Silver Hake − *Merluccius bilinearis*

Overall Vulnerability Rank = Low

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

	Merluccius bilinearis	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.2	2.7	
	Other Stressors	1.4	1.0	
	Population Growth Rate	1.7	2.2	
	Spawning Cycle	1.4	3.0	
	Complexity in Reproduction	1.8	2.8	
	Early Life History Requirements	2.1	2.3	
	Sensitivity to Ocean Acidification	1.2	2.0	
	Prey Specialization	1.5	3.0	
	Habitat Specialization	1.2	2.8	
	Sensitivity to Temperature	1.6	3.0	
	Adult Mobility	1.3	2.8	
	Dispersal & Early Life History	1.8	2.6	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	3.9	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.9	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		

Low
Moderate
High
Very High

Silver Hake (*Merluccius bilinearis*)

Overall Climate Vulnerability Rank: **Low** (100% 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 Silver Hake use marine habitats.

Biological Sensitivity: **Low**. No sensitivity attributes scored above 2.5.

Distributional Vulnerability Rank: **High** (100% certainty from bootstrap analysis). Silver Hake are habitat generalists that are moderately mobile and have dispersive early life stages (Lock and Packer, 2004).

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Silver Hake on the Northeast U.S. Shelf is very likely to be negative (>95% certainty in expert scores). Decreases in recruitment related to warming have been observed on the Scotian Shelf and the distribution has shifted northward with warming on the Northeast U.S. Shelf. Continued warming will likely cause continued decreases in recruitment and northward 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: On the Scotian Shelf, Silver Hake recruitment has been linked to temperature: lower recruitment in years of higher temperature (Sigaev, 1992). Bartolino et al. (2008) found a similar negative relationship between temperature and recruitment in a congener in the Mediterranean Sea. Silver Hake distribution also changes with temperature (Murawski, 1993) and has shifted northwards in recent years (Nye et al., 2009). In subsequent work, Nye et al. (2011) reported that Silver Hake distribution was correlated to the position of the Gulf Stream and hypothesized large-scale forcing on shelf dynamics as the causal link. Distribution of Pacific Hake, a congener, is also affected by local oceanographic conditions (Agostini et al., 2006).

Life History Synopsis**:** Silver Hake is a fast swimming, mostly benthic, marine finfish species that occurs from the Gulf of St. Lawrence to South Carolina, but is most abundant from Nova Scotia to New Jersey (Lock and Packer, 2004). The species reaches maturity between 2 and 3 years of age (NEFSC, 2011). Spawning occurs in inshore areas of the Gulf of Maine, southern Georges Bank, Nantucket Shoals, and south of Martha's Vineyard to Cape Hatteras (Klein-MacPhee, 2002). Spawning begins in January in the southern portion of the range with a peak in spring, and continues to the north with a northern US peak in summer and a Canadian peak in late summer (Lock and Packer, 2004). Silver Hake are serial spawners with up to three spawning events per season (Klein-MacPhee, 2002). Eggs are pelagic and hatch after about 2 days (Klein-MacPhee, 2002). Larvae are pelagic in the upper 40 m of water for approximately 1 month in the southern part of their range to up to 5 months in Canadian waters (Klein-MacPhee, 2002; Lock and Packer, 2004). Calanoid copepods are the main prey of larval Silver Hake (Klein-MacPhee, 2002). Larvae first mature into pelagic juveniles that associate with jellyfish, then settle to the benthos at 12-20mm fork length (Klein-MacPhee, 2002; Lock and Packer, 2004). Benthic juveniles prefer silt or sand bottom with amphipod tubes for cover (Klein-MacPhee, 2002). Copepods, amphipods, mysids, euphausiids, and small decapod shrimp are the main prey of juveniles (Klein-MacPhee, 2002). Adult Silver Hake prefer cool waters (3-17°C) at a variety of depths over sand or silt bottom from shallow inshore areas out to 400 m and possibly deeper (Klein-MacPhee, 2002). Silver Hake are more active and hunt at night for crustaceans, a large variety of small fish, and squid (Klein-MacPhee, 2002). An ontogenetic shift from mostly crustaceans to mostly fish and squid prey occurs at 20-25cm, and

cannibalism is also quite common in the species (Klein-MacPhee, 2002). Some of the many predators of Silver Hake include: Spiny Dogfish, Little Skate, Monkfish (Goosefish), Pollock, Atlantic Cod, Haddock, hakes, Acadian Redfish, Sea Raven, Bluefish, Atlantic Mackerel, Swordfish, flounders, Silver Hake, and harbor porpoise (Klein-MacPhee, 2002). Seasonal migrations from inshore summer and autumn habitat to offshore winter and spring habitat are influenced by temperature (Klein-MacPhee, 2002). Silver Hake also undergo along-shore migrations and the northern and southern stocks mix on Georges Bank in summer (Lock and Packer, 2004). Silver Hake is managed by the New England Fishery Management Council's small mesh multispecies plan as two stocks: northern Georges Bank and the Gulf of Maine to the north and southern Georges Bank to Cape Hatteras to the south (NEFSC, 2011). Based on a variety of metrics, the Gulf of Maine and Mid-Atlantic stocks are distinct, but the degree of mixing and the location of the boundary between stocks are not well understood (Lock and Packer, 2004). Based on the most recent assessment, neither stock is overfished, nor is overfishing occurring (NEFSC, 2011).

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