Small-scale fisheries in the maritime department of Ancona (Central Northern Adriatic Sea)

Gianna Fabi* and Fabio Grati*

Abstract
The paper reports data from the artisanal fishing fleet operating in the Adriatic Sea, in the area of the Ancona Maritime Department. The artisanal fleets existing in the area consist of 77 artisanal vessels having an average GRT of about 3.0, LOA of 6-12 m. The following fishing gears are described: gillnet for common sole (*Solea vulgaris*), gillnet for other highly valuable species (i.e. *Sciaena umbra*, *Umbrina cirrosa* and *Dicentrarchus labrax*, sparids), trammel net, basket traps for *Nassarius mutabilis* and traps (pots and fyke nets) for *Sepia officinalis*

Keywords: artisanal fishing; coastal fisheries; fishing vessels; Solea vulgaris, Sciaena umbra; Umbrina cirrosa; Dicentrarchus labrax; Nassarius mutabilis; Sepia officinalis MED, Adriatic Sea.

1. Introduction

Data reported in this context come mainly from investigations carried out since 1999 on the artisanal fleets operating along the Italian coast of the Adriatic Sea, in the area of Ancona Department extending between the Conero Promontory and Senigallia, about 35 km of shoreline (Fabi *et al*., 2002a). They can be considered as representative of the artisanal fleets operating along the coast of Marche region, from San Benedetto del Tronto to Pesaro; (Fabi and Grati, 2002). Investigations include:

- Census at both local maritime offices and landing sites for getting information on number and technical features of vessels, on technical characteristics of gears used in the different seasons and on the main target species;
- Weekly sampling at the main mooring places to record amounts and composition of landings, technical features of gears, fishing time and exploited grounds;
- Periodic observations onboard of commercial vessels over two years (1999-2000) for collecting biological data on the catches of target species and on the quali-quantitative composition of discard of the most important fishing gears (sole gillnet, trammel nets, traps for *Sepia officinalis*); catches were subdivided in: target species, kept by-catch, discard of commercial species (henceforth referred to as "discard C") and discard of non-commercial species ("discard NC").

Other data were obtained inside two research projects focused on specific aspects (Fabi and De Ranieri, 1998; Fabi and Sartor, 2001).

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2. Description of the investigated fleets

The artisanal fleets existing in the area consist of 77 artisanal vessels having an average GRT of about 3.0, LOA of 6-12 m, average engine power of about 40 kW and a crew of 1-2 people. They include both fibreglass planning vessels and wooden displacing boats. Most of these vessels moor at three landing places (Senigallia, Ancona and Portonovo), while the remaining ones are dislocated along the coast.

2.1 Listing if various fishing gears

Gillnet for common sole (*Solea vulgaris*), gillnet for other highly valuable species (i.e. *Sciaena umbra*, *Umbrina cirrosa* and *Dicentrarchus labrax*, sparids) and trammel net are the most common set nets used in the area. A relevant importance is also assumed by traps (pots and fyke nets) for *Sepia officinalis* and basket traps for *Nassarius mutabilis* (Table 1; Figure 1).

Table 1. Main fishing gears utilised in the study area and respective target species and fishing period.

FISHING GEAR	TARGET SPECIES	FISHING PERIOD
Sole gillnet	*Solea vulgaris*	January-December
Gillnet	*Lithognathus mormyrus*, *Dicentrarchus labrax*, *Sciaena umbra, Umbrina cirrosa,* mugilids	November-March
Trammel net	*Sepia officinalis*	April-June
Trammel net	*Lithognathus mormyrus*	February-March
Pots and fyke nets	*Sepia officinalis*	April-June
Basket traps	*Nassarius mutabilis*	October-May

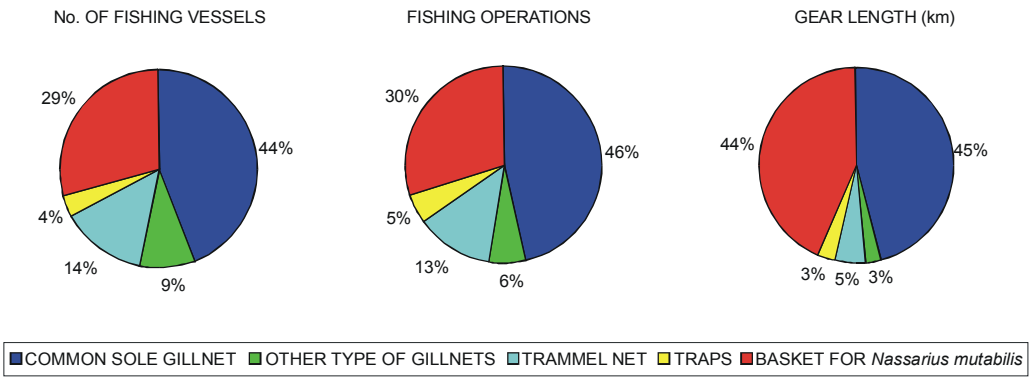

Figure 1. Percentage importance of the different set gears used by the artisanal fleets of Ancona Department.

2.2 Fishing grounds

The fleets mainly operate in a coastal area of about 300 km^2 extending between Marotta at north and the Conero Promontory at south and from 0.1 to 3 nautical miles offshore, because at greater distances the set gears could be damaged by trawling. These vessels extend their fishing grounds outside 3 nm from the coast only during the biological fishing stop (closed fishing season) of trawlers.

The sea bottom at north of Ancona is homogeneous and sand-muddy, gradually sloping down off-shore and reaching 15 m depth at about 3 nm from the coast. Conversely, it is mainly rocky or mixed rock-muddy at south, in front of Conero Promontory (Figure 2).

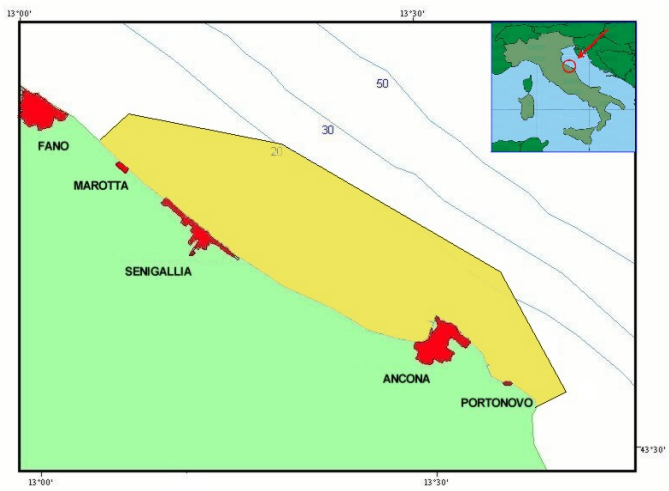

Figure 2. Fishing grounds of the artisanal fleets existing between Senigallia and Portonovo.

3. Gillnets for common sole

3.1 Fishing equipment

The artisanal fleets targeting common sole use a specific, polyamide monofilament gillnet having a low height (1.6-2.5 m) and a very low floating buoyancy which allows the gear to partially lay down on the seabed so favouring the capture of benthic fishes (Table 2). Diameter of netting yarn varies from 0.18 to 0.22 mm and the mesh size between 64 and 68 mm (stretched).
The length of nets ranges from 1,000 to 5,000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning.

Table 2. Technical characteristics of common sole gillnet.

PANEL						FLOATS Total No.	HEADLINE		LEADLINE (g/m)
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Diameter of the filament (mm)	Hanging ratio		Diam. (mm)	Material	
1.6	40	2000	68	0.20	0.29	16	3	PA	35
2.0	42	2000	68	0.18	0.31	16	4	PA	40
2.5	53	2000	64	0.20	0.41	8	5	PE	40
2.5	56	2000	68	0.20	0.41	8	5	PE	35
2.5	56	2000	64	0.22	0.43	8	5	PE	35

3.2 Fleets concerned

The fleet percentage using this gear varies among seasons, with the lowest values in winter and the highest ones in summer, when almost all operating vessels of the area target the

common sole with gillnets (Figure 3). The total number of vessels yearly devoted to this fishery increased in the last four years.

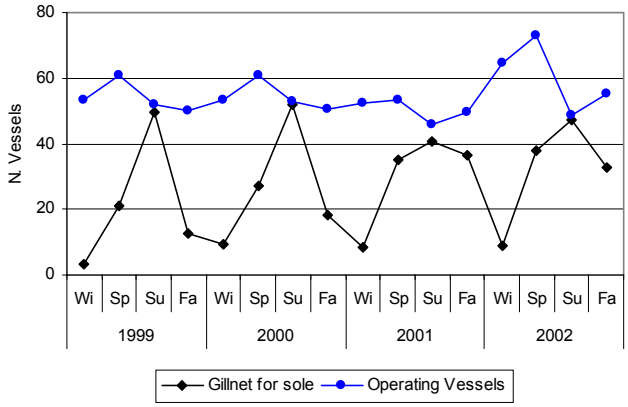

Figure 3. Seasonal trend of number of vessels using gillnet for common sole. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

3.3 Fishing grounds

The gillnet for common sole is employed on the coastal sandy and muddy seabeds between 1 and 4 nm offshore (Figure 4).

