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Shrimp Trawl Fishery By-catch in the Straits of Sicily (Central Mediterranean Sea)

by

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Abstract

The composition and biomass of the by-catch produced by the shrimp trawl fishery in the Straits of Sicily were investigated over one year. The main target species of this fishery were the red shrimp *Aristaeomorpha foliacea*, the violet shrimp *Aristeus antennatus* and the pink shrimp *Parapenaeus longirostris*. 77 trawl hauls were carried out at depths ranging from 300 to 585 m. The organisms caught were identified by researchers on board. Of the 170 taxa recorded 63 were bony fish, 37 crustaceans, 20 cartilaginous fish, 18 cephalopods, and 32 other groups. The weight of by-catch produced per kilo of shrimp was 9.6 kg of which 5.2 kg discarded. Bony fish were the largest fraction of the total catch representing 75.6%, followed by crustaceans (13.9%), cartilaginous fish (7.6%), cephalopods (2.7%) and others (0.2%). The total catch in weight was made up of 51% landed and 49% discard. Bony fish were the largest component of the discard, followed by cartilaginous fish. Bony fish component of the discard mainly consisted of silvery pout *Gadiculus argenteus*, followed by shortnose greeneye *Chlorophthalmus agassizi* and undersize specimens of hake *Merluccius merluccius*. Almost all skates were discarded; most of the crustaceans discarded consisted of pandalids *Plesionika* spp., true crabs (Brachyura), and pink shrimp *P. longirostris*. The cephalopods discarded mainly belonged to the family Sepiolidae. About half of the total trawl catch is thrown back into the sea as dead or alive organisms; data suggested a discard to shrimp weight ratio of 5:1.

Introduction

Most fisheries, directed to few commercial target species, catch a consistent number of non-target species, which form the by-catch. As some of them have economical value, they are usually retained by fishermen and sold in local markets. The others are discarded overboard during commercial fishing.

Species discarded can be distinguished into four groups (van Beek, 1998): 1) specimens of commercial species below the minimum legal landing size; 2) over-quota fish which is not allowed to be landed when this results to exceeding legal quota; 3) by-catch species of no commercial value; 4) fish with an undesired quality.

Most discarded species, when rejected overboard, do not survive as they get damaged either in the net during fishing or during the sorting process on board. On the other hand, they cannot be stocked and preserved by trawlers because of their limited freezing capacity.

Alverson *et al*. (1994) estimated that between 17.9 and 39.5 million tons (average 27.0 million) of marine organisms are discarded each year in commercial fisheries all over the world. The highest quantities of discards are from the Northwest Pacific region while tropical shrimp trawl fisheries generate the highest proportion of discards compared to any other fishery type.

The greatest level of discards is produced by demersal trawl fisheries as they are less selective than other fisheries producing discards and also due to the particular way fishing is being carried out (Saila, 1983).

Such a kind of fishery is one of the most practised in Sicily, together with small scale and purse seine fishery on pelagic fish, both characterised by high gear selectivity.

The main target species of the Straits of Sicily trawl fishery are giant red shrimp (*Aristaeomorpha foliacea*), violet shrimp (*Aristeus antennatus*) and deep-water pink shrimp (*Parapenaeus longirostris*). This fishery also produces important by-catches of *Merluccius merluccius*, *Nephrops norvegicus*, *Mullus barbatus* and *M. surmuletus*.

The aim of this study was to measure the composition of both the catch and the discard, which are produced by deep-sea fishery in the Straits of Sicily.

Materials and Methods

Evaluation of by-catch and discard production was carried out in the Straits of Sicily by observers on board of commercial trawlers, according to Saila (1983), in order to provide estimates to be more realistic and reliable than those obtained from randomial surveys. The study was carried out in an area near Cap Bon (36°50' N; 37°60' N; 9°02' E; 11°28' E; Fig. 1). The professional trawler "Aureola" (137 tons GRT, 400 hp), belonging to the Mazara fleet, was used for three season surveys (winter, spring, summer).

