Monterey Bay Aquarium
Seafood Watch®

Day Octopus and Night Octopus

Octopus cyanea and *Octopus ornatus*

Hawaii

Handline, Spear

January 23, 2014
Lisa Max, Seafood Watch staff

Disclaimer

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Final Seafood Recommendation

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Day octopus Hawaii Central Pacific - Handline	Yellow (2.64)	Green (3.32)	Yellow (3.00)	Green (3.67)	**Good Alternative (3.136)**
Night octopus Hawaii Central Pacific - Handline	Green (3.32)	Yellow (2.64)	Yellow (3.00)	Green (3.67)	**Good Alternative (3.136)**
Day octopus Hawaii Central Pacific - Spear	Yellow (2.64)	Green (3.32)	Yellow (3.00)	Green (3.87)	**Good Alternative (3.177)**
Night octopus Hawaii Central Pacific - Spear	Green (3.32)	Yellow (2.64)	Yellow (3.00)	Green (3.87)	**Good Alternative (3.177)**

Scoring note – Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact. Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

▲ **Best Choice** = Final Score between 3.2 and 5, **and** no Red Criteria, **and** no Critical scores

▲ **Good Alternative** = Final score between 2.2 and 3.199, **and** Management is not Red, **and** no more than one Red Criterion other than Management, **and** no Critical scores

▲ **Avoid** = Final Score between 0 and 2.199, **or** Management is Red, **or** two or more Red Criteria, **or** one or more Critical scores.

Executive Summary

This Seafood Watch report focuses on the commercial he'e or octopus fishery in Hawaii, whose catch is dominated by *Octopus cyanea*, or day octopus, and also includes the smaller *Octopus ornatus*, or night octopus (also referred to as ornate octopus). As a nearshore fishery occurring within state waters, the Hawaii Division of Aquatic Resources (HDAR) manages he'e. HDAR has no catch limit in place on he'e, but does maintain a minimum size limit per individual caught. No stock assessment exists, so it is difficult to assess the sustainability of the increasing commercial he'e catch, as well as the potentially much larger but undocumented recreational catch.

In terms of biomass caught, he'e ranked 28th of the 87 species/categories commercially fished in Hawaii in 2011 at 35,347 lbs., and had the highest catch of any invertebrate fishery. Combined with catch from the recreational fishery, the overall he'e catch is likely to be at least twice as large. In both the commercial and recreational fishery, he'e are primarily caught by three-pronged spear at shallow depths. Spear fishing accounted for 84% of the 2011 commercial landings, while handlining accounted for 14 percent.

Overall Seafood Watch ranks he'e as a "good alternative". Criterion 1, "Impacts of the Fishery on the Stock", ranks as yellow for *O. cyanea* and green for *O. ornatus* to the lower likelihood of fishing mortality. Both *O. cyanea*, as well the less common as *O. ornatus* have low inherent vulnerability scores because they are highly productive, fast growing species with short lifespans. Their stock status is considered of moderate concern due to the lack of any stock assessment and to the decreasing catch per unit of effort for both spear and handline methods. Fishing mortality is a moderate concern for *O. cyanea*, which is the largest contributor to the commercial (and recreational) catch, and low concern for *O. ornatus*, which is likely to be caught less frequently. Criterion 2, "Impacts of the Fishery on Bycatch and Other Retained Species" is not a contributing factor to the overall ranking because there is no bycatch and other species are not targeted in this fishery. Criterion 3, "Effectiveness of Fishery Management" is based on the harvest strategy, whose subcriteria score as moderate to highly effective. Criterion 4, "Impacts on Habitat and Ecosystem", scores as green due to the minimal, but unknown effects of he'e fishing methods on benthic habitats.

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Introduction

Scope of the analysis and ensuing recommendation

This seafood watch report focuses on the commercial he'e or day octopus (*Octopus cyanea*) fishery in Hawaii. According to the Hawaii Division of Aquatic Resources (HDAR), which regulates inshore fisheries in Hawaii, he'e can also refer to the less common night octopus (*Octopus ornatus*), which is also covered in this report. Gears employed in this fishery include spear and handline (using lures, traditionally made of a large cowry shell lashed onto a hook, but other lures are more common), though other gears, such as traps, rod and reel and scoop nets are sometimes used.

Overview of the species and management bodies

He'e or day octopus (*Octopus cyanea*) is a common cephalopod mollusk found throughout the tropical and subtropical Indo-pacific region, from Hawaii to East Africa, from 0 to 45 meters {Norman 1991}. It is the most common octopus on Hawaiian coral reefs, and comprises the bulk of the he'e harvest. This species is an opportunistic predator, and forages on mollusks, crustaceans and fish at dawn and dusk. A medium to large sized octopus, *O. cyanea* grows to 16 cm in mantle length with arms to at least 80 cm {Norman 1991}. Octopi, like *O. cyanea* grow quickly; they can increase in size by 200g in 15 days and can weigh up to 12kg {Guard 2003}{Van Heukelem 1983}. *O. cyanea* has a short lifespan (maximum age recorded in Hawaii is 400 days or ~ 13.3 months, in Australia 314 days or ~ 10.5 months) {Herwig et al. 2012}, mating once upon reaching maturity and then dying {Van Heukelem 1983}. *O. cyanea* is a highly productive species, with females laying between 100,000 to 400,000 eggs. {Boyle and Rodhouse 2005} Once hatching, the young (paralarvae) are approximately 2mm in total length, and are planktonic/pelagic until reaching approximately 1 cm in total length, developing directly into adults {Boyle and Rodhouse 2005}.

O. cyanea lives intertidally to depths of 60 meters {Van Heukelem 1983}, excavating dens in the substrate. Its preferred habitat is coral rubble, which consists of unconsolidated rocks and broken, dead coral covering a hard sandy bottom, but dens are also found in live coral and sand {Sims 1998}. In Hawaii, *O. cyanea* are found in greatest abundance during the fall and winter, but the mechanism determining this pattern has not been studied {Van Heukelem 1983}. Mature female *O. cyanea* and other octopus species have been found to migrate to deeper waters to spawn {Raberinary and Benbow 2012}. Hawaiian fisherman have noted that large individuals are found deeper at the end of winter, which could be females moving offshore to spawn, then die, which would indicate that the abundant octopi found in the shallows starting in the fall are new recruits to the population {Ivey, G. 2007}.

A small percentage of the octopi caught in the he'e fishery include one or two species other than *O. cyanea*. *Octopus ornatus*, the night octopus, is likely caught in the fishery. It is found throughout the tropical Western Pacific and Indian Oceans, is active at night, hiding inside the reef during the day {Norman 1993}. *O. ornatus* is generally smaller than *O. cyanea*, weighing up to 1 kg and reaching 1.2 m. It has moderate fecundity, with a female recorded as bearing 35,000 eggs {Norman 1993}.

