

Biodiversity and structure of rocky reef fish assemblages in the Sierra Helada Natural Park (South-western Mediterranean Sea)

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Abstract

Biodiversity and structure of rocky reef fish assemblages in the Sierra Helada Natural Park (South-western Mediterranean Sea).— In the present study the fish assemblages in the rocky-bottom habitat of the Sierra Helada Natural Park (Alicante, Spain) were recorded to provide data for future evaluation of any changes induced by long-term management. Visual censuses were carried out along strip transects by Scuba diving on rocky bottoms at depths between 1 and 32 m. In the seven localities sampled, 44 species were recorded. Number of species, abundance, biomass and size structure values recorded did not show differences between high and low protection areas. Species composition was similar to other marine protected areas of the western-Mediterranean. The main differences found between localities can be attributed to the high heterogeneity and complexity of the habitat at smaller spatial scales.

Key words: Fish assemblages, Rocky bottom, Biodiversity, Distribution, Visual census, Mediterranean sea.

Resumen

Biodiversidad y estructura de la comunidad íctica litoral sobre sustrato rocoso del Parque Natural de Sierra Helada (sudoeste del mar Mediterráneo).— En el presente estudio se analiza la comunidad íctica litoral sobre sustrato rocoso del Parque Natural de Sierra Helada (Alicante, España) y se aportan datos de base que permitirán evaluar a largo plazo los cambios debidos a diferentes medidas de gestión. Se realizaron censos visuales en transectos lineales sobre fondos rocosos entre 1 y 32 m de profundidad. En las siete localidades estudiadas se contaron 44 especies. El número de especies, abundancia, biomasa y estructura de tallas fueron similares entre las zonas con alta y baja protección. La composición de especies observada fue similar a los de otras áreas marinas protegidas del Mediterráneo occidental. Las diferencias entre localidades podrían ser causadas por la alta heterogeneidad y complejidad del hábitat a pequeña escala.

Palabras clave: Comunidad íctica, Fondos rocosos, Biodiversidad, Distribución, Censos visuales, Mar Mediterráneo.

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Introduction

Fishes are the main group of marine vertebrates and an important component of the marine biodiversity of the rocky Mediterranean infralittoral habitats. Their ecological role in the functioning of the ecosystems is often key to the structure and dynamics of marine communities. This may be due to either their position in the trophic chain or to the influence of their interactions with other fish, invertebrates and macroalgae (competition, depredation, parasitism). Furthermore, fishing has been practised in the area since ancient times and is a traditional source of economic activity.

Fish distribution patterns are influenced by biological and physical factors, such as variations in depth (Dufour et al., 1995), habitat structure resulting in differential availability of resources such as food or shelter (García–Charton et al., 2004), climatic differences (Holbrook et al., 1997), predation (Hixon, 1991), competition (Gladfelter et al., 1980), episodic disturbances (Chabanet et al., 1995), larval dynamics (Leis & McCormick, 2002), and recruitment variability (Booth & Brosnan, 1995). Additionally, in some places, management can promote differences in the fish assemblage depending on the level of protection applied (Russ, 2002). Many studies have shown significant relationships between fish assemblage and habitat structure (e.g. Jenkins & Weatley, 1998). Habitat structure may strongly affect fish assemblages and many marine protected areas have been chosen due to their intrinsic complex seascape. The most reasonable way to achieve better management and understanding of the functioning of these rocky habitats, particularly in the case of marine protected areas (MPAs), fishing areas or even artificial structures, is to have the best possible knowledge of the manner in which fish assemblages respond to this habitat complexity. In this way, it may be possible to avoid confusion between variability that is due to natural factors and effects derived from management.

Marine protected areas are being established worldwide at a rapid rate. Locations with important ecological and socio–economic features are being managed to protect habitats and biological richness, and restore fishing stocks and degraded areas (Agardy, 2000). In this framework, the study of spatial pattern of fish assemblages is crucial as a first step to understanding the causes of their distribution and abundance (Levin, 1992) and to provide a basis for monitoring their long–term changes due to both natural and human disturbances (Underwood, 1990). The Sierra Helada Natural Park (Alicante, Spain, Western Mediterranean) was constituted as a Natural Park with an extensive marine protected area (4920 ha) in 2005 (DOGV n° 4967, 16/03/05). The great heterogeneity of the bottoms, where a large number of the more characteristic benthic communities of the west and central Mediterranean are found, and their good state of conservation make the Sierra Helada an ideal place for the study of fish communities and the factors that determine their structure in the oligotrophic areas of the south–western Mediterranean. It is clear that to manage these marine protected areas and to adopt measures of conservation and regulation, it is necessary to define the criteria of action. To do so, we need to increase our knowledge on the different types of habitats and the species present in the area. The aim of this study was to characterize the fish assemblages inhabiting the rocky reefs in the Sierra Helada Natural Park (Western Mediterranean Sea) in order to determine species composition, defining the distribution and quantifying population abundance, biomass and size structure. Moreover, the selection of the study localities in areas that are affected by different management measures should provide a baseline for future evaluations of the changes produced by management and a source of data for future meta–analysis.

Material and methods

Study site and sampling design

The study was carried out in the Sierra Helada Natural Park (Alicante coast, Spain, SW–Mediterranean). The littoral zone is characterised by the large abundance and diversity of rocky infralittoral bottoms, composed primarily of boulders of diverse sizes interspersed with patches of sand and *Posidonia oceanica* seagrass meadow (DOGV nº 4967, 16/03/05). Wide zones with rocky blocks larger than 0.5 m in height, without patches of *Posidonia oceanica* and without sand were selected, ranging from 1 to 32 m depth. Seven areas were sampled in summer, between June and August 2007.

We selected three specially protected areas, Benidorm island, Mitjana island and Mascarat–Toix, where a number of activities (anchoring, fishing, motor–sailing, aquaculture) are forbidden but others are allowed (swimming, snorkelling, windsurfing, sailing, scientific research). The other four localities selected in this study have a lower level of protection (L'Olla island, Punta Albir, Punta Caballo and Finestrat) (fig. 1, table 1).

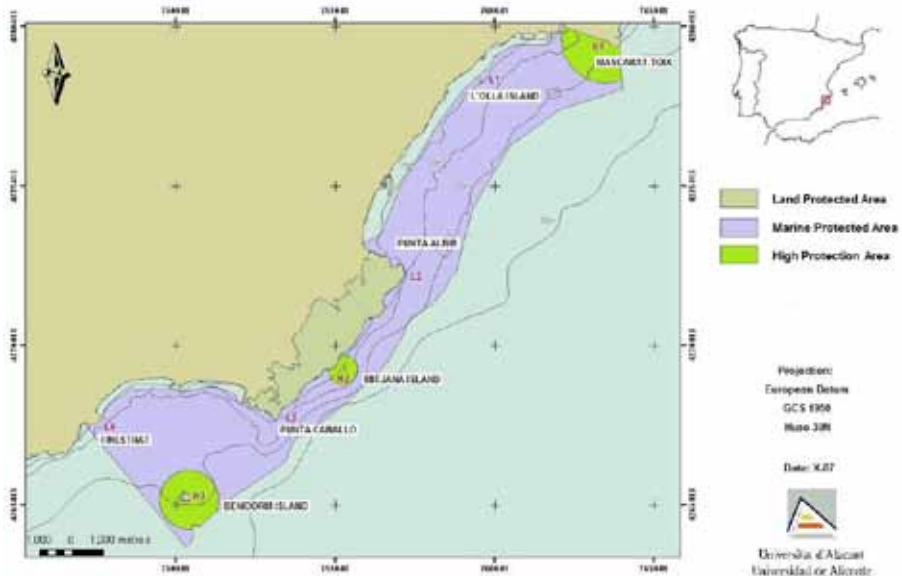


Fig. 1. Map of study area showing limits and zonation. The position of the localities sampled at each protection level is also indicated: H1. High protection locality one; H2. High protection locality two; H3. High protection locality three; L1. Low protection locality one; L2. Low protection locality two; L3. Low protection locality three; L4. Low protection locality four.

