# Monterey Bay Aquarium Seafood Watch®

## Mahi mahi and Wahoo

*Coryphaena hippurus* and *Acanthocybium solandri*

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## US Pacific (Hawaii); Troll
## US Atlantic; Troll, Handline, Rod and Reel

August 15, 2013

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# Final Seafood Recommendation

This report covers mahi mahi and wahoo from the troll fishery in the US Pacific (Hawaii) and the troll, handline and rod and reel fisheries in the US Atlantic. Due to similarities in gear deployment, bycatch and discard rates, these gears are assessed as a single handline/troll category for the US Atlantic region. Domestic catches account for less than 5% of the mahi mahi on the US market. Imports of wahoo are unknown. Little is known about the stocks of mahi mahi or wahoo in the Atlantic or Pacific, and management measures specific to the fisheries' impacts on these stocks is limited. Furthermore, a significant part of the retained catch in the Pacific is bigeye tuna, which is currently undergoing overfishing. Bycatch concerns in the Atlantic fishery are fewer.

Mahi mahi from Hawaii and wahoo from both fisheries is a Good Alternative, while mahi mahi from the Atlantic fishery is a Best Choice.

| **Stock** | **Fishery** | **Impacts on the Stock**<br><br>Rank (Score) | **Impacts on Other Species**<br><br>Lowest scoring species Rank*, Subscore, (Score) | **Manage-ment**<br><br>Rank (Score) | **Habitat and Ecosystem**<br><br>Rank (Score) | **Overall**<br><br>Recommendation (Score) |
|---|---|---|---|---|---|---|
| Wahoo | Pacific troll | Yellow (2.64) | Bigeye tuna Red, (2,2) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (2.8)** |
| Wahoo | Atlantic handline/ troll | Yellow (2.64) | Mahi mahi Yellow, (2.64,2.64) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (3)** |
| Mahi mahi | Pacific troll | Yellow (2.64) | Bigeye tuna Red, (2,2) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (2.8)** |
| Mahi mahi | Atlantic handline/ troll | Yellow (2.64) | Yellowfin tuna Green, (4.47,4.47) | Yellow (3) | Green (3.87) | **BEST CHOICE (3.42)** |

**Scoring note** – scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

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# Executive Summary

Mahi mahi (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) are found worldwide in tropical and subtropical waters. This assessment focuses on mahi mahi and wahoo troll fishery in the US Pacific (Hawaii) and the troll, handline and rod and reel fisheries in the US Atlantic. Due to similarities in gear deployment, bycatch and discard rates these gears are assessed as a single handline/troll category for the US Atlantic region. Domestic landings account for less than 5% of the mahi mahi available in the US marketplace. There are no data available regarding US wahoo imports and exports. U.S. longline-caught mahi mahi and wahoo are assessed in separate reports, as is imported mahi mahi.

Both mahi mahi and wahoo mature quickly, are short lived and highly fecund, and hence, are moderately resistant to fishing pressure. However, the stock status and fishing mortality rates for these species are almost entirely unknown. A single study of the Western Atlantic and Gulf of Mexico mahi mahi stock found biomass to exceed $B_{MSY}$, although the data in this analysis are outdated.

A number of other pelagic species are captured opportunistically in the Atlantic and Hawaiian mahi mahi and wahoo fisheries. Yellowfin tuna and swordfish are the chief incidentally captured species in the Atlantic handline/troll, whereas yellowfin tuna and bigeye tuna comprise the majority of incidental captures in the Hawaiian troll. A recent assessment of the status of Atlantic yellowfin stocks yielded some uncertainty in model estimates of biomass. This stock was deemed to be approaching an overfished state. Overfishing is likely occurring on the western central Pacific bigeye stock. Both the Atlantic handline/troll and Hawaiian troll fisheries capture very few fish relative to industrial scale fisheries like purse seiners and pelagic longliners.

Troll fishing has very low discard rates when compared to other commercial fishing methods, and while there are no estimates of fisheries discards for the Atlantic handline/troll and Hawaiian troll fleets, numerous studies have found that discards with these gear types are negligible.

In the Atlantic, mahi mahi and wahoo are jointly managed under a fishery management plan established by the SAFMC. There are some measures in place aimed at protecting the western Atlantic stocks, including size limits for mahi mahi in Florida, Georgia and South Carolina (>20" fork length (FL)), although there are currently no size restrictions on wahoo landed in US waters. The FMP also sets forth $B_{MSY}$ and optimal yields for each mahi mahi and wahoo and identifies potential future research topics to inform management agencies on stock status, fishery impacts, life history characteristics and essential habitat, although it is unclear whether any of the efforts to ascertain this information are underway. There is relatively little monitoring of handline and troll operators in this fishery and no program is in place for continued research on the effects of the current management plan on Atlantic mahi mahi and wahoo stocks. Compliance with FMP guidelines is enforced by state wildlife and fisheries

agencies, the US Coast Guard and NOAA. Various stakeholder groups have an interest in the management of mahi mahi and wahoo, chiefly commercial fishers and recreational/charter operators. A key objective of the FMP is to ameliorate competition between these constituencies and to this end the management plan prohibits the sale of recreationally landed mahi mahi and wahoo and set an annual cap on the quantity of mahi mahi landed by commercial fishers.

Mahi mahi and wahoo stocks in Hawaii are included in the Pacific Pelagic Fishery Ecosystem Plan (FEP). Most of the guidelines set forth in this plan pertain to industrial scale fisheries targeting pelagic management unit species, primarily bigeye tuna and yellowfin tuna. However, this document does provide a framework for the ongoing assessment of target species, including mahi mahi and wahoo, and prudent adjustments to management guidelines in order to achieve FEP goals. Commercial troll fishers must be licensed by the state of Hawaii and submit logbook data to the state division of aquatic resources. This catch database is maintained in order to monitor the status of marine resources in state waters and the EEZ. Beyond this, there are no specific measures in place to monitor the status of mahi mahi and wahoo stocks in the western central Pacific.

Handline and troll fisheries do not adversely impact the sea floor substrate, hence, no mitigation measures are necessary. Mahi mahi and wahoo are considered mid-trophic level predators, however, keystone species, including sharks, are very occasionally captured in both the US Atlantic handline/troll and Hawaiian troll fisheries, but do not comprise a significant proportion of the catch. Furthermore, sharks are generally not retained; handline and troll gear is highly selective, with fishers able to release undesirable species quickly, thus minimizing capture mortality. There are however, no efforts underway to assess the impacts of these gears on the Hawaiian or Atlantic pelagic ecosystems.

# Introduction

**Scope of the analysis and ensuing recommendation**

Mahi mahi (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*) are found worldwide in tropical and subtropical waters. This assessment focuses on mahi mahi and wahoo troll fishery in the US Pacific (Hawaii) and the troll, handline, and rod and reel fisheries in the US Atlantic. Due to similarities in gear deployment, and bycatch and discard rates, these gears are assessed as a single handline/troll category for the US Atlantic region. Domestic landings account for less than 5% of the mahi mahi available in the US marketplace. There are no data available regarding US wahoo imports and exports. US longline-caught mahi mahi and wahoo are assessed in separate reports, as is imported mahi mahi.

**Overview of the species and management bodies**

Mahi Mahi

Mahi mahi *(Coryphaena hippurus)* and pompano dolphinfish (*C. equiselis*) are the two species in the family Coryphaenidae. Both species have a global distribution and, while pompano dolphinfish are typically smaller than mahi mahi, they share a similar morphology and coloration. Accordingly, pompano dolphinfish are often mistaken for juvenile mahi mahi (Froese and Pauly 2012) and are sometimes sold as such (Whoriskey et al. 2011).

Mahi mahi are mid-trophic level predators, feeding primarily on other fishes and, occasionally, crustaceans and squid (Polovino et al. 2009, Pauly and Froese 2012). They are found worldwide (Figure 1) in tropical and subtropical waters warmer than 20̊C (FAO 2004). This species is extremely fast growing and reach sexual maturity in the first year of life. Size at maturity varies through its range (for a summary, see Collette et al. 2011). In the western central Atlantic, female mahi mahi mature at approximately 419 mm (50%, 16.5 in; McBride et al. 2012), whereas males mature at approximately 476 mm (50%, 18.7 in; Schwenke & Buckel 2008). Females are highly fecund, producing as many as 1.5 million eggs per spawning event, and short lived, with a typical lifespan of less than 5 years (Collette et al. 2011, Froese and Pauly 2012). Mahi mahi are sexually dimorphic, with males significantly larger than females; in the tropical Pacific, maximum sizes of 149cm FL for males and 137cm FL for females have been recorded (Uchiyama & Boggs, 2006). Mahi mahi school in feeding aggregations and these schools are commonly associated with floating objects, hence, they are often captured near fish aggregation devices (FADs; Olson & Galván-Magaña, 1996).

