with environmental variables, and compared to information about other MUS and fish communities to inform management of the species. A better distribution model could also allow some predictability of the potential effects on uku from stressors, upcoming projects, and fishing activities. Such a model could be a foundation for modeling other life stages of uku and determining how those life stages are linked, thus providing the potential to apply ecosystem-based fishery management to conserve, manage, and promote uku spawning, redistribution, recruitment, and population persistence.

3.3 Potential Effects of the Alternatives

NMFS will provide NEPA documentation of environmental impacts for the proposed action through a CE. The action is consistent with the type of activities described under NAO 216-6A Companion Manual, Appendix E, NOAA Trust Resource Management Actions, CE Reference Number A1, which applies to "an action that is a technical correction or a change to a fishery management action or regulation, which does not result in a substantial change in any of the following: fishing location, timing, effort, authorized gear types, or harvest levels." There are no direct or indirect effects expected from the proposed action on fishery operations, biology and conservation of the resource, socioeconomics, or safety at sea. Thus, adverse impacts to the fishery, its participants, and the related fishing community are unlikely. Similarly, we do not anticipate effects to the associated natural environment.

REFERENCES

Amesbury S. & R. Myers. 1982. Guide to the coastal resources of Guam. Vol. 1, The fishes. Univ. Guam Pr. University of Guam Marine Laboratory contribution nr 17.

Asher, J., I. D. Williams, & E. S. Harvey. 2017. An assessment of mobile predator populations along shallow and mesophotic depth gradients in the Hawaiian Archipelago. *Scientific Reports*, 7(1), 3905.

Ault, T. R. & C. R. Johnson. 1998. Spatial variation in fish species richness on coral reefs: habitat fragmentation and stochastic structuring processes. *Oikos*, pp.354-364.

Ayers A. 2022. Ecosystem & Socioeconomic Profile of uku (*Aprion virescens*) in the main Hawaiian Islands. Pacific Islands Fisheries Science Center Administrative Report H-22-01. https://doi.org/10.25923/9f2m-4e10.

Bantilan-Smith, M., G. L. Bruland, R. A. MacKenzie. A. R. Henry, & C. R. Ryder. 2009. A comparison of the vegetation and soils of natural, restored, and created coastal lowland wetlands in Hawai‘i. *Wetlands*, *29*, 1023-1035.

Barbier, E. B., S. D. Hacker, C. Kennedy, E. W. Koch, A. C. Stier, & B. R. Silliman. 2011. The value of estuarine and coastal ecosystem services. *Ecological Monographs* 81, no. 2: 169-193.

Breitburg, D. L. 1999. Are three-dimensional structure and healthy oyster populations the keys to an ecologically interesting and important fish community. Oyster Reef Habitat Restoration: a Synopsis and Synthesis of Approaches. Virginia Institute of Marine Science Press, Gloucester Point, Virginia: 239-250.

Colin, Y., M. Goñi-Urriza, C. Gassie, E. Carlier, M. Monperrus, & R. Guyoneaud. 2017. Distribution of sulfate-reducing communities from estuarine to marine bay waters. *Microbial Ecology*, *73*, pp.39-49.

Crain, C. M., K. Kroeker, & B. S. Halpern. 2008. Interactive and cumulative effects of multiple stressors in marine systems. Ecol. Lett. 11: 1304-15.

Crews, M. K. 2012. Artificial oyster reefs as a water quality remediation tool in a contaminated estuary. PhD Dissertation, University of Georgia. 104 pages.

Décima, M., M. R. Stukel, L. López-López, & M. R. Landry. 2019. The unique ecological role of pyrosomes in the Eastern Tropical Pacific. *Limnology and Oceanography*, 64(2), 728-743.

Department of Navy. 2013. Hawai‘i-Southern California Training and Testing Essential Fish Habitat Assessment. Accessed June 23, 2015. Available from http://hstteis.com/Portals/0/hstteis/SupportingTechnicalDocs/HSTT_Revised_Final_EFHA_8-01-13.pdf.

Department of the Navy. 2018. Hawai'i-Southern California Training and Testing (HSTT) Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) Phase III. Accessed November 3, 2023. Available from https://www.nepa.navy.mil/Completed-Projects/At-Sea-Ranges/Hawaii-Southern-California-Training-and-Testing-Environmental-Planning/Documents/

Druzhinin, A. 1970. The range and biology of snappers (family Lutjanidae). *Journal of Icthyology*. 10:717-36.

Edmunds, P. J. & S. C. Gray. 2014. The effects of storms, heavy rain, and sedimentation on the shallow coral reefs of St. John, US Virgin Islands. *Hydrobiologia*, *734*, pp.143-158.

Everson, A., H. Williams, & B. Ito. 1989. Maturation and reproduction in two Hawaiian eteline snappers, uku, Aprion virescens, and onaga, Etelis coruscans. Fish. Bull. 87(4):877-888.

Floros, C., M. H. Schleyer, & J. C. Maggs. 2013. Fish as indicators of diving and fishing pressure on high-latitude coral reefs. *Ocean & Coastal Management*, 84, 130-139.

Franklin EC. 2021. Model-based essential fish habitat definitions for the Uku *Aprion virescens* in the Main Hawaiian Islands. Honolulu: Western Pacific Regional Fishery Management Council.

Giddens J., D. R. Kobayashi, G. N. M. Mukai, J. Asher, C. Birkeland, M. Fitchett, M. A. Hixon, M. Hutchinson, B. C. Mundy, J. M. O'Malley, & M. Sabater. 2022. Assessing the vulnerability of marine life to climate change in the Pacific Islands region. PLoS ONE 17(7): e0270930. https://doi.org/10.1371/journal.pone.0270930

Gifford, S., H. Dunstan, W. O'Connor, & G. R. Macfarlane. 2005. Quantification of in situ nutrient and heavy metal remediation by a small pearl oyster (*Pinctada imbricata*) farm at Port Stephens, Australia. *Marine Pollution Bulletin* 50, no. 4: 417-422.

Gill, A.B., Gloyne-Phillips, I., Neal, K.J. & Kimber, J.A. 2005. The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms-a review. *Final Report: Collaborative Off-Shore Wind Energy Research in the Environment*. London (England): COWIRE 1.5 Electromagnetic Fields Review. 128p.

Grimes, C. 1987. Reproductive biology of Lutjanidae: a review. In: Polovina J, Ralston S, editors. Tropical snappers and groupers: biology and fisheries management. Boulder, CO: Westview Pr. p 239-94.

