CHAPTER 1

Introduction

BACKGROUND OF THE STUDY

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 (33°50'S, 26°16'E) in Algoa Bay, on the south east coast of southern African, to Cape Cross (21°46'S, 13°58'E) in Namibia; however, the species range extends further northward to Cape Frio (18°26'S, 12°00'E) (Fig. 1.1). At the time of this study, the total population was 1.5 to 2 million animals, two-thirds of which were on the Namibian coast (Butterworth & Wickens, 1990; Butterworth & Harwood, 1991) There were 25 breeding colonies (six on the mainland and 19 on small, rocky offshore islands) and an additional ten haul-out sites (six on the mainland and four on islands) (Oosthuizen, 1991[1]). The population was increasing at a rate of 4% per annum (Butterworth *et al.,* 1988).

The Cape fur seal is confined to the continental shelf area and its immediate vicinity. Although seals forage up to 220 km offshore (Warneke & Shaughnessy, 1985), the general foraging area is usually within 93 km of the shore (David, 1987*a*). On the west coast, seals generally remain south of 18°S 12˚E, however some animals disperse northward into the tropics, up to 11°S, assisted by the Benguela Current (Warneke & Shaughnessy, 1985; Oosthuizen 1991). On the east coast, animals seldom range further east than East London (Rand, 1967), with occasional sightings near Durban (29°50'S, 31°00'E) (Gabby Harris, pers. comm.). Although this species is non-migratory, there is considerable movement between colonies, particularly among juveniles (Oosthuizen, 1991). Both sexes travel considerable distances from their colonies to feeding grounds, which are situated mainly between Mossel Bay and Lambert's Bay; Cape Point and Lambert's Bay; north of Luderitz; and north of Cape Cross (Oosthuizen, 1991). Bulls in breeding condition and lactating females feed in the vicinity of their breeding colonies (Shaughnessy, 1981; Oosthuizen, 1991).

The majority of seals occur on the west coast. In this region the cold (10°C to 15°C), slow-flowing, nutrient-rich Benguela Current promotes high primary production and hence large stocks of fish and invertebrates for seals to feed on. 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[2] colonies and one haul-out site. Three of the five colonies (Geyser Rocks, Quoin Rock and Seal Island-False Bay) are situated west of the Agulhas/ Atlantic mixing area, i.e., in the south-east Atlantic ocean. The remanding three colonies (Seal Island-Mossel Bay, Rondeklippe-Plettenberg Bay and Black Rocks-Algoa Bay) are situated further east, in the south-west Indian ocean, inshore of the warm Agulhas Current (20°C to 25°C) (Rand, 1967). Population estimates for individual breeding colonies have been reported by Shaughnessy (1987, 1993).

