Port Phillip Bay Annual Trawl Sub-program.

Progress Report No 1.
2008

May 2008

Victoria
The Place To Be

Port Phillip Bay Annual Trawl Sub-program.

Progress Report No 1. 2008

Gregory D. Parry, Simon Heislers, Guy F. Werner

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Introduction

Regions of Port Phillip Bay (PPB) are important for fish as feeding, spawning and nursery grounds. Fish populations are sensitive to changes in predator and prey abundance. Similarly, changes in fish populations can have flow on effects to species both higher and lower in the food chain. These changes are influenced by fishing pressure and environmental conditions, such as water quality (including temperature and nutrients), currents and habitat availability, either through direct impacts on adults or indirectly from impacts on spawning and recruitment success.

The Channel Deepening Baywide Monitoring Program (CDBMP) includes sub-programs for monitoring fish stocks and recruitment in PPB. These sub-programs are:

1. Annual trawl survey of fish in PPB;
2. a) Egg and larval surveys for key fish species;
   b) Anchovy study;
3. Recreational fishery surveys, and
4. Fish in seagrass.

Sub-program 1 is based on the annual PPB trawl survey initiated in 1990 by the Department of Primary Industries (DPI). The objective of this sub-program is to detect interannual changes in the abundance of all common fish in Port Phillip Bay outside of expected variability.

This Report

In this report, fish biomass and abundance from the 2008 survey were examined to determine if changes from previous surveys were as expected, based on a long time-series of historical data for PPB.

Project Design and Methods

Materials, methods and statistical analysis for this sub-program are described in the Port Phillip Bay Annual Trawl Detailed Design CDP_ENV_MD_014 Rev 0 (Port of Melbourne Corporation 2007).

Field methods

Fish were collected using a wing trawl net (47 m long, 13 m wing spread, 5 m opening height and 45 m between trawl doors) at 22 depth-stratified sites in PPB (Figure 1). Sites were sampled between 5 and 8 March 2008.

Spatial differences in fish communities

Spatial differences in fish communities in PPB were examined by Parry *et al*. (2003) using multidimensional scaling (MDS). Using data from the first decade of the PPB trawl study they found that fish communities in the bay could be divided into four ecological types, termed regions: 'shallow', 'intermediate', 'deep' and 'west' (Figure 1).

Data Analysis

Data QA/QC.

Data QA/QC was undertaken for this report according to DPI Fisheries Victoria standard operating procedures.

Estimates of biomass

The total fish biomass and the biomass of each of the ten most common fish species were estimated for the four regions of the bay.

Changes in the biomass of the ten species with the highest biomass in the bay were plotted for the period 1990-2008, for each of the four regions in the bay.

Changes in biomass and abundance

The 2008 survey results for biomass and abundance of selected species were compared statistically in each of the four regions of the bay. Statistical analysis was restricted to eastern shovelnose stingaree, globefish, sand flathead, sparsely spotted stingaree and spiny gurnard. These species are abundant and non-schooling and therefore tests of significance for these species have a higher power than other species.

Statistical analysis was based on log transformed data (log(N+1) and Log (weight), where N is a measure of abundance and weight is a measure of biomass respectively). For selected species in each region, 2008 estimates of abundance and biomass were compared with the average from the four years 2004-07 to determine whether values obtained in 2008 were outside of expected variability (based on predicted values from the earlier data). Comparison between the current year and the historical minimum was based on Student's *t*, with the variance of the difference estimated from a mixed-model analysis of variance (Searle *et al.* 1992). Variance components and fixed effect parameters were estimated using the REML algorithm (Patterson and Thompson 1971). The overall year effect was considered to be a fixed effect, but year effects within each site were treated as a random variable (Verbeke and Molenberghs 1997). Mixed model calculations were performed using SAS PROC MIXED (Littell *et al*. 1996).

