CHAPTER 11(a)

Operational interactions between Cape fur seals *Arctocephalus pusillus pusillus* and fisheries off the Eastern Cape coast of South Africa: part one, trawl fishing

INTRODUCTION

The "inshore" fishing area off the south and east coasts of South Africa extends from Cape Agulhas (20° E) in the west, to the Great Fish River (27°10' E) in the east, and seawards to the 110 m depth contour. The main commercial fisheries based in this region are inshore bottom trawling, squid jigging, handline fishing, and hake-directed longline (experimental fishery commenced in 1994). The hake-directed inshore trawl vessels operate up to 70 km from the coast in depths of 50–150 m. The area seawards of the 110 m depth contour is utilised by deep sea trawlers which are restricted from fishing shallower, or inside, the 110 m isobath-contour east of Cape Agulhas 20° E (Peter Sims, pers. comm.).

Off the Eastern Cape coast (Plettenberg Bay, 33° 07'S, 23°25'E, to the Kwazulu-Natal boarder, 31°05'S, 30°11'E), trawling involves dragging a net along the sea bed (bottom trawling) for 2–4 hrs, and then hauling the net to the surface with its catch. The smaller inshore trawlers (14 m to 30 m in length) mainly target hake and sole, at depths of 50–150 m. The larger offshore vessels (30 m to 90 m in length) mainly target hake, at depths of 150–700 m. Inshore and offshore hake-directed trawlers operate from sunrise to sunset, while sole-directed trawlers operate day and night (Peter Sims, pers. comm.).

From 1992 to 1995, the inshore trawl fleet consisted of *c.* 37 vessels (30 based at Mossel Bay and 7 at Port Elizabeth) of which *c.* 10 operated off the Eastern Cape. The sole-directed vessels (*c.* 20) all worked west of Mossel Bay in depths of 50–80 m. The South African deep sea trawl fleet consisted of *c.* 60 vessels (mostly based at Cape Town and Saldanha Bay) which operated off the south/east and west coasts. Apart from the 3 deep sea vessels based at Port Elizabeth, and *c.* 3 small deep-sea vessels from Cape Town (which work grids 518–520), the deep sea fleet operates on the "chalk line" grounds which follow the 200/300 m depth contour. The main component of the deep sea fleet operates off the Cape and off the west coast (Peter Sims, pers. comm.).

The main trawl species off the east coast are shallow water hake (*Merluccius capensis*), deep water hake (*M. paradoxus*), horse mackerel (*Trachurus trachurus capensis*) and Agulhas sole[1] (*Austroglossus pectoralis*). The main by-catch species include kingklip (*Genypterus capensis*), John dory (*Zeus faber*), monk fish (*Lophius* sp.), ribbon fish (*Lepidopus caudatus*), rat tails (*Caelorinchus simorhynchus, C. braueri, Malacocephalus laevis* or *Lucigadus ori*), jacopever (*Helicolenus dactylopterus*), rays (*Raja* spp.), reds (capenter, *Argyrozona argyrozona*; santer, *Cheimerius nufa*r; panga *Pterogymnus laniarius*); and chub mackerel, *Scomber japonicus*.

In 1994, the hake Total Allowable Catch was 148 000 tons, which was divided on a 2:1 basis between the west and south/east coasts. The inshore hake TAC was 9 835 tons for the south/east coast, of which 590 tons was allocated to Port Elizabeth based companies. The deep sea hake TAC was *c.* 2 862 tons for Port Elizabeth based companies. The inshore sole TAC was 872 tons for the south/east coast, of which 35 tons was allocated to Port Elizabeth based companies. The horse mackerel TAC was split into: (i) a sectoral reserve held against bottom trawling deep sea (23 266 tons) and inshore (6 434 tons); and (ii) specific company quotas for directed mid-water (27 894 tons), of which 2 213 tons was held by Port Elizabeth based companies. The estimated landed value of deep sea hake was R2 265 per ton, inshore hake R2 184 per ton, sole R7 000 per ton and horse mackerel R840 per ton (Peter Sims, pers. comm.).

East coast trawl fishermen operate in an area inhabited by Cape fur seals. At the time of this study, *c.* 140 000 Cape fur seals[2] (8.5% of the total population) inhabited the south/east coast, between False Bay and Algoa Bay, at five breeding colonies and one haul-out site (J.H.M. David, pers. comm.). Three of the five colonies (Geyser Rocks, Quoin Rock and Seals 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–25°C) (Rand, 1967). Considering that some of the species eaten by Cape fur seals are of commercial importance to this industry (chapter 9), it is inevitable that seals and fisheries will come into conflict when fishing.

Some trawl fishermen complain that seals: consume large quantities of commercially important fish species which would otherwise be available to the industry; take fish from nets; damage nets and propellers; and disrupt fishing operations (when trapped in the factory area). The extent of the problem is not known.

Seals foraging on commercial trawl grounds are at risk. Seals are incidentally drowned in trawl nets, and deliberately killed (when trapped in the factory area). 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.

Research examining operational interactions between seals and the trawl fishing industry has been conducted on the west and south coast of southern Africa (Rand, 1959; Shaughnessy & Payne, 1979; Shaughnessy, 1985; Anon., 1987; Ryan & Moloney, 1988; David 1987; Wickens, 1989; Wickens *et al.,* 1992; Wickens, 1994); however, there is no comprehensive information for the Eastern Cape coast.

[1] Sole is mainly caught south-west of Plettenberg Bay.
[2] Inferred from pup counts for 1993.

This study documents an evaluation of operational interactions between the trawl fishing industry and Cape fur seals, in waters off the Eastern Cape coast of Southern Africa. Information was obtained from independent observation aboard commercial trawl vessels over a 57 day period (n = 196 trawls).

METHODS

Information on seal-fisheries operational interactions was collected by direct observation aboard commercial trawl vessels from July 1992 and April 1994. Observations focused on six key areas: (i) fishing operations; (ii) seal attendance; (iii) depredation and scavenging (feeding from nets; feeding on offal and discarded by-catch; (iv) damage to equipment; (v) disruption to fishing operations; and (vi) seal mortality (number of seals entrapped in nets; numbers drowned; numbers brought aboard alive; numbers deliberately killed by crew).

Information on the biology of drowned animals was also collected. Standard necropsies were performed and biological parameters recorded, based on recommendations of the Committee on Marine Mammals, American Society of Mammalogists (1967). Upper canines were collected for age determination.

Age was estimated from counts of growth layer groups in the dentine of thin tooth sections. Reproductive condition of males was determined by histological examination of the gonads (presence/absence of sperm in the epididymis).

Observations of seal-fisheries interactions were conducted from three deep sea commercial vessels–one side trawler (*Zuiderzee*) and two stern trawlers (*Midharvid*[3] and *Maria Clare*):

The *Zuiderzee* (30 m in length) has a fishing capacity of 35 tons. Average catch per year is *c.* 800 tons. The catch is preserved on ice. The usual length of fishing trip is 5–10 days, three times each month. As with all side trawlers, the catch is brought aboard over the side of the vessel.

The *Midharvid* (39 m in length) has a fishing capacity of 150 tons. Average catch per year is *c.* 1 500 tons. Some of the catch is frozen and some packed on ice. The usual length of trip is 4 days, eight times each month. As with all stern trawlers, the catch is brought aboard over the stern ramp of the vessel.

The *Maria Clare* (52 m in length) has a fishing capacity of 270 tons. Average catch per year is *c.* 3 600 tons. The catch is frozen. The usual length of trip is 21 days, once each month.

Preliminary analysis of 'seal attendance counts' found that the number of seals observed while hauling was significantly different for side and stern trawlers, therefore information for the two types of trawlers are presented separately. Means are always followed by the standard error.

RESULTS

Side trawl fishing

Fishing operations

A total of 33 days were spent aboard the *Zuiderzee* during which time 94 trawls were observed (Table 11(a).1).