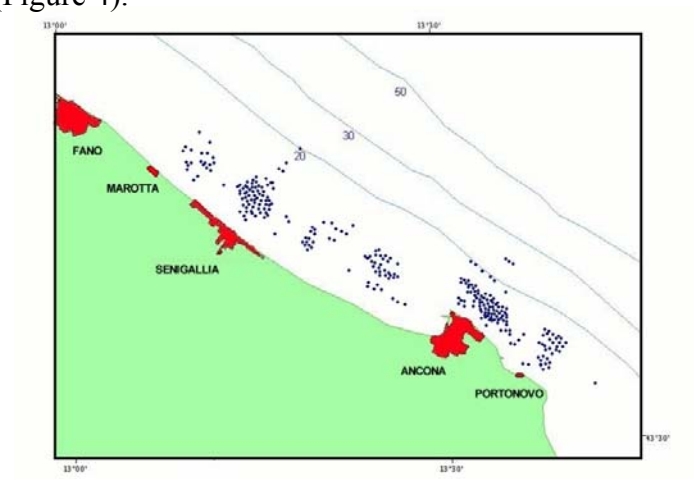

Figure 4. Fishing grounds of the artisanal fleets operating with gillnets for common sole.

3.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average permanence of 12 hours at sea. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and all year round, following a seasonal pattern characterised by the highest values in summer, when most of the small-scale fishing vessels are involved, and the lowest ones in winter. The extension of the fishing period increased in the last four years.

3.5 Data on catches

3.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 0.74 t to 125 t (Figure 5), showing only in the two first years a direct relationship with the amount of employed nets. The average seasonal landings per year increased from 1999 to 2000, remaining practically constant in the subsequent period. Differently, the average seasonal LPUEs per year amounted to 6.4 kg in 1999 and then stabilised at 4.5-5.0 kg/5000m/h.

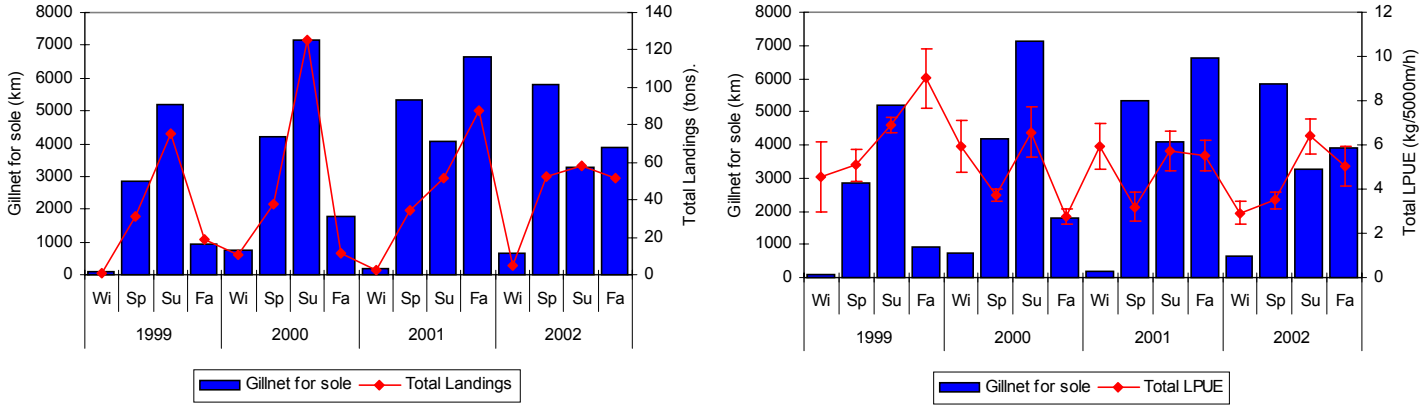

Figure 5. Seasonal trend of the total catches and LPUE of the vessels using gillnets for common sole.

Solea vulgaris accounted from 24% to 80% of the annual landed catch in weight. Annual landing of this species gradually increased over the four years reaching in 2002 a value corresponding to 2 times that recorded in 1999. At the same time LPUE remained practically constant (Figure 6).

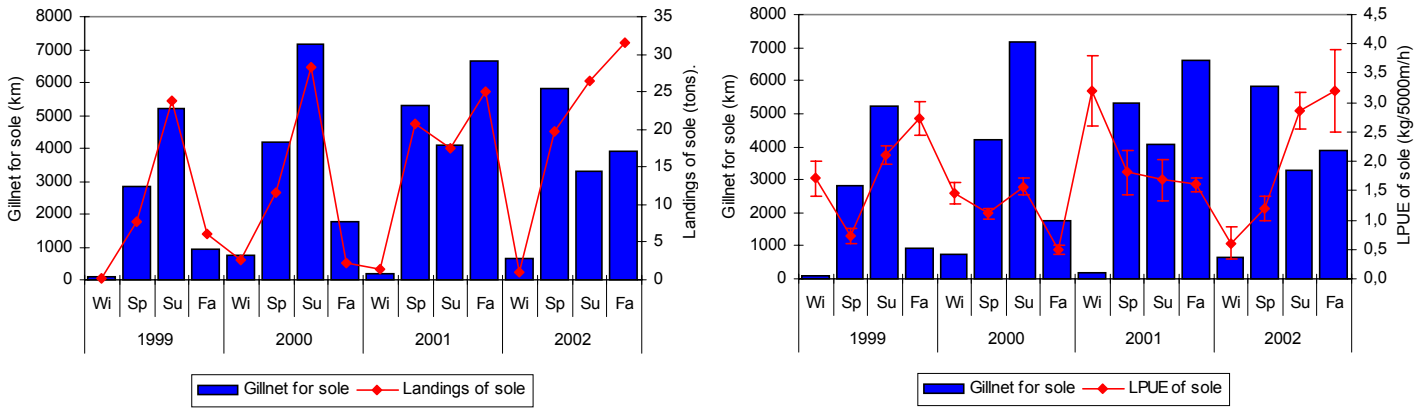

Figure 6. Seasonal trend of *S. vulgaris* total landings and LPUE.

Data on landing composition showed that *Squilla mantis* and *Trigla lucerna* can be considered respectively second and third target species for this fishery. Other accessory species are *Solea impar*, *Lithognathus mormyrus, Liza ramada, Diplodus annularis*, even though they appear in catches occasionally.

3.5.2 Discarding

Discard of commercial species is scarcely important for this fishery, representing 7% in weight of the total catches (Figure 7). The most relevant species are *Aporrhais pespelecani*, *S. mantis*, *Trachurus mediterraneus* and *T. lucerna.* The former is retained in other fisheries (i.e. artisanal trawling), but it is commonly discarded in set nets because scarcely abundant in catches. *S. mantis* e *T. mediterraneus* are generally represented by damaged specimens, while the discard of *T. lucerna* mainly includes no valuable specimens smaller than the sexual maturity size reported in the area (24.0 cm TL; Froglia, 1984). In fact, the juveniles of this species concentrate in the coastal area from spring to fall (Froglia, 1984) and easily enmesh in set nets independently from the mesh size because of their particular body shape (Fabi and De Ranieri, 1998). Discard of *S. vulgaris* is practically absent, as also the few damaged specimens are sold, although at lower prices in respect of the intact ones.

Alosa fallax, *Liocarcinus vernalis*, *Goneplax rhomboides* and *Corystes cassivelaunus* dominated discard NC, although their percentage contribution to this fraction noticeably changed among seasons.

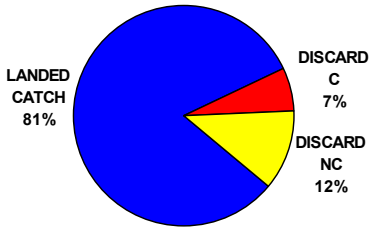

Figure 7. Composition of the total catches obtained with sole gillnets (1999-2000).

3.5.3 Demography and biological data of sole catches

Most of sole total catch obtained with the 64 mm and 68 mm mesh sizes consisted of juveniles belonging to age class 1, as shown in Table 3 realised on the basis of the Von Bertalanffy parameters estimated through the otolith reading method (Froglia and Giannetti;1986).

Table 3. Length/age percentage composition of *S. vulgaris* catches (1999-2000).

	Length (cm) / Age class											
Mesh size	13-18 / 0		19-25 / 1		26-30 / 2		31-33 / 3		34-35 / 4		36 / 5	
	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%
64 mm	1.73	3.45	89.56	92.07	8.71	4.48						
68 mm	0.75	1.84	77.86	85.04	19.83	12.54	1.56	0.58				

The length-frequency distributions of catches showed a slight shifting to the right side with the increasing of the mesh size, as a consequence of net selectivity. In fact, the 64 mm mesh catch ranged from 16.0 cm to 30.0 cm TL with an average length of 21.7 cm and a modal class at 21.0 cm TL, while that of the 68 mm mesh fell between 16.0 and 33.0 cm TL, with a mean TL of 23.0 cm and a modal class at 22.0 cm TL (Figure 8).

