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Fishery Independent Survey for the Southern and Eastern Scalefish and Shark Fishery – Winter 2016

Ian Knuckey, Matt Koopman and Simon Boag

2017

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Executive Summary

The Southern and Eastern Scalefish and Shark Fishery (SESSF) has a harvest strategy under which stock assessments are conducted for all quota species in order to set a recommended biological catch (RBC) and an annual Total Allowable Catch (TAC). Depending on the amount and quality of information available, these assessments range from fully quantitative integrated model-based assessments, to simple assessments based on trends in standardised commercial catch rates. Nearly all of the SESSF assessments use some form of catch per unit effort (CPUE) time series as the main index of stock abundance. Commercial CPUE data have some inherent issues as an index of abundance, particularly in a multispecies fishery, largely based on the critical assumption that there is a functional relationship between commercial catch rate and stock abundance. Key amongst these issues is that fishers modify their fishing practices, gear design and targeting to maximise returns from their quota in response to quota availability and market demands. In addition, complex management arrangements such as catch caps, bycatch limits, area closures, and gear restrictions are applied differently within and between the different SESSF sectors, also influencing the spatial and temporal patterns of fishing and hence CPUE. Discarding of quota species also occurs for a variety of reason but is not well reported in commercial logbooks. Further, several species are managed under 'bycatch' TACs, which prevents targeting and causes avoidance of certain areas at certain times of the year. All of these issues influence commercial CPUE and undermine its value as a good index of abundance.

Many of the above issues can be addressed using fishery independent surveys where the timing, location, fishing gear and fishing method is strictly controlled and conducted year after year to provide a time-series of abundance indices that are independent from commercial fishing. The growing need for an independent index of abundance saw the implementation of a multi-species independent trawl survey for the SESSF during 2008. Designed using a model-based approach to be more efficient and flexible compared to the conventional random stratified design, this survey has been conducted on a biennial basis ever since.

This report presents the results of the 2016 winter survey — the fifth survey in the time series. Details of the survey design can be found in Peel *et al.* (2012) and Knuckey *et al.* (2013). The survey was independently reviewed by O'Driscoll and Doonan (2015) who noted that value of a time series of surveys tends to increase over time and it was too early in the time series to make robust decisions on whether they should be continued or not. No major changes to the design were recommended although suggested improvements to minimise sources of variability were introduced during the 2016 survey including the use of motion-compensated scales on each survey vessel and specified start and ends points for each survey shot.

Three commercial trawl vessels were chartered to conduct surveys in eastern, NSW and western regions of the fishery during winter 2016. A total of 190 valid shots were conducted during July–September over 16 trips comprising 72 sea days. Total survey catch was 217.9 t, and comprised 256 different species or species groups. Total catches (including discards) of 82.3 t, 62.4 t and 73.2 t were caught in the eastern, NSW and western regions respectively. Main quota species caught were Blue Grenadier (44.1 t), Silver Warehou (23.7 t), Tiger Flathead (10.3 t), Mirror Dory (5.0 t) and Pink Ling (4.3 t). Pink Ling (100 shots), Silver Warehou (99 shots) and Tiger Flathead (97 shots), and were observed in the greatest number of survey shots.

A total of 16,278 length measurements were taken from 28 different species. Large numbers of length measurements were taken from Tiger Flathead (3,352), Bigeye Ocean Perch (1,728), Silver Warehou (1,582), Pink Ling (1,179) and Blue Grenadier (1,147). Otolith samples were taken from 1,875 fish comprising 19 different species including Tiger Flathead (449), Bigeye Ocean Perch (158), Gemfish (131) and Blue Grenadier (101).

In general, there is a broad correspondence between yearly survey catch weights and yearly abundance indices. There is good correspondence between years in the distribution of the number of survey shots spatially and in the two depth zones. There is also a good correspondence between the predicted and achieved CVs for most of the eleven main species considered in the survey design although during 2016, CVs were higher than expected for three species (Jackass Morwong, Silver Trevally and Redfish), and much lower for one species (Gemfish).

Reasonable CVs (≤0.3) were achieved for 12 species during the 2016 survey: John Dory (0..23), Gemfish (0.22), Tiger Flathead (0.12), Pink Ling (0.14), Mirror Dory (0.22), Silver Warehou (0.19), Gummy Shark (0.27), Blue Grenadier (0.23), Common Sawshark (0.15), Frostfish (0.30), King Dory (0.25) and Red Gurnard (0.24). Apart from Red Gurnard and Frostfish, CVs calculated for the species above have been below 0.30 in at least four of the five surveys conducted to date. The 2016 survey was the first in which the CV for Jackass Morwong (0.33) was above 0.3.

Five species show both an increase in total catch weight compared to all previous winter surveys and an increase in catch of more than 50% compared to the 2014 survey: Royal Red Prawn, Blue Grenadier, Jack Mackerel, Red Gurnard, Draughtboard Shark and Speckled Stargazer. In contrast, four species show both a decrease in total catch weight compared to all previous winter surveys and a decrease in catch of more than 50% compared to the 2014 survey: Eastern Gemfish, Silver Trevally, Alfonsino and Frostfish. Compared to the previous winter surveys, both the catch weights and the number of shots were considerably reduced for the following species in 2016: Eastern Gemfish, Jackass Morwong, Ocean Perch, Deepwater Flathead, Silver Dory and Spikey Oreodory.

The increasing time series of relative abundance is beginning to show consistent trends for some species / management units. Species / management units showing a steady increase in relative abundance include Western Pink Ling, Eastern Gemfish, Western Gemfish, Tasmanian Flathead, Ribaldo, Red Gurnard and Speckled Stargazer while all management units of Jackass Morwong, Blue Warehou, Frostfish have declined. Relative abundance of Eastern Pink Ling, Eastern Gummy Shark, Western Gummy Shark, School Shark, Common Sawshark and King Dory have remained relatively steady. A small number of very large "jackpot" catches caused the high variability in estimates of relative abundance of Silver Warehou between surveys.

All survey information has been prepared and transferred to CSIRO for use in the 2017 stock assessments and data summaries.

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Introduction

The Southern and Eastern Scalefish and Shark Fishery (SESSF) is one of Australia's largest fisheries and supplies much of the fresh fish to our domestic markets. The total landing of all species by the Commonwealth Trawl Sector (CTS) and Scalefish Hook Sector (ScHS) in 2015–16 was 9,026 t, and the 2014–15 gross value of production was $37.7m (Patterson, *et al*. 2016).

The SESSF has a harvest strategy, under which stock assessments are conducted for all quota species in order to set a recommended biological catch (RBC) and an annual Total Allowable Catch (TAC). Depending on the amount and quality of information available, these assessments range from fully quantitative integrated model-based assessments, to simple assessments based on trends in standardised catch rates. Nearly all of the SESSF assessments use some form of catch per unit effort (CPUE) time series as the main index of stock abundance, however CPUE data have some inherent problems, particularly in a multispecies fishery.

The main problem with using commercial CPUE as the primary index of abundance largely stems from the critical assumption that there is a functional relationship between commercial catch rate and stock abundance (Shelton 2005). The veracity of this relationship has been questioned for numerous fish stocks around the world (e.g. Clark and Mangel 1979; Hutchings and Myers 1994; Hutchings 1996; Walters and Maguire 1996; Rose and Kulka 1999), and there has been significant doubt regarding that relationship for many SESSF species for some time. Apart from the well documented effects of hyperstability (Hilborn and Walters 1992) and technology creep (Marchal *et al*. 2007), the SESSF has a number of other aspects that could readily affect the relationship between catch rates and abundance. With the large number of possible target species, fishers modify their fishing practices to suit quota availability and market demands. This means that it is often unclear what the target species of fishing effort is, and that effort may be expended on fishing grounds that are unsuitable for the species of interest. Compounding this problem is that patterns of fishing effort in the SESSF change from year to year and within seasons (Tilzey 1994). In addition, complex management arrangements such as catch caps, bycatch limits, area closures, and gear restrictions are applied differently within and between the different SESSF sectors, also influencing the spatial and temporal patterns of fishing and hence CPUE. Discarding of quota species also occurs for a variety of reason but has not been well reported in commercial logbooks historically. More recently, this has improved but the frequency and accuracy of reported discards is not at a standard that can be included in analysis of catch rates. Further, several species such as Eastern Gemfish and Blue Warehou have low or 'bycatch' TACs, which prevents targeting of those species and undermines the use of commercial CPUE as a good index of abundance.

Many of the above problems can be largely addressed by the implementation of fishery independent surveys to provide a time series of abundance indices that can be used in addition to, or instead of, commercial CPUE data (e.g. Gunderson 1993; Pennington and Strømme 1998). Although fishery independent surveys have been implemented for single species fisheries in the SESSF — such as for Orange Roughy (see summary in Kloser *et al.* 2011) and Blue Grenadier (Ryan and Kloser 2009) — there has always been a level of industry concern about the practicalities and cost-effectiveness of undertaking a fishery independent survey (FIS) for multiple species in the SESSF, which has prevented their implementation (Knuckey and Gason 2006). Despite these concerns, the growing need for an alternative and independent index of abundance saw the agreement to implement a multi-species fishery independent trawl survey during 2008.

As part of FRDC/AFMA Project 2006/028 "Implementation of fishery independent surveys for the Southern and Eastern Scalefish and Shark Fishery", a model-based survey design was

developed for the SESSF instead of a typical random stratified survey. This better enabled abundance estimates to be achieved for multiple species with low bias and reasonable (<30%) CVs (Peel *et al*. 2012). During this project, pilot surveys took place in summer and winter of 2008, and after review and subsequent small modifications to the design, the summer and winter surveys were repeated in 2010 (Knuckey *et al*. 2013a). The survey was continued in the summer and winter of 2012 (Knuckey *et al*. 2013b), with transitioning of the principal investigator position from Fishwell Consulting to the South East Trawl Fishing Industry Association (SETFIA) as originally intended.

Initially, both summer and winter surveys were conducted. During early 2012, SESSFRAG considered the CVs achieved during just the winter 2008 and 2010 surveys and agreed that it would be appropriate, given cost restrictions, to conduct only winter surveys, thereby achieving a good time-series of abundance estimates that could be used in stock assessments in a much shortened time period. The 2014 winter survey was conducted and is reported in Knuckey *et al*., 2015.

This report provides the results of the SESSF 2016 winter fishery independent survey. It appears that funds have also been committed to conduct a 2018 winter survey.

Objectives

1. Continue the time-series of fishery independent trawl surveys in the SESSF during 2016.
2. Provide fishery-independent indices of abundance for SESSF quota and byproduct species, particularly Tiger Flathead, Pink Ling, Jackass Morwong, John Dory, Mirror Dory, Redfish, Silver Warehou, Offshore Ocean Perch, Sawsharks, Blue Grenadier, and Gummy Shark.
3. Collect length frequencies and otoliths from all major quota species and selected high risk and non-quota species.
4. Prepare all survey information for use in fishery stock assessments and data summaries.

Material and Methods

SESSF Survey Design

The model-based approach used for the design of a FIS for the SESSF is described in Peel *et al*. (2012). Design components specific to the SESSF, and the rationale behind the sampling design using commercial trawls that was implemented in 2008, 2010, 2012, 2014 and 2016, are outlined in Knuckey *et al.* (2013a), Knuckey *et al*. (2013b) and Knuckey *et al*. (2015). We include a brief description of the methods, with emphasis on elements relevant for 2016, below.

In designing the SESSF FIS, the trawl CPUE data from shot by shot logbook records were analysed for eleven main species (Table 1) for two distinct seasons: summer (January to March) and winter (July to September). The SESSF CPUE dataset was used to inform the model-based survey design. The data include shot specific covariates such as location, depth, date, time of day, and shot duration. To minimize any confounding from operational changes, only summer and winter CPUE data between 2000 and 2005 were analysed, comprising about 50,000 shots (Upston *et al*. 2013). Since 2014, only the winter (July to September) season has been surveyed.

The survey area encompasses the entire extent of the Commonwealth Trawl Sector (CTS) (Figure 1), ranging eastward from Cape Jervis (longitude 138° 08′ 05″ E) in South Australia, around the Victorian, Tasmanian and NSW coastlines to Barranjoey Point (latitude 33° 34′ 54″).

This survey design uses depth and distance along a coastline curve (starting in South Australia) instead of using latitude and longitude to describe a location. Depth at a location is interpolated from bathymetric maps. Distance along the curve ("coastal position") is computed by projecting a location to the nearest point on the curve. Using this coordinate system, we model the two dimensions independently and parsimoniously, without the need for complicated interaction terms.

In the initial survey design, two strategies were adopted for depth sampling in the range 50–700 m, depending on season. The winter 2016 survey used the deeper of the two sampling strategies — as with previous winter surveys — to improve precision of Gemfish, Blue-eye Trevalla, and Mirror Dory.

The survey's spatial distribution was chosen to be an equal mixture of fisheries effort (focused near ports) and a uniform distribution across the spatial extent of the fishery. A further practical consideration was whether the ground was "trawlable" at a proposed sample site.

Figure 2 shows how the implemented design sits within the covariate space (i.e. coastal position versus depth) for each of the two survey seasons.

Field Methods

Detailed descriptions of field methods and vessel and gear specifications are reported in Knuckey *et al.* (2013a).

The position of these shots has been retained each year, with some modifications to avoid heavily fouled ground. Given the large geographical extent of the fishery, three survey vessels are chartered to complete the survey. Vessels were chartered through an open tender process, and the proceeds from the catch are retained by the project to offset costs. Shot locations were separated into three "regions" that can be defined as: NSW – Barranjoey Point to about Tathra (-37.71˚ S); East – Tathra to around south-eastern Tasmania to 146˚ E; and West – 146˚ E to Cape Jervis. While the East–West split was required because of the differences in fishing gear needed to fish those areas, the location of the NSW–East split was set to evenly distribute shots between vessels. Skippers were required to have local knowledge of their respective regions.

Standardised "generalist" survey nets and doors were used for the survey, with one net designed for the NSW and east survey region and a net design more suited to rougher ground in the west region (Table 2). Skippers were given start and end locations of survey sites, and were required to tow at a speed of 3 knots for a minimum duration of 1.5 hours. As far as practicable, skippers were required to follow a constant depth contour, start and end within 0.4 nautical miles of the start and end positions and to only set between the hours of 0500 and 1800 hrs.

Each survey vessel carried a scientific observer who was responsible for sampling the entire catch. Once on board, fish were identified to the lowest taxonomic level possible, and their total weights either measured or estimated. All three survey vessels carried calibrated electronic motion compensating scales to accurately weigh the total catch of quota species where possible. Very large catches of quota species were typically estimated by multiplying the number of bins of fish by the average weight of bins for that species. Catches of commercial species were verified by comparing estimates to landed weights. Length frequency measurements and otoliths were taken for important commercial species. Data were entered and archived on Olrac Dynamic Data Logger (V5.0.1). Where possible, LOTEK LAT1400 temperature-depth recorders were deployed on the nets during survey tows to record date, time, depth and temperature at the net at specified time intervals.

SESSF Model

A full technical description of the SESSF model is included in Peel *et al.* (2012) with a brief summary in Upston *et al.* (2013). Analyses were conducted in R (R Development Core Team, 2012[1]). R code used to run the model and produce outputs was developed by CSIRO.

The parameters to be estimated from each survey comprise only the change in spatial distribution of each species relative to its long term average, plus the overall mean for the year (Peel *et al.* 2012, Upston *et al.* 2013). To maintain the same structure and basis as the original fit, the survey model was re-parameterised using the model matrix and smooth matrix from the historical CPUE data fit. A new dispersion parameter was fitted to the survey data, and this reflects the sampling variance.

Relative abundance indices and CVs for 11 main species and select additional species were reported for winter in each survey year (2008, 2010, 2012, 2014 and 2016). There are some caveats in interpreting the relative abundance indices, and these are included in the footnotes of tables. The different trawl nets used in the east and west regions since 2010 are implicitly assumed to be comparable in their ability to catch species and can be treated as a single gear type. For the first time, CVs and abundance indices are also reported for management units where appropriate. For those species with eastern and western management units, any differences in selectivity between the two net configurations with no impact of abundance indices.

Quality Assurance

All data were recorded in an observer version of ORLAC Dynamic Data Logger (DDL), which includes quality insurance protocols including automatic data capture (time, date and position), field restrictions, range checks, mandatory fields and lookup tables. All data are manually error checked against data sheets before loading into the shore version of ORLAC DDL. This database is regularly backed up, and used to extract data for analyses. A subset of data summary outputs was reproduced and compared using an alternative software package.

Independent review of the survey design

The survey was independently reviewed by O'Driscoll and Doonan (2015). Although they were not sure that the complicated "model-based design" was required, they did not explore alternative survey options as they appeared to be cost-prohibitive for monitoring of the SESSF species.

They suggested that survey frequency should be dictated by monitoring and management objectives and fish biology, but recognised the risk of potentially misleading results is reduced for an annual time series. They noted the value of time series of surveys tends to increase over time, not only for individual species monitoring, but also for the development of additional indices for "environmental monitoring" (i.e., for bycatch species) and concluded that four surveys was too few to be able to assess this potential adequately.

They suggested that alternative approaches include CPUE analyses and more specific species-targeted surveys. They noted that CPUE analyses have potential to monitor fishery performance, but are best used when they have been validated to monitor abundance. Regular updates of CPUE analyses for some key species may be useful, in conjunction with surveys, to determine relative suitability over the longer term. The trawl survey time series is too short at this stage to make meaningful comparisons with CPUE trends.

[1] The superseded R version 2.14.2 was required by one of the packages used.

Overall, no major changes to the design were recommended although they suggested it would be useful to address the following:

- Determining for which species the demersal surveys method is most appropriate;
- Minimising sources of variability in abundance indices (e.g., by calibration of the survey vessels against each other);
- acoustic observations could be incorporated into the surveys to provide more information on inter-annual changes in vertical and areal availability of fish;
- Determination of factors affecting fish catchability and selectivity (in particular, seasonal changes in vertical and areal availability and aggregations; recording of maturity stage); and,
- More detailed examination of variability in size frequency and abundance indices (including CPUE) both spatially (including vertical distribution) and temporally, in relation to known stock distribution and movement and juvenile areas.

Work is underway to consider these recommendations and during 2016, we implemented various improvements to minimise sources of variability including the use of motion-compensated scales on each survey vessel and specified start and ends points for each survey shot.

Results and Discussion

Survey Coverage

Vessels selected to conduct surveys in eastern, NSW and western regions were the Western Alliance, Francesca and Moira Elizabeth respectively. With support from AFMA, vessels were issued scientific permits allowing them to use nets designed specifically for the survey (without bycatch reduction devices installed), and conduct survey shots located in fisheries closures (Western Alliance – permit number 1003124; Francesca – permit number 1003125; and Moira Elizabeth – permit number 1003123. A total of 190 valid shots were conducted during July–September 2016 (Table 3, Table 5, Table 11 and Figure 3), over 16 trips comprising 76 sea days. The mean tow speeds in all regions was 3.0 kts (Table 3).

Catch Composition

From the 190 valid shots, total catch during the winter 2016 FIS was 218 t, and comprised 256 different species or species groups (Table 10). Main quota species caught were Blue Grenadier (44.1 t), Silver Warehou (23.7 t), Tiger Flathead (10.3 t), Mirror Dory (5.0 t) and Pink Ling (4.3 t) (Figure 4 and Table 10). Pink Ling (100 shots), Silver Warehou (99 shots) and Tiger Flathead (97 shots), and were observed in the greatest number of shots (Figure 5).

Totals catches of 82.3 t, 62.4 t and 73.2 t were caught in the eastern, NSW and western regions respectively (Table 10). In the NSW region, Blacktip Cucumberfish (7.8 t, 13% of the total catch in that region), Whiptail & Rat-Tail (U) (7.0 t, 11.3%), Mirror Dory (4.5 t, 7%), and Spikey Dogfish (4.3 t, 7%) made up the majority of the catch (Figure 6, Figure 9 and Table 10). Other quota species caught in large quantities in the NSW region were Tiger Flathead (2.2 t, 4%) and Bigeye Ocean Perch (0.9 t, 1%). Silver Warehou (20.3 t, 25%), Tiger Flathead (7.8 t, 10%), Cocky Gurnard (3.7 t, 7%), Roundsnout Gurnard (5.2 t, 6%) and Barracouta (4.1 t, 5%) were the top five species caught in the eastern region (Figure 7, Figure 9 and Table 10), followed by Blacktip Cucumberfish (2.6 t, 3%), Toothed Whiptail (2.3 t, 3%) and Jack Mackerel (1.6 t, 3%). Species caught in the greatest quantities in the western region (Figure 8, Figure 9 and Table 10) were Blue Grenadier (42.8 t, 59%), Silver Warehou (3.3 t, 5%), Australian Burrfish (3.3 t, 5%), Pink Ling (2.7 t, 4%) and Latchet (2.3 t, 3%).

Length Frequencies

A total of 16,278 length measurements were taken from 28 different species during the 2016 FIS (Table 4). Large numbers of length measurements were taken from Tiger Flathead (3,352), Bigeye Ocean Perch (1,728), Silver Warehou (1,582), Pink Ling (1,179) and Blue Grenadier (1,147). Otolith samples were taken from 1,875 fish comprising 19 different species including Tiger Flathead (449), Bigeye Ocean Perch (158), Gemfish (131) and Blue Grenadier (101).

Lengths frequency distributions for major species from 2008, 2010, 2012, 2014 and 2016 surveys are shown in Figure 10 – Figure 29.

Size distributions for many species have remained stable over the duration of the FIS. For example, distributions for Tiger Flathead from the east have had modes of 35–40 cm with a scattering of larger fish, while those from NSW modes of 32–35 cm, however fish measured during the 2014 survey were notably smaller in both regions (Figure 22). The cause of this was unlikely to be caused by the survey, as the same methods and observers used in 2014 were the same as previous years. Length frequency distributions of Bigeye Ocean Perch were also consistent between years, with most fish 20–35 cm length in all regions (Figure 10). Clear cohorts can be seen in the length frequency distributions for some species. Eastern Gemfish recruits have appeared in samples from NSW most years (except 2010), ranging 25–35 cm fork length (Figure 15). No small Eastern Gemfish were measured in the Eastern region during the first three years of surveys, but during 2014 and 2016, 25–30 cm fish were measured. Different cohorts can also be seen for Blue Grenadier (Figure 11), Mirror Dory (Figure 17) and Silver Warehou (Figure 21).

CVs and relative abundance estimates

In general there is a broad correspondence between yearly survey catch weights and yearly abundance indices (Table 7, Table 8, Figure 30, Figure 32, Figure 33), in the distribution of the number of survey shots spatially and in the two depth zones between years (Table 5). There is also a good correspondence between the predicted and achieved CVs for most of the eleven main species considered in the FIS design for the 2016 winter survey (Table 6). Those that deviated from the predicted CVs were Jackass Morwong, Silver Trevally and Redfish. Catches and the numbers of shots in which those species were caught have significantly declined since the 2008 survey (Figure 32, Figure 33). While good CVs have never been obtained for Silver Trevally, CVs have steadily increased for Jackass Morwong from 0.20 in 2008 to 0.33 in 2016. Good CVs were calculated for Redfish in 2008, 2010 and 2014.

The total catch weights of quota and main species used by the model[2] for each winter survey are listed in Table 7. Five species show both an increase in total catch weight compared to all previous winter surveys and an increase in catch of more than 50% compared to the 2014 survey: Royal Red Prawn, Blue Grenadier, Jack Mackerel, Red Gurnard, Draughtboard Shark and Speckled Stargazer (Table 7). In contrast, four species show both a decrease in total catch weight compared to all previous winter surveys and a decrease in catch of more than 50% compared to the 2014 survey: Eastern Gemfish, Silver Trevally, Alfonsino and Frostfish (Table 7).

Reasonable CVs (<0.30 and without a flag for diagnostics) were obtained for nine quota species and three additional species (Table 8). Compared to the previous winter surveys, both the catch weights and the number of shots were considerably reduced in 2016 for:

[2] This only includes catches of 1kg or more from shots that fall within the prediction grid for that species.

- Tier 1 species – Eastern Gemfish, Eastern and Western Jackass Morwong, Deepwater Flathead (Figure 32, Figure 33); and
- Tier 3 and 4 and non-quota species: Blue Warehou, Ocean Perch and Frostfish (catch weight only) (Figure 34).

This contributed to resulting CVs of greater than 0.30 in 2016 for some of those species (Table 8). The 2016 abundance indices and CVs for all species / management units used in assessments by the CSIRO are provided in Table 9.

As the time series increases, consistent trends in the relative abundance of some species are becoming apparent (Figure 30). Western Pink Ling, Eastern Gemfish, Western Gemfish, Tasmanian Flathead, Ribaldo, Red Gurnard and Speckled Stargazer have all shown steady increases in relative abundance, while all management units of Jackass Morwong, Blue Warehou, Frostfish have declined. Relative abundance of Eastern Pink Ling, Eastern Gummy Shark, Western Gummy Shark, School Shark, Common Sawshark and King Dory have remained relatively steady. Overall, Flathead do show an increasing trend in relative abundance, and while the large increase in 2010 followed by a decrease in 2012 conflicts with this trend, 95% CIs calculated for those two years overlap with each other, and with those from 2016.

The increasing trend of Eastern Gemfish is curious given it the decrease in catch (Figure 32) and number of shots observed (Figure 33). Looking at the frequency of catch sizes, the 2016 survey recorded no catches greater than 40 kg, while catches of up to 500 kg were recorded in previous years (Figure 35). Comparison of diagnostics from with previous years reveals that the abundance estimates could be influenced largely by the higher than expected catches at the southern end of their range, and lower than expected catches in northern end of their range (Figure 39, Knuckey *et al*., 2013b, Knuckey *et al*., 2015). A planned study to re-assess the validity of assumptions used in SESSFIS model should further explain this result.

Silver Warehou stands out as the species with the largest range in the survey catch weight per shot and in the maximum shot size between years. The four largest shots for Silver Warehou in 2008 were over 3,000 kg, with no shots larger than 2,000 kg in 2010 or 2012, no shots over 1,000 kg in 2014 and catch of 17,000 kg in 2016 (Figure 35). The abundance estimates for Silver Warehou vary dramatically from one survey to the next. These results suggest that the variance is underestimated for this species, and that the impact of a few large "jackpot" shots on the survey results could be producing confounding results in this case. Results like this from a schooling species could distort the abundance estimates, so the abundance estimates for this species should be treated with some caution. These unusually large catches per shot were removed prior to analysis of the historical CPUE data for the full model to allow for more stable estimation of spatial variability (Knuckey *et al*. 2013). The large catches were thought to be a consequence of specific and unusual targeting practises aimed at large aggregations, which were assumed to be unlikely to occur in the FIS itself (Knuckey *et al.* 2013). While targeting of large aggregations of fish is unlikely to occur in the FIS, unusually large catches do occur through chance in some years. This will result in the under-estimation of the CV for the abundance index by the model (Day and Peel, 2015).

Conclusions

The results of this survey provide the fifth year of a fishery independent survey for SESSF species over a ten-year period in the area of the CTS. The primary objectives (objectives 1 and 2) of this project were to increase the time series of fishery independent estimates of abundance indices with reasonable CVs (<=0.3) for main quota and byproduct species. This was achieved

(Table 8) for John Dory (0.23), Gemfish (0.22), Tiger Flathead (0.12), Pink Ling (0.14), Mirror Dory (0.22), Silver Warehou (0.19), Gummy Shark (0.27), Blue Grenadier (0.23), Common Sawshark (0.15), Frostfish (0.30), King Dory (0.25) and Red Gurnard (0.24). CVs for most of those species (not Red Gurnard or Frostfish) have been <=0.3 in at least four of the five surveys conducted. The 2016 survey was the first in which the CV for Jackass Morwong (0.33) was above 0.3.

The third objective was to collect length frequencies and otoliths from all major quota species and selected high risk and non-quota species. 16,278 length measurements were taken from 28 different species including Tiger Flathead (3,352), Bigeye Ocean Perch (1,728), Silver Warehou (1,582), Pink Ling (1,179) and Blue Grenadier (1,147). 1,875 pairs of otoliths were taken from fish comprising 19 different species including Tiger Flathead (449), Bigeye Ocean Perch (158), Gemfish (131) and Blue Grenadier (101).

The forth objective was to prepare all survey information for use in stock assessments and data summaries. The data (abundance, CVs and length frequencies) have been sent to CSIRO. Collaboration with CSIRO during the design, implementation and continuation of the FIS ensures that data collected can be easily incorporated into stock assessments. In addition, large numbers of length measurements and otolith samples were taken from a variety of species for use in the stock assessments.

Acknowledgments

We wish to thank owners Mr David Guillot, Mr Tom Bibby, Mr Vince Bagnato and Mr Tony Bagnato for their involvement in the 2016 survey; and the skippers and crew of the Western Alliance, Moira Elizabeth and Francesca for their professional approach, advice and efforts. Support from Australian Fisheries Management Authority greatly assisted the ongoing implementation of a fishery independent survey for the SESSF region. Scientific observers for the 2016 surveys were Michael Davis, Russell Hudson and John Cooper. The initial FIS model and R code was developed by Mark Bravington, David Peel and Natalie Kelly of CSIRO CMIS, and developed further by Judy Upston and Jemery Day (CSIRO). David Peel and Jemery Day (CSIRO) provided the R code and advice on analysis of 2016 data.

