Egyptian Journal of Aquatic Research (2016) xxx, xxx–xxx

HOSTED BY

ELSEVIER

National Institute of Oceanography and Fisheries

Egyptian Journal of Aquatic Research

http://ees.elsevier.com/ejar
www.sciencedirect.com

FULL LENGTH ARTICLE

Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean)

T. Bottari [a,*], **P. Rinelli** [a], **S. Ragonese** [b]

[a] *Institute for Coastal Marine Environment (IAMC), National Research Council (CNR), Spianata S. Raineri, 86, 98122 Messina, Italy*
[b] *Institute for Coastal Marine Environment (IAMC), National Research Council (CNR), Via L. Vaccara, 61, 91026 Mazara del Vallo (TP), Italy*

Received 18 April 2016; revised 30 September 2016; accepted 23 October 2016

KEYWORDS

Galeus melastomus;
Blackmouth catshark;
Bottom trawl surveys;
Comparison;
Central Mediterranean Sea

Abstract Mediterranean young-fish oriented experimental bottom trawl surveys represent a precious source of information on both past and current standing stocks and their life history traits and exploitation state. In the present note, taking the occasion of the same vessel employed in the South of Sicily (Central Mediterranean), an indirect approach has been implemented to compare MEDITS (Mediterranean International Bottom Trawl Survey) and GRUND (Gruppo Nazionale Demersali) abundance and biological features of the blackmouth catshark *Galeus melastomus* Rafinesque, 1810 to highlight gear and season effects if any. Data were gathered between 1994 and 2006, in spring-summer (MEDITS) and autumn (GRUND). The density and biomass indexes and occurrences were substantially lower in spring than in autumn. On the contrary, the biological traits were more similar, although significant differences were detected in the length frequency distribution. The homogeneity of life traits between seasons and the critical features showed in this study demonstrate that an annual experimental trawl survey can be enough to monitor *G. melastomus*. Similar analysis could be useful to highlight seasonal and gear effects on the other demersal stocks to better figure out limits and possibility of Mediterranean young-fish oriented experimental bottom trawl surveys data.

* Corresponding author. Fax: +39 90 669003.
E-mail address: teresa.bottari@iamc.cnr.it (T. Bottari).

Peer review under responsibility of National Institute of Oceanography and Fisheries.

http://dx.doi.org/10.1016/j.ejar.2016.10.003

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

Introduction

Almost all the Mediterranean demersal stocks are affected by a long persistent history, steady state chronic growth, overfishing and decreasing landings (Lleonart and Maynou, 2003; COM, 2006). In order to better understand the reasons of such situation and to figure out the most proper management plans, fisheries scientists operating within scientific and management bodies such as the General Fisheries Commission for the Mediterranean (GFCM) as well as the Scientific Technical and Economic Committee for Fisheries (STECF), have been requested to produce more and more sophisticated assessments by using both fisheries dependent (commercial) and independent (experimental trawl surveys) figures. Both kinds of data present some problems in their proper use: commercial captures might be incomplete (cfr Pauly et al., 2014), whereas experimental surveys cover a narrow temporal window of the biological cycle not necessarily the best for all the stocks (Trenkel and Cotter, 2009). Notwithstanding its limits, Mediterranean young-fish oriented experimental bottom trawl surveys (herein MEBTS) might represent a precious source of information on both past and current standing stocks and on their life history traits and exploitation state (Levi et al., 1998; Colloca et al., 2015). At the present, within the EU countries, the most important experimental bottom trawl survey is represented by the Mediterranean International Bottom Trawl Survey (MEDITS) programme; it was started in 1994 with the main objective to obtain abundance indices that can be comparable among different Mediterranean Geographical Sub-Areas (GSAs; Abello et al., 2002). Other Mediterranean young-fish oriented experimental bottom trawl surveys have been more or less occasionally performed, as the Italian Gruppo Nazionale Demersali – GRUND programme covering the whole Italian seas carried out from 1985 to 2009 (Relini, 2000). Considering the Southern Sicilian area, the same vessel (32.2 m length overall; powered with a 736-kW engine) has been used for both bottom trawl surveys since the beginning, hauling two different gears which mainly differ in the vertical opening of the mouth (Table 1). Direct intercalibration trials have been attempted in Italy both at national (GRUND, 1999) and regional (Scalisi et al., 1998; Fiorentini et al., 1999) level but with very poor and inconclusive results unapplied in both cases. In the present note an indirect approach has been implemented to compare MEDITS and GRUND abundance and biological features of the blackmouth catshark *Galeus melastomus* Rafinesque, 1810 to highlight gear and season effects if any. In other words understanding the suitability of a single survey to give an invariant picture of the stock investigated.

