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Movements of packhorse rock lobsters (*Jasus verreauxi*) tagged along the eastern coast of the North Island, New Zealand

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Abstract One hundred and nineteen of the 1246 *Jasus verreauxi* tagged at 5 locations along the eastern coast of the North Island, New Zealand, during 1978-82 were recaptured by 31 May 1983. Seventy two of the recaptures were local (< 15 km from tagging site). All long distance movements (≥ 15 km) were in a general north-westerly direction towards the main breeding ground off Cape Reinga, with an overall average minimum distance moved of 142.3 km, at an average rate of 0.61 km d⁻¹. The movement towards Cape Reinga is probably critical in the recruitment mechanism for this species.

Keywords *Jasus verreauxi*; Palinuridae; tagging; movements; recruitment; fishery management; North Island; New Zealand

INTRODUCTION

An understanding of migratory movements, and their relationship to the overall recruitment mechanism, is helpful in the management of commercially important marine species. New Zealand has 2 palinurid species. The most important is the red rock lobster *Jasus edwardsii* which comprises at least 95% of the annual total landings. However, the green or packhorse rock lobster *Jasus verreauxi* (H. Milne Edwards) is an important species locally, particularly in the northernmost parts of the country (Booth 1979). An understanding of recruitment in *J. verreauxi* may also be helpful in determining the recruitment mechanism for *J. edwardsii*.

J. verreauxi occurs around mainland New Zealand and along the New South Wales and adjacent coasts (George 1966; Kensler 1967). The species is most abundant along the northern and eastern coasts of the North Island as far south as about Cape Turnagain (author's unpublished data). The main breeding population is off Cape Reinga; very few egg-bearing females are taken south of Whangarei Heads (Booth 1984). The proportion of undersized rock lobsters in the catches increases with distance south along the eastern coast of the North Island, at least as far south as Mahia Peninsula. Few legal-sized animals (216 mm tail length, equivalent to about 155 mm carapace length (CL) for females and about 163 mm CL for males) are taken south of the Mercury Islands (Booth & Bycroft 1980; author's unpublished data).

Booth (1978, 1979) tagged 713 mainly undersized (and for females at least, immature) *J. verreauxi* at North Cape during 1976-77. Most of the tag recaptures occurred to the west of the tagging site within the main area of the fishery for *J. verreauxi* off Cape Reinga. These movements, in conjunction with the known distribution of breeding adults, led to the speculation that North Cape may be an important nursery area for the Cape Reinga fishery.

The aim of the present study was to determine whether *J. verreauxi* from the eastern coast of the North Island south of North Cape, moved northward to contribute to the breeding population off Cape Reinga. Preliminary results were presented by Booth & Bycroft (1980) and Booth (1981). This paper summarises these observations and incorporates all tag returns to 31 May 1983.

METHODS

Six hundred and nine male *J. verreauxi* (size range 87-195 mm CL) and 637 females (81-196 mm CL) were tagged at 5 sites along the eastern coast of the North Island during 1978-82 (Table 1, Fig. 1 and 2).

Rock lobsters were tagged near Bream Head, within Bream Bay, and near Bream Tail (Whangarei Heads), near Red Mercury, Double, Flat, Ohinau, and Koruenga Islands, Whale Rock, and near the northern end of Mercury Bay (Mercury Islands),

Table 1 Numbers of *Jasus verreauxi* tagged on the eastern coast of the North Island, 1978–82, and the numbers and sizes of those recaptured either locally (< 15 km from tagging site) or \geq 15 km from tagging site by 31 May 1983. Localities are shown in Fig. 1. Sizes of rock lobsters at tagging are shown in Fig. 2. (CL, carapace length; M, male; F, female).

