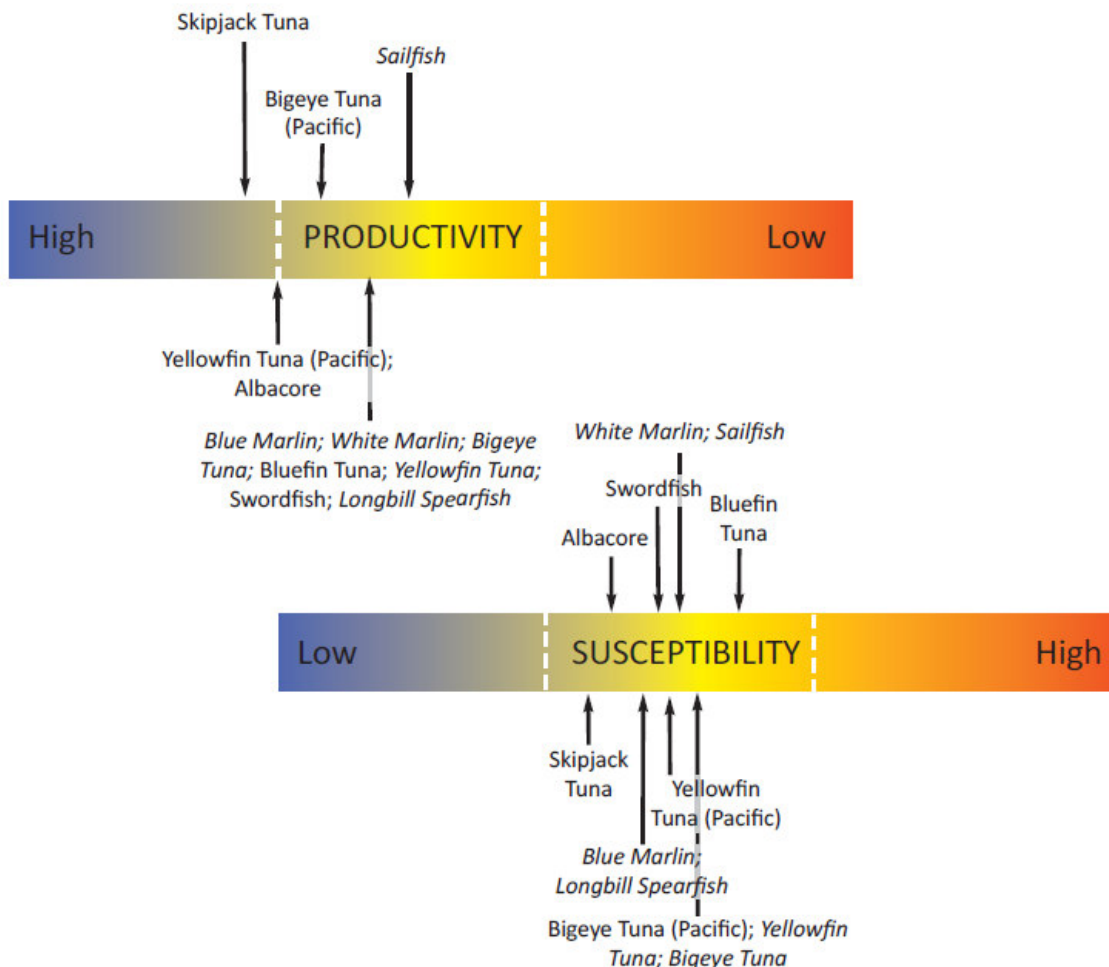


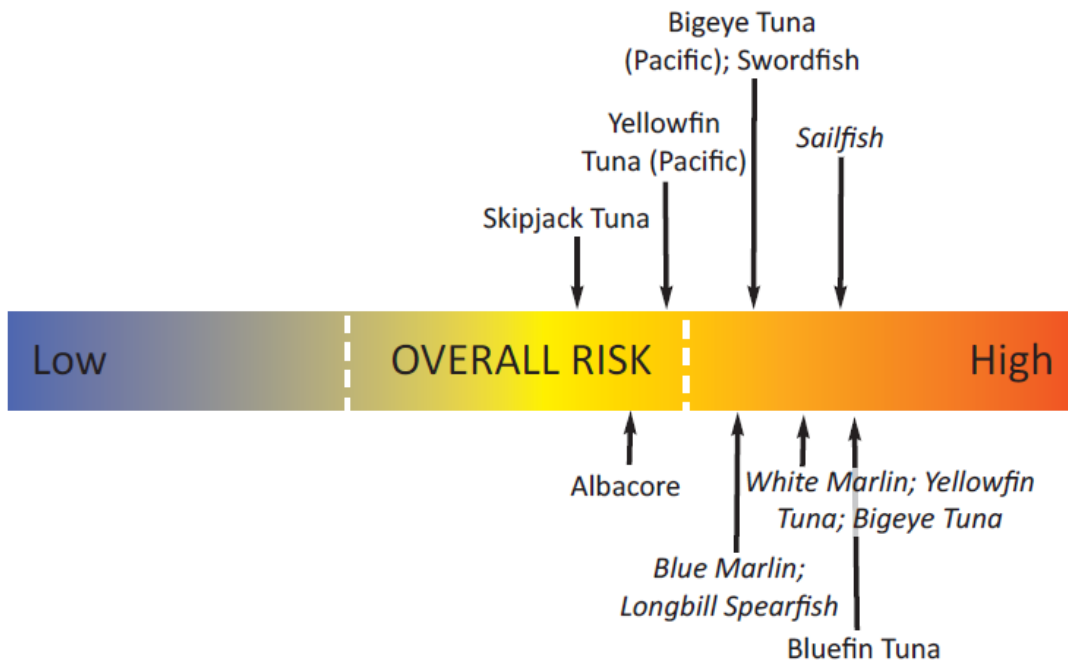
Productivity and Susceptibility Analyses: Atlantic HMS & Pacific Tuna