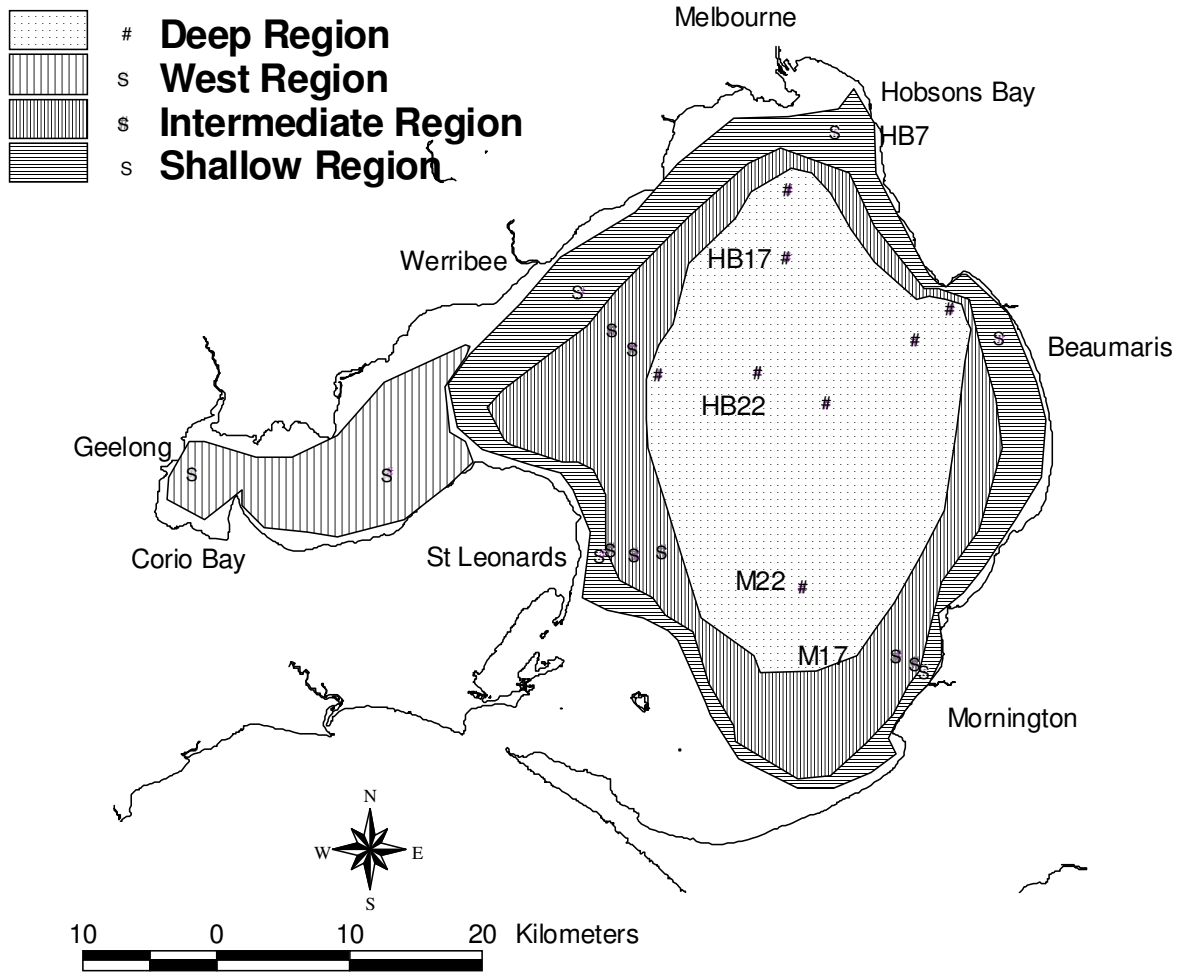

Figure 1. Location of depth-stratified 2008 trawl survey sites in Port Phillip Bay. Sites classified as 'Deep', 'Intermediate', 'Shallow' and 'West' are shown and the areas of the bay for which these sites are representative are shaded.

Results and Discussion

Biomass and Abundance

Plots of biomass for key species on a region specific basis indicate long term trends varying from static in some regions to declining in others (Table 1, Figures 2, 3, 4 and 5).

Changes in the total biomass of fish in all regions of the bay between 2007 and 2008 were comparable to other inter-annual changes observed during the study period, 1990–2008. The present biomasses reflect the continuance of a long-term decline in the abundance of many species in the 'intermediate' and 'deep' regions of the bay. There has been no clear long-term trend in total biomass in the 'shallow' and 'west' regions.

Statistical Significance

Tests of statistical significance for changes in the abundance of eastern shovelnose stingaree, globefish, sand flathead, sparsely spotted stingaree and spiny gurnard in each region are summarised in Table 2. Identical tests for changes in biomass are summarised in Table 3.

Test results were not statistically significant (Table 2 & 3), indicating that changes in both abundance and biomass for key species were not outside of natural variability.

Raw data

- Missing data: None.
- Calibrated measurements are provided with this report electronically as four Microsoft Excel files (see Appendix).

Exceptions

Exceptions for this study period according to the detailed design - CDP_ENV_MD_014_Rev 0. (Port of Melbourne Corporation 2007) have been documented separately and specifically relate to:

- Fishing efficiency of one of the nets, and
- The number of species for which biomass estimates were individually calculated.

