



C.A.P.E. ESTUARIES PROGRAMME

# Collection of Bait Organisms in Estuaries

# G.3

C.A.P.E. Estuarine Management Guideline



Version 1  
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**Our strategic vision for the estuaries in the Cape Floristic Region is:**

*Our estuaries are beautiful, rich in plants  
and animals, they attract visitors,  
sustain our livelihoods and  
uplift our spirits.*

*C.A.P.E. Estuaries Guideline 3: Collection of bait organisms in estuaries*

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*Bait Collection*

## Table of Contents

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1. INTRODUCTION	1
2. ESTUARINE BAIT ORGANISMS AND DESCRIPTIONS OF THEIR RESPECTIVE LIFE HISTORY STRATEGIES	1
3. METHODS OF BAIT COLLECTING AND IMPACTS	6
4. GUIDELINES FOR BAIT COLLECTING AND RECOMMENDATIONS	7
5. REFERENCES	9

## Figures

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Figure 1. Opening and closing of the mouth in the Great Brak between 1990 and 1995. Light bars indicate when the mouth was open, dark bars indicate times of mouth closure. The duration of mouth opening is indicated in days (d) or months (mo). Circles indicate when the estuarine mud prawn population was sampled in 1992 and 1993 (after Wooldridge 1999).	4
Figure 2. Size class distribution (based on carapace length) of <i>U. africana</i> population in the Great Brak Estuary on each of the four sampling dates (see Figure 9.2). The relatively small sample size shown in A and B is a reflection of the very low density of prawns in the estuary (see Figure 9.4). Note the growth rate and ultimate mortality of cohorts as the population aged. The maximum age of mud prawns is about 3-4 years (Hanekom & Baird 1992), although the current data suggest that it is nearer three years. The smallest prawns in the substratum have a carapace length of about 5 mm.	5
Figure 3. Recovery of the <i>Upogebia africana</i> population over 4 years following the extended period of mouth closure (1990-1991) in the Great Brak Estuary (see Figure 1). Data are compared to prawn density in the adjacent Klein Brak Estary that remained permanently open during the monitoring period.	6

## Tables

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Table 1. Flux of <i>Upogebia africana</i> Stage 1 larvae and postlarvae across the mouth of the Swartvlei Estuary during two 24 h sampling series (22-23rd October 1986, three days after maximum spring tide and 29-30th October 1986, three days after maximum neap tide). Water volumes were computed using the 1-dimensional hydrodynamic model of Huizinga (1987). Hourly flow volumes were integrated with larval abundance collected from the plankton (after Wooldridge 1994). Note that maximum export of Stage 1 larvae occurs around spring tides and not neap tides and maximum import of postlarvae is associated with neap tides when the start of the flood is crepuscular (after Wooldridge 1994).	3
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## 1. Introduction

Exploitation of invertebrates used as bait by recreational and subsistence anglers is a focal activity in most estuaries around the South African coast. Utilization of these living resources and the impact on other organisms and associated habitats may be persistent (e.g. close to urban environments) or more seasonal in nature (e.g. holiday resorts). In some estuaries, the impact of bait collection is considered very severe (van Driel 2000). Patterns of bait usage are obviously dependent on the estuary and fish species being targeted, but mud- and sand-prawns (*Upogebia africana* and *Callinassa kraussi* respectively) often emerge as the most sought after organisms (Wynberg & Branch 1994, Pradevand 1998). The former species dominates muddy intertidal regions and the latter in inter- and sub-tidal sandy areas (Day 1981). These two prawn species may also contribute substantially to intertidal and subtidal macrofaunal biomass (Hodgson *et al.* 2000). In the Swartkops estuary for example, the contribution of the two prawn species exceeds 90% of the biomass on non-vegetated banks (Hanekom *et al.* 1988). Mudprawns also contribute substantially to the diet of birds and fish, transferring significant levels of energy to higher trophic levels (Baird & Ulanowicz 1993). In the Swartkops estuary, the level of consumption by natural predators may exceed that removed by bait collectors (Hanekom & Baird 1992). In this estuary birds removed about 13% of annual somatic production, while bait collectors removed only 2% (Hanekom & Baird 1992). Similar levels or less of prawns removed by bait diggers are also reported for other estuaries (Wynberg & Branch 1994, Hodgson *et al.* 2000).

