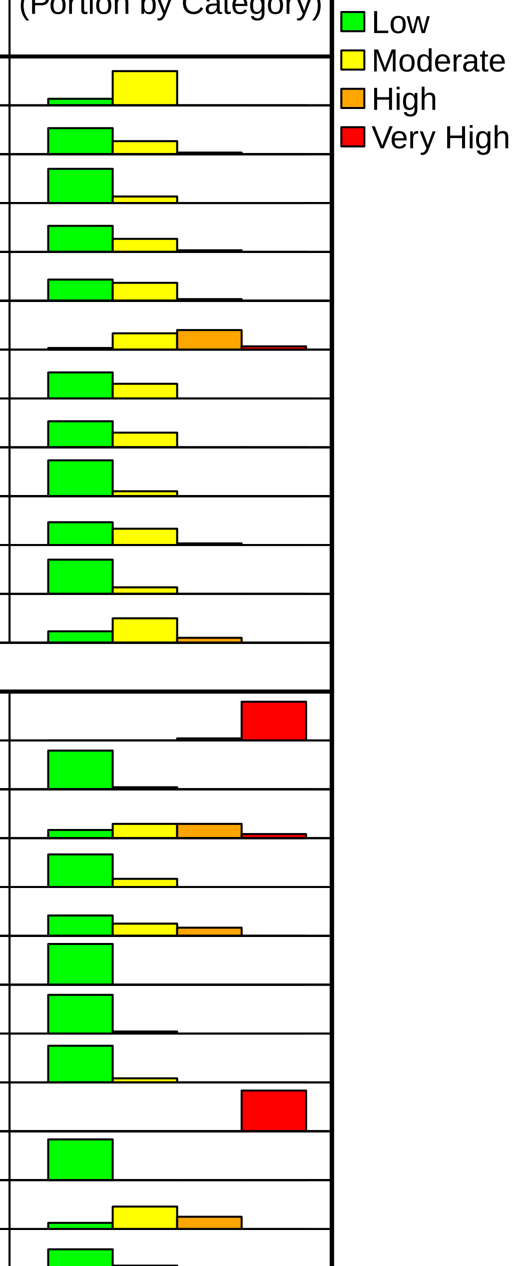
Longfin Inshore Squid − *Loligo pealeii*

Overall Vulnerability Rank = Low

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

	Loligo pealeii	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	1.8	2.6	
	Other Stressors	1.4	2.0	
	Population Growth Rate	1.2	2.6	
	Spawning Cycle	1.4	2.5	
	Complexity in Reproduction	1.5	2.4	
	Early Life History Requirements	2.6	1.8	
	Sensitivity to Ocean Acidification	1.4	2.4	
	Prey Specialization	1.4	2.8	
	Habitat Specialization	1.1	2.8	
	Sensitivity to Temperature	1.5	3.0	
	Adult Mobility	1.2	3.0	
	Dispersal & Early Life History	1.8	2.1	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	2.4	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	2.1	1.0	
	Sea Level Rise	1.3	1.5	
	Exposure Score	High		
Overall Vulnerability Rank		Low		



Longfin Inshore Squid (*Doryteuthis pealeii*)

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**. Only one sensitivity score was above 2.5: Early Life History Requirements (2.6). Longfin Inshore Squid have benthic egg masses, which are predominantly found in coastal waters.

Distributional Vulnerability Rank: **High** (100% certainty from bootstrap analysis). Three of the attributes indicated vulnerability to distribution shift. Longfin Inshore Squid are habitat generalists occurring pelagic habitats from the coast to at least the shelf edge. They are mobile and make onshore-offshore seasonal migrations. Spawning occurs in coastal waters and paralarvae have the potential to be broadly dispersed.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Longfin Inshore Squid on the Northeast U.S. Shelf is estimated to be positive, but this estimate is uncertain (66-90% certainty in expert scores). More habitat is likely to become available, particularly in the Gulf of Maine. However, productivity may decrease as ocean acidification continues.

Data Quality: 88% of the data quality scores were 2 or greater.

Climate Effects on Abundance and Distribution: Little is known about how climate will impact Longfin Inshore Squid; however, research on similar species suggests there may be some impact. For example, in the Northeast Atlantic, survival of embryos of the European Squid (*Loligo vulgaris*) decreased with increasing temperature and decreasing pH (Rosa et al., 2014). Timing of the inshore migration of Veined Squid (*Loligo forbesi*) is linked to temperature and in warmer years, this migration occurs earlier (Sims et al., 2001). Warming and ocean acidification will also likely impact Longfin Inshore Squid. Individuals raised under elevated pCO_2 demonstrated increased time to hatching and shorter mantle lengths; aragonite statoliths were also smaller, abnormally shaped and had an altered crystal structure (Kaplan et al., 2013). Manderson et al. (2011) found that temperature was an important component of Longfin Inshore Squid habitat and as temperature increases, the amount of available habitat should increase.