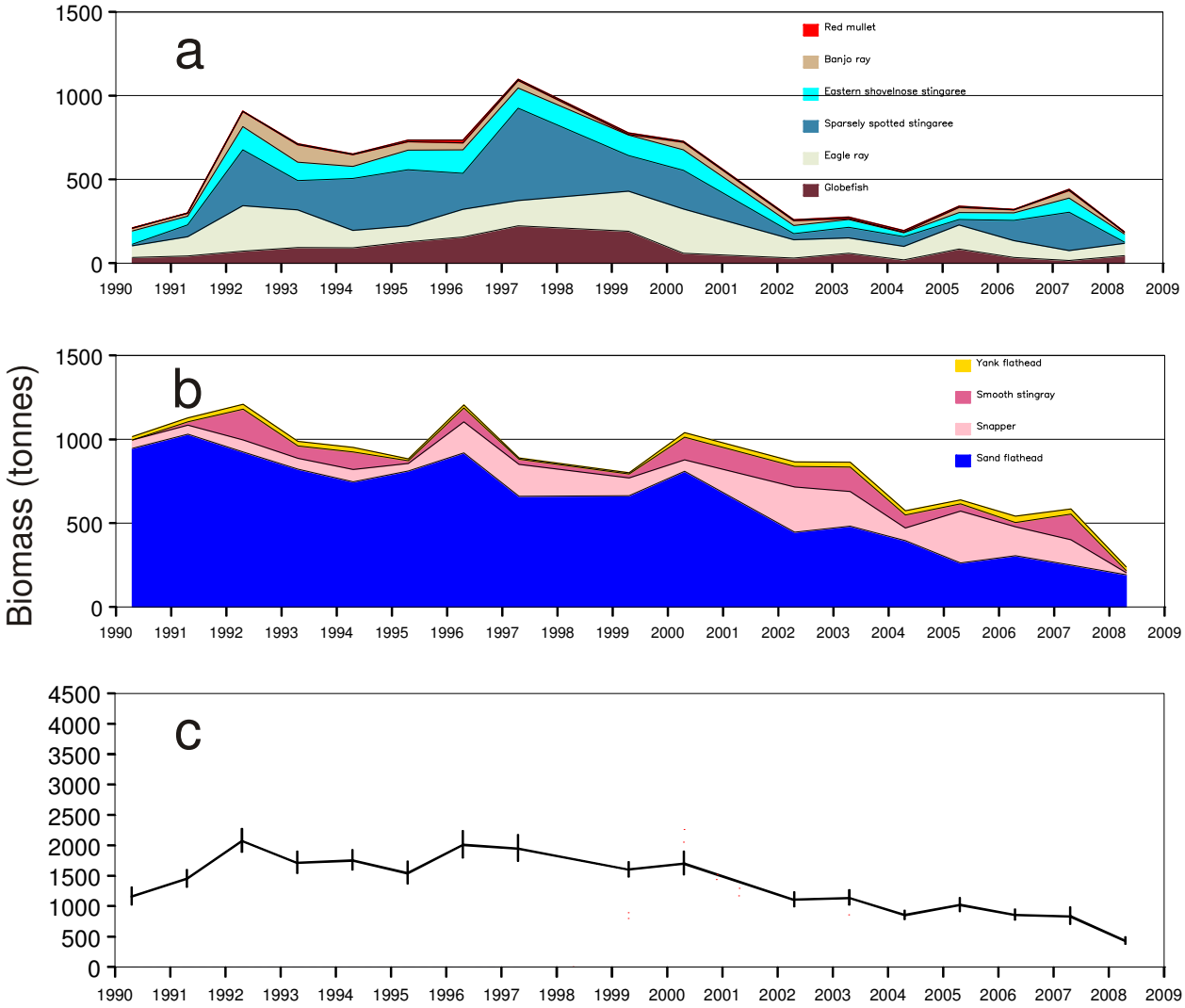

Figure 2. Total biomass (tonnes) of demersal fish between 1990 and 2008 in the 'deep' region of PPB; a) biomass of six most common obligate bottom feeding fish, b) biomass of four most common midwater and bottom-feeding fish, and c) total fish biomass and standard error for all species (calculated using log transformed biomasses).

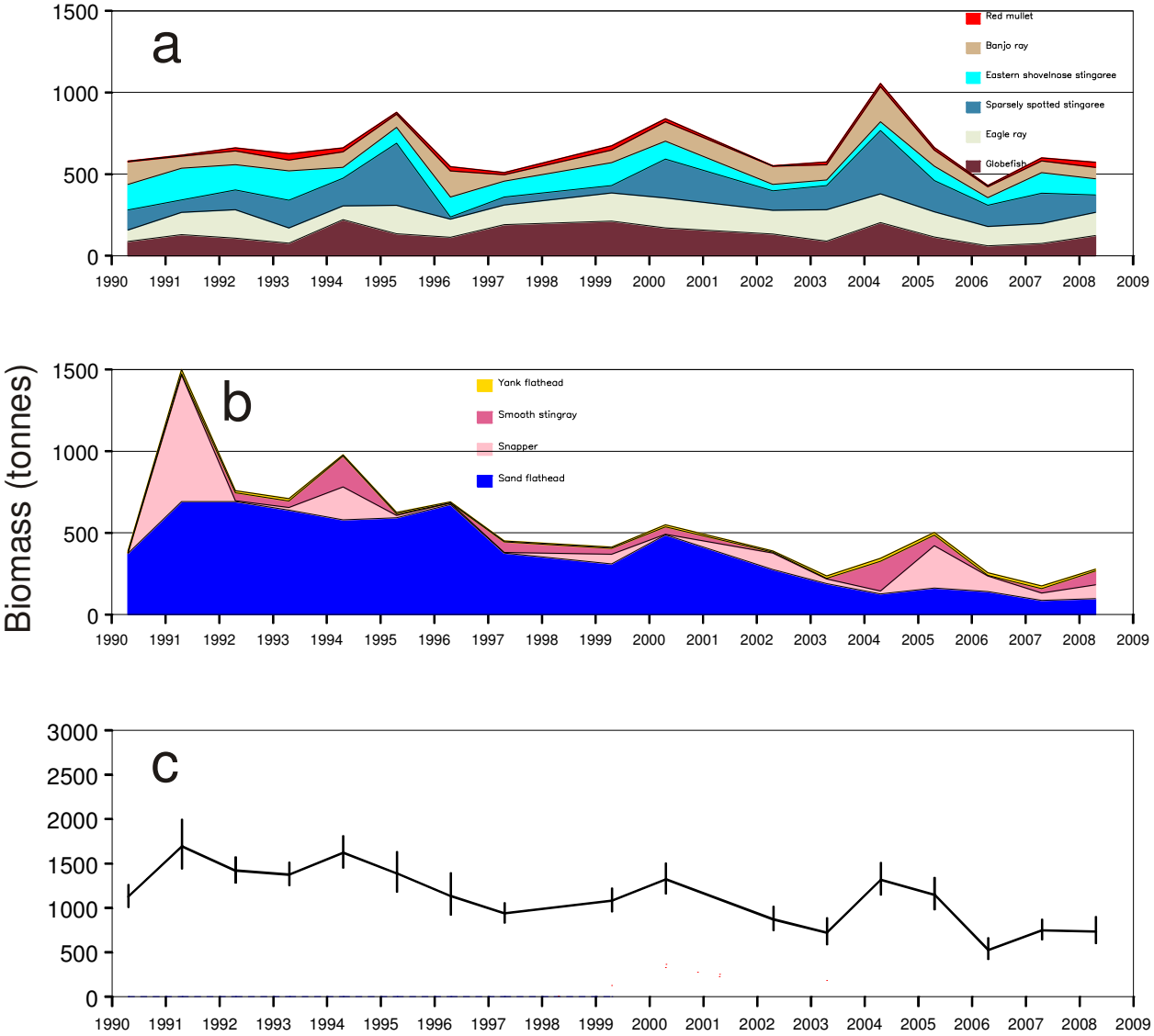

Figure 3. Total biomass (tonnes) of demersal fish between 1990 and 2008 in the 'intermediate' region of PPB; a) biomass of six most common obligate bottom feeding fish, b) biomass of four most common midwater and bottom-feeding fish, and c) total fish biomass and standard error for all species (calculated using log transformed biomasses).

