

Observations on the spawning behaviour of the dusky grouper *Epinephelus marginatus* (Lowe, 1834) in the North of Corsica (France)

*Observations du comportement reproducteur du mérrou brun Epinephelus marginatus
(Lowe, 1834) dans le nord de la Corse (France)*

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Mots clés : *Epinephelus marginatus*, mer Méditerranée, comportement, reproduction, ponte.

ABSTRACT

Pelaprat C., 1999 - Observations on the spawning behaviour of the dusky grouper *Epinephelus marginatus* (Lowe, 1834) in the North of Corsica (France). Mar. Life, 9 (1) : 59-65.

Both our observations and the observations of sport-divers have shown, in the last ten years, an increase in grouper density at the Punta Revellata site near the fishing reserve of Calvi, especially for small individuals (5-30 cm long). From late June to late August 1997 and 1998, gatherings of about 20 individuals were observed there, even though the site is frequently visited by scuba divers and spear-fishermen. The individuals were gathered between 8 and 30 m of depth over an area of about 400 m². Among these individuals, 12 individuals have been clearly identified by morphological characteristics. Swimming activity, site occupation and socio-behavioural trends have been monitored by visual census surveys. Only one dominant male has been observed at the site, identified by the silver streaked colour pattern characteristic of reproductive activity. Courtship activities have been observed from 08:00 to 09:30 and from 18:00 to 21:00. Despite the changes in the groupers' behaviour due to human presence, spawning events have been observed at sunset, on 02/08/98 and 04/08/98, for the first time in Northern Corsica and outside a marine protected area.

RÉSUMÉ

Pelaprat C., 1999 - [Observations du comportement reproducteur du mérrou brun *Epinephelus marginatus* (Lowe, 1834) dans le nord de la Corse (France)]. Mar. Life, 9 (1) : 59-65.

Les observations des nombreux plongeurs cumulées aux nôtres, ont montré depuis dix ans sur le site de la Punta Revellata à proximité du cantonnement de pêche de Calvi, une augmentation de la densité de mérours, principalement des petits individus (5-30 cm). Au cours des années 1997 et 1998, de fin juin à fin août, des rassemblements d'environ 20 individus ont été observés sur ce site très fréquenté par les plongeurs et chasseurs sous-marins. Les individus étaient rassemblés entre 8 et 30 mètres de profondeur sur une surface d'environ 400 m². Douze des plus grands individus ont été identifiés par des caractéristiques morphologiques. Leurs comportements sociaux, les trajets, l'occupation des sites ont été surveillés et répertoriés en plongée sous-marine. Un seul mâle a été observé sur le site, repéré principalement par sa livrée argentée, caractéristique d'une activité reproductrice. Des parades nuptiales ont été observées de 8h à 9h30 et de 18h à 21h. Malgré les changements comportementaux induits par la présence humaine, pour la première fois dans le nord de la Corse et en dehors d'une zone protégée, deux pontes ont été observées au coucher du soleil le 02 et le 04/08/98.

INTRODUCTION

The dusky grouper *Epinephelus marginatus* (Lowe, 1834) is certainly for spear-fishermen and scuba divers the most popular of littoral fishes along Mediterranean coasts. After a severe reduction of

NW Mediterranean stocks in the past decades, marine protected areas are now the only places where grouper can be seen in relatively high densities (Gracia, 1996; Zabala *et al.*, 1997a, 1997b). For several authors (Harmelin, Robert, 1992; GEM, 1993) intensive spear-fishing is one of the most important causes

of this decline in grouper density. Today *E. marginatus* is protected, and the spear-fishing of this species is banned throughout French coastal waters.

Reproduction of *E. marginatus* was thought to occur only south of 41.5° north (Chauvet, Francour, 1989), but recent sightings of young grouper (less than 10 cm long) and the observations of reproductive behaviour along the Northern Mediterranean coasts in Spain and France over the last five years (Harmelin, Robert, 1992; Lelong, 1993; Zabala *et al.*, 1997a, 1997b; Francour, Ganteaume, 1999), raise the possibility that reproduction now occurs on these coasts. This hypothesis was confirmed by direct observations of actual spawning in the Medes Island Marine Reserve (Zabala *et al.*, 1997a).

At Punta Revellata, in Northern Corsica, both our observations and those of other divers show a regular increase of the dusky grouper population over the last five to ten years, especially of small individuals (about 10-30 cm TL). This study concerns the group of dusky grouper which has gathered at the Punta Revellata site during the reproduction period since 1997.

