

**THE DISTRIBUTION OF CETACEANS OFF THE COAST OF SOUTH AFRICA AND
SOUTH WEST AFRICA / NAMIBIA.**

BY

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ABSTRACT

Thirty - seven species of cetacean are recorded from southern African waters. Four thousand, five hundred and thirty - seven records of approximately 60 000 cetaceans were analysed to define distribution patterns of these species, including dedicated sightings (both scientific and commercial), incidental sightings, commercial catches and specimens. Records of dedicated scientific sightings and incidental sightings were analysed by water depth, sea surface temperature and salinity and season, while commercial sightings and catches were analysed by month and water depth.

Of the thirty - seven species recorded within the region, four mysticetes and one odontocete could be described as migratory, having a marked seasonal occurrence within the region, three species were defined as possible migrators as they were not recorded in the dedicated data and showed seasonality in the incidental sighting and specimen databases, 20 species (19 odontocetes and one mysticete) could be described as resident (in that they were found throughout the year) and five species were termed "semi - resident" (certain components or forms of which showed strong seasonal occurrence, while other individuals had a year - round occurrence). Records of a further four species were too few to define distribution patterns or seasonality.

Analysis of the distribution of the large species showed three species (*Eubalaena australis*, *Megaptera novaeangliae* and *Caperea marginata*) to occur in nearshore waters and four species (*Balaenoptera musculus*, *B. physalus*, *B. borealis* and *P.macrocephalus*) to occur in deep waters only. *B. acutorostrata* was recorded in both nearshore and offshore waters, while the two forms of *B. edeni* were found in nearshore and offshore waters respectively.

The distribution analyses of the smaller odontocete species showed a number of component patterns including cosmopolitan, pelagic cosmopolitan, tropical, sub tropical and warm temperate components of

the Agulhas Current, warm temperate component of the south coast, a component of the Agulhas Bank, a south and east coast inshore component and west coast inshore and offshore components. The high diversity of species within the region results from the complex variety of zoogeographic components found within the relatively small study area. These arise from the complex oceanographic conditions, brought about by the upwelling of cold Central Atlantic water inshore on the west coast, the movement of subtropical water into the east coast region by the Agulhas Current and the mixing of Benguela and Agulhas Current waters to the south of the sub - continent.

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INTRODUCTION

Extant cetacean distribution patterns have been categorised into four types, namely, transequatorial (anti-tropical), circumpolar, endemic and cosmopolitan (Davies 1963, Marcuzzi and Pilleri 1971, Gaskin 1976 and Fordyce 1985). Species or genera which are discontinuously distributed across the equator have transequatorial (or anti-tropical) distributions, and both Davies (1963) and Fordyce (1985) note that several extant cetacean genera (including *Hyperoodon* and *Lissodelphis*) and species show antitropical distributions. Brownell (1974) maintains that the genera *Berardius*, *Lissodelphis*, *Hyperoodon*, *Phocoena* and *Lagenorhynchus* all show antitropical distributions. Certain species or genera inhabit the southern temperate or sub Antarctic waters of all oceans and are said to be circumpolar in distribution. Few cetacean species have endemic distribution patterns of which the most noteworthy are the 'river dolphins' and certain *Cephalorhynchus* species. Other species show world-wide or cosmopolitan distributions and Fordyce (1985) places *Megaptera novaeangliae*, *Ziphius cavirostris* and *Pseudorca crassidens* in this category.

A number of authors (Davies 1963, Perrin, Mitchell and van Bree 1978, Gaskin 1976, 1982) suggest that the Cape of Good Hope and its associated cold waters have played an important part in acting as a "variable one way filter" in east to west dispersion of tropical cetacea. Perrin *et al* (1978) suggest that the high diversity of *Stenella* species in the Atlantic Ocean has resulted from this. The region is therefore one of considerable zoogeographic interest.


Nine species of large cetacea and 28 species of small cetacea have been recorded off the coast of South Africa and South West Africa / Namibia. This is a surprisingly high species diversity compared to 27 species in the whole North Pacific and 28 species in the entire North Atlantic. Ross (1984) suggests that the high species diversity of small cetacea off the south east coast is due to complex

oceanographic conditions found in this area  pical/subtropical component, a temperate /sub-antarctic component, a cosmopolitan component and a mixed water component.

Of the nine species of large whale found off the South African coast, six are balaenopterids (*Balaenoptera musculus*, *B. physalus*, *B. borealis*, *B. acutorostrata*, *B. edeni* and *Megaptera novaeangliae*), one is a balaenid (*Eubalaena australis*), one is a neobalaenid (*Caperea marginata*) and one is a physeterid (*Physeter macrocephalus*). Of the small cetacean species, 18 are delphinids (*Orcinus orca*, *Pseudorca crassidens*, *Feresa attenuata*, *Peponocephala electra*, *Grampus griseus*, *Globicephala macrorhynchus*, *G. melaena*, *Delphinus delphis*, *Stenella longirostris*, *S. attenuata*, *S. coeruleoalba*, *Steno bredanensis*, *Lagenodelphis hosei*, *Lissodelphis peronii*, *Lagenorhynchus obscurus*, *Tursiops truncatus* (*truncatus* and *aduncus* forms), *Cephalorhynchus heavisidii* and *Sousa plumbea*), eight are ziphiids (*Ziphius cavirostris*, *Mesoplodon densirostris*, *M. hectori*, *M. layardi*, *M. mirus*, *M. grayi*, *Hyperoodon planifrons* and *Berardius arnouxi*) and two are physeterids (*Kogia simus* and *K. breviceps*).

Apart from literature arising from the whaling industry (reviewed in chapter 4), there is a lack of published data on detailed cetacean distributions within the area. Barnard (1954) described the South African Museum cetacean collection and included stranding records and specimens of 23 species. Best (1971) listed the known distributions of African cetacea. The only previous detailed discussion of cetacean distribution in the area is that of Ross (1984), who considered the small cetacean fauna of the south east coast region. Smithers' (1983) description of the cetacean fauna of the southern African subregion appears to be based heavily on Ross (1984), despite its precedence in time.

Large numbers of stranding and sighting records have been published from this coast (eg. Bannister and Gambell 1965, Best 1960, 1967, 1970a, 1970b, 1977, 1981, 1982, Best, Butterworth and Rickett 1984, Best and Gambell 1968, Best and Shaughnessy 1981, Brown 1982, Gambell 1972, McCann and Talbot 1963, Perrin, Best, Dawbin, Balcomb, Gambell and Ross 1973, Rice and Saayman 1984, Ross, Best and Donnelly 1975, Ross and Cockcroft in press, Ross, Cockcroft and Butterworth 1987, Ross, Cockcroft and

Cliff 1985, Ross and Tietz 1972, Talbot 1960  mithers 1938, Bass 1969, van Bree, Best and Ross 1978, Ross 1969, 1970, 1979, Tietz 1963, 1966, Cruikshank and Brown 1981, Saayman, Bower and Tayler 1972 and Saayman and Tayler 1979) and although these provide records of the species in the area they do not define the distributions within the region.

Cetacean distribution limits have been said to be determined by a number of topographical and oceanographic factors. Distributions have been linked to sea surface temperature (Sergeant and Fisher 1957, Gaskin 1968, Wursig and Wursig 1980, Au and Perryman 1985, Polacheck 1987), water depth (Kenney and Winn 1986, Wursig and Wursig 1978), bottom topography (Dohl, Bonnel and Ford, 1986, Hui 1979), area of frontal convergence (Gaskin 1968, Gaskin 1982, Polacheck 1987), thermocline depth (Au, Perryman and Perrin 1979, Au and Perryman 1985 and Polacheck 1987), ocean colour and turbidity (Smith, Dunstan, Au, Baker and Dunlap 1986) and salinity (Perrin, Scott, Walker, Ralston and Au 1983)

The objectives of this study are to :-

- a) review and define the distribution patterns of the cetacean species found in southern African waters.
- b) to analyse patterns of seasonal abundance and distribution to determine which species are migratory in southern African waters.
- c) to determine to what extent distributions are limited by environmental parameters of water depth, sea surface temperature and sea surface salinity.
- d) to compare the distributions of stranding/specimen records and incidental sightings in relation to distribution ranges determined from dedicated sightings.

THE STUDY AREA

The study area lies between $17^{\circ} 00' S$ and $38^{\circ} 00' S$ and between $11^{\circ} 00' E$ and $35^{\circ} 00' E$ and it includes the coasts of South West Africa /Namibia and South Africa and the surrounding oceans to a depth of over 3000 metres. The topography of the region is shown in figure 1. The eastern continental shelf is narrow to the north of the Tugela river mouth ($29^{\circ} 15' S$, $31^{\circ} 26' E$) (three to five miles wide), widening at the Tugela mouth, but narrowing again to about 10 km to the south off the Transkei coast. South of the sub-continent the shelf widens to form the Agulhas Bank and the south coast from Cape Recife to Cape Point is largely characterised by rocky capes and shallow (less than 50m deep) sandy bays. The west coast continental shelf is broader than that of the east coast and its width ranges from between 40 km (off the Cape Peninsula) to 180 km (off the Orange River ($28^{\circ} 35' S$ $16^{\circ} 25' E$)) the width of the shelf plays an important role in the formation of upwelling cells (Shannon 1985). Offshore the Walvis Ridge (running in a southwesterly direction to the west of the study area) forms a barrier between the Angola and Cape Basins and restricts northward and southward movements of water below a depth of 3000 metres. The east and south coasts are dominated by the fast flowing Agulhas current. Water in this southerly - flowing western boundary current originates from both the Mozambique current and the East Madagascar current. Pearce (1977) stated that the Agulhas Current is typical of western boundary currents and on the basis of current velocity divides the surface current into three zones:-

1) An inshore boundary separates the Agulhas current core from the cooler coastal water. This inshore region is characterised by a strong sea surface temperature gradient. Pearce (1977) noted that the offshore boundary of this zone (beyond which the current velocity is greater than one m/s) corresponds to an approximate depth of 500 metres off Durban ($29^{\circ} 55' S$ $31^{\circ} 00' E$), while Schumann (1982) found a variable recirculation current inshore of this boundary off Durban.

2) The Agulhas current core. Pearce (1977) defined this zone as the area where the current velocity

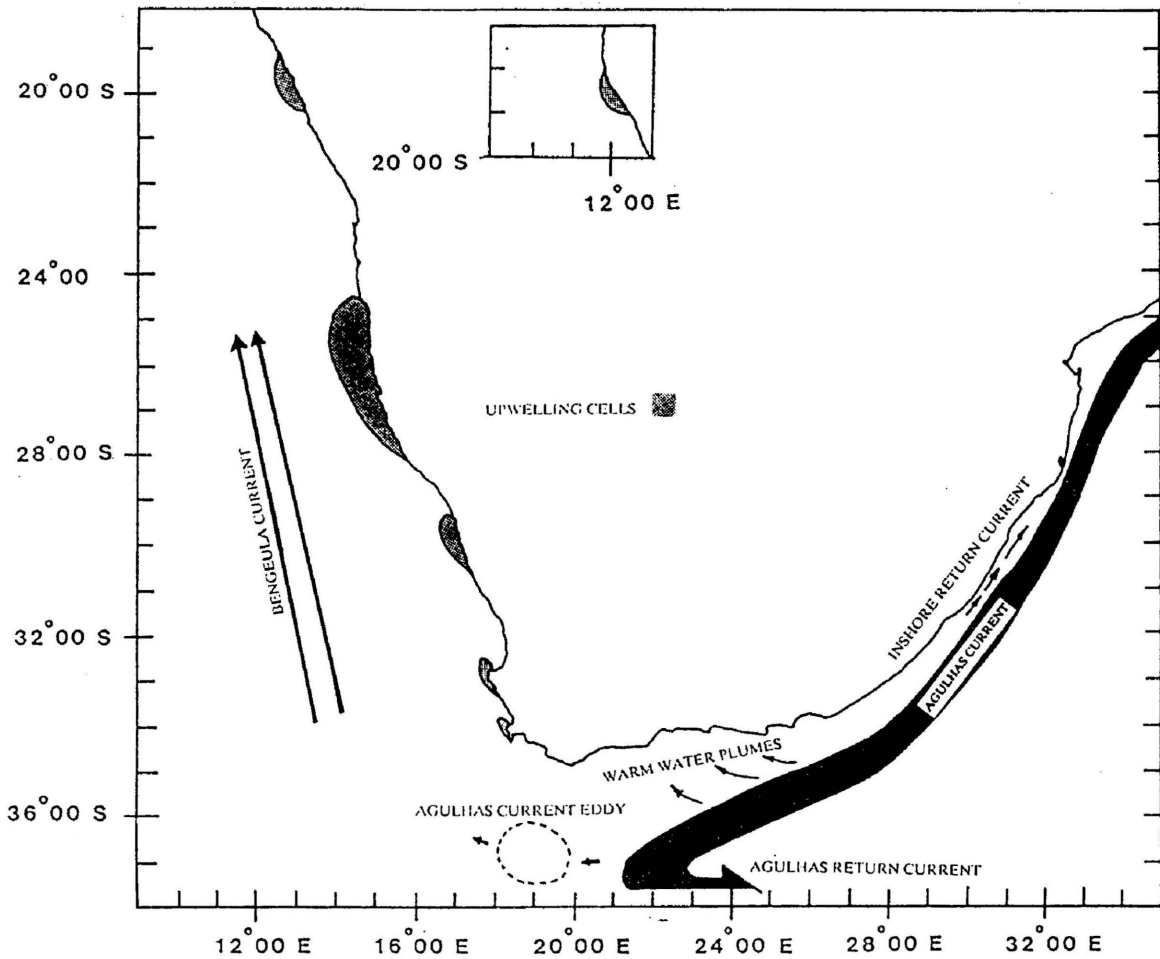
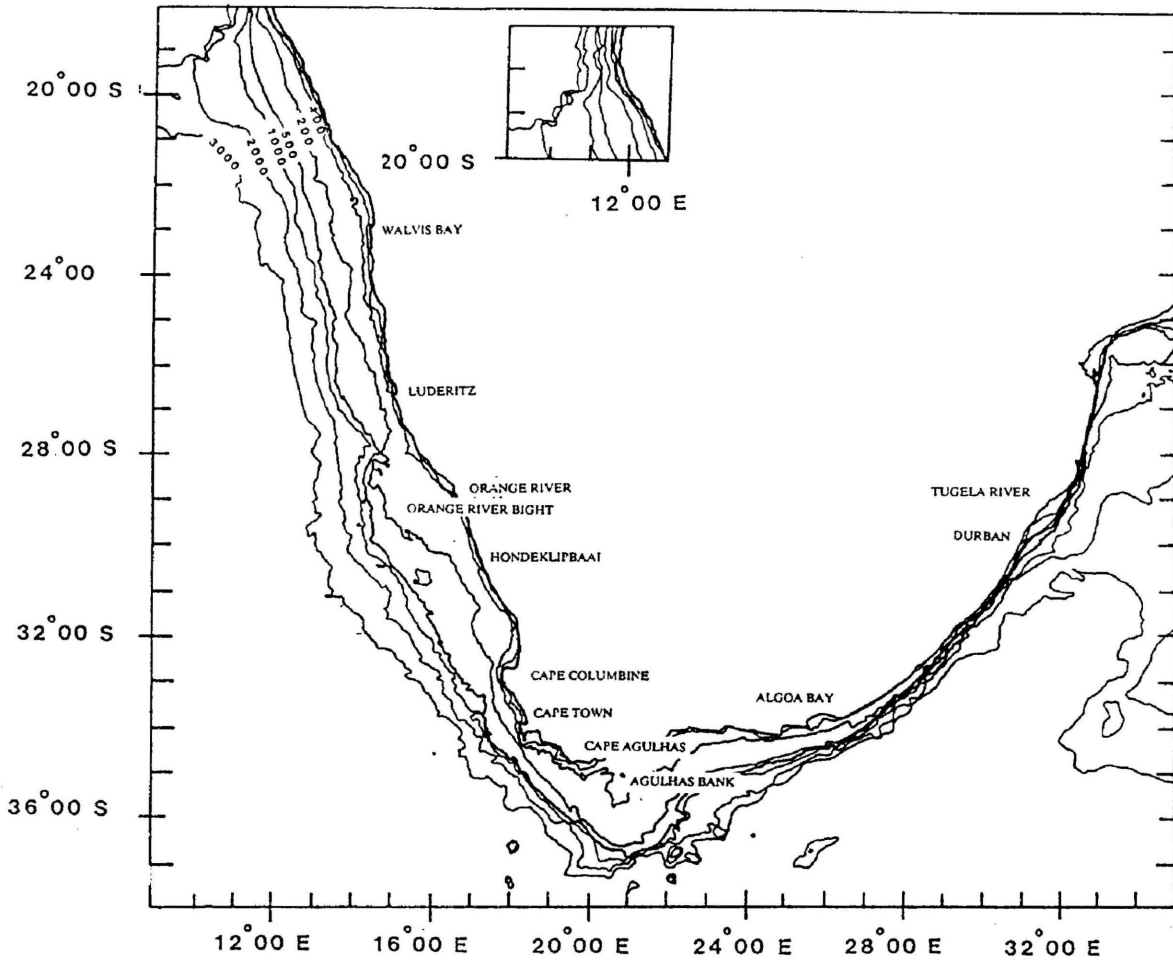


Figure 1. The bathymetry and oceanographic features of the study area.


3) The Eastern boundary zone. This is a zone to the east of the eastern 1m/s isotach. The water flow within this zone is linked to the Agulhas eddy anticyclonic gyre.

Gambell (1968) noted the occurrence of "current lines" in the East Coast whaling grounds (off Natal), running parallel to the coast and remarked at their consistency in position. Harris and Stravropoulos (1967) found a strong temperature gradient about 60 miles offshore associated with such a "current line".

South of the continent (in the region of $34^{\circ} 00' S$; $27^{\circ} 00' E$ the Agulhas Current veers away from the coast and follows the shelf edge, and a number of authors have noted that bottom topography greatly influences the course taken by it (Darbyshire 1972, Lutjeharms and Van Ballegooyen 1984). As the current moves along the edge of the Agulhas Bank, shear edge features are formed and plumes and eddies of warm water may occasionally disperse over large areas of the Agulhas Bank (Catzel and Lutjeharms 1987).

In the region to the south of Cape Agulhas ($34^{\circ} 50' S$ $20^{\circ} 00' E$) the current reflects to the east to become the Agulhas Return Current. The reflection results in the shedding of eddies from the Agulhas Current, some of which have been shown to move around the Cape Peninsula (Lutjeharms 1985). The contribution of Agulhas water into the West coast Benguela system is uncertain, but Shannon (1985) stated that it is substantial. The Agulhas Return Current flows eastward to the south of the study area, and the area lying between the Agulhas Return Current and the Agulhas Current is characterised by warm subtropical surface water to a depth of about 500 m.

The hydrology of the West coast is dominated by highly variable wind - generated upwelling systems. Temporally it can be divided into northern (north of $31^{\circ} 00' S$) and southern (south of about $31^{\circ} 00' S$) regions based on the seasonality of prevalent winds and upwelling. Andrews and Hutchings (1980) have

shown that the oceanography of the southern  on is regulated by the summer south - east trade winds which result in upwelling cells and give rise to a well defined front between the inshore upwelled water and the South Atlantic Surface Water. Winter westerly winds result in the relaxing of upwelling conditions and the collapse of the frontal system. Two main upwelling cells occur within this southern region, off the Cape Peninsula and off Cape Columbine ($32^{\circ} 53'S$ $17^{\circ} 55'E$). The Cape Peninsula upwelling plume and the associated oceanic front over the shelf break has been shown to be a semi-permanent feature during summer (Andrews and Hutchings 1980).

Within the northern West coast region (north of about $31^{\circ} 00' S$) the upwelling is less seasonal. A spring - summer maximum exists as far north as $25^{\circ} 00' S$ and a late winter - spring maximum exists to the north of this latitude. The two major areas of upwelling found in the northern Benguela region are :- a) The Namaqua upwelling area off Hondeklipbaai ($30^{\circ} 00'S$, $17^{\circ} 00'E$). This is a cool wedge - shaped zone extending northwards from Hondeklip Bay to the Orange Bight ($28^{\circ} 30'S$). Shannon (1985) noted that to the southwest of Hondeklip Bay the continental shelf is narrow which enhances the probability of upwelling in this region.

b) The Luderitz upwelling region. This is the largest upwelling region in the Benguela system and it stretches from the Orange River mouth to Luderitz ($26^{\circ} 40'S$ $18^{\circ} 10'E$)(Stander 1964).

Off-shore of the upwelling systems the Benguela current flows parallel to the coast in a northerly/north westerly direction. Nelson and Hutchings (1983) described it as an ill - defined movement of water which forms the eastern boundary of the South Atlantic gyre.

Certain of the data arise from sightings and catches in the east and west coast whaling grounds. For purposes of this study these grounds are defined as follows :

i) the east coast whaling ground :- an area between 27° and $33^{\circ} S$ and 28° and $35^{\circ} E$ (figure 2).

ii) the west coast :- the area between 31° and 19° E (figure 3).

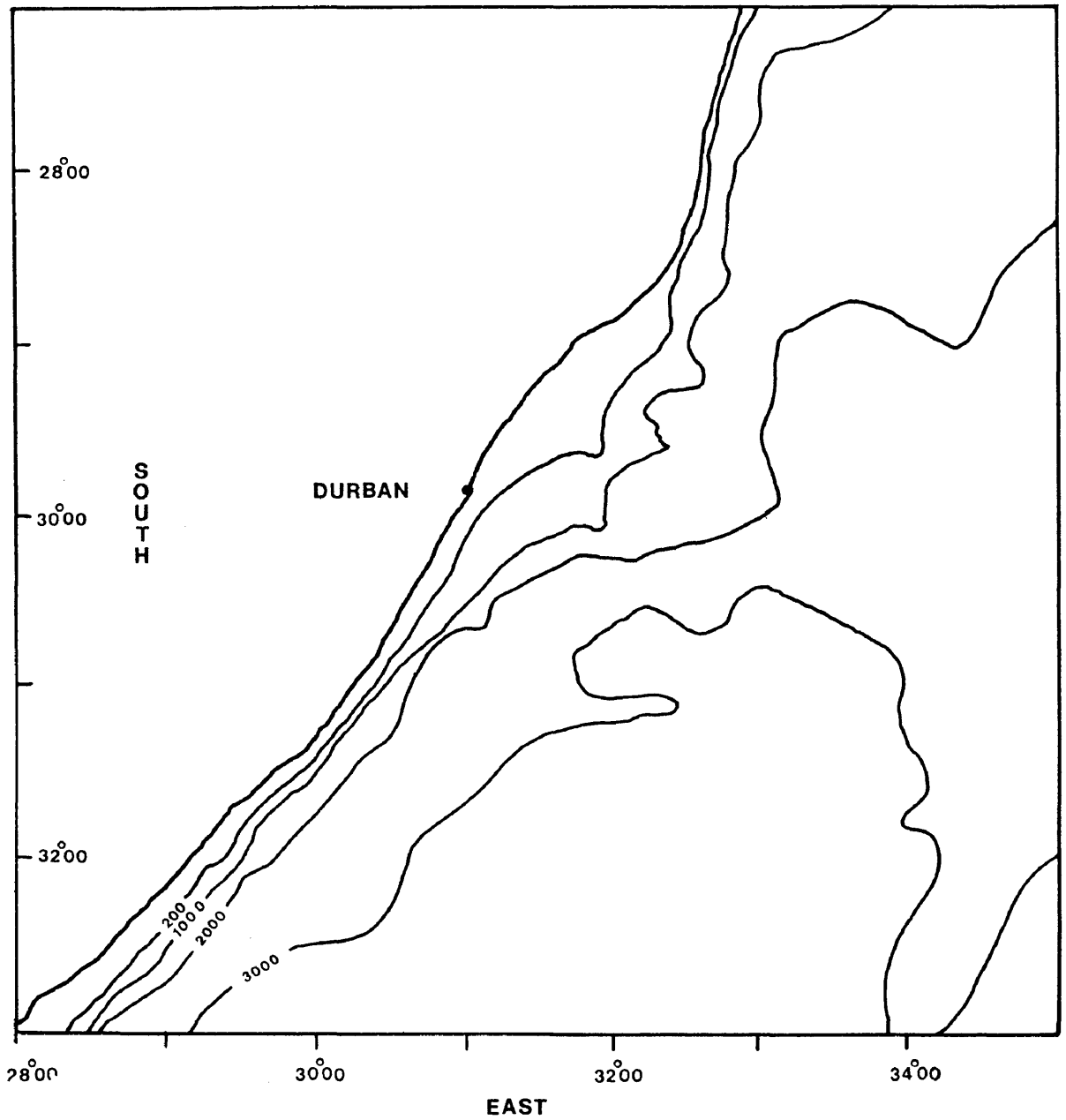


Figure 2. The bathymetry of the east coast whaling grounds. Isobaths are in metres.

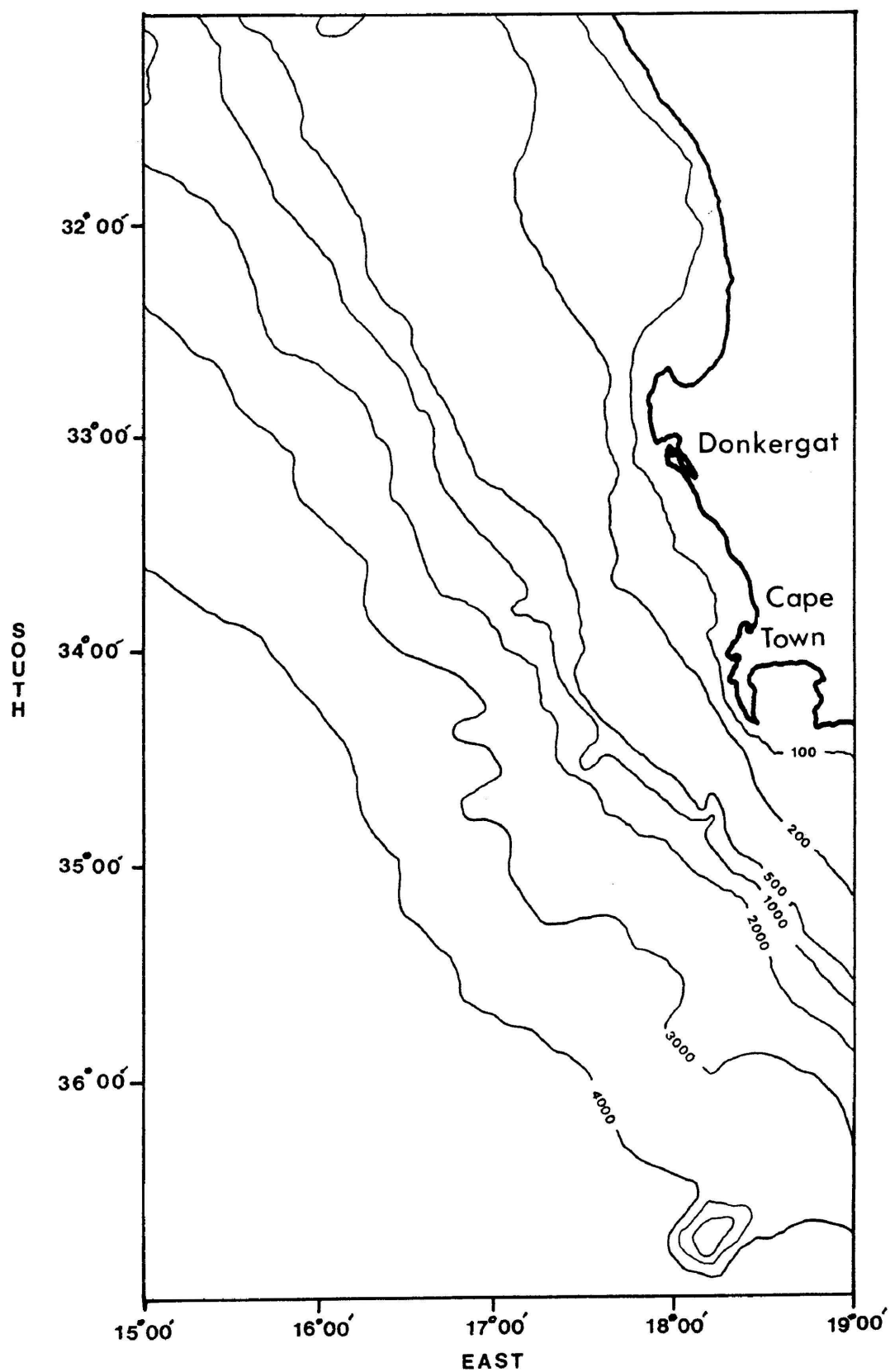


Figure 3. The bathymetry of the west coast whaling grounds. Isobaths are in metres.

