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MAPPING ROUGH BOTTOMS AND SHIP WRECKS AS A TOOL FOR IMPLEMENTING "NO-TAKE ZONE" STRATEGIES IN THE STRAIT OF SICILY

SUMMARY

Given the positive action of ship wrecks on various marine communities and species, the possibility to consider also submerged ship wrecks for setting no-take zones (NTZs) is worth analyzing. To possibly implement such a management tool, data on all the known ship wrecks occurring in the Strait of Sicily (Central Mediterranean Sea) have been gathered from different sources; altogether, about 1300 records were collected, allowing the identification of 457 different ship wrecks. Finally, since naturally untrawlable areas could have a synergic effect with the man-made obstacles to trawling, a joint "roughness index" has been calculated, and an integrated map of ship wrecks and rough bottoms has been produced for the investigated area.

RIASSUNTO

La mappatura dei fondi accidentati e dei relitti artificiali nello Stretto di Sicilia (Mediterraneo centrale) come ausilio per l'identificazione di zone marine protette. I dati raccolti in più di venti anni di campagne in mare con rete a strascico nello Stretto di Sicilia sono stati elaborati, insieme alla localizzazione dei relitti artificiali, per produrre una mappa di fondi accidentati. Data la nota funzione di oasi faunistiche ed attrattori biologici esercitata dai relitti sommersi, una carta sinottica potrebbe costituire un valido strumento di partenza per la formale istituzione di zone protette.

INTRODUCTION

No-take zones (NTZs), i.e., limited areas in which fishing is temporarily or permanently restricted, are generally considered a suitable tool for fisheries management and for the protection of sensitive spots (HORWOOD, 2000).

Regarding the demersal resources it has been suggested to set NTZs in areas characterized by natural (e.g., rocky outcrops) or man-induced (e.g., FAD stone anchors) obstacles.

Given the positive action of ship wrecks on various marine communities and species, the possibility to consider also submerged ship wrecks for setting NTZs should be analyzed. A ship wreck represents, particularly when located on a homogenous muddy or sandy bottom, a very diversified oasis, both in terms of biodiversity and of abundance (ARENA *et al.*, 2000); in fact, it could constitute a spawning aggregation spot for several semi-pelagic animals and, when located in shallow waters, a feeding, spawning and nursery substrate for many fish, crustacean and cephalopod species. Therefore, it is evident that a ship wreck may have a significant impact in restoring an overexploited ecosystem, both for its biological effects and as a physical deterrent against trawling, when situated in an area of high fishing pressure.

To possibly implement such a management tool, information on all the known ship wrecks and wreckages occurring in an area should be gathered: in the specific case of the Strait of Sicily, data from three main sources have been recovered, analyzed, matched to avoid replications. Moreover, since naturally untrawlable areas could have a synergic effect with the man-made obstacles to trawling (RAGONESE *et al.*, 2004), those information are to be integrated in *ad hoc* indexes and/or maps.

As a conclusion to this note, a plan to characterize the biological features of the ship wreck communities in some suitable sites is discussed, in order to obtain a scientifically-sound basis to establish working NTZs.

MATERIALS AND METHODS

219 positions on natural or man-induced rough and un-trawlable bottoms (broadly classified as “invalid” hauls) have been recovered from data gathered during 25 scientific trawl surveys carried out by the IRMA-CNR Institute in the Strait of Sicily (Central Mediterranean Sea).

In addition, 457 different ship wrecks have been identified in the Strait of Sicily within the area (257,500 km^2 of marine surface, of which: 46% shelf [0-200 m]; 41% upper slope [200-800 m]; 13% below -800 m) limited by these geographical points: 038°00’ N – 009°30’ E; 038°00’ N – 016°00’ E; 033°00’ N – 009°30’ E; 033°00’ N – 016°00’ E, from more than 1285 records gathered from the following three sources:

– The first set of data originates from fishing log-books, mainly of two captains of Mazara del Vallo, both with a 30-year experience in the Strait of Sicily as captain or mate on many different fishing vessels; on these log-books, the skippers recorded the exact coordinates where wreck-related fastenings (or graspings) occurred during fishing operations. All these geographical points were matched, and any redundancy was removed: thus, 282 records were obtained.

