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Fish assemblages in three tidal saltmarsh and mangrove flats in temperate NSW, Australia: a comparison based on species diversity and abundance

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Abstract

Fish assemblages in three geographically distinct saltmarsh meadows and mangrove forests in the Sydney region were examined using fyke nets over three common sampling periods. The saltmarshes at Towra Point and Allens Creek, though of contrasting geomorphic setting, showed similar fish assemblages during spring tides, with relatively high diversity and abundance. The saltmarsh at Bicentennial Park, reclaimed from dredge spoil in the early 1960's, showed significantly lower diversity and abundance. Fish assemblages in the three mangrove settings were each distinct, though with no significant differences in diversity and abundance between sites. The result raises questions about the efficacy of created saltmarsh as a compensatory habitat for fish.

Introduction

The primary cause of saltmarsh decline in NSW is replacement by mangrove (Saintilan and Williams 1999, 2000). The reasons for mangrove encroachment are not yet clear, but appear to relate to natural as well as anthropogenic factors. Recent research indicates saltmarsh may be an important contributor to estuarine food chains via the release of crab zoae on ebbing tides (Mazumder 2003). The relative importance of saltmarsh as a fish habitat is therefore of keen management interest. Saltmarsh is not protected under the NSW Fisheries Management Act (1994), which protects mangrove to the mean high water mark.

Mazumder et al. (2005), using buoyant pop nets, found a diverse range of fish species at one saltmarsh site in the Sydney region, with densities equivalent to those found in adjacent mangrove. The diversity and abundance of this temperate saltmarsh would seem more akin to the subtropical saltmarsh sampled by Thomas and Connolly (2001) than the temperate saltmarsh examined by Connolly et al. (1997). Diversity and abundance in the latter study was found to be low.

Before concluding that temperate NSW saltmarshes support a diverse fish fauna at high tide, it is necessary to consider variability between saltmarshes across estuaries and geomorphic settings. The site surveyed by Mazumder et al. (2005) was situated close to the estuarine mouth and within a nature reserve, factors which might promote diversity. The present study examined fish assemblages in three geographically distinct saltmarshes and mangroves in the Sydney region to take into account variability in saltmarsh and mangrove types and settings. The null hypothesis was that there were no differences in visiting fish assemblages between locations or habitats.

Methods

Study site

The study compared fish assemblages in the saltmarsh and mangrove environments in three distinct settings, all supporting similar mangrove and saltmarsh vegetation. Towra Point, within Botany Bay (Figure 1), represents a relatively undisturbed sandy marine delta. The site is within a nature reserve and aquatic reserve administered by the state government with restricted access provisions. Maximum tidal range is of the order of 2 m. The mangrove forest is dominated by *Avicennia marina* and the saltmarsh by a *Sarcocornia quinqueflora*/*Sporobolus virginicus* association, with *Triglochin striata* growing in less well-drained positions. *Juncus krausii* and *Suaeda australis* are also present in higher elevation environments (Clarke and Hannon 1967; Adam et al. 1988).

Allens Creek on the Hawkesbury River at Spencer is an example of a tributary delta within the fluvial deltaic segment of the Hawkesbury River estuary. Intertidal soils consist predominantly of silts and clays, and salinities are periodically diluted by freshwater flows (Saintilan 1996). The saltmarsh assemblage is similar to that of Towra Point, though *Suaeda australis* is absent. *Avicennia marina* and *Aegiceras corniculatum* are abundant.