Materials and methods

The present seasonal/gear comparison of *G. melastomus* refers to South of Sicily (Fig. 1), the geographical Sub-Area (GSA) 16 as defined by the General Fisheries Commission for the Mediterranean Sea (GFCM, 2001). South of Sicily has been subjected to traditionally high fishing pressures than the contiguous Malta island (GSA 15) area, although many large trawlers for fishing in distant waters, moved toward the African coast in the last decade (Garofalo et al., 2003). Bottom trawl fisheries operate almost exclusively within 700 m of depth. Average Bottom Sea Water Temperature (BSWT, °C), from 201 m up to 700–800 m, gathered during 1999–2004 surveys by minilog, denoted a seasonal homogeneity (13.9–14.1 °C).

Table 1 Features of trawl gear used in the experimental trawl surveys.

Parameter	Features	
	GOC 73 MEDITS	Tartana di banco GRUND
Horizontal opening (m)	15.6–18.7	19.6–28.8
Vertical opening (m)	2.4–2.6	0.6–1.3
Diameter of trawl warps (a.k.a. bridles)	16	14 mm
Features of otter boards (1)	Steel (Morgére WHS 8)	Rectangular, Steel (Morgére WHS 8)
Dimensions of otter boards (doors)	2.05 * 1.25	2.05 * 1.25
Weight of otter board	350 kg	350 kg
Construction materials of sweep lines	Polyamide-steel	Polyamide-steel
Sweep lines diameter	32 mm	32 mm
Sweep lines length	100/150 m	272 m
Diameter of sinker on groundrope	12 mm	12 mm
Construction materials of headrope	Steel	Polyamide
Diameter of headrope	10	22 mm
Length of headrope	24	46 m
Number of floats	50	54
Diameter of float	200 mm	120 mm
Construction materials of groundrope	Polyamide-steel	Polyamide-steel
Length of groundrope	29	72 m
Construction materials of cod end	Polyamide	Knotless Polyamide
Mesh opening of cod end (stretched, mean)	20 mm	20 mm

Data about the blackmouth catshark of South Sicily were gathered between 1994 and 2006, in spring-summer (MEDITS; MEDITS-Handbook, 2013) and autumn (GRUND, Relini, 2000). Overall 1572 valid hauls have been analysed: 703 and 869 during MEDITS and GRUND surveys respectively (Table 2). The haul catch was sorted for the blackmouth catshark, the overall abundance in weight and number was recorded and the corresponding biological material was frozen at −40 °C on board.

In the laboratory, each sampled specimen was measured (mm; total length, TL), weighted (g) and sexed (females/-males). The macroscopic maturity stage was assigned in accordance with Ragonese et al. (2006). Specimens were classified in: 1st, immature (small undeveloped ovaries – claspers do not extend past posterior edge of pelvic fin); 2nd, developing or recovering (ovaries beginning to enlarge with some small ova – claspers extend past pelvic fin edge; and 3rd, fully mature (large yellow ova – calcified claspers).

MEDITS data (already published in Ragonese et al. (2009) and new elaborated parameters derived by GRUND data concerning the blackmouth catshark were compared. Frequency of occurrence (f%) was computed as percentage of positive

