

FEEDING BEHAVIOUR OF NEW ZEALAND KINGFISHERS AT AN ESTUARY IN WINTER

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ABSTRACT

The feeding behaviour of New Zealand Kingfishers (*Halcyon sancta vagans*) overwintering at Brooklands Lagoon, a coastal North Canterbury estuary, is described. Kingfishers watched for crabs from perches on or near the mudflats and caught crabs on 96% of dives. Kingfishers then battered them against a perch; parts of the crabs such as the chelae were knocked off in the process. Fallen chelae (n = 225) provided information about species, size and sex of crabs taken. Crabs were collected in mud samples from 10 sites to compare the size, sex and species of crabs present on the mudflats with those taken by Kingfishers. Kingfishers fed only on the mud crab *Helice crassa*, which was the most abundant crab species on the mudflats. Male crabs and large crabs were taken more often proportionally than they were in the mud samples.

INTRODUCTION

New Zealand Kingfishers are throughout New Zealand and on most offshore islands, in forests and open country, on lake shores, along rivers and streams and on the coast. Kingfishers change their distribution seasonally, increasing in number on the coast and on estuaries in winter (Taylor 1966, Ralph & Ralph 1977). This change in distribution is probably due to scarcity of prey in the high country in winter. Kingfishers take a wide variety of prey, including mice, small birds, lizards, fish, freshwater crayfish, tadpoles, crabs, shellfish, earthworms, spiders and insects (O'Donnell 1981, Heather 1985, Fitzgerald *et al.* 1986). Foods such as tadpoles, lizards and cicadas, which are abundant in the high country in spring and summer, become less available in winter. Fish, crabs and other marine prey remain active and abundant throughout the year in coastal areas (Taylor 1966).

The aim of my research was to describe the feeding behaviour of Kingfishers on a coastal estuary. The main questions asked were:

1. What prey species, sexes and sizes were taken ?
2. How did the prey items taken relate to the prey available? That is, were Kingfishers selective foragers ?
3. What was the success rate of foraging Kingfishers ?
4. Were Kingfishers aggressive towards one another when feeding ?

STUDY AREA

Kingfishers were observed at Brooklands Lagoon, 15 km north-north east of Christchurch, during March to August 1987. Large areas of mudflat were exposed for 4-6 hours at low tide. In comparison with other New Zealand estuaries, Brooklands Lagoon has a very dense fauna, suggesting high biological productivity in the area (Knox & Bolton 1978).

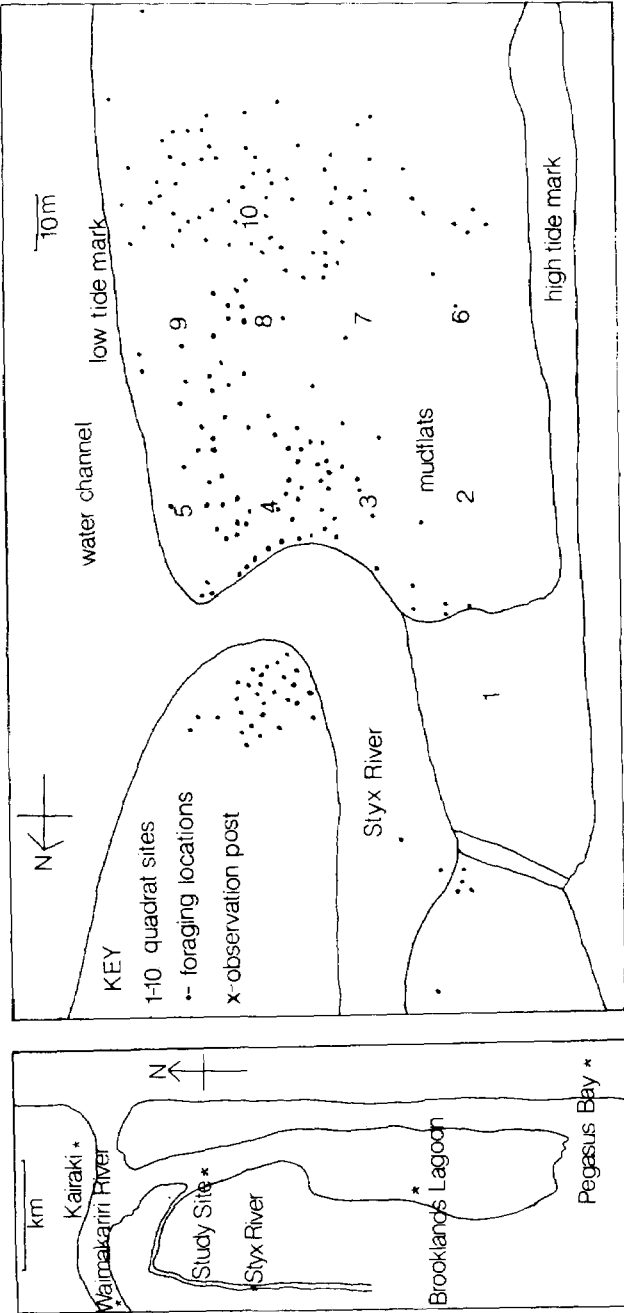


FIGURE 1 — Left: Brooklands Lagoon and the study site. Right: Prey capture locations for Kingfishers feeding at Brooklands Lagoon. Each dot represents where a crab was captured. Numbers show the ten sites where crabs were sampled

