Seafood Watch
Seafood Report

Atlantic Bluefin Tuna
*Thunnus thynnus*

(Atlantic bluefin tuna image © Monterey Bay Aquarium)

All Regions

Final Report
July 14, 2009
Life History and Stock Status Update, Bycatch Addendum
October 7, 2010

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About Seafood Watch® and the Seafood Reports

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.
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I. Executive Summary

There are three species of bluefin tuna: Atlantic bluefin (Thunnus thynnus), Pacific bluefin (Thunnus orientalis) and southern bluefin (Thunnus maccoyii). This report covers fisheries for Atlantic bluefin. Bluefin tuna are highly migratory and are targeted in various fisheries worldwide with a number of different gear types. Atlantic bluefin tuna exhibit a moderate age at first maturity (with some populations such as the eastern Mediterranean Sea bluefin tuna maturing earlier in response to excessive fishing pressure), and have moderate life spans. Bluefin tuna are considered more vulnerable to fishing pressure than tropical tuna species such as bigeye (Thunnus obesus) and yellowfin (Thunnus albacares). Overall, bluefin tuna is ranked as moderately vulnerable.

The stock status of Atlantic bluefin tuna is considered a critical conservation concern as they are both overfished and experiencing ongoing overfishing. This species has exhibited long-term declines in abundance, and excessive fishing mortality for many years. In addition, Atlantic bluefin tuna are listed on the World Conservation Union (IUCN) Red List of Threatened Species. The high quantity of illegal, unreported and unregulated (IUU) catches of Atlantic bluefin tuna, in addition to the high uncertainty of stock assessments, is additional cause for concern. For data on the stock status rankings, please see Criterion 2, beginning on page 28.

Bluefin tuna is caught with purse seines, pelagic longlines, trolls, handlines, pole and line gear, and harpoons. The level of bycatch varies according to each gear type. Pelagic longlines catch a number of incidental species, including endangered and threatened sea turtles, seabirds, sharks and billfish. These species are caught in some fisheries more commonly than others. It has been shown that the combination of 18/0 circle hooks and mackerel bait used in the U.S. Atlantic pelagic longline fishery has reduced loggerhead and leatherback interaction rates. In addition, bycatch trends for other species of special concern have been decreasing in this fishery. Therefore, Seafood Watch® deems bycatch in the U.S. Atlantic pelagic longline tuna fisheries to be a high conservation concern, whereas the greater bycatch in international longline tuna fisheries is a critical conservation concern. Purse seine sets on unassociated schools (such as those used to target schools of bluefin tuna) are considered to have moderate bycatch levels. Troll, handline, pole and line, and harpoon gear all have minimal bycatch.

Pelagic longlines and purse seine gear have negligible habitat effects, though the ecosystem effects of removing large predators such as tuna are not well understood. Combined with the benign habitat effects of purse seine and pelagic longline gear, this uncertainty results in an overall moderate conservation concern for these gear types. Other gear, including troll, pole and line, handline and harpoon have a low conservation concern for habitat and ecosystem impacts.

Bluefin tuna in the Atlantic are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Bluefin tuna management faces a number of challenges including lack of a bycatch plan, lack of enforcement, catch quota exceedance and inability to maintain stock productivity. Due to these concerns, management in the Atlantic is considered to be a critical conservation concern. However, the National Marine Fisheries Service (NMFS) manages the U.S. Atlantic bluefin tuna fishery using a total allowable catch (TAC), size limits, gear restrictions and seasonal closures. Management in the Canadian Atlantic bluefin fishery
enforces regulations using logbook reports, observer coverage and dockside monitoring. As such, management in these fisheries is considered to be a high conservation concern.

Overall, the combination of high to critical bycatch concerns, poor management and poor stock conditions results in an overall recommendation of **Avoid** Atlantic bluefin tuna.

Bluefin tuna are increasingly being ranched\(^1\), which will be evaluated in a separate Seafood Watch® report to be released at a later date. At the time of the writing of this report, the use of marine resources in bluefin tuna ranching is a critical conservation concern (according to our Recommendation Criteria for Farmed Seafood) because the feed conversion ratios for all three bluefin tuna species range from 7.0–25.6 (Zertuche-González et al. 2008), and as shown in this report, the status of the source stock (wild bluefin tuna) is ranked as **Avoid**. This critical conservation concern would lead to an Overall Recommendation of **Avoid** for ranched bluefin tuna.

**This report was updated on October 7, 2010. Please see Appendix II for a summary of the changes made.**

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\(^1\) The term *ranched*, rather than *farmed*, is used to describe bluefin tunas that are wild-caught, transferred to fattening cages/pens and then harvested once they reach appropriate market size.
### Table of Sustainability Ranks

<table>
<thead>
<tr>
<th>Sustainability Criteria</th>
<th>Conservation Concern</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Inherent Vulnerability</td>
<td></td>
</tr>
<tr>
<td>Status of Stocks</td>
<td></td>
</tr>
<tr>
<td>Nature of Bycatch</td>
<td>✓</td>
</tr>
<tr>
<td>Habitat &amp; Ecosystem Effects</td>
<td>✓</td>
</tr>
<tr>
<td>Management Effectiveness</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Nature of Bycatch</th>
<th>Status of Stocks</th>
<th>Habitat &amp; Ecosystem Effects</th>
<th>Management Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troll/pole, Handline, Harpoon</td>
<td>Atlantic bluefin tuna</td>
<td>U.S. Atlantic longline</td>
<td>Atlantic (US, Canada)</td>
</tr>
<tr>
<td>Unassociated purse seine sets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. Atlantic longline</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Int’l longline</td>
<td></td>
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</tbody>
</table>

### About the Overall Seafood Recommendation:

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria “average” to yellow (Moderate Conservation Concern) OR if the “Status of Stocks” and “Management Effectiveness” criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

### Overall Seafood Recommendation:

- **Best Choice**
- **Good Alternative**
- **Avoid**
Common acronyms and terms

CCSBT Commission for the Conservation of Southern Bluefin Tuna
CPUE Catch per unit effort
EEZ Exclusive Economic Zone
EPO Eastern Pacific Ocean
FAO Food and Agriculture Organization of the United Nations
FAD Fish Aggregating Device
FFA Forum Fisheries Agency
FMP Fishery Management Plan
FR Federal Rule
HMS Highly Migratory Species
IATTC Inter-American Tropical Tuna Commission
ICCAT International Commission for the Conservation of Atlantic Tunas
IOTC Indian Ocean Tuna Commission
ISC International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
IUCN International Union for Conservation of Nature
IUU Illegal, unreported, and unregulated
MSY Maximum sustainable yield
NEI Nowhere else included. These landings are mostly flag of convenience landings.
NMFS National Marine Fisheries Service
PFMC Pacific Fishery Management Council
SCRS Standing Committee on Research and Statistics
SPC Secretariat of the Pacific Community
SBR Spawning biomass ratio
TAC Total allowable catch
WCPO Western and Central Pacific Ocean
WIO Western Indian Ocean
WPFFMC Western Pacific Fishery Management Council
**Baitboat**
Fishers use a pole with fixed length line that has a barbless hook with either an artificial lure or live bait. In this way, fish are caught one at a time and any unwanted catch can be thrown back immediately. Pole and line-caught is another term for baitboat-caught; throughout this report the term *pole and line* will be used.

**Longline**
Longlines consist of a main horizontal fishing line that can be 50–65 nautical miles long. Smaller vertical lines with baited hooks are spaced intermittently along the main line and can be rigged to fish at various depths depending on the target species and fishing conditions. The longlines used to target tuna are pelagic longlines and are fished in the upper water column.

**Purse seine**
Purse seining involves encircling a school of tuna with a long net (typically 200 m deep and 1.6 km long) (Figures 1a, 1b). The net is weighted at the bottom and the top is kept at the surface of the water by a series of floats. One end of the net is pulled out from the main vessel by a skiff, which encircles the school of tuna, and the bottom of the net is then closed using a purse line running through the leadline by a series of rings. The upper portion of the net is then hauled in and brought onboard, leaving a small volume of water in the remaining net, allowing the corralled catch to be brought onboard using a large dip net (NRC 1992). There are several types of purse seine sets: those set on dolphins (dolphin sets); those set on floating objects or fish aggregating devices (FADs) (floating object sets); and those set on schools of tuna that are not associated with either dolphins or a floating object (unassociated sets). Dolphin sets are only set on yellowfin tuna in the eastern Pacific Ocean.

**Trolling**
Trolling consists of towing artificial lures with barbless hooks behind the fishing vessel (Childers 2003). Troll gear is also called jig gear. The term troll will be used in this report.

*Figures 1a, 1b.* Tuna purse seine vessel and purse seine net (Figures from FAO 2001).
II. Introduction

There are three species of bluefin tuna: Atlantic bluefin (*Thunnus thynnus*), Pacific bluefin (*Thunnus orientalis*) and southern bluefin (*Thunnus maccoyii*). All three species of bluefin tuna are highly migratory, and school by size as well as occasionally with other tunas such as bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) (Froese and Pauly 2007a, 2007b, 2007c). Bluefin tuna continuously generate heat to maintain their body temperature (including in the eye, brain and muscle) above that of the ambient water temperature (Fromentin and Powers 2005). In recent years, there has been a significant effort to track the migrations and behaviors of bluefin tuna (Block et al. 2005). Bluefin tuna schools commonly range in size from ten to several hundred individuals, although Lutcavage and Kraus (1995) documented a surface school of greater than 5000 individuals. Juvenile southern bluefin tuna commonly school in groups of 1000 individuals or more, although less is known about adult schools of southern bluefin tuna (T. Polacheck, pers. comm.).

Although all three species of bluefin tuna are wild-caught or ranched\(^2\) in fisheries across the globe, the majority of bluefin tuna catch ends up in the Japanese market (Figure 2) (WWF 2006). Bluefin tuna is a highly valuable commodity, in particular for the sashimi and sushi industry in Japan\(^3\). The high prices that bluefin tuna commands often result in considerable illegal fishing (IUCN 2000). In addition to Japanese demand, there are important markets for bluefin tuna in China, Taiwan, Russia and the U.S.

![Figure 2. Trade routes for bluefin tuna imported to Japan. SBFT=southern bluefin tuna, BFT=bluefin tuna, NEA=Northeast Atlantic, IUU=illegal, unreported and unregulated (Figure from WWF 2006).](image)

Atlantic bluefin tuna

\(^2\) Ranched bluefin tuna is not evaluated in this report, but will be evaluated in a separate Seafood Watch® report to be released at a later date. Please visit www.seafoodwatch.org for the most up-to-date information.

\(^3\) Sashimi consists of thinly sliced pieces of raw fish; sushi consists of raw fish combined with other ingredients.
Atlantic bluefin tuna can attain sizes of up to 700 kg (Porch 2005). Atlantic bluefin tuna is endothermic and highly migratory, enabling the species to traverse a wide variety of ocean temperatures and environmental conditions (Block et al. 2001; Porch 2005).

For management purposes, there are two stocks of Atlantic bluefin tuna, one in the eastern Atlantic (including the Mediterranean Sea) and one in the western Atlantic (Figure 3) (ICCAT 2005a). Atlantic bluefin tuna were not considered a commercially valuable species until the 1960s, when canned and fresh bluefin tuna became an international commodity (Buck 1995). During this same time period, the Japanese developed a longline fleet in the western Atlantic, and in the 1970s they began targeting the large spawning bluefin tuna in the Gulf of Mexico (Fromentin and Powers 2005).

Atlantic bluefin tuna is targeted by many countries (Figure 6), and catches vary by gear type (Figure 4) and region (Figure 5) in the eastern Atlantic, western Atlantic and Mediterranean (Table 1). The Mediterranean accounts for 41% of the catch in the Atlantic, followed by the eastern Atlantic (12%) and western Atlantic (3%). Purse seines are the most common gear used in the Mediterranean, while longlines are the most common gear used in the eastern Atlantic. In fact, the purse seine fishery in the eastern Atlantic and Mediterranean has increased in response to increased Japanese demand for ranched bluefin tuna (originating from the purse seine fisheries targeting small and medium-sized bluefin tuna) (Figure 4) (Miyake et al. 2004).
In the U.S. directed fishery for bluefin tuna, the most common gear types used are handlines (38%), troll lines (28%), longlines (20%), harpoons (12%) and purse seines (2%) (NMFS 2007). In 2002, the recorded catch of western Atlantic bluefin tuna (3,319 mt) was higher than any year since 1981 (ICCAT 2006). The U.S. was unable to meet its quota in the 2003 through 2008 fishing years, which may be due to a lack of bluefin tuna in the region of the U.S. fishery or a decline in the western Atlantic bluefin tuna population (ICCAT 2006). Throughout the Atlantic, France, Spain and Italy account for the majority of bluefin tuna landings (Figure 6).
Figure 6. Atlantic bluefin tuna catches, by country, 1950–2000. Note that catches are those reported to FAO, and IUU catches are not included in this figure (Figure from Miyake et al. 2004).
In the Mediterranean, elaborate net traps are used to divert and catch bluefin tuna as they enter the western Mediterranean to spawn; a traditional fishing method that has been used for thousands of years (Hattour et al. 2001). Since the 1500s, the average catch in the Mediterranean trap fisheries has been 15,000 mt annually, with a maximum of about 40,000 mt in the mid-1990s (Fromentin and Powers 2005; ICCAT 2006). In the Mediterranean, there has been an intense increase in purse seine catches, which are then transferred to open-water pens and ranch. The amount of ranched bluefin tuna in the Mediterranean has increased from 200 mt in 1997 to more than 20,000 mt each year since 2003 (SCRS 2006). Overall, fishing effort targeting Atlantic bluefin tuna has increased greatly since the 1950s (Figures 7, 8).

The international management agency responsible for bluefin tuna in the Atlantic Ocean is the International Commission for the Conservation of Atlantic Tunas (ICCAT), and U.S. fisheries operating in the Atlantic are managed by the Highly Migratory Species (HMS) Division of the U.S. National Marine Fisheries Service (NMFS). Regulations are purported to be based on recommendations by the staff or scientific committees of ICCAT and implemented by the member and cooperating countries (although scientific recommendations are often ignored, such as when setting quotas).

Figure 7. Atlantic bluefin tuna catch by major gear in the Atlantic Ocean and Mediterranean Sea from 1950–1959. LL=longline, BB=baitboat (pole and line), PS=purse seine, OTH=other (Figure from ICCAT 2006).
Figure 8. Atlantic bluefin tuna catch by major gear type in the Atlantic Ocean and Mediterranean Sea from 2000–2004. LL=longline, BB=baitboat (pole and line), PS=purse seine, OTH=other. Note the geographic expansion of the longline fishery and the increased use of purse seine gear (Figure from ICCAT 2006).

Table 1. Worldwide catch of Atlantic bluefin tuna by flag and gear type.

<table>
<thead>
<tr>
<th>Species</th>
<th>Region</th>
<th>Catch (2005)</th>
<th>Fishing Countries</th>
<th>Gears Used</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic BFT</td>
<td>East Atlantic</td>
<td>7,376 mt</td>
<td>Spain (38%); Japan (27%); Morocco (27%); France (8%); China, Portugal, and Ireland (&lt;1% each)</td>
<td>Longline (28%); trap (27%); pole and line (24%); purse seine (15%); other surface gears (5%); sport (1%)</td>
<td>ICCAT 2006</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>25,190 mt</td>
<td>(36% of total catch)</td>
<td>France (26%); Italy (19%); Libya (10%); Tunisia (9%); Spain (9%); Algeria (5%); Turkey (4%); Croatia (3%); Morocco (3%); NEI (3%); Korea (3%); Japan (3%); Greece (2%); Malta (1%); Cyprus, Taiwan (&lt;1% each)</td>
<td>Purse seine (69%); other surface gears (15%); longline (10%); sport (5%); traps (&lt;1%); pole and line (&lt;1%)</td>
<td>ICCAT 2006</td>
</tr>
</tbody>
</table>

4 Catch data for east Atlantic bluefin tuna are likely underestimated due to unreported landings in the Mediterranean Sea. Catch data for the Atlantic are from 2004.
| West Atlantic | 1,842 mt (3% of total catch) | U.S. (49%); Canada (29%); Japan (22%); Portugal (<1%) | Sport (62%); longline (29%); other surface gears (5%); purse seine (2%); traps (2%); pole and line (<1%) | ICCAT 2006 |

**Scope of the analysis and the ensuing recommendation**

This analysis encompasses wild-caught Atlantic bluefin tuna from domestic and international sources. The sustainability of ranched bluefin tuna is briefly evaluated based on its dependence on wild juvenile bluefin tuna as a seed stock.

**Availability of Science**

The International Commission for the Conservation of Atlantic Tunas (ICCAT) has identified several problem areas including under-reporting of catches, aggregated and unclassified data, lack of size composition data, as well as the quantity of data reported (Fromentin and Powers 2005). Comprehensive data regarding reproduction and growth of Atlantic bluefin tuna is also needed (Fromentin and Powers 2005). The inability to quantify mixing between the eastern and western Atlantic stocks remains a concern in the stock assessment (ICCAT 2006). Scientists from the Standing Committee on Research and Statistics (SCRS) have also questioned the quality of the fisheries data from the Atlantic and, in particular, the Mediterranean (SCRS 2006). Unreported catch remains a major concern in the Mediterranean fishery (SCRS 2006).