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

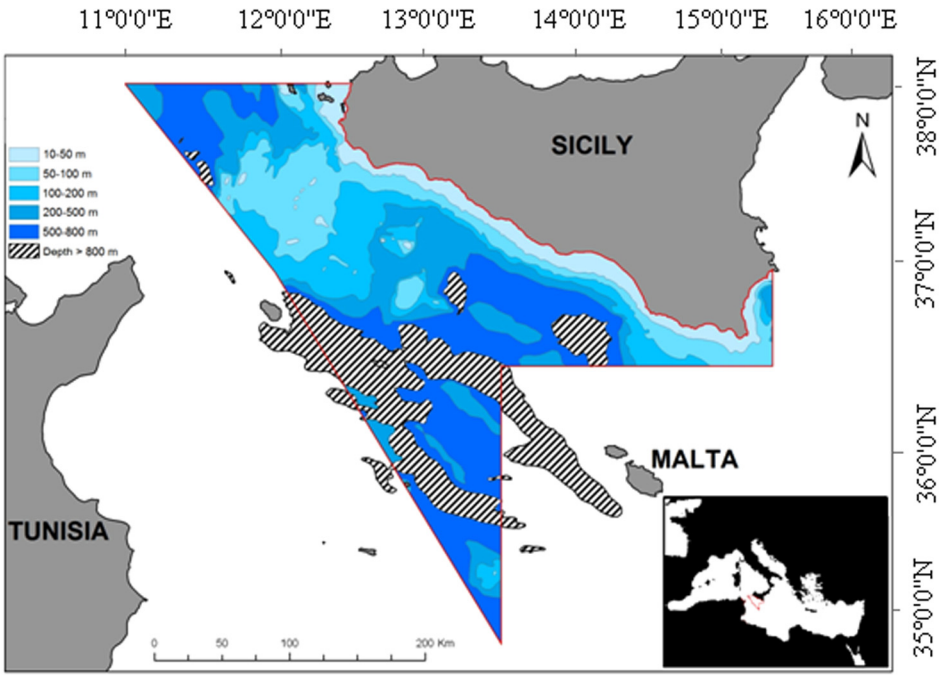

Fig. 1 South of Sicily (GSA 16 according the GFCM delimitation). The bottoms deeper than 800 m are not explored by MEDITS (Spring) and GRUND (Autumn) surveys.

hauls (presence of at least 1 specimen). Mean density index (DI; $N*km^{-2}$) and biomass index (BI; $kg*km^{-2}$) were estimated for each stratum and season according to the sweptarea principle (Gunderson, 1993).

The following biological parameters were estimated: median (Md) for sexes combined, sex ratio (Sr), defined as the proportion of females F on the total sexed individuals ($F + M$); median length for each maturity stage and size at the onset of sexual maturity (L_m, derived according to the logistic approach by using the 2nd and 3rd stages as "adults").

The individual lengths were combined by survey in classes of 20 mm width and the resulting lengthfrequency distribution (LFD) analysed using the FiSAT software (Gayanilo et al., 2005).

Both "spring" (MEDITS) and "autumn" (GRUND) surveys were compared by year and combined year: the Shapiro–Wilk and F-tests were applied to verify the assumptions of data distribution normality and homogeneity of variances, paired t-test to compare the biological parameters. The significance of the difference among the estimated and expected Sr were evaluated according to a χ^2 test. Kolmogorov–Smirnov (K–S) test was used for LFDs comparison.

Length and weight data were $\log_e$-transformed, and the linearised relationships were fitted by least square regression to estimate the intercept and the slope coefficients of the length-weight relationships.

Results

In the epibathyal stratum the blackmouth catshark occurred in the half of hauls without difference between spring and autumn. In the mesobathial stratum the stock showed a very high frequency of occurrence with significant differences between the two seasons (Table 3). In both strata density and biomass indexes were consistently lower in spring than in autumn with significant differences mainly to epibathial stratum (Table 3).

The median length (Table 4), estimated for sex combined, ranged between 310 and 380 mm TL (spring) and between 270 and 410 mm TL (summer). The overall estimators (351 vs. 329) indicate a slightly higher (although not significant) median in spring than in autumn with no significant differences (PT: 1.51, $p > 0.05$).

The Sr figures (Table 4) suggest a slight prevalence of males; it ranged between 0.46 and 0.55 (spring) and between 0.47 and 0.50 (autumn) without significant departures from the expected Sr of 0.5 (χ^2: 0.23, $p > 0.05$); the overall estimators (0.49 vs. 0.48) were almost coincident in both seasons (W: 0.84, $p > 0.05$).

Overall (all years combined) box-plot representation of length structure of *G. melastomus* by sex, maturity stage and season is shown in Fig. 2. The median length (TL) at stage pattern was quite similar in the two seasons. The logistic fit quite satisfactory the mature/adult component in females and males, the latter reaching earlier the sexual maturity (Fig. 3); the length at 50% maturity of was 436 mm (spring) and 433 mm (autumn) in females and 380 mm (spring) and 372 mm (autumn) in males.

As regards the length structure, the specimens ranged from 70 to 540 mm and from 80 to 550 mm for females and males, respectively (Fig. 4). The length–frequency distribution shape, by sex and season, showed multiple overlapping modes with a prevalence of medium and large sized specimens (i.e. a K oriented shape; Pauly, 1984) in both sexes in spring and the juvenile component more represented in autumn. The K–S test

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

Table 2 Examined MEDITS (spring) and GRUND (autumn) survey calendar carried out in the South of Sicily. Start and end refer to the day when the first and last hauls were realised. The 1999 is excluded since GRUND survey was not realised in that year.

