PRELIMINARY REPORT

INVERTEBRATE FAUNA AND WATERBIRD DIET AT MOSQUITO BREEDING AREAS OF LESCHENAULT INLET, BUNBURY, WESTERN AUSTRALIA

by

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SUMMARY

Saline pools in saltmarsh, the main mosquito breeding habitat at Leschenault Inlet, comprise an important breeding habitat for Grey Teal, Pacific Black Ducks and Australian Shelducks and the whole saltmarsh is used extensively by these species, at least sometimes, when flooded by high tides. The saline pools are also used extensively by Black-winged Stilts, Greenshank, White-faced Herons and Great Egrets.

Controlling the number of mosquito larvae in saline pools, particularly if runnelling is the control measure used, will adversely affect waterbird usage of the pools and will result in lowered duck production. It is possible that changes to the saltmarsh habitat (although only of a greater magnitude than caused by runnelling) would also affect waterbird usage of the tidal mudflats in Leschenault Inlet.

INTRODUCTION

The studies reported here were initiated by the Mosquito Control Review Committee (MCRC) as part of a project to evaluate the environmental effects of various methods of controlling mosquitoes. Previous work has shown that the most significant mosquito breeding areas near Bunbury are parts of the tidal saltmarsh around Leschenault Inlet. Until now the value of the tidal saltmarsh (and other parts of Leschenault Inlet) for conservation has been poorly documented and, therefore, the MCRC commissioned studies on waterbird usage of the tidal saltmarshes and other parts of the Inlet by Ninox Consulting and smaller-scale studies of the invertebrate fauna of the major mosquito breeding areas and the diets of waterbirds in these areas by CALM. The aim of the smaller studies was to determine the important prey items in the diet of waterbirds, the distribution of these prey items and the likely effect of mosquito control programmes on the distribution of the prey, which in turn could be expected to affect waterbird usage of various areas.

Currently accepted methods of controlling mosquitoes include fogging (spraying adults), the application of larvicides to pools where larvae occur, land-fill to cover breeding areas and runnelling to drain them. Of these methods only larvicides and runnelling are likely to be used extensively in Western Australia. At present the larvicide used is a granular formulation of the organophosphate pesticide temephos, marketed as "Abate". The alternative to using a larvicide is runnelling - digging shallow drains through the saltmarsh to drain pools created by high tides and to allow fish access to these pools while they contain water. The fish effectively control the number of mosquito larvae in the pools. However, not all pools are created by high tides alone. In winter the saltmarsh receives a substantial amount of water from adjacent land and some of the winter flooding of saltmarsh is due to rain rather than high tides and efforts to allow access of fish to these pools will

result in draining rain-filled pools that are a valuable freshwater resource for waterbirds rather than just allowing access of fish.

METHODS

Invertebrates

The aquatic invertebrate fauna of the various habitat units within the mosquito breeding areas was determined by sampling at two monthly intervals from July 1987 until June 1988. The sampling sites are listed in Table 1; the locations of the mosquito breeding areas are shown in Figure 1. Samples were collected by hand-net and Surber-sampler when sites contained standing water; on tidal mudflats only core samples were collected using the Surber-sampler.

Waterbird diet

One hundred and fifty-five birds were collected in the main mosquito breeding areas between September 1987 and May 1989 for dietary analysis. Notes were made on their feeding behaviour, the habitat unit in which they were feeding was recorded (nearly all birds were feeding when collected) and the oesophageal and gizzard contents were preserved separately in alcohol for later identification. At this stage only oesophageal contents have been examined in a cursory way. In the final report, after detailed examination of both oesophageal and gizzard contents, a more complete analysis of diet will be presented based on the dry weight consumed of each prey type.

Records were also kept of waterbird numbers, breeding activity and feeding activity in the mosquito breeding areas during the waterbird collecting trips.

RESULTS

Invertebrates

At least 101 species of aquatic invertebrate and three species of fish were collected in the mosquito breeding areas (Table 2). This diversity occurs within the saltmarsh and mudflats surrounding Leschenault Inlet; the Inlet itself was excluded from sampling. Furthermore, although we collected a large number of samples some rarely-occurring species were undoubtedly missed so that species richness has been under-estimated.