Table 11(a).1 ***Details of trips to observe seal-fisheries interactions during side trawling operations (independent observer aboard the Zeiderzee, n = 94 trawls)***

Trip No.	Start–End date[1]	No. of days at sea[1]	Total hours at sea[1]	No. of trawls observed	No. of trawls per day[2] (range)	Mean duration of trawl[3] ± SE (range)	Total trawl[3] hours
1	20/7/92–25/7/92	6	144	15	3 (1–3)	3 hrs 45 min ± 9 min (3 hrs–5 hrs)	56 hrs 18 min
2	11/8/92–14/8/92	4	96	13	3 (3–4)	3 hrs 2 min ± 11 min (2 hrs 20 min–4 hrs 50 min)	39 hrs 25 min
3	18/8/92–22/8/92	5	120	16	3 (3–4)	3 hrs 23 min ± 8 min (2 hrs 50 min–4 hrs 25 min)	47 hrs 27 min
4	31/10/92–9/11/92	10	240	29	4 (1–5)	3 hrs 7 min ± 8 min (40 min–3 hrs 50 min)	90 hrs 15 min
5	17/5/93–22/5/93	6	144	17	3 (2–3)	3 hrs 26 min ± 8 min (2 hrs 15 min–4 hrs 45 min)	58 hrs 22 min
6	19/4/94–20/4/94	2	48	4	- (1–3)	2 hrs 50 min ± 19 min (2 hrs 15 min–3 hrs 35 min)	11 hrs 21 min
6		**33**	**792**	**94**	**3 (1–5)**	**3 hrs 18 min ± 4 min**	**303 hr 8 min**

[1] Analysis excludes: (i) time taken to steam to fishing grounds; (ii) time net is aboard the vessel; and (iii) time taken to return to port after the last trawling operation, i.e., active trawl time only.

[2] Mode followed by range in round brackets.

[3] Trawl end times for 2 of the 94 trawls were not recorded, n = 92.

[3] The *Midharvid* is not a true stern trawler although the codend has to be lifted over the stern, onto the deck. A true stern trawler has a ramp to the water level, which then allows the codend to be hauled up the ramp quickly.

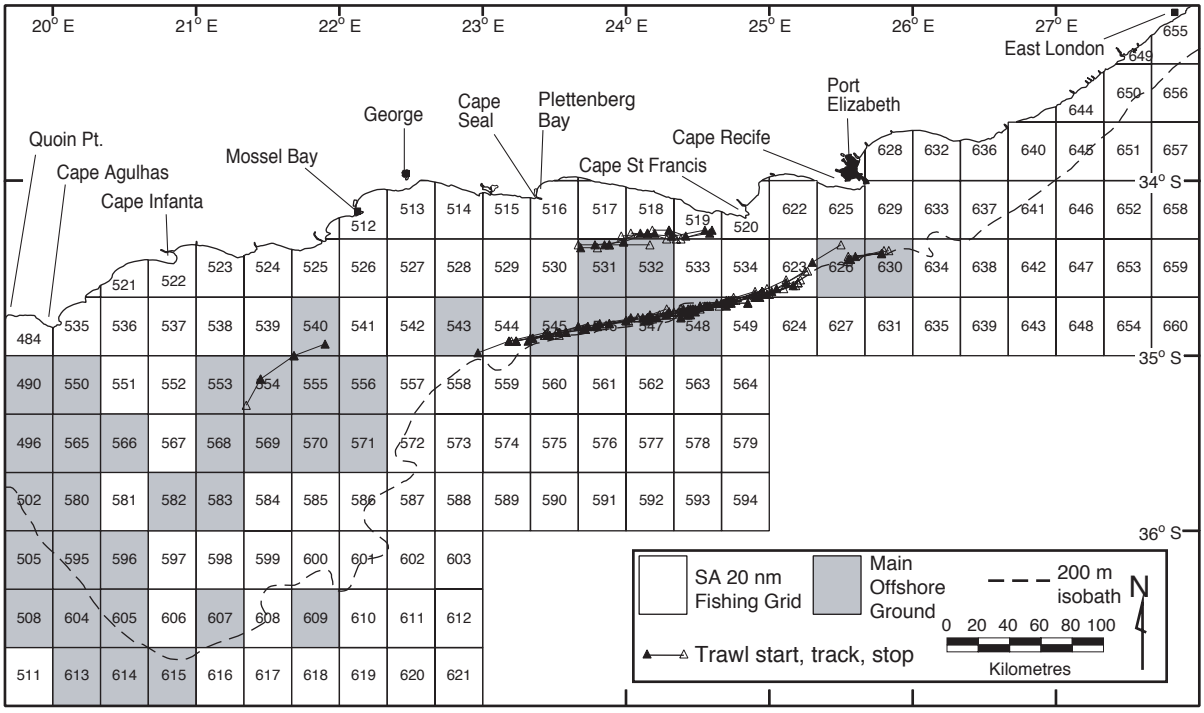

Fig. 11(a).1 Distribution of fishing effort (*n* = 93 trawls) aboard a commercial side trawler (*Zuiderzee*): start position and end position of individual trawls.
Trawl end position for 1 of the 94 trawls was not recorded, *n* = 93. Shaded areas represent the main offshore trawl grounds. The demersal grid system is divided into sub-areas (west 1.6, south 2.1 and east 2.2), with the division between east and south occurring at 25° E. The survey area off the Eastern Cape coast overlaps the two sub-areas.

Main target species and corresponding fishing locations

The main target species was hake, with limited catches of horse mackerel. The main by-catch species included John dory, monk fish, rat tails, jacopever and rays. Distribution of fishing effort is presented in fig. 11(a).1.

Minimum distance travelled when trawling

The net was dragged over a minimum distance of 1 064.0 nautical miles (*n* = 33 days). Mean minimum distance of a single trawl was 11.4 ± 0.3 nautical miles (Table 11(a).2).

Trawl times

The time of day that the *Zuiderzee* was actively fishing ranged from 0515–1945 hrs (*n* = 92 trawls). Mean start time for the first trawl of the day was 0642 hrs ± 20 min; second trawl was 1000 hrs ± 9 min (*n* = 28); third trawl was 1353 hrs ± 19 min; and the fourth trawl was 1534 hrs ± 35 min. On one occasion a fifth trawl was conducted (start time: 1530 hrs) (Fig. 11(a).2).

Fishing depth

The net was dragged at depths ranging from 106.1–398.7 m. Mean fishing depth was 237.2 ± 9.1 m; median 221.3 m (Table 11(a).3).

Table 11(a).2 ***Minimum distance travelled in nautical miles when trawling aboard the Zeiderzee (n = 93 trawls, side trawler)***

Trip No.	No. of trawls observed	Mean distance travelled per trawl Mean ± SE	Mean distance travelled per trawl Range	Total trawl distance per trip
1	15	10.97 ± 0.73	4.58–15.13	164.57
2	13	10.06 ± 1.06	5.85–18.36	130.75
3	14[1]	11.97 ± 0.50	8.77–15.14	191.52
4	29	11.05 ± 0.48	5.80–15.14	320.43
5	17	12.77 ± 0.85	8.44–23.13	204.30
6	4	13.10 ± 1.11	10.96–15.73	52.41
6	**921**	**11.44 ± 0.31**	**4.58–23.13**	**1063.98**

[1] Trawl end position for 1 of the 94 trawls was not recorded, *n* = 93.

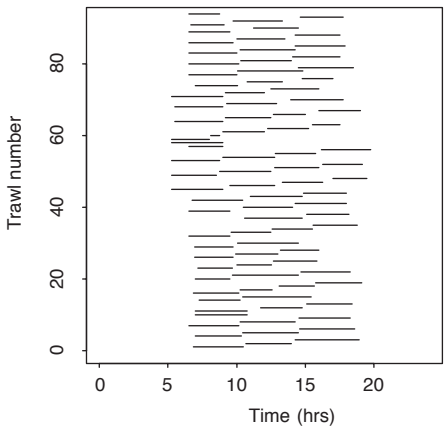

Fig. 11(a).2 Time of day side trawler actively fishing (*n* = 92 trawls).
Horizontal lines represent total trawl time for individual trawls (start time to end time for 92 trawls).
Trawl end times for 2 of the 94 trawls were not recorded, *n* = 92.