MATERIAL AND METHODS

Observations were carried out at the site known as Punta Revellata near the fishing reserve of Calvi in Corsica which is well known for the large numbers of fishes. The grouper have been observed in an area of about 400 m², between 8 and 30 m of depth. The bottom topography is characterised by a mix of boulders and several narrow valleys between steep rocky slopes. The shallow waters reach the highest temperature in August (up to 25°C), and the lowest in February-March (down to 12.5°C). This site is frequently visited by scuba divers and spear-fishermen, especially during the tourist season (150 to 200 divers per day). All individuals of the dusky grouper assemblage observed showed signs of fear, especially the larger individuals. Nevertheless a solitary diver can with care approach some of them to within 5 m.

A group of about twenty individuals has been observed gathering in the same area in 1997 and 1998 during the reproduction period. Focal observations on the behaviour of single individuals were made from late June to late August 1998. Swimming activity, site occupation and socio-behavioural trends were monitored by visual census surveys. At each dive the observer always followed the same itinerary, visiting each identified home range. For each grouper encountered, size, site, depth and colour pattern were noted. The sizes observed were between 20 and 85 cm, which were then divided into height classes (<20; 21-30; 31-40; 41-50; 50-60; 60-70; 70-80; 80-90). To identify the main colour patterns of *E. marginatus* during the reproductive activities, we have used the same code as that described by Louisy (1996) with eight different types. The depth was taken by a dive computer.

Each dive was made by only one observer. From late May to late October nineteen dives were made between 08:00 and 09:00 in the morning, nine between 20:00 and 21:00 in order to avoid the presence of other divers and in order to observe natural grouper behaviour. Three dives were carried out between 15:00 and 16:00 in the presence of many other divers at the site in order to verify changes in grouper behaviour patterns.

RESULTS

Spawning aggregation of the dusky grouper

From late May to late August 1998, about 20 individuals were observed at the Punta Revellata site (figure 1), within an area of about 400 m². The group observed was characterised (figure 2) by the lack of old individuals (specimens smaller than 40 cm represented 45% of the group) and the presence of only one dominant male (80-90 cm) identified by morphological characteristics and the silver streaked colour pattern, CP 6 (Zabala *et al.*, 1997b).

Individuals observed were distributed at 9 different sites between 8 and 30 m depth (table I). The

Table I - Proportions (%) of each size class of dusky grouper for the different Colour Patterns observed during the observation period. According to the CP described by Louisy (1996). / Proportions (%) de chaque classes de taille de mérrou brun pour les différentes livrées (CP) observées durant la période d'étude. Livrées décrites par Louisy (1996).

Colour patterns		Size classes (cm)					
		20 - 30	30 - 40	40 - 50	50 - 60	60 70	80 - 90
Standard mottled	(CP 1)	21.7	15.9	23.2	24.6	14.5	-
Dark with three blotches	(CP 2)	-	-	33.3	46.7	20.0	-
Uniformly dark	(CP 3)	-	-	-	-	100.0	-
Light	(CP 4)	-	-	55.5	25.9	18.5	-
Dark streaked light	(CP 5)	-	-	54.6	27.3	18.2	-
Silver streaked	(CP 6)	-	-	-	-	-	100.0
Basic male	(CP 7)	-	-	-	-	-	100.0
Light male	(CP 8)	-	-	-	-	-	100.0
Rounded abdomen		-	-	-	50.0	50.0	-

Table II - Percentage of site occupation for the twelve grouper identified by their morphological characteristics during the period of this study (from May to October 1998). / Pourcentage d'occupation des sites durant la période d'étude (de mai à octobre 1998) pour chacun des 12 individus identifiés par des caractéristiques morphologiques.

Individuals size classes	A	B	C	D	E	F	G	H	I	J	K	L
	30-40	30-40	40-50	40-50	50-60	50-60	50-60	60-70	60-70	60-70	60-70	80-90
Depth	Site											
8-10 m	1			20		10	36	50				18.6
10-15 m	2	33	44.5	40			9				33	9
10-15 m	3		11		60	40	36		50	50		16.2
15-20 m	4				50		9					2.3
20-25 m	5	17	44.5	20	20			50			22.3	11.6
20-25 m	6					20	20	9				16.2
20-25 m	7					20	20		50	50		18.6
20-25 m	8	50		40	10						22.3	2.3
25-30 m	9						10				22.3	4.7

biggest gathering of grouper was observed during the beginning of July (figure 1), with a maximum of 9 individuals at only one site (about 25 m², 5 of which were larger than 40 cm). From May to July the number of grouper larger than 40 cm observed during each dive increased gradually before it decreased in August (figure 3). During some dives carried out in November we observed no courtship behaviour, since the male had disappeared; only tree individuals of size classes 30-40 cm were observed.

