Planning Trawl Surveys and Sampling at Sea: the IRMA Experience and Proposals

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Abstract

The experience acquired by CNR-IAMC in performing bottom trawl surveys to monitor demersal resources in the Strait of Sicily is briefly presented. Proposals for continuing this activity under the new Italian Fishing Plan and the MedSudMed Project are also discussed.

Introduction

The role of the experimental trawl surveys in collecting fishery-independent information on the standing stock, the biology and the state of exploitation state of bottom-dwelling populations has been widely recognized as useful in the Mediterranean context (Abelló *et al*., 2002). The proper statistical design and planning of sampling procedures at sea is a crucial step in performing such a complex activity. Trawl surveys, in fact, are very expensive and time-consuming and, consequently, it is necessary to find a compromise between scientific requirements, technical and logistic constraints, and available funds and human resources. This contribution aims at illustrating the IRMA proposals for future programmes, taking into account the experience that has been gained since the first experimental trawl survey carried out in 1985 (Levi *et al.,* 1998). It is worth recalling that CNR-IAMC has been carrying out bottom trawl surveys in the Strait of Sicily since 1985, using a traditional Italian commercial gear (GRUND project; Relini, 2000), and since 1994, using an *ad hoc* designed gear with a high vertical mouth opening (MEDITS project; Abelló *et al.*, 2002).

Materials and methods

Study area

Different parts of the Strait of Sicily (*sensu lato*) have been traditionally explored by IRMA: the waters inside (A) and outside (B) the midline and the Sicilian and Maltese Exclusive Fishing Zones (MEFZ) within the GRUND and MEDITS programmes, respectively (Figure 1). Since 2002, the Geographical Sub-Areas (GSA, formerly Management Units, MU) adopted by the GFCM have been adopted as experimental trawl-survey areas; in particular, the GSAs 15 and 16 were covered by a joint Italian and Maltese team during the MEDITS 2002. GSA 15 includes the Maltese Exclusive Fishery Zone and a part of the eastern bottoms of the Strait of Sicily, whereas the GSA 16 covers the western bottoms; for both these GSAs, the outermost boundary is represented by the midline, and the overall surface is about 58,228 km^2 (23,583 and 34,645 km^2 for GSA 15 and 16, respectively).

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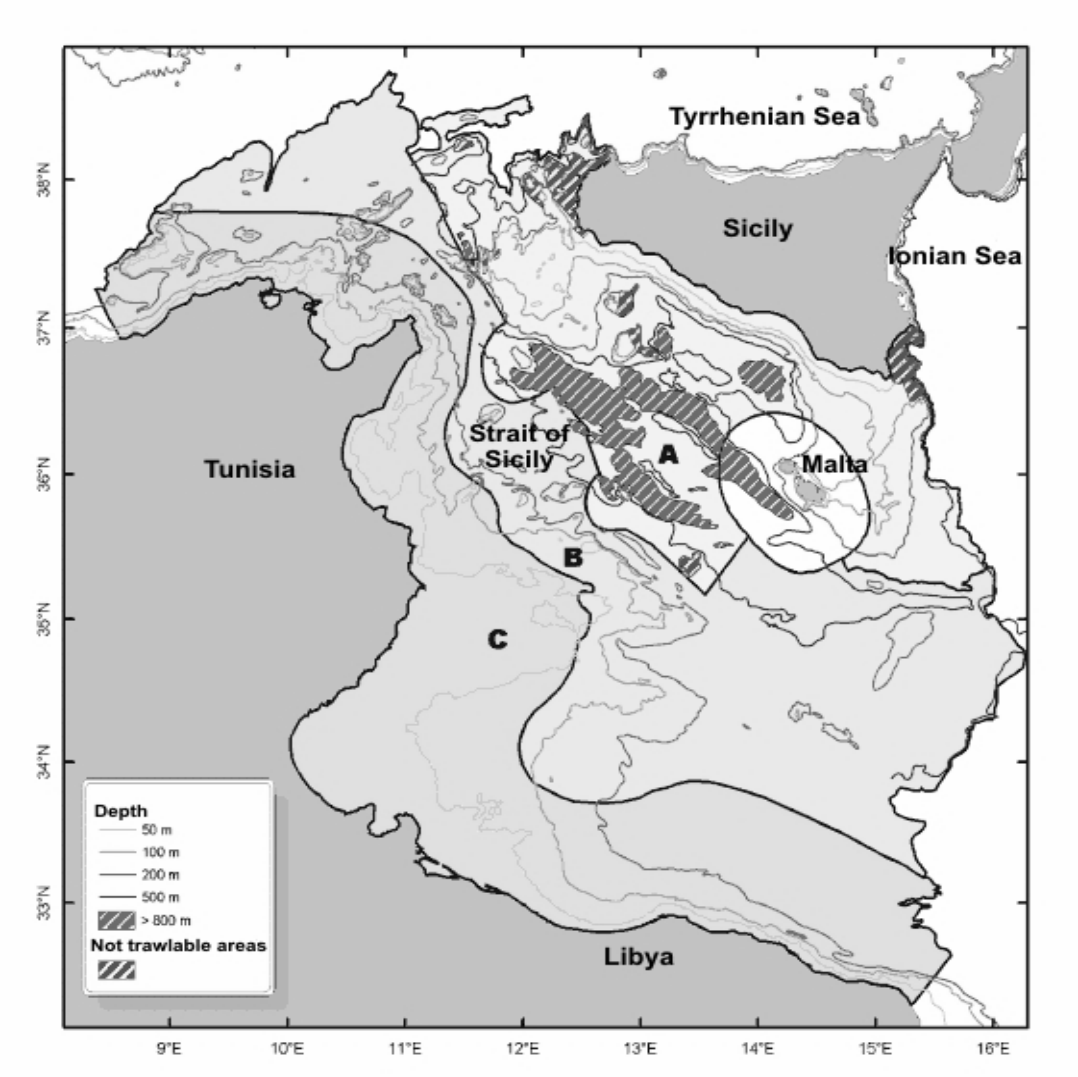

