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North Cape — a 'nursery area' for the packhorse rock lobster, *Jasus verreauxi* (Decapoda: Palinuridae)

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In the North Cape area (34°26'S, 173°07'E) there appears to be a concentration of late juvenile packhorse rock lobsters, *Jasus verreauxi* (H. Milne Edwards), which subsequently contributes significantly to the nearby fishery for adult *J. verreauxi* off Cape Reinga. Evidence for this is based on the overall smaller size and fewer mature rock lobsters at North Cape compared to areas nearby, and on the results of tagging experiments carried out during 1976-77. Rock lobsters tagged at North Cape moved 21-514 km, mainly west and south, before recapture at minimum rates of 0.03-2.00 km.d⁻¹. For females at least, the movement away from North Cape usually occurs at about the time that sexual maturity is attained. Rock lobsters tagged near Cape Reinga moved 3-34 km west at minimum rates of 0.04-0.35 km.d⁻¹.

Although the closure of the North Cape grounds to rock lobster fishing restricts the taking of the small number of legal-sized fish available in the area, the restriction ensures less mortality and damage to the undersized fish due to handling.

INTRODUCTION

The packhorse or green rock lobster, *Jasus verreauxi* (H. Milne Edwards), occurs around mainland New Zealand and on the coast of New South Wales (Kensler 1967a, George & Kensler 1970). The most productive fishing areas for the species in New Zealand have been parts of the east and north coasts of the North Island between Capes Runaway and Maria van Diemen (Kensler & Skrzynski 1970). The fishery is now, however, largely confined to the far north of the country west of North Cape (Fig. 1), the greatest numbers of legal-sized *J. verreauxi* (tail length greater than 216 mm) being taken by potting within a 25 km radius of Cape Reinga. An interesting feature of the distribution of *J. verreauxi* off northern New Zealand is the concentration of below legal size animals in an area of at least 3 km² near North Cape. Legislation enacted in October 1977 made fishing for rock lobsters in this area illegal because of the possible role of the area as a nursery for the main *J. verreauxi* fishery off Cape Reinga (Booth 1977).

The juvenile *J. verreauxi* off North Cape are concentrated on sand and slightly rough substrates in 80-130 m of water, 3-8 km south-east of the North Cape light house (34° 26'S, 173° 07'E) (see Fig. 5). Discussions with local fishermen revealed that the area was first commercially fished in September 1961, when the minimum legal size was 152 mm tail length. Typical catch rates were 35 kg per pot, with the rock lobsters averaging 0.9-1.4 kg in weight and 170-200 mm in tail length. In 1966 about 10 boats were fishing. In 1969 the minimum legal size for *J. verreauxi*

was increased to 216 mm tail length, which allowed most females to reach sexual maturity and spawn at least once before entering the fishery (Kensler 1967b). With the new size limit only a small percentage of the rock lobsters at North Cape were takeable, and the number of vessels decreased to about four. The area was fished for the next 8 years by this number of boats, until it was finally closed to rock lobster fishing in October 1977.

This paper presents evidence that in the North Cape area there is a concentration of late juvenile rock lobsters which later contributes significantly to the fishery for adult rock lobsters around Cape Reinga.

METHODS

The carapace length-frequency distributions of total pot contents from potting carried out at North Cape during 1976-78 were compared with the results of potting carried out in 1967, and with similar observations made in areas closer to the main fishing grounds around Cape Reinga in 1967 and 1976.

Three hundred and twenty-five male *J. verreauxi* (size range 123-172 mm carapace length (CL)) and 388 females (111-174 mm CL) were tagged at North Cape during 1976-77. Also, 42 males (143-169 mm CL) and 34 females (137-174 mm CL) were tagged near Cape Reinga in November 1976. All rock lobsters were tagged with sequentially numbered, yellow, 'Western Rock Lobster' tags (Chittleborough 1974), inserted dorsally just lateral to the mid-line, into the muscle between the posterior edge of the

carapace and the anterior edge of the first tail segment. Information recorded for each rock lobster included carapace length (dorsal mid-line measured from the antennal platform to the posterior edge of the carapace), sex, presence of setae on the endopodites of the pleopods as an indicator of sexual maturity (females only), and damage (loss of limbs, etc.).