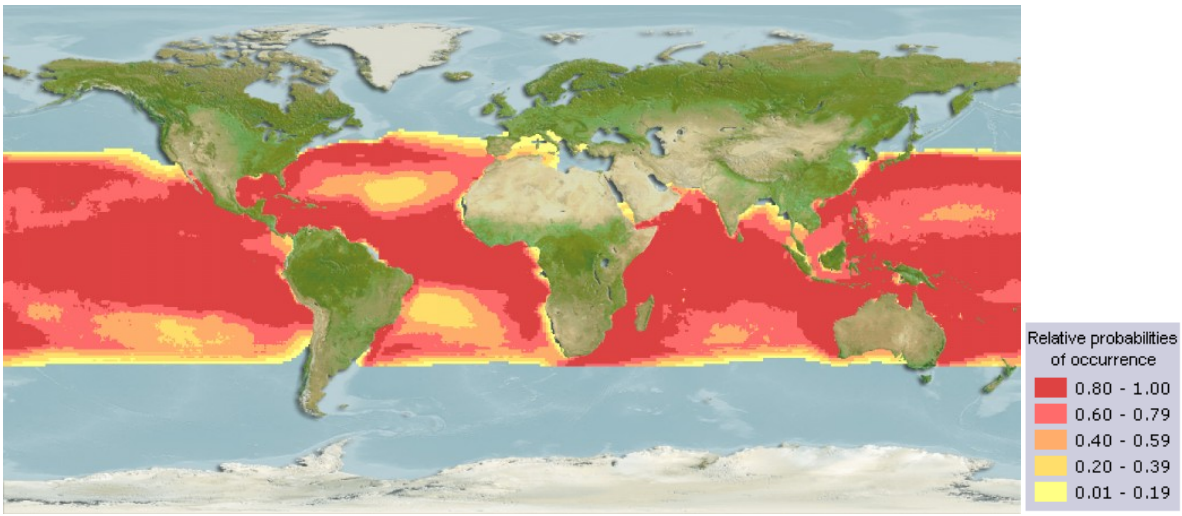


**Figure 1. Global distribution of mahi mahi (www.aquamaps.org)**

In the western Atlantic, mahi mahi occur from George's Bank, Nova Scotia to Rio de Janeiro, Brazil, as well as throughout the Gulf of Mexico and the Caribbean Sea (SAFMC 2003). It is generally accepted that there is a single mahi mahi stock in the western central Atlantic (Farrell 2009, NMFS 2009). Mahi mahi is a seasonal resource with peaks in landings in North and South Carolina from May to July, on Florida's east coast from April to June and from May to August in the Gulf of Mexico (SAFMC 2003). A long-term tracking study found that in early summer, mahi mahi, travel east from the Gulf of Mexico or west from the Old Bahama Channel, migrate northward along the east coast of the United States through the Straits of Florida or the east Bahamas Bank toward the Mid-Atlantic Bight before turning southward in early fall toward the Caribbean Sea or the Gulf of Mexico. However, some tagged fish have traveled as far as the Azores and Venezuela (Hammond 2011).

In contrast, exceedingly little is known about mahi mahi stocks in the central Pacific. In the Hawaiian Islands, commercial fishery catches peak once in the early spring and again in the fall, although mahi mahi are captured year round (Uchiyama and Boggs 2006).

In the US Atlantic, mahi mahi is managed by the South Atlantic Fishery Management Council (SAFMC), but the mahi mahi management plan, developed in 2003 for the entire fishery does not include fishery data from the Gulf of Mexico and the Caribbean Sea (Farrell, 2009). And while the Gulf of Mexico Fishery Management Council manages fishery resources in the Gulf of Mexico, and while mahi mahi are considered part of the Gulf of Mexico coastal migratory pelagic species fishery, they are not included in the management unit (GMFMC 2012). The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for conservation of highly migratory species in the Atlantic Ocean and adjacent seas, but does not

include mahi mahi among their species of interest. The Western Central Atlantic Fisheries Commission (WECAFC) includes mahi mahi as a species of interest and, while it can set management guidelines, the WECAFC does not have any enforcement authority.

In the western central Pacific the Western Pacific Regional Fishery Management Council manages the fisheries for Hawaii and Pacific territories. Both mahi mahi and wahoo are included in the Pacific Pelagic FEP management unit. The Inter-American Tropical Tuna Commission (IATTC) manages tuna and bycatch species in the Pacific Ocean. IATTC does consider mahi mahi as part of its management unit, although, as yet there are no management guidelines in place.

Wahoo

*Acanthocybium solandri* is only extant member of the genus *Acanthocybium*. Wahoo is a member of the family Scombridae, along with tunas and mackerels.

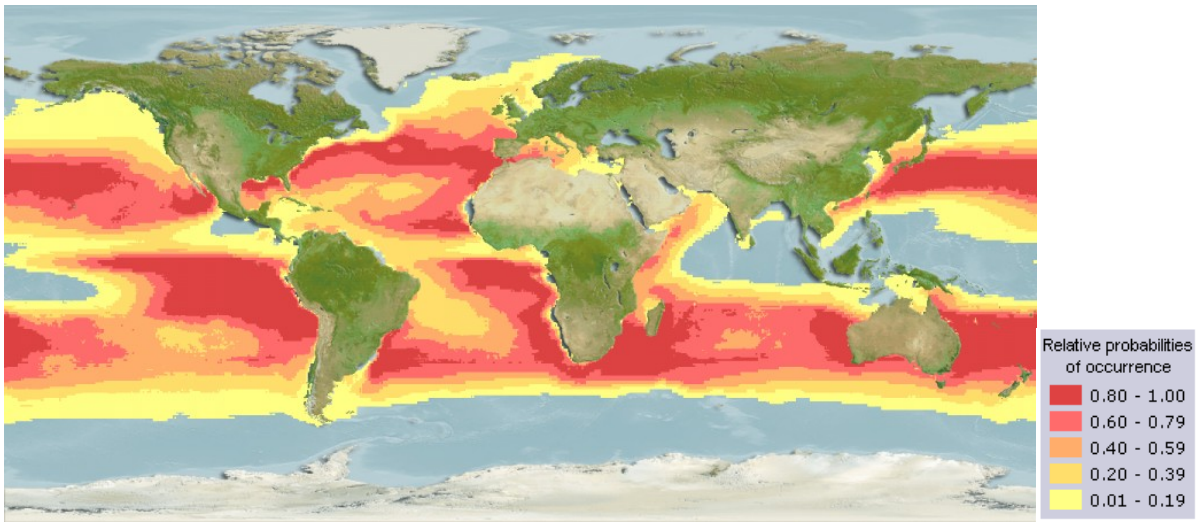


**Figure 2. Global distribution of wahoo (www.aquamaps.org)**

Wahoo are also mid-trophic level predators, feeding primarily on other fishes and occasionally cephalopods (Pauly and Froese 2012, Polovino et al. 2009). They are found worldwide (Figure 2) in tropical and subtropical waters between 20˚ and 30˚ C. (Zischke 2012). Wahoo are not sexually dimorphic. Both males and females reach sexual maturity in the first year of life (Jenkins and McBride 2009, Brown-Peterson et al. 2000). Brown-Peterson et al. (2000) found males in the Gulf of Mexico reached sexual maturity at approximately 93.5 cm FL (50%, 36.8 in) and females reach maturity at 102 cm FL (50%, 40.2 in). Wahoo grow to at least 200cm FL (Hogarth 1976, as cited in Collette et al. 2011) and females are also highly fecund, producing as many as 1.7 million eggs per spawning event (Jenkins and McBride 2009). Estimates of wahoo

lifespan range from 5 to 10 years (for review see Zischke 2012). Wahoo are often associated with floating debris and are frequently targeted near FADs (Collette et al. 2011).

In the northern Gulf of Mexico, 50% sexual maturity in males is reached before 93.5 cm FL, probably at an age of one year. In females, size at 50% maturity is approximately 102 cm FL, at an estimated age of two years (Brown-Peterson et al. 2000).

In the western Atlantic, wahoo range from New York to Colombia, including in the Gulf of Mexico and the Caribbean Sea (SAFMC 2003). Like mahi mahi, wahoo landings vary seasonally in the western Atlantic. Peak catches typically occur off North and South Carolina from April to September, in the eastern Caribbean between December and June. Wahoo are available year round in the Florida, Puerto Rico and the US Virgin Islands (SAFMC 2003). Very little is known about wahoo movement in the western central Pacific, although peak availability is May-October (Hawaii Seafood 2012). Wahoo are highly migratory, in one case, traveling a distance of 1,707 mi (2,747 km) in a just over 6 months (NMFS 1999). While the Pacific population is highly genetically homozygous (Theisen et al. 2008) there appear to be distinct subpopulations, as evidenced by a significant difference in morphometric measurements and parasite fauna among wahoo from the western and eastern Pacific (Zischke et al. 2013)

**Production statistics**

Mahi mahi is fished by commercial vessels throughout its range and landings have increased 7.5 fold over the last 60 years (Figure 3). Worldwide, the top producers include Brazil, Taiwan, Ecuador, Indonesia and Italy, although FAO reports mahi mahi landings in 51 nations and territories (FAO 2011). This increase in mahi mahi landings may be attributable to both increased fishing effort (Whorisky et al. 2011) and an increase in mahi mahi stock due to competitive release stemming from the decline of apex predators (Polovina et al. 2009).