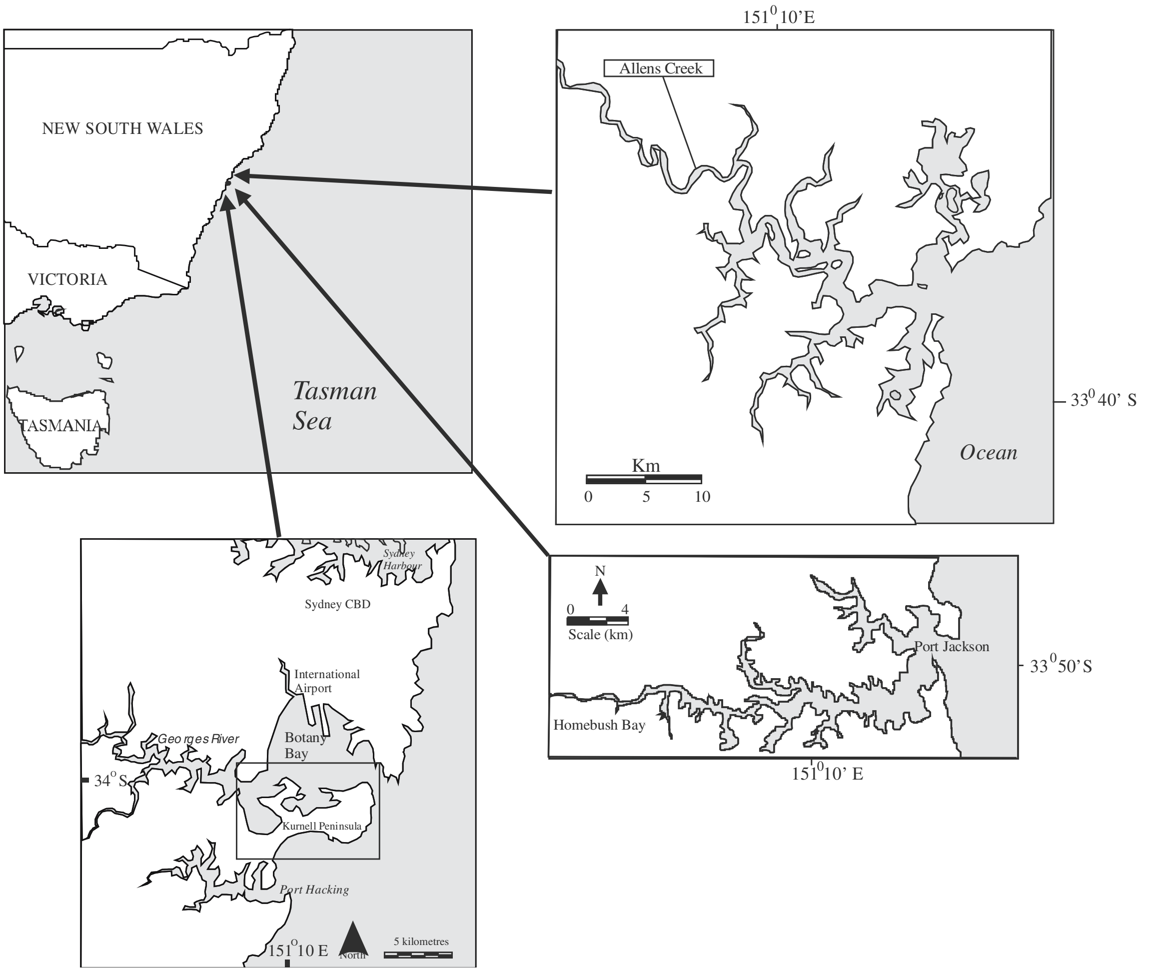

Figure 1. Map of Australia showing the location of study sites, Towra Point, Bicentennial Park and Allens Creek, NSW.

The site at Bicentennial Park site is also a tributary fluvial delta, occurring in the central reaches of the Parramatta River. The site has a more disturbed history than Towra Point or Allens Creek, with the current mangrove and saltmarsh environments occupying positions of reclaimed dredge spoil. Mangrove forest in Bicentennial Park is extensive and dominated by *Avicennia marina*, while the saltmarsh is patchy, and is dominated by *Sarcocornia quinqueflora*, *Sporobolus virginicus* and the introduced *Juncus acutus* (Clarke and Bensen 1988).

Fish collection

Fyke nets have previously been used (Morton et al. 1987; Williams et al. 1996) in the saltmarsh and mangrove wetlands to collect fish. We employed a 4 m long funnel-shaped fyke net with one central and two lateral wings and a 40 cm wide and 25 cm high entrance. Mesh size throughout was 2 mm. The net was secured in place by six large wooden stakes tied to the extremities; a metal plate kept the entrance on the bottom. Where needed, small metal pegs were also placed to keep the entrance funnel and wings tight against the substrata. The wings had floats and leads along their tops and bases respectively to keep them upright. Fyke nets were placed in the saltmarsh and mangrove flats before tides flooded these habitats.

