Littoral Fisheries Resources

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Abstract

We analysed the potential impact of the Sant Esteve storm on coastal fish populations by studying the artisanal daily catch statistics, from January 2008 to October 2009, of the fleet of Palamós, Costa Brava. Results showed that the abundance of most of the species accessible to artisanal nets and bottom long-lines was not altered by the storm. However, the catch rate patterns of a significant number of species (up to 18) changed substantially. Most species showed an increase in catch rates. This phenomenon might be due to an increase in the spatial aggregation of the species, which increased their fishing availability. If this proved true, the observed changes would be suggestive of an increase in species vulnerability and, therefore of a negative effect on the populations in the medium term. These results cannot be considered completely reliable because only a short time period could be analysed, and thus extrapolations from this report should be made with caution.

Image: *Palinurus elephas*, Columbretes, Spanish Western Mediterranean, by D. Díaz

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Impacts of 26th December 2008 storm on littoral fisheries resources

By

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Resumen

El impacto potencial de la tormenta de Sant Esteve sobre las poblaciones de peces litorales fue analizada mediante el estudio de las estadísticas diarias de capturas de la flota artesanal de Palamós, Costa Brava. El estudio se realizó con resolución mensual con datos entre Enero de 2008 y Octubre de 2009. Los resultados mostraron que la mayoría de especies accesibles a redes artesanales y palangres no fueron alteradas por la tormenta. No obstante, un número significativo de especies (hasta 18), sufrieron cambios sustanciales. La mayoría de especies experimentaron un aumento en las tasas de captura. Creemos que puede ser debido a un aumento en su accesibilidad debido a un aumento en la agregación espacial. De ser cierto, los cambios observados sugerirían un incremento en la vulnerabilidad de las especies con efectos negativos. Los resultados presentados en este estudio se deben considerar con prudencia ya que el periodo de estudio analizado es corto para aplicar ningún tipo de proyección.

Abstract

We analysed the potential impact of the Sant Esteve storm on coastal fish populations by studying the artisanal daily catch statistics, from January 2008 to October 2009, of the fleet of Palamós, Costa Brava. The temporal analysis was performed on a monthly basis. Results showed that the abundance of most of the species accessible to artisanal nets and bottom long-lines was not altered by the storm. However, the catch rate patterns of a significant number of species (up to 18) changed substantially. Most species showed an increase in catch rates. This phenomenon might be due to an increase in the spatial aggregation of the species, which increased their fishing availability. If this proved true, the observed changes would be suggestive of an increase in species vulnerability and, therefore of a negative effect on the populations. The results presented here should be taken with caution because the analysed period is short and they should not be used for any further projection.

Introduction

Although artisanal fisheries still represent a strong socio-cultural sector along the Mediterranean shoreline, there has been little research into their activity. The fleets are generally composed of a large number of boats, mostly of low tonnage, based in many different ports (Colloca et al., 2004). Although the size of the artisanal fleet has decreased by around 30% in Catalonia since 2006, this fleet is still

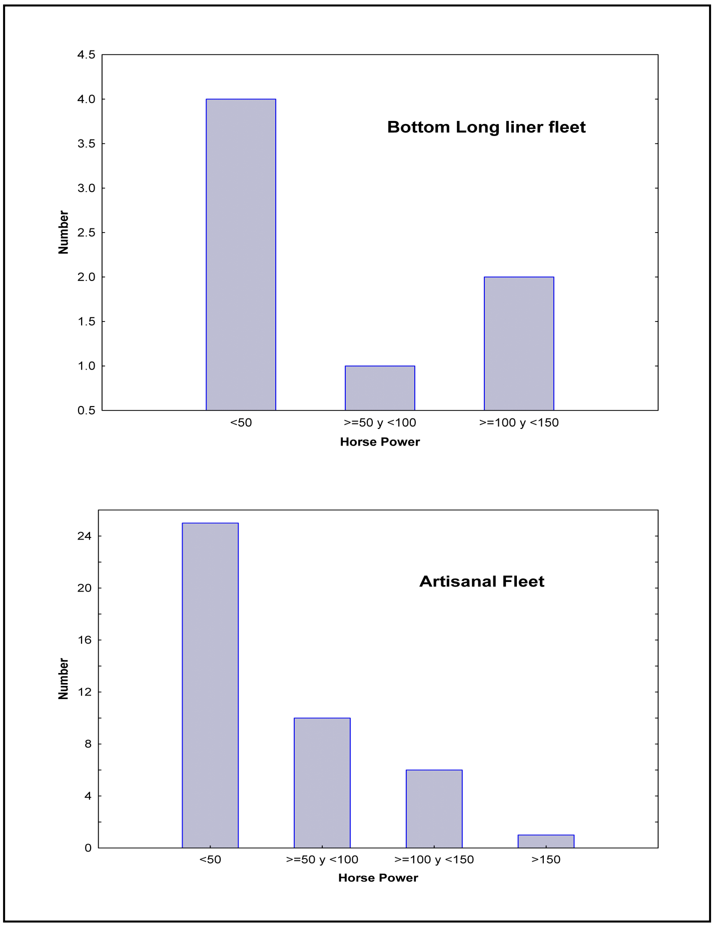

Figure 1. Characterization of the power of the artisanal fishery fleet of the port of Palamós.

significantly large and has around 550 vessels. Artisanal fishing is often associated with the notion of "coastal fishing" and consequently the catch is influenced by changes or disruptions in coastal fish populations. Based on this, we analysed the potential impact of the Sant Esteve storm on coastal fish populations by studying the artisanal daily catch statistics of the fleet moored in Palamós fishing port, a major fishing port on the Costa Brava.

