

Occurrence of ocean sunfish, *Mola mola* near fronts in the western English Channel

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Surface occurrence of ocean sunfish (*Mola mola*) was recorded during summer (May–September) in the western English Channel off Plymouth over a six-year period between 1995 and 2001. Fifteen individuals of between 0.5–0.7 m estimated total length were sighted during 1651 hours of observation. Nearly all sightings (93%) occurred in June and July in water between 13 and 17°C. Sunfish were mostly associated with frontal and stratified water masses (86%) rather than in cooler, mixed water.

The habitat preferences of large pelagic fish species such as the sunfish, *Mola mola* (L.) are poorly understood because they are rarely encountered and hence have not been the subject of sustained investigations. Sunfish are epipelagic migrants of the high seas in tropical and temperate regions of the Mediterranean, the Atlantic, Indian, and Pacific Oceans (Wheeler, 1969). Key aspects of their biology are largely unknown, such as annual and diel movements, and the mode and location of breeding (Fraser-Brunner, 1951; Reiger, 1983). It has been suggested that the larger part of their lives are spent in deep water, although they are thought to undertake seasonal inshore migrations (Fraser-Brunner, 1951; Lee, 1986).

Mola mola are considered uncommon on the open coasts of the British Isles during summer (Aflalo, 1904; Wheeler, 1969). The apparent inshore migrations of sunfish are unpredictable, but usually thought to coincide with invasions of medusae, salps and ctenophores upon which it feeds (Fraser-Brunner, 1951). Other food types such as crustacea, ophiuroids, molluscs and fish have been found in stomachs of inshore specimens (Aflalo, 1904; Fraser-Brunner, 1951). On account of some specimens having empty stomachs and swimming feebly on their sides at the surface, and that active, often young, sunfish have been sighted only occasionally in European waters, it has been proposed that most of those seen in coastal waters are weak or dying specimens (Wheeler, 1969).

The occurrence of *M. mola* was recorded during visual surveys for basking sharks (*Cetorhinus maximus*). Surveys were conducted from a 10-m vessel in a 450 km² area off Plymouth (50°16'N 04°09'W) in the western English Channel. Daily searches were conducted as regularly as weather permitted (sea state code <4; wave height <1.25–2.50 m) from 1 May to 10 September in 1995 (598 h in total), 3 May to 16 August in 1996 (390 h), from 1 May to 31 July in 1997 (155 h), in 1999 (111 h) and 2000 (151 h), and from 1 May to 8 August in 2001 (246 h). Sunfish seen at the surface were slowly approached and their total length estimated in relation to the vessel's length. The position of each fish was determined using a Global Positioning System (GPS) (Valsat 03, MLR Electronique, France). Sea surface temperature (SST) was recorded at set survey stations (Yellow Springs Instruments model 58 meter, Ohio, USA) and those closest to sunfish locations on each day were used to indicate thermal habitat. To investigate habitat preferences of sunfish further, remote sensing images of SST were used to determine the broad water-mass type in which

sunfish were seen. Fish locations were mapped onto false-colour images of SST taken by the Advanced Very High Resolution Radiometer aboard National Oceanic and Atmospheric Administration satellite 14. Images of SST used for mapping were those taken on the same day sunfish were sighted, or at times not greater than seven days prior to, or after sightings. Three water mass types off Plymouth are present seasonally: mixed, frontal and stratified water (Sims et al., 2000), with frontal water forming a boundary between warm, stratified and cold, mixed waters (Le Fevre, 1986). The water mass types occurring in each SST satellite image were identified. The SST at mapped sunfish locations was taken from each image and a mean was calculated between these and actual measurements taken at set stations.

In total, 15 *M. mola* were seen at the surface of the water in the study area off Plymouth during 1651 hours of observation. The maximum number sighted in any year was five, although no sightings were made in 1997 (Figure 1). All fish seen were estimated

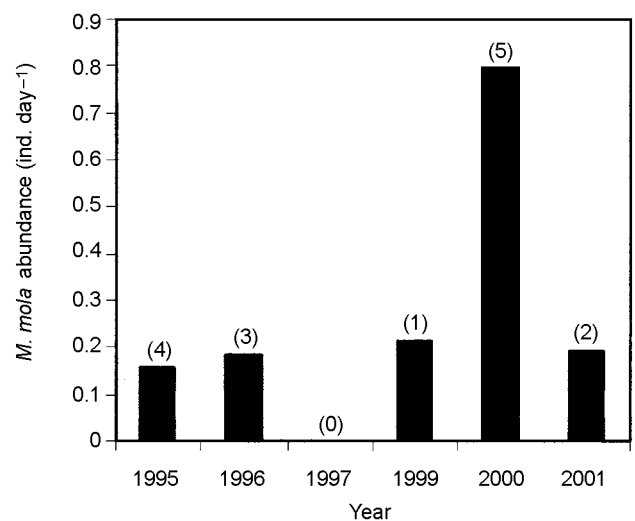


Figure 1. Occurrence of 15 individual *Mola mola* in the Plymouth study area between 1995–1997 and 1999–2001 as a function of annual search time grouped in 'day' (24 h) periods. The total number of *M. mola* sighted in each year is given in parentheses above the corresponding bar for each year.