**Market Availability**

**Common and market names**

In the U.S., the three species of bluefin tuna are known simply as bluefin tuna. When sold as sashimi, bluefin is often differentiated from other tunas due to its higher price and is often sold as *toro*. In Spanish, bluefin tuna is known as *atún de aleta azul*.

**Seasonal availability**

Bluefin tuna is available year-round due to imports, with the highest catches in U.S. waters occurring from July to September (NMFS 2007). Catches in the U.S. are primarily Atlantic bluefin tuna from Massachusetts and North Carolina.

**Product forms**

Sashimi quality bluefin tuna is a high-value commodity; in 2001, a single bluefin tuna sold for US$174,000 in Tokyo (Fromentin and Powers 2005). Atlantic bluefin tuna is most commonly used for sashimi, but is also canned (Froese and Pauly 2007a). Some southern bluefin tuna is canned, although most is used for sashimi in the Japanese market (Froese and Pauly 2007c). Atlantic bluefin tuna off the coast of New England have the highest lipid content in summer and fall, making them highly valued for sashimi (Buck 1995). Tuna sold in sushi restaurants is often sold by the type of meat; *toro* is the high quality belly meat and can be from any tuna species, including bluefin tuna (Figure 15).
Import and export sources and statistics
Bluefin tuna trade is monitored via the Bluefin Catch Document (BCD) program by ICCAT members and other participating countries. NMFS also receives data from U.S. Customs and Border Protection (CBP) regarding fresh and frozen bluefin tuna (NMFS 2006). Until 2005, the Bluefin Tuna Statistical Document (BSD) included only Atlantic and Pacific bluefin tuna; in 2005, southern bluefin tuna was added to the program (NMFS 2006). Atlantic bluefin tuna exports declined from 2001–2007 due to decreased catches in the U.S. (NMFS 2006). There are differences in the CBP and BSD data that may be due to compliance issues (NMFS 2006). The CCSBT also runs a Trade Information Scheme (TIS) for the import and export of southern bluefin tuna.

In 2005, a total of 2,023 mt of bluefin tuna was imported from 27 countries, primarily from Mexico, Spain, Canada and Indonesia (Figure 16) (NMFS 2007). Total U.S. bluefin tuna landings in 2005 were 676 mt, landed in Massachusetts (48%), California (31%), North Carolina (14%), Louisiana (6%), New Jersey (<1%) and Florida (<1%) (NMFS 2007). According to the NMFS Fisheries Statistics and Economic Division, there was a total of 2699 mt of bluefin tuna (imports and U.S. landings) available for domestic consumption and export. However, a total of 2,891 mt of bluefin tuna was exported and re-exported (NMFS 2007). The reason for this discrepancy is unclear. While U.S. exports have been declining, imports and re-exports have been increasing with re-exports of bluefin tuna rising due to increased imports of ranched bluefin tuna from Mexico, which is then re-exported to Japan (Figure 17) (NMFS 2006).
**Figure 17.** Import, export and re-export trends from 1999–2004 using data from the BSD program. The concurrent increase in imports and re-exports in recent years is due to increased imports from Mexican farms and subsequent re-export to Japan (Data from NMFS 2006).
III. Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

Atlantic bluefin tuna

The Atlantic bluefin tuna range extends in the western Atlantic from Canada south to the Gulf of Mexico, and in the Caribbean Sea south to Venezuela and Brazil (Table 2). Population structure is poorly understood (SCRS 2008). Currently, Atlantic bluefin are managed as separate eastern and Western stocks. Tuna in these two regions reach maturity at different ages (Rodriguez-Roda 1967; Baglin 1982; Nemerson et al. 2000), and have isolated spawning grounds in the Gulf of Mexico and Mediterranean Sea (Block et al. 2001). Electronic tagging data and recent genetic and microconstituent analysis of otolith studies (Block et al. 2005; Carlsson et al. 2007; Boustany et al. 2008; Rooker et al. 2008) confirm the distinctness of the two populations of Atlantic bluefin tuna. While each group has separate spawning grounds, individuals from each group overlap in their foraging grounds (Block et al. 2005).

However, recent research suggests population structure is likely more complex than currently assumed (SCRS 2008; Fromentin 2009). Reeb (2010) provides useful context for recent genetic research by Riccioni, Landi et al. (2010) comparing microsatellite loci from contemporary and historical BFT samples in the Mediterranean. The results from that research indicate “(1) that the Mediterranean contains genetically subdivided populations, (2) that this structure has persisted for nearly 100 years, and (3) that gene diversity has remained surprisingly intact despite decades of overexploitation and dramatic decline in numbers.” Reeb (2010) notes that these results confirm previous work using electronic tags and genetic markers (e.g. Boustany, Reeb et al. 2008) that suggests multiple breeding stocks of BFT in the Mediterranean.

In the western Atlantic, the area around the Bahamas and Straits of Florida has been hypothesized as a unique spawning ground for BFT (Richards 1976 in Boustany, Reeb et al. 2008). Electronic tagging studies have observed BFT travelling to and exhibiting prolonged periods of residency in these warm waters suitable for spawning (Block, Teo et al. 2005). Boustany, Reeb et al. (2008) failed to detect any genetic difference between the fish collected in this area and other areas, but results suggest they may be more similar to the stock(s) in the Mediterranean than those in the Gulf of Mexico. However, a small sample size may have confounded these results. In any case, the authors conclude that spawning status of the fish in the Florida/Bahamas area remains uncertain, and that further sampling may help determine whether there is a distinct spawning population in this area. Wilson and Block (2010) found that BFT foraging in this area were of western or unknown origin, and hypothesize that BFT may forage here in warm waters before entering the colder waters of the Gulf of Mexico. Recent data from tagging experiments suggests there may be genetic differentiation between bluefin tuna in the western Gulf of Mexico versus those in the eastern Gulf of Mexico (Shana Miller, Tag A Giant, pers. comm.).

Atlantic bluefin tuna spawn in warm waters greater than 24°C in the Gulf of Mexico (Teo et al. 2007) and above 23°C in the Mediterranean. Bluefin tuna have been shown in recent electronic tagging studies to show fidelity in consecutive years to either the Gulf of Mexico or the Mediterranean Sea (Block et al. 2005; Teo et al. 2007). Atlantic bluefin tuna are highly fecund
with mature bluefin tuna capable of producing five million eggs, and 15–20 year old bluefin tuna capable of producing 45 million eggs (Rodriguez-Roda 1967). Current stock assessments assume that Western Atlantic bluefin tuna have a maximum length of 382 cm, growth rate (Von Bertalanffy growth function K) of 0.079, maximum age of 32 years, and an age at maturity of 8 (SCRS 2008). Recent research suggests that the Gulf of Mexico population of bluefin tuna matures at later ages than currently supposed in stock assessments, ranging from 8–12 years (Block et al. 2005; Diaz and Turner 2006). Although the first age at maturity is eight years in the Gulf of Mexico, the average age based on catch appears to be greater than 10 years of age (ICCAT 2006; Gavaris, Hazin et al. 2009). Age at 50% maturity was estimated at 12 years (Diaz and Turner 2006).

Eastern bluefin tuna grow a little more quickly (K=0.093), reach a smaller maximum length (319cm), have a maximum longevity over 20 years, and an earlier age at maturity (4 years) (SCRS 2008). It is thought that eastern Atlantic bluefin tuna have evolved to mature at an earlier age due to millennia of fishing pressure (S. Miller, pers. comm.). Compared to tropical tunas (e.g., yellowfin and bigeye), Atlantic bluefin tuna are more vulnerable to fishing pressure due to slower growth and later maturity, in addition to other characteristics (Longhurst 1998; Fromentin and Fonteneau 2001) such as shorter spawning periods and aggregating behavior for spawning and foraging (Fromentin and Fonteneau 2001; Fromentin and Ravier 2005). In addition, Atlantic bluefin tuna have complex migratory patterns related to season and life history stage (Mather 1962). Atlantic bluefin tuna spend most of their time in surface waters, although they are also capable of diving to depths of 500–1000 m (Lutcavage et al. 2000; Block et al. 2001). In addition, Atlantic bluefin tuna have been shown to spend time foraging at oceanic fronts (Humston et al. 2000; Lutcavage et al. 2000; Boustany et al. 2001; Brill et al. 2001; Royer et al. 2004), possibly when their prey are spawning (Boustany et al. 2001). The specific migratory patterns of Atlantic bluefin tuna make them more vulnerable to fishing pressure (Buck 1995), as fleets can easily locate and target the migrating tuna.

**Figure 18.** Geographic range of Atlantic bluefin tuna. Dark areas represent spawning areas. Vertical line represents the management units used by ICCAT (Figure from NRC 1994).
Table 2. Life history characteristics of Atlantic bluefin tunas.

<table>
<thead>
<tr>
<th>Species</th>
<th>Intrinsic Rate of Increase (r)</th>
<th>Age at First Maturity (yrs)</th>
<th>Growth Rate (k)</th>
<th>Max Age (yrs)</th>
<th>Max Size (cm)</th>
<th>Fecundity (million eggs)</th>
<th>Species Range</th>
<th>Special Behaviors</th>
<th>Sources</th>
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<tr>
<td>Atlantic bluefin tuna, Eastern</td>
<td>Unknown</td>
<td>4-5</td>
<td>0.09</td>
<td>&gt;20</td>
<td>319</td>
<td>5 – 45 varying with age</td>
<td>North Atlantic Ocean, poorly understood stock structure</td>
<td>Aggregate to spawn and forage; known migratory routes</td>
<td>SCRS 2008; Gavaris, Hazin et al. 2009</td>
</tr>
<tr>
<td>Atlantic bluefin tuna, Western</td>
<td>8-12</td>
<td>0.08</td>
<td>32</td>
<td>382</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Synthesis
Atlantic bluefin tuna species grow at a relatively moderate rate with variation between populations. More age and growth work is required in all populations. Bluefin tunas are moderately long-lived, with an estimated longevity of 15–40 years for the three species. Bluefin tunas are highly migratory and have high fecundity, but exhibit several behaviors that may increase their vulnerability to fishing pressure such as established migration routes and aggregating in spawning and forage areas. Bluefin tuna are considered to be less resilient to fishing pressure than tropical tunas such as bigeye and yellowfin, based on their life history characteristics. Although eastern Atlantic bluefin have an earlier age at first maturity, this is a result of excessive fishing pressure and thus this species is not considered more resilient than the other bluefin tuna species. In addition, there are now thought to be two populations in the eastern Atlantic: one early maturing and resident, and one that matures later and migrates in and out of the Mediterranean. Overall, all three species of bluefin tuna are ranked as “moderately vulnerable.”

Inherent Vulnerability Rank:

<table>
<thead>
<tr>
<th>Species</th>
<th>Seafood Watch® Conservation Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>(none)</td>
<td>Resilient</td>
</tr>
<tr>
<td>Atlantic bluefin tunas</td>
<td>Moderately Vulnerable</td>
</tr>
<tr>
<td>(none)</td>
<td>Highly Vulnerable</td>
</tr>
</tbody>
</table>

Criterion 2: Status of Wild Stocks

*Atlantic bluefin tuna*
As noted in the inherent vulnerability discussion above, population structure of BFT remains poorly understood (SCRS 2008). In their investigation of historical data from Atlantic bluefin fisheries, Fromentin (2009) suggests that bluefin tuna sustained the massive increase in fishing effort in the Mediterranean in the 1980s due to immigration from outside the Mediterranean. But the author notes that now, the situation is drastically different because bluefin tuna have been heavily exploited over their whole range for more than a decade, all potential sub-populations are currently exploited, and there are no more refugia. As a result, bluefin tuna resilience is likely much less than it used to be. The author concludes that in “a context of heavy overexploitation and overfishing, it is crucial to better understand bluefin tuna population structure and spatial dynamics and their interactions with an integrated research project that would combine traditional (e.g. histological analyses, larval survey) and advanced (e.g. genetic and biochemical markers, electronic tags) techniques on a substantial number of fish sampled over the whole spatial distribution of the species.” Fonteneau and Le Person (2009) also examine historical fisheries data for Atlantic and Mediterranean bluefin tuna fisheries. The authors conclude that a major research effort is needed "to obtain a fully comprehensive and realistic modelling and stock assessment of the Atlantic bluefin population."

**Western Atlantic bluefin tuna**

The International Commission for the Conservation of Atlantic Tunas (ICCAT) Standing Committee on Research and Statistics (SCRS) is responsible for Atlantic bluefin tuna stock assessments. The SCRS comprises government scientists, as well as industry and conservation organization representatives (Sissenwine et al. 1998). The most recent stock assessment for western Atlantic bluefin tuna was conducted in 2008 (SCRS 2008) and shows that the stock is both overfished and experiencing ongoing overfishing.
The SCRS notes that both recent recruitment levels (the number of juvenile fish entering the fishery) and potential future levels are an important source of uncertainty. Recruitment during the 1970s is estimated to have been very high, and additional analyses by the SCRS using longer data series suggests that recruitment was also high in the 1960s (SCRS 2009b). Use of this data was unquestioned through the 1998 stock assessment, which determined that the then-annual catch of 2500 t could not be sustained, 2000 t was likely sustainable, and a quota near zero was necessary to restore the population to early 1970s levels ($SB_0$) within 20 years (Safina and Klinger 2008). Since then, an alternative recruitment scenario (“low” recruitment) has been analyzed by the SCRS with results presented alongside the original scenario (“high” recruitment). Use of the low recruitment scenario is based on the hypothesis of environmental change in the mid 1970s that makes the high recruitment rates of the 1960s and 1970s currently impossible. Thus, data prior to 1975 are excluded from this second scenario, making maximum spawning stock biomass ($SSB_{max}$) substantially lower (45,000 t) than $SB_0$ (80,000-221,000 t) (SCRS 2009a). This more optimistic model in turn leads to lower MSY-based benchmarks, and thereby higher quotas to meet the same objectives (i.e. rebuild by 2019). The SCRS considers each scenario equally plausible. Other authors have noted the regime-change hypothesis has no backing in data (Safina and Klinger 2008). Furthermore, the majority of members of an FAO expert panel convened in 2009 to review a proposal to uplist BFT to the most protective status possible under CITES preferred to use $SB_0$ as the baseline from which to calculate decline (i.e. the high recruitment scenario). This preference was due to the high recruitment scenario taking into account population decreases due to fishing prior to 1970 including catches off Brazil in the early history of the fishery (FAO 2010). The FAO Expert Panel thus concluded that both the eastern and western stocks are currently below 15 percent of unfished biomass (FAO 2010).

The 2008 stock assessment found that the relative biomass level ($SSB_{07}/SSB_{MSY}$)$^5$ is 0.57 under the low recruitment scenario and 0.14 under the high recruitment scenario. The SSB drastically declined between the early 1970s and 1992 (Figure 21). Since then, it has fluctuated between 18% and 27% of the 1975 level. Overfishing has been occurring for over 20 years on Atlantic bluefin tuna, with the current fishing mortality rate ($F_{2004-2006}/F_{MSY}$)$^6$ estimated at 1.27 under the low recruitment scenario and 2.18 under the high recruitment scenario (SCRS 2008a). The long and short-term abundance trends are declining (Figure 21), and there is evidence that the size distribution of the stock is skewed. In some fisheries, such as the U.S. longline fishery in the Gulf of Mexico, the catch of large Atlantic bluefin tuna has declined since the mid-1990s (Diaz and Turner 2006). Overall, fishing mortality on bluefin tuna over eight years of age increased from the 1970s to 2002 and has decreased somewhat since then (Figure 21).

Under the current 2009 quota of 1,900 mt, the outlook for western Atlantic bluefin tuna under the low recruitment scenario is predicted to have at least a 75% chance of preventing overfishing and rebuilding the stock to MSY by the target date of 2019. The outlook under the high recruitment scenario, which has a higher rebuilding target, is predicted to have a 50% chance of ending overfishing by 2013; however, even without fishing pressure the stock would not be expected to fully rebuild by 2019.

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$^5$ MSY calculated conditional that recruitment remains at recent (1976–2004) levels.

$^6$ $F_{2004-2006}$ refers to the geometric mean of the estimates for 2004–2006 (a proxy for recent F levels).
The SCRS warns that the assessment’s conclusions do not capture the full degree of uncertainty in the assessment, which includes uncertainties associated with western and eastern Atlantic population mixing, recent and potential future levels of recruitment (i.e. the high and low recruitment scenarios), and the growth curve (SCRS 2008a). Controversy has historically surrounded the stock assessments for western Atlantic bluefin tuna primarily due to uncertainty associated with mixing of the eastern and western populations, as well as the rebuilding plan for western Atlantic bluefin tuna (Sissenwine et al. 1998). Other factors further add to the uncertainty in stock assessment, including uncertainty over age at first maturity (S. Miller, pers. comm.), poorly understood stock structure (see inherent vulnerability discussion above), and various other parameters in the stock assessment model (Gavaris, Hazin et al 2009 ). Although ICCAT began collecting landings data in 1950, the SCRS stock assessments include abundance estimates from 1970 onward; ICCAT has concluded that heavy fishing in the 1960s and 1970s resulted in declines of western Atlantic bluefin tuna (Sissenwine et al. 1998). Continued fishing pressure on mature animals along the western Atlantic and increased effort in the central Atlantic led to high mortality throughout the 1990s (Tag-A-Giant Foundation, pers. comm.). In addition, there is concern regarding disagreement over the target population size (S. Miller, pers. comm.).

