Tautog − *Tautoga onitis*

Overall Vulnerability Rank = Very High

Biological Sensitivity = High
Climate Exposure = Very High
Data Quality = 83% of scores ≥ 2

	Tautoga onitis	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.1	0.8	
	Other Stressors	2.6	2.8	
	Population Growth Rate	3.3	2.6	
	Spawning Cycle	2.5	3.0	
	Complexity in Reproduction	1.6	2.6	
	Early Life History Requirements	2.4	1.4	
	Sensitivity to Ocean Acidification	2.2	2.8	
	Prey Specialization	1.9	3.0	
	Habitat Specialization	2.4	3.0	
	Sensitivity to Temperature	2.4	3.0	
	Adult Mobility	3.1	2.8	
	Dispersal & Early Life History	2.2	2.6	
	Sensitivity Score	High		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	2.1	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	1.7	1.5	
	Exposure Score	Very High		
	Overall Vulnerability Rank	Very High		

Low
Moderate
High
Very High

Tautog (*Tautoga onitis*)

Overall Climate Vulnerability Rank: **Very High** (79% 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 occur during the life stages. Tautog uses coastal and nearshore habitats during all life stages, and utilize offshore habitat in the winter.

Biological Sensitivity: **High**. Two sensitivity attributes scored above 3.0: Adult Mobility (3.1) and Population Growth Rate (3.3); and was at or above Tautog generally remain within the nearshore environment during all seasons with some offshore movement, particularly in the northern part of their range (Arendt et al. 2001). They are a relatively long-lived fish with low population growth rates potentially making them vulnerable to climate change (Steimle and Shaheen, 1999). However, in the southern part of the ecosystem

Distributional Vulnerability Rank: **Moderate** (82% certainty from bootstrap analysis). Three attributes indicated limited vulnerability to distribution shift: limited adult mobility, limited early life stage dispersal, and relatively high habitat specialization.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Tautog 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 range of Tautog extend just south of the Northeast U.S. Shelf and a northward shift would negatively affect Tautog in the region. However, no northward shift has been documented despite decades of warming. In addition Tautog primarily feed on molluscs and crustaceans and ocean acidification may weaken shells and thereby make prey more vulnerable to predation. Again, there is no evidence to support these suppositions and thus, the neutral effect of climate change and moderate uncertainty.

Data Quality: 88% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: There is relatively little information regarding the effect of climate on Tautog productivity. Temperature is important in triggering migratory behavior in the fall (Olla et al. 1980) and spawning in the late-spring and summer (Gauthier et al. 2008). Thus, changes in temperature have the potential to effect life history phenology, but whether these potential effects will impact productivity in unknown. Similarly, climate effects on Tautog distribution are unclear. Tautog were grouped with the cold-temperature species in Long Island Sound, New York and Narragansett Bay, Rhode Island and abundances have decreased over time (Howell and Auster, 2012; Collie et al., 2008), but there are no large-scale studies examining regional scale distribution. The low mobility of the different life stages suggest that the species would have limited ability to shift their range in the face of climate change.

Life History Synopsis**:** Tautog is a slow-growing, long-lived, coastal and estuarine species that occurs from Nova Scotia to South Carolina, but is primarily found from Cape Cod to Delaware Bay (Able and Fahay, 2010). Tautog are gonochoristic, and while males may begin maturing earlier than females, most fish reach maturity at 3-4 years (ASMFC, 2015). Spawning occurs between April and September, beginning in the southern portion of their range, at or near the mouth of estuaries and to a limited degree on wrecks and reefs on the inner shelf, with individuals generally returning to the same area

each year (Munroe, 2002; Able and Fahay, 2010; ASMFC, 2015). The females of the species increase fecundity, number of batches per season, and egg quality with size (Able and Fahay, 2010; ASMFC, 2015). Gametes are released in near-surface waters, and eggs are usually found in estuaries and sporadically on the inner-shelf and near beaches (Munroe, 2002; ASMFC, 2015). Incubation takes 2-7 days depending on temperature, and temperature >22^{o}C may impede embryonic and larval development (Munroe, 2002). Copepods are known to eat Tautog eggs (Able and Fahay, 2010). Larvae are planktonic for approximately 2-3 weeks and occur along the estuary-ocean gradient and near beaches, but move deeper and farther from shore later in the larval stage (Able and Fahay, 2010). Tautog settle to shallow vegetated areas of the estuary, particularly where sea lettuce or other macroalgae are present, then move to deeper nearshore areas with eelgrass or structure, such as rock, jetties, or shipwrecks, as they mature (Munroe, 2002). Most juveniles remain in estuaries year round, but by spring, some juveniles are associated with structure on the inner shelf (Munroe, 2002). Young Tautog consume copepods, amphipods, and some isopods and decapods, but rely more heavily on mussels as they grow (Munroe, 2002; Able and Fahay, 2010). Adult Tautog are sometimes found feeding on sandy bottom, but generally require structure such as rocky reefs, pilings, jetties, boulders, rubble, or mussel beds (Munroe, 2002; Able and Fahay, 2010). All feeding and activity occurs during the day, with larger fish moving farther away from the home site than smaller fish (Munroe, 2002; ASMFC, 2015). Tautog consume a variety of invertebrates, especially molluscs, barnacles, small crustaceans, echinoderms, and some small fishes (Munroe, 2002). All fish return to their shelter at night where they are inactive and possibly sleep (Munroe, 2002; ASMFC, 2015). The southern portion of the population remains in the estuaries year round, and a portion of the northern population remains on the inner shelf year round (Munroe, 2002; Able and Fahay, 2010). The majority of adult Tautog from the northern part of the population make seasonal migrations from the estuary in fall to areas approximately 3 km from shore with rugged terrain (Munroe, 2002). During cold winters, Tautog are sluggish, may hibernate in shelters, and are susceptible to cold-shock mortality events (Munroe, 2002; ASMFC, 2015). In spring, the fish return to the estuary to spawn and feed (Munroe, 2002). There is very little along-shelf movement during these migrations (Munroe, 2002). Many larger fishes and piscivorous birds consume Tautog, including Spiny Dogfish, skates, Red Hake, Monkfish (Goosefish), Striped Bass, Sea Raven, and cormorants (Munroe, 2002; Able and Fahay, 2010). The Atlantic States Marine Fisheries Commission manages the species as three stocks. As of 2013, the Southern New England stock is overfished and experiencing overfishing; the Connecticut-New York-New Jersey and the Delaware-Maryland-Virginia stocks are overfished, but not experiencing overfishing (ASMFC, 2015).

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