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Resource Survey of the Great Australian Bight Trawl Fishery 2007

Ian Knuckey and Russell Hudson

2007

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GABIA

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Executive Summary

The Great Australian Bight Trawl Fishery (GABTF) targets two main species, deepwater flathead (*Neoplatycephalus conatus*) and Bight redfish (*Centroberyx gerrardi*). Industry-based fishery-independent resource surveys of the Great Australian Bight (GAB) have been conducted since 2005 with the primary goal of obtaining robust annual indices of relative biomass of these two main species. These indices are incorporated into formal stock assessments, which were previously hampered by input data with little contrast.

The Great Australian Bight Industry Association (GABIA) supported the implementation of the industry-based fishery-independent resource survey of the GABTF, driven largely by industry's desire for a better understanding of the extent of shelf resources of their main target species. Surveys are conducted during February–April each year using a 'standard research' net. Relative biomass estimates are calculated using swept area calculations, avoiding the need to make assumptions regarding the catchability and efficiency of the gear. Industry observations, supported by preliminary analysis of data from the 2005 survey, showed large diurnal effects on catch rates of Bight redfish, but not deepwater flathead. Consequently, only data from night shots (when catch rates are higher) are used in calculations of relative biomass estimates of Bight redfish, but data from both day and night shots are used in calculations for deepwater flathead.

This report details the results of the 2007 GABTF resource survey – the third consecutive annual survey.

Two industry-based fishery-independent trawl surveys were successfully conducted in selected strata within the GAB during March and April 2007. Deepwater flathead and Bight redfish occurred in 100% and 97% respectively of the seventy-five valid survey tows that were completed.

Relative biomass indices with CVs<0.3 were obtained for deepwater flathead, Bight redfish and other main species within the survey area using swept area estimates from trawl shots in a stratified random survey design. The relative biomass estimate of Bight redfish for 2007 was 25,713 t (CV = 0.16), which is similar to the 2006 estimate (25,380 t, CV = 0.16) and 23% higher than the 2005 estimate (20,887 t, CV = 0.13). The relative biomass estimate of deepwater flathead during 2007 was 8,540 t (CV = 0.05). This is slightly higher than the 2006 estimate (8,415 t, CV = 0.06) and 30% lower than the 2005 estimate (12,152 t, CV = 0.05).

Bight redfish has comprised the greatest portion of the catch (22%–26%) in each year the survey has been conducted. Deepwater flathead, ocean jacket, wide stingaree and latchet were the next most commonly caught species each year.

Modal length of Bight redfish in samples from 2007 (34 cm) was similar to previous years (35 cm), however there was a noticeable decrease in the proportion of fish greater than 35 cm. Modal length of deepwater flathead in samples from 2007 (43 cm) was the same as in 2006, but smaller than in 2005 (46 cm).

Otolith samples of deepwater flathead and Bight redfish were also collected during the survey.

The results of this survey provide a third year of fishery-independent indices of abundance for both deepwater flathead and Bight redfish.

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Introduction

The Great Australian Bight Industry Association (GABIA) has supported the implementation of an industry-based fishery-independent resource survey of the Great Australian Bight Trawl Fishery (GABTF). This has been largely driven by industry's desire for a better understanding of the extent of shelf resources of their main target species, deepwater flathead (*Neoplatycephalus conatus*) and Bight redfish (*Centroberyx gerrardi*), and the level of impact that fishing might be having on these resources.

Until 2006, the GABTF was managed by input controls limiting the number of operators in the fishery to ten. Only a small number (typically 4–5) of the ten SFR holders had been active in the fishery during any one year over the decade to 2002. Catch and effort data from these vessels' logbooks showed no overall trend in catch rates for either deepwater flathead or Bight redfish and there remained little contrast in these data. Time series of length- and age-frequency data do not indicate any significant impact on the resources from this level of fishing either. Stock assessment models up to 2006 for Bight redfish and deepwater flathead were advanced, but suffered from the lack of contrast in any of the main fishery indicators. As a result, there was considerable uncertainty surrounding model outputs including estimates of stock biomass.

There was increased participation in the fishery and increases in fishing effort and fishing efficiency of active vessels during 2003–2005. Given the uncertain status of the stocks at this time, this raised concerns about future sustainability of the shelf resources. Under this scenario, industry agreed that quota management of the main target species would be introduced from 2006. They also agreed on equal allocation of quota between the ten SFR holders.

With the pending introduction of quotas during 2006, there was concern that low TACs would be introduced based on the high uncertainty of biomass estimates resulting from stock assessment models and this may inhibit the sustainable development of the fishery. Moreover, once quotas were introduced it was believed the use of commercial CPUE data as the main index of abundance in these models would be compromised and unlikely to provide the contrast that is needed to improve model outputs.

Industry investigated the feasibility of conducting a fishery-independent survey to provide a time-series of relative abundance indices for deepwater flathead and Bight redfish that can be used as an input to stock assessment models (FRDC Project 2002/072). Preliminary surveys of the main shelf areas of the fishery were successfully conducted during 2005 (Knuckey et al, 2006) and 2006 (Knuckey and Hudson, 2007). Continuing the random stratified survey during 2007 would extend the time series of relative biomass estimates of Bight redfish and deepwater flathead and would provide further evidence of whether appropriate TACs have been set.

Objectives

1. Determine a relative abundance index for Bight redfish and deepwater flathead in the current region of the main GABTF shelf fishery during 2007.
2. Collect biological and population data on these species.
3. Determine a relative abundance index of other main species in the current shelf fishery.

Material and Methods

Survey Design

Detailed description of survey design and vessel and gear specifications are reported in Knuckey et al, (2006). A briefly description is given below.

Although fishing for shelf species occurs outside of these areas, the survey was restricted to depth of 120–200 m and between longitude 126º00' and 132º30'. The longitudinal range was divided into four primary strata; 126º00'–127º45'(West2), 127º45'–129º00' (West1), 129º00'–130º15' (Central1), 130º 45'–132º30' (Central2) (Table 1). This represents the main fishing areas of the shelf component of the fishery. Catch rates of Bight redfish fluctuate throughout the year, being highest during February–April. Catch rates of deepwater fathead also fluctuate seasonally, however, not as much as Bight redfish. Consequently the survey is conducted during February–April.

Initial analyses of the catch and effort data indicated catch rates for Bight redfish was not affected by time of day of the shot, while catches of deepwater flathead were higher during the day from February to April. However, results from the preliminary survey during 2005 indicated catches of Bight redfish were higher during night shots, and future analyses of Bight redfish should only include night shots (Knuckey et al, 2006). For deepwater flathead there was no significant difference between day and night shots, and further analyses of this species would pool all shots. . These indications have proven correct in subsequent years, so survey design and methods have been repeated annually based on these analyses.

Analysis of the catch and effort data suggested the variation of catch rates for Bight redfish was higher for trawl durations <2.5 hours (including setting and retrieving net). A similar result was observed for deepwater flathead but was not as pronounced. To maintain a consistent sampling time it was agreed for each survey shot the net should be trawled for 2.5 hours and time setting and retrieving the net not included.

Analysis of logbook data indicated a minimum of 76 shots would be needed to achieve a CV of <20% for Bight redfish. This analysis was based on combining both day and night shots. After the preliminary survey was conducted in 2005, it was observed the number of 0 catches (a contributing factor to a high CV) of Bight redfishes was not as high as expected, and hence an analysis of only night shots (approximately half of the 76 shots) has provided an acceptable CV (Knuckey et al, 2006).

Number of shots allocated to each of the primary strata was proportional to the catch-weighted standard deviation of CPUE. Shot locations were selected randomly. A shot is deemed to be acceptable if the shot passes within 500 m of the selected position. If the shot has to be abandoned due to gear problems, it can still be considered acceptable if towed for a minimum of 1 hour and passed through the position. The start and finish position of each shot was recorded along with minimum and maximum depths average trawl speed, environmental conditions and direction of tow.

The tows were completed in a specified order to reduce temporal biases in the data collection, though the order of 1–3 tows was rearranged for logistical reasons. Tows were conducted at a speed ranging 3–3.2 knots, with the skipper deciding on the starting position and direction of the tow. When the tow was completed, the net was hauled aboard and the catch emptied on to the deck. Commercial species were gathered in fish bins and approximate weights of each species estimated. Discarded bycatch were identified by species where possible and an approximate weight of each species estimated. When the catch was unloaded in port the correct weights of Bight redfish and deepwater flathead were obtained and compared to the survey estimates. If there was a difference of ± >2% then the survey estimates were adjusted. Length measurements were collected randomly during the survey for deepwater flathead and Bight redfish, the total length measured for flathead and fork length for redfish. Otolith samples of the two species were also collected randomly during the survey recording the length and sex of each sample.

