

A. LIGAS¹, C. MUSUMECI¹, I. ROSSETTI², M. SARTINI², P. SARTOR¹, M. SBRANA¹,
C. VIVA¹, C. PRETTI¹

¹Consorzio per il Centro Interuniversitario di Biologia Marina ed Ecologia Applicata (CIBM), viale N. Sauro
4, 57128, Livorno (Italy)

²Aplysia Soc. Coop., Ricerche Applicate all'ecologia e alla Biologia Marina, Livorno (Italy)
ligas@cibm.it

THE RISE AND FALL OF THE FISHERY FOR SILVER SCABBARDFISH, *LEPIDOPUS CAUDATUS* EUPHRASEN, 1788 (ACTINOPTERYGII; TRICHIURIDAE) IN THE LIGURIAN AND NORTHERN TYRRHENIAN SEA (NW MEDITERRANEAN)

ESPANSIONE E DECLINO DELLA PESCA AL PESCE SCIABOLA, *LEPIDOPUS CAUDATUS* EUPHRASEN, 1788 (ACTINOPTERYGII; TRICHIURIDAE) NEL MAR LIGURE E TIRRENO SETTENTRIONALE (MEDITERRANEO NORD-OCCIDENTALE)

Abstract – In the early 2000s in the Ligurian and northern Tyrrhenian Sea (NW Mediterranean), new fisheries targeting *Lepidopus caudatus* Euphrasen, 1788 (Actinopterygii; Trichiuridae) were developed. These fisheries used ad hoc bottom trawl nets with higher vertical opening, gillnets and longlines. Any specific management measure did not regulate the development of these fisheries and due to the progressive reduction of catches, the target fisheries stopped. A stock assessment using data-limited tools (AMSY and CMSY) confirmed the overexploitation of silver scabbardfish.

Key-words: *Lepidopus caudatus*, fishery, stock assessment, overfishing, NW Mediterranean.

Introduction - The silver scabbardfish, *Lepidopus caudatus* Euphrasen, 1788 (Actinopterygii; Trichiuridae), is a mesopelagic species living on the shelf and slope down to 600m in temperate waters all around the world. The species occurs both on the continental shelf and slope. However, the bathymetric distribution varies according to season, the species being more common on the continental shelf in wintertime and moving to deeper zones in other seasons (Demestre *et al.*, 1993). Silver scabbardfish have a moderate commercial value and are caught worldwide mainly as commercial bycatch in bottom and pelagic trawl fisheries, as well as by set nets and longlines.

In the Mediterranean, the species is caught mainly by longlines with a marked seasonality. In the early 2000s, in the Ligurian and northern Tyrrhenian Sea (FAO-GFCM GSA 9; NW Mediterranean), new fisheries targeting *L. caudatus* were developed. These fisheries used ad hoc bottom trawl nets with a higher vertical opening, gillnets and longlines. Any specific management measures did not regulate the development of these fisheries and due to the progressive reduction of catches, the targeted fisheries stopped. A similar pattern was observed in other areas of the Mediterranean, such as the Strait of Sicily (Falsone *et al.*, 2021).

Materials and methods - Two different data sources were used for the stock assessment: (i) commercial landings data from 2004 to 2021 collected within the EU data collection framework (DCF), and (ii) biomass index (1994-2021) from the MEDITS surveys performed in GSA 9 (Fig. 1).

The AMSY is a data-limited method that estimates fisheries reference points (F/F_{MSY} , B/B_{MSY}) using time series of catch rate from scientific surveys combined with prior resilience estimates (Froese *et al.*, 2020). AMSY was performed using the biomass index time series (1994-2021) from the MEDITS survey in GSA 9. In addition, the stock status was evaluated through the Monte Carlo method (CMSY), based on catch data only, and the Bayesian State Space Schaefer model (BSM), using landings and

biomass index (Froese *et al.*, 2017). The BSM is included in the CMSY R code. The analyses were made using R 4.2.0.