Haight WR. 1989. Tropic Relationships, Density, and Habitat Associations of Deepwater Snappers (Lutjanidae) from Penguin Bank, Hawai'i. Master's Thesis, University of Hawai'i, Manoa. 86 pages.

Haight, W, D. Kobayashi, & K. Kawamoto. 1993a. Biology and management of deepwater snappers of the Hawaiian archipelago. Mar Fish Rev 55(2):20-7.

Haight, W., J. Parrish, & T. Hayes. 1993b. Feeding ecology of deepwater lutjanid snappers at Penguin Bank, Hawai‘i. Trans. Am. Fish. Soc. 122: 328-347.

Harmelin-Vivien, M.L., 1994. The effects of storms and cyclones on coral reefs: a review. *Journal of Coastal Research*, pp.211-231.

Hixon, M. A. & J. P. Beets. 1993. Predation, prey refuges, and the structure of coral-reef fish assemblages. *Ecological Monographs* 63, no. 1: 77-101.

Kashkina, A. A. 1986. Feeding of fishes on salps (Tunicata, Thaliacea). *Journal of Ichthyology*, 26(3), 57-64.

Kelley, C. & W. Ikehara. 2006. The impacts of bottomfishing on Raita and West St. Rogatien Banks in the Northwestern Hawaiian Islands. Atoll Research Bulletin. 543: 305-318.

Karlsson, T. M., A. D. Vethaak, B. Carney Almroth, F. Ariese, M. van Velzen, M. Hassellöv, & H. A. Leslie. 2017. Screening for microplastics in sediment, water, marine invertebrates and fish: method development and microplastic accumulation. *Marine Pollution Bulletin* 122, no. 1-2: 403-408.

Kiffney, P., J. Thompson, B. Blaud, & L. Hoberecht. 2022. Nonfishing Impacts on Essential Fish Habitat. U.S. Department of Commerce, NOAA White Paper NMFS-NWFSC-WP-2022-01.

Kramer, S. 1986. Uku. In: R.Uchida & J.Uchiyama, eds. *Fishery Atlas of the Northwestern Hawaiian Islands*. NOAA. Technical report nr NMFS 38

Leis, J. & K. Lee. 1994. Larval development in the lutjanid subfamily Etelinae (Pisces): the genera Aphareus, Aprion, Etelis, and Pristipomoides. *Bulletin of Marine. Science*. 55(1): 46-125.

Lieske, E. & R. Myers. 1994. *Coral Reef Fishes*. Harper Collins. Italy. pp. 50, 114.

Meyer, C., Y. Papastamatiou, & K. Holland. 2007. Seasonal, diel, and tidal movements of green jobfish (Aprion virescens, Lutjanidae) at remote Hawaiian atolls: implications for marine protected area design. *Marine Biology*. 151:2133–2143.

Minton, D. 2017. Non-fishing effects that may adversely affect essential fish habitat in the Pacific Islands Region. National Marine Fisheries Service, Pacific Islands Regional Office, Honolulu HI.

Mukai, GNM., Kobayashi DR, Mundy, B., O'Malley J., Giddens, J., Nelson, M. 2022. Pacific Islands Vulnerability Assessment Deep Slope Species Narrative. US Dep. Commer., PIFSC Data Report DR-22-022, 48 pp. https://doi.org/10.25923/p8mc-0386

Nadon, M. O. 2017. Stock assessment of the coral reef fisheries of Hawai‘i, 2016. US Dep. Commer., NOAA Technical Memorandum, NOAA-TM-NMFS-PIFSC-60, 212 p.

Nadon, M. O., M. Sculley, & F. Carvalho. 2020. Stock assessment of uku (*Aprion virescens*) in Hawaiʻi, 2020. U.S. Dept. of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-PIFSC-100, 119 pp. https://doi.org/10.25923/57nb-8138.

NMFS. 2006. Instruction 03-201-15: Guidance to Refine the Description and Identification of Essential Fish Habitat. Silver Spring, MD.

NMFS. 2008. Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern United States. NOAA Technical Memorandum, NMFS-NE-209. Available from http://www.fpir.noaa.gov/Library/HCD/NOAA%20Technical%20Memo%20NMFS-NE209.pdf

NMFS. 2011. Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska. Update to Appendix G of the 2005 Environmental Impact Statement for EFH Identification and Conservation in Alaska. Available from https://alaskafisheries.noaa.gov/habitat/efh/nonfishing/impactstoefh112011.pdf.

NMFS. 2015. Specification of an Annual Catch Limit and Accountability Measures for Main Hawaiian Islands Non-Deep 7 Bottomfish Fisheries in Fishing Years 2015 through 2018.

NMFS. 2020. Annual Catch Limits and Accountability Measures for Main Hawaiian Islands Gray Jobfish (*Aprion virescens*).

NMFS. 2022a. 2022-2025 Annual Catch Limits and Accountability Measures for Main Hawaiian Islands Uku (Gray Jobfish).

NMFS 2022b. Pacific Islands Aquaculture Management Program.

Parrish J. 1987. The trophic biology of snappers and groupers. In: Polovina J, Ralston S, editors. *Tropical Snappers and Groupers: Biology and Fisheries Management*. Boulder, CO: Westview Press. pp. 405-63.

Patranella, A., K. Kilfoyle, S. Pioch, & R. E. Spieler. 2017. Artificial Reefs as Juvenile Fish Habitat in a Marina. *Journal of Coastal Research* 33, no. 6: 1341–51.

Pinnegar, J. K., N. V. C. Polunin, P. Francour, F. Badalamenti, R. Chemello, M. L. Harmelin-Vivien, B. Hereu, M. Milazzo, M. Zabala, G. D'anna, & C. Pipitone. 2000. Trophic cascades in benthic marine ecosystems: lessons for fisheries and protected-area management. *Environmental Conservation*, *27*(2), pp.179-200.

Ralston, S. 1979. A description of the bottomfish fisheries of Hawaiʻi, American Samoa, Guam and the Northern Marianas. Honolulu: Western Pacific Regional Fisheries Management Council.

Ralston, S. & J. Polovina. 1982. A multispecies analysis of the commercial deep-sea hand line fishery in Hawaiʻi. Fish Bull. 80(3):435-48.

Ramirez A. 2012. Non-fishing effects on bottomfish essential fish habitat in Hawai'i. NOAA Fisheries, Pacific Islands Fisheries Science Center. Honolulu, HI.

Riisgård, H. U. & P. S. Larsen. 1995. Filter-feeding in marine macro-invertebrates: pump characteristics, modeling and energy cost. *Biological Reviews* 70, no. 1: 67-106.