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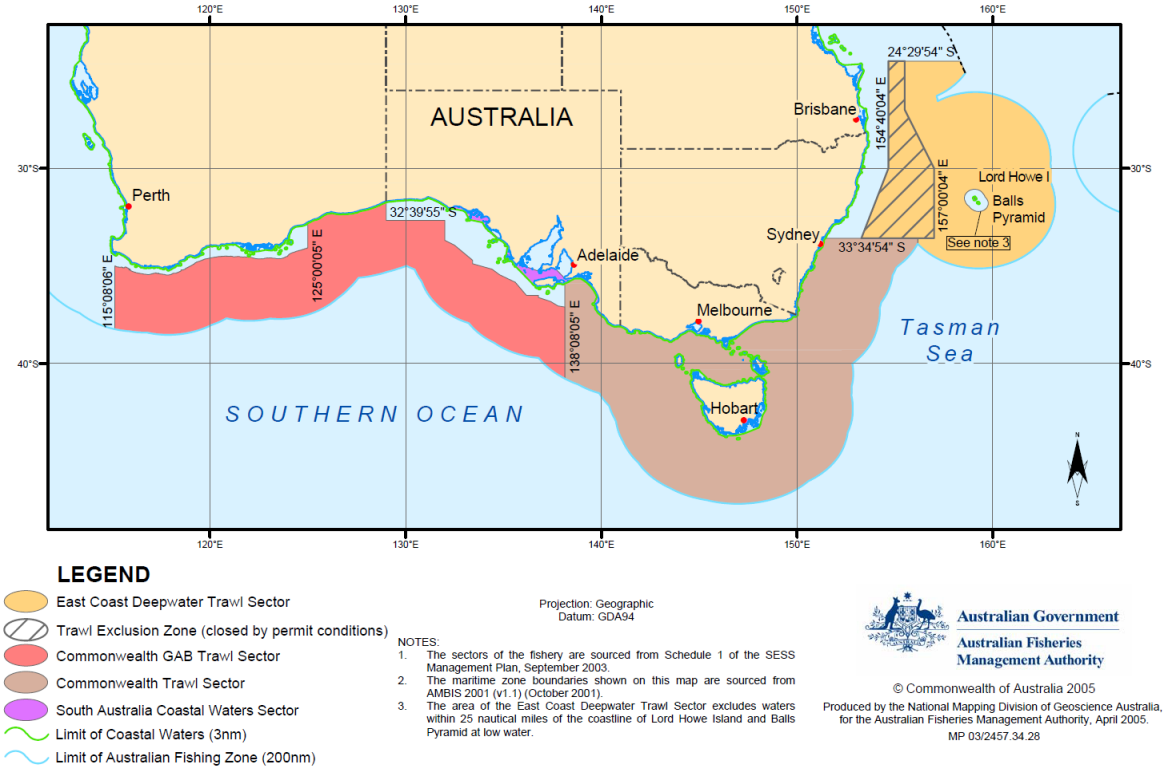

Figure 1. The Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery.

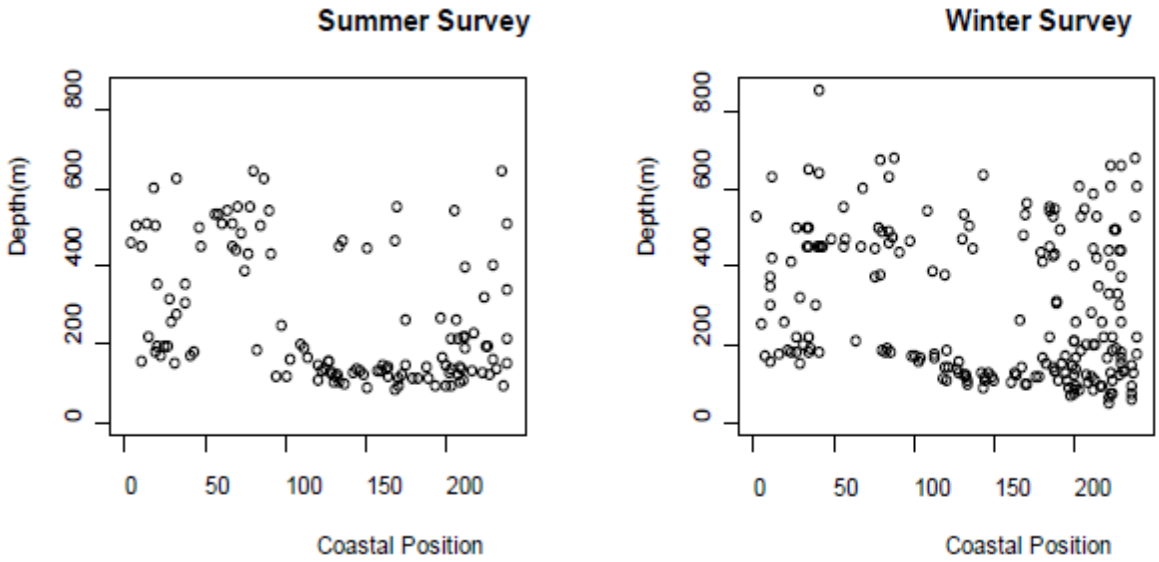

Figure 2. Covariate coverage (i.e. depth versus coastal locations) for the survey in summer and winter.

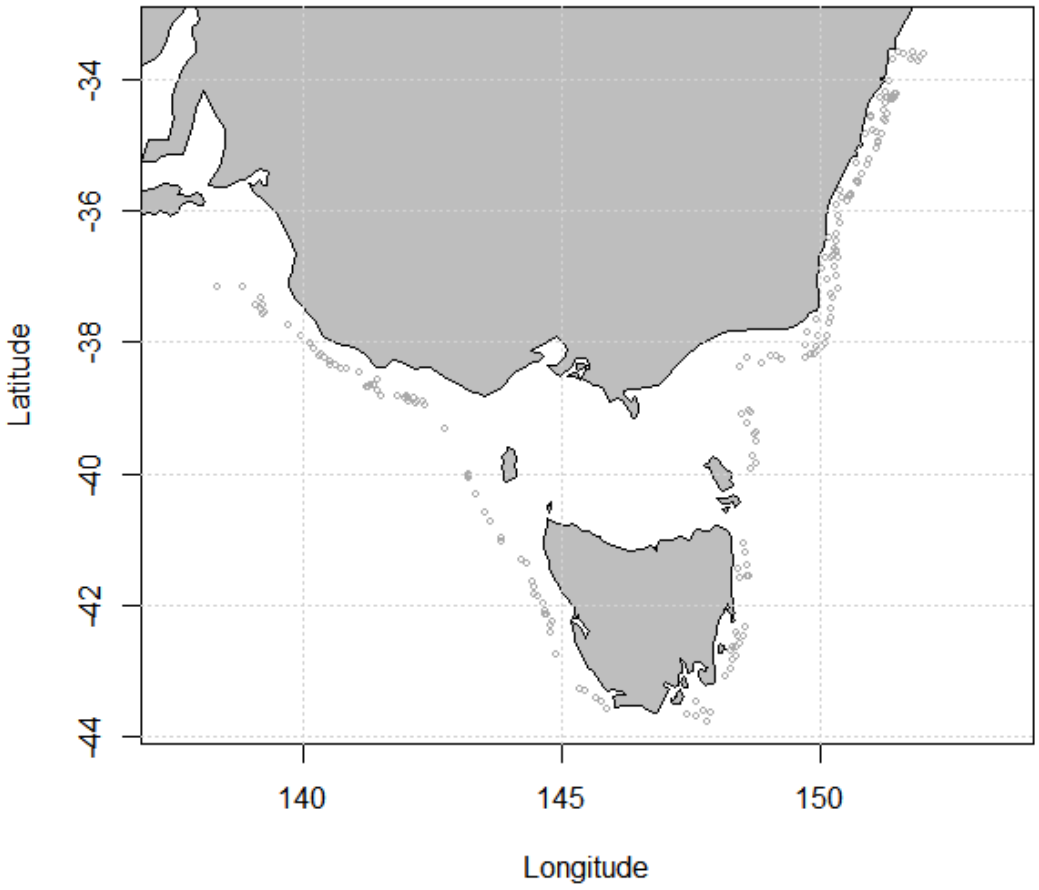

Figure 3. Locations of valid shots undertaken during the 2016 survey.

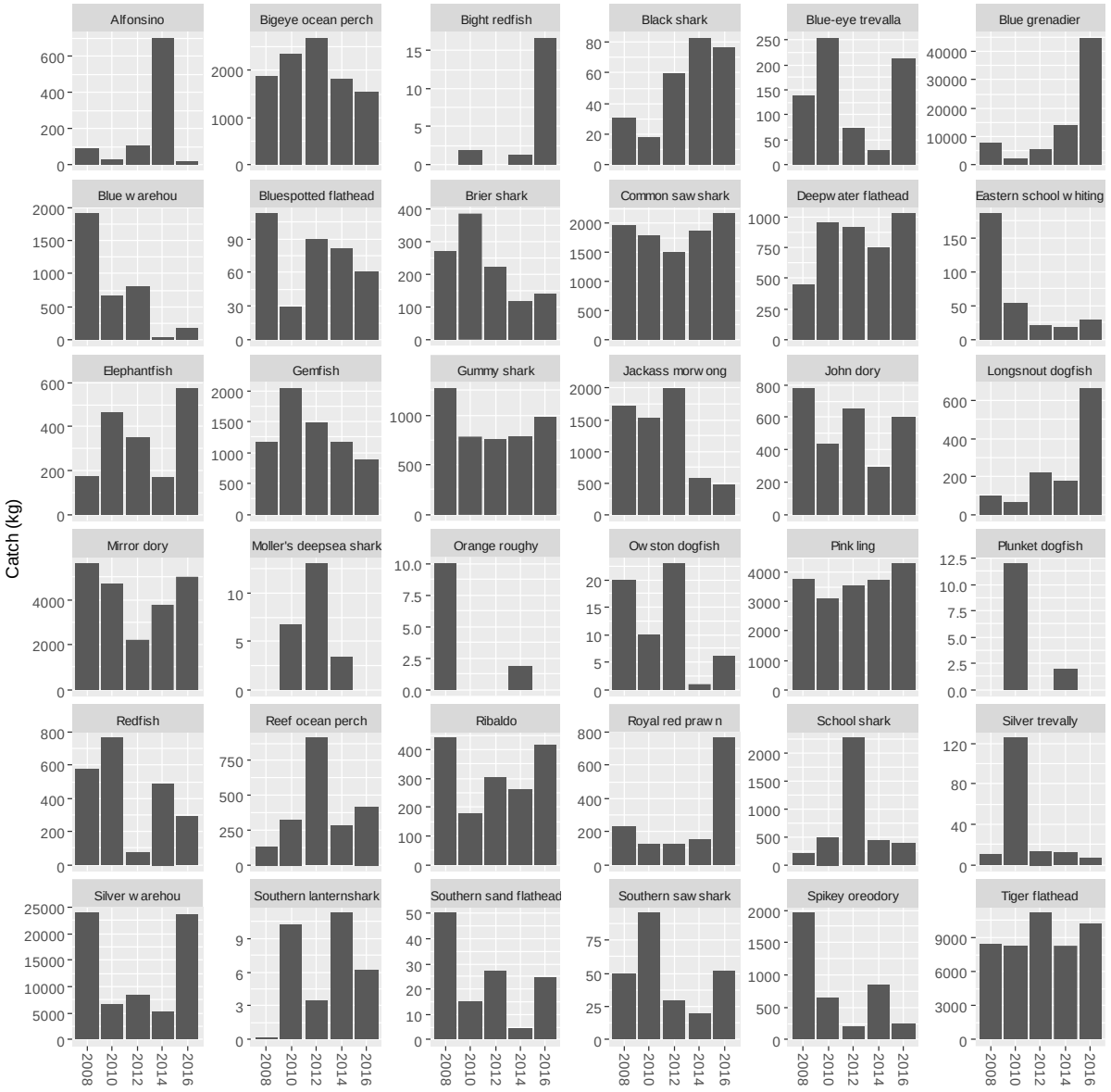

Figure 4. Total catch (kg) of quota species (including basket species) during winter 2008, 2010, 2012, 2014 and 2016 surveys.

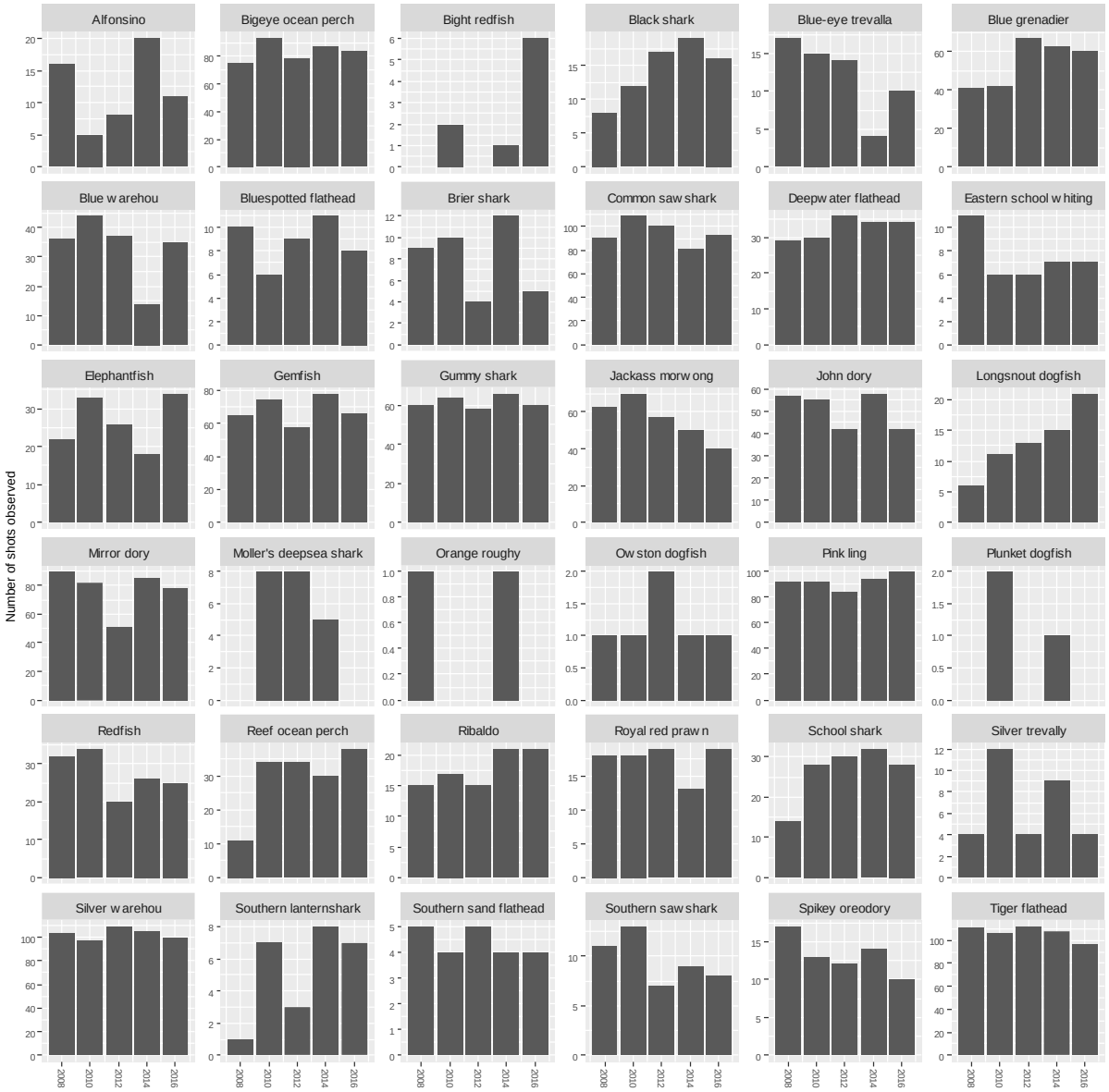

Figure 5. Number of shots containing quota species (including basket species) during winter 2008, 2010, 2012, 2014 and 2016 surveys.

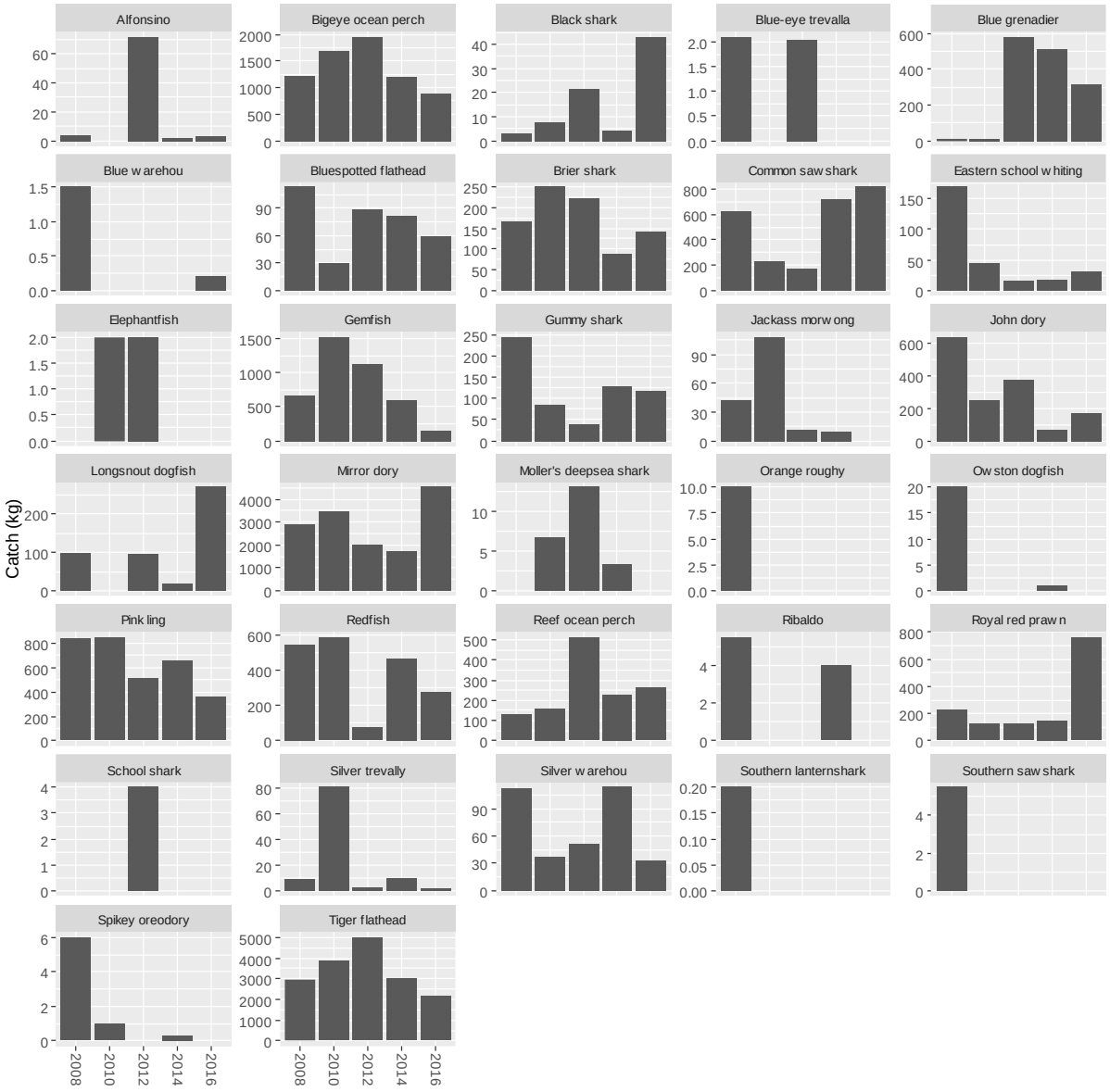

Figure 6. Total catch (kg) of quota species (including basket species) in NSW during winter 2008, 2010, 2012, 2014 and 2016 surveys.

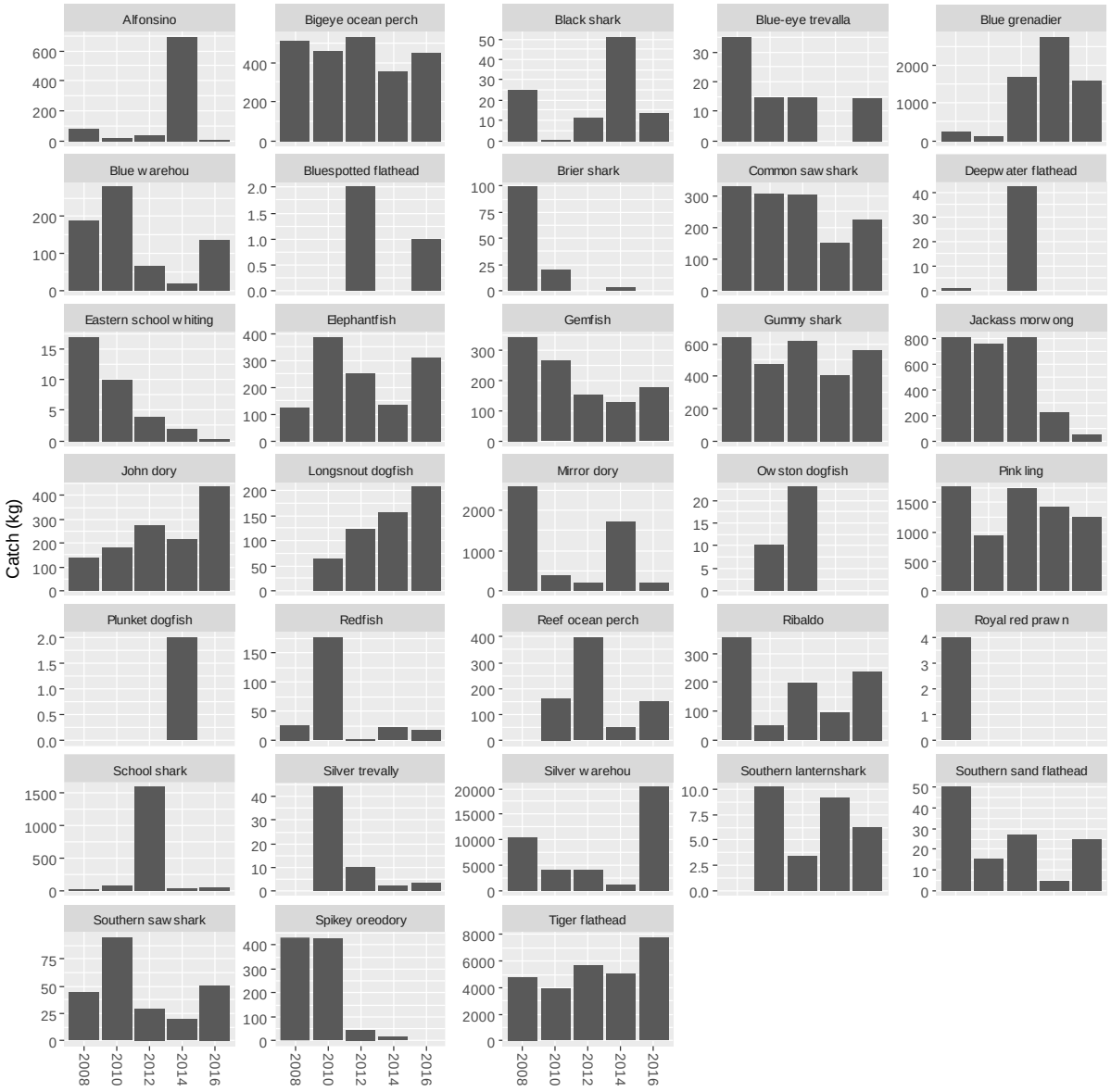

Figure 7. Total catch (kg) of quota species (including basket species) in the Eastern region during winter 2008, 2010, 2012, 2014 and 2016 surveys.

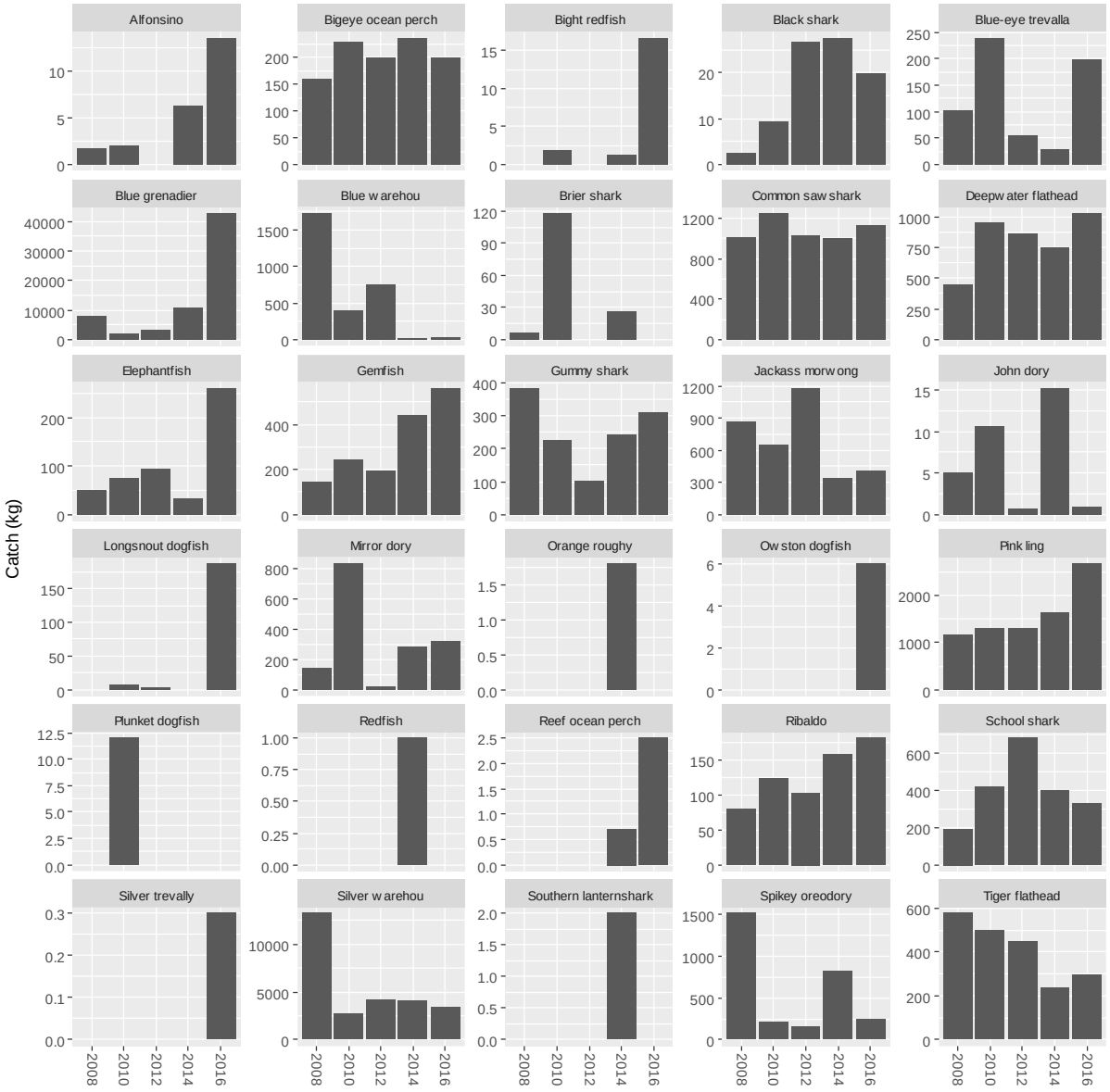

Figure 8. Total catch (kg) of quota species (including basket species) in the Western region during winter 2008, 2010, 2012, 2014 and 2016 surveys.

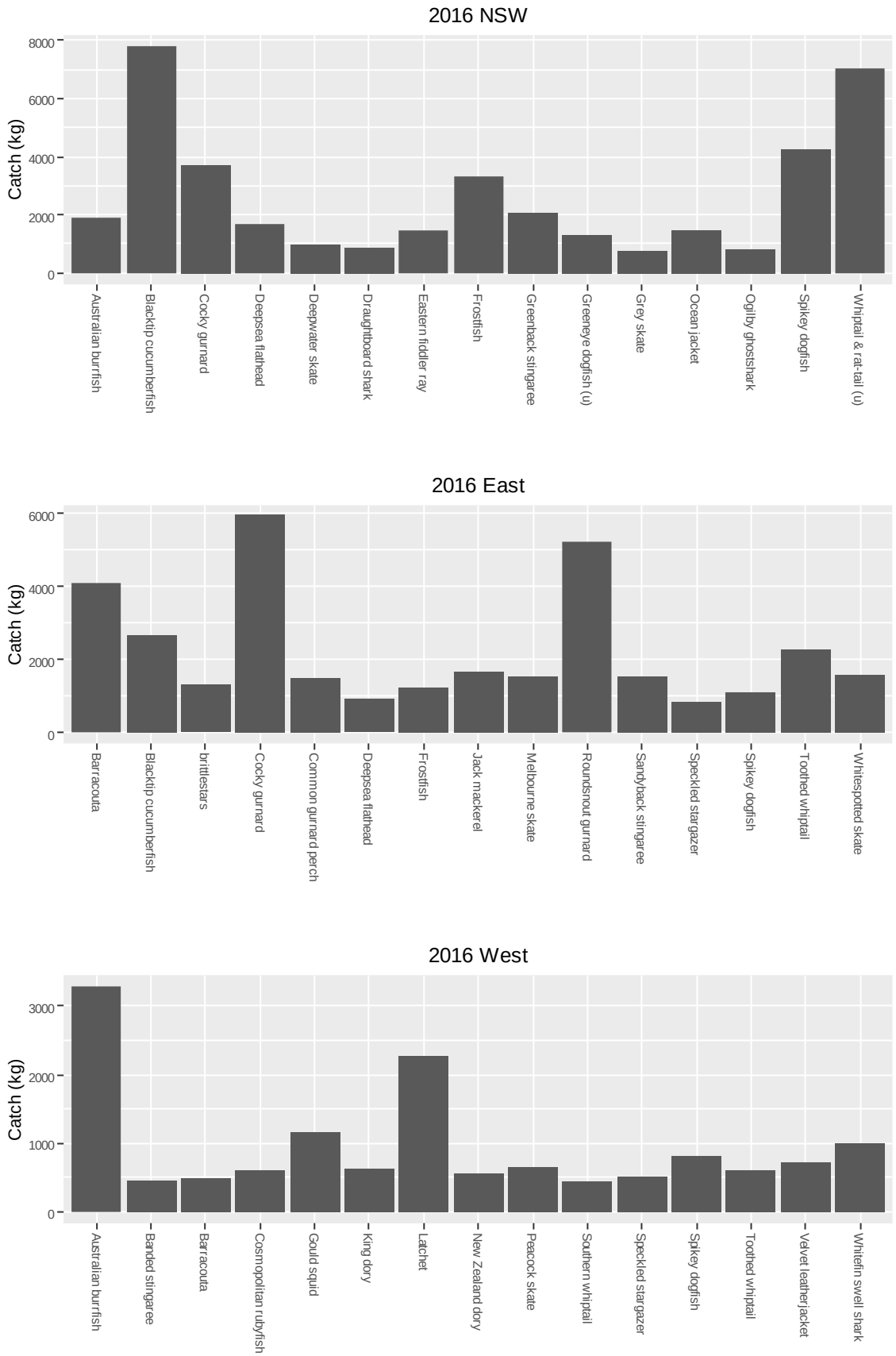

Figure 9. Catches of the top 15 non-quota species in each region during winter 2016.