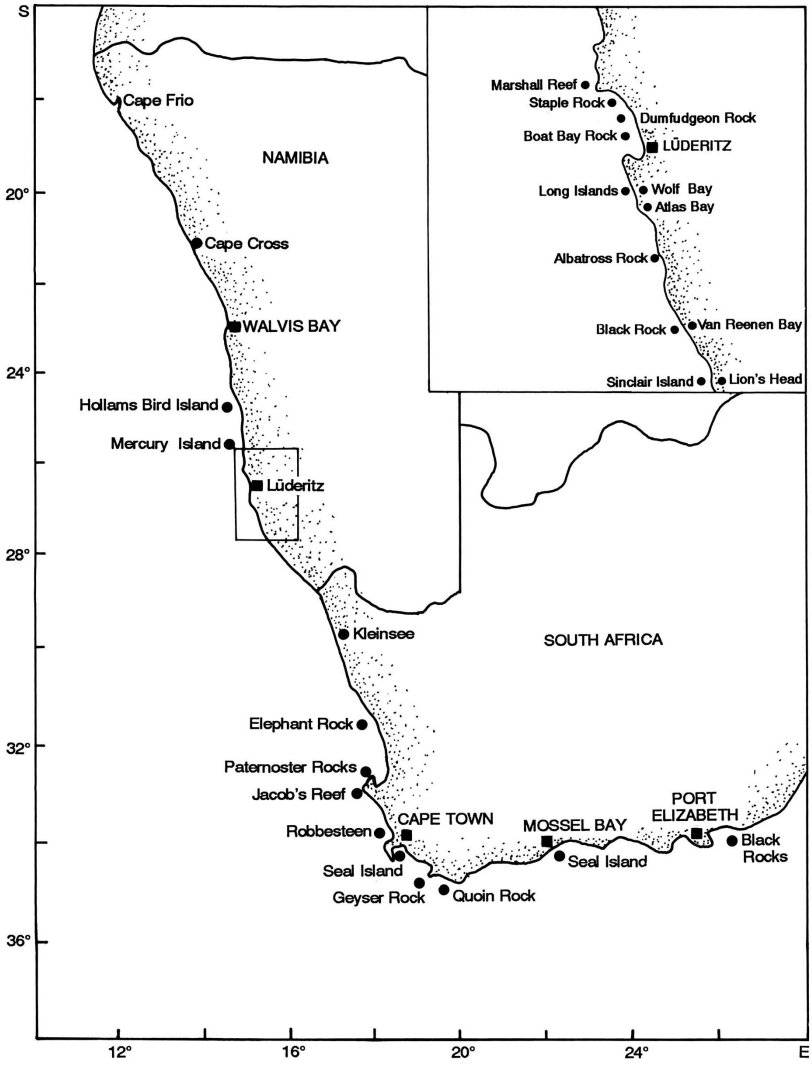

Fig. 1.1 Breeding and non-breeding colonies of the Cape fur seal around the coast of South Africa and Namibia, indicating ICSEAF (International Commission for the Southeast Atlantic Fisheries) areas.

[1] Refers to the number of colonies for the period 1992 to 1995 when the field work for this study was conducted, and includes the haul-out site at Plettenberg Bay (Rondeklippe).
[2] A seal colony is classified as a breeding colony when 1000 pups are born annually at that site.

Since 1610, Cape fur seals have been exploited by Europeans primarily for their fine quality furs. Rookeries were invaded throughout the year and animals slaughtered irrespective of sex and age class. By the end of the 19th century, seal numbers had been reduced to very low levels, i.e., < 100 000 animals. More than 20 island colonies had been extirpated. Subsequently, in 1893, the first legal restrictions over sealing in southern Africa were introduced (Cape Fish Protection Act) which prohibited commercial sealers from operating without a government permit. In 1909, harvesting of seals during the breeding season was prohibited. Sealing activities along the Namibian coast were not regulated until 1922 (Sealing and Fishing Proclamation), with additional restrictions introduced in 1949 (Sealing and Fisheries Ordinance). Both acts prohibited sealing without a licence (Shaughnessy, 1984; David, 1987*a*). Since 1973, sealing has been managed under the Sea Birds and Seals Protection Act. Permits issued under this Act specify the age, size and sex of seals killed; and the season and area where sealing may take place. Subsequent to this Act, seals have been exploited on a sustainable basis and seal numbers have been increasing steadily (Butterworth *et al.,* 1988).

Growth in the seal population has coincided with a decline in commercial catches in many sectors of the fishing industry. Some of the species eaten by seals are of commercial importance, therefore it is inevitable that seals and fisheries will come into conflict when fishing (= operational interactions) (Rand, 1959; Shaughnessy & Payne, 1979; Shaughnessy, 1980; Shaughnessy *et al.,* 1981; Shaughnessy, 1985; Anon., 1987, 1990*a*, *b*; David, 1987*b*; Butterworth *et al.,* 1988; Wickens, 1989). Consequences of interactions with the fisheries include: consumption of catches, disturbance of fishing operations and damage to gear. Consequences to seals include: deliberate shooting of seals, drowning in nets and entanglement in discarded fishing gear. Apart from conflicts during fishing operations, many commercial fishermen believe that seals consume substantial quantities of fish that would otherwise be available to the industry (= biological interactions). This unsubstantiated belief is based on two facts–seals eat fish and occur in the region where the fishery operates.

