

Introduction

Conventional stock assessment methods for lobsters generally assume that catchability is constant and that all individuals are equally vulnerable to traps. The capture process involves a series of steps governed primarily by lobster behaviour:

- movement of the lobster out of its shelter
- attraction to the trap by bait
- entry and retention by the trap

All of these actions may vary between individual lobsters, so not all lobsters will necessarily be vulnerable to capture on each fishing occasion. For most *Homarus gammarus* fisheries there is generally only anecdotal evidence which suggests that individual lobsters may remain in their shelters for significant periods of time, or may be actively moving around the sea bed without being attracted into traps. It has been difficult therefore to obtain any quantitative estimates of the proportion of the population which is vulnerable to trapping on any single fishing occasion, and the extent to which vulnerability varies over time in individual lobsters.

In this study we built up a resident population of tagged lobsters on an artificial reef in Poole Bay, England and used an electromagnetic telemetry system to continually monitor the position and activity of individual lobsters both within the reef structure and in relation to traps fished adjacent to the reef. These observations allowed us to determine whether individual lobsters were vulnerable to trapping during a fishing session. The results have implications for the estimation of fishing mortality and the response of the population to exploitation.



A lobster sheltering in a crevice in the artificial reef structure



A diver attending a lobster trap adjacent to the reef

Methods

The artificial reef consists of eight conical units (1 m high x 5m diameter reef units) of concrete or cement-stabilised coal ash blocks (40 x 20 x 20 cm) arranged in two rows of 4 with 10 m spacing between centres (Figure 1). The reef is close to natural reefs but the surrounding seabed is largely sedimentary composed of sand and silts and is not subject to commercial fishing. Lobsters were caught in baited traps, transmitting tags were attached to the cephalothorax with epoxy resin and the lobsters then returned to the reef.

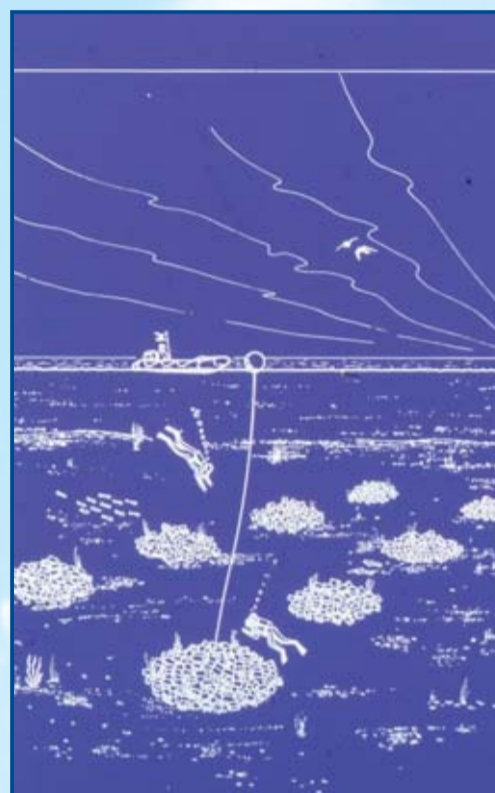


Figure 1: Schematic illustration of the artificial reef in Poole Bay

The reef telemetry system (Figure 2) has been described in detail by Smith *et al.*, (2000) and has been used to investigate diel and seasonal patterns of behaviour in *Homarus gammarus* (Smith *et al.*, 1998, 1999). A 5m diameter loop aerial was laid on the seabed around each of the reef units which permitted detection of tag signals. The tags contained a tilt switch which allowed monitoring of activity within the reef unit. The system therefore allows the activity of lobsters within the reef unit and movements between units (and off the reef altogether) to be monitored for a number of lobsters simultaneously.

Baited lobster traps were placed close to each reef unit, allowing us to relate activity and movement patterns of individuals to capture probability over numerous "fishing sessions". A total of 15 fishing sessions with 48 hr soak times were observed during which we monitored the activity and movements of between 3 and 11 individual lobsters on each session. We essentially monitored 84 lobster "behaviour patterns" across the 15 fishing sessions.

