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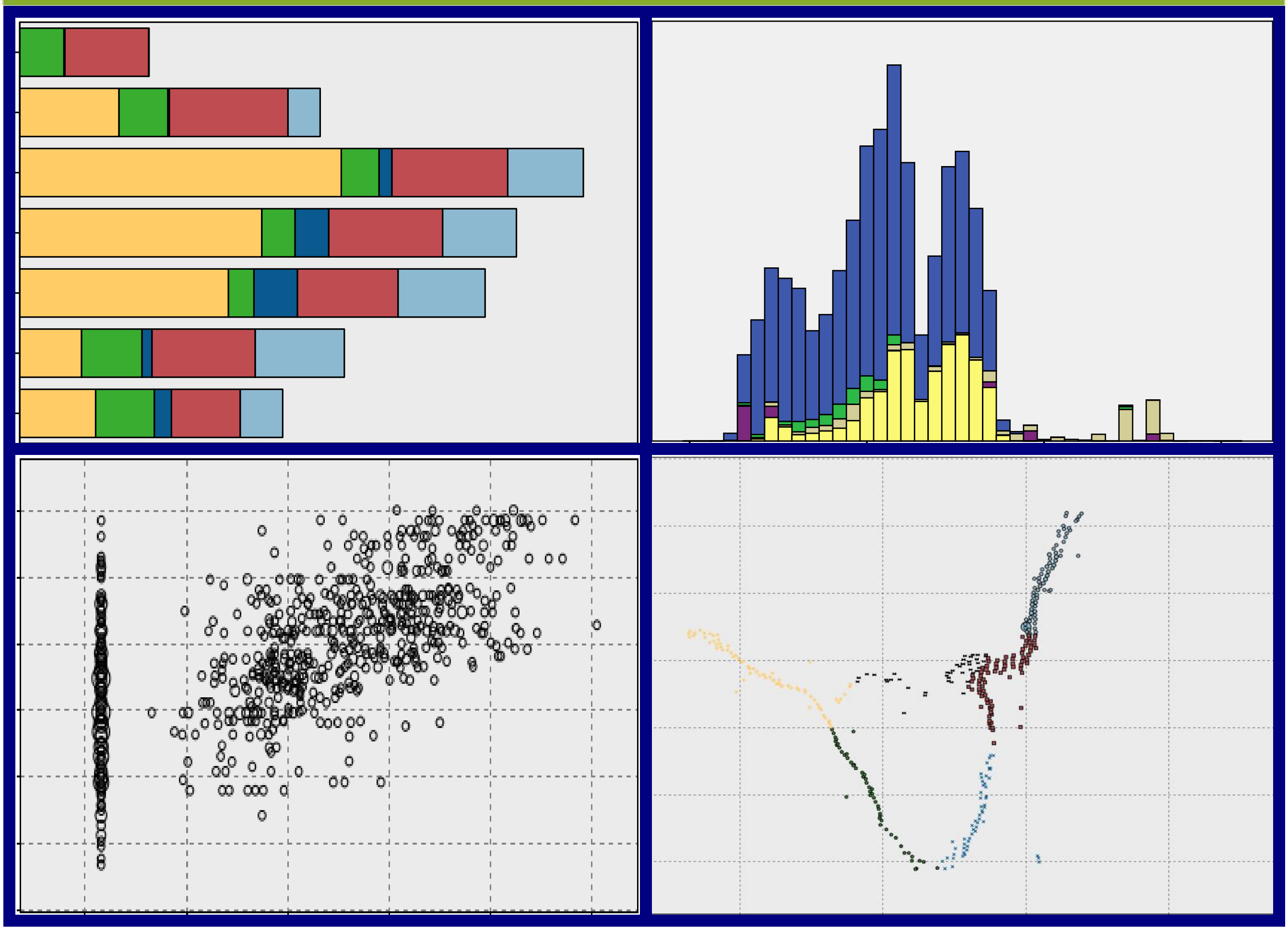
Revised sampling regime for the Southern and Eastern Scalefish and Shark Fishery – Final Report



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2009

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EXECUTIVE SUMMARY

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a complex multi-species, multi-gear fishery which was formed in 2003 from the amalgamation of four different fisheries; the Commonwealth Trawl Sector (CTS); the Great Australian Bight Trawl Fishery (GABTF); the Gillnet, Hook and Trap Fishery (GHATF) and the East Coast Deepwater Trawl Fishery (ECDWTF). Management of the fishery is conducted by the Australian Fisheries Management Authority (AFMA).

Scientific monitoring of the SESSF is an important aspect of the fishery's management. It collects critical information on the age and size structure of the main target species to feed into stock assessments as well as data on species catch composition and vessel interactions with threatened / endangered / protected (TEP) species. There have been various formal scientific monitoring programs on the different sub-fisheries of the SESSF over the last 15 years. The most extensive and long running of these has focussed on the CTS and has been formally designed to collect specific biological information and data on discard rates in the trawl sector as part of the Integrated Scientific Monitoring Program (ISMP). More recently, monitoring programs have been introduced into the various other trawl and non-trawl fisheries under the umbrella of the ISMP, but these have never been formally designed or reviewed. Initially, these monitoring programs focussed mainly on collection of information on the main quota species but over the last decade, the focus and level of monitoring of the fishery has changed to take into account its impact on bycatch/byproduct species and TEP species.

Over the last five years there have been considerable changes to both the structure and size of the SESSF fishing fleet, largely although not entirely as a result of the Commonwealth's Structural Adjustment Package (SAP). The current design of the monitoring program was not established to cover such a level of change in the fishery and may not adequately cover all of the information now required. As a result, there has been a need for a redesign of the SESSF monitoring program that includes all sectors and reflects changed management objectives.

To this end, AFMA funded this study entitled "A revised sampling regime for the Southern and Eastern Scalefish and Shark Fishery". The aim of this study was to undertake a complete redesign of the current ISMP sampling regime for all sectors of the SESSF to ensure that it is representative, effective and statistically robust. To do this, the study was required to consider all sectors of the SESSF and update the monitoring design so that it reflected the current structure of the fishery post-SAP. It needed to review and update stratification of the monitoring program including consideration of various coefficients of variation (CVs) for discard rates and size/age composition of the total catch (retained and discarded) for the SESSF quota species, major non-quota species, other non-quota species and any other species/groups identified by the ISMP Review Committee. Further, it was required to design effective and statistically robust coverage for recording the total number and circumstances of interactions with species identified as high risk through the ecological risk assessment (ERA) process and all TEP species. An important output from the study was the provision of a range of sampling redesign options for the SESSF, including a table of costs outlining what CVs will be achieved with each option and comparison of cost versus precision levels so that AFMA can consider the most appropriate future monitoring of the fishery.

The data used for this report included: logbook catch and effort data; catch landing data; on-board ISMP data; port-based ISMP data; age and length data mainly for SESSF quota species; and data related to interactions with threatened species, including birds, syngnathids and seals.

Data audits were carried out, to assess the various fields involved, their quality with respect to missing values, blanks, empty spaces etc, and their relationship to each other was established for the purposes of the study. A statistical review of previous stratification and sample allocation decisions for the ISMP was carried out with respect to distributional assumptions, stratification considerations and CV estimation and calculation approaches.

A critical difference from the previous design of the ISMP, was that the current ISMP design review was to include, not just estimation of total catch (retained and discarded) for quota species within certain CVs, but also estimation of the total catch and CVs for major non-quota species, other non-quota species, species identified as "high risk" through the ERA process and the interactions with TEP species. This difference required a fundamental change in the analysis and design process, because many of the additional species and species groups are not usually retained in the commercial catch.

To achieve the above, it was necessary to identify which of the 500+ species (or species groups) caught in the SESSF should be included in each of the above categories and reduce these to a workable number of groups termed 'Project Keys'. Obviously, identification of the quota species and species baskets was straight forward. The major non-quota species were identified as the species which, in addition to the quota species, cumulatively accounted for 80% of the total catch for each gear type. All remaining minor non-quota species (not included as high risk or TEP species) were grouped into: Chimaeras, Crustaceans, Dogfish, Echinoderms, Fish, Hagfish, Rays, Sawsharks, Molluscs, Sharks, Stingarees or Other. The above grouping resulted in a total of 68 Project Keys. The ~30 ERA "high risk" species were combined into 7 groups: Teleosts; Sharks; Upper Slope Dogfish; Other Dogfish; Rays/Skates; Molluscs; and Hagfish. TEP species were divided into five species groups: Seals (including sea lions), Sharks, Pipefish, Birds, Whales/Dolphins, and Reptiles (none recorded), of which by far the dominant groups are the seal group and the bird group.

Cluster analyses of the species composition of shots in each sub-fishery of the SESSF were conducted to elucidate appropriate spatial and temporal stratification for the ISMP design. Data on discard ratios were used to carry out additional analyses on these. This process resulted in 24 strata upon which determination of optimal survey designs was based.

Methods employed previously in estimating discard levels in the SESSF involved analysis of the discard proportion for each species at a stratum by stratum level using the landed catch, and then aggregation across strata to obtain an estimate, with associated CV, of a fishery-wide discarded proportion for each species under study. This was reasonable because it concentrated mainly on quota species which were generally retained and had good landings information. The present ISMP design, however, had to encompass a much larger range of species and species groups, many of which are discarded in high proportions. We therefore used a method to estimate the discarded catch mass in each stratum so that fishery-wide mean and variance on total discards could be obtained by simple addition of the stratum means and variances. This required more complexity in the calculation of the stratum-level statistics and these methods are described in detail in the report.

In previous designs, the target precision on discarding has been set in terms of a CV on the discarded proportion with reduced target CVs for increasing discard proportions. In the new design, the target was based on a flat 20% CV on the total catch mass (not discard proportion). Under this target specification, for a single species, the objective underlying optimization of the sample size distribution to strata is relatively simple — to allocate strata so as to minimize the CV for that species. With multiple species groups, however, a number of different objectives are possible depending on the competing requirements for different species. The results are presented under five different optimization methods:

VWCV: minimize the value-weighted average CV over the 68 non high-risk project keys based on the approximate price per kg of the commercial species;

MinS: maximize the number of 68 non high-risk project keys which have CV below the target threshold of 20%.

PROP: simply make an allocation of any given availability of sampling days in proportion to the number of sea-days expended by the fishery in each stratum;

CWCV-HR: minimize the catch-weighted average CV over the 7 high risk project keys; and,

MinS-HR: maximize the number of high-risk project keys which have CV below the target threshold of 20%.

None of the above procedures pre-suppose any particular constraint on total sampling effort available, but each presents a continuum of benefit vs sampling cost from which a sampling level may be selected. Though we recognize that observers will select trips rather than shots, we note also that the cost of observation is dependent on trip length. We thus use the sea-day as the measure of sampling effort.

Analysis of Quota, Non-quota and High Risk Species

The above optimizations have been modeled to show the CVs that are achieved for all 75 project keys based on 250 to 1500 sea-days at 250 sea-day increments. For presentation purposes, the CVs achieved are shown for each project key and have been grouped as:

Good **CV 0 – 20%,** **Medium** **CV 20 – 40%,** **Poor** **CV > 40%**

Of all the commercial allocation methods, method VWCV performed the most poorly resulting in only 40, 47 and 55 non high risk project keys with CVs below 20% for 250, 500 and 1000 sea-days of sampling respectively. In addition, more than 1000 sea-days are required to increase the number of high risk project keys with good CVs from three to four. The method MinS performed better for non high risk species resulting in 52, 59 and 62 project keys with good CVs for 250, 500 and 1000 sea-days of sampling, but performed just as poorly as method VWCV for high risk project keys. Method PROP performed poorly at low sample size (only 46 non high risk project keys had CVs below 20% with 250 sea-days), however performance increased greatly with an additional 250 sea-days where-after it performed nearly as well as method MinS. Method PROP performed well for high risk project keys, with all seven keys having good to medium CVs for 250 and 500 sea-days, and good CVs for 750+ sea-days.

Method CWCV-HR resulted in four of the seven high risk project keys having good CVs for 250–1000 sea-days, but only improves by one high risk project key at 1250–1500 sea-days. Just over half of the 68 non high risk project keys achieve good CVs with 250 sea-days of sampling, and this number increases only slightly with additional sea-days. Even at 1000 sea-days, only 48 non high risk project keys achieve good CVs. This illustrates one of the trade-offs to be made between the differing objectives of the program. Method MinS-HR achieved good CVs for five of the seven high risk project keys, but only 33 of the 68 non high risk project keys with 250 sea-days of sampling. The addition of 250 sea-days results in good CVs for all seven high risk project keys, and vastly improves the number of non high risk project keys with good CVs (to 54 keys), so much so that it is nearly on par with method PROP, and much better than method VMCV. A further increase in sampling to 750 sea-days makes little difference, however with 1000 sea-days, 61 non high risk project keys achieve good CVs.

Method VWCV	**Sea Days**					
	250	**500**	**750**	**1000**	**1250**	**1500**
68 NON HIGH RISK PROJECT KEYS						
Number with CV 20% of below	40	47	50	55	57	57
Number with CV 20% to 40%	17	13	13	10	8	9
Number with CV above 40%	11	8	5	3	3	2
7 HIGH RISK PROJECT KEYS						
High Risk Sharks	6%	4%	4%	3%	3%	3%
High Risk Teleosts	7%	5%	4%	4%	3%	3%
High Risk Molluscs	8%	7%	7%	7%	5%	5%
High Risk Dogfish Other	40%	29%	23%	21%	18%	17%
High Risk Hagfish	33%	27%	26%	25%	24%	24%
High Risk Skates / Rays	42%	35%	33%	25%	24%	20%
High Risk Upper Slope Dogfish	87%	57%	48%	41%	37%	33%

Method MinS	**Sea Days**					
	250	**500**	**750**	**1000**	**1250**	**1500**
68 NON HIGH RISK PROJECT KEYS						
Number with CV 20% of below	52	59	61	62	65	65
Number with CV 20% to 40%	7	6	4	3	0	1
Number with CV above 40%	9	3	3	3	3	2
7 HIGH RISK PROJECT KEYS						
High Risk Dogfish Other	4%	3%	3%	2%	2%	2%
High Risk Hagfish	5%	3%	3%	3%	3%	3%
High Risk Molluscs	8%	7%	7%	7%	7%	7%
High Risk Sharks	28%	27%	27%	27%	16%	16%
High Risk Skates / Rays	46%	25%	25%	25%	25%	25%
High Risk Teleosts	47%	26%	25%	25%	25%	25%
High Risk Upper Slope Dogfish	45%	43%	29%	28%	28%	28%

Method PROP	**Sea Days**					
	250	**500**	**750**	**1000**	**1250**	**1500**
68 NON HIGH RISK PROJECT KEYS						
Number with CV 20% of below	46	56	58	59	60	60
Number with CV 20% to 40%	13	6	5	5	5	6
Number with CV above 40%	9	6	5	4	3	2
7 HIGH RISK PROJECT KEYS						
High Risk Sharks	3%	2%	2%	2%	1%	1%
High Risk Teleosts	4%	3%	2%	2%	2%	2%
High Risk Molluscs	7%	5%	5%	4%	4%	4%
High Risk Hagfish	29%	20%	17%	15%	13%	12%
High Risk Upper Slope Dogfish	31%	22%	17%	15%	14%	12%
High Risk Dogfish Other	33%	23%	19%	16%	15%	13%
High Risk Skates / Rays	33%	23%	19%	17%	15%	13%

Method CWCV-HR	Sea Days					
	250	500	750	1000	1250	1500
68 NON HIGH RISK PROJECT KEYS						
Number with CV 20% of below	36	42	44	48	49	50
Number with CV 20% to 40%	14	12	13	9	10	10
Number with CV above 40%	18	14	11	11	9	8
7 HIGH RISK PROJECT KEYS						
High Risk Teleosts	4%	3%	3%	2%	2%	2%
High Risk Sharks	9%	5%	4%	4%	3%	3%
High Risk Molluscs	9%	6%	5%	5%	4%	4%
High Risk Dogfish Other	16%	11%	9%	8%	7%	6%
High Risk Upper Slope Dogfish	44%	31%	25%	22%	20%	18%
High Risk Hagfish	46%	34%	31%	29%	28%	27%
High Risk Skates / Rays	62%	41%	34%	29%	26%	24%

Method MinS-HR	Sea Days					
	250	500	750	1000	1250	1500
68 NON HIGH RISK PROJECT KEYS						
Number with CV 20% of below	33	54	55	61	64	65
Number with CV 20% to 40%	17	7	9	3	1	1
Number with CV above 40%	18	7	4	4	3	2
7 HIGH RISK PROJECT KEYS						
High Risk Sharks	8%	4%	3%	2%	2%	2%
High Risk Teleosts	12%	6%	4%	4%	3%	3%
High Risk Molluscs	15%	9%	8%	7%	7%	7%
High Risk Hagfish	16%	15%	15%	15%	15%	15%
High Risk Skates / Rays	19%	17%	16%	15%	15%	15%
High Risk Upper Slope Dogfish	25%	19%	19%	19%	19%	19%
High Risk Dogfish Other	93%	18%	18%	18%	16%	16%

We were only provided with very broad figures from which to estimate the cost of the various sampling designs and without additional information it is impossible to accurately determine the costs of any of the sampling designs. To enable a relative comparison of the different designs, we have simply estimated relative costs based on the sea-day requirements alone, at $1000 / per sea-day. This will be the very ***minimum*** cost as it does not take into account travelling time and expenses and any land-day costs, not does it include any port-based data requirements. The actual cost for port-sampling will depend on where the port-based samplers are based and the amount of length frequency data that will be collected at sea, which is dependent on which sampling design is ultimately chosen.

Thus, all that can be provided in this report is an indication of the relative sampling costs, where a sampling strategy requiring 500 days can be estimated to cost a minimum of $0.5 million, whereas one requiring 1500 days will cost a minimum of $1.5 million.

Analysis of fishery-TEP interactions

The collection of information on TEP interactions by previous observer programs was not based on a statistically robust sampling design, but rather during opportunistic sampling while recording estimates of the total weight and size composition of retained and discarded catches. While incidental capture of syngnathids and seals have been recorded in the catch composition since the inception of onboard observing in the former SEF, the ISMP was not required to record all TEP interactions observed (direct and indirect) until 2003.

Development of an optimised ISMP design for TEP species was undertaken at the stratum level for the SESSF, and was based on minimising the variance calculated from:

- the estimated total number of interacting TEP individuals for a particular species group;
- the variance of the mean number of interacting TEP individuals of that species observed for the stratum; and,
- the stratum sizes squared.

A lack of TEP interaction observations in most strata necessitated the introduction of additional underlying 'true mean interactions' (priors) for strata where there were no interactions for the period 2002–2008. Optimum design results are presented with and without allowance for the additional underlying interactions (referred to loosely as 'priors), and with the constraint that the total sampling intensity equals 400 sea-days.

Optimised for each of the five TEP species groups individually, CVs below 20% can be achieved for the bird and pipefish groups, and a CV of 24% achieved for seals. CVs were greater than 60% for the sharks and whales groups without introduced priors and about 120% with priors. Allocation of sampling effort to each stratum based on the average sampling required to optimise CVs for each species group results in higher CVs, but in most cases these increases were only small. CVs for the birds and pipefish groups increased to just above 21% and 19% respectively. A further (but mostly small) increase in CVs resulted from allocation of sampling pro-rata to the shot distribution evident in the fishery. CVs for the birds, pipefish and seals groups increased to 26%, 20% and 30% respectively, and remained at about 130% for both sharks and whales groups.

Results in this section should be treated with caution because of the paucity of data that was available for optimisation of TEP interactions.

No prior introduced	Sea-days=400				
	Birds	Pipefish	Seals	Sharks	Whales
CV when optimised for each group	15%	14%	24%	67%	84%
CV when optimised is averaged for each group	21%	24%	29%	124%	140%
CV when allocated pro rata to the shot distribution	27%	21%	31%	181%	202%

Prior introduced	Sea-days=400				
	Birds	Pipefish	Seals	Sharks	Whales
CV when optimised for each group	17%	16%	24%	120%	120%
CV when optimised is averaged for each group	21%	19%	27%	136%	128%
CV when allocated pro rata to the shot distribution	26%	20%	30%	137%	131%

Length and age sampling

<u>Length</u>

Methods were developed to make it possible to comment on the adequacy of the sampling for length and age. For this purpose it was assumed that the redesign of the SESSF ISMP would be primarily based on the retained and discarded catch information, and hence length– and age–related design considerations are an adjunct to the main drivers of the design. Given that context, the most important design issue considered for length was the trade-off between the number of fish sampled per shot or trip, and the number of shots or trips sampled. Shots are relevant to the at-sea sampling for length, while trip is applicable to the port-based length sampling. While the sampling frame for the sea samples can be approximated as a standard random stratified sampling scheme with infinite population sizes (even though the population sizes are finite), with the strata as defined here for the ISMP, the sampling frame for the port sampling is less easily characterised on that basis. In the first instance the concept strata for port sampling is not the ISMP strata, but rather each trip that is sampled. In that case, the stratum size is related to the total number of fish landed. However, since not all trips are sampled, and since there are apparently no within trip replicates, the applicable sampling frame falls into the class of complex sampling frames. Thus the method developed here, assuming that each trip represents a simple random sample of a length frequency distribution from an infinite population size of trips, is described as a short-cut method. For the port sampling data only, the multinomial within trip variance and the trip-to-trip variance is decomposed so that the implications of different numbers of fish sampled per trip, and trips sampled in total, can be explored. These results suggest that if the total annual number of individuals sampled per year is held constant, then the precision of length frequency estimates is always improved by increasing the number of trips sampled (and of course reducing the number of fish sampled per trip). There are indications that the port-based ISMP data collected during 2007 and 2008 shifted to sampling more fish per trip on fewer trips. This strategy would reduce the precision of length frequency estimates and should be avoided.

The same calculations were not carried out for the at-sea length frequency data, but the same result is extremely likely, i.e. that sampling of length frequencies from more shots will significantly reduce MWCVs for the length frequency distributions, and not the sampling of more fish per shot. Cost considerations obviously impinge on the shot/trip versus fish measured trade-off and the additional expense of more shots/trips is likely at some point to kick-in, but this threshold requires more detailed economic information than was available for this study. It is possible that if increasing the number of shots is much more expensive than increasing the number of fish sampled, then increasing the number of fish sampled per trip is the only economically feasible option. If so, one needs to appreciate that the benefits will be considerable less than 'root N' where N is the total number of fish sampled.

We do provide some information in the text on species specific MWCVs, and how to determine what sample size would be needed to achieve lower MWCVs. It is easy in this output to highlight species where the MWCVs are too large, for either the retained or discarded component of the catch.

The precision of the length frequency distributions from at-sea samples seems most inadequate overall for retained: gummy shark, gemfish, ribaldo. A large number of species from the discarded catch exhibit unacceptably high MWCVs for their length frequency distributions.

For the port sampling data the following species show MWCVs well in excess of 20%: redfish, school shark, blue-eye trevalla, alfonsino.

Age

The adequacy of ageing samples was studied using either the at-sea or port-based length frequency distributions as fixed quantities, and then calculating the MWCV for the age frequency distributions from the cumulation of multinomial error arising from the age-length key proportions and number of fish aged per length class. Assuming that the length frequencies are error free in this way allows one to focus on the errors in the catch age frequencies arising from the age-length key. It is of course acknowledged that the total variance of the age frequency distributions estimates involves both the errors in the length frequency estimates and the age frequency estimates per length class.

This calculation assumes that the age sampling was length stratified, which may not be the case, but the method is regarded as a useful index of the adequacy of age sampling. It is then a simple matter to inspect the output and ascertain where the age sampling needs to be increased or decreased to achieve a particular MWCV — we suggested a target MWCV of 10%, but the calculation is easily adapted to deal with other target MWCVs via the square root of N rule described in the text.

ISMP Data Management

The data pre-processing and analysis phase of this project highlighted that numerous improvements can be made to data collection and storage. The quality of the data available from sampling during 2007 and 2008 was poor with respect to spatial and temporal coverage and consistency compared to previous years. Compounding this problem, these data were also in a different database structure to previous years which made consistency in data extraction difficult. The greatest issue with the data are the inconsistencies in recording of a unique key and species code, both of which imposed difficulties in matching CDR, GENLOG and ISMP data, resulting in inefficiencies, increasing the possibility of errors being introduced and reducing the amount of data available for analysis. It is recommended that a common unique key (such as ‘vessel ID’, ‘trip end date’ and ‘trip end time’) be recorded for every fishing and observer trip, that a shot ID code (such as ‘shot start time’ or ‘shot number’) be recorded in GENLOG and ISMP data, and that the Codes for Australian Aquatic Biota (CAAB) be used as the standard species code in all SESSF fishery datasets. All of these variables are recorded in various databases, but not consistently or adequately enough to allow specific linking between all of the CDR, GENLOG and ISMP databases. The TEP data and databases require significant improvements if they are to support any level of formal analysis in the future.

Additional improvements to data collection and storage were recommended include: creating a validation procedure for GENLOG data entry to reduce errors in start, end and shot dates, standardising collection of TEP interaction data, and increasing the detail of trawl gear specifications recorded.

Improvements recommended will increase efficiencies for future data processing (such as during annual stock assessments), and make these data sets more compatible with other data such as those collected during Fishery Independent Surveys.

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1. Introduction

1.1 The Fishery

Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) is a complex multi-species, multi-gear fishery which was formed in 2003 from the amalgamation of four different fisheries; the Commonwealth Trawl Fishery (CTF); the Great Australian Bight Trawl Fishery (GABTF); the Gillnet, Hook and Trap Fishery (GHATF) and the East Coast Deepwater Trawl Fishery (ECDWTF). The area of operation covers almost half of the Australian Fishing Zone (see Figure 1), ranging from 24°30'S off Queensland to Cape Leeuwin in Western Australia and from shallow coastal waters to depths of over 1000 m. The SESSF caught approximately 22,000 t of fish during 2007 with a gross production valued at around $96 million during the 2006–07 financial year (Morison, 2008). More than 100 species of finfish and invertebrates are routinely taken in the SESSF, supplying most of the fresh fish for markets in NSW, Victoria, Tasmania and South Australia, and some product for the export market.

Output controls on the trawl sector of the SESSF were first introduced in 1988 when a total allowable catch (TAC) was set for eastern gemfish. TACs were set for orange roughy in 1990 and a further 15 species or species groups in 1992 (blue-eye trevalla, blue grenadier, blue warehou, flathead, western gemfish, jackass morwong, John dory, ling, mirror dory, ocean perch, orange roughy, redfish, royal red prawn, school whiting, silver trevally and spotted warehou). Since then, more species or species groups have been allocated TACs, and with amalgamation with the three other sectors, there are now 34 species or species groups subject to TACs in the SESSF. These 34 species or species groups comprise about 80% of the fisheries total catch (Morrison, 2008). Other output controls include prohibited species and trip, bycatch and size limits for some species. Input controls used to manage the fishery include limited entry, gear restrictions and some area closures.

1.2 Bycatch and Discarding

Fisheries bycatch and discards have received considerable worldwide attention with concern expressed over potential ecological effects, interactions with other fisheries and perceived wastage (e.g. Saila 1983, Alverson et al. 1994, Murawski 1996, Mace 1997, Hall et al. 2000), and a recent review of discards in the world's marine fisheries estimated that approximately 8% of fish caught are discarded (Kelleher 2005). While Kelleher (2005) reported that trawl fisheries only accounted for about 22% of the global landings, they accounted for more than 50% of the total estimated discards. For stock assessment it is crucial that the total catch is estimated as this may be considerably higher than the landed catch (Howell and Langan 1987, Hilborn and Walters 1992, Alverson et al. 1994).

Methods to estimate the discarded portion of the catch usually involve at-sea observations (Howell and Langan 1987, Atkinson et al. 1994, Gerrior et al. 1994, Murawski et al. 1996, Smith et al. 1997), but alternate methods have also been developed (e.g. Casey 1996). Port-based sampling of commercial landings for both size and age are also important components for monitoring the landed catch.

1.3 Monitoring in the SESSF

Catch monitoring in the then South East Fishery (SEF) began towards the end of 1992 by the Scientific Monitoring Program (SMP), after the introduction of TACs prompted concerns that they would lead to an increase in discarding (as argued by Tilzey, 1994). The SMP was implemented by the Bureau of Resource Sciences (BRS) to collect data on catches in the South East Trawl Fishery with the primary objective to provide information (including discards and bycatch) for stock assessment of the Commonwealth managed fisheries.

Participants in this project were AFMA, BRS, CSIRO, Industry and State fisheries agencies from NSW, Victoria and Tasmania.

A review of the SMP in 1995 recommended that the various elements of the SMP should be combined into a single integrated program, an Integrated Scientific Monitoring Program (ISMP). The term "Integrated" for the purposes of this program was given to mean the monitoring of trawler catches at-sea, landed trawl and non-trawl catches and the inclusion of fishing activities / catches from NSW ports north of Eden, where as previously these ports were not covered.

In September 1995, a meeting was held between AFMA and the research agencies involved in the SMP, to discuss objectives and design for an interim ISMP for 1996 and 1997. AFMA agreed to undertake a co-ordination role for this program. In October 1995, BRS, NSW Fisheries Research Institute and the Marine and Freshwater Research Institute (MAFRI) Victoria were contracted to undertake the interim ISMP on behalf of AFMA. This program did not include at-sea monitoring of the South East Non Trawl Fishery (SEFNT).

In July 1996, AFMA sought tenders for the design of a new ISMP for the SEF. In August 1996 the National Institute of Water and Atmospheric Research Ltd New Zealand (NIWA) and MAFRI were jointly contracted to design a new ISMP for the fishery. Final design of the new ISMP was received by AFMA in May of 1997 and submitted to various independent reviewers for comment. Comments from reviewers were received in early June 1997 and a meeting between key design people and various reviewers was held in late July 1997. As an outcome of this meeting the statistical design of the program (Smith et al. 1997) was accepted, however there were concerns about the lack of detail relating to the practical implementation of the program. Reviewers acknowledged that the presentation of detailed operational procedures in the design report was not part of the agreed project brief. It was agreed that there was a need for this level of detail and that it should be addressed as part of the tender process.

MAFRI submitted the successful tender and conducted the ISMP from 1998 to mid 2000. In April 2000, AFMA again sought tenders to undertake the ISMP in the SEF for a further three years, including two additional strata – East Coast Deepwater Zone and the Victorian Inshore Trawl.

It was recognised that in a complex and dynamic fishery such as the SEF, any revision of the sampling design would need to be undertaken on a regular basis to ensure that the monitoring program adequately sampled the fishery, yet the ongoing process needed to be relatively automated to minimise the costs involved (Knuckey and Gason, 2001). This 'adaptive survey design strategy' used past information as well as the most recent logbook and ISMP data to revise the ISMP sampling strategy on an annual basis. This sampling design has since been used to annually monitor discards in the fishery (see Talman et al., 2003; Talman et al., 2004; Koopman et al., 2005; Koopman et al., 2006; Koopman et al., 2007).

In contrast to the trawl sector of the SEF, there was limited information available on the non-trawl sector (SENTF) prior to 2000. To obtain the information necessary to design a sampling strategy for the SENTF, a pilot study was undertaken by MAFRI from 1999 to 2000. Based on the results of this project (Knuckey et al. 2001), the SENTF was stratified by gear and region, and the discard rates and associated coefficients of variations (CVs) of important species were estimated. Simulation modelling was undertaken to determine the number of shots within each stratum that would be required to achieve these target CVs. Discard rates for most of the main target species in each stratum were found to be low or non-existent. As a result, the ISMP only needed to undertake a low-level sampling regime to achieve target CVs for discard rates and adequately represent the spatial and (to a lesser extent) temporal characteristics of the catch composition from the different non-trawl methods. Based on feedback from South East Non-Trawl Management Advisory Committee (SENTMAC), on-board observer days were allocated to monitor the different fishing methods in the five zones of the South East Non-trawl Fishery. MAFRI conducted the ISMP for the SENTF for the two years 2001–02 and 2002–03.

MAFRI conducted an FRDC-funded pilot study in the Great Australian Bight Trawl Fishery (GABTF) from 2000 to 2001. This study assessed and quantified bycatch in the GABTF and collected additional biological information for major species. Upon completion of the project in June 2001, industry, scientists, AFMA and other stakeholders felt it was necessary to continue monitoring the fishery through an onboard observer program. At Industry's request, MAFRI has conducted the ISMP for the GABTF for the two years 2001–02 and 2002–03.

During 2003, Primary Industries Research Victoria (PIRVIC – previously MAFRI), successfully applied for a further three year tender to conduct the ISMP for the trawl, Great Australian Bight and non-trawl sectors. PIRVIC carried out this work until December 2006. AFMA decided to bring the ISMP 'in-house" during 2006 and has done so since January 2007.

Over the last five years there have been considerable changes to both the structure of the SESSF fishing fleet (largely although not entirely as a result of the Structural Adjustment Package) and the expectation of the focus and level of monitoring of the fishery to take into account its impact on high-risk bycatch/byproduct species and threatened / endangered / protected (TEP) species. The current design of the ISMP was not established to cover such a level of change in the fishery and may not adequately cover all of the information now required. As a result, there has been a need to call for a redesign of the SESSF monitoring program that includes all sectors and reflects changed objectives of the management needs.

2. Objectives

The following sets out the objectives for the entire study.

Undertake a complete redesign of the current ISMP sampling regime for all sectors of the SESSF to ensure that it is representative, effective and statistically robust including consideration of the following requirements:

(a) Update the ISMP sampling regime to reflect changes to the fishing fleet and fishing practices in the SESSF since the Australian Government's "Securing our Fishing Future" structural readjustment package as well as the inclusion of the Gillnet and Shark hooks sector to the SESSF in 2003. In addition, incorporation of any new data sources should be considered including those identified by the ISMP Review Committee.

(b) Review and update the stratification and various coefficients of variation (CVs) within the current sampling design in light of changes to the fishing industry and to develop new CVs and sampling regime for monitoring of the shark fishery, interactions by fishing operators with threatened, endangered and protected (TEP) and high risk species.

(c) Review and update the stratification and various coefficients of variation (CVs) within the current sampling design in light of changes to the fishing industry and to develop new CVs and sampling regime for monitoring of the shark fishery, interactions by fishing operators with threatened, endangered and protected (TEP) and high risk species.

(d) Review and update the stratification and coefficients of variation (CVs) within the current sampling design for the size/age composition of the total catch (retained and discarded) for selected (quota) species.

(e) Update the ISMP sampling regime to provide effective and statistically robust coverage for estimating the total catch (retained and discarded) through at sea and in port sampling of species, caught by all sectors of the SESSF, specifically:

(i) quota species;

(ii) major non-quota species;

(iii) other non-quota species;

(iv) any other species/groups identified by the ISMP Review Committee.

(f) Update the ISMP sampling regime to provide effective and statistically robust coverage for recording the total number and circumstances of interactions (including the life status at the time of the interaction) by all sectors of the SESSF with species identified as:

(i) high risk through the ecological risk assessment process;

(ii) TEP species (not identified as high risk through the ecological risk assessment process).

(g) Incorporate into the ISMP sampling regime the collection of additional information relevant to fishing trips/operations including:

(i) fishing gear type used on fishing trip/operation including any gear modifications;

(ii) use of mitigation tools used during fishing trip/operation including any mitigation tool modifications;

(iii) the level of observer coverage during the fishing trip/operation;

(iv) offal management systems in place during the fishing operation/trip;

(v) other significant fish trip related information.

(h) Provision of a range of sampling redesign options including a table of costs outlining what CVs will be achieved with each option – cost vs. precision levels will determine the size of the sampling program.

3. General Methods

3.1 Data gathering

All data relevant to the revision of the sampling regime was gathered. Such data included information pertaining to the following fisheries:

- Commonwealth Trawl Sector (including the Victorian Inshore Trawl)
- Gillnet, Hook and Trap Sector
- East Coast Deep Water Sector

- Great Australian Bight Trawl Sector

For each of these fisheries the data types comprised, where available (also see Appendix A):

- Catch and effort data
- Catch landing data for quota species
- On-board ISMP data
- Port based ISMP data
- Central Ageing Facility age and length data sets for SESSF species (as mentioned in page 4 of "ISMP EOI List of Docs – Final.doc")
- Various shark databases (as mentioned in Page 4 of "ISMP EOI List of Docs – Final.doc")
- Data related to interactions with threatened species, including birds, syngnathids and seals
- Data from Fishery Independent Surveys (FIS)

3.2 Data reconciliation

For all of the data, it was necessary to establish basic data connections and relationships (i.e. adequate digital reading of the data), as well as establishing a means to allocate data to strata, either strata used in ISMP studies historically, or candidate ISMP strata for consideration during the execution of the study. The identification of strata and variables for which CVs are to be estimated will involve certain critical data in the various datasets supplied.

For all data, data audits were carried out, to assess the various fields involved, their quality with respect to missing values, blanks, empty spaces etc, to determine how they are related to each other and to the objectives of the study.

Relation links had to be established between the different tables of relational databases as and when required.

Where required, disparate databases were merged on a sensible basis (e.g. port level data with at-sea level data), using the best methods available based either on a logical analysis of the situation, and/or guided by past practice for similar previous studies.

3.3 Statistical review

Parallel with the process of data reconciliation referred to above, a statistical review of previous stratification and sample allocation decisions for ISMP studies was carried out.

This review comprised

- Distributional assumptions
- Stratification considerations
- CV estimation and calculation approaches

The primary references were Knuckey and Gason (2001) and Smith et al. (1997), which document the reasoning behind previous sample designs and/or redesigns. Note that these studies were based on the 'main species' caught, while the EOI for this study specifically asked for CVs to be reported for 'other non-quota species' and 'any other species/groups identified by the ISMP Review Committee'. This requirement broadened the study beyond the scope of Knuckey and Gason (2001) and Smith et al. (1997).

Knuckey and Gason (2001) also base their design predominantly on discard rate (expressed as a proportion of the total catch coming up in the gear) and length frequency CVs, whereas we note that the EOI specifically states that CVs (and hence design requirements) need to be included for the retained catch as well.

The methods in Knuckey and Gason (2001) use a non-parametric re-sampling approach to the calculation of the distribution of the design variable of interest (e.g. the discard %). Although not reported here, this study explored the merits of the non-parametric bootstrap, and although this method, as well as a method based on the binomial distributions and its derivatives (the beta distribution and the beta prime distribution), showed considerable promise, particularly for the treatment of shot to shot correlations within trips, we eventually relied more heavily on a simpler approach using the sample variance information in the historic ISMP data, and only in certain cases did we rely on the beta distribution and the beta prime distribution.

Documentation available as part of the EOI made reference to certain minimum CVs that were treated as targets in the development of optimal ISMP designs. There was a lack of clarity, however, in the EOI with regard to the unit to which a given CV requirement is applicable, whether to a zone, a fishery, or all fisheries for a given stock/species. Proposals for the treatment of these issues are made in this document.

Not all sub-fisheries in the SESSF which are part of this study have been included in the ISMP process to date. For those that have, it was necessary to review the arguments for the stratification schema adopted in the past, and consider whether revisions are appropriate. For those that have not, the merits of stratification needs to be considered. The latter includes East Coast Deepwater, shark gillnet and Vic Inshore Trawl.

3.4 Statistical analyses

Following on from the statistical review, the capability to calculate CVs for desired quantities at the desired level of resolution (e.g. zone, fishery, or all fisheries for a given stock/species) was developed, essentially for the following three data types:

1. Discarded catches
2. Age and length frequency distributions
3. Interactions with TEP species

We note that the EOI specifies that the following species groups should be included in the development of robust sampling designs:

- Group 1: Quota species
- Group 2: Major non-quota species
- Group 3: Other non-quota species
- Group 4: Any other species/groups identified by the ISMP Review Committee
- Group 5 (nature of interactions): Species identified as high risk through the ecological risk assessment process.
- Group 6: TEP species (not identified as high risk through the ecological risk assessment process).

This list significantly expands the scope of the design compared to the work reported in, for example, Knuckey and Gason (2001).

One of the first steps in the analysis of the relevant data therefore involves identifying species that should be included in the analyses at a species level, and others that should be dealt with at the level of a group of species.

The ultimate aim is to be able to show the impact of including each species or species group in consideration of the optimal design, in sequential fashion. It seems likely that expanding the study from species groups 1 and 2, to include groups 3 to 6 will significantly expand the sample size requirements. In such a situation we expect that management will need to understand how the progressive expansion of the scope of the study impacts on sample sizes.

3.5 Collection of additional relevant information

The EOI sets out some additional requirements that need to form part of this study, namely

"Incorporate into the ISMP sampling regime the collection of additional information relevant to fishing trips/operations including:

1. fishing gear type used on fishing trip/operation including any gear modifications;
2. use of mitigation tools used during fishing trip/operation including any mitigation tool modifications;
3. the level of observer coverage during the fishing trip/operation;
4. offal management systems in place during the fishing operation/trip;
5. other significant fish trip related information."

3.6 Discarded catch amount

Clearly the discarded catch can only be determined from the at-sea ISMP sampling data (perhaps supplemented by survey data). For quota species, a stratified mean discard % can be calculated, and then applied to the total (by fishery) catch for quota species. Smith et al (1997) provides a basis for the estimation of the CV of the stratified mean discard %, and although there is no reason to question this, the statistical arguments underlying this were reviewed. The stratification schema also needs to be reviewed in light of the requirement that strata, in order to have any utility, need to reflect common discard patterns.

For non-quota species, the discarded catch can also only be determined from the at-sea ISMP sampling data (again possibly supplemented by survey data). A similar procedure to that described above for estimating discarded quota species catches is implemented to estimate the discarded non-quota species catches. This process was reviewed.

3.7 Retained and discarded length frequency distributions

The "Statement of Requirements" is not prescriptive about exactly which species need to be included in the sample redesign from the perspective of length frequency distributions. However, since the requirement does specify a need to review and update the existing ISMP, we take as our direction the current practices followed in ISMP for species sampled. This practice is to take length measurements for quota species.

3.8 Sampling for Age

The requirements for assessing the adequacy of sampling with respect to age distributions appear to involve, at a minimum, updating the work reported in Krusic-Golub and Gason

(2006, see Appendix 6 of Final report on ageing work on key SESSF species from the 2006 sampling year). Krusic-Golub and Gason's (2006) MWCV calculations cover the uncertainty in the final age distribution assuming a given true length frequency, and assuming correct ageing. The main source of error thus arises from the distribution of age classes found in each length class, in the case where age-length keys (ALKs) are used. Alternatively, if a straight age distribution is based on a random sample, then the variability is due to that distribution. Krusic-Golub and Gason (2006) also limit their simulations to scaling the overall sample up or down, and do not explore the possibility of alternative sample allocations across length classes in the case of ALKs. The work reported here is an update of the work in Krusic-Golub and Gason (2006).

3.9 Interactions with TEP species

There is a requirement in the request for EOI to develop new CVs and a sampling regime for monitoring interactions by fishing operators with threatened, endangered, protected (TEP) and high risk species. For this we studied the precision of the estimates of number of shots interacting with TEP species and number of animals involved in those interactions in the framework of either a binomial distribution or a negative binomial distribution. The former would be suitable for data where an event either does or does not occur linked to a fishing activity like a shot (e.g. whales were present) while the latter would be appropriate where the counts of numbers of individuals associated with a shot was recorded (e.g. 23 whales were present at the time of the shot).

3.10 Port based sampling versus at-sea sampling

As an "integrated" monitoring program, the design of the ISMP includes both on-board and in-port monitoring. The at-sea component of the ISMP provides size distributions for retained and discarded catches by strata and other information which can only be collected at-sea (TEP interactions, fishing practices etc). This information can be supplemented by port-based sampling during which length frequency and age data on the retained catch and species composition can be collected in a more cost effective manner. The potential benefits of using port-based monitoring to supplement information collected at-sea was considered in the redesign of the ISMP.

4. Interim Report

An Interim Report was provided to AFMA on 9th July 2009. AFMA provided feedback on the interim report in late August 2009, which has been used to modify some of the methodology presented in the interim report.

The timelines of this study were such that not all of the available data could be analysed for the Interim Report. However, this final report incorporates all known and available logbook, catch landing and ISMP data up to and including 2008.

The issues that AFMA addressed in their feedback on the interim report are as follows, with a summary of the responses that were made:

4.1 CV based on total catch

The question of (b) the appropriate method to be used to infer discard tonnages based on the ISMP records and (b) the precise definition of target levels of precision, was raised in the interim report. Past practice (refer previous ISMP annual reports or design studies) focus on the 'discard rate' d as the quantity of interest, where d is discarded divided by total catch. However, it is $d/(1-d)$ which must be multiplied by the retained catch in order to estimate the discarded tonnages from the catch disposal records, and the variance of the quantity $d/(1-d)$

becomes very large for large *d*. The interim report thus proposed that considering that the ultimate purpose was to quantify the 'total catch' including discards, it is more sensible to use statistical targets expressed as a C.V. on the total catch per se (previous ISMP studies refer to a C.V. on d as a target precision level). An important need for this change has been that, compared to previous designs, the current redesign must consider many more species or species groups (other than quota species) that are largely or completely discarded and otherwise not well identified or recorded in logbook data. This proposal was accepted by AFMA and others consulted about the interim report.

4.2 Stratification proposals

The stratification proposals made here are to stratify the GAB by depth, but not into longitude groups. For the GHAT, the proposal is to use the zones of the SET as a geographic zonation, although no zonation west of 138 degrees longitude is proposed. We note that the stratification presently in use (AFMA Observer Program: ISMP Progress Report, Progress report for May 2009) is somewhat different, for example it includes a longitudinal split for the GAB (far West, West, Central and East), and it has a similar but slightly different zonation for the GHAT including some additional spatial stratification west of 138 degrees longitude. The 2007/2008 ISMP data are quite few and probably insufficient to argue between the zonation proposed in this document and the zonation reported in the AFMA report referred to above. Any feedback on this matter would be valuable, such as overriding issues underlying the stratification in the AFMA 2009 document referred to above. AFMA requested that for the GHAT, the strata be established in accordance with existing practice, and this change is thus incorporated into the final report. Some reservations were expressed about the shift from longitudinal to depth splits for strata in the GAB, however no clear position was expressed in relation to this. This final report thus uses the depth-wise strata for the GAB.

4.3 Grouping of species

Another area where feedback was sought in the interim report was the way that species were grouped for the purpose of the interim report. In that work, the 500+ species that are at times recorded in the SESSF fishery, were reduced to a number of groups termed 'project keys'. The 'project key' is the same as a species designation for the major quota species and for important non-quota species, but thereafter species are grouped into broad taxonomic groups for all calculations and results. In all, species which are subject to capture are represented by 73 species and/or groups, the 'project key'. In addition, 5 species groups were defined for threatened, endangered or protected (TEP) species (Seals (Sea Lions included), Sharks, Pipefish, Birds, Whales/Dolphins, Reptiles (none recorded)), of which by far the dominant groups are the seal group and the bird group (from the point of view of species involved in interactions with fishing gear). The analyses looked at TEP species from two points of view (a) the number of shots involved in an interaction with TEP species and (b) the number of individuals for a TEP species involved in an interaction with the SESSF fishery. AFMA expressed agreement with this method of grouping, hence this approach remains for the final report.

4.4 Grouping of high risk species

The interim report contained a proposal to group the ~ 30 high risk species into 7 groups, i.e.

1. Teleosts
2. Sharks
3. Dogfish other
4. Rays/Skates
5. Endeavour Dogfish.
6. Molluscs

7. Hagfish

The following feedback was received from AFMA on this proposal (A-M Lynch, pers. Comm..)

"Secondly, looking at the proposed grouping for High Risk Species, a bit of clarification is required. The report lists 'Endeavour Dogfish' which is actually an old group term for Southern Dogfish, Endeavour Dogfish and Harrisson's Dogfish. It is suggested that another name such as High Risk upper slope dogfish (5 species) is used to define this group. It would be useful to group these dogfish species plus the Greeneye Dogfish (Squalus mitsukurii) and the Nilson's Deepsea Dogfish, also known as the Leafscale Dogfish (Centrophorus squamosus), all of which are in the current High Risk species list and are currently the focus of a management strategy that is being developed. Can you please let us know if this is possible?"

For this final report the grouping of the high risk species has been modified to accommodate the AFMA feedback received on the interim report.

1. Teleosts
2. Sharks
3. Dogfish other
4. Rays/Skates
5. Upper Slope Dogfish.
6. Molluscs
7. Hagfish

4.5 Design optimisation considerations

The interim report was unable to resolve the importance rating of different species and/or species groups for the survey design optimisation. Different objective functions were considered and presented. The following feedback was received from AFMA in this regard:

"**…** the optimization methods to be provided should be as follows -

1) the catch weighted CV for non-commercial species is minimized; and the value weighted CV for commercial species is minimized
2) as many species as possible have CVs below a defined threshold."

These recommendations are adopted for this final report. However we include as well a number of other methods of allocation in sample sizes to strata, including:

- Allocation of shots pro-rata to the shot distribution in the commercial SESSF fishery.
- For the TEP species groups, we include a sample size distribution which is the average of the optimised allocations for each of 5 TEP species groups (initially run separately).

A further point of clarification requested of AFMA was:

With regard to the multi-gear / fishery nature of the SESSF, we assume a unified ISMP across all gear and fishery sectors and hence the targets dealt with are expressed at the SESSF level. If there are, however, sample size quotas per fishery (GAB, GHAT, SET) which predefine the split of sampling effort between these sectors, then the authors need to be notified so that it can be brought into the optimisation explicitly.

AFMA did not comment on this and hence the design is optimised at SESSF level.

4.6 Sampling unit

Finally AFMA expressed reservations about the use in the interim report of shot as the sampling unit for the revision of the ISMP design. AFMA suggested instead that the unit of sampling should be trip. The authors argued that provided the correct analysis was done, whether trip or shot was used as a sampling unit was not germane to the final quantitative results. However, they acknowledged that under the heading 'correct analysis', it was necessary, in addition to catering for the number of shots per trip, to address the extent of within trip correlation. A compromise proposed to AFMA was to use shot as the fundamental sampling unit, but to include in the analyses a fair quantification for the within trip covariance referred to. In addition, since costs are paramount in the determination of the optimal survey design, we have optimised the design using number of days as the optimisation variable, in the process days are internally converted to shots by the appropriate factor for each stratum. This compromise proposal was accepted by AFMA.

5. Methods and Results

Due to the multiplicity of calculations this report is not structured traditionally by methods and results, but rather methods and results are addressed for each topic in turn. An overall discussion section follows once the presentation is complete for all data types and topics.

5.1 Data gathering

The following basic information was supplied in April 2009:

1. CDR: Catch disposal records for the SESSF
2. GENLOG: Logbook data for the SESSF
3. ISMP: Observer data, including onboard Length/Frequency observation tables, catch composition and weight tables for retained and discarded catch as well as interaction observations for threatened and endangered species (TEP).
4. PORTLENGTH: Port length frequency information
5. CAF: Catch at age data

The scope of the data was as follows:

5.1.1 CDR data

These data covered, by fishery, the following years:

- SET (including ECDW and VIT): 1996–2009
- GAB: 2001–2008
- GHAT: 1997–2008

5.1.2 GENLOG data

These data covered, by fishery, the following years:

- GENLOG 1985–2009

5.1.3 ISMP data

These data covered, by fishery, the following years:

- SET ISMP 1992–2008
- GHAT ISMP 1999–2008
- GAB ISMP 2000–2008

The TEP (TEP Interactions table and the TEP abundance table) data in the ISMP dataset only covered the period 2004 to 2008.

The initial tranche of ISMP data (supplied in April 2009) covered, by fishery, the years 1992 to 2007. However, the amount of 2007 data included was very limited. A revised ISMP dataset was made available on 3 June 2009. This dataset includes ISMP data for 2007 and 2008, albeit in an entirely different format to the data provided previously in April 2009. Since the TEP Interaction and TEP Abundance tables of the ISMP dataset only appear to be substantially populated post 2004, the TEP component of the analyses reported upon here is effectively limited to the period 2004 to 2008 inclusive.

5.1.4 Port based length frequency information

- Port length frequency data: 1979–2009

5.1.5 CAF: Catch at age data

- These data cover the period 1979 to 2008, for about 15 different species.

5.2 Data reconciliation

Much of the work underlying this report was involved with pre-processing the data to a point suitable for higher level analyses (see Appendix A for full details), and is not really reflected in the pages that follow. A crucial step in this regard is the much referred to merge between the port catch disposal record (CDR) dataset and the at-sea shot by shot (GENLOG) dataset. The reliability of this merge is central to the reliability of the final results. As is also documented in previous studies, the merge in question must be achieved without the aid of a unique key linking the shots of a fishing trip with the landing and catch disposal information. While this posed some difficulties in previous studies, the potential for error is magnified here since this study treats the data at a finer species resolution than previous similar work (including non-quota and high risk species). Thus the errors that arise out of ‘forcing the merge’ are potentially more significant for amounts such as discard estimates for less frequently caught and/or recorded species. Such errors are not necessarily adequately quantified by means of CVs, but would be revealed by adopting varying approaches to ‘forcing the merge’. Our concerns in this regard have only been addressed inasmuch as we limited the data to the post 2002 period, since there were higher level considerations that pointed to a risky CDR–GENLOG merge pre-2002. For example, a substantial proportion of the vessels in the CDR data do not appear in the GENLOG data pre-2002, and vice versa (see discussion Appendix A).

The CDR-GENLOG merge referred to above is achieved by a reconciliation of vessel IDs, trip start and end dates, and shot dates, as described in more detail in Appendix A. Whereas pre-2002 the potential for a reasonable proportion of shots in GENLOG to survive the merge is compromised somewhat by the mismatch between vessels in the CDR and GENLOG datasets (based on a macro view of the situation as outlined in Appendix A), post 2002 there are some challenges that arise due to the high level species resolution use made of the CDR and GENLOG data. In short, for a given trip, a species may occur in the GENLOG shots assigned to that trip (CDR) but may be completely absent in the CDR data, or the other way around (i.e. absent in the GENLOG data but present in the CDR trip data). Although some of this mismatch could be due to misallocation of GENLOG shots to the wrong trip, or to the failure of allocation of a GENLOG shot because of incorrect or absent vessel information, an additional potential source of error is the variable degree of species identification that occurs for shots, landings, and indeed observer covered shots (and perhaps landings). In previous work on this topic the ramifications of this species level source of error was limited because of the focus of that work on ~20 quota species and an 'other' category. Many of the species mismatch problems and errors occur 'internally' in the 'other' category and are thus quite opaque. However, the study reported here is far more ambitious in the species resolution that is attempted, given the project requirements w.r.t. species, and thus encounters this kind of issue on a scale that would not have been encountered in previous work. In order to address this in a way that seemed to retain the spirit of the project requirements, but imposed some limit on the extent of errors from the speciation issue described, a particular species grouping approach has been adopted, as described below.

5.3 Coding of species

Among the challenges involved in the linking of the three datasets involved in this study, are those related to the different coding of species in these datasets. The issues that were addressed covered the following:

- The ISMP data contained CAAB code, common name and scientific name.
- The CDR data contain a 3-letter AFMA code, common name and scientific name.
- The GENLOG data contain AFMA code and CAAB code.
- Thus no common key was available on all 3 datasets.
- There are instances in which more than one AFMA code is linked to the same CAAB code in the GENLOG data.
- Certain species appear to be present in one or two data-sets but not all three.
- Certain species are grouped for quota purposes, yet individual species within these groups have differing risk status.

A first step in addressing these matters was to link AFMA codes to CAAB codes using an external reference, so that CAAB code is a common key between the three datasets.

A total of 729 unique CAAB codes appeared in one or more of the 3 data sets. Of these, 297 appeared in the GENLOG, 580 in the ISMP and 317 in the CDR. Some means of grouping species was required in order to achieve a reasonable correspondence between the 3 datasets.

For the purposes of the discard rate and total catch analyses, we created the following system of classification, resulting in 75 distinct "Project Keys"

- The full list of quota species is given in Table 44. Where quota for a single species is allocated by AFMA, the species is allocated a Project Key. Where quota is allocated to a basket of species, a Project Key is allocated to the basket. This applies to the Deepwater Shark basket (18 species), Saw-shark basket (3 species) and the Oreo basket (3 species).
- In order to identify major non-quota species for each gear type, species were ranked by total catch recorded in the GENLOG for years 2002 to 2008. From these sorted lists, species which cumulatively accounted for 80% of the total catch for that gear

type were labelled as "major non-quota" species. Each of these was allocated a Project Key. The list of major non-quota species is shown in Table 45.

- Twelve additional project keys were created to group all remaining species, which are considered to be minor non-quota. These grouped keys are: Chimaeras, Crustaceans, Dogfish, Echinoderms, Fish, Hagfish, Rays, Saw-sharks, Molluscs, Sharks, Stingarees or Other.
- Birds, mammals and reptiles are not included in this classification (but are treated separately in the sections dealing with TEP species).
- In total, 75 distinct "Project Keys" were developed using the above methods (Table 46)

The components of this study which deal with High Risk Species and with TEP species are treated separately. In these, the species involved are treated individually. These species appear in Table 47 and Table 48.

5.4 Analysis of sub-fisheries and potential strata using clustering techniques

This section discusses whether the present stratification is appropriate for forthcoming ISMPs. It uses the plots of frequencies of clusters by year, depth and longitude to determine whether the cluster structures are stable over time, and whether there are grounds from the data summarised at this level to create additional strata for the ISMP, or whether some strata could perhaps be coalesced with others.

Notwithstanding the foregoing discussion about species grouping, the cluster analyses reported on here predated the species grouping step of the study, and hence these are based on individual species data throughout. Appendix B provided the graphical details of the cluster analyses performed in this section.

5.4.1 Commonwealth Trawl Sector (CTS)

The strata for the CTS are well established and, following analysis which revealed that the spatial distribution and catch composition of the fishery post-SAP had not changed appreciably, we saw no reason to propose re-stratification for this fishery.

5.4.2 Great Australian Bight Trawl

For the GAB, the data employed in the cluster analysis was the available GENLOG data from 2002. Five clusters Appendix B-Figure 1 were identified in the GAB fishery, as follows:

1. Deepwater Flathead Cluster – B-Figure 2 shows the species composition of this cluster which is dominated by deepwater flathead (~55% by weight on average).
2. Redfish Cluster - see B-Figure 3, this cluster is dominated by Bight redfish (~ 50% by weight on average).
3. Grenadier Cluster - see B-Figure 4, dominated by blue grenadier (~ 35% by weight on average).
4. Gemfish Cluster - see B-Figure 5 dominated by gemfish (~ 74% by weight on average).
5. Orange Roughy Cluster - see B-Figure 6, dominated by orange roughy (>95% by weight on average).

Frequency plots of these clusters in the GENLOG dataset by year suggests a changing pattern with a decline in Deepwater Flathead Cluster shots and an increase in the frequency of Redfish Cluster shots (see B-Figure 7 and B-Figure 8). The other three clusters have declined in shot frequency over the period 2002 to 2008.

Frequency plots of these clusters, by longitude, show some evidence of heterogeneity (see B-Figure 9 - B-Figure 12); however a separate plot versus depth reveals that this heterogeneity is actually due to depth (see B-Figure 13 - B-Figure 16).

As a result of this analysis, it is recommended that three depth strata be defined for the GAB component of the ISMP, at a depth split of:

- Inshore stratum: 0–250 metres
- Midshore stratum: 250–850 metres
- Offshore stratum: > 850 metres

See B-Figure 17 - B-Figure 20.

5.4.3 East Coast Deepwater Trawl
No cluster analyses were carried out for this sector. The intention is to model this by means of a single cluster.

5.4.4 Victorian Inshore Trawl
No cluster analyses were carried out for this sector. The intention is to model this by means of a single cluster.

5.4.5 GHaT – Longline (AL & BL)
The following clusters were identified B-Figure 21:

1. Pink Ling Cluster - see B-Figure 22, the species composition of this cluster is dominated by pink ling (~70% by weight on average).
2. Gummy Shark Cluster - see B-Figure 23, this cluster is dominated by gummy shark (~ 90% by weight on average).
3. Blue-Eye Trevalla Cluster - see B-Figure 24, dominated by blue-eye trevalla (~ 70% by weight on average).
4. Mixed Cluster - see B-Figure 25, dominated by five species comprising more than 90% by weight: gummy shark, snapper, southern eagle ray, broadnose shark, school shark.
5. Hapuku Cluster - see B-Figure 26, dominated by hapuku (~57% by weight on average).

A plot of cluster frequencies versus depth indicates a depth wise split of the clusters into two groups (B-Figure 33 - B-Figure 36), i.e.

- Shallow (< 200 metres) - Gummy Shark and Mixed Clusters.
- Deep (> 200 metres) - Pink Ling, Blue-Eye Trevalla and Hapuku Clusters.

Although this suggests a possible stratum based on a depth split, it turns out that the clusters group logically around gear type (see B-Figure 37 to B-Figure 44), i.e.

- Bottom longline (BL) - Gummy Shark and Mixed Clusters.
- Automatic longline and longline (AL) – Pink Ling, Blue-Eye Trevalla and Hapuku Clusters,

and so this issue is entirely addressed by stratification by gear rather than depth.

5.4.6 GHaT – Dropline

The following 2 clusters were identified (B-Figure 45):

1. Blue-Eye Trevalla Cluster – see B-Figure 46, the species composition of this cluster is dominated by blue-eye trevalla (~90% by weight on average).
2. Hapuku Cluster - see B-Figure 47, this cluster is dominated by hapuku (~ 35% by weight on average), with a 22% contribution from blue-eye trevalla.

Plots by longitude (B-Figure 50 - B-Figure 53) and depth (B-Figure 54 - B-Figure 57) do not suggest the need for additional stratification of the DL gear type within the GHAT fishery at this stage of the analysis.

5.4.7 GHaT – Demersal gillnet

The following 3 clusters were identified (B-Figure 58):

1. Gummy Shark Cluster - see B-Figure 59, the species composition of this cluster is dominated by gummy shark (~90% by weight on average).
2. Gummy Mixed Cluster - see B-Figure 60, this cluster is dominated by gummy shark (~ 42% by weight on average), with a fair contribution from a range of other species as shown.
3. School Shark Cluster - see B-Figure 61, the species composition of this cluster is dominated by school shark (~65% by weight on average).

Plots by longitude (B-Figure 64 - B-Figure 67) and depth (B-Figure 68 - B-Figure 71) do not suggest the need for additional stratification of the GN gear type within the GHAT fishery, although there is an increasing frequency of school shark shots with depth.

Despite the above, it was recommended by SharkRAG that the gillnet should be stratified by the shark zones previous used for School Shark. For this reason this stratification was applied to all the GHaT sectors.

5.5 Additional stratification considerations based on the discard ratio by cluster.

The ISMP data were used to carry out additional analyses on the clusters identified above. The ratio of discards to total catch (discarded + retained) was calculated regardless of species for each cluster. The F-test and the Kruskal-Walllis test were then carried out to test for statistically significant differences in this cluster-specific, but species-within-cluster-indifferent, discard ratio, across the following variables:

- GAB: by season, i.e. winter, spring, summer, autumn

- GAB: by longitude group, i.e. < 127 longitude, 127 – 130 longitude, > 130 longitude.
- GHAT: by season, i.e. winter, spring, summer, autumn
- GHAT: by zone, we used the SET zones 20, 30, 40, 50 and 60, GAB (west of 138 longitude) and a far NE zone, which we simply relabelled as '70' for subsequent analyses.

The use of the Kruskal-Wallis test is recommended given the non-normal distribution of the discard ratios described above.

The results are presented in Table 50 to Table 53. Although we inspected the pairwise post hoc results, only the overall statistics are shown here. Because many comparisons are examined one needs to be aware of the potential for false positive results. For this reason we discount the single statistically significant results at the 5% level in Table 51, for longitude grouping in the GAB. Similarly, we discount the single statistically significant result in the GAB for seasonal groups and analyses. As a result the stratification suggested for the GAB based on the cluster analyses remains at three strata, i.e.

Inshore, Midshore, Offshore.

Results for the GHAT by season are presented in Table 53. Only three gear codes are considered since the AL & BL gear types are combined in the GHAT ISMP data (but separated in the GHAT GENLOG data). One cluster-gear type combination shows up as statistically significant for the analysis by season. Using this as an argument to stratify by season is discounted for the same reason as before (the chance of obtaining a false positive result).

On the other hand the GHAT analyses carried out on discard ratio per zone as defined show generally statistically significant results (see Table 52). It is therefore recommended that each gear type be further stratified by a geographic variable, which in the analyses defined above would be the following gear/geographic breakdown:

- AL: zones GAB, 10, 20, 30, 40, 50, 60, NORTH EAST
- BL: zones GAB, 10, 20, 30, 40, 50, 60, NORTH EAST
- DL: zones GAB, 10, 20, 30, 40, 50, 60, NORTH EAST
- GN: zones GAB, 10, 20, 30, 40, 50, 60, NORTH EAST

As a result of feedback received on the interim report of this study, it is noted that the GHAT has a different historical spatial zonation pattern to the SET fishery. Thus the result obtained above for GHAT zoned via the SET zones is taken as a general finding that "gear – spatial" zonation is important and necessary for this fishery. For the GHAT we have thus modified our stratification recommendations to be consistent with the historic pattern of zonation, i.e. the following zones:

1. CSA
2. EBS
3. ESA
4. ET
5. NSW
6. SAV
7. WA
8. WBS

9. WSA
10. WT

In addition to that, the following considerations led to a further simplification of the strata for the purpose of optimal survey design calculations:

1. DL appears to be a very small fishery and has thus been subsumed into AL.

2. BL is subsumed under the heading AL, since it cannot be distinguished from AL in the ISMP data for the GHAT.

The following AL strata are concatenated for the purpose of optimal sample size calculations:

1. WA and WSA – reasoning – there is very little fishing in the GHAT taking place in WA, and there is no ISMP data for the GHAT in WA, so there is no basis to retain it as a separate stratum.

2. WT and ET – the reasoning is identical as for WA and WSA: there are no ISMP data for WT, and there is effectively no fishing in the GHAT taking place in WT.

3. SAV and WBS – very little fishing taking place in GHAT SAV, no ISMP data, hence merge SAV with an adjacent zone where there are ISMP data and there is fishing.

4. NSW and EBS – reasoning – the data suggest more shots sampled in the ISMP data than there are shots in GENLOG, a logical impossibility. Out of concern for basing strata conclusions on incorrect data we decided to merge NSW and EBS for the GHAT.

Note that there are no ISMP data in the 2002–2006 ISMP data used for this study to consider any particular stratification of the Victoria Inshore Trawl fishery, and given the relatively small size of this fishery, a single stratum is recommended.

There are also no ISMP data to use as the basis for stratification of the ECDW fishery, and therefore for this fishery a single stratum is recommended, as is also supported by the use of a single gear type in this fishery.

Furthermore, the strata for the CTF are well established and we saw no reason to propose re-stratification for this fishery.

Finally, there were no ISMP data available or 'sourceable' for the gillnet shark fishery within the limitations and timeframe and scope of this study. We understand that these were recorded as trawl fishing in the ISMP database (during 2007–2008). For the purpose of sample size calculations for optimal designs we therefore omit gillnet, but then post allocate sample size to that stratum on the basis of the number of shots in the GENLOG database.

The final recommendations for stratification of the SESSF ISMP **<u>for the determination of optimal survey designs</u>** are therefore the following 24 strata (omitting VIT since there are no ISMP data for VIT):

1. GAB: Inshore, Midshore, Offshore: 3 Strata.
2. GHAT: AL: WA+WSA, WT+ET, SAV+WBS, NSW+EBS, CSA, ESA: 6 Strata.
3. SET: ECDW_TR: 1 Stratum.

4. SET: BS_IN_TR, EDL_DS, EDL_IN_TR, EDL_OFF_TR, NSW_IN_TR, NSW_OFF_TR, NSW_RRP_TR, SW_BGS_TR, SW_ORO_TR, SW_TR, TAS_BGS_TR, TAS_E_TR, TAS_ORO_TR, TAS_W_TR: 14 Strata.

This does not suggest ignoring gillnet, but rather gillnet strata (and VIT, and the sub-gears of AL) will be reintroduced later, with sample sizes allocated pro rata to the number of GENLOG shots for the recent history of the fishery (2007 and 2008 are used).

5.6 Methods of estimation and optimal design for discarded catches

This section contains a complete treatment of the optimal design calculations based on the species or species group level for the retained and discarded catch amounts.

5.6.1 Principles underlying the methods for discard estimation.

Methods employed previously in estimating discard levels in the SESSF involved analysis of the ***discard proportion*** for each species at a stratum by stratum level, and then aggregation across strata to obtain an estimate, with associated CV, of a fishery-wide discarded proportion for each species under study. The use of proportions in such analyses brings with it a good deal of statistical complexity. In the aggregation across strata for example, the appropriate weighting on the stratum level proportions is the ***total catch*** (i.e. retained and discarded combined). However this total catch is itself subject to estimation variance (by virtue of its inclusion of the discards) and this then gives rise to SESSF-wide variance considerations which are far from straight-forward. Previous ISMP designs have avoided these complexities by using the ***landed catch*** as the weighting on strata instead of the total catch. This has been viewed as a reasonable approximation in those studies, since most of the species under study had low discard rates, and thus the retained catch ratios between strata was closely related to the corresponding ratios of total catch.

For this study, the scope of the ISMP has been enlarged to encompass a larger number of species and species groups. Many of these are discarded in high proportions. We have therefore been forced to depart from the previous approach based on the total catch, and thus we have used a method which involves estimating the ***discarded catch mass*** in each stratum.

The fishery-wide mean and variance on total discards can then be obtained by simple addition of the stratum means and variances. The price to be paid for the simplicity gained in the aggregation across strata, is the requirement of more complexity in the calculation of the stratum-level statistics (i.e. in the estimation of the discarded catch per species and stratum).

We have employed two methods to calculate these estimates from the ISMP data, each of which has merits and demerits in different circumstances:

- **Method A** is to estimate the *discarded catch* per shot in the ISMP and multiply this up by the number of shots recorded in the GENLOG.
- **Method B** is to estimate the *discarded to retained catch ratio* from the ISMP, and apply this to the total retained catch per stratum as recorded in the GENLOG and corrected by the CDR.

Method A is the simpler of the two methods and may be used more generally.

Method B on the other hand provides improvement in precision under conditions in which catch variability is high compared with the variability of the discard proportion. This requires a certain amount of complexity in analysis for 2 reasons:

i) If the discard rate d is 100% for any particular shot, the discarded to retained catch ratio is not defined.

ii) Even if the discard is < 100% for all shots, the mean of the shot level discard:retained catch ratio $E\left(\frac{d}{1-d}\right)$ is a biased estimator of the stratum level discarded:retained catch ratio. This is evident from a simple example of a stratum comprising 2 shots. One shot retains 1kg discarding 99 kg, the 2nd shot retains 99 kg and discards 1kg. The stratum level discard: retained ratio is 100:100 = 1:1 whereas the mean of the shot level discard: retained ratios is (99:1 + 1:99)/2 = 49.5:1.

We adopt instead $\frac{E(d)}{1-E(d)}$ as the unbiased estimator, the variance implications of which are discussed below.

5.6.2 Distributional assumptions for the discard proportions.

Many species strata have discard rates which are dichotomous at the shot level (i.e. either 0% or 100% of the catch of that species for each shot is retained) and thus have variances which are determined precisely by the mean discard rate d. i.e. V(d)=d(1-d).

If all species were dichotomous at the shot level and if discard rates for shots are uncorrelated within trip, then the true mean discard rate for the stratum may be assumed to be beta-distributed, d/(1-d) is beta prime distributed with the same parameters. The variance of the discarded catch for the species-stratum can be theoretically determined using only the mean discard rate, number of shots sampled and total retained catch.

However not all species-strata satisfy these two conditions and so provision needs to be made for:

(a) Non-dichotomy at the shot level, which will reduce variance

(b) Within-trip correlation of shot-level discard rates, which will increase the variance of estimated mean discard rate (this is because it is impractical for observers to sample shots individually, but rather they will select trips and sample all shots from these trips).

Both of these features can in principle be addressed in the same way, by adjustments on the sample size. i.e. we view each stratum species as comprising packets of fish which are uncorrelated in their discard rates and each of which is dichotomous. In case (a) above, such packets will be smaller than the shot level, and in case (b) larger than the shot level.

This leads to the concept of an effective sample size, which may be more or less than the actual number of shots sampled depending on the relative extent of (a) or (b) and may be calculated empirically from the data using the standard deviation of the proportion. The discard proportion itself and the effective sample size then provide a theoretical basis for determining the variances of the posterior distributions for d (assumed to be beta-distributed) and d/(1-d) assumed to be beta-prime distributed.

An alternative to this theoretical approach which we have explored extensively is to bootstrap the ISMP data to obtain numerical estimates of the variances associated with both the discarded mass and the discarded proportions at a stratum level for a range of candidate sample sizes.

In favour of the bootstrap is its ability to capture the variance implications of within-trip correlations of both the discarded mass and discarded proportions by shot.

We have opted for the theoretical approach for two principle reasons:

- The number of quantities to be estimated (species*stratum combinations) is large compared with the quantity of data available and are thus subject to substantial noise which would in any case warrant some smoothing by means of theoretical priors.
- A simple bootstrap in effect assumes the sample distribution as the underlying reality. If the discard proportions are, as we assume, beta distributed, then the discard proportions realized from bootstrap re-samples are binomially distributed and thus do not fully capture the uncertainty in the underlying population mean itself.

The within-trip correlation is then handled by means of a decomposition of variance to between and within trip components, which enables the calculation of appropriate multipliers of the variances for each species and stratum (see Equations D8 to D12 below.)

5.6.3 Algebraic formulation of the estimation methods.

Stratum level estimate, Method A:

From the ISMP data, we calculate the mean $\overline{D}_{H\,st}^{\;sp}$ and variance $V_H\left(D_{st}^{sp}\right)$ of the discarded catch in kg over *shots that encounter that species*.

$$\overline{D}_{H\,st}^{\;sp} = \frac{1}{n_{sr}^{O}.h_{st}^{sp}} \sum_{i \in st} D_i^{sp} \qquad (4.6.3 - D1)$$

$$V_H\,(D_{st}^{sp}) = \frac{1}{n_{sr}^{O}.h_{st}^{sp}} \sum_{i \in st} (D_i^{sp} - \overline{D}_{H\,st}^{\;sp})^2 \qquad (4.6.3 - D2)$$

where D_i^{sp} is the discarded catch in kg for species sp as recorded by the observer for shot i.

h_{st}^{sp} is the ISMP "hit rate" i.e. the proportion of shots observed in stratum *st* which encounter species *sp.*

n_{st}^{O} is the total number of shots observed in the stratum (as per the ISMP data.)

The mean and variance *over all shots fired* require an adjustment taking account of the hit rate

$$\overline{D}_{A\,st}^{\;sp} = h_{st}^{sp}..\overline{D}_{H\,st}^{\;sp} \qquad (4.6.3 - D3)$$

$$V_A\left(D_{st}^{sp}\right) = h_{st}^{sp}.V_H\left(D_{st}^{sp}\right) + \left[h._{st}^{sp}. - \left(h._{st}^{sp}\right)^2\right]\left(D_{H\,st}^{\;sp}\right)^2 \qquad (4.6.3 - D4)$$

The variance of the mean adjusted discarded catch per shot fired is then

$$V(\overline{D}_{A\,st}^{\;sp}) = \frac{V(D_{A\,st}^{\;sp}).\omega_{st}^{sp}}{n^{o}{}_{st}} \qquad (4.6.3 - D5)$$

where ω_{st}^{sp} is the variance multiplier due to within trip correlation.

The estimate of total discarded catch for species *sp* and stratum *st* is then

$$\hat{D}_{st}^{sp} = n_{st}^{F}\,\overline{D}_{A\,st}^{\;sp} \qquad (4.6.3 - D6)$$

With variance:

$$V\left(\hat{D}_{st}^{sp}\right) = \left(n_{st}^{F}\right)^2 V\left(\overline{D}_{A\,st}^{\;sp}\right) \qquad (4.6.3 - D7)$$

Where n_{st}^{F} is the total number of commercial shots fired in the stratum (as per the GENLOG data.)

Accounting for non-independence of errors within trip.

Equation D5 above, if ω_{st}^{sp} = 1, assumes independence of deviations in discarded catch between shots, whereas for some species in some strata there is in fact some measure of correlation of these errors within trip.

To this end, we model the discard catch for shot *i* on trip *t* in year *y* as follows. For the sake of simplicity of notation we omit the subscripts *sp* (species) and *st* (stratum) which are to be understood throughout.

$$D_{t,i} = \mu_y + \xi_t + \varepsilon_i \qquad (4.6.3 - D8^*)$$

$\mu_{y\,i}$ is a (fixed) year-dependent intercept

ξ_t is a random batch effect for trip t with variance ϕ^2

ε_i is a random error for shot i with variance σ^2

If N shots are sampled from T trips, then the expected variance of the mean discarded catch $\overline{D}$

assuming independence of the errors (i.e without accounting for trip) is:

$$V_1(\overline{D}) = \frac{V(D_i)}{n} = \frac{\phi^2 + \sigma^2}{n} \qquad (4.6.3 - D9^*)$$

On the other hand, assuming the model (D8*), the variance of the mean is

$$V_2(\overline{D}) = \frac{\phi^2}{T} + \frac{\sigma^2}{n} \qquad (4.6.3 - D9^*)$$

The variance multiplier for use in equation D5 is then

$$\omega = \frac{V_2(\overline{D})}{V_1(\overline{D})} = \frac{mr+1}{r+1} \qquad (4.6.3 - D10^*)$$

Where $m = \frac{N}{T}$ (4.6.3 - D11*)

is the average number of shots per trip (which encounter the species in question)

And $r = \frac{\phi^2}{\sigma^2}$ (4.6.3 - D12*)

is the ratio of between trip variance to within trip variance.

We have obtained the quantities m for each species and stratum using ISMP data from years 2002 to 2006. (2007 and 2008 data could not be used for this exercise because trip could not always be identified.) The quantities *r* are obtained using the same data, by a MINQUE decomposition of variance using SPSS17 software.

We have subsequently calculated the variance multipliers ω_{st}^{sp} for each species s and stratum (which we assume to be year-invariant.) Note that for some species and strata m < 1 because not all trips encounter the species. In this case we apply the constraint ω_{st}^{sp} >=1.

The multipliers ω_{st}^{sp} can be provided in a spreadsheet for reference and for application to future estimation of discards using this method.

Stratum level estimate, Method B:

For each shot *i* we define the discard rate as

$$d_i^{sp} = \frac{D_i^{sp}}{D_i^{sp} + R_i^{sp}} \qquad (4.6.3 - D13)$$

For each species *sp* and stratum *st*, we calculate the mean and variance of the discard rate d_i^{sp} for shots i in the stratum which encounter the species.

$$\bar{d}_{st}^{sp} = \frac{1}{n_{st}^{O}.h_{st}^{sp}} \sum_{i \in st} d_i^{sp} \qquad (4.6.3 - D14)$$

$$\mathrm{V}(d_i^{sp}) = \frac{1}{n_{st}^{O}.h_{st}^{sp}} \sum_{i \in st} (d_i^{sp} - \bar{d}_{st}^{sp})^2 \qquad (4.6.3 - D15)$$

The effective sample size is calculated as:

$$n^{eff}{}_{st}^{sp} = \frac{d_i^{sp}(1 - d_i^{sp}) n_{st}^{O}.h_{st}^{sp}}{V(d_i^{sp})} \qquad (4.6.3 - D16)$$

We calculate the theoretical parameters of the beta distribution corresponding to the mean and standard error on $\bar{d}_{st}^{sp}$

$$\alpha = n^{eff}{}_{st}^{sp}.\bar{d}_{st}^{sp} + 1 \qquad (4.6.3 - D17)$$

$$\beta = n^{eff}{}_{st}^{sp}.(1 - \bar{d}_{st}^{sp}) + 1 \qquad (4.6.3 - D18)$$

Use the beta parameters to calculate the theoretical variance of $\left(\frac{\bar{d}_{st}^{sp}}{1 - \bar{d}_{st}^{sp}}\right)$ on the assumption that this is beta-prime distributed.

$$.V\left(\frac{\bar{d}_{st}^{sp}}{1 - \bar{d}_{st}^{sp}}\right) = \frac{\alpha\left(\alpha + \beta - 1)\right)}{\left(B - 2\right)\left(\beta - 1^2\right)} \qquad (4.6.3 - D19)$$

{Note that If $\beta < 2$, i.e. if $n^{eff}{}_{st}^{sp}(1 - \bar{d}_{st}^{sp}) <= 1$ the variance is infinite. In this case, Method A is forced.}

The estimate of total discarded catch for species *sp* and stratum *st* is then

$$\hat{D}_{st}^{sp} = R_{st}^{sp}.\frac{\bar{d}_{st}^{sp}}{1 - \bar{d}_{st}^{sp}} \qquad (4.6.3 - D20)$$

With variance:

$$V\left(\hat{D}_{st}^{sp}\right)=\left(R_{st}^{SP}\right)^2 V\left(\frac{\bar{d}_{st}^{sp}}{1-\bar{d}_{st}^{sp}}\right)$$

(4.6.3 - D21)

Where $\hat{R}_{st}^{sp}$ is the total retained catch for species *sp* and stratum *st* as per the GENLOG/CDR data.

Aggregation across strata.

The SESSF-wide estimate of total discarded catch for species sp is

$$\vec{D}^{sp} = \sum_{st} \hat{D}_{st}^{sp}$$

(4.6.3 - D22)

With variance:

$$V(\vec{D}^{sp}) = \sum_{st} V\left(\hat{D}_{st}^{sp}\right)$$

(4.6.3 - D23)

The CV is given as

$$C.V. = \left(\sum_{st} V\left(\hat{D}_{st}^{sp}\right)\right)^{1/2} / \sum_{st} \hat{D}_{st}^{sp}$$

(4.6.3 - D24)

5.6.4 Conditions of selection of Method A vs Method B and implications for optimal sample size allocation to strata.

If we let

$$\gamma = n_{st}^{F} \frac{\sqrt{V_A\left(D_{A\,st}^{\ sp}\right)}}{D_{A\,st}^{\ sp}}$$

(4.6.4 - D25)

Then from equations (D5) and (D7) above we obtain

$$V\left(\hat{D}_{st}^{sp}\right)=\frac{\left(\gamma_{st}^{sp}\right)\left(D_{A\,st}^{\ sp}\right)^2}{n_{st}^{O}}$$

(4.6.4 - D26)

The CV on the estimate for the stratum is then

$$cv\left(\hat{D}_{st}^{sp}\right)=\frac{\gamma_{st}^{sp}}{\sqrt{n_{st}^{O}}}$$

(4.6.4 - D27)

which illustrates the inverse dependence of the variance of the stratum estimate on the sample size allocated to the stratum using Method A.

Note that this simple relationship does not apply with Method B, where the CV is

$$\sqrt{\frac{(n_{eff}\, d_{st}^{sp}+1)(n_{eff}+1)}{(n_{eff}(1-d_{st}^{sp})-1)n_{eff}^{\ 2}\, d_{st}^{sp\,2}}}$$

(4.6.4 - D28)

Table 9 shows the theoretical CVs on the estimate using methods A (CV1) and B(CV2) for a species with discard proportion of 50% and gamma = 3. Method B is more precise for sample sizes greater than 10, but becomes considerably less precise very quickly as the sample size decreases towards zero. While this is a particular example, the features shown are typical for proportions between 0.1 and 0.9

For proportions outside this range, Method A is almost invariably more precise, even at large sample sizes.

In principle, for estimation purposes, the data should be allowed to make their own decision where possible, i.e. calculate the estimate of discards CV by both methods and accept the estimate with the lower CV.

If the discard proportion is very close to 1, the variance by Method B is undefined, so Method A has to be used.

In our application of the Methods A and B to the ISMP data from 2002 to 2006 (Interim Report), only 1% of species–stratum combinations preferred Method B, and in those cases the degree of preference was slight. Thus, for the purposes of sample size design we have adopted Method A throughout in the interests of simplicity (see Figure 2).

5.6.5 Results of calculations of mean and CV for discarded catch 2002–2008.

Although ISMP data for years 2002–2006 were collected under the old design, we present here results of the calculations under the new stratification.

Table 1 shows, for each of the 32 strata, the number of shots fired (from the GENLOG data) and the number of shots observed (from the ISMP data.)

Note that no ISMP observations are available for the VIT or GN strata, which collectively make up 18% of all shots (25% of sea-days) recorded in the GENLOG.

Table 3 shows the estimated discarded catch and associated CV for the 27 strata for which data are available.

5.6.6 Interpolation of missing values.

Not all of the input quantities for equations D1 to D12 above are obtainable directly from the data at our disposal. Thus for purposes of optimization of sample size allocation to strata, it has been necessary to interpolate values in certain species*strata combinations.