The rock lobsters tagged at North Cape were caught by potting, immediately tagged, and released at the point of capture. Those tagged near Cape Reinga were caught by potting within 22 km of the cape, but could not be released at the point of capture because of the sea conditions. They were kept on deck, covered with moist sacks, for up to 3 h, then tagged and released within 15 km of Cape Reinga. The majority of recaptured, tagged rock lobsters were caught by potting and returned by local commercial fishermen.

RESULTS

SIZE OF ROCK LOBSTERS

The carapace length–frequency distributions of pot catches from North Cape and Spirits Bay during December 1967, a period of moderate or high exploitation in both areas, are shown in Fig. 2. Although the sample size for females from Spirits Bay is small, the size distribution is similar to that given by Kensler (1967b; figs 3 & 4) (based on a rostral spine measure) for 834 females from Spirits Bay in October and December 1966.

The carapace length–frequency distributions of pot catches from North Cape during 1976–78, a period of low exploitation, are given in Figs 3 and 4. Fig. 3 also shows the carapace length–frequency distributions of catches from Spirits Bay and Cape Maria van Diemen during February–March 1976, a period of moderate or high exploitation in both areas. Fishermen maintain that these size distributions were typical of their catches in those areas. Although accumulations of undersized *J. verreauxi*, apparently much less dense than at North Cape, have in the past been reported off Hooper Point (Fig. 1), this area does not now yield many rock lobsters. These data indicate that a smaller mean size of *J. verreauxi* occurs at North Cape than in areas further west. In addition, few females reach sexual maturity on the North Cape grounds.

TAGGING RESULTS

The tag return rates are given in Table 1; these underestimate the actual catch rate of tagged rock lobsters due to known non-reporting of tags by fishermen, and tag loss and mutilation.

The inferred movement of rock lobsters tagged at North Cape during 1976–77 and recovered by 20 August 1978 are given in Fig. 5 and Table 2. All but one of the 121 recoveries were made at North Cape (11) or from areas to the west and south-west of North Cape (109). Six were taken around Hooper Point and Spirits Bay, but the majority (98) were taken near Capes Reinga and Maria van Diemen, 30–50 km west of North Cape. Two were returned

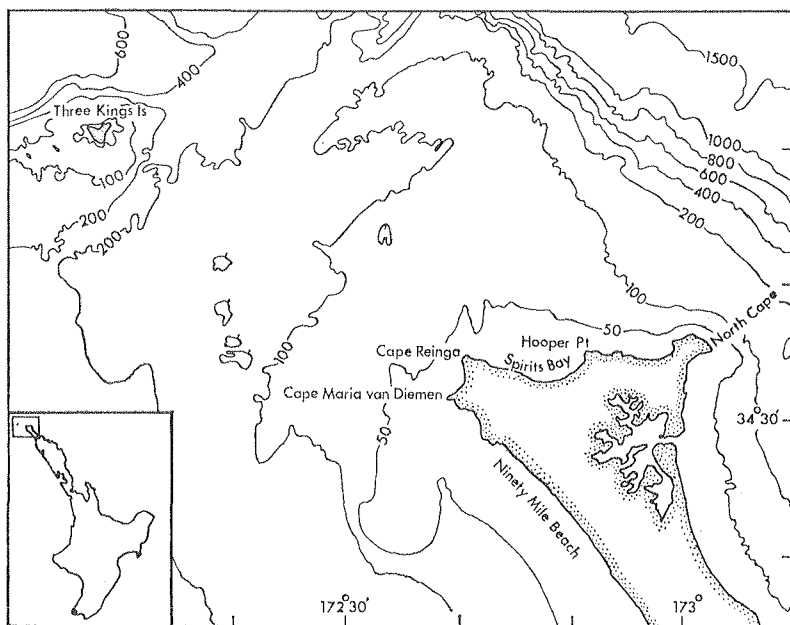


Fig. 1. Northern New Zealand showing areas mentioned in text (bathymetry in metres).

from Tauroa Point, 75 km to the south, and three from the Cape Egmont area, 435 km to the south of North Cape. Since this paper was submitted another male tagged at North Cape in July 1977 was recovered near Cape Egmont (Nov 1978). Only one rock lobster was recovered from the east coast despite commercial fishing in that area being at least as intensive as on the west coast of Northland. It was caught at Cape Karikari, 45 km SSE of North Cape.

