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FEEDING ASSOCIATIONS BETWEEN WHITE-FRONTED TERNS AND HECTOR'S DOLPHINS IN NEW ZEALAND[1]

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Abstract. I investigated the relationship between White-fronted Terns (*Sterna striata*) associating with Hector's dolphins (*Cephalorhynchus hectori*) while feeding in the near-shore environment of New Zealand. Associations were observed only in the austral spring and early summer. At this time up to 15.7% of all dolphin groups were accompanied by terns. The birds usually joined surface-feeding dolphins with single terns apparently hovering over single dolphins. Associated tern numbers were positively correlated with dolphin group size and increased significantly with the duration of the association. Terns were more often associated with significantly larger dolphin groups and under calmer sea conditions. Water clarity, however, appeared to have little influence in the birds' decision whether or not to associate with a group of foraging dolphins. The occurrence of feeding associations appeared to be restricted by the occurrence of small, inshore moving fish species. The associations are likely to constitute facultative commensalism by the birds and may be particularly advantageous during breeding when energetic demands are high.

Key words: Cephalorhynchus hectori, feeding association, Hector's dolphin, seabird-cetacean interaction, Sterna striata, White-fronted Tern.

Hector's dolphin (*Cephalorhynchus hectori*) is a small, coastal species endemic to New Zealand. It has been observed to feed in association with Spotted Shags (*Stictocarbo punctatus*) and Black-backed Gulls (*Larus dominicanus*) behind fishing trawlers at Banks Peninsula, Canterbury (Hawke 1994). Slooten and Dawson (1988) mention that feeding associations with White-fronted Terns (*Sterna striata*) were frequently observed, but give no further details regarding frequency and intensity of these associations.

I studied the feeding associations of White-fronted Terns with Hector's dolphins around the South Island of New Zealand between 1993 and 1997. White-fronted Terns as well as Hector's dolphins are known to feed in neritic waters throughout the year (Bull et al. 1985, Slooten and Dawson 1988). Here I describe the seasonal pattern of occurrence of feeding associations and the behavior involved, and investigate the impact of dolphin group size and environmental factors on feeding associations.

METHODS

Between 6 November 1993 and 5 April 1997, I spent a total of 431 days on coastal waters around the South Island of New Zealand (off Kaikoura, Moeraki, Westport, Greymouth, Jackson Bay, around Banks Peninsula, and in Porpoise Bay; 41–47°S, 167–174°E) studying the behavioral ecology and population biology of Hector's dolphins. The fieldwork covered all seasons of the year with 79 field days (18%) in spring (September to November), 197 (46%) in summer (December to February), 84 (19%) in autumn (March to May), and 71 (17%) in winter (June to August).

Dolphins were observed from a 4.5-m research vessel. Two to eleven hours were spent on the water daily depending upon weather conditions (surveys were terminated at sea states of 4–5 Beaufort representing wind speeds of 8–10 m sec^{-1}). Within a day, up to 60 km of coastline were systematically surveyed for the presence of dolphin groups. Once a group of Hector's dolphins was encountered, group size, number, and species of associated seabirds were recorded. Water depth, sea surface temperature, and water clarity (as vertical underwater visibility of a 30 cm Secchi disk) were measured. I attempted to stay with the dolphins for as long as possible (up to 95 min) and recorded feeding behaviors. An association was considered a

TABLE 1. Monthly association rate of White-fronted Terns with Hector's dolphins.

	Total number of dolphin groups observed	Number of dolphin-tern feeding associations	Proportion (%) of dolphin groups associated with terns
June–September	243	0	0.0
October	51	8	15.7
November	188	24	12.8
December	500	31	6.2
January	565	3	0.5
February–May	712	0	0.0
Total	2,259	66	2.9

feeding association only if the dolphins, or the birds associated with them, were seen chasing or taking prey. Values presented are $\bar{x} \pm$ SE.

RESULTS

Out of a total of 2,259 observed groups of dolphins, 66 (2.9%) were associated with terns. Only adult terns were observed to participate in these feeding associations. Despite my year-round effort, I observed terns associated with dolphins only in spring and summer (16 October–30 January). The proportion of dolphin groups associated with terns steadily declined from 15.7% in October to 0.5% in January (Table 1). However, only a small proportion of the terns present (e.g., several hundred pairs around Banks Peninsula) participated in the associations at any one time (no more than 30 terns even in view of a larger colony).

In all feeding associations, dolphins were seen chasing small (~ 5 cm) silvery fish, making frequent sharp turns while doing so. Fish were often seen jumping from the surface when chased. This feeding behavior was not observed outside spring/summer. Feeding associations were observed at all daylight hours with no obvious peak when corrected for survey effort. Whenever a feeding bout (1–95 min long) was observed from the beginning, it was initiated by the dolphins which were then joined by adult terns. Furthermore, all changes in general direction or feeding location by the dolphins were closely followed by the birds. During the association, terns hovered approximately 2–5 m over a hunting dolphin and dove when the fish came to the surface, often very close in front of the speeding dolphin. Successful feeding by terns was observed frequently where the bird would plunge-dive before emerging with live prey again. Although the terns often appeared to take the prey directly in front of a dolphin, it remained undetermined whether it was the same prey item the dolphin was pursuing. The feeding association usually ended when the terns appeared to lose interest after the dolphins stopped hunting.

