Seafood Watch
Seafood Report:

Hawaiian Octopus

Octopus cyanea

Image from http://marenostrum.org/galeria/erwin/Octopus_cyanea.jpg

Alice Cascorbi
Fishery Research Biologist
Monterey Bay Aquarium

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List of Five Component Ranks	Conservation Concern Low	Conservation Concern Moderate	Conservation Concern High	Conservation Concern Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Bycatch	√			
Habitat Effects		√		
Management Effectiveness		√		

Overall Seafood Rank: Good Alternative

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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 Alternative" or "Avoid". 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 Fishery 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.

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Executive Summary:
The Hawaiian commercial fishery for octopus is small, taking in just 10.6 metric tons in 2000. However, recreational and subsistance catch may be 17-24 times the commercial catch. In 2000, Hawaii also imported 68.6 metric tons of octopus from Asian nations. Hawaii's resident octopus, *Octopus cyanea*, matures within one year and lives no longer than 18 months. Its fecundity is high, with females laying up to 700,000 eggs during their one and only breeding cycle. Hawaii's commercial and recreational octopus fisheries employ low-bycatch methods (spearfishing and lure-and-line fishing), but the octopus inhabits fragile coral reef ecosystems that may be highly vulnerable to damage. Many basic population parameters remain unknown for Hawaiian octopus. There has been no stock assessment, and no fisheries management plan is in place. While this small fishery has exisited for years at the same low level, our criteria direct that we rank it "Good Alternative" because too many basic factors remain unknown.

A Note on Outside Review:
Seafood Watch is indebted to Dr. Alan Everson of the NMFS Pacific Islands Regional Office, Honolulu, who graciously reviewed this paper for scientific accuracy. It is important to note that scientific review does not constitute an endorsement of Seafood Watch on the part of the reviewing scientists; the Seafood Watch staff is solely responsible for the conclusions reached in this report.

Hawaiian Octopus

Local names: He'e, Tako, "Squid" [DAR, 2003]

The octopus caught in Hawaiian waters is *Octopus cyanea.* Common names for this species include the Big Blue Octopus and Cyane's Octopus [CephBase, 2003]. In Hawaii, this species is sometimes called the "day squid" or he'e mali [manandmollusc.net, 2003]. Some authorities point to another species, *Octopus marmoratus*, known as the "night squid" or he'e puloa [manandmollusc.net, 2003]; said to be reddish-brown with white spots [Scott, 1996]. However, the species name *O. marmoratus* is only a synonym for *O. cyanea* [CephBase, 2003]. There are even reports of a third species, the "crescent octopus", said to resemble a small-sized *O.cyanea* [Scott, 1996]. Like other octopuses, *O.cyanea* changes its skin color and texture readily and radically to match prevailing conditions of light and substrate, and may mature at large or small size [Van Heukelem, 2003], so it is perhaps understandable that one species could be thought to be several. *Octopus cyanea* may emerge from hiding during daylight hours, but is most active at dawn and dusk [Van Heukelem, 2003; Forsythe & Hanlon, 1997].

Figure 1:*Octopus cyanea* at home on a coral reef. Image from http://marenostrum.org/galeria/erwin/Octopus_cyanea.jpg

Octopus is valued as food in Hawaii. Hawaii's per-capita consumption of sashimi is second only to Japan's [DBEDT 2002], and cooked octopus ("tako" in Japanese) is one of the sliced specialties found on every sashimi menu. Much octopus is also prepared as the Hawaiian specialty "tako poke" (POH-kay), mixed salads of diced cooked octopus mixed with onions, other vegetables, and seasonings. Tako poke is made at home by many Hawaiians and is also widely available in Hawaiian supermarkets; there are any number of recipes [Chang 2002; Enomoto 1997].

In 1999, reported commercial landings of Hawaiian octopus totaled 23,370 pounds (10.6 metric tons) [DAR, 2002]. In 2000, that figure was 23,432 pounds (also 10.6 metric tons) [DAR Stats, 2002]. Locally-caught octopus sells at a premium in Hawaii markets [Bertram, 2003]; in 2000, the price per pound averaged $2.90 [DAR Stats, 2002]. Hawaiian-caught octopus is often cooked and frozen to help tenderize it [Bertram, 2003], but is also marketed raw, dried, and smoked [Takenaka, 2003].

