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John H. Annala

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Movements of rock lobsters (*Jasus edwardsii*) tagged near Gisborne, New Zealand

JOHN H. ANNALA
Fisheries Research Division
Ministry of Agriculture and Fisheries
P. O. Box 297
Wellington, New Zealand

Abstract A total of 4613 rock lobsters (*Jasus edwardsii*) were tagged and released between 1975 and 1978 in 4 areas along the east coast of the North Island near Gisborne. Of the 2131 returns to 31 May 1980, only 65 (3.1%) moved long distances (at least 5 km) from the release sites; the remainder were recovered within 5 km of the release sites. There was no apparent directionality to the movements, with the exception of animals tagged in one of the areas, and no large-scale migrations were observed.

Keywords *Jasus edwardsii*; Crustacea; tagging; movements; Gisborne; fishery resources.

INTRODUCTION

To understand the dynamics of a fishery, the movement patterns of the species and their relationship to feeding, reproduction, and recruitment must be known. Herrnkind (1977) reviewed movement patterns of palinurid crustaceans and described 3 major, common types: (1) migrations, wherein an individual or population moves a considerable distance, often, but not always, periodically or with a return to the original area; (2) nomadism, or wandering, by individuals over a large area without clear-cut start and end points; and (3) homing, involving periodic, often daily, excursions from a shelter to some nearby area with subsequent return to that shelter or others nearby.

Movement patterns have been described for both of New Zealand's rock lobster species. Booth (1979) observed long-distance movements of *Jasus verreauxi* in northern New Zealand which may play an important part in the recruitment mechanism of this species. Street (1969, 1971, 1973) described inshore–offshore movements and long-distance migrations of *J. edwardsii* in southern New Zealand.

The aim of this paper is to present information on the movements of *J. edwardsii* tagged along the east coast of the North Island near Gisborne.

METHODS

Rock lobsters were tagged with the "western rock lobster tag" (Chittleborough 1974) during the course of a programme to obtain information on growth rates (McKoy & Esterman 1981), mortality rates (Annala 1980), and movements (this paper) from 4 areas along the east coast of the North Island near Gisborne (see Annala (1980) for details of the tagging programmes and methods used). Rock lobsters were released as quickly as possible after capture to minimise losses due to handling, and as close as possible to their capture site to minimise any displacement effects. When possible, only undamaged animals were tagged, and no animals missing more than 2 appendages (antennae or pereiopods) were used.

The location and date of release, sex, carapace length (measured to the nearest 0.1 mm from the antennal platform to the posterior margin of the carapace along the dorsal midline), sexual maturity (using external characteristics for females only (Annala et al. 1980)), and damage were recorded for all animals tagged. The carapace lengths of those tagged ranged from 69 to 159 mm for males and from 60 to 126 mm for females, with most between 80 and 100 mm. Fishermen recapturing tagged rock lobsters were asked to give the date, location, method and depth of capture, and to return the entire animal so that its carapace length and state of sexual maturity could be determined.

Rock lobsters were recorded as having moved if the distance between release and recapture sites was a minimum straight-line sea distance of 5 km. On the basis of information supplied by fishermen, this was considered the minimum distance at which recaptures could reliably be assessed to have been caught outside the release area. Returns for which there was any uncertainty with regard to the recapture site were not included in the analysis.

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Table 1 Areas and dates of tagging, numbers of rock lobsters (*Jasus edwardsii*) tagged and returned, and numbers and percentage of returns that moved at least 5 km up to 31 May 1980 for tagging programmes on theeast coast of the North Island near Gisborne. Area boundaries shown in Fig. 1. Number returned does not include those recaptured more than once or with insufficient information to determine date or location of capture (m, male; f, female).

	Number tagged		Number returned		Number (%) of recaptures moving at 5 5 km	
	m	f	m	f	m	f
Gisborne Local (Young Nicks Head to Gable End Foreland)						
Oct 1975	392	97	197	25	0 (0.0%)	0 (0.0%)
Feb 1976	179	75	96	17	0 (0.0%)	0 (0.0%)
Jul 1976	444	105	273	28	1 (0.4%)	0 (0.0%)
Jul 1977	270	135	157	26	2 (1.3%)	1 (3.8%)
South of Young Nicks Head (Pukenui Beach to Young Nicks Head)						
Oct 1975	23	43	6	1	0 (0.0%)	0 (0.0%)
Mar 1977	560	28	283	6	0 (0.0%)	0 (0.0%)
Jul 1977	374	91	201	23	2 (1.0%)	1 (4.3%)
Mahia East (Portland Island to Pukenui Beach)						
Jul 1976	51	32	30	14	2 (6.7%)	2 (14.3%)
Oct 1976	129	256	59	116	5 (8.5%)	5 (4.3%)
Jul 1977	136	208	74	101	6 (8.1%)	5 (5.0%)
Jul 1978	214	152	117	76	13 (11.1%)	6 (7.9%)
Mahia West (Wairoa River to Portland Island)						
Oct 1975	75	107	16	12	1 (6.3%)	0 (0.0%)
Oct 1976	164	273	79	98	3 (3.8%)	10 (10.2%)
Total for all areas	3011	1602	1590	543	35 (2.2%)	30 (5.5%)