METHODS

To observe Kingfishers foraging I used a 25x spotting scope or 12x50 binoculars from distances of 20-250 m. I recorded feeding success, the height of feeding dives, the distance travelled to catch prey, whether prey was taken on the mudflats or underwater, handling time, whether the bird returned to the same perch, and any aggressive behaviour. To estimate height and distance of feeding dives, I used reference marks of known separation distance on the mudflats. Handling time was recorded to the nearest second with a stopwatch.

To divide the mudflat into areas of different feeding intensity, I plotted 200 sites where Kingfishers captured crabs (Fig. 1). Selecting 10 sites ranging from areas of little or no feeding to areas of heavy feeding, I sampled the crabs at low tide on 7 July 1987, using 0.25 m² quadrats at each site. I dug the samples to the depth of the deepest burrow (> 20 cm), extracted the mud and sorted for crabs by hand. Crabs were preserved in 70% alcohol and later blotted dry and weighed to the nearest 0.01 g on a Mettler balance. Chelae length and depth and carapace width were measured to 0.1 mm with vernier calipers, and the sex of each crab was recorded.

Kingfishers knocked parts off crabs before swallowing them. Each time I collected crab remains, I first removed old crab remains from beneath regular Kingfisher perches, or if possible, moved the perch several metres. After 2 hours, I collected from around the perches all the chelae and pellets the Kingfishers had dropped. I measured chelae lengths and depths with vernier calipers and sexed crab remains by the characteristic size and shape of the chelae (Hayes, unpub.).

To determine how often Kingfishers discarded or removed chelae during feeding, I recorded whether one, both or no chelae were dropped in each of 50 instances of a Kingfisher handling a crab.

RESULTS

The number of Kingfishers at Brooklands Lagoon ranged from three in March to ten in May and declined to five in August. The Kingfishers were tolerant of one another, often perching side by side. During 40 hours of watching I did not see any aggression or attempts to steal one another's prey.

Kingfishers at Brooklands Lagoon fed only at low tide, when *Helice crassa* were exposed feeding on the mudflats. Kingfishers used driftwood, rocks, wire and the goal post on the mudflats as perches (Fig. 2). Occasionally birds sat directly on the mud, but only when preferred perches were occupied. Kingfishers flew 2-60 m from perches and scooped up crabs in their beaks without touching the mud.

The success rate of Kingfishers at catching crabs was 96% (97 out of 101 attempts). The vertical drop of foraging dives depended largely on the height of perches available. The higher the perch, the further Kingfishers tended to fly to catch crabs (Fig. 3). Kingfishers with prey returned to the perch which they had flown from on 20 out of the 44 occasions recorded (46%). On very windy days the birds often carried the crabs back to the shelter of trees.

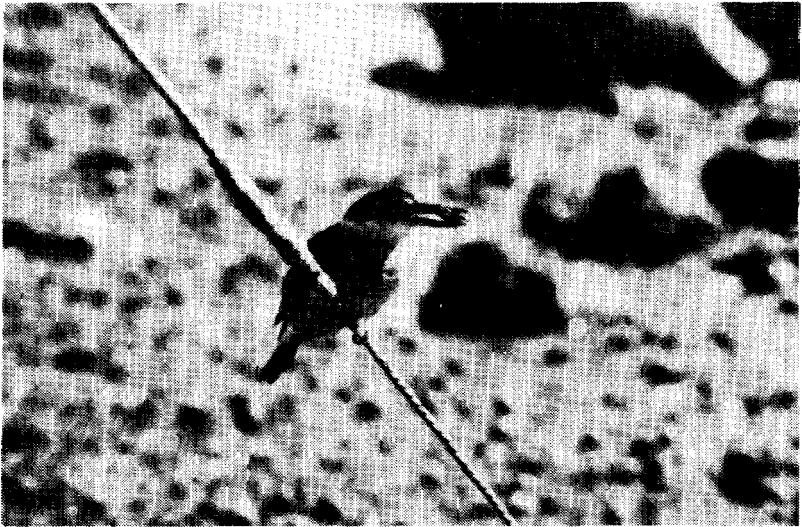


FIGURE 2 — Juvenile Kingfisher holding a mud crab (*Helice crassa*)