In 1986, a Commission of Enquiry into the Fishing Industry recommended that seals be culled in order to reduce the number of fish consumed by seals, thereby increasing the availability of fish to the industry (Anon., 1986; Diemont, 1986). Three years before this recommendation, the seal industry had crashed due to intense lobbying by conservation organisations in North America and Europe. Conservationists wanted the harvest to stop primarily for emotional and humanitarian reasons. This removed much of the commercial incentive for harvesting seals in southern Africa, and focused considerable international media attention on the culling debate. Since 1900, more than 2.5 million pups and bulls had been harvested in southern Africa.

In response to international pressure in 1990, the annual harvest of Cape fur seals in South Africa was postponed indefinitely until sufficient scientific information was available to make informed management decisions on the issue. This decision was based on the recommendations of an Advisory Committee (chaired by Dr John Hanks, WWF) appointed to counsel the Minister of Environment Affairs on the scientific aspects sealing. The committee concluded that there was "no scientific basis for culling". This decision was largely based on the research of Butterworth *et. al.,* (1988); Wickens (1989); Butterworth & Harwood (1991) and several anonymous reports (Anon., 1983, 1987, 1990*a*).

Consequently, various programs were initiated by Marine and Coastal Management (formerly Sea Fisheries Research Institute) to gather information on seal biology, population numbers, and seal-fisheries interactions for management. The majority of research was concentrated on seals inhabiting the south-east Atlantic coast, with little work, other than estimation of seal numbers, undertaken on seals of the south-west Indian ocean coast, particularly Algoa Bay, the eastern most boarder of the seals breeding range. Despite the small size of the seal population in this area, there is a continuing and increasing interaction between fishermen and seals for available resources, particularly that for line fish and chokker squid, the value of which, in combination, exceeds R100 million annually (e.g., from 1993–1995, white squid grossed between R112,646,538.00–R118,909,710.00 per annum and line fish grossed between R9,459,522.00–12,052,005.00 per annum[3]; Chris Wilke, pers. comm.). The effects of this on the local seal population are unknown, but unlike the west coast population, that on the Eastern Cape coast is not increasing.

Therefore, in 1992, a research program was initiated to examine the biology and conservation of Cape fur seals in the Eastern Cape (WWF project ZA–348). The program was based at the Port Elizabeth Museum, and funded by World Wide Fund for Nature – South Africa, in association with Total-South Africa. I was appointed project executant. Data collected from this program formed the basis of my PhD.

Specific objectives of the Eastern Cape seal study were to gather information on:

(i) general biology of the species.
(ii) impact of commercial harvest on the current distribution and abundance patterns of the local seal population.
(iii) actual/potential threats that may affect the local seal population.
(iv) nature and extent of seal-fisheries interactions in the region.
(v) population size.

Field studies were completed within a limited period of 4 years (May 1992 to August 1995).

[3] Gross earnings are for Port Alfred to Mossel Bay for the period 1993–1995.

This thesis reports on my research into the biology and conservation of the Cape fur seal from the Eastern Cape coast of South Africa. The first section of the thesis (chapters 2–9) documents the general biology of Cape fur seals. In chapter 2, gross and microscopic visceral anatomy of the male is described and the relationship between organ weight and age investigated. Chapters 3–5 describe the general morphology (body, skull and baculum) of the male. Growth relative to standard body length and age is examined, and age at social maturity established. In chapter 6, information on asymptotic size inferred from physiological (suture) age is presented. Sexual dimorphism is examined in chapter 7. In chapter 8, reproduction in the male is investigated and age at puberty established. Reproduction in the female has been examined previously (Rand, 1955; Warneke & Shaughnessy, 1985; David & Rand, 1986) and was therefore not investigated here. Chapter 9 investigates diet and foraging behaviour of the local seal population.

