A SURVEY OF THE WESTERN BLUE GROPER ON SOUTHERN YORKE PENINSULA

By

Scoresby A. Shepherd and James B. Brook

Reefwatch, c/o Conservation Council of South Australia,
120 Wakefield St, Adelaide, 5000.

24 January 2003

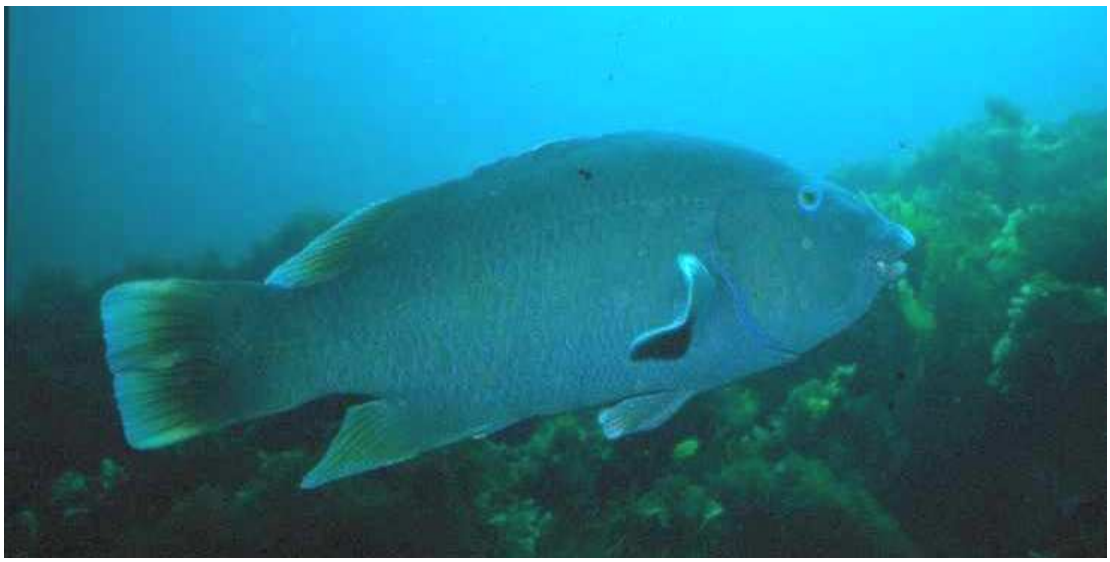

Photo: Adrian Brown

FISHERIES ACTION PROGRAM
A program of the Natural Heritage Trust

COASTCARE

Reef WATCH

A SURVEY OF THE WESTERN BLUE GROPER ON SOUTHERN YORKE PENINSULA, SOUTH AUSTRALIA

by Scoresby A. Shepherd [1] and James B. Brook[2]

[1]Senior Research Fellow, South Australian Research and Development Institute, PO Box 120 Henley Beach. 5022. Email address: shepherd.scoresby@saugov.sa.gov.au

[2]PO Box 111 Normanville, SA. 5204. Email address: jbrook@picknowl.com.au

SUMMARY

Thirteen sites on southern Yorke Peninsula were surveyed in order to estimate the abundance of the western blue groper, *Achoerodus gouldii*. Juveniles (<20 cm) were sporadically common at shallow, moderately sheltered sites in creviced rocky areas. Sub-adults (20-60 cm) occurred at depths of 2-6 m and their abundance was correlated with that of juveniles, suggesting local recruitment of juveniles to adjacent reefs. Sub-adults > 30 cm were rare and adults (> 60 cm) even rarer. Anecdotal evidence from the 1960s to the 1980s was that adult groper were once common off headlands of SW Yorke Pen. Using the mean size of adult blue-throated wrasse as an index of fishing intensity, we found a correlation between this index and the mean size of sub-adults. The correlation implies that, despite formal protection of the blue groper, fishing mortality may be a contributing factor to the rarity of sub-adults in in-shore waters. Measures such as no-take reserves would give better protection to this species on open coasts.