In order to ensure sustainability of our marine living resources (advocated by the Marine Living Resources Act; Act No. 18 of 1998), the Western Cape Estuaries Working Group is committed to ensure that estuaries in the region remain productive and biologically diverse. Bait collection is an integral part of resource management and currently, emphasis focuses on the way in which bait is collected and the maximum number of organisms that may be removed per day by collectors. The current document focuses on broad practical guidelines for management purposes, incorporating the following terms of reference:

- A brief description of the activity (and appropriate environmental impacts where applicable) that needs to be managed;
- Practical guidelines for the activity that needs to be managed, and
- Management recommendation towards implementing (and improving) the guidelines.

## 2. Estuarine bait organisms and descriptions of their respective life history strategies

The burrowing prawns *Callinassa kraussi* and *Upogebia africana* are probably the most common bait organisms targeted by collectors (Wynberg & Branch 1994, Pradevand 1998), although pencil bait (*Solen* spp.) and bloodworm *Arenicola loveni* are also popular bait organisms. Information on life history strategies is relatively good for the burrowing prawns, but poor for the other species.

Sand and mud prawns are particularly abundant in warm and cool temperate estuaries, with each species inhabiting a preferred sediment type. Mixed populations are

documented, but *C. kraussi* generally occurs in sand and *U. africana* in muddy sediments. Adults of both species have a wide salinity tolerance range and *U. africana* for example, can molt successfully in 3.4 psu (Hill 1981). Forbes (1978) reported populations of *C. kraussi* living in the upper reaches of Swartvlei and Keurbooms estuaries where salinity values are sometimes below 5 psu. However, experimental work on the tolerance levels of estuarine animals has mostly been done on adults and it cannot be assumed that larval stages or juveniles will have an equivalent tolerance level (Hill 1981).

The sand prawn (*C. kraussi*) is found in both permanently open and temporary open estuaries. It is also present in sheltered lagoons and bays off sandy beaches (Day 1957, Cockcroft & Tomalin 1987). *C. kraussi* has an abbreviated larval life without planktonic stages (Forbes 1973). Adult *C. kraussi* are able to tolerate salinity values as low as 1 psu, but successful development of eggs and larval stages requires salinity values > 20 psu (Forbes 1978). Populations living in areas where salinity values are permanently below 17 psu are not self-maintaining and must be recruited from elsewhere in an estuary. Both adults and juveniles appear to be involved in dispersal and recruitment of the species.

The mudprawn *Upogebia africana* is often abundant in permanently open estuaries. Day (1981) noted that mud prawns were absent from estuaries that had closed for 'extended periods' and provided reasons for its absence from these systems. More recent focus on the larval life history strategies has now shown that mud prawn larvae require an obligatory marine phase of development. First-stage larvae migrate from the estuary in highest numbers on the crepuscular ebb tide. After a period of development at sea (weeks), postlarvae return to estuaries in highest numbers on the crepuscular flood tide (Wooldridge 1999). Maximum release of Stage 1 larvae and the return of postlarvae therefore follow a semi-lunar rhythm. Peak emigration of larvae is synchronized to the start of the ebb tide at sunset (shortly after maximum spring tide amplitude) and the time of peak return of postlarvae is synchronized to the start of the flood at sunset. Maximum immigration of postlarvae is therefore before maximum spring tide amplitude. The timing of emigration of larvae and immigration of postlarvae relative to the state of the moon is not fixed, but will shift between winter and summer as the time of sunset changes between seasons.