RESULTS

The number of movements of rock lobsters tagged in the Gisborne Local and South of Young Nicks Head areas was low (Tables 1 & 2, Fig. 1). A number of tagged rock lobsters recaptured in the Gisborne Local and South of Young Nicks Head areas were known to have been transported between these areas and re-released by fishermen. Therefore, recaptures from either of these 2 areas of animals which had been released in the other were not considered to have moved a significant distance and are not included in Tables 1 & 2 and Fig. 1. Only 7 animals were included in this category, so any possible bias of the results was considered to be negligible.

The proportions of animals tagged in the Mahia East and Mahia West areas that moved were greater than for Gisborne Local or South of Young Nicks Head (Table 1). Of the 44 movements at Mahia East, 30 moved north from the release points and 14 moved south (Table 3, Fig. 2). The null hypothesis that equal numbers moved north and south from the release points was tested and rejected (G_{adj} = 5.22, d.f. = 1, $P < 0.05$; Sokal & Rohlf (1969), p. 566 ff.). Of the 30 rock lobsters moving north, 16 were males and 14 females, and of the 14 moving south, 10 were males and 4 females. The null hypothesis that the direction of movement was independent of sex was tested and accepted (G_{adj} = 0.658, d.f. = 1, $0.5 < P < 0.1$; Sokal & Rohlf (1969), p. 590 ff.).

Table 2 Number of days free and minimum distance (km) moved of *Jasus edwardsii* tagged and released in Gisborne Local and South of Young Nicks Head areas during 1975–77 and recaptured up to 31 May 1980 at least 5 km from release point.

Tagging date	Days free	Minimum distance moved (km)
Gisborne Local		
Jul 1976	80	12.9
Jul 1977	131	12.9
Jul 1977	148	5.7
Jul 1977	488	21.1
South of Young Nicks Head		
Jul 1977	391	66.6
Jul 1977	461	30.7
Jul 1977	504	31.8

Of the 14 movements at Mahia West, 10 moved south from the release points and 4 moved north (Table 4, Fig. 2). The null hypothesis that equal numbers moved north and south was tested and accepted (binomial test, $P \simeq 0.18$; Sokal & Rohlf (1969), p. 71 ff.).