In the Gillnet (GN) and Victoria Inshore Trawl (VIT) strata, we have no ISMP data for any of the project keys. No interpolation is attempted for these strata, but in the optimization procedures described below, these strata are allocated sea-days on a pro rata basis, in proportion to sea-days allocated to the rest of the fishery.

In addition, there are species-stratum combinations for which either GENLOG or ISMP data are not available. These are dealt with as follows:

- If a species-stratum does not appear in the ISMP or the GENLOG, we assume that the species is never caught in that stratum, thus the discards are zero with zero variance.
- If a species-stratum appears in the ISMP, but not the GENLOG, we assume that the discard rate is 100% regardless of the discard rate recorded by the ISMP observers.
- If the species–stratum appears in GENLOG but not ISMP we interpolate as follows:
    - Assume that the discarded: retained catch ratio is the same as the average for the species over strata for which data are available.
    - Multiply this assumed ratio by the retained catch as recorded in the GENLOG to infer a mean discarded catch.
    - Assume that the standard deviation: mean ratio for discarded catch is the mean of this ratio for the species over strata for which data are available.
    - Multiply this assumed ratio by the inferred mean discarded catch to infer a standard deviation on the discarded catch.

- Assume that the ISMP hit rate is the same as the GENLOG hit-rate.

5.6.7 Optimisation of ISMP design.

In previous designs, the target precision on discarding has been set in terms of a CV on the discarded proportion. This target level differed depending on the discard proportion itself.

Proportion	**Target CV**
> 20%	40%
5 – 20%	80%
< 5%	150%

These target CVs were in principle CVs on the discarded ***proportion.*** However, due to the nature of the calculations of these quantities (retained catch rather than total catch weighting in the aggregation of strata) these targets were effectively CVs on the discarded ***mass***. The rationale behind the gradation of these targets was that less precision is required when the discarded proportion is low, because in this case the uncertainty is not large compared with the total catch. This feature is illustrated in Figure 3, in which the target CVs on discards are shown together with the implied CV on the total catch.

The effect of the gradation is to confine the CV on total catch to between 0 and 40% at all proportions. See Figure 3.

In the new design, we proposed to restate the targets instead at a flat 20% CV on the total catch. Following feedback from AFMA after the interim report this has been revised to the following.

The target level of precision for each project key is:

- 20% CV on the total catch, if the discarded proportion > 13.33%
- 150% CV on the discarded catch if the discarded proportion $\leq$13.33%.

This is shown in Figure 4.

Given the above target specification, for a single species, the objective underlying optimization of the sample size distribution to strata is relatively simple — to allocate strata so as to minimize the CV for that species. However, with 75 species groups (Project Keys) involved, a number of different objectives are possible, in view of the potential for competing requirements for different species.

Following feedback from AFMA on the interim report of this study, we have settled on 3 optimization methods meeting 3 different objectives.

Allocation Method VWCV: For any given number of sampling days available, minimize the value-weighted average CV over the 68 commercial project keys. For this purpose, the value weighting we have used for each of commercial species is the estimated discarded catch in kg X the approximate price per kg. Average prices (from Sydney Fish Market) for 25 project keys are shown in Table 2. These prices range from A$ 1.75 to A$9.83 per kg. All other species are effectively catch-weighted with respect to each other. For the purposes of marrying the two weighting regimes, we impose a "dummy" price of $A1.00 per kg for all the remaining project keys.

Allocation Method MinS: For any given number of sampling days available, minimize the number of species which have CV above the target threshold of 20%. Note that changing this threshold may alter the resulting order of allocation, but we have not investigated that here.

The mechanism of this method is, at each increment — determine from among those species with CVs greater than the target CV — which species has the CV is closest to target. Add a sea-day in the stratum which most reduces the CV of that species.

Allocation Method PROP: This is simply an allocation of any given availability of sampling days in proportion to the number of sea-days expended by the fishery in each stratum.

Allocation Method CWCV-HR: For any given number of sampling days available, minimize the catch-weighted average CV over the 7 High Risk species groupings.

Allocation Method MinS-HR: For any given number of sampling days available, minimize the number of high-risk species groupings which have CV above the target threshold of 20%. If all high risk project keys are below target, then minimize the number of commercial project keys above target

The mechanism for this method is, at each increment – determined from among those species with CVs greater than the target CV, which species has the CV is closest to target. Add a sea-day in the stratum which most reduces the CV of that species.

Note that none of the above procedures above pre-suppose any particular constraint on total sampling effort available, but each presents a continuum of benefit vs sampling cost from which a sampling level may be selected.

Though we recognize that observers will select trips rather than shots, we note also that the cost of observation is dependent on trip length. **We thus use the sea-day as the basic sampling unit.** All sample sizes referred to below are expressed as numbers of sea-days per annum, though this is also translated into number of shots where appropriate. Implicit is the assumption that the observer will record all shots for each sea-day spent on board a vessel.

Each of the optimization procedures start with a single (seed) sea-day allocated to each stratum and all add single sea-days to the survey incrementally in 1 of 3 ways, depending on which of the above objectives is given priority:

- Method VWCV. At each increment - add a sea-day in the stratum which most reduces the value-weighted average CV across all species.
- Method MinS. At each increment – determine from among those species with CVs greater than the target CV, which species has the CV closest to target. Add a shot in the stratum which most reduces the CV of that species.
- Method PROP. At each increment – add a sea-day in the stratum which has the least proportional coverage by the ISMP as at the previous increment.
- Method CWCV-HR. At each increment - add a sea-day in the stratum which most reduces the catch-weighted average CV across the HIGH RISK species groups.
- Method MinS-HR. At each increment – determine from among those HIGH RISK species groups with CVs greater than the target CV, which species group has the CV closest to target. Add a shot in the stratum which most reduces the CV of that species.

Method VWCV, Method MinS and Method PROP are all used to optimize sampling for commercial species (commercial allocation), while Method CWCV-HR and Method MinS-HR are used to optimize sampling for high risk species (high risk allocation).

For each of the methods, we have continued the process up to a total sample size of 2000 observed sea-days per annum. In all cases the expected CV for a given stratum size is calculated using estimation Method A.

Figure 5 and Figure 6 illustrate the progress of the 5 allocation methods towards meeting the various objectives as the sample size is incrementally increased.

Figure 7 to Figure 16 show the sample sizes distributions in terms of number of sea-days at 250 sea-day increments from 500 to 1500 days by each of the 5 methods.

These distributions are also presented in Table 4 to Table 8, which show in addition the equivalent number of shots sampled.

Figure 17 to Figure 21 illustrate for each of the 5 methods, for project key, the progress towards target at 250 day increments in the total sample sizes.

Notable in Figure 7 for example, is the disproportionate sampling effort preferred in the EDL_IN_TR and GAB Inshore strata. Both of these strata have a lot of species (EDL has 60 out of 75, Gab Inshore has 62 out of 75). Both also have high average standard deviation to mean discard ratios of more than 1. Note that the EDL_INS _TR stratum is favoured by the VWCV method, implying that a lot of the high value species reside there. This stratum gets a high proportion of sampling effort right from the word go.

The GAB-Inshore stratum on the other hand is favoured by the MinS method. It also only starts blowing out when the sea-days gets to about 400 – i.e. when we get down to the last 10 to 15 species which are still above target. Note, that for 13 project keys, more than half of the total estimated discards for that project key occur in the GAB Inshore stratum, so that in order to get precision on the estimate of discards for these keys, considerable sampling is required in that area.

In Figure 6 we note that the MinS-HR method achieves its objective of bringing the 7 high risk project keys below target within 500 sea-days. However, at this level of sampling 14 of the commercial project keys are still above target. The MinS (commercial) method on the other hand has only 9 commercial species above target, but also 4 of the 7 high risk project keys. This illustrates one of the trade-offs to be made between the differing objectives of the program. The 4 plots of Figure 5 and Figure 6 represent 4 distinct objective functions (2 commercial and 2 high risk). Each plot is underscored by the method which is specifically designed to meet that objective.

5.7 Analysis of fishery-TEP interactions

The TEP species are grouped as follows:

1. Seals (includes Sea Lions)
2. Sharks
3. Pipefish
4. Birds
5. Whales/Dolphins
6. Reptiles (no records of Reptilian interactions in the data)

We note that for the 2004–2008 ISMP data, there are no data Reptiles and so these two groups do not appear in any of the analyses that follow.

5.7.1 Extraction of the TEP interaction data from multiple tables

We experienced difficulties in reconciling information on TEP species which interact with the fishing gear **<u>and/or</u>** are captured by the gear itself. As a result, the interaction may appear in the 'TEP Interactions' **<u>and/or</u>** the 'ISMP catch' table. The additional absence of a unique key linking a record in the 'TEP interactions' table and the 'ISMP catch' table posed significant data mining and data pre-processing challenges which are addressed here in only one of a number of possible ways.

In order to produce the TEP Interactions analysis, broken down by year and strata, it was necessary to match the records from the TEP Interactions table to records in the Trawl Catch table. In this way, it is possible to identify the strata where the interaction occurred. It should also be noted that since the format of the TEP interaction data received in April 2009 did not match the format of the TEP data received June 2009 — and each dataset exhibited distinct problems — two distinct exercises were required in order to produce a single, stratified table of TEP interactions for the period 2004–2008 inclusive.

5.7.2 Linking 2004–2006 TEP interaction data

The most obvious and reliable approach to this problem requires a record matching based on the vessel call sign, the shot date and the shot number. When we first attempted to merge the two datasets using this approach, we discovered two problems which were causing the majority of TEP Interaction records to drop out of the analysis (Table 9):

1. A vessel call sign which exists in the TEP interaction records does not exist in the ISMP Trawl database
2. The vessel call signs and shot dates can be matched, but there is no corresponding shot number in the Trawl table, so a TEP Interaction record cannot be matched to a Trawl.

The first of these problems cannot be remedied — we assume that the "unknown" vessels are capturing errors and drop these records from the analysis as there is no possibility of stratifying these records.

The second problem can be dealt with by using the following approach:

- Select records from the ISMP Trawl table such that a list of distinct combinations of vessel call sign, shot date and strata are created, and match the resulting table to the TEP records which fall into category 2 above.

This produces a stratified version of the TEP Interaction data which can then be appended to the previously matched TEP Interaction records. It should be noted that a potential problem with this approach arises if a particular vessel operated in more than one stratum on the same day — this scenario does affect 37 TEP Interaction records. This complication is handled by selecting the strata of the Trawl catch record with the closest shot number to the ambiguous record. By calculating the absolute difference between the TEP Interaction shot number and the Trawl table shot number it is possible to identify and select the record with the minimum difference — in this way we can determine the most likely strata for the ambiguous interaction records.

A further complication to the analysis of TEP interactions arises from the possibility of the TEP species group appearing in both the Interactions table and the Trawl Catch table — improper handling of these records would lead to duplication of interactions. The only species groups for which this could occur are "Seals" and "Pipefish". Identification of these records is accomplished by creating a field which contains a 1 if the record originated from the TEP Interactions table or a zero if the record originated from the Trawl Catch table along with a similar marker to indicate if the record originated from the Trawl Catch table. Shots which contain a duplicate can then be identified by combining the species separated catch and interaction records and aggregating down to a shot level, retaining the maximum value of the two marker fields. At this point, a record with duplicated shots will contain values for both marker fields which are greater than zero — using this information we can de-duplicate the records.

5.7.3 Linking 2006–2008 TEP interaction data

Unlike the pre 2007 data tranche, the 2006–2008 observer data did not contain unique trip identifiers, or shot numbers. This made it impossible to match the TEP interaction data based on shot date and shot number, as only shot date is common to both datasets. The only approach available in this case was to determine the strata that the vessel operated on a specific day, and assign any TEP interactions to those strata. This approach is vulnerable to two potential errors:

1. A TEP interaction record can appear on a date for which no fishing was recorded
2. A vessel have fished in one or more strata on a given day

The first of these problems cannot be solved, therefore all TEP interaction records for a vessel with no catch records on the same day were excluded from the analysis as they could not be stratified.

The second problem was resolved by using the latitude and longitude of the TEP interaction and catch records in order to calculate the distance between a stratified shot thrown on an ambiguous day and the TEP interactions for the same vessel and date. This calculation permitted stratification of the TEP interaction records by assigning it to the strata of the shot which was physically closest to the location of the interaction.

The resulting stratified 2006–2008 TEP interactions can then be appended to the 2002–2004 TEP interactions providing a single table with TEP interaction records for the period 2002–2008. See Table 9.

A description of the methods used for the analysis of the TEP interactions data follows. Although reference is made to seals, the same methods are used for all TEP species groups

5.7.4 Fishery-TEP interaction analyses

In the interim report, an analysis of the number of shots involved in an interaction with the TEP species / species group under consideration was presented. The question of the mean number of individuals interacting with the fishery, for any shot actually involved in an interaction, and the associated variance, was not analysed in any detail, although estimates of the number of interacting individuals were presented. In retrospect it is clear that separating the analysis for the TEP species groups in this way is problematic, hence a different approach has been developed for this final report.

The Poisson distribution provides a simple statistical framework for the joint analysis of the number of shots involved in interactions with TEP species groups, and the number of individuals per interaction. The Poisson distribution is however limited because the mean is equal to the variance. Since different species groups exhibit different degrees of 'clumpiness' in their distributions, a mass distribution function in which the variance can exceed the mean would provide a better vehicle for the determination of optimal ISMP designs. The obvious choice is the negative binomial distribution, although there are others such as the Sichel distribution which might be equally useful, but not as widely known.

The CVs that emerge from such an analysis are likely to be considerably larger for the same sample sizes than those that were reported in the interim report. The reason is that the CVs in the interim report were limited to considerations of the number of shots involved in interactions with TEP species groups, whereas the ensuing analysis caters for the additional variance of the number of individuals per interaction.

Of course one might ask why not base the optimal design on the empirical means and variances? This option has considerable merit. There is though the difficulty that the empirical means and variances are an inadequate basis for a survey design, based as they are on a limited sample. For example, in many strata there are no records of interactions with particular TEP species groups. Does this mean that no interactions will ever occur in those strata and hence that no sampling should be directed there (under circumstances where the TEP determine the optimal sample design)? Clearly not — some provision should be made for the possibility of TEP interactions even in strata where no interactions were observed.

So a parametric distribution might be useful in that it provides a basis for, for example, smoothing the empirical information about means and variances, and perhaps for the setting of plausible priors for strata where no interactions have been recorded.

Although the negative binomial distribution is indicated as the standard formulation, we suggest that explicit use of this mass distribution function is not necessary and instead we focus on the degree of over-dispersion in the data (i.e. the ratio of the variance to the mean).

Conceptually we suggest that there is a level of clumping (number of individuals) that can be applied to particular TEP species groups and that at that level, the frequency of occurrence of groups will be Poisson distributed. If we let V_c be the variance of the number of clumps observed, and μ_c the mean number of clumps, for the Poisson distribution:

$$V_c = \mu_c$$

Roughly then, the mean number of individuals (f) is $\mu_f = S\ \mu_c$, and the variance of the number of individuals is $V_f = S^2\ V_c$. From this it follows that

$$V_f = S\mu_f$$

Thus the slope of a linear relationship (passing through the origin) between the variance and the mean of the number of individuals interacting with fishing gear is the average clump size. It is suggested that this average clump size is an intrinsic property for the TEP species group, and can form the basis for smoothing the data and perhaps for the introduction of priors for strata which have not shown any interactions with TEP species groups in the past.

Figure 36 – Figure 42 show plots of the stratum/year level means and variances at the individual level, for different species groups.

Two plots are shown for ‘Seals’ (Figure 36 and Figure 37) and ‘Birds’ (Figure 39 and Figure 40), because the fit seems to have been distorted by a very high point in each case, and the second plot for each of these is carried out omitting this ‘outlier’. The average clump sizes which are thus obtained are:

- Birds: 37.50
- Pipefish: 1.74
- Seals: 8.40
- Sharks: 1.50
- Whales/Dolphins: 292.90

These results point to Birds, Seals and Whales/Dolphins operating in medium to large groups, while Pipefish and Sharks would seem to be operating more as independent individuals and/or perhaps in pairs, at least in respect to how they interact with the fishing gear.

In order to carry out the ISMP design optimisation exercise it is necessary to use a measure of stratum size. We know that the gillnet gear type is not distinguished from trawl in the ISMP data. However, the two gear types are distinguishable in the GENLOG data. Thus, for the purpose of calculating the stratum sizes as number of shots per stratum, the SET shots in the GENLOG data have been increased by about 38%, where 38% is the average number of gillnet shots in the SESSF as a whole, divided by the gillnet + trawl shots. Any sample size recommendations that emerge from the ISMP design optimisation therefore need to be disaggregated into gillnet and trawl at the end of the exercise.

A further consideration is that not all interactions with TEP species take place during a specific fishing event. To be more specific, it was not possible to link a record in the TEP interactions table with the catch table of the ISMP data. This has implications for the concept of what constitutes the population and the sample from a statistical standpoint, a topic which is outside the scope of this study. For this report we have simply treated a TEP interaction record as a 'shot' for the purpose of the analysis.

For the purpose of the determination of optimal designs driven solely by the TEP species groups and their interactions with fishing gear, the following steps were followed:

Optimal ISMP Design Analysis A (no priors)

1. The analysis takes place at the stratum level for the SESSF.
2. Calculate the mean number of interacting TEP individuals per stratum over years 2002–2008.
3. Use the clump sizes to convert the mean number of interacting TEP individuals observed for the stratum to variances.
4. The variance of the mean is the variance calculated above, divided by the ISMP sample size for that stratum.
5. Calculate the stratum size as the number of GENLOG shots for that stratum, as an average between 2007 and 2008.
6. The estimated total number of interacting TEP individuals for a particular species group equals the sum product of the means and the stratum sizes.
7. The variance of the 'estimated total number of interacting TEP individuals for a particular species group' equals the sum product of the 'variance of means' and the 'stratum sizes squared'.
8. Choose sample sizes for each stratum subject to a constraint that they sum to N_{tot} and minimise the variance calculated above. By sample size is meant the number of sea-days. The number of shots is based on the average number of shots per vessel per day per stratum from the GENLOG data (see Table 21).

This approach leads to the distribution of sample sizes shown in Table 22 and Table 23. The results are illustrative for N_{tot} = 400 sea-days, and fractional sea-days and shots have been permitted. The CVs for each TEP species group are shown in the output tables and figures as well. Note that the CVs are inversely proportional to the square root of sample size, provided that the distribution of shots per stratum does not change, just the overall scale of shots. Thus the sample size (say $N_{20\%}$) required to achieve a CV of, say 20%, is:

$N_{20\%} = 1000 \times [CV(N_{tot}1000)]^2/20^2$

Table 23 is a modification where additional underlying 'true mean interactions' were introduced for strata where there were no interactions for the period 2002–2008. These values were:

- **Birds, Seals:** 10% of the mean number of interactions per shot in strata where interactions did occur, calculated separately for the AL, SET or GAB sectors of the SESSF,

- **Pipefish, Sharks and Whales / Dolphins:** 10% of the mean number of interactions per shot in strata where interactions did occur, regardless of SESSF stratum.

Table 22 and Table 23 also provide the average optimal shot allocation across TEP species groups subject to the constraint that the total sea-days = 400.

Note as well that included in Table 22 and Table 23 are the results that are obtained if instead of using the optimization scheme to determine the shot and sea-day allocations, one were to instead base the shot allocation on a formulation in which shots are simply allocated pro-rata to the shot distribution evident in the fishery. The CV consequences of such an allocation scheme are shown.

The results in Table 22 and Table 23 are for a subset of the final number of strata that is envisaged in the final implementation of the ISMP for the SESSF. Whereas the following strata are readily identifiable in the CDR-GENLOG data:

AL CSA	EDL_OFF_TR	NSW_OFF_TR
AL EBS / NSW	GN CSA	NSW_RRP_TR
AL ESA	GN EBS / NSW	Offshore
AL ET / WT	GN ESA	SW_BGS_TR
AL WBS / SAV	GN ET / WT	SW_ORO_TR
AL WSA / WA	GN SAV	SW_TR
BS_IN_TR	GN WA / WSA GN WBS	TAS_BGS_TR
ECDW_TR	Inshore	TAS_E_TR
EDL_DS	Midshore	TAS_ORO_TR
EDL_IN_TR	NSW_IN_TR	TAS_W_TR
		VIT

The ISMP data are limited in the richness of the AL gear types that are identifiable. In addition gillnetting was not recorded as a separate gear type but was subsumed under trawling during 2007 and 2008 (SET). The strata that are identifiable in the historic ISMP data are as follows:

AL CSA	EDL_DS	Offshore
AL EBS / NSW	EDL_IN_TR	SW_BGS_TR
AL ESA	EDL_OFF_TR	SW_ORO_TR
AL ET / WT	Inshore	SW_TR
AL WBS / SAV	Midshore	TAS_BGS_TR
AL WSA / WA	NSW_IN_TR	TAS_E_TR
BS_IN_TR	NSW_OFF_TR	TAS_ORO_TR
ECDW_TR	NSW_RRP_TR	TAS_W_TR

In order to deal with the absence of gillnetting and VIT in the historic ISMP data, the stratum sizes for the SET strata were increased by 38% (based on information in the CDR-GENLOG data) prior to optimisation of designs using the more restricted set of strata listed immediately above. It is now necessary to disaggregate the 'design' allocation recommendations to the probable set of strata that are feasible in the actual implementation of the ISMP. The following initial considerations are required for this step:

1. Reduce the ISMP allocations to SET strata by 1/1.38, and allocate these shots to gillnetting strata based pro-rata on the gillnet shots recorded for the SESSF in the CDR-GENLOG data.

2. Make an allocation to VIT based pro-rata on the VIT shots recorded in the SESSF in the CDR-GENLOG data.

During 2007 and 2008, the proportion of gillnet shots in each of the 7 gillnet strata considered here was as follows:

GN CSA	0.270
GN EBS / NSW	0.326
GN ESA	0.032
GN ET / WT	0.075
GN SAV	0.029
GN WA / WSA	0.189
GN WBS	0.080

In addition, during 2007 and 2008, VIT shots comprised 1.061% of all GENLOG shots in all other strata.

Table 24 and Table 25 report the ISMP stratum allocation information for TEP species groups adjusted for gillnet and VIT as described above. Figure 43 and Figure 44 provides plots of sample size in terms of shots, comparing the average optimal allocation across TEP species groups, with shots allocated pro rata to the actual CDR-GENLOG shots per strata for 2007 and 2008 combined.

We note at this point that in addition to the recommendation that gillnetting and VIT be represented as separate strata in the ISMP planning and implementation, this study will recommend, consistent with the findings from the initial cluster analyses presented much earlier in this document, that the shots allocated to the 'AL' fishery category reflected in Table 22, Table 23, Table 24 and Table 25 be disaggregated on a pro rata basis into the gear types AL+LL (automatic longlining and long lining), BL and DL, based on the expected breakdown of shots by these gear types per 'AL' stratum.

5.7.5 Description of analytical techniques used for annual estimates

The methods used for estimating the number of individuals interacting with SESSF fishing gear, 2002–2008, follow directly from the methods described above. One of the main difficulties which are encountered with this approach is that in certain years, for certain strata, no shots were sampled in the SESSF ISMP. There are thus no estimates of the number of species interacting with the SESSF in certain years and strata and thus for those years the overall estimate will exclude the unsampled strata. Furthermore, in some years, there were no observations of interactions with certain TEP species groups. In these cases, for the years in question, no estimate is given for the CV. The estimates are given in Table 26 and Table 27, where Table 26 includes all individuals observed, whether dead or alive, while Table 27 if for dead individuals only.

5.8 Mapping shots to ports

This section is presented as an aid to planning the implementation of the ISMP. The main results presented here are clusters of ports which have a similar distribution of strata visited, presented separately for the AL, GN, SET, GAB and VIT fisheries.

The purpose of this section is to provide assistance with the selection of ports in order to achieve a predefined number of shots per stratum. In order to do so, the percentage of shots at each port falling into each of the 32 strata described above was calculated. Strata were then divided into the 'gear types' AL, GN, GAB, SET and VIT as indicated. Cluster analyses were carried out to cluster ports, for each of the groups AL, GN, GAB, SET and VIT using the percentages referred to (a K-means clustering algorithm was used). The number of clusters was set equal to the number of strata per group, i.e:

AL – 6
GN – 7
GAB – 3
SET – 15
VIT – 1

The following tables are presented:

- Table 28. A total of 108 ports appear in the data emerging from the CDR/GENLOG merge. A listing of the port names appearing in the CDR/GENLOG merge.
- Table 29. A listing of the 32 strata that arise if one uses the 25 strata from the survey design optimisation exercise, and the 7 gillnet strata shown. (Note that there are a total of 32 strata under the following conditions: (a) the 25 strata used in the survey design optimisation calculations, and (b) the 7 gillnet strata).
- Table 30. AL (6 clusters) – Cluster Membership
- Table 31. AL (6 clusters) – Mean Cluster Percentages
- Table 32. GN (7 clusters) – Cluster Membership
- Table 33. GN (7 clusters) – Mean Cluster Percentages
- Table 34. GAB (3 clusters) – Cluster Membership
- Table 35. GAB (3 clusters) – Mean Cluster Percentages
- Table 36 and Table 37. SET (15 clusters) – Cluster Membership
- Table 38. SET (15 clusters) – Mean Cluster Percentages
- Table 39. VIT (1 cluster) – Cluster Membership

The above results provide a basis for the selection of ports to achieve a particular number of shots.

5.9 Calculation of MWCVs for the ISMP at-sea length frequency data

The collection of length frequency data by observers at-sea forms a component of the ISMP. This section outlines the methods that are used to calculate the mean weighted CVs for relevant species using these data.

Let $n_{y,s,l,i}$ represent the number of individual fish sampled in year y, stratum s, length class l, shot i. We use the following dot notation to denote summation across particular subscripts, i.e.

$$n_{y,s,\bullet,i} = \sum_l n_{y,s,l,i} \tag{4.8- T21}$$

so that $n_{y,s,\bullet,i}$ is the total number of individuals (of a given species of course) sampled on the *i*-th shot in stratum *s* in year *y*. To calculate the estimated length frequency distribution, the length frequency distribution is first normalized for each shot in the ISMP:

$$p_{y,s,l,i} = n_{y,s,l,i} / n_{y,s,\bullet,i} \tag{4.8-T22}$$

A mean proportion $\overline{p}_{y,s,l}$ is then calculated for all shots in a particular year *y* and stratum *s*:

$$\overline{p}_{y,s,l} = p_{y,s,l,\bullet} / S_{y,s} \tag{4.8- T23}$$

Where $S_{y,s}$ is the number of shots per year *y* and stratum *s* combination. At this stage $\overline{p}_{y,s,l}$ would be normalised, i.e.

$$\sum_l \overline{p}_{y,s,l} = 1 \tag{4.8- T24}$$

Associated with this mean is a standard deviation of the proportion $\overline{p}_{y,s,l}$, $SD_{y,s,l}$, which is calculated ignoring the small sample size correction of $S_{y,s}/(S_{y,s}-1)$ on the square of the sample standard deviation. For cases where $S_{y,s}=1$, we replace the 'null' value of $SD_{y,s,l}$ by the mean standard deviation for all values (years and strata) for the same length class where $S_{y,s} > 1$:

$$SD_{y,s,l}(S_{y,s}=1) = \left. \sum_{\forall y,s(S_{y,s}>1)} SD_{y,s,l} \middle/ \sum_{\forall y,s(S_{y,s}>1)} 1 \right. \tag{4.8 - T25}$$

The stratum weight, $SW_{y,s}$ is year and stratum dependent, and is expressed on a mass basis. It is converted to a numbers basis $SN_{y,s}$ via the formula

$$SN_{y,s} = SW_{y,s} \big/ \overline{w}_{y,s} \tag{4.8 - T26}$$

where

$$\overline{w}_{y,s,i} = \sum_l l^3 \overline{p}_{y,s,l} \tag{4.8 - T27}$$

The estimate of the 'number of individuals' in year *y* stratum *s* in length class *l* is $\hat{N}_{y,s,i}$, where:

$$\hat{N}_{y,s,i} = SN_{y,s} \overline{p}_{y,s,l} \tag{4.8 - T28}$$

And the variance of this estimate $V\{\hat{N}_{y,s,i}\}$ is given by

$$V\{\hat{N}_{y,s,i}\} = \{SN_{y,s}\}^2 \{SD_{y,s,l}\}^2 / S_{y,s} \tag{4.8 - T29}$$

The estimate of the 'number of individuals' in year *y*, $\hat{N}_{y,\bullet,i}$, is

$$\hat{N}_{y,\bullet,i} = \sum_s \hat{N}_{y,s,i} \tag{4.8 - T30}$$

and the variance of this quantity $V\{\hat{N}_{y,\bullet,i}\}$ is:

$$V\{\hat{N}_{y,\bullet,i}\} = \sum_s \{SN_{y,s}\}^2 \{SD_{y,s,l}\}^2 / S_{y,s} \tag{4.8 - T31}$$

The CV for a particular year *y* and length class *l*, $CV_{y,l}$ is

$$CV_{y,l} = 100 \times \frac{\left[\sum_s \{SN_{y,s}\}^2 \{SD_{y,s,l}\}^2 / S_{y,s} \right]^{1/2}}{\hat{N}_{y,\bullet,i}} \tag{4.8 - T32}$$

and the MWCV associated with year *y* for the species under consideration is:

$$MWCV_y = \sum_s \{CV_{y,l}\} \frac{\hat{N}_{y,\bullet,i}}{\sum_l \hat{N}_{y,\bullet,i}} \tag{4.8 - T33}$$

A number of alternative calculation procedures have not been considered in this study. The main one involves a different prescription for averaging the shot level data to produce a year x stratum mean length frequency distribution. For example, a possibility is to weight each shot's length frequency distribution by the number of fish of that species sampled on that shot. Such an approach seems appropriate at low fish sample sizes per shot, where weighting by sample size is intended to down-weight shots which are likely to suffer from excessive variance due to low sample size. However, that can lead to overweighting of shots when a large number of fish are sampled for a given shot. Therefore, were such an approach is to be pursued, it should probably involve sample size weighting below a threshold of, say, 30 fish sampled and measured, and weighting by the threshold value (i.e. 30) when the actual sample size is above this threshold. For this interim report equal weighting of normalised shot level length frequency distributions is the approach followed, subject to the caveat that this might unduly overweight shots with very low sample sizes and underweight shots with larger sample sizes.

Table 40 and Table 41 provide the MWCV estimates described above in tabular format.

5.10 Calculation of MWCVs for the ageing data provided for this study, using the at-sea ISMP sampling data.

Ageing data were provided for this study, and the terms of reference for this study require that the CVs for catch-at-age should be presented. The MWCVs that will be developed here are limited to the MWCVs arising from the sampling errors in the ALKs. We define $p_{y,a,l}$ as the proportion of fish in length class *l* (in year *y*) which are from age class *a*. Thus for all *l*,

$$\sum_a p_{y,a,l} = 1 \qquad (4.10 - T34)$$

Let $p_{y,l}$ be the estimated proportion of fish in length class l in year y (the so-called length frequency distribution), i.e.

$$\sum_l p_{y,l} = 1 \qquad (4.10 - T35)$$

The estimated age frequency distribution (of the catch), $p_{y,a}$, is

$$\sum_l p_{y,a,l} p_{y,l} = p_{y,a} \qquad (4.10 - T36)$$

We suggest an approximate approach to determine the MWCV of $p_{y,a}$ It involves treating the Maximum Likelihood Estimate (MLE) based proportions from the available sample as equal to the true underlying proportions $p_{y,a,l}$. In addition, we ignore the variance of $p_{y,l}$, which reflects on the adequacy of sampling for length. An advantage of this approach is that the resultant MWCV for the age frequency will be solely due to the adequacy of sampling for the age-length key, and will not be involved in the length frequency estimation error. Since these two quantities are sampled via different approaches, separation of the length frequency MWCV and the age-frequency MWCV assuming a fixed length frequency distribution provides separate insights into the adequacy of sampling for length and sampling for age. This is useful since the so-called 'at-sea' samples are not the only data available for the estimation of age frequencies for retained catches, port sample are also available for retained catches. However, the 'at-sea' data will be the only available information to estimate the age frequency distributions for the discarded portion of landings.

Under these circumstances the resultant variance of $p_{y,a}$ is $V(p_{y,a})$, where:

$$V(p_{y,a}) = V(\sum_l p_{y,a,l} p_{y,l}) = \sum_l p_{y,l}^2 V(p_{y,a,l}) \qquad (4.10 - T37)$$

And, if $N_{y,l}$ fish are aged in length class l in year y, then:

$$V(p_{y,a,l}) = \frac{p_{y.a}(1 - p_{y,a})}{N_{y,l}} \qquad (4.10 - T38)$$

Therefore,

$$V(p_{y,a}) = V(\sum_l p_{y,a,l} p_{y,l}) = \sum_l p_{y,l}^2 V(p_{y,a,l}) \qquad (4.10 - T39)$$

Note that the above approach to calculating the MWCVs for the age frequency estimates makes the implicit assumption that the fish sampled for ageing are done on the basis of length class stratification, where the length strata are the 1 cm length classes used in the age data. Some caution needs to be used in interpreting the results obtained via this method, since it makes no allowance for the variance due to length classes for which there were no age-samples.

Values for $p_{y,l}$ can be sourced from either 'at-sea' samples, or from port samples. The first set of results that are presented here are for the 'at-sea' length frequency distributions, as derived from the previous section. In order to carry out the calculations referred to, overlap by year and species is required between the age and length samples. The relevant species that are considered here are those which appear in the age data between 2002 and 2008 as well as in the length data, for at least one corresponding year, i.e.:

1. BIGHT REDFISH
2. BLUE GRENADIER
3. BLUE WAREHOU
4. BLUE-EYE TREVALLA
5. DEEPWATER FLATHEAD
6. EASTERN SCHOOL WHITING
7. GEMFISH
8. JACKASS MORWONG
9. ORANGE ROUGHY
10. PINK LING
11. REDFISH
12. SILVER WAREHOU
13. TIGER FLATHEAD

For the period 2002–2008, there were no at-sea length frequency data provided for HAPUKU in the data supplied for the project.

Age frequency MWCVs calculated as described above are presented in Table 15 (retained) and Table 16 (discarded).

The actual sample sizes achieved for ageing (retained and discarded combined) are given in Table 17.

The MWCVs are approximately proportional to the inverse of the square root of overall sample size (for the same shot distribution across strata), and therefore, if a target MWCV for the age error as defined above is set at 10%, the required sample sizes can be calculated. These sample sizes are given in Table 18 (discarded) and Table 19 (retained). The ratios of the required sample sizes (for MWCV as defined to equal 10%) divided by the actual sample sizes are given.

These results indicate that for the 13 species cited above, and either the discarded or retained catch-at-age frequency estimates, the sample size is more than is required to achieve an MWCV of 10% in 8 cases, while it is inadequate in 18 cases. The 8 cases where the sample size is sufficient are:

1. Discarded blue warehou
2. Discarded eastern school whiting
3. Discarded gemfish
4. Discarded pink ling
5. Discarded silver warehou
6. Retained blue grenadier
7. Retained blue warehou
8. Retained gemfish

5.11 Calculation of MWCVs for the ageing data provided for this study, using the port length frequency data

A similar exercise to that carried out above for the at-sea ISMP length frequency samples can be carried out for the port length frequency data. There are however, some differences in approach which have to do with the sampling procedure for port based data. The essential difference is that it is not possible to fully disaggregate a port length frequency sample back to its constituent strata. Stratified weighting of the port length samples to obtain a full catch weighted length frequency distribution cannot therefore be readily achieved using the ISMP strata, whether historic or as proposed by this study. Achieving a catch weighted length frequency distribution is therefore probably best done according to strata which are available at the port level, and which reflect the proportion of the catch weight in each strata. The data contain variables such as 'Zone' and 'Grade' which can be used. For example, annual zone-level retained catches are available from the CDR-GENLOG merge carried out here. However, catches split by 'Grade' are not readily available at the CDR-GENLOG merge level.

Furthermore, the definition of a sampling unit for a port length frequency sample is not straightforward. There is, for example, a sampling process taking place regarding fish sampled for length measurement, however the data does not contain replicates at this level so other than proposing a multinomial sampling process, there is no empirical basis for quantifying the variance or uncertainty associated with the port sampling process for a given landing.

Another sampling process takes place w.r.t. to the selection of landing to be sampled. The sampling process (e.g. proportional random) could be used to generate variances for length frequency samples at this level.

Some of these complications seem to lie outside the scope of this study. The approach taken here has been to calculate a number of fish per length class at the following level:

- CSIROcode
- Year
- Month
- Day
- Gear code
- Zone code
- Grade
- Port
- Catch weight
- Length class

The reason that catch weight has been included as a key is that there are instances in the data where the value of catch weight is not unique with respect to a key obtained from CSIROcode, Year, Month, Day, Gear code, Zone code, Grade, Port, and Length class. The authors have concluded that there were probably other keys involved for which catch weight was unique. These keys are apparently not present in the data (various exploratory analyses were carried out to try to ascertain which variables might be involved). Consequently catch weight itself was used as an additional key, as a proxy for these other keys.

The number of fish in the catch at the key level was calculated assuming a cubic relationship between fish length and weight — the weight conversion of these numbers would sum to equal the catch weight. Annual and species specific estimates of fish catch numbers were produced at the following level of data aggregation:

- CSIROcode
- Year
- Length class

These fish numbers were then normalized across all length classes to produce a normalised length frequency estimate.

The length frequency distributions so described were then used to calculate the MWCVs inherent in the ageing data for the retained catch, as described in the previous section. Only a few species and years emerge after the merge between the port length frequency and ageing data available to this study. These are shown in Table 20, where the quantity shown is the MWCV associated with the 'multinomial ageing error'.

The results in Table 20 should be compared to those presented in Table 15. The only differences are that a different retained length frequency distribution is used as the basis for the calculations.

We note that the pink ling MWCV in 2008 was 10.11, despite the fact that only 10 pink ling were aged in 2008. This rather misleading MWCV estimate comes about because the MWCV estimation procedure for ageing ignores the variance associated with lengths that are not sampled. **A minimum requirement for age sampling would of course be that all length classes are sampled.** This is certainly not the case for the 10 pink ling sampled for ageing in 2008. The MWCVs reported here should therefore be regarded as negatively biased and hence somewhat optimistic, particularly for very low numbers aged, say less than 100, and or where it is clear that the ageing data only covers a limited range of the entire retained catch length frequency distribution. Despite this the results in Table 20 do reliably reflect the trends in ageing sample size for jackass morwong, where the sample size dropped from 245 in 2006, to 120 in 2007, with a corresponding increase in the MWCV from 23.98 (see Table 15) to 31.68 (see Table 20 above). This problem is related to the fact that the MWCVs have been calculated under the assumption that the underlying sampling process is length stratified, which is only the case for certain species and years. A more comprehensive analysis incorporating the full impact of completely random sampling for age is outside the scope of this study.

5.12 Calculation of the optimal combination of numbers of fish sampled per landing, and number of landings sampled, for the port length frequency sampling process

An exercise was carried out to provide input into the determination of the optimal combination of numbers of fish sampled per landing, and number of landings sampled, for the port length frequency sampling. The initial aim of this calculation is to determine the respective contributions to the total MWCV due to the number of fish sampled per trip, and the number of trips sampled.

To do this exercise it is necessary to identify trip in the port length frequency data. This was done by using the following key (which includes a split by species):

- CSIROcode
- Year
- Month
- Day
- Gear code
- Zone code
- Grade
- Port
- Catch weight

There are potential problems with this key, such as 'Grade', but the use of grading as a stratification variable is limited, hence we felt that this provided a workable definition of trip.

For each trip x species, a mean length frequency was calculated — these length frequencies were all padded out with zeroes so that they have the same dimensions. A mean and variance can then be calculated for each length class (length classes are 1 cm wide for most species although 0.5 cm is used in some cases such as redfish). This variance is the total variance of the proportion of fish sampled across trips, say Vtot, where it is implicit that this value differs for each length class. Calculation of the variance in this way without allowance for differences in total landings across trips is open to question but is a reasonable short cut approximation. The true sampling process involves a finite population, and possibly random selection of clusters, and a complete treatment would ultimately have to involve complex sampling theory, which is outside the scope of this study.

If Vtot was solely due to the multinomial error process involved in sampling fish, with the same true underlying length frequency distribution in catches from trip to trip, then it should closely approximate the theoretical multinomial variance from the known number of fish sampled per trip. This multinomial variance is simply p(1-p)/f where f is the number of fish sampled per trip. The variance due to trip is therefore approximated by the difference between Vtot and p(1-p)/f, which we will refer to as Vtrip, Vtrip = Vtot - p(1-p)/f. Vtrip can thus be calculated empirically for each species, year and length class, for the particular value of f that applied for 2008 (we use an average f across all trips for that year). We have limited our analysis to the 2008 data, or for species poorly sampled in 2008, the 2007 data, since these years reflect the most recent characteristics of the fishery. The variance of the mean proportion, Vmean, for any value of f and for any number of trips T is thus given by

$$\text{Vmean} = (\text{Vtrip} + p(1-p)/f)/T \qquad (4.12 – \text{T40})$$

And the MWCV is just the sum of

$$p \times 100[\text{Vmean}]^{1/2}/p \qquad (4.12 – \text{T41})$$

over all length classes.

It seems important to point out that in the port sampling data from the SESSF, Vtot exceeded p(1-p)/f (for the 2008 value of f) by a factor of between 5 and 25, indicating that trip to trip variance unrelated to multinomial noise plays a very important role in the determination of the MWCV.

The main conclusion that follows from this is that if there is no difference in cost for all combinations of f and T which have the same product fT (i.e. the same total number of fish sampled per year), then it is always better to increase the number of trips sampled, and reduce the number of fish sampled per trip, since the smallest MWCV will always be achieved for the largest possible value of T.

Naturally one expects there to be greater costs associated with increasing T subject to the constraint that fT is invariant. Although this matter is probably outside the scope of this study, if more detailed cost information becomes available, then it may be possible to carry out a more realistic optimisation calculation. In that case there may be a non-trivial optimal combination of f and T (i.e. one that does not simply favour the largest value of T possible).

We note that although the same analysis was not attempted for the at-sea length frequency data, we strongly suspect that it will conclude that the minimum MWCV is achieved by increasing the number of shots when the product of shots and fish sampled per shot is held constant (i.e. the total number of fish sampled at-sea remains invariant).

In relation to the above, it appears from Table 10 to Table 12 that the number of trips sampled per year is lower in 2007 and 2008 compared to 2002–2006, whereas the average number of fish sampled per landing is larger (by more than double). We are concerned that this may simply reflect a problem with our definition of trip. However if this is a real change in sampling strategy then it represents a sampling trend in the wrong direction when minimum MWCV is the objective.

A limited amount of output has been prepared for a selection of species to illustrate the application of the methods described above. This output is summarised in Figure 22–Figure 35, where the relationship between the MWCV and T is shown subject to the 2008 value of fT and a value of fT which is respectively twice or 50% as large.

5.13 Collection of additional information relevant to fishing trips/operations including

Thorough analysis of available data provided insight into the shortfalls in the information recorded as part of the routing fisheries and observer data collection programs. These shortfalls significantly increased the difficulty of analyses, and reduced the amount of data available for these analyses. Major issues are discussed in more detail in Appendix A.

The absence of a unique key to link CDR, GENLOG and observer data (at-sea and port) causes inefficiencies in data pre-processing that could be easily rectified. While merging these data sets has become more reliable since 2000, there is still considerable drop-out requiring “decision rules” that can introduce unnecessary error before analysis has even begun. We strongly advise — if this has not already been done — that such a key be established in the data recording process. An example of a unique key that would enable merging is including the fields: vessel ID, trip end date and trip end time in all datasets. Each fields, of course, should contain the same formatting in both datasets. Trip end time is required to take into account multiple landings on a single day. With the addition of shot number or shot time in the at-sea and GENLOG data, individual shots can also be matched between the data sets. Improvements in this area will increase the quality and quantity of data available for use in a wide range of analyses beyond this project.

The use of different species codes in CDR, GENLOG and ISMP data sets also required considerable effort to resolve. The ISMP data contained CAAB codes, the CDR data contained a 3-letter AFMA code and the GENLOG data contained both 3-letter AFMA code and CAAB codes. This was further complicated for instances in which more than one AFMA code is linked to the same CAAB code in the GENLOG data, and by species that appeared in one or two data-sets, but not all three. Australian Fish Names Standard AS SSA 5300 was approved in 2007 and incorporates the Codes for Australian Aquatic Biota (CAAB). We recommend that CAAB codes be used in all data sets that will make the merging of the data with each other easier, and also improve potential linking with other datasets (e.g. Fisheries Independent Surveys).

CDR data contained numerous instances of nonsensical issues that fall into six different categories:

- Trips for which end dates occur after the start date of the next trip for the same vessel – **overlapping trips**
- Trips in which the end date is equal to the start date of the next trip for the same vessel – **special kind of overlapping trip**
- Trips in which the end dates occur before start date – **inverted trips**
- Situations where shot dates lie in-between the end-date and start date of the next closest trips for the same vessel – **crack situation**
- Situations in which a trip is nested within another trip – **nested trips**

- Situations where two trips have the same start and/or end-dates – **really a special combination of all of the above**

These issues should be picked up and corrected during validation of data entry. If it is not already done, we recommend that a validation procedure is implemented to cross check start, end and shot dates and times for each vessel.

The observer data was delivered in a number of different structures including flat files, databases and Excel spreadsheets. Each tranche of data contained different fields and formats resulting in inefficiencies during the pre-processing stage, and increasing the risk of introducing errors. Consistent format and data storage should be employed for each of the datasets. This will also be beneficial for routine analysis (e.g. for stock assessment) and ad-hoc queries. A particular problem arose in trying to identify observer trips on gillnet vessels from trip on trawl vessels. It is unclear why this differentiation could not be made as there appears to be a number of fields available to accommodate gear code including "gear" and "TRAWLTYPE". Gear code recording procedures need to be improved for these data to be used in efficient, accurate analyses.

The TEP data was at times missing information on the life-state/fate of the interacting animal that might be required to more accurately assess impacts of fishing etc. This was particularly the case when interactions were recorded in the 'ISMP catch' table that contained no field for recording fate apart from 'Comments', which cannot easily be used in routine analyses.

There were two major difficulties in reconciling information on TEP species:

1. Interactions where the animal was caught were sometimes recorded in both the 'ISMP catch' table and the 'TEP interactions' table

2. A lack of unique key that could be used to match the 'TEP interactions' table and the 'ISMP catch' table

The first problem can be overcome by including a decision rule into the observer *Operation and Procedure Manual* (or equivalent) by specifying that either **all** interactions with TEP species get recorded on the 'TEP interactions' table only, or that **extractive** TEP interactions be recorded in the 'ISMP catch' table only. In light of the previous paragraph, it is preferable that the former option is adopted to enable information on the life-state/fate of the animal to be recorded. The second problem can only be overcome by the inclusion of a clear unique key that can be used to merge the 'TEP interactions' table 'ISMP catch' table, as mentioned near the top of this section.

While detailed gear information are routinely collected for the GHAT sector, the SET data lacks sufficient gear details to enable comparison of catch by gear type for example. Such information would be useful in examining impact of gear changes on discarding or of the use of BRDs and offal management on interactions with TEP species. Additional fields recommended to be collected as part of the at-sea observing are listed below:

Ground gear type
Disc size
Codend mesh size
Net type
Headrope length
Footrope length
Wing spread
Maximum wing mesh size

Sweep length
Bridle length
Length of rope per side
Mesh type
Maximum wing mesh size
Bycatch reduction device (e.g. square mesh panel/SED/Tori line)
Offal discharge management (e.g. bulk discharge/discharge while steaming)

6. Discussion

6.1 Data pre-processing

In preparing the data for analysis to meet this project's requirement a myriad of data pre-processing challenges were encountered. Some, such as the CDR-GENLOG merge, are a well known feature of the data and of this type of analysis; others were unique to this project, such as the difficulties of linking wildlife interaction records to fishing activities. In hindsight there are clear modifications to data recording procedures which would significantly enhance the value of the available data for analyses such as are carried out here. Examples of such modifications include the creation of a key that is able to link landing records (CDR data) with shot level fishing activity records (GENLOG data). Others are, for example, improvements in the gear code recording procedures – it is not possible to identify gillnet fishing in the ISMP data since there was, apparently no provision for this gear code to be recorded during the execution of the ISMP. Indeed recommendations for how to best make this modification forms part of the deliverables for this project. A compilation of all such issues does not appear here but can be gleaned from the Appendix dealing with data pre-processing (Appendix A).

It seems appropriate to offer a word of caution. The reader will have noted that the data pre-processing step of this project involved a substantial technical input. It also incorporated numerous assumptions centred predominantly around the CDR–GENLOG merge, and around other 'forced merges' which were required in the absence of keys linking operationally linked but data-wise unlinked tables. Much subsequent statistical analyses have been carried out using the data flowing from these processes. It is important to bear in mind that there are errors, perhaps better referred to as biases, which have been introduced by the data pre-processing steps. Their scale and direction have not been assessed for this document, and in some cases this is not possible.

6.2 ISMP Stratification

The re-stratification of the SESSF ISMP reported upon here has focussed on the GAB and GHAT components of the ISMP, given the longer history of the ISMP for the CTF, and the more established basis for stratification in that sector. The results suggest that the GAB needs to include some stratification by depth, while the GHAT needs stratification by gear and by a geographic zonation variable. The last mentioned is thus support for the current or similar geographic stratification scheme presently in use for the GHAT. The variable used to make recommendations on the stratification was (a) the species composition of catches, and (b) a gross discard measure for different catch species assemblages (clusters) identified in the SESSF fishery. Further stratification using other variables could be attempted, but was not carried out here.

The issue of stratification is a complex one in the context of this project. Broadly one envisages two sets of strata:

- For purposes of estimation – the historic strata used in the ISMP
- For purposes of a revised design for the SESSF ISMP – a new set of strata, as proposed broadly above

For this document we have however taken the liberty of presenting historic estimates using the new strata proposed for the revised ISMP (in effect mixing the two concepts above). In addition, the second category of strata must be separated further into:

- A set of strata used to determine the optimal sample size distribution across strata
- A set of strata which is the recommendation for strata to be used in the actual implementation of the revised SESSF ISMP

The reason for the difference in the two sets of strata referred to above is that certain strata which should be included in the revised SESSF ISMP cannot be identified in the ISMP data because:

1. As mentioned above gillnetting cannot be identified in the 2007/08 ISMP data and gillnet shots are recorded as trawl shots and hence subsumed in the SET strata.
2. VIT (Victoria Inshore Trawl) could not necessarily be identified as a separate stratum in the SESSF ISMP.
3. In many cases, the different types of line fishing (AL, LL, DL, BL) cannot be identified in the ISMP data.

It is thus necessary to concatenate certain strata which should ultimately be used in the revised SESSF ISMP, for the purpose of the design optimisation calculations. The way that this is done is as follows:

In order to deal with the absence of gillnetting and VIT in the historic ISMP data, the stratum sizes for the SET strata were increased by 38% (based on information in the CDR-GENLOG data) prior to optimisation of designs using the more restricted set of strata listed immediately above. It is now necessary to disaggregate the 'design' allocation recommendations to the probable set of strata that are feasible in the actual implementation of the ISMP. The following initial considerations are required for this step:

1. Reduce the ISMP allocations to SET strata by 1/1.38, and allocate these shots to gillnetting strata based pro rata on the gillnet shots recorded for the SESSF in the CDR-GENLOG data.
2. Make an allocation to VIT based pro rata on the VIT shots recorded in the SESSF in the CDR-GENLOG data.

During 2007 and 2008, the proportion of gillnet shots in each of the 7 gillnet strata considered here was as follows:

GN CSA	0.270
GN EBS / NSW	0.326
GN ESA	0.032
GN ET / WT	0.075
GN SAV	0.029
GN WA / WSA	0.189
GN WBS	0.080

In addition, during 2007 and 2008, VIT shots comprised 1.061% of all GENLOG shots in all other strata. Strata are, subsequent to the optimal design calculations, disaggregated into the final recommended strata, on a basis pro rata to shot frequency in the SESSF in 2007 and 2008 – to reflect the very recent structure of the fishery.

6.3 Optimal ISMP design considerations for total catch - commercial and high risk species

The analysis of discarding on a mass basis represents an important aspect of this study. Considerable conceptual complex was evident when we reviewed methods used in previous similar studies. The estimation of the tonnage discarded, based on ISMP records of retained and discarded amounts, has many facets to it. Does one base the estimate on the ratio of discarded to total catch, or on the mean discarded amount per shot? The pros and cons between these methods are numerous and by no means straightforward. They depend, for example, on whether estimates involve extrapolation into unsampled strata, and on the discarded amount expressed as a percentage. A composite method was eventually developed and formed the basis of the ISMP redesign analysis described here.

This report describes a progressive sample size allocation scheme which sequentially allocates samples, one at a time, based on predefined objectives.

Depending on the overall objective supplied to the ISMP optimisation algorithm, the progress of a sample allocation process can be tracked. This process can be stopped at an economically desired total number of shots, and so it becomes a useful tool for the development of the ISMP survey and sample size allocations per stratum. There are numerous areas though that could benefit from feedback from those responsible for the ISMP and its design and we have pointed out these areas at the beginning of this document. The main areas are the objectives for the design of which an important component is the relative importance of difference species.

Notable in Figure 7 for example, is the disproportionate sampling effort preferred in the EDL_IN_TR and GAB Inshore strata. Both of these strata contain many Project Keys (EDL_IN_TR has 60 out of 75, GAB Inshore has 62 out of 75). Both also have high average standard deviation to mean discard ratios of more than 1. Note that the EDL_INS _TR stratum is favoured by the VWCV method, implying that a lot of the high value species reside there. This stratum gets a high proportion of sampling effort right from the word go.

The GAB Inshore stratum on the other hand is favoured by the MinS method. It also only starts blowing out when the sea-days gets to about 400 (i.e. when we get down to the last 10 to 15 species which are still above target). Note, that for 13 project keys, more than half of the total estimated discards for that project key occur in the GAB Inshore stratum, so that in order to get precision on the estimate of discards for these keys, considerable sampling is required in that area.

In Figure 6 we note that the MinS-HR method achieves its objective of bringing the 7 high risk project keys below target within 500 sea-days. However, at this level of sampling 14 of the commercial project keys are still above target. The MinS (commercial) method on the other hand has only 9 commercial species above target, but also 4 of the 7 high risk project keys. This illustrates one of the trade-offs to be made between the differing objectives of the program. The 4 plots of Figure 5 and Figure 6 represent 4 distinct objective functions (2 commercial and 2 high risk). Each plot is underscored by the method which is specifically designed to meet that objective.

6.4 Costs of the sampling designs

We were only provided with very broad figures from which to estimate the cost of the various sampling designs. AFMA indicated that observer costs were currently $730.00 per land-day based on 117 land days and $1005.00 per sea-day based on 587 sea days. We understand that these costs include all AFMA overheads, but it was not clear if this included costs to analyse and report on the ISMP data. Without additional information on the locations of the observers relative to the ports and the method of determining the conditions under which land-days are paid, it is impossible to accurately determine the costs of any of the sampling designs. To enable a relative comparison of the different designs, we have simply estimated relative costs based on the sea-day requirements alone, based on $1000 / per sea-day. Thus, a sampling strategy requiring 500 days can be estimated to cost $500,000. It must be stated that this will be the very ***minimum*** cost as it does not take into account travelling time and expenses and any land-day costs. It should also be noted that these estimated costs are based on the current observer program and it could be reasonable to expect that greater at-sea observer coverage would give greater economies of scale.

The AFMA costs for port sampling were stated at $25 per hour, during which it was expected that approximately 60 length frequency or 12 pair of otoliths could be measured per hour. It is not clear how these output figures were derived, but they appear to be a very conservative estimate of what can be achieved. Again, we are unable to estimate the actual cost requirements for port-sampling without knowledge of where the port-based samplers will be based and the amount of length frequency data that will be collected at sea. This latter factor is also dependent on which sampling design is ultimately chosen.

6.5 Length and age frequency MWCVs

Lengths

Methods were developed to make it possible to comment on the adequacy of the sampling for length and age. For this purpose it was assumed that the redesign of the SESSF ISMP would be primarily based on the retained and discarded catch information, and hence length and age related design considerations are an adjunct to the main drivers of the design. Given that context, the most important design issue considered for length was the trade-off between the number of fish sampled per shot or trip, and the number of shots or trips sampled. Shots are relevant to the at-sea sampling for length, while trip is applicable to the port based length sampling. While the sampling frame for the at-sea samples can be approximated as a standard random stratified sampling scheme with infinite population sizes (even though the population sizes are finite), with the strata as defined here for the ISMP, the sampling frame for the port sampling is less easily characterised on that basis. In the first instance the concept strata for port sampling are not the ISMP strata, but rather each trip that is sampled. In that case the stratum size is related to the total number of fish landed. However, since not all trips are sampled, and since there are apparently no within trip replicates, the applicable sampling frame falls into the class of complex sampling frames. Thus the methods developed here, assuming that each trip represents a simple random sample of a length frequency distribution from an infinite population size of trips, is described as a short cut method. For the port sampling data only, the multinomial within trip variance and the trip to trip variance is decomposed so that the implications of different numbers of fish sampled per trip and trips sampled in total can be explored. These results suggest that if the total annual number of individuals sampled per year is held constant, then the precision of length frequency estimates is always improved by increasing the number of trips sampled (and of course reducing the number of fish sampled per trip). There are some indications in the data that in 2007 and 2008 the sampling strategy for port samples shifted from sampling more fish per trip on fewer trips. This strategy, if correctly inferred from the data, would reduce the precision of length frequency estimates.

The same calculations were not carried out for the at-sea length frequency data, but the same result is extremely likely (i.e. that more shots is the way to go to significantly reduce MWCVs for the length frequency distributions, and not more fish measured per shot). Cost considerations obviously impinge on the shot/trip versus fish measured trade-off and the additional expense of more shots/trips is likely at some point to kick-in, but this threshold requires more detailed economic information than was available for this study. It is possible that increasing the number of shots is so much more expensive than increasing the number of fish sampled that the latter is the only economically feasible option. If so one needs to appreciate that the benefits will be considerable less than ‘root N’ where N is the total number of fish sampled.

We do provide some information in the text on species specific MWCVs, and how to determine what sample size would be needed to achieve lower MWCVs. It is easy in this output to highlight species where the MWCVs are too large, for either the retained or discarded component of the catch.

The precision of the length frequency distributions from at-sea samples seems most inadequate overall for retained: gummy shark, gemfish, ribaldo; and for discarded a large number of species exhibit unacceptably high MWCVs .

For the port sampling data the following species show MWCVs well in excess of 20%: redfish, school shark, blue-eye trevalla and alfonsino.

Age

The adequacy of age sampling was studied using either the at-sea or port based length frequency distributions as fixed quantities, and then calculating the MWCV for the age frequency distributions from the cumulation of multinomial error arising from the age length key proportions and number of fish aged per length class. Assuming that the length frequencies are error free in this way allows one to focus on the errors in the catch age frequencies arising from the ALK. It is of course acknowledged that the total variance of the age frequency distributions estimates involves both the errors in the length frequency estimates and the age frequency estimates per length class.

This calculation assumes that the age sampling was length stratified which may not always have been the case, but the method is regarded as a useful index of the adequacy of age sampling. It is then a simple matter to inspect the output and ascertain where the age sampling needs to be increased or decreased to achieve a particular MWCV — we suggested a target MWCV of 10%, but the calculation is easily adapted to deal with other target MWCVs via the square root of N rule described in the text.

The number of ageing samples is most inadequate for retained species: Bight redfish, jackass morwong, orange roughy (2004 and 2005 only available), and for discarded species: Bight redfish, jackass morwong, orange roughy (2004 and 2005 only available).

6.6 Optimal ISMP design considerations for fishery-TEP interactions

The TEP interaction data and analysis work submitted here focuses on an analysis of the number of TEP species group individuals interacting with the SESSF. We also present estimates of the number of deaths occurring as part of TEP-SESSF interactions. The statistical model that is used is one in which the ratio of variance to mean for a TEP species group is invariant over space and time, although the mean may vary over space and time. This ratio is closely related to the typical or average group size for TEP species groups encountered by the SESSF, where the numbers obtained were:

Birds:	37.5
Pipefish:	1.74
Seals:	8.38
Sharks:	1.50
Whales/Dolphins:	292.91.

Consideration of the number of individuals involved in an 'interacting' shot is dealt with by multiplication of the mean number of individuals per interacting shot and the total number of interacting shots. This produces estimates of total individual numbers interacting with the fishery. In addition, using comments captured as free text in some of the data (ISMP TEP Interaction table), estimates of TEP mortalities recorded by ISMP observers were made and these were multiplied up to produce estimates of total annual mortalities in the TEP.

The results for the optimal design for TEP species groups are produced separately for each TEP species group. The results presented here are limited to illustrative results produced for 400 sea-days. Fractional days and shots are permitted in these calculations. The sample sizes required to achieve a CV_{target} different to the value shown here, CV, is obtained by multiplying 400 sea-days (or the corresponding number of shots) by the square of CV/CV_{target}. Given this, it is clear that it is only for 'Birds', 'Pipefish' and 'Seals' that the optimal design achieves a target CV less to or close to 20%. The sample size would have to increase by at least an order of magnitude to hope to achieve 20% for the Sharks and Whales/Dolphins groups.

At this stage the important issue is the distribution of shots for the said 400 sea-days. Optimised results are shown in Table 22 to Table 25. A decision on the preferred design will have to involve a compromise between different TEP species groups (aside from the compromise with the optimised design results for the commercial and high risk species groups). We offer here one simple compromise, averaging the optimal number of days and shots per stratum for each species group across all species groups. Table 22 shows that these average optimal shot allocations are markedly different to the shot allocations which are simply proportional to the shots in the fishery (from the GENLOG data).

It is clear from these results that the optimal shot distribution differs markedly between the different species groups. In many cases these are being driven by the stratum where there happens to have been a chance sighting of a particular TEP species individual. Many strata show no observations of TEP species groups in the ISMP between 2002 and 2008. It seems unlikely that there were in fact no interactions in the fishery, hence the use of a background level of SESSF-TEP interactions as an alternative basis for optimal design calculations (see Table 23 and Table 25). Here again we offer as a simple compromise, averaging the optimal number of days and shots per stratum for each species group across all species groups. Table 23 shows that this compromise is now closer to the proportional allocation to shots in GENLOG than for Table 22. This is because the inclusion of some underlying background level of TEP interactions tends to spread out the average optimal shot allocations.

The CV implications of these different results obviously need to be weighed up. Both Table 22 and Table 23 show the extent to which the optimal CVs increase when compromising on the average shot allocations, and again when moving to the proportional shot allocation approach. Since optimal cannot be achieved for each TEP species group, the important comparison is between something like average and proportional. Table 23 suggests that the increase in CV going from average to proportional is most marked for birds and seals, but immaterial for the other TEP species groups.

It seems appropriate to offer a word of caution. The reader will have noted that the data pre-processing step of this project involved a substantial technical input. It also incorporated numerous assumptions centred predominantly around the CDR – GENLOG merge, and around other 'forced merges' which were required in the absence of keys linking operationally linked but data-wise unlinked tables. Much subsequent statistical analyses have been carried out using the data flowing from these processes. It is important to bear in mind that there are errors, perhaps better referred to as biases, which have been introduced by the data pre-processing steps. Their scale and direction have not been assessed, and in some cases this is not possible.

6.7 Data collection

Many of the difficulties experienced during the pre-processing phase of this project could have been avoided if the CDR, GENLOG and ISMP data were more consistent. Merging these data sets was difficult because of the lack of consistent unique keys and species codes, and these issues are discussed more thoroughly in Section 5.12 and Appendix A. It is recommended that a common unique key (such as 'vessel ID', 'trip end date' and 'trip end time') be recorded for every fishing and observer trip. In addition, the recording of a shot ID code (such as 'shot start time' or 'shot number') in GENLOG and ISMP data would aid the merging of these data sets to the shot level. The Codes for Australian Aquatic Biota (CAAB) is an Australian Standard, and should be adopted as the standard species code in all SESSF fishery datasets. These two improvements will result in more efficient data processing in the future, reduce the risk of introducing errors, and increase the amount of quality data available for analysis. These benefits will be realised in applications such as routine stock assessments and data queries.

Other improvements recommended include creating a validation procedure for GENLOG data entry to reduce errors in start, end and shot dates, standardising collection of TEP interaction data, and increasing the detail of trawl gear specifications recorded.

7. Acknowledgments

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9. Figures and Tables

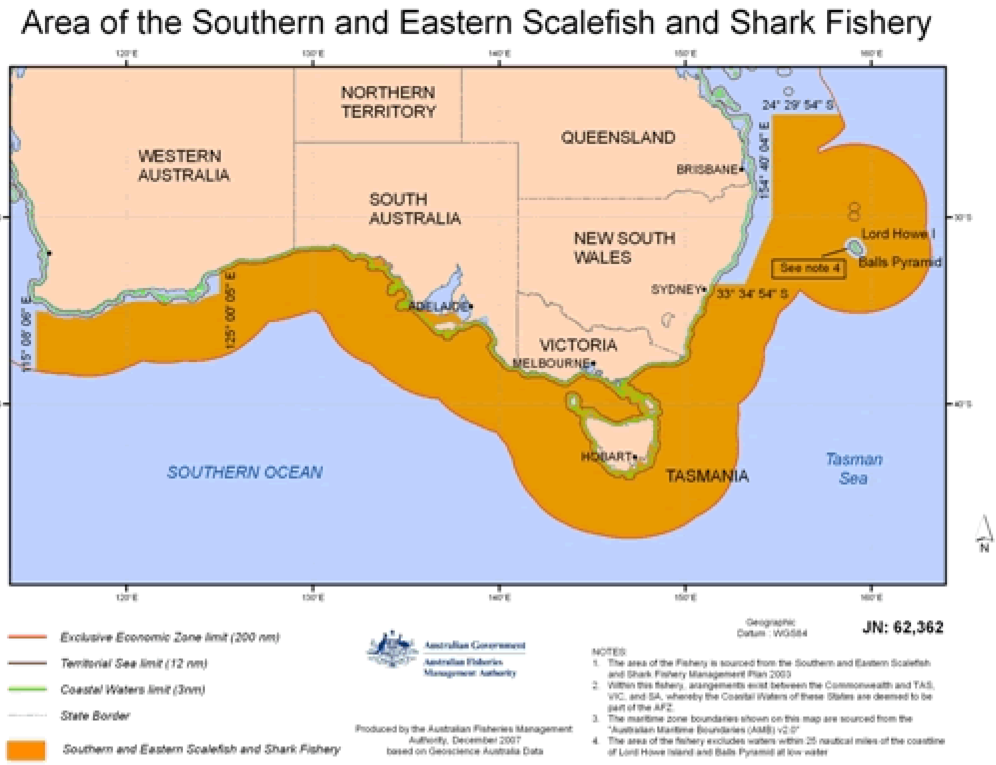

Figure 1 - Area of the Southern and Eastern Scalefish and Shark (© Commonwealth of Australia 2005).

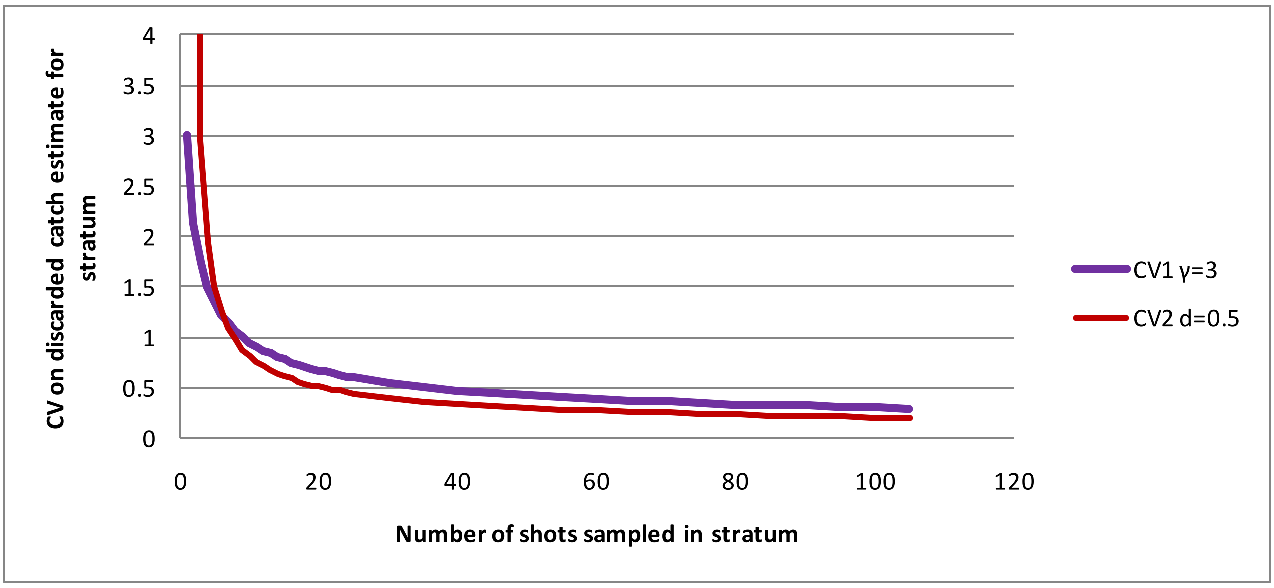

Figure 2 - Theoretical Comparison of CVs using Methods A and B for estimation of Discarded Catch. CV1 uses method A with an assumed gamma value of 3. CV2 uses method B with an assumed discarded proportion of 0.5.

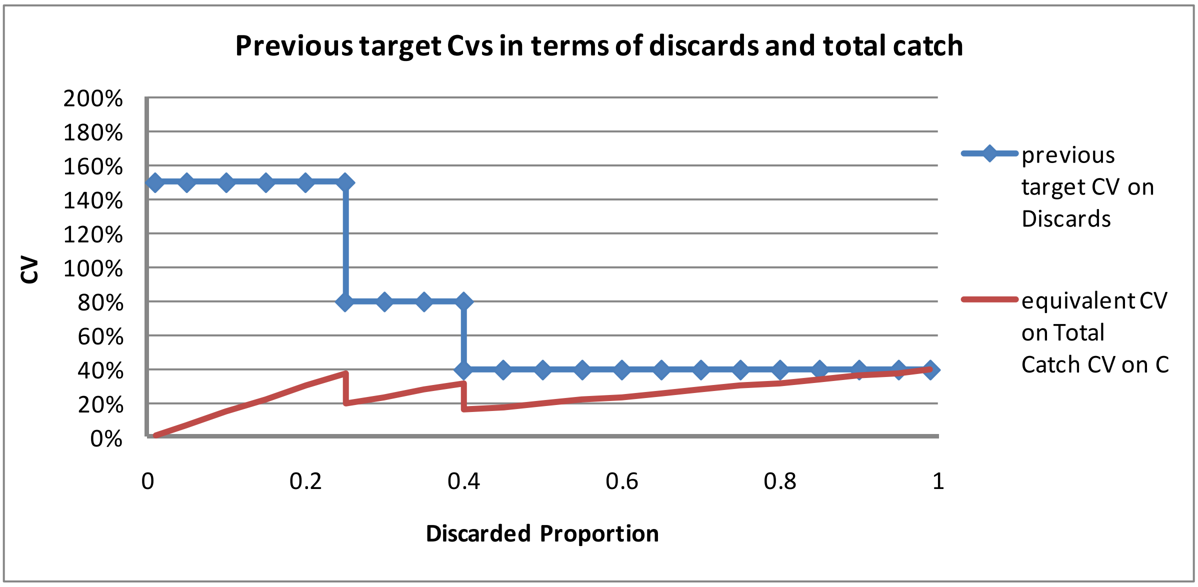

Figure 3. Comparison of CVs for the discards and the equivalent CV for the total catch.

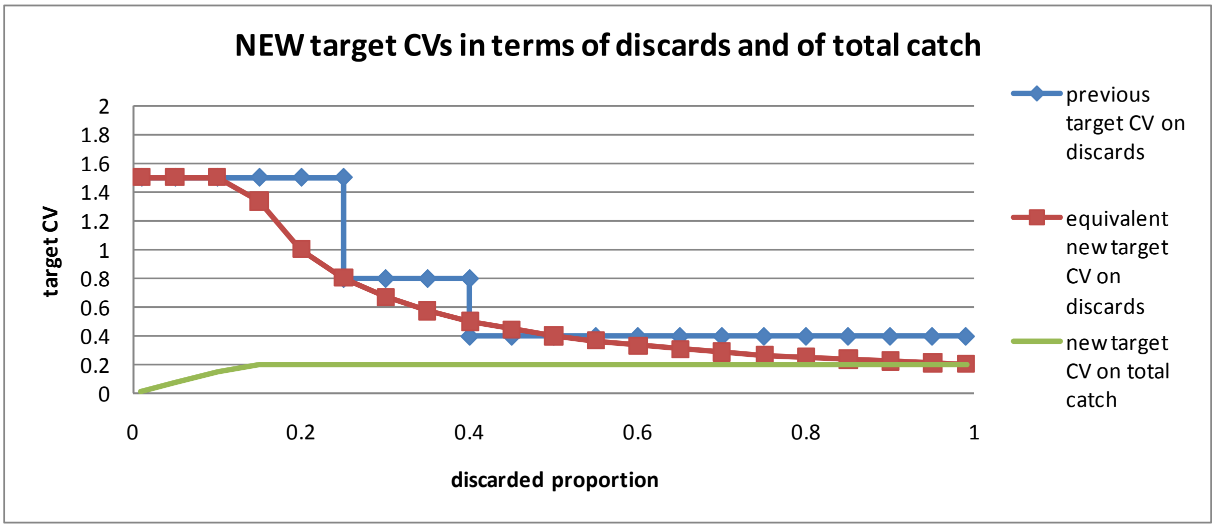

Figure 4. Comparison between a the new target CV n the total catch (no symbols, solid line), the equivalent CV on the discards (square symbols) and the target CVs on discards used in previous ISMP redesign studies (diamond symbols.)

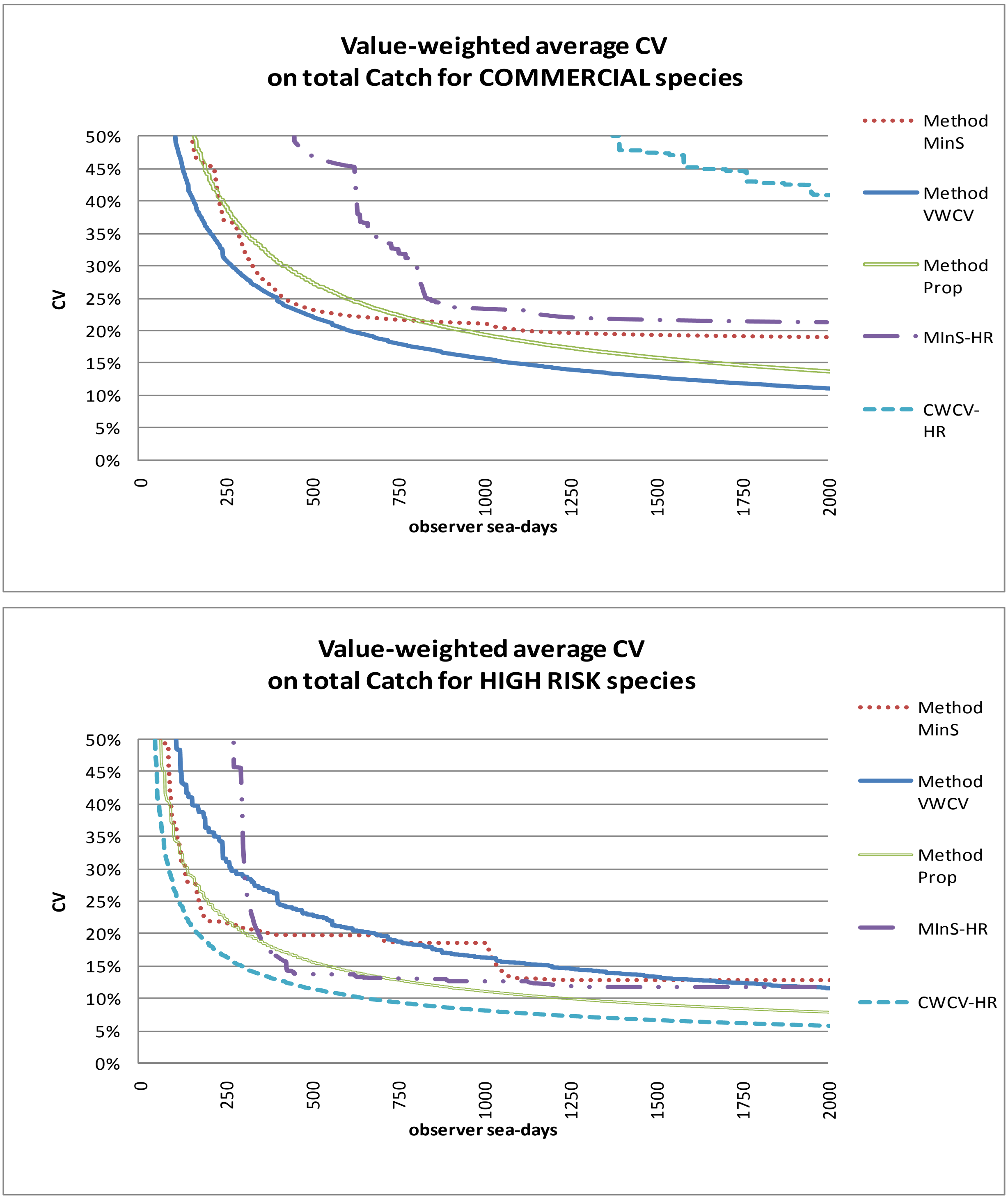

Figure 5. Progress of each of the 5 allocation methods by number of observer sea-days allocated. The statistic shown is the value-weighted average CV for the 68 commercial project keys (upper panel) and for the 7 HIGH RISK project keys (lower panel). The allocation methods used are: VWCV (which minimises the value-weighted average CV), MinS (which minimises the number of project keys with CVs above target); Prop (allocates sampling effort in proportion to the size of the fishery in each stratum); CWCV-HR (minimises the catch-weighted average CV for the HIGH RISK species), MinS-HR (minimises the number of HIGH RISK species groups with CVs above target.)

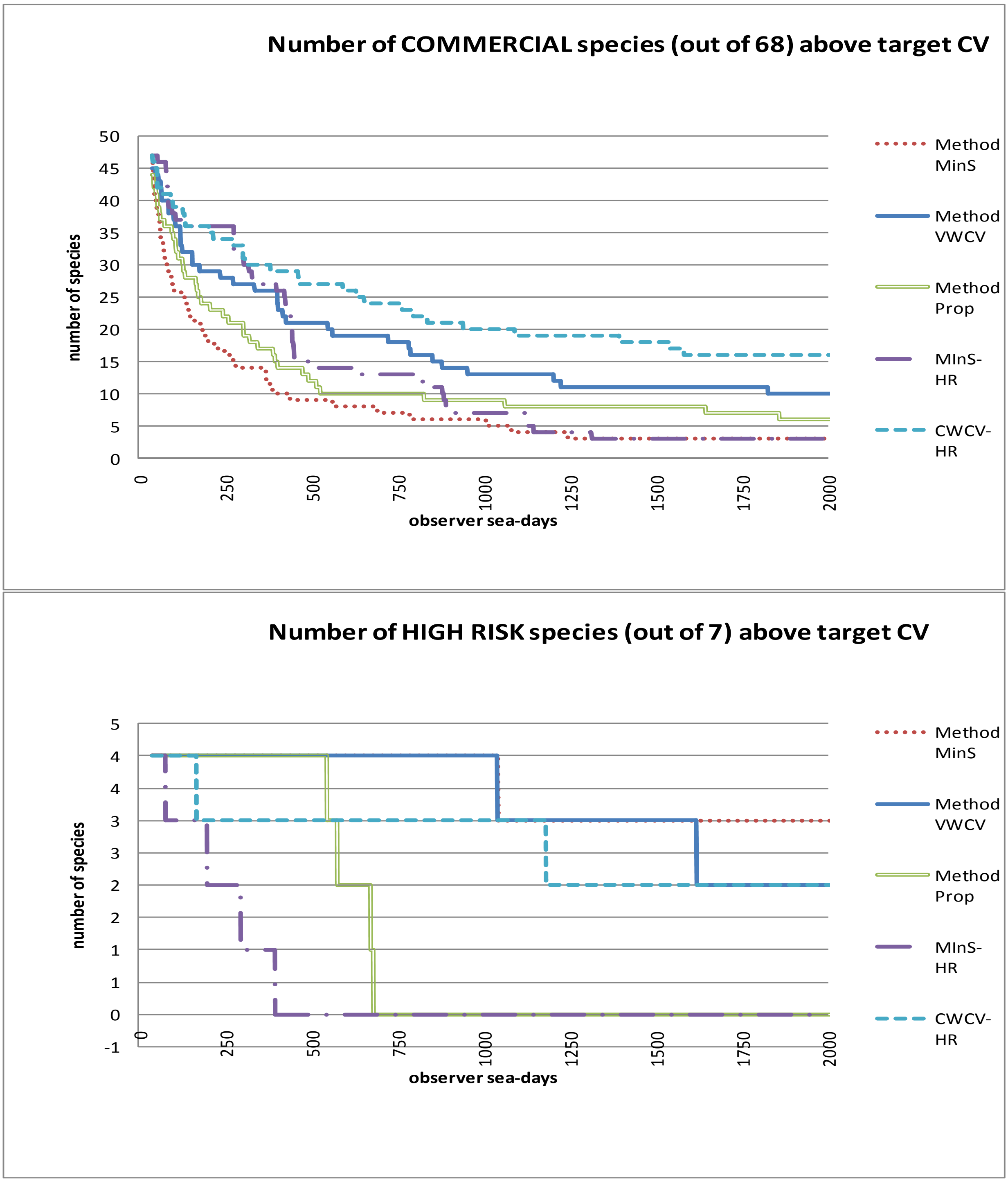

Figure 6. Progress of each of the 5 allocation methods by number of observer sea-days allocated. The statistic shown is the number of commercial project keys out of 68 (upper panel) and number of HIGH RISK project keys out of 7 (lower panel). The allocation methods used are: VWCV (which minimises the value-weighted average CV), MinS (which minimises the number of project keys with CVs above target); Prop (allocates sampling effort in proportion to the size of the fishery in each stratum); CWCV-HR (minimises the catch-weighted average CV for the HIGH RISK species), MinS-HR (minimises the number of HIGH RISK species groups with CVs above target.)

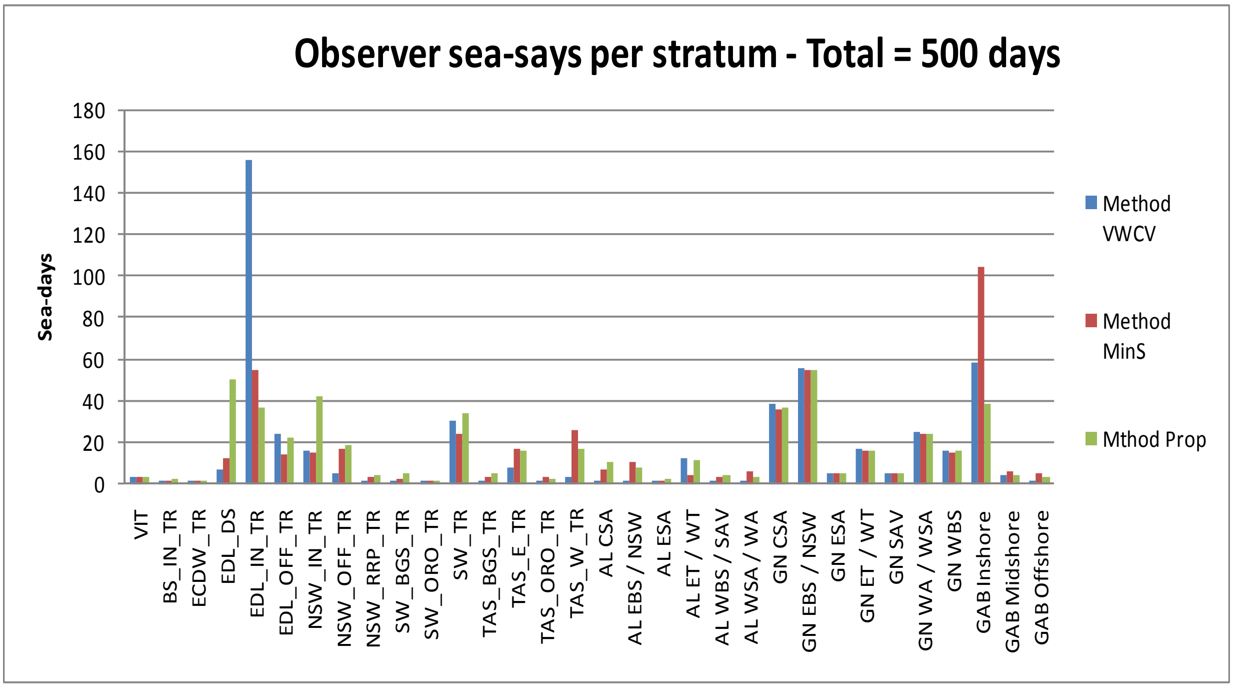

Figure 7 - Sample size distribution across strata for a total sample size of 500 observer sea-days by Methods: VWCV, MinS and Prop.