Year	Survey	Start	End	N of hauls
1994	MEDITS	11-Jun	15-Jul	36
	GRUND	7-Oct	6-Nov	83
1995	MEDITS	3-Jun	17-Jun	41
	GRUND	10-Oct	12-Nov	90
1996	MEDITS	31-May	12-Jun	41
	GRUND	11-Oct	31-Oct	60
1997	MEDITS	3-Jun	14-Jun	41
	GRUND	8-Sep	22-Nov	67
1998	MEDITS	16-Jun	27-Jun	42
	GRUND	17-Sep	12-Dec	62
2000	MEDITS	26-May	8-Jun	42
	GRUND	05-Sep	11-Nov	53
2001	MEDITS	19-May	1-Jun	42
	GRUND	03-Sep	18-Nov	53
2002	MEDITS	11-Jul	24-Aug	66
	GRUND	24-Sep	07-Oct	48
2003	MEDITS	13-Jul	13-Aug	65
	GRUND	12-Sep	6-Nov	48
2004	MEDITS	10-Jun	11-Jul	65
	GRUND	9-Sep	30-ott	47
2005	MEDITS	5-Jul	13-Aug	108
	GRUND	12-nov	23-dic	126
2006	MEDITS	19-May	14-Jun	114
	GRUND	14-nov	22-dic	132

Table 3 Comparison of frequency of occurrence (f%), mean density (DI) and biomass (BI) indexes of *Galeus melastomus* in the South of Sicily by stratum. PT: Paired *t*-test; WT: Wilcoxon test; Significance level: ns = not significant, * = 0.05, ** = 0.01.

Parameter	Depth range (m)	Survey	Year													Test	*P*
			1994	1995	1996	1997	1998	2000	2001	2002	2003	2004	2005	2006	Overall		
f(%)	201–500	Spring	20	45	36	42	55	55	64	50	39	67	46	60	48	PT: 0.4	ns
		Autumn	50	56	38	43	47	36	54	57	27	55	52	44	47		
	501–800	Spring	80	86	92	69	86	100	100	100	100	100	100	100	93	WT: 2	*
		Autumn	95	95	100	100	100	100	100	100	100	100	100	100	99		
DI (N/km^2)	201–500	Spring	5	49	25	14	33	33	18	69	22	49	90	105	43	PT: −2.9	*
		Autumn	318	166	17	84	67	226	240	115	31	29	69	336	141		
	501–800	Spring	164	109	190	54	97	270	167	205	281	269	329	384	210	PT: −2.4	*
		Autumn	250	179	356	390	214	264	164	245	319	224	289	511	284		
BI (kg/km^2)	201–500	Spring	0.4	1.2	1.0	0.4	1.0	1.5	1.6	2.5	1.2	2.8	3.5	4.8	1.8	PT: −3.5	**
		Autumn	12.0	7.7	0.7	3.1	2.0	7.5	8.9	2.4	5.6	1.4	4.6	10.5	5.5		
	501–800	Spring	39.1	16.8	28.6	10.1	19.4	51.6	29.1	31.6	50.8	53.0	48.3	60.9	37	PT: −2.4	*
		Autumn	45.2	33.2	61.1	63.4	37.1	48.0	28.6	38.2	66.5	45.0	44.9	78.1	49		

revealed significant differences between MEDITS and GRUND for females (D: 0.031–0.113; $p < 0.01$), mainly due to different consistence of size classes ranging from 170 to 330 mm TL. Differences were recorded also for males (D: 0.039–0.121 $p < 0.01$) for different consistence of size classes ranging from 160 to 430 mm TL.

G. melastomus showed an almost isometric condition ($b \approx 3$) in both sexes and season. Females showed a slight better condition (i.e. higher coefficient) than males. The *b* value ranges were practically coincident: from 3.01 (spring) to 3.02 (autumn) and from 2.95 (spring) to 2.93 (autumn) in females and males, respectively.

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

Table 4 Comparison of median length (mm) and sex ratio of *Galeus melastomus* between MEDITS (spring) and GRUND (autumn). WT: Wilcoxon test; PT: Paired *t*-test; P: Significance level; ns: not significant.

Parameter	Survey	Year								*Test*	*P*
		2000	2001	2002	2003	2004	2005	2006	Overall		
Median length (mm)	Spring	380	360	320	380	380	310	330	351	PT: 1.51	ns
	Autumn	310	270	300	410	390	330	290	329		
Sex ratio	Spring	0.55	0.51	0.47	0.46	0.51	0.49	0.47	0.49	WT: 0.84	ns
	Autumn	0.50	0.47	0.50	0.50	0.47	0.48	0.47	0.48		

