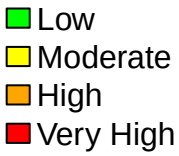
Haddock − *Melanogrammus aeglefinus*

Overall Vulnerability Rank = Low

Biological Sensitivity = Low
Climate Exposure = High
Data Quality = 83% of scores ≥ 2

	Melanogrammus aeglefinus	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.3	2.8	
	Other Stressors	1.3	1.6	
	Population Growth Rate	1.8	2.6	
	Spawning Cycle	2.4	3.0	
	Complexity in Reproduction	1.9	2.8	
	Early Life History Requirements	2.5	2.8	
	Sensitivity to Ocean Acidification	1.1	1.4	
	Prey Specialization	1.4	3.0	
	Habitat Specialization	2.0	3.0	
	Sensitivity to Temperature	2.4	3.0	
	Adult Mobility	2.1	2.8	
	Dispersal & Early Life History	1.6	3.0	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	3.9	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.4	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		



Haddock (*Melanogrammus aeglefinus*)

Overall Climate Vulnerability Rank: **Low** (73% 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 Haddock use marine habitats.

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

Distributional Vulnerability Rank: **High** (73% certainty from bootstrap analysis). Haddock are habitat generalists, with moderate mobility, and dispersive early life history stages.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Haddock on the Northeast U.S. Shelf is estimated to be negative, but this estimate is uncertain (66-90% certainty in expert scores). Haddock is a cold-temperate species and warming will likely cause reductions in available habitat. However, in recent years Haddock recruitment has been very high despite warming. Further, Haddock distribution has remained relatively constant even with temperature increases.

Data Quality: 83% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: Haddock productivity has been linked to a number of environmental factors including larval retention, larval feeding conditions, and adult conditions (Lough et al., 2006; Platt et al., 2003; Friedland et al., 2008). However, these environmental factors have not be directly linked with climate factors. Haddock distribution has remained relatively stable over the past several decades (Nye et al., 2007) and Murawski (1993) did not find a link between Haddock distribution and temperature. Thus, climate effects of Haddock productivity and distribution are not as clear as they are for other groundfish species in the Northeast U.S. Shelf Ecosystem.

Life History Synopsis**:** Haddock are a typical marine species living their entire life cycle in the ocean between the Strait of Belle Isle to Cape May, New Jersey, along the east coast of North America, along both coasts of southern Greenland, and from the Barents Sea and Iceland to the Bay of Biscay along the west coast of Europe (Brodziak, 2005; Fahay, 2007). Haddock mature at around 3 years (NEFSC, 2012). The location of spawning is limited by bottom type and primarily occurs on Georges Bank and the Gulf of Maine in United States waters (Cargnelli et al., 1999; Brodziak, 2005). Spawning occurs from January to July varying latitudinally and controlled by temperature (later in colder autumn/winter; Page and Frank, 1989; Cargnelli et al., 1999; Klein-MacPhee, 2002; Brodziak, 2005). Eggs hatch within a month (about 15 days at typical Georges Bank temperatures; Page and Frank, 1989; Klein-MacPhee, 2002). Larvae are pelagic (usually found within the thermocline) and forage on less motile prey such as invertebrate eggs, copepods, and phytoplankton (Klein-MacPhee, 2002; Brodziak, 2005). Metamorphosis occurs approximately a month after hatching, but juveniles remain in the epipelagic zone for 3-5 months before settling to the bottom (Cargnelli et al., 1999; Brodziak, 2005; Fahay, 2007). Juveniles prey on abundant organisms within a specific size range: copepods and pteropods while pelagic, but switching to ophiuroids and polychaetes during the transition to demersal habitat (Cargnelli et al., 1999; Brodziak, 2005). Once demersal, juveniles and adults occupy similar habitat: primarily cool, shelf water with gravel, pebble, clay, and smooth hard sand substrate, particularly smooth areas between rocky patches (Klein-MacPhee, 2002). Benthic juveniles primarily feed on benthic prey such as crustaceans, polychaetes, and small fish (Klein-MacPhee, 2002; Brodziak, 2005). Adults are indiscriminate consumers of benthic organisms such as echinoderms, polychaetes, Atlantic Herring eggs, small fish, and

crustaceans (Klein-MacPhee, 2002; Brodziak, 2005). Haddock are occasional prey for several species of fish, including larger Haddock, and gray seals (Klein-MacPhee, 2002). Haddock populations had declined and growth and maturation had shifted since the 1960s through the early 2000s (Klein-MacPhee, 2002; NEFSC, 2012). However, Haddock appear to be responding to reduced fishing mortality and recent management strategies, both United States stocks are no longer experiencing overfishing nor are they overfished. Haddock are managed under the Northeast Multispecies Fishery Management Plan (NEFSC, 2012).

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