Fish were collected from four replicate fyke nets in the saltmarsh and two replicate fyke nets from mangrove after the tide had fully receded. Fish samples were collected at each site from December 2001, January and August 2002 during the spring high tide (>1.8 m).

Statistical methods

Differences in assemblages of fish between saltmarsh and mangrove were examined from the Bray-Curtis measures of dissimilarity (Bray and Curtis 1957) using square root transformed data. Nonmetric multidimensional scaling (nMDS) plots were also used to demonstrate the patterns of fish assemblages in different sites between and within habitats (Clarke and Warwick 2001). Multivariate techniques such as ANOSIM (Clarke and Warwick 2001) were used to test the statistical significance of differences between the fish assemblages within habitats and between the sites. The contribution made by particular species to differences in species assemblages was determined using SIMPER (similarity percentages-species contribution, (Clarke and Warwick 2001) for habitats and sites.

Univariate analysis (ANOVA) and Post-hoc SNK tests were also performed to determine differences of fish abundance between sites in saltmarsh and mangrove with site considered as random factor with three levels. Species richness $d = (S-1)/\log(N)$; (Margalfe 1969) was determined using DIVERS (Clarke and Warwick 2001) between habitats and sites.

Results

Seventeen species of fish and decapod crustaceans were caught at Towra Point (TP: Table 1). Sixteen species were caught from saltmarsh, of which *Pseudomugil signifer* was most abundant contributing 29.5% of the total catch, followed by *Macrobrachium intermedium* (18%), *Gerres subfasciatus* (9%) and *Ambassis jacksoniensis* (8.9%). Among 16 species found in the saltmarsh seven were of commercial importance (Table 4), contributing 23% of the number of individuals. Of these, *G. subfasciatus* was the most abundant, followed by *Acanthopagrus australis* (4.9%). Within the mangrove, 13 species were caught, 5 being of commercial importance. *A. jacksoniensis* was the most abundant species in mangrove contributing 46.4%, followed by *M. intermedium* (15.5%) and *G. subfasciatus* (14.4%). One species, bridled goby (*Arenigobius bifrenatus*) was found only in mangrove (Table 1).

At Allens Creek 14 species of fish were collected (Table 1). Twelve species were caught in the saltmarsh, nine of which were also caught in the Towra Point saltmarsh. However, relative abundances of species differed to Towra, accounting for differences in assemblage composition. The most abundant species in saltmarsh at Allens Creek was *Gobiopterus semivestitus* (67.3%) followed by *M. intermedium* (10.1%) and *P. signafer* (7.9%). Of the commercially important species found in saltmarsh the most abundant was *Liza argentea* (2.8%) followed by *Platycephalus fuscus* (2.2%)

Table 1. Species caught from saltmarsh and mangrove with fyke nets at Towra Point, Bicentennial Park and Allens Creek, 2001–2002.