Much of the octopus sold in Hawaii is imported from Asian nations [Bertram, 2003; NMFS SWFSC Statistics, 2003], particularly Japan [Takenaka, 2003]. In 2000, the last year for which figures are available, Hawaii imported 68.6 metric tons of octopus [NMFS Stats, 2003]. Importing nations were China, Japan, the Philippines, and Thailand. All of this octopus was frozen product [NMFS SWFSC Statistics, 2003]. As of February, 2003, just one Japanese seafood processor, Kure Geiko Co. Ltd. of Kure City in Hiroshima prefecture, was licensed under Japanese government health codes to prepare cooked octopus for export to the United States [JDFS, 2003].

A brief exploration of Asian octopus fisheries revealed that Japan's octopus-fishing interests extend across the globe [FAO, 2001; FIS 1999a, 1999b]. Commercial fisheries for *Octopus dolfeini* (called tako) and *Paroctopus honkongensis* (mizu-dako) have existed in Japanese waters for centuries [Rathgen & Voss, 1987; Kanmaru & Yamashita, 1969]. These species are still important components of Japan's domestic fishery. Much of this octopus is taken by bottom-trawl methods, although traps and cast nets are also used [Rathgen & Voss, 1987; Fukuda& Takahashi, 1960]. But the Japanese market is supplied with octopus caught around the globe, both by Japanese vessels and by vessels of other nations. *Octopus dofleini*, the Pacific giant octopus, is sought off Alaska and British Columbia and marketed in Japan [Scheel, 2001; DFO 2002]. Alaskan and Canadian managers warn that stock assessments of this species are inherently difficult, and expansion of the fishery could easily result in overfishing [Scheel, 2001; DFO 2002]. The bulk of the world catch of the Atlantic octopus *Octopus vulgaris* is marketed in Japan [Rathgen & Voss, 1987]. There are major trawl fisheries for this species off Venezuela, and off the Saharan Banks of West Africa [Rathgen & Voss, 1987]. This latter includes the extensive octopus fisheries of Morocco, whose major market is Japan [FIS 1999a, 1999b]. Vessels from Japan, China and the European Union regularly trawl for octopus in the territorial waters of Mauritania, another West African nation [Rathgen & Voss, 1987; UNEP, 2002]. However, according to a U.N. report, overfishing and a lack of fishing-rule enforcement caused a 50% decline in Mauritanian octopus catches between 1998 and 2002 [UNEP, 2002]. Senegal's largely artisianal catch of *O. vulgaris* was up in 2002, responding to high prices for octopus in Japan, but industry sources note that minimum size limits and landing caps are routinely ignored in the Senegalese fishery [Infofish, 2002]. Meanwhile, an experimental fishery for *O.vulgaris* is opening off the coast of South Africa, where the species is considered underexploited [Dispatch 2002; Oceanlaw 2002]. The South African government intends this experimental trap fishery to provide data on the environmental impacts of developing South African octopus for export to Europe and Japan [Dispatch 2002].

In 2001, it was estimated that about 267 individual licensees participated in Hawaii's commercial "spear/squidding" octopus fishery [NMFS List of Fisheries, 2001]. Small amounts of octopus were also taken as incidental catch in Hawaii's trap fishery for spiny and slipper lobster [PCFFA, 2000]. This fishery is currently closed in the Northwest Hawaiian Islands and operating under extreme limitation in the Main Hawaiian Islands [Haight, 2003, pers.comm].

In 1999, reported commercial landings of Hawaiian octopus totaled 23,370 pounds (10.6 metric tons) [DAR, 2002]. In 2000, that figure was 23,432 pounds (also 10.6 metric tons) [DAR Stats, 2002]. Hawaiian octopus is landed every month of the year, but the biggest catches are made September-January [DAR Stats, 2002].

Hawaii's octopus fishery is unusual in that subsistence and recreational fishermen land the large majority of the catch. The example of Oahu's Kaneohe Bay illustrates this reality.

Figure 2: The island of Oahu. Kaneohe Bay is at middle right.
Map from www.oahu-hawaii-vacation.com

Octopus are plentiful along the shallow reefs and inshore areas of Kaneohe Bay and are sought by both commercial and recreational/subsistence fishers [DAR, 1997]. Between 1980 and 1994, reported **commercial** landings averaged 1446 pounds per year [DAR, 1997]. In 1991 and 1992, shoreline fishing surveys revealed **total** inshore landings of 25,852 lbs. and 34,068 lbs., respectively [DAR, 1997]. These data indicate that **recreational and subsistence take of tako totaled 17 to 24 times the commercial catch** [DAR, 1997]. While Kaneohe Bay is an area with an ususually large exploitable biomass of octopus due to its bottom topography [Everson, 2003], these recreational statistics have profound implications for the fishery, as well as for this seafood recommendation. If tby far the largest fraction of octopus is caught by recreational/subsistence fishers, who eat it themselves or give it to friends, then imports matter far less in terms of the total amount of tako consumed in Hawaii. Everson (2003), author of the Kaneohe Bay report, believes that Hawaii's total domestic tako catch increases dramatically when the recreational take is added to the commercial take. However, he believes that the multiplication factor is "probably not as big" in most areas as in Kaneohe Bay [Everson, 2003].

