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Estimated Bycatch in the British Columbia Shrimp Trawl Fishery

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Abstract

This paper is the third in a series of PSARC documents that utilise data from the bycatch sampling programme to address the issue of bycatch in the British Columbia shrimp trawl fishery. The first two papers dealt specifically with the bycatch of halibut and eulachon, while the focus of the current paper is to provide information on the bycatch of other non-target species in the shrimp-by-trawl fishery.

Bycatch sampling took place from 1997 to 1999 in 20 different Shrimp Management Areas. The majority of the sampling was conducted on otter trawlers off the West Coast of Vancouver Island and in Queen Charlotte Sound. Coverage of beam trawlers was more limited and focused on inshore areas and the Strait of Georgia.

Beam trawler bycatch was dominated by Selachii (dogfish, ratfish, and skates), followed by commercial flatfish, commercial roundfish, non-commercial roundfish, non-commercial invertebrates, and prawns. Selachii were particularly prevalent in beam trawl catches from the Strait of Georgia and Johnstone Strait. Otter trawl bycatch was dominated by eulachon, commercial flatfish, non-commercial roundfish, commercial roundfish, and Selachii.

Total estimated bycatch of beam trawls was generally higher than otter trawls both in terms of weight, and the percent of the total catch weight. Beam trawls from the Strait of Georgia had the highest ratios of bycatch to recorded catch. Otter trawls generally had much lower ratios of estimated bycatch to recorded catch, a notable exception being Area PRD in 1997.

The authors note that current levels of bycatch sampling are not adequate to address coastwide bycatch issues and recommend that specific bycatch concerns be identified and appropriate programmes developed to address those concerns. Alternatively, if monitoring of bycatch coastwide continues to be an objective, the authors recommend that a more expensive programme be considered that will provide greater sampling effort. In addition, they support the establishment of a multi-sector working group to address bycatch issues in all fisheries.

Résumé

La présente étude est la troisième d'une série de documents du CEESP fondée sur les données issues du programme d'échantillonnage des prises accessoires pour régler le problème des prises accessoires récoltées dans le cadre de la pêche de la crevette au chalut en Colombie-Britannique. Les deux premières études portaient nommément sur les prises accessoires de flétan et d'eulakane, tandis que la présente vise à fournir des renseignements sur les prises accessoires d'autres espèces non ciblées par les pêcheurs de crevette au chalut.

L'échantillonnage des prises accessoires a été fait dans 20 différentes zones de gestion des crevettes de 1997 à 1999. La plus grande partie de l'activité a visé les bateaux de pêche au chalut à panneaux pêchant au large de la côte ouest de l'île de Vancouver et dans le bassin Reine-Charlotte. La couverture des bateaux de pêche au chalut à perche, plus limitée, a visé les zones côtières et le détroit de Georgia.

Les sélaciens (aiguillat, chimère et raie) dominaient dans les prises accessoires à la perche, suivis de poissons plats marchands, de poissons ronds marchands et non commercialisables, d'invertébrés non commercialisables et de crevettes. Ils étaient particulièrement abondants dans les prises récoltées dans les détroits de Georgia et de Johnstone. L'eulakane, les poissons plats marchands, les poissons ronds marchands et non commercialisables et les sélaciens dominaient dans les prises accessoires au chalut.

Les prises accessoires totales estimatives à la perche étaient généralement plus élevées que celles obtenues au chalut, tant au plan du poids que du pourcentage du poids total des prises. Les bateaux de pêche à la perche dans le détroit de Georgia montraient le rapport des prises accessoires aux prises signalées le plus élevé, tandis que les bateaux de pêche au chalut affichaient généralement un rapport nettement moins élevé, la seule exception importante étant la zone PRD en 1997.

Les auteurs notent que les niveaux actuels d'échantillonnage des prises accessoires ne sont pas adéquats pour régler la question des prises accessoires à l'échelle de la côte. Ils recommandent donc que les problèmes particuliers de prises accessoires soient identifiés et que des programmes appropriés soient élaborés pour les régler. Par contre, si la surveillance des prises accessoires à l'échelle de la côte continue d'être un objectif, ils recommandent comme autre solution que l'on considère la mise en place d'un programme plus dispendieux d'échantillonnage plus exhaustif. Ils avalisent en outre la création d'un groupe de travail multisectoriel chargé d'étudier les problèmes de prises accessoires dans toutes les pêcheries.

Introduction

McCaughran (1992) defines bycatch as the sum of discarded catch plus incidental catch, where discarded catch is "the portion of the catch which is returned to the sea for economic, legal, or personal reasons" and incidental catch is "the retained catch of non-target species". During the 1990's, bycatch emerged as major issue in the management of fisheries throughout the world, largely due to increased public awareness through the actions of conservation and environmental groups (Alverson and Hughes 1995). Non-selective fishing techniques such as trawling have been targeted for concern due to the perception of waste, destruction of valuable and protected species, and inefficient use of available resources (Murawski 1995).

Estimating bycatch levels has traditionally been very difficult because bycatch is rarely reported in landings. Therefore, bycatch estimates are usually based on speculation or on the observation of a small sample of vessels. Despite the obvious uncertainty surrounding such figures, several authors have provided surprisingly large estimates of global bycatch and discard levels. Saila (1983) estimates a total world discard of 6.72 million tonnes, or 12% of total landings. Alverson et al (1994) estimate a global discard range of 17.9 – 39.5 million tonnes based on a total catch of 77 million tonnes. From a species and gear-type perspective, the shrimp trawl fisheries have been identified as having the highest ratio of discarded bycatch to landed catch, at 0.84 (Alverson et al 1994) and are considered the "dirtiest" fisheries in the world. However, this figure is based mainly on shrimp trawl fisheries in the tropics and west central Pacific.

The British Columbia shrimp trawl fishery has targeted primarily on three species of shrimp: *Pandalus jordani* (smooth pink), *P. borealis eous* (Northern pink), and *Pandalopsis dispar* (sidestripe). Species such as *Pandalus hypsinotus* (humpback), *P. danae* (coonstripe or dock), *P. goniurus* (flexed pink), and *P. platyceros* (prawn) have been caught incidentally or in small quantities. Only these seven species of shrimp can legally be retained in the shrimp trawl fishery, and there are limits on retention of prawns. However, a large variety of other species (both fish and invertebrates) are caught as bycatch and then discarded.

In 1995, a Shrimp Sectoral Bycatch Subcommittee was formed to address bycatch issues. The subcommittee met in December of 1995 to develop a coordinated approach to address bycatch problems in the shrimp trawl fishery. One of the key areas identified for action by the subcommittee was the development of a sampling programme to document the spatial and temporal nature of bycatch associated with this fishery. In April of 1996, the Department of Fisheries and Oceans, DFO, Ministry of Agriculture, Fisheries and Food, and MAFF, developed a collaborative agreement to train a student and initiate a bycatch sampling program over the summer of 1996. Since 1997, more concerted efforts were made at addressing this issue with funding being jointly provided by both DFO and industry.

The shrimp trawl industry has voluntarily adopted 100% implementation of bycatch reduction devices (BRDs) for the year 2000 fishery. As a result, bycatch composition and distribution may change significantly. It will be necessary to continue sampling over the next several years in order to monitor any changes in bycatch.

This paper is the third in a series of PSARC documents that utilise data from the bycatch sampling programme to address the issue of bycatch in the British Columbia shrimp trawl fishery. The first two papers dealt specifically with the bycatch of halibut (Boutillier et al 1999a) and eulachon (Hay et al 1999). The focus of the current paper is to provide information on the bycatch of other non-target species in the shrimp-by-trawl fishery. Specifically, the paper addresses the following objectives:

1. To describe the 1997-99 B.C. shrimp trawl bycatch monitoring programme and provide estimates of total bycatch and bycatch by species group by gear-type, Shrimp Management Area, and year.
2. To examine variations in bycatch due to gear differences such as gear-type and the use of bycatch reduction devices (BRDs).
3. To examine spatial and temporal variations in bycatch in the B.C. shrimp trawl fishery.
4. To compare bycatch levels in the B.C. shrimp trawl fishery to those in other trawl fisheries.
5. To review management strategies used in other trawl fisheries to reduce bycatch, and to provide bycatch reduction options for managers of the B.C. shrimp trawl fishery.

Methods

Observers were hired and trained to identify and sample target and bycatch species taken by commercial vessels in the British Columbia shrimp trawl fishery. The intent was to collect bycatch information for a variety of areas, times, and gear types.

During bycatch sampling, observers generally board a beam-trawl or otter-trawl vessel prior to the start of a fishing trip, and remain on board for all or part of the fishing trip, usually 2 or 3 days. Throughout the trip, observers sample the catch from each trawl set as it is brought on board. If possible, the entire catch is sorted to species and weighed. However, this is usually not feasible due to the large size of most catches. In these cases, observers obtain a random sample from the catch, sort this to species, and weigh. The estimated total catch weight of each species is then extrapolated by multiplying each species weight from the sampled catch by the total catch weight, divided by the weight of the sampled catch. For example, if the total catch weight is 500 kg and a random sample of 10 kg is sorted to species and weighed, a species weight of 2 kg would yield an estimated total catch for that species of 2 kg $\times$ 500 kg $\div$ 10 kg, or 100 kg. Species that are present in amounts too small to weigh are recorded as "trace" and are ultimately coded with a weight of 0.1 kg. In addition to catch data, associated information such as trawl location, gear-type, date, time, and duration of trawl are also recorded. Data are sent to the Shellfish Data Unit at the Pacific Biological Station, and are stored in an Access database, along with other shrimp trawl research data. Information on commercial effort by year, gear-type, and area are obtained from mandatory commercial logbooks. The Shellfish Data Unit also maintains these data in an Access database.

This analysis focuses on all species captured. The bycatch of selected commercially important species, or species that are caught in relatively large amounts, are presented individually. However, rather than present all of the numerous bycatch species individually, species are also categorised into larger groups based on broader taxonomic, management, and economic considerations (Table 1). Total bycatch of individual species or species groups is estimated by multiplying the mean observed catch rate of each by the total commercial effort for a given area. No bycatch estimate is made for areas where bycatch sampling did not occur. Temporal-spatial analysis is presented by year (1997 to 1999) and by Shrimp Management Area (Fig. 1). All confidence limits for the mean bycatch estimates were obtained using the bootstrap technique (S-PLUS, 1999).

Results

1. *Bycatch Observer Coverage*

Bycatch sampling took place from 1997 to 1999 in 20 different Shrimp Management Areas (124OFF, 125OFF, 12IN, 12OUT, 14, 16, 17, 18, 19, 23IN, 23OFF, 26IN, 27IN, 27OFF, 2IN, 8IN, FR, GSTE, PRD, and QCSND) (Table 2). The majority of the sampling was conducted on trawlers using otter trawl gear off the West Coast of Vancouver Island (23OFF, 27OFF, 123OFF, and 125OFF) and in Queen Charlotte Sound (QCSND). Coverage of beam trawlers was somewhat more limited and focused on inshore areas and the Strait of Georgia. This coverage reflects the distribution of the vessels using each gear type, as otter trawlers tend to fish offshore areas while beam trawlers fish inshore areas. The emphasis on otter trawlers reflects the level of concern over the bycatch of eulachon and halibut in offshore areas using this gear type. Over all areas and years, commercial beam trawlers were sampled at a level of approximately 1% in 1997 and 1999, and 0.5% in 1998, in terms of the number of tows and hours sampled, while otter trawl tows were sampled at a level of approximately 4% in 1997, 3% in 1998, and 2% in 1999.

The use of bycatch reduction devices (BRDs) in sampled sets was highly weighted towards otter trawls (Table 3). In fact, over the 3 years of sampling, about 97% of the sampled otter trawl sets had BRDs installed (Table 3). In contrast, only about 19% of sampled beam trawl sets had BRDs and most of these were used in one area, 23OFF.

2. *Bycatch Composition*

Based on available bycatch samples, the bycatch of beam trawlers is dominated by Selachii (dogfish, ratfish, and skates), followed by commercial flatfish, commercial roundfish, non-commercial roundfish, non-commercial invertebrates, and prawns (Fig. 2). Selachii are particularly prevalent in beam trawl catches from the Strait of Georgia and Johnstone Strait. In fact, in 1997, the percent of Selachii in the sampled catch was nearly equal to that of shrimp in areas 16 and FR, was almost double that of shrimp in area 17, and in 1999, was almost 5 times that of shrimp in Area 12OUT (Table 3). Similarly, the percent of commercial flatfish exceeded that of shrimp in sampled catches from Area 17 in 1997, and in Area 12OUT in 1999, while commercial roundfish exceeded shrimp in Area 17 in 1997, and non-commercial roundfish exceeded shrimp in Area 17 in 1997 and Area 12OUT in 1999 (Table 4). Most of the beam trawls sampled did not have BRDs. Given that the use of these devices became mandatory in 2000, the catch composition of beam trawls may change dramatically in 2000.

Otter trawl bycatch is dominated by eulachon, commercial flatfish, non-commercial roundfish, commercial roundfish, and Selachii (Fig. 2). Aside from 2 tows sampled from Area 124OFF in 1998 that apparently yielded no shrimp, and 1 tow sampled from Area 27IN in 1998, the percent of bycatch in sampled otter trawls never exceeded the catch of shrimp (Table 4, Fig. 3b, 3d, and 3f). Certain bycatch groups did exceed 10% of the total catch in several years and areas, most notably, eulachon in Area QCSND in 1997, commercial flatfish in Area PRD in 1997, commercial roundfish in Areas 12IN and 18 in 1998, and Area 19 in 1999, non-commercial roundfish in Area 18 in 1998, and Selachii in Area PRD in 1997 (Table 4). High bycatch in otter trawls in PRD in 1997 is probably mainly due to the relatively large number of sets sampled for which no BRD was used (Table 3).

3. Estimated Bycatch

Estimates of the total bycatch of each species group by year, gear, and area, were made by multiplying the mean catch per unit effort recorded from bycatch sampling (Table 5), by the commercial effort expended for the same year, gear, and area groups. Results are presented in Table 6. Table 7 lists the median and lower and upper 95% confidence limits for the mean bycatch estimates, obtained using bootstrap techniques (S-PLUS, 1999), while Table 8 provides estimates for individual species, rather than species groups. The analysis is obviously highly sensitive to the mean CPUE values recorded from bycatch samples, which are often quite variable and based on only a few tows. Therefore, the uncertainty in the estimates of total bycatch is sometimes considerable. For example, the lower and upper 95% confidence limits for the estimated bycatch of commercial flatfish in Area 17 by beam trawlers, based on only 3 sets sampled, are 2,034 Kg and 26,780 Kg, respectively (Table 7). No attempt is made to estimate bycatch in unsampled areas. Therefore, total, coastwide bycatch estimates are likely higher than the sum of the estimates presented here.

The total estimated bycatch of beam trawls is generally higher than otter trawls both in terms of total weight, and as a percent of the catch weight (Fig. 4). By Shrimp Management Area, estimates for beam trawls range from a high of over 200 tonnes (244% of the reported shrimp catch) in Area FR in 1997 (Fig. 4a), to a low of under 20 tonnes (22% of the reported shrimp catch) in Area 2IN in 1999 (Fig. 4e). In general, areas in the Strait of Georgia appear to have the highest ratios of bycatch to recorded catch (Fig. 4a, 4c, and 4e). Area FR stands out as having the highest overall bycatch estimate of any area for the years 1997-99 and is dominated by Selachii, commercial flatfish, non-commercial roundfish, and commercial roundfish (Table 6 and 7). In fact, in 1997 the estimated bycatch of Selachii is approximately 50 tonnes greater than the estimated or reported shrimp catch (Table 6). Unfortunately, despite the fact that this area is one of the most heavily trawled regions on the coast by beam trawlers, relatively little bycatch sampling occurred here between 1997 – 99 with only 0.4% of the commercial tows sampled.

Otter trawls generally have much lower ratios of estimated bycatch to recorded catch than beam trawls (Fig. 5) probably mainly due to the use of BRDs. However, the estimated bycatch in Area PRD in 1997 is almost three times as large as the reported shrimp catch and is dominated by commercial flatfish, Selachii, and non-commercial roundfish (Fig. 5b; Table 5 and 6). However otter trawl sets from PRD in 1997 include 11 sets where a BRD was not used. Although total otter trawl bycatch estimates in other areas are relatively low compared to recorded catch, the estimated bycatch of specific groups in some areas are still fairly high. In particular, eulachon in Areas QCSND and 23OFF in 1997 and 1998, and in Area 23OFF in 1999, commercial flatfish in Area QCSND in 1997 and 1998, commercial roundfish in Area

QCSND in 1998 and in Area 23OFF in 1999, and non-commercial roundfish in Area QCSND in 1998 and 1998 (Table 5 and 6).

The bycatch of individual commercial species in the shrimp trawl fishery is generally negligible compared to the quotas imposed for these species in their target fisheries. However, there are a few notable exceptions for some species in some years. For example, the estimated bycatch of Quillback and Copper rockfish in 1997 was just over 9 tonnes (Table 8). This is comparable to the 2000 groundfish trawl quota for these two species which, combined in an aggregate group with China and Tiger rockfish, was only 10 tonnes. It's also almost 10% of the 2000 quota for the inside hook-and-line fishery, which is main fishery for this species aggregate. Also noteworthy is the estimated bycatch of English sole in 1997 and 1999 (Table 8). At about 44 tonnes it represents nearly 6% of the total 2000 groundfish trawl quota of 771 tonnes. In addition, Dover sole bycatch estimates were relatively high in 1997 and 1999, at approximately 9 to 10 tonnes (Table 8), although this represents less than 1% of the 2000 groundfish trawl quota of 1,375 tonnes. Other species with high bycatch estimates, although not necessarily significant in terms of the quotas in their target fisheries, include Pacific Hake, which had a bycatch estimate of over 100 tonnes in 1999, Walleye Pollock, which had a bycatch estimate of over 30 tonnes in both 1998 and 1999, and Spiny Dogfish, which had bycatch estimates of over 100 tonnes in 1997 and over 50 tonnes in 1998 and 1999 (Table 8).

4. Variations in Bycatch CPUE: Spatial, temporal, and gear considerations

In general, the bycatch observer data is not consistent enough across years, areas, and gear-types to enable coastwide analyses of spatial and temporal trends in bycatch. However, there are a few areas where the data are extensive enough so that specific questions can be posed. These are listed in the following sections.

a. Does the use of BRDs significantly reduce bycatch CPUE?

This question can be addressed of both beam trawlers in Area 23OFF in 1998, and of otter trawlers in Area PRD in 1997. As Fig. 5a shows, the use of BRDs in beam trawls in 23OFF in 1998 did significantly reduce the bycatch CPUEs of several major species groups including commercial roundfish, commercial flatfish, and Selachii, and reduced, albeit not significantly, the catch of non-commercial roundfish. In 1997, otter trawlers in Area PRD that utilized BRDs had significantly lower bycatch CPUEs of commercial and non-commercial roundfish, commercial flatfish, and Selachii (Fig. 5b). The catch rates of eulachon in PRD were negligible (Fig. 5b).

b. Does bycatch CPUE vary between gear types?

An analysis of bycatch CPUEs from otter and beam gear fishing with BRDs in Area 23OFF in 1999 suggests that the CPUE of commercial roundfish and commercial flatfish are quite similar between the two gear types (Fig. 6). On the other hand, eulachon and non-commercial roundfish CPUE is significantly higher for otter trawlers, especially eulachon CPUE (Fig. 6). The CPUE of Selachii is low for both gear types (Fig. 6).

c. Does bycatch CPUE vary annually?

This question can be addressed of otter trawlers using BRDs in Area 23OFF in 1997 and 1999, and also for beam trawlers without BRDs in the same area in 1997, 1998, and 1999. Results indicate that for otter trawlers, bycatch CPUE dropped between 1997 and 1999 for all species groups except commercial roundfish (Fig. 7a). For beam trawlers, bycatch CPUE appears to have declined somewhat for most species groups over the period of 1997 to 1999, but the declines are not significant (Fig. 7b). In contrast, the CPUE of commercial roundfish went up significantly in 1999 (Fig. 7b). In 1999 there was a large increase in the catch of hake in Area 23OFF for both gear types. This accounts for the large increase in commercial roundfish CPUE seen for both gear types (Figs. 8a and 8b) and may be due to a change in the distribution of hake in 1999 compared to previous years.

d. Does bycatch CPUE vary spatially?

This question can be addressed using CPUEs from beam trawlers with no BRDs operating in Areas 23OFF and FR (Fig. 1) with data combined over the 3 years of sampling. Results indicate that bycatch CPUE is generally higher in Area FR, especially for non-commercial roundfish and Selachii (Fig. 8). There were no eulachon caught as bycatch in Area FR (Fig. 8).

5. Bycatch in Other Trawl Fisheries

Bycatch is a problem for world fisheries and may even be considered “the major problem” in many respects (Hall 1999). It has always been recognised as a problem but it wasn’t until the 1990’s that it became a very public issue including a United Nations General Resolution 49/118. This resolution called upon all states to take into consideration the effect on associated and dependent species when establishing conservation and management measures for target species in fisheries (Everett 1996). This resolution subsequently led FAO to formulate bycatch and discard provision in its Code of Conduct for fisheries.

