

Striped Bass – *Morone saxatilis*

Overall Vulnerability Rank = Very High ■

Biological Sensitivity = High ■

Climate Exposure = Very High ■

Data Quality = 88% of scores ≥ 2

| <i>Morone saxatilis</i> | | Expert Scores | Data Quality | Expert Scores Plots (Portion by Category) | |
|--|------------------------------------|-------------------------|--------------|---|--|
| Sensitivity attributes | Stock Status | 2.0 | 1.4 | | |
| | Other Stressors | 2.6 | 2.6 | | |
| | Population Growth Rate | 2.6 | 2.8 | | |
| | Spawning Cycle | 3.3 | 3.0 | | |
| | Complexity in Reproduction | 2.3 | 2.8 | | |
| | Early Life History Requirements | 3.0 | 3.0 | | |
| | Sensitivity to Ocean Acidification | 1.2 | 3.0 | | |
| | Prey Specialization | 1.2 | 3.0 | | |
| | Habitat Specialization | 1.9 | 3.0 | | |
| | Sensitivity to Temperature | 1.7 | 3.0 | | |
| | Adult Mobility | 1.6 | 3.0 | | |
| | Dispersal & Early Life History | 2.4 | 3.0 | | |
| | Sensitivity Score | | High | | |
| | Exposure variables | Sea Surface Temperature | 4.0 | 3.0 | |
| Variability in Sea Surface Temperature | | 1.0 | 3.0 | | |
| Salinity | | 1.8 | 3.0 | | |
| Variability Salinity | | 1.2 | 3.0 | | |
| Air Temperature | | 4.0 | 3.0 | | |
| Variability Air Temperature | | 1.0 | 3.0 | | |
| Precipitation | | 1.2 | 3.0 | | |
| Variability in Precipitation | | 1.3 | 3.0 | | |
| Ocean Acidification | | 4.0 | 2.0 | | |
| Variability in Ocean Acidification | | 1.0 | 2.2 | | |
| Currents | | 2.0 | 1.0 | | |
| Sea Level Rise | | 2.5 | 1.5 | | |
| Exposure Score | | Very High | | | |
| Overall Vulnerability Rank | | Very High | | | |

Striped Bass (*Morone saxatilis*)

Overall Climate Vulnerability Rank: **Very High** (69% certainty from bootstrap analysis).

Climate Exposure: **Very High**. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Air Temperature (4.0). Exposure to all three factors occurs during all life stages. Striped Bass spawn and develop in freshwater and low salinity habitats, while adults make seasonal north-south migrations in the coastal ocean.

Biological Sensitivity: **High**. Two sensitivity attributes scored above 3: Spawning Cycle (3.3) and Early Life History Requirements. Spawning occurs in the spring on the freshwater side of the salt-wedge. Eggs and larvae develop in brackish waters. Striped Bass are obligate estuarine dependent (Able 2005).

Distributional Vulnerability Rank: **High** (81% certainty from bootstrap analysis). Two attributes indicated vulnerability to distribution shift. Striped Bass are highly mobile making large seasonal north-south migrations. They also use a variety of estuarine, nearshore, and coastal habitats.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Striped Bass on the Northeast U.S. Shelf is estimated to be neutral, but with a moderate degree of uncertainty (66-90% certainty in expert scores). The uncertainty likely stems from the complex life history and the potential for different aspects of climate change to effect the species differently. Increasing temperatures could reduce habitat in the southern part of the Northeast U.S. Shelf while increasing habitat in the northern portions. Higher precipitation may increase recruitment, but combined with sea-level rise may decrease the salt-wedge area where Striped Bass spawn. The effect of ocean acidification over the next 30 years is likely to be minimal.

Data Quality: 88% of the data quality scores were 2 or greater.

Climate Effects on Abundance and Distribution: A number of studies indicated that Striped Bass productivity can be influenced by climate change. Hurst and Conover (1998) showed that temperature-induced overwinter mortality of juveniles was important to recruitment in northern portions of the range. Further, Coutant and Benson (1990) indicated that increasing summer temperatures resulted in a reduction of habitat in Chesapeake Bay. Egg and larval distribution relative to the position of the salt-wedge and estuarine turbidity maximum also are important to recruitment (North and Houde 2003). O'Connor et al. (2012) found that larval abundance was greater in the Hudson River in years with higher freshwater inputs. Thus, changes in temperature, precipitation and sea-level rise have the potential to affect population productivity.

