CHAPTER 14

Highly targeted fish species

Antoni Garcia-Rubies[1], Mikel Zabala[2] and Bernat Hereu[2]

[1] Centro de Estudios Avanzados de Blanes. Consejo Superior de Investigaciones Científicas.
[2] Departament d'Ecologia. Facultat de Biologia. Universitat de Barcelona

Abstract
The clearest evidence on the impact of the storm in the stocks of target fish species was the appearance of several specimens of dusky grouper (*Epienphelus marginatus*) dead on the beach. In addition, it was found that some species (*E. marginatus, D. cervinus*) had relatively low values of biomass and density compared to previous years, although these declines were in the range of interannual variations and framed in a negative trend that began before the storm. Only the sea bass (*Dicentrarchus labrax*) showed a significant decline from 2008 to 2009 that could have been caused by the storm. By contrast, the populations of common dentex (*Dentex dentex*) and meagre (*Sciaena umbra*) appeared to have emerged entirely unharmed, following their increasing trends in recent years. Apart from a slight increase of meagres and groupers in the partially protected coast of Montgrí, the scarcity of these species has prevented reaching any conclusive results in the unprotected area.

Image: Stranded individual of *Epinephelus marginatus* in the Costa Brava; by T. Garcia-Rubies

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Evaluation of the storm effects on highly targeted fish populations inside and outside the Medes Islands Marine Reserve.

By

Antoni Garcia-Rubies[1*], Mikel Zabala[2] and Bernat Hereu[2]

[1]Centro de Estudios Avanzados de Blanes. Consejo Superior de Investigaciones Científicas. Acceso a la Cala S. Francesc 14. 17300 Blanes, Spain.
[2]Departament d'Ecologia, Facultat de Biologia Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Spain
*tonigr@ceab.csic.es

Resumen

La evidencia más clara sobre el impacto del temporal en las poblaciones de peces altamente vulnerable a la pesca fue la aparición de diversos ejemplares de mero (*Epinephelus marginatus*) muertos en la playa. Además se constató que algunas especies (*E. marginatus* y *Diplodus cervinus*) presentaron valores de densidad y biomasa relativamente bajos respecto a años anteriores, si bien estas disminuciones se encontraban en el rango de variación interanual y encuadradas en una tendencia negativa que se inició antes del temporal respecto a otros años. Sólo la lubina (*D. labrax*) presentó un significativo descenso de 2008 a 2009 que pudiera haber sido causado por el temporal. Por el contrario, tanto las poblaciones de *D. dentex* como de *S. umbra*, parecen haber salido del todo indemnes del temporal, siguiendo la tendencia ir aumentando en los últimos años. Aparte de un ligero aumento de los meros y los corballos en la costa parcialmente protegida del Montgrí, la escasez de estas species ha impedido llegar a ningún resultado concluyente.

Abstract

The clearest evidence on the impact of the storm in the stocks of target fish species was the appearance of several specimens of dusky grouper (*Epienphelus marginatus*) dead on the beach. In addition it was found that some species (*E. marginatus, D. cervinus*) had relatively low values of biomass and density compared to previous years, although these declines were in the range of interannual variations and framed in a negative trend that began before the storm. Only the sea bass (*Dicentrarchus labrax*) showed a significant decline from 2008 to 2009 that could have been caused by the storm. By contrast, the populations of common dentex (*Dentex dentex*) and meagre (*Sciaena umbra*) appeared to have emerged entirely unharmed, following their increasing trends in recent years. Apart from a slight increase of meagres and groupers in the partially protected coast of Montgrí, the scarcity of these species has prevented reaching any conclusive results in the unprotected area.

Introduction

The most vulnerable species to fishing show the greatest differences when comparing protected and unprotected areas. According to a gradation of vulnerability, depending on the response to protection level (Garcia-Rubies, 1999), the extreme case would be represented by those species that can only be found with some frequency inside the marine protected areas. These species are therefore the best indicators of the so called 'reserve effect'. There are dense and demographically well balanced populations of these species only in the marine reserves. For instance, the reproduction of *Epinephelus marginatus* (Zabala et al., 1997a, 1997b) in the northern Catalan coast is restricted to totally (Medes Islands) o partially protected areas (Cap de Creus).

Marine reserves, however, can protect the highly vulnerable species populations from fishing, but cannot provide any defence from other anthropogenic (pollution, rising temperature, introduction of exotic and invasive species,...) or natural disturbances, such as diseases or particularly severe storms, although they can mitigate their results (Bohnsack, 1984; Roberts et al., 2003).

In this work we try to ascertain the effect of a particularly severe storm on the protected and unprotected populations of 6 fish species particularly vulnerable to fishing in the Mediterranean: dusky grouper (*Epinephelus mariginatus*), common dentex (*Dentex dentex*), zebra sea bream (*Diplodus cervinus*), sea bass (*Dicentrarchus labrax*), meagre (*Sciaena umbra*) and gilt-head sea bream (*Sparus aurata*). To do so, we compared a series of data collected from 1991 to 2008, in a frame of a long term monitoring project funded by the *Generalitat de Catalunya* (Catalan Government), with data collected in 2009 after the storm. Data collection in 2009 was entirely founded by this project (PIEC 200430E599).

