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Options for Establishing Status Determination Criteria for Kona Crab under the Hawaii Archipelago Fishery Ecosystem Plan

DRAFT

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Proposed Timeline

Date(s)	Task/Progress
September 13-22, 2022	Initial discussions at the SSC and Council Meetings
Early October, 2022	Action Team kickoff and frontloading
October, 2022	Draft FEP Amendment and NEPA analysis development
Early- to mid-November, 2022	Initial reviews back and forth between Council and PIRO
November 29-December 8, 2022	Initial Action at the SSC and Council Meetings
Mid- to late December, 2022	NOAA OLE review
January, 2023	NOAA GC "red flag" review
February, 2023	PIRO and Council update document and finalize
March, 2023	Final Action at the SSC and Council Meetings
Late March-early April, 2023	Final NOAA GC Review
Late April, 2023	Update documents and transmit to PIRO
Late April, 2023	PIRO initiates 95-day rulemaking process
May, 2023	NOA/Proposed Rule
June, 2023	Respond to comments
August, 2023	Final Rule

CHAPTER 1. Background Information

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) established the Western Pacific Fishery Management Council (WPFMC, or the Council) in 1976 to develop management plans for fisheries within the United States Fishery Conservation Zone around Hawaii, U.S. Pacific territories, commonwealth, and possessions of the United States in the Pacific Ocean. Crustacean fisheries in the Main Hawaiian Islands (MHI) harvest federally managed crustacean management unit species (CMUS), inclusive of the Kona crab, *Ranina ranina* (Linnaeus 1767), also referred to as the "spanner crab" or "frog crab."

The Council and the National Marine Fisheries Service (NMFS) manage the MHI Kona crab fishery in federal waters (i.e., the U.S. Exclusive Economic Zone, or EEZ, 3 to 200 nm from shore) around the MHI in accordance with the Fishery Ecosystem Plan (FEP) for the Hawaii Archipelago (WPFMC 2009), the Magnuson-Stevens Act, and implementing regulations at 50 CFR 665. The State of Hawaii manages the Kona crab fishery in State waters (i.e., generally 0 to 3 nm from shore) that are not part of the Hawaii FEP management area, though the State of Hawaii and NMFS collaborate to implement complementary management for federal fisheries.

Previously, the Council's Crustaceans Fishery Management Plan (FMP), implemented in 1983, considered Kona crab as a management unit species (MUS) since it was incidentally caught in the now-dormant Northwestern Hawaiian Islands (NWHI) spiny lobster fishery, but overfishing definitions were never developed for the species because catch was considered to be negligible in federal waters (WPFMC 1981). When the Council's species-based FMPs transitioned to into spatially oriented FEPs (75 FR 2198, January 14, 2010), the MUS status for Kona crab was retained without overfishing definitions despite the fishery beginning to grow in federal waters (e.g., Penguin Banks). Subsequently, after Amendment 3 to the Hawaii Archipelago FEP (76 FR 37285, June 27, 2011), the Council and NMFS began implement annual catch limits (ACLs) and conducting stock assessments for the species.

While the 2019 stock assessment indicated that the MHI Kona crab stock is not overfished nor experiencing overfishing (Kapur et al. 2019), the Council's Hawaii Archipelago FEP does not specify status determination criteria (SDC) for the Kona crab MUS. Thus, despite the results of the stock assessment, the stock status of MHI Kona crab remains "unknown" under the NMFS Fisheries Stock Sustainability Index (FSSI), a quarterly index that measures the performance of federally managed fish stocks (e.g., NMFS 2022a). Additionally, due to the lack of MHI Kona crab SDC, the FEP currently does not meet the requirements of National Standard 1 of the Magnuson-Stevens Act and does not allow for the determination and reporting of stock status consistent with section 304(e) of the Magnuson-Stevens Act.

1.1 Species Description

Kona crab is a commercially harvested species throughout its ecological range in the tropical and subtropical Indo-Pacific region, where it is widely considered a delicacy (Wiley et al. 2020). The species displays sexual dimorphism, with males growing to a much larger size than females (Uchida 1986). In Hawaii, males reach maturity at 2.9 inch carapace length, and the majority of females reach sexual maturity at 2.6 inch carapace length (Fielding and Haley 1976; Onizuka

1972). Fishers can easily differentiate the sexes of adult crabs based on morphology (NMFS 2020; Figure 1). The sex composition in catches of Kona crabs in the MHI is approximately 49% male and 51% female (Wiley and Pardee 2018; Wiley et al. 2020).

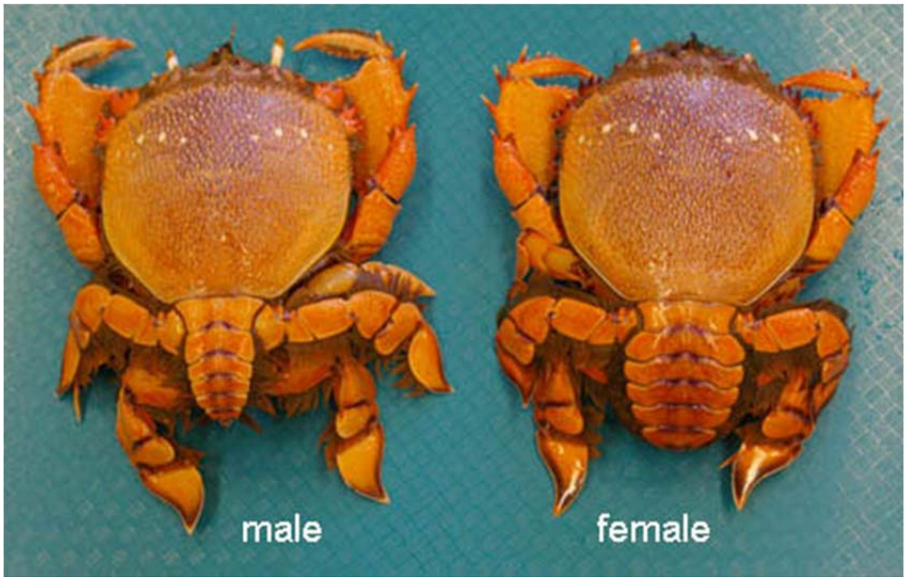

Figure 1. Dorsal view of male and female individuals of Kona crab.
Source: State of Hawaii Division of Aquatic Resources (HDAR) website.

Kona crabs bury themselves in sandy substrates from 2 to 200 m depths (Wiley et al. 2020), emerging only to scavenge (Onizuka 1972; Fielding and Haley 1976). The crabs spend roughly 22 hours per day buried in the sand on average, and females tend to be buried longer than males (Skinner and Hill 1986). Feeding rates and emergence time (i.e., time spent not buried in the sand) for females are associated with their reproductive cycle (Kennelly and Watkins 1994). From February to May, when ovarian growth for female Kona crabs tends to occur, feeding rates increase for female individuals (Fielding and Haley 1976). Egg-bearing (i.e., berried) females are less likely to emerge from the sand but most frequently do so between June and July (Onizuka 1972). Males must be large enough to successfully dig female crabs out of the sand in order to reproduce (Skinner and Hill 1986; Minagawa 1993). Many of these known life history traits for Kona crab in the MHI actively influence the directed fishery for this species.

