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LONGSHORE MOVEMENTS OF ADULT MALE *JASUS LALANDII*: EVIDENCE FROM LONG-TERM TAG RECAPTURES

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Large-scale longshore movements (>10 km) of adult male *Jasus lalandii* (>70 mm carapace length) were examined on the west coast of South Africa using tag-recapture information from the period 1968 to 2000. The average rate of recovery of tagged rock lobsters was 15.7% per fishing season. Only 0.48% of 43 885 recaptured rock lobsters moved >10 km, 0.31% southwards and 0.17% northwards. The mean distance moved by those lobsters was 28.6 km and the mean time at liberty was 241.8 days. In recent years, densities of *J. lalandii* have increased substantially at the south-eastern end of their geographic range. The data indicate that this could not be attributable to a population migration of adult male rock lobsters from the west coast of South Africa.

Key words: migration, rock lobsters, South Africa, tag-recapture

The west coast of southern Africa has historically been a lucrative fishing ground for rock lobster *Jasus lalandii* (Pollock *et al*. 2000). During the early 1990s, there was a notable increase in rock lobster abundance off the South-Western Cape (Tarr *et al*. 1996, Mayfield and Branch 2000). This increase was intuitively coupled with the decrease on the West Coast and a south-eastward migration was suggested. Long-distance movements have been recorded for several other species of spiny lobster (Herrnkind 1969, 1980, Moore and MacFarlane 1984, Booth 1997, Kelly 1999, Groeneveld 2002, Groeneveld and Branch 2002). Such migrations of rock lobsters are of considerable interest because they influence the efficacy of marine protected areas, i.e. the likelihood of adults spilling over into adjacent fished areas (Childress 1997), and the effectiveness of zone-specific management plans.

This study examines tag-recapture data for adult male *J. lalandii* (individuals >70 mm carapace length) between the period 1968 and 2000. Although the data were originally collected specifically to monitor the growth rate of *J. lalandii*, they were considered suitable for an examination of their large-scale movement patterns. The observations cover most of the period of commercial exploitation, including the early lucrative harvesting phase, when anecdotal reports of mass migrations of *J. lalandii* were common, through to the current situation of much-reduced stocks. Mayfield and Branch (2000) have shown that, in recent years, there have been dramatic increases in rock lobsters east of Cape Hangklip on the South-Western Cape (see Fig. 1), whereas numbers and productivity have declined on the West Coast. The data are used to explore the possibility that migration of adult males was responsible for this increase east of Cape Hangklip.

MATERIAL AND METHODS

All available tag, release and recapture data were obtained from Marine & Coastal Management, Cape Town. Goosen and Cockcroft (1995) describe the tagging procedure, using uniquely numbered t-bar spaghetti tags inserted dorsally between the carapace and abdomen. The tags are retained after moulting.

Data collected at the time of tagging included area of capture, area and date of release and rock lobster carapace length (*CL*). The fishery for the West Coast rock lobster is divided into fishing zones and the information relating to the release and recapture sites was only accurate to within the limits of these zones (Fig. 1). All recovered tagged rock lobsters were re-measured and the area and date of recapture recorded.

The general direction of movement (northwards or southwards) was determined and the total time at liberty (days) calculated. During the 1988/89 fishing season, two rock lobsters appeared to move >500 km, but these extreme distances were considered to be outliers and as such were excluded from the analysis.

The number of tags returned between 1968 and 2000 for each area were summed (x) and the total number of tagged rock lobsters moving out of that area (y) was subtracted from x (Equation 1). These values were converted to percentages (Equations 2 and 3) and square-root transformed for clearer presentation of the data (Fig. 1).

Number of lobsters that did not move:

$$t = x - y \quad (1)$$

Percentage of lobsters that did not move:

$$t\% = t/x \times 100 \quad (2)$$

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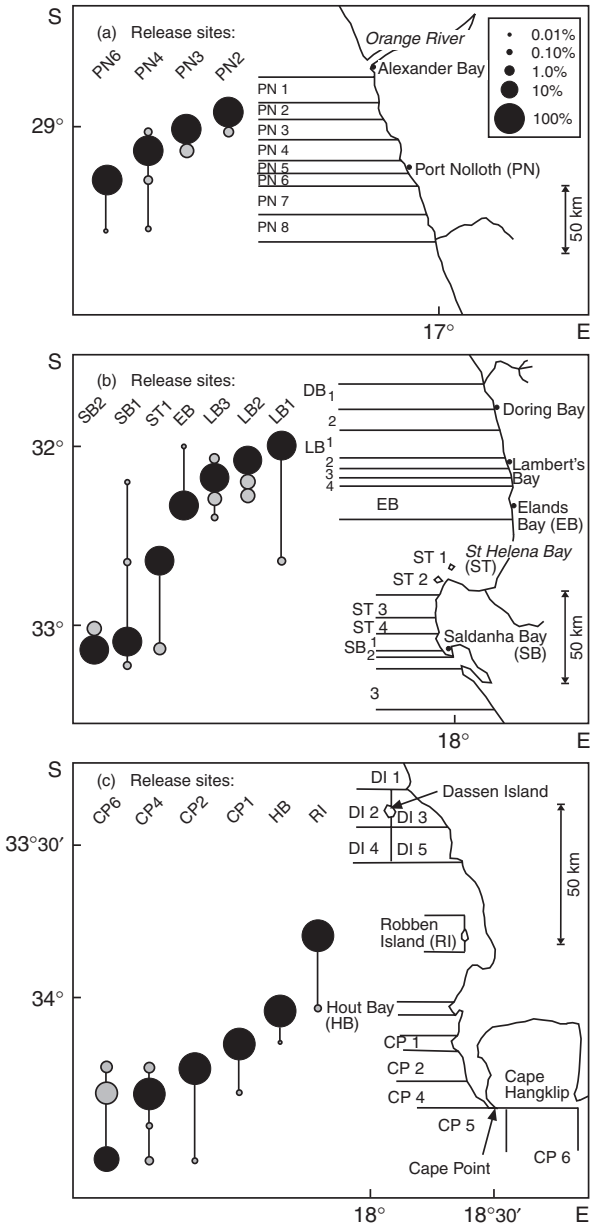

Fig. 1: Movements of rock lobsters released in (a) the Port Nolloth area, (b) the Doring Bay to Saldanha Bay area and (c) the Cape Peninsula area between 1968 and 2000. Rock lobsters were released at each of the sites indicated and then recovered at the release site (black circles) or at other sites (grey circles). The diameters of the circles are proportional to the relative percentage of lobsters recovered (after square-root transformation)

Percentage of lobsters that moved out of release area:

$$y\% = y/x \times 100 \quad (3)$$

RESULTS

The average recovery rate of tagged lobsters was 15.7% per fishing season. Over 32 seasons, longshore movements were found in only 10 cases (Table I). Of the 43 885 tagged rock lobsters recaptured since 1968, just 210 (0.48%) had moved, 73 (0.17%) northwards and 137 (0.31%) southwards. The average distance moved was 28.6 km, the average time at liberty was 241.8 days (Table I), and the average rate of movement was 0.17 km day^{-1}. During 22 of a possible 32 fishing seasons, none of the tagged rock lobsters moved, and their average time at liberty was 228.6 days.

The movements of rock lobsters released within the three major fishing areas on the West Coast (i.e. Port Nolloth, Doring Bay to Saldanha Bay and the Cape Peninsula) show several clear trends (Fig. 1). First, in all three areas, most (>99.5%) rock lobsters were recaptured in the fishing zone where they were released. The only exception was CP6 (Fig. 1c). Second, most movements involved shifts to adjacent or next-adjacent zones, and distances of <50 km. Some individuals, however, moved >100 km (e.g. from SB1, see Fig. 1b). Third, rock lobsters moved in both directions along the coast.

Movement tended to be concentrated in three periods: 1973–1977, 1981–1983 and 1987–1992 (Table I), during which the frequency of movement averaged 1.6%.

There was no correlation between distance moved and size of rock lobster ($r = 0.0007$). However, there was a significant relationship between distance (km) moved (y) and time at liberty (days, x; $y = 0.0247x + 22.68$; $r = 0.451$, $p < 0.001$).

Of the 9 335 rock lobsters tagged east of Cape Hangklip, 161 were recaptured. Of these, only three (1.86%) moved from their site of release, in an easterly direction and an average distance of 24.3 km.

DISCUSSION

Migration, as defined by Herrnkind (1980), is a direct locomotory movement of a distinct component of a population, within some confined time period and over relatively long distances. It is

Table I: Details of all recaptured rock lobsters *J. lalandii* for fishing seasons between 1968 and 2000 on the west coast of South Africa. Average distance moved and average distance moved per day are calculated only for rock lobsters that had moved between release and recapture sites. Average times at liberty are calculated for all recaptured rock lobsters