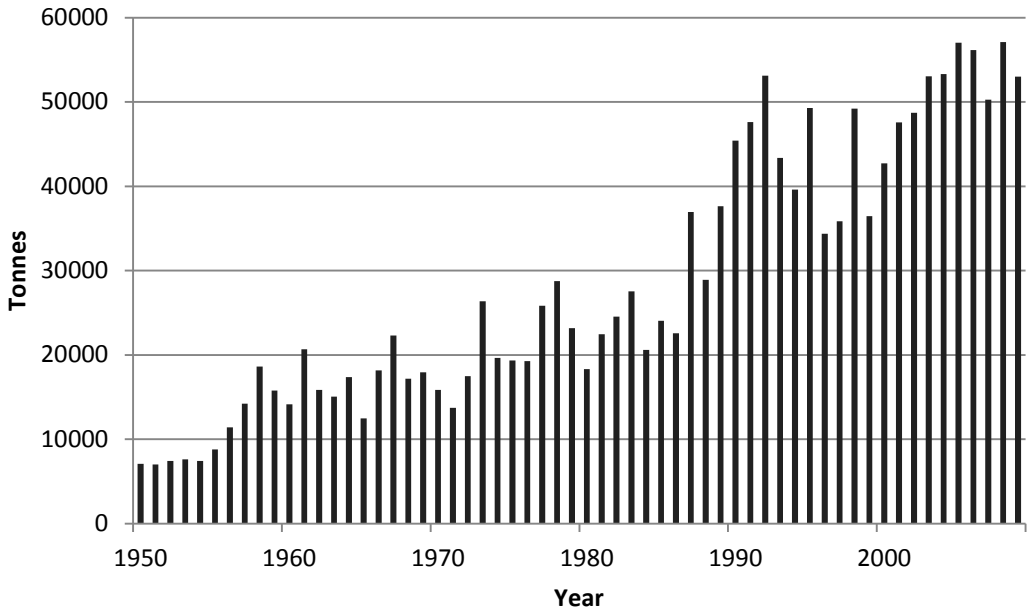


**Figure 3. Worldwide mahi mahi landings by year (FAO 2011)**

In the United States, mahi mahi is fished in the Pacific and Atlantic Oceans and in the Gulf of Mexico. In 2010, the United States landed 1022.5 mt of mahi mahi, primarily from commercial fisheries in Hawaii (67.3%), Florida (16.5%) and North Carolina (10.6%). Additional states reporting mahi mahi catches include California (<1%), Connecticut (<1%), Louisiana (<1%), Maryland (<1%), Massachusetts (<1%), New Jersey (1.1%), New York (<1%), Rhode Island (<1%), South Carolina (2.9%), Texas (<1%) and Virginia (<1%).

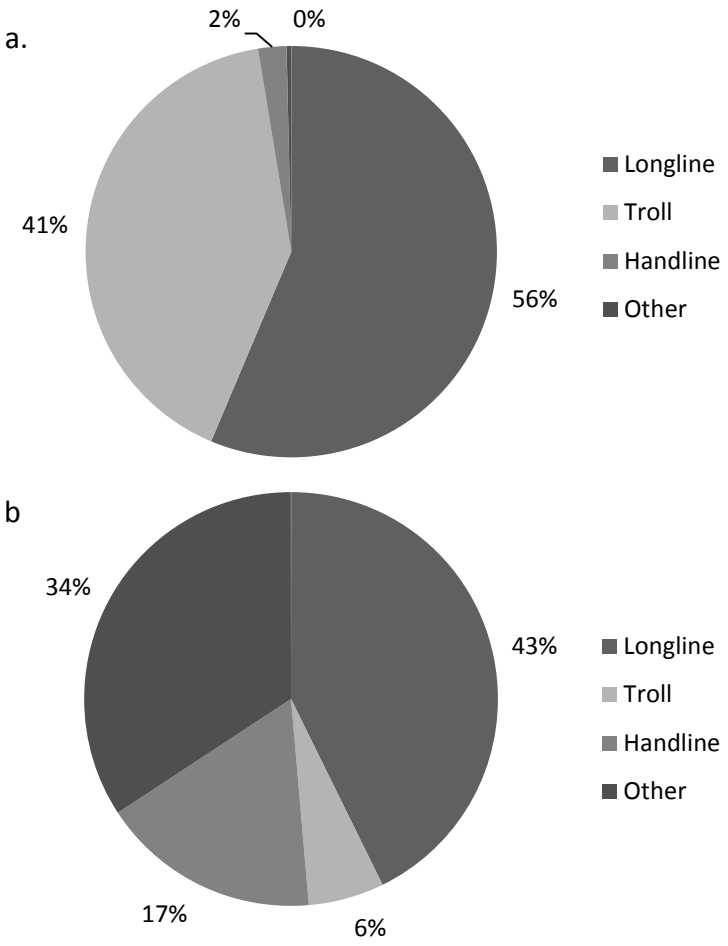


**Figure 4. Mahi mahi catch by gear type in (a) Hawaii and (b) US Atlantic. For Hawaiian catch, "other" gears (0.36%) include casting, spear fishing and other unspecified gears (HDAR 2011). For the US Atlantic, "other" gears include gill nets, diving outfits and combination gear (NMFS 2011).**

In Hawaii and in the US Atlantic regions, mahi mahi are captured by commercial fishers using a variety of methods, but the bulk of landings are generated by longline, troll (Hawaii) and handline (Atlantic) fishers (Figure 4). The majority of mahi mahi landed in Hawaii are consumed locally; Hawaiian mahi mahi is rarely available in the mainland United States (P.Dalzell, pers. comm.).

Mahi mahi is an important species to the recreational fishing industry and, while these fish do not make it into the US marketplace, sport fishery landings are substantial. In the US recreational operators reported over 4,341 mt of mahi mahi caught in 2010 (over 4x the US commercial take for the same year; NMFS 2010, Figure 5). Mahi mahi are caught by sport fisherman throughout their range and, while not included in this report, the impacts of this capture should be considered when assessing stock viability. In all cases, fishers landing mahi

mahi are bound by state laws and statutes while fishing in coastal state waters and must adhere to federal guidelines upon entering the US EEZ.

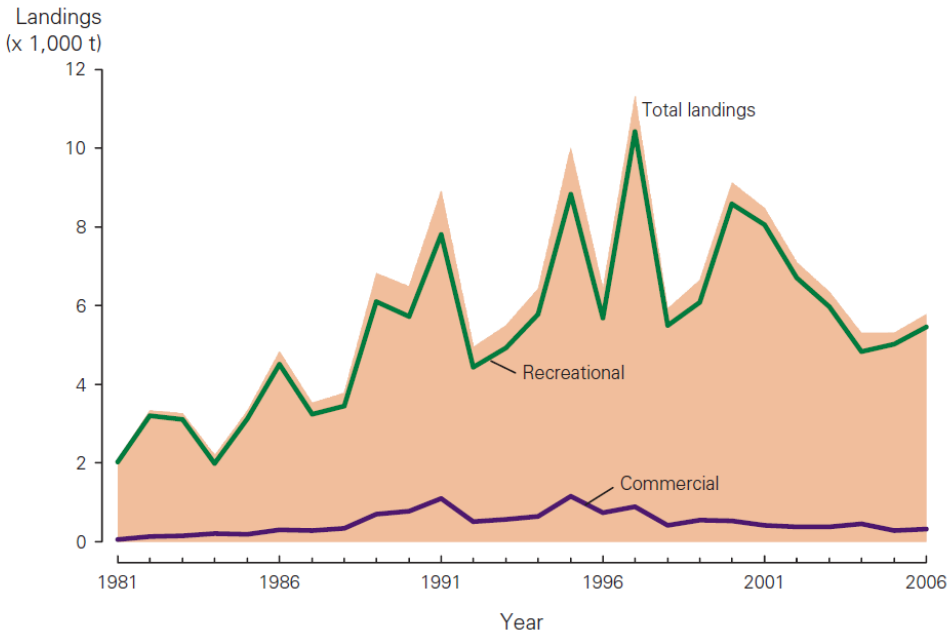


**Figure 5. Recreational vs. commercial mahi mahi landings in the Atlantic and Gulf of Mexico (NMFS 2009)**

Wahoo

Wahoo are incidentally captured throughout their range in fisheries targeting tuna, swordfish and mahi mahi (Zischke 2012). Global landings have increased significantly in the past 50 years (Figure 6). Anomalous peaks in landings due to sporadic reporting by major fishing nations, may indicate an historic underreporting of the worldwide wahoo catch, although recent data are likely more reliable (Zischke 2012).