Worldwide for all fisheries, Alverson et al (1994) estimated bycatch of 27 million tonnes of discards on a target catch of 77 million tonnes. Mean bycatch from the shrimp fisheries was estimated by Alverson et al (1994) to be 11.2 million tonnes while Andrew and Pepperell (1992) estimated the global discard figure of 16.7 million tonnes for shrimp fisheries alone. This is an extreme problem in some areas such as the United States South East Atlantic shrimp fishery, which has bycatch rates of weight of fish to shrimp in the order of 2.3:1, and in the Gulf of Mexico of 4.3 to 1 (Graham 1996). If one is to look at this question only in the context of what Alverson and Hughes (1996) define as Ecological Use Efficiency (EUE) i.e. the Retained Catch / Total Catch (Retained + Discarded) then we can see from Fig. 3, that the shrimp trawl fisheries in B.C. in comparison to other shrimp fisheries in the world are fairly clean. In particular, the otter trawlers seem to consistently have very good EUE ratios, which is probably due to their quick voluntary adoption of bycatch reduction devices (BRD). The beam trawlers on the other hand had much higher EUE rations in some of the inside areas although still not in the range of the Gulf of Mexico. This may be a function of both area and use of BRD. For the fishery in 2000, industry requested that the fishery made the use of BRD mandatory in all areas and with all gear types. Hopefully, this will significantly reduce the bycatch EUE for beam trawls.

Unfortunately as Hall (1999) points out, it is not just a question of how much is caught but more importantly it is necessary to classify the bycatch according to the type and level of effect. He developed the following categories to illustrate these issues:

1. Critical bycatches – bycatch of populations or species in danger of extinction.
2. Non-sustainable bycatches- populations not at risk but will lead to declines in population.
3. Sustainable bycatches – levels of bycatch that would not lead to declines in levels of abundance.
4. Non-biologically significant bycatches – bycatches so low they are considered negligible from the view of populations involved.
5. Bycatch of unknown levels – situation where we lack the basic data on abundance and mortality to determine the extent and sustainability of the bycatch.
6. Ecosystem-level impacts – the focus here is on the complex of animals being removed.
7. Charismatic bycatches – this category reflects different societal values and that some species have a special emotional value that may be independent of the level of the effect exerted or the conservation status of the species.

For the shrimp fishery in B.C. the bycatch issues vary between areas and between gear types and as such there is probably not a single solution to this complex problem.

6. Bycatch Management Strategies Used in Other Trawl Fisheries

Solutions to the issue of bycatch management are being sought globally. Thomson (1995) summarises the bycatch regulations in use in the fisheries off Alaska and provides a comprehensive list of techniques that may be utilised to manage bycatch:

- Time and area closures.
- Aggregate prohibited species caps (tonnage or number of individuals)
- Bycatch rates and mortality rates for both prohibited species and non-target species
- Allocation to selective gears with lower bycatch mortality
- "Pay-as-you-go" onboard observer programs
- Performance trawl definition
- Gear restrictions
- Techniques to release and minimise harm to bycatch
- Protection zones when abundances are below threshold levels
- Catch and bycatch data production and analysis with reports available to the public on a timely basis
- Publication of vessel-by-vessel bycatch rates, which identify the "dirty dozen", a peer pressure mechanism that has proven effective

Other techniques that have been suggested that recognise that some of the problem belongs to the management system that deals with allocation between user groups. Davis (1996) notes that it may be impossible to develop technology that would allow single species removal and suggests a multispecies management regime that shares the quota among all the impacting fisheries.

In some jurisdictions, some or all of the bycatch from trawling is utilised. In New South Wales, Australia, bycatch from the prawn trawl fishery is divided into bycatch that is discarded and "by-product" that is landed and marketable. This "by-product" is usually considered "acceptable" in terms of inter-fishery conflicts because alternative fisheries [for these species] are negligible (Kennelly 1994). In the Oregon shrimp trawl fishery, retention of commercially important groundfish species is permitted under retention limits of fish per trip and monthly limits for individual species. However, retention of some groundfish species was reduced in 1999 under a groundfish stock rebuilding strategy, and Oregon shrimpers have begun investigating the use of fish excluders to reduce the incidence of groundfish in shrimp trawls and improve shrimp quality (Hannah and Jones 2000).

In order to keep bycatch from increasing or force a reduction in bycatch, the first choice in bycatch management is usually a limit on the amount of bycatch or on bycatch mortality. Bycatch limits are usually necessary, but without additional management actions the result is often a race to fish. Individual incentive programs can be developed, such as assigning bycatch limits to individual vessels or vessel pools, which could effectively reduce the race to harvest fish before bycatch limits are reached (Trumble 1995). Limits (prohibited species caps) have been placed on the total harvest of prohibited species taken as bycatch in the groundfish fisheries of the Bering Sea, Aleutian Islands and Gulf of Alaska and there are currently several hundred individual bycatch limits explicitly or implicitly established in the management regime for these fisheries (Smith 1995). In the Eastern Bering Sea flatfish fisheries, regulations governing bycatch of prohibited species include area closures and aggregate bycatch caps. In the Eastern Bering Sea, data reporting is also used to identify bycatch rates and bycatch hot spots through satellite transmission of observer data, which are rapidly converted into plotted reports and bycatch rate assessments to allow the fleet to rapidly respond (both individually and collectively) to high bycatch rates, minimise bycatch of prohibited species, and to more effectively stay within the overall prohibited species bycatch caps (Gauvin 1995).

Within Canada's Pacific region, selective fishing strategies are being developed for all fisheries in which bycatch is an issue, in order to meet specified standards of selectivity (by 2005 for shellfish fisheries). The shrimp trawl fishery has already undertaken to initiate selective and responsible fishing practices. Management measures currently in place to control bycatch include time and area closures, "bycatch action levels" for particular species of concern (roughly equivalent to prohibited species caps), mandatory use of selectivity gear (fish excluders), retention and retention limits on incidental catch of some species, non-retention of finfish, and the dumping of species caught under the authority of the licence is prohibited. In addition, the catch sampling program collects catch and bycatch information to provide for, among other things, in-season monitoring of action levels. Extended fishing opportunities have been provided to gear that has been shown to be more selective for a particular species of concern and experimentation with selective fishing gear is ongoing. The industry has identified a Selective Fishing Subcommittee and Future Management Committee that report to the main advisory body for the fishery on issues related to bycatch and selective fishing practices.

Discussion

Since the programme began in 1997, bycatch sampling of shrimp trawls has been very inconsistent both spatially and temporally. Except in a few areas, most notably Area 23OFF, the data are insufficient to support analyses that would help determine spatial and temporal trends in bycatch. In addition, sampling of beam trawlers was heavily weighted towards those vessels that did not use BRDs while almost all of the otter trawls sampled had BRDs. This makes comparisons of bycatch between gear types difficult. In addition, given that the use of BRDs became mandatory in 2000, concerns over bycatch levels in beam trawls identified in this paper may already be resolved. Therefore, both the species composition and estimates of bycatch given in this paper, especially with respect to beam trawls, should only be considered a "snapshot" of conditions prior to 2000. In 2000 and beyond, we might expect to see a marked decline of bycatch in both beam and otter trawls.

To date, the mandate of the bycatch sampling program has really been nothing more than to "monitor changes in bycatch" with respect to time, area, and gear. Unfortunately, this objective is far too vague given the available level of sampling effort. In the future, specific objectives will need to be identified and prioritised and appropriate long-term programmes developed. If coastwide sampling continues to be an objective, then a more expensive programme will have to be considered as current levels of observer coverage are simply not adequate to address coastwide bycatch issues.

The existing data do provide a few opportunities to address some specific questions concerning the variation in bycatch catch rates between gear types, areas, and years. In particular, it seems that the use of BRDs significantly reduces the bycatch CPUE of most species groups in both otter trawls and beam trawls. Nevertheless, despite the use of BRDs, the bycatch of eulachon in otter trawls continues to be relatively high on the West Coast of Vancouver Island. With or without BRDs, bycatch CPUE seems to be declining over time for both beam and otter trawls, at least off the west coast of Vancouver Island. It's unclear whether this reflects changes in fishing practices or changes in the actual abundance of bycatch species. In at least one instance, a large increase in the abundance of hake on the west coast of Vancouver Island appears to have caused large increases in bycatch for both gear types. A limited comparison of beam trawls in Area 23OFF and Area FR suggests that bycatch does vary between areas, at least for certain species. For example, the bycatch of Selachii appears to be greater in Area FR while eulachon bycatch is greater in 23OFF. However, a more extensive and directed sampling programme will be required before between-area variation can effectively addressed.

Conclusions and Recommendations

Hall (1999) points out that knowing the mortality numbers themselves are not especially helpful, what we are concerned about is the impacts on the population. He suggests that understanding the impacts on populations will require a minimum of three pieces of information:

1. Reliable estimates of by-catch numbers.

2. Knowledge of stock identity and migration.
3. Reliable estimates of population size.

With respect to his first point, most shrimp trawl bycatch sampling effort has focused on otter trawls in Queen Charlotte Sound and off the West Coast of Vancouver Island, in a response to concerns over the bycatch of eulachon and halibut. The data are inadequate to address bycatch issues in most other areas, especially since the sampling effort has been inconsistent over the years. It is unlikely, given the current levels of funding, that sampling effort will ever be adequate to address bycatch concerns in all areas over all years.

Recommendation 1: Identify and prioritise specific bycatch concerns and develop long-term cost-effective sampling programs that will provide sufficient data to address these concerns.

If coastwide bycatch trends are indeed a priority then the sampling programme must be expanded accordingly. More funds may be required.

Recommendation 2: If coastwide sampling continues to be the focus, a more expensive bycatch sampling program should be considered, involving at-sea charters with observers that get on and off vessels at sea. Additionally, 100% observer coverage might be considered in certain areas.

Although we quantify the bycatch of individual species, we make no attempt to categorise species according to Hall's criteria listed in section 5. In most cases, we simply do not have enough information to make these judgements.

Recommendation 3: A DFO multi-sector working group should be established to identify species that are believed to fall in the categories: critical bycatch, non-sustainable bycatch, bycatch of unknown levels, and charismatic bycatch. The working group should identify data needs, in particular to address the questions of stock identity and migration and obtaining reliable population estimates.

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Appendix A. Request for Working Paper submitted by managers.

PSARC INVERTEBRATE SUBCOMMITTEE

Request for Working Paper

Date Submitted: October 13, 1999

Individual or group requesting advice:
(Fisheries Manager/Biologist, SWG, PSARC, Industry, Other stakeholder etc.)
Shrimp by Trawl industry, PCSCA, stakeholders and managers

Proposed PSARC Presentation Date: June 2000

Subject of Paper (title if developed): Catch composition of BC Shrimp Trawls and estimations of bycatch (3^{rd} paper in a three part series).

Stock Assessment Lead Author: Boutillier et al

Fisheries Management Author/Reviewer: Rick Harbo , Kim West, Laurie Convey.

Rationale for request:
(What is the issue, what will it address, importance, etc.)
Two reports have been tabled on the bycatch, with emphasis on halibut (PSARC 99/122) and eulachon (PSARC I-99) in the shrimp trawl fishery. The bycatch of other non-target species remains an outstanding issue identified by the PSARC review. This report would be the third in a three part series to complete the examination of bycatch in this fishery. A commitment was made to industry and managers to provide a report for the 1997/98 season, using all available data on effort, landings and bycatch (current and historical). A selective fishing policy for Pacific fisheries has been announced. RMEC encourages reduction of bycatch in the shrimp trawl fishery (from 1998 levels) and notes there should be linkages to the selective fishing policy.

(To be developed by initiator)

Objective of Working Paper:

(To be developed by FM & StAD)

To be able to meet the selective fishing objective by the target date of 2005 for shellfish fisheries. The selective fishing objective as stated in *Selective Fishing in Canada's Pacific Fisheries, A new Direction: The third in a Series of Papers from Fisheries and Oceans Canada* is that: "All Pacific Fisheries, in which bycatch is an issue, will meet specified standards of selectivity. In fisheries where selective harvesting standards are not met, and bycatches remain a constraint to achievement of conservation objectives, fishing opportunities will be curtailed". To recommend approaches to bycatch reduction in this fishery - time, area closures for AVOIDANCE and gear options for EXCLUDE and ESCAPE options.

Questions To be addressed in the Working Paper:

What is the quantity of bycatch in this fishery? A summary of the quantity of bycatch (total 'other non-target' species) by shrimp management area for each trawl gear type for each fishing season (as per table 8 in the eulachon PSARC paper in prep.). Identify areas with highest

bycatch.
How has the quantity of bycatch changed between fishing seasons? Identify changes in amount of bycatch between seasons. Are those changes fishery dependent or not? What behavioural changes and gear changes have there been?

What is the catch composition in shrimp trawls by gear and shrimp management area? A summary of the catch composition for each shrimp management area and for each trawl gear type, listing by species. **What commercially important or rare species are in the bycatch?** May need to be summarized by family or grouping of species - as was discussed, by functional groups - rather than by species. Alternatively, as a shortened list and/or with a full list of species provided as an appendix.

What is the bycatch as a percentage of the total catch (likely based on data from catch sampling data only) by shrimp management area and gear type? A summary of the catch composition – target species and total non-target species - for each shrimp management area and for each trawl gear type as a percentage of the total catch.

Does the bycatch vary by month or within the season? A summary of bycatch by month. Sample size may dictate whether this can be determined for each shrimp management area, trawl gear, and season.

Summaries may include eulachon estimates from PSARC I-99.

To finalize the available historical sampling data, including historical sampling data by a student(s) in 1996, and the 1997/98, 1998/99 and 1999/2000 catch sampling programs and to estimate bycatch as per the method recommended in PSARC I-99 *Assessment of bycatch in the 1997 and 1998 shrimp trawl fisheries in British Columbia, with emphasis on eulachons*.

Reference (citation) to the PSARC papers on eulachon and halibut bycatch to complete a three part series on bycatch.

Data from the gear questionnaire should be summarized and evaluated. **How many vessels are using escapement devices, etc. How many use beam, otter or are combination vessels?** The form may require revision and updating – if so, recommendations should be made.

Is there a gear type with lower bycatch? A comparison of the bycatch between vessels with and without selectivity devices. The comparison should be made within each gear type (beam or otter).

How does bycatch in this fishery compare to other trawl fisheries? A summary of bycatch or ongoing bycatch studies in other Canadian fisheries- Pacific groundfish fisheries, east coast groundfish and shrimp fisheries should be presented for comparison. **What management strategies are used in other trawl fisheries to reduce bycatch?** Including any specific management strategies (e.g. mandatory exclusion devices, time or area closures) employed in other jurisdictions.

What was the level of observer coverage over the sampling seasons? Levels of observer coverage in the 1997/98 and 1998/99 and 1999/2000 fishery should be documented by time, area, and gear. **Are there recommendations for design of future Catch Sampling Programs?** Recommendations should be made for the design of future bycatch programs and research topics (e.g. fish behaviour). Recommendations for the catch sampling program for the 2001/2002 fishery in preparation to meet strategies of the selective fishing policy.

Table 1. List of all species encountered during bycatch sampling of the British Columbia commercial shrimp trawl fleet, and the assigned species groups.

Shrimp	
Species	**Common**
Pandalopsis dispar	Sidestripe shrimp
Pandalus borealis	Pink shrimp
Pandalus danae	Coon stripe shrimp
Pandalus goniurus	Flexed pink shrimp
Pandalus hypsinotus	Humpback shrimp
Pandalus jordani	Smooth pink shrimp

Eulachon	
Species	**Common**
Thaleichthys pacificus	Eulachon

Halibut	
Species	**Common**
Hippoglossus stenolepis	Pacific halibut

Bird	
Species	**Common**
Family Phalacrocoracidae	Cormorants

Unknown	
Species	**Common**
	Fish eggs
	Unknown fish

Prawn	
Species	**Common**
Pandalus platyceros	Prawn

Commercial Rockfish	
Species	**Common**
Family Scorpaenidae	Scorpionfish
Sebastes aleutianus	Rougheye rockfish
Sebastes alutus	Pacific ocean perch
Sebastes babcocki	Redbanded rockfish
Sebastes borealis	Shortraker rockfish
Sebastes brevispinis	Silvergray rockfish
Sebastes caurinus	Copper rockfish
Sebastes crameri	Darkblotched rockfish
Sebastes diploproa	Splitnose rockfish
Sebastes elongatus	Greenstriped rockfish
Sebastes entomelas	Widow rockfish
Sebastes flavidus	Yellowtail rockfish
Sebastes maliger	Quillback rockfish
Sebastes paucispinis	Bocaccio
Sebastes pinniger	Canary rockfish
Sebastes proriger	Redstripe rockfish

Non-commercial Rockfish	
Species	**Common**
Subfamily Sebastinae	Rockfish

Dogfish, ratfish, and skates	
Species	**Common**
Family Chimaeridae	Ratfish
Family Rajidae	Skates
Hydrolagus colliei	Spotted ratfish
Raja binoculata	Big skate
Raja rhina	Longnose skate
Squalus acanthias	Spiny dogfish

Commercial Roundfish	
Species	**Common**
Anoplopoma fimbria	Sablefish
Gadus macrocephalus	Pacific cod

Table 1. continued.

Commercial Rockfish (continued)	
Species	**Common**
Sebastes reedi	Yellowmouth rockfish
Sebastes ruberrimus	Yelloweye rockfish
Sebastes variegatus	Harlequin rockfish
Sebastes zacentrus	Sharpchin rockfish
Sebastolobus alascanus	Shortspine thornyhead
Subfamily Sebastolobinae	Thornyheads

Commercial Roundfish (continued)	
Species	**Common**
Merluccius productus	Pacific hake
Microgadus proximus	Pacific tomcod
Ophiodon elongatus	Lingcod
Theragra chalcogramma	Walleye pollock

Non-commercial Roundfish	
Species	**Common**
Agonomalus mozinoi	Kelp poacher
Allosmerus elongatus	Whitebait smelt
Alosa sapidissima	American shad
Anarrhichthys ocellatus	Wolf eel
Aptocyclus ventricosus	Smooth lumpsucker
Artedius lateralis	Smoothhead sculpin
Bothrocara brunneum	Twoline eelpout
Catostomus macrocheilus	Largescale sucker
Chitonotus pugetensis	Roughback sculpin
Clupea pallasi	Pacific herring
Cryptacanthodes aleutensis	Dwarf wrymouths
Cryptacanthodes gigantea	Giant wrymouth
Cymatogaster aggregata	Shiner perch
Engraulis mordax mordax	Northern anchovy
Eptatretus deani	Black hagfish
Eptatretus stouti	Pacific hagfish
Family Acipenseridae	Sturgeons
Family Agonidae	Poachers
Family Cottidae	Sculpins
Family Cryptacanthodidae	Wrymouths
Family Cyclopteridae	Lumpfishes and snailfishes
Family Engraulidae	Anchovies
Family Hexagrammidae	Greenlings
Family Icosteidae	Ragfishes

Commercial Flatfish	
Species	**Common**
Atheresthes stomias	Arrowtooth flounder
Family Bothidae	Lefteye flounders
Citharichthys sordidus	Pacific sanddab
Eopsetta exilis	Slender sole
Eopsetta jordani	Petrale sole
Errex zachirus	Rex sole
Hippoglossoides elassodon	Flathead sole
Microstomus pacificus	Dover sole
Platichthys stellatus	Starry flounder
Pleuronectes bilineatus	Rock sole
Pleuronectes vetulus	English sole
Order Pleuronectiformes	Flatfish
Pleuronichthys coenosus	C-o sole
Psettichthys melanostictus	Sand sole

Non-commercial Flatfish	
Species	**Common**
Citharichthys stigmaeus	Speckled sanddab

Commercial Invertebrates	
Species	**Common**
Cancer magister	Dungeness crab
Cancer productus	Red rock crab

Table 1. continued.

Non-commercial Roundfish (continued)	
Species	**Common**
Family Macrouridae	Grenadiers
Family Myxinidae	Hagfish
Family Osmeridae	Smelts
Family Pholidae	Gunnels
Family Ptilichthyidae	Quillfish
Family Stichaeidae	Pricklebacks
Family Zoarcidae	Eelpouts
Gasterosteus aculeatus	Threespine stickleback
Hemilepidotus hemilepidotus	Red irish lord
Hexagrammos decagrammus	Kelp greenling
Hypomesus pretiosus	Surf smelt
Liparis fucensis	Slipskin snailfish
Lycodes palearis	Wattled eelpout
Nautichthys oculofasciatus	Sailfin sculpin
Odontopyxis trispinosa	Pygmy poacher
Oncorhynchus gorbuscha	Pink salmon
Oncorhynchus tshawytscha	Chinook salmon
Platax teira	Longfin batfish
Podathecus acipenserinus	Sturgeon poacher
Porichthys notatus	Plainfin midshipman
Regalecus glesne	Oarfish
Rhacochilus vacca	Pile perch
Sardinops sagax	Pacific sardine
Scomber japonicus	Chub mackerel
Scorpaenichthys marmoratus	Cabezon
Subfamily Cyclopterinae	Lumpfishes
Subfamily Liparinae	Snailfishes
Trachurus symmetricus	Jack mackerel
Trichodon trichodon	Pacific sandfish
Zaprora silenus	Prowfish

Commercial Invertebrates (continued)	
Species	**Common**
Chionoecetes tanneri	Tanner crab
Chlamys hastata	Spiny scallop
Class Holothuroidea	Sea cucumbers
Loligo opalescens	Opal squid
Strongylocentrotus droebachiensis	Green urchin
Order Octopoda	Octopus
Octopus spp.	Octopus

Non-commercial Invertebrates	
Species	**Common**
Actiniaria (order)	Anemone
Amphipoda (order)	Amphipods
Anomura (section)	
Anthozoa (class)	
Asteroidea (class)	Starfish
Atelostomata (superorder)	Heart urchins
Berryteuthis magister	Red squid
Bivalvia (class)	Bivalves
Cancridae (family)	Cancer crabs
Cephalopoda (family)	
Chionoecetes bairdi	
Chionoecetes spp	Tanner crabs
Chorilia longipes	Redclaw crab
Cirripedia (subclass)	Barnacles
Crangon spp	
Crustacea (class)	Crustaceans
Echinacea (superorder)	Sea urchins
Eualus spp	
Gastropoda (class)	Gastropods
Gnathostomata (superorder)	Sand dollars
Hydrozoa (class)	Hydroid
Lebbeus groenlandicus	Spiny side shrimp
Lopholithodes spp	Box crabs

Table 1. continued.