Table 11(a).3 ***Water depth*[1] *at which the trawl net was dragged (n = 94 trawls, side trawler)***

Trip No.	No. of trawls observed	Water depth[1] (m) Mean ± SE	Water depth[1] (m) Range
1	15	195.68 ± 2.86	184.71–228.60
2	13	278.50 ± 11.20	226.80–356.60
3	16	271.80 ± 16.90	188.40–371.20
4	29	263.20 ± 23.00	111.60–398.70
5	17	193.00 ± 11.40	106.1–254.20
6	4	118.87 ± 2.69	113.39–124.36
6	**94**	**237.18 ± 9.14**	**106.10–398.70**

[1] Depth is based on trawl start times. However, net depth may be adjusted during the trawl depending on the quantity of fish entering the net, etc.

Seal attendance

Number of seals in the vicinity of nets while hauling

The mean number of seals observed in the vicinity of the net (while the full net was hauled to the water surface and loaded over the side of the vessel) was 10.7 ± 0.8; median 9 (*n* = 92 hauls) (Table 11(a).4). At least one seal was observed near the net during most (98%) hauls, and less than 10 seals were observed at *c.* 50% of the hauls (Table 11(a).5). The maximum number of seals observed during a single haul was 36.

Table 11(a).4 ***Number of seals in the vicinity of net during hauling operations (n = 92 trawls, side trawler)***

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	15	17.67 ± 2.18 (18)	5–36
2	13	15.85 ± 1.95 (14)	7–34
3	15[1]	10.27 ± 1.54 (10)	4–22
4	29	6.14 ± 1.16 (4)	0–28
5	16[1]	8.69 ± 0.87 (8)	5–18
6	4	11.50 ± 2.50 (11)	6–18
6	**92**[1]	**10.74 ± 0.79 (9.0)**	**0–36**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

[2] Median given in round brackets.

Table 11(a).5 ***Percent frequency of seals in the vicinity of net during hauling operations (n = 92 hauls, side trawler)***

No. of seals	No. of trawls	Percent of hauls	Cumulative percent
0	2	2.2	2.2
1	3	3.3	5.4
2	3	3.3	8.7
3	3	3.3	12.0
4	8	8.7	20.7
5–9	29	31.5	52.2
10–19	33	35.9	88.0
20–29	9	9.8	97.8
30-39	2	2.2	100.0
	92[1]		

[1]Counts not conducted during 2 of the 94 trawls, *n* = 92.

Depredation and scavenging

Number of seals feeding directly from the net

The mean number of seals observed feeding directly from the net (while the full net was hauled to the water surface and loaded over the side of the vessel) was 10.1 ± 0.8; median 8 (*n* = 92 hauls) (Table 11(a).6). At least one seal was observed feeding from the net during most (91%) hauls. Less than 10 seals were observed feeding from the nets at *c.* 50% of the hauls (Table 11(a).7). The maximum number of seals observed feeding from the nets during a single haul was 36.

Table 11(a).6 ***Number of seals feeding directly from the net during hauling operations (n = 92 hauls, side trawler)***

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	15	17.67 ± 2.18 (18)	5–36
2	13	15.85 ± 1.95 (14)	7–34
3	15[1]	10.27 ± 1.54 (10)	4–22
4	29	5.69 ± 1.21 (4)	0–28
5	16[1]	8.69 ± 0.87 (8)	5–18
6	4	0	0
6	**92**[1]	**10.10 ± 0.83 (8)**	**0–36**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

[2] Median given in round brackets.

Table 11(a).7 ***Percent frequency of seals feeding directly from the net during hauling operations (n = 92 hauls, side trawler)***

No. of seals	No. of trawls	Percent of trawls	Cumulative percent
0	8	8.7	8.7
1	5	5.4	14.1
2	1	1.1	15.2
3	4	4.4	19.6
4	7	7.6	27.2
5–9	26	28.3	55.4
10–19	30	32.6	88.0
20–29	9	9.8	97.8
30-39	2	2.2	100.0
	92[1]		

[1]Counts not conducted during 2 of the 94 trawls, *n* = 92.

Number of seals feeding on offal and discarded by-catch

The mean number of seals feeding on discarded fish head/gut (offal) and whole fish (by-catch) was 10.6 ± 0.8; median 8.5 (*n* = 92) (Table 11(a).8). At least one seal was observed feeding on discarded offal/by-catch during most (97%) hauls, and less than 10 seals were observed feeding on discarded offal/by-catch at *c.* 50% of the hauls (Table 11(a).9). The maximum number of seals observed feeding on discarded offal/by-catch during a single haul was 36.

Table 11(a).8 *Number of seals feeding on discarded offal/by-catch (n = 92 hauls, side trawler)*

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	15	17.67 ± 2.18 (18)	5–36
2	13	15.85 ± 1.95 (14)	7–34
3	15[1]	10.27 ± 1.54 (10)	4–22
4	29	6.00 ± 1.18 (4)	0–28
5	16[1]	7.88 ± 0.63 (7.5)	5–15
6	4	11.50 ± 2.50 (11.0)	6–18
6	**92**[1]	**10.55 ± 0.79 (8.5)**	**0–36**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

[2] Median given in round brackets.

Table 11(a).9 *Percent frequency of seals feeding on discarded offal/by-catch (n = 92 hauls, side trawler)*

No. of seals	No. of trawls	Percent of trawls	Cumulative percent
0	3	3.3	3.3
1	3	3.3	6.5
2	3	3.3	9.8
3	3	3.3	13.0
4	7	7.6	20.7
5–9	30	32.6	53.3
10–19	32	34.8	88.0
20–29	9	9.8	97.8
30-39	2	2.2	100.0
	92[1]		

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

Damage to equipment

Although seals did not tear/damage nets directly, on one occasion, two entrapped seals were cut from the net and released alive. Therefore the incidence of net damage was 1.06 per 100 trawls (based on 94 trawls).

On July 22, 1992 two entrapped seals were cut from the net and released alive. The cut measured *c.* 50 cm × 50 cm and took 5–10 min to repair. At the time, a large number of seals were in the area, i.e., 36 seals were observed in the vicinity of the net while hauling.

No propeller damage was reported during this study.

Disturbance to operations

Apart from cutting two seals from the net, seals did not cause disruption to fishing operations. Live seals that were brought aboard the vessel returned to sea immediately, i.e., no animals were trapped in the factory area.

Seal mortality or injury

Number of seals incidentally entrapped in the net

A total of 28 seals were incidentally entrapped in nets during the 92 trawls (Table 11(a).10). The mean number of seals entrapped in nets was 30.4 ± 6.7 per 100 trawls. The maximum number of seals entrapped during a single trawl was three.

11(a).10 *Number of seals incidentally entrapped in the net (n = 92 trawls, side trawler)*

Trip No.	No. of trawls	No. seals caught per trawl 0	1	2	3
1	15	7	5	3	0
2	13	9	2	2	0
3	15[1]	12	2	1	0
4	29	28	1	0	0
5	16[1]	12	3	0	1
6	4	4	0	0	0
6	**92**[1]	**72**	**13**	**6**	**1**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

Number of seals incidentally entrapped in the net and returned to sea alive

Of the 28 seals incidentally entrapped in nets, 12 (43%) were returned to sea alive (Table 11(a).11). The mean number of seals that returned to sea alive was 13.0 ± 3.9 per 100 trawls. The maximum number of seals retuned to sea alive in a single trawl was two.