1.2 Fishery Description

Kona crabs are a prized food species in Hawaii that are harvested for consumption at social gatherings, graduations, weddings, and holidays (NMFS 2020; Wiley et al. 2020). Fishers target the species by setting strings of baited, circular tangle-nets over sandy bottom areas for an average of one hour (Kennelly and Craig 1989). Individuals emerge from the sand and become entangled in the mesh of the nets as they walk across it to eat the bait.

Fishing for Kona crab occurs in both State and federal waters around the MHI, and the fishing year runs from January 1 through December 31 annually. In federal waters, fishing for Kona crab primarily occurs at Penguin Bank, an area off the coasts of Maui, Molokai, and Lanai for which a vessel is required to access. Though fishing trips for Kona crab at Penguin Bank account for only

20% of all trips, fishing in this area tends to result in a higher catch per unit effort (CPUE) and the harvest of larger individuals (Thomas 2011).

The MHI Kona crab fishery is tightly regulated by both State and federal management. Under the Magnuson-Stevens Act, the Council and NMFS must implement and monitor the fishery against an ACL and AMs to ensure the stock remains sustainable. The FEP management regime prohibits the use of non-selective and destructive gear (e.g., bottom trawls, bottom-set nets, explosives, and poisons) to harvest Kona crab. The State of Hawaii has also implemented a suite of management regulations intended to conserve Kona crab resources, including a prohibition on taking of female Kona crab (Hawaii Revised Statutes §188-58.5), a minimum size for male crabs of 4 inches carapace length, seasonal closures from May to August for breeding (§HAR 13-95), and gear restrictions (e.g., no spearfishing and a minimum net mesh size; Hawaii Administrative Rule Title 13, Subtitle 4, Chapter 95 §13-95-51). Based on the size regulations, it would take an average of 4.3 years for male crabs and 6.3 years for female crabs to reach the legal size in Hawaii (Kapur et al. 2019). These management provisions result in a high number of regulatory discards for the fishery due to size and sex restrictions on harvested individuals.

Due to the high rate of undersized and female discards for Kona crab, stock assessments and management regimes must consider the post-release mortality for the species, in consideration of injuries sustained during net disentanglement and predation, to better understand total mortality (Wiley et al. 2020). Recent studies show that post-release mortality of female crabs in Hawaii is just over 10% (Wiley 2017; Wiley and Pardee 2018). A study also found the total mortality of uninjured crabs to be around 4.5% (Wiley et al. 2020), in contrast with previous studies indicating higher rates (Onizuka 1972; Kennelly et al. 1990; Kirkwood and Brown 1998). The same study calculated the annual fishing mortality for Kona crabs in the Hawaii fishery to be 1.4 times that of the reported landed crabs due to death after release associated with injury or stresses of fishing pressure and corresponding with an unaccounted mortality rate (i.e., the combined rates of post-release mortality and total predation) of 10.9% (Wiley et al. 2020). While the loss of an entire limb has notable impacts on Kona crab post-release survival rates, the mortality rate greatly decreased when the limb was cut cleanly at the base rather than pulled off (Wiley et al. 2020). Hawaiian Kona crabs can seal wounds and regenerate lost limbs from injuries associated with fishing or predation, but breakage caused by fishing and associated blood loss sustained likely affects their survival rates and growth rates after molting (Wiley et al. 2020).

In addition to gear, size, and sex regulatory restrictions, the State of Hawaii requires that fishers have a Commercial Marine License (CML) to harvest Kona crab for commercial purposes and report catch on a monthly basis. Over the past 20 years, the annual number of CML holders, trips taken, catch, and CPUE generally trended downward before reaching all-time lows in 2016 for each metric except for the number of CML holders (Table 1; Figure 2). Since 2016, participation and effort have had relatively consistent trends despite interannual variability, while catch and CPUE generally increased despite a slight reduction in 2021 (Table 1; Figure 2). Considering the commercial sector of the MHI Kona crab fishery, trends in adjusted

annual revenue and pounds sold tend to closely track with total estimated catch (Table 2;

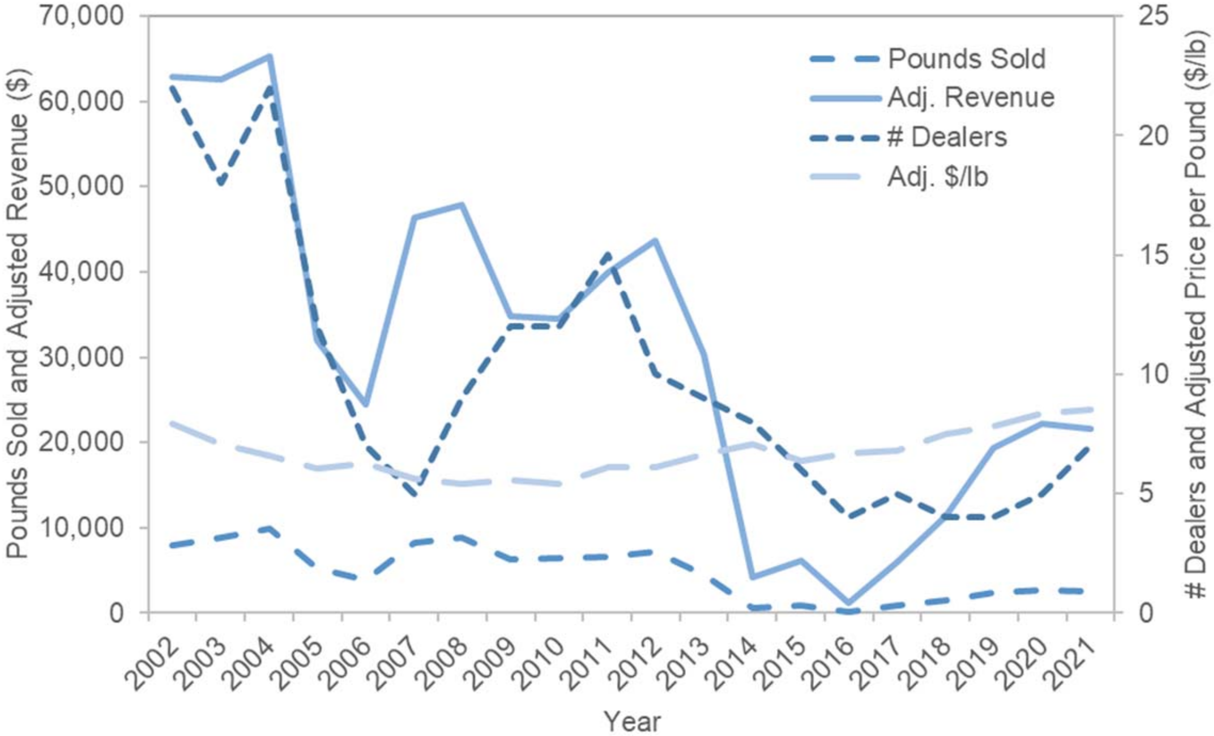

Figure 3). Despite the decline of values through 2016, average adjusted price per pound of Kona crab has continued to trend upward (Table 2;