Analysis of Seafood Watch Criteria for Sustainable Wild-Caught Products Relative to Hawaii

Criterion 1: Inherent Vulnerability to Fishing Pressure

Intrinsic rate of increase ('r'):
Not known for *Octopus cyanea* in the wild [Van Heukelem, 1983].

Age at 50% sexual maturity: Low: Less than 5 years
Octopus cyanea males are sexually mature at 7-9 months after they settle out of the plankton [Van Heukelem, 1983]. Females lay their one and only clutch of eggs at about 10-11 months, having mated about a month earlier [Van Heukelem, 1983].

In this species, sexual maturity seems to be based on age, not size [Van Heukelem, 1983]. Mature adults commonly weigh between 340 and 6000 grams [Van Heukelem, 1983], although Hawaii's state record octopus, caught in 2000 off Oahu, weighed 8623 grams (19.01 pounds) [Hawaiian Fishing News, 2003]. Each individual's adult size depends heavily upon the conditions of food availability, water temperature and day length during the juvenile growth period [Van Heukelem, 1983]. When those conditions are favorable, *Octopus cyanea* are capable of very rapid growth. In the laboratory, juveniles gained up to 4.1% of body weight per day when fed *ad libitum* [Van Heukelem, 1983].

Validated maximum age: Low: Less than 10 years
Octopus cyanea live for just 12-15 months after settling from the plankton [Van Heukelem, 1983]. (The length of the planktonic larval stage is not known [Van Heukelem, 1983], but the total lifespan of this species, from egg to senescent death, is most likely less than 18 months).

Reproductive potential (fecundity): Medium (e.g. egg layer)
Octopus cyanea breed once and then die [Van Heukelem, 1983]. Females lay 300,000-700,000 eggs in this single breeding cycle [Van Heukelem, 1983], with larger females laying more eggs [Van Heukelem, 1983].

Additional Factors to evaluate:
Species range: Broad
Octopus cyanea is widely distributed throughout the warmer waters of the Indian and Pacific oceans. It is considered a common (not rare) species throughout its range [Van Heukelem, 1983].

Evidence of special behaviors that increase ease of capture (spawning aggregations, site fidelity, etc): No
While *Octopus cyanea* do shelter in dens, they stay a maximum of 40 days or so in one den. [Van Heukelem, 1983]. Spawning occurs year-round in Hawaiian waters [Van Heukelem, 1983]. Females brood their eggs, but go into hiding and do not eat during this

process [Van Heukelem, 1983], making them unlikely to enter a trap or follow a fishing lure.

Evidence of high population variability driven by physical environmental change (e.g El Nino, Decadal Oscillations): No

No climate-driven oscillations in populations have been reported [Van Heukelem, 1983].

Synthesis, analysis and evaluation of relevant factors

A combination of low age at sexual maturity, low maximum age and high fecundity make *Octopus cyanea* an Inherently Resistant species.

Inherent Vulnerability Rank: **Inherently Resilient**

Criterion 2: Status of Wild Stocks

Classification status: Unknown

As a nearshore fishery, the Hawaiian octopus fishery is regulated by Hawaii's Division of Aquatic Resources (DAR). The DAR does not classify octopus as overfished, and has no special seasons or bag limits in place, but no stock assessment has been performed [DAR 2002; DAR Stats 2002; DAR 2003].

Current population abundance relative to BMSY: BMSY is unknown

Short- and long-term trend in population abundance, as measured by fishery-independent means (stock assessment): Trend is flat unknown

There has been no stock assessment of Hawaiian octopus [DAR 2002; DAR Stats 2002; DAR 2003]. There are some localized, fishery-dependant abundance surveys, such as the 1991 and 1992 surveys of total catch in Kaneohe Bay [DAR, 1997].