Family	Genus/species	Common name	Contribution to catch											
			Towra Point				Allens Creek				Bicentennial Park			
			Saltmarsh		Mangrove		Saltmarsh		Mangrove		Saltmarsh		Mangrove	
			Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
Fish														
Platycephalidae	*Platycephalus fuscus*	Dusky flathead*	35	2.90	0	0.00	15	2.23	1	1.27	0	0.00	10	2.30
Chandidae	*Ambassis jacksoniensis*	Glassfish	108	8.94	398	46.44	14	2.08	4	5.06	0	0.00	10	2.30
Sillaginidae	*Sillago clliata*	Sand whiting*	6	0.50	13	1.52	0	0.0	0	0.00	0	0.00	0	0.0
Gerreidae	*Gerres subfasciatus*	Silver biddy*	109	9.02	124	14.47	0	0.00	0	0.00	0	0.00	10	2.30
Sparidae	*Acanthopagrus australis*	Yellow fin bream*	60	4.97	25	2.92	7	1.04	0	0.00	0	0.00	5	1.15
Sparidae	*Rhabdosargus sarba*	Tarwhine*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	1.15
Mugilidae	*Liza argenta*	Flat tail mullet*	12	0.99	2	0.23	19	2.82	2	2.53	0	0.00	11	2.53
Mugilidae	*Myxus elongatus*	Sand mullet*	37	3.06	28	3.27	4	0.59	0	0.00	0	0.00	0	0.00
Mugilidae	*Mugil cephalus*	Sea mullet*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Teraponidae	*Pelates quadrilineatus*	Trumpeter*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Atherinidae	*Pseudomugil signafer*	Blue eye	357	29.55	32	3.73	53	7.88	2	2.53	46	46.00	32	7.37
Poeciliidae	*Gambusia holbrooki*	Mosquito fish	14	1.16	0	0.00	0	0.00	0	0.00	0	0.00	56	12.90
Gobiidae	*Gobiopterus semivestitus*	Glass goby	49	4.06	57	6.65	453	67.31	17	21.52	9	9.00	13	3.00
Gobiidae	*Mugilogobius paludis*	Mangrove goby	12	0.99	7	0.82	2	0.30	8	10.13	20	20.00	30	6.91
Gobiidae	*Mugilogobius stigmaticus*	Checkered mangrove goby	78	6.46	9	1.05	22	3.27	7	8.86	0	0.00	14	3.23
Gobiidae	*Pseudogobius olorum*	Blue spot goby	78	6.46	24	2.80	6	0.89	0	0.00	17	17.00	191	44.01
Gobiidae	*Redigobius macrostoma*	Largemouth goby	0	0.00	0	0.00	0	0.00	3	3.80	0	0.00	0	0.00
Gobiidae	*Arenigobius bifrenatus*	Bridled goby	0	0.00	1	0.58	0	0.00	0	0.00	0	0.00	4	0.92
Gobiidae	*Taenioides mordax*	Snake head goby	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	Mogurnda australis	Striped gudgeon	0	0.00	0	0.00	0	0.00	11	13.92		0.00	0	0.00
	Butis amboinensis	Flathead gudgeon	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	6	1.38
Tetraodontidae	*Tetractenos hamiltoni*	Common toad	17	1.41	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
		Unidentified fish	0	0.00	0	0.00	0	0.00	0	0.00	0	5.00	17	3.92
Crustacean														
Atyidae	*Macrobrachium intermedium*	Grass shrimp	218	18.05	133	15.52	68	10.10	24	30.38	3	3.00	20	4.61
Alpheidae	*Alpheus edwardsi*	Common pistol shrimp	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Penaeidae	*Metapenaeus macleayi*	School prawn*	18	1.49	0	0.00	10	1.49	0	0.00	0	0.00	0	0.00
Total no.of species			16		13		12		10		6		16	

The asterisk (*) designates species of commercial and or recreational significance.

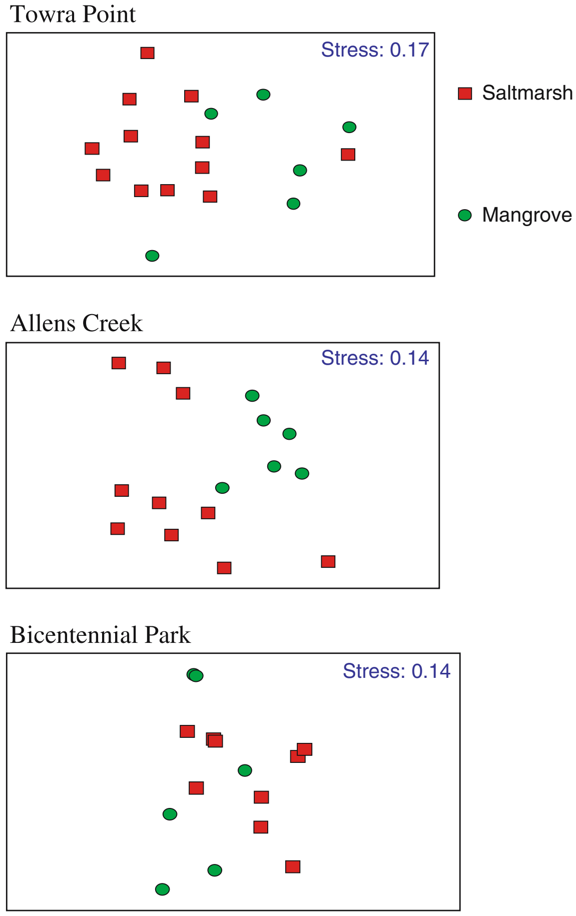

Figure 2. nMDS ordinations showing differences in assemblages of fish in saltmarsh and mangrove in at Towra Point, Allens Creek and Bicentennial Park.

and *Metapenaeus macleayi* (1.5%). Within the mangrove, 10 different species of fish were caught, two being of commercially importance (Table 1).