In terms of species richness there is little consistent difference between the various habitat types occurring in the mosquito breeding areas (Figure 2) although the flooded paddock opposite Pelican Point (Paddock 104 in the Mosquito Eradication Campaign report) contains most species. This is a highly disturbed example of a fringing freshwater seasonal wetland, which would originally have been common on the landward side of the saltmarsh around Leschenault Inlet; it contained a number of freshwater wetland species that were not collected at any other locality.

The number of species in saline pools, flooded samphire, mosquito runnels (ignoring the results for July 1987 when only core samples were taken), tidal channels and mudflats did not differ greatly, especially when the range of values obtained are compared, although mudflats generally contained slightly fewer species. Fewer species were collected in mangal mud (and mangal tidal channel) than other habitats. The highest number of species in single samples were collected in saline pools and flooded samphire. Although the relationship is not a strong one there appears to be a tendency for species richness to decline slowly from the 'freshwater' wetlands across the saltmarsh to the tidal mudflats.

Complete results for June 1988 are not available yet but the number of species collected, particularly in saline pools and flooded samphire, appears to be high. When the complete results are available a more detailed analysis of seasonal trends at individual sites will be carried out but this is not expected to differ markedly from the picture given in Figure 2. Community composition will be analysed in the final report but it would appear that there are three primary communities: the mudflat community, the saline pool community, which contains most of the mudflat community and a range of extra species including chironomids and mosquito larvae, and the freshwater wetland community. A more detailed analysis will be required to determine the affinities of mosquito runnels and the tidal channels but provisionally they are probably best placed mid-way between the mudflat and saline pool communities.

Waterbird diet

Ninety-six birds contained food in their oesophagus (Table 3). Most waders feed on the tidal mudflats where polychaetes were the main food items, although amphipods and molluscs were also eaten. However Black-winged Stilts and Greenshanks, which are the most visually prominent waders, fed mostly in saline pools and tidal channels; in both species mosquito larvae constituted the main food item. In May 1989 Black-winged Stilts fed extensively in samphire that had been flooded by a high tide and the few Greenshanks present at this time of year were also in the flooded samphire. A single Bar-tailed Godwit was collected over summer while feeding in samphire although this species usually feeds on mudflats. Common Sandpipers were frequently encountered feeding along mosquito runnels but this proved an extremely difficult habitat type in which to collect birds and none was collected. Nevertheless, the data collected for all waders leads to the conclusion that irrespective of habitat type polychaetes, amphipods and gastropods probably constitute their main food items. Where other foods (such as mosquito larvae) are particularly

abundant, species like Black-winged Stilts and Greenshanks that are adapted to feed in water rather than on bare mudflats will utilize these foods.

The three species of duck had varied diets. The saltmarsh was extremely important to them because all three species bred in this habitat in areas containing trees and dense beds of sedges. The saline pools on the north-eastern side of the Inlet (Figure 1) were probably the most productive breeding area and are an example of the importance of fringing estuarine wetlands in maintaining duck numbers in south-western Australia. During the breeding season all three duck species fed in saline pools and flooded samphire, eating a wide variety of foods, including mosquito larvae. Ostracods, however, were the dominant food item for Grey Teal and Australian Shelduck. In late summer large numbers of all three duck species fed on tidal mudflats. Grey Teal were the only species accessible in this situation; the diet was similar to that of waders in nearby areas except that it also included plant seeds. The other two duck species probably fed on similar items. When they contained water, saline pools continued to be used by Grey Teal and Australian Shelduck in summer. Their diet in the pools was the same as in spring. During autumn when the number of ducks present on the Inlet was high samphire areas were used extensively when flooded and comprised the most important habitat for ducks at this time. Their diet was varied but mosquito larvae were a significant component.

White-faced Herons and Great Egrets used saline pools, flooded samphire, runnels and tidal channels extensively. Their diet mostly consisted of fish and prawns but they also ate orthoptera, which occurred in the samphire, and probed for polychaetes in mosquito runnels. Both species used samphire extensively when flooded by high tides in autumn.

Due to a shortage of time and various misfortunes we were unable to collect many ducklings feeding around Leschenault Inlet. Limited data suggest that their diet is not

identical to that of adults and that micro-crustaceans are consumed in significant quantities. We hope to address this question further.

The dietary results presented here are preliminary. We will be able to operate with a larger data set when gizzard contents are analysed from all birds collected and will be able to define diets more precisely from oesophageal contents when these have been analysed on a dry-weight basis.

