Short Communications

Diets of the Pacific Gull *Larus pacificus* and the Kelp Gull *Larus dominicanus* in Tasmania

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The Pacific Gull *Larus pacificus* is endemic to Australia, while the Kelp Gull *L. dominicanus* has a circumaustral distribution (Watson 1975) and has become established in Australia only in the present century (Serventy *et al.* 1971). Since the two species are similar in size and morphology, it could be expected that they would compete for resources, including food. Components of the diet of the Pacific Gull have been reviewed by Barker & Vestjens (1989) but no information has been published on the diet of the Kelp Gull in Australia, although considerable information is available from other areas of the species' range.

In this paper we present data on the diets of sympatric Pacific and Kelp Gulls in south-eastern Tasmania and summarise other data on the diets of the two species, allowing some comparisons to be made.

Methods

Freshly regurgitated pellets were collected within discrete clusters of nests of each species on Green Island, located about 40 km south of Hobart in the D'Entrecasteau Channel, south-eastern Tasmania, from 6 November to 5 December 1981. Green Island is low and treeless, with an area of 4.9 ha. During the 1981–82 breeding season there were 27 Pacific Gull nests and 275 Kelp Gull nests on the island. Nests were identified by their distinctive shapes (J.G.K. Harris pers. comm. 1981) that were confirmed by observations from a hide. Only pellets that could be confidently assigned to a particular species were collected.

In total, 43 Pacific and 44 Kelp Gull pellets were examined. They were broken apart for analysis of contents and examined under a dissecting microscope when necessary. Reference collections of crabs and chitons were made to facilitate the identification of fragments of these taxa found in pellets. Where possible, fish were identified by the characteristic shape of the skull. Each type of food was scored as present or absent, indicating its frequency of occurrence in the pellets. This measure provides a reasonable guide to the relative wet weight contribution of larger food items, such as fish and crabs, in the diet of gulls but overestimates the proportion of total mass provided by small items such as goose barnacles (Buckley 1990). Soft, easily digested food items do not occur in pellets. However, the method does enable the diets of Kelp Gulls and Pacific Gulls to be compared.

Results and discussion

A range of marine invertebrates, fish, plant material, refuse and stones were identified in the pellets. Table 1 shows the proportion of pellets containing each category of food. Many (44% of Pacific Gull pellets and 59% of Kelp Gull pellets) contained food from more than one of these categories.

Pacific Gull diet

The most frequent category of food in Pacific Gull pellets was crabs, most commonly *Ovalipes australiensis* and *Paragrapsus gaimardii*, found in 56% of pellets, followed by fish (47%) and chitons (28%) (Table 1). The majority of fish bones were from Sand Flathead *Platycephalus bassensis*, estimated to be > 20 cm long. The size of the fish and the predominance of fish heads in the pellets indicated that the principal source of fish was waste obtained from fish that were cleaned on wharves and beaches. Both species were seen regularly feeding in this way. It is likely that fishing waste was also the main source of cephalopods. The gastropod mollusc *Turbo undulatus*, cephalopods, sea urchins and refuse each occurred in less than 10% of pellets. Crabs were not included in the list of food of the Pacific Gull compiled by Barker & Vestjens (1989), although Sutton (1935) and Jones (1979) reported Pacific Gulls feeding

Table 1 Contents of pellets regurgitated by Pacific Gulls and Kelp Gulls.

Food type	Frequency of occurrence (%) in pellets	
	Pacific Gull	Kelp Gull
INVERTEBRATES		
Molluscs		
Chitons:	28.0	36.4
Plaxiphora albida	16.3	27.3
Chiton pelliserpentis	16.3	25.0
Gastropods:		
Turbo undulatus *	9.3	0.0
Cephalopods:	7.0	6.8
Squid beak	4.7	6.8
Cuttle bone	2.3	0.0
Crustaceans		
Crabs:	55.8	11.4
Petrolisthes elongatus	7.0	6.8
Philyra laevis	4.7	0.0
*Ovalipes australiensis**	25.6	2.3
*Paragrapsus gaimardii**	18.6	0.0
Cancer novaezelandiae	4.7	0.0
Cyclograpsus granulosus	4.7	2.3
Unidentified crab fragments	4.7	2.3
Echinoderms		
Sea urchins:		
*Heliocidaris erythrogramma**	9.3	0.0
VERTEBRATES		
Fish	46.5	34.1
PLANT	0.0	25.0
REFUSE: This category includes glass, string, plastic, paper, bones and aluminium foil.*	2.3	54.5
STONES	0.0	15.9

* Categories identified by standardised residuals as responsible for a significant chi-square value ($P \leq 0.01$). Plants and stones were not included in this analysis.

on crabs. Chitons, cephalopods and refuse are also additions to Barker & Vestjens' (1989) list.

Pacific Gulls scavenge at rubbish tips and at abattoirs in Tasmania and, to a lesser extent, in other parts of Australia (Thomas 1976; Coulson & Coulson 1982; Fleming 1987). Other food items eaten by Pacific Gulls include eggs, young and adults of a wide variety of seabirds (e.g. Serventy *et al.* 1971), mussels and insects (Barker & Vestjens 1989).

Kelp Gull diet

Refuse, including glass, string, plastic, paper, aluminium foil and chop bones (all presumably derived mainly from rubbish tips) was the most frequent category in Kelp Gull pellets (55%) (Table 1). While items like bones clearly represent food, the overall food value of refuse is difficult to estimate as indigestible items such as plastic and aluminium foil in garbage are also likely to be associated with food. Chitons (36%) and fish (34%) were also quite common. Again, the fish appeared to be derived principally from human fishing. Crabs were found in only 11% of Kelp Gull pellets. Almost all pellets containing plant material and half of those containing stones also contained refuse, so it is probable that plants and stones were ingested incidentally by Kelp Gulls while feeding on refuse.