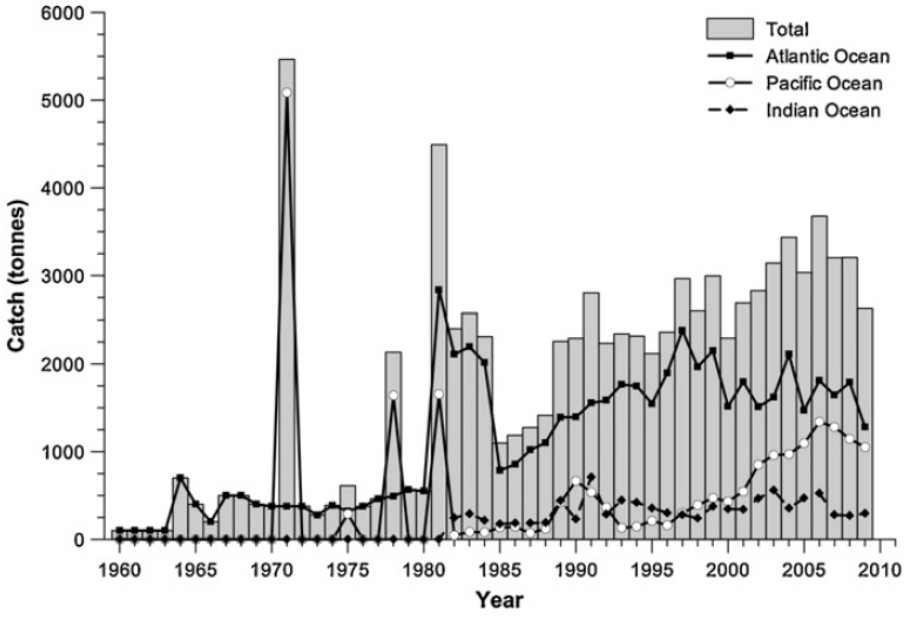


**Figure 6: Worldwide wahoo landings by year and ocean basin (from Zischke 2012, data from FAO 2011).**

The vast majority of domestically landed wahoo originate from the Hawaiian Islands (91.1%). The remainder is landed primarily in Florida (cumulative east and west coasts, 4.8%) and North Carolina (1.9%). Other states reporting nominal wahoo catch (<1% of US landings) include South Carolina, Texas, Virginia, New York, New Jersey, Connecticut, Massachusetts and Louisiana (NMFS 2011). Wahoo captured in Hawaii is typically retained for local consumption and is rarely available to consumers on the mainland US (P. Dalzell, pers. comm.).

Wahoo in Hawaii and the Atlantic are landed primarily with longline, troll and handline gears (Figure 7, R. Kokubun pers. com.; NMFS 2011).

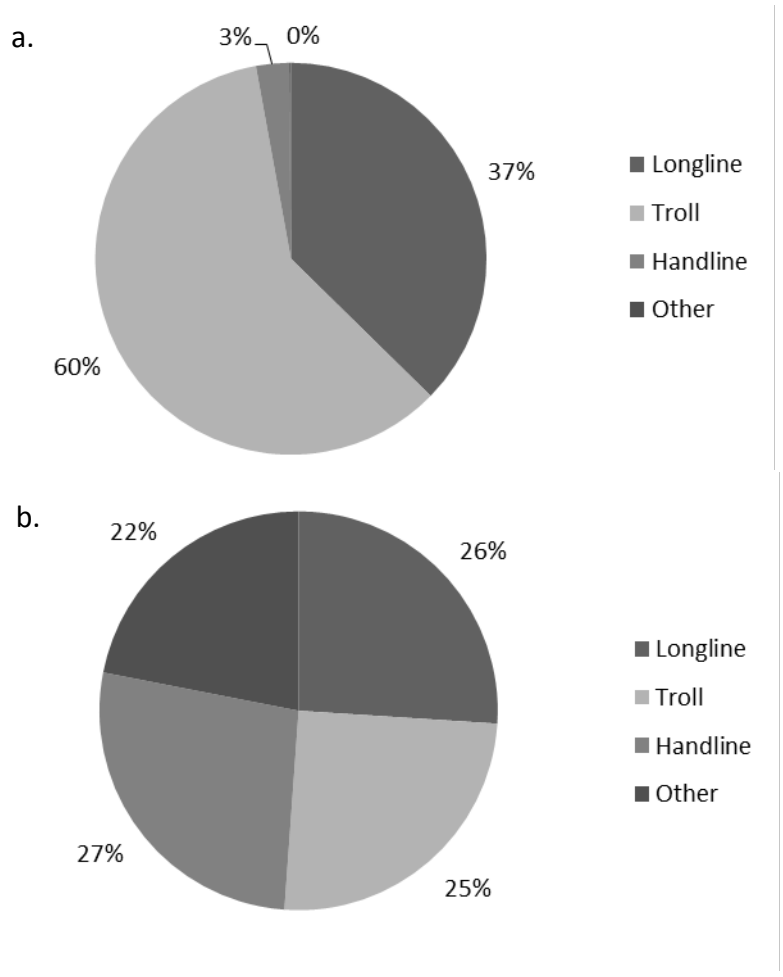


**Figure 7. Wahoo catch by gear type in the (a.), Hawaii and (b.), US Atlantic. For Hawaiian catch "other" gears (0.13%) include nets and other unspecified gears (data from HDAR 2011). For US Atlantic "other" gears include gill nets, diving outfits and combination gear (NMFS 2011).**

**Importance to the US/North American market**

The majority of mahi mahi available in the United States come from imports from Central and South America and Southeast Asia, with over 73% originating in Ecuador (26.0% of total imports), Peru (24.3%) or Taiwan (23.3%). Other major trade partners include Guatemala (7.0%), Costa Rica (3.5%) and Mexico (3.0%). In 2010 US landings comprised less than 5% of the mahi mahi available in the US marketplace that year (NMFS, 2010). In recent years the US has not exported or re-exported mahi mahi (NMFS, 2011).

The United States Census Bureau's foreign trade database, based on import and export declarations made to US Customs and Border Protection, does not include a separate category

for wahoo and therefore no foreign trade data (imports, exports, re-exports) are available for this species (M. Liddel, pers. comm.).

**Common and market names**

In the United States, *C. hippurus* is most commonly marketed as mahi mahi or dolphinfish. *A. solandri* is sold both as wahoo and ono.

**Primary product forms**

Mahi mahi is primarily available as fresh or frozen fillets. Wahoo is available as fresh or frozen whole, fillets, steaks, and headed and gutted.

# 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 www.seafoodwatch.org.

# Criterion 1: Stock for Which You Want a Recommendation

**Guiding Principles**

- The stock is healthy and abundant. Abundance, size, sex, age and genetic structure should be maintained at levels that do not impair the long-term productivity of the stock or fulfillment of its role in the ecosystem and food web.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

| Stock | Fishery | Inherent Vulnerability Rank | Stock Status Rank(Score) | Fishing Mortality Rank (Score) | Crit 1 Rank |
|---|---|---|---|---|---|
| Mahi mahi | Pacific troll | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | Yellow |
| Mahi mahi | Atlantic handline/ troll | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | Yellow |
| Wahoo | Pacific troll | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | Yellow |
| Wahoo | Atlantic handline/ troll | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | Yellow |

*Mahi Mahi*

**Factor 1.1 Inherent Vulnerability – Moderate**
Mahi mahi has been given a FishBase score of 39/100 (Froese & Pauly, 2012).

**Factor 1.2 Stock Status – Moderate Concern**
There is little data available on the US mahi mahi stocks (NMFS, 2009). A stock assessment based on data for the Western Atlantic and Gulf of Mexico mahi mahi from 1986 to 1997 found

$B>B_{MSY}$ (Prager 2000). This assessment showed tremendous variation in abundance from year to year. While it is possible that mahi mahi populations naturally fluctuate widely in accordance with climatic variables (Lasso and Zapata 1999, FAO 2011), absent additional corroboration, these data should be interpreted with caution (Prager 2000). Given this and the age of the stock assessment, stock status is considered a moderate concern.

There is no stock assessment for mahi mahi in the Pacific Ocean (NMFS, 2009). Data for Hawaiian mahi mahi landings demonstrate generally stable to increasing CPUE values, likely due in part to ecosystem-wide declines of primary mahi mahi predators (i.e. sharks and billfish) (PIFSC, 2008, WPRFMC, 2013). This increase is not in evidence for other species at a similar trophic level (i.e. wahoo, skipjack tuna) which may further indicate that Hawaiian Pacific mahi mahi stocks are healthy and robust (PIFSC, 2008). However, without a comprehensive stock assessment it is difficult to disentangle the effects of a suite of potentially confounding variables which may be influencing CPUE rates (i.e., life history characteristics, fishery attributes).

