Aspects of the ecology of feral cats on Dassen Island, South Africa

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Numbers of feral cats on Dassen Island (33°25′S/18°06′E) increased from 20 – 25 in May 1979 to 37 – 50 in June 1980. Kittens were born in eight months of the year with birth peaks in October – November and in January. Mean litter size was 2,7 and 80% of kittens born between August 1979 and January 1980 survived until June 1980. Kittens died from starvation and disease. In June 1980 51 – 56% of the cats were <1 year old. The number of cats is recovering rapidly from heavy culling. Depredation by cats is a potential threat to sea-bird colonies. The diet and feeding behaviour of the cats were studied in order to assess the importance of this threat. An 'average' cat's annual diet, assessed from scats, included: 134 European rabbits (*Oryctolagus cuniculus*), 37 jackass penguins (*Spheniscus demersus*), 25 Cape cormorants (*Phalacrocorax capensis*), 31 other birds and 24 house mice (*Mus musculus*). Each cat killed 105 rabbits and 13 birds each year, the balance of its diet being made up by carrion. Adverse effects of the presence of cats, compared to other factors, were not yet so serious as to necessitate artificial control of cat numbers.

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Wilde huiskatte te Dasseneiland (33°25′S/18°06′E) het vanaf 'n beraamde 20 – 25 individue in Mei 1979 tot 'n beraamde 37 – 50 individue in Junie 1980 vermeerder. Katjies word gedurende agt maande van die jaar gebore met pieke in geboortes gedurende Oktober – November, en in Januarie. Gemiddelde werpselgrootte was 2,7 en 80% van die kleintjies wat tussen Augustus 1979 en Januarie 1980 gebore is het nog in Junie 1980 geleef. Katjies het as gevolg van verhongering na spening en van siektes gevrek. Gedurende Junie 1980 was 51 – 56% van die katte <1 jaar oud. Die katgetalle herstel snel na vorige intensiewe uitdunning. Katpredasie hou 'n moontlike bedreiging in vir die seevoëlkolonies. Die dieet en voedingsgedrag van die katte is bestudeer om vas te stel hoe belangrik hierdie bedreiding is. Die jaarlikse dieet van 'n 'gemiddelde' kat op die eiland, gebaseer op die bestudering van mismonsters, sluit in: 134 Europese konyne (*Oryctolagus cuniculus*), 37 Kaapse pikkewyne (*Spheniscus demersus*), 25 trekduikers (*Phalacrocorax capensis*), 31 ander voëls en 24 huismuise (*Mus musculus*). Elke kat het jaarliks 105 hase en 13 voëls doodgemaak, terwyl die balans in sy dieet deur aas verteenwoordig is. Die nadelige uitwerking van die teenwoordigheid van katte in vergelyking met ander faktore is tans nog nie sodanig ernstig om kunsmatige beheermaatreëls te noodsaak nie.

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Feral domestic cats (*Felis catus*) occur almost throughout the world as a result of man's activities. Cats show a remarkable behavioural and ecological adaptability (see *inter alia* McMurry & Sperry 1941; Hubbs 1951; Jones 1977; Macdonald & Apps 1978; Dards 1978, 1980; Corbett 1979; Fitzgerald & Karl 1979; van Aarde 1980; Liberg 1980; Oppenheimer 1980) which in some cases has allowed them to colonize and exploit isolated ecological communities previously lacking terrestrial predators. In several such cases depredation by cats has had serious deleterious effects on local fauna, most notably ground-nesting sea-birds on islands (Taylor 1968; Derenne & Mougin 1976; Jones 1977; van Aarde 1980). It is necessary that the ecological role of the feral cats on Dassen Island be properly understood if appropriate management measures are to be taken. This paper presents information on the number of cats on Dassen Island, their breeding pattern, diet and ecological impact. It is based on the results of field-work on the island carried out between March 1979 and June 1980.

Study area

Dassen Island (33°25′S/18°06′E) is a small (2,24 km^2), flat, low-lying island of rock outcrops, tumbled boulders and sandy soil lying 8 km off the west coast of South Africa 65 km NNW of Cape Town. The island's climate is Mediterranean (hot, dry summers, cool, wet winters). Its vegetation is heavily influenced by the seasonality of rainfall, the input of salts from sea spray and manuring and disturbance by sea-birds and is sparse, low-growing and halophytic (Brooke & Crowe 1982).