Fig. 1. Mapa del àrea de estudi mostrant els límits i les zones. Se indica també la posició de les localitats muestreades per cada nivell de protecció: H1. Localitat uno de alta protecció; H2. Localitat dos de alta protecció; H3. Localitat tres de alta protecció; L1. Localitat uno de baixa protecció; L2. Localitat dos de baixa protecció; L3. Localitat tres de baixa protecció; L4. Localitat quatre de baixa protecció.

Table 1. Geographical coordinates of the study locations using UTM (Universal Transversal Mercator). (For other abbreviations see fig. 1.)

Tabla 1. Coordenadas geográficas de las localidades de estudio usando UTM (Universal Transversal Mercator). (Para otras abreviaturas, ver fig. 1.)

Localities	Code	Geographical		
		zone	Latitude (X)	Longitude (Y)
L'Olla Island	L1	30S	759576 E	4278430 N
Punta Albir	L2	30S	757153 E	4272566 N
Punta Caballo	L3	30S	753025 E	4267852 N
Finestrat	L4	30S	747502 E	4267789 N
Mascarat–Toix	H1	31S	241052 E	4279618 N
Mitjana Island	H2	30S	755096 E	4269481 N
Benidorm Island	H3	30S	750353 E	4265542 N

Underwater visual census and data analysis

Fish assemblages were visually surveyed by scuba diving (Harmelin–Vivien et al., 1985) along each 25 x 5 m strip transect, recording the abundances and individual sizes in 2 cm size classes for each species encountered. Several observers participated in the sampling operations, after several training sessions. It has been observed in previous studies that fish counts, size estimations and habitat measurements do not differ significantly among trained observers (Bell et al., 1985). Small-sized, cryptic species (belonging to families Gobiidae, Callyonimidae, Bleniidae, Gobiocidae and Tripterygiidae) were excluded from the censuses to avoid biases. Each observation was assigned to one of nine predetermined abundance classes proposed by Harmelin (1987), the limits of which coincide with the terms of a geometric series (base 2). Geometric means of each fish abundance class were used for calculations. All censuses were done between 10:00 and 15:00 h, with optimal water conditions (turbidity and swell). These sampling methods have been used extensively in MPAs because they are non-destructive and guarantee that the fish community is not affected by sampling. Interference with previous evaluations of the effects of protection is avoided, and a high degree of consistency of gathered data among observers is maintained over time (*i.e.*, performance to survey the most visually observable fraction of the fish with the same efficiency) (Harmelin–Vivien & Francour, 1992).

After counting fishes, the same observer covered the transect length in the opposite direction to record data on the habitat heterogeneity and complexity within each transect. We visually measured (i) the relative percentage of cover of different substrate types (rock, clumps of *Posidonia oceanica* over rock, and patches of sand), (ii) the number of rocky boulders (classified by the size of their major length [ML]: small [ML ≤ 1 m], medium [1 m < ML ≤ 2 m], and large [ML > 2 m]) and (iii) the maximum depth and a verticality index (vertical distance between the deepest and shallowest point inside each transect). Fish species biomass was estimated from the abundance data by size-classes within each transect, using weight-length relationships calculated from experimental and commercial fishing data obtained in the same geographical area.

Table 2. Number of census (N) and medium values of habitat heterogeneity and complexity carried on low and high protection areas: SEM. Standard error of the mean.

Tabla 2. Número de censos (N) y valores medios de la heterogeneidad y complejidad del hábitat realizados en áreas de baja y alta protección: SEM. Error estándar de la media.

	Medium values (\pm SEM)			
	Low protection area			
	L'Olla Island	Punta Albir	Punta Caballo	Finestrat
N	5	17	14	4
Rock (%)	67,00 \pm 10,44	87,29 \pm 3,02	76,28 \pm 4,58	96,25 \pm 2,39
Min. depth (m)	4,20 \pm 0,80	10,75 \pm 1,63	3,55 \pm 0,31	1,75 \pm 0,32
Máx. depth (m)	5,30 \pm 0,94	12,72 \pm 1,64	4,67 \pm 0,30	3,45 \pm 0,26
Verticality (m)	2,20 \pm 0,37	5,07 \pm 1,29	2,05 \pm 0,26	1,12 \pm 0,37
Number of boulders	8,40 \pm 2,63	18,85 \pm 3,43	18,50 \pm 5,15	12,50 \pm 1,19
Number of blocks	3,60 \pm 0,97	10,35 \pm 1,75	5,50 \pm 1,40	11,00 \pm 1,00
Number of big blocks	5,40 \pm 1,07	10,71 \pm 3,00	2,28 \pm 0,72	5,50 \pm 1,65

	High protection area		
	Mascarat–Toix	Mitjana Island	Benidorm Island
N	16	11	26
Rock (%)	76,50 \pm 4,15	88,63 \pm 4,37	97,11 \pm 1,04
Min. depth (m)	7,75 \pm 0,78	4,95 \pm 0,41	12,97 \pm 1,53
Max depth (m)	9,53 \pm 0,79	10,68 \pm 1,48	15,93 \pm 1,60
Verticality (m)	2,81 \pm 0,77	3,00 \pm 0,26	2,84 \pm 0,77
Number of boulders	11,43 \pm 2,29	9,09 \pm 1,92	13,61 \pm 3,95
number of blocks	4,75 \pm 0,72	10,18 \pm 3,17	2,61 \pm 0,49
Number of big blocks	3,50 \pm 0,83	6,54 \pm 0,87	3,57 \pm 0,69

Results

We carried out a total of 93 census in all study localities, 40 of these in low protection areas and 53 in higher ones (table 2). The highest percentages for rocky habitat and maximum depth were in Benidorm Island (97,11 \pm 1,04% and 15,93 \pm 1,60 m depth). The lowest values of minimum depth and verticality were in Finestrat (1,75 \pm 0,32 m and 1,12 \pm 0,37 m, respectively). The highest values of verticality (5,07 \pm 1,29 m) and highest number of boulders, blocks and big blocks were in Punta Albir.

We observed a total of 44 fish species (belonging to 17 families); 11 of these species appeared in all localities (annex 1). In terms of species richness, between 15 and 33 species appeared in low protection areas, whereas in high protection areas we observed between 26 and 31 species. High protection areas showed a relatively higher abundance and higher biomass values than low protection areas. The highest mean total abundance was recorded in Mitjana Island (411,14 \pm 34,28 individuals/125 m²), while the lowest value was recorded in Finestrat (54,25 \pm 1,18

individuals/125 m²) (table 3). The 6 most abundant species in the study area were *Chromis chromis*, *Sarpa salpa*, *Diplodus vulgaris*, *Diplodus sargus*, *Oblada melanura* and *Coris julis*. The highest mean total biomass ranged between a maximum of 13345,319 ± 1605,896 g/125 m² in Mitjana Island, and a minimum of 1133,85 ± 28,370 g/125 m² in Finestrat (table 4). The species that showed the highest values of biomass in the study area were *D. vulgaris*, *D. sargus*, *S. salpa* and *C. chromis*. Ten species (*C. julis*, *Symphodus ocellatus*, *S. roissalii*, *S. tinca*, *Thalassoma pavo*, *Serranus scriba*, *Diplodus cervinus*, *D. vulgaris*, *O. melanura* and *S. salpa*) were very common and appeared in every site. Other species like *Sardina pilchardus*, *Mugil* spp., *Boops boops*, *Scorpaena* spp., *Phycis phycis*, *Symphodus doderleini*, *Mycteroperca rubra*, *Lithognatus mormyrus* and *Pagrus* spp. were recorded with very low frequencies.