MATERIALS AND METHODS.

A review of both published and unpublished records of sightings, strandings and specimens, reported from within the study area prior to the end of June 1986, was carried out to define distribution patterns. In order to facilitate analysis the data were organised in data retrieval files depending on their source. The data had their origins in :-

1) Dedicated scientific surveys:

These were surveys in which an associated measure of effort was recorded so that densities of animals may be calculated. Effort is usually defined as the distance steamed or flown during times of active searching. Usually there was no associated measure of the width of the effective search path, so that measures of density are in reality "encounter rates", and as such reflect relative rather than absolute densities. These surveys can be divided into two types:-

a) **Scientific flights and cruises.** Here government research vessels or specially chartered aircraft and vessels were used and vessel search tracks and aircraft flight paths are shown in figure 4. These search tracks and flight paths are representative of search effort in that only periods of active searching are plotted. Marine mammal scientists were present on all such flights and cruises which include;

- 1) Eleven Sea Fisheries Research Institute marine mammal cruises between 1975 and 1986,
- 2) Seven Indian Ocean whale marking cruises between 1968 and 1975 (IOS 1969, 1971, 1972, 1973, 1975),
- 3) one West Coast whale marking cruise in 1963,
- 4) Three Benguela Ecology Programme predator cruises between 1983 and 1985,
- 5) One Southern African Bryde's whale (inshore stock) survey cruise in 1983,

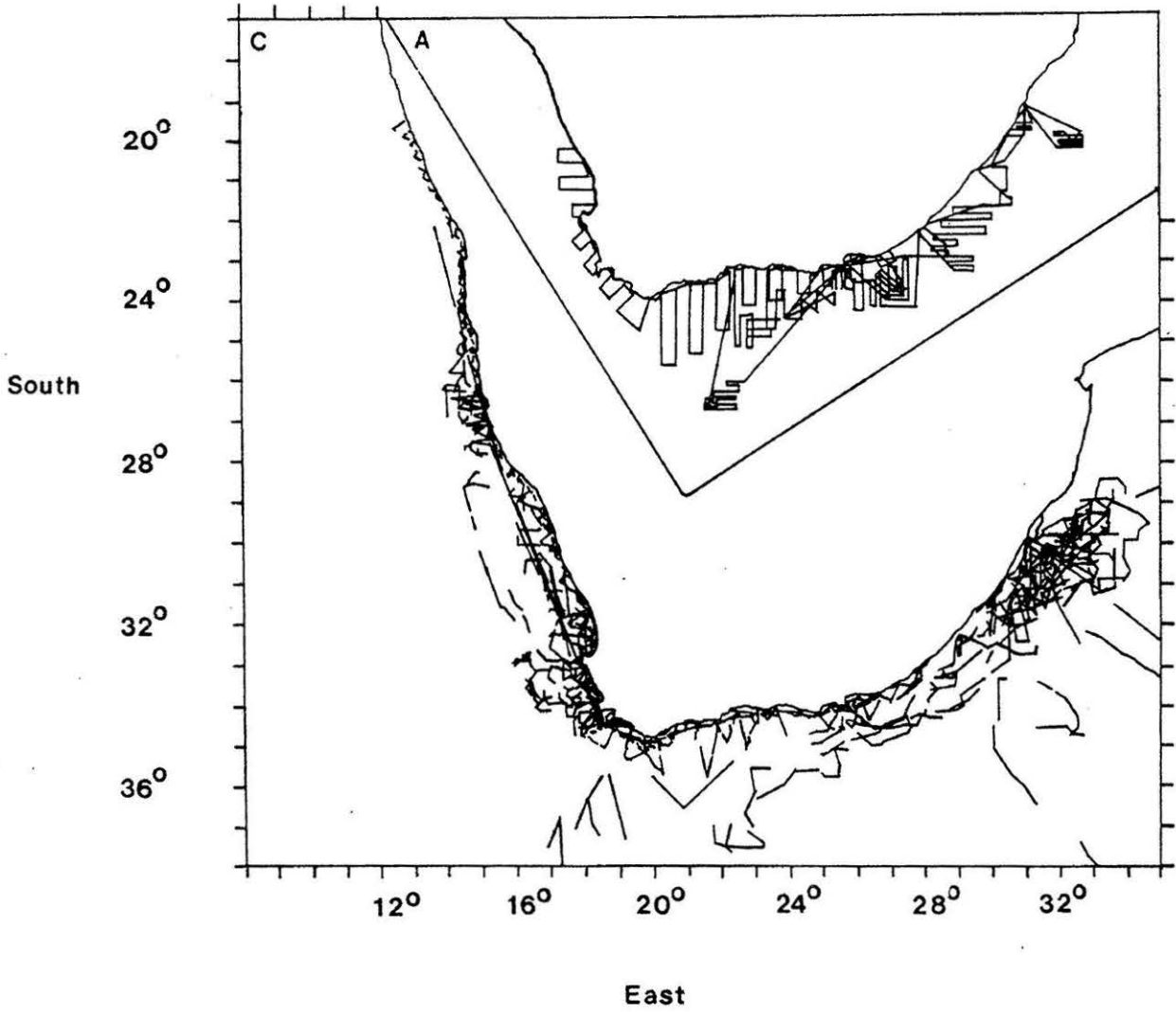


Figure 4. The distribution of scientific cruise (C) and aerial (A) search effort analysed in this study.

- 6) the East coast dolphin census flights carried out by Port Elizabeth Museum in 1980 and 1984,
- 7) one South coast Aerial census for Bryde's whales in 1982,
- 8) one whale marking aerial spotter flight in 1975.

All species of cetacea seen were recorded. The sightings positions were entered into the database to the nearest one minute of latitude and longitude (as navigation technology used hardly justified any greater accuracy). Each record was given field entries which described both their type (primary - on effort; secondary - off effort) and status (whether species identity and / or number confirmed). When an estimated range of school sizes was recorded by the observer, the number entered into the database was the mean of the range, rounded upwards to the nearest integer where necessary. In total some 25 000 nautical miles were searched during scientific cruises and a further 8 000 nautical miles during flights. Seven hundred and forty seven sightings of a total of approximately 26,000 cetacea were recorded on these surveys.

b) Commercial searches.

These data arise from two sources namely :-

i) West coast whaling operations, 1963. Catches and aerial sightings of whales made off Saldanha Bay by catchers and spotter aircraft attached to the Donkergat whaling Company between March and October 1963 were analysed. The aerial spotter data had been collected from a Piper Apache aircraft with a crew of one pilot and two spotters flown at an altitude of 1000 feet and at a speed of 100 to 120 knots (depending on the weather and other factors). Species recorded included fin, sei, sperm, Bryde's and killer whales (i.e. most species of small cetacean were either unrecognised or unrecorded). The catches were made by a total of six catchers. Two of these catchers operated for the entire season, while further catchers were added to the fleet on the seventeenth of March (one), the seventh of May (two)

and one further catcher operated from the fifth the second of October. Blue, fin, sei, minke, humpback, Bryde's and sperm whales were taken on these grounds. The area searched by the spotter aircraft each day was recorded as the number (and identity) of 10 minute squares of latitude and longitude visited. The search pattern of the catchers had to be reconstructed from their positions radioed in five times a day (07h15, 11h15, 15h15, 17h15 and 20h15) to the station. These positions were connected by straight lines for each catcher, and search effort recorded as the number of 10 minute squares visited at least once each day by each catcher. Periods when the catcher was picking up flagged whales or towing them in were not included. Effort was entered into separate data retrieval files as the total number of visits of either the aircraft or the catchers to each cell for each month, March to October inclusive. Distributions of aerial and catcher search effort are shown in figures 5 and 6 respectively. Sightings and catches were entered into separate data retrieval files as the total number of either sightings or catches of each species in each cell for each month from March to October. Relative densities were then expressed as the number of whales seen (by the aircraft) or caught (by the catchers) per visit to that square. It should be noted that these are not entirely independent indices as the search area of the aircraft was partly influenced by the positions of the catchers, and in particular some of the whales caught by the catchers may have been spotted first by the aircraft. Unfortunately however no measure of the possible level of this interaction exists, and it has been assumed that both are independent for the purposes of this thesis. Certainly the spotter aircraft was not as efficient, nor did it work so closely with the catchers, as the aircraft off Durban (P. B. Best, pers. comm.). In total, 344 sightings of 3174 animals and 728 catches of 3476 animals were made in the west coast whaling grounds in 1963.

ii) East Coast Whaling operations, 1972 - 1975. Daily charts giving the flight path searched and the associated sightings made by the spotter aircraft working for the Union Whaling Company in the east coast whaling grounds were made available for 628 flights between 1972 and 1975. This material amounted to some 430 000 nautical miles of searching off the Natal coast between the months of February and October inclusive. The altitude and speed of the spotter aircraft (a Cessna 310) were usually 500 feet and 135 knots respectively, although these were weather dependent. The crew usually

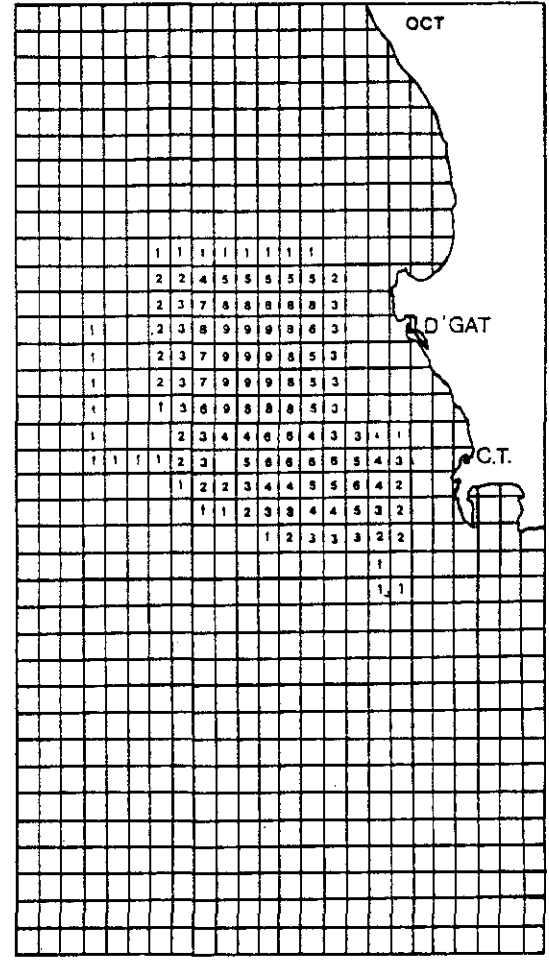
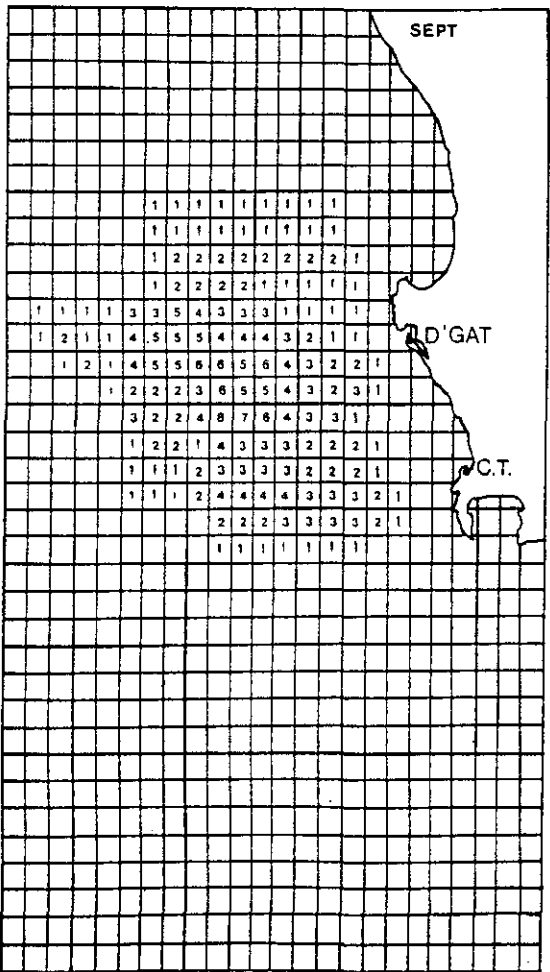
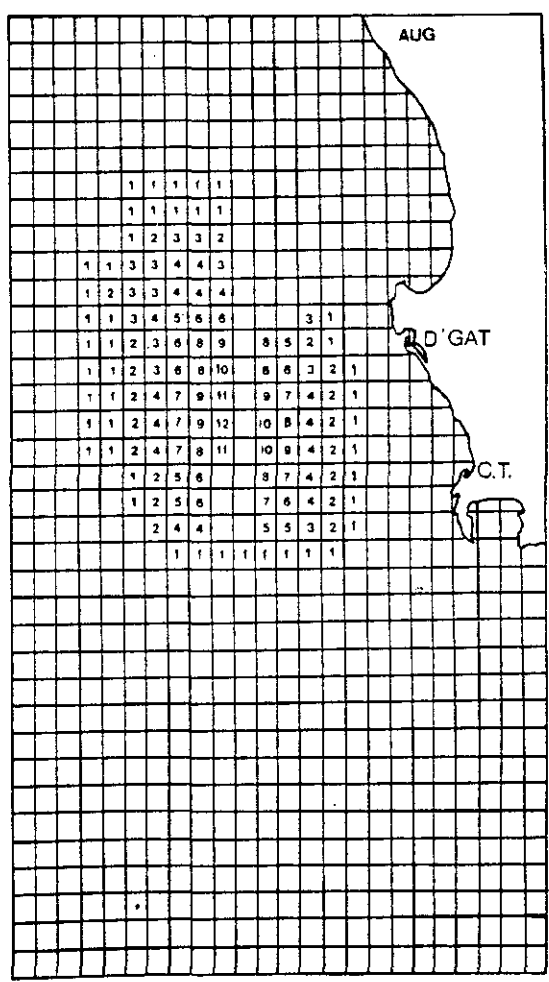
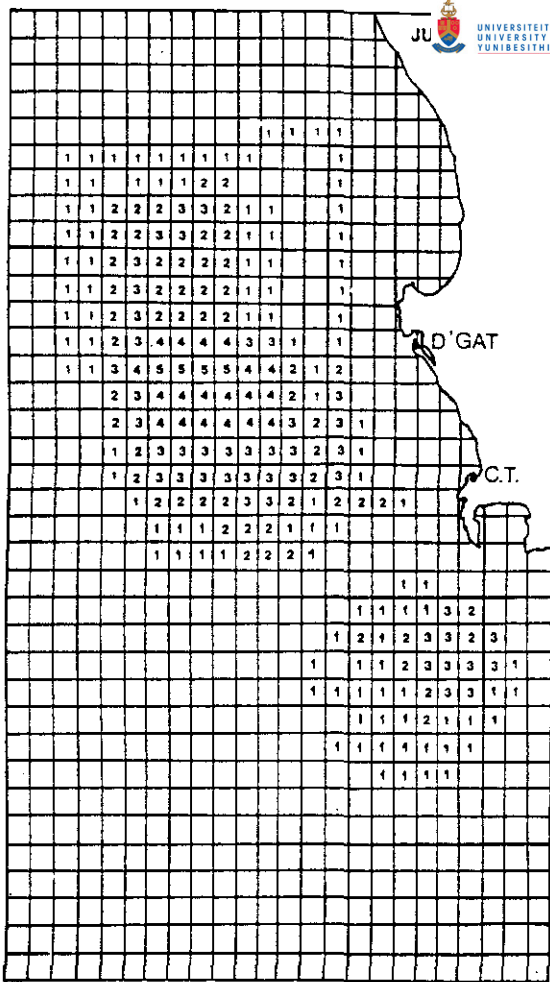


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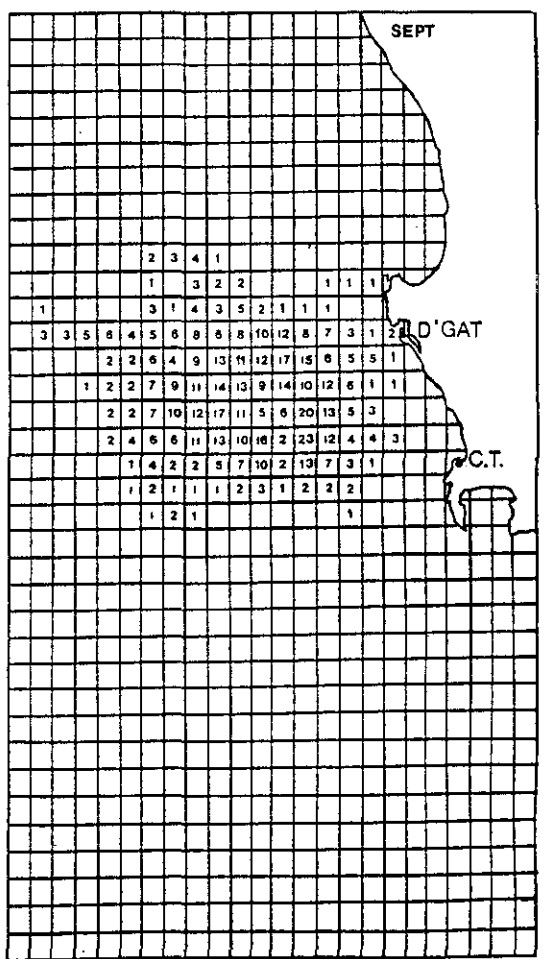
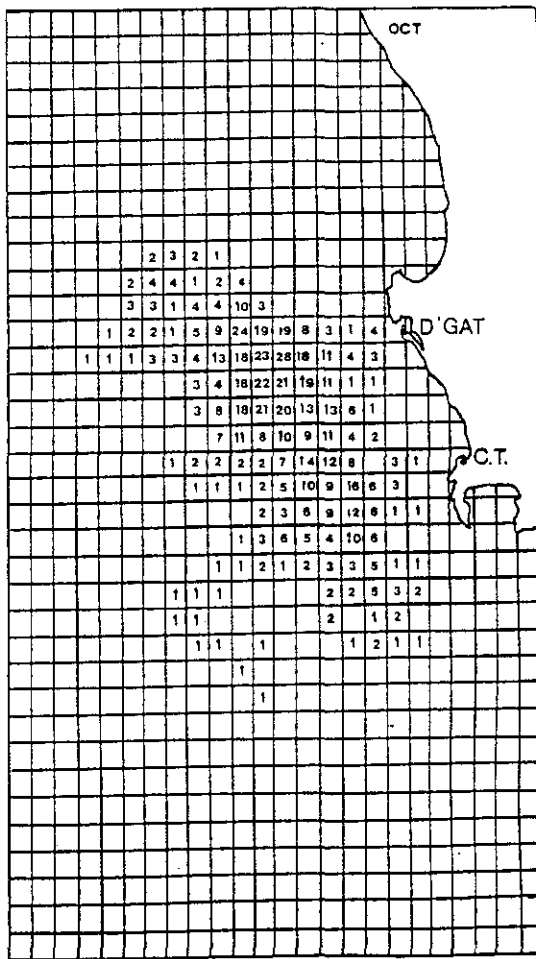
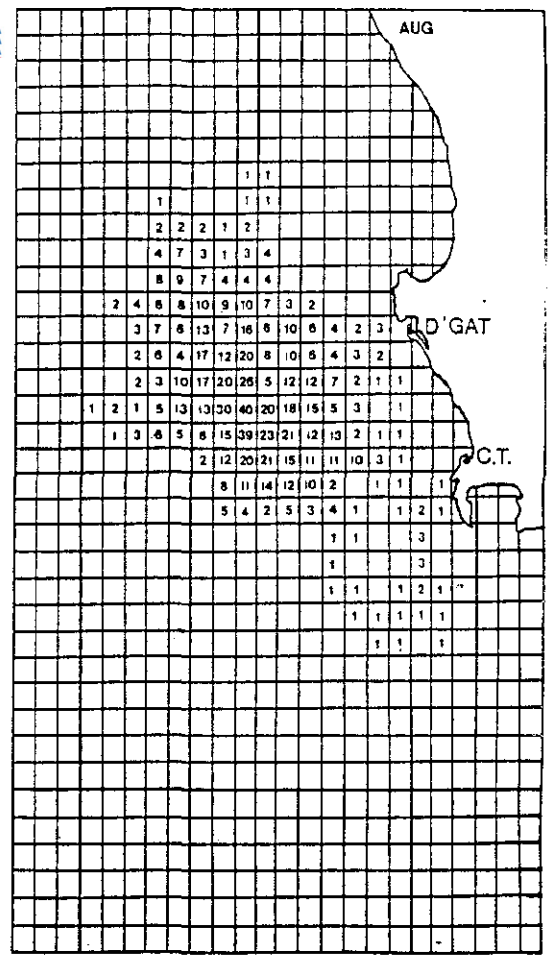
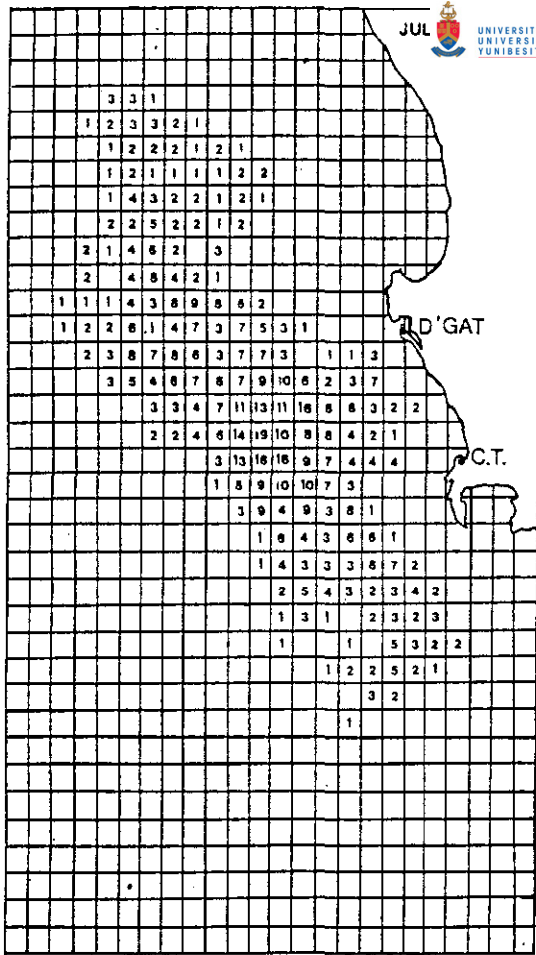


Figure 6. continued.

consisted of a pilot and one spotter. All positions plotted were measured as bearings and distances from Durban harbour by radio beacon. The flight paths and the species, number and positions of each sighting were entered into a data retrieval file for each flight undertaken. Species recorded in the east coast whaling grounds included blue, fin, sei, minke, humpback, sperm, bottlenose and killer whales (i.e. most species of small cetacea went unrecognised or unrecorded). Flight paths were entered from the daily charts as a startpoint, waypoints and an endpoint for each flight, while the positions of the sightings were entered from a separate diarised log as bearings and distances from Durban harbour. Positions of sightings were converted from bearings and distances to latitudes and longitudes by a Fortran application programme, and as longitudinal distances vary with latitude, that used in the algorithm was taken as a mean of the longitudinal distances at Durban and at the latitude at which the sighting occurred. Because of the imprecise navigation aides used at that time, effort and sightings were analysed per 10 minute square of latitude and longitude. The monthly distribution of search effort is shown in figure 7. Densities were calculated on an "encounter - rate" basis (as the number of whales seen per nautical mile searched). As with the other dedicated sighting data, no estimates of track width are available, so that the encounter rates and as such they must be considered as relative rather than absolute densities. A total of 2302 sightings of 22472 animals was made in this whaling ground between 1972 and 1975.