Apart from occasional visits from Cape fur seals (*Arctocephalus pusillus*) and a single, vagrant southern elephant seal bull (*Mirounga leonina*) Dassen Island's mammal fauna is made up entirely of introduced species; feral house cats, feral European rabbits (*Oryctolagus cuniculus*) and house mice (*Mus musculus*). Rabbits were first introduced between 1662 and 1668 and further introductions have occurred subsequently (Cooper & Brooke 1982) and the mice have probably been on the island for at least as long. In view of the extensive human activity on the island for sealing and egg collecting in the late seventeenth century, cats were probably also an early introduction though the earliest known record of their presence is for the second half of the nineteenth century (Green 1950). Recently pet cats introduced by island residents have turned feral. Dassen Island's present mammal fauna has become established over the past 300 years.

Eighteen species of birds breed on Dassen Island (Brooke & Crowe 1982) and several more feed or roost there. Of greatest importance to the present study are the

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jackass penguin (*Spheniscus demersus*), population 32 000 in 1979 (Sea Fisheries Institute count, McLachlan pers. comm.); the Cape cormorant (*Phalacrocorax capensis*); the kelp gull (*Larus dominicanus*), population 2 000 in 1971 – 1972 (Cooper 1977a), 5 784 in 1979 (Crawford, Cooper & Shelton 1982); Hartlaub's gulls (*Larus hartlaubii*); common terns (*Sterna paradisea*), population 25 000 in 1971 – 1972 (Cooper 1977a) and Arctic terns (*S. macrura*), population 2 500 in 1971 – 1972 (Cooper 1977a).

Dassen Island has a 300-year-history of human exploitation and interference. Exploitation of Cape fur seals and dassies (*Procavia capensis*) (Skead 1972) resulted in the disappearance of these two species from the island and farming and gardening activities (Spilhaus 1949; Burman & Levin 1974) were probably the source of alien plants. The jackass penguin population has suffered serious losses, at least partly because of egg collecting (Frost, Siegfried & Cooper 1976).

Methods

Cat numbers

Preliminary surveys of the island indicated that the number of cats was low (less than 30), that the cats were elusive and that their behaviour led to violations of requirements for transect sampling (Burnham, Anderson & Laake 1980: p.14). It was anticipated that the cats would be difficult to trap and that trapping them would lead to trap shyness. The small size of the island (2,24 km^2) allowed it to be frequently and thoroughly surveyed for cats. In the course of work on the cats' behaviour the whole island was traversed at least once a month, the coastal boulder strip at least once a week and the western coastal area at least once a day except when it was necessary to avoid colonies of nesting birds.

Under these circumstances the most appropriate method of assessing the number of cats on the island was a version of that given by Boguslavsky (1956). 'Samples of one' were 'drawn' by sighting cats, 'future identification' was on the basis of recognition of natural markings or identity collars. The Boguslavsky stopping criterion for 90% confidence limits is 140 samples for a population equal to the number of cats assessed to be on the island in May 1979 and 300 samples for a population equal to the number of cats assessed to be on the island in June 1980. The assessment of cat numbers in May 1979 was based on 309 sightings and the assessment of cat numbers in June 1980 was based on 1 280 sightings. Faulty identification was a source of error (personal error *sensu* Topping 1972: p.10). The size of this error was determined on the basis of unresolved cases of uncertain recognition representing, at the extremes, repeated sightings of a single cat (giving a minimum number of cats present) or single sightings of a number of cats (giving a maximum number of cats present). Since identification errors exceeded sampling variation (stopping criteria above) numbers of cats are presented as extremes of error ranges.

Cat carcases found in the field were examined for cause of death. Causes of death for cats or kittens which disappeared were inferred from the animal's condition before disappearance.

Diet and feeding habits

Four sources of information were used; examination of cat scats, examination of food remains, observation of foraging and feeding cats and feeding of caged cats. Since observations of feeding cats were rare (3% of 1 280 observations) and signs of cats' feeding were more easily detected on rabbit than on bird carcases the examination of scats provided the best available basis for an assessment of the cats' diet.

