LENGTH-WEIGHT RELATIONSHIPS OF SWORDFISH (*XIPHIAS GLADIUS L.*) CAUGHT BY LONGLINERS IN THE MEDITERRANEAN SEA

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SUMMARY

The present study presents data on the length-weight (L-W) relationship for the Mediterranean swordfish. The biometric data are presented to provide information required for pending stock assessment and life-history studies of this species. These data will provide new information since previous data mainly concentrated on the gilled-gutted weights (GWT) of Atlantic swordfish. The length-weight relationship was obtained from the Lower Jaw Fork Length (LJFL) and the Round Weight (RWT). This relationship showed a very high correlation for the swordfish longline fishing industry operating in the Mediterranean Sea as shown below: $RWT = 6E\text{-}06*LJFL^{3.1448}$ ($R2 = 0.9308$). These authors recommend using this relationship to convert LJFL to RWT and vice-versa for the Mediterranean swordfish. Moreover, in accordance with the current Italian legal framework, where the minimum catch-at-size is also measured using the Full Length (FL) which includes the Sword Length (SL), an additional equation was developed on the basis of this further length parameter with the following correlation: $RWT = 5E\text{-}07*FL^{3.3375}$ ($R2 = 0.8999$). Further studies on other biometric correlations are required to further clarify the differences between sex, areas, seasons and condition factor of this important socio-economic species.

RÉSUMÉ

La présente étude apporte des données sur la relations taille-poids de l'espadon de la Méditerranée. Les données biométriques sont présentées afin de fournir les informations nécessaires pour la prochaine évaluation des stocks et les études sur le cycle vital de cette espèce. Ces données fourniront de nouvelles informations vu que les données antérieures concernaient principalement les poids éviscérés et sans branchies (GWT) de l'espadon de l'Atlantique. La relation taille-poids a été obtenue sur la base de la longueur maxillaire inférieur-fourche (LJFL) et du poids vif (RWT). Cette relation présentait une corrélation très forte pour l'industrie halieutique palangrière d'espadon active en Méditerranée, comme illustré ci-après : $RWT = 6E^{-06}*LJFL^{3.1448}$ ($R^2 = 0,9308$). Ces auteurs ont recommandé d'utiliser cette relation pour convertir la LJFL en RWT et inversement pour l'espadon de la Méditerranée. De surcroît, conformément au cadre juridique actuel italien, selon lequel la prise par taille minimale est également mesurée au moyen de la taille complète (FL) qui inclut la longueur de l'éperon (SL), une équation supplémentaire a été élaborée sur la base de ce paramètre de taille supplémentaire appliquant cette corrélation : $RWT = 5E^{-07}*FL^{3.3375}$ ($R^2 = 0,8999$). Des études supplémentaires portant sur d'autres corrélations biométriques sont requises afin de clarifier davantage les différences entre les sexes, les zones, les saisons et le facteur de condition de cette espèce socio-économiquement importante.

RESUMEN

Este estudio presenta los datos sobre la relación talla-peso (L-W) para el pez espada del Mediterráneo. Se presentan los datos biométricos para proporcionar la información requerida para la siguiente evaluación del stock y los estudios sobre el ciclo vital de esta especie. Estos datos proporcionarán nueva información dado que los datos anteriores se centraban principalmente en los pesos eviscerados y sin agallas (GWT) del pez espada del Atlántico. La

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relación talla-peso se obtuvo a partir de la longitud a la horquilla (LJFL) y el peso vivo (RWT). Esta relación presentaba una elevada correlación para la industria pesquera del palangre dirigida al pez espada y que opera en el Mediterráneo, como se muestra a continuación. RWT = $6E^{-06}*SFL^{3.1448}$ (R^2 = 0,9308). Estos autores recomendaron que se usara esta relación para convertir la LJFL a RWT, y viceversa, para el pez espada del Mediterráneo. Además, de conformidad con el actual marco legal italiano, en el que la captura por talla mínima se mide también utilizando la longitud total (FL), que incluye la longitud de la espada (SL), se elaboró una ecuación adicional basándose en este parámetro adicional de longitud, con la siguiente correlación: RWT = $5E^{-07}*SFL^{3.3375}$ (R^2 = 0,8999).Son necesarios más estudios sobre las correlaciones biométricas para aclarar las diferencias entre sexo, áreas, temporadas y el factor de condición de esta especie, tan importante socioeconómicamente.