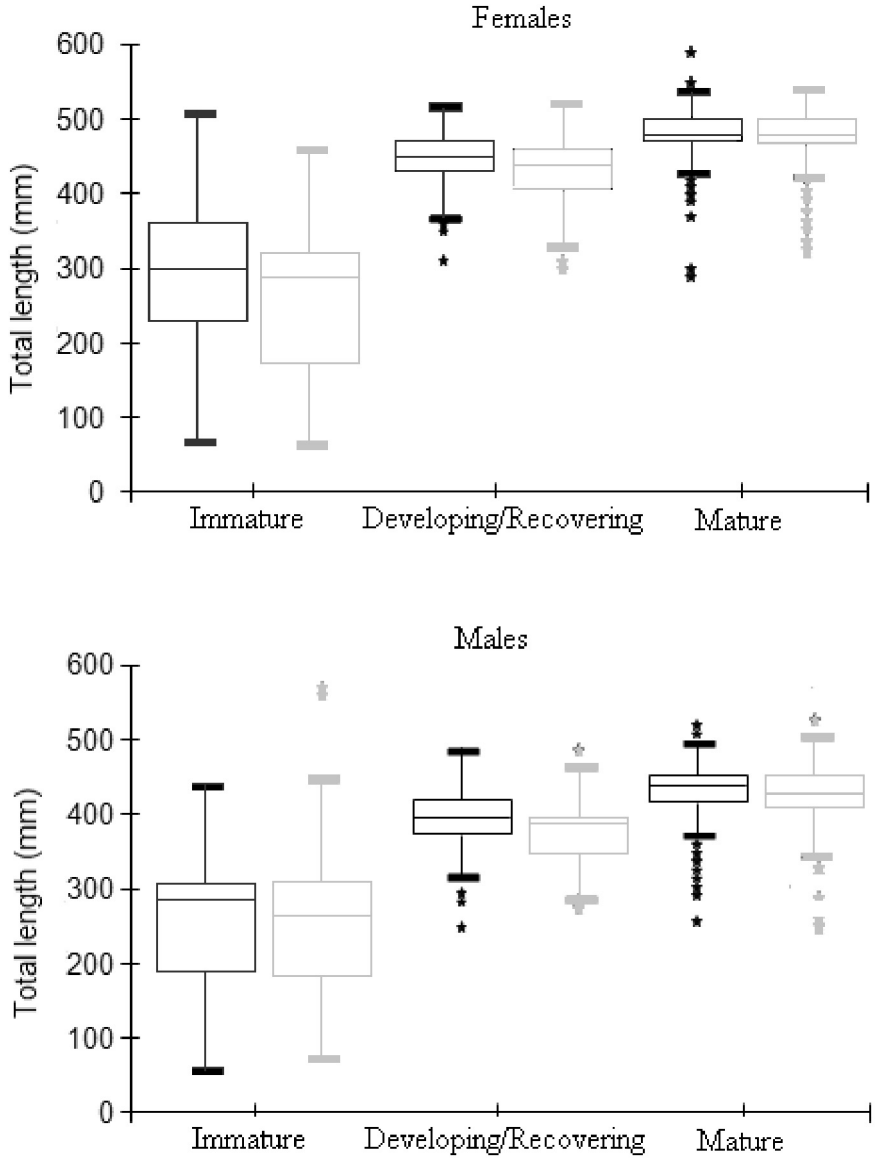

Fig. 2 Overall (all years combined) box-plot representation of length structure of *Galeus melastomus* by sex and maturity stage. Black and grey colors refer to spring (MEDITS) and autumn (GRUND), respectively.

Discussion

In this study the blackmouth catshark populations were a frequent catch at epibathial level and a constant occurrence in the bathyal stratum that it confirms to be its preferential stratum (Tursi et al., 1993; Rinelli et al., 2005). Density and biomass showed seasonal differences with the highest values recorded always in the GRUND surveys as already reported by some authors (Rinelli et al., 2005). The consistent higher AI might be attributed mainly to gear differentials i.e. as generally