Riisgård, H. U. & P. S. Larsen. 2010. Particle capture mechanisms in suspension-feeding invertebrates. *Marine Ecology Progress Series* 418: 255-293.

Riley, G. A. 1970. Particulate organic matter in sea water. *Advances in Marine Biology*, 8, 1-118.

Roff, G., S. Bejarano, M. Priest, A. Marshell, I. Chollett, R. S. Steneck, C. Doropoulos, Y. Golbuu, & P. J. Mumby. 2019. Seascapes as drivers of herbivore assemblages in coral reef ecosystems. *Ecological Monographs* 89, no. 1: 1–18.

Sandlin S. A, S. M. Walsh, & J. B. C. Jackson. (2010.) Prey Release, Trophic Cascades, and Phase Shifts in Tropical Nearshore Ecosystems. In *Trophic Cascades; Predators, Prey, and the Changing Dynamics of Nature*. Eds. J. Terborgh and J. A. Estes. Island Press, Washington. pp. 71-90.

Schmidt A. L., J. L. Whitney, J. Suca, & K. Tanaka. 2023. NOAA Fisheries Larval ecology of Aprion virescens: a review from historical data NOAA Technical Memorandum, TM-PIFSC-145, 71 p. https://doi.org/10.25923/aevx-hr06.

Seki, M. P. & M. W. Callahan. 1988. The feeding habits of two deep slope snappers, *Pristipomoides zonatus* and *P. auricilla*, at Pathfinder Reef, Mariana Archipelago. *Fishery Bulletin*, 86(4), 807-811.

Tanaka K. R., A. L. Schmidt, T. L. Kindinger, J. L. Whitney, J. C. Samson. 2022. Spatiotemporal assessment of *Aprion virescens* density in shallow main Hawaiian Islands waters, 2010-2019. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-132, 33 pp. https://doi.org/10.25923/f24q-k056.

WPFMC. 2005. Essential Fish Habitat Descriptions for Western Pacific Archipelagic and Remote Island Areas Fishery Ecosystem Plan Management Unit Species (Crustacean, Bottomfish, Precious Coral and Coral Reef Ecosystem Species). Honolulu: Western Pacific Regional Fishery Management Council.

WPFMC. 2009. Fishery Ecosystem Plan for the Hawai'i Archipelago. Honolulu: Western Pacific Regional Fishery Management Council.

WPFMC. 2011. WPSAR Hawai'i Archipelago Bottomfish EFH/HAPC Working Group final report. Honolulu: Western Pacific Fishery Management Council.

WPFMC. 2016. Amendment 4 to the Fishery Ecosystem Plan for the Hawai'i Archipelago: Revised Descriptions and Identification of Essential Fish Habitat and Habitat Areas of

Particular Concern for Bottomfish and Seamount Groundfish of the Hawaiian Archipelago. Honolulu: Western Pacific Regional Fishery Management Council.

WPFMC. 2018. Amendment 4 to the Fishery Ecosystem Plan for American Samoa, Amendment 5 to the Fishery Ecosystem Plan for the Mariana Archipelago, Amendment 5 to the Fishery Ecosystem Plan for the Hawai‘i Archipelago. Ecosystem Components. Honolulu: Western Pacific Regional Fishery Management Council.

WPFMC. 2022. Report of the External Independent Review under the Western Pacific Stock Assessment Review process. Level 1 & 2 Essential Fish Habitat Models for Main Hawaiian Islands Uku (*Aprion virescens*). 2022 July 12-14. Honolulu: Western Pacific Regional Fishery Management Council.

WPFMC. 2023. Annual Stock Assessment and Fishery Evaluation Report for the Hawai‘i Archipelago Fishery Ecosystem Plan 2022. T Remington, M Seeley, A Ishizaki (Eds.). Honolulu: Western Pacific Regional Fishery Management Council.

APPENDIX A: DATA AND MAPS

1.0 DATA SOURCES

Data for maps can be found at the following locations:

EFH Maps for Level 1 that include uncertainty:
https://github.com/jsuca18/Uku_EFH

EFH Hotspot Layers:

- EFH level 1 hotspots

https://github.com/krtanaka/pifsc_efh/blob/main/outputs/option_2_percentile_efh.png

- EFH level 2 hotspots

https://github.com/krtanaka/pifsc_efh/blob/main/outputs/option_3_percentile_efh.png

2.0 ADDITIONAL MAPS

Ensemble BRT presence absence models were created following the data sources and predictor layers described in Franklin (2021), using the stationary point count survey for waters 0-30 m and MOUSS and BRUV data for waters >40 m. In each case, parameters of the model (the bag fraction, tree complexity, learning rate, and number of trees) were exactly as described in Franklin (2021). Predictors were also kept consistent to the degree possible. For all water models, bathymetry data came from the Pacific Islands Benthic Habitat Mapping Center (https://www.soest.hawaii.edu/pibhmc/cms/). Rugosity was calculated as the terrain roughness index. Franklin (2021) lists using slope as a predictor; however, slope is highly collinear (r>0.8) with rugosity, and thus slope of slope was used instead. Rugosity, slope of slope, and aspect were all calculated using the terra package in R. Mean and max wave height for 2010-2019 were calculated from WaveWatch III model estimates, closely matching those used in Franklin (2021).

For substrate information, benthic habitat layers were not publicly accessible, thus the methods used changed slightly from Franklin (2021). We used backscatter data from Pacific Islands Benthic Habitat Mapping Center for the deep models (>40 m) as a proxy for substrate type. However, this predictor was excluded from the 0-30 m model as there is near zero overlap in backscatter estimates and observations in this depth range (see the very sparse rug plot for sand in Fig. 12 of Franklin 2021). Mean and max wave height were only used for the 0-30 m models following Franklin (2021).

To generate BRT ensembles, models were fitted with a random 75 percent fraction of each dataset and tested over the remaining 25 percent. This was repeated 100 times, with response curve estimates averaged over this ensemble generating smoother responses. Each of these 100 models per depth range were then used to predict uku occurrence over the full domain (separate 100 model ensembles for shallow and deep strata). Mean estimates per location were then calculated over the ensemble along with range and coefficients of variation. Range was calculated as the difference from the highest estimated probability of occurrence and lowest for each location (highest individual model estimate - lowest individual model estimate at a given location). Coefficients of variation (CV) were calculated as the standard deviation of model estimates at a given location divided by the mean at that location. Model estimates of mean, range, and CV were then mapped at ~500 m resolution throughout the main Hawaiian Islands.