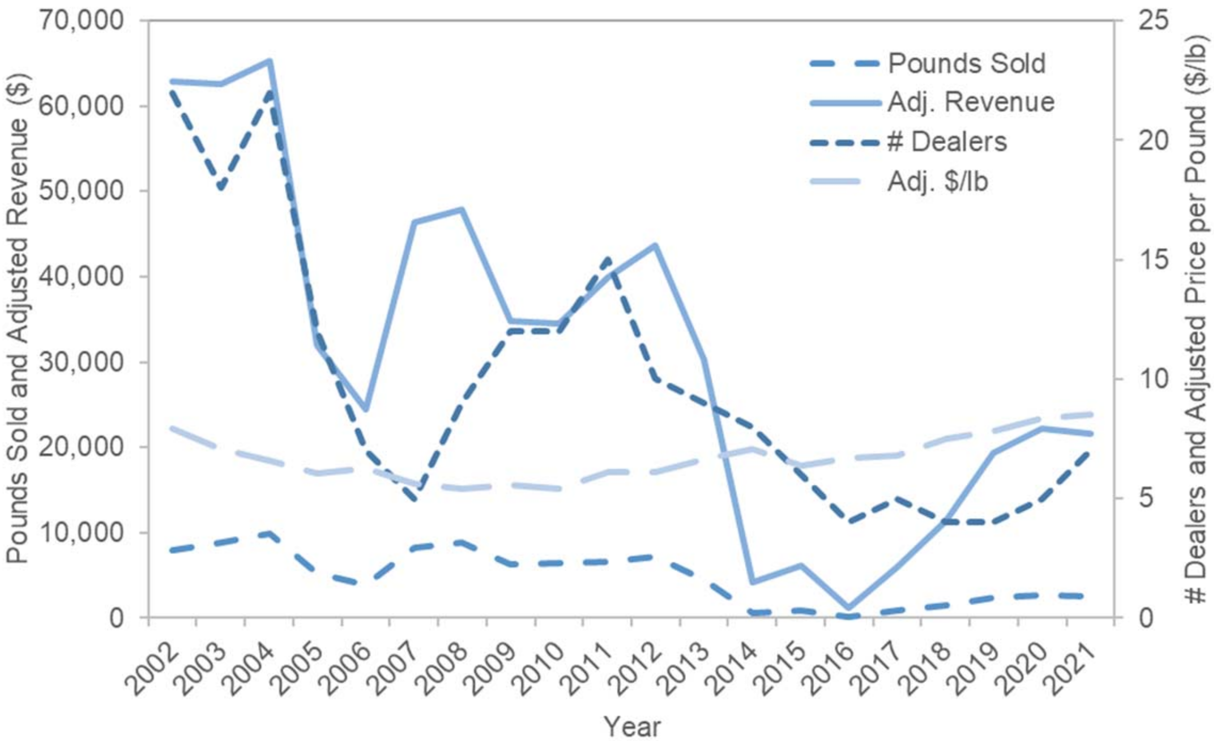

Figure 3).

Federally, according to the NMFS 2022 List of Fisheries (LOF), the MHI Kona crab loop net fishery consists of approximately 20 vessels and/or fishers harvesting the species (87 FR 23133, April 19, 2022), down from 33 vessels/persons in the 2021 LOF (86 FR 3028, January 14, 2021).

Table 1. Time series data for the Main Hawaiian Islands Kona crab loop net fishery.

Fishing Year	# CML Holders Reporting Catch	# Trips	Catch (lb)	CPUE (lb/trip)
2002	63	196	12,830	65.46
2003	49	158	11,841	74.94
2004	48	167	12,164	72.84
2005	46	161	9,937	61.72
2006	35	128	6,749	52.73
2007	31	188	9,773	51.98
2008	36	201	10,940	54.43
2009	41	191	9,097	47.63
2010	46	178	9,913	55.69
2011	46	172	10,876	63.23
2012	35	121	7,980	65.95
2013	33	83	7,330	88.31
2014	24	59	2,029	34.39
2015	26	62	2,902	46.81
2016	16	25	745	29.80
2017	19	53	2,753	51.94
2018	20	52	2,769	53.25
2019	24	71	5,688	80.11
2020	12	42	4,201	100.02
2021	17	45	3,822	84.93
5-year average	**18**	**53**	**3,847**	**74**
10-year average	**23**	**61**	**4,022**	**64**
20-year average	**33**	**118**	**7,217**	**62**

Source: WPFMC (2022).

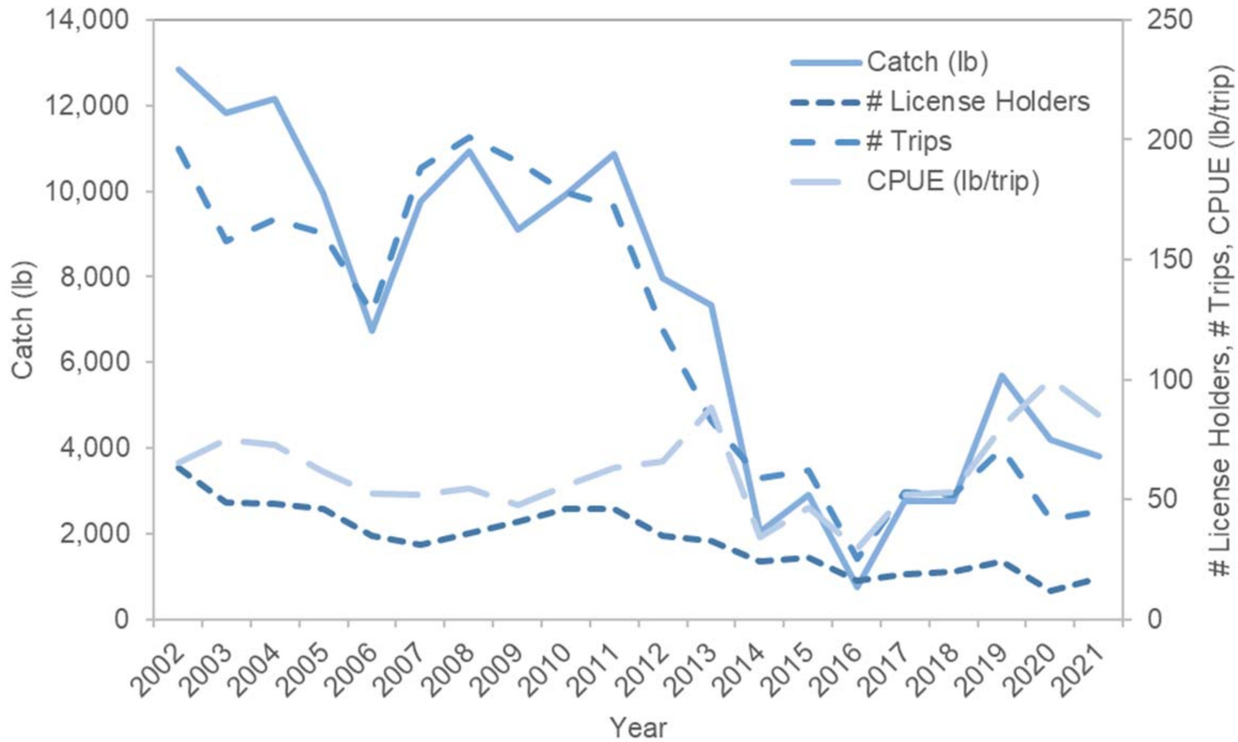

Figure 2. Visualization of time series data for the Main Hawaiian Islands Kona crab loop net fishery.
Source: WPFMC (2022).