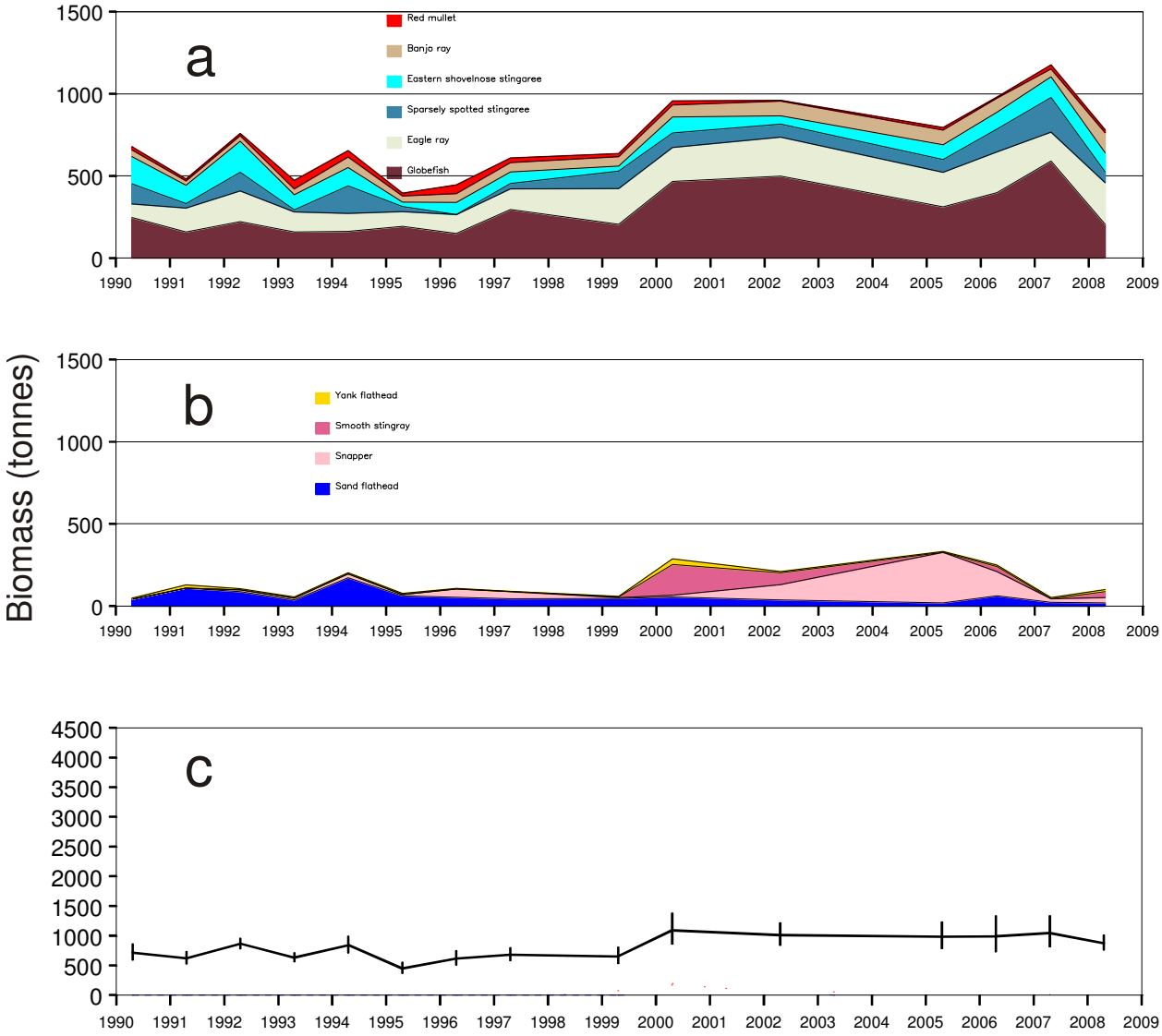

Figure 4. Total biomass (tonnes) of demersal fish between 1990 and 2008 in the 'shallow' region of PPB; a) biomass of six most common obligate bottom feeding fish, b) biomass of four most common midwater and bottom-feeding fish, and c) total fish biomass and standard error for all species (calculated using log transformed biomasses).

