Acoustic tracking of small-scale movement in juvenile southern rock lobster (*Jasus edwardsii*)

David Mills, Caleb Gardner, Sam Ibbott and Simon Willcox

Tasmanian Aquaculture and Fisheries Institute
Marine Research Laboratories
Nubeena Crescent, Taroona TAS 7053

Abstract

Acoustic tracking was used successfully to monitor short-term movement and behaviour of lobsters released to the wild after on-growing in captivity for one year. Tagged on-grown and wild-caught (control) lobsters were released on an area of patch reef. Each tag emitted a unique frequency to allow individual identification of lobsters in close proximity. The combination of a sensitive, narrow-band boat-mounted receiver, and a diver-held receiver enabled tagged lobsters to be located regularly by divers. There were no detectable differences in behaviour or habitat usage between treatments. Lobsters were recaptured at the completion of the field trial to assess feeding success, and change in condition during liberty. While this approach to tracking was labour-intensive, data quality was high, and the ability to recapture animals invaluable.

Introduction

There is considerable interest in starting a southern rock lobster aquaculture industry in Tasmania. While research into closing the life cycle is gaining momentum, commercial culture from the egg to market size is still a long way off. It is possible, however, to capture large numbers of the late larval stage, called puerulus, from the wild (e.g. Mills *et al.* in press). An industry could commence based on the on-growing of wild-caught puerulus to a marketable size. However, there is a high-value wild fishery for this species, and there is concern that the harvest of puerulus would increase exploitation of the stock.

Two mechanisms have been proposed to compensate for puerulus removal: commercial quota purchase; or reseeding of one-year-old juveniles. Commercial quota purchase involves a reduction in catch of adult animals, achieved by reduction in fishing effort through quota purchase. However, the implementation of this method has proved contentious, and details of the number of puerulus to be harvested per quota unit removed could not be resolved. Additional problems were the effect of this method on egg production of undersize females and the concentration of effort (on both puerulus and adults) in sheltered regions. The alternative method of reseeding of one-year-old juveniles is based on the discrepancy between post-settlement survival in the wild and in captivity. Mortality associated with settlement and first year post-settlement in the wild for various lobster species has been estimated at between 75% and 97%. First year mortality of *J. edwardsii* puerulus removed from the wild into culture is between 1.1% and 7% (Crear *et al.* 1998).

If, after a year of on-growing, 25% of captured lobsters are released to the areas of capture, this should compensate for the puerulus removed, and may represent a level of fishery enhancement. The remaining 75% of lobsters are available for culture.

The success of this method depends entirely on the ability of animals on-grown for a year to survive when released. To estimate relative survival, it was proposed to release similar numbers of on-grown and wild-caught lobsters onto an area of patch reef which was

divided up in a searchable grid. All animals would be marked with a diver-visible tag to allow individual identification. The numbers and position of on-grown and control animals could be scored by divers on regular occasions. Movement between grid squares on the reef could be used to estimate emigration from the grid, and accordingly loss of lobsters due to emigration could be separated from loss due to mortality.

Juvenile lobsters are difficult to capture by traditional trapping methods, as they are not attracted to bait and will not readily enter pots. As a result, little is known about the behaviour and movement of this life history stage. If parameters such as distance moved and habitat usage vary detectably between on-grown and control lobsters, the methods described would not be appropriate. Movement information is also required to calculate a biologically relevant size for the search grid. A method of tracking which allows regular sighting of tagged animals was seen as the best way to obtain these data.

Methods

Acoustic tracking was seen as the most appropriate method for tracking lobsters. Radio tracking is not an option, as radio frequencies do not transmit well in the high conductivity marine environment. While electromagnetic tracking has been used successfully on small lobsters (e.g. Jernakoff and Phillips 1986), appropriate systems are not commercially available, and specialist knowledge is required.