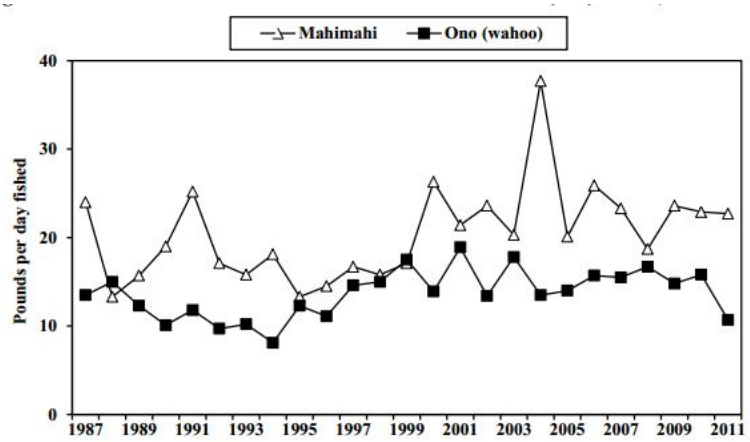


**Figure 8. CPUE for Hawaiian troll fishery (1987-2011) (WPRFMC, 2013)**

**Factor 1.3 Fishing Mortality – Moderate Concern**

There is very little data available on the US mahi mahi fishing mortality (NMFS 2009). The Western Atlantic and Gulf of Mexico mahi mahi stock were assessed by Prager (2000), who found $F_{1997}/F_{MSY}=0.51$, although, there is significant uncertainty around this estimate (Prager 2000), and the assessment is now out of date. $F_{MSY}$ for the Pacific is unknown (NMFS 2009).

## Wahoo

**Factor 1.1 Inherent Resilience – Medium Resilience**

Wahoo has been given a FishBase score of 46/100 (Froese and Pauly 2012).

**Factor 1.2 Stock Status – Unknown or Risk of Overfished**
There is little data available on the US wahoo stocks (NMFS, 2009). There are currently no comprehensive stock assessments for either Atlantic or Pacific wahoo stocks (SAFMC, 2003, Zischke, 2012).

**Factor 1.3 Fishing Mortality – Unknown or Risk of Overfishing**
$F_{MSY}$ for the wahoo stocks in the Pacific, Atlantic regions are unknown (NMFS, 2009).

# Criterion 2: Impacts on Other Retained and Bycatch Stocks

**Guiding Principles**

- The fishery minimizes bycatch. Seafood Watch® defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given each impacted species' abundance and productivity, accounting for scientific uncertainty, management uncertainty and non-fishery impacts such as habitat degradation.

The Criterion 2 score for each species under assessment is the lowest score of all the other main species caught with it, multiplied by a factor based on the discard rate in the fishery. A species is included in the assessment as a main species if:

- The catch of the species in the fishery under assessment composes >5% of that fishery's catch, *or*
- The species is >1% of that fishery's catch *and* the fishery causes >5% of the species' total mortality across all fisheries, *or*
- The species is <1% of that fishery's catch *and* the fishery causes >20% of species' total mortality across all fisheries, *or*
- The species is overfished, depleted, a stock of concern, endangered, threatened, IUCN Near Threatened, US MMPA strategic species, and/or subject to overfishing *and* the fishery causes >1% of species' total mortality across all fisheries.
- If there are no other main species (based on the above guidance) besides the one assessed under Criterion 1, but the total catch of other discarded and retained species is >5% (i.e. catch of Criterion 1 species is <95% of total), assess the top 3 species by volume of catch (if there are only 1-2 other species caught, assess those species).

In cases where the actual species and/or quantity/number of the species being caught in the fishery is unknown, main species and their scores are based on the 'unknown bycatch matrix' (see Seafood Watch Criteria for more information).

**Summary**

Mahi —Atlantic Handline/Troll

| **Stock** | **Inherent Vulnerability** Rank | **Stock Status** Rank (Score) | **Fishing Mortality** Rank (Score) | **Subscore** | **Score** (subscore*discard modifier) | **Rank** (based on subscore) |
|---|---|---|---|---|---|---|
| Yellowfin tuna | Moderate | Low Concern (4) | Very Low Concern (5) | 4.47 | 4.47 | Green |
| Swordfish | High | Very Low Concern (5) | Very Low Concern (5) | 5.00 | 5.00 | Green |

Wahoo – Atlantic Handline/Troll

| **Stock** | **Inherent Vulnerability** Rank | **Stock Status** Rank (Score) | **Fishing Mortality** Rank (Score) | **Subscore** | **Score** (subscore*discard modifier) | **Rank** (based on subscore) |
|---|---|---|---|---|---|---|
| Mahi mahi | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | 2.64 | 2.64 | Yellow |
| Yellowfin tuna | Moderate | Low Concern (4) | Very Low Concern (5) | 4.47 | 4.47 | Green |
| Swordfish | High | Very Low Concern (5) | Very Low Concern (5) | 5.00 | 5.00 | Green |

Mahi —Pacific Troll

| **Stock** | **Inherent Vulnerability** Rank | **Stock Status** Rank (Score) | **Fishing Mortality** Rank (Score) | **Subscore** | **Score** (subscore*discard modifier) | **Rank** (based on subscore) |
|---|---|---|---|---|---|---|
| Bigeye tuna | High | Low Concern (4) | High Concern (1) | 2.00 | 2.00 | Red |
| Yellowfin tuna | Moderate | Very Low Concern (5) | Very Low Concern (5) | 5.00 | 5.00 | Green |

Wahoo – Pacific Troll

| **Stock** | **Inherent Vulnerability**<br><br>Rank | **Stock Status**<br><br>Rank (Score) | **Fishing Mortality**<br><br>Rank (Score) | **Subscore** | **Score** (subscore*discard modifier) | **Rank** (based on subscore) |
|---|---|---|---|---|---|---|
| Bigeye tuna | High | Low Concern (4) | High Concern (1) | 2.00 | 2.00 | Red |
| Mahi mahi | Moderate | Moderate Concern (3) | Moderate Concern (2.33) | 2.64 | 2.64 | Yellow |
| Yellowfin tuna | Moderate | Very Low Concern (5) | Very Low Concern (5) | 5.00 | 5.00 | Green |

**Justification of Scores**

**Atlantic Handline/Troll**

There is no observer program in place for the Atlantic handline or troll fisheries, so logbook data are used here (Table 1). Other species, such as oceanic whitetip, thresher, silky and tiger sharks, which may be of conservation concern, are also very occasionally captured, but these are not retained and are generally discarded alive (NMFS 2008). More generally, discard mortality in these fisheries is thought to be minimal due to low catch rates and high survival upon release (see factor 2.4). Swordfish and yellowfin tuna are assessed because they comprise more than 5% of the catch. Mahi mahi also comprises more than 5% of the catch and so are included in the assessment for wahoo. No other species are assessed as they are unlikely to meet any of the criteria above given the relative mortality of the handline/troll fishery compared to other pelagic fisheries likely to interact with these species (e.g., longline, purse seine) (NMFS 2011c, NMFS 2011a).

**Table 1. Species captured in the US Atlantic using handline or rod and reel gears, 2008. Data were extracted from the 2008 Pelagic Logbook data for the Southeast Fisheries Science Center (NMFS 2008). Only 97 rod and reel and 8 handline trips are included in this database. Whether these gears were trolled or set was not specified.**

| Species | % of Total |
|---|---|
| Mahi mahi | 58.4% |
| Swordfish | 18.6% |
| Yellowfin tuna | 11.0% |
| Bigeye tuna | 4.1% |
| Escolar | 3.1% |
| Albacore | 2.4% |
| Bonito | 1.1% |
| Bluefin tuna | 0.7% |
| Blackfin tuna | 0.7% |
| Wahoo | 0.3% |
| Skipjack tuna | 0.1% |

Yellowfin tuna, *Thunnus albacares*

**Factor 2.1 Inherent Vulnerability — Moderate**
Yellowfin tuna has been given a FishBase score of 46/100 (Froese and Pauly, 2012).

**Factor 2.2 Stock Status – Low Concern**
A stock assessment for Atlantic yellowfin was conducted by ICCAT in 2011. This analysis found that for the most recent year (2010) the Atlantic yellowfin stocks were estimated to be below the target reference point ($B_{2010}$ /$B_{MSY}$=0.85; ICCAT 2011), although there is some uncertainty around this estimate. The state of Atlantic yellowfin tuna stocks was assessed using both production and age-structured population models and while the age-structured models indicate a decrease in stock biomass, the production models indicate an increase in stock biomass. When the uncertainty in the point estimates for all models was taken into account, however, ICCAT concluded that these stocks are most likely 15% below target value (ICCAT 2011). The stock is thus not considered overfished, but is approaching an overfished condition (NMFS 2013.

**Factor 2.3 Fishing Mortality – Very Low Concern**
Despite the decades-long decrease in yellowfin abundance, the 2011 stock assessment found that overfishing was not occurring ($F_{2010}$/$F_{MSY}$=0.87) (ICCAT 2011). There is some uncertainty around this estimate, and different models suggest opposite trends in fishing mortality. ICCAT (2011) recommends that stock exploitation remain at or below current harvest levels (110,000 mt) in order to facilitate species recovery in the coming years.