While he'e is caught throughout its range using lures, baited lines, traps, spears, rod and reel and by hand, commercial fisherman in Hawaii primarily use spears and use handlines to a lesser extent. Most he'e fishing in Hawaii occurs at shallow depths by spear (either by boat or free diving), while between 30-60 meters handline fishing with a lure predominates. Octopi are attracted to the moving lure, pounce on it, become impaled on the hooks and are hauled rapidly to the surface {Van Heukelem 1983}.

The Hawaiian octopus fishery is inshore, occurring within state waters, falling under regulation by the state's Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR). Although no stock assessment exists, DAR does not classify the fishery as overfished {HDAR 2013c}. To fish for octopus commercially, all that is required is a state of Hawaii commercial fishing permit. There is a one-pound minimum size limit and there is no harvest limit {§13-95-55}. HDAR does collect commercial he'e fishing data, which for each trip includes the weight landed (for all octopus species combined), gear used, hours spent fishing and commercial license number.

Production Statistics

Globally, production of octopus species is high and is increasing, with 2011 production totaling over 290,000 MT (see Figure 1)

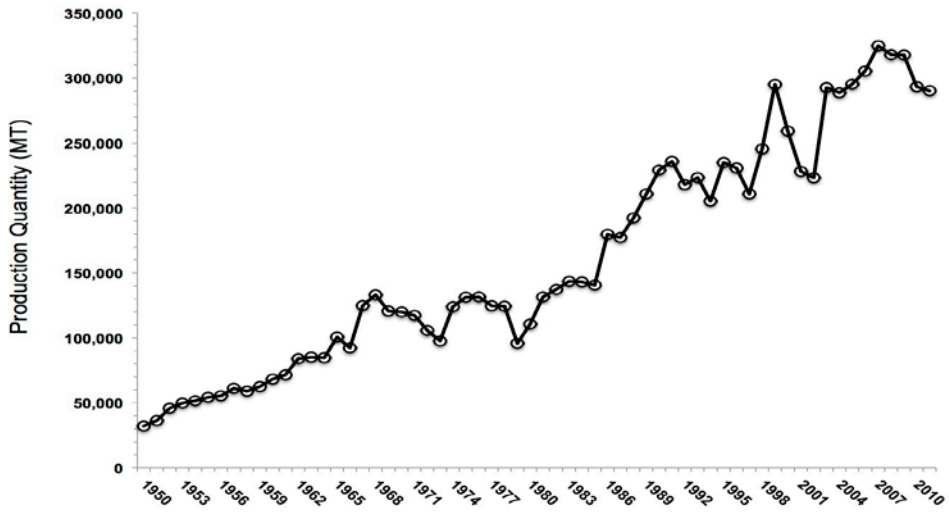

Figure 1: The highest landings are in Asia.

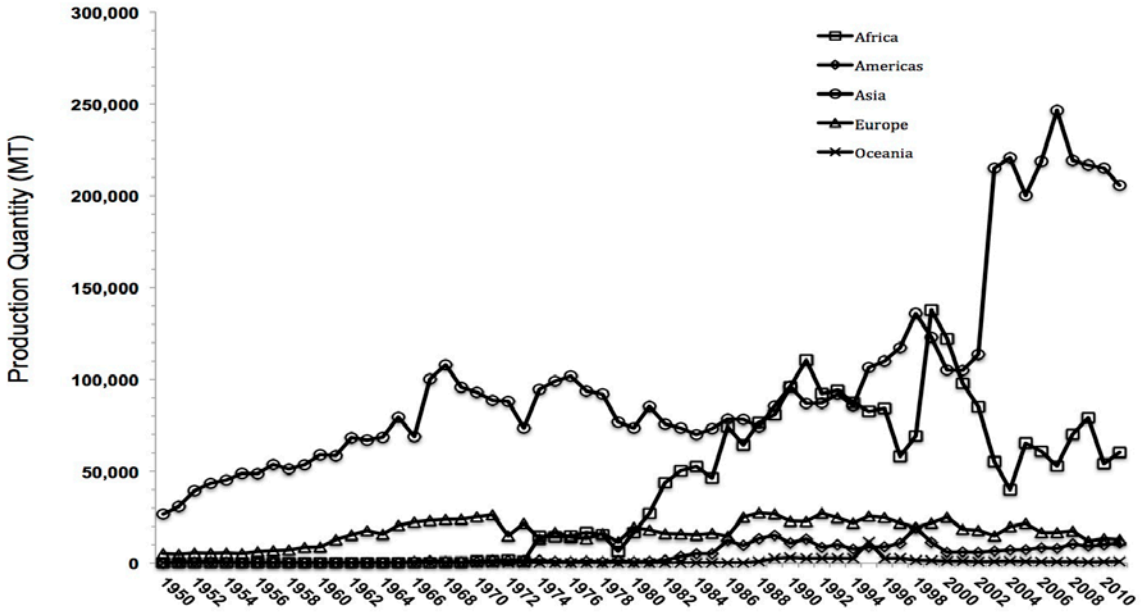

Figure 2: China dominating production as of 2002.

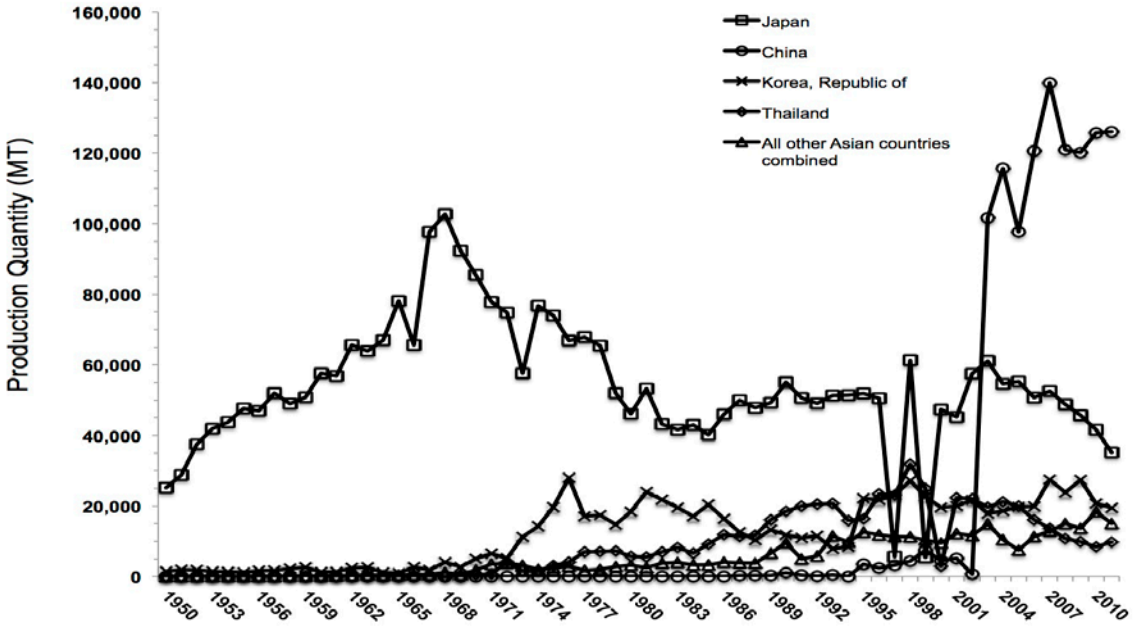

Figure 3: China's production peaked in 2007 at 139,858 MT, and was over 126,000 MT in 2011.

