Eastern Oyster − *Crassostrea virginica*

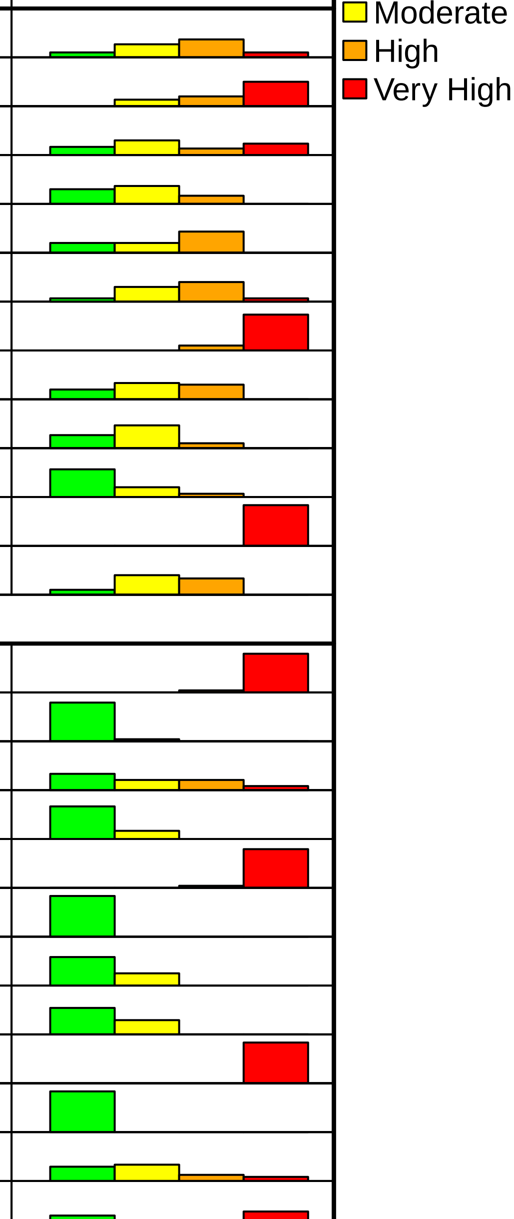
Overall Vulnerability Rank = Very High

Biological Sensitivity = High

Climate Exposure = Very High

Data Quality = 88% of scores ≥ 2

	Crassostrea virginica	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.6	1.4	
	Other Stressors	3.4	3.0	
	Population Growth Rate	2.5	2.0	
	Spawning Cycle	1.8	3.0	
	Complexity in Reproduction	2.3	2.6	
	Early Life History Requirements	2.6	3.0	
	Sensitivity to Ocean Acidification	3.9	2.2	
	Prey Specialization	2.1	2.6	
	Habitat Specialization	1.8	2.6	
	Sensitivity to Temperature	1.4	3.0	
	Adult Mobility	4.0	3.0	
	Dispersal & Early Life History	2.3	3.0	
	Sensitivity Score	High		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	2.0	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	2.6	1.5	
	Exposure Score	Very High		
Overall Vulnerability Rank		Very High		



Eastern Oyster (*Crassostrea virginica*)

Overall Climate Vulnerability Rank: **Very High** (100% certainty from bootstrap analysis).

Climate Exposure: **Vey High**. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Air Temperature (4.0) and Ocean Acidification (4.0). Eastern Oyster utilize near coastal habitats and have a calcium carbonate shell.

Biological Sensitivity: **High**. Three sensitivity attributes scored above 3.0: Sensitivity to Ocean Acidification (3.9), Adult Mobility (4.0) and Other Stressors (3.4). Eastern Oyster are sessile and have a calcium carbonate shell. Adults are reef building and found in estuarine habitats. They are subject to a number of other stressors including contaminants, invasive species, and habitat loss.

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

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Eastern Oyster 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 Eastern Oyster. Increased precipitation may also reduce available habitat in estuarine areas as upper estuaries become fresher.

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

Climate Effects on Abundance and Distribution: Shell growth of juvenile Eastern Oysters is lower under lower aragonite saturation states (Ries et al., 2009) and lower pH (Waldbusser et al., 2011). Larvae experienced lowered growth and delayed metamorphosis at higher CO_2 concentrations (Talmage and Goblet, 2009). Kimmel and Newell (2007) indicated that reduced recruitment in Chesapeake Bay was due to decreased spawning stock biomass and climate-driven changes in environmental conditions, mostly changes in precipitation and freshwater input into the Bay (Kimmel et al., 2012).