A total of 77 hauls were carried out at depths ranging from 300 to 585 m from January to August 1993, 10 of which in winter during 5 days, 28 in spring during 8 days, 39 in summer during 11 days. The average duration of haul was about three hours.

One scientist observed on board the fishing operations without interfering with any of the fishing crew decisions regarding the choice of fishing ground, depth, duration of haul or sorting and selection operations of the species and the individuals.

The organisms caught were divided by fishermen in two fractions, commercial and discard, and identified to the lowest possible taxon by researchers. All the species or taxa of the commercial and discard fractions were weighed before storing or discarding; in the case of big catches, two randomial subsamples of at least 10 kg each were considered. Vegetables were classified and weighed.

All the computation was made using the weight per fishing hour.

Results

Twelve hauls were conducted on giant red shrimp ground, from 360 to 585 m of depth; all the others were conducted on pink shrimp ground, from 300 to 462 m of depth.

During the three trips 170 taxa were recorded. Table 1 lists the taxa and their occurrence in landed and discarded fractions with indication of fishery ground. Very small differences between the two shrimp grounds were found in commercial and discard proportions; subsequent computations, therefore, were made considering all the hauls together.

The average catch over all the trips was 23 kg/hour. Bony fish were the largest fraction of the total catch representing 75.6%, followed by crustaceans (13.9%), cartilaginous fish (7.6%), cephalopods (2.7%) and others (0.2%). The catch of target shrimps was 7.5 kg/hour of which 0.5% was discarded; pink shrimp represented 86% of target shrimps.

The commercial by-catch was mostly represented by hake (28%), followed by *Chlorophthalmus agassizi* (23.7%).

The total catch in weight was composed of 51% landed and 49% discard, the highest percentage of discard being recorded in summer (53%).

65% of the landed catch was represented by bony fish, 25% by crustaceans, 6% by cartilaginous fish and 4% by cephalopods; bony fish were the largest component of the discards (86.5%), followed by cartilaginous fish (9%), crustaceans (2.6%), cephalopods (1.3%) and others (0.6%).

The percentages of landed and discarded fractions for each category are shown in Fig. 2.

The total catch, in terms of number of species, was composed of 63 bony fish, 37 crustaceans, 20 cartilaginous fish, 18 molluscs cephalopods, and 32 among bivalves, gastropods, sponges, cnidaria, echinoderms and brachiopods. Of those: 40 bony fish, 30 crustaceans, 11 cartilaginous fish, 7 cephalopods, and all the other species were completely discarded. In total, 39 species were present both in landing and in discard fraction.

Bony fish component of the discard consisted mainly of silvery pout *Gadiculus argenteus*, followed by shortnose greeneye *Chlorophthalmus agassizii* and undersize specimens of hake *Merluccius merluccius* (Fig. 3). Among cartilaginous fish, almost all skates were discarded, with the gray skate *Raja batis* being the species most discarded. Most of the crustaceans discarded consisted of pandalids *Plesionika* spp., true crabs (Brachyura) and pink shrimps *P. longirostris*. Most of the cephalopods discarded belonged to the family Sepiolidae.

Silvery pout, shortnose greeneye and hake contributed in weight to the total discard 39.8%, 9.4% and 5.6% respectively. From the main target species, less than 0.3% of the total pink shrimp caught were discarded.

The weight of by-catch produced per kilo of shrimp was 9.6 kg of which 5.2 kg discarded.

The biggest catch was recorded in summer when 42.1 kg/haul of commercial species and 47.4 kg/haul of discard were produced, whereas both commercial (26.3 kg/haul) and discard (15.9 kg/haul) lowest quantities were recorded in spring. Fig. 4 summarises the percent composition of commercial and discard fractions in the three seasons examined.

Discussion

Discard from trawlers represents a high incidence anthropic source of alteration for marine ecosystems. The dumping of large amounts of discards might have significant ecological effects: discards may be contributing to biological overfishing and altering the structure of marine ecosystems. Moreover, it may lead to an under exploitation of the potential productivity of the commercial fish stocks. Information on the qualitative and quantitative composition of discard will therefore contribute to a better understanding of the effects of fishery activities on the marine biota.

