LARVAL DRIFT OF DEEP-SEA SHRIMP *ARISTEUS ANTENNATUS* FROM LIMITED AREAS OF TRAWLING

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Introduction

Bottom trawl fishery dedicated to the valuable commercial deep-sea red shrimp (*A. antennatus*) is limited in Palamós harbour by national decision (BOE). The management plan aims to preserve the juveniles and sustain the local stock.

The efficiency of the management plan is estimated by studying the connectivity of Palamós fishing grounds with other fishings grounds. The shrimp larvae is the only phase of the shrimp cycle which realise high dispersals.

Northwestern Mediterranean sea is under a strong geostrophic southward current following the coastal line from surface to 200 m depth (called Northern current) and advect pelagic larvae further than where the parents spawn.

By preserving the resource, the assumption underlying the trawling limitation is that the spawning biomass present on the ground will seed it with their offspring. In other words: the juveniles recruiting at Palamós are from the population of Palamós.

Through Lagrangrian drift of virtual individuals parametrised as *A. antennatus larvae*, we evaluate the connectivity of Palamós fishing ground with itself and other grounds.

Material and Methods

The North Western Mediterranean hydrodynamic is daily modelled by the ocean model ROMS.

Eggs and larvae from the benthic red shrimp *Aristeus antennatus* are released in July - August from mature females aggregated between 500 and 800 m in Palamós canyon (Figure 1). Using the velocity fields from ROMS, a Lagrangian tool simulates the drift of eggs and larvae from the spawning event to the settlement of postlarvae and daily tracks the displacements of each individual.

Due to the scarce knowledge about eggs and larvae, the pelagic ecology of the early-life shrimp stages is adapted from the information on Penaeid shrimp species. The drift duration of *Aristeus antennatus* larvae is estimated from the relationship of water temperature and the Pelagic larval duration of Penaeids with $log(duration_{stage}) = -0.072*Temperature + 1.51*Eggs + 2.66*Nauplius + 3.68*Protozoa + 3.64*Mysis.$

Two case of larval behaviour were explored with one scenario where larvae had **no behaviour** (passive drift) and a second scenario where eggs were **positively buoyant:** 884 ± 36 kg/m^3 (buoyant drift).

The connectivity between Palamós and the other zones (Figure 1) is computed as the ratio of individuals arriving in a zone on the total of individuals released in Palamós zone.

Main results

Passive drift: Larvae stayed in Palamós canyon or dispersed to near southern ground. PC retained 38.8 % of the individuals (Figure 2). A ratio of 24.5 % individuals went in upper water (250- 500 m) than the release depth. Individuals from PC connected with the nearest downstream area by 61.2 % of larvae. Individuals with bottom drift were advected by slow velocity currents along the continental slope with a southward direction. No strong vertical current led individuals to the surface.

Buoyant eggs and drift: Individuals drifted in open sea mainly toward the Southwest. Individuals from PC were retained for 5.3 % of them (Figure 3). 40 % individuals drifted to Balearic Islands grounds (BI 1 and BI 2) and 16 % individuals advected towards BI drifted at underneath layers (5 - 100 m). Connectivity between the PC and BI was possible due to the duration of the drift for individuals in the cold water underneath the surface. A 40 % individuals drifted to south of Blanes (OS 4). 30 % were in the surface layer (0 - 5 m). Those individuals followed the main current direction which was affected by meander at the head of BC and a gyre in Bcn zone.

Sum up

Auto-recruitment on Palamós fishing ground is possible if eggs are not buoyant. Otherwise, individuals drifted to the south of Blanes and up to the Balearic Islands. There were not a high ratio of individuals which seeded the limited area of trawling in PC. Regarding the hydrodynamic of NW Mediterranean sea, the source of settlement in Palamós ground may come from upstream areas.

