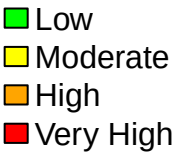
Anchovies − *Anchoa spp.*

Overall Vulnerability Rank = Low

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

	Anchoa spp.	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	1.7	1.4	
	Other Stressors	2.1	2.2	
	Population Growth Rate	1.2	2.8	
	Spawning Cycle	1.6	3.0	
	Complexity in Reproduction	1.3	2.2	
	Early Life History Requirements	2.5	2.2	
	Sensitivity to Ocean Acidification	1.4	2.4	
	Prey Specialization	1.2	2.4	
	Habitat Specialization	1.5	3.0	
	Sensitivity to Temperature	1.4	2.6	
	Adult Mobility	2.2	2.4	
	Dispersal & Early Life History	1.9	2.6	
	Sensitivity Score	Low		
Exposure variables	Sea Surface Temperature	4.0	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	2.6	3.0	
	Variability Salinity	1.2	3.0	
	Air Temperature	3.4	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.1	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	2.3	1.5	
	Exposure Score	High		
Overall Vulnerability Rank		Low		



Anchovies (*Anchoa hepsetus / Anchoa mitchilli*)

Overall Climate Vulnerability Rank: **Low** (80% 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 attribute was scored at a 2.5 or higher: Early Life History Requirements (2.5). Anchovies spawn in estuarine and nearshore habitats.

Distributional Vulnerability Rank: **High** (89% certainty from bootstrap analysis). Two attributes contributed to the high vulnerability for a distribution shift. Anchovies are habitat generalists and occur in estuarine and coastal waters throughout the southern portion of the Northeast U.S. Shelf. Anchovies also have early life stages that disperse in the coastal zone; whether there is exchange among estuarine systems is unknown.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on anchovies on the Northeast U.S. Shelf is very likely to be positive (>95% certainty in expert scores). As warming continues more habitat in the Northeast U.S. is expected to become available. Based on research in other regions, population productivity is also likely to increase with continued warming. The effect of ocean acidification over the next 30 years is likely to be minimal.

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

Climate Effects on Abundance and Distribution: There have been surprisingly few studies of the effect of climate change on *Anchoa* spp., especially in the Northeast U.S. Shelf ecosystem. Lou and Brandt (1993) developed a bioenergetics model for *Anchoa mitchilli* in the Chesapeake Bay; their work indicated that Bay Anchovy consumption of zooplankton will increase with warming waters. In the Black Sea using an ecosystem bioenergetics model, Güraslan et al. (2014) indicated that population productivity of anchovies would increase as temperature rises.

Life History Synopsis**:** Anchovies are small, coastal, pelagic, schooling species found along most of the western North Atlantic coast including the Gulf of Mexico (Able and Fahay, 2010). These highly fecund species mature early (after their first winter or approximately 10 months), have a long spawning season (spring to early fall in temperate waters, possibly year-round in subtropical zones), and batch spawn often (every 1-4 days for a total of approximately 55 batches in a season; Munroe, 2002). The energy for this large spawning effort comes from daily consumption, not stored energy, and peak spawning corresponds to peak microzooplankton abundance (Munroe, 2002). Eggs are pelagic and hatch in approximately 24 hours (Hildebrand, 1963). Larvae absorb yolk within 2 days (Hildebrand, 1963; Munroe, 2002). Eggs and larvae are planktonic, both in estuaries and on the inner shelf, and are usually found in surface waters, but may go deeper at night (Munroe, 2002; Able and Fahay, 2010). Anchovy larvae are very common and are often the most abundant ichthyoplankton in collections (Munroe, 2002). Juvenile anchovies occur in estuaries during summer, but some species or regional populations may make winter migrations to deeper water within the estuary or to the inner-shelf (Munroe, 2002). Able to tolerate a wide range of salinities, adult anchovy occur from as far offshore as the Gulf Stream all the way into freshwater, but are most common on the coastal inner-shelf and in estuaries (Munroe, 2002; Able and Fahay, 2010). Cross-shelf and along-shelf seasonal migrations to avoid sharp drops in

temperature may occur (Munroe, 2002; Able and Fahay, 2010). Juvenile and adult anchovies are planktivorous, consuming zooplankton such as copepods, mysids, and occasionally (when >100 mm) fish larvae and other small fish (Munroe, 2002; Able and Fahay, 2010). Weakfish, Bluefish, Atlantic Mackerel, and many other predatory fish, sharks, and birds prey on anchovies (Hildebrand, 1963; Munroe, 2002; Able and Fahay, 2010). Anchovy are not managed in the western North Atlantic and are generally one of the most abundant species in bays, estuaries, and coastal systems (Munroe, 2002). However, natural mortality is very high (approximately 95%) for this well-utilized prey species that links secondary production directly to fisheries (Munroe, 2002).

Literature Cited:

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