Calculation of Relative Biomass and Coefficient of Variation

The estimation of the relative biomass is based on the method adopted by Schnute and Haigh (2003), where in simplistic terms, typical surveys consist of numerous tows, each tow giving a biomass density estimate

$$Density = \frac{biomass\ captured}{area\ swept\ by\ net}$$

And total biomass (abundance) estimated by calculating the mean density (with an associated coefficient of variation) from all tows and applying that to habitat or stratum area:

$Biomass = density \times area$ (Schnute and Haigh, 2003)

Determining the density

For tows where Bight redfish and deepwater flathead are present in the catch (non-zero measurements), the mean density for each stratum is

$$\mu_h = \frac{1}{n_h}\sum_{i=1}^{n_h}\mu_{hi}$$

The squared inverse of the CV is

$$v_h = \mu_h^2 / s_h^2$$

The mean density of measurements for each stratum is

$$\delta_h = (1 - p_h)\mu_h$$

The variance of density of measurements each stratum is

$$\sigma_h = \sqrt{\left((1 - p_h)(1 + p_h v_h)\left({\mu_h}^2 / v_h\right)\right)}$$

The estimated biomass of each stratum *h* is

$$b_h = A_h \delta_h$$

The CV of biomass estimate of each stratum is

$$cv_h = \sqrt{\sigma_h} / b_h\, n_h$$

Where p_h is the proportion of hauls with zero catch for the species in stratum h, μ_h is the mean kgs per area swept (m^2) of species where catch >zero, s_h is the std kgs per area swept (m^2) of species where catch >zero, A_h is the total area of stratum, n_h is the number of tows and b_h is the estimated relative biomass.

Total relative biomass and CV for each species were calculated as follows;

$$B = \sum_h b_h$$

$$cv = \sum_h cv_h$$

The number of shots, n_h, in each stratum that produced the desired coefficient of variation, cv_h, was randomly allocated within each stratum.

Relative biomass was estimated using the swept area method.

The density measure was estimate as follows:

$$\mu_{hi} = {C_{hi}}\big/{v_{hi} d_{hi} E_{hi}}$$

Where each shot i in spectrum h has a known catch of C_{hi}, effort (tow duration hour) E_{hi}, vessel speed (m/hour) v_{hi} and door spread d_{hi}.

The swept area of the trawl net can be expressed as either the area swept by the net or the area swept by the net. Net width was estimated as 50% of the headline length while door width involved measuring the distance between the warps at the pulleys (blocks) then 1 metre along the warps towards the trawl net. The difference in width would then be multiplied by the length of the warp let out:-.

$$d = (w_1 - w_2) \times WL + (w_2)$$

where w_1 is the distance between the warps one meter down from the blocks, w_2 is the distance between the warps at the back of the blocks and WL is the warp length.

Results

Survey Coverage

The surveys were successfully completed for each of the survey strata well within the time frame and budget allocated. The random stratified survey sampled 75 sites of the 76 sites during March and April 2007 (Figure 1). Because of the timing of the full moon, the two trips were conducted later than the optimum months of February and March. One tow was excluded from the analysis after being towed outside the selected depth strata. The mean tow lengths in the four strata were 14.5 km (Central 1), 14.7 km (Central 2), 14.8 km (West 1) and 13.8 km (West 2) (Table 2).

Gear Performance

Door spread was estimated on 19 occasions. Door spread measurements ranged considerably 78–128 m reflecting the uncertainty and difficulty in measuring the distance between warps to the nearest centimetre a metre from the blocks. After consistent low door spreads were recorded for shots 1–18; it was discovered smaller chains on the door had been installed than what is normally prescribed. The chains were replaced and door spread increased for the remaining shots. Hence for the March trip two different door spreads were used; 84 m (±6.3 m SD) for shots 1–18 and 99.6 m (±3.3 m SD) for shots 19–39. The door spread for the April trip (shots 40–76) was 109.6 m (± 4.2 m SD).

Catch Composition and Length Frequencies

The total catch during the March and April surveys combined (79.7 t) comprised 85 identified species or species groups with the largest catches occurring in the West1 stratum (Table 3). Bight redfish 20.1 t (25%), wide stingarees 9.8 t (12%) and deepwater flathead 9.8 t (12%) made up the majority of the catch, followed by ocean jackets 8.5 t (11%), and latchets 8.2 t

(10%) (Figure 2). Deepwater flathead and Bight redfish occurred in 100% and 97% of tows respectively during 2007.

Catches of Bight redfish during the survey varied more than catches of deepwater flathead (Figure 3, Figure 4, Table 4). Three hauls contained more than 1000 kg of Bight redfish while over a third (36%) contained catches ranging 1–50 kg. Range of size of catches was a lot smaller for deepwater flathead with 75% of the hauls catching between 50–150 kg (Figure 4).

Catch of Bight redfish varied considerably with time of day. Tows commencing during 0000 hours and 0600 hours caught nearly ten times more Bight redfish than catches between 1200 hours and 1800 hours (Figure 5). In contrast there was no difference in catches of deepwater flathead between night and day tows (Figure 6).

The lengths of 881 Bight redfish were measured during the 2007 surveys (Table 5). Substantially more Bight redfish were measured in the central zones, than the western zones because of the larger number of shots and fish caught in these zones. Lengths ranged 23–58 cm, however, most fish measured were between 28–38 cm (Figure 7).

The lengths of 1023 deepwater flathead were measured during the 2007 surveys (Table 5). Lengths ranged 31–66 cm, however, most fish measured were between 40–48 cm (Figure 8).

A total of 227 otoliths were collected from deepwater flathead, while 239 were collected from Bight redfish (Table 5).

Relative Biomass Estimates

Using only night shots (1800–0600 hours) and net-width in swept-area calculations, the relative biomass estimate of Bight redfish for the 2007 survey was 25,713 t with a CV of 0.16 (Table 6). The relative biomass estimate for 2007 was very similar to the 2006 estimate of 25,380 t, and higher than the 2005 estimate of 20,887 t (Figure 9).

Using both day and night time shots net-width in swept-area calculations, the relative biomass estimate of deepwater flathead for the 2007 survey was 8,540 t with a CV of 0.05 (Table 6). The relative biomass estimate for 2007 was very similar to the 2006 estimate of 8,415 t, and lower than the 2005 estimate of 12,152 t (Figure 9).

Relative biomass estimates for a number of other important GABTF species were also calculated (Table 6). CVs of these species were generally below 0.30. Other species with the greatest relative biomasses estimates were latchets (7,040 t) and ocean jackets (6,701 t). Trends in relative biomasses estimates varied from species to species (Figure 9 and Figure 10). Species that showed an increase in relative biomasses estimates between 2005-2007 survey estimates were common sawshark, jackass morwong and picked dogfish. Gummy shark, knifejaw, latchet and ornate angel sharks all showed a decrease in relative biomasses estimate between 2005 and 2007 surveys. Relative biomasses estimates of ocean jackets were similar during 2005 and 2007 surveys, but were about 30% higher during 2006.

Discussion

Survey Coverage

The primary objective of the random stratified survey was to determine a relative abundance index for Bight redfish and deepwater flathead in the current region of the main GABTF shelf fishery. No attempts have been made to estimate absolute biomass from the survey results. The survey was also designed to collect biological and population data on these species, and to determine a relative abundance index of other main species in the current shelf fishery. All of these objectives were met, with 75 sites successfully surveyed during March and April 2007, adding to the existing 2 year time series.

Gear Performance

It has been continually stressed that there are many uncertainties and assumptions regarding herding, escapement and catchability associated with trawl nets and the use of survey results as an absolute index of abundance. For this reason, the data collected during these surveys are only intended to be used as a relative biomass estimate based on net width in swept-area calculations.

Despite the above, there was an interest in the use of the 2005 survey results to provide an absolute abundance index for deepwater flathead and Bight redfish that would assist in setting appropriate initial Total Allowable Catches (TACs) for these species (discussed in Knuckey *et. al.* 2006),. A literature review of escapement and catchability of trawl gear was conducted (Hudson and Knuckey, 2005) to facilitate this process. Subsequently, data from the these surveys have only been used as relative indices of abundance in the stock assessment models. In terms of gear performance

The narrower door widths recorded in shots 1 to 18 did not appear to contribute to lower catch rates for Bight redfish, and some of the largest catches of the species were observed during this period. For deepwater flathead, however, some of the lowest catch rates of the 2005–2007 surveys were observed during this period. We have not been able to make any quantitative assumptions about gear performance during these initial shots, but the narrower door spread has been taken into account in the swept area analyses to estimate relative biomass.