Large sparids showed the highest abundance values for size 2 (table 5), and they were most abundant at Mitjana Island. Small sparids, however, were widely distributed, and the highest value was size 2, also at Mitjana Island. Large serranids were less abundant than smaller serranid, and both had highest values of size 2. Large labrids were frequent throughout the study area, with highest values of size 3 and 4. A similar occurrence was observed for small labrids where sizes 2 and 3 recorded the highest abundance values. The other commercial species, red mullet (*Mullus surmuletus*) and brown meagre (*Sciaena umbra*), exhibited the highest abundance values of size 2, but size 4 was recorded frequently in high protection areas in both cases. Biomass recorded for large and small sparids showed a maximum value in size 2 and the highest sizes were recorded in Benidorm and Mitjana Islands (table 6). Large serranids showed the highest values of biomass in size 2, and small serranids were more frequent in size 3. Large and small labrids exhibited higher biomass values in sizes 4 and 3, respectively. The highest size of red mullets was recorded in Mascarat-Toix, a high protection area, and the maximum of biomass was size 2. The highest size and biomass values for brown meagre were observed in Benidorm Island.

Discussion

In terms of composition, the rocky reef fish assemblages of the Sierra Helada Natural Park were similar to those recorded in other marine protected areas in the western–Mediterranean sea (e.g. Reñones et al., 1997; Forcada, 2004). Species richness, total abundance and biomass values recorded did not show great differences between high and low protection areas as regulations limiting fishing were not yet enforced. The main differences found between localities can be attributed to differences in the heterogeneity and complexity of the habitat (García Charton et al., 2004). Those factors changed at a very small scale, conditioning the distribution and presence of fishes, and should be taken into account in order to assess the effect of protection without bias. Our findings suggest that the intrinsic complexity of the habitat in Mitjana and Benidorm Islands may favour the appearance of targeted species such as big serranids (*Epinephelus* spp.) or large sparids (*Dentex dentex*) when regulations are enforced.

Table 3. List of species observed, species richness (total number of species observed), mean specific and total abundance (individuals/125 m² ± standard error of the mean) recorded in each site of low and high protection areas.

Tabla 3. Lista de especies observadas, riqueza específica (número total de especies observadas), media por especie y abundancia total (individuos/125 m² ± error estándar de la media) registradas en cada tipo de áreas de baja y alta protección.

Species	Low protection area				High protection area		
	L'Olla Island	Punta Albir	Punta Caballo	Finestrat	Mascarat–Toix	Mitjana Island	Benidorm Island
<i>Apogon imberbis</i>	6,40 ± 4,53	2,00 ± 0,56	0,21 ± 0,21	0 ± 0	2,56 ± 1,28	0,36 ± 0,29	2,80 ± 1,50
<i>Spicara maena</i>	0 ± 0	4,17 ± 4,17	0,64 ± 0,64	0 ± 0	0 ± 0	0,09 ± 0,09	0 ± 0
<i>Sardina pilchardus</i>	0 ± 0	1,05 ± 1,05	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Phycis phycis</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,11 ± 0,06	0 ± 0
<i>Pomadasys incisus</i>	0 ± 0	0,06 ± 0,06	0,64 ± 0,57	0 ± 0	0 ± 0	70,09 ± 39,44	0 ± 0
<i>Coris julis</i>	8,00 ± 1,81	8,94 ± 1,27	4,21 ± 1,07	3,75 ± 1,43	4,75 ± 1,19	4,27 ± 1,17	7,92 ± 1,99
<i>Labrus merula</i>	0,40 ± 0,24	0,29 ± 0,14	0,14 ± 0,09	0 ± 0	0,31 ± 0,11	0,27 ± 0,20	0,07 ± 0,05
<i>Symphodus cinereus</i>	0 ± 0	0,11 ± 0,11	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Symphodus doderleini</i>	0 ± 0	0 ± 0	0,07 ± 0,07	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Symphodus mediterraneus</i>	0 ± 0	0,23 ± 0,10	0,71 ± 0,71	0 ± 0	0,18 ± 0,10	0 ± 0	0,15 ± 0,09
<i>Symphodus melanocercus</i>	0 ± 0	0,11 ± 0,11	0,78 ± 0,71	0 ± 0	0,06 ± 0,06	0 ± 0	0 ± 0
<i>Symphodus ocellatus</i>	3,20 ± 1,93	1,35 ± 0,42	0,28 ± 0,28	0,75 ± 0,47	1,50 ± 0,61	0,36 ± 0,21	0,07 ± 0,05
<i>Symphodus roissalii</i>	0,80 ± 0,37	0,11 ± 0,08	0,42 ± 0,17	0,75 ± 0,47	0,68 ± 0,31	0,27 ± 0,20	0,11 ± 0,06
<i>Symphodus tinca</i>	1,20 ± 0,58	3,17 ± 0,87	1,5 ± 0,4	1,75 ± 0,85	2,75 ± 0,56	3,09 ± 0,85	0,61 ± 0,16
<i>Thalassoma pavo</i>	1,00 ± 0,31	2,17 ± 0,67	5,71 ± 1,36	0,50 ± 0,28	0,93 ± 0,23	3,00 ± 1,42	5,19 ± 2,14
<i>Liza aurata</i>	0 ± 0	1,06 ± 1,06	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,73 ± 0,73
<i>Mugil spp.</i>	0 ± 0	0 ± 0	0 ± 0	5,75 ± 4,80	0 ± 0	0 ± 0	0 ± 0
<i>Mullus surmuletus</i>	0 ± 0	0,41 ± 0,24	0,21 ± 0,11	4,50 ± 4,50	1,18 ± 0,8	0,91 ± 0,38	0,42 ± 0,25
<i>Muraena helena</i>	0,20 ± 0,20	0 ± 0	0,07 ± 0,07	0 ± 0	0,06 ± 0,06	0 ± 0	0,07 ± 0,07
<i>Chromis chromis</i>	37,00 ± 21,01	108,05 ± 32,02	118,28 ± 48,52	0 ± 0	45,31 ± 13,61	283,63 ± 75,74	99,42 ± 23,96
<i>Sciaena umbra</i>	0 ± 0	0,11 ± 0,08	0,14 ± 0,09	0 ± 0	0 ± 0	0 ± 0	0,88 ± 0,66
<i>Scorpaena porcus</i>	0 ± 0	0,06 ± 0,06	0 ± 0	0 ± 0	0 ± 0	0,18 ± 0,12	0 ± 0
<i>Scorpaena scrofa</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,03 ± 0,03
<i>Anthias anthias</i>	0 ± 0	0,11 ± 0,11	0 ± 0	0 ± 0	0 ± 0	0 ± 0	6,96 ± 3,37

Table 3. (Cont.)