Materials and methods

Sampling method and selected species

Inventories of 7 highly targeted fish species were performed in 7 zones of the marine protected area at the Medes Islands from 1991 to 2009). In 1991, only the dusky grouper (*Epinephelus marginatus*) population was monitored; however, in 1992 five more fish populations were added to the monitoring program (*Dentex dentex, Dicentrarchus labrax, Diplodus cervinus, Sparus aurata, Sciaena umbra*). In 1998 the assessment was extended to 2 zones in the partially protected area of el Molinet, and in 1999, 2 zones of the unprotected area of the Montgrí coast (Figure 2) were added (see Table 1 to see acronyms and situation of the sampling zones) . From then on, monitoring was carried out annually until 2008, with a few gaps (1995, 1997, 1998 and 2006), within the context of a long-term program funded by the Catalan Government ("*Evaluació de l'estat de les espècies i comunitats a les àrees marines protegides de les Illes Medes, el Cap de Creus i el Montgrí*"). The assessment carried out in 2009 was financed entirely by the CSIC and its objective was to ascertain if the storm affected 6 of the most targeted Mediterranean fish populations.

Table 1. Areas, protection level, zones and acronyms of the sampling trips

Area	Trip	Acronym
Medes Is. Marine reserve (fully protected area)	Tascó Petit-Carall Bernat	TPCB
	Ferranelles – Tascó Gros	FETG
	Meda Petita	MP
	Infern – Cova de la Vaca	ICV
	Cova de la - Vaca Salpatxot	SCV
Molinet (partially protected area)		
	Pta. Salines - Arquets	PSALARQ
	Arquets - Molinet	ARQMOL
Rossinyol- Falaguer (unprotected area)		
	Rossinyol - Falaguer	ROSFAL
	Falaguer – I. Dui	FALDUI

Briefly, the different degrees of protection of the study areas are as follows: all fishing has been strictly forbidden since 1983 in the zones included in the totally protected area of the Medes Islands; limited sport and commercial artisanal fishing is permitted in the partially protected area of el Molinet, while spearfishing has been totally banned since 1994. Although the protection measures have recently been strengthened, poaching by spearfishermen is not uncommon in the partially protected area (Garcia-Rubies, pers. obs.). This poaching may explain the poor results obtained by partial protection of highly targeted fish species, although the lack of suitable habitats could also be a cause of the low densities of some species (Garcia-Rubies et al., 2008).

Both the Medes Islands and the neighbouring coast suffered the full brunt of the storm of 28-29 December, 2008.

During the whole monitoring program, counts were always based on long surveys of 45 to 60 minutes in the different zones. During each survey, the observer swam slowly at a distance of about 1m above the bottom. Each survey was subdivided into shorter counts of 5 minutes each in which the diver covered an area of approximately 50 x 10m (500m^2). Counts were mainly carried out in zones of 15-20m deep and always over rocky bottoms. All individuals belonging to the 6 selected species were counted and their size was estimated within a ±5cm error. Biomasses were calculated for each species according to the length-weight transformations given in Morey et al. 2003).

Variations in average density and biomass per species were tested using two-way analysis of variance (ANOVA). Zone and year were the predictive variables, which were treated as fixed and orthogonal factors in the analyses. The basic sampling unit was a count each 5 minutes along each zone. The number of 5 minute sections varied among zones, which implies that the number of samples per zone was not exactly the same. However, the difference was not great, which minimised the potential risk of

Figure 1. Trip surveyed in the Medes Islands marine protected area (left) and in the Montgrí coast (right)

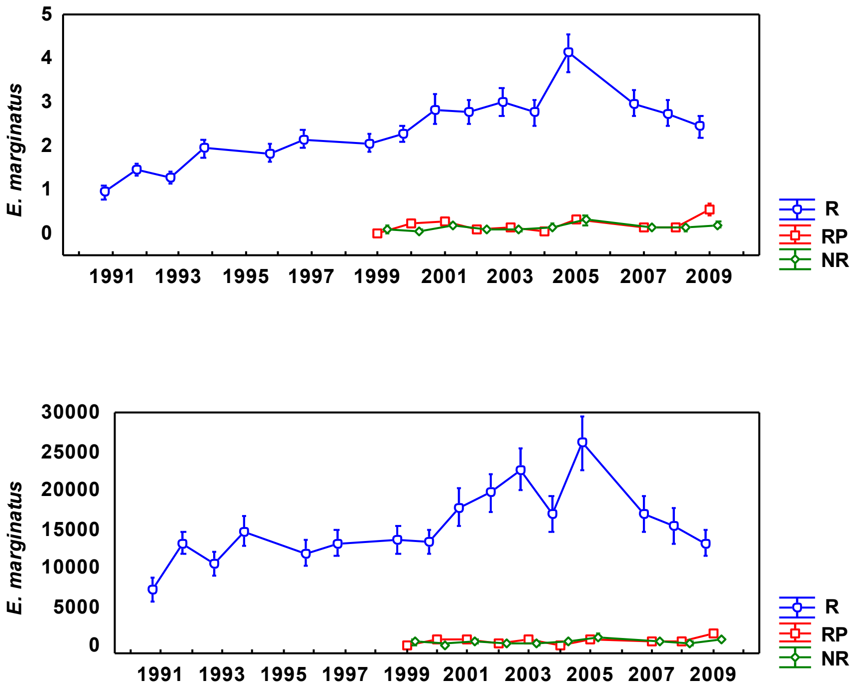


Figure 2. Top: evolution of dusky grouper mean density (nº ind.m^{-2}). Bottom: interanual variations of biomass (g.500m^{-2}).