The potential economic impact of the storm on the fishing fleet and the impact on the fishery resources were evaluated from the daily catch per boat reported in the port of Palamós.

The analysis focused on assessing the possible effects of the storm on coastal fishery resources by analysing fluctuations in the catch rate from January 2008 to October 2009. The aim of the study was to observe if there were any abnormal temporal patterns that could be related to the impact of the storm. In this study we analysed the total catch of 49 vessels (42 operating mainly with nets and 7 with bottom long-lines). A total of 5681 daily catch reports were analysed.

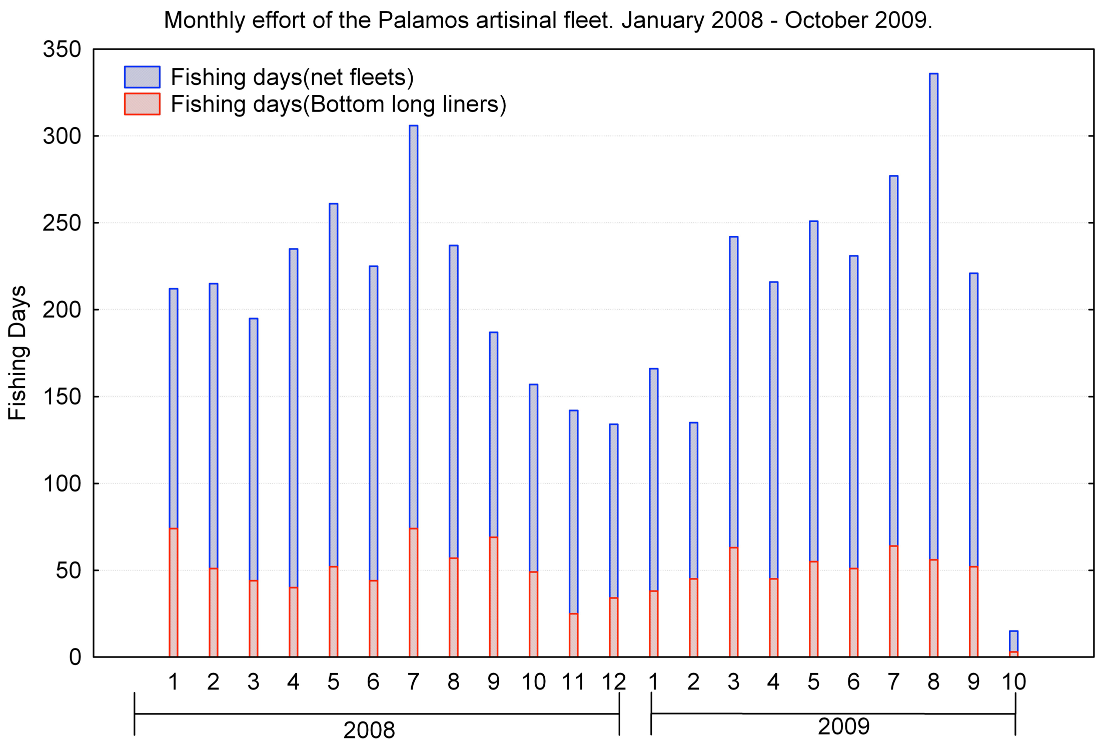

Figure 2. Monthly fishing days of the artisanal fleet of Palamós during the period studied.

Materials and Methods

Characterization of the fishing fleet and activity

The artisanal fleet is characterised by low power vessels, from a minimum of 8 horse power (HP) to a maximum of 204 HP (Figure 1); 50% of the boats do not exceed 50 HP. In 2008 the artisanal fishery caught up to 135 t with sales to a value of 936 086 €, while the bottom long-line catch was around 39 t and made 266 966€. Although fishing is carried out continuously throughout the year (Figure 2) there is some seasonal variability, in particular there is a decrease in activity from October to February.

The temporal analysis was performed on a monthly basis. The catch rate at species level was analysed for the whole fleet. It is accepted that the catch rate or catch per unit effort (CPUE) is proportional to resource abundance (fishing mortality induced by each unit of fishing effort) (e.g. Hilborn and Walters 1992). Catch rate patterns in monthly units are not related to changes in abundance but may be indicative of changes in the local density or spatial distribution of the resources. Thus, monthly catch rate patterns are indicative of monthly patterns in catchability and the fishing mortality induced by the fleet.