There have been three attempts to list bluefin tuna under CITES (Convention on International Trade in Endangered Species) (Buck 1995). In 1991, Sweden proposed that western Atlantic bluefin tuna be listed under Appendix I and eastern Atlantic bluefin tuna be listed under Appendix II. In 1994, Kenya proposed listing all Atlantic and southern bluefin tuna under Appendix II. In each case, input and pressure from Japan was important in the withdrawal of the proposals to list bluefin tuna (Buck 1995). Most recently, Monaco proposed that all Atlantic bluefin tuna be listed under Appendix I (CITES 2009). Despite a majority (not a consensus) of the FAO Expert Panel agreeing that the available evidence supported the inclusion of Atlantic bluefin tuna on Appendix I (FAO 2010), the proposal was again rejected. Atlantic bluefin tuna in the western Atlantic is listed as “Critically Endangered” on the IUCN Red List, which is defined as “an extremely high risk of extinction in the wild in the immediate future” (Safina 1996a; IUCN Red List 2007). A petition has also been filed in the US to list Atlantic bluefin as endangered or threatened under the Endangered Species Act (CBD 2010).

Due to the fact that western Atlantic bluefin tuna is listed as “Critically Endangered”, and the stock is overfished with overfishing occurring, Seafood Watch® concludes that the stock status of western Atlantic bluefin tuna is a critical conservation concern.
Eastern Atlantic bluefin tuna

Eastern Atlantic bluefin tuna is currently overfished with substantial overfishing occurring (SCRS 2008a). As for the western Atlantic stock, the 2008 assessment used high and low recruitment scenarios. The low recruitment scenario resulted in a current biomass level (SSB2007) that is 35% of the biomass needed to support maximum sustainable yield (SSB_FMAX), while the high recruitment estimate was only 14% of the maximum sustainable yield. While SSB has been declining, fishing mortality (F) has been increasing rapidly, especially for large bluefin (ages 8+) (Figure 22). The current relative fishing mortality rate (F07/FMAX) is 3.04 for reported catches and 3.42 for adjusted catches. The increase in F for large bluefin tuna is consistent with a shift over the last decade in targeting larger bluefin for fattening or farming operations, mostly in the Mediterranean. Recent F is too high and recent SSB too low to be consistent with the Convention Objectives (SCRS 2008a). In addition, catches of larger bluefin tuna in other fisheries such as the Spanish trap fishery (which has historically caught bluefin tuna entering the Mediterranean to spawn) are increasing (SCRS 2006).

Although stock assessments are conducted for Atlantic bluefin tuna, considerable uncertainty remains concerning the total catch and size distribution in many eastern Atlantic and Mediterranean fisheries (ICCAT 2005a). In particular, size composition data are unavailable and not collected for the increasing proportion of bluefin tuna that is transferred to pens rather than landed (Fromentin and Ravier 2005). In addition, the proportion of larger fish in the catch has increased as fleets have shifted to targeting higher value large fish (Fromentin and Powers 2005). Even while the SCRS has estimated catches of up to 61,000 mt in the eastern Atlantic and Mediterranean, under and non-reporting remain an issue of concern in this region (SCRS 2008a).

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7 Catches were adjusted to account for underreporting (SCRS 2008).
The under-reporting of overall catches and the lack of reliable historical information means the stock cannot be confidently monitored, and therefore severe depletion can easily go undetected. If the value of F continues at current levels, the spawning stock biomass will decline to very low levels (~ 18% of SSB in 1970 and 6% of unfished SSB). The stock runs a high risk of collapse due to the combination of high F, low SSB, and overcapacity (MacKenzie et al. 2008; SCRS 2008a). It has been suggested that MSY is not an appropriate target for eastern Atlantic bluefin tuna because it does not account for long-term natural population fluctuations (Kell et al. 2000).

In the Atlantic, U.S. longline fleets are prohibited from using live bait in the Gulf of Mexico fishery targeting yellowfin; however, the Mexican fleet operating in the same fishery often uses live bait. It is possible that this practice results in increased bycatch of billfish species such as Atlantic blue marlin, white marlin, sailfish and swordfish, as well as bluefin tuna (50 CFR 635, August 1, 2000). The quantity of bycatch relative to the target species is low, however, with yellowfin tuna accounting for more than 70% of the catch (Brown et al. 2004). The incidental take of Atlantic bluefin tuna in the pelagic longline fisheries in the Gulf of Mexico is a serious conservation concern, as recent data have shown that the northern slope waters of the Gulf of Mexico is a hotspot for bluefin tuna spawning (Block et al. 2005). Time and area closures for longline fleets operating in these waters would reduce the bycatch of Atlantic bluefin tuna (Block et al. 2005), which are overfished and experiencing overfishing (NMFS 2004b; Beerkircher et al. 2009).

According to Fromentin and Powers (2005, pg. 299), the current catch of Atlantic bluefin tuna in the eastern Atlantic and Mediterranean is “more than two times higher than historical records and mean estimated productivity....” Similarly, in the Mediterranean, an International Union for Conservation of Nature (IUCN) Fisheries Working Group concluded that “…fishery mortality on bluefin tuna in the Mediterranean Sea must be significantly reduced” (IUCN 2000, pg. 4). Due to the life history characteristics of Atlantic bluefin tuna, fishing on juveniles should be minimized (Fromentin and Fonteneau 2001).

The spatial distribution of Atlantic bluefin tuna may be impacted by environmental variables (Fromentin and Powers 2005), and poor recruitment may have led to increased numbers of older Atlantic bluefin tuna in the eastern Atlantic and Mediterranean fisheries (Pusineri et al. 2002 in Fromentin and Powers 2005).

Bluefin tuna in the eastern Atlantic is listed as “Endangered” on the IUCN Red List, which is defined as “facing a very high risk of extinction in the wild in the near future” (Safina 1996b, IUCN Red List 2007).

**Overall, the long and short-term trends in biomass are declining. The Seafood Watch® rank for the stock status of East Atlantic bluefin tuna is a critical conservation concern, as the stock is listed as “Endangered” by the IUCN and is overfished with overfishing occurring.**
Figure 22. Fishing mortality (for ages 1–5 and 8+), spawning stock biomass and recruitment estimates for the eastern Atlantic. Spawning stock biomass has declined in the eastern Atlantic, and is currently 35% of $B_{MSY}$ according to the low recruitment estimate and 14% of $B_{MSY}$ according to the high recruitment estimate. Fishing mortality on bluefin tuna 8 years of age and older has increased dramatically in recent years in the eastern Atlantic (Figure from SCRS 2008a).
Synthesis
Atlantic bluefin tuna is overfished with overfishing occurring on both stocks, accompanied by declining biomass trends. In addition, in the eastern Atlantic, uncertainty is high due to under-reported catches as well as transfer of wild catches to ranching operations. Overall, the status of Atlantic bluefin tuna is a critical conservation concern.

Status of Wild Stocks Rank:

<table>
<thead>
<tr>
<th>Species and Region</th>
<th>Class. Status</th>
<th>B/BMSY</th>
<th>Occurrence of Overfishing</th>
<th>F/FMSY</th>
<th>Abundance Trends/CPUE</th>
<th>Age/Size/Sex Distribution</th>
<th>Degree of Uncertainty in Stock Status</th>
<th>Sources</th>
<th>SFW Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Atlantic BFT</td>
<td>Overfished</td>
<td>Low recruitment estimate: $B_{2007}/B_{MSY/R} = 0.57$; High recruitment estimate: $B_{2007}/B_{MSY/R} = 0.14$</td>
<td>Overfishing occurring</td>
<td>Low recruitment estimate: $F_{2004-2006}/F_{MSY/R} = 1.27$; High recruitment estimate: $F_{2004-2006}/F_{MSY/R} = 2.18$</td>
<td>Long-term declining; short-term stable</td>
<td>Skewed</td>
<td>Moderate</td>
<td>SCRS 2008a</td>
<td>Critical</td>
</tr>
<tr>
<td>East Atlantic BFT</td>
<td>Overfished</td>
<td>Low recruitment estimate: $SSB_{2007}/SSB_{FMAX} = 0.35$; High recruitment estimate: $SSB_{2007}/SSB_{FMAX} = 0.14$</td>
<td>Overfishing occurring</td>
<td>Reported catches: $F_{2007}/F_{MAX} = 3.04$ Adjusted catches: $F_{2007}/F_{MAX} = 3.42$</td>
<td>Long and short-term declining trends</td>
<td>Skewed</td>
<td>High</td>
<td>SCRS 2008a</td>
<td>Critical</td>
</tr>
</tbody>
</table>

Criterion 3: Nature and Extent of Bycatch

<table>
<thead>
<tr>
<th>Species and Region</th>
<th>Species</th>
<th>Seafood Watch® Conservation Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>(none)</td>
<td>Healthy</td>
<td></td>
</tr>
<tr>
<td>(none)</td>
<td>Moderate/Unknown</td>
<td></td>
</tr>
<tr>
<td>(none)</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>Atlantic bluefin tuna (49% of total catch)</td>
<td>Critical</td>
<td></td>
</tr>
</tbody>
</table>
Seafood Watch® defines sustainable wild-caught seafood as marine life captured using fishing techniques that successfully minimize the catch of unwanted and/or unmarketable species (i.e., bycatch). Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for and managed in some way.

(Please note that a detailed discussion of bycatch follows on pages 38–58. The bycatch ranking for each gear type is summarized at the end of each gear type section. An overall synthesis of Criterion 3: Nature and Extent of Bycatch begins on page 57).

Specific bycatch data for the bluefin tuna fisheries may not be available in all the regions where bluefin tuna are fished, and extrapolations from tuna longline and purse seine fisheries in general have been applied to the bluefin tuna fishery in this analysis. In addition, there may be spatial differences within regions (Solana-Sansores 2001).

**Pole and Line, Troll, Handline, and Harpoon**

In addition to being caught in longline and purse seine fisheries, bluefin tuna is caught by pole and line, handline and harpoon. In pole and line/handline fishing, fishers use a pole with a fixed length line that has a barbless hook with either an artificial lure or live bait. Using this method, fish are caught one at a time and any unwanted catch can be thrown back immediately. In troll fishing, fishers tow fishing lines behind or alongside a boat and use a variety of lures and baits to “troll” for different fish at different depths. Using this method, fishermen can quickly release unwanted catch from their hooks since lines are reeled in soon after a fish takes the bait. When harpooning, fishers spot a fish and thrust or shoot a long aluminum or wooden harpoon into the targeted fish. Bycatch of unwanted marine life is not a concern because harpoon fishermen visually identify the species and size of the targeted fish before killing it and bringing it aboard. In the surface fisheries (e.g., pole and line, handline and harpoon) for bluefin tuna, bycatch is negligible compared to bycatch in the pelagic longline fisheries. In troll fisheries, there may be some concerns associated with post-release mortality of marlin (Graves et al. 2002; Domeier et al. 2003), which are commonly caught in troll fisheries targeting bluefin tuna. The average discard rate, or the proportion of total catch that is discarded, for highly migratory species (HMS) in troll fisheries globally is 0.1% (Kelleher 2004). **Given the negligible quantities of bycatch, bycatch in pole and line, handline troll, and harpoon tuna fisheries is a low conservation concern.**

**Longlines**

The majority of bluefin tuna caught outside of the Pacific and Mediterranean are taken using longline gear. Although pelagic longlines are set at different depths and configured to target specific species, non-target species also interact with this gear. In longline fisheries, interactions occur with a range of species, including endangered and protected sea turtles, seabirds, marine mammals, sharks and other fishes. These non-target animals approach or are attracted to baited longline hooks and may become hooked or entangled in the gear, causing them to be injured or killed (NMFS 2001). Tuna are caught using deep-set longline gear, which generally results in one-tenth the bycatch rate in the shallow-set fishery targeting swordfish (Lewison et al. 2004b; Kaplan 2005). However, mortality rates for some species, including sea turtles, are higher for deep-set longlines since the animals cannot surface to breathe.
Although comprehensive global bycatch data are not available, there are some data for specific longline fisheries. Longline gear varies according to the size and intensity of the fishery, the configuration of the gear, the region in which the gear is used, and the vessels’ country of origin. While these differences may result in differing levels of bycatch, Seafood Watch® adopts a precautionary approach in assuming that problematic bycatch levels in one tuna fishery are similar to other tuna fisheries unless there are data to show otherwise. The average discard rate for HMS longline fisheries is 22% (Kelleher 2005). In the U.S., the discard to landings ratio for finfish in the HMS fishery (pelagic longline, bottom longline and drift/set gillnets) is estimated to be 0.52. The discard to landings ratio for the pelagic longline fishery alone is 0.67, with swordfish and sharks comprising the major species that are discarded (Harrington et al. 2005). Of all the gear types used to catch tuna in the Atlantic, longlines catch the highest diversity of both fish and seabirds (ICCAT 2005b). However, overall seabird bycatch is lower in the Atlantic than in other ocean basins. As evidenced by observer data in the western and central Pacific Ocean (WCPO), mortality rates differ for the various types of longlines (Figure 28).

Figure 28. Mortality rates in the WCPO shallow set longline fishery (A), WCPO deep-set longline fishery (B), and temperate albacore fishery (C). The x-axis shows the year and the y-axis shows mortality per 100 hooks. Noting the change in scale for each panel, sea turtle mortalities were highest in the deep-set fishery and shark mortalities were highest in the shallow set fishery (Figure from Molony 2005).
**Longlines: Fish bycatch rates**

Discards of swordfish and tuna in the U.S. Atlantic pelagic longline fishery generally exhibited a gradual decline from 1995–2004 (NMFS 2006). Discards of these target species may be economic or regulatory discards. For highly migratory species, both the number of individuals kept and the number of individuals discarded have declined over this time period, as has fishing effort (Figure 29) (NMFS 2004a). The reason for this decline is unknown.

![Figure 29](image-url)  
*Figure 29. Decline of marlin, sailfish and spearfish discards in the U.S. Atlantic pelagic longline fishery (Data from NMFS 2004a).*

Billfish are caught incidentally in the pelagic longline fisheries, although for fisheries where logbook data are available, the catch ratio of billfish to the targeted species is low. Billfish catch is approximately 5% of the total combined catch of albacore, yellowfin, bigeye, bluefin and southern bluefin tunas (Uozumi 2003).

It is important to note that recreational catch-and-release fisheries for billfish species also contribute to total mortality rates, although the magnitude of these mortalities is far less than for the pelagic longline fishery. For instance, over 99% of all white marlin are released in recreational fisheries (Goodyear and Prince 2003). The survival of these released marlin may be affected by the type of hook used. In the western North Atlantic recreational fishery, white marlin survival is higher when caught on circle hooks (100%) than when caught on J-hooks (65%) (Horodysky and Graves 2005). In addition, there are few data examining survival rates following stomach eversion (Horodysky and Graves 2005). Although this mortality affects the stock status of billfish, Seafood Watch® does not incorporate recreational fishery effects when evaluating commercial fisheries. When 16/0 circle hooks were compared to 9/0 J-hooks in the U.S. Atlantic pelagic longline fishery, circle hooks were found to reduce mortality of non-target species and may result in higher survival for undersize swordfish and billfishes (Kerstetter and Graves 2006). In addition, the use of 16/0 circle hooks was found to have a minimal impact on the catch of target species (Kerstetter and Graves 2006).

The mortality of billfish in longline fisheries targeting swordfish and tunas varies according to fishery and species. When data sets from the U.S., Japanese and Venezuelan fisheries were combined, the proportion of billfish already dead upon gear retrieval ranged from 0.472 for blue
marlin in the Gulf of Mexico to 0.673 for white marlin in the northwest Atlantic (Farber and Lee 1991). Observer data from Japanese fisheries in Australia suggest that 74% of black marlin, 71% of blue marlin and 60% of striped marlin were dead or moribund when the gear was retrieved (Findlay et al. 2003). There are, however, differences in billfish mortality rates in different fisheries operating in the same waters: Japanese and Australian fisheries operating in the same waters have been shown to have different billfish mortality rates due to differences in gear configuration (Findlay et al. 2003).

In the Indian Ocean, 2005 observer data from Western Australia longline vessels suggest that more than half of the species caught were bycatch, most commonly sharks. While some bycatch species, such as dolphinfish, are kept and sold, there is no market for other species that are commonly caught, such as stingrays (IOTC 2005).

**Longlines: Fish population impacts**

The stock status of billfish species varies by ocean basin and species (Table 4). In the Atlantic, biomass estimates for blue marlin, white marlin and sailfish are all below B_{MSY} while fishing mortality on these stocks is above F_{MSY} (Peel et al. 2003; Uozumi 2003). The Atlantic blue marlin stock is at 40% of B_{MSY}, current fishing mortality is four times F_{MSY}, and overfishing has been occurring for the last 10–15 years (ICCAT 2001a). The only international management measure in place for Atlantic blue marlin is a reduction of pelagic longline and purse seine landings to 50% of 1996 or 1999 levels, whichever is greater (ICCAT 2001a). White marlin occurs only in the Atlantic, and the most recent assessment for this species was in 2000 indicating that biomass throughout the late 1990s was about 15% of B_{MSY} while fishing mortality was more than five times F_{MSY} (ICCAT 2001a). Similar to blue marlin, the only international management measure in place for white marlin is a limit on longline and purse seine landings to 33% of the 1996 or 1999 level (ICCAT 2001a). For Atlantic sailfish, MSY is not estimated and there are no international management measures in place (ICCAT 2001b).