Table 11(a).11 *Number of seals incidentally entrapped in the net and returned to sea alive (n = 92 trawls, side trawler)*

Trip No.	No. of trawls	No. seals caught per trawl 0	1	2
1	15	11	3	1
2	13	11	2	0
3	15[1]	13	2	0
4	29	29	0	0
5	16[1]	13	3	0
6	4	4	0	0
6	**92**[1]	**81**	**10**	**1**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

Number of seals that incidentally drowned in the net

Of the 28 seals incidentally entrapped in nets, 16 (57%) had drowned (Table 11(a).12). The mean number of seals incidentally drown was 17.4 ± 4.5 per 100 trawls. The maximum number of seals that had drowned in a single trawl was two.

Table 11(a).12 *Number of seals incidentally drowned in the net (n = 92 trawls, side trawler)*

Trip No.	No. of trawls	No. seals incidentally drowned per trawl 0	1	2
1	15	10	4	1
2	13	9	4	0
3	15[1]	13	2	0
4	29	28	1	0
5	16[1]	14	1	1
6	4	4	0	0
6	**92**[1]	**78**	**12**	**2**

[1] Counts not conducted during 2 of the 94 trawls, *n* = 92.

Table 11(a).13 ***Details of trips to observe seal-fisheries interactions during stern trawling operations (independent observer aboard the Maria Clare and the Midharvid, n = 102 trawls)***

Trip No.	Start-End date[1]	No. of days at sea[1]	Total hours at sea[1]	No. of trawls observed	No. of trawls per day[2] (range)	Mean duration of trawl[3] ± SE (range)	Total trawl[3] hours
1	7/9/92–25/9/92	19	456	71	4 (1–5)	3 hrs 22 min ± 6 min (1 hr 20 min–6 hrs 15 min)	215 hrs 56 min
2	23/6/93–27/6/93	5	120	31	4 (2–4)	2 hrs 22 min ± 6 min (1 hr 30 min–3 hrs 35 min)	73 hrs 21 min
2		**24**	**576**	**102**	**4 (1–5)**	**3 hrs 22 min ± 6 min (1 hr 20 min–6 hrs 15 min)**	**289 hrs 17 min**

[1] Analysis excludes: (i) time taken to steam to fishing grounds; (ii) time net is aboard the vessel; and (iii) time taken to return to port after the last trawling operation, i.e., active trawl time only.

[2] Mode followed by range in round brackets.

[3] Trawl start times for 2 of the 102 trawls, and trawl end times for 7 of the 102 trawls, were not recorded, *n* = 95.

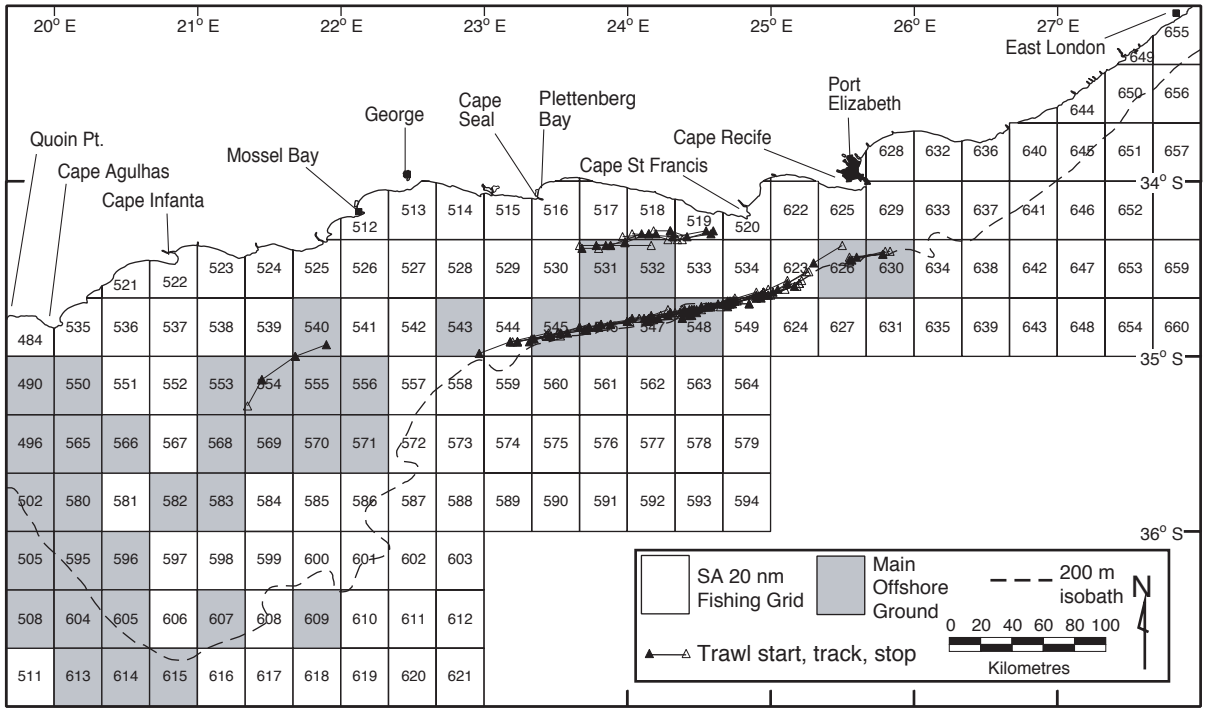

Fig.11(a).3 Distribution of fishing effort (*n* = 100 trawls) aboard a commercial stern trawler (*Maria Clare; Midharvid*): start position and end position of individual trawls.
Trawl end position for 2 of the 102 trawls was not recorded, *n* = 100. Shaded areas represent the main offshore trawl grounds. The demersal grid system is divided into sub-areas (west 1.6, south 2.1 and east 2.2), with the division between east and south occurring at 25° E. The survey area off the Eastern Cape coast overlaps the two sub-areas.

Number of seals deliberately killed by the captain/crew

No seals were killed by the captain or crew. All seals that came aboard alive (*n* = 12) in the net were allowed to return to sea unharmed, i.e., individual animals jumped over the side or the stern of the vessel. All seals returned to the water immediately.

Stern trawl fishing

Fishing operations

A total of 24 days were spent aboard the *Midharvid* and *Maria Clare* during which time 102 trawls were observed (Table 11(a).13).

Main target species and corresponding fishing locations

The main target species was hake, with limited catches of horse mackerel. The main by-catch species included ribbon fish, John dory, monk fish, rat tails, jacopever and rays. Distribution of fishing effort is presented in fig. 11(a).3.

Minimum distance travelled when trawling

The nets of the two trawlers were dragged over a combined minimum distance of 1 132.1 nautical miles. Mean minimum distance of a single trawl was 11.4 ± 0.5 nautical miles (Table 11(a).14).

Trawl times

Table 11(a).14 ***Minimum distance travelled in nautical miles when trawling (n = 100 trawls, stern trawlers)***

Trip No.	No. of trawls observed	Mean distance traveled per trawl Mean ± SE	Mean distance traveled per trawl Range	Total trawl distance per trip
1	69[1]	12.03 ± 0.62	2.47–38.07	818.41
2	31	10.11 ± 0.77	5.07–26.98	313.67
2	**100**[1]	**11.44 ± 0.49**	**2.47–38.07**	**1132.08**

[1] Trawl end position for 2 of the 102 trawls was not recorded, *n* = 100.

The time of day that the stern trawlers were actively fishing ranged from 0107–2600 hrs, i.e., on one occasion the first trawl of the day started early in the morning at 0107 hrs; and several trawls which stated late at night ended near midnight, or early the following morning at 0030 hrs and 0200 hrs (*n* = 95 trawls).

Mean start time for the first trawl of the day was 0623 hrs ± 27 min; second trawl was 0958 hrs ± 17 min; third trawl was 1320 hrs ± 19 min; and the fourth trawl was 1550 hrs ± 23 min. On one occasion a fifth trawl was conducted (start time: 2115 hrs) (Fig. 11(a).4).