Table 2. Commercial time series data for the Main Hawaiian Islands Kona crab fishery.

Fishing Year	# Dealers	Pounds Sold	Revenue ($)	Adjusted Revenue ($)	Price per Pound ($)	Adjusted Price per Pound ($)
2002	22	7,925	38,188	62,857	4.82	7.93
2003	18	8,868	38,910	62,606	4.39	7.06
2004	22	9,912	41,911	65,255	4.23	6.59
2005	12	5,259	21,312	31,989	4.05	6.08
2006	7	3,899	17,263	24,462	4.43	6.28
2007	5	8,216	34,292	46,363	4.17	5.64
2008	9	8,868	36,887	47,842	4.16	5.40
2009	12	6,228	26,948	34,763	4.33	5.59
2010	12	6,403	27,342	34,560	4.27	5.40
2011	15	6,561	32,823	39,978	5.00	6.09
2012	10	7,161	36,655	43,619	5.12	6.09
2013	9	4,563	25,989	30,381	5.70	6.66
2014	8	602	3,708	4,272	6.16	7.10
2015	6	966	5,389	6,149	5.58	6.37
2016	4	177	1,059	1,185	6.00	6.71
2017	5	876	5,477	5,975	6.26	6.83

Fishing Year	# Dealers	Pounds Sold	Revenue ($)	Adjusted Revenue ($)	Price per Pound ($)	Adjusted Price per Pound ($)
2018	4	1,530	10,713	11,474	7.00	7.50
2019	4	2,471	18,336	19,326	7.42	7.82
2020	5	2,656	21,329	22,140	8.03	8.34
2021	7	2,537	21,653	21,653	8.54	8.54
5-year average	**5**	**2,014**	**15,502**	**16,113.6**	**7.45**	**7.81**
10-year average	**6**	**2,354**	**15,031**	**16,617.4**	**6.58**	**7.20**
20-year average	**10**	**4,784**	**23,309**	**30,843**	**5.48**	**6.70**

Source: Western Pacific Fisheries Information Network (WPacFIN) data request.

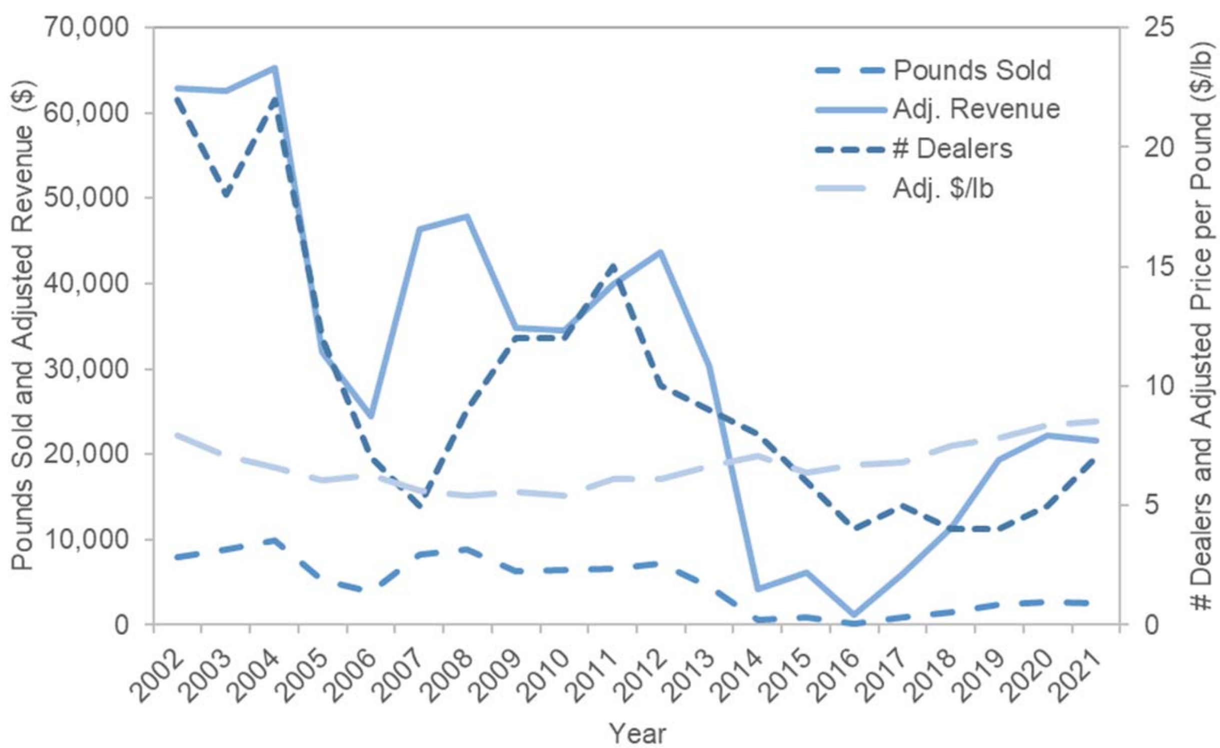

Figure 3. Visualization of commercial time series data for all gear types in the Main Hawaiian Islands Kona crab fishery.
Source: WPacFIN data request.

1.3 Overview of the Control Rules and Status Determination Criteria

Federal Regulations

The Magnuson-Stevens Act requires the Council's FMPs to evaluate and describe several items to manage federal fisheries that harvest stocks that require conservation and management, including maximum sustainable yield (MSY), SDC, control rules, and other items associated with specifying ACLs and accountability measures (AMs; 50 CFR 600.310(c)). A stock's MSY is the largest long-term average catch that can be taken from a stock under prevailing conditions based on the best scientific information available (BSIA). The MSY fishing mortality rate (F_{MSY}) is the fishing mortality rate that would result in MSY over the long term, and the MSY stock size (B_{MSY}) is the long-term average size of the stock that would be achieved by fishing at F_{MSY}.

SDC refer to measurable and objective factors that are used to determine if overfishing has occurred or if the stock is overfished, which can include the maximum fishing mortality threshold (MFMT), overfishing limit (OFL), minimum stock size threshold (MSST), or associated proxies. The Magnuson-Stevens Act defines both 'overfishing' and 'overfished' to mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the MSY on a continuing basis. The term 'overfished' usually refers to the biomass of the stock, while 'overfishing' is associated with a rate or level of removal from a stock (50 CFR 600.310(e)(2)). Thus, the MFMT is the level of fishing mortality on an annual basis above which overfishing is occurring, the OFL is the annual amount of catch that corresponds to the MFMT estimate applied to a stock's abundance, and the MSST is the level of biomass below which a stock is considered overfished. A stock is considered to be approaching an overfished condition when it is projected that there is greater than a 50% chance that the stock's biomass will decline below MSST within two years.

Each FMP (or FEP) must describe how SDCs will be established, and SDCs are often based on fishing rates or biomass levels associated with MSY or MSY proxies. In specifying SDC, a Council must provide an analysis of how the SDC were chosen and how they relate to reproductive potential of stocks of fish within the fishery (50 CFR 600.310(e)(2)). To use SDC to determine the overfishing status of a stock, the Council may specify the fishing mortality rate exceeding MFMT or catch exceeding the OFL. In using SDC to determine the overfished status of a stock, the MSST should be expressed in terms of spawning biomass, or other measure of reproductive potential, between $0.5*B_{MSY}$ and B_{MSY}.