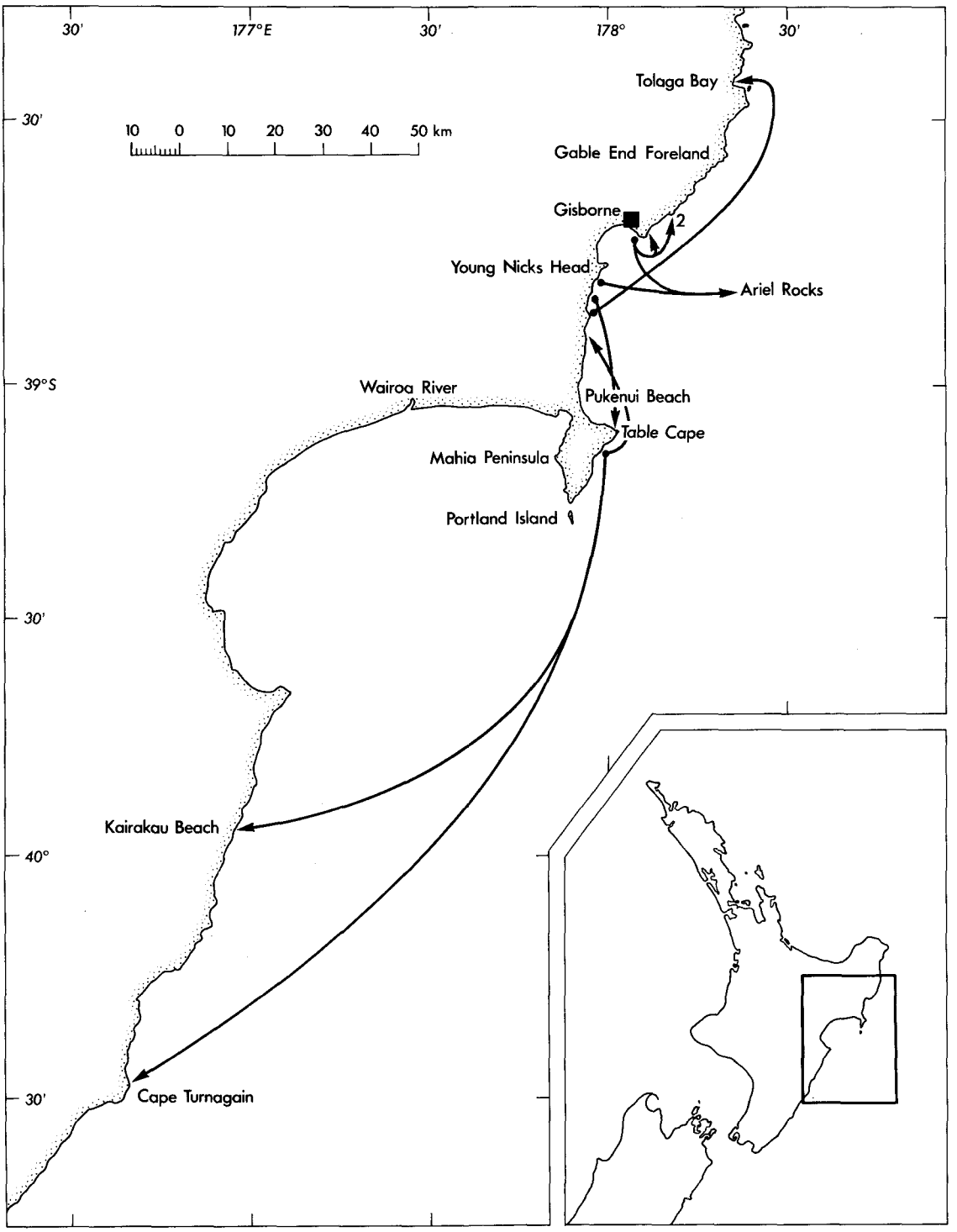

Fig. 1 Movements of *Jasus edwardsii* tagged and released in 4 areas along the east coast of the North Island, near Gisborne; arrows without numbers represent movement of 1 rock lobster; arrow with number represents movement of 2 rock lobsters.

Table 3 Number of *Jasus edwardsii* tagged and released in Mahia East area during 1975–78 and recaptured up to 31 May 1980 moving north (N) or south (S) at least 5 km from release point, number of days free, and minimum distance moved (–, no recaptures during time interval).

Days free	Minimum distance (km) moved 5.0–9.9	10.0–14.9	15.0–19.9	20.0–24.9	<24.9
1– 50	1N	–	–	–	–
51–100	3N	1S	–	–	–
101–150	3N, 1S	3N, 1S	1N	–	–
151–200	4N, 1S	1N, 1S	2N	–	–
201–250	–	–	1N	–	–
251–300	–	1N	–	–	–
301–350	1N	–	–	–	–
351–400	–	–	1N	–	1S
401–450	1N	–	1S	–	–
451–500	3N, 3S	1N	–	1N	1N, 1S
501–550	1S	–	1S	–	–
>550	1N	–	–	–	1S

Table 4 Number of *Jasus edwardsii* tagged and released in Mahia West area during 1975–76 and recpatured up to 31 May 1980 moving north (N) or south (S) at least 5 km from release point, number of days free, and minimum distance moved (–, no recaptures during time interval).

Days free	Minimum distance (km) moved 5.0–9.9	10.0–14.9
1–50	2S	–
51–100	1S	–
101–150	1S	–
151–200	–	–
201–250	1S	–
251–300	–	–
301–350	1S	1N
351–400	1N, 1S	1N
401–450	1N, 1S	–
451–500	–	–
501–550	1S	–

DISCUSSION

Herrnkind (1977) discussed the problems associated with the interpretation of tag return data to determine movement patterns. He noted that most tagged animals are often recaptured near the release point soon after release, which may be characteristic of either a resident population or of highly effective fishing effort. The highest proportion of recaptures may occur where fishing effort is greatest, even if the animals disperse randomly, resulting in an apparent directionality of dispersion that does not exist. If migration from fished to unfished areas occurs, then the recapture rate will be low and the direction of migration may not be determined.

The overall recapture rates from all 4 areas were high (53% for males and 34% for females) and are considered sufficient to determine the existence of any long-distance movement patterns. However, a large proportion were recaptured near the release points during the months immediately after tagging (Annala 1980), which may have biased the results against long-distance movements. All the recaptures moving the greatest distances were free for the longest times, with those which moved more than 19.9 km free for at least 351 days (Tables 2 & 3).

