

Atlantic Mackerel – *Scomber scombrus*

Overall Vulnerability Rank = Moderate ■

Biological Sensitivity = Moderate ■

Climate Exposure = High ■

Data Quality = 83% of scores ≥ 2

<i>Scomber scombrus</i>		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)	
Sensitivity attributes	Stock Status	2.6	1.4		
	Other Stressors	1.5	1.7		
	Population Growth Rate	1.6	2.7		
	Spawning Cycle	2.5	3.0		
	Complexity in Reproduction	2.0	2.7		
	Early Life History Requirements	2.6	2.5		
	Sensitivity to Ocean Acidification	1.4	2.0		
	Prey Specialization	1.1	3.0		
	Habitat Specialization	1.5	3.0		
	Sensitivity to Temperature	1.5	3.0		
	Adult Mobility	1.1	2.8		
	Dispersal & Early Life History	1.5	2.4		
	Sensitivity Score		Moderate		
	Exposure variables	Sea Surface Temperature	4.0	3.0	
Variability in Sea Surface Temperature		1.0	3.0		
Salinity		1.4	3.0		
Variability Salinity		1.2	3.0		
Air Temperature		1.9	3.0		
Variability Air Temperature		1.0	3.0		
Precipitation		1.0	3.0		
Variability in Precipitation		1.1	3.0		
Ocean Acidification		4.0	2.0		
Variability in Ocean Acidification		1.0	2.2		
Currents		2.1	1.0		
Sea Level Rise		1.1	1.5		
Exposure Score		High			
Overall Vulnerability Rank		Moderate			

Atlantic Mackerel (*Scomber scombrus*)

Overall Climate Vulnerability Rank: **Moderate** (80% certainty from bootstrap analysis).

Climate Exposure: **High.** Two exposure factors contributed to this score: Ocean Surface Temperature (4.0) and Ocean Acidification (4.0). Exposure to ocean surface temperature and ocean acidification occurs during all life stages.

Biological Sensitivity: **Moderate.** The highest sensitivity attributes were Stock Status (2.6), Early Life History Requirements (2.6), and Spawning Cycle (2.5). The stock status of Atlantic Mackerel is currently unknown, but fewer older fish are present in the population compared to historical periods (TRAC, 2010). Atlantic Mackerel spawn in a distinct season and larvae develop quickly. The spawning cycle and early life stages may also be influenced by warming waters.

Distributional Vulnerability Rank: **High** (81% certainty from bootstrap analysis). Three of the attributes indicated vulnerability to distribution shift: Atlantic Mackerel have low Habitat Specialization, are highly mobile and make large seasonal migrations, and larvae are planktonic with potentially broad dispersal.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Atlantic Mackerel on the Northeast U.S. Shelf is very likely to be negative (>95% certainty in expert scores). Dramatic changes have already been observed in Atlantic Mackerel distribution in both the Northeast and Northwest Atlantic and these changes have been linked to warming temperatures. The effect of ocean acidification over the next 30 years is likely to be minimal.

Data Quality: 83% of the data quality scores were 2 or greater.

Climate Effects on Abundance and Distribution: Few studies have examined the effect of climate on the productivity of Atlantic Mackerel. However, numerous studies have indicated that Atlantic Mackerel populations shift as a result of changing environmental conditions. In the Northeast Atlantic, Atlantic Mackerel have expanded into Icelandic waters in the past decade (Astthorsson et al., 2012). Shifts in Atlantic Mackerel distribution also have been observed in the Northwest Atlantic (Overholtz et al., 2011). The timing of spawning and migrations has been linked to temperature in the Northeast Atlantic (Jansen and Gislason, 2011; Radlinski et al., 2013).

Life History Synopsis: Atlantic Mackerel is a highly mobile, pelagic, schooling, marine species found from the Labrador to Cape Lookout, North Carolina. Mackerel reach sexual maturity after 2-3 years (Studholme et al., 1999). There are two spawning contingents, but both migrate to inshore spawning grounds (Studholme et al., 1999). The southern contingent aggregates off the coast of the mid-Atlantic states and western Gulf of Maine from April – June (Studholme et al., 1999). The northern contingent spawns from May to August in the southern Gulf of St. Lawrence (Studholme et al., 1999). Mackerel are batch spawners, and the onset of spawning may be triggered by warm water temperature, ensuring eggs hatch during periods of high zooplankton abundance (Studholme et al., 1999). Eggs are pelagic, near the surface, and hatch within a week of spawning (Studholme et al., 1999). Larvae occur in offshore waters from Chesapeake Bay to the southern Gulf of St. Lawrence, with light intensity, age, and the location of the thermocline effecting depth distribution (Studholme et al., 1999; MAFMC, 2011). Mackerel larvae are generalist planktivores, limited by mouth size, and may cannibalistically consume smaller mackerel (Studholme et al., 1999). Larvae transition to the juvenile stage gradually, but after approximately two months switch from planktonic to swimming and schooling behavior (Studholme et

al., 1999). While generally common offshore, Atlantic Mackerel juveniles are found farther inshore than adults and in some estuaries in the mid-Atlantic during spring (Studholme et al., 1999). The depth distribution of juvenile Atlantic Mackerel changes seasonally: mid-depths in fall, deeper in winter, more vertically dispersed in spring, and shallower in summer (Studholme et al., 1999). Juveniles are opportunistic feeders, using both filter feeding and biting behavior to capture small crustaceans, pelagic molluscs, chaetognaths and other small pelagic fish and invertebrates (Studholme et al., 1999). Squid, seabirds and larger piscivores, including Atlantic Cod, are major predators of juvenile Atlantic Mackerel (Studholme et al., 1999). Adult Atlantic Mackerel from the two spawning contingents appear to follow different seasonal migration paths: the southern contingent stays farther inshore, the northern contingent stays more offshore, but the two paths cross during spring and fall (Studholme et al., 1999). The primary fishery occurs in winter and is composed of unknown proportions of the two spawning contingents. Adult Atlantic Mackerel distribution throughout the water column also changes seasonally: mid-depths during summer and fall, shallower in winter, and dispersed throughout water column in spring, with diel vertical migrations following food (Studholme et al., 1999). The diet of adult Atlantic Mackerel includes a variety of planktonic organisms, including: euphausiids, small crustaceans, squid, and small fish (Studholme et al., 1999). Predation is a very important source of natural mortality, with a large number of predators including several large and small fish, whales, seals, seabirds, sharks, and skates (Studholme et al., 1999). Atlantic Mackerel is assessed as one unit and managed under the Mid-Atlantic Fishery Management Plan for Atlantic Mackerel, Squid, and Butterfish (MAFMC, 2011). As of the 2010 assessment, the status of the stock is unknown (TRAC, 2010).

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