American Eel − *Anguilla rostrata*

Overall Vulnerability Rank = High

Biological Sensitivity = Moderate
Climate Exposure = Very High
Data Quality = 71% of scores ≥ 2

	Anguilla rostrata	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.7	1.0	
	Other Stressors	2.8	1.7	
	Population Growth Rate	2.8	1.8	
	Spawning Cycle	2.5	2.2	
	Complexity in Reproduction	2.7	1.9	
	Early Life History Requirements	2.6	1.2	
	Sensitivity to Ocean Acidification	1.1	2.0	
	Prey Specialization	1.1	3.0	
	Habitat Specialization	2.6	3.0	
	Sensitivity to Temperature	1.3	3.0	
	Adult Mobility	1.2	3.0	
	Dispersal & Early Life History	1.1	2.6	
	Sensitivity Score	Moderate		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.6	3.0	
	Variability Salinity	1.2	3.0	
	Air Temperature	4.0	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.3	3.0	
	Variability in Precipitation	1.4	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.4	1.0	
	Sea Level Rise	2.6	1.5	
	Exposure Score	Very High		
	Overall Vulnerability Rank	High		

Low
Moderate
High
Very High

American Eel (*Anguilla rostrata*)

Overall Climate Vulnerability Rank: **High** (95% 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). American Eel are semelparous and catadromous: spawning in the ocean, developing in marine, estuarine, and freshwater water habitats, then feeding growing, and maturing in freshwater.

Biological Sensitivity: **Moderate**. Seven sensitivity attributes scored above 2.5, but none above a 3.0: Other Stressors (2.8), Population Growth Rate (2.8), Complexity in Reproduction (2.7), Stock Status (2.7), Early Life History Requirements (2.6), Habitat Specialization (2.6), and Spawning Cycle (2.5). American Eel are catadromous and exposed to a number of other stressors including habitat destruction, blockage to spawning habitats, and contaminants (Limburg and Waldman, 2009). In Northeast U.S. Shelf Ecosystem, the species is at or near historically low levels due to a combination of historical overfishing, habitat loss, food web alterations, predation, turbine mortality, environmental changes, toxins and contaminants, and disease (ASMFC, 2012). American Eel are relatively late maturing, migrate to specific areas in the Sargasso Sea to spawn, specialized larval stages – leptocephalia – disperse and enter river systems coastwide while undergoing metamorphosis.

Distributional Vulnerability Rank: **High** (100% certainty from bootstrap analysis). Two attributes indicated vulnerability to distribution shift. American Eel larvae are widely dispersed over much of the North Atlantic and adults are highly mobile returning to the Sargasso Sea from river systems along most of the North American coast. However, the ability for individual American Eel to shift distribution once in freshwater habitats is limited.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on American Eel is estimated to be neutral, but this estimate has uncertainty (66-90% certainty in expert scores). American Eel is found in a range of habitats and it is unclear the effect of climate change on population productivity and distribution. However, American Eel spawn in the Sargasso Sea, so shifts in the Gulf Stream have the potential to effect larval dispersal, survival, and potentially recruitment, but the direction and magnitude of these effects are unclear. The effect of ocean acidification over the next 30 years is likely to be minimal.

Data Quality: 71% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: Correlations have been found between American Eel recruitment and climate factors including the North Atlantic Oscillation, ocean temperatures, frontal locations, and ocean currents (see Friedland et al., 2007; Miller and Casselman, 2014). Castonguay et al. (1994) identified synchronous declines in American and European Eel recruitment and indicated basin-scale processes were the likely cause, specifically identifying climate-driven changes in ocean circulation. Bonhommeau et al. (2008) proposed that decreases in oceanic primary production through climate-driven processes has caused a reduction in recruitment of Anguillid species worldwide, including the American Eel. Sullivan et al. (2006) found glass eel (a young stage before pigmentation forms) abundance entering estuaries was related to winter precipitation and hypothesized that increased freshwater flow into the coastal ocean enhanced detection by returning glass eels. Thus, climate factors operating on multiple scales will likely effect the productivity of American Eel. The American Eel occurs throughout the eastern United States stretching south through Central America and the Caribbean and

north through Atlantic Canada and Greenland (Miller Casselman, 2014), thus changes in distribution, if they occur, will have little impact in the Northeast U.S. Shelf Ecosystem, which is in the north central part of their range.

Life History Synopsis**:** The life history of the American Eel differs from almost all other fish found in the United States. Eels are among the few catadromous species, meaning they live in freshwater but reproduce in salt water (McCleave, 2001; Cairns et al., 2005). They range from Venezuela to Greenland and all come from the same genetic stock (panmictic; Avise, 2003). They aggregate in the Sargasso Sea to spawn, and the spawning site varies depending on environmental conditions (McCleave, 2001; Cairns et al., 2005). After spawning, eggs hatch into leptocephali – long, flat, leaf-like larvae – that float like plankton. They drift with the currents for about a year feeding off detritus and marine snow before metamorphosing into glass eels and moving into coastal areas (McCleave, 2001; Cairns et al., 2005). Glass eels are transparent, around 2-3 inches long, and gain yellow/green pigmentation as they migrate up river and grow (McCleave, 2001; Cairns et al., 2005). Most of the eel's life is spent in fresh or brackish waters where it feeds on an assortment of foods including crustaceans, fish, insect larvae, and plankton (McCleave, 2001; Cairns et al., 2005). When eels reach and appropriate size and have enough stores of fat (3-24 years old) they metamorphose into silver eels and begin the long migration back to the Sargasso Sea to complete their life cycle (McCleave, 2001; Cairns et al., 2005). Eels have a very plastic life history strategy that allows individuals to adapt to a broad diversity of habitats. Due to the panmictic nature of the species, there is currently no estimate of total abundance or population status. In 2010, the U.S. Fish and Wildlife Service received a petition to list the American Eel as threatened under the Endangered Species Act (CESAR, 2010). The The U.S. Fish and Wildlife Service found information indicates that the petition "may be warranted by a causal link between oceanic changes … and decreasing glass eel recruitment (USFWS, 2011)."

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