Street (1969, 1971) found that the time over which returns were considered was important in determining movement patterns of *J. edwardsii* in southern New Zealand, with recaptures moving the greatest distances being taken the longest times after tagging. He suggested that migrating rock lobsters recaptured within 2 months of tagging may not have been able to disperse before recapture.

C Most of the inshore areas of rocky bottom out to depths of 50–60 m near Gisborne are heavily fished, so any movements of tagged rock lobsters to or within these areas would probably be detected. Rock lobsters also inhabit offshore areas of rocky bottom to depths of at least 300 m which are fished lightly or not at all. Rock lobsters tagged in inshore areas may be moving undetected to these deeper areas. However, limited experimental fishing in these deeper areas from 1978 to 1980 has not resulted in the recapture of any rock lobsters tagged in inshore areas (author's unpubl. data).

The factors that must be considered when analysing long-distance movements are the numbers and proportions moving; the distances travelled; the directionality, duration or rate, and seasonality of movement; and the size and maturity of animals moving.

Street (1969, 1971, 1973) found in most of his studies that only a small proportion (0–4.2%) of *J. edwardsii* tagged in southern New Zealand moved significant distances from the release site. However, he specifically tagged migrating animals at 3

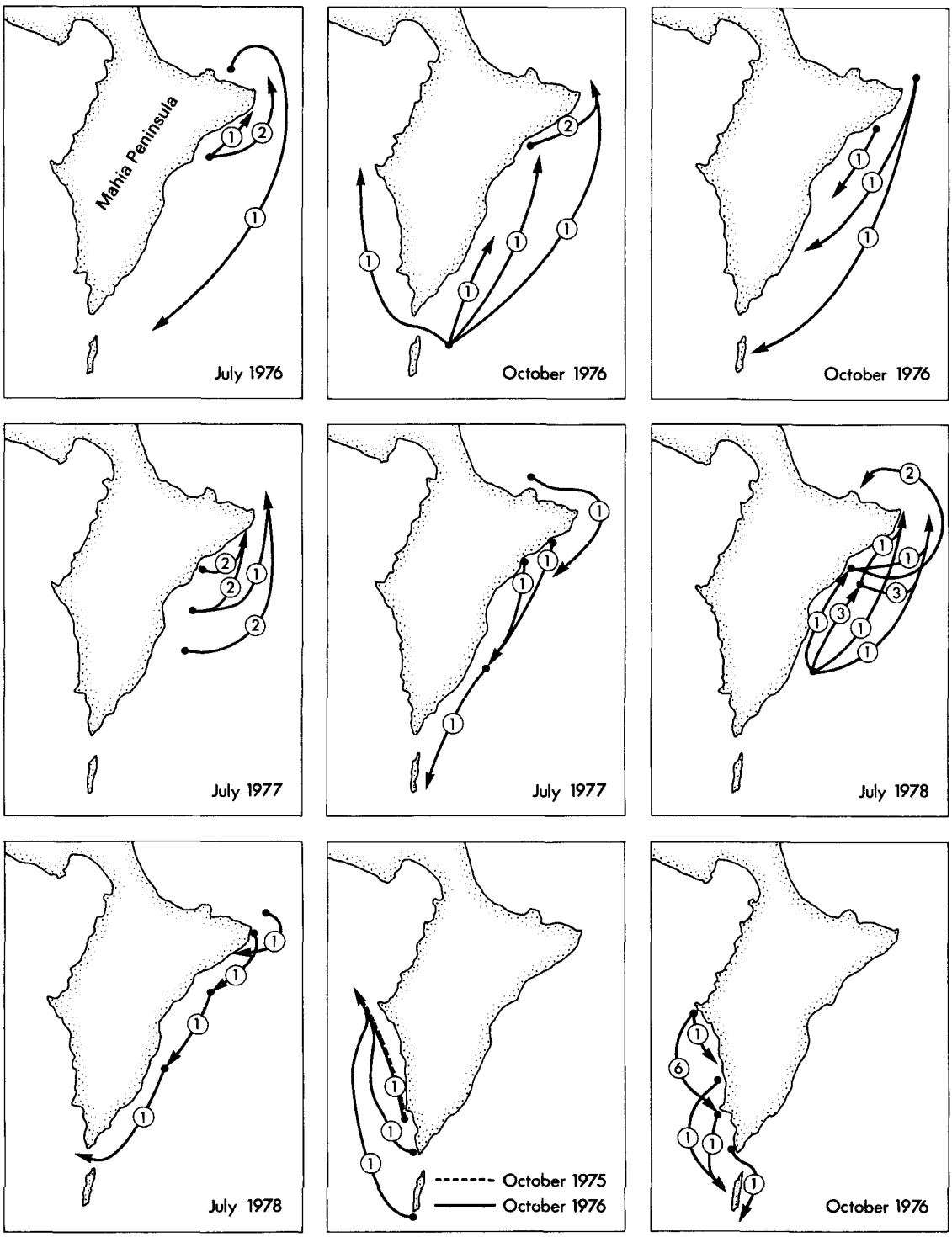

Fig. 2 Movements of *Jasus edwardsii* tagged and released between Portland Island and Pukenui Beach (Mahia East) and between the Wairoa River and Portland Island (Mahia West) (see Fig. 1); numbers in circles represent numbers of tagged rock lobsters that moved.

different locations, and larger proportions of the recaptures moved long distances: (1) 27.6% of those released in eastern Foveaux Strait in 1966 moved at least 2½ miles (4 km); (2) 28.6% of those released off the Otago Peninsula in 1970 were recaptured between 3 miles (4.8 km) and 145 miles (232 km) from the tag site; and (3) 35.0% of those released off Milford Sound in 1971 moved at least 6 miles (9.6 km).

The long-distance movements of *J. edwardsii* tagged in southern New Zealand have usually been highly directional—southward along the Otago and Stewart Island coasts, westward through Foveaux Strait, and northward along the Fiordland coast, in opposition to the prevailing current systems (Street 1969, 1971, 1973; J. L. McKoy, pers. comm.; author's unpubl. results). These movements also appear to be distinctly seasonal, usually occurring off Otago and through Foveaux Strait during September–November and along the Fiordland coast during November–January. These migrations coincide with, and the migrating animals contribute to, the peak catches in these areas.