In the Mediterranean, an intense fishing activity producing great quantities of discard is represented by shrimp trawling.

This fishery mainly acts on pink shrimp *P. longirostris*, the most interesting demersal resource of the epibathyal layer (between 200 and 450 m), especially in the Straits of Sicily and in the Ionian Sea where it is particularly abundant (Arena and Li Greci, 1973; Relini *et al*., 1999). Pink shrimp is exploited all year round in these areas and almost the whole catch is marketable, the biggest specimens being of greater commercial value.

Together with pink shrimp, two deepwater shrimps, *A. foliacea* and *A. antennatus*, represent the highest profitable target for the trawl fisheries in the Sicilian waters. Here, the largest Italian shrimp fishery, the Mazara del Vallo fleet, operates.

During the usual fishing operations, Sicilian fishermen tend to maximise trawling time, as in other fisheries (Wassemberg and Hill, 1989), in order to increase the total catch. Longer trawl hauls increase the amount of discard fraction, cause more damage to organisms and increase sorting time per haul which consists in higher mortality of discard species due to long-time exposure on the deck, particularly during the summer season.

By the results of our study it appears that about half of the total trawl catch is thrown back into the sea as dead or alive organisms. Moreover, data suggested a discard to shrimp weight ratio of 5:1 according to those reported by Saila (1983) for shrimp world fisheries.

The greatest majority of the by-catch is discarded, as it is normal practice for Mazara's off-shore fisheries used to trips of 18-20 days. The amount of the discard is higher than the shrimp themselves, resulting in high mortality rate and wastage of precious resources often returned to the sea to feed birds, epipelagic organisms and benthic scavengers, producing an increase of opportunistic small sized and fast growing species at the expense of large size more sensitive and vulnerable species.

The discard fraction of each haul has a variable size and species composition, usually consisting mainly of small demersal bony fish with little or no economic value. The importance of cartilaginous fish in the catch, then in the discard, seems to depend on the degree of exploitation of the fishing ground.

Seasonal pattern showed a higher discard in summer because of the consistent number of recruits resulting from the previous reproduction period (D'Onghia *et al*., 1997). Usually these juveniles are discarded, with the only exception of juveniles of hake *M. merluccius* which is partly sold. This species is present throughout the year, in constant yield per hour in all the surveys, according to Andreoli *et al*. (1982).

The great quantity of discards produced by trawl fishery may have considerable impact on marine ecosystems, as it represents additional food for scavengers and may alter the composition and behaviour of communities living in the exploited grounds.

Considering the scarcity of data or estimates about discarding in Mediterranean fisheries, this work represents a preliminary investigation aimed at encouraging future research on the subject in the studied area.

Particularly, the comprehension of the problems involved in the fate of discard, in terms of ecosystem impact, should be the next step of this investigation.

Similarly, the recycling of portions of discard should be also promoted, as the nutritional features of some discarded species make them suitable to be employed in the food industry and zootechny.

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Table 1. List of the taxa and their occurrence in commercial and discard fractions, with indication of fishery ground (P = pink shrimp ground; G = giant red shrimp ground).