Catch Composition and Length Frequencies

Bight redfish have comprised the largest portion of the catch in all surveys (apart from the December 2005 survey); 22% in 2005 (Knuckey *et. al.* 2006), 26% in 2006 (Knuckey and Hudson, 2007) and 25% in 2007 (Figure 2). The proportion of the total catch comprising deepwater flathead has decreased since 2005 from 19% to 12% in 2007. Wide stingarees were the second most commonly caught species during 2007 (12%), despite comprising less than 1% and 2% of the total catches in 2005 and 2006 respectively. Ocean jackets and latchets have been large components of the catch in each year of the survey.

Modal lengths of Bight redfish measured during 2005, 2006 and 2007 surveys were 35 cm (Knuckey *et. al.* 2006), 35 cm (Knuckey and Hudson, 2007) and 34 cm respectively (Figure 7). Despite these similarities, there appears to be less fish greater than 35 cm in samples measured during 2007 than previous years. This increased skewness to the left may be a result of above recruitment in recent years. This could be determined by examination of age frequencies.

Modal lengths of deepwater flathead measured during 2005, 2006 and 2007 surveys were 46 cm (Knuckey *et. al.* 2006), 43 cm (Knuckey and Hudson, 2007) and 43 cm respectively (Figure 8). Compared to previous years, the proportion of deepwater flathead larger than 43 cm was smaller in samples collected during 2007.

Relative Biomass Estimates

Bight redfish

The 2007 relative biomass estimate of 25,713 t Bight redfish was almost 25% higher than the 2005 estimate (20,887 t) but comparable to the 2006 estimate (25,380 t). These estimates were based on night shots only.

The CV for night shots during 2007 was similar to the 2006 estimates (0.16) but larger than the 2005 estimates (0.13). The high CV's during 2006 and 2007 are a result of a single shot producing a large catch (>2000 kg) of Bight redfish.

Deepwater flathead

The relative biomass estimate for deepwater flathead (day and night combined) during 2007 was similar to 2006 but about 30% lower than the 2005 February and March estimates (Knuckey *et. al.* 2006, Knuckey and Hudson 2007). It is unclear whether the decline in relative biomass estimates during 2006 and 2007 represents a decline in the population or simply seasonal variability in the estimate. A longer time series of surveys is needed better interpret this trend.

The CV obtained during 2007 for day and night shots combined (0.05) was slightly less than obtained during 2006 (0.06) and equal to that obtained during 2005 (0.05).

Other species

There was considerable variation between the 2007 relative biomass estimates and the 2006 and 2005 estimates for other main species. Relative biomass estimates of ocean jackets increased about 30% during 2006, before falling to just below the 2005 level in 2007. Three other species showed an overall increase in relative biomasses estimates, while four other species showed a decline in relative biomasses estimates.

Conclusions

The 2007 Great Australian Bight resource surveys achieved all objectives. The target CVs for relative biomass estimates were achieved for both Bight redfish and deepwater flathead and the relative biomass estimates were comparable to the 2006 and 2005 results. In addition, relative biomass estimates of other main species were estimated with low to medium CVs. Sufficient length-frequency and otolith samples were collected for both target species.

The survey also demonstrated that a scientifically rigorous fishery-independent survey can be consistently conducted by the fishing industry.

Acknowledgments

We wish to thank the owner, Mr Semi Skoljarev, and the skipper and the crew of the Explorer S for their professional approach to conducting the 2007 survey, and Dr Mike Bergh and Dr Paul Starr for assistance with the design of the survey. From the Department of Primary Industries Victoria, we wish to thank Mrs Anne Gason for providing the statistical analysis of the data. Thanks to Dr Matt Koopman for assistance in the preparation of the final report.

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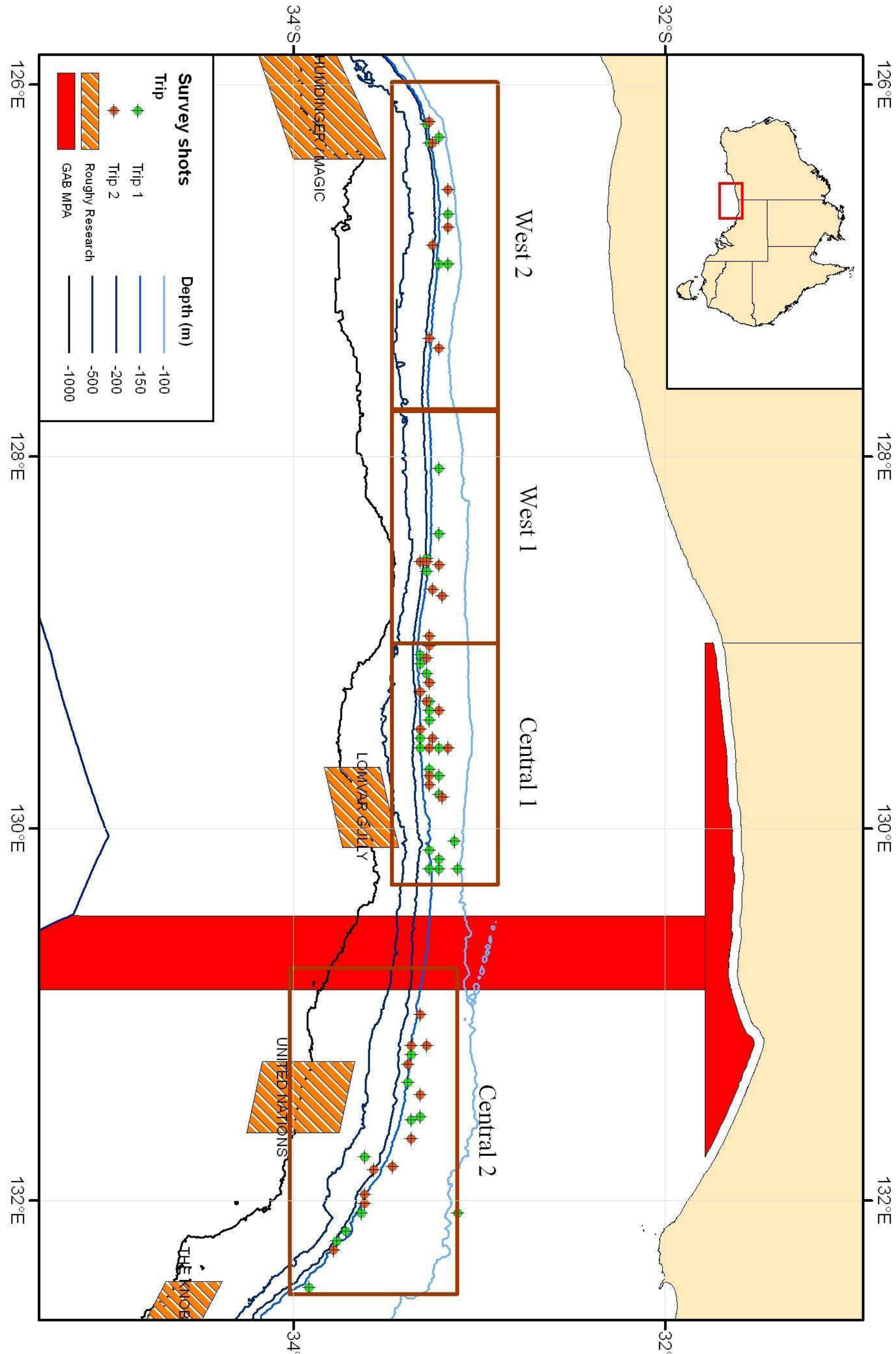

Figure 1. Survey strata and shot locations of trawl survey.