Swordfish—*Xiphias gladius*

**Factor 2.1 Inherent Vulnerability — High**
Swordfish has a FishBase score of 72/100 (Froese and Pauly 2012).

**Factor 2.2 Stock Status – Very Low Concern**
Despite severe overfishing in the 1990s, the North Atlantic swordfish stocks have rebuilt significantly. Due in large part to a comprehensive international management plan, the most recent stock assessment (ICCAT 2009) found a greater than 50% probability that North Atlantic swordfish stocks are above the management objective ($B_{2009}/B_{MSY}$ =1.05). A new stock assessment is planned for 2013 (ICCAT 2013).

**Factor 2.3 Fishing Mortality – Very Low Concern**
The North Atlantic swordfish is $F_{2008}/F_{MSY}$=0.76, indicating that overfishing is not occurring (ICCAT 2009).

**Factor 2.4 Overall Discard Rate—0%–20%**
Handline and troll fishing have very low discard rates when compared to other commercial fishing methods (Bailey 1996, Harrington et al. 2005, Kelleher 2005, Powers et al.2007). A recent nationwide assessment of discards in US fisheries also suggests the discard rate in the coastal migratory species troll fisheries in the South Atlantic are low: 8,774.48 individuals discarded and 985,790 individuals landed (NMFS 2011c), though the assessment did not calculate actual discard rates due to multiple confounding factors.

**Pacific Troll**

Catch data, collected by the Hawaii Division of Aquatic Resources (HDAR), are available for the Pacific troll fishery (Table 2, R. Kokubun pers. comm.). For the reasons described for the Atlantic fishery above, this assessment focuses on yellowfin and bigeye tuna, each of which comprise >5% of the catch in this fishery. Mahi mahi also comprises more than 5% of the catch and so are included in the assessment for wahoo. Rates of bycatch are generally very low in troll fisheries and, while mako and thresher sharks may be captured occasionally in the Hawaiian troll fishery (Haight and Dalzell 2000), these species are not retained and are generally discarded alive (P. Dalzell pers. comm.).

**Table 2. Catch composition for troll trips in the Hawaiian Islands, 2011. These data include species captured on reported troll trips wherein more than 150lbs (0.07 mt) of mahi mahi were sampled by fisheries inspectors. It is not necessary for troll fishers to declare a target species for each trip, so the minimum weight threshold is intended to narrow total troll landings to those trips targeting mahi mahi. This subset of the Hawaiian troll data accounts for 33% of all troll trips reporting mahi mahi landings (HDAR data, R. Kokubun pers. comm.).**

| Species | #Caught | Tonnes | % of Total | #Discarded |
|---|---|---|---|---|
| Mahi mahi | 21,768 | 121.58 | 56.4% | 41 |
| Bigeye tuna | 4,449 | 45.87 | 21.3% | 14 |
| Yellowfin tuna | 3,566 | 34.27 | 15.9% | 28 |
| Skipjack tuna (Aku) | 1,548 | 8.02 | 3.7% | 10 |
| Blue marlin | 31 | 2.70 | 1.3% | 0 |
| Wahoo (Ono) | 244 | 2.17 | 1.0% | 0 |
| Striped marlin | 18 | 0.39 | 0.2% | 1 |
| Grey snapper (Uku) | 48 | 0.25 | 0.1% | 0 |
| Short nosed spearfish | 13 | 0.19 | 0.1% | 0 |
| Rainbow runner | 19 | 0.05 | 0.0% | 0 |
| Frigate mackerel (Kawakawa) | 9 | 0.05 | 0.0% | 0 |

Yellowfin Tuna—*Thunnus albacares*

**Factor 2.1 Inherent Vulnerability — Moderate**
Yellowfin tuna has a FishBase score of 46/100 and is therefore considered to be of medium inherent resilience (Froese and Pauly 2012).

**Factor 2.2 Stock Status – Very Low Concern**
The most recent stock assessment (WCPFC 2012a) was conducted in 2011 and concluded that the total stock biomass in the Western Central Pacific region is greater than $B_{MSY}$ ($B_{2011t}/B_{MSY}$=1.33). Similarly, spawning biomass (SB) was found to be greater than $SB_{MSY}$ ($SB_{2011t}/SB_{MSY}$=1.47) (WCPFC 2012a).

**Factor 2.3 Fishing Mortality – Very Low Concern**
According to the most recent assessment (WCPFC 2012a) $F_{2011}/F_{MSY}$=0.77 for yellowfin tuna, indicating that overfishing is not currently occurring in the WCPO region.

Bigeye tuna—*Thunnus obesus*

**Factor 2.1 Inherent Vulnerability — High**
Bigeye tuna has a FishBase score of 72/100 and is therefore considered to be of low inherent resilience (Froese and Pauly 2012).

**Factor 2.2 Stock Status – Low Concern**

The most recent assessment for bigeye tuna in the western central Pacific (WCPFC 2012a) indicates that the WCPO bigeye stocks are over the target reference point ($B_{current}/B_{MSY}$=1.25; $SB_{current}/SB_{MSY}$=1.19). However, there is significant uncertainty around this estimate, with some model runs suggesting biomass may be below the reference point (though not below a reasonable limit reference point e.g., 50%$SB_{MSY}$) (Davies et al. 2012).

**Factor 2.3 Fishing Mortality – High Concern**

Bigeye tuna is $F_{current}/F_{MSY}$=1.46 (WCPFC 2012a), indicating that overfishing is occurring in bigeye stocks in the WCPO.

Detailed Rationale

According to the WCPFC Annual Yearbook for 2011 (WCPFC 2012b) troll captures are responsible for a negligible quantity of the bigeye tuna landed in the WCPFC statistical area (Table 4). However, bigeye still comprises more than 20% of the landings, suggesting the fishery targets the species. Stated another way, relative to the quantity of mahi mahi landed, the quantity of bigeye landed is substantial (approx. 38%). For this reason, the fishery-specific mortality is scored the same as for all other fisheries that target this stock.

**Table 4. Summary of bigeye tuna catch by gear in the western central Pacific region (from WCPFC 2012b).**

| Gear | Tonnes | % of Total |
|---|---|---|
| Longline | 75,986 | 48% |
| Pole and Line | 5,540 | 3% |
| Purse Seine | 72,424 | 45% |
| Troll | 267 | 0% |
| Other | 5,262 | 3% |
| Total | 159,479 | |

**Factor 2.4 Overall Discard Rate—0%–20%**

According to trip data, discards in the Hawaiian troll fishery are close to zero (Table 2; HDAR data, R. Kokubun pers. comm.).

# Criterion 3: Management Effectiveness

**Guiding Principle**

- The fishery is managed to sustain the long-term productivity of all impacted species. Management should be appropriate for the inherent resilience of affected marine life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long-term productivity or ecological role of any species in the future.

**Summary**

| **Fishery** | **Management: Retained Species** Rank (Score) | **Management: Non-retained species** Rank (Score) | **Criterion 3** Rank Score |
|---|---|---|---|
| Pacific troll | Moderate Concern (3) | All Species Retained (N/A) | Yellow 3 |
| Atlantic handline/ troll | Moderate Concern (3) | All Species Retained (N/A) | Yellow 3 |

**Factor 3.1 Management of fishing impacts on retained species**

| **Fishery** | **Critical?** | Mgmt strategy and implement. | Recovery of stocks of concern | Scientific research and monitoring | Scientific advice | Enforce. | Track record | Stakeholder inclusion | **Management of Retained Species Rank (Score)** |
|---|---|---|---|---|---|---|---|---|---|
| Pacific troll | No | Moderately Effective | Moderately Effective | Moderately Effective | Highly Effective | Highly Effective | Moderately Effective | Highly Effective | Moderate Concern (3) |
| Atlantic handline/ troll | No | Moderately Effective | N/A | Moderately Effective | Moderately Effective | Highly Effective | Moderately Effective | Highly Effective | Moderate Concern (3) |

**Atlantic**

Key Relevant Information:

In the Atlantic, mahi mahi and wahoo are managed under a joint fishery management plan established by SAFMC (2003). There are some measures in place aimed at protecting the western Atlantic stocks, including size limits for mahi mahi in Florida, Georgia and South Carolina (>20" FL), although there are currently no size restrictions on wahoo landed in US

federal waters. The FMP sets forth $B_{MSY}$ and optimal yields for each mahi mahi and wahoo and identifies potential future research topics to inform management agencies on stock status, fishery impacts, life history characteristics and essential habitat, although it is unclear whether any of the efforts to ascertain this information are underway (B. Cheuvront, pers. comm.). There is relatively little monitoring of handline/troll operators in this fishery and no program is in place for continued research on the effects of the current management plan on Atlantic mahi mahi and wahoo stocks. Compliance with FMP guidelines is enforced by state wildlife and fisheries agencies, the US Coast Guard and NOAA. Various stakeholder groups have an interest in the management of mahi mahi and wahoo, chiefly, commercial fishers and recreational/charter operators. A key objective of the FMP is to ameliorate competition between these constituencies and, to this end, the management plan prohibits the sale of recreationally landed mahi mahi and wahoo and has set an annual cap on the quantity of mahi mahi landed by commercial fishers.