The small individuals (< 40 cm long) were always observed with the CP 1 colour pattern. This

colour pattern and the colour pattern with three blotches (CP 2) were observed for all individuals larger than 40 cm. CP 5, the dark streaked light colour pattern, was mainly observed (from the 25/06/98), in the size class 40-50 cm. Typical of these individuals was the fact that they remained solitarily 50 cm above the bottom. We were unable to link this solitary behaviour to this particular colour pattern. CP 4 appeared the first time on the 16/05/98 and as for CP 5, was observed only for individuals larger than 40 cm. All these observations are summarised in the table II.

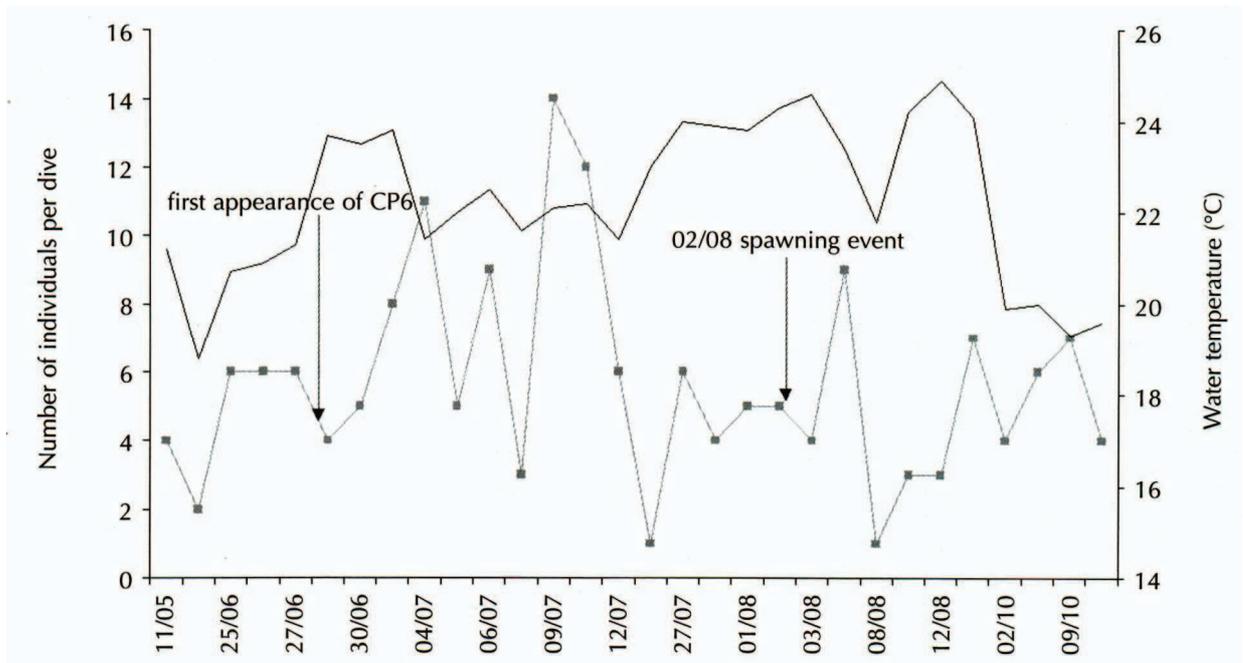


Figure 1 - Number of individuals (■) observed for each dive - water temperature (°C) noted at each dive (-3 m of depth, from May to October 1998). / Nombre d'individus (■) observés à chaque plongée - Température de l'eau relevée à chaque plongée (à -3 m de profondeur, de mai à octobre 1998).