error inherent in a seriously unbalanced sampling design (Underwood, 1997). It was taken that significant differences between years would demonstrate that the storm had an impact on the species, i.e. if the values obtained in 2009 differed significantly from other years and/or the interaction between zone and year if the different zones were unevenly affected by the storm.

Most species treated here only have high densities within the totally protected area. The differences between partially and non-protected areas are so obvious that we considered it unnecessary to demonstrate again the so-called 'reserve effect'. Therefore, the analyses of variance of mean abundances and biomasses were carried out separately: one for the totally protected area and one for the zones from both the partially protected and unprotected areas.

We included all the years encompassed by the original monitoring program, from 1991 to 2009, in the case of *E. marginatus* inside the totally protected area of the Medes Islands (1992-2009 for the other species), and since 1999 in the partially protected and unprotected zones. The years 1995, 1998 and 2006 were not included in the analysis as sampling was not carried out in some zones. 1998 was also omitted from the comparison, given that only the partially protected zone was monitored that year on the coast of el Montgrí.

Although some authors have compared the last few years with the year after the storm (2009), in our case we preferred to include the entire series in order to consider the possible variations due to the storm within the context of the 'normal' interannual variability.

Results

Epinephelus marginatus

Dusky groupers were undoubtedly affected by the storm as more than 30 specimens were found on the beach of l'Estartit the day after. However, the differences in mean abundances could not be attributed to the storm effect in spite of the significant interannual differences found between the first years of monitoring, in which the densities were lower. The largest increases in mean density occurred during the first years of monitoring until 2005 (Figure 2). From then on the density tended to stabilise, with a certain tendency to decrease during the last years. The relatively low value of mean abundance in 2009 could be part of the slightly downward trend of this species in the Medes Islands which began in 2005 (Figure 2).

The results of the ANOVA also showed significant differences between mean abundances of the zones inside the totally protected area (Table 2).

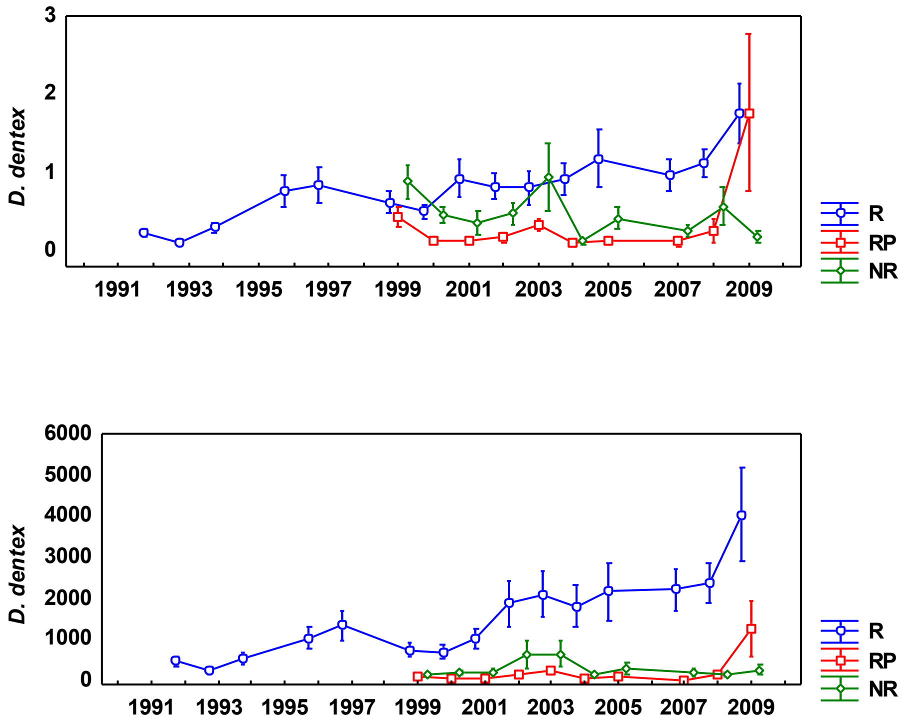
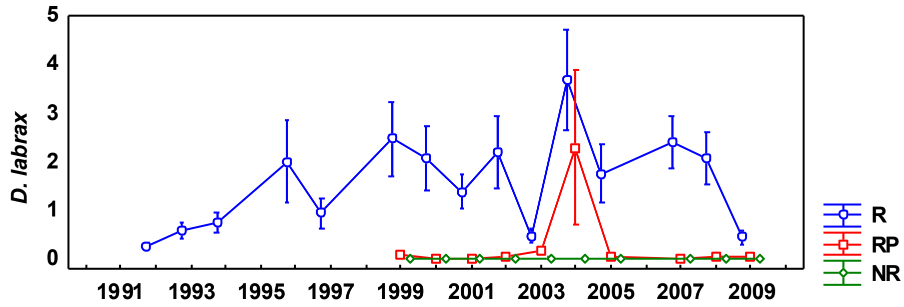


Figure 3. Interanual variation of common dentex mean density (top) and biomass (bottom). A rising trend can be observed inside and outside the marine protected area.

