CHAPTER 6

SURVIVAL OF *Urohaustorius metungi* IN THE WATERS OF INTERMITTENTLY CLOSED ESTUARIES: A TRANSLOCATION EXPERIMENT

Foreword

The aim of this chapter was to test some of the major findings that had arisen from previous chapters, primarily by manipulating a key discriminatory population within the estuarine community. However, following deployment of the experiment in October 2004, it was destroyed only a few days later by a major climatic event (heavy rain resulting in major opening events across all closed estuaries). The experiment was re-run at the next available opportunity in June 2005. This time, one week after deployment, the entire north coast of NSW was devastated by floods. In some parts these were the worst floods in 70-100 years. Again, the experiment could not be satisfactorily completed.

To put these events into perspective, floods in the area generally occur during February - March. Therefore, to have two consecutive floods at unusual times of the year was not only completely unexpected but also impossible to predict. Still, to do justice to the many hours spent planning and preparing the experiment, collecting fauna and setting up the experiment in the field, a detailed description is given of what was attempted. It is hoped that this will also demonstrate the thought processes linking this to previous outcomes and the considerations to manipulative scientific methodology that were required in the experimental design.

6.1 Introduction

Comparisons of benthic community structure among a number of estuaries within the Solitary Islands Marine Park have determined that distinct assemblages occur in the different estuary types (Chapters 4 & 5). The species that was primarily responsible for differentiating these estuary types, on repeated occasions, was the urohaustoriid amphipod *Urohaustorius metungi*. Throughout coastal New South Wales, *U. metungi* is one of the most common crustaceans in sandy habitats, including those of estuarine, near-shore marine and sandy beach environments (Barnard & Drummond 1982; Dexter 1992). However, whilst highly abundant throughout the lower, sandy reaches of the permanently open estuaries, *U. metungi* was rarely detected among adjacent intermittently closed estuaries and absent altogether from a third of the estuaries within this type.

It was hypothesized that there were two general mechanisims that could potentially explain this phenomenon. Firstly, the low abundances of *U. metungi* within the intermittently closed estuaries may be due to a physical barrier, whereby the repeated entrance closures in an estuary result in reduced marine influences. Consequently, access to such an estuary may be severely restricted, particularly if entrance closure coincides with the timing of key dispersal and recruitment periods for this species. Alternatively, *U. metungi* is able to access the intermittently closed estuaries and it is the effects that entrance closure has on either abiotic (e.g. water movement, water quality, sedimentary parameters) and/or biotic (e.g. competitive interactions, food availability) conditions that limit the viability and survival of the species in these estuaries.

This study aimed to examine these ideas by removing any potential physical barrier by translocating specimens of *U. metungi* into closed estuaries. I could then test the hypotheses that fauna are limited in intermittently closed estuaries due to: i) restricted access; ii) entrance closure effects on abiotic conditions, including water quality and sediment parameters; or iii) entrance closure effects on biotic conditions (Fig. 6.1). There are a number of potential outcomes (Fig. 6.1), each of which will provide direction for subsequent experiments to further determine the reason for the very low occurrence of *U. metungi* in the intermittently closed estuaries. For example, if water quality is found to limit the survival of this species, then laboratory experiments may be conducted to determine which specific water quality variable is of most importance.