Tagging locations and dates	No. tagged		No. recaptured < 15 km from tagging site		Recaptures by 31 May 1983				Size range (mm CL at recapture)		Overall % recapture rate	
					No. recaptured \geq 15 km from tagging site		Size range (mm CL at recapture)					
	M	F	M	F	M	F	M	F	M	F	M	F
Whangarei Heads												
Nov 1979	100	103										
Oct–Nov 1980	33	37	7	3	145–172	139–154	10	4	145–174	150–166	12.8	5.0
Mercury Islands												
Nov 1979	76	97										
Aug–Dec 1981	42	44	8	10	117–158	114–158	5	1	124–167	155	11.0	7.8
Matakaoa Point												
Feb 1981	145	174										
Aug 1981	40	41	13	13	106–160	115–141	2	7	143–154	146–160	8.1	9.3
Gisborne												
Apr 1979–Mar 1981	23	16	2	0	104–132	–	1	1	134	143	13.0	6.3
Mahia Peninsula												
Dec 1978–Sep 1982	150	125	8	8	124–153	112–145	9	7	132–157	123–145	11.3	12.0
Total	609	637	38	34			27	20			10.7	8.5

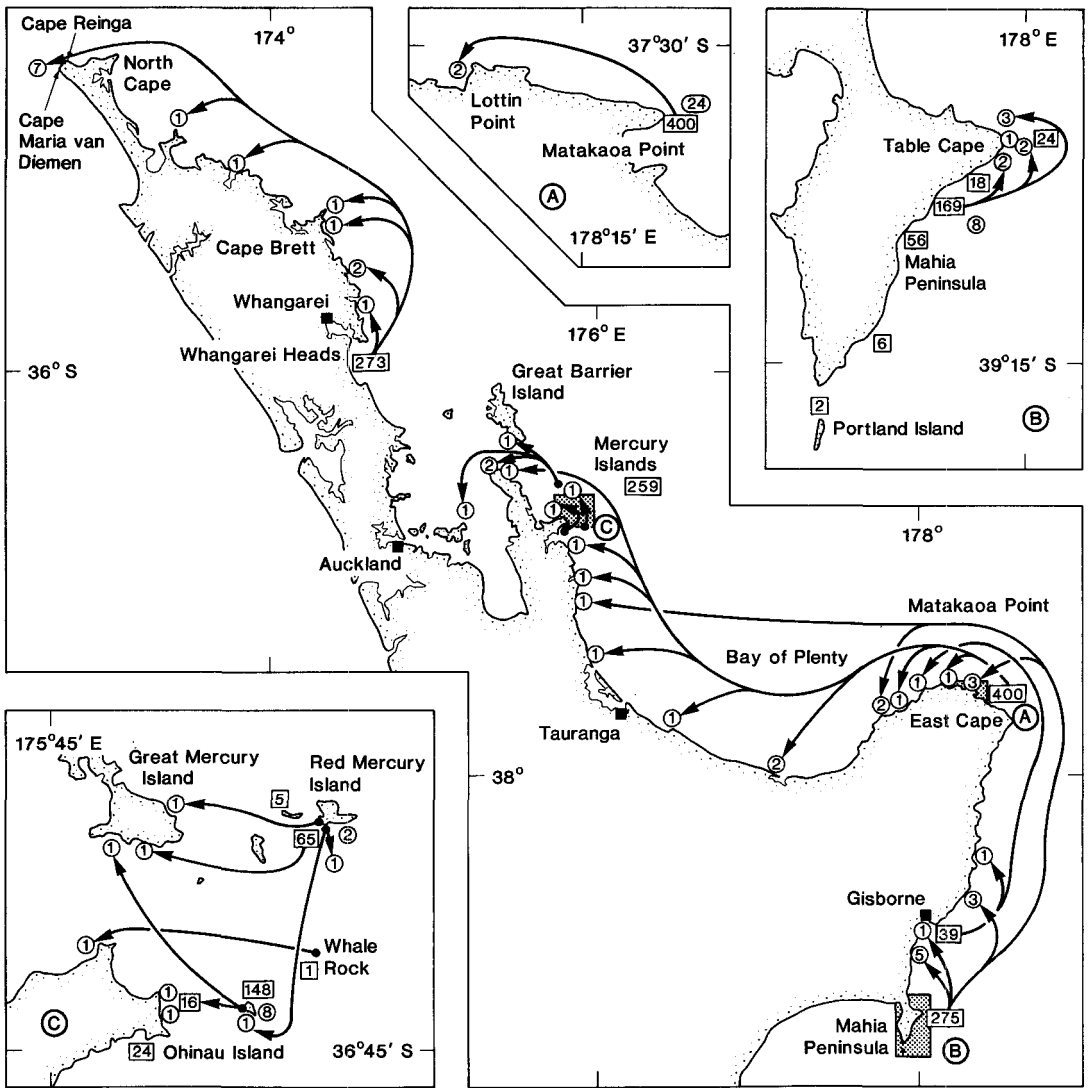


Fig. 1 Local recaptures (< 15 km from tagging site) (inserts) and long distance (≥ 15 km) movements of *Jasus verreauxi* tagged at Whangarei Heads, Mercury Islands, Matakaoa Point, Gisborne, and Mahia Peninsula during 1978–82 and recaptured by 31 May 1983. Figure in box gives number of animals tagged; line gives inferred movement; figure in circle gives number of tagged rock lobsters recaptured at or near that point. All local recaptures at Whangarei Heads and Gisborne were made at or near the point of tagging.

near Kaiti Beach (Gisborne), and Table Cape to Portland Island (Mahia Peninsula). Animals tagged and released near Matakaoa Point were caught between East Cape and Lottin Point.

All rock lobsters were tagged with individually numbered, yellow, "western rock lobster" tags (Chittleborough 1974), following the technique used earlier at North Cape (Booth 1979). The rock

