Northern Quahog − *Mercenaria mercenaria*

Overall Vulnerability Rank = Very High

Biological Sensitivity = Very High
Climate Exposure = High
Data Quality = 88% of scores ≥ 2

	Mercenaria mercenaria	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.3	0.6	
	Other Stressors	3.6	2.8	
	Population Growth Rate	2.4	2.2	
	Spawning Cycle	2.2	3.0	
	Complexity in Reproduction	2.2	2.8	
	Early Life History Requirements	2.3	2.7	
	Sensitivity to Ocean Acidification	3.8	2.6	
	Prey Specialization	1.3	3.0	
	Habitat Specialization	2.5	3.0	
	Sensitivity to Temperature	1.7	3.0	
	Adult Mobility	3.9	3.0	
	Dispersal & Early Life History	2.2	2.8	
	Sensitivity Score	Very 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	3.1	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	2.4	1.5	
	Exposure Score	High		
	Overall Vulnerability Rank	Very High		

Low
Moderate
High
Very High

Northern Quahog (*Mercenaria mercenaria*)

Overall Climate Vulnerability Rank: **Very High** (74% 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 Air Temperature was also high (3.1). Northern Quahog utilize near coastal and intertidal habitats and have a calcium carbonate shell.

Biological Sensitivity: **Very High**. Three sensitivity attributes scored above 3.5: Sensitivity to Ocean Acidification (3.8), Adult Mobility (3.9) and Other Stressors (3.6). Northern Quahog are sessile and have a calcium carbonate shell. Adults are intertidal / shallow water and subject to a number of other stressors including contaminants and habitat loss.

Distributional Vulnerability Rank: **High** (54% certainty from bootstrap analysis).

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Northern Quahog on the Northeast U.S. Shelf is very likely to be negative (>95% certainty in expert scores). Ocean acidification will likely negatively impact molluscs, including Northern Quahog. Larval survival and recruitment could be negatively impacted by warming, thereby decreasing productivity. Warming may also decrease available habitat resulting in shifts in distribution.

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

Climate Effects on Abundance and Distribution: Growth in Northern Quahog is related to temperature (Jones et al., 1989). Larval survival and growth exhibit a domed shaped response to temperature with an optimum between 25-30 ^{o}C (Davis and Calabrese, 1964). Larval development is during summer and temperatures in excess of 30 ^{o}C could be detrimental. Larval growth and survival are also related to salinity with an optimum at a salinity of 27. Under CO_2 concentrations estimated to occur later this century, Northern Quahog larvae exhibited declines in survivorship (>50%), as well as significantly delayed metamorphosis and significantly smaller sizes (Talmage and Gobler, 2009). Net calcification rate also decreased with decreasing aragonite saturation state (Reis et al., 2009). However, carbonate chemistry and ocean acidification are affected by many factors including atmospheric CO_2, making future aragonite saturation state in these systems difficult to project (Waldbusser and Salisbury, 2014).

Life History Synopsis**:** Northern Quahog, or the hard clam, is a highly fecund, estuarine and marine shellfish species found from the Gulf of St. Lawrence to the Atlantic coast of Florida and in Texas. Quahog need up to three years to reach maturity (Stanley and Dewitt, 1983). Spawning occurs from May - August beginning in the southern part of the range and continuing to the north (Stanley and Dewitt, 1983). Gamete release is triggered by rising temperatures within the range of 21-30 ^{o}C, and females release eggs several times over a 2-2.5 month period with the first release being the largest (Stanley and Dewitt, 1983). The pelagic eggs hatch after 12-14 hours and can be carried many kilometers from the spawning site (Stanley and Dewitt, 1983). The larval or veliger stage can be as short as 6-12 days depending on temperature (Stanley and Dewitt, 1983). Settlement is determined by size and can be delayed by low salinities (Stanley and Dewitt, 1983). Seed clams prefer sandy substrate with bits of shell or detritus (Stanley and Dewitt, 1983). Juveniles consume phytoplankton and small zooplankton (Stanley and Dewitt, 1983). Adult Northern Quahogs inhabit intertidal and subtidal bays and estuaries and move very little (a few cm) once settled (Stanley and Dewitt, 1983). As filter feeders, Northern Quahog strain plankton and microorganisms from the bottom water (Stanley and Dewitt, 1983). Gastropods, crabs,

shrimp, sea stars, fish, and birds consume Northern Quahog (Stanley and Dewitt, 1983; Tarnowski, 2007). There is no federal stock assessment for this species. Commercial and recreational harvests are managed on a state-by-state basis mostly through bag limits and gear limitations (e.g., NCDMF, 2001; MDDNR, 2012).

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