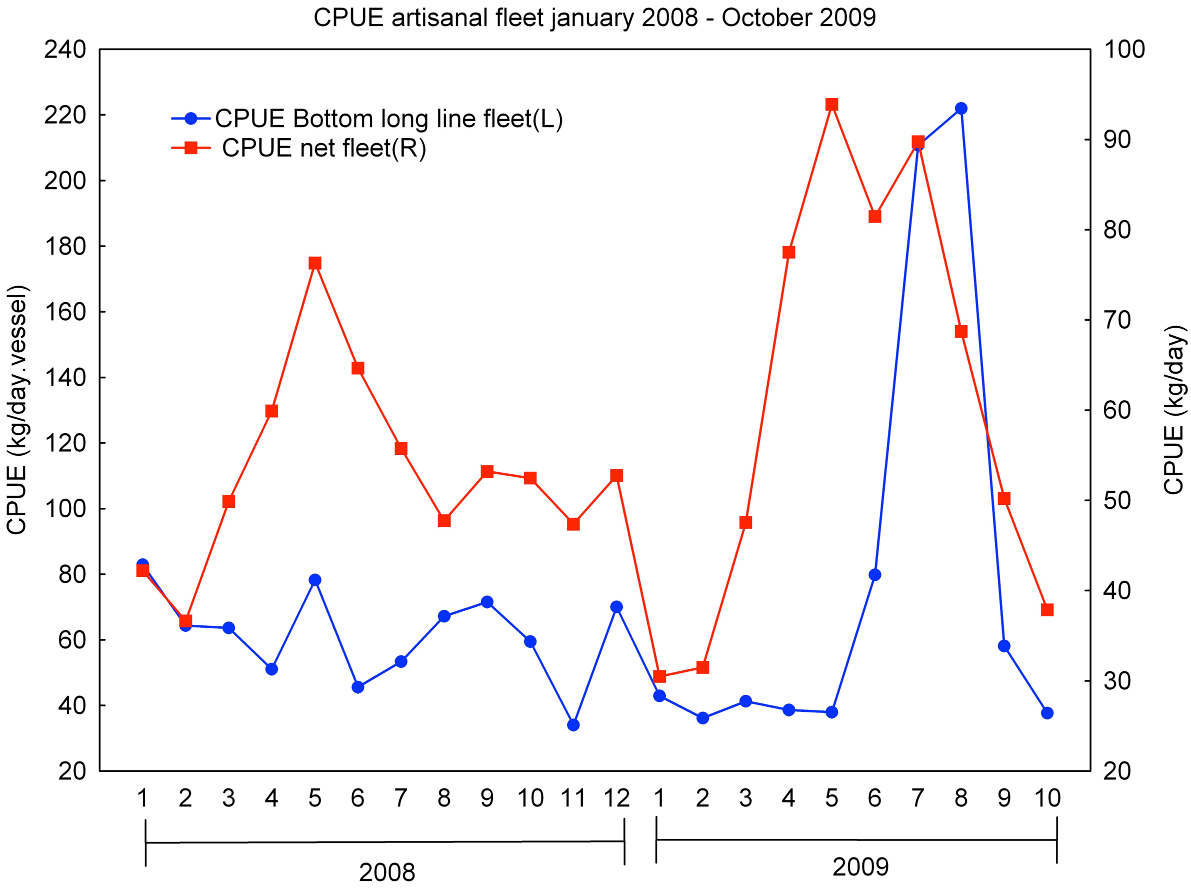

Figure 3. Evolution of catch per unit effort of the artisanal fleet of Palamós during the period studied in this work. The interpretation of total yield is complex and requires a detailed analysis of the temporal evolution of each specific catches.

At species level the monthly catch rate (∑kg/∑fishing days) was analysed jointly with the catch frequency analyses (number of days caught/number of fishing days). The two variables can provide complementary information on changes in the spatial distribution of fish resources. Frequency fluctuations are usually proportional to fluctuations in the local abundance, estimated according to daily catch rates. Therefore, an increase in CPUE normally implies an increase in the catch frequency. However, this pattern can be altered by changes in the spatial aggregation or dispersion of a species. Thus, if one species aggregates, the frequency of occurrence will diminish even though catch rates can be enhanced due to an increase in local density. As a consequence, the vulnerability of the species increases. If spatial dispersion occurs, the CPUE can decrease though the frequency may increase.

Results and discussion

Fishing activity is continuous all year round (Figure 2), although it shows some seasonality and is at its lowest between October and February.

