1.8 STATUS DETERMINATION CRITERIA

1.8.11 Bottomfish and Crustacean Fishery

Status determination criteria (SDC), overfishing criteria, and control rules are specified and applied to individual species within a multi-species stock whenever possible. When this is not possible, they are based on an indicator species for that multi-species stock. It is important to recognize that individual species would be affected differently based on this type of control rule, and it is important that for any given species, fishing mortality (F) does not currently exceed a level that would result in excessive depletion of that species. No indicator species are used for the bottomfish multi-species stock complexes. Instead, the control rules are applied to each stock complex as a whole.

The maximum sustainable yield (MSY) control rule is used as the maximum fishing mortality threshold (MFMT). The MFMT and minimum stock size threshold (MSST) are specified based on the recommendations of Restrepo et al. (1998) and both are dependent on the natural mortality rate (M). The value of M used to determine the reference point values is not specified in this section. The latest estimate published annually in the annual SAFE report is used, and the value is occasionally re-estimated using the best available information. The range of M among species within a stock complex is taken into consideration when estimating and choosing the M to be used for the purpose of computing the reference point values.

In addition to the thresholds MFMT and MSST, a warning reference point, B_{FLAG}, is specified at some point above the MSST to provide a trigger for consideration of management action prior to B_{FLAG} reaching the threshold. MFMT, MSST, and B_{FLAG} are specified as indicated in Table 1. Note that the MFMT listed here only applies to Hawaiian bottomfish.

Table 1. Overfishing threshold specifications for Hawaiian bottomfish and NWHI lobsters

MFMT	MSST	B_{FLAG}
$F(B) = \frac{F_{MSY} B}{c\, B_{MSY}}$ for $B \le c\, B_{MSY}$ $F(B) = F_{MSY}$ for $B > c\, B_{MSY}$	$c\, B_{MSY}$	B_{MSY}
where $c = \max(1\text{-}M, 0.5)$		

Standardized values of fishing effort (E) and catch-per-unit-effort (CPUE) are used as proxies for F and B, respectively, so E_{MSY}, $CPUE_{MSY}$, and $CPUE_{FLAG}$ are used as proxies for F_{MSY}, B_{MSY}, and B_{FLAG}, respectively.

In cases where reliable estimates of $CPUE_{MSY}$ and E_{MSY} are not available, they would be estimated from catch and effort times series, standardized for all identifiable biases. $CPUE_{MSY}$ would be calculated as half of a multi-year average reference CPUE, called $CPUE_{REF}$. The multi-year reference window would be objectively positioned in time to maximize the value of $CPUE_{REF}$. E_{MSY} would be calculated using the same approach or, following Restrepo et al. (1998), by setting E_{MSY} equal to E_{AVG}, where E_{AVG} represents the long-term average effort prior to declines in CPUE. When multiple estimates are available, the more precautionary option is typically used.

Since the MSY control rule specified here applies to multi-species stock complexes, it is important to ensure that no species within the complex has a mortality rate that leads to excessive depletion. In order to accomplish this, a secondary set of reference points is specified to evaluate stock status with respect to recruitment overfishing. A secondary "recruitment overfishing" control rule is specified to control fishing mortality with respect to that status. The rule applies only to those component stocks (species) for which adequate data are available. The ratio of a current spawning stock biomass proxy ($SSBP_t$) to a given reference level ($SSBP_{REF}$) is used to determine if individual stocks are experiencing recruitment overfishing. SSBP is CPUE scaled by percent mature fish in the catch. When the ratio $SSBP_t/SSBP_{REF}$, or the "SSBP ratio" (SSBPR) for any species drops below a certain limit ($SSBPR_{MIN}$), that species is considered to be recruitment overfished and management measures will be implemented to reduce fishing mortality on that species. The rule applies only when the SSBP ratio drops below the $SSBPR_{MIN}$, but it will continue to apply until the ratio achieves the "SSBP ratio recovery target" ($SSBPR_{TARGET}$), which is set at a level no less than $SSBPR_{MIN}$. These two reference points and their associated recruitment overfishing control rule, which prescribe a target fishing mortality rate ($F_{RO-REBUILD}$) as a function of the SSBPR, are specified as indicated in Table 2. Again, E_{MSY} is used as a proxy for F_{MSY}.

