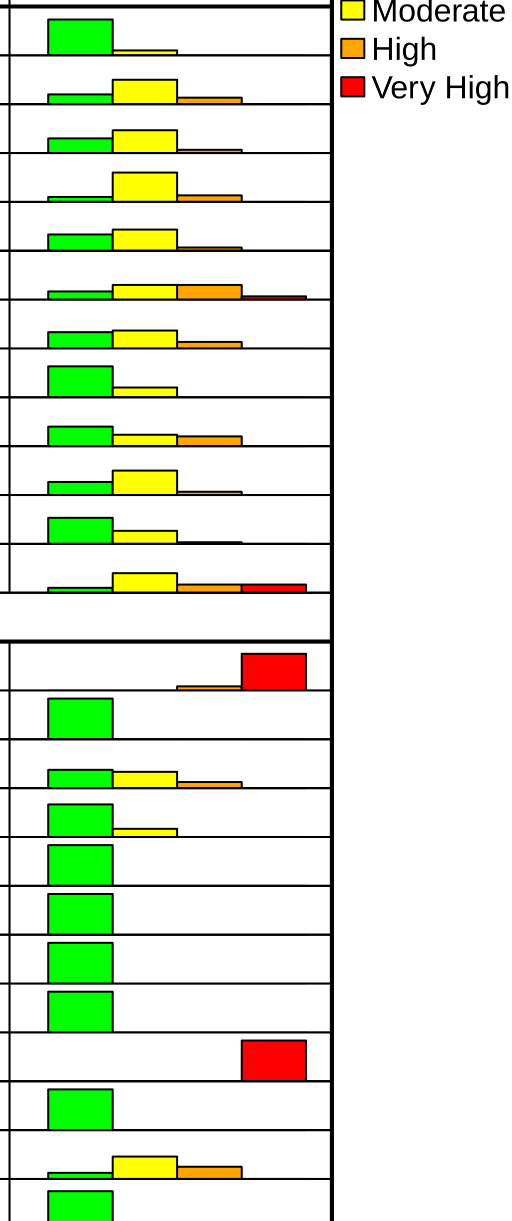
Red Hake − *Urophycis chuss*

Overall Vulnerability Rank = Low

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

	Urophycis chuss	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	1.1	3.0	
	Other Stressors	1.9	2.6	
	Population Growth Rate	1.7	2.4	
	Spawning Cycle	2.0	3.0	
	Complexity in Reproduction	1.7	2.8	
	Early Life History Requirements	2.3	2.0	
	Sensitivity to Ocean Acidification	1.8	2.4	
	Prey Specialization	1.2	3.0	
	Habitat Specialization	1.8	3.0	
	Sensitivity to Temperature	1.8	3.0	
	Adult Mobility	1.4	2.8	
	Dispersal & Early Life History	2.5	1.6	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	3.9	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.7	3.0	
	Variability Salinity	1.2	3.0	
	Air Temperature	1.0	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.0	3.0	
	Variability in Precipitation	1.0	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.1	1.0	
	Sea Level Rise	1.1	1.5	
	Exposure Score	High		
Overall Vulnerability Rank		Low		



Red Hake (*Urophycis chuss*)

Overall Climate Vulnerability Rank: **Low** (94% 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 Red Hake use marine habitats.

Biological Sensitivity: **Low**. Only one sensitivity attributes scored above 2.5. Dispersal of early life stages may be partially limited as juveniles are commensal with Atlantic Sea Scallops (Steiner et al., 1982). This relationship with Atlantic Sea Scallops is likely facultative.

Distributional Vulnerability Rank: **High** (94% certainty from bootstrap analysis). Adults are habitat generalists and mobile. Eggs and larvae are planktonic.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Red Hake on the Northeast U.S. Shelf is estimated to be neutral, but with a moderate degree of uncertainty (66-90% certainty in expert scores). Red Hake is a temperate fish and warming in the Northeast U.S. seems to have made more of the Gulf of Maine available to the species. Abundance in the southern portions of the system may be decreasing, but the region-wide affects are unclear.

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

Climate Effects on Abundance and Distribution: There is little information regarding the effect of climate on productivity, but the abundance of Red Hake has decreased in Narragansett Bay with increasing temperatures (Collie et al., 2008). Distribution has also changed dramatically in recent years with the population shifting northwards (Nye et al., 2009). Further, Murawski (1993) indicated that Red Hake distribution changed in response to temperature.