Analysis done on zooplankton samples collected in the mouth of the Swartvlei Estuary provided an estimate of the number of emigrating Stage 1 larvae on the ebb tide and the return of postlarvae on the flood tide (Table 1). Plankton data were collected over 24 hrs on each occasion and are integrated with computed water volumes moving in and out of the estuary over the same 24 h period (Huizinga 1987). The data in Table 1 replicates the same semi-lunar pattern of behaviour previously described. At the time of sampling in October, over  $5 \times 10^6$  Stage 1 larvae were exported from Swartvlei Estuary on a single nocturnal ebb tide. A week later, over  $200 \times 10^3$  postlarvae recruited back to Swartvlei on a single nocturnal flood tide to potentially settle on the estuarine mud banks. Over the period of the breeding season (months) the efflux and influx of larvae must be considerable, provided the tidal prism is not constrained through mouth constriction or closure.

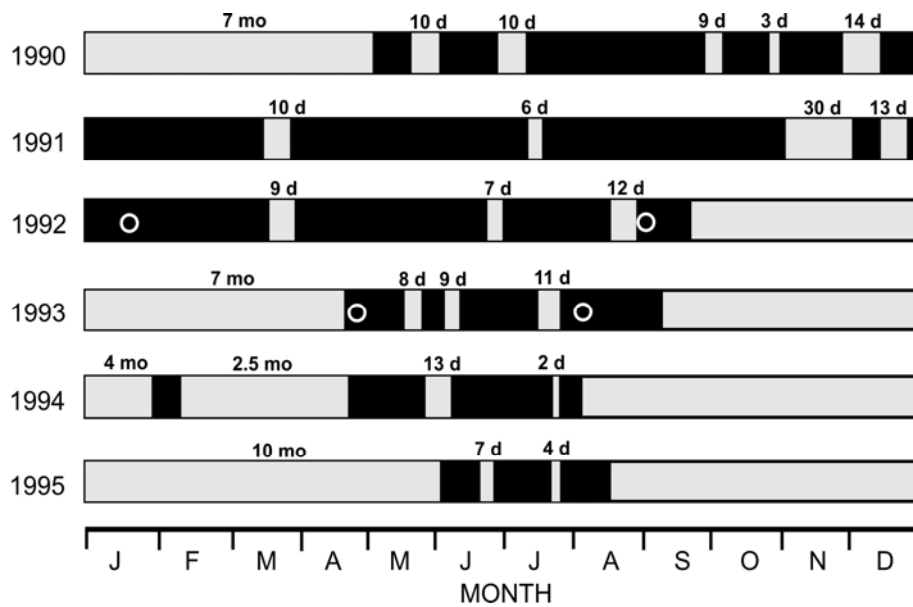
The importance of these data reflects potential recruitment to mudbank populations in the Swartvlei estuary on a single tide. Most postlarvae return to estuaries around neaps leading to pulse events every two weeks (determined by the lunar cycle) for the duration of the breeding season (although number will also vary between recruitment events).

**Table 1.** Flux of *Upogebia africana* Stage 1 larvae and postlarvae across the mouth of the Swartvlei Estuary during two 24 h sampling series (22-23rd October 1986, three days after maximum spring tide and 29-30th October 1986, three days after maximum neap tide). Water volumes were computed using the 1-dimensional hydrodynamic model of Huizinga (1987). Hourly flow volumes were integrated with larval abundance collected from the plankton (after Wooldridge 1994). Note that maximum export of Stage 1 larvae occurs around spring tides and not neap tides and maximum import of postlarvae is associated with neap tides when the start of the flood is crepuscular (after Wooldridge 1994).