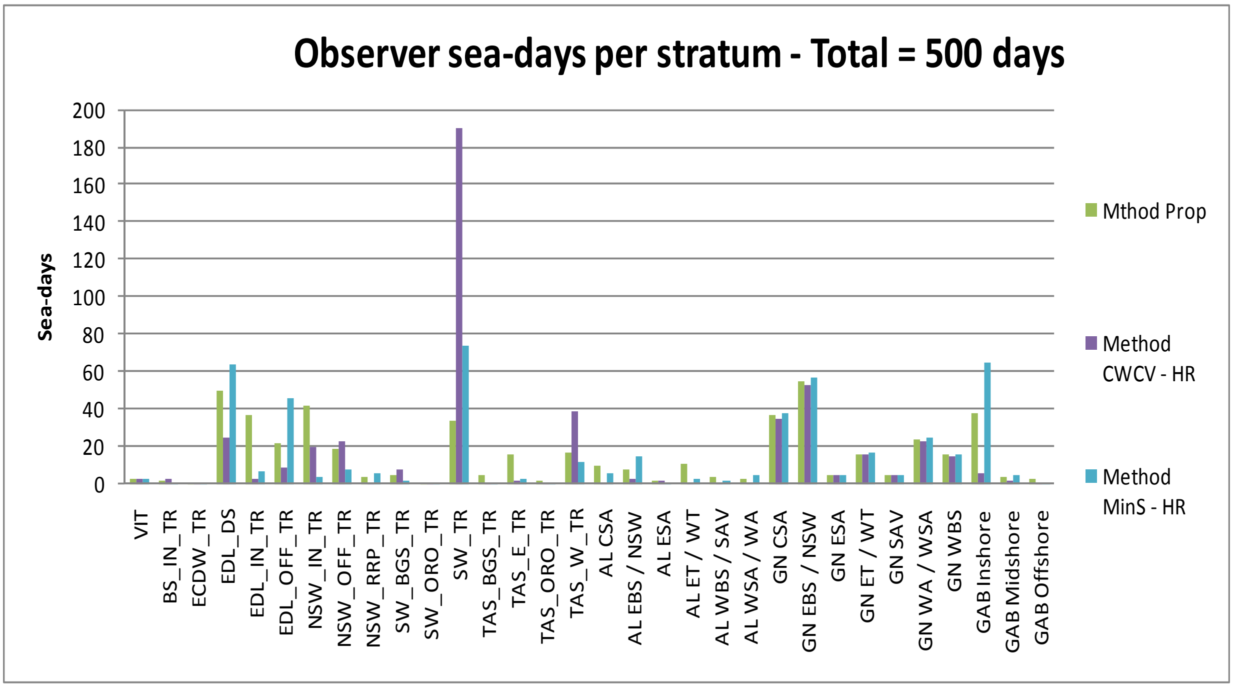

Figure 8 - Sample size distribution across strata for a total sample size of 500 observer sea-days by Methods: CWCV-HR, MinS-HR and Prop.

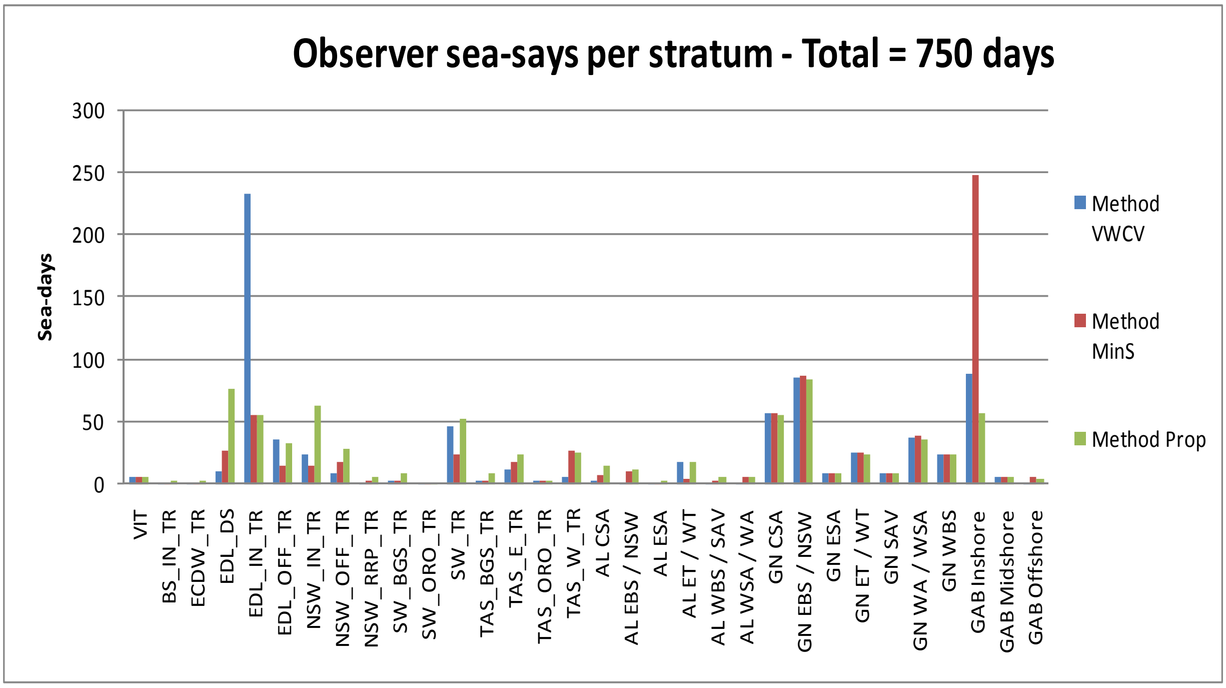

Figure 9 - Sample size distribution across strata for a total sample size of 750 observer sea-days by Methods VWCV, MinS and Prop.

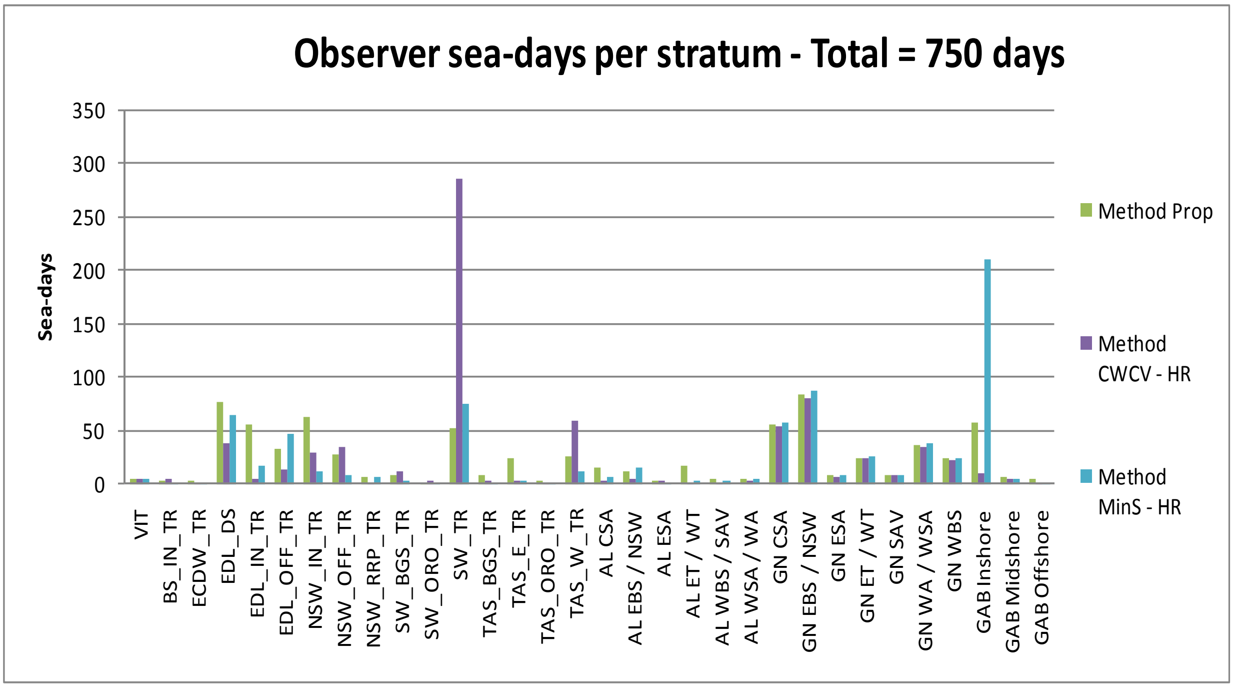

Figure 10 - Sample size distribution across strata for a total sample size of 750 observer sea-days by Methods CWCV-HR, MinS-HR and Prop.

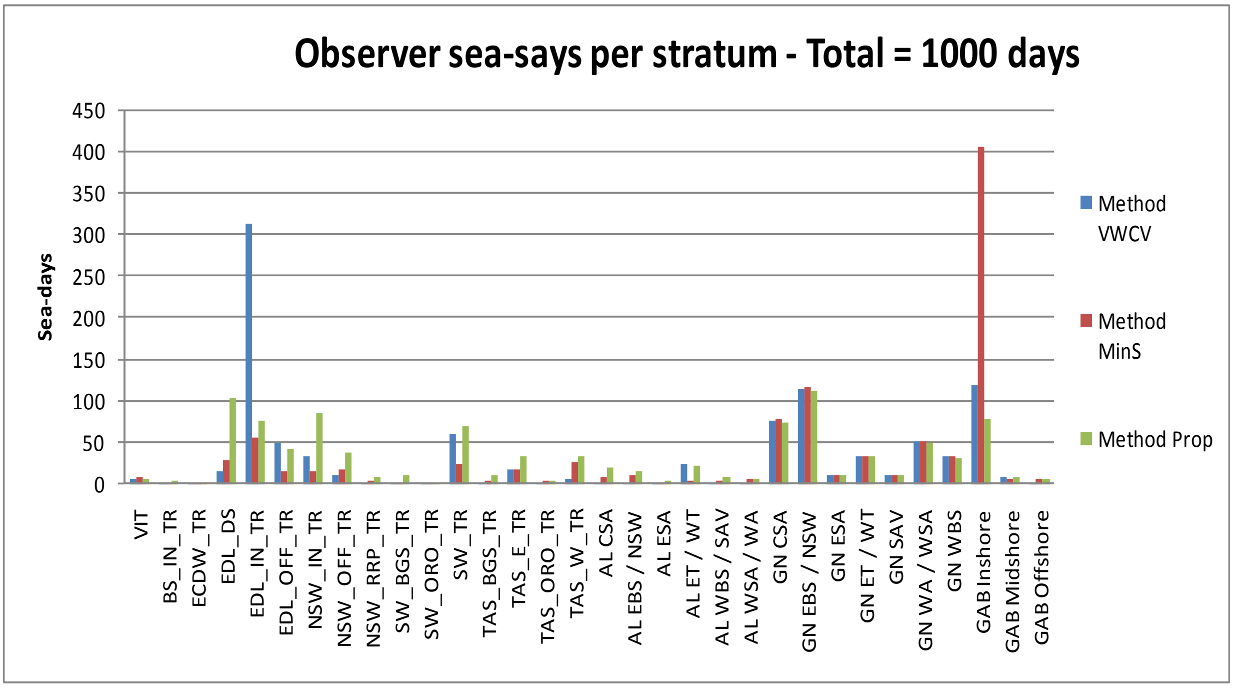

Figure 11 - Sample size distribution across strata for a total sample size of 1000 observer sea-days by Methods VWCV, MinS and Prop.

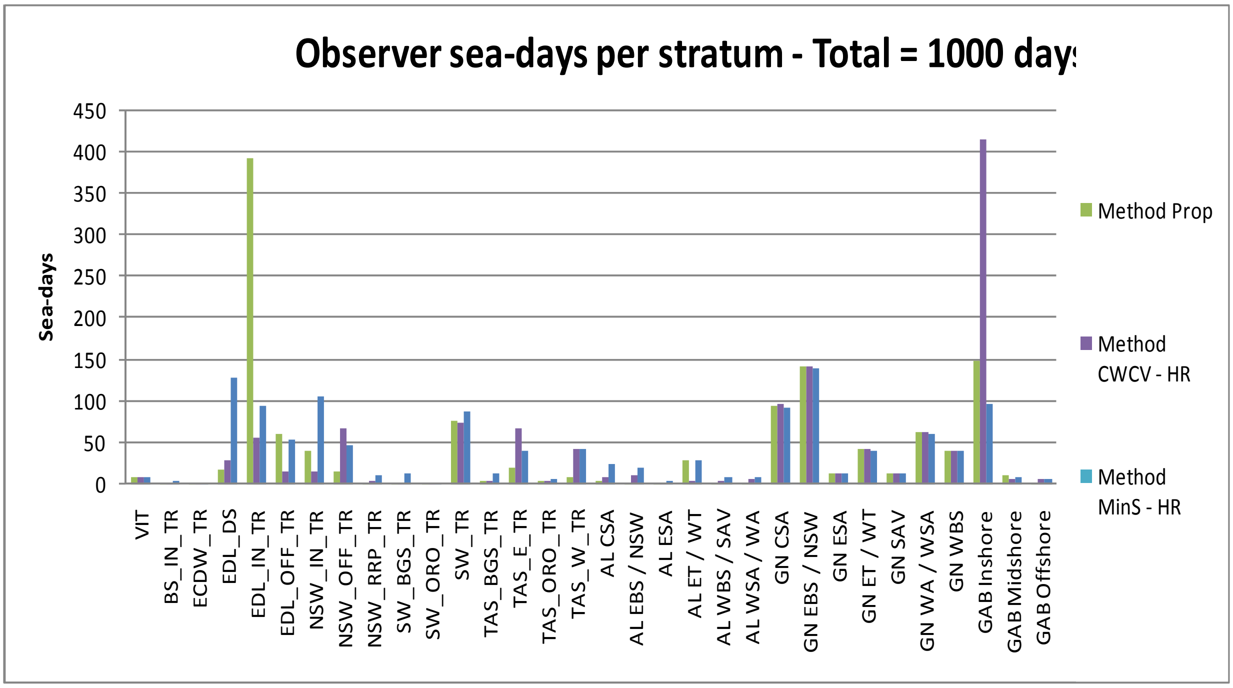

Figure 12 - Sample size distribution across strata for a total sample size of 1000 observer sea-days by Methods CWCV-HR, MinS-HR and Prop.

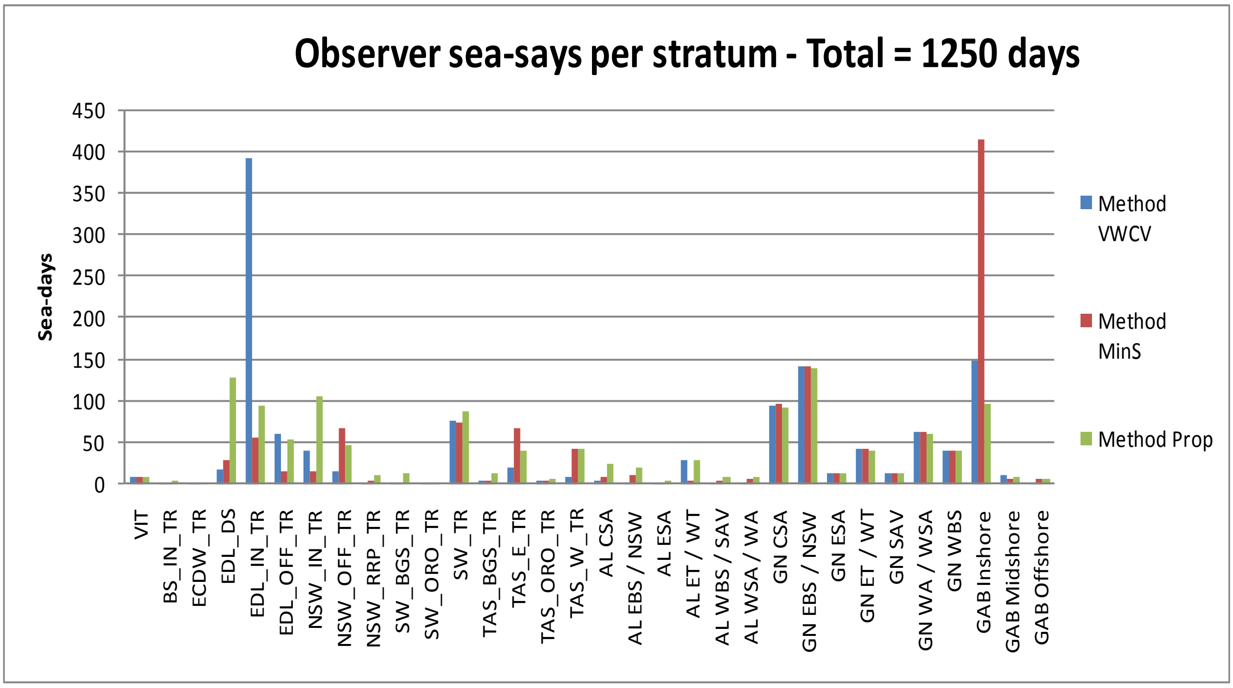

Figure 13 - Sample size distribution across strata for a total sample size of 1250 observer sea-days by Methods VWCV, MinS and Prop.

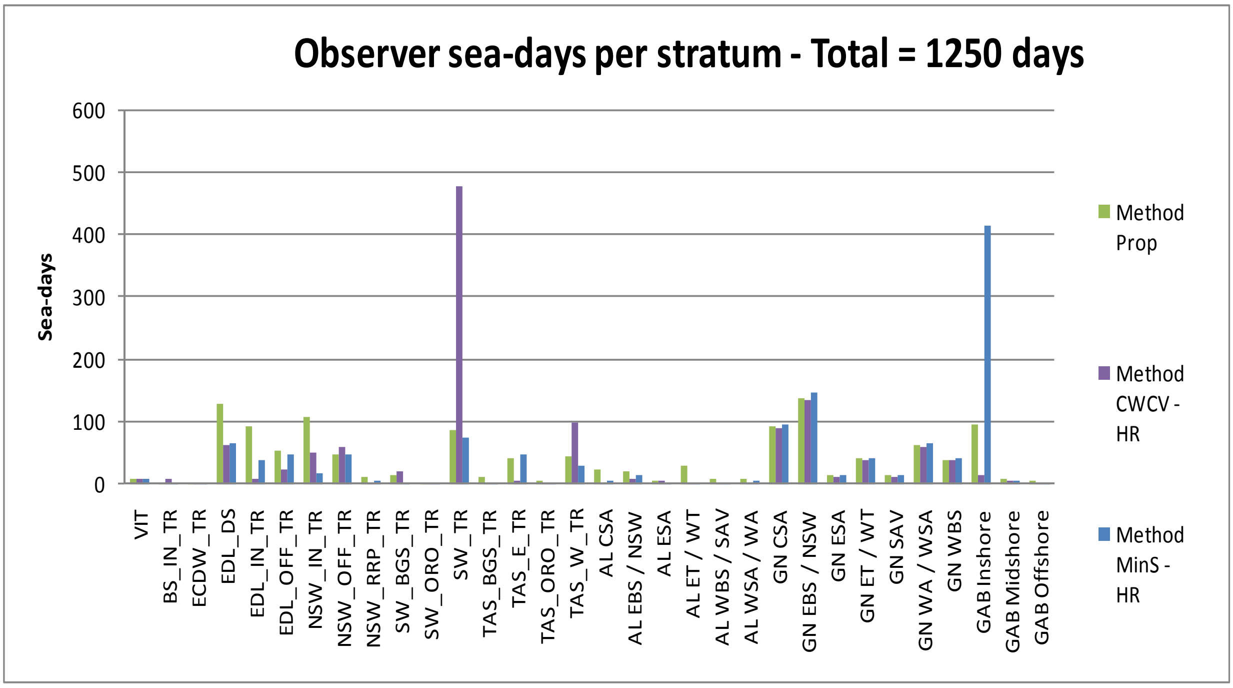

Figure 14 - Sample size distribution across strata for a total sample size of 1250 observer sea days by Methods CWCV-HR, MinS-HR and Prop.

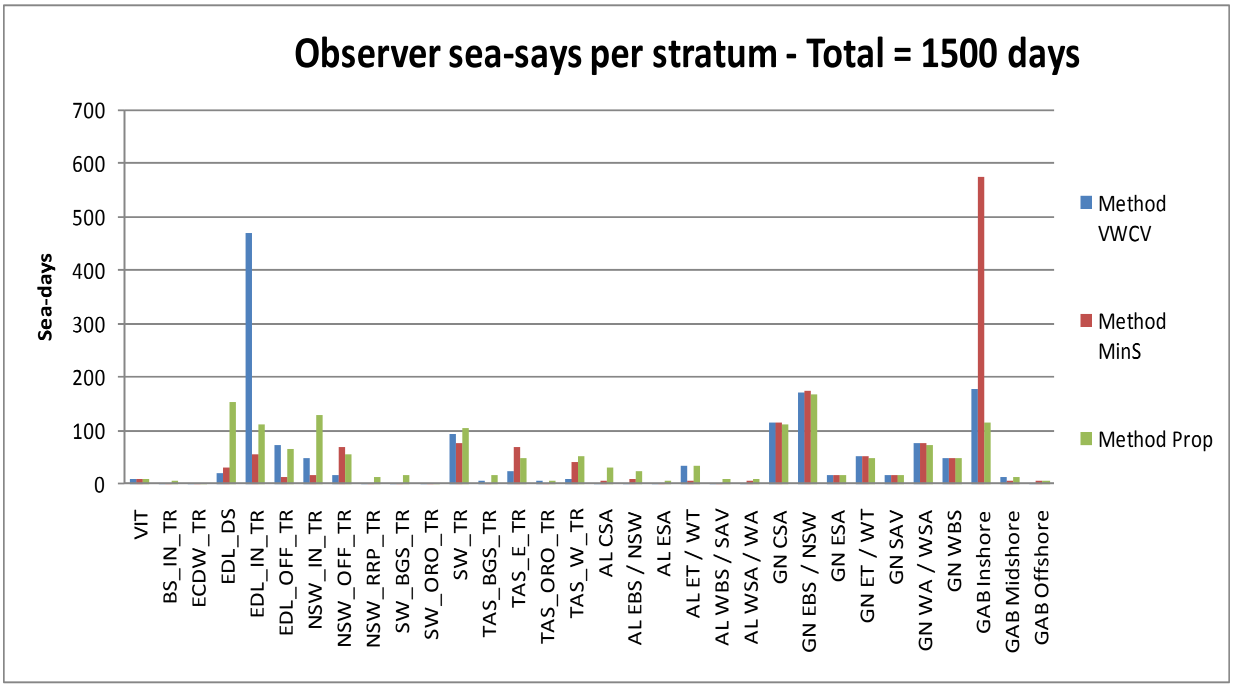

Figure 15 - Sample size distribution across strata for a total sample size of 1500 observer sea-days by Methods VWCV, MinS and Prop.

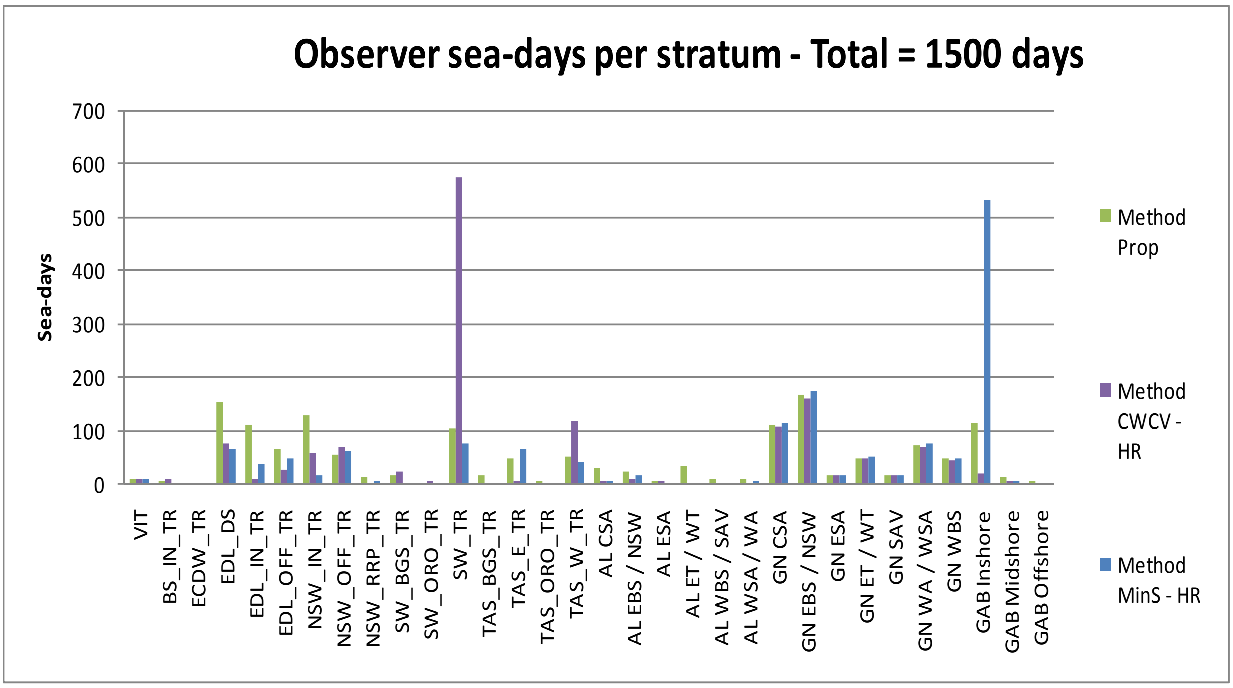

Figure 16 - Sample size distribution across strata for a total sample size of 1500 observer sea days by Method CWCV-HR, MinS-HR and Prop.

	CV (%) on Total Catch: Method VWCV					
Sea-days	250	500	750	1000	1250	1500
OCEAN BLUE-EYE TREVALLA	0	0	0	0	0	0
Sawsharks	0	0	0	0	0	0
STRIPED TRUMPETER	0	0	0	0	0	0
WHISKERY SHARK	0	0	0	0	0	0
BIGHT REDFISH	1	0	0	0	0	0
PINK LING	1	1	0	0	0	0
YELLOWSPOTTED BOARFISH	1	1	1	1	1	0
GUMMY SHARK	1	1	1	1	1	1
ORANGE ROUGHY	2	1	1	1	1	1
HAPUKU	2	2	1	1	1	1
BLUE-EYE TREVALLA	2	2	1	1	1	1
BLUE GRENADIER	3	2	2	1	1	1
STARGAZER (UNSPECIFIED)	3	2	2	2	1	1
BROADNOSE SHARK	2	2	2	2	2	2
JOHN DORY	3	2	2	2	1	1
ROYAL RED PRAWN	3	2	2	2	2	2
ALFONSINO	3	3	2	2	2	1
DEEPWATER FLATHEAD	4	3	2	2	2	2
TIGER FLATHEAD	4	3	2	2	2	2
SILVER TREVALLY	4	3	2	2	2	2
SCHOOL SHARK	3	3	3	2	2	2
BOARFISH (UNSPECIFIED)	4	3	3	3	2	2
EASTERN SCHOOL WHITING	6	4	4	3	3	2
OCTOPUS	7	5	4	3	3	3
SQUID (GENERAL)	8	5	4	4	3	3
Molluscs	5	4	4	4	3	3
GOULD SQUID	8	6	5	4	4	3
BRONZE WHALER	7	6	5	4	4	3
BLUE MORWONG	8	6	5	4	4	4
JACKASS MORWONG	12	8	7	6	5	5
SNAPPER	13	9	7	6	6	5
MIRROR DORY	12	9	7	6	6	5
INSHORE OCEAN PERCH	13	9	8	7	6	5
SMOOTH HAMMERHEAD	13	9	8	7	6	6
BLUESTRIPED GOATFISH	16	10	8	7	7	6
SILVER WAREHOU	15	11	9	7	7	6
RED GURNARD	15	11	9	7	7	6
RIBALDO	13	10	8	8	7	7
TRIGGERFISH & LEATHERJACKET	17	12	10	8	7	7
GEMFISH	19	14	11	9	8	8
SAWSHARK BASKET	21	15	12	10	9	8
SOUTHERN EAGLE RAY	23	16	13	12	10	10
Echinoderms	26	18	15	13	12	11
ELEPHANTFISH	28	18	15	13	12	11
SILVER DORY	25	19	15	13	12	11
Fish	22	19	15	14	12	11
SMOOTH OREODORY	25	20	15	14	12	11
KNIFEJAW	30	21	17	15	13	12
BLUE WAREHOU	30	24	18	17	15	14
Crustaceans	27	21	18	17	17	16
Chimaeras	27	23	21	17	17	15
DEEPWATER SHARK BASKET	35	25	20	17	16	14
Dogfish	34	26	21	18	17	16
OREO BASKET	32	27	21	19	17	16
REDFISH	37	28	22	19	17	16
KING DORY	46	31	25	22	20	18
ORNATE ANGELSHARK	45	31	26	22	20	18
DRAUGHTBOARD SHARK	39	38	31	27	24	23
AUSTRALIAN ANGELSHARK	33	32	32	32	32	32
OCEAN JACKET	55	38	31	27	24	22
Stingarees	60	41	34	29	26	24
BARRACOUTA	53	43	33	30	26	25
GUITARFISH (UNSPECIFIED)	66	46	38	33	29	27
Sharks	46	45	41	34	33	30
Rays	76	53	43	37	33	31
FROSTFISH	85	65	52	45	40	37
LATCHET	165	115	93	80	72	66
Hagfish	112	110	109	109	108	108
Number of project keys with CVs 0 to 20%	40	47	50	55	57	57
Number of project keys with CVs 21 to 40%	17	13	13	10	8	9
Number of Species above 40%	11	8	5	3	3	2
HIGH RISK SPECIES						
High Risk Sharks	6	4	4	3	3	3
High Risk Teleosts	7	5	4	4	3	3
High Risk Molluscs	8	7	7	7	5	5
High Risk Dogfish Other	40	29	23	21	18	17
High Risk Hagfish	33	27	26	25	24	24
High Risk Skates / Rays	42	35	33	25	24	20
High Risk Upper Slope Dogfish	87	57	48	41	37	33

Figure 17 - Progress of CVs (expressed as percentages) for each of the 75 project keys for different sample sizes, at increments of 250 sea-days, allocated to strata using Method VWCV — which minimises the value-weighted average CV.

	CV (%) on Total Catch: Method MinS					
Sea-days	250	500	750	1000	1250	1500
OCEAN BLUE-EYE TREVALLA	0	0	0	0	0	0
Sawsharks	0	0	0	0	0	0
STRIPED TRUMPETER	0	0	0	0	0	0
WHISKERY SHARK	0	0	0	0	0	0
BIGHT REDFISH	1	0	0	0	0	0
YELLOWSPOTTED BOARFISH	2	1	0	0	0	0
PINK LING	1	0	0	0	0	0
BLUE-EYE TREVALLA	1	1	1	1	1	1
GUMMY SHARK	1	1	1	1	1	1
ORANGE ROUGHY	2	1	1	1	1	1
HAPUKU	1	1	1	1	1	1
ROYAL RED PRAWN	2	1	1	1	1	1
BROADNOSE SHARK	1	1	1	1	1	1
ALFONSINO	2	1	1	1	1	1
JOHN DORY	2	2	2	2	2	2
BLUE GRENADIER	3	2	2	2	2	2
STARGAZER (UNSPECIFIED)	2	2	2	2	2	2
TIGER FLATHEAD	3	2	2	2	2	2
EASTERN SCHOOL WHITING	3	3	2	2	2	2
BLUE MORWONG	10	4	3	2	2	2
DEEPWATER FLATHEAD	4	3	2	2	2	1
SCHOOL SHARK	3	3	3	3	3	3
GOULD SQUID	11	4	3	3	2	2
SILVER TREVALLY	5	3	3	3	3	3
BOARFISH (UNSPECIFIED)	3	3	3	3	3	3
Molluscs	4	4	4	4	4	4
OCTOPUS	7	4	4	4	4	4
BRONZE WHALER	5	4	4	4	4	4
JACKASS MORWONG	15	6	5	4	4	3
SMOOTH HAMMERHEAD	7	7	5	4	4	4
SNAPPER	7	7	5	5	5	5
BLUESTRIPED GOATFISH	8	8	5	5	5	5
RIBALDO	9	6	6	6	5	5
SQUID (GENERAL)	6	6	6	6	3	3
INSHORE OCEAN PERCH	14	7	7	7	5	5
MIRROR DORY	11	7	7	7	6	6
SMOOTH OREODORY	11	9	9	9	6	6
RED GURNARD	16	10	9	9	8	7
SOUTHERN EAGLE RAY	14	12	10	9	9	9
SILVER WAREHOU	13	11	11	11	7	7
OREO BASKET	13	11	11	11	8	8
GEMFISH	14	11	11	11	10	10
ELEPHANTFISH	16	15	12	12	10	10
Fish	16	13	12	12	11	11
Dogfish	19	16	14	13	11	11
Chimaeras	14	14	14	14	13	13
TRIGGERFISH & LEATHERJACKET	20	14	14	14	13	13
AUSTRALIAN ANGELSHARK	15	15	15	15	14	14
BLUE WAREHOU	18	16	16	16	11	11
DRAUGHTBOARD SHARK	17	17	17	17	17	17
SILVER DORY	18	17	17	17	11	11
Sharks	20	18	18	18	18	18
SAWSHARK BASKET	29	11	8	6	6	6
BARRACOUTA	24	17	17	17	13	13
Echinoderms	28	18	17	17	16	16
DEEPWATER SHARK BASKET	26	17	17	17	9	9
Crustaceans	35	20	20	20	19	19
REDFISH	27	20	20	20	16	16
KNIFEJAW	41	16	10	8	8	7
ORNATE ANGELSHARK	62	23	15	12	12	10
OCEAN JACKET	76	29	19	15	15	13
Stingarees	78	31	21	17	17	15
KING DORY	35	35	35	35	20	20
Rays	104	39	26	20	20	17
FROSTFISH	51	36	36	36	20	20
LATCHET	225	85	55	43	43	36
Hagfish	118	68	68	68	67	67
GUITARFISH (UNSPECIFIED)	101	72	72	72	72	72
Number of project keys with CVs 0 to 20%	52	59	61	62	65	65
Number of project keys with CVs 21 to 40%	7	6	4	3	0	1
Number of Species above 40%	9	3	3	3	3	2
HIGH RISK SPECIES						
High Risk Dogfish Other	4	3	3	2	2	2
High Risk Hagfish	5	3	3	3	3	3
High Risk Molluscs	8	7	7	7	7	7
High Risk Sharks	28	27	27	27	16	16
High Risk Skates / Rays	46	25	25	25	25	25
High Risk Teleosts	47	26	25	25	25	25
High Risk Upper Slope Dogfish	45	43	29	28	28	28

Figure 18 - Progress of CVs (expressed as percentages) for each of the 75 project keys for different sample sizes, at increments of 250 sea-days, allocated to strata using Method MinS — which minimises the number of commercial project keys (out of 68) that are above the target CV.

	CV (%) on Total Catch: Method PROP					
Sea-days	250	500	750	1000	1250	1500
OCEAN BLUE-EYE TREVALLA	0	0	0	0	0	0
Sawsharks	0	0	0	0	0	0
STRIPED TRUMPETER	0	0	0	0	0	0
WHISKERY SHARK	0	0	0	0	0	0
PINK LING	1	0	0	0	0	0
BIGHT REDFISH	1	0	0	0	0	0
GUMMY SHARK	1	1	1	0	0	0
BLUE-EYE TREVALLA	1	1	1	0	0	0
HAPUKU	1	1	1	1	1	0
YELLOWSPOTTED BOARFISH	1	1	1	1	1	1
ROYAL RED PRAWN	1	1	1	1	1	1
ORANGE ROUGHY	2	1	1	1	1	1
BROADNOSE SHARK	2	1	1	1	1	1
JOHN DORY	2	1	1	1	1	1
ALFONSINO	2	1	1	1	1	1
BLUE GRENADIER	2	1	1	1	1	1
EASTERN SCHOOL WHITING	2	2	1	1	1	1
TIGER FLATHEAD	3	2	1	1	1	1
SCHOOL SHARK	3	2	2	1	1	1
STARGAZER (UNSPECIFIED)	3	2	2	2	1	1
BOARFISH (UNSPECIFIED)	3	2	2	2	2	2
DEEPWATER FLATHEAD	4	3	2	2	2	2
OCTOPUS	5	3	3	2	2	2
SNAPPER	5	3	3	2	2	2
Molluscs	4	3	3	2	2	2
SILVER TREVALLY	5	4	3	3	2	2
SMOOTH HAMMERHEAD	5	4	3	3	2	2
BLUESTRIPED GOATFISH	5	4	3	3	2	2
BRONZE WHALER	7	5	4	3	3	3
SQUID (GENERAL)	7	5	4	4	3	3
RIBALDO	8	6	5	4	4	3
MIRROR DORY	8	6	5	4	4	3
BLUE MORWONG	9	6	5	4	4	4
GOULD SQUID	10	7	6	5	4	4
INSHORE OCEAN PERCH	12	8	7	6	5	5
SILVER WAREHOU	13	9	7	6	6	5
SMOOTH OREODORY	14	9	8	7	6	5
SOUTHERN EAGLE RAY	14	10	8	7	6	6
ELEPHANTFISH	14	10	8	7	6	6
JACKASS MORWONG	14	10	8	7	6	6
RED GURNARD	17	12	10	8	7	7
OREO BASKET	17	12	10	9	8	7
Fish	17	12	10	9	8	7
GEMFISH	17	12	10	9	8	7
Dogfish	18	13	10	9	8	7
DRAUGHTBOARD SHARK	20	14	12	10	9	8
BLUE WAREHOU	21	14	12	10	9	8
SILVER DORY	22	15	13	11	10	9
TRIGGERFISH & LEATHERJACKET	23	16	13	11	10	9
Crustaceans	23	16	13	12	10	9
DEEPWATER SHARK BASKET	25	17	14	12	11	10
REDFISH	25	17	14	12	11	10
Chimaeras	23	16	14	12	11	10
SAWSHARK BASKET	26	18	15	13	11	10
Echinoderms	28	20	16	14	12	11
AUSTRALIAN ANGELSHARK	23	19	16	15	13	12
BARRACOUTA	29	20	17	14	13	12
Sharks	28	20	17	15	13	12
KNIFEJAW	37	26	21	18	16	15
KING DORY	42	29	24	21	18	17
FROSTFISH	52	36	30	26	23	21
ORNATE ANGELSHARK	56	39	32	27	24	22
OCEAN JACKET	69	47	39	33	30	27
Stingarees	71	49	40	34	31	28
Hagfish	82	58	47	41	37	33
Rays	95	65	53	46	41	37
GUITARFISH (UNSPECIFIED)	118	82	68	58	52	47
LATCHET	206	141	116	99	89	81
Number of project keys with CVs 0 to 20%	46	56	58	59	60	60
Number of project keys with CVs 21 to 40%	13	6	5	5	5	6
Number of Species above 40%	9	6	5	4	3	2
HIGH RISK SPECIES						
High Risk Sharks	3	2	2	2	1	1
High Risk Teleosts	4	3	2	2	2	2
High Risk Molluscs	7	5	5	4	4	4
High Risk Hagfish	29	20	17	15	13	12
High Risk Upper Slope Dogfish	31	22	17	15	14	12
High Risk Dogfish Other	33	23	19	16	15	13
High Risk Skates / Rays	33	23	19	17	15	13

Figure 19 - Progress of CVs (expressed as percentages) for each of the 75 project keys for different sample sizes, at increments of 250 sea-days, allocated to strata using Method Prop — which allocates sea-days to strata in proportion to the size of the fishery.

	CV (%) on Total Catch: Method CWCV-HR					
Sea-days	250	500	750	1000	1250	1500
OCEAN BLUE-EYE TREVALLA	0	0	0	0	0	0
Sawsharks	0	0	0	0	0	0
STRIPED TRUMPETER	0	0	0	0	0	0
WHISKERY SHARK	1	1	0	0	0	0
PINK LING	1	1	1	1	0	0
BIGHT REDFISH	2	1	1	1	1	1
HAPUKU	1	1	1	1	1	1
BOARFISH (UNSPECIFIED)	2	2	1	1	1	1
BLUE-EYE TREVALLA	2	2	1	1	1	1
ROYAL RED PRAWN	2	1	1	1	1	1
BLUE GRENADIER	3	2	2	1	1	1
GUMMY SHARK	2	2	1	1	1	1
ALFONSINO	3	2	2	1	1	1
EASTERN SCHOOL WHITING	3	2	2	2	1	1
ORANGE ROUGHY	3	3	2	2	2	2
YELLOWSPOTTED BOARFISH	4	3	2	2	2	1
SQUID (GENERAL)	4	3	2	2	2	2
JOHN DORY	4	3	2	2	2	2
BROADNOSE SHARK	2	2	2	2	2	2
STARGAZER (UNSPECIFIED)	5	3	3	2	2	2
Molluscs	7	4	4	3	3	3
OCTOPUS	8	5	4	4	3	3
BLUESTRIPED GOATFISH	8	5	4	4	3	3
TIGER FLATHEAD	9	5	4	4	3	3
SNAPPER	8	5	4	4	3	3
DEEPWATER FLATHEAD	8	6	5	4	4	3
SMOOTH OREODORY	8	6	5	4	4	4
SMOOTH HAMMERHEAD	7	5	5	4	4	4
SCHOOL SHARK	5	5	5	5	5	5
RIBALDO	10	7	6	5	5	4
ELEPHANTFISH	13	9	8	7	6	5
OREO BASKET	12	9	7	7	6	5
MIRROR DORY	16	11	9	8	7	6
SILVER TREVALLY	19	11	10	9	7	7
KING DORY	18	12	10	9	8	7
SILVER WAREHOU	18	13	11	9	8	7
GEMFISH	24	17	13	11	10	9
BLUE MORWONG	22	15	13	11	10	9
BRONZE WHALER	25	14	12	11	9	9
GOULD SQUID	24	17	14	12	11	10
INSHORE OCEAN PERCH	28	19	15	13	12	11
BLUE WAREHOU	32	19	16	15	12	12
Fish	26	21	17	16	14	14
SILVER DORY	37	22	19	17	14	13
JACKASS MORWONG	37	25	21	18	16	15
Dogfish	36	25	20	18	16	14
Chimaeras	35	26	21	19	18	17
SOUTHERN EAGLE RAY	43	25	22	19	16	15
Crustaceans	36	26	23	21	19	18
RED GURNARD	52	32	27	24	21	19
DRAUGHTBOARD SHARK	39	38	29	29	26	24
AUSTRALIAN ANGELSHARK	33	32	32	32	32	32
BARRACOUTA	55	34	29	25	22	20
REDFISH	58	35	30	26	23	21
Sharks	52	41	32	30	26	25
SAWSHARK BASKET	63	45	36	32	28	26
DEEPWATER SHARK BASKET	69	49	40	35	31	28
TRIGGERFISH & LEATHERJACKET	91	54	46	41	35	33
Echinoderms	102	61	52	47	40	37
KNIFEJAW	92	65	53	46	41	37
FROSTFISH	103	73	59	51	46	42
ORNATE ANGELSHARK	138	98	80	69	62	56
OCEAN JACKET	170	120	98	85	76	69
Stingarees	177	124	102	88	79	72
Hagfish	118	112	111	110	109	109
Rays	233	164	134	116	104	95
GUITARFISH (UNSPECIFIED)	486	283	245	220	187	175
LATCHET	503	356	291	252	225	206
Number of project keys with CVs 0 to 20%	36	42	44	48	49	50
Number of project keys with CVs 21 to 40%	14	12	13	9	10	10
Number of Species above 40%	18	14	11	11	9	8
HIGH RISK SPECIES						
High Risk Teleosts	4	3	3	2	2	2
High Risk Sharks	9	5	4	4	3	3
High Risk Molluscs	9	6	5	5	4	4
High Risk Dogfish Other	16	11	9	8	7	6
High Risk Upper Slope Dogfish	44	31	25	22	20	18
High Risk Hagfish	46	34	31	29	28	27
High Risk Skates / Rays	62	41	34	29	26	24

Figure 20 - Progress of CVs (expressed as percentages) for each of the 75 project keys for different sample sizes, at increments of 250 sea-days, allocated to strata using Method CWCV-HR — which minimises the catch-weighted average CV of the 7 HIGH RISK project keys.

	CV (%) on Total Catch: Method MinS-HR					
Sea-days	250	500	750	1000	1250	1500
OCEAN BLUE-EYE TREVALLA	0	0	0	0	0	0
Sawsharks	0	0	0	0	0	0
STRIPED TRUMPETER	0	0	0	0	0	0
WHISKERY SHARK	0	0	0	0	0	0
BIGHT REDFISH	1	0	0	0	0	0
YELLOWSPOTTED BOARFISH	1	1	0	0	0	0
PINK LING	1	0	0	0	0	0
HAPUKU	3	1	1	1	1	1
BLUE-EYE TREVALLA	1	1	1	1	1	1
GUMMY SHARK	1	1	1	1	1	1
ORANGE ROUGHY	2	1	1	1	1	1
ALFONSINO	4	1	1	1	1	1
BLUE GRENADIER	3	1	1	1	1	1
ROYAL RED PRAWN	2	1	1	1	1	1
JOHN DORY	5	2	2	1	1	1
BROADNOSE SHARK	2	2	2	2	2	2
DEEPWATER FLATHEAD	8	2	2	2	2	1
EASTERN SCHOOL WHITING	3	2	2	2	2	2
TIGER FLATHEAD	9	4	2	2	2	2
STARGAZER (UNSPECIFIED)	4	2	2	2	2	2
OCTOPUS	3	3	3	2	2	2
GOULD SQUID	9	5	3	3	2	2
BOARFISH (UNSPECIFIED)	7	3	3	3	3	3
SCHOOL SHARK	5	3	3	3	3	3
SILVER TREVALLY	18	7	5	3	3	3
BLUE MORWONG	7	5	4	3	2	2
BLUESTRIPED GOATFISH	4	3	3	3	3	3
SNAPPER	8	4	4	3	3	3
Molluscs	7	4	4	4	4	4
SMOOTH HAMMERHEAD	5	4	4	4	3	3
RIBALDO	13	6	6	5	4	4
MIRROR DORY	15	11	10	7	5	5
GEMFISH	18	12	12	11	10	10
SQUID (GENERAL)	21	4	4	4	4	4
JACKASS MORWONG	20	10	6	5	4	4
BRONZE WHALER	25	10	7	5	4	4
SAWSHARK BASKET	20	14	8	6	6	5
INSHORE OCEAN PERCH	21	9	8	7	5	4
SILVER WAREHOU	34	11	11	7	6	6
ELEPHANTFISH	31	8	8	8	8	8
SMOOTH OREODORY	28	10	10	9	7	6
KNIFEJAW	29	20	11	9	8	7
OREO BASKET	30	14	14	12	10	9
Crustaceans	29	14	13	12	12	12
Fish	36	18	16	14	13	13
Dogfish	38	19	17	16	11	10
Chimaeras	24	18	18	17	15	15
DRAUGHTBOARD SHARK	30	18	18	18	18	18
Sharks	29	19	19	19	19	19
RED GURNARD	48	18	13	9	8	8
SOUTHERN EAGLE RAY	44	17	12	9	9	9
SILVER DORY	66	18	14	12	12	11
BLUE WAREHOU	58	19	16	13	12	12
KING DORY	121	20	20	20	20	20
ORNATE ANGELSHARK	44	30	17	13	12	10
TRIGGERFISH & LEATHERJACKET	92	37	26	17	16	16
OCEAN JACKET	60	38	21	17	15	14
DEEPWATER SHARK BASKET	40	40	40	19	11	9
BARRACOUTA	63	30	27	20	16	14
Stingarees	69	40	24	18	17	15
Echinoderms	97	41	30	19	17	17
AUSTRALIAN ANGELSHARK	36	32	32	32	18	18
REDFISH	79	37	28	26	17	17
Rays	74	50	28	22	20	18
FROSTFISH	86	68	68	46	23	20
LATCHET	160	108	60	48	43	38
Hagfish	48	47	47	47	46	46
GUITARFISH (UNSPECIFIED)	487	186	125	84	84	84
Number of project keys with CVs 0 to 20%	33	54	55	61	64	65
Number of project keys with CVs 21 to 40%	17	7	9	3	1	1
Number of Species above 40%	18	7	4	4	3	2
HIGH RISK SPECIES						
High Risk Sharks	8	4	3	2	2	2
High Risk Teleosts	12	6	4	4	3	3
High Risk Molluscs	15	9	8	7	7	7
High Risk Hagfish	16	15	15	15	15	15
High Risk Skates / Rays	19	17	16	15	15	15
High Risk Upper Slope Dogfish	25	19	19	19	19	19
High Risk Dogfish Other	93	18	18	18	16	16

Figure 21 - Progress of CVs (expressed as percentages) for each of the 75 project keys for different sample sizes, at increments of 250 sea-days, allocated to strata using Method MinS-HR — which minimises the number of HIGH RISK project keys (out of 7) that are above the target CV.

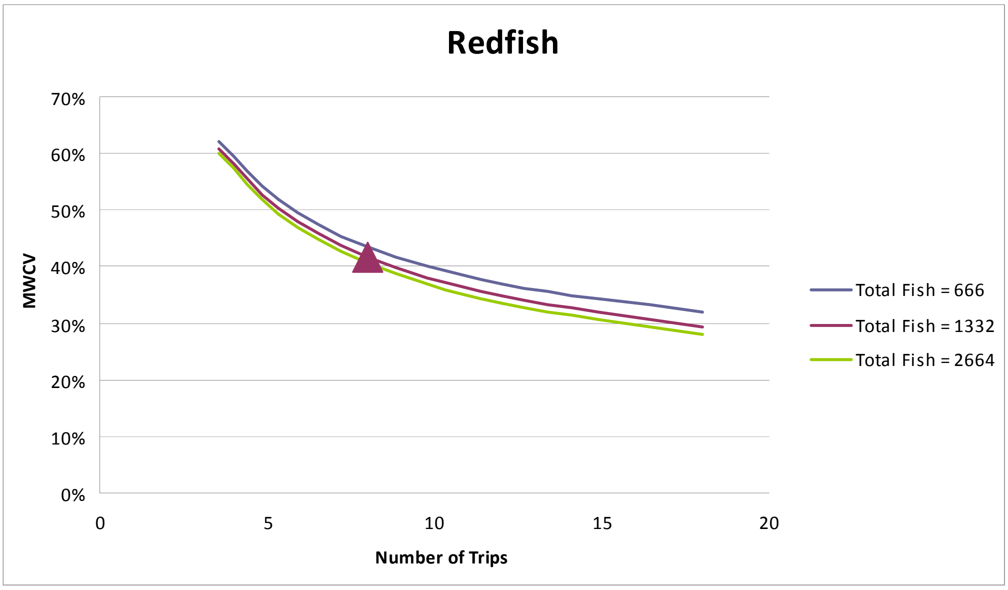

Figure 22. Three different tradeoffs between number of redfish sampled per landing (trip) and the total number of landings sampled. Each trade-off represents a different total number of fish sampled per year. The 2008 data are used and the triangle represents the 2008 estimate, while the central curve is for the total number of fish sampled in 2008. The upper curve involves twice the number of fish and the lower curve half the number of fish sampled per year.

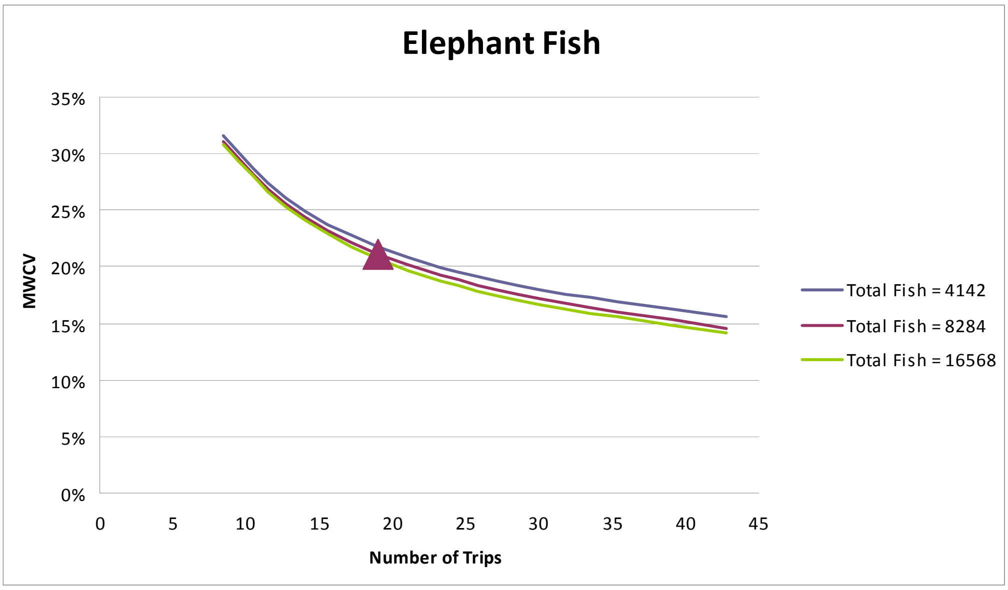

Figure 23. Three different tradeoffs between number of elephant fish sampled per landing (trip) and the total number of landings sampled.

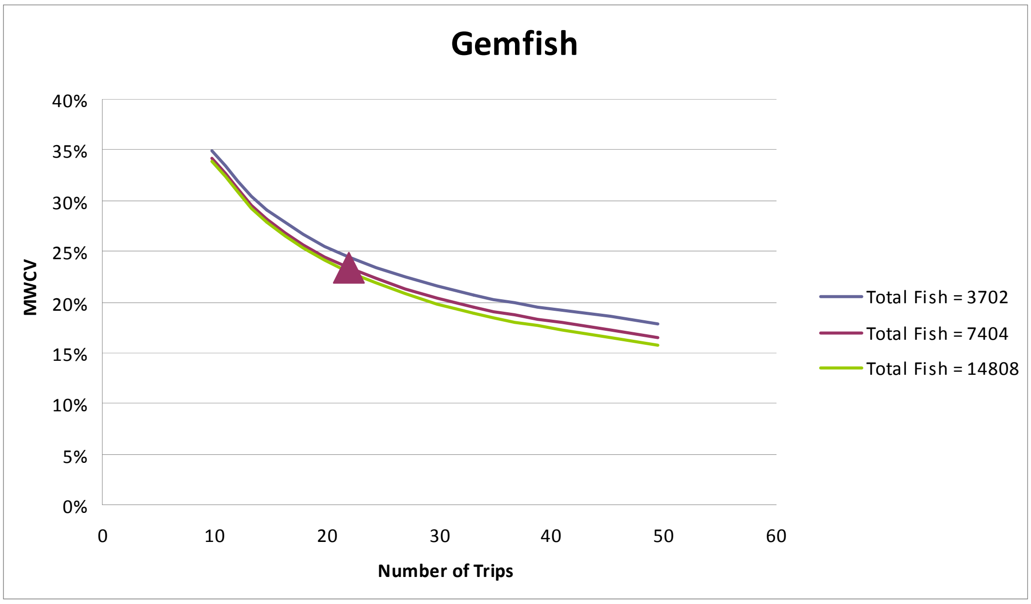

Figure 24. Three different tradeoffs between number of gemfish sampled per landing (trip) and the total number of landings sampled.

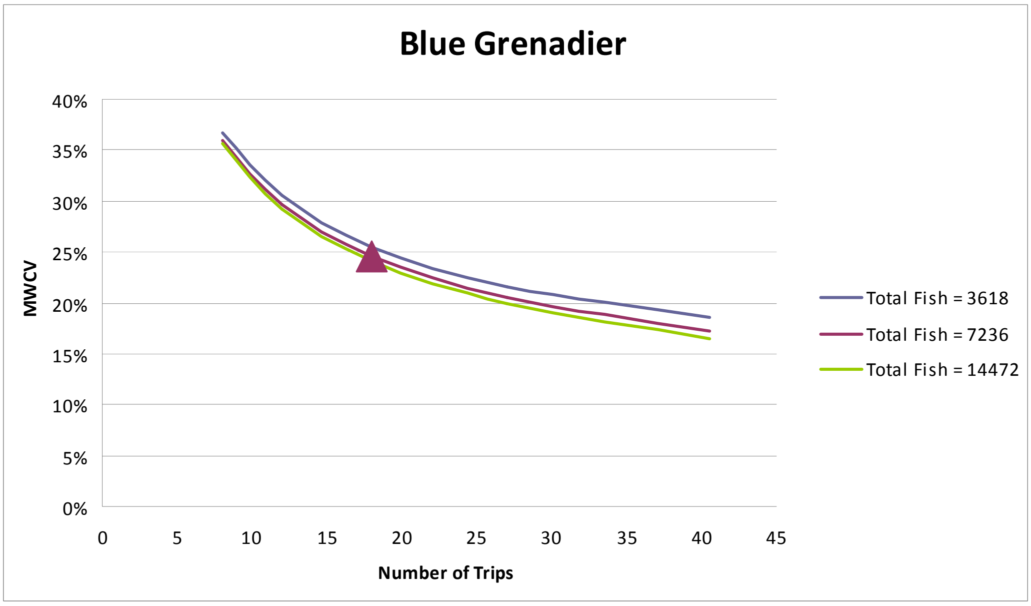

Figure 25. Three different tradeoffs between number of blue grenadier sampled per landing (trip) and the total number of landings sampled.

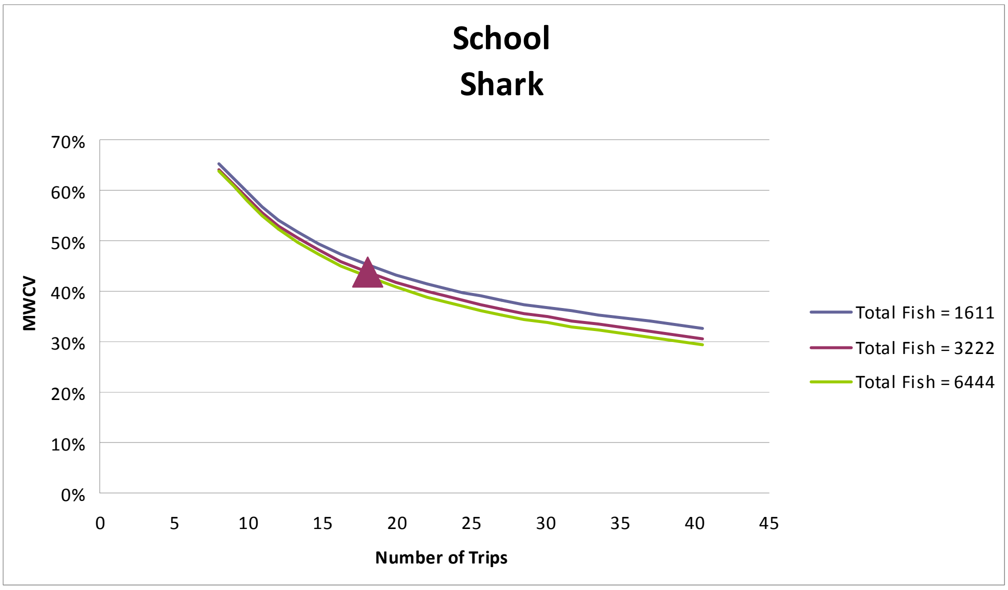

Figure 26. Three different tradeoffs between number of school shark sampled per landing (trip) and the total number of landings sampled.

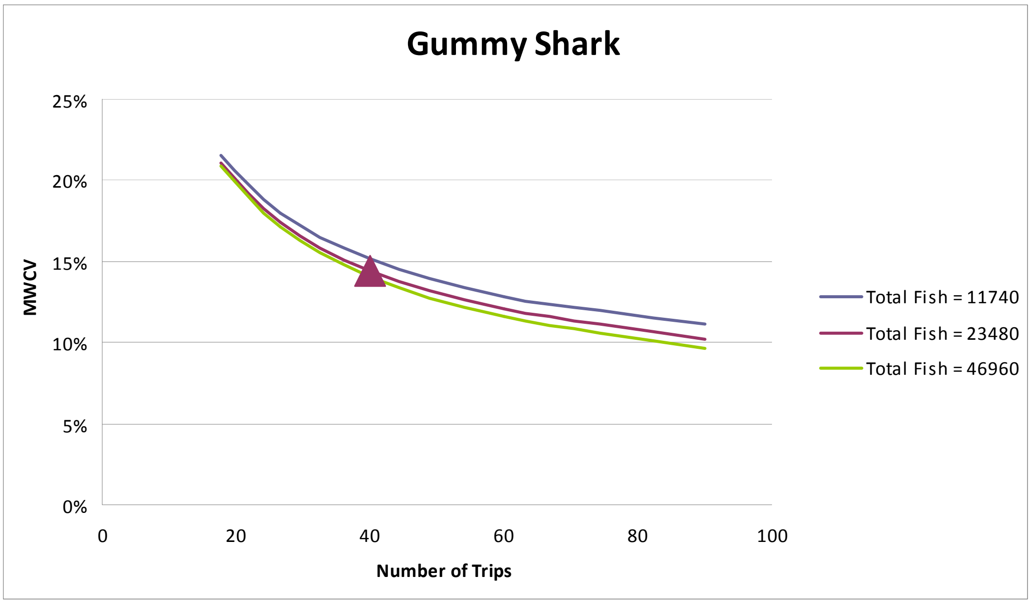

Figure 27. Three different tradeoffs between number of gummy shark sampled per landing (trip) and the total number of landings sampled.

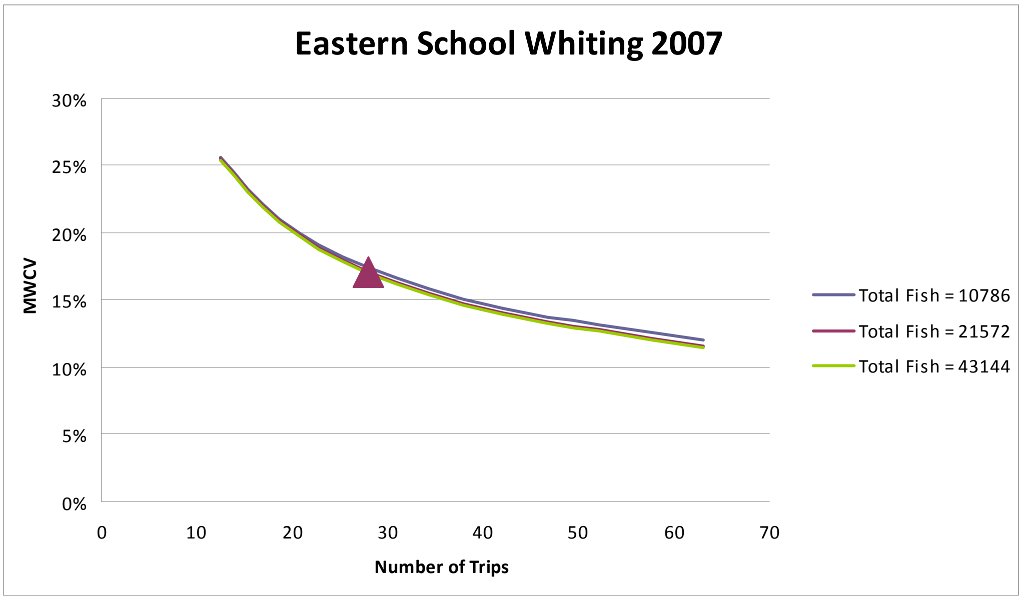

Figure 28. Three different tradeoffs between number of eastern school whiting sampled per landing (trip) and the total number of landings sampled. 2007 data were used as the species was more intensively sampled.

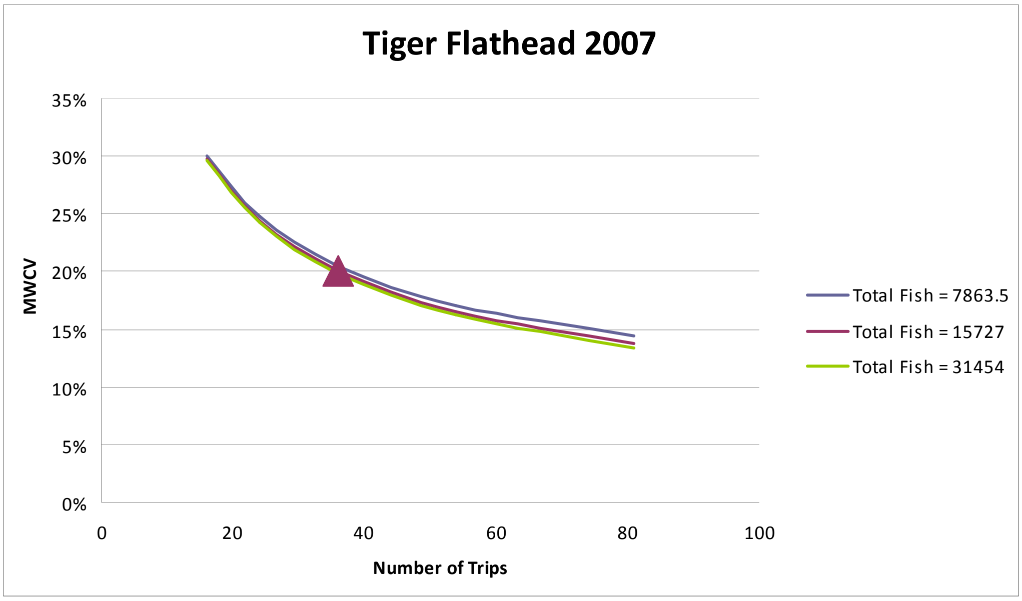

Figure 29. Three different tradeoffs between number of tiger flathead sampled per landing (trip) and the total number of landings sampled. 2007 data were used as the species was more intensively sampled. 2007 data where the species was more intensively sampled.

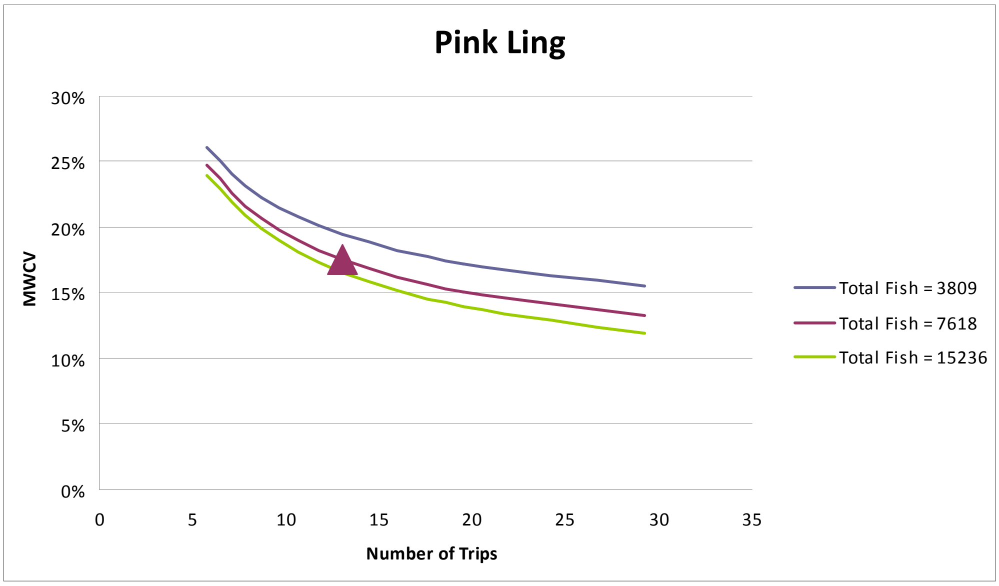

Figure 30. Three different tradeoffs between number of pink ling sampled per landing (trip) and the total number of landings sampled.

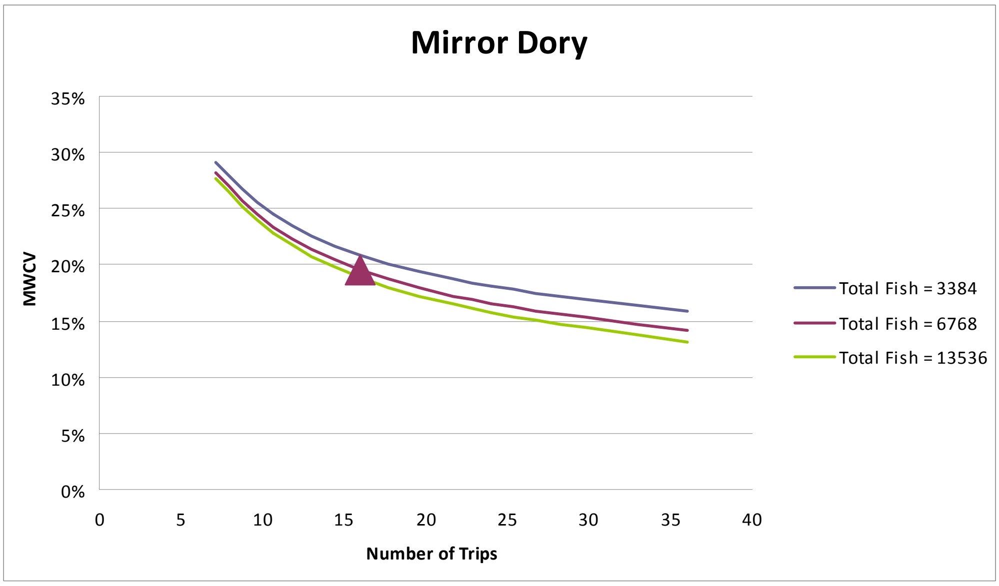

Figure 31. Three different tradeoffs between number of mirror dory sampled per landing (trip) and the total number of landings sampled.

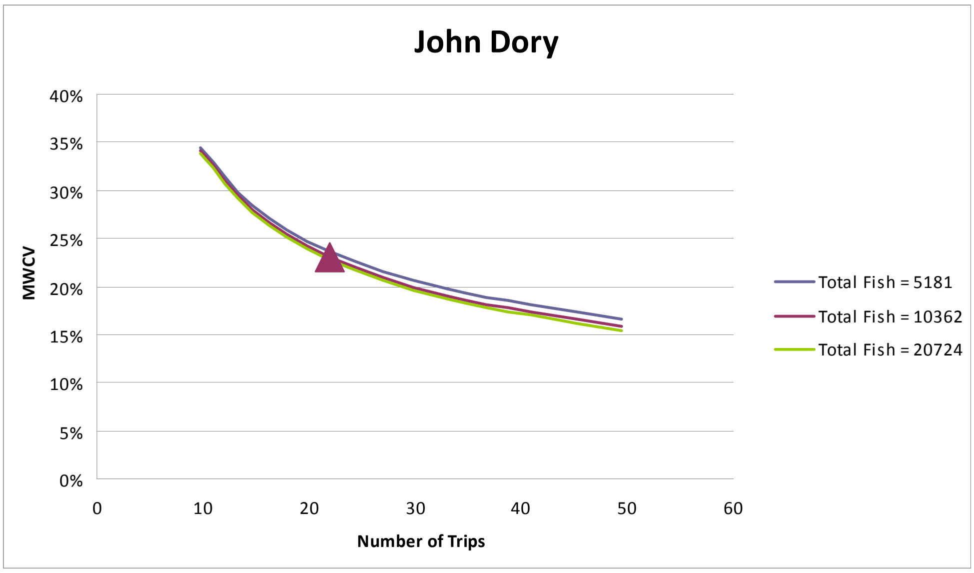

Figure 32. Three different tradeoffs between number of John dory sampled per landing (trip) and the total number of landings sampled.

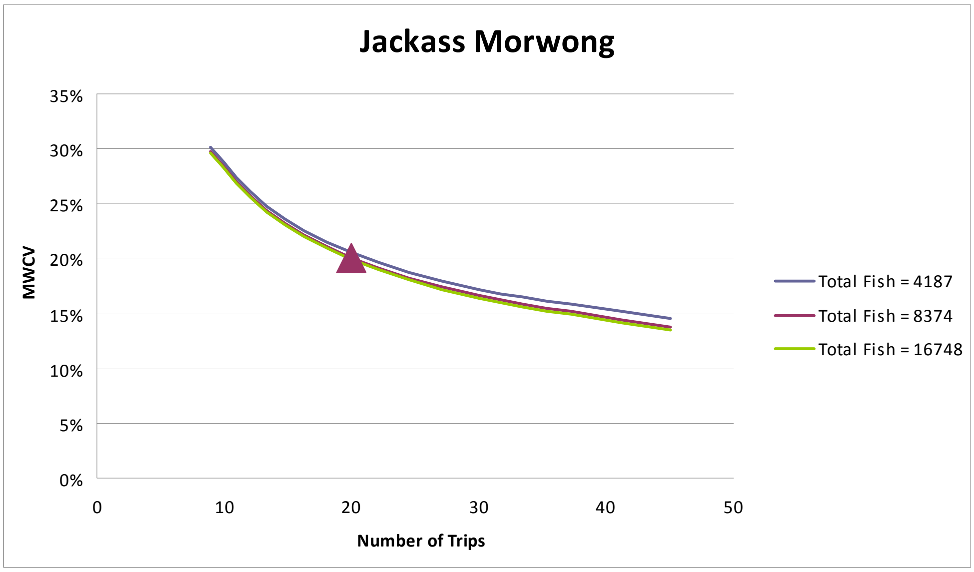

Figure 33. Three different tradeoffs between number of jackass morwong sampled per landing (trip) and the total number of landings sampled.

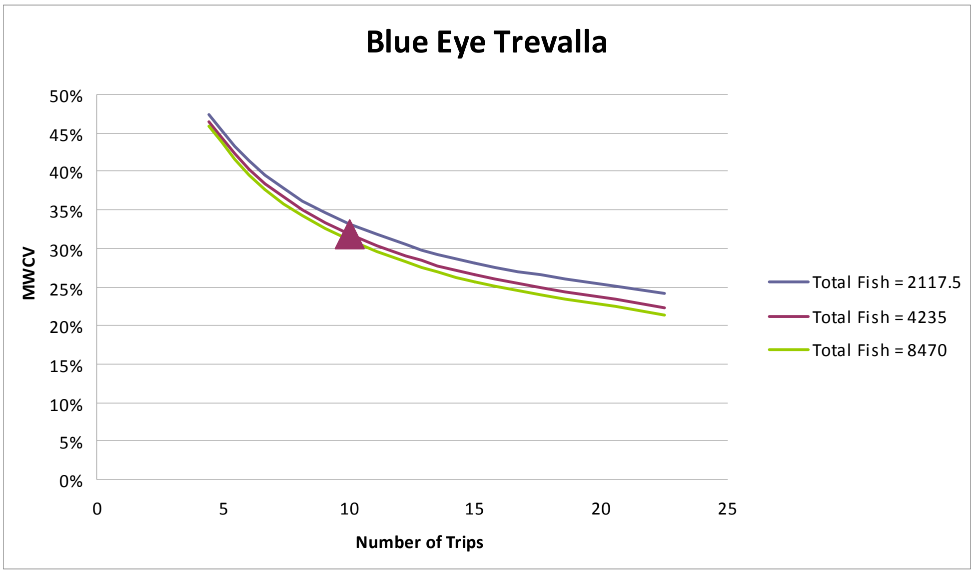

Figure 34. Three different tradeoffs between number of blue-eye trevalla sampled per landing (trip) and the total number of landings sampled.

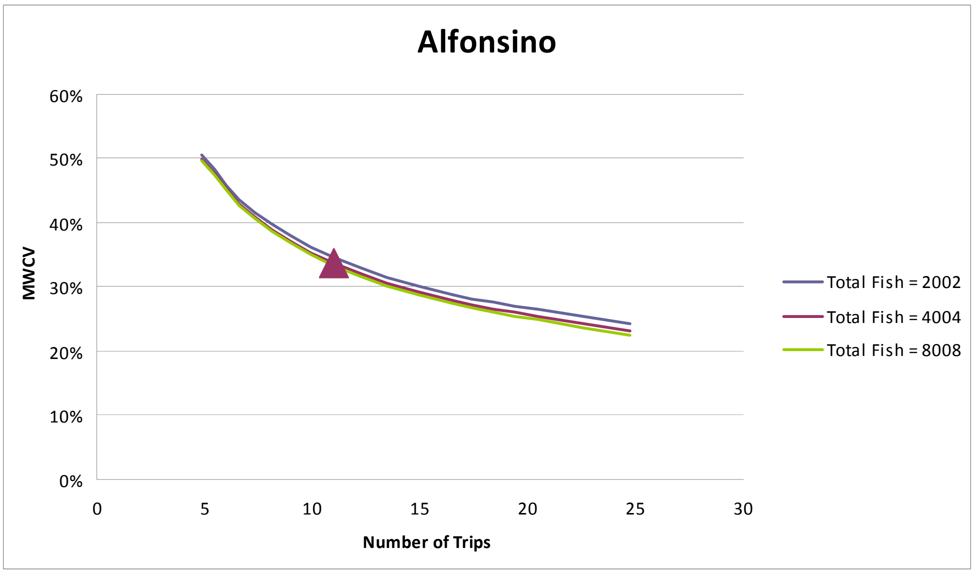

Figure 35. Three different tradeoffs between number of alfonsino sampled per landing (trip) and the total number of landings sampled.

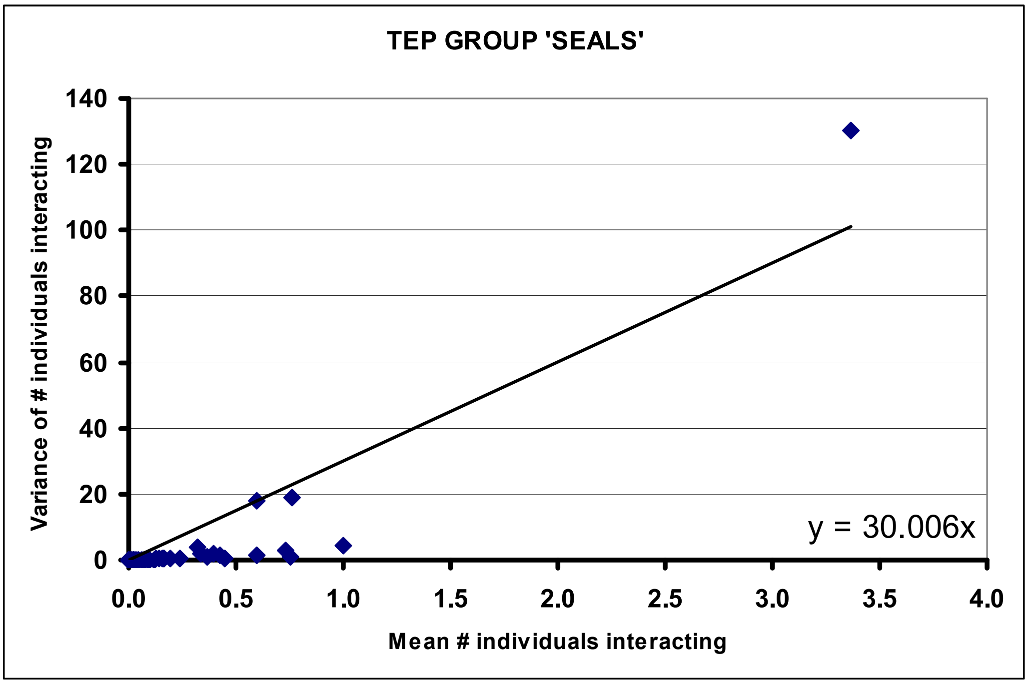

Figure 36. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Seals'.

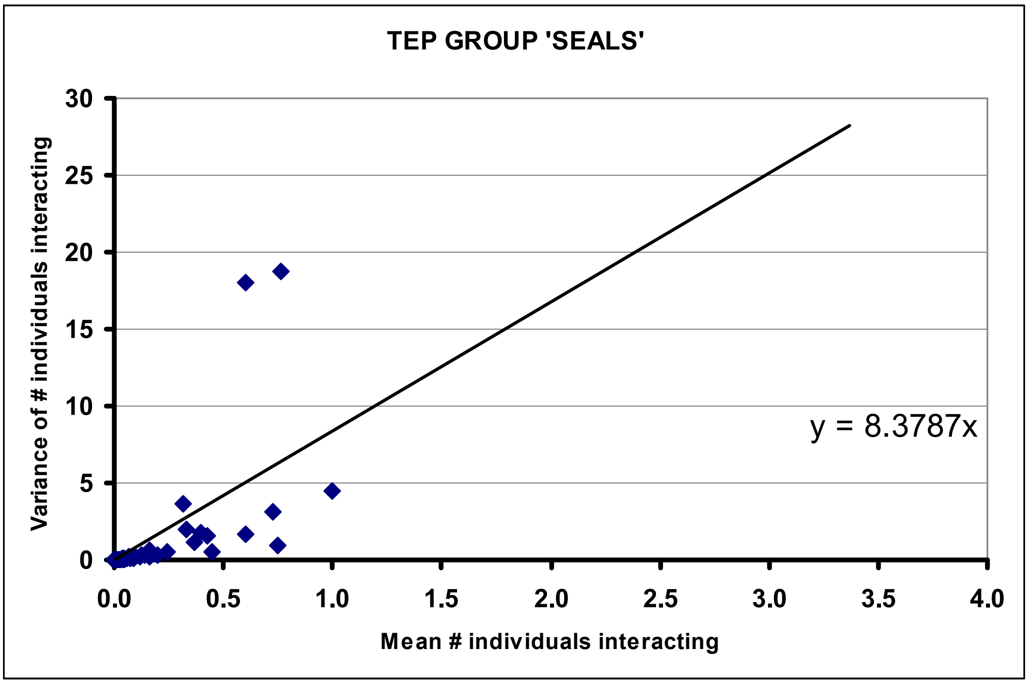

Figure 37. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Seals'. This plot is a subset of the earlier plot for 'Seals' (Fig. M5a) where the high point is omitted.

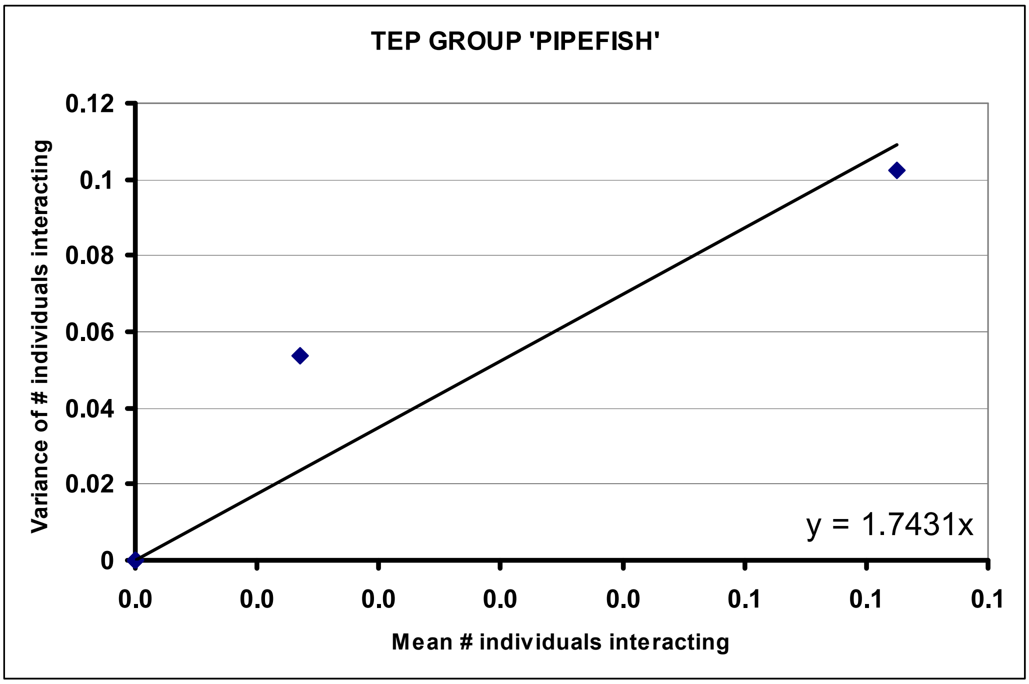

Figure 38. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Pipefish'.