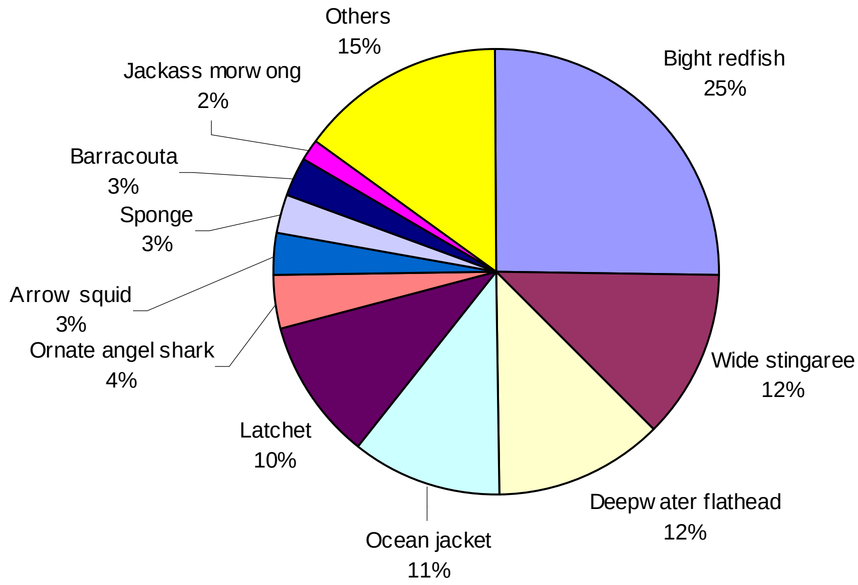

Figure 2. Proportion (of weight) of major species captured during the 2007 survey.

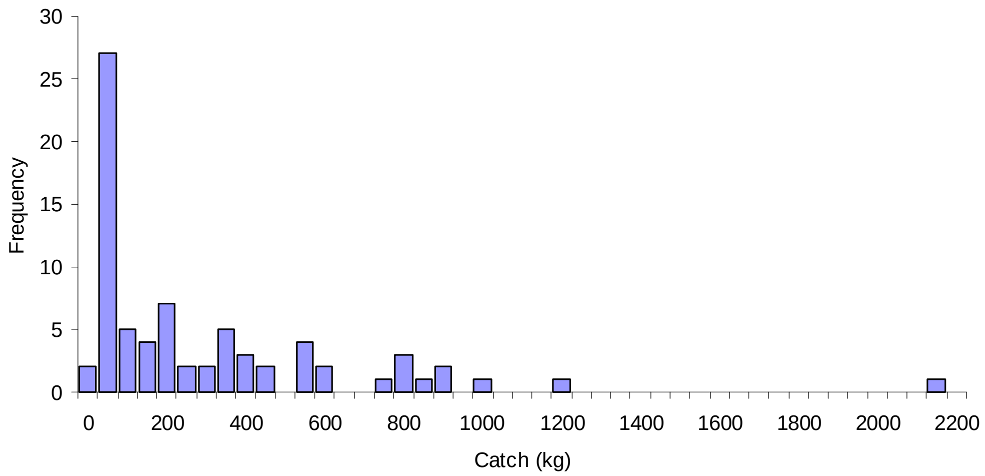

Figure 3. Frequency of catches (kg) of Bight redfish during the 2007 survey.

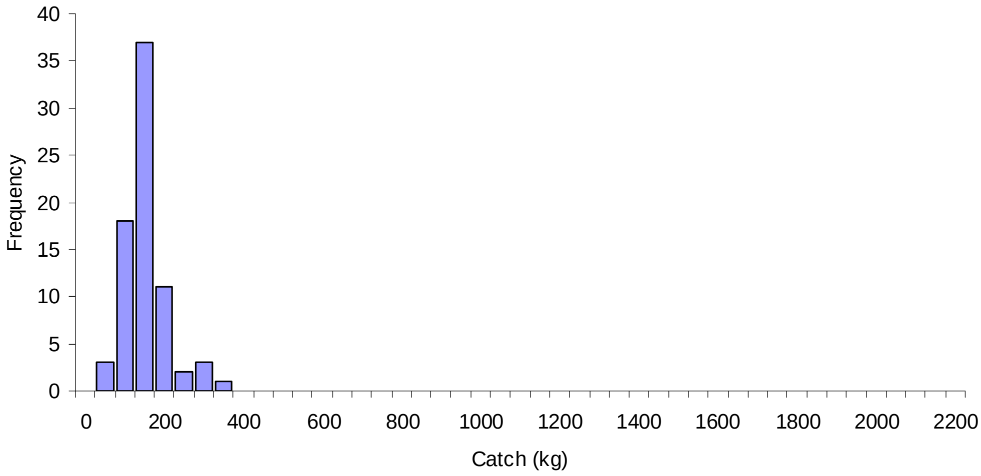

Figure 4. Frequency of catches (kg) of deepwater flathead during the 2007 survey.

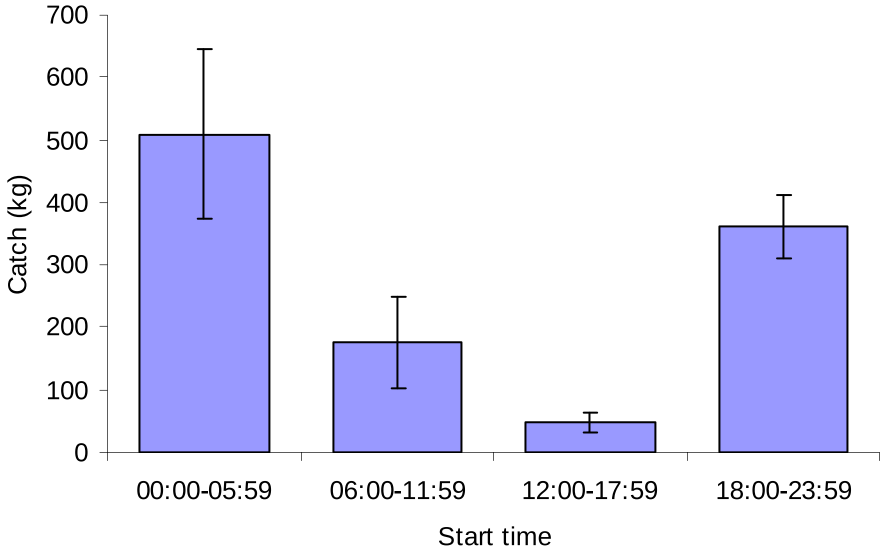

Figure 5. Mean and standard error of Bight redfish catches by time of day during the 2007 survey.

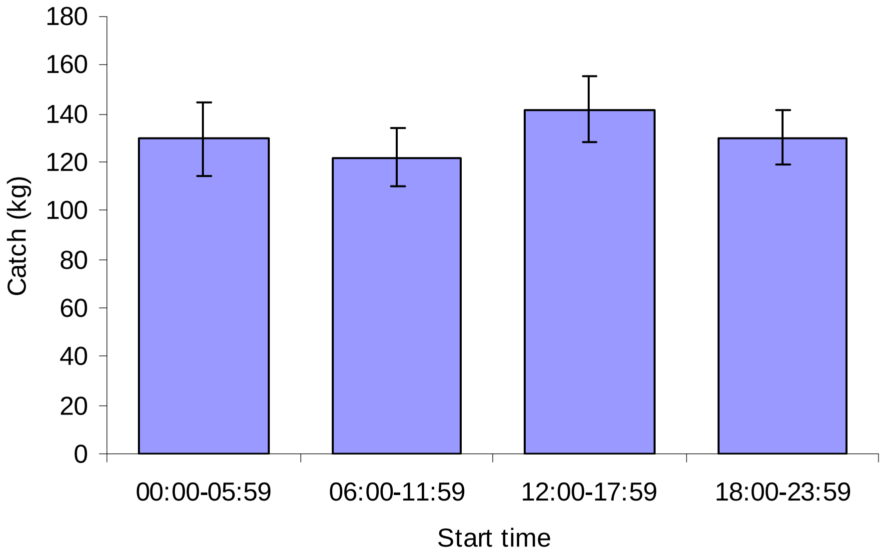

Figure 6. Mean and standard error of deepwater flathead catches by time of day during the 2007 survey.