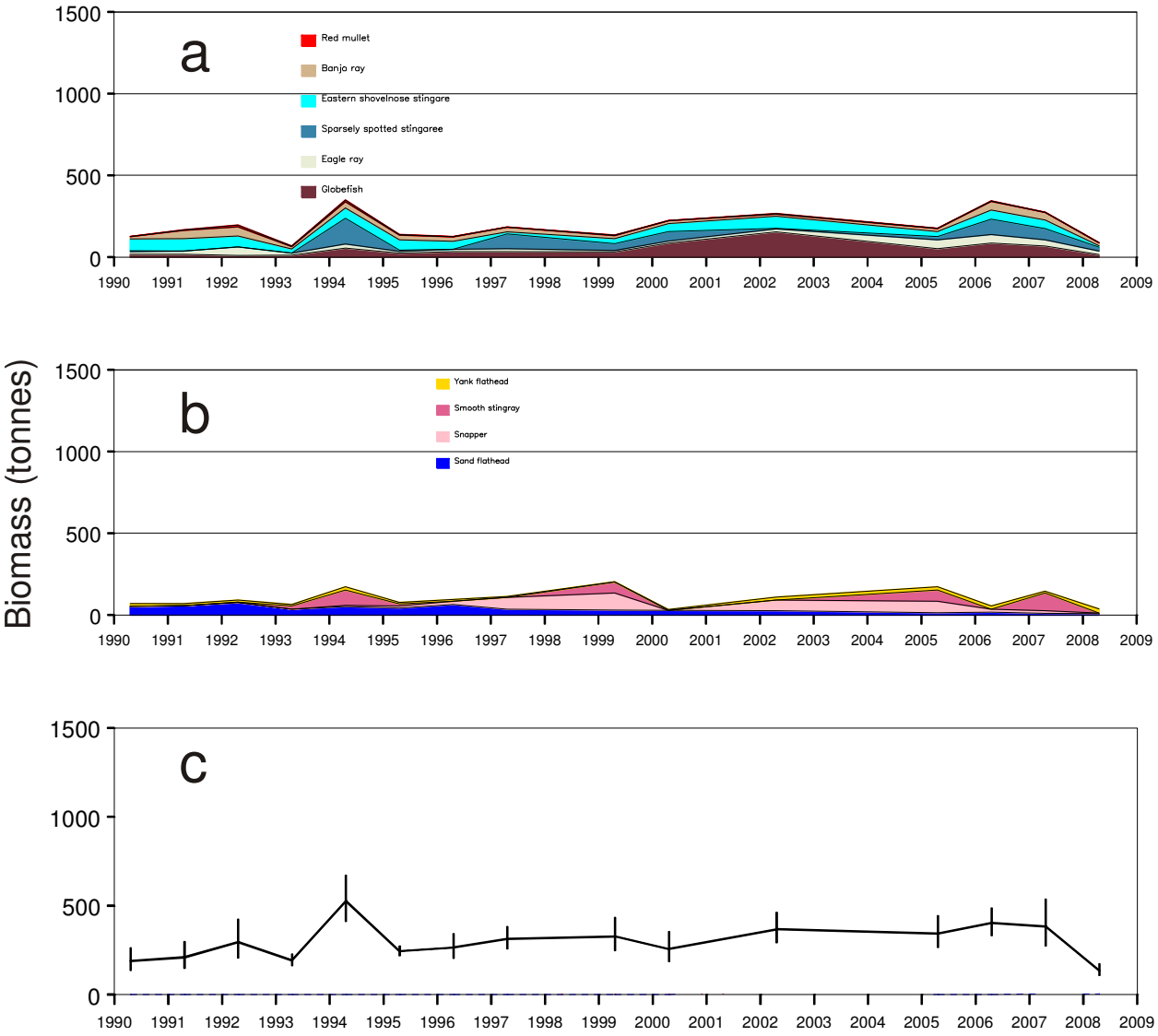

Figure 5. Total biomass (tonnes) of demersal fish between 1990 and 2008 in the 'west' region of PPB; a) biomass of six most common obligate bottom feeding fish, b) biomass of four most common midwater and bottom-feeding fish, and c) total fish biomass and standard error for all species (calculated using log transformed biomasses).

Table 1. Total fish biomass and mean biomass (kg/5 min tow) for the ten most abundant species of fish in four regions of Port Phillip Bay between 1990-2008.