The mean distance travelled between tagging and recapture by all rock lobsters tagged at North Cape and recovered away from North Cape before 20 August 1978 is 59.4 km after an average of 250 days at liberty. Minimum movement rates for rock lobsters recovered near Cape Reinga and Cape Maria van Diemen were 0.03–1.98 km.d⁻¹. The minimum sea distance covered by those recovered at Tauroa Point was 122 km with minimum rates of movement

of 0.30 and 0.60 km.d⁻¹; those recovered near Cape Egmont moved 503–514 km at minimum rates of 1.25, 1.37, and 2.00 km.d⁻¹.

Both male and female *J. verreauxi* moved in a similar fashion; 45.6% of the rock lobsters tagged at North Cape were males and 45.5% of the tag recoveries made outside North Cape were males. Most of those recovered outside North Cape had changed in colour from the dark green of the juvenile towards the olive green of the larger adults taken in the main fishery around Cape Reinga.

The initial and final carapace lengths of rock lobsters tagged at North Cape and recovered outside North Cape by 20 August 1978 are given in Fig. 6; all had moulted before recapture, judging from the change in carapace length. The initial carapace lengths of the 50 males recovered ranged from 123 to 162 mm, and the final carapace lengths from 132 to 169 mm. For the 60 females, the initial carapace lengths were 122–159 mm and the final carapace lengths 129–166 mm.

Two of the 11 rock lobsters tagged and recaptured at North Cape had moulted; both were males, tagged in July 1977 and recaptured the following November and January. The others, which had been at liberty from February/March to July 1977 (4 males, 2 females), from February to May 1977 (1 female), and from February to March 1977 (1 male, 1 female), had not grown.

Although only 10% of the females from North Cape bore setae on the pleopods at the time of tagging,

Table 1. Numbers of *J. verreauxi* tagged at North Cape and Cape Reinga during 1976–77 and recovered by 20 Aug 1978.

Date of tagging	No. tagged	Recovery (%)
North Cape		
Feb 1976	138	4.4
Feb–Mar 1977	88	11.4
Jul 1977	487	21.6
Total	713	17.0
Cape Reinga		
Nov 1976	76	11.8