Analysis of gonads carried out on a total of 1087 specimens (517 males and 570 females) did not show any difference between the two sexes in spring and summer, while in fall catches males were significantly more abundant than females (Table 4).

In spring and summer, when the fishing activity is greater, most of catches consisted of immature individuals, but the percentage of sexually mature specimens gradually increased during the year until to reach about 38% of males and 7% of females in fall.

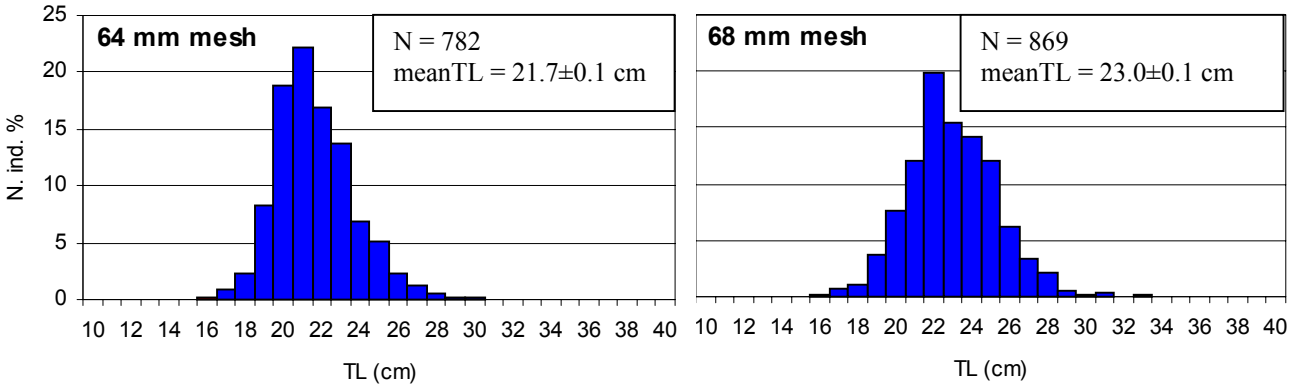

Figure 8. Demographic structure of gillnet catches of *S. vulgaris* obtained with the two mostly used mesh sizes.

Table 4. Number of *S. vulgaris* males and females recorded in the catches of vessels using sole gillnets (1999-2000). ** = highly significant.

SEASON	N. MALES	N. FEMALES	TOTALE	SEX RATIO M/F	TEST χ^2
Spring	91	110	201	0.83	0.180
Summer	331	333	664	0.99	0.938
Fall	148	74	222	2.00	0.000**
Total	570	517	1087	1.10	0.108

4. Other types of gillnets

4.1 Fishing equipment

The other types of gillnet used in the area can be grouped into only one category as they are made of polyamide monofilament, are 3-6 m high and have a great floating buoyancy and a mesh size ranging from 72 to 100 mm (stretched; Table 5). The length of nets ranges from 1,000 to 5,000 m.

Table 5. Technical characteristics of gillnets.

PANEL						FLOATS Total No.	HEADLINE		LEADLINE (g/m)
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Filament diameter (mm)	Hanging ratio		Diam. (mm)	Material	
3-6	80	2000	100	0.25	0.40	48	5	PA	100
3-4	64	2000	80	0.25	0.40	48	5	PA	100
3-4	64	2000	76	0.20	0.42	48	5	PA	100
3-4	53	2000	72	0.20	0.37	48	5	PA	100

4.2 Fleets concerned

These nets (Table 5) are occasionally used by a few fishing vessels mooring in the area between Ancona and Portonovo to catch either striped sea breams, sea basses and corbs in particular sea conditions or grey mullets in winter.

The scarce importance of this fishing *métier* is confirmed by the low number of vessels seasonally practicing it, which ranged from 0 (spring'02) to 10 (winter '99) in the overall period (Figure 9).

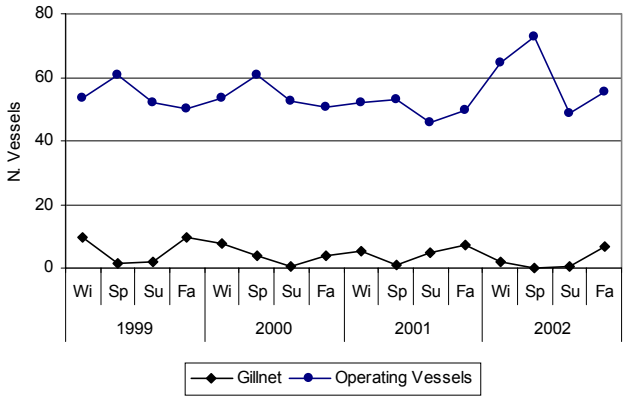

Figure 9. Seasonal trend of vessels using gillnet. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

4.3 Fishing grounds

The fishing grounds are represented by rocky and sand-rocky bottoms located between 0.1 and 2 nm off the Conero Promontory and by a sand-muddy area placed about 5 km at north of Ancona characterised by the presence of sealines connecting off-shore platforms with the coast (Figure 10).

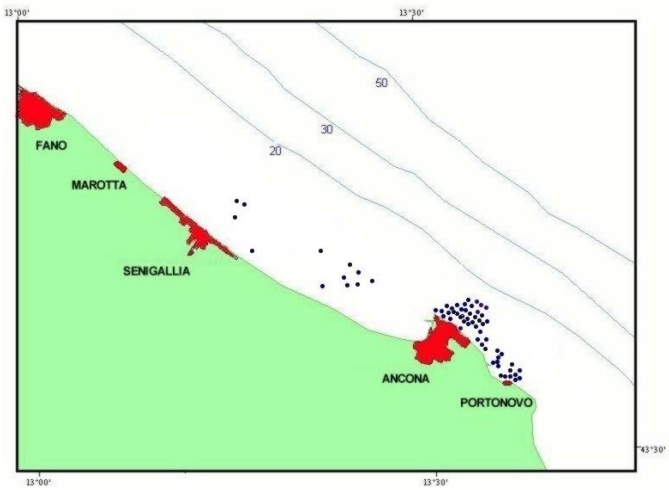

Figure 10. Fishing grounds of the Ancona and Portonovo artisanal vessels operating with gillnets.

4.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average of 12 hours at sea. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and follows a seasonal pattern characterised by the lowest values in summer.

4.5 Data on catches

4.5.1 Landings and LPUE

Over the period 1999-2002 seasonal landings ranged from 0.01 t (summer '00) to 17 t (fall '01; Figure 11), with a direct relationship with the total amount of employed nets. The average seasonal landing per year showed some fluctuations, reaching a peak (6 t) in 2001 and ranging from 2 to 4 t in the other years. The average seasonal LPUE per year went from 6 to 16 kg/5000m/h.

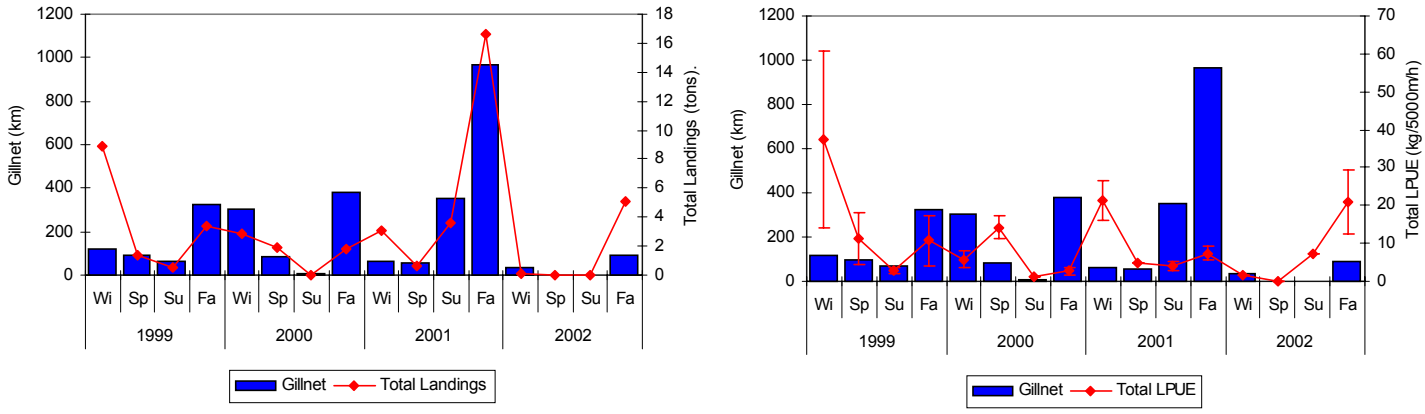

Figure 11. Seasonal trend of total catches and LPUE of the vessels using gillnets.