2) Incidental sightings:

These sightings were made from various platforms (land, ship-board or aerial), and were reported to the Sea Fisheries Research Institute or the Mammal Research Institute by casual observers or were extracted from published literature. No associated searching effort was available, so the sightings can only be analysed on a qualitative basis. Incidental sightings were only included in the database when it was certain that the identification was correct (i.e. where the observer supplied clear photographs or was known to have had sufficient experience in cetacean identification). Near-shore records of southern right whales (*Eubalaena australis*) on the South African coast were excluded from this database due to much more extensive data collected during the annual southern right whale censuses between 1969 and 1987 (see Best 1981, in press). Records of live captures of small cetacea for oceanaria were included as

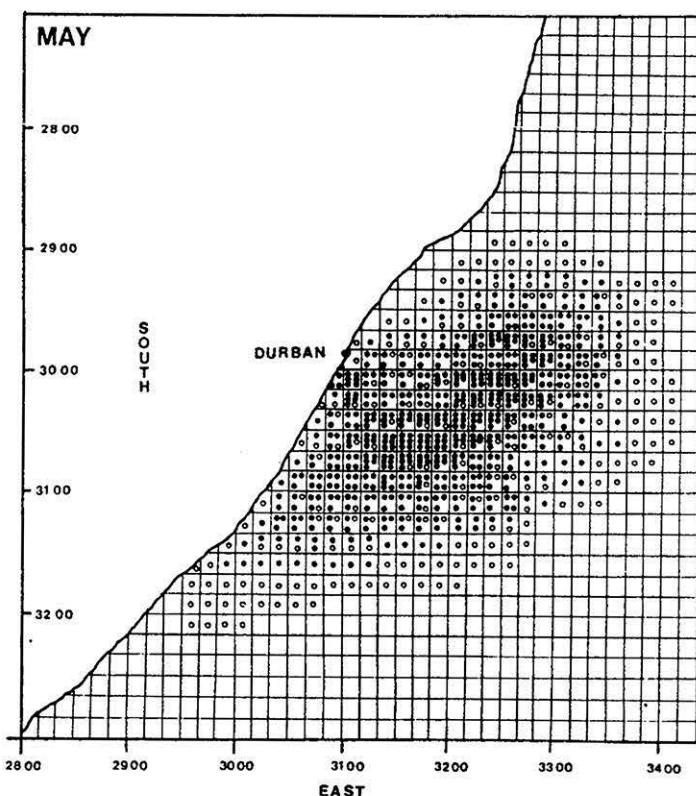
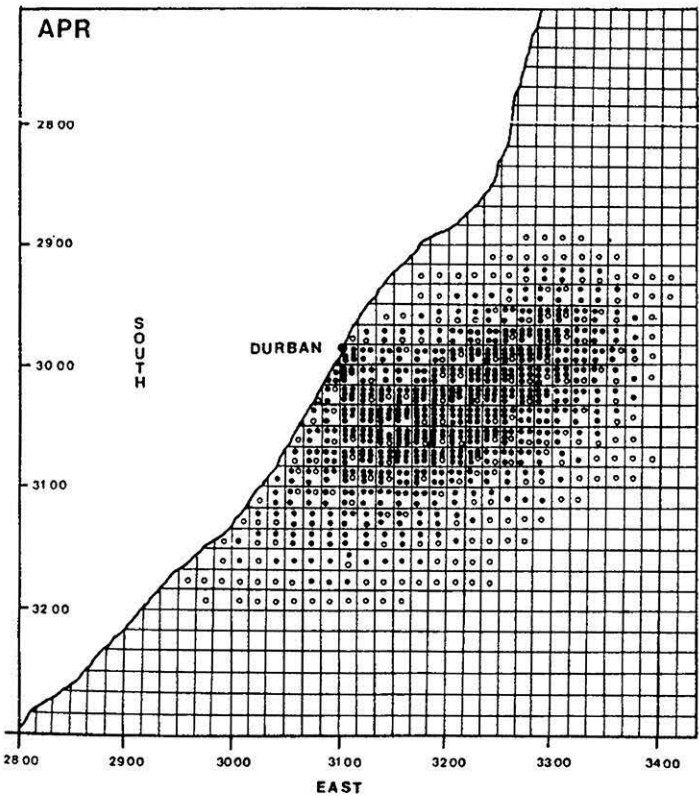
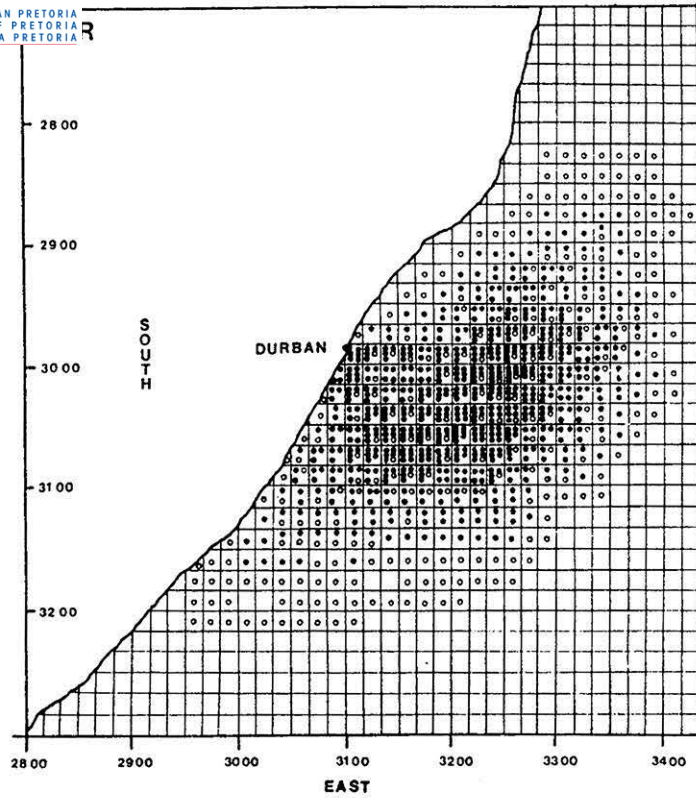
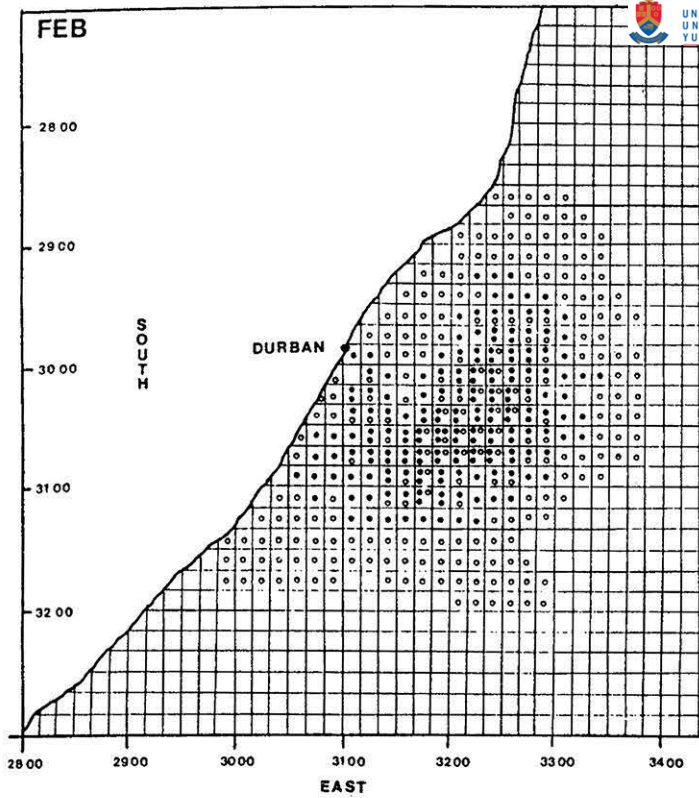


Figure 7. Distribution of aerial effort in the east coast whaling grounds between 1972 and 1975 per month.

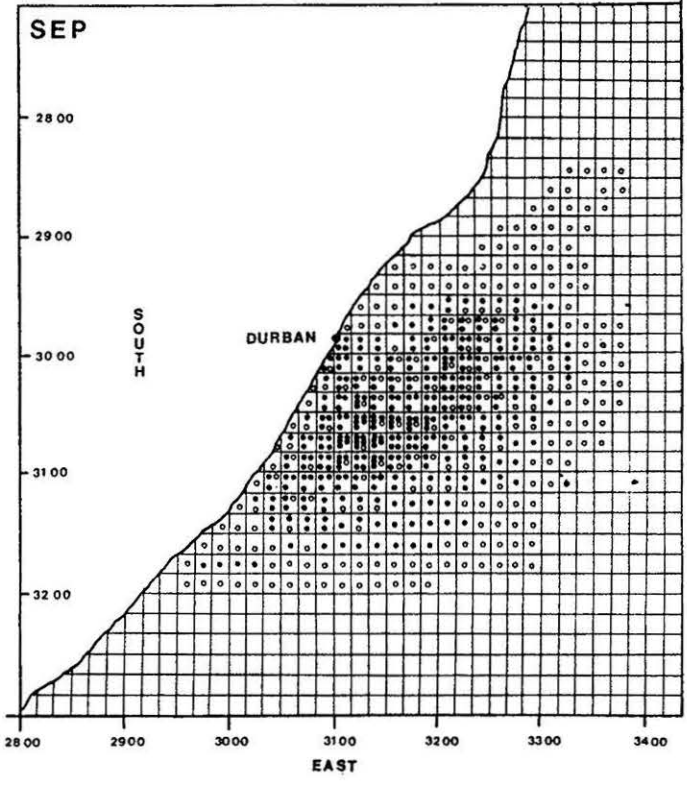
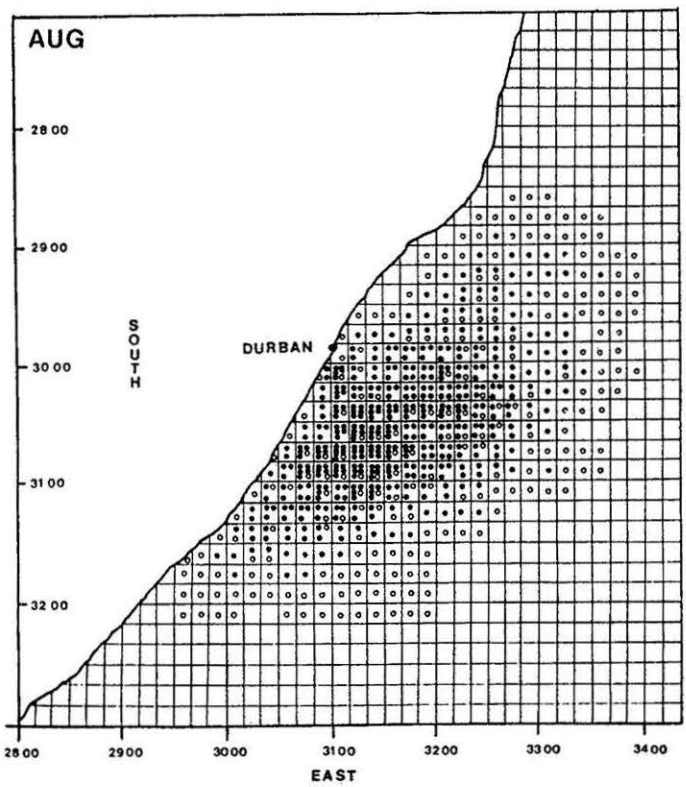
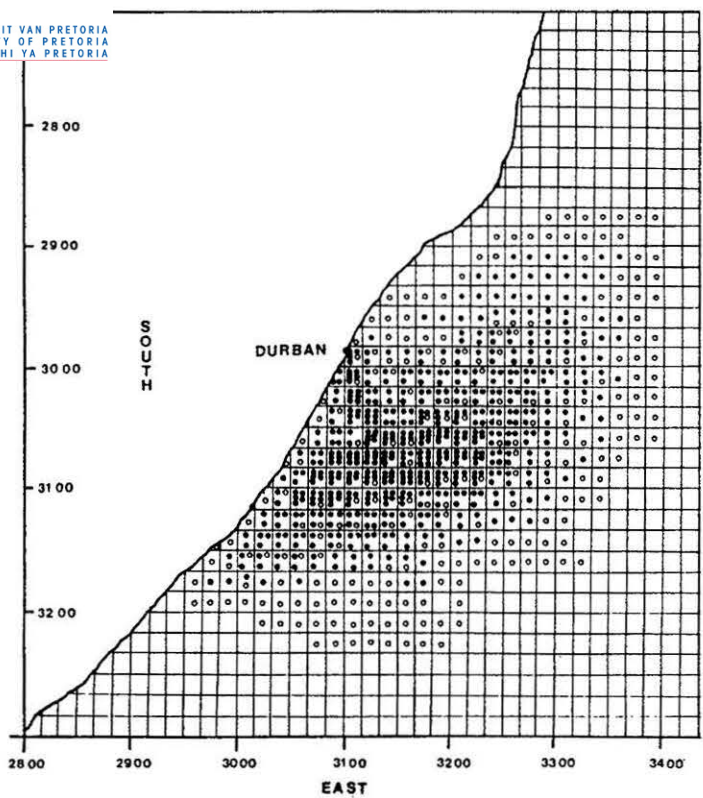
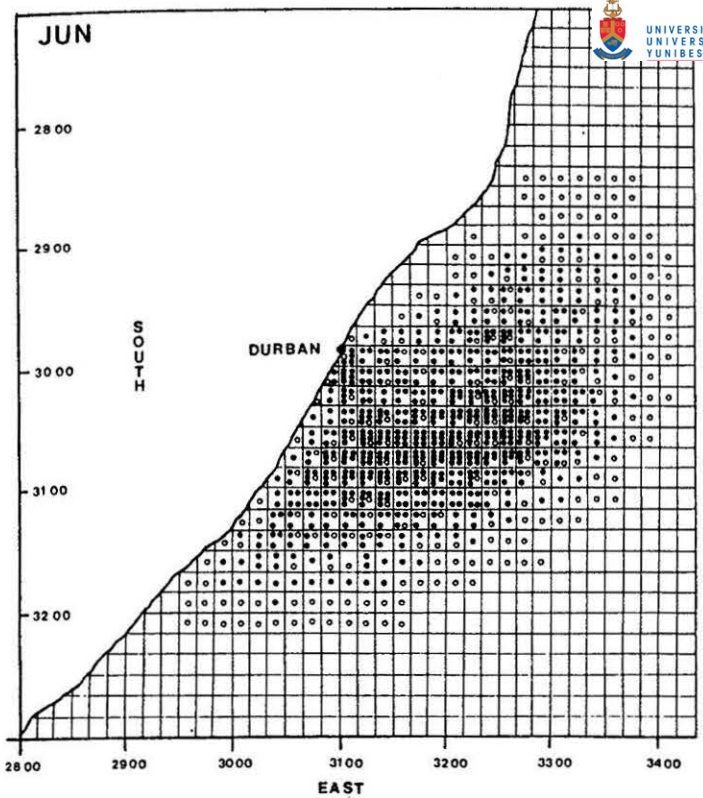
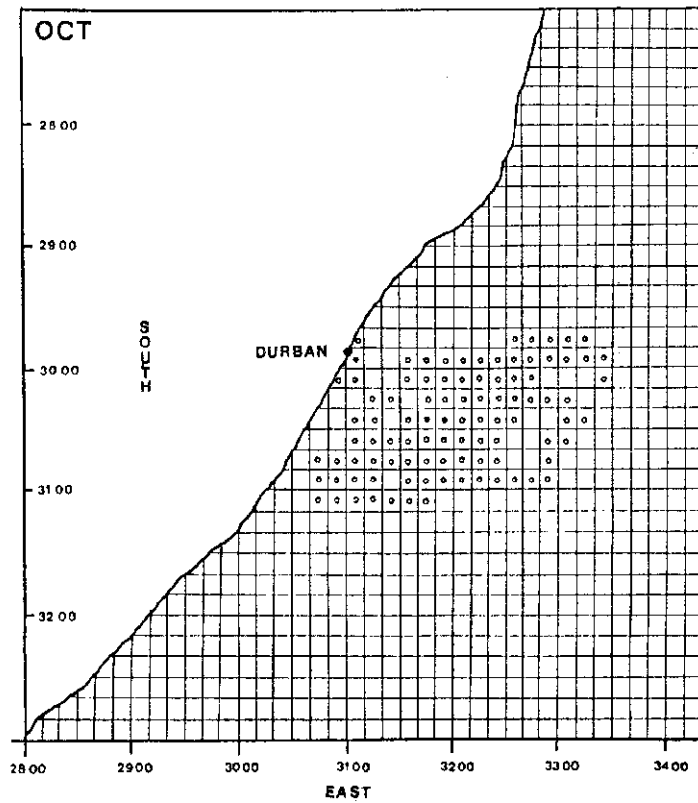



Figure 7. continued.



Key (nautical miles searched)

0 - 49	○	200 - 249	● ●	400 - 449	● ● ● ● ○
50 - 99	●	250 - 299	● ● ●	450 - 499	● ● ● ● ●
100 - 149	○ ●	300 - 349	● ● ● ●	500 - 549	● ● ● ● ● ● ● ● ○
150 - 199	● ●	349 - 400	● ● ● ● ●	550 - 599	● ● ● ● ● ● ● ● ● ●

Figure 7. continued.

incidental sightings (the number observed in  UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA ered and not the number caught), as were a number of published sightings (eg. Cruickshank and Brown 1981; Saayman, Bower and Tayler 1972 - original data supplied by D.Bower). Some 408 records of incidental sightings of a total of approximately 18,800 animals have been placed in the database.

Although useful in supplementing the data on certain species' distribution (i.e. killer whales off Cape Point and southern right -whale dolphins off Luderitz), incidental sightings show a definite bias towards more densely populated areas and areas of high utilisation by humans (figure 8). This bias has not been corrected for.

3) Specimens

One thousand, four hundred and seventy - seven specimens of a total of 2165 animals stranded or present in museum collections were reviewed and placed in a data retrieval file. Specimens were classified as animals stranded live (625) stranded dead (44), found dead at sea (23 animals) or dead on the shore (609), skeletal remains found on beaches (79) or dredged or trawled up at sea (nine), animals found in the gut of a predator (two) and animals caught incidentally (including shark net mortalities) (506) or directly (138). The data records arose from the following sources :-

a) Specimen records held by Dr P B Best. The majority of these specimens were recorded from the Kunene river mouth to Mossel Bay and associated material is lodged in the South African Museum.

b) Specimen records held by Dr G.J.B.Ross and Mr V. Cockcroft - Port Elizabeth Museum. The majority of these specimens were recorded from between Mossel Bay and Punta du Ouro, and associated material is lodged in the Port Elizabeth Museum.

c) Published records. The literature was searched for additional historical records of strandings as far back as they could be accurately verified.

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

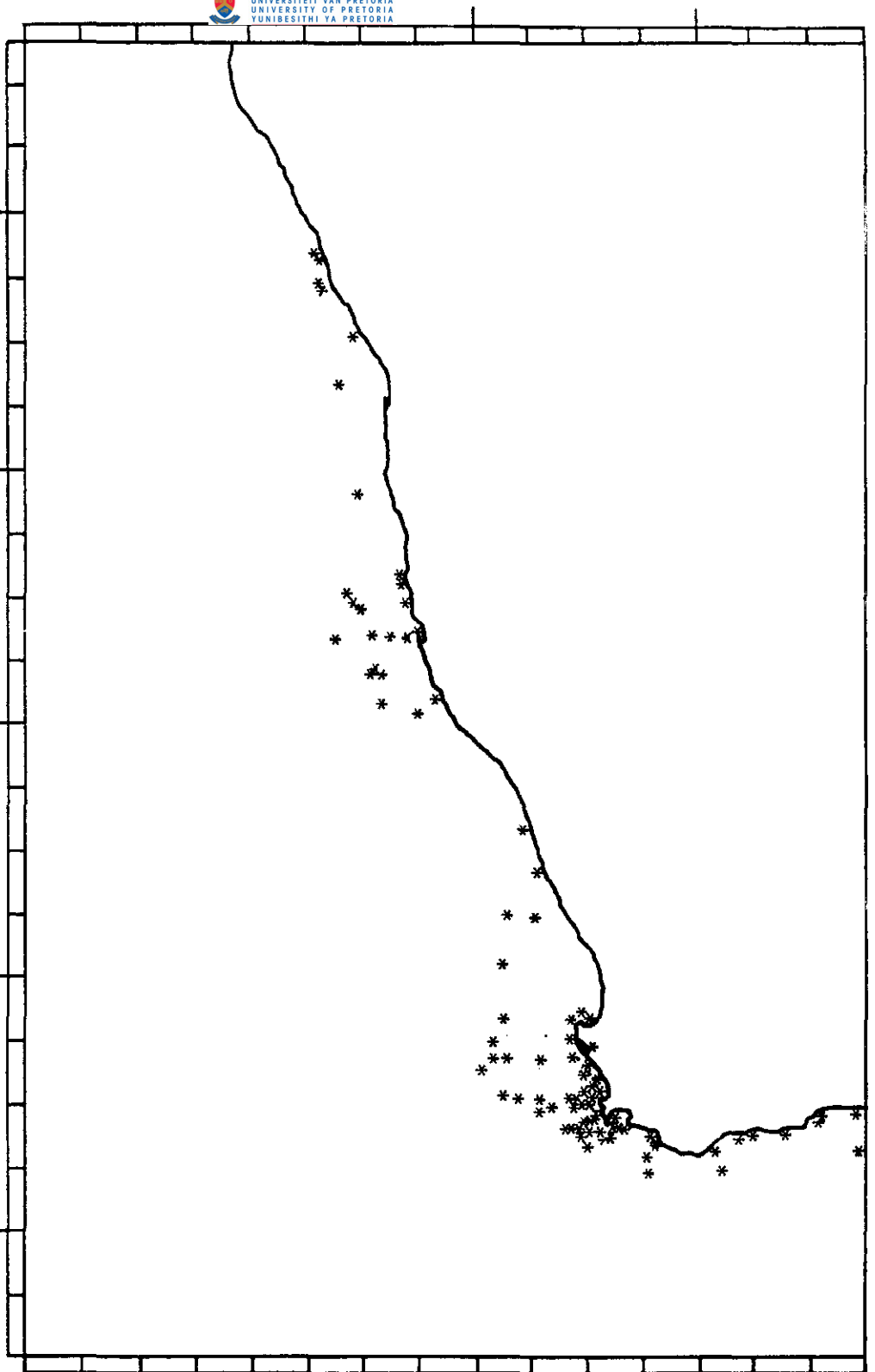


Figure 8. The distribution of all incidental sightings of all species.

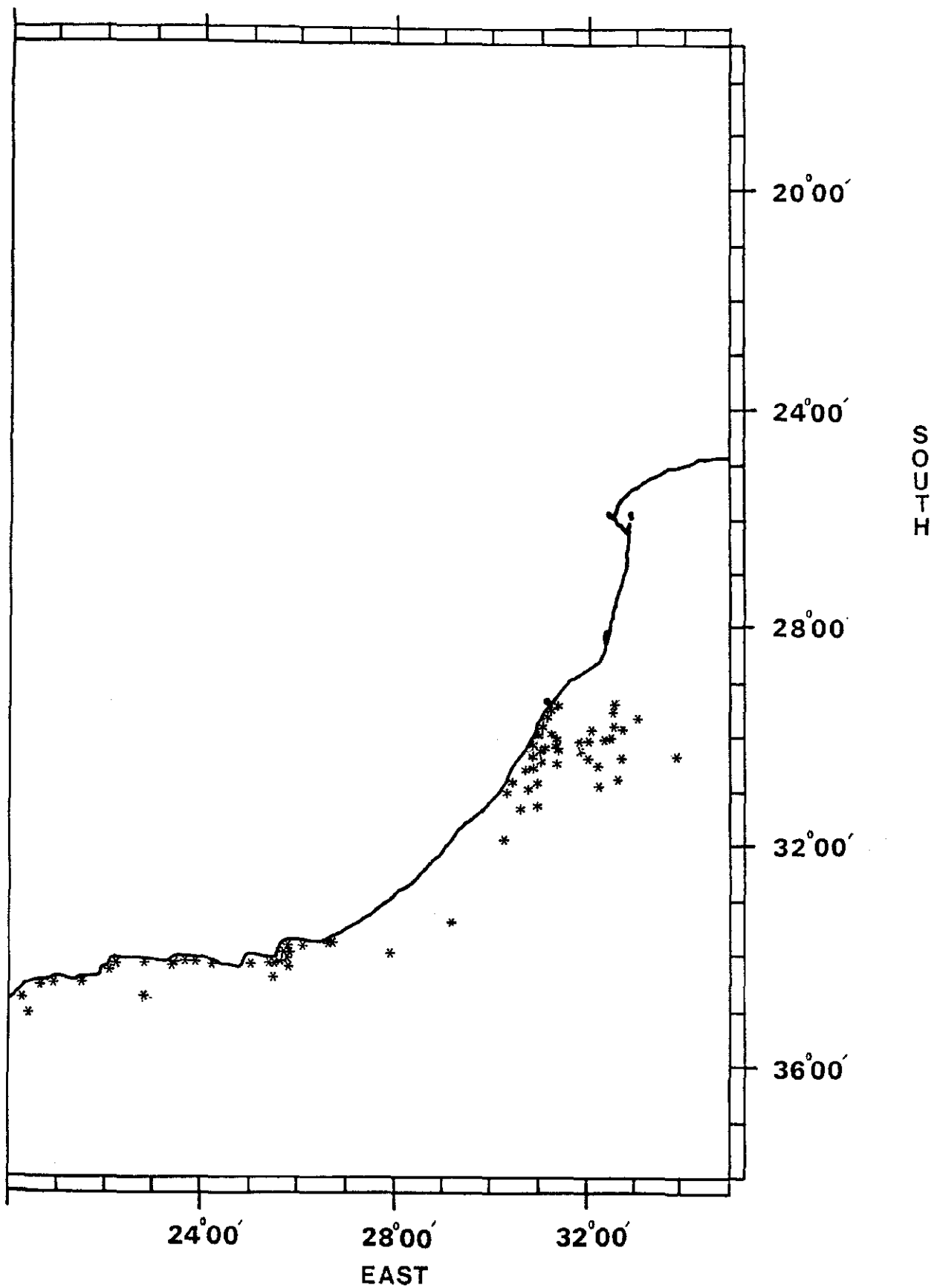


Figure 8. (continued).

d) Museum specimens. Additional records from South Africa held in museums were included in the database where an accurate locality and date of provenance could be determined.

e) Unattended strandings. These are records of strandings that were reported, but not visited, and for which skeletal material was not available. Often the identification was established from photographs.

Certain areas of the southern African coast are relatively unpopulated and under-utilised (particularly on the West coast and there is a noticeable lack of stranding records from such areas (figure 9). By contrast a high incidence of strandings in populated areas is evident. Correction of this bias is difficult as there is a further seasonal bias due to coastal utilisation by holiday makers during the summer months and little quantitative data on beach utilisation are available.

This source file is held by the Whale Unit of the Mammal Research Institute, P O Box 61, Cape Town.

The bathymetry of southern Africa was digitised from the South African Navy charts (scale 1 : 600 000) and included the coast, 50 m, 100 m, 200 m, 500 m, 1000 m, 2000 m, and 3000 m depth contours.

Application programmes written in Fortran and Pascal allowed for:

- 1) the plotting of contour maps, cruise and flight tracks and associated sightings, incidental sightings and specimen localities.
- 2) the calculation of the depth interval over which the sighting occurred.
- 3) the calculation of the distance searched on a dedicated cruise or flight per five minute cell.
- 4) the calculation of the relative densities of animals sighted per five minute cell as a function of distance searched or number of visits. (Only primary ("on effort") sightings were used in the calculation of relative densities.)

