

Use of Small ROV Systems to Survey Mesophotic Ecosystems

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ABSTRACT

Mesophotic coral ecosystems (MCEs) are challenging to assess due to both depth and geomorphology, but their characterization is important for the assessment of fisheries resources habitat health and threatened species. Surveys based on rebreather and mixed-gas diving are costly and limited in bottom time. Patchy distributions and depth variations further complicate MCE assessments. We report on use of small Remotely Operated Vehicles (ROVs) to characterize habitats and resources to depths of 130 m, primarily off La Parguera and Ponce, Puerto Rico. The ROV is equipped with parallel laser beams for size estimation, and a sampling claw, and it can be deployed off of small boats using a portable generator. Preparation times for ROV dives are shorter than other methods. All video images are recorded on digital tape using a camcorder, which provides a permanent record and allows for subsequent analyses by experts in various taxonomic or scientific disciplines. These surveys allow for baseline observations of fish communities and benthic cover, habitat use (including nursery areas) and behavior. Results to date include (1) the documentation of new areas of MCE development, (2) the abundance and distribution of threatened species, (3) the deep occurrence of commercially shallow species, (4) documenting the depth and spatial extent of spawning aggregations, (5) the apparent deep refugia for overfished shallow species, (6) the occurrence of deeper commercially important species, (5) the impacts of sedimentation on MCEs, and the colonization of MCEs by invasive lionfish. ROVs are excellent companions to any mesophotic research diving program.

KEYWORDS: ROV, mesophotic coral ecosystems

Uso de Pequeños ROV's para Evaluar Ecosistemas Mesofóticos

Los ecosistemas Mesofóticos son difíciles de evaluar debido a su profundidad y geomorfología, sin embargo su caracterización es importante para la evaluación del estado de los hábitats utilizados por los recursos pesqueros. Evaluaciones basadas en respiradores de profundidad con mezcla de gases son costosas y limitadas en el tiempo de estudio. Distribuciones de tipo parcho y cambios en las profundidades complican aún más el estudio de los MCE's. En este trabajo se presenta el uso de pequeños vehículos remotos (ROVs) como alternativa para la caracterización de los hábitats y recursos de La Parguera y Ponce (Puerto Rico) a profundidades de hasta 130m. La unidad utilizada está equipada con un láser de medición y un brazo de muestreo; el mismo puede ser utilizado desde pequeñas embarcaciones con el uso de un generador de energía. Los tiempos de preparación son menores que los de otros métodos y las imágenes de video son grabados en una cámara digital que permite el almacenamiento de la información de forma permanente y su distribución a los expertos de identificación taxonómica. Estas evaluaciones sirven de observaciones base de las comunidades bénticas y de peces, uso de los hábitats (incluyendo áreas de desarrollo de juveniles) y el comportamiento de los organismos. Los resultados obtenidos al día de hoy incluyen (1) la identificación de nuevas áreas de desarrollo de MCEs (2) la abundancia y distribución de especies en peligro (3) la observación de especies de aguas poco profunda en áreas mesofóticas (4) descripción de la profundidad y distribución espacial de agregaciones reproductivas (5) una protección aparente de las especies poco profundas en estas áreas (6) la observación de especies de interés comercial (7) los impactos de la sedimentación en los MCEs y la invasión de los mismos por el pez león. Los ROVs son excelentes accesorios para toda investigación de las áreas mesofóticas.

PALABRAS CLAVE: ROV, hábitat, ecosistemas de arrecifes mesofóticos

Utilisation de Petits Systèmes de ROV d'Examiner des Écosystèmes de Mesophotic

MOTS CLÉS: ROV, l'habitat, écosystèmes de mesophotic

INTRODUCTION

Mesophotic coral ecosystems (MCEs), located along insular and continental slopes from 50 m and 130 m, are challenging to assess due to both depth and their steep and irregular geomorphology, but their characterization is important for the evaluation of fisheries resources, habitat health and threatened species. Located beyond the normal range of air diving, surveys of these systems based on rebreather and mixed-gas diving are costly and limited in bottom time. Patchy distributions and depth variations further complicate MCE assessments. Under these conditions, the ability to conduct long and frequent quantitative or qualitative transects both horizontally and

vertically are needed to wholly survey an area. Remotely Operated Vehicles (ROVs) offer a potential solution to this problem. We have conducted ROV surveys extensively to depths of 130 m, off La Parguera and Ponce along Puerto Rico's south coast. In that work, our objectives were to assist in the characterization of the community composition and structure, including how these are limited by biological and geomorphological factors, the assessment of connectivity between deep and shallow reefs and the evaluation of the vulnerability of deep reefs to anthropogenic stress. In this paper, we show how ROV surveys can be conducted, even from small boats, to assess MCE habitat and resources.

METHODS

We used a SeaBotix LBV 200 ROV (Figure 1), which is a small (53 cm length), light weight (11 kg) portable system capable of working to depths of 200 m. Our system had a standard 520-line video camera and was further equipped with parallel laser beams (5cm spacing) for size estimation and a manipulator arm equipped with sampling claw. The cable connects to a control unit consisting of a video monitor and a separate joy-stick box that controls all functions of the ROV. For a permanent record of each dive, and for subsequent analyses and species identification by taxonomic experts, video signals were exported to a digital video camera where the images were stored on to digital video tape.