			1990		1991		1992		1993		1994		1995		1996		1997		1999		2000		2002		2003		2004		2005		2006		2007		2008	
Region	Rank	Species	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se
Shallow	1	Sand flathead	2.85	1.58	7.55	3.7	6.02	3.14	2.62	0.96	11.89	4.22	4.35	1.31	3.76	1.73	3.11	1.27	3.24	1.48	3.81	0.87	2.55	0.53	ND		ND		1.3	0.24	4.32	1.41	1.58	0.54	1.37	0.44
	2	Globefish	17.23	5.79	11.06	3.31	15.35	3.97	11.01	2.82	11.31	3.04	13.38	3.94	10.37	1.99	20.5	4.74	14.38	2.4	32.49	9.63	34.76	11.2	ND		ND		21.65	3.88	27.68	6.37	41.05	8.91	14.33	3.63
	3	Sparsely spotted stingaree	5.68	1.26	10.11	2.45	13.06	2.11	8.53	1.34	7.69	2.6	6.3	1.57	7.99	0.91	8.85	1.15	15.16	2.74	14.31	4.04	16.5	1.89	ND		ND		14.75	3.03	17.27	4.27	12.34	2.2	17.61	2.74
	4	Eagle ray	8.5	3.88	1.93	1.9	7.98	5.38	0.92	0.58	11.62	4.82	2.12	1.99	0	0	2.12	1.11	7.32	4.36	6.13	3.94	5.49	5.06	ND		ND		5.32	3.2	9.58	6.81	14.64	11.55	4.58	2.48
	5	Eastern shovelnose stingaree	11.45	2.1	7.76	2.01	13.17	2.58	6.31	2.07	7.7	2.21	1.93	0.48	5.23	1.8	5.03	1.67	2.09	0.76	6.81	1.67	3.52	0.89	ND		ND		6.29	2.38	7.21	2.4	8.65	2.36	8.11	1.82
	6	Snapper	0.01	0.01	0.01	0.01	0.76	0.48	0.64	0.24	1.73	1.29	0.53	0.49	3.45	1.69	2.95	1.46	0.34	0.22	0.75	0.48	6.48	2.52	ND		ND		21.43	7.21	10.29	4.46	1.44	0.65	2.17	1.54
	7	Banjo ray	2.96	1.17	1.91	0.69	2.26	0.85	2.58	1.41	4.53	1.19	2.55	0.64	3.8	0.97	3.97	0.75	3.93	1.08	5.18	1.85	6.27	2.04	ND		ND		6.24	2.6	6.08	1.72	3.46	1.88	8.48	2.57
	8	Smooth stingray	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	13	8.95	5	5	ND		ND		0	0	2.11	2.11	0	0	2.48	1.69
	9	Yank flathead	0.42	0.13	1.39	0.6	0.55	0.14	0.63	0.24	0.41	0.1	0.49	0.15	0.29	0.12	0.16	0.12	0.15	0.11	2.43	1.46	0.59	0.25	ND		ND		0.3	0.15	0.61	0.19	0.5	0.2	0.9	0.22
	10	Red mullet	1.28	0.56	0.76	0.34	0.93	0.39	3.55	1.4	2.62	1.58	1.2	0.54	3.52	1.87	1.93	0.93	1.33	0.9	1.59	0.39	0.21	0.08	ND		ND		1.01	0.3	0.35	0.12	1.57	0.68	1.05	0.35
		others	7	1.88	6.18	2.13	3.02	1.04	9.75	2.21	4.83	0.76	3.77	0.88	12.1	3.58	3.79	0.97	4.33	0.92	10.08	4.65	2.82	0.31	ND		ND		3.96	0.8	3.45	0.89	5.49	1.43	4.96	0.99
		Total	**57.41**	**9.23**	**48.67**	**8.34**	**63.1**	**6.38**	**46.55**	**4.93**	**64.33**	**8.76**	**36.63**	**5.96**	**50.5**	**9.28**	**52.4**	**7.37**	**52.58**	**7.76**	**96.58**	**22.23**	**84.18**	**20.08**	ND		ND		**82.25**	**13.87**	**88.94**	**16.79**	**90.73**	**17.29**	**66.05**	**7.82**
Intermediate	1	Sand flathead	20.52	3.19	37.82	2.81	37.88	3.83	35	2.78	31.76	3.75	32.49	4.23	36.82	6.42	20.61	3.65	16.95	2.66	26.78	5.48	15.12	4.76	10.44	4.17	6.88	1.02	8.91	2.23	7.74	2.76	4.82	0.93	5.39	1.03
	2	Globefish	4.85	1.07	7.04	1.74	5.9	1.86	4.24	1.24	12.09	3.36	7.41	1.58	6.27	1.44	10.4	2.44	11.65	2.33	9.32	1.66	7.28	1.25	4.89	1.29	11.1	2.11	6.28	2.1	3.34	0.71	4.12	0.94	6.74	1.89
	3	Sparsely spotted stingaree	3.76	0.63	7.54	0.72	9.6	1.22	5.12	1.15	4.62	0.93	9.49	3.05	6.03	0.75	6.66	1.51	9.49	1.93	10.1	1.77	7.96	1.6	10.65	3.62	9.67	2.16	8.52	1.2	6.5	1.74	6.78	1.14	7.87	1.92
	4	Eagle ray	6.7	2.44	4.19	1.04	6.54	2.92	9.29	5.21	9.3	6.13	20.77	7.91	0.66	0.35	2.68	1.32	2.39	2	12.93	6.32	6.48	3.21	8.04	4.46	21.16	10.17	10.41	6.29	7.14	3.3	10.06	4.08	5.83	3.34
	5	Eastern shovelnose stingaree	8.62	1.58	10.59	2.4	8.51	2.35	9.79	1.92	3.62	1.08	5.34	0.81	6.76	1.69	5.27	1.23	7.68	2.31	6.11	1.61	2.19	0.93	1.83	0.5	3.04	0.81	4.82	1.47	2.54	0.62	6.95	2.01	5.35	0.97
	6	Snapper	0.19	0.16	42.52	40.32	0.25	0.17	0.92	0.6	11.06	10.92	0.73	0.57	0.54	0.33	0.15	0.05	3.28	1.87	0.16	0.07	5.49	3.09	1.55	1.33	0.99	0.43	14.11	5.39	5.23	2.44	2.43	2.05	4.57	4.01
	7	Banjo ray	7.62	2.68	3.99	0.9	4.57	1.48	3.73	1.16	5.21	1.21	4.41	0.53	8.73	2.36	2.15	0.65	4.21	1.17	6.49	0.74	6.09	1.23	5.19	1.57	11.76	3.52	5.47	1.35	3.66	0.94	3.88	1.21	3.88	1.26
	8	Smooth stingray	0	0	0.36	0.25	2.63	1.79	2.11	1.71	10.28	5.78	0.49	0.37	0	0	3.57	3.57	2	1.78	2.43	2.43	0.29	0.29	0.15	0.15	10.04	5.9	3.57	3.57	0.2	0.2	1.46	1	4.7	3.02
	9	Yank flathead	0.61	0.2	1.37	0.32	0.73	0.16	0.83	0.23	0.41	0.14	0.5	0.22	0.41	0.1	0.31	0.12	0.36	0.13	0.67	0.14	0.4	0.12	0.76	0.29	0.9	0.15	0.99	0.33	0.83	0.19	0.92	0.22	0.5	0.13
	10	Red mullet	0.15	0.05	0.37	0.17	1.08	0.29	2	0.78	1.32	0.33	0.66	0.2	1.35	0.37	0.74	0.26	1.44	0.61	0.96	0.19	0.19	0.08	0.84	0.28	0.98	0.28	0.74	0.23	0.31	0.1	1.05	0.52	1.64	0.58
		others	14.1	6.87	6.99	3.71	5.25	0.93	6.81	1.26	6.94	2.79	6.42	1.36	7.36	2.08	3.4	0.67	5.49	0.97	4.13	0.47	3.09	0.63	7.07	3.69	4.58	0.97	9.28	2.91	2.03	0.43	4.38	1.17	4.33	1.18
		Total	**67.13**	**8.18**	**122.78**	**40.83**	**82.93**	**7.84**	**79.84**	**7.75**	**96.61**	**12.19**	**88.69**	**12.74**	**74.93**	**9.44**	**55.92**	**5.97**	**64.95**	**7.45**	**80.07**	**9.66**	**54.57**	**7.64**	**51.4**	**9.73**	**81.08**	**10.92**	**73.1**	**10.73**	**39.51**	**8.38**	**46.85**	**6.21**	**50.79**	**8.74**