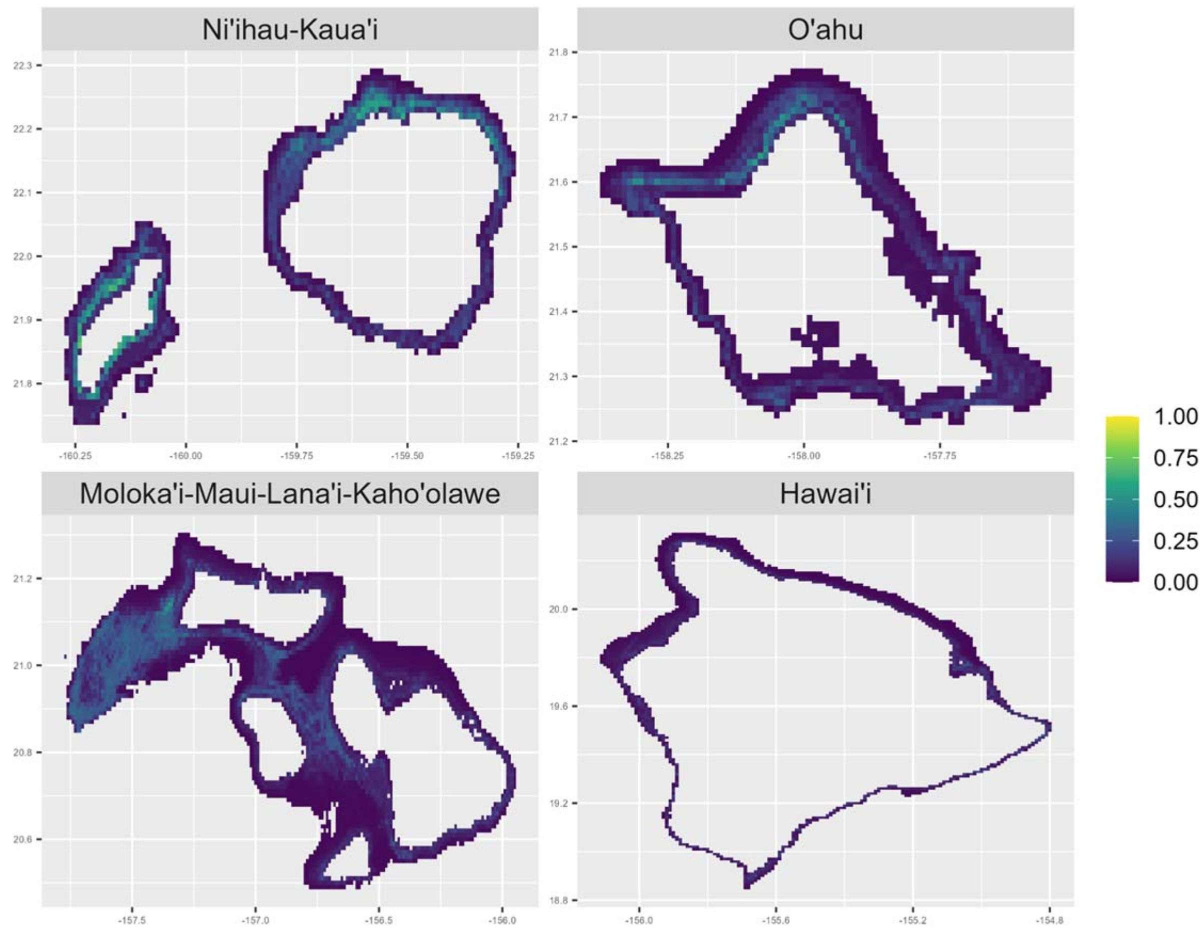

Figure 9. Mean probability of occurrence for sub-adult/adult uku throughout the main Hawaiian Islands (Level 1) using a 100 iteration BRT ensemble. Each model of the ensemble was trained on a random 75 percent split of the full data. For waters <30 m, data were fit to presence-absence from the stationary point count data from NCRMP. For waters >30 m depth, presence-absence comes from drop-camera surveys from PIFSC. Model predictions were originally at 500 m but aggregated to 0.01 decimal degrees.