Trend in catch and fishing effort: Catch and effort are stable OR unknown

Catch and effort appear to be relatively stable over the last twenty years (1980-2000) [DAR 1997; DAR 2002; DAR Stats 2002; DAR 2003]. It was noted by the DAR that offshore areas serve as "de facto" marine reserves for octopus [DAR 1997], as fishers do not go after octopus in water deeper than about 60 meters [Van Heukelem, 1983].

Occurrence of overfishing (current level of fishing mortality relative to overfishing threshold): Overfishing likelihood unknown, as both overfishing threshold and mortality are unknown.

Current age, size or sex distribution of the stock relative to natural condition: Distribution unknown

Additional Factors to evaluate:

Scientific evidence that disputes the stock classification: None found.

Degree of uncertainty in status of stock: Medium (e.g. Only limited, fishery dependent data on stock status are available)

There are some localized, fishery-dependant surveys of octopus abundance in Hawaii, such as the 1991 and 1992 surveys of total catch in Kaneohe Bay [DAR, 1997].

Scheel (2001) notes that it is inherently difficult to conduct stock assessments on octopuses, because the animals are solitary, shy, and possess excellent camouflage abilities [Scheel, 2001]. In Alaska, fisheries managers are considering using availability of suitable habitat as a surrogate for actual counts of animals when preparing stock assessments for the giant octopus (*Enteroctopus dofleini*) [Scheel, 2001].

Synthesis, analysis and evaluation of relevant factors

While general information about catch and effort seems to suggest that Hawaii's octopus stocks have been stable since record-keeping began in 1980, there has been no stock assessment, and most of the basic stock parameters remain unknown.

Status of the Stocks Rank **Stock Unknown**

Criterion 3: Nature and Extent of Bycatch

Composition of the bycatch, including any species of "special concern" (i.e. those identified as "endangered", "threatened" or "protected" under state, federal or international law): Bycatch includes a low diversity of organisms (e.g. a single or only a few species), none of which are of "special concern"

Hawaii's commercial and recreational octopus fishery employs two methods: spearfishing and lure-and-line fishing [Van Heukelem, 1983]. These are both highly selective methods that take little or no bycatch. These methods are not even mentioned in UN FAO studies of the bycatch effects of fishing methods [FAO 1996; FAO 1997]. No interactions with protected marine mammals are recorded in Hawaii's octopus ("spear/squidding") fishery [NMFS List of Fisheries, 2001].

Population consequences of bycatch:
Low: Quantity of bycatch is thought to have little or no impact on population levels

For bycatch species of similar or lower trophic level relative to the targeted species--Quantity of bycatch relative to the quantity of targeted landings:

Not Applicable ☐

Short and long-term trend in quantity and composition of bycatch as a result of management decisions including gear innovations:
Trend in quantity and/or diversity of bycatch is flat around "minimal bycatch"

Additional Factor to evaluate
Evidence that the ecosystem has been or will likely be altered in response to the removal of the bycatch species: No

Synthesis, analysis and evaluation of relevant factors
Bycatch is very low by the nature of the fishing methods used. There is no trend toward other methods or higher bycatch.

Nature and Extent of Bycatch Rank **Bycatch Low**

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Effect of fishing gear on physical and biogenic habitats (known for specific fishery or inferred from other studies): Minimal damage (spearfishing, lure-and-line)
Two fishing methods dominate Hawaii's sport and commercial octopus fisheries: spearfishing and lure-and-line [Van Heukelem, 1983]. Spearfishing is done from a boat in water less than one meter deep, and by snorkel divers in water deeper than this [Van Heukelem, 1983], down to the limits of breath-hold diving. In water 30 to 60 meters deep, lure fishing predominates [Van Heukelem, 1983]. In this method, the fisher bumps a small, rounded lure along the bottom [Van Heukelem, 1983]. The lure, traditionally a small cowrie shell [Van Heukelem, 1983], but now sometimes synthetic [HawaiiLure, 2003], bristles with thin, barbless hooks. Octopuses are attracted to the moving lure, pounce on it, become impaled on the hooks and are hauled rapidly to the surface [Van Heukelem, 1983].