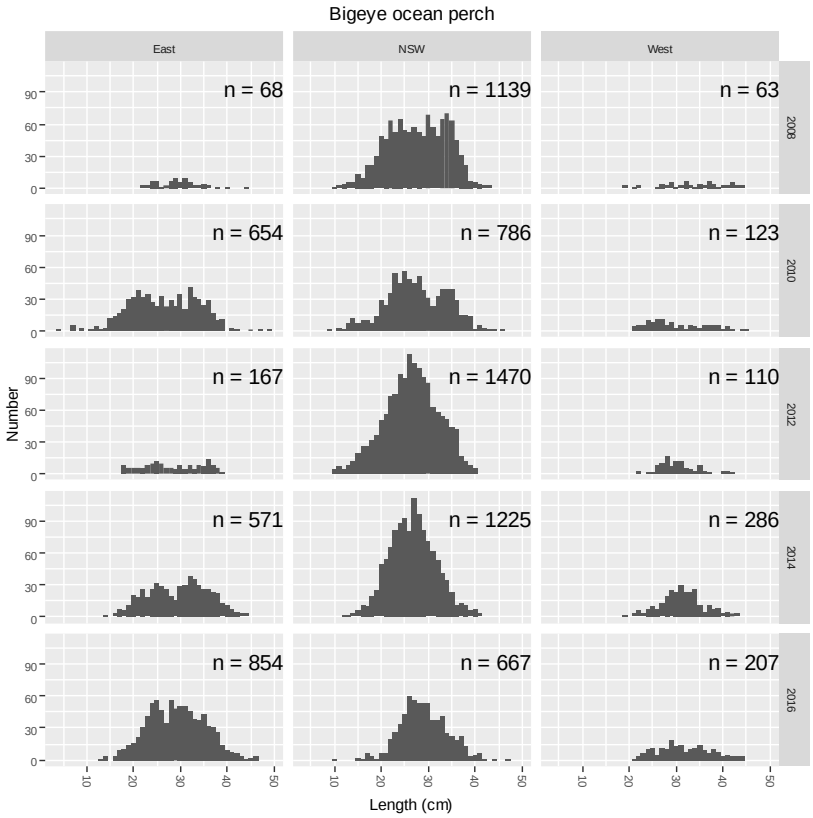

Figure 10. Length frequency of Bigeye Ocean Perch in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

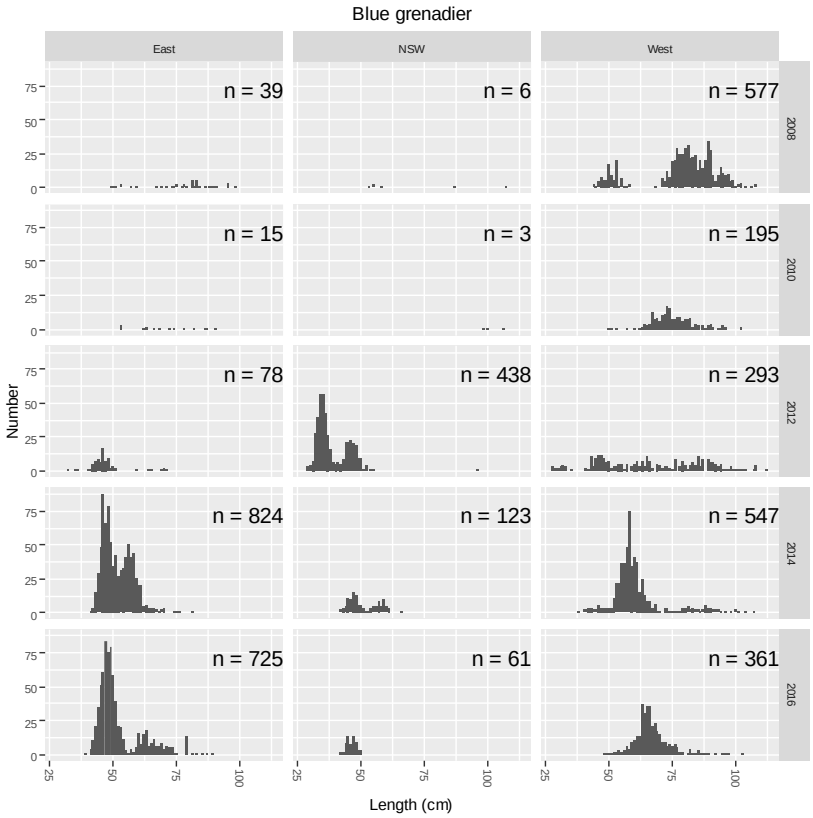

Figure 11. Length frequency of Blue Grenadier in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

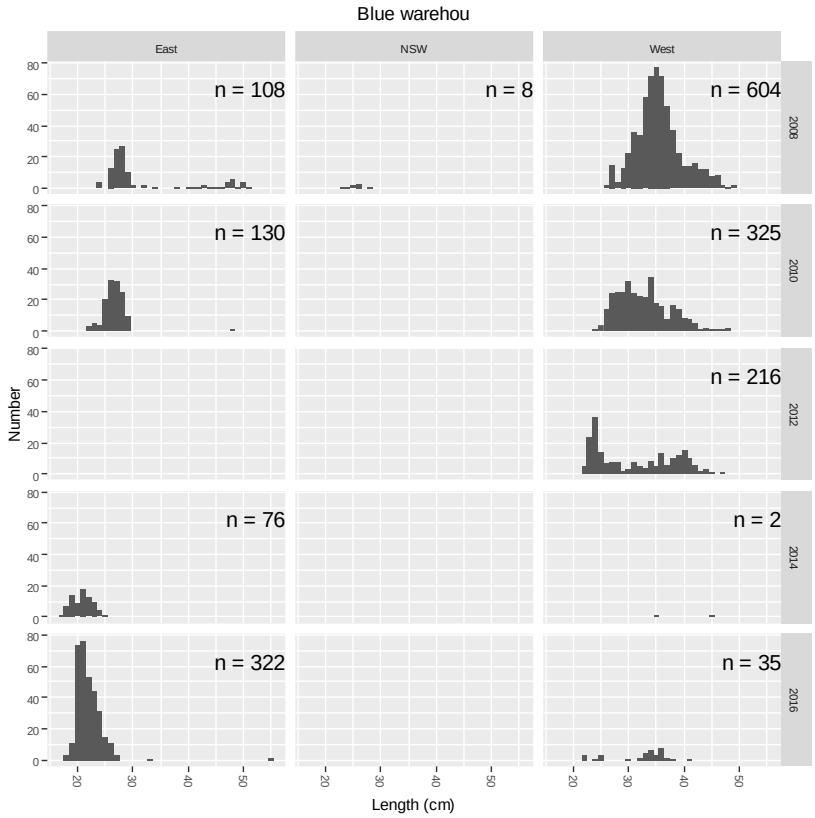

Figure 12. Length frequency of Blue Warehou in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

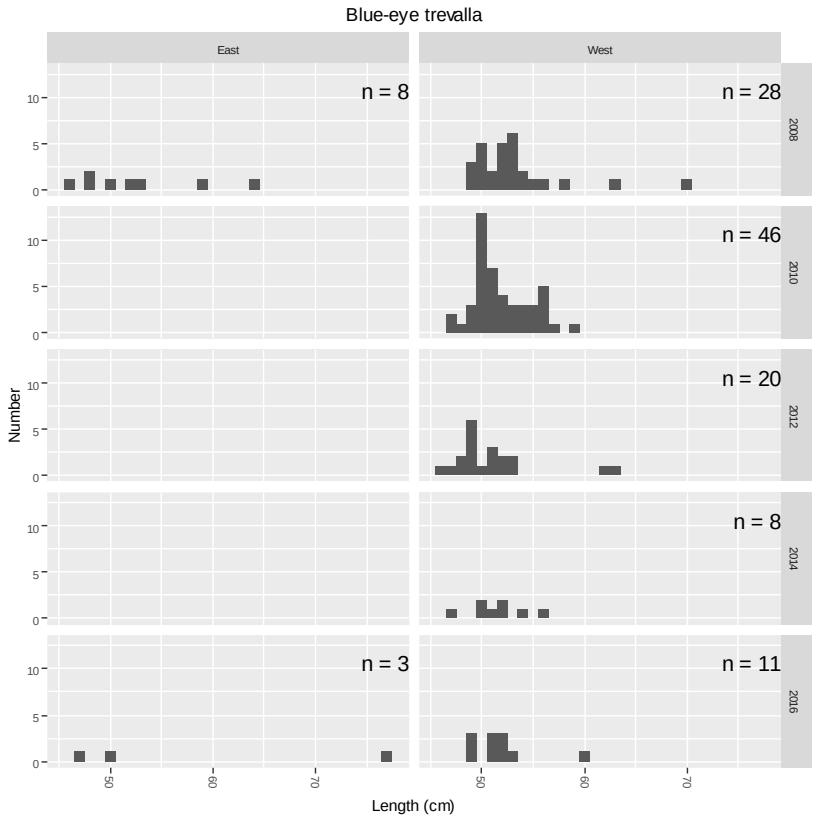

Figure 13. Length frequency of Blue-eye Trevalla in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

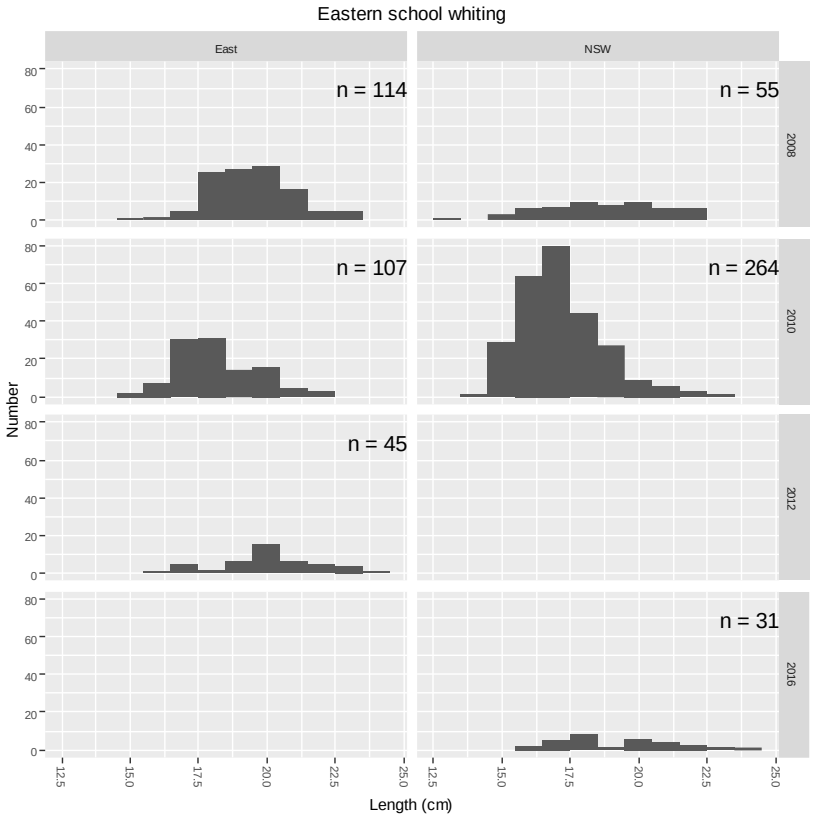

Figure 14. Length frequency of Eastern School Whiting in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

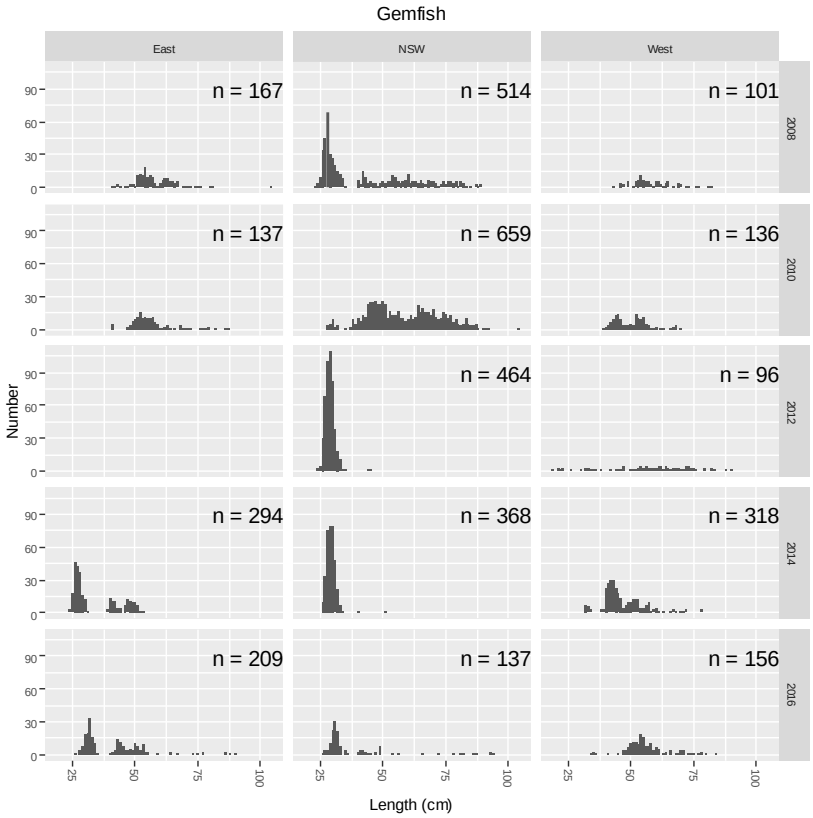

Figure 15. Length frequency of Gemfish in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

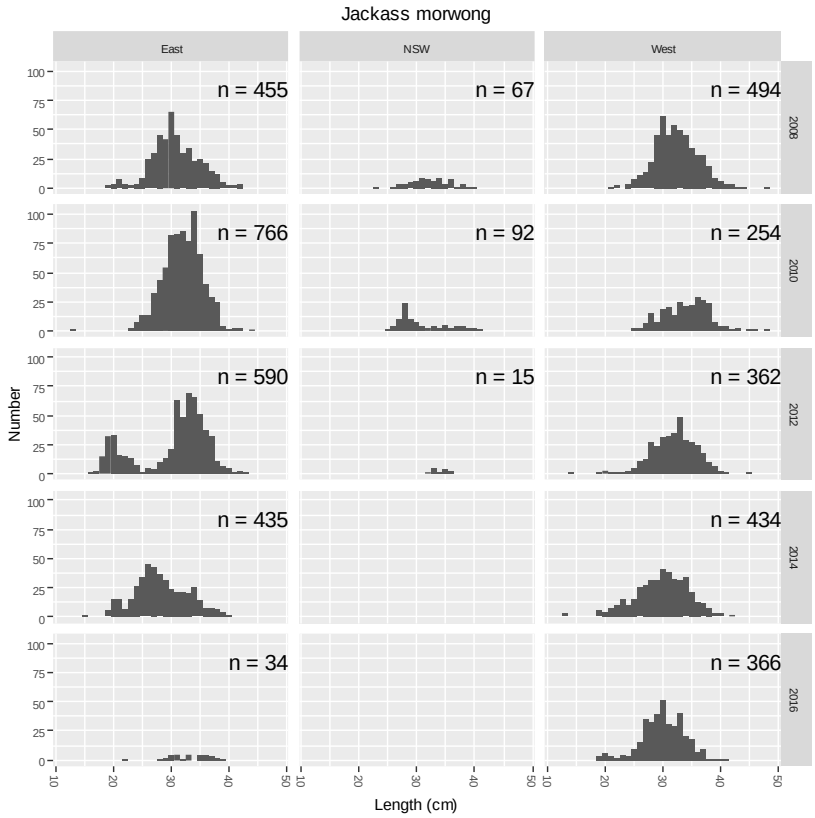

Figure 16. Length frequency of Jackass Morwong in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

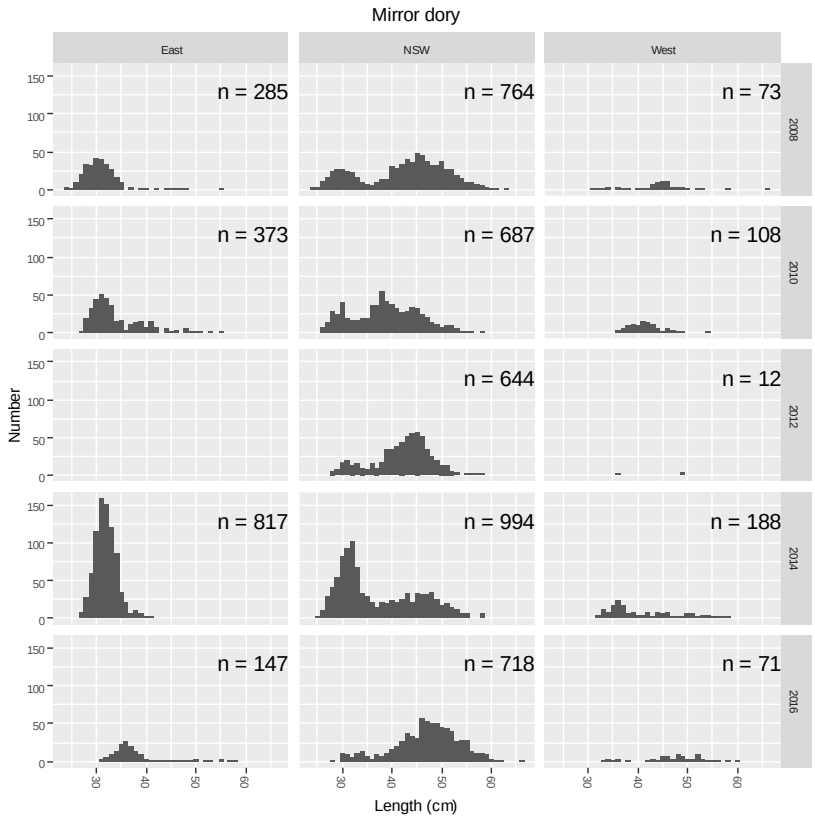

Figure 17. Length frequency of Mirror Dory in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

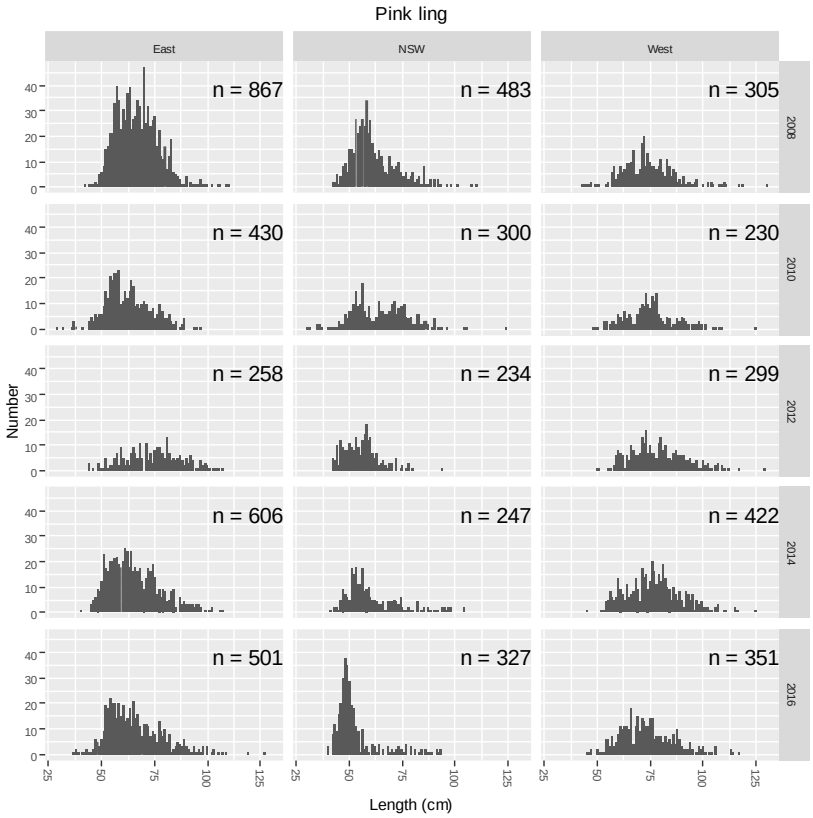

Figure 18. Length frequency of Pink Ling in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

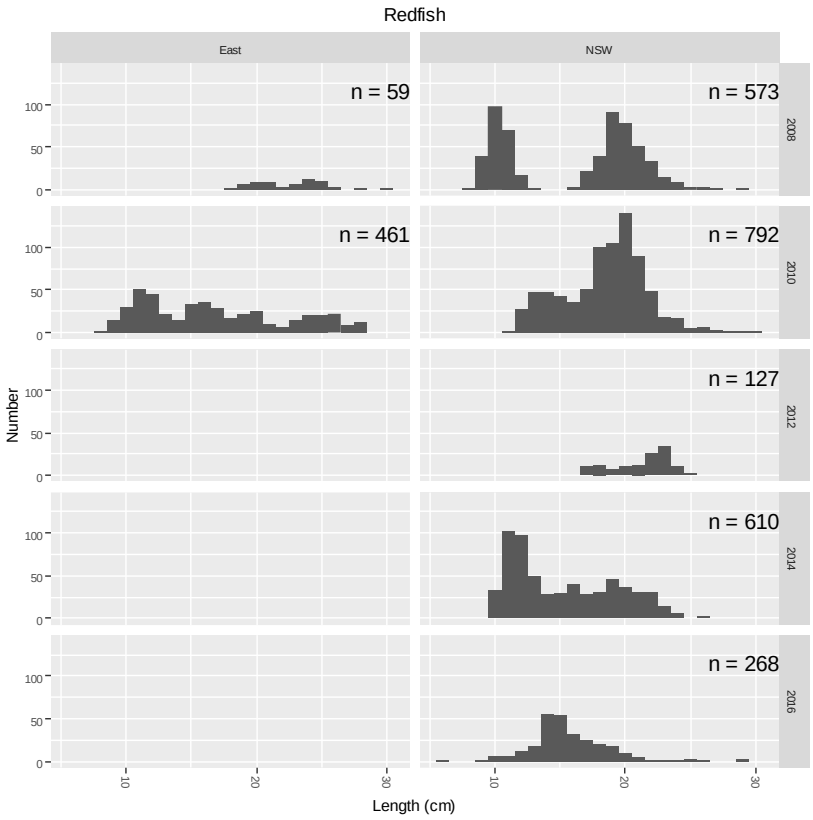

Figure 19. Length frequency of Redfish in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

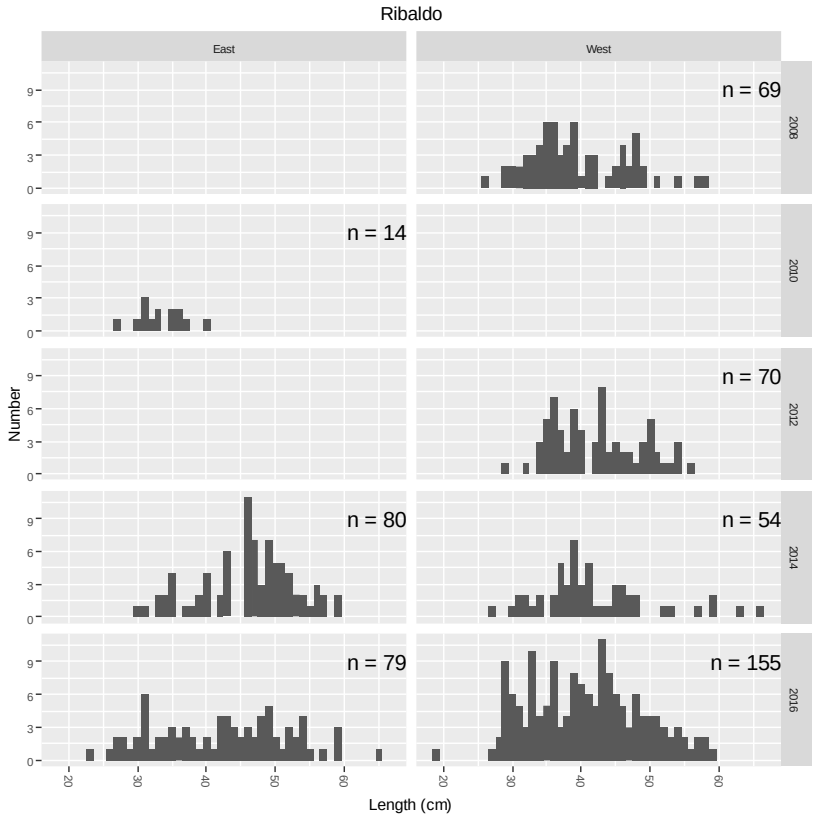

Figure 20. Length frequency of Ribaldo in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

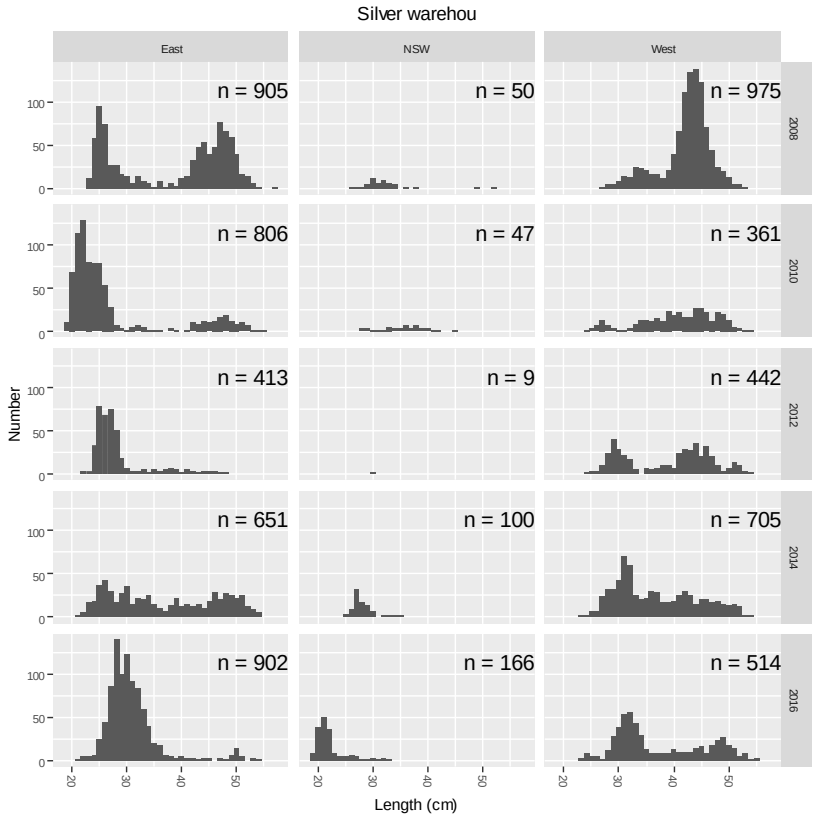

Figure 21. Length frequency of Silver Warehou in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

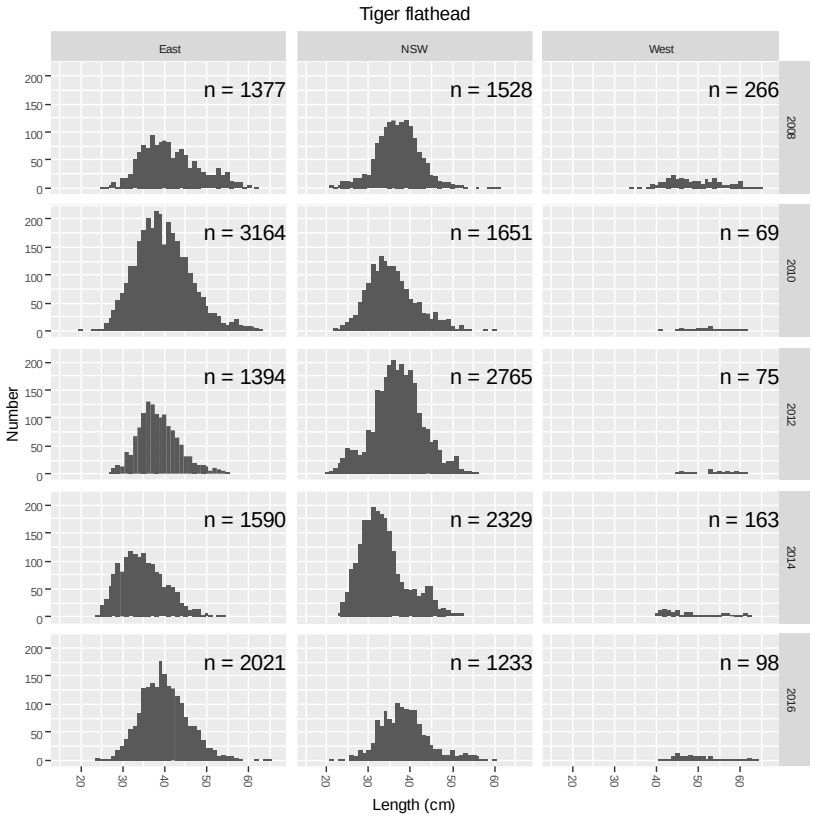

Figure 22. Length frequency of Tiger Flathead in each region during 2008, 2010, 2012, 2014 and 2016 surveys.

