Blue Crab − *Callinectes sapidus*

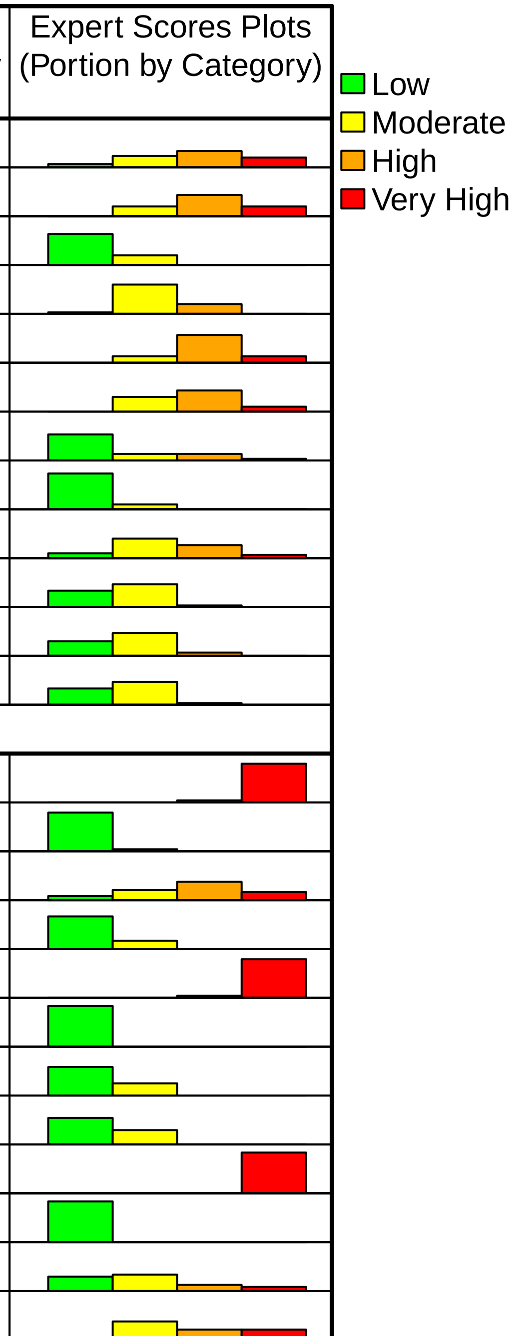
Overall Vulnerability Rank = Very High

Biological Sensitivity = High

Climate Exposure = Very High

Data Quality = 92% of scores ≥ 2

	Callinectes sapidus	Expert Scores	Data Quality
Sensitivity attributes	Stock Status	2.8	2.0
	Other Stressors	3.0	2.4
	Population Growth Rate	1.2	3.0
	Spawning Cycle	2.2	3.0
	Complexity in Reproduction	3.0	2.8
	Early Life History Requirements	2.8	2.8
	Sensitivity to Ocean Acidification	1.6	2.6
	Prey Specialization	1.1	2.8
	Habitat Specialization	2.4	3.0
	Sensitivity to Temperature	1.6	3.0
	Adult Mobility	1.7	2.8
	Dispersal & Early Life History	1.6	3.0
	Sensitivity Score	**High**	
Exposure variables	Sea Surface Temperature	4.0	3.0
	Variability in Sea Surface Temperature	1.0	3.0
	Salinity	2.8	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	2.0	1.0
	Sea Level Rise	2.7	1.5
	Exposure Score	**Very High**	
Overall Vulnerability Rank		**Very High**	



Blue Crab (*Callinectes sapidus*)

Overall Climate Vulnerability Rank: **Very High** (42% certainty from bootstrap analysis).

Climate Exposure: **Very High**. Three exposure factors contributed to this score: Ocean Surface Temperature (3.9), Air Temperature (4.0) and Ocean Acidification (4.0). Blue Crab use estuarine and ocean habitats during different portions of the life cycle.