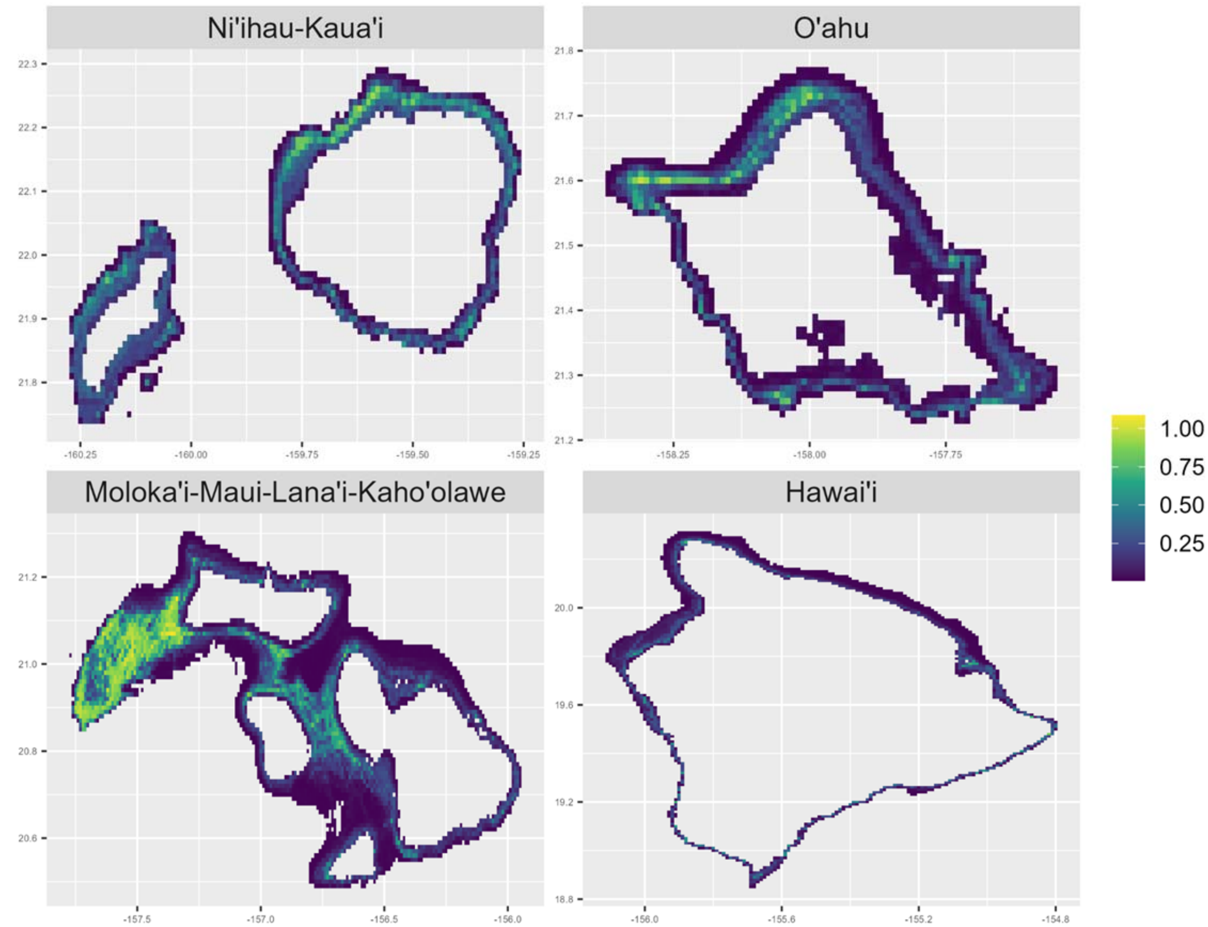

Figure 10. CV of probability of occurrence for sub-adult/adult uku throughout the main Hawaiian Islands (Level 1) using a 100 iteration boosted regression tree ensemble. CV was calculated as the standard deviation of individual model estimates within the ensemble for location divided by the mean of individual model estimates at that location. Each model of the ensemble was trained on a random 75 percent split of the full data. For waters <30 m, data were fit to presence-absence from the stationary point count data from NCRMP. For waters >30 m depth, presence-absence comes from drop-camera surveys from PIFSC. The model derived CV were originally at 500 m but aggregated to 0.01 decimal degrees.

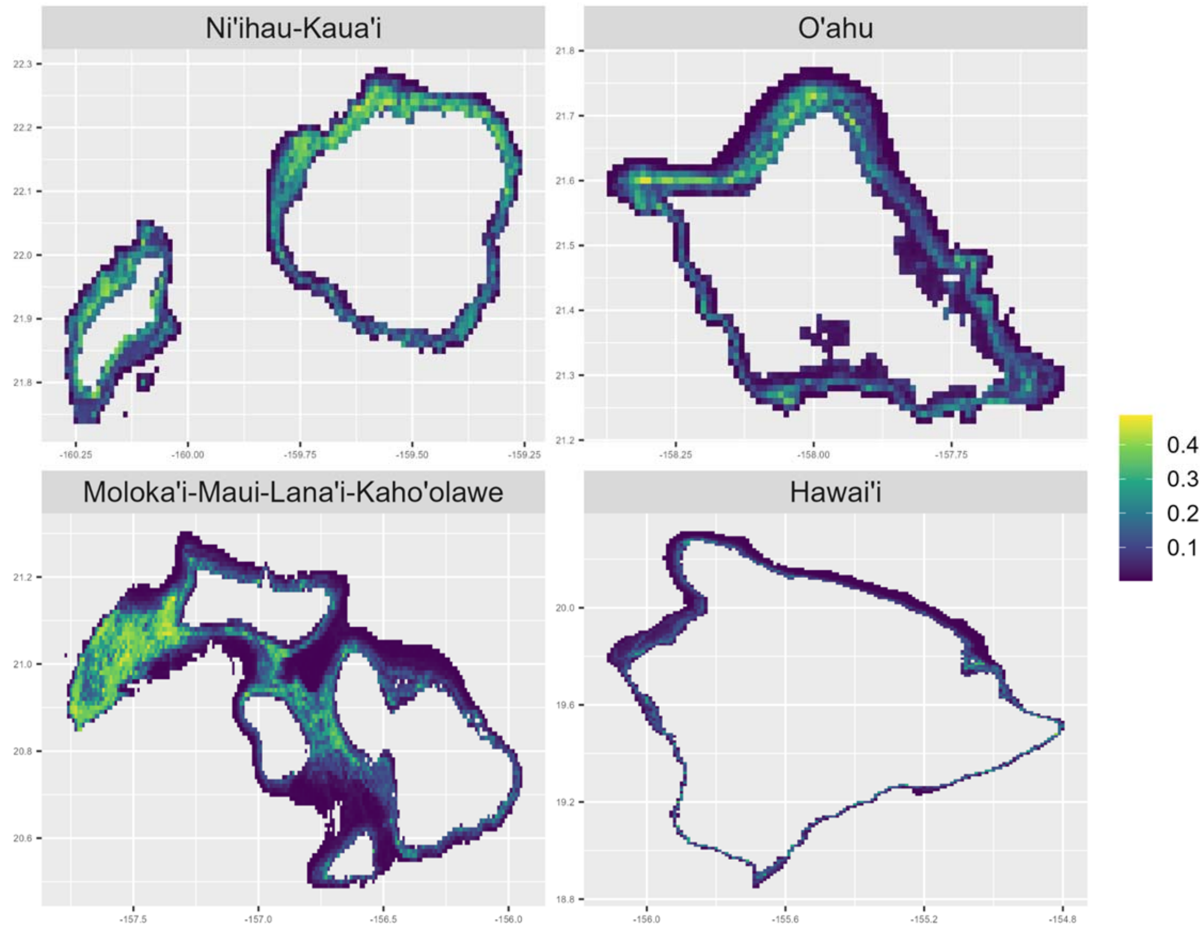

Figure 11. Range of probability of occurrence for sub-adult/adult uku throughout the main Hawaiian Islands (Level 1) using a 100 iteration boosted regression tree ensemble. Range was calculated as the difference between the highest probability of occurrence estimated from an individual model within the ensemble for location and the lowest. Each model of the ensemble was trained on a random 75 percent split of the full data. For waters <30 m, data were fit to presence-absence from the stationary point count data from NCRMP. For waters >30 m depth, presence-absence comes from drop-camera surveys from PIFSC. The model derived range was originally 500 m but aggregated to 0.01 decimal degrees.