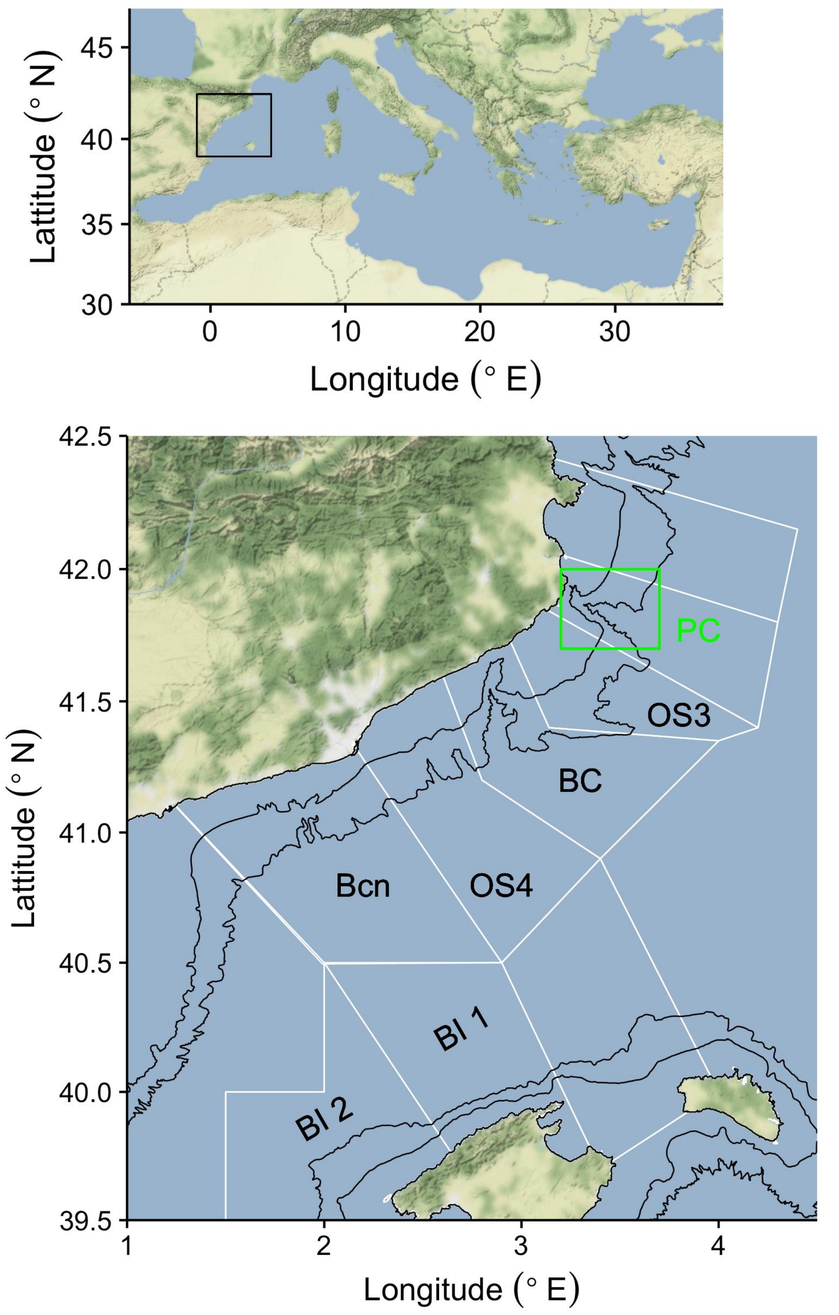

Figure 1 Study area in Mediterranean Sea (top panel) and polygons defined for the connectivity ratio (Bottom panel) Limited area of trawling is within the green rectangle. PC: Palamós Canyon, OS: Openslope, BC: Blanes Canyon BI: balearic Island, Bcn: Barcelona

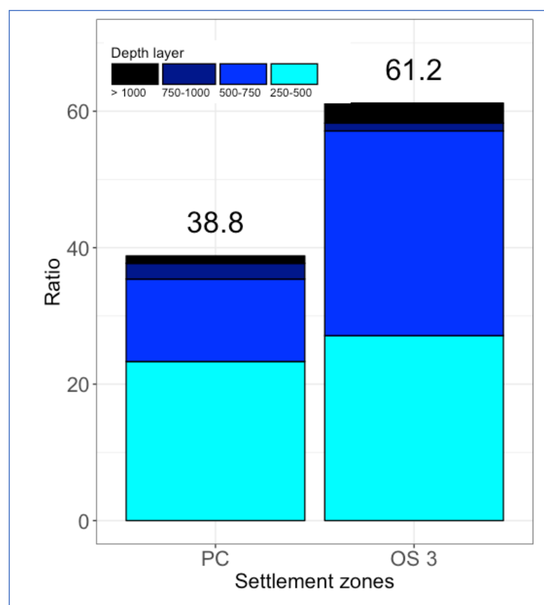

Figure 2 Connectivity rate for passive individuals from PC to the settlement zones by drift depth. Settlement zones as in Figure 1.