Acoustic tags can be individually identified by two methods; frequency and 'ping codes'. Tags on the same frequency can be separated by 'ping codes'. For example, the signal transmitted may be broken down into three pulses, followed by two pulses, followed by four pulses, with a short silence between ('ping code' is 3-2-4). While the search process is simplified by having all tags on one frequency, this method of separation is not appropriate if animals are likely to remain close to each other. If two tags can be heard at once with similar intensity, it is difficult to separate the ping codes. Given the gregarious nature of lobsters, and little information about how far they were likely to move, tags separated by frequency were chosen.

To minimise the possibility of tag loss due to moulting, all lobsters were moult-staged prior to tag attachment, and only intermoult lobsters were used. Tags (Sonotronics IBT-96-1) measured 8 mm by 20 mm and weighed approximately 1.5 g. Tag frequencies were from 70 to 80 KHz , were separated by 1 KHz and had an operational life of 21 days. Tags were glued to the lobster carapace using 5 minute Araldite epoxy glue.

Two receivers were used to locate tagged lobsters; a narrow-band boat-mounted unit (Sonotronics USR-96) with directional hydrophone (Sonotronics DH-4), and a diver-held unit (Vemco VUR-96).

Nine lobsters were tagged: three on-grown, three wild 'controls' caught at the experimental site, and three wild 'controls' caught away from the experimental site. Lobsters were released by divers into good lobster habitat at randomised locations within the study site. Lobsters were tracked with the boat-mounted unit every three hours for 12 hours post-release, every six hours for the following 48 hours, then daily and eventually every second day for a total of 12 days. The diver-held unit was used to re-sight animals daily initially, then every second day.

Once located, lobster positions were marked with a surface buoy attached to a weight. Distances and bearings between subsequent positions were measured with a tape measure and hand-held compass by two people in the water.

Results

The range at which tags could be detected by both receivers varied greatly depending on water conditions. High turbidity, and the presence of a distinct halocline could reduce the effective range of the boat-mounted receiver from a maximum of 150 m to approximately 20 m. The maximum detection range

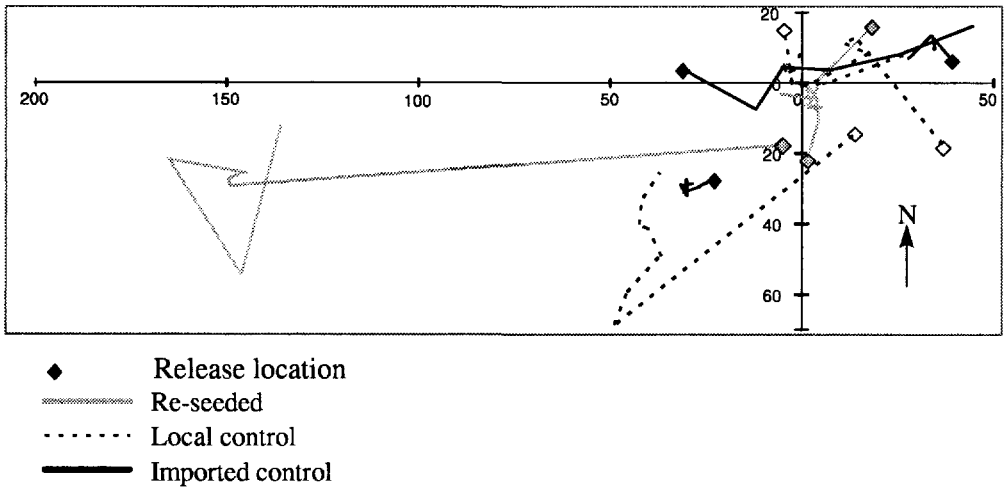

Figure 1. Movement of nine lobsters from three treatments over a period of 12 days. Axes in metres.

of the diver-held unit was about 20 m, but reduced to 5 m in poor conditions. The range of both receivers was considerably greater when tested in open water away from reef.