	STAGE 1 LARVAE		POSTLARVAE	
	DAY	NIGHT	DAY	NIGHT
<i>Spring tides</i>				
Flood	0	817	7613	883670
Ebb	0	540528	0	0
Net export (-) or import (+)		- 539711		+ 95980
<i>Neap tides</i>				
Flood	0	0	0	202455
Ebb	0	9843	0	2175
Net export (-) or import (+)		- 9843		+ 200280

Stage 1 larvae do not metamorphose through subsequent larval stages if trapped in estuaries and this probably accounts for the absence of the species in closed systems. The continued existence of *Upogebia africana* in Temporary Open Estuaries (TOE's) is directly dependent on the relationship between open and closed phases of the tidal inlet. Opening of the mouth during the breeding season may still enable populations of *U. africana* to survive over time in some estuaries (e.g. Great Brak). However, should the mouth remain mostly closed during the breeding season (summer), recruitment ceases and estuarine mud prawn densities decline or even become locally extinct. The construction of the Wolwedans Dam on the Great Brak River is an example of how estuarine populations of *U. africana* can be affected by changes in the natural opening and closing of the mouth.

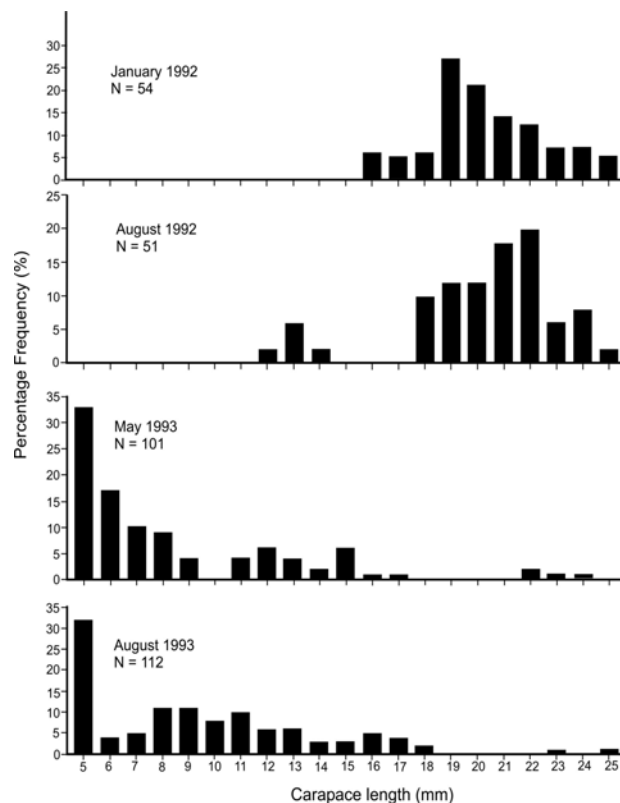
The Wolwedans Dam (maximum capacity  $24 \times 10^6 \text{ m}^3$ ) was completed at the end of summer in 1990 (March-April). Little freshwater reached the estuary over the following 28 months as the dam filled. During this time the estuary remained mostly closed, opening occasionally for a few days. In November 1991 the estuary opened for 30 days. The dam reached the designed storage level in the spring of 1992 (September). Thereafter, a management plan that included planned releases of freshwater from the dam when required ensured that the estuary returned to the typical pattern of opening in summer and closing during the dry season.



**Figure 1.** Opening and closing of the mouth in the Great Brak between 1990 and 1995. Light bars indicate when the mouth was open, dark bars indicate times of mouth closure. The duration of mouth opening is indicated in days (d) or months (mo). Circles indicate when the estuarine mud prawn population was sampled in 1992 and 1993 (after Wooldridge 1999).

The impact of extended mouth closure over the 28 months following completion of the dam is clearly seen in **Figure 3**. Recruitment to the estuarine *Upogebia africana* population ceased during this period resulting in discontinuous distribution of size classes. Integration of mud prawn growth rate (Hanekom & Baird 1992) and the lower size limit of the smallest cohorts shown in Figure 3 A -E provide an indication when recruitment last took place each time the estuary was sampled. Recruitment only occurred when the mouth was open to the sea. In Figure 9.3A for example, the smallest cohorts (16-18 mm carapace length) sampled in January of 1992 were about 17-21 months old, indicating that recruitment last occurred in April 1990, shortly before the period of extended mouth closure (**Figure 2**). Some recruitment occurred in November 1991 when the mouth opened for 30 days; reflected in the three smallest size classes (12-14 mm carapace length) shown in Figure 2B. Good recruitment occurred after the mouth again opened during most of the summer of 1993 (Figure 2C and 2D).

