

Seasonal variability of spawning grounds of squid and cuttlefish in north European waters

Vladimir Laptikhovsky¹, Louise Allcock², Leigh Barnwall², Christopher Barrett¹, Gavan Cooke³, Christian Drerup³, Christopher Firmin¹, Angus Jackson¹⁰, Sophie Lozach¹, Eleanor MacLeod⁵, Daniel Oesterwind⁶, Michael Petroni², Jean-Paul Robin⁷, Edel Sheerin², Anne-Marie Power², Graham J. Pierce^{8,9}

1 - Centre for Environment, Fisheries and Aquaculture Science (Cefas), Lowestoft, UK

2 - Ryan Institute, School of Natural Sciences, NUI Galway, Ireland

3- The Cephalopod Citizen Science Project, Dorset, UK

4- Marine Behavioural Ecology Group, Department of Zoology, University of Cambridge, UK

5 - Marine Scotland Science, Aberdeen, UK

6 - Thünen Institute of Baltic Sea Fisheries, Rostock, Germany

7 - Normandie Université, UNICAEN, Caen, France

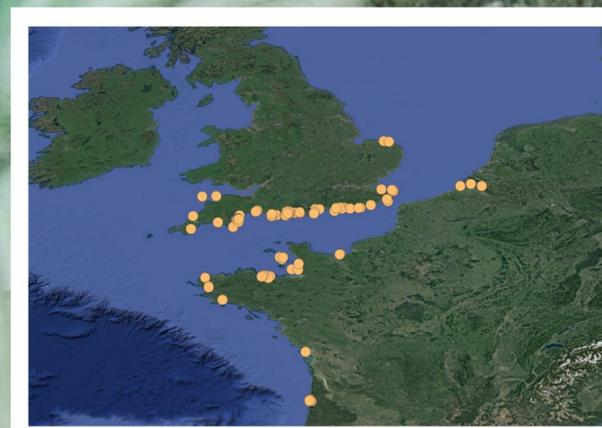
8 - Instituto de Investigaciones Marinas (CSIC), Vigo, Spain

9 - School of Biological Sciences, University of Aberdeen, Ross-on-Wye, U.K.

10 - Seasearch, Marine Conservation Society, Ross-on-Wye, UK



Reports on squid egg masses by Citizen Science (rectangles and triangles – identified to the species)



Reports on egg masses of the Common cuttlefish, *Sepia officinalis* by Citizen Science

Data on occurrence of squid (*Loligo forbesii* and *L.vulgaris*) and cuttlefish (*Sepia officinalis*) eggs both under water and washed on beaches in the ecoregions of Celtic Seas and Greater North Sea were collected by recreational divers, beach walkers, and just cephalopod enthusiasts. Recreational fishers provided some information on squid species composition and maturity. Citizen scientists collected observations on 378 squid egg masses, and on 328 cuttlefish egg masses and spawning behaviour. The Citizen Science information was considered together with scientific data of international research bodies (U.K., Ireland, France, Germany) obtained from catches of research and commercial vessels.

Spawning grounds of *L. forbesii* were found to form an external offshore semi-circle around the inshore spawning grounds of *L. vulgaris*, with the latter being centred on the English Channel and southernmost North Sea. Seasonally, the spawning grounds of both squids gradually shift eastward being driven by the local temperature regime. Spawning of both *Loligo* begins around November ending in July, though some developing egg masses persist until August–November. Nursery grounds follow the same seasonal shift from west to east, at least in *L. forbesii*.

Reproduction of cuttlefish begins in the western English Channel in March and also gradually progresses eastward following water warming. It attains the Netherlands in May, when peripheral spawning grounds expand north to Norfolk and into the Irish Sea. Despite a thermal regime favourable for egg development existing all around the UK and Ireland, spawning is normally restricted to the English Channel and southernmost North Sea with egg masses occasionally observed as far north as Isle of Man and Norfolk. Some other factors but temperature and availability of favourable spawning habitats might be responsible for absence of cuttlefish spawning in the northern part of the North Sea and west of Scotland.

Citizen science involved:

Facebook groups

Kalmaru, žukle, Norvegijoje (<https://www.facebook.com/groups/1135839429939981/>)

Squid fishing UK" (<https://www.facebook.com/groups/774425619306338>)

UK Cephalopod Reports (<https://www.facebook.com/groups/1772714999700580/>),

Blekksprutobservasjoner i Norge (<https://www.facebook.com/groups/669716393533330>)

Inktvis waarnemingen Nederland/Belgie (<https://www.facebook.com/groups/1915579675410208>)

Tintenfisch-Sichtungen Deutschland (<https://www.facebook.com/groups/1011071792400550>).

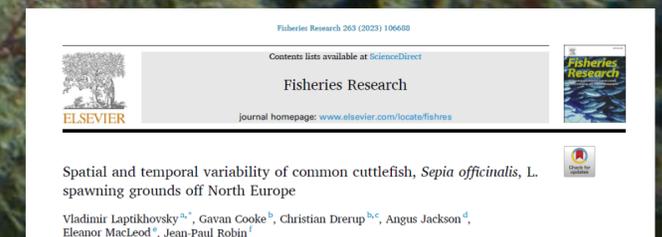
Other Citizen Science sources:

Seasearch (<https://www.seasearch.org.uk/>)

Base pour l'inventaire des observations subaquatiques (<https://bioobs.fr/les-especes/especes-recherchees/>)

iSpotNature (<https://www.ispotnature.org/communities/uk-and-ireland>)

Beach Explorer (<https://www.beachexplorer.org/en/>)



Ongoing Citizen Science Projects of the Centre for Environment, Fisheries and Aquaculture Science (Cefas) :

- Estimation of natural mortality and its variation in the common cuttlefish of the Northeast Atlantic using measurement of *post-mortem* cuttlebones found on beaches;
- Estimation of the extension and seasonal variability of squid spawning grounds in the Mediterranean Sea