In order to investigate temporal changes in diet the scats were divided into three age classes according to their degree of weathering:

- fresh scats, less than a week old, no sign of weathering,
- old scats, more than a week old, produced since the previous winter, slight to heavy weathering (loosening of surface, bleaching, leaching of mucus and fine particles)
- very old scats, more than a year old, heavily weathered despite being in protected positions and usually impregnated with guano.

Forty-eight old scats found in a midden at Wall Rock were examined separately to test for temporary food specialization. Differences between collections were evaluated by χ^2 tests.

Scats were crushed and examined dry. Bird remains were identified from feathers, beaks and/or claws and mammal remains from bones, teeth and/or fur. Where possible a broad size/age class was assigned to each food item but because of the frequent occurrence of scavenging no attempt was made to estimate food intake by dividing food items into narrow size classes. Scats collected from March to October 1979 were examined in November 1979 (the November general collection) and those collected from December 1979 to June 1980 were examined in July 1980 (the July general collection).

All prey carcases found were examined for cause of death, time since death (from degree of desiccation, size of fly larvae, state of decomposition) and occurrence of scavenging (signs of fresh feeding on an old carcase). Carcases less than one day old were visited on subsequent days and their rate of decomposition and further removal by cats was recorded so that other carcases could be aged by comparison.

Food intake and ecological impact

The occurrence in a scat of remains from a particular food item indicated only that at least part of that item had been eaten by a cat. It provided no, or very little, information on the amount eaten or the means whereby the food was obtained. Both of these are central considerations in assessing the ecological role of the cats.

Several workers have developed methods for relating food intake to the occurrence of remnants in scats (*inter alia* Lockie 1959; Floyd, Mech & Jordan 1978). Mainly owing to the common occurrence of large items in the diet of the cats on Dassen Island (Table 1) these methods were inapplicable to the present study. Raw data from the examination of scats were therefore corrected by the factors given below which were derived from the examination of carcases and observation of cats.

(i) *Representation Index*. This is an estimate for each food type of the number of scats in which remnants of a single item will appear. As a working approximation it was assumed that this would equal the number of times which a cat (or cats) usually fed from such an item. This was determined by examining food carcases for signs of scavenging and by counting the number of cats which sometimes gathered to feed from a single carcase. If the defaecation rate (number of scats per day) is known the number of each food item eaten in unit time can be estimated from:

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Table 1 Exhaustive listing of food types known to have been eaten by feral cats on Dassen Island on the evidence of cat eaten remnants (c), observations of feeding cats (f) and the occurrence of remnants in cat scats collected between March 1979 and June 1980 (s) and numbers of scats containing remnants of each food type in each of five collections of scats made during that time

			Scat collection				
		Evidence	November general	July general	Midden	Fresh	Very old
Rabbit *Oryctolagus cuniculus*	Adult	s f c	18	18	7	5	18
	Young	s f c	20	12	3	4	20
	Unaged	s	2	48	13	13	0
Mouse *Mus musculus*		s f	5	9	0	0	7
Jackass penguin *Spheniscus demersus*	Adult	s f c	13	26	1	2	13
	Fledged juvenile	s f c	3	4	3	1	3
	Unaged	s	0	4	0	0	0
Cape cormorant *Phalacrocorax capensis*	Adult	s	3	2	2	0	10
	Chick	s f c	7	14	12	0	0
Gulls and terns *Larus* sp./*Sterna* sp.		s	5	10	2	1	4
Cape wagtail *Motacilla capensis*		f	0	0	0	0	0
Starling *Sturnus vulgaris*		c	0	0	0	0	0
Hen *Gallus domesticus*		c	0	0	0	0	0
Downy chicks		s	0	3	0	0	1
Unidentifiable birds (bone splinters and feather fragments)		s	1	2	3	3	1
Unidentifiable hard parts (bone fragments)		s	5	0	3	3	5
Eggs		s	2	3	0	0	2
Arthropoda (various species)		s f	3	16	0	1	3
Fish regurgitated by birds		f	0	0	0	0	0
Domestic refuse		f c	0	0	0	0	0
Vegetation		s f	4	17	3	3	4
Stones and mollusc shells		s	4	5	2	0	7
Total no. of scats			77	131	48	33	77

$$Np = \frac{Sr}{RI}$$

$$T = \frac{Se}{Dr}$$

$$\frac{Np}{T} = \frac{Sr}{RI} \div \frac{Se}{Dr}$$

$$= \frac{Sr}{Se} \times \frac{Dr}{RI}$$

where
Np = number of items eaten,
T = time,
Sr = number of scats containing remnants of food type,
Se = number of scats examined,
Dr = defaecation rate,
RI = Representation Index of the food type.