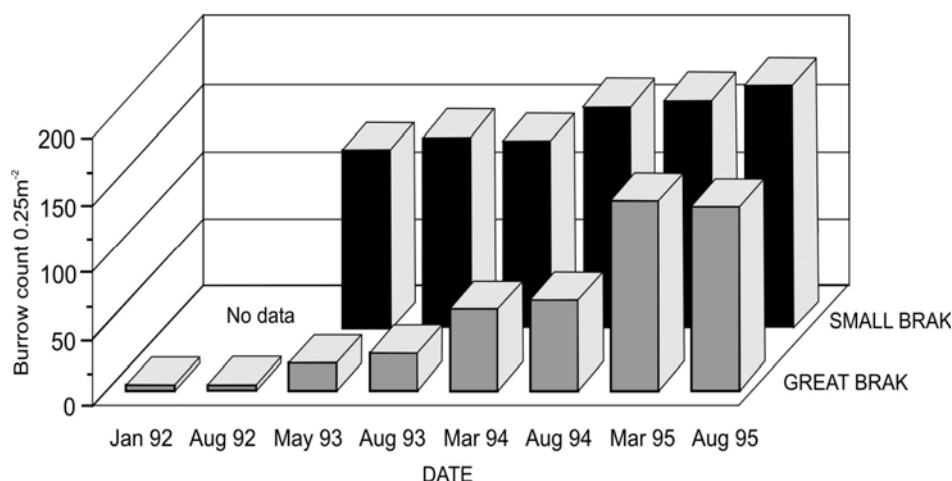
Population recovery (expressed as changes in prawn density over time) after the extended period of mouth closure in 1990 and 1991 (**Figure 2**) in the Great Brak Estuary was relatively slow and was monitored over four years (1992-1995, **Figure 3**). Recovery was exponential, with no recruitment to the population during winter (non-breeding period) when the mouth was closed (reflected in the similarity in prawn density within each year sampled, **Figure 3**). Data from the adjacent permanently open Klein Brak Estuary over this time period are provided for comparative purposes.



**Figure 2.** Size class distribution (based on carapace length) of *U. africana* population in the Great Brak Estuary on each of the four sampling dates (see Figure 9.2). The relatively small sample size shown in A and B is a reflection of the very low density of prawns in the estuary (see Figure 9.4). Note the growth rate and ultimate mortality of cohorts as the population aged. The maximum age of mud prawns is about 3-4 years (Hanekom & Baird 1992), although the current data suggest that it is nearer three years. The smallest prawns in the substratum have a carapace length of about 5 mm.

There are also other estuarine organisms that have a similar lifestyle to *Upogebia africana* and include numerous crab species (Hill 1975, Pereyra Lago 1993, Papadopoulos *et al.* 2002). These populations are therefore also dependent on the state of the mouth with respect to recruitment to estuarine populations. Unlike *U. africana*, *Callinassa kraussi* does not have a marine phase during its life cycle and is not dependent on the state of the mouth in order for recruitment to take place.

Extensive quantitative investigations of molluscs in Temporary Open Estuaries in the warm or cool temperate regions of South Africa have not been undertaken, although populations are fairly well studied in permanently open systems. According to Day (1951), bivalve molluscs are relatively scarce in South African estuaries and they do not reach the high densities recorded in Europe (McLachlan 1974). Pencil bait species such as *Solen capensis* and *S. cylindraceus* may be locally common in some estuaries (Hodgson 1987), with the former species present in sandy substrata and *S. cylindraceus* occurring in muddy areas. Both *Solen* species concentrate around the inter- and sub-tidal interface. The growth rate of local estuarine molluscs is described as moderate, with *Solen cylindraceus* living to about five years (McLachlan 1974).



**Figure 3.** Recovery of the *Upogebia africana* population over 4 years following the extended period of mouth closure (1990-1991) in the Great Brak Estuary (see Figure 1). Data are compared to prawn density in the adjacent Klein Brak Estuary that remained permanently open during the monitoring period.

