Balaclava Island 2014 Fish Survey

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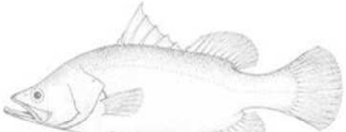

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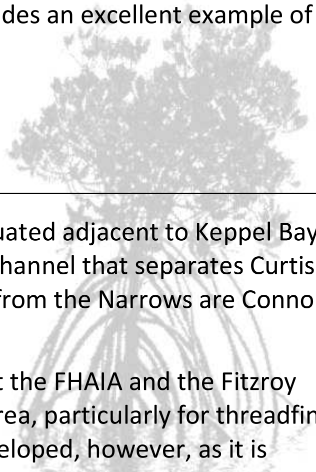
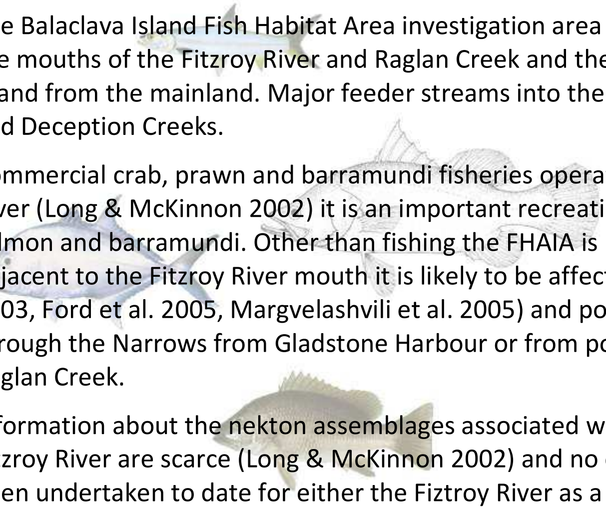
Executive Summary

- A detailed field survey of the Balaclava Island Fish Habitat Area investigation area (FHAIAI) was undertaken and supported by a desktop survey of available literature to provide information about nekton assemblage structure, abundance and species diversity in the FHAIA.
- Pre-existing nekton information was very limited and focused on the adjacent Fitzroy River and Keppel Bay. No prior FHAIA-specific nekton inventory existed.
- Composition of the FHAIA nekton assemblage was very similar to nekton composition reported from 2002/03 nekton sampling in the lower reaches of the Fitzroy River.
- Species diversity (species richness) and abundances of most species were relatively low but this was consistent with 2002/03 results for the lower Fitzroy River area.
- A large majority of fish and crustaceans recorded from the FHAIA were juvenile indicating this area functions as a nursery.
- Nekton assemblages around the FHAIA are excellent representations of the fisheries communities of the lower Fitzroy River system (the largest macro-tidal estuary system along Australia's northeast coastline) indicating that the FHAIA provides an excellent example of a critical and unique area of fish habitat.

Introduction





The Balaclava Island Fish Habitat Area investigation area (FHAIA) is situated adjacent to Keppel Bay, the mouths of the Fitzroy River and Raglan Creek and the Narrows, a channel that separates Curtis Island from the mainland. Major feeder streams into the FHAIA apart from the Narrows are Connor and Deception Creeks.

Commercial crab, prawn and barramundi fisheries operate throughout the FHAIA and the Fitzroy River (Long & McKinnon 2002) it is an important recreational fishing area, particularly for threadfin salmon and barramundi. Other than fishing the FHAIA is largely undeveloped, however, as it is adjacent to the Fitzroy River mouth it is likely to be affected by river-borne stressors (Webster et al. 2003, Ford et al. 2005, Margvelashvili et al. 2005) and potentially by movement of pollutants through the Narrows from Gladstone Harbour or from port operations at Port Alma in the mouth of Raglan Creek.

Information about the nekton assemblages associated with the Balaclava Island FHAIA and adjacent Fitzroy River are scarce (Long & McKinnon 2002) and no detailed inventory of fisheries resources has been undertaken to date for either the Fiztroy River as a whole or the Balaclava Island FHAIA in particular. Fish research in the Fitzroy region has been primarily focused on wetlands (Bruinsma & Danaher 1999, Hyland 2002, Sheaves et al. 2006a, Sheaves et al. 2007, Sheaves & Johnston 2008), functionality of the fishway at the Rockhampton barrage (Kowarsky & Ross 1981, Stuart & Mallen-Cooper 1999, Stuart et al. 2007), effects of local climate (Sawynok & Patten 2011) and climate change (Tanimoto et al. 2012), or on commercial species such as barramundi (Sawynok 1998, Capricorn Sunfish 2002, Stuart and McKillop 2002, Robins et al. 2006, Milton et al. 2008) and threadfin salmon (Halliday et al. 2008).