Productivity and susceptibility analyses (PSA) were conducted for 50 species of highly migratory fishes and sharks that are managed under the National Marine Fisheries Service's (NMFS) Atlantic Highly Migratory Species Division (HMS) Fishery Management Plan; an additional two species are the Eastern Pacific Yellowfin tuna managed by the Pacific Fishery Management Council (PFMC) and Pacific Bigeye tuna managed jointly by the PFMC and the Western Pacific FMC

Of these 52 stocks, three scored moderate overall risk, and forty-nine scored high overall risk. Of the forty-nine high risk scores, eighteen are missing information for at least one attribute. Nine of those eighteen (six HMS fish and three sharks) are missing information for one attribute; seven (all sharks) are missing information for two attributes; and two (both sharks) are missing information for three or more attributes. In the following figures, the italicizes stock names are those stocks where at least one attribute is missing information and was given a high score due to that uncertainty, in accordance with the CSIRO's treatment of uncertainty in their ERAEF methodology. In the plotted results below, open symbols indicate uncertainty.

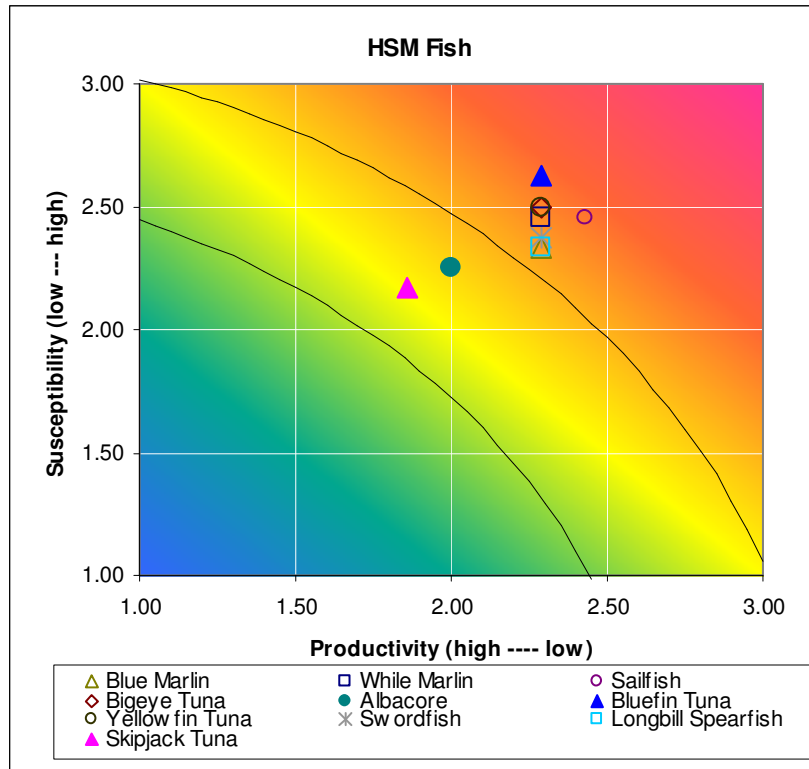
HMS Fish (Atlantic & Pacific)





Atlantic HMS Tunas, Swordfish and Billfish: Blue Marlin, White Marlin, Sailfish, Bigeye Tuna, Albacore, Bluefin Tuna, Yellowfin Tuna, Swordfish, Longbill Spearfish, Skipjack Tuna

Highly migratory species in the Atlantic Ocean are managed in the US Exclusive Economic Zone (EEZ, 0 – 200 miles) by the Atlantic Highly Migratory Species Division. Management of these stocks is complicated, as US catches often amount to only small portions of the total due to extensive foreign fishing, requiring some degree of international cooperation. For many stocks, scientific data remain sparse, and some are undergoing rebuilding plans based on limited information (i.e. in the absence of quantitative estimates of targets and thresholds). Annual reports do describe the state of the fisheries; however, full assessments have been a challenge due to unreported catches and other absent data from foreign fleets. Below are the productivity and susceptibility analyses for the evaluation of risk to each species. These fish are highly prized recreational and commercial catches and as a result there is some information on most. Overall, the HMS fish species are at medium risk due in combination to their low to medium productivity and medium to high susceptibility.