The lack of interaction between the two factors evidenced that dissimilarities among zones were quite persistent over the years. Dusky groupers always tended to be abundant in the southernmost zones of the Medes Islands, such as TPCB and FETG, where the mean density has remained relatively constant with little annual variations over recent years. However, in the zones that were relatively unpopulated at the beginning of monitoring, such as SCV, the mean abundance has increased substantially. Results of the ANOVA on mean biomass showed exactly the same results (Table 2). The mean biomass of 2009 was only significantly lower than the value observed in 2005, which was the highest of the whole series as demonstrated by the paired post-hoc tests (Figure 2).

On the coast of Montgrí mean densities have always remained well below the values observed in the protected area of the Medes Islands (Figure 2). Only a few individuals have appeared and it seems that partial protection has not had miraculous effects. The ANOVA results show the precariousness of the dusky grouper on the Montgrí coast. The mean abundance was significantly different between zones and years as well as the interaction of the two factors, which implies that the temporal evolution of the species was uneven in different zones. However, the mean densities of 2009 were the highest since 1999 (Figure 2). Post hoc tests demonstrated that in ARQMOL, the mean abundance in 2009 was significantly higher than that observed in 1999, 2000, 2002 and 2004. In



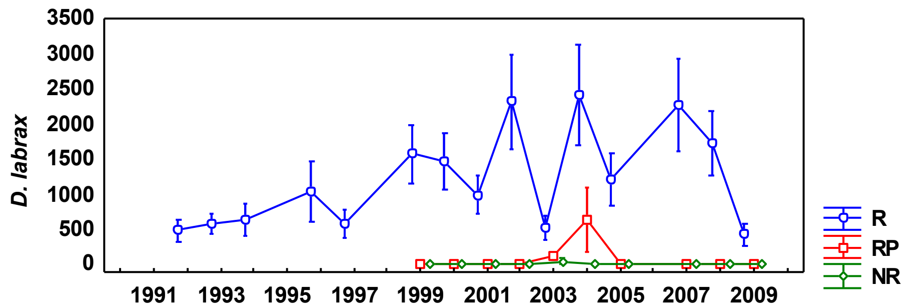


Figure 4. Interannual variations of mean density and biomass of seabass. It can be observed the peak in 2004 due to an entry of specimens escaped from a nearby fish farm, and the sharp decline of 2009.

PSALARQ the highest value was also obtained in 2009, although it was significantly higher compared to the 1999 value, when no specimen at all was observed. Both zones are inside the partially protected area, whereas in the non-protected area only one zone, FALDUI, obtained the maximum value since 1999 (Figure 2). Due to the low densities in these zones these results could not be considered conclusive; however, the upward trend contrasted with the pattern observed in the totally protected areas of the Medes Islands (Figure 2).
Similarly, the mean biomass for the year 2009 was the highest since 1999, but was only significantly higher than the lowest values obtained in 1999 and 2005. There were also significant differences between zones. The mean abundances observed in ROSFAL and ARQMOL were significantly higher than in FALDUI, which had the lowest value. There was no interaction between the two factors (Table 2).

Dentex dentex

Dentex density within the protected areas of the Medes Islands confirmed the nearly perfect upward trend, topped by the peak value reached in 2009 (Figure 3). The ANOVA gave significant differences between years and zones without interaction between the two factors (Table 2). The average density of 2009 was significantly higher than that observed in the years with lower values (post hoc test: 2009> 1992= 1993= 1994= 1996= 1999= 2003). Among zones, the mean density of D. dentex was significantly higher in TPCB than in the rest of zones (TPCB> FETG = MP = ICV = SCV). Similar results were obtained when the mean biomass was analysed (Table 2), which confirmed the increasing trend obtained when mean abundances were compared. The highest value was also obtained in 2009 (*post hoc* tests: 2009 > 1992 = 1993 = 1994 = 1999) in the TPCB zone. There was no significant interaction among factors, so the differences between zones remained fairly constant over time.

In the unprotected or partially protected zones of el Montgrí the average density of *D. dentex* also increased notably in 2009 (Figure 3). Since the increase only affected a zone of the partially protected area (ARQMOL), differences between years were not strictly significant, which explains the interaction among years and zones. In spite of the increase in mean density, the mean biomass of *D. dentex* did not show significant interannual variations and the differences among zones were at the very limit of statistical significance (Table 2).

