PART 5

General Biology
Diet and Foraging

CHAPTER 9

Diet and foraging behaviour of the Cape fur seal *Arctocephalus pusillus pusillus* (Pinnipedia: Otariidae) from the Eastern Cape coast of South Africa

INTRODUCTION

The Cape (South African) fur seal, *Arctocephalus pusillus pusillus*, occurs only on the coasts of South Africa and Namibia, and is the only resident seal species in southern Africa. Breeding rookeries are distributed from Black Rocks (33º50'S, 26º16'E) in Algoa Bay, on the south east coast of Southern African, to Cape Cross (21º46'S, 13º58'E) in Namibia. The majority of seals occur on the west coast. The remainder of the population (*c.* 8.5%; 140 000 seals in 1993; J.H.M. David, pers. comm.) inhabits the south/east coast, between False Bay and Algoa Bay, at five breeding colonies and one non-breading colony. Their distribution overlaps important commercial fishing grounds.

Cape fur seals feed predominantly on teleost fish, and to a lesser extend cephalopods, with crustaceans forming a relatively minor part of the diet (Rand, 1959; David, 1987; Lipinski and David, 1990; Castley *et al.*, 1991). On the south coast of southern Africa, teleost fish contribute 67.7% to the diet, cephalopods 29.7%, crustaceans 1.2% and elasmobranchs 1.2%; and the most important prey species are anchovy (*Engraulis capensis*), horse mackerel (*Trachurus trachurus capensis*), pilchard (*Sardinops ocellatus*) and hake (*Merluccius capensis; M. paradoxus*) (*n* = 115 stomachs) (David, 1987).

Some of the more common species eaten by Cape fur seals are of commercial importance. Subsequently, many fishermen have adopted a negative attitude towards seals. Recently, fishing effort in Eastern Cape waters (Plettenberg Bay, 33º 07'S, 23º25'E, to the Kwazulu-Natal boarder, 31°05'S, 30°11'E) has increased significantly, particularly that for line fish, and chokker squid (*Loligo vulgaris reynaudii*). In 1992–1995, 234–254 squid vessels and 403–438 line fish vessels operated between Port Alfred and Mossel Bay[1]. White squid grossed between R46,236,024.00–R118,909,710.00 per annum, and line fish grossed between R9,459,522.00–R16,600,173.00 per annum[1]. In addition, *c.* 10 inshore trawlers and *c.* 6 deep sea trawlers operated in the area, targeting mainly hake and horse mackerel.

The effects of increased fishing efforts on the local seal population are unknown, but unlike the west coast population, that on the Eastern Cape coast is not increasing. Considering that the reduction in prey populations have been implemented in the decline of several species of otariids, including the northern fur seal (*Callorhinus ursinus*) (Loughlin, 1991), and the Steller's sea lion (*Eumetopias Jubatus*) (Loughlin, 1991; Trites & Larkin, 1992), it is necessary to obtain quantitative information on the diet of Cape fur seals in this region. Currently, dietary information is limited to a study of 36 stomachs from stranded (beached) seals collected between 1976 and 1990, in which hake and chokker squid were reported to be the most important prey species (Castley *et al.*, 1991).

In the present study, we document the diet and foraging behaviour of Cape fur seals from the Eastern Cape coast. Specific objectives were to: (i) determine the composition of the diet from: faecal samples/regurgitates collected from breeding and non-breeding colonies; stomachs collected from stranded animals; and stomachs collected from animals incidentally entrapped in commercial trawl nets; (ii) investigate the potential for competition between seals and the commercial fisheries; and (iii) document diving behaviour and movement patterns, using satellite telemetry.

MATERIALS AND METHODS

Collection of food samples from faeces and regurgitates

Fresh faecal samples, which showed no obvious signs of desiccation, were collected in polythene bags from non-breeding (Rondeklippe, Plettenberg Bay) and breeding (Black Rocks, Algoa Bay) colonies. Faecal samples were not always found in discrete units therefore, all samples obtained during a designated collection trip were pooled and treated as a single sample.

At Rondeklippe, fresh faecal samples were usually collected several times a month between June 8, 1993 and November 6, 1995 (Table 9.1). Three to six samples were collected per field trip (*n* = 64 field trips).

At Black Rocks, faecal samples were collected on an opportunistic basis between May 11, 1992 and November 11, 1995 (Table 9.2). Five to twenty samples were collected per field trip (*n* = 13 trips). At Black Rocks, samples included regurgitated material and material dredged from rock pools.

Table 9.1 ***Monthly distribution of faecal samples (n = 64) collected at Rondeklippe colony, Plettenberg Bay, between June 1993 and November 1995***

Season	Month	Year		
		1993	**1994**	**1995**
Summer	Dec.	1	0	–
	Jan.	–	1	0
	Feb.	–	0	4
Autumn	Mar.	–	3	3
	Apr.	–	3	3
	May	–	2	0
Winter	Jun.	3	0	3
	Jul.	5	0	6
	Aug.	3	1	1
Spring	Sep.	3	2	2
	Oct.	2	5	1
	Nov.	3	3	1
		20	**20**	**24**

[1] This data was extracted from the National Marine Linefish System (NMLS) based on data provided by the permit holders on a monthly basis (Chris Wilke, pers. comm.).

Table 9.2 *Monthly distribution of faecal samples and regurgitations (n = 13) collected at Black Rocks seal colony, Algoa Bay, between May 1992 and November 1995*

Season	Month	Year			
		1992	1993	1994	1995
Summer	Dec.	–	1	1	–
	Jan.	–	–	–	1
	Feb.	–	–	1	–
Autumn	Mar.	–	2	–	–
	Apr.	–	–	–	–
	May	1	–	–	1
Winter	Jun.	–	–	–	–
	Jul.	–	–	–	–
	Aug.	–	–	–	1
Spring	Sep.	–	–	1	–
	Oct.	–	–	1	–
	Nov.	–	1	–	1
		1	**4**	**4**	**4**

One sample = all faeces/regurgitates collected during one sampling trip.

Collection of food samples from stomachs

A total of 41 stomachs were collected from Cape fur seals stranded (beach dead) off the Eastern Cape coast between January 1991 and December 1995. An additional 37 stomachs were collected from seals incidentally entrapped in trawl nets during commercial fishing operations off the Eastern Cape coast between July 1992 and August 1995. Details of animals which had prey remains in their stomach are presented in Table 9.3 and 9.4.

Standard necropsies were performed and biological parameters recorded, based on recommendations of the Committee on Marine Mammals, American Society of Mammalogists (1967). Stomachs were excised, ligatured at the oesophageal and duodenal ends, and placed on ice (1–4 days), or chilled in a cold room (4ºC) overnight before examination.

In the laboratory, stomachs were weighed and then incised longitudinally. Food items were flushed from the stomach through nested sieves (2 mm; 0.5 mm) over a large tray. Fish otoliths were removed from skulls. Whole fish and fish pieces were identified where possible, measured and weighted. Otoliths, cephalopod beaks, crustacea and other food items were sorted and preserved for further analysis. Otoliths were stored in gelatin capsules; other material was stored in 70% ethanol. Empty stomachs were then weighed to calculate content mass.

All faecal samples/regurgitates were soaked in a solution of one part liquid detergent to 100 part water overnight, and were then washed through nested sieves (2 mm; 0.5 mm). Food material remaining in the sieve was sorted and preserved (as above) for further analysis.

Identification and analysis of food samples

Otoliths and cephalopod beaks were identified to the lowest taxon possible with the aid of published keys (Clarke, 1986; Smale *et al.,* 1993; Smale *et al.,* 1995), and reference specimens held at the Port Elizabeth

Table 9.3 *Stranded (beached) Cape fur seals collected off the Eastern Cape coast between January 1991 and December 1995 with prey remains in their stomach*

	ID No.	Date of collection	Approximate location	Sex	Length[a] (cm)
1.	PEM1829	13 Jan 91	Seaview (34º 01'S, 25º 17'E)	M	–
2.	PEM1832	14 Mar 91	Cape Recife, PE (34º 02'S, 25º 42'E)	M	205
3.	PEM1840	26 May 91	*c.* 1 km W of Cape Recife	–	–
4.	PEM1841	26 May 91	*c.* 1 km W of Cape Recife	M	222
5.	PEM1868	24 Sep 91	Cape Recife, PE (34º 02'S, 25º 42'E)	M	199
6.	PEM1890	13 Jul 92	Cape Recife, PE (34º 02'S, 25º 42'E)	M	192
7.	PEM2057	28 Jun 93	Pollock Beach, PE (33º 59'20"S, 25º 40' 30"E)	M	172
8.	PEM2087	17 Aug 93	Plettenberg Bay (34º 07'S, 23º 25'E), Robberg	M	190
9.	PEM2137	5 Jan 94	Summerstrand, PE (34º 00'S, 25º 42'E)	M	118
10.	PEM2141	17 Jan 94	39 km E of Sundays River Mouth, WC	M	198
11.	PEM2143	21 Jan 94	Seaview (34º 01'S, 25º 17'E)	M	189
12.	PEM2186	7 Apr 94	Amsterdamhoek (33º 52'S, 25º 38'E)	M	90
13.	PEM2191	4 May 94	Port Alfred (33º 36'S, 26º 55'E)	M	100
14.	PEM2198	Jul 94	Plettenberg Bay (34º 03'S, 23º 24'E)	M	105
15.	PEM2203	18 Jul 94	Port Elizabeth Harbour (33º 58'S, 25º 37'E)	M	204
16.	PEM2204	23 Jul 94	Maitland River Mouth (33º 59'S, 25º 18'E)	F	86
17.	PEM2261	Nov 94	Cape Recife, PE (34º 02'S, 25º 42'E)	M	118
18.	PEM2348	14 Nov 94	Humewood, PE (33º 59'S, 25º 40'E)	M	189
19.	PEM2379	12 Apr 95	Bokness (33º 41'S, 26º 31'E)	M	189
20.	PEM2454	8 Nov 95	Noordhoek (34º 02'S, 25º 39'E)	M	196
21.	PEM2458	3 Dec 95	Cape St. Francis (34º 12'S, 24º 52'E)	M	110

An additional 20 stomachs were examined which were empty (PEM1882, PEM1885, PEM1900, PEM1901, PEM2018, PEM2049, PEM2081, PEM2134, PEM2140, PEM2155, PEM2201, PEM2238, PEM2248, PEM2350, PEM2359, PEM2374, PEM2402, PEM2403, PEM2404 and PEM2405).

[a] Standard body length (tip of snout to tip of tail with animal lying on its back).

Table 9.4 *Cape fur seals incidentally entrapped in trawl nets during commercial fishing operations off the Eastern Cape coast between July 1992 and August 1995 with prey remains in their stomach*

	ID No.	Date of collection	Approximate location	Sex	Length (cm)
1.	PEM1999	20 Jul 92	EC trawl grounds (34º 52'S, 23º 35'E–34º 50'S, 23º 48'E)	M	155[b]
2.	PEM2000	21 Jul 92	EC trawl grounds (34º 50'S, 23º 48'E–34º 48'S, 24º 00'E)	M	146[b]
3.	PEM2002	22 Jul 92	EC trawl grounds (34º 55'S, 23º 14'E–34º 53'S, 23º 26'E)	M	163[b]
4.	PEM2003	24 Jul 92	EC trawl grounds (34º 51'S, 23º 42'E–34º 49'S, 23º 53'E)	M	145[b]
5.	PEM2004	25 Jul 92	EC trawl grounds (34º 45'S, 24º 18'E–34º 48'S, 24º 00'E)	M	194[b]
6.	PEM2005	11 Aug 92	EC trawl grounds (34º 43'S, 24º 34'E–34º 40'S, 24º 45'E)	M	145[b]
7.	PEM2006	13 Aug 92	EC trawl grounds 34º 45'S, 24º 25'E–34º 42'S, 24º 40'E)	M	153[b]
8.	PEM2008	14 Aug 92	EC trawl grounds (34º 41'S, 24º 42'E–34º 38'S, 24º 54'E)	M	147[b]
9.	PEM2009	22 Aug 92	EC trawl grounds (34º 41'S, 24º 45'E–34º 37'S, 24º 59'E)	M	148[b]
10.	PEM2010	22 Aug 92	EC trawl grounds (34º 47'S, 24º 11'E–34º 46'S, 24º 25'E)	M	147[b]
11.	PEM2011	8 Sep 92	EC trawl grounds (33º 50'S, 27º 06'E–34º 37'S, 24º 59'E)	M	160[b]
12.	PEM2012	9 Sep 92	EC trawl grounds (34º 40'S, 24º 41'E–34º 39'S, 24º 53'E)	F	162[b]
13.	PEM2013	13 Sep 92	EC trawl grounds (34º 24'S, 25º 50'E–34º 25'S, 26º 02'E)	M	166[b]
14.	PEM2014	25 Sep 92	EC trawl grounds (34º 23'S, 26º 04'E–34º 23'S, 25º 58'E)	M	162[b]
15.	PEM2015	3 Nov 92	EC trawl grounds (34º 17'S, 24º 36'E–34º 20'S, 24º 23'E)	M	158[b]
16.	PEM2046	19 May 93	EC trawl grounds (35º 00'S, 21º 41'E–35º 08'S, 21º 27'E)	M	141[a]
17.	PEM2047	20 May 93	EC trawl grounds (34º 53'S, 23º 27'E–34º 50'S, 23º 40'E)	M	167[a]
18.	PEM2048	20 May 93	EC trawl grounds (34º 53'S, 23º 27'E–34º 50'S, 23º 40'E)	M	157[a]
19.	PEM2051	28 Jun 93	EC trawl grounds (34º 44'S, 24º 29'E–34º 45'S, 24º 20'E)	M	168[a]
20.	PEM2052	28 Jun 93	EC trawl grounds (34º 44'S, 24º 29'E–34º 45'S, 24º 20'E)	M	171[a]
21.	PEM2053	28 Jun 93	EC trawl grounds (34º 46'S, 24º 21'E–34º 44'S, 24º 32'E)	M	153[a]
22.	PEM2054	29 Jun 93	EC trawl grounds (34º 45'S, 24º 28'E–34º 47'S, 24º 18'E)	M	165[a]
23.	PEM2055	29 Jun 93	EC trawl grounds (34º 46'S, 24º 22'E–34º 44'S, 24º 32'E)	M	179[a]
24.	PEM2056	29 Jun 93	EC trawl grounds (34º 46'S, 24º 22'E–34º 44'S, 24º 32'E)	M	139[a]
25.	PEM2082	Jul 93	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	176[a]
26.	PEM2252	22 Aug 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	172[a]
27.	PEM2253	27 Aug 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	152[a]
28.	PEM2254	27 Aug 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	146[a]
29.	PEM2256	17 Sep 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	198[a]
30.	PEM2257A	19 Sep 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	142[a]
31.	PEM2257B	7 Oct 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	170[a]
32.	PEM2258	8 Oct 94	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	186[a]
33.	PEM2400	13 Jul 95	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	176[a]
34.	PEM2401	13 Jul	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	146[a]
35.	PEM2414	25 Aug 95	EC trawl grounds (c. 30 nm S of Cape St. Francis)	M	148[a]

An additional 2 stomachs were examined which were empty (PEM2001, PEM2007).