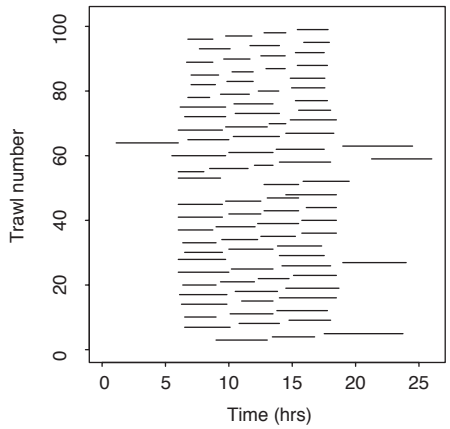

Fig. 11(a).4 Time of day stern trawler actively fishing (*n* = 95 trawls).
Horizontal lines represent total trawl time for individual trawls (start time to end time for 95 trawls; 1–5 trawls per day over 24 days).
Trawl start times for two of the 102 trawls and trawl end times for seven of the 102 trawls, were not recorded, *n* = 95.

Fishing depth

The nets were dragged at depths ranging from 125.0–331.0 m. Mean fishing depth was 203.3 ± 5.5 m; median 186.1 m (Table 11(a).15).

Table 11(a).15 ***Water depth[1] at which the trawl nets were dragged (n = 100 trawls, stern trawlers)***

Trip No.	No. of trawls observed	Water depth[1] (m) Mean ± SE	Water depth[1] (m) Range
1	69[2]	187.95 ± 6.22	124.96–309.17
2	31	237.48 ± 48.10	138.00–331.00
2	**100**[2]	**203.30 ± 5.53**	**124.96–331.00**

[1] Depth is based on trawl start times. However, net depth may be adjusted during the trawl depending on the quantity of fish entering the net, etc.

[2] Depth for 2 of the 102 trawls was not recorded, *n* = 100.

Seal attendance

Number of seals in the vicinity of nets while hauling

The mean number of seals observed in the vicinity of the net (while the full net was hauled to the water surface and brought aboard over the stern of the vessel) was 6.3 ± 0.7; median 4 (*n* = 95 hauls) (Table 11(a).16). At least one seal was observed near the net during most (87%) hauls, and ≤ 4 seals were observed at *c.* 50% of the hauls (Table 11(a).17). The maximum number of seals observed during a single haul was 37.

Table 11(a).16 ***Number of seals in the vicinity of net during hauling operations (n = 98 trawls, stern trawlers)***

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	67[1]	4.18 ± 0.54 (3)	0–18
2	31	10.94 ± 1.45 (8)	0–37
2	**98**[1]	**6.32 ± 0.67 (4.0)**	**0–37**

[1] Counts not conducted during 4 of the 102 trawls, *n* = 98 trawls.

2 Median given in round brackets.

Table 11(a).17 ***Percent frequency of seals in the vicinity of net during hauling operations (n = 98 hauls, stern trawlers)***

No. of seals	No. of trawls	Percent of hauls	Cumulative percent
0	13	13.27	13.27
1	4	4.08	17.35
2	13	13.27	30.61
3	15	15.31	45.92
4	6	6.12	52.04
5–9	25	25.51	77.55
10–19	19	19.39	96.94
20–29	1	1.02	97.96
30-39	2	2.04	100.00
	98[1]		

[1] Counts not conducted during 4 of the 102 trawls, *n* = 98.

Depredation and scavenging

Number of seals feeding directly from the net

The mean number of seals observed feeding directly from the net (while the full net was hauled to the water surface and brought aboard over the stern of the vessel) was 6.3 ± 0.7; median 4 (n = 95 hauls) (Table 11(a).18). At least one seal was observed feeding from the net during most (85%) hauls, and ≤ 4 seals were observed at *c.* 50% of the hauls (Table 11(a).19). The maximum number of seals observed feeding from the nets during a single haul was 37.

Table 11(a).18 ***Number of seals feeding directly from the net during hauling operations (n = 95 hauls, stern trawlers)***

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	64[1]	4.08 ± 0.54 (3)	0–18
2	31	10.87 ± 1.46 (8)	0–37
2	**95**[1]	**6.30 ± 0.68 (4)**	**0–37**

[1] Counts not conducted during 7 of the 102 trawls, n = 95.

[2] Median given in round brackets.

Table 11(a).19 ***Percent frequency of seals feeding directly from the net during hauling operations (n = 95 hauls, stern trawlers)***

No. of seals	No. of trawls	Percent of trawls	Cumulative percent
0	14	14.74	14.74
1	4	4.21	18.95
2	11	11.58	30.53
3	14	14.74	45.26
4	6	6.32	51.58
5–9	25	26.32	77.89
10–19	18	18.95	96.84
20–29	1	1.05	97.89
30-39	2	2.11	100.00
	95[1]		

[1] Counts not conducted during 7 of the 102 trawls, n = 95.

Number of seals feeding on offal and discarded by-catch

The mean number of seals feeding on discarded fish head/gut (offal) and whole fish (by-catch) was 6.3 ± 0.7; median 4 (n = 95 hauls) (Table 11(a).20). At least one seal was observed feeding on discarded offal/by-catch during most (85%) hauls, and ≤ 4 seals were observed feeding on discarded offal/by-catch at *c.* 50% of the hauls (Table 11(a).21). The maximum number of seals observed feeding on discarded offal/by-catch during a single haul was 37.

Damage to equipment

No net damage, or propeller damage, attributed to seal activity was observed in this study.

Table 11(a).20 ***Number of seals feeding on discarded offal/by-catch (n = 94 hauls, stern trawlers)***

Trip No.	No. of trawls	No. of seals[2] Mean ± SE	No. of seals Range
1	63[1]	4.11 ± 0.55 (3)	0–18
2	31	10.87 ± 1.46 (8)	0–37
2	**94**[1]	**6.34 ± 0.69 (4)**	**0–37**

[1] Counts not conducted during 8 of the 102 trawls, n = 94.

2 Median given in round brackets.

Table 11(a).21 ***Percent frequency of seals feeding on discarded offal/by-catch (n = 94 hauls, stern trawlers)***

No. of seals	No. of trawls	Percent of trawls	Cumulative percent
0	14	14.89	14.89
1	4	4.26	19.15
2	10	10.64	29.79
3	14	14.89	44.68
4	6	6.38	51.06
5–9	25	26.60	77.66
10–19	18	19.15	96.81
20–29	1	1.06	97.87
30-39	2	2.13	100.00
	94[1]		

[1] Counts not conducted during 8 of the 102 trawls, n = 94.

Disturbance to operations

One seal brought aboard the vessel was trapped in the factory area. Fish processing stopped for *c.* 10 minutes, after which time the seal was killed.

Seal mortality or injury

Number of seals incidentally entrapped in the net

A total of 21 seals were incidentally entrapped in nets during the 98 trawls (Table 11(a).22). The mean number of seals entrapped in nets was 21.4 ± 8.5 per 100 trawls. The maximum number of seals entrapped during a single trawl was seven.

Table 11(a).22 ***Number of seals incidentally entrapped in the net (n = 98 trawls, stern trawlers)***

Trip No.	No. of trawls	No. seals caught per trawl 0	1	2	3	7
1	67[1]	62	4	0	1	0
2	31	25	3	2	0	1
2	**98**[1]	**87**	**7**	**2**	**1**	**1**

[1] Counts not conducted during 4 of the 102 trawls, n = 98.

Number of seals incidentally entrapped in the net and returned to sea alive

Of the 21 seals incidentally entrapped in nets, 10 (48%) were returned to sea alive (Table 11(a).23). The mean number of seals that returned to sea alive was 10.2 ± 5.5 per 100 trawls. The maximum number of seals returned to sea alive in a single trawl was five.

Table 11(a).23 ***Number of seals incidentally entrapped in the net and returned to sea alive (n = 98 trawls, stern trawlers)***

Trip No.	No. of trawls	No. seals caught per trawl 0	1	5
1	67[1]	65	2	0
2	31	27	3	1
2	**98**[1]	**92**	**5**	**1**

[1] Counts not conducted during 4 of the 102 trawls, *n* = 98.