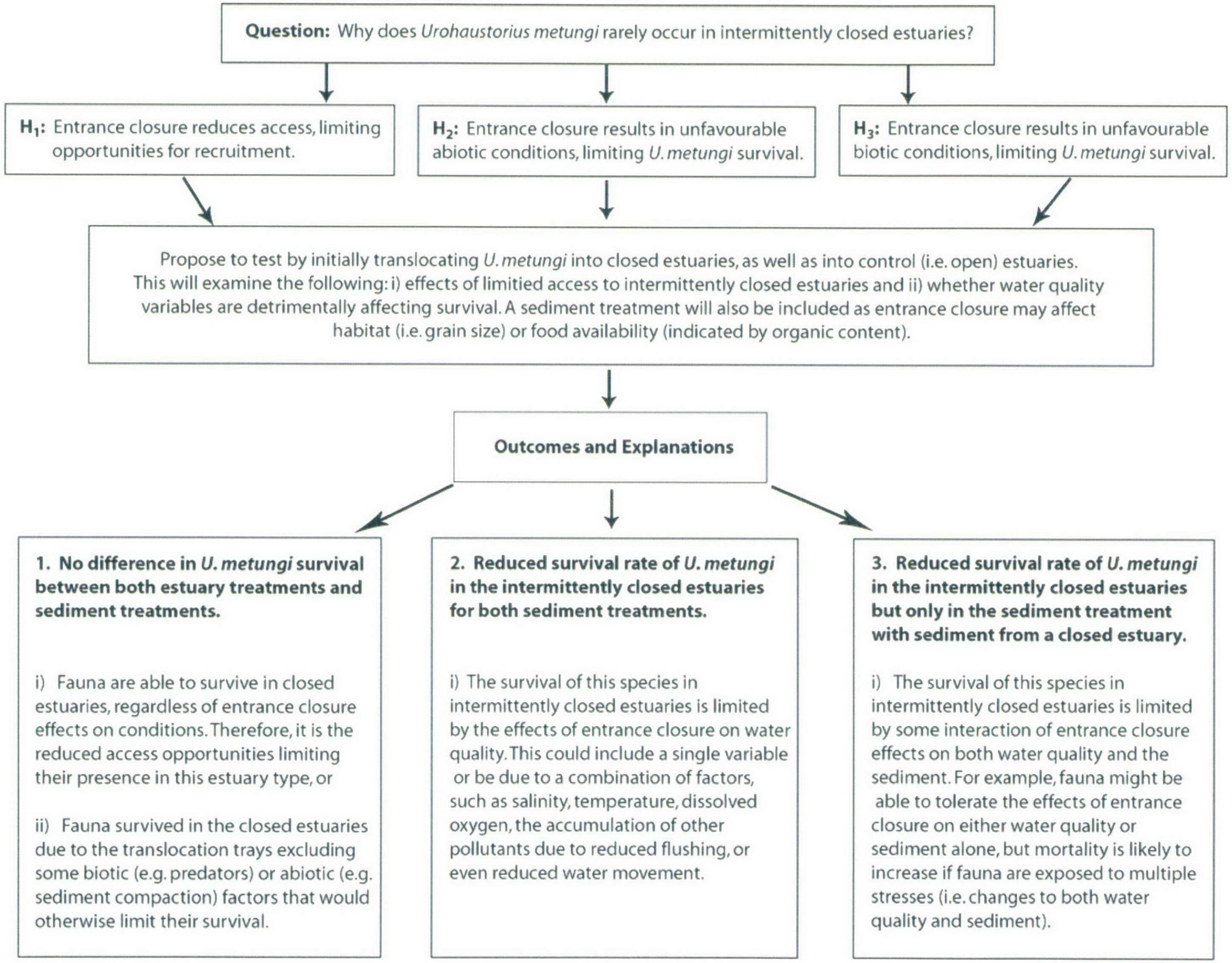

Fig. 6.1 Experimental plan with proposed hypotheses and expected outcomes.

6.2 Methods

6.2.1 Study Location

Two permanently open estuaries, Moonee Creek and Corindi River, as well as two intermittently closed estuaries, Hearns Lake and Darkum Creek, were selected as study locations. *Urohaustorius metungi* commonly occurs in very high abundances in Moonee Creek and Corindi River. In contrast, previous surveys over a two-year period failed to detect this species in Hearns Lake and only an occasional individual occurred in Darkum Creek. Before commencement of the experiment, the two intermittently closed estuaries had been without marine input for two months, which allowed for some time to elapse between the initial time of entrance closure and the occurrence of any direct, or indirect, effects on within-estuary conditions. All of the animals used in this study were collected from a fifth estuary, the permanently open Coffs Creek. The study was also conducted wholly within the lower sites of the estuaries as the test species, *U. metungi*, only occurs in sandy habitats.