Table 2. Recruitment overfishing control rule specifications for the BMUS in Hawaii

$F_{RO-REBUILD}$	$SSBPR_{MIN}$	$SSBPR_{TARGET}$
$F(SSBPR) = 0$ for $SSBPR \leq 0.10$ $F(SSBPR) = 0.2\, F_{MSY}$ for $0.10 < SSBPR \leq SSBPR_{MIN}$ $F(SSBPR) = 0.4\, F_{MSY}$ for $SSBPR_{MIN} < SSBPR \leq SSBPR_{TARGET}$	0.20	0.30

The Council adopted a rebuilding control rule for the NWHI lobster stock, which can be found in the supplemental overfishing amendment to the Sustainable Fisheries Act omnibus amendment on the Council's website.

1.8.12 Current Stock Status

1.8.12.1 Deep 7 Bottomfish Management Unit Species Complex

Despite availability of catch and effort (from which CPUE is derived), some life history, and fishery independent information, the MHI Deep 7 BMUS complex is still considered as data moderate. The stock assessment is conducted on a subset of the population that is being actively managed because of the closure of the NWHI to commercial fishing. The assessment is also conducted on the Deep 7 species complex because the State of Hawaii designates the seven species together, and a typical bottom fishing trip is comprised primarily of these seven species.

Generally, data are only available on commercial fishing and associated CPUE by species. The 2018 benchmark stock assessment by PIFSC utilized a state-space surplus production model with explicit process and observation error terms (Langseth et al. 2018). Determinations of overfishing and overfished status were made by comparing current biomass and harvest rates to MSY-based reference points. As of 2015, the MHI Deep 7 bottomfish complex is not subject to overfishing and is not overfished (Table 3). A stock assessment update for MHI Deep 7 BMUS will be completed in 2021.

Table 3. Stock assessment parameters for the MHI Deep 7 bottomfish complex (Langseth et al. 2018)

Parameter	Value	Notes	Status
MSY for total catch	1.048 ± 0.481	Mean ± std. error, units in million lbs.	
MSY for reported catch	509,000 ± 233,000	Mean ± std. error, units in lbs.	
H_{2015}	4.0%		
H_{MSY}	6.9% ± 2.6%	Mean ± std. error	
H/H_{MSY}	0.51		No overfishing occurring
B_{2015}	20.03	Mean, units in million lbs.	
B_{MSY}	15.4 ± 4.9	Mean ± std. error, units in million lbs.	
B/B_{MSY}	1.31		Not overfished

1.8.12.2 Uku

The application of the SDCs for former MUS in the coral reef fisheries of the MHI was limited due to various challenges. First, the thousands of species previously included in the coral reef MUS made the SDC and status determination impractical. Second, the species-specific CPUE comes from Hawaii DAR Fisher Reporting System (FRS). The third challenge was that there was no attempt to estimate MSY for the former coral reef MUS until the 2007 re-authorization of the MSA that requires the Council to specify ACLs for species in the FEPs.

In 2016, 27 species of Hawaii reef fish and non-Deep 7 bottomfish were assessed by PIFSC using a length-based spawning potential ratio (SPR) method, with overfishing limits calculated as the catch level required to maintain SPR = 0.30 (defined as C_{30}) using either abundance from diver surveys or commercial catch estimates (Nadon 2017). Since the assessment was finalized, only one species (uku, *Aprion virescens*) remains a MUS. Results from the uku assessment are presented in Table 4.

Table 4. Results from 2016 stock assessment for MHI uku (Nadon 2017)

Parameter	Value	Notes	Status
F	0.15 ± 0.07	Median ± SD, units yr^{-1}	
F_{30}	0.16 ± 0.01	Median ± SD, units yr^{-1}	
F/F_{30}	0.90 ± 0.5	Median ± SD	No overfishing occurring
SPR	0.33 ± 0.16	Median ± SD	
C_{30} from commercial catch	104,000 ± 226,000	Median ± SD, units kg	
C_{30} from diver survey	60,000 ± 12,100	Median ± SD, units kg	

1.8.12.3 Crustacean

The application of the SDCs for the crustacean MUS is only specified for the NWHI lobster stock. Previous studies conducted in the MHI estimated the MSY for spiny lobsters at approximately 15,000 – 30,000 lobsters per year of 8.26 cm carapace length or longer (WPFMC

1983). There are insufficient data to estimate MSY values for MHI slipper lobsters. MSY for MHI deepwater shrimp has been estimated at 40 kg/nm^2 (Ralston and Tagami 1992).