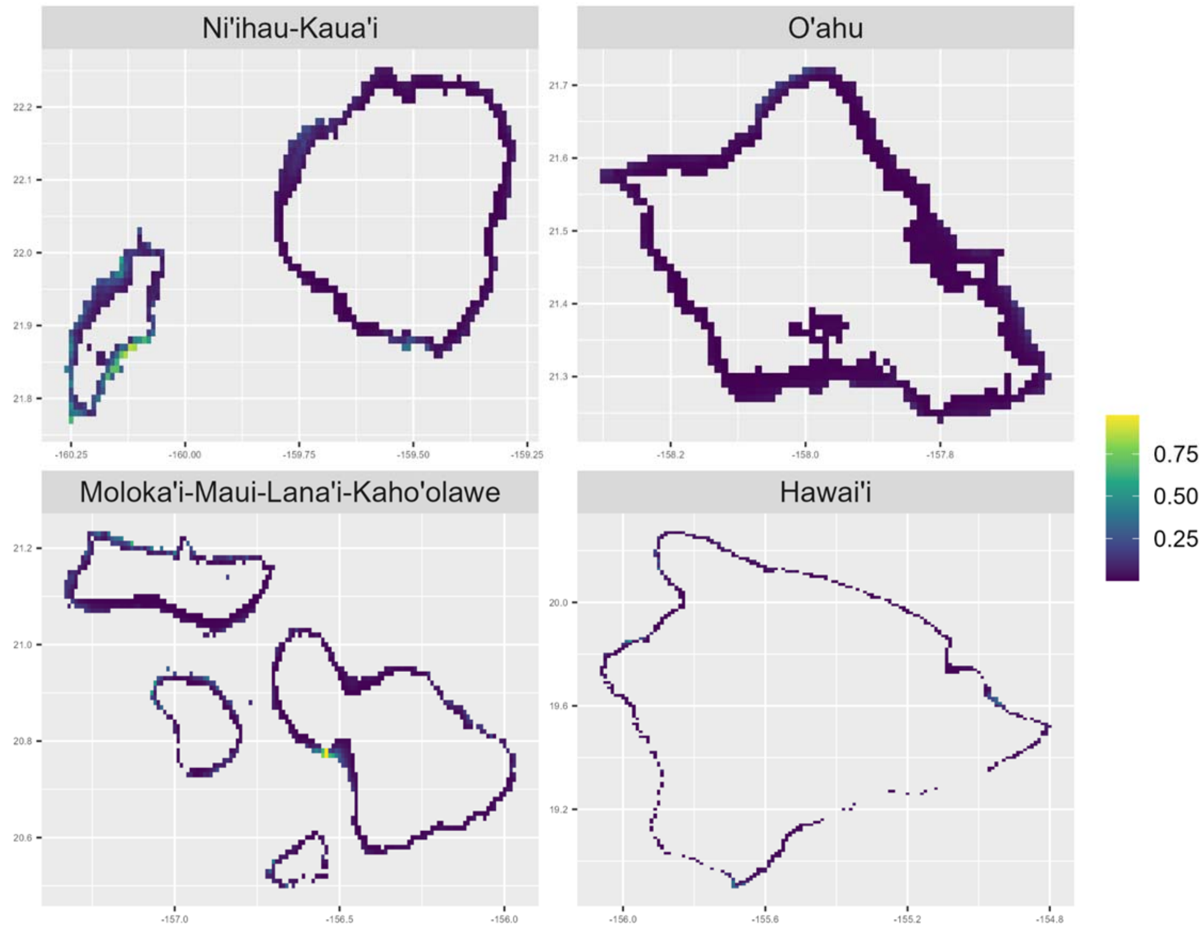

Figure 12. Mean relative density for sub-adult/adult uku throughout the main Hawaiian Islands. Model predictions were originally at 3 arc seconds (~90 m) but aggregated to 0.1 decimal degrees.

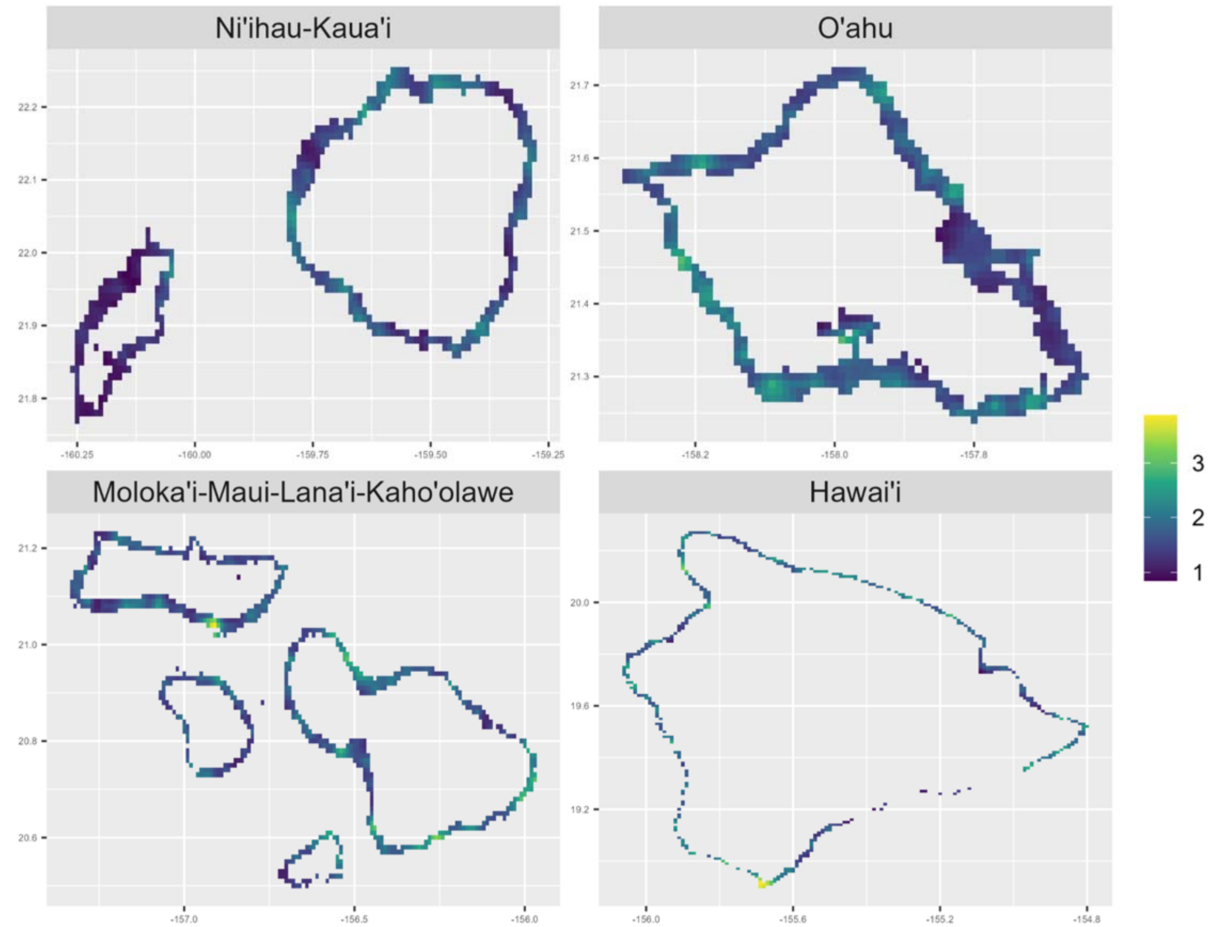

Figure 13. CV of estimated relative density for sub-adult/adult uku throughout the main Hawaiian Islands. CV is used to represent EFH level 2 density model output uncertainty and is computed using 100 simulations with the joint precision matrix (nsim = 100 in the predict function) by taking the ratio of the standard deviation of individual model estimates to their mean at each location. Model predictions were originally at 3 arc seconds (~90 m) but aggregated to 0.1 decimal degrees.