The bloodworm *Arenicola loveni loveni* is also a popular bait organism, although distribution is not restricted to estuaries. Estuarine abundance levels are highly variable and the species is easily over-exploited in some estuaries where it occurs. Bloodworms prefer sandy substrata and relatively high salinities and are therefore found on sandbanks near the mouth of open estuaries. Reproduction occurs during a synchronized annual epidemic spawning event in mid to late summer (Lewis 2005). Information on the life history strategy is generally described as 'poor' (Britz *et al.* 2001). However, in North East England, bloodworms attain an age of about six years and breed several times during their life (Fowler 1999).

### 3. Methods of bait collecting and impacts

The most common legal method used by invertebrate bait collectors is the prawn or suction pump. Pencil bait is more commonly collected using a length of hooked wire. In both these methods, sediment core disturbance is minimal when compared to the amount of sediment turnover using a spade or long blade. However, it is important to distinguish between the number of bait organisms removed and the longer term effects on the target species, associated benthic communities and birds utilizing the former undisturbed habitat. In the following discussion, the microflora and meiofauna will not be covered, although negative impacts on these groups are widely reported in the literature (see Wynberg & Branch 1994 for examples).

Wynberg & Branch (1991) calculated that only 3.2% of the sand- and mudprawn population in Langebaan Lagoon was removed annually. Although a relatively small proportion, bait collecting inflicted serious damage on other components of the macrofaunal assemblage. These species not utilized by fishermen were negatively impacted through avian or fish predation and physical injury caused by pumping. Together with other studies, results suggest that the cumulative impacts of bait collecting led to noticeably lower densities of target species in heavily exploited areas over time (Wynberg & Branch 1991 and references therein). Because larger prawns are usually

removed by bait collectors, further impact on population structure may also result (Wynberg & Branch 1991).

Long-term effects of bait-collecting on biota inhabiting sediment are also apparent. The impact of bait pumping and trampling of mudflats may affect the sediment down to at least 20 cm, as reported in one Australian study (Contessa & Bird 2004). Sediment compaction may explain the slow recovery (18 months) of *Callinassa kraussi* and *Upogebia africana* to former densities at experimental sites of high-intensity harvesting (Wynberg & Branch 1994). A variety of other macrofaunal species were also adversely affected, with much slower rates of recovery than anticipated.

The impact of illegal bait collecting using a spade and overturning large volumes of sediment will also have severe negative consequences for many species. In addition to trampling effects, some near-surface dwelling invertebrates are buried too deep for their subsequent survival (Cryer *et al.* 1987). McLusky *et al.* (1983) reported a protracted period of recovery for the bloodworm *Arenicola marina* in the Forth estuary in Scotland, with reduced abundance on dug mounds for over three months after digging. Cryer *et al.* (1987) also working on bloodworm in South Wales, reported no significant increase in density of worms after six months in areas depopulated by digging. Similar results were reported by van den Heiligenberg (1987) working in the Dutch Wadden Sea.

Disturbance caused by bait collectors on bird populations is also well documented. Impact on birds may be due to:

- habitat changes caused by bait collectors;
- changes in the biotic assemblage brought about by physical disturbance; or
- direct disturbance of foraging birds by bait collectors.

The latter impact is exacerbated by birds and bait collectors targeting banks at similar times; i.e., after the exposure of banks on the ebbing tide. Because bait collectors tend to spread across the lower intertidal areas when collecting, prime sites are often unavailable to foraging birds, at least temporarily.

#### 4. Guidelines for bait collecting and recommendations

As reported by Wynberg & Branch (1994), physical disturbance of sand- and mudprawns banks is also a key factor affecting benthic populations. A publication focusing on *Callinassa kraussi* (Wynberg & Branch 1997) confirmed that trampling *per se* had almost the same effect as the removal of the prawns, impacting negatively on both the target species and on the associated biotic assemblage. Similar statements are made by other researchers, e.g. Contessa & Bird (2004). Consequently, management guidelines for bait-collecting must include:

- protection of habitat;
- protection of non-target components of the benthic community;
- protection of birds utilizing intertidal habitats, either through direct disturbance or through impact on food resources; and
- bag limits on target bait species.