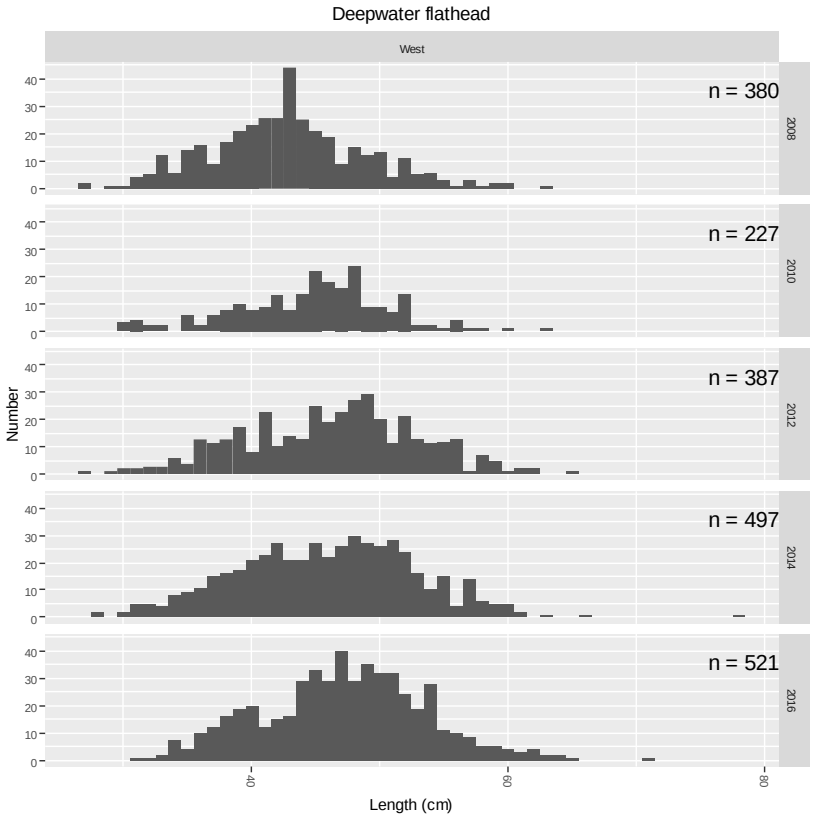

Figure 23. Length frequency of Deepwater Flathead in the western region during 2008, 2010, 2012, 2014 and 2016 surveys.

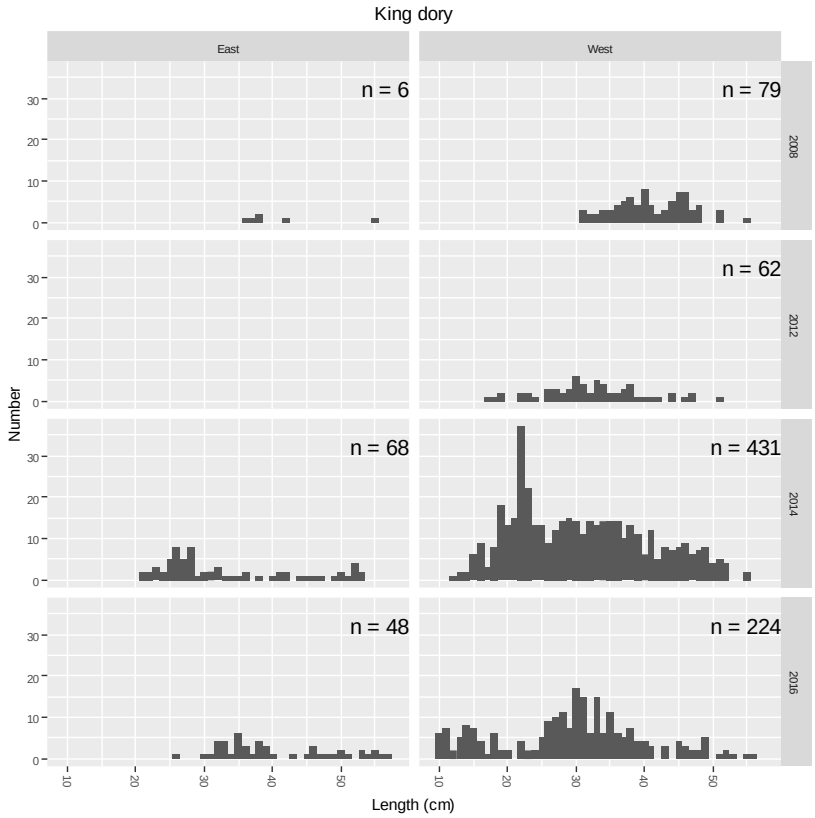

Figure 24. Length frequency of King Dory in the western region during 2008, 2010, 2012, 2014 and 2016 surveys.

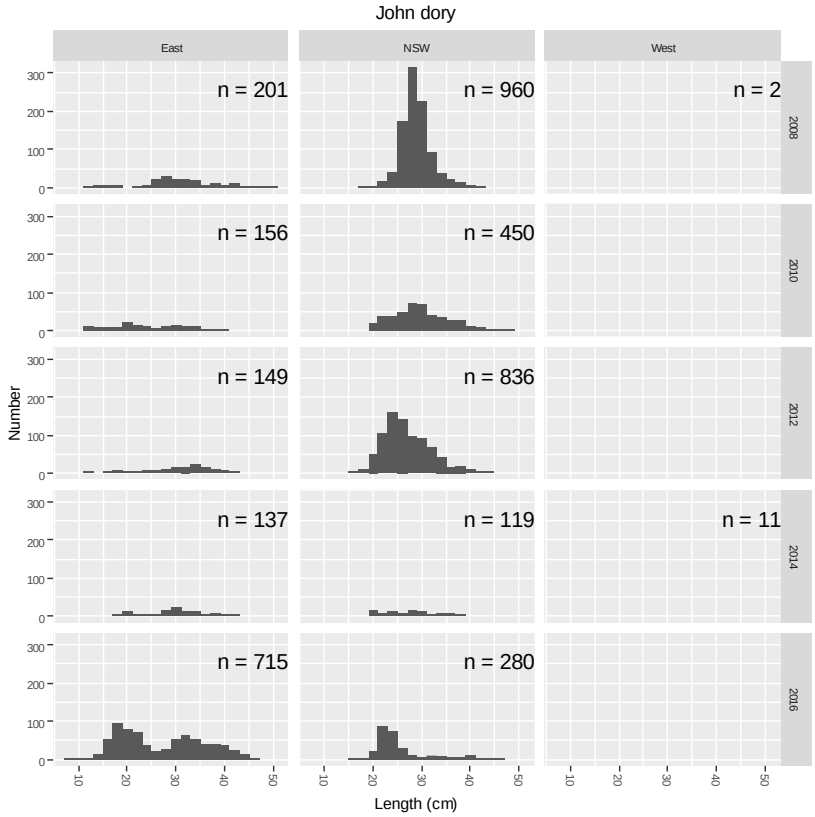

Figure 25. Length frequency of John Dory in the western region during 2008, 2010, 2012, 2014 and 2016 surveys.

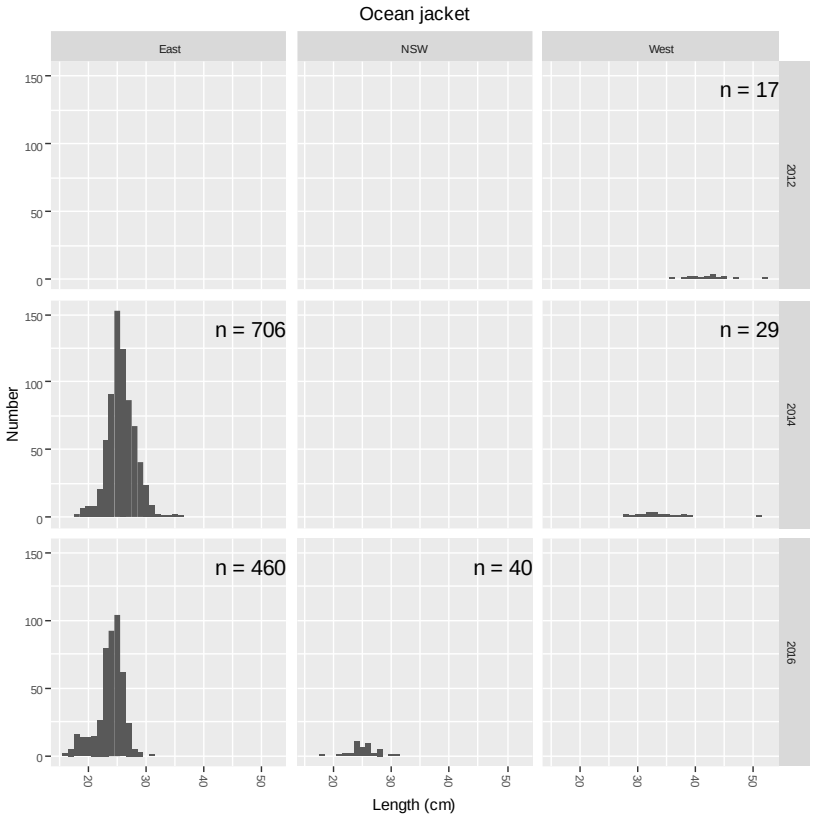

Figure 26. Length frequency of Ocean Jacket in the each region during 2008, 2010, 2012, 2014 and 2016 surveys.

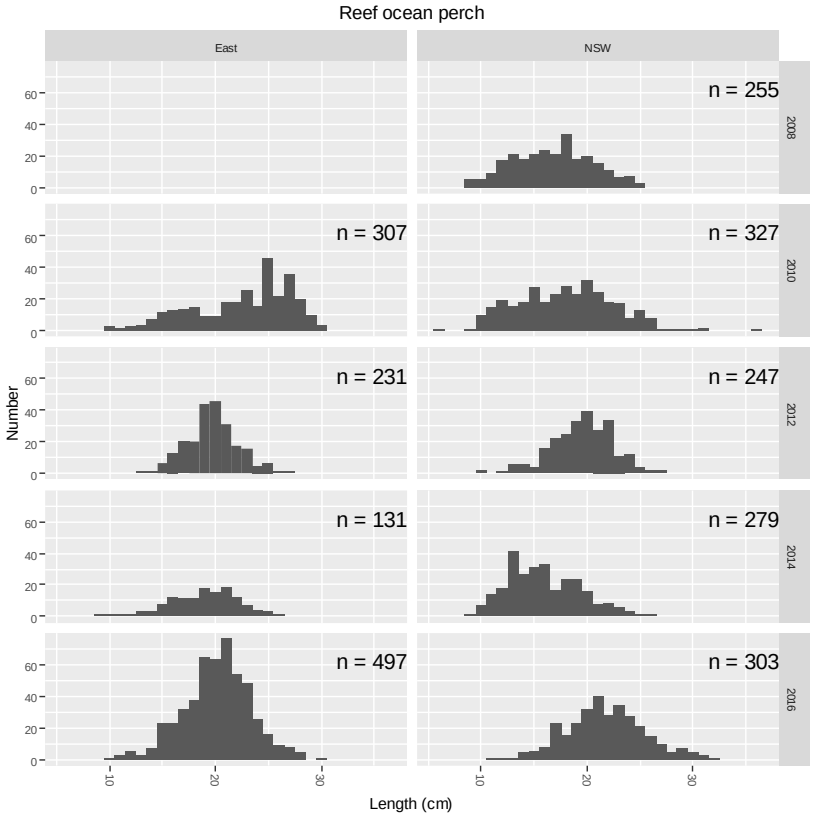

Figure 27. Length frequency of Reef Ocean Perch in the each region during 2008, 2010, 2012, 2014 and 2016 surveys.

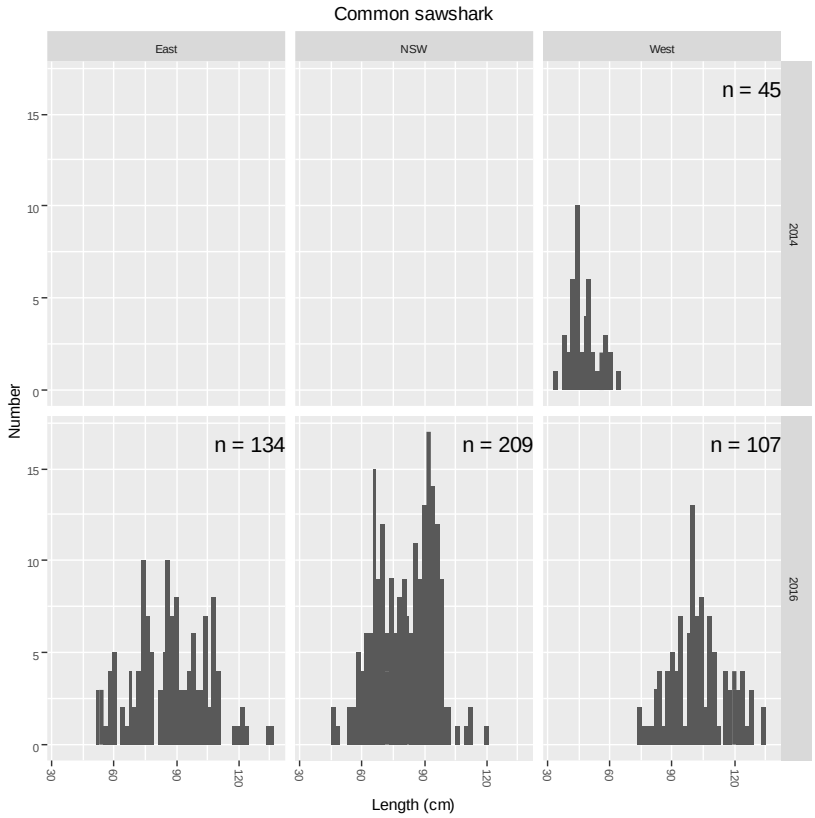

Figure 28. Length frequency of Common Saw Shark in the each region during 2008, 2010, 2012, 2014 and 2016 surveys.

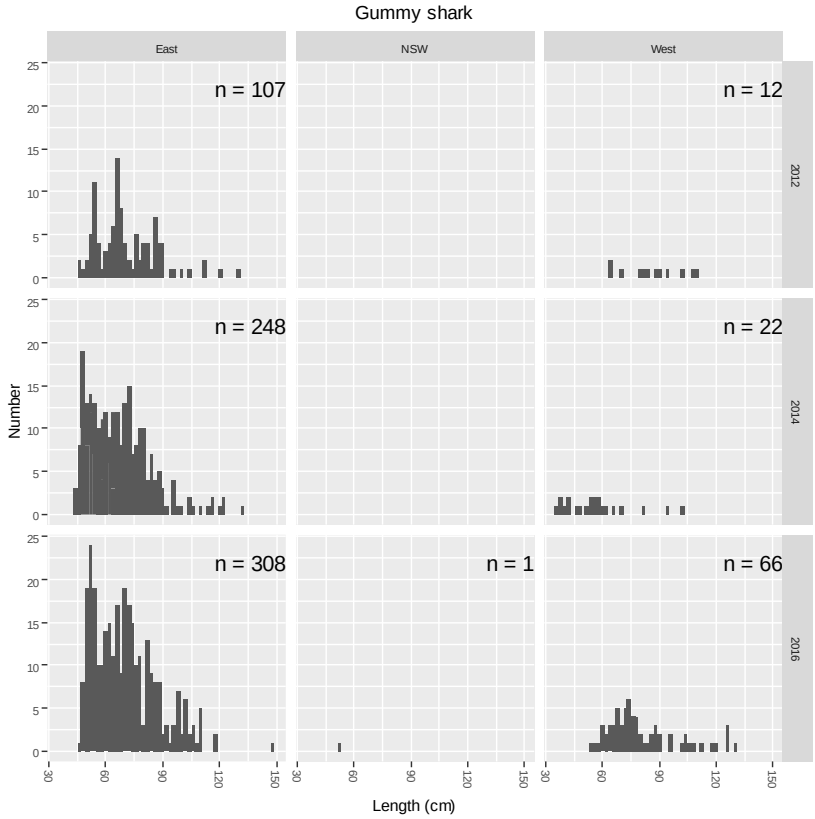

Figure 29. Length frequency of Gummy Shark in the each region during 2008, 2010, 2012, 2014 and 2016 surveys.

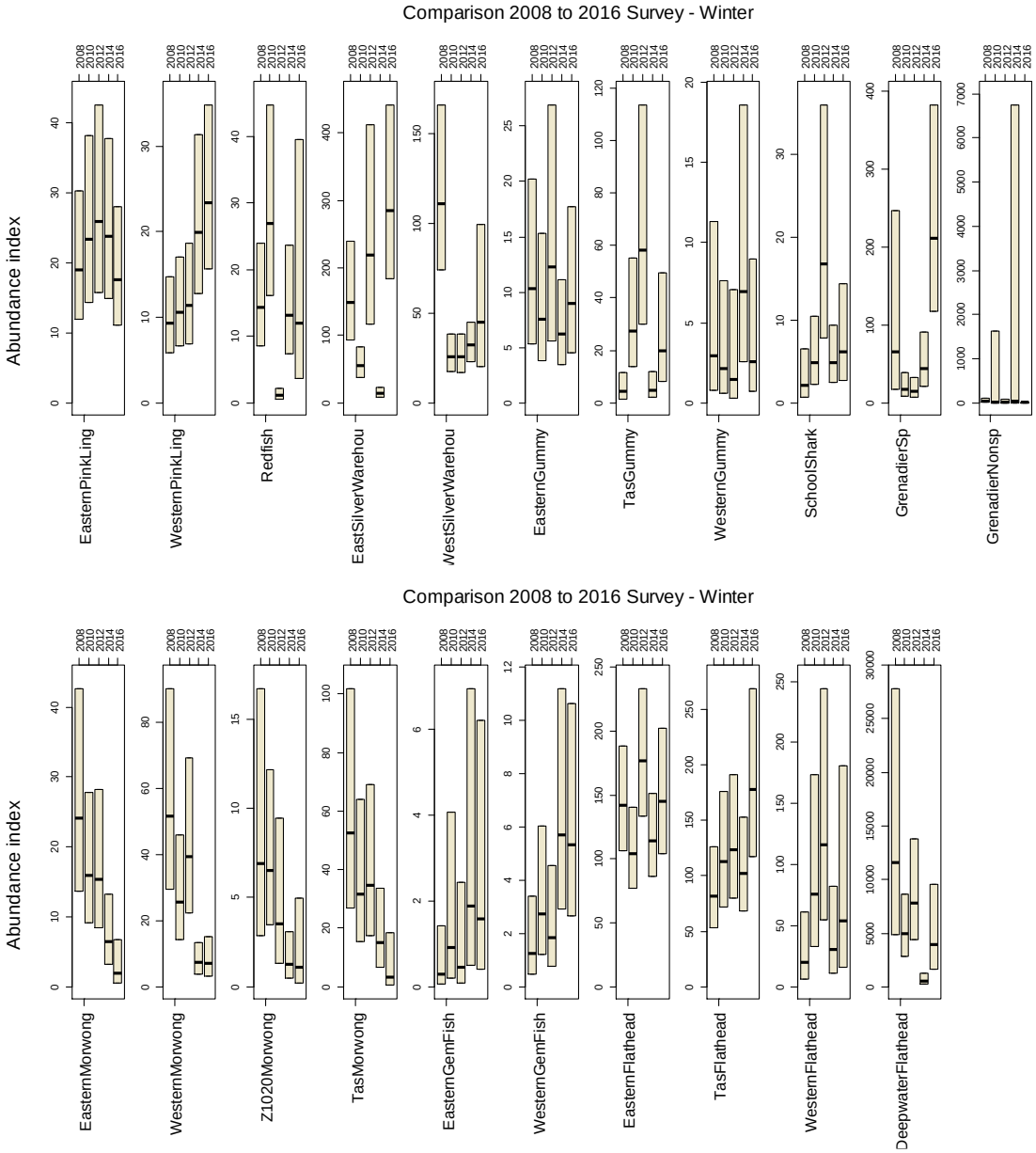

Figure 30. Estimates of relative abundance indices and 95% CIs Tier 1 species / management units for the winter 2008, 2010, 2012, 2014 and 2016 surveys. Spatial groupings are defined in Table 9.

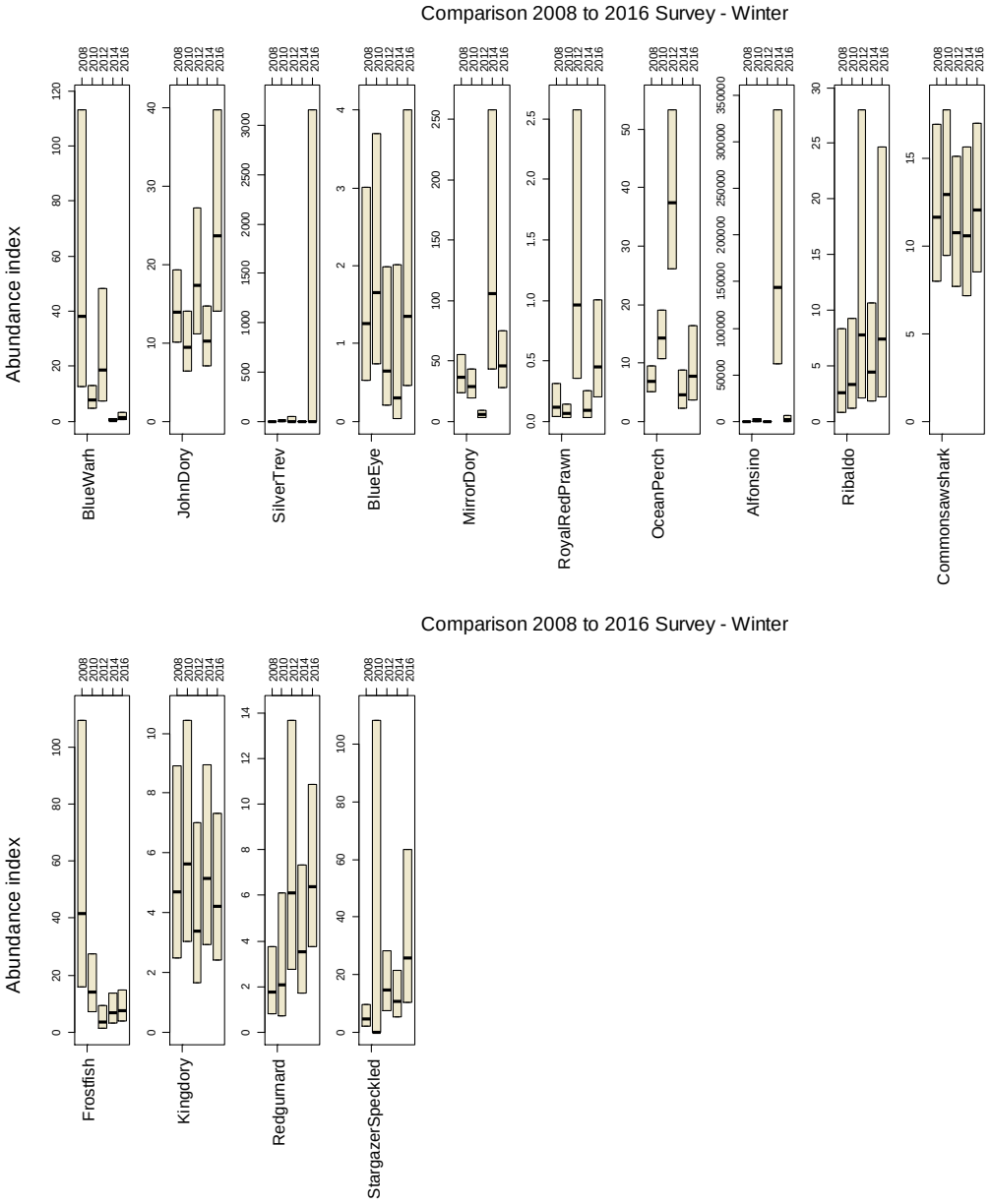

Figure 31. Estimates of relative abundance indices and 95% CIs Tier 3 and 4 (top panel) and major non-quota species (bottom panel) for the winter 2008, 2010, 2012, 2014 and 2016 surveys. Spatial groupings are defined in Table 9. Note that Ocean Perch includes Reef Ocean Perch, Bigeye Ocean Perch and Deepsea Ocean Perch.

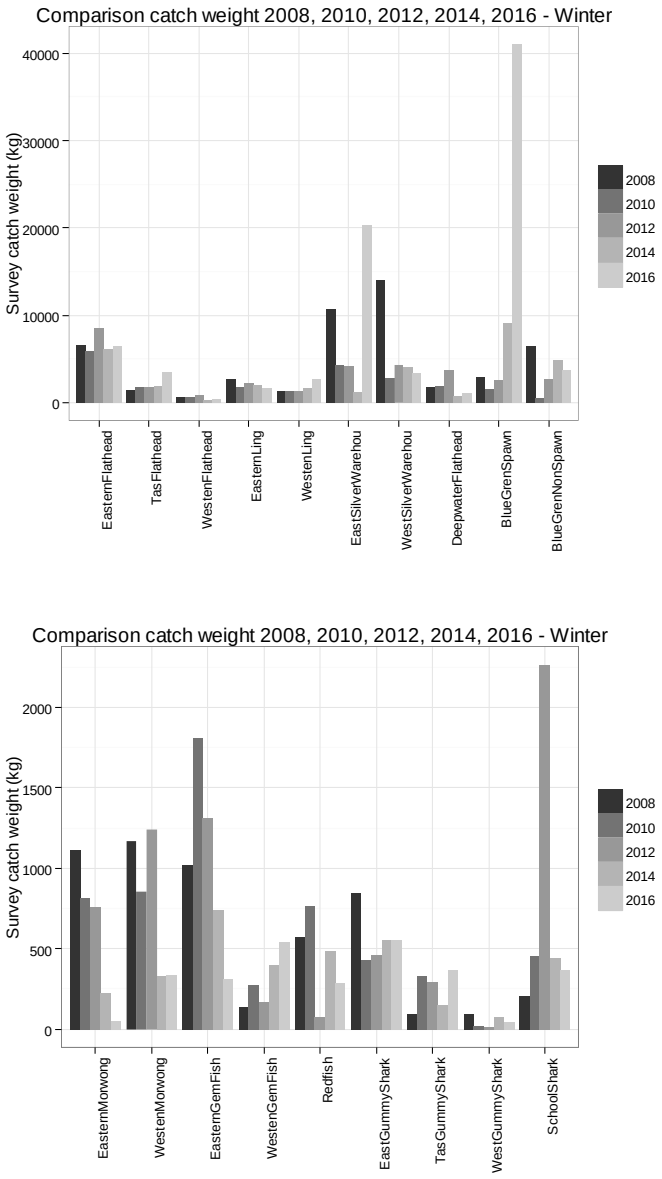

Figure 32. Catch weight for Tier 1 species / management units for the 2008, 2010, 2012, 2014 and 2016 winter surveys. Apart from the separation into management units, these differs from figures in Figure 4 because some shots are outside of the restrictions in range of coastal distance and depth for each species, and because the processing workflow rounds down catches to the nearest integer, making values of less than 1 = 0.

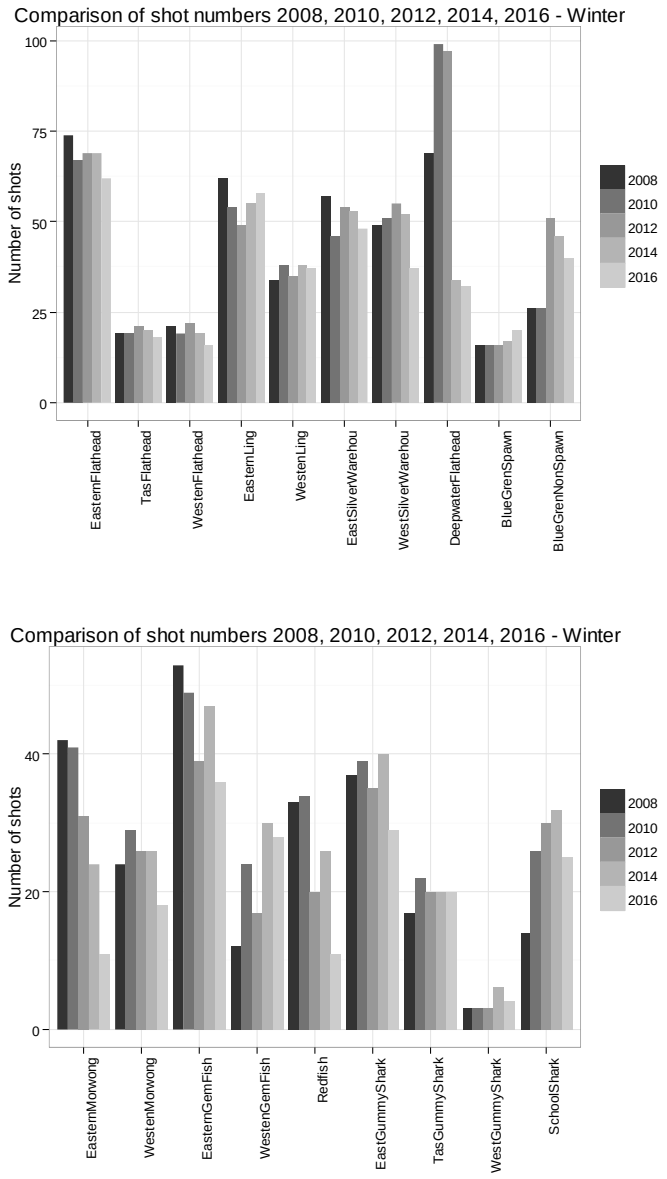

Figure 33. Number of shots with catches for Tier 1 species / management units for the 2008, 2010, 2012, 2014 and 2016 winter surveys. Apart from the separation into management units, these differs from figures in Figure 5 because some shots are outside of the restrictions in range of coastal distance and depth for each species, and because the processing workflow rounds down catches to the nearest integer, making values of less than 1 = 0.