Atlantic Highly Migratory Fish Species

		Blue Marlin	White Marlin	West Atlantic Sailfish	Bigeye Tuna	N. Atlantic Albacore	Bluefin Tuna	Yellowfin Tuna	N. Atlantic Swordfish	W. Atl. Longbill Spearfish	W. Atlantic Skipjack Tuna	
Productivity	Age at maturity	med	med	med	med	high	high	med	high	med	med	
	Size at maturity	high	high	high	high	high	high	high	high	high	med	
	Maximum age	unk	unk	med	unk	low	med	low	med	low	med	
	Maximum size	high	high	high	high	med	high	high	high	high	med	
	Fecundity	low	low	unk	low	low	low	unk	low	unk	low	
	Reproductive strategy	low	low	low	low	low	low	low	low	low	low	
	Trophic level	high	high	high	high	high	high	high	high	high	high	
Productivity Score		2.29	2.29	2.43	2.29	2.00	2.29	2.29	2.29	2.29	1.86	
Susceptibility	Availability	Global Dist	med	med	med	low	low	med	low	low	med	low
		Behavior	med	high	high	high	high	high	high	high	med	med
	Encounterability	Habitat	low	low	low	low	low	low	low	low	low	low
		Bathymetry	high	high	high	high	high	high	high	high	high	high
	Selectivity	Size at Mat	high	high	high	high	high	high	high	high	high	med
		Max Size	high	high	high	high	med	high	high	high	high	med
		Desirability	low	low	low	high	low	high	high	high	high	low
Post Capture Mortality		high	high	high	high	high	high	high	high	high	high	
Susceptibility Score		2.33	2.46	2.46	2.50	2.25	2.63	2.50	2.38	2.33	2.17	
Overall Risk Score		3.27	3.36	3.46	3.39	3.01	3.48	3.39	3.30	3.27	2.85	
Risk Ranking		High	High	High	High	Med	High	High	High	High	Med	
Overfishing		yes	yes	yes	no	yes	yes	no	no	unk	unk	
Overfished (Depleted)		yes	yes	yes	no	yes	yes	no	no	unk	unk	

unk = unknown attribute values are treated with precaution and assigned high risk; stock status unknown

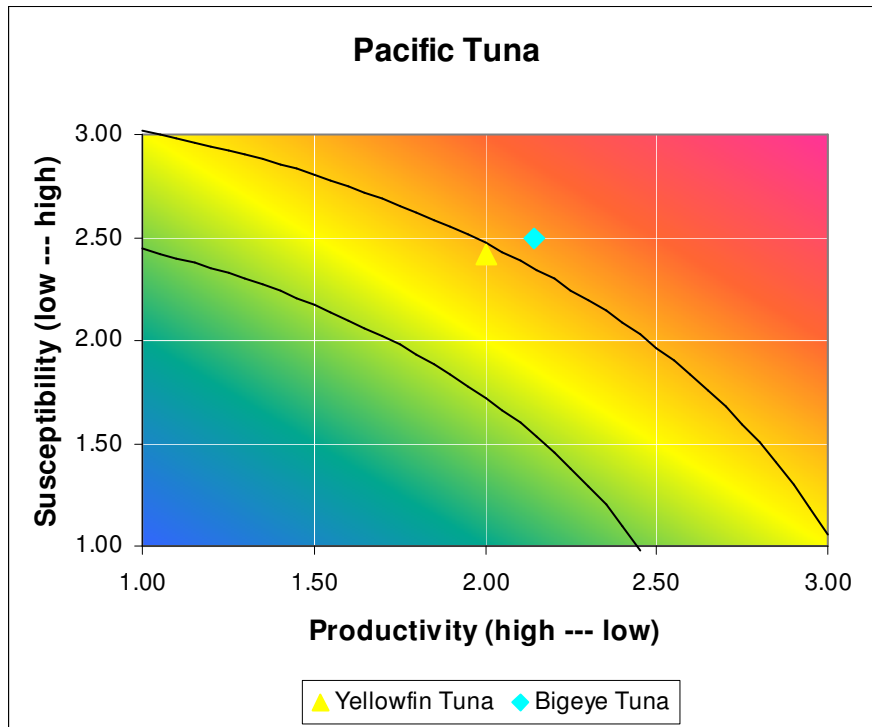
low, med, high = risk score for attribute value

RED = overfished and overfishing is occurring

Pacific Highly Migratory Pelagics: Yellowfin Tuna, Bigeye Tuna

Pelagic tuna species are straddling stocks posing complications for federal management; as US catches of these stocks typically comprise a small portion of the whole. The US is a member of the Inter-American Tropical Tuna Commission (IATTC), which is responsible for the conservation and management of fisheries for tunas and other species taken by tuna-fishing vessels. Tuna are primarily managed through size, gear and catch restrictions.

Of important note relevant to the vulnerability of these species is their susceptibility to fish aggregation devices. Tuna species congregate around flotation devices and this aggregation behavior, which not completely understood is often capitalized on by fishermen. There are concerns that FADs contribute to the depletion of tuna populations because of higher catches of juvenile tuna, particularly bigeye and yellowfin, by purse seine methods in FAD-associated sets compared to other types of set.