lobsters at all sites were caught by potting and, except at Matakaoa Point, were immediately tagged and released at the site of capture. Those tagged at Matakaoa Point were caught by commercial fishermen and held in holding pots for periods of up to 20 days before being tagged and released. About equal numbers of males and females were tagged at each locality.

Table 2 Relationship between number of days at liberty and minimum distance moved for *Jasus verreauxi* tagged on the eastern coast of the North Island, 1978-82, and recaptured at least 15 km from the tagging site by 31 May 1983 (-, no rock lobsters recaptured during that time interval). Rate of movement is given in parentheses.

Days at liberty	Whangarei Heads	Minimum distance moved (km) (Minimum rate of movement (km d ⁻¹))			Mahia Peninsula
		Mercury Islands	Matakaoa Point	Gisborne	
1-50	25.9 (0.61)	50.0 (1.29)	-	-	44.5, 51.9 (1.64), (1.73)
51-100	77.8 (1.02)	94.5 (1.69)	-	-	44.5, 61.1 (0.72), (0.91)
101-150	18.5, 124.1 (0.15), (0.91)	-	133.4 (1.05)	-	44.0 (0.41)
151-200	49.3, 302.0, 302.0, 302.0 (0.26), (1.66), (1.70), (1.70)	51.9 (0.27)	-	-	-
201-250	66.7 (0.27)	16.7 (0.08)	31.5 (0.13)	-	44.5 (0.19)
251-300	-	-	211.2 (0.81)	-	57.4 (0.20)
301-350	176.0 (0.52)	-	53.7, 292.7 (0.16), (0.86)	-	44.5, 49.8, 49.8, 188.9 (0.14), (0.14), (0.15), (0.57)
351-400	-	51.9 (0.14)	231.6 (0.66)	-	188.9 (0.49)
401-450	-	15.0 (0.04)	-	-	235.3 (0.58)
451-500	302.0, 322.4 (0.60), (0.65)	-	133.2, 169.3 (0.27), (0.34)	-	200.0, 261.2 (0.42), (0.57)
501-550	-	-	-	209.3 (0.42)	-
551-600	-	-	-	-	-
601-650	-	-	-	-	-
651-700	-	-	231.0 (0.33)	-	-
701-750	276.1 (0.38)	-	-	79.7 (0.10)	-
751-800	-	-	-	-	-
801-850	-	-	-	-	-
851-900	302.0 (0.35)	-	-	-	-
901-950	-	-	-	-	416.9 (0.45)
Overall mean	189.1 (0.77)	46.6 (0.59)	165.3 (0.51)	144.5 (0.26)	124.0 (0.58)