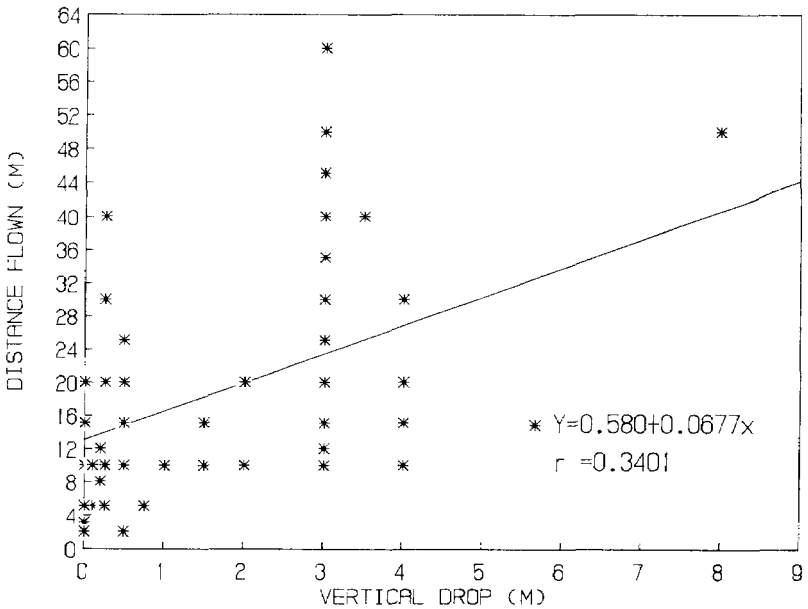


FIGURE 3 — The relationship between vertical drop and distance flown for Kingfisher feeding dives

Back at a perch, Kingfishers battered crabs against the perch to prepare them for swallowing. Birds attempting to eat crabs while sitting on the mud often flew to a solid perch to batter the crab against. Dealing with a crab before swallowing took on average $11.0 \text{ s} \pm \text{SD } 5.98$ (range 3-30 s, $n = 77$), larger crabs seeming to take longest. After eating several crabs, birds regurgitated a pellet of indigestible chitinous material.

H. crassa was the only crab found in the ten quadrats ($n = 50$ crabs), although low numbers of *Halicarcinus whitei*, *Hemigrapsus crenulatus* and *Macrophthalmus hirtipes* are also at Brooklands Lagoon (Knox & Bolton 1978).

The chelae dropped by the Kingfishers were all of *H. crassa* ($n = 225$). When Kingfishers bashed the crabs against perches ($n = 50$), both chelae were removed 45.2% of the times, one chela was removed 19.1% and no chela was removed 35.7% of the times. Smaller crabs were swallowed with less bashing than larger crabs, and so most crabs with no chela removed were probably small. The samples of discarded chelae probably contained more than one chela from some large crabs and lacked the chelae of some small crabs because they had not been knocked off. However, the occasions where two chelae were removed were about equal in number to the occasions where no chelae were removed. I did a chi-square test to see whether right chelae were discarded more often than left chelae. The ratio of right to left chelae was 1:1.05 and therefore neither side was preferred. Swallowed chelae were regurgitated whole in a pellet of indigestible remains, and therefore were included in calculations of sex ratios and size of crabs taken by Kingfishers. The chelae sample is likely to be only slightly biased towards crabs from which two chelae were removed.

The crab samples contained mostly small and medium-sized individuals ranging in carapace width from 3 mm to 15 mm, with a mean $9.1 \text{ mm} \pm 3.07$ (Table 1). Kingfishers dropped around the perches chelae significantly larger than those of crabs in the quadrat samples (females, $t = 4.06$, $p < 0.05$; males, $t = 11.30$, $p < 0.05$; Fig. 4), indicating that the Kingfishers did not take crab sizes randomly. As no chelae from crabs with a carapace width smaller than 10 mm were collected from around the perches, only crabs larger than 10 mm were important to the Kingfishers.