Life History Synopsis**:** Eastern Oyster is an estuarine keystone species found from the Gulf of St. Lawrence, Canada, to Key Biscayne, Florida, the Gulf of Mexico to the Yucatan Peninsula, and the West Indies to Venezuela (Sellers and Stanley, 1984). Eastern Oyster has also been introduced to Japan, Australia, Great Britain, Hawaii, and the west coast of North America (Sellers and Stanley, 1984). The species is dioecious, but most young individuals are males while older individuals are females, and there is evidence that individuals can change gender back and forth annually if needed (Sellers and Stanley, 1984; EOBRT, 2007). Spawning is stimulated by temperature, but the spawning temperature is stock-specific (Sellers and Stanley, 1984). In northern climates, spawning occurs in the summer, and can occur year round in southern climates if temperatures remain above 20^{o}C and salinities above 10 (EOBRT, 2007). Males release gametes into the water column first, inducing females to release eggs (Sellers and Stanley, 1984). Female oysters are highly fecund, producing tens of millions of eggs, and can spawn multiple times per season (Sellers and Stanley, 1984). Eggs incubate for 4-6 hours, and larvae progress through a series of planktonic stages over a period of 2-3 weeks post-fertilization, but can delay the settlement process up to 2 months to search for suitable attachment sites (Sellers and Stanley, 1984; EOBRT, 2007). The initial larval stage, the trochophore stage, lasts 1-2 days and is non-feeding (EOBRT, 2007). The veliger stages are marked by the secretion of a shell, development of a ciliated velum for swimming and feeding on planktonic organisms (Sellers and Stanley, 1984; EOBRT, 2007). Larvae do not tolerate high temperatures and have a narrower salinity tolerance range than adults (Sellers and Stanley, 1984; EOBRT, 2007). Larvae can be quite abundant in the plankton and are food for a variety of filter feeders (Sellers and Stanley, 1984). By the end of the veliger stage, the larvae have a foot with a byssal gland and react to changes in salinity by changing depth distribution, aiding retention within the estuary (Sellers and Stanley, 1984). At the end of the larval stage, and likely triggered by rising temperatures, young oysters drop to the bottom and begin crawling in a circular search area, seeking substrate (Sellers and Stanley, 1984). Shells seem to be the preferred substrate, but other hard surfaces or mud that can support the weight of the reef are also used (Sellers and Stanley, 1984). A current strong enough to supply food but not re-suspend sediment is necessary for survival (Sellers and Stanley, 1984; EOBRT, 2007). Once, a suitable attachment site is found, the oysters reabsorb the foot and velum and become sedentary spat (Sellers and Stanley, 1984). Settlement can be repeated until suitable habitat is found, but once metamorphosis is complete, the oyster is permanently sessile (EOBRT, 2007). Therefore, adult distribution is determined by the factors effecting larval dispersal, settlement, and survival. Oyster Drills, Channeled Whelk, starfish, crabs, and the Flat Worm, *Stylochus ellipticus*, are predators of small oysters (Sellers and Stanley, 1984). Adult oysters are sessile and usually occur in groups called beds or reefs in a variety of habitats including: oceanic bays, estuaries, drowned river mouths, and behind barrier beaches with wide ranges in temperature, salinity, and water clarity (Sellers and Stanley, 1984). The extent of Eastern Oyster distribution to the north and inland in the northern extent of their range are temperature limited, and predation and food availability also play a role in distribution and survival (EOBRT, 2007). Eastern Oysters are filter feeders of phytoplankton and suspended detritus (Sellers and Stanley, 1984). Oyster Drills and Channeled Whelks are common predators of adults (Sellers and Stanley, 1984). Easter Oyster is a keystone species in most estuaries throughout their range, providing habitat for many managed and unmanaged species and promoting species diversity, effecting water circulation patterns, and improving water quality (EOBRT, 2007). Harvesting of most natural beds in the northeastern United States is no longer cost-effective (Sellers and Stanley, 1984; EOBRT, 2007). Aquaculture is a major source of commercial oysters (EOBRT, 2007). Eastern Oysters are managed by each state in the United States and by Canadian and Caribbean governing bodies. A petition to list Eastern Oyster as endangered or threatened was denied because the long-term persistence of oyster throughout its range is not believed to be at risk in the foreseeable future (EOBRT, 2007).

<u>Literature Cited</u>:

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