An inventory of nekton in the Calliope River, around 40 km south of the FHAIA, in 1994 reported 76 species of fish, five species of prawn and two species of crab (McKinnon & Lupton 1995) however the relevance of this study to the FHAIA is unclear given that fish assemblages can vary substantially between estuaries over short distances (Ley 2005, Sheaves 2006, Sheaves & Johnston 2009). Johnston and Sheaves (unpublished data) indicate at least 60 species of fish, 8 species of prawn/shrimp and 1 species of crab are found in the Fitzroy River, but this study incorporates the entire tidal extent of the river from the mouth to the barrage at Rockhampton. Species lists published by Long and McKinnon (2002) contained 97 species of fish, 12 species of prawns and 3 species of crab, however this list not only encompasses the Fitzroy River but also a large area of Keppel Bay and is based largely on commercial and recreational fishing data, rather than being fisheries-independent. Detailed information about fish and crustacean assemblages in the lower reaches of the Fitzroy River adjacent to the FHAIA suggest relatively low species richness, 43 species (36 fish, 7 prawns/shrimp) and just 32 species of fish and 7 species of prawn/shrimp at the river mouth (Johnston & Sheaves unpublished data).

The objectives of this study were to produce an inventory of fish species for the Balaclava Island FHAIA and adjacent lower reaches of the Fitzroy River. To achieve this we undertook a detailed field survey of the FHAIA supported by a desktop survey of available literature to provide information about nekton assemblage structure, abundance and species diversity.

Methods

Site descriptions

Data were collected from five sites in the Balaclava Island Fish Habitat Area investigation area (FHAIA) (Fig. 1) during an intensive field trip between 6th and 9th January 2014. All sites were

