Northern Shortfin Squid − *Illex illecebrosus*

Overall Vulnerability Rank = Low

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

	Illex illecebrosus	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.1	2.2	
	Other Stressors	1.2	1.2	
	Population Growth Rate	1.1	2.6	
	Spawning Cycle	1.3	2.1	
	Complexity in Reproduction	1.5	1.9	
	Early Life History Requirements	2.4	2.4	
	Sensitivity to Ocean Acidification	1.8	2.0	
	Prey Specialization	1.3	2.8	
	Habitat Specialization	1.2	2.8	
	Sensitivity to Temperature	1.3	2.8	
	Adult Mobility	1.0	2.6	
	Dispersal & Early Life History	1.2	2.7	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.7	3.0	
	Variability Salinity	1.2	3.0	
	Air Temperature	1.7	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.0	3.0	
	Variability in Precipitation	1.1	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.2	1.0	
	Sea Level Rise	1.1	1.5	
	Exposure Score	High		
	Overall Vulnerability Rank	Low		

Low
Moderate
High
Very High

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

Climate Exposure: **High**. Two exposure factors contributed to this score: Ocean Surface Temperature (4.0) and Ocean Acidification (4.0). Exposure to ocean surface temperature and ocean acidification occurs during all life stages.

Biological Sensitivity: **Low**. All sensitivity scores were below 2.5.

Distributional Vulnerability Rank: **Very High** (100% certainty from bootstrap analysis). Four of the attributes indicated vulnerability to distribution shift. Northern Shortfin Squid are habitat generalists and occur in pelagic habitats both on and off the continental shelf. They are highly mobile and make large seasonal migrations on and off the shelf. Spawning occurs in slope waters and larvae (called paralarvae) have the potential to be broadly dispersed.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Northern Shortfin Squid on the Northeast U.S. Shelf is estimated to be positive, but this estimate is highly uncertain (<66% certainty in expert scores). Warming may increase available habitat on the Northeast U.S. Shelf and a northward shift in the Gulf Stream may result in more squid on the shelf. However, population productivity may decrease as ocean acidification continues creating some uncertainty in the directional effect of climate change.

Data Quality: 83% of the data quality scores were 2 or greater.

Climate Effects on Abundance and Distribution: There is some evidence that Northern Shortfin Squid are affected by climate factors. Egg development is inhibited below a threshold of 12.5 °C (Coelho et al., 1994) and thus warming may open more spawning habitat off the Northeast U.S. Shelf. Abundance fluctuates in concert with the North Atlantic Oscillation (NAO; Dawe et al., 2000). Dawe et al. (2007) suggested environmentally driven alternation between Northern Shortfin Squid and Inshore Longfin Squid. This suggests that conditions that increase productivity of Northern Shortfin Squid may decrease productivity of Inshore Longfin Squid.

Life History Synopsis**:** Northern Shortfin Squid is a highly migratory, short-lived, marine species that occurs from the Sea of Labrador to the Straits of Florida (Hendrickson and Holmes, 2004). The spawning patterns of Northern Shortfin Squid are largely unknown. In captivity, females matured in 40-60 days (Hendrickson and Holmes, 2004). The lifespan of the semelparous Northern Shortfin Squid is <1 year with mortality within days of spawning (Hendrickson and Holmes, 2004). The majority of spawning occurs between October and June, but the species may spawn year round (Hendrickson and Holmes, 2004). The winter spawning habitat is unknown, but spawning has been confirmed on the Mid-Atlantic shelf and offshore areas along the Gulf Stream-Slope water frontal zone; south of Cape Hatteras may also be important based on observations of paralarvae and hatchlings in these areas (Hendrickson and Holmes, 2004). Females can produce multiple, neutrally buoyant, egg masses housed in a gelatinous balloon and containing thousands of eggs (10,000 – 100,000; Hendrickson and Holmes, 2004). Eggs hatch after 1-2 weeks depending on temperature (Hendrickson and Holmes, 2004). Paralarvae hatch at 1.1 mm mantle length, develop into a transitional stage by 5 mm mantle length, and reach the juvenile stage at 7-10 mm mantle length (Hendrickson and Holmes, 2004). Paralarvae occur year round in the Gulf Stream, but are most common in winter-spring (Hendrickson and Holmes, 2004). Eggs and paralarvae require waters > 12.5^{o}C, and the Gulf Stream is likely the main route of transport

(Hendrickson and Holmes, 2004; Dawe et al., 2007). Hatchlings have been collected only south of Cape Hatteras, but identification to species is difficult in this area (Hendrickson and Holmes, 2004). Juveniles and adults migrate onto the Newfoundland to Cape Hatteras shelf in spring and by late autumn migrate offshore, possibly to a winter spawning site (Hendrickson and Holmes, 2004). The proportion of the population that remains offshore year round is unknown (Hendrickson and Holmes, 2004). Males are smaller than females and begin to disappear from the shelf in early autumn (Hendrickson and Holmes, 2004). The cause of this shift in sex ratio is unknown, but the males could be migrating to offshore mating grounds earlier than females or experiencing increased mortality, possibly due to cannibalism by the larger females (Hendrickson and Holmes, 2004). Fish, squid, and crustaceans make up the majority of the diet, with an ontogenetic shift from primarily crustaceans to fish (early life stages of several species and adult Capelin) and squid (including cannibalism) with increased size (Hendrickson and Holmes, 2004). Predators of Northern Shortfin Squid include several benthic and pelagic predators such as Bluefin Tuna, Silver and Red Hakes, Bluefish, Monkfish (Goosefish), Fourspot Flounder, Atlantic Cod, Sea Raven, Spiny Dogfish, Swordfish, pilot whales, common dolphin, shearwaters, gannets, and fulmars (Hendrickson and Holmes, 2004). Northern Shortfin Squid has an interesting array of defense mechanisms including: camouflage coloration, schooling behavior, jetting, and ink release (Hendrickson and Holmes, 2004). Although considered one stock commercially exploited from Newfoundland to Cape Hatteras, North Carolina, the species is managed by Northwest Atlantic Fisheries Organization in Canadian waters and by the Mid-Atlantic Fishery Management Council in United States waters. The Mid-Atlantic Council manages Northern Shortfin Squid as part of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. In 2005, the stock was overfished and overfishing status could not be determined due to a lack of reliable stock biomass and fishing mortality estimates (NEFSC, 2006).

Literature Cited:

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