Non-commercial Invertebrates (continued)	
Species	**Common**
Mediaster aequalis	Vermillion starfish
Moroteuthis robusta	Giant squid
Munida quadrispina	Squat lobster
Nantantia (order)	Shrimp
Nudibranchiata (suborder)	Seaslugs
Ophiuroidea (class)	
Oxyrhyncha (superfamily)	Spider crabs
Pandalidae (family)	Pandalid shrimp
Pandalus montaqui tridens	Yellowleg shrimp
Pandalus stenolepsis	Bluespot shrimp
Paracrangon echinata	Spike shrimp
Pasiphaea pacifica	Glass shrimp
Pectinidae (family)	Scallop
Pennatulacea (order)	Sea pens
Phylum annelida	Segmented worms
Phylum arthropoda	
Phylum echinodermata	Echinoderms
Polyplacophora (subclass)	Chitons
Pugettia gracilis	
Repiantia (suborder)	
Rossia pacifica	Squat squid
Scyphozoa (class)	Jellyfish
Sedentaria (subclass)	Tube worms
Sepiodea (order)	Sepiolea and cuttlefish
Teuthoidea (order)	Squid
Upogebiinae (subfamily)	Ghost shrimp

Table 2. Level of bycatch sampling compared to total commercial effort by year, gear, and area. N = number of commercial trawls, n = number of sampled trawls, %N = percent of commercial trawls sampled, E = total commercial effort (hrs), e = commercial effort sampled (hrs), %E = percent of commercial effort sampled. Commercial effort data were obtained from logbooks.

Year Gear	Area	N	n	%N	E	e	%E
1997 Beam	10IN	123			196		
	11IN	1			0		
	124OFF	248	6	(2.4)	578	15	(2.6)
	125OFF	5			14		
	126OFF	2			1		
	12IN	1,008	25	(2.5)	1,424	57	(4.0)
	12OUT	348			1,108		
	14	1,769	17	(1.0)	2,766	30	(1.1)
	16	491	9	(1.8)	1,256	20	(1.6)
	17	559	3	(0.5)	1,129	4	(0.3)
	18	2,242	13	(0.6)	3,613	18	(0.5)
	19	1,195	24	(2.0)	1,632	34	(2.1)
	23IN	1,625	14	(0.9)	3,444	33	(1.0)
	23OFF	2,982	62	(2.1)	6,149	116	(1.9)
	24IN	20			27		
	25IN	29			36		
	27IN	16			144		
	27OFF	2			2		
	2IN	7			20		
	3IN	317			645		
	5IN	4			5		
	6IN	43			138		
	7IN	74			85		
	9IN	2			22		
	FR	2,534	10	(0.4)	7,583	19	(0.3)
	GSTE	1,610	22	(1.4)	3,186	38	(1.2)
	PRD	1,916			4,975		
	QCSND	3			6		
		19,175	**205**	**(1.1)**	**40,182**	**382**	**(1.0)**

Table 2 continued.

Year	Gear	Area	N	n	%N	E	e	%E
1997	Otter	10IN	1			1		
		124OFF	1,858	57	(3.1)	3,367	102	(3.0)
		125OFF	478	18	(3.8)	675	18	(2.6)
		126OFF	2			1		
		12IN	1			0		
		14	256	15	(5.9)	339	16	(4.8)
		16	9			10		
		17	11			14		
		18	17			25		
		19	1			1		
		21OFF	37			51		
		23IN	185	14	(7.6)	397	23	(5.8)
		23OFF	1,645	32	(1.9)	2,712	47	(1.7)
		24IN	46			63		
		25IN	7			8		
		27OFF	114			128		
		2IN	4			7		
		3IN	79			101		
		5IN	44			41		
		5OFF	3			7		
		6IN	470			583		
		7IN	40			48		
		8IN	8			11		
		9IN	90			112		
		DXE	7			8		
		FR	5			4		
		GSTE	175			104		
		PRD	1,550	90	(5.8)	2,533	109	(4.3)
		QCI	2			3		
		QCSND	2,082	137	(6.6)	3,652	263	(7.2)
			9,227	**363**	**(3.9)**	**15,004**	**578**	**(3.9)**

Table 2 continued.

Year	Gear	Area	N	n	%N	E	e	%E
1998	Beam	10IN	34			32		
		11IN	83			104		
		124OFF	33			78		
		125OFF	2			4		
		12IN	1,249	22	(1.8)	1,508	32	(2.1)
		12OUT	397			1,108		
		14	3,024	11	(0.4)	6,497	20	(0.3)
		16	513			1,368		
		17	506			1,174		
		18	2,611	11	(0.4)	5,143	19	(0.4)
		19	492			655		
		20	2			4		
		21OFF	5			11		
		23IN	1,060	20	(1.9)	2,343	43	(1.8)
		23OFF	8,211	38	(0.5)	18,520	87	(0.5)
		24IN	14			22		
		25IN	25			77		
		26IN	6			4		
		27IN	90			227		
		27OFF	16			28		
		2IN	210			393		
		3IN	115			229		
		5IN	18			44		
		6IN	16			117		
		6OFF	5			25		
		7IN	135			174		
		8IN	28	2	(7.1)	30		
		9IN	481			1,146		
		FR	3,570	15	(0.4)	10,593	33	(0.3)
		GSTE	1,695			3,313		
		PRD	1,744	15	(0.9)	4,498	29	(0.6)
		QCSND	151	1	(0.7)	286	3	(0.9)
			26,541	**135**	**(0.5)**	**59,752**	**264**	**(0.4)**

Table 2 continued.

Year Gear	Area	N	n	%N	E	e	%E
1998 Otter	10IN	1		(0.0)	1		(0.0)
	124OFF	246	2	(0.8)	406	2	(0.6)
	125OFF	938			1,825		
	126OFF	10			19		
	12IN	71	2	(2.8)	91	3	(3.0)
	12OUT	8			13		
	14	281			399		
	16	12			24		
	18	177	1	(0.6)	249	1	(0.4)
	19	4			5		
	21OFF	10			15		
	23IN	5			9		
	23OFF	2,584	4	(0.2)	4,617	8	(0.2)
	25IN	39			87		
	26IN	91	1	(1.1)	148		
	27IN	3	1	(33.3)	1	1	(100.0)
	27OFF	290	23	(7.9)	412	22	(5.3)
	2IN	65			78		
	3IN	76			146		
	5IN	2			3		
	5OFF	2			2		
	6IN	336			389		
	6OFF	37			44		
	7IN	155			214		
	8IN	56	1	(1.8)	84		
	9IN	282			489		
	FR	6			16		
	GSTE	12			11		
	PRD	1,787			3,687		
	QCI	3			3		
	QCSND	3,716	296	(8.0)	7,172	587	(8.2)
		11,305	**331**	**(2.9)**	**20,656**	**624**	**(3.0)**

Table 2 continued.

Year Gear	Area	N	n	%N	E	e	%E
1999 Beam	10IN	58			96		
	11IN	2			3		
	124OFF	50			111		
	12IN	292	31	(10.6)	299	32	(10.6)
	12OUT	395	2	(0.5)	1,129	2	(0.1)
	14	1,195	11	(0.9)	2,319	20	(0.9)
	16	1,020	4	(0.4)	2,407	10	(0.4)
	17	147			339		
	18	363	3	(0.8)	751	9	(1.2)
	19	254	1	(0.4)	494	2	(0.4)
	20	6			7		
	23IN	696	26	(3.7)	1,579	68	(4.3)
	23OFF	4,491	64	(1.4)	10,679	143	(1.3)
	24IN	41			106		
	25IN	18			43		
	2IN	67	6	(9.0)	259	12	(4.6)
	3IN	192			372		
	5IN	61			108		
	6IN	6			12		
	6OFF	16			35		
	7IN	23			32		
	8IN	12			19		
	9IN	239			776		
	FR	2,650	10	(0.4)	7,548	26	(0.3)
	GSTE	1,686	12	(0.7)	3,246	28	(0.9)
	PRD	1,323			3,446		
	QCI	3			12		
	QCSND	22			121		
		15,328	**170**	**(1.1)**	**36,347**	**351**	**(1.0)**

Table 2 continued.

Year	Gear	Area	N	n	%N	E	e	%E
1999	Otter	124OFF	37			66		
		125OFF	263	18	(6.8)	432	29	(6.7)
		12IN	38			59		
		12OUT	5			4		
		14	214	8	(3.7)	262	10	(3.9)
		16	4			5		
		17	20			57		
		18	16			49		
		19	19	1	(5.3)	22	2	(10.1)
		21OFF	2			1		
		23OFF	2,570	80	(3.1)	4,734	162	(3.4)
		24IN	4			8		
		25IN	86			140		
		26IN	23			51		
		27IN	31			41		
		27OFF	182	14	(7.7)	243	16	(6.7)
		3IN	104			153		
		5IN	57			58		
		6IN	88			133		
		7IN	7			8		
		8IN	12			35		
		9IN	376			873		
		DXE	3			5		
		FR	16			36		
		GSTE	98			263		
		PRD	1,797			3,584		
		QCSND	221	5	(2.3)	329	7	(2.3)
			6,293	**126**	**(2.0)**	**11,650**	**228**	**(2.0)**

Table 2 continued. Summary of bycatch sampling effort by year and gear type.

Year	Gear	N	n	%N	E	e	%E
1997	Beam	19,175	205	(1.1)	40,182	382	(1.0)
	Otter	9,227	363	(3.9)	15,004	578	(3.9)
1998	Beam	26,541	135	(0.5)	59,752	264	(0.4)
	Otter	11,305	331	(2.9)	20,656	624	(3.0)
1999	Beam	15,328	170	(1.1)	36,347	351	(1.0)
	Otter	6,293	126	(2.0)	11,650	228	(2.0)
		87,869	**1,330**	**(1.5)**	**183,591**	**2,427**	**(1.3)**

Table 3. The use of bycatch reduction devices (BRD) in bycatch sampled sets. BRD = Number of sets with BRD installed; None = Number of sets with no BRD installed; Proportion = Proportion of sets with BRD installed.

		Beam			Otter		
Year	**Area**	**BRD**	**None**	**Proportion**	**BRD**	**None**	**Proportion**
1997	124OFF	0	6	0.00	57	0	1.00
	125OFF				18	0	1.00
	12IN	0	25	0.00			
	14	0	17	0.00	15	0	1.00
	16	0	9	0.00			
	17	0	3	0.00			
	18	0	13	0.00			
	19	0	24	0.00			
	23IN	0	14	0.00	14	0	1.00
	23OFF	0	52	0.00	42	0	1.00
	FR	0	10	0.00			
	GSTE	7	15	0.32			
	PRD				79	11	0.88
	QCSND				137	0	1.00
1997 Total:		**7**	**188**	**0.04**	**362**	**11**	**0.97**
1998	124OFF				2	0	1.00
	12IN	0	22	0.00	0	2	0.00
	14	0	11	0.00			
	18	0	11	0.00	0	1	0.00
	23IN	6	14	0.30			
	23OFF	20	18	0.53	3	1	0.75
	26IN				0	1	0.00
	27IN				1	0	1.00
	27OFF				22	1	0.96
	8IN	0	2	0.00	0	1	0.00
	FR	0	15	0.00			
	PRD	10	5	0.67			
	QCSND				297	0	1.00
1998 Total:		**36**	**98**	**0.27**	**325**	**7**	**0.98**
1999	125OFF				18	0	1.00
	12IN	0	31	0.00			
	12OUT	0	2	0.00			
	14	0	11	0.00	0	8	0.00
	16	0	4	0.00			
	18	0	4	0.00			
	19	0	1	0.00	0	1	0.00
	23IN	9	17	0.35			
	23OFF	44	15	0.75	85	0	1.00
	27OFF				14	0	1.00
	2IN	0	6	0.00			
	FR	0	10	0.00			
	GSTE	0	12	0.00			
	QCSND				5	0	1.00
1999 Total:		**53**	**113**	**0.32**	**122**	**9**	**0.93**
Total:		96	399	**0.19**	809	27	**0.97**

Table 4. Catch composition by percent of major species groups in bycatch sampled tows. Groups are B = birds, E = eulachon, FC = commercial flatfish, FNC = non-commercial flatfish, H = halibut, IC = commercial invertebrates, INC = non-commercial invertebrates, IS = "structural" invertebrates (sponges and corals), P = prawns, RKC = commercial rockfish, RKNC = non-commercial rockfish, RDC = commercial roundfish, RDNC = non-commercial roundfish, SHR = shrimp, S = Selachii (dogfish, skates, and ratfish), U = unknown.

Year	Gear	Area	B	E	FC	FNC	H	IC	INC	IS	P	RCK	RKNC	RDC	RDNC	SHR	S	U
1997	Beam	124OFF		0.11	9.67			0.18	0.18		0.13			1.11	0.33	85.87	2.43	0.01
		12IN		0.01	8.71			0.03	2.14	0.03	2.77	0.04		0.55	2.99	65.55	14.39	2.78
		14		0.06	7.53			0.40	7.01		4.62	0.93		4.34	6.08	49.80	19.22	
		16		0.01	15.20			0.08	0.32		2.30	1.31		24.45	4.04	26.36	25.92	
		17			18.72				0.28		0.05	6.39		12.10	31.73	10.88	19.86	
		18			4.02				0.49		1.23	0.11		2.79	9.62	81.52	0.21	
		19			6.60	0.08		0.20	4.16		1.21	0.38		4.76	3.34	56.83	22.45	
		23IN	0.16	0.80	5.64			0.01	0.13		0.10	0.14		5.74	2.63	80.10	4.55	
		23OFF		0.91	5.34			0.22	0.19		0.07	0.20		2.58	2.31	80.01	8.16	
		FR			7.64			0.10	2.66		2.07	1.32		4.34	7.52	39.47	34.88	
		GSTE			1.44			0.03	0.74		2.03	1.12		7.51	8.60	68.20	10.31	
		Total	**0.02**	**0.36**	**6.71**	**0.01**		**0.13**	**1.47**	**0.01**	**1.30**	**0.40**		**4.00**	**3.87**	**69.62**	**11.59**	**0.53**
1997	Otter	124OFF		0.96	1.67			0.00	0.13		0.01	0.10		2.97	0.27	93.42	0.13	0.34
		125OFF		2.92	0.71			0.03				0.06		0.06	1.17	95.05		
		14		0.09	0.98			0.10	0.42		3.04	0.37		3.35	6.03	85.56	0.06	
		23IN		5.94	3.91			0.13	0.12		0.07	0.01		1.43	2.14	86.21	0.03	
		23OFF		5.78	1.80			0.06	0.05		0.06	0.01		0.79	3.03	88.06	0.35	
		PRD		0.46	14.00		0.89	2.21	0.50	0.36	0.43	3.13		2.04	5.38	57.38	13.22	0.00
		QCSND		13.61	2.59		0.05	0.07	0.16		0.01	0.20		0.04	2.43	80.73	0.11	0.00
		Total		**8.74**	**3.69**		**0.13**	**0.31**	**0.19**	**0.04**	**0.12**	**0.50**		**0.90**	**2.52**	**81.15**	**1.65**	**0.05**
1998	Beam	12IN		0.05	4.48			0.27	0.34		0.55	0.02		2.71	2.05	85.27	4.26	
		14			6.69			0.17	1.46		1.60	0.61		2.45	7.79	75.09	4.13	
		18			10.49			0.49	23.05		0.43	0.17		6.20	9.72	38.04	11.40	
		23IN		0.43	2.96			0.07	6.48		1.69		0.01	3.57	4.30	76.81	3.67	0.01
		23OFF		1.23	2.32	0.00		0.13	0.93		0.27	0.02		1.74	1.65	88.70	2.99	0.00
		FR			5.64	3.38		0.90	4.14	0.01	0.56	0.46		8.39	10.85	55.51	10.17	
		PRD		0.21	34.42			0.32	0.46		0.22	0.80		3.38	1.43	46.75	12.02	
		Total		**0.35**	**7.78**	**0.28**		**0.28**	**3.32**	**0.00**	**0.63**	**0.18**	**0.00**	**3.41**	**3.73**	**74.25**	**5.79**	**0.00**

Table 4 continued.

Year	Gear	Area	B	E	FC	FNC	H	IC	INC	IS	P	RKC	RKNC	RDC	RDNC	SHR	S	U
1998	Otter	124OFF			36.15			6.92						20.77	29.23		6.92	
		12IN		2.37	0.17				4.78		0.23			29.92	1.48	61.06		
		18			6.78			3.39						45.76	33.90	8.47	1.69	
		23OFF		9.79	0.39				1.21		1.15			1.17	0.83	85.46		
		27IN			20.00									60.00		20.00		
		27OFF		0.71	7.45			0.03			0.02	0.07		3.05	1.55	84.70	2.41	
		QCSND		1.62	1.85			0.07	0.34		0.01	0.15		1.67	0.96	93.31	0.03	
		Total		**1.64**	**1.99**			**0.06**	**0.38**		**0.02**	**0.15**		**2.02**	**0.99**	**92.66**	**0.10**	
1999	Beam	12IN		0.10	8.41				0.45		1.78			2.89	5.30	76.40	3.49	
		12OUT			12.43				0.30					4.74	17.44	10.35	54.74	
		14			5.80			0.05	0.30		1.15	0.07		1.32	7.29	74.65	9.37	
		16			6.64				1.58	0.05	4.53	2.65		3.38	2.04	52.85	26.28	
		18			15.40			0.92	3.02		1.28			8.95	3.83	60.47	6.13	
		19			5.53				0.17		4.16			12.52	5.57	72.05		
		23IN		0.12	1.84			0.06	0.10		0.15	0.00		18.06	2.75	75.68	1.24	
		23OFF		0.47	2.05			0.02	0.11		0.10	0.00		7.57	1.21	87.48	0.98	
		2IN			6.53				0.14		0.52	0.08		4.92	0.86	83.49	3.46	
		FR			9.58			1.90	1.58		1.66	0.78	0.02	8.66	6.02	53.72	16.08	
		GSTE			7.88			0.19	0.89		1.46	0.11		4.08	8.58	75.47	1.34	
		Total		**0.21**	**4.84**			**0.17**	**0.41**	**0.00**	**0.83**	**0.13**	**0.00**	**7.69**	**3.59**	**77.88**	**4.06**	
1999	Otter	125OFF		2.82	0.19						0.01	0.04		0.01	0.00	96.92		
		14			7.06				0.27		0.06	0.02		3.44	4.88	84.13	0.13	
		19			5.16			4.10	3.24		1.02			11.33	2.03	65.92	7.19	
		23OFF		3.87	0.63			0.03	0.08		0.10	0.00		2.64	1.00	91.64	0.01	0.00
		27OFF		0.97	2.01			0.56	1.24					1.39	0.54	89.25	1.25	2.78
		QCSND														100.00		
		Total		**3.27**	**1.06**			**0.07**	**0.12**		**0.08**	**0.01**		**2.19**	**1.06**	**91.98**	**0.11**	**0.04**

Table 5. Mean CPUE (kg/hr) of major species groups recorded from bycatch samples. B = birds, E = eulachon, FC = commercial flatfish, FNC = non-commercial flatfish, H = halibut, IC = commercial invertebrates, INC = non-commercial invertebrates, IS = structural invertebrates (sponges and corals), P = prawns, RKC = commercial rockfish, RKNC = non-commercial rockfish, RDC = commercial roundfish, RDNC = non-commercial roundfish, SHR = shrimp, S = Selachii (dogfish, skates, and ratfish), U = unknown.

