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South East Fishery Non-Trawl Pilot Monitoring Program

Final Report to the Australian Fisheries Management Authority

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South East Fishery
Pilot Non-trawl Monitoring Program

TABLE OF CONTENTS

Executive Summary

The South East Non-trawl Fishery (SENTF) consists primarily of dropline, demersal longline, mesh-net and trap vessels, targeting blue warehou, blue eye trevalla and pink ling as the principal species. Under management by the Australian Fisheries Management Authority (AFMA), a Bycatch Action Plan has been developed for the fishery to provide a strategic approach to addressing bycatch and help ensure the ecological sustainability of the fishery. An important component of the Plan is the collection of detailed information on the species composition of both the catch and bycatch. In recognising this need, AFMA commissioned a one year pilot non-trawl monitoring project with the following objectives: 1) provide information on the species composition, weight and length frequency of the total catch (retained and discarded) taken by non-trawl vessels operating in the South East Fishery; and 2) determine the sampling intensity that would be required to achieve target coefficients of variation for the discard rates of quota species from non-trawl vessels.

The spatial and temporal characteristics of the sampling regime for the pilot study were based on analysis of the 1997/98 GN01 catch figures. The analysis used the total landings from the different non-trawl gear types to apportion 120 on-board observer days across the fishery by season and region. Catches of dropline, longline, mesh-net and trap vessels were monitored to determine target species, catch composition and discard rates in the various Gear x Season x Region cells. Based on the results of this monitoring, the fishery was stratified by gear and region and the discard rates and associated coefficients of variations (CVs) of important species were estimated. Similar to the sampling design for the trawl fishery species, discard rates were categorised into: Low (<5%), Moderate (5–20%), and High (>20%) with target CVs of 1.5, 0.8 and 0.4 respectively. Simulation modelling was undertaken to determine the number of shots within each stratum that would be required to achieve these target CVs.

The project had very positive and wide-spread industry support. A total of 125 days were monitored in the different strata, representing about 5% of the annual fishing effort. The total effort monitored in the fishery was about 33,000 dropline hooks, 70,000 longline hooks, 130 km of mesh nets and 230 traps. Catches totaling 52 t from 522 shots across the four different fishing methods were recorded. Over 80 species were identified from the four non-trawl gears and nearly 14,000 fish across 38 species were measured. A breakdown of the retained and discarded catch composition is provided for each gear. The overall discard rates for the various non-trawl fisheries were categorised as Low or Moderate. The discard rate for the mesh-net fishery was 19% and discard rates for the dropline, trap and longline fisheries were

9%, 4% and 3% respectively. Details of the discard rates of each species and the life-state of the discards is provided.

Any interactions of the fishing operations with marine fauna were noted. The presence of killer whales reduced dropline catch rates but there was no incident where a killer whale was observed to be hooked by the gear. In the 392 dropline shots, one seal was observed to have been hooked and tangled in the line and had drowned. Despite many birds being present during fishing operations, there were no observed interactions between seabirds and any of the fishing gears.

Apart from discarding of spotted warehou and blue warehou in the mesh-net fishery (15 and 8% respectively), discard rates for most of the main target species in each stratum were generally minimal or non-existent. Most discarding of commercial species was usually because the fish had been damaged and were not marketable. Although they formed a relatively small component of the catch, discarding of other non-target species ranged up to 60 %. Target CVs for discard rates of all species were achieved. Simulation modelling of the discard rates revealed that minimal sampling of the non-trawl fishery is required (10 – 20 shots per strata) if the criteria for determining sampling intensity was solely determined by the achievement of target CVs for discard rate, as is the case for monitoring of the SEF trawl fishery. If these criteria are to be used, incorporation of an on-board non-trawl component into the current ISMP would only require a low-level sampling regime (30 – 40 days) to adequately represent the spatial and (to a lesser extent) temporal characteristics of the catch composition from the different non-trawl methods. Slightly more sampling may be necessary to detect and monitor any significant changes that may occur in the fishery.

Background

Australia's South East Fishery (SEF) is a multi-sector, multi-species commonwealth fishery that provides most of the fresh fish for markets in south-eastern Australia and has a growing export market to Asia. Managed by the Australian Fisheries Management Authority (AFMA), the fishery is worth over $60 million annually, of which landings from the non-trawl comprise about 8% (Smith and Wayte 2000). The SEF non-trawl fleet consists primarily of dropline, demersal longline, mesh-net vessels, targeting blue warehou, blue eye trevalla and pink ling as the principal species. The South East Non-trawl Fishery (SENTF) covers an extensive area of south eastern Australia, including all waters of the Australian Fishing Zone (AFZ) off South Australia, Victoria and Tasmania up to the low water mark and Commonwealth managed waters of the AFZ off southern Queensland (to Sandy Cape) and New South Wales which lie outside a line drawn approximately 80 nautical miles from the coast (AFMA, 2001a).

Under Section 3 of the *Fisheries Management Act 1991 (Commonwealth)*, AFMA is required to ensure "that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, in particular the need to have regard to the impact of fishing activities on non-target species and the long term sustainability of the marine environment." To this end, the Commonwealth Policy on Fisheries Bycatch was developed to provide a strategic approach to addressing bycatch so that fisheries in Australian waters are ecologically sustainable. The Commonwealth, through AFMA and stakeholders, has approached this by developing and implementing fishery specific Bycatch Action Plans (AFMA 2001a,b). Such plans have been developed for both the trawl and non-trawl sectors of the SEF. An important component of each of these Bycatch Action Plans is the collection of detailed information on the species composition of the catch and bycatch. In the SEF trawl sector, this has been accomplished by the establishment of the Integrated Scientific Monitoring Program (ISMP). The ISMP uses on-board field scientists to collect information on the quantity, size and age composition of the retained and discarded catch taken by board trawlers and Danish seine vessels working in the SETF (Knuckey and Sporcic, 1999; Knuckey *et al.* 1999, 2000). Although many of the same species are caught by the non-trawl sector, there has been no systematic monitoring of these catches and consequently, there is limited information on catch composition, bycatch and discarding in the non-trawl fleet.

With the introduction of global quotas for blue warehou, ling and blue eye trevalla and the move towards management of the SEF as a whole, AFMA recognised the need for information on the non-trawl sector similar to that collected by the ISMP on trawl vessels. As such, AFMA funded a one-year pilot study to monitor catches by the non-trawl fleet. The objectives of the pilot study were to:

- Provide information on the species composition, weight and length frequency of the total catch (retained and discarded separately) taken by non-trawl vessels operating in the South East Fishery.

- Determine the sampling intensity required to achieve target coefficients of variation for the discard rates of quota species from non-trawl vessels.

From this information, it was envisaged onboard monitoring of non-trawl vessels could then be incorporated into a "unified" ISMP sampling design across the SEF. A year of field work on the various non-trawl vessels began in May 1999. The results of this research on the South East Non-trawl Fishery are presented to AFMA in this final report.

Methods

The study was designed to provide information on the catch composition and discard rates of the various non-trawl methods used throughout the SEF, including dropline, longline, mesh-net and traps. The study did not include monitoring of the NSW dropline fishery which is managed and studied by NSW Fisheries. Nor did the study include the Southern Shark Fishery, which is monitored separately through the ongoing AFMA funded Southern Shark Monitoring Project.

Coverage of the fishery

The spatial and temporal characteristics of the one-year sampling regime for the pilot study were developed based on analysis of the 1997/98 catch and effort statistics recorded in the GN01 logbooks. The analysis used the total landings from dropline, longline, mesh-net and trap vessels to apportion 120 on-board observer days across the fishery by season and region (Table 1). This sampling plan was used as a guide to ensure that the observer covered all aspects of the SEF non-trawl fishery. It could not be used as a definitive description of what would be achieved by the monitoring program for several practical reasons. For example, many of the Gear x Season x Region cells only indicated one day of monitoring, yet most of the vessels go out on 2 – 7 day trips. Also, the sampling plan was based on the analysis of

previous year's data and may not accurately reflect the fishing activities that took place in 1999/2000. Nevertheless, the observer used the plan as a guide for targeting trips on vessels working in the different parts of the fishery.

Sampling began in May 1999 and continued until May 2000. Based on the seasonal breakdown of the fishery in the sampling plan, the observer approached various non-trawl vessels to secure appropriate fishing trips. Preference was given to vessels that had a significant catch history in the fishery. Although vessels were only required to take the observer out on a voluntary basis, most vessels approached were willing to do this. A number of vessels, however, did not have the capacity or sufficient safety gear to allow an extra person on board. Where possible, the observer endeavoured to board as wide a range of vessels as possible within each Gear x Season x Region cell. In practice, apart from the dropline fishery off Tasmania, there were only one or two vessels within each cell that could be utilised.

Data collection

When on-board, the observer collected information from each shot including: operational data on the fishing activities (location, depth, time, gear type etc) and biological data on the catch. After capture, all fish were identified to species level where possible. The number and weight of fish (retained and discarded) was recorded for each species and the length of a representative sub-sample of important fish species was measured (down to the nearest centimetre). Copies of the data sheets, indicating the range of operational and biological data collected, are included in the Appendix.

Life-state of discards

At the SENTMAC meeting in September 1999 it was recommended that the project should incorporate estimates of the life-state of discarded fish. This recommendation was adopted and the life-state of discard species was recorded after October 1999. The life-state of the discards was a subjective assessment by the observer as to whether the fish was likely to survive when it was discarded. The life-state was recorded after the fish was landed on deck and the hook removed. The assessment took into account the general condition of the fish after it has been handled by the crew and factors such as scale loss, bloating of the swim bladder and liveliness of the fish. The life-state of discards was categorised as 1) Discarded alive; 2) Discarded dead; and 3) Damaged. Damaged fish referred to commercial species that were discarded only because they were damaged.

Dropout

Another recommendation of the September SENTMAC meeting was that the dropout of target species should be recorded. Dropout is defined as the number of fish that are caught but not landed. Dropout rate was estimated by documenting the number of fish that had unhooked/unmeshed and floated to the surface as a result of bloating of the gut (commonly referred to as "floaters"). The number of floaters around the boat was recorded during and immediately after the haul. The number of "floaters" that were retrieved was recorded and subtracted from the dropout figure.

Stratification of the fishery

Using the Gear x Season x Region cells established in the proposed sampling plan, information was obtained during the year from which the fishery could be better stratified for estimation of catch composition and discard rates. The main factor used in the stratification of the fishery was the gear type: dropline, longline, mesh-net and trap. These gear categories were further stratified by the zone in which they were deployed. The division of the fishery into zones was based on Klaer and Tilzey (1994) as modified by the South East Fishery Assessment Group (SEFAG 2001, Figure 1) . After the monitoring was completed, the number of shots in each stratum was tallied and a number of strata were pooled over zone. This was done in cases where there were no major differences in the target species or discard rates between the zones. It helped to improve the sample size for each stratum without compromising the ability of the monitoring program to adequately represent the fishery. The major species caught in each stratum were used as the "defining" species for which discard rates were estimated. All species that were not defining species in each stratum were pooled into a "Non-defining" species group.

Calculation of discard rates and CVs

The data gained from the present study were used to estimate discard rates and coefficients of variation (CVs) for the main species (quota and non-quota) in each stratum. The term *discard rate* used in this study is a percentage rate defined as $\frac{100 \times \text{discarded}}{\text{discarded} + \text{retained}}$.

Estimates of discard rates and CVs were made for defining and non-defining species groups in each stratum. Where defining species were caught in other strata, the catch and discard rate information was pooled into a separate stratum called 'Other stratum'. The mean weighted discard rate and corresponding CV for each defining species and other species were calculated

for each stratum. The weighting factor was the sum of total discard and retained weights of each species in each stratum. The method by which the discard rates and CVs were calculated is represented below.

The mean discard rate $\overline{D}_{si}$ for species s in stratum i is given by

$$\overline{D}_{si} = \frac{1}{k}\sum_{j=1}^{k}\frac{d_{sij}w_{si}}{d_{sij}+r_{sij}}\times 100 \quad \text{where } i \in [1,n], \text{ trip } j \in [1,k] \text{ and } w \text{ is the weighting factor and}$$

where d_{sij} is weight of species s discarded from jth shot in ith stratum discard weight

r_{sij} is weight of species s retained from jth shot in ith stratum discard weight

w is the weighting factor

stratum $i \in [1,n]$, shot $j \in [1,k]$.

The CV of the mean discard rate CV($\overline{D}_{si}$), for species s in stratum i is given by

$$CV(\overline{D}_{si}) = \frac{\sqrt{\text{var}(D_{si})}}{\overline{D}_{si}}$$

where var(D_{si}) is weighted variance of discard rates of species from jth shot in ith stratum .

Based on the ISMP sampling design for the trawl fishery (Smith *et al* 1997) species discard rates were categorised into: low (<5%), moderate (5–20%), and high (>20%). Previous correspondence with AFMA has indicated that the target CVs for these three categories were 1.5, 0.8 and 0.4, respectively. The discard rates and CVs obtained for species in the various non-trawl strata were compared against these targets.

Simulation modelling

To achieve the second objective of the project, simulation modelling was required to determine the number of shots within each stratum that would be required to achieve the designated target CV of discard rates. Each shot monitored during the project was assigned to a stratum based on its region and gear as described above. The species group with either the greatest CV or the greatest discard rate (and therefore required the lowest target CV) in each stratum was defined as the "limiting species" and was used to determine the minimum sampling intensity required in each stratum. The sample pool consisted of all shot information

containing the limiting species from each stratum. To undertake the simulations, shots from 2 to the maximum available shots in the stratum, were randomly selected from the pool and the discard rate and CV were calculated for each sample. This procedure was repeated 100 times to calculate the variation of the CV and obtain the probability of achieving the target CV for each sample size. This was performed for each of the strata.

The probability of achieving the target CV was

$$P_{ziS} = \frac{\sum_{n=1}^{100} 1_{(CVziS < .4)}}{\sum_{n=1}^{100} 1},$$

where $z \in [1,100]$, stratum $i \in [1, n]$,number of shots $S \in [2, k]$,

The mean, maximum and minimum calculated CVs from these simulations were plotted against the number of shots within each stratum and the number of shots required to achieve the target CV for discard rate of the limiting species was estimated.

Results and discussion

Gear description

Dropline

Droplines consist of a vertical mainline rope with an anchor at the bottom and a series of floats and flags at the surface. Snoods with baited hooks are attached to the mainline at various depths, depending on the target species. There was considerable variation in the dropline gear used by the different fishers in the non-trawl sector of the SEF.

Most fishers used between 6 and 10 mm diameter polyethylene rope from the floats down to a point above where the first snood joined the mainline. Some dropliners used pressure buoys at this point to hold the gear more upright and therefore higher in the water column. At this point it was common to have a swivel connecting to a heavy breaking strain mono-filament mainline to which the snoods were attached and which ran down to the anchor. Some fishers used galvanised multi-strand wire or rope for this section of the mainline. When using a mono-filament mainline, the baited snoods were attached to the mainline with stainless steel clips during setting. Crimps on the mainline prevented the snoods sliding up and down. Where polyethelene rope was used, the snoods were tied into the mainline and stored in racks where the hooks could be pre-baited. The advantage of the latter system was that the gear could be set much quicker and enabled the skipper to target good bottom with greater ease. The number of hooks per line ranged from 60 to 150 and there was also considerable variation

in the length of snoods and distance between snoods on the mainline. The hooks on the snoods varied in size but the majority were circle hooks.

Longline

The demersal longlines consisted of a single heavy-duty rope mainline that was set along the ocean floor with an anchor or series of anchors at either end. Buoy-lines were attached to the anchors and ran to the surface, enabling the mainline to be hauled. The mono-filament snoods were generally about 30 cm long and were set with baited hooks along the mainline at intervals of about 1 metre.

The vessel from which the majority of the longline shots were observed had an automated system that baited the hooks at a rate of about four hooks per second. This system enabled very large numbers of hooks to be set and retrieved each day. Most longline shots had between 2000 and 3000 hooks.

Mesh-nets

The mesh-nets used in the non- trawl sector of the South East Fishery are bottom-set nets that were very negatively buoyant and sunk relatively quickly to depths of between 60 and 300 fathoms depending on the target species. The mesh size was 150 mm monofilament (stretched) and each net was about 200 metres in length. Depending on their permit entitlements, vessels used up to 15 or 16 nets which may have been joined together and set as one continuous net or split into shorter sections.

Traps

The fish traps observed during this project were designed to target pink ling. The traps were set in longlines with approximately 20 traps per line. The traps were constructed of a steel frame approximately 1.5m x 1.5m x 3m long, with a single funnel opening. They were covered with galvanised chicken wire and had appropriate escape gaps. The traps were set at depths of between 100 and 300 fathoms on reef or soft bottom and were baited with trash fish or other meat.

Coverage of the fishery

Overall, the project had very positive and wide-spread industry support. The observer for the project, Mr Steven Gill, established good rapport with industry members and the full cooperation of the skippers and crews made it possible to record numbers and estimated weights of all retained bycatch and discarded species and to collect length frequency

information on close to 100% of the target species brought on board. As a result, sufficient overall coverage of the fishery was obtained and both objectives of the project were achieved as outlined below.

The proposed sampling plan for the pilot monitoring project (Table 1) indicated a target of 122 sea days spread across the various Gear x Season x Region cells. In total, 102 sea days were undertaken by the observer during the year, covering 81 days of actual fishing and 522 separate shots (Table 2) across the four different fishing methods. Some of the sea days were assigned to more than one cell, however, because either more than one gear was used in a day (dropline / longline or fishtrap/gillnet) or shots within a day were undertaken in more than one fishing zone. As a result, there was a total 125 days undertaken in the various Gear x Season x Region cells. This compares reasonably with the initial sampling target off 122 days.

There was some variation in the seasons in which monitoring was undertaken, but otherwise, the amount of monitoring actually undertaken by the observer for the different gears was extremely close to that proposed in the sampling plan. The sampling plan proposed 65, 19, 28 and 10 sea days allocated to dropline, longline, mesh-net and trap respectively. The actual monitoring undertaken was 66, 16, 33 and 10 days, respectively. Most of the seasonal/spatial variations from the sampling plan reflected differences in the fleet dynamics of the fishery during the monitoring year (1999/2000) compared to those from which the sampling plan was designed (1997/98). A few examples are provided below. During the 1997/98 season, one dropline vessel consistently worked in Eastern Zone B, but it had since left the fishery and during the period of the study, there was only a few intermittent trips to this area from Tasmania. Several vessels in the SEF non trawl fleet were regularly fishing on the Gascoyne Plateau just outside the AFZ, and it was considered appropriate for the observer to monitor the catches from a demersal longliner working this area although it was not highlighted in the initial plan.

There was good coverage of the species composition of the retained and discarded components of the catches from all gear types (Table 3). Overall, the composition of more than 52 t of catch was monitored across the fishery. From this, 84 species were identified and nearly 14,000 fish across 38 species were measured. Generally, length frequency information was collected without knowledge of the sex of the fish, but in areas of the fishery where crews gut, or gill and gut certain species of fish at sea, it was possible to collect length frequency data by sex. This was often the case for pink ling, where 97% of the 3469 fish were sexed.