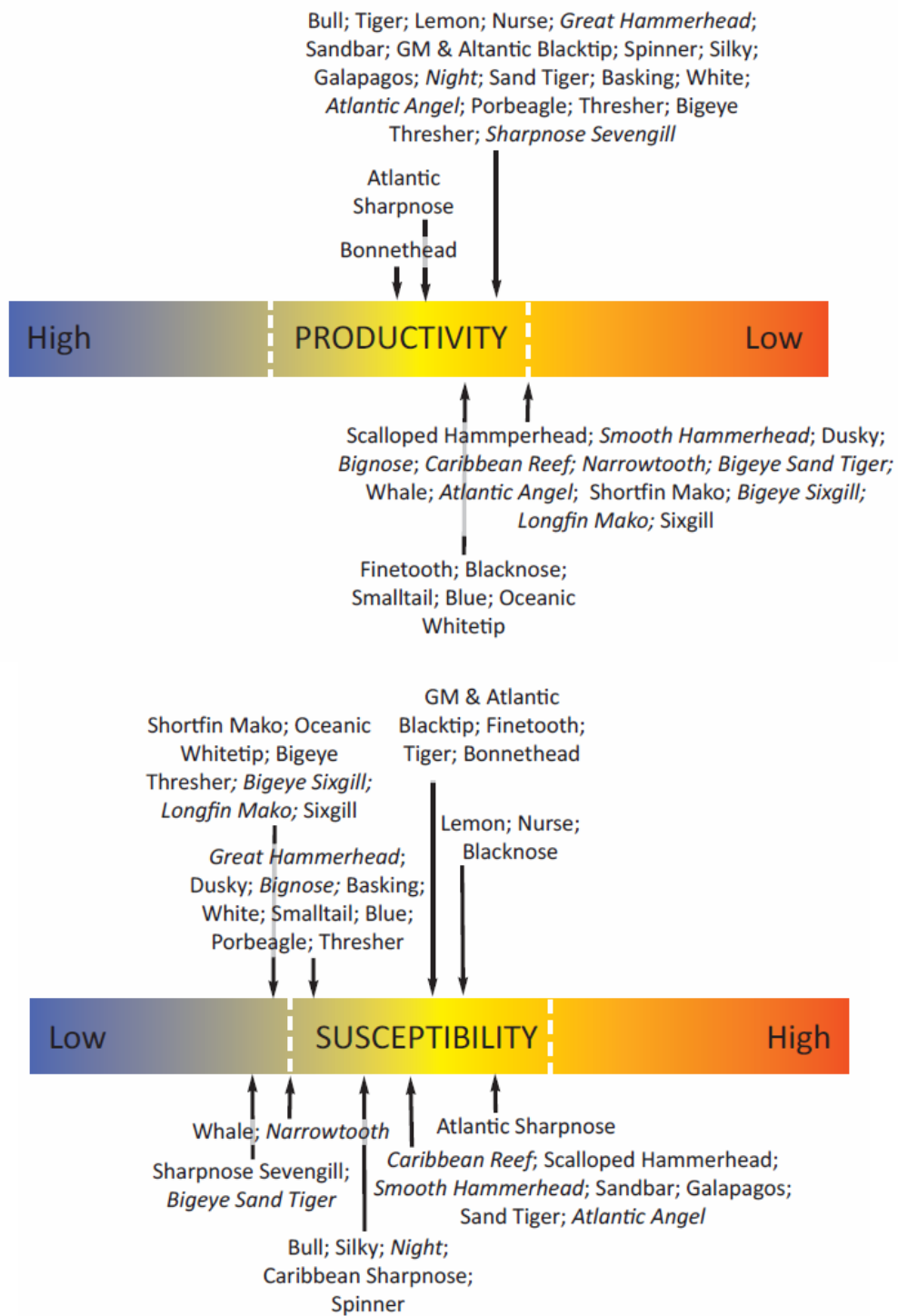


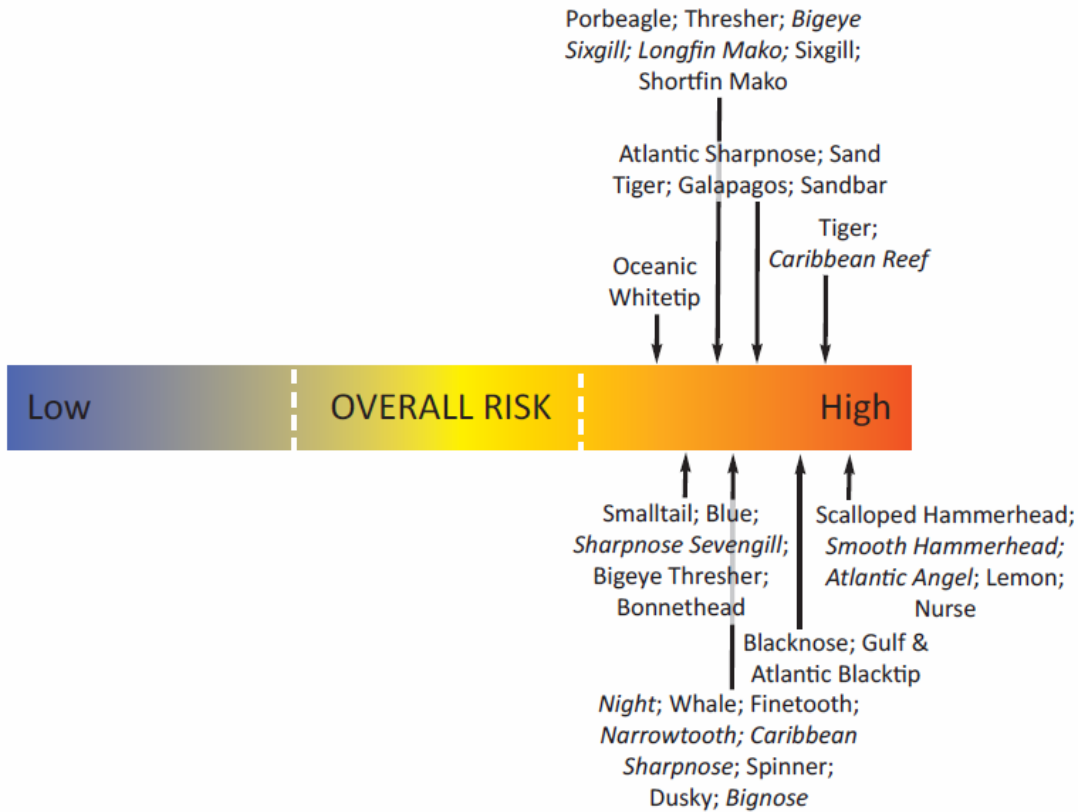
		Yellowfin Tuna	Bigeye Tuna	
Productivity	Age at maturity	med	med	
	Size at maturity	high	high	
	Maximum age	low	med	
	Maximum size	high	high	
	Fecundity	low	low	
	Reproductive strategy	low	low	
	Trophic level	high	high	
Productivity Score		2.00	2.14	
Susceptibility	Availability	Global Dist	low	low
		Behavior	high	high
	Encounterability	Habitat	low	low
		Bathymetry	high	high
	Selectivity	Size at Mat	high	high
		Max Size	high	high
		Desirability	med	high
	Post Capture Mortality		high	high
Susceptibility Score		2.42	2.50	
Overall Risk Score		3.14	3.29	
Risk Ranking		Med	High	
Overfishing		yes	yes	
Overfished (Depleted)		no	no	