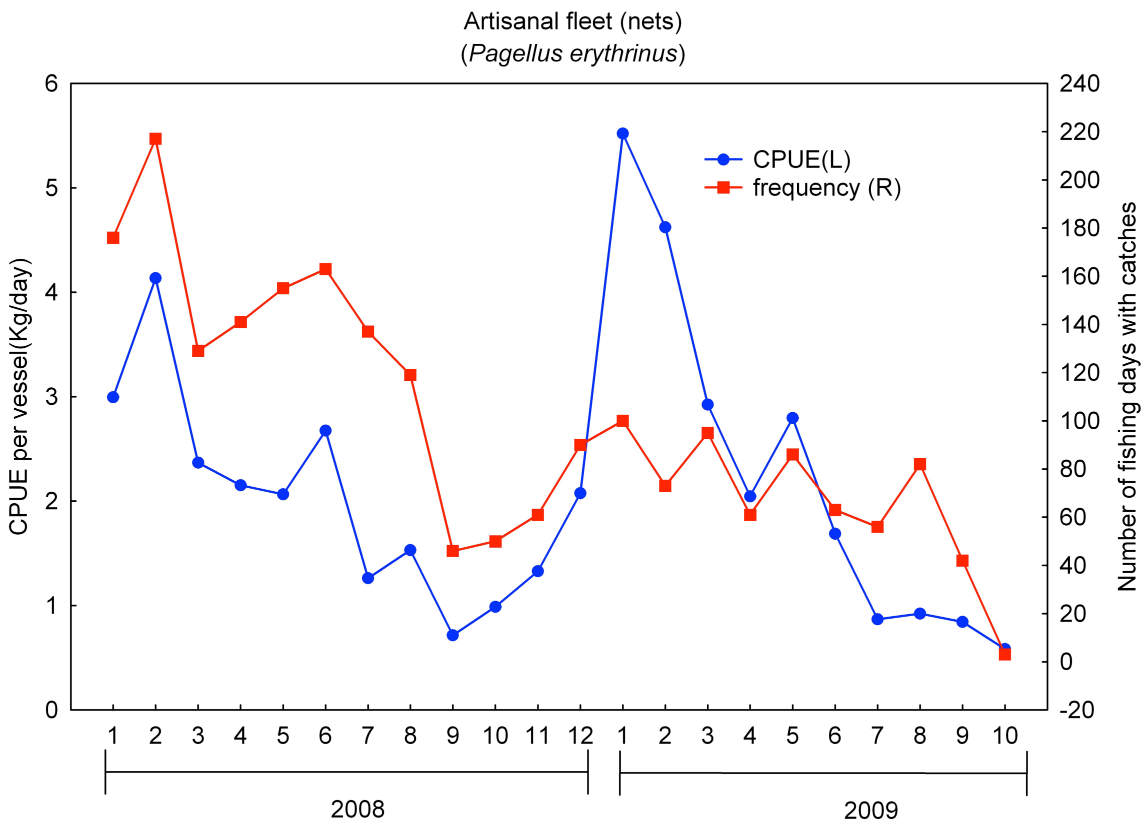

Figure 4. Monthly CPUE and frequency for *Pagellus erythrinus* catch of Palamós artisanal fleet.

The analysis of individual vessel activity demonstrated high variability in the reported fishing days per year. Annual fishing days per vessel varies from a minimum of just 1 fishing day per year to a maximum of 175 days. It is worth highlighting the large variability in the fishing days and the low activity recorded for most of the fleet. In fact, 17 boats reported less than 30 fishing days per year. The average number of officially declared fishing days was around 60 days per year for the boats operating with nets, and 87 days for those working with bottom long-lines. In addition, annual sales did not exceed €10 000 per boat and year in 26 out of the total 47 boats registered at the port. The low activity, together with the small profits, could mean that fishing only represents a small fraction of the professional activity of the fishermen or that the catches were not sold in an official way, reaching the final consumer through uncontrolled channels.

Temporal evolution of fishery resources

The monthly CPUE pattern of the artisanal fishery showed clear seasonality (Figure 3), with a peak around May and a minimum from January to February. Inter-annual differences were observed in: a) a larger period of maximum yield; b) the highest yield obtained in 2009; and c) the minimum values were observed at