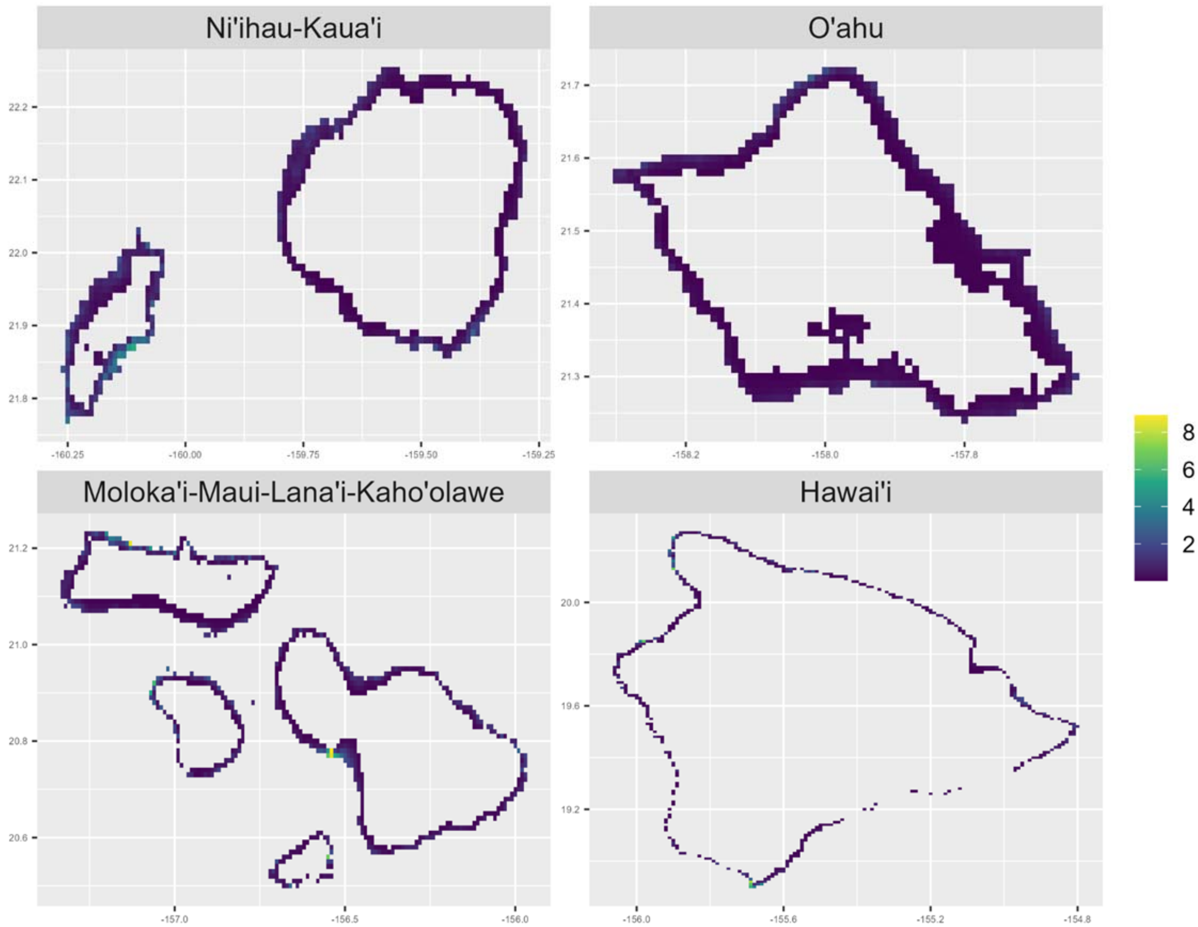

Figure 14. Range of estimated relative density for sub-adult/adult uku throughout the main Hawaiian Islands (Level 2). The range was computed by taking the difference between upper and lower bounds, averaged across all years. The upper and lower bounds were derived from the 2.5th and 97.5th percentiles of the exponentiated results of 100 simulations using the joint precision matrix (nsim = 100 in the predict function), forming a 95 percent confidence interval around the model's predictions. Model predictions were originally at 3 arc seconds (~90 m) but aggregated to 0.1 decimal degrees.