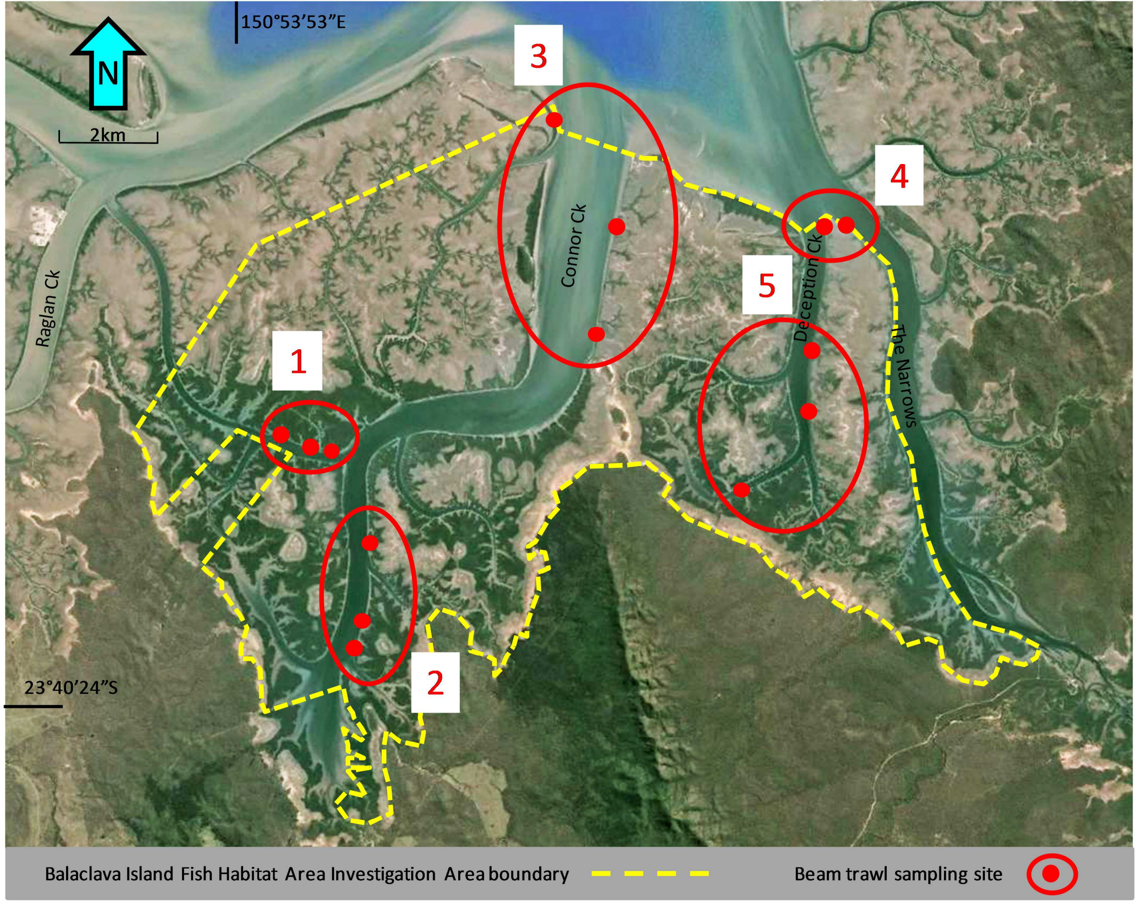


Figure 1: Balaclava Island Fish Habitat Area investigation area.

mangrove-lined and backed by saltpan. Mangroves were predominantly *Rhizophora* spp. and *Avicennia marina* with patches of *Ceriops* spp. and *Aegialitis annulata.* The FIAIA is located adjacent to the mouths of the Fitzroy River, Raglan and Connor Creeks. Tidal range in the area can reach 5.5 metres (Webster et al. 2003, Webster et al. 2005). Intertidal areas below the mangrove fringes are dominated by relatively low angle sand and mud banks that have little structure other than being cut by small drains. Intertidal banks generally lack complex structure such as fallen timber, probably because smaller structure is removed by the strong tidal currents.

Nekton sampling

Nekton were sampled using beam trawls (1.8 m wide, 0.75 m high, 4.5 m long, 18 mm multi-filament mesh). Beam trawls had a trap fitted to the entrance of a relatively long (2.5 m) cod end to improve retention of fish during recovery operations. Beam trawls were towed against the current for 100 metres at a speed of 6 knots. Trawl speed and distance were measured by GPS (this makes speed relative to substrate, not the water body). Depth of each trawl was measured at the start of the trawl and as far as possible trawls tracked the isobath of starting depth using sonar to maintain a relatively constant depth throughout the trawl. This approach mirrors that of earlier work conducted in the Fitzroy River during 2002/03 (Johnston & Sheaves unpublished data). The 2002/03 river data were partially reported in Long & McKinnon (2002) as "Beam trawl data". The full data set has been made available for this study to provide supplementary data that allow a more temporally extensive picture from an area adjacent to the FHAIA.

Nekton sampling was restricted to areas where the substrate was firm enough to allow beam trawling to work efficiently. Because most intertidal banks in the FHAIA are relatively soft this reduced the number of sampling opportunities so site selection related to availability of suitable banks. Only three replicate trawls were possible from four of the sites and only two successful trawls were obtained from the fifth site. Data were collected during the lower half of neap tides once mangrove forests were no longer accessible to nekton. Neap tides were used to avoid complications associated with working nets in strong tidal currents. Nekton were identified to species, counted in the field and released as quickly as possible. A small number of taxa that could not be reliably classified to species in the field were retained for laboratory examination.

Size structure of the FHAIA assemblage was investigated in terms of nursery function by classification into adult (above size at first reproduction) or juvenile (below size at first reproduction). However reproductive information for most non-commercial species is lacking, so a proxy measure was used to classify those species, with individuals under 50% of maximum published length classified as juvenile. This default aligns with protocols in the Fishbase life history tool (Froese & Pauly 2013) for species without specific and detailed reproductive information. This study makes the assumption that a tool which is based on established relationships among species with known reproductive details provides a reliable approach to estimating reproductive status.

Physical data

Salinity, turbidity and water temperature were measured at the completion of each replicate trawl using an AquaRead Aquameter. Measurements were taken at 0.5 m. depth.

Data analysis

Low abundances and patchy distributions across the FHAIA for most species were problematic for analyses so data were analysed as presence/absence data to avoid biasing results with occasional nets with higher catch rates. Only species which occurred in at least 5% of samples were used for formal analyses. This approach provides a more reliable representation of the study area.

Non-metric multidimensional scaling (nMDS) based on S7 Jaccard similarity was used to examine potential similarities between the FHAIA samples collected during January 2014 and data collected from the Fitzroy River during 2002/03. Jaccard similarity provides information about composition of samples by providing greater weighting to joint presences in the data matrix. Analysis of Similarity (ANOSIM) was used to determine whether there were statistical differences between FHAIA and River sites. Four river locations were sampled five times over the course of 15 months but had no January sample to provide a clear temporal comparison with the current FHAIA sample. These data were pooled to a site level for analysis. ANOSIM and nMDS was also employed to examine relationships among sites in the FHAIA. All analyses were conducted using Primer 6 software.