– The second data source was a commercial CD-ROM (SEMERARO, 2001), reporting all the ship sinking which happened in the last century, mainly during wars, in the Mediterranean. This 1800-ships database is built with two kind of historical information: the last position taken/transmitted by the ship just before sinking or, when the last geographical position is unknown, the general sea area where the ship was lost. Given the low precision of the second kind of information, only the geographical coordinates coming from the first set, within the limit of the Strait of Sicily, have been used for the realization of this work. With a relative degree of uncertainty, another 85 ship wreck positions were kept.
– The last source of information was represented by some detailed, large-scale nautical charts of different areas of the Strait of Sicily (1:250000), which provided 90 more positions of ship wrecks (IIM, 1993, 1994, 1995).

All of this geo-referenced information has been used to calculate, in trawlable grounds, the "roughness index" (RI) of a "standard" pixel (1 nm by 1 nm, about 3.3 km^2; 78250 pixels in the whole studied area); the dimension of this elemental surface agrees with current literature on the identification of NTZs and closed areas (HORWOOD, 2000; LINDEBOOM, 2000; PIET & RIJNSDORP, 1998) and on ecological and environmental studies (BAKUN & AGOSTINI, 2001), considering the specific conditions of limited extension and high fishing effort in the Mediterranean.

Each fastening inside each pixel has been counted and expressed as a percentage of the total number of recorded fastening; the same procedure has been done for the ship wrecks. In a second step, an *ad hoc* joint roughness index has been calculated for each pixel, adding both values but using a weighting factor of 1.5 for the ship wrecks data, given their higher capability to aggregate benthic and pelagic animals (ARENA *et al.* 2000; GARCIA CHARTON & PEREZ RUZAFA, 2002; GIOVANARDI & RINALDI, 1999; PRANOVI *et al.*, 2000):

$$RI = \frac{\textit{of fastenings in the pixel}}{\textit{total graspings}} \bullet 100 + 1.5 \bullet \frac{\textit{of wrecks in the pixel}}{\textit{total wrecks}} \bullet 100$$

Finally, an integrated "surface map" of the roughness index has been produced, using interpolation (kriging method) and drawing capabilities of the Surfer Golden software (SCHLITZER, 2003); the actual ship wrecks were superimposed.

RESULTS AND DISCUSSION

The percentage of pixels by roughness index (RI) ranges is:

0.1<RI<2.4 49%; 2.4<RI<4.7 24%; 4.7<RI<7.1 19%; 7.1<RI<9.5 7%; 9.5<RI<12.7 1%.

The produced map (Fig. 1) shows the areas where the roughness index (RI) is above 4.7, and the actual ship wrecks; it is evident from the map that, while the whole area is scattered with many fishing obstructions, there is a greater roughness in the upper left corner; in particular the highest value of the joint roughness index (RI = 12.64) is recorded for the pixel 037°37'50" N - 12°12'50" E, which corresponds to the Adventure Bank, while the mean value of all pixels with RI>0 is 1.52. Three factors contribute to this result: the presence of a heavily fished bank (intense and repeated "exploration" of the area), the geomorphology of banks and the closeness of Sicily and Africa (more maritime traffic).

Since the early '80s there has been ample literature (GREGG & MURPHEY, 1994; GROSSMAN *et al.*, 1997) on whether ship wrecks may present a redeeming ecological value. The ships often become artificial reefs and habitats, providing shelter for the very creatures threatened by humanity's original intrusion. In fact, fishermen keep fishing on "risky" bottoms because they balance the chance of damaging the gear with that of greater and better catches.

When a ship sinks, it immediately becomes shelter for marine organisms. Such habitats provide new food sources, greater protection for juveniles, and more space for settlement. In fact, in the Adriatic Sea, areas around ship wrecks (considered as un-fished areas) were sampled in experimental trawl surveys: the comparison with normally-exploited grounds demonstrate that several taxa are significantly less abundant in the fished areas; maybe the ship wreck effect is indirect, due to the modification of the local benthic community (PRANOVI *et al.*, 2000).