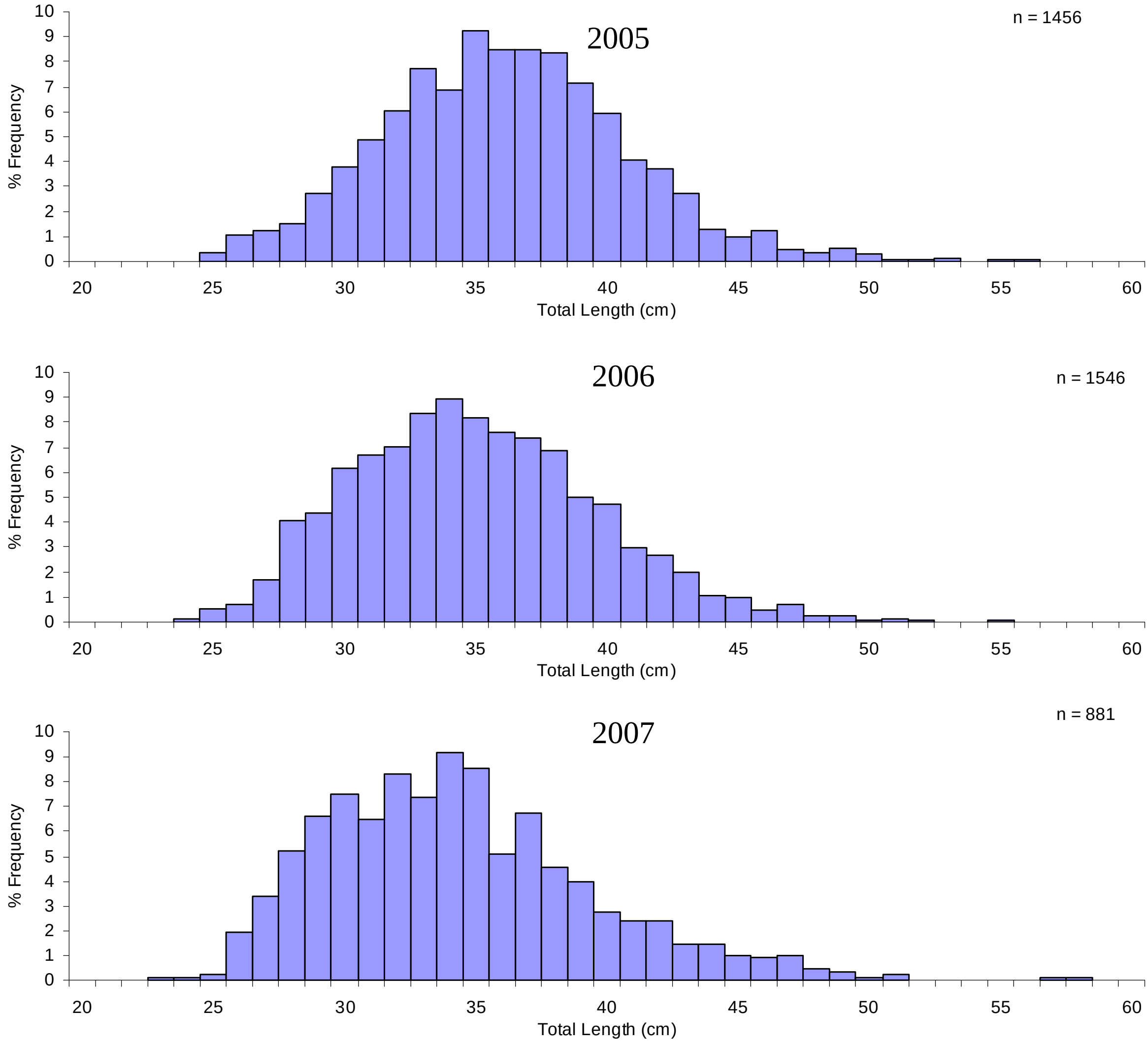

Figure 7. Length-frequencies of Bight redfish during each survey.

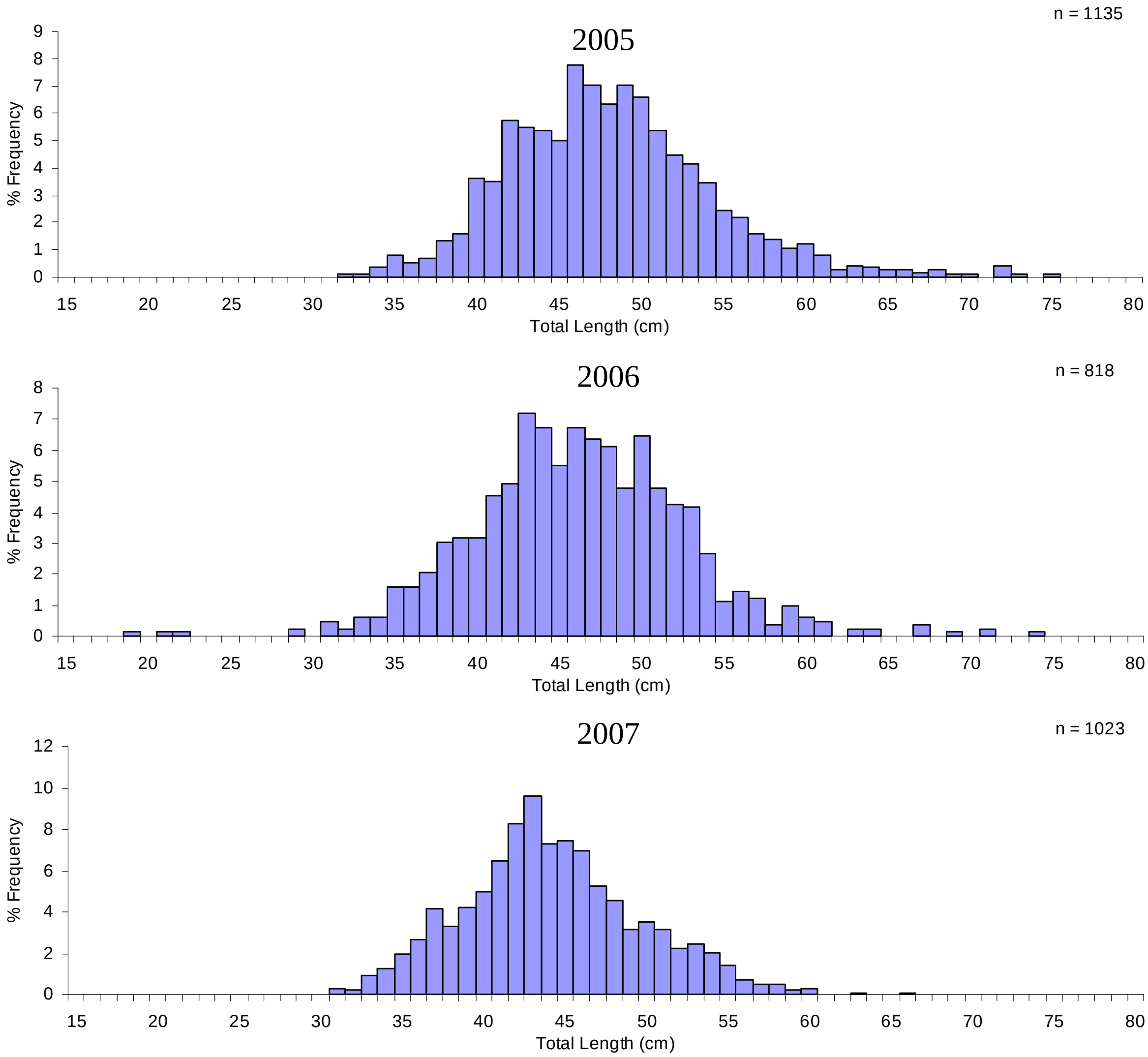

Figure 8. Length-frequencies of deepwater flathead during each survey.