For blue eye trevalla, on the other hand, only 19% of the 3224 fish were sexed because market preferences demanded that fish destined for the Melbourne markets were retained whole.

Catch composition

Dropline

Over the year, 54 sea days were spent monitoring the catches of eight dropline vessels operating throughout the SEF. Catches were monitored from a total of 289 shots comprising 32,742 hooks. From these, 7483 kg of fish were caught of which 641 kg (9% by weight) were discarded (Table 4). A total of 30 species were caught, but blue eye trevalla was the main target species and comprised the bulk of the catch (5432kg). The other main species retained were hapuku (427kg), pink ling (167kg), porbeagle shark (115kg) and blue grenadier (95kg). Of the fish that were discarded, a very small percentage (less then 0.01 %) was quota species. The very small numbers of blue eye trevalla that were discarded were unmarketable because of damage by predators such as shark, killer whales, seals or birds, because they were squashed in the roller during hauling. The most commonly discarded species were greeneye dogfish (271kg), white-spotted dogfish and swellsharks (115kg).

During the onboard monitoring of dropline catches, length frequency data was collected from 1801 fish, of which 1575 were blue eye trevalla. Other species measured included gemfish (51), hapuku (42), ling (41), and blue grenadier (36). The length frequency of blue eye trevalla is shown in Figure 2.

Catch rates for blue eye trevalla were highly variable from shot to shot, ranging from 0 to over 2000kg/1000 hooks. The average catch rate was 240kg/1000 hooks and most shots achieved a catch rate of between 50 and 100kg/1000 hooks (Figure 3). The presence of killer whales during the deployment of droplines significantly reduced catch rates. About 20% of the shots that were monitored were affected by the presence of killer whales. In shots in which no killer whales were present, catch rates of blue eye trevalla were 267kg/1000 hooks (±26 s.e.) but the catch rates fell to 98±26kg/1000 hooks when killer whales were observed in the vicinity Figure 4.

Longline

Twelve days of onboard monitoring was undertaken on two demersal longline vessels operating in two main regions: on the Gascoyne Plateau, outside the AFZ due east of Merimbula (6 days); and on the west coast of Tasmania (6 days). Overall, catches were

monitored from a total of 26 shots comprising 70,250 hooks. Separate descriptions of the longline catch composition from the two regions are provided.

Gascoyne Plateau

The catches from 21 shots (43,000 hooks) were monitored on a longline vessel working the Gascoyne Plateau, outside the AFZ. A total of 5,570 kg of fish comprising 19 species were caught, of which only 122 kg (2% by weight) were discarded (Table 5). King tarakihi was the most common species caught (4104 kg), but significant amounts of yellowtail kingfish, (1219 kg), Tasmanian trumpeter, (508 kg), greeneye dogfish (508 kg), blue eye trevalla (352 kg) and hapuku (435 kg) were also caught. Apart from the discarding of 5% of the greeneye dogfish, virtually all fish of the above species were retained. The only fish that were always discarded were ringed toadfish, Australian burrfish and moray eels.

The mean catch rate of king tarakihi (for shots in which this species was caught) was 97 kg/1000 hooks. Catch rates for yellowtail kingfish and Tasmanian trumpeter were 33 kg/1000 hooks and 13 kg/1000 hooks, respectively.

During the onboard monitoring of longline catches on the Gascoyne Plateau, more than 1400 fish were measured, of which 1252 were king tarakihi (Figure 5) 162 were yellowtail kingfish (Figure 6) and 80 were Tasmanian trumpeter (Figure 7).

Western Tasmania

A total of five demersal longline shots comprising 27,250 hooks were monitored off the west coast of Tasmania. Of the 7,781 kg of fish caught, pink ling accounted for 7,150 kg. Most of the shots targeted pink ling, but a total of 22 species were caught (Table 6). Other retained species included blue eye trevalla, ribaldo, ocean perch, Tasmanian trumpeter and various shark species. Overall, 308 kg (4% by weight) of fish was discarded, mainly consisting of whiptails, skates and various small shark and dogfish species.

Length frequency information from over 1700 fish was collected during the onboard monitoring of longline catches off western Tasmania, most of which were from pink ling. The length frequency distribution of ling is shown in Figure 8.

Mesh-nets

There was good observer coverage of the mesh-net fishery during the pilot monitoring program. In total, 29 days were spent on board 2 vessels working off the east coast of Victoria. During this time, 91 shots were observed, representing over 128 km of net. There

were 62 different species caught totalling 29,461 kg, of which 5,546 kg (19%) was discarded (Table 7). Blue warehou (8,837 kg), blue eye trevalla (5,956 kg) and pink ling (4680 kg) were the main target species. Generally, the target species was determined by the depth at which the nets were set. Shots targeting blue warehou (22) tended to be set shallower at between 140 and 320 metres, whereas shots targeting blue eye trevalla and ling (69) were set deeper, between 320 and 600 metres. Other species caught in shots targeting blue warehou were spotted warehou, some pink ling, striped trumpeter and jackass morwong. The main discard species in these shots were jack mackerel and greeneye dogshark although some of the latter were retained. Shots targeted at blue eye trevalla and ling also caught spotted warehou, jackass morwong, blue grenadier and imperador. The major discards at this depth were gemfish, greeneye dogshark and draughtboard sharks. The significant discarding of gemfish (92%) was a direct result of the trip limits imposed on non-trawl vessels (zero in 1999 and 50 kg in 2000) in an effort to ensure complementary management with the low TACs for eastern gemfish in the trawl sector. Overall, discarding of non-trawl quota species was categorised as moderate or low. Eight percent (by weight) of blue warehou were discarded, usually because they were damaged and only 1% of blue eye trevalla and pink ling.

Length frequency measurements were taken on a number of the species from mesh-net vessels, including 3696 blue warehou (Figure 9), 1500 blue eye trevalla (Figure 10), 1134 pink ling (Figure 11), 612 spotted warehou (Figure 12), 173 imperador (Figure 13), 109 eastern gemfish (Figure 14) that were usually discarded and 167 draughtboard sharks (Figure 15) that were always discarded.

Traps

In the trap fishery, 12 shots comprising about 230 traps were observed over 7 days. There were 9 different species caught in traps totaling 2,129 kg, of which only 28 kg (1%) was discarded (Table 8). The target species was pink ling (1865 kg), and all 732 of these fish were sexed and measured Figure 16. The other retained species were jackass morwong (Figure 17), ocean perch ribaldo cod and hapuku. The main discard species was draughtboard shark, but only 7 fish were discarded.

Dropout rates and life-state of discards

The discard rates in the trap fishing (4%) and demersal longline fishing (3%) were categorised as low (<5%) and no quantitative categorisation of the life state of these discards was undertaken. In the trap fishery, spider crabs and draughtboard sharks were the only significant discards. The former were usually killed in order to remove them from the traps,

whilst draughtboard sharks were always returned alive. In the longline catches off Tasmania, the whiptails were generally dead but the dogfish, draughtboard sharks and skates were usually released alive.

Dogfish and draughtboard sharks were the main discard species from dropline catches and, generally, they were released alive (Figure 18). The majority (~80%) of endeavour dogshark, however, were dead when they were discarded, but only formed a low proportion (<10%) of all discards. Negligible amounts of blue eye trevalla were discarded (<0.1%). They were generally damaged either by predators such as shark, killer whales, seals or birds or by getting squashed in the roller during hauling.

The mortality of discards was generally high in the mesh net fishery, the only exception being spookfish, in which about 75% were released alive (Figure 19). Only about 20% of gemfish, greeneye dogfish and draughtboard sharks were categorised as alive when discarded and most other species were dead. Discarding of commercial species due to damage was prevalent in the mesh-net fishery and in most cases, the damage was caused by the meshed carcasses being eaten by lice or polychaete worms. This problem has been recorded in the Southern Shark Fishery, where similar gear is used (Walker *et al.* 1999). In the present study, there was significant discarding of spotted (15%) and blue warehou (8%) as a result, but such damage affected most commercial species caught in mesh nets to some extent. Endeavour dogsharks were also recorded as damaged, but in this case, it was because the livers were retained for sale and the carcasses were discarded.

Dropout was only measured for the mesh net and dropline fisheries. Although dropout is recognised as an issue in the mesh-net fishery, the major target species – blue warehou (and spotted warehou to a lesser extent) – tend to sink rather than float if they fall out of the nets. As a result, dropout rate of these species was impossible to record by a vessel-based observer and the measurement of dropout was solely restricted to blue eye trevalla caught by mesh-net and dropline.

Subsequent to the suggestion of SENTMAC, dropout was monitored in a total of 96 dropline shots. Based on these shots, 19% of all the blue eye caught dropped out of the gear within sight of the observer prior to being landed (Figure 20). Seventy eight percent of these fish were retrieved by the fishers. The remaining 22% of the dropout (3% of the total observed catch) were lost. Based on 28 shots, blue eye trevalla dropout rates in the mesh net fishery were less (5%) and of those, 80% were retrieved by fishers with only 20% of dropouts (1% of those observed to be meshed) were lost (Figure 21).

Wildlife interactions

As previously mentioned, the presence of killer whales on the fishing grounds had a dramatic effect on dropline catch rates. Not only may the presence of killer whales scare fish away, it was clear that the killer whales preyed on fish that were hooked on the droplines. The lines were frequently returned with only heads or the jaws of fish still attached to the hook. It was unclear whether whales preyed on the catch when the lines were on the bottom or during hauling. There was no incident where a killer whale was observed to be hooked by the gear. During one haul in Eastern Tasmania a seal was landed. The seal had been hooked and tangled in the line and had drowned. This was the only recorded interaction between seals and dropline gear during the deployment of over 32,000 hooks.

Despite many birds being present during fishing operations (at times over 100 birds were observed following some vessels), there were no observed interactions between seabirds and any of the fishing gears monitored during this project.

Stratification of the fishery

After analysing the data obtained from the Gear x Season x Region cells used in the proposed sampling plan, many cells were pooled into the final strata that were used to estimate discard rates and CVs. Seven strata were identified: 3 dropline strata (East, Western Tasmania and Western Victoria); 2 longline strata (Gascoyne and Tasmania); 1 Fish trap stratum in Eastern Victoria; and, 1 Mesh-net stratum in Eastern Victoria (Table 9). The defining species for each of these strata are highlighted. A summary of the number of shots, fishing days and strata days monitored in each stratum is provided in Table 10. Although a seasonal breakdown of the monitoring undertaken in each stratum is also provided (Table 11), ultimately, season was not included in the final stratum for the following reasons. Despite seasonal changes in effort in some parts of the fishery, there was not a noticeable influence of season on either the target species or discard rates for any of the gears. Also, dropline vessels were the only gear type to be sampled in each season. For the other gears, minimal or no fishing occurred in one or more seasons, which prevented adequate sampling. Finally, pooling over season improved the statistically robust definition of the strata through the increased number of shots per stratum. The broad regions used to provide the spatial stratification were endorsed at the 2001 SEFAG plenary.

Estimate of discard rates and CVs

Discard rates of the defining species in each stratum were generally minimal or non-existent Table 12. The highest discard rates for defining species were in the mesh net fishery with spotted warehou (15% discarded by weight) and blue warehou (8%) being categorised as a moderate discard rate. Discarding of these fish was usually because they had been damaged and were not marketable. Otherwise the discard rates for defining species was less than 1%. Although they formed a relatively small component of the catch, discarding of the non-defining species was often categorised as high (>20%) and ranged up to 60 % in the different strata.

Because the discard rates of most defining species were low (<5%), the target CVs were 1.5. This target CV was achieved in each case. The target CV of 0.8 was also achieved for the moderate levels of discarding of blue and spotted warehou. Despite the high levels of discarding of non-defining species, the CVs for discard rate were also always well below the target CV of 0.4. Nevertheless, because non-defining species had the greatest discard rate (Table 12), and therefore required the lowest target CV, this group was the "limiting" factor in determining the minimum sampling intensity required in each stratum through simulation modelling. The results of the simulation modelling are graphically represented in Figures 22 – 35. In all strata other than Dropline (West Tas), there was a 100% probability of achieving the smallest target CV of 0.4 (indicated by a horizontal reference line) with a minimum monitoring level of ten shots per stratum. In the Dropline (West Tas) stratum, a minimum monitoring level of 25 shots was required to reach a 100% probability of achieving the target CV.

Conclusions

The SEF Pilot Non-trawl Monitoring Program was successful in achieving its objectives of: 1) providing information on the species composition, weight and length frequency of the total catch (retained and discarded) taken by non-trawl vessels; and 2) determining the sampling intensity required to achieve target coefficients of variation for the discard rates of quota species from non-trawl vessels.

At the time that the pilot monitoring program was undertaken, the catch composition and discard rates for most of the SEF Non-trawl fishery could be adequately described by categorisation into seven Gear x Region strata. Discard rates in these strata were variable, but generally low. Commercial species formed the bulk of the catch (>90%) and although they

were usually retained by the fishers, some were discarded due to management restrictions or because they were damaged. Although comprising a low proportion of the total catch, there was significant discarding of non-commercial bycatch species. Survival of these discards was dependent on the particular species and the gear by which it was caught. Whales, seals and seabirds were observed during the fishing operations, but the only mortality was one seal that was caught on a dropline.

Apart from moderate discarding of blue and spotted warehou in the mesh net fishery, discard rates of the defining species in each stratum were generally low (<1%). Discarding of non-defining species was generally high (>20%) but they formed a relatively small component of the catch. In all cases, the CVs for discard rate were well below the targets. Although the criteria governing the sampling intensity of the non-trawl fleet has yet to be confirmed, based on the low discard rates of most commercial species and the low CVs of discard rates across all species, simulation modelling predicted that only minimal sampling (generally <10 shots per strata) was required in the SENTF in order to achieve the target discard CV criteria stipulated by AFMA for the monitoring of the trawl sector of the SEF. If these criteria are to be used, incorporation of an on-board non-trawl component into the current ISMP would only require a low-level sampling regime (30 – 40 days) to adequately represent the spatial and (to a lesser extent) temporal characteristics of the catch composition from the different non-trawl methods. Slightly more sampling may be necessary to detect and monitor any significant changes that may occur in the fishery.

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Tables and Figures

Table 1 Proposed sampling plan for on-board monitoring of South East Fishery Non-Trawl vessels during 1999/2000.

Season	Gear	Zone	Proposed sea days
Winter	Demersal longline	Eastern zone A	3
	Dropline	Eastern zone B	3
		Eastern Tas	2
		Western Tas	1
		Western zone	2
	Fish traps	Eastern zone B	2
	Mesh-netting	Eastern zone B	17
		Total	**30**
Spring	Demersal longline	Eastern zone A	5
		Western Tas	1
	Dropline	Eastern zone B	2
		Eastern Tas	10
		Western Tas	3
		Western zone	3
	Fish traps	Eastern zone B	8
	Mesh-netting	Eastern zone B	2
		Total	**34**
Summer	Demersal longline	Eastern zone A	1
		Western Tas	5
	Dropline	Eastern zone B	6
		Eastern Tas	9
		Western Tas	4
		Western zone	2
	Mesh-netting	Eastern zone B	1
		Total	**28**
Autumn	Dropline	Eastern zone B	4
		Eastern Tas	6
		Western Tas	1
		Western zone	2
	Mesh-netting	Eastern zone B	5
		Total	**18**
Not seasonal	Demersal longline	Eastern zone B	2
		Eastern Tas	1
		Far western	1
	Dropline	Eastern zone A	3
		Bass Strait	1
		Far western	1
	Mesh-netting	Bass Strait	1
		Western zone	1
		Far western	1
		Total	**12**
Total sea days			**122**

Table 2. On-board monitoring of SEF non-trawl vessels undertaken during 1999/2000 and a summary of the total catch (retained and discarded) and the number of fish measured.

Fishing method	Monitoring level				Catch				
	Vessels	Days	Shots	Effort	Retained catch (kg)	Discarded catch (kg)	Total catch (kg)	% Weight discarded	Fish measured
Dropline	8	66	392	32,742 hooks	6,810	641	7,451	9%	1801
Longline	2	16	27	70,250 hooks	12,921	430	13,351	3%	3172
Mesh net	2	33	91	127,947 metres	23,904	5,546	29,450	19%	7803
Trap	1	10	12	229 traps	2,101	78	2,179	4%	943
TOTAL	10	125	522		45,736	6,695	52,431	13%	13719

Table 3. Number of fish of each species measured from catches SEF dropline, longline, mesh-net and trap vessels monitored during the pilot study.

Species	Non-trawl method				Total
	Dropline	Longline	Mesh-net	Trap	
Blue warehou			3696		3696
Pink ling	41	1554	1134	740	3469
Blue eye trevalla	1575	66	1583		3224
King teraki		1252			1252
Spotted warehou			612		612
Jackass morwong	1		35	140	176
Imperador			173		173
Draughtboard shark			167		167
Yellowtail kingfish		162			162
Gemfish	51		109		160
Blue grenadier	36		92		128
Tasmanian trumpeter	1	80	32		113
Hapuku	42	28	40	1	108
Ocean perch	16	26		51	93
Alfonsino	19		46		65
Southern sawshark			24		24
Gummy shark			18		18
Sharp nose seven-gill shark			11		11
Orange perch				10	10
Mirror dory			10		10
White warehou	9				9
Rudderfish			7		7
Bastard trumpeter			5		5
Blue morwong			4		4
Ocean blue eye		3			3
Rays Bream	3				3
Mako shark	2				2
Blue Whaler	2				2
School shark	1		1		2
Giant boarfish			2		2
Pigfish		1			1
John dory			1		1
Ribaldo				1	1
Melbourne skate	1				1
Endeavour dogfish	1				1
Snapper			1		1
Grand Total	1801	3172	7803	943	13719

Table 4 Species composition of the retained and discarded components of the catch by SEF dropline vessels.

Species	Retained catch		Discarded catch		Total catch	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Blue eye trevalla	5432	1566	7	5	5439	1571
Hapuku	427	46	0	0	427	46
Pink ling	167	41	0	0	167	41
Gemfish	154	56	4	1	158	57
Porbeagle shark	115	3	0	0	115	3
Blue grenadier	95	43	0	2	95	45
Mako shark	80	2	0	0	80	2
Ocean perch	61	55	10	11	71	66
Ribaldo	48	26	0	0	48	26
School shark	32	3	0	0	32	3
Alfonsino	31	23	0	0	31	23
White warehou	23	11	0	0	23	11
Jackass morwong	15.5	12	0	0	15.5	12
Green eyed dogfish	7	2	271	205	278	207
Tassie trumpeter	6	1	0	0	6	1
Draughtboard shark	4	1	115	35	119	36
Rays bream	3	3	0	0	3	3
Blue whaler	3	1	2	1	5	2
White-Spotted dogfish	3	1	127	43	130	44
Knifejaw	2	1	0	0	2	1
Whiptail, [Unspecified]	2	1	0	0	2	1
Barracouta	1	1	0	0	1	1
Spikey oreo	1	1	0	0	1	1
Reef ocean perch	0.5	1	0	0	0.5	1
Skate, Melbourne	0	0	14	2	14	2
Endeavour dogfish	0	0	51	13	51	13
Southern frostfish	0	0	3	1	3	1
Platypus dogshark	0	0	17	5	17	5
Sawtail shark	0	0	2	1	2	1
Seven-gilled shark	0	0	5	1	5	1
Grand Total	6713	1901	628	326	7341	2227

Table 5 Species composition of the retained and discarded components of the catch by longline vessels working on the Gascoyne Plateau.