6.2.2 Fauna Collection

Live specimens of *U. metungi* were collected from shallow, subtidal areas Coffs Creek where they were known to occur. They were collected during a low tide by sieving sand through a 1 mm mesh; the specimens retained were transferred into containers of saltwater using a wide pipette. The containers of saltwater were aerated, insulated and also contained a thin layer of sand to allow the animals to burrow, as they would normally do in their natural habitat. Once enough specimens were collected, they were transported to the laboratory and remained in their aerated, saltwater containers until being relocated to other estuaries.

6.2.3 Experimental Unit

When the fauna were translocated to another estuary they were placed in an enclosed translocation tray. The translocation trays consisted of a plastic base and sides, approximately 21 x 30 x 7 cm. The tops of the tray, as well as openings that comprised much of their sides, were covered with a fine, plankton-type mesh that removed the possibilities of: i) *U. metungi* escaping; ii) other adult macrofauna entering the tray; and ii) predation. This mesh, together with the holes in the tray sides, allowed horizontal water movement through the enclosed tray. The translocation trays were completed by being ¾ filled with defaunated sediment (i.e. sand).

The sediment had been defaunated using a two-step process. Initially it was wet sieved through a 1 mm mesh and anything greater than 1 mm, including fauna, was discarded. It was then frozen at – 15 °C for 48 hours to destroy any remaining juvenile macrofauna, before being thawed to room temperature (Stark et al. 2003). Each deployed translocation tray was always secured in place by four stainless steel stakes.

6.2.4 Study Design

The experiment was designed so that equal numbers of translocation trays, with the test species enclosed, would be placed in two closed estuaries and in two control (i.e. permanently open) estuaries. A consistent number of randomly selected trays would then be retrieved from the experiment at various time intervals and examined to determine survival rates. However, there were still a number of factors that had to be taken into consideration. Firstly, it would be preferable to ensure that the movement and handling of *U. metungi*, including their collection, transportation, storage and deployment in the translocation trays themselves, was not detrimentally affecting their survival. Secondly, how many individuals of *U. metungi* should be deployed in each of the experimental trays and, thirdly, how long should the translocation trays be left in their respective estuaries before retrieval?

The translocation trays were approximately the same size and dimensions as the sampling unit that had been used to identify the previously mentioned differences in community structure between estuary types. Data from these studies determined that the average number *U. metungi* individuals collected in samples this size from sandy habitats was 10. Therefore, all translocation trays that were deployed in this manipulative study contained 10 individuals *of U. metungi*. The remaining issues were addressed with a pilot study. In the pilot, study three trays, each containing 10 animals, were deployed as translocation controls in Coffs Creek, the estuary where the test species was originally collected. This allowed an examination of whether the fauna were affected by the handling and translocation process. An additional three translocation trays were simultaneously deployed in a closed estuary, Darkum Creek. One tray was then retrieved from each estuary after two days, one week and two weeks following deployment, to determine an appropriate duration for the larger experiment. All fauna were alive in the trays retrieved from Coffs Creek at all time intervals. The results were the same for Darkum Creek until the final tray was retrieved at two weeks, when survival of *U. metungi* declined to 70 %.

Following the results of the pilot study, together with the inclusion of two sediment treatments (i.e. translocation trays containing defaunated sediments from either (1) an intermittently closed or (2) permanently open estuary) the final experimental design is summarised in Fig. 6.2.1. Thus, within each estuary 18 translocation trays were deployed, half of which contained sediment treatment 1 and the remaining half sediment treatment 2 (Fig. 6.2.2). Each also contained 10 individuals of *U. metungi*.