At Bicentennial Park (BP) 16 species were caught (Table 1). Six species were collected from the saltmarsh none of which were of economic significance. *Pseudomugil signafer* was again the most abundant contributing 46.0% of the total catch by number, followed by *Mugilogobius paludis* (20.0%) and *Pseudogobius olorum* (17.0%). Within the mangrove, 16 different species of fish were caught, with 5 being of commercial importance (Table 1). Nine species encountered at both Allens Creek and Towra Point were not found at Bicentennial Park.

Table 2. Contribution of fish species to differentiation between saltmarsh and mangrove at Towra Point (TP), Allens Creek (AC) and Bicentennial Park (BP) during December 2001, January and August 2002.

TP Saltmarsh vs. TP Mangrove				AC Saltmarsh vs. AC Mangrove				BP Saltmarsh vs. BP Mangrove			
Species	Av. Abund TP saltmarsh.	Av. Abund TP mangrove	% contribut. to dissim.	Species	Av. Abund AC saltmarsh	Av. Abund AC mang	% contrib. to dissim.	Species	Av. Abund BP salt	Av. Abund BP mang	% contrib. to dissim.
A. jacksoniensis	9.00	66.33	13.26	*G. semivestitus*	50.33	2.83	24.45	*P. olorum*	1.70	31.83	21.10
M. intermedium	18.17	22.17	12.08	*P. signafer*	5.89	0.33	12.80	*P. signafer*	4.60	5.33	9.26
P. signafer	29.75	5.33	12.01	*M. intermedium*	7.56	4.00	11.44	*G. holbrooki*	0.00	9.33	8.64
G. subfasciatus	9.08	20.67	10.70	*M. stigmaticus*	2.44	1.17	7.59	*M. paludis*	2.00	5.00	8.21
G. semivestitus	4.08	9.50	6.82	*M. australis*	0.00	1.83	7.28	*M. intermedium*	0.30	3.33	8.12
P. olorum	6.50	4.00	6.08	*P. fuscus*	1.67	0.17	6.79	*L. argenta*	0.00	1.83	7.47
M. elongates	3.08	4.67	5.69	*A. jacksoniensis*	1.56	0.67	6.52	*G. semivestitus*	0.90	2.17	5.86
A. australis	5.00	4.17	5.52	*L. argenta*	2.11	0.33	6.29	*A. jacksoniensis*	0.00	1.67	4.82
M. stigmaticus	6.50	1.50	5.19	*M. paludis*	0.22	1.33	6.21	*B. amboinensis*	0.00	1.00	4.33
P. fuscus	2.92	0.00	4.58	*M. macleayi*	1.11	0.00	3.39	*A. australis*	0.00	0.83	4.13
T. hamiltoni	1.42	0.00	3.42					*M. stigmaticus*	0.00	2.33	3.07
M. paludis	1.00	1.17	3.35								
M. macleayi	1.50	0.00	3.15								

Table 3. Contribution of fish species to differentiation across saltmarsh sites at Towra Point (TP), Allens Creek (AC) and Bicentennial Park (BP) during December 2001, January and August 2002.