The weight percentage of target species pool on the total landings greatly varied among seasons, going from 0 to 100% (Figure 12). Anyway, in most of cases their contribution was similar or higher than that of the accessory species and ranged from 47% to 98%.

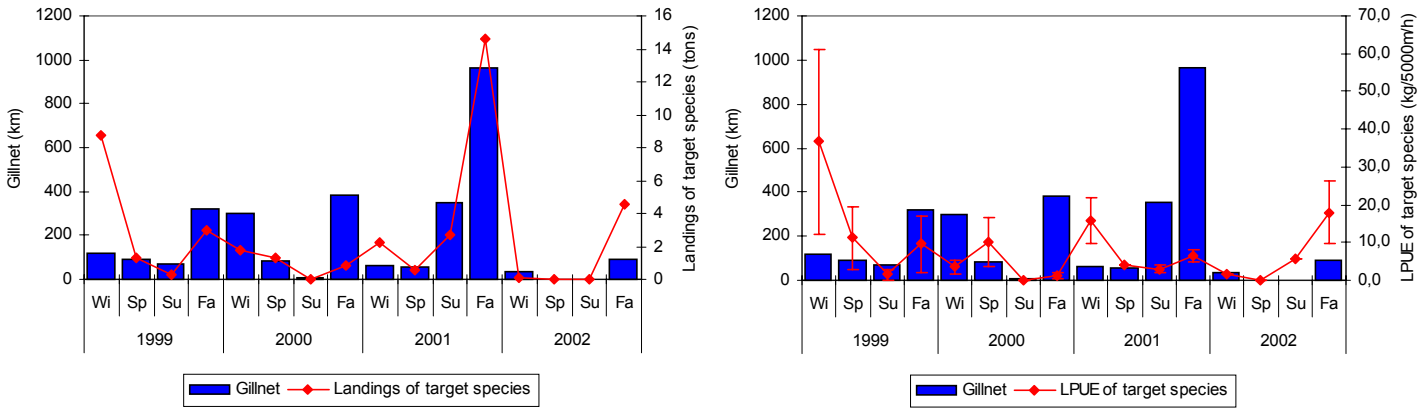

Figure 12. Total landings and LPUE seasonal trend of the pool of target species caught with gillnets.

Data on landing composition show that these gillnets are used for catching five target species: *L. ramada*, *L. mormyrus*, *D. labrax*, *S. umbra* e *U. cirrosa*. *L. ramada* and *L. mormyrus* were the main target species in landings, while *Diplodus annularis*, *Liza saliens*, *T. lucerna* and *Seriola dumerili* dominated the landed by-catch.

4.6 Selectivity

Selectivity of this type of nets towards *L. mormyrus* was estimated through Sechin method (Sechin, 1969) considering 45 mm and 70 mm mesh sizes (stretched; Fabi and De Ranieri, 1998; Fabi et al., 2002b).
With the 45 mm mesh optimal catch size was 16.5 cm TL, corresponding to a selection range (p≥5%) of 13.6-19.8 cm TL (Table 6). Some specimens exceeded this range as a consequence of the tangled and/or pocket effects which were negligible on the left side (small individuals) and greater on the right one (greater individuals).
With the 70 mm mesh optimal catch size was 26.3 cm TL, corresponding to a selection range (p≥5%) of 22.7-30.3 cm TL. The portion of specimens felling out of the selection range was greater than in the 45 mm mesh and more consistent for the small individuals.

Table 6. Selection parameters obtained for *L. mormyrus* through the Sechin method.

Mesh size (mm)	Optimal catch size(cm)	Size range (cm) p>=5%		% individuals		
				p<5%	p>=5%	p<=5%
45	16.5	13.6	19.8	0.5	92.1	7.4
70	26.3	22.7	30.3	14.3	77.1	8.6

5. Trammel net

5.1 Fishing equipment

In the central northern Adriatic Sea trammel net underwent several modifications in the last few years, mainly consisting in the use of thinner filaments. At present, the most commonly used net is made of a polyamide twisted filament, the outer panels and the inner one are 2 and 3 m high respectively and the mesh size is 340 mm (stretched) in the formers and 70 mm in the latter (Table 7). Length of nets ranges from 500 to 1,000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning.

Table 7. Technical characteristics of trammel net.

INNER PANEL						**FLOATS Total No.**	**HEADLINE**		**LEADLINE (g/m)**
Height (m)	**Length (m)**	**No. of meshes / Length**	**Stretched mesh size (mm)**	**Filament diameter (mm)**	**Hanging ratio**		**Diam. (mm)**	**Material**	
3.0	50	2000	70	210/1	0.36	57	5	PA	100
OUTER PANELS									
Height (m)	**Length (m)**	**No. of meshes / Length**	**Stretched mesh size (mm)**	**Filament diameter (mm)**	**Hanging ratio**				
2.0	50	334	340	210/6	0.44				

5.2 Fleets concerned

Trammel nets are used only by fishers who operate in the area between Ancona and Portonovo to catch striped sea breams in winter and cuttlefishes in spring. Fleet percentage using this net strongly varies among seasons, with the highest values in winter-spring and the lowest ones in summer, when no vessel adopts this gear (Figure 13).

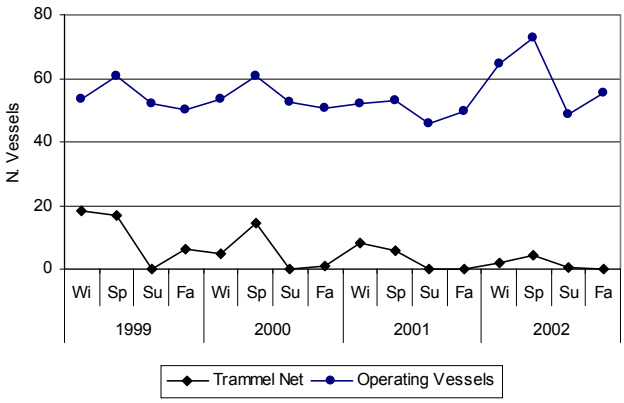

Figure 13. Seasonal trend of vessels using trammel nets. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

The number of vessels yearly devoted to this fishery gradually decreased over the four years, likely due to the scarce abundance of the two target species at sea, as shown in the following chapters.

5.3 Fishing grounds

The fishing areas for striped seabream (*L. mormyrus*) are represented by sand-rocky bottoms between 1.5 and 3 nm from the Ancona harbour and between few hundreds of meters and 1.5 nm from the coast in the Portonovo bay. In spring, when *S. officinalis* migrates inshore for reproduction, the local fishers utilise trammel nets in the same areas, but exploit also shallower waters (5-15 m; Figure 14).

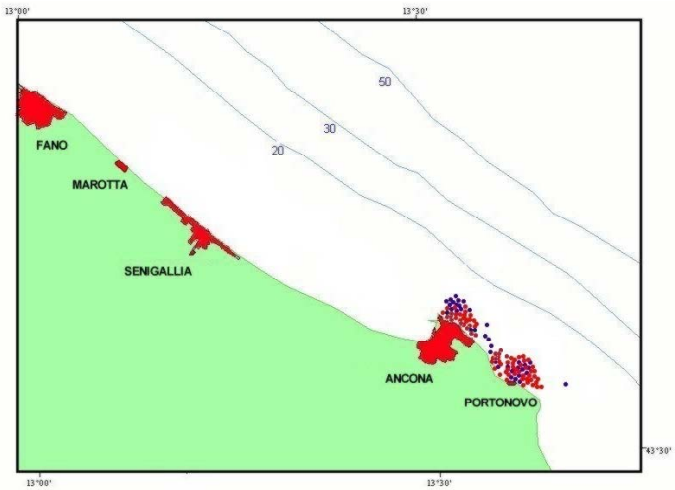

Figure 14. Fishing grounds of the artisanal vessels operating with trammel nets. Grey spots: *S. officinalis*; black spots: *L. mormyrus*.

5.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average of 12 hours at sea in the catch of *L. mormyrus*, while they are left at sea for 24 hours in the case of *S. officinalis*. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and from fall to spring, although the fishing season was shorter in the last two years then in 1999-2000 (Figure 13).

5.5 Data on catches

5.5.1 Landings and LPUE

Over the years 1999-2002 seasonal landings ranged from 0.1 t (winter '02) to 20 t (winter '99), showing a direct relationship with the total amount of employed nets (Figure 15). The average seasonal landing per year amounted to 10 t in 1999 and decreased afterwards. Also the average seasonal LPUE per year gradually decreased, reaching in 2002 a value corresponding to 50% of that recorded in 1999.