to be between 0.5 and 0.7 m total length, and all were observed to be active swimmers: they dived out of sight with rapid beats of the dorsal and ventral fins when the research vessel came within 2–3 m range. Sunfish were not seen in May in any year, but occurred almost entirely during June and July, although in 1995 an individual was sighted in early September. Between 0.16 and 0.22 individuals day⁻¹ (24 h) were observed during each survey period in 1995, 1996, 1999 and 2001, but this number increased to 0.80 ind day⁻¹ in 2001 (Figure 1). Sunfish were observed throughout the day (0800–1600 h) and were located predominantly in frontal water (53% of individuals) between 14.0 and 16.6°C and in stratified water (33%) from 14.5 to 17.0°C. Only two sunfish were seen associated with mixed-water masses. Seven individuals were sighted in water of 10–30 m depth, with an equal number observed in water between 50 and 70 m deep, but only one sunfish between 30 and 50 m. The minimum temperature water for *M. mola* in this study was 13.0°C at the beginning of June (Figure 2), whereas the highest temperature recorded was 17.0°C in late June and early September in different years (Figure 2).

The ocean sunfish (*M. mola*) is one of the largest marine-teleost fish species, with an adult length of 3 to 4 m and a weight of around 1410 kg (Fraser-Brunner, 1951). The results of the present study show that sunfish off Plymouth were all young fish <1 m in length. Moreover, they were all active and did not appear to be weak or dying as suggested by Wheeler (1969). Sunfish observed in the western Atlantic off North Carolina showed similar activity when approached and were not randomly distributed by season or location (Lee, 1986). In the latter study, *M. mola* were most frequently encountered in spring (mid-April to mid-May) and occasionally in the summer and autumn, but were absent in winter. In addition, they occurred in an offshore zone between 20 and 80 m deep, rather than at the surface over shallow or deeper water (Lee, 1986). In another study, sunfish were observed to move north with the Gulf Stream in spring to forage, and return south in September (Reiger, 1983). These studies indicate sunfish selected particular areas for seasonal migration and foraging. Whilst in this study we have no data on individual movements, sunfish occurred at the surface near fronts when temperatures reached 13°C at about the same time each year (in June and July). Furthermore, sunfish were found at the surface of shallow water (10–30 m depth) in 1996 and 2001 when the seasonally-persistent tidal front was located closer inshore (Sims & Quayle, 1998). However, they were found predominantly in deeper water (50–70 m) when the front occurred further offshore in 1995 and 2000. Although the number of sunfish observed off Plymouth was low (e.g. in comparison to basking sharks, *Cetorhinus maximus*), our data show sunfish are active in warmer inshore waters and productive fronts annually, presumably for foraging. The seasonal occurrence of young sunfish off Plymouth may also be due to water movements carrying them further inshore than adults. Hence, there is a need for 'pop-up' satellite-tracking studies to determine the movements and habitat preferences of this species over seasonal

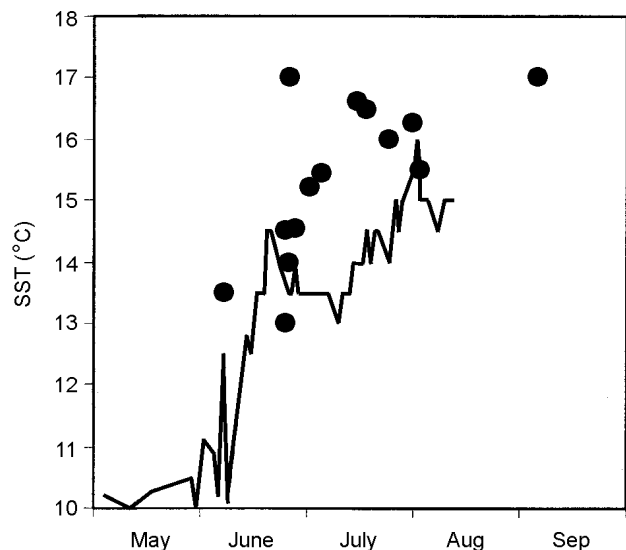


Figure 2. Sea surface temperature (SST) at *Mola mola* locations (filled circles) for all years compared to the typical seasonal increase in SST (solid line) measured during 1996 at Station 1 (S1; 50°18.2'N 4°9.2'W), which is located inshore and north of the thermal front.

scales. This is especially important in some regions because *M. mola*, for example, makes up 70–95% of driftnet catches in the Mediterranean alone (Silvani et al., 1999) which suggests populations could potentially be at risk from fishing exploitation.

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