year gear	area	B	E	FC	FNC	H	IC	INC	IS	P	RKC	RKNC	RDC	RDNC	SHR	S	U
1997 Beam	124OFF	-	0.138	11.085	-	-	0.205	0.236	-	0.175	-	-	1.314	0.394	103.862	2.888	0.007
	12IN	-	0.008	6.271	-	-	0.029	1.766	0.071	2.213	0.030	-	0.387	2.113	47.829	12.057	2.470
	14	-	0.037	3.641	-	-	0.205	3.615	-	2.395	0.437	-	2.060	3.116	25.332	8.666	-
	16	-	0.004	5.282	-	-	0.029	0.113	-	0.846	0.621	-	8.569	1.456	9.456	9.445	-
	17	-	-	11.622	-	-	-	0.177	-	0.033	4.023	-	7.198	17.985	6.620	12.020	-
	18	-	-	1.868	-	-	-	0.240	-	0.535	0.043	-	1.359	5.052	39.695	0.104	-
	19	-	-	4.266	0.095	-	0.175	2.178	-	0.716	0.339	-	3.965	1.722	37.312	20.716	-
	23IN	0.144	0.646	5.265	-	-	0.015	0.117	-	0.106	0.147	-	5.198	2.570	70.489	4.438	-
	23OFF	-	0.536	3.539	-	-	0.175	0.134	-	0.045	0.175	-	1.450	1.525	48.549	6.018	-
	FR	-	-	3.227	-	-	0.026	0.829	-	0.583	0.372	-	1.762	3.103	12.907	19.517	-
	GSTE	-	-	0.857	-	-	0.023	0.466	-	1.098	0.648	-	3.373	3.735	36.698	5.034	-
1997 Beam Average:		**0.013**	**0.124**	**5.175**	**0.009**	**-**	**0.080**	**0.897**	**0.006**	**0.795**	**0.621**	**-**	**3.330**	**3.888**	**39.886**	**9.173**	**0.225**
Otter	124OFF	-	1.472	2.134	-	-	0.002	0.391	-	0.008	0.100	-	4.178	0.328	125.164	0.177	0.374
	125OFF	-	2.661	0.728	-	-	0.020	-	-	-	0.094	-	0.048	1.810	80.527	-	-
	14	-	0.089	0.940	-	-	0.107	0.428	-	2.836	0.361	-	3.365	6.547	91.382	0.056	-
	23IN	-	11.245	4.660	-	-	0.202	0.217	-	0.099	0.028	-	2.337	2.630	123.023	0.047	-
	23OFF	-	6.886	1.902	-	-	0.081	0.069	-	0.075	0.014	-	0.947	3.199	119.247	0.382	-
	PRD	-	0.510	22.576	-	1.255	3.553	0.755	0.969	0.677	3.631	-	2.535	9.621	54.235	19.330	0.001
	QCSND	-	25.957	4.497	-	0.089	0.114	0.289	-	0.020	0.353	-	0.085	4.462	152.046	0.188	0.006
1997 Otter Average:		**-**	**6.974**	**5.348**	**-**	**0.192**	**0.583**	**0.307**	**0.138**	**0.531**	**0.655**	**-**	**1.928**	**4.085**	**106.518**	**2.883**	**0.054**
1997 Average:		**0.008**	**2.788**	**5.242**	**0.005**	**0.075**	**0.276**	**0.668**	**0.058**	**0.692**	**0.634**	**-**	**2.785**	**3.965**	**65.799**	**6.727**	**0.159**
1998 Beam	12IN	-	0.093	8.196	-	-	0.424	0.649	-	1.100	0.126	-	3.441	3.264	212.649	8.687	-
	14	-	-	1.924	-	-	0.054	0.376	-	0.492	0.135	-	0.792	1.955	25.450	0.780	-
	18	-	-	5.757	-	-	0.263	13.885	-	0.226	0.083	-	3.299	5.566	22.030	5.038	-
	23IN	-	0.167	1.143	-	-	0.028	2.373	-	0.725	-	0.006	1.479	1.783	32.290	1.645	0.003
	23OFF	-	0.366	0.997	0.001	-	0.044	0.385	-	0.116	0.009	-	0.729	0.720	30.088	1.231	0.001
	FR	-	-	1.901	1.181	-	0.315	1.900	0.003	0.196	0.247	-	3.589	4.285	18.911	3.423	-
	PRD	-	0.108	16.480	-	-	0.240	0.227	-	0.101	0.385	-	1.886	0.777	25.741	6.403	-
1998 Beam Average:		**-**	**0.105**	**5.200**	**0.169**	**-**	**0.195**	**2.828**	**0.000**	**0.422**	**0.141**	**0.001**	**2.174**	**2.621**	**52.451**	**3.887**	**0.001**

Table 5 continued.

year gear	area	B	E	FC	FNC	H	IC	INC	IS	P	RKC	RKNC	RDC	RDNC	SHR	S	U
Otter	124OFF	-	-	1.120	-	-	0.231	-	-	-	-	-	0.623	0.958	-	0.231	-
	12IN	-	6.200	0.467	-	-	-	12.933	-	0.600	-	-	85.100	3.900	163.327	-	-
	18	-	-	2.000	-	-	1.000	-	-	-	-	-	13.500	10.000	2.500	0.500	-
	23OFF	-	4.826	0.186	-	-	-	0.533	-	0.619	-	-	0.568	0.412	40.804	-	-
	27IN	-	-	4.775	-	-	-	-	-	-	-	-	14.324	-	4.775	-	-
	27OFF	-	0.726	8.234	-	-	0.049	-	-	0.023	0.078	-	3.300	1.751	98.175	2.328	-
	QCSND	-	2.352	2.284	-	-	0.095	0.459	-	0.008	0.216	-	1.970	1.311	123.341	0.041	-
1998 Otter Average:		**-**	**2.015**	**2.724**	**-**	**-**	**0.196**	**1.989**	**-**	**0.179**	**0.042**	**-**	**17.055**	**2.619**	**61.846**	**0.443**	**-**
1998 Average:		**-**	**1.060**	**3.962**	**0.084**	**-**	**0.196**	**2.409**	**0.000**	**0.300**	**0.091**	**0.000**	**9.614**	**2.620**	**57.149**	**2.165**	**0.000**
1999 Beam	12IN	-	0.048	11.041	-	-	-	0.504	-	2.983	-	-	2.460	6.142	124.752	4.697	-
	12OUT	-	-	10.042	-	-	-	0.263	-	-	-	-	4.167	14.094	8.239	47.470	-
	14	-	-	4.105	-	-	0.028	0.183	-	1.007	0.099	-	0.677	4.737	51.864	7.412	-
	16	-	-	2.835	-	-	-	0.580	0.019	1.941	0.718	-	1.167	0.890	22.815	10.352	-
	18	-	-	4.415	-	-	0.190	0.783	-	0.308	-	-	2.555	0.975	17.046	1.431	-
	19	-	-	7.371	-	-	-	0.229	-	5.543	-	-	16.686	7.429	96.057	-	-
	23IN	-	0.042	0.806	-	-	0.023	0.056	-	0.063	0.001	-	7.025	1.059	32.261	0.537	-
	23OFF	-	0.264	1.046	-	-	0.014	0.062	-	0.061	0.002	-	4.049	0.620	44.980	0.506	-
	2IN	-	-	4.436	-	-	-	0.098	-	0.359	0.046	-	3.276	0.563	56.762	2.213	-
	FR	-	-	4.763	-	-	0.598	0.801	-	1.069	0.517	0.022	5.236	3.285	30.522	7.776	-
	GSTE	-	-	3.816	-	-	0.099	0.441	-	0.800	0.056	-	2.024	4.394	38.704	0.684	-
1999 Beam Average:		**-**	**0.032**	**4.971**	**-**	**-**	**0.087**	**0.364**	**0.002**	**1.285**	**0.131**	**0.002**	**4.484**	**4.017**	**47.637**	**7.552**	**-**
Otter	125OFF	-	5.655	0.363	-	-	-	-	-	0.018	0.094	-	0.013	0.007	186.308	-	-
	14	-	-	12.282	-	-	-	0.490	-	0.102	0.048	-	6.628	8.292	179.852	0.215	-
	19	-	-	5.867	-	-	4.667	3.689	-	1.156	-	-	12.889	2.311	74.978	8.178	-
	23OFF	-	3.765	0.628	-	-	0.025	0.085	-	0.135	0.002	-	2.937	1.128	96.887	0.015	0.005
	27OFF	-	0.276	0.531	-	-	0.152	0.329	-	-	-	-	0.394	0.146	31.844	0.357	0.751
	QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	10.762	-	-
1999 Otter Average:		**-**	**1.616**	**3.278**	**-**	**-**	**0.807**	**0.765**	**-**	**0.235**	**0.024**	**-**	**3.810**	**1.981**	**96.772**	**1.461**	**0.126**
1999 Average:		**-**	**0.591**	**4.373**	**-**	**-**	**0.341**	**0.505**	**0.001**	**0.914**	**0.093**	**0.001**	**4.246**	**3.298**	**64.979**	**5.403**	**0.044**

Table 6. Estimated catch (kg) of major species groups based on mean CPUE from bycatch samples multiplied by commercial effort. B = birds, E = eulachon, FC = commercial flatfish, FNC = non-commercial flatfish, H = halibut, IC = commercial invertebrates, INC = non-commercial invertebrates, IS = structural invertebrates (sponges and corals), P = prawns, RKC = commercial rockfish, RKNC = non-commercial rockfish, RDC = commercial roundfish, RDNC = non-commercial roundfish, SHR = shrimp, S = Selachii (dogfish, ratfish, and skates), U = unknown.

year gear	area	B	E	FC	FNC	H	IC	INC	IS	P	RKC	RKNC	RDC	RDNC	SHR	S	U
1997 Beam	124OFF	-	78	6,322	-	-	117	135	-	100	-	-	750	225	59,236	1,647	4
	12IN	-	11	8,779	-	-	41	2,472	99	3,098	42	-	542	2,959	66,959	16,880	3,458
	14	-	99	9,796	-	-	552	9,728	-	6,444	1,175	-	5,541	8,384	68,158	23,317	-
	16	-	6	6,575	-	-	37	140	-	1,053	773	-	10,667	1,812	11,772	11,757	-
	17	-	-	12,914	-	-	-	196	-	37	4,470	-	7,998	19,984	7,356	13,356	-
	18	-	-	6,547	-	-	-	842	-	1,875	151	-	4,761	17,704	139,101	365	-
	19	-	-	6,830	152	-	280	3,488	-	1,147	543	-	6,349	2,758	59,743	33,170	-
	23IN	484	2,170	17,694	-	-	51	395	-	356	495	-	17,469	8,638	236,871	14,912	-
	23OFF	-	3,253	21,493	-	-	1,065	813	-	274	1,062	-	8,808	9,260	294,878	36,555	-
	FR	-	-	24,180	-	-	194	6,212	-	4,369	2,791	-	13,204	23,255	96,718	146,244	-
	GSTE	-	-	2,682	-	-	71	1,460	-	3,437	2,028	-	10,561	11,694	114,900	15,760	-
1997 Beam Total:		**484**	**5,617**	**123,813**	**152**	**-**	**2,408**	**25,881**	**99**	**22,189**	**13,531**	**-**	**86,650**	**106,671**	**1,155,691**	**313,964**	**3,462**
Otter	124OFF	-	4,935	7,154	-	-	6	1,312	-	27	336	-	14,006	1,101	419,555	595	1,253
	125OFF	-	1,777	487	-	-	13	-	-	-	63	-	32	1,209	53,792	-	-
	14	-	30	313	-	-	36	143	-	944	120	-	1,121	2,180	30,426	19	-
	23IN	-	4,463	1,849	-	-	80	86	-	39	11	-	928	1,044	48,824	19	-
	23OFF	-	18,549	5,124	-	-	219	186	-	202	38	-	2,550	8,618	321,211	1,028	-
	PRD	-	1,286	56,889	-	3,164	8,954	1,902	2,442	1,707	9,150	-	6,388	24,243	136,665	48,710	2
	QCSND	-	93,696	16,233	-	322	412	1,044	-	71	1,275	-	308	16,107	548,834	679	23
1997 Otter Total:		**-**	**124,736**	**88,049**	**-**	**3,486**	**9,720**	**4,672**	**2,442**	**2,991**	**10,993**	**-**	**25,332**	**54,502**	**1,559,306**	**51,049**	**1,279**
1997 Total:		**484**	**130,353**	**211,861**	**152**	**3,486**	**12,128**	**30,553**	**2,541**	**25,180**	**24,523**	**-**	**111,982**	**161,173**	**2,714,998**	**365,013**	**4,741**
1998 Beam	12IN	-	139	12,209	-	-	632	967	-	1,639	188	-	5,125	4,862	316,773	12,941	-
	14	-	-	12,238	-	-	347	2,393	-	3,132	857	-	5,041	12,437	161,900	4,963	-
	18	-	-	28,893	-	-	1,319	69,685	-	1,135	417	-	16,557	27,935	110,558	25,286	-
	23IN	-	381	2,610	-	-	63	5,419	-	1,655	-	14	3,378	4,073	73,744	3,757	7
	23OFF	-	6,688	18,231	19	-	802	7,037	-	2,117	160	-	13,316	13,153	549,932	22,497	27
	FR	-	-	19,917	12,376	-	3,296	19,908	27	2,054	2,590	-	37,600	44,889	198,105	35,861	-
	PRD	-	480	73,421	-	-	1,070	1,011	-	448	1,717	-	8,402	3,462	114,682	28,528	-
1998 Beam Total:		**-**	**7,689**	**167,519**	**12,395**	**-**	**7,528**	**106,419**	**27**	**12,179**	**5,929**	**14**	**89,420**	**110,811**	**1,525,694**	**133,833**	**34**

Table 6 continued.

year	gear	area	B	E	FC	FNC	H	IC	INC	IS	P	RKC	RKNC	RDC	RDNC	SHR	S	U
1998	Otter	124OFF	-	-	445	-	-	92	-	-	-	-	-	247	380	-	92	-
		12IN	-	537	40	-	-	-	1,121	-	52	-	-	7,375	338	14,155	-	-
		18	-	-	488	-	-	244	-	-	-	-	-	3,296	2,442	610	122	-
		23OFF	-	22,118	852	-	-	-	2,444	-	2,834	-	-	2,604	1,887	186,987	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	292	3,313	-	-	20	-	-	9	32	-	1,328	704	39,501	937	-
		QCSND	-	16,593	16,116	-	-	669	3,238	-	55	1,525	-	13,899	9,254	870,293	289	-
	1998 Otter Total:		**-**	**39,539**	**21,254**	**-**	**-**	**1,025**	**6,803**	**-**	**2,950**	**1,556**	**-**	**28,749**	**15,005**	**1,111,546**	**1,440**	**-**
	1998 Total:		**-**	**47,228**	**188,773**	**12,395**	**-**	**8,553**	**113,222**	**27**	**15,130**	**7,486**	**14**	**118,170**	**125,816**	**2,637,240**	**135,273**	**34**
1999	Beam	12IN	-	14	3,282	-	-	-	150	-	887	-	-	731	1,826	37,083	1,396	-
		12OUT	-	-	11,258	-	-	-	295	-	-	-	-	4,671	15,800	9,237	53,218	-
		14	-	-	9,282	-	-	64	415	-	2,277	224	-	1,531	10,713	117,287	16,762	-
		16	-	-	6,777	-	-	-	1,386	46	4,639	1,717	-	2,789	2,128	54,538	24,745	-
		18	-	-	3,252	-	-	140	576	-	227	-	-	1,881	718	12,555	1,054	-
		19	-	-	3,592	-	-	-	111	-	2,701	-	-	8,130	3,620	46,804	-	-
		23IN	-	65	1,234	-	-	35	86	-	97	1	-	10,754	1,621	49,383	822	-
		23OFF	-	2,778	11,021	-	-	148	655	-	640	22	-	42,664	6,532	473,914	5,336	-
		2IN	-	-	1,150	-	-	-	25	-	93	12	-	849	146	14,716	574	-
		FR	-	-	35,471	-	-	4,456	5,966	-	7,964	3,847	165	38,993	24,464	227,292	57,903	-
		GSTE	-	-	12,172	-	-	317	1,405	-	2,553	179	-	6,457	14,016	123,446	2,181	-
	1999 Beam Total:		**-**	**2,857**	**98,490**	**-**	**-**	**5,160**	**11,071**	**46**	**22,077**	**6,003**	**165**	**119,451**	**81,584**	**1,166,254**	**163,991**	**-**
	Otter	125OFF	-	2,440	157	-	-	-	-	-	8	41	-	6	3	80,392	-	-
		14	-	-	3,123	-	-	-	125	-	26	12	-	1,685	2,108	45,730	55	-
		19	-	-	110	-	-	88	69	-	22	-	-	242	43	1,406	153	-
		23OFF	-	17,646	2,942	-	-	119	398	-	631	7	-	13,766	5,285	454,081	71	25
		27OFF	-	65	126	-	-	36	78	-	-	-	-	93	35	7,558	85	178
		QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	3,536	-	-
	1999 Otter Total:		**-**	**20,152**	**6,457**	**-**	**-**	**243**	**670**	**-**	**687**	**60**	**-**	**15,793**	**7,474**	**592,703**	**364**	**203**
	1999 Total:		**-**	**23,009**	**104,948**	**-**	**-**	**5,403**	**11,741**	**46**	**22,764**	**6,063**	**165**	**135,244**	**89,058**	**1,758,958**	**164,355**	**203**

Table 7. Median and upper and lower confidence intervals for the estimated mean catch (kg) of major species groups based on bootstrapped mean CPUE from bycatch samples multiplied by commercial effort. B = birds, E = eulachon, FC = commercial flatfish, FNC = non-commercial flatfish, H = halibut, IC = commercial invertebrates, INC = non-commercial invertebrates, IS = structural invertebrates (sponges and corals), P = prawns, RKC = commercial rockfish, RKNC = non-commercial rockfish, RDC = commercial roundfish, RDNC = non-commercial roundfish, SHR = shrimp, S = Selachii (dogfish, ratfish, and skates), U = unknown.

Year	Gear	Area		B			E			FC			FNC			H	
1997	Beam	124OFF	-	-	-	23	67	125	2,556	5,507	9,845	-	-	-	-	-	-
		12IN	-	-	-	-	8	24	4,494	6,515	8,689	-	-	-	-	-	-
		14	-	-	-	-	83	205	5,072	8,230	11,478	-	-	-	-	-	-
		16	-	-	-	-	5	15	4,285	6,059	7,486	-	-	-	-	-	-
		17	-	-	-	-	-	-	2,034	11,436	26,780	-	-	-	-	-	-
		18	-	-	-	-	-	-	3,944	5,539	7,404	-	-	-	-	-	-
		19	-	-	-	-	-	-	3,522	5,086	7,184	-	114	341	-	-	-
		23IN	-	431	1,293	1,120	1,912	2,812	10,229	15,705	21,873	-	-	-	-	-	-
		23OFF	-	-	-	1,781	2,918	4,200	14,388	19,166	24,571	-	-	-	-	-	-
		FR	-	-	-	-	-	-	10,242	22,839	46,659	-	-	-	-	-	-
		GSTE	-	-	-	-	-	-	1,490	2,306	3,371	-	-	-	-	-	-
	Otter	124OFF	-	-	-	2,415	4,052	6,177	3,805	5,942	8,675	-	-	-	-	-	-
		125OFF	-	-	-	744	1,284	1,918	164	348	617	-	-	-	-	-	-
		14	-	-	-	-	23	49	125	240	434	-	-	-	-	-	-
		23IN	-	-	-	1,466	3,800	7,616	851	1,616	2,517	-	-	-	-	-	-
		23OFF	-	-	-	10,860	15,696	20,847	1,819	4,224	7,340	-	-	-	-	-	-
		PRD	-	-	-	587	969	1,557	21,536	43,116	75,359	-	-	-	150	2,304	5,922
		QCSND	-	-	-	64,383	75,511	86,894	10,431	12,997	15,702	-	-	-	-	249	651
1998	Beam	12IN	-	-	-	43	104	186	3,355	8,748	18,155	-	-	-	-	-	-
		14	-	-	-	-	-	-	3,235	10,052	22,509	-	-	-	-	-	-
		18	-	-	-	-	-	-	11,226	25,016	44,620	-	-	-	-	-	-
		23IN	-	-	-	146	334	609	1,085	2,345	3,933	-	-	-	-	-	-
		23OFF	-	-	-	4,044	6,054	8,444	8,133	16,512	28,961	-	17	52	-	-	-
		FR	-	-	-	-	-	-	5,164	19,163	36,815	2,245	11,598	22,520	-	-	-
		PRD	-	-	-	176	448	785	30,802	66,177	122,856	-	-	-	-	-	-
	Otter	124OFF	-	-	-	-	-	-	134	381	627	-	-	-	-	-	-
		12IN	-	-	-	198	341	484	18	26	33	-	-	-	-	-	-
		18	-	-	-	-	-	-	346	346	346	-	-	-	-	-	-
		23OFF	-	-	-	16,089	19,113	21,789	311	736	1,161	-	-	-	-	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	-	-	130	229	371	1,718	2,673	3,732	-	-	-	-	-	-
		QCSND	-	-	-	11,005	14,058	19,069	10,727	13,837	17,359	-	-	-	-	-	-
1999	Beam	12IN	-	-	-	6	23	48	4,112	5,638	7,299	-	-	-	-	-	-
		12OUT	-	-	-	-	-	-	6,835	12,272	17,708	-	-	-	-	-	-
		14	-	-	-	-	-	-	7,580	13,193	19,603	-	-	-	-	-	-
		16	-	-	-	-	-	-	3,068	7,530	13,811	-	-	-	-	-	-
		18	-	-	-	-	-	-	1,689	5,289	10,417	-	-	-	-	-	-
		19	-	-	-	-	-	-	4,836	4,836	4,836	-	-	-	-	-	-
		23IN	-	-	-	28	59	99	847	1,140	1,424	-	-	-	-	-	-
		23OFF	-	-	-	1,376	2,460	4,391	6,806	10,391	15,127	-	-	-	-	-	-
		2IN	-	-	-	-	-	-	480	1,085	1,796	-	-	-	-	-	-
		FR	-	-	-	-	-	-	25,787	37,466	48,611	-	-	-	-	-	-
		GSTE	-	-	-	-	-	-	5,803	13,477	24,178	-	-	-	-	-	-
	Otter	125OFF	-	-	-	1,671	2,037	2,377	93	129	165	-	-	-	-	-	-
		14	-	-	-	-	-	-	2,806	6,015	11,055	-	-	-	-	-	-
		19	-	-	-	-	-	-	411	411	411	-	-	-	-	-	-
		23OFF	-	-	-	12,383	16,358	21,128	1,821	2,725	4,007	-	-	-	-	-	-
		27OFF	-	-	-	7	52	106	2	100	292	-	-	-	-	-	-
		QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7 continued.