Importance to the US/North American market

Octopus imports into Honolulu are high (see Figure 4).

Figure 4: Lbs. of octopus imported into U.S. via the Port of Honolulu from 1989 to 2012. U.S. foreign trade data from NMFS. Available at http://www.st.nmfs.noaa.gov/st1/trade/

Peaking in 1993 at over 600,000 lbs., 2012 imports to Honolulu totaled less than 300,000 lbs., approximately 8 times greater than Hawaiian commercial production. Currently, the greatest amount of imported octopus comes from China, dwarfing imports from Japan, the Philippines and Vietnam (see Figure 5).

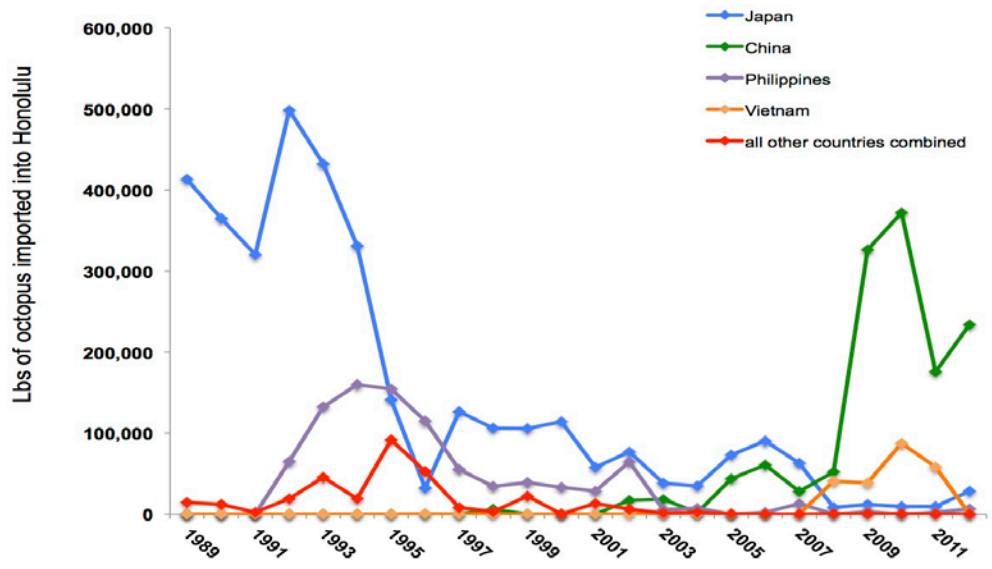

Figure 5: Lbs. of octopus imported into U.S. via the Port of Honolulu from 1989 to 2012, listed by main countries of origin. U.S. foreign trade data from NMFS. Available at http://www.st.nmfs.noaa.gov/st1/trade/

In Hawaii, imported octopus is used for human consumption and for bait. Imported octopus from Asia can sell for as little $1 per pound; it is less expensive and less desirable than locally caught he'e. The price for locally caught he'e fluctuated around $3 per pound from the mid 1990's to mid 2000's, and has increased steeply since 2005, selling for an average price of $4.36 per pound in 2011 (see Figure 6) {HDAR and PIFSC 2012}. The steep price increase may signal increased demand and/or resource scarcity.

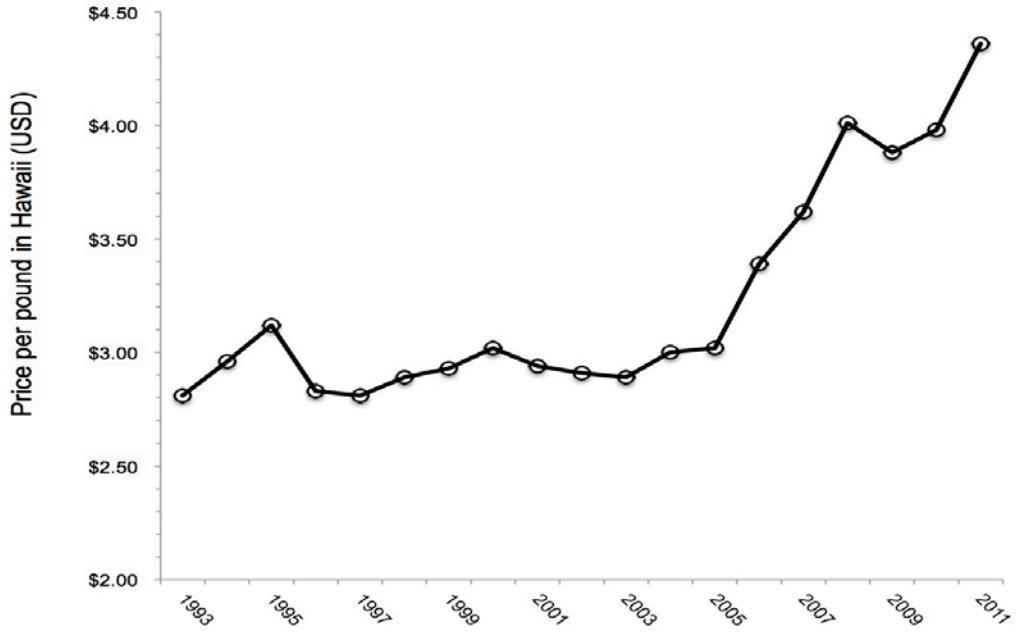

Figure 6: Price per pound for Hawaiian caught he'e from 1993 to 2011. From Hawaii DAR Fishery Statistics, PIFSC website. Available at: http://www.pifsc.noaa.gov/wpacfin/hi/dar/Pages/hi_data_1.php

Common and market names

He'e, octopus, tako, squid {HDARd 2013} he'e mauli, day octopus {University of Hawaii 2013}, Cyane's octopus, big blue octopus {Palomares and Pauly 2013}, ornate octopus, white-striped octopus

Primary product forms

Frozen, raw, dried, and smoked

Analysis

Scoring Guide

- All scores result in a zero to five final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of five indicates high performance.
- The full Seafood Watch Fisheries Criteria that the following scores relate to are available on our website at http://www.seafoodwatch.org

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 Score is determined by taking the geometric mean of the abundance and fishing mortality scores.