TP Saltmarsh vs. BP Saltmarsh				TP Saltmarsh vs. AC Saltmatsh				BP Saltmarsh vs. AC Saltmarsh			
Species	Av. Abund TP salt.	Av. Abund BPsalt	% contrib. to dissim.	Species	Av. Abund TP salt	Av. Abund ACsalt	% contrib. to dissim.	Species	Av. Abund Bpsalt	Av. Abund ACsalt	% contrib. to dissim.
P. signafer	29.75	4.60	13.84	*P. signafer*	29.75	5.89	11.81	*G. semivestitus*	0.90	50.33	24.62
M. intermedium	18.17	0.30	7.47	*M. intermedium*	18.17	7.56	10.22	*M. intermedium*	0.30	7.56	16.28
G. subfasciatus	9.08	0.00	10.05	*G. subfasciatus*	9.08	0.00	9.08	*P. signafer*	4.60	5.89	12.69
A. jacksoniensis	9.00	0.00	13.50	*A. jacksoniensis*	9.00	1.56	9.53	*L. argenta*	0.00	2.11	5.54
M. stigmaticus	6.50	0.00	4.74	*P. olorum*	6.50	0.67	5.32	*A. jacksoniensis*	0.00	1.56	5.53
A. australis	5.00	0.00	7.01	*A. australis*	5.00	0.78	6.18	*P. fuscus*	0.00	1.67	6.53
P. olorum	6.50	1.70	6.34	*G. semivestitus*	4.08	50.33	15.49	*M. stigmaticus*	0.00	2.44	6.09
G. semivestitus	4.08	0.90	6.29	*M. stigmaticus*	6.50	2.44	6.32	*M. paludis*	2.00	0.22	6.75
P. fuscus	2.92	0.00	5.89	*L. argenta*	1.00	2.11	4.32	*P. olorum*	1.70	0.67	6.03
M. paludis	1.00	2.00	5.21	*P. fuscus*	2.92	1.07	4.28				
T. hamiltoni	1.42	0.00	4.63	*M. macleayi*	1.50	1.11	4.11				
M. macleayi	1.50	0.00	4.29	*T. hamiltoni*	1.42	0.00	4.07				
Myxus elongatus	3.08	0.00	3.87								

Fish assemblages at sites

Non-metric multidimensional scaling (nMDS) ordinations representing fish assemblages in saltmarsh and mangrove at suggested different assemblages at all sites (Figure 2). Analysis of similarities (ANOSIM) showed that fish assemblages in saltmarsh differed significantly from mangrove at all sites (Towra Point: $p = 0.007$, Allens Creek: $p = 0.032$ and Bicentennial Park: $p = 0.011$).

Contributions of species to dissimilarity between mangrove and saltmarsh at each site is presented in Table 2. *P. signafer* ranks highly in the differentiation of mangrove and saltmarsh communities at all three sites, with higher abundances in the saltmarsh. Otherwise there is little consistent pattern in the contribution of species to these differences.

Comparison of fish assemblages between saltmarshes

A non-metric multidimensional scaling (nMDS) ordination (Figure 3) showed differences in the fish assemblage between the Towra Point, Allens Creek and Bicentennial Park saltmarsh (ANOSIM: $p < 0.001$). Towra Point and Allens Creek, though clearly distinct assemblages, are grouped more closely together than Bicentennial Park.

Table 3 presents the results of a similarity percentages-species contribution (SIMPER) analysis which calculates the contribution of species to the dissimilarity in assemblages between sites. Differences between Bicentennial Park and other sites is due to the lower abundance or absence of species at Bicentennial Park. Differences between Allens Creek and Towra Point is due primarily due to the abundance of *G. subfasciatus* and *T. hamiltoni* in Towra Point and their absence in Allens Creek.

Fish abundance and species richness across saltmarsh sites

ANOVA results showed that fish abundance in saltmarsh varied significantly ($p = 0.02$) across these sites. The *post-hoc* SNK test for fish abundance within the sites showed that mean fish abundance at Towra Point and Allens Creek were higher than at Bicentennial Park, but no signifi-

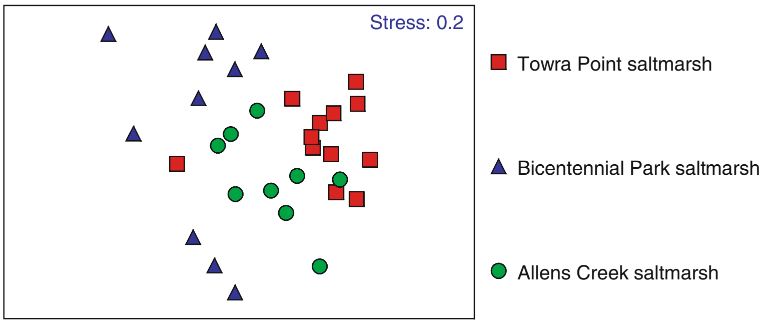

Figure 3. nMDS ordination showing assemblages of fish comparing Towra Point, Allens Creek and Bicentennial Park saltmarsh in December 2001, January and August 2002.

cant difference could be found between the abundances at Towra Point and Allens Creek.