The term Sr/Se is the frequency of occurrence of the food type in scats and is often used to present data from scat analyses (Delibes 1980).

The Representation Index is similar to a correction factor used by Delibes (1980) in assessing the diet and ecological role of the Iberian lynx (*Lynx pardina*). Delibes' factor is a maximum estimate of the number of scats in which a carcase appears and therefore, other things being equal, gives a minimum estimate of intake and ecological impact. The Representation Index is a minimum estimate and therefore yields a maximum estimate of intake and ecological impact more appropriate to problems involving control of possible pest predators.

(ii) *Kill Frequency*. The number of a given prey type eaten by a predator is not necessarily the same as the number killed by it. Observations of feeding cats and examination of the remains of their meals showed whether food was obtained by scavenging or by hunting. The number of prey killed by a cat is estimated from:

$$Np \times KF = Nk$$

where
Np = number of prey eaten,
KF = kill frequency,
Nk = number of prey killed by predator.

In order to assess the ecological impact of the island's cats as a whole it was assumed that scats were collected at random with respect to the different classes (juveniles, adults, males, females, rabbit specialists, bird specialists, etc) of cats which produced them. If, as is extremely likely, this assumption is valid the occurrence of food remains in scats represents the diet of an 'average' cat. This diet can be multiplied by the number of cats present to give the feeding habits of the island's cats as a whole. For management purposes these calculations are most usefully based on the maximum figures for cat numbers.

The validity of the assumptions and approximations made in assessing Representation Indices and Kill Frequencies and the accuracy of the Indices and Frequencies was checked by comparing the resulting diet with the food intake of two caged cats.

Results

Cat numbers

The number of feral cats on Dassen Island was assessed as being between 20 and 25 in May 1979. By June 1980 this

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number had increased to between 37 and 50. Between August and November 1979 all four cats known then to be adult females (from examination when trapped) gave birth. Though the sample is small it includes between 40 and 57% of the adult females on the island at that time so that it is reasonable to suppose that all 7 – 10 of them gave birth during this period. Five litters were counted when they emerged from their dens. Mean litter size was 2,4 (range 2 – 3) kittens which indicates a total production of between 17 and 24 kittens. The progress of eight kittens born during this period was followed until June 1980 when six of them were still alive (75,0% survival). One out of three known adult females gave birth in January 1980, indicating a total production of 2 – 3 litters during that month. One of these litters was counted shortly after birth, another when it emerged from its den. Mean litter size was 3,5 kittens. The survival rate of these January kittens was 85,7% to June 1980. Thus births in January contributed between 6 and 9 kittens to the population in June.

In June 1980, 51 – 56% of the cats on Dassen Island were less than one year old.

Mortality, disease and injury

Of six kittens known to have died (two carcases found and four disappearances) three showed symptoms of infections of the upper respiratory tract, one of starvation and one of some form of ataxia. One died of unknown causes. Upper respiratory tract infections whose symptoms resembled those caused by feline, viral rhinotracheitis and feline calcivirus (Dawson 1950; Wright & Walters 1980) affected all kittens at times of stress. Most kittens recovered, with sporadic reappearance of symptoms. One kitten suffered permanent damage to one eye and a marked growth check as a result of upper respiratory tract infections. Of 15 adults trapped only one showed symptoms of upper respiratory tract infections.

One adult was shot by an island resident. The only other adult cat known to have died during the study period (a radio-collared, adult male) apparently died from old age and/or disease.

Of 12 cat skulls collected on Dassen Island five (42%) showed heavy wear of the carnassial teeth. Three kittens suffered temporary swelling of the face, consistent with damage to teeth or gums during tooth replacement. One adult male was found to lack a lower, left canine tooth, another had a distorted left forefoot and right hind-foot. Despite these abnormalities both animals were in good condition.

Reproductive pattern

The ages of kittens were estimated from physical appearance and extrapolated to give the number of litters born in each month (Figure 1). Kittens were born in eight months of the year with a major break in autumn and winter (May – July) and a shorter pause in summer (December). The birth peaks were in spring (October and November) and mid-summer (January).