Billfish bycatch in the Atlantic is a critical conservation concern due to the poor stock status of billfish species.

**Table 4.** Stock status of billfish in the Atlantic Ocean (Table from Uozumi 2003).

<table>
<thead>
<tr>
<th>Species</th>
<th>Stock</th>
<th>Stock status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic blue marlin</td>
<td>Atlantic</td>
<td>Lower than MSY</td>
</tr>
<tr>
<td>White marlin</td>
<td>Atlantic</td>
<td>Lower than MSY</td>
</tr>
<tr>
<td>Atlantic sailfish</td>
<td>East Atlantic</td>
<td>Lower than MSY</td>
</tr>
<tr>
<td>Longbill spearfish</td>
<td>Atlantic</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
**Longline: Sea turtle bycatch rates**

All seven species of sea turtles are listed as threatened or endangered under the U.S. Endangered Species Act (ESA) of 1978, and six of these species are also listed on the IUCN Red List of Threatened Species (Table 5). Some of these sea turtle species are caught as bycatch in the pelagic longline fisheries targeting tuna and swordfish, particularly green, hawksbill, Kemp's ridley, leatherback, loggerhead, and olive ridley turtles. Sea turtles are more commonly caught as bycatch in tropical waters, and in shallow-set fisheries targeting swordfish more than in deep-set fisheries targeting tuna (Beverly et al. 2004). As evidenced by the closure of the U.S. longline fishery in the Northeast Distant Waters (NED), sea turtles are also caught as bycatch in other regions. Loggerhead sea turtles have been shown to spend the majority of their time at depths shallower than 100 m, and the elimination of shallow-set longlines would result in reduced bycatch of loggerheads (Polovina et al. 2003). Even in deep-set longlines, however, there is the potential for hooks to be present at shallow depths when the gear is being set and retrieved, or if the line does not sink to the appropriate depth (Polovina et al. 2003). There does not appear to be a difference in the survivability between jaw-hooked and esophageal-hooked turtles (Polovina et al. 2000; Parker et al. in press). Leatherback sea turtles, attracted to the squid bait used on longlines (Skillman and Balazs 1992), can become entangled in the lead lines and drown, even if not hooked (NMFS and USFWS 1998). Estimates of sea turtle post-release mortality using satellite tracking has been controversial and problematic (Hays et al. 2003; Chaloupka et al. 2004a; Chaloupka et al. 2004b; Hays et al. 2004a) with estimates ranging from 0.08 for lightly hooked turtles to 0.38 for deeply hooked turtles (Chaloupka et al. 2004a). In general, takes greatly exceed documented mortalities in longline fisheries, although there are little data on delayed mortality.

<table>
<thead>
<tr>
<th>Species</th>
<th>Status under the U.S. ESA</th>
<th>Status on the IUCN Red List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Threatened, Endangered</td>
<td>Endangered</td>
</tr>
<tr>
<td>Hawksbill</td>
<td>Endangered</td>
<td>Critically endangered</td>
</tr>
<tr>
<td>Kemp’s ridley</td>
<td>Endangered</td>
<td>Critically endangered</td>
</tr>
<tr>
<td>Leatherback</td>
<td>Endangered</td>
<td>Critically endangered</td>
</tr>
<tr>
<td>Loggerhead</td>
<td>Threatened</td>
<td>Endangered</td>
</tr>
<tr>
<td>Olive ridley</td>
<td>Threatened</td>
<td>Endangered</td>
</tr>
</tbody>
</table>
Although more countries are beginning to collect bycatch data, they are generally not available and therefore a thorough analysis of sea turtle bycatch interactions with foreign vessels in international fisheries is difficult. However, Lewison, Freeman et al. 2004 attempted to quantify the incidental take of loggerhead and leatherback sea turtles on a global scale. By integrating catch data from more than 40 nations and bycatch data from 13 international observer programs, it was estimated that over 200,000 loggerhead and 50,000 leatherback sea turtles were taken as bycatch in pelagic longline fisheries in the year 2000. Lewison et al. suggest a large number of interactions with protected species continue regularly with the international longline fleets, jeopardizing the continued survival of endangered and threatened sea turtle species.

Although the pelagic longline fishery in the Atlantic interacts with other sea turtle species, loggerheads and leatherbacks are the primary concern due to their high interaction rates (Figure 30). Sea turtle bycatch estimates for the U.S. pelagic longline fishery in the Atlantic in 2002 were 575 loggerhead takes (2 mortalities), 962 leatherback takes (33 mortalities) and 50 unidentified turtle takes (NMFS 2004d). The number of loggerhead and leatherback turtle takes varied from 1992–2005, although there was a peak in loggerhead takes in 1995. Leatherback takes peaked in 2004 and declined in 2005 to approximately 400 takes (Walsh and Garrison 2006).

![Figure 30. Estimated takes in the U.S. Atlantic pelagic longline fishery, 1992–2002. Takes do not imply mortalities (Data from NMFS 2004d).](image)

Though total loggerhead takes appear high in the Atlantic longline fisheries, the estimated mortalities are low; the average annual loggerhead morality from 1992–2002 was 7 individuals, with an estimate of only two loggerheads in 2002 (NMFS 2004d). The mortality data for leatherbacks are far more variable, with an estimated 88 leatherbacks in 1992, zero estimated mortalities from 1993–2001, and 33 estimated leatherback mortalities in 2002 (NMFS 2004d). Estimates of zero mortality may be a reflection of the low level of observer coverage in this fishery rather than low sea turtle bycatch. From 1995–2000, observer coverage ranged from 2.5–5.2% (NMFS 2004d). The 2004 Biological Opinion (BiOp) found that the expected number of

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8 These take estimates do not include any estimates of post-release mortality.
takes and mortalities in the Atlantic HMS fishery is likely to reduce the survival or recovery of leatherbacks.

For the pelagic longline fishery, the most effective management measures are likely to be gear modifications rather than area closures (which potentially result in the displacement of effort to other areas where bycatch may be higher) (James et al. 2005). Hook and gear modifications were required in the U.S. Atlantic pelagic longline fishery in mid-2004, and in 2005 the take of leatherbacks was greatly reduced (NMFS 2006). If this declining trend continues, the conservation concern for this fishery will continue to be ranked differently than the international longline fleets. Mexican longline vessels targeting tunas in the Gulf of Mexico have been shown to catch 5 turtles/100 trips with incidental mortality at 1.6 turtles/100 trips (Ulloa Ramírez and González Ania 2000).

Additional bycatch estimates from longline fisheries in the South Atlantic have found that the combined CPUE for loggerheads and leatherbacks was 0.37/1,000 hooks from 86 sets (Achaval et al. 2000). With over 13 million hooks set in 1999 by Brazilian boats alone in the southwest Atlantic (ICCAT 2001c), the potential for large amounts of sea turtle bycatch is high. In addition, fishery closures in the North Atlantic due to overfished species such as swordfish and tunas may result in effort being displaced to the South Atlantic, possibly increasing sea turtle bycatch there (Kotas et al. 2004). Lewison et al. (2004b) estimate that 1.4 billion hooks were set with pelagic longline gear in the year 2000 alone, with 1.2 billion of those hooks targeting tunas. In the Indian Ocean, South African observer data suggest a catch rate of 0.05 turtles/1,000 hooks; turtles were alive in 85% of these interactions (IOTC 2005). In the eastern Atlantic, olive ridleys and leatherbacks have been observed interacting with longlines targeting swordfish and tunas with a CPUE of 0.09 for olive ridleys and 0.39 for leatherbacks. In the Gulf of Guinea, the CPUE for olive ridleys was 0.38 and the CPUE for leatherbacks was 0.64. Of the 40 leatherbacks caught, 5% were observed mortalities with no estimates for post-release mortality for either species (Carranza et al. 2006).

All these studies demonstrate that sea turtle bycatch occurs regularly in many fisheries across most ocean basins. Although observer coverage or logbook data are not always available for every fishery targeting tuna, the available data suggest that sea turtle bycatch is an issue in many, if not all, of these fisheries.

**Longlines: Sea turtle population impacts**

Sea turtle populations face several threats including incidental take in fisheries, the killing of nesting females, egg collection at nesting beaches, habitat loss, and impairment due to pollution and debris. The population impacts of sea turtle bycatch vary according to the sea turtle species and the region.

**Mediterranean**

The conservation of loggerheads is threatened by the level of loggerhead bycatch associated with longline fisheries in the Mediterranean (Laurent et al. 1998). Loggerheads found in the Mediterranean are from several populations, including loggerheads from the southeast U.S. (Laurent et al. 1998); thus Mediterranean longline fisheries impact more than just the loggerheads from the Mediterranean population. Even considering that bycatch in deep-set
longline fisheries is lower than in shallow-set longline fisheries, this level of bycatch is still a cause for concern.

**Atlantic**

Population data for leatherbacks in the Atlantic are uncertain and conflicting. However, the main nesting beaches in French Guiana and Suriname have exhibited a declining trend, with nesting declining at about 15% annually (NMFS 2004c). Leatherback bycatch in the Atlantic pelagic longline fishery has more severe population consequences than loggerhead bycatch for several reasons. Approximately half of the leatherbacks taken in the pelagic longline fishery are mature breeders while the other half are sub-adults. Because leatherbacks are sexually mature at 5–15 years, the bycatch of leatherback sub-adults has more severe population consequences than does the bycatch of loggerheads, which mature later (NMFS 2004c). Using the estimates of turtle bycatch from Lewison et al. (2004b), as well as post-interaction mortality estimates, sex ratio data and adult to juvenile ratio data, total leatherback mortality for adult females was estimated at 4,100 leatherbacks per year in the international fisheries in the Atlantic and Mediterranean (NMFS 2004c). While the U.S. longline fleet in the Atlantic accounts for only 1.2–1.4% of this mortality per year, the annual mortality of adult and sub-adult females in the U.S. fishery is “not discountable” (NMFS 2004c p. 6–8). In addition, there is considerable uncertainty associated with the status and trends of leatherbacks in the Atlantic. It has been shown that a combination of 18/0 circle hooks and mackerel bait reduces loggerhead interaction rates by 90% and leatherback interactions by 65% (Watson et al. 2005). The 2004 BiOp concludes that the proposed management measures in the U.S. Atlantic pelagic longline fishery are likely to jeopardize the continued existence of leatherbacks, but not the existence of other turtle species taken as bycatch in this fishery. A jeopardy finding by NMFS was based on estimated annual mortalities in the U.S. fishery of approximately 200 leatherbacks, continuing indefinitely (NMFS 2004c).

**Longlines: Seabird bycatch rates**

There are an estimated 61 seabird species affected by longline fisheries, 25 of which are threatened with extinction as a result of longline bycatch (Brothers et al. 1999). Estimates for seabird bycatch in longline fisheries in the North Pacific alone are approximately 35,000 albatross takes per year (Cousins et al. 2001). In addition, observed mortalities of seabirds may be underestimated, as seabirds have been observed to fall from hooks before being hauled on deck (Cousins and Cooper 2000; Ward et al. 2004). Mortality estimates for some seabirds may be underestimated by as much as 45% (Ward et al. 2004).

In addition to the bycatch of endangered albatrosses, there is also bycatch of seabird species that are not listed by either the U.S. Endangered Species Act or the IUCN Red List. Cory’s shearwaters, for instance, are caught in large numbers in the Mediterranean. Spanish longlining vessels alone have been estimated to catch as much as 4–6% of the local breeding population each year, which is considered unsustainable for the long-term existence of this colony (Cooper et al. 2003). In general, there are few data concerning seabird bycatch in the Mediterranean (Cooper et al. 2003).

Seabird takes in the Atlantic are low, which is likely due to the night-setting of pelagic longlines (NMFS 2004d) as well as the absence of albatross species in the region.
**Longlines: Seabird population impacts**

Seabirds are particularly vulnerable to population decreases, as they are long-lived, have low reproductive rates and mature late (Tuck et al. 2003). The bycatch of seabirds in longline fisheries worldwide is one of the principal threats to their populations (Gilman 2001). Some seabird species are at risk of becoming extinct, and their survival is threatened by the global presence of longline fisheries (Gilman 2001). For example, Lewison and Crowder (2003) conclude that U.S., Japanese and Taiwanese longline vessels are the largest source of mortality to the black-footed albatross. The combined mortality due to U.S. and international longline vessels is likely above the estimated potential biological removal (PBR) threshold of 10,000 birds per year (Lewison and Crowder 2003).

Pelagic longlines also result in seabird bycatch in the Mediterranean (Prince et al. 1998; Belda and Sanchez 2001).

**Longlines: Marine mammal bycatch rates and population impacts**

The U.S. longline fishery for large pelagics in the Atlantic Ocean, Gulf of Mexico and the Caribbean is considered a Category I fishery due to interactions with humpback whales, minke whales, Risso’s dolphins, long-finned pilot whales, short-finned whales, common dolphins, Atlantic spotted dolphins, pantropical spotted dolphins, striped dolphins, bottlenose dolphins, harbor porpoises and pygmy sperm whales (69 FR 153, August 10, 2004). The only two species in this fishery listed as endangered under the ESA, and therefore as strategic under the Marine Mammal Protection Act (MMPA), are humpback whales and pygmy sperm whales in the western North Atlantic.

Additionally, of all the protected species interactions, pelagic longlines do not generally result in as much marine mammal bycatch as other gear types such as gillnets (Lewison et al. 2004a; Reeves et al. 2005).

**Longlines: Shark and ray bycatch rates**

Despite their known vulnerability to overfishing, sharks have been increasingly exploited in recent decades, both as bycatch from the 1960s onward, and as the target of directed fisheries, which expanded rapidly in the 1980s Baum, Myers et al. 2003. The most common shark and ray species caught in longline fisheries are blue sharks, silky sharks, pelagic stingrays and oceanic whitetip sharks (Williams 1997). As with other species caught as bycatch in the pelagic longline fisheries targeting tunas, the type and quantity of shark bycatch may vary with fishing location, gear configuration, etc.

Blue sharks and *Carcharinus* spp. are the most commonly discarded species in the pelagic longline fishery (Kelleher 2005). Data from the observer program in the U.S. Atlantic longline fishery targeting swordfish and tunas suggest that 69% of the blue sharks caught are released alive (Diaz and Serafy 2005). Discard mortality is also higher in younger blue sharks (Diaz and Serafy 2005). Other than the recent work on the decline of Atlantic shark species by Baum et al.

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9 To be considered a Category I fishery, the annual mortality and serious injury of a marine mammal stock in the fishery is greater than or equal to 50% of the PBR level. The PBR level is “the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimal sustainable population” (69 CR 153, August 10 2004).
(2003), few data are available detailing the international exploitation of sharks, particularly in the Pacific. Earlier studies, such as that conducted by Stevens 1996, suggest that high seas Pacific fisheries take millions of blue sharks each year, with unknown consequences for the population structure of this species. Estimates of annual fishing mortality range from 10–20 million blue sharks worldwide (IUCN 2004).

Overall, discards of dead pelagic sharks in the U.S. Atlantic, the Gulf of Mexico and the Caribbean declined from 1987–2000, with peaks in 1993 and 1996 (Cortés 2002). In 1987, a total of 13,092 pelagic sharks were discarded dead, and in 2000 a total of 7,495 pelagic sharks were discarded dead in the pelagic longline fishery (Cortés 2002). Recent estimates suggest that from 26,000–37,000 mt of blue sharks were discarded dead in the Atlantic in 1987 (ICCAT 2005b).

In the Gulf of Mexico, oceanic whitetip sharks have declined by 99% and silky sharks have declined by 90%, based on catch rates using pelagic longline data from fisheries targeting yellowfin tuna (Baum and Myers 2004). In addition, the mean size for these species is at or below the size at maturity, which may increase the rate of decline (Baum and Myers 2004). Baum and Myers (2004) conclude that it is possible that similar declines in oceanic sharks have occurred in other regions. A preliminary ICCAT stock assessment concluded that the biomass of blue sharks is likely above B_{MSY}, while the shortfin mako stock may be below B_{MSY} (ICCAT 2005b).

A recent study found that shark catch rates vary by longline fishery and gear configuration, ranging from 0.7 sharks/1,000 hooks in the Italian swordfish longline fishery in the Mediterranean to 17 sharks/1,000 hooks in the Hawaii-based swordfish longline fishery (Gilman et al. 2007). The range of catch rates expands when less confident data are used (Table 6) (Gilman et al. 2007).
Table 6. Shark catch rate in 12 pelagic longline fisheries (Table from Gilman et al. 2007).

