Northern rock sole − *Lepidopsetta polyxystra*

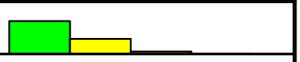
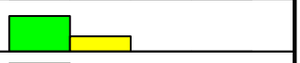
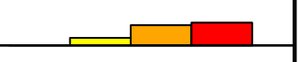
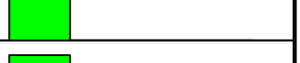
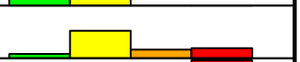
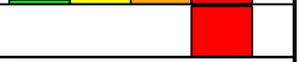
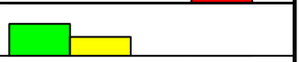
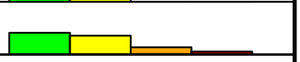
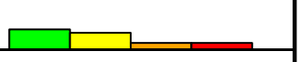
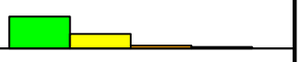
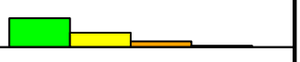
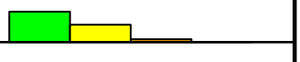
Overall Vulnerability Rank = Low

Biological Sensitivity = High

Climate Exposure = Low

Sensitivity Data Quality = 92% of scores ≥ 2

Exposure Data Quality = 56% of scores ≥ 2

	Lepidopsetta polyxystra	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.4	3.0	
	Prey Specificity	1.4	3.0	
	Adult Mobility	1.3	3.0	
	Dispersal of Early Life Stages	1.2	2.5	
	Early Life History Survival and Settlement Requirements	2.8	1.8	
	Complexity in Reproductive Strategy	1.6	2.8	
	Spawning Cycle	3.3	2.8	
	Sensitivity to Temperature	1.4	2.2	
	Sensitivity to Ocean Acidification	1.1	2.8	
	Population Growth Rate	3.4	3.0	
	Stock Size/Status	1.0	3.0	
	Other Stressors	1.3	2.8	
	Sensitivity Score	High		
Exposure factors	Sea Surface Temperature	2.1	2.5	
	Sea Surface Temperature (variance)	1.3	2.5	
	Bottom Temperature	2.0	3.0	
	Bottom Temperature (variance)	1.5	3.0	
	Salinity	1.4	2.0	
	Salinity (variance)	2.5	2.0	
	Ocean Acidification	4.0	3.0	
	Ocean Acidification (variance)	1.4	3.0	
	Phytoplankton Biomass	1.8	1.2	
	Phytoplankton Biomass (variance)	1.9	1.2	
	Plankton Bloom Timing	1.4	1.0	
	Plankton Bloom Timing (variance)	2.0	1.0	
	Large Zooplankton Biomass	1.5	1.0	
	Large Zooplanton Biomass (variance)	1.6	1.0	
	Mixed Layer Depth	1.3	1.0	
	Mixed Layer Depth (variance)	1.7	1.0	
	Currents	1.3	2.0	
	Currents (variance)	1.5	2.0	
	Air Temperature	NA	NA	
	Air Temperature (variance)	NA	NA	
	Precipitation	NA	NA	
	Precipitation (variance)	NA	NA	
	Sea Surface Height	NA	NA	
	Sea Surface Height (variance)	NA	NA	
	Exposure Score	Low		
Overall Vulnerability Rank		Low		

Low
Moderate
High
Very High

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Northern rock sole (*Lepidopsetta polyxystra*)

Overall Climate Vulnerability Rank: **Low**. (52% certainty from bootstrap analysis).

Climate Exposure: **Low**. With the exception of ocean acidification (4.0), all exposure factors had scores less than 2.5.

Biological Sensitivity: **High**. Spawning cycle (3.3) and population growth rate (3.5) were ranked as "high" sensitivity, and early life history survival (2.8) was ranked as "moderate" sensitivity.