Life History Synopsis: Striped Bass is a freshwater, estuarine, and coastal-anadromous species found from the lower St Lawrence and southern Gulf of St. Lawrence to Florida and the northern shore of the Gulf of Mexico as well as being introduced to rivers, reservoirs, and estuaries throughout the United States and several places in Europe (Klein-MacPhee, 2002). Females reach sexual maturity between 4-6 years, and males at 2-3 years or possibly later (Klein-MacPhee, 2002). Spawning occurs from February to July in freshwater usually within 40 km of the salt-wedge as temperatures rise above 11-14°C (Klein-MacPhee, 2002; Able and Fahay, 2010). Striped Bass return to natal rivers throughout their eastern United States range, but the majority of spawning in the northeastern US occurs in the Chesapeake Bay, the Delaware Bay, and the Hudson River in areas with a strong current (Klein-MacPhee, 2002; Able and Fahay, 2010). Striped Bass are highly fecund broadcast spawners producing large, semi-buoyant eggs

that require a strong current to stay afloat (Klein-MacPhee, 2002). Incubation takes about 2 days, or up to 5 days in cooler water, with survival dependent on low salinity and temperatures <27°C, although several water quality parameters can mean the difference between survival of the egg or not (Klein-MacPhee, 2002). Eggs and larvae follow currents downstream to the lower tidal reaches, but survival rates are higher in low salinity water (Able and Fahay, 2010). Larvae occur in 13-22°C water with larval durations of about 1 month on average, but up to 2 months in cooler water (Klein-MacPhee, 2002). Larvae consume copepods and cladocerans as big as they can catch (Klein-MacPhee, 2002). Many larger fish likely prey on larval Striped Bass, but they are rarely seen in the stomachs of wild-caught fish (Klein-MacPhee, 2002). Juvenile habitat includes shallow waters with sluggish currents, sand or gravel bottom, and dissolved oxygen levels >3mg l⁻¹ (Klein-MacPhee, 2002; Able and Fahay, 2010). Early juveniles consume a variety of prey including insect larvae, polychaete worms, larval fishes, mysids, amphipods, and Crangon shrimps, but begin consuming a higher proportion of small fishes as they grow (Klein-MacPhee, 2002; Able and Fahay, 2010). Schooling behavior is common among juveniles and small adults (up to 4.5 kg) (Klein-MacPhee, 2002). Most adults larger than 4.5 kg are found singly (Klein-MacPhee, 2002). There is a large degree of variability in the range of migrations and the use of oceanic habitat. In general, there are resident populations throughout the range of the species that remain in freshwater or river/estuarine systems for the duration of their life (Klein-MacPhee, 2002). Between Cape Hatteras and New England, there are also migratory anadromous populations whose members stay within natal estuaries for 1-3 years before leaving the estuary for coastal summer habitat (Klein-MacPhee, 2002; Able and Fahay, 2010; NEFSC, 2013). The amount and distance of migrations increases with fish size, so large females are the most likely to migrate and to migrate the farthest in a season (Klein-MacPhee, 2002; Able and Fahay, 2010). Oceanic migrations tend to be to the north and east during spring and to the south and west, returning to estuaries, during fall, rarely venturing farther than 6-8 km from shore, and often observed feeding near beaches (Klein-MacPhee, 2002; Able and Fahay, 2010; NEFSC, 2013). Adults are voracious predators and feed on a variety of seasonally available freshwater and marine fish and invertebrates, including crustaceans, worms, squid, soft clams, mussels, and small fish (Klein-MacPhee, 2002). Large Bluefish, Weakfish, and possibly Atlantic Cod, Silver Hake, and larger Striped Bass feed on Striped Bass, but humans are the major predator of the species (Klein-MacPhee, 2002). Striped Bass are managed as a single stock from North Carolina to Maine; however, the Albemarle Sound/Roanoke River population is managed separately due to the perception of low contribution rates to the northern populations (NEFSC, 2013). The National Marine Fisheries Service conducts a coast-wide assessment, but management is coordinated among states by the Atlantic States Marine Fisheries Commission (NEFSC, 2013). Commercial fishing is prohibited in New Jersey, Pennsylvania, Connecticut, New Hampshire, Maine, and the District of Columbia, but recreational fisheries exist throughout the stock region (NEFSC, 2013). The stock is not overfished or experiencing overfishing as of 2012 (NEFSC, 2013).

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