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

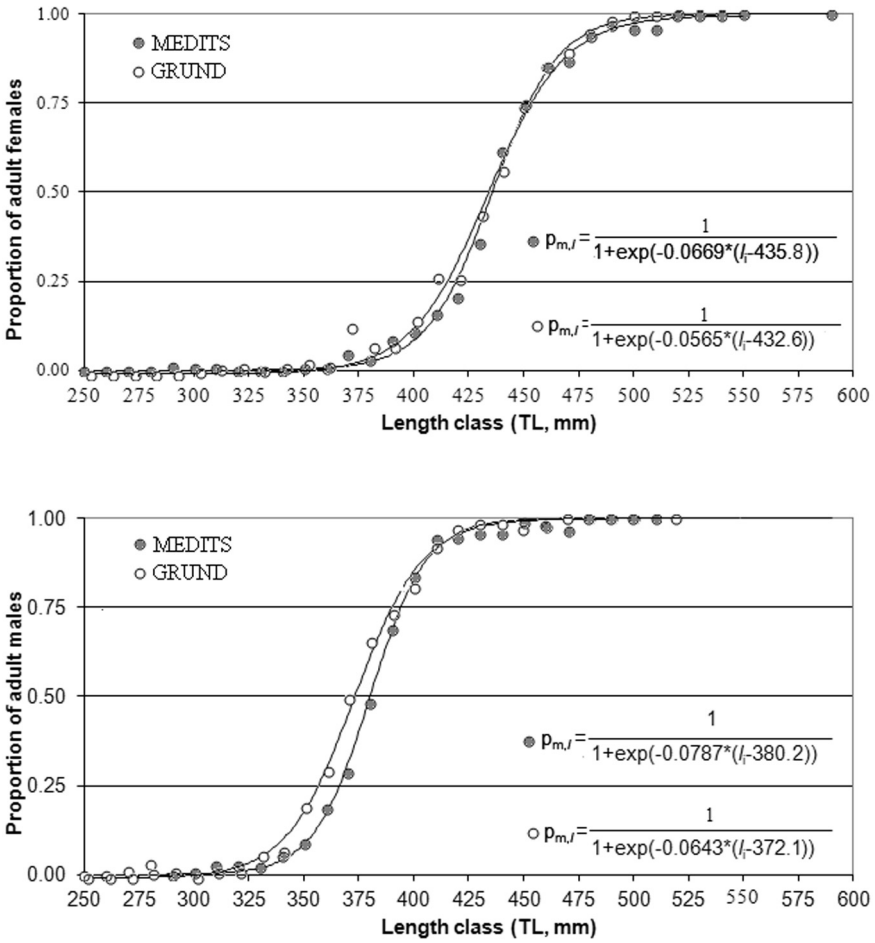

Fig. 3 Overall (all years combined) logistic fit of juveniles/adult proportions of *Galeus melastomus* for MEDITS and GRUND surveys.

reported GOC gear performs badly in deeper waters and secondly to a differential in recruitment of juveniles in autumn.

Most of the life traits were similar in the two seasons and coherent to those of other *G. melastomus* stocks in other Mediterranean fishing grounds and hence seem unaffected by season or gear. Among these invariant figures: the overall sex ratio is around 0.5 in both seasons (Capapé and Zaouali, 1977; Rinelli et al., 2005; Capapé et al., 2008). The size at 50% maturity and the median length for maturity stage were also similar in both seasons. Also the isometric W-L relationship is generally observed for *G. melastomus* in both sexes and seasons according to what was recorded in the Southern Tyrrhenian and Ionian Seas (Tursi et al., 1993; Rinelli et al., 2005).

On the contrary the higher percentage of young fish in the GRUND surveys could reflect a seasonal effect in the spawning activity of females since the mesh size in the cod end and the sea water temperature at the bottom are the same. However, the specific literature usually indicates that a continuous recruitment has been reported for *G. melastomus* in the Alboran Sea with the presence of spawning fish all year together (Rey et al., 2004). A continuous reproductive cycle has been also supposed for *G. melastomus* in other Mediterranean areas (Capapé and Zaouali, 1977; Tursi et al., 1993). Consequently, considering also the similarity of the adults components between the two seasons the higher juveniles component recorded in this study during the autumnal season could be related to a higher avoidance capability of young catshark in the gear components other than the cod end, a phenomenon already observed in MEDITS for example for Norway lobster juveniles.

The present results indicate that two experimental bottom trawl surveys investigated yield an almost invariant picture of *G. melastomus* although MEDITS figures consistently underestimate both the abundance indexes and the % of young specimens; the former is more conservative since it is better an underestimation than overestimation of the abundance (but there is some doubt in using MEDITS to calibrate commercial based analytical methods), whereas the latter might be more critical since an assumed low recruitment might result in too optimistic mortality estimations.

The homogeneity of life traits among seasons and the critical features shown in this study demonstrate that an annual experimental trawl survey can be enough for monitoring *G. melastomus*, which is an important component of the mesobathyal assemblages (D'Onghia et al., 2003; Moranta et al., 2008; Busalacchi et al., 2010; Bottari et al., 2014) in several Mediterranean areas, and it is already landed and consumed in some locations (it might represent a suitable source of protein in the future).

Similar analysis could be useful to highlight seasonal and gear effects on the other demersal stocks to better figure out