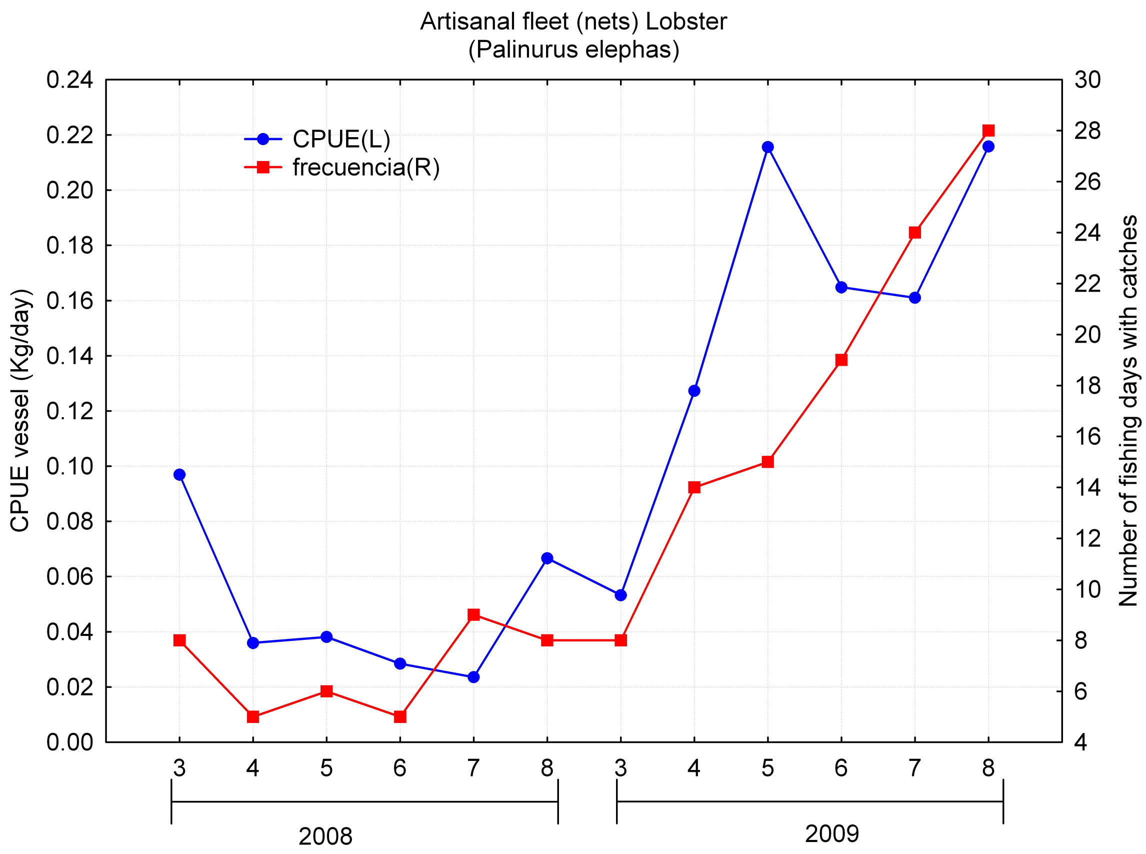

Figure 5. Monthly evolution of the CPUE and frequency of spiny lobster, *Palinurus elephas,* in the catch of the artisanal fleet of Palamós.

the beginning of 2009 (January and February).

The bottom long-line fishery showed a quite different pattern during 2008 (before the storm) without marked seasonality, although the maximum yield during the summer of 2009 might indicate otherwise. The low yields during the first five months of 2009 should also be highlighted (Figure 3).

Annex 1 contains the 53 species caught by artisanal nets according to the sales data of 2008 for the port of Palamós. The 27 species caught by bottom long-lines are shown in Annex 2. The species which were not present at least in 25 days per year were excluded from the two tables (Tables 1 and 2). Catches of hake were segmented into three size classes in increasing order, according to the different value of small, medium and big hakes. It seems that some species are hardly accessible by the reported gear, such as the swordfish, which is the third most abundant species among the bottom long-line catches. These inconsistencies in the data can be attributed to the high fishing versatility of a single boat, which can use different gears in spite of being classed in one single category.

Monthly catch rates and species frequency showed possible storm-related alterations in 18 of the species studied. These changes differed in sign