A stock assessment model was conducted by PIFSC in 2018 for Kona crab stock in the MHI (Kapur et al. 2019). This assessment used a Bayesian state-space surplus production model to estimate parameters needed to determine stock status. Based on this, the Kona crab stock is not overfished, and overfishing is not occurring (Table 5).

Table 5. Stock assessment parameters for the Hawaiian Kona crab stock (Kapur et al. 2019)

Parameter	Value	Notes	Status
MSY for total catch	73,069	In lbs.	
MSY for reported catch	25,870	In lbs.	
H_{2016}	0.0081	Expressed as proportion	
H_{MSY}	0.114	Expressed as proportion	
H/H_{MSY}	0.0714		No overfishing occurring
B_{2016}	885,057	In lbs.	
B_{MSY}	640,489	In lbs.	
B_{2016}/B_{MSY}	1.3977		Not overfished

For ACL-specification purposes, the MSY for spiny lobsters is determined by using the Biomass-Augmented Catch-MSY approach (Sabater and Kleiber 2014). This method estimates MSY using plausible combination rates of population increase (denoted by *r*) and carrying capacity (denoted by *k*) assumed from the catch time series, resilience characteristics (from FishBase), and biomass from existing underwater census surveys done by PIFSC. This method was applied to species complexes grouped by taxonomic families. The most recent MSY estimates are found in Table 6.

Table 6. Best available MSY estimates for the Crustacean MUS in Hawaii

Fishery	Management Unit Species	MSY (lbs.)
Crustacean	Deep-water shrimp	598,328
	Kona crab	73,069

Sources: Deepwater shrimp (Tagami and Ralston 1992); Kona crab (Kapur et al. 2019).

OVERFISHING LIMIT, ACCEPTABLE BIOLOGICAL CATCH, AND ANNUAL CATCH LIMITS

1.8.13 Brief description of the ACL process

The Council developed a tiered system of control rules to guide the specification of ACLs and Accountability Measures (AMs; WPRFMC 2011). The process starts with the use of the best scientific information available (BSIA) in the form of, but not limited to, stock assessments, published papers, reports, and/or available data. These data are categorized into the different tiers in the control rule ranging from Tier 1 (i.e., most information available, typically a stock assessment) to Tier 5 (i.e., catch-only information). The control rules are applied to the BSIA. Tiers 1 to 3 involve conducting a Risk of Overfishing Analysis (denoted by P*) to quantify the scientific uncertainties associated with the assessment to specify the Acceptable Biological Catch (ABC), lowering the MSY-based overfishing limit (OFL) to the ABC. A Social, Ecological, Economic, and Management (SEEM) Uncertainty Analysis is performed to quantify the uncertainties associated with the SEEM factors, and a buffer is used to lower the ABC to an ACL. For Tier 4, which is comprised of stocks with MSY estimates but no active fisheries, the control rule is 91 percent of MSY. For Tier 5, which has catch-only information, the control rule is a one-third reduction in the median catch depending on a qualitative evaluation of stock status via expert opinion. Implemented ACL can choose from a variety of methods including the above mentioned SEEM analysis or a percentage buffer (i.e., percent reduction from ABC based on expert opinion) or the use of an Annual Catch Target (ACT). NMFS can implement ACLs on an annual basis, but the Council normally recommends a multi-year specification.

The AM typically implemented Hawaii insular fisheries is post-season AM in the form of an overage adjustment. The subsequent ACL is downward adjusted with the amount of overage relative to the previous ACL based on a three-year running average. A three-year average of recent catch is utilized as recommended by the Council at its 160th meeting to avoid large fluctuations in catch due to data quality and outliers. The uku and Kona crab fisheries, however, also implemented an in-season AM where, if the catch is projected to reach the implemented ACT, the fishery will be closed in Federal waters for the remainder of the fishing year. Similarly, an in-season AM for precious coral fisheries will close individual coral beds if the ACL for that bed is projected to be reached.

