Investigating Terrain Changes Around Two Artificial Reefs by using the Multibeam Echosounder (Western Adriatic Sea, Italy)

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Abstract: During the last thirty years, fourteen artificial reefs were built-up along the Western Adriatic coast at a depth ranging from 11 to 15 meters. In the present work the artificial structures of Senigallia and Portonovo were considered after about sixteen years from their construction to observe how they altered in the time, as well as the effects on sea-bottom morphology due to the whole reef and on terrain changes around individual reef units.

Senigallia reef placed at about 15 nm North-West from Ancona, represents one-oasis model and was built-up at a depth of 11 m, about 1.2 nm offshore, on a sandy-muddy seabed far from natural hard substrates. The reef was constructed in 1987 and consists of 29 pyramids, each made of five 2-m cubic concrete blocks, and twelve concrete cages (6x4x5 m) for shellfish culture placed in a rectangular arrangement. Portonovo reef was deployed in 1988 in Portonovo Bay (Conero Promontory) on sandy bottom at a depth of 10 m. It consists of 87 pyramids and 36 cages arranged in three oasis of the same type as Senigallia reef and placed about 100 m from each other. It is placed at about 10 nm South-East from Ancona and 0.5 nm offshore. The main difference between the two reefs is their geographical position: Senigallia reef is an open area, exposed to winds between NW-SE and currents that run parallel to the shoreline in the same direction; while the Portonovo reef is more protected from winds and currents due to the indented coastline of the promontory.

The two artificial reefs were investigated through the Kongsberg-Simrad multibeam EM-3000 system to evaluate terrain changes around the structures. EM-3000 bathymetric system mounted on research M/N "Tecnopesca II" belonging to ISMAR – CNR of Ancona, operates at a frequency of 300 kHz, fanning out up to 127 acoustic beams at a maximum ping rate of 25 Hz and at an angle of 140° (1.5°x1.5° beams are spaced 0.9° apart). This yielded swaths that were up to ~4 times the water depth. The position of the boat was obtained via 24-hour, differential global positioning system (DGPS) navigation connected to a geostationary satellite, an Anshutz Standard 20 gyrocompass and a sound velocimeter. With differential GPS, the system was capable of cm resolution with a depth accuracy of 10-15 cm RMS and a horizontal positional accuracy of less than 1 m. The swath survey bathymetry was processed using the Simrad Neptune software. Post-processing steps included the "cleaning" of the navigation, then tidal corrections were applied to the depth soundings using verified downloaded tide data. Processed depth soundings from the EM-3000 system were available as ASCII xyz files. Their processing using Roxar C-floor software was the next step to obtain 3D images of the reefs.

Maps of the investigated areas created with data from the multibeam system were of excellent quality in terms of the morphological features that were detailed in them. This allowed to evidence any alteration incurred in the artificial reefs.

The geometric structure of both reefs and how the terrain around concrete blocks was changed were illustrated using sun-illuminated option. Darker areas just around the single units evidenced a certain subsidence of the terrain, followed by more light boundary that represented the bank of removed substrate.

Regarding the complete bathymetric coverage of the two artificial reefs, it was possible to observe the sinking of the whole sea-bottom under the structures and particularly strong subsidence was evidenced in the central zone of the areas. It is likely that the close settlement of one pyramid or cage with the other made the reef as a single large structure that acted on the bottom and induced this significant change of the entire sea substrate's morphology.