The information presented in this paper may be useful in assessing the quantitative importance of such refuges in the resilience of the resources to trawl fishery, through the assessment of a roughness index combining hard bottoms and ship wrecks present in the study area. In fact, the specific literature (GARCIA CHARTON & PEREZ RUZAFA, 1999; HORWOOD, 2000) has demonstrated the necessity of a proper spatial and dynamic evaluation before setting NTZs.

Grounds that are almost untrawlable due to the bottom morphology might have received a low RI, because fishermen tend to avoid them, and therefore data on grapings and fastening are here more limited; conversely, the experimental trawl surveys have the advantage of being performed following a scientific design. Even a qualitative analysis of the species (and size) composition in the capture of invalid hauls could show significant differences

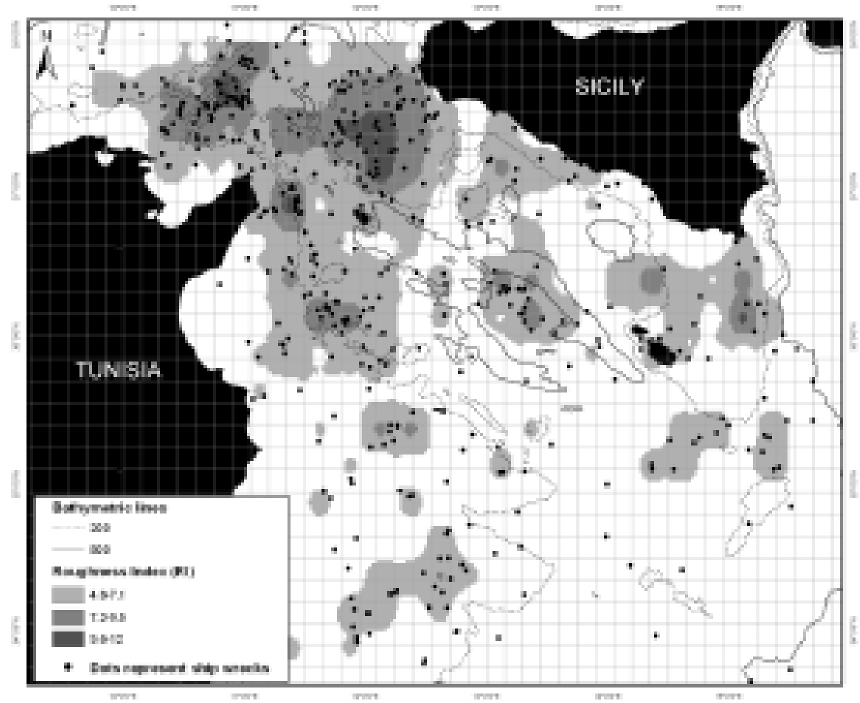

Fig. 1 — Integrated "surface map" of the roughness index (RI) derived from fastenings and ship wrecks in the Strait of Sicily; only ship wrecks are superimposed (black dots).

vs. the catch from neighboring grounds; unfortunately, the catch in such hauls has been irregularly recovered and seldom recorded until nowadays: for the future, this oversight will be corrected, and detailed information will be collected to allow some sort of comparison (invalid hauls are *per se* not strictly comparable with valid hauls) between assemblages (RAGONESE *et al.*, 2004).

The innovative approach of this work is to obtain at least some of the "undoubtedly many potential benefits [authors' note: protection of specific species or groups; protection of juveniles; restoring natural age structure of fish populations; habitat protection; prevention of effects of chronic disturbance; scientific research and monitoring purposes] that might be derived from the creation of protected areas in the marine environment … and the benefits that fishery might have" (LINDEBOOM, 2000) without the need of too "invasive" regulations, using the existing wrecks and rough bottoms (i.e., areas already difficult and dangerous for trawl fishing, let's say with an RI greater than 9.5) as core seeds for establishing NTZs in a highly exploited trawling area, such as the Strait of Sicily.

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