Terns preferred to associate with larger dolphin groups. The dolphin groups associated with terns contained on average 8.5 ± 0.9 individuals (range 1–30, $n = 66$) compared to 5.9 ± 0.3 dolphins ($n = 405$) in groups without terns (Mann-Whitney U-test: $z_{66,405} = -2.88$, $P = 0.004$). On average, dolphin groups were associated with 6.6 ± 0.7 White-fronted Terns ($n = $

62). There was no correlation between dolphin group size and tern flock size ($r = 0.18$, $n = 62$, $P > 0.1$). However, the flock size of associated White-fronted Terns increased significantly with the duration of the association ($r = 0.34$, $n = 62$, $P < 0.01$).

Terns also preferred to associate with dolphin groups under calmer wind conditions. Terns associated with dolphins in all wind conditions producing sea states of 0–4 Beaufort ($\approx$ 0–8 m sec^{-1}). However, 79% of all associations were observed with no or very little wind (0–2 Beaufort, equivalent to 0–3.1 m sec^{-1}, $n = 49$). Dolphin-tern associations took place at an average sea state of 1.5 ± 0.2 Beaufort, whereas dolphin groups without terns were observed at 2.1 ± 0.1 Beaufort (Mann-Whitney U-test: $z_{35,288} = -2.63$, $P = 0.008$). For observed associations, the water clarity ranged from 1.5–5.2 m ($n = 23$) and did not differ significantly from that for dolphin groups without associated terns during the same season (Mann-Whitney U-test: $z_{21,91} = -0.52$, $P > 0.6$).

Twelve dolphin groups (0.5%) were accompanied by Hutton's Shearwaters (*Puffinus huttoni*) and terns at the same time. The shearwaters foraged underwater in close proximity to the dolphins, which they followed intermittently by flying short distances and plunge-diving directly into the water again. Shearwater flock sizes ranged from 1–20 individuals (5.9 ± 2.0, $n = 12$). They appeared to respond slower to the occurrence of feeding dolphins than did the terns. Hence, shearwaters were never associated with dolphins without terns present.

Feeding associations of other bird species with feeding Hector's dolphins were rare and appeared to involve a different prey. In the winter, two Caspian Terns (*Hydroprogne caspia*) associated with a group of 11 dolphins feeding in the surf (Moeraki, 30 June 1996), and an adult Australasian Gannet (*Sula serrator*) fed with a group of 5 dolphins (Kaikoura, 13 August 1996). Feeding associations with Spotted Shags were never observed in the study period, although there are over 22,000 pairs nesting around Banks Peninsula alone between September and January (Doherty and Bräger 1997).

DISCUSSION

Feeding associations of White-fronted Terns with Hector's dolphins took place only in late spring and early summer, most often with larger groups of dolphins under calm wind conditions. Only at this time of year do some dolphins exploit a food source which appears to become available seasonally when the fish move inshore into shallow coastal water or upstream as larvae or reproductive adults. Several of the potential prey species are diadromous; that is, they have obligatory marine and freshwater life-history phases with seasonal migrations between the two habitats (Jellyman et al. 1997). Furthermore, there are several schooling species living in the neritic environment. Small-scale inshore movements for spawning also have been documented for many species with a completely marine life-history (Ayling and Cox 1982, Lalas 1983, McDowall 1990). During these spawning migrations, fish are exposed to an increased avian predation risk in the littoral zone (Adams et al. 1994). The continuous reduction in the

monthly association rate (Table 1) appears to resemble a decreasing intensity in the fish migration. This means that dolphins and terns are feeding opportunistically on a seasonally abundant food source. The majority of dolphins, however, are likely to feed on larger and/or benthic fish species (Slooten and Dawson 1988). This takes place too far below the surface to be of any interest to terns. Therefore, the ecological importance of the tern-dolphin feeding association is restricted to the occurrence of small prey near the surface in spring and summer.

Dolphin group size and duration of the feeding bout may be important for long-range detection by the birds as well as potential profitability for them. Larger dolphin groups probably are more obvious for terns at long distances. Hovering terns are likely to be used as a cue to signal a good foraging opportunity to other terns, which would explain why the associated flock size continues to increase over time. Furthermore, larger dolphin groups also may provide better foraging opportunities as each tern appears to stay with one dolphin at a time although no data on this were collected.

Feeding associations of White-fronted Terns with Hector's dolphins appear to constitute "type C" associations, as they involve "birds that appear to be actively drawn to marine mammals because the foraging activities of the mammals drive or otherwise force prey to the surface where birds have access" (Pierotti 1988). Evans (1982) summarized the main advantages of feeding associations to seabirds as long-distance detection of and finding concentrated prey as well as increased accessibility of prey chased to the surface. No benefit to the dolphins was apparent from this relationship and, hence, it is considered to be a commensal association.

For terns, facultative commensalism as a foraging tactic could be most advantageous during egg-production, incubation, and chick rearing (October to December) when energetic demands are particularly high. In contrast to dolphins, terns are exclusively visually oriented hunters with a very small body mass. Wind speed, therefore, can constrain the foraging success of terns by reducing the transparency of the water surface and hindering prey detection and also possibly by over-proportionally increasing the energetic costs of flying at higher wind speeds. Sagar and Sagar (1989) found that increasing wind speed significantly reduced capture rates and feeding success in Antarctic Terns (*Sterna vittata*). In the European Wadden Sea, Common Tern (*Sterna hirundo*) chick mortality was positively correlated with wind speed due to reduced food provisioning by the adults (Becker and Specht 1991). Hence, feeding associations at low wind speeds are likely to improve the hunting success of the terns. Future research will have to determine the importance of this food source to White-fronted Terns, especially because only a small proportion of terns appears to engage in it at any one time.

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