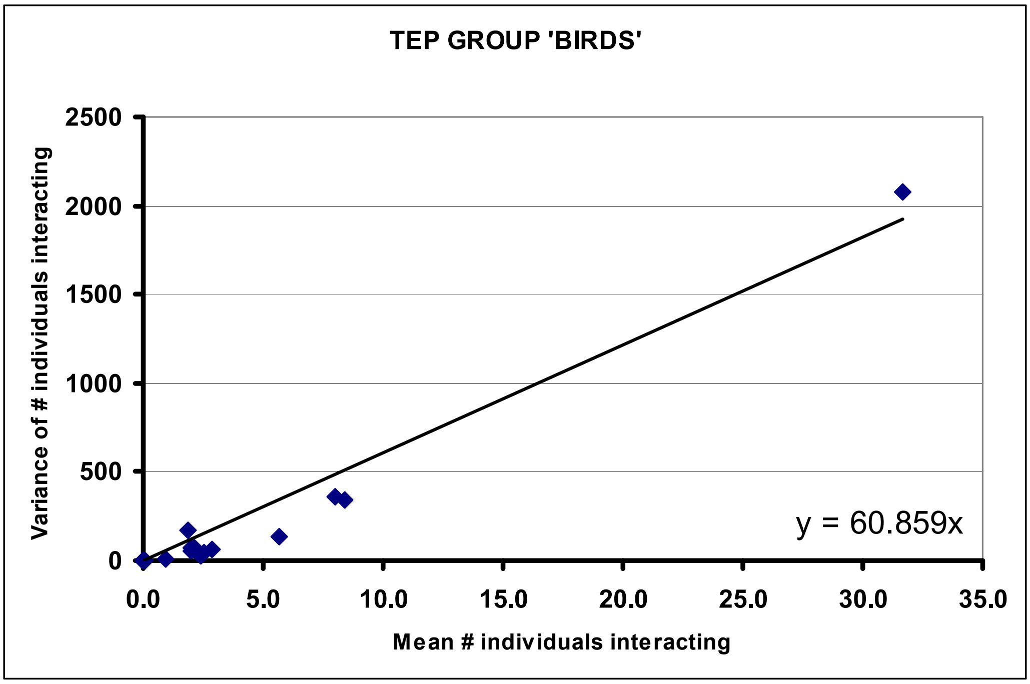

Figure 39. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Birds'.

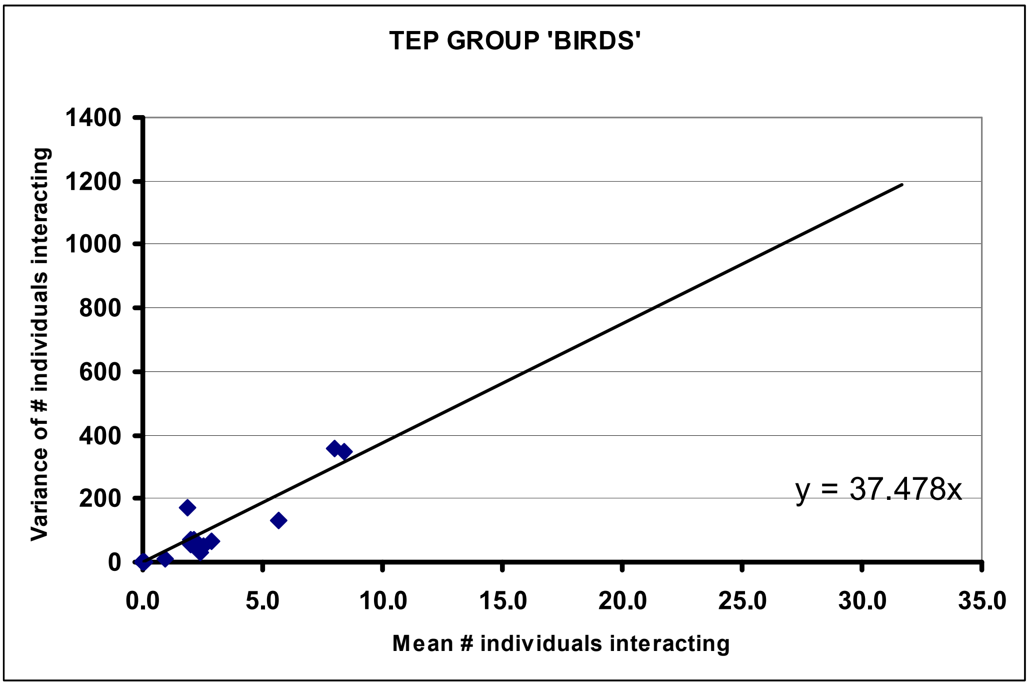

Figure 40. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Birds'. This plot is a subset of the earlier plot (Fig. M7a) for 'Birds' where the high point is omitted.

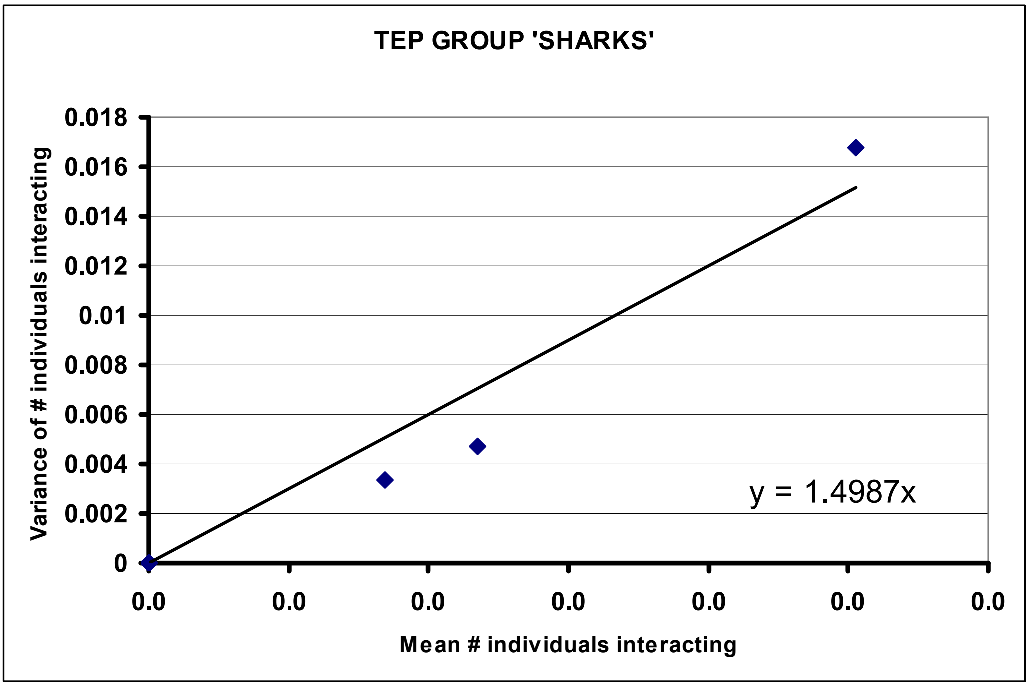

Figure 41. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Sharks'.

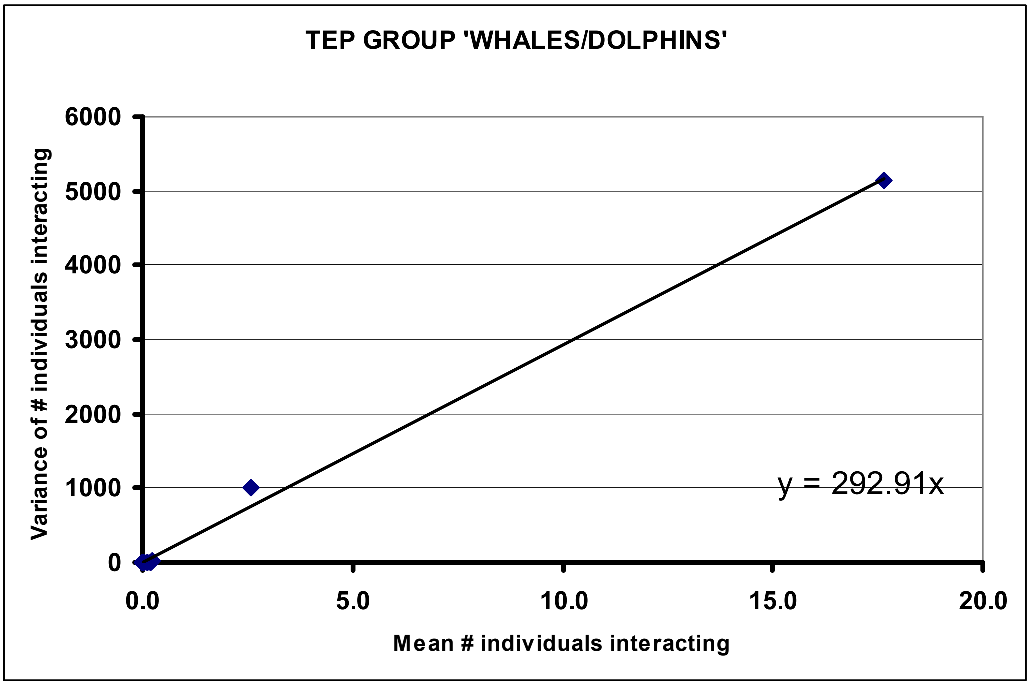

Figure 42. Plot of the variance versus the mean number for individuals interacting with the fishing gear, where the level of aggregation for the calculation of means and variances was year and stratum. This plot is for the TEP group 'Whales / Dolphins'.

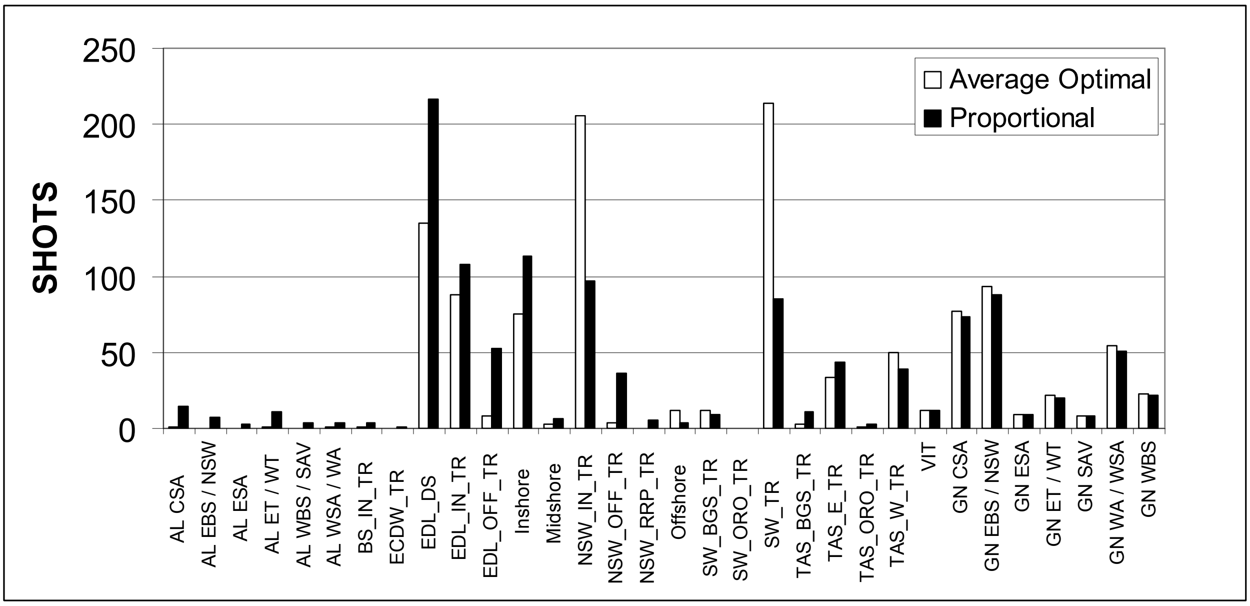

Figure 43. Average optimal shot allocation across TEP species groups, compared to the shot allocation proportional to the number of shots per stratum for 2007 and 2008.

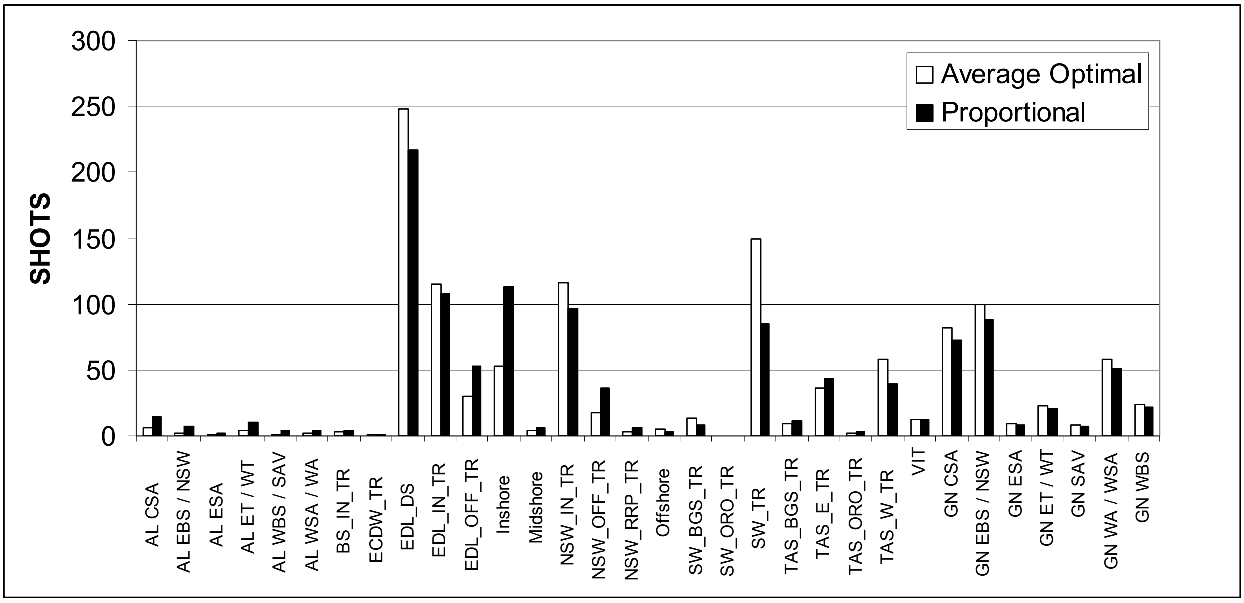

Figure 44. Average optimal shot allocation across TEP species groups, compared to the shot allocation proportional to the number of shots per stratum for 2007 and 2008. These values correspond to Table M6d, i.e. they make some provision in the design optimisation for an underlying true interaction in strata where no interaction was recorded over the period 2002 to 2008. In this output fractional shots are permitted.

Table 1 - Average annual number of shots fired in each of the 32 strata, as obtained from GENLOG data and average annual number of shots observed by the ISMP for years 2002 to 2008. Both of these quantities are also expressed as proportions. Also shown is the average number of shots recorded in the GENLOG per sea-day for each stratum.

Code	Stratum	GENLOG shots per year	ISMP shots per year	Proportion of shots (GENLOG)	Proportio n of shots (ISMP)	Average number of shots per sea-day
1	VIT	306		0.9%		3.6
2	BS IN TR	107	16	0.3%	1.2%	3.5
3	ECDW TR	45	49	0.1%	3.8%	2.4
4	EDL DS	6400	69	18.5%	5.3%	4.6
5	EDL IN TR	3189	93	9.2%	7.2%	3.1
6	EDL OFF TR	1567	64	4.5%	4.9%	2.7
7	NSW IN TR	2862	214	8.3%	16.5%	2.5
8	NSW OFF TR	1081	75	3.1%	5.8%	2.1
9	NSW RRP TR	178	10	0.5%	0.8%	1.8
10	SW BGS TR	258	21	0.7%	1.6%	2.0
11	SW ORO TR	8	3	0.0%	0.2%	2.3
12	SW TR	2501	120	7.2%	9.3%	2.6
13	TAS BGS TR	325	16	0.9%	1.2%	2.5
14	TAS E TR	1292	39	3.7%	3.0%	3.0
15	TAS ORO TR	95	18	0.3%	1.4%	2.1
16	TAS W TR	1156	25	3.3%	1.9%	2.5
17	AL CSA	436	45	1.3%	3.4%	1.7
18	AL EBS /	233	82	0.7%	6.3%	1.2
19	AL ESA	67	4	0.2%	0.3%	1.5
20	AL ET / WT	319	52	0.9%	4.0%	1.1
21	AL WBS /	119	37	0.3%	2.8%	1.3
22	AL WSA / WA	117	72	0.3%	5.5%	1.5
23	GN CSA	2183	4	6.3%	0.3%	2.2
24	GN EBS /	2650		7.7%		1.8
25	GN ESA	259		0.7%		1.9
26	GN ET / WT	621		1.8%		1.4
27	GN SAV	232		0.7%		1.6
28	GN WA / WSA	1559		4.5%		2.4
29	GN WBS	672		1.9%		1.6
30	Inshore	3446	131	10.0%	10.1%	3.3
31	Midshore	193	19	0.6%	1.5%	2.0
32	Offshore	102	20	0.3%	1.5%	1.7

Table 2 - Assumed price in $A per kg for purposes of value weighting of species in the value-weighted average CV — which is used as the objective function in one of the optimization procedures.

	$A per kg
John dory	9.83
King dory	9.83
Blue-eye trevalla	9.42
Ocean blue-eye trevalla	9.42
Gummy shark	7.01
Orange roughy	6.13
Silver trevally	5.23
Inshore ocean perch	5.07
Pink ling	5.03
Alfonsino	4.66
Gemfish	4.34
Tiger flathead	4.24
Oreo basket	3.95
Blue grenadier	3.44
Eastern school whiting	3.26
Smooth oreodory	3.11
Jackass morwong	2.86
Bight redfish	2.72
Redfish	2.72
Mirror dory	2.57
Silver dory	2.57
Sawshark basket	2.25
Blue warehou	2.17
Silver warehou	1.91
Squid	1.75
All other species	1

Table 3 - Estimate of discarded catch and associated CVs for each of the 75 project keys for years 2002 to 2006. Only 27 of the 32 strata are included in this analysis. Excluded strata are the VIT and GN strata.

	RETAINED	ESTIMATE OF DISCARDED CATCH	S.E. OF DISCARDS	ESTIMATE OF TOTAL CATCH	DISCARDED PROPORTION	CV (DISCARDS)	CV (TOTAL CATCH)
Alfonsino	214,911	9,085	2,274	223,997	4%	25.0%	1.0%
Australian angelshark	179,549	71,731	25,993	251,281	29%	36.2%	10.3%
Barracouta	171,783	591,890	191,826	763,673	78%	32.4%	25.1%
Bight redfish	1,006,150	14,482	2,148	1,020,632	1%	14.8%	0.2%
Blue grenadier	6,444,957	392,465	102,615	6,837,422	6%	26.1%	1.5%
Blue morwong	83,696	61,107	6,584	144,802	42%	10.8%	4.5%
Blue warehou	336,987	361,750	104,732	698,737	52%	29.0%	15.0%
Blue-eye trevalla	640,453	9,996	648	650,449	2%	6.5%	0.1%
Bluestriped goatfish	29,133	6,058	1,314	35,192	17%	21.7%	3.7%
Boarfish (unspecified)	56,833	9,622	1,240	66,455	14%	12.9%	1.9%
Broadnose shark	48,998	11,038	377	60,037	18%	3.4%	0.6%
Bronze whaler	26,131	26,411	3,919	52,542	50%	14.8%	7.5%
Chimaeras	25,004	13,836	2,273	38,840	36%	16.4%	5.9%
Crustaceans	47,800	57,565	21,600	105,365	55%	37.5%	20.5%
Deepwater flathead	1,897,768	101,426	15,212	1,999,195	5%	15.0%	0.8%
Deepwater shark basket	313,080	128,494	84,615	441,574	29%	65.9%	19.2%
Dogfish	93,887	243,444	76,478	337,331	72%	31.4%	22.7%
Draughtboard shark	36,298	91,493	9,865	127,791	72%	10.8%	7.7%
Eastern school whiting	534,215	49,374	11,510	583,589	8%	23.3%	2.0%
Echinoderms	-	33,670	6,776	33,670	100%	20.1%	20.1%
Elephantfish	112,448	128,266	156,872	240,715	53%	122.3%	65.2%
Fish	592,139	2,372,557	126,352	2,964,697	80%	5.3%	4.3%
Frostfish	151,761	511,716	226,991	663,476	77%	44.4%	34.2%
Gemfish	740,981	310,627	60,536	1,051,608	30%	19.5%	5.8%
Gould squid	1,031,701	119,739	15,821	1,151,440	10%	13.2%	1.4%
Guitarfish (unspecified)	68,723	676,987	617,975	745,710	91%	91.3%	82.9%
Gummy shark	2,428,197	865,705	10,784	3,293,901	26%	1.2%	0.3%
Hagfish	-	572	280	572	100%	49.0%	49.0%
Hapuku	165,150	8,602	940	173,752	5%	10.9%	0.5%
Inshore ocean perch	377,668	205,827	49,677	583,496	35%	24.1%	8.5%
Jackass morwong	1,194,220	363,997	57,758	1,558,217	23%	15.9%	3.7%
John dory	154,713	15,622	1,414	170,336	9%	9.1%	0.8%
King dory	295,878	86,391	87,289	382,268	23%	101.0%	22.8%
Knifejaw	116,888	41,095	4,107	157,983	26%	10.0%	2.6%
Latchet	324,043	1,095,845	152,822	1,419,888	77%	13.9%	10.8%
Mirror dory	544,068	200,756	39,896	744,824	27%	19.9%	5.4%
Molluscs	171,510	29,017	3,974	200,527	14%	13.7%	2.0%
Ocean blue-eye trevalla	1,601	-	-	1,601	0%	0.0%	0.0%
Ocean jacket	714,251	542,984	122,117	1,257,235	43%	22.50%	9.70%
Octopus	81,272	22,592	3,814	103,864	22%	16.90%	3.70%
Orange roughy	1,903,671	38,016	24,328	1,941,687	2%	64.00%	1.30%
Oreo basket	217,103	114,259	114,625	331,362	34%	100.30%	34.60%
Ornate angelshark	163,587	83,421	9,263	247,007	34%	11.10%	3.80%

Table continues over page…

Table 3 Continued…

	RETAINED	ESTIMATE OF DISCARDED CATCH	S.E. OF DISCARDS	ESTIMATE OF TOTAL CATCH	DISCARDED PROPORTION	CV (DISCARDS)	CV (TOTAL CATCH)
Pink ling	1,791,126	68,778	5,739	1,859,904	4%	8.30%	0.30%
Rays	91,588	452,075	54,217	543,663	83%	12.00%	10.00%
Red gurnard	348,939	277,205	60,723	626,144	44%	21.90%	9.70%
Redfish	402,305	355,210	283,632	757,515	47%	79.80%	37.40%
Ribaldo	225,755	58,303	18,091	284,058	21%	31.00%	6.40%
Royal red prawn	184,400	7,037	1,832	191,436	4%	26.00%	1.00%
Sawshark basket	462,336	159,585	21,793	621,921	26%	13.70%	3.50%
Sawsharks	8,499	95	-	8,593	1%	0.00%	0.00%
School shark	235,863	38,042	2,211	273,905	14%	5.80%	0.80%
Sharks	47,950	53,007	3,705	100,957	53%	7.00%	3.70%
Silver dory	103,929	133,248	28,273	237,176	56%	21.20%	11.90%
Silver trevally	167,200	36,551	6,932	203,752	18%	19.00%	3.40%
Silver warehou	3,279,278	748,531	215,474	4,027,809	19%	28.80%	5.30%
Smooth hammerhead	9,814	3,273	778	13,087	25%	23.80%	5.90%
Smooth oreodory	263,587	88,449	39,804	352,035	25%	45.00%	11.30%
Snapper	112,362	43,331	9,213	155,693	28%	21.30%	5.90%
Southern eagle ray	24,220	23,503	6,005	47,724	49%	25.50%	12.60%
Squid (general)	670,546	224,760	39,267	895,306	25%	17.50%	4.40%
Stargazer (unspecified)	288,201	24,983	4,548	313,184	8%	18.20%	1.50%
Stingarees	-	484,373	88,133	484,373	100%	18.20%	18.20%
Striped trumpeter	7,324	-	-	7,324	0%	0.00%	0.00%
Tiger flathead	4,008,944	760,303	98,773	4,769,247	16%	13.00%	2.10%
Triggerfish & leatherjacket	130,090	75,917	35,872	206,007	37%	47.30%	17.40%
Whiskery shark	35,058	4,887	95	39,945	12%	2.00%	0.20%
Yellowspotted boarfish	159,561	10,242	1,686	169,803	6%	16.50%	1.00%
High risk dogfish other	191,289	498,834	144,982	690,124	72%	29.10%	21.00%
High risk hagfish	-	2,711	506	2,711	100%	18.70%	18.70%
High risk molluscs	180,758	51,162	8,383	231,920	22%	16.40%	3.60%
High risk sharks	56,197	54,980	3,639	111,177	49%	6.60%	3.30%
High risk skates / rays	-	48,629	10,063	48,629	100%	20.70%	20.70%
High risk teleosts	629,000	251,623	25,535	880,622	29%	10.10%	2.90%
High risk upper slope	7,788	70,400	29,978	78,188	90%	42.60%	38.30%
AVERAGE CV ON TOTAL CATCH							**10.3%**
VALUE-WEIGHTED CV ON TOTAL CATCH							**9.6%**

Table 4 - Sample size distribution across strata for a total sample size of 500 observer sea-days by Methods: VWCV (which minimises the value-weighted average CV); MinS (which minimises the number of project keys with CVs above target); Prop (which allocates sampling effort in proportion to the size of the fishery in each stratum); CWCV-HR which minimises the catch-weighted average CV for the high risk species groupings and MinS-HR which minimizes the number of high risk species groups above target. Distributions are shown in terms of sea-days and in terms of the estimated equivalent number of shots sampled.

Total Sample Size = 500 observer seadays.										
	Number of Sea-Days					Number of Shots				
	Method VWCV	Method MinS	Method Prop	Method CWCV - HR	Method MinS - HR	Method VWCV	Method MinS	Metho d Prop	Method CWCV - HR	Method MinS - HR
VIT	3	3	3	3	3	11	11	11	11	11
BS_IN_TR	1	1	2	3	1	3	3	7	10	3
ECDW_TR	1	1	1	1	1	2	2	2	2	2
EDL_DS	7	12	50	25	64	32	55	229	115	293
EDL_IN_TR	156	55	37	3	7	487	172	115	9	22
EDL_OFF_TR	24	14	22	9	46	64	37	58	24	122
NSW_IN_TR	16	15	42	20	4	40	37	104	49	10
NSW_OFF_TR	5	17	19	23	8	11	36	40	49	17
NSW_RRP_TR	1	3	4	1	6	2	5	7	2	11
SW_BGS_TR	1	2	5	8	2	2	4	10	16	4
SW_ORO_TR	1	1	1	1	1	2	2	2	2	2
SW_TR	30	24	34	190	74	79	63	89	500	195
TAS_BGS_TR	1	3	5	1	1	2	7	12	2	2
TAS_E_TR	8	17	16	2	3	24	51	48	6	9
TAS_ORO_TR	1	3	2	1	1	2	6	4	2	2
TAS_W_TR	3	26	17	39	12	7	65	42	97	30
AL CSA	1	7	10	1	6	2	12	17	2	10
AL EBS / NSW	1	10	8	3	15	1	12	9	3	17
AL ESA	1	1	2	2	1	2	2	3	3	2
AL ET / WT	12	4	11	1	3	13	4	12	1	3
AL WBS / SAV	1	3	4	1	2	1	4	5	1	3
AL WSA / WA	1	6	3	1	5	1	9	4	1	7
GN CSA	38	36	37	35	38	83	78	81	76	83
GN EBS / NSW	56	55	55	53	57	99	97	97	93	100
GN ESA	5	5	5	5	5	9	9	9	9	9
GN ET / WT	17	16	16	16	17	24	23	23	23	24
GN SAV	5	5	5	5	5	8	8	8	8	8
GN WA / WSA	25	24	24	23	25	59	57	57	54	59
GN WBS	16	15	16	15	16	25	24	25	24	25
GAB Inshore	58	104	38	6	65	190	340	124	20	213
GAB Midshore	4	6	4	2	5	8	12	8	4	10
GAB Offshore	1	5	3	1	1	2	9	5	2	2
total	501	499	501	500	500	1297	1255	1269	1222	1310

**** - Note that the AL strata ultimately have to be disaggregated to the various line gear types pro rata to expected shots in those gear types (AL+LL, BL, DL).**

Table 5 - Sample size distribution across strata for a total sample size of 750 observer sea-days by Methods: VWCV MinS, Prop, CWCV-HR , MinS-HR. Distributions are shown in terms of Sea-days and in terms of the estimated equivalent number of shots sampled.

Total Sample Size = 750 observer seadays.										
	Number of Sea-Days					Number of Shots				
	Method VWCV	Method MinS	Metho d Prop	Method CWCV - HR	Method MinS - HR	Method VWCV	Method MinS	Metho d Prop	Method CWCV - HR	Method MinS - HR
VIT	5	5	5	5	5	18	18	18	18	18
BS_IN_TR	1	1	2	5	1	3	3	7	17	3
ECDW_TR	1	1	2	1	1	2	2	5	2	2
EDL_DS	10	27	76	38	64	46	124	348	174	293
EDL_IN_TR	233	55	55	4	16	727	172	172	12	50
EDL_OFF_TR	36	14	32	13	46	95	37	85	34	122
NSW_IN_TR	24	15	63	29	12	59	37	156	72	30
NSW_OFF_TR	8	17	28	35	8	17	36	59	74	17
NSW_RRP_TR	1	3	6	1	6	2	5	11	2	11
SW_BGS_TR	2	2	8	12	2	4	4	16	23	4
SW_ORO_TR	1	1	1	2	1	2	2	2	5	2
SW_TR	46	24	52	286	74	121	63	137	752	195
TAS_BGS_TR	2	3	8	2	1	5	7	20	5	2
TAS_E_TR	12	17	24	3	3	36	51	72	9	9
TAS_ORO_TR	2	3	3	1	1	4	6	6	2	2
TAS_W_TR	5	26	25	59	12	12	65	62	147	30
AL CSA	2	7	15	2	6	3	12	25	3	10
AL EBS / NSW	1	10	11	4	15	1	12	13	5	17
AL ESA	1	1	3	2	1	2	2	5	3	2
AL ET / WT	17	4	17	1	3	18	4	18	1	3
AL WBS / SAV	1	3	5	1	2	1	4	7	1	3
AL WSA / WA	1	6	5	2	5	1	9	7	3	7
GN CSA	56	57	55	53	58	122	124	120	116	126
GN EBS / NSW	85	86	83	80	87	150	151	146	141	153
GN ESA	8	8	8	7	8	15	15	15	13	15
GN ET / WT	25	25	24	23	26	35	35	34	32	37
GN SAV	8	8	8	8	8	13	13	13	13	13
GN WA / WSA	37	38	36	35	38	87	90	85	83	90
GN WBS	24	24	23	22	24	38	38	37	35	38
GAB Inshore	88	248	57	9	210	288	811	186	29	687
GAB Midshore	6	6	6	4	5	12	12	12	8	10
GAB Offshore	1	5	4	1	1	2	9	7	2	2
total	750	750	750	750	750	1943	1973	1903	1837	2003

**** - Note that the AL strata ultimately have to be disaggregated to the various line gear types pro rata to expected shots in those gear types (AL+LL, BL, DL).**

Table 6 - Sample size distribution across strata for a total sample size of 1000 observer sea-days by Methods: VWCV, MinS, Prop, CWCV-HR , MinS-HR. Distributions are shown in terms of Sea-days and in terms of the estimated equivalent number of shots sampled.

Total Sample Size = 1000 observer seadays.										
	Number of Sea-Days					Number of Shots				
	Method VWCV	Method MinS	Metho d Prop	Method CWCV - HR	Method MinS - HR	Method VWCV	Method MinS	Metho d Prop	Method CWCV - HR	Method MinS - HR
VIT	6	7	6	6	7	21	25	21	21	25
BS_IN_TR	1	1	3	6	1	3	3	10	21	3
ECDW_TR	1	1	2	1	1	2	2	5	2	2
EDL_DS	14	29	102	50	64	64	133	467	229	293
EDL_IN_TR	313	55	75	5	37	977	172	234	16	115
EDL_OFF_TR	48	14	43	18	46	127	37	114	48	122
NSW_IN_TR	32	15	84	39	13	79	37	207	96	32
NSW_OFF_TR	11	17	37	47	8	23	36	78	100	17
NSW_RRP_TR	1	3	8	1	6	2	5	14	2	11
SW_BGS_TR	2	2	10	16	2	4	4	20	31	4
SW_ORO_TR	1	1	1	3	1	2	2	2	7	2
SW_TR	61	24	69	384	74	160	63	181	1010	195
TAS_BGS_TR	2	3	10	2	2	5	7	25	5	5
TAS_E_TR	16	17	32	4	13	48	51	95	12	39
TAS_ORO_TR	2	3	4	1	1	4	6	9	2	2
TAS_W_TR	6	26	34	79	18	15	65	85	197	45
AL CSA	2	7	20	2	6	3	12	33	3	10
AL EBS / NSW	2	10	15	6	15	2	12	17	7	17
AL ESA	1	1	4	3	1	2	2	6	5	2
AL ET / WT	23	4	22	1	3	24	4	23	1	3
AL WBS / SAV	2	3	7	1	2	3	4	9	1	3
AL WSA / WA	1	6	6	2	5	1	9	9	3	7
GN CSA	75	77	74	71	78	164	168	161	155	170
GN EBS / NSW	113	116	111	107	117	199	204	195	188	206
GN ESA	10	11	10	10	11	19	20	19	19	20
GN ET / WT	33	34	32	31	34	47	48	45	44	48
GN SAV	11	11	10	10	11	18	18	16	16	18
GN WA / WSA	50	51	49	47	51	118	120	116	111	120
GN WBS	32	33	31	30	33	51	52	49	48	52
GAB Inshore	118	406	77	12	333	386	1328	252	39	1089
GAB Midshore	9	6	7	5	5	18	12	14	10	10
GAB Offshore	1	5	5	1	1	2	9	9	2	2
total	1000	999	1000	1001	1000	2594	2671	2542	2450	2690

**** - Note that the AL strata ultimately have to be disaggregated to the various line gear types pro rata to expected shots in those gear types (AL+LL, BL, DL).**

Table 7 - Sample size distribution across strata for a total sample size of 1250 observer sea-days by Methods: VWCV, MinS, Prop, CWCV-HR , MinS-HR. Distributions are shown in terms of Sea-days and in terms of the estimated equivalent number of shots sampled.

Total Sample Size = 1250 observer seadays.										
	Number of Sea-Days					Number of Shots				
	Method VWCV	Method MinS	Method Prop	Method CWCV - HR	Method MinS - HR	Method VWCV	Method MinS	Method Prop	Method CWCV - HR	Method MinS - HR
VIT	8	8	8	8	8	28	28	28	28	28
BS_IN_TR	2	1	3	8	1	7	3	10	28	3
ECDW_TR	1	1	2	2	1	2	2	5	5	2
EDL_DS	17	29	127	63	64	78	133	582	289	293
EDL_IN_TR	392	55	93	7	37	1223	172	290	22	115
EDL_OFF_TR	61	14	54	22	46	162	37	143	58	122
NSW_IN_TR	40	15	106	49	16	99	37	262	121	40
NSW_OFF_TR	14	67	47	59	46	30	142	100	125	98
NSW_RRP_TR	1	3	10	1	6	2	5	18	2	11
SW_BGS_TR	2	2	13	20	2	4	4	25	39	4
SW_ORO_TR	1	1	1	3	1	2	2	2	7	2
SW_TR	76	74	87	478	74	200	195	229	1257	195
TAS_BGS_TR	3	3	12	3	2	7	7	30	7	5
TAS_E_TR	20	67	40	5	47	60	200	119	15	140
TAS_ORO_TR	3	3	5	1	1	6	6	11	2	2
TAS_W_TR	8	42	43	98	29	20	105	107	244	72
AL CSA	3	7	24	3	6	5	12	40	5	10
AL EBS / NSW	2	10	19	7	15	2	12	22	8	17
AL ESA	1	1	4	4	1	2	2	6	6	2
AL ET / WT	29	4	28	1	3	31	4	30	1	3
AL WBS / SAV	2	3	9	1	2	3	4	12	1	3
AL WSA / WA	1	6	8	3	5	1	9	12	4	7
GN CSA	94	95	92	89	96	205	207	201	194	209
GN EBS / NSW	141	142	138	133	145	248	250	243	234	255
GN ESA	13	13	13	12	13	24	24	24	22	24
GN ET / WT	41	42	40	39	42	58	59	56	55	59
GN SAV	13	13	13	12	14	21	21	21	20	23
GN WA / WSA	62	62	61	58	64	146	146	144	137	151
GN WBS	40	40	39	37	41	64	64	62	59	65
GAB Inshore	147	414	96	15	414	481	1354	314	49	1354
GAB Midshore	11	6	9	6	5	22	12	18	12	10
GAB Offshore	1	5	6	1	3	2	9	10	2	5
total	1250	1248	1250	1248	1250	3245	3267	3175	3059	3331

**** - Note that the AL strata ultimately have to be disaggregated to the various line gear types pro rata to expected shots in those gear types (AL+LL, BL, DL).**

Table 8 - Sample size distribution across strata for a total sample size of 1500 observer sea-days by Methods: VWCV, MinS, Prop, CWCV-HR , MinS-HR. Distributions are shown in terms of Sea-days and in terms of the estimated equivalent number of shots sampled.

Total Sample Size = 1500 observer seadays.										
	Number of Sea-Days					Number of Shots				
	Method VWCV	Method MinS	Method Prop	Method CWCV - HR	Method MinS - HR	Method VWCV	Method MinS	Method Prop	Method CWCV - HR	Method MinS - HR
VIT	10	10	9	9	10	36	36	32	32	36
BS_IN_TR	2	1	4	10	1	7	3	14	35	3
ECDW_TR	1	1	3	2	1	2	2	7	5	2
EDL_DS	21	29	153	76	64	96	133	701	348	293
EDL_IN_TR	470	55	112	8	37	1466	172	349	25	115
EDL_OFF_TR	73	14	65	27	46	193	37	172	72	122
NSW_IN_TR	48	15	127	59	16	119	37	314	146	40
NSW_OFF_TR	16	67	56	70	63	34	142	119	148	134
NSW_RRP_TR	1	3	12	1	6	2	5	21	2	11
SW_BGS_TR	3	2	15	24	2	6	4	29	47	4
SW_ORO_TR	1	1	1	4	1	2	2	2	9	2
SW_TR	92	74	105	575	74	242	195	276	1512	195
TAS_BGS_TR	4	3	15	3	2	10	7	37	7	5
TAS_E_TR	24	67	48	6	64	72	200	143	18	191
TAS_ORO_TR	4	3	5	1	1	9	6	11	2	2
TAS_W_TR	9	42	51	118	40	22	105	127	294	100
AL CSA	3	7	29	4	6	5	12	48	7	10
AL EBS / NSW	3	10	23	9	15	3	12	26	10	17
AL ESA	1	1	5	5	1	2	2	8	8	2
AL ET / WT	35	4	33	1	3	37	4	35	1	3
AL WBS / SAV	2	3	10	1	2	3	4	13	1	3
AL WSA / WA	1	6	9	3	5	1	9	13	4	7
GN CSA	113	115	110	106	116	246	251	240	231	253
GN EBS / NSW	169	173	166	160	174	297	304	292	282	306
GN ESA	16	16	15	15	16	30	30	28	28	30
GN ET / WT	50	51	49	47	51	71	72	69	66	72
GN SAV	16	16	16	15	16	26	26	26	25	26
GN WA / WSA	74	76	73	70	76	175	179	172	165	179
GN WBS	48	48	47	45	49	76	76	75	72	78
GAB Inshore	176	575	116	18	533	576	1880	379	59	1743
GAB Midshore	13	6	11	7	5	27	12	22	14	10
GAB Offshore	1	5	7	1	3	2	9	12	2	5
total	1500	1499	1500	1500	1499	3894	3968	3814	3676	3998

**** - Note that the AL strata ultimately have to be disaggregated to the various line gear types pro rata to expected shots in those gear types (AL+LL, BL, DL).**

Table 9. Extent to which records in the TEP Interaction table can be matched to records in the ISMP catch table using vessel as the linking key.

	Un Matched Vessel	No Matching Shot	Matched Shot	Total Interactions
Birds	19	182	0	**201**
Pipefish	1	1	1	**3**
Seals	9	100	0	**109**
Sharks	0	0	1	**1**
Whales/Dolphins	0	6	1	**7**

Table 10. The number of trips sampled per species and year for length frequency distribution information, at the point of landing – the difference between species is assumed to be due partly to hit rate but may also reflect sampling decisions.

	CSIRO	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2007/2008**	**2002–2006**
Gummy shark	37017001	25	13	22	36	2	22	40	**31**	**20**
School shark	37017008	7	4	6	7	1	18	18	**18**	**5**
Elephantfish	37043001	0	0	0	0	0	11	27	**19**	**0**
Ribaldo	37224002	0	0	0	0	0	1	9	**5**	**0**
Blue grenadier	37227001	75	39	43	50	31	10	18	**14**	**48**
Pink ling	37228002	59	35	41	46	28	24	13	**19**	**42**
Orange roughy	37255009	16	26	19	17	4	0	0		**16**
Alfonsino	37258002	2	6	1	0	0	6	11	**9**	**2**
Redfish	37258003	48	42	60	56	41	7	8	**8**	**49**
Bight redfish	37258004	0	16	13	14	2	0	0		**9**
Mirror dory	37264003	47	46	38	44	31	16	16	**16**	**41**
John dory	37264004	60	45	61	46	33	13	22	**18**	**49**
Oreo basket	37266001	2	8	0	1	0	0	3	**2**	**2**
Smooth oreodory	37266003	0	0	3	0	0	0	0		**1**
Inshore ocean perch	37287001	13	15	19	10	16	0	0		**15**
Tiger flathead	37296001	136	82	156	133	79	36	9	**23**	**117**
Deepwater flathead	37296002	0	25	38	40	9	0	0		**22**
Eastern school whiting	37330014	28	22	55	40	40	28	8	**18**	**37**
Silver trevally	37337062	21	5	32	25	45	13	4	**9**	**26**
Boarfish (unspecified)	37367003	0	1	0	0	1	0	0		**0**
Jackass morwong	37377003	80	64	60	67	89	26	20	**23**	**72**
Gemfish	37439002	70	55	50	41	14	6	22	**14**	**46**
Blue-eye trevalla	37445001	80	40	31	12	11	4	10	**7**	**35**
Blue warehou	37445005	54	32	31	25	32	5	8	**7**	**35**
Silver warehou	37445006	164	88	79	83	60	10	12	**11**	**95**

Table 11. The average number of fish sampled per trip by species and year for length frequency distribution information, at the point of landing.

	CSIRO	2002	2003	2004	2005	2006	2007	2008	2007/2008	2002--2006
Gummy shark	37017001	98	89	155	280	413	508	587	**548**	207
School shark	37017008	21	18	27	63	18	158	179	**169**	29
Elephantfish	37043001						348	436	**392**	
Ribaldo	37224002						404	560	**482**	
Blue grenadier	37227001	126	129	103	126	93	375	428	**402**	115
Pink ling	37228002	92	51	57	62	76	498	586	**542**	68
Orange roughy	37255009	92	191	127	119	178				141
Alfonsino	37258002	29	47	128			430	364	**397**	68
Redfish	37258003	103	99	169	131	262	916	167	**541**	153
Bight redfish	37258004		101	100	86	88				93
Mirror dory	37264003	140	64	58	68	71	439	423	**431**	80
John dory	37264004	117	98	108	76	96	408	471	**440**	99
Oreo basket	37266001	63	62		115			478	**239**	80
Smooth oreodory	37266003			39						39
In. Ocean perch	37287001	125	97	77	54	122				95
Tiger flathead	37296001	110	88	103	130	199	757	596	**676**	126
D.w. flathead	37296002		101	147	224	186				164
E. School whiting	37330014	88	88	221	215	422	770	514	**642**	207
Silver trevally	37337062	69	114	80	105	337	630	465	**548**	141
Boarfish	37367003		13			45				29
Jackass morwong	37377003	136	97	96	134	186	556	419	**487**	130
Gemfish	37439002	100	87	73	50	43	209	337	**273**	70
Blue-eye trevalla	37445001	80	67	66	95	226	378	424	**401**	107
Blue warehou	37445005	119	101	110	94	105	570	215	**392**	106
Silver warehou	37445006	134	102	99	149	147	613	451	**532**	126

Table 12. The total number of fish sampled per year for length frequency distribution information, at the point of landing.

Quota species	**CSIRO**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Gummy shark	37017001	2442	1155	3405	10086	826	11178	23485
School shark	37017008	150	72	161	440	18	2848	3221
Elephantfish	**37043001**						**3824**	**11782**
Ribaldo	37224002						404	5043
Blue grenadier	37227001	9416	5023	4413	6310	2874	3748	7709
Pink ling	37228002	5411	1788	2325	2861	2140	11952	7612
Orange roughy	37255009	1466	4973	2416	2021	711		
Alfonsino	37258002	58	282	128			2580	4008
Redfish	37258003	4925	4178	10132	7316	10741	6412	1332
Bight redfish	37258004		1608	1298	1200	175		
Mirror dory	37264003	6600	2922	2209	2993	2209	7028	6772
John dory	37264004	7004	4397	6618	3494	3180	5308	10371
Oreo basket	37266001	126	494		115			1433
Smooth oreodory	37266003			117				
Inshore ocean perch	37287001	1627	1458	1468	539	1947		
Tiger flathead	**37296001**	**14978**	**7231**	**16047**	**17346**	**15727**	**27260**	**5360**
Deepwater flathead	37296002		2514	5577	8954	1678		
Eastern school whiting	**37330014**	**2453**	**1930**	**12166**	**8612**	**16866**	**21572**	**4112**
Silver trevally	37337062	1439	571	2557	2636	15170	8192	1860
Boarfish (unspecified)	37367003		13			45		
Jackass morwong	**37377003**	**10885**	**6231**	**5773**	**9004**	**16570**	**14460**	**8374**
Gemfish	37439002	6987	4781	3637	2037	605	1256	7404
Blue-eye trevalla	37445001	6436	2679	2032	1142	2491	1512	4235
Blue warehou	37445005	6400	3230	3415	2341	3360	2848	1719
Silver warehou	**37445006**	**22043**	**8999**	**7783**	**12326**	**8849**	**6132**	**5412**

Table 13. A summary of the ISMP shots recorded by year and by strata.

Strata	2002	2003	2004	2005	2006	2007	2008
AL CSA	0	0	51	10	60	43	0
AL EBS / NSW	175	168	58	10	4	23	87
AL ESA	0	0	0	0	0	4	0
AL ET / WT	71	75	64	23	36	4	45
AL WBS / SAV	14	35	55	5	31	78	3
AL WSA / WA	0	0	0	91	0	31	90
BS_IN_TR	12	30	6	1	0	0	17
ECDW_TR	69	0	25	0	0	0	0
EDL_DS	34	115	48	70	129	47	13
EDL_IN_TR	81	100	47	133	117	68	103
EDL_OFF_TR	62	73	76	74	66	31	56
GN	4	0	0	0	0	0	0
Inshore	113	89	123	203	133	132	120
Midshore	6	23	29	1	25	12	12
NSW_IN_TR	208	296	297	272	213	47	121
NSW_OFF_TR	75	94	127	81	88	9	16
NSW_RRP_TR	26	11	4	5	4	6	0
Offshore	23	19	21	11	15	26	17
SW_BGS_TR	12	14	31	30	15	0	0
SW_ORO_TR	2	6	1	2	0	0	0
SW_TR	144	97	97	187	120	77	101
TAS_BGS_TR	9	33	8	19	5	0	0
TAS_E_TR	64	22	35	21	66	0	10
TAS_ORO_TR	9	9	25	25	22	0	0
TAS_W_TR	40	31	1	28	9	26	3

Table 14. A summary of the GENLOG shots recorded by year and by strata, after the CDR/GENLOG merge.

Strata	2002	2003	2004	2005	2006	2007	2008
AL CSA	144	317	661	567	747	500	381
AL EBS / NSW	184	497	677	395	292	274	181
AL ESA	46	154	205	456	226	84	51
AL ET / WT	29	492	445	370	348	345	288
AL WBS / SAV	131	339	685	382	231	128	108
AL WSA / WA	24	46	223	338	453	117	118
BS_IN_TR	157	165	411	749	602	45	177
ECDW_TR	88	167	230	60	1	75	1
EDL_DS	8939	10111	8323	7681	6489	6394	6405
EDL_IN_TR	5353	4889	4853	5588	4254	3186	3193
EDL_OFF_TR	3114	3623	2816	2606	2075	1462	1667
GN CSA	2840	2860	3060	2838	2994	2125	2244
GN EBS / NSW	4346	4758	4363	3743	3326	2772	2509
GN ESA	429	342	393	263	171	266	252
GN ET / WT	687	685	801	537	591	772	440
GN SAV	687	564	501	597	531	290	173
GN WA / WSA	1584	1770	1695	1423	2249	2010	1051
GN WBS	1668	1671	1764	1456	910	832	461
Inshore	2284	3810	4696	5325	5165	4044	2659
Midshore	0	169	474	649	488	313	48
NSW_IN_TR	6103	7491	7849	6151	4843	2834	2889
NSW_OFF_TR	2225	2395	2132	2024	1515	1045	1114
NSW_RRP_TR	1442	644	441	437	323	211	134
Offshore	2	205	246	177	192	123	78
SW_BGS_TR	353	317	501	414	435	315	191
SW_ORO_TR	141	90	93	79	55	8	0
SW_TR	5238	4255	4966	3902	3660	2871	2153
TAS_BGS_TR	1095	1082	831	445	482	332	318
TAS_E_TR	3494	2840	2978	2391	1951	1254	1328
TAS_ORO_TR	654	300	245	270	245	68	116
TAS_W_TR	3463	2646	1944	1451	1057	1343	955
VIT	415	174	314	739	421	342	263

Table 15. A table of the MWCVs for the age frequency estimates obtained for the retained catch using the ageing data provided, and the ISMP at-sea length frequency data provided.

RETAINED CATCH – AGE FREQUENCY MWCVs							
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Bight redfish	34.48	36.50	27.14	26.95	25.25	28.69	
Blue grenadier	6.10	9.12	7.88	7.56	6.85	12.42	
Blue warehou	6.88	10.12	7.54	7.76	7.62	20.66	
Blue-eye trevalla	6.64	14.61	15.65	15.63	12.67	14.80	
Deepwater flathead	12.99	24.36	19.09	11.79	13.01	11.96	
Eastern school whiting	6.41	7.28	5.82	8.69	14.01	14.68	10.98
Gemfish	6.57	8.54	7.26	9.10	9.04	10.53	
Jackass morwong	24.05	21.30	20.54	21.76	24.00	33.44	
Orange roughy			21.92	25.38			
Pink ling	10.61	11.05	12.74	9.65	11.40	10.65	
Redfish	18.88	18.96	13.57				
Silver warehou	10.68	13.53	13.25	10.73	16.41	16.52	22.51
Tiger flathead	10.01	13.02	13.17	13.72			

Table 16. A table of the MWCVs for the age frequency estimates obtained for the retained catch using the ageing data provided, and the ISMP at-sea length frequency data provided.

DISCARDED CATCH – AGE FREQUENCY MWCVs							
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Bight redfish	34.48	36.50	27.14	26.95	25.25	28.69	
Blue grenadier	6.10	9.12	7.88	7.56	6.85	12.42	
Blue warehou	6.88	10.12	7.54	7.76	7.62	20.66	
Blue-eye trevalla	6.64	14.61	15.65	15.63	12.67	14.80	
Deepwater flathead	12.99	24.36	19.09	11.79	13.01	11.96	
Eastern school whiting	6.41	7.28	5.82	8.69	14.01	14.68	10.98
Gemfish	6.57	8.54	7.26	9.10	9.04	10.53	
Jackass morwong	24.05	21.30	20.54	21.76	24.00	33.44	
Orange roughy			21.92	25.38			
Pink ling	10.61	11.05	12.74	9.65	11.40	10.65	
Redfish	18.88	18.96	13.57				
Silver warehou	10.68	13.53	13.25	10.73	16.41	16.52	22.51
Tiger flathead	10.01	13.02	13.17	13.72			

Table 17. Presentation of the number of fish sampled for ageing in the SESSF, regardless of whether retained or discarded.

DISCARDED AND RETAINED SAMPLE SIZES FOR AGEING							
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Bight redfish	307	245	605	581	540	293	0
Blue grenadier	1687	1514	1484	1815	1607	1574	0
Blue warehou	750	297	1118	743	742	108	15
Blue-eye trevalla	637	1013	601	1066	894	410	0
Deepwater flathead	555	87	207	685	476	459	0
Gemfish	494	381	469	1257	800	666	0
Hapuku	0	0	0	143	210	0	0
Jackass morwong	379	250	557	471	245	120	0
Pink ling	707	886	688	793	902	1084	10
Redfish	672	658	684	0	0	0	0
Orange roughy	0	0	2033	800	0	0	0
Eastern school whiting	560	471	649	393	314	421	68
Silver warehou	646	444	639	625	395	316	132
Tiger flathead	1302	102	326	891	0	0	0

Table 18. Ageing sample sizes required in order to obtain an MWCV for each of the species listed of 10%, for the retained length frequency distribution.

Retained	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Bight redfish	3650	3264	4455	4219	3443	2412	
Blue grenadier	627	1258	922	1038	755	2429	
Blue warehou	355	304	635	448	430	461	
Blue-eye trevalla	281	2163	1472	2604	1435	898	
Deepwater flathead	936	516	754	952	805	657	
Eastern school whiting	203	202	159	949	1571	1435	
Gemfish	163	182	293	390	200	133	
Jackass morwong	4089	4022	2903	3754	5196	12123	
Orange roughy			3285				
Pink ling			3301	745			
Redfish	1996	1692	1195				
Silver warehou	737	812	1122	719	1064	862	669
Tiger flathead	1305	173	566	1677			

Table 19. Ageing sample sizes required in order to obtain an MWCV for each of the species listed of 10%, for the discarded length frequency distribution.

Discarded	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Bight redfish			5228				
Blue grenadier		22051	34	524	657		
Blue warehou	67	464	368	230	184		
Blue-eye trevalla			3921				
Deepwater flathead			409	1337	1238	1927	
Eastern school whiting	64	157	129	1482	0		
Gemfish	213	160	299	97	181	594	
Jackass morwong	3372	3182	2151	3950	6786		
Orange roughy			39584				
Pink ling							
Redfish	999	998	796				
Silver warehou	678	338	468	530	127		575
Tiger flathead	2657	154	429	759			

Table 20. MWCVs associated with the multinomial ageing error from the age-length key, using the length frequency derived from port sampling as a quantity known without error (this quantity obviously has error associated with it, but as discussed elsewhere in this document, the assumption that the lf distribution is error free is a device to determine the adequacy of the age sampling).

	2002	2003	2004	2005	2006	2007	2008
Bight redfish		38.14	25.06	28.98	33.81		
Blue grenadier	26.44	14.27	5.36	6.15	6.34	5.98	
Blue warehou	6.89	12.37	6.86	11.11	9.14	5.70	
Blue-eye trevalla	8.64	10.46	11.35	13.92	9.26	13.33	
Deepwater flathead		25.74	18.75	11.49	13.24		
Eastern school whiting	5.79	8.38	7.95	8.85	14.05	8.46	15.88
Gemfish	6.13	7.62	7.24	6.46	9.32	7.78	
Jackass morwong	26.78	23.74	20.39	20.60	23.14	31.68	
Orange roughy			34.55	44.37			
Pink ling	12.34	12.88	13.18	11.02	11.05	8.42	10.11
Redfish	19.24	21.97	13.87				
Silver warehou	10.58	12.71	11.48	10.52	21.52	17.08	20.68
Tiger flathead	8.55	11.91	13.38	15.83			

Table 21. Average number of shots per vessel-day per stratum, as derived from the GENLOG data after exclusion of records where vessels straddle two or more strata in the same day.

AL CSA	1.648
AL EBS / NSW	1.149
AL ESA	1.534
AL ET / WT	1.063
AL WBS / SAV	1.306
AL WSA / WA	1.468
BS_IN_TR	3.485
ECDW_TR	2.400
EDL_DS	4.577
EDL_IN_TR	3.123
EDL_OFF_TR	2.650
GN CSA	2.185
GN EBS / NSW	1.756
GN ESA	1.859
GN ET / WT	1.414
GN SAV	1.641
GN WA / WSA	2.356
GN WBS	1.593
Inshore	3.273
Midshore	2.036
Offshore	1.707
NSW_IN_TR	2.471
NSW_OFF_TR	2.124
NSW_RRP_TR	1.766
SW_BGS_TR	1.945
SW_ORO_TR	2.298
SW_TR	2.629
TAS_BGS_TR	2.460
TAS_E_TR	2.979
TAS_ORO_TR	2.139
TAS_W_TR	2.492
VIT	3.558

Table 22. Optimal design results for TEP species groups. For each species group, the optimal number of days is shown per stratum. The associated optimal number of shots is calculated from the optimal days, using the average number of shots per vessel per day reported in Table %%. The CVs associated with the optimal design are shown, as are the CVs associated with a sample day allocation equal to the average over all species groups.

	Birds		Pipefish		Seals		Sharks		Whales		Average		
	Days	Shots	Days	Shots	Days	Shots	Days	Shots	Days	Shots	Days	Shots	Shots prop
AL CSA	2.08	3.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.69	14.86
AL EBS / NSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.67
AL ESA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28
AL ET / WT	0.00	0.00	0.00	0.00	6.00	6.37	0.00	0.00	0.00	0.00	1.20	1.27	10.68
AL WBS / SAV	0.54	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.14	3.98
AL WSA / WA	1.14	1.68	0.00	0.00	0.59	0.87	0.00	0.00	0.00	0.00	0.35	0.51	3.96
BS_IN_TR	0.00	0.00	0.00	0.00	2.22	7.74	0.00	0.00	0.00	0.00	0.44	1.55	5.10
ECDW_TR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82
EDL_DS	0.00	0.00	173.59	794.54	30.25	138.45	0.00	0.00	0.00	0.00	40.77	186.60	298.80
EDL_IN_TR	7.54	23.56	125.74	392.66	61.16	190.99	0.00	0.00	0.00	0.00	38.89	121.44	148.92
EDL_OFF_TR	6.98	18.49	0.00	0.00	13.99	37.08	0.00	0.00	0.00	0.00	4.19	11.11	72.92
Inshore	3.38	11.07	17.12	56.04	11.08	36.26	0.00	0.00	83.04	271.84	22.92	75.04	113.06
Midshore	5.76	11.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	2.34	6.09
NSW_IN_TR	35.18	86.94	83.55	206.44	54.81	135.43	400.00	988.42	0.00	0.00	114.71	283.45	133.57
NSW_OFF_TR	3.60	7.65	0.00	0.00	9.33	19.82	0.00	0.00	0.00	0.00	2.59	5.49	50.36
NSW_RRP_TR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.10
Offshore	4.87	8.31	0.00	0.00	0.00	0.00	0.00	0.00	29.55	50.46	6.88	11.75	3.39
SW_BGS_TR	22.81	44.37	0.00	0.00	19.15	37.25	0.00	0.00	0.00	0.00	8.39	16.32	11.89
SW_ORO_TR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
SW_TR	177.70	467.23	0.00	0.00	114.87	302.04	0.00	0.00	268.77	706.69	112.27	295.19	117.76
TAS_BGS_TR	0.00	0.00	0.00	0.00	7.96	19.57	0.00	0.00	0.00	0.00	1.59	3.91	15.18
TAS_E_TR	26.57	79.16	0.00	0.00	31.41	93.57	0.00	0.00	18.64	55.52	15.32	45.65	60.23
TAS_ORO_TR	0.00	0.00	0.00	0.00	2.28	4.88	0.00	0.00	0.00	0.00	0.46	0.98	4.26
TAS_W_TR	101.84	253.78	0.00	0.00	34.91	86.99	0.00	0.00	0.00	0.00	27.35	68.15	53.90
N	**400**	**1018**	**400**	**1450**	**400**	**1117**	**400**	**988**	**400**	**1085**	**400.00**	**1131.60**	**1149**
CV opt	14.68		13.53		24.08		66.59		84.49				
CV ave	21.37		23.62		29.34		124.35		140.02				
CV prop	27.04		20.63		30.51		181.14		201.63				

Table 23. Optimal design results for TEP species groups. For each species group, the optimal number of days is shown per stratum. The associated optimal number of shots is calculated from the optimal days, using the average number of shots per vessel per day reported in Table %. The CVs associated with the optimal design are shown, as are the CVs associated with a sample day allocation equal to the average over all species groups. For this version of results additional priors were introduced for strata where there were no interactions for the period 2002 – 2008. These priors were: birds, seals: 10% of the mean number of interactions per shot in strata where interactions did occur, calculated separately for the AL, SET or GAB sectors of the SESSF, pipefish, sharks and whales / dolphins: 10% of the mean number of interactions per shot in strata where interactions did occur, regardless of SESSF stratum.

	Birds		**Pipefish**		**Seals**		**Sharks**		**Whales**		**Average**		
	Days	**Shots**	**Days**	**Shots**	**Days**	**Shots**	**Days**	**Shots**	**Days**	**Shots**	**Days**	**Shots**	**Shots prop**
AL CSA	1.70	2.81	3.20	5.28	1.55	2.55	5.45	8.98	6.58	10.85	3.70	6.09	14.86
AL EBS / NSW	0.45	0.52	1.98	2.28	0.96	1.10	3.37	3.87	4.07	4.68	2.17	2.49	7.67
AL ESA	0.12	0.18	0.51	0.78	0.25	0.38	0.87	1.33	1.05	1.60	0.56	0.85	2.28
AL ET / WT	0.65	0.69	2.87	3.05	5.90	6.27	4.88	5.18	5.89	6.26	4.04	4.29	10.68
AL WBS / SAV	0.44	0.58	0.96	1.26	0.47	0.61	1.64	2.14	1.98	2.59	1.10	1.43	3.98
AL WSA / WA	0.93	1.37	0.91	1.33	0.58	0.86	1.54	2.26	1.86	2.73	1.16	1.71	3.96
BS_IN_TR	1.22	4.25	0.77	2.67	2.19	7.62	1.30	4.54	1.57	5.49	1.41	4.91	5.10
ECDW_TR	0.50	1.21	0.32	0.76	0.38	0.91	0.54	1.29	0.65	1.56	0.48	1.15	1.82
EDL_DS	61.38	280.93	138.08	632.00	29.80	136.40	65.57	300.14	79.19	362.44	74.80	342.38	298.80
EDL_IN_TR	6.17	19.28	100.01	312.31	60.24	188.13	39.57	123.56	47.78	149.21	50.76	158.50	148.92
EDL_OFF_TR	5.71	15.13	12.38	32.81	13.78	36.53	21.07	55.83	25.44	67.42	15.68	41.55	72.92
Inshore	2.77	9.06	13.62	44.59	10.91	35.72	29.43	96.33	24.75	81.02	16.30	53.34	113.06
Midshore	4.71	9.59	1.18	2.40	0.24	0.48	2.01	4.09	2.43	4.94	2.11	4.30	6.09
NSW_IN_TR	28.80	71.17	66.46	164.23	53.99	133.41	126.19	311.83	48.19	119.08	64.73	159.94	133.57
NSW_OFF_TR	2.95	6.26	9.54	20.27	9.19	19.52	16.24	34.49	19.61	41.65	11.50	24.44	50.36
NSW_RRP_TR	2.66	4.70	1.67	2.95	2.01	3.56	2.85	5.02	3.44	6.07	2.53	4.46	8.10
Offshore	3.98	6.80	0.72	1.23	0.14	0.24	1.22	2.09	8.81	15.04	2.98	5.08	3.39
SW_BGS_TR	18.67	36.32	2.34	4.55	18.85	36.67	3.98	7.74	4.80	9.34	9.73	18.92	11.89
SW_ORO_TR	0.05	0.12	0.03	0.08	0.04	0.09	0.06	0.13	0.07	0.16	0.05	0.12	0.19
SW_TR	145.48	382.52	19.96	52.47	113.12	297.43	33.96	89.29	79.87	210.01	78.48	206.34	117.76
TAS_BGS_TR	4.25	10.46	2.67	6.57	7.84	19.28	4.54	11.17	5.49	13.49	4.96	12.19	15.18
TAS_E_TR	21.75	64.78	9.64	28.70	30.94	92.15	16.40	48.85	5.56	16.55	16.85	50.21	60.23
TAS_ORO_TR	1.29	2.76	0.81	1.73	2.24	4.80	1.38	2.95	1.67	3.56	1.48	3.16	4.26
TAS_W_TR	83.34	207.68	9.38	23.36	34.39	85.70	15.96	39.76	19.27	48.02	32.47	80.90	53.90
N	**400**	**1139.18**	**400**	**1347.658**	**400**	**1110.41**	**400**	**1162.873**	**400**	**1183.76**	**400.00**	**1149.00**	**1149.00**
CV opt	16.76		16.06		24.38		119.93		120.31				
CV ave	21.23		19.28		26.70		136.32		128.26				
CV prop	26.13326		20.05407		30.4652		136.5351		131.1711				

Table 24. Shot allocations modified from Table 22 to include the VIT and gillnet strata on a pro rata basis as described in the text (w.r.t. to the CDR-GENLOG shots in 2007 and 2008). The conversion between shots and days would need to be implemented to see the below in terms of sea-days.

	Birds Shots	Pipefish Shots	Seals Shots	Sharks Shots	Whales Shots	Average Shots	Proportion Shots
AL CSA	3.43	0	0	0	0	0.69	14.86
AL EBS / NSW	0	0	0	0	0	0	7.67
AL ESA	0.00	0.00	0.00	0.00	0.00	0.00	2.28
AL ET / WT	0.00	0.00	6.37	0.00	0.00	1.27	10.68
AL WBS / SAV	0.71	0.00	0.00	0.00	0.00	0.14	3.98
AL WSA / WA	1.68	0.00	0.87	0.00	0.00	0.51	3.96
BS_IN_TR	0.00	0.00	5.61	0.00	0.00	1.12	3.70
ECDW_TR	0.00	0.00	0.00	0.00	0.00	0.00	1.32
EDL_DS	0.00	575.75	100.33	0.00	0.00	135.22	216.52
EDL_IN_TR	17.07	284.54	138.40	0.00	0.00	88.00	107.91
EDL_OFF_TR	13.40	0.00	26.87	0.00	0.00	8.05	52.84
Inshore	11.07	56.04	36.26	0.00	271.84	75.04	113.06
Midshore	11.72	0.00	0.00	0.00	0.00	2.34	6.09
NSW_IN_TR	63.00	149.59	98.14	716.25	0.00	205.40	96.79
NSW_OFF_TR	5.54	0.00	14.36	0.00	0.00	3.98	36.49
NSW_RRP_TR	0.00	0.00	0.00	0.00	0.00	0.00	5.87
Offshore	8.31	0.00	0.00	0.00	50.46	11.75	3.39
SW_BGS_TR	32.15	0.00	26.99	0.00	0.00	11.83	8.62
SW_ORO_TR	0.00	0.00	0.00	0.00	0.00	0.00	0.14
SW_TR	338.57	0.00	218.87	0.00	512.09	213.91	85.33
TAS_BGS_TR	0.00	0.00	14.18	0.00	0.00	2.83	11.00
TAS_E_TR	57.36	0.00	67.80	0.00	40.23	33.08	43.64
TAS_ORO_TR	0.00	0.00	3.54	0.00	0.00	0.71	3.09
TAS_W_TR	183.90	0.00	63.04	0.00	0.00	49.38	39.06
VIT	10.80	15.38	11.85	10.48	11.51	12.01	12.19
GN CSA	72.88	103.51	79.76	73.42	56.61	77.24	73.01
GN EBS / NSW	88.09	125.12	96.41	88.74	68.43	93.36	88.26
GN ESA	8.64	12.27	9.46	8.70	6.71	9.16	8.66
GN ET / WT	20.22	28.72	22.13	20.37	15.71	21.43	20.25
GN SAV	7.72	10.97	8.45	7.78	6.00	8.18	7.74
GN WA / WSA	51.06	72.52	55.88	51.44	39.67	54.11	51.15
GN WBS	21.57	30.64	23.60	21.73	16.75	22.86	21.61

Table 25. Shot allocations modified from Table 23 to include the VIT and gillnet strata on a pro-rata basis as described in the text (w.r.t. to the CDR-GENLOG shots in 2007 and 2008).

	Birds	Pipefish	Seals	Sharks	Whales	Average	Proportion
	Shots	Shots	Shots	Shots	Shots	Shots	Shots
AL CSA	2.81	5.28	2.55	8.98	10.85	6.09	14.86
AL EBS / NSW	0.52	2.28	1.1	3.87	4.68	2.49	7.67
AL ESA	0.18	0.78	0.38	1.33	1.60	0.85	2.28
AL ET / WT	0.69	3.05	6.27	5.18	6.26	4.29	10.68
AL WBS / SAV	0.58	1.26	0.61	2.14	2.59	1.43	3.98
AL WSA / WA	1.37	1.33	0.86	2.26	2.73	1.71	3.96
BS_IN_TR	3.08	1.93	5.52	3.29	3.98	3.56	3.70
ECDW_TR	0.88	0.55	0.66	0.93	1.13	0.83	1.32
EDL_DS	203.57	457.97	98.84	217.49	262.64	248.10	216.52
EDL_IN_TR	13.97	226.31	136.33	89.54	108.12	114.86	107.91
EDL_OFF_TR	10.96	23.78	26.47	40.46	48.86	30.11	52.84
Inshore	9.06	44.59	35.72	96.33	81.02	53.34	113.06
Midshore	9.59	2.40	0.48	4.09	4.94	4.30	6.09
NSW_IN_TR	51.57	119.01	96.67	225.96	86.29	115.90	96.79
NSW_OFF_TR	4.54	14.69	14.14	24.99	30.18	17.71	36.49
NSW_RRP_TR	3.41	2.14	2.58	3.64	4.40	3.23	5.87
Offshore	6.80	1.23	0.24	2.09	15.04	5.08	3.39
SW_BGS_TR	26.32	3.30	26.57	5.61	6.77	13.71	8.62
SW_ORO_TR	0.09	0.06	0.07	0.09	0.12	0.09	0.14
SW_TR	277.19	38.02	215.53	64.70	152.18	149.52	85.33
TAS_BGS_TR	7.58	4.76	13.97	8.09	9.78	8.83	11.00
TAS_E_TR	46.94	20.80	66.78	35.40	11.99	36.38	43.64
TAS_ORO_TR	2.00	1.25	3.48	2.14	2.58	2.29	3.09
TAS_W_TR	150.49	16.93	62.10	28.81	34.80	58.62	39.06
VIT	10.80	15.38	11.85	10.48	11.51	12.01	12.19
GN CSA	82.27	95.48	78.90	76.99	78.29	82.39	73.01
GN EBS / NSW	99.44	115.41	95.37	93.07	94.63	99.58	88.26
GN ESA	9.75	11.32	9.35	9.13	9.28	9.77	8.66
GN ET / WT	22.82	26.49	21.89	21.36	21.72	22.85	20.25
GN SAV	8.72	10.12	8.36	8.16	8.30	8.73	7.74
GN WA / WSA	57.64	66.89	55.28	53.94	54.85	57.72	51.15
GN WBS	24.35	28.26	23.35	22.79	23.17	24.38	21.61

Table 26. Estimates of the number of individuals interacting with the SESSF, by year and TEP species group, dead and alive combined.

	2002	2003	2004	2005	2006	2007	2008
Seals	1518.2	326.8	3272.9	7039.1	7341.1	6390.0	2866.7
CV	34.2	37.0	24.3	22.6	28.1	34.5	29.0
Birds	0	0	23078.1	20261.8	91913.8	7891.0	704.9
CV	-	-	23.6	32.6	26.2	83.3	81.0
Pipefish	0	1610.5	4378.7	447.4	63.0	1809.4	2746.9
CV		44.4	38.8	46.1	100.0	78.1	33.8
Sharks	0	33.1	105.1	0	31.5	0	0
CV		100.0	74.4		100.0		
Whales	0	0	4649.8	1311.6	13029.1	30.4	357.3
CV			83.0	100.0	112.7	100.4	100.0

Table 27. Estimates of the number of individuals interacting with the SESSF, by year and TEP species group, dead only.

	2002	2003	2004	2005	2006	2007	2008
Seals	1035.5	229.8	551.6	1291.8	739.1	1061.7	1983.9
CV	47.1	42.5	53.2	28.1	28.3	33.8	39.4
Birds	0	0	311.6	538.0	1341.3	323.1	589.2
CV			62.8	41.1	31.8	54.4	95.6
Pipefish	0	1610.5	3338.7	447.4	63.0	1809.4	2746.9
CV		44.4	35.9	46.1	100.0	78.1	33.8
Sharks	0	33.1	70.1	0	31.5	0	0
CV		100.0	70.6		100.0		
Whales	0	0	0	0	0	30.4	357.3
CV						100.4	100.0

Table 28. A list of the port names which are to be found in the data arising from the CDR/GENLOG merge.

1	ADELAIDE	29	DUNALLEY	57	NELSON BAY	85	SORRENTO
2	ALBANY	30	EAGLEHAWK NECK	58	NELSON NZ	86	SOUTHEND
3	AMERICAN RIVER	31	EDEN	59	NEWCASTLE	87	SOUTHPORT
4	APOLLO BAY	32	EDINBURGH	60	NEWHAVEN	88	SOUTHPORT TAS
5	AUCKLAND	33	EMU POINT	61	NORTH ARMS	89	STANLEY
6	BANDY CREEK	34	ESPERANCE	62	NUBEENA	90	ST HELENS
7	BATEMANS BAY	35	EUCLA	63	PIRATES BAY	91	STRAHAN
8	BEACHPORT	36	FOWLERS BAY	64	POINT TURTON	92	STREAKY BAY
9	BEAUTY POINT	37	FREMANTLE	65	PONDALOWIE BAY	93	SUNSET COVE
10	BELL BAY	38	GEORGETOWN	66	PORT ADELAIDE	94	SYDNEY
11	BERMAGUI	39	GRASSY	67	PORT ALBERT	95	TERRIGAL
12	BICHENO	40	GREENWELL POINT	68	PORT ARTHUR	96	THEVENARD
13	BLACKFELLOWS	41	HOBART	69	PORT FAIRY	97	TRIABUNNA
14	BRIDPORT	42	KANGAROO POINT	70	PORT FRANKLIN	98	ULLADULLA
15	BRISBANE	43	KETTERING	71	PORT HUON	99	VENUS BAY
16	BROKENDOWN	44	KILLECRANKIE	72	PORT JACKSON	100	VICTOR HARBOUR
17	BURNIE	45	KING ISLAND	73	PORT KEMBLA	101	VIVONNE BAY
18	CAPE JAFFA	46	KINGSCOTE	74	PORT KENNY	102	WARRNAMBOOL
19	CAPE JERVIS	47	LADY BARRON	75	PORTLAND	103	WHITEMARK
20	CEDUNA	48	LAKES	76	PORT LINCOLN	104	WILLIAMSTOWN
21	COFFIN BAY	49	LAKES ENTRANCE	77	PORT MACDONNELL	105	WIRRINA COVE
22	COFFS HARBOUR	50	MARGATE	78	PORT MELBOURNE	106	WOLLONGONG
23	COLES BAY	51	MARION BAY	79	PORT STEPHENS	107	WOOLGOOLGA
24	CREMORNE	52	MELBOURNE	80	PORT WELSHPOOL	108	WYNYARD
25	CURRIE	53	MOOLOOLABA	81	QUEENSCLIFFE		
26	DEVONPORT	54	MUSSEL ROE BAY	82	ROBE		
27	DODGES FERRY	55	NAMBUCCA HEADS	83	SAN REMO		
28	DOVER	56	NELSON	84	SMITHTON		

Table 29. A listing of the 32 strata that arise if one uses the 25 strata from the survey design optimisation exercise, VIT, and the 7 gillnet strata shown.

1	AL CSA	AL	17	BS_IN_TR	SET
2	AL EBS / NSW	AL	18	ECDW_TR	SET
3	AL ESA	AL	19	EDL_DS	SET
4	AL ET / WT	AL	20	EDL_IN_TR	SET
5	AL WBS / SAV	AL	21	EDL_OFF_TR	SET
6	AL WSA / WA	AL	22	NSW_IN_TR	SET
7	GN CSA	GN	23	NSW_OFF_TR	SET
8	GN EBS / NSW	GN	24	NSW_RRP_TR	SET
9	GN ESA	GN	25	SW_BGS_TR	SET
10	GN ET / WT	GN	26	SW_ORO_TR	SET
11	GN SAV	GN	27	SW_TR	SET
12	GN WA / WSA	GN	28	TAS_BGS_TR	SET
13	GN WBS	GN	29	TAS_E_TR	SET
14	GAB Inshore	GAB	30	TAS_ORO_TR	SET
15	GAB Midshore	GAB	31	TAS_W_TR	SET
16	GAB Offshore	GAB	32	VIT	VIT

Table 30. AL (6 clusters) – Cluster Membership for ports.

Port Unloaded	Cluster	Port Unloaded	Cluster
CAPE JAFFA	AL-1	PORT ALBERT	AL-4
ADELAIDE	AL-1	BEAUTY POINT	AL-4
AMERICAN RIVER	AL-1	MOOLOOLABA	AL-4
ROBE	AL-1	BRIDPORT	AL-4
PORT ADELAIDE	AL-1	COFFS HARBOUR	AL-4
NORTH ARMS	AL-1	NELSON BAY	AL-4
KINGSCOTE	AL-1	DEVONPORT	AL-4
VIVONNE BAY	AL-1	LAKES ENTRANCE	AL-4
EMU POINT	AL-1	EDEN	AL-4
CAPE JERVIS	AL-1	GEORGETOWN	AL-4
VICTOR HARBOUR	AL-1	KILLECRANKIE	AL-4
MELBOURNE	AL-1	PORT STEPHENS	AL-4
WIRRINA COVE	AL-1	PORT WELSHPOOL	AL-4
APOLLO BAY	AL-2	SYDNEY	AL-4
SOUTHPORT TAS	AL-2	MUSSEL ROE BAY	AL-4
STANLEY	AL-2	PORTLAND	AL-5
GRASSY	AL-2	SOUTHEND	AL-5
STRAHAN	AL-2	PORT MACDONNELL	AL-5
SAN REMO	AL-2	BEACHPORT	AL-5
WARRNAMBOOL	AL-2	BICHENO	AL-6
KING ISLAND	AL-2	COLES BAY	AL-6
PORT FAIRY	AL-2	DOVER	AL-6
PORT HUON	AL-2	NUBEENA	AL-6
QUEENSCLIFFE	AL-2	ST HELENS	AL-6
SMITHTON	AL-2	PORT ARTHUR	AL-6
STREAKY BAY	AL-3	KETTERING	AL-6
PORT KENNY	AL-3	HOBART	AL-6
PORT LINCOLN	AL-3	EAGLEHAWK NECK	AL-6
VENUS BAY	AL-3	TRIABUNNA	AL-6
COFFIN BAY	AL-3	ULLADULLA	AL-6
THEVENARD	AL-3	DUNALLEY	AL-6
		MARGATE	AL-6

Table 31. AL (6 clusters) – Mean Cluster Percentages. These are the mean proportion of shots falling into different strata for each cluster.

	AL CSA	AL ESA	AL ET / WT	AL WSA / WA	AL EBS / NSW	AL WBS / SAV
AL-1	0.923	0.022	0.000	0.054	0.000	0.002
AL-2	0.019	0.000	0.021	0.000	0.012	0.948
AL-3	0.147	0.006	0.000	0.761	0.000	0.085
AL-4	0.006	0.001	0.061	0.002	0.916	0.014
AL-5	0.182	0.707	0.000	0.004	0.001	0.106
AL-6	0.001	0.000	0.884	0.000	0.067	0.047

Table 32. GN (7 clusters) – Cluster Membership.

SOUTHEND	GN-1	KILLECRANKIE	GN-3
NEWHAVEN	GN-1	MUSSEL ROE BAY	GN-3
SAN REMO	GN-1	LADY BARRON	GN-3
APOLLO BAY	GN-1	PORT WELSHPOOL	GN-3
CURRIE	GN-1	EDEN	GN-3
QUEENSCLIFFE	GN-1	ST HELENS	GN-3
WILLIAMSTOWN	GN-1	PORT ALBERT	GN-3
STRAHAN	GN-1	WHITEMARK	GN-3
WYNYARD	GN-1	GEORGETOWN	GN-3
MELBOURNE	GN-1	PORT FRANKLIN	GN-3
STANLEY	GN-1	EUCLA	GN-4
EDINBURGH	GN-2	CEDUNA	GN-4
ADELAIDE	GN-2	COFFIN BAY	GN-4
AMERICAN RIVER	GN-2	FOWLERS BAY	GN-4
BEACHPORT	GN-2	STREAKY BAY	GN-4
VIVONNE BAY	GN-2	THEVENARD	GN-4
WIRRINA COVE	GN-2	VENUS BAY	GN-4
KINGSCOTE	GN-2	BICHENO	GN-5
MARION BAY	GN-2	KETTERING	GN-5
CAPE JAFFA	GN-2	HOBART	GN-5
KANGAROO POINT	GN-2	CREMORNE	GN-5
NORTH ARMS	GN-2	PIRATES BAY	GN-5
POINT TURTON	GN-2	DOVER	GN-5
PONDALOWIE BAY	GN-2	DUNALLEY	GN-5
PORT ADELAIDE	GN-2	EAGLEHAWK NECK	GN-5
PORT LINCOLN	GN-2	MARGATE	GN-5
ROBE	GN-2	DODGES FERRY	GN-5
SUNSET COVE	GN-2	SOUTHPORT	GN-5
VICTOR HARBOUR	GN-2	TRIABUNNA	GN-5
LAKES ENTRANCE	GN-3	BLACKFELLOWS	GN-6
BEAUTY POINT	GN-3	PORT MACDONNELL	GN-6
BELL BAY	GN-3	PORT FAIRY	GN-7
BRIDPORT	GN-3	WARRNAMBOOL	GN-7
DEVONPORT	GN-3	PORTLAND	GN-7

Table 33. GN (7 clusters) – Mean Cluster Percentages. These are the mean proportion of shots falling into different strata for each cluster.

	GN CSA	GN ESA	GN WBS	GN SAV	GN WA / WSA	GN ET / WT	GN EBS / NSW
GN-1	0.000	0.000	0.895	0.005	0.006	0.004	0.089
GN-2	0.936	0.029	0.000	0.000	0.034	0.000	0.000
GN-3	0.000	0.000	0.029	0.000	0.000	0.063	0.907
GN-4	0.061	0.001	0.000	0.000	0.937	0.000	0.000
GN-5	0.000	0.000	0.021	0.000	0.000	0.973	0.006
GN-6	0.006	0.888	0.005	0.101	0.000	0.000	0.000
GN-7	0.006	0.034	0.046	0.816	0.007	0.003	0.088

Table 34. GAB (3 clusters) – Cluster Membership.

ADELAIDE	GAB-1
BANDY CREEK	GAB-1
CEDUNA	GAB-1
ESPERANCE	GAB-1
HOBART	GAB-1
LAKES ENTRANCE	GAB-1
MELBOURNE	GAB-1
PORT ADELAIDE	GAB-1
PORT ALBERT	GAB-1
PORT LINCOLN	GAB-1
PORT WELSHPOOL	GAB-1
STRAHAN	GAB-1
THEVENARD	GAB-1
FREMANTLE	GAB-2
PORTLAND	GAB-2
ALBANY	GAB-3

Table 35. GAB (3 clusters) – Mean Cluster Percentages. These are the mean proportion of shots falling into different strata for each cluster.

	GAB-Inshore	GAB-Midshore	GAB-offshore
GAB-1	0.885	0.058	0.057
GAB-2	0.039	0.575	0.385
GAB-3	0.101	0.009	0.890

Table 36. SET (15 clusters) – Cluster Membership.