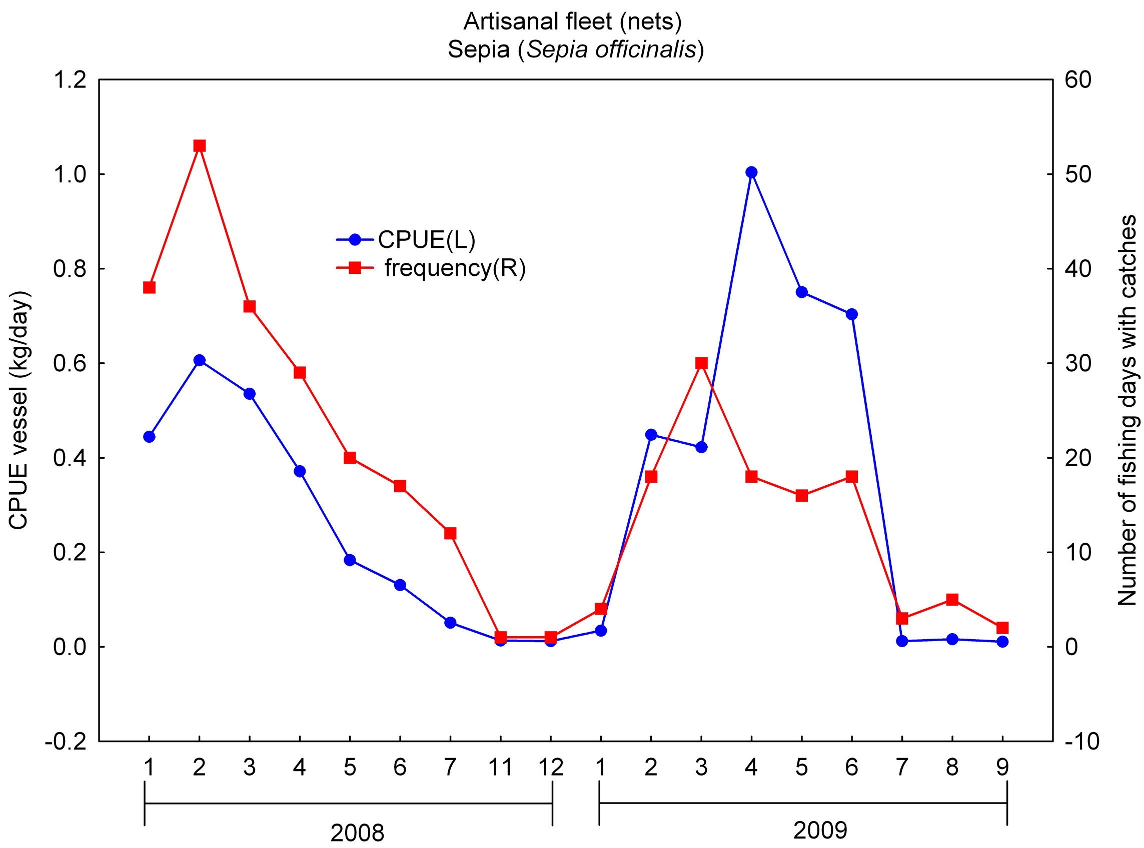

Figure 6. Monthly evolution of the CPUE and frequency of *Sepia officinalis* in the catch of the artisanal fleet of Palamós.

and intensity. In 7 cases the disturbance did not last long: for about one or two months after the storm. The changes in the remaining 11 species were maintained throughout the entire analysed period.

Most species showed an increase in catch rates. In most cases the increase in catch rates was associated with equal or lower frequencies than expected. We believe that this phenomenon is due to an increase in the spatial aggregation of the species, which increased their fishing availability. In three species (*Trachinus draco, Scorpaena scrofa, Serranus cabrilla*), which showed short-term alterations after the storm, both the catch rate and frequency of occurrence increased. The short duration of these changes excludes the possibility of an actual increase in the populations, and therefore can be considered as a temporary rise in vulnerability.

Occasionally, both the frequency and catch rates decreased. These situations could be interpreted as a clear reduction in the local density of the species. *Octopus vulgaris*, *Phycis blennoides*, *Mullus sp*. and *Scorpaena sp*. showed this pattern. On the contrary, the spiny lobster (*Palinurus elephas*) and *Phycis phycis* showed the opposite pattern. Both species displayed an increasing trend in catch rate and frequency throughout the entire period following the storm. In this case, the effect of the storm may have had the unlikely result of

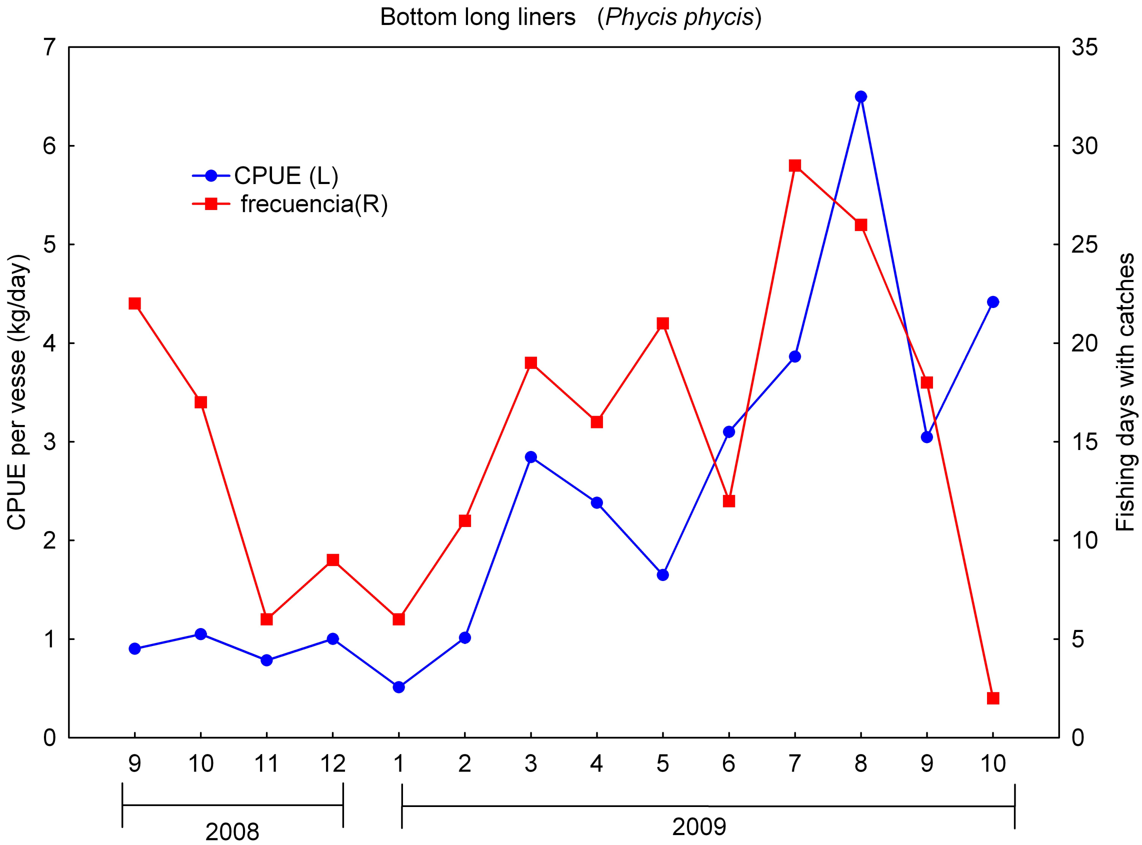

Figure 7. Monthly evolution of the CPUE and frequency of *Phycis phycis* in the catch of the artisanal fleet of Palamós.

increasing abundance. The increase in both species occurred nearly immediately after the storm and continued steadily during the entire study period. It could be argued that the increase was rather caused by an increase in the local density of population, but not in total abundance, due to immigration from adjacent areas.