Species	Retained catch		Discarded catch		Total catch	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
King Teraki	4104	1252	2	1	4106	1253
Yellowtail kingish	1219	164	0	0	1219	164
Tassie trumpeter	508	77	0	0	508	77
Green eyed dogfish	457	95	22	5	479	100
Blue eye trevalla	352	28	0	0	352	28
Hapuku	270	22	0	0	270	22
Bass grouper	165	4	0	0	165	4
Ocean perch	46	34	0	0	46	34
Ocean blue eye	10	3	0	0	10	3
Foxfish	4	2	1	1	5	3
Banded sea perch	4	2	0	0	4	2
Eastern blackspot pigfish	3	2	0	0	3	2
Orange perch	3	2	0	0	3	2
Redfish	2	1	0	0	2	1
Swallow tail	2	1	0	0	2	1
Banded Morwong	2	1	0	0	2	1
Butterfly gurnard	1	1	0	0	1	1
Pufferfish, Ringed(Toadfish)	0	0	6	6	6	6
Pufferfish (porcupine)	0	0	121	121	121	121
Moray eel	0	0	16	16	16	16
Grand Total	7152	1691	168	150	7320	1841

Table 6 Species composition of the retained and discarded components of the catch by SEF longline vessels working on the west coast of Tasmania.

Species	Retained catch		Discarded catch		Total catch	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Pink ling	7150	1552	2	2	7152	1554
Blue eye trevalla	119	37	0	0	119	37
Ribaldo	43	21	0	0	43	21
Mako shark	40	1	0	0	40	1
Blue whaler	36	5	0	0	36	5
Ocean perch	33	27	0	0	33	27
Tassie trumpeter	20	6	0	0	20	6
School shark	15	1	0	0	15	1
Red cod	12	12	0	0	12	12
Inshore ocean perch	5	7	0	0	5	7
Alfonsino	4	2	0	0	4	2
Rays Bream	3	2	0	0	3	2
Whiptail, [Unspecified]	2	1	55	43	57	44
Jackass morwong	2	1	0	0	2	1
Blue grenadier	1	1	0	0	1	1
Serpent eel	0	0	12	12	12	12
Green eyed dogfish	0	0	8	4	8	4
Draughtboard shark	0	0	33	11	33	11
Skate	0	0	20	5	20	5
Melbourne skate	0	0	40	10	40	10
Southern whiptail	0	0	140	76	140	76
Black shark	0	0	6	6	6	6
Grand Total	7485	1676	316	169	7801	1845

Table 7 Species composition of the retained and discarded components of the catch by SEF mesh-net vessels.

Species	Retained catch		Discarded catch		Total catch	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Blue warehou	8837	4105	724	355	9561	4460
Blue eye trevalla	5956	1524	47.5	18	6003.5	1542
Pink ling	4680	1129	59	18	4739	1147
Spotted warehou	1347	667	234	117	1581	784
Mako shark	470	9	0	0	470	9
Blue grenadier	396	127	55	22	451	149
Imperador	367	192	2	2	369	194
Sharpnose seven-gill shark	268	68	1	1	269	69
Hapuku	252	46	4	1	256	47
Endeavour dogfish	201	65	9	2	210	67
Gummy shark	174	39	7	2	181	41
Gemfish	168	38	1865	353	2033	391
Jackass morwong	128	121	3	3	131	124
Spookfish	112	62	8	5	120	67
Tassie trumpeter	107	34	0	0	107	34
Southern sawshark	82	27	0	0	82	27
School shark	75	10	0	0	75	10
Seven-gilled shark	70	9	0	0	70	9
Platypus dogshark	56	19	1	1	57	20
Thresher shark	40	2	0	0	40	2
Rudderfish	38	9	5	1	43	10
Mirror dory	25	30	53	54	78	84
Angel shark	20	5	10	1	30	6
Green eyed dogfish	19	5	446	303	465	308
Ocean perch	10	11	1	1	11	12
Bastard trumpeter	8	6	0	0	8	6
Redfish	5	7	0	0	5	7
Snapper	4	1	0	0	4	1
Blue morwong	4	3	0	0	4	3
Black shark	3	1	0	0	3	1
Giant boarfish	3	2	0	0	3	2
Reef ocean perch	2	2	0	0	2	2
John dory	2	2	0	0	2	2
Silver dory	1	2	36	35	37	37
Jack mackerel	1	1	145	222	146	223
Long-snouted boarfish	1	1	0	0	1	1
Draughtboard shark	0	0	1278	398	1278	398
Port Jackson shark	0	0	266	37	266	37
Broad bill swordfish	0	0	85	3	85	3
Prickly shark	0	0	60	1	60	1
Melbourne skate	0	0	40	4	40	4
Red cod	0	0	38	30	38	30
Deep sea flathead	0	0	16	15	16	15
King crab	0	0	10	1	10	1
Smooth stingray	0	0	8	2	8	2
Redbait	0	0	7	19	7	19
Slimey mackerel	0	0	7	7	7	7
Common roughy	0	0	6	8	6	8
Barracouta	0	0	6	5	6	5
Stargazer	0	0	5	4	5	4
Cookie cutter shark	0	0	3	2	3	2
Prickley dogfish	0	0	3	2	3	2
Rusty Catshark	0	0	3	1	3	1
Whiptail, [Unspecified]	0	0	2	1	2	1
Crocodile fish	0	0	2	2	2	2
Rays Bream	0	0	1	1	1	1
Gurnard, [Unspecified]	0	0	1	1	1	1
Ribaldo	0	0	1	1	1	1
Cucumber Fish	0	0	0.5	1	0.5	1
Grand Total	23932	8381	5564	2063	29496	10444

Table 8 Species composition of the retained and discarded components of the catch by SEF trap vessels.

Species	Retained catch		Discarded catch		Total catch	
	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Pink ling	1865	732	0	0	1865	732
Jackass morwong	123	146	0	0	123	146
Ocean perch	67	93	0	0	67	93
Ribaldo	34	34	0	0	34	34
Hapuku	7	1	0	0	7	1
Spider crab	0	0	50	153	50	153
Draughtboard shark	0	0	26	7	26	7
Red cod	0	0	1	1	1	1
Banded bellows fish	0	0	0	3	0	3
Orange perch	0	0	1	3	1	3
Grand Total	2096	1006	78	167	2174	1173

Table 9 Stratification of the SEF non-trawl fishery and defining species used to estimate discard rates and CVs.

Strata	Gear	Fishing zone	Defining species
Dropline (East)	Dropline	East Victoria and East Tasmania	blue eye trevalla, hapuku pink ling
Dropline (West Vic)	Dropline	West Victoria	blue eye trevalla, hapuku pink ling
Dropline (West Tas)	Dropline	West Tasmania	blue eye trevalla, hapuku pink ling
Longline (Gascoyne)	Demersal longline	Gascoyne Plateau	Tasmanian trumpeter, king tarakihi, yellowtail kingfish,
Longline (Tasmania)	Demersal longline	East & West Tasmania	pink ling
Mesh-net (East Vic)	Mesh-net	East Victoria	blue eye trevalla, pink ling, blue warehou, spotted warehou
Fish trap (East Vic)	Fish trap	East Victoria	pink ling, jackass morwong

Table 10 Number of shots, fishing days and strata days undertaken in each of the SEF non-trawl strata during 1999/2000.

Strata	**Shots**	**Fishing days**	**Strata days**
Dropline (East)	106	8	25
Dropline (West Tas)	132	9	18
Dropline (West Vic)	154	13	23
Total Dropline	**392**	**30**	**66**
Longline (Gascoyne)	22	5	8
Longline (Tasmania)	5	3	8
Total Longline	**27**	**8**	**16**
Fishtrap (East Vic)	**12**	**5**	**10**
Mesh-net (East Vic)	**91**	**38**	**33**
Total	**522**	**81**	**125**

Table 11 Number of shots, fishing days and strata days monitored in each of the SEF non-trawl strata during 1999/2000, summarised by season.

Season	Stratum	Shots	Fishing days	Strata days
Winter	Dropline (East)	23	2	11
	Dropline (West Vic)	24	3	5
	Fishtrap (East Vic)	12	5	10
	Longline (NSW)	22	5	8
	Mesh-net (East Vic)	31	15	15
Winter total		112	30	59
Spring	Dropline (East)	41	3	7
	Dropline (West Vic)	41	3	6
	Dropline (West Tas)	31	2	4
	Longline (Tasmania)	4	2	4
Spring total		117	10	21
Summer	Dropline (East Tas)	42	3	7
	Dropline (West Vic)	89	7	12
	Dropline (West Tas)	9	1	4
	Longline (Tasmania)	1	1	4
Summer total		141	12	27
Autumn	Dropline (West Tas)	92	6	10
	Mesh-net (East Vic)	60	23	18
Autumn total		152	29	28
Total		522	81	125

Table 12 Estimated percentage discard rates and (CVs) for each species within their defining strata.

Species	Dropline (east)	Dropline (south)	Dropline (west)	Longline (Gascoyne)	Longline (Tasmania)	Mesh-net	Fish trap	other
Blue warehou						7.57(0.03)		
Pink ling	0.00 (.)	0.00 (.)	0.00 (.)		0.03 (0.60)	1.24 (0.06)	0.00 (.)	0.00 (.)
Blue eye trevalla	0.19(0.56)	0.17(0.07)	0.00 (.)			0.79(0.05)		0.00 (.)
King tarakihi				0.05(0.26)				
Spotted warehou						14.80(0.01)		
Jackass morwong							0.00 (.)	2.02(0.13)
Yellowtail kingfish				0.00 (.)				
Tasmanian trumpeter				0.00 (.)				0.00 (.)
Hapuku	0.00 (.)	0.00 (.)	0.00 (.)					0.57(0.37)
Non-defining	62.41(0.02)	48.20(0.01)	18.11(.03)	5.17(0.05)	48.38(0.09)	59.11(0.01)	20.59(0.11)	

Table 13 Estimated minimum number of shots and sea-days (including steaming) necessary for an on-board monitoring program to achieve the target CVs for discarding of non-defining species in each non-trawl stratum.

Strata	**Minimum shots to achieve CV**	**Shots per sea-day**	**Minimum sea days**
Dropline (East)	10	4.2	3
Dropline (West Vic)	25	6.6	4
Dropline (West Tas)	10	7.7	2
Longline (Gascoyne)	6	2.7	3
Longline (Tasmania)	6	0.6	11
Mesh-net (East Vic)	8	2.7	3
Fish trap (East Vic)	7	1.2	6
Total	72		32

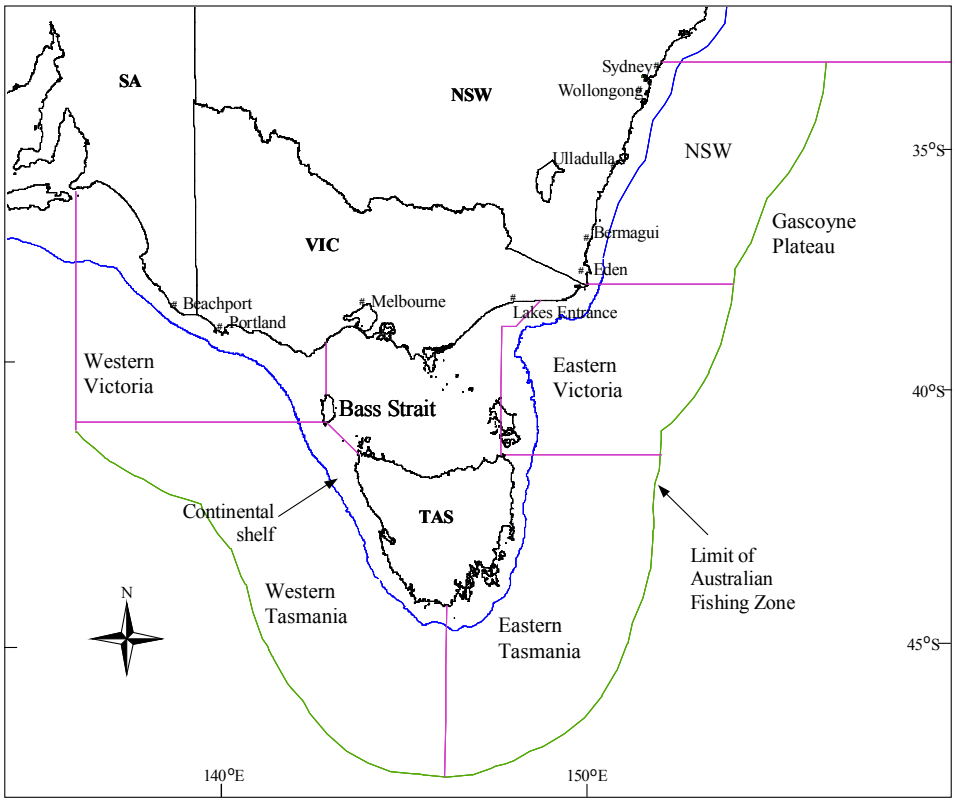

Figure 1 Fishing zones used to define the spatial stratification of the SEF non-trawl fishery.

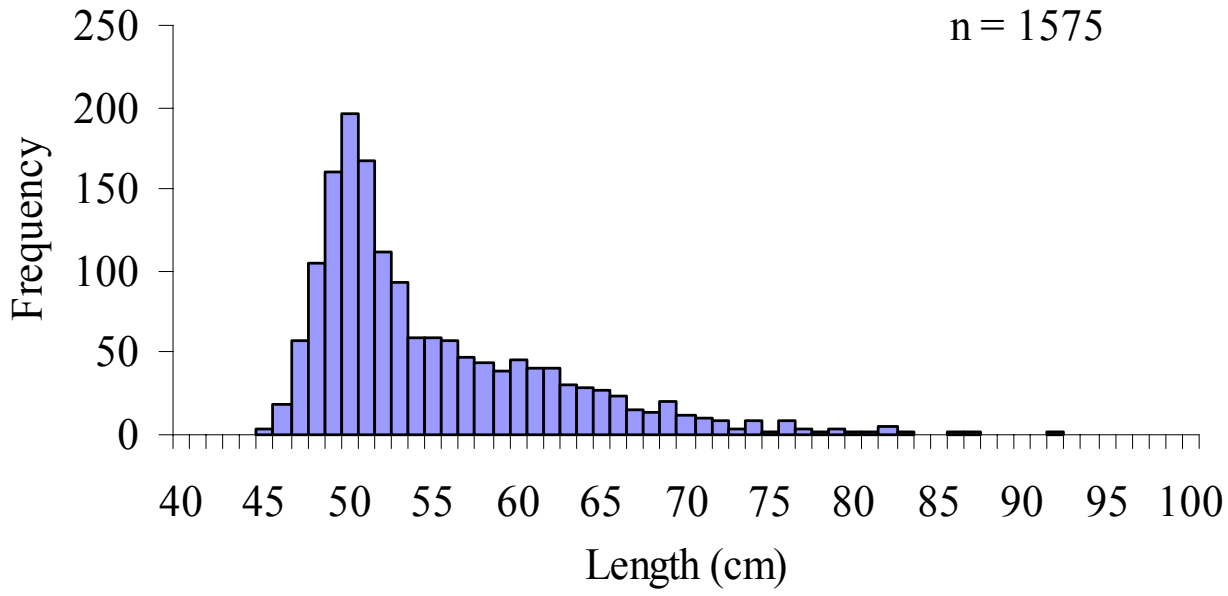

Figure 2 Length frequency distribution of blue eye trevalla caught by SEF dropline vessels monitored during 1999/2000.

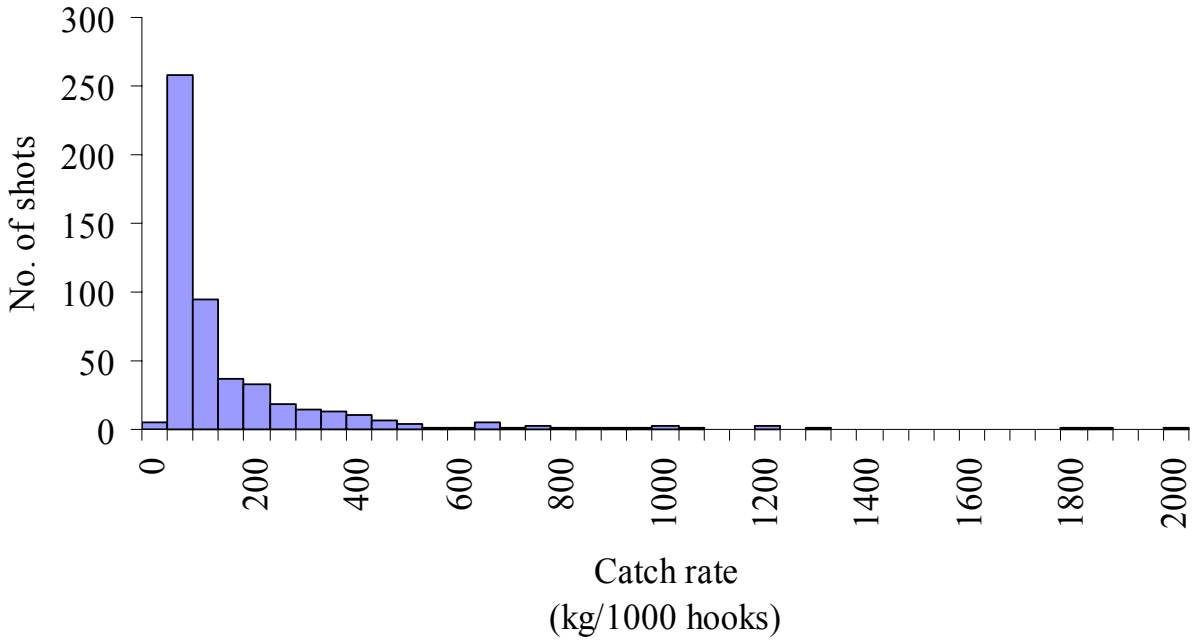

Figure 3 Distribution of blue eye trevalla catch rates in SEF dropline shots by monitored during 1999/2000.