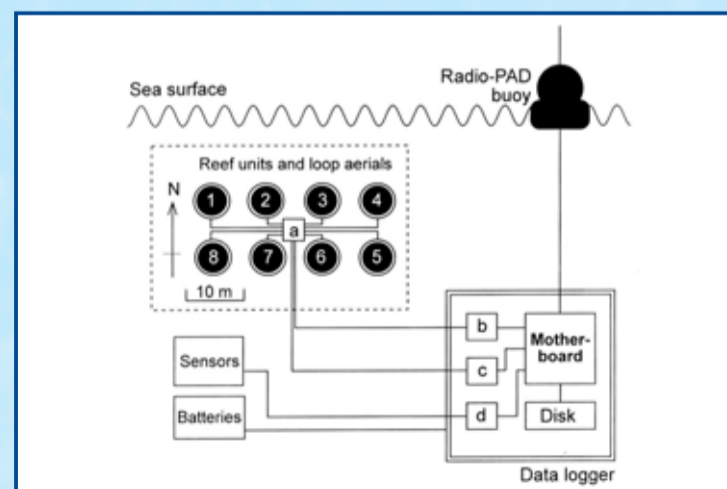


Figure 2: Schematic diagram of the electromagnetic telemetry system (a) analog aerial selector switch, (b) tuned radio frequency receiver, (c) shift register, (d) analog to digital converter

Results

Lobsters were caught in baited traps on 10 of the 15 fishing sessions (Table 1), from which some general conclusions can be drawn:

- Individuals which were captured showed more movements than those that were not captured. i.e. some individuals move more than others during the soak time and may be more vulnerable to capture.
- Some individuals did not move at all between reef units, i.e. they did not cross the loop around their reef unit and so were not vulnerable to trapping during the fishing session. Of 84 lobster "behaviour patterns" monitored during the 15 fishing sessions, 18 exhibited no movement during the soak time, suggesting that on approximately 20% of fishing occasions the individual lobster was invulnerable to trapping.
- There were invulnerable individuals, individuals with a lower chance of capture and those with a higher chance of capture.
- Detailed analysis shows that some individuals were invulnerable to trapping on all fishing occasions, whereas others were invulnerable on some fishing occasions, but captured on other occasions.
- This study may have underestimated the proportion of lobsters that is invulnerable to trapping because all tagged lobsters were originally trap caught, so they may have a naturally higher catchability than non-tagged individuals in the population.

Table 1: Number of inter-reef movements by tagged lobsters on the artificial reef during 48 h soak period of traps.

Fishing session	No. tagged animals on reef	No. caught in traps	No. movements by trapped animals	No. movements by animals not trapped
1	4	0	–	0, 5, 5, 21
2	4	0	–	–
3	6	3	1, 4, 9	0, 7, 11
4	7	0	–	0, 4, 6, 7, 7, 12, 14
5	4	1	5	5, 9, 20
6	5	2	2, 3	0, 0, 3
7	5	1	0	0, 1, 1, 21
8	4	0	–	0, 0, 0, 0
9	3	0	–	–
10	6	2	2, 9	0, 0, 1, 8
11	5	1	3	0, 2, 2, 4
12	7	2	2, 3	0, 2, 3, 5, 7
13	8	2	7, 8	0, 0, 3, 3, 12, 19
14	11	2	12, 28	0, 0, 2, 3, 4, 9, 11, 14
15	5	1	2	2, 10, 13, 20

Discussion

As a trap was set next to each reef unit, every inter-reef movement could be considered as an approach to a trap. There were 20 captures from a total of 407 inter-reef movements, suggesting approximately 5% of approaches result in capture. In comparison Karnofsky and Price (1989) estimated that only 2% of approaches led to capture of *Homarus americanus* in a semi-natural habitat.

There may be important implications for the resilience of lobster populations to exploitation if a significant proportion of the total population is invulnerable to trapping. Current estimates of fishing mortality based on the assumption that all individuals are equally available to trapping would over-estimate the impact on the population, suggesting that lobster populations are in fact more resilient to exploitation. We need to know more however about any patterns of invulnerability to trapping. If some individuals are invulnerable to trapping over their whole lifespan, then there may be a "hidden" proportion of the population which provides a buffer against exploitation of the population, and estimates of fishing mortality rates may over-estimate the risk of over-exploitation. However, if all individuals are vulnerable to trapping at some stage of the year, then high fishing mortality rates are still likely to risk over-exploitation of the stock.

References

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