[a] Standard body length (from the tip of the snout to the tip of tail with the animal lying on its back).

[b] Curve linear body length (from the tip of the snout to tip of the tail with the animal lying on its back, over the curve of the body).

Museum. Dr. M. Smale and Dr. N. Klages confirmed the identity of specimens which were difficult to key.

Complete otoliths showing no or little sign of erosion were measured under a dissection microscope fitted with an eyepiece micrometer (± 0.01 mm), i.e., maximum length or maximum breadth as appropriate. Cephalopod beaks were measured using vernier callipers (± 0.05 mm), i.e., lower rostral length (LRL) for all squid; and lower crest length (LCL) for all octopus. The dimensions of each otolith and cephalopod beak were used to estimate the original length (total length or dorsal mantle length) and wet mass of the fish and cephalopod prey, using the appropriate regression equations, i.e., Smale *et al.,* 1993; Smale *et al.,* 1995; N. Klages, pers. comm.

In order to determine the number of prey items and the frequency of occurrence of each prey item, two methods were followed. Firstly, all left and right otoliths, and all upper and lower cepahlopd beaks, were counted. Secondly, the maximum number of left or right otoliths, and the maximum number of upper or lower beaks, per sample, were counted. The latter provided an estimate of the minimum number of prey items. Damaged or eroded otoliths of a given species, that could not be divided into left or right, were divided by two.

Percentage of total mass for each prey item was calculated for all stomachs, including those with only trace remains. The mean mass for each individual species was multiplied by the minimum number of prey items.

Interviews with experienced local fishermen

Further information on the diet of seals was obtained from interviews conducted with experienced local fishermen at Plettenberg Bay.

Satellite telemetry

SLTDR

Wildlife computers microprocessor-controlled satellite-linked-time-depth-recorders (SLTDR) type 3 were used in this study. The type 3 software provides

both at-sea and on-land locations through the Service Argos system, and the type 3 recorders transmit information on dive depths and duration. The SLTDRs were pre-programmed to sample depth every 10 seconds to determine dive duration and maximum depths.

Deployment of SLTDR

SLTDRs were attached to two female Cape fur seals at Black Rocks, Algoa Bay. The females selected for study were lactating (observed with a healthy pup) and had finished moulting.

The females were caught in a specially designed hoop net, and then strapped onto a harness board, and given 7 ml of valium. A section of the hoop net was untied, exposing the upper back of the animal. A patch of fur immediately behind the shoulders (along the mid-line) was washed with acetone to remove any oil, and then dried with paper towel. Devcon Plastic Welder-TM or Devcon 5-minute epoxy 14270 was massaged into the fur with a spatula, and was also smoothed over the base of the SLTDR. The SLTDR was placed firmly in position, with the aerial facing towards the head of the animal. The adhesive was smoothed up the side of the SLTDR. Tape was removed from the pressure transducer and the conductivity sensors, and cleaned with alcohol. The communication port was filled with silicon and covered with adhesive. Each seal was measured (SBL), and tagged in the left and right fore flippers before release.

SLTDR 15990 was deployed on March 19, 1993 attached to a 160 cm female tagged P6962 and P6963. SLTDR 15989 was deployed on September 15, 1994, attached to a 143 cm female tagged P6970 and P6971.

When decoding the dive depth and duration data, only messages which complied with all checks were included in analysis. When each of the checks (seven data bytes) were summed, the message was considered to be valid only if the sum was evenly divisible by 256. If not, the message may have been corrupted during reception and was subsequently discarded. Location data was classed from 0–3 (where 3 is best). When decoding location data, only locations classed as 1–3 were included in analysis. Statistical analysis and graphics were implemented in Microsoft ® Excel 97 (Microsoft Corp., Seattle, 1997).

RESULTS

Rodeklippe, Plettenberg Bay (non-breeding colony)

General composition of diet

Identifiable prey items were found in 98.5% of faecal samples collected at Rondeklippe colony. A total of 1 172 prey items were retrieved, including teleost fish (93.8%), cephalopods (3.9%), crustaceans (0.9%), and miscellaneous items (1.5%) (Table 9.5).

Fish otoliths occurred in 61 (95.3%) faecal samples. A total of 25 species of fish and 15 families were identified. Sixty one (5.6%) individual otoliths were broken or severely eroded and therefore could not be identified.

When all otoliths (n = 1 099) were examined, the most numerous fish species were *Cynoglossus zanzibarensis/capensis* (35% of otoliths), *Austroglossus pectoralis* (24% of otoliths), *Trachurus trachurus capensis* (10% of otoliths) and *Sardinops ocellatus* (10% of otoliths). A similar trend was observed when the maximum number of right or left otoliths in each sample was examined (n = 701), i.e., *C. zanzibarensis/capensis* (30% of otoliths), *A. pectoralis* (22% of otoliths), *S. ocellatus* (11% of otoliths) and *T. trachurus capensis* (10% of otoliths). The most frequently occurring fish species were *C. zanzibarensis/capensis* (in 58% of samples), *A. pectoralis* (in 55% of samples), *S. ocellatus* (in 30% of samples), *T. trachurus capensis* (in 28% of samples) and *Liza richardsonii* (in 23% of samples).

Cephalopod beaks occurred in 30 (46.9%) faecal samples (Table 9.5). A total of four species and three families were identified. Seven (15%) upper squid beaks were broken and therefore could not be identified. The most numerous and frequently occurring cephalopod species was *Loligo vulgaris reynaudii* (a minimum of 23 individuals in seven samples). *Todaropsis eblanae*, *Octopus magnificus* and *Octopus vulgaris* occurred infrequently.

Crustacean remains (10 items) occurred in 10 (15.6%) faecal samples (Table 9.5). The remains of one whole amphipod, and the claws and carapace fragments of at least nine decapods were recovered.

Miscellaneous dietary items included nine egg cases from a dogfish shark, *Squalus* sp. (in one sample); seaweed (in three samples); and fragments of unidentified molluscs (in five samples) (Table 9.5).

Reconstituted length and mass of individual prey species are presented in Table 9.6. The mean reconstituted fish prey mass and total length was 68 g and 177 mm, respectively. The mean reconstituted cephalopod prey mass and dorsal mantle length was 253 g and 191 mm, respectively.

Table 9.5 ***The composition of prey species, by number and frequency, occurring in faecal samples from Cape fur seals collected at Rondeklippe colony, Plettenberg Bay, between June 1993 and November 1995***

Prey taxon	Number of prey items				Frequency of occurrence		Prey habitat
	N^a	% N^a	N^b	% N^b	F	% F	
TELEOST FISH							
Callanthiidae							
1. *Callanthias legras*	4	0.34	3	0.39	1	1.56	Benthic
Carangidae							
2. *Trachurus trachurus capensis*	114	9.73	67	8.77	18	28.13	Pelagic-midwater
Cheilodactylidae	1	0.09	1	0.13	1	1.56	Benthic
Clupeidae							
3. *Sardinops ocellatus*	112	9.56	77	10.08	19	29.69	Pelagic
Coracinidae							
4. *Coracinus capensis*	1	0.09	1	0.13	1	1.56	Benthic
Cynoglossidae							
5.*Cynoglossus zanzibarensis/ C. capensis*	383	32.68	213	27.88	37	57.81	Benthic
Engraulidae							
6. *Engraulis japonicus*	14	1.19	11	1.44	5	7.81	Pelagic
Haemulidae							
7. *Pomadasys commersonnii*	1	0.09	1	0.13	1	1.56	Benthic
8. *Pomodasys olivaceum*	12	1.02	7	0.92	1	1.56	Benthic
Merlucciidae							
9. *Merluccius capensis/ M. paradoxus*	35	2.99	29	3.80	11	17.19	Benthic
Monodactylidae							
10. *Monodactylus falciformis*	2	0.17	1	0.13	1	1.56	Bentho-pelagic
Mugilidae							
11. *Liza dumerilii*	1	0.09	1	0.13	1	1.56	Benthic
12. *Liza richardsonii*	24	2.05	21	2.75	15	23.44	Benthic
13. *Mugil cephalus*	3	0.26	3	0.39	2	3.13	Benthic
Pomatomidae							
14. *Pomatomus saltrix*	8	0.68	8	1.05	2	3.13	Benthic-midwater
Sciaenidae							
15. *Argyrosomus thorpei*	1	0.09	1	0.13	1	1.56	Benthic
16. *Umbrina canariensis*	2	0.17	2	0.26	2	3.13	Benthic
Soleidae							
17. *Austroglossus pectoralis*	262	22.35	152	19.90	35	54.69	Benthic
Sparidae							
18. *Argyrozona argyrozona*	1	0.09	1	0.13	1	1.56	Benthic
19. *Diplodus sargus capensis*	5	0.43	5	0.65	3	4.69	Benthic
20. *Lithognathus mormyrus*	48	4.10	31	4.06	9	14.06	Benthic
21. *Pagellus belottii natalensis*	2	0.17	2	0.26	2	3.13	Benthic
22. *Rhabdosargus sarba*	1	0.09	1	0.13	1	1.56	Benthic
23. *Sarpa salpa*	1	0.09	1	0.13	1	1.56	Benthic
Unidentified otoliths	61	5.20	61	7.98	23	35.94	
	1099	**93.81**	**701**	**91.75**	**194**		
CEPHALOPODS							
Loliginidae							
24. *Loligo vulgaris reynaudii*	31	2.65	23	3.01	7	10.94	Pelagic
Ommastrephidae							
25. *Todaropsis eblanae*	6	0.51	4	0.52	1	1.56	Pelagic
Unidentified squid	7	0.60	7	0.92	6	9.38	Pelagic
Octopodidae							
26. *Octopus magnificus*	1	0.09	1	0.13	1	1.56	Benthic
27. *Octopus vulgaris*	1	0.09	1	0.13	1	1.56	Benthic
	46	**3.94**	**36**	**4.71**	**16**		
CRUSTACEA							
Decapoda	9	0.77	9	1.18	9	14.06	
Amphipoda	1	0.09	1	0.13	1	1.56	
	10	**0.86**	**10**	**1.31**	**10**		
OTHER							
Dogfish shark egg cases (*Squalus sp.*)	9	0.77	9	1.18	1	1.56	
Unidentified molluscs	5	0.43	5	0.65	5	7.81	
Seaweed	3	0.26	3	0.39	3	4.69	
	17	**1.46**	**17**	**2.22**	**9**		
	1172	**100**	**764**	**100**	**64**		

1. goldie; 2. maasbanker; 3. South African pilchard; 4. galijoen; 5. redspotted tonguefish/sand tonguefish; 6. Cape anchovy; 7. spotted grunter; 8. piggy; 9. shallow-water hake/deep-water hake; 10. Cape moony; 11. groovy mullet; 12. southern mullet; 13. flathead mullet; 14. elf; 15. squaretail kob; 16. baardman; 17. east coast sole; 18. carpenter; 19. blacktail; 20. sand steenbras; 21. red tjor-tjor; 22. Natal stumpnose; 23 strepie; 24. chokker squid; 25. lesser flying squid; 26. giant octopus; and 27. common octopus.

N^a, total number of left and right otoliths per sample, or total number of upper and lower cephalopod beaks per sample.

N^b, minimum number of prey items present (maximum number of either right or left otoliths per sample, or maximum number of either upper or lower cephalopod beaks per sample).

F, frequency of occurrence (number of prey items per sample, n = 64 samples).