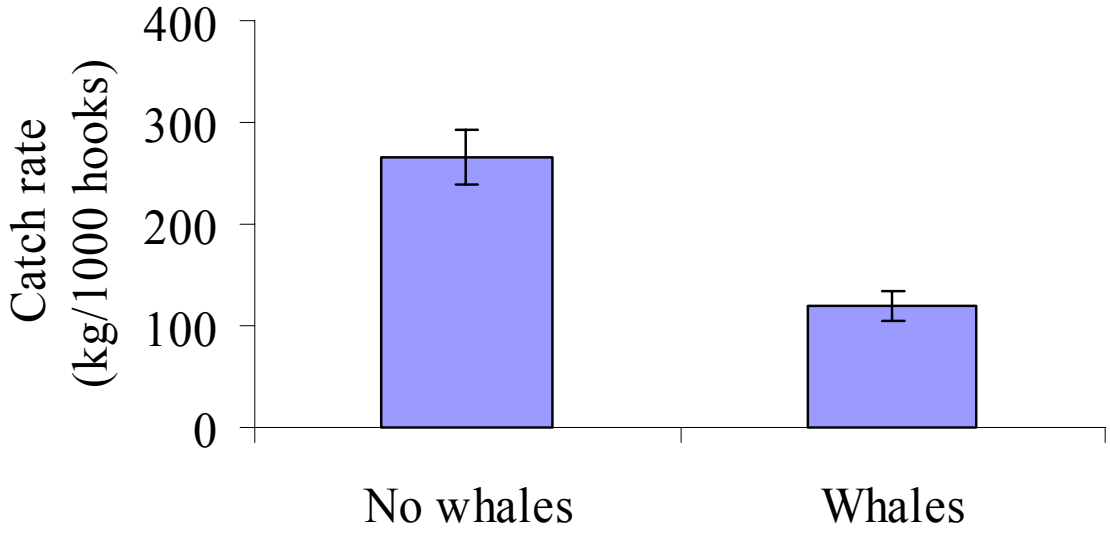

Figure 4 Comparison between mean catch rates of blue eye trevalla (kg/1000 hooks ± s.e.) by SEF dropline vessels when no killer whales were present and when killer whales were present in the vicinity of the fishing operations.

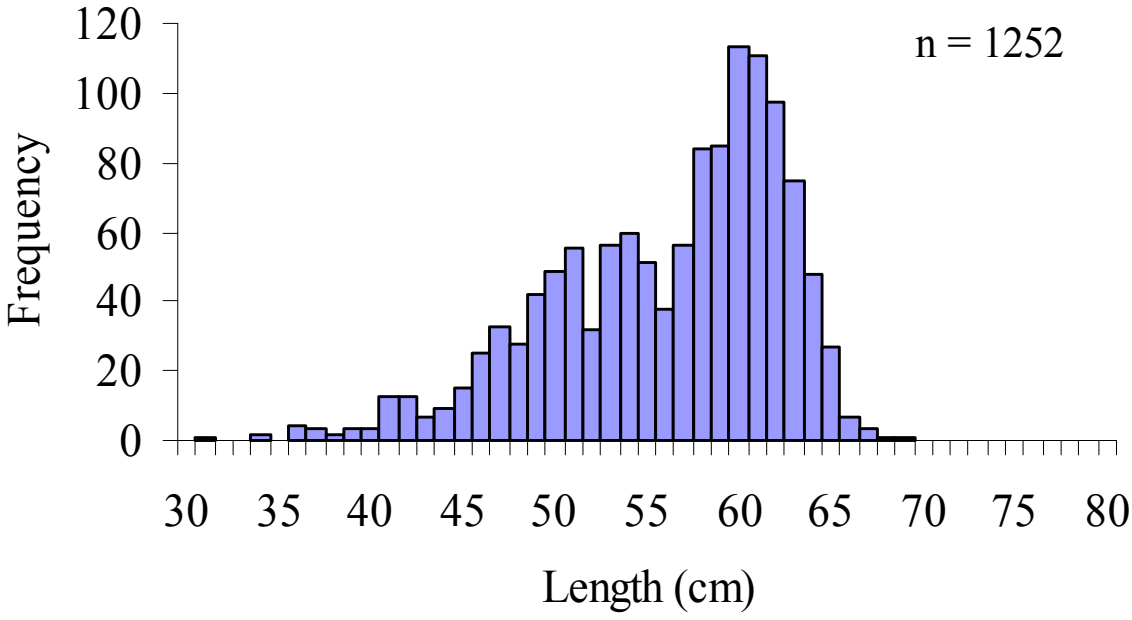

Figure 5 Length frequency distribution of king tarakihi caught by longline vessels working on the Gascoyne Plateau outside the AFZ during 1999/2000.

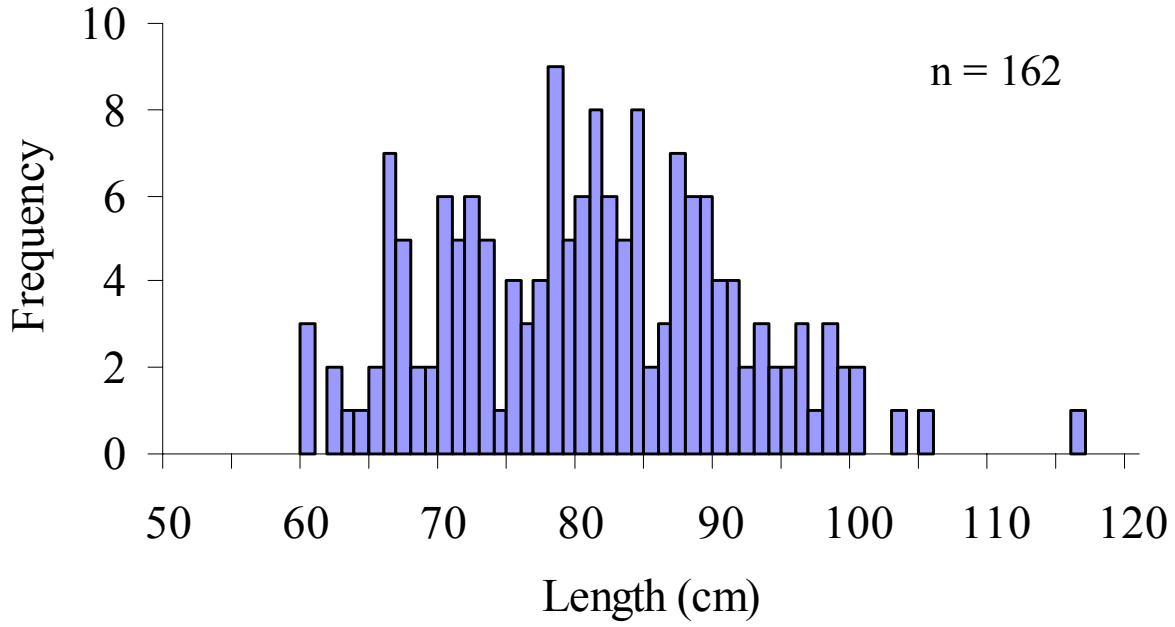

Figure 6 Length frequency distribution of yellowtail kingfish caught by longline vessels working on the Gascoyne Plateau outside the AFZ during 1999/2000.

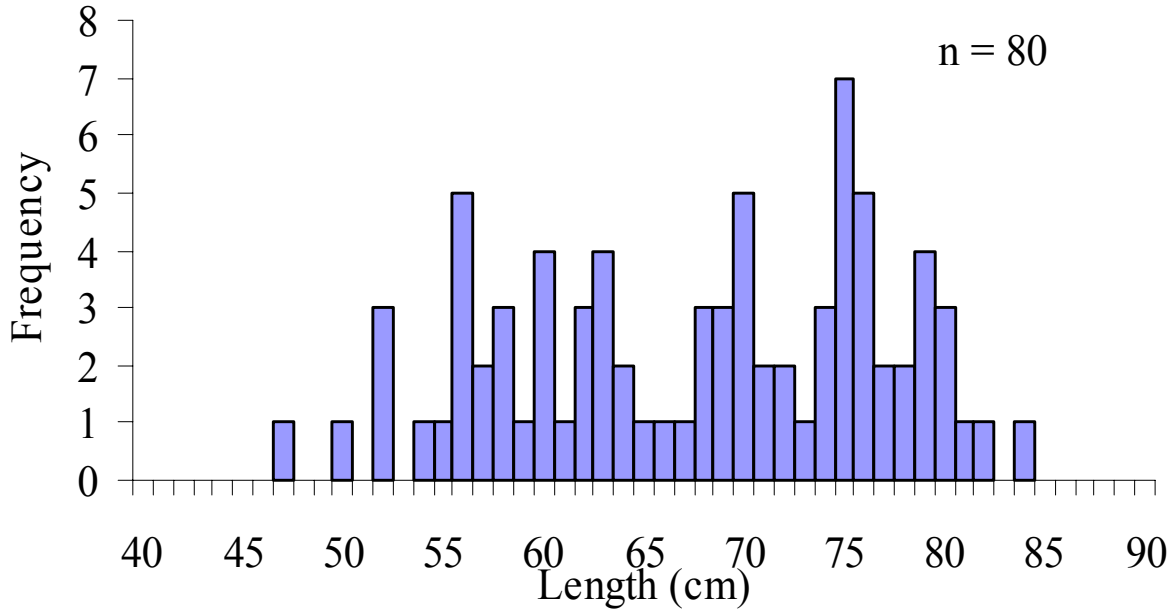

Figure 7 Length frequency distribution of Tasmanian trumpeter caught by longline vessels working on the Gascoyne Plateau outside the AFZ during 1999/2000.

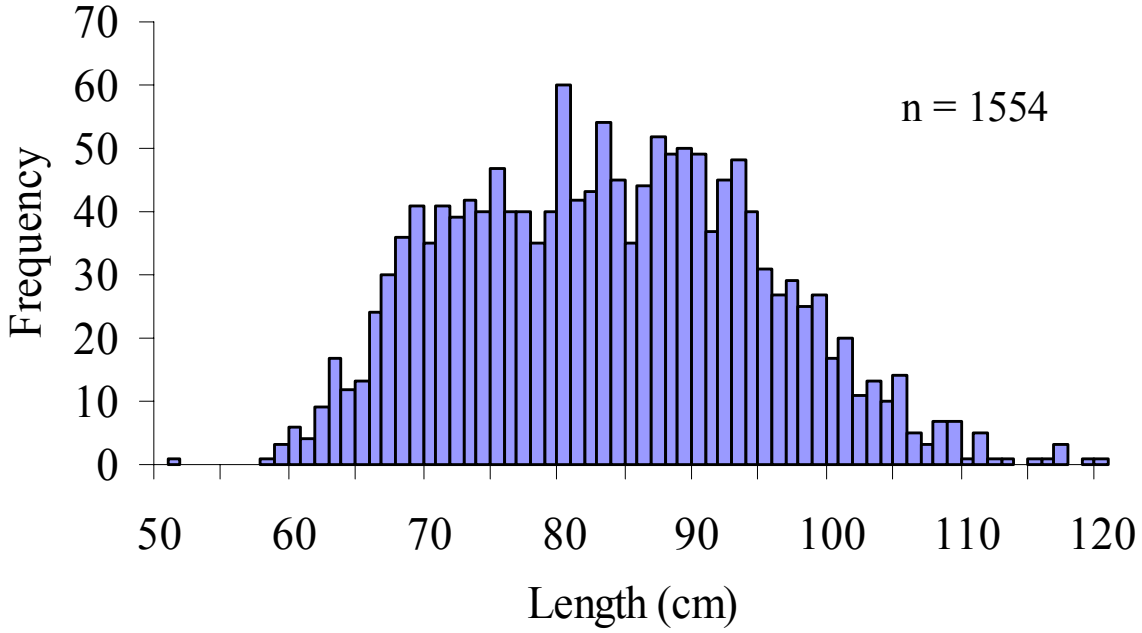

Figure 8 Length frequency distribution of pink ling caught by SEF longline vessels working off western Tasmania during 1999/2000.

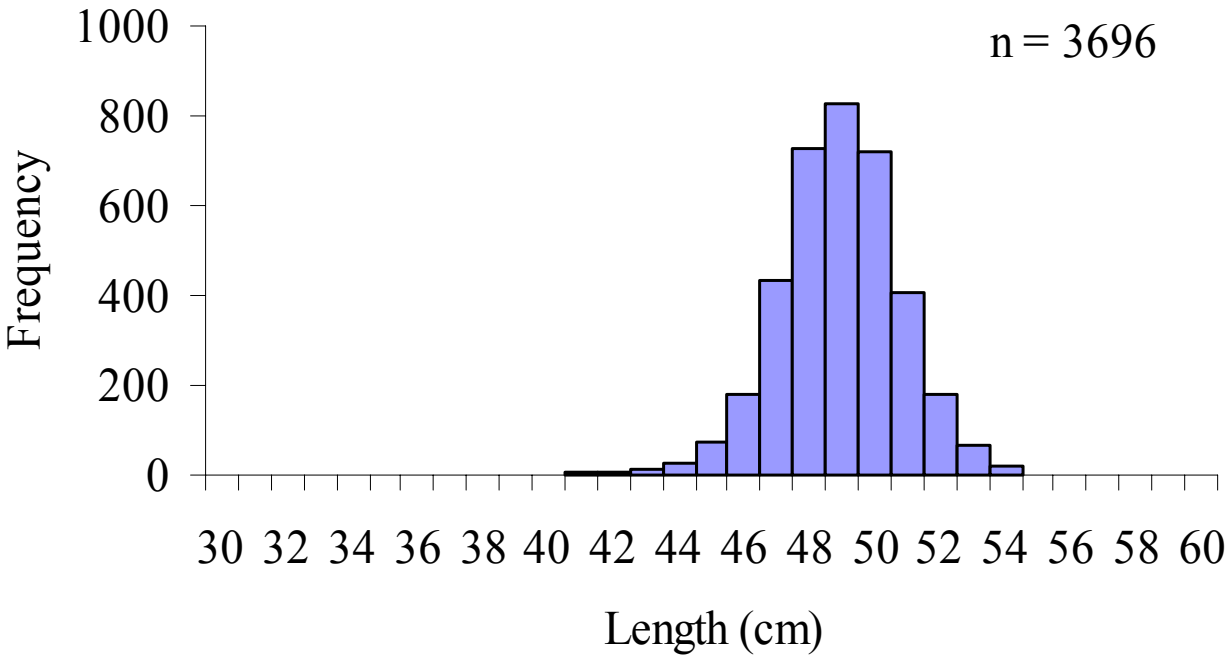

Figure 9 Length frequency distribution of blue warehou caught by SEF mesh-net vessels working off eastern Victoria during 1999/2000.

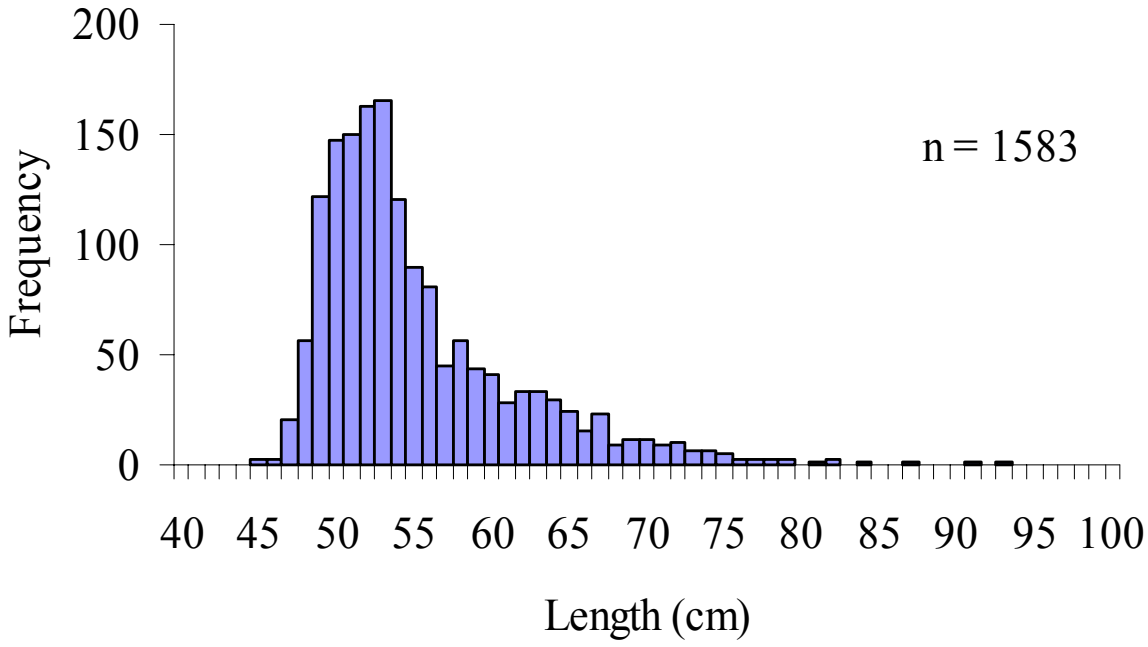

Figure 10 Length frequency distribution of blue eye trevalla caught by SEF mesh-net vessels working off eastern Victoria during 1999/2000.

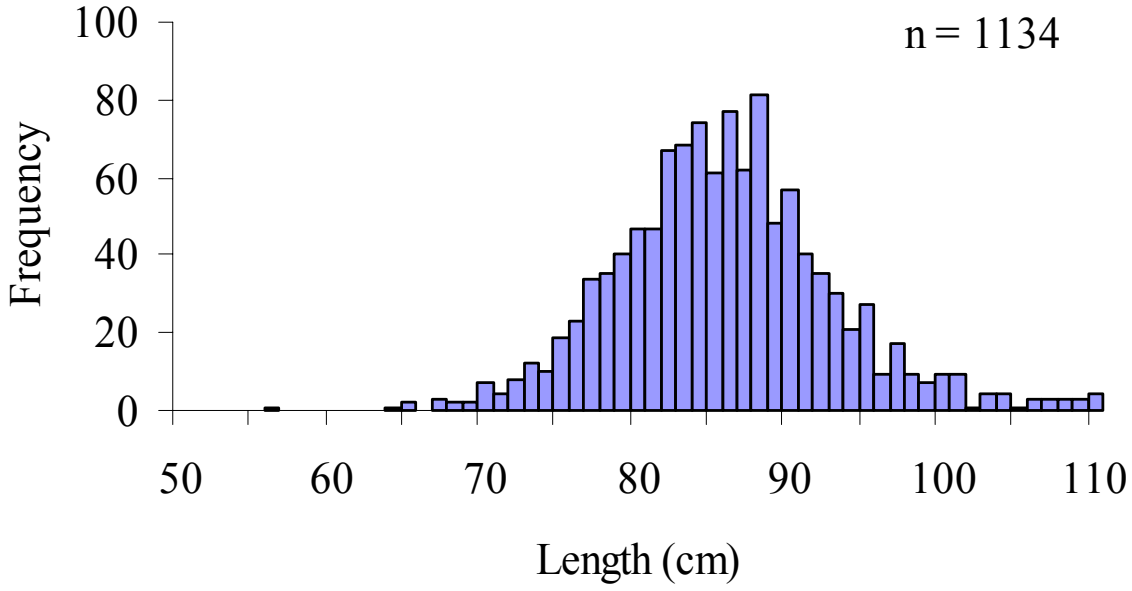

Figure 11 Length frequency distribution of pink ling caught by SEF mesh-net vessels working off eastern Victoria during 1999/2000.

