American Lobster − *Homarus americanus*

Overall Vulnerability Rank = Moderate

Biological Sensitivity = Moderate

Climate Exposure = High

Data Quality = 88% of scores ≥ 2

Homarus americanus		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.3	1.7	
	Other Stressors	2.6	2.4	
	Population Growth Rate	3.3	2.7	
	Spawning Cycle	2.7	3.0	
	Complexity in Reproduction	1.4	2.4	
	Early Life History Requirements	2.4	2.6	
	Sensitivity to Ocean Acidification	2.1	2.6	
	Prey Specialization	1.1	3.0	
	Habitat Specialization	1.6	3.0	
	Sensitivity to Temperature	2.3	2.6	
	Adult Mobility	2.1	2.4	
	Dispersal & Early Life History	1.9	2.8	
	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	2.4	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.2	3.0	
	Variability in Precipitation	1.2	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.1	1.0	
	Sea Level Rise	1.3	1.5	
	Exposure Score	High		
Overall Vulnerability Rank		Moderate		

Low
Moderate
High
Very High

American Lobster

Overall Climate Vulnerability Rank: **Moderate** (93% certainty from bootstrap analysis).

Climate Exposure: **High**. Two exposure factors contributed to this score: Ocean Surface Temperature (3.9) and Ocean Acidification (4.0). All life stages of American Lobster use marine habitats.

Biological Sensitivity: **Moderate**. Three sensitivity attributes scored above 2.5: Population Growth Rate (3.3), Spawning Cycle (2.7), and Other Stressors (2.6). American Lobster are relatively slow-growing and can reach ages >50 years. Fertilization occurs after molting in the summer. Eggs are carried for almost a year before release as planktonic larvae. Other stressors are effecting lobster including a shell disease and decreased water quality in once highly productive bays and sounds in the region (e.g., Long Island Sound).

Distributional Vulnerability Rank: **High** (97% certainty from bootstrap analysis).

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on American Lobster on the Northeast U.S. Shelf is estimated to be neutral, but with a moderate degree of uncertainty (66-90% certainty in expert scores). Research suggests that crustaceans are not negatively impacted by ocean acidification. American Lobster has changed distribution and abundances in the southern part of the region have decreased, but abundances in the northern part have increased dramatically. Thus, across the whole region the effects of climate change are estimated to be neutral.

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

Climate Effects on Abundance and Distribution: Recent warming has been linked to population decreases in the southern portion of the Northeast U.S. Shelf (Wahle et al., 2015) and population increases in the northern portion (Mills et al., 2012). Similar regional patterns were observed during a system-wide warming event in the 1950s (Taylor et al., 1957). Experimental work indicates negative physiological effects at summer temperatures now common in the southern part of the range (Dove et al., 2005). Juvenile shell growth increased under lower aragonite saturation state suggesting positive effects of ocean acidification (Ries et al., 2009). However, larval growth decreased and development times increased under lower pH conditions (Keppel et al., 2012).

Life History Synopsis**:** American Lobster is a benthic marine species ranging from Maine to New Jersey in inshore waters, and from Maine to North Carolina in offshore waters (ASMFC, 2014). Females may take 10 years to mature (Acheson and Steneck, 1997). Spawning occurs after the female molts from Late May through September (Factor, 1995). Sperm can be held internally by the female for up to two years before being extruded to fertilize eggs (ASMFC, 2014). Eggs are attached to the underside of the female and carried for 9-11 months, hatching in mid-May to mid-June (ASMFC, 2014). Associated with the surface layer, larvae are dispersed by a combination of surface drift, vertical migrations, and directed swimming, allowing lobster spawned offshore to settle in inshore habitats (Harding et al., 1982; Katz et al., 1994; Factor, 1995). Larvae are pelagic for up to two months (Factor, 1995). The timing and location of settlement are determined by temperature and the presence or absence of the thermocline (Templeman, 1936; Boudreau et al., 1992; Factor, 1995). Larvae and postlarvae eat phytoplankton and zooplankton (copepods and other invertebrate larvae) and are preyed upon by Cunner and other fish (Factor, 1995). As juveniles, American Lobster are restricted to sheltered benthic habitat such as rocks, cobble, and vegetation, sometimes burrowing in mud, and are more active at night (Wahle and Steneck,

1991). Adult American Lobsters also use shelter such as boulders and kelp, but are not as restricted (Wahle and Steneck, 1991; Acheson and Steneck, 1997). Juveniles and adults undergo an ontogenetic shift in diet from softer, more easily acquired prey, such as scavenged flesh, Blue Mussels, and macroalgae to increased reliance on hard-shelled taxa such as Rock Crab in addition to molluscs, echinoderms, and polychaetes as they grow (Elner and Campbell, 1987; Sainte-Marie and Chabot, 2002). American Lobster is managed as three stock units based on life history differences: Gulf of Maine, Georges Bank, and southern New England. All three stocks are managed by the Atlantic States Marine Fisheries Commission to increase female egg production particularly for the depleted southern New England stock (ASMFC, 2014).

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