Contribution to the Special Issue: “MEDiteranean International Acoustic Survey (MEDIAS)”

The “MEDiteranean International Acoustic Survey”: An introduction

Marianna GIANNOLAKI¹, Juan ZWOLINSKI², Ali CEMAL GUCU³, Andrea De FELICE⁴ and Stylianos SOMARAKIS¹

¹ Hellenic Centre for Marine Research (HCMR), Institute of Marine Biological Resources and Inland Waters, Heraklion, Greece
² University of California Santa Cruz, Affiliated to Southwest Fisheries Science Center, NOAA, USA
³ Middle East Technical University, Institute of Marine Sciences, Erdemli-Mersin, Turkey
⁴ National Research Council (CNR), IRBIM-Institute for Marine Biological Resources and Biotechnologies, Largo Fiera della Pesca, 160125 Ancona, Italy

Over five decades active acoustic methods have been routinely used worldwide for surveying the water column for fisheries research, aiming mostly to derive single-species abundance indices for direct input into stock assessments (Misund, 1997; Simmonds & MacLennan, 2005). It is well known that the most effective monitoring programs globally for forage fish, like small pelagics, are based on fishery-independent surveys such as daily egg production and/or acoustics (Barange et al. 2009). Forage fish productivity can rapidly decline and stock assessments based on catch per unit effort can be slow to detect this change, offering limited value (Essington et al. 2015). A dedicated working group of the International Council for the Exploration of the Sea, the Working Group on Fisheries Acoustics Science and Technology (WGFAST) was created in 1984 following a recommendation from the ICES Fish Capture Committee in 1982, being the major international forum where scientists working in fisheries acoustics network are met to discuss on-going developments in acoustic trawl surveys. Presently, a great deal of monitoring studies on the small pelagic fish is done through acoustic surveys worldwide.

As the Mediterranean presents no exception, all sixteen assessments of anchovy and sardine stocks, currently carried out within the FAO General Fisheries Commission for the Mediterranean Working Group on Stock Assessment of Small Pelagics (GFCM WGSASP, 2021), rely on acoustics estimates as abundance indices. This is largely attributable to the mandatory acoustic surveys operating under the umbrella of the MEDITerranean Acoustic Survey (MEDIAS). The MEDIAS (http://www.medias-project.eu/medias/website/) started in 2009 following the extensive, regular, and internationally coordinated hydroacoustic surveys that had been launched within the framework of the EU Fisheries Data Collection Regulation (EC 199/2008) based on the recommendation of the Sub-group on Research Needs of the EU Scientific, Technical and Economic Committee for Fisheries for the Mediterranean EU countries. Since then, the MEDIAS is required to perform annually in a standardised way to inform management bodies and provide input for the assessment of European anchovy (Engraulis encrasicolus, Linnaeus 1758) and European sardine (Sardina pilchardus, Walbaum 1792) stocks.

In less than 13 years, the MEDIAS has successfully embraced different scientific groups that were already collecting acoustic data in the framework of national surveys, some of them dating back to the 70s and 80s. It was a challenge to bring together people from different scientific groups to agree on a common survey protocol (MEDIAS, 2021), standardize the work among different institutes largely varying in infrastructure, research vessel capacity, type and frequencies of scientific echosounders available, operating in diverse ecosystems in terms of productivity, topography and fish aggregations. The MEDIAS Steering Committee, which convenes annually, was established with scientists from six European countries (Spain, France, Italy, Slovenia, Malta and Greece) and blossomed covering six Mediterranean basins (Ibrian Coast, Gulf of Lion, Ligurian and Tyrrhenian Seas, Strait of Sicily, Adriatic Sea, Aegean and the eastern Ionian Sea). It brought together scientists from both the Mediterranean and the Black Sea, from 8 European countries (Spain, France, Italy, Slovenia, Croatia, Greece, Bulgaria and Romania) as well as 4 non EU countries, namely Morocco, Algeria, Tunisia and Turkey. The latter regularly attend the meetings and adhere to the MEDIAS protocol. The open dialog and commitment to collaboration among members, was key to improving the collective knowledge and helped to address many technical issues that arose along the way.

The harmonization of the Mediterranean acoustic surveys that allowed for the merging of datasets collected over large spatial and temporal scales (e.g. Giannoulaki et al. 2011; Tugores et al. 2011; Giannoulaki et al. 2013; Machias et al. 2013; Bonnano et al. 2014; Barra et al. 2015; Giannoulaki et al. 2017), is reflected in the MEDIAS handbook (MEDIAS, 2021). Furthermore, the scientific importance of the MEDIAS is mirrored in this Special Issue, which includes selected papers that passed the peer-review process of the Mediterranean Marine
Science journal and are allocated into two sections. The papers highlight not only the maturation and standardization of acoustic methods but also the utility of periodic surveys to pursue novel fundamental research.

**Section 1: Review and technical issues related to the MEDIAS surveys**

- As Leonori et al. (2021) state, in this review paper, early experiments based on the acoustic methodology in the Mediterranean date back to the 50s, with the first pilot studies taking place in the 70s in the Adriatic Sea, Baleares Archipelago and the Gulf of Lions. Fisheries acoustics were soon recognized as a powerful tool to monitor the abundance of small pelagic species and became a common research method that was adopted by several countries. This review work summarizes how the hydroacoustic surveys conducted by each country have evolved over time. The study also represents the outlines of the steps taken to overcome the challenges faced in achieving standardization among surveys throughout the implementation of the MEDIAS project since 2009. The paper’s importance also lies in presenting the historical time series of biomass for small pelagics in the different areas and the inclusion of decadal maps showing the spatial and temporal distribution of small pelagic species in the European Mediterranean Sea. Furthermore, it discusses the use of MEDIAS data for stock assessment purposes, the potential of the surveys to acquire information on zooplankton, ichthyoplankton and mesopelagic assemblages, emphasizes the ability to gather auxiliary information for ecosystem-based management as well as the need for further standardization and anticipation of future challenges.