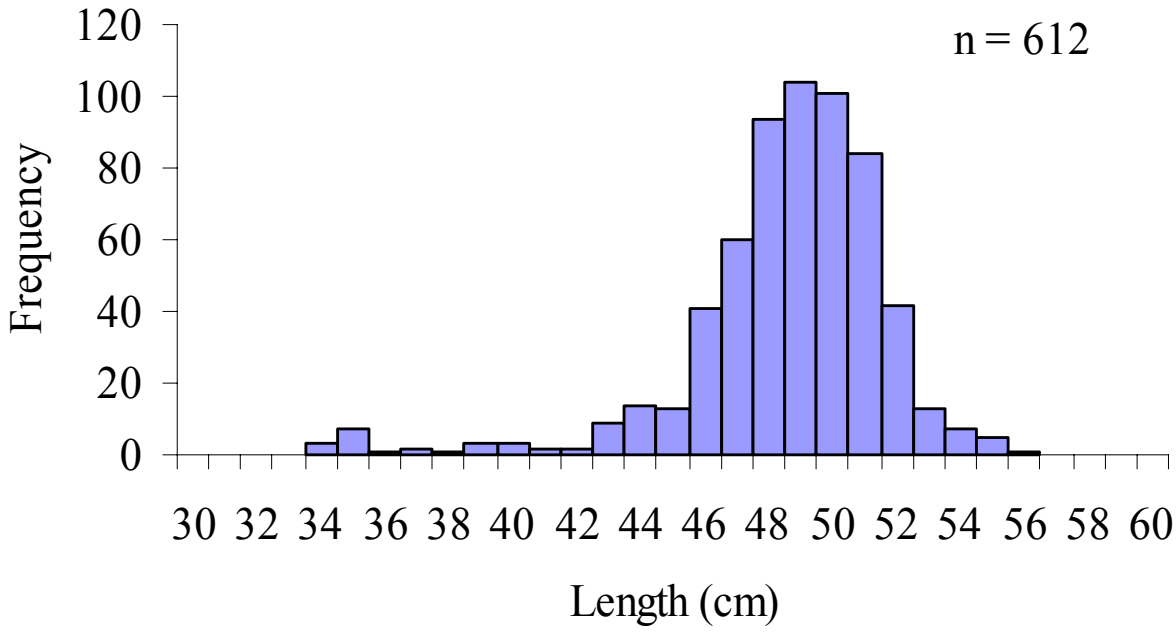

Figure 12 Length frequency distribution of spotted warehou caught by SEF mesh-net vessels working off eastern Victoria during 1999/2000.

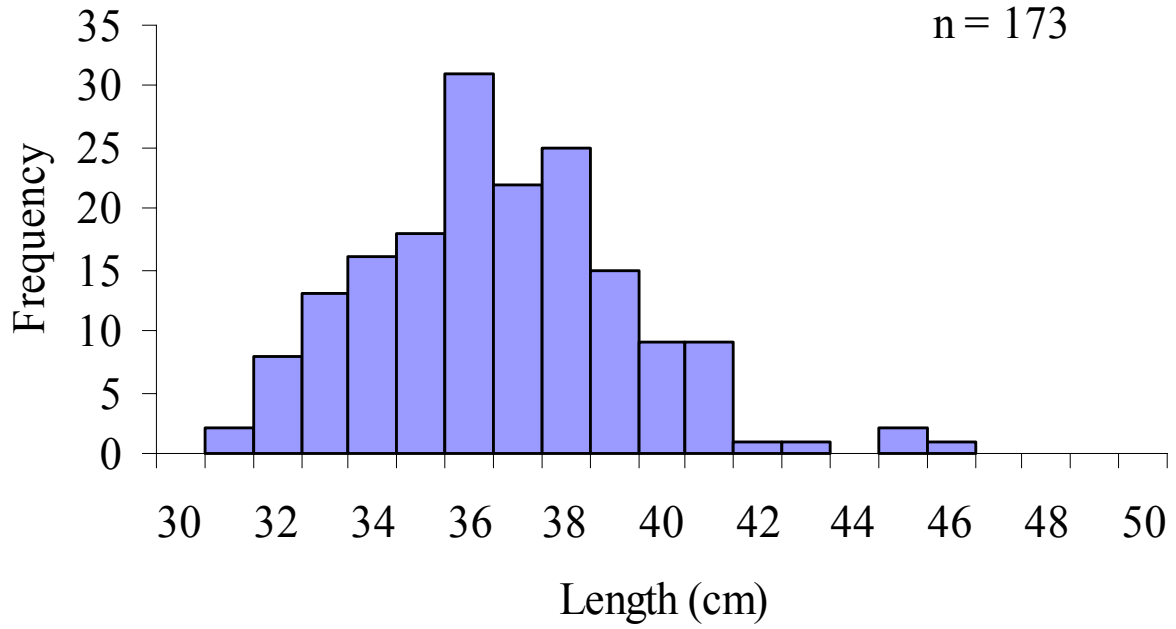

Figure 13 Length frequency distribution of imperador caught by SEF mesh-net vessels working off eastern Victoria during 1999/2000.

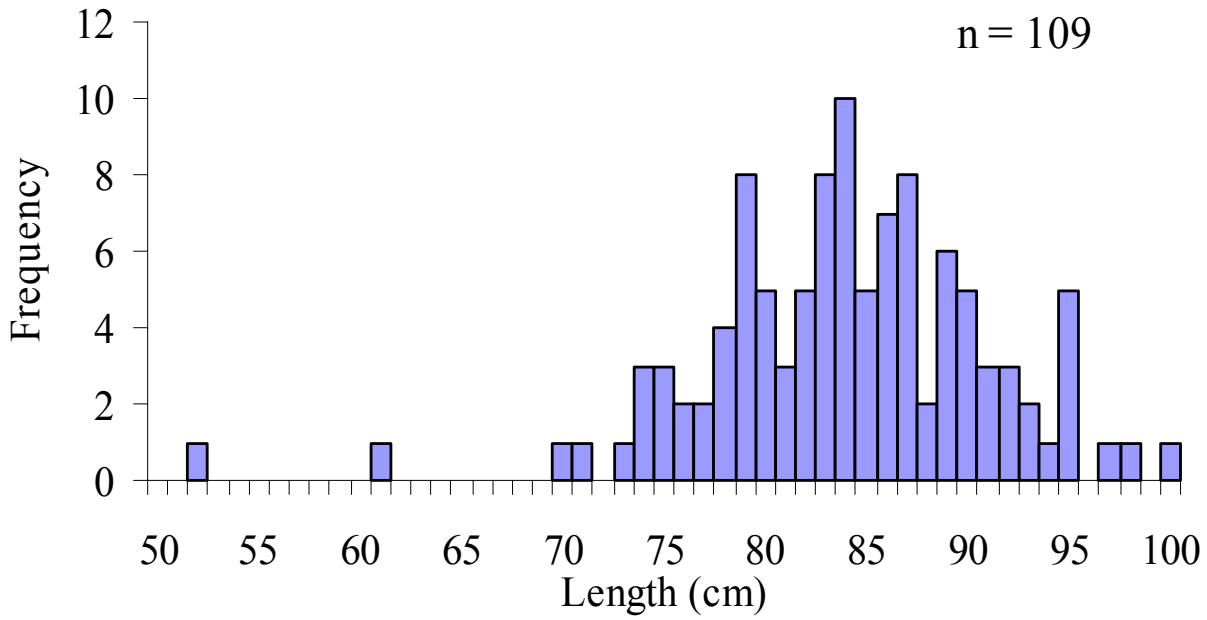

Figure 14 Length frequency distribution of eastern gemfish caught by SEF mesh-net vessels during 1999/2000. Most gemfish were discarded

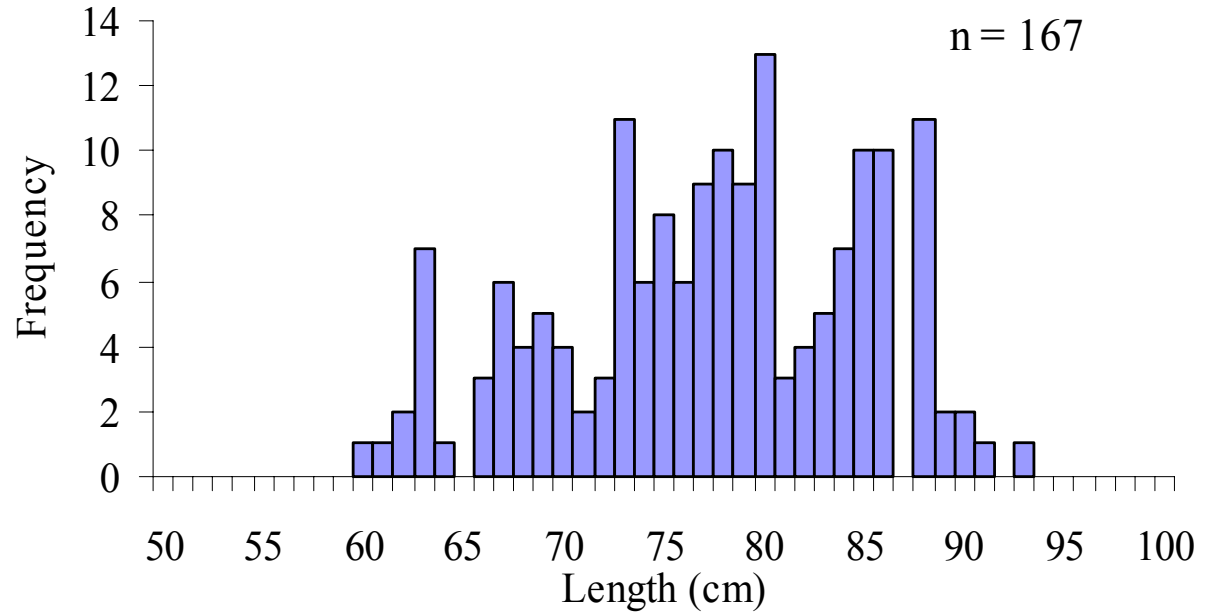

Figure 15 Length frequency distribution of draughtboard caught by SEF mesh-net vessels during 1999/2000. All draughtboard sharks were discarded

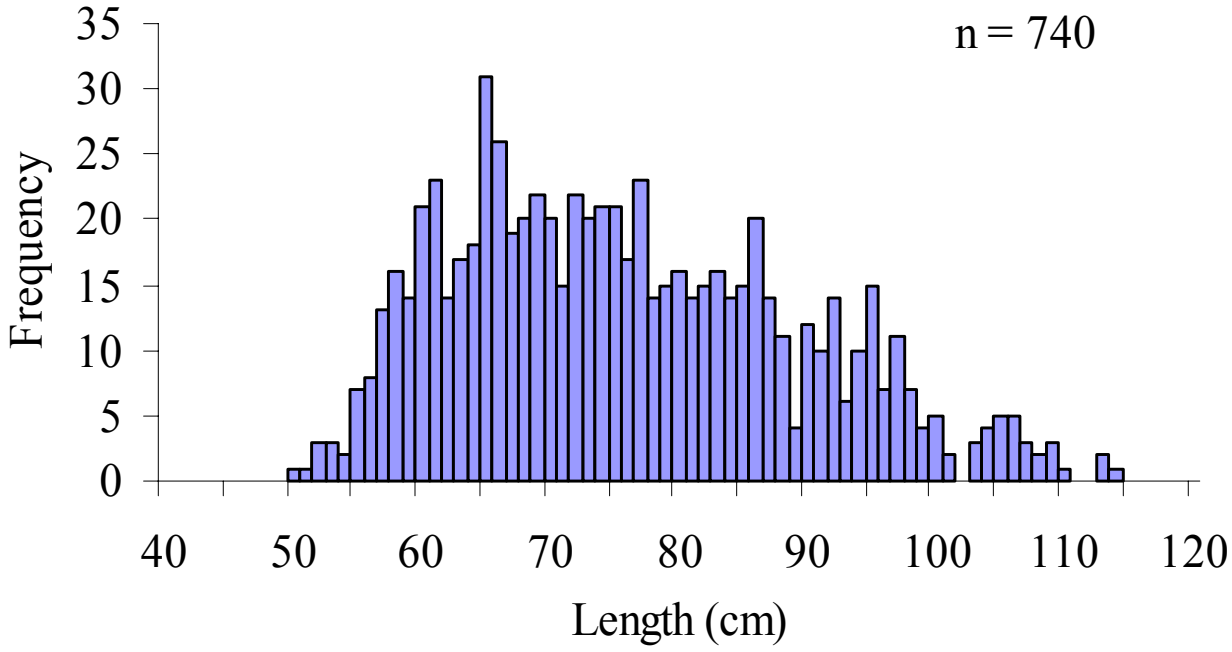

Figure 16 Length frequency distribution of pink ling caught by SEF trap vessels during 1999/2000.

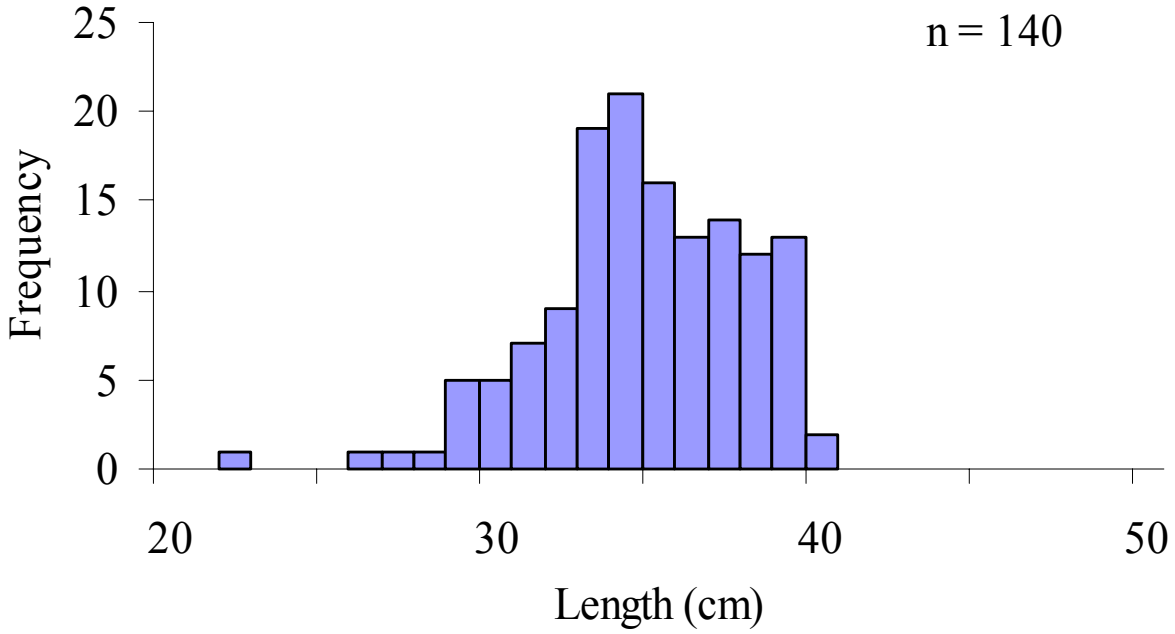

Figure 17 Length frequency distribution of jackass morwong caught by SEF trap vessels during 1999/2000.

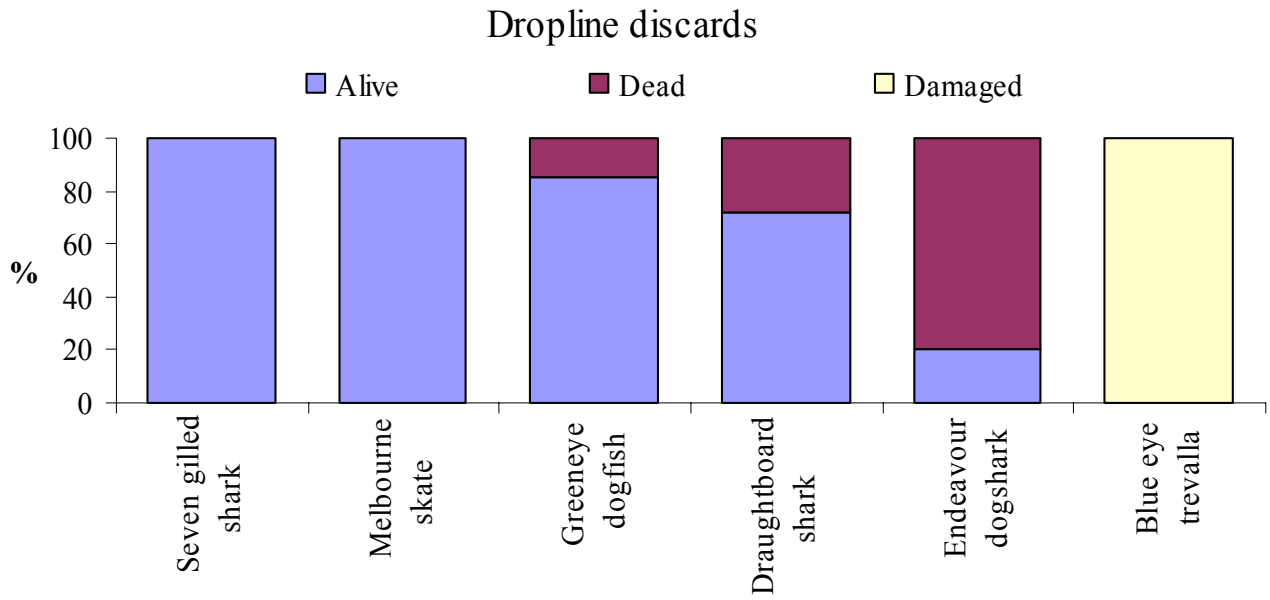

Figure 18 Subjective categorisation of the life-state of fish species discarded by SEF dropline vessels during 1999/2000. "Damaged" indicates that these fish were only discarded because they had a degree of damaged that rendered them unmarketable.