Diet

The cats' diet included a wide range of foods (Table 1). Significance levels of differences among the scat collections in the occurrence of food remains are shown in Table 2.

The number of each prey species eaten and killed per year, and the annual food intake of the 'average' cat are shown in Table 3. Figures for weight of edible meat per carcase of each prey type are 66% of total carcase weight (the percentage weight eaten from carcases of adult rabbits by a caged, adult cat (n = 5)). Carcase weights for rabbits are from those shot for cat bait (n = 30). Bird weights are from the literature (penguins, Cooper 1977b; Cape cormorants, Berry 1976; gulls, M. Schramm pers. comm.). Any correction factors for which data were lacking were estimated by reference to the food species closest in size and general habits. The defaecation rate (Dr) has been taken as one scat per day (Howard 1957; Fitzgerald & Karl 1979; pers. obs.).

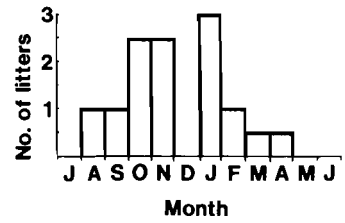

Figure 1 Number of litters of feral kittens born in each month on Dassen Island, 1979 – 1980.

Table 2 Significance levels of differences in occurrence of food remnants in collections of feral cat scats from Dassen Island collected between March 1979 and June 1980. Differences tested by χ^2 with categories lumped to avoid small classes and effects of estimating age classes. H_o = no difference

	November general	July general	Midden	Very old
November general	–	–	$0,01 > P$	$P > 0,1$
July general	$0,05 > P > 0,01$	–	–	–
Very old	–	$0,05 > P > 0,01$	–	–

A caged, young, adult male cat ate a mean of 540 g per day and a young, adult female a mean of 440 g per day when supplied with fresh, whole carcases of rabbits and birds.

Over the period October 1978 to June 1980 (when the old scats were deposited) the 'average' cat on Dassen Island killed 105 rabbits and 13 birds annually. Taking for management purposes the highest estimate of cat numbers in June 1980 (50) this represents a loss of 5 250 rabbits and 650 birds annually.

Of 87 Cape cormorant chicks found dead in January 1980 54,0% had been pecked by gulls (*L. dominicanus*) and 9,2% had been chewed by cats. A further 35,6% were intact, indicating death by starvation. Of eight Cape cormorant chicks cached by cats two had been pecked by gulls.

Discussion

Cat numbers

The cat density on Dassen Island in June 1980 (16,5 – 22,8 cats km^{-2}) was higher than that on Marion Island in 1975 – 1976 (13,85 cats km^{-2}, van Aarde 1980); Macquarie Island (4 – 7 cats km^{-2}, Jones 1977); L'ile aux Cochons (2,5 – 10 cats km^{-2}, Derenne & Mougin 1976); Kerguelen (6 – 13 cats km^{-2}, Pascal 1980) and the Monach Islands (3,7 cats km^{-2}, Corbett 1979). It also exceeds densities in some mainland areas e.g. 12,5 cats km^{-2} in rural California (Hubbs 1951) and 6 cats km^{-2} in rural Devon (Macdonald & Apps 1978) although it is similar to densities of semi-dependent cats in rural Scotland (Corbett 1979) and much lower than the 740 cats km^{-2} found by Oppenheimer (1980) in urban Baltimore, U.S.A.

The high cat density on Dassen Island compared to other

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Table 3 Estimates of Representation Index (RI), Kill Frequency (KF), mass (kg) of edible meat per carcase (Ce), number of scats in a collection of 287 containing remnants of the food type (Sr), number of scats in one cat year's production of scats (365) containing remnants of the food type (Ny), number of carcases eaten annually by an 'average' cat (Np), number of prey killed annually by an 'average' cat (Nk) and mass (kg) of meat contributed to the diet (M) for each vertebrate food type of feral cats on Dassen Island March 1979 – June 1980. Figures in brackets are sample sizes