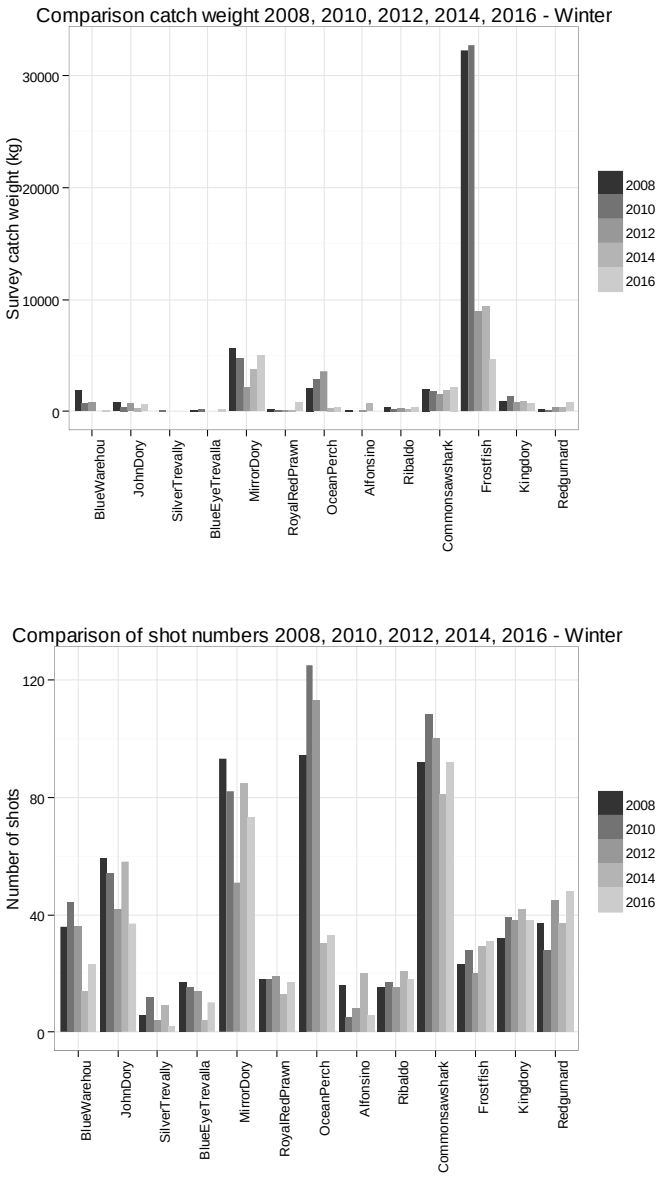

Figure 34. Catch weights (top panel) and number of shots with catches (bottom panel) for Tier 3 and 4 and non-quota species for the 2008, 2010, 2012, 2014 and 2016 winter survey. Note that Ocean Perch includes Inshore, Offshore and Deepsea Ocean Perch. These differs from figures in Figure 4 and Figure 5 because some shots are outside of the restrictions in range of coastal distance and depth for each species, and because the processing workflow rounds down catches to the nearest integer, making values of less than 1 = 0.

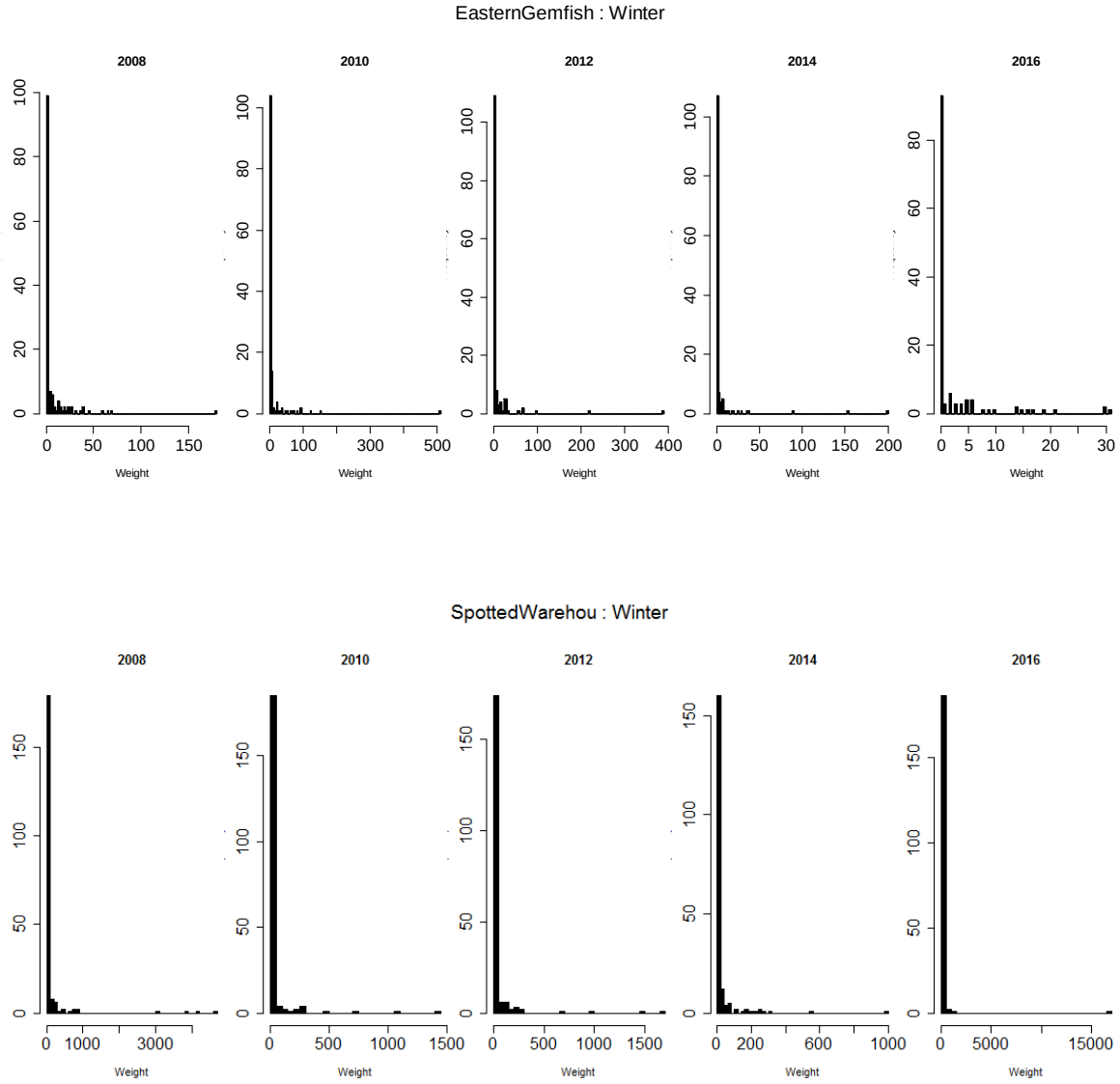

Figure 35. Catch per shot frequency for Eastern Gemfish (top panel) and Silver Warehou (bottom panel) for the 2008, 2010, 2012, 2014 and 2016 winter surveys. For Silver Warehou, note the four shots over 3000 kg in 2008, one shot over 15000 kg in 2016 and no shots over 1000 kg in 2014.

Table 1. Key species design considered in design process.

Blue Warehou (*Seriolella brama*)
Jackass Morwong (*Nemadactylus macropterus*)
John Dory (*Zues faber*)
Western and Eastern Gemfish (*Rexea solandri*)
Tiger Flathead (*Neoplatycephalus richardsoni*)
Pink Ling (*Genypterus blacodes*)
Silver Trevally (*Pseudocaranx dentex*)
Redfish (*Centroberyx affinis*)
Blue-Eye Trevalla (*Hyperoglyphe antarctica*)
Mirror Dory (*Zenopsis nebulosis*)
Silver Warehou (*Seriolella punctata*)

Table 2. Key features of nets designed for NSW, eastern and western regions for the FIS.

SESSF Survey net	
NSW and Eastern Survey Regions	**Western Survey Region**
• Operating 50-600m depth • A basic, generalist wing or diamond trawl net • 1800 – 2000 inch round net opening • To suit a vessel of minimum 350Hp towing at 3.0 knots average • Lengthener 100 mesh long 90mm single • Codend 33 mesh long 100 mesh round 90mm single / double • Approximate headline height 3-4 m • Rubber line with 6 inch discs and leads (70 kg)	• Operating 100-600m depth • A basic, generalist wing or diamond trawl net • 2000-2400 inch round net opening • To suit a vessel of minimum 450Hp towing at 3.0 knots average • Lengthener 100 mesh long 100 mm single • Codend 50 mesh long 100 mesh round 102mm double • Approximate headline height 4-5 m • Rubber line with 9 inch discs and leads (100 kg)

Table 3. Number of trips, sea days, number of valid shots, shot duration and tow speed during the 2016 survey.

Region	Number of trips	Number of seadays	Number of shots	Average shot duration (hrs)	Average tow speed (kts)
East	4	23	64	2:01	3.0
NSW	5	18	60	2:03	3.0
West	5	31	66	1:58	3.0
Total	16	72	190	2:01	3.0

Table 4. Species and numbers of fish for which length frequency and otolith samples were collected during the 2016 survey.

Species	West		East		NSW		Total	
	LF	Otol	LF	Otol	LF	Otol	LF	Otol
Gummy Shark	66		308		1		375	0
School Shark	18		43				61	0
Southern Sawshark			39				39	0
Common Sawshark	107		134		209		450	0
Ribaldo	155	34	79	10			234	44
Blue Grenadier	361	41	725	60	61		1,147	101
Pink Ling	351	23	501	40	327	17	1,179	80
Alfonsino					1		1	0
Redfish					268	10	268	10
King Dory	224	27	48	23			272	50
Mirror Dory	71		147	10	718	15	936	25
John Dory			715	51	280		995	51
Reef Ocean Perch		1	497	35	303	15	800	51
Bigeye Ocean Perch	207	33	854	61	667	145	1,728	239
Tiger Flathead	98	11	2,021	150	1,233	288	3,352	449
Bluespotted Flathead					131	20	131	20
Hapuku			1				1	0
Eastern School Whiting					31	12	31	12
Silver Trevally			54		1		55	0
Jackass Morwong	366	35	34	20			400	55
Gemfish	156	69	209	40	137	22	502	131
Blue-Eye Trevalla	11		3				14	0
Blue Warehou	35	20	322	30			357	50
Silver Warehou	514	73	902	60	166	25	1,582	158
White Warehou					2		2	0
Ocean Jacket			460	30	40	0	500	30
Deepwater Flathead	521	33					521	33
Spikey Oreodory	345	21					345	21
							0	0
Total	3,606	421	8,096	620	4,576	569	16,278	1610

Table 5. Number of survey shots included in analyses for each year and season. "East" refers to shots at sites >= 146 degrees longitude (including NSW).

Year	Season	Number of shots				
		East	West	<200 m	>=200 m	Total
2008	Summer	79	47	71	55	126
	Winter	140	65	97	108	205
2010	Summer	71	50	67	54	121
	Winter	135	67	104	98	202
2012	Summer	70	51	70	51	121
	Winter	132	65	103	94	197
2014	Winter	130	65	101	94	195
2016	Winter	124	66	95	95	190

Table 6. Predicted vs achieved CV values for 2016 winter surveys for the main species.

	Winter	
Species	**Predicted**	**Real**
Blue Warehou	0.39	0.37
Jackass Morwong	0.25	0.33
John Dory	0.24	0.23
Gemfish	0.36	0.22
Tiger Flathead	0.15	0.12
Pink Ling	0.18	0.14
Silver Trevally	0.81	3.4
Redfish	0.22	0.53
Blue-eye Trevalla	0.50	0.48
Miror Dory	0.22	0.22
Silver Warehou [2]	0.16	0.19

2 = CV is likely to be under-estimated due to occasional very large catches.

Table 7. Total catch weight (kg) for 2008, 2010, 2012, 2014 and 2016 surveys. SESSF quota species are in bold type. Catch weights differ from those in Table 10 because they don't include the catches from shots outside the model's bounds for each species, and because the catches are rounded down for the model fit.

	Winter Catch (kg)					
Species	**2008**	**2010**	**2012**	**2014**	**2016**	
Blue Warehou	1916.5	673.4	815.2	30.8	158	
Jackass Morwong	2285.4	1672.7	1996.5	560.6	388	
John Dory	802.1	438.8	653.3	296.8	595	
Gemfish	1156.3	2078.2	1477.1	1138.2	857	
Eastern Gemfish	1016	1803.5	1281.4	742.6	314	-
Western Gemfish	140.3	274.7	195.7	395.6	543	
Tiger Flathead	8536.5	8228.3	11135	8286.8	10247	
Pink Ling	3856.8	3122.2	3548	3714.3	4281	
Silver Trevally	11.1	125	13	12	5	-
Redfish	573.5	762.3	77.4	491.2	287	
Blue-eye Trevalla	136.6	253.5	73.05	28.8	212	
Mirror Dory	5685.1	4736.5	2221.4	3746.9	5026	
Silver Warehou	24772.1	7146.4	8499.5	5234.1	23653	
Orange Roughy	10	0	0	1.8	0	
Royal Red Prawn	229	126.3	122.5	149	761	+
Ocean Perch [&]	2074	2796.6	3595.5	282.4	411	
School Whiting	185.8	53.6	20	18.5	28	
Alfonsino	88.8	23	103.5	700.1	16	-
Ribaldo	439.9	177.5	301.7	260.7	413	
Gummy Shark	1037.3	779.2	759.5	781.5	968	
School Shark	209	455.5	2264.4	439.1	372	
Deepwater Flathead	1786.75	1848.7	909.2	751.1	1016	
Blue Grenadier	9379.5	2048.5	5205.2	14057	44696	+
Common Sawshark	1966.7	1785	1510.2	1871.3	2148	
Frostfish	32237	32720.5	8953	9350	4604	-
Ocean Jacket	1608.2	1853.7	1251.8	4849	2119	
Barracouta	15043.7[#]	17747.3	4186	231.7	4638	
Silver Dory *	4082.7	3642.7	2227	274.9	253	
Southern Ocean Arrow Squid *	2931.8	0	32	0	0	
Latchet *	1773.65	2381	2450.8	3113	2769	
Gould's Squid *	942.8	1439.3	2117.3	1039.5	1914	
Toothed Whiptail *	1877.9	2176.2	5622	1844.7	3390	
Jack Mackerel	1667.7	1449.1	2058	1332.3	2076	+
Spikey Oreodory	1952.2	636	202	840.6	248	
King Dory	877	1330.3	777.6	918.9	717	
Red Gurnard	195.1	143.4	409.9	396.3	767	+
Draughtboard Shark	820.1	410	544.5	306	1233	+
Whitefin Swell Shark	1058	970.2	1326.2	1113.3	1169	
Speckled Stargazer *	593.4	1	1087	884.4	1328	+
New Zealand dory *	834.2	16.5	1092.2	1314	677	

*Catches not directly comparable between years due to species being re-defined/ database changes.

[#]Previous reports underreported the catch of Barracouta in this year as it was recorded under the incorrect common name of "Snook"

[&] Includes Inshore, Offshore and Deepsea Ocean Perch

Key: + increase in catch in 2016 c.f. 2014 by > 50% AND 2016 catch greater than in 2008 – 2014;
- refers to a > 50% decrease in catch in 2016 c.f. 2014 AND 2016 catch less than in 2008 – 2014

Table 8. Abundance indices and CV estimates for 2008, 2010, 2012, 2014 and 2016 winter surveys. The 2008, 2010 and 2012 results are from Upston *et al.* (2013) while the 2014 results are from Day and Peel (2014). CVs < 0.30 are highlighted. SESSF quota species are in bold type. Key: 'nc' no convergence; 'na' no CPUE fit/ model result implausible.

Species	Abundance2008	CV2008	Abundance2010	CV2010	Abundance2012	CV2012	Abundance2014	CV2014	Abundance2016	CV2016	Diagnostics 2016
Blue Warehou	38.10	0.49	7.84	0.23	18.74	0.42	0.39	0.47	1.42	0.37	
Jackass Morwong	41.51	0.20	23.97	0.21	27.00	0.21	6.87	0.24	4.41	0.33	
John Dory	13.99	0.14	9.46	0.17	17.38	0.20	10.24	0.16	23.66	0.23	
Gemfish	3.50	0.29	4.81	0.21	2.90	0.21	3.98	0.19	3.54	0.22	
Eastern Gemfish	0.30	0.69	0.92	0.66	0.45	0.76	1.89	0.58	1.59	0.61	
Western Gemfish	1.26	0.44	2.72	0.35	1.85	0.40	5.70	0.30	5.32	0.31	
Tiger Flathead	93.06	0.11	91.06	0.12	152.36	0.11	97.22	0.10	138.43	0.12	
Pink Ling	18.16	0.15	19.72	0.15	18.75	0.17	21.89	0.15	20.46	0.14	
Silver Trevally	0.24	1.09	6.53	0.51	2.50	1.30	0.64	0.62	1.55	3.40	1
Redfish	14.37	0.23	26.89	0.23	1.14	0.31	13.20	0.26	12.02	0.53	
Blue-eye Trevalla	1.26	0.39	1.66	0.36	0.65	0.50	0.30	0.85	1.35	0.48	
Mirror Dory	36.56	0.19	29.21	0.18	5.39	0.24	105.77	0.40	45.81	0.22	
Silver Warehou	106.69	0.14	32.87	0.14	114.80	0.25	24.12	0.13	155.67	0.19	2
Orange Roughy	0.01	2.18	nc	nc	nc	nc	0.00	2.31	nc	nc	
Royal Red Prawn	0.12	0.44	0.06	0.35	0.96	0.44	0.09	0.44	0.45	0.36	
Ocean Perch [&]	6.90	0.14	14.34	0.13	37.38	0.16	4.49	0.30	7.82	0.33	
Alfonsino	16.93	0.43	521.14	0.72	4.58	0.57	143930.50	0.38	1467.58	0.66	
Ribaldo	2.62	0.52	3.28	0.46	7.77	0.57	4.45	0.39	7.42	0.54	
Dogfishes	25.81	0.19	12.83	0.14	16.85	0.16	0.05	1.38	1.07	0.72	
Gummy Shark	11.89	0.26	20.04	0.23	27.41	0.24	5.83	0.20	12.16	0.27	
School Shark	2.10	0.51	4.81	0.35	16.76	0.34	4.85	0.30	6.20	0.37	
Deepwater Flathead	11629.86	0.39	4913.68	0.25	na	na	536.79	0.37	3923.78	0.40	
Blue Grenadier	15.83	0.30	3.38	0.28	10.75	0.23	19.65	0.21	58.20	0.23	
Common Sawshark	11.62	0.17	12.94	0.14	10.75	0.15	10.59	0.17	12.03	0.15	
Frostfish	41.73	0.43	14.11	0.30	3.46	0.45	6.68	0.32	7.67	0.30	
King Dory	4.68	0.29	5.64	0.27	3.39	0.32	5.13	0.25	4.21	0.25	
Red Gurnard	1.76	0.34	2.08	0.48	6.12	0.36	3.54	0.32	6.39	0.24	
Greeneye Dogfish*	16.64	0.27	6.41	1.38	9.46	0.41	8.47	0.88	5.97	0.64	
Triggerfish and leatherjacket	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	
Speckled Stargazer*	4.58	0.33	nc	nc	14.51	0.30	10.69	0.31	25.66	0.40	

*Abundance estimates not directly comparable between years, due to species being re-defined/ database changes.
& Includes Inshore, Offshore and Deepsea Ocean Perch
Diagnostics: 1= Silver Trevally were only caught in 4 survey shots, however two of those were outside of the bounds for that species, and another was less than 1 kg, and subsequently rounded down to 0 kg for the for the model fit;
2 = CV is likely to be under-estimated;

Table 9. 2016 CVs and abundance estimates for each species / management units. Zones comprising management units and assessment Tier levels are also shown.

Species / stock name in analyses	Common name	Species name	CAAB code	Zones	Tier level	CV	Abundance
catch_GummyShark	Gummy Shark	Mustelus antarcticus	37017001	All zones in prediction grid	1	0.274803988	12.16219741
catch_EasternGummy	Gummy Shark	Mustelus antarcticus	37017001	North of latitude -41 and east of longitude 141	1	0.302948966	8.967410377
catch_TasGummy	Gummy Shark	Mustelus antarcticus	37017001	South of latitude -41	1	0.406040382	19.96124434
catch_WesternGummy	Gummy Shark	Mustelus antarcticus	37017001	North of latitude -41 and west of longitude 141	1	0.561725317	2.549287195
catch_SchoolShark	School Shark	Galeorhinus galeus	37017008	All zones in prediction grid	1	0.37462738	6.195833461
catch_BlueGrenadier	Blue Grenadier	Macruronus novaezelandiae	37227001	All zones in prediction grid	1	0.233252728	58.20350949
catch_Z40BlueGren	Blue Grenadier	Macruronus novaezelandiae	37445001	Zone 40	1	0.263933798	211.2925309
catch_AllOtherBlueGren	Blue Grenadier	Macruronus novaezelandiae	37445001	All Zones except Zone 40	1	0.342189111	10.38624426
catch_Ling	Pink Ling	Genypterus blacodes	37228002	All zones in prediction grid	1	0.1363632	20.4558808
catch_EasternPinkLing	Pink Ling	Genypterus blacodes	37228002	East of longtiude 147	1	0.206384356	17.67307027
catch_WesternPinkLing	Pink Ling	Genypterus blacodes	37228002	West of longtiude 147	1	0.177953125	23.33977498
catch_OrangeRoughy	Orange Roughy	Hoplostethus atlanticus	37255009	All zones in prediction grid	1	13576.26409	3.3766E-107
catch_Redfish	Redfish	Centroberyx affinis	37258003	All zones in prediction grid	1	0.531766406	12.02095746
catch_Flathead	Tiger Flathead	Platycephalus richardsoni	37296001	All zones in prediction grid	1	0.121923971	138.4273301
catch_EasternFlathead	Tiger Flathead	Platycephalus richardsoni	37296001	Zones 10 and 20	1	0.147077657	145.2764928
catch_TasFlathead	Tiger Flathead	Platycephalus richardsoni	37296001	South of latitude -40.75 and east of longitude 147	1	0.184668262	177.275433
catch_WesternFlathead	Tiger Flathead	Platycephalus richardsoni	37296001	West of longtiude 147	1	0.542353291	53.72409145
catch_DeepwaterFlathead	Deepwater Flathead	Platycephalus conatus	37296002	All zones in prediction grid	1	0.398855361	3923.783797
catch_Morwong	Jackass Morwong	Nemadactylus macropterus	37377003	All zones in prediction grid	1	0.333566679	4.411825112
catch_EasternMorwong	Jackass Morwong	Nemadactylus macropterus	37377003	East of longtiude 147	1	0.556020987	1.92749282
catch_WesternMorwong	Jackass Morwong	Nemadactylus macropterus	37377003	West of longtiude 147	1	0.339599448	7.030677184
catch_Z1020Morwong	Jackass Morwong	Nemadactylus macropterus	37377003	Zones 10 and 20	1	0.680361648	1.077424763
catch_TasMorwong	Jackass Morwong	Nemadactylus macropterus	37377003	South of latitude -40.75 and east of longitude 147	1	0.768954098	3.31840744
catch_GemFish	Gemfish	Rexea solandri	37439002	All zones in prediction grid	1	0.219355302	3.542203455
catch_EasternGemFish	Eastern Gemfish	Rexea solandri	37439002	East of longtiude 145	1	0.608233812	1.587939959
catch_SpottedWarehou	Silver Warehou	Seriolella punctata	37445006	All zones in prediction grid	1	0.193652731	155.6746451
catch_EasternSilverWarehou	Silver Warehou	Seriolella punctata	37445006	East of longtiude 147	1	0.194884635	284.8409363
catch_WesternSilverWarehou	Silver Warehou	Seriolella punctata	37445006	West of longtiude 147	1	0.354906779	44.77943444
catch_Alfonsino	Alfonsino	Beryx splendens	37258002	All zones in prediction grid	3	0.660024153	1467.580872
catch_JohnDory	John Dory	Zeus faber	37264004	All zones in prediction grid	3	0.231102395	23.65951991
catch_RoyalRedPrawn	Royal Red Prawn	Haliporoides sibogae	28714005	All zones in prediction grid	4	0.35509223	0.454288914
catch_Commonsawshark	Common Sawshark	Pristiophorus cirratus	37023002	All zones in prediction grid	4	0.153018255	12.03216365
catch_Ribaldo	Ribaldo	Mora moro	37224002	All zones in prediction grid	4	0.536133132	7.42445166
catch_MirrorDory	Mirror Dory	Zenopsis nebulosus	37264003	All zones in prediction grid	4	0.222032198	45.80755224
catch_SilverTrav	Silver Trevally	Pseudocaranx georgianus	37337062	All zones in prediction grid	4	3.399676109	1.547102777
catch_WesternGemFish	Western Gemfish	Rexea solandri	37439002	West of longtiude 145	4	0.307852039	5.322915544
catch_BlueEye	Blue-eye Trevalla	Hyperoglyphe antarctica	37445001	All zones in prediction grid	4	0.484473909	1.351025774
catch_BlueWarh	Blue Warehou	Seriolella brama	37445005	All zones in prediction grid	4	0.371503662	1.421940726
catch_OceanPerch	Ocean Perch	Helicolenus barathri and Helicolenus percoides	37287093 and 37287001	All zones in prediction grid	4	0.329342211	7.823078042
catch_Draughtboardshark	Draughtboard Shark	Cephaloscyllium laticeps	37015001	All zones in prediction grid	Non-quota	0.227524842	9.1149E+37
catch_Kingdory	King Dory	Cyttus traversi	37264001	All zones in prediction grid	Non-quota	0.248212279	4.205054229
catch_Redgurnard	Red Gurnard	Chelidonichthys kumu	37288001	All zones in prediction grid	Non-quota	0.236308332	6.393256363
catch_StargazerSpeckled	Speckled Stargazer	Kathetostoma canaster	37400018	All zones in prediction grid	Non-quota	0.403314388	25.65593807
catch_Frostfish	Frostfish	Lepidopus caudatus	37440002	All zones in prediction grid	Non-quota	0.295942103	7.674876887
catch_Whitefinswellshark	Whitefin Swellhark	Cephaloscyllium albipinnum	37 015013	All zones in prediction grid	Non-quota	0.278443224	5.01483E+36
catch_Greeneyedogfish	Greeneye dogfish	Squalus spp	37 020901	All zones in prediction grid	Non-quota	0.637676727	5.967294458
catch_NewZealanddory	New Zealand Dory	Cyttus novaezealandiae	37 264005	All zones in prediction grid	Non-quota	0.001683	3.31886E+19

Appendix 1 – Catch and shot details for the 2016 winter surveys.

Table 10. Total catch (kg) of all species in each region during the winter 2016 survey. Note that (u) denoted animal not identified to species level.