Bag limits on bait organisms are particularly important in low-density populations (e.g. the bloodworm *Arenicola loveni loveni*) or for species that are spatially limited in distribution (populations in small estuaries). Small systems dominate estuaries in terms of size in the CAPE region and usually close off periodically from the sea. Mouth closure will naturally affect estuarine recruitment of species that have an obligatory phase of marine development (e.g. the mudprawn *Upogebia africana*), leading to relatively high variation in estuarine population biomass. Variation in biomass is in turn linked to the timing and duration of mouth closure. In the case of *Upogebia africana*, prolonged mouth closure after dam construction in the Great Brak estuary resulted in a population crash that took years to recover (refer to Figures 1-3, this document).

Based on:

- available life history requirements of target bait species;
- population distribution patterns of bait species;
- the disturbance and destruction of habitat and associated biotic assemblages; and
- disturbance of bird communities,

the following broad management guidelines are recommended:

- Estuarine Bait Protected Areas (EBPA's) should be established in non-vegetated intertidal areas of individual systems. The area set aside as an EBPA will probably vary between estuaries, but should approximate 20 - 30% of intertidal flats that include sand and muddy habitats. Demarcation of a designated EBPA is possible using signboards. Within these EBPA's, no human disturbance of any sort should be permitted.
  - An EBPA would eliminate trampling effects (negative impacts on target species and the associated biotic assemblage); and
  - Reduce disturbance on birds (foraging and roosting).
- The location of EBPA's should not be permanently fixed, since benthic populations vary as habitat changes occur. A large flood or a prolonged period of mouth closure can lead to shifts in intertidal characteristics. An EPBA may also expand, reduce or change to a new locality based on new management issues.
- No collection of mudprawns (*Upogebia africana*) by bait collectors should be permitted in Temporary Open Estuaries, unless large populations persist over time. The motivation includes:
  - Biomass of populations are likely to show high variance as they respond to mouth condition; and
  - Recovery rates from a low base (prolonged mouth closure aggravated by excessive harvesting by bait collectors) may take 3-4 years to recover (refer to Great Brak example).
- The life history of the sandprawn *Callianassa kraussi* on the other hand, is independent of the state of the mouth and the population is often more abundant in the subtidal if suitable sediment is present. However, in closed estuaries where salinity falls below ca 20 ppt for protracted periods during the breeding season, consideration of closing the estuary to bait collecting should be considered. Little information on life history strategies of other bait organisms exists currently and no collecting of these species should be permitted until an informed decision can be made. *C. kraussi* is widespread, also occurring in the marine environment.
- The bag limit of 50 prawns (*Upogebia africana* and *Callianassa kraussi*) per day should be reviewed after consultation with stakeholders. Current feeling is that although 50

prawns may be collected by individuals, not all will be utilized for the purposes for which they were intended. The removal of 50 prawns *per se* from large populations is not an issue, but associated impacts become cumulatively damaging. If fewer prawns are collected, these associated impacts will be reduced. This strategy may offset at least in part, increased effort by collectors in the smaller area where collectors are permitted to harvest prawns (establishment of an EBPA reduces total area available to bait collectors).

- The use of spades, forks and long blades must be more strictly controlled, as these tools are particularly damaging to habitat and biota.
- Bait collecting should not be permitted after sunset since larval release and postlarval settlement are maximal at this time. Any disturbance to the sediment in the lower intertidal is likely to have a greater impact on these cohorts after sunset compared to other times of the diel cycle. Available information suggests that the lower intertidal supports a greater proportion of gravid and newly settled prawns compared to higher up the gradient. Small prawns are also likely to construct shallow burrows (a few centimeters) compared to larger prawns, but further research is required to confirm observations.

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