Species	L'Olla Island	Low protection area			High protection area		
		Punta Albir	Punta Caballo	Finestrat	Mascarat–Toix	Mitjana Island	Benidorm Island
<i>Epinephelus marginatus</i>	0 ± 0	0,11 ± 0,08	0,07 ± 0,07	0 ± 0	0 ± 0	0 ± 0	0,04 ± 0,04
<i>Mycteroperca rubra</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,04 ± 0,04
<i>Serranus cabrilla</i>	0 ± 0	0,82 ± 0,38	0,28 ± 0,16	0 ± 0	0,06 ± 0,06	0,27 ± 0,20	1,11 ± 0,23
<i>Serranus scriba</i>	1,20 ± 0,37	1,41 ± 0,33	1,35 ± 0,32	0,25 ± 0,25	1,81 ± 0,39	1,54 ± 0,57	1,03 ± 0,27
<i>Boops boops</i>	0 ± 0	0 ± 0	1,28 ± 1,28	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Dentex dentex</i>	0,2 ± 0,2	0,11 ± 0,11	0,78 ± 0,71	0 ± 0	0,06 ± 0,06	0 ± 0	0,42 ± 0,12
<i>Diplodus annularis</i>	1,60 ± 0,97	1,00 ± 0,36	0,28 ± 0,19	0 ± 0	2,12 ± 1,08	0,63 ± 0,40	0,30 ± 0,23
<i>Diplodus cervinus</i>	0,40 ± 0,24	0,05 ± 0,05	0,21 ± 0,11	0,25 ± 0,25	0,12 ± 0,08	0,36 ± 0,21	0,27 ± 0,10
<i>Diplodus puntazzo</i>	0 ± 0	0,29 ± 0,11	0,14 ± 0,09	0 ± 0	0,25 ± 0,14	0,36 ± 0,21	0,84 ± 0,35
<i>Diplodus sargus</i>	3,00 ± 1,41	6,94 ± 1,68	14,42 ± 4,08	6,75 ± 1,65	10,18 ± 2,44	36,36 ± 11,91	9,57 ± 1,94
<i>Diplodus vulgaris</i>	3,40 ± 1,03	15,00 ± 2,47	16,85 ± 4,27	7,75 ± 1,10	17,56 ± 5,13	164,45 ± 73,04	21,04 ± 5,16
<i>Lithognathus mormyrus</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,27 ± 0,20	0 ± 0
<i>Oblada melanura</i>	55,20 ± 22,67	3,64 ± 1,73	188,28 ± 86,41	0,75 ± 0,25	6,50 ± 3,55	18,36 ± 14,22	0,46 ± 0,24
<i>Pagrus auriga</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,06 ± 0,06	0 ± 0	0 ± 0
<i>Pagellus erythrinus</i>	0 ± 0	0,11 ± 0,08	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Pagrus pagrus</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0,37 ± 0,15	0 ± 0	0,65 ± 0,38
<i>Sparus aurata</i>	0 ± 0	0,11 ± 0,08	0,07 ± 0,07	0 ± 0	0,12 ± 0,12	0,09 ± 0,09	0,11 ± 0,08
<i>Spondyliosoma cantharus</i>	0 ± 0	0,17 ± 0,12	0,07 ± 0,07	0,25 ± 0,25	0,06 ± 0,06	26,45 ± 14,18	0,42 ± 0,24
<i>Sarpa salpa</i>	38,60 ± 15,42	8,82 ± 3,43	21,00 ± 5,95	11,50 ± 4,33	12,37 ± 4,44	50,63 ± 18,15	6,30 ± 2,05
<i>Sphyaena sphyraena</i>	0 ± 0	0 ± 0	0 ± 0	9,00 ± 5,19	0 ± 0	6,45 ± 6,76	0,03 ± 0,03
Mean total abundance	135,25 ± 6,47	173,8 ± 16,31	354,71 ± 27,99	54,25 ± 1,18	114,26 ± 8,41	411,14 ± 34,28	186,46 ± 15,50
Species richness	17	33	30	15	26	26	31

Table 4. List of species observed, mean specific and total biomass (gr/125 m² ± standard error of the mean) recorded in each site of low and high protection areas.

Tabla 4. Lista de especies observadas, biomasa específica media y total (gr/125 m² ± error estándar de la media) registradas en cada lugar de las áreas de baja y alta protección.

Species	Low protection area				High protection area		
	L'Olla Island	Punta Albir	Punta Caballo	Finestrat	Mascarat–Toix	Mitjana Island	BenidomIsland
<i>Apogon imberbis</i>	86,28 ± 43,86	13,20 ± 3,56	0,7 ± 0,7	0 ± 0	40,90 ± 20,55	5,80 ± 4,45	17,82 ± 7,26
<i>Spicara maena</i>	0 ± 0	31,64 ± 31,64	2,8 ± 2,8	0 ± 0	0 ± 0	0,69 ± 0,69	0 ± 0
<i>Sardina pilchardus</i>	0 ± 0	63,29 ± 63,29	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Phycis phycis</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	34,04 ± 23,51
<i>Pomadasys incisus</i>	0 ± 0	3,7 ± 3,7	40,40 ± 35,84	0 ± 0	0 ± 0	6024,89 ± 3312,16	0 ± 0
<i>Coris julis</i>	105,78 ± 18,13	110,08 ± 18,46	47,20 ± 15,06	45,15 ± 19,07	68,10 ± 15,10	65,91 ± 23,11	92,10 ± 22,91
<i>Labrus merula</i>	128,06 ± 79,14	33,75 ± 17,53	7,33 ± 4,98	0 ± 0	45,61 ± 28,52	17,01 ± 13,95	13,84 ± 11,26
<i>Symphodus cinereus</i>	0 ± 0	1,60 ± 1,60	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Symphodus doderleini</i>	0 ± 0	0 ± 0	0,93 ± 0,93	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Symphodus mediterraneus</i>	0 ± 0	5,33 ± 2,77	19,42 ± 19,42	0 ± 0	5,35 ± 3,12	0 ± 0	4,25 ± 2,69
<i>Symphodus melanocercus</i>	0 ± 0	1,31 ± 1,31	12,33 ± 11,50	0 ± 0	0,70 ± 0,70	0 ± 0	0 ± 0
<i>Symphodus ocellatus</i>	13,68 ± 6,22	27,83 ± 12,91	0,76 ± 0,76	8,42 ± 5,05	18,56 ± 7,24	4,29 ± 2,27	0,51 ± 0,35
<i>Symphodus roissalii</i>	16,08 ± 9,44	1,26 ± 0,92	4,07 ± 1,62	8,97 ± 5,38	15,03 ± 6,00	3,92 ± 2,80	1,10 ± 0,65
<i>Symphodus tinca</i>	46,16 ± 26,89	205,66 ± 44,90	54,42 ± 15,32	111,92 ± 57,43	216,04 ± 38,55	123,47 ± 45,04	88,41 ± 24,41
<i>Thalassoma pavo</i>	9,68 ± 4,01	19,41 ± 7,34	29,98 ± 9,68	4,08 ± 3,53	13,11 ± 3,70	26,61 ± 10,72	48,42 ± 17,83
<i>Liza aurata</i>	0 ± 0	108,57 ± 108,57	0 ± 0	0 ± 0	0 ± 0	0 ± 0	335,24 ± 335,24
<i>Mugil spp.</i>	0 ± 0	0 ± 0	0 ± 0	126,50 ± 105,65	0 ± 0	0 ± 0	0 ± 0
<i>Mullus surmuletus</i>	0 ± 0	28,65 ± 17,59	9,32 ± 5,05	51,92 ± 51,92	52,83 ± 22,33	30,29 ± 13,34	15,78 ± 8,15
<i>Muraena helena</i>	101,1 ± 101,1	0 ± 0	14,37 ± 14,37	0 ± 0	40,97 ± 40,97	0 ± 0	20,03 ± 20,03
<i>Chromis chromis</i>	6,56 ± 3,72	703,57 ± 217,65	451,23 ± 245,51	0 ± 0	175,25 ± 50,14	2291,14 ± 579,66	999,68 ± 319,28
<i>Sciaena umbra</i>	0 ± 0	5,70 ± 3,97	4,73 ± 3,29	0 ± 0	0 ± 0	0 ± 0	196,07 ± 153,57
<i>Scorpaena porcus</i>	0 ± 0	6,02 ± 6,02	0 ± 0	0 ± 0	0 ± 0	10,89 ± 7,47	0 ± 0
<i>Scorpaena scrofa</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	5,59 ± 5,59
<i>Anthias anthias</i>	0 ± 0	1,82 ± 1,82	0 ± 0	0 ± 0	0 ± 0	0 ± 0	146,48 ± 84,16
<i>Epinephelus marginatus</i>	0 ± 0	167,02 ± 129,10	85,78 ± 85,78	0 ± 0	0 ± 0	0 ± 0	71,40 ± 71,40

Table 4. (Cont.)