<table>
<thead>
<tr>
<th>Pelagic Longline Fishery</th>
<th>Shark Catch Rate (number per 1,000 hooks)</th>
<th>Shark Retention (fins and/or carcass; percent of total number caught sharks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia—tuna and billfish</td>
<td>5.5</td>
<td>Not available</td>
</tr>
<tr>
<td>Chile—artisanal mahi mahi and shark</td>
<td>24</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Chile—swordfish</td>
<td>8</td>
<td>&gt;99</td>
</tr>
<tr>
<td>Fiji—tuna</td>
<td>1.1</td>
<td>78–90</td>
</tr>
<tr>
<td>Italy (Mediterranean)—swordfish</td>
<td>0.74</td>
<td>Not available</td>
</tr>
<tr>
<td>Japan—distant water tuna</td>
<td>0.021</td>
<td>Not available</td>
</tr>
<tr>
<td>Japan—offshore longline</td>
<td>0.175</td>
<td>Not available</td>
</tr>
<tr>
<td>Japan—nearshore longline</td>
<td>0.020</td>
<td>Not available</td>
</tr>
<tr>
<td>Peru—artisanal mahi mahi and shark</td>
<td>0.99</td>
<td>84</td>
</tr>
<tr>
<td>South Africa—tuna and swordfish</td>
<td>4.0</td>
<td>80</td>
</tr>
<tr>
<td>U.S. (Hawaii)—tuna</td>
<td>2.2</td>
<td>2.1</td>
</tr>
<tr>
<td>U.S. (Hawaii)—swordfish</td>
<td>16.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Both ICCAT and the IATTC have banned shark finning in the Atlantic and the EPO, respectively (Gilman et al. 2007). Individual countries may also have shark finning bans in their respective EEZs (e.g., Australia, Italy, South Africa and the U.S.) while vessels from other countries may comply with such regulations while fishing in other countries’ EEZs (Gilman et al. 2007). Some fleets, such as Fiji, are known to fin sharks (Gilman et al. 2007). Implementation of shark finning regulations has been shown to decrease shark mortality in countries such as Australia, where now more than 75% of sharks caught are released (Rose and McLaughlin 2001; Hobday et al. 2004 in Gilman et al. 2007). There is a minimum size limit for retained sharks in the Peruvian longline fishery, but enforcement and awareness of regulation is poor; fishermen are known to retain sharks smaller than the minimum size (Alfaro and Mangel 2002 in Gilman et al. 2007). Despite the existence of shark finning regulations, concern remains over the increased demand for shark meat and the lack of catch restrictions for sharks (Gilman et al. 2007; Hareide et al. 2007; Oceana 2007). In addition, Hareide et al. (2007) question the effectiveness of the EU shark finning ban since total imports and exports of shark fins greatly exceed reported landings. Although studies have shown circle hooks to be effective in reducing interactions with certain species and size classes of sea turtles, there is some evidence suggesting that shark catch increases with the use of circle hooks (Gilman et al. 2007), and consequently the multi-species impacts of these hooks should be considered. Concurrent conservation measures such as the use of circle hooks and catch-and-release of sharks and marlins is more likely to increase the abundance of these species (Kaplan et al. 2007).

**Longlines: Shark and ray population impacts**

Blue sharks have been shown to be sensitive to low exploitation rates (Schindler et al. 2002), but in the Atlantic, blue shark biomass appears to be above B\textsubscript{MSY} (ICCAT 2005b). The status of the Atlantic shortfin mako stock, however, is highly uncertain. It is possible that current Atlantic shortfin mako biomass levels are below B\textsubscript{MSY}, particularly in light of the 50% depletion seen in CPUE data (ICCAT 2005b). The IUCN Red List of Threatened Species categorizes the blue

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10 Australian data are a rough estimate based on unpublished data.
11 Chilean data are a rough estimate based on interview responses from fishers.
12 Japanese data based on logbook data.
shark as “Lower Risk,” although it is close to qualifying for the “Vulnerable” category (IUCN 2004). The IUCN defines “Vulnerable” as facing a high risk of extinction in the wild (IUCN 2004).

As with seabirds and sea turtles, the impacts of longline fisheries on shark populations are not fully understood. The population consequences of bycatch of shark species in the Pacific is not well known, but the findings of Baum et al. (2003) in the Atlantic Ocean indicate caution is warranted for these highly vulnerable species.\(^\text{13}\)

The quantity of bycatch in bluefin tuna longline fisheries is mostly unknown. In the absence of data demonstrating that bycatch rates are declining, Seafood Watch® must adopt the precautionary approach in considering the severity of the bycatch problem in global longline fisheries. Data from other longline tuna fisheries show that species of special concern (such as billfish, seabirds, sea turtles, sharks and rays) are caught regularly, a factor in limiting their recovery. It has been shown, however, that a combination of 18/0 circle hooks and mackerel bait used in the U.S. Atlantic pelagic longline fishery has reduced loggerhead and leatherback interaction rates. In addition, bycatch trends of other species of special concern have been decreasing in this fishery. Therefore, Seafood Watch® deems bycatch in the U.S. Atlantic pelagic longline tuna fisheries to be a high conservation concern, whereas bycatch in international longline tuna fisheries is a critical conservation concern.

**Purse Seines**

*Note that bycatch data are not available for bluefin purse seine fisheries, and thus data from other unassociated purse seine tuna fisheries are used to estimate bycatch in the bluefin tuna purse seine fisheries.*

There are several types of purse seine sets generally used to catch tuna: those set on dolphins (dolphin sets), those set on floating objects or fish aggregating devices (FADs) (floating object sets) and those set on a school of tuna that is not associated with either dolphins or a floating object (unassociated sets). Bluefin tuna are only caught by purse seines in unassociated sets, and thus the FAD and dolphin-set fisheries are not evaluated in this report. In general, unassociated school sets have minimal bycatch since they target individual schools of bluefin (AFMA 2005). However, according to the Australian Fisheries Management Authority (AFMA 2005), there is a lack of observer-verified bycatch data for the southern bluefin tuna purse seine fishery (there is currently 10% observer coverage for this fishery). The most common bycatch taken in unassociated school sets are sharks, rays and marlins (Bromhead et al. undated).

**Purse seines: Fish bycatch rates and population impacts**

Discards of tuna from school sets were generally less than 10% from 1992–1998 (Lennert-Cody and Hall 2000).

\[\text{For more information on sharks, please see the Seafood Watch® Sharks Report at:}\]
\[\text{http://www.mbayaq.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_SharksReport.pdf}\]
The quantity of billfish bycatch by the Spanish and French purse seiners in the eastern Atlantic is low relative to the targeted landings, at less than 0.021% of the total tuna catches (Gaertner et al. 2002). Marlin bycatch occurs in only 4% of unassociated school sets (Gaertner et al. 2002).

There is less billfish bycatch in the purse seine fisheries than in the longline fisheries targeting tuna and swordfish. There is also little population impact of billfish bycatch in the eastern Atlantic purse seine fisheries (Gaertner et al. 2002). Despite the low interaction rates, the stock status for billfish species in the eastern Atlantic fishery is poor.

**Purse seines: Seabirds bycatch rates and population impacts**
Seabird bycatch is not thought to be a concern in the purse seine fisheries for bluefin tuna. There has been no seabird bycatch documented by any observer program on purse seiners. It can be concluded that purse seine fisheries have no direct impact on seabirds.

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**Purse seines: Shark and ray bycatch rates**

**Purse seines: Shark and ray population impacts**

Sharks and rays are generally not resilient to fishing pressure (Hoenig and Gruber 1990 in Musick et al. 2000), as they have a low intrinsic rate of increase (Smith et al. 1998), low fecundity, slow growth rates and mature late in life (Camhi et al. 1998 in Musick et al. 2000). Sharks are in fact probably some of the most sensitive species to fishing pressure, and generalizations about declines in all predatory fishes may underestimate the declines in shark species. Indeed, the high sensitivity of sharks to fishing pressure means that they may be twice as likely to go extinct as bony fishes under even moderate fishing pressures (Myers and Worm 2003). Although the best data are from the North Atlantic, many shark populations seem to have declined worldwide (Myers and Ottenmeyer 2005). This has led to considerable concern in national and international organizations such as the IUCN, CITES and the FAO (Musick et al. 2000). Indeed, there are more elasmobranch species (263) than other marine fish (210) on the IUCN Red List of Threatened Species; 199 of these are sharks (the other 64 species are rays and skates). Due to the high volume of unreported catches of pelagic shark species in many fisheries (mainly longliners but also purse seine fisheries operating in the WIO), there may be severe population impacts on many shark species (Romanov 2002). Throughout the world’s oceans, sharks are facing an increasing threat from tuna fisheries since they are frequently caught as bycatch (Fonteneau 2003). Several of the shark and ray species that are caught as bycatch in the purse seine fisheries are on the IUCN Red List of Threatened Species (Table 7).

Many shark species have exhibited population declines, as shown through decreasing CPUE rates; however, other than the recent work on the decline of Atlantic shark species by Baum et al. (2003), few data are available detailing the international exploitation of sharks, particularly in the Pacific. Moreover, the magnitudes of the declines found by Baum et al. (2003) have been

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14 Portions of this section were taken verbatim from the Seafood Watch® Sharks Report available at: http://www.mbayaq.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_SharksReport.pdf.
challenged based on a number of factors including inadequate data and the exclusion of data from stock assessments (Burgess et al. 2005). Earlier studies, such as that conducted by Stevens 1996, suggest that high seas Pacific fisheries take millions of blue sharks each year with unknown consequences for the population structure of this species. Estimates of annual fishing mortality range from 10–20 million blue sharks worldwide (IUCN 2004).

The quantity of bycatch in bluefin tuna purse seine fisheries is mostly unknown. Data from other unassociated purse seine tuna fisheries show that several shark and ray species on the IUCN Red List are regularly caught; however, there has been a decreasing trend in bycatch of these species. Given this information, Seafood Watch® considers bycatch in the unassociated purse seine bluefin tuna fisheries to be a moderate conservation concern.

Table 7. Shark and ray species caught as bycatch in the purse seine fishery along with their IUCN Red List status.

<table>
<thead>
<tr>
<th>Species</th>
<th>Status on the IUCN Red List</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blacktip shark (Carcharhinus limbatus)</td>
<td>Lower Risk/Near Threatened</td>
<td>NW Atlantic population assessed; highly vulnerable to fishing pressure</td>
<td>Shark Specialist Group 2000a</td>
</tr>
<tr>
<td>Blue shark (Prionace glauca)</td>
<td>Lower Risk/Near Threatened</td>
<td>Annual fishing mortality as bycatch is likely affecting global population; inadequate data to assess the scale of possible decline</td>
<td>Stevens 2000a</td>
</tr>
<tr>
<td>Crocodile shark (Pseudocarcharias kamoharai)</td>
<td>Lower Risk/Near Threatened</td>
<td>Vulnerable as bycatch in pelagic longline fisheries; population decline probable but no CPUE records available</td>
<td>Compagno and Musick 2000</td>
</tr>
<tr>
<td>Hammerhead sharks (Sphryna spp.)</td>
<td>Data Deficient, Lower Risk/Near Threatened, Near Threatened</td>
<td>Some declines reported; lack of data on population trends; probable bycatch in tropical longline fishery</td>
<td>Denham 2000; Kotas 2000; Mycock 2004</td>
</tr>
<tr>
<td>Manta rays (Mobula spp.)</td>
<td>Near Threatened, Vulnerable</td>
<td>M. japonica commonly caught in surface gillnets targeting tuna</td>
<td>White 2003</td>
</tr>
<tr>
<td>Manta ray (Manta birostris)</td>
<td>Data Deficient</td>
<td>Highly vulnerable life history; bycatch in global fisheries thought to be rare, but declines have been observed in locations where targeted</td>
<td>Ishihara et al. 2002</td>
</tr>
<tr>
<td>Shortfin mako shark (Isurus oxyrinchus)</td>
<td>Lower Risk/Near Threatened</td>
<td>Wide-ranging; low reproductive capacity; significant targeted catch and bycatch in some regions</td>
<td>Stevens 2000b</td>
</tr>
<tr>
<td>Dusky shark (Carcharhinus obscurus)</td>
<td>Lower Risk/near threatened with a declining trend</td>
<td>Highly vulnerable to depletion due to low intrinsic rate of increase; high mortality rate when taken as bycatch</td>
<td>Shark Specialist Group 2000b</td>
</tr>
<tr>
<td>Tiger shark (Galeocerdo cuvier)</td>
<td>Lower Risk/Near Threatened</td>
<td>Fast growing and fecund, but declines have been observed in populations that are heavily fished</td>
<td>Simpfendorfer 2000</td>
</tr>
<tr>
<td>Whitetip shark (Carcharhinus longimanus)</td>
<td>Lower Risk/Near Threatened</td>
<td>Common bycatch species in tuna fishery; bycatch is inadequately reported or not recorded; population impacts unknown</td>
<td>Smale 2000</td>
</tr>
</tbody>
</table>

Synthesis

Pole and line, handline, troll and harpoon fishing methods are highly selective and therefore have minimal bycatch (0.1%), and are considered to be a low conservation concern.
The quantity of bycatch in bluefin tuna longline fisheries is mostly unknown. In the absence of data demonstrating that bycatch rates are declining, Seafood Watch® must adopt the precautionary approach in considering the severity of the bycatch problem in global longline fisheries. Data from other longline tuna fisheries show that species of special concern (such as billfish, seabirds, sea turtles, sharks and rays) are caught regularly, a factor in limiting their recovery. It has been shown, however, that a combination of 18/0 circle hooks and mackerel bait use in the U.S. Atlantic pelagic longline fishery has reduced loggerhead and leatherback interaction rates. In addition, bycatch trends for other species of special concern have been decreasing in this fishery. Therefore, Seafood Watch® deems bycatch in the U.S. Atlantic pelagic longline tuna fisheries to be a high conservation concern, whereas bycatch in international longline tuna fisheries is a critical conservation concern.

The quantity of bycatch in bluefin tuna purse seine fisheries is mostly unknown. Data from other unassociated purse seine tuna fisheries show that several shark and ray species on the IUCN Red List are caught regularly, but there has been a decreasing trend in the bycatch of these species. Given this information, Seafood Watch® considers bycatch in the unassociated purse seine bluefin tuna fisheries to be a moderate conservation concern.

For the purposes of this report, generalizations are made in order to form recommendations for the general public, although Seafood Watch® recognizes that there are differences between the various tuna longline fisheries. Country or fishery-specific data may be used to refute these generalizations and provide a higher level of resolution for seafood buyers.

**Nature of Bycatch Rank:**

<table>
<thead>
<tr>
<th>Gear</th>
<th>Seafood Watch® Conservation Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troll/pole</td>
<td>Low</td>
</tr>
<tr>
<td>Handline</td>
<td></td>
</tr>
<tr>
<td>Harpoon</td>
<td></td>
</tr>
<tr>
<td>Unassociated purse seine sets</td>
<td>Moderate</td>
</tr>
<tr>
<td>U.S. Atlantic longline</td>
<td>High</td>
</tr>
<tr>
<td>International longline</td>
<td>Critical</td>
</tr>
</tbody>
</table>

**Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems**

**Habitat Effects**

The gear types used to catch bluefin tuna (i.e., pole and line, handline, pelagic longline and purse seine) have minimal effects on the seafloor as they are either pelagic or surface gears and do not come into contact with the benthic environment (Chuenpagdee et al. 2003).

**Ecosystem Effects**
It has been suggested by Myers and Worm (2003) that the global oceans have lost 90% of the large predators (such as tunas) due to the expanding and pervasive pelagic longline fishery. Based on CPUE data, these authors found that while catches in a previously unfished area remained high at first, local catches declined after several years of fishing pressure. However, this argument has proved to be highly controversial, with questions raised concerning methodology (Walters 2003) and the period and magnitude of the declines (Hampton et al. 2005; Sibert et al. 2006). Myers and Worm (2005) concluded that their “estimates of decline remain conservative,” after correcting for the biases suggested in Hampton et al. (2005) and Sibert et al. (2006). A recent study (Sibert et al. 2006) concluded that the magnitude of the decline in the biomass of large predators varied by stock and region; for instance, exploited bigeye and yellowfin declined in the western Pacific while skipjack increased. The authors acknowledge that more conservative management measures may be needed for ecosystem-based management (Walters et al. 2001 in Sibert et al. 2006). Both climate change and fishing pressure have been linked to ocean-wide declines in large predator diversity, with fishing being the primary driver behind long-term variation (Ward and Myers 2005; Worm et al. 2005). According to Worm et al. (2005), diversity in the world’s oceans has declined by 10–50% over the last 50 years. In the Indian Ocean, recent catches in the tuna (albacore, bigeye and yellowfin) longline fishery have led to regional population declines in many of the major tuna stocks (Polacheck 2006).

In the tropical Pacific, large-scale commercial fishing has been linked to ocean ecosystem changes such as declines in large predator abundance and increases in small species abundance (Ward and Myers 2005). Ward and Myers (2005) looked at scientific survey data from the 1950s and observer data from the 1990s and found that the number of fish caught declined from 58 fish/1000 hooks to 25 fish/1000 hooks over this time period. However, other studies have found dissimilar results (Cox et al. 2002). Using an ecosystem model, Cox et al. (2002) found fewer declines of large predators such as tunas and billfishes in a larger area of the Pacific.

Kitchell et al. (2002) found that central North Pacific tunas and swordfishes are likely more important predators than blue sharks. Pauly and Palomares (2005) found that the total length of tunas and billfishes caught worldwide exhibited a continual decline from 1950–2000, and that “fishing down the food web” is more prevalent than previously thought. The removal of apex predators by commercial fisheries may have a large impact on trophic dynamics and thus pelagic ecosystems, even with sustainable fishing mortality rates (Essington et al. 2002).