Table 9.6 *Mean length and mean mass of prey species occurring in faecal samples from Cape fur seals collected at Rondeklippe colony, Plettenberg Bay, between June 1993 and November 1995*

	Otolith or cephalopod beak			Prey species	
Prey taxon	**Mean length ± SE (mm)**	**Range (mm)**	***n***	**Mean length ± SE (mm)**	**Mean mass ± SE (g)**
TELEOST FISH					
Callanthiidae					
1. *Callanthias legras*	7.48 ± 0.19	7.19–7.97	4	– [a]	– [a]
Carangidae					
2. *Trachurus trachurus capensis*	5.94 ± 0.11	3.34–10.28	91	190.45 ± 3.68	67.79 ± 5.14
Cheilodactylidae	12.85	–	1	– [a]	– [a]
Clupeidae					
3. *Sardinops ocellatus*	3.98 ± 0.10	2.69–9.30	82	217.60 ± 6.12	108.20 ± 23.29
Coracinidae					
4. *Coracinus capensis*	13.1	–	1	– [a]	– [a]
Cynoglossidae					
5. *Cynoglossus zanzibarensis (C. capensis)*	3.69 ± 0.04	1.79–6.04	379	196.19 ± 2.51 (120.99 ± 0.53)	197.35 ± 23.56 (32.28 ± 1.34)
Engraulidae					
6. *Engraulis japonicus*	3.37 ± 0.07	2.95–3.73	14	99.52 ± 0.16	11.73 ± 0.65
Haemulidae					
7. *Pomadasys commersonnii*	9.00	–	1	218.70	105.53
8. *Pomodasys olivaceum*	7.17 ± 0.38	5.14–9.77	12	142.61 ± 8.47	45.49 ± 8.27
Merlucciidae					
9. *Merluccius capensis (M. paradoxus)*	7.51 ± 0.30	4.4–11.4	30	159.07 ± 7.29 (165.26 ± 8.06)	33.85 ± 5.09 (33.80 ± 5.57)
Monodactylidae					
10. *Monodactylus falciformis*	7.58 ± 0.9	5.78–7.58	2	181.58 ± 28.91	122.15 ± 54.94
Mugilidae					
11. *Liza dumerilii*	NR	–	0	–	–
12. *Liza richardsonii*	8.42 ± 0.31	6.04–10.92	20	306.66 ± 14.99	306.98 ± 41.94
13. *Mugil cephalus*	9.01 ± 1.16	6.9–10.92	3	396.23 ± 7.13	593.24 ± 32.74
Pomatomidae					
14. *Pomatomus saltrix*	NR	–	0	–	–
Sciaenidae					
15. *Argyrosomus thorpei*	NR	–	0	–	–
16. *Umbrina canariensis*	8.21 ± 1.31	6.90–9.51	2	197.71 ± 38.26	118.02 ± 64.14
Soleidae					
17. *Austroglossus pectoralis*	3.65 ± 0.04	1.67–7.08	259	237.58 ± 3.10	83.67 ± 4.1
Sparidae					
18. *Argyrozona argyrozona*	6.29	–	1	134.49	34.20
19. *Diplodus sargus capensis*	7.14 ± 0.51	5.78–7.97	4	250.07 ± 22.94	276.61 ± 67.01
20. *Lithognathus mormyrus*	5.52 ± 0.13	3.98–9.51	47	157.24 ± 5.65	69.19 ± 13.51
21. *Pagellus belottii natalensis*	7.71 ± 0.13	7.58–7.84	2	179.35 ± 3.17	76.53 ± 4.19
22. *Rhabdosargus sarba*	8.61	–	1	293.15	388.75
23. *Sarpa salpa*	5.65	–	1	195.00	107.49
	4.35 ± 0.05	**1.67–13.1**	**957**	**176.77 ± 2.16**	**67.53 ± 3.29**
CEPHALOPODS					
Loliginidae					
24. *Loligo vulgaris reynaudii*	3.54 ± 0.14 [b]	2.31–4.70	14	220.21 ± 11.07	269.92 ± 32.46
Ommastrephidae					
25. *Todaropsis eblanae*	1.55 ± 0.05 [b]	1.50–1.60	2	48.23 ± 1.73	7.36 ± 0.71
Octopodidae					
26. *Octopus magnificus*	15.9 [c]	–	1	158.35	468.49
27. *Octopus vulgaris*	10.2 [c]	–	1	97.64	290.98
	4.38 ± 0.80	**1.5–15.9**	**18**	**190.85 ± 16.65**	**252.95 ± 34.51**

[a] No regression available.

[b] Lower rostral length.

[c] Crest length.

NR, otolith length not recorded because the otolith was broken or eroded.
Mean length and mean mass for all fish combined was calculated using *Cynoglossus zanzibarensis* and *Merluccius capensis*.
Reconstituted length is dorsal mantle length for cephalopods and total length for fish.
Common names for fish and cephalopods given in Table 9.5.

Black Rocks, Algoa Bay (breeding colony)

General composition of diet

Identifiable prey items were found in all faecal samples/regurgitates collected at Black Rocks. A total of 1 483 prey items were retrieved including teleost fish (41.3%), cephalopods (57.3%), crustaceans (1.2%), and miscellaneous items (0.2%) (Table 9.7).

Fish otoliths occurred in 12 (92.3%) faecal samples/regurgitates. A total of 24 species of fish and 13 families were identified. Fifty two (8.5%) individual otoliths were broken or severely eroded and therefore could not be identified. Three otoliths were classified to family level only – two Mugilidae and one Sparidae.

Table 9.7 ***The composition of prey species, by number and frequency, occurring in faecal samples and regurgitates from Cape fur seals collected at Black Rocks seal colony, Algoa Bay, between May 1992 and November 1995***

Prey taxon	Number of prey items				Frequency of occurrence		Prey habitat
	N[a]	% N[a]	N[b]	% N[b]	F	% F	
TELEOST FISH							
Carangidae							
1. *Trachurus trachurus capensis*	115	7.75	64	7.32	10	76.92	Pelagic-midwater
Clupeidae							
2. *Sardinops ocellatus*	68	4.59	42	4.81	9	69.23	Pelagic
Cynoglossidae							
3. *Cynoglossus zanzibarensis*/ *C. capensis*	40	2.70	22	2.51	7	53.85	Benthic
Engraulidae							
4. *Engraulis japonicus*	111	7.48	63	7.21	7	53.85	Pelagic
Haemulidae							
5. *Pomodasys olivaceum*	1	0.07	1	0.11	1	7.69	Benthic
Merlucciidae							
6. *Merluccius capensis*/ *M. paradoxus*	49	3.30	35	4.00	10	76.92	Benthic
Mugilidae							
7. *Mugil cephalus*	2	0.13	2	0.23	1	7.69	Benthic
Unidentified Mugilidae	2	0.13	2	0.23	1	7.69	Benthic
Ophidiidae							
8. *Genypterus capensis*	16	1.08	13	1.49	4	30.77	Benthic
Sciaenidae							
9. *Argyrosomus hololepidotus*	11	0.74	10	1.14	5	38.46	Benthic
10.*Umbrina canariensis*	14	0.94	9	1.03	6	46.15	Benthic
Scorpaenidae							
11. *Helicolenus dactylopterus*	5	0.34	3	0.34	2	15.38	Benthic
Soleidae							
12. *Austroglossus pectoralis*	23	1.55	14	1.60	8	61.54	Benthic
Sparidae							
13. *Argyrozona argyrozona*	2	0.13	2	0.23	1	7.69	Benthic
14. *Boopsoidae inornata*	1	0.07	1	0.11	1	7.69	Benthic
15. *Chrysoblephus cristiceps*	1	0.07	1	0.11	1	7.69	Benthic
16. *Diplodus sargus capensis*	2	0.13	1	0.11	1	7.69	Benthic
17. *Lithognathus mormyrus*	3	0.20	3	0.34	2	15.38	Benthic
18. P*agellus belottii natalensis*	85	5.73	47	5.38	8	61.54	Benthic
19. *Rhabdosargus holubi*	8	0.54	8	0.92	6	46.15	Benthic
Unidentified Sparidae	1	0.07	1	0.11	1	7.69	Benthic
Trichiuridae							
20. *Lepidopus caudatus*	1	0.07	1	0.11	1	7.69	Bentho-pelagic
Unidentified otoliths	52	3.51	27	3.09	7	53.85	
	613	**41.34**	**372**	**42.56**	**100**		
CEPHALOPODS							
Loliginidae							
21. *Loligo vulgaris reynaudii*	836	56.37	470	53.78	13	100	Pelagic
Ommastrephidae							
22. *Todaropsis eblanae*	1	0.07	1	0.11	1	7.69	Pelagic
Unidentified squid	4	0.27	2	0.23	1	7.69	Pelagic
Octopodidae							
23. *Octopus vulgaris*	7	0.47	7	0.80	5	38.46	Benthic
Sepiidae							
24. *Sepia* sp.	1	0.07	1	0.11	1	7.69	Benthic
	849	**57.25**	**481**	**55.03**	**21**		
CRUSTACEA							
Decapoda	18	1.21	18	2.06	7	53.85	
	18	**1.21**	**18**	**2.06**	**7**		
OTHER							
Dogfish shark egg cases (*Squalus* sp.)	2	0.13	2	0.23	1	7.69	
Penguin feathers	1*	0.07	1*	0.11	1	7.69	
	3	**0.20**	**3**	**0.34**	**2**		
	1483	**100**	**874**	**100**	**13**		

1. maasbanker; 2. South African pilchard; 3. redspotted tonguefish/sand tonguefish; 4. Cape anchovy; 5. piggy; 6. shallow-water hake/deep-water hake; 7. flathead mullet; 8. kingklip; 9. kob; 10. baardman; 11. jacopever; 12. east coast sole; 13. carpenter; 14. fransmadam; 15. dageraad; 16. blacktail; 17. sand steenbras; 18. red tjor-tjor; 19. Cape stumpnose; 20. buttersnoek; 21. chokker squid; 22. lesser flying squid; 23. common octopus; and 24. cuttlefish.

N[a], total number of left and right otoliths per sample, or total number of upper and lower cephalopod beaks per sample.

N[b], minimum number of prey items present (maximum number of either right or left otoliths per sample, or maximum number of either upper or lower cephalopod beaks per sample).

F, frequency of occurrence (number of prey items per sample; n = 13 samples).

* Five feathers presumably from one penguin.

When all otoliths (n = 613) were examined, the most numerous fish species were *T. trachurus capensis* (19% of otoliths), *Engraulis japonicus* (18% of otoliths), *Pagellus bellottii natalensis* (14% of otoliths) and *S. ocellatus* (11% of otoliths). A similar trend was observed when the maximum number of right or left otoliths in each sample was examined (n = 372), i.e., *T. trachurus capensis* (17% of otoliths), *E. japonicus* (17% of otoliths), *P. bellottii natalensis* (13% of otoliths) and *S. ocellatus* (11% of otoliths). The most frequently occurring fish species were *T. trachurus capensis* (in 77% of samples), *Merluccius capensis/paradoxus* (in 77% of samples), *S. ocellatus* (in 69% of samples), *P. bellottii natalensis* (in 62% of samples) and *A. pectoralis* (in 62% of samples).

Cephalopod beaks occurred in all faecal samples/regurgitates (Table 9.7). A total of three species of cephalopods and four families were identified (Table 9.6). Two upper and two lower beaks (0.5%) were broken and therefore could not be identified. One cuttlefish was identified to genus level only - *Sepia* sp. The most numerous and frequently occurring cephalopod species was

Table 9.8 ***Mean length and mean mass of prey species occurring in faecal samples and regurgitates from Cape fur seals collected at Black Rocks seal colony, Algoa Bay, between May 1992 and November 1995***

	Otolith or cephalopod beak			Prey species	
Prey taxon	**Mean length ± SE (mm)**	**Range (mm)**	***n***	**Mean length ± SE (mm)**	**Mean mass ± SE (g)**
TELEOST FISH					
Carangidae					
1. *Trachurus trachurus capensis*	9.49 ± 0.52	6.50–12.80	46	313.18 ± 8.34	299.07 ± 23.81
Clupeidae					
2. *Sardinops ocellatus*	3.73 ± 0.07	2.57–5.14	53	214.11 ± 4.06	82.65 ± 4.90
Cynoglossidae					
3. *Cynoglossus zanzibarensis (C. capensis)*	4.36 ± 0.15	1.79–6.04	38	240.92 ± 10.01 (203.48 ± 9.07)	89.79 ± 9.15 (64.20 ± 7.48)
Engraulidae					
4. *Engraulis japonicus*	3.68 ± 0.5	2.96–6.29	95	133.31 ± 1.49	15.47 ± 0.70
Haemulidae					
5. *Pomodasys olivaceum*	7.40	–	1	147.33	44.84
Merlucciidae					
6. *Merluccius capensis (M. paradoxus)*	12.58 ± 0.92	7.30–21.30	18	286.49 ± 23.97 (309.33 ± 27.57)	251.04 ± 68.22 (307.08 ± 90.86)
Mugilidae					
7. *Mugil cephalus*	9.40	–	2	418.32	592.14
Ophidiidae					
8. *Genypterus capensis*	12.09 ± 2.37	8.90–15.20	7	545.93 ± 61.63	968.42 ± 303.60
Sciaenidae					
9. *Argyrosomus hololepidotus*	12.07 ± 0.45	10.20–14.20	6	339.23 ± 22.65	377.70 ± 75.31
10. *Umbrina canariensis*	9.38 ± 0.37	7.30–12.30	14	232.61 ± 2.93	192.41 ± 10.72
Scorpaenidae					
11. *Helicolenus dactylopterus*	11.10 ± 0.30	10.80–11.40	2	289.76 ± 0.82	398.23 ± 3.09
Soleidae					
12. *Austroglossus pectoralis*	4.49 ± 0.15	3.08–5.78	21	302.03 ± 11.65	172.85 ± 21.10
Sparidae					
13. *Argyrozona argyrozona*	12.45	11.70–13.20	2	313.44 ± 23.35	372.69 ± 77.00
14. *Boopsoidae inornata*	NR	–	0		
15. *Chrysoblephus cristiceps*	NR	–	0		
16. *Diplodus sargus capensis*	7.40 ± 0.70	6.70–8.10	2	261.68 ± 32.24	309.11 ± 111.57
17. *Lithognathus mormyrus*	8.97 ± 0.20	8.60–9.30	3	315.71 ± 1.01	500.86 ± 3.93
18. *Pagellus belottii natalensis*	8.23 ± 0.10	4.90–10.30	84	192.12 ± 2.56	99.13 ± 3.90
19. *Rhabdosargus holubi*	11.10 ± 0.83	9.00–13.50	6	371.13 ± 33.67	946.43 ± 244.71
Trichiuridae					
20. *Lepidopus caudatus*	12.0	–	1	–	–
	6.59 ± 0.16	**1.79–21.30**	**401**	**225.53 ± 4.60**	**154.51 ± 11.87**
CEPHALOPODS					
Loliginidae					
21. *Loligo vulgaris reynaudii*	3.73 ± 0.55[a]	1.9–4.9	321	232.65 ± 2.13	308.42 ± 6.48
Ommastrephidae					
22. *Todaropsis eblanae*	2.1[a]	–	1	67.76	18.20
Octopodidae					
23. *Octopus vulgaris*	10.34 ± 1.44[b]	7.9–15.2	5	74.76 ± 1.48	155.79 ± 6.73
Sepiidae					
24. *Sepia* sp.	NR	–	0	–	–
	3.83 ± 0.06	**1.90–15.20**	**327**	**229.73 ± 2.40**	**305.20 ± 6.51**

[a] Lower rostral length.