unk = unknown attribute values are treated with precaution and assigned high risk; stock status unknown

low, med, high = risk score for attribute value

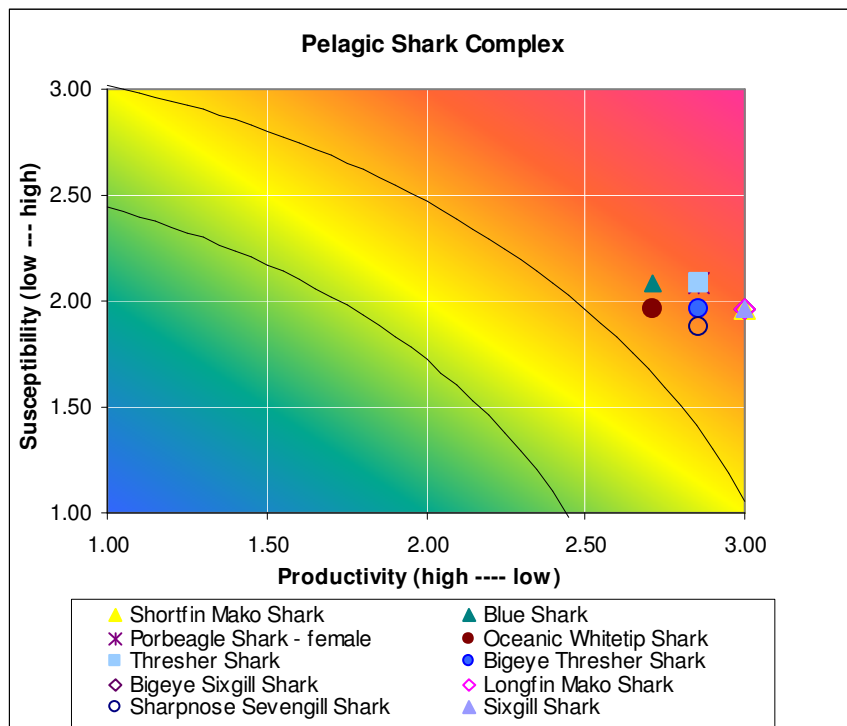
HMS Sharks





Atlantic Pelagic Shark Complex: Shortfin Mako, Blue, Porbeagle, Oceanic Whitetip, Thresher, Bigeye Thresher, Bigeye Sixgill, Longfin Mako, Sevengill, Sixgill

The HMS Pelagic Shark Complex includes 10 species of sharks, four of which are prohibited. These sharks are generally wide ranging in the upper zones of the ocean and often travel entire ocean basins. As a result, there is limited information for most and they are difficult to assess.