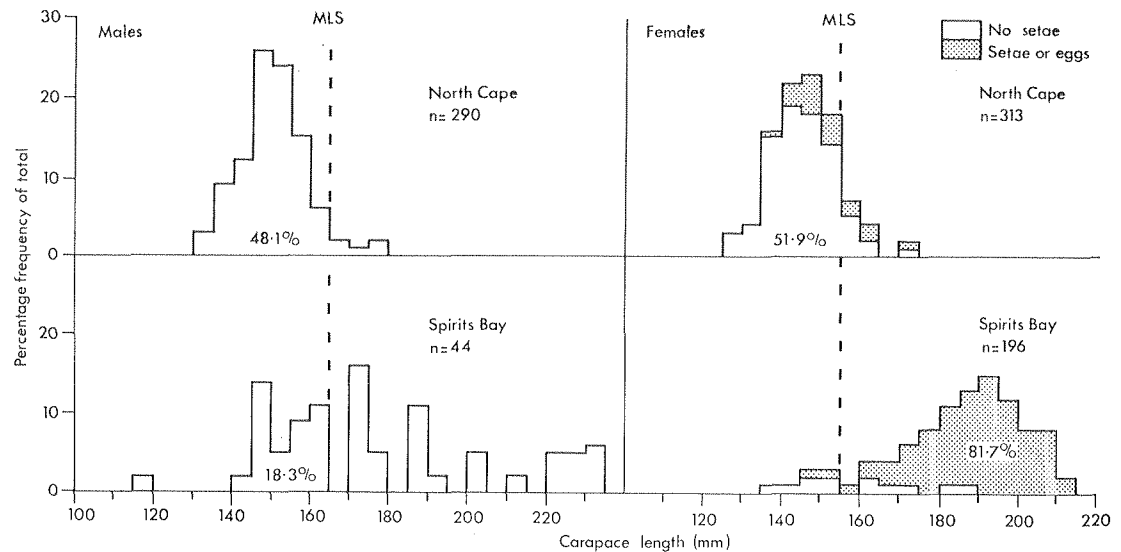


Fig. 2. Carapace length-frequency distributions of male (left) and female (right) *Jasus verreauxi* in pot catches (no escape gaps) from North Cape (upper) and Spirits Bay (lower), Dec 1967. The present minimum legal size (MLS; 216 mm tail length), equivalent to about 165 mm carapace length (CL) for males and 155 mm CL for females, is indicated.

80% were sexually mature upon recapture; most had been at liberty for less than 9 months. No egg-bearing females were taken at North Cape, despite potting having been carried out during the period in which egg-bearing females were caught in pots near Cape Reinga (November–February). Fishermen corroborated these observations in that they used to catch very few berried females at North Cape, and

found the proportion of egg-bearing females became greater closer to Cape Maria van Diemen. Seemingly the females move away from North Cape at about the time of the moult which results in the appearance of setae on the pleopods, and before egg-bearing occurs. Sexual maturity was not recorded for males because there is no satisfactory means of determining this externally.

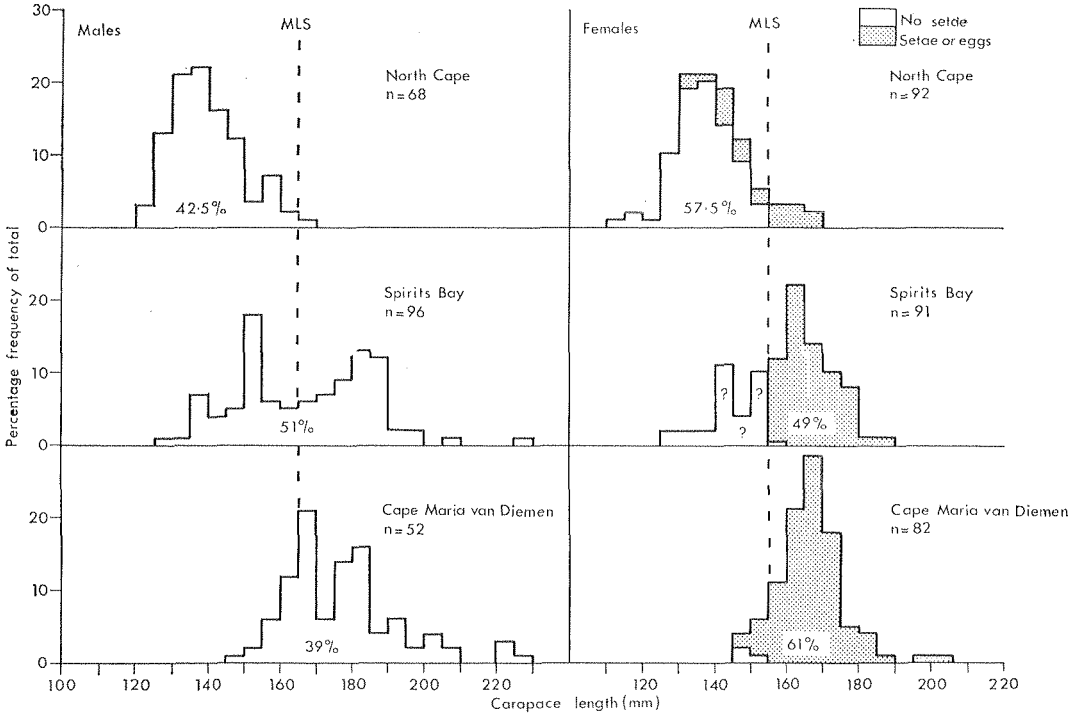


Fig. 3. Carapace length-frequency distributions of male (left) and female (right) *Jasus verreauxi* in pot catches from North Cape (upper), Spirits Bay (middle) and Cape Maria van Diemen (lower), Feb–Mar 1976. Pots fished at Spirits Bay and Cape Maria van Diemen had escape gaps 300 × 54 mm, which would have allowed rock lobster less than 100 mm carapace length to escape. Present minimum legal size (see caption to Fig. 2) is indicated.