Biological Sensitivity: **High**. Two sensitivity attributes scored above 3.0: Other Stressors (3.0) and Complexity in Reproduction (3.0). Blue Crab adults are mostly estuarine and exposed to numerous other stressors including contaminants and habitat loss. Fertilization occurs in estuarine waters and adults migrate to estuarine mouths to release eggs. Early life stages are marine and return to estuaries prior to settlement.

Distributional Vulnerability Rank: **High** (99% certainty from bootstrap analysis).

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Blue Crab 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. Warming may lead to increased productivity and northward shifts in the region, both of which would represent positive effects of climate change, but more research is needed to confirm these effects.

Data Quality: 92% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: Blue Crab survival in Chesapeake Bay is higher during mild winters (Rome et al., 2005; Bauer and Miller, 2010) and thus, warmer winters should lead to higher survival and increases in population productivity. Blue Crab also are moving into the Gulf of Maine and this has been linked to increasing temperatures (Johnson, 2014). Calcification rate was greater under lower aragonite saturation states, a pattern found in several crustacean species (Ries et al., 2009). Therefore, ocean acidification may not be as detrimental for crustaceans as it is for many molluscs.

Life History Synopsis**:** Blue Crab is an estuarine and coastal shellfish species found from the Gulf of Maine to the eastern coast of South America, including the Gulf of Mexico (Hill et al., 1989). Sexual maturity is reached after 12-30 months, with some evidence that crabs that hatch in spring mature after approximately 15 months, while those that spawn later in the summer may delay maturity until the following spring (approximately 21 months; UMCES, 2011). Blue Crabs are sexually dimorphic, and females likely have a terminal molt (only molt once during adulthood; Hill et al., 1989). Males may maintain the ability to molt after maturity, although seem to do so infrequently (UMCES, 2011). Females can only be mated with during their intermolt phase, and so, only mate once in their lives (Hill et al., 1989). Mating occurs in low-salinity waters in the upper estuary or lower parts of rivers during May – October, immediately after the female molts (Hill et al., 1989). Males carry females from molt to shell hardening, and females store the sperm for use over several spawning events over 1-2 years (Hill et al., 1989). After mating, females migrate to high-salinity water of estuaries, sounds, and near-shore spawning areas and burrow in the mud to wait 2-9 months before spawning (Hill et al., 1989). Some females release eggs (700,000 – 2 million) into a mass attached to the abdomen during the same season as mating, but most appear to wait until the following summer (Hill et al., 1989; UMCES, 2011). Females in the Gulf of Mexico may spawn year round (Vanderkooy, 2013). In Chesapeake Bay, ovigerous females migrate to the mouth of the bay from where eggs and larvae are carried seaward on the ebb tide (UMCES, 2011). Eggs incubate 1-2 weeks, and hatch in salinities of 23-33 and temperatures of 19-29^{o}C during the nocturnal high tide (Hill et al., 1989; UMCES, 2011). Many fishes and a parasitic worm (*Carcinonemertes carcinophila*) consume eggs, and on average, 1 per million eggs survives to adulthood (Hill et al., 1989). Larvae go through a series of molts and two larval stages before transforming into juveniles. The first larval stage, the zoeae, looks nothing like a grown crab, and individuals drift out to the continental shelf to feed and grow (Hill et al., 1989; UMCES, 2011). Zoeae are planktonic filter feeders on phytoplankton and molt 7-8 times over 1-2 months before reaching the second stage, the megalops (Hill et al., 1989). Megalopae look more crab-like, are 2.5 mm carapace width, and can swim freely, but stay close to the bottom (Hill et al., 1989). The megalop stage lasts 1-3 weeks, during which time the larvae reinvade the lower estuary through vertical migrations (Hill et al., 1989; UMCES, 2011). Megalopae consume fish larvae, small shellfish, and aquatic plants, and cannibalism is common during all life stages (Hill et al., 1989). Fish, shellfish, jellyfish, ctenophores, and many planktivores consume larval Blue Crabs (Hill et al., 1989). First crab, or juvenile-stage individuals look like the adult Blue Crab, and will molt and grow 9 or 10 times by winter, when molting and growth stop (Hill et al., 1989). Over the next year, juveniles gradually migrate to shallow, less-saline water in the upper estuaries and rivers to grow and mature (Hill et al., 1989). Seagrass serves as nursery habitat where the juveniles are omnivorous benthic-carnivores and scavengers on dead and live fish, crabs, organic debris, shrimp, molluscs, and aquatic plants (Hill et al., 1989; UMCES, 2011). Juvenile crabs are prey to many fish, such as Striped Bass, Spotted Sea Trout, Red Drum, Black Drum, and Sheepshead, as well as shorebirds, wading birds, and mammals (Hill et al., 1989; UMCES, 2011). Adult Blue Crabs are coastal, primarily in bays and brackish estuaries (Hill et al., 1989). Males migrate to low-salinity creeks, rivers, and upper estuaries in warm months; females may make short migrations to sea, but generally once females reach the spawning grounds they stay (Hill et al., 1989). Both males and females enter deeper water to bury in mud in winter and emerge in spring to return to rivers, tidal creeks, salt marshes, and sounds (Hill et al., 1989). Temperature and salinity effect growth, so while the number of molts is consistent among crabs, growth rates are not (Hill et al., 1989). Blue Crab eat molluscs, including many commercially valuable clams and oysters, and other invertebrates that bury shallowly, but are also detritivores and scavengers (Hill et al., 1989; UMCES, 2011). Cannibalism is also common (UMCES, 2011). Many estuarine and marine fish consume Blue Crab, including Striped Bass, American Eel, Sandbar Shark, birds, and mammals (Hill et al., 1989). The Blue Crab fisheries are managed by the states, mostly through controls on the harvest of females. Based on a recent assessment, the Chesapeake Bay fishery is not overfished or experiencing overfishing (UMCES, 2011). However, while not overfished or experiencing overfishing, the Gulf of Mexico stock is depleted (Vanderkooy, 2013).