Pelagic Shark Complex

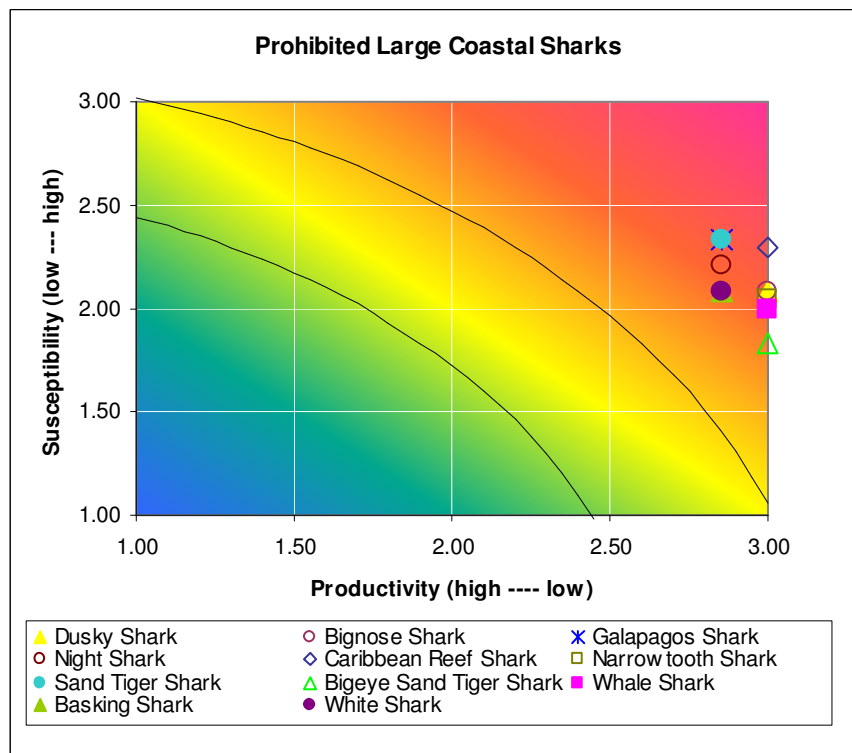
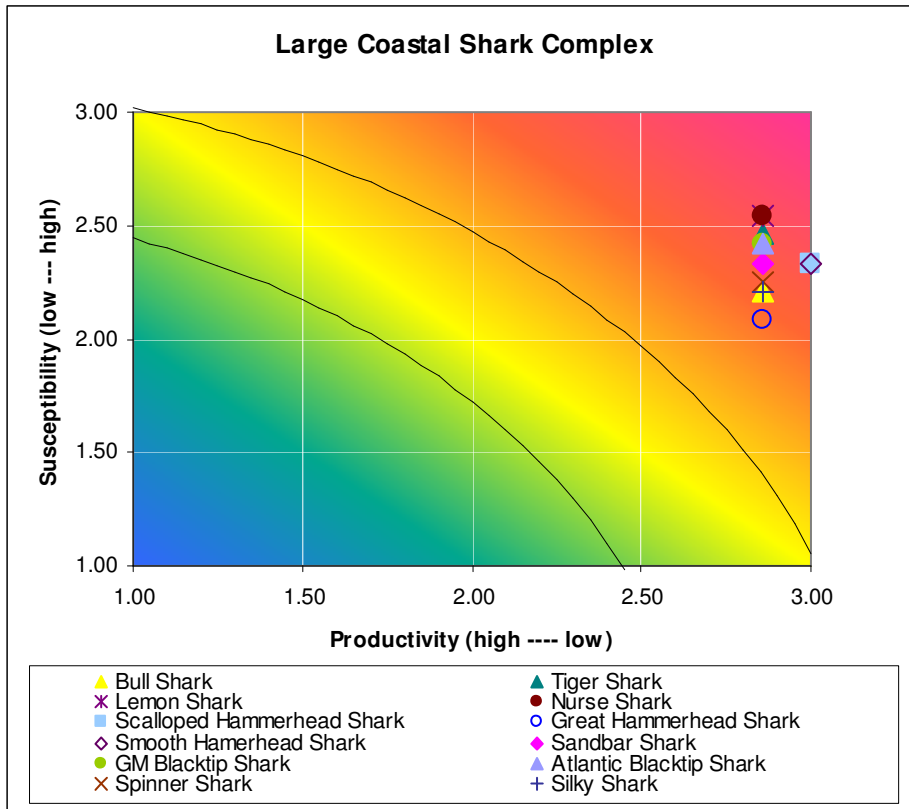
		Shortfin Mako Shark	Blue Shark	Porbeagle Shark	Oceanic Whitetip Shark	Thresher Shark	Bigeye Thresher Shark	<i>Prohibited</i>				
								Bigeye Sixgill Shark	Longfin Mako Shark	Sevengill Shark	Sixgill Shark	
Productivity	Age at maturity	high	med	high	med	med	high	unk	unk	unk	high	
	Size at maturity	high	high	high	high	high	high	high	high	high	high	
	Maximum age	high	med	med	med	high	med	unk	unk	unk	high	
	Maximum size	high	high	high	high	high	high	high	high	med	high	
	Fecundity	high	high	high	high	high	high	high	high	high	high	
	Reproductive strategy	high	high	high	high	high	high	high	high	high	high	
	Trophic level	high	high	high	high	high	high	high	high	high	high	
	Productivity Score		3.00	2.71	2.86	2.71	2.86	2.86	3.00	3.00	2.86	3.00
Susceptibility	Availability	Global Dist	low	low	low	low	low	low	low	low	low	low
		Behavior	med	high	high	med	high	med	low	med	low	low
	Encounterability	Habitat	low	low	low	low	low	low	med	low	med	med
		Bathymetry	high	high	high	high	high	high	high	high	high	high
	Selectivity	Size at Mat	high	high	high	high	high	high	high	high	high	high
		Max Size	high	high	high	high	high	high	high	high	med	high
		Desirability	low	low	low	low	low	low	low	low	low	low
	Post Capture Mortality	med	med	med	med	med	med	med	med	med	med	
	Susceptibility Score		1.96	2.08	2.08	1.96	2.08	1.96	1.96	1.96	1.88	1.96
Overall Risk Score		3.58	3.42	3.54	3.35	3.54	3.46	3.58	3.58	3.42	3.58	
Risk Ranking		High	High	High	High	High	High	High	High	High	High	
Overfishing		unk	unk	yes	unk	unk	unk	unk	unk	unk	unk	
Overfished (Depleted)		unk	unk	no	unk	unk	unk	unk	unk	unk	unk	

unk = unknown attribute values are treated with precaution and assigned high risk; stock status unknown

low, med, high = risk score for attribute value

Atlantic HMS Large Coastal Sharks: Bull, Tiger, Lemon, Nurse, Scalloped Hammerhead, Great Hammerhead, Smooth Hammerhead, Sandbar, Gulf of Mexico Blacktip, Atlantic Blacktip, Spinner, Silky, Dusky, Bignose, Galapagos, Night, Caribbean Reef, Narrowtooth, Sand Tiger, Bigeye Sand Tiger, Whale, Basking, White