The position of lobsters could be repeatedly pinpointed with the boat unit to a circle of uncertainty of approximately 5 m radius. In all but the worst conditions, this allowed easy detection by the diver-held unit. It was found to be advantageous for the diver to swim on the surface until a signal was received, before descending.

All tagged lobsters were tracked successfully throughout the 12 day release trial (Figure 1). Lobsters were found to move at night, and remain stationary during the day. The greatest movement was observed within the first two days post-release, with the single longest daily movement being 145 m. This distance was recorded from an on-grown lobster, and included movement of at least 50 m over unstructured sand. No consistent differences were observed between treatment groups.

No differences were observed in habitat selection between treatments. Lobsters from all treatments were found singly in small hides, and with other wild lobsters in larger dens. On-grown lobsters appeared to respond appropriately to the presence of large 'predators' (a diver) by withdrawing into dens.

All tagged, and nine untagged, lobsters were captured by divers at the end of the trial. Stomachs were removed and gut fullness estimated (Figure 2). All lobsters had been successfully feeding during the trial, and the presence of acoustic tags did not appear to impede feeding.

To calculate the optimal size of the search grid for the survival trial, lobster movement was re-plotted with all release points at the origin (release in the survival trial was to be from a single central point). A graph of number of lobster location points included in increasing size of search grid (Figure 3) shows that maximum search efficiency is gained in a grid of 32 m side length (1024 square metres). By increasing the grid length to 56 m (effectively tripling the search area), only a further 8% of points would be included.

Discussion

Tracking cryptic animals in a high-relief environment such as rocky reef is problematic. Acoustic transmission can become directional if a lobster is situated deep within a den, and acoustic waves can propagate off adjacent rocks, leading to displacement

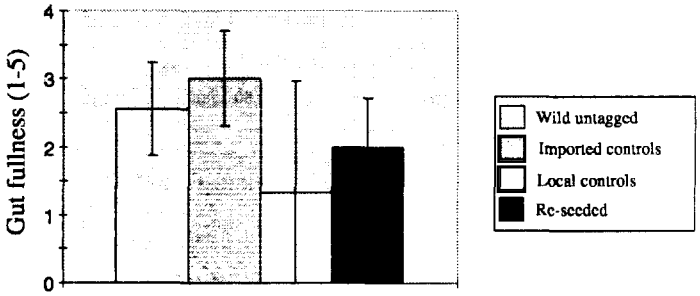

Figure 2. Gut fullness index of three experimental treatments and untagged wild lobsters at time of recapture.

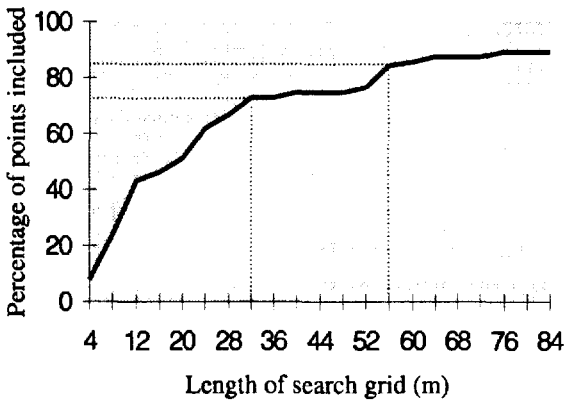

Figure 3. Percentage of recorded lobster locations contained within a search grid of increasing size (size given as length of one side of search grid).

of the apparent signal source. Such problems make the use of the emerging technique of acoustic real-time 3-dimensional tracking difficult, the biggest problem being the fixed positions of the receiver array. Van der Meeren (1997) used such a system to track four lobsters over a period of 21 days. Only 72 reliable position fixes were made during the trial, and there were often periods of several days when no reliable fixes could be recorded.

While labour- intensive, manual tracking proved ideal for our application. The detectable range of tags was of similar magnitude to maximum movement of lobsters. The diver-held receiver enabled lobsters to be re-sighted regularly, and high quality information on habitat usage was collected.

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