The second section of the thesis, conservation biology (chapters 10–14), investigates actual/potential threats that may influence the future status of the local seal population, and provides estimates of population size. Chapter 10 investigates the impact of commercial harvest on the current distribution and abundance patterns of the local seal population. In chapter 11, the nature and extent of seal-fisheries operational interactions are investigated. Information on direct killing of seals by fishermen, incidental catch in fishing nets and entanglement in discarded fishing gear is presented, and the impact of seals on fisheries accessed. Chapter 12 documents the concentrations of heavy metals and organochlorine contaminants in the blubber of seals. In chapter 13, information on endoparasites in the stomach and blubber of seals is presented, and evidence of pathological manifestations assessed. Shark predation on the local seal populations is examined in chapter 14

In the final chapter, I present the conclusions of the study, and specify areas where further research is needed to assist in the future management of this species in the Eastern Cape coast.

THE STUDY AREA

The Eastern Cape coast extends from Robberg, Plettenberg Bay (33°07'S, 23°25'E) to the Kwazulu-Natal boarder (31°05'S, 30°11'E), encompassing *c.* 800 km of coast-line (Fig 1.2). Considering that Cape fur seals are seldom seen further north than East London, field studies were conducted between Plettenberg Bay and East London, with much of the work concentrated within Algoa Bay.

Seal colonies

There are two seals colonies in the Eastern Cape, a breeding colony at Black Rocks, Algoa Bay, and a small non-breeding colony at Robberg (Rondeklippe), Plettenberg Bay (33°06'S, 23°24'E) (Fig. 1.2).

Black Rocks consists of five small rocky outcrops composed of quartzitic sandstones of the Table Mountain Group (Council for Geoscience, pers. comm.). The outcrops are partially joined together by a reef of drying and submerged rocks. They are situated 8–9 km off-shore (not sheltered by headlands); small in size (the largest rocky outcrop is 8 360 m^2); low-lying (the largest outcrop is 6 m above mean sea level); and often surrounded by heavy breakers (Rand, 1963, 1972; Chart SAN 1025). Water depth is *c.* 30 m (Bremner, 1991a). In 1992 the estimated seal population was 2 315 seals, and in 1996 it was 1 480 seals (Marine & Coastal Management, Unpubl. data).

Rondeklippe consists of a rocky platform composed of quartzitic sandstones of the Robberg Formation (Council for Geoscience, pers. comm.). The rocky platform covers an area *c.* 240 m^2. The highest point is *c.* 2.8 m above mean sea level. Water depth is 3.5 m. From 1992 to 1996, seal numbers increased from *c.* 12 to *c.* 50.

Seal Island, Mossel Bay (34°09'S, 22°07'E), lies to the west of Plettenberg Bay, just outside the study area. In 1992 the estimated seal population was 3 770 seals, and in 1996 it was 4 945 seals (Marine & Coastal Management, Unpubl. data).

Although it is probable that the seals along the east coast share feeding grounds, the extent of movement between the three colonies is not known.

Coastal and bottom topography

Algoa Bay is a large, crenulated embayment facing the south-west Indian ocean, on the south east coast of South Africa (Goschen & Schumann, 1988). Cape Recife forms the western boundary of Algoa Bay, and the less prominent Cape Padrone forms the eastern boundary, with the port installations and the city of Port Elizabeth in the western section. Large columns of fresh water flow offshore from the Swartkops, Coega, and Sundays rivers.

There are five separate areas of Palaeozoic outcrop within Algoa Bay: (i) the inner shelf south of Cape Recife; (ii) Riy Bank; (iii) the Bird Island complex (Bird, Stag and Seal Islands; Black Rocks); (iv) the St Croix islands (St Croix Island; Jahleel and Brenton Islets) including the mouth of the Coega River; and (v) off Cape Padrone. Three of these outcrops (Cape Recife, Riy Bank and the flanks of Bird Island) are linked by a ridge known as the Recife-Bird