Food type		RI	KF	Ce	Sr	Ny	Np	Nk	M
Rabbit *Oryctolaous cuniculus*	Adult	1,79 (61)	0,66 (6)	1,20	48	62	34,64	22,86	41,57
	Young	1,12 (8)	0,88 (8)	0,27	39	50	44,64	39,29	12,05
	Unaged	1,46	0,78	0,74	63	80	54,79	42,74	40,54
Total							134,07	105,13	94,16
Mouse *Mus musculus*			1,00	0,025	16	20	24,00	24,00	0,60
Jackass penguin *Spheniscus demersus*	Adult	2,00 (2)	0,00 (3)	1,4	42	53	26,50	0,00	37,10
	Fledged juvenile	2,10 (13)	0,00 (3)	0,8	8	10	4,76	0,00	3,05
	Hatchling	1,00	0,39 (13)	0,06	5	6	6,00	2,34	0,36
Total							37,26	2,34	40,51
Cape cormorant *Phalacrocorax capensis*	Adult	1,98	0,13	0,72	7	9	4,55	0,59	3,28
	Chick	2,08 (13)	0,13	0,72	33	42	20,19	2,63	14,54
Total							24,74	3,22	17,82
Gulls and Terns *Larus* sp./*Sterna* sp.		1,00	0,13	1,2	18	23	23,00	2,99	27,60
Downy chicks		2,10	0,39 (13)	0,3	6	8	3,81	1,49	1,14
Unidentifiable birds			0,13		9	11	6,29	0,82	

islands may be due to differences in climate. The Mediterranean climate of Dassen Island contrasts with the cold, wet, oceanic-temperate conditions on the subantarctic and Monach Islands and allows penguins to breed throughout the year and rabbits to breed in the winter. This reduces the seasonal variability of food availability which is a major cause of mortality on other islands (Jones 1977; Corbett 1979). The cats on Dassen Island may be expected to be under less thermoregulatory stress than those in colder areas. To what extent cold contributes to mortality has not been quantified however.

If attainable cat density (Apps in prep.) is a valid indicator of food availability the large number of rabbits and dead birds on Dassen Island provides its cats with a richer source of food than is available in rural, temperate areas. It is not as rich, however, as the food supply provided by humans which allows urban cats to reach such high densities (Dards 1980; Oppenheimer 1980).

The seasonality of breeding in the Dassen Island cats is in agreement with that of cats elsewhere (Fox 1975; Derenne & Mougin 1976; van Aarde 1978; Corbett 1979) and should probably be ascribed to pre-adaptation (Wilson 1975: p.34). The pause in kitten production in December may be an artifact of the small number of cats on the island. The limited evidence available, and comparison with detailed data from cats elsewhere (Jones 1977; van Aarde 1978; Pascal 1980; Liberg 1981: p.73) shows that a bimodal distribution of breeding activity is a common feature among feral and house cats and that this is related to the production of two litters per year by some female cats.

Upper respiratory tract infections accounted for at least 50% of the mortality observed among kittens. The disease symptoms (severe nasal congestion, running eyes, ulceration of the mouth, loss of appetite and general lethargy) make it difficult for an affected cat to find food, especially by scavenging, since the sense of smell is seriously affected. Hunger, respiratory infections and secondary infections act synergistically. Upper respiratory tract infections are extremey contagious (Wright & Walters 1980) and in dense populations are a major cause of mortality (Dards 1980), thus they may be expected to have important effects as the number of cats on Dassen Island increases.

The rapid growth of the number of cats on Dassen Island is probably a consequence of the relaxation of culling pressure, which had been heavy in 1976 and 1977. How far and how fast the number of cats will grow in the continued absence of culling is being investigated.

Diet, food intake and ecological impact

Observations of feeding cats, examination of the remains of their meals and examination of scats are sampling procedures. Thus it must be accepted that cats fed on, and/or killed, species of birds not listed in Table 1. Some misidentification of material in scats may also have occurred; most probably the assignment of rare items to common classes. In a brief treatment of the diet of cats on Dassen Island, Cooper (1977a) listed five species of birds as 'prey' of cats. Of these only one; the black oystercatcher (*Haematopus moquini*) was not recorded as prey or food in the present study. Any other feeding or depredation by cats must have occurred at very low frequencies to have been unrecorded during both Cooper's and my work.

The mean food intake of the two caged cats was equivalent to an annual consumption of 178,9 kg. The diet derived from scat data by application of Representation Indices is equivalent to an annual intake of 199,7 kg. The close similarity between these two figures indicates that the assumptions made, and values used, in estimating the Representation Indices are not seriously in error.