[b] Crest length.

NR, otolith length not recorded because the otolith was broken or eroded.

Mean length and mean mass for all fish combined was calculated using *Cynoglossus zanzibarensis* and *Merluccius capensis*.

Reconstituted length is dorsal mantle length for cephalopods and total length for fish.

Common names for fish and cephalopods are given in Table 9.7.

L. vulgaris reynaudii (a minimum of 470 individuals in 13 samples) followed by *O. vulgaris* (a minimum of seven individuals in five samples). *Todaropsis eblanae* and *Sepia* sp. occurred infrequently.

Crustacean remains (18 items) occurred in seven (54%) samples (Table 9.7). The claws and carapace fragments of at least 18 decapods were recovered.

Miscellaneous items included two egg cases from a dogfish shark, *Squalus* sp. (in one sample); and five feathers from an African penguin, *Spheniscus demersus* (in one sample) (Table 9.7).

Reconstituted length and mass of individual prey species are presented in Table 9.8. The mean reconstituted fish prey mass and total length was 155 g and 226 mm, respectively. The mean reconstituted cephalopod prey mass and dorsal mantle length was 305 g and 230 mm, respectively.

Cape fur seals stranded along the Eastern Cape coast

General composition of diet

Forty one stomachs collected from stranded (dead) seals along the Eastern Cape coast between January 1991 and December 1995 were examined. Twenty one stomachs (51%) contained identifiable remains (Table 9.9). The remanding 20 stomachs were empty. A total of 329 prey items were retrieved, including

Table 9.9 ***The composition of prey species, by number and frequency, occurring in the stomachs of Cape fur seals stranded off the Eastern Cape coast between January 1991 and December 1995***

	Number of prey items				Frequency of occurrence		Prey habitat
Prey taxon	**N[a]**	**% N[a]**	**N[b]**	**% N[b]**	**F**	**% F**	
TELEOST FISH							
Carangidae							
1. *Trachurus trachurus capensis*	54	16.41	29	14.50	4	9.76	Pelagic-midwater
Clupeidae							
2. *Etrumeus whiteheadi*	38	11.55	22	11.00	2	4.88	Pelagic
3. *Sardinops ocellatus*	7	2.13	4	2.00	2	4.88	Pelagic
Cynoglossidae							
4. *Cynoglossus zanzibarensis/ C. capensis*	24	7.30	13	6.50	3	7.32	Benthic
Merlucciidae							
5. *Merluccius capensis/ M. paradoxus*	17	5.17	9	4.50	3	7.32	Benthic
Ophidiidae							
6. *Genypterus capensis*	1	0.30	1	0.50	1	2.44	Benthic
Scorpaenidae							
7. *Helicolenus dactylopterus*	4	1.22	3	1.50	2	4.88	Benthic
Soleidae							
8. *Austroglossus pectoralis*	2	0.61	1	0.50	1	2.44	Benthic
Sparidae							
9. *Argyrozona argyrozona*	6	1.82	4	2.00	1	2.44	Benthic
10. *Pagellus belottii natalensis*	45	13.68	24	12.00	1	2.44	Benthic
11. *Pterogymnus laniaris*	1	0.30	1	0.50	1	2.44	Benthic
12. *Rhabdosargus sarba*	2	0.61	1	0.50	1	2.44	Benthic
Unidentified otoliths	6	1.82	3	1.50	2	4.88	
	207	**62.92**	**115**	**57.50**	**24**		
CEPHALOPODS							
Loliginidae							
13. *Loligo vulgaris reynaudii*	77	23.40	42	21.0	8	19.51	Pelagic
Octopodidae							
14. *Octopus vulgaris*	1	0.30	1	0.50	1	2.44	Benthic
Unidentified octopus	6	1.82	4	2.0	4	9.76	Benthic
	84	**25.53**	**47**	**23.50**	**13**		
CRUSTACEA							
Decapoda	2	0.61	2	1.00	1	2.44	
Amphipoda	20	6.08	20	10.00	1	2.44	
	22	**6.69**	**22**	**11.00**	**2**		
OTHER							
Dogfish shark egg case (*Squalus* sp.)	1	0.30	1	0.50	1	2.44	
Stones	15	4.56	15	7.46	2	4.88	
	16	**4.86**	**16**	**8.00**	**3**		
	329	**100**	**200**	**100**	**41**		

1. maasbanker; 2. redeye roundherring; 3. South African pilchard; 4. redspotted tonguefish/ sand tonguefish; 5. shallow-water hake/deep-water hake; 6. kingklip; 7. jacopever; 8. east coast sole; 9. carpenter; 10. red tjor-tjor; 11. panga; 12. Natal stumpnose; 13. chokker squid; and 14. common octopus.

N[a], total number of left and right otoliths per sample, or total number of upper and lower cephalopod beaks per sample.

N[b], minimum number of prey items present (maximum number of either right or left otoliths per sample, or maximum number of either upper or lower cephalopod beaks per sample).

F, frequency of occurrence (number of prey items per sample, *n* = 41 stomachs).

teleost fish (63%), cephalopods (26%), crustaceans (7%), and miscellaneous items (5%) (Table 9.8).

Fish otoliths occurred in 10 (48%) stomachs. A total of 14 species of fish and eight families were identified. Six (2.9%) individual otoliths could not be identified.

When all otoliths (n = 207) were examined, the most numerous fish species were *T. trachurus capensis* (26% of otoliths), *P. bellottii natalensis* (22% of otoliths), *Etrumeus whiteheadi* (18% of otoliths), *C. zanzibarensis/capensis* (12% of otoliths) and *M. capensis/paradoxus* (8% of otoliths). A similar trend was observed when the maximum number of right or left otoliths in each sample was examined (n = 115), i.e., *T. trachurus capensis* (25% of otoliths), *P. bellottii natalensis* (21% of otoliths), *E. whiteheadi* (19% of otoliths), *C. zanzibarensis/capensis* (11% of otoliths) and *M. capensis/paradoxus* (8% of otoliths). The most frequently occurring fish species were *T. trachurus capensis* (in 10% of stomachs), *C. zanzibarensis/capensis* (in 7% of stomachs) and *M. capensis/paradoxus* (in 7% of stomachs).

Cephalopod beaks occurred in 12 (57%) stomachs (Table 9.9). A total of two species and two families were identified. Four lower and two upper (7%) octopus beaks could not be identified. The most numerous and frequently occurring cephalopod species was *L. vulgaris reynaudii* (a minimum of 42 individuals in eight stomachs). A minimum of four unidentified octopus species occurred in four stomachs. *O. vulgaris* occurred infrequently.

Crustacean remains (22 items) occurred in two (9.5%) stomachs (Table 9.9). The remains of 20 whole amphipods, and the claws and carapace fragments of at least two decapods were recovered.

Miscellaneous dietary items included one egg case from a dogfish shark, *Squalus* sp. (in one stomach); and 15 stones (in two stomachs) (Table 9.9). One young male (PEM2198, 105 cm SBL) had 13 stones in its stomach which weighed 34.3 g. A second animal, an old male (PEM2203, 204 cm SBL) had two stones in its stomach which weighed 40.4 g. Mean mass of the 15 stones was 5.1 ± 1.8 g (range 0.1–25.0 g); mean length was 18.3 ± 2.3 mm (range

Table 9.10 ***Mean length and mean mass of prey species occurring in the stomachs of Cape fur seals stranded off the Eastern Cape coast between January 1991 and December 1995***

Prey taxon	Otolith or cephalopod beak			Prey species			
	Mean length ± SE (mm)	Range (mm)	*n*	Mean length ± SE (mm)	Mean mass ± SE (g)	Total mass (g)	%Total mass
TELEOST FISH							
Carangidae							
1. *Trachurus trachurus capensis*	8.91 ± 0.37	7.00–12.21	23	293.13 ± 12.82	252.89 ± 34.43	7333	27.59
Clupeidae							
2. *Etrumeus whiteheadi*	3.96 ± 0.06	3.3–4.4	23	205.13 ± 3.55	65.89 ± 3.51	1450	4.14
3. *Sardinops ocellatus*	3.92 ± 0.06	3.86–3.98	2	225.55 ± 3.69	91.69 ± 4.76	367	0.19
Cynoglossidae							
4. *Cynoglossus zanzibarensis (C. capensis)*	5.03 ± 0.17	2.27–6.43	23	286.51 ± 11.75 (245.28 ± 10.76)	138.93 ± 13.47 (105.16 ± 11.65)	1806 (1367)	3.05
Merlucciidae							
5. *Merluccius capensis (M. paradoxus)*	10.56 ± 0.34	9.20–11.80	8	233.61 ± 8.58 (248.19 ± 9.68)	95.41 ± 10.84 (102.30 ± 12.65)	859 (921)	1.00
Ophidiidae							
6. *Genypterus capensis*	11.3	–	1	484.43	501.70	502	0.07
Scorpaenidae							
7. *Helicolenus dactylopterus*	9.98 ± 0.96	7.10–11.20	4	254.99 ± 29.58	298.99 ± 77.17	897	0.30
Soleidae							
8. *Austroglossus pectoralis*	4.11	–	2	272.13	111.57	112	0.01
Sparidae							
9. *Argyrozona argyrozona*	13.38 ± 0.35	12.90–14.40	4	328.30 ±16.46	402.27 ± 80.63	1609	0.84
10. *Pagellus belottii natalensis*	8.59 ± 0.31	7.19–10.15	24	200.96 ± 4.46	112.88 ± 7.86	2709	8.44
11. *Pterogymnus laniaris*	8.4	–	1	185.99	105.10	105	0.01
12. *Rhabdosargus sarba*	10.4	–	1	925.25	384.19	384	0.05
	7.26 ± 0.26	**2.27–14.40**	**116**	**251.56 ± 5.97**	**164.09 ± 13.76**	**352494**	**45.73**
CEPHALOPODS							
Loliginidae							
13. *Loligo vulgaris reynaudii*	3.42 ± 0.06[a]	2.60–4.30	38	210.68 ± 4.47	237.06 ± 12.23	418174	54.25
Octopodidae							
14. *Octopus vulgaris*	6.7[b]	–	1	60.57	105.15	105	0.01
Unidentified octopus	17.00 ± 1.50	15.50–18.50	2	–	–	–	–
	4.16 ± 0.47	**2.60–18.50**	**41**	**206.64 ± 5.81**	**233.67 ± 12.38**	**418279**	**54.27**

[a] Lower rostral length.

[b] Crest length.

Mean length and mean mass for all fish combined was calculated using *Cynoglossus zanzibarensis* and *Merluccius capensis*.

Reconstituted length is dorsal mantle length for cephalopods and total length for fish.

Common names for fish and cephalopods are given in Table 9.9.

Total mass and % total mass was calculated from the minimum number of prey items present. Regression equations for *Cynoglossus zanzibarensis* and *Merluccius capensis* were used.

8.0–39.1 mm); and mean width was 13.1 ± 1.6 mm (range 4.3–23.7 mm).

Reconstituted length and mass of individual prey species are presented in Table 9.10. The mean reconstituted fish prey mass and total length was 164 g and 252 mm, respectively. The mean reconstituted cephalopod prey mass and dorsal mantle length was 234 g and 207 mm, respectively.

The most important prey species based on percent total mass were *L. vulgaris reynaudii* (54%), *T. trachurus capensis* (28%), *P. bellottii natalensis* (8%), *E. whiteheadi* (4%) and *C. zanzibarensis/capensis* (3%) (Table 9.10).

An additional five stomachs from black pups (68–81 cm in length) were examined and analysed separately. Two of these stomachs contained milk (PEM2020, PEM2021); and one contained one small stone, one piece of seaweed and two molluscs (PEM2024). The remaining two stomachs were empty (PEM2022, PEM2025).

Cape fur seals incidentally entrapped in trawl nets during commercial fishing operations (by-catch) off the Eastern Cape coast

General composition of diet

Thirty seven stomachs collected from seals incidentally entrapped in trawl nets during commercial fishing operations off the Eastern Cape coast between July 1992 and August 1995 were examined. Thirty five stomachs (95%) contained identifiable remains (Table 9.11). The remanding two stomachs were empty. A total of 785 prey items were retrieved, including teleost fish (87%), cephalopods (10%), crustaceans (2%), and miscellaneous items (1%) (Table 9.11).

Fish otoliths occurred in 35 (95%) stomachs. A total of 17 species of fish and 15 families were identified. Eleven (1.6%) individual otoliths could not be identified.