Life History Synopsis**:** Longfin Inshore Squid is a short-lived, coastal, schooling, pelagic cephalopod species that occurs from Newfoundland to the Gulf of Venezuela (NEFSC, 2011). This semelparous species most likely has a lifespan of less than one year (Cargnelli et al., 1999; NEFSC, 2011). Males grow faster and get larger than females, but most individuals mature around 16 cm mantle length (Cargnelli et al., 1999; NEFSC, 2011). Spawning occurs in bays and shallow coastal areas and on Georges Bank, probably year round, but with a peak in spring – summer (Cargnelli et al., 1999). Egg masses are laid in clusters on sand or mud bottom and attach to fixed objects like rocks, small boulders, and aquatic vegetation (Cargnelli et al., 1999; NEFSC, 2011). Eggs hatch after 10-27 days depending on temperature. Larvae are called paralarvae and are pelagic in near surface waters, but go deeper as they mature (Cargnelli et al., 1999). Paralarvae consume copepods primarily (Cargnelli et al., 1999). Paralarvae mature into juveniles, a stage that lasts approximately one month during which the squid remain in the near surface waters, but undergo a shift in diet from copepods to euphausiids and arrow worms (Cargnelli et al., 1999). At approximately 45 mm, the juvenile squid transition from a surface to a demersal lifestyle and begin to look and migrate like the adults (Cargnelli et al., 1999). Subadults occur year-round, migrating offshore in fall, overwintering along the continental shelf edge, returning inshore in spring, and mingling with adults in the summer (Cargnelli et al., 1999). The diet of subadults transitions from planktonic organisms to benthic crustaceans, polychaetes, shrimp, and small squid (Cargnelli et al., 1999). Adult Longfin Inshore Squid form large schools based on size and migrate offshore to the shelf edge and slope for the winter and inshore for the summer (Cargnelli et al., 1999). Longfin Inshore Squid also make diel vertical migrations into the water column at night (Cargnelli et al., 1999; NEFSC, 2011). Temperature effects migrations, distribution, growth, and spawning of the species (NEFSC, 2011). Adult squid consume crustaceans, polychaetes, small fish, and other squid, with an increasing reliance on fish and squid with size and while onshore, and more crustaceans consumed while offshore (Cargnelli et al., 1999). Longfin Inshore Squid are prey to marine mammals (longfin pilot whale and common dolphin), finfish (Bluefish, Black Sea Bass, Atlantic Mackerel, Atlantic Cod, Haddock, Pollock, Silver Hake, Red Hake, Sea Raven, Angel Shark, Monkfish (Goosefish), Spiny Dogfish, and Summer Flounder), and diving birds (Cargnelli et al., 1999). The species is most abundant between Georges Bank and Cape Hatteras, North Carolina, and this region is managed as a single stock (Cargnelli et al., 1999). The Mid-Atlantic Fishery Management Council manages Longfin Inshore Squid under the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. In 2010, Longfin Inshore Squid was not overfished, but it was unknown whether overfishing was occurring (NEFSC, 2011).

Literature Cited:

Cargnelli LM, Griesbach SJ, McBride C, Zetlin CA, Morse WW. 1999. Essential fish habitat source document: Longfin inshore squid, Loligo pealeii, life history and habitat characteristics. NOAA Tech Memo NMFS NE 146; 27 p. Accessed Online (October 2014): http://www.nefsc.noaa.gov/nefsc/publications/tm/tm146/

Kaplan MB, Mooney TA, McCorkle DC, Cohen AL. Adverse effects of ocean acidification on early development of squid (Doryteuthis pealeii). PLOS ONE, 2013; 8(5): e63714. doi: 10.1371/journal.pone.0063714

Manderson J, Palamara L, Kohut J, Oliver MJ. Ocean observatory data are useful for regional-habitat modeling of species with different vertical habitat preferences. Mar Ecol Prog Ser. 2011; 438: 1-17. doi:10.3354/meps09308

Mid-Atlantic Fishery Management Council (MAFMC). 2011. Amendment 11 to the Atlantic mackerel, squid, and butterfish (MSB) fishery management plan (FMP). MAFMC [Dover, DE]. 559 p + appendices. Accessed online (June, 2014): http://www.mafmc.org/fisheries/fmp/msb

Northeast Fisheries Science Center. 2011. 51st Northeast Regional Stock Assessment Workshop (51st SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-02; 856 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. Accessed online (October 2014): http://www.nefsc.noaa.gov/publications/crd/crd1102/

Rosa R, Trübenbach K, Pimentel MS, Boavida-Portugal J, Faleiro F, Baptista M, et al. Differential impacts of ocean acidification and warming on winter and summer progeny of a coastal squid (Loligo vulgaris). J Exp Biol 2014; 217(4): 518-525. doi: 10.1242/jeb.096081

Sims DW, Genner MJ, Southward AJ, Hawkins SJ. Timing of squid migration reflects North Atlantic climate variability. Proc Biol Sci. 2001; 268(1485): 2607-2611. doi: 10.1098/rspb.2001.1847