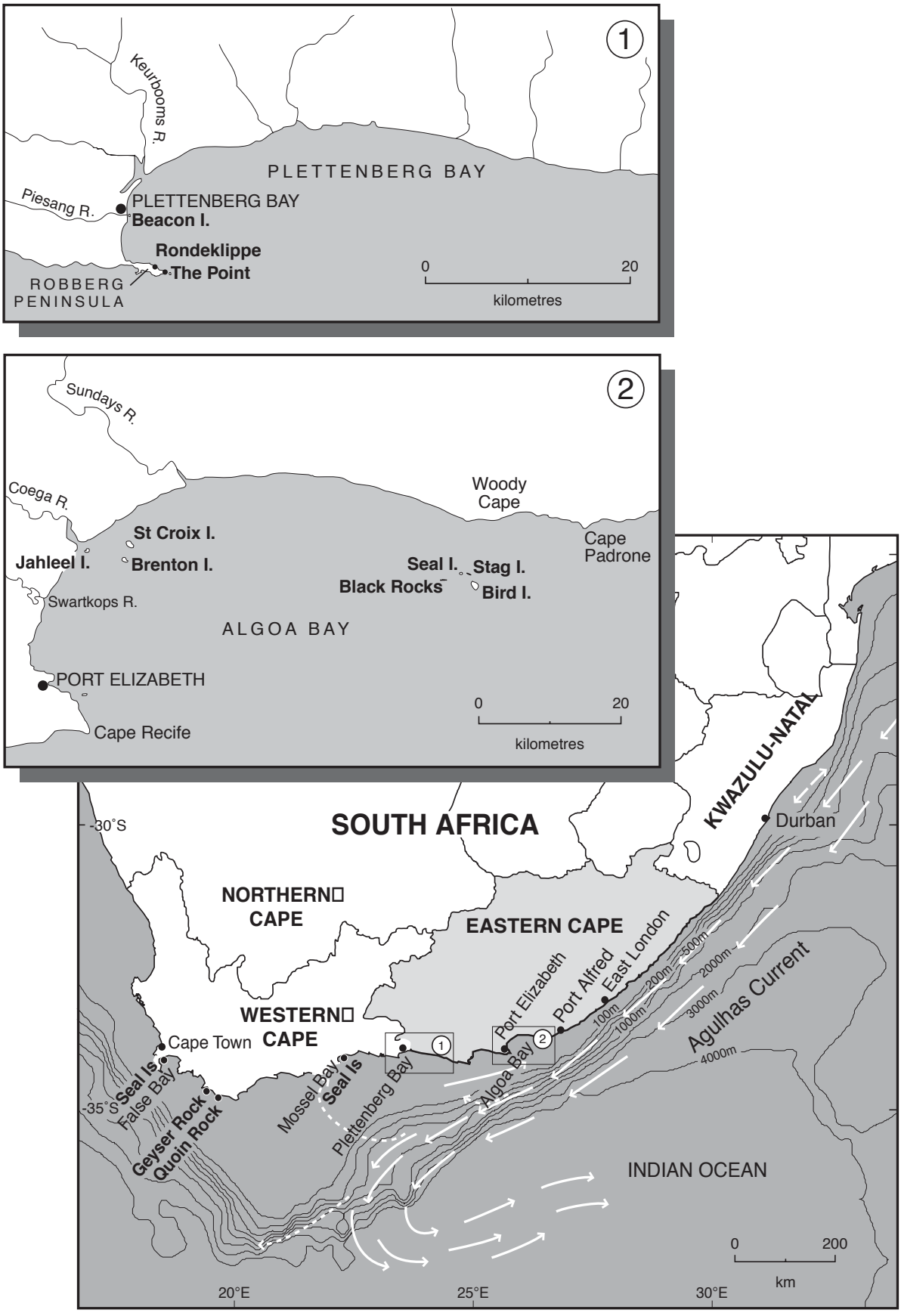

Fig. 1.2 The distribution of Cape fur seals along the Eastern Cape coast of southern Africa, indicating the breeding colony at Black Rocks (Algoa Bay), and the haul-out site at Rondeklippe (Plettenberg Bay).

Ridge (Bremner & Day, 1991). Sand flats occur underwater between reefs.