RESULTS

Most tagged rock lobsters were recaptured by commercial pot fishermen after at least 30 days at liberty, although a few were returned by divers. Tag recapture rates up to 31 May 1983 were generally low (10.7% for males and 8.5% for females) (Table 1). However, it is likely that the return rate of tagged rock lobsters has been underestimated because of non-reporting of tags and loss and tag mutilation. Fifty-nine percent of the male and 63% of the female tag recoveries were made locally (within 15 km of

the tagging site). However, some long distance (≥ 15 km) movements occurred from all tagging sites after every tagging period.

Local recaptures (< 15 km from tagging site)

All local recaptures at Whangarei Heads and Gisborne were made at or near the tagging site. Local recaptures at the other tagging localities are given in Fig. 1. Although 18 rock lobsters were recovered locally at the Mercury Islands, 2 females and 1 male were recaptured more than once. Similarly, 2

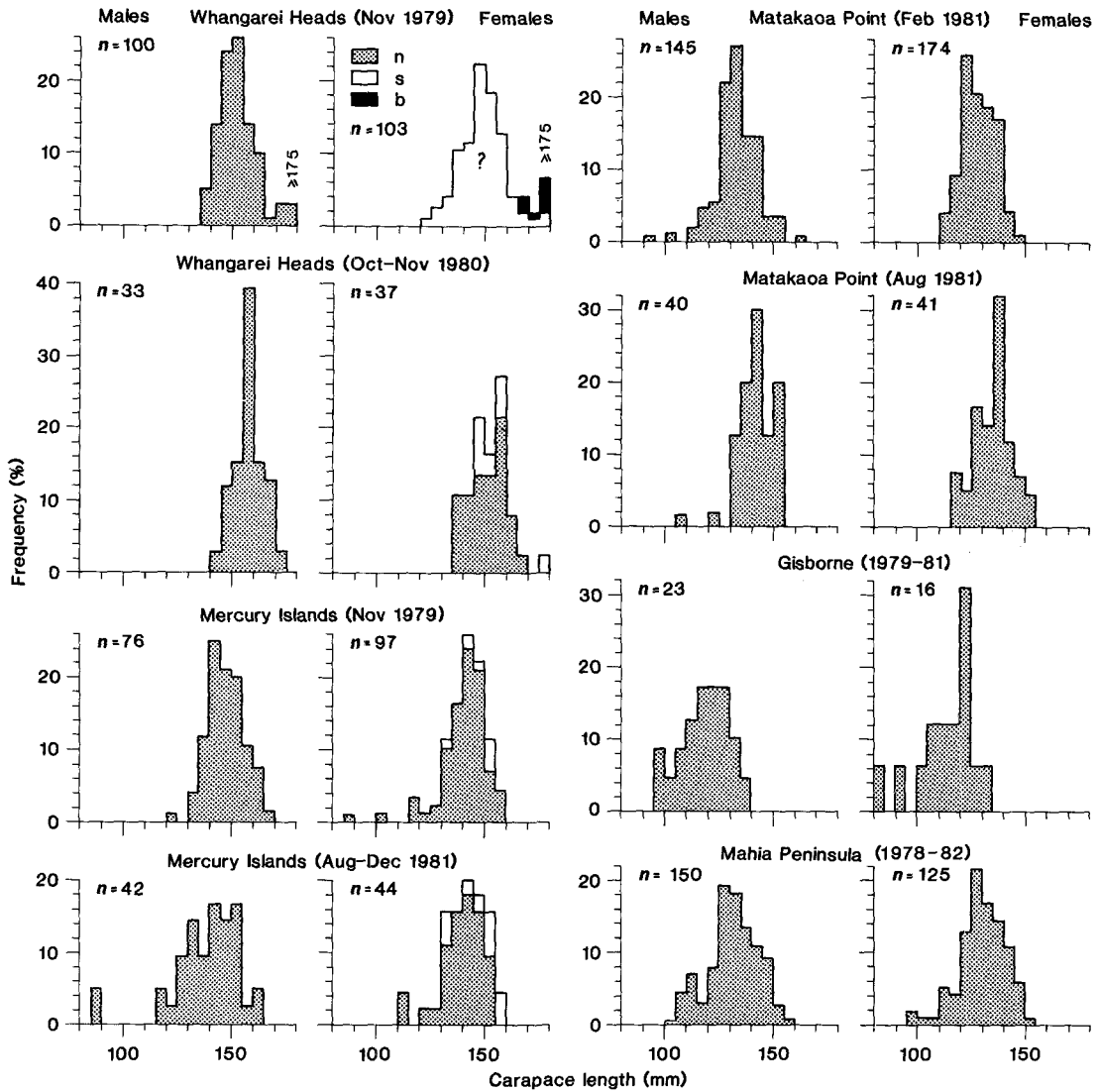


Fig. 2 Carapace length-frequency distributions of male and female *Jasus verreauxi* tagged along the eastern coast of the North Island, 1978-82 (n, no setae; s, setae on pleopods; b, egg-bearing; ?, no information on proportion with setae).

females and 1 male were recaptured more than once at Mahia Peninsula. Most local movements took place in a general west to north direction.

Some rock lobsters moved locally within 90 days of taggings carried out during August-February. However, none of the small number of animals tagged during March-July that were recovered had moved, so it is unknown whether local movements also occur during winter.

Similar proportions of males and females over a wide size range were recaptured locally (Table 1). The null hypothesis that equal proportions of males and females were recaptured was tested and not rejected ($G = 0.414$, d.f. = 1, $0.9 > P > 0.5$; Sokal & Rohlf 1969, p. 590 ff). Most of the females tagged were sexually immature (based on the absence of setae on the pleopods — Fig. 2), as were the females recaptured locally. Some males and females over a