Twenty-three species of sharks are managed in the Large Coastal Shark (LCS) Complex, 11 of which are prohibited. A recent assessment of the complex found that the LCS population was above the overfished threshold and no overfishing was occurring. The status was determined to be the same when the population was assessed without accounting for prohibited species, blacktip or sandbar sharks; with only a small difference in the probability of rebuilding the complex by 2030. In general, the large coastal species are a group that biologists consider to be most vulnerable to overfishing. Compared with other shark species, more information exists for assessment and management of these stocks. However, individually, the status of only three species is known, two of which are overfished. Among the species in the complex, some sharks exhibit schooling behavior (i.e. hammerheads, reef sharks, lemon shark), while others (i.e. blacktip and dusky sharks) are known to congregate; both of these behaviors make them more vulnerable to fishing pressure.



Large Coastal Shark Complex

		Bull Shark	Tiger Shark	Lemon Shark	Nurse Shark	Scalloped Hammerhead Shark	Great Hammerhead Shark	Smooth Hammerhead Shark	Sandbar Shark	Gulf of Mexico Blacktip Shark	Atlantic Blacktip Shark	Spinner Shark	Silky Shark
Productivity	Age at maturity	high	high	high	high	high	unk	unk	high	high	high	high	high
	Size at maturity	high	high	high	high	high	high	high	high	high	high	high	high
	Maximum age	med	med	med	med	high	med	unk	med	med	med	med	med
	Maximum size	high	high	high	high	high	high	high	high	high	high	high	high
	Fecundity	high	high	high	high	high	high	high	high	high	high	high	high
	Reproductive strategy	high	high	high	high	high	high	high	high	high	high	high	high
	Trophic level	high	high	high	high	high	high	high	high	high	high	high	high
Productivity Score		2.86	2.86	2.86	2.86	3.00	2.86	3.00	2.86	2.86	2.86	2.86	2.86
Susceptibility	Availability	Global Dist	low	low	med	med	low	low	low	low	low	low	low
		Behavior	med	med	high	high	high	low	high	high	high	high	med
	Encounterability	Habitat	low	high	high	high	low	low	low	low	high	high	low
		Bathymetry	high	high	high	high	high	high	high	high	high	high	high
	Selectivity	Size at Mat	high	high	high	high	high	high	high	high	high	high	high
		Max Size	high	high	high	high	high	high	high	high	high	high	high
		Desirability	low	low	low	low	low	low	low	low	low	low	low
Post Capture Mortality		high	high	high	high	high	high	high	high	high	high	high	
Susceptibility Score		2.21	2.46	2.54	2.54	2.33	2.08	2.33	2.33	2.42	2.42	2.25	2.21
Overall Risk Score		3.61	3.77	3.82	3.82	3.80	3.54	3.80	3.69	3.74	3.74	3.64	3.61
Risk Ranking		High	High	High	High	High	High	High	High	High	High	High	High
Overfishing		unk	unk	unk	unk	unk	unk	unk	yes	no	unk	unk	unk
Overfished (Depleted)		unk	unk	unk	unk	unk	unk	unk	yes	no	unk	unk	unk

unk = unknown attribute values are treated with precaution and assigned high risk; stock status unknown

low, med, high = risk score for attribute value

RED = overfished and overfishing is occurring

Large Coastal Shark Complex

		<i>Prohibited</i>										
		Dusky Shark	Bignose Shark	Galapagos Shark	Night Shark	Caribbean Reef Shark	Narrowtooth Shark	Sand Tiger Shark	Bigeye Sand Tiger Shark	Whale Shark	Basking Shark	White Shark
Productivity	Age at maturity	high	unk	high	unk	unk	high	high	unk	high	high	high
	Size at maturity	high	high	high	high	high	high	high	high	high	high	high
	Maximum age	high	unk	med	med	unk	unk	med	unk	high	high	med
	Maximum size	high	high	high	high	high	high	high	high	high	high	high
	Fecundity	high	high	high	high	unk	high	high	unk	high	high	high
	Reproductive strategy	high	high	high	high	high	high	high	high	high	high	high
	Trophic level	high	high	high	high	high	high	high	unk	high	med	high
Productivity Score		3.00	3.00	2.86	2.86	3.00	3.00	2.86	3.00	3.00	2.86	2.86
Susceptibility	Availability	Global Dist	low	low	low	med	med	low	low	low	low	low
		Behavior	high	med	high	med	high	med	high	med	high	high
	Encounterability	Habitat	low	med	high	med	high	high	high	low	low	low
		Bathymetry	high	high	high	high	high	high	high	med	high	high
	Selectivity	Size at Mat	high	high	high	high	high	high	high	high	high	high
		Max Size	high	high	high	high	high	high	high	high	high	high
		Desirability	low	low	low	low	low	low	low	low	low	low
Post Capture Mortality		med	med	med	med	med	med	med	med	med	med	
Susceptibility Score		2.08	2.08	2.33	2.21	2.29	2.04	2.33	1.83	2.00	2.08	2.08
Overall Risk Score		3.65	3.65	3.69	3.61	3.78	3.63	3.69	3.52	3.61	3.54	3.54
Risk Ranking		High	High	High	High	High	High	High	High	High	High	High
Overfishing		yes	unk	unk	unk	unk	unk	unk	unk	unk	unk	unk
Overfished (Depleted)		yes	unk	unk	unk	unk	unk	unk	unk	unk	unk	unk