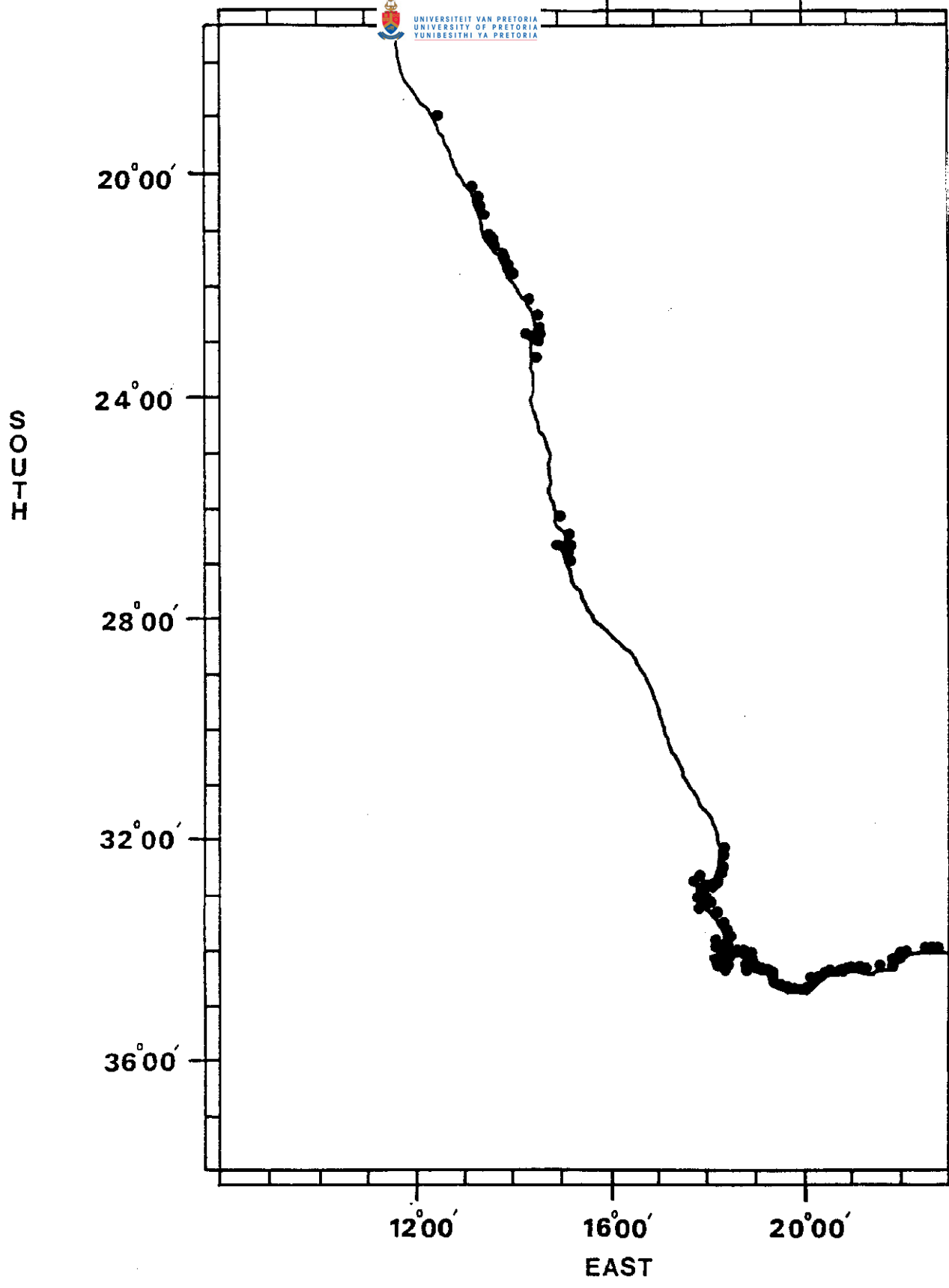


Figure 9. The distribution of all specimen records reviewed in this study.

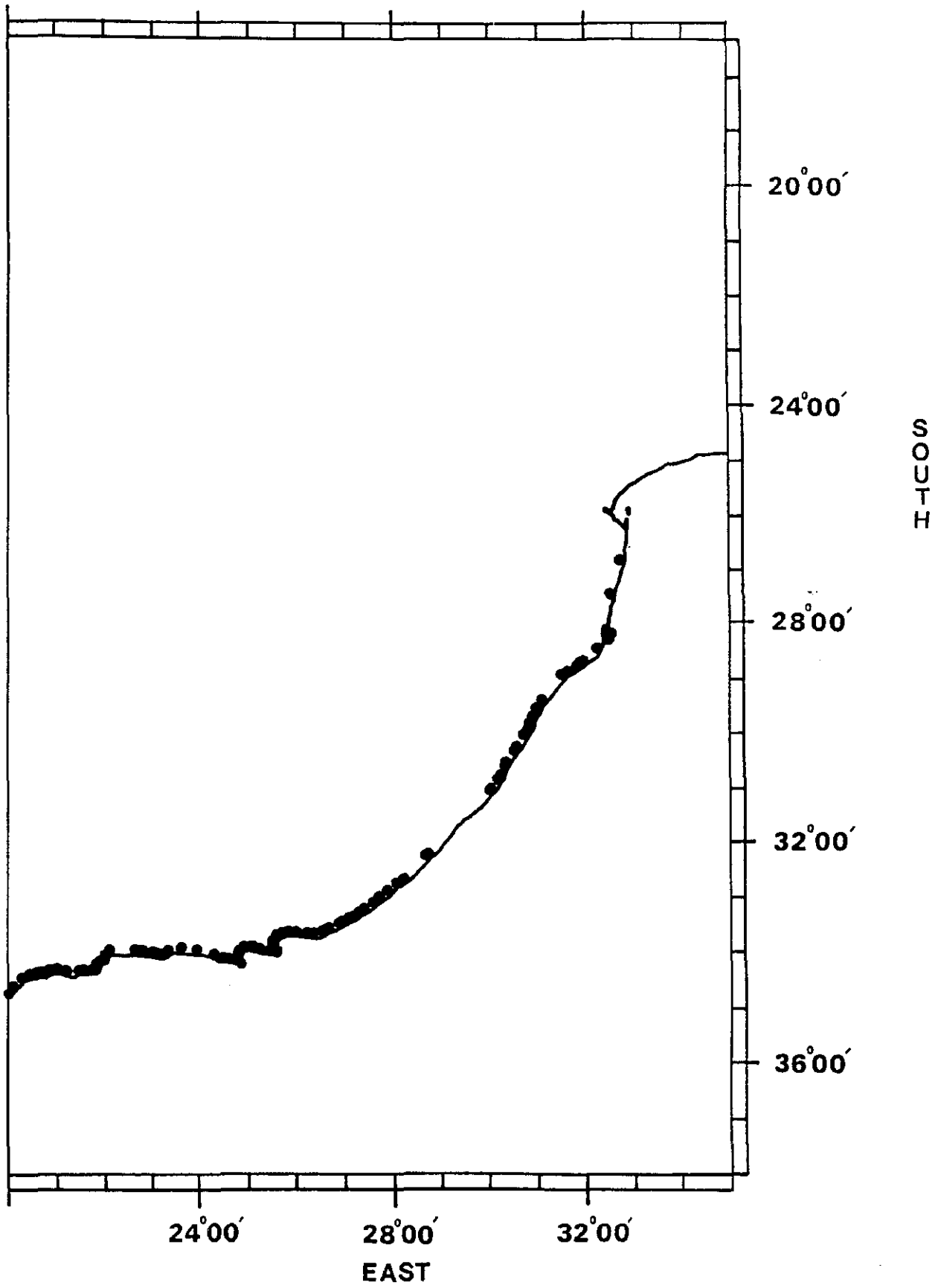


Figure 9. (continued).

5) the calculation of the numbers of strandings per unit distance of coastline per 10 minute square.

Sea surface temperature and salinities, thermocline depths and dissolved oxygen concentrations were extracted from the SADCO (South African Data Center for Oceanology, CSIR, Stellenbosch) database, as means of data collected in each cell of a 30' x 30' grid covering the entire study area. These data have their origin in over 100 years of scientific cruises within the area and it must be noted that they are neither sighting - associated nor real - time measurements, but are taken to represent average conditions for the regions. Means were extracted separately for summer (October to March) and winter (April to September). However, the data coverage for both thermocline depth and dissolved oxygen concentration was not complete or uniform enough to allow for meaningful correlation with cetacean distributions over the entire study area, and such analyses were not carried out.

For analysis of sightings the study area was divided into four areas on the basis of plotted cetacean distributions. The four areas are: -

- 1) Area I - the region west of the subcontinent and north of $32^{\circ} 00' S$
- 2) Area II - the region west of $19^{\circ} 00' E$ and south of $32^{\circ} 00' S$
- 3) Area III - the region lying to the south of the subcontinent between $19^{\circ} 00' E$ and $27^{\circ} 00' E$ and
- 4) Area IV - the region to the east of $27^{\circ} 00' E$.

Search effort and number of each species seen on scientific cruises / flights were extracted for 5 minute square cells of latitude and longitude, and relative densities of each species seen were calculated for each Area in summer and winter. Relative densities were also calculated by depth interval (0-50, 50-100, 100-200, 200-500, 500-1000, 1000-2000 and greater than 3000 metres), sea surface temperature interval ($10^{\circ} - 32^{\circ} C$ in two - degree intervals) and sea surface salinity interval (34.0 - 36.0 ppt in 0.2

ppt intervals) for each of the four Areas. Sea surface temperature and salinity are shown in figure 10. Densities were calculated by summing the number of animals observed in all of the 5 minute cells falling within a particular interval and dividing the result by the distance searched in all 5 minute cells within that particular interval. Densities were calculated separately for summer (October to March and winter (April to September) in each of the four Areas.

Depth, salinity and temperature interval values were also calculated for each incidental sighting and the incidence of the latter are expressed as number of animals sighted per interval.

In discussing the depth distribution of the animals, the term "pelagic" has been used to describe animals occurring off the continental shelf and "neritic" has been used to describe animals occurring over the continental shelf.

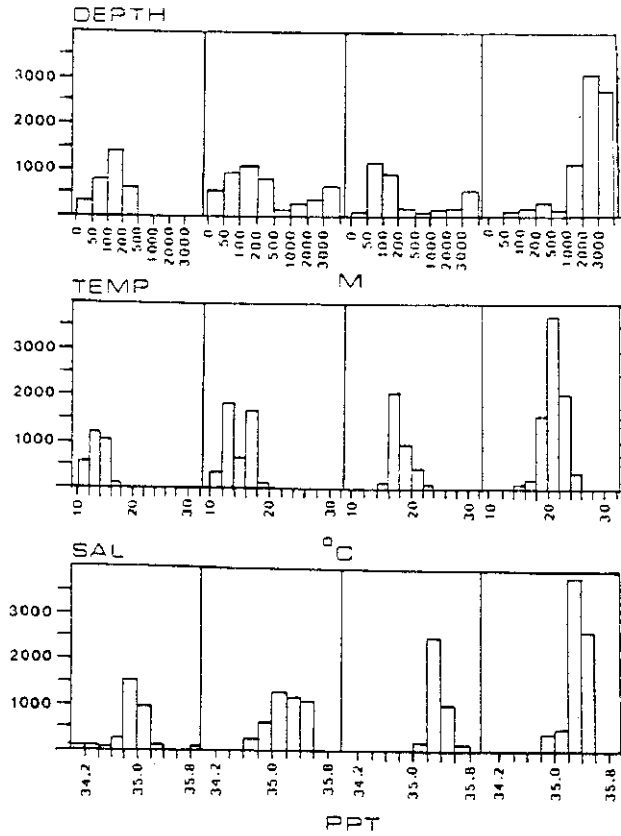
The seasonal abundance of each species in the east coast whaling grounds was calculated as the total number sighted during each month as a function of the distance searched that month, while seasonal abundance in the west coast whaling grounds was calculated as the total number sighted or total number taken during each month as a function of the total number of visits by aircraft or catchers respectively during that month. The density of animals in each of the following depth intervals (0-50, 50-100, 100-200, 200-500, 500-1000, 1000-2000, 2000-3000 and greater than 3000 metres) was calculated as a function of search effort in that interval (nautical miles searched in the case of the east coast and catcher/aircraft visits in the case of the west coast). No attempt was made to analyse these records seasonally with regards to sea surface temperature or salinity as the SADC environmental data sets were not complete enough to allow for monthly correlation to cetacean distributions. The limitations of using mean temperature and salinity values must be further noted in the light of the potential mobility of these cetacean species.

Average school size was calculated for each species sighted in the east coast whaling ground. Averages of

SHIPBOARD

SUMMER

AREA: 1 2 3 4



NAUTICAL MILES SEARCHED

WINTER

AREA: 1 2 3 4

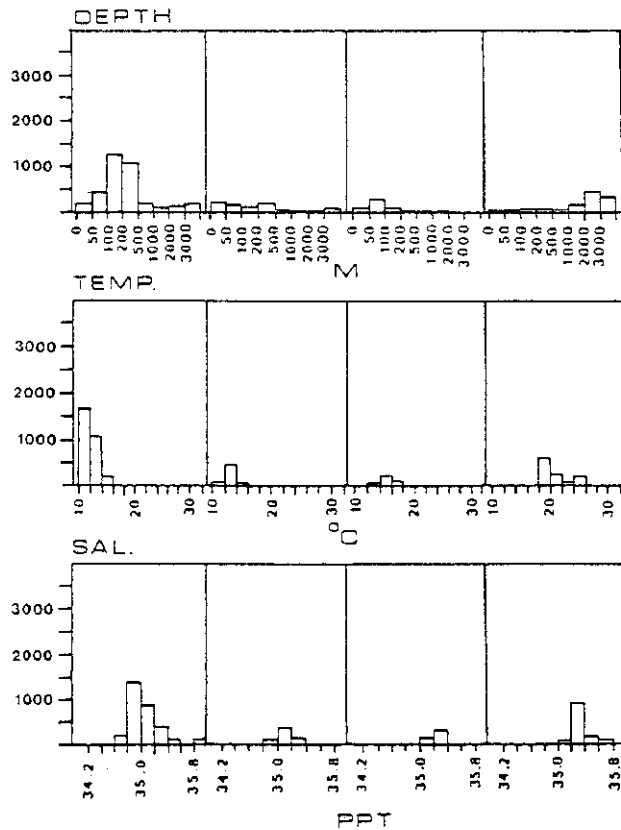
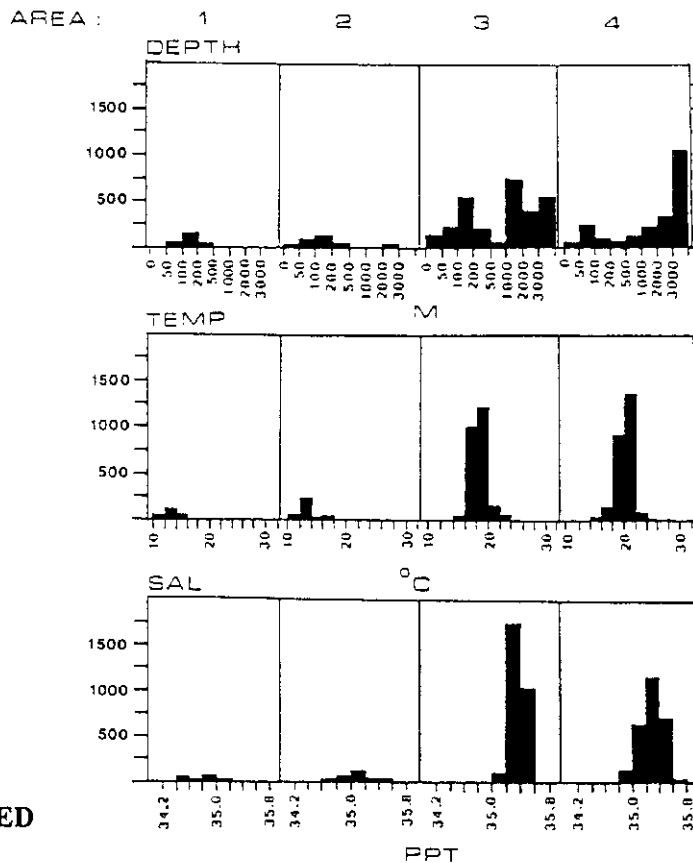


Figure 10. Distribution of dedicated shipboard and aerial search effort by depth, temperature and salinity interval.

AERIAL

SUMMER



WINTER

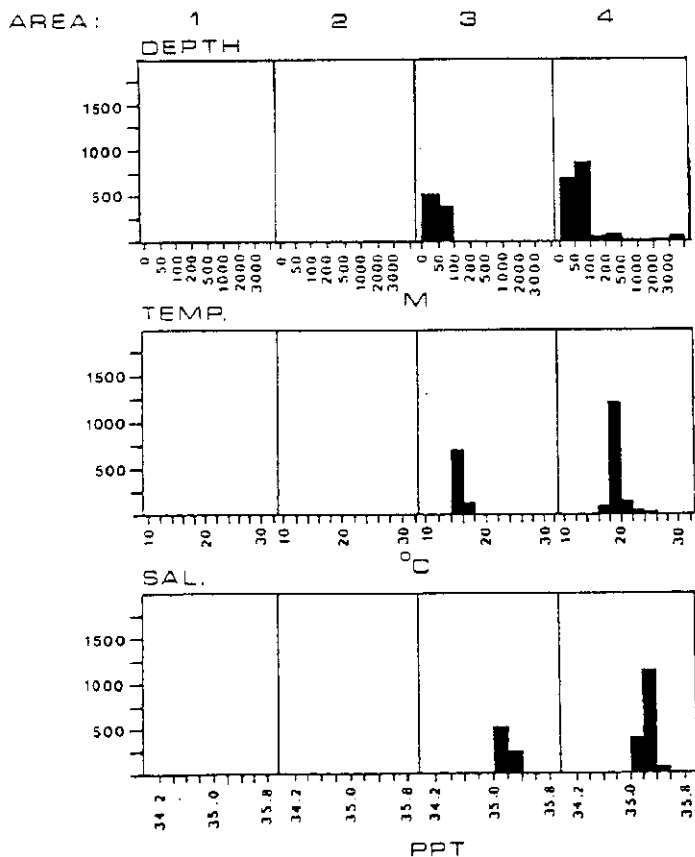


Figure 10. continued.

school size of animals sighted in the west coast whaling ground were not calculated as the data were available as number of animals per cell per month and not as individual sightings.

RESULTS

THE MYSTICETI (Whalebone Whales)

BALAENOPTERIDAE

The blue whale (*Balaenoptera musculus*).

Mackintosh (1942) notes that although the summer Antarctic distribution of blue whales is well documented, little is known of their destination in winter. Kasamatsu, Hembree, Joyce, Tsunoda, Rowlett and Nakano (in press) found that of the 42 schools of blue whales recorded on IWC / IDCR minke whale assessment cruises between 1978 and 1984, 70 percent were within 60 nautical miles of the pack ice. Yochem and Leatherwood (1985) note that blue whales have been recorded as far north as Madagascar on the east coast and Angola on the west coast. Blue whales have reported from the northern Indian Ocean almost all year round (Leatherwood, Peters, Santerre, Santerre and Clarke 1984) and Yochem and Leatherwood (1985) suggest that these may be a separate stock. A further distinct population of blue whales, the pygmy blue whale, is found in the Southern Hemisphere. Ichihara (1964) found their summer distribution to be north of 54° S between the longitudes of 0 to 80° E.

One dedicated sighting of a single animal was recorded in December during the scientific surveys (at 36° 48' S, 21° 53' E) and no conclusions can be drawn as to distribution with respect to water depth, temperature or salinity. The one sighting was recorded in a cell of water depth of over 3000 metres, of mean temperature of between 18° and 20° C and of salinity of between 35.2 and 35.4 ppt.

No incidental sightings or specimens of blue whales were reviewed in this study.

Five sightings of a total of six blue whales were made in the east coast whaling grounds between 1972 and 1975 (figure 11) and two blue whales were taken separately off Donkergat in 1963 (figure 12). These sightings and catches were all in water deeper than 500 metres (figure 13). Olsen (1914 - 15, in Hinton 1915) maintained that blue whales kept far offshore (40 - 60 miles) from the Cape coast, but

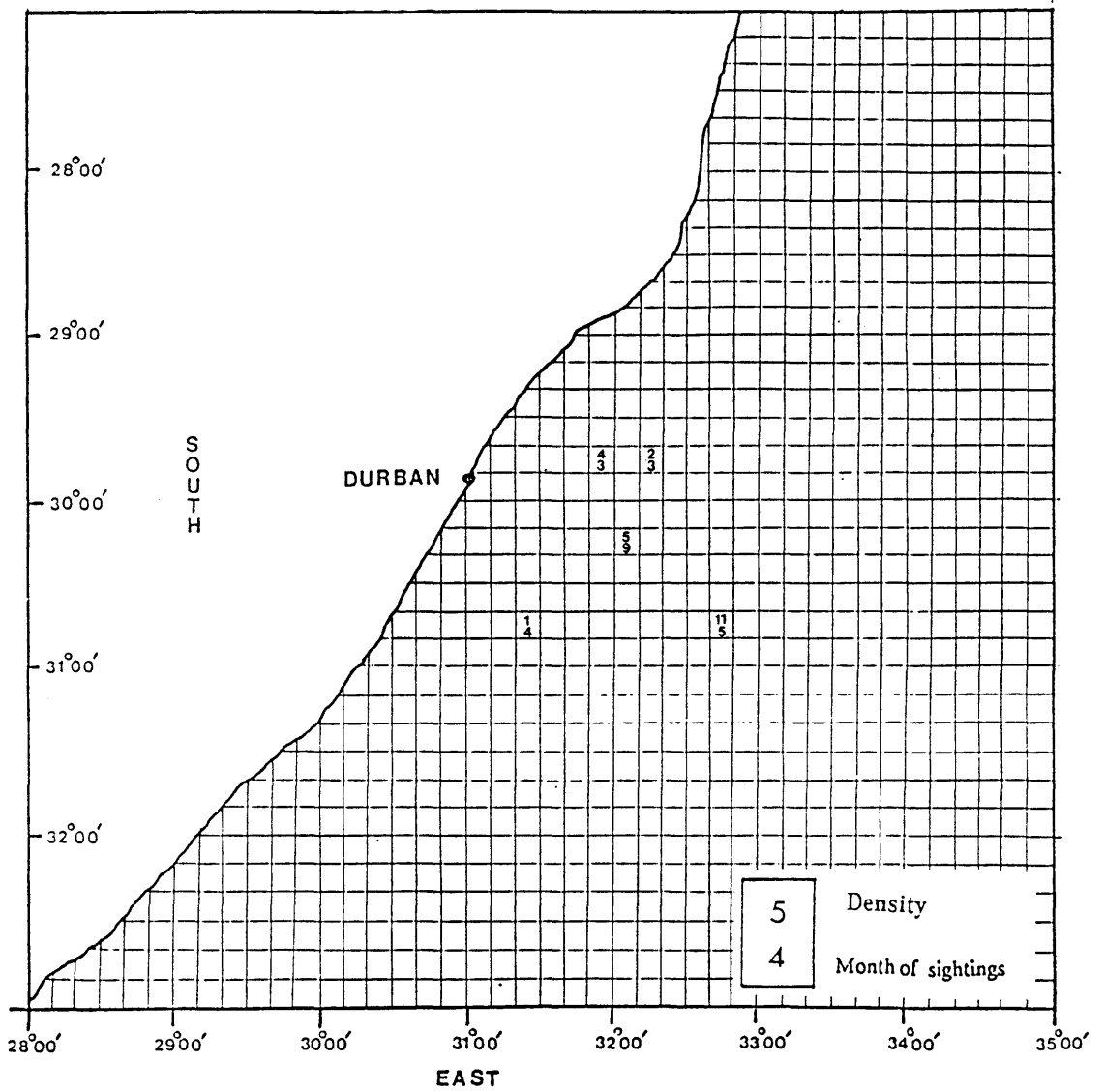


Figure 11. The densities of blue whales sighted off Durban between 1972 and 1975.