WOOLGOOLGA	SET-1	PORT KEMBLA	SET-8
ADELAIDE	SET-2	MOOLOOLABA	SET-8
PORTLAND	SET-2	BRISBANE	SET-8
PORT ADELAIDE	SET-2	AUCKLAND	SET-8
EDEN	SET-3	NELSON	SET-9
WILLIAMSTOWN	SET-3	BURNIE	SET-9
DEVONPORT	SET-4	STANLEY	SET-9
HOBART	SET-4	NELSON NZ	SET-9
BELL BAY	SET-4	NAMBUCCA HEADS	SET-10
PORT ALBERT	SET-5	DOVER	SET-11
PORT FAIRY	SET-6	KETTERING	SET-11
PORT MACDONNELL	SET-6	MELBOURNE	SET-11
SOUTHEND	SET-6	PORT MELBOURNE	SET-11
ROBE	SET-6	STRAHAN	SET-11
VICTOR HARBOUR	SET-6	BEAUTY POINT	SET-12
PORT JACKSON	SET-7	PORT WELSHPOOL	SET-12
GREENWELL POINT	SET-7	APOLLO BAY	SET-13
BROKENDOWN	SET-7	SORRENTO	SET-13
BERMAGUI	SET-7	SAN REMO	SET-13
BATEMANS BAY	SET-7	QUEENSCLIFFE	SET-13
NEWCASTLE	SET-7	LAKES	SET-13
TERRIGAL	SET-7	LAKES ENTRANCE	SET-13
ULLADULLA	SET-7	BEACHPORT	SET-14
WOLLONGONG	SET-7	PORT LINCOLN	SET-14
SYDNEY	SET-7	ST HELENS	SET-15
		BICHENO	SET-15
		CEDUNA	SET-15
		PORT ARTHUR	SET-15
		PIRATES BAY	SET-15
		TRIABUNNA	SET-15

Table 37. SET (15 clusters) – Main Strata per Port Cluster.

	Main Stratum	
SET-1	NSW_RRP_TR	
SET-2	SW_TR	
SET-3	EDL_OFF_TR	
SET-4	TAS_E_TR	
SET-5	BS_IN_TR	EDL_DS
SET-6	SW_TR	
SET-7	NSW_IN_TR	
SET-8	ECDW_TR	
SET-9	TAS_BGS_TR	
SET-10	NSW_OFF_TR	
SET-11	TAS_W_TR	
SET-12	EDL_IN_TR	
SET-13	EDL_DS	
SET-14	SW_TR	
SET-15	TAS_E_TR	

Table 38. SET (15 port clusters) – Mean Cluster Percentages. These are the mean proportion of shots falling into different strata for each cluster.

	SW_TR	EDL_DS	ECDW_TR	TAS_E_TR	BS_IN_TR	TAS_W_TR	EDL_IN_TR	NSW_IN_TR	SW_ORO_TR	SW_BGS_TR	EDL_OFF_TR	NSW_OFF_TR	TAS_ORO_TR	NSW_RRP_TR	TAS_BGS_TR
SET-1														1.000	
SET-2	0.716			0.023		0.041			0.051	0.156			0.001		0.011
SET-3		0.002	0.001	0.021	0.001		0.402	0.091			0.457	0.024			
SET-4	0.015		0.005	0.333	0.004	0.179	0.051			0.006	0.050	0.011	0.125		0.222
SET-5		0.500			0.500										
SET-6	1.000														
SET-7		0.005	0.034				0.001	0.720				0.150		0.089	
SET-8			1.000												
SET-9						0.116									0.884
SET-10												1.000			
SET-11	0.052	0.042		0.020	0.001	0.782			0.004	0.004			0.008		0.087
SET-12	0.010	0.126		0.203	0.006	0.064	0.466				0.080	0.001	0.001		0.043
SET-13	0.004	0.936		0.005	0.009	0.001	0.030				0.014				
SET-14	0.860			0.004		0.047			0.002	0.088					
SET-15	0.024	0.010		0.858	0.008	0.029	0.030				0.035		0.001		0.005

Table 39 - M17. VIT PORTS

VIT' PORTS
APOLLO BAY
EDEN
HOBART
LAKES ENTRANCE
PORT ALBERT
PORT MELBOURNE
PORT WELSHPOOL
PORTLAND
QUEENSCLIFFE
SAN REMO
SORRENTO
ULLADULLA

Table 40. A breakdown, by species and year, of the MWCVs of the length frequencies obtained from the sea based ISMP sampling data, for the retained component of the LF distribution.

SPECIES	Retained						
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Alfonsino	24.6	65.5	25.2	64.4	84.5	80.2	40.8
Bight redfish	20.7	18.1	19.7	14.9	15.4	28.4	24.7
Blue grenadier	16.8	25.5	12.7	36.6	25.4	60.9	29.8
Blue warehou	36.4	58.5	29.5	15.2	27.0	59.1	45.2
Blue-eye trevalla	147.1	23.5	20.1	32.9	40.7	31.1	46.5
Deepwater flathead	13.6	16.8	15.7	11.4	17.9	26.1	20.5
Deepwater shark basket		167.1	47.9	7.9	90.2		
Eastern school whiting	14.2	16.1	21.5	16.5	27.1	22.4	30.9
Gemfish	32.8	28.1	23.9	52.7	28.9	75.2	50.3
Gummy shark	70.2	74.8	69.2	87.5		83.7	112.9
Inshore ocean perch	33.3	51.3	26.7	56.9	33.4	39.7	26.9
Jackass morwong	13.6	26.7	16.5	10.7	14.9	31.4	19.2
John dory	46.7	17.3	16.5	28.3	27.7	37.1	25.5
Mirror dory	18.3	25.1	12.7	15.0	22.3	62.7	35.5
Orange roughy	14.4	12.0	11.3	10.7	10.4	34.1	28.6
Oreo basket	99.0	54.1	55.8	23.0		88.7	
Pink ling	19.7	14.4	41.3	18.1	20.2	42.1	34.9
Redfish	15.1	13.4	14.8	14.2	10.4	29.9	32.4
Ribaldo		38.6	28.6	52.4	45.6	78.8	56.2
Royal red prawn	10.7	19.0	12.4	21.2	23.5	27.2	
Sawshark basket	64.0	90.3	73.0		2.9	74.5	143.6
School shark	4.5	48.4	61.7	41.7	28.3	83.7	32.1
Silver trevally	18.8	21.1	15.3	19.3	24.9	90.0	29.4
Silver warehou	24.5	21.8	27.2	17.0	21.2	33.6	34.4
Tiger flathead	27.3	7.4	12.3	9.5	6.0	22.5	15.6
Yellowspotted boarfish	25.9	27.8	20.4	26.6	37.3	25.7	

Table 41. A breakdown, by species and year, of the MWCVs of the length frequencies obtained from the sea based ISMP sampling data, for the discarded component of the LF distribution.

SPECIES	Discarded						
	2002	2003	2004	2005	2006	2007	2008
Alfonsino						100.0	72.3
Bight redfish			59.6				7.3
Blue grenadier		93.2	34.9	25.8	17.3	100.0	71.7
Blue warehou	64.7	45.5	22.2	28.8	34.9		41.0
Blue-eye trevalla			83.3				29.3
Deepwater flathead		30.0	22.1	55.7	59.4	17.9	78.6
Deepwater shark basket		90.0		0.0			
Eastern school whiting	19.5	27.1	58.5	46.4			31.2
Gemfish	52.4	35.9	32.9	47.9	98.3	81.1	57.7
Gummy shark	66.8	71.8	52.9			10.5	30.6
Inshore ocean perch	36.7	28.0	31.5	20.4	35.4	38.1	66.6
Jackass morwong	49.5	36.8	61.8	19.9	23.5	6.4	63.8
John dory	89.4	100.0	2.4				54.0
Mirror dory	30.0	22.5	27.1	86.8	48.7	1.4	41.2
Orange roughy	52.6	31.9	14.6	37.8	96.6	100.0	39.1
Oreo basket	123.3	87.5			96.0	62.3	
Pink ling		47.1				0.0	42.2
Redfish	16.4	16.5	18.8	29.8	55.9		81.8
Ribaldo					12.9		104.1
Royal red prawn							
Sawshark basket						100.0	34.2
School shark		75.0	0.0	16.7		0.0	0.0
Silver trevally	0.0		84.0	50.9			19.8
Silver warehou	29.8	40.3	31.4	44.2	42.1		32.9
Tiger flathead	22.4	20.8	29.9	36.4	21.3	71.9	19.1
Yellowspotted boarfish							

Table 42 - Data sets required for design of ISMP sampling regime.

Data set	Brief description	Custodian
Catch and Effort logbook data for all SESSF sectors and all years until December 2008.	Records of catch by species, effort and gear used for each fishing event.	AFMA
Catch Disposal Record data from all SESSF sectors and all years until December 2008.	Records of landed catch by species for each fishing event trip.	AFMA
AFMA Observer data for all SESSF sectors and all years until December 2008.	Independent on-board observations of retained and discarded catch weights and biological (length and otoliths) sampling.	AFMA
Fishery Independent survey data for all SESSF sectors where available.	Statistically robust estimates of relative abundance of species caught and biological sampling.	AFMA
Ecological Risk Assessment database.	List of species caught by each sector and the relative risks to those species by each sector.	CSIRO
ISMP onboard observer data for all SESSF sectors and all years until December 2008.	Independent on-board observations of retained and discarded catch weights, fishing effort and biological (length and otoliths) sampling.	AFMA/Fisheries Victoria
ISMP port-based observer data for all SESSF sectors and all years until December 2008.	Independent port-based observations of biological (length and otoliths) sampling of catches.	AFMA/Fisheries Victoria
ISMP PET interactions data for all SESSF sectors and all years until December 2008.	Independent on-board observations of PET interactions.	AFMA/Fisheries Victoria
CAF aging database for all SESSF species and all years until December 2008.	Biological data (e.g. age and length) from sampled catches.	AFMA/Fisheries Victoria
Shark database.	Historical records of shark catch by species, effort and gear used for each fishing event.	Fisheries Victoria

Table 43 - The breakdown of the SESSF into fisheries and gears.

Fishery	Sub-Fishery	Gear	Strata
SESSF	SET	Danish Seine (DS)	1
		Board Trawl (TW)	14
	VIT	Trawl	1
	GAB	Trawl	3
	GHAT	Line. Includes Automatic longline (ALL); other longline (LL); drop line (DL); bottom line (BL)	6
		Gillnet (GN)	7

Table 44. Quota species in the SESSF.

Project Key	CAAB	Common Name	Scientific Name
ALFONSINO	37258002	Alfonsino	*Beryx splendens*
BIGHT REDFISH	37258004	Bight redfish	*Centroberyx gerrardi*
BLUE GRENADIER	37227001	Blue Grenadier	*Macruronus novaezelandiae*
BLUE WAREHOU	37445005	Blue Warehou	*Seriolella brama*
BLUE-EYE TREVALLA	37445001	Blue-eye Trevalla	*Hyperoglyphe antarctica*
BOARFISH (UNSPECIFIED)	37367000	Boarfishes	*Pentacerotidae*
DEEPWATER FLATHEAD	37296002	Deepwater flathead	*Neoplatycephalus conatus*
DEEPWATER SHARK BASKET	37020905	Platypus shark (mixed)	*Deania calcea & quadrispinosa*
DEEPWATER SHARK BASKET	37020003	Brier Shark	*Deania calcea*
DEEPWATER SHARK BASKET	37020004	Longsnout Dogfish	*Deania quadrispinosa*
DEEPWATER SHARK BASKET	37020013	Plunket's Dogfish	*Centroscymnus plunketi*
DEEPWATER SHARK BASKET	37020021	Southern lanternshark	*Etmopterus granulosus*
DEEPWATER SHARK BASKET	37020904	Roughskin dogfish	*Centroscymnus & Deania spp*
DEEPWATER SHARK BASKET	37020906	Deepwater dogfish	*Centroscymnus spp.*
DEEPWATER SHARK BASKET	37020907	Lantern shark (mixed)	*Etmopterus spp*
EASTERN SCHOOL WHITING	37330014	Eastern School Whiting	*Sillago flindersi*
ELEPHANTFISH	37043001	Elephantfish	*Callorhinchus milii*
GEMFISH	37439002	Gemfish	*Rexea solandri*
GUMMY SHARK	37017001	Gummy shark	*Mustelus antarcticus*
INSHORE OCEAN PERCH	37287001	Reef Ocean Perch	*Helicolenus Percoides*
JACKASS MORWONG	37377003	Jackass Morwong	*Nemadactylus macropterus*
JOHN DORY	37264004	John Dory	*Zeus faber*
MIRROR DORY	37264003	Mirror Dory	*Zenopsis nebulosus*
ORANGE ROUGHY	37255009	Orange roughy	*Hoplostethus atlanticus*
OREO BASKET	37266001	Spikey oreo dory	*Neocyttus rhomboidalis*
OREO BASKET	37266004	Warty oreo	*Allocyttus verrucosus*
OREO BASKET	37266005	Black oreo dory	*Allocyttus niger*
PINK LING	37228002	Pink ling	*Genypterus blacodes*
REDFISH	37258003	Redfish	*Centroberyx affinis*
RIBALDO	37224002	Ribaldo	*Mora moro*
ROYAL RED PRAWN	28714005	Royal red prawn	*Haliporoides sibogae*
SAWSHARK BASKET	37023000	Sawsharks	*Pristiophoridae*
SAWSHARK BASKET	37023001	Southern Sawshark	*Pristiophorus nudipinnis*
SAWSHARK BASKET	37023002	Common Sawshark	*Pristiophorus cirratus*
SCHOOL SHARK	37017008	School shark	*Galeorhinus galeus*
SILVER TREVALLY	37337062	Silver Trevally	*Pseudocaranx dentex*
SILVER WAREHOU	37445006	Silver warehou	*Seriolella punctata*
SMOOTH OREODORY	37266003	Smooth oreo dory	*Pseudocyttus Maculatus*
TIGER FLATHEAD	37296001	Tiger flathead	*Neoplatycephalus richardsoni*

Table 45. Major Non-Quota species in the SESSF.

Project Key	Caab Cd	Common Name	Scientific Name
AUSTRALIAN ANGELSHARK	37024001	Australian Angelshark	*Squatina australis*
BARRACOUTA	37439001	Barracouta	*Thyrsites atun*
BLUE MORWONG	37377004	Blue Morwong	*Nemadactylus valenciennesi*
BLUESTRIPED GOATFISH	37355001	Bluestriped Goatfish	*Upeneichthys lineatus*
BROADNOSE SHARK	37005002	Broadnose Shark	*Notorynchus cepedianus*
BRONZE WHALER	37018001	Bronze Whaler	*Carcharhinus brachyurus*
CUTTLEFISH (UNSPECIFIED)	23607000	Cuttlefishes	*Sepiidae*
DRAUGHTBOARD SHARK	37015001	Draughtboard Shark	*Cephaloscyllium laticeps*
FROSTFISH	37440002	Frostfish	*Lepidopus caudatus*
GOULD SQUID	23636004	Gould's squid	*Nototodarus gouldi*
GUITARFISH (UNSPECIFIED)	37026000	Guitarfishes unspecified	*Rhynchobatidae*
GUITARFISH (UNSPECIFIED)	37026001	Giant guitarfish	*Rhynchobatus djiddensis*
HAPUKU	37311006	Hapuku	*Polyprion oxygeneios*
HAPUKU (UNSPECIFIED)	37311902	Hapuku and Bass Groper	*Polyprion spp*
KING DORY	37264001	King Dory	*Cyttus traversi*
KNIFEJAW	37369002	Knifejaw	*Oplegnathus woodwardi*
LATCHET	37288006	Latchet	*Pterygotrigla polyommata*
OCEAN BLUE-EYE TREVALLA	37445014	Ocean Blue-eye Trevalla	*Schedophilus labyrinthica*
OCEAN JACKET	37465006	Ocean Jacket	*Nelusetta ayraudi*
OCTOPUS	23650000	Octopoda	*Octopoda*
OCTOPUS	23659000	Octopuses	*Octopodidae*
ORNATE ANGELSHARK	37024002	Ornate Angelshark	*Squatina tergocellata*
RED GURNARD	37288001	Red Gurnard	*Chelidonichthys Kumu*
SILVER DORY	37264002	Silver Dory	*Cyttus australis*
SMOOTH HAMMERHEAD	37019004	Smooth Hammerhead	*Sphyrna zygaena*
SNAPPER	37353001	Snapper	*Pagrus auratus*
SOUTHERN EAGLE RAY	37039001	Southern Eagle Ray	*Myliobatis australis*
SQUID (GENERAL)	23615000	Squids	*Teuthoidea*
STARGAZER (UNSPECIFIED)	37400000	Stargazers	*Uranoscopidae*
STRIPED TRUMPETER	37378001	Striped Trumpeter	*Latris lineata*
TRIGGERFISH & LEATHERJACKET (UNSPECIFIED)	37465000	Leatherjackets	*Balistidae Monacanthidae*
WHISKERY SHARK	37017003	Whiskery Shark	*Furgaleus macki*
YELLOWSPOTTED BOARFISH	37367001	Yellowspotted Boarfish	*Paristiopterus gallipavo*

Table 46. Alphabetical List of the 75 Project Keys used for discard rate analyses. Included are the 7 HIGH RISK project keys groupings.

1	ALFONSINO		
2	AUSTRALIAN ANGELSHARK	39	OCEAN JACKET
3	BARRACOUTA	40	OCTOPUS
4	BIGHT REDFISH	41	ORANGE ROUGHY
5	BLUE GRENADIER	42	OREO BASKET
6	BLUE MORWONG	43	ORNATE ANGELSHARK
7	BLUE WAREHOU	44	PINK LING
8	BLUE-EYE TREVALLA	45	RAYS
9	BLUESTRIPED GOATFISH	46	RED GURNARD
10	BOARFISH (UNSPECIFIED)	47	REDFISH
11	BROADNOSE SHARK	48	RIBALDO
12	BRONZE WHALER	49	ROYAL RED PRAWN
13	CHIMAERAS	50	SAWSHARK BASKET
14	CRUSTACEANS	51	SAWSHARKS
15	DEEPWATER FLATHEAD	52	SCHOOL SHARK
16	DEEPWATER SHARK BASKET	53	SHARKS
17	DOGFISH	54	SILVER DORY
18	DRAUGHTBOARD SHARK	55	SILVER TREVALLY
19	EASTERN SCHOOL WHITING	56	SILVER WAREHOU
20	ECHINODERMS	57	SMOOTH HAMMERHEAD
21	ELEPHANTFISH	58	SMOOTH OREODORY
22	FISH	59	SNAPPER
23	FROSTFISH	60	SOUTHERN EAGLE RAY
24	GEMFISH	61	SQUID (GENERAL)
25	GOULD SQUID	62	STARGAZER (UNSPECIFIED)
26	GUITARFISH (UNSPECIFIED)	63	STINGAREES
27	GUMMY SHARK	64	STRIPED TRUMPETER
28	HAGFISH	65	TIGER FLATHEAD
29	HAPUKU	66	TRIGGERFISH & LEATHERJACKET
30	INSHORE OCEAN PERCH	67	WHISKERY SHARK
31	JACKASS MORWONG	68	YELLOWSPOTTED BOARFISH
32	JOHN DORY	69	HIGH RISK DOGFISH, OTHER
33	KING DORY	70	HIGH RISK MOLLUSCS
34	KNIFEJAW	71	HIGH RISH HAGFISH
35	LATCHET	72	HIGH RISK SHARKS
36	MIRROR DORY	73	HIGH RISK SKATES/RAYS
37	MOLLUSCS	74	HIGH RISK TELEOSTS
38	OCEAN BLUE-EYE TREVALLA	75	HIGH RISK UPPER SLOPE DOGFISH

Table 47. List of high risk and very high risk species available in the either the CDR, GENLOG or ISMP data supplied for the redesign of the ISMP for the SESSF, either by CAAB_code, or some other species indicator.

CAAB Code	Species Name	Scientific Name	Group	Status	Project Key
23607000	Cuttlefishes	*Sepiidae*	Molluscs	Major NonQuota	Molluscs
23607001	Giant cuttlefish	*Sepia apama*	Molluscs	Minor	Molluscs
23607901	Cuttlefish (mixed)	*Sepia spp*	Molluscs	Minor	Molluscs
23608003	Southern bottletail squid	*Sepiadarium austrinum*	Molluscs	Minor	Molluscs
23610000	Pygmy squids	*Idiosepiidae*	Molluscs	Minor	Molluscs
23650000	Octopoda	*Octopoda*	Molluscs	Major NonQuota	Molluscs
23651000	Finned octopuses	*Cirroteuthidae*	Molluscs	Minor	Molluscs
23659000	Octopuses	*Octopodidae*	Molluscs	Major NonQuota	Molluscs
23659003	Maori octopus	*Pinnoctopus cordiformis*	Molluscs	Minor	Molluscs
23659004	Pale octopus	*Octopus pallidus*	Molluscs	Minor	Molluscs
23659013	Southern blue-ringed octopus	*Hapalochlaena maculosa*	Molluscs	Minor	Molluscs
37004001	Longfin Hagfish	*Eptatretus longipinnis*	Hagfish	Minor	Hagfish
37005002	Broadnose Shark	*Notorynchus cepedianus*	Sharks	Major NonQuota	Sharks
37010001	Shortfin Mako	*Isurus oxyrinchus*	Sharks	Minor	Sharks
37017003	Whiskery Shark	*Furgaleus macki*	Sharks	Major NonQuota	Sharks
37018001	Bronze Whaler	*Carcharhinus brachyurus*	Sharks	Major NonQuota	Sharks
37018003	Dusky Whaler	*Carcharhinus obscurus*	Sharks	Minor	Sharks
37019004	Smooth Hammerhead	*Sphyrna zygaena*	Sharks	Major NonQuota	Sharks
37020001	Endeavour dogfish	*Centrophorus moluccensis*	Dogfish	Minor	High Risk Upper Slope Dogfish
37020005	Blackbelly lanternshark	*Etmopterus lucifer*	Dogfish	Minor	Dogfish Other
37020007	Greeneye dogfish	*Squalus mitsukurii*	Dogfish	Minor	Dogfish Other
37020009	Leafscale gulper shark	*Centrophorus squamosus*	Dogfish	Minor	High Risk Upper Slope Dogfish
37020010	Dumb gulper shark	*Centrophorus harrissoni*	Dogfish	Minor	High Risk Upper Slope Dogfish
37020011	Little gulper shark	*Centrophorus uyato*	Dogfish	Minor	High Risk Upper Slope Dogfish
37020902	Endeavour dogfish (mixed)	*Centrophorus harrissoni & C moluccensis & C uyato*	Dogfish	Minor	High Risk Upper Slope Dogfish
37020905	Platypus shark (mixed)	*Deania calcea & quadrispinosa*	Dogfish	Quota	Dogfish Other
37031005	Skate sp A	*Dipturus sp A*	Rays	Minor	Skates / Rays
37031028	Skate sp B	*Dipturus sp B*	Rays	Minor	Skates / Rays
37031035	Dipturus sp J	*Dipturus sp J*	Rays	Minor	Skates / Rays
37311006	Hapuku	*Polyprion oxygeneios*	Fish	Major NonQuota	Teleosts
37327001	Bigeye deepsea cardinalfish	*Epigonus lenimen*	Fish	Minor	Teleosts
37327010	Pencil cardinal	*Epigonus denticulatus*	Fish	Minor	Teleosts
37327018	Robust cardinalfish	*Epigonus robustus*	Fish	Minor	Teleosts
37445001	Blue-eye Trevalla	*Hyperoglyphe antarctica*	Fish	Quota	Teleosts

Note: The column 'Project Key' indicates the level of grouping that was used for the analysis of these species to meet the project requirements.

Table 48. List of threatened, endangered and protected species available in either the CDR, GENLOG or ISMP data supplied for the redesign of the ISMP for the SESSF, either by CAAB_code, or some other species indicator.

CAAB code	Species Name	Scientific Name	Group	status	Project Key
37008000	Grey nurse sharks	*Odontaspididae*	Sharks	Minor	Sharks
37008001	Grey nurse shark	*Carcharias taurus*	Sharks	Minor	Sharks
37010003	White Shark	*Carcharodon carcharias*	Sharks	Minor	Sharks
37014001	Whale shark	*Rhincodon typus*	Sharks	Minor	Sharks
39001001	Turtles	*Testudines*	Omit	Minor	Reptiles
39012001	Pignose turtle	*Carettochelys insculpta*	Omit	Minor	Reptiles
39020001	Loggerhead turtle	*Caretta caretta*	Omit	Minor	Reptiles
39020002	Green turtle	*Chelonia mydas*	Omit	Minor	Reptiles
39020003	Hawksbill turtle	*Eretmochelys imbricata*	Omit	Minor	Reptiles
39020004	Pacific (Olive) Ridely turtle	*Lepidochelys olivacea*	Omit	Minor	Reptiles
39020005	Flatback turtle	*Natator depressus*	Omit	Minor	Reptiles
39021001	Leatherback turtle	*Dermochelys coriacea*	Omit	Minor	Reptiles
39125000	Seasnakes	*Hydrophiidae*	Omit	Minor	Reptiles
40000000	Birds	*Avians*	Omit	Minor	Birds
40000006	Red Cormorant	*Red Cormorant*	Omit	Minor	Birds
40001000	Penguins	*Spheniscidae*	Omit	Minor	Birds
40040000	Albatrosses	*Diomedeidae*	Omit	Minor	Birds
40040001	Bullers Albatross	*Thalassarche bulleri*	Omit	Minor	Birds
40040002	Shy Albatross	*Thalassarche cauta*	Omit	Minor	Birds
40040003	Yellow Nosed Albatross	*Thalassarche chlororhynchos*	Omit	Minor	Birds
40040004	Grey Headed Albatross	*Thalassarche chrysostoma*	Omit	Minor	Birds
40040005	Southern Royal Albatross	*Diomedea epomophora*	Omit	Minor	Birds
40040006	Wandering Albatross	*Diomedea exulans*	Omit	Minor	Birds
40040007	Black Browed Albatross	*Thalassarche melanophrys*	Omit	Minor	Birds
40040008	Sooty Albatross	*Phoebetria fusca*	Omit	Minor	Birds
40040009	Light Mantled Sooty Albatross	*Phoebetria palpebrata*	Omit	Minor	Birds
40040010	Gibsons Albatross	*Diomedea gibsoni*	Omit	Minor	Birds
40040012	Northern Royal Albatross	*Diomedea sanfordi*	Omit	Minor	Birds
40040013	Campbell Albatross	*Thalassarche impavida*	Omit	Minor	Birds
40040014	Indian Yellow Nosed Albatross	*Thalassarche carteri*	Omit	Minor	Birds
40041000	Petrels Prions and Shearwaters	*Procellariidae*	Omit	Minor	Birds
40041003	Cape Petrel	*Daption capense*	Omit	Minor	Birds
40041007	Southern Giant Petrel	*Macronectes giganteus*	Omit	Minor	Birds
40041008	Northern Giant Petrel	*Macronectes halli*	Omit	Minor	Birds
40041013	Fairy Prion	*Pachyptila turtur*	Omit	Minor	Birds
40041015	Snow petrel	*Pagodroma nivea*	Omit	Minor	Birds
40041018	White Chinned Petrel	*Procellaria aequinictialis*	Omit	Minor	Birds
40041019	Grey Petrel	*Procellaria cinerea*	Omit	Minor	Birds
40041020	Parkinsons petrel	*Procellaria parkinsoni*	Omit	Minor	Birds
40041021	Westland Petrel	*Procellaria westlandica*	Omit	Minor	Birds
40041022	Tahiti Petrel	*Pseudobulweria rostrata*	Omit	Minor	Birds
40041025	White Necked Petrel	*Pterodroma cervicalis*	Omit	Minor	Birds
40041030	Coulds Petrel	*Pterodroma leucoptera*	Omit	Minor	Birds
40041031	Great Winged Petrel	*Pterodroma macroptera*	Omit	Minor	Birds
40041035	Providence Petrel	*Pterodroma solandri*	Omit	Minor	Birds
40041038	Flesh Footed Shearwater	*Puffinus carneipes*	Omit	Minor	Birds
40041040	Fluttering Shearwater	*Puffinus gavia*	Omit	Minor	Birds
40041042	Sooty Shearwater	*Puffinus griseus*	Omit	Minor	Birds
40041043	Huttons Shearwater	*Puffinus huttoni*	Omit	Minor	Birds
40041045	Wedge Tailed Shearwater	*Puffinus pacificus*	Omit	Minor	Birds
40041047	Short Tailed Shearwater	*Puffinus tenuirostris*	Omit	Minor	Birds
40041999	Shearwaters	*Puffinus spp*	Omit	Minor	Birds
40042004	Wilsons Storm Petrel	*Oceanites oceanus*	Omit	Minor	Birds
40042007	White Faced Storm Petrel	*Pelagodroma marina*	Omit	Minor	Birds
40047002	Australian gannet	*Morus serrator*	Omit	Minor	Birds
40047004	Masked booby	*Sula dactylatra*	Omit	Minor	Birds
40128000	Gulls skuas noddys and terns	*Laridae*	Omit	Minor	Birds
40128004	South polar skua	*Catharacta maccormicki*	Omit	Minor	Birds
40128005	Great Skua	*Catharacta skua*	Omit	Minor	Birds
40128013	Silver gull	*Larus novaehollandiae*	Omit	Minor	Birds
40128025	Crested Tern	*Sterna bergii*	Omit	Minor	Birds
40128028	Sooty tern	*Sterna fuscata*	Omit	Minor	Birds
40128031	Gull-billed tern	*Sterna nilotica*	Omit	Minor	Birds
40128999	Terns	*Terns*	Omit	Minor	Birds
41000001	Whales	*Whales (order Cetacea in part)*	Omit	Minor	Whales/Dolphins
41000002	Toothed whales	*Toothed whales (suborder Odontoceti in part)*	Omit	Minor	Whales/Dolphins
41000003	Baleen whales	*Baleen whales (suborder Mysticeti)*	Omit	Minor	Whales/Dolphins
41110000	Baleen whales	*Mysticeti*	Omit	Minor	Whales/Dolphins

CAAB code	Species Name	Scientific Name	Group	status	Project Key
41110001	Southern right whale	*Eubalaena australis*	Omit	Minor	Whales/Dolphins
41110002	Pygmy right whale	*Caperea marginata*	Omit	Minor	Whales/Dolphins
41112001	Minke whale	*Balaenoptera acutorostrata*	Omit	Minor	Whales/Dolphins
41112002	Sei whale	*Balaenoptera borealis*	Omit	Minor	Whales/Dolphins
41112003	Brydes whale	*Balaenoptera edeni*	Omit	Minor	Whales/Dolphins
41112004	Blue whale	*Balaenoptera musculus*	Omit	Minor	Whales/Dolphins
41112005	Fin whale	*Balaenoptera physalus*	Omit	Minor	Whales/Dolphins
41112006	Humpback whale	*Megaptera novaeangliae*	Omit	Minor	Whales/Dolphins
41116000	Dolphins	*Delphinidae*	Omit	Minor	Whales/Dolphins
41116001	Common dolphin	*Delphinus delphis*	Omit	Minor	Whales/Dolphins
41116002	Pygmy killer whale	*Feresa attenuata*	Omit	Minor	Whales/Dolphins
41116003	Short-finned pilot whale	*Globicephala macrorhynchus*	Omit	Minor	Whales/Dolphins
41116004	Long-finned pilot whale	*Globicephala melas*	Omit	Minor	Whales/Dolphins
41116006	Frasers dolphin	*Lagenodelphis hosei*	Omit	Minor	Whales/Dolphins
41116008	Dusky dolphin	*Lagenorhynchus obscurus*	Omit	Minor	Whales/Dolphins
41116009	Southern right whale dolphin	*Lissodelphis peronii*	Omit	Minor	Whales/Dolphins
41116011	Killer whales	*Orcinus orca*	Omit	Minor	Whales/Dolphins
41116012	Melon-headed whale	*Peponocephala electra*	Omit	Minor	Whales/Dolphins
41116013	False killer whale	*Pseudorca crassidens*	Omit	Minor	Whales/Dolphins
41116014	Indo-Pac. hump-backed dolphin	*Sousa chinensis*	Omit	Minor	Whales/Dolphins
41116015	Pantropical spotted dolphin	*Stenella attenuata*	Omit	Minor	Whales/Dolphins
41116016	Striped dolphin	*Stenella coeruleoalba*	Omit	Minor	Whales/Dolphins
41116017	Spinner dolphin	*Stenella longirostris*	Omit	Minor	Whales/Dolphins
41116018	Rough-toothed dolphin	*Steno bredanensis*	Omit	Minor	Whales/Dolphins
41116019	Bottlenose dolphin	*Tursiops truncatus*	Omit	Minor	Whales/Dolphins
41117001	Spectacled porpoise	*Australophocaena dioptrica*	Omit	Minor	Whales/Dolphins
41119001	Pygmy sperm whale	*Kogia breviceps*	Omit	Minor	Whales/Dolphins
41119002	Dwarf sperm whale	*Kogia simus*	Omit	Minor	Whales/Dolphins
41119003	Sperm Whale	*Physeter catodon*	Omit	Minor	Whales/Dolphins
41120000	Beaked whales	*Mesoplodon spp*	Omit	Minor	Whales/Dolphins
41120001	Arnouxs beaked whale	*Berardius arnuxii*	Omit	Minor	Whales/Dolphins
41120002	Southern bottlenose whale	*Hyperoodon planifrons*	Omit	Minor	Whales/Dolphins
41120003	Longmans beaked whale	*Mesoplodon pacificus*	Omit	Minor	Whales/Dolphins
41120004	Andrews beaked whale	*Mesoplodon bowdoini*	Omit	Minor	Whales/Dolphins
41120005	Blainvilles beaked whale	*Mesoplodon densirostris*	Omit	Minor	Whales/Dolphins
41120006	Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	Omit	Minor	Whales/Dolphins
41120007	Grays beaked whale	*Mesoplodon grayi*	Omit	Minor	Whales/Dolphins
41120008	Hectors beaked whale	*Mesoplodon hectori*	Omit	Minor	Whales/Dolphins
41120009	Strap-toothed whale	*Mesoplodon layardii*	Omit	Minor	Whales/Dolphins
41120010	Trues beaked whale	*Mesoplodon mirus*	Omit	Minor	Whales/Dolphins
41120011	Sherpherds beaked whale	*Tasmacetus shepherdi*	Omit	Minor	Whales/Dolphins
41120012	Cuviers beaked whale	*Ziphius cavirostris*	Omit	Minor	Whales/Dolphins
41120999	Whales	*Whales*	Omit	Minor	Whales/Dolphins
41131000	Eared seals	*Otariidae*	Omit	Minor	Seals
41131001	New Zealand fur seal	*Arctocephalus forsteri*	Omit	Minor	Seals
41131002	Antarctic fur seal	*Arctocephalus gazella*	Omit	Minor	Seals
41131003	South African fur seal	*Arctocephalus pusillus*	Omit	Minor	Seals
41131004	Subantarctic fur seal	*Arctocephalus tropicalis*	Omit	Minor	Seals
41131005	Australian sea lion	*Neophoca cinerea*	Omit	Minor	Seals
41131006	New Zealand sea lion	*Phocarctos hookeri*	Omit	Minor	Seals
41131999	Sealions	*Sealions*	Omit	Minor	Seals
41132999	Seals	*Otariidae and Phocidae*	Omit	Minor	Seals
41136001	Leopard seal	*Hydrurga leptonyx*	Omit	Minor	Seals
41136002	Weddell seal	*Leptonychotes weddellii*	Omit	Minor	Seals
41136003	Crabeater seal	*Lobodon carcinophagus*	Omit	Minor	Seals
41136004	Southern elephant seal	*Mirounga leonina*	Omit	Minor	Seals
41206001	Dugong	*Dugong dugon*	Omit	Minor	Omit

Note: The column 'Project Key' indicates the level of grouping that was used for the analysis of these species to meet the project requirements.

Table 49 - A summary of the GENLOG and ISMP shots on record, for all years considered, and for the years 2004 to 2006.

	ALL YRS	ALL YRS	2004		2005		2006	
Stratum	GENLOG	ISMP	GENLOG	ISMP	GENLOG	ISMP	GENLOG	ISMP
AL 10	1	0	0	0	1	0	0	0
AL 20	805	52	396	38	229	10	180	4
AL 30	707	80	342	53	199	14	166	13
AL 40	977	89	514	53	279	5	184	31
AL 50	1978	11	598	5	852	6	528	0
AL 60	345	14	147	14	101	0	97	0
AL 70	15	0	2	0	4	0	9	0
AL GAB	1598	206	382	51	440	95	776	60
BS_IN_TR	1762	7	411	6	749	1	602	0
DL 20	40	0	36	0	2	0	2	0
DL 30	491	46	141	14	171	9	179	23
DL 40	45	0	28	0	7	0	10	0
DL 50	183	0	116	0	56	0	11	0
DL 60	2	0	2	0	0	0	0	0
DL 70	63	0	17	0	23	0	23	0
DL GAB	435	0	174	0	129	0	132	0
ECDW_TR	291	25	230	25	60	0	1	0
EDL_DS	22493	249	8323	48	7681	71	6489	130
EDL_IN_TR	14695	297	4853	47	5588	133	4254	117
EDL_OFF_TR	7497	216	2816	76	2606	74	2075	66
GN 10	2	0	2	0	0	0	0	0
GN 20	3019	0	1024	0	920	0	1075	0
GN 30	2313	0	990	0	798	0	525	0
GN 40	1079	0	382	0	398	0	299	0
GN 50	6866	0	2427	0	2327	0	2112	0
GN 60	10646	0	4357	0	3473	0	2816	0
GN GAB	10264	0	3389	0	2929	0	3946	0
GAB Inshore	15186	459	4696	123	5325	203	5165	133
GAB Midshore	1611	55	474	29	649	1	488	25
NSW_IN_TR	18843	782	7849	297	6151	272	4843	213
NSW_OFF_TR	5671	297	2132	128	2024	81	1515	88
NSW_RRP_TR	1201	13	441	4	437	5	323	4
GAB Offshore	615	47	246	21	177	11	192	15
SW_BGS_TR	1350	76	501	31	414	30	435	15
SW_ORO_TR	227	3	93	1	79	2	55	0
SW_TR	12528	404	4966	97	3902	187	3660	120
TAS_BGS_TR	1758	32	831	8	445	19	482	5
TAS_E_TR	7320	122	2978	35	2391	21	1951	66
TAS_ORO_TR	760	72	245	25	270	25	245	22
TAS_W_TR	4452	38	1944	1	1451	28	1057	9
VIT	1474	0	314	0	739	0	421	0

Table 50. Results of analyses on the seasonal patterns of discard ratios for clusters identified in the GAB fishery. One out of 7 tests indicate a significant difference in discard ratios for a cluster across seasons (the grenadier cluster in the offshore depth zone). The sample size for this particular comparison is relatively small, however the trend in discard ratio from summer to autumn to winter is consistently increasing.

Depth Category	Cluster	Autumn			Spring			Summer			Winter			F	Sig.	Kruskal Wallace Chi Square	Sig.
		Sample	Mean Discard	Variance	Sample	Mean Discard	Variance	Sample	Mean Discard	Variance	Sample	Mean Discard	Variance				
Inshore	DEEP WATER FLATHEAD	140	0.4518	0.0367	135	0.4466	0.0312	129	0.4351	0.0349	110	0.4912	0.0262	2.109	.098	6.737	0.081
	GEMFISH	0			6	0.4656	0.0290	21	0.3107	0.0262	0			4.182	.052	3.704	0.054
	GRENADIER	0			0			1	0.7837		0						
	ORANGE ROUGHY	1	0.4950		0			0			0						
	REDFISH	60	0.3591	0.0301	4	0.4209	0.0568	48	0.3268	0.0304	6	0.2441	0.0045	1.240	.299	3.488	0.322
Midshore	DEEP WATER FLATHEAD										5	0.5458	0.0047				
	GEMFISH	1	0.3527		4	0.4416	0.0554	5	0.4069	0.0272	1	0.5114		.131	.939	1.291	0.731
	GRENADIER	27	0.2435	0.0234	3	0.5274	0.0588	22	0.3290	0.0384	9	0.3492	0.0327	2.973	.039	6.978	0.073
	ORANGE ROUGHY	1	0.0127		0			0			6	0.0343	0.0035	.114	.749	0	1
	REDFISH	0			0			0			0						
Offshore	DEEP WATER FLATHEAD	0			0			0			0						
	GEMFISH	0			0			0			0						
	GRENADIER	4	0.4147	0.1546	0			4	0.1964	0.0048	10	0.7751	0.1043	5.692	.014	6.335	0.042
	ORANGE ROUGHY	7	0.2935	0.2102	0			0			62	0.1371	0.0526	2.307	.133	0.095	0.757
	REDFISH	0			0			0			0						

Table 51. Results of analyses on the longitudinal patterns of discard ratios for clusters identified in the GAB fishery. One out of 9 tests indicate a significant difference in discard ratios for a cluster across longitude groupings (the grenadier cluster in the offshore depth zone).Discard rates for this cluster are larger in the far eastern group

Depth Category	Cluster	long <= 127			127<long<=130			long > 130			F	Sig.	Kruskal Wallace Chi Square	Sig.
		Sample	Mean Discard	Variance	Sample	Mean Discard	Variance	Sample	Mean Discard	Variance				
Inshore	DEEP WATER FLATHEAD	188	0.4563	0.0324	206	0.4530	0.0270	120	0.4551	0.0438	.017	.983	0.161	0.922
	GEMFISH	14	0.3030	0.0119	13	0.3904	0.0480				1.765	.196	1.592	0.207
	GRENADIER				1	0.7837								
	ORANGE ROUGHY	1	0.4950											
	REDFISH	13	0.3490	0.0276	39	0.3281	0.0377	66	0.3492	0.0267	.191	.827	1.291	0.524
Midshore	DEEP WATER FLATHEAD	5	0.5458	0.0047										
	GEMFISH	3	0.2727	0.0197	7	0.4991	0.0229	1	0.3527		2.559	.138	4.39	0.111
	GRENADIER	1	0.5872		15	0.3767	0.0363	45	0.2733	0.0310	3.126	.051	5.653	0.059
	ORANGE ROUGHY	6	0.0109	0.0002				1	0.1525		113.748	.000	2.291	0.13
	REDFISH													
Offshore	DEEP WATER FLATHEAD													
	GEMFISH													
	GRENADIER	5	0.8537	0.1070				13	0.4559	0.1244	4.760	.044	3.921	0.048
	ORANGE ROUGHY	42	0.1346	0.0361				27	0.1816	0.1194	.532	.468	0.237	0.626
	REDFISH													

Table 52. Results of analyses on the zonal patterns of discard ratios for clusters identified in the GHAT fishery. 6 out of 8 tests indicate a significant difference in discard ratios for a cluster across seasons. On this basis it is recommended that the ISMP design for the GHAT fishery comprises a zonal split.

Gear Code	Cluster		Zone							F	Sig.	Kruskal Wallace Chi Square	Sig.
			GAB	20	30	40	50	60	NORTH EAST				
AL & BL	AL BLUE-EYE TREVALLA	Sample	66	8	58	11	2		3	2.440	0.037	8.285	0.141
		Mean Discard	0.2142	0.1804	0.1176	0.1423	0.1291		0.0000				
		Variance	0.0510	0.0169	0.0124	0.0296	0.0012		0.0000				
	AL GUMMY SHARK	Sample		2	1			14		2.998	0.082	6.050	0.049
		Mean Discard		0.6080	0.6982			0.3542					
		Variance		0.0003				0.0515					
	AL HAPUKU	Sample	41	1	2				3	0.532	0.663	7.260	0.867
		Mean Discard	0.2363	0.0310	0.1564				0.0326				
		Variance	0.1073		0.0067				0.0015				
	AL MIXED	Sample	3	3	2	1	6		16	17.346	0.000	17.017	0.004
		Mean Discard	0.0000	0.4806	0.7500	0.0000	0.1565		0.0313				
		Variance	0.0000	0.0705	0.1250		0.0194		0.0019				
	AL PINK LING	Sample	96	62	124	152	3		2	4.401	0.001	56.417	0.000
		Mean Discard	0.2087	0.1331	0.2233	0.1231	0.1920		0.0023				
		Variance	0.1076	0.0140	0.0322	0.0255	0.1106		0.0000				
DL	DL BLUE-EYE TREVALLA	Sample		87	121	116	96	1	122	8.495	0.000	60.819	0.000
		Mean Discard		0.0144	0.0215	0.0173	0.1056	0.0000	0.0739				
		Variance		0.0040	0.0081	0.0066	0.0362		0.0269				
	DL HAPUKU	Sample		60	38	31	36		42	22.431	0.000	62.120	0.000
		Mean Discard		0.0355	0.3542	0.1395	0.4323		0.6733				
		Variance		0.0122	0.2061	0.1167	0.1904		0.1842				
GN	GN GUMMY MIXED	Sample		99				4		55.162	0.000	10.415	0.001
		Mean Discard		0.1454				0.7999					
		Variance		0.0287				0.0692					
	GN GUMMY SHARK	Sample						1					
		Mean Discard						0.4143					
		Variance											
	GN SCHOOL SHARK	Sample		1									
		Mean Discard		0.3723									
		Variance											

Table 53. Results of analyses on the seasonal patterns of discard ratios for clusters identified in the GHAT fishery. One out of 8 tests indicate a significant difference in discard ratios for a cluster across seasons (the Blue-Eye Trevalla Cluster for automatic longlining AL, longlining LL and bottom longline BL).

Gear Code	Cluster	Autumn			Spring			Summer			Winter			F	Sig.	Kruskal Wallace Chi Square	Sig.
		Sample	Mean Discard	Variance	Sample	Mean Discard	Variance	Sample	Mean Discard	Variance	Sample	Mean Discard	Variance				
AL & BL	AL BLUE-EYE TREVALLA	41	0.120	0.020	15	0.174	0.019	48	0.091	0.014	44	0.280	0.050	11.348	.000	23.576	0
	AL GUMMY SHARK							16	0.318	0.055	1	0.698		2.490	.134	1.5	0.221
	AL HAPUKU	3	0.010	0.000	2	0.155	0.007	5	0.130	0.049	37	0.247	0.113	0.695	0.56	1.929	0.587
	AL MIXED	4	0.360	0.105				9	0.271	0.002	18	0.028	0.058	6.835	0.004	5.104	0.078
	AL PINK LING	117	0.150	0.020	109	0.126	0.019	135	0.132	0.030	78	0.335	0.118	21.342	.000	6.003	0.111
DL	DL BLUE-EYE TREVALLA	98	0.022	0.007	189	0.046	0.020	122	0.052	0.018	134	0.059	0.021	1.548	0.201	6.564	0.087
	DL HAPUKU	33	0.276	0.181	74	0.381	0.220	42	0.344	0.171	58	0.207	0.135	1.985	.117	5.351	0.148
GN	GN GUMMY MIXED	63	0.145	0.037							40	0.212	0.059	2.428	0.122	1.059	0.304
	GN GUMMY SHARK	1	0.414														
	GN SCHOOL SHARK	1	0.372														

Table 54. A breakdown, by species and year, of the MWCVs of the length frequencies obtained from the sea based ISMP sampling data, by retained and discarded

MWCVs	Retained						Discarded					
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Alfonsino	24.59	71.04	25.22	63.86	84.52							
Bight redfish	20.72	18.05	19.74	14.87	15.38				59.64			
Blue grenadier	16.82	25.51	12.78	36.62	25.77			69.66	34.85	24.14	17.26	
Blue warehou	36.25	56.14	29.62	15.00	26.99		63.04	45.62	22.25	27.56	34.83	
Blue-eye trevalla	159.34	24.89	20.54	33.09	35.28				83.33			
Deepwater flathead		16.82	15.70	11.43	17.85			38.32	22.06	55.70	59.38	
Deepwater shark basket		157.06	60.01	6.02	90.24			89.98		0.00		
Eastern school whiting		16.09	21.50	16.46	27.12	47.38	19.52	41.17	58.72	46.36		
Gemfish	32.69	28.17	23.43	62.98	27.97		51.99	33.57	32.29	47.79	92.29	
Gummy shark	72.20	74.76	71.37	87.50			66.83	68.71	63.68			
Inshore ocean perch	29.34	43.95	26.67	48.97	29.28		36.62	28.02	31.48	20.41	35.57	
Jackass morwong	13.57	26.36	16.54	10.71	14.81		49.76	34.30	60.03	19.60	23.41	
John dory	46.53	17.35	16.61	28.28	27.68		89.43	100.00	0.00			
Mirror dory	18.25	25.08	12.70	14.79	21.57		30.01	22.53	27.00	86.34	48.97	
Orange roughy	14.43	11.96	11.12	10.78	10.38		42.18	31.46	13.64	37.77	96.58	
Oreo basket	101.59	54.49	55.01	23.03								
Pink ling	19.75	14.33	43.12	18.34	19.36			46.31				
Redfish		13.37	14.82	14.18	10.37		16.00	15.93	18.83	29.72	55.93	
Ribaldo		40.85	30.48	66.47	42.44							
Royal red prawn	10.72	18.99	12.15	21.25	23.52							
Sawshark basket	90.77	90.40	73.03		0.60							
School shark	56.49	53.64	69.90	67.71	28.07			38.69	0.00	16.67		
Silver trevally		21.07	15.38	19.33	24.93		0.00		84.01	82.93		
Silver warehou	24.47	21.83	25.10	16.98	19.97		29.77	39.69	31.17	44.24	41.96	
Smooth oreodory												
Tiger flathead		7.38	12.25	9.48	5.97	28.50		20.82	29.28	35.38	21.28	44.16

Yellowspotted boarfish	27.78	20.42	26.58	37.28

Appendix A – Data Pre-Processing

The following broad categories of data were supplied:

1. ISMP – data gathered from the independent monitoring – see A-Table 1.

2. GENLOG – shot level catch data (referred to as SEF1 in earlier ISMP reports and design studies) – see A-Table 2.

3. CDR- Catch Disposal Records (referred to as SEF2 in earlier ISMP reports and design studies) – see A-Table 3.

Initially, four data pre-processing activities were carried out to prepare the data for higher level analyses to consider the merits of different experimental designs for future ISMP programs for the SET, GAB and GHAT fisheries. These are as follows:

1. Analysis 1. Merging the CDR and GENLOG data.

2. Analysis 2. Combine ISMP data sources and allocation of ISMP shots to ISMP strata.

3. Analysis 3. Allocation of the GENLOG shots to ISMP strata.

The reason for carrying out Analysis 1 was twofold,

a) To link GENLOG shots to the PORT information in the CDR data – since there is no record of PORT in the GENLOG data. The reason for requiring PORT information at the level PORT (preferably port of departure) is that, since observers are required to select vessels for ISMP sampling purposes, they need to be given some indication of which vessels to choose in order to achieve particular sample size by stratum targets. Thus it is important to be able to build a profile of the typical stratum breakdown of vessels operating from particular ports and this can only be done if port of departure is linked in the data to actual shots.

b) To correct the GENLOG catch weight estimates at the level of shots. The rationale behind this part of the exercise is that the shot estimates of catch are regarded as being imprecise estimates, while the PORT estimates of catch are regarded as accurate estimates of the actual catch for the trip. This situation pertains to many fisheries around the world, and it is typical to correct shots such that the sum of catch over all shots for a trip is equal to the landing recorded for the trip as a whole. This exercise is carried out separately for each species.

The reason for carrying out Analysis 2 is to be able to allocate ISMP shots to strata so as to be able to calculate stratified means and variances for the existing ISMP design in order to be able to draw comparisons with alternative ISMP designs.

The need for Analysis 3 is to provide an estimate of the size of the strata used for the recent ISMP. This statement is only applicable to the SET fishery, since the ISMP's for the GAB and GHAT fisheries have not been carried out according to an explicit stratified design.

These stratum proportions are required in order to be able to calculate stratified means and variances for the existing ISMP design, as well as for alternative ISMP designs that may be considered.

Appendix A - Analysis 1 - Merging the CDR and GENLOG data

The GENLOG data covers the year range 1985 – 2009. The CDR data supplied to the study spans the year range 1996 – 2008. Therefore, if a merge to correct shot level catches in the GENLOG data on the basis of trip landings catch records is obligatory, then the GENLOG data from 1985 – 1995 and 2009 will have to be excluded from the analysis. Although a request for CDR data prior to 1996 was considered, on subsequent reanalysis of the data it was felt that merging the 1992 – 1995 CDR data with the 1992 – 1995 GENLOG data was either (a) probably not a feasible exercise, or (b) feasible computationally but insufficiently reliable for the purpose of the calculations reported in this document. Thus the earliest year for which a CDR – GENLOG merge was contemplated was 1996. Please see, A-Table 4, Table 5 and A-Table 6 for a detailed breakdown.

We note that the CDR – GENLOG merge is not simple to achieve since there is no single key which links shots in the GENLOG data to landings in the CDR data. The reasons for this are historic. **We would however strongly advise, if this has not already been done, that such a key be established in the data recording process, since the absence of this key compromises the quality and amount of data available for a wide range of analyses (not just that which is presently under consideration).**

In the absence of the key just mentioned, the basis for a merge of the CDR and the GENLOG data therefore has to be a combination of a unique vessel identifier and a logical test on shot and trip dates, along the lines that

"a shot belongs to a designated trip if the vessel for the shot matches the vessel of the trip
AND
the shot date lies in between or on the start and/or end dates of the trip".

Merging of the CDR and GENLOG data was carried out separately for the SET, GAB and GHAT fisheries.

Appendix A - Merging the CDR and GENLOG data

i) Shot level dataset merge issues

A preliminary analysis showed that, restricting the GENLOG data to the period after and including 1996, about 100 of the Vessel_IDs in the GENLOG data do not appear in the CDR data and in the order of 30-40 of the Vessel_IDs in the CDR data do not appear in the GENLOG data. On the basis of this preliminary analysis, Vessel_ID did not appear to be a good basis for a merge of the CDR and GENLOG data post-1996. Vessel_Names offer an alternative basis for such a merge but a preliminary analysis of the Vessel_Names which are common between the CDR data and the GENLOG data suggested a similar situation existed as for Vessel_IDs.

Two other tables in the GENLOG dataset which contained what appear to be a range of legacy variables related to vessel were considered as providing ancillary information which might assist with the CDR – GENLOG merge for the SET fishery. These tables are VESSELS_CSIRO and VESSELS_CSIRO_ALLVESSELS.

A-Table 7 summarises the results of the investigative work conducted to determine the possibility of using either Vessel_ID or Vessel_Name as the basis for the merge.

A speculative investigation was then launched on the assumption that the match of Vessel_Ids between the CDR and the GENLOG data might perhaps have improved over time.

The results of this investigation are presented in A-Table 8 below. They clearly show that the number of matched vessels increases significantly from the year 2000 onwards. This bears out the assumption that the quality of the matching based on Vessel_Ids will improve with time. The quality of the resulting dataset can be further assessed by examining the number of GENLOG shots and CDR landings which would be lost as a result of a merge based on Vessel_Ids - the results of this analysis are presented in A-Table 9**.**

The above analytical work demonstrates that using Vessel_ID as a basis for merging the CDR and GENLOG datasets becomes increasing reliable from 2000 onwards. The authors of this document chose to limit the data included in the analysis to records of shots occurring during or after 2002 on this basis.

Despite the above, it is important to record that the following data issues and problems exist in the in the CDR data:

- Trips for which end dates occur after the start date of the next trip for the same vessel – **overlapping trips**
- Trips in which the end date is equal to the start date of the next trip for the same vessel – **special kind of overlapping trip**
- Trips in which the end dates occur before start date – **inverted trips**
- Situations where shot dates lie in-between the end-date and start date of the next closest trips for the same vessel – **crack situation**
- Situations in which a trip is nested within another trip – **nested trips**
- Situations where two trips have the same start and/or end-dates – really a special combination of all of the above

The approach that is taken for this report for dealing with these problems relies on the basic assumptions that the end dates are more reliable and that erroneous start dates are causing many, but not all, of the problems mentioned above. The generic method developed here to deal with this issue is as follows:

- **Step 1.** Merge all trips which have the same end date.
- **Step 2.** Merge all trips for which end dates are equal to the start date of the next trip – overlapping trips – the merged 'super trip' will have a start date equal to the earlier trip.
- **Step 3.** For trips for which end dates occur after the start date of the next trip for the same vessel – make the start data of the second trip equal to the end date of the previous trip plus 1 day.

The rationale behind Step 3 is that it seems likely that an overlapping trip is the result of an error, and that the error is more likely to lie in the start date – hence we keep those trips separate. In the case of Step 2, when the end date is exactly equal to the start date of the next trip, it seems that this coincidence is less likely to be due to an error and hence the two trips are merged.

- **Step 4.** For all other trips, start dates are set equal to [the end date of the previous trip + 1 day].

The method was tested (a) in terms of its logic, (b) for specific examples in the data which correspond to the situations described as well as various combinations of those situations, and (c) by checking that all shots were allocated to trips provided that a matching vessel existed, and (d) checking that no shots were allocated to more than one trip.

ii) Shot-species level dataset merge issues

Having merged the CDR data to the GENLOG catch data, an analysis of the quality of record matching based on species was launched. The aim of this analysis was to establish the methodology required to calculate per shot catch weight correction factors for GENLOG records. During the course of this analysis, it became evident that a number of landed species in the CDR landings table had no matching GENLOG catch record. The authors theorise that this is due to imprecise species identification in the GENLOG catch records meaning that species were either not identified as part of a catch by the vessel skipper, or were incorrectly identified. The landed catch is, of course subjected to a more detailed scrutiny and would provide a more accurate breakdown of the species caught.

This species mismatching presents two problems to the calculation of corrected catch weights:

1) When calculating correction factors for GENLOG retained weight values, unreasonable large, or small catch correction factors are derived
2) Species identified in CDR landing records but not found in GENLOG catch records for that trip.

The first of these problems is illustrated in A-Figure 1 which shows histogram of the distribution of the calculated catch correction factor. The catch correction factors are calculated in such a way that the summed retained catch weight per species from the GENLOG catch data can be adjusted to match the landed weight for that species in the CDR data. In order to deal with the excessively large correction factors, a pragmatic approach was adopted to set a maximum correction factor of 4. In this way, unrealistic values are truncated down to a more reasonable level based on the argument that a recorded retained catch weight from the GENLOG data will never be less than ¼ of the landed catch (correction factors greater than 0 imply that the vessel skipper underestimated the catch weight). The distribution of the resulting correction factors is shown in A-Figure 2.

The second problem results in small differences in the summed strata weights (corrected by landing weights) when compared to the landed totals on a species by species basis. Therefore the summed retained catch weight from the GENLOG tables is less than the total species catch for a particular species.

Table 10 illustrates this problem by listing the total landed weight by quota and major non-quota species against the summed GENLOG catch weights.

In order to correct the final computed stratum weights for this error an additional weighting factor was calculated after determining the stratum weights. This factor was used to assign the landed weight from the CDR records not accounted for in the GENLOG catch data to the strata on a pro rata basis. In this way the summed strata weights match the summed landing weights.

Appendix A - Analysis 2 - Combine ISMP datasets

ISMP observer data was supplied by AFMA in two different formats, a Microsoft Access Database: ISMP_ARCHIVE_DATA and 3 delimited text files: onbl.txt, onbw.txt and portlf.txt. The analysis described below was initially built on data sourced from the ISMP_ARCHIVE_DATA, since this was the data initially provided – this source provided usable data for the period 2002 to 2006. During the course of the project, additional data was provided by AFMA which contained observer data for 2007 and 2008. It should be noted that the two datasets, while containing similar data, were not in the same format. This resulted in additional work to enable the data pre-processing tasks to run correctly against the final ISMP dataset for the period 2002-2008.

Appendix A - Analysis 2a - Allocation of ISMP shots to ISMP strata, SET Fishery

There are two main aspects to the allocation of ISMP shots to the strata definitions used for the design of the existing SET ISMP. The first is the allocation of shots to ISMP zones.

Appendix A - Zones

This involves the application of an algorithm to decide whether a shot lies in one of 7 different zones being:

70 – East Coast Deep Water Zone
60 – Bass Strait
50 – Western Victoria
40 – Western Tasmania
30 – Eastern Tasmania
20 – Eastern Victoria
10 – New South Wales

The allocation of ISMP shots to Zones is achieved by rendering each of the areas described above into a collage of one or more trapezoids with parallel eastern and western boundary lines running north – south. Each trapezoid can thus be described by six values (two longitudes and four latitudes), i.e.

LongW, LongE, LatNE, LatNW, LatSE, LatSW.

A shot lies within a trapezoid if its longitude value lies between LongW and LongE, and if its latitude value lies in between the latitude values obtained by the intersection of the north-south line passing through the location of the shot and the following two lines

A northern boundary line passing between the two points (LongW; LatNW), (LongE ; LatNE)
And
A southern boundary line passing between the two points (LongW; LatSW), (longE; LatSE).

A shot lies within a zone if it falls inside one of the trapezoids corresponding to that zone. The trapezoid values for the 7 zones described for the SET fishery are given in A-Table 11.

This includes values for the East Coast Deep Water zone not previously included in the SET ISMP.

A-Figure 3 shows the ISMP shots per zone as a scatter plot using the longitude and latitude of the shot.

Appendix A - Remainder of Stratum allocation

The next phase of the allocation of strata as per the most recent design and implementation (see A-Figure 3) involves a combination of species (presence/absence), depth, gear and seasonal considerations. There are 15 strata in the final design for the SET ISMP, as shown in A-Table 12. Note that A-Table 12 also shows the stratum definitions. The column headed 'Precedence' means that rules take precedence in the order 1-15. For example, if there is any ambiguity and a shots falls into more than one stratum, then the precedence order will remove that ambiguity.

The procedure described above still left a number of unknown shots pre-1999 as shown in A-Table 13. As a result an additional set of rules was used to deal with these unallocated shots:

Designate the shots inshore or offshore. This is largely based on the known depth distributions of the target species - refer to Table 9 in Smith et al 1997 (Design of an ISMP for the SEF) which reports depth distributions for main species (also see the attached table of depth distributions). This can be backed up by looking at the depths of targeted shots for these species when depth is known. This worked for 16 of the target species which together make up 70% of the troublesome shots.

Unfortunately 2 of the main species straddle the 200m depth: redfish and spotted warehou, as does Goulds squid. They make up 23% of the shots. The following algorithm was used to sort out most of the unallocated shots based on the species that appear to be characteristic for each depth category (inshore/offshore).

To allocate inshore/offshore the following rule is used:

1. If target_sp= 37264004 or 37296001 or 37337062 or 37377003 or 37445005 then depth_strata=inshore;
2. Else if target_sp= 37020000 or 37020003 or 37020905 or 37227001 or 37228002 or 37255009 37264003 or 37287093 or 37439002 then depth_strata=offshore;
3. Else if target_sp= 28714005 then depth_strata=RRP; Else do; if the shot contains (John dory 37264004 and/or grey morwong 37377002 and/or blackspot boarfish 37367005) and does NOT contain (offshore ocean perch 37287093 and/or deepsea flathead 37297001), then depth_strata=inshore;
4. else if the shot does NOT contain (John dory 37264004 and/or grey morwong 37377002 and/or blackspot boarfish 37367005) and does contain (offshore ocean perch 37287093 and/or deepsea flathead 37297001), then depth_strata=offshore;
5. else depth_strata="unknown.

Application of this rule in conjunction with the other rules applied leads to the shot allocation results presented in A-Table 14 which are regarded as satisfactory to proceed.

Note: In the data supplied for this study the Royal Red Prawn code has been changed to the species code 28714005.

Appendix A - Analysis 2b - Allocation of ISMP shots to ISMP strata, GAB Fishery

As previously discussed, stratification of the GAB Fishery is based on depth criteria which were developed by a close examination of the species content per shot with the shot depth overlaid. As previously discussed, the utility of a spatial component was also assessed.

The analysis was conducted in two stages:

1. Group shots by similar species content using the K-Means clustering algorithm and score each shot record with its assigned cluster name/description.
2. Overlay the resulting cluster names against the depth and location of the shot.

Step 1 of the analysis required the calculation of a new column of data for each species caught in a shot. The percentage of the retained catch weight for this species was then stored in this new field. The resulting dataset contained, for each shot, the species caught and the percentage of the catch for that species. This data was then passed through the clustering algorithm and the resulting dataset was used to determine the rules for stratifying the GAB fishery.

The analytical work briefly outlined above resulted in the determination of 3 depth bands as the strata for the GAT fishery.

Appendix A - Analysis 2c - Allocation of ISMP shots to ISMP strata, GHAT Fishery

The stratification of the GHAT fishery followed the same basic process as the GAB fishery – this led to the selection of GEAR as. Since the GHAT fishery spans both the SET and GAB fisheries spatially, it was decided to further subdivide the GHAT Fishery into the SET Zones and one additional zone representing the are covered by the GAB fishery (since the SET fishery and the GAB fishery are spatially distinct). The zoning of the GHAT fishery data required the re-use of the processes developed for the SET fishery (as discussed in Analysis 2a above), amended to include the GAB area. These zones, in conjunction with the GEAR type were used to determine the possible strata for the GHAT fishery.

Appendix A - Analysis 3a. Allocation of GENLOG shots to ISMP strata for the SET Fishery

In order to allocate GENLOG shots to the ISMP strata, it was necessary to create a variable mapping which allowed the GENLOG shots to be fed through the existing strata allocation process. Using this approach we were able to re-use much of the work completed for the ISMP strata allocation process, it should be noted, however that a number additional modifications in order to ensure that the process functioned correctly. Of particular note was a systematic error which appeared when an analysis of the resulting strata was conducted – the results of which are shown in A-Table 15. As can be seen from this result, the strata BS_IN_TR, EDL_IN_TR and NSW_IN_TR were not represented in the allocated strata dataset. Further analysis of the data revealed that the underlying cause of the missing strata was a result of missing or "null" values in the depth field for catch records which should have been allocated to these strata (see A-Table 8 for the stratum rules)

In order to resolve the missing depth values, a process needed to be developed which would accurately impute a depth value for those records with null or missing depths. An examination of the strata allocation rules (A-Table 8) revealed that it was not necessary to impute the actual value of the missing depth, the model need only determine if the correct depth should be greater or less than 200 m.

In order to impute the missing depth, a dataset containing a dichotomous variable representing the depth of the shot was created such that "Y" = Depth > 200 m and "N" < 200 m. Acting on the premise that the catch content would be a strong indicator of shot depth, additional variables were derived to represent all possible species which could have been caught. These derived variables were then populated with the percentage of the retained catch for each species of a shot (a value of zero, in this case would indicate that the species was not caught in this shot). The resulting fields were then presented to a decision tree algorithm as independent variables along with fields describing the vessel and gear used with the dichotomous depth variable as the dependent variable.

A "hold out" sample of 50% of the available data was used to test and validate the resulting model. Various diagnostic tools revealed that the decision tree had achieved an accuracy of ~92% on both the testing and training datasets and showed no evidence of over fitting when the model fit was checked against the training dataset and the validation dataset. A-Figure 5 and A-Figure 6 display "Gains" plots, panelled by the dataset of the decision tree's accuracy in assigning a shot to a depth > 200m or to a depth < 200m.

These diagnostics indicate a stable model which was deemed to be acceptable for the purposes of the stratum allocations. Using the results of the decision tree model, the missing strata could be filled, resulting in A-Table 16.

Table 1 - Appendix A: ISMP Dataset Supplied by AFMA.

TABLE: Catch	TABLE: Cruise	TABLE: Lengthfreqs
RECORD COUNT: 271939	**RECORD COUNT: 2413**	**RECORD COUNT: 306078**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
ID	ID	ID
Db	Db	db
fishery	Fishery	fishery
CALLSIGN	CALLSIGN	CALLSIGN
depart_date	depart_date	depart_date
shot_date	STATE	shot_date
shot_number	OBSERVER	shot_number
retained_number	Portdepart	CAAB_code
retained_kgs	Portreturn	lf_type
discard_number	Boardingdate	lf_percentage
discard_kgs	Boardingtime	length
CAAB_code	Disembarkingdate	lengthcode
common_name	Disembarkingtime	retained
scientific_name	COMMENTS	discarded
lf_type		sorted
lf_percentage		total_number
COMMENTS		males
		females
TABLE: PORTLENFREQ	**TABLE: TblPetabundance**	**TABLE: TblPetinteraction**
RECORD COUNT: 210641	**RECORD COUNT: 5898**	**RECORD COUNT: 420**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
ID	ID	ID
CALLSIGN	CALLSIGN	CALLSIGN
Vessel_name	depart_date	depart_date
Fisher	shot_date	shot_date
sample_date	shot_number	shot_number
gear	Observer	observer
observer	start_time	start_time
port	Endtime	CAAB_code
state	CAAB_code	contactcode
zone	IRR	contactcount
CAAB_code	Int	contactpoint
catch_kgs	ROM	earsample
catch_no	Count	latitude
sample_kgs	Countmethod	longitude
sample_no	Total	length
grade	Comments	Number Dead
length_code		sex
length		sightcount
frequency		sightdistancecode
females		sightmethodcount
males		vesselactivity
		contactmortality
		age
		comments

Table 1 - Appendix A: ISMP Dataset Supplied by AFMA Continued….

FILE NAME: portlf.txt	**FILE NAME: onbw.txt**	**FILE NAME: portlf.txt**
RECORD COUNT:	**RECORD COUNT:**	**RECORD COUNT:**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
CAAB species code	CSIROcode	CSIROcode
Calendar year	Year	Year
Month	Month	Month
Day	Day	Day
Gear code	Latitude	Latitude
Zone code	Longitude	Longitude
Grade	Gear code	Gear code
Lencode	RetWhole	Length
CatchWeight	RetNumber	Lencode
CatchNum	DisWhole	NuMale
SampleWeight	DisNumber	NuFemale
SampleNum	DepthMin	TotNum
Length	DepthMax	DepthMin
TotalNum	Process	DepthMax
CallSign	CallSign	lfret
Port		lfdis
		Process
		Sorted
		Retained
		Discarded
		TempSST
		CallSign
TABLE: Trawls		
RECORD COUNT: 14499		
FIELD NAMES:		
ID	Dimension1	TRAWLTYPE
db	Dimension2	TVI1
fishery	Dimension3	TVI2
CALLSIGN	Dimension4	DISCARD
depart_date	Dimension5	Discardsobserved
shot_date	Dimension6	ESTCATCH
SHOTNU	Dimension7	REASONOTH
dtstart	Gearloss	RETCATCH
endlatitude	Haulfinishtime	BENTHOS
endlongitude	Haulfrom	BOTTOMSUB
startlatitude	Haulstarttime	BOTTOMTOP
startlongitude	Longlinetype	SUBOTHER
DEPTHMAX	Material1	TEMPNETS
DEPTHMIN	Material2	TEMPSST
hauldate	Material3	TOPOTHER
searchtime	Material4	Tidedirection
CONTACT	Material5	VALOTHER
DSEM1	Material6	WINDDIR
DSEM2	NETNU	WINDSPEED
DSEM2OTHER	NETOPEN	CLOUD
GRIDFIN	Numberoffloaters	Moonphase
GRIDSTART	Setdamage	SEAHT
LATERR	Shotfinishtime	SWELLHT
LONGERR	Sinkrate	INFOCOMP
TIMEZONE	TOWDIR	Targetfish
gear	TOWSPEED	target1
Baitefficiency	TRAWLDES1	target2
Baiter	TRAWLDES3	target3
		targetshot
		COMMENTS

Table 2 - Appendix A: GENLOG Dataset Supplied by AFMA.

TABLE: Ms_san_operator_landing	**TABLE: Ms_san_receiver_landing**	**TABLE: Ms_species_code**
RECORD COUNT: 723366	**RECORD COUNT: 859780**	**RECORD COUNT: 631**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
log_book_type_code	log_book_type_code	species_code
log_book_serial_no	log_book_serial_no	csiro_code
log_book_page_no	log_book_page_no	effective_date
species_code	species_code	fao_species_code
process_form_code	process_form_code	animal_type
state_catch_kg	state_catch_kg	caab_version
commonwealth_catch_kg	Commonwealth_catch_kg	common_name
high_seas_catch_kg	high_seas_catch_kg	converted_wt_type
area_of_waters	area_of_waters	quota_species_code
permissible_activity	permissible_activity	redundant_date
container_type_code	container_type_code	species_name
csiro_code	csiro_code	default_process_form_code
number_of_carcasses	number_of_carcasses	epbc_act_defined
number_of_containers	number_of_containers	
process_conversion_factor	process_conversion_factor	
record_no	record_no	
trip_limit_trigger_flag		
TABLE: Ms_vessels		**TABLE: OPERATION_COLLECTION**
RECORD COUNT: 12604		**RECORD COUNT: 646**
FIELD NAMES:	**...**	**FIELD NAMES:**
vessel_id	vessel_contact_phone	ID_CSIRO
vessel_name	vessel_depth	record_no
carrying_capacity	vessel_depth_type	dive_method
home_port	vessel_length	depth_maximum
hull_material	vessel_length_type	depth_measure
hull_units	vessel_photo	depth_minimum
last_hull_survey	vessel_tonnage	no_of_divers
nationality	year_built	no_of_tenders
other_dist_symbol	Vcode	total_dive_hours
other_dist_state	vms_required	trip_length
owner_id	Vtype	
place_built	port_of_registry	
power_units	previous_flag	
primary_dist_symbol	australian_flag_status	
primary_dist_state		
radio_call_sign		
int_radio_call_sign		
registered_user_id		
registration_date		
ships_register_number		
vessel_breadth		
vessel_breadth_type		
vessel_colour		
TABLE: OPERATION	**TABLE: OPERATION_CSIRO**	**TABLE: OPERATION_DREDGE**
RECORD COUNT: 2264962	**RECORD COUNT: 2264962**	**RECORD COUNT: 3051**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
ID_CSIRO	ID_CSIRO	ID_CSIRO
log_book_type_code	ERA_SUB_FISHERY_ID	record_no
log_book_serial_no	FISHERY_ID	depth_maximum
log_book_page_no	LOG_BOOK_TYPE_CODE	depth_measure
shot_number	GEAR_CODE_CSIRO	depth_minimum
activity_code	TRAWL_STRATA	grids_traversed
authorised_representative	ACTIVITY_CODE	hours_fished
client_id	AVG_TRAWL_DEPTH_METRES	number_of_hauls
concession_id	AVG_TRAWL_DEPTH_METRES_ ID_DATA_QUALITY	operation_activity
distinguishing_symbol	AVG_TRAWL_DEPTH_METRES_GIS	
end_grid	LENGTH_KM	**TABLE:**

		OPERATION_LONGLINE
end_latitude	TRAWL_SPEED_KMHR	**RECORD COUNT: 490270**
end_latitude_degrees	START_TIME_DEC	**FIELD NAMES:**
end_latitude_minutes	END_TIME_DEC	ID_CSIRO
end_location	EFFORT_TIME_DECIMAL	ID_HISTORICAL
end_longitude	UTC_OFFSET	record_no
end_longitude_degrees	DAY_NIGHT	avg_branch_line_length
end_longitude_minutes	SEF_ZONE	avg_branch_ln_len_meas
end_time	OR_ZONE	avg_bubble_line_length
fishery_id	SEF_ZONE_GIS	avg_bubble_ln_len_meas
fishing_method	STATE_WATERS_GIS	depth_code
fishing_method_historical	SHARK_AREA	depth_maximum
gear_code	SHARK_REGION	depth_measure
gear_code_historical	VESSEL_ID_CSIRO	depth_minimum
licence_no	VESSEL_NAME_CSIRO	direction_of_set
moon_phase	VESSEL_CALLSIGN_CSIRO	line_shooter_used
record_no	VESSELNAME_CALLSIGN	main_line_length
season	DANISHSEINE	main_line_length_meas
shot_date	SHOT_NUMBER_CSIRO	no_hooks_btwn_bubbles
start_grid	SHOT_DATE	no_light_sticks_used
start_latitude	YEAR	number_of_hooks
start_latitude_degrees	MONTH	number_of_lines
start_latitude_minutes	DAY	set_direction
start_location	LONGITUDE_START	gear_lost_line_length
start_longitude	LATITUDE_START	gear_lost_no_hooks
start_longitude_degrees	LONGITUDE_END	time_start_haul
start_longitude_minutes	LATITUDE_END	time_end_haul
start_time	QUARDEG_CODE	start_haul_latitude_degrees
time_zone	HALFDEG_CODE	start_haul_latitude_minutes
vessel_id	HALFDEG_CODE_AFMA	start_haul_latitude
waters_fished	C_SQ_CODE	start_haul_longitude_degrees
zone_marker	INDEX1KM_ID	start_haul_longitude_minutes
vessel_name	INDEX1KM_ID_TRAWLEND	start_haul_longitude
entered_by	DATA_SOURCE	end_haul_latitude_degrees
entered_on	DATA_SOURCE_ID	end_haul_latitude_minutes
changed_by	LENGTH_KM_GREATCIRCLE	end_haul_latitude
changed_on	RECORD_NO	end_haul_longitude_degrees
DATA_SOURCE	ID_HISTORICAL	end_haul_longitude_minutes
ID_CSIRO_2008	ID_CSIRO_2007	end_haul_longitude
ID_CSIRO_2008_AUTONUMBER	VESSEL_NAME_FROMID	vessel_shooting_speed
ID_HISTORICAL	VESSEL_SYMBOL_FROMID	
	ID_CSIRO_AUTONUMBER	
	ID_CSIRO_2008A	
TABLE: OPERATION_MINOR_LINE	**TARGET_SPECIES**	**TABLE: ZONES_SHARK_AREA**
RECORD COUNT: 31114	net_mesh_size	**RECORD COUNT: 58**
FIELD NAMES:	total_net_length	**FIELD NAMES:**
ID_CSIRO	net_height	ZONENAME
record_no	ID_Historical, total_net_length_lost	ZONENO
fishing_method		LATITUDE
am_hours_fished	**TABLE: VESSELS_CSIRO**	LONGITUD
depth_maximum	**RECORD COUNT: 1631**	wlong
depth_measure	**FIELD NAMES:**	elong
depth_minimum	VESSEL_ID_CSIRO	nwlat
hours_fished	VESSEL_NAME	nelat
hours_searched	DISTINGUISHING_SYMBOL	swlat
no_of_crew	BUYOUT	selat
no_of_tenders	VESSEL_NAME_ORIGINAL	
number_of_hooks	DISTINGUISHING_SYMBOL_ORIGINAL	**TABLE: ZONES_SHARK_REGIONS**
number_of_lines	VESSEL_ID_CSIRO_20070214	**RECORD COUNT: 13**
pm_hours_fished		**FIELD NAMES:**
trip_length	**TABLE: VESSELS_CSIRO_ALLVESSELS**	ZONENAME
port_of_departure	**RECORD COUNT: 2257**	ZONENO

target_group	**FIELD NAMES:**	WLONG
weight_conversion_code	VESSEL_ID_CSIRO	ELONG
ave_weight_per_carton	VESSEL_NAME	NWLAT
no_trays_or_cartons	DISTINGUISHING_SYMBOL	NELAT
gear_lost_line_length	VESSEL_BUYOUT	SWLAT
gear_lost_no_hooks	VESS_STD	SELAT
line_length	COMMENT	shregcode
no_of_line_lifts	VESSEL_NAME_AFMA	shreg
avg_hooks_per_line	DISTINGUISHING_SYMBOL_AFMA	
time_start_haul	VESSEL_ID_AFMA	**TABLE: CATCH**
time_end_haul	VESSEL_ID_AFMA_ORIGINAL	**RECORD COUNT: 7652739**
ID_Historical	VESSEL_ID_CSIRO_20070214	**FIELD NAMES:**
	NAME_FROMID	ID_CSIRO
TABLE: OPERATION_MITIGATION_MEASURES	SYMBOL_FROMID	csiro_code
RECORD COUNT: 200357	CountOfID_CSIRO	csiro_code_historical
FIELD NAMES:		species_code
ID_CSIRO	**TABLE: Zones_OR**	species_code_historical
record_no	**RECORD COUNT: 8**	catch_kg
mitigation_measure_code	**FIELD NAMES:**	fishing_method
number_used	ZONENAME	weight_conversion_code
ID_Historical	ZONENO	meridian
	WLONG	tender_number
TABLE: OPERATION_NET	ELONG	grade
RECORD COUNT: 32505	NWLAT	life_status
FIELD NAMES:	NELAT	conversion_factor_used
ID_CSIRO	SWLAT	est_percent_of_school
record_no	SELAT	estimated_kgs_discarded
assisted_by_pole_boat		estimated_kgs_kept
assisting_dist_symbols	**TABLE: Zones_SEF**	hours_fished
depth_maximum	**RECORD COUNT: 18**	no_of_fish_kept
depth_measure	**FIELD NAMES:**	no_of_fish_released
depth_minimum	ZONENAME	number_of_boxes
end_depth	ZONENO	number_of_cartons
end_haul	WLONG	targeted_flag
hours_searched	ELONG	comments
net_code	NWLAT	DISCARD_CODE
spotter_plane_used	NELAT	RECORD_NO
start_depth	SWLAT	ID_Historical
start_haul	SELAT	ID_CSIRO_2007
TABLE: CODE_Depths	**TABLE: CODE_FISHERY_SUBFISHERY**	**TABLE: OPERATION_CSIRO_DATAQUALITY**
RECORD COUNT: 21	**RECORD COUNT: 50**	**RECORD COUNT: 794549**
FIELD NAMES:	**FIELD NAMES:**	**FIELD NAMES:**
MINDEPTH	ERA_SUB_FISHERY_ID	ID_CSIRO
MAXDEPTH	ERA_FISHERY_ID	ID_DATA_QUALITY
	SUB_FISHERY_STATUS	
TABLE: CODE_Effort_unit_code	FISHERY_ID_OLD	**TABLE: DANISH_SEINE_YEARED**
RECORD COUNT: 34	FISHERY_TEP	**RECORD COUNT: 631**
FIELD NAMES:	ERA_SUB_FISHERY_NAME	**FIELD NAMES:**
ID	DBUPDATES_ENDSTAGE2	FISHERY_ID
effort_unit_code	CODE_SPATIAL_UNIT	VESSEL_ID_CSIRO
description	EFFORT_MIN_SHOTS	YEAR
	SHAPEFILE_NAME	VesselName
TABLE: CODE_Effort_unit_sub_code	SHAPEFILE_NAME_AFMA	CallSign
RECORD COUNT: 31	SPATIAL_OVERLAP	VesselName_CallSign
FIELD NAMES:	SPATIAL_OVERLAP_HABITATS	SOURCE
ID		
effort_unit_sub_code	**TABLE: CODE_DATA_QUALITY**	**TABLE: Dim_Depth**
description	**RECORD COUNT: 50**	**RECORD COUNT: 2550**
	FIELD NAMES:	**FIELD NAMES:**
TABLE: CODE_FISHERY	ID_DATA_QUALITY	Depth

RECORD COUNT: 31	DATA_QUALITY	Depth_Band_10M
FIELD NAMES:	DATA_QUALITY_SQL	Depth_Band_50M
ERA_FISHERY_ID	MODULE	Depth_Band_100M
ERA_FISHERY_NAME		Depth_Strata
	TABLE: CODE_QUOTA_SPECIES	Depth_Sub_Strata
TABLE: CODE_FISHERY_OPS_GEARTYPES	**RECORD COUNT: 42**	Depth_Strata_Sort
RECORD COUNT: 118	**FIELD NAMES:**	Depth_Sub_Strata_Sort
FIELD NAMES:	ID	
ERA_FISHERY_ID	Fishery_CSV	**TABLE: Fishery**
ERA_SUB_FISHERY_ID	AFMA_Code	**RECORD COUNT: 73**
FISHERY_ASSESSED	CAAB_Code_8Digit_NewAFMA	**FIELD NAMES:**
NAME_AFMA	CAAB_Code_8Digit_CSIRO_lng	fishery_id
FISHERY_ID	CAAB_Code_6Digit_OldAFMA	name
LOG_BOOK_TYPE_CODE	CAAB_Code_MAFRI_6Digit	previous_season
GEAR_CODE_CSIRO	Scientific_name	current_season
GEAR_ASSESSED	Common_Name	next_season
EFFORT_MIN_SHOTS	Notes	description
code_description	VALUE_DOLLARSPERKG_MEL_2005	compliance_contact
CountOfID_CSIRO		concession_renew_date
Comment	**TABLE: Ms_mss_codes_master**	fish_receiver_permit
NAME_AFMA_SHAPEFILE	**RECORD COUNT: 196**	fishery_manager
	FIELD NAMES:	fishery_manager_phone
	code_type	fishery_operational
	code_type_name	fishery_type_id
	code_type_units	fishing_permit
	code_type_description	licensing_contact
		licensing_contact_phone
		monitoring_contact
		monitoring_contact_phone
		principle_concess_type
		principle_contact
		senior_licensing_contact
		sfr_certificate
		sfr_extract
TABLE: Ms_san_landing	TABLE: Meta_Quota_Species_Current	**TABLE: OPERATION_TRAWL**
RECORD COUNT: 895123	RECORD COUNT: 43	**RECORD COUNT: 1534015**
FIELD NAMES:	FIELD NAMES:	**FIELD NAMES:**
VESSEL_NAME_FROMID	CAAB_CODE	**ID_CSIRO**
VESSEL_SYMBOL_FROMID	QUOTA_FISHERY	**record_no**
VESSEL_ID_CSIRO	QUOTA_SPECIES	**depth_maximum**
VESSELNAME_CALLSIGN		**depth_measure**
log_book_type_code	**TABLE: Ms_logbook**	**depth_maximum_metres**
log_book_serial_no	**RECORD COUNT: 95**	**depth_minimum**
log_book_page_no	**FIELD NAMES:**	**depth_temperature**
species_code	**log_book_type_code**	**depth_temperature_meas**
permissible_activity	**log_book_name**	**depth_temperature_type**
process_form_code	**log_book_use_type**	**depth_type_code**
fishery_id	**replaces_log_book**	**est_wt_cod_end_meas**
season	**catch_summary_table**	**est_wt_cod_end_pre_sort**
area_of_waters		**ground_gear_code**
decrement_quota_code	**TABLE: Ms_mss_codes_detail**	**hours_searched**
op_commonwealth_total_kg	**RECORD COUNT: 2064**	**net_code**
op_high_seas_total_kg	**FIELD NAMES:**	**shot_valid**
op_number_of_carcasses	**code_type**	**trawl_speed**
op_state_total_kg	**short_code**	**trawl_speed_meas**
port_unloaded	**long_code**	**trawl_time**
quota_holder_client_id	**code_description**	**cod_end_mesh_size**
rec_commonwealth_total_kg		**cod_end_mesh_size_meas**
rec_high_seas_total_kg	**TABLE: OPERATION_NON_TRAWL**	**mesh_configuration**
rec_number_of_carcasses	**RECORD COUNT: 147167**	**ground_gear_disk_height**
rec_state_total_kg	**FIELD NAMES:**	**ground_gear_disk_height_meas**
record_no	**ID_CSIRO**	**trawl_configuration**
trip_end_date	**record_no**	**trawl_strata**
unit_code	**depth_measure**	**avg_trawl_depth**

vessel_id	**hours_searched**	**avg_trawl_depth_meas**
converted_wt	**depth_maximum**	**avg_trawl_depth_temp**
converted_wt_type	**depth_minimum**	**avg_trawl_depth_temp_meas**
decrement_fishery_id	**target_species**	**target_species_code**
decrement_licence_no	**time_end_haul**	**total_no_shots**
decrement_concession_id	**time_start_haul**	**ID_Historical**
last_updated_timestamp	**ID_Historical**	
YEAR		
DANISHSEINE		
TABLE: FISHING_EFFORT		
RECORD COUNT: 1573671		
FIELD NAMES:		
ID_CSIRO		
gear_code		
effort_unit_code		
effort_unit_sub_code		
effort_unit_value		
effort_unit_sub_code_value		
record_no		
ID_Historical		

Table 3: Appendix A: CDR Dataset Supplied by AFMA.