Number of seals that incidentally drowned in the net

Of the 21 seals incidentally entrapped in nets, 10 (48%) had drowned (Table 11(a).24). The mean number of seals incidentally drown was 10.2 ± 3.7 per 100 trawls. The maximum number of seals that had drowned in a single trawl was two.

Table 11(a).24 ***Number of seals incidentally drowned in the net (n = 98 trawls, stern trawlers)***

Trip No.	No. of trawls	No. seals incidentally drowned per trawl 0	1	2
1	67[1]	63	4	0
2	31	27	2	2
2	**98**[1]	**90**	**6**	**2**

[1] Counts not conducted during 4 of the 102 trawls, *n* = 98.

Number of seals deliberately killed by the captain/crew

Of the ten seals that came aboard alive, entrapped in the net, one was deliberately killed by the crew, i.e., 1.02 seals per 100 trawls (based on 98 trawls).

On September 24, 1992 an adult male seal was trapped in the factory area. The animal was subsequently killed to prevent possible harm to crew. The animal was hit on the head with a spade, hauled to the deck with ropes, and thrown overboard.

DISCUSSION

In waters off the Eastern Cape coast interactions between the trawl fishing industry and Cape fur seals can result in: (i) revenue losses to fishermen and (ii) mortality/injury to seals.

Seal attendance

On the Eastern Cape coast, at least one seal was observed near the net during most hauls. The mean number of seals observed in the vicinity of commercial trawl vessels (when the net was hauled aboard) was 11 for side trawlers and 6 for stern trawlers. Seal attendance figures were significantly higher for side trawlers (T = 4.29, p = 0.000, df = 180) (present study).

Counts of Cape fur seals from commercial trawl vessels for the south coast are: 4 (Shaughnessy & Payne, 1979), 3 (offshore trawlers) (Wickens, 1994) and 10 (inshore trawlers) (Wickens, 1994). Counts for the west coast are: 6 (Shaughnessy & Payne, 1979) and 18 (offshore trawlers) (Wickens, 1994). Thus, mean attendance estimates for the Eastern Cape coast are comparatively high (present study).

Seal attendance figures are higher on the west coast than in other areas because there are larger seal colonies on the west coast, and offshore trawling takes places closer inshore and is therefore more accessible to seals (Wickens, 1994).

Seal attendance figures on the Eastern Cape coast (present study) were higher than on the south coast. Regional differences may be partially attributed to two factors: (i) the type of vessel, and (ii) the number of vessels in the vicinity when hauling. On the south coast, Wickens (1994) conducted all counts from stern trawlers, and other vessels were visible on 40% of observed hauls. In comparison, on the Eastern Cape coast (present study) half of the counts were made from side trawlers (more seals attend side trawl operations), and other vessels were visible on 3% of the observed hauls (seals not distributed between vessels).

Depredation and damage to equipment

Number of seals feeding directly from the net

On the Eastern Cape coast, at least one seal was observed feeding directly from the net during most hauls. The mean number of seals observed feeding directly from the net was 10 for side trawlers, and 6 for stern trawlers. The number of seals feeding directly from the net while hauling was similar for both types of trawl vessel (T = -1.66, p = 0.099, df = 105) (present study).

Deep sea trawlers generally use 110 mm codend mesh in the survey area, except when targeting horse mackerel (85–90 mm) (Peter Sims, pers. comm.). Although seals are unable to pull large fish from the nets, smaller fish, and the heads/tails of large hake and kingklip which protrude from the net (stickers), are taken. Fish that float free from the net are also consumed by seals (present study). Loss of fish, and damage to fish, causes some loss of revenue to fishermen. However, considering that hauls range from 1/2 ton to 30 tons, depredation and damage by seals is negligible.

Losses are presumably higher for side trawlers. The reason for this is because during side trawl operations, the catch lies at the surface for some time while the codend is split and loaded over the side of the vessel. This allows time (*c.* 20 minutes) for seals to feed from the net. In contrast, stern trawlers haul the catch straight up the stern ramp, therefore there is minimal time (*c.* 5 minutes) for seals to feed from the net.

Number of seals feeding on offal and discarded by-catch

On the Eastern Cape coast, at least one seal was observed feeding on discarded offal/by-catch during most hauls. The mean number of seals feeding on offal/by-catch was 11 for side trawlers, and 6 for stern trawlers. The number of seals feeding on offal/by-catch was significantly higher for side trawlers ($T = 3.49$, $p = 0.001$, $df = 177$) (present study).

Soon after the net it brought aboard the vessel, the catch is processed. This involves discarding certain by-catch species which are of little/no value to the industry, and discarding offal (fish guts, fish heads, and trimmings). Seals are attracted to the net by the sound of the winch when hauling. When the net is at the surface, seals feed directly from the net. When the net is aboard, the seals remain near the vessel feeding on discards.

Damage to equipment

In this study, seals did not directly damage (tear) nets. However, on one occasion, two entrapped seals were cut from the net and released alive (present study).

Other observations indicate that seals do occasionally tear the net when attempting to free themselves, however damage is usually minor (Wickens, 1994).

Disturbance to operations

In this study, there was only one case where a seal was trapped in the factory area. Operations stopped for *c.* 10 minutes, after which time the seal was killed. On the west coast, Wickens (1994) reported two cases where a seal was trapped in the factory area of commercial trawlers ($n = 185$ trawls). On the south coast, Shaughnessy & Payne (1979) reported four cases ($n = 129$ trawls).

A loose seal trapped in the factory of a trawler is potentially dangerous, especially when it is a large adult male. Therefore, at least some of the crew must stop work until the animal is removed (or killed). This results in lost fishing time.

Seal mortality or injury

Number of seals incidentally entrapped in the net

On the Eastern Cape coast, the mean number of seals entrapped in nets was 30 per 100 trawls for side trawlers, and 21 per 100 trawls for stern trawlers. The maximum number of seals entrapped during a single trawl was 7. Side trawlers are more likely than stern trawlers to catch at least one seal per trip ($Z = 1.96$, $P = 0.050$) (present study).

The mean number of Cape fur seals entrapped in commercial trawl nets, per 100 trawls, in other areas is: 8.2 seals for the south coast, and 8.0 seals for the west coast (Shaughnessy & Payne, 1979). Thus, the frequency of entrapment for the Eastern Cape coast is comparatively high (present study).

Number of seals that incidentally drowned in the net

On the Eastern Cape coast, the mean number of seals incidentally drown was 17 per 100 trawls for side trawlers, and 10 per 100 trawls for stern trawlers. The maximum number of seals that had drowned in a single trawl was two. The likelihood of entrapping at least one drowned seal per trip is the same for side and stern trawlers ($Z = 1.52$, $p = 0.130$) (present study).

The mean number of Cape fur seals incidentally drowned in commercial trawl nets, per 100 trawls, in other areas is: 3.2 seals (Shaughnessy & Payne, 1979) and 5 seals (inshore trawlers) (Wickens, 1994) for the south coast; and 4.6 seals (Shaughnessy & Payne, 1979), and 1.6 seals (offshore trawlers) (Wickens, 1994) for the west coast. Thus, the frequency of drowning for the Eastern Cape coast is comparatively high (present study).

Number of seals deliberately killed by the captain/crew

When seals become trapped below the deck (in the factory area) they are often deliberately killed because they are potentially harmful to the crew, and difficult to remove.