FEP

The FEP established an MSY control rule that specifies the relationship of fishing mortality to biomass under an MSY harvest policy, which is useful for specifying SDC to identify when the fishery is overfished (WPFMC 2009). National Standard guidelines (74 FR 3178, January 16, 2009) require that SDC include two limit reference points or thresholds, one for fishing mortality to identify when overfishing is occurring and another for biomass to indicate when the stock is overfished (WPFMC 2009). An example of the MSY control rule listed in the Hawaii Archipelago FEP is presented in Figure 4.

The FEP also states that MFMT is the status determination criterion for fishing mortality while the MSST is the criterion for biomass. If fishing mortality exceeds the MFMT for a period of one year or more, overfishing is occurring; a stock is considered overfished when its biomass falls below MSST (WPFMC 2009). In the example in Figure 4, the MSY control rule sets the MFMT constant at F_{MSY} for biomass greater than the MSST and decreases the MFMT linearly with biomass for values less than the MSST. Additionally, the MSST should equal whichever of the following is greater: one-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock were exploited at the MFMT. In Figure 4, the MSST is indicated by a vertical line at a biomass level somewhat less than B_{MSY}. Lastly, the FEP describe a warning reference point, B_{FLAG}, that provide an indication that biomass or fishing mortality are approaching their respective thresholds. The Figure 4 example shows that B_{FLAG} is specified at some point above MSST.

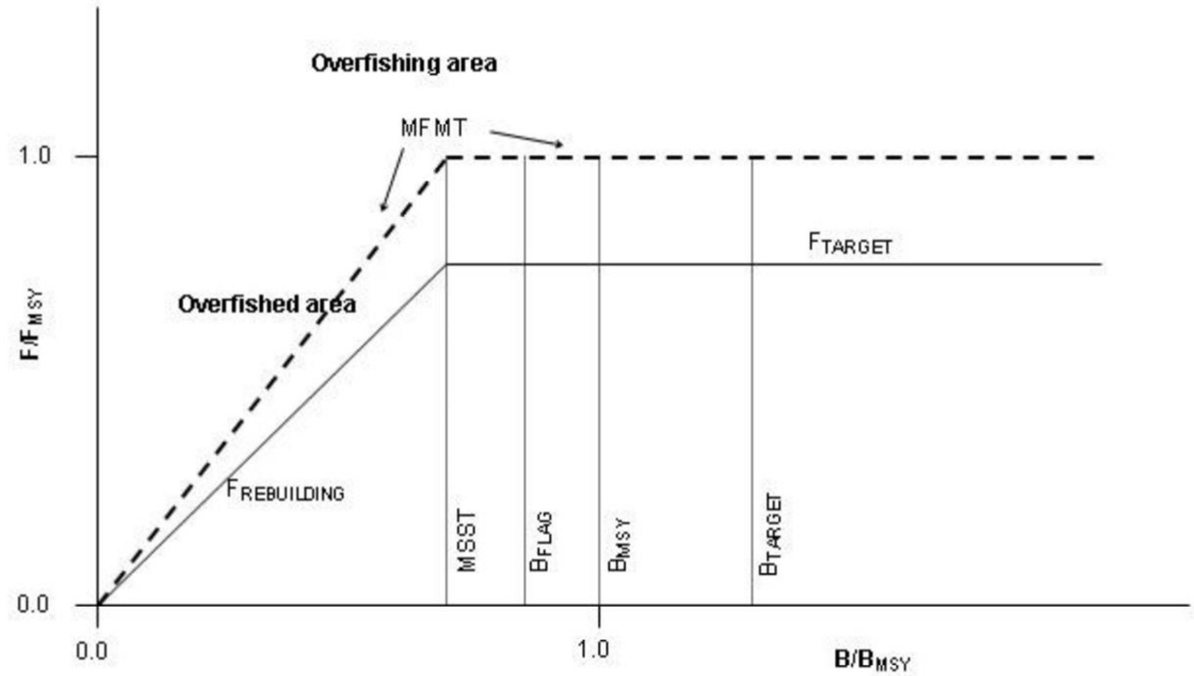

Figure 4. Example of MSY, target, and rebuilding control rules.
Note: the dashed horizontal and diagonal lines represent a model MSY control rule that is used as the MFMT; the solid horizontal and diagonal lines represent a model integrated target (F_{target}) and rebuilding ($F_{rebuilding}$) control rule. Source: Restrepo et al. (1998).

In addition to the MSY control rule and status determination criteria, the FEP describes target and rebuilding control rules, which are also showed in the example provided in Figure 4. A target control rule specifies the relationship of fishing mortality to biomass for a harvest policy aimed at achieving a given target, such as optimum yield (OY). OY is the yield that will provide the greatest overall benefits to the nation and is specified based on a reduction to MSY for any relevant economic, social, or ecological factors; thus, MSY is an upper limit for OY (WPFMC 2009). The target control rule can be specified using reference points such as F_{TARGET} and B_{TARGET}. Rebuilding control rules would be used in lieu of target control rules if the biomass for a stock falls below MSST. In the Figure 4 example, under the rebuilding control rule, fishing mortality would be controlled as a linear function o biomass until biomass recovers to MSST (see $F_{REBUILDING}$), then held constant at F_{TARGET} until biomass recovers to B_{MSY} (WPFMC 2009).

1.4 Existing Status Determination Criteria in the FEP for Crustacean MUS

SDC, overfishing criteria, and control rules are specified and applied to MUS to ensure that fishing mortality does not exceed a level that would result in excessive depletion of that species. Though NWHI lobster stocks are no longer considered MUS under the FEP, the established SDC for the stock remains. The MSY control rule is used as the MFMT. While the MSST is specified based on the recommendations of Restrepo et al. (1998), the MFMT is more conservative than the default recommendation as the threshold would be based on a higher level of B (i.e., B_{MSY} rather than some level less than B_{MSY}; WPFMC 2009). Both MFMT and MSST are dependent on the natural mortality rate (M) that is occasionally re-estimated using BSIA. 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 (WPFMC 2009; WPFMC 2022). The MFMT, MSST, and B_{FLAG} for NWHI lobster stocks, which are the only crustacean MUS in the Western Pacific region with established SDC in the FEP, are specified in Figure 5 illustrates the MSY control rule and reference points for NWHI lobster stocks as specified in the Hawaii Archipelago FEP (WPFMC 2009).

Table 3. Figure 5 illustrates the MSY control rule and reference points for NWHI lobster stocks as specified in the Hawaii Archipelago FEP (WPFMC 2009).

Table 3. Overfishing threshold specifications for NWHI lobster stocks in the Hawaii Archipelago FEP.

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

Source: WPFMC (2009).