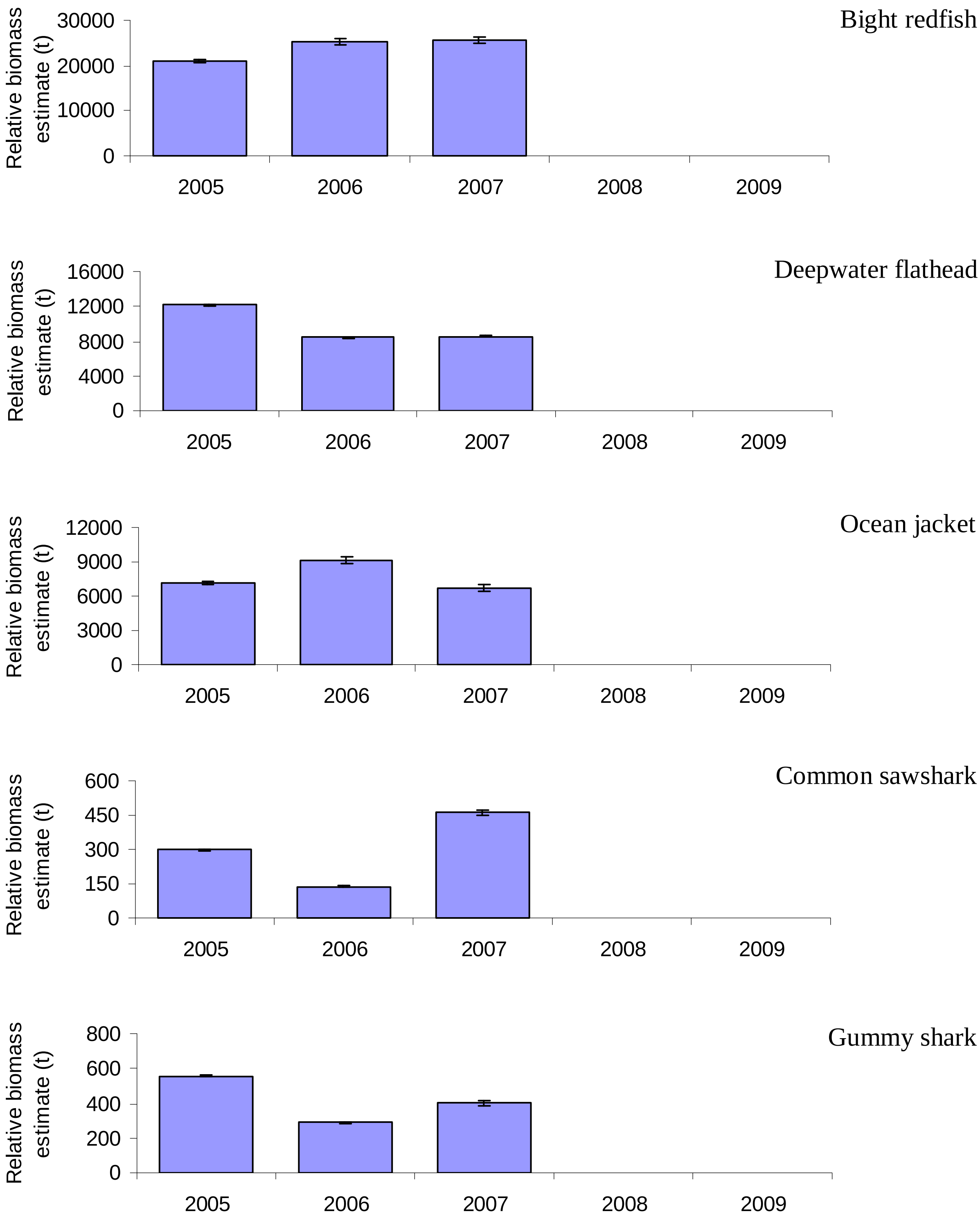

Figure 9. Relative biomass estimate (t ±SE) of Bight redfish, deepwater flathead, ocean jacket, common sawshark and gummy shark from annual surveys.

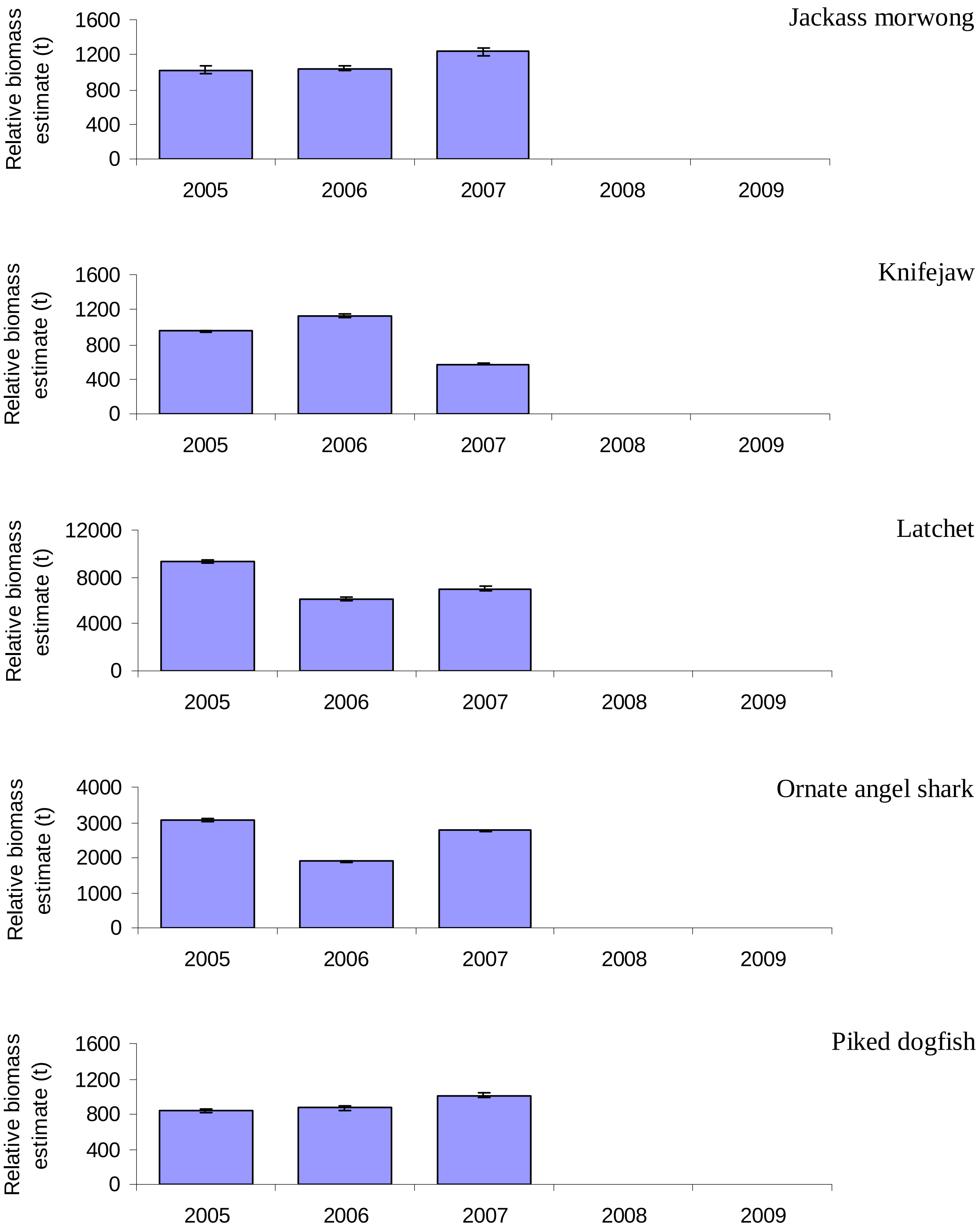

Figure 10. Relative biomass estimate (t ±SE) of jackass morwong, knifejaw, latchet, ornate angel shark and piked dogfish from annual surveys.

Table 1. Description of strata sampled during the 2007 survey.

Stratum	Depth (m)	Longitude	Area (km^2)	Number of shots
Central 2	120–200	130.75–132.50	5720	22
Central 1	120–200	129.00–130.25	3965	30
West 2	120–200	127.75–129.00	2700	11
West 1	120–200	126.00–127.75	2600	13

Table 2. Mean and standard deviation (SD) length (m), swept area (km^2)m, speed (knots) and depths (m) of tows in each stratum.

Stratum	Month	Tow length		Area swept		Tow speed		Tow depth	
		Mean (m)	SD	Mean (km^2)	SD	Mean (knots)	SD	Mean (m)	SD
Central 1	Mar	14469	416	1.348	0.030	3.13	0.07	138	14
Central 2	Mar	14531	517	1.311	0.157	3.14	0.10	140	8
West 1	Mar	14607	368	1.450	N/A	3.18	0.08	136	10
West 2	Mar	14587	243	1.440	0.255	3.18	0.05	138	14
Central 1	April	14542	1888	1.511	0.377	3.26	0.15	133	6
Central 2	April	14835	932	1.462	0.197	3.21	0.19	137	9
West 1	April	14904	635	1.900	0.842	3.23	0.14	128	9
West 2	April	13289	3272	1.503	0.08	3.28	0.11	126	7

Table 3. Total catch (kg) of all species in each stratum and across all strata during the 2007 survey.