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

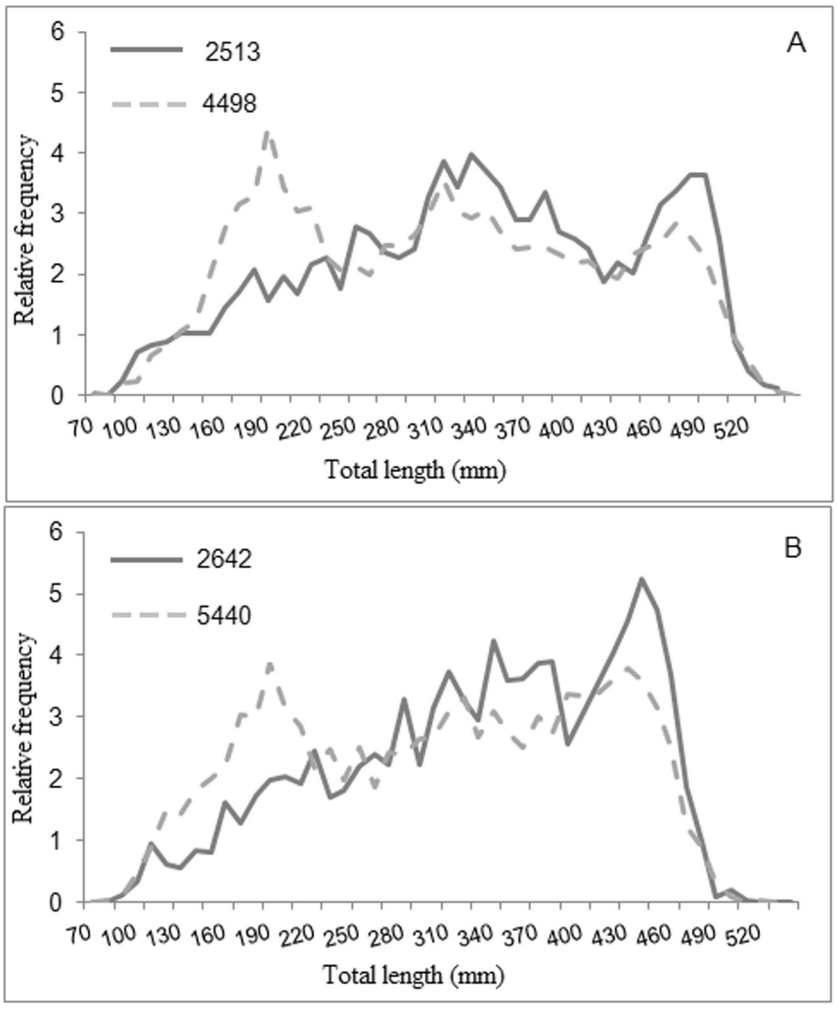

Fig. 4 Total length distribution of *Galeus melastomus* females (A) and males (B) for MEDITS (continuous line) and GRUND (dotted line) surveys. The absolute number of captured specimens is reported on the upper left corner.

limits and possibility of Mediterranean young-fish oriented experimental bottom trawl surveys data.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Abello, P., Bertrand, J., Gil De Sola, L., Papakonstantinou, C., Relini, G., Souplet, A., 2002. Marine demersal resources of the Mediterranean: the MEDITS International trawl survey (1994–1999). Sci. Mar. 66 (Suppl. 2), 280.

Bottari, T., Busalacchi, B., Profeta, A., Mancuso, M., Giordano, D., Rinelli, P., 2014. Elasmobranch distribution and assemblages in the Southern Tyrrhenian Sea (central Mediterranean). J. Aquac. Res. Dev. 5, 216.

Busalacchi, B., Rinelli, P., De Domenico, F., Profeta, A., Perdichizzi, F., Bottari, T., 2010. Analysis of demersal fish assemblages off the Southern Tyrrhenian Sea (central Mediterranean). Hydrobiologia 654, 111–124.

Capapé, C., Zaouali, J., 1977. Contribution à la biologie des Scyliorhinidae des côtes tunisiennes–VI–*Galeus melastomus* Rafinesque, 1810–Répartition géographique et bathymétrique, sexualité, reproduction, fécondité. Cah. Biol. Mar. 18, 449–463.

Capapé, C., Guélorgeta, Y., Vergnea, L., Reynaud, C., 2008. Reproductive biology of the blackmouth catshark, *Galeus melastomus* (Chondrichthyes: Scyliorhinidae) off the Languedocian coast (Southern France, Northern Mediterranean). JMBA UK 88 (2), 415–421.

Colloca, F., Garofalo, G., Bitetto, I., Facchini, M.T., Grati, F., Martiradonna, A., 2015. The seascape of demersal fish nursery areas in the North Mediterranean Sea, a first step towards the implementation of spatial planning for trawl fisheries. PLoS One 10 (3), e0119590. http://dx.doi.org/10.1371/journal.pone.0119590.

COM, 2006. 360 final. Communication from the commission to the Council and the European Parliament. Implementing sustainability in EU fisheries through maximum sustainable yield. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0360:FIN:EN:PDF.

D'Onghia, G., Mastrototaro, F., Matarrese, A., 2003. Biodiversity of the upper slope demersal community in the Eastern Mediterranean: preliminary comparison between two areas with and without trawl fishing. J. Northw. Atl. Fish. Sci. 31, 263–273.

Fiorentini, L., Dremière, P.Y., Leonori, I., Sala, A., Palumbo, V., 1999. Efficiency of the bottom trawl used for the Mediterranean international trawl survey (MEDITS). Aquat. Living Resour. 12 (3), 187–205.