Pagellus erythrinus, *Palinurus elephas* and *Sepia officinalis* showed three different patterns (Figures 4-6). *P. erythrinus* had a short period of vulnerability followed by a gradual return to its original condition. *P. elephas* gradually increased in the catches after the storm, and continued to increase over the entire subsequent period. Several studies have shown changes in lobster catchability, but these were related to changes in temperature and associated seasonality (Ziegler et al 2002, 2004). *S. officinalis* showed a long trend alteration/disturbance, with increased vulnerability and an apparently seasonal change in monthly rates.

The results of the artisanal bottom long-line fleet showed changes in six species (Table 2), all of them also showed changes in net catches. The two gears showed variations of equal sign except *Scorpaena sp.* whose catch frequency decreased while its catch rate increased.

Table 1. Species showing altered patterns in abundance and/or frequency of occurrence in the catches of the artisanal fleet. The symbols represent the sign of change and the repeated signs denote the presence of a trend line.

Common Name (Nombre común)	Scientific Name	Punctual Variation	Occurrence Variation	Yield Variation	Vulnerability
Conger (Congrio)	*Conger conger*	No	-	+	+
Pandora (Breca)	*Pagellus erythrinus*	Yes	-	+	+
Poulp (Pulpo)	*Octopus vulgaris*	No	-	-	
Tub gurnard (Bejel)	*Trigla lucerna*	Yes		+	+
White seabream (Sargo)	*Diplodus sargus*	Yes		+	+
Blackbelly rosefish (Gallineta)	*Helicolenus dactylopterus*	No		+	+
Axillary seabream (Aligote)	*Pagellus acarne*	Yes		+	+
Dentex (Dentón)	*Dentex sp.*	No	-	+	+
Greater forkbeard (Alfaneca)	*Phycis blennoides*	No	-	-	
Greater weever (Araña)	*Trachinus draco*	Yes	+	+	+
Mullet (Salmonete)	*Mullus sp.*	No	-	-	
Scorpion fish (Cabracho)	*Scorpaena sp.*	No	-	-	
Large-scaled scorpion fish (“)	*Scorpaena scrofa*	Yes	+	+	+
Cuttle-fish (Sepia)	*Sepia officinalis*	No	-	+	+
Comber (Cabrilla)	*Serranus cabrilla*	Yes	+	+	+
Forkbeard (Brótola de roca)	*Phycis phycis*	No	++	++	+
Zebra seabream (Sargo real)	*Diplodus cervinus*	No	=	-	
Spiny-lobster (Langosta)	*Palinurus elephas*	No	++	++	+

Phycis phycis showed the most remarkable temporal evolution in bottom long-line catches with a large increase in frequency and CPUE during 2009 (Figure 7). *P. phycis* did not even appear in the catches of the fleet before September 2008, when the daily catch per boat was around 1kg per day. One year later daily catches of this species were three times as large without any variation in its frequency of presence. Given the short time period of this study no firm conclusions can be drawn about changes in abundance or vulnerability, but the increase in total catches by bottom long-lines (Figure 3) can be mainly attributed to this species.

Conclusions

The results of the analysis of the catches of the artisanal fleet of Palamós show that the abundance of most of the species accessible to artisanal nets and bottom long-lines was not altered by the storm. However, the catch rate patterns of a significant number of species (up to 18) changed substantially. These changes cannot be considered completely consistent because the analysed period was short and thus extrapolations or temporal projections made from this report should be considered with caution. Nevertheless, the fact that the same changes occurred in the same species in the

Table 2. List of species showing altered patterns in abundance and/or frequency of occurrence in the catches of the bottom long-line fleet. The symbols represent the sign of change and the repeated signs denote the presence of a trend line.

Common name (Nombre común)	Scientific Name	Punctual Variation	Occurrence Variation	Yield Variation	Vulnerability
Blackbelly rosefish (Gallineta)	*Helicolenus dactylopterus*	No	-	+	+
Pandora (Breca)	*Pagellus erythrinus*	No	-	+	+
Greater forkbeard (Alfaneca)	*Phycis blennoides*	No	--		
Poulp (Pulpo)	*Octopus vulgaris*	Yes	-	-	
Forkbeard (Brótola de roca)	*Phycis phycis*	No	++	++	+
Scorpion fish (Cabracho)	*Scorpaena sp.*	No	-	+	+

two fishing gears (nets and bottom long-lines) increases the reliability of the results. Since the increase in catch rates can be attributed to an increase in catchability instead of an increase in abundance, the observed changes point to an increase in species vulnerability.