wide size range were recaptured within 2 km of the tagging sites up to 2 years after tagging.

Long distance movements (≥ 15 km from tagging site)

All long distance movements were in a general north-westerly direction along the eastern coast of the North Island (Fig. 1). Many of the recaptures from the Mahia Peninsula taggings occurred north of the adjacent tagging sites (Gisborne and Matakaoa Point). Similarly, 1 rock lobster tagged at Matakaoa Point moved northwards of the Mercury Islands, and several tagged at Whangarei Heads were recaptured beyond North Cape, an earlier tagging site. In addition, since this paper was written, an immature female tagged at Matakaoa Point in February 1981 at 128 mm CL was recaptured 384 km north-west of Matakaoa Point, near Bream Head (Whangarei Heads), after 948 days at liberty.

The depths at which most of the recaptures were made suggest that movements generally occurred within the shelf edge, probably within the 100 m contour. However, movements at greater depths are not precluded. The largest number of recaptures were made near Cape Reinga, but none were made on the western coast south of Cape Maria van Diemen.

The minimum straight line sea distance travelled ranged up to 416.9 km, and did not appear to be consistently related to time. The minimum rates of movement ranged between 0.04 and 1.73 km d⁻¹. (Table 2). The overall mean minimum distance travelled between tagging and recapture was 142.3 km, the overall mean minimum rate of movement 0.61 km d⁻¹. Rock lobsters moved within 90 days of taggings carried out during September–January but movements may also have occurred at other times of the year. Long distance movements occurred during and after all years of tagging (1978–82).