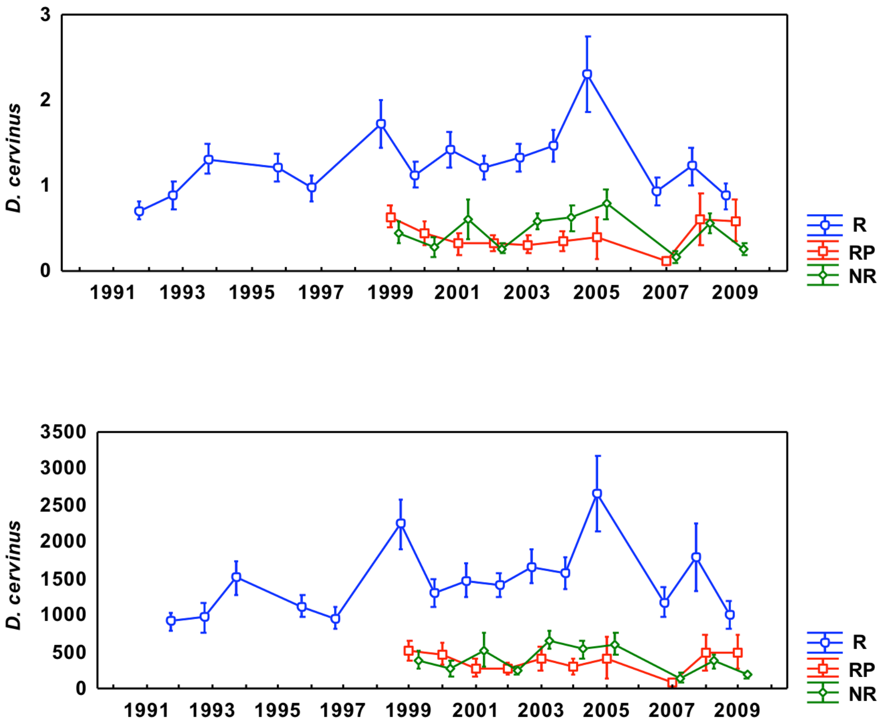
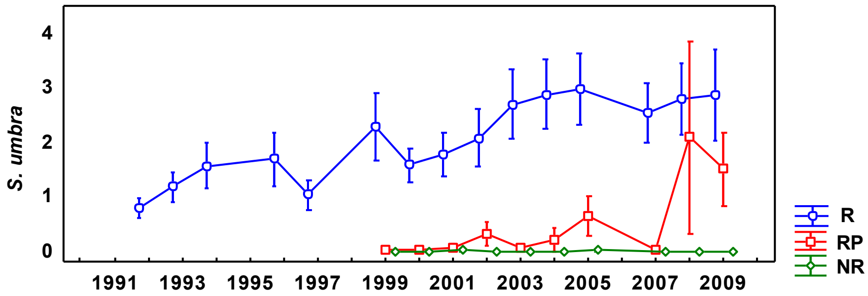


Figure 5. Evolution of mean density and biomass of the zebra sea bream.

Dicentrarchus labrax

The analysis of variance of mean density resulted in significant differences between zones in the Medes Islands marine protected area and also among years, with an interaction among the two factors



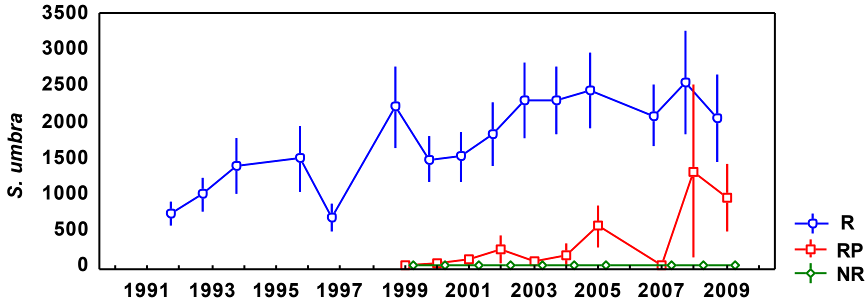


Figure 6 . Evolution of mean density and biomass of meagre. An increasing trend can be observed in the totally and partially protected areas.

(Table 2). The decrease from 2008 to 2009 was significant, and the mean density of 2009 was the second lowest since 1992 (Figure 4). The decline affected the zones where sea bass were more abundant, such as FETG, TPCB and to a lesser extent SCV. As expected, the average biomass also showed a notable decline (Figure 4). This resulted in significant differences between years (Table 2) in spite of the enormous variance that prevented significant results being obtained in the paired post hoc comparisons. In any case, the mean biomass value of 2009 was the lowest recorded since 1992 (Figure 4).

Sea bass were never abundant on the coast of el Montgrí and this trend was totally confirmed in 2009. The whole series showed very low annual mean density values except for the abundance peak observed in 2004, when a large quantity of sea bass escaped from a fish farm in Castelló d'Empúries. This anomalous rise was also detected in the protected area of Medes Islands but it was especially noticeable on the coast of el Montgrí due the usually low abundances. Since this input of farmed individuals only affected the ARQMOL zone, the sudden increase in mean abundance produced significant differences among zones and years and an interaction between the two factors. Similar results were obtained when mean biomasses were compared (Table 2).