Species	Low protection area				High protection area		
	L'Olla Island	Punta Albir	Punta Caballo	Finestrat	Mascarat–Toix	Mitjana Island	Benidom Island
<i>Mycteroperca rubra</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	71,40 ± 71,40
<i>Serranus cabrilla</i>	0 ± 0	19,99 ± 9,72	3,02 ± 1,80	0 ± 0	1,79 ± 1,79	5,98 ± 4,05	33,86 ± 7,29
<i>Serranus scriba</i>	70,50 ± 34,95	35,58 ± 8,88	39,69 ± 9,95	5,50 ± 5,50	91,55 ± 31,68	45,82 ± 16,56	62,49 ± 20,56
<i>Boops boops</i>	0 ± 0	0 ± 0	7,17 ± 7,17	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Dentex dentex</i>	15,26 ± 15,26	16,58 ± 16,58	45,52 ± 38,17	0 ± 0	11,50 ± 11,50	0 ± 0	396,50 ± 171,72
<i>Diplodus annularis</i>	25,96 ± 18,86	55,38 ± 36,68	3,45 ± 2,48	0 ± 0	27,32 ± 9,53	12,25 ± 7,19	44,81 ± 38,76
<i>Diplodus cervinus</i>	16,22 ± 10,37	1,83 ± 1,83	25,91 ± 18,84	27,10 ± 27,10	18,73 ± 12,80	30,16 ± 16,37	146,16 ± 71,73
<i>Diplodus puntazzo</i>	0 ± 0	14,72 ± 7,51	4,44 ± 3,01	0 ± 0	76,95 ± 55,32	28,11 ± 16,04	277,60 ± 144,13
<i>Diplodus sargus</i>	122,50 ± 55,08	333,27 ± 87,86	685,50 ± 268,27	184,1 ± 38,06	668,17 ± 232,47	3108,97 ± 1298,84	1824,02 ± 399,78
<i>Diplodus vulgaris</i>	171,04 ± 70,80	624,34 ± 125,61	409,10 ± 93,78	163,85 ± 48,78	944,81 ± 317,38	8590,35 ± 5106,96	1795,57 ± 379,42
<i>Lithognathus mormyrus</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	37,64 ± 25,85	0 ± 0
<i>Oblada melanura</i>	1631,12 ± 988,19	67,62 ± 34,14	67,00 ± 22,56	7,47 ± 3,04	149,49 ± 82,99	571,81 ± 465,75	143,51 ± 102,55
<i>Pagrus auriga</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	5,23 ± 5,23	0 ± 0	0 ± 0
<i>Pagellus erythrinus</i>	0 ± 0	3,69 ± 2,99	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
<i>Pagrus pagrus</i>	0 ± 0	0 ± 0	0 ± 0	0 ± 0	25,98 ± 12,08	0 ± 0	141,75 ± 84,94
<i>Sparus aurata</i>	0 ± 0	14,43 ± 9,88	8,76 ± 8,76	0 ± 0	20,48 ± 20,48	38,24 ± 38,24	125,51 ± 93,27
<i>Spondyliosoma cantharus</i>	0 ± 0	2,43 ± 1,77	0,98 ± 0,98	0,45 ± 0,45	0,50 ± 0,50	561,12 ± 293,27	12,89 ± 6,35
<i>Sarpa salpa</i>	1842,46 ± 725,92	771,92 ± 385,58	2308,59 ± 1804,12	341,87 ± 119,74	537,60 ± 169,39	4850,48 ± 1995,12	1259,32 ± 474,77
<i>Sphyaena sphyraena</i>	0 ± 0	0 ± 0	0 ± 0	46,52 ± 28,53	0 ± 0	3215,03 ± 3215,03	64,92 ± 64,92
Mean Total Biomass	3906,925	3673,67	1608,257	1133,85	3342,95	8807,846	558,012
	±	±	±	±	±	±	±
	295,359	352,655	103,21	28,370	249,506	13345,319	1605,896

Table 5 . Mean total abundance (individuals/125 m² ± standard error of the mean) of different sizes within each group selected recorded in the study area.

Tabla 5. Abundancia total media (individuos/125 m² ± error estándar de la media) registrada para los distintos tamaños dentro de cada grupo seleccionado en el área de estudio.

Group	Protection level	Size 1	Size 2	Size 3	Size 4
Big sparids group					
<i>(Dentex dentex, Pagrus spp., Pagellus erythrinus, Sparus aurata, Spondylisoma cantharus)</i>					
Low protection areas					
	L'Olla Island	0,03 ± 0,03	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0,04 ± 0,02	0,05 ± 0,02	0 ± 0	0 ± 0
	Punta Caballo	0,14 ± 0,11	0,01 ± 0,01	0 ± 0	0 ± 0
	Finestrat	0,04 ± 0,04	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0,07 ± 0,03	0,04 ± 0,02	0 ± 0	0 ± 0
	Mitjana Island	0,32 ± 0,27	4,09 ± 2,44	0,01 ± 0,01	0 ± 0
	Benidorm Island	0,09 ± 0,06	0,12 ± 0,04	0,04 ± 0,02	0,01 ± 0,01
Small sparids group					
<i>(Diplodus spp.)</i>					
Low protection areas					
	L'Olla Island	0,12 ± 0,06	1,40 ± 0,42	0,12 ± 0,08	0,04 ± 0,04
	Punta Albir	0,29 ± 0,22	4,02 ± 0,81	0,27 ± 0,09	0,01 ± 0,01
	Punta Caballo	0,35 ± 0,25	5,98 ± 1,44	0,04 ± 0,03	0 ± 0
	Finestrat	0,40 ± 0,18	2,55 ± 0,76	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0,32 ± 0,22	4,97 ± 1,23	0,72 ± 0,19	0,02 ± 0,01
	Mitjana Island	0,74 ± 0,70	38,98 ± 15,83	0,71 ± 0,41	0 ± 0
	Benidorm Island	0,01 ± 0,01	3,67 ± 1,10	2,50 ± 0,49	0,16 ± 0,04
Big serranids group					
<i>(Epinephelus marginatus, Mycteroperca rubra)</i>					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	0,05 ± 0,04	0 ± 0	0 ± 0
	Punta Caballo	0 ± 0	0,03 ± 0,03	0 ± 0	0 ± 0
	Finestrat	0 ± 0	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Mitjana Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	0,02 ± 0,02	0,02 ± 0,02	0 ± 0

Table 5. (Cont.)

Group	Protection level	Size 1	Size 2	Size 3	Size 4
	Localities				
Small serranids group (<i>Serranus</i> spp.)					
Low protection areas					
	L'Olla Island	0 ± 0	0,30 ± 0,15	0,30 ± 0,21	0 ± 0
	Punta Albir	0,03 ± 0,03	1,00 ± 0,24	0,08 ± 0,06	0 ± 0
	Punta Caballo	0,07 ± 0,07	0,64 ± 0,18	0,10 ± 0,05	0 ± 0
	Finestrat	0 ± 0	0,12 ± 0,12	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0 ± 0	0,37 ± 0,11	0,56 ± 0,23	0 ± 0
	Mitjana Island	0 ± 0	0,82 ± 0,92	0,09 ± 0,09	0 ± 0
	Benidorm Island	0,02 ± 0,02	0,77 ± 0,16	0,21 ± 0,07	0,07 ± 0,04
Big labrids group (<i>Labrus merula</i> , <i>Symphodus tinca</i>)					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0,50 ± 0,26	0,30 ± 0,15
	Punta Albir	0 ± 0	0,06 ± 0,04	0,47 ± 0,25	1,08 ± 0,34
	Punta Caballo	0 ± 0	0,14 ± 0,06	0,50 ± 0,20	0,17 ± 0,07
	Finestrat	0 ± 0	0 ± 0	0,25 ± 0,25	0,62 ± 0,32
High protection areas					
	Mascarat–Toix	0,03 ± 0,03	0,03 ± 0,03	0,62 ± 0,24	0,50 ± 0,14
	Mitjana Island	0 ± 0	0,32 ± 0,15	0,68 ± 0,25	0,68 ± 0,34
	Benidorm Island	0 ± 0	0,02 ± 0,02	0,03 ± 0,02	0,15 ± 0,06
Small labrids group (<i>Symphodus</i> spp., <i>Coris julis</i> , <i>Thalassoma pavo</i>)					
Low protection areas					
	L'Olla Island	0 ± 0	0,55 ± 0,25	0,85 ± 0,31	0,17 ± 0,08
	Punta Albir	0 ± 0	0,69 ± 0,19	0,67 ± 0,17	0,14 ± 0,05
	Punta Caballo	0,01 ± 0,01	0,92 ± 0,24	0,38 ± 0,11	0,13 ± 0,09
	Finestrat	0 ± 0	0,25 ± 0,12	0,37 ± 0,17	0,03 ± 0,03
High protection areas					
	Mascarat–Toix	0 ± 0	0,28 ± 0,10	0,40 ± 0,11	0,18 ± 0,05
	Mitjana Island	0 ± 0	0,47 ± 0,17	0,36 ± 0,11	0,11 ± 0,07
	Benidorm Island	0 ± 0	1,00 ± 0,29	0,57 ± 0,17	0,10 ± 0,02

Table 5. (Cont.)