Detailed Rationale:

*Management Strategy and Implementation – Moderately Effective*
In the Atlantic the mahi mahi and wahoo fisheries are managed jointly under an FMP set forth by the SAFMC, with the support of the New England Fishery Management Council and the Mid-Atlantic Fishery management Council (SAFMC 2003, Farrell 2009). The FMP makes no provisions, however, for the Caribbean and Gulf of Mexico regions (Farrell 2009). Likely due to a dearth of data on the status of mahi mahi stocks in the Atlantic, the FMP identifies a very broad range for MSY of mahi mahi, between 18.8 and 46.5 million pounds (8,527.5 – 21,092.0 mt). The MSY range of wahoo is much narrower, with MSY falling between 1.41 and 1.63 million pounds (639.6 -739.4 mt). Optimal yields are designated as 75% of MSY and 100% of MSY for mahi mahi and wahoo, respectively.

The state of Florida requires commercially landed mahi mahi to be of 20" (50.8 cm) minimum FL in both Gulf of Mexico and Atlantic state waters. Within state waters mahi mahi can be harvested using spear and hook and line gear. Outside state waters, longlines can be used. Georgia and South Carolina also require commercial mahi mahi catch to be of individuals >20" (50.8 cm) FL. There are no size restrictions in any other Atlantic states (SAFMC 2012a). There are no state or federal restrictions on the size of wahoo landed in US waters (SAFMC 2003).

*Recovery of Stocks of Concern – N/A*
The handline/troll fisheries are not significant contributors to the mortality of any stocks of concern.

*Scientific Research and Monitoring – Moderately Effective*
The FMP identifies several knowledge deficits regarding the biology and stock status of mahi mahi and wahoo in the Atlantic EEZ, and makes recommendations for future research. These recommendations include: data collection to improve estimates of life history characteristics like growth and fecundity, identification of essential habitat, implementation of observer programs and studies of post-release mortality to examine the efficacy of minimum size

requirements. As yet, it is unclear whether there are any research programs underway to address these deficits.

Due to the catch magnitude, more attention has been paid to ensuring observer coverage on longline vessels, particularly in terms of documenting catch composition and mitigating bycatch of sensitive species. Although, as with all federal fisheries, commercial handline and troll operators must comply with NMFS requests for logbook accounts of catch composition and effort. Additionally, landing weighout reports collected from seafood dealers, biological samples and onboard or dockside interviews are conducted by both state and federal agencies, to ascertain catch data pertaining to mahi mahi and wahoo landings with handlines, trolls and other hook and line gears.

*Scientific Advice – Moderately Effective*
The FMP does not make explicit allowances for scientific oversight of proposed mahi mahi and wahoo management strategies.

*Enforcement – Highly Effective*
The SAFMC has no law enforcement authority and thus works closely with a number of state and federal agencies to ensure that fishers comply with fisheries regulations including state departments of wildlife and/or fisheries resources, the US Coast Guard and NOAA. Additionally, SAFMC has convened a Law Enforcement Advisory Panel to make recommendations on enforcement strategies (SAFMC 2012b). SAFMC also publishes quarterly reports on law enforcement activities conducted in the Atlantic EEZ.

*Track Record – Moderately Effective*
Prior to the creation of the FMP, no management plan existed for mahi mahi or wahoo in the Atlantic EEZ.

*Stakeholder Inclusion – Highly Effective*
The stated goals of the FMP include balancing the competing interests of commercial and recreational fishers. The FMP proposes several actions to accomplish this, including a prohibition on the sale of mahi mahi and wahoo caught by recreational fisheries in the Atlantic EEZ and an annual cap of 1.5 million pounds (680.4 mt) of mahi mahi, or 13% of total catch (whichever is greater) landed by commercial fishers. Individuals from state and federal marine resource and conservation agencies, non-governmental organizations, as well as commercial and recreational fisheries associations were consulted in the process of writing the management plan (SAFMC 2003).

**Pacific (Hawaii)**

Mahi mahi and wahoo stocks in Hawaii are part of the Pacific Pelagic FEP (WPRFMC 2009), although most of the guidelines set forth in this plan pertain to industrial-scale fisheries targeting pelagic management unit species, primarily bigeye tuna and yellowfin tuna. However,

this document does provide a framework for the ongoing assessment of target species, including mahi mahi and wahoo, and prudent adjustments to management guidelines in order to achieve FEP goals. Commercial troll fishers must be licensed by the state of Hawaii and submit logbook data to the state Division of Aquatic Resources (HDAR). This catch database is maintained in order to monitor the status of marine resources in state waters and the EEZ. Beyond this, there are no specific measures in place to monitor the status of mahi mahi and wahoo stocks in the western central Pacific.

Detailed Rationale:

*Management Strategy and Implementation – Moderately Effective*
WPFMC has ceded the establishment of catch and fishing effort guidelines to IATTC and WCPFC for the pelagic management unit species. The US is required to adhere to management recommendations made by these bodies for pelagic straddling stocks. At present there are no TAC or ACL restrictions for mahi mahi or wahoo in the western central Pacific (P.Dalzell, pers. comm.), including the US EEZ. The state of Hawaii, similarly, has no size restrictions, bag limits, or seasonal closures of the commercial mahi mahi and wahoo fisheries. However, both species are managed under the Pacific Pelagic FEP, meaning that the management infrastructure and landings data are being collected and analyzed (e.g. CPUE).

*Recovery of Stocks of Concern: Moderately Effective*
Bigeye tuna comprises a significant portion of the landings in the troll fishery (see Criterion 2). In the western central Pacific, the WPRFMC must take remedial action within two years if a stock is overfished, undergoing overfishing, or approaching an overfished state. If the stock is overfished, a rebuilding plan must be developed and management must shift from a target-control rule to a rebuilding-control rule. The rebuilding-control rule allows WPRFMC to determine that the conservation and management plans are working. If they do not appear to be working, additional measures will be put into place. The United States is a member of the Western and Central Fisheries Commission and, therefore, abides by those recovery efforts as well (WPRFMC 2009}. Because the targeted species in this fishery—tuna—is highly migratory, and bigeye tuna is approaching an overfished status, the success of any recovery plans will be dependent on other nations as well, earning a moderate score for recovery of stocks of concern.

*Scientific Research and Monitoring – Moderately Effective*
At present, there appears to be no research underway to assess the status or fishery impacts on mahi mahi and wahoo stocks in the western central Pacific region.

Any fishing vessel operating in the US EEZ or territorial seas is required to carry an observer when directed to do so by NMFS (WPRFMC 2009), although health and safety concerns can make deploying observers on small vessels prohibitive (P. Dalzell, pers. comm.). The HDAR has been collecting catch data from Hawaiian commercial fisherman since 1948, and these data are used to monitor changes in CPUE for exploited fish stocks.

Due to the catch magnitude, more attention has been paid to ensure observer coverage on longline vessels, particularly in terms of documenting catch composition and mitigating bycatch of sensitive species. For example, in Hawaii, the National Observer Program mandates 100% coverage for the longline swordfish trips, has observers on 25% of the trips, and collects samples from 100% of the pelagic longline trips targeting tuna (NMFS 2012). By comparison, there are no observers on troll trips. Although, as with all federal fisheries, commercial troll operators must comply with NMFS requests for logbook accounts of catch composition and effort. Additionally, landing weighout reports collected from seafood dealers, biological samples, and onboard or dockside interviews are conducted by both state and federal agencies, to ascertain catch data pertaining to mahi mahi and wahoo landings with troll and other hook and line gears.

*Scientific Advice – Highly Effective*
According to HDAR, catch data collected from commercial fishers are an important tool used by fishery managers to make management recommendations and, hence, maintain sustainable fisheries (HDAR 2012). Federal agencies, as well as regional fishery management organizations, utilize this data to inform management actions in the broader EEZ and territorial seas.

The WPRFMC Pacific Pelagics FEP includes an FEP plan team, which is tasked with reviewing the status of MUS stocks. While there are currently no management guidelines or total annual catch limits for mahi mahi or wahoo, the plan team produces annual stock assessments and fishery evaluation reports and makes recommendations for adjusting management guidelines based on all available data.

*Enforcement – Highly Effective*
Enforcement of Hawaiian commercial fishing regulations is conducted by the state's Division of Conservation and Resources Enforcement. In the EEZ, compliance with federal fishing statutes is enforced by NOAA's Office of Law Enforcement and the US Coast Guard. While there are currently no restrictions regarding mahi mahi or wahoo, the infrastructure and resources are in place should management objectives change in the future.

