BLUE WHITING

Stock name: Blue whiting
Latin name: *Micromesistius poutassou*
Geographical area: Northeast Atlantic (ICES subareas 1-2, 4-8, division 3a)
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Stock Sensitivity Attributes

HABITAT SPECIFICITY: The widely distributed blue whiting (*Micromesistius poutassou*, Gadidae) is a pelagic planktivorous gadoid found throughout the Northeast Atlantic. The species is distributed from the Iberian Peninsula and the Mediterranean in the south to the Barents Sea in the north, from the North Sea to the Mid-Atlantic ridge and even as far as the east coast of North America (Høines, 2018; ICES, 2018; Payne et al., 2012). During the spawning season, the species inhabits the west coast of the British Isles, Ireland and the Norwegian Sea (Bailey, 1982; Bainbridge & Cooper, 1973; Heino et al., 2008; Monstad, 2004; Payne et al., 2012).

PREY SPECIFICITY: The main feeding grounds of the blue whiting stock are found in the Norwegian Sea, to which individuals return after spawning along the Irish–Scottish shelf edge in spring (Høines, 2018; Huse et al., 2012). Blue whiting diet is broad, ranging from crustaceous zooplankton like krill and amphipods (together forming the main food items) to smaller fishes, including cannibalism. Particularly young blue whiting may compete for food with herring and mackerel, although at least with regard to the latter species, blue whiting stays or tend to stay deeper in the water column (V. Trenkel et al., 2015; V. M. Trenkel et al., 2014). Food availability is known to significantly affect growth rate (V. Trenkel et al., 2015).

SPECIES INTERACTION: Blue whiting may compete with the pelagic fish herring and mackerel for prey in the Norwegian Sea, as they utilize many of the same prey groups and species. Herring and blue whiting are potential competitors at the Arctic front, where the diet overlap can be quite high. However, these species differ to some extent in the size of prey, and they often have different vertical distributions in the water masses (Bachiller et al., 2016; Langøy et al., 2012; Utne et al., 2012). So, regarding larger prey such as euphausiids and amphipods, blue whiting shows a low dietary overlap with mackerel and herring, and stomach fullness and feeding incidence increase with length. Significant annual effects on diet composition and feeding-related variables suggests that the three species can adapt to different food and environmental conditions (Bachiller et al., 2016).

ADULT MOBILITY: Blue whiting may stay in a range of environmental conditions, from cold to warm temperate and with different prey types. Adults cover a significantly broader geographical area than younger specimens, especially in the more southern parts of the oceanic Atlantic (Belikov et al., 2011; Høines, 2018). Blue whiting should be considered highly mobile but the fact that the individuals are rather small in size (up to max 50 cm total length and 800 g total weight) implies rather high migration costs, especially during the lengthy spawning migration of those specimens inhabiting the outer part of the distribution area, e.g. found at high latitudes (Ushakov & Mazhirina, 1978).

DISPERSAL OF EARLY LIFE STAGES: The drift pattern of eggs of larvae might vary significantly among years due to large-scale oceanographic phenomena such as North Atlantic Oscillation (NAO) (Heino et al., 2008; Miesner & Payne, 2018) (see below).

EARLY LIFE HISTORY SURVIVAL AND SETTLEMENT REQUIREMENTS: The recruitment dynamics of blue whiting is highly variable indicating that both abiotic and biotic conditions are critically important, the latter includes e.g. predation by mackerel on pre-recruits of blue whiting (Heino et al., 2008; ICES, 2018; Miesner & Payne, 2018; Payne et al., 2012).

COMPLEXITY IN REPRODUCTIVE STRATEGY: Blue whiting spawns in high-saline Atlantic water masses from west of Ireland to north of Scotland (Ådlandsvik et al., 2001) where the offspring is transported with the Atlantic inflow towards the Norwegian Sea. Additionally, high spawning migration costs are given for parts of the population, which probably explains that atresia (resorption of developing oocytes) might be highly prevalent significantly reducing fecundity (Kjesbu, 1987; Mazhirina, 1978; Miesner & Payne, 2018).