Group	Protection level	Size 1	Size 2	Size 3	Size 4
	Localities				
Red mullet group (<i>Mullus surmuletus</i>)					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	0,05 ± 0,05	0,35 ± 0,24	0 ± 0
	Punta Caballo	0 ± 0	0,21 ± 0,11	0 ± 0	0 ± 0
	Finestrat	0 ± 0	4,50 ± 4,50	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0,43 ± 0,43	0,43 ± 0,37	0,25 ± 0,14	0,06 ± 0,06
	Mitjana Island	0 ± 0	0,90 ± 0,36	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	0,38 ± 0,25	0,03 ± 0,03	0 ± 0
Brown meagre group (<i>Sciaena umbra</i>)					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	0,11 ± 0,08	0 ± 0	0 ± 0
	Punta Caballo	0 ± 0	0,14 ± 0,09	0 ± 0	0 ± 0
	Finestrat	0 ± 0	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Mitjana Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	0 ± 0	0,73 ± 0,52	0,15 ± 0,15

Table 6. Mean total biomass (gr/125 m² ± standard error of the mean) of different sizes within each group selected recorded in the study area.

Tabla 6. Biomasa total media (gr/125 m² ± error estándar de la media) registrada en los distintos tamaños dentro cada grupo seleccionado en el área de estudio.

Groups		Size 1	Size 2	Size 3	Size 4
Protection level	Localities				
Big sparids group					
<i>(Dentex dentex, Pagrus spp., Pagellus erythrinus, Sparus aurata, SpondylIOSoma cantharus)</i>					
Low protection areas					
	L'Olla Island	2,54 ± 2,54	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0,53 ± 0,32	5,66 ± 3,25	0 ± 0	0 ± 0
	Punta Caballo	7,75 ± 6,44	1,46 ± 1,46	0 ± 0	0 ± 0
	Finestrat	0,07 ± 0,07	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	3,58 ± 1,64	7,03 ± 4,23	0 ± 0	0 ± 0
	Mitjana Island	4,31 ± 3,77	89,21 ± 53,23	6,37 ± 6,37	0 ± 0
	Benidorm Island	4,67 ± 3,90	34,40 ± 15,43	59,34 ± 30,49	14,35 ± 14,35
Small sparids group					
<i>(Diplodus spp.)</i>					
Low protection areas					
	L'Olla Island	0,62 ± 0,42	57,68 ± 18,88	6,24 ± 5,07	2,59 ± 2,59
	Punta Albir	3,09 ± 2,04	169,43 ± 35,08	25,18 ± 12,75	0,76 ± 0,76
	Punta Caballo	3,59 ± 2,37	217,87 ± 64,57	4,21 ± 3,77	0 ± 0
	Finestrat	1,54 ± 0,78	73,47 ± 21,76	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0,52 ± 0,25	242,82 ± 65,87	101,88 ± 31,43	1,96 ± 1,40
	Mitjana Island	0,04 ± 0,03	2248,43 ± 1110,43	105,48 ± 69,88	0 ± 0
	Benidorm Island	0,06 ± 0,06	239,56 ± 52,61	499,41 ± 97,32	70,84 ± 22,46
Big serranids group					
<i>(Epinephelus marginatus, Mycteroperca rubra)</i>					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	83,51 ± 65,20	0 ± 0	0 ± 0
	Punta Caballo	0 ± 0	42,89 ± 42,89	0 ± 0	0 ± 0
	Finestrat	0 ± 0	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Mitjana Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	35,70 ± 35,70	35,70 ± 35,70	0 ± 0

Table 6. (Cont.)

Group	Protection level	Localities	Size 1	Size 2	Size 3	Size 4
Small serranids group (<i>Serranus</i> spp.)						
Low protection areas						
		L'Olla Island	0 ± 0	7,87 ± 4,15	27,37 ± 19,04	0 ± 0
		Punta Albir	0,02 ± 0,02	22,81 ± 5,47	4,95 ± 3,71	0 ± 0
		Punta Caballo	0,18 ± 0,18	15,63 ± 4,27	5,53 ± 3,07	0 ± 0
		Finestrat	0 ± 0	2,75 ± 2,75	0 ± 0	0 ± 0
High protection areas						
		Mascarat–Toix	0 ± 0	9,67 ± 3,26	36,99 ± 17,67	0 ± 0
		Mitjana Island	0 ± 0	21,20 ± 7,74	4,69 ± 4,69	0 ± 0
		Benidorm Island	0,11 ± 0,11	21,42 ± 4,28	16,40 ± 5,88	10,23 ± 6,16
Big labrids group (<i>Labrus merula</i> , <i>Symphodus tinca</i>)						
Low protection areas						
		L'Olla Island	0 ± 0	0 ± 0	15,72 ± 8,96	71,39 ± 42,39
		Punta Albir	0 ± 0	3,16 ± 2,35	25,95 ± 10,82	70,60 ± 21,44
		Punta Caballo	0 ± 0	4,52 ± 2,56	13,79 ± 5,76	12,55 ± 5,40
		Finestrat	0 ± 0	0 ± 0	8,50 ± 8,50	47,46 ± 26,51
High protection areas						
		Mascarat–Toix	0,19 ± 0,19	0,37 ± 0,37	26,27 ± 9,24	47,69 ± 17,24
		Mitjana Island	0 ± 0	6,62 ± 3,09	21,02 ± 7,85	42,59 ± 22,75
		Benidorm Island	0 ± 0	1,41 ± 1,41	1,30 ± 0,91	16,18 ± 7,17
Small labrids group (<i>Symphodus</i> spp., <i>Coris julis</i> , <i>Thalassoma pavo</i>)						
Low protection areas						
		L'Olla Island	0 ± 0	3,75 ± 1,72	8,88 ± 3,34	4,84 ± 2,66
		Punta Albir	0 ± 0	3,76 ± 0,93	10,61 ± 2,85	3,26 ± 1,34
		Punta Caballo	0,01 ± 0,01	3,42 ± 0,88	5,80 ± 1,85	3,66 ± 2,51
		Finestrat	0 ± 0	1,55 ± 0,84	5,72 ± 2,67	0,21 ± 0,21
High protection areas						
		Mascarat–Toix	0 ± 0	2,05 ± 0,68	6,12 ± 1,82	4,24 ± 1,11
		Mitjana Island	0 ± 0	2,98 ± 1,00	5,74 ± 1,78	3,40 ± 2,36
		Benidorm Island	0 ± 0	6,33 ± 1,90	8,64 ± 2,36	3,01 ± 0,92

Table 6. (Cont.)