The removal of large predators such as tunas, sharks, and billfishes from the ecosystem may affect the interactions between these species as well as result in considerable top-down effects (effects on prey species’ populations and the food chain below these large predators) (Fonteneau 2003). The potential ecosystem effects of removing these predators from the world’s oceans and the bycatch of vulnerable and threatened species have been identified as two environmental risks associated with the increased pressure by tuna fisheries (Fonteneau 2003). Since surface gear (pole and line, troll, harpoon) is more selective, tuna fisheries using these gear types remove tuna from the ecosystem but not other large predators, and as such, likely have moderate impacts on the food web. Purse seine and pelagic longline tuna fisheries remove other large predators in addition to the targeted tuna; therefore, these fisheries likely affect a larger part of the food web and are a higher conservation concern.
Synthesis
Surface gear (purse seine, pelagic longline, pole and line, handline, troll and harpoon) have negligible habitat effects. The total impact on the ecosystem of removing large apex predators such as tunas, billfishes and sharks, remains controversial. Pole and line, handline, harpoon, and troll tuna fisheries are able to harvest tuna from the ecosystem with minimal bycatch of other large predatory species. Purse seine and pelagic longline tuna fisheries, while targeted, are more likely to remove other large predators. As such, the purse seine and pelagic longline fisheries likely affect a larger part of the food web than the surface fisheries. Given this information, the conservation concern for surface gear types is low, while the conservation concern for purse seines and pelagic longlines is moderate.

Effect of Fishing Practices Rank:

<table>
<thead>
<tr>
<th>Gear</th>
<th>Seafood Watch® Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troll/pole</td>
<td>Benign</td>
</tr>
<tr>
<td>Handline</td>
<td></td>
</tr>
<tr>
<td>Harpoon</td>
<td></td>
</tr>
<tr>
<td>Longline</td>
<td>Moderate</td>
</tr>
<tr>
<td>Purse seine</td>
<td></td>
</tr>
<tr>
<td>(none)</td>
<td>Severe</td>
</tr>
<tr>
<td>(none)</td>
<td>Critical</td>
</tr>
</tbody>
</table>

Criterion 5: Effectiveness of the Management Regime

There are a number of concerns regarding the management of the three bluefin tuna species, including illegal, unreported and unregulated (IUU) catches, as well as a lack of effective and independent monitoring of catches and fishing activities.

Atlantic bluefin tuna

The international management body responsible for Atlantic bluefin tuna management is the International Commission for the Conservation of Atlantic Tunas (ICCAT). Atlantic bluefin tuna is managed as two separate stocks, although this assumption may not be accurate (Buck 1995) due to the mixing of the eastern and western stocks. This mixing of stocks and their impact on management decisions has led to criticism of the current regime; in fact, the separation of the two stocks by management has been criticized (Fromentin and Powers 2005). The most recent stock assessment was completed in 2008; the next scheduled assessment is for 2010 (ICCAT 2008).

Although commercial fishing effort for Atlantic bluefin tuna did not increase appreciably until the 1960s, by the end of that decade western Atlantic bluefin tuna were already showing signs of overfishing (Buck 1995). The western Atlantic population continued to decline despite the management measures implemented by ICCAT throughout the 1970s and 1980s (Table 8) (Buck 1995). In the 1960s, the fishery was characterized by increased fishing capacity and declining CPUE (Buck 1995). As early as the 1970s, the Standing Committee on Research and Statistics...
(SCRS) was concerned with the population status of Atlantic bluefin tuna (Fromentin and Powers 2005). In 1981, ICCAT recommended that the catch of western Atlantic bluefin tuna be as close to zero as possible (Buck 1995), and 1981 was the first year that a total allowable catch (TAC) was implemented for western Atlantic bluefin tuna (ICCAT 2006). Although the EU TAC for Atlantic bluefin tuna was lowered in 2007 to 16,780 mt (down from 18,301 mt in 2006) (Independent 2007), the high volume of IUU catch remains a concern. In addition, conservation organizations and scientists believe that the quota should be further reduced to prevent collapse of the eastern Atlantic and Mediterranean fishery (WWF 2007). The scientific committee of ICCAT recommended a maximum TAC of 15,000 tons; however, in November 2008, ICCAT ignored this advice and approved a quota of 22,000 tons in 2009, 19,950 tons in 2010 and 18,500 tons in 2011.
### Table 8: ICCAT management measures for Atlantic bluefin tuna since the mid-1970s ([Tag-A-Giant Foundation, http://www.tagagiant.org/Policy.shtml](http://www.tagagiant.org/Policy.shtml)).

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>First minimum size established (6.4 kg, with a 15% tolerance for smaller fish)</td>
</tr>
<tr>
<td>1981</td>
<td>Western bluefin fishery closed; 800 mt quota for scientific purposes</td>
</tr>
<tr>
<td>1982</td>
<td>Increased western quota to 2,660 mt for 1983; 15% tolerance for western bluefin less than 120 cm fork length</td>
</tr>
<tr>
<td>1991</td>
<td>8% tolerance for western bluefin less than 30 kg (115 cm)</td>
</tr>
<tr>
<td>1993</td>
<td>Reduce western quota to 1,995 mt for 1994 and 1,200 mt for 1995; Prohibit longline fishing for bluefin in the Mediterranean Sea during spawning months (June 1–July 31)</td>
</tr>
<tr>
<td>1994</td>
<td>Prevent catch increases in East Atlantic and reduce catch by 25% starting in 1996; Increase western quota to 2,200 mt for 1995</td>
</tr>
<tr>
<td>1996</td>
<td>Purse seine fishing prohibited in the Mediterranean August 1–31; Prohibit catch of bluefin &lt;1.8 kg; Increase western quota to 2,354 mt for 1997</td>
</tr>
<tr>
<td>1998</td>
<td>First catch limits for East Atlantic and Mediterranean (Total Allowable Catch (TAC) = 32,000 mt for 1999); 20-year rebuilding plan established for western bluefin: TAC = 2,500 mt until 2018; Prohibit catch of bluefin &lt;3.2 kg; Purse seine fishing prohibited in the Adriatic Sea May 1–31, in the Mediterranean July 16–August 15</td>
</tr>
<tr>
<td>2000</td>
<td>Eastern quota reduced to 29,500 mt</td>
</tr>
<tr>
<td>2002</td>
<td>TAC for western bluefin increased to 2,700 mt for 2003; Eastern quota increased to 32,000 mt for 2003</td>
</tr>
<tr>
<td>2004</td>
<td>Prohibit catch of bluefin &lt;10 kg in the Mediterranean Sea</td>
</tr>
<tr>
<td>2006</td>
<td>15-year recovery plan established for eastern bluefin: quota set at 29,500 mt for 2007, decreasing to 25,500 mt by 2010; Purse seine closure extended to July 1–December 31; Minimum size raised to 30 kg; Spotter planes prohibited; TAC for western bluefin reduced to 2,100 mt</td>
</tr>
<tr>
<td>2008</td>
<td>Western bluefin rebuilding plan revised: TAC reduced to 1,900 mt for 2009 and 1,800 mt for 2010 with rollover of under-harvest limited to 10% starting in 2010; Eastern bluefin recovery plan revised: TAC reduced to 22,000 mt for 2009, decreasing to 18,500 mt by 2011. Spawning area purse seine closure extended to June 15–April 15; New measures to reduce capacity and improve compliance</td>
</tr>
</tbody>
</table>
U.S. fishery for Atlantic bluefin tuna
The U.S. bluefin tuna fishery is regulated by several management measures including quotas, seasons, gear restrictions, and catch and size limits (NMFS 2006). It has been suggested that time-area closures in the Gulf of Mexico would reduce the incidental take of Atlantic bluefin tuna in the longline fisheries that operate there (Block et al. 2005). As of this writing, fishery managers have not adopted any time-area closures to protect spawning bluefin tuna in the Gulf of Mexico. Block et al. (2005) also suggest that Atlantic bluefin tuna may be more susceptible to mortality when caught incidentally in this area due to increased stress from being caught in warm surface waters. The SCRS has suggested that management measures implemented in the eastern Atlantic and Mediterranean are likely to affect western Atlantic bluefin tuna, in particular because the population in the eastern Atlantic and Mediterranean is larger (ICCAT 2006). Management measures in the western Atlantic include a 1,900 mt TAC (which includes discards), a minimum size of 30 kg (115 cm FL) with 10% tolerance, and prohibition of a directed fishery in the Gulf of Mexico (ICCAT 2006). From 1988–1997, landings (including discards) of Atlantic bluefin tuna exceeded the catch limits every year except for 1992 and 1997 (NMFS 2006). This trend continued in 2000–2002, with 2002 catch exceeding the limit by 715 mt (28.6%) (NMFS 2006). In the last five years, however, the U.S. has been unable to catch its quota.

Canada
In Atlantic Canada, bluefin tuna is managed by the Department of Fisheries and Oceans (DFO) under the Integrated Fisheries Management Plan for Atlantic Bluefin Tuna, which was enacted in 2002 (DFO 2007). The fishery occurs from late July to October, when the fish are spawning and have a higher fat content (thus higher value) (DFO 2007). While catch data for tuna is not differentiated according to species by the DFO in their summary data tables, the most recent data presented in the IFMP is from 2001, when 524 mt of bluefin tuna were landed (DFO 2007). Since 1982, bluefin tuna landings in Atlantic Canada have not exceeded 600 mt (DFO 2007). In 2001, a new management system was introduced, departing from the competitive allocation management system used from 1989–2000 (DFO 2007). Management measures for the Canadian fishery now include areas closed to fishing, observer coverage15, dockside monitoring, log books, tagging all landed species, quotas for the various fleet sectors, licenses and a minimum size limit of 30 kg (DFO 2007). There are some gear restrictions as well: rod and reel, tended line (defined as “a line equipped with only one hook, attached at all times to a fishing vessel”) and other gears may be used with a license condition such as longlines in the offshore fishery, harpoons in the inshore fishery and trapnets (DFO 2007).

Atlantic bluefin tuna management in the Mediterranean
Current management measures in the Mediterranean include a minimum size limit and prohibition against catching bluefin tuna less than one year old (IUCN 2000). The minimum size limit of 30 kg has been in place in the Atlantic since 1975 (there is an 8% tolerance for fish down to 10 kg); however, juvenile Atlantic bluefin tuna is targeted in this fishery, and thus it is likely that these minimum size limit regulations are frequently violated (Fromentin and Powers 2005). For species with life history characteristics like those of the Atlantic bluefin tuna, minimum size limits are more important than for other, faster producing tunas such as skipjack (Fromentin and Fonteneau 2001). Fisheries in the eastern Atlantic and Mediterranean have proven to be less

15 The level of observer coverage was not available (DFO 2007 website).
compliant with ICCAT recommendations than fisheries in the western Atlantic (Buck 1995). For instance, in 1991, ICCAT concluded that the percentage of undersize Atlantic bluefin tuna caught in the eastern Atlantic and Mediterranean ranged from 26–51% over 1976–1989 (Buck 1995). In general, management measures designed to reduce catch in the eastern Atlantic and Mediterranean are not thought to be effective (Bjørndal and Brasao 2004; Fromentin and Ravier 2005; ICCAT 2005a). Current catches exceed the quotas set in the eastern Atlantic and Mediterranean; the quota for 2007 was 29,500 tons and the estimated catch was 61,000 tons (over double the quota) (SCRS 2008b). There are often discrepancies between the data reported nationally and the data reported to ICCAT (WWF 2006). In addition, there is concern over fishing effort shifting from the spawning grounds in the western Mediterranean, which are described as “considerably exhausted” (WWF 2006, pg. 3), to spawning aggregations in the Levant Sea (WWF 2006).

Illegal, unreported and unregulated (IUU) fishing is a considerable problem in this fishery, with IUU purse seine fleets from France, Libya and Spain accounting for approximately 17,000 mt of illegal bluefin tuna catch in the Mediterranean. These countries are ICCAT contracting parties yet this illegal catch continues (WWF 2006). A 2006 report published by the World Wildlife Fund (WWF 2006) recommends that until a recovery plan is developed (which should contain the four measures below), the fishery should be closed immediately to prevent collapse:

1. Extend the current seasonal closure for the purse seine fishery.
2. Improve the reporting system, including the use of observers.
3. Allocate a country-by-country quota for bluefin tuna ranching.
4. Establish a minimum size limit of 30 kg, the size at which Atlantic bluefin tuna reach maturity.

Table 10. Commercial fishery management measures for the Atlantic, southern and Pacific bluefin tuna fisheries.

<table>
<thead>
<tr>
<th>Species</th>
<th>Management Jurisdictions &amp; Agencies</th>
<th>Total Allowable Landings</th>
<th>Size Limit</th>
<th>Gear Restrictions</th>
<th>Trip Limit</th>
<th>Area Closures</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic bluefin tuna</td>
<td>ICCAT, HMS</td>
<td>1,900 mt in the western Atlantic; 22,000 mt in the eastern Atlantic</td>
<td>30 kg in the eastern Atlantic; 30 kg in the western Atlantic w/ 10% tolerance</td>
<td>U.S. &amp; Canada: gear restrictions</td>
<td>US: 3 bluefin tuna/vessel/trip (size limit is a minimum of 73” curved fork length); this is for the General Category fishery only and changes</td>
<td>U.S.: No directed fishery in the Gulf of Mexico; longline closure off NJ; Canada: closed areas; Mediterranean: spawning areas closed</td>
<td>ICCAT 2006</td>
</tr>
</tbody>
</table>

**Synthesis**

Bluefin tuna in the Atlantic are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). In the majority of the Atlantic Ocean, bluefin tuna management faces a number of challenges including lack of a bycatch plan, lack of enforcement, catch quota
exceedance and the inability to maintain stock productivity. For these reasons, management in the Atlantic is considered to be a critical conservation concern. The NMFS manages the U.S. Atlantic bluefin tuna fishery with a TAC, size limits, gear restrictions and seasonal closures, and management in the Canadian Atlantic bluefin fishery enforces regulations by logbook reports, observer coverage and dockside monitoring. As such, management in these fisheries is considered to be a high conservation concern rather than a critical conservation concern.

Effectiveness of Management Rank:

<table>
<thead>
<tr>
<th>Fishery Region</th>
<th>Seafood Watch® Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>(none)</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>(none)</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Atlantic (U.S. longline &amp; Canada)</td>
<td>Ineffective</td>
</tr>
<tr>
<td>Atlantic (except U.S. longline &amp; Canada)</td>
<td>Critical</td>
</tr>
</tbody>
</table>

IV. Analysis of Seafood Watch® Sustainability Criteria for Farm-raised Species

This section provides a basis for recommendations on ranched bluefin tuna based on a critical conservation concern for Criterion 1: Use of Marine Resources. Criteria 2–5 are not assessed in this report.

Criterion 1: Use of Marine Resources

According to Seafood Watch® criteria, “use of marine resources” is deemed to be a critical conservation concern and a species is ranked Avoid, regardless of other criteria, if the wild fish in to farmed fish out ratio (WI:FO) for feed conversion (FCR) is greater than 2.0 AND the source of seed stock is ranked as poor.

Capture-based tuna aquaculture operations almost exclusively use whole baitfish (e.g., sardines, herring, mackerel, pilchards, squid, etc.) to feed bluefin tuna. Therefore the WI:FO in our criteria is equivalent to a wet basis FCR, as WI:FO is defined as the ratio of the weights of whole fish inputs to whole fish outputs. The published wet basis FCR range for bluefin is from 7.0 to 25.6 (Table 11; from Zertuche-Gonzalez et al. 2008), which means the WI:FO is clearly greater than the threshold of 2.0.
Currently, most commercially available ranched bluefin tuna is based on the capture and fattening of wild bluefin tuna\textsuperscript{16}. Since all bluefin tuna stocks have a stock status of either poor or critical in this report, the source of seed stock is ranked as poor.

Driven by the high market demand for bluefin tuna, there has been increasing pressure on wild bluefin tuna stocks as seed for capture-based bluefin tuna farming, all of which rank as high or critical conservation concerns according to Seafood Watch® criteria. Given these factors, ranched bluefin tuna presently ranks as a critical conservation concern for the use of marine resources based on Seafood Watch® criteria.

**Use of Marine Resources Rank:**

*Low* [Green]  *Moderate* [Yellow]  *High* [Red]  *Critical* [Black]

### V. Overall Evaluation and Seafood Recommendation

There are three species of bluefin tuna: Atlantic bluefin (*Thunnus thynnus*), Pacific bluefin (*Thunnus orientalis*) and southern bluefin (*Thunnus maccocyii*). This report covers fisheries for Atlantic bluefin. Bluefin tuna are highly migratory and are targeted in various fisheries worldwide with a number of different gear types. Atlantic bluefin tuna exhibit a moderate age at first maturity (with some populations such as the eastern Mediterranean Sea bluefin tuna maturing earlier in response to excessive fishing pressure), and have moderate life spans.

\textsuperscript{16} We are aware that researchers from Kinki University in Japan are currently developing technology to close the bluefin tuna life cycle in aquaculture, which could enable the production of hatchery-reared juveniles. This report does not address that technology, as it is not yet commercially available on a widespread basis.
Bluefin tuna are considered more vulnerable to fishing pressure than tropical tuna species such as bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*). Overall, bluefin tuna is ranked as moderately vulnerable.

The stock status of Atlantic bluefin tuna is considered a critical conservation concern as they are both overfished and experiencing ongoing overfishing. This species has exhibited long-term declines in abundance, and excessive fishing mortality for many years. In addition, Atlantic bluefin tuna are listed on the World Conservation Union (IUCN) Red List of Threatened Species. The high quantity of illegal, unreported and unregulated (IUU) catches of Atlantic bluefin tuna, in addition to the high uncertainty of stock assessments, is additional cause for concern. For data on the stock status rankings, please see Criterion 2, beginning on page 28.