Species	Catch (kg)				
	Central 2	Central 1	West 2	West 1	Total
Arrow squid	860	907	160	575	2502
Australian tusk	25.5	50	7.3	31.5	114.3
Banded grubfish	2.5	0.7	0.5		3.7
Barracouta	920	539	90	528	2077
Bight redfish	6426	8374.7	1123	4172	20095.7
Bight skate	27.5				27.5
Black spotted gurnard	127	139	68	51	385
Blue mackerel	31	11		2	44
Blue warehou	168	56.8		2	226.8
Broadnose sevengill shark			15		15
Common bellowfish	2	3		2.5	7.5
Common sawshark	26	185	116	227.5	554.5
Conger eel	32	40	4		76
Coral	90				90
Cucumberfishes	1				1
Cuttlefish	29	33	1	11	74
Deepwater bug	3.5	6			9.5
Deepwater burrfish	120	28	15	38	201
Deepwater flathead	3176	3407	1247	1962	9792
Deepwater stargazer	121	130	20	31	302
Dory, John	1	3.5		12.5	17
Football sweep	3	1.8		3	7.8
Gemfish	5			10	15
Green eye dogfish	107	7		458	572
Gulf gurnard perch	37	15.2		4	56.2
Gummy shark	77.5	122	106.5	148	454
Hermit crab	1.5	3	1	6	11.5
Jack mackerel	352	79	60	40	531
Jackass morwong	611.5	339.5	267	75	1293
Knifejaws	246.5	197.5	54.2	153	651.2
Latchet	2615	2381	792.5	2419	8207.5
Leatherjacket six-spined	3	9	14	4	30
Long Finned boarfish	310.3	240	57.5	95	702.8
Mosaic leatherjacket	9	5.8	3		17.8
Ocean jacket	368.5	3099	789	4228	8484.5
Ocean perch	4.8	46.1	12.5	5	68.4
Octopus	0.5		3	1	4.5

Species	Catch (kg)				
	Central 2	Central 1	West 2	West 1	Total
Orange perch	3.5				3.5
Ornate angel shark	784	1098	484	806	3172
Perch, splendid		1.5			1.5
Piked dogfish	396	173	234	200	1003
Pineapple fish				0.3	0.3
Port jackson shark	54	60.5	24	30	168.5
Queen snapper	208	302	142.5	104	756.5
Ray,southern fiddler	128	140	18	148	434
Red cod	11	16		8	35
Red gurnard	55.7	118	23	63.5	260.2
Redbait	12	7.5	2		21.5
Ringed toadfish	83	104	73	92	352
Rough gurnard perch	21	9		15	45
Round skate	18				18
Rubyfish	2	107	53	42	204
Rusty catshark	48.5	23	16	151	238.5
Samson fish	6			8	14
Sandpaper fish	34	31	8	5	78
Sandy numbfish	3	2			5
Sawtail shark	5			2	7
School shark	8.5	2.8		5	16.3
Seastar	4	1		1.5	6.5
Sergeant baker	45	52	21.5	15	133.5
Serpent eel	2.5				2.5
Sharpnose sevengill shark	20	4.4			24.4
Shovel nose ray				17	17
Silver dory	19.5	11	3	4	37.5
Silver trevally		106.5	10	70	186.5
Skate,melbourne	36		9	134	179
Skipjack tuna	3				3
Snapper	17	9	16.5	2	44.5
Southern chimaera	2.5				2.5
Southern fiddler ray	10			11	21
Southern rock lobster	2.5				2.5
Southern sawshark	78	36	12.5	104.5	231
Spiny boxfishes	16.5	16.5	4.5	6	43.5
Sponge	1220	460	220	347	2247
Stingray, black	43	53	55	90	241
Stingrays	21	30		35	86
Swallowtail	122	381	590	175	1268
Thetis fish	42	13	12	12.5	79.5
Unknown eel	1			1	2
Veilfin	10	8		3	21
White barred boxfish	2	8	3	8	21
Wide stingaree	1059	459	194	8100	9812
Yellow eye snapper	78	57.4	109	74	318.4
Yellow tailed boarfish	43.7	38	20	52.5	154.2
Total	21720.5	24398.7	7384.5	26237.8	79741.5

Table 4. Catch (kg) Bight redfish and deepwater flathead for each stratum point sampled during the 2007 survey.

Shot code	Shot	Stratum point		Shot date	Time of shot	Start Point		Finish Point		Catch (kg)	
		Lat	Long			Lat	Long	Lat	Long	Bight redfish	Deepwater flathead
C2-01-2007	1	33°55'	132°28'	1/03/2007	17:49	33°54.94'	132°29.79'	33°51.42'	132°21.78'	28	48
C2-02-2007	2	33°43'	132°10'	1/03/2007	21:45	33°44.04'	132°12.48'	33°38.82'	132°05.52'	270	79
C2-03-2007	3	33°37'	132°04'	2/03/2007	0:50	33°38.82'	132°05.88'	33°32.34'	132°06.01'	780	74
C2-04-2007	5	33°23'	131°26'	2/03/2007	6:34	33°22.86'	131°30.36'	33°23.10'	131°20.70'	890	150
C2-04-2007	4	33°22'	131°07'	2/03/2007	10:17	33°23.04'	131°10.92'	33°21.24'	131°01.68'	2	135
C1-06-2007	6	33°16'	130°13'	2/03/2007	17:21	33°17.88'	130°17.40'	33°12.18'	130°11.64'	14	105
C1-07-2007	7	33°07'	130°13'	2/03/2007	20:53	33°06.54'	130°13.26'	33°13.98'	130°10.20'	550	125
C1-08-2007	8	33°16'	130°07'	3/03/2007	0:03	33°16.14'	130°08.10'	33°14.40'	129°58.32'	820	105
C1-09-2007	9	33°13'	129°49'	3/03/2007	3:05	33°14.04'	129°56.46'	33°13.56'	129°46.86'	752	105
C1-10-2007	10	33°16'	129°41'	3/03/2007	6:42	33°15.96'	129°40.44'	33°13.32'	129°50.28'	513	28
C1-11-2007	11	33°13'	129°34'	3/03/2007	12:10	33°12.90'	129°34.74'	33°16.68'	129°27.00'	1	105
C1-12-2007	12	33°16'	129°25'	3/03/2007	15:30	33°15.48'	129°24.54'	33°11.52'	129°18.66'	25	145
C1-13-2007	13	33°16'	129°19'	3/03/2007	18:58	33°15.72'	129°21.30'	33°15.84'	129°11.22'	860	113
C1-14-2007	14	33°17'	129°10'	3/03/2007	22:08	33°15.91'	129°13.68'	33°18.13'	129°05.19'	581	110
C1-15-2007	15	33°19'	129°04'	4/03/2007	1:15	33°18.13'	129°05.19'	33°18.00'	128°55.20'	340	74
W2-16-2007	16	33°17'	128°33'	4/03/2007	6:06	33°17.18'	128°34.62'	33°15.84'	128°25.22'	310	99
W2-17-2007	17	33°13'	128°04'	4/03/2007	10:19	33°13.24'	128°10.44'	33°13.26'	128°00.73'	30	115
W1-18-2007	18	33°10'	126°58'	4/03/2007	18:10	33°10.08'	127°00.15'	33°11.16'	126°50.58'	30	115
W1-19-2007	19	33°16'	126°19'	4/03/2007	22:57	33°14.33'	126°27.24'	33°16.00'	126°18.48'	510	79
W1-20-2007	20	33°17'	126°13'	5/03/2007	2:06	33°15.12'	126°16.26'	33°17.34'	126°07.86'	2141	274
W1-21-2007	21	33°13'	126°17'	5/03/2007	5:15	33°17.35'	126°08.49'	33°12.83'	126°17.50'	748	150
W1-22-2007	22	33°10'	126°42'	5/03/2007	10:02	33°10.32'	126°33.66'	33°10.46'	126°43.92'	5	100
W1-23-2007	23	33°13'	126°58'	5/03/2007	13:23	33°12.48'	126°49.44'	33°13.02'	126°59.46'	12	186
W2-24-2007	24	33°13'	128°25'	6/03/2007	11:20	33°12.72'	128°24.24'	33°14.88'	128°33.66'	10	110
W2-25-2007	25	33°17'	128°37'	6/03/2007	14:17	33°16.11'	128°34.56'	33°16.22'	128°44.58'	8	133
C1-26-2007	26	33°19'	129°07'	6/03/2007	18:53	33°19.18'	129°03.89'	33°15.18'	129°11.82'	306	140
C1-27-2007	27	33°16'	129°13'	6/03/2007	21:55	33°15.90'	129°11.49'	33°15.66'	129°21.33'	374	74
C1-28-2007	28	33°16'	129°22'	7/03/2007	0:55	33°16.26'	129°20.52'	33°12.38'	129°28.56'	70	89
C1-29-2007	29	33°19'	129°31'	7/03/2007	4:15	33°13.74'	129°24.93'	33°20.07'	129°32.00'	170	84
C1-30-2007	30	33°19'	129°34'	7/03/2007	7:17	33°19.18'	129°32.68'	33°16.20'	129°40.08'	3	106
C1-31-2007	31	33°13'	129°43'	7/03/2007	10:15	33°15.80'	129°39.28'	33°09.96'	129°47.14'	1	108
C1-32-2007	32	33°08'	130°04'	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C1-33-2007	33	33°13'	130°10'	7/03/2007	17:07	33°07.78'	130°04.56'	33°13.24'	130°11.13'	62	145
C1-34-2007	34	33°13'	130°13'	7/03/2007	20:05	33°12.72'	130°11.87'	33°13.14'	130°21.61'	250	166
C2-35-2007	35	33°22'	131°13'	8/03/2007	3:13	33°22.06'	131°10.53'	33°21.48'	131°21.42'	986	242
C2-36-2007	36	33°22'	131°34'	8/03/2007	6:15	33°21.66'	131°24.02'	33°21.00'	131°34.53'	1190	286
C2-37-2007	37	33°19'	131°33'	8/03/2007	9:15	33°23.16'	131°40.13'	33°25.28'	131°37.33'	106	110
C2-38-2007	38	33°38'	132°04'	8/03/2007	13:50	33°37.52'	132°03.33'	33°43.91'	132°09.87'	1	145
C2-39-2007	39	33°46'	132°13'	8/03/2007	16:52	33°45.62'	132°12.35'	33°49.54'	132°20.82'	3	327
C2-40-2007	40	33°47'	132°16'	1/04/2007	19:27	33°49.44'	132°20.30'	33°43.60'	132°13.20'	380	220
C2-41-2007	41	33°37'	131°58'	1/04/2007	22:54	33°39.43'	132°07.17'	33°36.54'	131°57.30'	756	140
C2-42-2007	42	33°28'	131°49'	2/04/2007	2:08	33°32.89'	131°55.92'	33°27.82'	131°48.78'	420	175
C2-43-2007	43	33°19'	131°26'	2/04/2007	6:11	33°22.19'	131°34.49'	33°18.66'	131°25.20'	158	80
C2-44-2007	44	33°22'	131°10'	2/04/2007	9:29	33°20.37'	131°18.72'	33°21.96'	131°08.94'	7	130
C2-45-2007	45	33°19'	131°00'	2/04/2007	12:27	33°21.42'	131°07.68'	33°18.39'	130°57.23'	11	130
C1-46-2007	46	33°16'	129°46'	2/04/2007	20:29	33°16.56'	129°53.94'	33°15.48'	129°44.22'	567	170
C1-47-2007	47	33°16'	129°34'	2/04/2007	23:31	33°15.28'	129°41.10'	33°15.15'	129°31.90'	420	135
C1-48-2007	48	33°15'	129°31'	3/04/2007	2:51	33°14.88'	129°30.60'	33°11.16'	129°24.05'	189	105
C1-49-2007	49	33°13'	129°22'	3/04/2007	5:30	33°11.75'	129°24.04'	33°16.42'	129°16.92'	315	125
C1-50-2007	50	33°19'	129°16'	3/04/2007	8:35	33°18.43'	129°17.04'	33°17.40'	129°07.62'	189	170
C1-51-2007	51	33°17'	129°05'	3/04/2007	11:36	33°17.45'	129°07.86'	33°16.32'	129°01.73'	18	100
W2-52-2007	52	33°16'	128°58'	3/04/2007	13:40	33°16.23'	129°01.32'	33°15.45'	128°52.40'	221	170
W2-53-2007	53	33°15'	128°43'	3/04/2007	17:06	33°14.94'	128°45.96'	33°14.58'	128°36.66'	126	160