Group	Protection level				
	Localities	Size 1	Size 2	Size 3	Size 4
Red mullet group					
<i>(Mullus surmuletus)</i>					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	0,67 ± 0,67	27,98 ± 17,64	0 ± 0
	Punta Caballo	0 ± 0	9,32 ± 5,05	0 ± 0	0 ± 0
	Finestrat	0 ± 0	51,92 ± 51,92	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	2,54 ± 2,54	13,93 ± 11,09	19,26 ± 10,85	17,10 ± 17,10
	Mitjana Island	0 ± 0	30,29 ± 13,34	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	13,07 ± 7,87	2,70 ± 2,70	0 ± 0
Brown meagre group					
<i>(Sciaena umbra)</i>					
Low protection areas					
	L'Olla Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Punta Albir	0 ± 0	5,70 ± 3,97	0 ± 0	0 ± 0
	Punta Caballo	0 ± 0	4,73 ± 3,29	0 ± 0	0 ± 0
	Finestrat	0 ± 0	0 ± 0	0 ± 0	0 ± 0
High protection areas					
	Mascarat–Toix	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Mitjana Island	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	Benidorm Island	0 ± 0	0 ± 0	139,82 ± 101,74	56,24 ± 56,24

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Annex 1. Species and localities: Gz. Geographical zone.

Anexo 1. Relación de especies y localidades: Gz. Zona geográfica.

Species	Locality	Gz	UTM-X	UTM-Y
<i>Apogon imberbis</i>	L'Olla Island	30S	759576	4278430
<i>Apogon imberbis</i>	Punta Albir	30S	757153	4272566
<i>Apogon imberbis</i>	Punta Caballo	30S	753025	4267852
<i>Apogon imberbis</i>	Mascarat–Toix	31S	241052	4279618
<i>Apogon imberbis</i>	Mitjana Island	30S	755096	4269481
<i>Apogon imberbis</i>	Benidorm Island	30S	750353	4265542
<i>Spicara maena</i>	Punta Albir	30S	757153	4272566
<i>Spicara maena</i>	Punta Caballo	30S	753025	4267852
<i>Spicara maena</i>	Mitjana Island	30S	755096	4269481
<i>Sardina pilchardus</i>	Punta Albir	30S	757153	4272566
<i>Phycis phycis</i>	Mitjana Island	30S	755096	4269481
<i>Pomadasys incisus</i>	Punta Albir	30S	757153	4272566
<i>Pomadasys incisus</i>	Punta Caballo	30S	753025	4267852
<i>Pomadasys incisus</i>	Mitjana Island	30S	755096	4269481
<i>Coris julis</i>	L'Olla Island	30S	759576	4278430
<i>Coris julis</i>	Punta Albir	30S	757153	4272566
<i>Coris julis</i>	Punta Caballo	30S	753025	4267852
<i>Coris julis</i>	Finestrat	30S	747502	4267789
<i>Coris julis</i>	Mascarat–Toix	31S	241052	4279618
<i>Coris julis</i>	Mitjana Island	30S	755096	4269481
<i>Coris julis</i>	Benidorm Island	30S	750353	4265542
<i>Labrus merula</i>	L'Olla Island	30S	759576	4278430
<i>Labrus merula</i>	Punta Albir	30S	757153	4272566
<i>Labrus merula</i>	Punta Caballo	30S	753025	4267852
<i>Labrus merula</i>	Mascarat–Toix	31S	241052	4279618
<i>Labrus merula</i>	Mitjana Island	30S	755096	4269481
<i>Labrus merula</i>	Benidorm Island	30S	750353	4265542
<i>Symphodus cinereus</i>	Punta Albir	30S	757153	4272566
<i>Symphodus doderleini</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus mediterraneus</i>	Punta Albir	30S	757153	4272566
<i>Symphodus mediterraneus</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus mediterraneus</i>	Mascarat–Toix	31S	241052	4279618
<i>Symphodus mediterraneus</i>	Benidorm Island	30S	750353	4265542
<i>Symphodus melanocercus</i>	Punta Albir	30S	757153	4272566
<i>Symphodus melanocercus</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus melanocercus</i>	Mascarat–Toix	31S	241052	4279618
<i>Symphodus ocellatus</i>	L'Olla Island	30S	759576	4278430
<i>Symphodus ocellatus</i>	Punta Albir	30S	757153	4272566
<i>Symphodus ocellatus</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus ocellatus</i>	Finestrat	30S	747502	4267789
<i>Symphodus ocellatus</i>	Mascarat–Toix	31S	241052	4279618
<i>Symphodus ocellatus</i>	Mitjana Island	30S	755096	4269481
<i>Symphodus ocellatus</i>	Benidorm Island	30S	750353	4265542
<i>Symphodus roissalii</i>	L'Olla Island	30S	759576	4278430

Annex 1. (Cont.)

Species	Locality	Gz	UTM-X	UTM-Y
<i>Symphodus roissalii</i>	Punta Albir	30S	757153	4272566
<i>Symphodus roissalii</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus roissalii</i>	Finestrat	30S	747502	4267789
<i>Symphodus roissalii</i>	Mascarat–Toix	31S	241052	4279618
<i>Symphodus roissalii</i>	Mitjana Island	30S	755096	4269481
<i>Symphodus roissalii</i>	Benidorm Island	30S	750353	4265542
<i>Symphodus tinca</i>	L'Olla Island	30S	759576	4278430
<i>Symphodus tinca</i>	Punta Albir	30S	757153	4272566
<i>Symphodus tinca</i>	Punta Caballo	30S	753025	4267852
<i>Symphodus tinca</i>	Finestrat	30S	747502	4267789
<i>Symphodus tinca</i>	Mascarat–Toix	31S	241052	4279618
<i>Symphodus tinca</i>	Mitjana Island	30S	755096	4269481
<i>Symphodus tinca</i>	Benidorm Island	30S	750353	4265542
<i>Thalassoma pavo</i>	L'Olla Island	30S	759576	4278430
<i>Thalassoma pavo</i>	Punta Albir	30S	757153	4272566
<i>Thalassoma pavo</i>	Punta Caballo	30S	753025	4267852
<i>Thalassoma pavo</i>	Finestrat	30S	747502	4267789
<i>Thalassoma pavo</i>	Mascarat–Toix	31S	241052	4279618
<i>Thalassoma pavo</i>	Mitjana Island	30S	755096	4269481
<i>Thalassoma pavo</i>	Benidorm Island	30S	750353	4265542
<i>Liza aurata</i>	Punta Albir	30S	757153	4272566
<i>Liza aurata</i>	Benidorm Island	30S	750353	4265542
<i>Mugil</i> spp.	Finestrat	30S	747502	4267789
<i>Mullus surmuletus</i>	Punta Albir	30S	757153	4272566
<i>Mullus surmuletus</i>	Punta Caballo	30S	753025	4267852
<i>Mullus surmuletus</i>	Finestrat	30S	747502	4267789
<i>Mullus surmuletus</i>	Mascarat–Toix	31S	241052	4279618
<i>Mullus surmuletus</i>	Mitjana Island	30S	755096	4269481
<i>Mullus surmuletus</i>	Benidorm Island	30S	750353	4265542
<i>Muraena helena</i>	L'Olla Island	30S	759576	4278430
<i>Muraena helena</i>	Punta Caballo	30S	753025	4267852
<i>Muraena helena</i>	Mascarat–Toix	31S	241052	4279618
<i>Muraena helena</i>	Benidorm Island	30S	750353	4265542
<i>Chromis chromis</i>	L'Olla Island	30S	759576	4278430
<i>Chromis chromis</i>	Punta Albir	30S	757153	4272566
<i>Chromis chromis</i>	Punta Caballo	30S	753025	4267852
<i>Chromis chromis</i>	Mascarat–Toix	31S	241052	4279618
<i>Chromis chromis</i>	Mitjana Island	30S	755096	4269481
<i>Chromis chromis</i>	Benidorm Island	30S	750353	4265542
<i>Sciaena umbra</i>	Punta Albir	30S	757153	4272566
<i>Sciaena umbra</i>	Punta Caballo	30S	753025	4267852
<i>Sciaena umbra</i>	Benidorm Island	30S	750353	4265542
<i>Scorpaena porcus</i>	Punta Albir	30S	757153	4272566
<i>Scorpaena porcus</i>	Mitjana Island	30S	755096	4269481
<i>Scorpaena scrofa</i>	Benidorm Island	30S	750353	4265542

Annex 1. (Cont.)