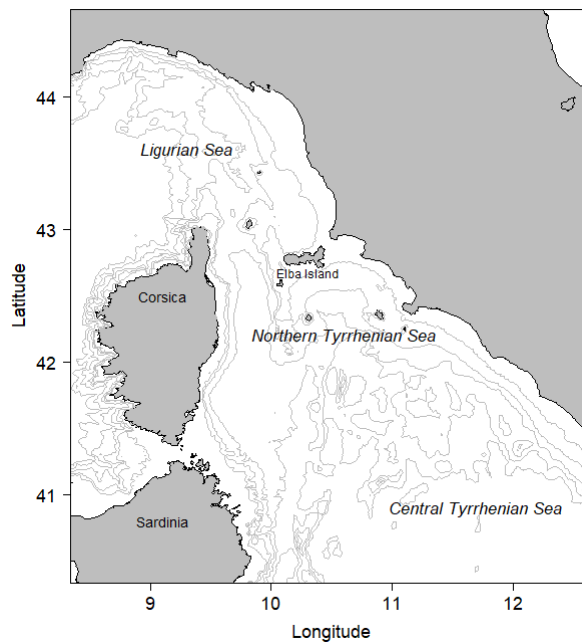


Fig. 1 - Study area: Ligurian and northern Tyrrhenian Sea, FAO-GFCM Geographic Sub-Area 9 (GSA 9).
 Area di studio: Mar Ligure e Tirreno Settentrionale, Sub-Area Geografica FAO-GFCM 9 (GSA 9).

Results - According to the official data, landings of silver scabbardfish in the Ligurian and northern Tyrrhenian Sea (FAO-GFCM GSA 9) reached a peak of about 300 tons in 2011, then dropped from 250 tons in 2017 to less than 50 tons in 2020 (Fig. 2). This decline was also observed in the biomass index derived from the MEDITS surveys in GSA 9 (Fig. 2).

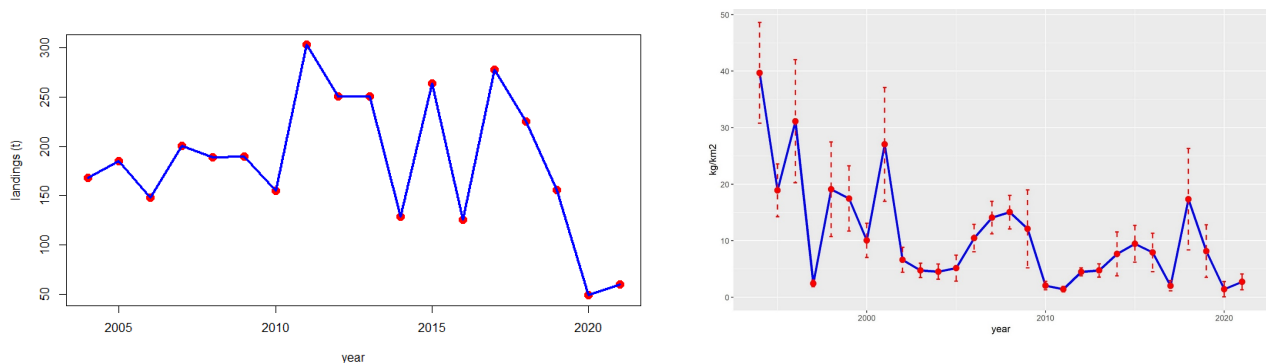


Fig. 2 - Official landings (tonnes, 2004-2021) from EU DCF (left panel) and biomass index (kg/km², 1994-2021) from the MEDITS surveys (right panel) of silver scabbardfish, *L. caudatus*, in the Ligurian and northern Tyrrhenian Sea (GSA 9).
 Sbarcato ufficiale (tonnellate, 2004-2021) riportato da UE DCF (a sinistra) ed indice di biomassa (kg/km², 1994-2021) della campagna MEDITS (a destra) di pesce sciabola, *L. caudatus*, nel Mar Ligure e Tirreno Settentrionale (GSA 9).

According to the outputs of the AMSY model, the biomass index from 1994 to 2018 showed a decreasing trend even if, in 2018, a peak of biomass, due likely to a good recruitment, was recorded. The AMSY model outputs show that the stock is both overfished ($F/F_{MSY} > 1$) and overexploited ($B/B_{MSY} < 1$).

The overall dynamics of the stock, shown by the Kobe plot (Fig. 3), show a progressive worsening of the stock status starting from the early 2000s, followed by a high exploitation level associated with a low standing stock biomass for most of the investigated period.

Despite very being similar, the outputs of BSM are slightly more optimistic than the results of AMSY. The Kobe plot based on BSM estimations shows a probability of 71 and 29% that the status stock is falling in the overfished area (red part) or recovering status (yellow part) of the graph, respectively (Fig. 3).