Analysis of Variance (ANOVA) was used to examine physical data. Temperature, salinity and Turbidity data were log transformed prior to analysis to stabilise variances.

Results

Fish sampling during January 2014 captured 81 individuals representing 13 Families and 14 species (Table 1). In addition, 182 crustaceans representing 3 Families and 5 species were recorded. Species richness (number of species) of fish and crustaceans were similar to those reported from the area around the Fitzroy River mouth during December 2002 and were consistent with numbers of species reported across the spring-summer recruitment period for 2002.

Three species of fish (*Esculalosa thoracata*, *Gerres filamentosus*, *Leiognathus equulus*) from the January 2014 survey were not recorded for the area during the 2002/03 survey (Table 1). There were 19 species of fish reported from the 2002/03 survey were not recorded during January 2014 however their absences probably reflect the relatively low numbers of fish generally present in this area and their seemingly patchy distributions which both contribute to reduced probability of capture. For many species their absences probably represent seasonal shifts in availability. The situation was similar for crustaceans with 3 species absent from January 2014 samples and *Scylla serrata* the only additional species recorded from beam trawls for the area during January 2014. Small individuals (< 100 mm FL) made up 96.3% of the Balaclava Island (January 2014) catch with a large majority of those individuals below size at first reproduction (Table 1). *Ambassis vachellii*, *Lates calcarifer* and the mud crab *Scylla serrata* were the only species represented by reproductive sized individuals.

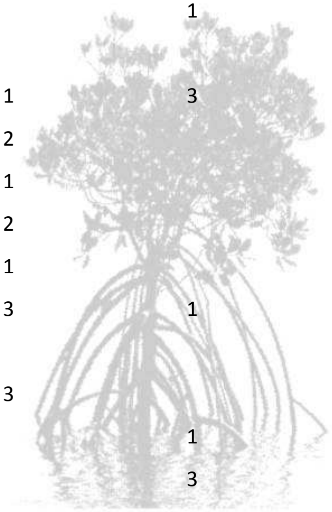
Nekton assemblage composition in the Balaclava Island sample from 2014 was similar to compositions in the Fitzroy River sites from 2002/3 (Fig. 2a). Assemblage composition of the FHAIA sample was not significantly different from those of the Fitzroy River sites (ANOSIM Global R = 0.025, p = 0.58). In part, the inability to differentiate among sites is a reflection of large temporal differences in assemblage compositions within sites in the River as evident in the two sites most adjacent to the FHAIA (Fig. 2b). Temporal shifts in the river sites were largely attributable to more frequent occurrences of *Nematolosa come* and *Neoarius greaffei* and less frequent occurrences of *Paraplagusia guttata*, *P. bilineata* and *Pseudorhombus arsius* during March coupled with more frequent occurrences of *Metapenaeopsis novaeguineae* and *Paradicula setifer* during September (Figs. 2a,b).

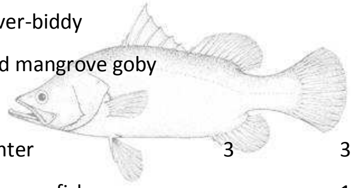
Replicate samples within FHAIA sites were quite variable in assemblage composition (Fig. 3) however ANOSIM indicated there were no significant differences between sites (Global R = 0.023, p = 0.09). Species such as *Fenneropenaeus merguiensis*, *Johnius pacificus* and *Callionymus sagitta* occurred more frequently in sites 2 and 5 and in one replicate from site 3 than in other sites/replicates, site 3 and one site 1 replicate had more occurrences of *Paleomonetes atribunes* and *Nuchequula gerreoides* than other sites/replicates, and site 4 tended to have average to low occurrences of most species.

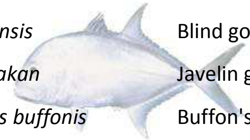
There were no significant differences in mean water temperature, salinity or turbidity between sites in the FHAIA (Table 2). Water temperature and salinity varied little across the FHAIA whereas turbidity was relatively variable (Fig. 4) with recordings ranging from 19 (site 2) to 304 (site 3) NTU.

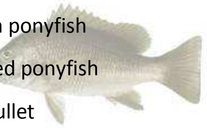
Table 1: Species lists from Johnston & Sheaves 2002/03 nekton sampling for the lower reaches of the Fitzroy River and 2014 sampling (grey columns) from the Balaclava Island FHAIA.