INTRODUCTION

This is the second in a series of reports on the abundance of the western blue groper (WBG), *Achoerodus gouldii*, on the coasts of South Australia. The first report in the series (Shepherd *et al*. 2002) described the biology and ecology of the species and provided data on its abundance on Kangaroo Island. In this report we summarise the results of surveys on southern Yorke Peninsula in which we recorded the abundance of WBG at exposed and sheltered sites. The survey was restricted to the western and south coasts of the foot of the peninsula as previous surveys and observations had indicated that there were none elsewhere on the peninsula. We hypothesized that juvenile groper recruited in shallow, inshore habitats and that with increasing size they moved into adjacent deeper habitat. So we sought to obtain data at each site in both inshore waters where recruits might be found as well as in deeper habitat. Ancillary data collected on abundance of other reef fishes will be presented elsewhere, except that we use mean size data on the blue-throated wrasse, *Notolabrus tetricus,* as an index of fishing intensity.

METHODS

Surveys were variously carried out from 7-12 October 2002 and 28-30 December 2002 at sites selected for their accessibility from land by divers (Fig. 1). The visual census technique along transect lines was used to estimate the abundance and size of fish. We used previously trained divers or trained them during the survey, but used the data of trainees only when satisfied that they were adequately trained.

The divers swam, by snorkelling or with SCUBA, along a 100 m transect line recording the species identity and length of all species seen within a swathe of 5 m width. Divers were trained to swim the transect line at a constant speed and complete it in about 10 minutes; thereafter, for many transects trained divers simply did 10 minute counts, which were then transformed to estimates of density. The distance covered in the timed swims was validated with a 100 m transect line from time to time. Replicate transects were variously done in parallel or sequentially according to site; we preferred sequential replicates because divers then covered a longer section of coastline, and very often suitable habitat for juveniles or sub-adults only occurred in a narrow inshore band. Our earlier study (Shepherd *et al*. 2002) showed that 5-8 100m replicates were required to give reasonably precise estimates of density, given the low numbers encountered. We followed the same protocol in this study, but had less replication at places with limited available habitat, or with zero abundance.

Characteristics of the substratum were noted in terms of substratum complexity (SC) and exposure to swell (EI) by estimating index values for each, following Edgar (1981) and Shepherd and Brook (2003) respectively. Dominant canopy-forming algae were also noted.

Density data for WBG from the surveys are presented in three length classes: juveniles < 20 cm long, sub-adults 20-60 cm long, and adults > 60 cm as in our earlier report.. In all, we examined 13 sites, which were subdivided, where possible, into near-shore shallow, and off-shore deeper components to recognize the habitat differences between juveniles and sub-adults.

RESULTS

Bottom habitats

The south western corner of Yorke Peninsula is exposed to strong prevailing SW swell. Along the west coast, headlands are subject to strong exposure to swell, but bays are more sheltered. Along the south coast there is a gradient from full exposure in the west to less exposure in the eastern bays, Sturt Bay and Foul Bay. Southern sites are also exposed to short seas from the south and southeast.

The substratum varies among sites. At some sites a granitic substratum is exposed, and, at others, the rocky substratum is calcarenite, composed of solidified dunes with high shell content, compressed and eroded to form a friable, coarsely grained rock (Savarton et al. 1987, Edyvane 1999).

The dominant canopy species of algae generally reflect the gradient in water movement both along the coast and from headlands to sheltered shores in bays. *Ecklonia, Cystophora siliquosa, C. retorta, Acrocarpia* and *Scytothalia* tend to dominate the vegetation at exposed sites, whereas *C. monilifera, C. subfarcinata, Sargassum fallax* and *S. linearifolium* variously dominate less exposed sites, with *Scaberia,* some species of *Sargassum,* and *Caulocystis* dominant in sheltered sites (see Collings and Cheshire 1998). The habitat features and algal dominants are summarised in Table 1. More detailed descriptions of some sites are given by Savarton et al.(1987)

Abundance of WBG

The abundances of juveniles, sub-adults and adults at sites examined are given in Table 2. Geographically abundances were greatest in the southwest corner of the peninsula and declined toward the north and toward the east. None were seen at Corny Point nor at Coobowie.

In general, juveniles were only seen in shallow water (< ~2 m), which is moderately sheltered (EI ≈ 2), and has plentiful cryptic rocky habitat (SC ≥ 2), presumably for shelter. The habitat is very similar to that of juvenile blue-throated wrasse (*Notolabrus tetricus).* Suitable habitat was sometimes quite restricted spatially such as in the Browns Beach lagoon, where juveniles were abundant in the northern part with a substratum of creviced calcarenite, but absent in the southern part with a smooth granitic substratum of low relief. The habitat of sub-adults (20-60 cm) was in somewhat more exposed conditions (EI = 2-3), and somewhat deeper (2-5 m depth). At most sites the habitats of juveniles and sub-adults overlapped, so that abundance estimates of each size group were obtained during the same transects. Only in West Bay (Site 7a,b) and at Chinamans Hat I. (Site 9a,b) were juvenile and sub-adult habitats spatially distinct.
We examined by linear regression the relation between juvenile (J) and sub-adult (SA) densities within sites, and wrote the regression:

$$SA = 0.66 + 0.53\ J \qquad (N = 13;\ R^2 = 0.67;\ P < 0.001)$$

In this analysis we used only data from sites from which there were records of juveniles or sub-adults, and for Sites 7 and 9 we used juvenile abundance data from inshore nursery habitat, and sub-adult abundance from the adjacent deeper habitat. The data are plotted in Figure 2.

Adults were in very low abundance and limited to the southwest coast between Groper Bay and Chinamans Hat I. Anecdotal information suggests that they may also occur in deeper water (> 10 m) off headlands to the north (eg Daly Heads and off islands such as the Althorpe Is., which were not investigated.

Juveniles were mostly in the size range 15-20 cm, sub-adults 20-30 cm and the only adults seen were small and < 70 cm. A length-frequency distribution for all data combined (N = 272) is given in Figure 3.

Next we examined the hypothesis that recreational fishing, either by line-fishing or spearing, was a contributing cause to the sharp decline in abundance of sub-adults > 30 cm size (see Fig. 3). As an index of fishing intensity we used the mean size of blue-throated wrasse > 20 cm size with which we compared the mean size of WBG > 30 cm for each site (see below). In this analysis we excluded sites without sub-adults.

The mean size data for wrasses and WBG are given in Table 3 for 9 sites. The mean size of WBG was weakly correlated with the mean size of wrasse ($r = 0.64$; $P \approx 0.06$).

DISCUSSION

The survey covered the whole coast in which WBG have been recorded on southern Yorke Peninsula, except Troubridge Point, which was not surveyed. WBG have been seen occasionally in Coobowie Bay, but were not seen in this survey. The results enable us to now characterise the habitat of juvenile WBG as moderately sheltered sites in creviced rocky habitat at depths of 1-3 m, thus confirming the suggestions from our earlier Kangaroo I. survey (Shepherd et al. 2002) where we recorded juveniles in abundance only in sheltered shallow habitat at the north-eastern end of the island. As on Kangaroo I., sub-adult habitat appears to be in adjacent rocky reefs at depths of 2-8 m, and that of adults from about 5 m and deeper.

A hitherto perplexing problem has been the origin of sub-adults on coastal reefs. Do they recruit in a few optimal locations and then migrate widely along the coast, or do they recruit locally at many sites? In this study the strong correlation between densities of juveniles and sub-adults at many sites implies that local settlement of juveniles in sheltered sites provides recruits to adjacent coastal waters, with no evidence as yet of more distant migration of juveniles to sub-adult habitat.

What is the reason for the steep decline in abundance of sub-adults over a size of ~30 cm? There are two non-mutually exclusive explanations. First, sub-adults after reaching ~30 cm size tend to move into deeper water (Shepherd and Brook 2003) i.e. into deeper habitats than were sampled at many sites in this study. Secondly, recreational fishing may inflict some mortality on sub-adults, so reducing their average size. With respect to the first hypothesis, while some of our sites were in shallow habitats from which sub-adults with increasing size would be likely to migrate into adjacent deeper water, as at Browns Beach, other sites surveyed extended into deeper water of 10-12 m, but even at these sites we observed very few larger sub-adults and virtually no adults.

The second hypothesis is equally plausible. Commercial fishers operate from Pondalowie Bay, where 10-20 fishing boats are permanently moored. Recreational fishing is promoted as an important tourist activity for lower Yorke Peninsula and is important for the local economies (Edyvane 1999). At least eight charter boats operate off south western Yorke Peninsula, and other charter boats, such as Falie, no doubt, visit sites there. Charter boat fishing has increased dramatically during the 1990s and now comprises 1-2% of recreational fishing in South Australia (K. Jones pers. comm.). In the mid-1990s total annual fishing effort from recreational boats in lower Yorke Peninsula alone exceeded 60,000 boat-hours, about six times the effort of commercial fishers (McGlennon and Kinloch 1997). In the year 2000-1 ~145 000 campers visited Innes National Park alone, of whom ~40 000 ± 6 000 came to fish (R. Morcom pers. comm.). Rock fishers operate from all accessible rocky shores, and probably comprise the major fishing effort close to shore. Spearfishers are less common.