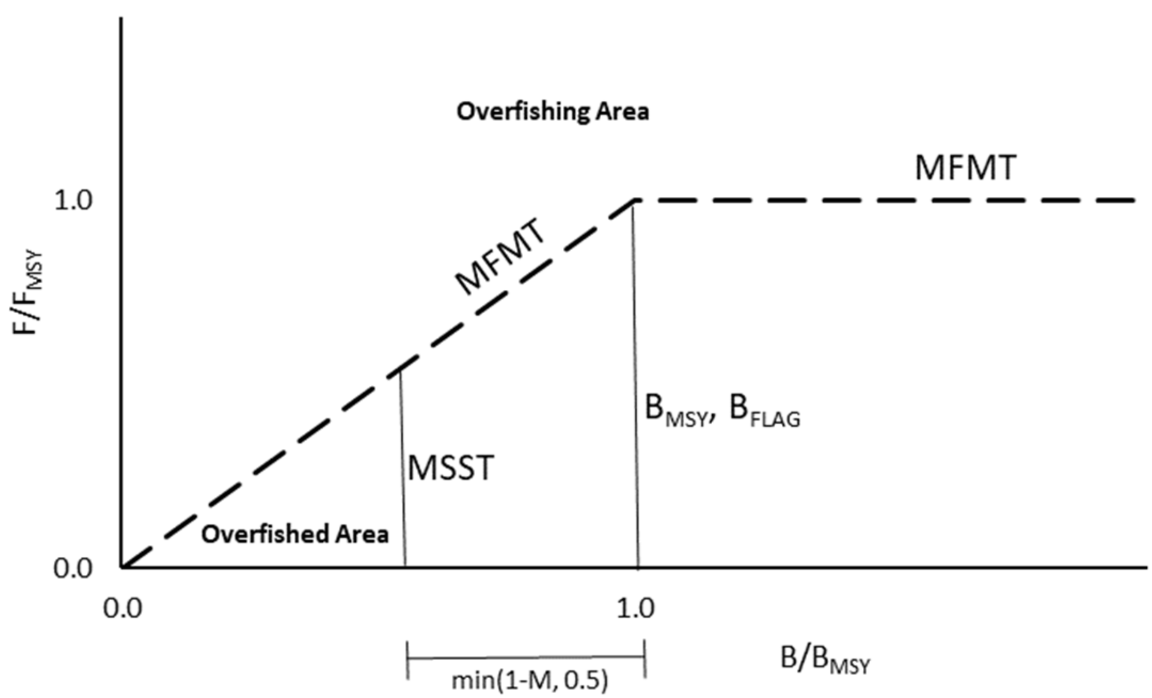

Figure 5. Depiction of MSY control rule and reference points for NWHI lobster stocks.

Source: WPFMC (2009).

1.5 Stock Status

A stock assessment for Kona crab by Thomas et al. (2015) estimated abundance, fishing mortality, and biomass for the MHI fishery using commercial catch data from 1970 through 2006. This past assessment indicated that the MHI Kona crab stock was overfished as of 2006 and was likely still overfished in 2010. A peer review by the Center for Independent Experts (CIE) supported the assessment's determination that the stock was overfished but noted uncertainty with the projections of the stock status in the future (Hall 2015). Upon request from the Council after reviewing the Thomas et al. (2015) assessment and CIE review, the NMFS Pacific Islands Regional Office (PIRO) requested that the NMFS Pacific Islands Fisheries Science Center (PIFSC) conduct an additional review. In early 2016, PIFSC agreed with the CIE review that the stock projections beyond 2006 were likely inaccurate (NMFS 2020).

The most recent stock assessment was a benchmark conducted by PIFSC (Kapur et al. 2019), which was peer reviewed through the Western Pacific Stock Assessment Review (WPSAR) process in Honolulu, Hawaii on September 10 to 14, 2018, and finalized in February 2019. The benchmark stock assessment addresses the concerns by Hall (2015) regarding the future projections for the MHI Kona crab stock generated by Thomas et al. (2015). The 2019 assessment addressed uncertainty previously unaccounted for, including unreported catch and incidental mortality of female crab catch following the State's prohibition on the harvest of female crabs in 2006 (NMFS 2020). The benchmark stock assessment indicated that the MHI Kona crab stock was not overfished or experiencing overfishing (Table 4) borrowing reference points specified in the FEP for NWHI lobster stocks (Kapur et al. 2019). At its 131st meeting, held in Honolulu, Hawaii on March 12, 2019, the Council's Scientific and Statistical Committee discussed the benchmark stock assessment and considered it BSIA. Subsequently, at its 176th meeting, held in Honolulu, Hawaii on March 19, 2019, the Council accepted the SSC BSIA recommendation, and on September 24, 2019, the PIFSC also determined the stock assessment to be BSIA (NMFS 2020).

Table 4. Stock assessment parameters for the Main Hawaiian Islands Kona crab stock.

Parameter	Value	Notes	Status
MSY for total catch	73,069	In lb	
MSY for reported catch	25,870	In lb	
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 lb	
B_{MSY}	640,489	In lb	
B_{2016}/B_{MSY}	1.3977		Not overfished

Source: Kapur et al. (2019).

1.6 Purpose and Need for Action

The purpose of this proposed action is to comply with section 303(a) of the Magnuson-Stevens Act and implementing regulations at 50 CFR 600.310(e)(2), which require the specification of SDC for the Kona crab stock in the MHI under the Hawaii Archipelago FEP. The need for this action is to apply a technical correction to the FEP to establish these SDC to allow for the determination and reporting of stock status consistent with section 304(e) of the Magnuson-Stevens Act. This action is also needed to further support sustainable management of the Kona crab fishery in the MHI.

1.7 Action Area

The action area is waters where fishing for Kona crab occurs in State and federal waters throughout the MHI. Kona crab fishing occurs over sandy substrate from approximately 5 m to 400 m depth. Waters around the NWHI are not part of the action area because commercial fishing is prohibited in Papahānaumokuākea Marine National Monument (50 CFR 404.6).

CHAPTER 2. Development of the Options

2.1 Development of Options for to Action to Establish SDC for Kona Crab

The options under consideration by the Council were developed in coordination with NMFS PIRO.

2.2 Options for Establishing SDC for Kona Crab in the MHI

The following options are under consideration. Under each option, all Magnuson-Stevens Act requirements other than those pertaining to SDC would be unchanged, including those associated with essential fish habitat, fishery and bycatch monitoring, human communities, and ACL and AM specifications.

2.2.1 Option 1: No Action (Status Quo)

Under Option 1, SDC for Kona crab in the MHI would not be established, and there would continue to be no official SDC in the Hawaii Archipelago FEP for the species. Thus, Option 1 would retain the Hawaii Archipelago FEP as it currently exists without establishing Kona crab SDC. This option would not comply with Magnuson-Stevens Act requirements under National Standard 1 for the FEP to specify methods used to determine the overfishing and overfished status for each federally managed stock (50 CFR 600.310(e)(2)).

The recent stock assessment that analyzed Kona crab in the MHI (Kapur et al. 2019) would remain the BSIA under Option 1 until the next stock assessment is completed for the fishery. However, future assessments would have no established SDC to allow for a stock status determination to be made. Thus, the Kona crab stock status would remain as "unknown" under the NMFS FSSI regardless of the results of the recent or upcoming stock assessments as it has through the present (NMFS 2022a), and .