			Catch (kg)			
CAABcode	Common Name	Species Name	NSW	East	West	Total
10038000	Sponges (Coral)	*Corallistidae - undiff*		373		373
10216000	Sponge (U)	*Grantiidae - undiff*	206	169.2	64	439.2
11120000	Jellyfish (U)	*Scyphozoa spp - undiff*	8			8
11176000	Soft Coral (U)	*Alcyoniidae - undiff*	2.5		50	52.5
11208000	Seapens	*Order Pennatulacea - undiff*		1		1
11229000	Anemones	*Order Actinaria - undiff*	129.5	23		152.5
11305002	Hard Coral	*Barabattoia amicorum*	12			12
11307030	Stony Coral	*Homophyllia australis*	13			13
23270007	Commercial Scallop	*Pecten fumatus*		0.2		0.2
23607000	Cuttlefish (U)	*Sepiidae - undiff*	76.5	329.8	12.6	418.9
23607001	Giant Cuttlefish	*Sepia apama*		0.5		0.5
23617005	Southern Calamari	*Sepioteuthis australis*		78.55	3.7	82.25
23630000	Squids (U)	*Histioteuthidae - undiff*	89	62		151
23632000	Deepsea Squid (U)	*Bathyteuthidae - undiff*	6	2	10.5	18.5
23636004	Gould Squid	*Nototodarus gouldi*	376	412	1145	1933
23636007	Red Ocean Squid	*Ommastrephes bartramii*		25		25
23636009	Yellow-Backed Squid	*Sthenoteuthis oualaniensis*	4			4
23659000	Octopus (U)	*Octopodidae - undiff*	54		15.8	69.8
23659003	Maori Octopus	*Pinnoctopus cordiformis*		212.9		212.9
23659004	Pale Octopus	*Octopus pallidus*		150.3		150.3
24000000	Gastropod (U)	*Class Gastropoda - undiff*		320.1		320.1
24155000	Cowrie (U)	*Cypraeidae - undiff*		24.5		24.5
24207000	Volute (U)	*Volutidae - undiff*	3			3
24207001	False Bailer Shell	*Livonia mammilla*	5	528.05		533.05
24207073	Bailer Shell	*Melo umbilicatus*	1			1
24420000	Nudibranchs	*Order Nudibranchia - undiff*	41.5			41.5
25102000	Seastar (U)	*Class Asteroidea - undiff*	8.2	97.6	6.5	112.3
25160000	Brittlestars	*Class Ophiuroidea - undiff*		1300	400.5	1700.5
25200000	Sea Urchin (U)	*Class Echinoidea - undiff*	269	321		590
25400000	Holothurian (U)	*Class Holothuroidea - undiff*	54.5	0.4	119	173.9
28030000	Mantis Shrimp (U)	*Order Stomatopoda - undiff*		0.2		0.2
28200000	Isopods	*Order Isopoda - undiff*	0.2			0.2
28710000	Prawn (U)	*Penaeoidea & Caridea - undiff*	12	3.9		15.9
28712008	Giant Scarlet Prawn	*Aristaeopsis edwardsiana*	0.3			0.3
28714005	Royal Red Prawn	*Haliporoides sibogae*	762.5			762.5
28820001	Southern Rock Lobster	*Jasus edwardsii*	1			1
28821001	Deepwater Bug	*Ibacus alticrenatus*			14.9	14.9
28821004	Eastern Balmain Bug	*Ibacus peronii*	30.2	26.5		56.7
28821904	Bug	*Ibacus & Thenus spp*		1.1		1.1
28827000	Hermit Crabs	*Diogenidae - undiff*	197.7	252.3		450
28840000	Squat Lobster (U)	*Galatheidae, Munididae & Munidopsidae - undiff*		0.1		0.1
28850000	Crab (U)	*Brachyura - undiff*	20			20
28880000	Spider Crab (U)	*Majidae & related families - undiff*	335	580.5	10.8	926.3
28910901	Crystal Crabs	*Chaceon spp.*	1			1
28911020	Swimmer Crab	*Ovalipes molleri*	399	47		446
28925001	Giant Crab	*Pseudocarcinus gigas*		4.6	12.5	17.1
35000000	Ascidian (U)	*Ascidiacea - undiff*		16		16
37005001	Sharpnose Sevengill Shark	*Heptranchias perlo*	101	23	15.5	139.5
37005002	Broadnose Shark	*Notorynchus cepedianus*	3	26.6	5	34.6
37007001	Port Jackson Shark	*Heterodontus portusjacksoni*	638	80	49	767
37012001	Thresher Shark	*Alopias vulpinus*	380			380
37013001	Banded Wobbegong	*Orectolobus ornatus*			100	100
37013003	Spotted Wobbegong	*Orectolobus maculatus*	65			65
37013005	Rusty Carpetshark	*Parascyllium ferrugineum*		21	35.3	56.3
37015001	Draughtboard Shark	*Cephaloscyllium laticeps*	866	360.5	7	1233.5
37015009	Sawtail Catshark	*Figaro boardmani*	730	45.7	4.5	780.2
37015013	Whitefin Swell Shark	*Cephaloscyllium albipinnum*		178	991.5	1169.5
37015020	Pinocchio Catshark	*Apristurus australis*		1.5		1.5
37015024	Orange Spotted Catshark	*Asymbolus rubiginosus*	60	256.7		316.7
37015027	Grey Spotted Catshark	*Asymbolus analis*	7			7
37017001	Gummy Shark	*Mustelus antarcticus*	118	559.7	311.8	989.5
37017008	School Shark	*Galeorhinus galeus*		49.55	331.7	381.25
37018022	Tiger Shark	*Galeocerdo cuvier*		89.5		89.5
37020001	Endeavour Dogfish	*Centrophorus moluccensis*	169		9.6	178.6
37020002	Black Shark	*Dalatias licha*	43	13.7	19.9	76.6
37020003	Brier Shark	*Deania calcea*	140			140
37020004	Longsnout Dogfish	*Deania quadrispinosa*	270	206.5	187.8	664.3
37020006	Spikey Dogfish	*Squalus megalops*	4272.5	1109	801	6182.5
37020007	Greeneye Dogfish	*Squalus mitsukurii*	16.5	90	116.5	223
37020008	Whitespotted Dogfish	*Squalus acanthias*		1	3	4
37020009	Leafscale Gulper Shark	*Centrophorus squamosus*		67.5		67.5
37020011	Southern Dogfish	*Centrophorus zeehaani*		4	5	9
37020019	Owston Dogfish	*Centroscymnus owstonii*			6	6

			Catch (kg)			
CAABcode	**Common Name**	**Species Name**	**NSW**	**East**	**West**	**Total**
37020021	Southern Lanternshark	*Etmopterus baxteri*		6.2		6.2
37020901	Greeneye Dogfish (U)	*Squalus spp*	1298			1298
37020904	Roughskin Dogfish	*Centroscymnus, Centroselachus, Deania & Scymnodon spp.*	128			128
37020907	Lantern Shark	*Etmopterus spp.*	84.5		0.4	84.9
37021001	Prickly Dogfish	*Oxynotus bruniensis*	19	1.5	1.5	22
37023001	Southern Sawshark	*Pristiophorus nudipinnis*		50.9		50.9
37023002	Common Sawshark	*Pristiophorus cirratus*	814	226.55	1134	2174.55
37024001	Australian Angelshark	*Squatina australis*	621	19	17	657
37024004	Eastern Angel Shark	*Squatina albipunctata*		31		31
37024900	Angel Shark	*Squatina spp*		13.6		13.6
37027006	Eastern Fiddler Ray	*Trygonorrhina fasciata*	1437	60		1497
37027009	Eastern Shovelnose Ray	*Aptychotrema rostrata*	216	10		226
37027011	Southern Fiddler Ray	*Trygonorrhina dumerilii*		4	34	38
37028002	Tasmanian Numbfish	*Narcine tasmaniensis*	110	258	15.3	383.3
37028003	Short-Tail Torpedo Ray	*Torpedo macneilli*	131	84	51.5	266.5
37031001	Southern Round Skate	*Irolita waitii*			3	3
37031002	Sydney Skate	*Dipturus australis*	392	147		539
37031003	Whitespotted Skate	*Dipturus cerva*	10	1585		1595
37031005	Longnose Skate	*Dipturus confusus*	23	426		449
37031006	Melbourne Skate	*Spiniraja whitleyi*		1525	99	1624
37031007	Thornback Skate	*Dentiraja lemprieri*			170	170
37031009	Peacock Skate	*Pavoraja nitida*		75.7	634	709.7
37031010	Bight Skate	*Dipturus gudgeri*		680.4	117	797.4
37031028	Grey Skate	*Dipturus canutus*	738	261	27	1026
37031035	Deepwater Skate	*Dipturus acrobelus*	941.5		8	949.5
37035001	Smooth Stingray	*Dasyatis brevicaudata*	664			664
37035002	Black Stingray	*Dasyatis thetidis*		60		60
37038000	Stingaree & Giant Stingaree (U)	*Urolophidae, Plesiobatidae - undiff*			10	10
37038001	Sandyback Stingaree	*Urolophus bucculentus*	308	1505	225	2038
37038002	Banded Stingaree	*Urolophus cruciatus*	160	679	448.8	1287.8
37038004	Sparsely-Spotted Stingaree	*Urolophus paucimaculatus*		631	182	813
37038006	Common Stingaree	*Trygonoptera testacea*	185			185
37038007	Greenback Stingaree	*Urolophus viridis*	2051.5	753.8	5	2810.3
37038008	Wide Stingaree	*Urolophus expansus*			40	40
37039001	Southern Eagle Ray	*Myliobatis australis*	19	40	77.8	136.8
37042001	Ogilby Ghostshark	*Hydrolagus ogilbyi*	817		8	825
37042003	Blackfin Ghostshark	*Hydrolagus lemures*		110.1	266.8	376.9
37042005	Southern Chimaera	*Chimaera fulva*		50	19.4	69.4
37043001	Elephantfish	*Callorhinchus milii*		313.7	260.4	574.1
37044001	Bigspine Spookfish	*Harriotta raleighana*		0.9		0.9
37067000	Conger & Short-Tail Conger Eel (U)	*Congridae, Colocongridae - undiff*	2			2
37067900	Conger Eel	*Conger verreauxi & Conger wilsoni*		18.4	10.7	29.1
37070001	Basketwork Eel	*Diastobranchus capensis*			4	4
37083001	Southern Spineback	*Notacanthus sexspinis*	5	0.2		5.2
37117001	Sergeant Baker	*Aulopus purpurissatus*		0.5		0.5
37118002	Painted Grinner	*Trachinocephalus myops*	3			3
37120001	Blacktip Cucumberfish	*Paraulopus nigripinnis*	7813	2648.9	156.8	10618.7
37122000	Lanternfish (U)	*Myctophidae - undiff*	3.6		0.2	3.8
37208000	Goosefish (U)	*Lophiidae - undiff*	3	8		11
37211000	Coffinfish (U)	*Chaunacidae - undiff*	6	0.1		6.1
37211003	Furry Coffinfish	*Chaunax endeavouri*		1.5		1.5
37224002	Ribaldo	*Mora moro*		237.8	181.1	418.9
37224003	Bearded Rock Cod	*Pseudophycis barbata*		0.9	3.7	4.6
37224004	Chiseltooth Grenadier Cod	*Tripterophycis gilchristi*		2.4		2.4
37224006	Red Cod	*Pseudophycis bachus*		3.4	2.5	5.9
37227001	Blue Grenadier	*Macruronus novaezelandiae*	315	1581.6	42810	44706.6
37228002	Pink Ling	*Genypterus blacodes*	360.7	1255.35	2689.9	4305.95
37232000	Whiptail & Rat-Tail (U)	*Macrouridae & Bathygadidae - undiff*	7025		15	7040
37232001	Southern Whiptail	*Coelorinchus australis*		366.4	424	790.4
37232003	Gargoyle Fish	*Coelorinchus mirus*			15	15
37232004	Toothed Whiptail	*Lepidorhynchus denticulatus*	551.3	2252	587.8	3391.1
37232005	Blackspot Whiptail	*Lucigadus nigromaculatus*		1.3		1.3
37232007	Smooth Whiptail	*Malacocephalus laevis*		55.5		55.5
37232017	Blueband Whiptail	*Coelorinchus matamua*		25	26.5	51.5
37232047	Little Whiptail	*Coelorinchus gormani*		146.2	51.7	197.9
37253001	Berndt's Beardfish	*Polymixia berndti*	1.5			1.5
37255001	Blacktip Sawbelly	*Hoplostethus intermedius*	15.5	7.5	0.4	23.4
37255003	Sandpaper Fish	*Paratrachichthys macleayi*			1	1
37258000	Alfonsino (U)	*Berycidae - undiff*		3.45		3.45
37258001	Imperador	*Beryx decadactylus*			2	2
37258002	Alfonsino	*Beryx splendens*	3	2.3	13.5	18.8
37258003	Redfish	*Centroberyx affinis*	274.6	18.05		292.65
37258004	Bight Redfish	*Centroberyx gerrardi*			16.6	16.6
37258005	Swallowtail	*Centroberyx lineatus*			0.8	0.8
37259001	Australian Pineapplefish	*Cleidopus gloriamaris*	0.2			0.2
37263000	Bighead Dories	*Zeniontidae - undiff*	0.2			0.2
37264001	King Dory	*Cyttus traversi*	2	100	628.1	730.1
37264002	Silver Dory	*Cyttus australis*	7.1	67.3	187.3	261.7
37264003	Mirror Dory	*Zenopsis nebulosus*	4525.5	193.1	321.6	5040.2
37264004	John Dory	*Zeus faber*	167.7	434.6	1	603.3
37264005	New Zealand Dory	*Cyttus novaezealandiae*		123.1	556.8	679.9
37265001	Thorny Tinselfish	*Grammicolepis brachiusculus*	2.5			2.5
37266001	Spikey Oreodory	*Neocyttus rhomboidalis*		2.3	249.3	251.6

			Catch (kg)			
CAABcode	**Common Name**	**Species Name**	**NSW**	**East**	**West**	**Total**
37278000	Flutemouth (U)	*Fistulariidae - undiff*	3.5			3.5
37279000	Bellowsfish (U)	*Macroramphosidae - undiff*	2			2
37279001	Banded Bellowsfish	*Centriscops humerosus*	165.7	239	139.6	544.3
37279002	Common Bellowsfish	*Macroramphosus scolopax*	5.3	1.8	7.7	14.8
37279003	Crested Bellowsfish	*Notopogon lilliei*		50.1		50.1
37279005	Orange Bellowsfish	*Notopogon xenosoma*	0.5			0.5
37282029	Spiny Pipehorse	*Solegnathus spinosissimus*		3.8		3.8
37287001	Reef Ocean Perch	*Helicolenus percoides*	265	150.1	2.5	417.6
37287005	Common Gurnard Perch	*Neosebastes scorpaenoides*	6	1495	115	1616
37287006	Thetis Fish	*Neosebastes thetidis*		49.5	292.5	342
37287093	Bigeye Ocean Perch	*Helicolenus barathri*	883	451.2	201.4	1535.6
37288001	Red Gurnard	*Chelidonichthys kumu*	593.5	183.2	24.9	801.6
37288003	Butterfly Gurnard	*Lepidotrigla vanessa*		428		428
37288005	Painted Latchet	*Pterygotrigla andertoni*	196.5	17.8		214.3
37288006	Latchet	*Pterygotrigla polyommata*		517	2262.8	2779.8
37288007	Cocky Gurnard	*Lepidotrigla modesta*	3686.7	5940.4	113	9740.1
37288008	Roundsnout Gurnard	*Lepidotrigla mulhalli*		5218.6		5218.6
37288023	Spotted Armour Gurnard	***non-current code** Satyrichthys rieffeli*		0.3		0.3
37288902	Armour Gurnards (U)	*Peristediidae - undiff*	89			89
37296000	Flathead (U)	*Platycephalidae - undiff*	10			10
37296001	Tiger Flathead	*Platycephalus richardsoni*	2157	7800.2	298	10255.2
37296002	Deepwater Flathead	*Platycephalus conatus*			1029.3	1029.3
37296003	Southern Sand Flathead	*Platycephalus bassensis*		24.5		24.5
37296007	Bluespotted Flathead	*Platycephalus caeruleopunctatus*	59	1		60
37296011	Freespine Flathead	*Ratabulus diversidens*	37.5			37.5
37296036	Longspine Flathead	*Platycephalus longispinis*	49			49
37296038	Marbled Flathead	*Platycephalus marmoratus*	5			5
37297001	Deepsea Flathead	*Hoplichthys haswelli*	1670.8	929.2	208.6	2808.6
37305001	Smooth-Head Blobfish	*Psychrolutes marcidus*	3		10.5	13.5
37311001	Eastern Orange Perch	*Lepidoperca pulchella*	1.7			1.7
37311002	Butterfly Perch	*Caesioperca lepidoptera*		1		1
37311006	Hapuku	*Polyprion oxygeneios*	4	9	62.5	75.5
37311053	Threespine Cardinalfish	*Apogonops anomalus*	169	9.7		178.7
37311152	Eightbar Grouper	*Epinephelus octofasciatus*	0.8			0.8
37311161	Spinycheek Seabass	*Ostracoberyx paxtoni*	27.3			27.3
37326001	Spotted Bigeye	*Priacanthus macracanthus*	27.5			27.5
37327010	White Deepsea Cardinalfish	*Epigonus denticulatus*			0.5	0.5
37327018	Robust Deepsea Cardinalfish	*Epigonus robustus*		4.2		4.2
37330014	Eastern School Whiting	*Sillago flindersi*	29.6	0.2		29.8
37331006	Pink Tilefish	*Branchiostegus wardi*	1.5			1.5
37334002	Tailor	*Pomatomus saltatrix*	11			11
37337002	Jack Mackerel	*Trachurus declivis*	432	1644.9	0.8	2077.7
37337003	Yellowtail Scad	*Trachurus novaezelandiae*	142			142
37337062	Silver Trevally	*Pseudocaranx dentex*	2.2	3.5	0.3	6
37342001	Ray Bream	*Brama brama*			4	4
37345001	Redbait	*Emmelichthys nitidus*		52.9	6.8	59.7
37345003	Cosmopolitan Rubyfish	*Plagiogeneion rubiginosum*			608.3	608.3
37353001	Snapper	*Pagrus auratus*	2.5		30.5	33
37355001	Bluestriped Goatfish	*Upeneichthys lineatus*	11.6	5		16.6
37361002	Footballer Sweep	*Neatypus obliquus*			2.2	2.2
37367001	Yellowspotted Boarfish	*Paristiopterus gallipavo*			121.2	121.2
37367002	Giant Boarfish	*Paristiopterus labiosus*	8			8
37367003	Longsnout Boarfish	*Pentaceropsis recurvirostris*	34.5	78.7		113.2
37367004	Bigspine Boarfish	*Pentaceros decacanthus*	20	40.7	0.2	60.9
37367005	Blackspot Boarfish	*Zanclistius elevatus*	39	25.1	8.3	72.4
37369002	Knifejaw	*Oplegnathus woodwardi*			117.8	117.8
37377002	Grey Morwong	*Nemadactylus douglasii*	211.1	38.2		249.3
37377003	Jackass Morwong	*Nemadactylus macropterus*		54.05	412.4	466.45
37378002	Bastard Trumpeter	*Latridopsis forsteri*	1.5			1.5
37382002	Snook	*Sphyraena novaehollandiae*	8			8
37390001	Barred Grubfish	*Parapercis allporti*	41.3	41.7	2	85
37400001	Bulldog Stargazer	*Xenocephalus armatus*	415.5	300.7		716.2
37400003	Common Stargazer	*Kathetostoma laeve*		0.1		0.1
37400004	Deepwater Stargazer	*Kathetostoma nigrofasciatum*			0.5	0.5
37400005	Scaled Stargazer	*Pleuroscopus pseudodorsalis*	4	1		5
37400018	Speckled Stargazer	*Kathetostoma canaster*	12	810.94	512.5	1335.44
37427001	Common Stinkfish	*Foetorepus calauropomus*		0.51		0.51
37439000	Longfin Escolars & Gemfishes	*Scombrolabracidae, Gempylidae - undiff*	17			17
37439001	Barracouta	*Thyrsites atun*	80	4078.5	481	4639.5
37439002	Gemfish	*Rexea solandri*	141	174.8	560.2	876
37439901	Escolar	*Lepidocybium flavobrunneum & Ruvettus pretiosus*	8		3	11
37440002	Frostfish	*Lepidopus caudatus*	3344	1239.1	22.5	4605.6
37441000	Mackerel (U)	*Scombridae - undiff*		60.5		60.5
37441001	Blue Mackerel	*Scomber australasicus*	13	4.6		17.6
37445001	Blue-Eye Trevalla	*Hyperoglyphe antarctica*		14.3	199.4	213.7
37445002	Tasmanian Rudderfish	*Tubbia tasmanica*		4.1		4.1
37445004	Rudderfish	*Centrolophus niger*	17		0.8	17.8
37445005	Blue Warehou	*Seriolella brama*	0.2	135.1	33.65	168.95
37445006	Silver Warehou	*Seriolella punctata*	33.5	20294.8	3343.7	23672
37445011	White Warehou	*Seriolella caerulea*	2	54.3	15.9	72.2
37446010	Blue Cubehead	*Cubiceps caeruleus*	16.7			16.7
37460001	Crested Flounder	*Lophonectes gallus*		0.7		0.7
37460002	Smalltooth Flounder	*Pseudorhombus jenynsii*	5.9			5.9

CAABcode	Common Name	Species Name	Catch (kg) NSW	East	West	Total
37465003	Mosaic Leatherjacket	*Eubalichthys mosaicus*		2		2
37465005	Velvet Leatherjacket	*Meuschenia scaber*		101.1	714	815.1
37465006	Ocean Jacket	*Nelusetta ayraud*	1481	611.5	27.7	2120.2
37465007	Rough Leatherjacket	*Scobinichthys granulatus*	1			1
37465008	Brownstriped Leatherjacket	*Meuschenia australis*		5.7		5.7
37465035	Yellowstriped Leatherjacket	*Meuschenia flavolineata*	2			2
37465039	Black Reef Leatherjacket	*Eubalichthys bucephalus*	6			6
37466002	Eastern Smooth Boxfish	*Anoplocapros inermis*	10	0.4		10.4
37466003	Shaw Cowfish	*Aracana aurita*	3	0.1		3.1
37467000	Toadfish (U)	*Tetraodontidae - undiff*		3.5		3.5
37467002	Ringed Toadfish	*Omegophora armilla*		0.1	46.9	47
37467004	Balloonfish	*Sphoeroides pachygaster*		43.9		43.9
37467007	Silver Toadfish	*Lagocephalus sceleratus*	365			365
37468000	Pufferfish (U)	*Triodontidae - undiff*			3.8	3.8
37469002	Australian Burrfish	*Allomycterus pilatus*	1898	638	3297.5	5833.5
41131003	Australian Fur Seal	*Arctocephalus pusillus doriferus*	80	450	185	715
54000000	Brown Algae	*Class Phaeophyceae - undiff*	94			94
	Total		62415	82252	73210	217877

Table 11. Details of all shots conducted during the 2016 survey. Greyed out shots were declared invalid.

Shot code	Region	Shot date	Time of shot	Shot duration (hrs)	Start point		End point		Mean depth (m)
					Latitude	Longitude	Latitude	Longitude	
107	East	4-Aug-16	10:07:35	12:12:06	2:04	-38.3333	148.8714	-38.3733	148.7466
106	East	4-Aug-16	14:03:35	16:07:33	2:03	-38.2433	148.5837	-38.3104	148.484
105	East	4-Aug-16	16:58:54	19:06:47	2:07	-38.3626	148.445	-38.4619	148.3989
99	East	5-Aug-16	5:02:02	7:02:19	2:00	-39.3877	148.7355	-39.4865	148.7654
98	East	5-Aug-16	7:39:51	9:41:21	2:01	-39.512	148.7766	-39.6153	148.7982
97	East	5-Aug-16	10:51:32	12:59:02	2:07	-39.7283	148.7127	-39.8292	148.7629
96	East	5-Aug-16	13:28:13	15:33:04	2:04	-39.8379	148.765	-39.9412	148.7832
95	East	5-Aug-16	16:40:57	18:45:41	2:04	-39.9358	148.663	-40.0373	148.7071
90	East	6-Aug-16	7:04:23	9:07:32	2:03	-41.4582	148.416	-41.5619	148.4286
91	East	6-Aug-16	9:50:54	11:49:37	1:58	-41.5902	148.4614	-41.4916	148.4792
87	East	6-Aug-16	12:56:38	14:58:30	2:01	-41.5619	148.5865	-41.6625	148.5592
88	East	6-Aug-16	17:29:46	19:26:02	1:56	-41.5676	148.6411	-41.6809	148.6172
80	East	7-Aug-16	6:43:49	8:46:43	2:02	-42.64	148.3285	-42.7448	148.3079
77	East	7-Aug-16	9:43:17	11:54:44	2:11	-42.8326	148.3068	-42.936	148.2585
76	East	7-Aug-16	12:27:16	14:32:46	2:05	-42.9702	148.2664	-43.0725	148.229
75	East	7-Aug-16	15:45:02	17:57:29	2:12	-43.0793	148.1843	-43.1774	148.1133
74	East	8-Aug-16	5:13:08	7:13:33	2:00	-43.7624	147.8307	-43.6801	147.9125
73	East	8-Aug-16	8:01:34	9:35:57	1:34	-43.6425	147.8812	-43.7126	147.8341
72	East	8-Aug-16	11:01:23	13:04:47	2:03	-43.595	147.7643	-43.6628	147.6552
69	East	8-Aug-16	13:39:04	15:52:29	2:13	-43.6815	147.5956	-43.766	147.4916
70	East	8-Aug-16	17:06:17	19:12:56	2:06	-43.6542	147.4412	-43.5716	147.5327
71	East	9-Aug-16	5:00:15	7:01:59	2:01	-43.4736	147.6012	-43.5385	147.4973
83	East	11-Aug-16	5:07:01	7:10:52	2:03	-42.6884	148.2657	-42.5917	148.3173
85	East	11-Aug-16	9:16:47	11:19:44	2:02	-42.477	148.5157	-42.6073	148.4715
81	East	11-Aug-16	12:42:39	14:41:26	1:58	-42.5791	148.4734	-42.7027	148.4263
78	East	11-Aug-16	16:16:37	17:50:49	1:34	-42.7622	148.3954	-42.8592	148.3626
86	East	12-Aug-16	5:14:04	7:13:39	1:59	-42.3358	148.5592	-42.4314	148.5295
84	East	12-Aug-16	9:36:44	11:36:00	1:59	-42.4166	148.4011	-42.5104	148.3529
82	East	12-Aug-16	12:32:51	14:43:04	2:10	-42.4814	148.4341	-42.5871	148.4088
79	East	12-Aug-16	15:53:44	16:45:16	0:51	-42.6268	148.3829	-42.6641	148.3506
92	East	13-Aug-16	5:04:18	7:10:16	2:05	-41.3844	148.6076	-41.2753	148.6181
93	East	13-Aug-16	8:25:42	10:39:43	2:14	-41.2065	148.5661	-41.0893	148.5703
94	East	13-Aug-16	11:19:47	13:22:59	2:03	-41.0616	148.5414	-40.9565	148.5324
100	East	14-Aug-16	5:17:27	7:15:44	1:58	-39.358	148.7729	-39.2619	148.7307
103	East	14-Aug-16	8:47:42	10:58:12	2:10	-39.2286	148.5812	-39.13	148.5199
102	East	14-Aug-16	12:38:28	14:23:23	1:44	-39.032	148.6336	-39.1121	148.6766
101	East	14-Aug-16	15:50:16	17:55:34	2:05	-39.0608	148.678	-39.181	148.7166
104	East	15-Aug-16	5:02:39	7:04:14	2:01	-39.1055	148.5025	-39.0183	148.427
108	East	16-Aug-16	8:00:14	10:04:18	2:04	-38.2101	149.0402	-38.2105	149.1741
110	East	16-Aug-16	11:29:23	13:45:26	2:16	-38.2083	149.164	-38.1294	149.2697
109	East	16-Aug-16	15:43:40	17:45:36	2:01	-38.2532	149.2785	-38.2784	149.1505
112	East	17-Aug-16	5:34:31	7:26:33	1:52	-38.2353	149.7279	-38.2114	149.8371
113	East	17-Aug-16	8:39:34	10:18:19	1:38	-38.1902	149.901	-38.1309	149.9732
119	East	17-Aug-16	11:15:39	13:12:02	1:56	-38.1325	149.9714	-38.0772	150.075
118	East	17-Aug-16	14:13:50	16:31:24	2:17	-38.069	150.0476	-37.9652	150.1092
120	East	17-Aug-16	17:40:59	19:49:36	2:08	-38.0024	150.1204	-37.898	150.1591
127	East	18-Aug-16	5:54:25	7:50:23	1:55	-37.3177	150.254	-37.4156	150.2134
126	East	18-Aug-16	8:51:12	10:44:44	1:53	-37.5014	150.2264	-37.597	150.1891
122	East	18-Aug-16	11:22:03	13:21:47	1:59	-37.6399	150.2214	-37.7385	150.1822
123	East	18-Aug-16	14:15:00	16:08:56	1:53	-37.7205	150.1933	-37.8099	150.1369
117	East	18-Aug-16	17:44:37	19:43:01	1:58	-37.9062	149.9871	-37.8169	150.0462
121	East	19-Aug-16	5:16:22	7:19:55	2:03	-37.8944	150.1389	-37.99	150.0903
124	East	19-Aug-16	12:05:25	13:59:42	1:54	-37.65	149.9281	-37.7413	149.8878
131	East	20-Aug-16	7:07:33	9:12:16	2:04	-36.8942	150.0489	-36.7861	150.0484
135	East	20-Aug-16	10:44:39	12:38:21	1:53	-36.7288	150.2022	-36.8239	150.1885