Figure 1. Seabotix 200 LBV remotely operated vehicle used for study of mesophotic coral ecosystems. ROV is shown hovering over the shelf break.

Our primary vessel was a 27 ft (8.3 m) Boston Whaler with a small cabin, with the ROV system powered by a sine-wave capable portable generator. On larger vessels we used the ship's electrical power supply through a UPS with a sine-wave filter. In both cases the unit was deployed and recovered by hand. Preparation times were between 10 and 20 minutes. Typically, dives were 40 to 90 minutes in duration.

OBSERVATIONS

We have used the ROV for a variety of purposes, including exploratory surveys, characterizations and collections. These efforts have focused both on benthic organisms, especially corals, and fishes. For the latter, the ROV is particularly useful for characterizing the large fish fauna, including commercially valuable species, over broad depth ranges not easily surveyed by divers. Noted new observations were the occurrence of invasive lionfish in MCEs (Figure 2), the definition of critical nursery habitat for deep species (Figure 3) and the increased abundance of large predators at depth (Figures 4 and 5). Larger fish can be readily approached, which facilitates

obtaining size information (Figure 4), and locating and characterizing spawning aggregations (Figure 5).



Figure 2. Lionfish recorded at 61 m off Mona Island. A second individual is hidden behind the sponge at left of center (black and white image of a color video capture).



Figure 3. A large school of juvenile blackfin snapper residing along a ledge in an otherwise barren landscape at 64 m off Buck Island National Monument, St. Croix, USVI (black and white image of a color video capture).



Figure 4. Measuring a black grouper at 84 m. Arrows point to the two parallel laser beams set 5 cm apart (black and white image of a color video capture).



Figure 5. Assessing the extent and abundance of yellowfin groupers (in circles) at an aggregation site, which extends from 30 to 50 m (black and white image of a color video capture).

In our characterization of benthic organisms we were able to count, identify and measure individual coral colonies (Figure 6). Photographs extracted from video images taken perpendicular to the surface can be used for gross calculations of percent cover, using the parallel laser beams to scale the size of the image and thus control height of the photo off the bottom. The manipulator arm was useful for collecting only small specimens, including rhodoliths (Figure 7) and samples of small weakly-attached benthic invertebrates for identification and genetic analysis. Frequently seen during our surveys have been species of concern, such as sharks and, to a lesser degree turtles (Figure 8).

Surveys off of Ponce, on Puerto Rico's south coast showed that, although deep, these areas can be threaten with high sedimentation (Figure 9), preventing MCE development or smothering existing benthic communities. New substrate from the late 1990's (deep outfall pipe; boulder backfill) showed no coral colonization in meso-photic depths, but antipatharians were abundant.



Figure 6. Characterization of mesophotic coral ecosystems, showing a colony of *Agarica undata* at 93 m. Colony is approximately 25 cm across the horizontal based on the parallel laser beams = two light spots in the center of the image (black and white image of a color video capture).



Figure 7. Using the manipulator arm to sample rhodoliths at 92 m (black and white image of a color video capture).



Figure 8. Male hawksbill turtle observed feeding at 65 m (black and white image of a color video capture).



Figure 9. Insular slope at 70 m off of Ponce, Puerto Rico showing the area to be completely sediment covered and devoid of any benthic community (black and white image of a color video capture).

DISCUSSION

As a consequence of our work with this ROV, we were able to document new areas of MCE development, the abundance and distribution of threatened species, and the deep occurrence of commercially valuable deep and shallow species. This latter work was critical in recogniz-

ing MCEs as apparent deep refugia for overfished shallow species and the connectivity between shallow and mesophotic areas, with the dependence of some components of the MCE fish community on shallow nursery areas. In contrast, coral communities below 50 m were comprised primarily of species restricted to deeper waters, and those shallow species that did occur (e.g., *Montastraea cavernosa*) were small and widely scattered, questioning both their maturation/fecundity and ability to have eggs fertilized. This suggests that coral at these depths have little connectivity to shallow water coral ecosystems and cannot be looked upon as a source of recruits to recolonize shallow reefs.

Our observations suggest that the use of small ROVs can greatly enhance the assessment of mesophotic habitats and resources. However, there are limitations, not the least of which is cost; our unit when new was close to \$50,000 US (we also had an acoustic tracking unit installed). The low video resolution makes identification of smaller or more cryptic individuals difficult, although a high definition camera can be added (but at a large increase in price). Much of our work has been in conjunction with the use of mixed-gas rebreather diving, with ROV surveys being used to locate sites for detailed field work and extending the range of observations. This is particularly useful in depths below 70 m, where we have limited diver-based surveys due to exponential increases in the time needed for outgassing when ascending. Small ROVs have limited collection capabilities; the arm can only be used to collect one item, and cannot lift heavy objects or break off specimens that are solidly attached, including, on occasion, those sea whips and wire corals that foul the propellers. Lastly, ROVs cannot be launched in high wind or wave conditions, which still would allow diver activities, due the inability of the ship to hold position.