Life History Synopsis**:** Red hake is a marine, demersal species found from the Gulf of St. Lawrence to North Carolina, but is most abundant from the western Gulf of Maine through southern New England (NEFSC, 2011). Red Hake reach maturity around 1.4 (males) and 1.8 years (females; NEFSC, 2011), with females generally older and larger than males (Steimle et al., 1999). Spawning occurs from April through November (July to November in the Gulf of Maine) on the continental shelf and in coastal embayments (Steimle et al., 1999). Spawning in the Mid-Atlantic Bight may produce the majority of recruits (Steimle et al., 1999). Within a week from spawning, buoyant eggs hatch into small pelagic larvae that prey on copepods and other small planktonic crustaceans (Steimle et al., 1999). Larvae transition into pelagic juveniles at approximately 20-30 mm standard length (Fahay, 2007) and remain pelagic for approximately 2 months relying on floating debris, sargassum, and jellyfish tentacles for shelter (Steimle et al., 1999). By 35-40 mm total length, Red Hake begin a gradual descent to the benthos. They settle on fine-sand sediment on the shelf, and in larger estuaries in areas such as Sea Scallop beds, depressions in open seabeds, Atlantic surfclam shells, Moon Snail egg-case collars, anemone and polychaete tubes, debris, and artificial reefs (Steimle et al., 1999). Settlement occurs in September to December, but a strong thermocline may delay descent (Steimle et al., 1999). Throughout the juvenile stage, Red Hake prey on small crustaceans including larval and small decapod shrimp and crabs, mysids, euphausiids, and amphipods (Steimle et al., 1999). Red Hake are mostly demersal, but can be found in the water column. They tolerate a large range of temperatures, but may be sensitive to low dissolved oxygen levels (Steimle et al., 1999). Like juveniles, adult hake prefer soft sediments and use depressions in the sediment, shell beds, and inshore reefs (natural and artificial) for shelter, and are rarely found in open sandy bottom (Steimle et al., 1999). Red Hake make seasonal migrations influenced by temperature, preferring inshore habitat during warm months, and offshore habitats during colder months (Steimle et al., 1999). Adult hake prey upon crustaceans, demersal and pelagic fish, and squid (Steimle et al., 1999). Predators on adult and juvenile hake include many large piscivores such as Striped Bass, Spiny Dogfish, Monkfish (Goosefish), other hake species, Sea Raven, harbor porpoise, and larger Red Hake (Steimle et al., 1999). Red Hake are managed as two stocks: northern Georges – Gulf of Maine and southern Georges Bank – Mid-Atlantic Bight region as part of the Northeast Fishery Management Council's Northeast Small Mesh Multispecies Fishery Management Plan (NEFSC, 2011; NEFMC, 2012). Based on the 2010 stock assessment, neither stock is overfished nor undergoing overfishing (NEFSC, 2011).

Literature Cited:

Collie JS, Wood AD, Jeffries HP. Long-term shifts in the species composition of a coastal fish community. Canadian J Fish Aquat Sci. 2008; 65(7): 1352-1365. DOI: 10.1139/F08-048

Fahay MP. 2007. Early Stages of Fishes in the western North Atlantic Ocean (Davis Strait, Southern Greenland and Flemish Cap to Cape Hatteras). Accessed Online (August 2015): http://www.nafo.int/publications/fahay/pdfs.html

Murawski SA. Climate change and marine fish distributions: forecasting from historical analogy. Trans Amer Fish Soc. 1993; 122(5): 647-658. DOI: 0.1577/1548-8659(1993)122<0647:CCAMFD>2.3.CO;2

New England Fishery Management Council (NEFMC). Final amendment 19 to the Northeast Multispecies FMP (Small-mesh multi species) Environmental Assessment regulatory impact review and initial regulatory flexibility analysis. Newburyport, MA. 2012; Accessed online (August 2015): http://archive.nefmc.org/mesh/planamen/Amend%2019/Final%20Amendment%2019%20revised.pdf

Northeast Fisheries Science Center (NEFSC). 51st Northeast Regional Stock Assessment Workshop (51st SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 2011; 11-02: 856 p. Accessed Online (August 2014): http://www.nefsc.noaa.gov/publications/crd/crd1102/

Nye JA, Link JS, Hare JA, Overholtz WJ. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Mar Ecol Prog Ser. 2009; 393: 111-129. DOI: 0.3354/meps08220

Steimle FW, Morse WW, Berrien PL, Johson DL. 1999. Essential fish habitat source document: Red Hake, *Urophycis chuss*, life history and habitat characteristics. NOAA Tech Memo NMFS NE 1999; 133: 34 p. Accessed Online (August 2015): http://www.nefsc.noaa.gov/nefsc/publications/tm/tm133/

Steiner WW, Luczkovich JJ, Olla BL. Activity, shelter usage, growth and recruitment of juvenile Red Hake *Urophycis chuss*. Mar Ecol Prog Ser. 1982; 7(2): 125-135. Accessed Online (August 2015): http://www.int-res.com/articles/meps/7/m007p125.pdf