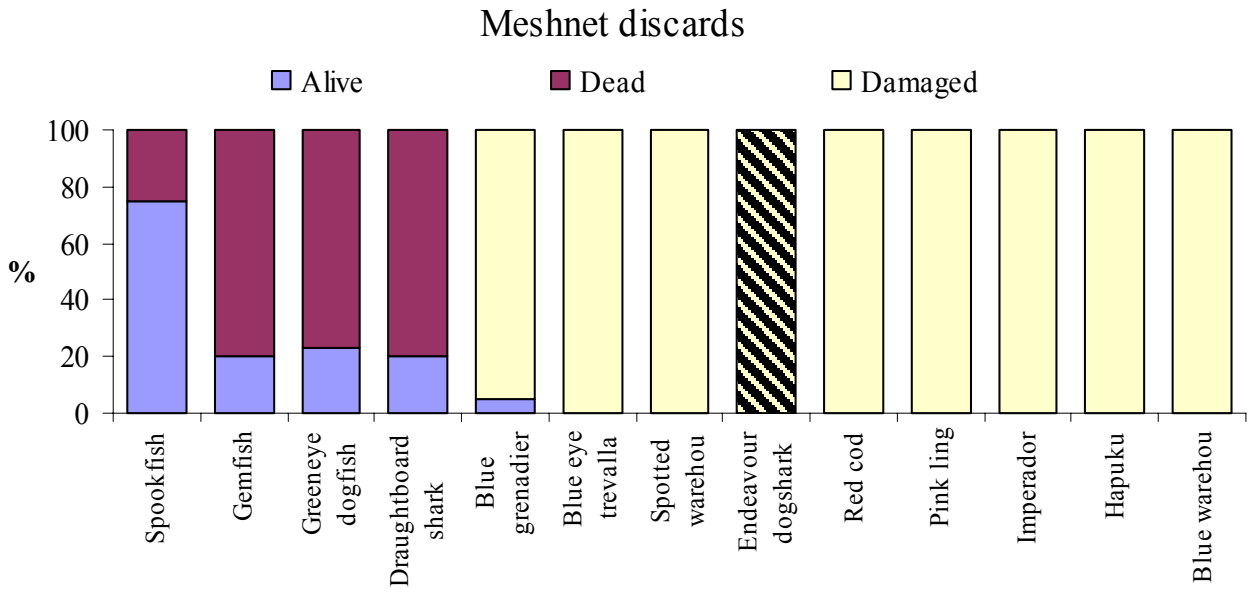

Figure 19 Subjective categorisation of the life-state of fish species discarded by SEF mesh-net vessels during 1999/2000. NB. "Damaged" indicates that these fish were only discarded because they had a degree of damaged that rendered them unmarketable.

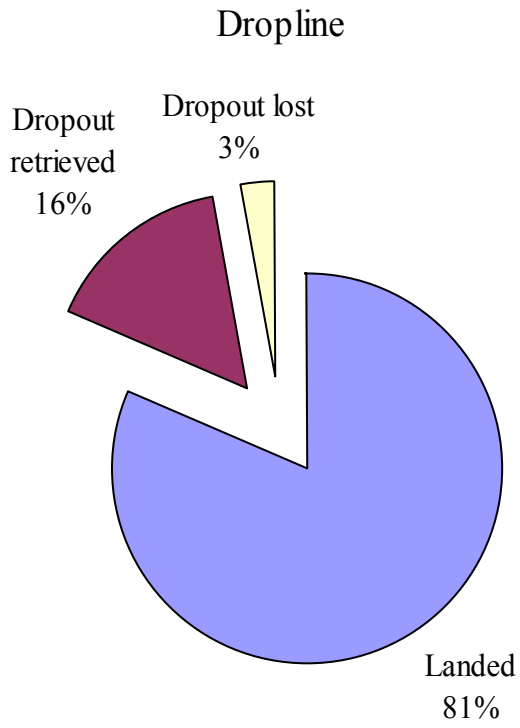

Figure 20 Breakdown of the total blue eye trevalla catch by dropline vessels into those landed by the gear, those which dropped out of the gear but were retrieved and those which dropped out of the gear and were lost. Figures based on the observations of an on-board observer on 96 shots.

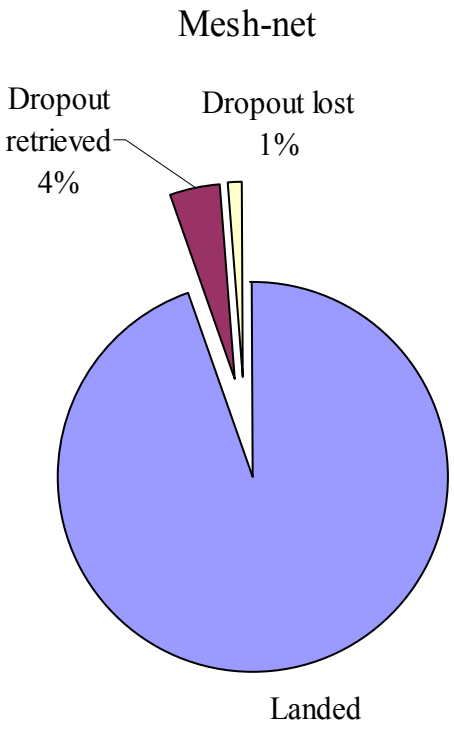

Figure 21 Breakdown of the total blue eye trevalla catch by dropline vessels into those landed by the gear, those which dropped out of the gear but were retrieved and those which dropped out of the gear and were lost. Figures based on the observations of an on-board observer on 28 shots.

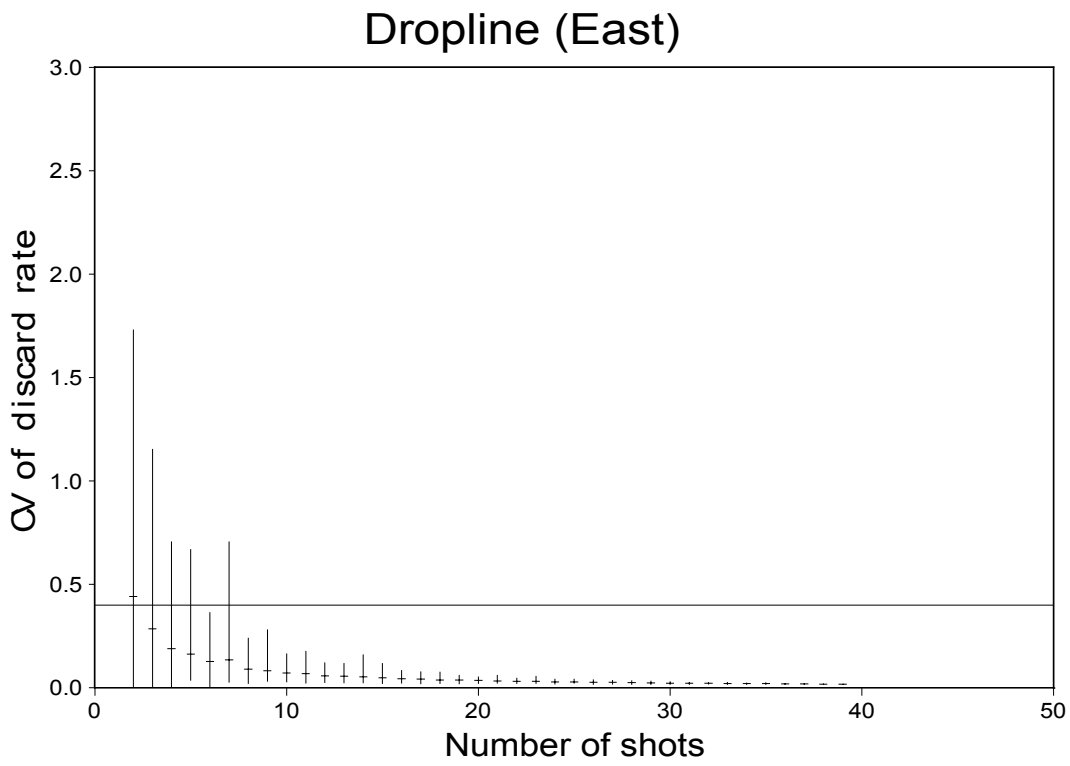

Figure 22 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Dropline (East) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

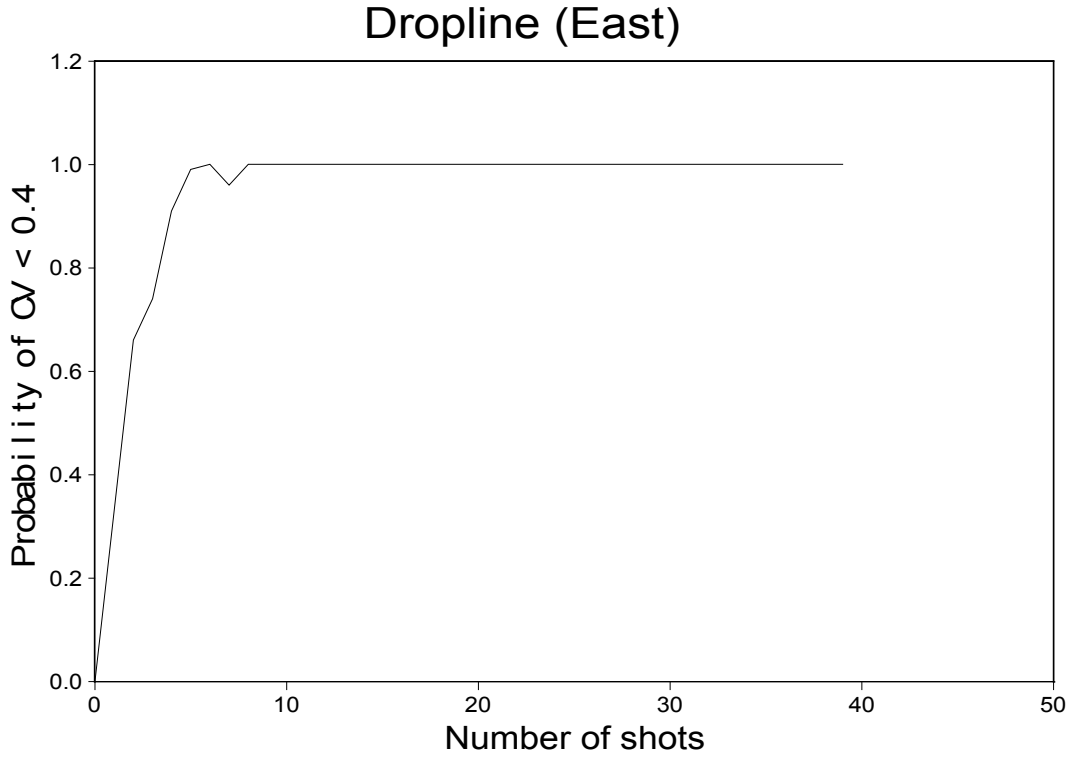

Figure 23 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Dropline (East) stratum.

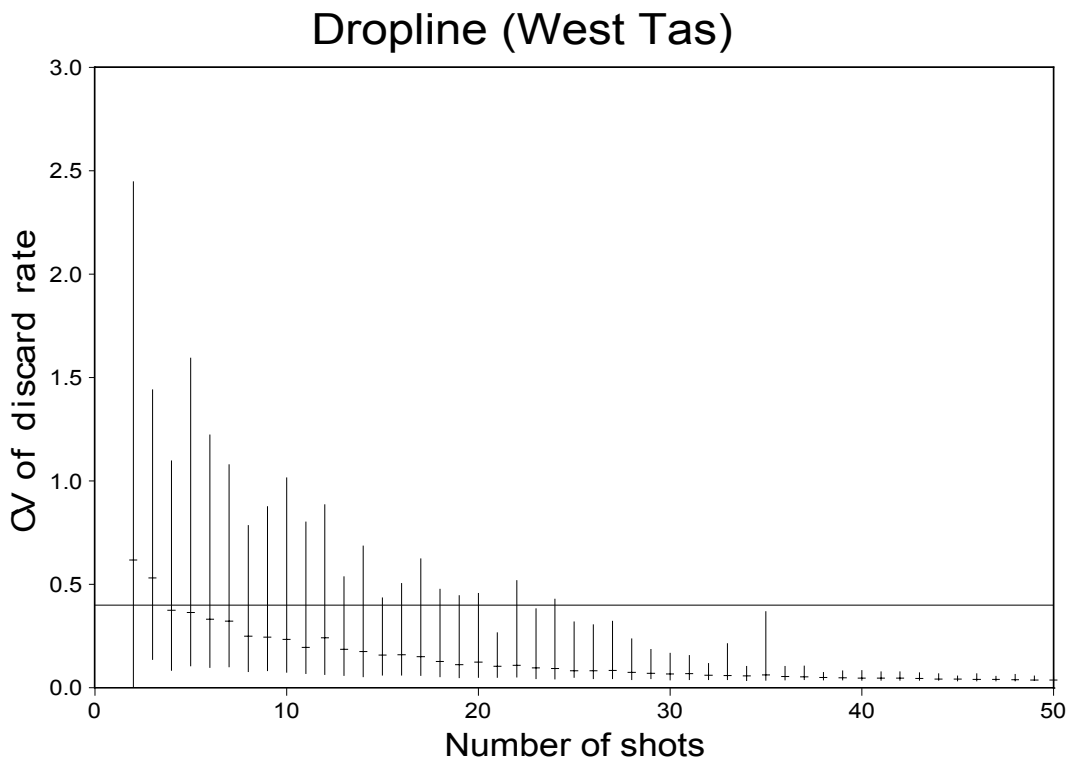

Figure 24 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Dropline (West Tas) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

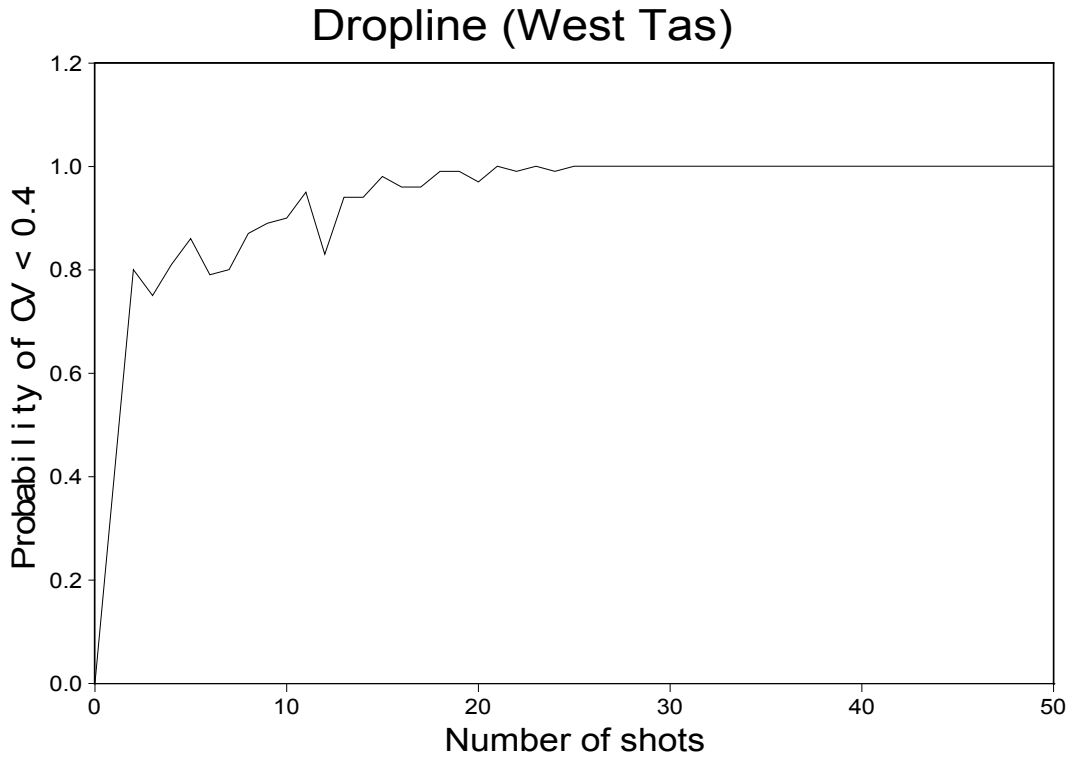

Figure 25 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Dropline (West Tas) stratum.

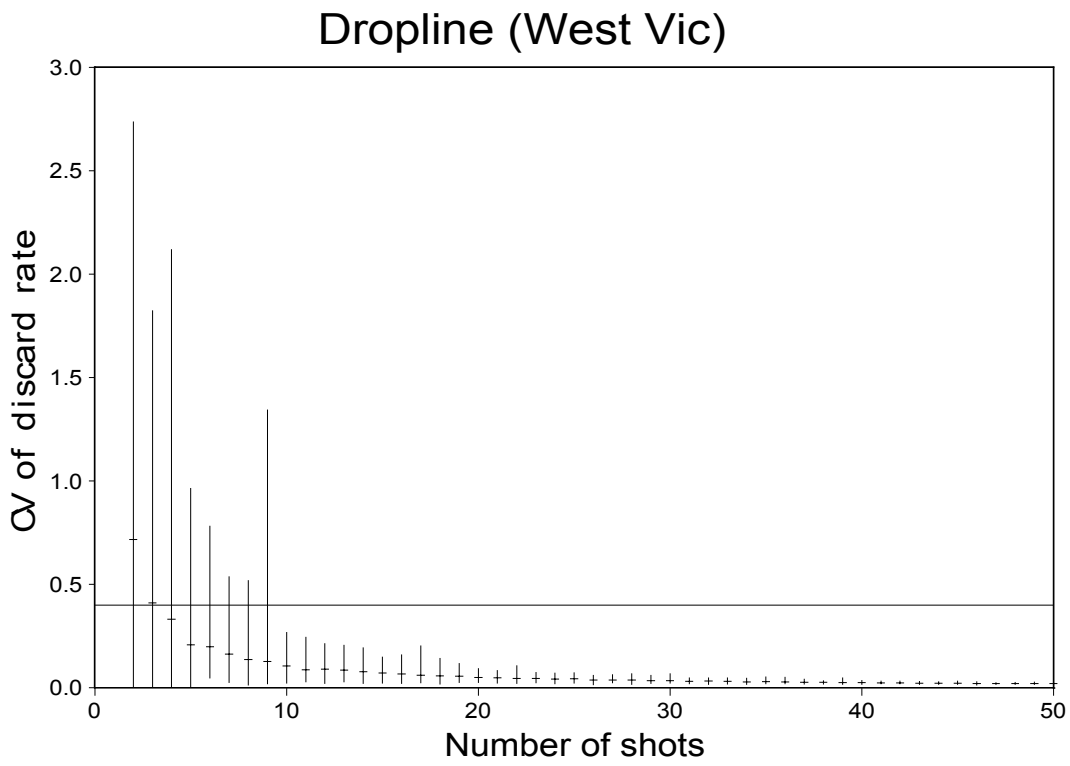

Figure 26 Mean CV (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Dropline (West Vic) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

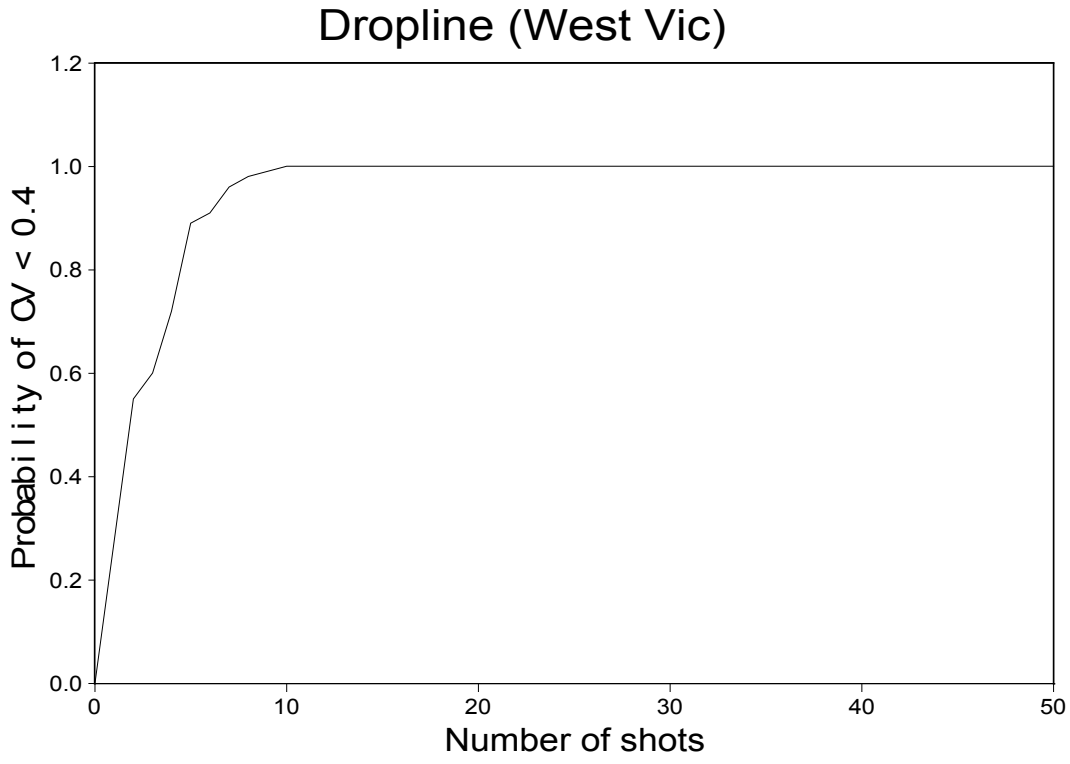

Figure 27 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Dropline (West Vic) stratum.