Shot code	Region	Shot date	Time of shot	Shot duration (hrs)	Start point		End point		Mean depth (m)
					Latitude	Longitude	Latitude	Longitude	
133	East	20-Aug-16	13:55:06	16:13:42	2:18	-36.8469	150.2778	-36.9601	150.3083
130	East	20-Aug-16	17:48:46	19:59:53	2:11	-37.0465	150.1595	-37.1524	150.1209
132	East	21-Aug-16	6:58:13	9:16:33	2:18	-36.9881	150.311	-37.1046	150.3246
128	East	21-Aug-16	10:17:07	12:29:39	2:12	-37.176	150.3498	-37.286	150.3408
129	East	21-Aug-16	14:05:16	16:02:05	1:56	-37.2593	150.2217	-37.152	150.236
116	East	22-Aug-16	5:05:22	7:16:00	2:10	-37.8612	149.7591	-37.9274	149.6472
115	East	22-Aug-16	8:33:40	10:37:29	2:03	-38.0344	149.7349	-38.0086	149.8685
114	East	22-Aug-16	11:38:21	13:31:46	1:53	-38.0683	149.9285	-38.1243	149.8225
111	East	22-Aug-16	15:01:09	17:06:27	2:05	-38.1878	149.8397	-38.1315	149.9522
195	NSW	30-Jul-16	5:17:05	7:23:15	2:06	-34.0347	151.3431	-34.1371	151.2951
194	NSW	30-Jul-16	8:16:24	10:19:14	2:02	-34.1885	151.2667	-34.277	151.2044
187	NSW	30-Jul-16	11:13:31	13:20:44	2:07	-34.2711	151.1748	-34.3712	151.1293
179	NSW	30-Jul-16	15:37:31	17:44:41	2:07	-34.5807	151.0091	-34.6852	150.9803
202	NSW	31-Jul-16	5:06:39	7:15:48	2:09	-33.7129	151.9011	-33.6277	151.9704
201	NSW	31-Jul-16	8:39:01	11:00:19	2:21	-33.6081	152.0083	-33.6968	151.94
205	NSW	31-Jul-16	12:00:36	14:12:24	2:11	-33.671	151.9399	-33.5843	152.0087
204	NSW	31-Jul-16	16:26:05	18:32:46	2:06	-33.6704	151.842	-33.5865	151.913
203	NSW	1-Aug-16	5:01:21	7:09:41	2:08	-33.71	151.7791	-33.6218	151.8527
199	NSW	1-Aug-16	7:59:19	10:01:39	2:02	-33.5915	151.8134	-33.6741	151.7315
200	NSW	1-Aug-16	11:03:20	13:14:44	2:11	-33.6211	151.6301	-33.7105	151.5411
197	NSW	1-Aug-16	14:14:52	16:22:29	2:07	-33.707	151.4221	-33.6252	151.5179
198	NSW	1-Aug-16	17:02:56	19:05:51	2:02	-33.5957	151.5082	-33.6643	151.4069
189	NSW	7-Aug-16	5:29:28	7:38:22	2:08	-34.2857	151.297	-34.3823	151.2428
188	NSW	7-Aug-16	8:27:55	11:11:35	2:43	-34.3746	151.2849	-34.2817	151.3525
192	NSW	7-Aug-16	12:55:03	14:56:20	2:01	-34.2247	151.4852	-34.3127	151.4306
186	NSW	7-Aug-16	16:29:50	18:27:04	1:57	-34.2914	151.4635	-34.3787	151.4024
193	NSW	8-Aug-16	5:21:04	7:24:25	2:03	-34.238	151.4609	-34.3296	151.4065
185	NSW	8-Aug-16	8:42:50	10:46:15	2:03	-34.3115	151.4228	-34.401	151.3611
184	NSW	8-Aug-16	12:30:25	14:27:29	1:57	-34.3215	151.3801	-34.4057	151.3244
191	NSW	8-Aug-16	16:15:14	18:04:07	1:48	-34.3158	151.3694	-34.4003	151.3152
190	NSW	9-Aug-16	5:16:00	7:14:52	1:58	-34.2709	151.3681	-34.356	151.3043
181	NSW	9-Aug-16	8:19:10	10:14:17	1:55	-34.4657	151.2501	-34.5704	151.1939
178	NSW	9-Aug-16	12:13:45	14:10:21	1:56	-34.5455	150.985	-34.6455	150.9573
172	NSW	9-Aug-16	15:27:21	17:13:01	1:45	-34.7758	151.0385	-34.8794	151.0389
163	NSW	10-Aug-16	6:54:14	8:38:04	1:43	-35.2631	150.698	-35.2867	150.6363
164	NSW	14-Aug-16	5:11:30	7:06:29	1:54	-35.2277	150.953	-35.3132	150.8912
165	NSW	14-Aug-16	7:59:27	9:53:42	1:54	-35.2943	150.905	-35.372	150.8443
161	NSW	14-Aug-16	11:03:08	13:09:41	2:06	-35.4506	150.7999	-35.5323	150.7471
159	NSW	14-Aug-16	14:36:29	16:18:12	1:41	-35.582	150.7436	-35.5038	150.7881
160	NSW	14-Aug-16	17:46:35	19:36:56	1:50	-35.5658	150.7447	-35.4826	150.7901
136	NSW	15-Aug-16	5:09:16	7:12:02	2:02	-36.6391	150.3131	-36.7429	150.3144
137	NSW	15-Aug-16	8:00:57	9:51:34	1:50	-36.7049	150.3433	-36.6152	150.338
140	NSW	15-Aug-16	10:34:06	12:36:19	2:02	-36.607	150.317	-36.509	150.3025
139	NSW	15-Aug-16	13:29:56	15:38:19	2:08	-36.566	150.2887	-36.671	150.2793
141	NSW	15-Aug-16	16:22:48	18:38:08	2:15	-36.6761	150.2565	-36.5648	150.2722
147	NSW	16-Aug-16	5:11:10	7:08:03	1:56	-36.1688	150.4166	-36.2572	150.387
146	NSW	16-Aug-16	8:27:57	10:17:22	1:49	-36.3627	150.3186	-36.452	150.2995
145	NSW	16-Aug-16	17:33:13	19:47:57	2:14	-36.4607	150.3406	-36.3649	150.3609
134	NSW	17-Aug-16	5:03:18	7:14:09	2:10	-36.7096	150.1274	-36.6005	150.1312
144	NSW	17-Aug-16	9:00:24	10:52:57	1:52	-36.4081	150.1899	-36.3144	150.2362
149	NSW	17-Aug-16	12:30:24	14:38:16	2:07	-36.198	150.3828	-36.0934	150.4052
148	NSW	17-Aug-16	15:38:16	17:48:32	2:10	-36.0798	150.365	-35.9756	150.3688
155	NSW	18-Aug-16	5:17:00	8:15:47	2:58	-35.7651	150.6167	-35.6747	150.6782
156	NSW	18-Aug-16	10:45:27	12:32:25	1:46	-35.6775	150.3782	-35.6035	150.4521
153	NSW	22-Aug-16	5:07:20	7:02:10	1:54	-35.7524	150.6161	-35.8361	150.5716
151	NSW	22-Aug-16	8:16:38	10:27:23	2:10	-35.7848	150.5815	-35.8798	150.5282
154	NSW	22-Aug-16	11:37:07	13:36:52	1:59	-35.8603	150.529	-35.9499	150.481
150	NSW	22-Aug-16	15:00:36	16:58:31	1:57	-35.9029	150.3166	-35.8145	150.3701
152	NSW	22-Aug-16	17:45:01	19:53:29	2:08	-35.7949	150.4289	-35.6981	150.4543
158	NSW	27-Aug-16	13:15:01	14:56:41	1:41	-35.5437	150.6938	-35.6324	150.6387
175	NSW	28-Aug-16	8:35:23	10:17:46	1:42	-34.83	150.8863	-34.9185	150.913
168	NSW	28-Aug-16	12:05:03	14:13:53	2:08	-34.9525	151.1356	-35.0458	151.0954
171	NSW	28-Aug-16	15:24:44	17:52:32	2:27	-35.0594	151.108	-34.965	151.1529
170	NSW	29-Aug-16	5:08:06	7:14:54	2:06	-34.8435	151.1951	-34.9352	151.1627
169	NSW	29-Aug-16	8:22:38	10:26:45	2:04	-34.9691	151.1353	-35.0579	151.0904
167	NSW	29-Aug-16	12:01:46	13:51:49	1:50	-35.0534	151.0815	-34.9731	151.1095
176	NSW	29-Aug-16	15:34:14	17:33:39	1:59	-34.818	151.1051	-34.7309	151.1245
183	NSW	30-Aug-16	5:07:11	7:05:09	1:57	-34.6017	151.247	-34.5144	151.2828
182	NSW	30-Aug-16	8:01:28	10:03:30	2:02	-34.5243	151.3114	-34.6139	151.269
180	NSW	30-Aug-16	10:52:39	12:48:44	1:56	-34.6274	151.2645	-34.7117	151.2266
10	West	29-Jul-16	10:24:50	12:19:16	1:54	-37.9117	139.9613	-37.8603	139.8815
9	West	29-Jul-16	14:31:49	16:42:06	2:10	-37.7292	139.72	-37.6474	139.6261
1	West	30-Jul-16	9:53:29	11:31:51	1:38	-37.1494	138.3463	-37.1334	138.2741
2	West	31-Jul-16	7:24:17	9:25:32	2:01	-37.1489	138.831	-37.1783	138.9428
8	West	31-Jul-16	12:22:27	13:46:35	1:24	-37.3296	139.2135	-37.3895	139.2503
5	West	31-Jul-16	15:01:42	16:42:09	1:40	-37.4301	139.2289	-37.5176	139.2564
3	West	1-Aug-16	7:37:49	9:47:10	2:09	-37.5481	139.2638	-37.4801	139.1776
4	West	1-Aug-16	10:35:56	12:14:59	1:39	-37.4829	139.1826	-37.554	139.2296
6	West	1-Aug-16	13:35:55	15:26:19	1:50	-37.5818	139.2377	-37.5265	139.1462
7	West	1-Aug-16	17:08:11	18:52:58	1:44	-37.4317	139.0933	-37.5116	139.0837
11	West	2-Aug-16	8:02:49	10:10:25	2:07	-38.0269	140.1317	-38.1067	140.229
-11	West	2-Aug-16	11:30:34	13:39:25	2:08	-38.1096	140.2317	-38.1771	140.3404
12	West	2-Aug-16	14:55:10	16:44:27	1:49	-38.2121	140.3126	-38.2629	140.4032

Shot code	Region	Shot date	Time of shot	Shot duration (hrs)	Start point		End point		Mean depth (m)
					Latitude	Longitude	Latitude	Longitude	
13	West	3-Aug-16	8:03:25	9:52:05	1:48	-38.1815	140.35	-38.2394	140.4379
14	West	3-Aug-16	10:53:00	13:05:30	2:12	-38.2429	140.4348	-38.2988	140.5417
15	West	3-Aug-16	14:04:29	16:00:12	1:55	-38.2885	140.5314	-38.3369	140.6492
16	West	4-Aug-16	7:55:12	9:45:58	1:50	-38.3465	140.5242	-38.3876	140.6158
17	West	4-Aug-16	10:52:45	12:54:47	2:02	-38.3355	140.6277	-38.3812	140.7404
18	West	4-Aug-16	13:50:54	15:46:00	1:55	-38.4018	140.7522	-38.4454	140.8643
19	West	5-Aug-16	7:46:53	9:52:25	2:05	-38.3925	140.8499	-38.432	140.9718
-19	West	5-Aug-16	11:05:59	13:17:03	2:11	-38.4539	141.1014	-38.4982	141.2085
20	West	5-Aug-16	15:03:43	17:01:34	1:57	-38.6839	141.2393	-38.7372	141.3327
25	West	6-Aug-16	7:37:55	9:45:07	2:07	-38.5779	141.4625	-38.6692	141.405
21	West	6-Aug-16	11:16:44	13:30:25	2:13	-38.6753	141.2607	-38.7306	141.3759
24	West	11-Aug-16	12:51:50	15:03:50	2:12	-38.6487	141.2983	-38.6862	141.4211
22	West	11-Aug-16	16:19:57	18:23:37	2:03	-38.6562	141.3696	-38.7268	141.4502
26	West	14-Aug-16	11:12:32	13:30:32	2:18	-38.8279	141.5187	-38.8177	141.4103
27	West	14-Aug-16	15:00:55	17:04:43	2:03	-38.7271	141.4509	-38.7668	141.5767
28	West	15-Aug-16	8:08:21	10:05:47	1:57	-38.8296	141.8293	-38.8353	141.942
29	West	15-Aug-16	11:00:50	13:06:13	2:05	-38.837	141.9655	-38.8674	142.0782
31	West	15-Aug-16	14:15:55	16:37:11	2:21	-38.8435	142.0591	-38.7941	141.9415
38	West	16-Aug-16	6:35:15	8:32:08	1:56	-40.0012	143.2003	-40.0906	143.249
41	West	16-Aug-16	11:40:28	13:41:59	2:01	-40.3056	143.3404	-40.2369	143.3125
44	West	17-Aug-16	7:42:12	9:57:51	2:15	-41.033	143.8573	-40.9578	143.7797
43	West	17-Aug-16	11:25:26	13:48:25	2:22	-40.969	143.8327	-40.8842	143.7343
40	West	18-Aug-16	6:30:24	8:18:46	1:48	-40.0539	143.2154	-40.1347	143.2507
42	West	18-Aug-16	13:08:03	15:10:49	2:02	-40.5893	143.5223	-40.6815	143.5963
-42	West	18-Aug-16	16:05:06	18:11:29	2:06	-40.7182	143.6249	-40.8032	143.7031
37	West	19-Aug-16	8:09:06	10:18:14	2:09	-39.3216	142.742	-39.2386	142.6748
39	West	23-Aug-16	5:19:07	7:33:57	2:14	-40.0401	143.2191	-40.1373	143.2691
45	West	23-Aug-16	17:32:38	19:35:33	2:02	-41.3093	144.2266	-41.3664	144.3259
52	West	24-Aug-16	5:22:05	7:38:51	2:16	-41.9664	144.6555	-42.0648	144.717
54	West	24-Aug-16	8:42:12	10:56:09	2:13	-42.0806	144.6896	-42.1859	144.7327
63	West	25-Aug-16	5:37:12	7:35:45	1:58	-43.4157	145.6653	-43.4737	145.7622
64	West	25-Aug-16	8:27:21	10:30:37	2:03	-43.4569	145.7738	-43.5249	145.876
65	West	25-Aug-16	11:35:10	13:35:56	2:00	-43.5646	145.8777	-43.6523	145.9484
62	West	25-Aug-16	17:44:31	20:03:59	2:19	-43.2986	145.4573	-43.2086	145.3626
61	West	26-Aug-16	6:08:21	8:09:34	2:01	-43.263	145.372	-43.1927	145.2866
60	West	26-Aug-16	13:33:32	14:58:48	1:25	-42.7531	144.9045	-42.6902	144.9051
59	West	26-Aug-16	18:13:22	19:51:08	1:37	-42.4138	144.7937	-42.4932	144.8119
58	West	27-Aug-16	8:06:00	9:38:39	1:32	-42.3091	144.7861	-42.2499	144.7674
50	West	28-Aug-16	6:29:45	8:17:07	1:47	-41.8583	144.5422	-41.9397	144.5831
55	West	28-Aug-16	11:02:48	12:44:53	1:42	-42.1399	144.7094	-42.0609	144.6798
56	West	28-Aug-16	14:44:37	16:36:35	1:51	-42.1282	144.682	-42.2155	144.7239
57	West	28-Aug-16	17:47:17	18:45:40	0:58	-42.254	144.8158	-42.2069	144.8067
49	West	29-Aug-16	5:33:47	7:47:52	2:14	-41.8389	144.4953	-41.7414	144.4496
47	West	29-Aug-16	8:52:41	10:45:52	1:53	-41.718	144.4662	-41.6382	144.4218
48	West	29-Aug-16	12:05:50	14:15:59	2:10	-41.6485	144.4463	-41.5455	144.4144
46	West	29-Aug-16	16:11:08	17:29:38	1:18	-41.3715	144.3513	-41.3317	144.2817
-36	West	30-Aug-16	14:54:56	16:56:51	2:01	-38.9629	142.3548	-38.8982	142.2441
32	West	30-Aug-16	17:44:06	19:58:10	2:14	-38.8904	142.2234	-38.8331	142.0949
34	West	31-Aug-16	7:03:00	9:07:26	2:04	-38.8109	142.0189	-38.8685	142.1425
33	West	2-Sep-16	6:03:14	8:01:16	1:58	-38.8933	142.0518	-38.9337	142.165
30	West	2-Sep-16	9:07:57	11:09:31	2:01	-38.922	142.1864	-38.8728	142.0768
35	West	2-Sep-16	12:30:01	14:27:24	1:57	-38.8351	142.1616	-38.8859	142.2723
36	West	2-Sep-16	15:25:15	16:31:26	1:06	-38.8965	142.3174	-38.8708	142.2585

Summer and winter survey model fits for 11 main quota species and Blue Grenadier

Blue Warehou – Winter 2016

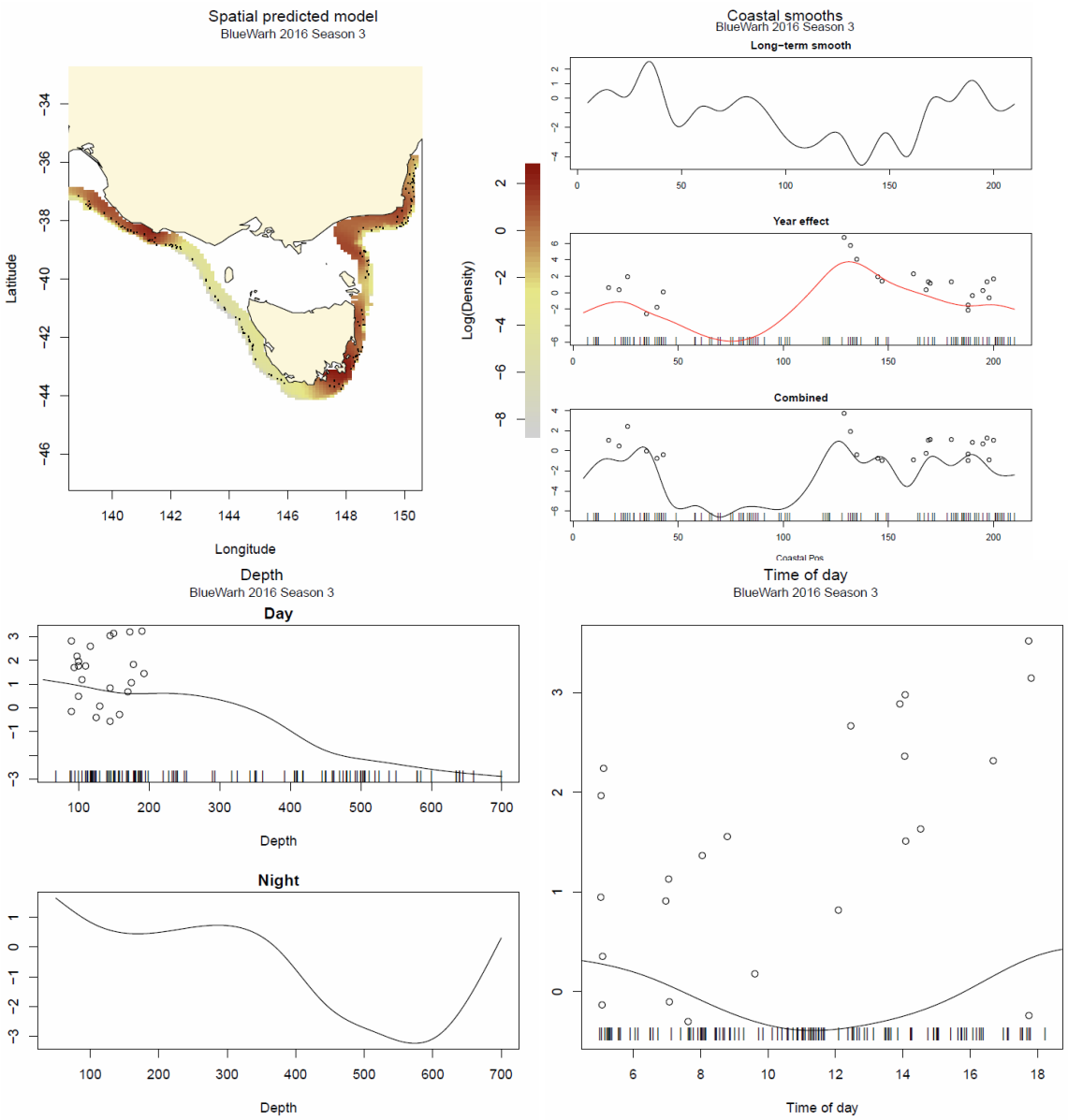

Figure 36. Winter survey model fits for Blue Warehou. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

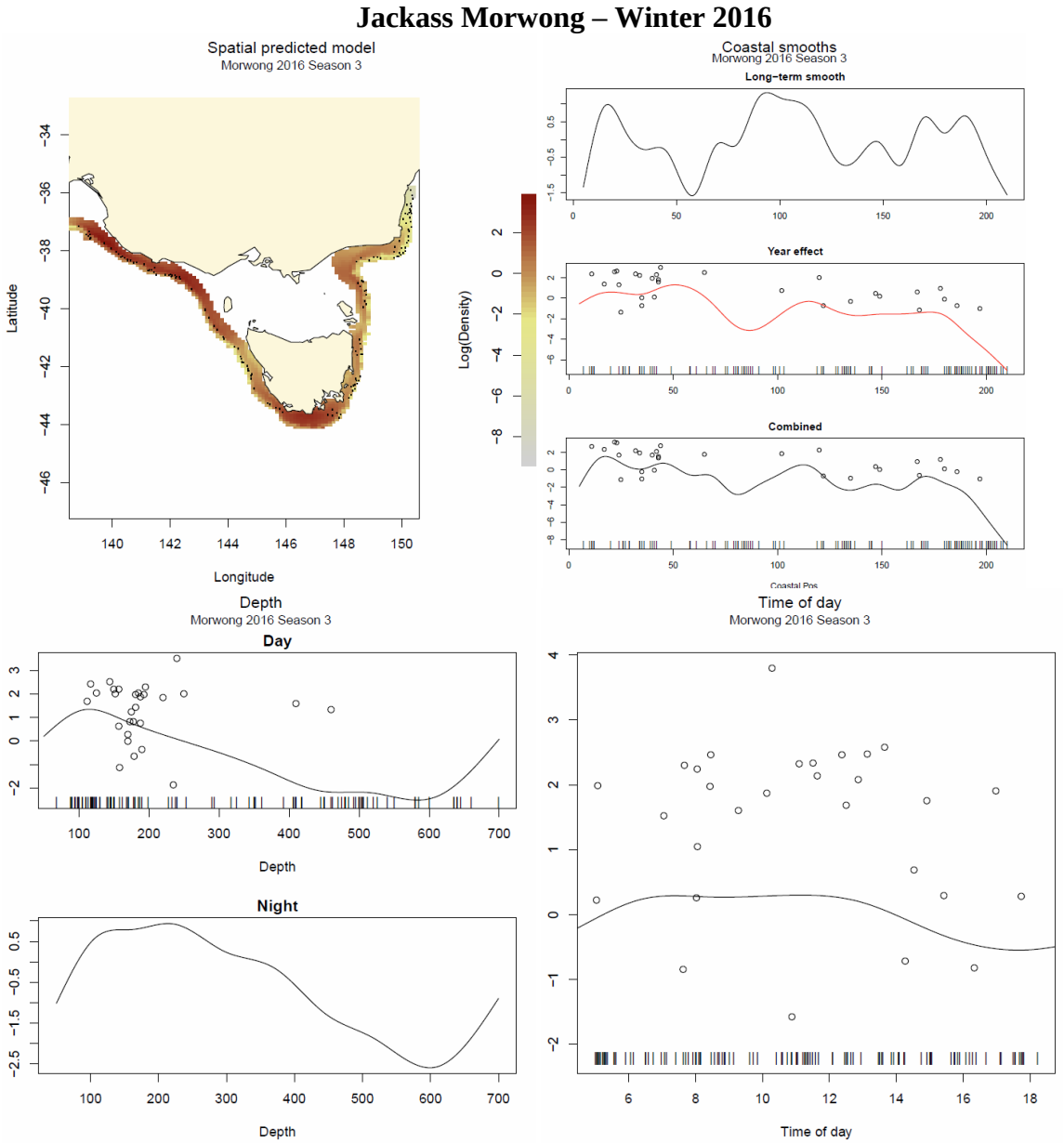

Figure 37. Winter survey model fits for Jackass Morwong. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

John Dory – Winter 2016

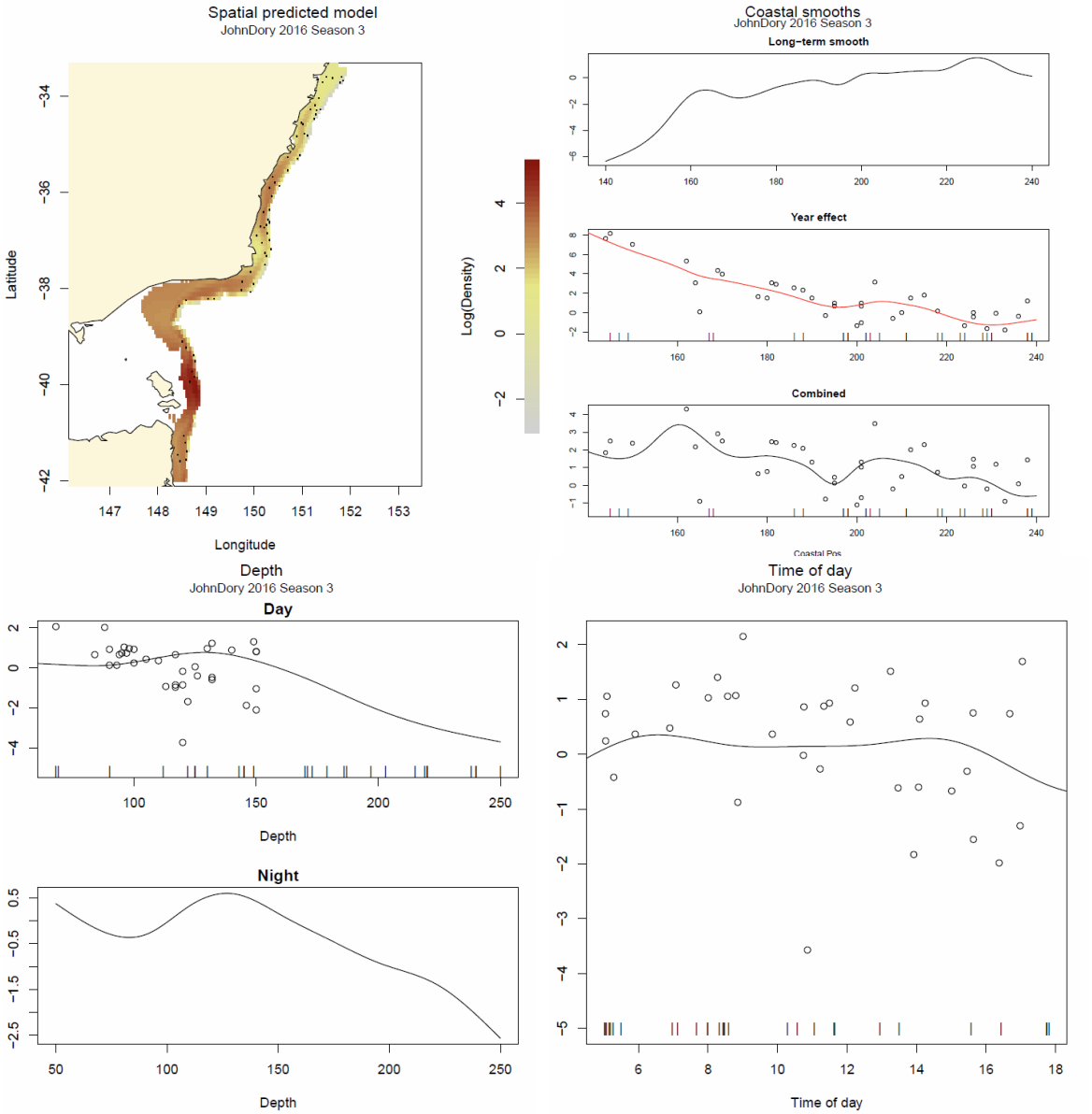

Figure 38. Winter survey model fits for John Dory. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Gemfish – Winter 2016

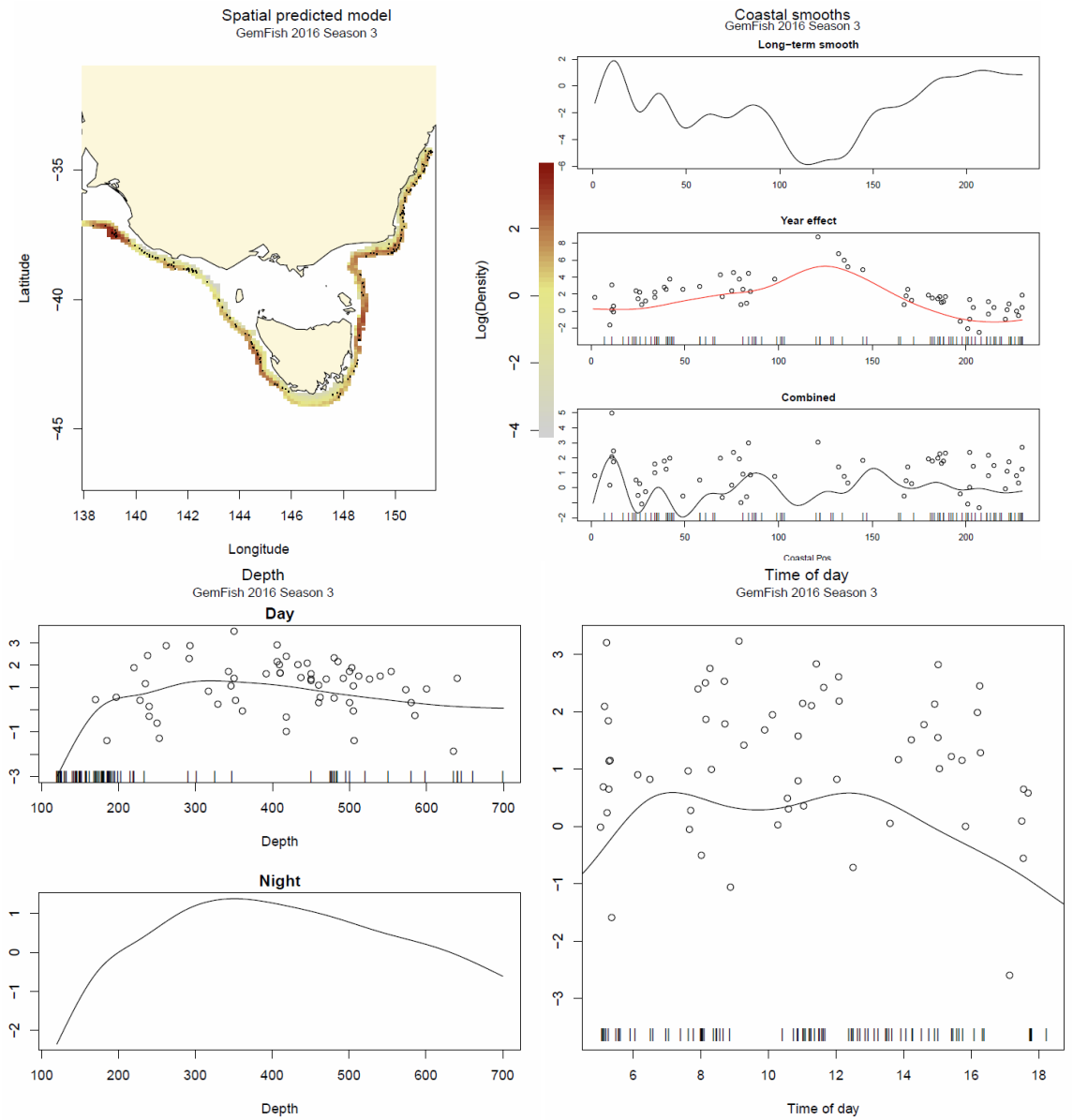

Figure 39. Winter survey model fits for Gemfish. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Tiger Flathead – Winter 2016