Elsewhere, Kelp Gulls feed on an extensive range of items, and have been described as 'both a seafood gourmet and a scavenger' (Merilees 1984). Offal produced by fishing and meat processing works has been a major source of food in some areas (e.g. Fordham 1970). Feeding at rubbish tips has been reported throughout the range of the species, in South Africa (Brooke & Cooper 1979), South America (Murphy 1936), New Zealand (Fordham 1970), subantarctic islands (Merilees 1984) and Antarctica (Parmelee *et al.* 1977). In Australia, Kelp Gulls have been observed feeding at rubbish tips and abattoirs in Tasmania (Thomas 1976; Coulson & Coulson 1982) and Victoria (Coulson & Coulson unpubl. data). In this study, refuse was the major component of the diet in Tasmania.

Bivalve molluscs are the main natural food of Kelp Gulls in New Zealand (Oliver 1974; Brunton 1978), South America (Hockey 1988; Hockey *et al.* 1989) and South Africa (Brooke & Cooper 1979; McLachlan *et al.* 1980). However, limpets are increasingly important in the Kelp Gull's diet in the more southerly parts of its distribution. Blankley (1981) recorded limpets and bivalve molluscs (offshore *Gaimardia* sp.) as the main foods at subantarctic Marion Island, while snails, limpets and chitons were the most frequent marine foods apparently taken at Macquarie Island (Merilees 1984). Kelp Gulls on the Antarctic Peninsula fed mainly on limpets (Bernstein 1983). Although both bivalve molluscs and limpets are well represented in the coastal fauna of the study area (E. Turner pers. comm.), these

taxa were not found in pellets of Kelp Gulls in our study. If the diet of Kelp Gulls in Tasmania is consistent with the dietary pattern observed elsewhere, the absence of limpets is not surprising but the lack of bivalve molluscs is unexpected.

In other studies, Kelp Gulls have been seen to eat the soft parts of larger sand-burrowing clams (Brunton 1978) and mussels (Hockey & Bosman 1988) leaving the shells behind, while only smaller specimens were swallowed whole, their shells appearing later in regurgitated pellets. It is possible that Kelp Gulls in south-east Tasmania were eating bivalves but selecting only larger specimens which escaped detection due to the shells not being swallowed. Direct observation of feeding or analysis of stomach contents would be needed to test this possibility. This may also apply to Pacific Gulls; they eat mussels after breaking the shells by dropping them from a height (Wheeler 1946; Watson 1955). Alternatively, food items eaten infrequently or seasonally may not have been detected due to the restricted samples and time period of our study.

Other natural foods recorded for Kelp Gulls elsewhere include taxa found in our study as well as a wide variety of other marine and terrestrial invertebrates (e.g. Fordham 1964; Burger 1978; Merilees 1984). Vertebrate food items include live prey such as small fish and reptiles (Oliver 1974), amphibians (Fordham 1964), eggs, young and adults of birds (e.g. Burger & Gochfeld 1981) and small mammals (Fordham 1964). Larger vertebrates are eaten as carrion (e.g. Morant & Winter 1983; Merilees 1984).

Comparison of diets

There is considerable overlap in the diet of Pacific and Kelp Gulls. Both species utilise a wide range of food sources, obtained by predation and scavenging. However, our study shows that the two sympatric species were utilising available resources to different extents. There was a significant difference in the diet of the two species ($\chi^2 = 53.876$, $P < 0.0001$). The categories responsible for this difference, identified by analysis of standardised residuals (Everitt 1977), are identified in Table 1. Crabs were found in 56% of Pacific Gull pellets but occurred in only 11% of Kelp Gull pellets. Conversely, refuse was found in 55% of Kelp Gull pellets but in only 2% of Pacific Gull pellets. Chitons and fish, the other main sources of food for both species, were present in approximately equal proportions in both species. Dietary overlap, calculated by the method of Pianka (1974) and using 'high level' prey identification as recommended by Greene & Jaksic (1983), was 0.57.

Differences in the pellet contents of Pacific and Kelp Gulls are consistent with the distribution of the two species at feeding sites. Comparison of ratios of Pacific Gulls to Kelp Gulls seen feeding at different sites with the known population ratio for south-eastern Tasmania showed that Kelp Gulls preferentially fed at rubbish tips and Pacific Gulls preferred to feed at shoreline sites (Coulson & Coulson 1982). If fish and cephalopods are obtained from predominantly human sources, 72% of Pacific Gull pellets contained foods obtained by foraging in natural conditions, from four taxa of marine invertebrates (chitons, gastropods, crustaceans and echinoderms), while only 41% of Kelp Gull pellets contained 'natural' foods, from two groups (chitons and crustaceans).

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The Importance of *Pandanus spiralis* to Birds

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Pandanus spiralis (hereafter referred to as Pandanus) is a conspicuous tree in a variety of habitats in Kakadu National Park. It belongs to a large family (Pandanaceae) of trees, shrubs and climbers of the Old World tropics (Heywood 1978). Its architecture differs from all other trees in the region. The woody stems, 5-8 m high, are covered in tight, spirally arranged, long (1-2 m), narrow (5-7 cm) leaves that are armed with small spines along the margins. Dead, downward hanging leaves may remain on the tree for many years, creating a tough skirt with many potential hiding places for animals. More often the leaves burn off in the frequent fires. Most trees consequently show bare trunks with a