Family	Species	Common name	April 2002	June 2002	September 2002	December 2002	March 2003	January 2014	% 2014 juveniles
Fish									
Ambassidae	*Ambassis vachellii*	Glass perchlet		1				3	0
Clupeidae	*Escualosa thoracata*	White sardine						7	99.8
Callionymidae	*Callionymus sagitta*	Arrow dragonette				1		6	100
Cynoglossidae	*Cynoglossus* sp.	Toungesole	1						
	Paraplagusia bilineata	Doublelined toungesole	1	1	1	3			
	Paraplagusia guttata	Toungesole	1	1	2		4	3	100
Eleotridae	*Butis butis*	Duckbill sleeper			1				
	Ophiocara porocephala	Northern mud gudgeon	2	2	2				
Engraulidae	*Stolephorus spp.*	Anchovy			1				
	Thryssa hamiltonii	Hamilton's anchovy			3	1		13	100
Geriidae	*Gerres filamentosus*	Whipfin silver-biddy						1	100
Gobiidae	*Acentrogobius gracilis*	Bluespotted mangrove goby			3				
	Karsten totoyensis	Blind goby				1	2		
Haemulidae	*Pomadasys kaakan*	Javelin grunter	3	3		3	3	2	100
Hemiramphidae	*Zenarchopterus buffonis*	Buffon's river garfish		1					
Lattidae	*Lates calcarifer*	Barramundi						1	0
Leiognathidae	*Leiognathus equulus*	Common ponyfish						1	100
	Nuchequula gereoides	Decorated ponyfish			1	1		33	100
Mugilidae	*Rhinomugil nasutus*	Shark mullet			1			1	nk*
	Valamugil/Moolgarda spp.	Mullet					2		
Paralichthyidae	*Pseudorhombus arsius*	Largetooth flounder			1	1			

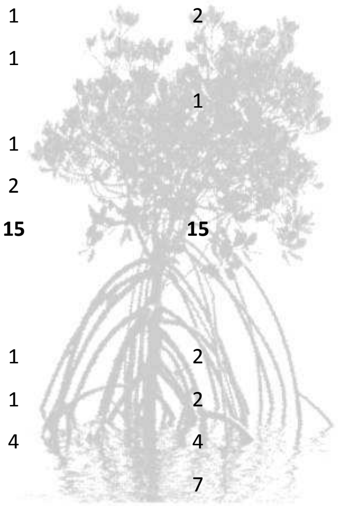


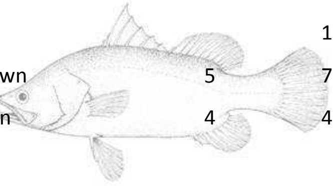


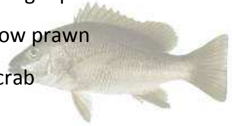




Platycephalidae	*Platycephalus endrachtensis*	Northern sand flathead					1		
	Platycephalus fuscus	Dusky flathead					1		
	Platycephalus indicus	Bartail flathead				1	9		
Polynemidae	*Eleutheronema tetradactylum*	Fourfinger threadfin	1			1		4	100
	Polydactylus multiradiatus	Australian threadfin				2	1		
Sciaenidae	*Johnius pacificus*	Pacific croaker	3	1		5	2	4	100
Sillaginidae	*Sillago sihama*	Silver sillago	2	4	2	4			
Soleidae	*Paradicula setifer*	Sole	2	2	1	2	7	2	nk*
Sparidae	*Acanthopagrus australis*	Yellow-finned bream			1				
Synodontidae	*Harpodon translucens*	Glassy Bombay duck	4	2		1			
Tetraodontidae	*Chelonodon patoca*	Milkspotted puffer			1				
	Marilyna pleurosticta	pufferfish			2				
Total # species			**10**	**10**	**15**	**15**	**9**	**14**	
Crustaceans									
Paleominidae	*Paleomonetes atribunes*	Shrimp		1	1	2	7	13	nk*
Penaeidae	*Atypopenaeus formosus*	Go home prawn	5	7	1	2	1		
	Feneropenaeus merguiensis	Banana prawn	4	4	4	4	1	145	100
	Metapenaeopsis novaeguineae	Prawn				7			
	Metapenaeus bennettae	Greentail prawn	1		2	6	5	21	100
	Penaeus esculentus	Brown tiger prawn				1			
	Parapenaeopsis sculptilis	Rainbow prawn	4	4	8	4	11	2	100
Portunidae	*Scylla serrata*	Mud crab						1	0
Total # species			**4**	**4**	**5**	**7**	**5**	**5**	







* nk denotes no information available about size of first reproduction or maximum size for species

The high variability in turbidity was primarily due to a combination of water surface conditions (moderate to strong winds) and tidal current flows (Margvelashvili et al 2003) at the time of sampling.