BLE: CDR
RECORD COUNT: 923485
FIELD NAMES:
Vessel Name
Primary Dist Symbol
Log Book Type Code
Log Book Serial No
Log Book Page No
Species Code
Common Name
Species Name
Permissible Activity
Process Form Code
Fishery Id
Season
Area Of Waters
Decrement Quota Code
Op Commonwealth Total Kg
Op High Seas Total Kg
Op Number Of Carcasses
Op State Total Kg
Port Unloaded
Quota Holder Client Id
Rec Commonwealth Total Kg
Rec High Seas Total Kg
Rec Number Of Carcasses
Rec State Total Kg
Record No
Trip End Date
Unit Code
Vessel Id
Converted Wt
Converted Wt Type
Decrement Fishery Id

Table 4 - Appendix A: Record count (at trip level) breakdown of the CDR data supplied by AFMA for this study by Fishery_ID.

Fishery	Trip Count
GAB	1746
GHAT	20359
SET	89614

For the purpose of this study the Fishery_Ids have been allocated to Fisheries GAB, GHAT or SET on the following basis:

SET = ECD, SEN, SET or VIT
GAB = GAB, GBQ
GHAT = GHT, SSF, SSG or SSH.
Fishery_Ids ‘SCW’, ‘STR’ and ‘TCW’ have been omitted from the redesign of the ISMPs.

Table 5 - Appendix A: Breakdown of the record count in the CDR data by Fishery (as defined above) and year of Trip start date.

YEAR	GAB	GHAT	SET
1996	0	0	1
1997	0	14	636
1998	0	18	10417
1999	0	930	10497
2000	0	1482	10212
2001	167	1728	9286
2002	117	1343	9518
2003	250	2801	8252
2004	326	2807	8062
2005	308	2348	7204
2006	255	2198	5726
2007	215	2646	5344
2008	108	2044	4459

Table 6 - Appendix A: A breakdown of the record count in the GENLOG data by Fishery (as defined above) and year of shot date.

YEAR	GAB	GHAT	SET
1985	0	0	17425
1986	368	0	66275
1987	753	0	61883
1988	4621	0	67587
1989	9270	0	67970
1990	4832	0	61234
1991	3105	0	51453
1992	2830	0	38187
1993	2170	0	41362
1994	1857	0	43735
1995	2812	0	42187
1996	3329	0	47568
1997	4373	2	61920
1998	3717	3686	62606
1999	3715	11437	56585
2000	2977	13377	49554
2001	3215	12934	47138
2002	2586	13181	44710
2003	4601	15135	43446
2004	5589	15967	40994
2005	6261	13742	36858
2006	5921	13596	30311
2007	4537	10692	22307
2008	2831	8428	21998

Table 7 - Appendix A: Potential for using vessel_Ids or vessel_names as the basis for the CDR – GENLOG merge.

FISHERY = SET					
Dataset	Time Period	# null vessel_ids	#unique vessel_ids	#vessel_ids in GENLOG not in CDR	#vessel_ids in CDR not in GENLOG
GENLOG	>= 1996	0	360		
	>= 2001	0	191	10	
CDR	>= 1996	0	298		
	>= 2001	0	220		39
FISHERY = SET					
Dataset	Time Period	# null vessel_names	#unique vessel_names	#vessel_names in GENLOG not in CDR	#vessel_names in CDR not in GENLOG
GENLOG	>= 1996	0	393		
	>= 2001	0	184	16	
CDR	>= 1996	0	271		
	>= 2001	0	206		36
FISHERY = GAB					
Dataset	Time Period	# null vessel_ids	#unique vessel_ids	#vessel_ids in GENLOG not in CDR	#vessel_ids in CDR not in GENLOG
GENLOG	>= 1996	**0**	**360**		
	>= 2001	**0**	**191**	**10**	
CDR	>= 1996	**0**	**298**		
	>= 2001	**0**	**220**		**39**
FISHERY = GAB					
Dataset	Time Period	# null vessel_names	#unique vessel_names	#vessel_names in GENLOG not in CDR	#vessel_names in CDR not in GENLOG
GENLOG	>= 1996	**0**	**393**		
	>= 2001	**0**	**184**	**16**	
CDR	>= 1996	**0**	**271**		
	>= 2001	**0**	**206**		**36**
FISHERY = GHAT					
Dataset	Time Period	# null vessel_ids	#unique vessel_ids	#vessel_ids in GENLOG not in CDR	#vessel_ids in CDR not in GENLOG
GENLOG	>= 1996	**0**	**360**		
	>= 2001	**0**	**191**	**10**	
CDR	>= 1996	**0**	**298**		
	>= 2001	**0**	**220**		**39**
FISHERY = GHAT					
Dataset	Time Period	# null vessel_names	#unique vessel_names	#vessel_names in GENLOG not in CDR	#vessel_names in CDR not in GENLOG
GENLOG	>= 1996	**0**	**393**		
	>= 2001	**0**	**184**	**16**	
CDR	>= 1996	**0**	**271**		
	>= 2001	**0**	**206**		**36**

Table 8 - Appendix A: Distinct vessels in the CDR and GENLOG datasets with the number of matched vessels and the percentage of GENLOG vessels matched by fishery

	GAB				GHAT				SET			
	CDR Vessels	GENLOG Vessels	Matched Vessels	% Matched	CDR Vessels	GENLOG Vessels	Matched Vessels	%Matched	CDR Vessels	GENLOG Vessels	Matched Vessels	% Matched
1996	0	1	0	0.00%	0	0	0	0.00%	1	1	0	0.00%
1997	0	1	0	0.00%	7	1	0	0.00%	65	158	54	34.18%
1998	0	1	0	0.00%	2	58	1	1.72%	174	138	66	47.83%
1999	0	1	0	0.00%	69	107	59	55.14%	179	78	67	85.90%
2000	0	11	0	0.00%	93	95	76	80.00%	179	156	144	92.31%
2001	7	10	7	70.00%	90	112	81	72.32%	173	144	137	95.14%
2002	6	8	5	62.50%	75	109	74	67.89%	171	151	143	94.70%
2003	11	13	11	84.62%	144	141	139	98.58%	105	104	103	99.04%
2004	10	12	10	83.33%	136	134	133	99.25%	97	99	96	96.97%
2005	10	10	10	100.00%	114	116	112	96.55%	99	98	97	98.98%
2006	12	12	12	100.00%	104	104	100	96.15%	86	87	85	97.70%
2007	9	9	9	100.00%	85	85	79	92.94%	56	54	52	96.30%
2008	6	7	6	85.71%	74	74	64	86.49%	54	52	51	98.08%

Table 9 - Appendix A: Percent loss of CDR Landing Records and GENLOG Shot records using Vessel_Ids as the basis for merging CDR and GENLOG records.

	GAB		GHAT		SET	
	Percent Shots Lost	Percent Landings Lost	Percent Shots Lost	Percent Landings Lost	Percent Shots Lost	Percent Landings Lost
1996	100.00%	100.00%	0.00%	0.00%	100.00%	100.00%
1997	100.00%	100.00%	100.00%	100.00%	88.48%	11.01%
1998	100.00%	100.00%	98.53%	5.56%	88.15%	86.25%
1999	100.00%	100.00%	22.30%	8.82%	89.40%	83.55%
2000	100.00%	100.00%	7.36%	6.01%	27.72%	7.06%
2001	2.24%	0.00%	25.54%	3.94%	1.75%	6.89%
2002	10.09%	8.55%	35.39%	1.04%	0.66%	5.89%
2003	6.65%	0.00%	0.38%	0.61%	0.01%	0.11%
2004	0.54%	0.00%	0.46%	0.18%	0.20%	0.15%
2005	0.00%	0.00%	0.69%	2.13%	0.14%	0.03%
2006	0.00%	0.00%	1.90%	0.73%	1.57%	0.03%
2007	0.00%	0.00%	0.82%	1.70%	0.09%	2.25%
2008	3.00%	0.00%	1.68%	3.72%	0.02%	0.56%

Table 10 - Appendix A: Total landed weight by quota and major non-quota species against the summed GENLOG catch weights.

This table illustrates the species mismatching problem in the CDR-GENLOG merge for all fisheries where YEAR >= 2002

Project Key	GENLOG Catch Weight	CDR Landing Weight	Percentage Match
Royal red prawn	1350009.9	1371434.4	98.44%
Orange roughy	17038623.5	17309543.3	98.43%
Redfish	3380943.3	3486894.73	96.96%
Eastern school whiting	3871403.2	3997978.7	96.83%
Ornate angelshark	1105432.1	1152120.1	95.95%
Blue-eye trevalla	3989024.35	4175656.1	95.53%
Blue grenadier	50861167.53	54177170.41	93.88%
Bight redfish	6094551.9	6515329.99	93.54%
Smooth oreodory	1777876.5	1906056.05	93.28%
Deepwater flathead	13241539.36	14334068.37	92.38%
Mirror dory	3648492.3	3992210.46	91.39%
Whiskery shark	212147.42	235478.58	90.09%
Pink ling	11719972.05	13050593.69	89.80%
Blue morwong	521770.75	581155.42	89.78%
Silver warehou	23328625.9	25987733.97	89.77%
Blue warehou	2308993.22	2582293.87	89.42%
Hapuku	815399.34	919319.09	88.70%
Tiger flathead	24753102.47	28236611.55	87.66%
Deepwater shark basket	2428702.56	2771367.36	87.64%
Inshore ocean perch	2458553.61	2806436.58	87.60%
Frostfish	852027.72	981601.59	86.80%
Gemfish	4224221.95	4877661.41	86.60%
Knifejaw	681818.68	792319.43	86.05%
Gould squid	5680313.95	6634745.29	85.61%
Jackass morwong	7260210.73	8487013.3	85.54%
John dory	958326.32	1121145.38	85.48%
Bronze whaler	159404.44	187136.41	85.18%
Alfonsino	1019790.37	1201555.94	84.87%

Project Key	**GENLOG Catch Weight**	**CDR Landing Weight**	**Percentage Match**
King dory	1786586.95	2110343.14	84.66%
School shark	1433681.9	1694569.23	84.60%
Ribaldo	1401461.65	1684531.13	83.20%
Silver trevally	920948.95	1120009.29	82.23%
Barracouta	762319.4	928758.7	82.08%
Gummy shark	13475799.48	17005277.75	79.24%
Hapuku (unspecified)	39845.25	51398.31	77.52%
Octopus	504855.95	653635.57	77.24%
Triggerfish & leatherjacket (unspecified)	668825.79	867109.31	77.13%
Sawshark basket	2589056.1	3356834.21	77.13%
Snapper	501050.42	653897.2	76.63%
Crustaceans	296067.25	390483.75	75.82%
Stargazer (unspecified)	1633748.06	2155280.12	75.80%
Yellowspotted boarfish	860571.18	1145863.9	75.10%
Smooth hammerhead	55151.25	73790.45	74.74%
Oreo basket	1505866.16	2024952.07	74.37%
Latchet	1642283.12	2240577.83	73.30%
Bluestriped goatfish	155837.81	213983.71	72.83%
Broadnose shark	251877.14	356314.44	70.69%
Southern eagle ray	95799.2	141038.47	67.92%
Sharks	222740.77	331385.72	67.21%
Ocean jacket	3124600.36	4899550.72	63.77%
Elephantfish	497483.86	782578.41	63.57%
Fish	3079245.36	4864152.66	63.30%
Guitarfish (unspecified)	277948.7	443514.9	62.67%
Red gurnard	1445804.86	2323327.39	62.23%
Silver dory	408001.28	657278.31	62.07%
Dogfish	472209.76	762515.25	61.93%
Boarfish (unspecified)	245753.51	404982.01	60.68%
Rays	352575	607942.08	57.99%
Striped trumpeter	22218.29	39083.93	56.85%
Chimaeras	71489.9	152009.38	47.03%
Ocean blue-eye trevalla	711.56	1601	44.44%
Australian angelshark	480989.5	1165809	41.26%
Squid (general)	516289.76	1358246.38	38.01%
Molluscs	442672.85	1172277.82	37.76%
Sawsharks	21399.8	57739.3	37.06%
Draughtboard shark	46991.2	141324.55	33.25%
Triggerfish & leatherjacket (unspecified)	668825.79	867109.31	77.13%
Sawshark basket	2589056.1	3356834.21	77.13%
Snapper	501050.42	653897.2	76.63%
Crustaceans	296067.25	390483.75	75.82%
Stargazer (unspecified)	1633748.06	2155280.12	75.80%
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Red gurnard	1445804.86	2323327.39	62.23%
Silver dory	408001.28	657278.31	62.07%
Dogfish	472209.76	762515.25	61.93%
Boarfish (unspecified)	245753.51	404982.01	60.68%

Project Key	GENLOG Catch Weight	CDR Landing Weight	Percentage Match
Rays	352575	607942.08	57.99%
Striped trumpeter	22218.29	39083.93	56.85%
Chimaeras	71489.9	152009.38	47.03%
Ocean blue-eye trevalla	711.56	1601	44.44%
Australian angelshark	480989.5	1165809	41.26%
Squid (general)	516289.76	1358246.38	38.01%
Molluscs	442672.85	1172277.82	37.76%
Sawsharks	21399.8	57739.3	37.06%
Draughtboard shark	46991.2	141324.55	33.25%

Table 11 - Appendix A: The six values associated with each trapezoid describing in total the area of each of the 7 zones in the SET fishery.

ZONENAME	ZONENO	WLONG	ELONG	NWLAT	NELAT	SWLAT	SELAT
NSW	10	147	155.9543	33.583	33.583	37.25	37.25
East Victoria	20	148	148.317	38.4	38.4	40.75	40.75
East Victoria	20	148.317	148.733	38.4	37.75	40.75	40.75
East Victoria	20	148.733	155	37.25	37.25	40.75	40.75
East Tasmania	30	147	148	42	40.75	48	48
East Tasmania	30	148	154	40.75	40.75	48	48
West Tasmania	40	138.133	144	40	40	48	48
West Tasmania	40	144	146	40	42	48	48
West Tasmania	40	146	147	42	42	48	48
West Victoria	50	138.1	144	34	34	40	40
Bass Strait	60	144	146	37.25	37.25	40	42
Bass Strait	60	146	147	37.25	37.25	42	42
Bass Strait	60	147	148	37.25	37.25	42	40.75
Bass Strait	60	148	148.317	37.25	37.25	38.4	38.4
Bass Strait	60	148.317	148.733	37.25	37.25	38.4	37.75
ECDW	70	155.5	157	24.49833	24.49833	27	30
ECDW	70	157	165	24.49833	24.49833	35	35
ECDW	70	155.9543	157	33.58167	33.58167	34.00717	35

Table 12 - Appendix A: Stratum definitions for the SET ISMP study.

The column headed 'Precedence' means that rules take precedence in the order 1-15. For example, if there is any ambiguity and a shots falls into more than one stratum, then the precedence order will remove

Stratum Code	Description	Precedence	ZONE / depth / month	Gear	Flag code	Species
1. BS_IN_TR	Victoria Inshore Trawl	14	60 / <200 / all	Not D	Vicin	**Any**
2. ECDW_TR	East Coast Deep Water Trawl	15	70	Not D	Ecdw	**Any**
3. EDL_DS	Victoria East Coast Danish Seine	11	All / all / all	D	Edlds	**Any**
4. EDL_IN_TR	Victoria East Coast Inshore Trawl	12	20 / <200 / all	Not D	Edin	**Any**
5. EDL_OFF_TR	Victoria East Coast Offshore Trawl	13	20 / >200 / all	Not D	Edoff	**Any**
6. NSW_IN_TR	New South Wales Inshore Trawl	9	10 / <200 / all	Not D	Nswin	**Any**
7. NSW_OFF_TR	New South Wales Offshore Trawl	10	10 / >200 / all	Not D	Nswoff	**Any**
8. NSW_RRP_TR	New South Wales Royal Red Prawn Trawl	8	All / all / all	All	Rrp	**701004 > 50kg**
9. SW_BGS_TR	Victoria West Orange Roughy	7	50 / all / 6-8	All	Bgs	**227001 present**
10. SW_ORO_TR	South West Orange Roughy Trawl	2	50 / all / 6-9	All	Oros	**255009 > 50%**
11. SW_TR	South West Trawl	5	50 / all / all	All	Oths	**Any**
12. TAS_BGS_TR	Tasmania Spawning Blue Grenadier	6	30,40 / all / 6-8	All	Bgt	**227001 present**
13. TAS_E_TR	Tasmania East Coast Trawl	3	30 / all / all	All	Othe	**Any**
14. TAS_ORO_TR	Tasmania Orange Roughy Trawl	1	30,40 / all / 6-9	All	Orot	**255009 > 50%**
15. TAS_W_TR	Tasmania West Coast Trawl	4	40 / all / all	All	Othw	**Any**

Table 13 - Appendix A: Unknown SEF ISMP shots emerging from the zone allocation and first set of stratum allocation rules as described in the text.

	BS_IN_TR	ECDW_TR	EDL_DS	EDL_IN_TR	EDL_OFF_TR	NSW_IN_TR	NSW_OFF_TR	NSW_RRP_TR	SW_BGS_TR	SW_ORO_TR	SW_TR	TAS_BGS_TR	TAS_E_TR	TAS_ORO_TR	TAS_W_TR	unknown	Total
1992	0	0	0	2	12	7	2	0	0	0	0	13	9	14	0	0	**59**
1993	0	0	27	25	24	18	8	0	0	0	0	15	103	24	74	200	**518**
1994	0	0	246	51	37	0	0	0	4	36	100	2	42	21	27	272	**838**
1995	13	0	180	42	25	0	0	0	12	0	125	18	0	0	57	122	**594**
1996	1	0	0	43	27	0	0	6	21	0	178	10	45	0	0	264	**595**
1997	0	0	0	148	52	0	0	0	31	11	132	0	28	0	4	314	**720**
1998	0	0	23	90	97	87	76	16	20	10	120	52	51	14	15	1	**672**
1999	2	0	47	93	65	224	131	54	24	2	120	40	89	40	12	0	**943**
2000	6	6	27	73	53	243	111	8	16	4	85	8	114	20	4	0	**778**
2001	16	32	41	118	93	236	134	17	23	8	94	42	62	22	36	0	**974**
2002	12	13	34	81	62	208	75	26	12	2	144	9	64	9	40	1	**792**
2003	30	0	114	100	73	296	94	11	14	6	97	33	22	9	31	1	**931**
2004	6	0	48	47	76	297	128	4	31	1	97	8	35	25	1	0	**804**
2005	1	0	71	132	74	271	80	5	30	2	187	19	21	25	28	1	**947**
2006	0	0	130	116	66	213	88	4	15	0	120	5	66	22	9	1	**855**
2007	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	**24**
Total	**87**	**51**	**1012**	**1161**	**836**	**2100**	**927**	**151**	**253**	**82**	**1599**	**274**	**751**	**245**	**338**	**1177**	**11044**

Table 14 - Appendix A: Allocation of shots to strata for the SET ISMP data after applying zone and strata allocation correction rules.

	BS_IN_TR	ECDW_TR	EDL_DS	EDL_IN_TR	EDL_OFF_TR	NSW_IN_TR	NSW_OFF_TR	NSW_RRP_TR	SW_BGS_TR	SW_ORO_TR	SW_TR	TAS_BGS_TR	TAS_E_TR	TAS_ORO_TR	TAS_W_TR	unknown and/or unzonable
1992	0	0	0	2	12	7	2	0	0	0	0	13	9	14	0	0
1993	0	0	27	25	24	140	77	0	0	0	0	15	103	24	74	9
1994	0	0	246	51	37	170	87	0	4	36	100	2	42	21	27	15
1995	13	0	180	42	25	56	57	0	12	0	125	18	0	0	57	9
1996	1	0	0	43	27	159	96	6	21	0	178	10	45	0	0	9
1997	0	0	0	148	52	192	110	0	31	11	132	0	28	0	4	37
1998	0	0	23	91	97	87	76	16	20	10	120	52	51	14	15	20
1999	2	0	47	93	65	224	132	54	24	2	120	40	89	40	12	3
2000	6	51	27	73	53	243	111	8	16	4	85	8	114	20	4	1
2001	16	32	41	118	93	236	134	17	23	8	94	42	62	22	36	3
2002	12	69	34	81	62	208	75	26	12	2	144	9	64	9	40	1
2003	30	0	114	100	73	296	94	11	14	6	97	33	22	9	31	2
2004	6	25	48	47	76	297	128	4	31	1	97	8	35	25	1	0
2005	1	0	71	133	74	272	81	5	30	2	187	19	21	25	28	0
2006	0	0	130	117	66	213	88	4	15	0	120	5	66	22	9	0
2007	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	**177**	**1012**	**1164**	**836**	**2800**	**1348**	**151**	**253**	**82**	**1599**	**274**	**751**	**245**	**338**	**109**

Table 15 - Appendix A: Shows the number of shots allocated per strata for the GENLOG database, illustrating the missing strata caused by null or missing values in the recorded shot depth.

Strata	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
BS_IN_TR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECDW_TR	0	0	0	0	0	1	0	53	62	421	113	169	230	60	1	75	1
EDL_DS	8116	8263	8874	8108	9478	10131	10981	10018	7722	8260	8948	10129	8330	7689	6495	6397	6440
EDL_IN_TR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EDL_OFF_TR	6046	7204	7853	7436	7910	10917	9688	9633	10277	8820	8549	8516	7677	8247	6816	4652	4911
NSW_IN_TR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NSW_OFF_TR	6608	7568	9169	8984	9327	8495	8189	8864	9565	8766	8432	9918	10048	8236	6401	3882	4103
NSW_RRP_TR	420	747	894	1319	1493	1153	1222	1430	1282	1094	1447	648	444	442	327	211	157
SW_BGS_TR	193	279	247	180	381	424	297	479	540	388	353	317	502	414	435	315	191
SW_ORO_TR	66	267	459	662	412	236	270	195	110	158	141	90	93	79	55	8	0
SW_TR	2704	2886	2859	3794	4778	7982	7716	5755	5574	5715	5247	4261	4966	3963	3721	2882	2243
TAS_BGS_TR	208	203	324	477	525	577	614	1158	992	1220	1095	1082	831	446	482	332	318
TAS_E_TR	3479	3464	3692	2712	2958	3623	3776	3718	3395	3400	3584	2846	2981	2424	1955	1268	1364
TAS_ORO_TR	1234	1690	1324	779	1016	694	582	598	1134	692	654	300	247	270	245	68	116
TAS_W_TR	1753	1994	1973	2838	1985	2583	3051	2536	2945	3857	3464	2647	1944	1459	1059	1377	1067
VIT	0	0	0	0	0	0	0	0	488	606	415	174	341	740	424	355	275
unknown	1512	1994	1382	896	1325	8573	8764	4870	1915	1922	1054	1352	1644	1783	1472	213	479

Table 16 - Appendix A: Shows the number of shots allocated per strata for the GENLOG database, after imputing the missing depth values using a decision tree.

Strata	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
BS_IN_TR	1236	1334	702	336	582	4484	4223	2689	728	414	159	166	412	749	608	47	178
ECDW_TR	0	0	0	0	0	1	0	53	62	421	113	169	230	60	1	75	1
EDL_DS	8116	8263	8874	8108	9478	10131	10981	10018	7722	8260	8948	10129	8330	7689	6495	6397	6440
EDL_IN_TR	4039	4680	5064	4987	5425	7292	6512	5754	6301	5247	5417	4890	4853	5631	4605	3190	3224
EDL_OFF_TR	2007	2524	2789	2449	2485	3625	3176	3879	3976	3573	3132	3626	2824	2616	2211	1462	1687
NSW_IN_TR	4590	5355	6610	6583	6594	5356	5280	5718	6456	6408	6179	7513	7892	6173	4881	2837	2983
NSW_OFF_TR	2018	2213	2559	2401	2733	3139	2909	3146	3109	2358	2253	2405	2156	2063	1520	1045	1120
NSW_RRP_TR	420	747	894	1319	1493	1153	1222	1430	1282	1094	1447	648	444	442	327	211	157
SW_BGS_TR	193	279	247	180	381	424	297	479	540	388	353	317	502	414	435	315	191
SW_ORO_TR	66	267	459	662	412	236	270	195	110	158	141	90	93	79	55	8	0
SW_TR	2704	2886	2859	3794	4778	7982	7716	5755	5574	5715	5247	4261	4966	3963	3721	2882	2243
TAS_BGS_TR	208	203	324	477	525	577	614	1158	992	1220	1095	1082	831	446	482	332	318
TAS_E_TR	3479	3464	3692	2712	2958	3623	3776	3718	3395	3400	3584	2846	2981	2424	1955	1268	1364
TAS_ORO_TR	1234	1690	1324	779	1016	694	582	598	1134	692	654	300	247	270	245	68	116
TAS_W_TR	1753	1994	1973	2838	1985	2583	3051	2536	2945	3857	3464	2647	1944	1459	1059	1377	1067
VIT	0	0	0	0	0	0	0	0	488	606	415	174	341	740	424	355	275
unknown	276	660	680	560	743	4089	4541	2181	1187	1508	895	1186	1232	1034	864	166	301

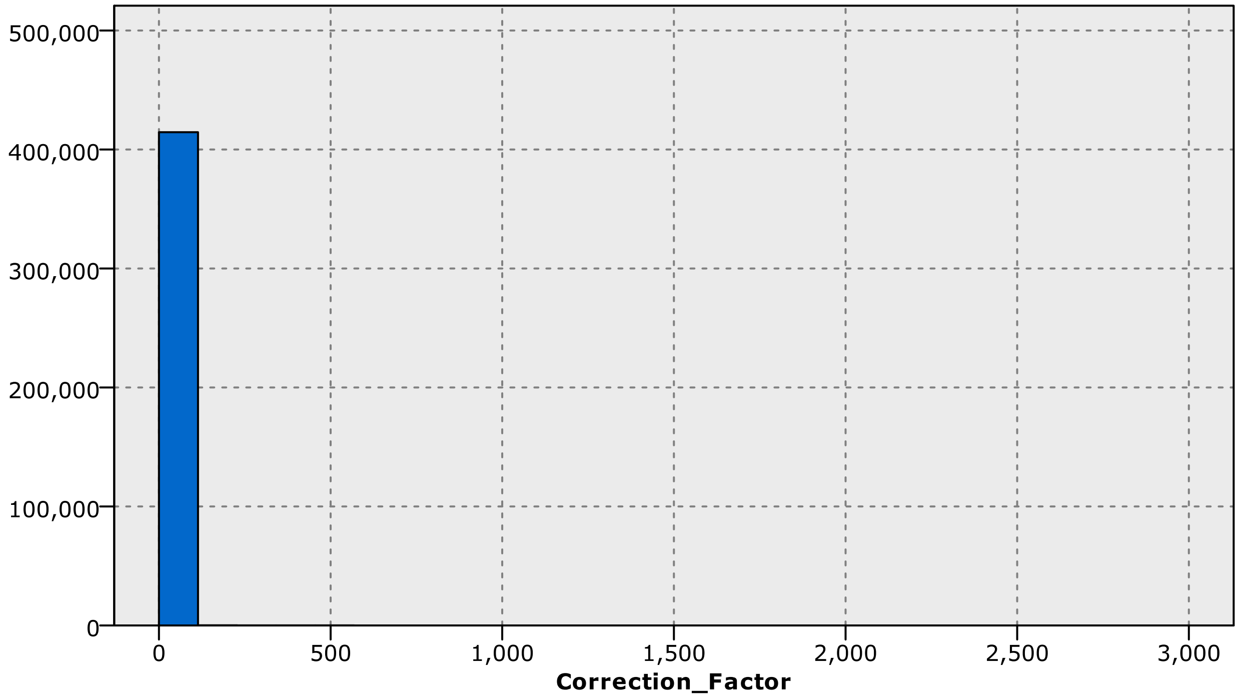

Figure 1 - Appendix A: Histogram of the distribution of computed GENLOG catch weight correction factors illustrating the unreasonably large correction values discussed in the text.

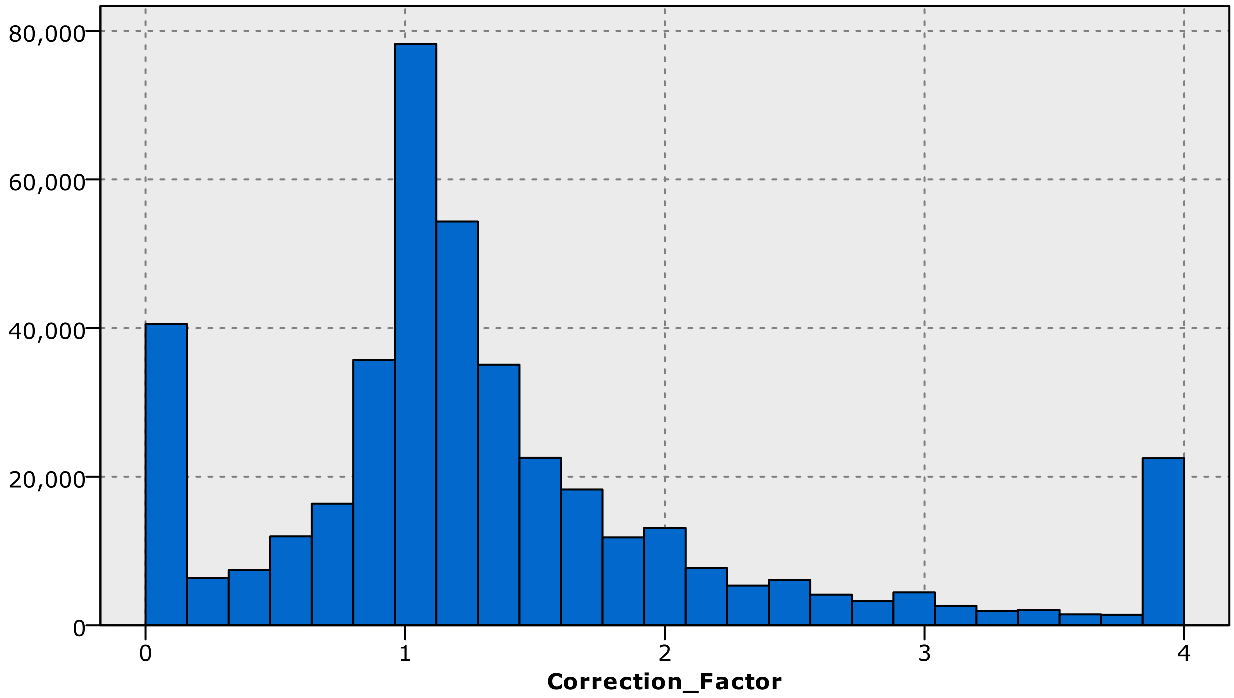

Figure 2 - Appendix A: Histogram of the distribution of computer GENLOG catch weight correction factors, limiting the factor to a maximum of 4.

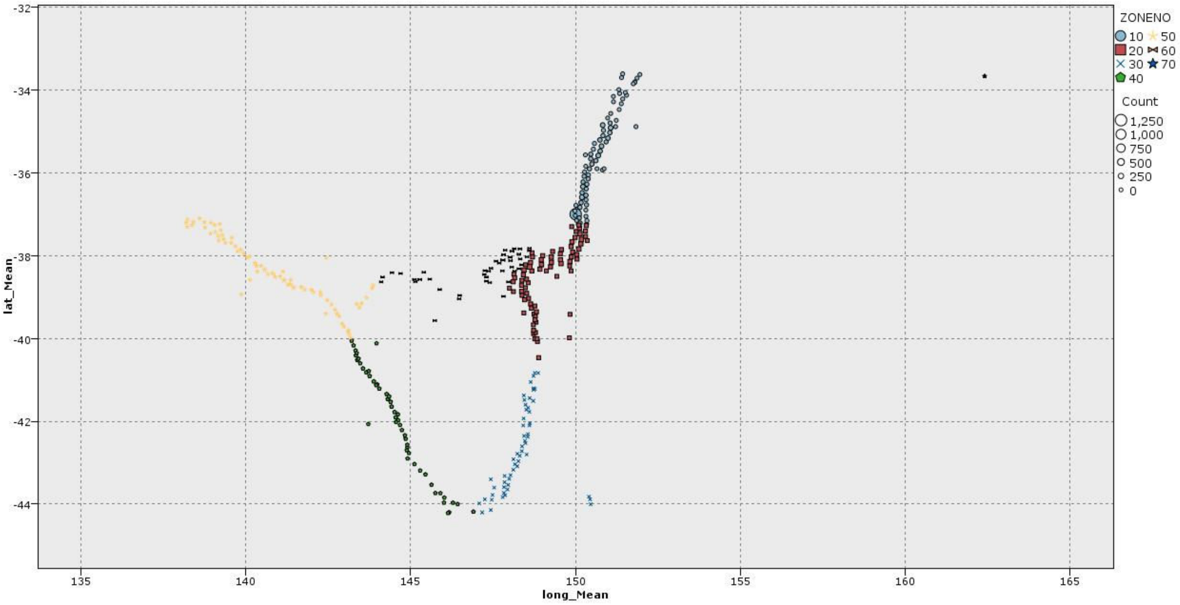

Figure 3 - Appendix A: A plot of the locations of the SEF ISMP shots, for shots that fall into zones 10, 20, 30, 40, 50, 60 and 70.

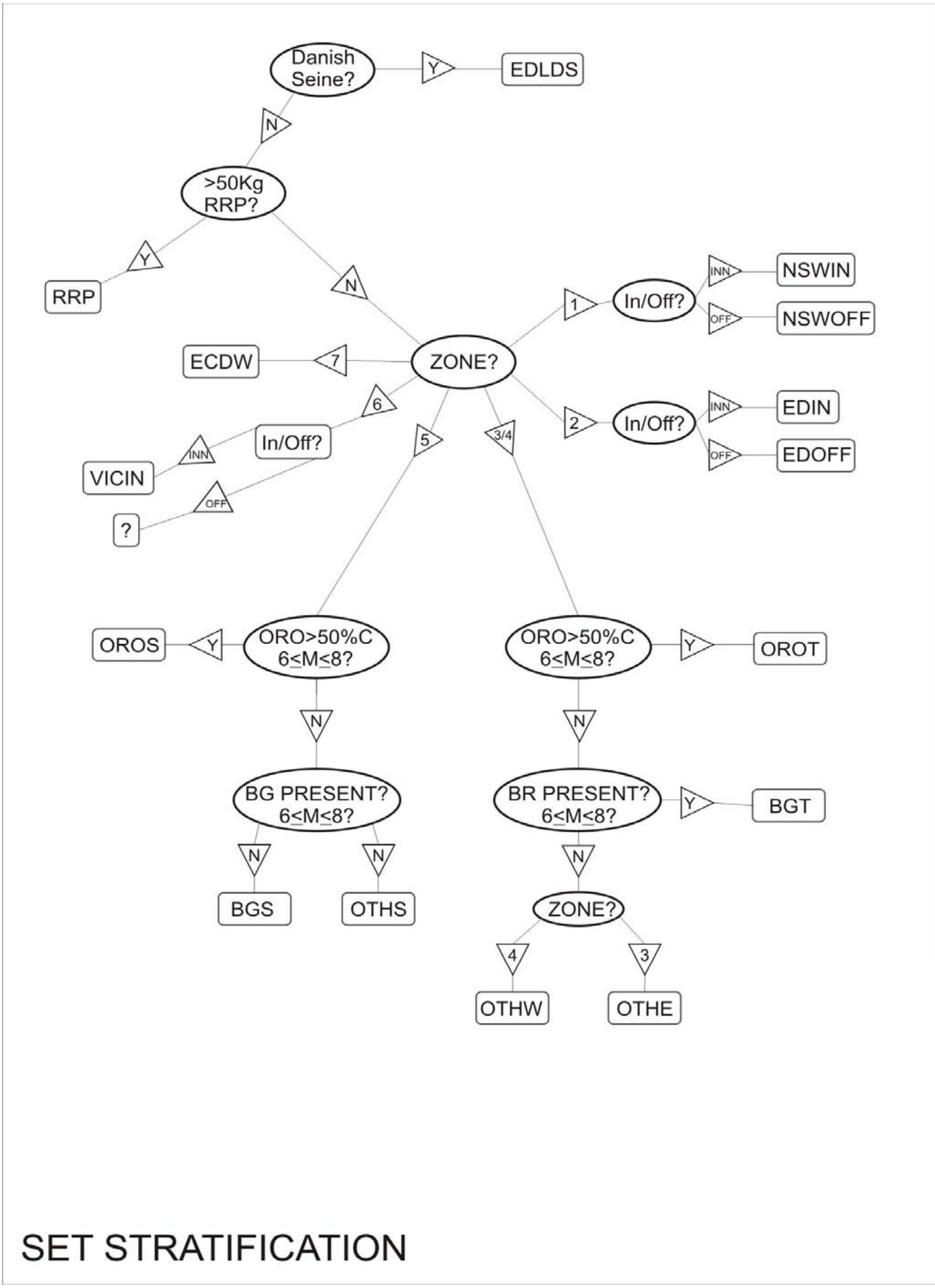

Figure 4 - Appendix A: Graphical representation of existing ISMP Strata rule definitions for the SET Fishery.

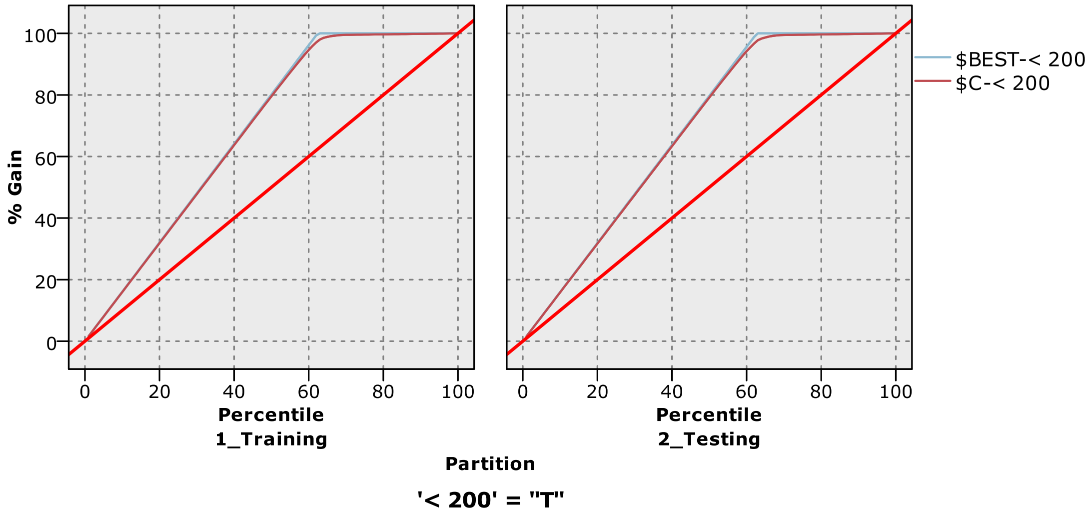

Figure 5 - Appendix A: “Gains” plot, panelled by the dataset partition of the decision tree’s accuracy at imputing the depth category for shots with a depth greater than 200m.

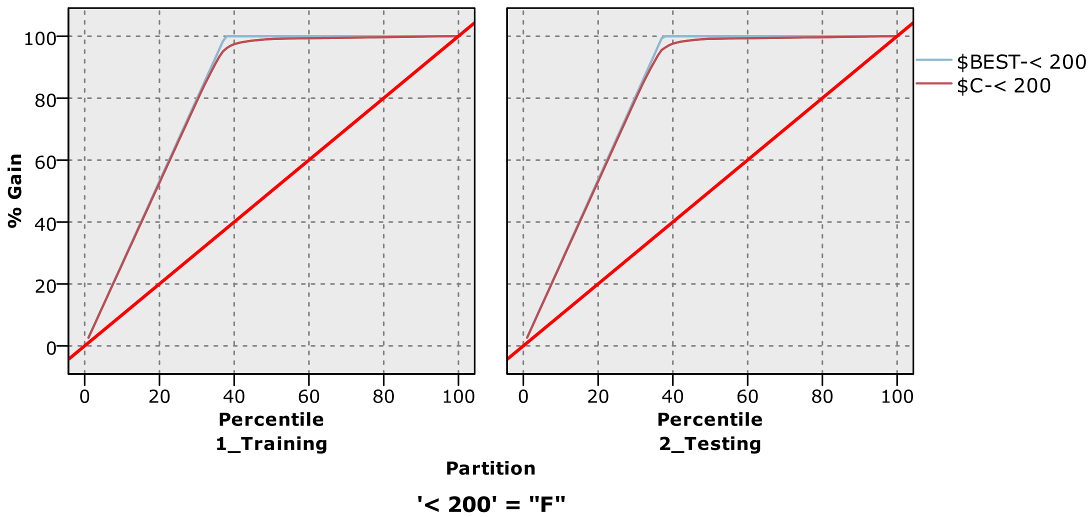

Figure 6 - Appendix A: “Gains” plot, panelled by the dataset partition of the decision tree’s accuracy at imputing the depth category for shots with a depth less than 200m.

Appendix B - Cluster Analysis Results

Appendix B - Cluster Analysis Results for GABTF

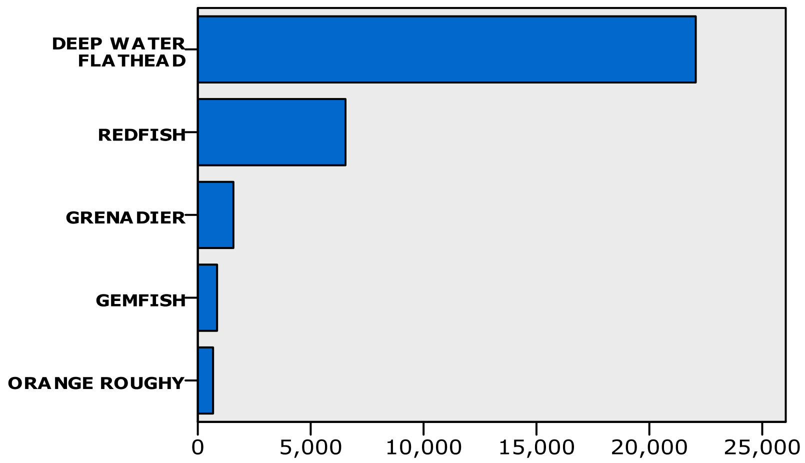

Figure 1 - Appendix B: GAB Fishery, Cluster sizes.

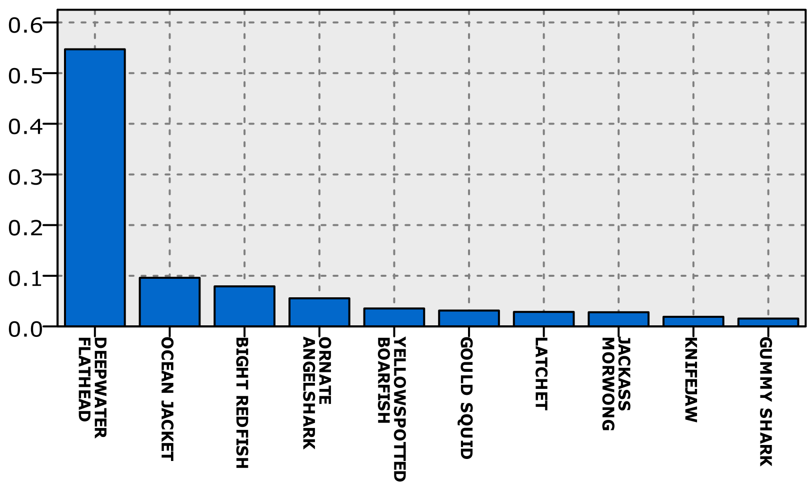

Figure 2 - Appendix B: GAB Fishery Deepwater Flathead Cluster species composition.

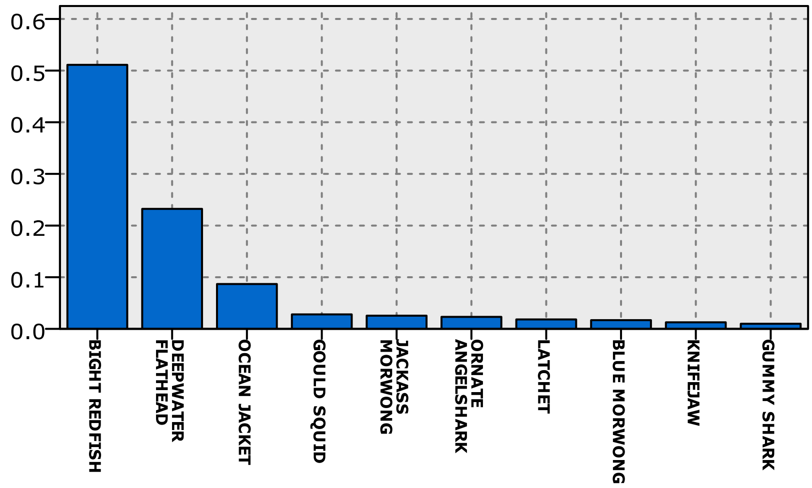

Figure 3 - Appendix B: GAB Fishery Redfish Cluster species composition.

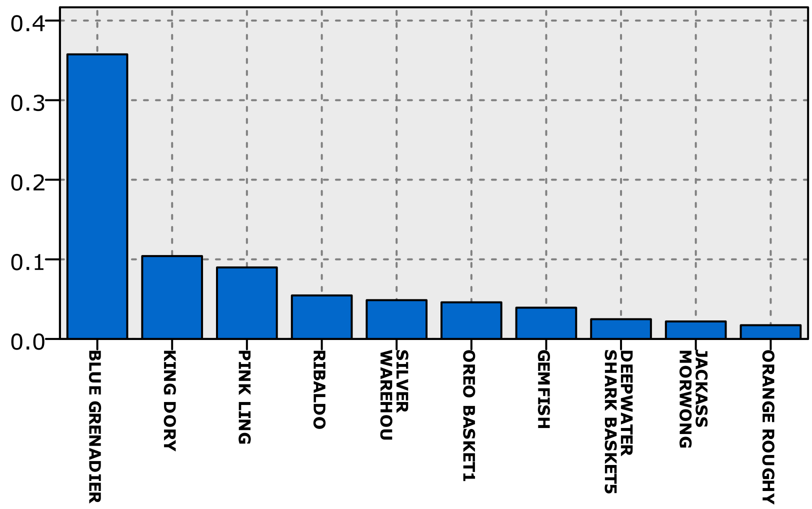

Figure 4 - Appendix B: GAB Fishery Grenadier Cluster species composition.

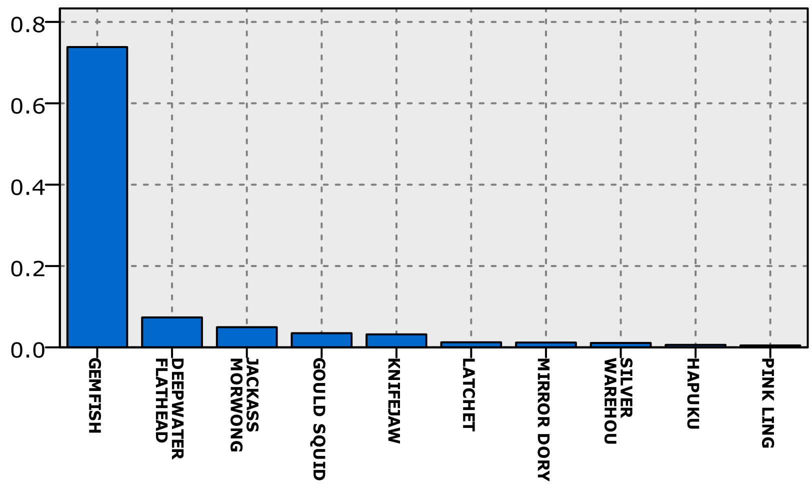

Figure 5 - Appendix B: GAB Fishery Gemfish Cluster species composition.

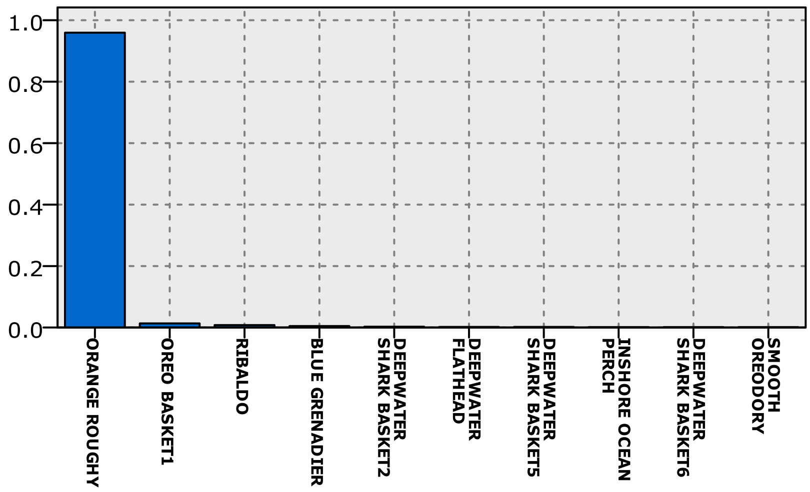

Figure 6 - Appendix B: GAB Fishery Orange Roughy Cluster species composition.

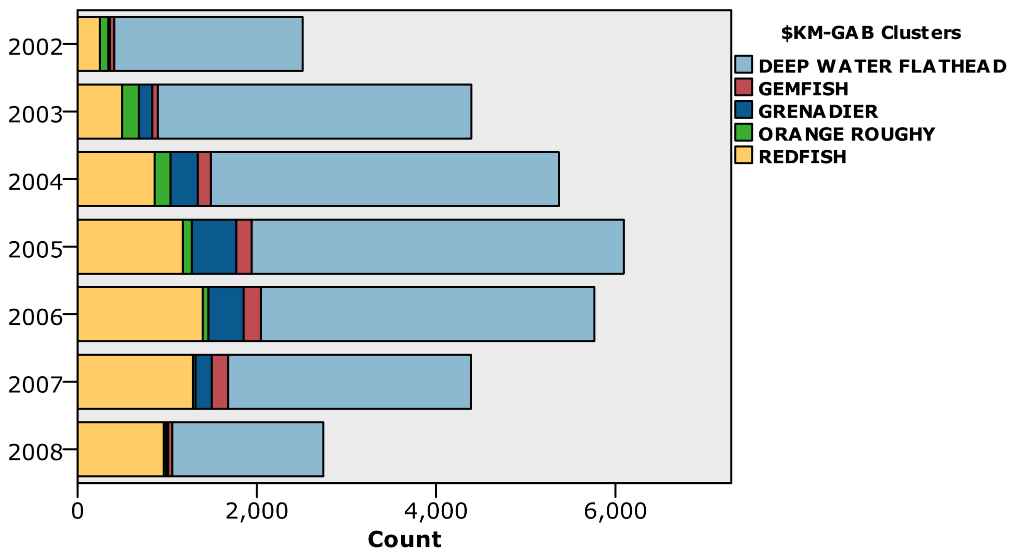

Figure 7 - Appendix B: GAB Clusters By Year.

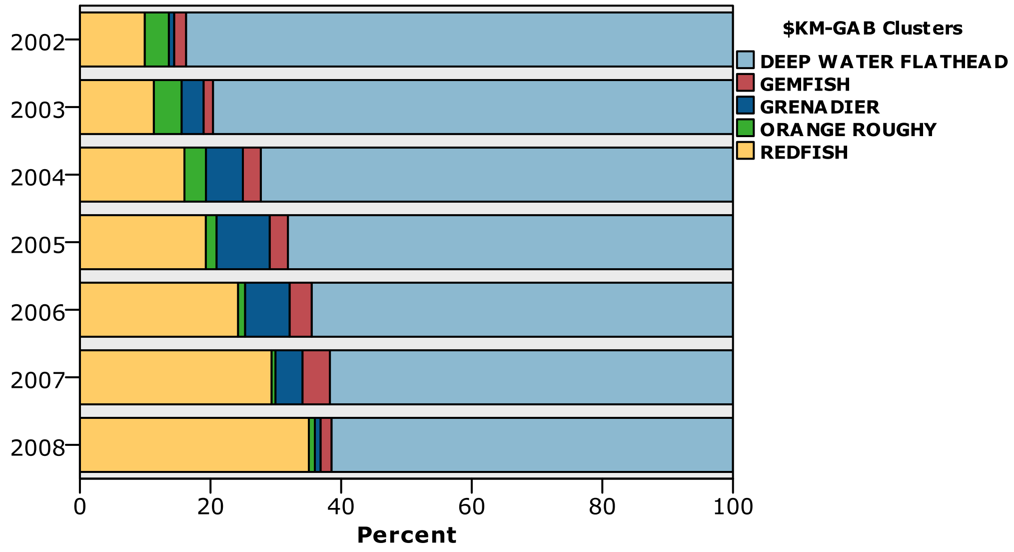

Figure 8 - Appendix B: GAB Clusters By Year Normalised.

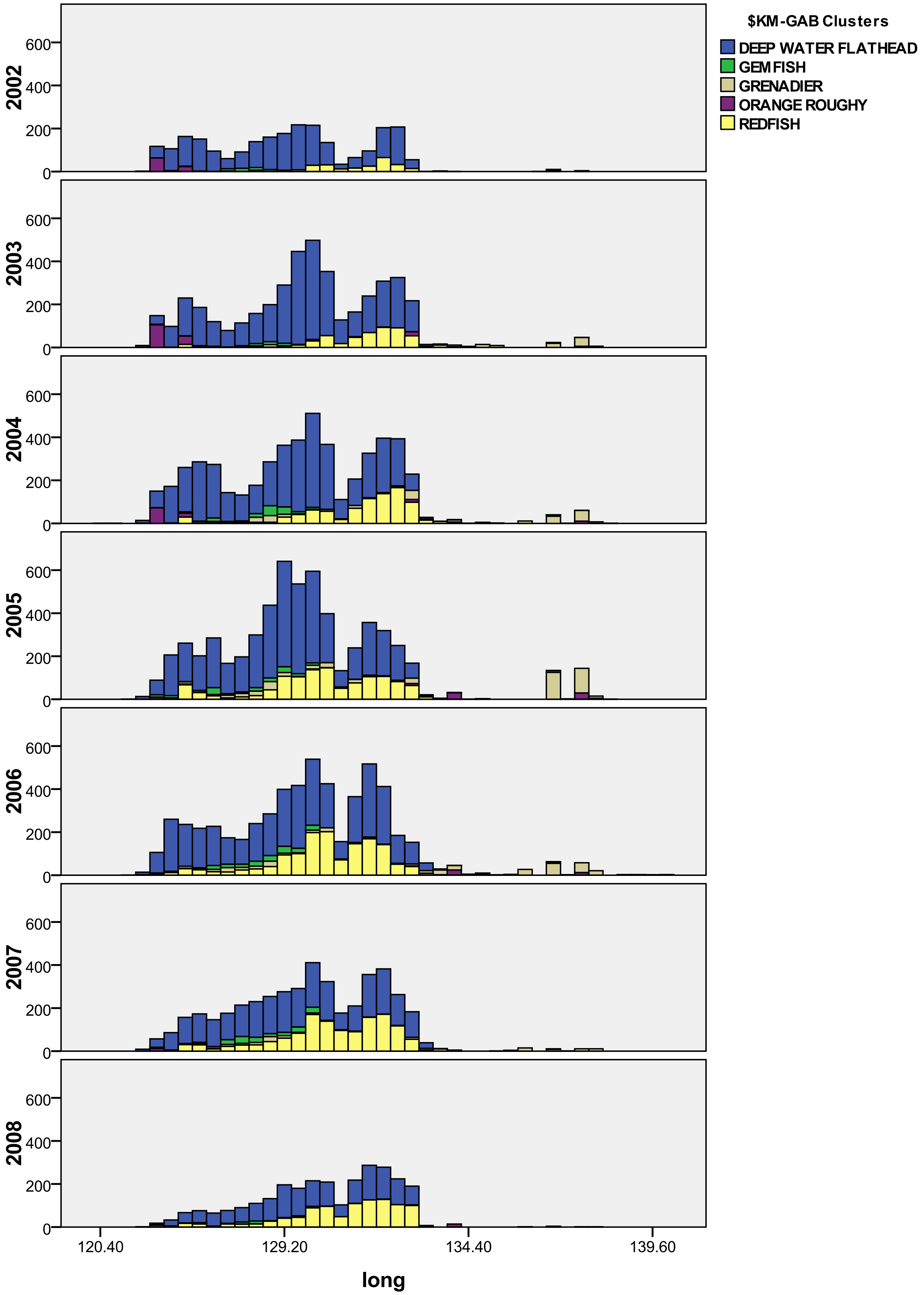

Figure 9 - Appendix B: GAB Clusters, Longitude, Cluster, Year.

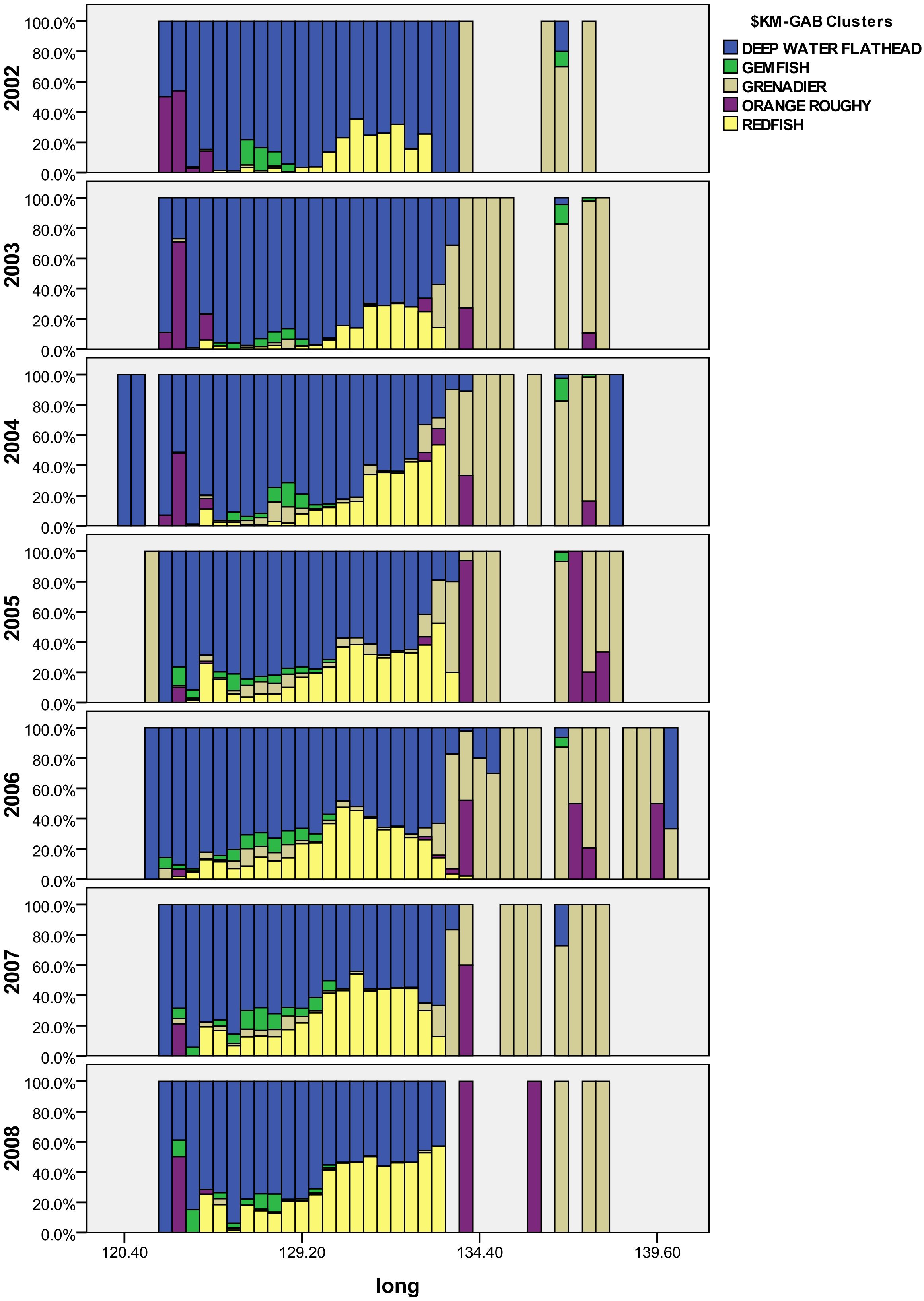

Figure 10 - Appendix B: GAB Clusters, Longitude, Cluster, Year (Normalised).

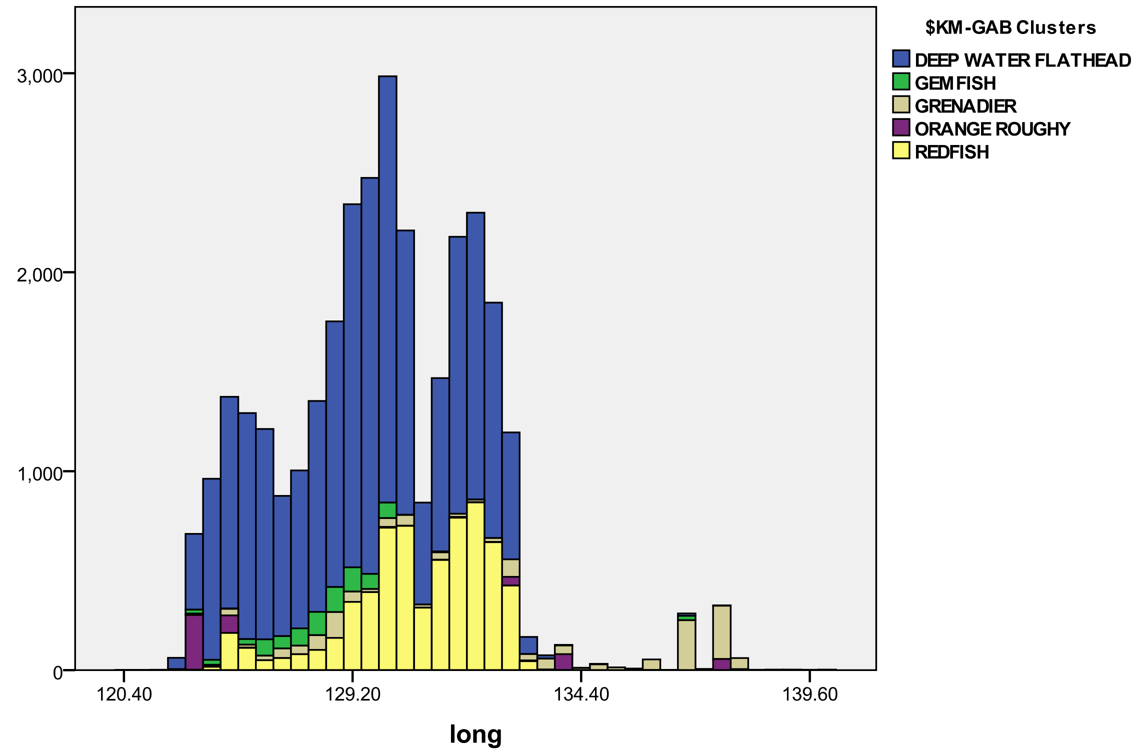

Figure 11 - Appendix B: GAB Clusters By Longitude.

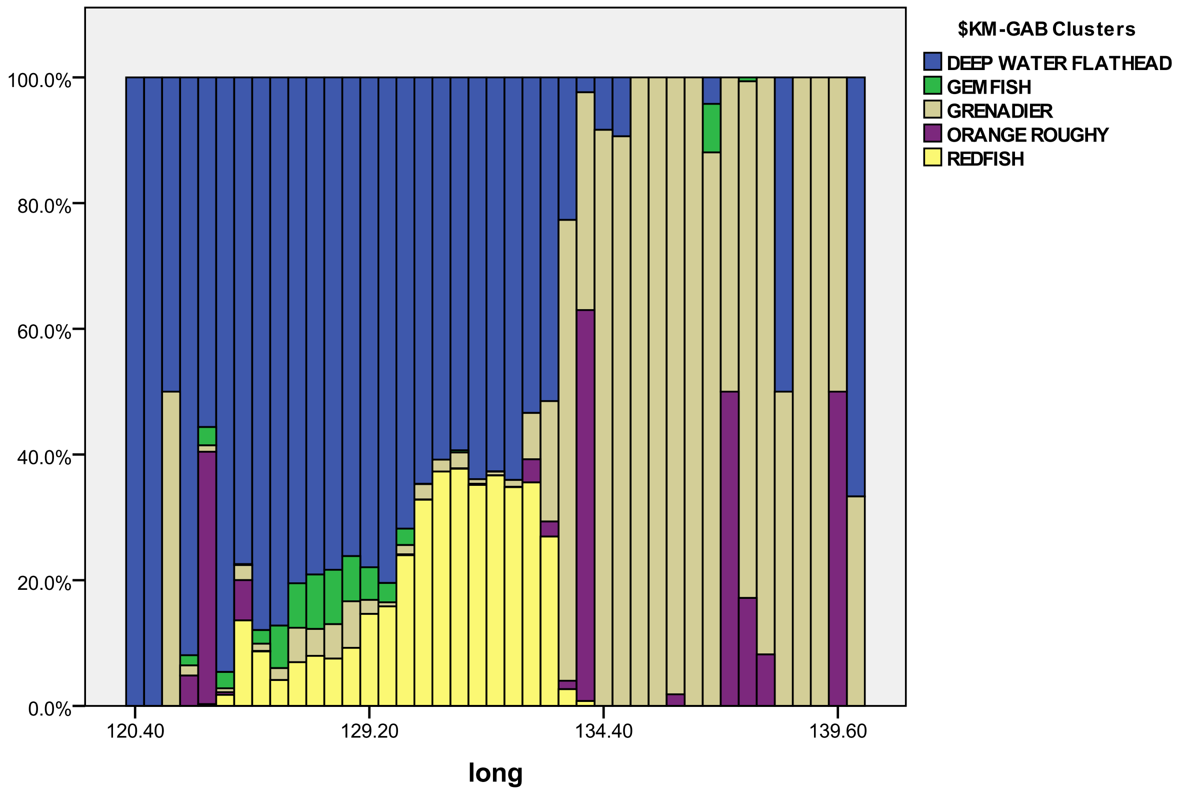

Figure 12 - Appendix B: GAB Clusters By Longitude (Normalised).

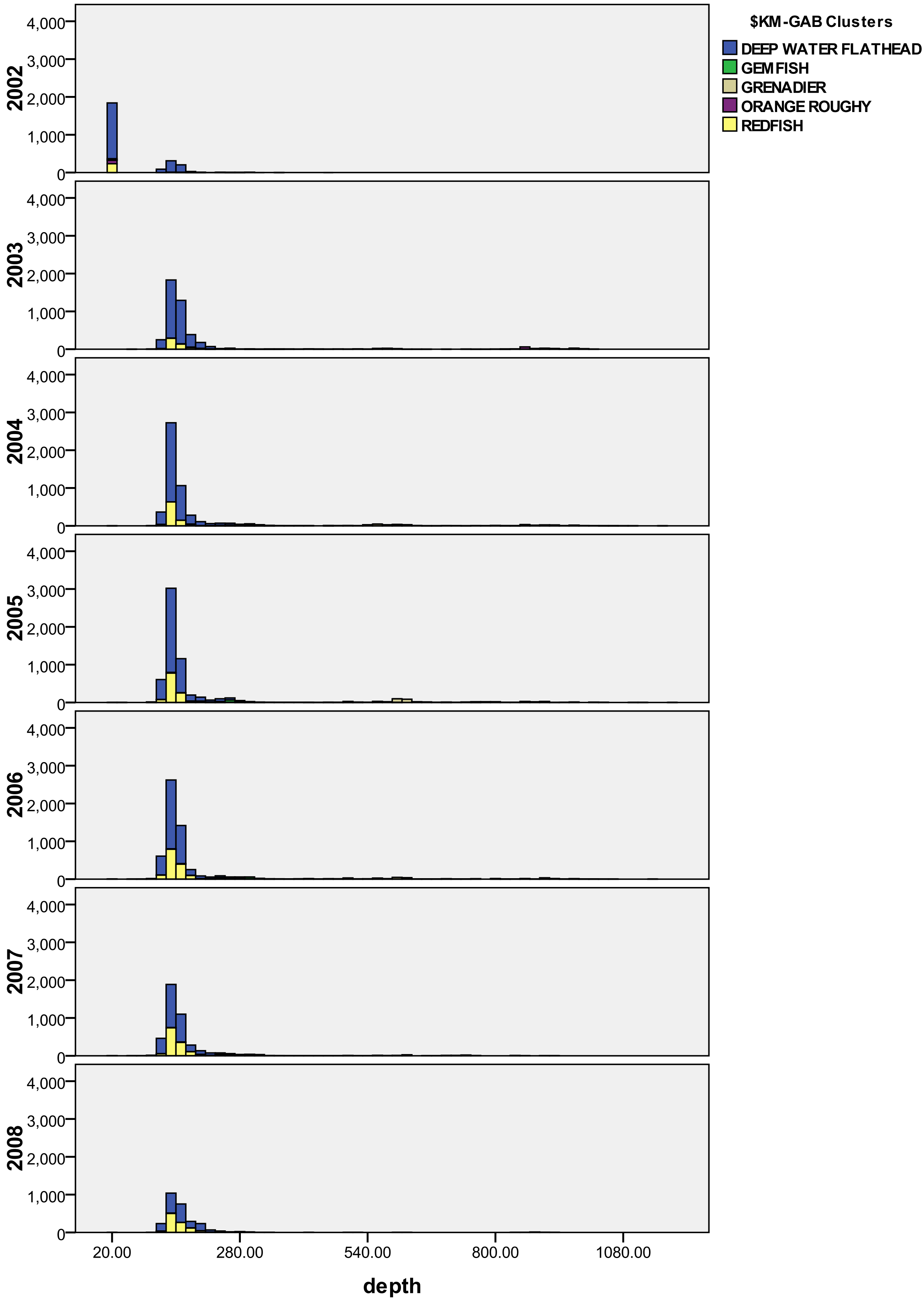

Figure 13 - Appendix B: GAB Clusters by Depth, Panelled By Year.

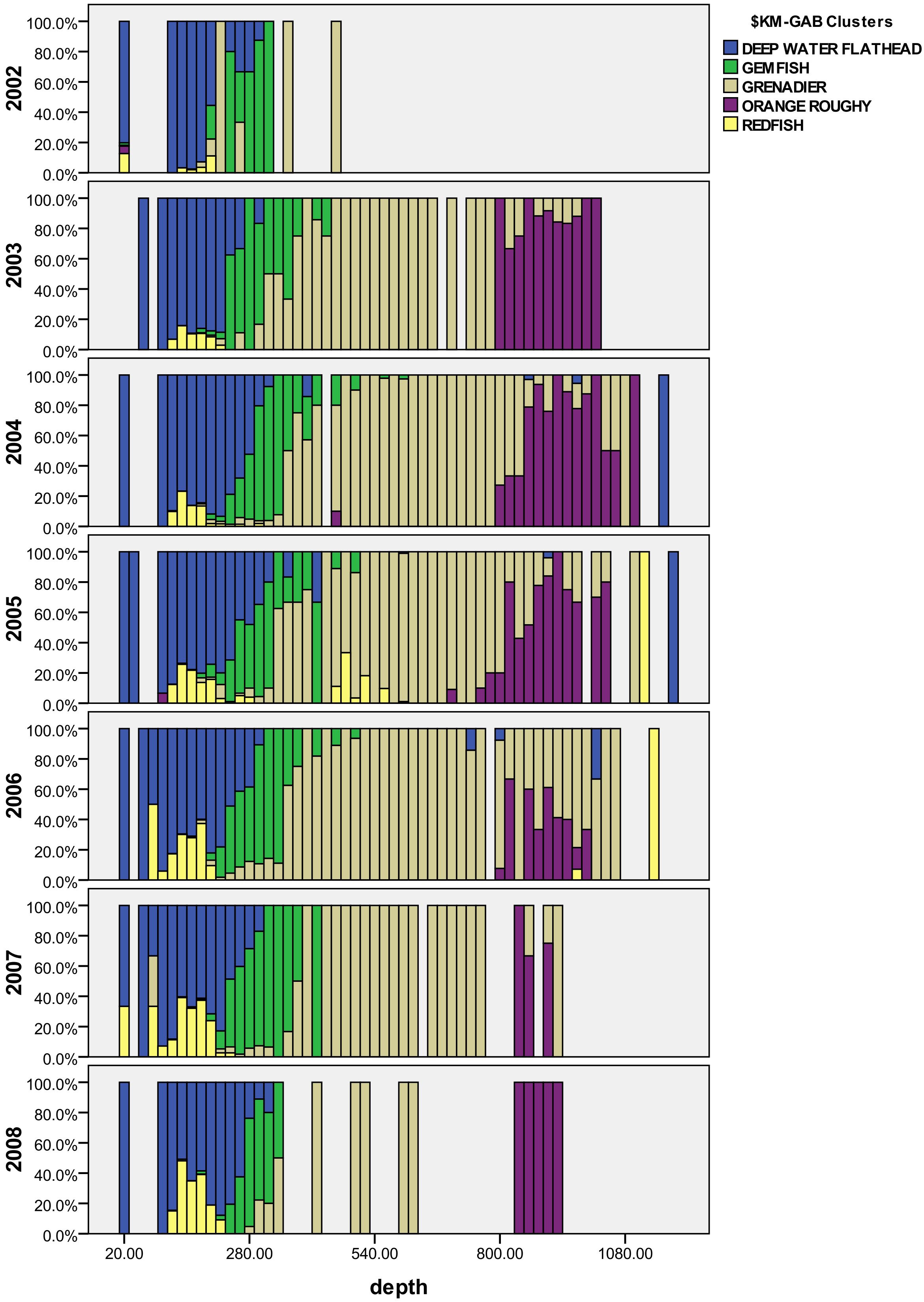

Figure 14 - Appendix B: GAB Clusters By Depth, Panelled By Year - Normalised.

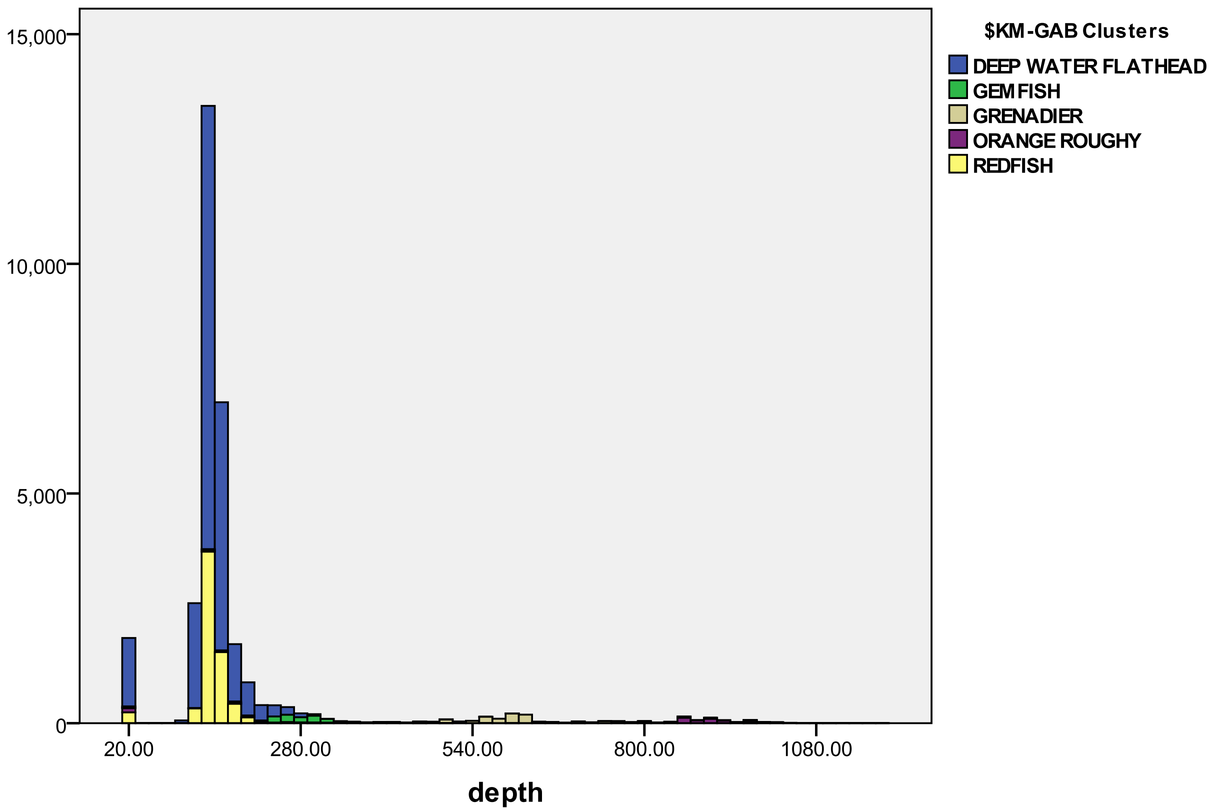

Figure 15 - Appendix B: GAB Clusters By Depth.

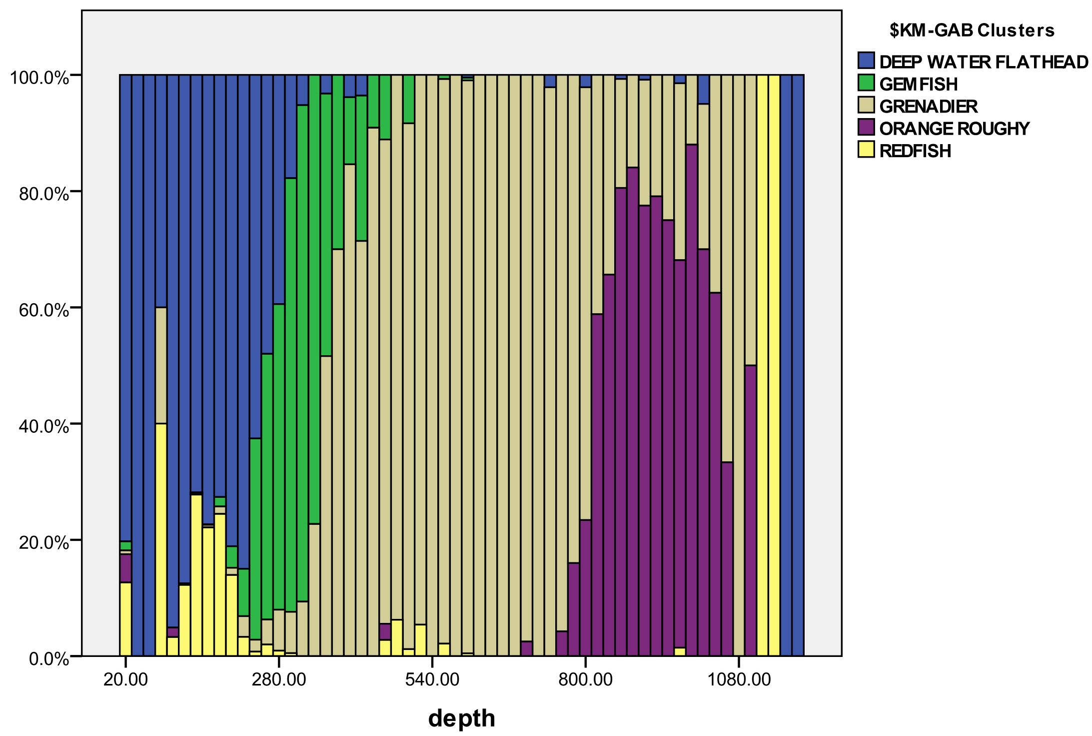

Figure 16 - Appendix B. GAB Clusters By Depth, Normalised.

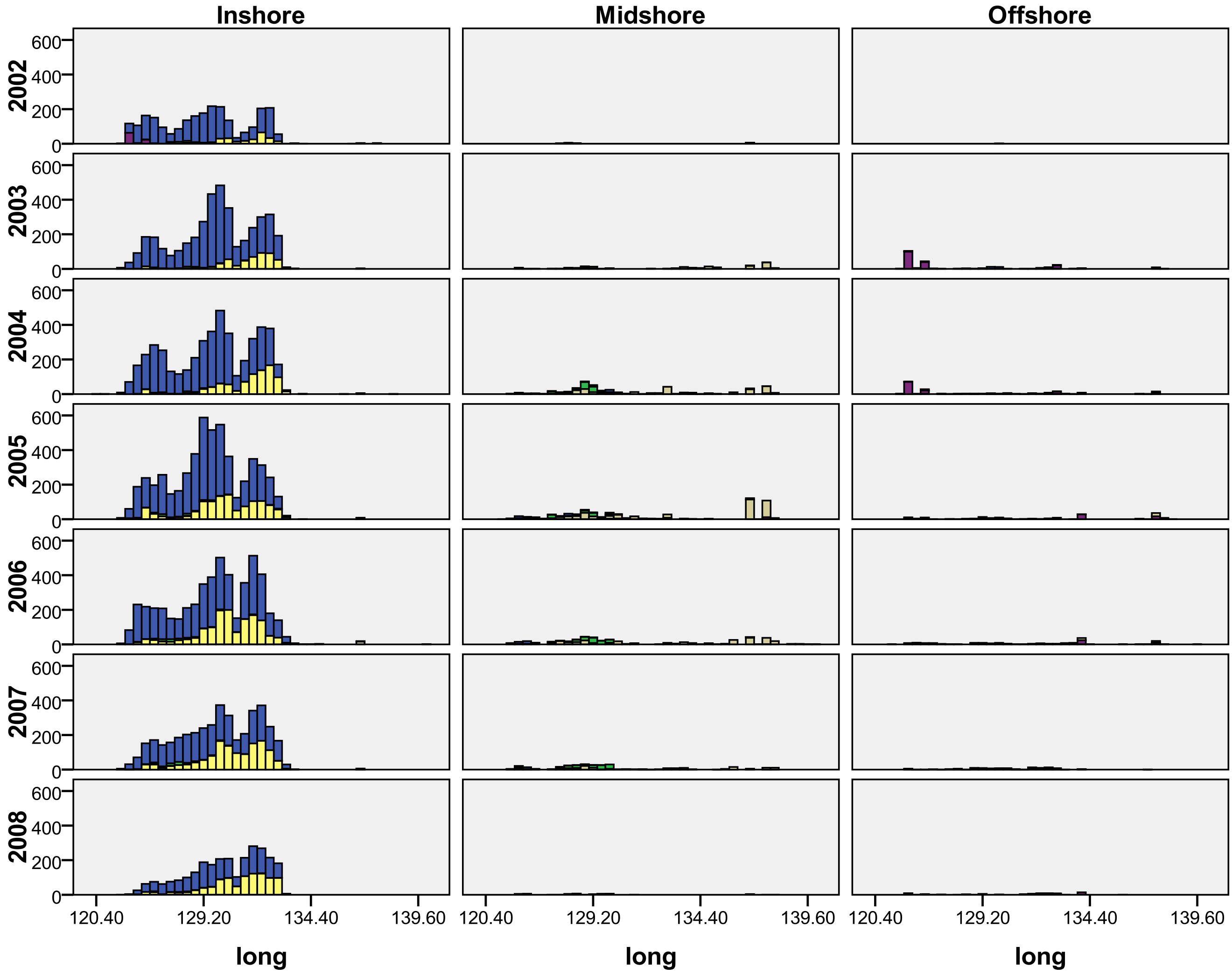

Figure 17 - Appendix B: GAB Clusters by Year, Depth and Longitude.