Species	Locality	Gz	UTM-X	UTM-Y
<i>Anthias anthias</i>	Punta Albir	30S	757153	4272566
<i>Anthias anthias</i>	Benidorm Island	30S	750353	4265542
<i>Epinephelus marginatus</i>	Punta Albir	30S	757153	4272566
<i>Epinephelus marginatus</i>	Punta Caballo	30S	753025	4267852
<i>Epinephelus marginatus</i>	Benidorm Island	30S	750353	4265542
<i>Mycteroperca rubra</i>	Benidorm Island	30S	750353	4265542
<i>Serranus cabrilla</i>	Punta Albir	30S	757153	4272566
<i>Serranus cabrilla</i>	Punta Caballo	30S	753025	4267852
<i>Serranus cabrilla</i>	Mascarat–Toix	31S	241052	4279618
<i>Serranus cabrilla</i>	Mitjana Island	30S	755096	4269481
<i>Serranus cabrilla</i>	Benidorm Island	30S	750353	4265542
<i>Serranus scriba</i>	L'Olla Island	30S	759576	4278430
<i>Serranus scriba</i>	Punta Albir	30S	757153	4272566
<i>Serranus scriba</i>	Punta Caballo	30S	753025	4267852
<i>Serranus scriba</i>	Finestrat	30S	747502	4267789
<i>Serranus scriba</i>	Mascarat–Toix	31S	241052	4279618
<i>Serranus scriba</i>	Mitjana Island	30S	755096	4269481
<i>Serranus scriba</i>	Benidorm Island	30S	750353	4265542
<i>Boops boops</i>	Punta Caballo	30S	753025	4267852
<i>Dentex dentex</i>	L'Olla Island	30S	759576	4278430
<i>Dentex dentex</i>	Punta Albir	30S	757153	4272566
<i>Dentex dentex</i>	Punta Caballo	30S	753025	4267852
<i>Dentex dentex</i>	Mascarat–Toix	31S	241052	4279618
<i>Dentex dentex</i>	Benidorm Island	30S	750353	4265542
<i>Diplodus annularis</i>	L'Olla Island	30S	759576	4278430
<i>Diplodus annularis</i>	Punta Albir	30S	757153	4272566
<i>Diplodus annularis</i>	Punta Caballo	30S	753025	4267852
<i>Diplodus annularis</i>	Mascarat–Toix	31S	241052	4279618
<i>Diplodus annularis</i>	Mitjana Island	30S	755096	4269481
<i>Diplodus annularis</i>	Benidorm Island	30S	750353	4265542
<i>Diplodus cervinus</i>	L'Olla Island	30S	759576	4278430
<i>Diplodus cervinus</i>	Punta Albir	30S	757153	4272566
<i>Diplodus cervinus</i>	Punta Caballo	30S	753025	4267852
<i>Diplodus cervinus</i>	Finestrat	30S	747502	4267789
<i>Diplodus cervinus</i>	Mascarat–Toix	31S	241052	4279618
<i>Diplodus cervinus</i>	Mitjana Island	30S	755096	4269481
<i>Diplodus cervinus</i>	Benidorm Island	30S	750353	4265542
<i>Diplodus puntazzo</i>	Punta Albir	30S	757153	4272566
<i>Diplodus puntazzo</i>	Punta Caballo	30S	753025	4267852
<i>Diplodus puntazzo</i>	Mascarat–Toix	31S	241052	4279618
<i>Diplodus puntazzo</i>	Mitjana Island	30S	755096	4269481
<i>Diplodus puntazzo</i>	Benidorm Island	30S	750353	4265542
<i>Diplodus sargus</i>	L'Olla Island	30S	759576	4278430
<i>Diplodus sargus</i>	Punta Albir	30S	757153	4272566
<i>Diplodus sargus</i>	Punta Caballo	30S	753025	4267852

Annex 1. (Cont.)

Species	Locality	Gz	UTM-X	UTM-Y
<i>Diplodus sargus</i>	Finestrat	30S	747502	4267789
<i>Diplodus sargus</i>	Mascarat–Toix	31S	241052	4279618
<i>Diplodus sargus</i>	Mitjana Island	30S	755096	4269481
<i>Diplodus sargus</i>	Benidorm Island	30S	750353	4265542
<i>Diplodus vulgaris</i>	L'Olla Island	30S	759576	4278430
<i>Diplodus vulgaris</i>	Punta Albir	30S	757153	4272566
<i>Diplodus vulgaris</i>	Punta Caballo	30S	753025	4267852
<i>Diplodus vulgaris</i>	Finestrat	30S	747502	4267789
<i>Diplodus vulgaris</i>	Mascarat–Toix	31S	241052	4279618
<i>Diplodus vulgaris</i>	Mitjana Island	30S	755096	4269481
<i>Diplodus vulgaris</i>	Benidorm Island	30S	750353	4265542
<i>Lithognathus mormyrus</i>	Mitjana Island	30S	755096	4269481
<i>Oblada melanura</i>	L'Olla Island	30S	759576	4278430
<i>Oblada melanura</i>	Punta Albir	30S	757153	4272566
<i>Oblada melanura</i>	Punta Caballo	30S	753025	4267852
<i>Oblada melanura</i>	Finestrat	30S	747502	4267789
<i>Oblada melanura</i>	Mascarat–Toix	31S	241052	4279618
<i>Oblada melanura</i>	Mitjana Island	30S	755096	4269481
<i>Oblada melanura</i>	Benidorm Island	30S	750353	4265542
<i>Pagellus erythrinus</i>	Punta Albir	30S	757153	4272566
<i>Pagrus auriga</i>	Mascarat–Toix	31S	241052	4279618
<i>Pagrus pagrus</i>	Mascarat–Toix	31S	241052	4279618
<i>Pagrus pagrus</i>	Benidorm Island	30S	750353	4265542
<i>Sparus aurata</i>	Punta Albir	30S	757153	4272566
<i>Sparus aurata</i>	Punta Caballo	30S	753025	4267852
<i>Sparus aurata</i>	Mascarat–Toix	31S	241052	4279618
<i>Sparus aurata</i>	Mitjana Island	30S	755096	4269481
<i>Sparus aurata</i>	Benidorm Island	30S	750353	4265542
<i>Spondyliosoma cantharus</i>	Punta Albir	30S	757153	4272566
<i>Spondyliosoma cantharus</i>	Punta Caballo	30S	753025	4267852
<i>Spondyliosoma cantharus</i>	Finestrat	30S	747502	4267789
<i>Spondyliosoma cantharus</i>	Mascarat–Toix	31S	241052	4279618
<i>Spondyliosoma cantharus</i>	Mitjana Island	30S	755096	4269481
<i>Spondyliosoma cantharus</i>	Benidorm Island	30S	750353	4265542
<i>Sarpa salpa</i>	L'Olla Island	30S	759576	4278430
<i>Sarpa salpa</i>	Punta Albir	30S	757153	4272566
<i>Sarpa salpa</i>	Punta Caballo	30S	753025	4267852
<i>Sarpa salpa</i>	Finestrat	30S	747502	4267789
<i>Sarpa salpa</i>	Mascarat–Toix	31S	241052	4279618
<i>Sarpa salpa</i>	Mitjana Island	30S	755096	4269481
<i>Sarpa salpa</i>	Benidorm Island	30S	750353	4265542
<i>Sphyaena sphyraena</i>	Finestrat	30S	747502	4267789
<i>Sphyaena sphyraena</i>	Mitjana Island	30S	755096	4269481
<i>Sphyaena sphyraena</i>	Benidorm Island	30S	750353	4265542