The coast-line to the west of Algoa Bay consists of a series of large, warm, sheltered bays (Plettenberg, Mossel, Jeffreys, and Cape St Francis) connected by stretches of open rocky shore. Approximate water depth at the outer extremities of these bays is: Plettenberg Bay < 60 m; Mossel Bay < 50 m; Jeffreys and Cape St Francis combined < 70 m (Council for Geoscience, pers. comm.).

The coast-line to the north-east of Algoa Bay straightens out progressively and is therefore less sheltered. Along this stretch of coast, the 50 m isobath contour lies *c.* 2.4–5.6 km offshore, e.g., *c.* 5.6 km from the coast-line at Kenton-on-sea; *c.* 4.6 km from the coast-line at Port Alfred; 2.8 km from the coast-line at Great Fish Point; from the coast-line at Keiskamma Point (3.7 km); and from the coast-line at East London Light House (2.4 km) (Council for Geoscience, pers. comm.).

The continental shelf (200 m isobath contour) lies *c.* 228 km from the coast-line off Cape Agulhas (at its widest point south of the Agulhas Bank); *c.* 96 km from the coast-line off Plettenberg Bay; *c.* 44.5 km from the coast-line off Port Elizabeth Lighthouse; and *c.* 24.1 km from the coast-line off East London (Council for Geoscience, pers. comm.).

Hydrological features

Agulhas Current

The most prominent oceanic feature of the study area is the Agulhas Current which originates from the Mozambique Current and the East Madagascar Current. The Agulhas Current forms between southern Mozambique and Durban (25°S–30°S). It is deep, narrow and fast-flowing, transporting 70–80 million cubic metres of water each second, with an average surface speed of 1–2 $m.s^{-1}$ (Shannon, 1989). Surface temperature varies seasonally between 22°C in August (winter) and 27°C in March (autumn) (Heydorn *et al.,* 1978). Central Water lies beneath the current in depths of 200 m to 800 m, and its temperature and salinity decrease with depth (Heydorn *et al.,* 1978).

The Agulhas Current flows in a south-westerly direction along the coast, roughly following the edge of the continental shelf. The inner boundary of the current is usually located above the 200 m isobath contour. Between Durban and East London the shelf is narrow, therefore the current flows close to the shore. Between East London and Port Elizabeth the shelf broadens, therefore, the current begins to diverge from the coast. It then veers south before reaching the Agulhas Bank. The current becomes an 'unstable jet' 350 to 400 km offshore (Harris, 1978) and then turns back on itself in an anticlockwise direction to form the Agulhas Return Current.

There is no direct and continuous flow of warm Agulhas water into the south-east Atlantic ocean. However, west of Algoa Bay, meanders and frontal eddies of the Agulhas Current increase in dimension (Goschen, 1991). Plumes of warmer water attached to eddies may cross the shelf edge, advecting warmer, high-salinity water (24°C+) over the Agulhas Bank (Eagle & Orren, 1985; Swart & Largier, 1987; Goschen & Schumann, 1988; Lutjeharms, 1981; Dr Ian Hunter, pers. comm.).

The Agulhas Current supports a diverse range of fish species; however, fish abundance is considerably less than that on the west coast. The reason for this is because the surface waters of the Agulhas Current originate in warm tropical regions; and are low in nutrients and oxygen (Shillington, 1986).

Wind induced upwelling

Water movement in the near-shore region of Algoa Bay is mainly due to wind forcing (Roberts, 1990). At the Bird Islands, the prevailing winds (W–SW and E–NE) are parallel with the general orientation of the coast (Illenberger 1986; Goschen, 1988, 1991; Schumann & Martin, 1991). Westerly-component winds are common for most of the year, with easterly-component winds dominant in summer (Schumann, 1992).

In summer, easterly component winds increase in strength and frequency causing localised up-welling at the major Capes and a subsequent fall is SST (Schumann, Ross & Goschen, 1988; Goschen, 1991). Localised up-welling enhances primary productivity by bringing nutrient salts into the euphotic zone, promoting the growth of plankton which indirectly benefits large predators by increasing prey availability. In winter, the frequency of easterly-component winds decreases, and the depth of the surface isothermal layer over the shelf increases, resulting in a reduction in wind driven up-welling (Goschen, 1991).