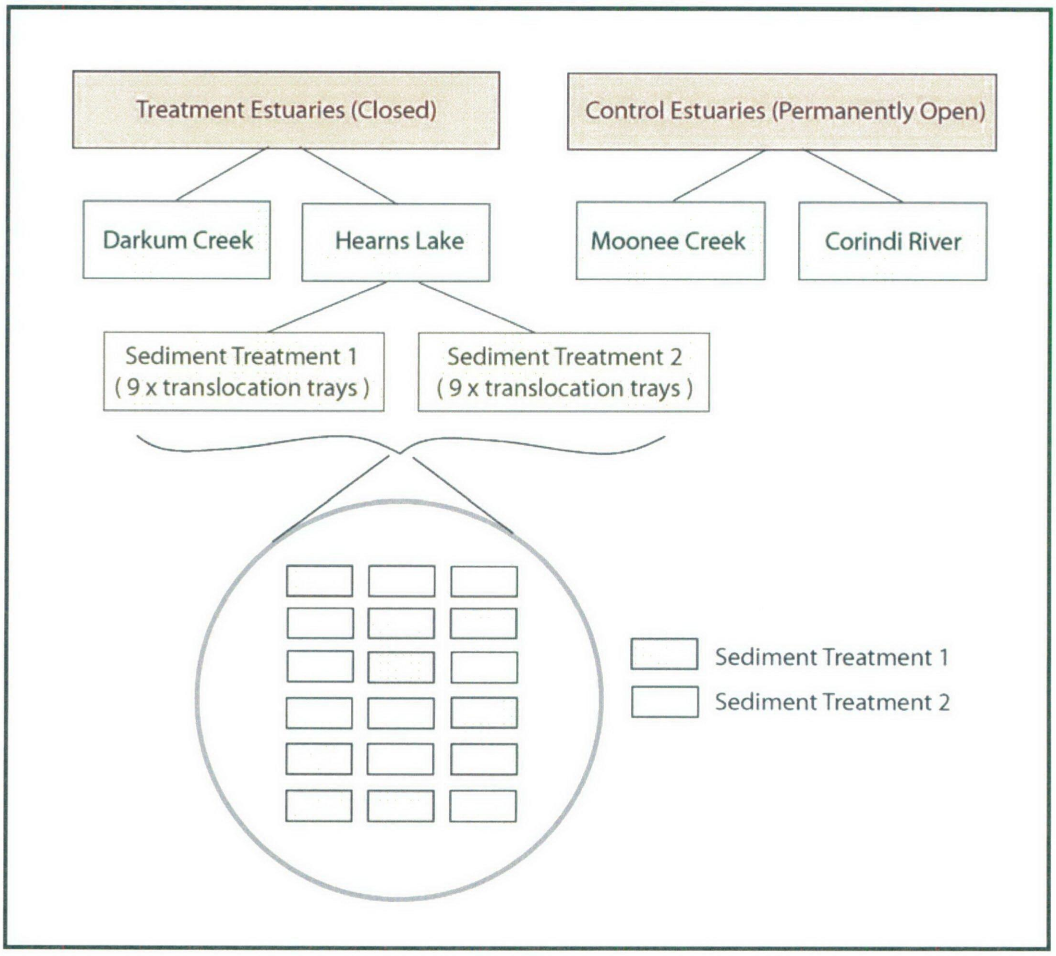

Fig. 6.2.1 Diagrammatical representation of the experimental design. The sediment treatment and the number of translocation trays were identical in each estuary (i.e. 18 translocation trays per estuary). Sediment treatment 1 = sediment from a closed estuary; sediment treatment 2 = sediment from a permanently open estuary. Each translocation tray contains 10 individuals of *Urohaustorius metungi*.

Three time intervals were selected for tray retrieval, these being two, four and eight weeks. On each of these occasions three randomly selected trays from each sediment treatment, six trays in total, were retrieved from an estuary. The contents were sieved through a 1 mm mesh and examined for surviving fauna. This was repeated concurrently cross all four estuaries.

Fig. 6.2.2 Eighteen mesh-covered translocation trays deployed in Moonee Creek, October 2004.

6.3 Results / Discussion

Before the first two-week data were collected, all estuaries experienced flooding, which impacted the experiment from two aspects. Firstly, the entrances of the two intermittent estuaries opened, which immediately nullified the estuary type treatment by getting rid of any entrance closure effects on water quality since, once open, the intermittently closed estuaries experience high levels of water flushing and marine exchange. The opening events in the intermittently closed estuaries also caused massive amounts of sediment scouring so that up to 1 m or more of the sediment beneath the experimental trays was washed out to sea (Fig. 6.3.1) and, in most cases, the trays went with it. Flood-waters also dislodged a number of experimental trays in Corindi River.