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003

Garofalo, G., Gristina, M., Fiorentino, F., Cigala Fulgosi, F., Norrito, G., Sinacori, G., 2003. Distributional pattern of rays (Pisces, Rajidae) in the Strait of Sicily in relation to the fishing pressure. Hydrobiologia 503, 245–250.

Gayanilo, F.C., Sparre, P., Pauly, D., 2005. FAO-ICLARM Stock Assessment Tools II (FiSAT II): user's Guide. FAO Computerized Information Series (Fisheries) 8, 168 p.

GFCM, 2001. Report of the SAC Working group on management units, Alicante (Spain), 26 p.

GRUND, 1999. Valutazione delle risorse demersali nei mari italiani. Gruppo Nazionale Metodologie Statistiche, relazione finale, Mola di Bari (Italy).

Gunderson, D.R., 1993. Surveys of Fisheries Resources. John Wiley & Sons, Inc., New York, p. 248.

Levi, D., Ragonese, S., Andreoli, M.G., Norrito, G., Rizzo, P., Giusto, G.B., 1998. Sintesi delle ricerche sulle risorse demersali dello Stretto di Sicilia (Mediterraneo centrale) negli anni 1985–1997 svolte nell'ambito della legge 41/82. Biol. Mar. Medit. 5, 130–139.

Lleonart, J., Maynou, F., 2003. Fish stock assessments in the Mediterranean: state of the art. Sci. Mar. 67, 37–49.

MEDITS-Handbook, 2013. Version n. 7, MEDITS Working Group: 120 p.

Moranta, J., Quetglas, A., Massutí, E., Guijarro, B., Hidalgo, M., Diaz, P., 2008. Spatio-temporal variations in deep-sea demersal communities off the Balearic Islands (western Mediterranean). J. Mar. Syst. 71 (3–4), 346–366.

Pauly, D., 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev. 8, 325.

Pauly, D., Ulman, A., Piroddi, C., Bultel, E., Coll, M., 2014. Reported versus likely fisheries catches of four Mediterranean countries. Sci. Mar. 78 (Suppl. 1), 11–17.

Ragonese, S., Nardone, G.D., Ottonello, D., Gancitano, S., Giusto, G. B., Sinacori, G., 2009. Distribution and biology of the blackmouth catshark *Galeus melastomus* in the Strait of Sicily. Medit. Mar. Sci. 10 (1), 55–72.

Ragonese, S., Di Giovanni, R., Gancitano, S., Giusto G.B., Sinacori G., Bianchini, M.L., 2006. Procedures for determining sex and macroscopic maturity stages employed within the experimental bottom trawl surveys carried out in the Strait of Sicily (Central Mediterranean Sea). DCR MEDITS meeting in Kavala (Greece) 02–06 April 2006.

Relini, G., 2000. Demersal trawl surveys in Italian seas: a short review. In: Demersal Resources in the Mediterranean. In: Bertrand, J.A., Relini, G. (Eds.), . In: Actes de Colloques, Vol. 26. Ifremer, Plouzané, pp. 76–93.

Rey, J., De Sola, L., Massutì, E., 2004. Distribution and biology of the blackmouth catshark *Galeus melastomus* in the Alboran Sea (Southwestern Mediterranean). J. Northw. Atl. Fishery Sci. 35, 215–223.

Rinelli, P., Bottari, T., Florio, G., Romeo, T., Giordano, D., Greco, S., 2005. Observations on distribution and biology of *Galeus melastomus* (Chondrichthyes, Scyliorhinidae) in the Southern Tyrrhenian Sea (central Mediterranean). Cybium 29 (1), 41–46.

Scalisi, M., Levi, D., Fiorentini, L., Giusto, G.B., Palumbo, V., Rizzo, P., 1998. Experimental approach to intercalibrate data of trawl surveys conducted with different nets. Biol. Mar. Medit. 5 (2), 40–51.

Trenkel, V., Cotter, J., 2009. Choosing survey time series for populations as part of an ecosystem approach to fishery management. Aquat. Living Resour. 22 (2), 121–126.

Tursi, A., D'onghia, G., Matarrese, A., Piscitelli, G., 1993. Observations on population biology of the blackmouth catshark *Galeus melastomus* (Chondrichthyes, Scyliorhinidae) in the Ionian Sea. Cybium 17 (3), 187–196.

Please cite this article in press as: Bottari, T. et al., Investigating gear and seasonal effects in experimental trawl surveys: The case of *Galeus melastomus* Rafinesque, 1810 (Chondrichthyes, Scyliorhinidae) in the South of Sicily (Central Mediterranean). Egyptian Journal of Aquatic Research (2016), http://dx.doi.org/10.1016/j.ejar.2016.10.003