Figure 1. Subdivisions of the Strait of Sicily (*sensu lato*) traditionally explored by CNR-IAMC within MEDITS (zone A) and GRUND (zones A and B) experimental bottom trawl surveys. Zone C is not investigated by CNR-IAMC trawl surveys.

Stratification and strata limits

A depth-stratified sampling design has been adopted since the first GRUND survey, although depth limits were subsequently changed slightly. At present, five depth strata (in metres) are defined within both GRUND and MEDITS: stratum A (10–50 m, covering 161 km^2 in GSA 15 and 3,031 km^2 in GSA 16); stratum B (51–100 m, covering 2,044 and 5,827 km^2, likewise); stratum C (101–200 m, covering 6,069 and 5,681 km^2); stratum D (201–500 m, covering 6,195 and 10,646 km^2); and stratum E (501–800 m, covering 9,114 and 9,460 km^2). Each stratum overlies trawlable and non-trawlable bottoms; unknown areas are conventionally considered as "trawlable" until evidence to the contrary is obtained during the survey.

Sampling stations/hauls and allocation

The sampling stations/hauls (only one haul is normally carried out at each station) are randomly allocated within the strata, with the number of hauls being proportional to the surface of sea bed covered by each stratum. A 1:1-million-scale digital map (The IOC

International Bathymetric Chart of the Mediterranean, IBCM, using the GEBCO software, 5th ed.) was used in conjunction with a GIS to estimate the sea-bed surface under each stratum. Hauls are selected randomly on the basis of a grid of points (separated by a distance of 3 nautical miles). The location and expected depth and the GPS coordinates of each haul are recorded on a map and stored in electronic format on board. The positions of the hauls thus selected are maintained (in MEDITS) or may be re-selected after each survey cycle (every 3 years in GRUND).

Haul identification and execution

A sequential number is assigned to each haul in order of execution, regardless of whether or not the operation proves to be valid. Valid hauls are those carried out between 1 h after dawn and 1 h before sunset. The nominal (solar) haul time (nHT) is 1 h (under GRUND and for slope hauls under MEDITS) and half an hour on the continental shelf (under MEDITS). The nHT is set from the time the winch stops (GRUND), adding a lag-time, variable with depth (MEDITS), to the beginning of warp retrieval; GRUND and MEDITS 1-h hauls that actually last less than 40 min are considered non-valid. The direction of the haul is chosen according to sea conditions and the local bottom topography, and, whenever possible, towards the point of departure of the next haul; the vessel speed during a haul is maintained at about 3 knots (but reduced to 2.2–2.5 knots in deep water). Beyond the duration of 40 min, haul validity is judged by the chief scientist on the basis of subjective criteria (anomalies in the performance, gear breakage, anomalous catch, such as the presence of waste in the codend). Invalid haul specifications and catch composition are recorded in any case and a new haul is chosen among those pre-determined, preferably in the same area/strata. The overall number of hauls varies from one year to another, depending on the availability of funds; in 2002, when the investigated area was limited to the GSA 15 and GSA 16, 120 valid hauls were carried out during the MEDITS survey, and only 65 in the GRUND survey.