Year	Gear	Area	IC			INC			IS			P			RKC			RKNC		
1997	Beam	124OFF	4	105	214	46	121	197	-	-	-	4	89	191	-	-	-	-	-	-
		12IN	-	31	92	1,139	1,803	2,787	-	74	223	1,601	2,315	3,082	-	31	87	-	-	-
		14	191	456	763	641	8,100	22,974	-	-	-	2,785	5,344	8,668	663	983	1,311	-	-	-
		16	-	29	91	94	127	165	-	-	-	573	968	1,318	117	662	1,676	-	-	-
		17	-	-	-	-	174	446	-	-	-	-	33	98	339	3,958	9,819	-	-	-
		18	-	-	-	-	715	2,145	-	-	-	970	1,602	2,317	54	130	212	-	-	-
		19	3	206	598	796	2,561	4,600	-	-	-	417	860	1,336	81	386	811	-	-	-
		23IN	-	45	119	153	342	581	-	-	-	167	311	503	94	421	912	-	-	-
		23OFF	292	946	1,837	437	733	1,066	-	-	-	70	228	483	192	925	2,296	-	-	-
		FR	-	186	521	2,947	5,890	9,331	-	-	-	2,072	4,175	6,357	1,489	2,706	3,765	-	-	-
		GSTE	-	58	171	857	1,253	1,750	-	-	-	1,973	2,957	4,040	1,190	1,746	2,366	-	-	-
	Otter	124OFF	-	5	12	197	1,071	2,782	-	-	-	10	23	39	41	280	748	-	-	-
		125OFF	-	10	29	-	-	-	-	-	-	-	-	-	-	46	120	-	-	-
		14	-	26	70	84	113	147	-	-	-	209	704	1,623	42	93	151	-	-	-
		23IN	42	71	105	23	74	143	-	-	-	20	35	54	-	9	24	-	-	-
		23OFF	105	182	278	70	153	275	-	-	-	86	171	274	2	30	77	-	-	-
		PRD	1,940	6,459	13,297	547	1,429	2,729	-	1,893	5,681	622	1,280	2,272	3,051	6,841	14,450	-	-	-
		QCSND	182	322	493	369	810	1,633	-	-	-	37	57	82	761	1,017	1,286	-	-	-
1998	Beam	12IN	55	463	1,130	366	693	1,247	-	-	-	235	1,178	2,576	-	136	397	-	-	-
		14	162	313	473	1,292	2,121	3,549	-	-	-	839	2,628	5,773	168	758	1,883	-	-	-
		18	223	1,168	2,244	1,237	62,151	137,253	-	-	-	173	963	2,487	-	374	1,069	-	-	-
		23IN	26	57	90	875	4,845	12,515	-	-	-	244	1,450	3,190	-	-	-	-	13	39
		23OFF	375	734	1,212	4,189	6,450	8,844	-	-	-	838	1,893	3,418	21	144	306	-	-	-
		FR	863	3,109	6,043	8,825	18,061	32,650	-	26	77	1,239	1,954	2,775	752	2,305	4,895	-	-	-
		PRD	15	1,000	2,910	526	944	1,448	-	-	-	155	410	894	293	1,484	3,628	-	-	-
	Otter	124OFF	-	78	157	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		12IN	-	-	-	671	711	752	-	-	-	11	33	55	-	-	-	-	-	-
		18	173	173	173	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23OFF	-	-	-	-	2,112	6,336	-	-	-	-	2,449	7,348	-	-	-	-	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	16	46	-	-	-	-	-	-	-	8	23	2	23	62	-	-	-
		QCSND	351	566	843	2,175	2,753	3,384	-	-	-	17	46	85	1,012	1,309	1,635	-	-	-
1999	Beam	12IN	-	-	-	188	255	332	-	-	-	725	1,460	2,920	-	-	-	-	-	-
		12OUT	-	-	-	277	322	367	-	-	-	-	-	-	-	-	-	-	-	-
		14	-	91	274	296	582	891	-	-	-	572	3,126	7,653	-	301	881	-	-	-
		16	-	-	-	1,092	1,540	1,936	-	51	102	1,989	5,155	9,351	155	1,908	5,325	-	-	-
		18	-	228	647	389	938	1,311	-	-	-	24	369	714	-	-	-	-	-	-
		19	-	-	-	150	150	150	-	-	-	3,636	3,636	3,636	-	-	-	-	-	-
		23IN	3	30	75	40	78	131	-	-	-	45	87	144	-	1	4	-	-	-
		23OFF	83	139	202	367	594	1,003	-	-	-	387	593	842	-	20	46	-	-	-
		2IN	-	-	-	7	24	43	-	-	-	21	88	203	-	12	26	-	-	-
		FR	845	4,489	11,113	2,541	5,997	11,934	-	-	-	3,728	8,619	13,877	141	3,952	11,224	-	176	528
		GSTE	-	326	989	1,203	1,591	1,939	-	-	-	1,240	2,821	4,891	22	196	496	-	-	-
	Otter	125OFF	-	-	-	-	-	-	-	-	-	2	6	11	22	33	47	-	-	-
		14	-	-	-	129	236	385	-	-	-	31	49	79	6	24	42	-	-	-
		19	327	327	327	258	258	258	-	-	-	81	81	81	-	-	-	-	-	-
		23OFF	62	108	171	263	369	486	-	-	-	247	571	1,036	-	7	15	-	-	-
		27OFF	-	29	60	2	60	171	-	-	-	-	-	-	-	-	-	-	-	-
		QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7 continued.

Year	Gear	Area	RDC			RDNC			SHR			S			U		
1997	Beam	124OFF	372	673	946	90	200	317	38,260	53,460	66,705	513	1,471	2,444	-	4	11
		12IN	172	391	637	1,538	2,203	2,931	40,337	49,579	58,749	8,945	12,368	16,598	-	2,566	7,699
		14	2,773	4,607	6,685	4,780	7,064	9,707	38,090	55,791	80,752	9,138	18,709	34,103	-	-	-
		16	6,079	9,950	12,834	977	1,666	2,349	7,395	10,780	14,839	6,047	10,569	15,648	-	-	-
		17	3,051	7,083	13,390	13,734	17,697	24,102	1,092	6,514	13,837	4,068	11,828	18,655	-	-	-
		18	1,442	3,960	8,522	11,048	15,132	19,418	94,863	117,787	139,574	-	310	930	-	-	-
		19	2,554	4,615	7,793	954	2,007	3,531	37,612	44,657	52,544	13,478	24,378	38,896	-	-	-
		23IN	11,618	15,543	19,674	5,916	7,602	9,548	164,645	208,949	263,592	6,976	12,913	21,408	-	-	-
		23OFF	4,913	7,830	11,432	5,666	8,331	11,409	232,318	266,646	305,890	18,093	32,623	51,890	-	-	-
		FR	5,539	12,291	23,044	10,485	21,319	39,416	62,622	92,763	123,184	35,265	134,038	298,339	-	-	-
		GSTE	5,099	9,031	14,093	2,962	9,831	23,771	81,811	99,145	121,168	8,097	13,557	22,245	-	-	-
	Otter	124OFF	6,309	11,756	18,018	200	921	2,329	297,000	355,257	414,119	112	468	1,179	-	1,059	4,238
		125OFF	-	24	55	119	861	2,296	25,529	38,849	54,740	-	-	-	-	-	-
		14	414	876	1,476	975	1,694	2,500	16,388	23,672	34,034	-	15	44	-	-	-
		23IN	501	811	1,318	815	932	1,073	32,305	42,944	63,045	4	16	37	-	-	-
		23OFF	1,181	2,137	3,203	4,420	7,195	11,042	222,047	273,586	332,786	307	886	1,636	-	-	-
		PRD	2,814	4,766	8,030	7,861	18,118	34,205	90,629	105,459	122,893	22,517	37,911	57,735	-	2	5
		QCSND	160	243	358	11,467	12,947	14,512	406,551	441,103	475,487	235	539	951	5	18	36
1998	Beam	12IN	2,020	3,797	6,161	2,188	3,602	5,517	151,594	236,883	339,715	2,013	9,085	21,197	-	-	-
		14	3,080	4,562	6,056	3,793	10,687	20,196	86,837	145,823	213,060	-	4,529	13,544	-	-	-
		18	6,298	14,318	25,129	13,919	24,142	37,764	66,544	99,776	136,756	6,184	22,354	43,997	-	-	-
		23IN	1,967	3,079	4,284	1,903	3,586	6,272	51,536	67,221	84,377	790	3,113	6,967	-	6	18
		23OFF	7,526	12,131	17,431	8,694	12,047	16,106	403,843	504,928	624,688	5,443	20,574	42,762	-	25	74
		FR	14,356	35,083	61,514	22,949	42,118	69,164	154,757	186,761	233,936	20,960	33,415	48,491	-	-	-
		PRD	4,755	7,851	11,692	1,728	3,119	5,292	76,450	105,811	154,688	17,526	26,855	37,034	-	-	-
	Otter	124OFF	110	212	314	24	326	627	-	-	-	-	78	157	-	-	-
		12IN	2,453	4,681	6,908	143	214	286	7,278	8,983	10,688	-	-	-	-	-	-
		18	2,336	2,336	2,336	1,730	1,730	1,730	433	433	433	87	87	87	-	-	-
		23OFF	1,881	2,250	2,866	1,368	1,630	1,893	88,936	161,585	256,433	-	-	-	-	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	652	1,065	1,561	379	569	799	26,894	32,190	37,065	380	754	1,269	-	-	-
		QCSND	8,398	11,837	16,097	6,454	7,966	9,514	678,914	746,606	829,642	171	248	339	-	-	-
1999	Beam	12IN	706	1,238	2,001	2,063	3,134	4,385	38,922	62,931	88,939	1,029	2,341	4,240	-	-	-
		12OUT	4,180	5,092	6,003	9,696	17,223	24,749	4,524	10,069	15,613	53,476	58,009	62,542	-	-	-
		14	522	2,065	4,378	6,636	14,957	25,972	53,532	162,909	297,412	2,918	22,666	52,247	-	-	-
		16	1,056	3,143	4,781	66	2,331	6,319	30,278	60,597	90,363	19,938	27,495	35,067	-	-	-
		18	1,578	3,060	4,536	619	1,167	1,716	12,554	20,422	28,288	104	1,714	3,383	-	-	-
		19	10,946	10,946	10,946	4,873	4,873	4,873	63,013	63,013	63,013	-	-	-	-	-	-
		23IN	7,993	10,003	12,181	1,128	1,494	1,871	39,044	45,231	54,169	356	735	1,282	-	-	-
		23OFF	26,712	39,745	59,275	4,422	6,097	8,065	386,192	447,362	510,754	2,788	5,032	7,677	-	-	-
		2IN	72	808	2,158	60	141	220	10,893	14,023	17,495	13	463	1,334	-	-	-
		FR	20,684	40,900	67,170	10,849	25,755	44,522	171,939	241,673	318,454	18,471	58,896	127,340	-	-	-
		GSTE	4,343	7,254	10,826	5,974	15,384	27,961	96,072	141,173	190,792	543	2,489	4,648	-	-	-
	Otter	125OFF	1	5	9	-	2	6	56,199	66,472	75,783	-	-	-	-	-	-
		14	1,662	3,241	4,954	1,398	3,941	7,502	51,870	91,650	131,697	12	104	267	-	-	-
		19	902	902	902	162	162	162	5,248	5,248	5,248	572	572	572	-	-	-
		23OFF	7,561	12,709	20,711	3,636	4,927	6,483	372,294	423,217	481,994	45	67	90	3	21	53
		27OFF	17	74	136	2	26	71	4,048	5,965	8,326	17	68	127	7	135	370
		QCSND	-	-	-	-	-	-	2,953	3,361	3,627	-	-	-	-	-	-

Table 8a. Estimated bycatch (kg) of selected commercially important flatfish.

Year	Gear	Area	Arrowtooth flounder	C-O sole	Dover sole	English sole	Flathead sole	Petrale sole	Rex sole	Rock sole	Sand sole	Slender sole	Starry flounder
1997	Beam	124OFF	157	-	157	1,458	-	381	867	34	-	87	-
		12IN	1,411	-	282	1,093	2,780	-	950	-	-	-	-
		14	570	-	738	2,416	485	-	858	163	-	2,972	-
		16	137	-	62	2,954	741	-	383	44	-	1,693	-
		17	2,345	-	-	2,678	-	-	6,264	-	-	-	149
		18	-	-	121	183	242	198	174	1,465	155	28	-
		19	33	-	597	1,565	4	5	644	579	83	6	-
		23IN	275	-	575	3,979	1,513	81	2,860	-	-	2,634	-
		23OFF	2,325	-	2,390	1,438	1,333	376	3,225	212	5	1,422	-
		FR	-	-	415	13,651	1,625	-	914	1,113	123	4,457	-
		GSTE	854	-	52	1,340	-	-	84	-	-	-	-
1997 Beam Total:			**8,107**	**-**	**5,389**	**32,757**	**8,723**	**1,041**	**17,224**	**3,610**	**366**	**13,300**	**149**
	Otter	124OFF	3,351	-	59	-	283	-	1,644	-	3	818	-
		125OFF	-	-	-	-	148	-	207	-	-	-	-
		14	-	-	-	15	29	-	-	8	51	144	-
		23IN	-	-	24	72	49	46	418	-	-	759	-
		23OFF	422	-	495	156	-	425	1,661	-	-	335	-
		PRD	7,749	-	2,387	11,124	19,838	-	1,653	924	-	15	448
		QCSND	5,154	-	700	12	1,094	33	3,320	-	27	2,710	-
1997 Otter Total:			**16,676**	**-**	**3,664**	**11,380**	**21,442**	**504**	**8,902**	**931**	**81**	**4,781**	**448**
1997 Total:			**24,783**	**-**	**9,053**	**44,137**	**30,165**	**1,545**	**26,127**	**4,541**	**447**	**18,081**	**597**
1998	Beam	12IN	2,445	-	219	1,755	2,884	-	461	569	139	199	501
		14	-	-	79	2,829	449	-	501	-	-	7,309	-
		18	153	-	1,347	5,753	5,861	33	2,794	821	1,324	5,793	-
		23IN	97	5	127	106	450	-	440	-	7	657	-
		23OFF	2,334	-	751	1,126	1,049	-	2,264	120	-	1,717	-
		FR	170	-	270	8,298	3,010	-	1,703	292	511	3,747	-
		PRD	29,309	-	1,112	13,066	19,476	-	5,987	15	-	302	-
1998 Beam Total:			**34,508**	**5**	**3,905**	**32,933**	**33,178**	**33**	**14,150**	**1,817**	**1,981**	**19,725**	**501**
	Otter	124OFF	-	-	-	-	-	-	290	-	-	12	-
		12IN	-	-	-	-	-	-	8	-	-	17	-
		18	-	-	-	173	-	-	87	-	-	-	-
		23OFF	279	-	308	-	-	-	105	-	-	44	-
		27IN	-	-	-	-	-	-	-	-	-	-	-
		27OFF	1,422	-	102	-	169	8	983	-	-	-	-
		QCSND	6,329	-	672	92	1,867	140	2,220	-	15	2,275	-
1998 Otter Total:			**8,030**	**-**	**1,082**	**265**	**2,036**	**149**	**3,694**	**-**	**15**	**2,349**	**-**
1998 Total:			**42,538**	**5**	**4,986**	**33,198**	**35,215**	**181**	**17,844**	**1,817**	**1,996**	**22,073**	**501**
1999	Beam	12IN	59	-	60	1,908	890	112	263	1,673	176	231	271
		12OUT	-	-	719	6,989	1,984	-	2,510	69	-	-	-
		14	-	-	-	2,486	356	-	98	-	272	9,943	-
		16	-	-	1,135	2,036	-	-	1,092	59	-	3,089	-
		18	-	-	506	1,513	515	-	431	-	411	112	-
		19	-	-	1,799	600	-	-	-	-	-	-	-
		23IN	-	-	98	148	454	-	134	12	-	188	-
		23OFF	1,679	-	2,456	1,367	534	591	2,800	5	420	348	-
		2IN	-	-	-	-	-	-	114	125	219	650	-
		FR	211	-	2,171	19,662	4,443	-	710	160	-	7,346	81
		GSTE	-	-	37	8,615	-	-	33	66	-	5,166	-
1999 Beam Total			**1,949**	**-**	**8,983**	**45,324**	**9,177**	**703**	**8,185**	**2,170**	**1,498**	**27,074**	**352**
	Otter	125OFF	-	-	-	1	-	10	62	-	-	56	-
		14	-	-	-	1,000	171	-	-	-	-	4,921	-
		19	-	-	81	327	-	-	3	-	-	-	-
		23OFF	60	-	548	37	180	36	1,327	22	379	36	-
		27OFF	-	-	-	-	-	-	55	-	-	45	-
		QCSND	-	-	-	-	-	-	-	-	-	-	-
1999 Otter Total:			**60**	**-**	**629**	**1,365**	**351**	**46**	**1,448**	**22**	**379**	**5,058**	**-**
1999 Total:			**2,009**	**-**	**9,611**	**46,688**	**9,528**	**749**	**9,633**	**2,192**	**1,877**	**32,132**	**352**

Table 8b. Estimated bycatch (kg) of selected commercially important rockfish.

Year	Gear	Area	Bocaccio	Canary rockfish	Copper rockfish	Pacific ocean perch	Quillback rockfish	Redbanded rockfish	Redstripe rockfish	Rougheye rockfish	Shortraker rockfish	Shortspine thornyhead	Silvergray rockfish	Widow rockfish	Yelloweye rockfish	Yellowmouth rockfish	Yellowtail rockfish
1997	Beam	124OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		12IN	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-
		14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		16	-	-	-	-	573	-	-	-	-	-	-	-	-	-	-
		17	-	-	-	-	526	-	-	-	-	-	-	-	-	-	-
		18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		19	-	-	61	-	331	-	-	-	-	-	-	-	-	-	-
		23IN	-	-	-	-	201	-	45	-	-	-	-	-	-	-	195
		23OFF	39	30	-	5	644	-	32	-	-	-	-	-	-	-	134
		FR	-	-	-	-	590	-	325	-	-	-	-	-	-	-	-
		GSTE	-	-	-	-	184	-	-	-	-	-	-	-	104	-	-
1997 Beam Total:			**39**	**30**	**61**	**5**	**3,047**	**7**	**402**	**-**	**-**	**-**	**-**	**-**	**104**	**-**	**329**
	Otter	124OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	234
		125OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23IN	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
		23OFF	-	-	-	6	-	-	21	-	-	-	-	-	-	-	2
		PRD	-	-	2,948	553	189	-	742	-	932	4	-	-	-	948	387
		QCSND	3	-	-	606	-	74	-	113	-	145	-	10	-	-	1
1997 Otter Total:			**3**	**-**	**2,948**	**1,165**	**189**	**74**	**773**	**113**	**932**	**149**	**-**	**10**	**-**	**948**	**624**
1997 Total:			**42**	**30**	**3,009**	**1,170**	**3,237**	**81**	**1,176**	**113**	**932**	**149**	**-**	**10**	**104**	**948**	**953**
1998	Beam	12IN	-	-	-	-	131	-	5	-	-	-	-	-	-	-	-
		14	-	-	94	-	-	-	-	-	-	-	-	-	-	-	-
		18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23OFF	-	-	-	-	-	-	102	-	-	-	-	-	-	-	-
		FR	-	-	-	-	-	-	-	-	-	-	115	-	-	-	-
		PRD	-	-	-	147	-	-	-	1,287	133	-	-	-	-	-	-
1998 Beam Total:			**-**	**-**	**94**	**147**	**131**	**-**	**107**	**1,287**	**133**	**-**	**115**	**-**	**-**	**-**	**-**
	Otter	124OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		12IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
		QCSND	-	-	-	245	-	24	-	42	10	603	-	-	-	-	16
1998 Otter Total:			**-**	**-**	**-**	**248**	**-**	**24**	**-**	**42**	**10**	**603**	**-**	**-**	**-**	**-**	**16**
1998 Total:			**-**	**-**	**94**	**395**	**131**	**24**	**107**	**1,329**	**143**	**603**	**115**	**-**	**-**	**-**	**16**
1999	Beam	12IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		12OUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		16	-	-	-	-	-	-	-	319	-	66	-	-	-	-	-
		18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
		2IN	-	-	-	-	4	-	7	-	-	-	-	-	-	-	-
		FR	-	-	-	-	-	-	-	-	-	-	44	-	-	-	-
		GSTE	-	-	-	-	-	-	-	-	-	-	53	-	-	-	-
1999 Beam Total:			**-**	**-**	**-**	**-**	**4**	**-**	**7**	**319**	**-**	**66**	**97**	**-**	**-**	**-**	**7**
	Otter	125OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		23OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999 Otter Total:			**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
1999 Total:			**-**	**-**	**-**	**-**	**4**	**-**	**7**	**319**	**-**	**66**	**97**	**-**	**-**	**-**	**7**

Table 8c. Estimated bycatch (kg) of selected commercially important roundfish, invertebrates, skates, and dogfish.