Deep	1	Sand flathead	33.05	5.1	36.01	3.72	32.28	1.63	28.73	2.2	26.06	3.15	28.36	3.15	32.16	3.45	23.08	2.82	23.2	2.21	28.27	3.85	15.6	1.62	16.82	2.15	13.81	1.37	9.2	0.92	10.72	1.78	8.77	1.12	6.75	0.65
	2	Globefish	1.19	0.74	1.47	0.67	2.46	0.62	3.23	1.03	3.19	0.73	4.42	0.97	5.44	0.95	7.78	2.07	6.65	2.06	2.01	0.4	1.08	0.4	2.06	0.89	0.66	0.18	2.96	1.6	1.21	0.56	0.56	0.18	1.55	0.75
	3	Sparsely spotted stingaree	2.42	0.37	4.06	0.58	9.53	1.49	7.88	1.38	3.65	0.9	3.36	0.86	5.83	0.55	5.3	0.64	8.37	1.35	9.31	2.09	3.85	0.81	3.23	0.64	2.84	0.37	4.99	1.38	3.47	0.97	2.08	0.38	2.57	0.53
	4	Eagle ray	0.33	0.25	2.42	0.77	11.67	3.37	6.06	1.77	10.84	2.4	11.69	6.8	7.49	2.55	19.26	4.53	7.44	2	8.03	3.86	1.22	0.53	2.17	0.95	2.02	1.04	1.14	0.67	4.25	1.68	7.99	4.62	0.28	0.15
	5	Eastern shovelnose stingaree	2.79	0.57	1.82	0.57	4.81	1.53	3.86	0.83	2.51	0.65	4.07	0.6	4.87	1.11	4.2	1.22	4.26	1.09	4.27	0.99	1.73	0.65	1.66	0.66	0.81	0.58	1.44	0.61	1.51	0.43	2.99	1.25	1.7	0.6
	6	Snapper	1.76	1.03	1.9	0.62	2.56	0.79	2.27	0.78	2.61	1.41	1.56	0.51	6.41	2.31	6.63	1.57	3.73	1.34	2.39	0.83	9.42	1.78	7.25	1.42	2.68	0.85	10.77	1.72	6	1.23	5.25	2.5	0.42	0.16
	7	Banjo ray	0.56	0.56	0.64	0.34	3.18	1.05	3.7	1.25	2.44	0.69	1.78	0.66	1.42	0.69	1.58	0.5	0.11	0.08	1.62	0.74	1	0.55	0.17	0.12	0.13	0.13	1.12	1	0.65	0.5	1.5	0.79	0.36	0.18
	8	Smooth stingray	0	0	0.66	0.46	6.39	2.63	2.6	1.19	3.65	2.13	0.56	0.56	2.94	1.86	1.1	0.85	0.81	0.81	4.69	2.48	4.28	3.29	5.11	4.35	2.7	1.51	1.5	1.09	0.93	0.81	5.31	5.31	0.46	0.37
	9	Yank flathead	0.68	0.17	0.87	0.14	1.02	0.26	0.89	0.23	0.88	0.18	0.42	0.11	0.6	0.2	0.26	0.09	0.25	0.08	1	0.14	0.95	0.16	0.96	0.23	0.89	0.17	0.85	0.13	1.24	0.28	1.13	0.3	0.76	0.11
	10	Red mullet	0.02	0.02	0.01	0.01	0.03	0.02	0.21	0.1	0.14	0.07	0.32	0.24	0.58	0.21	0.23	0.08	0.35	0.09	0.19	0.1	0.15	0.06	0.33	0.11	0.31	0.11	0.25	0.07	0.1	0.04	0.3	0.14	0.08	0.03
		others	2.77	0.39	3.89	0.74	3.05	0.66	5.08	0.79	10.23	3.82	4.25	1.08	8.93	2.86	4.17	1.13	3.28	0.55	3.45	0.5	3.03	0.9	3.92	0.7	4.7	0.95	5	1.23	2.24	0.42	1.44	0.33	2.05	0.39
		Total	**45.57**	**6.18**	**53.75**	**4.06**	**77**	**6.75**	**64.51**	**5.92**	**66.19**	**7.87**	**60.79**	**8.62**	**76.68**	**8.99**	**73.59**	**6.85**	**58.45**	**4.41**	**65.22**	**7.18**	**42.3**	**4.86**	**43.67**	**5.72**	**31.54**	**2.74**	**39.23**	**4.56**	**32.32**	**3.27**	**37.32**	**7.99**	**16.97**	**1.97**
West	1	Sand flathead	7.49	3.17	8.15	2.81	10.6	4.8	4.99	0.97	7.34	2.74	6.21	1.4	9.15	3.76	4.98	1.94	4.36	1.47	4.16	0.93	3.71	0.85	ND		ND		2.01	0.34	2.33	0.63	1.54	0.55	1.2	0.24
	2	Globefish	2.54	1.92	2.56	1.56	1.62	0.08	1.79	0.61	7.88	1.99	3.55	0.46	4.85	2.74	4.94	0.48	4.6	0.36	12.28	3.02	21.95	12.66	ND		ND		7.5	3.23	12.18	2.66	9.73	4.66	2.45	0.92
	3	Sparsely spotted stingaree	2.24	1.31	2.65	1.2	7.3	3.03	1.82	1.24	3.63	1.55	1.6	0.65	2.04	1.11	2.58	1.4	1.45	0.63	1.93	0.92	2.61	1.03	ND		ND		7.7	2.41	7.58	1.02	5.4	2.9	2.79	0.52
	4	Eagle ray	0.82	0.67	0	0	0	0	0	0	22.42	14.32	1.03	1.03	0	0	12.63	4.95	5.86	5.71	8.25	8.25	0.5	0.5	ND		ND		2.63	2.63	13.23	11.05	9.75	3.63	3.5	3.5
	5	Eastern shovelnose stingaree	10.2	3.43	10.82	5.89	9.38	0.83	3.45	1.57	8.75	2.67	9.08	2.56	7	3.14	1.88	1.03	4.24	0.24	6.7	0.91	10.58	4.62	ND		ND		4.45	1.9	8.05	2.04	7.38	3.48	1.34	0.62
	6	Snapper	0	0	0	0	0.74	0.74	0.01	0.01	1.28	0.86	1.67	0.8	2.93	1.07	10.39	6.12	14.7	14.43	0.02	0.01	9.33	1.83	ND		ND		10.03	6.24	2.58	2.06	2.2	1.33	0.55	0.49
	7	Banjo ray	2.1	1.26	7.22	3.76	8.25	6.27	2.21	1.03	5.63	1.52	3.94	2.13	3.85	1.57	4.15	3.4	2.63	1.14	2.75	1.46	1.83	1.17	ND		ND		2.48	2.18	7.48	3.24	6.7	3.42	2.41	1
	8	Smooth stingray	0	0	0	0	0	0	2.8	2.8	13	12.02	1.75	1.75	0	0	0	0	9.5	9.5	0	0	0	0	ND		ND		9.75	8.02	0	0	15.49	7.38	0	0
	9	Yank flathead	2.42	1.43	1.85	0.54	1.75	0.47	1.58	0.61	3.1	1.05	1.53	0.42	1.67	0.6	0.75	0.31	0.4	0.18	0.66	0.27	2.64	1.72	ND		ND		2.74	0.75	2.99	1.11	1.55	0.97	3.47	0.69
	10	Red mullet	0.13	0.07	0.5	0.38	1.26	0.56	0.54	0.12	1.37	0.67	0.55	0.22	0.09	0.07	0.01	0.01	0.41	0.37	0.05	0.05	0.47	0.41	ND		ND		0.44	0.36	0.53	0.23	0.06	0.06	0.02	0.02
		others	3.31	0.6	2.22	0.58	10.02	3.83	9.26	1.64	6.76	1.03	4.48	1.9	10.03	2.02	4.98	2.08	3.94	0.56	5.95	3.83	3.22	1.24	ND		ND		4.07	1.31	3.55	1.38	3.52	0.52	3.43	1.29
		Total	**31.26**	**9.27**	**35.99**	**12.71**	**50.92**	**18.12**	**28.46**	**4.17**	**81.16**	**17.8**	**35.37**	**3.86**	**41.61**	**10.92**	**47.28**	**9.07**	**52.09**	**13.49**	**42.74**	**14.44**	**56.83**	**14.4**	**ND**		**ND**		**53.78**	**13.23**	**60.48**	**11.53**	**63.31**	**17.83**	**21.15**	**5.45**