On the Eastern Cape coast, the mean number of seals deliberately killed by the crew was one for stern trawlers (1.02 seals per 100 trawls) and nil for side

Table 11(a).25 ***Entrapment of Cape fur seals incidental to trawling by commercial vessels off the Eastern Cape coast of South Africa.***

Year	Estimated no.of trawls[1] per depth zone (m)			Total estimated no. of trawls[1]	Estimated no. of seals caught in trawl nets	Estimated no. of seals drowned trawl nets	Estimated no. of seals drowned in trawl nets & deliberately killed
	≤ 100	101–200	201–300				
1992	1295	2797	19	4111	1061	563	584
1993	1333	2804	104	4241	1094	581	602
1994	1047	2399	103	3549	916	486	504
1995	1295	2124	139	3558	918	487	505
mean ± SE	**1243 ± 66**	**2531 ± 165**	**91 ± 25**	**3865 ± 182**	**997 ± 47**	**529 ± 25**	**549 ± 26**

[1] The number of trawls per year and depth zone completed by the inshore fleet to the east of 24º E, between 1992 and 1995 (Robert Leslie, pers. comm.).

trawlers (present study). The mean number of Cape fur seals entrapped in commercial trawl nets, per 100 trawls, in other areas is: 1.8 for the south coast (Shaughnessy & Payne, 1979); and 0.5 seals on the west coast (Wickens, 1994). Thus, the frequency of deliberate killing is negligible for all areas.

Overall seal mortality

Considering that the minimum mean distance travelled when trawling was similar for both side and stern trawlers (T = 0.01, p = 0. 992, *n* = 161); and that the number of trawls observed aboard side and stern trawlers were similar (*n* = 94 and 102 trawls), it is possible to pool the data and estimate overall seal mortality for the Eastern Cape coast. From the observed entrapment rates of seals (0.258 seals per trawl), the annual number of seals entrapped and brought aboard by commercial trawlers was estimated to be 977. From the observed mortality rates of seals due to drowning (0.137 seals per trawl), the annual mortality rate was estimated to be 529. From the observed overall mortality rates (0.142 seals drowned and deliberately killed per trawl), the annual overall mortality rate was estimated to be 549 (Table 11(a). 25).

Trawl depth

In the present study, 26 seals were drowned in commercial trawl nets (*n* = 190 trawls) (Appendix 11(a).1). Twenty one were entrapped towards the end of trawls (animals warm when on deck), and five were caught early in trawls (animals cold when on deck/signs of rigor mortis).

Commercial trawlers were operating between 106 m and 399 m, usually at 237 m (side trawler) and 203 m (stern trawlers). Cape fur seals can dive > 160 m. Therefore, seals are presumably entrapped when the net is held at ≤ 160 m. Although most animals were entrapped towards the end of trawls (when hauling), some animals entered the net when the net was deployed and/or being dragged along the sea bed.

In order to minimise the number of seals entrapped, trawlers should: (i) deploy the nets as quickly as possibly; (ii) trawl at depths > 160 m; and (iii) and retrieve the full net as quickly as possible.

Biology of drowned seals

The sex ratio of drowned animals was 1 female: 25 males. Counts of growth layer groups in thin tooth sections indicated that 23 of the drowned animals were ≥ 5 y. Three animals were of unknown age; however body length (curve) measurements suggested that they were all ≥ 5 y.

Most animals were in good physical condition, with blubber thickness ranging from 11.2–29.6 mm (mean 20.2 ± 1.4, *n* = 21). Five animals were slightly thin, with blubber thickness ranging from 6.0–7.6 mm (6.9 ± 0.3, *n* = 5).

Histological examination of the testis and epididymis indicated that all males collected between August and January were in reproductive condition, i.e., sperm observed in the epididymal tubules. Two of the six males collected in July had sperm in the epididymis. Males collected outside this period (between February and June) did not have sperm in the epididymis. Cape fur seals are seasonal breeders. The pupping/breeding season extends from November to late December. In most males, the testis regress between February and June, i.e, sperm is absent from the epididymis between February to June.

Examination of the reproductive tract of the female (PEM2012) indicated that she was also in reproductive condition. This animal was carrying a foetus measuring 42.5 cm (nose to tail) and weighing 3 123 g.

An additional 11 animals, drowned in nets off the Eastern Cape coast, were brought in by captains of the *Zuiderzee* and *Midharvid* (when the observer was not aboard the vessel) (Appendix 11(a).2). Counts of growth layer groups in thin tooth sections were made for five animals, all of which were ≥ 6 y. Standard body lengths of animals of unknown age suggested that these animals were all ≥ 5 y. Blubber thickness ranged from 17.0–39.9 mm (mean 28.0 ± 2.1, *n* = 10). One animal was slightly thin (blubber thickness 4.4 mm). All animals were male.

When all drowned animals are pooled (n = 37), two patterns are clearly evident. Firstly, animals are predominantly males, i.e., 1 female : 36 males. Secondly, animals were ≥ 5 y, i.e., 14 animals were 5–7 y (subadults); 12 were 8–9 y, and two were > 12 y (n = 28 canine aged animals). Examination of bacular length and canine age, suggested that about half of the animals had attained social maturity (8–10 y). Mean bacular length was 105.6 ± 2.2; range 85.9–136.1 (n = 34).

These results suggest that males are more likely to feed from trawl vessels than females; and males feeding from trawlers are generally older animals (≥ 5 y). Possible reasons for these observations are: older males have gradually learnt to associate trawl vessels with food; and younger males generally feed closer inshore, away from the offshore trawl grounds. These conclusions are in agreement with Oosthuizen (1991) who examined tagged Cape fur seals recovered at sea (seals drowned in fishing nets and shot for research).

CONCLUSION

On the Eastern Cape coast, some seals take fish from trawl nets, damage gear and disrupt fishing operations. Such interaction results in some loss of revenue to the fishermen; however, losses are negligible compared to the landed value of the fishery. Seals feeding from trawlers mainly consume stickers, fish floating free from the net, discarded by-catch and offal, thus loss and spoilage of fish is negligible. Sometimes fishermen have to cut the trawl net to free entrapped seals, but this cost is minimal. Occasionally a live seal is trapped in the factory area causing disruption and lost fishing time.

Cape fur seals are incidentally drowned in trawl nets, and are occasionally killed on vessels (when trapped in the factory area). The annual overall mortality rate (seals drowned and deliberately killed) for the Eastern Cape coast was estimated to be 549 seals. This mortality is negligible in comparison to the total population size (*c.* 1.5–2 million seals), and is likely to have little impact on the viability of the local population.

Cape fur seals are highly polygynous species, therefore only a small percentage of males reproduce. The removal of some 'surplus' males would not impact on the viability of the local population e.g., 'territorial bulls' were harvested for many years by Government Guano Islands, and then in the 1970s by private concessionaires, and the population continued to increase.

However, although this small seal population remains viable, the long term effects of changing the population structure, by removing males ≥ 5 years, are unknown. From a humanitarian view point, by-catch of any marine mammal is highly undesirable.

Future management studies should be concentrated in four key areas. Firstly, in order to prevent seals being entrapped in trawl nets, research is needed to develop effective non-lethal methods of deterring seals from fishing operations, e.g., deterrents to repel seals from fishing gear and/or conditioning seals to avoid fishing areas. Secondly, discarding of whole/parts of fish encourages seals to follow vessels. Therefore, efficient utilisation of/or disposal of offal and by-catch should be addressed. Thirdly, each vessel should be supplied with suitable equipment to capture and remove seals from the factory area. The market could subsidise such research by increasing the price of fish, and conservation organisations could assist with training crew on safe handling of seals. Finally, considering that large numbers of seals are being drowned in this area, on-going monitoring of the seal population is required.