Diplodus cervinus

D. cervinus decreased markedly in 2009, which led to a similar density to that observed at the beginning of the monitoring program in the protected area of the Medes Islands. Only in 1992 were mean densities lower than those of 2009 (Figure 5). In spite of this clear decrease compared to other years, differences between years were not strictly significant, since the significance level was increased to $p<0.01$ due to the poor statistical quality of the data (Underwood, 1997). Significant differences were observed between zones without any significant interaction among zone and year. Like D. labrax, D. cervinus had decreased since 2007 when it was particularly abundant in certain zones (FETG and TPCB). Mean biomasses only differed between zones (Table 2), and were significantly higher at TPCB and FETG than at ICV and MP. No significant differences were observed among years despite the mean value of 2009 being the lowest in the entire series except for 1992 (Table 2).

In the partially and unprotected areas the mean density of D. cervinus remained relatively stable over time with rather low values compared with those of the fully protected areas of Medes Islands (Figure 5). Differences were significant between zones, and were higher in ROSFAL (unprotected) than in PSALARQ (partially protected). The annual difference in mean biomass was at the limit of statistical significance (Table 2); however, the value obtained in 2009 was the highest of the whole series except for that observed in 2003 (Figure 5).

Sciaena umbra

The meager (Sciaena umbra) has steadily increased without wide variations and with only two non-significant discontinuities (Figure 6): from 1999 to 2000 and from 2008 to 2009. According to the ANOVA results on mean densities, significant differences were only found between zones (Table 2), which is a quite expected result given the extremely sedentary nature of this species. The most populated zones have always been FETG and TPCB, with mean densities that are significantly higher than the rest of the zones. Similar results were obtained when mean biomass was analysed (Table 2; Figure 6).

On the coast of el Montgrí the meagre has always been extremely rare, although it seems that in recent years this species was beginning to appear regularly and exclusively in the zone of ARQMOL, inside the partially protected area of el Molinet. This is why differences among mean densities and mean biomasses among zones were significant (Table 2), and also why there were interactions among zones and years, since the maximum values were only observed in ARQMOL during the last two years (2008 and 2009) of the monitoring program.

Sparus aurata

The annual evolution of the mean density of S. aurata inside the totally protected areas of Medes Islands was somewhat paradoxical in an environment free of exploitation. Its mean density increased at the start of the monitoring period from 1992 to 1994, then the species decreased very steeply to more discrete values from

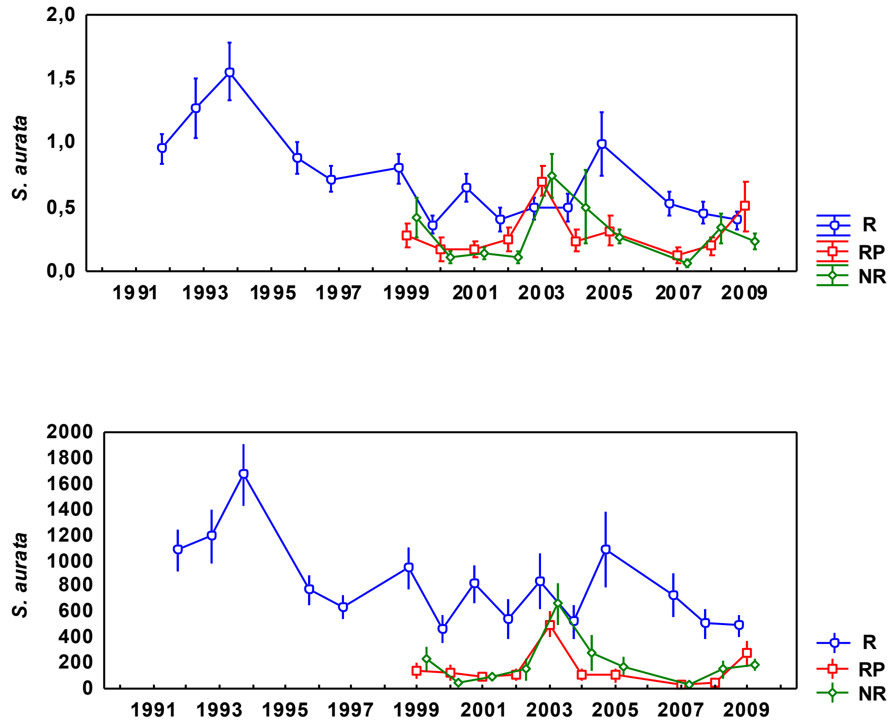


Figure 7 . After a marked rise, mean density and biomass of guilt-head sea bream showed a clear decline inside the protected área.

1995 to 2009 (Figure 7). The ANOVA resulted in a significant difference in mean densities between years (Table 2) due to the elevated values of 1993 and 1994, which were significantly higher than those observed at the beginning of the 2000s. Differences between zones were also significant as S. aurata was more abundant in FETG and, to a lesser extent, SCV. As expected, the mean annual biomass followed a very similar pattern: the high value in 1994 was significantly higher than the lowest annual mean values (1994>2000= 2002= 2004= 2007= 2008= 2009). It should be noted that, except in 2008, the mean biomass observed in 2009 was the lowest since 1992 (Figure not shown).