Figure 3: Octopus lures made by HawaiiLure Company; cowrie shell (left) and artificial crab (right). Note the barbless hooks. Images from http://www.hawaiilure.com/catalog/takolures.html

Resilience of physical and biogenic habitats to disturbance: Low (coral reef)
Octopus cyanea live on and around coral reefs. They are most often found at depths of 1-60 meters [Van Heukelem, 1983], the same depths as the "living" parts of the corals which are considered very vulnerable to disturbance [WRI, 1998]. A recent Australian study showed that about 15% of dives on coral reef by qualified recreational scuba divers result in damage to the reef, mostly from kicks by fins [Rouphael & Inglis, 1995]. In 2001, the University of Hawaii's Sustainable Tourism and Environment Program began a study of damage to Hawaii's reefs caused by skin diving and shallow-water trampling [STEP-UP, 2003]. Results of this study are not yet available. However, some of *O. cyanea*'s habitat is less-fragile "coral rubble", rather than living coral. *O. cyanea* dens are found most often in coral rubble, only occasionally in living coral [Van Heukelem, 1983]. However, the octopuses move through both living and non-living structure as they feed [Van Heukelem, 1983].

Evidence that the removal of targeted species has or will likely substantially disrupt the food web: Unknown
There is a suggestion, but no more than that, that because octopus is a food source for the endangered Hawaiian monk seal, removal of octopus may compromise the recovery of the seal [PCFFA, 2000; Pacific Whale Foundation, 2002]. This issue was much more important for the Northwest Hawaiian Islands spiny lobster fishery, which is currently closed, partly due to concerns about the monk seal [Haight, 2003, pers.comm].

Evidence that the fishing method has caused or is likely to cause ecosystem state changes, including alternate stable states or regime shifts: Unknown

This question was not answered in the literature searched.

Synthesis, analysis and evaluation of relevant factors

While the main fishing methods cause little habitat damage, and the fishery is quite small, the coral reef habitat is extremely vulnerable to physical disturbance. Ecosystem effects of the fishery are unstudied, and therefore unknown. Considering all these factors together, I give Hawaiian octopus a combined ranking of "moderate" for effects of fishing practices on the marine environment.

Effects of Fishing Practices Rank **Fishing Effects Moderate**

Criterion 5: Effectiveness of the Management Regime

As a nearshore fishery, the Hawaiian octopus fishery is regulated by the State of Hawaii through its Division of Aquatic Resources (DAR). There is a minimum size limit of one pound for both commercial and recreational take [DAR 2003]. The DAR has not deemed it necessary to implement any other controls on this small fishery; there are currently no seasonal closures, bag limits or gear restrictions [DAR 2003].

Stock Status: Management implements a stock assessment that seeks scientific knowledge related to the short and long-term status of the stock:
No stock assessment available or planned in the near future

Scientific Monitoring: Management regularly collects data and analyzes it with respect to stock abundance: Regular collection of fishery dependent data only
Commercial landings are recorded each year by the DAR [DAR Stats, 2002]. There are some localized, fishery-dependant surveys of octopus abundance in Hawaii, such as the 1991 and 1992 surveys of total catch in Kaneohe Bay [DAR, 1997].

Bycatch: Management implements an effective bycatch reduction plan:
No bycatch plan needed because bycatch is "low"

Fishing practices: Management addresses the effect of the fishing method(s) on the habitats and ecosystems:
No measures needed because fishing method is deemed to be "benign"

Enforcement: Management and appropriate government bodies enforce fishery regulations: Regulations enforced by fishing industry or by voluntary/honor system

Hawaii's commercial octopus fishermen are required to report their landings to the DAR. However, as noted in the introduction to this report, recreational/subsistence landings comprise the vast majority of the octopus caught in Hawaiian waters, and there is no systematic reporting system for these landings [DAR, 1997].

Synthesis, analysis and evaluation of relevant factors
In this small commercial fishery, management has been minimal, because there has not seemed a pressing need for management.

Effectiveness of Management Rank: moderately effective

Overall Evaluation and Seafood Ranking

Octopus cyanea is inherently resilient to fishing pressure. There is little bycatch taken in this spear fishery. However, status of the stocks is unknown, as no stock assessment has been performed—clues to stock status come only from yearly commercial-landings reports. The effect of fishing methods on the marine environment is rated as "moderate" because of the vulnerability of coral reef habitat, even though spearfishing would otherwise be considered a low-impact fishing method. No stock assessments are planned, and the only take regulation in place is a one-pound minimum size limit, so management is rated only "moderately effective". One study of Kaneohe Bay suggests that the unlicensed recreational fishery lands far more octopus than the commercial fishery. While Hawaii's commercial octopus fishery has exisited for years at the same low level of reported catches, our criteria direct that we rank it "Good Alternative" because many basic factors remain unknown.

List of Five Component Ranks	Conservation Concern Low	Conservation Concern Moderate	Conservation Concern High	Conservation Concern Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Bycatch	√			
Habitat Effects		√		
Management Effectiveness		√		

Overall Seafood Rank: **Good Alternative**

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