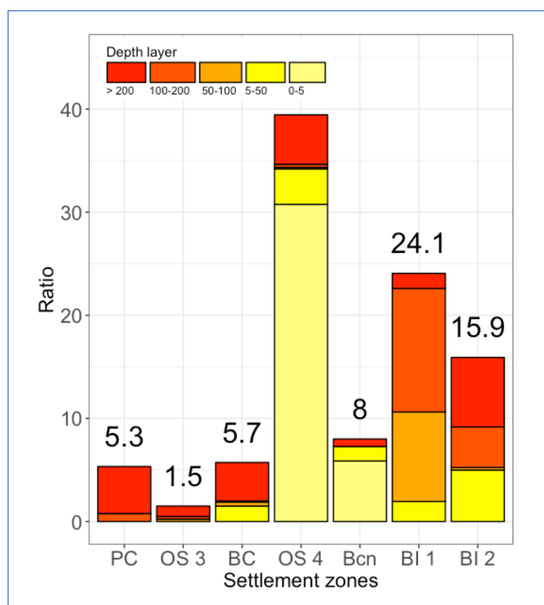

Figure 3 Connectivity rate for individuals from PC to the settlement zones by drift depth when eggs are buoyant. Settlement zones as in Figure 1.

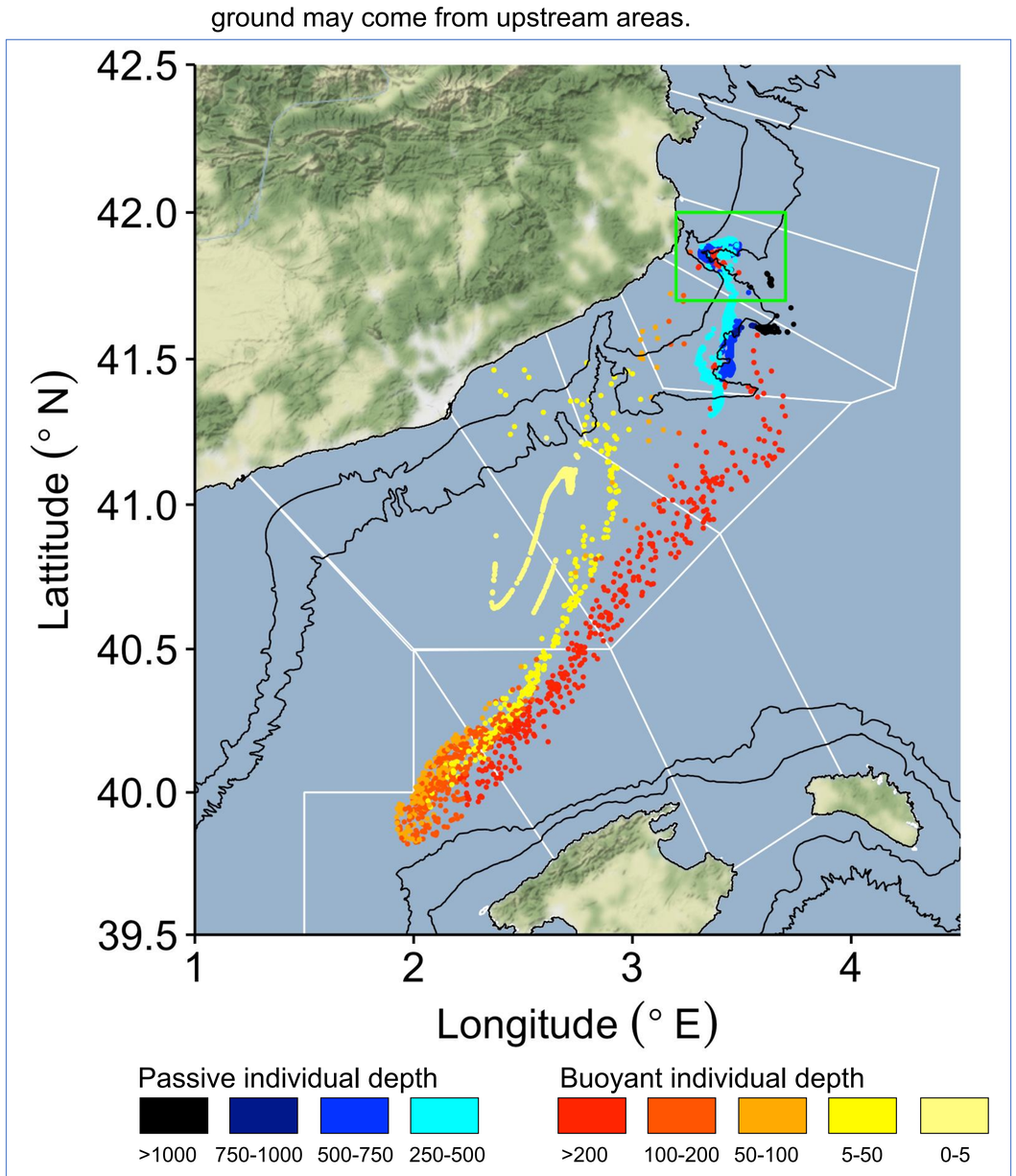

Figure 4 Position of the individuals at the end of their pelagic life in relation to the passive drift scenario or the buoyant drift scenario in the NW Mediterranean Sea.

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