When all otoliths (n = 684) were examined, the most numerous fish species were *M. capensis/paradoxus* (41% of otoliths), *T. trachurus capensis* (33% of otoliths), *Helicolenus dactylopterus* (7% of otoliths) and *Scomber japonicus* (5% of otoliths). A similar trend was observed when the maximum number of right or left otoliths in each sample was examined (n = 378), i.e., *M. capensis/paradoxus* (41% of otoliths), *T. trachurus capensis* (32% of otoliths), and *H. dactylopterus* (7% of otoliths). The most frequently occurring fish species were *M. capensis/paradoxus* (in 24% of stomachs), *T. trachurus capensis* (in 24% of stomachs) and *Lepidopus caudatus* (in 13% of stomachs).

Cephalopod beaks occurred in 24 (65%) stomachs (Table 9.11). A total of five species and four families were identified. Six lower and six upper (15%) octopus beaks could not be identified. The most numerous and frequently occurring cephalopod species were *L. vulgaris reynaudii* (a minimum of 17 individuals in six stomachs), *Lycoteuthis diadema* (a minimum of 10 individuals in six stomachs) and *O. magnificus* (a minimum of 7 individuals in four stomachs). A minimum of six unidentified octopus species occurred in four stomachs. *Todaropsis eblanae* and *Ommastrephes bartramii* occurred infrequently.

Crustacean remains (13 items) occurred in eight (22%) stomachs (Table 9.11). One whole mantis shrimp (stomatopoda), and the claws and carapace fragments of at least twelve decapods were recovered.

One male (PEM2258, 170 cm SBL) had eight stones in its stomach which weighed 34.3 g. Mean mass of the eight stones was 22.5 ± 7.3 g (range 0.8–54.5 g); mean length was 38.7 ± 6.9 mm (range 9.7–75.5 mm); and mean width was 25.4 ± 3.8 mm (range 9.5–41.3 mm).

Reconstituted length and mass of individual prey species are presented in Table 9.12. The mean reconstituted fish prey mass and total length was 1067 g and 363 mm, respectively. The mean reconstituted cephalopod prey mass and dorsal mantle length was 1 090 g and 184 mm, respectively.

The most important prey species based on percent total mass were *L. caudatus* (71%), *M. capensis/paradoxus* (9%), *T. trachurus capensis* (7%), and *O. magnificus* (6%) (Table 9.12).

Analysis based on the modified volume approach (David, 1991), which is a revised method for calculation of components of seal diet from stomachs which contain undigested prey remains, is presented elsewhere.

Table 9.11 ***The composition of prey species, by number and frequency, occurring in the stomachs of Cape fur seals incidentally entrapped in trawl nets during commercial fishing operations off the Eastern Cape coast between July 1992 and August 1995***

Prey taxon	Number of prey items				Frequency of occurrence		Prey habitat
	N^a	% N^a	N^b	% N^b	F	% F	
TELEOST FISH							
Anguillidae							
1. *Gnathophis capensis*	10	1.27	7	1.58	2	5.41	Benthic
Carangidae							
2. *Trachurus trachurus capensis*	227	28.92	121	27.31	24	64.86	Pelagic-midwater
Clupeidae							
3. *Etrumeus whiteheadi*	12	1.53	6	1.35	2	5.41	Pelagic
4. *Sardinops ocellatus*	2	0.25	1	0.23	1	2.70	Pelagic
Cynoglossidae							
5. *Cynoglossus zanzibarensis/ C. capensis*	8	1.02	4	0.90	1	2.70	Benthic
Gonorhynchidae							
6. *Gonorhynchus gonorhynchus*	2	0.25	1	0.23	1	2.70	Benthic
Lophiidae							
7. *Lophiodes* sp.	2	0.25	1	0.23	1	2.70	Benthic
Merlucciidae							
8. *Merluccius capensis/ M. paradoxus*	283	36.05	155	34.99	24	64.86	Benthic
Myctophidae	5	0.64	3	0.68	1	2.70	
Sciaenidae							
9. *Umbrina canariensis*	2	0.25	1	0.23	1	2.70	Benthic
Scombridae							
10. *Scomber japonicus*	33	4.20	17	3.84	7	18.92	Epipelagic-demersal
Scorpaenidae							
11. *Helicolenus dactylopterus*	47	5.99	28	6.32	7	18.92	Benthic
Soleidae							
12. *Austroglossus pectoralis*	2	0.25	1	0.23	1	2.70	Benthic
Sparidae							
13. *Rhabdosargus sarba*	2	0.25	1	0.23	1	2.70	Benthic
Trichiuridae							
14. L*epidopus caudatus*	30	3.82	22	4.97	13	35.14	Bentho-pelagic
Zeidae							
15. *Zeus faber*	6	0.76	3	0.68	1	2.70	Benthic
Unidentified otoliths	11	1.40	6	1.35	2	5.41	
	684	**87.13**	**378**	**85.33**	**90**		
CEPHALOPODS							
Loliginidae							
16. *Loligo vulgaris reynaudii*	32	4.08	17	3.84	6	16.22	Pelagic
Lycoteuthidae							
17. *Lycoteuthis diadema*	15	1.91	10	2.26	6	16.22	Pelagic
Ommastrephidae							
18. *Todaropsis eblanae*	5	0.64	3	0.68	2	5.41	Pelagic
19. *Ommastrephes bartramii*	2	0.25	1	0.23	1	2.70	Pelagic
Octopodidae							
20. *Octopus magnificus*	14	1.78	7	1.58	4	10.81	Benthic
Unidentified octopus	12	1.53	6	1.35	4	10.81	Pelagic
	80	**10.19**	**44**	**9.93**	**23**		
CRUSTACEA							
Decapoda	12	1.53	12	2.71	7	18.92	
Stomatopoda	1	0.13	1	0.23	1	2.70	
	13	**1.66**	**13**	**2.93**	**8**		
OTHER							
Stones	8	1.02	8	1.81	1	2.70	
	785	**100**	**443**	**100**	**37**		

1. southern conger; 2. maasbanker; 3. redeye roundherring; 4. South African pilchard; 5. redspotted tonguefish/sand tonguefish; 6. beaked sandfish; 7. monk fish; 8. shallow-water hake/deep-water hake; 9. baardman; 10. mackerel; 11. jacopever; 12. east coast sole; 13. Natal stumpnose; 14. buttersnoek; 15. John Dory; 16. chokker squid; 17. a squid; 18. lesser flying squid; 19. neon flying squid; and 20. giant octopus.

N^a, total number of left and right otoliths per sample, or total number of upper and lower cephalopod beaks per sample.

N^b, minimum number of prey items present (maximum number of either right or left otoliths per sample, or maximum number of either upper or lower cephalopod beaks per sample).

F, frequency of occurrence (number of prey items per sample, n = 37 stomachs).

Table 9.12 ***Mean length and mean mass of prey species occurring in the stomachs of Cape fur seals incidentally entrapped in trawl nets during commercial fishing operations off the Eastern Cape coast between July 1992 and August 1995***

Prey taxon	Otolith or cephalopod beak			Prey species			
	Mean length ± SE (mm)	Range (mm)	*n*	Mean length ± SE (mm)	Mean mass ± SE (g)	Total mass (g)	% Total mass
TELEOST FISH							
Anguillidae							
1. *Gnathophis capensis*	8.18 ± 0.49	7.07–11.60	10	296.45 ± 29.21	137.89 ± 55.52	965	0.17
Carangidae							
2. *Trachurus trachurus capensis*	10.07 ± 9.70	6.43–18.35	65	333.55 ± 7.17	362.26 ± 34.03	43834	7.88
Clupeidae							
3. *Etrumeus whiteheadi*	4.13 ± 0.14	3.73–4.49	6	76.47 ± 8.84	235.51 ± 221.02	459	0.08
4. *Sardinops ocellatus*	4.2	–	1	242.81	115.79	116	0.02
Cynoglossidae							
5. *Cynoglossus zanzibarensis* (*C. capensis*)	4.85 ± 0.48	3.86–6.04	4	136.16 ± 0.96 (274.07 ± 3.48)	94.00 ± 5.24 (2085.02 ± 38.72)	8340 (376)	1.50
Gonorhynchidae							
6. *Gonorhynchus gonorhynchus*	4.55 ± 0.05	4.50–4.60	2	406.13 ± 4.50	331.23 ± 12.14	331	0.06
Lophiidae							
7. *Lophiodes sp.*	NR	–	–	–	–	–	–
Merlucciidae							
8. *Merluccius capensis* (*M. paradoxus*)	14.27 ± 0.28	8.80–25.20	133	329.52 ± 7.56 (358.34 ± 8.79)	340.82 ± 30.05 (423.35 ± 41.66)	52827 (65619)	9.50
Myctophidae	2.22 ± 0.11	1.93–2.44	4	–	–	–	–
Sciaenidae							
9. *Umbrina canariensis*	12.85 ± 1.00	12.80–12.90	2	340.84 ± 1.62	571.31 ± 8.44	571	0.10
Scombridae							
10. *Scomber japonicus*	5.59 ± 0.32	5.27–5.90	2	327.07 ± 8.94	473.92 ± 34.62	8057	1.45
Scorpaenidae							
11. *Helicolenus dactylopterus*	9.51 ± 0.22	7.70–11.10	24	239.67 ± 6.79	233.02 ± 19.33	6524	1.17
Soleidae							
12. *Austroglossus pectoralis*	NR	–	–	–	–		
Sparidae							
13. *Rhabdosargus sarba*	11.95 ± 0.05	11.90–12.00	2	468.75 ± 2.81	1751.08 ± 33.63	1751	0.31
Trichiuridae							
14. *Lepidopus caudatus*	8.15 ± 1.42	5.78–22.30	11	1431.46 ± 416.35	17900.33 ± 17039.26	393807	71
Zeidae							
15. *Zeus faber*	NR	–	–	–	–	–	–
	11.57 ± 0.25	**1.93–25.20**	**266**	**363.27 ± 21.11**	**1067.23 ± 681.52**	**583578**	**93.05**
CEPHALOPODS							
Loliginidae							
16. *Loligo vulgaris reynaudii*	3.39 ± 0.11[a]	2.50–4.30	15	208.80 ± 7.91	233.28 ± 21.93	3966	0.71
Lycoteuthidae							
17. *Lycoteuthis diadema*	3.52 ± 0.04[a]	3.30–3.70	9	99.94 ± 1.26	45.75 ± 1.66	458	0.08
Ommastrephidae							
18. *Todaropsis eblanae*	5.13 ± 0.43[a]	4.30–5.70	3	184.54 ± 17.04	274.02 ± 61.43	822	0.15
19. *Ommastrephes bartramii*	4.4[a]	–	1	174.18	134.41	134	0.02
Octopodidae							
20. *Octopus magnificus*	24.79 ± 2.29[b]	11.50–30.30	7	239.87 ± 20.99	4756.68 ± 1155.22	33297	5.99
	7.88 ± 1.52	**2.50–30.30**	**35**	**183.95 ± 10.38**	**1090.41 ± 382.41**	**38677**	**6.95**

[a] Lower rostral length.

[b] Crest length.

NR, otolith length not recorded because the otolith was broken or eroded.

Mean length and mean mass for all fish combined was calculated using *Cynoglossus zanzibarensis* and *Merluccius capensis*.

Reconstituted length is dorsal mantle length for cephalopods and total length for fish.

Common names for fish and cephalopods given in Table 9.11.

Total mass and % total mass was calculated from the minimum number of prey items present. Regression equations for *Cynoglossus zanzibarensis* and *Merluccius capensis* were used.

Table 9.13 *Size of commercially important prey items in the diet of the Cape fur seals from the Eastern Cape coast (Plettenberg Bay to Port Alfred)*

	Seal prey size			Size of the local commercial catch	
Species	**Mean ± SE (mm)**	**Mode (mm)**	***n***		
Trawl fishery				**Range (mm)**	
Merluccius capensis	294.30 ± 7.45	287.73	189	30–980	a
Merluccius paradoxus	318.36 ± 8.56	309.59		60–850	
Trachurus trachurus capensis	267.38 ± 5.43	184.82	225	60–560	a
Squid jig fishery				**Mode (mm)**	
Loligo vulgaris reynaudii	229.13 ± 1.92	229.96	388	290 males 180 females	b

(a) Species lengths derived from research surveys aboard inshore/offshore trawlers in Eastern Cape waters in 1997 (Chris Wilke, pers. comm).

(b) Augustyn & Smale, 1995.

Prey size and size of local commercial catches

Seal prey species which were: (i) the most abundant, (ii) occurred most frequently, and (iii) were also of importance to the local commercial fisheries, included *Trachurus trachurus capensis*, *Merluccius capensis/paradoxus* and *Loligo vulgaris reynaudii*. Modal prey size of these four species were within the size range of local commercial catches (Table 9.13). This indicates that in Eastern Cape waters there is potential competition between seals and the hake directed trawl fishery, horse mackerel trawl fishery, and the squid jig fishery.

Prey habitat

Of the 37 fish identified to species level, 29 (78.4%) were demersal, 3 (8.1%) were pelagic, 2 (5.4%) were bentho-pelagic, 2 (5.4%) were pelagic-midwater, and 1 (2.7%) was epipelagic-demersal. Of the 7 cephalopod identified, 43% were demersal and 57% were pelagic (Tables 9.5, 9.7, 9.9, 9.11). These observations suggest that on the Eastern Cape coast, seals forage extensively on the sea floor.

Interviews with experienced local fishermen

Interviews with experienced local fishermen (M. Brett, R. Colbold, A. Crawford, G. Edwards, A. Farquhar; B. Joubert, G. Lawrence, A. & C. Lilford) whom fish off the rocks at the Robberg Nature and Marine Reserve (Plettenberg Bay) indicate that 'on at least one occassion' seals have been observed feeding on: kob (*Argyrosomus hololepidotus*), galjoen (*Coracinus capensis*), red roman (*Chrysoblephus laticeps**), black musselcracker (*Cymatoceps nasutus**), springer/ladyfish (*Elops machnata**), southern mullet (*Liza richardsonii*), octopus sp., blue hottentot (*Pachymetopon aeneum**), spotted grunter (*Pomadasys commersonnii*), elf (*Pomatomus saltatrix*), lesser guitarfish (*Rhinobatos annulatus**), electric rays (*Torpedo sp.**) and blue-tail mullet (*Valamugil buchanani**). Seven of these records (marked with an astrict) add to the listing of seal prey species for the Eastern Cape coast.