TAXA	Commercial	Discard
PHYCOPHYTA		W
Asparagopsis armata Harvey, 1855		W
Vidalia volubilis (L.) J. Agardh, 1863		W
PORIFERA		W
CNIDARIA		W
Anthozoa		
Actinia sp		G P
Antipathes sp		P
Funiculina quadrangularis (Pallas, 1766)		G P
Hydrozoa		P
MOLLUSCA		
Bivalvia		P
Glossus humanus (Linnaeus, 1758)		P
Venus casina (Linnaeus, 1758)		P
Cephalopoda		
Alloteuthis sp	P	G P
Argonauta argo Linnaeus, 1758		G
Bathypolypus sponsalis (P. & H. Fischer, 1892)		G P
Eledone cirrhosa (Lamarck, 1798)	P	P
Eledone moschata (Lamarck, 1798)	P	
Illex coindetii (Verany, 1839)	P	P
Loligo forbesii Steenstrup, 1856	G P	P
Loliginidae	P	P
Octopus defilippi Verany, 1851		P
Octopus vulgaris Cuvier, 1797	P	G P
Ommastrephidae		G P
Pteroctopus tetracirrhus (Delle Chiaje, 1830)		P
Rossia macrosoma (Delle Chiaje, 1830)		P
Scaeurgus unicirrhus (Delle Chiaje, 1841)		P
Sepia officinalis Linnaeus, 1758	P	P
Sepia orbignyana Férussac, 1826	P	P
Sepiolidae	P	G P
Todaropsis eblanae (Ball, 1841)	P	
Gastropoda		G P
Aporrhais serresianus (Michaud, 1828)		P
Charonia lampas (Linnaeus, 1758)		P
Cymatium parthenopeum (Salis Marschlins, 1793)		P
Fusiturris undatiruga (Ant. Bivona in And. Bivona, 1838)		P
Galeodea echinophora (Linnaeus, 1758)		P
Galeodea sp		P
Natica stercusmuscarum (Gmelin, 1791)		P
ARTHROPODA		
Crustacea		
Alpheus sp		P
Aristaeomorpha foliacea (Risso, 1827)	G P	G P
Aristeus antennatus (Risso, 1816)	G P	
Brachyura		G P
Calappa granulata (Linnaeus, 1758)		P
Cirripedia		G P
Crangon crangon (Linnaeus, 1758)		G P
Decapoda		P
Galatheidae		G P
Geryon longipes A.Milne Edwards, 1882		G P
Goneplax rhomboides (Linnaeus, 1758)		P
Latreillia elegans Roux, 1830		P

Table. 1. (continued)

Macropipus tuberculatus (Roux, 1830)		G P
Maja goltziana d'Oliveira, 1888		G P
Medorippe lanata (Linnaeus, 1767)		P
Munida sp		G P
Natantia		G P
Nephrops norvegicus (Linnaeus, 1758)	G P	P
Pagurus sp		G P
Palinurus mauritanicus Gruvel, 1911	P	P
Palinurus sp		P
Parapenaeus longirostris (Lucas, 1846)	G P	P
Paromola cuvieri (Risso, 1816)		P
Parthenope massena (Roux, 1830)		G P
Pasiphaea multidentata Esmark, 1866		P
Pasiphaea sivado (Risso, 1816)		P
Plesionika antigai Zariquiey Alvarez, 1955		P
Plesionika edwardsii (Brandt, 1851)	G P	G P
Plesionika heterocarpus (A. Costa, 1871)		P
Plesionika sp	G P	G P
Polycheles typhlops Heller, 1862		G P
Processa edulis (Risso, 1816)		P
Rissoides sp		P
Sergia robustus (S.I. Smith, 1882)		G P
Solenocera membranacea (Risso, 1816)		G P
Squilla mantis (Linnaeus, 1758)		P
Xanthidae		P
BRACHIOPODA		
Gryphus vitreus (Born, 1778)		G P
ECHINODERMATA		
Asteroidea		P
Astropecten sp		P
Crinoidea		P
Echinoidea		G P
Cidaris cidaris (Linnaeus, 1758)		P
Echinus sp		P
Holoturioidea		
Holothuria sp		P
Stichopus regalis (Cuvier, 1817)		P
TUNICATA		P
Microcosmus sp		P
Phallusia sp		P
VERTEBRATA		
Chondrichthyes		P
Etmopterus spinax (Linnaeus, 1758)		G P
Galeus melastomus Rafinesque, 1810		G P
Heptranchias perlo (Bonnaterre, 1788)		P
Raja asterias Delaroche, 1809	P	P
Raja batis Linnaeus, 1758	P	G P
Raja clavata Linnaeus, 1758	P	G P
Raja miraletus Linnaeus, 1758	P	G P
Raja montagui Fowler, 1910	P	
Raja naevus Müller & Henle, 1841		P
Raja polystigma Regan, 1923		P
Scyliorhinus canicula (Linnaeus, 1758)	G P	G P
Scyliorhinus stellaris (Linnaeus, 1758)	P	P
Squalus acanthias Linnaeus, 1758	G P	P
Squalus blainvillei (Risso, 1826)	P	G P
Squatina aculeata Cuvier, 1829		P
Squatina squatina (Linnaeus, 1758)		P