Potential for distribution change: **Very High** (82% certainty from bootstrap analysis). Three attributes (adult mobility, dispersal of early life stages, and habitat specificity) indicated very high potential for distribution change.

Directional Effect in the Eastern Bering Sea: Projected climate change in the eastern Bering Sea is expected to have a neutral effect on northern rock sole, with 78% certainty in expert scores.

Data Quality: 92% of the sensitivity attributes, and 56% of the exposure factors, had average data quality scores of 2 or greater (indicating at least "moderate" data quality).

Climate Effects on Abundance and Distribution:

It is not known what effect climate has on the distribution of late juvenile and adult Bering Sea northern rock sole. Favorable, strong recruitment has been found to be positively correlated with anomalously warm bottom temperature and on-shore springtime winds (Wilderbuer et al. 2002, Wilderbuer et al. 2013, Cooper et al. 2014, Cooper and Nichol 2016). In addition, a year effect has been observed on somatic growth where temperature is positively correlated with annual bottom temperature (Matta et al. 2010). Studies on the spatial abundance from survey catches did not indicate large differences in population distributions between warm and cold years (Spencer 2008).

Life History Synopsis: Northern rock sole (*Lepidopsetta polyxystra*) are distributed primarily on the eastern Bering Sea continental shelf and in much lesser amounts in the Aleutian Islands region. Two species of rock sole are known to occur in the North Pacific Ocean, a northern rock sole (*L. polyxystra*) and a southern rock sole (*L. bilineata*) (Orr and Matarese 2000). These species have an overlapping distribution in the Gulf of Alaska, but the northern species comprise the majority of the Bering Sea and Aleutian Islands populations where they are managed as a single stock.

Centers of abundance for rock soles occur off the Kamchatka Peninsula (Shubnikov and Lisovenko 1964), British Columbia (Forrester and Thompson 1969), the central Gulf of Alaska, and in the southeastern Bering Sea (Alton and Sample 1975). Adults exhibit a benthic lifestyle and seem to occupy separate winter (spawning) and summertime feeding distributions on the southeastern Bering Sea continental shelf. Northern rock sole in the Bering Sea are managed as a single stock and there is no evidence of stock structure. They spawn during the winter-early spring period of December-March.

Adults live year round on the shelf and move seasonally within its limits. From over-winter grounds near the shelf margins, adults begin a migration onto the central and northern shelf of the eastern Bering Sea, primarily at depths of less than 100 m. Large spawning aggregations capable of supporting a roe fishery form on the middle shelf and some near shore areas of Bristol Bay. Migrations for spawning, using selective tidal stream transport, have been documented from archival tags. Spawning usually occurs during the winter-early spring period of December through March on hard sandy ground. This habitat is abundant and partially disturbed. Existing on both sand and mud and sand/mud habitats, they may be considered habitat generalists. Adults consume polycheates, bivalves, amphipods and sand dollars (Livingston and DeReynier 1996). Diet depends on substrate type and they tend to be generalists (Yang and Yeung 2013, Yeung and Yang 2014, Yeung et al. 2013). They occur in survey catches in the Northern Bering Sea but are less abundant than on the southern Bering Sea shelf (Lauth 2011).

Eggs are demersal and, after hatching, larvae have been found in ichthyoplankton sampling over a widespread area of the Bering Sea shelf, typically in April - June. Advection may be crucial for northern rock sole as the spawning and nursery grounds are 1000's of km apart. This species must rely on tides, currents and winds to deliver larvae to inshore areas where metamorphosis occurs. The age at metamorphosis is unknown but is assumed to be around 100 days. Upon settlement in nearshore areas from 1-40 m deep, juveniles preferentially select sediment suitable for feeding on meiofaunal prey and burrowing for protection but may be prevented from settling inshore by the seasonal inner front. Juveniles are separate from the adult population, remaining in shallow areas until they reach approximately 15-20 cm. The age at 50% maturity is estimated at 7.8 years (Stark 2012).

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