Year	Gear	Area	Pacific cod	Pacific hake	Pacific tomcod	Lingcod	Sablefish	Walleye pollock	Dungeness crab	Red rock crab	Sea cucumber	Green urchin	Opal squid	Spiny scallop	Big skate	Longnose skate	Spiny dogfish
1997	Beam	124OFF	461	90	121	-	-	-	86	-	-	-	4	-	-	1,039	284
		12IN	-	1	-	-	-	401	-	-	-	-	-	-	-	1,535	5,620
		14	102	3,799	-	-	-	739	-	-	-	-	-	-	38	1,347	5,226
		16	495	8,657	-	200	-	451	-	-	29	-	-	-	-	23	8,186
		17	827	3,738	-	-	-	2,518	-	-	-	-	-	-	-	-	10,237
		18	702	41	25	187	-	3,085	-	-	-	-	-	-	233	-	78
		19	95	-	87	-	-	4,572	-	-	13	-	-	-	200	3,604	7,581
		23IN	55	13,239	-	44	129	2,097	-	-	-	-	18	-	298	1,433	-
		23OFF	600	4,786	234	283	27	2,032	48	-	-	-	15	-	1,183	5,805	4,094
		FR	557	8,647	-	-	-	3,408	150	-	-	-	-	-	137	417	134,795
		GSTE	173	8,450	-	32	-	523	-	-	-	-	-	-	25	7	8,499
1997 Beam Total:			**4,068**	**51,448**	**467**	**747**	**155**	**19,826**	**284**	**-**	**42**	**-**	**37**	**-**	**2,114**	**15,209**	**184,598**
	Otter	124OFF	3	11,580	-	187	-	287	-	-	-	-	3	-	306	-	78
		125OFF	-	24	-	-	-	-	-	-	-	-	10	-	-	-	-
		14	11	828	-	46	-	-	-	-	-	-	-	-	-	7	-
		23IN	108	315	-	-	-	409	-	-	-	-	72	-	-	-	2
		23OFF	223	501	-	-	-	1,455	-	-	-	-	42	-	-	-	190
		PRD	244	-	-	-	1,546	3,167	4,251	-	2,247	-	-	-	14,914	500	438
		QCSND	46	194	-	-	7	-	-	-	284	-	-	-	-	447	75
1997 Otter Total:			**634**	**13,441**	**-**	**233**	**1,553**	**5,318**	**4,251**	**-**	**2,530**	**-**	**126**	**-**	**15,220**	**955**	**783**
1997 Total:			**4,701**	**64,889**	**467**	**980**	**1,709**	**25,144**	**4,534**	**-**	**2,572**	**-**	**163**	**-**	**17,334**	**16,164**	**185,381**
1998	Beam	12IN	268	2,698	195	-	68	620	328	-	2	-	-	-	-	-	6,303
		14	26	3,584	607	-	-	383	-	-	-	-	-	-	-	-	1,211
		18	930	93	2,751	-	-	11,079	205	-	-	-	-	-	-	-	11,888
		23IN	11	2,838	26	24	-	184	-	-	-	-	16	-	10	774	10
		23OFF	188	6,499	-	499	-	5,036	-	-	-	-	113	-	-	-	13,596
		FR	1,062	28,288	-	630	-	5,830	2,481	-	378	-	-	-	-	-	16,392
		PRD	534	1,639	-	-	256	5,497	-	-	-	-	-	-	4,770	2,664	186
1998 Beam Total:			**3,020**	**45,640**	**3,579**	**1,152**	**324**	**28,628**	**3,014**	**-**	**380**	**-**	**130**	**-**	**4,780**	**3,439**	**49,586**
	Otter	124OFF	78	133	-	-	-	-	-	-	-	-	-	-	-	-	-
		12IN	-	4,540	-	-	-	141	-	-	-	-	-	-	-	-	-
		18	-	346	-	-	-	1,990	-	87	-	87	-	-	-	-	-
		23OFF	-	799	-	-	-	1,451	-	-	-	-	-	-	-	-	-
		27IN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		27OFF	-	751	-	-	-	325	-	-	-	-	-	-	-	-	-
		QCSND	-	7,222	-	23	50	4,651	-	-	489	-	1	-	-	5	10
1998 Otter Total:			**78**	**13,791**	**-**	**23**	**50**	**8,558**	**-**	**87**	**489**	**87**	**1**	**-**	**-**	**5**	**10**
1998 Total:			**3,098**	**59,431**	**3,579**	**1,176**	**375**	**37,186**	**3,014**	**87**	**869**	**87**	**131**	**-**	**4,780**	**3,443**	**49,596**
1999	Beam	12IN	169	559	116	-	5	409	-	-	-	-	-	-	521	-	30
		12OUT	2,148	2,714	69	-	69	92	-	-	-	-	-	-	161	-	-
		14	703	1,287	50	91	-	39	-	-	-	-	-	-	-	-	22,262
		16	30	1,948	-	-	-	1,121	-	-	-	-	-	-	-	-	5,182
		18	-	298	397	-	-	2,365	-	-	-	-	-	-	-	-	-
		19	37	-	-	-	-	10,908	-	-	-	-	-	-	-	-	-
		23IN	-	9,245	52	-	194	428	20	-	5	-	-	-	-	175	45
		23OFF	540	34,852	15	431	2,852	1,500	-	-	-	-	25	-	588	863	898
		2IN	-	683	-	-	45	90	-	-	-	-	-	-	-	-	102
		FR	763	33,019	-	-	-	7,699	4,205	-	-	-	-	-	-	-	25,385
		GSTE	-	3,024	-	-	-	4,359	333	-	-	-	-	-	-	-	920
1999 Beam Total:			**4,389**	**87,628**	**700**	**522**	**3,166**	**29,011**	**4,558**	**-**	**5**	**-**	**25**	**-**	**1,269**	**1,038**	**54,825**
	Otter	125OFF	-	4	-	-	-	1	-	-	-	-	-	-	-	-	-
		14	-	3,288	-	-	-	-	-	-	-	-	-	-	-	-	-
		19	-	-	-	-	-	902	-	-	327	-	-	-	-	-	-
		23OFF	228	11,569	226	18	-	854	2	-	-	-	49	3	3	-	3
		27OFF	8	66	-	-	-	-	-	-	29	-	-	-	-	-	-
		QCSND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999 Otter Total:			**236**	**14,927**	**226**	**18**	**-**	**1,758**	**2**	**-**	**355**	**-**	**49**	**3**	**3**	**-**	**3**
1999 Total:			**4,625**	**102,555**	**926**	**540**	**3,166**	**30,769**	**4,560**	**-**	**361**	**-**	**74**	**3**	**1,272**	**1,038**	**54,828**

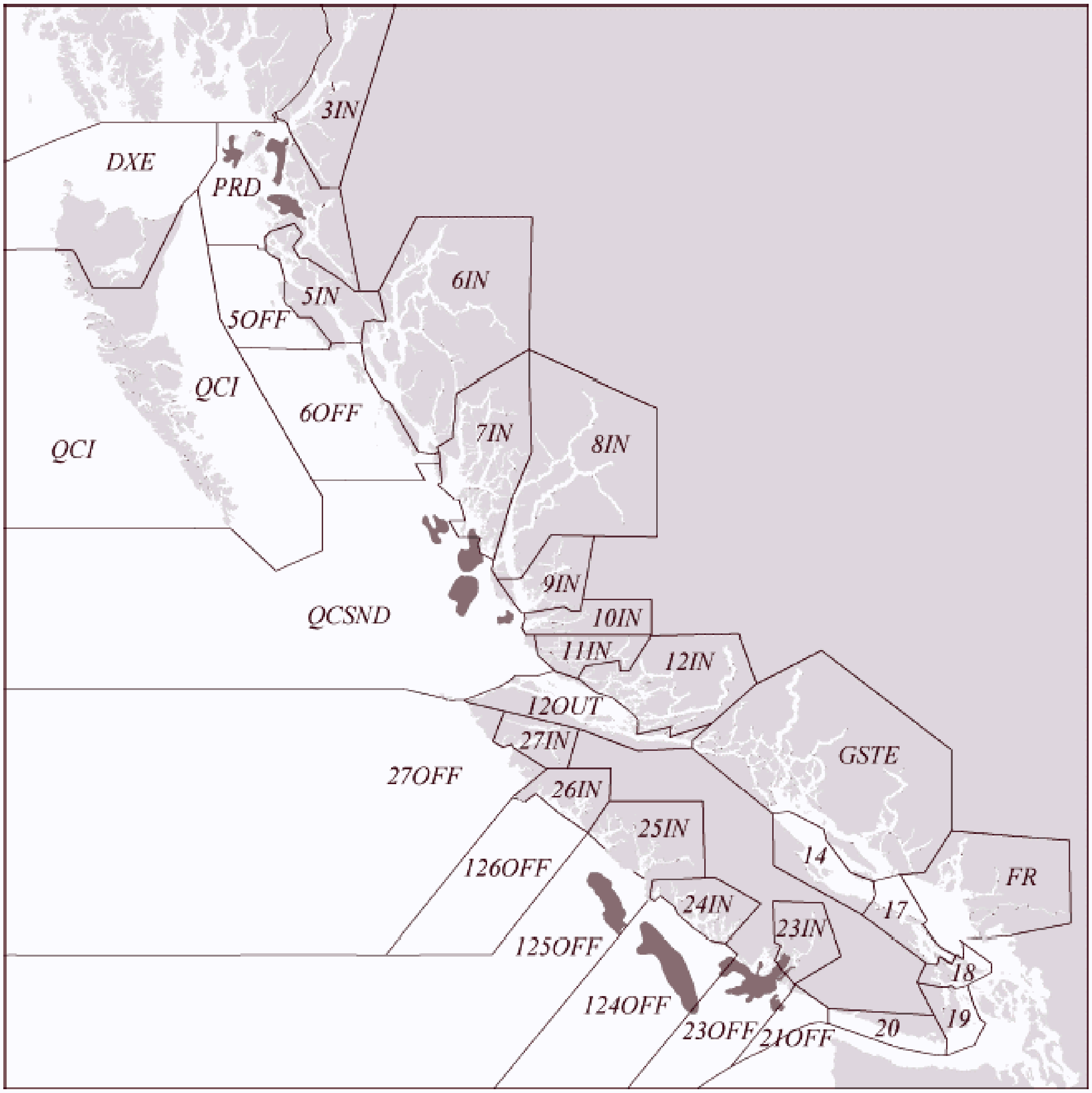


Fig. 1. British Columbia Shrimp Management Areas. Shaded areas indicate some of the areas that are annually surveyed by DFO stock assessment.

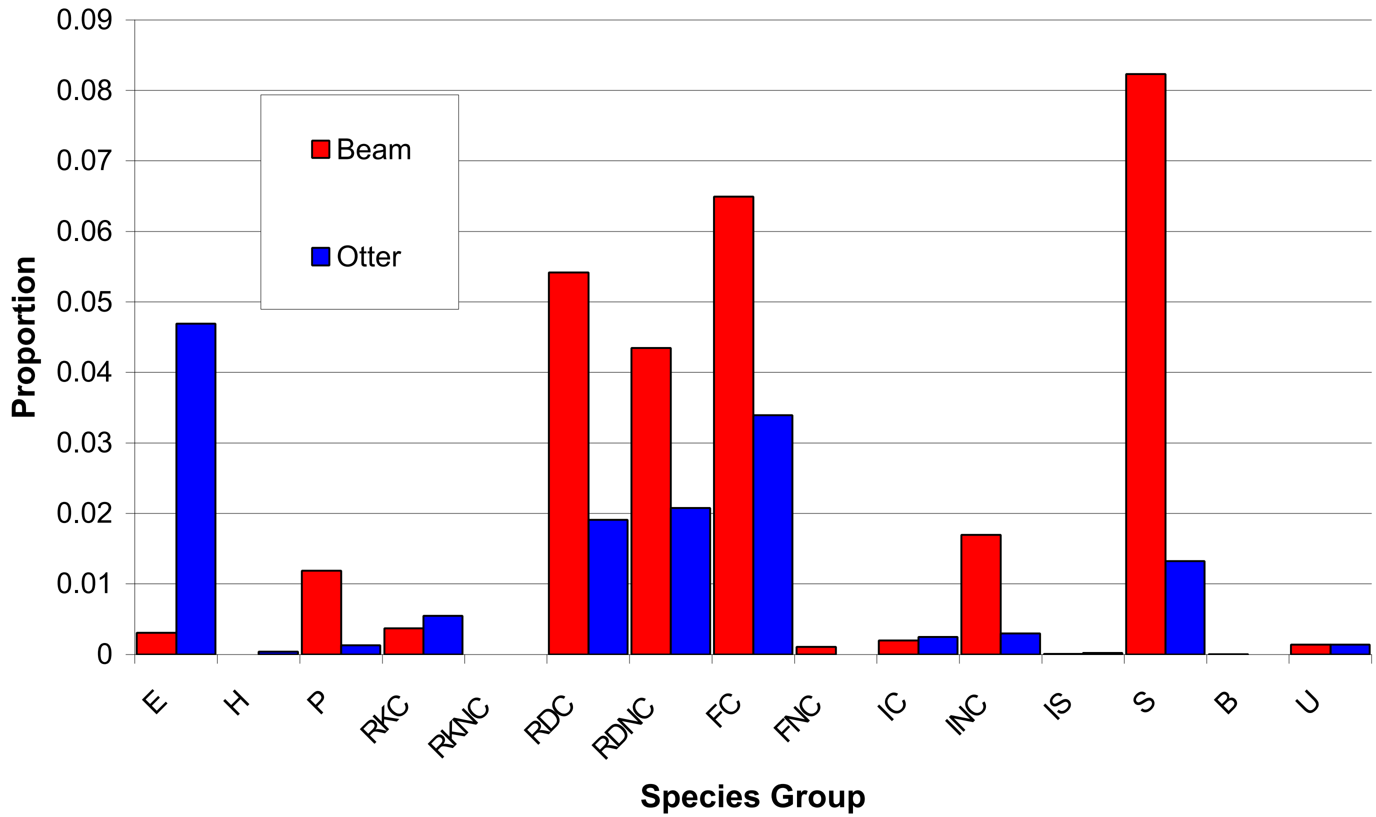
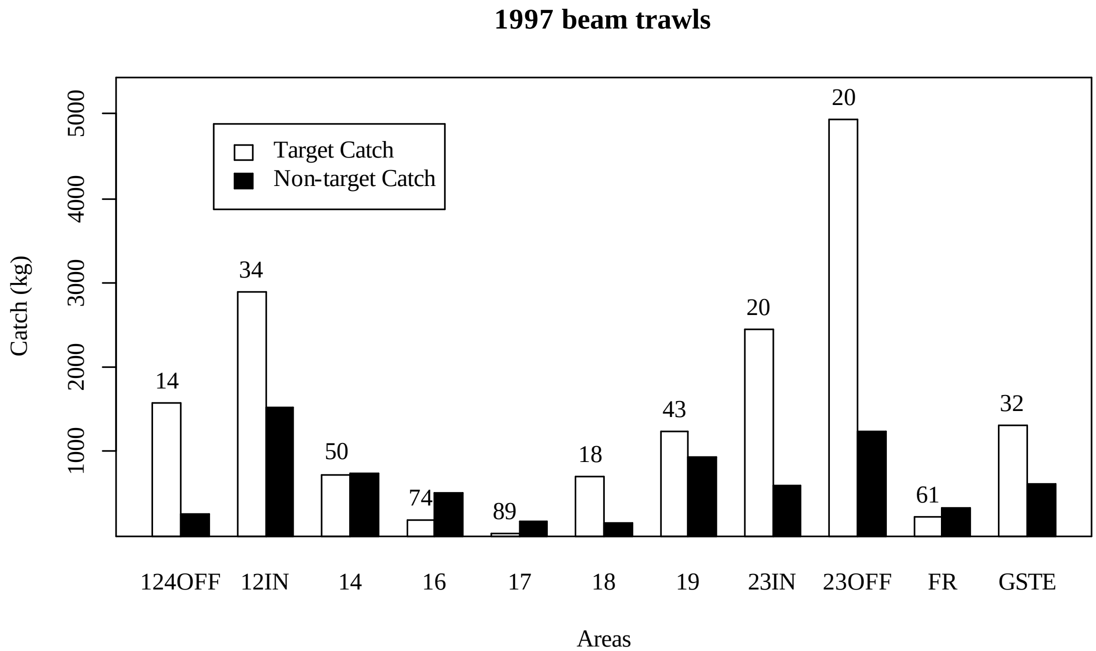
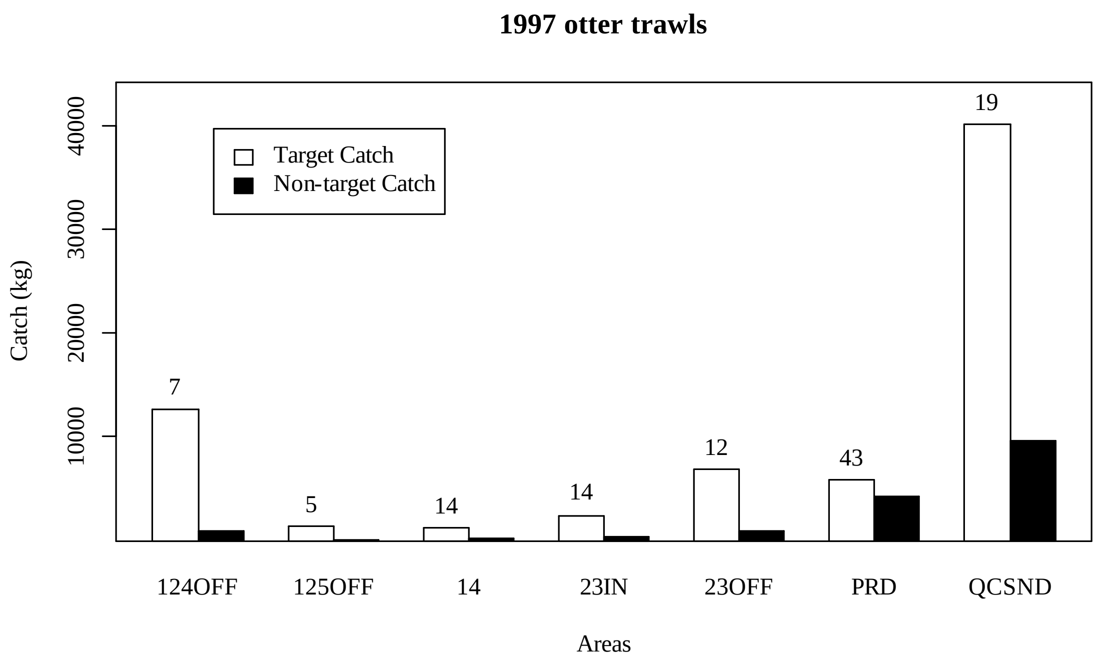


Fig. 2. Composition of bycatch as proportions of major species groups from beam trawls, and otter trawls. Proportions are averaged from coastwide, tow-by-tow records for 1997 – 99. Groups are E = eulachon, H = halibut, P = prawns, RKC = commercial rockfish, RKNC = non-commercial rockfish, RDC = commercial roundfish, RDNC = non-commercial roundfish, FC = commercial flatfish, FNC = non-commercial flatfish, IC = commercial invertebrates, INC = non-commercial invertebrates, IS = structural invertebrates (sponges and corals), S = dogfish, ratfish, and skates, B = birds, and U = unknown.