Table. 1. (continued)

Torpedo marmorata Risso, 1810		P
Torpedo nobiliana Bonaparte, 1835		P
Holocephala		
Chimaera monstrosa Linnaeus, 1758		G P
Osteichthyes		
Argentina sphyraena Linnaeus, 1758	P	P
Arnoglossus laterna (Walbaum, 1792)		P
Arnoglossus sp		G P
Bellottia apoda Giglioli, 1883		P
Belone belone (Linnaeus, 1758)		G P
Boops boops (Linnaeus, 1758)		P
Callionymus sp		P
*Capros aper (*Linnaeus, 1758)		P
Centracanthus cirrus Rafinesque, 1810		G P
Chauliodus sloani Schneider, 1801		G P
Chlorophthalmus agassizii Bonaparte, 1840	P	G P
Citharus linguatula (Linnaeus, 1758)	P	G P
Coelorhynchus coelorhynchus (Risso, 1810)		G P
Conger conger (Linnaeus, 1758)		G P
Electrona rissoi (Cocco, 1829)		G P
Epigonus telescopus (Risso, 1810)		G P
Eutrigla gurnardus (Linnaeus, 1758)	P	
Gadiculus argenteus Guichenot, 1850	P	P
Gaidropsarus mediterraneus (Linnaeus, 1758)		G P
Gnathophis mystax (Delaroche, 1809)		P
Helicolenus dactylopterus (Delaroche, 1809)	G P	G P
Hoplostethus mediterraneus Cuvier, 1829		G P
Hymenocephalus italicus Giglioli, 1884		G P
Lampanyctus crocodilus (Risso, 1810)		P
Lepidopus caudatus (Euphrasen, 1788)		G P
Lepidorhombus boscii (Risso, 1810)	G P	G P
Lepidorhombus whiffiagonis (Walbaum, 1792)	G P	G P
Lepidotrigla cavillone (Lacépède, 1801)		P
Lophius piscatorius Linnaeus, 1758	G P	P
Macrorhamphosus scolopax (Linnaeus, 1758)		P
Merluccius merluccius (Linnaeus, 1758)	G P	P
Micromesistius poutassou (Risso, 1826)	P	G P
Molva d. macrophthalma (Rafinesque, 1810)		G P
Mora moro (Risso, 1810)		G P
Mullus barbatus Linnaeus, 1758	G P	
Mullus surmuletus Linnaeus, 1758	P	
Muraenidae		P
Myctophidae		G P
Nettastoma melanurum Rafinesque, 1810		G P
Nezumia sclerorhynchus (Valenciennes, 1838)		G P
Notacanthus bonapartei Risso, 1840		G P
Pagellus acarne (Risso, 1826)	P	P
Pagellus erythrinus (Linnaeus, 1758)		P
Peristedion cataphractum Linnaeus, 1758	P	G P
Phycis blennoides (Brünnich, 1768)	G P	G P
Phycis phycis (Linnaeus, 1758)		P
Polyprion americanus (Schneider, 1801)	P	
Scomber scombrus Linnaeus, 1758	P	
Scorpaena scrofa Linnaeus, 1758	P	
Serranus cabrilla (Linnaeus, 1758)		P
Serranus hepatus (Linnaeus, 1758)		P
Solea sp		P
Spicara maena (Linnaeus, 1758)		P

Table. 1. (continued)

Spicara smaris (Linnaeus, 1758)		P
Symphurus ligulatus (Cocco, 1844)		G P
Symphurus nigrescens Rafinesque, 1810		G P
Synchiropus phaeton (Günther, 1861)		G P
Trachurus mediterraneus (Steindachner, 1868)		P
Trachurus trachurus (Linnaeus, 1758)		G P
Trigla lucerna Linnaeus, 1758	P	
Trigla lyra Linnaeus, 1758	P	P
Trigloporus lastoviza (Brünnich, 1768)	P	P
Zeus faber Linnaeus, 1758	P	P