Sea surface temperature

Temperature structure within Algoa Bay is caused by seasonal variability in the surface heat fluxes and mass transports of water (Goschen, 1991). SST's decrease from the shoreline to the shelf, and then increase again to the Agulhas Current (Goschen, 1991). A strong thermocline (surface layer 15°C to 20°C; bottom layer 9°C to 12°C) is present over the continental shelf off Algoa Bay (Goschen, 1991). However, the shallow inshore waters are generally well mixed due to wind-forcing (Goschen & Schumann, 1988).

At Black Rock seal colony, daily SST ranges from 12°C to 23°C, with mean monthly temperatures peaking in January/February (19°C), and reaching a low in July–October (16°C) (Appendix A).

At Plettenberg Bay, daily SST ranges from 10°C to 24°C, with mean monthly temperatures peaking in summer (22°C), and reaching a low in winter (15.8°C) (Chantal Greenwood, pers. comm.).

At East London, daily SST ranges from 12.5°C to 22.5°C, with mean monthly temperatures peaking in summer (19°C), and reaching a low in winter/early spring (17.0°C to 17.5°C) (Chantal Greenwood, pers. comm.).

Swell

The most common swell along the Eastern Cape coast is from the south-west, usually originating from low pressure systems moving from west to east over the southern ocean. Abnormal waves, with amplitudes in excess of 18 m, occasionally occur along the shelf break, and waves around 10 m or more occasionally enter Algoa Bay (Bremner, 1991*b*).

Air temperature

At the Black Rock seal colony, daily air temperature ranges from 9°C to 33°C, with mean monthly temperatures peaking in January/February (26°C), and reaching a low in winter and early/mid spring (21°C to 22°C) (Appendix A).

At Storms River mouth near Plettenberg Bay, daily air temperature ranges from 5.3°C to 41.7°C, with mean monthly temperatures peaking in January/February (22.0°C to 22.1°C), and reaching a low in July (15.6°C) (Chantal Greenwood, pers. comm.).

At East London, daily air temperature ranges from 2.2°C to 38.7°C, with mean monthly temperatures peaking in January/February (23.7°C to 23.9°C), and reaching a low in July (11.5°C) (Chantal Greenwood, pers. comm.).

STUDY ANIMAL

The Cape fur seal is a large, amphibious marine mammal, inhabiting cool coastal waters. Information on the general morphology and natural history of this species is summarised in Table 1.1.

Table 1.1 ***South African (Cape) fur seal fact sheet***

Classification	
Family	Otariidae
Superfamily	Arctocephalinae (fur seals)
Species	*Arctocephalus pusillus* (Schreber, 1776)
Subspecies	*Arctocephalus pusillus pusillus* (Schreber, 1776)
Description	
New born pups	Colour: velvety black Length: 60–80 cm. Weigh: 5–6 kg.
Adult males	Colour: dark blackish-grey dorsally; lighter ventrally Length: up to 234 cm. Weight: up to 360 kg.
Adult females	Colour: brownish-grey dorsally; light brown ventrally Length: up to 176 cm. Weight: up to 122 kg.
Reproduction	
Breeding system	Polygynous (mean size of harems: 28 females)
First parturition	4–5 yrs
Age when males attain territorial status	8–13 yrs
Pupping/mating season	Late October to late December
Gestation	Twelve months (delay of implantation of 3.5–4 months)
No. of offspring	One pup each year (twins rare)
Weaning	Usually 8–10 months (up to 12 months or longer)
Breeding habitat	Small, rocky offshore islands and sand beaches on the mainland
Longevity	Few reach 25 yrs of age in the wild (females live slightly longer than males)
Diet	Primarily fish and cephalopods (mainly squid)
Predators	Black backed jackals, brown hyenas, sharks and killer whales
Population size	1.5 to 2 million
Distribution	Namibia and South Africa
Migration	Non-migratory but disperses over long distances
Conservation status	Protected under the Sea Birds and Seals Protection Act of 1973

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