DAY OCTOPUS				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Hawaii Central Pacific Handline	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**
Hawaii Central Pacific Spear	3.00:Low	3.00:Moderate Concern	2.33:Moderate Concern	**Yellow (2.644)**

NIGHT OCTOPUS				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Hawaii Central Pacific Handline	3.00:Low	3.00:Moderate Concern	3.67:Low Concern	**Green (3.318)**
Hawaii Central Pacific Spear	3.00:Low	3.00:Moderate Concern	3.67:Low Concern	**Green (3.318)**

The inherent vulnerability of he'e species (both *Octopus cyanea*/day octopus and the less common *Octopus ornatus*/night octopus) are low, as they are fast growing, short lived and highly fecund species. Although he'e are highly productive, their stock status is considered of moderate concern due to the lack of any stock assessment and to the decreasing catch per unit of effort for both spear and handline methods. Fishing mortality is a moderate concern for *O. cyanea*, which is the largest contributor to the commercial (and recreational) catch, and low concern for *O. ornatus.*

Justification of Ranking

Factor 1.1 - Inherent Vulnerability to Fishing

- Low = FishBase vulnerability score for species 0-35 OR species exhibits life history characteristics that make it resilient to fishing, e.g., early maturing (<5 years), short lived (< 10 years), small maximum size, and low on food chain.
- Medium = FishBase vulnerability score for species 36-55 OR life history characteristics that make it neither particularly vulnerable or resilient to fishing, e.g. moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain.
- High = FishBase vulnerability score for species 56-100 OR life history characteristics that make is particularly vulnerable to fishing, e.g. long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator.

  Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g. schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Factor 1.2 - Abundance

- 5 (Very Low Concern) = Strong evidence that population is above target abundance level (e.g. biomass at maximum sustainable yield, BMSY) or near virgin biomass
- 4 (Low Concern) = Population may be below target abundance level, but it is considered not overfished.
- 3 (Moderate Concern) = Abundance level is unknown and species has a low or medium inherent vulnerability to fishing
- 2 (High Concern) = Population is overfished, depleted, or a species of concern OR Abundance is unknown and species has a high inherent vulnerability to fishing.
- 1 (Very High Concern) = Population is listed as threatened or endangered.

Factor 1.3 - Fishing Mortality

- 5 (Very Low Concern) = Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY) OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality)
- 3.67 (Low Concern) = Probable (>50% chance) that fishing mortality is at or below a sustainable level, but some uncertainty OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible OR fishing

mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught)

- 2.33 (Moderate Concern) = Fishing mortality is fluctuating around sustainable levels OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery, and if species is depleted, reasonable management is in place.
- 1 (High Concern) = Overfishing is occurring, but management is in place to curtail overfishing OR fishing mortality is unknown, species is depleted and no management is in place
- 0 (Critical) = Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

DAY OCTOPUS

1.1 - Inherent Vulnerability

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Low**

Calculated inherent vulnerability = 2.5 (low inherent vulnerability). This calculation is based on the following life history characteristics: a short lifespan, reproductive maturity at < 5 years, it is egg laying demersal spawner, and is not known to exhibit density dependence {Van Heukelem 1983}.The maximum age of *O. cyanea* in Hawaii is 400 days, while in Australia it is 314 days {Herwig et al. 2012}. In a study of Australian populations, males matured at 155 days and/or 0.35 kg and females at 225 days and/or 0.52 kg {Herwig et al. 2012}. Fecundity is high, mature females lay between 100,000 to 400,000 eggs {Boyle and Rodhouse 2005}.

1.2 - Stock Status

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Moderate Concern**

No stock assessment exists for the he'e stock complex in Hawaii, of which O. cyanea is the largest contributor to the catch. However, based on *O. cyanea'*s life history, namely its short life span, early age at maturity and high fecundity, it is likely that this species' stock is highly productive can support high exploitation rates. In combination with this high productivity, the nature of the Hawaiian coastline is

such that large stretches of nearshore areas are difficult to harvest from, giving octopus populations refuges from fishing pressure (pers. comm D. Kobayashi, PIFSC). A Hawaii Department of Aquatic Resources (HDAR) newsletter from 1997 mentions that because most fishing for he'e occurs at the shallower end of he'e's depth range, deeper areas serve as refuge from fishing pressure (HDAR 1997). Lending support to this hypothesis, commercial as well as recreational catch data shows that spearing catches the majority of he'e, which is carried out on snorkel or freediving (i.e. at shallow depths). Annually from 2003 and 2012, an average of 72% +/- 10% of the commercial he'e catch was caught via spear (HDAR 2013), and between 2003 and 2010, 88% of all recreational catch records for he'e list spear as the gear used (HMRFS/HDAR 2013).

Commercial data from 2003-2012 collected by the Hawaii Division of Aquatic Resources (HDAR 2013), shows that catch per unit of effort has decreased with increasing catch since 2007 for the overall catch and for both the handline fishery and spear fishery individually (see Figure 1). This suggests increased pressure on the he'e resource. See image below. Earlier CPUE data (from 1980-1990) show that octopus landings in Hawaii have varied as a function of the number of trips and the magnitude of CPUE (Smith 1993).

The increasing pressure on the he'e resource suggested by the recent commercial CPUE data may also be indicative of pressures exerted by the recreational fishery. In some areas, such as Kaneohe Bay, recreational catch can far exceed the commercial take, exemplified by 1991 and 1992 surveys which revealed that the recreational catch in Kaneohe Bay was 17 to 24 higher than the commercial catch (HDAR 1997).

Rationale:

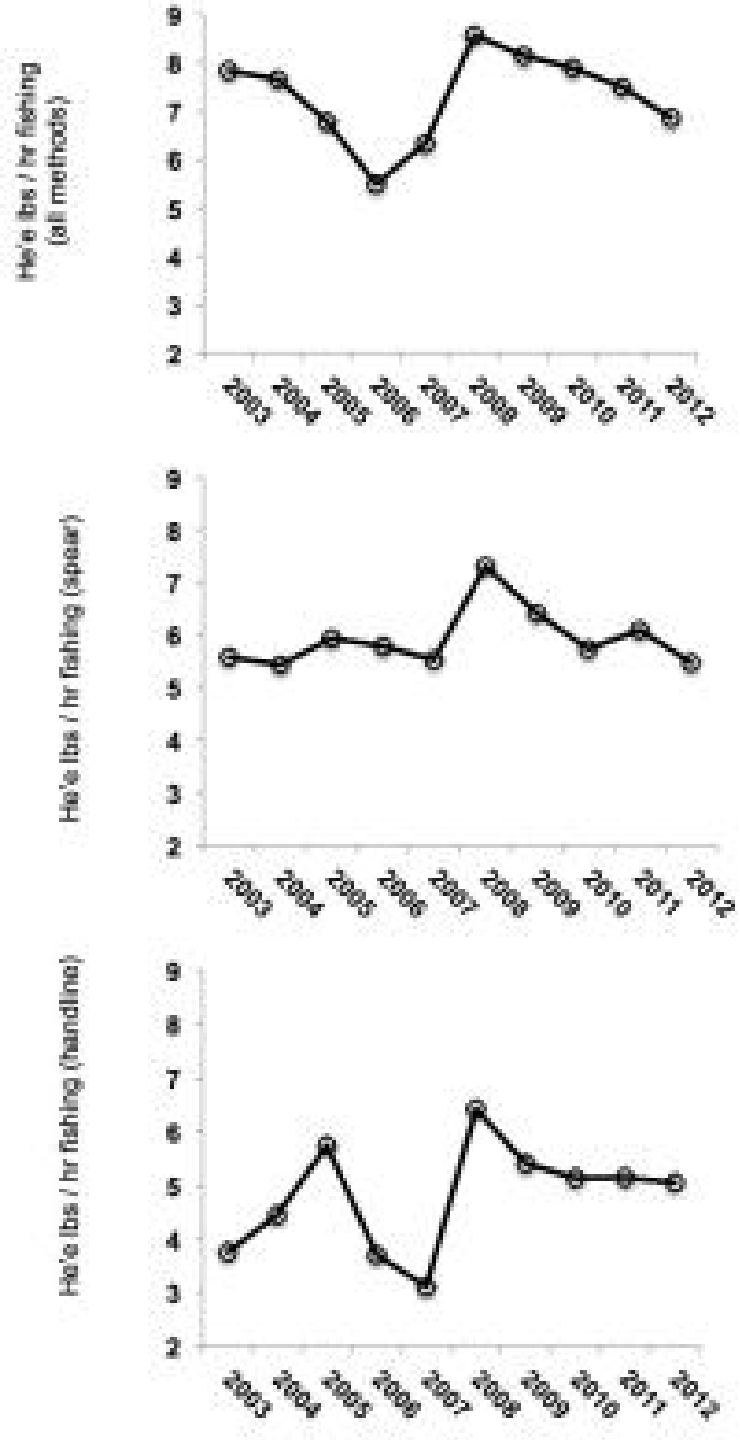

Figure 7: 2003 through 2012 commercial catch (lbs) per unit of effort (hours) for the he'e fishery in Hawaii.

1.3 - Fishing Mortality

Hawaii Central Pacific, Handline

2.33 **Moderate Concern**

A stock assessment is lacking for Hawaiian octopus, so Fishing Mortality at Maximum Sustainable Yield (F_{MSY}) is unknown. Mortality in the commercial fishery has increased over time (see images below) (DeMello 2004)(HDAR 2013), and there is a large recreational octopus fishery, which may be a larger contributor to fishing mortality than the commercial fishery in certain areas (Smith 1993) (pers comm T. Ogawa).

Rationale:
Commercial octopus landings have increased from approximately 5000 pounds in 1966 to over 35,000 pounds in 2012. {DeMello 2004}{HDAR 2013} The octopus catch had a high of over 40,000 pounds in 1986 and has never dropped below 5000 lbs. since that time.

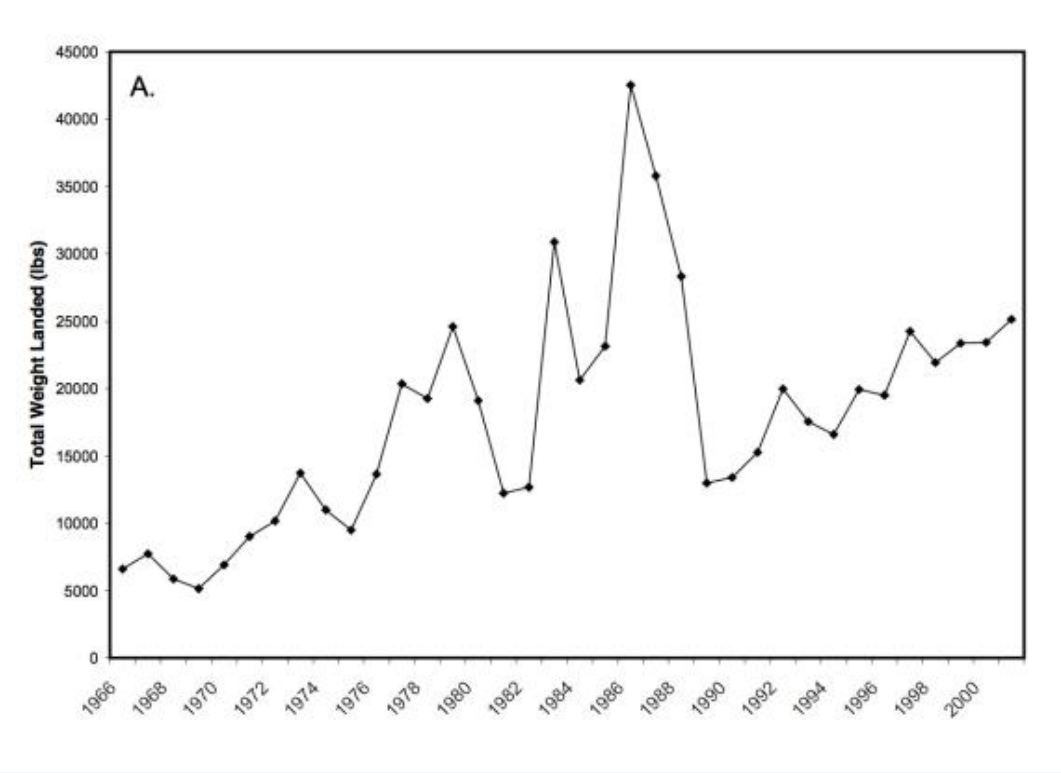

Figure 8: Total commercial landings of octopus from 1966-2001 in the Hawaiian Archipelago, from DeMello 2004. Available online at: http://ccma.nos.noaa.gov/publications/c1851_fish.pdf