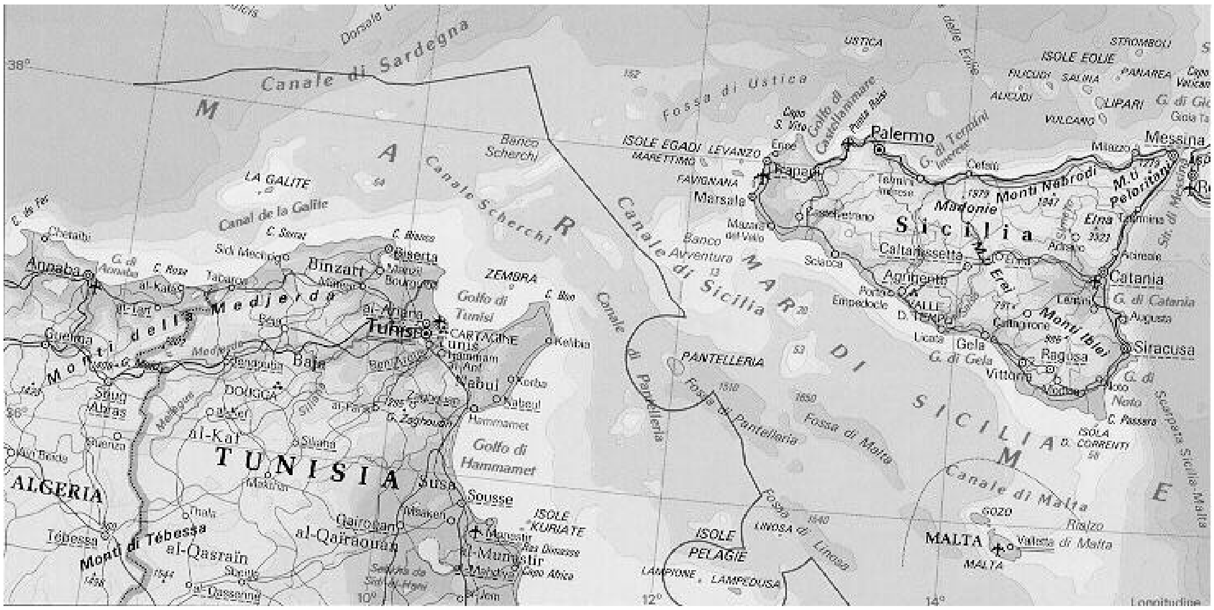
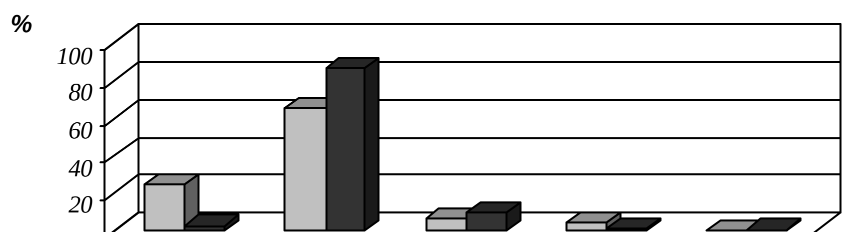


Fig. 1. Study area.

Percent composition of commercial and discard fractions in the main categories.



	Crustacea	Osteichthyes	Condrichthyes	Cephalopoda	others
Commercial	24,7	65,2	6,0	4,1	0
Discard	2,6	86,5	9,3	1,3	0,4

Fig. 2. Percent composition of commercial and discard fractions in the main categories.