Vessel, gear and equipment

Sampling at sea has been conducted always with the same vessel since 1985: a commercial stern trawler ("S. Anna") harboured in Mazara del Vallo (built in 1981; 32.2 m, length overall, 197.1 GRT, powered with an engine of 736 kW (1,012 hp), 750 revolutions per minute, maximum,, colour echo sounder, and 2,300 m of trawl warp). She can berth up to 12 persons (crew and scientific staff). Two types of bottom trawl have been used: the *ad hoc* GOC 73 (MEDITS) and the traditional "Mazarese" commercial "*tartana di banco*" (GRUND). The two gears mainly differ in the vertical opening of the mouth: 2.4–2.9 m (MEDITS) and 0.6–1.3 m (GRUND), whereas the codends mount the same mesh size (diamond; 20 mm, stretched). Furthermore, wood and iron trawl boards are used in the GRUND and the MEDITS gear, respectively. The area swept in each haul is computed according to the trawling speed, haul duration and horizontal net opening (HNO; estimated by using a model). Recently, Scanmar equipment was bought by IRMA to determine a direct link between trawling depth and the corresponding HNO. Since 1999, the bottom water temperature is recorded routinely with a specific device (minilog) fixed to the floatline of the gear.

Discussion

Other designs (systematic, simple, transects, etc.) and methods of allocating survey effort (optimal, Neymann, two-phase etc.) have been explored and proposed for the bottom trawl surveys (Gunderson, 1993). The design in use, however, remains the most "flexible" and adaptable choice, although a reduction in the number of strata would be welcomed.

Survey periodicity and time of the year are two other important issues; it would be advisable to perform at least seasonal surveys (with the same vessel/equipment) to measure the periodicity of the biological phenomena (as already done during the first survey cycle; 1985–1988). At present, surveys are conducted during spring (MEDITS) and late summer (GRUND) when most of the target species show peaks of biological activity (recruitment, growth, sexual maturity, etc.).

Concerning the choice of the proper sampling gear, it is always better to adopt a commercial-oriented gear. The mesh size in the codend should be set according to the minimum size usually used by fishermen (notwithstanding the existing legal dispositions in this respect), even if that might produce some biases in the catching of big and more active swimming fish.

Diel variations in the availability of many species should be investigated by *ad hoc* studies, since a proper continuous sampling activity is not ordinarily feasible.

The most relevant controversy is related to the variable performance of the bottom trawls by depth. Recent experiments (Bertrand *et al*., 2002) confirmed that the gear towed in deep water requires more time to stabilize. Some authors suggest that the nominal haul time should be increased in order to guarantee the limits placed on haul duration (50 min to 1 h), but this would imply a reduction in the number of hauls per day, and consequently an increase in the cost of survey that may be unbearable. On the contrary, other authors (Godo *et al.,* 1990), on the basis of the auto-correlation in the samples taken from the same haul, recommend increasing the number of hauls by reducing the nominal haul duration. Besides the opportunity to perform specific trials to highlight the influence of haul duration on the catch of the specific gear, a possible compromise would be to maintain the nominal haul duration in order to compare the previous data and to correct the bias by introducing a weighting factor (nominal/effective time) when the data collected in the different depth strata are merged for the purpose of analysis.

Whatever the general protocol adopted, it is fundamental to maintain it unchanged at least for a given time interval (in our case, 5–10 yr) in order to ensure the consistency of the data. Although expensive and imprecise, gear standardization and intercalibration should be foreseen when technical or logistic constraints require a change in vessel/equipment and/or protocol.

Conclusions

Although any experiment at sea includes sampling noise and biases, trawl data collected within both national (GRUND) and international (MEDITS) programmes represent a precious and consistent source of information for the assessment of spatial patterns, abundance and dynamics of exploited demersal resources. The relevance of these surveys is enhanced by the difficulty in collecting, on a regular basis, representative biological data from the highly diversified and scattered commercial fleets in the Mediterranean Sea.

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