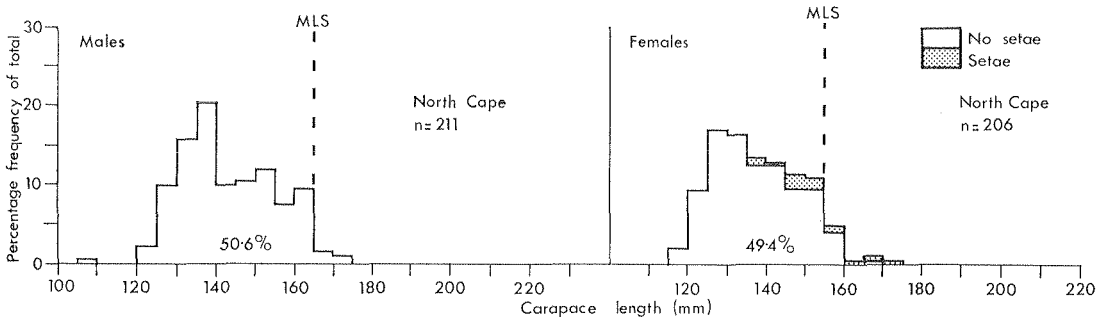
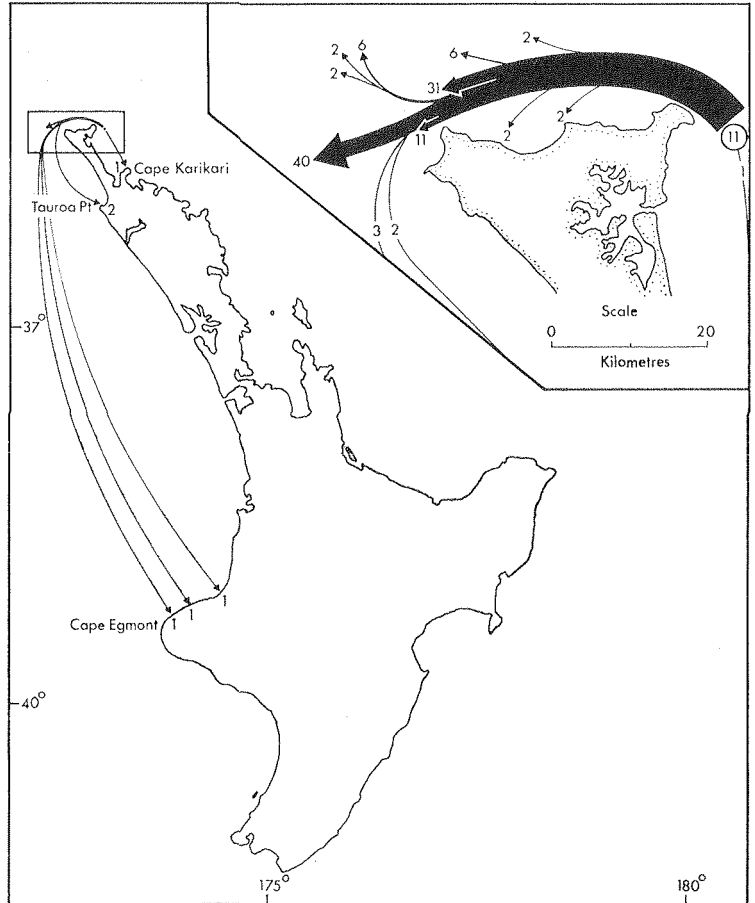


Fig. 4. Carapace length–frequency distributions of male (left) and female (right) *Jasus verreauxi* in pot catches (no escape gaps) from North Cape, combined data from Feb–Mar 1977 and Jan–Feb 1978. Present minimum legal size (see caption to Fig. 2) is indicated.