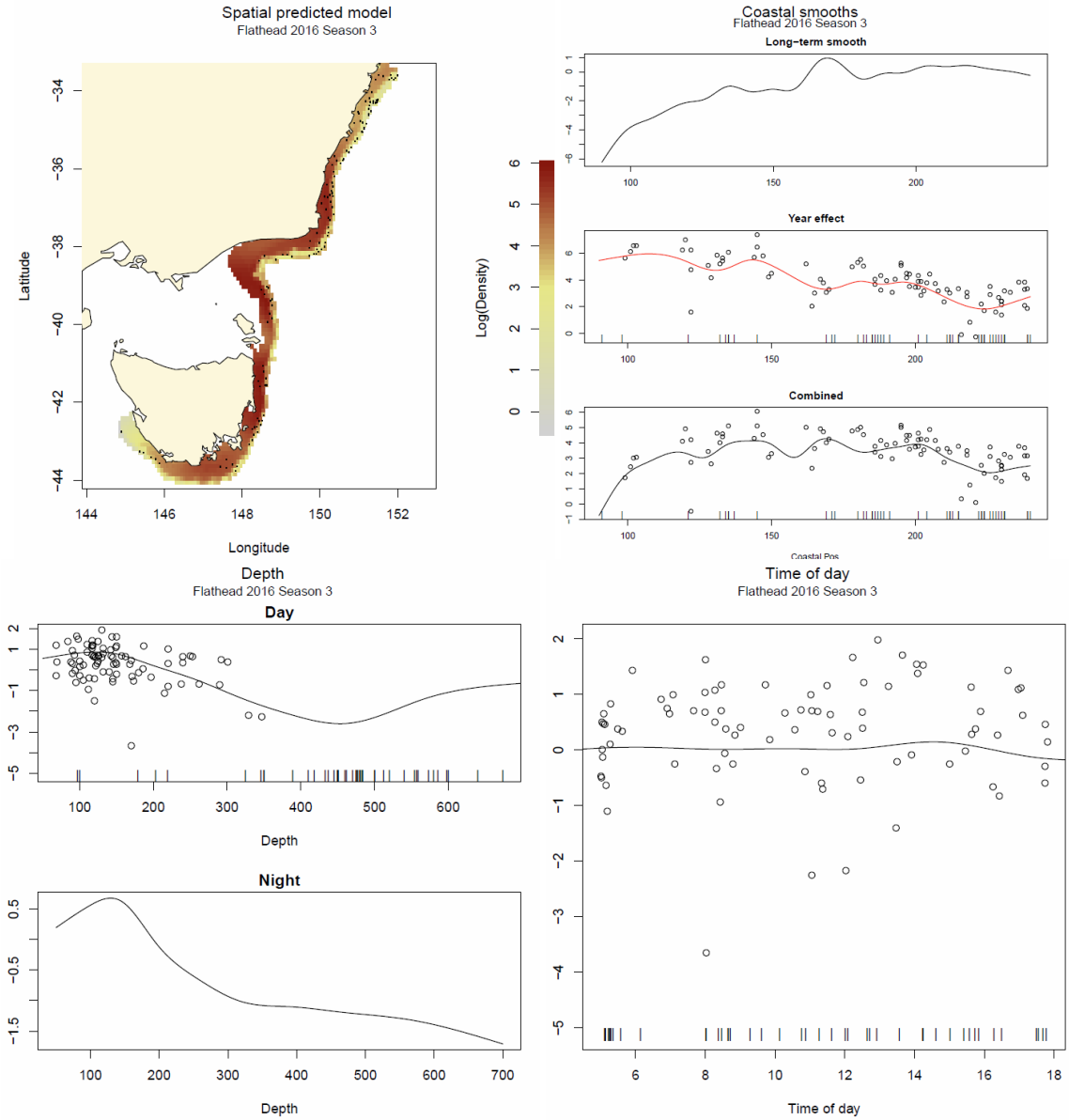

Figure 40. Winter survey model fits for Tiger Flathead. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Pink Ling – Winter 2016

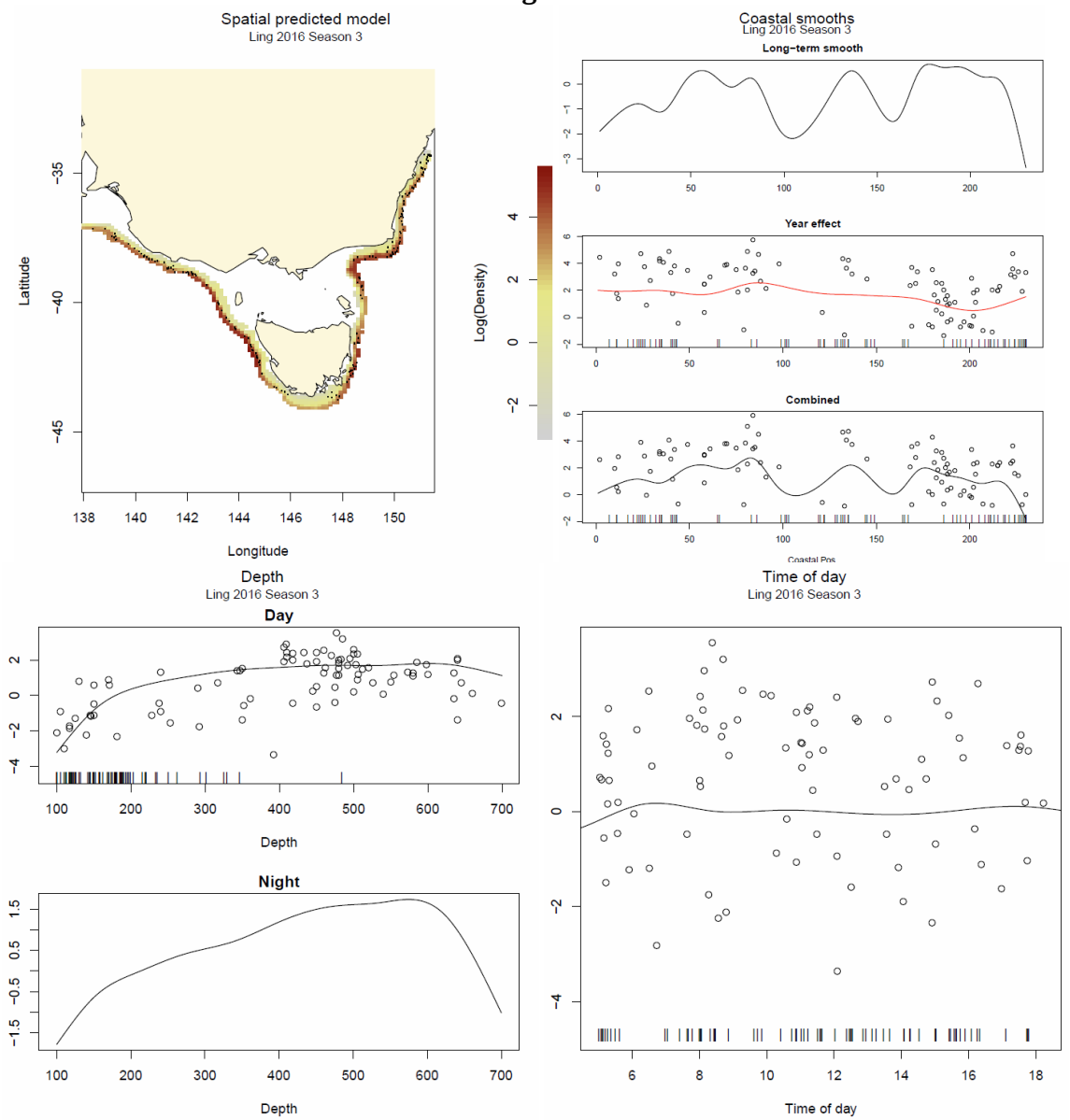

Figure 41. Winter survey model fits for Pink Ling. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Silver Trevally – Winter 2016

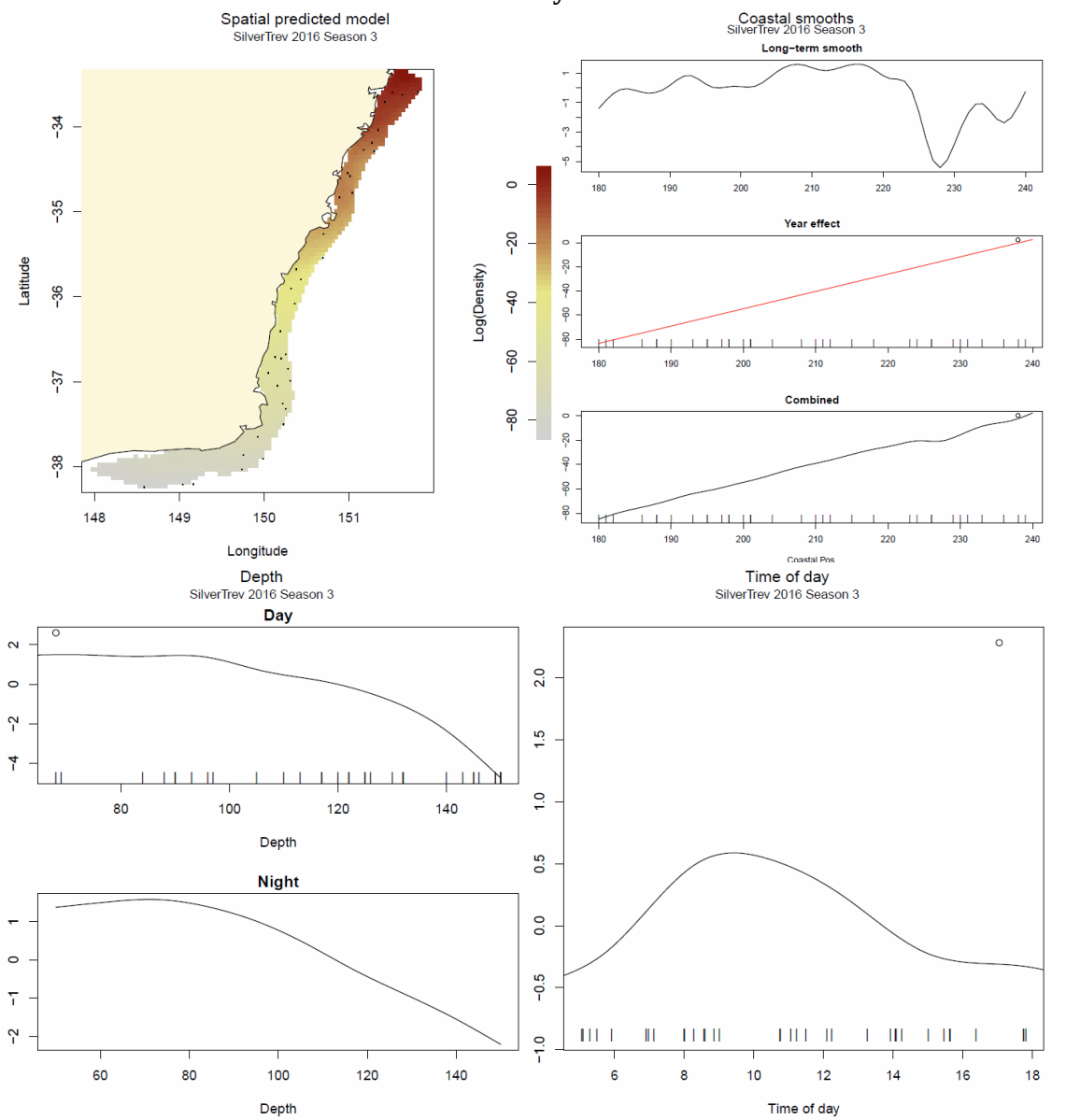

Figure 42. Winter survey model fits for Silver Trevally. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

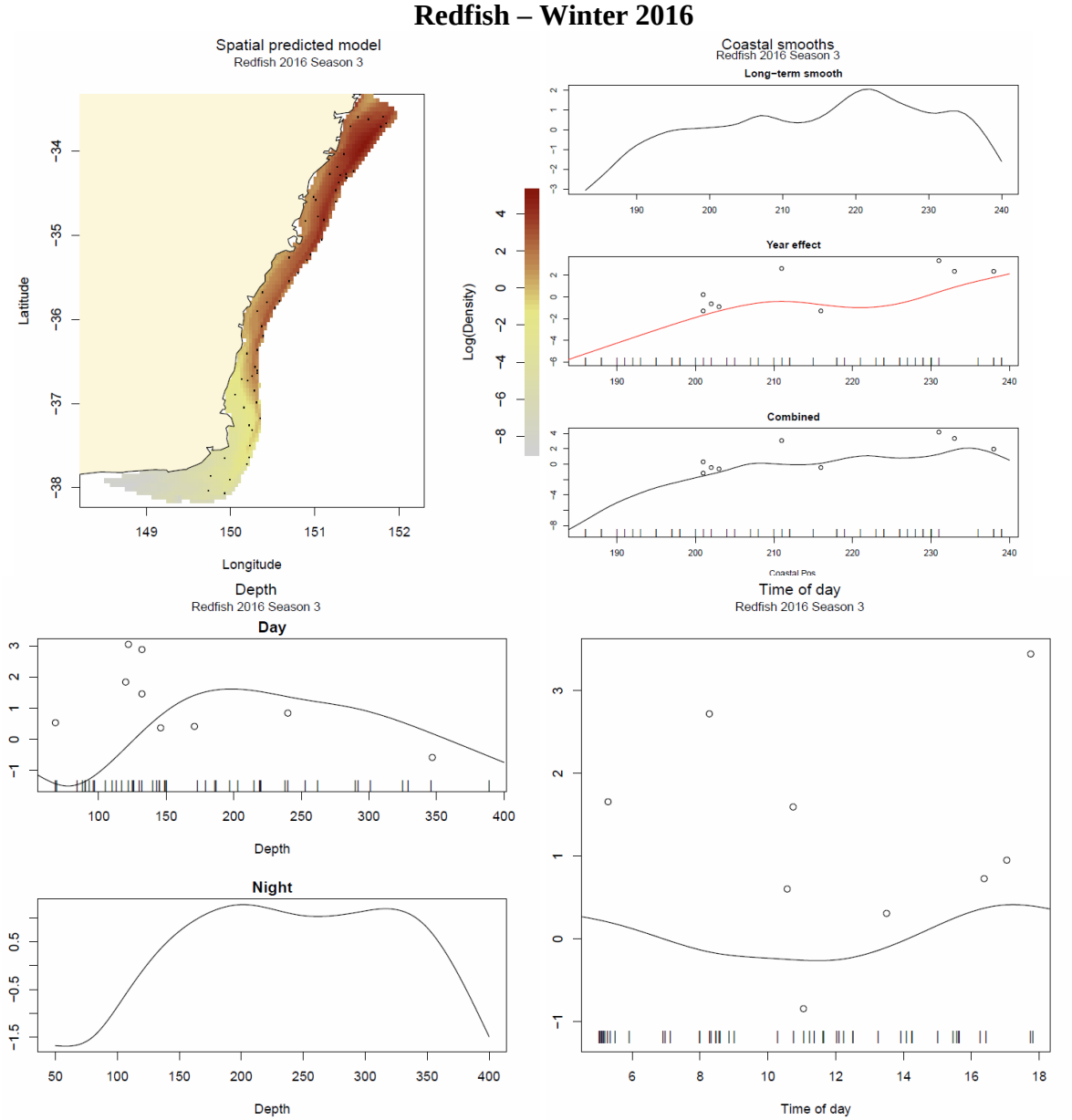

Figure 43. Winter survey model fits for Redfish. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Blue-eye Trevalla – Winter 2016

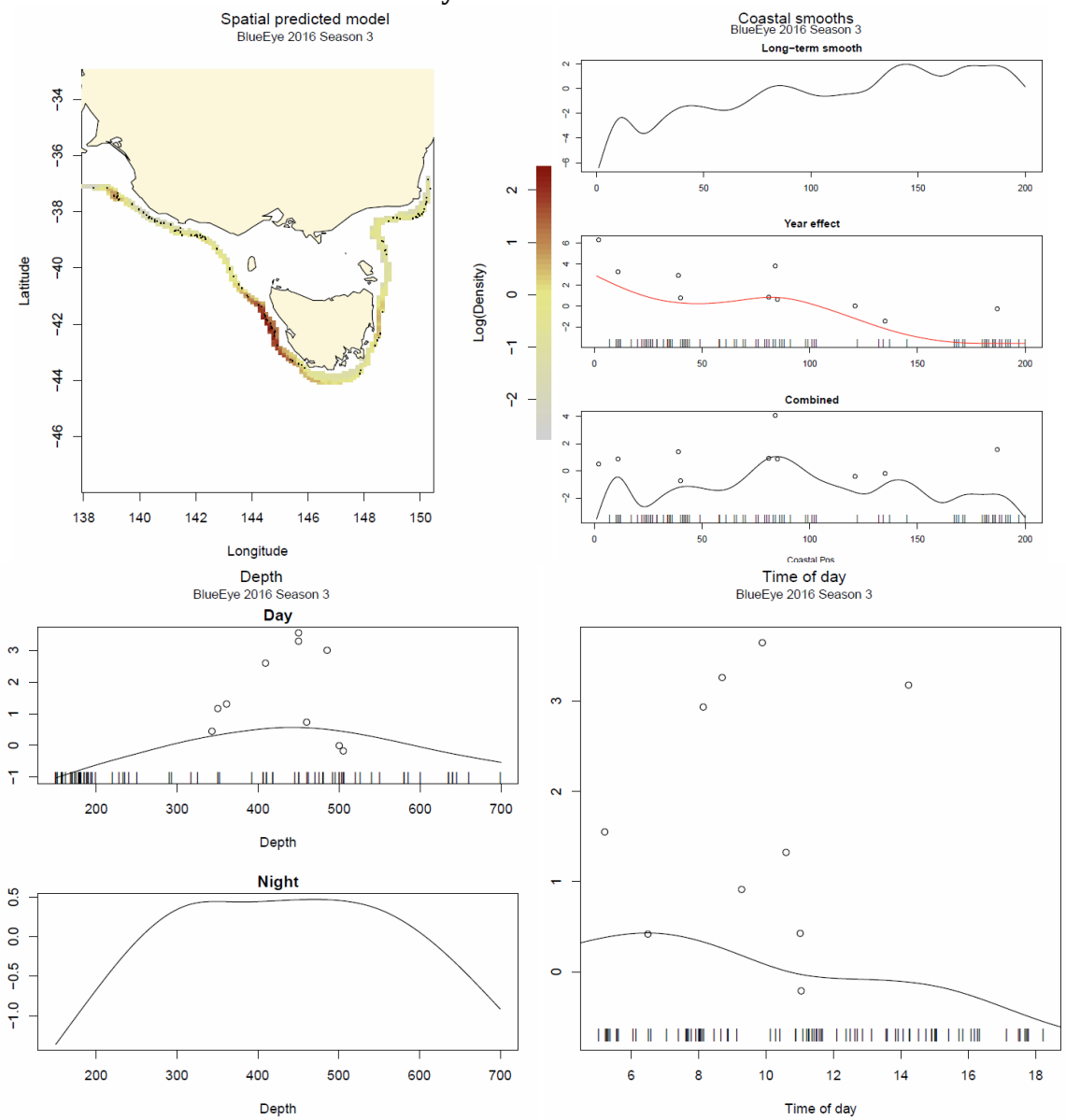

Figure 44. Winter survey model fits for Blue-eye Trevalla. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

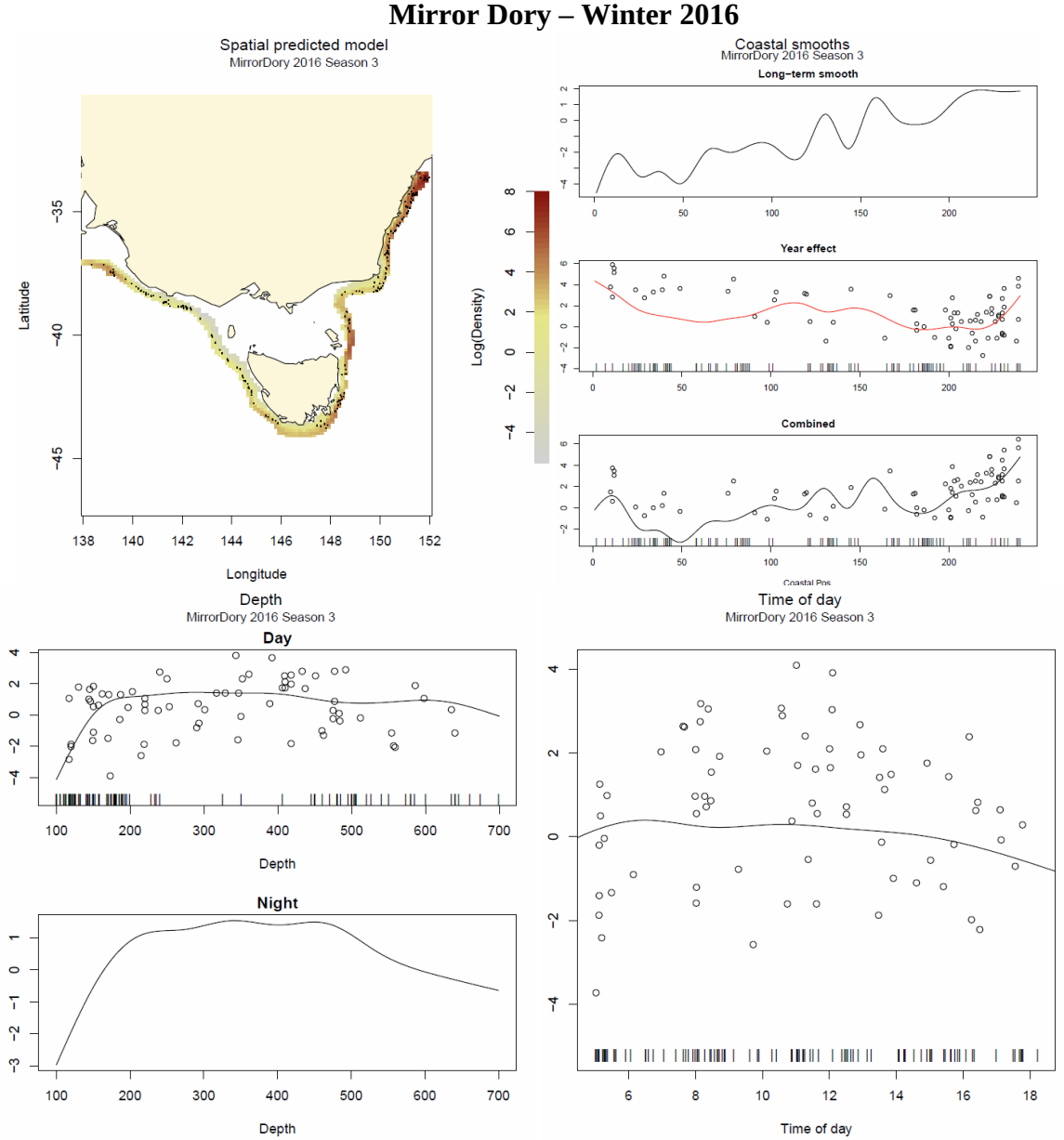

Figure 45. Winter survey model fits for Mirror Dory. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Silver Warehou – Winter 2016

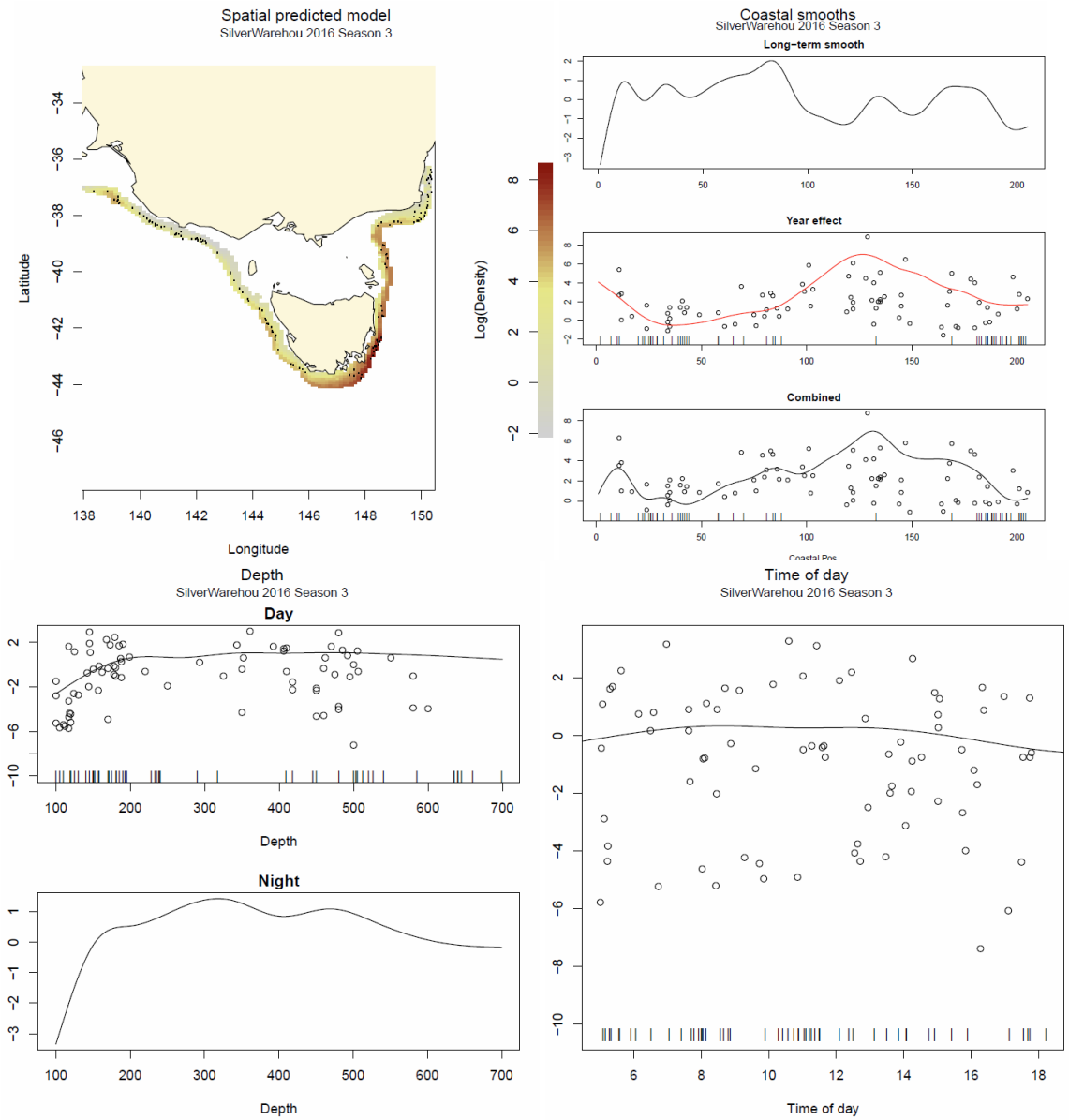

Figure 46. Winter survey model fits for Silver Warehou. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.

Blue Grenadier – Winter 2016

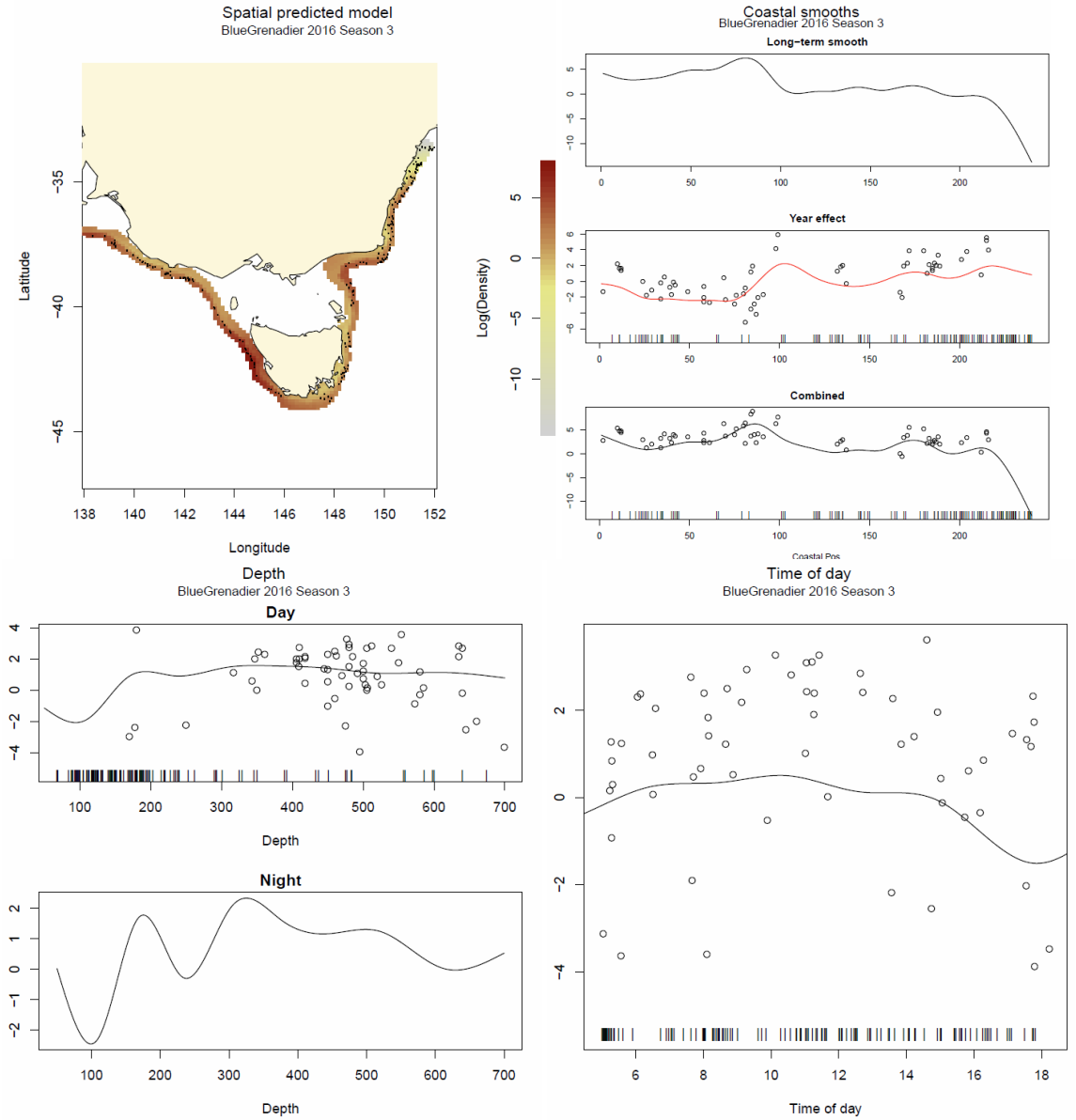

Figure 47. Winter survey model fits for Blue Grenadier. Points on map show survey shot locations. "Rug" tick marks indicate zero shots. Y-axis labels for all plots other than the made are "Log effect". Depth is in metres and time of day is 24 hr time.