1.8.14 Current OFL, ABC, ACL, and Recent Catch

The most recent implementation of OFLs, ABCs, and ACLs covers fishing years 2019-2021 for the MHI Deep 7 bottomfish stock complex, 2020-2023 for Kona crab (85 FR 79928, December 11, 2020), 2019-2021 for uku, 2019-2021 for deepwater shrimp, and 2019-2021 for precious corals (85 FR 26622, May 5, 2020). The fisheries for deep sea precious corals remain relatively inactive. ACLs are no longer specified for coral reef species nor several crustacean species due to the recent ecosystem component species amendment (84 FR 2767, February 9, 2019). Note that the MHI Deep 7 stock complex operates based on fishing year and is still open. The ACT for Kona crab was newly implemented, and any projected exceedance of the ACT will result in a Federal fishery closure for the species. The ACLs shown in Table 7 are the most recently implemented ACLs by NMFS. Recent average catch for the MHI Deep 7 Bottomfish stock complex (217,846 lbs.) accounted for 44.3% of its implemented ACL (492,000 lbs.; Table 7).

Table 7. Hawaii 2020 ACLs with three-year recent average catch (lbs.)

Fishery	Management Unit Species	OFL	ABC	ACL	ACT	Catch
Bottomfish	MHI Deep 7 stock complex	558,000	508,000	492,000	NA	192,805
	Aprion virescens (uku)	132,277	127,205	127,205	NA	71,059
Crustacean	Deepwater shrimp	N.A.	250,773	250,773	NA	n.d.
	Kona crab	33,989	30,802	30,802	25,491	4,219
Precious Coral	Auau Channel black coral	NA	7,508	5,512	NA	n.d.
	Makapuu Bed pink coral	NA	3,009	2,205	NA	n.d.
	Makapuu Bed bamboo coral	NA	571	551	NA	n.d.
	180 Fathom Bank pink coral	NA	668	489	NA	n.d.
	180 Fathom Bank bamboo coral	NA	126	123	NA	n.d.
	Brooks Bank pink coral	NA	1,338	979	NA	n.d.
	Brooks Bank bamboo coral	NA	256	245	NA	n.d.
	Kaena Point Bed pink coral	NA	201	148	NA	n.d.
	Kaena Point Bed bamboo coral	NA	37	37	NA	n.d.
	Keahole Bed pink coral	NA	201	148	NA	n.d.
	Keahole Bed bamboo coral	NA	37	37	NA	n.d.
	Hawaii Exploratory Area precious corals	NA	2,205	2,205	NA	n.d.

Notes: "n.d." indicates that the data could not be disclosed due to issues with data confidentiality (i.e., less than three licenses reporting). "NA" indicates that there is no value for the given parameter (i.e., not estimated or implemented).

BEST SCIENTIFIC INFORMATION AVAILABLE

1.8.15 Main Hawaiian Island Deep 7 Bottomfish Fishery

1.8.15.1 Stock Assessment Benchmark

In 2018, PIFSC completed a benchmark stock assessment for the MHI Deep 7 bottomfish fishery (2018 stock assessment) using data through 2015 (Langseth et al. 2018). The 2018 stock assessment used a Bayesian state-space surplus production model and included several improvements, such as updated filtering and standardization methods for CPUE from commercial data based on a series of workshops that included input from various management, scientific, and industry participants (Yau 2018). It also incorporated a fishery-independent estimate of abundance as estimated from Richards et al. (2016).

The 2018 assessment estimates a maximum sustainable yield (MSY) for reported catch of 509,000 lbs. for the MHI Deep 7 bottomfish stock complex. The 2018 stock assessment also included projection results of a range of commercial catches of Deep 7 bottomfish that would produce probabilities of overfishing ranging from 0 percent to 100 percent and 1 percent intervals. If 558,000 lbs. of reported catch occur from fishing years 2018-2022, there is a 50% risk of overfishing in 2022; this is the overfishing limit.

1.8.15.2 Stock Assessment Updates

A stock assessment update for the MHI Deep 7 bottomfish complex will be completed in 2021.