Most of the migrating female rock lobsters caught off Otago and in Foveaux Strait were sexually immature (Street 1969, 1971, 1973, J. L. McKoy, pers. comm.). The size at onset of maturity (size at which 50% are mature) of females from these 2 areas varies between 97 and 121 mm carapace length, while the size at onset of maturity for Fiordland is between 80 and 89 mm (Annala et al. 1980). Thus, there appears to be a highly seasonal, highly directional migration of rock lobsters, with most females being immature, from areas with a large size at onset of maturity to an area with a smaller size at onset of maturity.

The proportions that moved in this study were generally low for all 4 areas and ranged from 0 to 14.3% (Table 1). The only directional movements observed were in Mahia East, where a significantly larger number moved to the north than the south. However, there were no significant differences between the sexes in the proportions moving north or south. Fig. 2 suggests that many of the tagged rock lobsters moved northward to the area near Table Cape. All the recaptures moving north travelled quite short distances (maximum 23 km), and no explanation for this apparent directionality can be offered.

Rock lobsters were tagged near Gisborne during February, March, July, and October of various years (Table 1). However, peak catches in this area usually occur during October–December, so it is possible that animals were not tagged during migrations.

Only a small proportion of the females tagged near Gisborne were immature (201 (12.5%) out of the total of 1602). The size at onset of maturity of females from inshore areas near Gisborne is small (maximum of 74 mm carapace length (Annala et al. 1980)), and few immatures were captured. Moreover, the "western rock lobster tag", the only tag used in this study, is not suitable for animals of less than about 70 mm carapace length.

There was no significant difference between the proportions of immature and mature females which moved. Of the 201 immature females tagged, 7 (3.5%) moved, and of the 1401 mature females tagged, 23 (1.6%) moved. The null hypothesis that equal proportions of immature and mature females moved was tested and accepted ($G = 2.690$, d.f. = 1, $0.5 < P < 0.1$; Sokal & Rohlf (1969), p. 590 ff.). However, if there is a relationship between maturity and movement for females, it is probably complex, and not all immature females in all areas may undergo large-scale migrations.

Fishermen report catching *J. edwardsii* in set nets and trawls on open-bottom areas away from the main rock lobster fishing grounds near Gisborne, which indicates that some rock lobsters in this area do move. However, the sizes of these individuals vary widely, and the few animals caught may represent the movements of only a small segment of the population.

In summary, no large-scale migrations of the *J. edwardsii* tagged in this study were observed. The proportion of the recaptures that moved long distances was low and, with the exception of rock lobsters tagged at Mahia East, there was no directionality to the movements. Most of the recaptures were made within a short distance of the release points and may be examples of local nomadism or homing.

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