Fig. 5. Movements of *Jasus verreauxi* tagged at North Cape during 1976-77 and recovered by 20 August 1978. Arrows give inferred movements; figure at arrow gives number of tagged rock lobsters recovered at or near that point. In inset, width of arrow approximately proportional to number of rock lobsters recovered at that point; figure in circle gives number of tagged rock lobsters recovered at tagging site.



Days at liberty	No. of recaptures	Minimum distance moved (km)	Mean minimum distance moved (km)	Minimum rate of movement (km.d ⁻¹)	Mean minimum rate of movement (km.d ⁻¹)
21-70	2	36-56	45	0.87-1.98	1.43
71-120	1	55	55	0.62	0.62
121-170	6	25-36	31	0.19-0.28	0.24
171-220	21	21-122	42	0.12-0.60	0.23
221-270	60	36-503	57	0.14-2.00	0.23
271-320	11	40-55	46	0.14-0.19	0.16
321-370	—	—	—	—	—
371-420	6	41-514	212	0.11-1.37	0.55
421-470	—	—	—	—	—
471-520	—	—	—	—	—
521-570	—	—	—	—	—
571-620	—	—	—	—	—
621-670	—	—	—	—	—
671-720	1	21	21	0.03	0.03
721-770	1	57	57	0.08	0.08
771-820	1	40	40	0.05	0.05

Table 2. Relationship between number of days at liberty and minimum distance moved for *J. verreauxi* tagged at North Cape (1976-77) and recovered away from North Cape by August 1978. (—, no rock lobsters recovered during that time interval.)

The rate of return of rock lobsters in the far north area from one tagging period (9 July 1977) at North Cape is shown in Fig. 7. The effort being expended in the packhorse fishery was determined by discussion with the local commercial fishermen. From November 1977 to late February 1978, most fishing effort was concentrated on the red rock lobster, *Jasus edwardsii*, which usually occurs on different grounds from the packhorse rock lobster, and the recovery rate of tagged rock lobsters was low. The highest rate of recovery of tagged *J. verreauxi* (76 caught over 56 days) was during February to April 1978 when the fishing effort on the species was greatest. Fishing for both species had ceased by May 1978.

Nine of the 76 rock lobsters tagged near Cape Reinga in November 1976 were recovered, all between 28 January and 27 March 1977. All had moved west of the tagging points (Fig. 8), moving a mean distance of 16.9 km (range 3–34 km) at a mean minimum rate of 0.15 km.d⁻¹ (range 0.04–0.35 km.d⁻¹). None had moulted before recapture.

DISCUSSION

Although concentrations of juveniles have been recognised in a number of rock lobster species overseas, they have not previously been recorded for *Jasus verreauxi*. In most of these species the juveniles occur in shallow water and disperse into deeper

water as they mature, e.g., *Panulirus argus* (Witham *et al.* 1968), *P. ornatus* (Pyne 1970), *P. longipēs* (Chittleborough & Phillips 1975) and *P. interruptus* (Serfling & Ford 1975). In a few species, the juveniles are known or suspected to occur in deeper waters than those occupied by the main adult population, e.g., *Palinurus delagoae* (Berry 1973). However, reports of juveniles moving alongshore to contribute to fisheries undertaken within a depth range similar to that in which the juveniles originate are less common, and have included *Panulirus argus* in Brazil (Paiva & Filho 1968) and *Jasus edwardsii* in New Zealand (Street 1971, 1973).

Juvenile *J. verreauxi* appear to concentrate near North Cape and migrate alongshore to the area of the main fishery off Cape Reinga; this is associated, in females at least, with the onset of sexual maturity. Alternatively, the adult rock lobsters become unavailable to potting at North Cape for some other reason.

Possible reasons for the accumulation of small rock lobsters at North Cape include high exploitation levels, slow growth due to food or habitat shortage, or the particular recruitment mechanism which operates in the area.