The comparison of mean densities on the coast of el Montgrí only led to significant differences between years (Table 2) due to the peak that occurred in the abundance of the species in 2003, which was significantly higher than the mean densities obtained in the years 2000, 2002, 2007 and 2008. In 2009 the mean density increased somewhat from the immediately preceding years (Figure 7).

Similarly, the comparison of mean biomasses only showed a significant difference between years (Table 2) due the high value observed in 2003, which was significantly higher than those of the rest of the years, except 2009, which had the second highest value of the whole series (Figure 7).

Discussion and conclusions

Although dusky groupers were undoubtedly affected by the storm as evidenced by the 30 specimens found on the beach of l'Estartit the day after the storm (Figure 2), from the results obtained here it cannot be concluded that the storm of 26 December 2008 had a significant impact on the species most favoured by protection. There are, at best, some indications of possible effects, such as the reduction in dusky groupers in the totally protected area of Medes Islands, along with the increase in this species in the partially protected area of el Molinet. Since mean abundance and biomass were much higher than those observed on the coast of el Montgrí, the decline in the totally protected area is not strictly significant and appears to be part of the slightly downward trend that has occurred since 2005, when the highest peaks of density and biomass were observed. It is therefore very difficult to distinguish between what might be a normal drop, within the context of interannual variations, and what is a decrease due to the mortality caused by the storm. In other words, although the observed decrease may have been caused by the storm it remains within the range of 'normal' interannual variations. In any case, the decrease observed in the Medes Islands contrasts with the significant increase in the species in the partially protected area, which was the largest since 1999. While this increase may be due to an improved surveillance of the area, where poaching is not uncommon (Garcia-Rubies, obs. pers.), it is not unlikely that the increase could also be due to an intake of specimens from the totally protected area of Medes Islands. Against this hypothesis is the extremely sedentary behaviour of the dusky grouper exhibited in mark and recapture experiments or in more recent studies using sensors. However, assessments of the effects of hurricanes on coral reef fish communities have documented that some fish species change location after an extreme weather event (Kaufman, 1983; Lassig, 1983, Letourneur et al., 1993). Something similar could have occurred in this case because certain rocky bottoms in the Medes Islands were transformed greatly due to the movement of the rocks, which could have prevented fish from recognizing their original home area after the storm. Dead specimens found on the beach were carried away by the waves; however, the many scars on their bodies seem to demonstrate that the main cause of death of most individuals was the sudden and violent movements of large boulders among which the groupers spend most of the winter hidden and virtually inactive.

There is no clear evidence that other highly targeted species were significantly affected by the storm, although in some cases the density and biomass values were among the lowest since 1992. This is the case of *Diplodus cervinus* and *Dicentrarchus labrax*, although there are some differences among the two populations: while the decrease in *D.*

cervinus in the Medes Islands seems to be part of a downward trend that began in 2005, *D. labrax* showed a sharp decline from 2008 to 2009 that may have been caused by the storm, and which led to the minimum values for this species since 1992. The poor statistical quality of the density and biomass data of *D. labrax* (with many zeros and huge variations among counts) prevents the possible consequences of the storm from being statistically significant. As this species is very rare on the partially and non-protected coast, the decline in sea bass in the Medes Islands protected area cannot be corroborated here. Anecdotally, we can remark that the sudden increase in abundance in 2004, following a massive escape from a fish farm, was completely diluted a year later, which may put into question the effectiveness of restocking depleted natural populations by releasing captive-bred specimens.

Both *D. dentex* and *S. umbra* seem to have gone virtually untouched by the storm following positive development in the protected and in the partially protected areas. In both cases it seems clear that protection, more than any other factor, is at the origin of the positive evolution of the two populations. Remarkable differences in the size frequency distributions of *D. dentex* demonstrate that the population from the totally protected area and the population of the partially protected area remained fairly isolated.

Finally sea bream (*S. aurata*) showed rather low mean density and biomass values in the Medes Islands protected area, which are characteristic of the recent years of monitoring. In fact, density values inside the protected area seemed to converge with the values observed on the neighbouring coast, where, in spite of the protection level, the species shows parallel development with large ups and downs. While the average density of *S. aurata* not only reached comparable values but even slightly higher values than in the totally protected area, there was still a notable difference in mean biomass in favour of the totally protected area due to the enormous difference in sizes (Figure not shown). This disparity seems to dispel the possibility of a real spill-over from the totally protected area to the neighbouring coast. In any case, the population of *S. aurata* does not seem to have been affected at all by the storm.

This study has demonstrated that, in spite of some losses, most of the populations of highly targeted species (except perhaps *D. labrax*) resisted the impact of the storm quite well in the totally protected area of the Medes Islands. The storm had no clear effect on the partially protected area except the notable increase in *E. marginatus*. The low values from the unprotected area prevented us from determining any significant effects of the storm.

Acknowledgements

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Table 2. Summary of the results of the ANOVAs comparing the mean density and biomass of each of the trips carried out in the Medes Islands marine protected area and the coast of Montgrí.