Courtship behaviour

The male (80-90 cm) which appeared at the beginning of June took the bright silver colour pattern (CP 6), characteristic of the reproductive activity, only at the end of the month (figure 1). From the 29 June to the beginning of October, the male exhibited intense courting activity. Females were dispersed at different sites, each of them within their home range (except when a diver or the male came to disturb it). The male visited all sites in order to try to find a

receptive female. This difference in frequency of visits between the male and the females appear clearly in the table II; whereas the female visited three or four sites during the entire period of this study, the male was observed at all sites during the reproductive period. When the male found a receptive female, it placed itself above its mate, approaching it from behind. Then flapping its tail, it tilted sideways to an almost horizontal position. After that the male pursued the receptive female across differ-

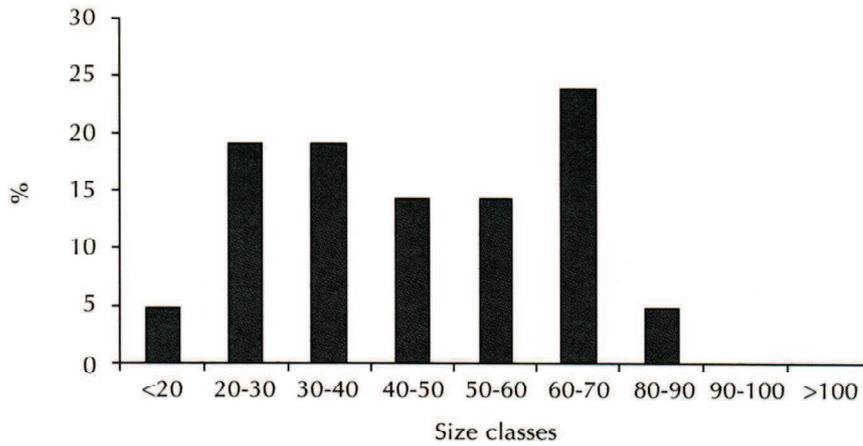


Figure 2 - Demographic structure of the grouper assemblage observed at the Punta Revellata site during the entire period of this study (from May to October 1998). / Structure démographique de la population de mérous observée sur le site de la Punta Revellata pour toute la période d'étude (de mai à octobre 1998).

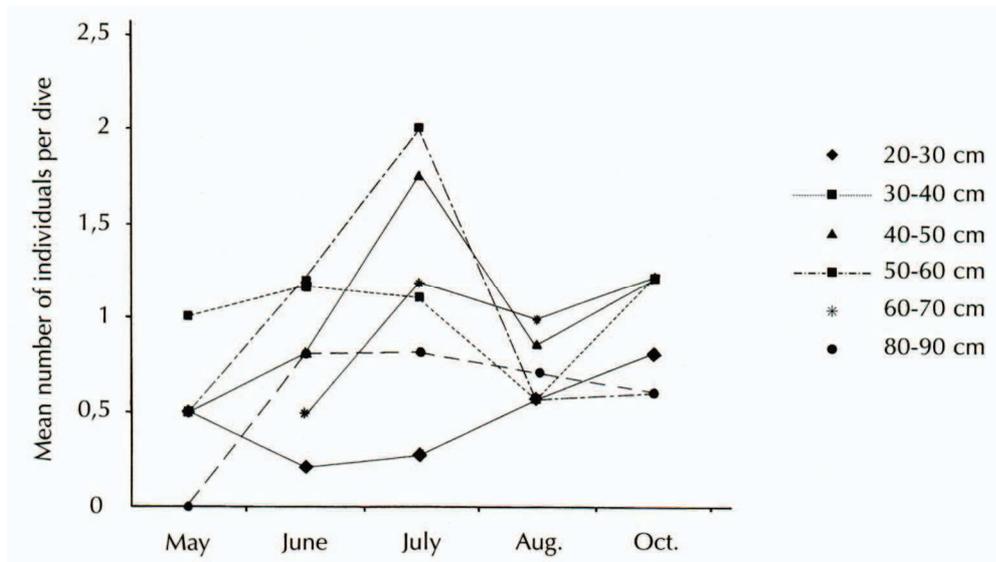


Figure 3 - Progression patterns of dusky grouper numbers observed per dive for each size class from May to October 1998. / Évolution du nombre de mérous observés par plongée pour chaque classe de taille de mai à octobre 1998.

rent sites until it found another female and then started again (the females involved are always larger than 40-50 cm). During this behaviour the male kept the bright silver CP 6 (Zabala *et al.*, 1997b) while the female shows CP 1 or 2. This behaviour, already observed in July and August 1997, was only observed after 18:00 and in the morning until 09:00.