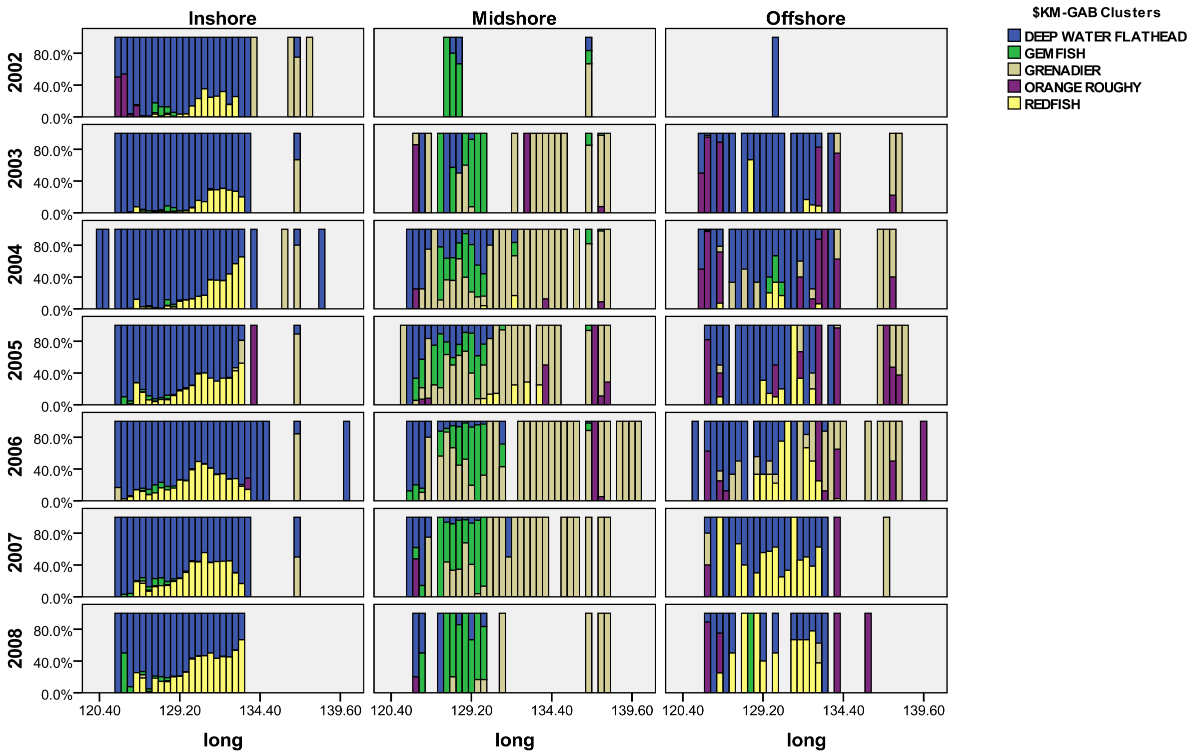

Figure 18 - Appendix B: GAB Clusters by Year, Depth Category and Longitude, Normalised.

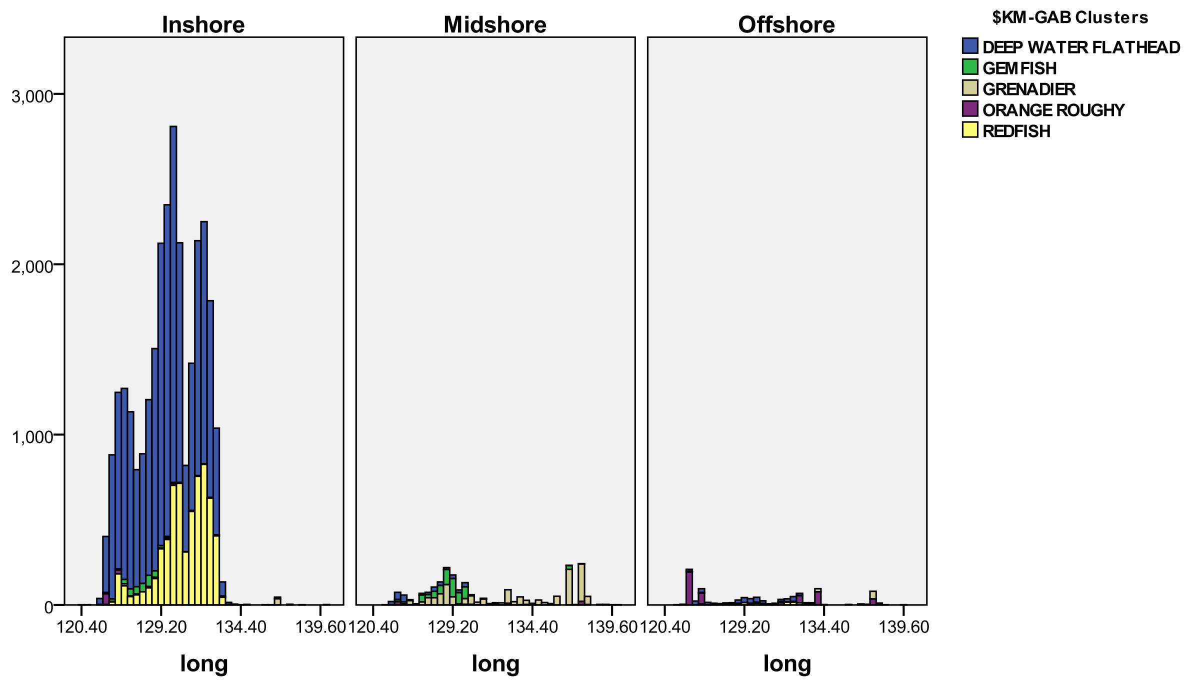

Figure 19 - Appendix B: GAB Clusters by Depth Category and Longitude.

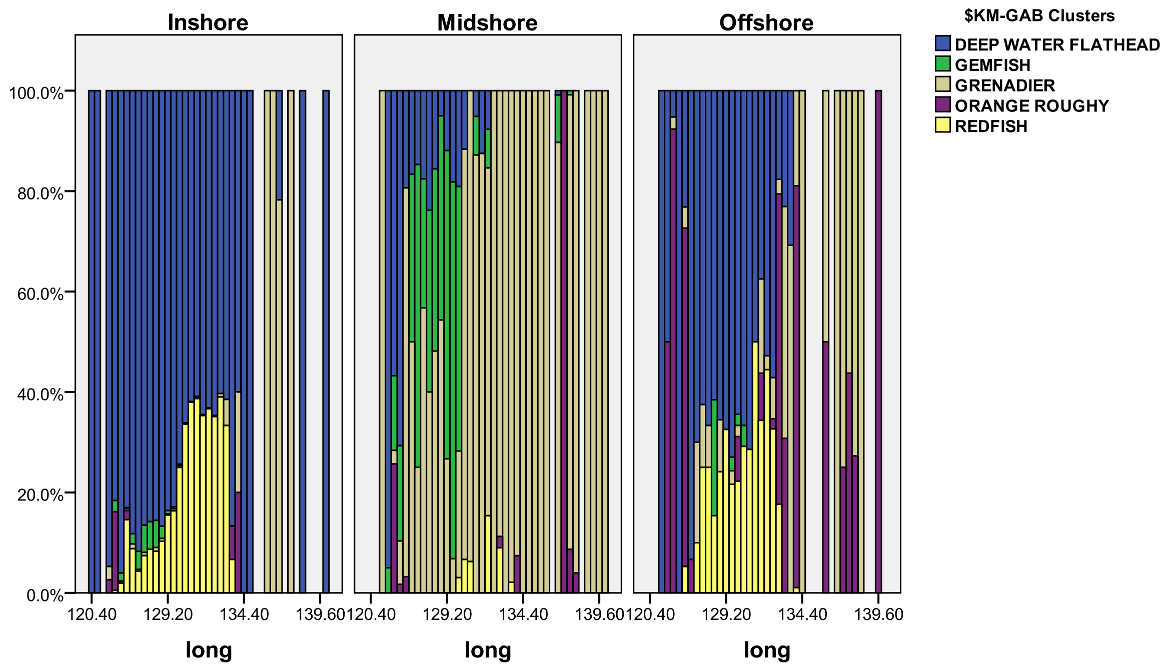

Figure 20 - Appendix B: GAB Clusters by Depth Category and Longitude, Normalised.

Appendix B - Cluster Analysis Results for GHAT (AL & BL)

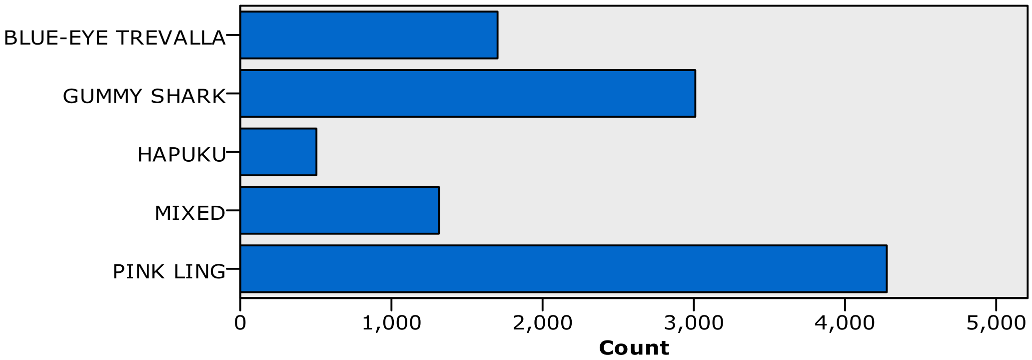

Figure 21 - Appendix B: GHaT (AL & BL) Cluster Sizes

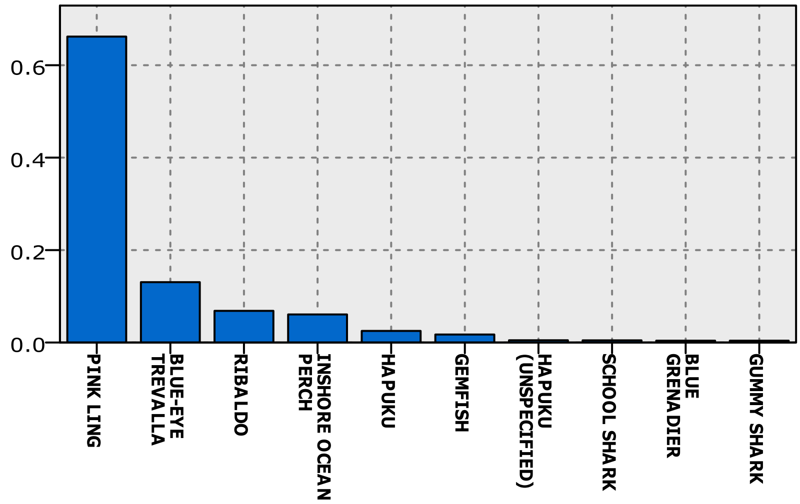

Figure 22 - Appendix B: GHaT (AL & BL) Pink Ling Cluster Species Composition.

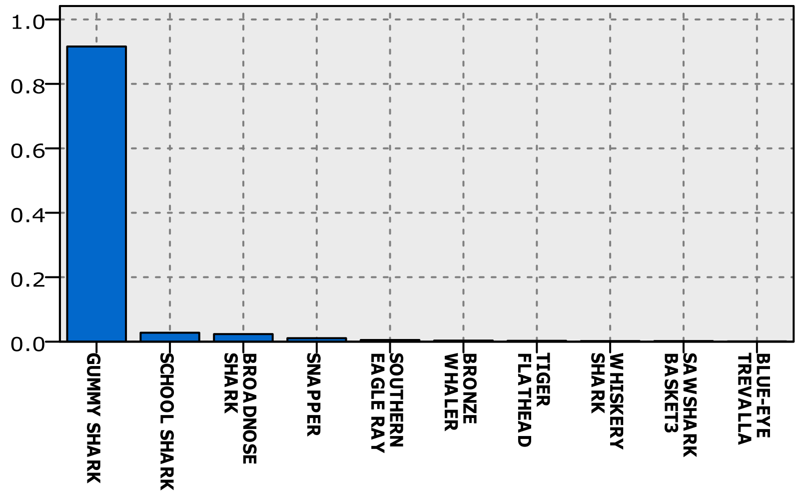

Figure 23 - Appendix B: GHaT (AL & BL) Gummy Shark Cluster Species Composition.

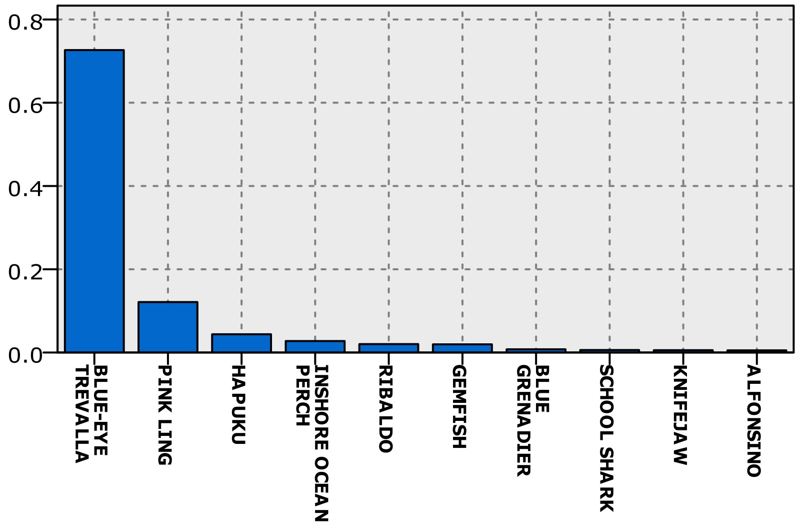

Figure 24 - Appendix B: GHaT (AL & BL) Blue-Eye Trevalla Cluster Species Composition.

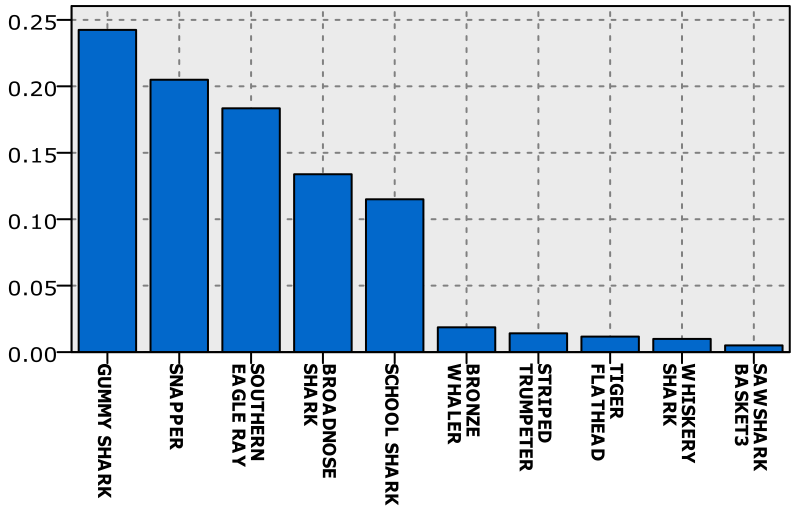

Figure 25 - Appendix B: GHaT (AL & BL) Mixed Cluster Species Composition.

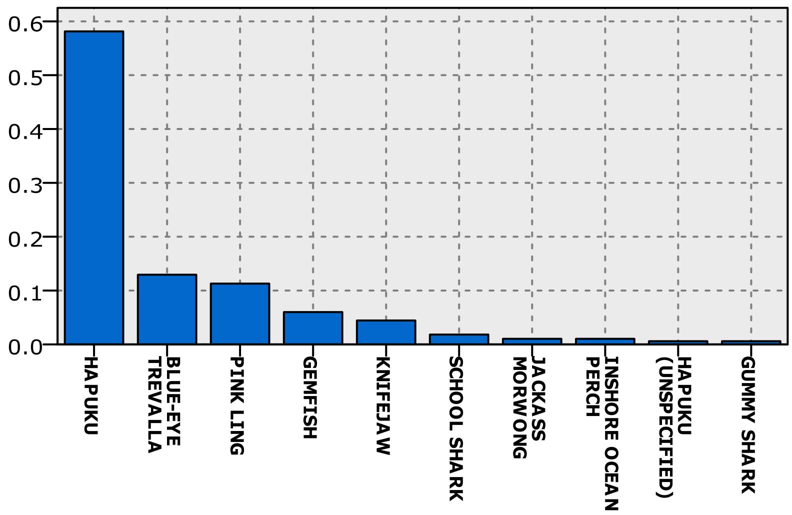

Figure 26 - Appendix B: GHaT (AL & BL) Hapuku Cluster Species Composition.

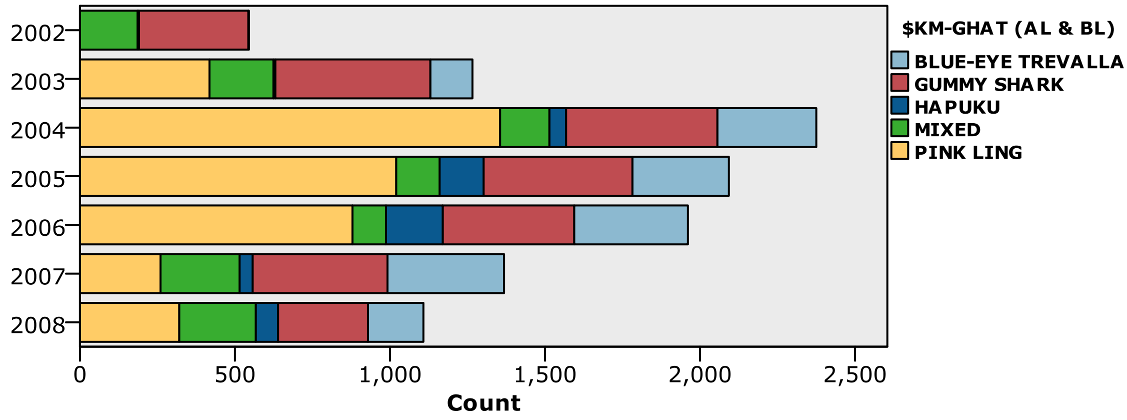

Figure 27 - Appendix B: GHaT (AL & BL) Clusters By Year.

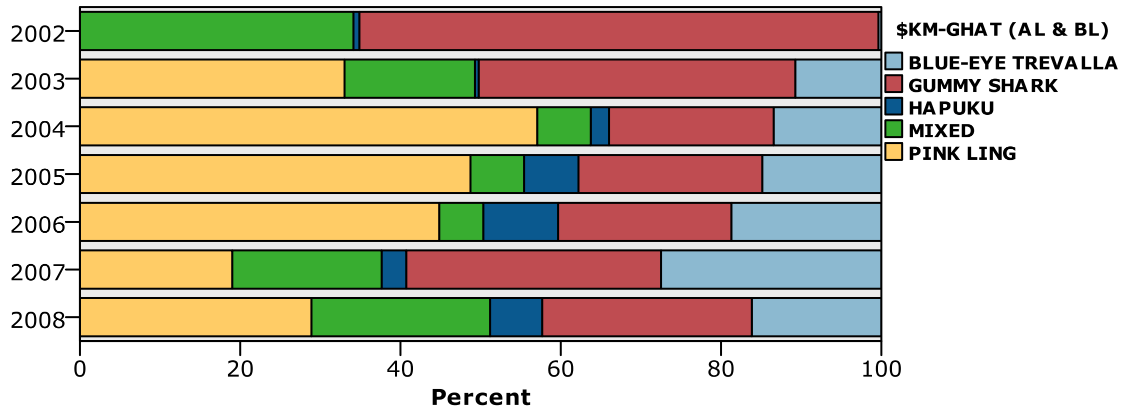

Figure 28 - Appendix B: GHaT (AL & BL) Clusters By Year Normalised.

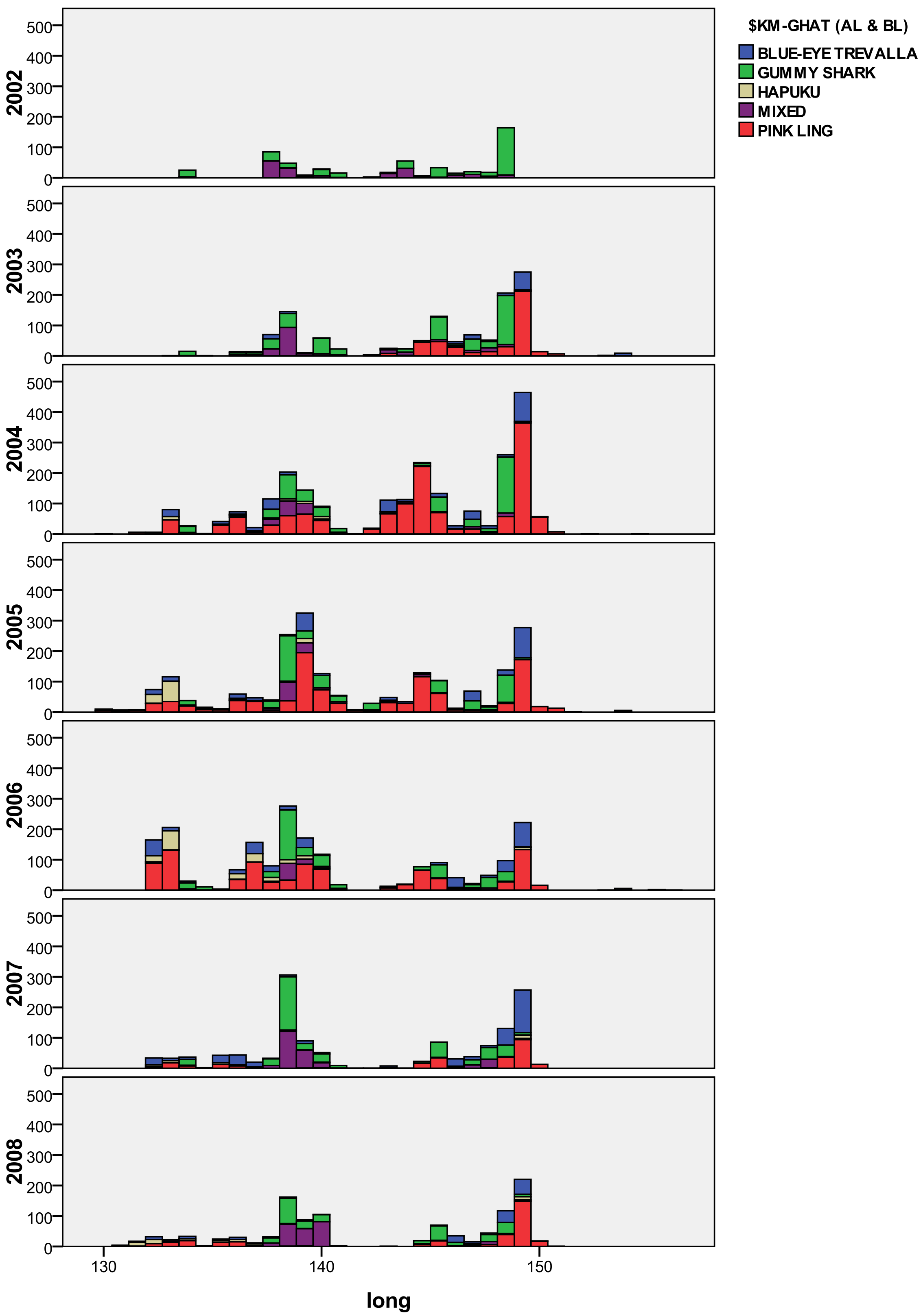

Figure 29 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Year.

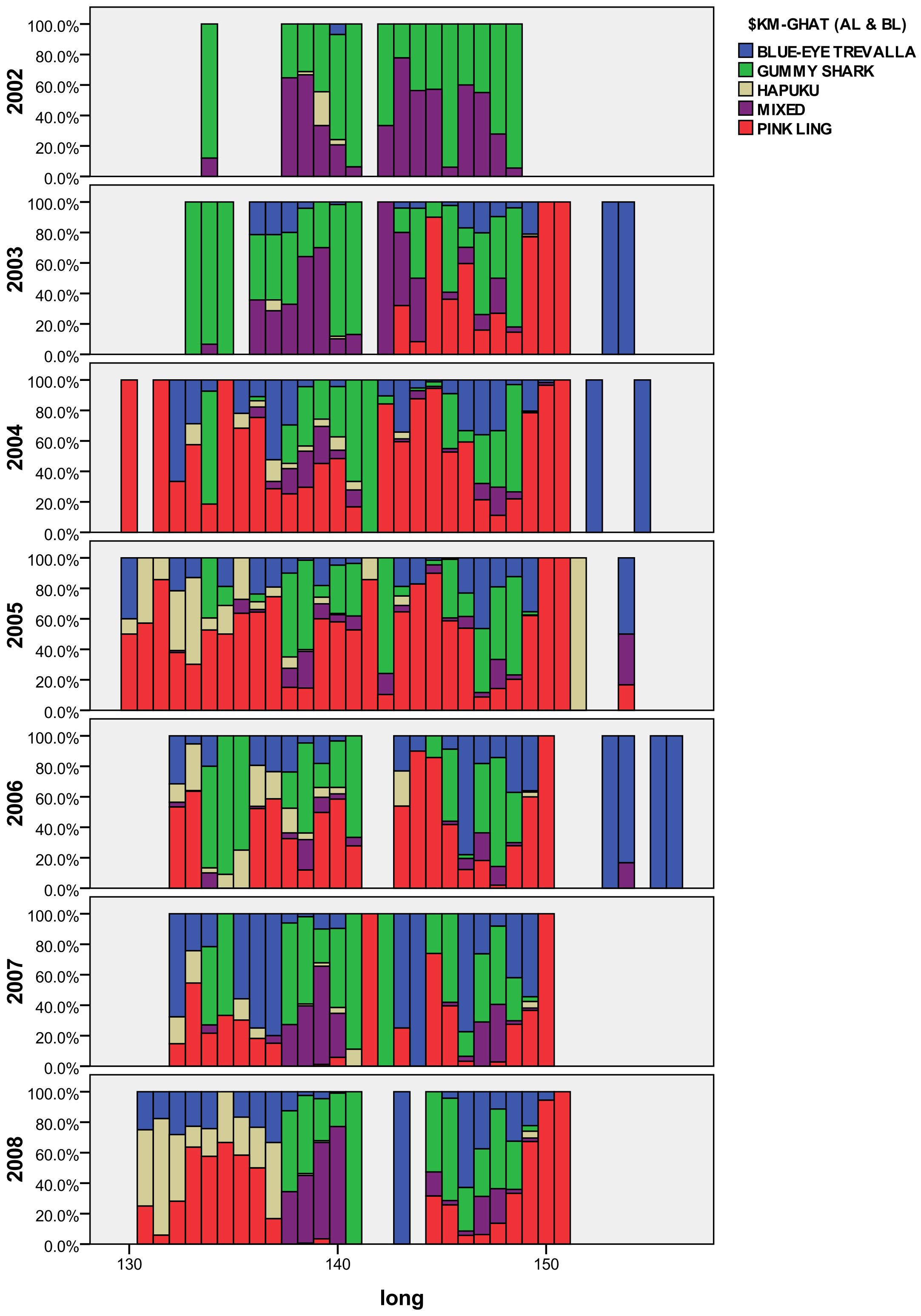

Figure 30 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Year: Normalised.

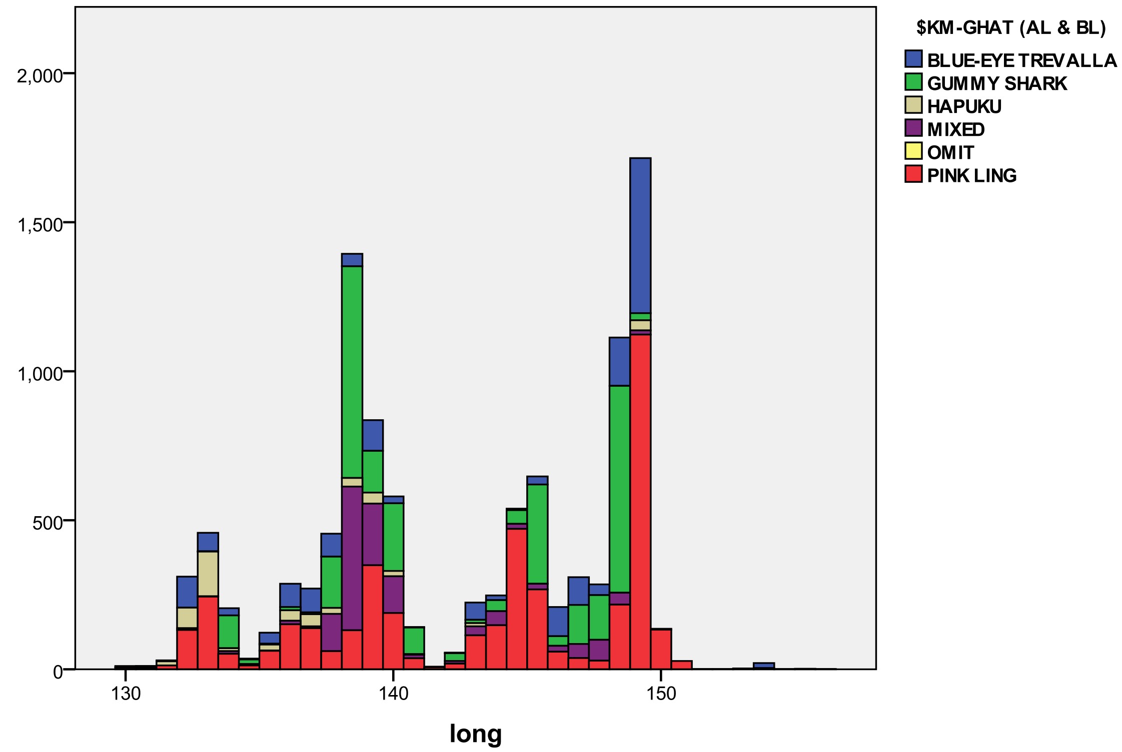

Figure 31 - Appendix B: GHaT (AL & BL) Longitude.

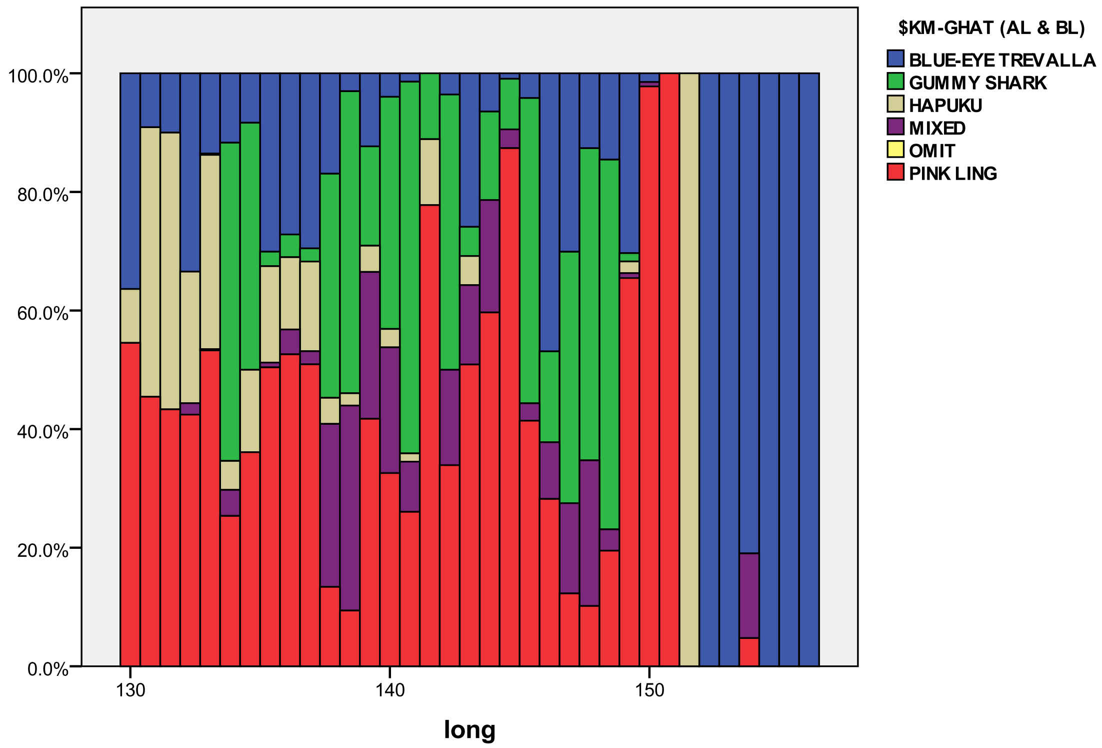

Figure 32 - Appendix B: GHaT (AL & BL) Longitude, Cluster (Normalised).

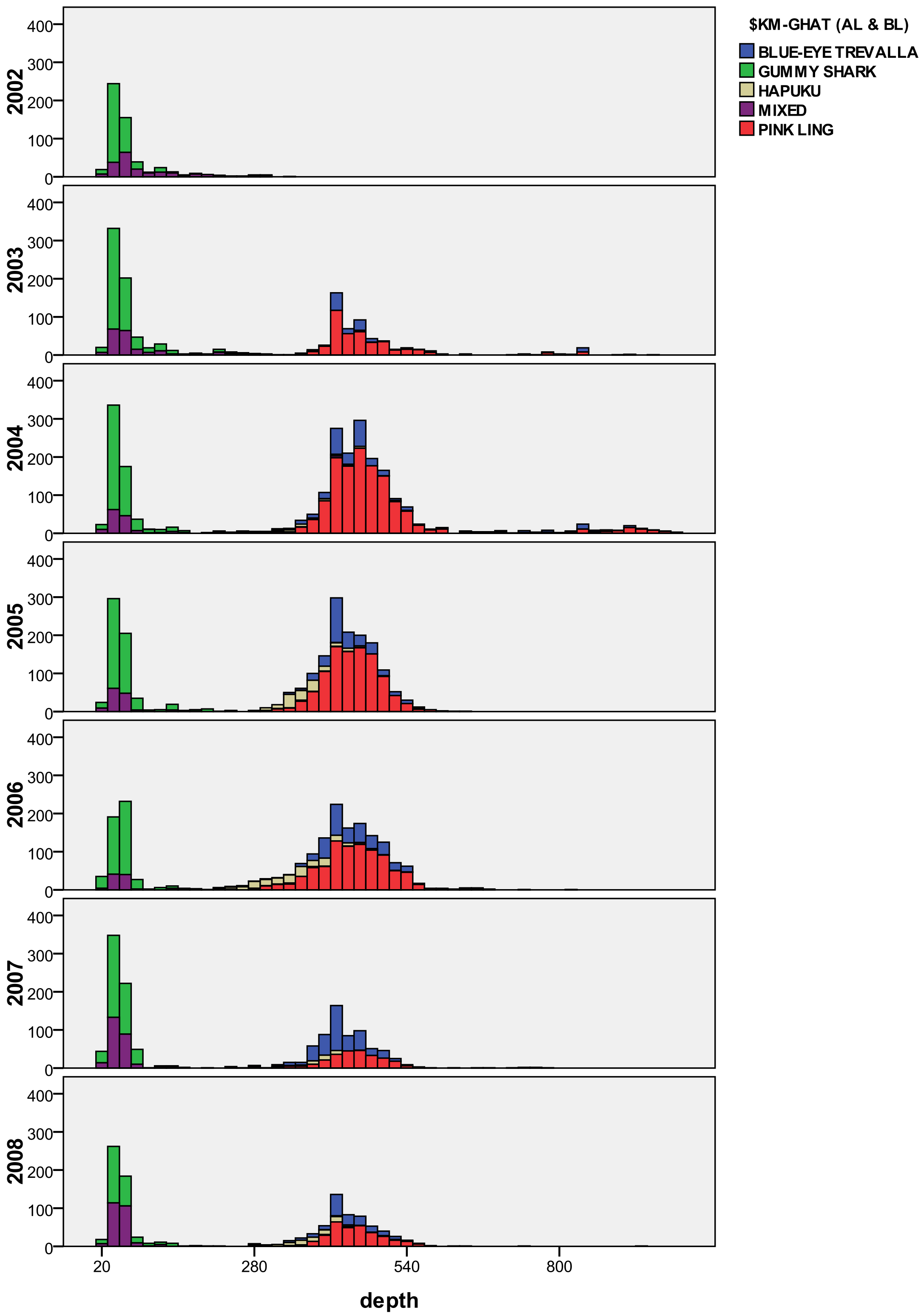

Figure 33 - Appendix B: GHaT (AL & BL) Depth, Cluster, Year.

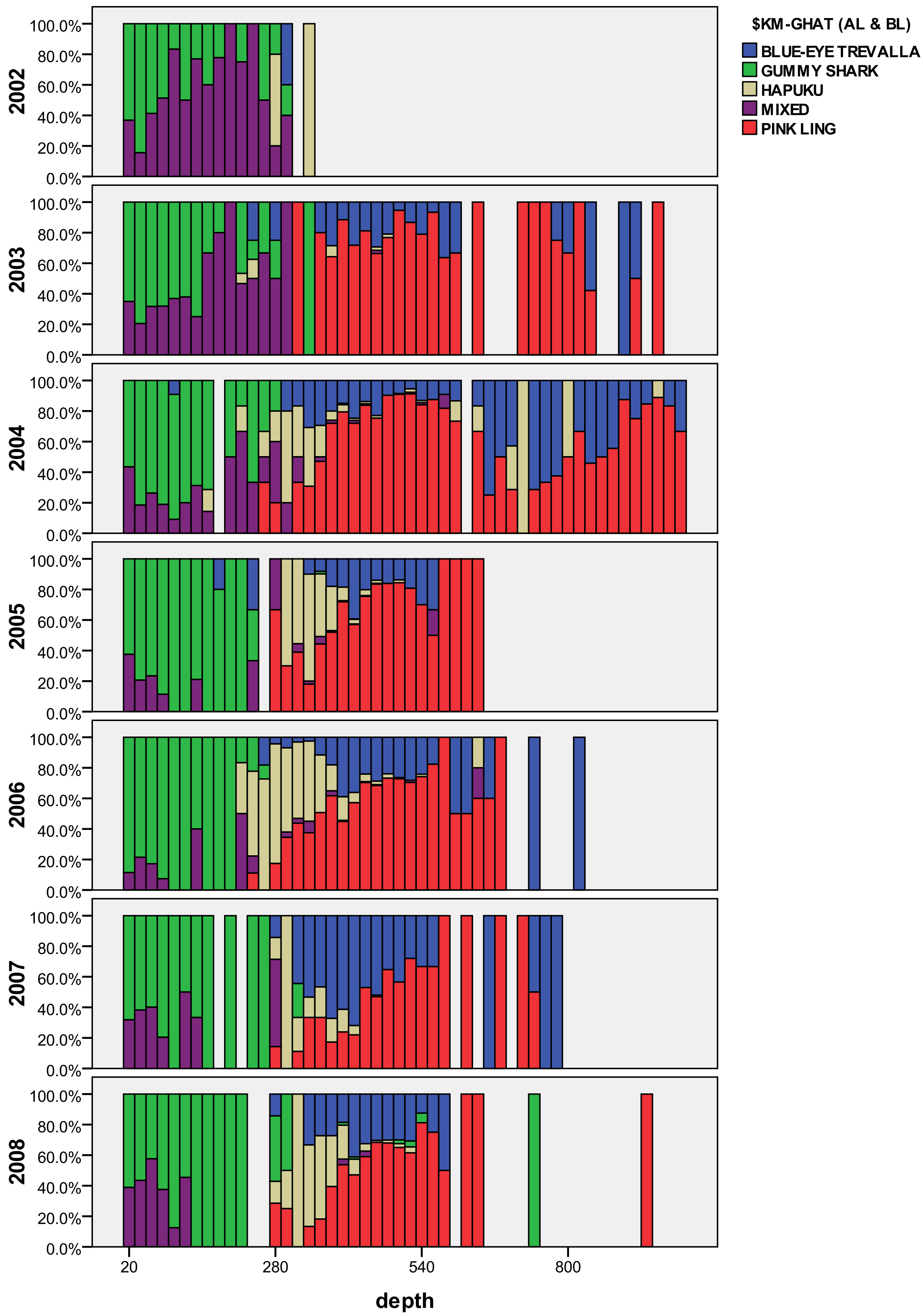

Figure 34 - Appendix B: GHaT (AL & BL) Depth, Cluster, Year: Normalised.

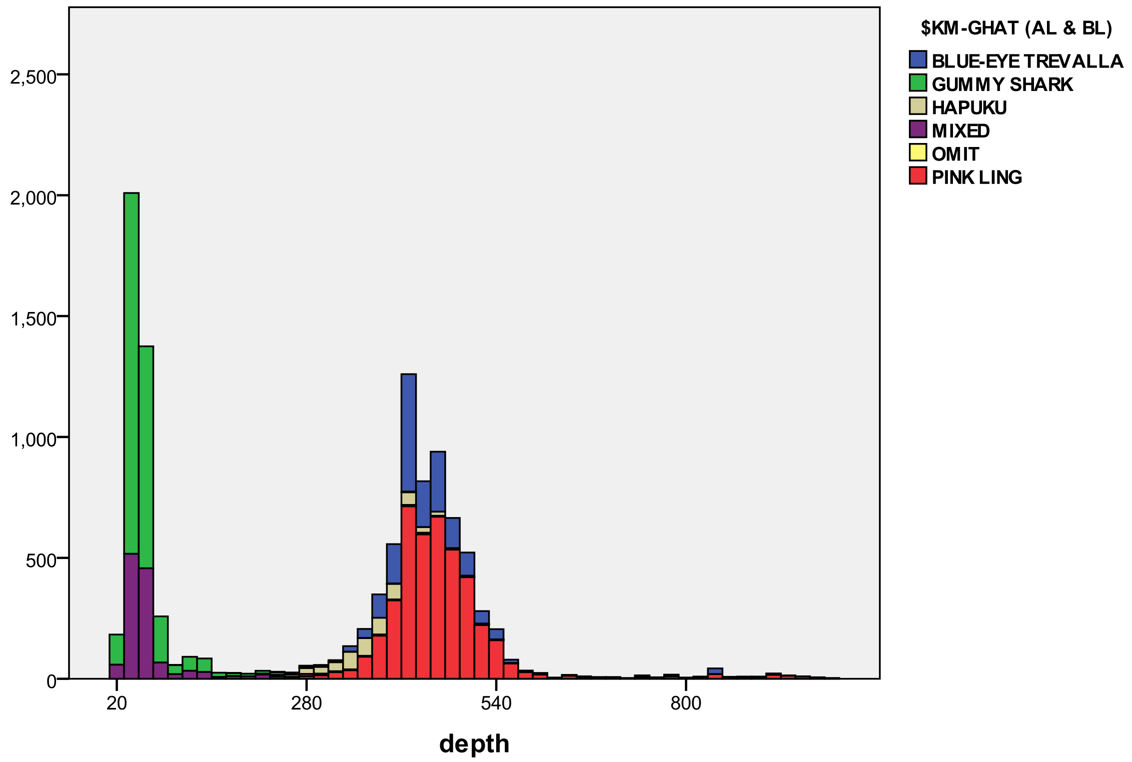

Figure 35 - Appendix B: GHaT (AL & BL) Clusters By Depth.

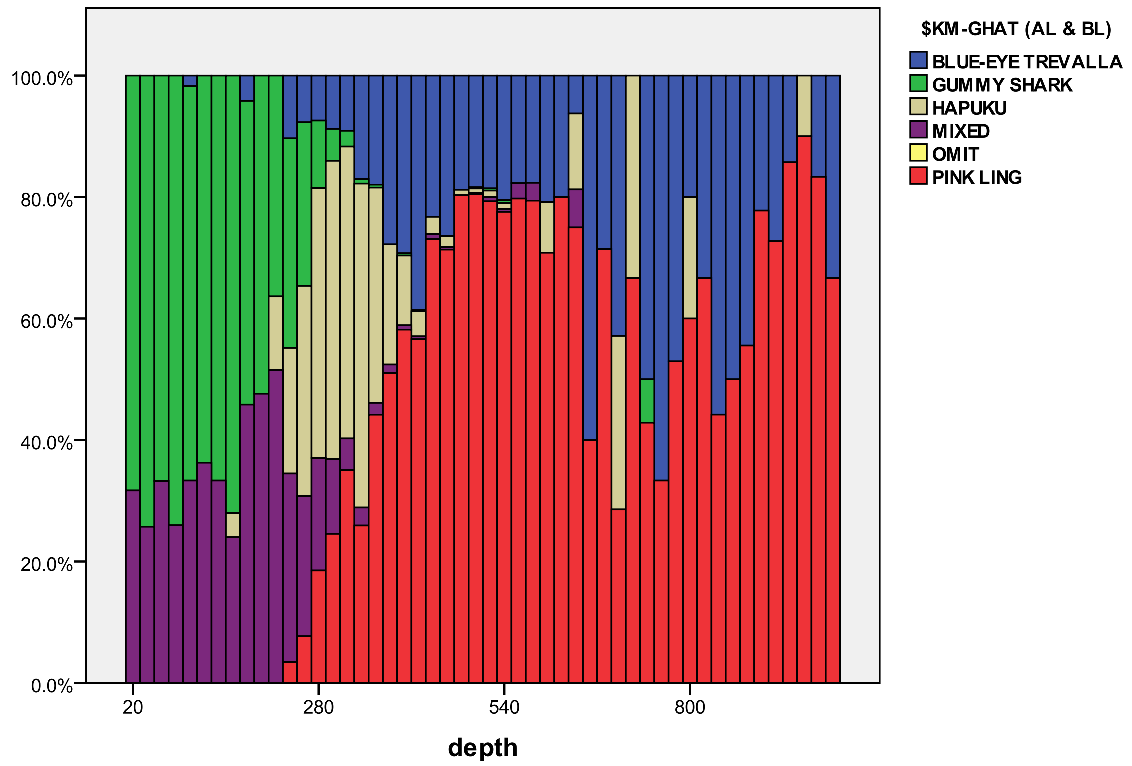

Figure 36 - Appendix B: GHaT (AL & BL) Clusters By Depth: Normalised.

Appendix B - Argument for Gear separation:

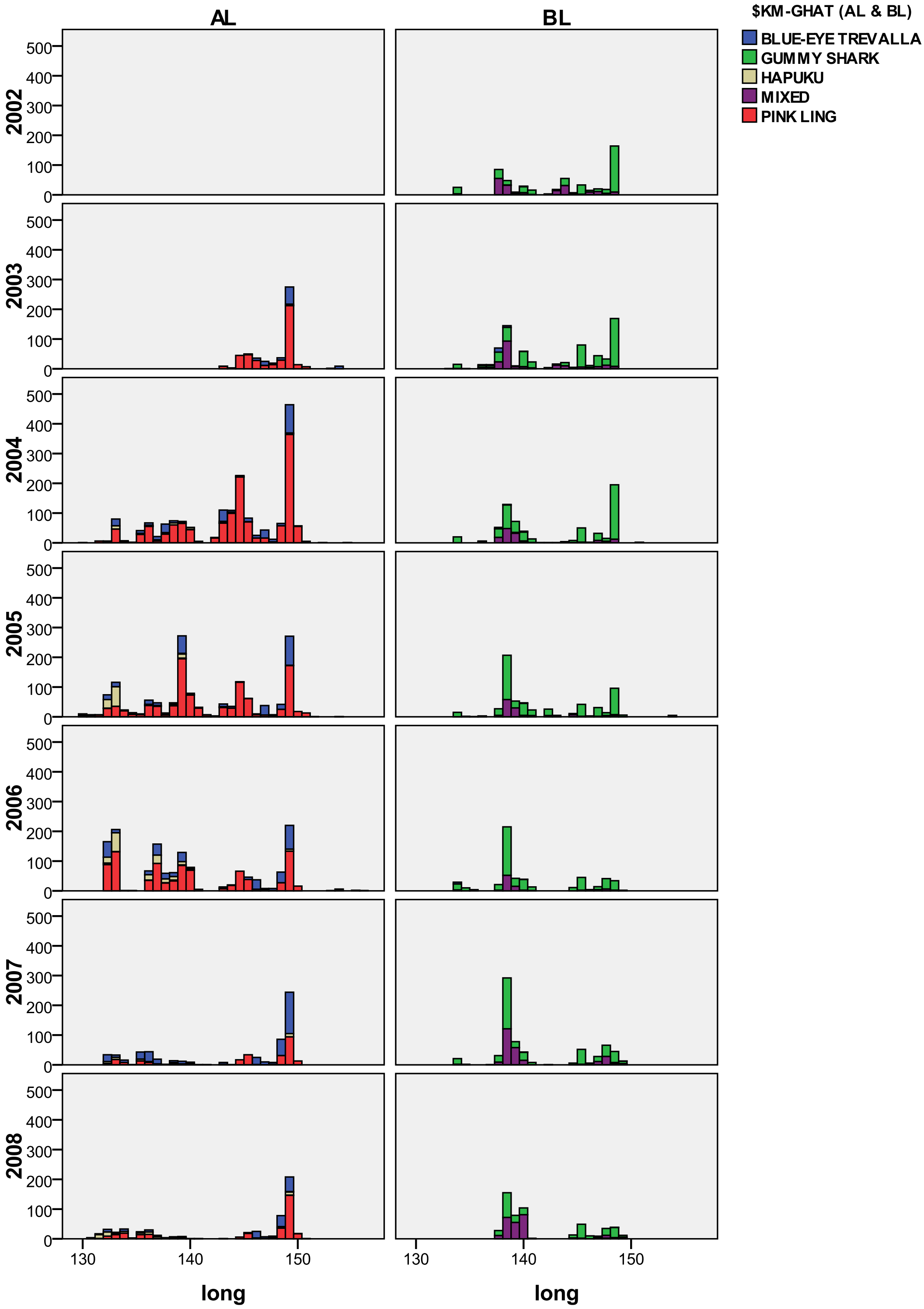

Figure 37 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Year, Gear.

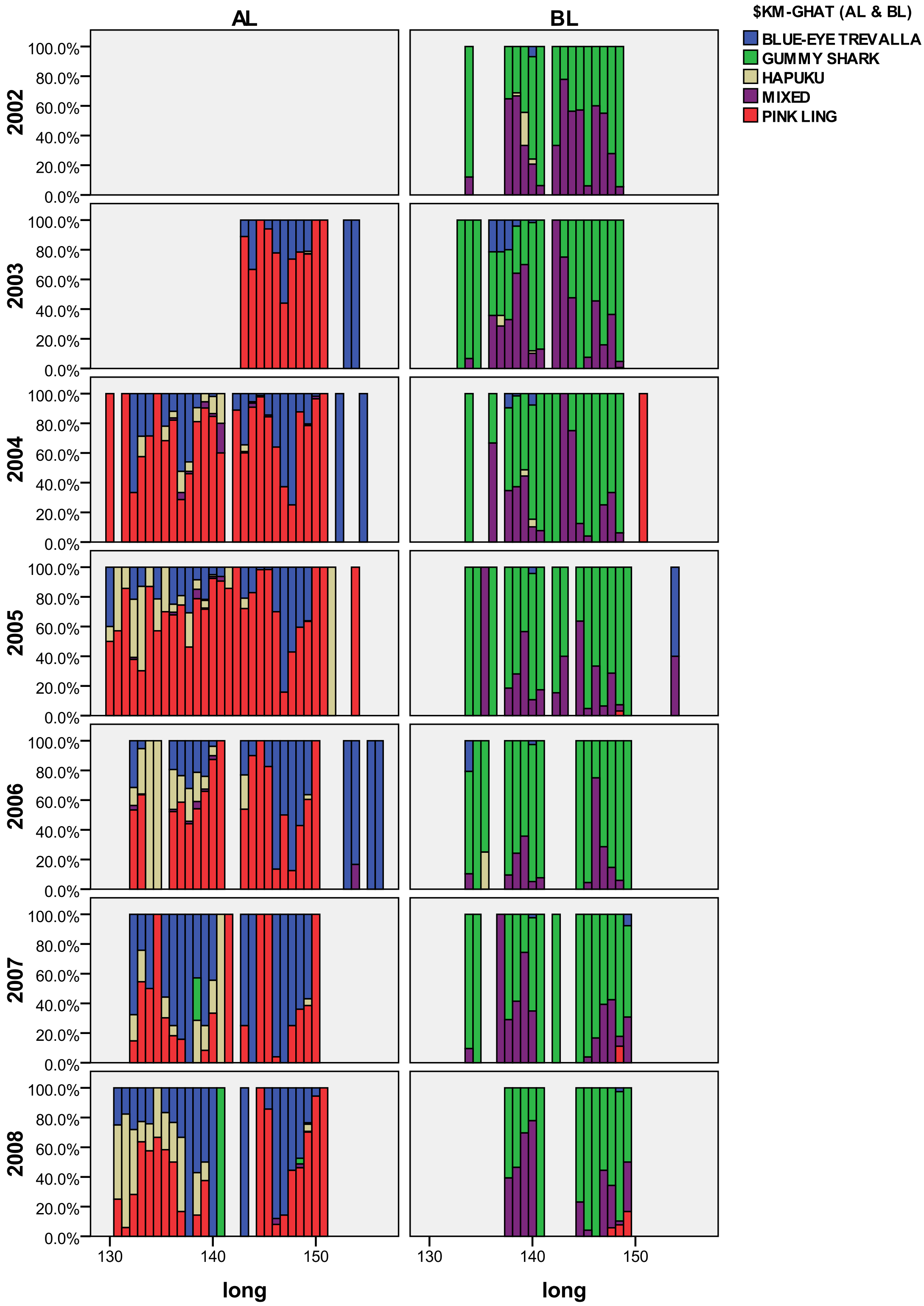

Figure 38 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Year, Gear (Normalised).

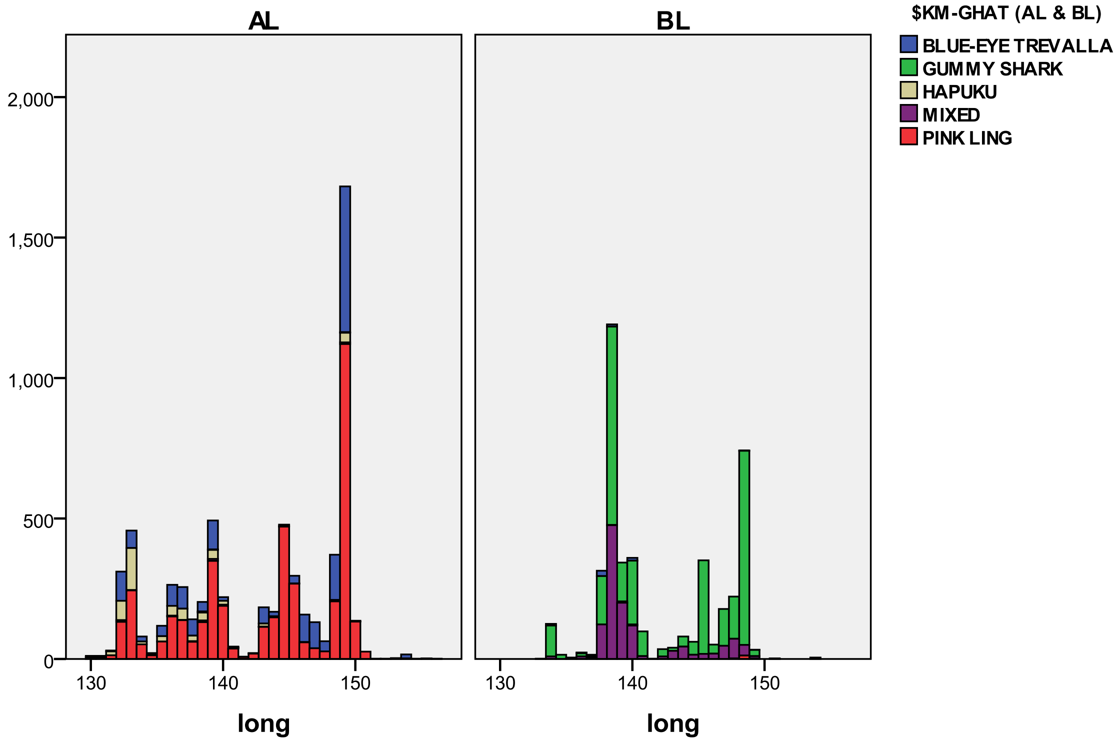

Figure 39 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Gear.

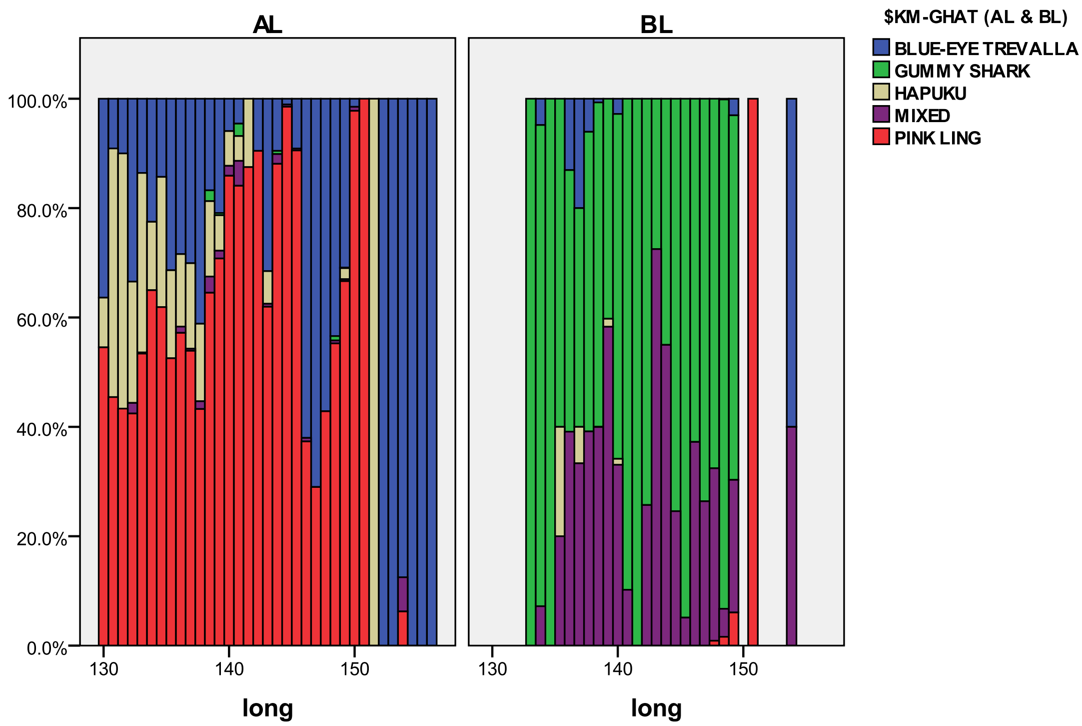

Figure 40 - Appendix B: GHaT (AL & BL) Longitude, Cluster, Gear (Normalised).

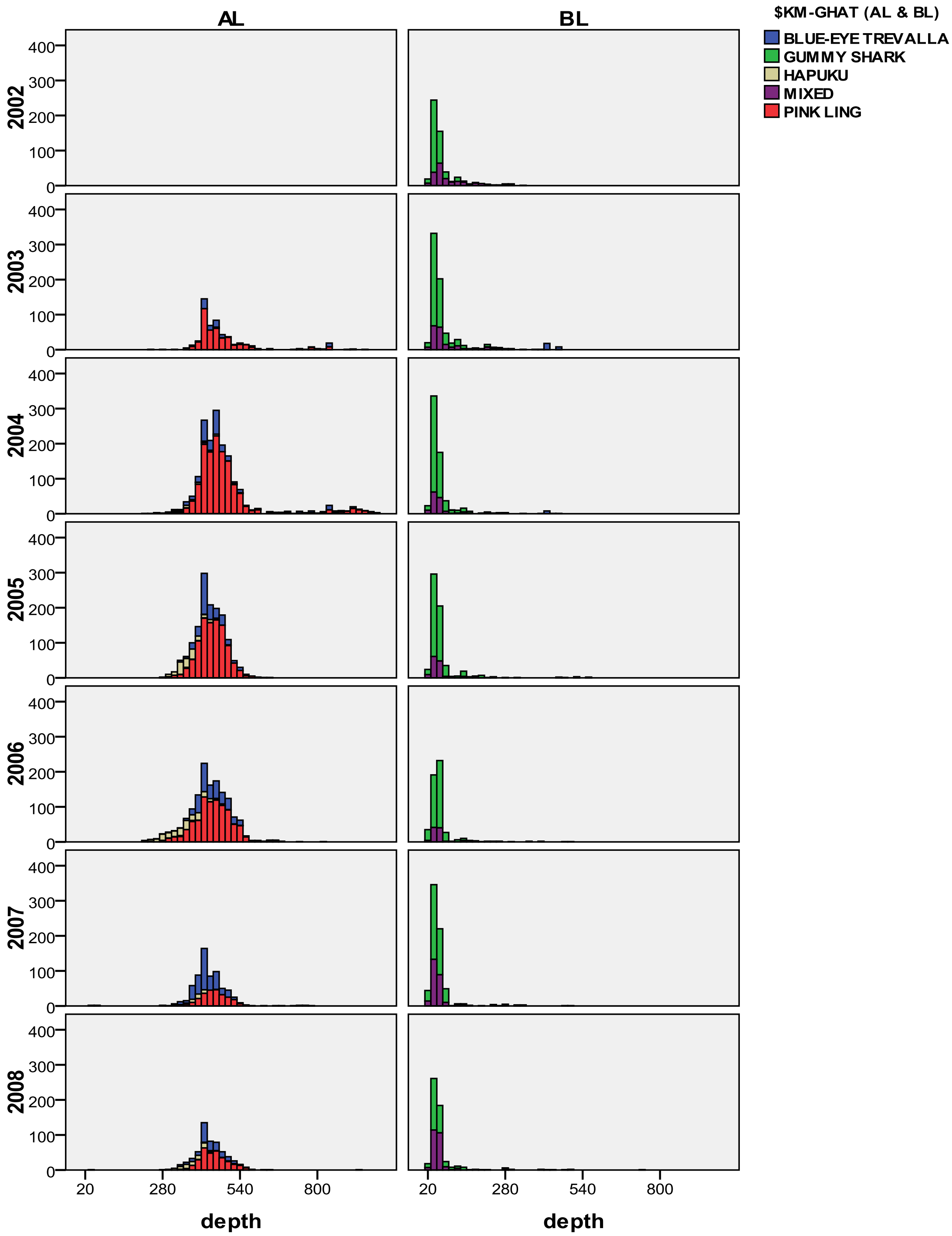

Figure 41 - Appendix B: GHaT (AL & BL) Depth, Cluster, Year, Gear.

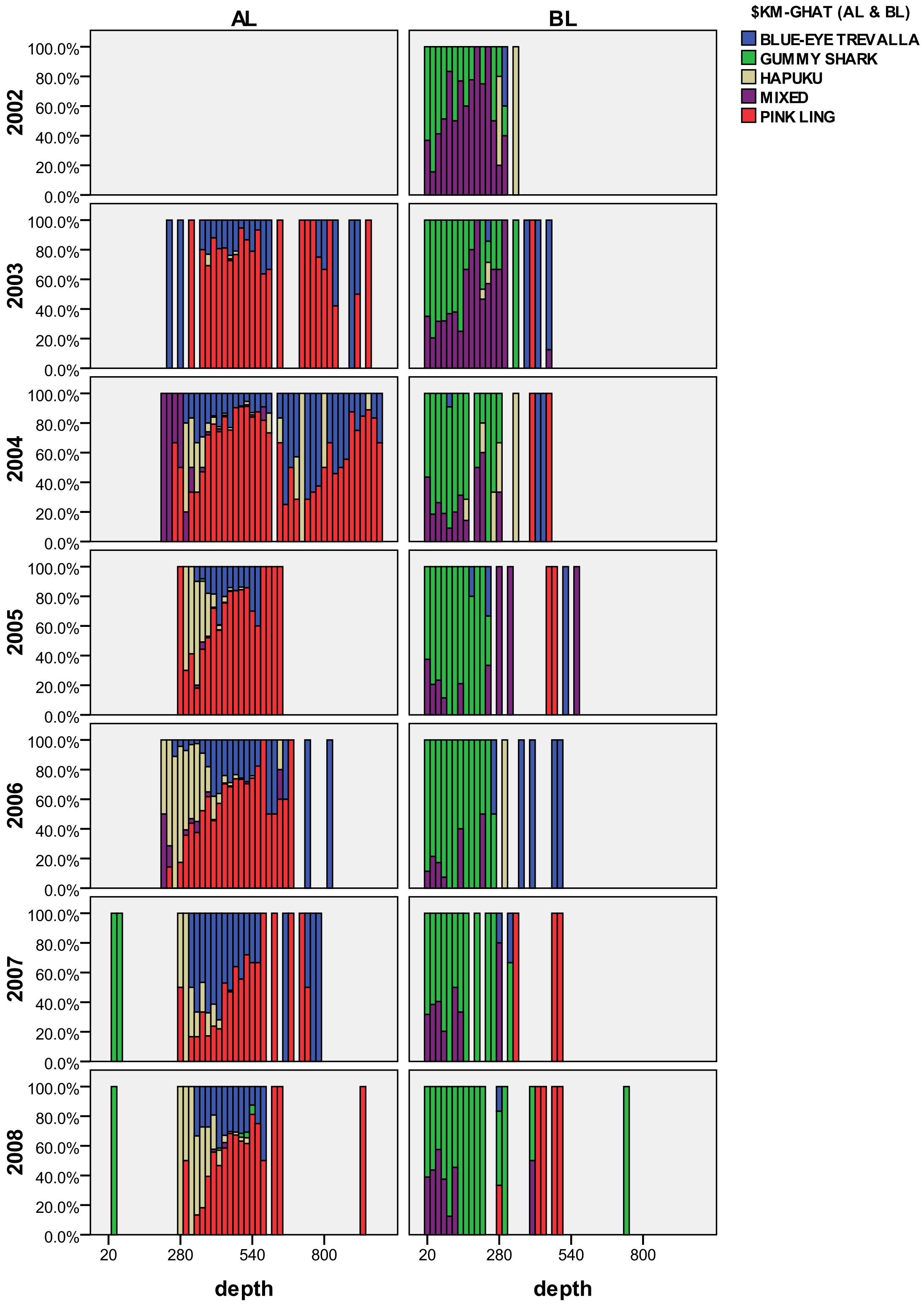

Figure 42 - Appendix B: GHaT (AL & BL) Depth, Cluster, Year, Gear (Normalised).

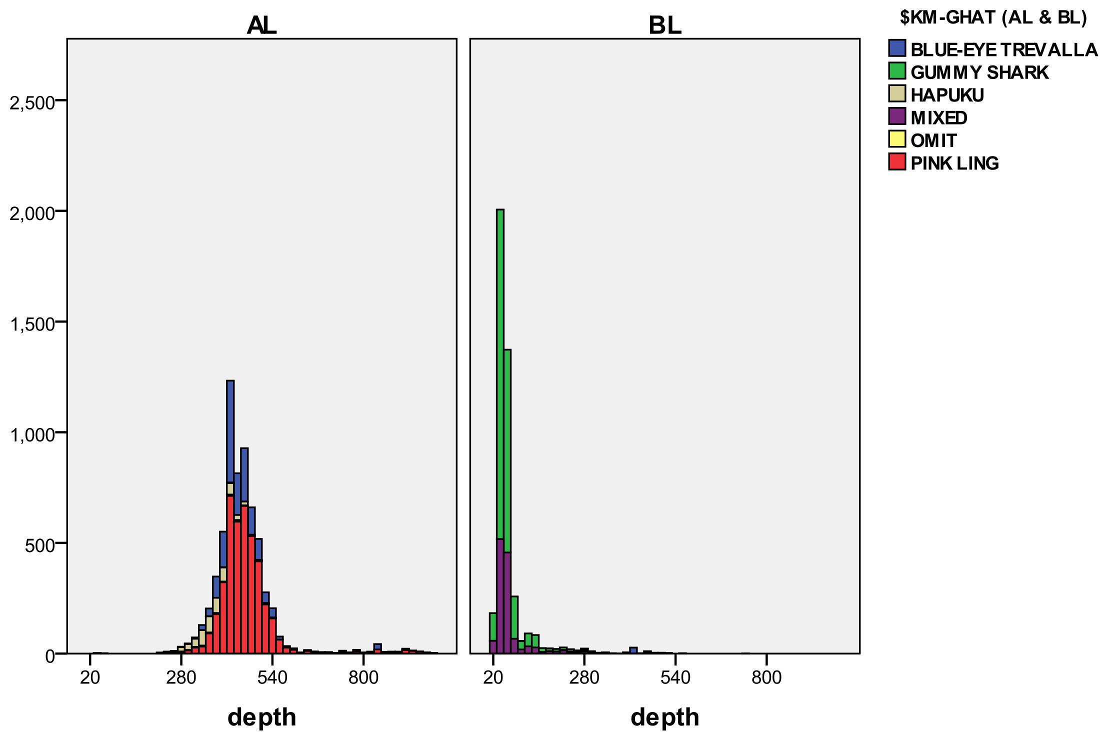

Figure 43 - Appendix B: GHaT (AL & BL) Depth, Cluster, Gear.

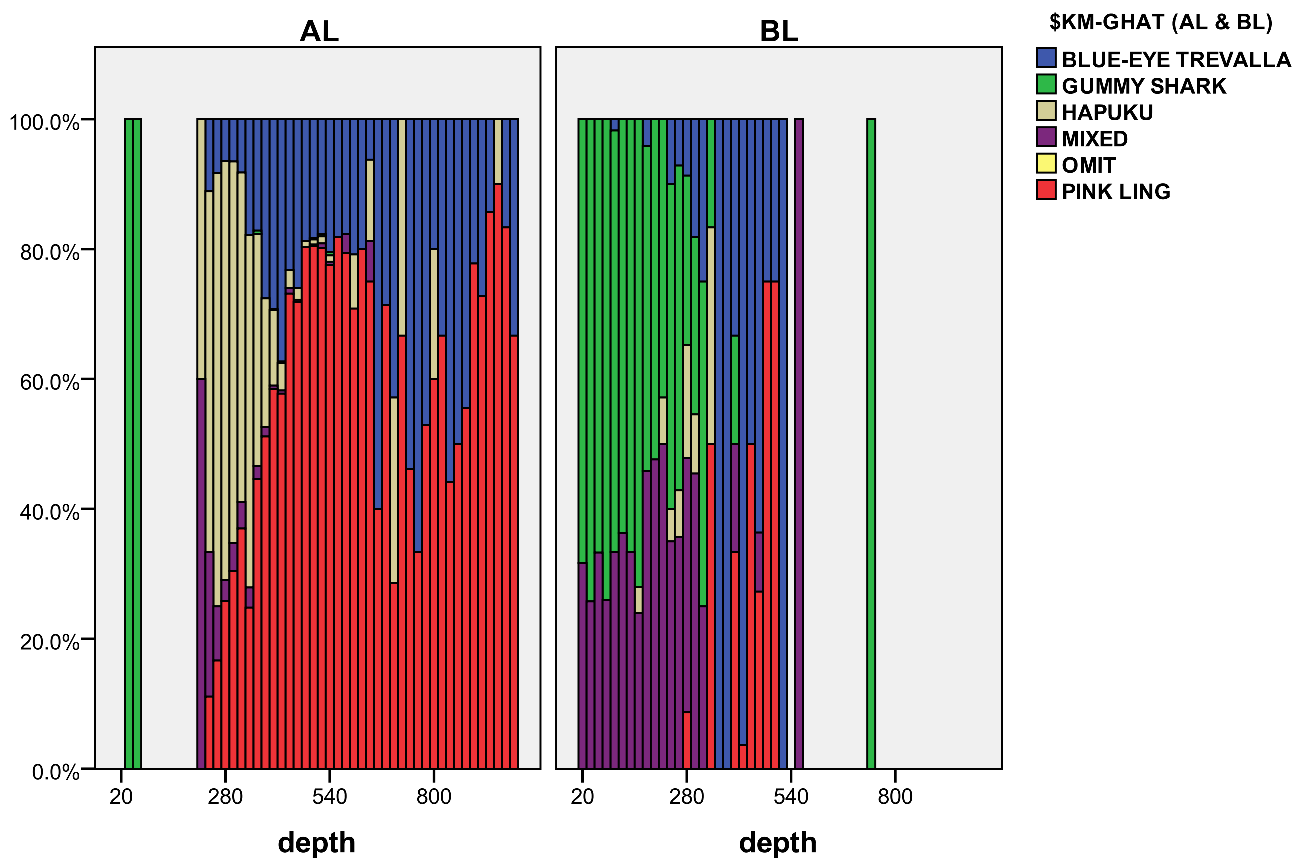

Figure 44 - Appendix B: GHaT (AL & BL) Depth, Cluster, Year, Gear (Normalised).

Appendix B - Cluster Analysis Results for GHAT (DL)

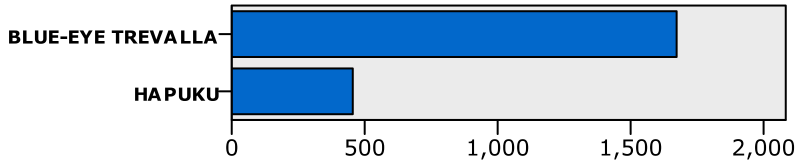

Figure 45 - Appendix B: GHaT (DL) Cluster Sizes

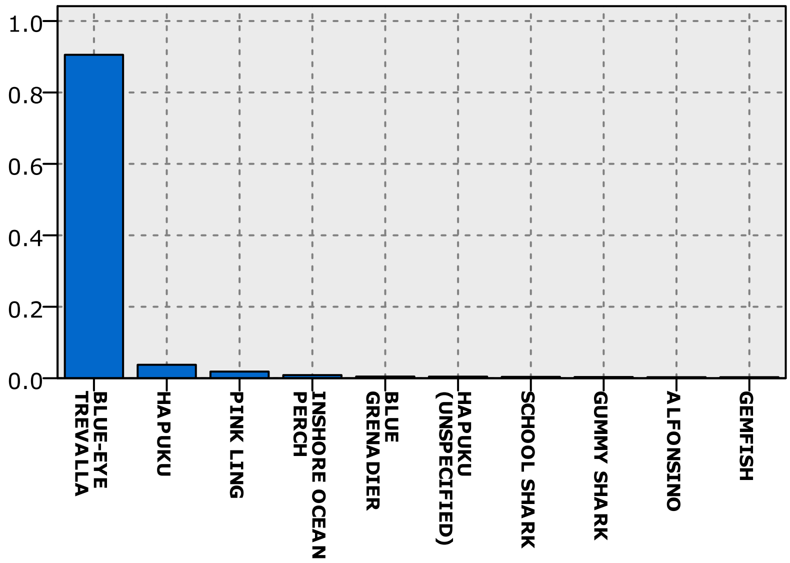

Figure 46 - Appendix B: GHaT (DL) Cluster Composition Blue-Eye Trevalla.

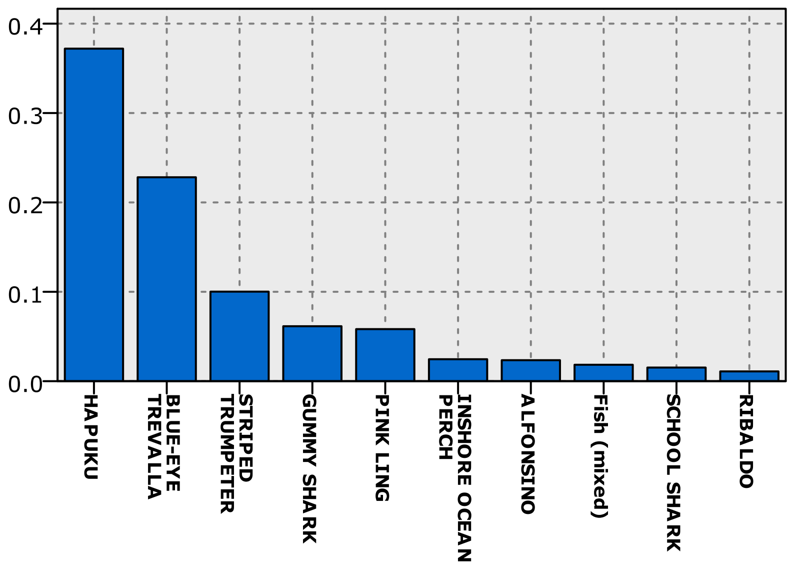

Figure 47 - Appendix B: GHaT (DL) Cluster Composition Hapuku.

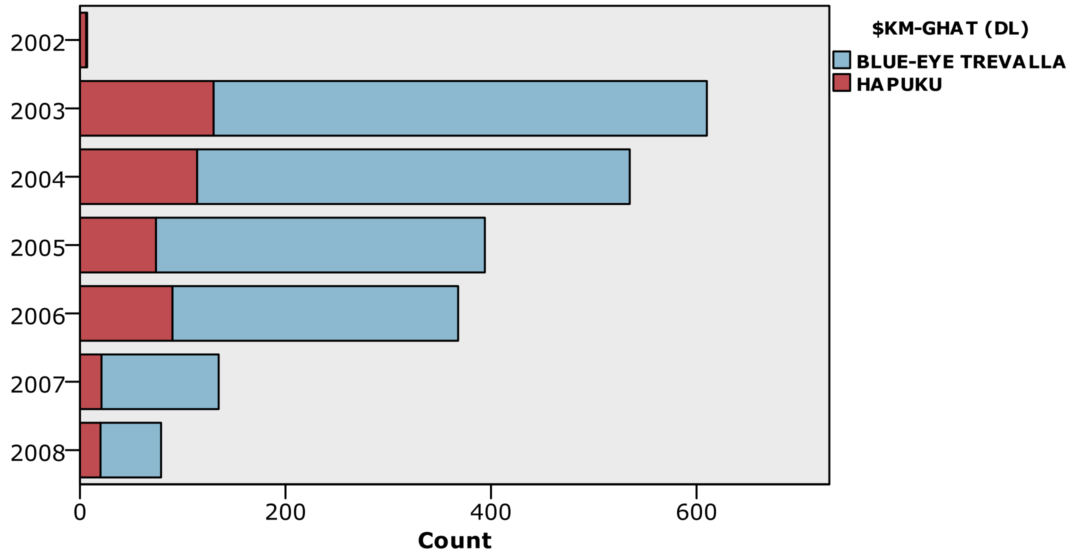

Figure 48 - Appendix B: GHaT (DL) Clusters By Year.

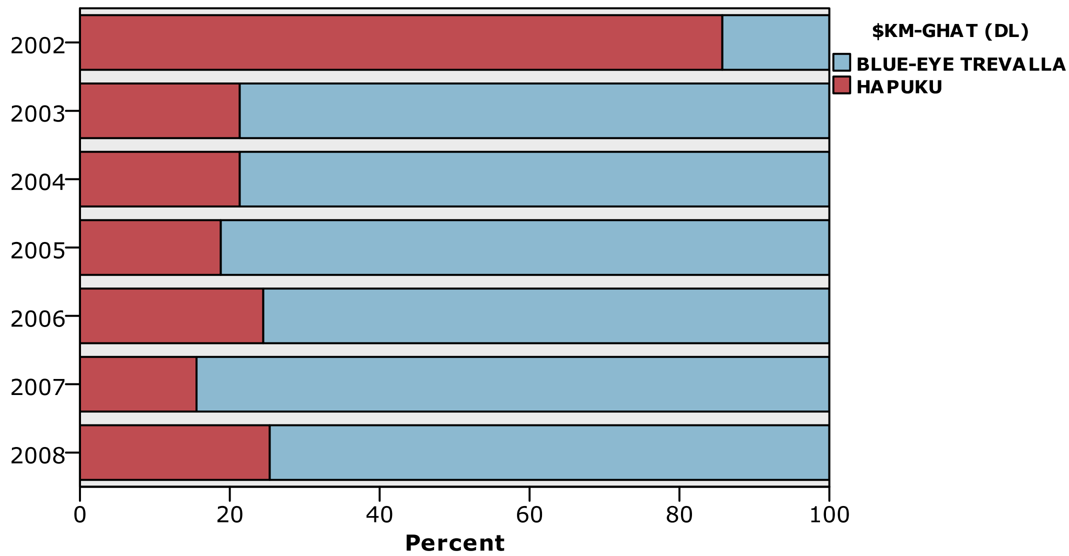

Figure 49 - Appendix B: GHaT (DL) Clusters By Year Normalised.

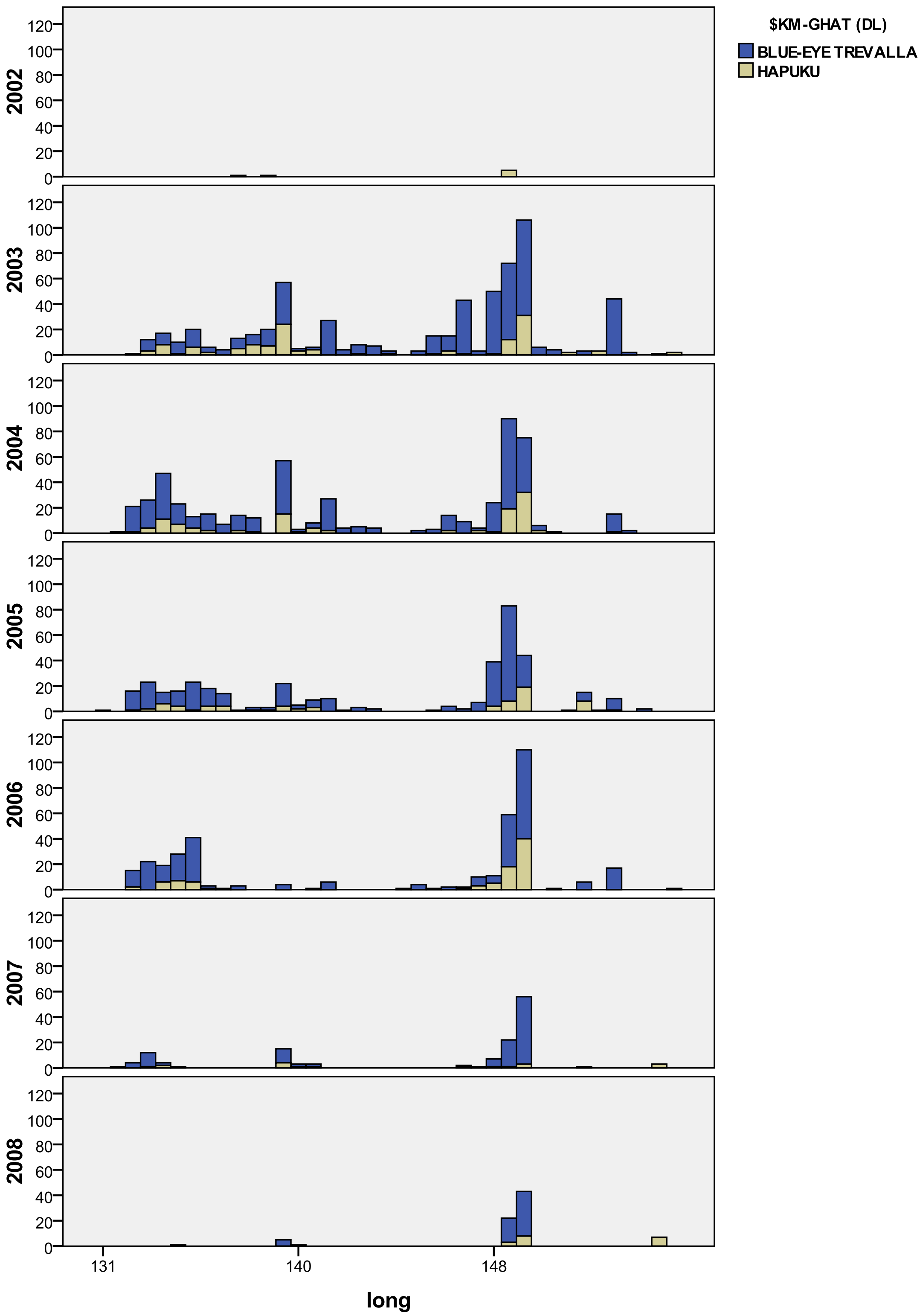

Figure 50 - Appendix B: GHaT (DL) Longitude, Cluster, Year.