1. Introduction

Swordfish (*Xiphias gladius*) is a large pelagic migratory species of high commercial value that is heavily exploited in the Atlantic Ocean and the Mediterranean Sea. It migrates toward temperate or cold waters in the summer and back to warm waters in the fall at a depth range of 0–800 m (Tserpes et al., 2003; Froese and Pauly, 2016). Swordfish lives solitary or in small groups and feeds on small schooling fish and squids; it uses its bill to slash into a school of fish to stun its prey, and also probably uses the bill to dig into the substrate to disclose benthic organisms (Golani et al., 2006).

According to ICCAT records, the biggest producers of swordfish in the Mediterranean Sea in recent years (2003-2014) are: EU-Italy (45%), Morocco (14%), EU-Spain (13%), EU-Greece (10%) and Tunisia (8%).

Swordfish catches are landed in different conditions in the various Mediterranean fisheries (round, gilled, gutted and dressed). For practical fishery management purposes, biometric measurements (length, weight) are usually obtained from landed fish (mainly gilled-gutted) and therefore there is a need for working out robust equations for conversion among different measurements. The accuracy of the length-weight (L-W) relationships is obviously very important for the creation of a database for both fishery management and stock assessment (Tserpes et al. 2002).

In the case of Mediterranean fisheries, several authors have proposed L-W relationships for conversion of Lower Jaw-Fork Length (LJFL) measurements in different weight forms: Round Weight (RWT), Gilled-Gutted Weight (GWT), Dressed Weight (DWT) and Live Weight (RW) (De Metrio et al., 1987, cited in ICCAT 1990; Tsimenides and Tserpes, 1989; Mejuto and de la Serna, 1993; De la Serna et al., 1995; Hattour, 1996; Orsi-Relini et al., 1999; Alicli and Oray, 2001).

For the Mediterranean region, ICCAT had adopted an equation for the LJFL–GWT during the late 1980's. The use of a LJFL–RW relationship that is based on data from the Spanish fisheries exploiting the western Mediterranean basin was then proposed (Mejuto & de la Serna, 1993). However, recent SCRS meetings indicated that the L-W relationships currently in use in ICCAT for the entire Mediterranean might not be the most appropriate, as there may be spatial differences between the east and west Mediterranean. Moreover, in accordance with the current Italian legal framework, the minimum catch-at-size is also based measuring the Full Length (FL) which includes the Sword Length (SL). Ongoing work and preliminary results, presented at the Working Group during the 2016 Mediterranean Swordfish Stock Assessment, indicate the necessity to obtain additional data to build a realistic scenario in this field.

Based on these recommendations, this study aims to present L-W relationships for the Mediterranean swordfish for conversion of Round Weight (RWT) from Lower Jaw-Fork Length (LJFL) and Full Length (FL).

2. Materials and Methods

A total of 385 measurements were obtained by Department of Life and Environmental Sciences (DiSVA) - Università Politecnica delle Marche, Ancona (Italy) with the support of OCEANIS Srl (Italy). The study was financially supported by the MiPAAF (Italy).

Data were collected from July to August 2016 from the landings of the Italian, Spanish and Greek fleets operating in the Mediterranean Sea. An initial visual inspection of the dataset identified 46 obvious errors that were excluded from further analysis; hence a total of 339 LJFLs, FLs and RWTs were finally analysed.

The two relationships were determined from the linear transformation of the classical L–W relationship:

$$W = a*L^b$$

where W (weight) and L (length) are variables and a and b are parameters.

The coefficient of determination (R^2) was used as index of the quality of the estimates.

3. Results

The present work intends to estimate length-weight relationships for the Mediterranean swordfish, based on data obtained from the Italian, Spanish and Greek fisheries exploiting the Mediterranean Sea.
Based on ICCAT standard measurement as LJFL, the L-W relationship (Fig. 1) obtained in this study is described by the following equation:

$$RWT = 6E^{-06}*LJFL^{3.1448} \quad (R^2 = 0.9308)$$

Based on Italian length measurements as FL, which includes SL, the L-W relationship (Fig. 2) obtained in this study is described by the following equation:

$$RWT = 5E^{-07}*FL^{3.3375} \quad (R^2 = 0.8999)$$

4. Conclusions

In the past, several LJFL–W relationships for the Mediterranean swordfish have been developed based on data collected from the landings of various fisheries.

The present study proposes a correlation of biometric data by a LJFL-RWT relationship for Mediterranean swordfish and the authors recommend using this relationship to convert Lower Jaw Fork Length to Round Weight and vice-versa for the Mediterranean swordfish.