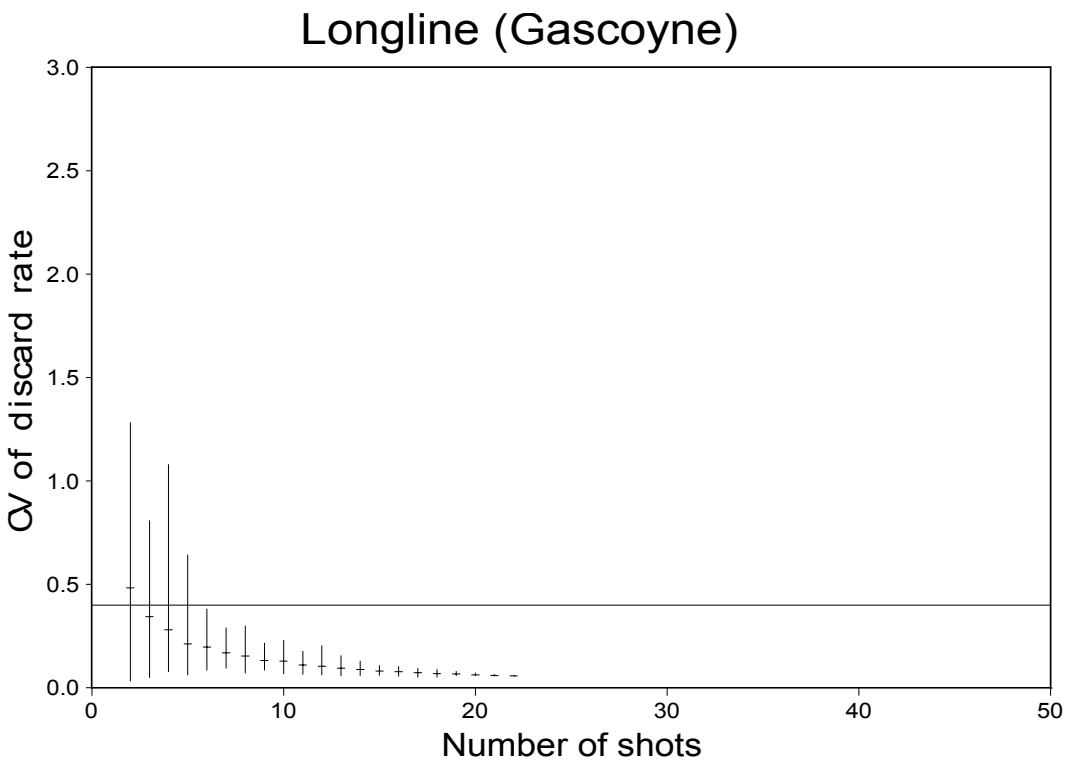

Figure 28 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Longline (Gascoyne) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

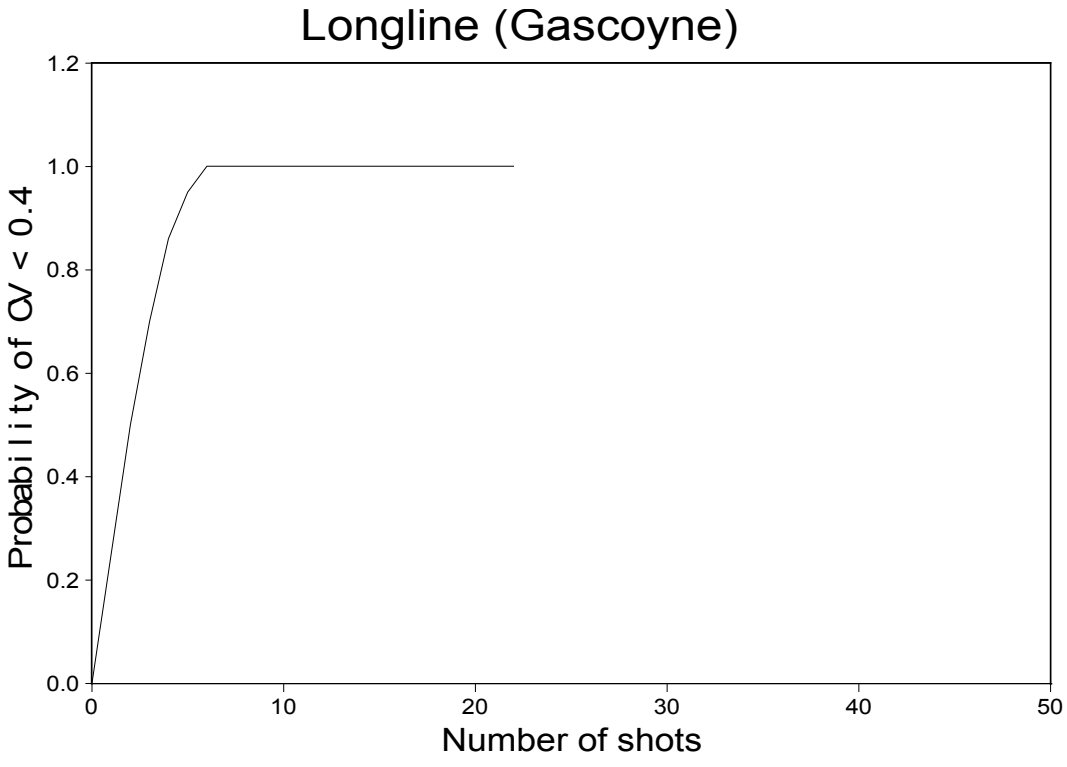

Figure 29 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Longline (Gascoyne) stratum.

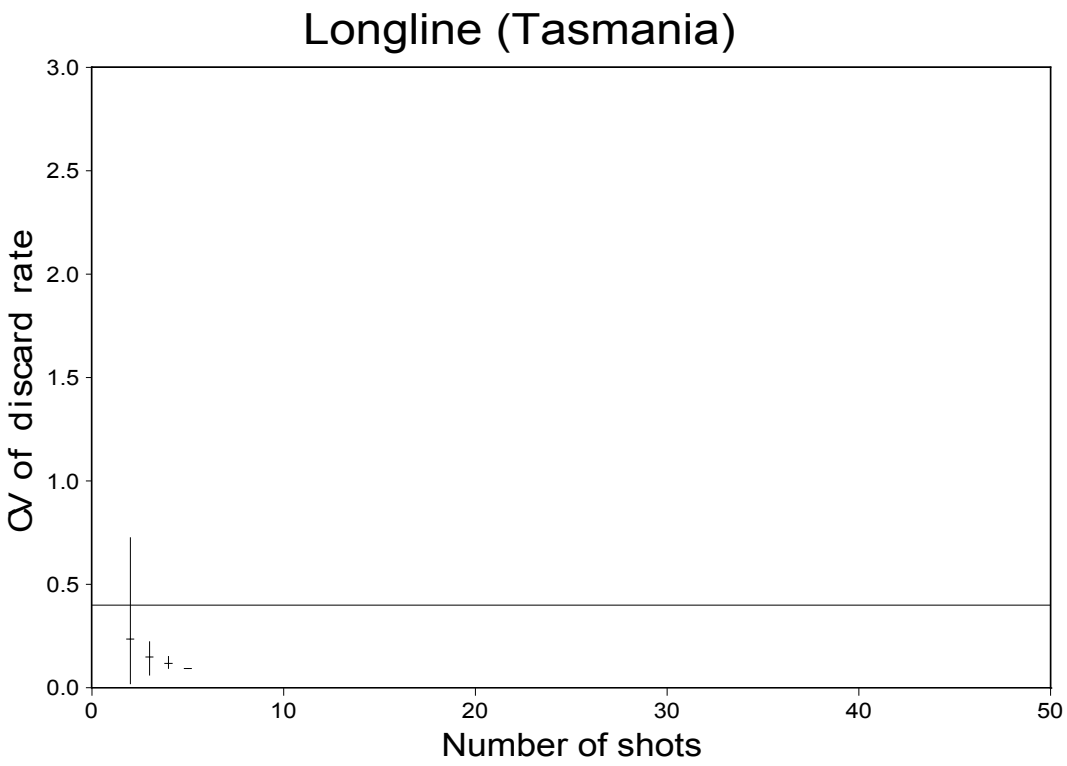

Figure 30 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Longline (Tasmania) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

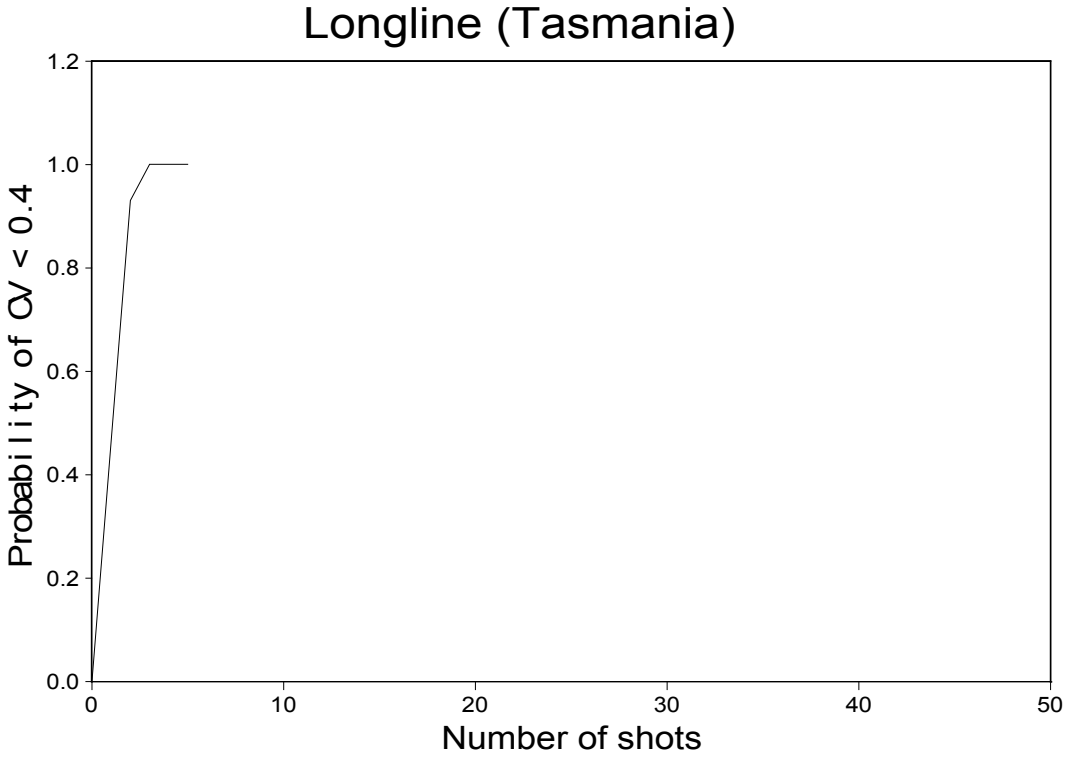

Figure 31 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Longline (Tasmania) stratum.

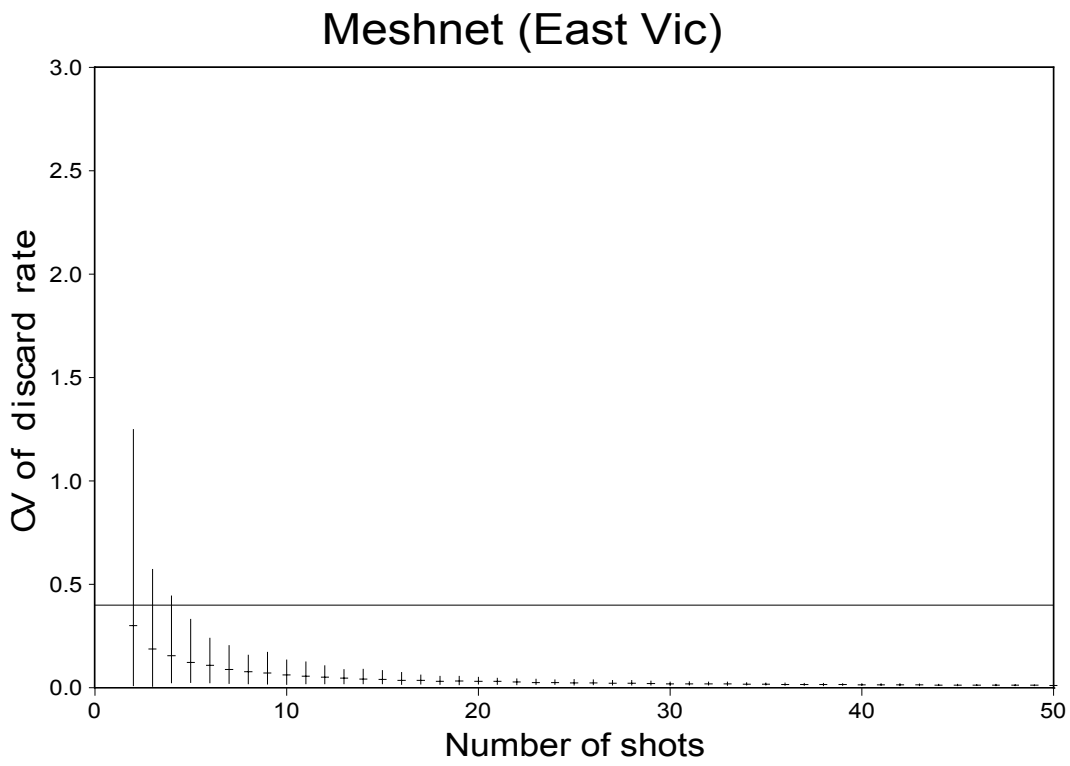

Figure 32 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Mesh-net (East Vic) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

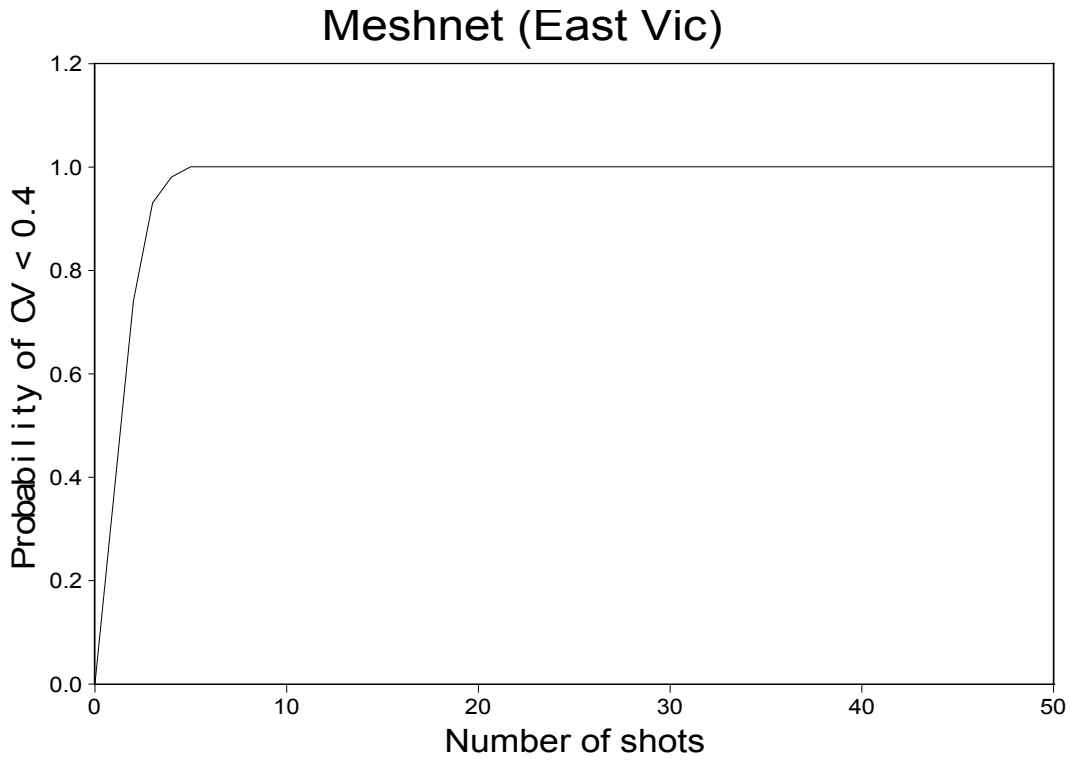

Figure 33 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Mesh-net (East Vic) stratum.