Seal movement

Female 15990

SLTDR 15990 was deployed on March 19, 1993 and went offair on June 2, 1993, during which time a total of 34 valid locations were obtained (Figure 9.1 and 9.2).

Thirty (88%) recordings were within 10 km of Black Rocks. Mean distance from Black Rocks was 7.63 ± 2.38 km. The most southerly movement recorded was 34.075S, 25.68E, 60.12 km from Black Rocks. The most westerly movement was 34.075S, 25.68E, 60.12 km from Black Rocks. The most easterly movement was 33.863S, 36.321E, 5.95 km from Black Rocks.

Female 15989

SLTDR 15989 was deployed on September 15, 1994 and went off air on October 26, 1994, during which time a total of 26 locations were obtained (Figure 9.1 and 9.3).

Twenty (77%) recordings were within 10 km of Black Rocks. Mean distance from Black Rocks was 18.37 ± 7.64 km. The most southerly movement recorded was 34.478S, 26.466E, 73.44 km from Black Rocks. The most westerly movement was 33.814S, 26.2E, 6.52 km from Black Rocks. The most easterly movement was 34.308S, 28.088E, 176.23 km from Black Rocks.

Dive behaviour

Female 15990

A total of 277 'valid dives' were recorded for female 15990. Dive depth exceeded 160 m. Fifty one percent of dives were more than 60 m, of which 29% were 80–160 m. Deep dives, more than 160 m, represented only 4% of all dives.

The majority of dives (75%) were less than one minute in duration. Maximum dive duration was 2–3 minutes (Table 9.14, Fig. 9.4).

A bimodal distribution in the frequency of diving at different hours of the day was observed with most dives occurring near dawn (40% of all dives) and dusk (38% of all dives). The most frequently attained depth intervals were 60–80 m near dawn (34%); and 4–20 m (22%) and 80–160 m (26%) near dusk (Table 9.14, Fig. 9.5).

Female 15989

A total of 192 'valid dives' were recorded for female 15989. Dive depth exceeded 160 m. Sixty two percent of dives were more than 60 m, 48% of which were 80–160 m. Deep dives, more than 160 m, represented 12% of all dives.

The majority of dives (82%) were less than one minute in duration. Maximum dive duration was 3–5 minutes (Table 9.15, Fig. 9.4).

A bimodal distribution in the frequency of diving at different hours of the day was observed with most dives occurring near dawn (58% of all dives) and dusk (41% of all dives). The most frequently attained depth intervals were 60–80 m near dawn (45%); and surface (30%) and 80–160 m (36%) near dusk (Table 9.15, Fig. 9.5).

Table 9.14. ***Dive depth and duration summary data for female 15900 relative to time of day***

	Night	Dawn	Day	Dusk	No. of dives (%)
Depth					
surface	10.2	11.7	16.7	17.1	38 (13.72)
4–20	10.0	19.0	25.0	22.0	52 (18.77)
20–40	12.2	2.7	16.7	4.8	16 (5.78)
40–60	10.2	11.7	0.0	10.5	29 (10.47)
60–80	22.4	14.4	16.7	18.1	48 (17.33)
80–160	26.5	34.2	25.0	25.7	81 (29.24)
160^{+}	8.2	6.3	0.0	1.9	13 (4.69)
Total dives	**49**	**111**	**12**	**105**	**277**
Duration					
0–1	63.2	77.5	91.7	77.1	209 (75.45)
1–2	32.6	18.9	8.3	18.1	57 (20.58)
2–3	4.1	3.6	0.0	4.8	11 (3.97)
3–5	0.0	0.0	0.0	0.0	0
5–7	0.0	0.0	0.0	0.0	0
7^{+}	0.0	0.0	0.0	0.0	0
Total (minutes)	**40.53**	**67.91**	**4.15**	**71.51**	**277**

Based on local time (= GMT + 2 hrs)

Night (2100–0259 hrs); dawn (0300–0859 hrs); day (0900–1459 hrs); and dusk (1500–2059 hrs).

Table 9.15. ***Dive depth and duration summary data for female 15989 relative to time of day***

	Night	Dawn	Day	Dusk	No. of dives (%)
Depth					
surface	0	6.3	0	29.5	30 (15.63)
4–20	0	9.0	50	9.0	18 (9.38)
20–40	0	9.9	50	6.4	17 (8.85)
40–60	0	5.4	0	2.6	8 (4.17)
60–80	0	9.0	0	10.6	18 (9.38)
80–160	0	45.0	0	35.9	78 (40.63)
160^{+}	100	15.3	0	6.4	23 (11.98)
Total dives	**1**	**111**	**2**	**78**	**192**
Duration					
0–1	100	79.3	100	85.9	158 (82.30)
1–2	0	20.7	0	11.6	32 (16.70)
2–3	0	0	0	1.3	1 (0.52)
3–5	0	0	0	1.3	1 (0.52)
5–7	0	0	0	0	0
7^{+}	0	0	0	0	0
Total (minutes)	**0.35**	**75.03**	**1.83**	**39.23**	**192**

Based on local time (= GMT + 2 hrs)

Night (2100–0259 hrs); dawn (0300–0859 hrs); day (0900–1459 hrs); anddusk (1500–2059 hrs).

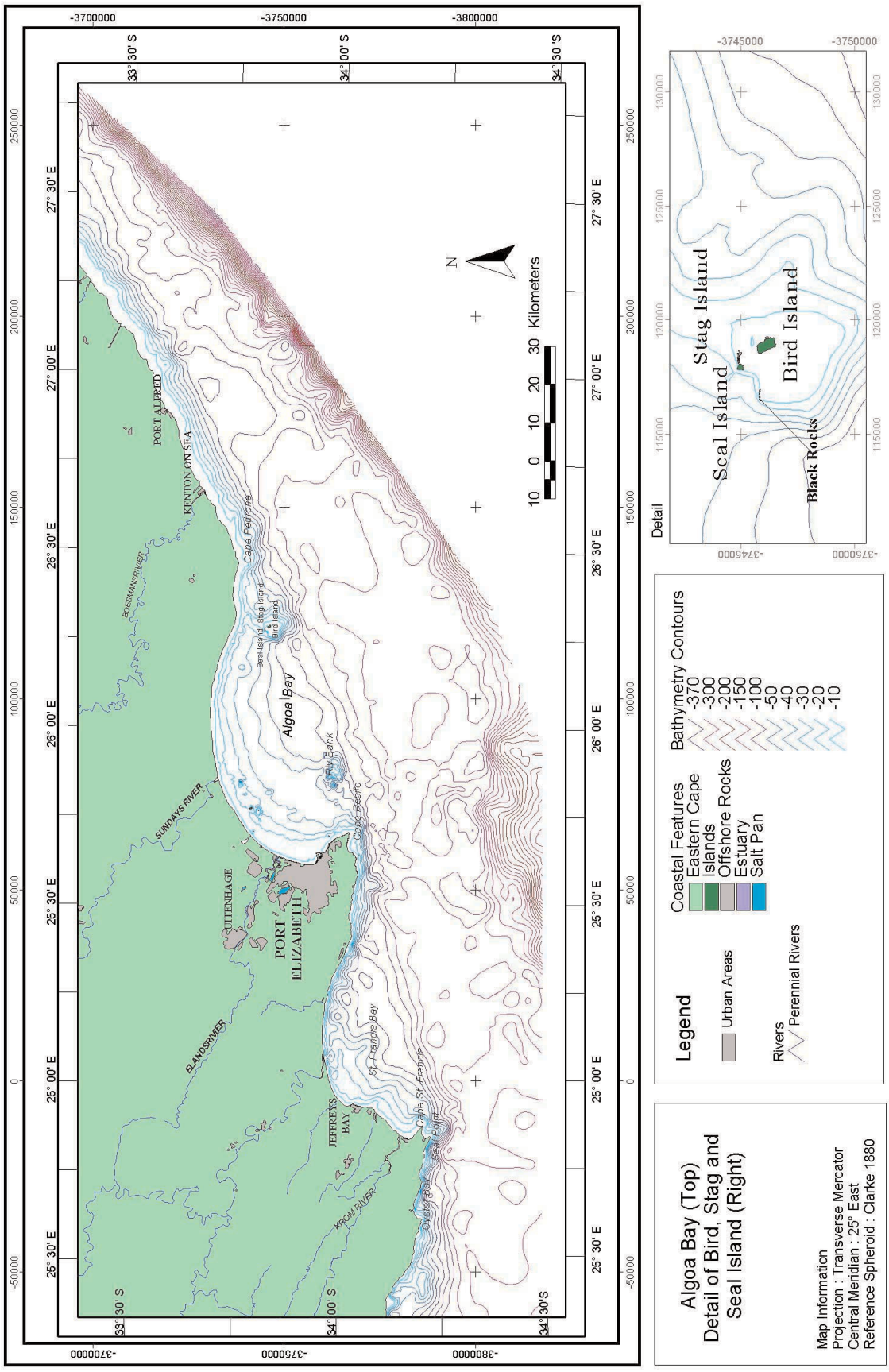

Fig. 9.1 Bathymetry of Black Rocks study area.

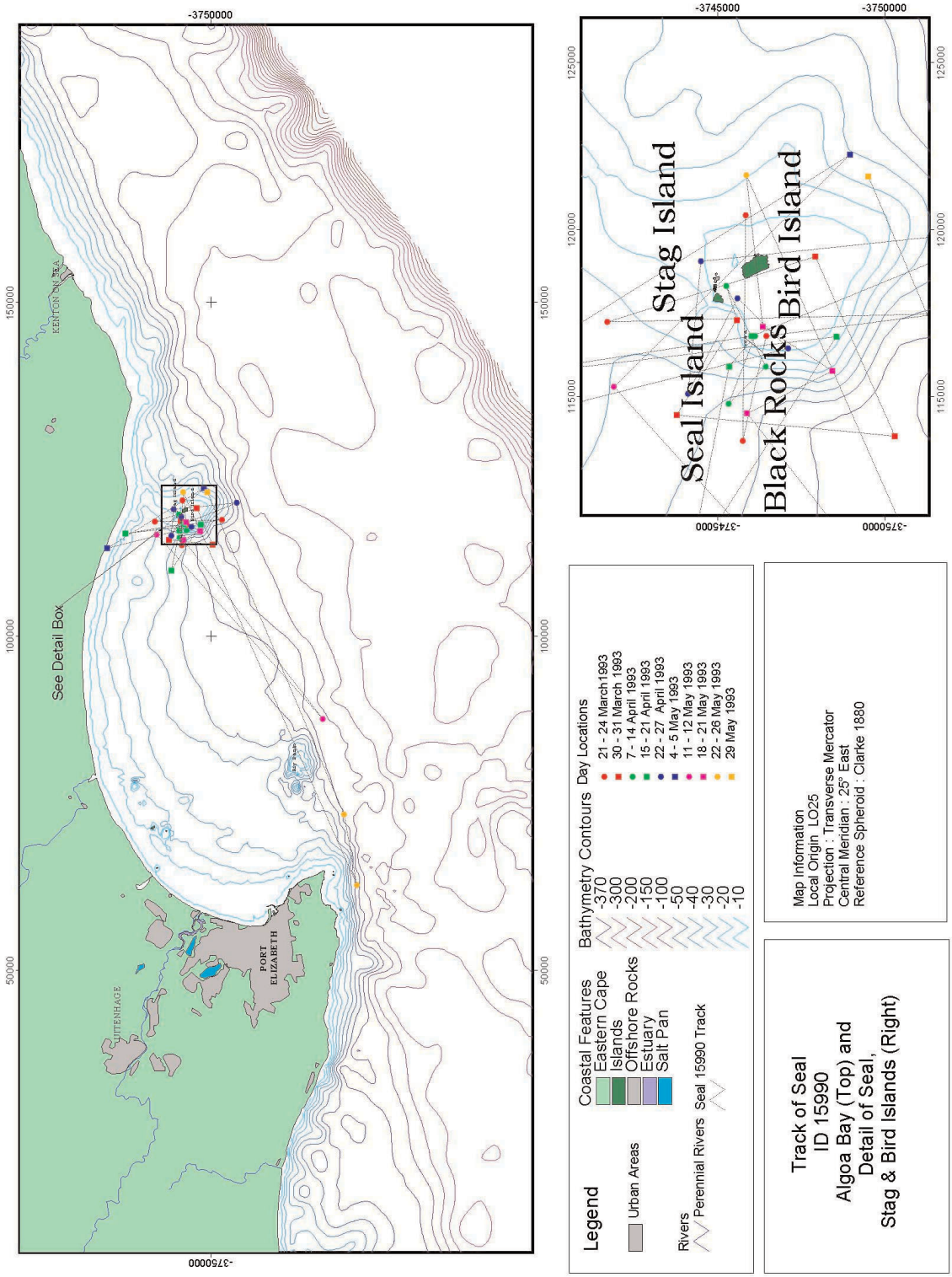

Fig. 9.2 Black Rocks study area showing SLTDR locations of an adult female Cape fur seal.
SLTDR 15990 was deployed at Black Rocks (Algoa Bay) on September 15, 1993, and went off the air on October 26, 1993.