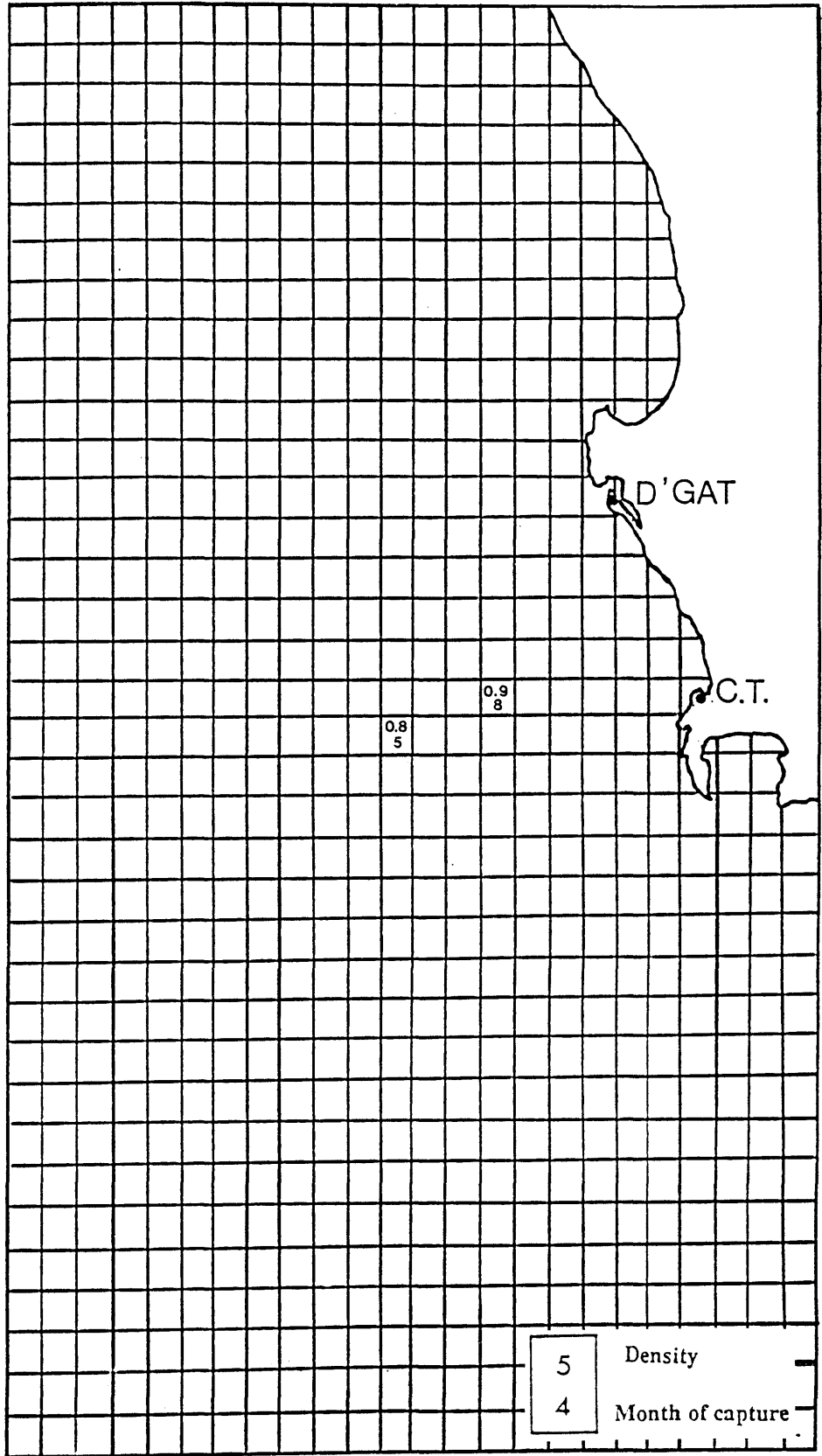


Figure 12. The densities of catches of blue whales off Donkergat during 1963

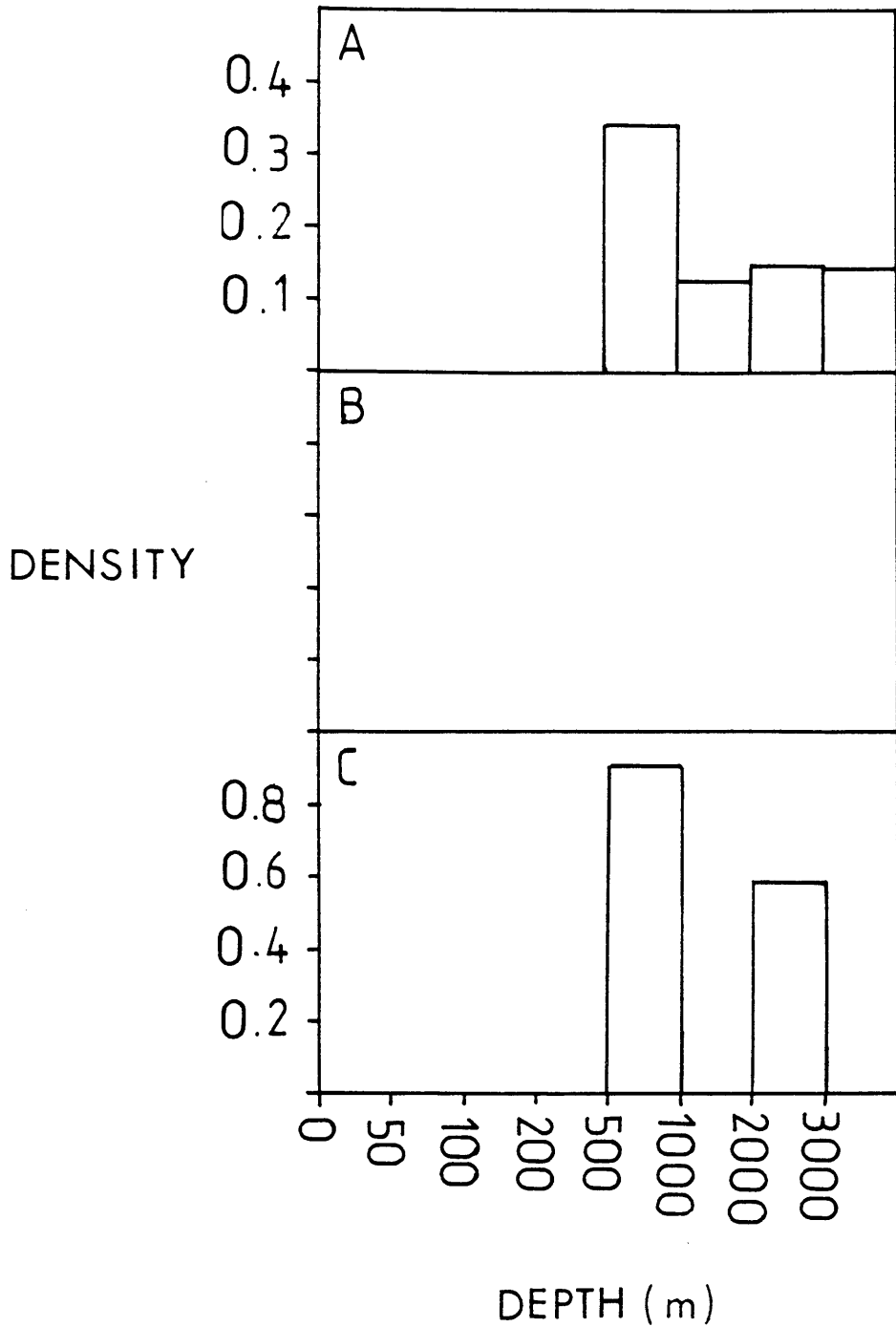


Figure 13. The depth distribution of blue whales recorded in the east and west coast whaling grounds. A: East coast whaling grounds (expressed as number sighted per 1000 miles searched), B: West coast whaling ground sightings (none sighted) and C: West coast whaling ground catches (expressed as number taken per 100 visits).

during June to August large schools migrate from the north. The seasonal abundance of blue whales in the commercial records from both Durban and Donkergat has a bimodal tendency, but the data are too few to draw any conclusions about any migration patterns, except that the species occurs in the east coast whaling grounds between March and September and in the west whaling grounds between May and August. Prior to 1913 Olsen (1914 -15, in Hinton 1915) found blue whales to be present off Cape Province from May to June prior to 1913 and to be scarce off Durban and states that none were taken off Linga Linga ($24^{\circ} 00' S$). Between 1922 and 1928 Harmer (1931) found unimodal (in 1924) and bimodal (other years between 1922 and 1928) trends in seasonal abundance of catches of blue whales off the Cape Province between 1922 and 1928 (although no months of maxima are given), and unimodal trends of catches off Walvis Bay (maximum in August) and Moccamedes Angola (maximum during July and August) between 1924 and 1927. On the basis of the Angola peak being sharper than the Walvis Bay peak he concluded that Angola was nearer to the northernmost point of migration of blue whales than Walvis Bay. Mackintosh and Wheeler (1929) found that a high percentage (80 to 90 percent) of the blue and fin whales taken off South West Africa between 1922 and 1926 were immature animals.

Harmer (1931) further found a unimodal trend in seasonal abundance of catches off Natal with a maximum from June to August, and suggested that the blue whales did not migrate as far north on the east coast due to the warmer Indian Ocean waters. Between 1954 and 1963 Bannister and Gambell (1965) found that blue whales were present off Durban from April to September with a unimodal peak of abundance between April and June and they suggest that although the 56 whales taken over this period are too few to draw any conclusions about the seasonality of the species, the blue whale migrations appear to precede those of other *Balaenopteridae*. Bannister and Grindley (1966) refer to a pygmy blue whale caught off Donkergat in 1962 and suggest that one of the blue whales examined by them at the Durban station in 1962 was a pygmy blue whale. Gambell (1964) refers to a pygmy blue whale taken off Durban during 1964.

The seasonal abundance of the few blue whales recorded in the whaling grounds in these data would confirm the early season arrival of the species in southern African waters, although the one scientific

NUMBER
SIGHTED
PER
1000
MILES
SEARCHED

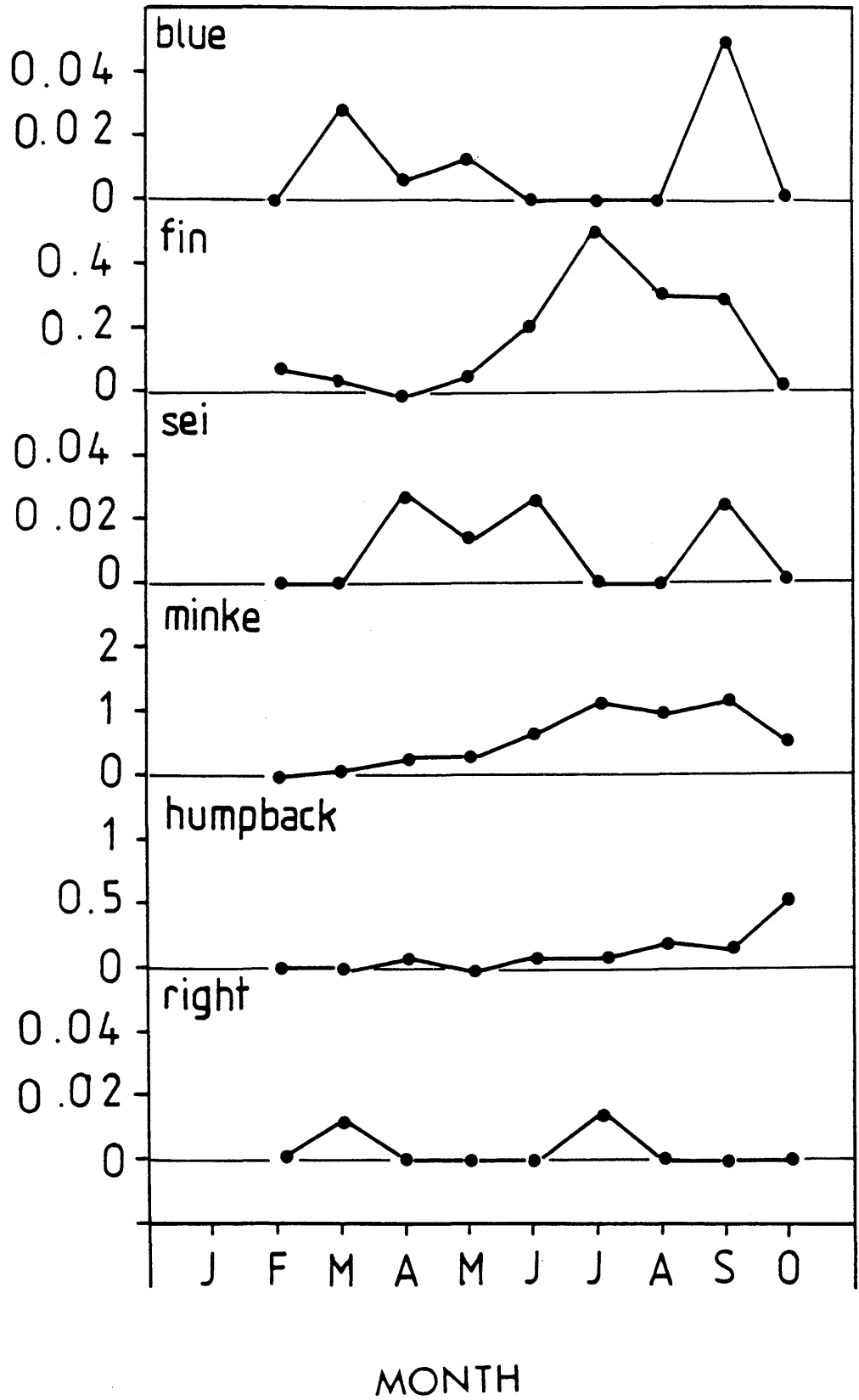
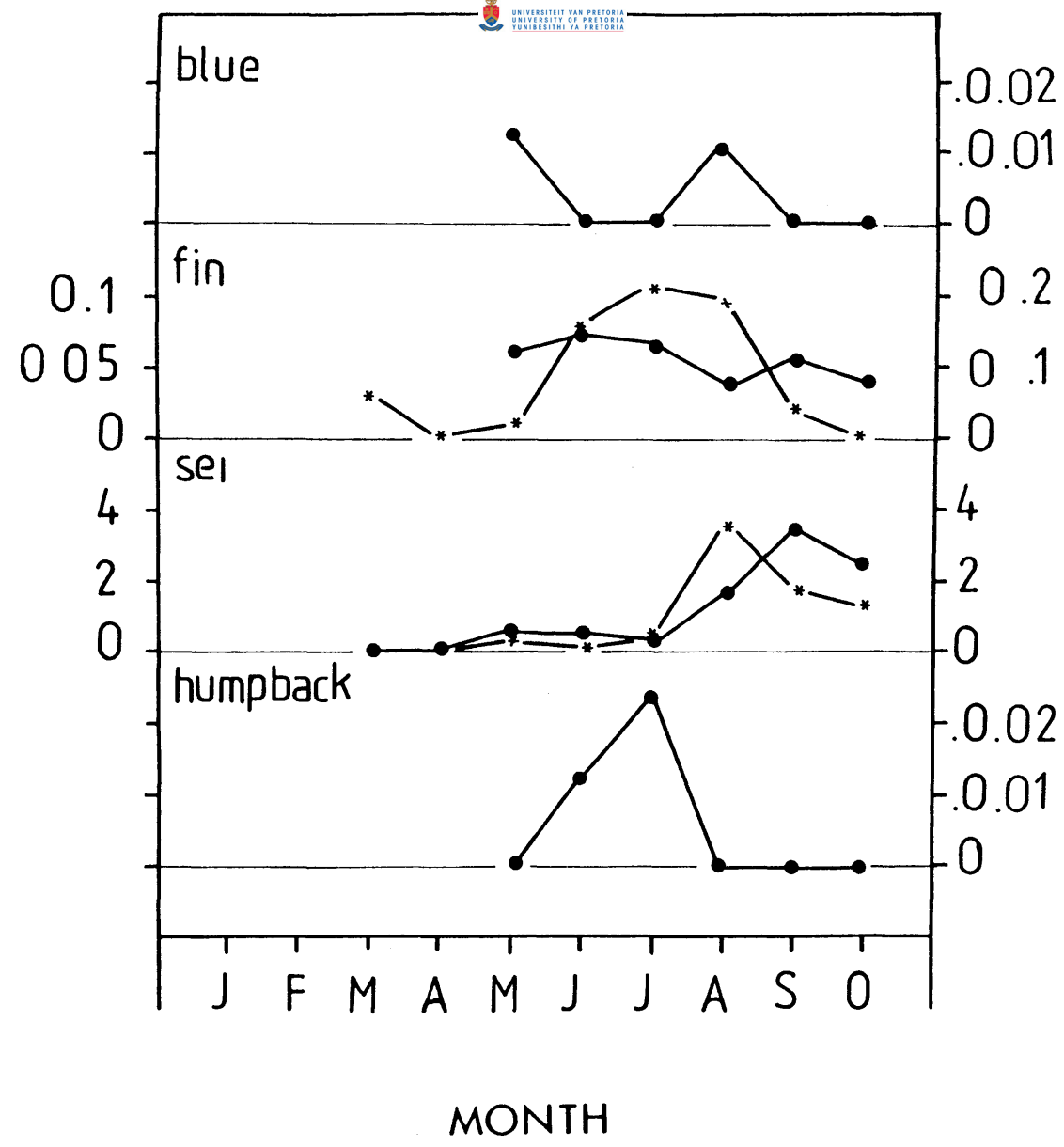


Figure 14. The seasonal abundance of sightings of baleen whales off Durban between 1972 and 1975.

NUMBER
SIGHTED
PER
10 VISITS



NUMBER
CAUGHT
PER
10 VISITS

Figure 15. The seasonal abundance of sightings and catches of blue, fin, sei and humpback whales off Donkergat during 1963.

sighting recorded in summer suggests individuals may remain in temperate waters during summer. Unfortunately no data are available as to the sex or age of this animal.

The fin whale (*B. physalus*).

Mackintosh (1942) maintains that like the blue whale little is known of the over-wintering grounds of southern fin whales, and he suggests (Mackintosh 1966) that they do not migrate as far north as humpback whales. Gambell (1985) noted that fin whales tend to migrate to and from the Antarctic after the blue whales, but before the sei whales, and suggests that the winter Indian and Atlantic Ocean destinations are to the north of South Africa. Kasamatsu *et al* (in press) found that of the 77 groups of fin whales sighted to the south of 58° S on the IWC/IDCR minke whale assessment cruises between 1978 and 1984, only 30 percent were within 60 miles of the pack ice edge.

Five dedicated scientific sightings of fin whales were made (figure 16). Four of these sightings were of single animals while one was of a pair of animals and all were made in August. Kasamatsu *et al* (in press) found the mean school size of fin whales recorded in Antarctic waters to be 2.83 whales per group. The relatively high densities of scientific sightings recorded off the Natal coast may be biased by the majority of vessels used for searching in this area being chartered commercial whaling vessels with crew more experienced in whale searches than crews on other census vessels.

No incidental sightings of fin whales were reported.

One verifiable specimen of a fin whale was included in this review. This specimen was taken off Saldanha Bay during 1914.

The scientific sightings of fin whales were all made in waters more than 1000 metres deep in Area IV within waters in the 18° to 22° C temperature interval and of salinities of over 35.4 ppt (figure 17).

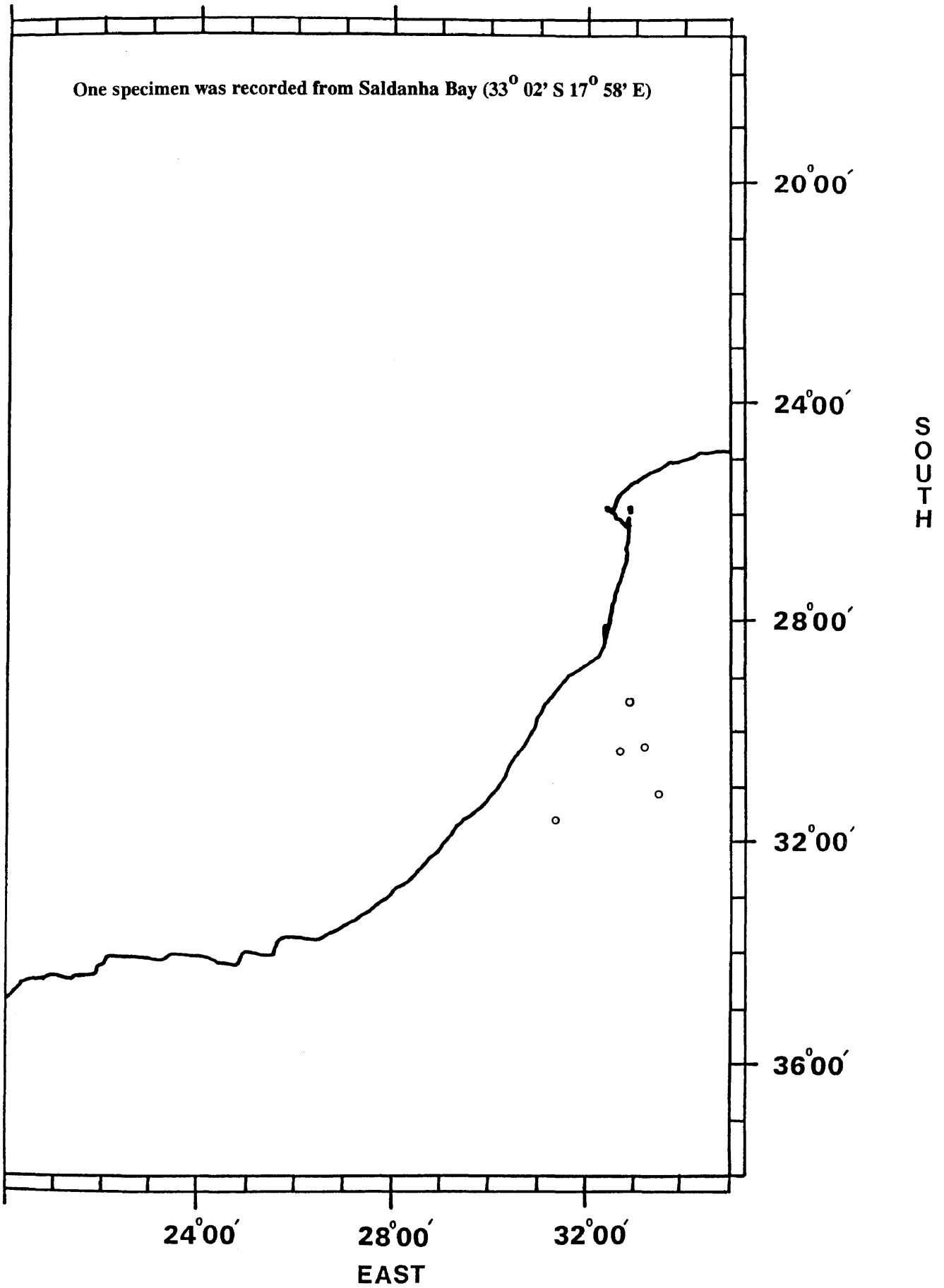


Figure 16. Scientific sightings (O) and specimens (●) of fin whales reviewed in this study.

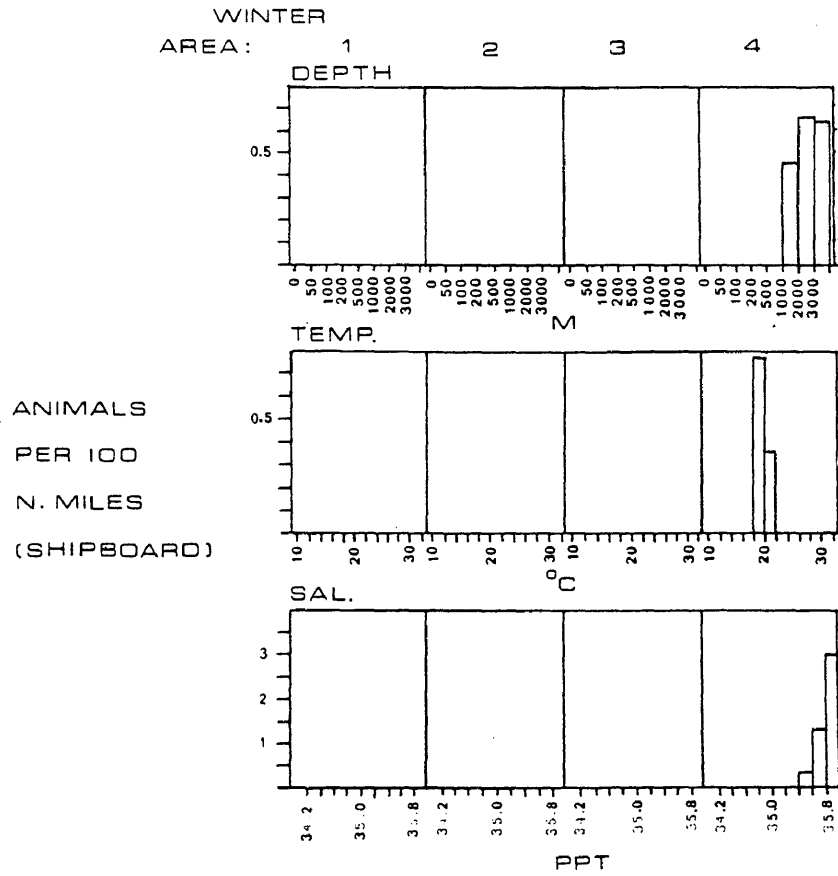


Figure 17. Densities of scientific sightings of fin whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during winter. No sightings were made during summer.

Fifty - two aerial sightings of fin whales were made between 1972 and 1975. Group size ranged between 1 and 3 animals per group with a mean of 1.58 (sd± 0.69). The monthly distributions of these fin whales off Durban are shown in figure 18. Bannister and Gambell (1965) maintain that the spotters generally noted that the fin whales followed the shelf edge in a north easterly direction until mid-July and returned into the grounds from the east in a southwesterly direction thereafter. It seems that this is borne out by the distributions shown in figure 18 as an alignment parallel to the coast and shelf edge becomes apparent as the season progresses. The unimodal distribution of monthly abundance and the direction of movement of fin whales found by Bannister and Gambell (1965) led them to believe that the southern migration occurred further offshore than its northern counterpart and the coast of the sub - continent acted as a 'funnel' in the northward migration of fin whales. All sightings of fin whales off Durban were made in water depths of over 500 metres (figure 19). The seasonal abundance of fin whales off Durban show a unimodal pattern with a peak of abundance in July (figure 14) suggesting that fin whales do not migrate to the north of this whaling ground on the east coast or as Bannister and Gambell (1965) suggested, the southern migration occurs further offshore.

Fourteen aerial sightings and 34 catches of fin whales were made off Donkergat in 1963 (figures 20 and 21). Seasonality of the sightings off Donkergat show a unimodal trend with a marked maximum in June to August, while the catches of fin whales off Donkergat show a slight bimodal trend with maxima in May to July and September (figure 15). All sightings and catches of fin whales made off Donkergat were in waters of over 200 m deep (figure 19). The depth distribution off both the East and West Coast whaling grounds would suggest, (as maintained by Bannister and Gambell (1965)), that fin whales follow the shelf edge as they pass through these whaling grounds.