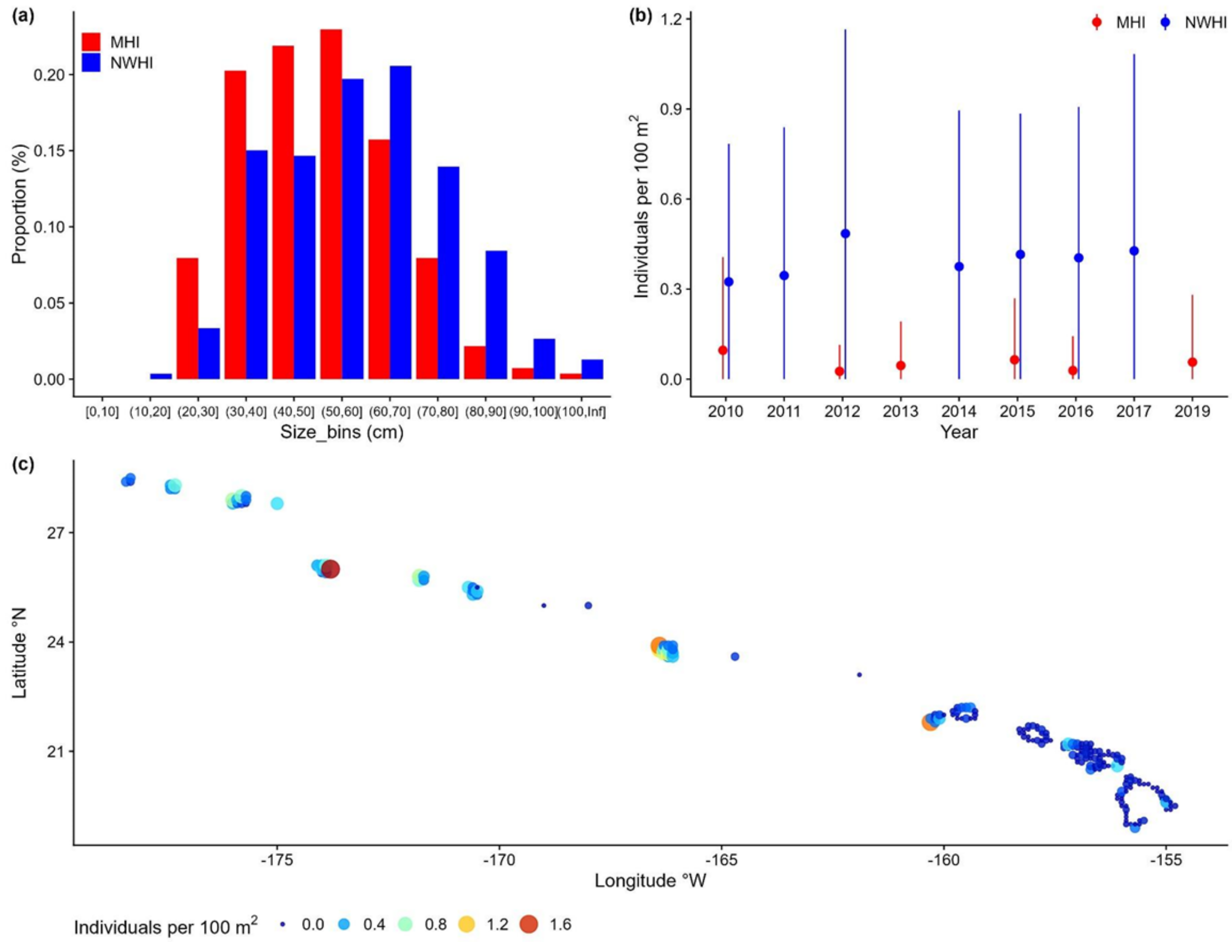

Figure 15. Fishery-independent (a) size compositions, (b) temporal trends, and (c) spatial distributions of *Aprion virescens* density observations in the shallow MHI and NWHI for the 2010-2019 period. Data were provided from the NCRMP.

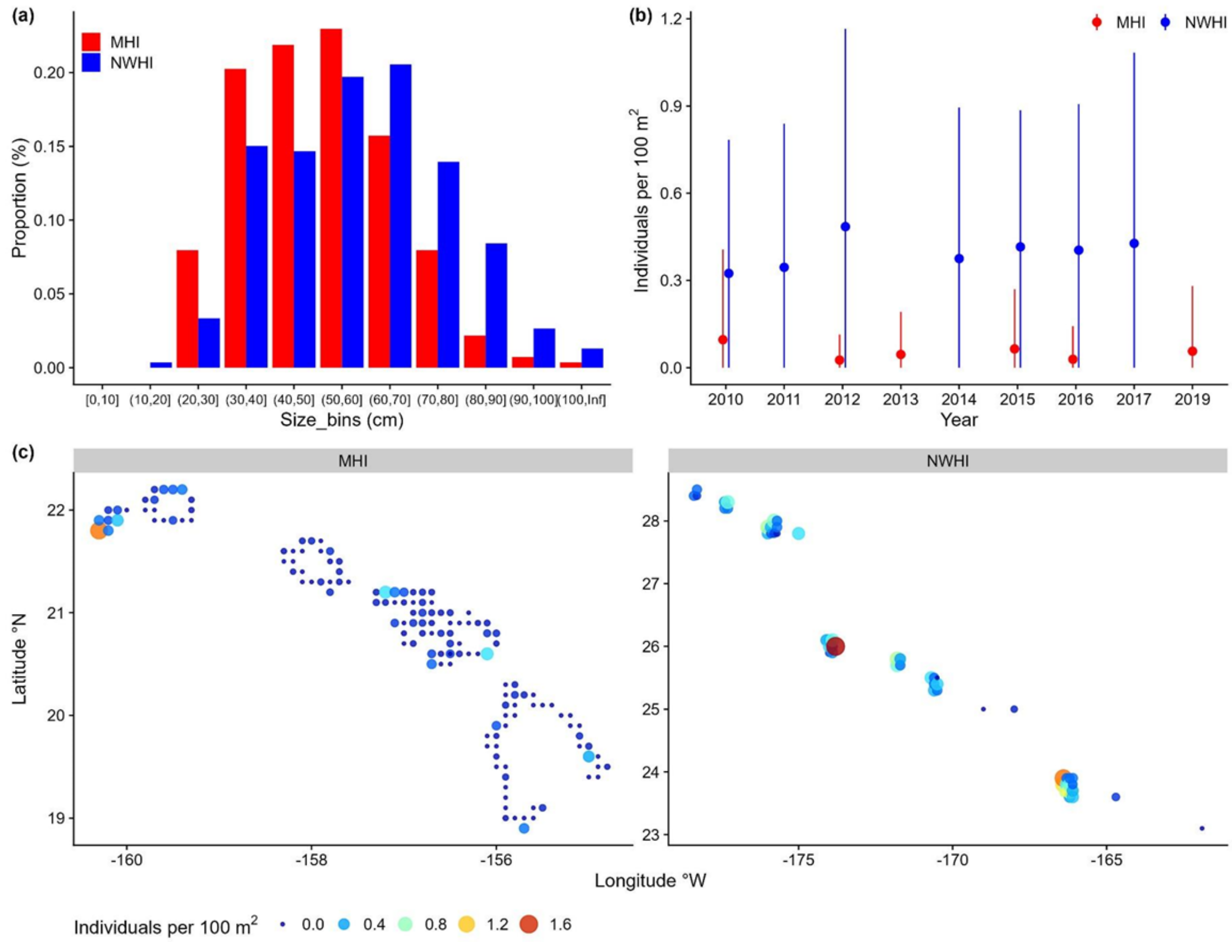

Figure 16. Two panels comparing the size distribution (a), density (b), and distribution (c) of uku between the MHI and NWHI. The spatial resolution of panel c is 0.5 decimal degrees; therefore, it presents the number of uku per 100 m^2 aggregated to 0.5 dec. deg. resolution.