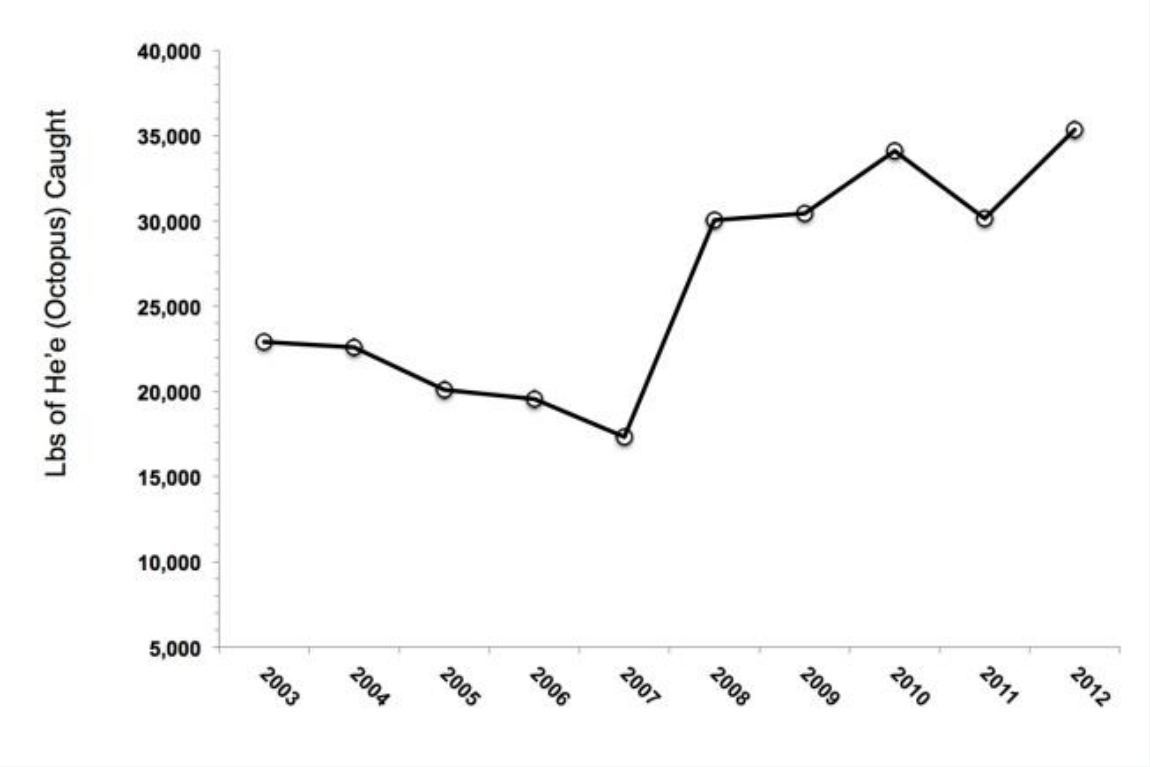

Figure 9: Lbs. of he'e (octopus) caught in Hawaii from 2003 through 2012. Data from commercial logbook data (obtained from Reginald Kokubun/HDAR).

Hawaii Central Pacific, Spear

2.33 **Moderate Concern**

A stock assessment is lacking for Hawaiian octopus, so F_{MSY} is unknown. Mortality in the commercial fishery has increased over time (see figure 8 and 9) {DeMello 2004}{HDAR 2013}, and there is a large recreational octopus fishery, which may be a larger contributor to fishing mortality than the commercial fishery in certain areas {Smith 1993} (pers comm T. Ogawa).

Rationale:
Commercial octopus landings have increased from approximately 5000 pounds in 1966 to over 35,000 pounds in 2012. {DeMello 2004}{HDAR 2013} The octopus catch had a high of over 40,000 pounds in 1986 and has never dropped below 5000 lbs. since that time.

NIGHT OCTOPUS

1.1 - Inherent Vulnerability

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Low**

There is insufficient information on this species lifespan and age at maturity to calculate an accurate inherent vulnerability score. However, the majority of medium sized coastal cephalopod species are typically highly productive, with short lifespans (1-2 years maximum), fast maturation rates and high fecundity, reproducing once upon reaching maturity and then dying {Boyle and Rodhouse 2005}. One female *O. ornatus* was recorded as bearing 35,000 eggs {Norman 1993}, which would be considered high fecundity. *O. ornatus* is widely distributed from Indian Ocean through Western and Central Pacific Oceans {Norman 1993}.

1.2 - Stock Status

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Moderate Concern**

No stock assessment exists for the he'e stock complex in Hawaii, of which *O. ornatus* likely makes up a small percentage of the catch (because it is only fished at night, hiding undetectable in lairs during the day {Norman 1993}). Based on tropical cephalopod life history, namely their short life span, early age at maturity and high fecundity, it is likely that this species' stock is highly productive can support the current (though unknown) level of exploitation. In combination with this high productivity, the nature of the Hawaiian coastline is such that large stretches of nearshore areas are difficult to harvest from, providing a refuge from fishing (pers. comm D. Kobayashi, PIFSC).

Commercial data from 2003-2012 collected by the Hawaii Division of Aquatic Resources {HDAR 2013}, shows that catch per unit of effort has decreased with increasing catch since 2007 for the overall catch and for both the handline fishery and spear fishery individually (see Figure 1). This suggests increased pressure on the he'e resource. See image below. Earlier CPUE data (from 1980-1990) show that octopus landings in Hawaii have varied as a function of the number of trips and the magnitude of CPUE {Smith 1993}.

The increasing pressure on the he'e resource suggested by the recent commercial CPUE data may also be indicative of pressures exerted by the recreational fishery. In some areas, such as Kaneohe Bay, recreational catch can far exceed the commercial take, exemplified by 1991 and 1992 surveys which revealed that the recreational catch in Kaneohe Bay was 17 to 24 higher than the commercial catch {HDAR 1997}.

Rationale: See Figure 7.

1.3 - Fishing Mortality

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.67 **Low Concern**

A stock assessment is lacking for Hawaiian octopus, so Fishing Mortality at Maximum Sustainable Yield (F_{MSY}) for *O. ornatus* (night tako) is unknown. However, commercial fishing mortality for *O. ornatus* is likely to be low given that the minimum size requirement is one pound and the average weight of *O. ornatus* is 1 kg (Norman 1993). This minimum size requirement also applies to recreational fisherman but because enforcement is lax it is likely that undersize *O. ornatus* are taken in the recreational fishery. Also, because O. ornatus is only active at night (Norman 1993) it is possible that less people target this species (though night fishing for octopus does occur).

Mortality in the commercial he'e fishery has increased over time (see Figures 2 and 3) (DeMello 2004)(DLNR data), and there is a large recreational octopus fishery, which may be a larger contributor to fishing mortality than the commercial fishery in certain areas (Smith 1993) (pers comm T. Ogawa).

Rationale:
Commercial octopus landings have increased from approximately 5000 pounds in 1966 to over 35,000 pounds in 2012. {DeMello 2004} {HDAR 2013} The octopus catch had a high of over 40,000 pounds in 1986 and has never dropped below 5000 lbs. since that time.

Criterion 2: Impacts on other retained and bycatch stocks

All retained and primary bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch.

Day octopus: Hawaii Central Pacific, Handline

Subscore:: 3.318 **Discard Rate:** 1.00 **C2 Rate:** 3.318

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
DAY OCTOPUS	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
NIGHT OCTOPUS	3.00: Low	3.00: Moderate Concern	3.67: Low Concern	**3.318**

Day octopus: Hawaii Central Pacific, Spear

Subscore:: 3.318 **Discard Rate:** 1.00 **C2 Rate:** 3.318

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
DAY OCTOPUS	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
NIGHT OCTOPUS	3.00: Low	3.00: Moderate Concern	3.67: Low Concern	**3.318**

Night octopus: Hawaii Central Pacific, Handline

Subscore:: 2.644 **Discard Rate:** 1.00 **C2 Rate:** 2.644

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
DAY OCTOPUS	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
NIGHT OCTOPUS	3.00: Low	3.00: Moderate	3.67: Low Concern	**3.318**

		Concern		

Night octopus: Hawaii Central Pacific, Spear				
Subscore:: **2.644**	**Discard Rate:** **1.00**		**C2 Rate:** **2.644**	
Species	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
DAY OCTOPUS	3.00: Low	3.00: Moderate Concern	2.33: Moderate Concern	**2.644**
NIGHT OCTOPUS	3.00: Low	3.00: Moderate Concern	3.67: Low Concern	**3.318**

Justification of Ranking

Only species that scored 'red' are included here. All other species evaluations are in Appendix 1. See criterion 1 for scoring definitions.