*Track Record – Moderately Effective*
Prior to the creations of the Pacific Pelagics FEP, mahi mahi and wahoo were managed under the Pelagics FMP. Available CPUE data for Hawaiian mahi mahi and wahoo landings suggest that the populations of both species are stable (Figure 8; P. Dalzell pers. comm.), although to date, there have been no assessments of either stock status or fishing mortality, nor are there any size or bag limits, trip limits or quota restrictions for mahi mahi or wahoo in either Hawaiian State waters or the US Pacific EEZ.

*Stakeholder Inclusion – Highly Effective*
The WPRFMC Pacific Pelagics FEP provides for an advisory panel, which consists of representatives from commercial, recreational and subsistence fishery groups. The panel meets at the direction of WRPFMC to ensure stakeholder inclusion in ongoing and proposed management actions (WPRFMC 2009).

**Factor 3.2 Management of Fishing Impacts on Bycatch Species**

In general, troll and other hook and line gear is highly selective. The majority of hooked fish are retained and there is very little bycatch (P. Dalzell, pers. comm., R. Kokubun, pers. comm.).

# Criterion 4: Impacts on the Habitat and Ecosystem

**Guiding Principles**

- 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.
-

| Fishery | Gear type and substrate<br><br>Rank (Score) | Mitigation of gear impacts<br><br>Rank (Score) | EBFM<br><br>Rank (Score) | Criterion 4 Score | Criterion 4 Rank |
|---|---|---|---|---|---|
| Pacific troll | Gear does not touch bottom (5) | N/A | Moderate (3) | 3.87 | Green |
| Atlantic handline/ troll | Gear does not touch bottom (5) | N/A | Moderate (3) | 3.87 | Green |

**Factor 4.1 Impact of the Fishing Gear on the Substrate – Gear Does not Touch Bottom**
Troll and handline fishing gear does not impact the sea floor substrate.

**Factor 4.2 Modifying Factor: Mitigation of Fishing Gear Impacts – N/A**

**Factor 4.3 Ecosystem and Food Web Considerations — Moderate**
Mahi mahi and wahoo are both considered mid-trophic level species (Polovina et al. 2009, SAFMC 2003). Removal of any component of a biological community can have cascading effects on a host of other species (Crowder et al. 2008). Meso-predators like mahi mahi and wahoo undoubtedly play an important ecological role (Crooks and Soule 1999, Estes et al. 1998), however this report focuses on the effects of commercial fisheries on organisms considered to be of exceptional importance to ecosystem function and food web structure. An example would be those species whose effects on ecological processes are greater than would be predicted by their biomass alone, including top predators, ecosystem engineers and important primary producers (i.e. Sergio et al. 2008, Mumby et al. 2008).

Several shark species are occasionally captured in both the US Atlantic handline/troll and Hawaiian troll fisheries, but do not comprise a significant proportion of the catch. Furthermore, sharks are not generally retained (NMFS 2008, P. Dalzell pers. comm.); troll and handline gears are highly selective, with fishers able to release undesirable species quickly, thus minimizing capture mortality. There are, however, no efforts underway to assess the impacts of troll gears on the Hawaiian or South Atlantic pelagic ecosystems.

# Overall Recommendation

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

The overall recommendation for the fishery is calculated as follows:

- **Best Choice** = Final score ≥ 3.2 **and** scores for Criteria 1, 3 and 4 are all ≥ 2.2 **and** Criterion 2 *subscore* ≥ 2.2
- **Some Concerns** = Final score ≥ 2.2 **and** Criterion 3 ≥ 2.2 **and** **(**Final score ≤ 3.2 **or** scores for Criteria 1 &4 ≤ 2.2 **or** Criterion 2 *subscore* ≤ 2.2)
- **Red**= Final score < 2.2 **or** score for Criterion 3 < 2.2 **or** any one criterion has a critical score **or** two or more of the following are < 2.2: Criterion 1 score, Criterion 2 *subscore*, Criterion 4 score

| **Stock** | **Fishery** | **Impacts on the Stock**<br><br>Rank (Score) | **Impacts on Other Species**<br><br>Lowest scoring species Rank*, Subscore, (Score) | **Manage-ment**<br><br>Rank (Score) | **Habitat and Ecosystem**<br><br>Rank (Score) | **Overall**<br><br>Recommendation (Score) |
|---|---|---|---|---|---|---|
| Wahoo | Pacific troll | Yellow (2.64) | Bigeye tuna Red, (2,2) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (2.8)** |
| Wahoo | Atlantic handline/ troll | Yellow (2.64) | Mahi mahi Yellow, (2.64,2.64) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (3)** |
| Mahi mahi | Pacific troll | Yellow (2.64) | Bigeye tuna Red, (2,2) | Yellow (3) | Green (3.87) | **GOOD ALTERNATIVE (2.8)** |
| Mahi mahi | Atlantic handline/ troll | Yellow (2.64) | Yellowfin tuna Green, (4.47,4.47) | Yellow (3) | Green (3.87) | **BEST CHOICE (3.42)** |

# 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 Mitchell Zischke and two anonymous reviewers for graciously reviewing this report for scientific accuracy.

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# Appendix A: All Species Included in Assessment

| Species/Stock | Fishbase vulnerability score (fish only) | B/BMSY and/or mgmt classification | F/FMSY and/or mgmt classification | Fishery Specific Fishing Mortality (optional) | Sources |
|---|---|---|---|---|---|
| Wahoo (Pacific) | 46 | Unknown | Unknown | Unknown | NMFS 2009 |
| Wahoo (Atlantic) | 46 | Unknown | Unknown | Unknown | NMFS 2009, SAFMC 2003 |
| Mahi mahi (Atlantic) | 39 | Unknown | Unknown | Unknown | NMFS 2009, SAFMC 2003 |
| Mahi mahi (Pacific) | 39 | Unknown | Unknown | Unknown | NMFS 2009 |
| Yellowfin tuna (Pacific) | 46 | B/BMSY=1.33 | F/FMSY=0.77 | Unknown | WPRFMC 2010 |
| Skipjack tuna (Pacific) | 39 | B/BMSY=2.68 | F/FMSY=0.37 | Unknown | WPRFMC 2010 |
| Yellowfin tuna (Atlantic) | 46 | $B_{2010}/B_{MSY}$=0.85 | $F_{2010}/F_{MSY}$=0.87 | Unknown | ICCAT 2011a |
| Escolar (Atlantic) | 85 | Unknown | Unknown | Unknown | |
| Bonito (Atlantic) | 33 | Unknown | Unknown | Unknown | ICCCAT 2011c |
| Skipjack tuna (Atlantic) | 39 | Unknown | Unknown | Unknown | NMFS 2009 |
| Bigeye tuna (Atlantic) | 72 | $B=B_{MSY}$-- rebuilding | Not overfishing | Unknown | NMFS 2009 |
| Albacore tuna (Atlantic) | 58 | $B=B_{MSY}$-- overfished | Overfishing occurring | Unknown | NMFS 2009 |
| Blackfin tuna (Atlantic) | 41 | Unknown | Unknown | Unknown | ICCAT 2011c |
| Striped marlin (Pacific) | 56 | Unknown | Unknown | Unknown | NMFS 2009 |
| Swordfish (Atlantic) | 72 | $B_{2009}/B_{MSY}$=1.04 | $F_{2008}/F_{MSY}$=0.76 | Unknown | ICCAT 2011b |
| Blue marlin (Pacific) | 52 | $B/B_{MSY}$=1.4 | $F/F_{MSY}$=0.50 | Unknown | NMFS 2009 |
| Bigeye tuna (Pacific) | 72 | $B/B_{MSY}$=1.25 | $F/F_{MSY}$=1.46 | Unknown | WCPFC 2006 |
| Shortnosed spearfish (Pacific) | 43 | Unknown | Unknown | Unknown | |

| | | | | | |
|---|---|---|---|---|---|
| Albacore tuna (S. Pacific) | 58 | $B/B_{MSY}$=1.26 | $F/F_{MSY}$=0.26 | Unknown | WPRFMC 2010 |
| Rainbow runner (Pacific) | 41 | Unknown | Unknown | Unknown | |
| Grey Snapper (Pacific) | 40 | Unknown | Unknown | Unknown | |
| Barracuda (Pacific) | 79 | Unknown | Unknown | Unknown | |
| Frigate mackerel (Pacific) | 26 | Unknown | Unknown | Unknown | |

# Appendix B*:* Review Schedule

There is little specific information available about forthcoming mahi mahi and wahoo stock assessments or management actions in the US. There are no research efforts, planned or currently underway, to address the data deficits identified in the Atlantic FMP. While WPRFMC continues to monitor CPUE of mahi mahi and wahoo stocks in the western central Pacific there appear to be no plans to conduct detailed assessments of mahi mahi and wahoo stocks in the region.

# 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.

**Disclaimer**

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch® and Seafood Reports are made possible through a grant from the David and Lucile Packard Foundation.

# Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished1 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.

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

**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.