2.2.2 Option 2: Amend the FEP to establish SDC for Kona crab in the Main Hawaiian Islands based on Restrepo et al. (1998), consistent with the SDC for other Council MUS fisheries and the most recent Kona crab stock assessment

Under Option 2, the Council would amend the Hawaii Archipelago FEP to establish SDC for the MHI Kona crab stock based on SDC developed according to Restrepo et al. (1998), consistent with management provisions of other Council MUS fisheries. This SDC for MHI Kona crab would be identical to the SDC specified for NWHI lobsters in the FEP and applied by the PIFSC Stock Assessment Program (SAP) during the 2019 benchmark stock assessment for MHI Kona crab (Kapur et al. 2019), including a more conservative MFMT than the default recommendation made by Restrepo et al. (1998). Thus, the proposed SDC for MHI Kona crab would be identical to the overfishing threshold specifications using values for MFMT and MSST provided in Table 3. No other changes would be made to the management structure for MHI Kona crab under the Hawaii Archipelago FEP, and this option would not change the results of the most recent stock assessment.

This option would serve to fill the management gap for this species under the Hawaii Archipelago FEP by establishing SDC used in the 2019 benchmark stock assessment (Kapur et al. 2019) to the MHI Kona crab stock. The proposed revisions to the FEP under this option would bring the FEP into compliance with the Magnuson-Stevens Act and the associated National Standard guidelines. Because the SDC would be identical to those applied in the most recent benchmark stock assessment for MHI Kona crab, stock status could be determined immediately after establishing the SDC. Thus, stock status would be changed from "unknown" in the NMFS FSSI to reflect the results of the 2019 stock assessment (Kapur et al. 2019) that concluded the stock is not overfished nor experiencing overfishing. The subsequent stock assessment completed by PIFSC-SAP could be conducted as an assessment update utilizing the same SDC as the 2019 benchmark stock assessment.

Because the proposed action would establish SDC for the fishery and change no other management provisions, it is not likely that the proposed action would result in any direct impacts to the MHI Kona crab fishery or its operations.

2.2.3 Option 3: Amend the FEP to establish SDC for Kona crab in the Main Hawaiian Islands based on management provisions of crab fisheries outside the Western Pacific region

Though Kona crab is well-known in the Pacific Islands as a Hawaiian delicacy, there are other domestic and international fisheries for this species and other species of crab whose management could inform SDC to be established for the MHI Kona crab fishery. The establishing of any of these SDC for the Hawaii Archipelago FEP would bring the FEP into compliance with the National Standard 1 guidelines under the Magnuson-Stevens Act. Implementing the SDC under any of these sub-options, or comparable SDC, would not directly impact fishery operations, but rather the action would revise the metrics by which the MHI Kona crab stock are evaluated using the best available data during stock assessments conducted by the PIFSC-SAP. Under this option, NMFS could not use the benchmark stock assessment (Kapur et al. 2019) to determine stock status, and thus, the status of Kona crab would remain "unknown" in the NMFS FSSI until the next stock assessment is completed. Further, the subsequent stock assessment conducted by PIFSC-SAP would need to be a benchmark in order to utilize any of the proposed SDC, as a stock assessment update would be constrained by the SDC used in the previous assessment.

Domestic Fisheries for Other Crab Species

Management of the Chesapeake Bay blue crab (*Callinectes sapidus*) stock is coordinated across the State of Maryland, the Commonwealth of Virginia, and the Potomac River Fisheries Commission by the Chesapeake Bay Stock Assessment Committee (CBSAC) under the coordination of the NOAA Chesapeake Bay Office. The most recent benchmark stock assessment for the species was conducted in 2011 and recommended biomass and exploitation reference points based on MSY for females only (Miller et al. 2011). As of the start of the 2022 crabbing season, the CBSAC determined that the Chesapeake Bay blue crab stock is not depleted and overfishing is not occurring (CBSAC 2022).

Under the current management framework for Chesapeake Bay blue crab, there are targets and limits for female crab abundance that are based on stock size to produce MSY and the target is the abundance that would be produced by fishing at 75% of F_{MSY}. The abundance of mature female crabs (age 1+) is estimated from the annual, bay-wide Winter Dredge Survey conducted by the State of Maryland and the Virginia Institute of Marine Science. Relatedly, annual estimates of exploitation (U) are calculated as the annual harvest of female crabs in a given year (not inclusive of bycatch, discards, or unreported losses) divided by the total number of female crabs (age 0+) estimated in the population at the beginning of the season (CBSAC 2020). The overfishing limit for the fishery is the exploitation rate of age 0+ female crabs that coincides with MSY (i.e., U_{MSY}), and the overfished abundance threshold is estimated by $0.5*N_{MSY}$, where N is abundance (Miller et al. 2011). Empirical estimates of exploitation rate are compared with target and threshold reference points derived from the model of the benchmark stock assessment in 2011 (Miller at al. 2011) and the subsequent stock assessment update in 2017 (see Table 5). The blue crab fishery should ideally operate to meet the target values, never exceed the exploitation rate threshold, and never fall below the abundance threshold. The target exploitation rate is set at $0.75*U_{MSY}$, while the target abundance is established as $N_{0.75*U_{MSY}}$ (Miller et al. 2011).

Table 5. Biological reference points generated by the 2011 benchmark stock assessment and the 2017 stock assessment update for Chesapeake Bay blue crab.

Stock Assessment	Female Abundance (Age 1+) in millions		Female Exploitation Rate (Age 0+) per year	
	Target	Threshold	Target	Threshold
2011	215	70	25.5%	34%
2017	196	72.5	28%	37%

Source: CBSAC (2022).

The New England Fishery Management Council (NEFMC) developed the Atlantic Deep-Sea Red Crab FMP, which was implemented by NMFS in October 2002 (NEFMC 2002). The fishery for Atlantic deep-sea red crab (*Chaceon quinquedens*) operates year round with trap/pot gears over 400 to 800 m depth (NMFS 2022b). The stock is considered data-poor, so the OFL is unknown while the ACL was set at 4.41 million lb for 2020 to 2023 (87 FR 3697, January 25, 2022).

MSY for the red crab resource is estimated to be 6.24 million lb based on the biomass of male crabs (i.e., the primary fishery target) and assuming a natural mortality rate of 0.15; OY is specified based on 95% of MSY (NEFMC 2002). The overfishing definition for Atlantic red crab is any rate of exploitation such that the ration of current exploitation to an ideal exploitation under MSY condition exceeds a value of 1.0 (NEFMC 2002). Estimates of exploitation rate are calculated using proxies, such as F/F_{MSY}, which may be calculated as the ratio of landings (L) to CPUE against MSY to $CPUE_{MSY}$. Otherwise, landings divided by MSY may be used as a proxy if data are not available to implement the above indicators (see Table 6). The stock is considered overfished if any of the following three conditions are met:

1) The current biomass of the stock is below $0.5*B_{MSY}$ in the NEFMC management area;
2) The annual fleet average CPUE (in number of crabs landed per haul) continues to decline below a baseline level for three or more consecutive years; or

3) The annual fleet average CPUE falls below a minimum threshold level in any year (NEFMC 2002; see Table 6).

The overfished and overfishing definitions were designed based on Restrepo et al. (1998) to utilize BSIA and offer the most flexibility to the NEFMC and NMFS when making a status determination.

Table 6. Summary of status determination criteria and reference points for Red Crab FMP.

