LUMPFISH

Stock name: Lumpfish
Latin name: *Cyclopterus lumpus*
Geographical area: Barents Sea and Norwegian Sea (ICES subareas 1 and 2)
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Stock Sensitivity Attributes

HABITAT SPECIFICITY: Lumpfish (*Cyclopterus lumpus*, Cyclopteridae) is present across the northern Atlantic Ocean and is most abundant around the waters of Iceland, Norway, Greenland and Canada (Davenport, 1985; Eriksen et al., 2014). Lumpfish is also found in the North and Baltic Seas, and specimens have been caught along the coast of Portugal, the Mediterranean Sea and off Galicia, Spain. The stock definition is unclear, but populations in the eastern and western Atlantic are genetically differentiated (Kennedy et al., 2019; Pampoulie et al., 2014). It seems likely that there is some exchange of individuals between the Icelandic and Norwegian population due to the continuous distribution between Iceland and Norway (Kennedy et al., 2019; Pampoulie et al., 2014). The degree of exchange is unknown and thus it is unclear if it has any significant implications for assessment or management.

PREY SPECIFICITY: The feeding ecology of lumpfish is strongly opportunistic. Adults feed mainly on large planktonic organisms living in surface/mid waters. Specifically, studies on gut contents have reported: euphausiids, mysids and ctenophores, amphipods, isopods, small sandeels, and polychaetes (Davenport, 1985; Ingólfsson & Kristjánsson, 2002). They also prey on benthic organisms, particularly those dwelling upon seaweed.

SPECIES INTERACTION: Lumpfish has few known predators (Kennedy et al., 2019), e.g. killer whales (*Orcinus orca*, Delphinidae) (Jourdain et al., 2020). There is probably low competition from other species since the diet of lumpfish is so broad. One of their main food items are ctenophores for which there is little competition (Imsland et al., 2015).

ADULT MOBILITY: Lumpfish has a high swimming ability and displays long-distance migrations. Spawning takes place in coastal areas distributed all along the Norwegian coast. Furthermore, it seems that there is some exchange of individuals between the Icelandic and Norwegian populations (Pampoulie et al., 2014). Therefore, lumpfish can very likely move to new locations (Kennedy et al., 2015).

DISPERSAL OF EARLY LIFE STAGES: Dispersal occurs at a later stage (juvenile, probably 3 to 6 months old). It is unknown whether lumpfish return to their hatching area to spawn. The low genetic differentiation between Iceland and Norway suggests some exchange of individuals between the two countries and therefore high dispersal capacities (Pampoulie et al., 2014).

EARLY LIFE HISTORY SURVIVAL AND SETTLEMENT REQUIREMENTS: Larval requirements in the wild are not well known but lumpfish are easily reared in aquaculture (Imsland et al., 2015; Kennedy, 2018).

COMPLEXITY IN REPRODUCTIVE STRATEGY: Lumpfish spawn once (rarely twice) during their lifecycle (Kennedy, 2018).

SPAWNING CYCLE: Lumpfish has an extended ovary development period (at least 8 months for vitellogenesis) (Kennedy, 2018) and a relatively long spawning season (from late March until mid-July in Iceland) (Kennedy & Ólafsson, 2019).

SENSITIVITY TO TEMPERATURE: Lumpfish is abundant in the Barents Sea and found in a broad

temperature range of 0-11 °C. However, the majority of fish was found in the temperature range of 5-7 °C (juveniles) and 4-7 °C (adults), indicating a strong association with Atlantic water masses in the Barents Sea (Eriksen et al., 2014).

SENSITIVITY TO OCEAN ACIDIFICATION: This is unknown, but there are no obvious links between ocean acidification and lumpfish, whether it is direct or indirect (prey items or habitat).

POPULATION GROWTH RATE: Low to moderate: K= 0.256, age at maturation = 2 years, maximum age < 10 years, maximum length around 60 cm (Hedeholm et al., 2017; Kasper et al., 2014).

STOCK SIZE/STATUS: The current stock status of lumpfish populations spans the whole range from healthy and fairly certain, to depleted and unknown depending on the country. The populations in Iceland and Norway have increased after low population biomasses in the 1990s and are currently above the long-term average (Kennedy et al., 2019). Lumpfish population in Canada is depleted. There is less certainty about the population status in Greenland due to the short time-series. The population status in the Baltic Sea and Kattegat is unknown due to lack of reliable data. In the Barents Sea the lumpfish abundance and biomass were generally low during the 1980s, increased in the 1990s and were highest during the 2000s (Eriksen et al., 2014). The lowest biomass (212 t) and abundance index (36 million) were recorded in 1986, while the highest biomass (143,000 t) and abundance index (143 million) were recorded in 2007.

OTHER STRESSORS: There are no other known stressors than fishing.

Scoring of the considered sensitivity attributes

Sensitivity attributes, climate exposure based on climate projections allowing the evaluations of impacts of climate change, and accumulated directional effect scoring for Lumpfish (*Cyclopterus lumpus*) in ICES subareas 1 and 2. L: low; M: moderate; H: high; VH: very high, $Mean_w$: weighted mean; N/A: not applicable. Usage: this column was used to make ad hoc notes, including considerations about the amount of relevant data available: 1 = low, 2 = moderate; 3 = high. N/A = not applicable.

Lumpfish (*Cyclopterus lumpus*) in ICES subareas 1 and 2

SENSITIVITY ATTRIBUTES	L	M	H	VH	$Mean_w$	Usage	Remark
Habitat Specificity	5	0	0	0	**1.0**		
Prey Specificity	0	5	0	0	**2.0**		
Species Interaction	5	0	0	0	**1.0**		
Adult Mobility	5	0	0	0	**1.0**		
Dispersal of Early Life Stages	5	0	0	0	**1.0**		
ELH Survival and Settlement Requirements	5	0	0	0	**1.0**		
Complexity in Reproductive Strategy	5	0	0	0	**1.0**		
Spawning Cycle	0	0	5	0	**3.0**		
Sensitivity to Temperature	0	5	0	0	**2.0**		
Sensitivity to Ocean Acidification	5	0	0	0	**1.0**		
Population Growth Rate	3	2	0	0	**1.4**		
Stock Size/Status	5	0	0	0	**1.0**		
Other Stressors	5	0	0	0	**1.0**		
Grand mean					**1.34**		
Grand mean SD					**0.62**		

CLIMATE EXPOSURE	L	M	H	VH	$Mean_w$	Usage	*Directional Effect*
Surface Temperature	0	0	0	0		N/A	
Temperature 100 m	3	2	0	0	**1.4**	2	1
Temperature 500 m	0	0	0	0		N/A	
Bottom Temperature	0	0	0	0		N/A	
O_2 (Surface)	4	1	0	0	**1.2**	1	-1
pH (Surface)	4	1	0	0	**1.2**	1	-1
Gross Primary Production	1	2	1	1	**2.4**	1	1
Gross Secondary Production	1	1	2	1	**2.6**	1	1
Sea Ice Abundance	0	0	0	0		N/A	
Grand mean					**1.76**		
Grand mean SD					**0.68**		
Accumulated Directional Effect					**–**		**4.0**

***Accumulated Directional Effect*: POSITIVE**	**4.0**

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