Fishing Season	Numbers not moved	Numbers and percentages moved northwards	Numbers and percentages moved southwards	Average distance moved (km) ±*SE*	Average time at liberty (days) ±*SE* of rock lobsters that moved	Average time at liberty (days) ±*SE* of rock lobsters that did not move	Average distance moved (km) per day
1968/1969	1 174 (100%)	0	0	0	0	130 ± 2.04	0
1969/1970	2 841(100%)	0	0	0	0	144 ± 2.7	0
1970/1971	1 773 (100%)	0	0	0	0	216 ± 4.1	0
1971/1972	1 609 (100%)	0	0	0	0	203 ± 5.0	0
1972/1973	138 (100%)	0	0	0	0	609 ± 19.9	0
1973/1974	124 (90%)	8 (6%)	6 (4%)	18	63 ± 12.6	643 ± 38.4	0.29
1974/1975	51 (85%)	7 (12%)	2 (3%)	18	157 ± 6.4	595 ± 22.1	0.11
1975/1976	464 (100%)	0	0	0	0	193 ± 3.7	0
1976/1977	598 (90.7%)	5 (0.8%)	56 (8.5%)	19.6 ± 0.7	77 ± 9.2	85 ± 2.9	0.25
1977/1978	120 (100%)	0	0	0	0	113 ± 7.1	0
1978/1979	637 (100%)	0	0	0	0	139 ± 4.6	0
1979/1980	468 (100%)	0	0	0	0	186 ± 3.2	0
1980/1981	1 773 (100%)	0	0	0	0	134 ± 2.6	0
1981/1982	1 220 (99.92%)	1 (0.08%)	0	54	50	146 ± 1.9	1.08
1982/1983	896 (96.4%)	0	33 (3.6%)	43	557 ± 15.4	263 ± 2.9	0.08
1983/1984	502 (100%)	0	0	0	0	428 ± 3.2	0
1984/1985	984 (100%)	0	0	0	0	93 ± 2.6	0
1985/1986	2 993 (100%)	0	0	0	0	75 ± 4.5	0
1986/1987	2 546 (100%)	0	0	0	0	173 ± 4.2	0
1987/1988	3 328 (99.4%)	10 (0.3%)	11 (0.3%)	25.7 ± 1.3	311 ± 59.5	224 ± 3.5	0.08
1988/1989	2 117 (99.52%)	3 (0.15%)	7* (0.3%)	23.1 ± 2.7	461 ± 131	257 ± 5.8	0.05
1989/1990	1 252 (99.92%)	0	1 (0.1%)	94.8	1 020	282 ± 8.6	0.09
1990/1991	1 186 (99.58%)	5 (0.42%)	0	62.7 ± 19.6	625 ± 209.5	177 ± 6.0	0.10
1991/1992	1 904 (97.19%)	34 (1.74%)	21 (1.1%)	31.8 ± 1.6	183 ± 28.4	149 ± 4.9	0.17
1992/1993	1 957 (100%)	0	0	0	0	220 ± 4.0	0
1993/1994	1 265 (100%)	0	0	0	0	313 ± 7.3	0
1994/1995	3 138 (100%)	0	0	0	0	349 ± 5.0	0
1995/1996	1 731 (100%)	0	0	0	0	330 ± 6.9	0
1996/1997	1 453 (100%)	0	0	0	0	399 ± 8.2	0
1997/1998	1 546 (100%)	0	0	0	0	418 ± 7.8	0
1998/1999	987 (100%)	0	0	0	0	382 ± 9.5	0
1999/2000	900 (100%)	0	0	0	0	375 ± 16.5	0
Total	43 675 (99.5%)	73 (0.17%)	137 (0.3%)	28.6†	241.8	228.67	0.17†

* Excluding outliers (see text)
† Calculated only for years in which there was movement

clear that a very small component of the rock lobster under study moved long distances, so it can therefore be concluded that *J. lalandi* >70 mm *CL* (those considered to be sexually mature) showed no evidence of any distinct longshore migrations between 1968 and 2000. However, because only large, sexually mature and mostly male *J. lalandii* were tagged (Goosen and Cockcroft 1995), the data were limited to the adult population. Groeneveld (2002) and Groeneveld and Branch (2002) found that juvenile rock lobsters *Palinurus gilchristi* and *P. delagoae* displayed longshore migration on the South African south coast, as a possible mechanism to redress larval displacement by current flow. There was no indication in the present data to suggest that small rock lobsters moved farther than large ones.

The larvae of other species of spiny rock lobster are transported in a fixed direction by prevailing currents (Booth 1997, Pollock 1990), necessitating contranatant (against the current) migrations of juveniles or adults to maintain their geographic range, e.g. *P. gilchristi* (Groeneveld and Branch 2002), *Jasus edwardsii* and *J. verreauxi* (Booth 1997). The prevailing direction of the Benguela Current is northwards, but there is no evidence to suggest that the larvae of *J. lalandii* are distributed that way, although larvae of the species have been found far offshore in the South Atlantic (Pollock 1990, Booth and Ovenden 2000). Therefore, it may not be necessary for *J. lalandii* to undertake contranatant migrations to redress directional dispersal of their larvae, as suggested by the lack of migratory movement in the adult population

under study.

Several studies have shown a marked increase in the standing stock of *J. lalandii* east of Cape Hangklip during the mid 1990s (Tarr *et al*. 1996, Mayfield and Branch 2000). Currently their numbers are high in that region (Mayfield and Branch 2000), raising concerns that consequent depletions of sea urchins *Parechinus angulosus* and other grazers by lobster predation could result in a radical ecosystem shift and collapse of abalone *Haliotis midae* recruitment and juveniles (Day and Branch 2002). However, the results presented here do not support the suggestion that a south-eastward migration of adults from the West Coast could explain the recent increases in rock lobster densities east of Cape Hangklip (Mayfield and Branch 2000).

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