Table 2. Values of variance components, change and the criterion statistic, C_i, and significance values for one-tailed test of the hypothesis that the abundance (log N+1) of selected common species in four regions of Port Phillip Bay in 2008 was not less than the minimum predicted from historical data for the period 2004-2007 (ns, not significant).

		Variance components				
Species	Region	Year within Site σ^2_{SY}	Shot σ^2_{Shot}	Change Δ_i	Criterion C_i	Significance criterion, C_i <-1.96
Spiny gurnard	Shallow	0.315	0.350	0.512	0.655	ns
	Intermediate	0.360	0.314	0.618	0.768	ns
	Deep	0.237	0.214	0.208	0.318	ns
	Western	0.322	0.436	0.128	0.156	ns
Globefish	Shallow	0.184	0.385	-0.267	-0.390	ns
	Intermediate	0.554	0.494	0.059	0.059	ns
	Deep	0.477	0.320	0.086	0.096	ns
	Western	0.011	0.690	-1.038	-1.556	ns
Eastern shovelnose stingaree	Shallow	0.219	0.418	0.229	0.313	ns
	Intermediate	0.349	0.342	0.591	0.733	ns
	Deep	0.063	0.280	-0.089	-0.176	ns
	Western	0.136	0.266	-0.705	-1.216	ns
Sparsely spotted stingaree	Shallow	0.285	0.325	0.690	0.922	ns
	Intermediate	0.410	0.333	-0.144	-0.170	ns
	Deep	0.409	0.227	-0.240	-0.297	ns
	Western	0.374	0.493	-0.170	-0.193	ns
Sand flathead	Shallow	0.478	0.484	0.484	-0.018	ns
	Intermediate	0.389	0.169	0.169	-0.141	ns
	Deep	0.137	0.113	0.113	-0.425	ns
	Western	0.326	0.276	0.276	0.165	ns

Table 3. Values of variance components, change and the criterion statistic, C_i, and significance values for one-tailed test of the hypothesis that biomass (log Weight) of selected common species in four regions of Port Phillip Bay in 2008 was not less than the minimum predicted from historical data for the period 2004-2007 (ns, not significant).

		Variance components				
Species	Region	Year within Site σ^2_{SY}	Shot σ^2_{Shot}	Change Δ_i	Criterion C_i	Significance criterion, C_i <-1.96
Spiny gurnard	Shallow	0.008	0.010	0.073	0.582	ns
	Intermediate	0.041	0.040	0.120	0.434	ns
	Deep	0.025	0.021	0.019	0.091	ns
	Western	0.016	0.007	0.011	0.073	ns
Globefish	Shallow	0.237	0.308	-0.377	-0.540	ns
	Intermediate	0.289	0.399	0.061	0.078	ns
	Deep	0.212	0.170	0.089	0.147	ns
	Western	0.000	0.465	-0.953	-1.768	ns
Eastern shovelnose stingaree	Shallow	0.148	0.439	0.374	0.552	ns
	Intermediate	0.190	0.443	0.384	0.535	ns
	Deep	0.112	0.450	0.037	0.057	ns
	Western	0.092	0.424	-0.854	-1.385	ns
Sparsely spotted stingaree	Shallow	0.296	0.172	0.676	0.979	ns
	Intermediate	0.261	0.210	-0.115	-0.170	ns
	Deep	0.286	0.138	-0.143	-0.215	ns
	Western	0.151	0.403	-0.290	-0.437	ns
Sand flathead	Shallow	0.240	0.172	-0.086	-0.135	ns
	Intermediate	0.273	0.112	-0.142	-0.222	ns
	Deep	0.121	0.088	-0.347	-0.762	ns
	Western	0.202	0.106	-0.129	-0.228	ns

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Appendix

Electronic data files are as follows:

CATCH.xls

LENGTHFREQ.xls

SHOT.xls

catchREADME.doc

lengthfreqREADME.doc

shotREADME.doc

The latter three files detail the metadata for the above datasets.