2 Technological developments (ToR d)

2.1 Creel fishing and acoustic tracking trials in the No-Take zone off Palamós-Roses (Northwester Mediterranean Sea) at 350-420 m depth

(Aguzzi J., Navarro J., Bahamon N., García J.A., Rotllant, G., Gomáriz S., Masmitja I., Vigo M., Carreras M., del Río J., Company J.B.; Instituto de Ciencias del Mar (ICM-CSIC), Barcelona, Universidad Politécnica de Cataluña (UPC), Barcelona, University of Girona (UdG), Girona, Spain)

The OBSEA as testing site for acoustic tracking technologies

Fixed-point cabled observatories provide highly-integrated biological and environmental data measurements that are continuous (i.e. benefitting from nearly unlimited power supply), and at very high frequencies, allowing species counts to be corrected by intrinsic species-specific biorhythmic fluctuations in response to environmental cycles (reviewed by Aguzzi et al., 2012; Danovaro et al., 2017). The dataset of images acquired by the camera installed on the OBSEA observatory (www.obsea.es) was used to track burrow emergence in 3 *Nephrops norvegicus* specimens (**Figure 2.1.1**), hosted in artificial burrows (i.e. the deployment depth of the infrastructure is shallower than the populations range of distribution in the Mediterranean) (**Figure 2.1.2**).

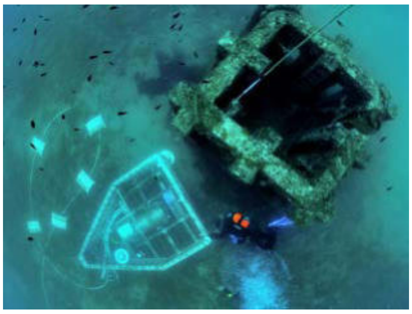

Figure 2.1.1. Images of the artificial reef area where *Nephrop*'s burrowing behavioural video-observations and creeling capture tests were performed at 20 m depth, off Vilanova I la Gertrú (Barcelona, Spain).

Figure 2.1.2. Images of the created enclosure in PVC material holding a contention net plus PVC tunnels embedded in concrete material, as deployed in front of the small satellite camera of the OBSEA platform. A frame depicting an animal in "door-keeping" behaviour (*sensu* Aguzzi et al., 2007) is also reported.

Nephrops individuals were released in February 2019, when the water superficial temperature is below 14 ºC (close to the optimum temperature for this crustacean). Ten individuals were released by a canister (**Figure 2.1.3**). At the end of the experiment, all animals were eliminated by natural predators (probably an octopus) and their corpses were visible in the enclosure area.

Figure 2.1.3. The canister and the presence of alive and dead animal in the OBSEA monitored enclosure. *Nephrops* specimens were also endowed with plastic black and white geometric tags to facilitate automated video-imaging approaches to track their movement (procedure yet to be developed).

All the behavioural information is being currently processed, in order to evaluate tracking procedures of utility for other ongoing actions such as the EMSO-Link Transnational Access (TNA) Project "SmartLobster" at the other coastal video-cabled observatory, SmartBay in the Galway Bay area (www.smartbay.ie; Dr. A Berry as IP), as one of the major fishery ground for the species in the European Atlantic. In that project, Smartbay camera and a new autonomous imaging device (Marini et al., 2018) are being used for monitoring the burrow emergence behaviour in N. *norvegicus*, through a continuous day-night video and multiparametric environmental data collection, in collaboration with the Irish members of the WGNEPS (Dr. C. lordan and Dr. J. Doyle).

The field acoustic tracking

Nephrops individuals (n=33) were tagged with VEMCO transmitters connected by cyanoacrylate on the upper part of the cephalothorax. These tags are capable to reveal the position of each animal, since they operate on unique individualized frequencies (Rotllant et al., 2015). Tagged animals were deployed in June 2018 at 350-420 m depth, in a no take zone off Palamós-Roses Coast (**Figure 2.1.4**). The deployment area was equipped with 4 mooring lines, each holding a receiver for tracking signal presence (emergence)-absence (burial) and for triangulating animals' movement (competition for burrows and spatial movements) and efficiency in restoration procedures (i.e. tracking displaced ranges tom better tune the no-take zone surface area.