2.4 - Discard Rate

Hawaii/Central Pacific, Handline

1.00 **< 20%**

Hawaii/Central Pacific, Spear

1.00 **< 20%**

Key Relevant Info:

Generally, only the targeted species is caught when fishing with spear (three prong), so the discard rate is low to zero.

Criterion 3: Management effectiveness

Management is separated into management of retained species and management of non-retained species/bycatch. The final score for this criterion is the geometric mean of the two scores.

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Hawaii Central Pacific Handline	3.000	All Species Retained	Yellow(3.000)
Hawaii Central Pacific Spear	3.000	All Species Retained	Yellow(3.000)

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Hawaii Central Pacific Handline	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective
Hawaii Central Pacific Spear	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective

Factor 3.1: Management of Fishing Impacts on Retained Species

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective', 'moderately effective', or 'highly effective'.

- 5 (Very Low Concern) = Rated as 'highly effective' for all seven subfactors considered
- 4 (Low Concern) = Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective'.
- 3 (Moderate Concern) = All subfactors rated at least 'moderately effective'.
- 2 (High Concern) = At minimum meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective'.
- 1 (Very High Concern) = Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective'
- 0 (Critical) = No management exists when a clear need for management exists (i.e., fishery catches threatened, endangered, or high concern species) OR there is a high level of Illegal, Unregulated, and Unreported Fishing occurring.

3.1.0 - Critical?

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

0.00 **No**

The Hawaiian he'e fishery is managed.

Subfactor 3.1.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place, are there appropriate management goals, and is there evidence that management goals are being met. To achieve a highly effective rating, there must be appropriate management goals and evidence that the measures in place have been successful at maintaining/rebuilding species.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

2.00 **Moderately Effective**

The only restriction on catch is the minimum 1 pound weight limit per octopus caught {§13-95-55}. There is no quota, but the Hawaii Department of Aquatic Resources does keep track of commercial landings via mandatory catch reporting. Although he'e stocks are minimally managed, SFW rates this criterion as moderate effective rather than ineffective because he'e are highly productive and fishing effort is unevenly distributed along the Hawaiian islands coastlines, allowing for stock rebuilding from difficult to access coastal areas and from deeper waters which are not fished as intensively (pers. comm D. Kobayashi, PIFSC).

There are several types of Marine Managed Areas (MMAs) in Hawaii, ranging from gear-restricted areas, rotational or seasonal closures to full and partial closures {Jokiel et al. 2010}. Marine Life Conservation Districts (MLCDs) are a subset of MMAs where collection of marine life, including he'e, is prohibited. The areal extent of these fully protected areas is limited; there are 3 on O'ahu covering a total of 208 acres, 5 on Hawai'i covering a total of 777 acres, 1 on Maui covering 45 acres, 1 on Lanai covering 309 acres and one on Molokini covering 77 acres {HDARa 2013}.

Subfactor 3.1.2 - Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success. To achieve a rating of highly effective, rebuilding

strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

-1.00 **N/A**

There are currently no overfished, depleted, endangered or threatened species targeted or retained in the fishery.

Subfactor 3.1.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species. To receive a highly effective score, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

2.00 **Moderately Effective**

Commercial logbook data is collected on he'e landings. Data collected includes information on fishing license, number of trips, gear used, and pounds of octopus harvested and pounds of other catch harvested (on the same trip) {HDAR 2013}.

We note here that *O. cyanea* populations in Madagascar have benefited from under-exploitation of deeper water habitats {Raberinary and Benbow 2012}. Handlining targets he'e at the deeper end of their habitat range, and although no studies have focused on deeper waters as refuges for *O. cyanea* in Hawaii, it is possible that this also holds true in Hawaii {HDAR 1997}.

Subfactor 3.1.4 - Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels). A highly effective rating is given if managers nearly always follow scientific advice.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

2.00 **Moderately Effective**

There is no scientific advice offered for this fishery, and there are no management targets, so this subcriterion is not applicable.

Subfactor 3.1.5 - Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations. To achieve a highly effective rating, there must be regular enforcement of regulations and verification of compliance.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

2.00 **Moderately Effective**

The only limitation on he'e catch is the 1 lb. minimum, which applies to the commercial and recreational fisheries {§13-95-55}. While there is an incentive for commercial fisherman who bring their he'e to market to adhere to this minimum size limit, recreational fishers who do not need to report their catch do not share this same incentive. Size limits for inshore fisheries like he'e are enforced by the state, specifically by DLNR's Division of Conservation and Resource Enforcement (DOCARE). According to a 2004 study funded by the U.S. National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii and a 2011 review paper, DOCARE's effectiveness is low due to funding and staffing deficiencies that undermine its ability to fulfill its wide a mandate (DOCARE is responsible for enforcing all state laws and county ordinances on all state lands, beaches, inshore waters, and county parks) {Cesar 2004}{Jokiel et al. 2010}. However, a public-private partnership, announced in 2011 {The State of Hawaii 2011}, is funding the creation of Fishery Enforcement Units within DOCARE, with a pilot project beginning on a 13 mile section of the Maui coast (extending 3 miles seaward) in spring 2013 {Lahaina News 2013}.

Marine Managed Areas (MMAs), including Marine Life Conservation Districts (MLCDs) where collecting of marine life (including he'e) is prohibited, are also enforced by DOCARE, which as mentioned above currently has limited effectiveness. Whether the to be created Fishery Management Units will be effective is not known.

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels. A highly

effective rating will be given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

2.00 **Moderately Effective**

Management of the commercial he'e fishery is minimal, so it is difficult to assess this subcriterion.

Subfactor 3.1.7 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process. Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g. fishermen, conservation groups, etc.). A highly effective will be given if the management process is transparent and includes stakeholder input.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Highly Effective**

The Hawaii Division of Aquatic Resources (HDAR) issues public announcements for input when formulating new regulations relating to fisheries and other aquatic resource management in state waters (HDARb 2013). DLNR/DAR manages Hawaii's coral reef resources (which include associated fisheries resources) as part of the Hawaii Coral Reef Strategy, which includes collaborations with federal partners (NOAA and USGS) as well as the University of Hawaii (The State of Hawaii 2010). There is state legislation, enacted in 1994, to enable the creation of Community-based Subsistence Fishing Areas (CBSFAs) (§188-22.6), which allows for partial community based control of resource management. The CBSFA process has met with very limited success (Richmond and Levine 2012).