DISCUSSION

As a result of a preliminary analysis of our data, the following points emerge:

1) Saline pools and the mosquito larvae they contain are an extremely important resource for breeding ducks, for Black-winged Stilts and Greenshanks and for large wading birds (although these do not eat mosquito larvae).

2) Efficient draining of these pools to control mosquitoes will certainly have an adverse impact on the bird species mentioned above.

3) At times when the saltmarsh is flooded for prolonged periods as a result of high tides (e.g. May 1989) the flooded samphire is used extensively by ducks, large wading birds and Black-winged Stilts. Improved drainage of saltmarsh will reduce the feeding resources of these birds.

4) The extent of the impact of using larvicides to control mosquitoes is unclear but intuitively, since mosquito larvae are an important dietary component for some species and the larvicide is probably not very specific, it seems likely that applying larvicides will

also have a detrimental effect on the birds, albeit it a lesser one than runnelling.

In terms of both bird breeding and invertebrate species richness the 'freshwater' wetlands that once occurred behind the saltmarsh around Leschenault Inlet were the prime habitat. These have now been lost as a result of agricultural clearing, which has increased the importance of the saline pools at the landward side of the saltmarsh that are surrounded by trees. The pools on the north-eastern side of the Inlet and at Pelican Point are examples of this habitat and warrant greater protection than they currently receive.

In terms of numbers of birds occurring there the mudflats along the edge of the estuary comprise the prime habitat of Leschenault Inlet because they are the main wader habitat, although flooded samphire is a significant feeding area for ducks, large wading birds and resident waders. However, it is far from certain that the mudflats would continue to support large numbers of birds without saltmarsh along the shoreline. The saltmarsh, together with the rivers entering the Inlet, is probably an important source of organic matter and nutrients for the tidal mudflats. It is also important in preventing erosion of the shoreline and without it the attractiveness of the mudflats may decline.

A second point is that the saltmarsh provides shelter during periods of high tides and strong wind when the tidal mudflats are inundated. Without an area to which they can retreat, Leschenault Inlet would provide unsatisfactory habitat for waders.

In conclusion, this study has shown that there is a group of birds that utilize the saline pools and flooded samphire in the saltmarsh where mosquitoes breed. Any form of mosquito control, but particularly runnelling, will affect them adversely. Although our study did not address the indirect benefits of the saltmarsh habitat, it probably has an

essential role in maintaining high numbers of birds on the tidal mudflats.

Table 1 Sampling sites for invertebrates at Leschenault Inlet

S = sweep, C = core

Site 1 The Blunders
- a) Saline pool in samphire S C
- b) Flooded samphire S C
- c) Mosquito runnel S C
- d) Mud in mangal S C
- e) Tidal channel in mangal C
- f) Mudflat C

Site 2 Preston River
- a) Saline pool in samphire S C
- b) Flooded samphire S C
- c) Large saline pool west of bund S C
- d) Mudflat C

Site 3 North-western side of Inlet
- a) Saline pool in samphire S C
- b) Flooded samphire S C
- c) Saline pool in samphire S C
- d) Mudflat C

Site 4 Point Duoro
- a) Saline pool in samphire S C
- b) Flooded samphire S C
- c) Tidal channel (fish trap) S C
- d) Mosquito runnel S C
- e) Mudflat C

  Pelican Point
- f) Large saline pool S C

Site 5 North-eastern side of Inlet
- a) Saline pool in samphire S C
- b) Flooded samphire S C
- c) Mudflat C

Site 6 Paddock opposite Pelican Point

a) Flooded paddock

Table 2 Preliminary list of the aquatic invertebrate species and fish collected at the sampling sites

CNIDARIA (Jellyfish etc.)

one species of jellyfish

NEMATODA (Roundworms)

unknown number of species

MOLLUSCA (Snails, mussels etc.)

Bivalvia

Mysella sp.

Arthritica semen

Sanguinolaria biradiata

Bivalve sp. 2

sp. 4

Gastropoda

Nassarius burchardi

Calliostoma australe

Acteocina sp.

Hydrococcus brazieri

Muricidae sp.

