Underwater robots are key to understanding and protecting deep-water species

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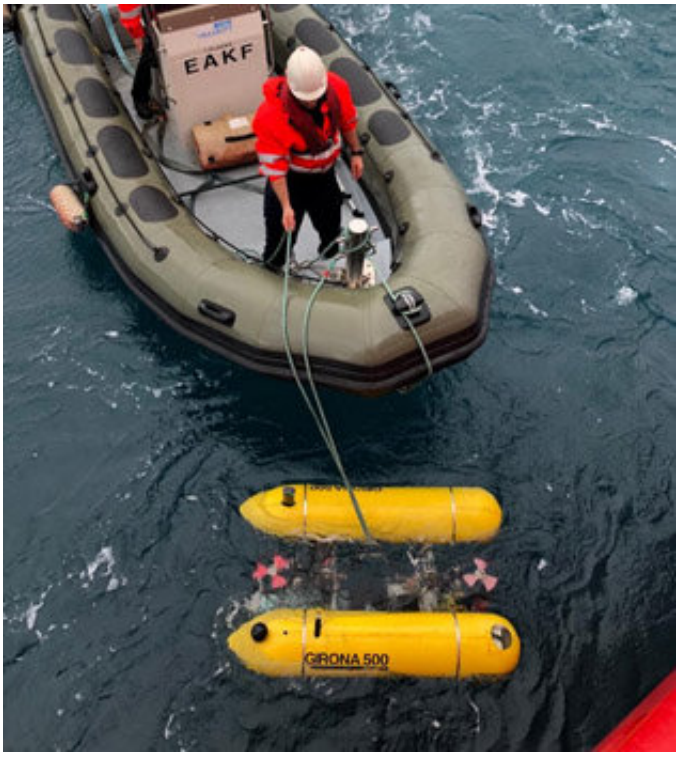

Underwater robots have great flexibility and speed of operation. Credit: Universitat Politècnica de Catalunya

A new study shows that the combined use of fixed acoustic reception stations and underwater robots for the study of deep-sea species allows for a better understanding of their ecology. These technological advances could improve the recovery of deep-sea demersal populations.

Exploration of marine ecosystems requires the development of technologies that allow in-depth research for an unlimited time. Acoustic reception stations fixed to the seabed are a good option, as they offer great temporary resolution, but they have a high deployment cost and their use is limited to the anchorage area. Therefore, the possibility of combining their use with that of remotely operated and autonomous underwater vehicles, commonly known as ROVs and AUVs, is essential.

This is the main conclusion of a study carried out by researchers from the Institut de Ciències del Mar (ICM-CSIC), the Universitat Politècnica de Catalunya · BarcelonaTech (UPC) and the Universitat de Girona (UdG) and published in the journal *Science Robotics*. The authors claim that underwater robots act as the perfect complement to fixed stations since they have great flexibility, can move fast and are able to cover much larger study areas.

This improvement in operational capacity allows biological and ecological information on the activity patterns of benthic marine organisms to be collected. This should in turn allow the recovery actions of their populations, many of which are suffering as a result of human exploitation, to be improved.

"Through the installation of acoustic sensors on 33 Norway lobsters and the use of a network of robotic instruments, we have been able to see, for the first time, the species' patterns of movement at a depth of 400 meters," celebrate Joan Navarro and Joan Baptista, researchers at the ICM-CSIC and leaders of the RESNEP project, the framework for part of the experimental work done to carry out the study.

The experimental work includes three oceanographic campaigns that took place from 2019 to 2020 in a pilot area of a fishing reserve in one of the main prawn fishing grounds in Spain: the marine zone between Roses and Palamós, on the Costa Brava. In addition, the team carried out

technological validation tests beforehand at the Obsea underwater observatory, which is operated by the UPC and located 4 kilometers from the port of Vilanova i la Geltrú and 20 meters deep.

"This has allowed us to carry out an exhaustive analysis of the methods for positioning acoustic labels and synchronizing the different receivers, which are essential for a correct geolocation of marked individuals," explains Ivan Masmitja, first author of the study and a postdoctoral researcher at the UPC.

Credit: Universitat Politècnica de Catalunya

The study also addresses the problems inherent to species-monitoring at great depths and proposes solutions such as the use of autonomous vehicles in underwater acoustic applications and algorithms based on the calculation of probability by detection area.

"This experimental work is a very important qualitative leap for the study of this type of species in its own habitat in that it provides new methods and practices for the proper monitoring of deep-sea marine species," add Jacopo Aguzzi, a researcher, and María Vigo, a Ph.D. student, both at the ICM-CSIC, for whom "this type of study is essential to establish conservation policies and correctly manage natural marine resources."

"The use of AUVs significantly reduces costs in obtaining data from the seabed, not only by reducing the necessary infrastructure but also because more than one can be used in the same campaign," highlights UdG researcher Marc Carreras, who is responsible for the Girona 500 AUV used in the project. The researcher claims that "this technology will be essential in the future and, for this reason, we are developing new capabilities that allow vehicles to be more autonomous and adaptable to applications."

A cross-disciplinary collaboration

Apart from the ICM-CSIC, the UPC and the UdG, researchers from the Monterey Bay Aquarium Research Institute (MBARI) in California (U.S.), the Institut Supérieur de l'Électronique et du Numérique (ISEN Yncréa Ouest) in Brest (France) and Oslo Metropolitan University (OsloMet) in Oslo (Norway) have also participated in the study by providing complementary and essential technological and ecological knowledge to meet the challenges that are expected in the study of seas and oceans.

Collaboration between institutions is the key to carrying out these types of studies in which the work of both scientists and technologists is needed. An example of this is the collaboration between the ICM and the UPC's SARTI group, which, through Tecnoterra, a unit associated with the CSIC, has managed to provide technological solutions to various scientific challenges that needed, in addition to data obtained during oceanographic campaigns, other data gathered in situ.

Joaquín del Río, UPC researcher and head of the Obsea observatory used in the project validation process, underlines the importance of validating the sensors and technologies used later in deeper waters in a real environment: "the prior validation of the technologies and devices used in this research is crucial to increase the campaign's chance of success."

More information: I. Masmitja et al. Mobile robotic platforms for the acoustic tracking of deep-sea demersal fishery resources, *Science Robotics* (2020). DOI: 10.1126/scirobotics.abc3701

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