Bluefin tuna is caught with purse seines, pelagic longlines, trolls, handlines, pole and line gear, and harpoons. The level of bycatch varies according to each gear type. Pelagic longlines catch a number of incidental species, including endangered and threatened sea turtles, seabirds, sharks and billfish. These species are caught in some fisheries more commonly than others. It has been shown that the combination of 18/0 circle hooks and mackerel bait used in the U.S. Atlantic pelagic longline fishery has reduced loggerhead and leatherback interaction rates. In addition, bycatch trends for other species of special concern have been decreasing in this fishery. Therefore, Seafood Watch® deems bycatch in the U.S. Atlantic pelagic longline tuna fisheries to be a high conservation concern, whereas the greater bycatch in international longline tuna fisheries is a critical conservation concern. Purse seine sets on unassociated schools (such as those used to target schools of bluefin tuna) are considered to have moderate bycatch levels. Troll, handline, pole and line, and harpoon gear all have minimal bycatch.

Pelagic longlines and purse seine gear have negligible habitat effects, though the ecosystem effects of removing large predators such as tuna are not well understood. Combined with the benign habitat effects of purse seine and pelagic longline gear, this uncertainty results in an overall moderate conservation concern for these gear types. Other gear, including troll, pole and line, handline and harpoon have a low conservation concern for habitat and ecosystem impacts.

Bluefin tuna in the Atlantic are managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Bluefin tuna management faces a number of challenges including lack of a bycatch plan, lack of enforcement, catch quota exceedance and inability to maintain stock productivity. Due to these concerns, management in the Atlantic is considered to be a critical conservation concern. However, the National Marine Fisheries Service (NMFS) manages the U.S. Atlantic bluefin tuna fishery using a total allowable catch (TAC), size limits, gear restrictions and seasonal closures. Management in the Canadian Atlantic bluefin fishery enforces regulations using logbook reports, observer coverage and dockside monitoring. As such, management in these fisheries is considered to be a high conservation concern.

Overall, the combination of high to critical bycatch concerns, poor management and poor stock conditions results in an overall recommendation of **Avoid** Atlantic bluefin tuna.
Bluefin tuna are increasingly being ranched\(^{17}\), which will be evaluated in a separate Seafood Watch® report to be released at a later date. At the time of the writing of this report, the use of marine resources in bluefin tuna ranching is a critical conservation concern (according to our Recommendation Criteria for Farmed Seafood) because the feed conversion ratios for all three bluefin tuna species range from 7.0–25.6 (Zertuche-González et al. 2008), and as shown in this report, the status of the source stock (wild bluefin tuna) is ranked as Avoid. This critical conservation concern would lead to an Overall Recommendation of Avoid for ranched bluefin tuna.

This report was updated on October 7, 2010. Please see Appendix II for a summary of the changes made.

### Table of Sustainability Ranks

<table>
<thead>
<tr>
<th>Sustainability Criteria</th>
<th>Conservation Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td></td>
</tr>
<tr>
<td><strong>High</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Critical</strong></td>
<td></td>
</tr>
<tr>
<td>Inherent Vulnerability</td>
<td></td>
</tr>
<tr>
<td>Status of Stocks</td>
<td></td>
</tr>
<tr>
<td>Nature of Bycatch</td>
<td></td>
</tr>
<tr>
<td>Habitat &amp; Ecosystem Effects</td>
<td></td>
</tr>
<tr>
<td>Management Effectiveness</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Capture-based Farmed (Ranched) Bluefin Tuna</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conservation Concern</strong></td>
</tr>
<tr>
<td><strong>Low</strong></td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
</tr>
<tr>
<td><strong>High</strong></td>
</tr>
<tr>
<td><strong>Critical</strong></td>
</tr>
<tr>
<td>Use of Marine Resources</td>
</tr>
</tbody>
</table>
Overall Seafood Recommendation

(Wild Atlantic Bluefin Tuna and Capture-based Farmed Bluefin Tuna, All Species):

- Best Choice
- Good Alternative
- Avoid

Acknowledgments

Seafood Watch® thanks three anonymous reviewers who graciously reviewed this report for scientific accuracy.

*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.*

Supplemental Information

Consumption advice on the Seafood Watch® pocket guides is provided by the Environmental Defense Fund. The Environmental Defense Fund applies the same risk-based methodology as the U.S. Environmental Protection Agency (EPA) to data from government studies and papers published in scientific journals.

The Environmental Defense Fund has issued a consumption advisory for bluefin tuna for men and women (ages 18–75) and children (ages 0–12) due to elevated mercury and PCB levels. Women and children should not consume bluefin tuna at all, while men should limit their consumption to no more than half a meal (4 ounces) per month. More detailed information about the Environmental Defense Fund advisory can be found at [http://www.edf.org/page.cfm?tagID=15775](http://www.edf.org/page.cfm?tagID=15775).
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VII. Appendices

Appendix I. Wild-capture fisheries evaluation

Seafood Watch® defines sustainable seafood as originating from sources, whether fished 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. Species from sustainable capture fisheries:

- have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics;
- have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity;
- are captured using techniques that minimize the catch of unwanted and/or unmarketable species;
- are captured in ways that maintain natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and do not result in irreversible ecosystem state changes; and
- have a management regime that implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

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

1. Inherent vulnerability to fishing pressure
2. Status of wild stocks
3. Nature and extent of discarded bycatch
4. Effect of fishing practices on habitats and ecosystems
5. Effectiveness of the management regime

Each criterion includes:

- Primary factors to evaluate and rank
- Secondary factors to evaluate and rank
- Evaluation guidelines to synthesize these factors
- A resulting rank for that criterion

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18 “Fish” is used throughout this document to refer to finfish, shellfish and other wild-caught invertebrates.
19 Evaluation Guidelines throughout this document reflect common combinations of primary and secondary factors that result in a given level of conservation concern. Not all possible combinations are shown – other combinations should be matched as closely as possible to the existing guidelines.
Once a rank has been assigned to each criterion, an **overall seafood recommendation** for the species in question is developed based on additional evaluation guidelines. The ranks for each criterion, and the resulting overall seafood recommendation, are summarized in a table. Criterion ranks and the overall seafood recommendation are color-coded to correspond to the categories of the Seafood Watch pocket guide:

**Best Choices/Green:** Consumers are strongly encouraged to purchase seafood in this category. The wild-caught species is sustainable as defined by Seafood Watch.

**Good Alternatives/Yellow:** Consumers are encouraged to purchase seafood in this category, as they are better choices than seafood in the Avoid category. However, there are some concerns with how this species is fished and thus it does not demonstrate all of the qualities of a sustainable fishery as defined by Seafood Watch.

**Avoid/Red:** Consumers are encouraged to avoid seafood in this category, at least for now. Species in this category do not demonstrate enough qualities to be defined as sustainable by Seafood Watch.
CRITERION 1: INHERENT VULNERABILITY TO FISHING PRESSURE

Guiding Principle: Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

<table>
<thead>
<tr>
<th>Primary Factors to evaluate</th>
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<tbody>
<tr>
<td>Intrinsic rate of increase (‘r’)</td>
<td></td>
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<tr>
<td>➢ High (&gt; 0.16)</td>
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<tr>
<td>➢ Medium (0.05 - 0.16)</td>
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<tr>
<td>➢ Low (&lt; 0.05)</td>
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<tr>
<td>➢ Unavailable/Unknown</td>
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<table>
<thead>
<tr>
<th>Age at 1st maturity</th>
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<tbody>
<tr>
<td>Low (&lt; 5 years) EAtl (ages 4-5) but is a result of fishing pressure</td>
<td></td>
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<tr>
<td>Medium (5 - 10 years) WAtl (ages 8-12); Pac (ages 5-6); SO (8-15)</td>
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<tr>
<td>High (&gt; 10 years)</td>
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<tr>
<td>Unavailable/Unknown</td>
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<tr>
<th>Von Bertalanffy growth coefficient (‘k’)</th>
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<tbody>
<tr>
<td>High (&gt; 0.16)</td>
<td></td>
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<tr>
<td>Medium (0.05 - 0.15) Atl (0.05 – 0.06); EAtl (0.09); SBT (0.14 – 0.15)</td>
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<tr>
<td>Low (&lt; 0.05)</td>
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<td>Unavailable/Unknown</td>
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<table>
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<tr>
<th>Maximum age</th>
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<tr>
<td>Low (&lt; 11 years)</td>
<td></td>
</tr>
<tr>
<td>Medium (11 - 30 years) Atl (30); Pac (15); SO (30)</td>
<td></td>
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<tr>
<td>High (&gt; 30 years)</td>
<td></td>
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<tr>
<td>Unavailable/Unknown</td>
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</tbody>
</table>

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Reproductive potential (fecundity)
- High (> 100 inds./year) **All**
- Moderate (10 – 100 inds./year)
- Low (< 10 inds./year)
- Unavailable/Unknown

**Secondary Factors to evaluate**

Species range
- Broad (e.g. species exists in multiple ocean basins, has multiple intermixing stocks or is **highly migratory**)
- Limited (e.g. species exists in one ocean basin)
- Narrow (e.g. endemism or numerous evolutionary significant units or restricted to one coastline)

Special Behaviors or Requirements: Existence of special behaviors that increase ease or population consequences of capture (e.g. migratory bottlenecks, spawning aggregations, site fidelity, unusual attraction to gear, sequential hermaphrodites, segregation by sex, etc., OR specific and limited habitat requirements within the species’ range).

- No known behaviors or requirements OR behaviors that decrease vulnerability (e.g. widely dispersed during spawning)
- Some (i.e. 1 - 2) behaviors or requirements
  1) **Aggregates to spawn on the surface; 2) Distinct migratory patterns**
- Many (i.e. > 2) behaviors or requirements

Quality of Habitat: Degradation from non-fishery impacts
- Habitat is robust **Pelagic**
- Habitat has been moderately altered by non-fishery impacts
- Habitat has been substantially compromised from non-fishery impacts and thus has reduced capacity to support this species (e.g. from dams, pollution, or coastal development)
Evaluation Guidelines

1) Primary Factors
   a) If ‘r’ is known, use it as the basis for the rank of the Primary Factors.
   b) If ‘r’ is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e. Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

Conservation Concern: Inherent Vulnerability

- Low (Inherently Resilient)
- Moderate (Moderately Vulnerable) All bluefin tuna
- High (Highly Vulnerable)

Note: Although East Atlantic bluefin tuna have an earlier age at maturity, they are ranked as moderately vulnerable because this earlier age at maturity is a result of excessive fishing pressure.
CRITERION 2: STATUS OF WILD STOCKS

Guiding Principle: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

Primary Factors to evaluate

Management classification status
- Underutilized OR close to virgin biomass
- Fully fished OR recovering from overfished OR unknown Pacific
- Recruitment or growth overfished, overexploited, depleted or “threatened” Southern, W ATL, E ATL

Current population abundance relative to BMSY
- At or above BMSY (> 100%)
- Moderately Below BMSY (50 – 100%) OR unknown Pacific
- Substantially below BMSY (< 50%) Southern, W ATL, E ATL

Occurrence of overfishing (current level of fishing mortality relative to overfishing threshold)
- Overfishing not occurring (Fcurr/Fmsy < 1.0)
- Overfishing is likely/probable OR fishing effort is increasing with poor understanding of stock status OR Unknown Southern
- Overfishing occurring (Fcurr/Fmsy > 1.0) Pacific, W ATL, E ATL

Overall degree of uncertainty in status of stock
- Low (i.e. current stock assessment and other fishery-independent data are robust OR reliable long-term fishery-dependent data available)
- Medium (i.e. only limited, fishery-dependent data on stock status are available) WAtl
- High (i.e. little or no current fishery-dependent or independent information on stock status OR models/estimates broadly disputed or otherwise out-of-date) PBF, EAtl, Southern
Long-term trend (relative to species’ generation time) in population abundance as measured by either fishery-independent (stock assessment) or fishery-dependent (standardized CPUE) measures

- Trend is up
- Trend is flat or variable (among areas, over time or among methods) OR Unknown

Pacific

- Trend is down **W ATL, E ATL, Southern**

Short-term trend in population abundance as measured by either fishery-independent (stock assessment) or fishery-dependent (standardized CPUE) measures

- Trend is up
- Trend is flat or variable (among areas, over time or among methods) OR Unknown

W ATL

- Trend is down **E ATL, Southern, Pacific**

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

- Distribution(s) is(are) functionally normal
- Distribution(s) unknown **PBF**
- Distribution(s) is(are) skewed **E ATL, W ATL, SBT**
Evaluation Guidelines

A “Healthy” Stock:
1) Is underutilized (near virgin biomass)
2) Has a biomass at or above BMSY AND overfishing is not occurring AND distribution parameters are functionally normal AND stock uncertainty is not high

A “Moderate” Stock:
1) Has a biomass at 50-100% of BMSY AND overfishing is not occurring
2) Is recovering from overfishing AND short-term trend in abundance is up AND overfishing not occurring AND stock uncertainty is low
3) Has an Unknown status because the majority of primary factors are unknown.

A “Poor” Stock:
1) Is fully fished AND trend in abundance is down AND distribution parameters are skewed
2) Is overfished, overexploited or depleted AND trends in abundance and CPUE are up.
3) Overfishing is occurring AND stock is not currently overfished.

A stock is considered a Critical Conservation Concern and the species is ranked “Avoid”, regardless of other criteria, if it is:
1) Overfished, overexploited or depleted AND trend in abundance is flat or down
2) Overfished AND overfishing is occurring
3) Listed as a “threatened species” or similar proxy by national or international bodies

Conservation Concern: Status of Stocks

- Low (Stock Healthy)
- Moderate (Stock Moderate or Unknown)
- High (Stock Poor) Pacific
- Stock Critical Atlantic, Southern
CRITERION 3: NATURE AND EXTENT OF DISCARDED BYCATCH\textsuperscript{21}

Guiding Principle: A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

Primary Factors to evaluate

Quantity of bycatch, including any species of “special concern” (i.e. those identified as “endangered”, “threatened” or “protected” under state, federal or international law)

- Quantity of bycatch is low (< 10% of targeted landings on a per number basis) AND does not regularly include species of special concern \textsuperscript{T/P}
- Quantity of bycatch is moderate (10 – 100% of targeted landings on a per number basis) AND does not regularly include species of special concern OR Unknown \textsuperscript{PS (unassociated set)}
- Quantity of bycatch is high (> 100% of targeted landings on a per number basis) OR bycatch regularly includes threatened, endangered or protected species \textsuperscript{LL}

Population consequences of bycatch

- Low: Evidence indicates quantity of bycatch has little or no impact on population levels \textsuperscript{T/P}
- Moderate: Conflicting evidence of population consequences of bycatch OR Unknown
- Severe: Evidence indicates quantity of bycatch is a contributing factor in driving one or more bycatch species toward extinction OR is a contributing factor in limiting the recovery of a species of “special concern” \textsuperscript{PS (unassociated set), LL}

Trend in bycatch interaction rates (adjusting for changes in abundance of bycatch species) as a result of management measures (including fishing seasons, protected areas and gear innovations):

- Trend in bycatch interaction rates is down \textsuperscript{PS, LL (HI, US Atl)}
- Trend in bycatch interaction rates is flat OR Unknown \textsuperscript{LL (All other Atl)}
- Trend in bycatch interaction rates is up
- Not applicable because quantity of bycatch is low \textsuperscript{T/P}

\textsuperscript{21} Bycatch is defined as species that are caught but subsequently discarded because they are of undesirable size, sex or species composition. Unobserved fishing mortality associated with fishing gear (e.g. animals passing through nets, breaking free of hooks or lines, ghost fishing, illegal harvest and under or misreporting) is also considered bycatch. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, is accounted for, and is managed in some way.
Secondary Factor to evaluate

Evidence that the ecosystem has been or likely will be substantially altered (relative to natural variability) in response to the continued discard of the bycatch species

- Studies show no evidence of ecosystem impacts  \( T/P \)
- Conflicting evidence of ecosystem impacts OR Unknown
- Studies show evidence of substantial ecosystem impacts  \( LL; PS \) -- Removal of large predators (sharks)

Evaluation Guidelines

Bycatch is “Minimal” if:

1) Quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Bycatch is “Moderate” if:

1) Quantity of bycatch is 10 - 100% of targeted landings
2) Bycatch regularly includes species of “special concern” AND bycatch has little or no impact on the bycatch population levels AND the trend in bycatch interaction rates is not up.

Bycatch is “Severe” if:

1) Quantity of bycatch is > 100% of targeted landings
2) Bycatch regularly includes species of “special concern” AND evidence indicates bycatch rate is a contributing factor toward extinction or limiting recovery AND trend in bycatch is down.

Bycatch is considered a Critical Conservation Concern and the species is ranked “Avoid”, regardless of other criteria, if:

1) Bycatch regularly includes species of special concern AND evidence indicates bycatch rate is a factor contributing to extinction or limiting recovery AND trend in bycatch interaction rates is not down.
2) Quantity of bycatch is high AND studies show evidence of substantial ecosystem impacts.