The comparisons between collections of scats of different ages (Table 2) give rise to the following suggestions for temporal changes in the cats' diet. There has been a long-term trend of increasing importance of rabbit and decreasing importance of penguin in the cats' diet (July general *vs* very old collections). This trend has been maintained during periods of increasing cat numbers (July general *vs* November general collections) but not during periods of decreasing cat numbers (November general *vs* very old collections). It seems likely that this trend in diet is, at least in part, due to a functional response by the cats to changes in the relative availability of these two

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foods. The frequency of occurrence of Cape cormorant remnants in cat scats was stable in both the short term (July general *vs* November general) and the long term (July general *vs* very old). This is consistent with saturation of the cats by a superabundance of Cape cormorants for a similar period each year. If this is the case it could have important consequences for the effect of cat depredation upon Cape cormorant numbers. The highly significant differences between scats from the midden and those in the November general collection are due to Cape cormorant remnants being 2,25 times as common in the midden scats with a correspondingly lower frequency of penguin and miscellaneous items. A specialization in Cape cormorants is clearly indicated. The midden was found only a few metres from a major Cape cormorant nesting site and cats were seen to feed exclusively on deserted Cape cormorant chicks for the short time that they were available.

The diet and feeding habits of feral cats under a variety of circumstances have been reviewed by Fitzgerald & Karl (1979). Feral cats are primarily predators of mammals up to the size of European rabbits. Birds form a major part of feral cats' diets only when birds are available to the cats in very large numbers and mammals in very small numbers. The large intake of birds by the cats on Dassen Island despite the year-round presence of rabbits may be a consequence of difficulties experienced by the cats in catching rabbits and/or of the ready availability of bird carrion. Birds which the cats killed themselves made up only 5% of the cats' food intake. This in in close agreement with the dietary importance of birds in other cases where mammal prey and carrion or garbage are available to feral cats (Coman & Brunner 1972; Fitzgerald & Karl 1979).

Losses of Cape cormorant chicks to kelp gulls were six times as heavy as losses to cats. Kelp gulls were seen to take unattended eggs and nestlings of *Phalacrocorax capensis, P. carbo, P. coronatus, P. neglectus, Spheniscus demersus, Pelecanus oncrotalus, Larus dominicanus* and *L. hartlaubii*. The predatory activities of the kelp gull need to be considered in an assessment of the ecological effects of the presence of feral cats.

It is possible that some species of birds are excluded from breeding on Dassen Island by the presence of feral cats. Other causes of bird mortality and disturbance also occur on the island, though their effects have not been investigated. The breeding activity of jackass penguins is disturbed by the presence of humans (Hockey & Hallinan 1981) to a greater extent than by the presence of feral cats (pers. obs.).

Feral cats are potentially serious pests of sea-bird communities not previously exposed to terrestrial predators. A management strategy for the feral cats on Dassen Island should form part of conservation measures on the island. There have been feral cats on Dassen Island for at least 100 years. According to accounts by island residents and visitors cat numbers have at times been extremely high. Any damage to the island's ecology resulting from the presence of feral cats is likely to have already been done and further deterioration in the near future is not to be expected. Any control measures directed against the cats are likely to be expensive and time consuming and on financial grounds alone should be deferred until their necessity has been adequately investigated. Our present knowledge of the terrestrial ecology of Dassen Island is superficial and further work in this area is urgently needed.

Interactions among cats, rabbits, birds and vegetation are unlikely to be simple (Gillham 1963) and it is probable that Dassen Island will require considerably more sophisticated management than islands which have shorter histories of human interference and have suffered fewer introductions of exotic plants and animals. There is a clear need for further research to supply the information on which this management will need to be based. Major aspects of the interactions among the island's fauna, and between its flora and fauna should prove to be accessible to study by exclosure experiments.

In the light of these considerations I suggest that in comparison with mortality and disturbance of birds due to other causes, the effects of the presence of feral cats on Dassen Island during March 1979 to June 1980 were not so serious as to necessitate the artificial control of cat numbers before the terrestrial ecology of Dassen Island has been further investigated and the long-term role of its exotic components clarified. Since artificial control of cat numbers is likely to hinder this clarification I suggest that for the time being no control measures be applied.

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