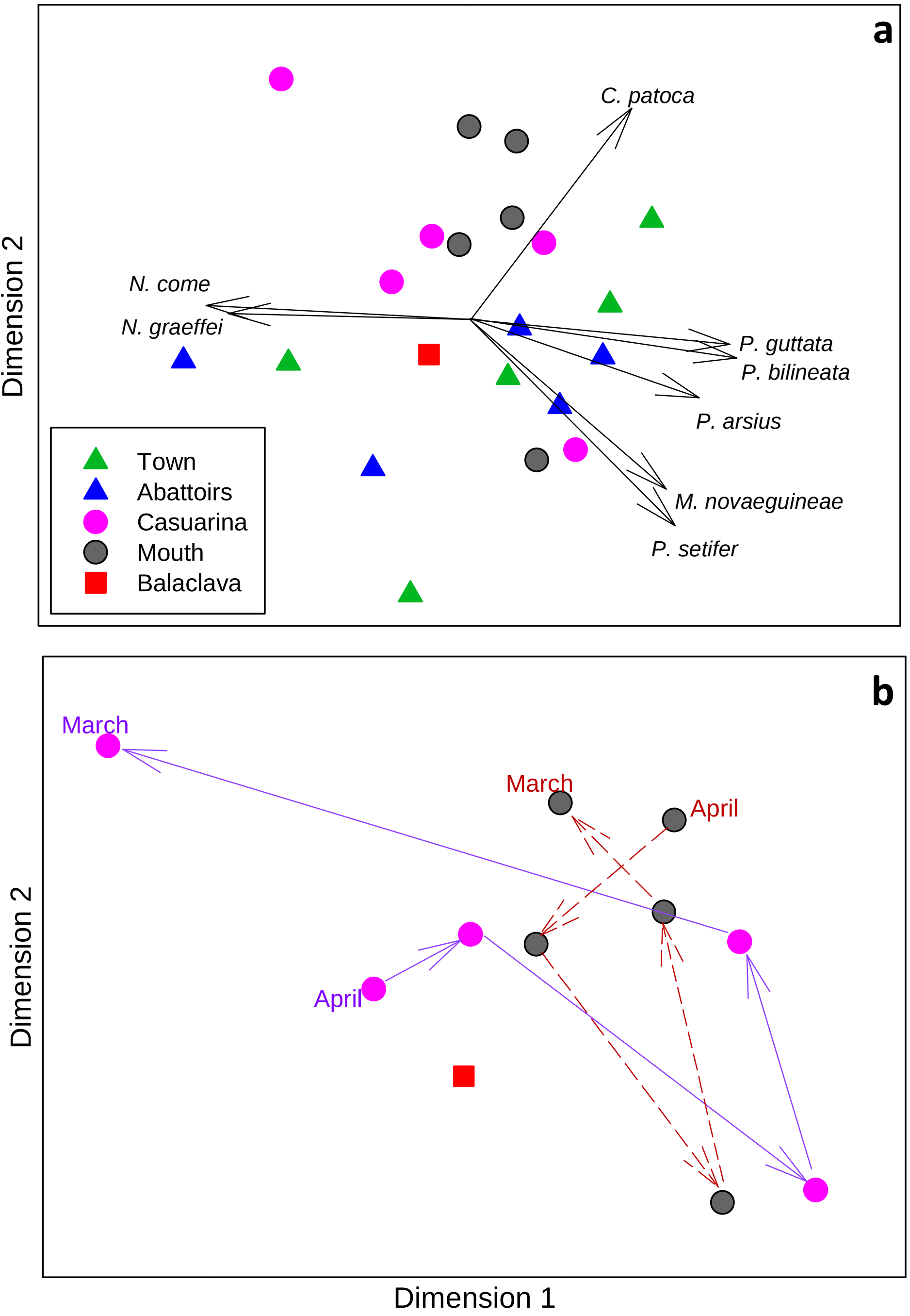


Figure 2: nMDS (stress 0.17) of relationships among nekton compositions for four Fitzroy River sampling locations (Town, Abattoirs, Casuarina, Mouth) and the Balaclava Island FHAIA, Panel a, and temporal variability of the two downstream locations, panel b. Vectors represent species with >0.55 correlations with the nMDS space. Vectors are re-scaled x 3 and vector length is proportional to R^2.