Between all the above groups fishing pressure is clearly intense. Blue-throated wrasse are the most abundant of resident reef species on lower Yorke Peninsula and readily take the bait. They are regarded as a nuisance species by fishers who often do not return them to the water but retain them for bait. Hence they are useful as an index of fishing intensity. Our own unpublished observations indicate that the mean size of adults (> 20 cm) of this wrasse is reduced where fishing intensity is high due to the capture of large individuals, whereas large females and males are abundant where there is little or no fishing. Similarly, Gomelyuk and Marantelli (2003) in studies of fishes inside and outside reserves in Victoria found that the blue throated wrasse decreased in mean size with increasing intensity of fishing and suggested the use of mean size of this species (or the sex ratio) as an index of fishing intensity.

Our observations on Yorke Peninsula qualitatively supported our inferences about fishing intensity indicated by mean size of blue-throated wrasse. Sites 7, 9 and 12 were easily accessible by shore fishers and potentially subject to intense fishing, whereas other sites surveyed (eg Sites 2, 3, 9d, 10 and 11) were far enough off-shore to be beyond casting reach of shore fishers, (although accessible by boat and spear fishers). The correlation between mean size of wrasse and groper suggests that the average size (and hence survival) of sub-adult WBG is reduced by fishing. However, we emphasize the need for caution in this conclusion due to the few sites available for comparison and the low numbers of WBG. It is

likely, of course, that both factors, habitat suitability and fishing, combine to reduce the numbers of larger in-shore sub-adults, and ultimately adults further offshore.

Is there evidence for the historic decline of adult WBG on Yorke Peninsula? Anecdotal evidence from the 1960s is that large WBG to 1.2 m long were commonly sighted off Chinamans Hat I., in Groper Bay and Green Bay (the bay south of Groper Bay and bounded on the south by West Cape) (C.C. Von Der Borch pers. comm. and SAS unpublished observations). In 1983 J. Johnson of Department of Fisheries surveyed the region and recorded adult WBG off Cape Spencer, Reef Head and Groper Bay (J. Johnson pers. comm.). Adults were seen off Troubridge Point in the early 1980s (D. Muirhead pers. comm.). A spearfisher, familiar with the region, saw large groper off some headlands until about the mid-1990s. However, adults were never seen off Yorke Point near Foul Hill (C.C. Von Der Borch pers.comm.). Thus large WBG, apparently once common off many headlands of south west Yorke Peninsula, have largely disappeared in the last two decades.

Overall, our study highlights the inadequacy of the current protective measures on WBG on lower Yorke Peninsula. There was much anecdotal information from fishers that WBG down to a size of 10 cm readily take specific baits and that they are taken from time to time by boat fishers, shore fishers and spearfishers. Indeed it is likely that, given the pale greenish-grey colour of juvenile and sub-adult WBG, quite different from the blue colour of adults, many shore-fishers and spearfishers might not recognize them as groper. Some might even think that WBG are a legitimate take in view of the charter promotion publicity in Stenhouse Bay shops (eg Rhino's) displaying fishers holding large captured WBG. We suggest that adequate protection of WBG requires more publicity by well displayed notices, as may be seen on Kangaroo I., and by appropriately located reserves to protect the habitats of sub-adults and adults. If shallow, inshore reefs have a function as nurseries, as our data suggest, then protection of such habitats may be especially important.

ACKNOWLEDGEMENTS
This survey was funded by grants from Coastcare to Reefwatch under the auspices of the Conservation Council of South Australia. We thank Sue Murray-Jones for comments on this report and her and Patricia Carvalho for their support for the project, and Reef Watch volunteers, Janine Baker, Adrian and Kathy Brown, Julia Murrie and Kevin Smith for assistance with the surveys. Janine Baker provided information on recreational fishing, and Chris Von Der Borch and John Johnson information on the historic abundance of WBG. We also thank Robyn Morcom and other rangers of Innes National Park for support for the study, the provision of camping facilities in the park, and information on numbers of visitors.

REFERENCES
Collings, G. and A.C. Cheshire (1998) Composition of subtidal macroalgal communities of the lower gulf waters of South Australia, with reference to water movement and geographical separation. Aust. J. Botany 46: 657-669.

Edgar, G.J. (1981) An initial survey of potential marine reserves in Tasmania. National Parks and Wildlife Service, Tasmania. Occasional Papers No. 4.