The carapace length–frequency distributions of pot catches at North Cape during the period of fairly heavy exploitation (1967) are compared with those during lower exploitation levels (1976–78) in Figs 2–4. Even though fishing effort decreased and the

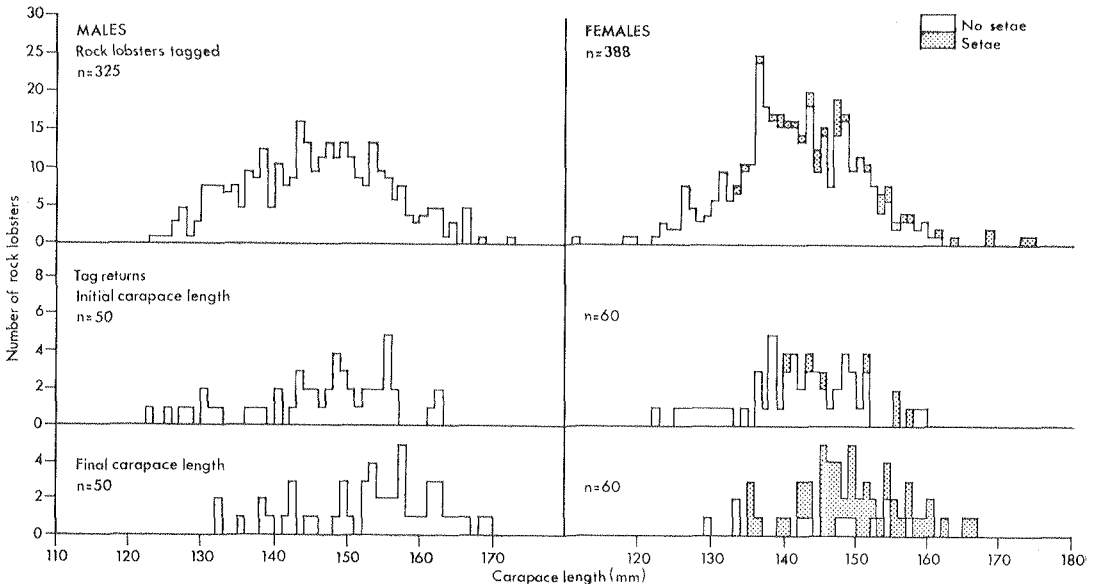


Fig. 6. Carapace length–frequency distributions of male (upper left) and female (upper right) *Jasus verreauxi* tagged at North Cape, 1976–77. Initial carapace length–frequency distributions of male (middle left) and female (middle right) rock lobsters and final carapace length–frequency distributions of male (lower left) and female (lower right) rock lobsters tagged at North Cape but recovered outside North Cape by 20 Aug 1978.

minimum legal tail size was increased by 64 mm between these years, the average size of both males and females decreased slightly. This suggests that fishing intensity is unlikely to be the cause of the smaller sizes at North Cape. There was no information available on the growth rate of rock lobsters at North Cape compared with that on the Cape Reinga grounds because none of those recovered from the Cape Reinga taggings had moulted. However, females become sexually mature at similar sizes in both areas; this may indicate that they grow equally well in both areas. A likely cause of the occurrence of small rock lobsters at North Cape is that the area forms an integral location in the recruitment mechanism that maintains the population of *J. verreauxi* in the far north. Although many postlarvae and early juveniles would be expected to occur in the area, they have not been located. The smallest male taken by potting at North Cape was 106 mm CL, the smallest female 111 mm CL, but there were few individuals less than 120 mm CL. The only confirmed occurrence of early juveniles of *J. verreauxi* in the area were 6 specimens (60–100 mm CL) taken by diving in 2 m of water off North Cape beach in December 1967 (G. D. Waugh, Fisheries Research Division, MAF, Wellington, pers. comm.). However, the paucity of early juveniles observed (especially from potting) is not surprising since this seems to be a feature of several other palinurid species, including *J. edwardsii* in New Zealand (pers. obs.).