1.8.15.3 Best Available Scientific Information

National Standard 2 requires that conservation and management measures be based on the BSIA and be founded on comprehensive analyses. National Standard 2 guidelines (78 FR 43087, July 19, 2013) state that scientific information that is used to inform decision making should include an evaluation of its uncertainty and identify gaps in the information (50 CFR 600.315(a)(1). The guidelines also recommend scientific information used to support conservation and management be peer reviewed (50 CFR 600.315(a)(6)(vii)). However, the guidelines also state that mandatory management actions should not be delayed due to limitations in the scientific information or the promise of future data collection or analysis (50 CFR 600.315(a)(6)(v)).

The PIFSC determined that the 2018 benchmark stock assessment by Langseth et al. (2018) was the BSIA. This is based on the assessment passing a Western Pacific Stock Assessment Review by a three-person independent peer review panel.

1.8.16 Uku Fishery

1.8.16.1 Stock Assessment

In February 2017, PIFSC released the final species level assessment for the main Hawaiian Islands (Nadon 2017). This assessment covers 27 species of fishes, one of which is uku (*Aprion virescens*). The remaining 26 species are no longer MUS.

This assessment utilized a different approach compared to the existing model used for the fishing years 2015-2018 specification. It used life history information and a length-based approach to obtain stock status based on SPR rather than MSY. When life history information is not available for a species, a data-poor approach is used to simulate life history parameters based on known relationships (Nadon and Ault 2016). Fishery independent size composition and abundance data from diver surveys were combined with fishery dependent catch estimates to calculate current fishing mortality rates (F), SPR, SPR-based sustainable fishing rates (F_{30}; F resulting in SPR = 30%), and catch levels corresponding to these sustainable rates (C_{30}). A length-based model was used to obtain mortality rates and a relatively simple age-structured population model to find the various SPR-based stock status metrics. The catch level to maintain the population at SPR=30%, notated as C_{30}, was obtained by combining F_{30} estimates with current population biomass estimates derived directly from diver surveys or indirectly from the total catch. The OFL to a 50% risk of overfishing was defined as the median of the C_{30} distribution.

1.8.16.2 Stock Assessment Updates

There are no stock assessment updates available for uku.

1.8.16.3 Best Scientific Information Available

The Nadon (2017) assessment underwent peer review starting with the Center for Independent Experts (CIE) review on September 8 to 11, 2015 (Dichmont 2015; Pilling 2015; Stokes 2015) which focused on the individual method. The assessment author addressed the CIE review comments and recommendations and developed a stock assessment report that was reviewed by a Western Pacific Stock Assessment Review panel from August 29, 2016 to September 2, 2016 (Choat 2016; Franklin 2016a; Franklin 2016b; Stokes 2016), which was asked to review the application of the method to individual species. The assessment author revised the draft assessment addressing the WPSAR panel comments and recommendation and presented the final stock assessment document at the 125th and 169th meeting of the SSC and Council, respectively. PIFSC and the Council consider these assessments the BSIA for these species.

1.8.17 Crustacean Fishery

1.8.17.1 Stock Assessment Benchmark

Deep-water Shrimp: The deepwater shrimp (*Heterocarpus laevigatus* and *H. ensifer*) initial resource assessment was conducted in the early 1990s by Ralston and Tagami (1992). This involved depletion experiments, stratified random sampling of different habitats, and calculation of exploitable biomass using the Ricker equation (Ricker 1975). Since then, no new estimates were calculated for this stock.

Kona Crab: A benchmark stock assessment model was completed by PIFSC scientists in 2019 (Kapur et al. 2019). This assessment utilized a Bayesian state-space surplus production model. Based on this, the Kona crab stock is not overfished and not experiencing overfishing.

PIFSC determined the Kapur et al. (2019) stock assessment to be the BSIA for Kona crabs because the assessment passed independent peer review by a WPSAR three-person panel.

1.8.17.2 Stock Assessment Updates

There are no stock assessment updates available for the crustacean MUS.

1.8.17.3 Best Scientific Information Available

To date the best available scientific information for the crustacean MUS are as follows:

- Deepwater shrimp – Ralston and Tagami (1992)
- Kona crab – Kapur et al. (2019)