Status	Criteria	Reference Point	Proxy	Remedy if Threshold Exceeded
Overfishing	F	$F/F_{MSY} > 1.0$	$\frac{L}{CPUE}:\frac{MSY}{CPUE_{MSY}}$	Rebuilding Plan
			$\frac{L}{MSY}$	Rebuilding Plan
Overfished	B	$B < 0.5*B_{MSY}$	None	Rebuilding Plan
	CPUE	$CPUE < 0.5*CPUE_0$	N/A	Rebuilding Plan
		$CPUE < 0.25*CPUE_0$	N/A	Rebuilding Plan

Source: NEFMC (2002).

The Eastern Bering Sea snow crab (*Chionoecetes opilio*) is managed by the State of Alaska under the Bering Sea/Aleutian Islands King and Tanner Crab FMP (NPFMC 2021) developed by the North Pacific Fishery Management Council (NPFMC). The commercial fishery for Alaska snow crabs is lucrative, with more than 36.6 million pounds landed in 2020, valued over $101.7 million. The most recent stock assessment for the fishery determined that Alaska snow crabs are overfished but not experiencing overfishing based on 2020 data (Szuwalski 2021).

North Pacific crab fisheries operate based on a five-tier system for setting overfishing limits (OFLs) and acceptable biological catches (ABCs; see Table 7). Generally, for North Pacific crab fisheries, a stock is determined to be overfished by comparing annual biomass estimates to the MSST, which is defined as $0.5*B_{MSY}$. Overfishing is determined by comparing the OFL, which is set equal to MSY, with catch estimates in a given year. The instantaneous fishing mortality from the fishery used to calculate the overfishing limit (F_{OFL}) has a maximum value of F_{MSY} when $B > B_{MSY}$. Proxies for F_{MSY} are frequently used, such as $F_{x\%}$, which is the F that results in x% of the equilibrium spawning per recruit relative to the unfished value; $F_{35\%}$ is specified for use for Tier 3 stocks (Table 7). In the 2021 stock assessment, morphometrically mature male biomass (MMB) is used to determine stock status since the fishery primarily targets and captures large males. The OFL was calculated using proxies for biomass and fishing mortality reference points calculated using spawner-per-recruit methods (i.e, $F_{35\%}$ and $B_{35\%}$; Szuwalski 2021). While studies have found that the assumption $F_{MSY} = F_{35\%}$ is generally reasonable, changes in recruitment over time may impact the estimation of B_{MSY} (Punt et al. 2014).

Table 7. Five-tier system of setting overfishing limits for crab stocks in the NPFMC management area.

Information available	Tier	Stock status level	F_{OFL}
B, B_{MSY}, F_{MSY}, and pdf of F_{MSY}	1	a. $\frac{B}{B_{msy}} > 1$	$F_{OFL} = \mu_A$ =arithmetic mean of the pdf
		b. $\beta < \frac{B}{B_{msy}} \le 1$	$F_{OFL} = \mu_A \frac{B/B_{msy} - \alpha}{1-\alpha}$
		c. $\frac{B}{B_{msy}} \le \beta$	Directed fishery F = 0 $F_{OFL} \le F_{MSY}$†
B, B_{MSY}, F_{MSY}	2	a. $\frac{B}{B_{msy}} > 1$	$F_{OFL} = F_{msy}$
		b. $\beta < \frac{B}{B_{msy}} \le 1$	$F_{OFL} = F_{msy} \frac{B/B_{msy} - \alpha}{1-\alpha}$
		c. $\frac{B}{B_{msy}} \le \beta$	Directed fishery F = 0 $F_{OFL} \le F_{MSY}$†
B, $F_{35\%}$*, $B_{35\%}$*	3	a. $\frac{B}{B_{35\%^*}} > 1$	$F_{OFL} = F_{35\%}$ *
		b. $\beta < \frac{B}{B_{35\%}*} \le 1$	$F_{OFL} = F^*_{35\%} \frac{\frac{B}{B^*_{35\%}} - \alpha}{1-\alpha}$
		c. $\frac{B}{B_{35\%}*} \le \beta$	Directed fishery F = 0 $F_{OFL} \le F_{MSY}$†
B, M, $B_{msy^{prox}}$	4	a. $\frac{B}{B_{msy^{prox}}} > 1$	$F_{OFL} = \gamma M$
		b. $\beta < \frac{B}{B_{msy^{prox}}} \le 1$	$F_{OFL} = \gamma M \frac{B/B_{msy^{prox}} - \alpha}{1-\alpha}$
		c. $\frac{B}{B_{msy^{prox}}} \le \beta$	Directed fishery F = 0 $F_{OFL} \le F_{MSY}$†
Stocks with no reliable estimates of biomass or M.	5		OFL = average catch from a time period to be determined, unless the SSC recommends an alternative value based on the best available scientific information.

*35% is the default value unless the SSC recommends a different value based on the best available scientific information.

† An $F_{OFL} \le F_{MSY}$ will be determined in the development of the rebuilding plan for that stock.

Source: NPFMC (2021).

Global Fisheries for Kona Crab

Spanner crabs, as Kona crab is referred to in Australia, has a single biological stock along the east coast off of New South Wales and Queensland, though Queensland accounts for roughly 80% of harvest (Roelofs et al. 2021). Despite the lack of a stock assessment, the East Coast spanner crab stock is officially classified as a sustainable stock due to reduced catches relative to the total allowable commercial catch (TACC) level (Roelofs et al. 2021).

Because there is no stock assessment for East Coast spanner crabs, commercial standardized CPUE (sCPUE) and standardized fishery-independent survey (sFIS) data are used as performance indicators to infer the status of the stocks using established decision rules (State of Queensland 2020). The harvest strategy and associated decision rules for East Coast spanner crabs currently focus on setting the TACC to rebuild the stock from its stock status of "depleting." The target reference point for spanner crabs is based on the average of sCPUE and sFIS catch rates from 2006 to 2010, which represents a time of operational efficiency for the commercial fishery, while the lower limit reference point is set at a commercial index value of 0.5 kg per dilly (i.e., net) lift (i.e., a proxy for approximately 20% biomass in the fishery; see Table 8). These limit reference points are likely to reduce the chance of a fishery closure according to a management strategy evaluation (State of Queensland 2020).

Table 8. Performance indicators and reference points for the spanner crab fishery.

Performance Indicator	Reference Point/Buffer	Reference Level
Standardized commercial catch rate of spanner crabs in kilogram per dilly lift (sCPUE)	Target reference point proxy for 60% biomass	95% of the 2006-2010 average standardized catch rate
Catch rate of spanner crabs from the standardized fishery independent survey in legal crabs per ground line (sFIS)	Target reference point proxy for 60% biomass	95% of the 2006-2010 average standardized catch rate
sCPUE of spanner crabs averaged over two conservative years	Limit reference point proxy for 20% biomass	0.5 kg per dilly lift
Pooled index – average of the sCPUE and sFIS	Target reference point	1
TACC	Upper limit	1,300 mt
TACC	Lower limit	300 mt
TACC change	Minimum change buffer	50 mt
TACC change	Maximum change buffer	200 mt

Source: State of Queensland (2020).

2.3 Advisory Group Action

The Council Advisory Groups will discuss the viability of each of these options and provide input on establishing SDC for Kona crab in the MHI before making a recommendation to the Council.

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