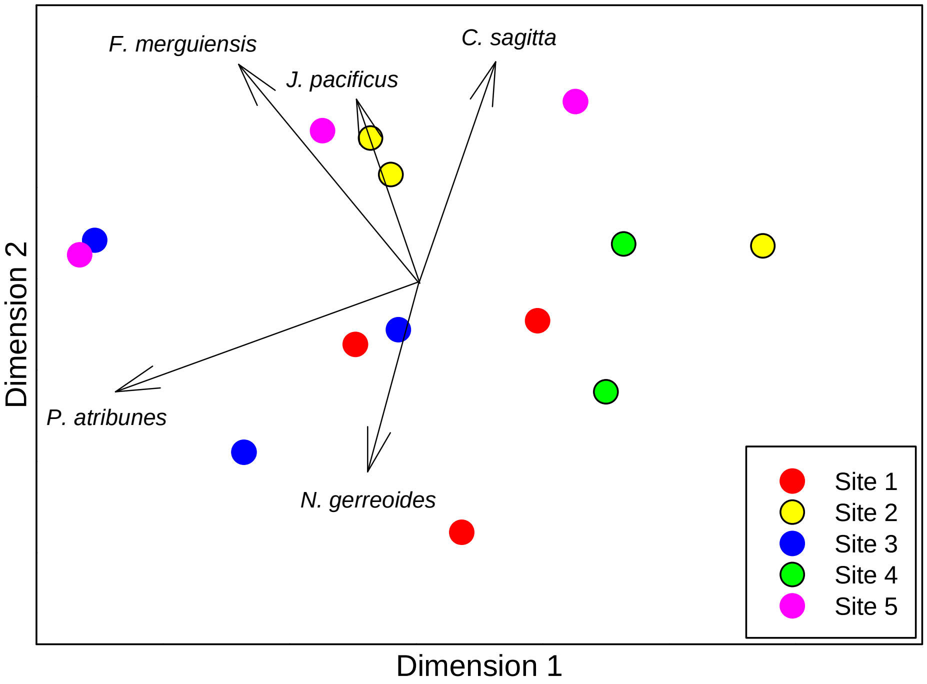


Figure 3: nMDS (stress 0.09) of relationships among nekton compositions of the five sampling sites in the Balaclava Island FHAIA. Vectors represent species with correlations with the nMDS space >0.5. Vectors are re-scaled x 3 and length is proportional to R^2.

Table 2: Results of ANOVA analyses for physical variables.

Physical variable	df	F	p
Water temperature (log)	4,9	1.0	0.42
Salinity (log)	4,9	0.82	0.54
Turbidity (log)	4,9	1.3	0.35

Discussion

Fish and crustacean abundances, assemblage compositions and species richness for the FHAIA were very similar to those previously reported for adjacent areas in the lower Fitzroy River (Long & McKinnon 2002) and contained in unpublished data held by Johnston and Sheaves. Abundances and species richness were relatively low however this appears to be common for the local area. The lower Fitzroy River is a highly turbid environment due to sediment resuspension by strong tidal flows (Webster et al. 2003, Ford et al. 2005, Margvelashvili et al. 2005) so it is reasonable to expect similar conditions to exist in the FHAIA due to its proximity and multiple connections to the lower Fitzroy River area. Moreover, with topographically simple habitats predominating throughout the FHAIA (unstructured sand/mud banks), as is the case in the lower Fitzroy River (Johnston 2005), it is not surprising that numbers of species and individuals are similar across the two areas.