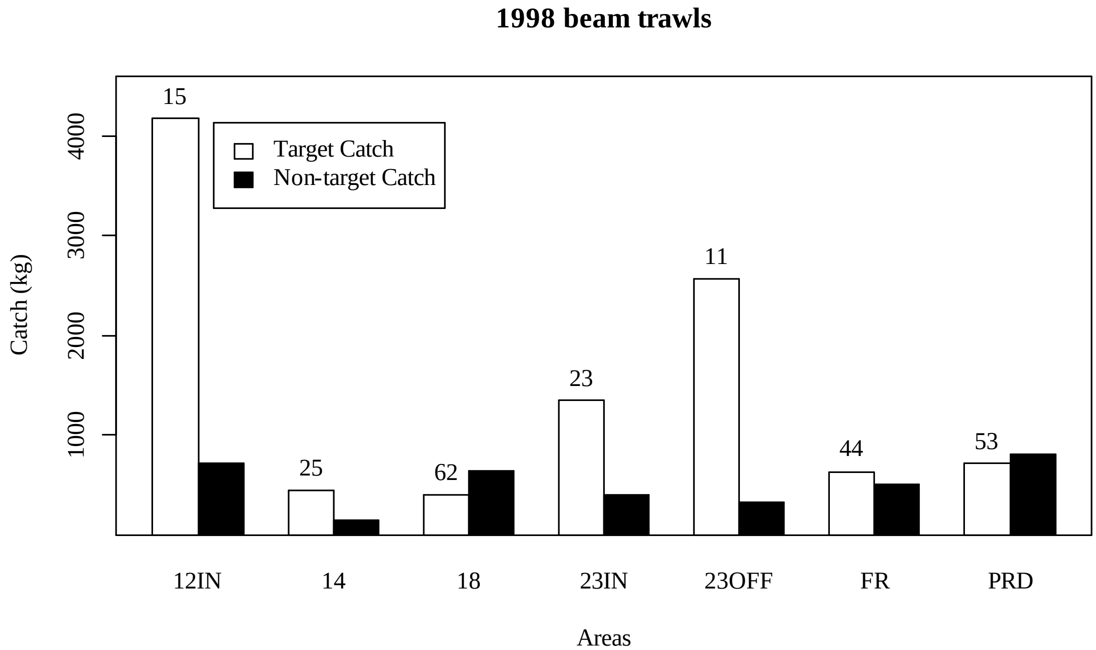


(a)

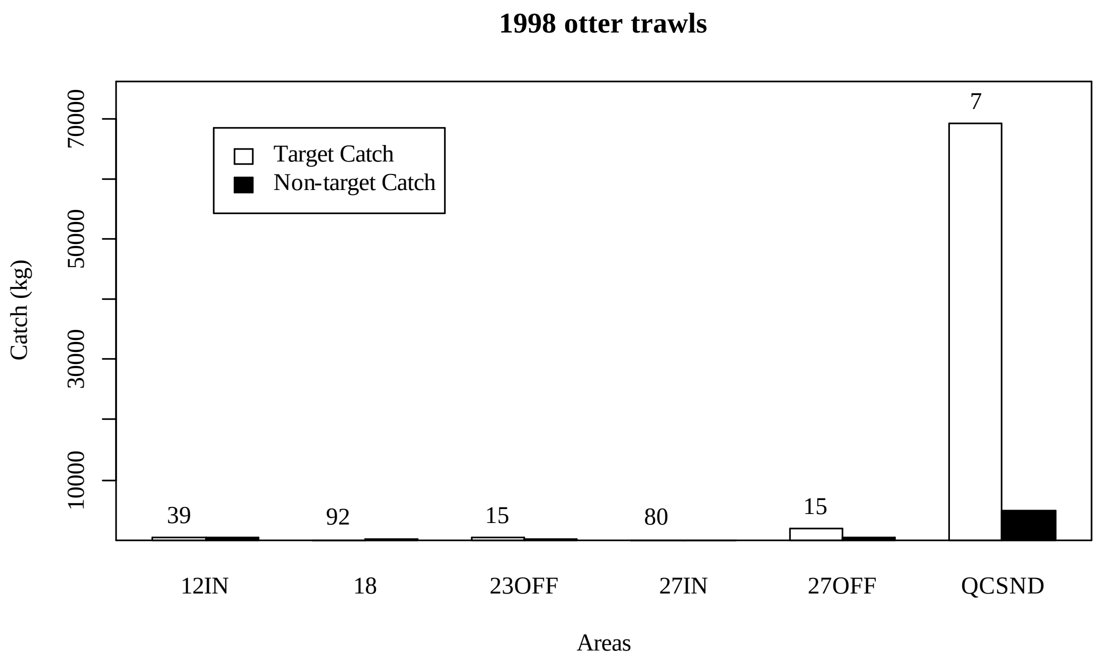


(b)

Fig. 3. 1997 target and non-target catch recorded from bycatch observer trawls by year, area, and gear type for (a) beam trawls, and (b) otter trawls.

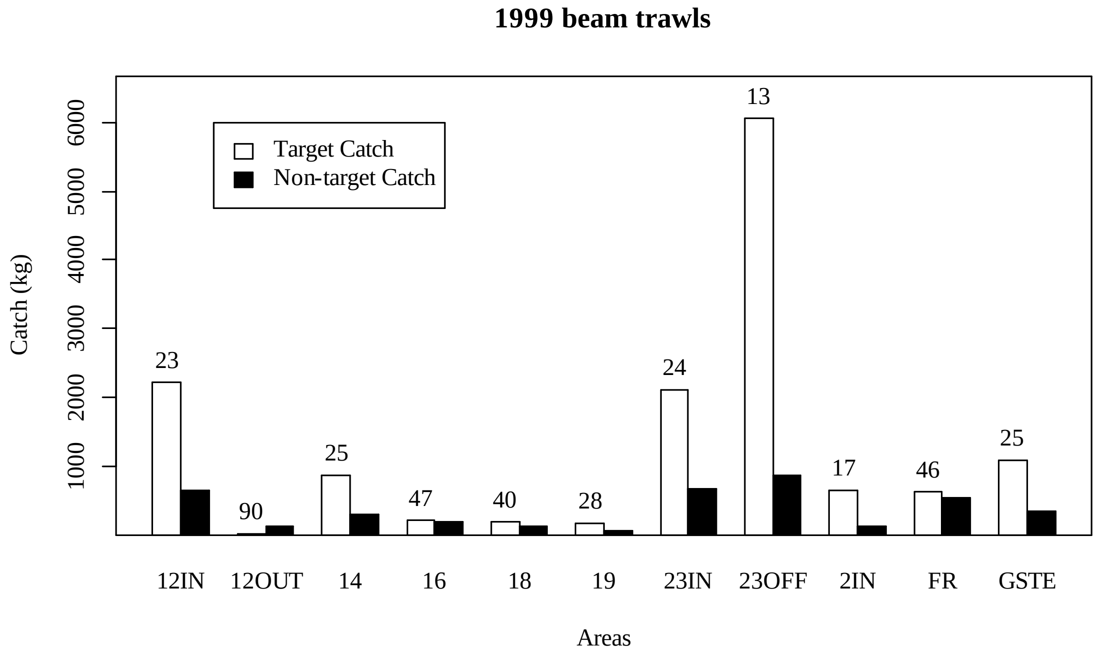


(c)

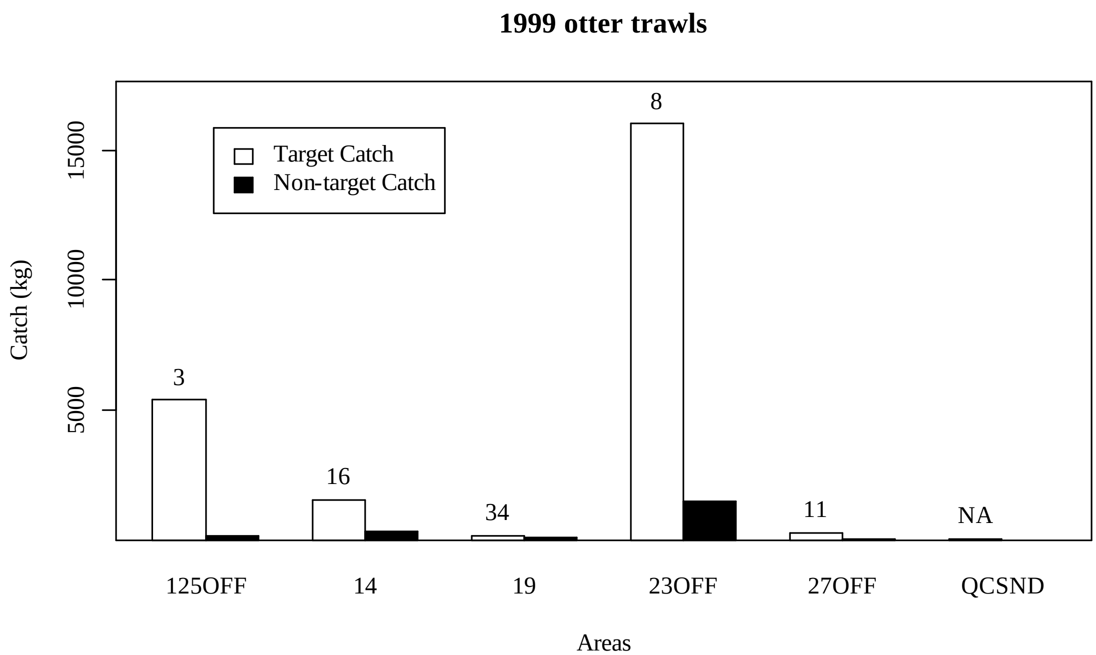


(d)

Fig. 3 continued. 1998 target and non-target catch recorded from bycatch observer trawls by year, area, and gear type for (c) beam trawls, and (d) otter trawls. The non-target catch, as percent of the total catch, is shown above each pair of bars.

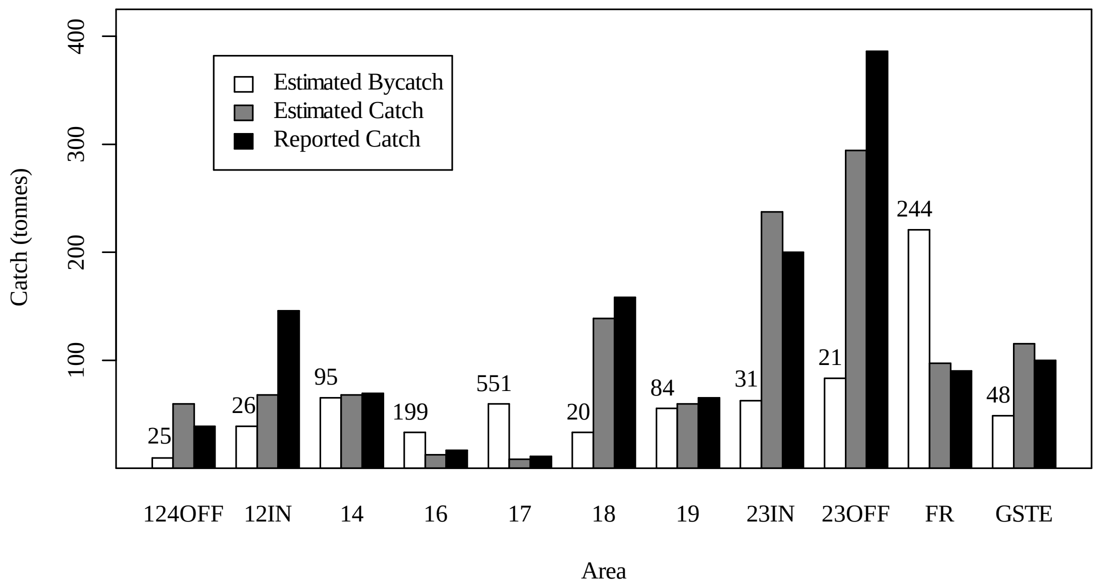


(e)

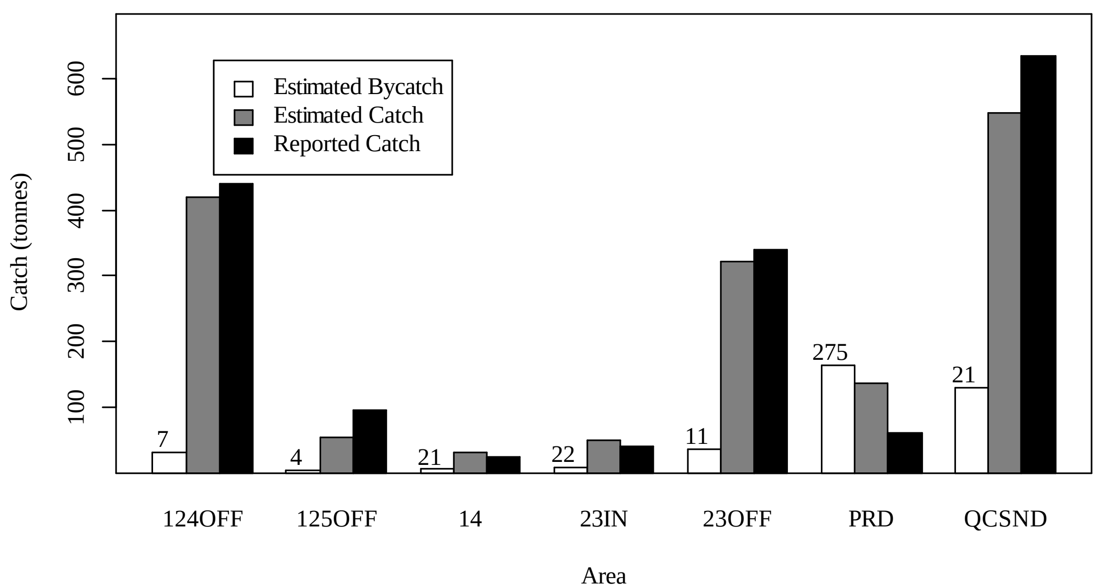


(f)

Fig. 3 continued. 1999 target and non-target catch recorded from bycatch observer trawls by year, area, and gear type for (e) beam trawls, and (f) otter trawls.

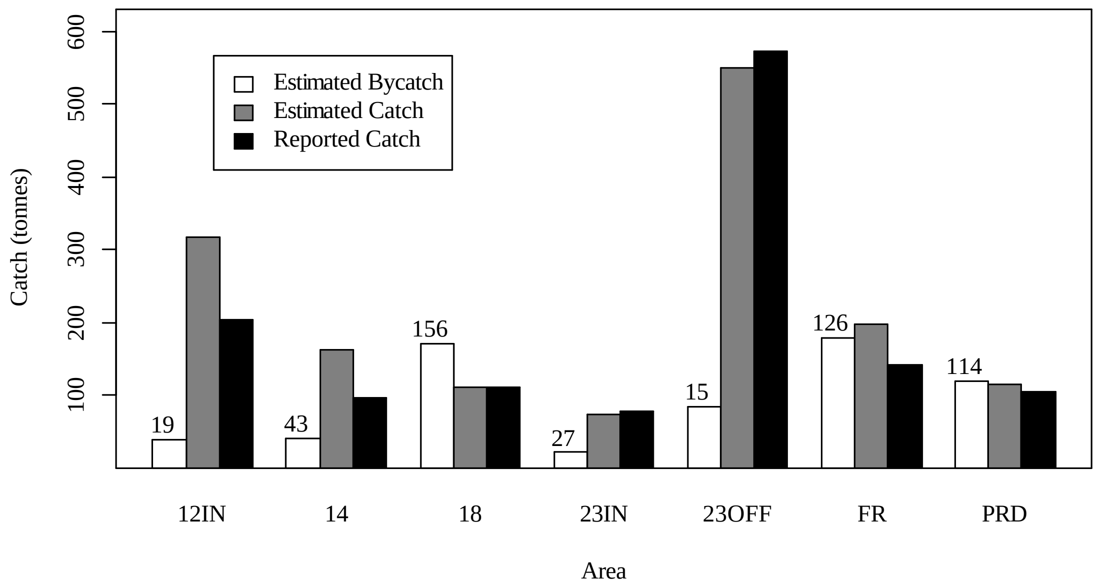


(a)

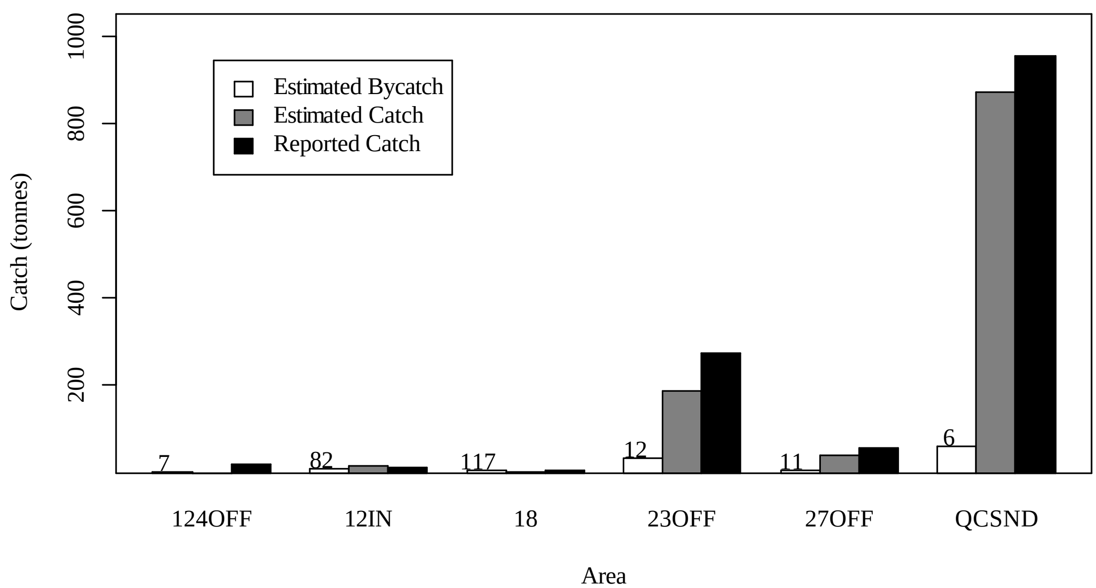


(b)

Fig. 4. 1997 reported catch from shrimp trawl commercial logbooks, and catch and bycatch estimated from bycatch samples and commercial effort for (a) beam trawls by area, and (b) otter trawls by area. The number above each white bar indicates the estimated bycatch (white bar) as a percent of the reported catch (black bar).

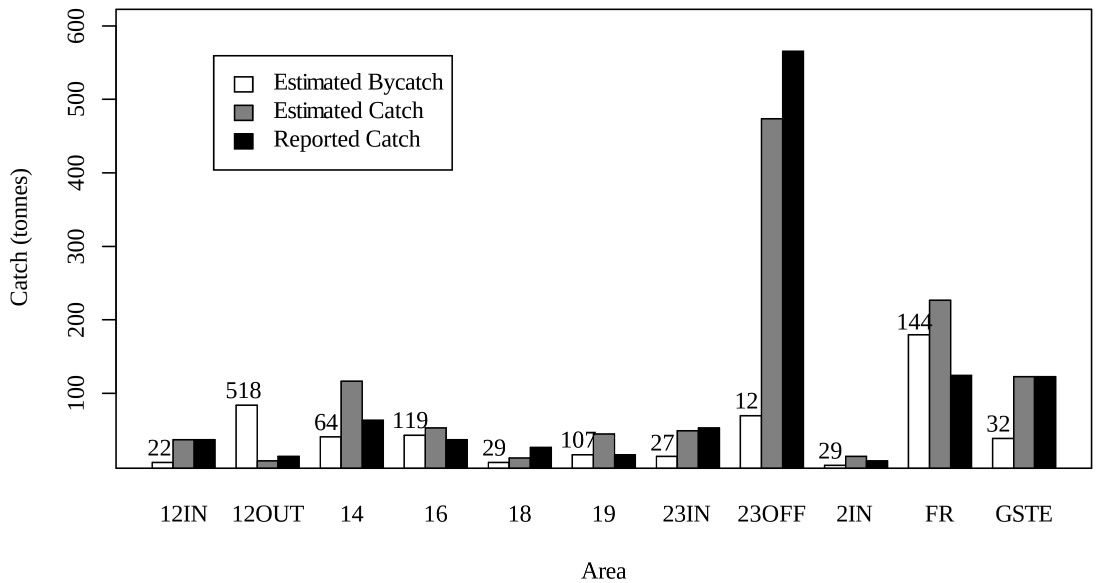


(c)

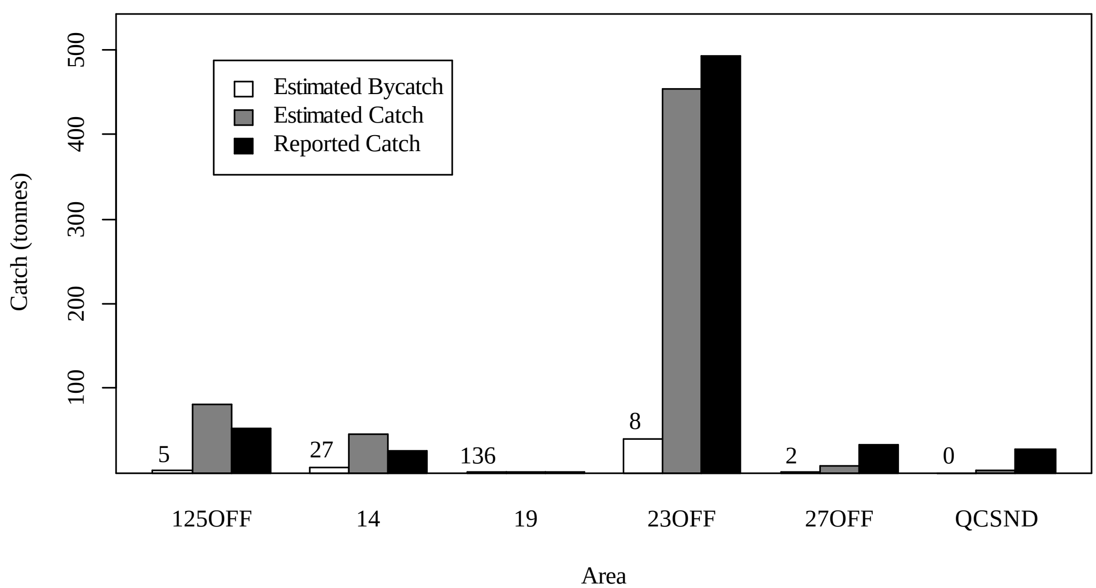


(d)

Fig. 4. continued. 1998 reported catch from shrimp trawl commercial logbooks, and catch and bycatch estimated from bycatch samples and commercial effort for (c) beam trawls by area, and (d) otter trawls by area. The number above each white bar indicates the estimated bycatch (white bar) as a percent of the reported catch (black bar).