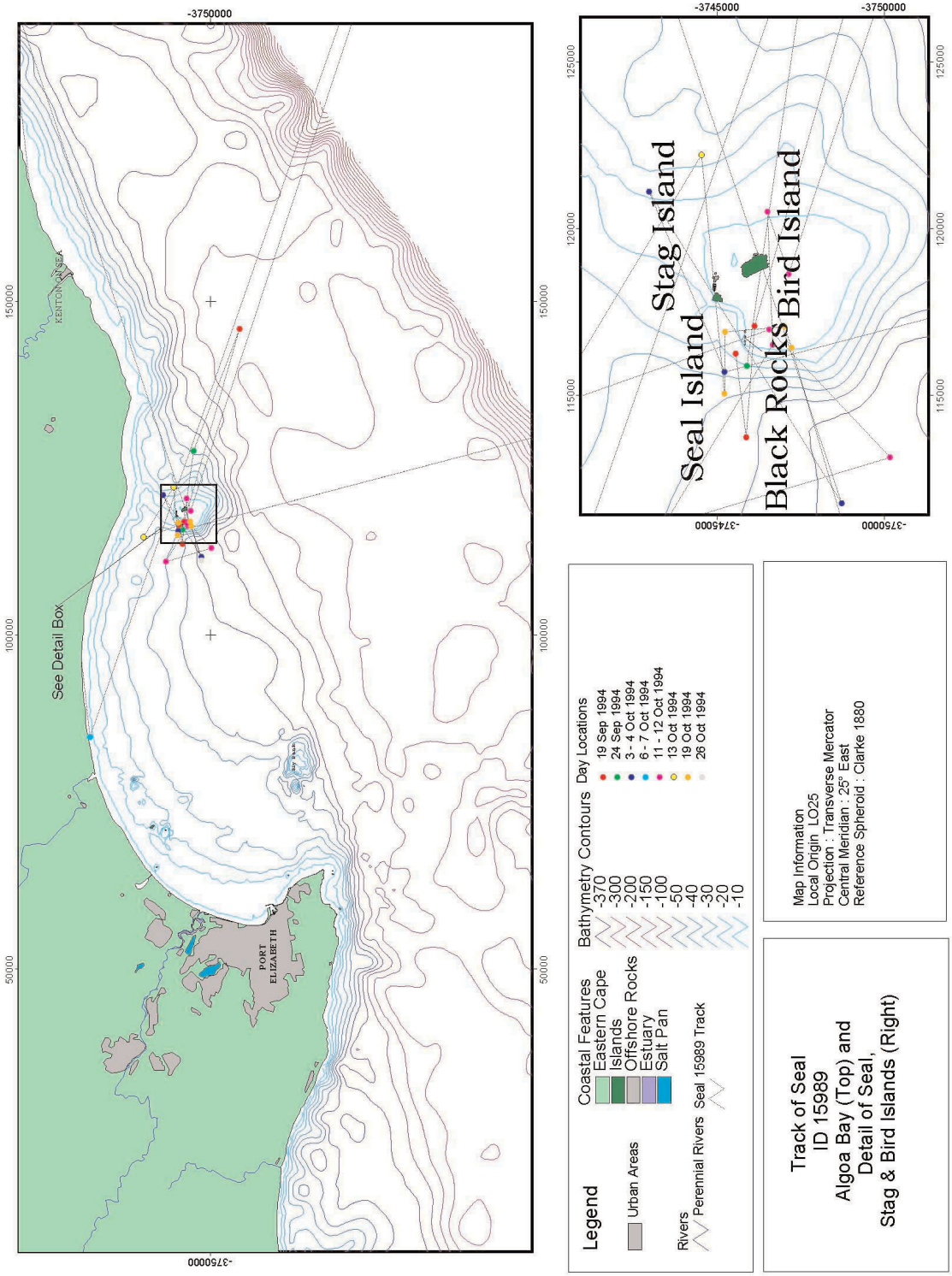

Fig. 9.3 Black Rocks study area showing SLTDR locations of an adult female Cape fur seal. SLTDR 15989 was deployed at Black Rocks (Algoa Bay) on September 15, 1994, and went off the air on October 26, 1994.

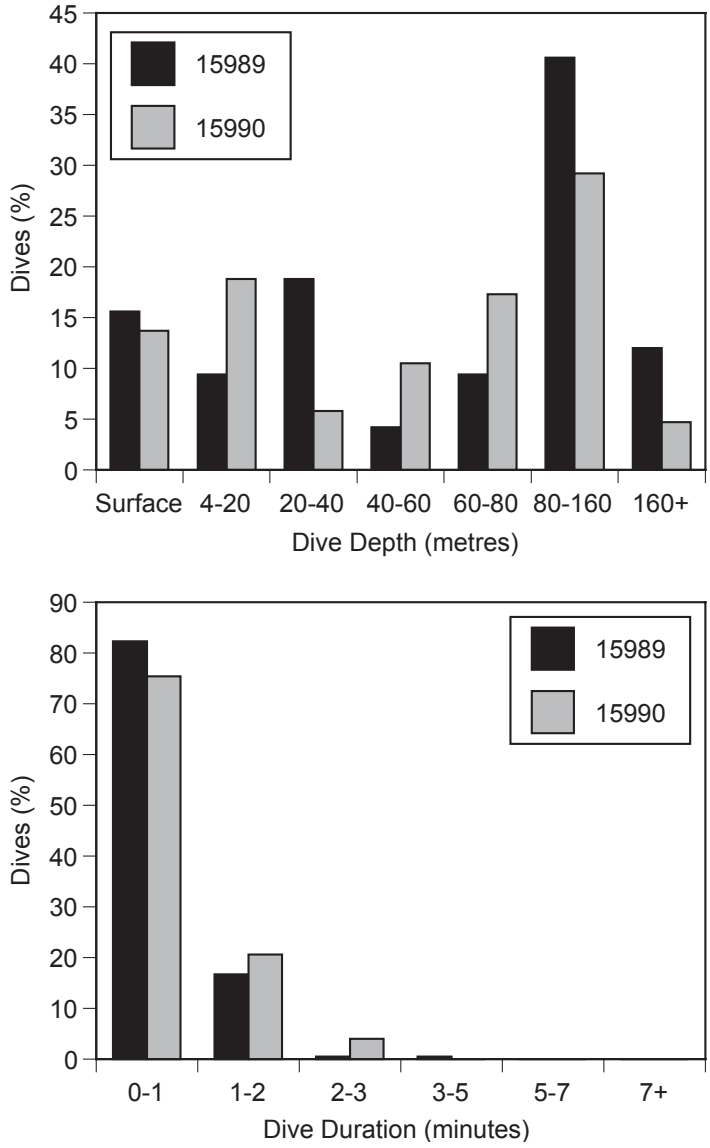

Fig. 9.4 Dive depth frequency and dive duration frequency.
Data is for two adult female Cape fur seals (SLTDR 15900 and SLTDR 15989) tagged at Black Rocks, Algoa Bay.

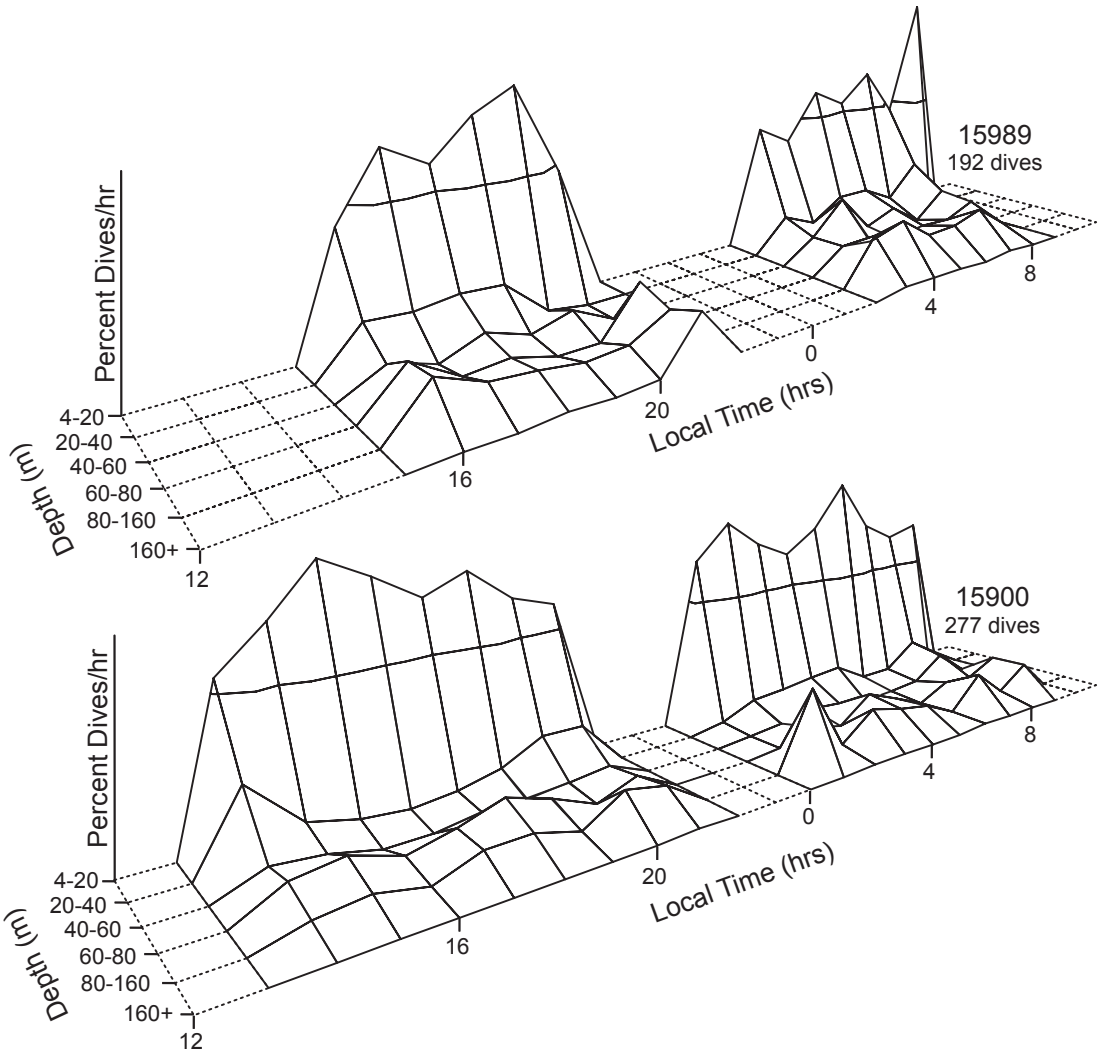

Fig. 9.5 Three-dimensional frequency analysis for depth of dive, time of day, and number of dives.
Data is for two adult female Cape fur seals (SLTDR 15900 and SLTDR 15989) tagged at Black Rocks, Algoa Bay.

DISCUSSION

Potential bias in seal dietary studies

In the present study, killing of animals was not desired, therefore non-lethal methods were used to acquire dietary samples, i.e., the collection of: (i) faecal samples (and regurgitates if present); (ii) stomach contents from stranded animals; and (iii) stomach contents from animals drowned incidentally in trawl nets. As with all methods of acquiring seal dietary samples, known biases are associated with these methods which prevent an accurate quantitative assessment of the data. Furthermore, there is no single method of presenting results which is free from bias (Croxall, 1993).

The use of fish otoliths to determine composition of the diet is potentially bias because: (i) some otoliths may be completely digested in the gastrointestinal tract (especially smaller fragile otoliths), therefore they may be underestimated in the stomach and faeces; (ii) some otoliths may be partially digested in the gastrointestinal tract, therefore they may not always represent the size of fish ingested; and (iii) large fish may be underestimated if the heads (otoliths) are not eaten (Boulva & McLaren, 1979; Brown & Mate, 1983; da Silva & Neilson, 1985; Murie & Lavigne, 1985; Prime & Hammond, 1987; Härkönen, 1986; Dellinger & Trillmich, 1988; Harvey, 1989; Gales & Cheal, 1992).

Use of cephalopod beaks to determine composition of the diet is potentially bias because: (i) the irregular shape of the beaks makes then prone to retention in the stomach folds, therefore they may be overestimated in the stomach and underestimated in the faeces; (ii) beaks are often regurgitated, therefore they may be underestimated in the stomach and faeces; and (iii) smaller beaks may pass through the pylorus of the stomach more easily than larger beaks, therefore, larger cephalopod prey may be underestimated in faeces (Miller, 1978; Pitcher, 1980; Bigg & Fawcett, 1985; Richardson & Gales, 1987; Gales & Cheal, 1992).

The use of stomach contents from stranded animals is potentially bias because: (i) stranded animals may have died of injury or illness, therefore stranded animals may be less selective about prey species than healthy ones; and (ii) due to the extended period of fasting, cephalopod remains may be overestimated and fish remains may be underestimated (Selzer *et al.,* 1986; Gales & Cheal, 1992).

Therefore, to minimise potential biases in the present study, only otoliths with little or no obvious erosion were measured; regurgitates were collected if present; and composition of the diet was presented using several methods, i.e., by number, frequency of occurrence, and mass.

Composition of the diet

On the Eastern Cape coast, Cape fur seals are opportunistic feeders, and take predominantly benthic prey. Prey species recovered from dietary samples included 37 species of fish, 7 species of cephalopods, a small number of crustacea (mostly decapoda), and other miscellaneous items, i.e., African penguin feathers (*Spheniscus demersus*), dogfish shark egg cases (*Squalus* sp.), unidentified molluscs, stones and seaweed.

The most important prey species (by percent mass) in the stomach contents of stranded seals were *L. vulgaris reynaudii*, *T. trachurus capensis*, *P. bellottii natalensis*, *E. whiteheadi* and *C. zanzibarensis/capensis*. However, the predominance of *L. vulgaris reynaudii* is likely to be overestimated due to the extended period of fasting prior to death.