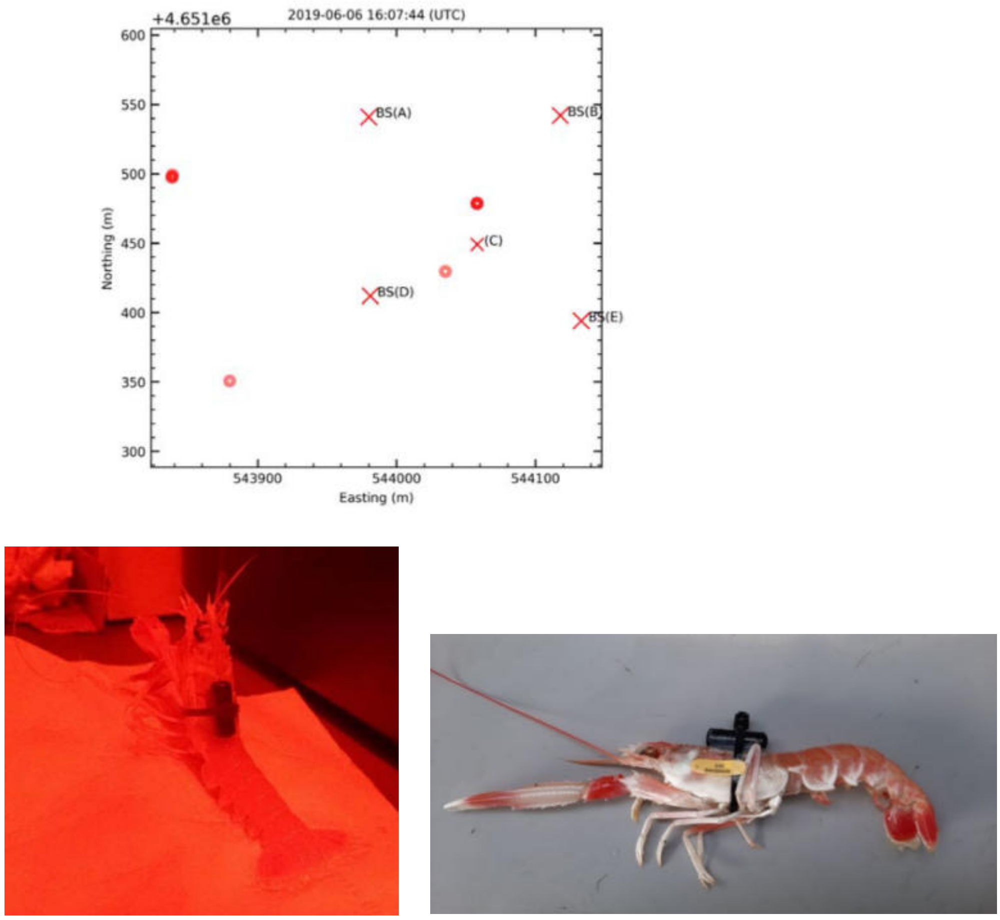

Figure 2.1.4. *N. norvegicus* with a eTag attached. The moored VEMCO listening model asset is also presented. Map of coordinates for the deployed mooring asset to track burrow emergence behaviour (x: deployed GPS point at Surface for each mooring; o: acoustically estimation of the position on the bottom).

All tagged individuals were detected and their movement tracked over a period of 4 months until the hydrophones retrieval in November the 8th of 2019. Time series of data are about to be extracted and then elaborated.

The AUV acoustic monitoring testing

A trial to track the presence of animals outside the moored polygon was performed with the Autonomous Underwater vehicle (AUV) Girona 500 (https://cirs.udg.edu/auvs-technology/auvs/girona-500-auv/) (**Figure 2.1.5**). This is a reconfigurable platform designed for a maximum operating depth of up to 500 m. The vehicle is composed of an aluminium frame which supports three torpedo-shaped hulls of 0.3 m in diameter and 1.5 m in length as well as other elements like the thrusters. This design offers a good hydrodynamic performance and a large space for housing the equipment, while maintaining a compact size which allows to operate the vehicle from small boats. The platform was equipped with a VEMCO listening unit (**Figure 2.1.4**), and carried out progressively growing concentric trajectories at 35 m depth above the monitored bottom area. That trialling was also repeated by a ROV device, the Liropus 2000, which explored the area in order to track animals' presence but also performed kriging dives to cover the whole area and determine burrow density and spatial distribution. Both the ROV (**Figure 2.1.5**) and the AUV trials showed negative results given the interference of thrusters' noise with the weaker emission intensity of VEMCO tags, according to the flying depth. This will be reduced in future cruise tests.

Figure 2.5. The Girona 500 platform and the Liropus 2000 ROV, plus a screen of envisioned seabed surface with *Nephrops* tunnel systems.

References

Aguzzi J., Company J.B., Sardà F. 2007. The activity rhythm of berried and unberried females of *Nephrops norvegicus* (Crustacea, Decapoda). Crustaceana 80(9): 1121-1134

Aguzzi J., Chatzievangelou D., Marini S., Fanelli E., Danovaro R., Flögel S., Lebris N., Juanes F., De Leo F., Del Rio J., Thomsen L., S., Costa C., Riccobene G., Tamburini C., Lefevre D., Gojak C., Poulain P.M., Favali P., Griffa A., Purser A., Cline D., Edigington D., Navarro J., Stefanni S., Company J.B. 2018. New high-tech interactive and flexible networks for the future monitoring of deep-sea ecosystems. Contributions in Environmental Sciences and Technology, 53: 6616-6631.Danovaro et al., 2017

Danovaro R., Aguzzi J., Fanelli E., Billet D. Gjerde K., Jamieson A., Ramirez-Llodra E, Smith C.R., Snelgrove P.V.R., Thomsen L., Van Dover C. 2017. A new international ecosystem-based strategy for the global deep ocean. Science, 355: 452-454.

Marini S., Corgnati L., Manotovani C., Bastianini M., Ottaviani E., Fanelli E., Aguzzi J., Griffa A., Poulain P.M. 2018. Automated estimate of fish abundance through the autonomous imaging device GUARD-ONE. Measurement, 126: 72-75.

Rotllant, G., Aguzzi, J., Sarria, D., Gisbert, E., Sbragaglia, V., Del Río, J., Simeó, C.G., Mànuel, A., Molino, E., Costa, C. & Sardà, F. 2015. Movement patterns of adult spiny lobster (*Palinurus mauritanicus*) and spider crab (*Maja squinado*) by acoustic tracking in an artificial reef. Hydrobiologia 742: 27–38. DOI: 10.1007/s10750-014-1959-5.