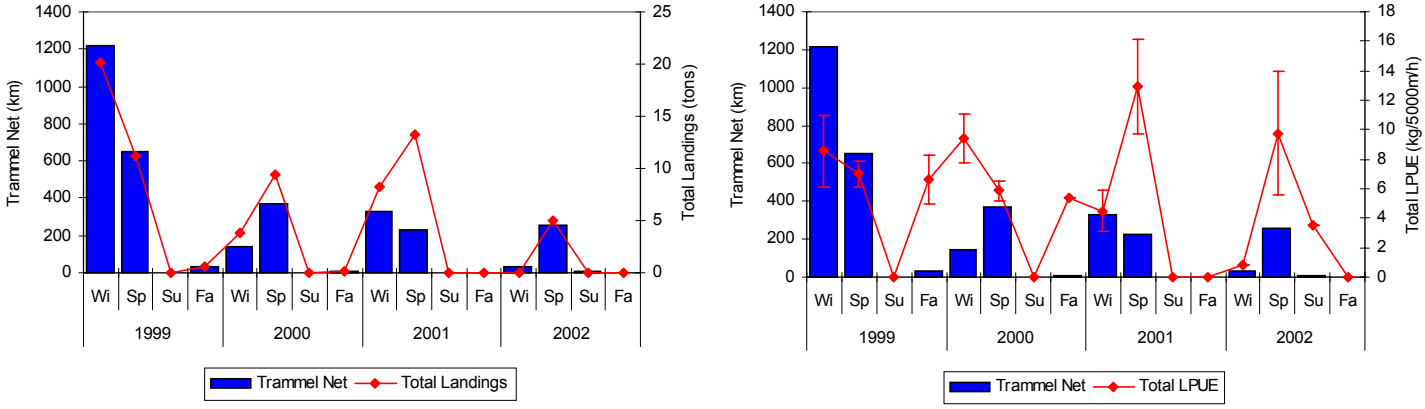

Figure 15. Seasonal trend of the total catches and LPUE of the vessels using the trammel nets.

Figure 16 and 17 clearly show the different seasonal occurrence of the two target species in landings: *L. mormyrus* reaches the highest values in winter and *S. officinalis* in spring. *Lithognathus mormyrus* accounted from about 70% of the total landing in weight in winter 1999, afterwards its contribution drastically fell down until to become nil in 2002 (Figure 16). A similar trend was also recorded for LPUEs of this species.

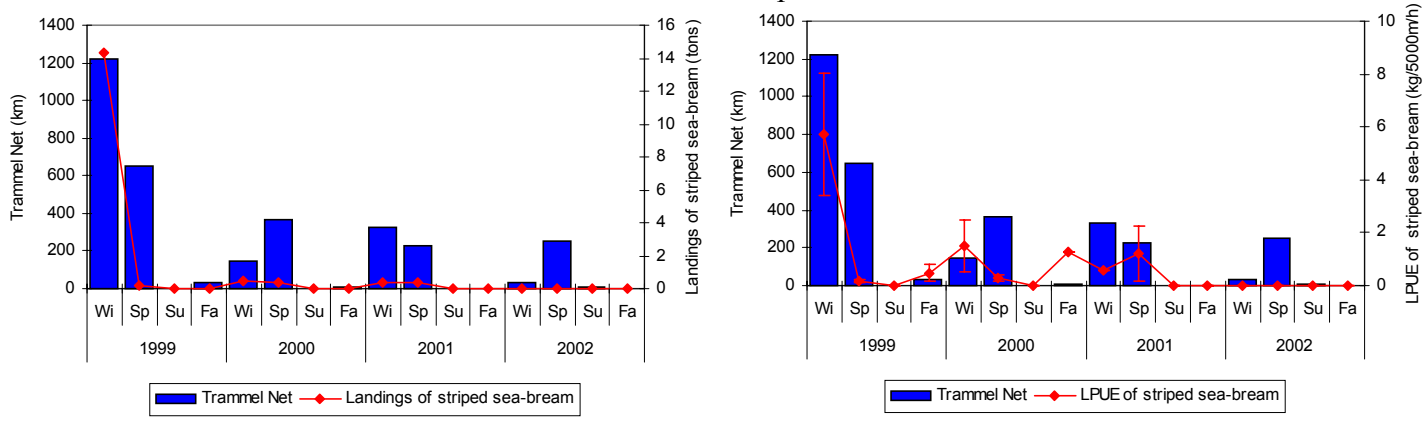

Figure 16. Seasonal trend of total landings and LPUE of *L. mormyrus*.

In spring, when *S. officinalis* represents the main target species for the trammel net fishery, the seasonal landings of this cephalopod ranged from 3 to 12 t, corresponding from 60% to 90% of total landings obtained with this type of net. In the remaining seasons the percentage contribution of cuttlefish to the total landings was generally less than 4%.

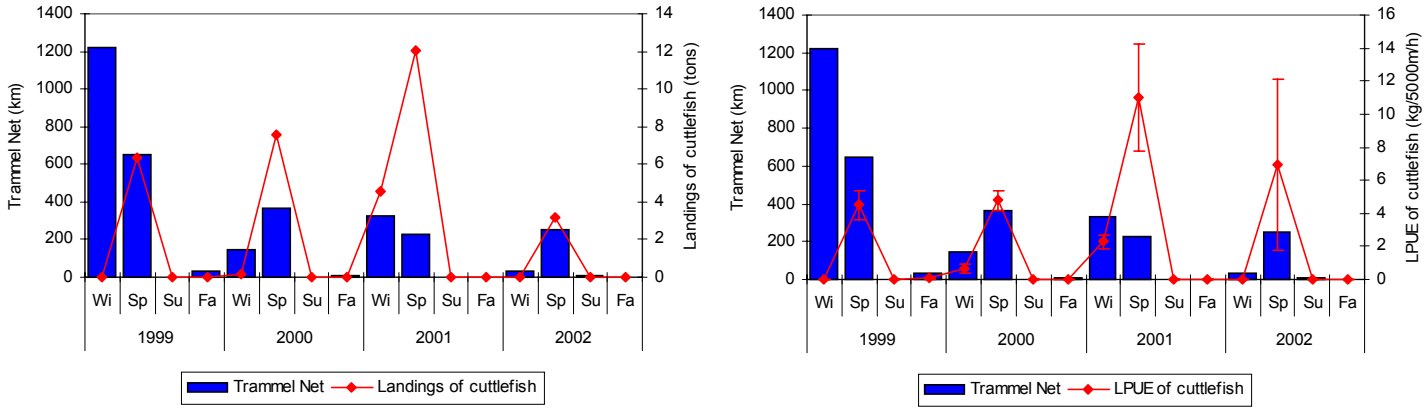

Figure 17. Seasonal trend of total landings and LPUE of *S. officinalis*.

The average seasonal landing per year increased until 2001 and drastically dropped down in the last year, independently from the reduction of the fishing effort (Figure 17). Conversely, the LPUEs increased in the last two years, even though they were characterised by a higher variability.

By-catch was dominated by *L. ramada* in winter-spring, *S. mantis* in spring, *D. annularis* and *Eledone cirrhosa* in fall. This last species was represented by adults having mature gonads.

5.5.2 Discarding

Discard of commercial species is low in this fishery, amounting to about 3% of the total catch (Figure 18). It mainly consists of damaged specimens of *L. mormyrus* in winter and of small, no valuable individuals of *T. lucerna* in spring.

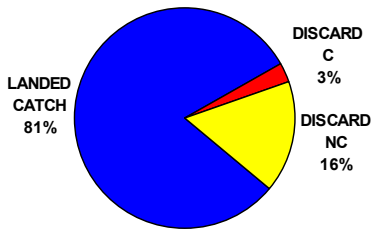

Figure 18. Composition of the total catches obtained with trammel nets (1999-2000).

Discard of non-commercial species appears more consistent, representing about 16% of the total catch and is dominated by *Maja crispata* and *Liocarcinus vernalis*.

5.5.3 Demography and biological data of striped seabream catches

The trammel net total catch of striped seabream obtained with the 70 mm mesh size consisted of specimens greater than the size at first sexual maturity reported for this species (14.0 cm TL; Fischer *et al*., 1981). Most of them belonged to age classes 3 and 4, as shown in Table 8 based on the Von Bertalanffy parameters estimated by Kraljevic *et al*. (1995).

Table 8. Length/age percentage composition of the commercial catches of *L. mormyrus*.

	Length / Age class													
Mesh size	17-21 / 2		22-25 / 3		26-28 / 4		29-30 / 5		31 / 6		32 / 7		33 / 8	
70 mm	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%
	2.6	5.6	62.4	68.3	26.3	21.1	5.4	3.4	0.6	0.3	1.3	0.7	1.4	0.6

The caught individuals fell in the size range 17.0–33.0 cm TL and had an average length of 24.7 cm. The size-frequency distribution showed three modes, but 94% of specimens had a mode at 24.0 cm TL and was included between 20.0 and 30.0 cm (Figure 19).

