

Collective behaviour of herring around the spawning peak

Georg Skaret and Aril Slotte

Abstract

We investigated collective behaviour of Norwegian spring spawning herring (*Clupea harengus* L.) around the peak spawning in the most important spawning area. Over a period of one month, 17 repeated quasi-identical acoustic surveys (nine at night-time and eight during day), each covering an area of approximately 450 square nautical miles and lasting for about 12 hours, were conducted. A single major spawning wave built up from 50 000 to 1.2 million tons in two days and subsequently decreased to 0.5 million tons during the next five days. This synchronous timing was corresponded by spatial synchrony through aggregative behaviour, as average shoal size experienced by the individuals increased with increasing biomass. A selection pressure therefore seems to be present not only for synchronous timing, but for spatial synchronisation probably as an anti-predatory strategy. Aggregation was strongest at the bottom during night-time, indicating that the major spawning happened in darkness. Night-time shoals were characterised by low packing density with little variance contrary to daytime shoals distributed deeply with generally high, but variable packing density. Apart from the bottom shoals, herring were typically dispersed in pelagic layers during night. The layers were recorded successively deeper towards the spawning peak corresponding with higher temperatures in the deep and suggesting that spawning synchrony is facilitated by an active use of the temperature profile to adjust rate of gonad maturation. Furthermore, there was a successive decrease in shoal height throughout the period probably reflecting a decreasing degree of motivational conflict within shoals. Individual preferences for vertical positions are likely to differ when variation in maturation state is high, since herring are demersal spawners and the bottom is a high-risk predation zone. When maturation states converge, individual motivations likely converge and a lower shoal height is expected. These observed variations in shoal height support model results of collective individual's responses to reproduction and predation in periods of dynamic motivation. We argue that observed collective behaviour during spawning is largely a reflection of the trade-off between reproduction and survival, including aggregation on the bottom to reduce an individual's risk of being targeted by a predator and variable packing density as adaptive responses to various levels of predation. The huge implications of the recorded behaviour for acoustic abundance estimates are briefly discussed.

G. Skaret¹ and A. Slotte. Institute of Marine Research, P.O. Box 1870, Nordnes, N-5817 Bergen, Norway.

¹ Corresponding author (e-mail:georg.skaret@imr.no)