(e)



(f)

Fig. 4. continued. 1999 reported catch from shrimp trawl commercial logbooks, and catch and bycatch estimated from bycatch samples and commercial effort for (e) beam trawls by area, and (f) otter trawls by area. The number above each white bar indicates the estimated bycatch (white bar) as a percent of the reported catch (black bar).

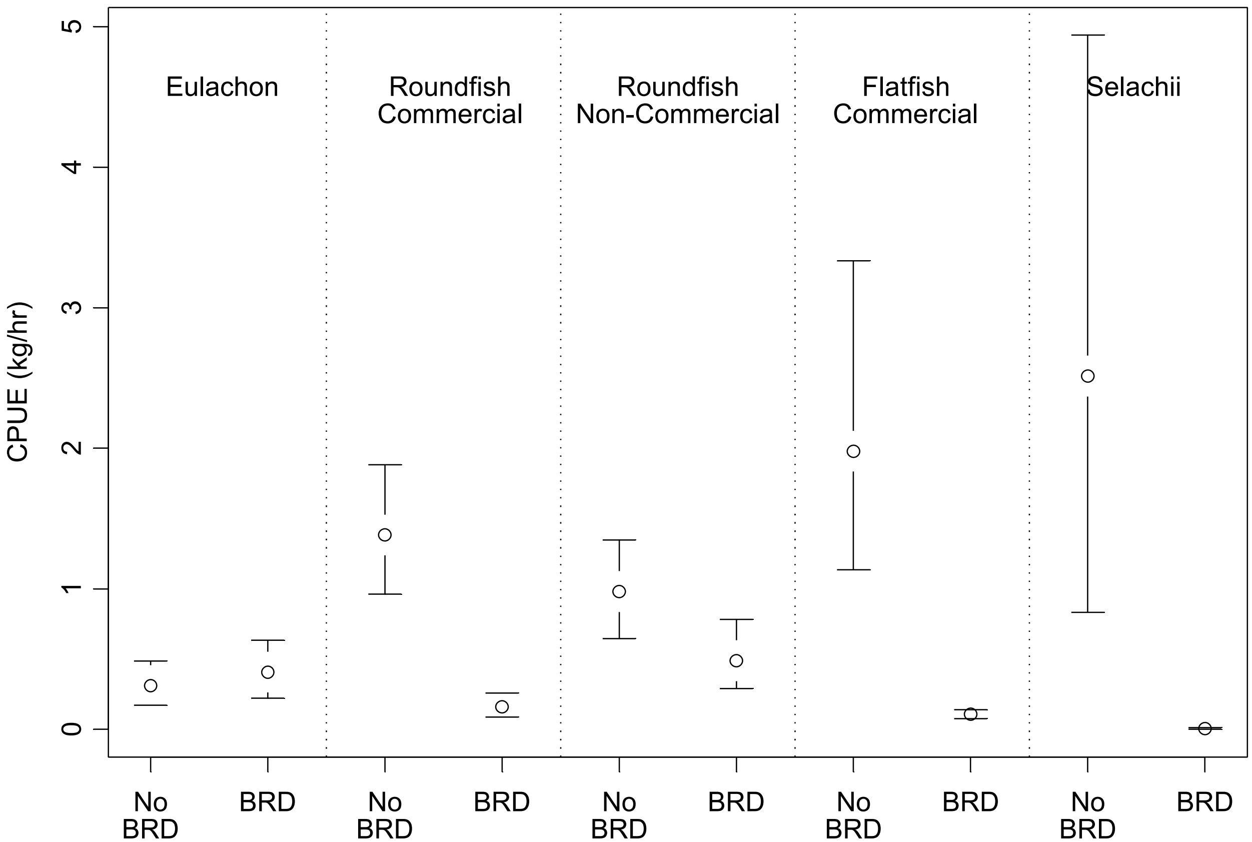


Fig. 5a. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for beam trawl sets from Area 23OFF in 1998. Each panel represents a species group; within each panel sets made with Bycatch Reduction Devices (BRDs) are compared to those made without BRDs.

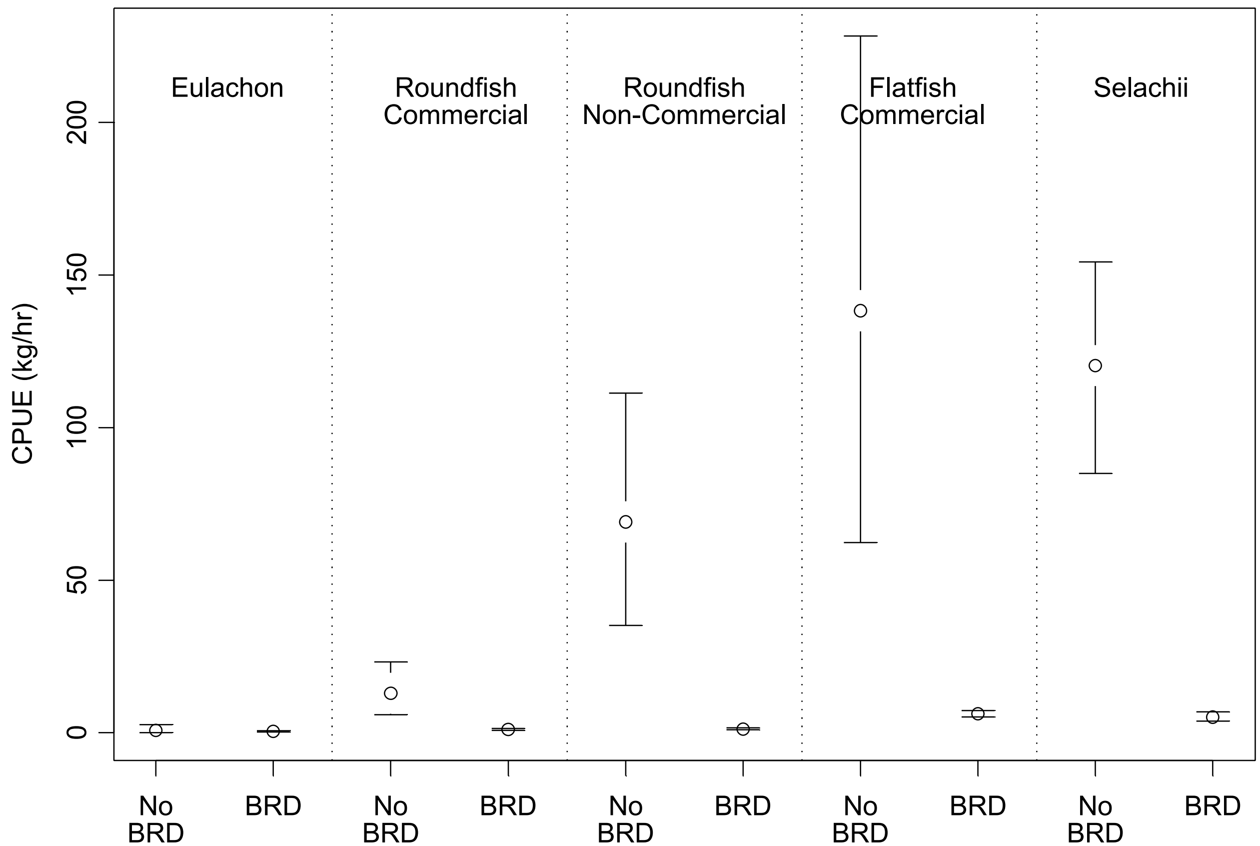


Fig. 5b. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for otter trawl sets from Area PRD in 1997. Each panel represents a species group; within each panel sets made with Bycatch Reduction Devices (BRDs) are compared to those made without BRDs.

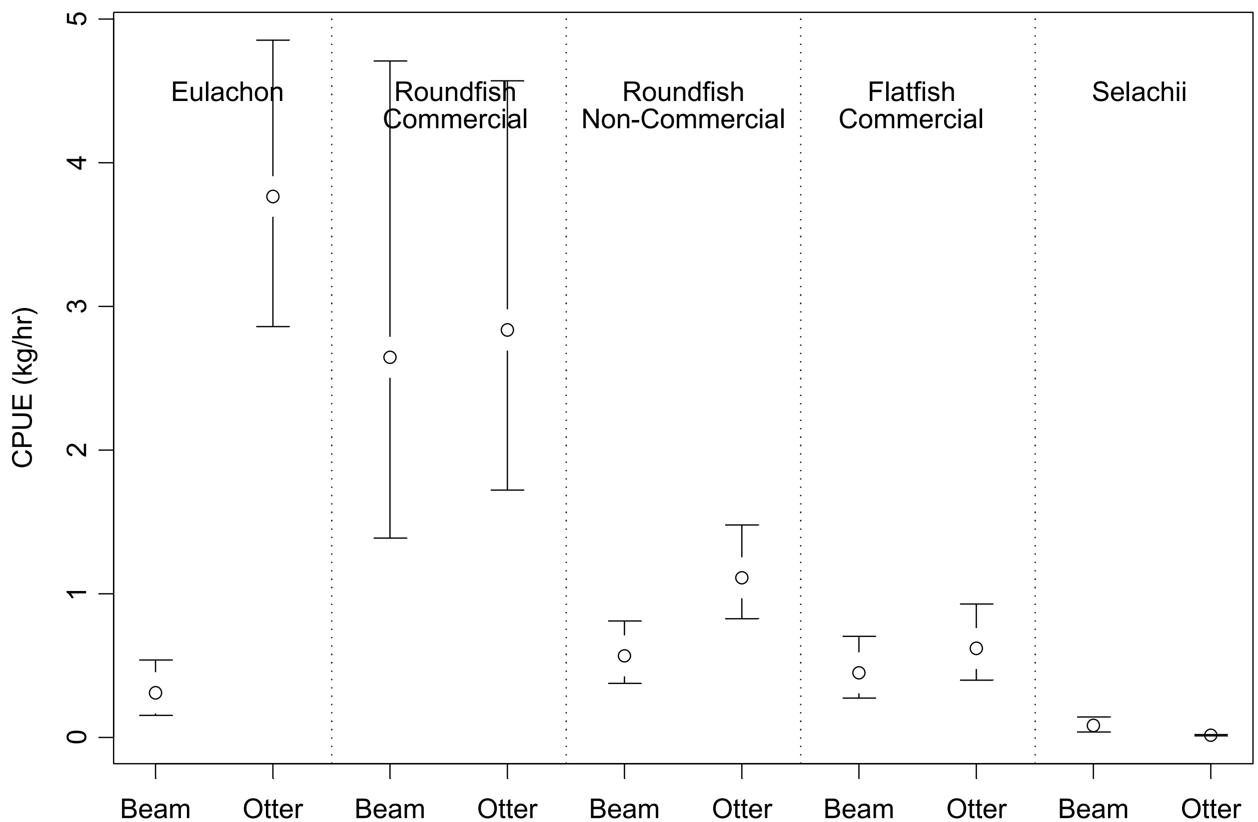


Fig. 6. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for trawl sets from Area 23OFF in 1999. Each panel represents a species group; within each panel sets made by Beam trawlers are compared to those made by otter trawlers.

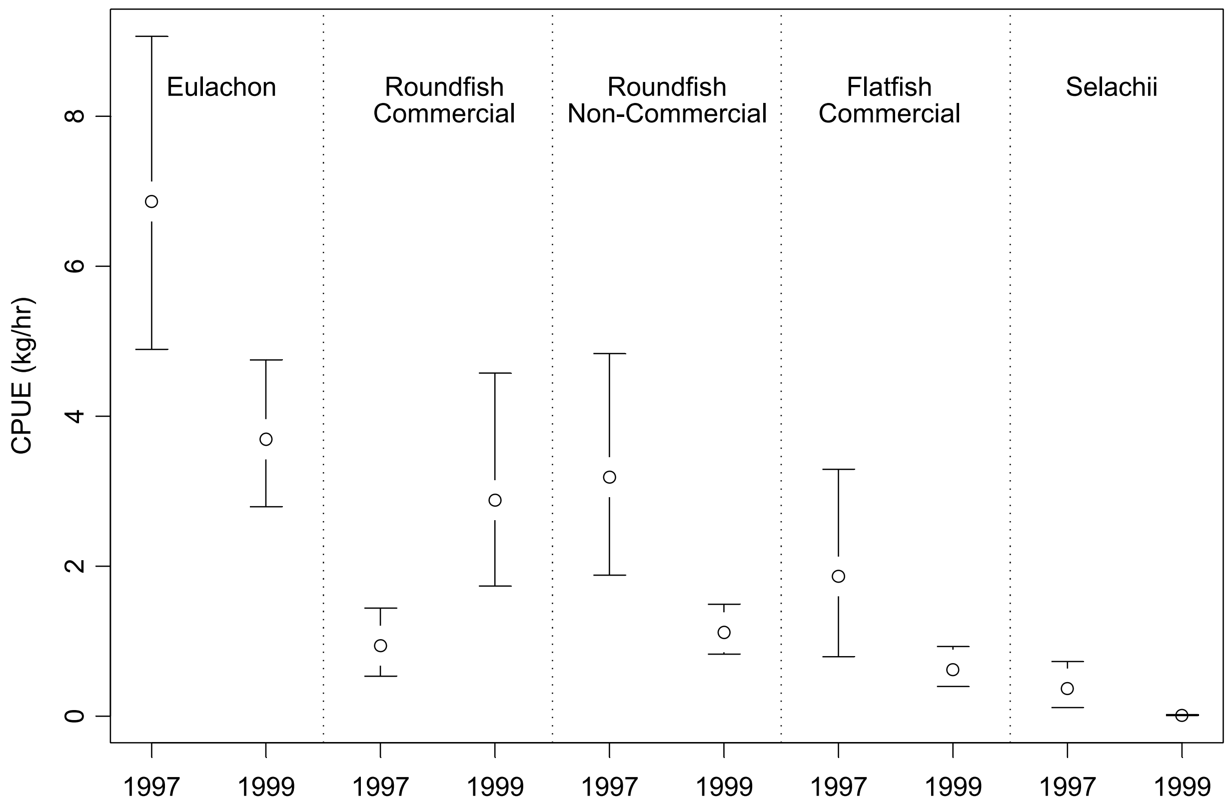


Fig. 7a. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for otter trawl sets from Area 23OFF. Each panel represents a species group; within each panel sets made in 1997 are compared to those made in 1999.

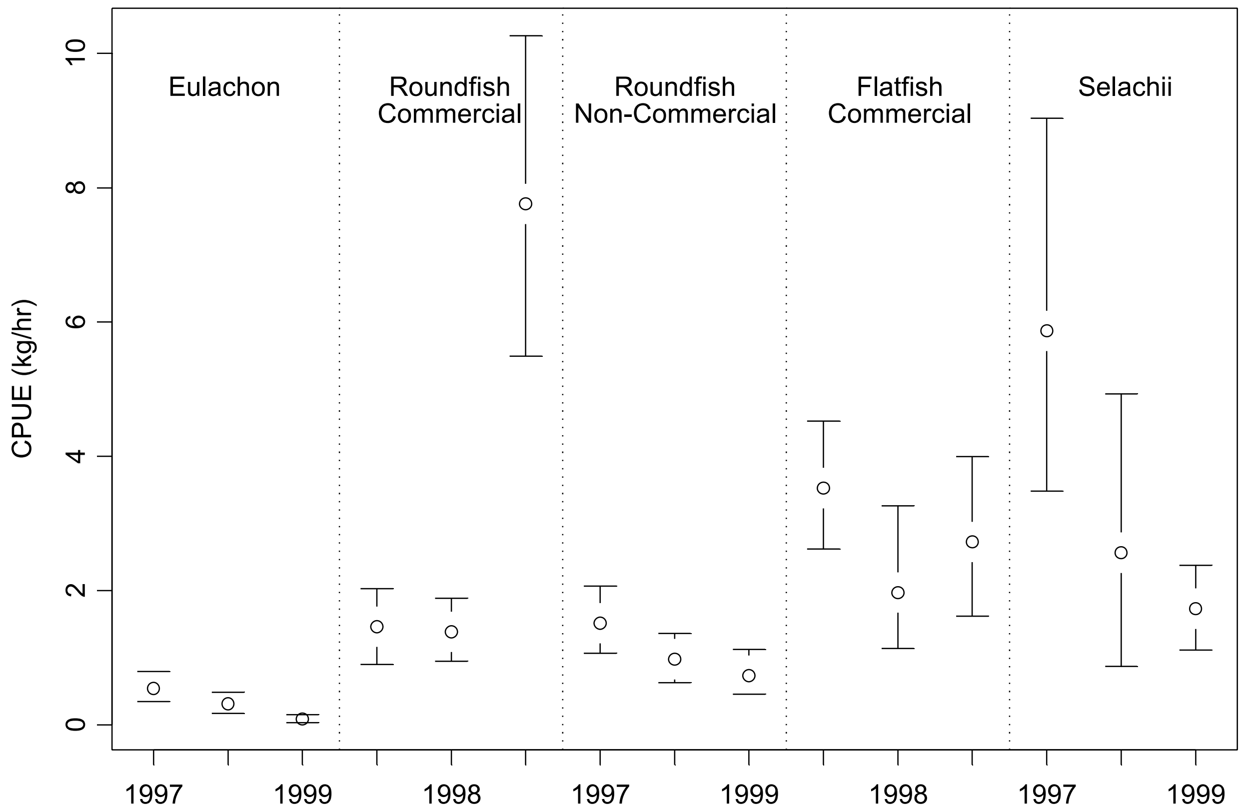


Fig. 7b. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for beam trawl sets from Area 23OFF. Each panel represents a species group; within each panel sets made in 1997, 1998, and 1999 are compared.

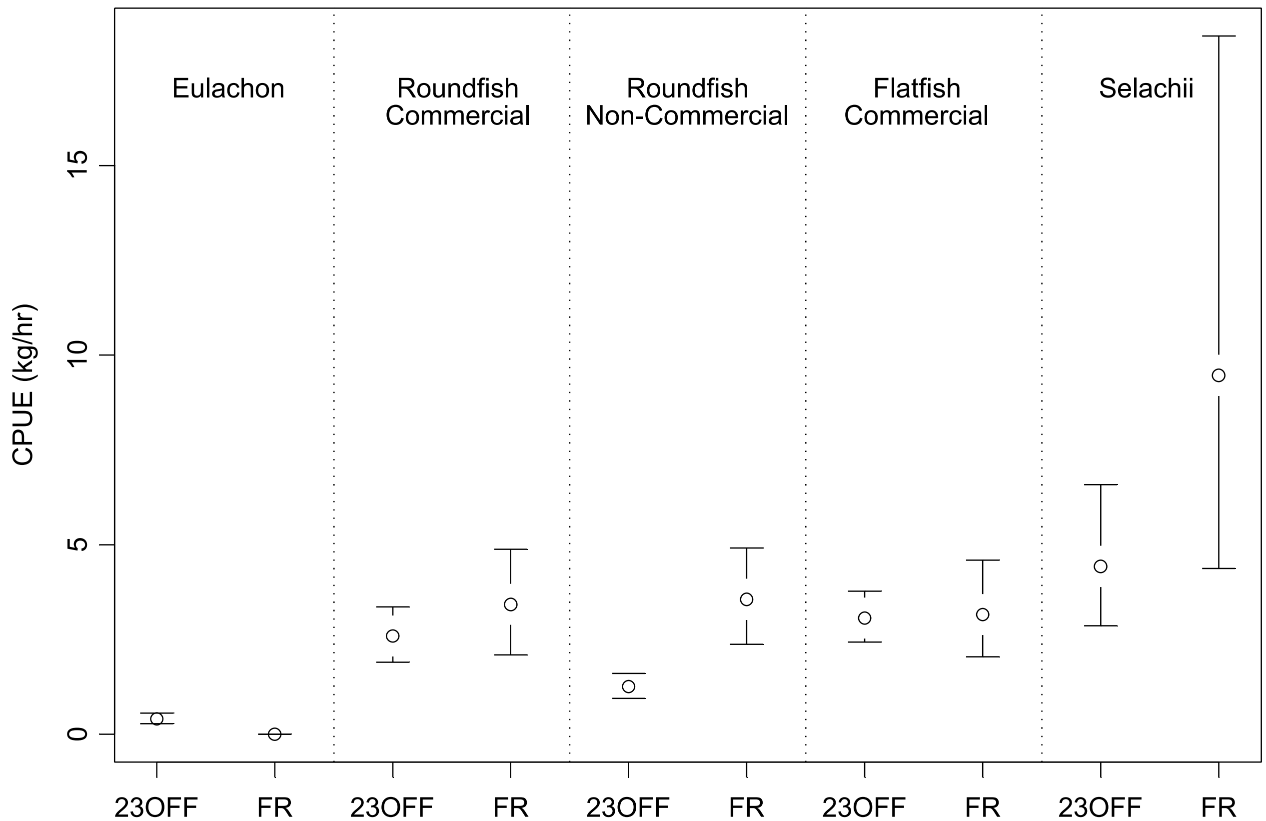


Fig. 8. Median and 95% confidence limits for the bootstrapped mean CPUE estimates of 5 major species groups for beam trawl sets from Area 23OFF and FR for the period 1997 to 1999. Each panel represents a species group; within each panel sets made in 23OFF are compared to those made in FR.