Edyvane, K.S. (1999) Conserving marine biodiversity in South Australia. Part 2. Identification of areas of high conservation value in South Australia. South Australian Research and Development Institute. Report No. 38. 281 p. 20 maps.

Gomelyuk, V. and A Marantelli (2003) Subtidal fish communities on temperate reefs: a comparison of fished sites and reserve. Unpublished Ms.

McGlennon, D. and M.A. Kinloch (1997) Resource allocation in the South Australian scalefish fishery. South Australian Research and Development Institute FRDC Report 93/249. 105 p.

Savarton, F., T. Flaherty, M. Robinson and P. Seager (1987) Innes National Park, South Australia Marine Survey 1984-1987. Nature Conservation Society of S.A. Report. 104 p. Appendices I-IV.

Shepherd, S.A. and J.B. Brook (2003) Reef fishes of St Francis Isles. Trans. R. Soc. S. Aust. (in press)

Shepherd, S.A., J. Brook and A. Brown (2002) A preliminary survey of the western blue groper on Kangaroo Island. Reefwatch, Conservation Council of South Australia. 10 p.

Table 1. Habitat features of study sites on southern Yorke Peninsula, ordered from Corny Point south and east to Troubridge Point. Exposure index (EI) in relation to swell is: 4 - strong; 3 - moderate; 2 - sheltered; 1 - very sheltered. Substratum complexity (SC) is: 0 – flat rock with crevices, fissures rare or absent; 1 – rock to 1 m relief with crevices, fissures occasional; 2 – reef of moderate to high relief (1-2 m) with many crevices, fissures; 3 – reef of high relief (>2 m) with many caves, crevices and fissures. Algal dominants (canopy species) with average % cover values where obtained are given.

Site No.	Site	EI	Substratum	Location of transects	Algal dominants
1	**Corny Point**	2	Gneissic sheets or blocks. Relief 1 m SC=1.	Northern sheltered side of Point Depth 1-2 m	*Cystophora subfarcinata, C. monilifera.*
2	**Gleesons Landing**	1-3	Granitic sheets. Relief 2 m. SC=2	Rocky shore at southern end of Bay Depth 2-6 m	*Scaberia, Cystophora* spp., *Ecklonia*
3	**Baby Lizard, Formby Bay**	3	Calcarenite Relief 2 m SC=2	Reef at southern end of Bay Depth 1-3 m	E*cklonia* occ. Mainly *Cystophora* spp.
4a	**Browns Beach lagoon (north)**	2	Calcarenite Relief 1 m SC=1-2	Reefs in northern part of backreef lagoon, sheltered by fringing reef Depth 2 m	Mainly *C.moniliformis , C. siliquosa; Amphibolis* on sand
4b	**Browns Beach lagoon (south)**	2	Smooth granite: relief 0.5 m SC=0	Reefs in southern lagoon Depth 2 m	*Ecklonia 10%, C.siliquosa, C .moniliformis, Amphibolis antarctica* on sand
5a	**Shell Beach East**	2-2.5	Smooth granite blocks. Relief 2 m SC=1	Point at eastern end of Bay Depth 3-10 m	Mixed *Ecklonia-Cystophora-Sargassum* community (*S. fallax, S. linearifolium, Acrocarpia, Carpoglossum)* At 8-10 m *Ecklonia* 30%, *Scytothalia* 70%
5b	**Shell Beach West**	2-2.5	Granite blocks: relief 1-2 m SC=1	Point at western end of Bay. Depth 1-6 m	As above, with *C. retorta* And *C. racemosa*
6	**Pondalowie Bay**	0	Calcarenite Relief 05 m SC=1	Western side of Bay. Depth 1 m	Mainly *C. moniliformis*
7a	**Headland north of Groper Bay**	3	Calcarenite Relief 2-3 m SC=3	Around headland from Groper Bay into adjacent northern bay. Depth 2-10 m	*Ecklonia (90%), Cystophora siliquosa, C. moniliformis, C. racemosa, C. retorta Caulerpa* spp.
7b	**Backreef in Groper Bay**	2	Calcarenite Relief 1-2 m SC=3	Backreef channel and shallow depths seaward Depth 0.5 - 2 m	*Ecklonia* 80%, *C. moniliformis, Caulerpa* spp 20%
8a	**Howling Cave Bay west (near the Gap)**	2-3	Granite blocks. Relief 2 m SC=1	Western side of Bay from shore toward point.. Depth 1-5 m	Mainly *Cystophora* spp. Toward point *Ecklonia* 10%.

