Has the biomass of jellyfish already surpassed small pelagic fish in the NW Mediterranean Sea? Results from an intense spatiotemporal survey during 2011-2014 and comparison with the long-term trend.

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Summary

Jellyfish, especially the scyphozoan *Pelagia noctiluca* cause recurrent and persistent problems to human activities in the Mediterranean Sea, in particular along the French Riviera. Population oscillations have been observed for over 100 years showing alternative periods of presence and absence; however the spatial and temporal intensity of these blooms remains unclear. By means of year-round night-time transects and intensive spatial surveys during summer months, the abundance and biomass of *P. noctil*uca was quantified in the Ligurian Sea. *Pelagia noctiluca* was always found in greatest abundance in the core of the Ligurian current, with lower abundances in the central Ligurian basin and coastal areas. In 2013 the population was observed to grow to a very large size and at high abundance. While population biomass was below one tonne per square kilometre in 2012, in the summer of 2013 this biomass surpassed 10 tonnes km^{-2}, potentially greater than the biomass of small pelagic fishes. Fortunately for tourists, this large population of jellyfish remained offshore and was not pushed to the coast by onshore winds.

Introduction

The scyphozoan jellyfish *Pelagia noctiluca* attracts widespread attention from both the popular and scientific media because of its quasi-annual bloom formations, which affect regional communities when they come to shore (e.g. De Donno *et al.*, 2014, Doyle *et al.*, 2008). Collected observations in the western Mediterranean region have revealed a periodic presence-absence cycle, with more frequent observations in recent years (Bernard *et al.*, 2011). However, beyond these basic observations and first aid records, little real quantification of these populations exists.

Materials and Methods

An ongoing time-series of night-time surveys was established in 2011 to monitor the abundances of gelatinous zooplankton off the SE coast of France Ferraris et al (2012). An enhanced version of this protocol was used to obtain quantitative counts. As before, the boat cruised at approximately 5 knots and the sea was illuminated with a single spotlight mounted at the widest point of the vessel 3.5 m above the sea surface, lighting a path 4m wide. Observations were carried out from a fixed point enumerating the jellyfish observed within the spotlight area with regular changes of observer to avoid fatigue and bias of the data. Most surveys were only conducted under calm conditions (waves < 0.20 m). Unlike the previous study,

where numbers were estimated using categories, a mechanical counting device was now used to count the jellyfish as the vessel moved through the water. Numbers were recorded every five minutes throughout the survey together with GPS location. This enhanced version improved both spatial accuracy of the counts, and also allowed finer-scale estimates to numbers per m^2. Additional observations of jellyfish in the Ligurian Sea were conducted on a 17 m sailing boat or a 24.9 m oceanographic vessel between June and August 2013 using the same protocol, but with different speeds and illuminations distances (6 and 10 kt; 4.5 and 6m respectively). On those surveys counts were conducted for the entire night, finishing when the jellyfish were descending through the water column as dawn approached.

Whenever possible, *P. noctiluca* were caught individually from the surface using a hand-net and transferred to 15-L buckets of seawater on the open deck. All caught individuals were measured (over the lappets) within 24 hours and sexed, and, in the case of the regular sampling weighed. Width to wet mass conversion factors (Lilley *et al.*, *in press-b*) were used otherwise. Observed survey densities of jellyfish were multiplied by the average individual mass during that survey to obtain biomass estimates.

Results and Discussion

Pelagia noctiluca collected during surveys offshore displayed a regular wet mass of around 70 ±24 grams, but that increased to a peak of 323 ±155 g in early June 2013. This, combined with a high density of individuals at this time (up to 20 individuals per $100m^2$ on the same date), resulted in very high biomass estimates (>10 t km^{-2}). By contrast, individuals in 2012 were never heavier than 129g and were observed at low densities. Previous published data showed a comparable growth rate in 1969 (Lilley *et al.*, *in press-b*), but individuals reached a smaller maximum size (8cm diameter; 28g using the equation in Lilley *et al.*, *in press-a*). The larger size in 2013 may have resulted from a longer growing season compared to 1969.

Pelagia noctiluca frequently occurs on the French coast, causing problems for tourists, but despite the high densities observed offshore, 2013 was no worse than previous years. Given this disconnection between the observed densities and stings, care must be taken in using coastal abundances in isolation to infer ecosystem level changes in jellyfish abundance.

References

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