Spawning patterns of shallow-water hake (Merluccius capensis) and deep-water hake (M. paradoxus) in the Benguela Current Large Marine Ecosystem inferred from gonadosomatic indices

We use gonad- and body-weight data from 54,000 samples of Merluccius capensis and Merluccius paradoxus collected in all months of the years between 1991 and 2013 to infer peak spawning periods and areas in the Benguela Current Large Marine Ecosystem. We develop and apply a new gonadosomatic index threshold for identification of spawning individuals. Spawning M. capensis were observed throughout the study area, mainly in areas of about 100 m bottom depth. The highest proportions of spawning M. capensis females in the northern Benguela region were observed off central Namibia between 24.0 and 26.0°S. In the southern Benguela, peaks in the proportions of spawning M. capensis were observed in two areas off the South African West Coast (31.0-32.5°S and 34.5-36.0°S), whereas spawning females off the South African South Coast (east of 20°E) appeared to be more evenly distributed in space. Seasonality differed between areas. In the northern Benguela, the main spawning season of M. capensis appeared to be the austral winter (July-September, peaking in August), while off the South African South Coast, the main spawning season is suggested to be in summer (around January). Between these two extremes, on the western Agulhas bank in the southern Benguela, spawning peaks were observed in both summer and winter. These peaks largely coincided with peaks in phytoplankton production that are linked to upwelling conditions in the region. Hake condition decreased subsequent to the development of the gonads. The annual spawning cycle differed between small and large M. capensis. The current October-closure of the fishery in Namibia may not match the peak spawning in August/September and may need to be shifted to earlier in the year. Spawning M. paradoxus were mainly found in areas of 200-650 m bottom depths. In the northern Benguela, spawning M. paradoxus were observed as far north as 25°S in August. The proportion of spawning females peaked between 34.5°S and 36.5°S off the West Coast, and between 23.0°E and 26.5°E off the South Coast. It was suggested that M. paradoxus spawn throughout the year off the South African coast, with increased intensity around March and August-October. The finding of multiple spawning seasons and areas of both M. capensis and M. paradoxus strongly suggest multiple stocks (reproductive units).

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