Conservation Concern: Nature and Extent of Discarded Bycatch

- Low (Bycatch Minimal)  \( T/P \)
- Moderate (Bycatch Moderate)  \( PS \) (unassociated)
- High (Bycatch Severe)  \( LL \) (US Atl)
- Bycatch Critical  \( LL \) (all other)
CRITERION 4: EFFECT OF FISHING PRACTICES ON HABITATS AND ECOSYSTEMS

Guiding Principle: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

Primary Habitat Factors to evaluate

Known (or inferred from other studies) effect of fishing gear on physical and biogenic habitats

- Minimal damage (i.e. pelagic longline, midwater gillnet, midwater trawl, purse seine, hook and line, or spear/harpoon)  **PS (unassociated), TP, LL**
- Moderate damage (i.e. bottom gillnet, bottom longline or some pots/ traps)
- Great damage (i.e. bottom trawl or dredge)

For specific fishery being evaluated, resilience of physical and biogenic habitats to disturbance by fishing method

- High (e.g. shallow water, sandy habitats)
- Moderate (e.g. shallow or deep water mud bottoms, or deep water sandy habitats)
- Low (e.g. shallow or deep water corals, shallow or deep water rocky bottoms)
- Not applicable because gear damage is minimal

If gear impacts are moderate or great, spatial scale of the impact

- Small scale (e.g. small, artisanal fishery or sensitive habitats are strongly protected)
- Moderate scale (e.g. modern fishery but of limited geographic scope)
- Large scale (e.g. industrialized fishery over large geographic areas)
- Not applicable because gear damage is minimal

Primary Ecosystem Factors to evaluate

Evidence that the removal of the targeted species or the removal/deployment of baitfish has or will likely substantially disrupt the food web

- The fishery and its ecosystem have been thoroughly studied, and studies show no evidence of substantial ecosystem impacts
- Conflicting evidence of ecosystem impacts OR **Unknown** T/P
- Ecosystem impacts of targeted species removal demonstrated **LL, PS (unassociated)**
Evidence that the fishing method has caused or is likely to cause substantial ecosystem state changes, including alternate stable states

- The fishery and its ecosystem have been thoroughly studied, and studies show no evidence of substantial ecosystem impacts
- Conflicting evidence of ecosystem impacts OR Unknown
- Ecosystem impacts from fishing method demonstrated

**Evaluation Guidelines**

The effect of fishing practices is "**Benign**" if:
1) Damage from gear is minimal AND resilience to disturbance is high AND neither Ecosystem Factor is red.

The effect of fishing practices is "**Moderate**" if:
1) Gear effects are moderate AND resilience to disturbance is moderate or high AND neither Ecosystem Factor is red.
2) Gear results in great damage AND resilience to disturbance is high OR impacts are small scale AND neither Ecosystem Factor is red.
3) Damage from gear is minimal and one Ecosystem factor is red.

The effect of fishing practices is "**Severe**" if:
1) Gear results in great damage AND the resilience of physical and biogenic habitats to disturbance is moderate or low.
2) Both Ecosystem Factors are red.

Habitat effects are considered a **Critical Conservation Concern** and a species receives a recommendation of "**Avoid**", regardless of other criteria if:
- Four or more of the Habitat and Ecosystem factors rank red.

**Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems**

- Low (Fishing Effects Benign) **T/P**
- Moderate (Fishing Effects Moderate) **LL; PS (unassociated)**
- High (Fishing Effects Severe)
- Critical Fishing Effects
CRITERION 5: EFFECTIVENESS OF THE MANAGEMENT REGIME

Guiding Principle: The management regime of a sustainable wild-caught species implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

Primary Factors to evaluate

Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock

- Stock assessment complete and robust
- Stock assessment is planned or underway but is incomplete OR stock assessment complete but out-of-date or otherwise uncertain
  - SO, Atl, Pac
- No stock assessment available now and none is planned in the near future

Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock

- Regular collection and assessment of both fishery-dependent and independent data
  - Atl, SO
- Regular collection of fishery-dependent data only
  - Pac
- No regular collection or analysis of data

Scientific Advice: Management has a well-known track record of consistently setting or exceeding catch quotas beyond those recommended by its scientific advisors and other external scientists:

- No
- Yes
  - Atl, SO
- Not enough information available to evaluate OR not applicable because little or no scientific information is collected
  - Pac

Bycatch: Management implements an effective bycatch reduction plan

- Bycatch plan in place and reaching its conservation goals (deemed effective)
- Bycatch plan in place but effectiveness is not yet demonstrated or is under debate
- No bycatch plan implemented or bycatch plan implemented but not meeting its conservation goals (deemed ineffective)
  - Pac, Atl, SO
- Not applicable because bycatch is “low”
Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems

- Mitigative measures in place and deemed effective
- Mitigative measures in place but effectiveness is not yet demonstrated or is under debate
- No mitigative measures in place or measures in place but deemed ineffective
- Not applicable because fishing method is moderate or benign

Enforcement: Management and appropriate government bodies enforce fishery regulations

- Regulations regularly enforced by independent bodies, including logbook reports, observer coverage, dockside monitoring and similar measures
  
  **Atlantic (U.S., Canada), Pacific (Mexico – observer coverage)**

- Regulations enforced by fishing industry or by voluntary/honor system
- Regulations not regularly and consistently enforced
  
  **Atl (except US & Canada), SO, Pac (except Mexico)**

Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity

- Management has maintained stock productivity over time OR has fully recovered the stock from an overfished condition
- Stock productivity has varied and management has responded quickly OR stock has not varied but management has not been in place long enough to evaluate its effectiveness OR
- Measures have not maintained stock productivity OR were implemented only after significant declines and stock has not yet fully recovered **Atl, SO, Pac**
Evaluation Guidelines

Management is deemed to be “Highly Effective” if the majority of management factors are green AND the remaining factors are not red.

Management is deemed to be “Moderately Effective” if:
1) Management factors “average” to yellow
2) Management factors include one or two red factors

Management is deemed to be “Ineffective” if three individual management factors are red, including especially those for Stock Status and Bycatch.

Management is considered a Critical Conservation Concern and a species receives a recommendation of “Avoid”, regardless of other criteria if:
1) There is no management in place
2) The majority of the management factors rank red.

<table>
<thead>
<tr>
<th>Conservation Concern: Effectiveness of Management</th>
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<tbody>
<tr>
<td>➢ Low (Management Highly Effective)</td>
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<tr>
<td>➢ Moderate (Management Moderately Effective)</td>
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<tr>
<td>➢ High (Management Ineffective) Pacific (Mexico), Atl (US, Canada)</td>
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<tr>
<td>➢ Critical (Management Critically Ineffective)</td>
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<tr>
<td>Pacific (except Mexico), Atl (except US &amp; Canada), SO</td>
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<tr>
<td>Sustainability Criteria</td>
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<tr>
<td>Inherent Vulnerability</td>
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<td>Status of Stocks</td>
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<td>Nature of Bycatch</td>
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<tr>
<td>Habitat &amp; Ecosystem Effects</td>
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<tr>
<td>Management Effectiveness</td>
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</tbody>
</table>

Conservation Concern

- **Inherent Vulnerability**: √
- **Status of Stocks**: √ (Pacific bluefin tuna), Atlantic bluefin tuna, Southern bluefin tuna
- **Nature of Bycatch**: √ (Troll/pole, Handline, Harpoon), Unassociated purse seine sets, U.S. Atlantic longline, Int’l longline
- **Habitat & Ecosystem Effects**: √ (Troll/pole, Handline, Harpoon), Unassociated purse seine sets
- **Management Effectiveness**: √ (Pacific (Mexico)), Atlantic (US, Canada), Atlantic (except US & Canada), Southern Ocean, Pacific (except Mexico)
Aquaculture Evaluation Guidelines as applied to Capture-based Bluefin Tuna Farming

Criterion 1: Use of Marine Resources

Guiding Principle: To conserve ocean resources and provide net protein gains for society, aquaculture operations should use less wild-caught fish (in the form of fish meal and fish oil) than they produce in the form of edible marine fish protein.

Use of marine resources is “Low” when WI:FO is between 0.0 and 1.1.

Use of marine resources is “Moderate” when WI:FO is between 1.1 and 2.0.

Use of marine resources is “Extensive” when:
1. WI:FO is greater than 2.0
2. Source of stock for the farmed species is ranked red
3. Stock status of the reduction fishery is ranked red

Use of marine resources is deemed to be a Critical Conservation Concern and a species is ranked Avoid, regardless of other criteria, if:
1. WI:FO is greater than 2.0 AND the source of seed stock is ranked red.
2. WI:FO is greater than 2.0 AND the stock status of the reduction fishery is ranked red

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Conservation Concern: Use of Marine Resources

Low (Low Use of Marine Resources)  
Moderate (Moderate Use of Marine Resources)  
High (Extensive Use of Marine Resources)  
Critical Use of Marine Resources

Appendix II – October 2010

Inherent Vulnerability and Stock update.
Criteria 1 and 2 have been updated to reflect new science on population structure and life history. The latest stock assessment (for Atlantic stocks only) show only minor changes in status, and no changes were made to the rankings.

Bycatch addendum.
In this report, the only longline fisheries that receive a high conservation concern rating for bycatch (as opposed to a critical rating) are the US Atlantic and Hawaii fisheries. This is due to these fisheries having observer programs (and associated analyses) that demonstrate declining bycatch trends or otherwise providing evidence that they are not contributing to the decline of a
species. However, several recent developments suggest the need for an updated and comprehensive analysis of the bycatch in these fisheries. These developments are provided below for interested readers. Seafood Watch fully intends to conduct this updated analysis once the current process to revise the fisheries assessment criteria is complete.

**Sea turtles**

A recent Endangered Species Act (ESA) status of loggerhead sea turtles indicates a far more complicated stock structure than assumed at the time of the most recent Biological Opinions (BiOps) for the US longline fisheries (NOAA/USFWS 2009). There is now evidence that the global population is composed of at least nine subpopulations (Distinct Population Segments or DPS in ESA parlance). Each DPS is genetically unique and represents a unique ecosystem; the loss of any one DPS would represent a significant loss of genetic diversity and would result in a significant gap in the species’ range (NOAA/USFWS 2009). Seven of the DPS meet the criteria for listing as ‘Endangered’; the remaining two still meet the criteria for listing as ‘Threatened’ (all loggerheads are currently listed as Threatened). The DPS’ with which US longline fisheries interact (primarily the North Pacific Ocean DPS and the Northwest Atlantic Ocean DPS, though also possibly the Northeast Atlantic Ocean DPS) both meet the criteria for listing as endangered. Both continue to decline, and declines are driven primarily by fisheries bycatch. Fisheries bycatch is also the primary threat to most of the other DPS’ (and a major threat to all DPS’) (NOAA/USFWS 2009). The nesting loggerheads in the US are one of the two aggregations that compose the majority of nesting populations worldwide, and are thus of paramount importance to the survival of the species (NOAA/USFWS 2009). Furthermore, recent work estimating loggerhead fecundity on US beaches using satellite telemetry suggests that current estimates of population size may be considerable overestimates (by 32%) (Tucker 2010).

The bycatch rate of loggerheads in the US Atlantic fishery increased from 2005 (one of the lowest rates in the last two decades) to 2008 and there was relatively high uncertainty in the estimates (as shown by a considerable 95% CI range, especially in 2008). The most recent observer data however indicates a decline in 2009 to the lowest rate since 1992 (when the observer program began) and a much higher certainty (Garrison and Stokes 2010). Although this is a positive sign, the most recent BiOp (2004) needs review in light of the new information on stock structure and status outlined above. Specifically, current loggerhead bycatch limits may need to be modified considerably to ensure the fishery does not jeopardize the continued existence of this species. The same applies to the Hawaiian longline fishery, in which the take limit for loggerheads was recently increased in the Hawaiian shallow-set pelagic longline fishery to allow for expansion of the fishery (the most recent BiOp found no jeopardy from this action, but again did not consider the new information on stock structure and status - NOAA 2008).

**Marine mammals**

In the US Atlantic pelagic longline fishery, bycatch rates for Risso’s dolphins and pilot whales are generally down over a longer time series and takes are below PBRs. According to observer data, bycatch rates increased in 2008 (2007-2008 for Risso’s dolphins), but decreased again in 2009 (Garrison and Stokes 2010). This decrease may reflect measures implemented in 2009 to reduce the number of interactions (fishing effort increased in 2009), but it is too early to make that determination yet (especially as the timeline for reducing interactions through these measures is five years).
Until recently, the Hawaiian pelagic longline fishery was listed as Category I in the List of Fisheries (LoF). In 2009, the fishery was split into two separate fisheries. The deep-set fishery for tuna remained Category I due to the continued exceedance of the false killer whale PBR (the fishery remains Category I in the 2010 LoF). The shallow-set fishery was (and continues to be in the 2010 LoF) re-listed as Category II due primarily to the bycatch of humpback whales. Based on inference and limited data, the pelagic longline fisheries targeting tuna and swordfish out of American Samoa are listed as Category II. As required under the MMPA, a Take Reduction Team (TRT) was convened in January 2010 with the goal of reducing the bycatch of false killer whales to levels less than the PBR within six months of implementation of the plan (FKWTRT 2010). Recommendations in the current draft report include closure of the area north of the main Hawaiian islands year round (it is currently a seasonal closure), the use of circle hooks, and the use of ‘weak’ hooks should experiments provide evidence that the cetaceans can straighten the hook out and thus escape (FKWTRT 2010). Recommendations in the report will also apply to the shallow-set fishery.

**Bluefin Tuna**

Bluefin tuna is a species of particular concern in the Atlantic, as all stocks are overfished with overfishing still occurring. The species is currently managed as separate eastern and western stocks, which reach age at maturity at different ages and have isolated spawning grounds in the Gulf of Mexico and Mediterranean Sea (SCRS 2008). Recent tagging and genetic research suggests stock structure is likely more complex, with multiple breeding stocks in the Mediterranean (Reeb 2010; Riccioni, Landi et al. 2010), and possibly additional population structure in the Gulf of Mexico (S Miller, Tag A Giant, pers. comm.). This and other factors (e.g. growth curve, past and future recruitment, degree of stock mixing, age at maturity) result in significant uncertainty in the status of Atlantic bluefin tuna (SCRS 2008). Current assessments suggest a strong likelihood that both the eastern and western stocks have a biomass lower than 15% of unfished biomass (SCRS 2008). Declining catch rates by the major fisheries in the Western Atlantic (US, Canada, and Japan) suggest past projections have been overly optimistic, at least for the western stock (Restrepo 2009). Various authors have predicted the collapse of Atlantic bluefin tuna both in the west Safina and Klinger 2008 and the east MacKenzie, Mosegaard et al. 2009, and concerns have been great enough over failed management that petitions have been made to get the species listed under CITES (Buck 1995; CITES 2009) and the US Endangered Species Act (CBD 2010).

According to logbook data, bluefin tuna discards in the US Atlantic longline fishery targeting tunas have generally been increasing since 2001 (Figure A-VI) (HMS logbook data, 1992-2008). The data suggest bluefin discards were less than two times the retained catch in 2001-2005, but have been closer to three times the retained catch since then (2006-2008). Moreover, observer data in the fishery suggest that logbook data may underestimate the number of discards of bluefin (relative to retained), indicating that discards of bluefin for 2001-2005 outnumbered retained fish by over four times (Pelagic Observer Program data).
Billfish

The pelagic longline fisheries targeting yellowfin and bigeye tuna and swordfish account for the majority of mortality of Atlantic blue marlin, white marlin (only found in the Atlantic) and Atlantic sailfish (Peel, Nelson et al. 2003; SCRS 2009). All remain overfished with overfishing occurring. US mortality of Atlantic marlins and sailfish for the time period 2000-2008 (average) was about 3%, 1%, and 0.2% for white marlin, blue marlin, and Atlantic sailfish respectively (data from SCRS 2009).

White marlin in particular has been considered as among the most overexploited species under ICCAT management (Beerkircher, Arocha et al. 2010). Concern over the future of the species has been high enough that a petition to list the species as endangered under the US Endangered Species Act was filed in 2001. NOAA recently concluded that listing was not warranted NOAA 2007. However, concerns now exist over the longstanding misidentification of the recently discovered roundscale spearfish (Tetrapturus georgii) as white marlin, throwing considerable doubt on scientists’ understanding of the life history of white marlin (e.g., age and growth, reproduction, feeding habits, migratory patterns, and habitat utilization). Recent population assessments (in lieu of full stock assessments) suggest white marlin have been overfished since at least the early 1990s and perhaps as far back as the mid-1960s, and is still showing declining biomass despite decades of international management (Beerkircher, Arocha et al. 2010). The majority of simulations suggest the species was overfished in 2001 and that overfishing is still occurring (Beerkircher, Arocha et al. 2010). While early data on the proportion of misidentified roundscale spearfish landed was included in the ESA review noted above, the more recent findings suggest further review is necessary.


CBD (2010). Petition to list the Atlantic bluefin tuna (Thunnus thynnus) as Endangered under the United States Endangered Species Act, Center for Biological Diversity.

CITES (2009). Proposal to include Atlantic Bluefin Tuna (Thunnus thynnus (Linnaeus, 1758)) on Appendix I of CITES in accordance with Article II 1 of the Convention.


NMFS (2001). Final Environmental Impact Statement: Pelagic Fisheries of the Western Pacific Region, Southwest Fisheries Science Center, NMFS/NOAA.