Analysis of variance using Margalfe indices (d) for species richness for Towra Point saltmarsh was significantly higher ($d = 1.639$) than in the Bicentennial Park ($d = 0.527$) and Allens Creek ($d = 0.902$), though no significance difference was found between Allens Creek and Bicentennial Park.

The relative abundance of *A. jacksoniensis*, *M. intermedium*, *G. subfasciatus* and *G. semisvestitus* at Towra Point dominates differences between fish assemblages at this site and the other two sites (Table 4). Differences between Bicentennial Park and Allens Creek mangrove is due primarily to higher abundances of a number of species at Bicentennial Park (*P. olorum*, *G. holbrooki*, *M. paludis* and *P. signafer*).

Comparison of fish assemblages between mangroves

A non-metric multidimensional scaling (nMDS) ordination comparing sites showed a different assemblage of fish in the mangrove at Towra Point, Bicentennial Park and Allens Creek (Figure 4).

Mangrove fish assemblages varied significantly between sites. ANOSIM results showed significant difference between Towra Point and Bicentennial Park ($p = 0.004$), between Towra Point and Allens Creek ($p = 0.013$) and between Bicentennial Park and Allens Creek (ANOSIM: $p = 0.002$).

Fish abundance and species richness across mangrove sites

ANOVA results showed that fish abundance in mangroves within different mangrove sites varied significantly ($p = 0.05$). The *post-hoc* SNK test for fish abundance within the sites showed mean fish abundance at Towra Point to be significantly higher than the Allens Creek, but no significant difference could be found between the abundances at Towra Point and Bicentennial Park, and between Allens Creek and Bicentennial Park.

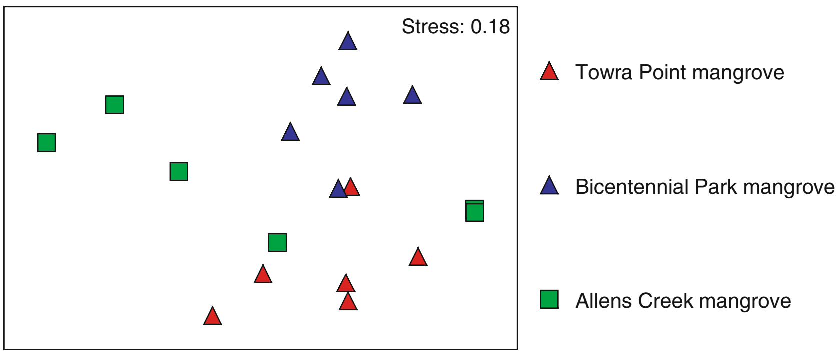

Figure 4. nMDS ordination showing assemblages of fish comparing Towra Point, Allens Creek and Bicentennial Park mangrove in December 2001, January and August 2002.

Table 4. Contribution of fish species to differentiation across mangrove sites at Towra Point (TP), Bicentennial Park (BP) and Allens Creek (AC) during December 2001, January and August 2002.