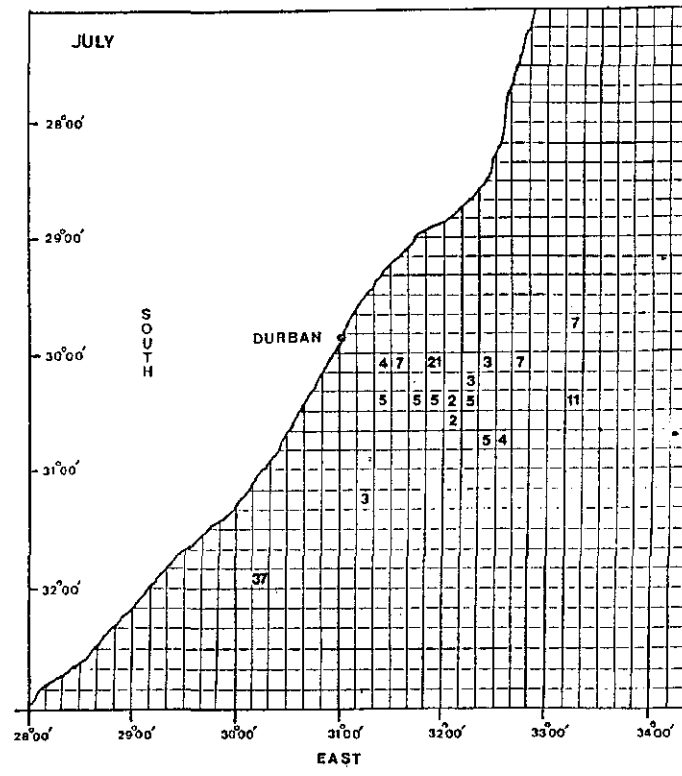
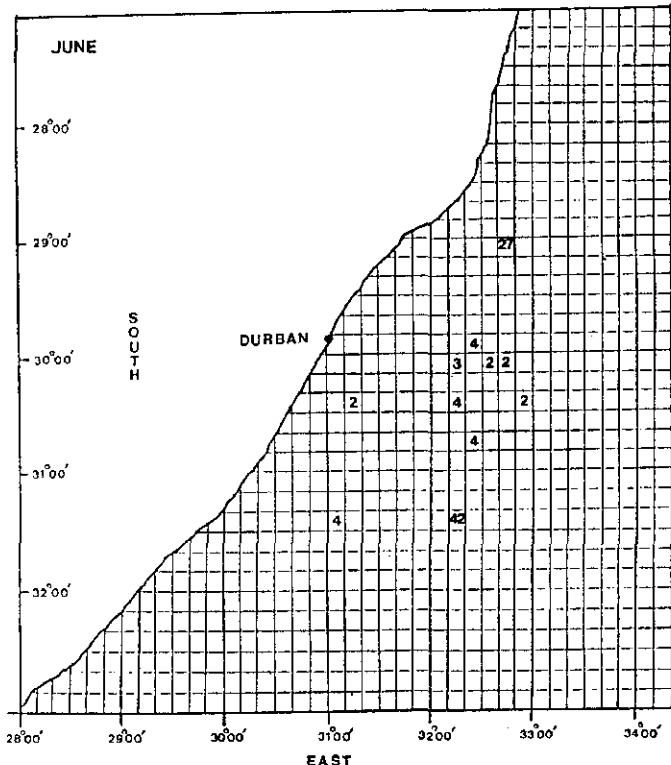
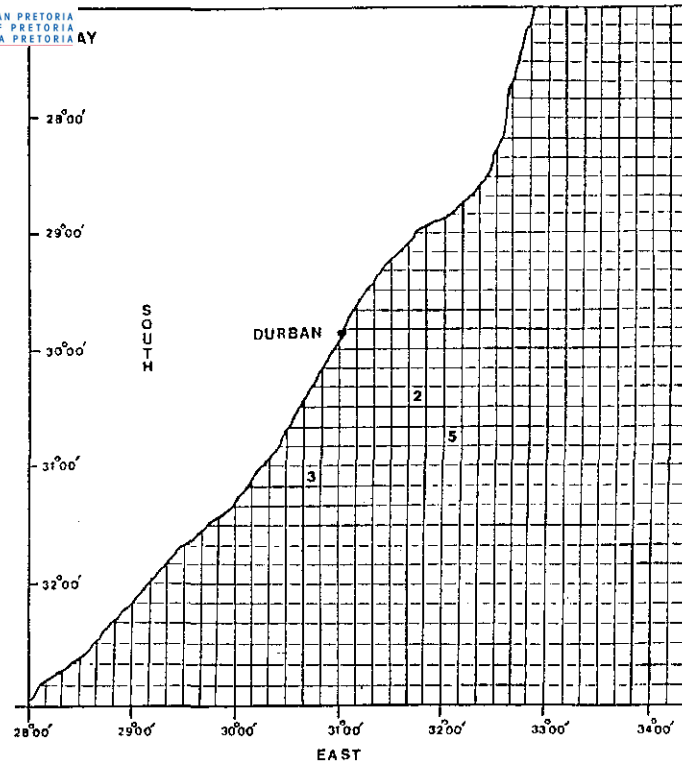
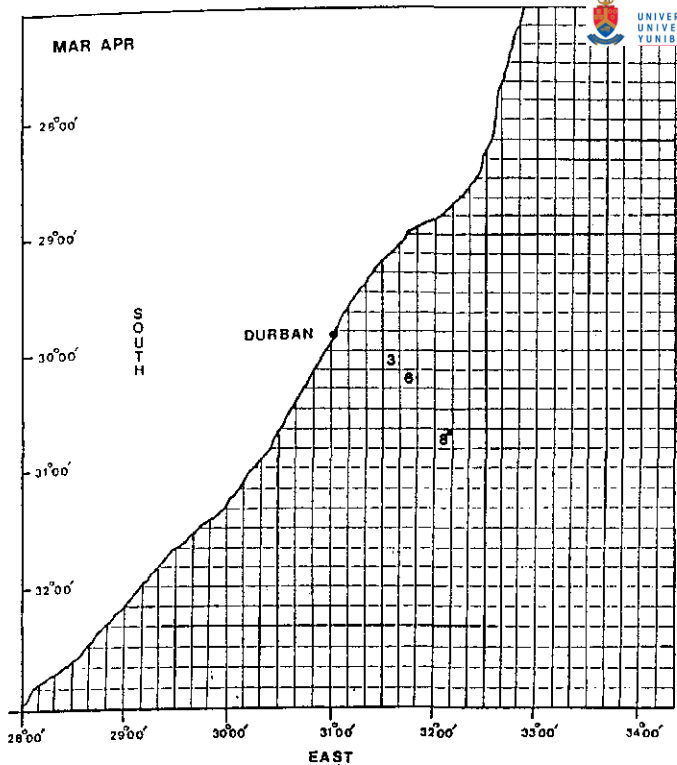


Figure 18. The distribution of fin whales sighted in the east coast whaling grounds between 1972 and 1975.

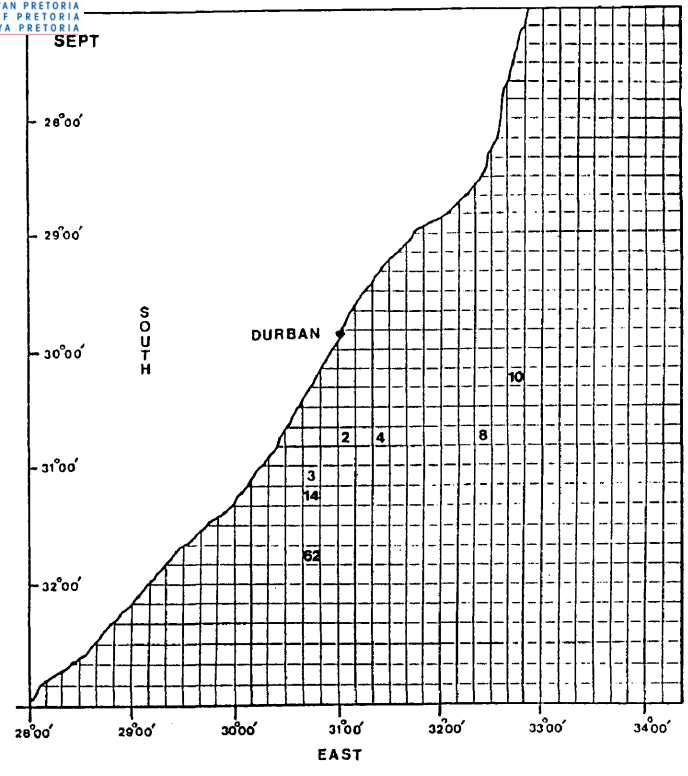
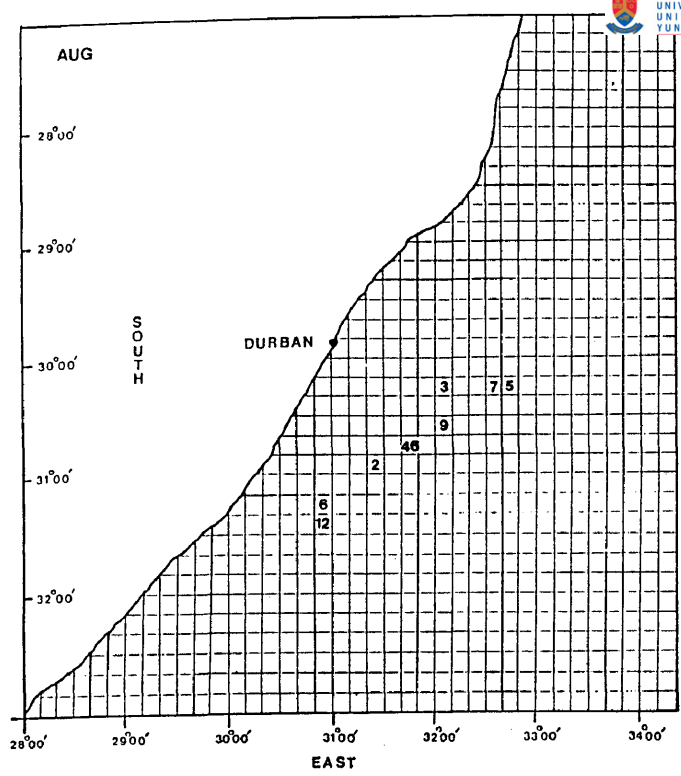


Figure 18.(continued).

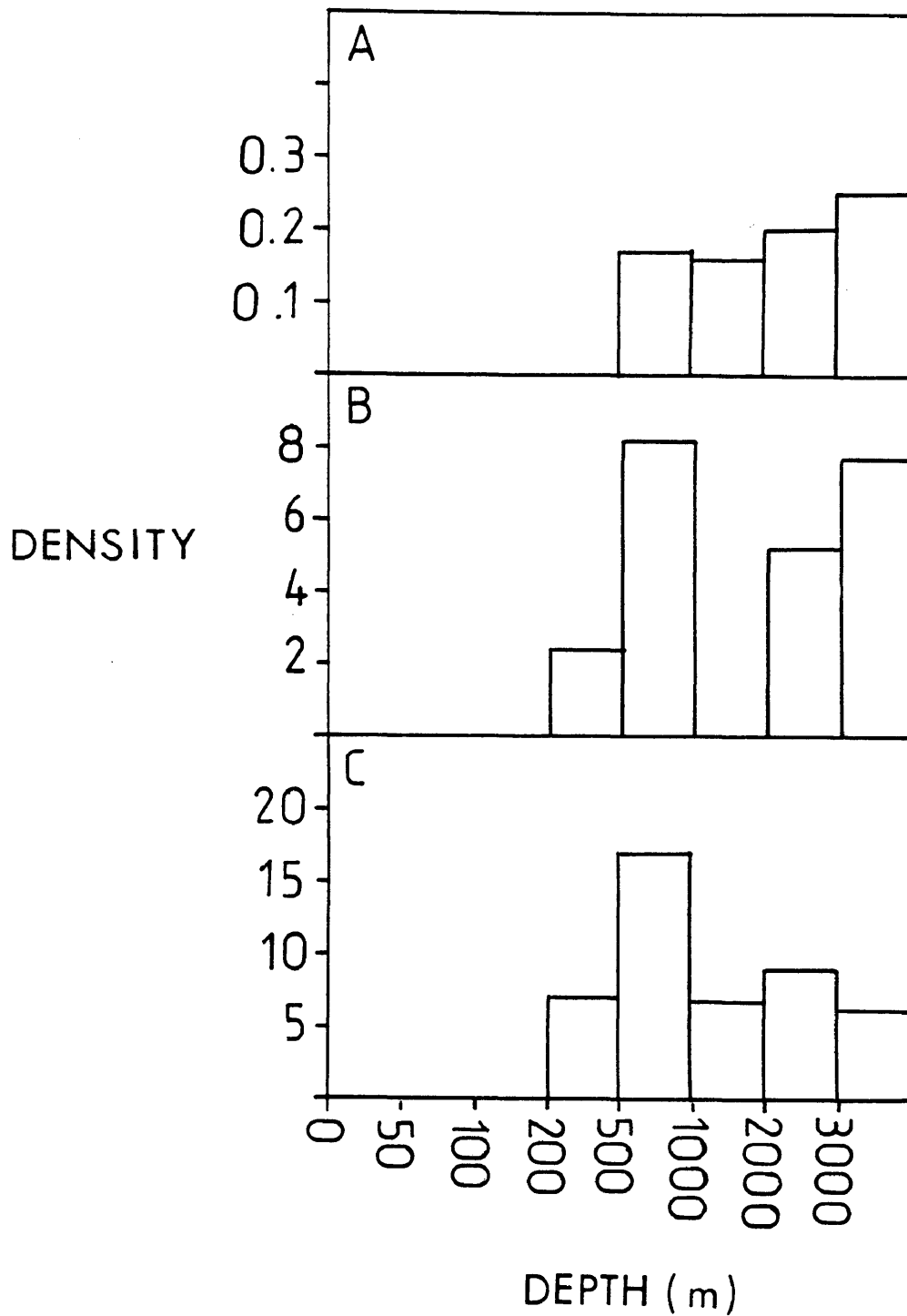


Figure 19. The depth distributions of fin whales recorded in the east and west coast whaling grounds. A: East coast whaling grounds (expressed as number sighted per 1000 miles searched) and B: West coast whaling ground sightings and C: West coast whaling ground catches (both expressed as number taken per 100 visits).

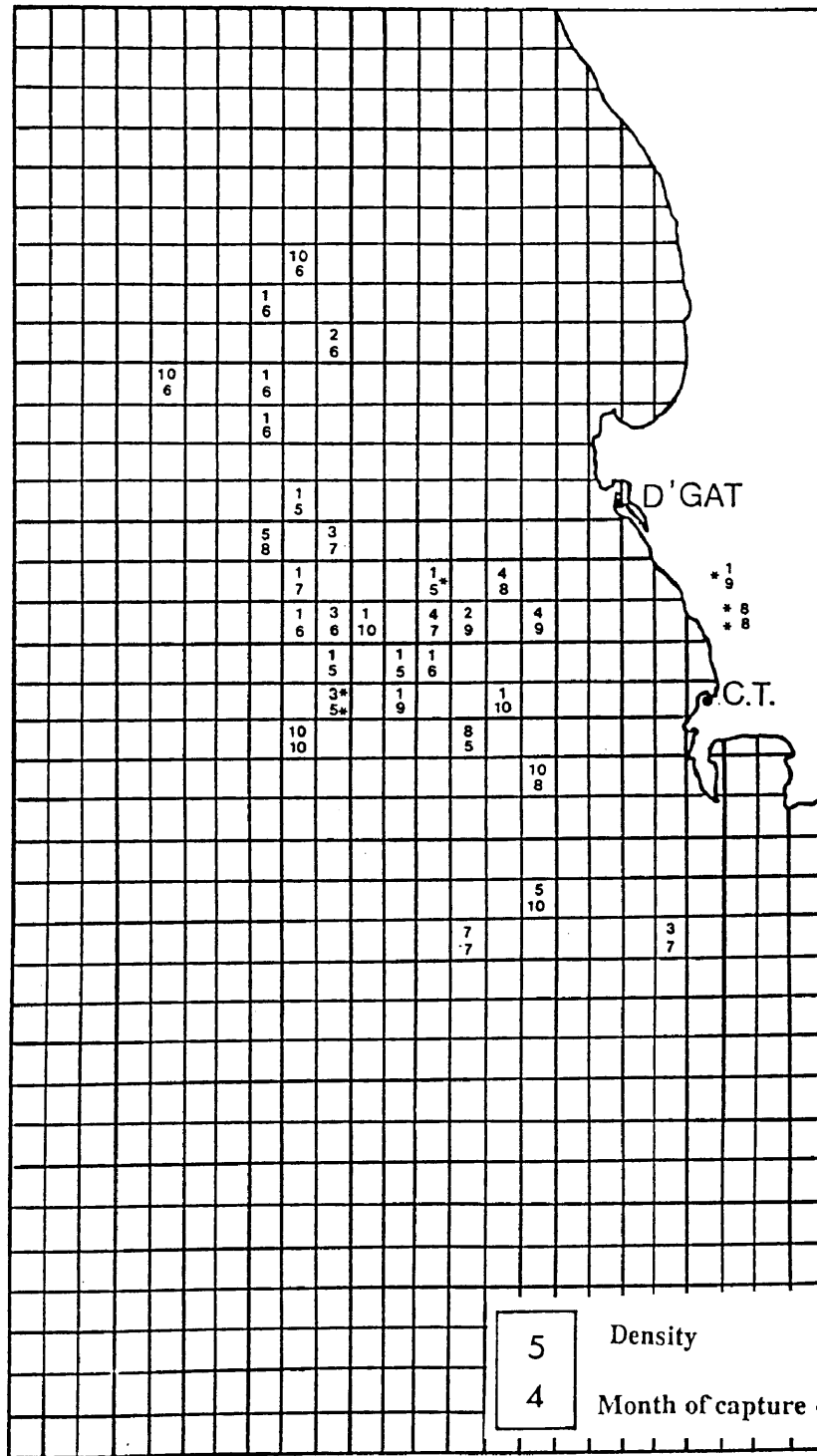


Figure 20. Densities of fin whales taken off Donkergat during 1963 per 10 minute cell.

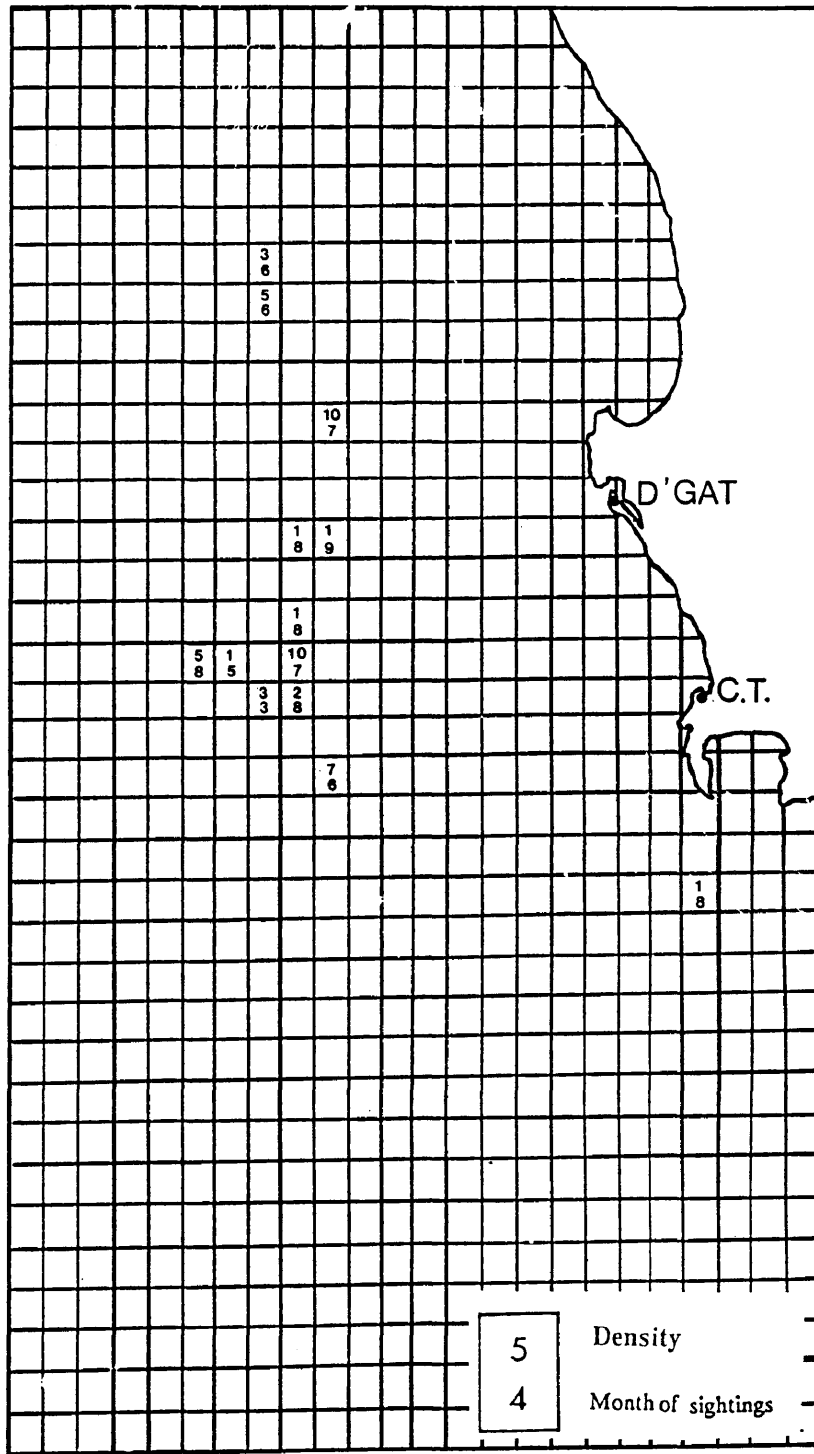


Figure 21. Densities of fin whales sighted off Donkergat during 1963 per 10 minute cell.

Table 1. Mark recoveries of fin and sei whales marked or recaptured in southern African waters (excluding marks from whales both marked and recaptured in these waters).

MARKED		RECOVERED			
Date	Position	Date	Position		
	Lat Long		Lat Long		
FIN WHALES					
10-12-57	52 12 S 19 45 E	19-07-58	33 03 S 15 54 E		
24-11-54	53 16 S 19 06 E	26-07-59	30 31 S 31 33 E		
22-11-54	52 57 S 24 02 E	29-07-59	30 31 S 31 33 E		
16-12-57	59 40 S 35 00 E	11-05-59	30 31 S 32 33 E		
24-02-35	64 52 S 22 30 E	30-06-37	33 04 S 17 50 E		
19-11-72	58 28 S 49 44 E	27-06-73	20 09 S 33 13 E		
19-11-63	39 43 S 81 08 E	27-06-67	31 20 S 33 00 E		
18-11-57	59 09 S 33 35 E	09-68	DURBAN		
29-08-69	30 39 S 33 06 E	25-02-71	43 32 S 53 16 E		
12-12-62	56 33 S 46 55 E	27-08-63	DURBAN		
15-11-55	54 07 S 07 03 E	20-06-63	DURBAN		
28-09-54	54 07 S 09 47 E	03-07-62	DURBAN		
SEI WHALES					
22-02-63 *	33 16 S 16 02 E	15-07-73	00 32 S 05 10 E		
22-08-69	29 50 S 32 19 E	01-04-73	43 18 S 82 26 E		
22-08-69	29 50 S 32 19 E	28-03-73	45 50 S 51 24 E		
22-08-69	30 03 S 32 31 E	11-02-70	44 04 S 50 54 E		
22-08-69	29 31 S 32 20 E	24-02-70	45 30 S 71 25 E		
17-11-65	36 19 S 12 57 W	10-09-66	34 38 S 17 20 E		

* - Probably Bryde's whale.

Harmer (1928) found that fin whales were present in similar numbers to blue whales off Walvis Bay or Angola and were not found off the French Congo. Harmer (1931) found a bimodal distribution in the seasonal abundance of fin whale catches off the Cape Colony (with maxima in May to July and October to November) and a unimodal distribution of catches of this species off Natal with a maximum in June and July and concluded that fin whales do not migrate much further north than Durban on the east coast, but to the north of Donkergat on the west coast. Bannister and Gambell (1965) found that fin whales were present off Natal between April and October with a peak of abundance in July, inferring that these grounds must be near to the most northern point of the migration. Table 1 shows the positions of fin whales marked and recovered from southern African waters and the movement of fin whales into these waters between May and September is clearly evident.

The seasonal abundance of fin whales for suggests that the east coast whaling ground must be near to the northern most point of the east coast migration. Both Laws (1959) and Bannister and Gambell (1965) suggest that June is the average time of conception of southern fin whales and as such pairing must take place off Durban or to the south of Durban. The north easterly movement of fin whales early in the season and the movement into the ground from the east on the southerly migration suggests that the northernmost point of the migration lies close to and to the north east of the east coast whaling ground. Although the abundance of sightings of fin whales in the west coast whaling ground sightings show a unimodal trend (inferring that some fin whales remain in these grounds throughout the season) the west coast catches and seasonal abundance reported by Harmer (1931) suggest fin whales migrate further north than these grounds. Reports of sightings of fin whales off South West Africa / Namibia and Angola (Harmer 1928) and as far north as 20° S by Wheeler (1946) and of catches of fin whales off Gabon in 1934 (Budker and Collignon 1952) provide evidence of fin whale migrations well to the north of the west coast whaling grounds.

The sei whale (*B. borealis*)

Horwood (1987) maintains that sei whales are found in warm (8° to 18° C) oceanic waters near to the equator during winter, and towards the polar regions (but not as far south as other rorquals) during summer. Kasamatsu *et al* (in press) found that all of the sei whales (38 schools) recorded on IWC / IDCR minke whale assessment cruises between 1978 and 1984 were more than 120 nautical miles from the pack ice edge. Mean group size of these sightings was 3.09 whales per group and water temperatures associated with these sightings ranged between 0.4 to 7.0° C.

The six dedicated scientific sightings of sei whales were all recorded in August. Four of these records were made on the same day (22.8.1969) and all were sighted within one week. Group size of these sightings ranged between one and five with a mean of 2.83 animals per group (sd± 1.47). Only one incidental sighting of a group of three whales was recorded. As with the fin whales there may be some bias in the high concentrations of sei whales off Durban due observer expertise (figure 22).

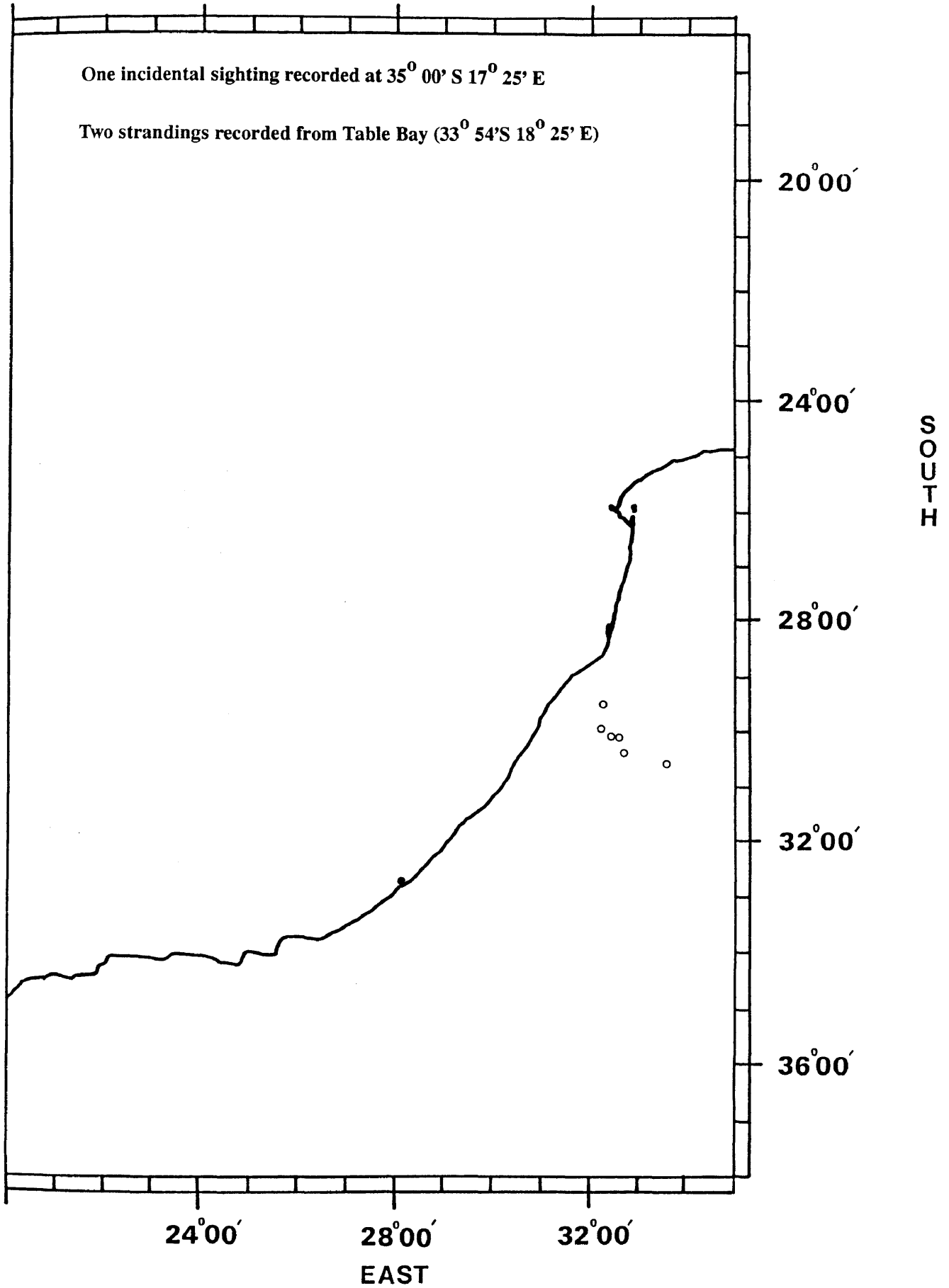


Figure 22. Scientific sightings (○) and specimens (●) of sei whales reviewed in this study.

