Thorny Skate − *Amblyraja radiata*

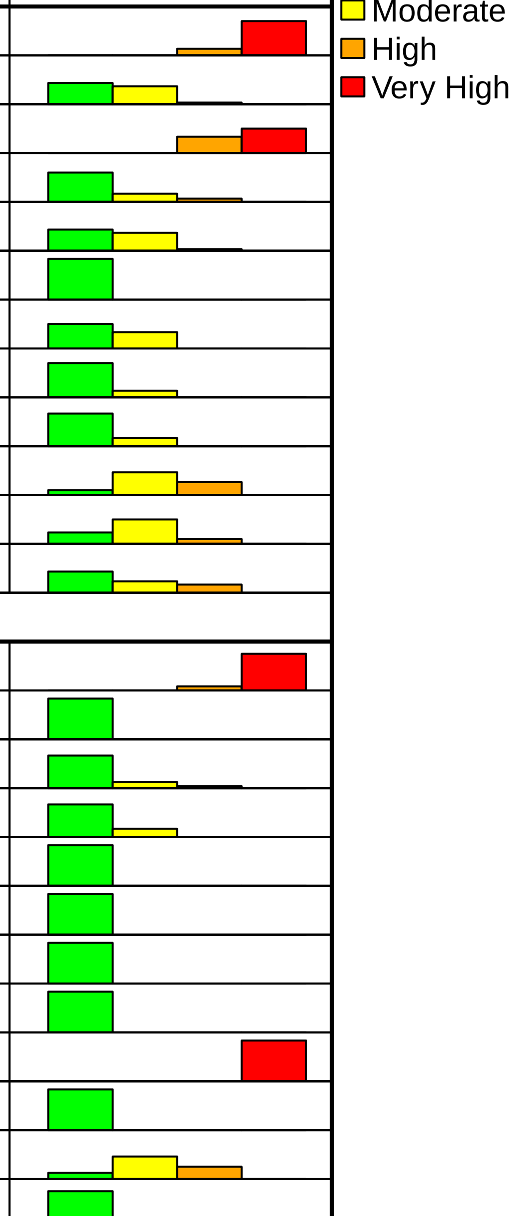
Overall Vulnerability Rank = High

Biological Sensitivity = High

Climate Exposure = High

Data Quality = 88% of scores ≥ 2

	Amblyraja radiata	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	3.8	2.8	
	Other Stressors	1.5	1.8	
	Population Growth Rate	3.6	2.6	
	Spawning Cycle	1.4	2.8	
	Complexity in Reproduction	1.5	2.0	
	Early Life History Requirements	1.0	3.0	
	Sensitivity to Ocean Acidification	1.4	3.0	
	Prey Specialization	1.2	3.0	
	Habitat Specialization	1.2	3.0	
	Sensitivity to Temperature	2.2	2.8	
	Adult Mobility	1.8	2.4	
	Dispersal & Early Life History	1.7	2.8	
	Sensitivity Score	High		
Exposure variables	Sea Surface Temperature	3.9	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.2	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		High		



Thorny Skate (*Amblyraja radiata*)

Overall Climate Vulnerability Rank: **High** (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). Thorny Skate are demersal and complete their life cycle in marine habitats.

Biological Sensitivity: **High**. Two attributes scored above 3.0: Stock Status (3.8) and Population Growth Rate (3.6). The Thorny Skate index is below the biomass target and biomass threshold and has been declining since the 1960s (NEFSC 2013). In general, skates have a low population growth rate (higher sensitivity to climate change) (Frisk 2010).

Distributional Vulnerability Rank: **High** (100% certainty from bootstrap analysis). Thorny Skate are habitat generalists and moderately mobile as adults. In addition, skate egg cases are subject to movement by currents and juveniles may move on scales of 1-10 km's.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Thorny Skate is very likely to be negative (>95% certainty in expert scores). Thorny Skate is a cold-water species that has shown declines in abundance in recent years. Warming and acidification may reduce productivity further.

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

Climate Effects on Abundance and Distribution: Little specific information exists on the effect of climate on Thorny Skate. Di Santo (2015) found that increased warming and acidification reduce body condition of newly hatched Little Skate. These reductions in size could result in reduced juvenile survival and thus recruitment if similar effects occur in Thorny Skate. Nye et al. (2009) found a small shift southward accompanied by a shift into deeper water. Swain and Benoit (2006) documented a shift into deeper water in the Gulf of Saint Lawrence and argued that this resulted from density-dependent habitat selection not a climatic shift in preferred habitat.

Life History Synopsis**:** Thorny Skate is a boreal to arctic, large-bodied skate species found on both sides of the Atlantic Ocean. In the western North Atlantic, Thorny Skate occurs from western Greenland to South Carolina, but is uncommon south of Georges Bank (Packer et al., 2003). Thorny Skate is a late maturing species that begins to mature between 5-11 years and mates using internal fertilization (Packer et al., 2003; Sulikowski et al., 2006). Eggs are encapsulated singly in a rectangular, horned egg case (Packer et al., 2003). Females with fully formed egg capsules are found year round, but the proportion of females with eggs is highest during summer (Packer et al., 2003). Later maturing females produce larger eggs (Packer et al., 2003). Embryonic development in the egg case may take 2-3 years in cold water (Packer et al., 2003). Halibut, Monkfish (Goosefish), Greeland Sharks, and predatory gastropods eat embryonic skates (Packer et al., 2003). After hatching, the juvenile skate consumes yolk for 2-4 months before beginning active feeding (Packer et al., 2003). Juveniles are common in the Gulf of Maine and northern Georges Bank over sand, gravel, broken shell, pebbles, or soft mud of the mid- and outer-shelf, in areas with 4-9^{o}C bottom water (Packer et al., 2003). In the southern part of their range, Thorny Skate are only found on the continental slope (McEachran, 2002). Adults occur in similar conditions, but tend not to occur as shallow as younger skates (Packer et al., 2003). Thorny Skate may make small seasonal movements, but in tagging studies, are rarely collected far from the tagging site, and appear to be nearly sedentary (McEachran, 2002; Packer et al., 2003). Thorny Skate prey opportunistically on the most abundant benthic prey species in the area (Packer et al., 2003). Polychaetes, decapods, and cephalopods are major prey species, but fishes are occasionally dominant (Packer et al., 2003). An ontogenetic shift in the importance of prey from crustaceans to polychaetes to fish and squid has been observed, but regional differences in prey abundance complicate the pattern (Packer et al., 2003). Seals, sharks, and Halibut are common predators of the species (Packer et al., 2003). The New England Fishery Management Council manages Thorny Skate as part of a skate complex. Steady declines in abundance since the 1970s led the Council to prohibit its possession since 2003 (NEFSC, 2007). In the most recent assessment update, Thorny Skate was overfished, and also experiencing overfishing (NEFSC, 2014).

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