	***E. marginatus* (abundance)**						***E. marginatus* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	597,14	149,29	39,466	0,000	831062	207765,5	51,92	0,000
	YEAR	16	410,11	25,63	6,776	0,000	210580	13161,3	3,29	0,000
	ZONE*YEAR	64	257,96	4,03	1,066	0,343	274553	4289,9	1,07	0,331
	Error	961	3635,08	3,78			3845575	4001,6		
MONTGRÍ										
	ZONE	3	2,29	0,76	10,343	0,000	13098,17	4366,06	12,76	0,000
	YEAR	10	3,45	0,35	4,681	0,000	15082,57	1508,26	4,41	0,000
	ZONE*YEAR	30	3,90	0,13	1,764	0,009	16375,85	545,86	1,59	0,027
	Error	348	25,65	0,07			119119,27	342,30		
	***D. dentex* (abundance)**						***D. dentex* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	189,83	47,46	18,874	0,000	157155,88	39288,97	47,95	0,000
	YEAR	14	140,20	10,01	3,983	0,000	54844,44	3917,46	4,78	0,000
	ZONE*YEAR	56	204,89	3,66	1,455	0,018	77216,77	1378,87	1,68	0,002
	Error	853	2144,84	2,51			698909,15	819,35		
MONTGRÍ										
		df	SS	MS	F	p	SS	MS	F	p
	ZONE	3	6,61	2,20	1,993	0,115	889,85	296,62	1,98	0,117
	YEAR	10	21,78	2,18	1,971	0,036	3874,85	387,49	2,59	0,005
	ZONE*YEAR	30	85,82	2,86	2,588	0,000	8912,00	297,07	1,98	0,002
	Error	348	384,60	1,11			52118,68	149,77		
	***D. cervinus* (abundance)**						***D. cervinus* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	171,68	42,92	16,83	0,000	63563,50	15890,88	29,938	0,000
	YEAR	14	95,90	6,85	2,686	0,001	24999,48	1785,68	3,364	0,000
	ZONE*YEAR	56	237,88	4,25	1,666	0,002	60762,96	1085,05	2,044	0,000
	Error	853	2175,01	2,55			450115,05	530,80		
MONTGRÍ										
	ZONE	3	5,39	1,80	4,152	0,007	2344,70	781,57	3,987	0,008
	YEAR	10	5,71	0,57	1,318	0,219	4121,79	412,18	2,103	0,024
	ZONE*YEAR	30	15,13	0,50	1,165	0,257	8084,32	269,48	1,375	0,095
	Error	348	150,71	0,43			67627,64	196,02		
	***D. labrax* (abundance)**						***D. labrax* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	1828,7	457,2	25,01	0,000	166274,15	41568,54	57,196	0,000
	YEAR	14	1130,4	80,74	4,417	0,000	39341,8391	2810,13	3,867	0,000
	ZONE*YEAR	56	1715,6	30,64	1,676	0,002	66585,3241	1189,02	1,636	0,003
	Error	853	15592	18,28			619942,636	726,78		
MONTGRÍ										
	ZONE	3	17,193	5,731	3,889	0,009	883,756977	294,59	8,521	0,000
	YEAR	10	38,135	3,814	2,588	0,005	791,147928	79,11	2,288	0,013
	ZONE*YEAR	30	113,55	3,785	2,569	0,000	1859,651	61,99	1,793	0,008
	Error	348	512,8	1,474			12031,1751	34,57		
	***S. umbra* (abundance)**						***S. umbra* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	786,42	196,61	10,600	0,000	117876,54	29469,13	27,497	0,000
	YEAR	14	403,25	28,80	1,553	0,087	24723,84	1765,99	1,648	0,062
	ZONE*YEAR	56	760,84	13,59	0,733	0,929	62272,76	1112,01	1,038	0,402
	Error	853	1154,9	18,55			914170,27	1071,71		
MONTGRÍ										
	ZONE	3	51,58	17,19	5,180	0,002	6028,25	2009,42	15,911	0,000
	YEAR	10	35,71	3,57	1,076	0,380	1960,27	196,03	1,552	0,120
	ZONE*YEAR	30	113,24	3,77	1,137	0,287	6778,30	225,94	1,789	0,008
	Error	348	1154,86	3,32			43949,84	126,29		
	***S. aurata* (abundance)**						***S. aurata* (biomass)**			
MEDES		df	SS	MS	F	p	SS	MS	F	p
	ZONE	4	61,69	15,42	14,863	0,000	24567,66	6141,91	15,169	0,000
	YEAR	14	78,12	5,58	5,377	0,000	20843,50	1488,82	3,677	0,000
	ZONE*YEAR	56	85,68	1,53	1,475	0,015	29667,76	529,78	1,308	0,068
	Error	853	885,11	1,04			344982,09	404,91		
MONTGRÍ										
	ZONE	3	0,34	0,11	0,494	0,686	201,49	67,16	0,660	0,577
	YEAR	10	10,37	1,04	4,504	0,000	7252,57	725,26	7,126	0,000
	ZONE*YEAR	30	7,78	0,26	1,127	0,300	3236,29	107,88	1,060	0,385
	Error	348	80,11	0,23			35419,75	101,78		