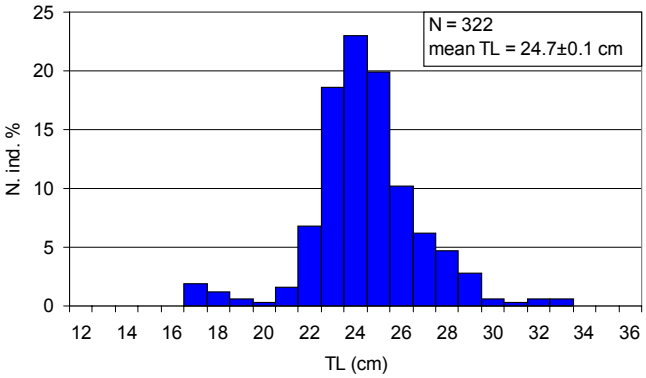

Figure 19. Demographic structure of *L. mormyrus* catches obtained with 70 mm mesh (1999-2000).

Analysis of gonads of 310 specimens (88 males, 177 females and 45 intersex) showed a significant dominance of females in winter (Table 9). Ratio between sexually mature and immature individuals was 3:1 for both sexes.

Table 9. Number of *L. mormyrus* males and females recorded in the winter catches of vessels using trammel nets (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	N. INTERSEX	TOTAL	SEX RATIO M/F	TEST χ^2
88	177	45	310	0.49	0.000**

5.5.4 Demography and biological data of cuttlefish catches

The cuttlefish catches obtained with 70-mm mesh trammel nets fell in the size range 9.0–25.0 cm ML with an average length of 14.9 cm. Most of specimens had a mode at 14.0 cm ML and measured between 9.0 and 22.0 cm (Figure 20).

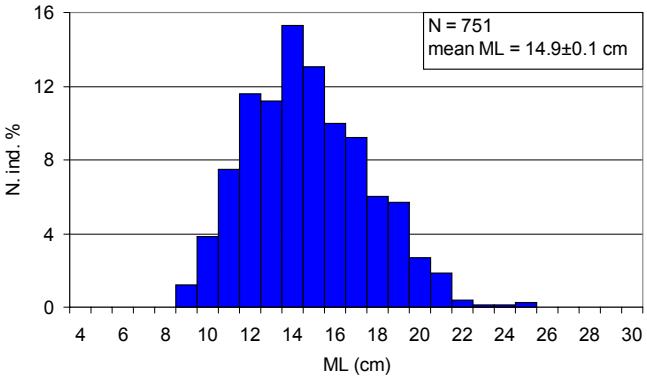

Figure 20. Demographic structure of *S. officinalis* catches obtained with 70 mm mesh (1999-2000).

Analysis of gonads carried out on 751 cuttlefishes (488 males and 263 females) showed a significant dominance of males (Table 10). Ratio between sexually mature and immature individuals was 3:1 for both sexes.

Table 10. Number of *S. officinalis* males and females recorded in catches of vessels using 70-mm trammel nets (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	TOTAL	SEX RATIO M/F	TEST χ^2
488	263	751	1.86	0.000**

5.6 Selectivity

Selectivity of this net towards *L. mormyrus* was estimated through Sechin method (Sechin, 1969) considering 45-mm and 70-mm mesh sizes (stretched; Fabi and De Ranieri 1998; Fabi et al., 2002b). The 45-mm mesh gave an optimal catch size of 16.5 cm TL and a selection range (p≥5%) of 13.6-19.8 cm TL (Table 11). About 29% of specimens exceeded this range because of the tangled and/or pocket effects, which were negligible for the small individuals and more consistent for the greatest ones. With the 70-mm mesh optimal catch size was 26.3 cm TL, corresponding to a selection range (p≥5%) of 22.7-30.3 cm TL. The specimens exceeding the selection range amounted to 33% of the catch, with a similar repartition on the left and right side of the interval.

Table 11. Selection parameters obtained for *L. mormyrus* through the Sechin method.

Mesh size (mm)	Optimal catch size(cm)	Size range (cm) p>=5%		% individuals		
				p<5%	p>=5%	p<=5%
45	16.5	13.6	19.8	0.7	70.9	28.4
70	26.3	22.7	30.3	17.9	66.7	15.4

6. Basket traps for *Nassarius mutabilis*

Basket trap fishery is practised exclusively in the central and northern Adriatic Sea for catching changeable nassa (*N. mutabilis*). In the investigated area this activity is regulated by Ancona Port Authority, who establishes yearly duration of fishing season and TAC for each vessel.

6.1 Fishing equipment

Basket traps are frustum of cone shaped and consist of an iron frame whose basis and lateral surface are covered by a polyamide twisted filament net having a stretched mesh size of 18 mm. These gears are bounded at 10 m of distance each other to a rope anchored on the seabed and are baited with dead fish.

6.2 Fleets concerned

This fishery is practised by a good portion of vessels operating in the whole area. The fleet percentage varies among seasons, with a gradual decrease from winter to summer, when this fishery is usually forbidden and an increase in fall (Figure 21).

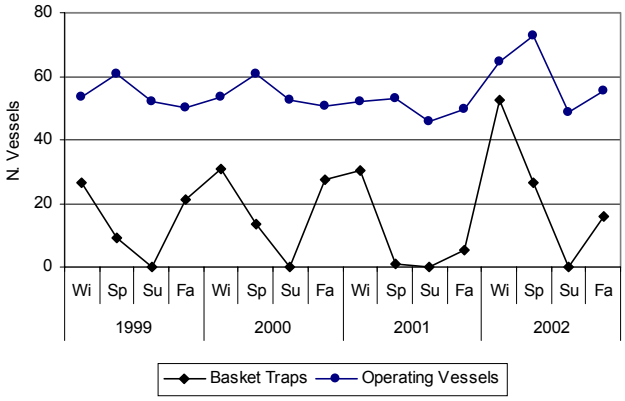

Figure 21. Seasonal trend of vessels using basket traps for *N. mutabilis*. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

6.3 Fishing grounds

The fishing grounds are represented by sand-muddy and rock-muddy bottoms located between 0.5 and 3 nm offshore (Figure 22).

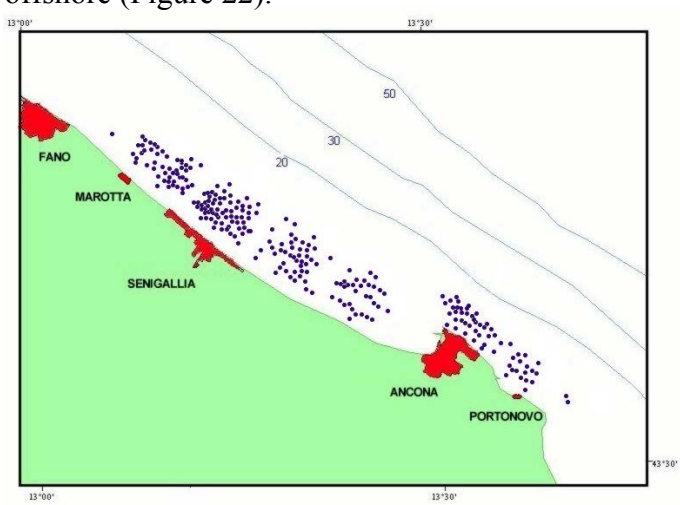

Figure 22. Fishing grounds of the artisanal vessels using basket traps for *N. mutabilis.*

6.4 Fishing time over the year

The fishing season commonly extends from fall to late spring. The gears are lowered into the sea at the beginning of this period and definitively recovered at its end. Fishing operations, consisting of emptying, baiting and control of gears, take place at 24-48 hour intervals, over all the week and show a seasonal trend characterised by a gradual increase from fall to spring.

6.5 Data on catches

6.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 4 to 340 t (Figure 23). In each year, seasonal landings showed a direct relationship with the total amount of employed gears, with an

increase from fall to winter and a decrease in spring. In winter, when the highest fishing capacity is applied, they gradually increased over the years. Total annual landings ranged from 194 t (1999) and 561 t (2002). The average seasonal LPUE remained rather constant on 4-8 kg/5000m/h.

The target species always made up almost entirely the total landing (Figure 24).