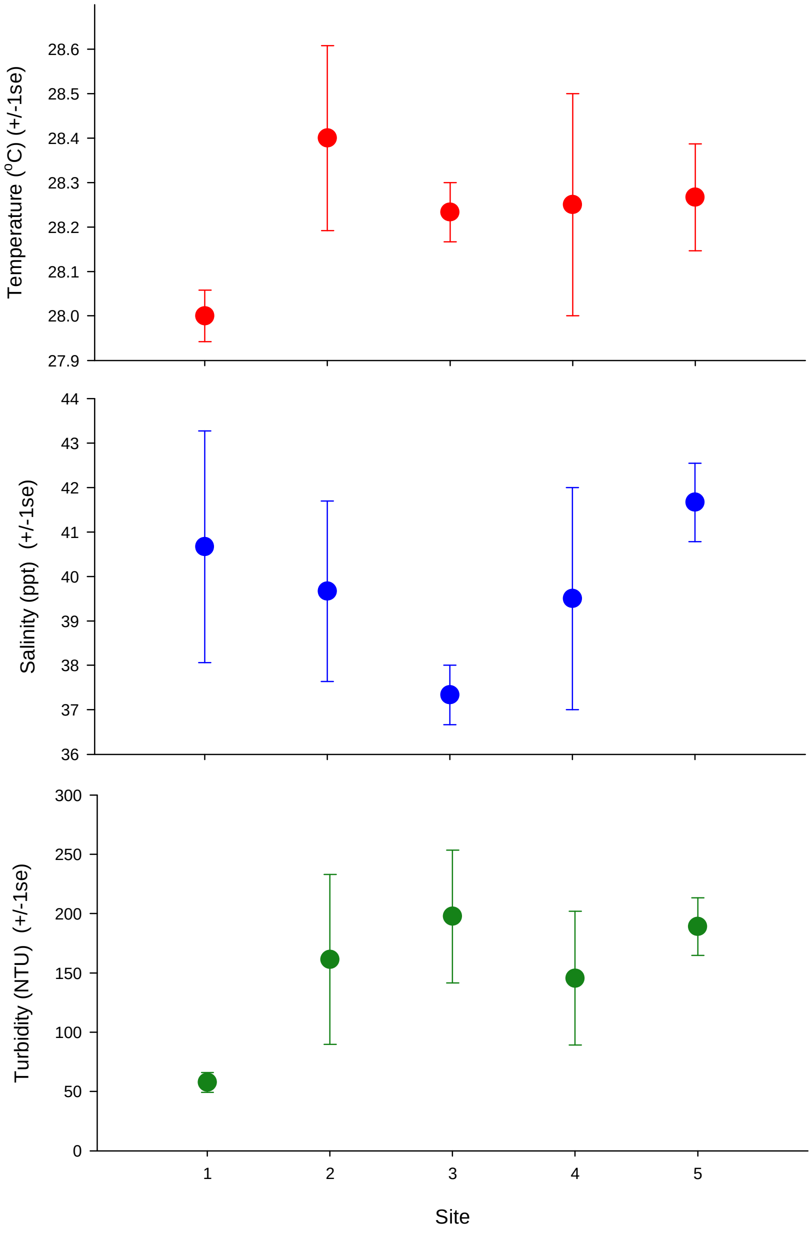


Figure 4: Mean values for physical variables among sampling sites in the Balaclava Island FHAIA.

Assemblage compositions were also similar between the FHAIA and lower Fitzroy River indicating a likely common source of recruits (Sheaves et al. 2013) and confirming the similarity of habitats available (Long & McKinnon 2002) among the two areas. This suggests that species lists generated for the lower Fitzroy River could be used to supplement information for an inventory of the Balaclava Island FHAIA with a high degree of confidence. Taking this approach there are at least 33 species of fish and 7 species of shrimp as well as mud crabs likely to be encountered in the FHAIA. Here it should be noted that just 14 and 5 species of fish and crustaceans were recorded during the 2014 sampling of the FHAIA. One likely reason for this relatively low number of species compared to the lower Fitzroy River was the lack of temporal component in this study (Sheaves & Johnston 2010, Sheaves et al. 2012). Consequently, despite strong similarities with the lower Fitzroy River, some uncertainty remains about the overall make-up of the FHAIA nekton assemblage and how well it is represented in this study.

The size structure of the FHAIA assemblage was heavily weighted towards juvenile individuals, with few reproductive sized individuals recorded. This indicates use of the FHAIA as a nursery area, although low abundances of most species suggest the relative nursery value to the broader region may be low (Beck et al. 2001, Dahlgren et al. 2006). That said, degradation of any nursery area may have unpredictable effects on populations because judgement of the value of a nursery on numbers alone is very risky (Sheaves et al 2006b). Numbers don't necessarily reflect overall contributions to succeeding generations (Sheaves et al 2006b).

Overall, the data indicate that the fish and crustacean assemblages around the FHAIA are excellent representations of the fisheries communities of the lower Fitzroy River system; the largest macro-tidal estuary system along Australia's northeast coastline. Thus the Balaclava Island area provides an excellent example of a critical and unique area of fish habitat.

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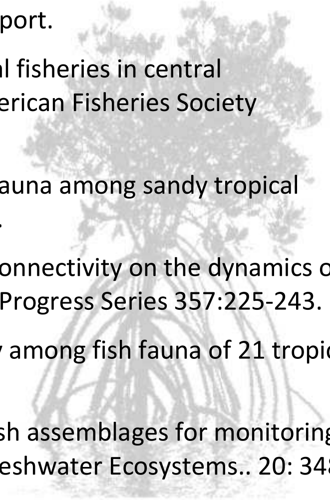

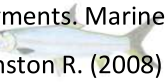

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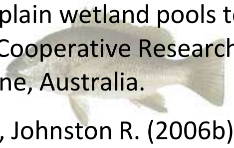

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