Gastropoda sp. 1

sp. 2

sp. 3

sp. 4

sp. 5

sp. 6

sp. 7

ANNELIDA (True worms)

Oligochaeta

Aelosoma ? hemprichi

Aelosoma ? niveum

Aelosomanineum sp. 1

Polychaeta

Australonereis ehlersi
Ceratonereis aequisetum
Nicon aestuarensis
Capitella sp.
Prionospio sp.

ARACHNIDA (Mites, crustacea etc.)
Hydracarina
one species

Oribatida
two species

Chelonethida
one species

Crustacea
Cladocera
Daphnia carinata
Macrothricidae sp. 1
sp. 2

Ostracoda
Cyprideis australiensis
Paracypria sp.
Reticypris clava
Newnhamia fenestra
Alboa warooa
Sarscypridopsis aculeata
Diacypris spinosa
Mytilocypris tasmanica chapmani
Australocypris insularis
Limnocythere mowbrayensis
Ostracod sp. 163

Copepoda
Gladioferens imparipes
Calanoid sp.
Apocyclops sp.

Mesocyclops sp.
Mesochra flava
Harpacticoid sp. 3
sp. 4
sp. 5
sp. 8
sp. 9
sp. 10
sp. 11

Isopoda
two species

Amphipoda
Austrochiltonia subtenuis
Melita zeylanica kauerti
Gammaridae sp.
Corophium sp.
Paracorophium sp.
Caprellidae sp.

Decapoda
Palaemonetes australis
Atyidae sp.
three species of crab

INSECTA
Hemiptera
Anisops thienemanni
Micronecta robusta

Diptera
Culcidae
Aedes camptorhynchus
A. vigilax
Anopheline sp.

Chironomidae
Corynoneura scutellata

Chironomus alternans
C. australis
Tanytarsus barbitarsus
Camptocladius sp.
Procladius villosimanus
Pseudosmittia sp.
Dicrotendipes conjunctus
Limnophyes pullus
Pontomyia sp.

Ceratopogonidae
Atrichopogan sp.
Ceratopogonid sp. or spp.

Stratiomyidae
one species

Tabanidae
one species

Ephydridae
two species

Muscidae
two species

Coleoptera
Hydrochus sp.
Ochthebius sp.
Stenus sp.
Berosus sp.
Necterosoma penicillatus
Haliplus sp.
Allodessus bistrigatus
Liodessus dispar
Enochrus sp.

CHORDATA
Pisces

Pseudogobius olorum
at least two other species

Table 3. Diet of various species of waterbird in the different habitat types at Leschenault Inlet based on oesophageal contents. Main food items are highlighted in cases where several items are consumed.

Species	Habitat					
	Samphire	Saline pool	Runnel	Tidal channel	Mudflat	Mangal
Little Black Cormorant (N = 1)			fish			
White-faced Heron (N = 6)	crabs/coleoptera	prawns/fish	polychaeta/orthoptera	fish		
Sacred Ibis (N = 1)	crabs					
Australian Shelduck (N = 9)		ostracoda/copepoda/ ephrydidae/mosquito larvae/amphipoda				
Pacific Black Duck (N = 5)	seeds/gastropoda/ terr. isopoda	fish, gastropoda/ crabs/statiomyidae/ mosquito larvae		amphipoda		
Grey Teal (N = 17)	seeds/gastropoda	seeds/ostracoda/ coleoptera/ mosquito larvae/stratiomyidae/ fish	gastropoda/ amphipoda		amphipoda/polychaeta/ bivalvia/seeds	
Dusky Moorhen (N = 1)						insecta/vegetation
Pied Oystercatcher (N = 1)					polychaeta	
Grey Plover (N = 1)				polychaeta		

Species	Habitat					
	Samphire	Saline pool	Runnel	Tidal channel	Mudflat	Mangal
Red-capped Plover (N = 1)					'flies'/amphipoda	
Black-winged Stilt (N = 12)	isopoda/ mosquito larvae	mosquito larvae/ ephydridae		polychaeta	polychaeta	
Banded Stilt (N = 5)					polychaeta/gastropoda	
Red-necked Avocet (N = 4)					polychaeta	
Common Sandpiper (N = 1)					polychaeta	
Greenshank (N = 6)		mosquito larvae/ polychaeta/gastropoda		amphipoda	ephydridae	
Bar-tailed Godwit (N = 1)	gastropoda/ ephydridae					
Great Knot (N = 1)					gastropoda	
Sharp-tailed Sandpiper (N = 2)					amphipoda/polychaeta	
Red-necked Stint (N = 16)		polychaeta			amphipoda/polychaeta gastropoda	
Curlew Sandpiper (N = 4)					polychaeta/amphipoda	