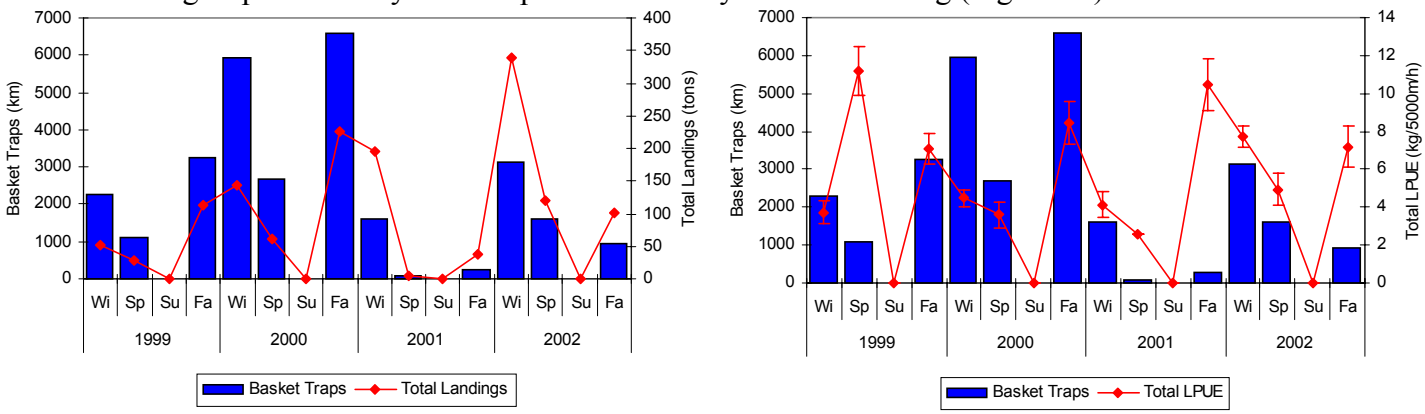

Figure 23. Seasonal trend of total catches and LPUE of the vessels using basket traps for *N. mutabilis*.

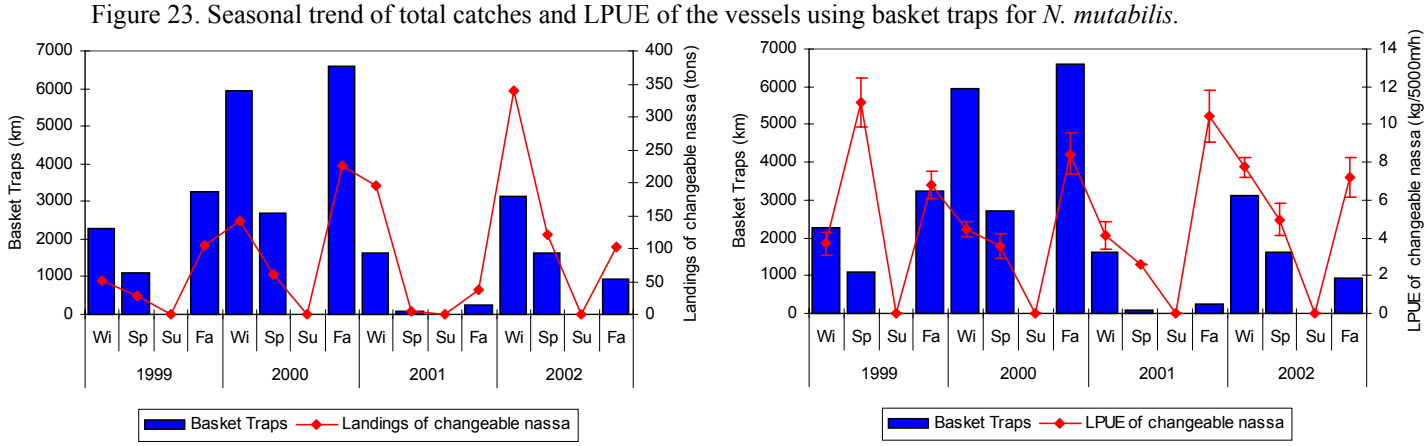

Figure 24. Total landings and LPUE seasonal trend of *N. mutabilis*.

The kept by-catch was dominated by *Gobius niger* and *Naticarius stercumuscarum*. Sometimes it also includes small amounts of *Bolinus brandaris*.

6.5.2 Discarding

Data on discard from direct observations on board are not available. Anyway, it has to be evidenced that total catches also include great amounts of *Nassarius reticulatus*, a gastropod having the same habitat and feeding behaviour of *N. mutabilis*. As this species has no commercial value, it is commonly destroyed or rejected at sea alive.

7. Traps for cuttlefish

7.1 Fishing equipment

Two types of traps are used in the area to catch cuttlefishes: fyke nets and pots. The formers

consist of plastic rings (5-6) sustaining an external polyamide twisted filament net and internal frustum of cone shaped openings made of the same net. Pots are parallelepiped shaped and consists of an iron frame covered by polyamide twisted filament net; each longer side is provided with an opening permitting the cuttlefishes to enter but not to go out. Fishermen put inside these gears either laurel branches or plastic strips to provide a substrate for cuttlefish egg attachment. Both fyke nets and pots are bounded at about 10 m from each other to a rope anchored to the seabed.

7.2 Fleets concerned

This fishery is practised especially in the northern part of the area where the sea bottom is more suitable. The fleet percentage devoted to it showed some fluctuations among the years (Figure 25).

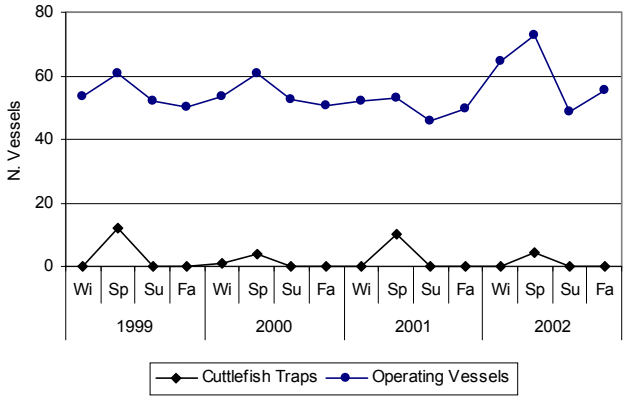

Figure 25. Seasonal trend of vessels using traps for cuttlefish. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

7.3 Fishing grounds

Traps are mainly employed on sandy and muddy bottoms located at north of Ancona, between 1 and 3 nm offshore (Figure 26).

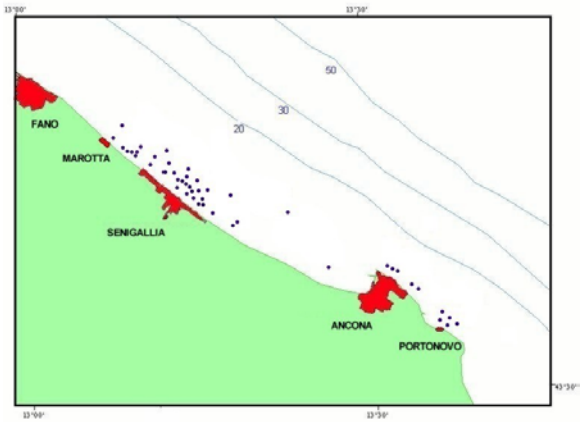

Figure 26. Fishing grounds of the artisanal vessels using traps for cuttlefish.

7.4 Fishing time over the year

The fishing season commonly extends from late winter to late spring. The gears are placed at

sea at the beginning of this period and definitively recovered at its end. Fishing operations, consisting of emptying, baiting and control of gears, take place at 24-48 hour intervals from Monday to Saturday, and show a seasonal trend characterised by an increase from winter to spring.

7.5 Data on catches

7.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 0.2 to 45 t (Figure 27), showing a direct relationship with the total amount of employed gears and great fluctuations among the years. A similar trend was also observed for LPUEs, which ranged between 0.7 kg/5000m/h and 4.5 kg/5000m/h. The target species always made up almost totality of landings (Figure 28).

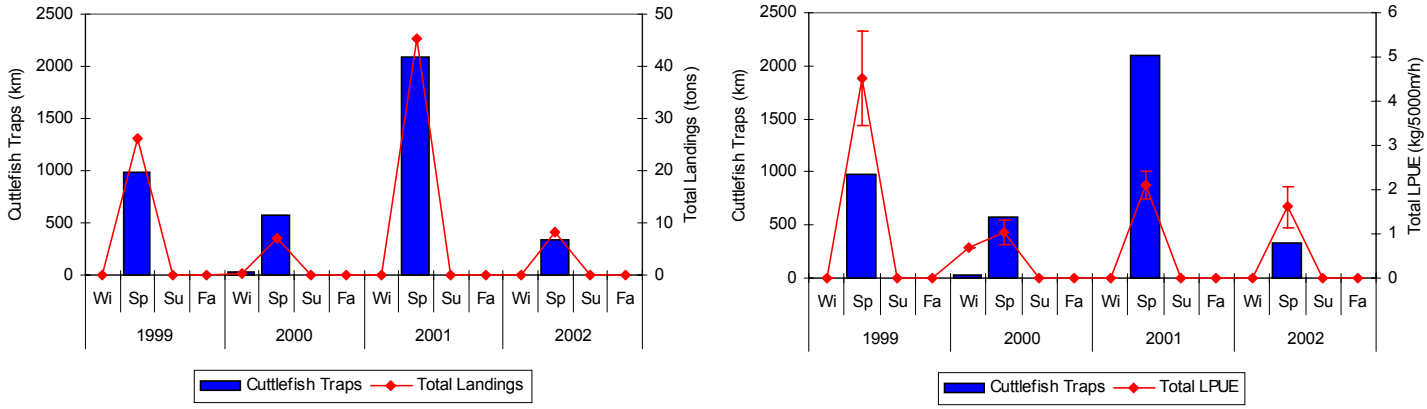

Figure 27. Seasonal trend of the total catches and LPUE of the vessels using traps for cuttlefish.

