Alewife − *Alosa pseudoharengus*

Overall Vulnerability Rank = Very High

Biological Sensitivity = High
Climate Exposure = Very High
Data Quality = 79% of scores ≥ 2

Alosa pseudoharengus		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	2.5	1.4	
	Other Stressors	3.3	2.2	
	Population Growth Rate	2.2	1.4	
	Spawning Cycle	3.2	2.9	
	Complexity in Reproduction	3.2	3.0	
	Early Life History Requirements	3.3	2.4	
	Sensitivity to Ocean Acidification	1.5	1.8	
	Prey Specialization	1.5	3.0	
	Habitat Specialization	2.6	3.0	
	Sensitivity to Temperature	2.0	3.0	
	Adult Mobility	1.6	2.8	
	Dispersal & Early Life History	2.8	2.6	
	Sensitivity Score	High		
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	4.0	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.3	3.0	
	Variability in Precipitation	1.4	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.0	1.0	
	Sea Level Rise	2.8	1.5	
	Exposure Score	Very High		
Overall Vulnerability Rank		Very High		

Low
Moderate
High
Very High

Alewife (*Alosa pseudoharengus*)

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

Climate Exposure: **Very High**. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Air Temperature (4.0). Alewife are anadromous, spawning in freshwater, developing in freshwater and estuarine habitats, feeding as adults in marine habitats.

Biological Sensitivity: **High**. Four sensitivity attributes scored above 3.0: Other Stressors (3.3), Early Life History Requirements (3.3), Spawning Cycle (3.2), Complexity in Reproduction (3.2). Alewife are anadromous and exposed to a number of other stressors including habitat destruction, blockage to spawning habitats, and contaminants (Limburg and Waldman, 2009). Spawning time varies latitudinally and is linked to spring warming (Monroe, 2002). Eggs and larvae inhabit freshwaters and then juveniles move to estuarine and ocean waters.

Distributional Vulnerability Rank: **Low** (62% certainty from bootstrap analysis). Alewife have a relatively high degree of spawning site fidelity, limiting the ability of the species to shift distribution.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Alewife is likely to be negative (90-95% certainty in expert scores). Climate change will probably cause marine distributions to continue to shift, thereby causing longer migrations to natal rivers. Changes in rivers from increased precipitation and warming may cause decreases in productivity particularly in the southern portion of the Northeast U.S. shelf. The effect of ocean acidification over the next 30 years is likely to be minimal.

Data Quality: 79% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: Alewife productivity and distribution are susceptible to climate change. Tommasi et al. (2015) indicated that recruitment was affected by stream temperatures and river flow, both of which will be impacted by climate change. A number of other components of Alewife physiology and ecology are affected by temperature (Kellogg, 1982; Ellis and Vokoun, 2009) and other climate factors such as changes in streamflow and sea-level rise may also affect Alewife (NMFS, 2012). Distribution in the marine stage is also affected by temperature. Nye et al. (2009) found large shifts in the distribution of Alewife at sea and Lynch et al. (2014) developed projections of the change in the distribution of thermal habitat. However, natal homing is an important element in Alewife life history, thus the marine distribution may be changing faster than the spawning distribution.

Life History Synopsis**:** Alewife is an anadromous species, meaning adults migrate from estuarine and marine feeding habitat to freshwater spawning and nursery habitat. Alewife are iteroparious; adults can return to rivers in multiple years to spawn. Alewife occurs from Newfoundland to Florida, but individuals are predominantly found from Nova Scotia to Virginia (Munroe, 2002). The stock is contiguous range wide, but three regional genetic groupings have been documented: Northern New England, Southern New England, and Mid Atlantic (Palkovacs et al., 2013; NMFS, 2013). Alewife reach sexual maturity after 3-5 years for males and 4-6 years for females, and some portion of the population are repeat spawners (Loesch, 1987; Munroe, 2002). The spawning migration begins in early spring through August, varying by latitude and affected by water temperature (Monroe, 2002). Spawning occurs in slow moving freshwater and lasts a few days before spent adults move downstream (Munroe, 2002). Migration distances vary by river, but movement upstream is influenced by light intensity, water

flow, and temperature (Munroe, 2002). Eggs are demersal for the first several hours, but become less adhesive during hardening and are eventually pelagic (Munroe, 2002). Eggs and larvae can survive a range of salinities, but prefer freshwater (Loesch, 1987; Klauda et al., 1991; Wang and Kernehan, 1979). The egg stage lasts less than a week; during which time, the egg and yolk-sac-stage larvae drift downstream to slower-moving water with cool to mild temperatures (Wang and Kernehan, 1979; Munroe, 2002). Feeding begins within a week of hatching (Munroe, 2002). Larvae are selective feeders on cladocerans and copepods adding larger specimens as they grow (Nigro and Ney, 1982; Stone and Jessop, 1992; Munroe, 2002). Transformation to the juvenile stage occurs a little over a month after hatching, but juveniles remain in slow-moving, freshwater and estuarine nursery habitat until the summer or autumn migration to sea (Bigelow and Shroeder, 1953; Jones et al., 1978; Wang and Kernehan, 1979; Munroe, 2002). Juveniles are opportunistic feeders on seasonally available zooplanktonic and benthic organisms such as insects, amphipods, ostracods, and oligochaete worms (Watt and Duerden, 1974; Gregory et al., 1983; Grabe, 1996). Alewife adults can occur in landlocked freshwater systems, but are most often found from nearshore estuarine to offshore marine habitats (Munroe, 2002; Nye et al., 2013). This pelagic schooling species uses diel vertical migrations to follow zooplankton such as copepods, amphipods, and chaetognaths, and small fishes (Bowman et al., 2000, Monroe, 2002). Adults are most common in areas with cool bottom temperatures in a wide range of salinities (Munroe, 2002; Nye et al., 2013). Alewife at all stages is important prey for fish, birds, amphibians, reptiles and mammals (Klauda et al., 1991, Monroe, 2002). Alewife abundance has been in decline throughout the species' range for decades likely caused by heavy fishing and habitat destruction (Haas-Castro, 2006). As a result, NMFS has declared Alewife a Species of Concern, several states have declared fishing moratoriums, and efforts are being made to restore access to spawning and nursery habitat throughout the range (ASMFC, 2012).

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