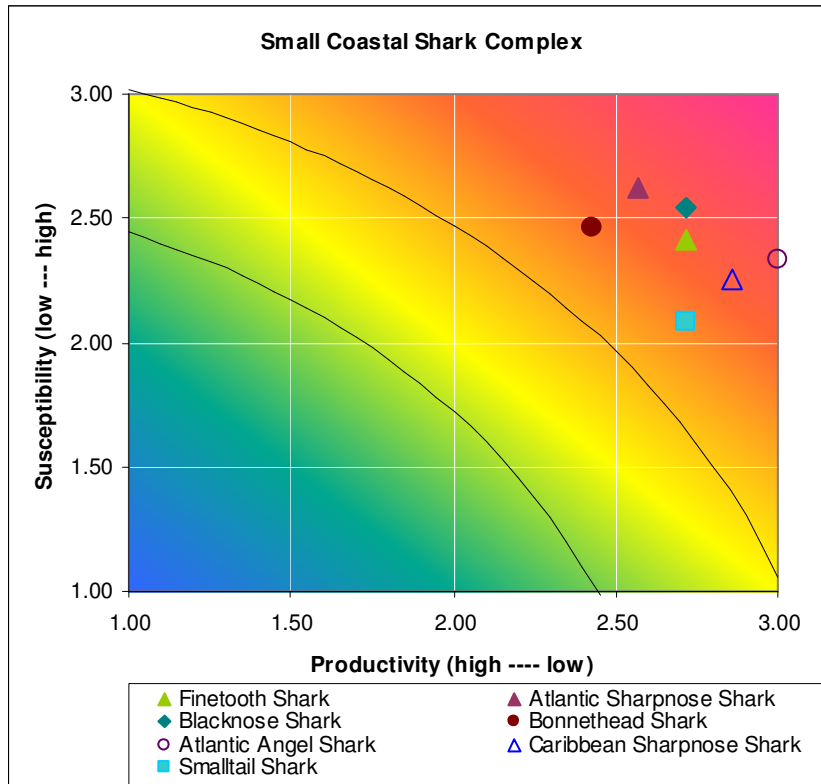
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low, med, high = risk score for attribute value

RED = overfished and overfishing is occurring

Atlantic HMS Small Coastal Sharks: Finetooth, Atlantic Sharpnose, Blacknose, Bonnethead, Atlantic Angel, Caribbean Sharpnose, Smalltail

The Small Coastal Shark Complex includes seven species of sharks, three of which are prohibited. The complex was assessed in 2007 by the Southeast Data, Assessment and Review (SEDAR). Of the seven species, stock status is known for four species. The complex is not overfished and overfishing is occurring only on finetooth sharks. As with all sharks, the species in this complex exhibit a reproductive strategy that includes small litter size, slow growth rate, and a relatively long gestation period; resulting in medium risk productivity scores.



Small Coastal Shark Complex

			Finetooth Shark	Atlantic Sharpnose Shark	Blacknose Shark	Bonnethead Shark	<i>Prohibited</i>		
							Atlantic Angel Shark	Caribbean Sharpnose Shark	Smalltail Shark
Productivity	Age at maturity		high	med	med	med	unk	unk	high
	Size at maturity		high	high	high	high	high	high	high
	Maximum age		low	med	med	med	unk	unk	med
	Maximum size		high	med	high	med	high	med	med
	Fecundity		high	high	high	high	high	high	high
	Reproductive strategy		high	high	high	high	high	high	high
	Trophic level		high	high	high	med	high	high	high
Productivity Score			2.71	2.57	2.71	2.43	3.00	2.86	2.71
Susceptibility	Availability	Global Dist	low	med	med	med	med	med	med
		Behavior	high	high	high	high	med	med	med
	Encounterability	Habitat	high	high	high	high	high	high	high
		Bathymetry	high	high	high	high	high	high	high
	Selectivity	Size at Mat	high	high	high	high	high	high	high
		Max Size	high	med	high	med	high	med	med
		Desirability	low	low	low	low	low	low	low
	Post Capture Mortality			high	high	high	high	med	med
Susceptibility Score			2.42	2.63	2.54	2.46	2.33	2.25	2.08
Overall Risk Score			3.63	3.67	3.72	3.46	3.80	3.64	3.42
Risk Ranking			High	High	High	High	High	High	High
Overfishing			no	no	no	no	unk	unk	unk
Overfished (Depleted)			yes	no	no	no	unk	unk	unk

unk = unknown attribute values are treated with precaution and assigned high risk; stock status unknown

low, med, high = risk score for attribute value