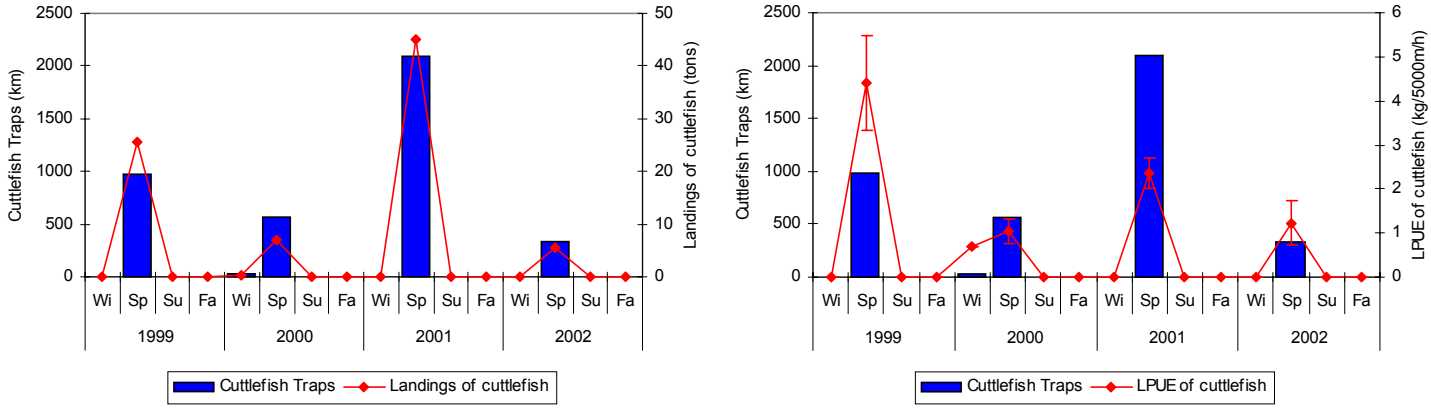

Figure 28. Seasonal trend of *S. officinalis* total landings and LPUE.

Landed by-catch was occasionally represented by *Conger conger, D. annularis, S. umbra*, *L. mormyrus* and *Liza* spp.

7.5.2 Discarding

Discard of commercial species is very scarce for this fishery, representing 3% in weight of the total catches (Figure 29). The most relevant species of this fraction are *Gobius niger* and *D. annularis*. Discard of non-commercial species amounts to about 6% of the total catch and mainly consists of *L. vernalis* and *N. reticulatus*.

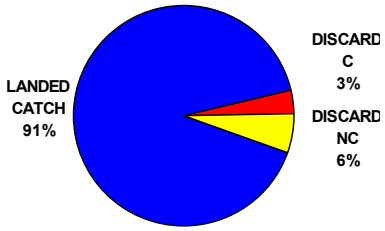

Figure 29. Composition of the total catches obtained with the traps for cuttlefish (1999-2000).

7.5.3 Demography and biological data of cuttlefish catches

Cuttlefish catches obtained with both types of traps fell in the size range 8.0–23.0 cm ML with an average mantle length of 13.8 cm (Figure 30).

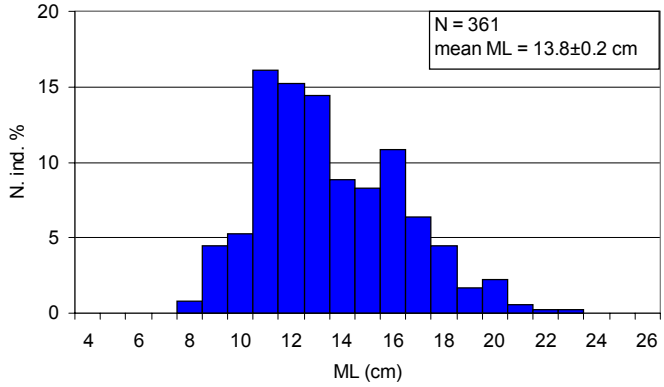

Figure 30. Demographic structure of *S. officinalis* catches obtained with traps (1999-2000).

Analysis of gonads carried out on 358 specimens (188 males and 170 females) did not show any significant difference between the two sexes (Table 12). All males and 85% of females had ripening gonads according with the fact that this species come inshore for reproduction. A deeper analysis on catch composition of the two types of traps evidenced that pots and fyke nets catch cuttlefishes in 17.6% and 16.1% of the possible cases respectively (Table 13; (Fabi and Sartor, 2001; Scarcella *et al*., 2002). In 60% of these cases catches consist either of one specimen, male or female (sex ratio of 1:0 or 0:1), or of a couple of individuals (1:1).

Table 12. Number of *S. officinalis* males and females recorded in catches of vessels using traps (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	TOTAL	SEX RATIO M/F	TEST χ^2
188	170	358	1.11	0.341

Table 13. Frequency of traps according to the sex composition of each trap.

	Total number of traps	FREQUENCY OF TRAPS BY SEX COMPOSITION (MALES:FEMALES)																		
		0:0	5:0	4:0	3:0	2:0	1:0	5:1	4:1	3:1	2:1	1:1	0:1	0:2	1:2	2:2	2:3	2:4	3:2	1:3
POTS	900	742	3	1	5	7	23	2	1	3	17	40	43	2	2	6	1	1	1	0
FYKE NETS	898	753	0	0	3	11	41	1	0	0	9	21	44	5	5	3	0	0	1	1

Further analysis carried out on the catches made of two or three specimens suggested, for males and only in the pots, a possible sexual attraction due to the occurrence of a female into the gear. On the contrary, the entry of females into the traps seems casual for pots, while in the case of fyke nets they show an attraction due to the presence of another female trapped inside

8. References cited

Fabi G. &De Ranieri S. (1998) Trammel and gill net selectivity in the Adriatic and Tyrrhenian sea. Study contract n. 94/086. Final Report for EC, DG XIV. 162+XVIII pp.

Fabi G. & Grati F. (2002) Valutazione degli effetti del fenomeno "mucillagini" sull'attività della piccola pesca dell'alto e medio Adriatico e sulle mitilicolture off-shore dell'area di Porto Garibaldi. Report for Agricul. and For. Pol. Min., Fish. and Aquacul. Gen. Div. 25 pp.

Fabi G., Grati F. & Sbrana M. (2002a) Attrezzi della piccola pesca utilizzati in funzione della successione stagionale e dell'eco-etologia delle specie ittiche in due aree costiere (Tirreno settentrionale e medio Adriatico). Final report for Agricul. and For. Pol. Min., Fish. and Aquacul.Gen. Div. 159 pp.

Fabi G. & Sartor P. (2001) *Sepia officinalis*: impact of three set gear fishing techniques in the Adriatic and the Ligurian Sea. Study contract n. 98/069. Final Report for the EC, DG XIV. 119+IX pp.

Fabi G., Sbrana M., Biagi F., Grati F., Leonori I. & Sartor P. (2002b) Trammel and gill net selectivity for *Lithognathus mormyrus* (L., 1758), *Diplodus annularis* (L., 1758) and *Mullus barbatus* (L., 1758) in the Adriatic and the Ligurian seas. *Fish. Res.*, 54: 375-388.

Fischer W., Bianchi G.& Scott W.B. (eds.). (1981) FAO species identification sheets for fishery purposes. Eastern Central Atlantic; fishing areas 34, 47 (in part). Canada Funds-in-Trust. Ottawa, Department of Fisheries and Oceans Canada, by arrangement with the Food and Agriculture Organization of the United Nations. Vol. III.

Froglia C. (1984) Presupposti bio-ecologici e tecnici per una nuova regolamentazione della pesca a strascico entro le tre miglia dalla costa. Report for Merc. Mar. Min., Fish Gen. Dir. 104 pp.

Froglia C. & Giannetti G. (1986) Remarks on rings formation in otoliths of *Solea vulgaris* and other flatfishes from Adriatic Sea. *FAO Fish. Rep*., 345: 121-122.

Kraljevic M., Dulcic J., Pallaoro A., Cetnic P. & Jug-Dujakovic J. (1995) Sexual maturation, age and growth of striped sea bream, *Lithognathus mormyrus* L., on the eastern coast of the Adriatic sea. *J. Appl. Ichthyol.*, 11 (1-8).

Scarcella G., Fabi G., Grati F. & Lucchetti A. (2002) Fattori che influenzano l'ingresso di *Sepia officinalis* L. 1758 nelle trappole. *Biol. Mar. Medit*., 9 (1): 161-169.

Sechin Y.T. (1969) A mathematical model for the selectivity curve of a gill net. *Rybn. Khoz*., 45 (9): 56-58.