8b	**Howling Cave Bay east (near the Gap)**	2-3	Calcareous rock. Vertical wall, with caves. Relief 3 m SC=3	Eastern side of Bay under steep mainland cliffs north of Gap. Depth 3-5 m	*Ecklonia* 10%, erect coralline algal turf. *Cystophora* spp. at foot of wall
9a	**Chinamans Hat Island West**	2-3	Deeply dissected reef of calcarenite Relief 3 m SC=3	Westward from the island toward rocky outcrops near western point. Depth 3-7 m	*Ecklonia* 60%, *Acrocarpia* 20% *C. moniliformis, C. monilifera* etc
9b	**Chinamans Hat Island lagoon**	1-2	Calcarenite reef Relief 1 m SC=2	Backreef channel protected by Island and fringing reef Depth 1-2 m	*C. moniliformis, C. siliquosa Amphibolis* patches
9c	**Chinamans Hat Island**	3	Calcarenite reef . Relief 3 m. SC=3	Outside Island Depth 6-9 m	*Ecklonia* 75%, *Cystophora* spp
9d	**East of Chinamans Hat Island**	2	Calcarenite reef Relief 3 m SC=3	East of Island near wreck of Marion. Depth 2-7 m	*C. retorta, Cystophora* spp., *Sargassum* spp., *Ecklonia* sparse.
10a	**Stenhouse Bay**	2	Calcarenite reef. Relief 2 m SC=3	Reef offshore from carpark 2 km west of Rhino Head Depth 5-10 m	*Ecklonia, C. siliquosa, C. subfarcinata, C. monilifera, C. retorta*
10b	**Stenhouse Bay** (inshore)	0	Calcarenite reef Relief 1 m SC=2	Sheltered reef inshore of above site Depth 1-2 m	*Caulocystis* sp. *C. monilifera, Scaberia; Amphibolis* and *Posidonia* patches
11	**Foul Hill**	3	Calcarenite reef Relief 2 m SC=2	Exposed reefs 2 km SW of Point Yorke Depth 2-3 m	*Acrocarpia, C. moniliformis, C. subfarcinata, C. monilifera*
12a	**Foul Bay south (near point)**	2	Metamorphosed rock Relief 1 m SC=1	Semi-exposed reefs 2 km north of Point Yorke Depth 2-3 m	Mixed community. *Ecklonia,C. moniliformis, C. subfarcinata, C. siliquosa, C. monilifera*
12b	**Foul Bay south (inshore)**	0	Calcarenite substratum Relief 0.5 m SC=1	Sheltered backreef channel inside seagrass beds Depth 1 m	Mainly barren with occasional *Scaberia*
13	**Coobowie Bay**	0	Calcarenite substratum Relief 0.5 m SC=0-1	Sheltered part of Bay near swimming pool Depth 1-2 m	*Ulva, Scaberia.* Dictyotales And *Heterozostera* patches

Table 2. Density (numbers.500 m^{-2}) of juvenile (<20 cm), subadult (20-60 cm), and adult groper (> 60 cm) at 13 sites on southern Yorke Peninsula. N = number of replicate 500 m^2 samples. Standard errors are in brackets.

Site	N	Juveniles (s.e.)	Sub-adults (s.e.)	Adults (s.e.)	Total
1. Corny Point	2	0	0	0	0
2. Gleesons Landing	9	0.22 (0.14)	0.33 (0.16)	0	0.55 (0.22)
3. Baby Lizard, Formby Bay	8	0	0.38 (0.17)	0	0.38 (0.17)
4a. Browns Bch Lagoon north	7	7.00 (1.14)	3.71 (0.56)	0	10.71 (1.60)
4b. Browns Bch Lagoon south	2	0	0	0	0
5a. Shell Bch E.	8	0	0.13 (0.12)	0	0.13 (0.12)
5b. Shell Bch W	9	0.11 ((0.10)	0	0	0.11 (0.10)
6. Pondalowie	2	0	0	0	0
7a. Headland (nth of Site 7b)	18	0.44 (0.20)	2.11 (0.55)	0.11 (0.07)	2.66 (0.61)
7b. Groper Bay	4	3.5 (0.9)	0.75 (0.41)	0	4.25 (0.82)
8a. Howling Cave Bay west	4	2.0 (0.35)	1.75 (0.54)	0.25 (0.22)	2.00 (0.71)
8b. Howling Cave Bay east	8	0	0	0.13 (0.12)	0.13 (0.12)
9a. Chinamans Hat I. west	5	1.40 (0.46)	2.80 (1.72)	0	4.20 (1.04)
9b. Chinamans Hat lagoon	2	4.50 (0.35)	0	0	4.50 (0.35)
9c. Chinamans Hat I.	5	0	0	0	0
9d. East of Chinamans Hat	8	1.50 (0.35)	2.87 (0.65)	0.25 (0.15)	4.63 (0.93)
10a. Stenhouse Bay	4	0.5 (0.25)	1.00 (0.35)	0	1.50 (0.25)
10b. Stenhouse Bay inshore	4	0	0	0	0
11. Foul Hill Bay	5	1.40 (0.35)	1.20 (0.72)	0	1.60 (1.04)
12a. Foul Bay Sth (at point)	7	2.14 (0.59)	1.86 (0.55)	0	4.00 (1.07)
12b. Foul Bay inshore	3	0.67 (0.27)	0.67 (0.27)	0	1.33 (0.27)
13. Coobowie Bay	8	0	0	0	0