There was no significant difference between the proportions of males and females moving long distances. The null hypothesis, that equal proportions of males and females moved long distances, was tested and not rejected ($G = 1.336$, d.f. = 1, $0.5 > P > 0.1$; Sokal & Rohlf 1969, p. 590 ff). The majority of females were still immature when recaptured.

DISCUSSION

All long distance movements (≥ 15 km) during all years took place in a general north-westerly direction from all tagging sites. A majority of the local movements (< 15 km) were also in this general direction.

Table 3 Final recapture sizes of male and female *Jasus verreauxi* which were recaptured locally (within 15 km of tagging site) and which had moved long distances (≥ 15 km from tagging site) by 31 May 1983.

Size at recapture (mm carapace length)	Numbers of rock lobsters	
	Recaptured locally	Moving long distances
< 130	14	4
130–9	21	8
140–9	16	11
150–9	15	15
≥ 160	6	9
Total	72	47

Rock lobster fishing takes place most intensively along the eastern, southern, and south-western coasts of New Zealand, and also along the northern coast in the region of Cape Reinga and Cape Maria van Diemen (e.g., Sanders 1983). Although rock lobsters are also potted along the western coast of the country. Fishermen's catches indicate that *J. verreauxi* are much more abundant along the northern and eastern coasts, than on the western coast (author's unpublished data). This, in conjunction with the low numbers of tag returns from the western coast, suggests that the generally north-westward movement towards Cape Reinga observed in this study accurately reflects events occurring in nature. It seems unlikely that the holding of some rock lobsters for periods of up to 20 days before tagging and release at Matakaoa Point has distorted natural movement patterns from this site.

The overall tag recapture rate (9.6%) is lower than that observed for *J. verreauxi* tagged off North Cape during 1976–77 (17.0% — Booth 1979). However, the direction and rates of movement are very similar, with the Cape Reinga area appearing to be the ultimate destination.

The often long delay between tagging and recapture makes it difficult to determine the size at which rock lobsters begin to move long distances. It is not known whether rock lobsters < 100 mm CL are moving, since few of this size were tagged and no animals were < 100 mm CL at recapture. No rock lobsters < 120 mm CL at recapture had moved long distances, although a few 100–119 mm CL had moved locally after at least 30 days at liberty. It is possible that some of these animals were already engaged in long distance movements before recapture. The final recapture sizes of all rock lobsters which moved long distances were similar to those which were recaptured locally (Table 3). The null hypothesis that the sizes of males and females

combined were similar was tested and not rejected ($G = 8.168$, d.f. = 4, $0.1 > P > 0.05$; Sokal & Rohlf 1969, p. 599 ff). This suggests that in many instances the local movements which were observed may have been part of longer movements.

It appears that most rock lobsters in the southern localities eventually move northward, even though some tagged animals remained near the tagging sites for up to 2 years. Only a small proportion > 155 mm CL are caught south of the Mercury Islands. Either the rock lobsters move out of these areas, or else become unavailable to potting for another reason. Furthermore, very few females with eggs are taken south of Whangarei Heads, and high proportions of egg-bearing females are taken only near Cape Reinga (Booth 1984). Hence for females at least, the northward movement is probably associated with the onset of sexual maturity. The tagging data are consistent with this; most females moving long distances along the eastern coast of the North Island were immature, but many developed setae for the first time upon reaching Cape Reinga.

The movement of *J. verreauxi* from North Cape towards Cape Reinga is probably associated with the recruitment mechanism for this species (Booth 1979). The present study indicates that the movement of rock lobsters towards the breeding area off Cape Reinga takes place along at least the eastern coast of the North Island north of Mahia Peninsula. This entire coastline is an important migratory pathway for *J. verreauxi*, and is almost certainly critical to the maintenance of the fishery for this species.

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