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Appendix 11(a). 1 *Cape fur seals incidentally drowned in trawl nets off the Eastern Cape coast of South Africa between 1992 and 1995. Seals collected by independent observer aboard commercial trawl vessels (n = 196 trawls)*

	Accession no.	Date caught	Time caught (hrs)	Location	Trawl vessel (trip no., haul no.)	Trawl depth (m)	Dead seal on deck (W/C)[1]	Sex	Curve body length[2] (cm)	Blubber thickness[3] (mm)	Age[4] (y)	Sperm (Absent/ Present)	Testis weight (g)	Bacular length (mm)
1	PEM1999	20 Jul 1992	1040–1400	34°52' 23°35'–34°50' 23°48'	side (1, 2)	194	W	M	155	6.3	5	P	21.6/21.4	105.4
2	PEM2000	21 Jul 1992	0700–1020	34°50' 23°48'–34°48' 24°00'	side (1, 4)	188	C	M	146	6.0	5	A	21.5/19.3	89.4
3	PEM2001	21 Jul 1992	0700–1020	34°50' 23°48'–34°48' 24°00'	side (1, 4)	188	W	M	144	7.0	7	A	25.5/24.3	90.1
4	PEM2002	22 Jul 1992	1432–1815	34°55' 23°14'–34°53' 23°26'	side (1, 9)	192	W	M	163	7.6	8	A	30.6/28.5	121.0
5	PEM2003	24 Jul 1992	1145–1445	34°51' 23°42'–34°49' 23°53'	side (1, 12)	192	W	M	145	12.0	6	A	27.7/26.7	96.7
6	PEM2004	25 Jul 1992	1025–1525	34°45' 24°18'–34°48' 24°00'	side (1, 15)	210	W	M	194	18.0	> 12	P	44.9/41.6	112.1
7	PEM2005	11 Aug 1992	1545–1905	34°43' 24°34'–34°40' 24°45'	side (2, 19)	241	W	M	145	7.4	7	P	36.7/36.1	104.0
8	PEM2006	13 Aug 1992	1240–1550	34°45' 24°25'–34°42' 24°40'	side (2, 25)	313	W	M	153	13.3	7	P	31.7/29.7	99.3
9	PEM2007	14 Aug 1992	0955–1300	34°42' 24°51'–34°42' 24°42'	side (2, 27)	326	W	M	182	22.0	9	P	33.8/32.4	115.5
10	PEM2008	14 Aug 1992	1310–1600	34°41' 24°42'–34°38' 24°54'	side (2, 28)	278	W	M	147	29.4	–	P	28.2/27.6	121.1
11	PEM2009	22 Aug 1992	0645–1026	34°47' 24°11'–34°46' 24°25'	side (3, 42)	274	C (15.8°C)	M	148	11.2	5	P	24.5/23.3	96.6
12	PEM2010	22 Aug 1992	1100–1445	34°45' 24°29'–34°41' 24°45'	side (3, 43)	357	W (30.8°C)	M	147	11.3	7	P	28.7/25.9	85.9
13	PEM2011	8 Sep 1992	1443–1800	33°50' 27°06'–34°37' 24°59'	stern (1, 9)	183	W	M	160	11.8	–	P	31.8/30.7	92.3
14	PEM2012	9 Sep 1992	0630–0900	34°40' 24°41'–34°39' 24°53'	stern (1, 10)	186	C	F	162	29.3	–	_	–	–
15	PEM2013	13 Sep 1992	1410–1800	34°24' 25°50'–34°25' 26°02'	stern (1, 26)	139	C	M	166	18.7	8	P	28.1/27.7	–
16	PEM2014	25 Sep 1992	1450–1830	34°23' 26°04'–34°23' 25°58'	stern (1, 71)	142	W	M	162	22.0	7	P	38.8/–	97.2
17	PEM2015	3 Nov 1992	0630–0900	34°17' 24°36'–34°20' 24°23'	side (4, 57)	113	W	M	158	22.5	> 12	P	36.7/34.3	–

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	Accession no.	Date caught	Time caught (hrs)	Location	Trawl vessel (trip no., haul no.)	Trawl depth (m)	Dead seal on deck (W/C)[1]	Sex	Curve body length[2] (cm)	Blubber thickness[3] (mm)	Age[4] (y)	Sperm (Absent/ Present)	Testis weight (g)	Bacular length (mm)
18	PEM2046	19 May 1993	1017–1400	35°00' 21°41'–35°08' 21°27'	side (5, 81)	106	C	M	– (141)	11.7	7	A	21.4/19.2	105.4
19	PEM2047	20 May 1993	0630–1000	34°53' 23°27'–34°50' 23°40'	side (5, 83)	187	W	M	_ (167)	23.5	7	A	20.9/20.3	104.9
20	PEM2048	20 May 1993	0630–1000	34°53' 23°27'–34°50' 23°40'	side (5, 83)	187	W	M	– (157)	18.0	8	A	23.1/22.1	94.6
21	PEM2051	28 Jun 1993	1230–1425	34°44' 24°28'–34°45' 24°19'	stern (2, 91)	202	W	M	174 (168)	20.0	8	A	25.6/25.0	107.2
22	PEM2052	28 Jun 1993	1230–1425	34°44' 24°28'–34°45' 24°19'	stern (2, 91)	202	W	M	_ (171)	22.0	7	A	21.7/21.3	115.0
23	PEM2053	28 Jun 1993	1515–1730	34°46' 24°21'–34°44' 24°31'	stern (2, 92)	293	W	M	158 (153)	24.5	7	A	22.2/22.0	93.3
24	PEM2054	29 Jun 1993	1140–1400	34°44' 24°27'–34°47' 24°17'	stern (2, 94)	315	W	M	183 (165)	29.6	9	A	30.8/28.6	111.3
25	PEM2055	29 Jun 1993	1555–1755	34°45' 24°21'–34°43' 24°32'	stern (2, 95)	269	W	M	191 (179)	26.8	8	A	17.9/17.4	104.9
26	PEM2056	29 Jun 1993	1555–1755	34°45' 24°21'–34°43' 24°32'	stern (2, 95)	269	W	M	150 (139)	26.8	8	A	22.2/21.9	118.0

[1] W, dead seal warm on deck; C, dead seal cold on deck.

[2] In rough sea conditions it was not always possible to record SBL, therefore curve body length was taken with the animal lying on its back. SBL is given in round brackets when recorded.

[3] Blubber thickness taken at the base of the sternum.

[4] Age inferred from growth layer groups in the dentine of thin tooth sections.

Note, animals could not be weighed aboard the vessels.

Appendix 11(a). 2 *Cape fur seals incidentally drowned in trawl nets off the Eastern Cape coast of South Africa between July 1993 and August 1995.* These animals were collected by the ship's captain (no independent observed aboard) and taken to the Port Elizabeth Museum for biological examination.

	Accession no.	Date caught	Trawl vessel	Sex	Body length[1] (cm)	Body mass (kg)	Blubber thickness[2] (mm)	Age[3] (y)	Bacular length (mm)
1	PEM2082	19–20 Jul 1993	side	M	182 (176)	116	30.0	9	124.3
2	PEM2252	22–25 Aug 1994	stern	M	196[4] (172)	106	25.6	9	116.4
3	PEM2253	27–29 Aug 1994	side	M	166 (152)	86	33.0	–	113.6
4	PEM2254	27–29 Aug 1994	side	M	155 (146)	71	33.4	–	88.4
5	PEM2256	17–20 Sep 1994	stern	M	211[4] (198)	183	4.48	–	136.1
6	PEM2258	8–10 Oct 1994	stern	M	199 (186)	143	29.9	8	117.9
7	PEM2257A	19–22 Sep 1994	stern	M	159 (142)	73	17.0	6	96.2
8	PEM2257B	7–10 Oct 1994	stern	M	195 (170)	128	39.9	9	123.6
9	PEM2400	13–17 Jul 1995	stern	M	– (176)	97	26.0	–	110.3
10	PEM2401	13–17 Jul 1995	stern	M	161 (146)	69	22.6	–	88.2
11	PEM2414	25 Aug 1995	stern	M	151 (148)	58	22.3	–	95.0

Animals could not be weighed aboard the vessels.

[1] Body length was taken with the animal lying on its back. SBL is given in round brackets.

[2] Blubber thickness taken at the base of the sternum.

[3] Age inferred from growth layer groups in the dentine of thin tooth sections.

[4] Animals PEM2252 and PEM2256 were bloated.