The provenances of three specimens of sei  in figure 22. One of these specimens was a live stranding, one was a stranding as a result of a catch attempt and the category of origin of the third is unknown.

Scientific sightings of sei whales are confined to waters of between 500 and 2000 metres in Area IV (figure 23). Temperatures measured in waters where scientific sightings of sei whales were recorded were between 18^o and 24^o C, while corresponding salinity measurements fell in the 35.2 to 35.4 ppt interval. The one incidental sighting of three sei whales was made in waters of over 3000 m depth and associated with temperatures of between 16^o and 18^o C and salinities of between 35.2 and 35.4 ppt.

Four aerial sightings of sei whales were made off Durban between 1972 and 1975 (figure 24). Two of these were of single animals and two were of pairs of animals. The seasonal abundance of these four sightings (figure 14) cannot be commented on as the data are too few, and although their occurrence is in agreement with trends found by Bannister and Gambell (1965), Bannister and Gambell (1965) found that the greatest abundance occurred in September with a lesser peak occurring in June.

Sixty - three sightings and 195 records of catches of sei whales were recorded off Donkergat in 1963. The relative paucity of sightings off Durban between 1972 and 1975 (compared to the numbers off Donkergat in 1963) reflects the collapse of the Southern Hemisphere sei whale stock in 1967/1968 (Best and Gambell 1968). The distributions of sightings and catches of sei whales off Donkergat in 1963 are shown in figures 25 and 26 respectively.

The unimodal trend in the seasonal abundance of sei whales off Donkergat (figure 15) presumably reflects the southward migration and it is possible that the northward migration earlier in the season was too far offshore to be detected. In the bimodal patterns of abundance off Donkergat found by Matthews (1938), Best (1967) and Best and Lockyer (1977 ms, in Horwood 1987) the May - June peak is far lower than the August - October peak. Harmer (1928) found that sei whales were particularly numerous off the Cape Colony, but notes the possible confusion between sei and Bryde's whales. Best and

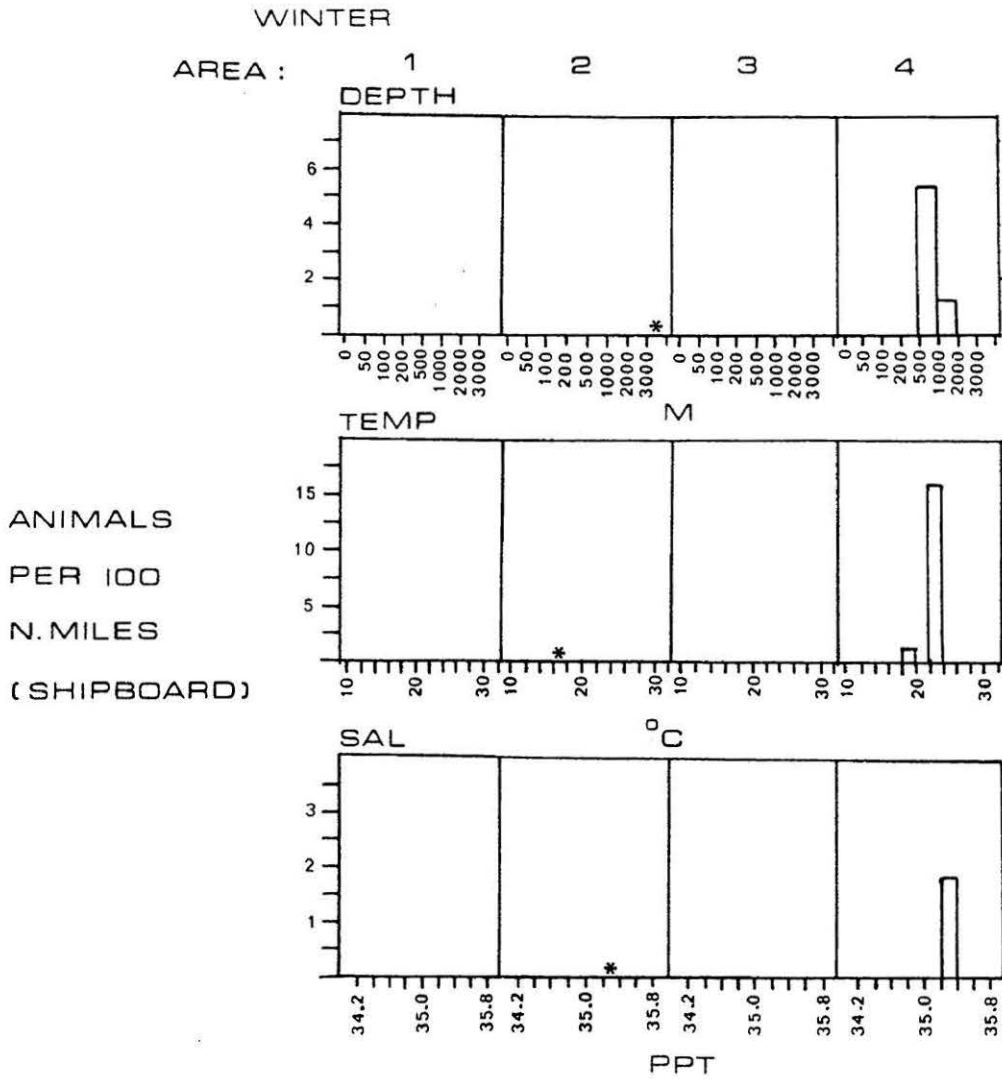



Figure 23. Densities of scientific sightings and occurrence of incidental sightings (*) of sei whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during winter. No sightings were made during summer.

Lockyer (1977 ms) suggest that this confusion  ed until as late as 1962. Harmer (1931) found bimodal trends in the catches of sei whales off both the Cape Colony and Natal, while Matthews (1938) found that catches of sei whales off the Cape Province between 1920 and 1925 showed a marked bimodal trend in abundance with the northward migration occurring in May and the southward migration occurring in the months August to October. North of these latitudes, off the African West Coast and Angola, the seasonal abundance of catches showed unimodal trends, but no month of maximum is given. Matthews further found a unimodal abundance of catches of sei whales off the Natal coast between 1918 and 1926 and noted that the June peak for these catches was too early for Natal to be the northernmost point of the sei whale migration. Bannister and Gambell (1965) found that sei whales were present off Durban between April and October, but that the greatest abundance occurred in September with a lesser peak occurring during June. They suggest that Durban lies to the south of the northernmost point of the migration and that the southward migration occurred further offshore than the catchers of Matthews' period of study were operating.

Although the seasonal abundance off Durban arises from four sightings only the bimodal trend is in agreement with a June northward migration (as suggested by Matthews (1938)) and a September southward migration (as suggested by Bannister and Gambell (1965)). The seasonal abundance of sei whales off Donkergat (this study) is very similar to the pattern found off Donkergat by Matthews (1938), Best (1967) and Best and Lockyer (1977 ms, in Horwood 1987) in that the northward migration was largely undetected and was presumed to occur outside the whaling grounds. Matthews (1938) notes the irregular occurrence of sei whales in African waters and suggests that this may arise from ocean current variations from year to year, but Best (pers. comm.) suggests that might have arisen from sei whales being an irregular target species at that time.

Table 1 presents the returns of sei whales marked or caught in southern African waters. The one return from the equator (marked with an asterisk) probably refers to a Bryde's whale (Best 1977). Those sei whales marked in southern African waters were all returned from between 43° and 46° S, but well to the east of the longitudes on which they were marked. This infers that sei whales do not migrate as far south as other *Balaenoptera* species during the austral summer. All sei whales sighted off Donkergat were in waters of over 200 metres depth, while the four sightings off Durban were in waters of over 500 metres depth (figure 27). Best (1967) suggested that sei whales off the west coast are mainly found in waters of $16 - 18^{\circ}$ C, 60 to 100 miles offshore and not in the cold Benguela Current waters.

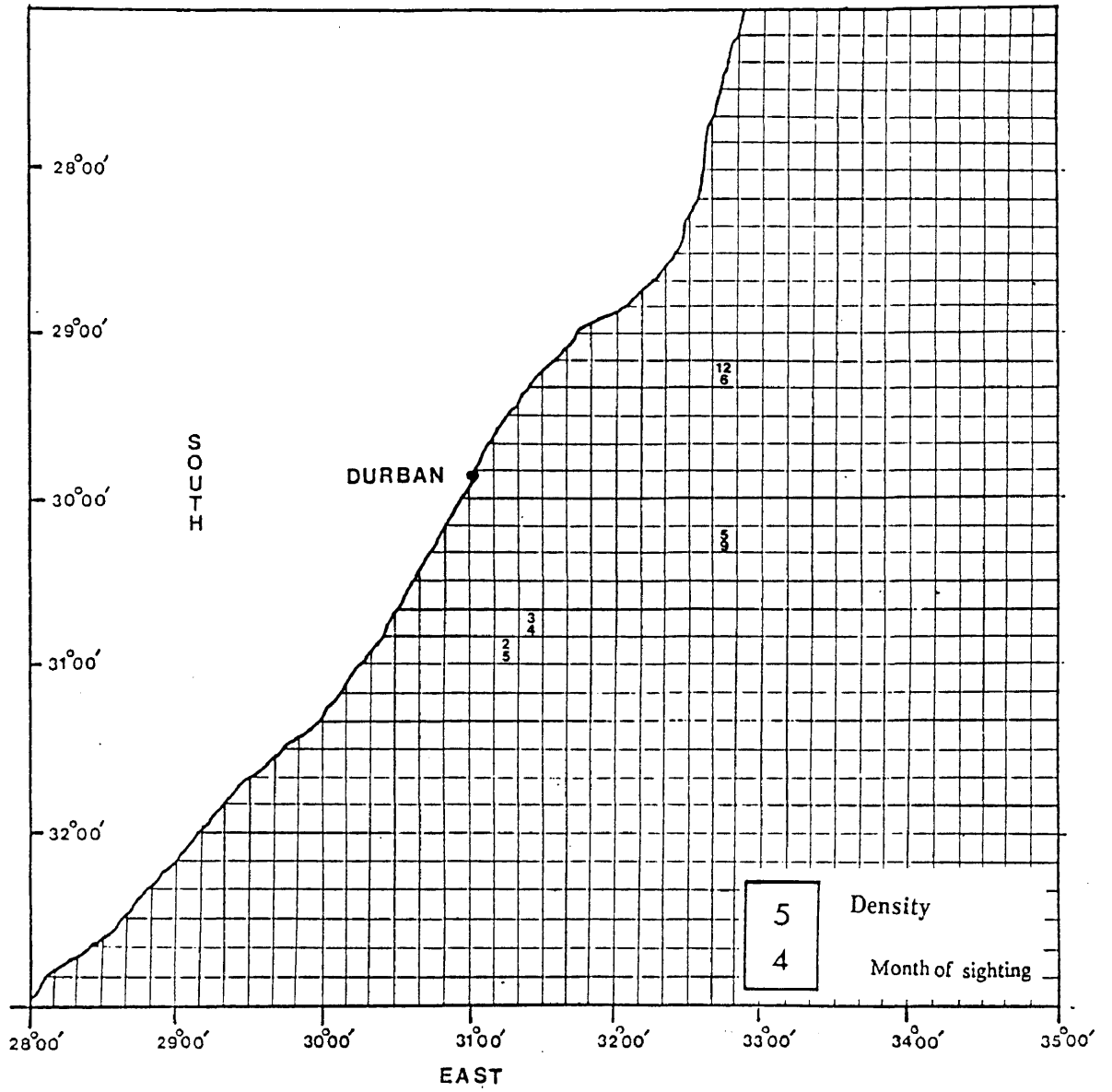


Figure 24. The distribution of sei whales sighted off Durban between 1972 and 1975.

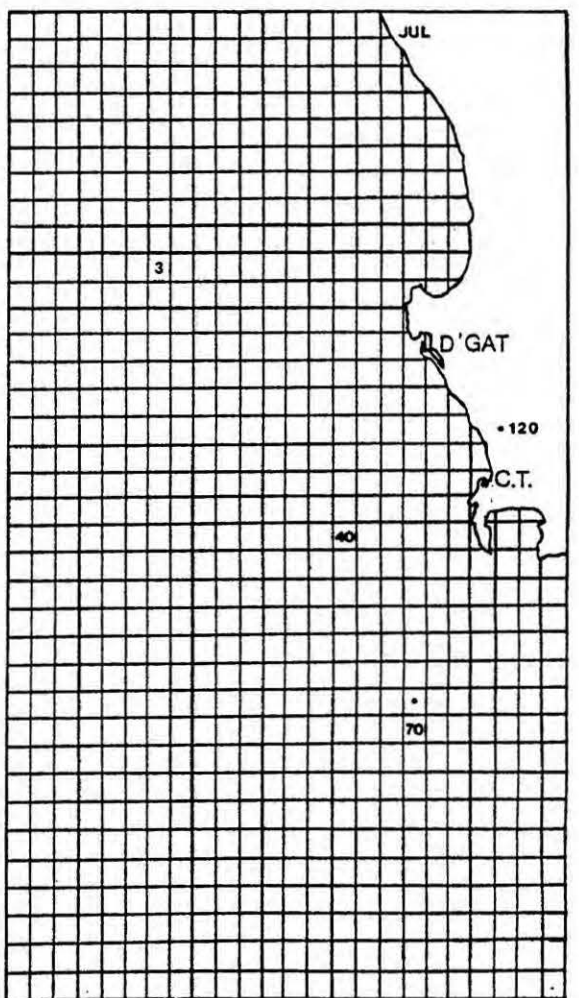
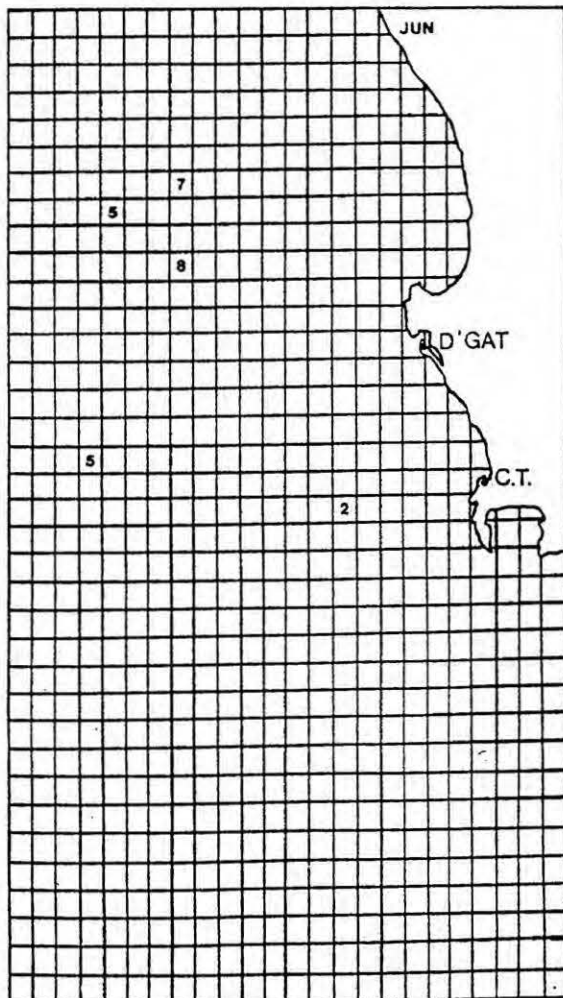
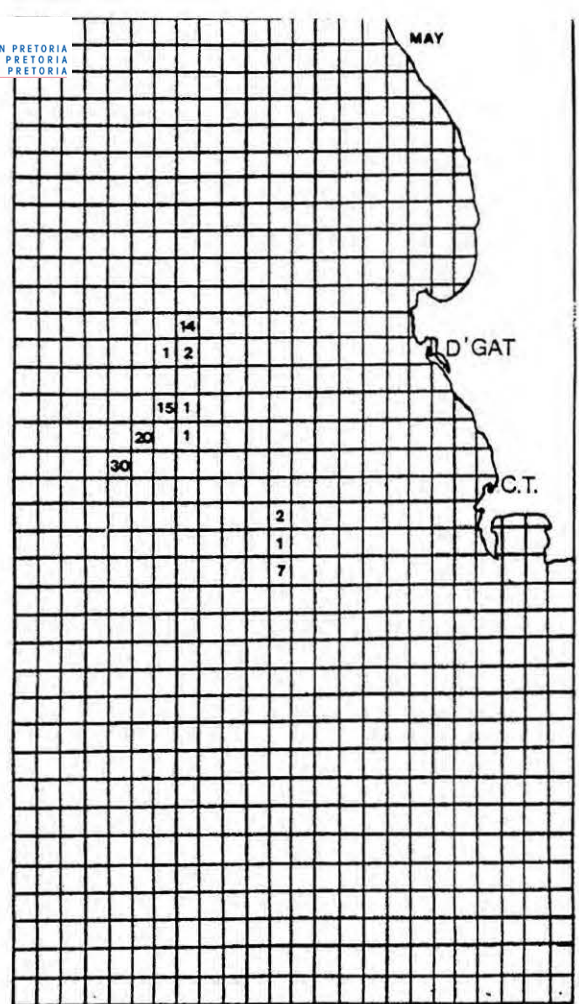
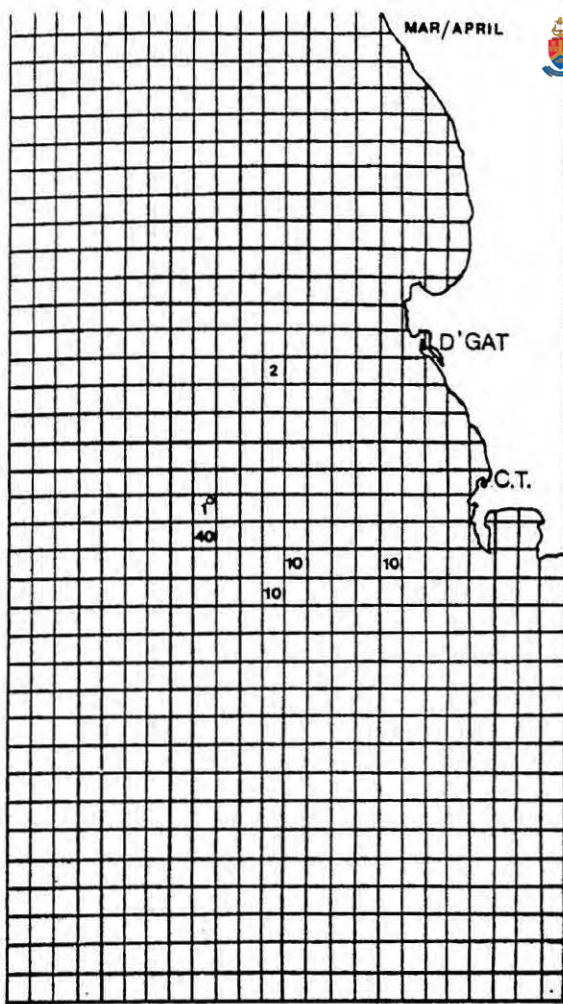


Figure 25. The distribution of sei whales sighted off Donkergat during 1963.

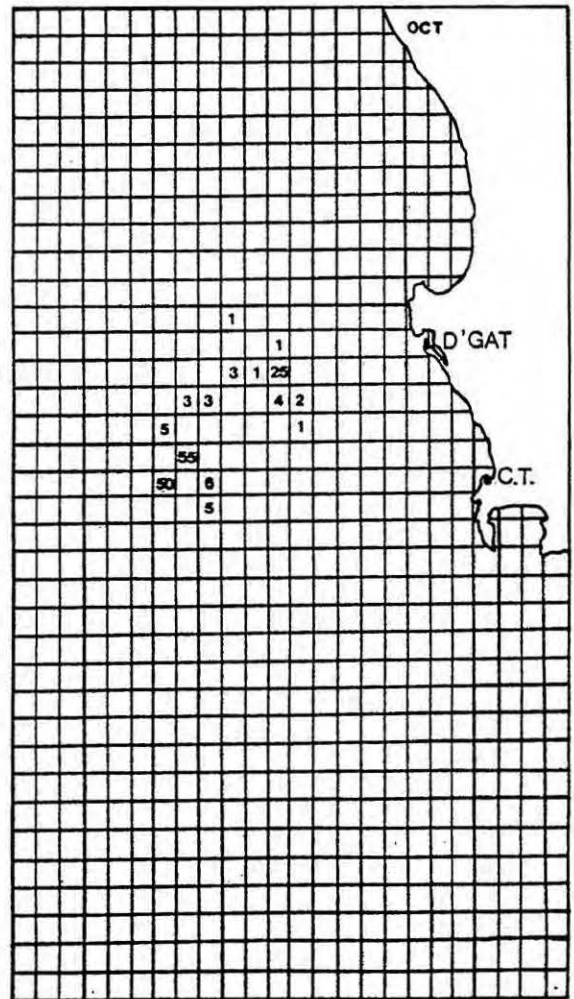
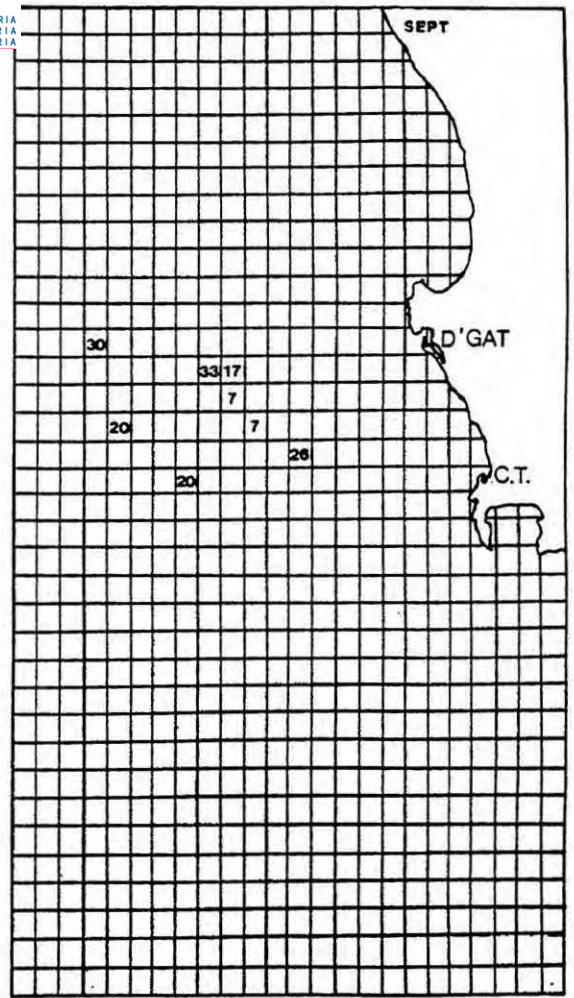
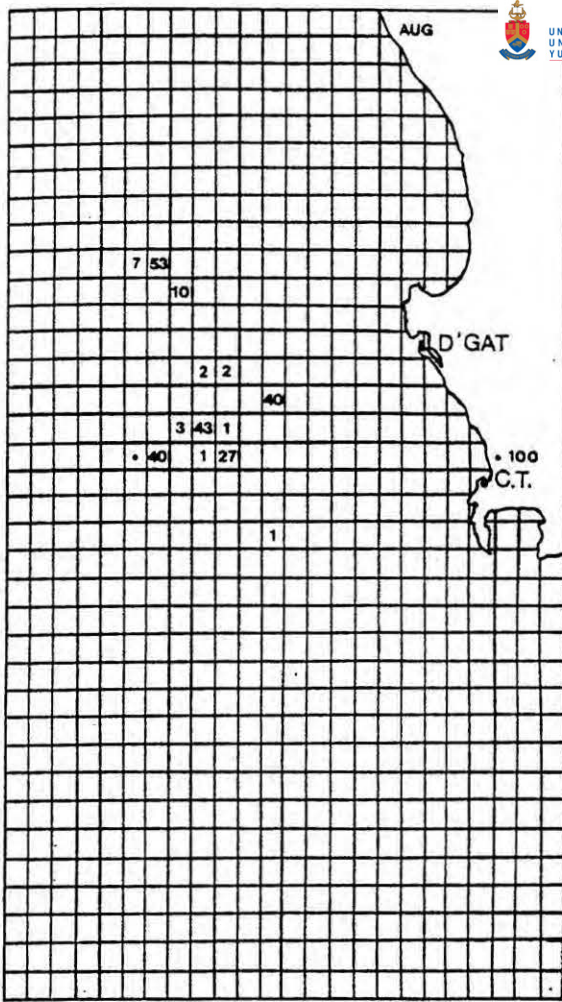


Figure 25. (continued).