The movement of rock lobsters from North Cape to the Cape Reinga area may also be an essential part of the recruitment mechanism. In some other palinurid species, migratory behaviour which is specifically associated with larval release has been observed. For example, Sutcliffe (1953) noted that

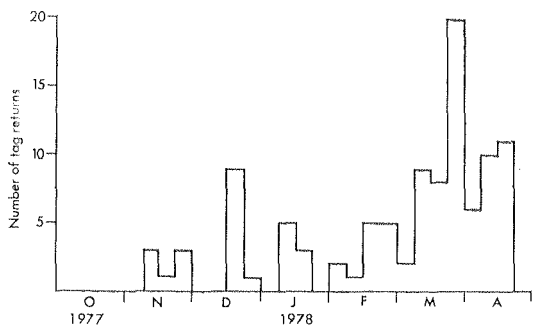


Fig. 7. Rate of return of *Jasus verreauxi* tagged at North Cape 9 July 1977 and recovered outside North Cape during subsequent fishing season.

spawning adults of *Panulirus argus* move closer to oceanic water to release their larvae; mass migrations of *Palinurus delagoae* in opposition to the current in which the larvae develop have been observed by Berry (1973). It is possible that the movement of maturing rock lobsters from North Cape towards Cape Reinga puts them into a location for larval hatching that subsequently results in successful larval recruitment to the area. In addition, their movement down the west coast of the North Island, at least as far south as Cape Egmont, contributes to the small patches of *J. verreauxi* found along this coast. Considering the weak, largely wind-generated and north-moving currents off the west coast of the North Island (Roberts & Paul 1978), these patches may be maintained more by movement of late juveniles from the far north area than by larval recruitment.

The distance moved by rock lobsters tagged at North Cape was not directly a function of time (Table 2). The higher of the minimum migration rates of 0.03–2.00 km.d⁻¹ are similar to the 1.5–1.8 km.d⁻¹ found for *Panulirus argus* and *P. longipes cygnus* (Herrnkind 1977). These rates are, however, lower than fishermen's estimates of at least 3 km.d⁻¹, which are based on the rate at which they must move pots in order to maintain catches of apparently migrating *J. verreauxi*.

Although far fewer rock lobsters were tagged near Cape Reinga than at North Cape, all returns were made west of the tagging sites, and there was no evidence of any return migration from the Cape Reinga area back to North Cape.

This interpretation of rock lobsters moving as they near sexual maturity, for females at least, is in keeping with observations on a number of other palinurid

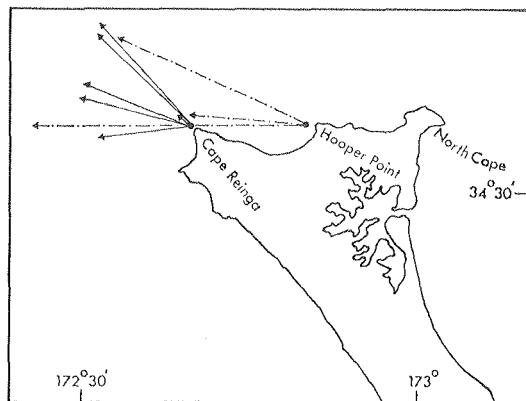


Fig. 8. Movements of *Jasus verreauxi* tagged near Cape Reinga during Nov 1976 and recovered by 20 Aug 1978. Arrows give inferred movement of 1 tagged rock lobster.

species, including *J. edwardsii* in New Zealand (Street 1973) and *Panulirus argus* (Witham *et al.* 1968) and *P. longipes cygnus* (George 1958) overseas. Although most females had reached sexual maturity by the time of their recapture outside the North Cape area, none bore eggs. They included 25 sexually mature female rock lobsters caught near Cape Reinga during November–January, the main egg-bearing season. Possibly these females were unmated, or incapable of egg extrusion at the time, even though externally they appeared mature.

The size distribution of the catches and the tagging data indicate that in the North Cape area there is a concentration of late juveniles that later makes a significant contribution to the main fishery for adult *J. verreauxi* off Cape Reinga. Although it may not be the only concentration of juveniles, it is probably the largest. Assuming North Cape is the major source of juvenile rock lobsters for the Cape Reinga fishery, sampling of size distributions and abundance at North Cape may prove useful in predicting catch rates in the Cape Reinga fishery. The closure of the North Cape area to rock lobster fishing helps to ensure less damage and mortality due to handling of undersized rock lobsters, even though it restricts the taking of the small percentage of legal-sized animals available in the area.

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