Moreover, taking into account the current Italian legal framework based on FL measurements, an additional equation was developed on the basis of this further length parameter as FL-RWT. The number of fish analysed and the solid correlations obtained indicate that these data and the relative equations can be a valuable contribution to the advancement of knowledge on the assessment of the swordfish population in the Mediterranean Sea. Furthermore, they could be considered as bases of discussion into the catch-at-size analysis in future SCRS swordfish stock assessment sessions.

Further studies on additional biometric correlations are in progress to better clarify the differences between sex, areas, seasons and condition factor of this important socio-economic species.

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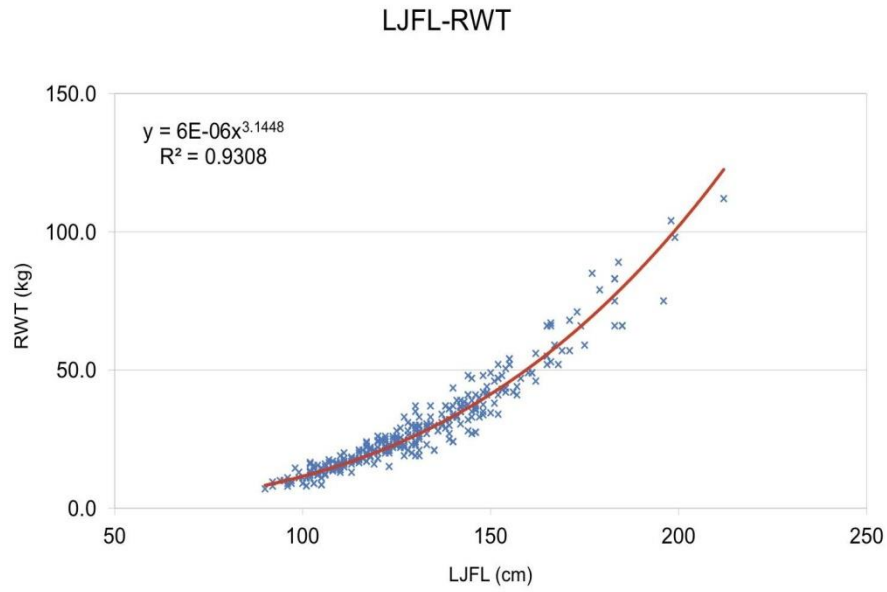
LJFL-RWT

$$y = 6E\text{-}06x^{3.1448}$$
$$R^2 = 0.9308$$

Figure 1. LJFL- RWT relationship ($RWT = 6E^{-06}*LJFL^{3.1448}$; $R^2 = 0.9308$) for the Mediterranean swordfish.

FL-RWT

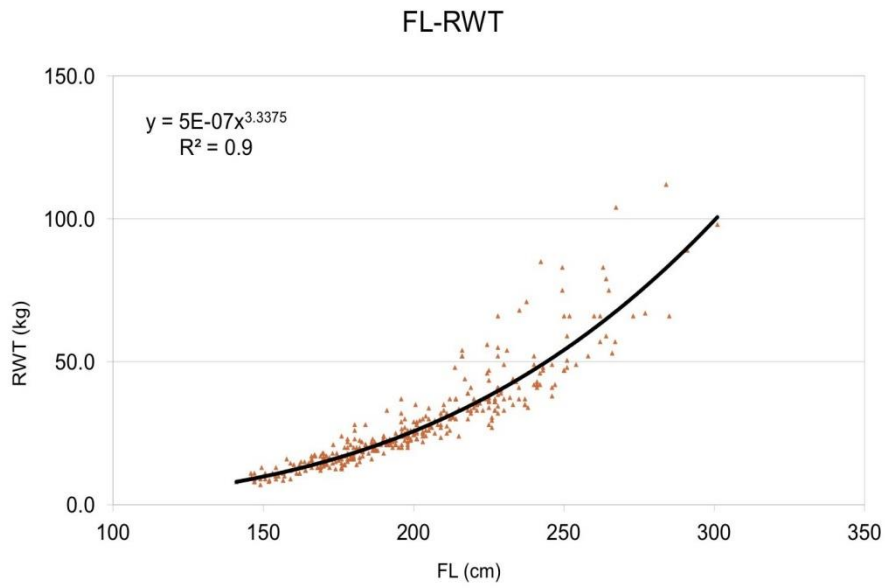$$y = 5E\text{-}07x^{3.3375}$$
$$R^2 = 0.9$$

Figure 2. FL- RWT relationship ($RWT = 5E^{-07}*FL^{3.3375}$; $R^2 = 0.8999$) for the Mediterranean swordfish.