SPAWNING CYCLE: Each female spawns several batches of eggs during the spawning. The fecundity style is, however, rather atypical for gadoids as it tends to be semi-determinate. The length of the spawning season lasts from February to April (Kjesbu, 1987; Mazhirina, 1978). The main spawning ground is along the edge of the continental shelf west of the British Isles and on the Rockall Bank plateau. Some spawning takes place in Norwegian fjords. Recent research indicates that adults actively select suitable spawning conditions (Belikov et al., 2011; Miesner & Payne, 2018).

SENSITIVITY TO TEMPERATURE: Blue whiting as a species may experience a broad temperature range as it inhabits waters off Morocco to the west of Svalbard.

SENSITIVITY TO OCEAN ACIDIFICATION: It is uncertain how ocean acidification might affect blue whiting, but, at least, it is clear that this species does not feed on “sensitive taxa” containing calcareous structures.

POPULATION GROWTH RATE: The various descriptors of blue whiting growth rate show highly various scores (Ushakov & Mazhirina, 1978): maximum length (50 cm): low score; maximum age (20 years): high score; age-at-maturity (2-3 years): moderate score; von Bertalanffy K (0.16-0.25): moderate score.

STOCK SIZE/STATUS: The blue whiting is managed in accordance with a Harvest Control Rule agreed by the coastal states, i.e. a long-term strategy where F (fishing mortality rate) = F_{MSY} (fishing mortality consistent with achieving maximum sustainable yield). However, there are disagreements between the coastal states with regards to the sharing of the quota between them. This has resulted in an increased harvest to a level above the agreed total allowable catches (TAC). This is a threat to a stock that is otherwise well managed through appropriate advice, regulations and enforcement (Høines, 2018; ICES, 2018, 2019). Over the last two decades ICES assessments show B/B_{MSY} (biomass/biomass maximum sustainable yield) ≥ 1.2, but where F (ages 3-7) has been above F_{MSY}, except for a short period around 2010. Corresponding figures on recruitment (age 1) has varied substantially (Was et al., 2008).

OTHER STRESSORS: Fishing plus environmental factors, especially during spawning (cf. salinity) (Heino et al., 2008; ICES, 2018; Miesner & Payne, 2018; Payne et al., 2012).

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 Blue whiting (*Micromesistius poutassou*) stock in ICES subareas 1-2, 4-8, division 3a. 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.

Blue whiting (*Micromesistius poutassou*) in ICES subareas 1-2, 4-8, division 3a

SENSITIVITY ATTRIBUTES	L	M	H	VH	$Mean_w$	Usage	Remark
Habitat Specificity	4	1	0	0	**1.2**		
Prey Specificity	4	1	0	0	**1.2**		
Species Interaction	3	2	0	0	**1.4**		
Adult Mobility	2	3	0	0	**1.6**		
Dispersal of Early Life Stages	4	1	0	0	**1.2**		
ELH Survival and Settlement Requirements	0	0	5	0	**3.0**		
Complexity in Reproductive Strategy	0	5	0	0	**2.0**		
Spawning Cycle	0	0	5	0	**3.0**		
Sensitivity to Temperature	5	0	0	0	**1.0**		
Sensitivity to Ocean Acidification	5	0	0	0	**1.0**		
Population Growth Rate	1	3	0	1	**2.2**		
Stock Size/Status	4	1	0	0	**1.2**		
Other Stressors	0	5	0	0	**2.0**		
Grand mean					**1.69**		
Grand mean SD					**0.70**		

CLIMATE EXPOSURE	L	M	H	VH	$Mean_w$	Usage	*Directional Effect*
Surface Temperature	0	0	0	0		N/A	
Temperature 100 m	0	0	0	0		N/A	
Temperature 500 m	0	3	2	0	**2.4**		1
Bottom Temperature	0	0	0	0		N/A	
O_2 (Surface)	5	0	0	0	**1**		0
pH (Surface)	4	1	0	0	**1.2**		-1
Gross Primary Production	5	0	0	0	**1**		1
Gross Secondary Production	0	5	0	0	**2**		1
Sea Ice abundance	0	0	0	0		N/A	
Grand mean					**1.52**		
Grand mean SD					**0.64**		
Accumulated Directional Effect					**–**		**4.2**

***Accumulated Directional Effect*: POSITIVE**	**4.2**

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