Occurrence of spawning

Among the fishes observed, only 12 individuals were identified by their individual morphological characteristics, which made it possible to study them.

From 31/07/98 the male remained within a smaller area (Site 7) than before at a depth of 25-27 m and seemed to be less active during daytime. But on 02/08/98 and 04/08/98 a spawning event was observed at sunset (21:00) within this small area (concerning only two individuals; thermocline deeper than 30 m). During the entire spawning there were no changes of the colour pattern, the male kept the bright silver CP 6 and the female the standard CP 1.

We observed the male turning around a female of 50-60 cm (female E on 02/08 and F on 04/08, table I), performing rapid small gyres (5-7 m of diameter, counterclockwise). After two circles the male approached the female with the usual caudal flapping. They described two circles together and ascended in parallel, belly to belly, to 6-7 m above the bottom. After this ascent both individuals stayed there, side by side for 30 seconds above the bottom, then separated and came back to the bottom. They resumed this procedure three times, each time remaining longer at the top of the ascent. Actual spawning occurs after these three false rises. Both the individuals ascent once more, but this time with a frenetic acceleration to about 10 m above the bottom. At the top of the ascent there was an immediate separation of the pair, each mate returning to the bottom. At the top of this last ascent, the gamete release was not observed, but was confirmed by the rapid arrival of some *Oblada melanura* at the top of the ascent. This predatory behaviour of saddled breams on eggs just after their release has already been observed in the Medes island (Zabala *et al.*, 1997a).

It is important to note that during this period of actual spawning the water temperature was at its maximum (figure 1).

Human influence on reproductive behaviour

Scuba divers and spear-fishermen frequently visit the Punta Revellata site from the beginning of July to the end of August. Until the end of June, 80% of the individuals observed were spread over sites between 8 and 15 m depth (figure 4) and were relatively easy to observe. But during the tourist season (July-August), individuals went deeper (20-30 m), and only 47% of individuals were observed between 8 and 15 m depth. At 09:00 corresponding to the divers' arrival, the male grouper stopped all reproductive behaviours and some individuals were observed taking refuge within the reserve.

Another change of behaviour observed was the stopping during the spawning event of any activity of the female in order to observe the diver, when he was not discreet enough.

DISCUSSION

Observations of courtship behaviour as well as the increase of dusky grouper density, especially for individuals of 1 or 2 years old (5-10 cm long), are more and more frequent in various marine-reserves of the North-Western Mediterranean sea (Chauvet, Francour, 1989; Chauvet, 1991; Harmelin, Robert, 1992; GEM, 1993; Lelong, 1993; Garcia Rubies, Zabala, 1994; Louisy, 1996; Zabala *et al.*, 1997b; Francour, Ganteaume, 1999). Even though we lack precise data at the Punta Reveliata site, it is obvious that grouper density has also increased over the last five years (divers and personal observations). This increase of the dusky grouper density in the Northern Mediterranean sea is probably due to three phenomena: the protection of the dusky grouper by the creation of several marine reserves, the ban on spear-fishing on French coasts for the past few years and finally the increase of the water temperature in recent years (Lelong, 1993).

But all these observations do not in themselves prove that actual reproduction occurs in these areas, because the juveniles observed at these sites could have arrived after larval transportation and because courtship behaviour could be observed without actual spawning (false rises). The few direct proofs of reproductive activity on the Northern Mediterranean coasts are spawning observations in which gametes were clearly observed in the Medes Island Marine Reserve (Zabala *et al.*, 1997a). This paper provides a

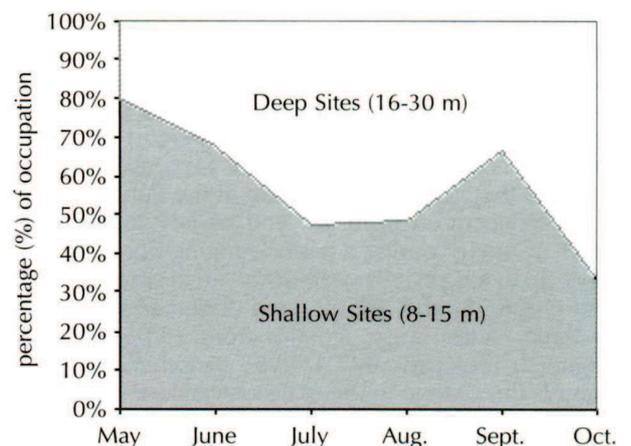


Figure 4 - Percentage of deep and shallow site occupation by all individuals observed during the entire study period (from May to October 1998). / Pourcentage d'occupation des sites profonds et superficiels par l'ensemble des individus observés durant toute la période d'étude (de mai à octobre 1998).

supplementary proof. Furthermore the observations were made for the first time outside a protected area.