Although we cannot draw conclusions about increases or decreases in local populations, the results obtained here suggest that there has been an increased fishing pressure on certain species whose spatial distribution has changed. Although the factors of spatial disorder are too complex to identify, the consequences of fishing can be detected. It can be concluded that most of the changes after the storm increased the effectiveness of the fishing effort; therefore, in the short term, these changes could seem positive for the fishing fleet. Nevertheless, this improvement is only apparent, since it must not be confused with an increase in the abundance of the resources. On the contrary, the enhancement in the catch rates implies an increase in fishing mortality. It is necessary to differentiate the direct effects from the indirect effects of the impact of the storm on coastal resources in the medium and long term. In this case it seems that, at least for some populations, the consequences of the storm led to an increase in fish catchability and increased vulnerability with negative consequences for fish populations.

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Annex I. List of species and total catch by the artisanal fishing fleet of Palamós.

Common Name	Nombre común	Scientific Name	Catch (kg)
Sand-eel	Sonso	*Gymnammodytes cicerelus*	53072
Hake (1)	Merluza	*Merluccius merluccius*	10996
Conger	Congrio	*Conger conger*	5870
Sword-fish	Pez espada	*Xiphias gladius*	5795
Scabbard-fish	Sabre	*Lepidopus caudatus*	5659
Atlantic bonito	Bonito	*Sarda sarda*	5600
Pandora	Breca	*Pagellus erythrinus*	5138
Poulp	Pulpo	*Octopus vulgaris*	4155
Tub gurnard	Bejel	*Trigla lucerna*	2870
White seabream	Sargo	*Diplodus sargus*	2854
Blackbelly rosefish	Gallineta	*Helicolenus dactylopterus*	2178
Axillary seabream	Aligote	*Pagellus acarne*	2032
Gilthead seabream	Dorada	*Chrysophrys aurata*	1929
Atlantic mackerel	Caballa	*Scomber scombrus*	1888
Dentex	Dentón	*Dentex sp.*	1673
Skate, ray	Raya	*Raja sp.*	1498
Greater forkbeard	Alfaneca	*Phycis blennoides*	1473
Greater weever	Araña	*Trachinus draco*	1236
Angler	Rape	*Lophius sp.*	1201
Bullet tuna	Melva	*Auxis rochei*	1169
Mullet	Salmonete	*Mullus sp.*	1108
Hake (2)	Merluza	*Merluccius merluccius*	1074
Stargazer	Rata	*Uranoscopus scaber*	1072
Scorpion fish	Cabracho, rascacio	*Scorpaena sp.*	971
Black tail seabream	Oblada	*Oblada melanura*	892
Big-eyed mackerel	Estornino, Bisol	*Scomber japonicus*	789
Large-scaled scorpion fish	Cabracho	*Scorpaena scrofa*	728
Horse Mackerel	Chicharro, Jurel	*Trachurus sp.*	677
Bass	Lubina	*Dicentrarchus labrax*	559
Dolphinfish	Dorado, llampuga	*Coryphaena hippurus*	538
Cuttle-fish	Sepia	*Sepia officinalis*	512
Grey mullet	Cabezudo, albur, lizarra	*Mugilidae*	473
Barracuda	Barracuda, espetón	*Sphyraena sphyraena*	428
John Dory	Pez de San Pedro	*Zeus faber*	413
Red porgy	Pargo	*Pagrus Pagrus*	406
Bogue	Boga	*Boops boops*	391
Common sole	Lenguado	*Solea vulgaris*	352

Common Name	Nombre común	Scientific Name	Catch (kg)
Squid	Calamar	*Loligo vulgaris*	316
Round sardinella	Alacha	*Sardinella aurita*	303
Comber	Cabrilla	*Serranus cabrilla*	175
Forkbeard	Brótola de roca	*Phycis phycis*	145
Goldline	Salema	*Sarpa salpa*	139
Poor cod	Capellán, Faneca menor	*Trisopterus minutus*	118
Lesser spotted dogfish	Pintarroja	*Scyliorhinus canicula*	118
Sand steenbras	Herrera	*Lithognathus mormyrus*	116
Spotted flounder	Peluda, solleta	*Citharus linguatula*	104
Turbot	Rodaballo	*Psetta maxima*	98
Black seabream	Chopa	*Spondyliosoma cantharus*	88
Zebra seabream	Sargo breado, sargo real	*Cervinus*	85
Rock-lobster, spiny-lobster	Langosta	*Palinurus elephas*	67
Blue whiting, Poutassou	Bacaladilla	*Micromesistius poutassou*	65
Hake (3)	Merluza	*Merluccius merluccius*	65
Purple dye murex	Cañadilla	*Bolinurus brandaris*	57
Brown meagre	Corvina	*Sciaena umbra*	49
Dusky Grouper	Mero	*Epinephelus marginatus*	44
Other species			3377