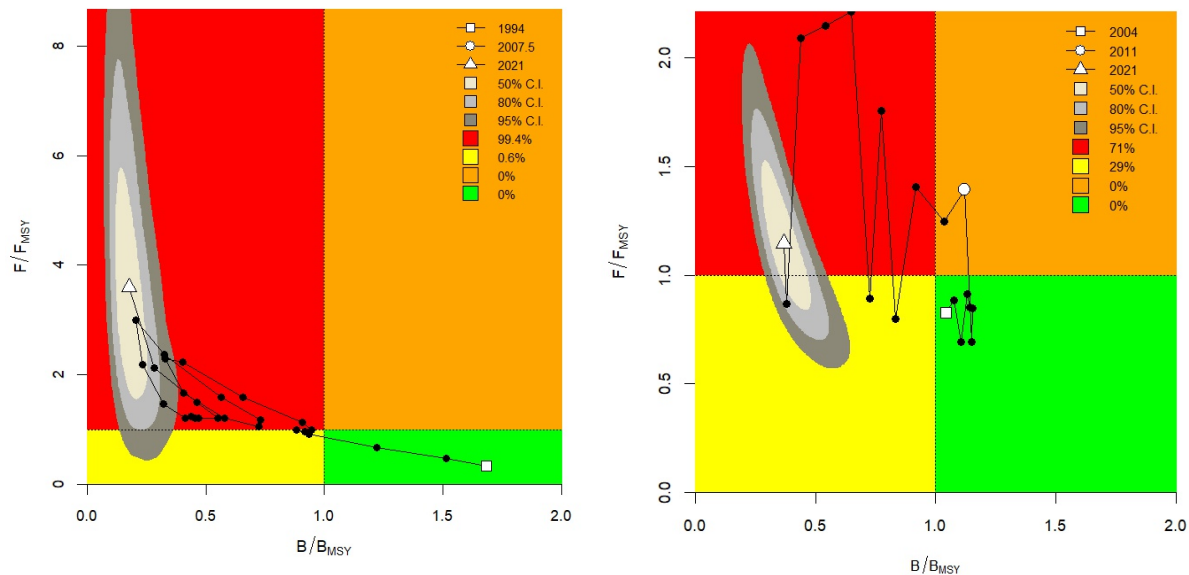


Fig. 3 - Kobe plot showing B/B_{MSY} against F/F_{MSY} ratios estimated by AMSY (left panel) and BSM (right panel). Shaded areas indicate the confidence interval at 50% (light grey), 80% (grey), and 95% (dark grey) and quadrants are color-coded, i.e., green (not overfished, no overfishing), red quadrant (overfished and overfishing), or yellow (recovering status).

Grafici di Kobe che mostrano il rapporto B/B_{MSY} rispetto al rapporto F/F_{MSY} stimati da AMSY (a sinistra) e BSM (a destra). Le aree ombreggiate indicano gli intervalli di confidenza al 50% (grigio chiaro), 80% (grigio) e 95% (grigio scuro) ed i quadranti sono codificati secondo il colore, ad esempio, verde (non sovrasfruttato e non in sovrasfruttamento), rosso (sovrasfruttato ed in sovrasfruttamento), giallo (in recupero).

Conclusions - Marine species are widely threatened by anthropogenic activities, including fishing and human-induced climate change. Specific fisheries targeting *L. caudatus*, have developed from the early 2000s, especially in the northern Tyrrhenian Sea. These fisheries were started by the Civitavecchia fishing fleet, followed by the trawl fleet based in Porto Santo Stefano (Monte Argentario). These fisheries showed a sudden increase in yield and fishing effort, followed by a progressive decline through time. The stock trend in terms of biomass showed a decline, with the lowest values observed in the last years.

The two data-limited approach for stock assessment that were attempted in the present study show consistent results. Considering the lack of discard data in the investigated area, the BSM assessment was performed using only official landing data. This might affect the stock status estimation, giving a more optimistic state of the exploited stock compared to the AMSY approach, which is based on fishery independent data only, and showed a clear overfished and overfishing condition of silver scabbardfish stock in the Ligurian and northern Tyrrhenian Sea.

Information on the discarding of silver scabbardfish in Mediterranean fisheries is still scarce and contradictory. Tzanatos *et al.* (2007) and Sánchez *et al.* (2004) report that catches of silver scabbardfish are fully discarded by gillnet and trawl fisheries in the

Aegean Sea and Catalan Sea, respectively. In contrast, Soykan *et al.* (2016) observed a 30% discards of silver scabbardfish in Turkish fisheries in the central Aegean Sea, while Carbonell and Mallol (2012) report discard rates of about 10% in trawl fisheries in the Catalan Sea.

Further investigations shall attempt to derive reliable estimates of the discarding of silver scabbardfish in the Ligurian and northern Tyrrhenian Sea fisheries to inform stock assessment models better, thus providing more robust advice on the status of the stock.

Following the development of a new fishery since the beginning, this study provides a further example of how unregulated exploitation leads to a heavily overfished state of stock and the collapse of fishing activities. Learning from the case of *L. caudatus* fishery in the Ligurian and northern Tyrrhenian Sea, as well as in other areas of the Mediterranean (e.g., the Strait of Sicily, Falsone *et al.*, 2021), it would be important to monitor both stock biomass and fishing activities and adopt multiannual management plan to guarantee the fishery sustainability.

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