Literature Cited:

Bauer LJ, Miller TJ. Spatial and interannual variability in winter mortality of the blue crab (*Callinectes sapidus*) in the Chesapeake Bay. Estuar Coasts. 2010; 33(3): 678-687. DOI: 10.1007/s12237-009-9237-x

Hill J, Fowler DL, Van Den Avyle MJ. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic)—Blue crab. U S Fish Wildl. Serv. Biol. Rep. 1989; 82(11.100). U. S. Army Corps of Engineers, TR EL-82-4. 18 pp. Accessed online (August 2015): http://www.nwrc.usgs.gov/publications/specprof.htm

Johnson DS. The savory swimmer swims north: a northern range extension of the blue crab *Callinectes sapidus*?. J Crust Biol. 2015; 35(1): 105-110. DOI: 10.1163/1937240X-00002293

Ries JB, Cohen AL, McCorkle DC. Marine calcifiers exhibit mixed responses to CO2-induced ocean acidification. Geol. 2009; 37(12), 1131-1134. doi: 10.1130/G30210A.1

Rome MS, Young-Williams AC, Davis GR, Hines AH. Linking temperature and salinity tolerance to winter mortality of Chesapeake Bay blue crabs (*Callinectes sapidus*). J Exp Mar Biol Ecol. 2005; 319(1): 129-145. DOI: 10.1016/j.jembe.2004.06.014

University of Maryland Center for Environmental Science (UMCES). Stock Assessment of Blue Crab in Chesapeake Bay 2011. Final Assessment Report. Technical Report Series 2011; TS-614-11: 192 pp. Accessed Online (August 2015): http://hjort.cbl.umces.edu/crabs/Assessment.html

VanderKooy SJ. GDAR01 Stock Assessment Report Gulf of Mexico Blue Crab. Gulf States Marine Fisheries Commission. Ocean Springs, MS. 2013. Accessed online (August 2015): http://www.gsmfc.org/publications/GSMFC%20Number%20215.pdf