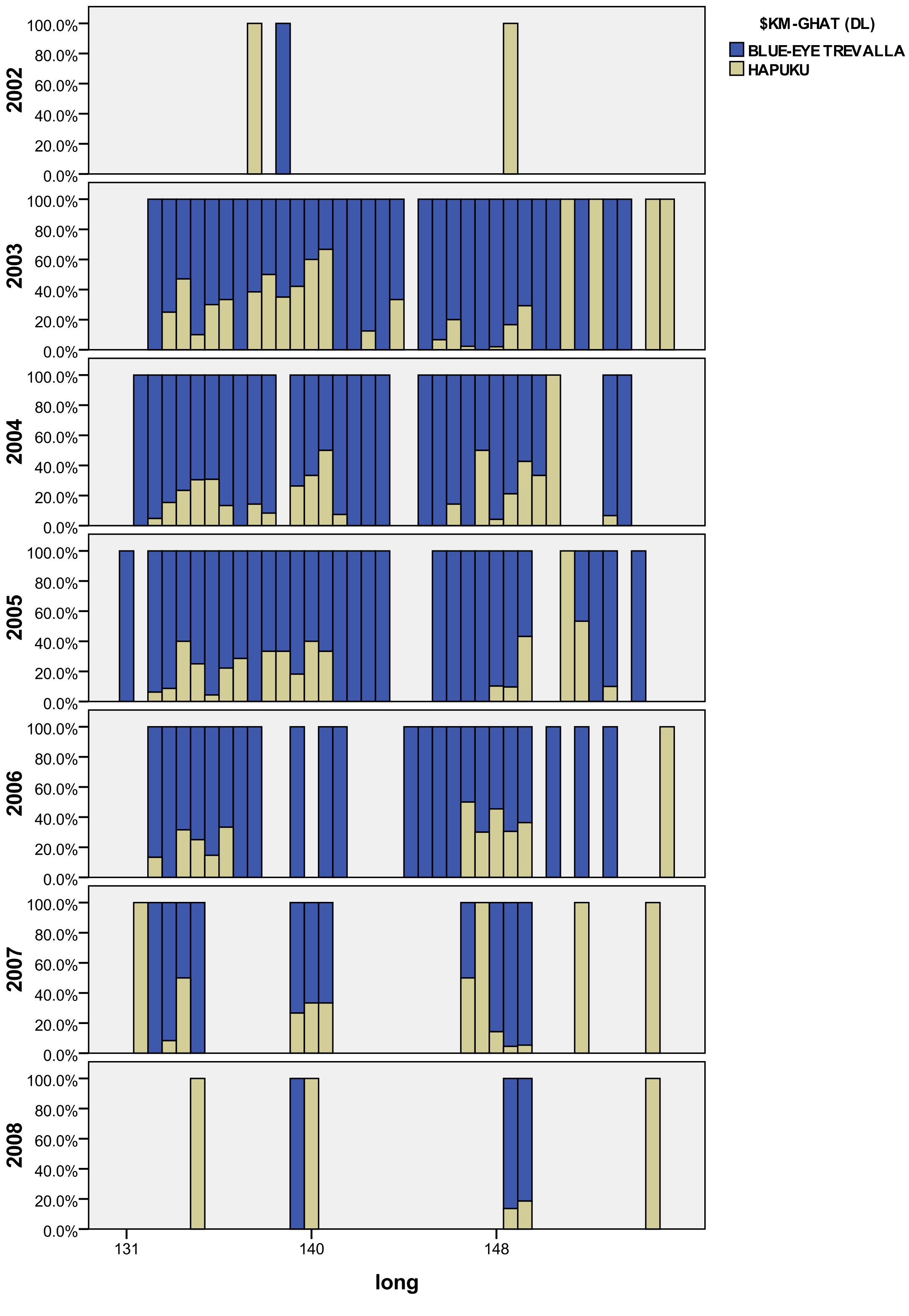

Figure 51 - Appendix B: GHaT (DL) Longitude, Cluster, Year (Normalised).

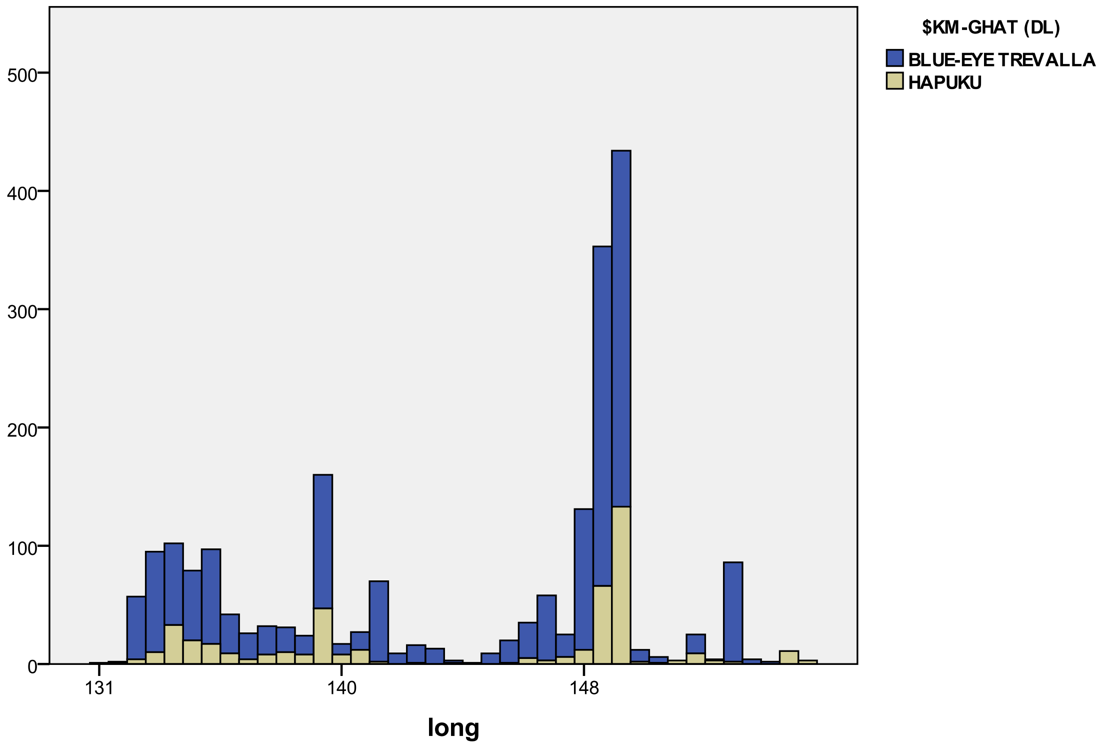

Figure 52 - Appendix B: GHaT (DL) Longitude, Cluster.

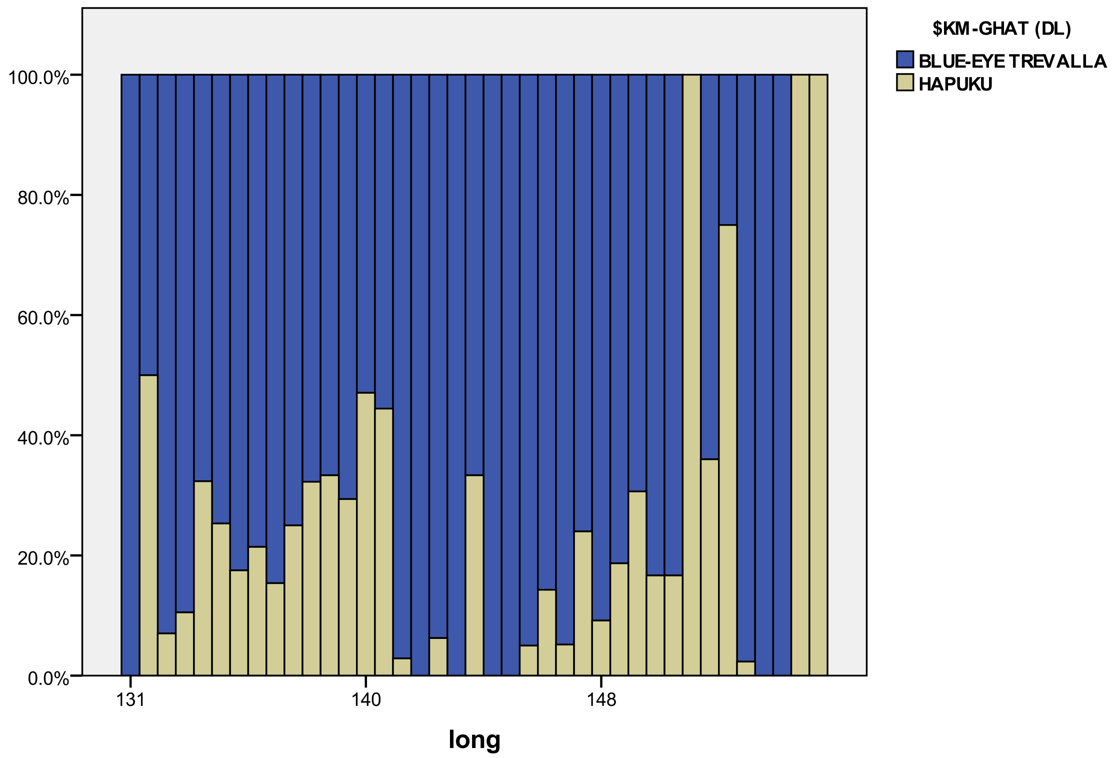

Figure 53 - Appendix B: GHaT (DL) Longitude Cluster (Normalised).

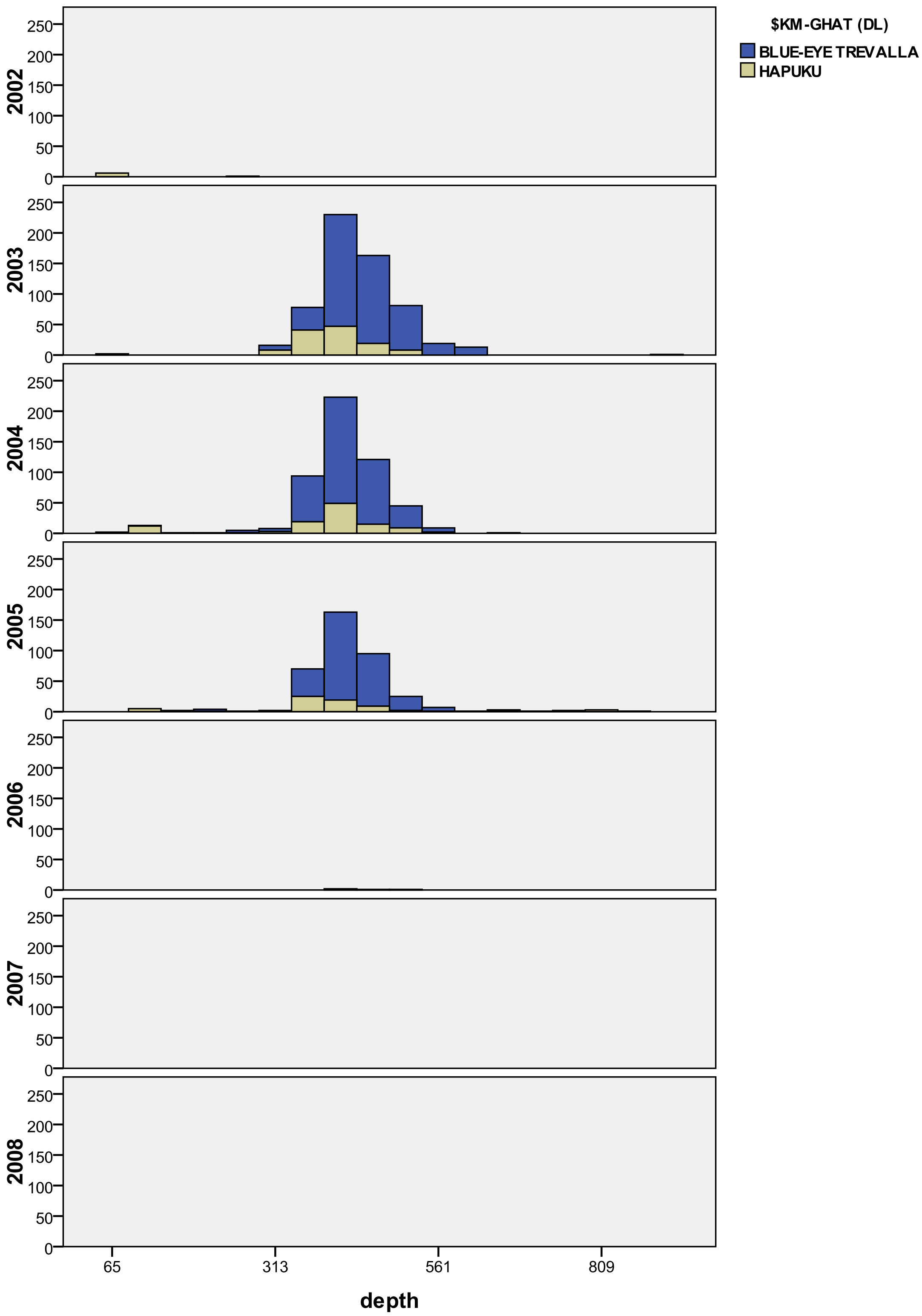

Figure 54 - Appendix B: GHaT (DL) Depth, Cluster, Year.

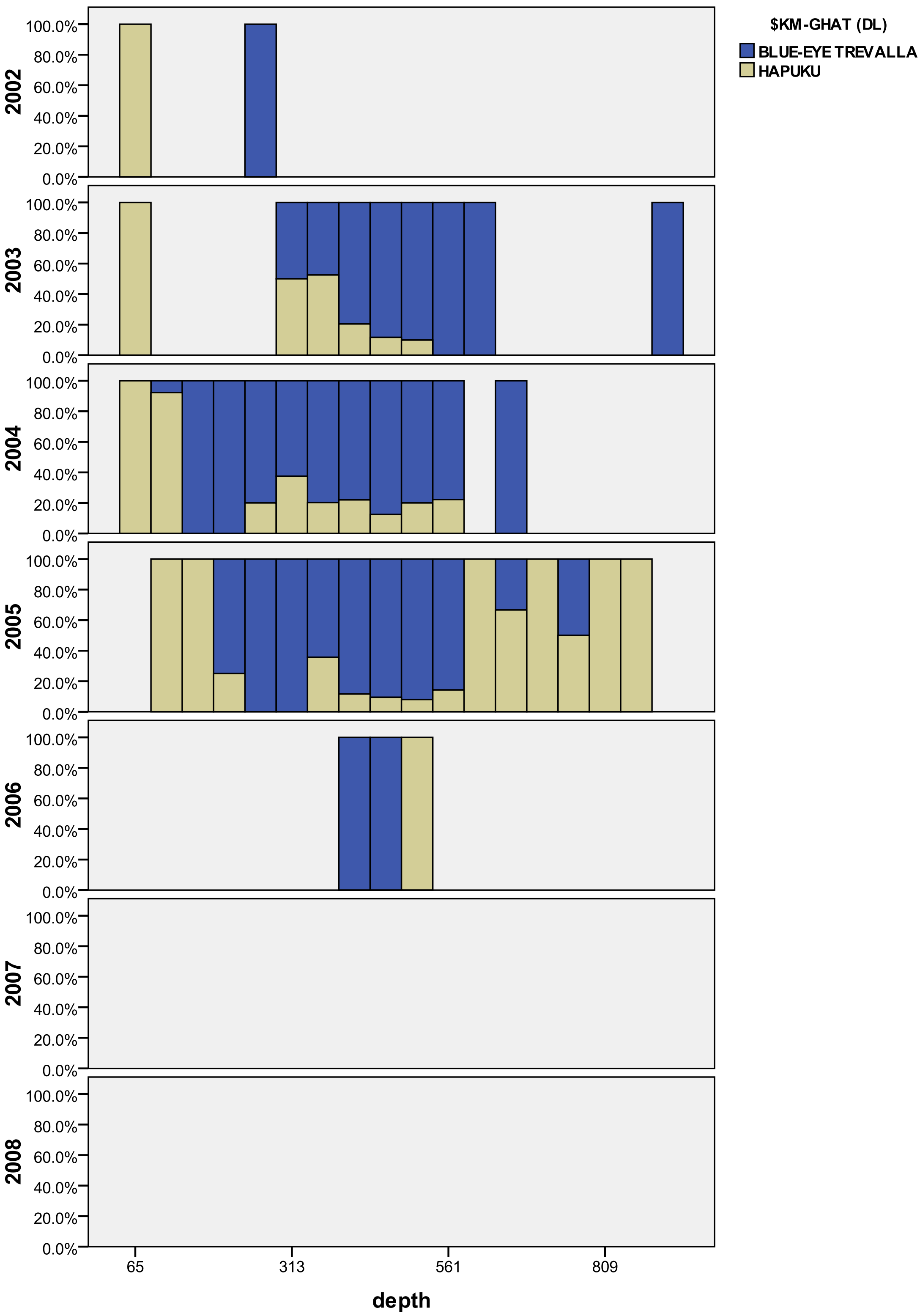

Figure 55 - Appendix B: GHaT (DL) Depth, Cluster, Year (Normalised).

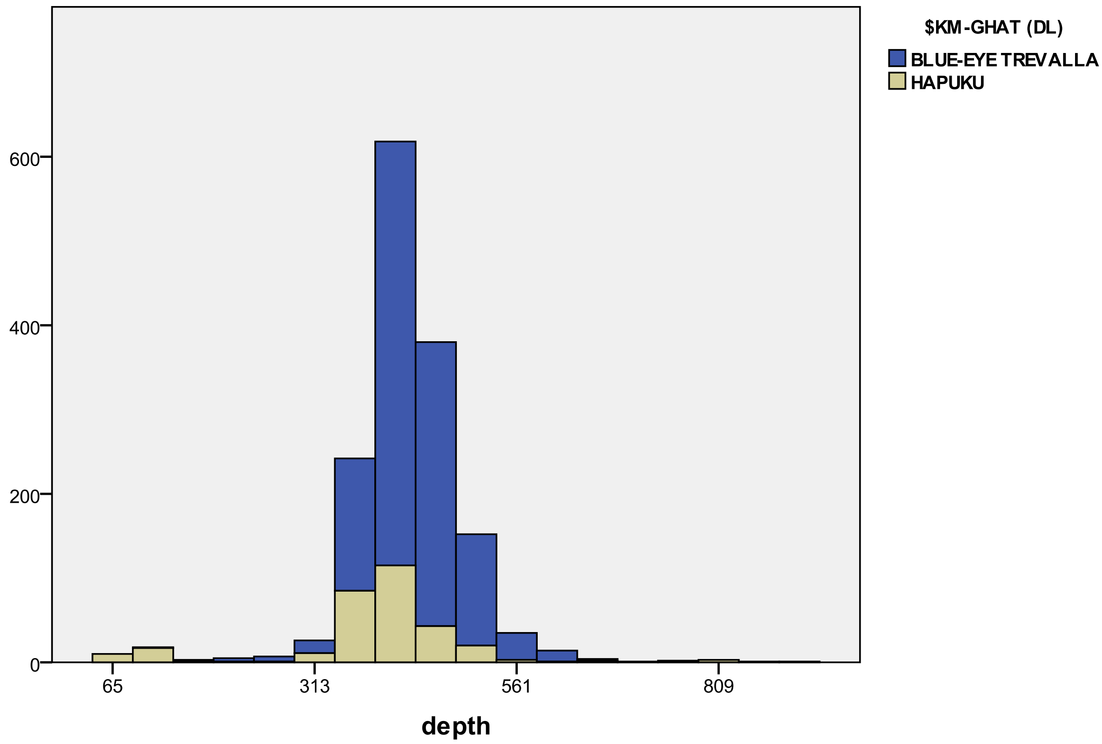

Figure 56 - Appendix B: GHaT (DL) Depth, Cluster.

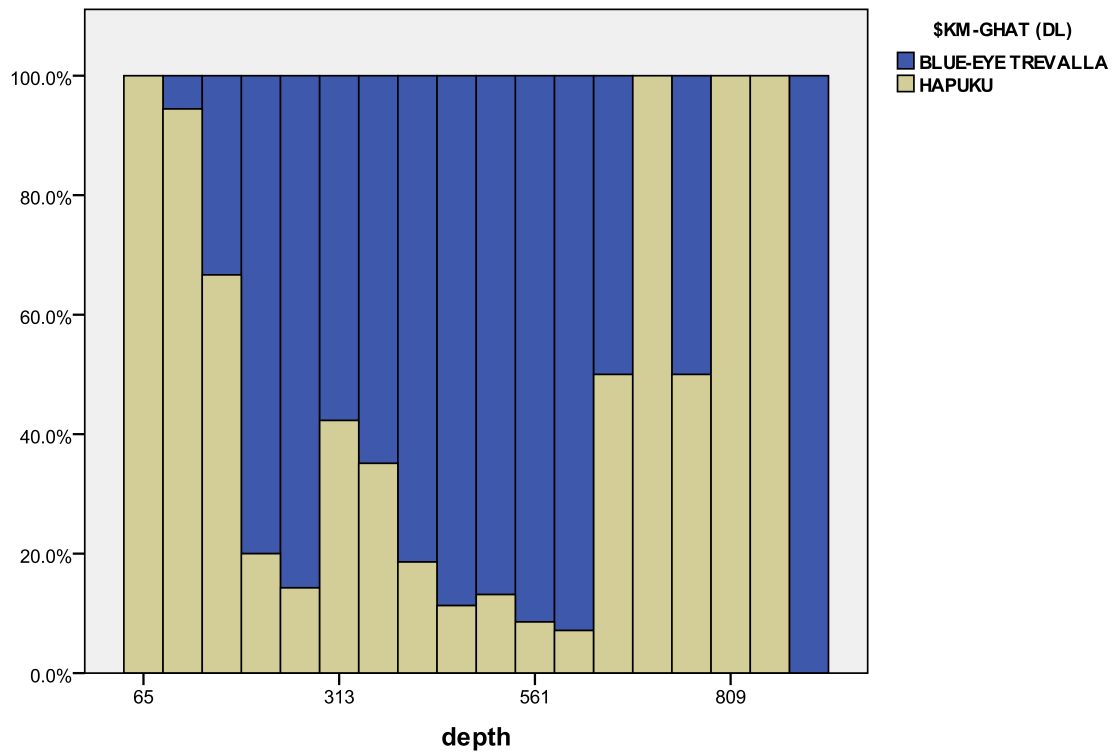

Figure 57 - Appendix B: GHaT (DL) Depth, Cluster (Normalised).

Appendix B - Cluster Analysis Results for GHAT (GN)

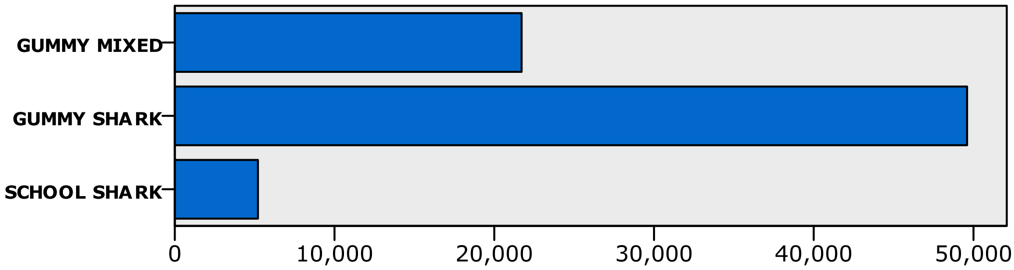

Figure 58 - Appendix B: GHaT (GN) Cluster Sizes.

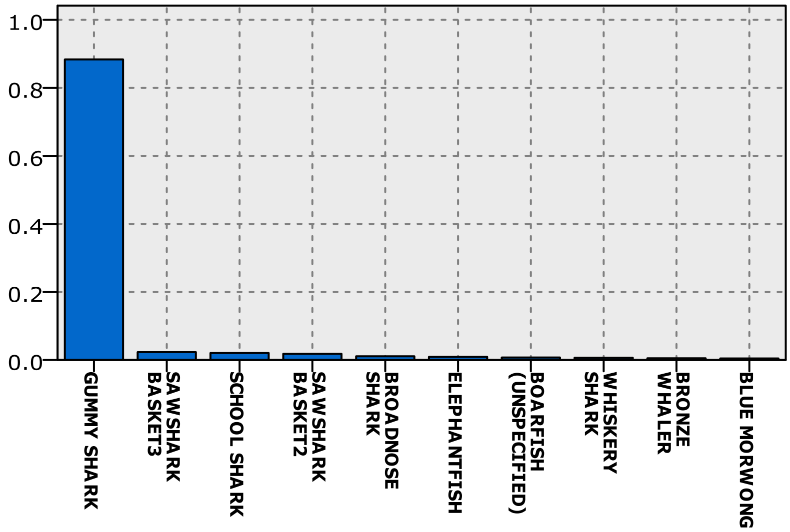

Figure 59 - Appendix B: GHaT (GN) Cluster Analysis Results Gummy Shark.

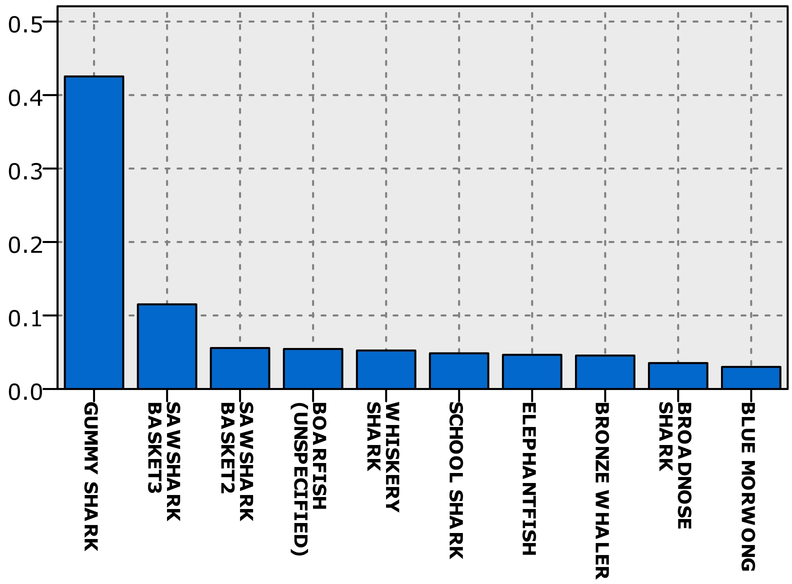

Figure 60 - Appendix B: GHaT (GN) Cluster Analysis Results Gummy Mixed.

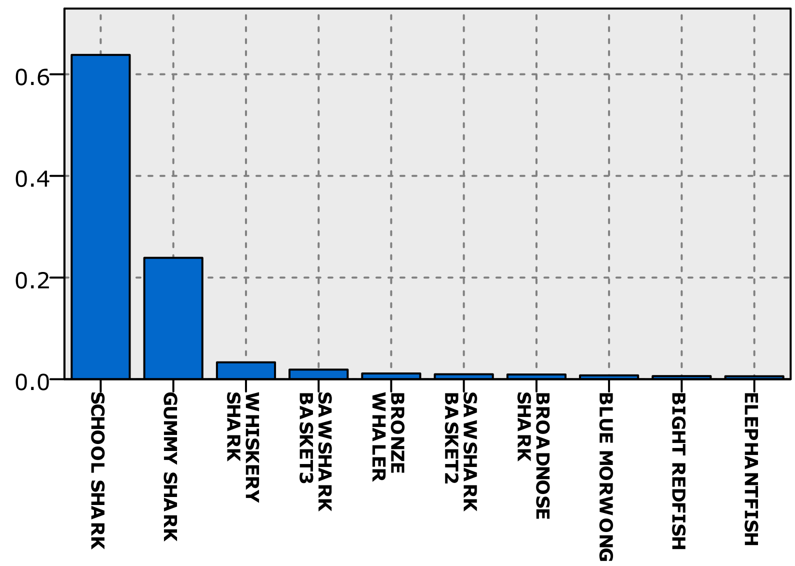

Figure 61 - Appendix B: GHaT (GN) School Shark.

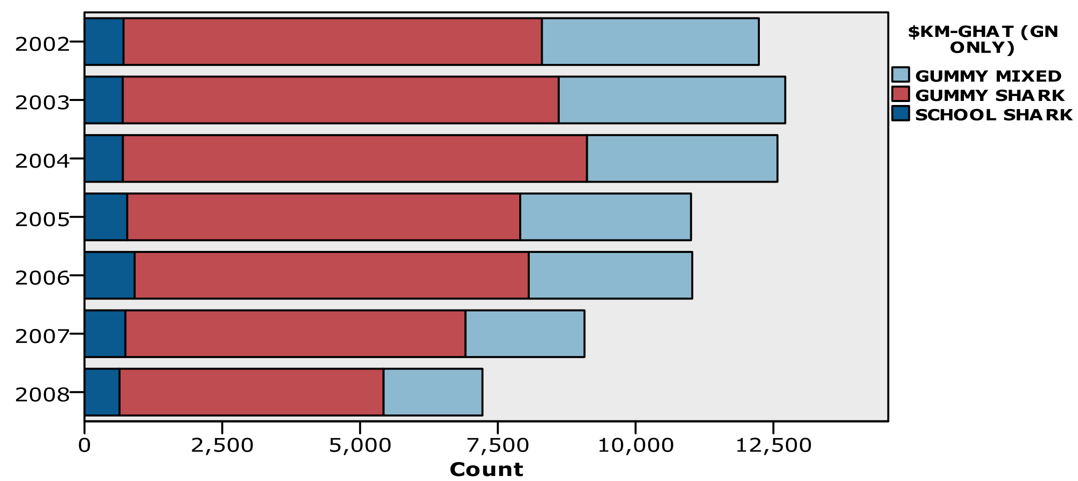

Figure 62 - Appendix B: GHaT (GN) Clusters By Year.

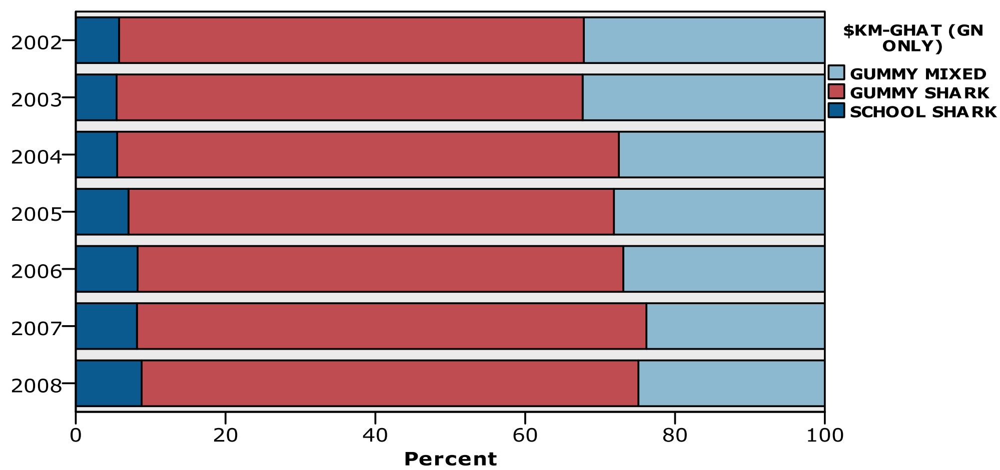

Figure 63 - Appendix B: GHaT (GN) Clusters By Year Normalised.

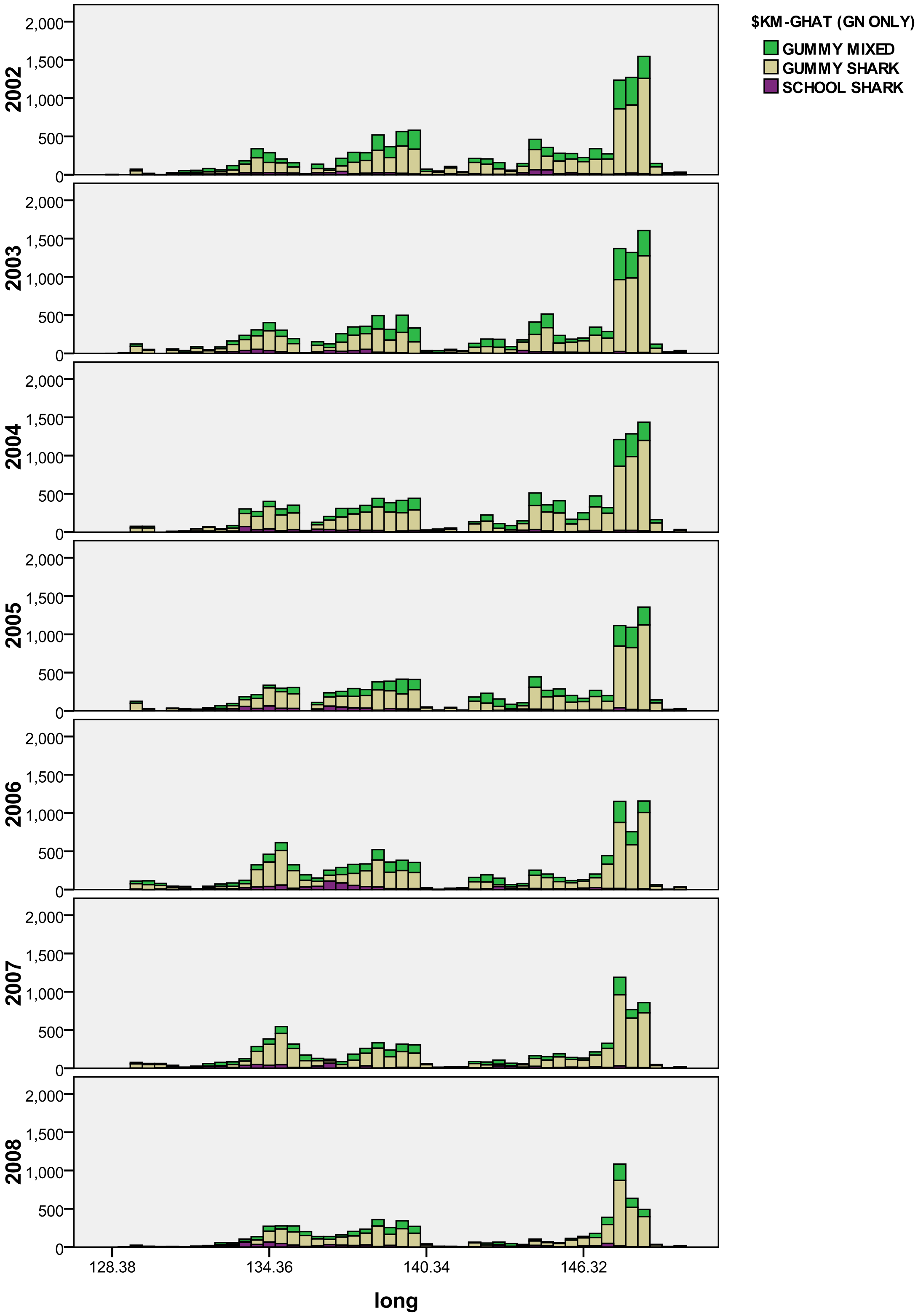

Figure 64 - Appendix B: GHaT (GN) Longitude, Cluster, Year.

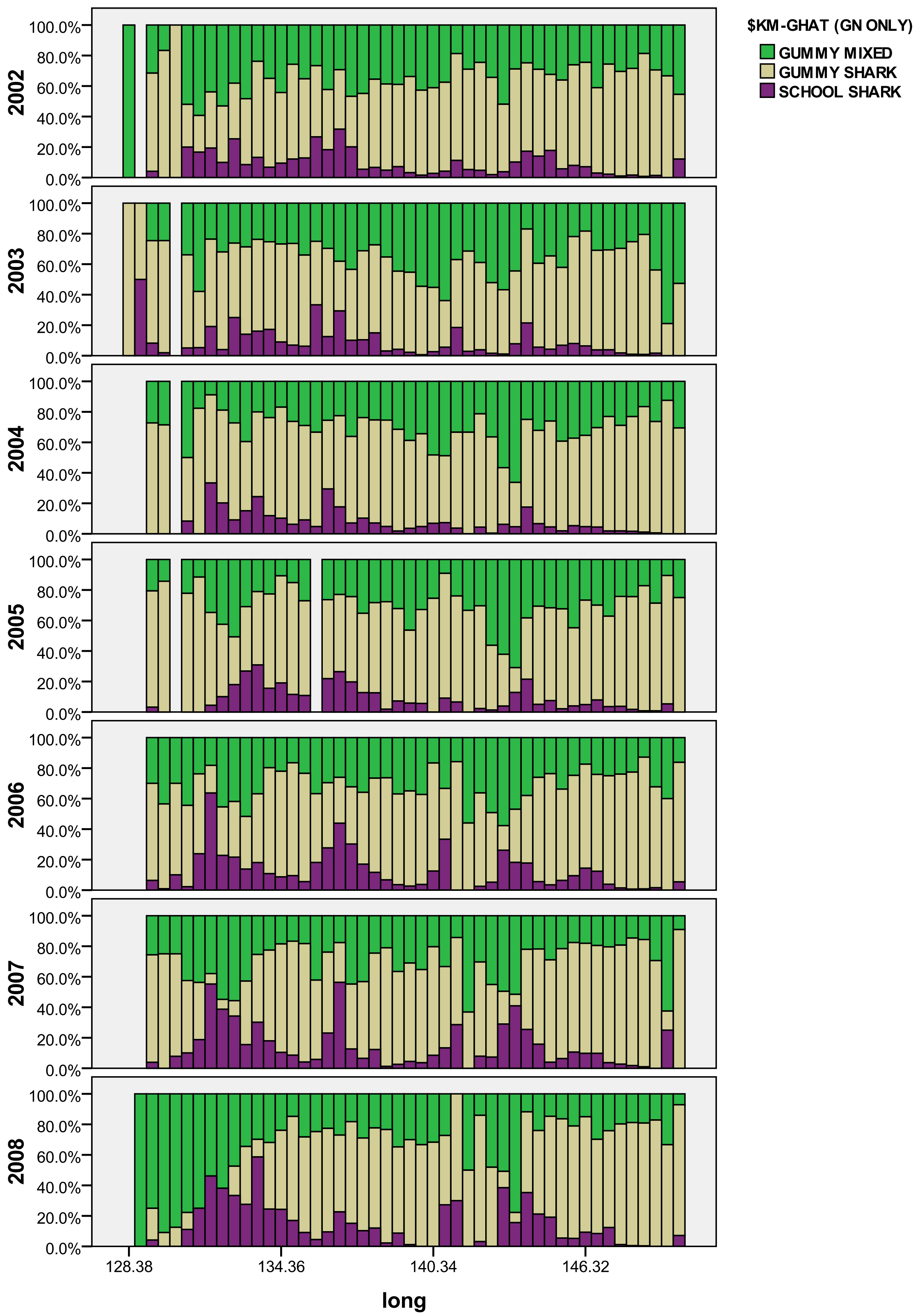

Figure 65 - Appendix B: GHaT (GN) Longitude, Cluster Year (Normalised).

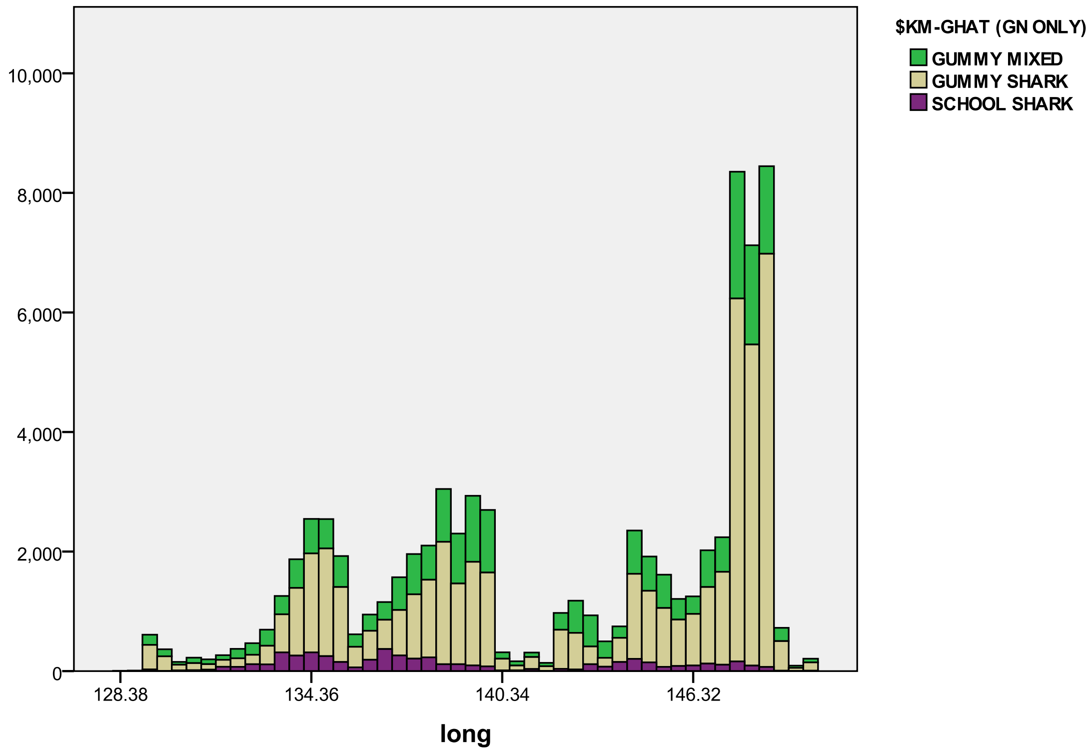

Figure 66 - Appendix B: GHaT (GN) Longitude, Cluster.

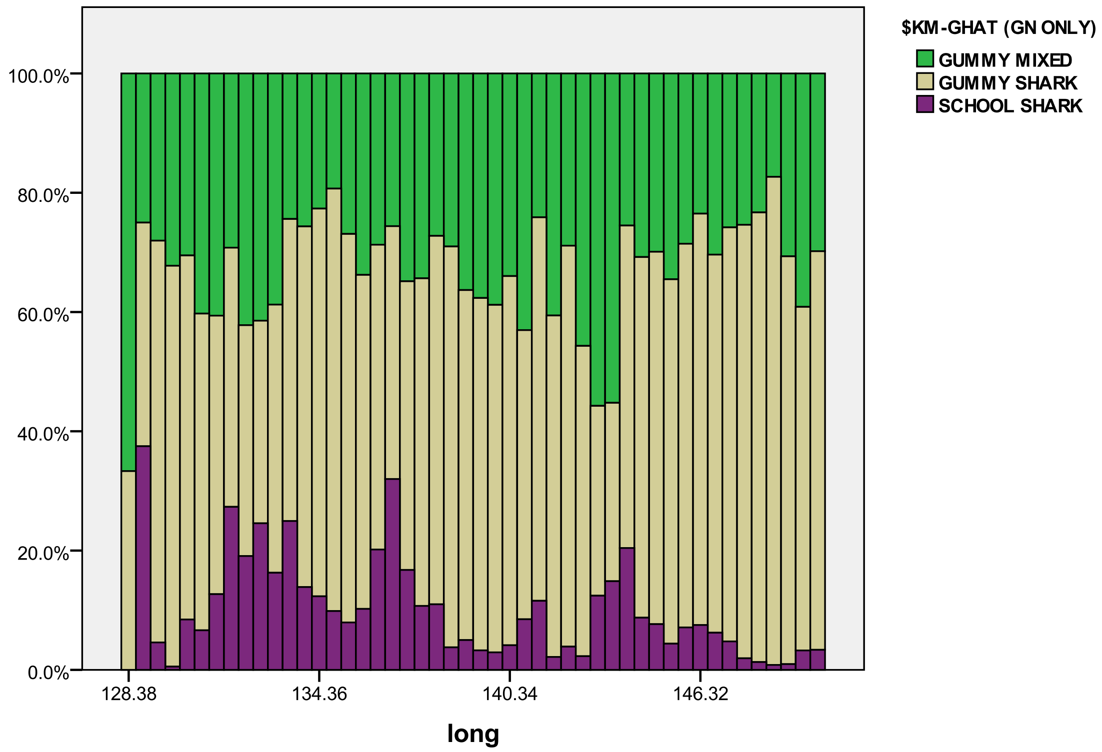

Figure 67 - Appendix B: GHaT (GN) Longitude, Cluster (Normalised).

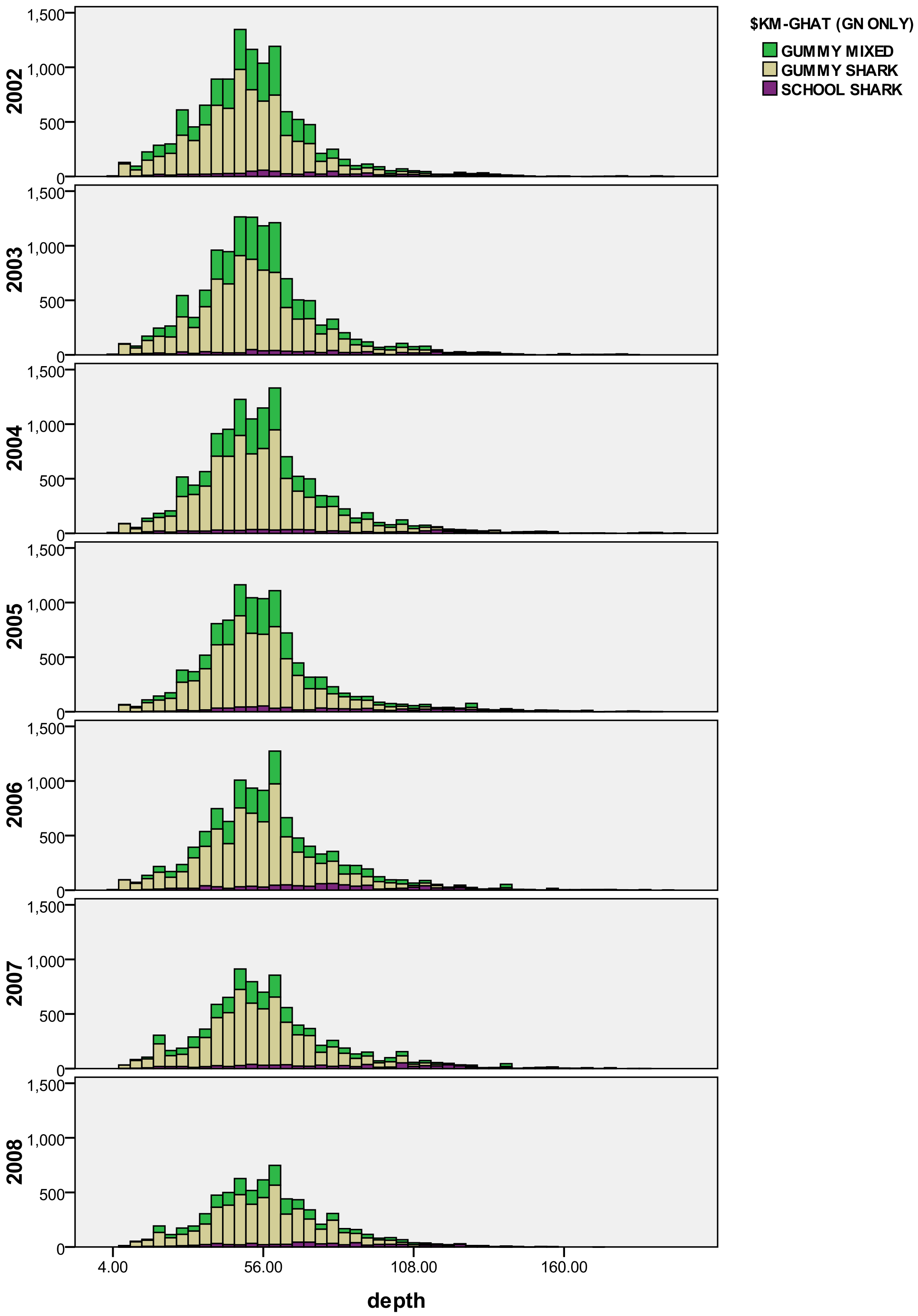

Figure 68 - Appendix B: GHaT (GN) Depth, Cluster, Year.

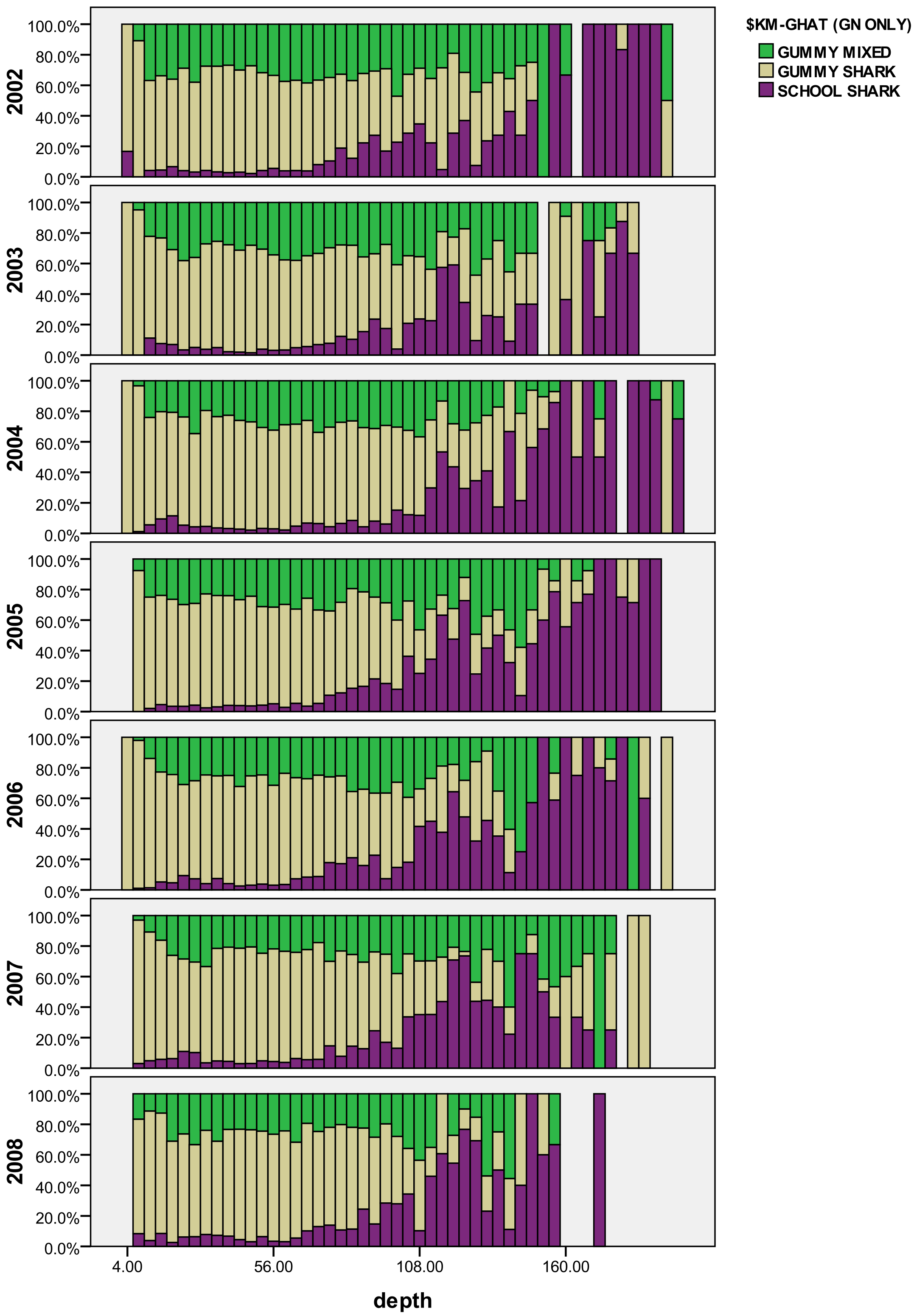

Figure 69 - Appendix B: GHaT (GN) Depth, Cluster, Year (Normalised).

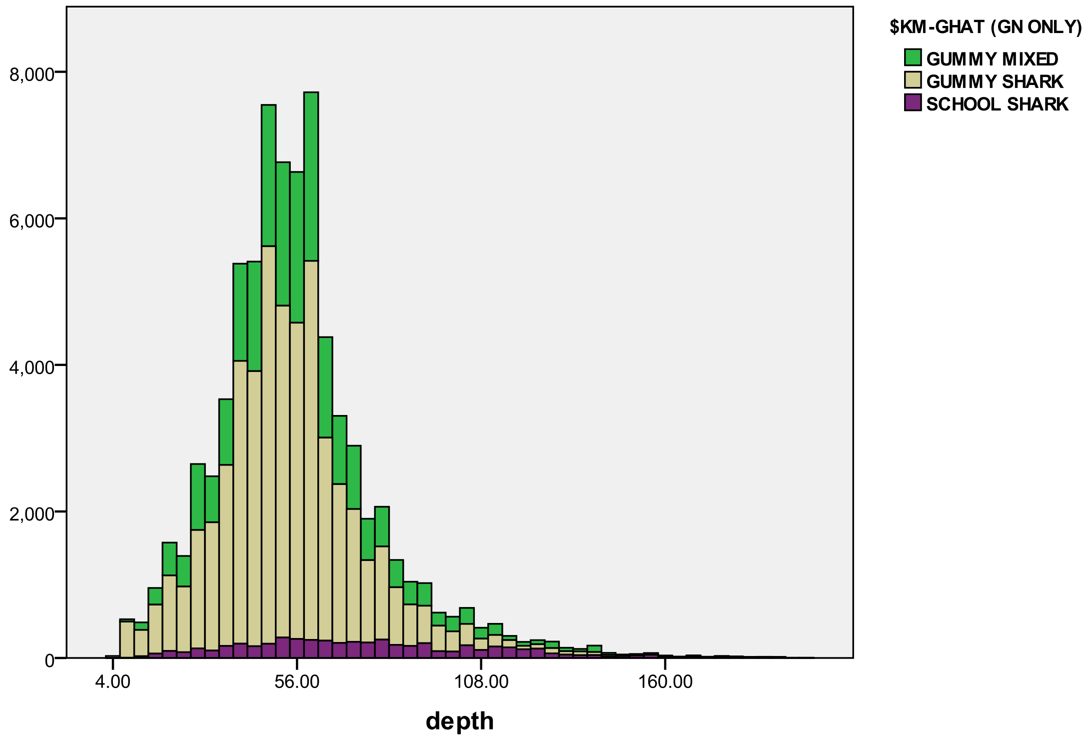

Figure 70 - Appendix B: GHaT (GN) Depth, Cluster.

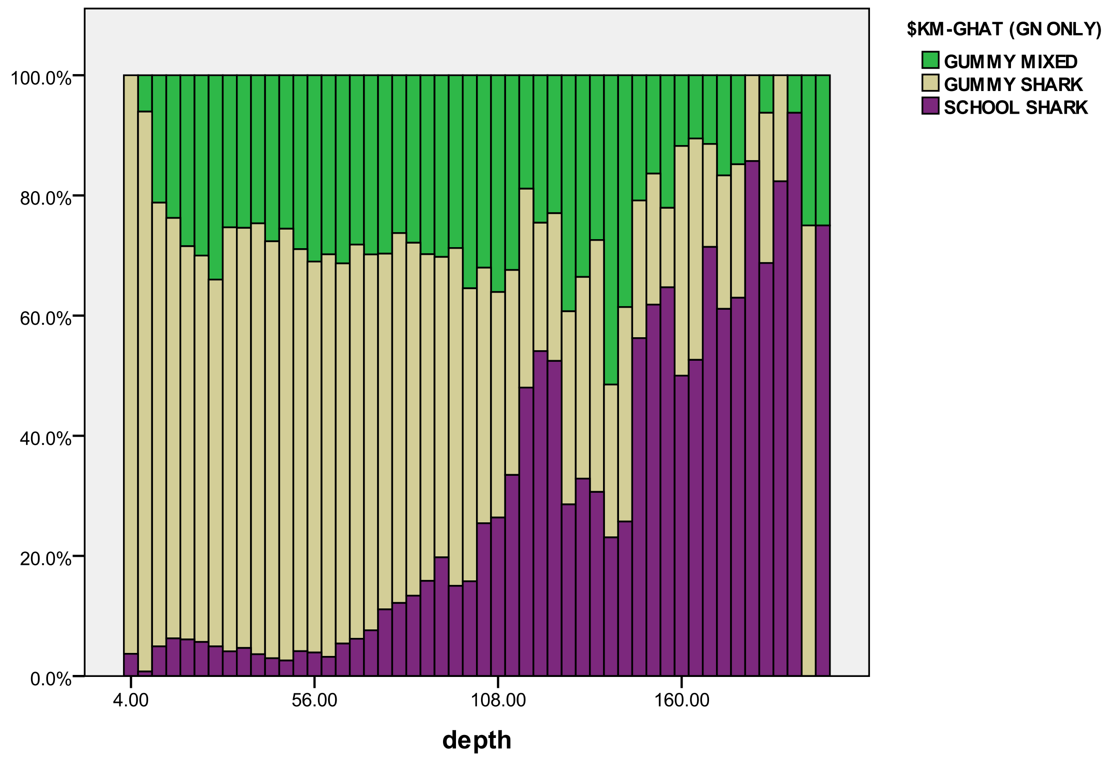

Figure 71 - Appendix B: GHaT (GN) Depth, Cluster (Normalised).

CDR/GENLOG Species Match

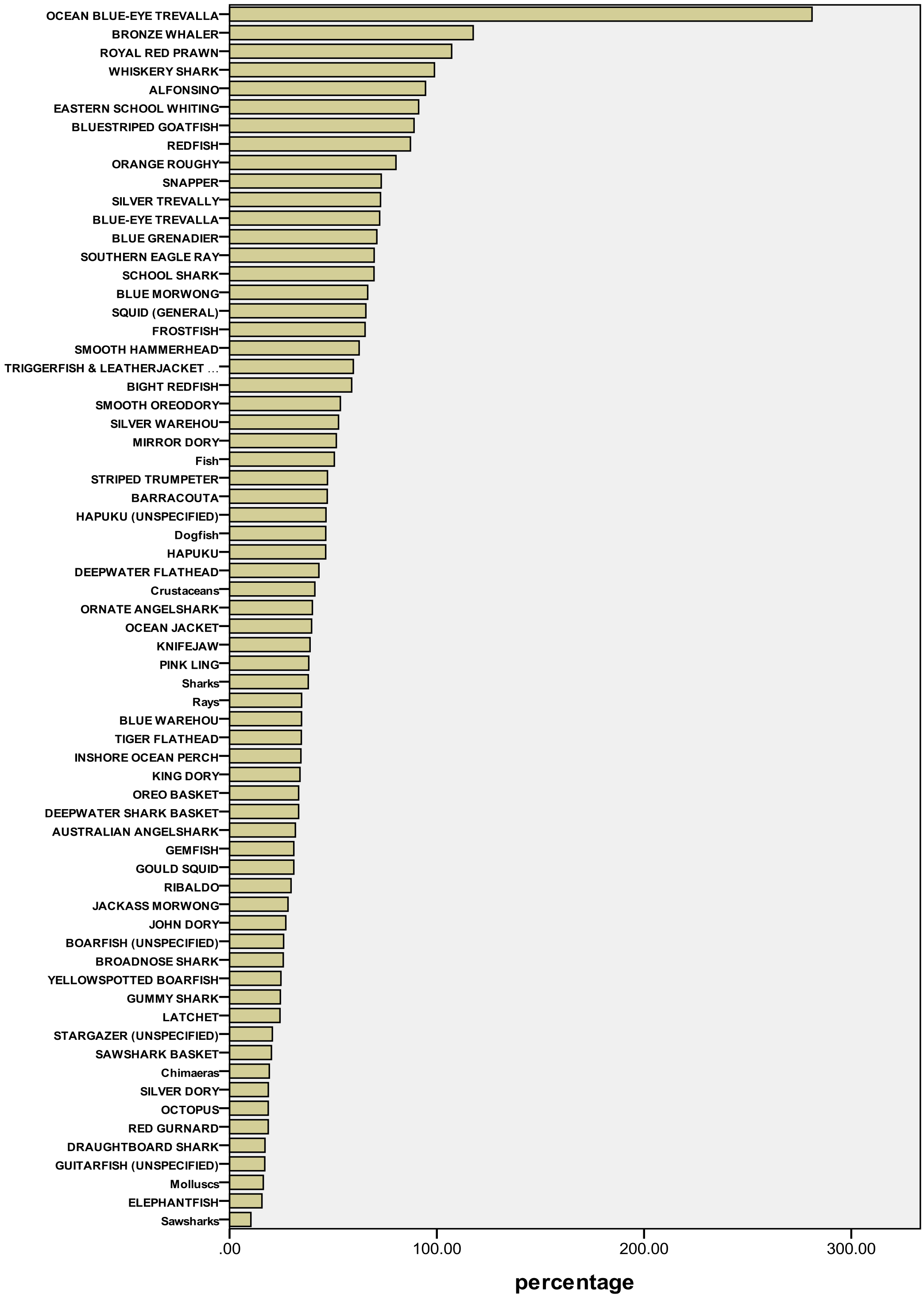

Figure 72 - Appendix B: GHaT (GN) Percentage of CDR in GENLOG by species (All Fisheries).

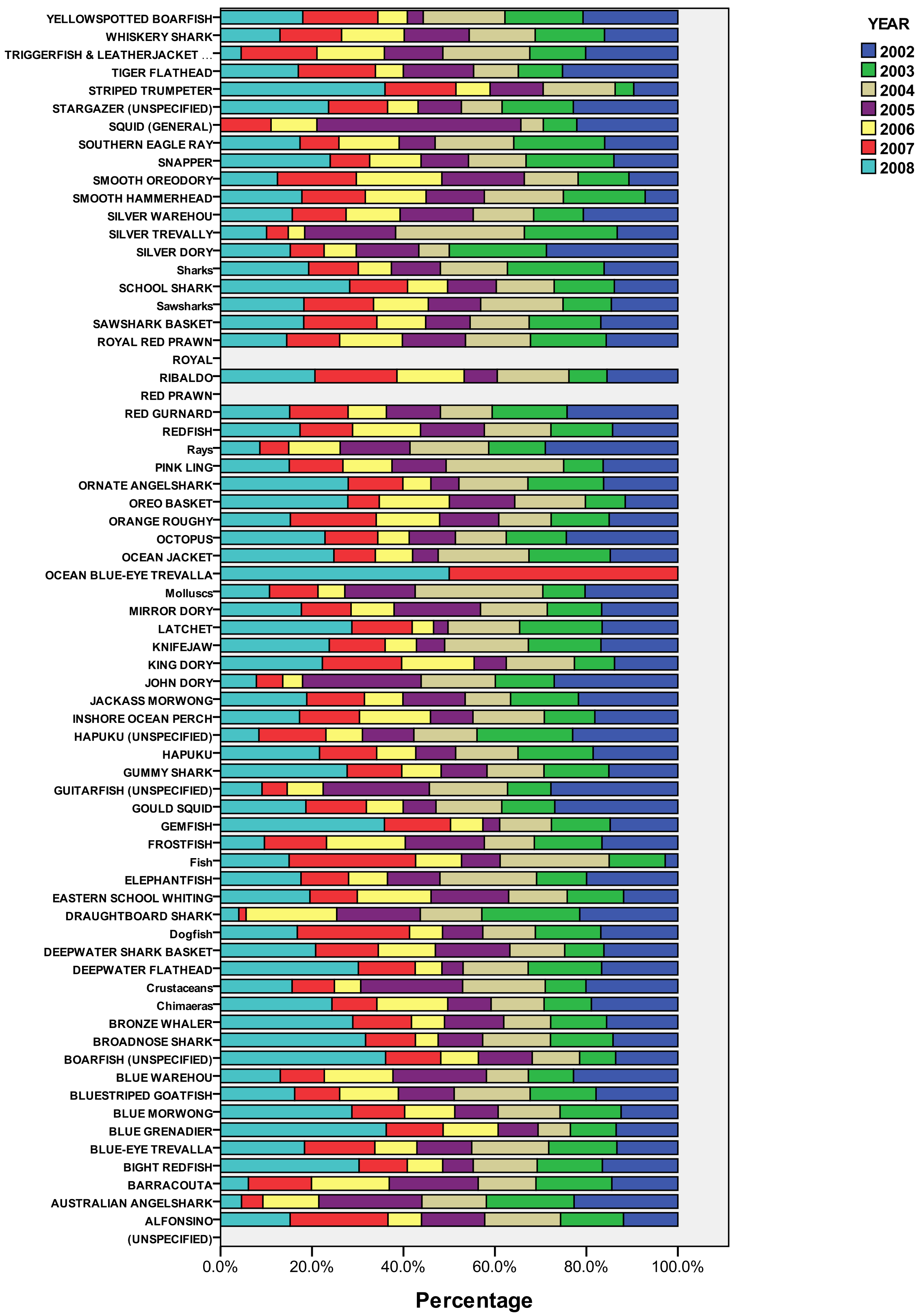

Figure 73 - Appendix B: GHaT (GN) Percentage of CDR in GENLOG by species and year (All Fisheries).

Appendix B - TEP Analysis

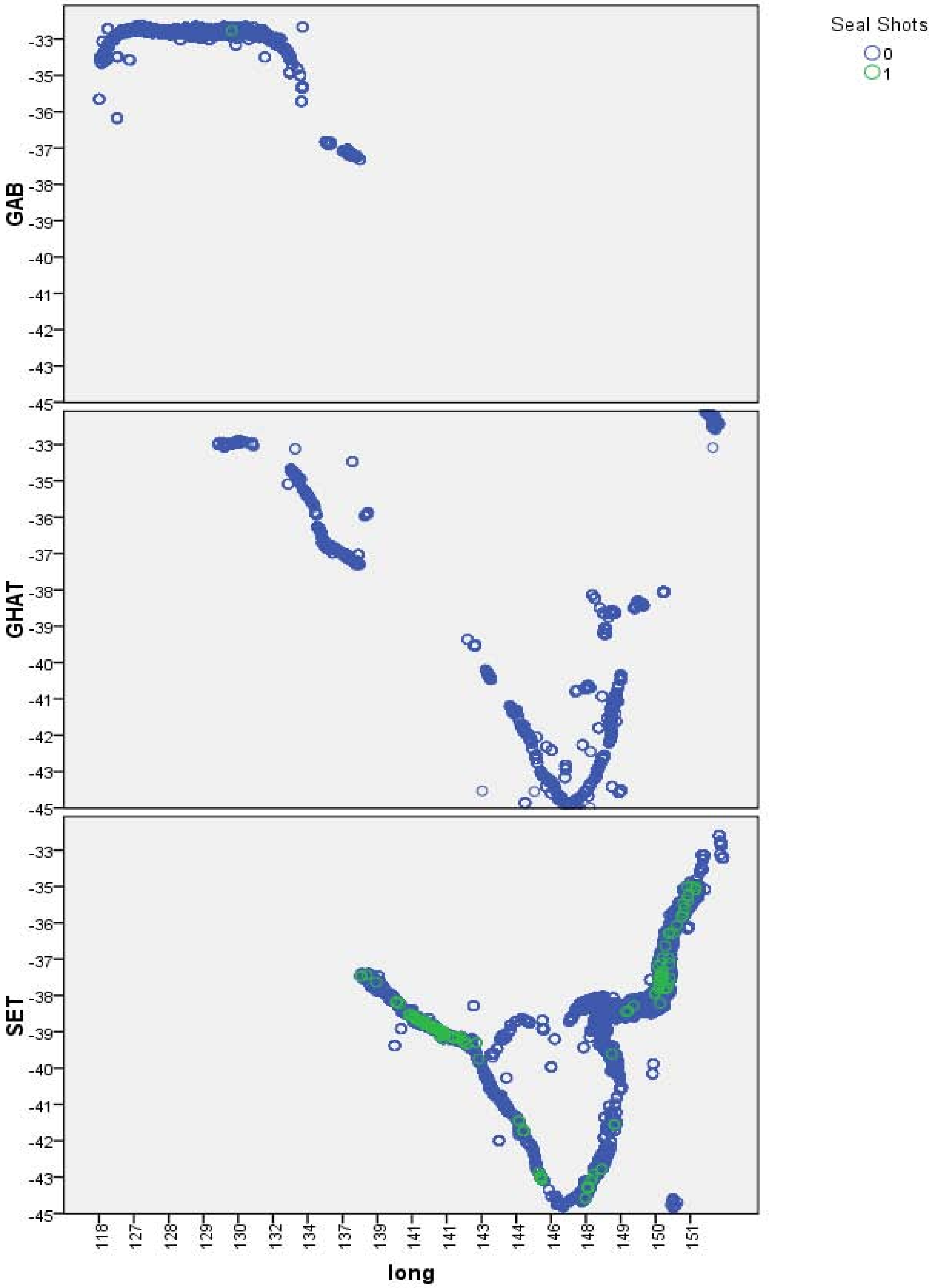

Figure 74 - Appendix B: TEP Analysis, Spatial Plot Seals.

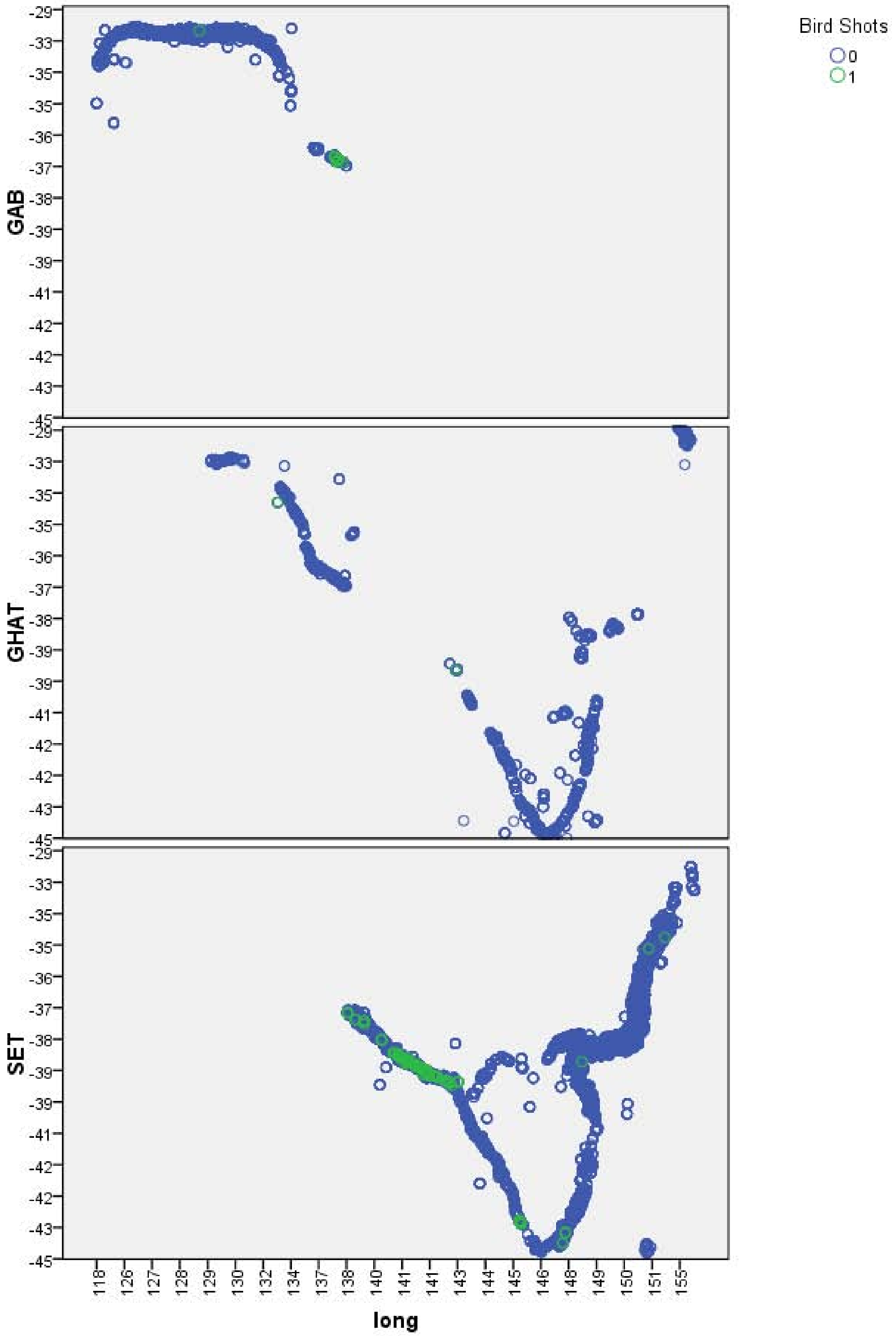

Figure 75 - Appendix B: TEP Analysis, Spatial Plot Birds.

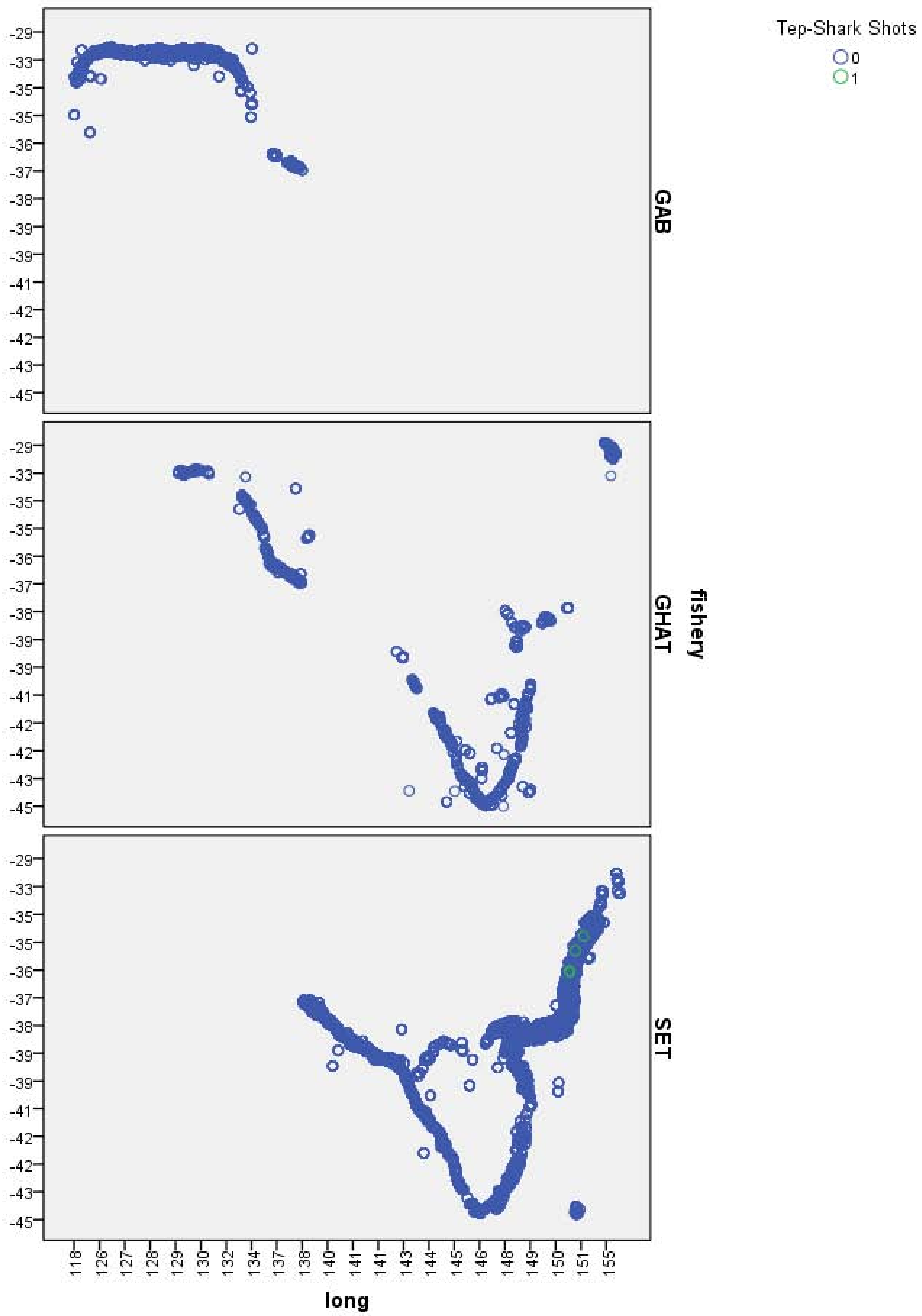

Figure 76 - Appendix B: TEP Analysis, Spatial Plot Sharks.

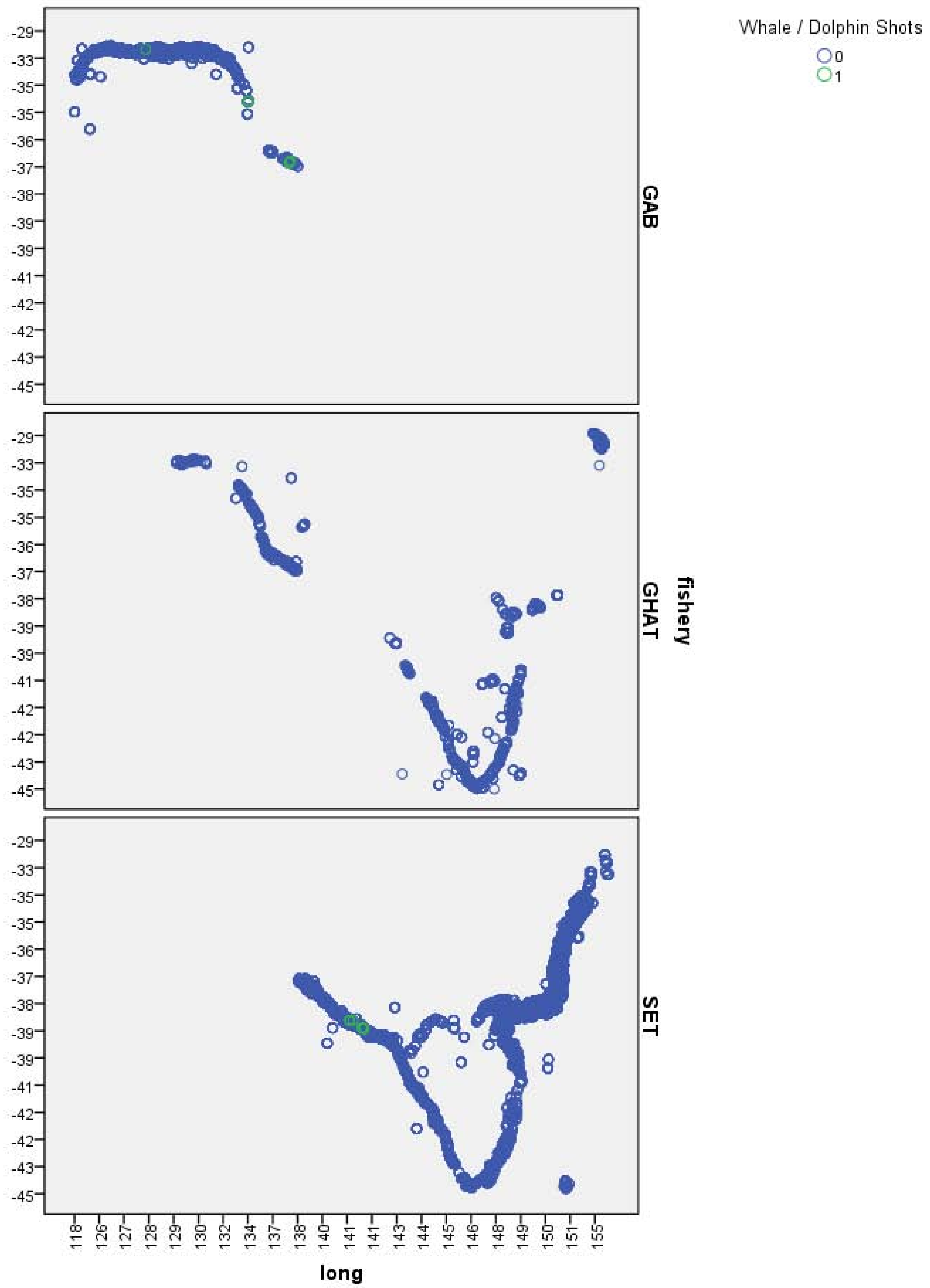

Figure 77 - Appendix B: TEP Analysis, Spatial Plot Whales/Dolphins.

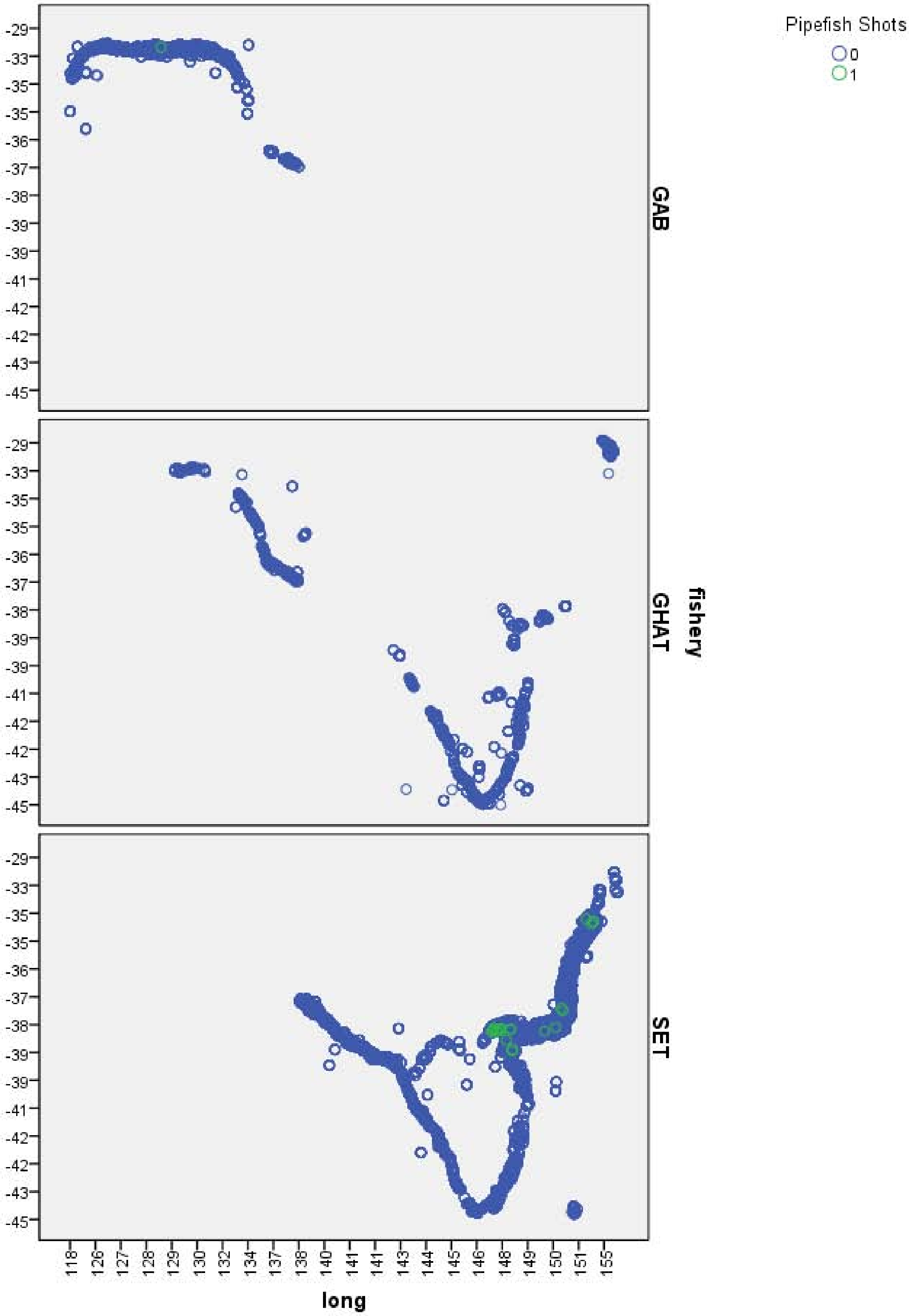

Figure 78 - Appendix B: TEP Analysis, Spatial Plot Pipefish.