Factor 3.2: Management of fishing impacts on bycatch species				
Region / Method	**Strategy**	**Research**	**Advice**	**Enforce**
Hawaii Central Pacific Handline	N/A	N/A	N/A	N/A
Hawaii Central Pacific Spear	N/A	N/A	N/A	N/A

Justification of Ranking

Factor 3.2: Management of Fishing Impacts on Bycatch Species

Four subfactors are evaluated: Management Strategy, Scientific Research/Monitoring, Following of Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective', 'moderately effective', or 'highly effective'. Unless reason exists to rank Scientific Research/Monitoring, Following of Scientific Advice, and Enforcement of Regulations differently, these ranks are the same as in 3.1.

- 5 (Very Low Concern) = Rated as 'highly effective' for all four subfactors considered
- 4 (Low Concern) = Management Strategy rated 'highly effective' and all other subfactors rated at least 'moderately effective'.
- 3 (Moderate Concern) = All subfactors rates at least 'moderately effective'.
- 2 (High Concern) = At minimum meets standards for 'moderately effective' for Management Strategy but some other factors rated 'ineffective'.
- 1 (Very High Concern) = Management exists, but Management Strategy rated 'ineffective'
- 0 (Critical) = No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery.

3.2.0 - All Species Retained?

Hawaii Central Pacific, Handline

1.00	**Yes**

Hawaii Central Pacific, Spear

1.00	**Yes**

Criterion 4: Impacts on the habitat and ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of Ecosystem Based Fisheries Management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (plus the mitigation of gear impacts score) and the EBFM score.

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
Hawaii Central Pacific Handline	4.00:Very Low Concern	0.50:Moderate Mitigation	3.00:Moderate Concern	**Green (3.674)**
Hawaii Central Pacific Spear	5.00:None	0.00:Not Applicable	3.00:Moderate Concern	**Green (3.873)**

Impacts on Habitat and Ecosystems by spear and handline fishing of he'e are likely to be minimal, but are unknown.

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

- 5 (None) = Fishing gear does not contact the bottom
- 4 (Very Low) = Vertical Line Gear
- 3 (Low) = Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom *occasionally* (<25% of the time) or purse seine known to commonly contact bottom
- 2 (Moderate) = Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand;
- 1 (High) = Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g. cobble or boulder).
- 0 (Very High) = Dredge or trawl fished on biogenic habitat, e.g. deep-sea corals, eelgrass and maerl.

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive plausible habitat type.

Hawaii Central Pacific, Handline

4.00 **Very Low Concern**

In general, handline gear has minimal contact with the substrate, so is rated as "very low concern".

When using a handline, the fisher bumps a small, rounded lure along the bottom. Octopi are attracted to the moving lure, pounce on it, become impaled on the hooks and are hauled rapidly to the surface. Unconsolidated rubble is the target species' (*O. cyanea*'s) preferred habitat, but it is also found in live coral. It is uncertain if this gear is used over both unconsolidated rubble and live coral.

Hawaii Central Pacific, Spear

5.00 **None**

Spearfishing has been found to have little to no effect on coral reef benthic communities {Frisch et al 2012}.

Factor 4.2 - Mitigation of Gear Impacts

- +1 (Strong Mitigation) = Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.
- +0.5 (Moderate Mitigation) = 20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.
- +0.25 (Low Mitigation) = A few measures in place, e.g., vulnerable habitats protected but other habitats not protected; some limits on fishing effort/intensity, but not actively being reduced.
- 0 (No Mitigation) = No effective measures are in place to limit gear impacts on habitats.

Hawaii Central Pacific, Handline

0.50 **Moderate Mitigation**

The state of Hawaii protects coastal and nearshore marine areas via its system of 11 Marine Life Conservation Districts (MLCDs), and has coverage on the islands of Hawaii, Maui, Molokini, Lanai and Oahu (Kauai has no coverage). Sizes of MLCD's range from 35 to 315 acres. Species and habitat protection varies between MLCD's, some are full protected as 'no-take' while others allow various forms of fishing (although none allow taking of octopus/he'e) {HDARa 2013}. Additional informal protected areas exist on various islands. There have been studies that demonstrate the effectiveness of some of these MLCD's for enhancing finfish populations and coral cover, but not for enhancing non-coral invertebrate species {Friedlander et al 2010}.

Handline/trolling for octopus occurs in nearshore areas which may not or may not be included within

MLCD's (MLCD's generally extend from the shoreline out to several hundred feet offshore).

Hawaii Central Pacific, Spear

0.00 **Not Applicable**

This gear does not make contact with the substrate.

Factor 4.3 – Ecosystem-Based Fisheries Management

- 5 (Very Low Concern) = Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g. large proportion of fishery area protected with marine reserves, abundance is maintained at sufficient levels to provide food to predators).
- 4 (Low Concern) = Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. If hatchery supplementation or fish aggregating devices (FADs) are used, measures are in place to minimize potential negative ecological effects.
- 3 (Moderate Concern) = Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species. OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.
- 2 (High Concern) = The fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.
- 1 (Very High Concern) = The use of hatchery supplementation or Fish Aggregating Devices (FADs) in the fishery is having serious negative ecological or genetic consequences. OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.

Hawaii Central Pacific, Handline

Hawaii Central Pacific, Spear

3.00 **Moderate Concern**

The fishery does not catch "exceptional species" and scientific assessment and management of

ecosystem impacts of this fishery are not yet underway, nor are there plans to carry out such an assessment. However, the Hawaii Division of Aquatic Resources (the agency responsible for nearshore marine resource management) is cooperating with NOAA, USGS and the University of Hawaii to carry out the Hawaii Coral Reef Strategy (HCRS), which focuses on overall improvement of coral reef ecosystem health in Hawaii. While invertebrate fisheries like he'e are not a focus of the HCRS, mobile invertebrate species are monitored as part of the overall effort {The State of Hawaii 2010}.

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Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® would like to thank Dr. Donald Kobayashi of the National Oceanic and Atmospheric Administration Pacific Islands Fishery Science Center and Dr. Thomas Ogawa of the Hawaii Department of Land and Natural Resources and one anonymous reviewer for graciously reviewing this report for scientific accuracy.

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch and Seafood Reports, please contact the Seafood Watch program at Monterey Bay Aquarium by calling 1-877-229-9990.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following **guiding principles** illustrate the qualities that capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species/stock for which you want a recommendation
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and rank
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rank** for that criterion

Once a score and rank has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ranks and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

Best Choices/Green: Are well managed and caught or farmed in environmentally friendly ways.

Good Alternatives/Yellow: Buy, but be aware there are concerns with how they're caught or farmed.

Avoid/Red: Take a pass on these. These items are overfished or caught or farmed in ways that harm other marine life or the environment.

1 "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.