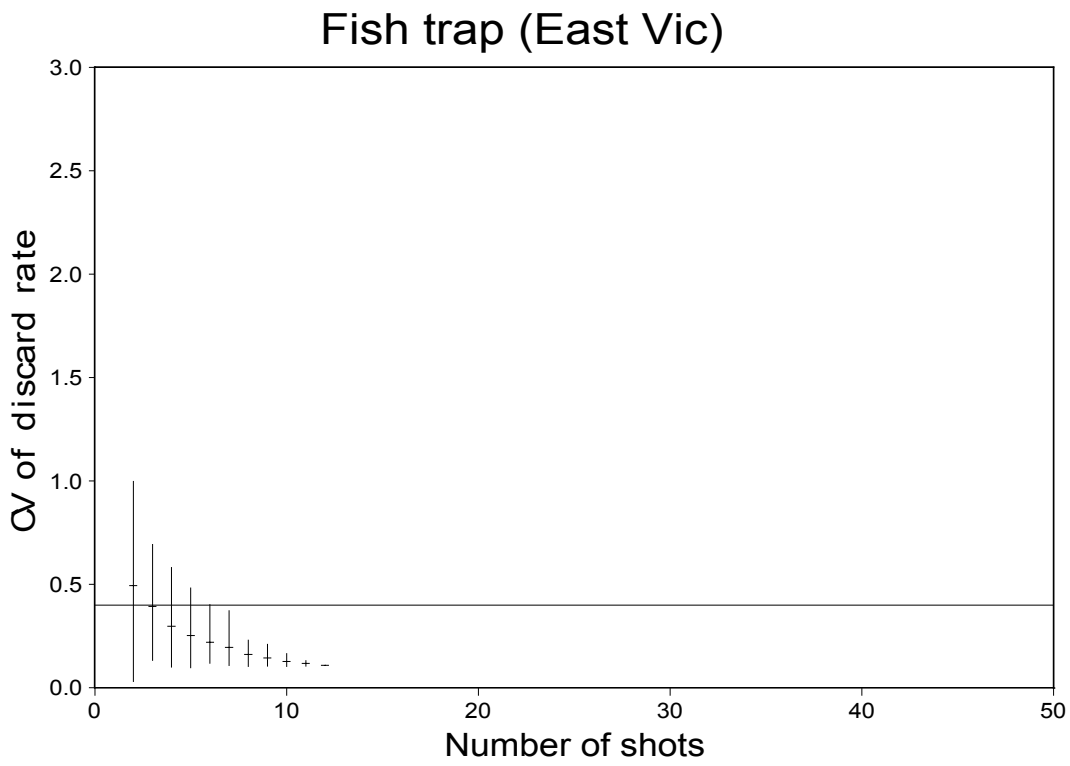

Figure 34 Mean CVs (± max and min) of discard rate of non-defining species against the total number of shots undertaken in the Trap (East Vic) stratum. The horizontal reference line represents a CV of 0.4 – the level designated by AFMA for high discard species.

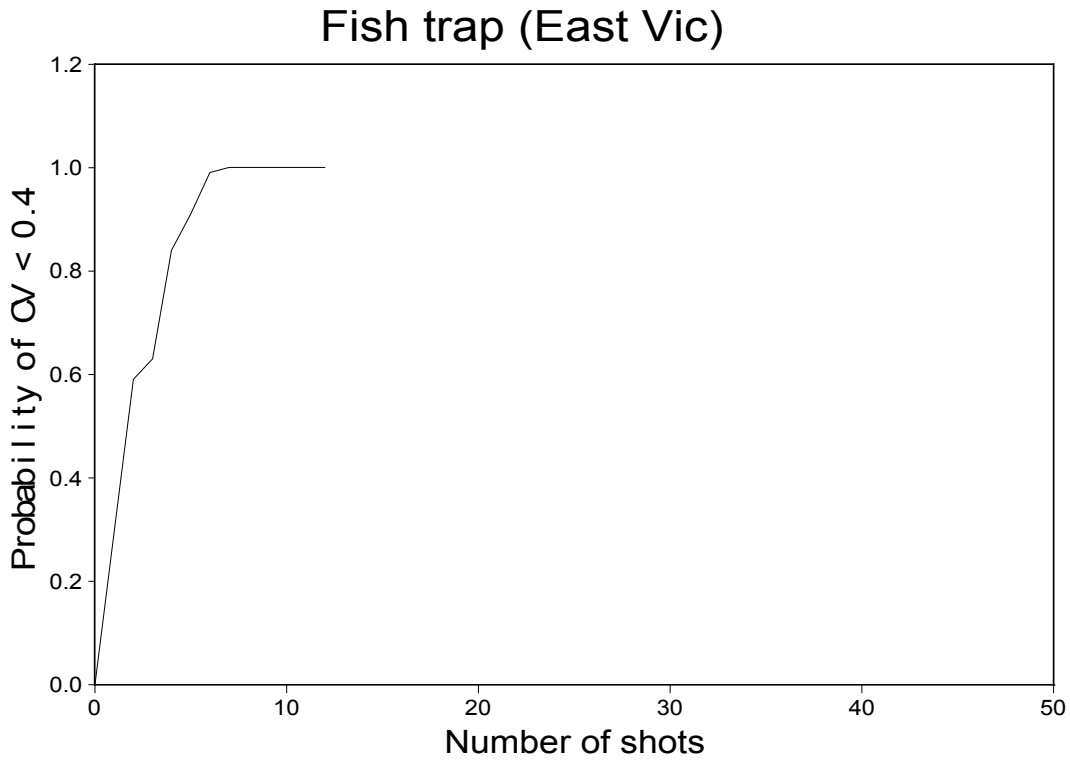

Figure 35 Probability of obtaining a CV ≤ 0.4 for non-defining species against the total number of shots undertaken in the Fish trap (East Vic) stratum.

Appendix 1

Common name, scientific name and CAAB number for species observed in the non-trawl monitoring project.

Species	Scientific Name	CAAB
Alfonsino	*Beryx splendens*	37 258002
Angel shark	*Squatina australis*	37 024001
Banded morwong	*Cheilodactylus spectabilis*	37 377006
Banded sea perch	*Hypoplectrodes nigroruber*	37 311037
Barracouta	*Thyrsites atun*	37 439001
Bastard trumpeter	*Latridopsis forsteri*	37 378002
Black shark	*Dalatias licha*	37 020002
Blue eye trevalla	*Hyperoglyphe antarctica*	37 445001
Blue grenadier	*Macruronus novaezelandiae*	37 227001
Blue mackerel	*Scomber australasicus*	37 441001
Blue warehou	*Seriolella brama*	37 445005
Blue whaler	*Prionace gauca*	37 018004
Broad nose seven-gill shark	*Notorynchus cepedianus*	37 005002
Broad-billed swordfish	*Xiphias gladius*	37 442001
Butterfly gurnard	*Lepidotrigla vanessa*	37 288003
Cookie-cutter shark	*Isistius brasiliensis*	37 020014
Crocodile fish	*Satyrichthys lingi*	37 288030
Cucumber fish	*Chlorophthalmus nigripinnis*	37 120001
Draughtboard shark	*Cephaloscyllium spp.*	37 015013
Eastern black spot pigfish	*Bodianusunimaculatus*	37 384061
Eastern foxfish	*Bodianus sp.*	37 384035
Endeavour dogfish	*Centrophorus moluccensis*	37 020001
Gemfish	*Rexea solandri*	37 439002
Giant boarfish	*Paristiopterus labiosus*	37 367002
Greeneye dogfish	*Squalus mitsukurii*	37 020007
Grey morwong	*Nemadactylus douglasi*	37 337002
Gummy shark	*Mustelus antarcticus*	37 017001
Gurnard, [Unspecified]	*Triglidae*	37 288000
Hapuku	*Polyprion oxygeneios*	37 311006
Imperador	*Beryx decadactylus*	37 258001
Inshore ocean perch	*Helicolenus percoides*	37 287001
Jack mackerel	*Trachurus declivis*	37 337002
Jackass morwong	*Nemadactylus macropterus*	37 377003
John dory	*Zeus faber*	37 264004
King crab	*Pseudocarcinus gigas*	28 925001
King tarakihi	*Nemadactylus Sp.*	37 377014
Knifejaw	*Oplegnathus woodwardi*	37 369002
Long-snouted boarfish	*Pentaceropsis recurvirostris*	37 367003
Mako shark	*Isurus Sp.*	37 01001/2
Melbourne skate	*Raja whitleyi*	37 031006
Mirror dory	*Zenopsis nebulosus*	37 264003
Moray eel	*Muraenidae*	37 060000
Ocean blue eye	*Schedophilus labyrinthica*	37 445014

Appendix 1 contd….

Common name, scientific name and CAAB number for species observed in the non-trawl monitoring project.

Species	Scientific Name	CAAB
Offshore cean perch	*Helicolenus barathri*	37 287093
Orange scorpion fish	*Neosebastes entaxis*	37 289009
Pink ling	*Genypterus blacodes*	37 228002
Platypus dogshark	*Deania calcea*	37 020003
Porbeagle shark	*Lamna nasus*	37 010004
Porcupine fish	*Diodontidae*	37 469000
Port Jackson shark	*Heterodontus portusjacksoni*	37 007001
Prickley dogfish	*Oxynotus bruniensis*	37 021001
Prickly shark	*Echinorhinus cookei*	37 022002
Rays bream	*Brama brama*	37 342001
Red cod	*Pseudophycis bachus*	37 224006
Redbait	*Emmelichthys nitidus*	37 345001
Redfish	*Centroberyx affinis*	37 258003
Ribaldo	*Mora moro*	37 224002
Ringed toadfish	*Omegophora armilla*	37 467002
Rudderfish	*Centrolophus niger*	37 445004
Rusty catshark	*Parascyllium ferrugineum*	37 013005
Sandpaper fish	*Paratrachichthys Sp. 1*	37 255003
Saw tail shark	*Galeus boardmani*	37 015009
School shark	*Galeorhinus galeus*	37 017008
Serpent eel	*Ophisurus serpens*	37 068001
Sharp nose seven-gill shark	*Heptranchias perlo*	37 005001
Silver dory	*Cyttus australis*	37 264005
Skate	*Rajidae*	37 031000
Smooth stingray	*Dasyatis brevicaudata*	37 035001
Snapper	*Pagrus auratus*	37 353001
Southern frostfish	*Lepidopus caudatus*	37 440002
Southern sawshark	*Pristiophorus nudipinnis*	37 023001
Southern whiptail	*Coelorinchus australis*	37 232001
Spikey oreo	*Hoplichthys haswelli*	37 297001
Spikey oreo	*Neocyttus rhomboidalis*	37 266001
Spookfish	*Harriotta raleighana*	37 044001
Spotted warehou	*Seriolella punctata*	37 445006
Stargazer	*Uranoscopus cognatus*	37 400008
Striped trumpeter	*Latris lineata*	37 378001
Swallowtail	*Centroberyx lineatus*	37 258005
Thresher shark	*Alopias vulpinus*	37 021001
Whiptail, [Unspecified]	*Macrouridae*	37 232000
White warehou	*Seriolella caerulea*	37 445011
White-spotted dogfish	*Squalus acanthias*	37 020008
Yellowtail kingfish	*Seriola lalandi*	37 337006

Operational data sheet used for the dropline fishery

VESSEL CODE		RECORDER		DEPARTURE		
				Day	Month	Year

STATION INFORMATION

DROPLINE	Shot No		Date	

POSITION		TIMES eg EDST EST SST		
S-Latitude deg min sec	S-Longitude deg min sec	Search Time hhmm	Set Start Time hhmm	Haul Start Time hhmm

Depth	(m) or (ftms)	Set configuration code	
		Target species	CSIRO code

BOTTOM DETAILS				ENVIROMENT DETAILS				
SUBSTRATUM		TOPOGRAPHY		WIND			SEA	
CODE		CODE		Direction (deg)	Speed(kts)	Cloud Cover (%)	Swell Hgt (m)	Sea Hgt(m)
Temperature □C	Tide Direction	Moon Phase						
SST								

GEAR DETAILS

Bobber	Snood length	No Hooks	Hook Size	Length Dropline	material	Length with hooks	Bait (s)

SHOT DETAILS

VALID SET YES □ NO □ TARGET SET YES □ NO □

		REASON FOR SHOT CODE	
0 Normal Shot		1 Known area	
1Net Pinned		2 Previous Shot(s)	
2 Tide Affected		3 Previous Trip(s)	
3 Gear Damage no obvious fish loss		4 Other vessels	
4 Gear damage some fish loss		5 Obvious marks	
5 Gear damage major fish loss		6 New Ground/Exploratory Fishing	
6 Other		7 Other Advice	
		8 Other	

Catch details Use l/f and catch composition sheets if required

Species	Length (cm)	sex	Retained (Y/N)	Est. weight	Species	Length (cm)	sex	Retained (Y/N)	Est. weight

TOTAL CATCH

Est Total Catch		Est Retained Catch		Est Discards		Est Benthos in Shot	

ESTIMATION METHOD

Data Source		How Estimated			
1 Scientist/ObserverPersonally collected data		1 Eyeball estimate of net by Scientist/ Observer		3 Figure extracted from vessel logbook. Scientist/ Observer not present when net hauled	
2 Captain entered data		2 Calculated by Scientist/ Observer from bin volumes		4 Figure extracted from vessel logbook. Scientist/ Observer present when net hauled	
3 Data extracted from vessel logbook				5 Other	

COMMENTS	PAGE of

Operational data sheet used for the longline fishery

VESSEL CODE		RECORDER		DEPARTURE		
				Day	**Month**	**Year**

STATION INFORMATION

LONGLINE	Shot No		Date	

POSITION **TIMES** eg EDST EST SST

S-Latitude deg min sec	S-Longitude deg min sec	Search Time hhmm	Set Start Time hhmm	Set Finish Time hhmm
F-Latitude deg min sec	**F-Longitude deg min sec**			

Haul from Start		Finish	
	Haul Start Time hhmm		Haul Finish Time hhmm

Depth range	(m) or (ftms)	Set configuration code	
Min	Max	Target species	CSIRO code

BOTTOM DETAILS

SUBSTRATUM		TOPOGRAPHY	
CODE		CODE	

Temperature □C	Tide Direction	Moon Phase
SST		

ENVIROMENT DETAILS

WIND			SEA	
Direction (deg)	Speed (kts)	Cloud Cover (%)	Swell Hgt (m)	Sea Hgt (m)

GEAR DETAILS

Total Length of longline	longline Details				
	No. hooks)	Hook size	Dist. Between hooks	Snood length	Bait
	No. hooks)	Hook size	Dist. Between hooks	Snood length	Bait
	No. hooks)	Hook size	Dist. Between hooks	Snood length	Bait

SHOT DETAILS

VALID SET YES □ NO □ TARGET SET YES □ NO □

			REASON FOR SHOT CODE	
0 Normal Shot			1 Known area	
1Net Pinned			2 Previous Shot(s)	
2 Tide Affected			3 Previous Trip(s)	
3 Gear Damage no obvious fish loss			4 Other vessels	
4 Gear damage some fish loss			5 Obvious marks	
5 Gear damage major fish loss			6 New Ground/Exploratory Fishing	
6 Other			7 Other Advice	
			8 Other	

TOTAL CATCH

Est Total Catch		Est Retained Catch		Est Discards		Est Benthos in Shot	

ESTIMATION METHOD

Data Source		How Estimated			
1 Scientist/Observer Personally collected data		1 Eyeball estimate of net by Scientist/ Observer		3 Figure extracted from vessel logbook. Scientist/ Observer not present when net hauled	
2 Captain entered data		2 Calculated by Scientist/ Observer from bin volumes		4 Figure extracted from vessel logbook. Scientist/ Observer present when net hauled	
3 Data extracted from vessel logbook				5 Other	

COMMENTS PAGE of

Operational data sheet used for the mesh-net fishery

VESSEL CODE		RECORDER		DEPARTURE		
				Day	Month	Year

STATION INFORMATION

MESH		Shot No		Date	

POSITION — **TIMES eg EDST EST SST**

S-Latitude deg min sec	S-Longitude deg min sec	Search Time hhmm	Set Start Time hhmm	Set Finish Time hhmm
F-Latitude deg min sec	**F-Longitude deg min sec**			

Haul from Start		Finish	
	Haul Start Time hhmm		Haul Finish Time hhmm

Depth range	(m) or (ftms)	Set configuration code	
Min	Max	Target species	CSIRO code

BOTTOM DETAILS				**ENVIROMENT DETAILS**				
SUBSTRATUM		TOPOGRAPHY		WIND			SEA	
CODE		CODE		Direction (deg)	Speed (kts)	Cloud Cover (%)	Swell Hgt (m)	Sea Hgt (m)
Temperature □C	Tide Direction	Moon Phase						
SST								

GEAR DETAILS

Total Length of Net Lifted	Gillnet Details			
	Mesh Size (mm)	No of Nets of this Size	Net Length	Mesh No
	Mesh Size (mm)	No of Nets of this Size	Net Length	Mesh No
	Mesh Size (mm)	No of Nets of this Size	Net Length	Mesh No

SHOT DETAILS

VALID SET YES □ NO □ TARGET SET YES □ NO □

		REASON FOR SHOT CODE	
0 Normal Shot		1 Known area	
1Net Pinned		2 Previous Shot(s)	
2 Tide Affected		3 Previous Trip(s)	
3 Gear Damage no obvious fish loss		4 Other vessels	
4 Gear damage some fish loss		5 Obvious marks	
5 Gear damage major fish loss		6 New Ground/Exploratory Fishing	
6 Other		7 Other Advice	
		8 Other	

TOTAL CATCH

Est Total Catch		Est Retained Catch		Est Discards		Est Benthos in Shot	

ESTIMATION METHOD

Data Source		How Estimated			
1 Scientist/Observer Personally collected data		1 Eyeball estimate of net by Scientist/ Observer		3 Figure extracted from vessel logbook. Scientist/ Observer not present when net hauled	
2 Captain entered data		2 Calculated by Scientist/ Observer from bin volumes		4 Figure extracted from vessel logbook. Scientist/ Observer present when net hauled	
3 Data extracted from vessel logbook				5 Other	

COMMENTS	PAGE of

Operational data sheet used for the trap fishery

VESSEL CODE		RECORDER		DEPARTURE		
				Day	Month	Year

STATION INFORMATION

TRAP		Shot No		Date	

POSITION		TIMES eg EDST EST SST		
S-Latitude deg min sec	S-Longitude deg min sec	Search Time hhmm	Set Start Time hhmm	Haul Start Time hhmm

Depth	(m) or (ftms)	Set configuration code		
		Target species	CSIRO code	

BOTTOM DETAILS				ENVIROMENT DETAILS				
SUBSTRATUM		TOPOGRAPHY		WIND			SEA	
CODE		CODE		Direction (deg)	Speed (kts)	Cloud Cover (%)	Swell Hgt (m)	Sea Hgt (m)
Temperature □C	Tide Direction	Moon Phase						
SST								

GEAR DETAILS

Trap details	Bait

SHOT DETAILS

VALID SET YES □ NO □ TARGET SET YES □ NO □

		REASON FOR SHOT CODE	
0 Normal Shot		1 Known area	
1Trap Pinned		2 Previous Shot(s)	
2 Tide Affected		3 Previous Trip(s)	
3 Gear Damage no obvious fish loss		4 Other vessels	
4 Gear damage some fish loss		5 Obvious marks	
5 Gear damage major fish loss		6 New Ground/Exploratory Fishing	
6 Other		7 Other Advice	
		8 Other	

Catch details Use l/f and catch composition sheets if required

Species	Length (cm)	sex	Retained (Y/N)	Est. weight	Species	Length (cm)	sex	Retained (Y/N)	Est. weight

TOTAL CATCH

Est Total Catch		Est Retained Catch		Est Discards		Est Benthos in Shot	

ESTIMATION METHOD

Data Source		How Estimated			
1 Scientist/Observer Personally collected data		1 Eyeball estimate of net by Scientist/ Observer		3 Figure extracted from vessel logbook. Scientist/ Observer not present when net hauled	
2 Captain entered data		2 Calculated by Scientist/ Observer from bin volumes		4 Figure extracted from vessel logbook. Scientist/ Observer present when net hauled	
3 Data extracted from vessel logbook				5 Other	

COMMENTS	PAGE of