The most important prey species (by percent mass) in the stomach contents of seals incidentally caught in commercial trawl nets were *L. caudatus*, *M. capensis/paradoxus*, *T. trachurus capensis* and *O. magnificus*. *L. caudatus* is often caught in trawl nets as by-catch. Discarded by-catch is frequently eaten by adult male Cape fur seals (Stewardson, pers. obs).

The most important prey species (by number and frequency of occurrence[1]) in faecal samples and regurgitates at Black Rocks were *L. vulgaris reynaudii* *T. trachurus capensis* and *S. ocellatus*; whereas the most important prey species (by number and frequency of occurrence[1]) in faecal samples at Rondeklippe were *C. zanzibarensis/capensis*, *A. pectoralis*, *S. ocellatus* and *T. trachurus capensis*. Preliminary studies examining otoliths in faecal samples from four captive Cape fur seals suggest that: (i) fish otoliths pass through the seal's digestive tract within 24–48 hrs of ingestion; (ii) the recovery rate of otoliths in the faeces is > 58%; (iii) the mean length of reduction of otoliths recovered from faeces is *c.* 23%; and (iv) *c.* 25% of left and right otoliths recovered in the faeces are uneroded (Millar, Wickens & Lowry, pers. comm.). Therefore, in the present study, it is likely that: (i) some of the prey items were not consumed over a one day period; (ii) larger, more robust otoliths were likely to be overestimated and smaller, fragile otoliths were likely to be underestimated; and (iii) the estimated original sizes derived from the regression equations will be underestimated. Furthermore, the predominance of *L. vulgaris reynaudii* at Black Rocks is likely to be overestimated because regurgitates may represent several meals over several days.

David (1987) examined stomach contents of *c.* 1 000 Cape fur seals shot at sea between Namibia and the south coast of South Africa, from 1974 to 1985. He reported that on the Namibian coast, teleost fish contributed 90.6% to the diet, cephalopods 8.2% and crustaceans 1.2%; and the most important species were pelagic goby (*Sufflogobius bibarbatus*) and *T. trachurus capensis* (n = 302 stomachs). On the west coast of South Africa, teleost fish contributed 64.4% to the diet, cephalopods 18.4%, crustaceans 9.3%, rock lobster 6.8% and elasmobranchs 1.0%; and the most important species were *E. capensis* and *M. capensis/pardadoxus* (n = 279 stomachs). On the south coast of South Africa, teleost fish contributed 67.7% to the diet, cephalopods 29.7%, crustaceans 1.2% and elasmobranchs 1.2%; and the most important prey species were *E. capensis*, *T. trachurus capensis*, *M. capensis/pardadoxus* and *S. ocellatus* (n = 115 stomachs). Differences in collection area and collection methods prevented direct comparison with the present study. However, four prey species (*T. trachurus capensis*, *M. capensis/pardadoxus* and *S. ocellatus*) which were found to be important on the south coast (David, 1987), were also identified as important prey species in Eastern Cape waters (present study). Furthermore, teleost fish were also found to be the most important prey group overall, i.e., teleost fish (41–94%), cephalopods (4–57%), crustaceans (0.9–7%), and miscellaneous items (0.2–5%) (present study).

Castley *et al.,* (1991) reported that the most important prey species (by percent total mass) isolated from the stomachs of 36 stranded Cape fur seals collected between Knysna and East London from 1976 to 1990 were *L. vulgaris reynaudii* (34.5%), *M. capensis* (24.1%), *T. trachurus capensis* (12.6%) and *C. zanzibarensis* (7.7%). In the present study, the most important prey species (by percent total mass) were *L. vulgaris reynaudii* (54%), *T. trachurus capensis* (28%), *P. bellottii natalensis* (8%), *E. whiteheadi* (4%) and *C. zanzibarensis/capensis* (3%). Castley *et al.,* (1991) identified 14 fish species and 7 cephalopod species in the stomach contents of stranded seals. All species reported by Castley *et al.*, (1991) were identified in the present study apart from *Cheimerius nufar*, *Chelidonichthys capensis*, *Argonauta nodosa*, *Ocythoe tuberculata* and *Onychoteuthis banksi*.

[1] Percent number and percent frequency of a given species are both of a high magnitude.

Regional variation in diet based on faecal analysis at the two seal colonies

The most important prey species (by number and frequency of occurrence[1]) in faecal samples and regurgitations at Black Rocks were *L. vulgaris reynaudii T. trachurus capensis* and *S. ocellatus*; whereas the most important prey species (by number and frequency of occurrence[1]) in faecal samples at Rondeklippe were *C. zanzibarensis/capensis*, *A. pectoralis*, *S. ocellatus* and *T. trachurus capensis*.

These differences are likely to reflect temporal and geographical differences in the abundance of certain prey species. For example, the main sole (*A. pectoralis* and *Cynoglossus* sp.) trawling grounds lie between Struis Bay and Plettenberg Bay, near the Rondeklippe seal colony, where there is considerable 'muddy bottom' habitat suitable for sole. In contrast, there are only isolated patches of 'muddy bottom' habitat between Cape St Francis and East London, near the Black Rocks seal colony (Payne & Badenhorst, 1995).

Differences in the age and/or sex of animals at the two sites; differences in the foraging range of seals with respect to water depth, temperature and bottom topography; and differences in collection methods, would also contribute to observed differences.

Potential competition between seals and fisheries

Eastern Cape trawl fishery

The most important trawl species in Eastern Cape waters (*Merluccius capensis*, *Merluccius paradoxus*, *Trachurus trachurus capensis* and *Austroglossus pectoralis*) are also important prey species of Cape fur seals (present study).

The modal size of *M. capensis* taken by Cape fur seals in this study was 287.73 mm, which was within the size range of local commercial catches (30–980 mm) (Table 9.13). The modal size of *M. paradoxus* was 309.59 mm, which was also within the size range of local commercial catches, e.g., 60–850 mm (Table 9.13). *M. capensis* inhabits the shelf and slope to 400 m, whereas *M. paradoxus* is generally found in deeper water (200–1 000 m) (Smith & Heemstra, 1986). Most hake migrate upwards at dusk and return to the sea bed at dawn. Satellite telemetry suggests that Cape fur seals feed mainly around dawn and dusk (present study). Therefore, it is likely that seals feed on hake when hake are near the water surface at night. Adult male seals also take hake during the day when they follow trawlers, e.g., feed on discarded offal and small hake which float free from the net (Stewardson, pers. obs.).

Modal size of *T. trachurus capensis* taken by Cape fur seals was 184.82 mm, which was within the size range of local commercial catches, e.g., 60–560 mm (Table 9.13). Smaller horse mackerel feed near the water surface, whereas older horse mackerel feed predominantly in midwater. At night, older horse mackerel form dense concentrations away from the sea bed. During the day these concentrations break down and individuals settle near the sea bed (Crawford, 1995). It is likely that seals feed on older horse mackerel when horse mackerel are away from the sea bed at night. Adult male seals also take horse mackerel during the day when they scavenge from trawlers (Stewardson, pers. obs.).

Commercially important *A. pectoralis* also contributed significantly to the diet of seals in this area. Modal size taken by Cape fur seals in this study was 232.70 mm (n = 281), which is within the range of local commercial catches, e.g., range 30–590 mm. However, the inshore sole directed trawl fishery operates south/south-west of the study area and is therefore excluded for further discussion.

Many species taken by Cape fur seals occur as trawl by-catch, including kingklip (*Genypterus capensis*), John dory (*Zeus faber*), monk fish (*Lophius* sp.), ribbon fish (*Lepidopus caudatus*), jacopever (*Helicolenus dactylopterus*), reds (e.g., capenter, *Argyrozona argyrozona*; panga *Pterogymnus laniarius*), chub mackerel, *Scomber japonicus* and chokker squid. Adult males are frequently observed following trawl vessels, feeding on offal and by-catch (Stewardson, pers. obs).

Squid jig fishery

Since the early 1980s, there has been a substantial chokker squid jigging fishery in Eastern Cape waters, between Plettenberg Bay and Port Elizabeth. The modal mantle length of chokker squid jig catches in these waters is *c.* 290 mm for males and *c.* 180 mm for females (Augustyn & Smale, 1995). Modal size taken by Cape fur seals is 229.96 mm (present study), which is within the range of local commercial catches (Table 9.13).

Chokker squid is a pelagic species. It undertakes daily vertical migrations, and is found to 300 m depth. It is likely that seals feed on chokker squid when the squid move towards the surface at night. In summer, chokker squid moves inshore to spawn, laying their eggs in shallow bays (15–40 m) between Plettenberg Bay and Port Elizabeth. It is likely that at this time of the year, chokker is consumed in larger quantities, and is taken at day and night.

Teleost line fishery

The main line fish species in Eastern Cape waters, which are also taken by Cape fur seals, include hake (*Merluccius* sp.), silver fish *(Argyrozona argyrozona*), panga (*Pterogymnus laniarius*), kob *(Argyrosomus hololepidotus*), dageraad (*Chrysoblephus cristiceps*), mackerel (*Scomber japonicus*) and elf (*Pomatomus*

[1] Percent number and percent frequency of a given species are both of a high magnitude.

saltatrix). Currently, size frequency distribution for the Eastern Cape line fisheries is not available (Chris Wilke, pers. comm.).

Annual consumption by seals

The total annual consumption of prey for Cape fur seals in Eastern Cape waters can be obtained by multiplying the number of foraging animals, by the estimated average daily ration, by 365 days.

At least some seals from Seal Island (Mossel Bay) feed in Eastern Cape waters. Therefore, inorder to estimate annual consuption in this region, the total estimated population for Black Rocks and Mossel Bay was combined. Pup numbers at Black Rocks were 463 in 1992 and 296 in 1996 (Marine & Coastal Management, unpubl. data). Pup numbers at Mossel Bay were 754 in 1992 and 989 in 1996 (Marine & Coastal Management, unpubl. data). Therefore, the combined estimated size of the population in the general area is 6 085 in 1992 and 6 425 in 1996 (i.e., the estimated total pup number was multiplied by 5).

The estimated average daily ration for Cape fur seals is *c.* 3.2 kg (Meÿer *et al.,* 1992). Hence, estimated total annual consumption was:

$$6\,085 \times 3.2 \times 365 = 7\,107 \text{ tons in } 1992$$

$$6\,425 \times 3.2 \times 365 = 7\,504 \text{ tons in } 1996$$

This will be a maximum estimate of total consumption because it includes animals < 1 year, which do not forage.

Diving behaviour and movement patterns

A bimodal distribution in the frequency of diving at different hours of the day was observed, with most dives occurring near dawn and dusk (present study). A similar dive pattern has also been reported in two female Cape fur seals at Kleinsee on the west coast of South Africa (Kooyman & Gentry, 1986), and in several female northern fur seals at St. George Island (Gentry *et al.,* 1986). Activity near dawn and dusk may be associated with changes in the accessibility of some important prey species. For example, *L. vulgaris reynaudii*, *M. capensis* and *T. trachurus capensis* move away from the sea bed at night. Observed activity patterns may also be associated with an increase in prey vulnerability at this time of the day. Some fish are more susceptible to predation at dawn and dusk when available light wavelengths in the water column rapidly shift out of their range of peak spectral sensitivity (Gentry *et al.,* 1986).

In the present study, the most frequently attained depth range was 80–160 m. In comparison, Kooyman & Gentry (1986) reported that the most frequently attained depth for two female Cape fur seals was ≤ 50 m, but dives to 100 m were common; and Gentry *et al.,* (1986) reported that the most frequently attained depths for seven northern fur seals were 50–60 m and 175 m.

In the present study, the majority of dives (75–82%) were less than one minute in duration, with a maximum dive duration of 3–5 minutes. In comparison, Kooyman & Gentry (1986) reported that the maximum dive duration for two female Cape fur seals was 2.1 minutes, with a maximum dive duration of 7.5 minutes; and Gentry *et al.,* (1986) reported that the maximum dive duration for seven female northern fur seals was 2.6 minutes, with a maximum dive duration of 5–7 minutes.

Maximum dive depth for both females exceeded 160 m (present study). In comparison, Kooyman & Gentry (1986) reported that the maximum dive depth for two female Cape fur seals was 204 m; and Gentry *et al.,* (1986) reported that the maximum dive depth for seven female northern fur seals was 207 m. In the present study, deep dives, more than 160 m, represented 4% of dives for female 15 990 and 12% of dives for female 15 989 (present study). This indicates that a small proportion of dives were made at or near the continental shelf break (200 isobath contour).

Positional data indicated that females with pups tend to forage close to the colony (i.e., usually within 10–18 km). However, they can travel long distances in search of food, e.g, 60–70 km south of the colony.

CONCLUSION

Known biases associated with the collection of seal dietary samples prevented an accurate quantitative assessment of the data. However, results indicate that Cape fur seals are opportunistic feeders and take predominantly benthic prey, including 37 species of teleost fish, 7 species of cephalopod, a small number of crustacea (mostly decapoda), and other miscellaneous items. *T. trachurus capensis*, *M. capensis/paradoxus*, and *S. ocellatus* were the most important prey species overall. Differences in the composition of the diet at Black Rocks and Rondeklippe are likely to reflect temporal and geographical differences. The model size of *M. capensis*, *M. paradoxus*, *T. trachurus capensis*, *A. pectoralis* and *L. vulgaris reynaudii* consumed by Cape fur seals fell within the range of local commercial catches, indicating potential competition between seals and the fisheries in this region. A bimodal distribution in the frequency of diving at different hours of the day was observed, with most dives occurring near dawn (± 3 hours) and dusk (± 3 hours) (n = 2 females). This activity may be associated with changes in the accessibility of some important prey species (e.g., *L. vulgaris reynaudii*, *M. capensis* and *T. trachurus capensis*) and/or changes in prey vulnerability.

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