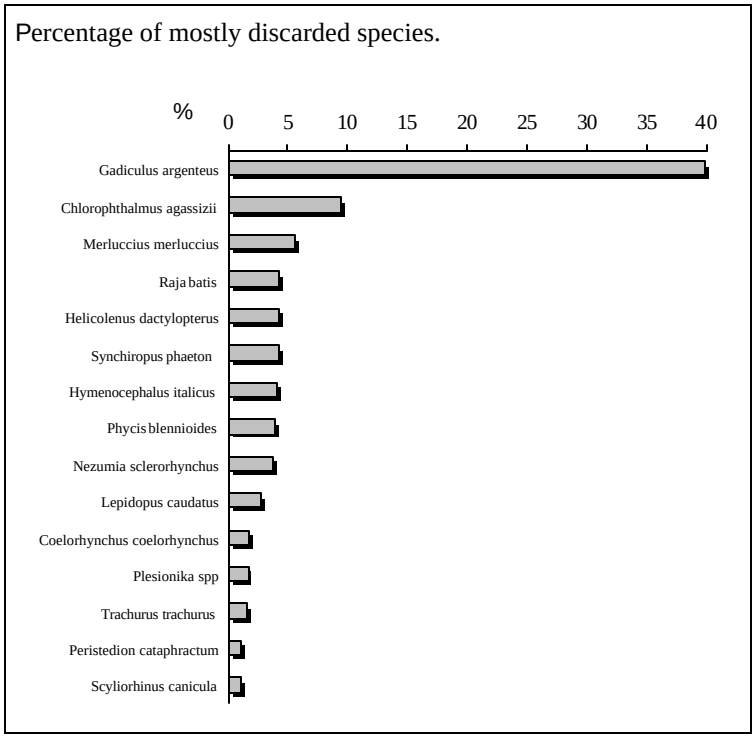


Fig. 3. Percentage of mostly discarded species.

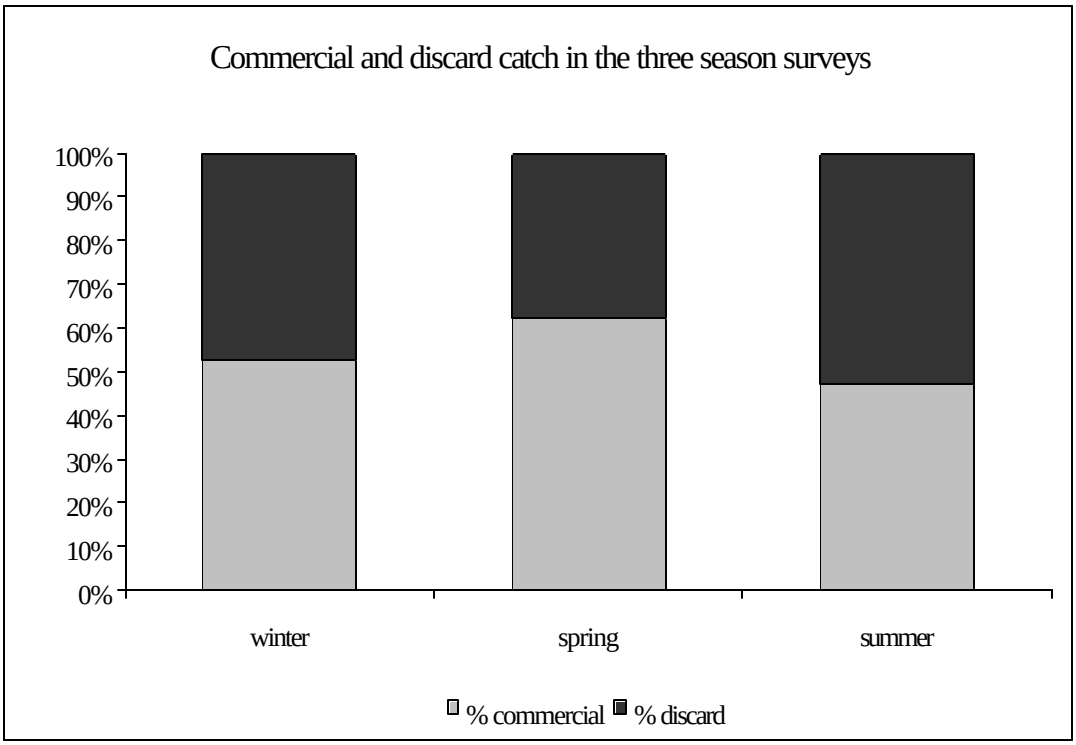


Fig. 4. Percent composition of commercial and discard fractions in the three season surveys.