Table 3. Data on mean sizes of WBG (> 30 cm) and of blue-throated wrasse (> 20 cm) (BTW) at various sites.

Site	WBG	BTW
2	37.5	26.2
3	47	27.8
7	32.5	24.4
8	42.5	25.7
9a,b	32.5	24.5
9d	40.5	26.9
10	40.5	30.5
11	37.5	27.7
12	32.5	25.4

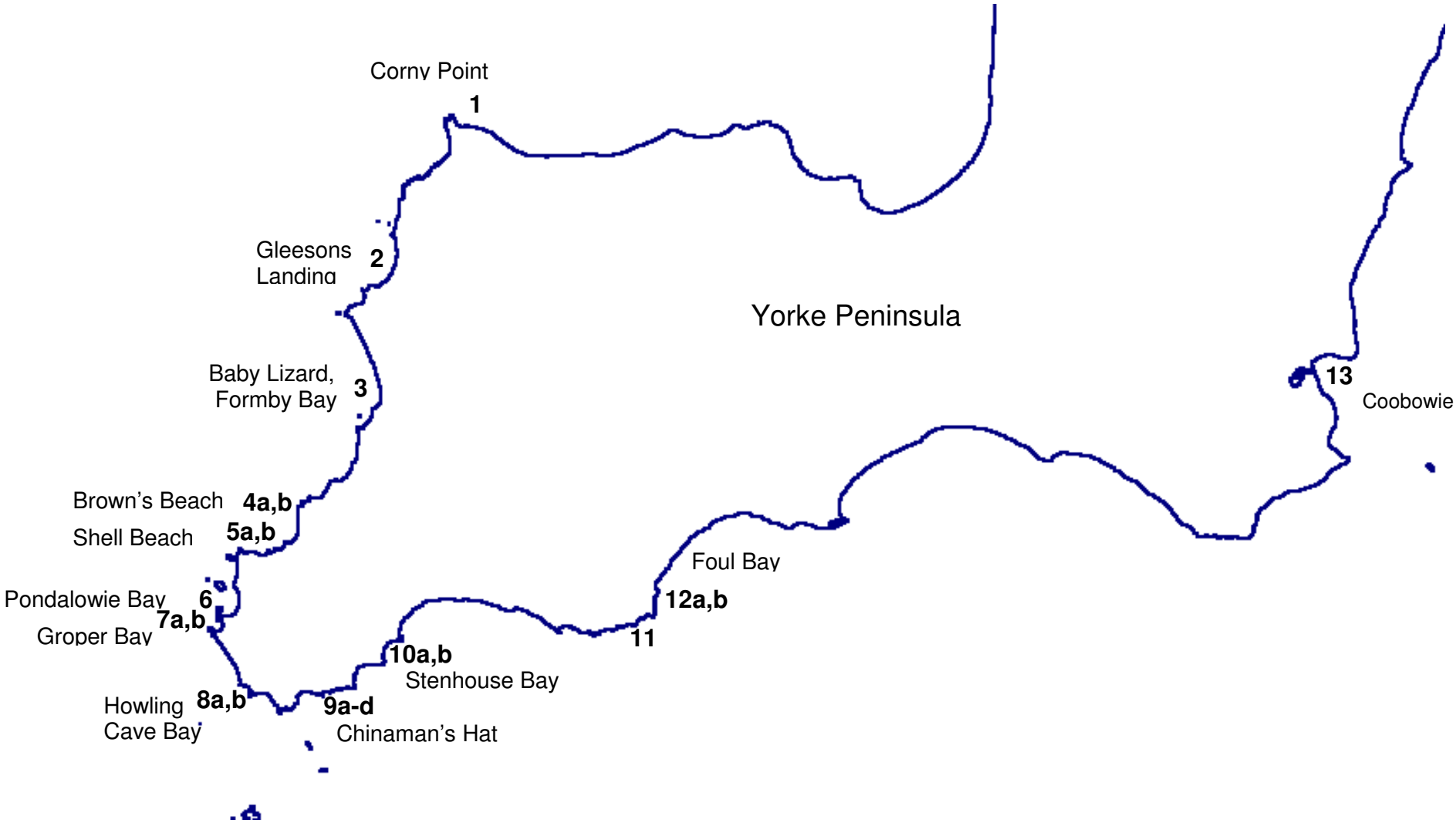