The most important parameter to explain the grouper gatherings on the Punta Revellata, is certainly the cape effect observed at this site (confirmed by a large quantity of fishes). Grouper probably find at this site a quantity of food and a topography which suit them. The topography of the Punta Revellata site seems to be similar to those observed for the grouper gatherings within the Cerbère-Banyuls and Medes Island marine reserves (Zabala *et al.*, 1997b). But in contrast to these protected areas, human presence has led to deeper distribution of the home range of grouper. Moreover the Punta Revellata site is situated near the fishing reserve of Calvi, and the possibility of taking refuge within the reserve to escape divers and spear-fishermen is probably an additional explanation for the grouper gatherings at this site.

As for tropical grouper species, the reproduction of the dusky grouper *E. marginatus* occurs inside polygynic systems (Zabala *et al.*, 1997a, 1997b). If reproduction behaviour was not previously observed at Punta Revellata site, despite grouper gatherings, it was certainly because individuals were much too young for sexual reversion. So in agreement with various authors (Gracia, 1996), this study confirms that in natural conditions, sexual reversion is not possible before fishes reach the size of 80-90 cm long corresponding to individuals 14-17 years old (Bruslé, Bruslé, 1976; Bruslé, 1985; Chauvet, 1991; Gracia, 1996).

As for the other studies on the reproduction of the dusky grouper (GEM, 1993; Louisy, 1996; Zabala *et al.*, 1997a, 1997b), the reproduction period is characterised intensive courtship activity of the male during several month. This period (from June to late October in 1997 and 1998), seems to be the same in the majority of studies (Zabala *et al.*, 1997a; Hereu, personal communication).

Nobody has really any idea of the exact duration of the period of actual spawning in the Northern Mediterranean sea. Nevertheless, certain observations within the Medes Island Marine reserve suggest that spawning occurs at sunset during a period of about 10 days at the beginning of August (Zabala, personal communication). Several facts allow us to suppose that actual reproduction at the Punta Revellata site occurred from the end of July to the first week of August during a period ranging from 7 to 15 days. Spawning events were observed at sunset on 02 and 04/08/98, and the rounded abdomen observed in three of the larger females from 25/06/98, had begun to disappear by 01/08/98. Another essential point is the change in the male's behaviour observed from the end of July to the first week of August. It remains within its home range and it decreases its activity during the daytime. Even though the spawning period seems to occur between July and August, as all observations mentioned for the Northern Mediterranean sea are of a sporadic nature (Louisy, Culioli, 1999), it is not possible to define the precise duration of the spawning period. In addition, other

authors have mentioned longer periods in the Southern Mediterranean sea (Barnabé, 1974; Bouain, 1980; Bruslé, 1985; Chauvet, 1988).

Certain authors thought that, as for some tropical grouper (Colin *et al.*, 1987; Shapiro *et al.*, 1993), the reproduction period was related to the lunar cycle. However, our observations as well as those made on the grouper assemblages of the South of Corsica (Culioli, personal communication) or of the Medes Island marine reserve (Zabala, personal communication) for the years 1997 and 1998 show no relation between these two parameters.

Certain authors (Zabala *et al.*, 1997b) have also observed a particular pattern of distribution of individuals in relation to the thermocline. Since high temperatures favour the maturation of the gonads (Gracia, 1996), females could prefer to stay at the top of the thermocline, while the males could be less sensitive to this parameter and establish their territory deeper. Before the tourist season females at Punta Revellata were also observed at the top of the thermocline with a home range ranging from 8 to 15 m depth. But as we have seen in this study, human presence has led at the Punta Revellata site to a change in individual behaviour, which certainly explains the absence of a direct relation between the distribution of individuals and the thermocline.

This study allows us to confirm the effectiveness of the protection measures for dusky grouper on the French Mediterranean coasts. Reproduction and an increase in dusky grouper density may be observed not only within marine reserves, but also outside protected areas.

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