TABLE 1 — Sex ratio and numbers of crabs in 10 0.25 m^2 mud samples taken in areas in which Kingfishers fed at Brooklands Lagoon. Sex ratio (F:M) 1:1.77 ($\chi^2 = 3.92$, $p < 0.05$)

	Males (n=32)		Females (n=18)	
	x	SD	x	SD
Weight (g)	0.46	0.84	0.64	0.36
Carapace width (mm)	8.2	3.2	10.6	2.1
Chelae length R (mm)	5.4	2.9	5.7	1.5
Chelae length L (mm)	5.3	2.9	5.7	1.5
Chelae depth (mm)	3.3	2.0	2.6	0.6

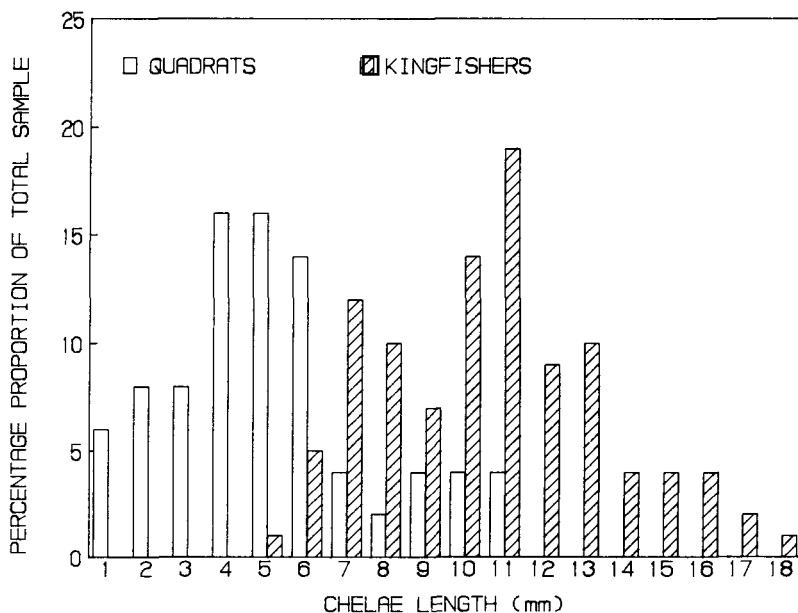


FIGURE 4 — The distribution of chelae lengths from *Helice crassa* found in the sampling quadrats ($n=50$) compared with those discarded by Kingfishers ($n=225$)

The sex ratio of the crabs in the sample was 1:1.77 (F:M), which is significantly biased towards males ($X^2 = 3.92$, $p < 0.05$). The sex ratio of the dropped chelae was 1:5.6 (F:M), which is significantly different from 1:1. The sex ratio of crabs in the sample is significantly different from the sex ratio of dropped chelae ($X^2 = 11.64$, $p < 0.005$). When only crabs larger than 10 mm from the quadrat samples were considered, the sex ratio was 1.2:1 (F:M), slightly biased towards females. Despite this bias, the Kingfishers took large male crabs significantly more often than large female crabs ($X^2 = 18.47$, $p < 0.05$; Table 1).

DISCUSSION

The Kingfishers preferred to feed on the mudflats, although they commonly dived in the nearby Styx River to wash. Although many species of fish were in the Styx River and Brooklands Lagoon (Knox & Bolton 1978), Kingfishers did not take fish, concentrating on mud crabs at low tide. They did not feed at high tide because the water on the mudflats was discoloured.

The Kingfishers generally used perches, although occasionally they sat on the mud. They needed something solid for bashing the crabs against, and perches presumably gave an elevated and extended view of the mudflats. In spite of the better view and larger attack area from high perches, the Kingfishers did not seem to prefer them on an open mudflat where the birds are more obvious to aerial predators such as the Harrier (*Circus approximans*).

If Kingfishers fly further to catch crabs from higher perches, using a high perch may cost Kingfishers more energy than the greater catch would justify. Choice of perch may depend also on what perches are available near patches of high prey density.

Boag (1982) suggested that European Kingfishers (*Alcedo althis*) were less territorial and less aggressive in coastal areas than elsewhere because territories were poorly defined and the birds were flexible in their choice of feeding area. In these respects the Kingfishers at Brooklands appeared to behave like coastal kingfishers in Britain.

Kingfishers took large crabs and male crabs proportionally more frequently than they were on the mudflats. More large crabs may have been taken because large crabs were more obvious, offered a larger meal, or behaved more conspicuously than smaller crabs. Male crabs may be preferred for the same reasons. Beer (1959) suggested that female *H. crassa* are more timid and so may move underground at a hint of danger more quickly than male crabs.

Arkell (1978) studied the Giant Kingfisher (*Megaceryle maxima*), which fed on Cape River crabs (*Potamon perlatum*) in South Africa. Arkell compared discarded chelae and carapaces with the sizes of live crabs available. Giant Kingfishers also seemed to select larger Cape River crabs, or perhaps swallowed small crabs whole (since no regurgitated pellets were examined).

The Kingfishers at Brooklands Lagoon fed only on the mud crab *Helice crassa* during the winter. This was a very restricted diet compared with the large number of prey types taken by Kingfishers in other habitats. However, crabs are active and abundant on the mudflats all year round and are a reliable source of food for Kingfishers in winter.

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