Followed by two manuscripts on two long-standing technical issues related to acoustic surveys,

- Due to the daily change of aggregative behavior in small pelagic species, acoustic surveys are overwhelmingly conducted during the day. However, sampling over the 24h cycle can be feasible in some locations, provided that diet differences in the fish detection, both acoustically and through trawls are known. Working on data collected in three different areas of the Mediterranean basin during both daytime and nighttime Bonnano et al. (2021) aims to estimate a correction factor to compensate for nighttime sampling, effectively opening the possibility for surveying round the clock, with substantial increases in surveying efficiency.

Acoustic surveys present a unique feature, as the echosounders allow us to look at the ecosystem as a whole – from the surface to the seafloor – within the same dataset. In addition, the survey itself allows the collection of different datasets at the same time. This feature is reflected on the second section of the Special Issue.

**Section 2: Mediterranean acoustic surveys as a platform to address ecological and biological issues**

- Hattab et al. (2021) address the applicability of Bergmann’s rule to the populations of small pelagic fish species examining 10 species collected in pelagic trawl hauls carried out during acoustic surveys in the Mediterranean Sea. Anchovy, sardine, Atlantic chub mackerel, bogue and blue jack mackerel showed significant negative effect of temperature on mean body size with larger individuals being more common at lower temperature. The adherence of 5 out of 10 pelagic fish to Bergmann’s rules strongly suggest that temperature is a major determinant of their body sizes and enables them to act as sentinel species for identifying the drivers and consequences of warming in the Mediterranean ecosystems.

- Sardinella aurita and Sprattus sprattus are two species sitting at opposite ends of the thermal range. In the Mediterranean Sea available information is limited due to the low commercial interest for these species. DeFelice et al. (2021) come to anticipate this, integrate acoustic estimates from Spanish Mediterranean waters, the Gulf of Lions, Ligurian and Thyrrenian Seas, the Strait of Sicily and the Adriatic Sea and examine the biomass response to environmental changes highlighting the differences.

- The invasive ctenophore Mnemiopsis leidyi has been an issue for extensive scientific discussions during the last fifteen years as the species out-breaks can have massive consequences on fish stocks and marine food webs. Budiša et al. (2021) investigated the distribution, abundance and diet of this ctenophore in the northeastern Adriatic from 2016 to 2019 in terms of environmental variables. Going further, through the eyes of simultaneous monitoring, they revealed that M. leidyi’s presence coincided with a reduction in anchovy abundance, assuming that the anchovy drop is
a consequence of competition for food. The work underlined the potential of the MEDIAS to support the ecosystem based management approach and monitor large-scale changes in macrozooplankton communities and other ecosystem’s components.

- Malavolti et al. (2021) evaluated short-term genetic changes of the European anchovy in the Adriatic Sea by applying molecular markers in samples of adults and larvae collected in three different areas of the Adriatic Sea potentially belonging to different populations. Results detected a possible reduction in genetic diversity between adults and offspring. As the successive mixing in nursery areas – due to the passive larval transport by currents – enables the preservation of the population, findings highlight the need to protect the main nursery areas of the Adriatic to avoid critical erosion of genetic diversity over time. Moreover, authors showed evidence that the genetic structure of anchovy populations in the Adriatic Sea may be affected by short-term events. The genetic pool may reflect annual differences induced by interactions among biological factors affecting anchovy populations and the complex climatic conditions and oceanographic characteristics of the Adriatic basin.

- Size at first sexual maturity ($L_{50}$) represents an important life history trait known to display variability due to fishing pressure, geographical gradient and environmental features. It contains basic information for management preventing the exploitation of immature individuals. Ferreri et al. (2021) investigate the $L_{50}$ variability among different areas of the Mediterranean and Black Sea based on samples collected in the framework of the MEDIAS surveys under a standardized protocol. Obtained results evidenced a significant effect of latitude and condition factor as well as differences on $L_{50}$ values among areas and between sexes, with males reaching the maturity at lower length than females. The observed variability at a basin scale highlights the importance to consider area and habitat peculiarities into management suggestions towards the ecosystem approach to fisheries management.

The MEDIAS started out as a monitoring survey for single species with single frequency echosounders, but ahead is the future challenge to gain a much broader view combining different datasets over large spatial and temporal scales, interpreting large features and patterns in ecology and biology as well as the changes in those patterns. The MEDIAS Special Issue is the first step towards this direction.

References


Barra, M., Petitgas, P., Bonnano, A., Somarakis, S., Woillez, M. et al., 2015. Interannual changes in biomass affect the spatial aggregations of anchovy and sardine as evidenced by Geostatistical and spatial indicators. PLoS ONE, 10 (8), e0135808.


De Felice, A., Iglesias, M., Saraux, C., Bonanno, A., Tičina, V. et al., 2021. Environmental drivers influencing the abundance of round sardinella (Sardinella aurita) and European sprat (Sprattus sprattus) in different areas of the Mediterranean Sea. Mediterranean Marine Science, Special Issue, 22 (4), 812-826.