Figure 1. Map of southern Yorke Peninsula showing the numbered sites referred to in the text. See text for names of sites.

Figure 2. Plot of sub-adult vs juvenile abundance of WBG for various sites. Data are in numbers per 500 m^2.

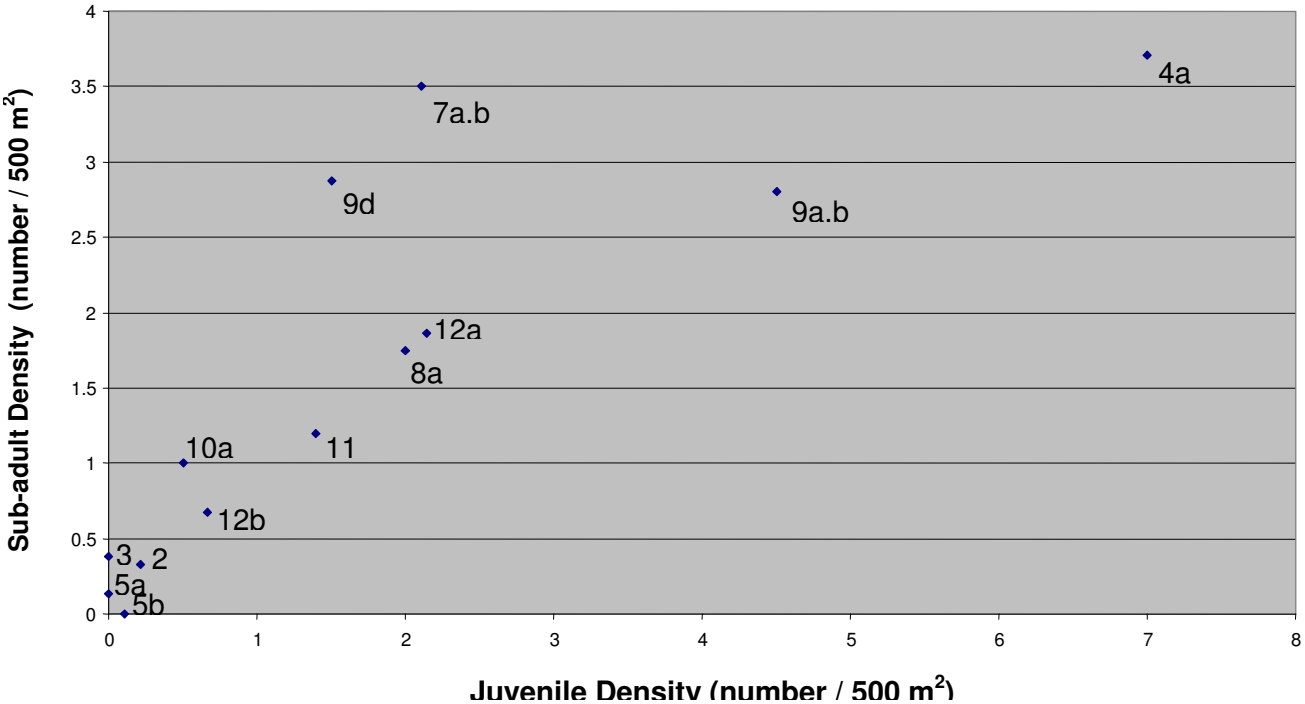

Figure 3. Length-frequency distribution of western blue groper for all sites combined