Shot code	Shot	Stratum point		Shot date	Time of shot	Start Point		Finish Point		Catch (kg)	
		Lat	Long			Lat	Long	Lat	Long	Bight redfish	Deepwater flathead
W2-54-2007	54	33°19'	128°34'	3/04/2007	20:26	33°15.97'	128°33.99'	33°13.98'	128°26.10'	315	130
W1-55-2007	55	33°13'	127°25'	4/04/2007	5:36	33°13.94'	127°28.38'	33°11.51'	127°18.68'	33	80
W1-56-2007	56	33°15'	126°52'	4/04/2007	11:29	33°10.05'	126°48.17'	33°09.95'	126°38.08'	3	130
W1-57-2007	57	33°10'	126°34'	4/04/2007	14:30	33°09.65'	126°37.80'	33°12.22'	126°28.92'	0	125
W1-58-2007	58	33°16'	126°12'	4/04/2007	19:42	33°18.40'	126°05.60'	33°13.68'	126°13.08'	105	275
W1-59-2007	59	33°15'	126°19'	4/04/2007	22:50	33°15.07'	126°12.51'	33°14.91'	126°22.37'	525	128
W1-60-2007	60	33°10'	126°46'	5/04/2007	4:09	33°09.13'	126°43.97'	33°10.72'	126°53.86'	55	190
W1-61-2007	61	33°16'	127°22'	5/04/2007	9:24	33°15.80'	127°19.71'	33°16.09'	127°29.35'	5	130
W2-62-2007	62	33°17'	128°34'	5/04/2007	17:07	33°15.71'	128°24.14'	33°14.19'	128°33.71'	8	130
W2-63-2007	63	33°13'	128°35'	5/04/2007	20:00	33°13.66'	128°34.01'	33°12.18'	128°37.46'	11	100
W2-64-2007	64	33°12'	128°45'	6/04/2007	0:07	33°11.44'	128°43.32'	33°13.79'	128°51.35'	84	100
C1-65-2007	65	33°16'	129°01'	6/04/2007	3:46	33°15.83'	128°59.16'	33°17.17'	129°09.17'	252	105
C1-66-2007	66	33°16'	129°13'	6/04/2007	6:55	33°16.64'	129°10.10'	33°16.07'	129°20.86'	13	125
C1-67-2007	67	33°17'	129°19'	6/04/2007	10:25	33°16.79'	129°18.52'	33°20.14'	129°27.37'	4.5	180
C1-68-2007	68	33°19'	129°28'	6/04/2007	13:30	33°19.62'	129°27.91'	33°12.78'	129°33.36'	1.2	100
C1-69-2007	69	33°10'	129°34'	6/04/2007	16:57	33°09.73'	129°33.54'	33°15.15'	129°40.16'	200	105
C1-70-2007	70	33°16'	129°43'	6/04/2007	20:10	33°16.72'	129°41.22'	33°13.84'	129°50.74'	368	100
C1-71-2007	71	33°12'	129°50'	6/04/2007	23:41	33°11.99'	129°48.99'	33°14.01'	129°58.15'	160	65
C2-72-2007	72	33°17'	131°10'	7/04/2007	9:07	33°17.00'	131°07.39'	33°20.43'	131°15.73'	63	45
C2-73-2007	73	33°23'	131°16'	7/04/2007	12:20	33°22.89'	131°15.30'	33°22.64'	131°25.38'	0	180
C2-74-2007	74	33°22'	131°40'	7/04/2007	15:40	33°22.42'	131°31.06'	33°22.03'	131°41.09'	136	110
C2-75-2007	75	33°34'	131°50'	7/04/2007	19:34	33°30.96'	131°47.93'	33°35.40'	131°55.97'	36	180
C2-76-2007	76	33°37'	132°01'	7/04/2007	22:35	33°36.22'	131°57.74'	33°39.26'	132°07.29'	189	85

Table 5. Species and numbers of fish for which length, sex, and otolith samples were collected during 2007 survey.

Species	Length frequency (unsexed)	Otoliths collected
Deepwater flathead	1023	227
Bight redfish	881	239

Table 6. Estimated total relative biomass (t) with coefficient of variation (c.v.) of major commercial species in across all strata from 2005, 2006 and 2007 surveys assuming net width of 16.3 m.

	Estimated Relative biomass					
Species	2005		2006		2007	
	t	c.v.	t	c.v.	t	c.v.
Bight redfish	20887 [A]	0.13	25380[A]	0.16	25713[A]	0.16
Deepwater flathead	12152	0.05	8415	0.06	8540	0.05
Ocean jacket	7163	0.14	9111	0.26	6701	0.37
Common sawshark	298	0.16	138	0.23	462	0.24
Yellow spotted boarfish	349	0.19	181	0.15	142	0.26
Gummy shark	558	0.17	288	0.25	402	0.23
Jackass morwong	1025	0.34	1037	0.23	1236	0.31
Knifejaw	955	0.12	1133	0.14	570	0.13
Latchet	9401	0.13	6135	0.25	7040	0.21
Ornate angel shark	3078	0.09	1887	0.10	2770	0.11
Piked dogfish	834	0.24	867	0.30	1006	0.23
Other species	11693	0.13	14405	0.14	22990	0.14

[A] night hauls only