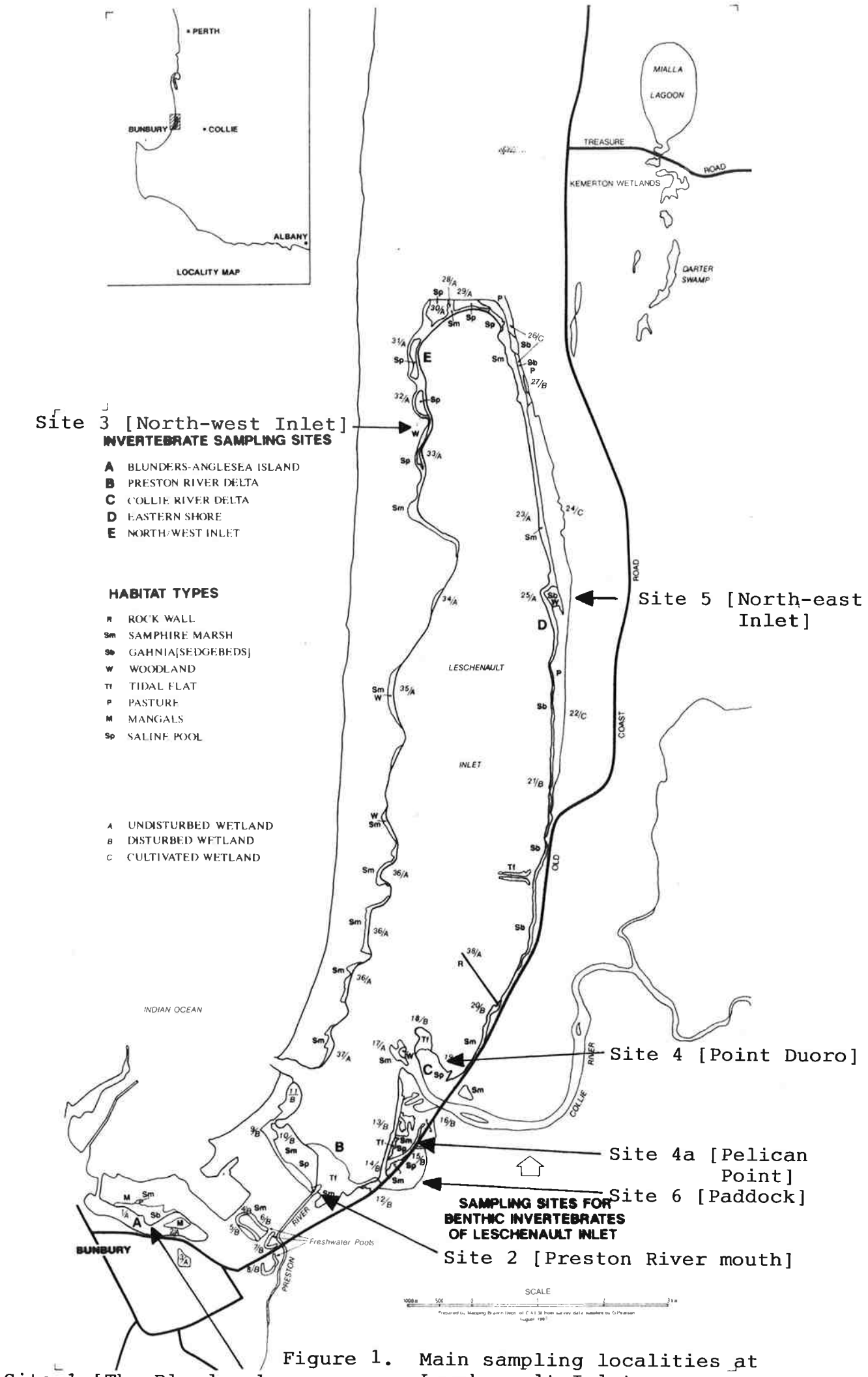

Figure 1. Main sampling localities at Leschenault Inlet.

Figure 2. Numbers of invertebrate species in each habitat type on the different sampling dates. Means and ranges are shown, sample size is indicated in parentheses.