

Atlantic Wolffish – *Anarhichas lupus*

Overall Vulnerability Rank = High ■

Biological Sensitivity = High ■

Climate Exposure = High ■

Data Quality = 83% of scores ≥ 2

<i>Anarhichas lupus</i>		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)	
Sensitivity attributes	Stock Status	3.6	1.4		
	Other Stressors	1.4	1.8		
	Population Growth Rate	3.6	2.6		
	Spawning Cycle	3.0	2.2		
	Complexity in Reproduction	1.8	2.8		
	Early Life History Requirements	1.9	2.1		
	Sensitivity to Ocean Acidification	2.5	2.1		
	Prey Specialization	1.1	3.0		
	Habitat Specialization	1.1	2.8		
	Sensitivity to Temperature	2.0	2.8		
	Adult Mobility	2.6	2.7		
	Dispersal & Early Life History	2.2	2.5		
	Sensitivity Score		High		
	Exposure variables	Sea Surface Temperature	3.9	3.0	
Variability in Sea Surface Temperature		1.0	3.0		
Salinity		1.1	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			

Atlantic Wolffish (*Anarhichas lupus*)

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). All life stages of Atlantic Wolffish use marine habitats.

Biological Sensitivity: **High**. Three sensitivity attributes scored above 3.0: Stock Status (3.6), Population Growth Rate (3.6), and Spawning Cycle (3.0). Atlantic Wolffish is on the NMFS Species of Concern List, but a petition to list Atlantic Wolffish under the Endangered Species Act was denied (Atlantic Wolffish Biological Review Team, 2009; NMFS, 2009). Atlantic Wolffish are late maturing (5-6 years) and slow growing (Atlantic Wolffish Biological Review Team, 2009). Male Atlantic Wolffish provide parental care for eggs during the spring reproduction season (Keats et al. 1985) and thus, reproductive output is relatively low and the spawning occurs in a particular season.

Distributional Vulnerability Rank: **Moderate** (74% certainty from bootstrap analysis). Atlantic Wolffish are relatively sedentary and prefer complex habitats. In addition, dispersal of early life stages is limited.

Directional Effect in the Northeast U.S. Shelf: The effect of climate change on Atlantic Wolffish on the Northeast U.S. Shelf is very likely to be negative (>95% certainty in expert scores). Atlantic Wolffish is a cold-temperate species and warming could limit habitat; shifts into deeper water have been observed. Ocean acidification may also negatively affect molluscan prey and thereby indirectly affect Atlantic Wolffish.

Data Quality: 83% of the data quality scores were 2 or greater indicate that data quality is moderate.

Climate Effects on Abundance and Distribution: Atlantic Wolffish is adapted for cold-water environments, producing antifreeze proteins (Desjardins et al., 2012). The optimal temperature for juvenile growth is 9-11°C (McCarthy et al., 1999). The effect of warming on population productivity has not been explicitly addressed, but given the temperature preferences for the species, it is likely that productivity will decrease in the Northeast U.S. Shelf Ecosystem. In addition, distributions are deepening both in the Northeast U.S. Shelf and the North Sea (Dulvy et al., 2008; Nye et al., 2009).

Life History Synopsis: Atlantic Wolffish is a benthic marine species found along both coasts of the northern North Atlantic, but particularly from Davis Strait to southern New England in the western North Atlantic (Rountree, 2002). Atlantic Wolffish reach maturity in 5-6 years (Atlantic Wolffish Biological Review Team, 2009). Adults make spawning migrations to colder waters and rocky substrate (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Males and females form bonded pairs during spring or summer, and mate, through internal fertilization, during summer and autumn (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Eggs are hidden in nests under rocks and boulders and guarded by males for several months (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Eggs remain benthic and hatch after 3-9 months partially influenced by water temperature (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Early larvae remain on the bottom near the hatch site from several hours to up to a week; then enter the water column and remain pelagic from 2 weeks to up to 2 months, in colder climates, before settling to the benthos (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). While pelagic, larvae consume other fish larvae and small crustaceans such as amphipods and decapod larvae (Rountree, 2002). Juveniles can be found throughout a range of substrates and depths on the continental shelf and slope, but show

a slight preference for the shelter of rocks, large stones and sandy feeding habitats (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Juvenile diet includes echinoderms and molluscs (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Spiny Dogfish, Sea Raven, and Atlantic Cod are the primary predators of juveniles (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Adult Atlantic Wolffish make seasonal migrations from shallow to deep waters in the autumn and deep to shallow in spring (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Adults use their formidable teeth to consume hard-shelled invertebrates such as molluscs, crustaceans, echinoderms, and occasionally fish (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Adult wolffish act as apex predators in some habitats, but have been collected from the stomachs of Greenland Shark, Atlantic Cod, Haddock, gray seal, and Sea Raven (Rountree, 2002; Atlantic Wolffish Biological Review Team, 2009). Atlantic Wolffish are rarely collected and the population is believed to be in decline; however a review committee determined listing the species as Endangered or Threatened was unwarranted. The western Atlantic population of Atlantic Wolffish remains on the Species of Concern List (Atlantic Wolffish Biological Review Team, 2009; NMFS, 2009).

Literature Cited:

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