TP Mangrove vs. BP Mangrove				TP Mangrove vs. AC Mangrove				BP Mangrove vs. AC Mangrove			
Species	Av. Abund TP mang	Av. Abund BPmang	% contrib. to dissim.	Species	Av. Abund TPmang	Av. Abund ACmang	% contrib. to dissim.	Species	Av. Abund BPmang	Av. Abund ACmang	% contrib. to dissim.
A. jacksoniensis	66.33	1.67	14.29	*A. jacksoniensis*	66.33	0.67	18.76	*P. olorum*	31.83	0.00	22.64
M. intermedium	22.17	3.33	8.17	*G. subfasciatus*	20.67	0.00	11.96	*G. holbrooki*	9.33	0.00	7.98
G. subfasciatus	20.67	1.67	9.28	*M. intermedium*	22.17	4.00	10.97	*M. paludis*	5.00	1.33	7.63
G. semivestitus	9.50	2.17	6.64	*G. semivestitus*	9.50	2.83	8.46	*P. signafer*	5.33	0.33	6.60
G. holbrooki	0.00	9.33	6.28	*P. olorum*	4.00	0.00	8.38	*G. semivestitus*	2.17	2.83	6.54
B. amboinensis	0.00	1.00	2.79	*L. argenta*	4.67	0.00	8.12	*M. intermedium*	3.33	4.00	6.26
P. olorum	4.00	31.83	11.17	*A. australis*	4.17	0.00	5.53	*M. stigmaticus*	2.33	1.17	4.41
M. stigmaticus	1.50	2.33	3.74	*M. australis*	0.00	1.83	4.58	*M. australis*	0.00	1.83	4.71
P. signafer	5.33	5.33	6.16	*P. signafer*	5.33	0.33	4.95	*L. argenta*	1.83	0.33	6.03
M. elongatus	4.67	0.00	6.14	*M. stigmaticus*	1.50	1.17	4.70	*A. jacksoniensis*	1.67	0.67	4.73
M. paludis	1.17	5.00	5.20	*M. paludis*	1.17	1.33	4.60	*Unidentified sp.*	2.83	0.00	4.38
A. australis	4.17	0.83	4.44					*B. amboinensis*	1.00	0.00	3.90
L. argenta	0.33	1.83	4.13					*A. australis*	0.83	0.00	3.67
Unidentified sp.	0.00	2.83	3.42					*P. fuscus*	1.67	0.17	2.97

Analysis of variance using Margalfe indices for fish species richness between different mangrove forests revealed significantly higher species richness of fish in Bicentennial Park mangrove (d = 1.855) than Allens Creek (d = 0.916) and Towra Point (d = 1.337). Species richness between Towra Point and Allens Creek were found not differ significantly.

Discussion

The diversity and abundance of fish visiting saltmarsh submerged at high tide has been described for a temperate South Australian saltmarsh by Connolly et al. (1997) and a subtropical saltmarsh by Thomas and Connolly (2001). The results of the two studies present a contrast. The temperate saltmarsh was depauperate, with only 19 individuals of two species caught across 48 pop net releases. The subtropical site was more intensively utilized by fish during the high tide, with 577 individuals from 23 species collected across 134 pop net releases. The only published study between these two latitudes concerns fish sampled in creeks adjacent to saltmarsh (Gibbs 1986) in Wallis Lake (320°20″ S) where eleven species of fish including juveniles of seven commercially important species were collected.

With the exception of the Bicentennial Park site, the saltmarshes examined in this study presented a range and abundance of species more akin to the subtropical Australian sites than the temperate sites in South Australia. At Towra Point, 1208 individuals of 16 species were caught in the saltmarsh, which compares well with the 13 species caught during the same high tides in the adjacent mangroves. At Allens Creek on the Hawkesbury River 673 individuals from 12 species were caught, while 100 individuals from 6 species were caught at Bicentennial Park during the same spring tide cycles.

The tidal wetlands of Bicentennial Park occupy land reclaimed by dredge spoil and have occupied their present position for approximately 30 years (Rogers and Saintilan 2002). Saltmarsh occurs in patches, occasionally infested with *Juncus acutus*. The site emerged as a relatively poor site with regards to fish diversity and abundance, lower than Towra Point, as well as Allens Creek, which occurs in a similar geomorphic setting (tributary bayhead delta in the middle reaches of the estuary). More systematic sampling would be required to test the hypothesis suggested by the result; that reclaimed or constructed saltmarshes are of lower fisheries value, even after several decades. By contrast, the mangrove at Bicentennial Park was well utilized, with 16 species recorded, a diversity and abundance comparable to other sites sampled.

Clynick and Chapman (2002) found significant differences of fish assemblages in patchy mangroves from site to site in the same bay and among bays, as did Louis et al. (1995) who found the distribution of species varying across eight mangrove stations sampled in the Bay of Fort-de-France, Martinique, West Indies. The findings of spatial variability in fish use of mangroves raises issues about the relative importance of mangroves between geomorphic settings (Baran 2001).

An *a-priori* expectation might have been that mangrove environments support similar fish assemblages, which might be contrasted to saltmarsh fish assemblages. The data reveals much greater inter-site variability. Neither a mangrove or saltmarsh fish community could be characterized. Fish assemblages appear to depend on both position in the intertidal zone and position in the estuary.

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