Fig. 6.3.1 Sediment scour has exposed bedrock in the lower reaches of Hearns Lake after a major opening event, October 2004.

The experiment only remained intact at Moonee Creek and the experimental trays in this estuary were retrieved and examined following the time schedule that had been originally selected. This was done so that some data could be salvaged from the experiment to examine the sediment treatment. Based on the data collected from Moonee Creek, analysis-of-variance revealed that the sediment treatment had no significant effect ($F = 0.03_{1,8}$; $p = 0.866$) on the survival of the relocated amphipods, with an average of more than 60 % surviving in each of the sediment treatments throughout the eight weeks of the experiment (Fig. 6.3.2)

A second attempt to run this experiment was conducted six months later in June 2005. It was necessary to wait this long as the intermittent estuaries had to close, and remain closed for some time. Due to approaching reporting deadlines, severe time restrictions applied this time around and the lack of an effect for the sediment treatment revealed in the first experiment was taken into account. Consequently, the sediment treatment was excluded and all trays contained sediment from the same estuary, thereby reducing the number of experimental units to only nine per estuary. This approach, however, needed to be taken with caution as, although no significant sediment treatment effects were previously found in Moonee Creek, this does not exclude

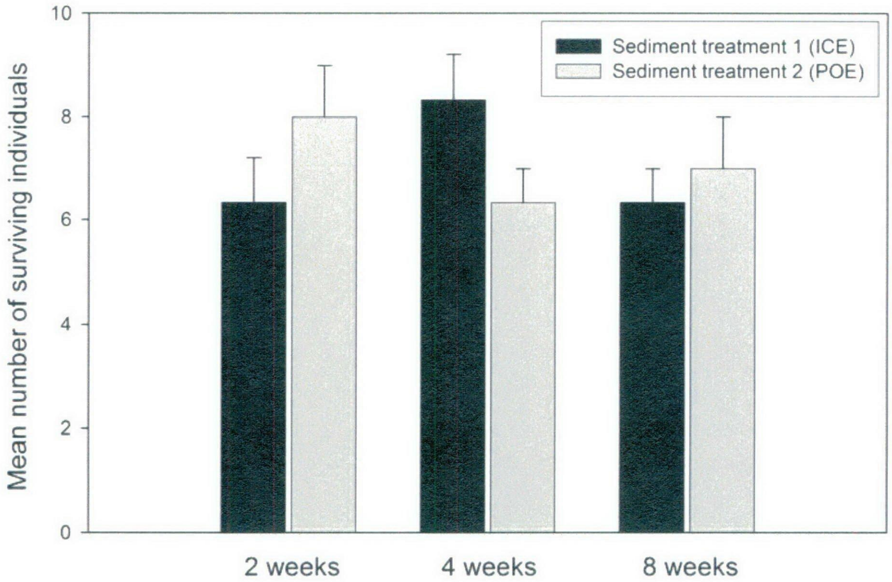

Fig 6.3.2 Mean number of *Urohaustorius metungi* surviving for each sediment treatment when translocation trays (n = 3) were retrieved at two, four and eight-week intervals. Sediment treatment 1 contained sediments collected from an intermittently closed estuary, whilst sediment treatment 2 contained sediments from a permanently open estuary. Data from Moonee Creek only.

potential sediment x estuary type interactions. The reduced experiment was deployed using the previous methods and planned to run over the same time frame.

Unfortunately, the experiment was again ravaged by floods across all estuaries and major opening events in the intermittently closed estuaries, this time only one week following deployment (Figs. 6.3.3, 6.3.4). Due to climatic interferences prematurely ending these experiments, no conclusive results could be determined. These results highlight the difficulty in conducting manipulative experiments in these unpredictable and dynamic estuarine systems.

Fig. 6.3.3 Sediment scour and subsequent removal of benthic habitat in Hearns Lake following a major opening event, June 2005.

Fig. 6.3.4 The original positions of some of the experimental trays can be seen in the bottom-right corner. At the time of deployment, this area was covered by 0.6 m of water. In this case, both sediment scoring and a large reduction in waterway area has occurred following entrance closure.