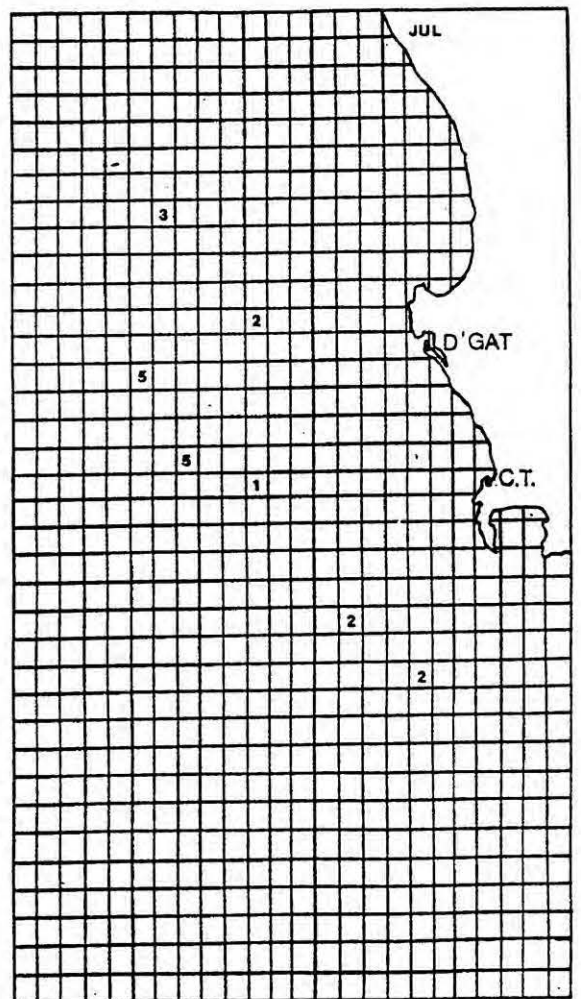
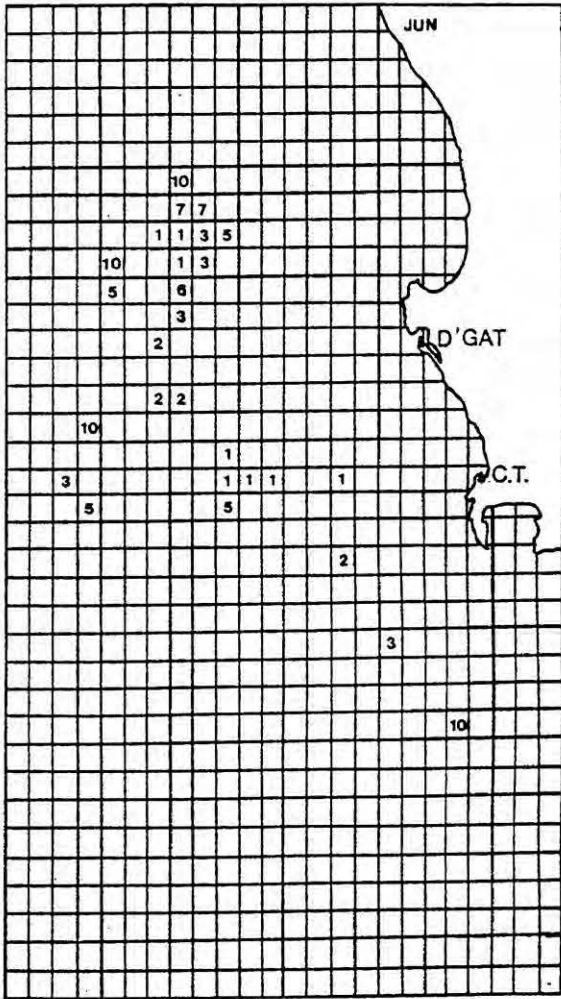
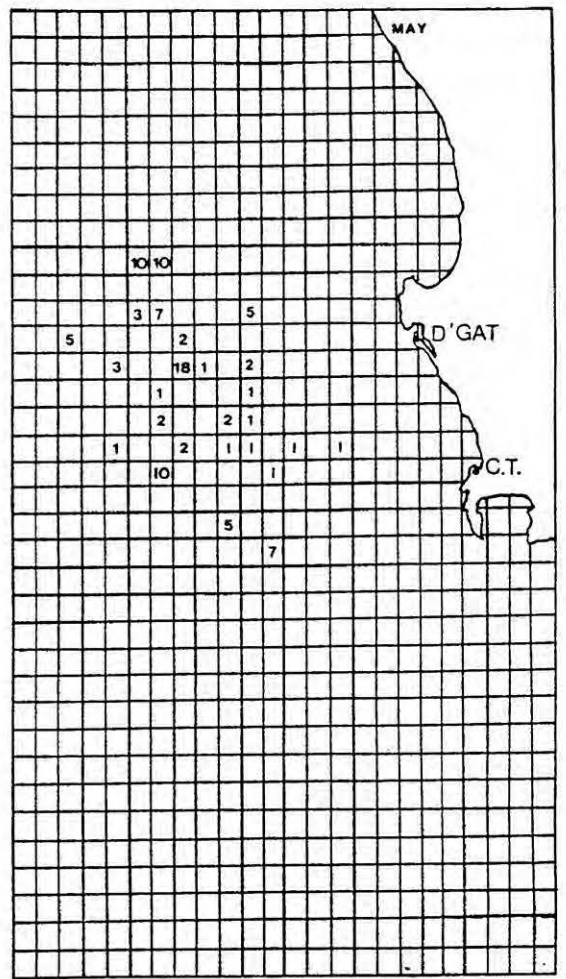
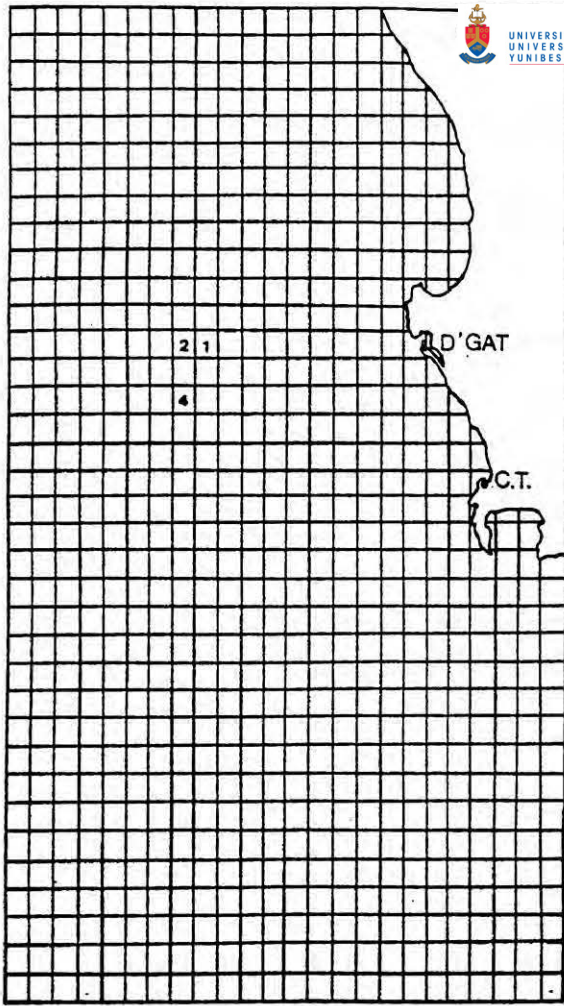


Figure 26. The distribution of sei whales taken off Donkergat during 1963.

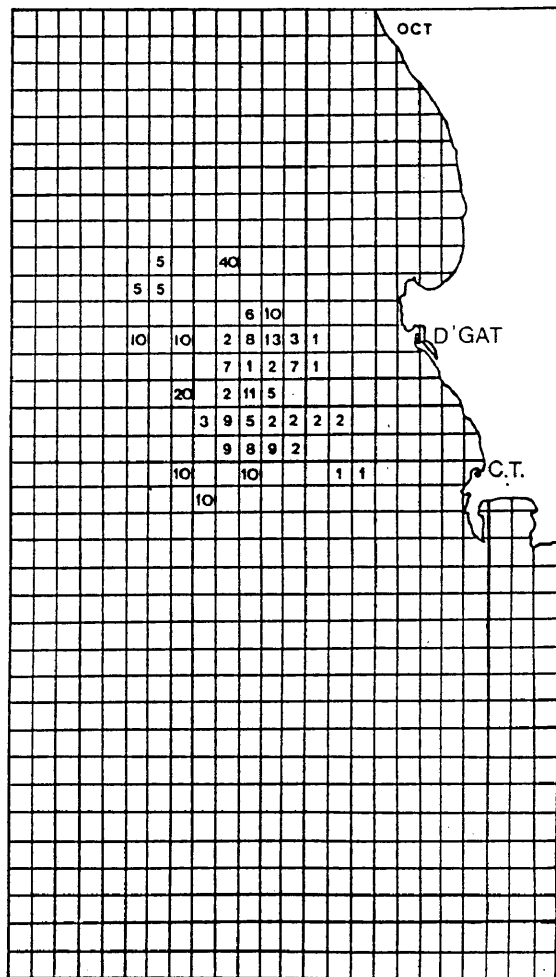
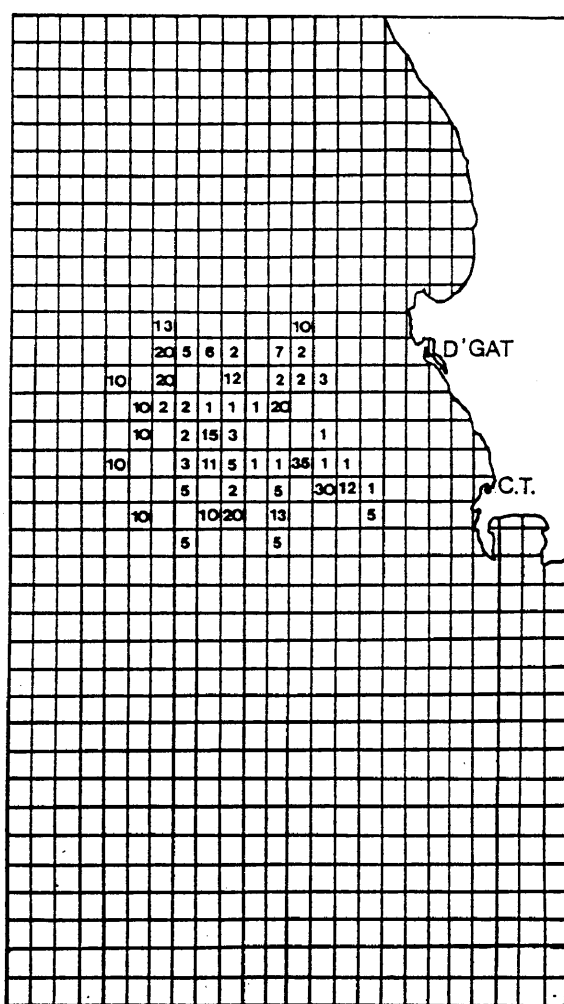
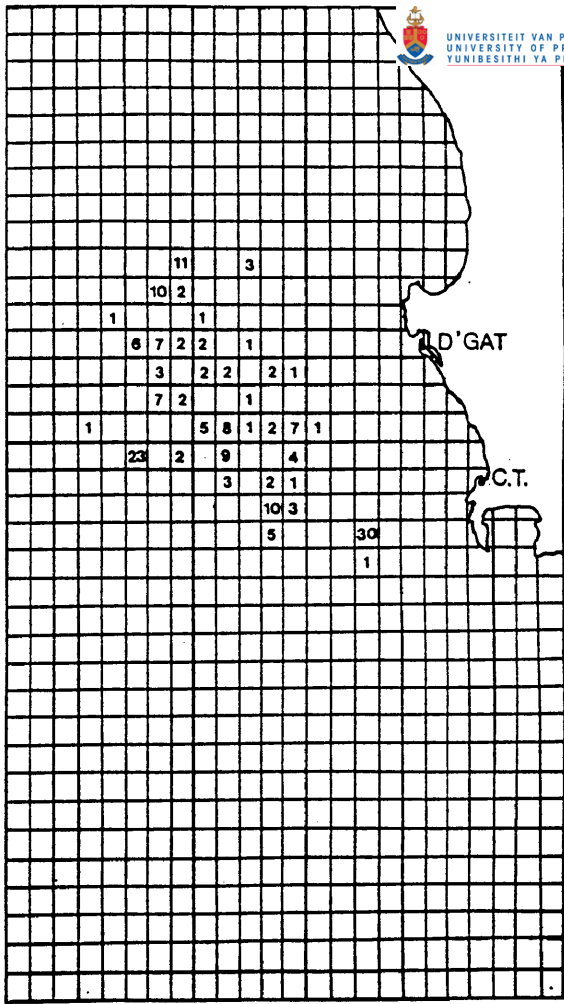


Figure 26. (continued).

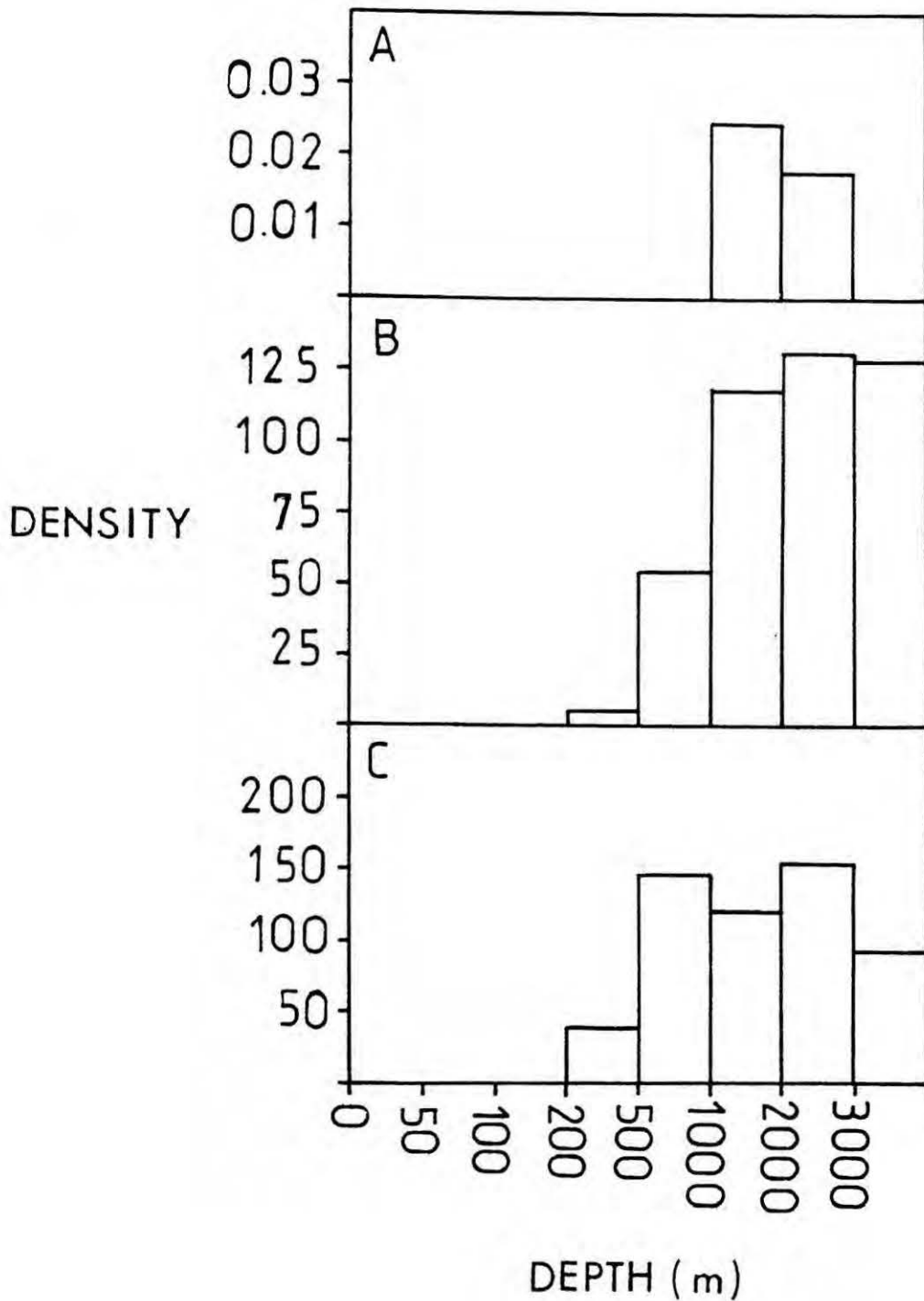
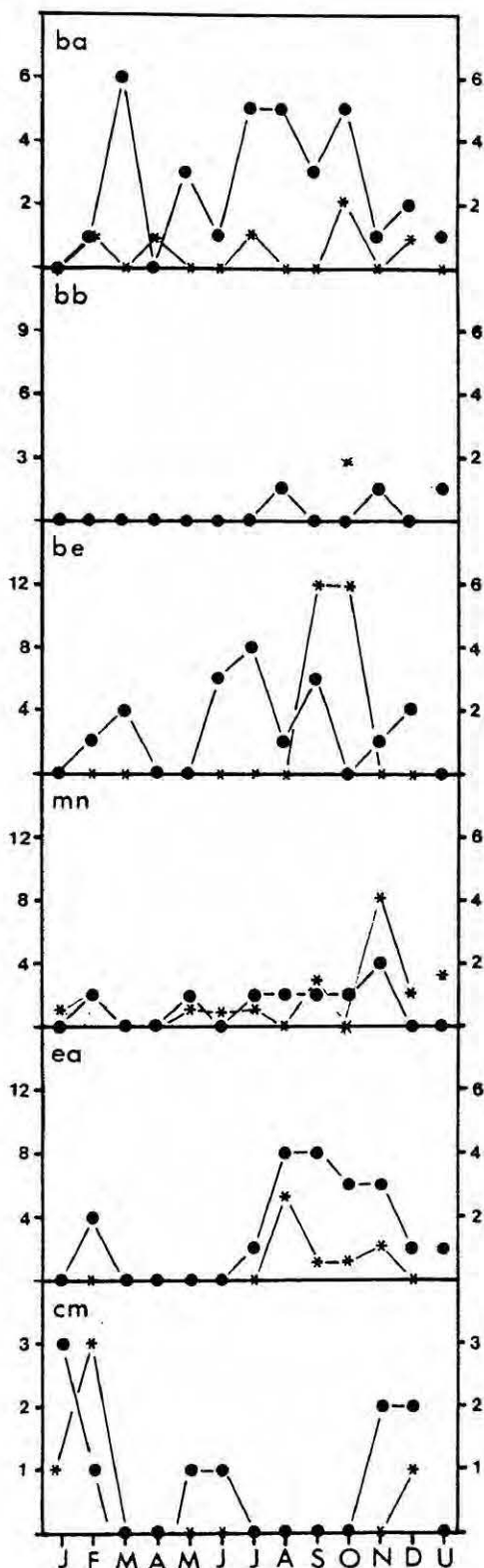


Figure 27. The depth distributions of sei whales recorded in the east and west coast whaling grounds. A: East coast whaling grounds (expressed as number sighted per 1000 miles searched) and B: West coast whaling ground sightings and C: West coast whaling ground catches (both expressed as number taken per 100 visits).

NUMBER
OF
ANIMALS
SIGHTED
*



NUMBER
OF
ANIMALS
STRANDED
●

Figure 28. The seasonal occurrence of incidental sightings and specimens of baleen whales reviewed in this study. (ba - *Balaenoptera acutorostrata*, bb - *B. borealis*, be - *B. edeni*, mn - *Megaptera novaeangliae*, ea - *Eubalaena australis*, cm - *Caperea marginata*.)

(U = month of incidence unknown.)

The minke whale (*B. acutorostrata*).

Stewart and Leatherwood (1985) describe minke whales as being common in Antarctica during the summer, occurring off the west coast of South Africa and Angola and present throughout the year off Durban. Kasamatsu *et al* (in press) note that Ohsumi (1979), Kasamatsu and Ohsumi (1981) and Shimadzu (1981) showed that the peak of occurrence close to the ice edge was in January. Kasamatsu *et al* (in press) found that the highest densities of minke whales recorded to the south of 58° S on IWC / IDCR minke whale assessment cruises were close to the pack ice edge. Best (1982) noted that, although minke whales were present in the southwest Indian Ocean throughout the whaling season between 1968 and 1975, a peak of abundance occurred between June and September. Best (1985) noted the occurrence of a smaller second form of minke whale in southern African waters and that catches of this form off Durban were earlier in the year and generally closer inshore than catches of other minke whales.

Fourteen scientific sightings of minke whales were made during January, February and August. Group size ranged from one to two animals per group. Three summer records (one in January and two in February) and one winter record were of cow and calf pairs. Three records of "like minke whales" were noted in the cruise reports and a further category was created to accommodate these. Two of these sightings were of one animal each while the other was of four animals. Six incidental sightings of minke whales were reviewed. These sightings were all of single animals and the seasonality and localities are shown in figure 28 and 29 respectively. Thirty - three specimens of minke whale were reviewed in this study. The localities of these are plotted in figure 29, while the category and month of origin are shown in table 2 and figure 28 respectively.

The distributions of these scientific sightings, incidental sightings and strandings (figure 29) show that the species occurs throughout southern African waters, and the stranding records off the South West Africa / Namibia coast further substantiate the presence of this species off the west coast, while the relative abundance of sightings of minke whales off the Natal coast may yet again reflect bias in searcher expertise.

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

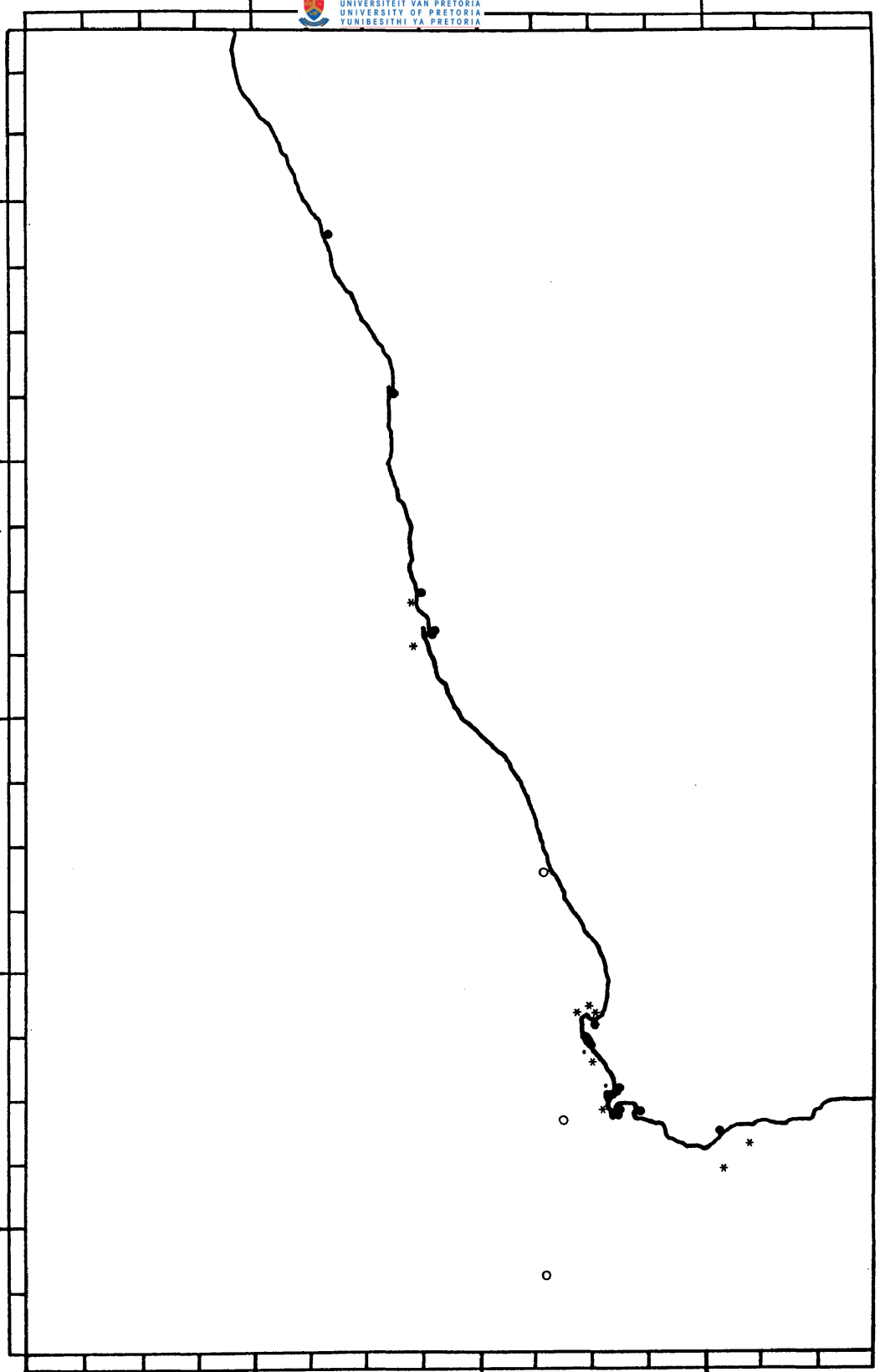


Figure 29. Scientific (○) and incidental (*) sightings and strandings (●) of minke whales and "like minke whales" reviewed in this study.

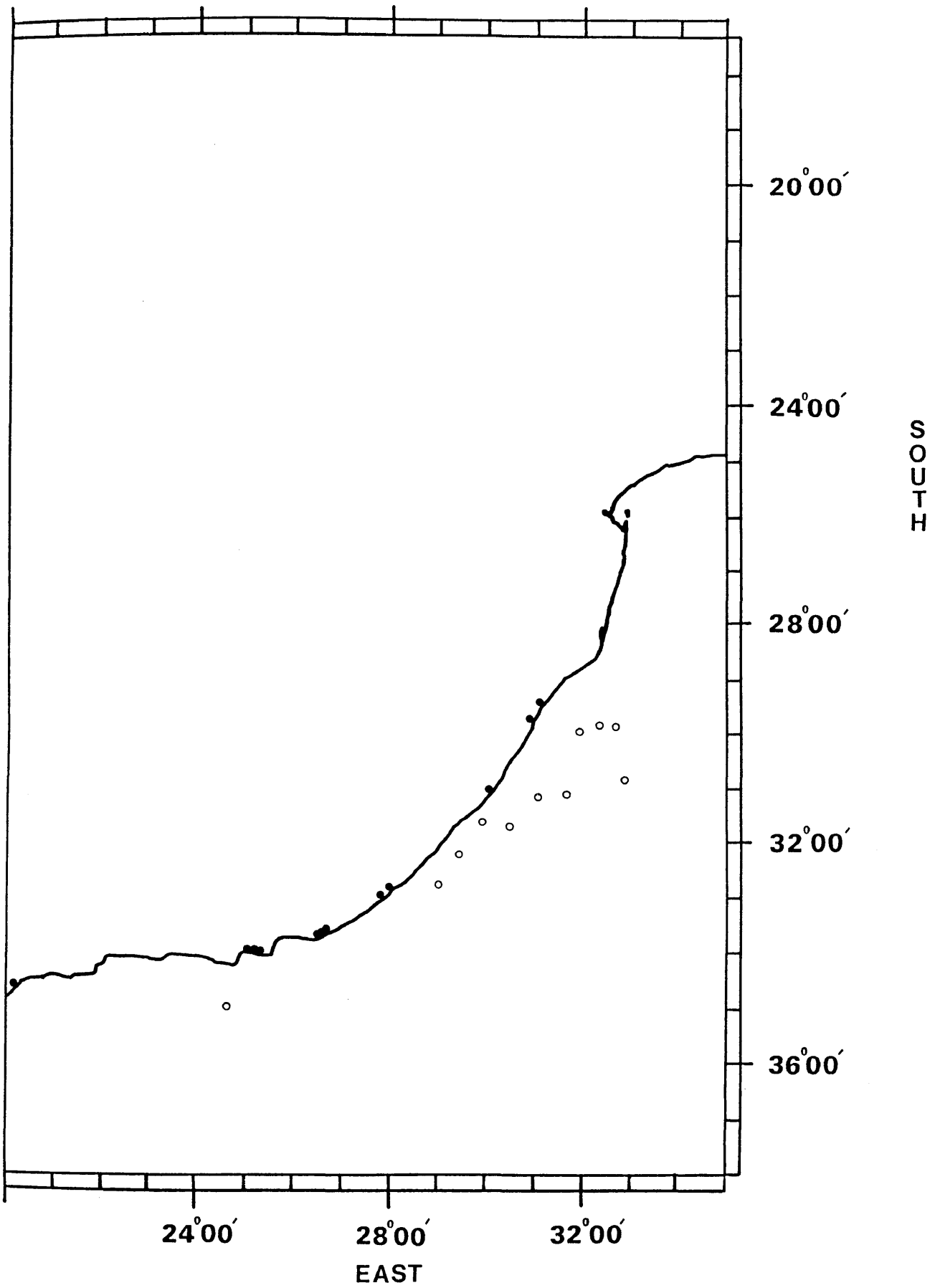


Figure 29. (continued)

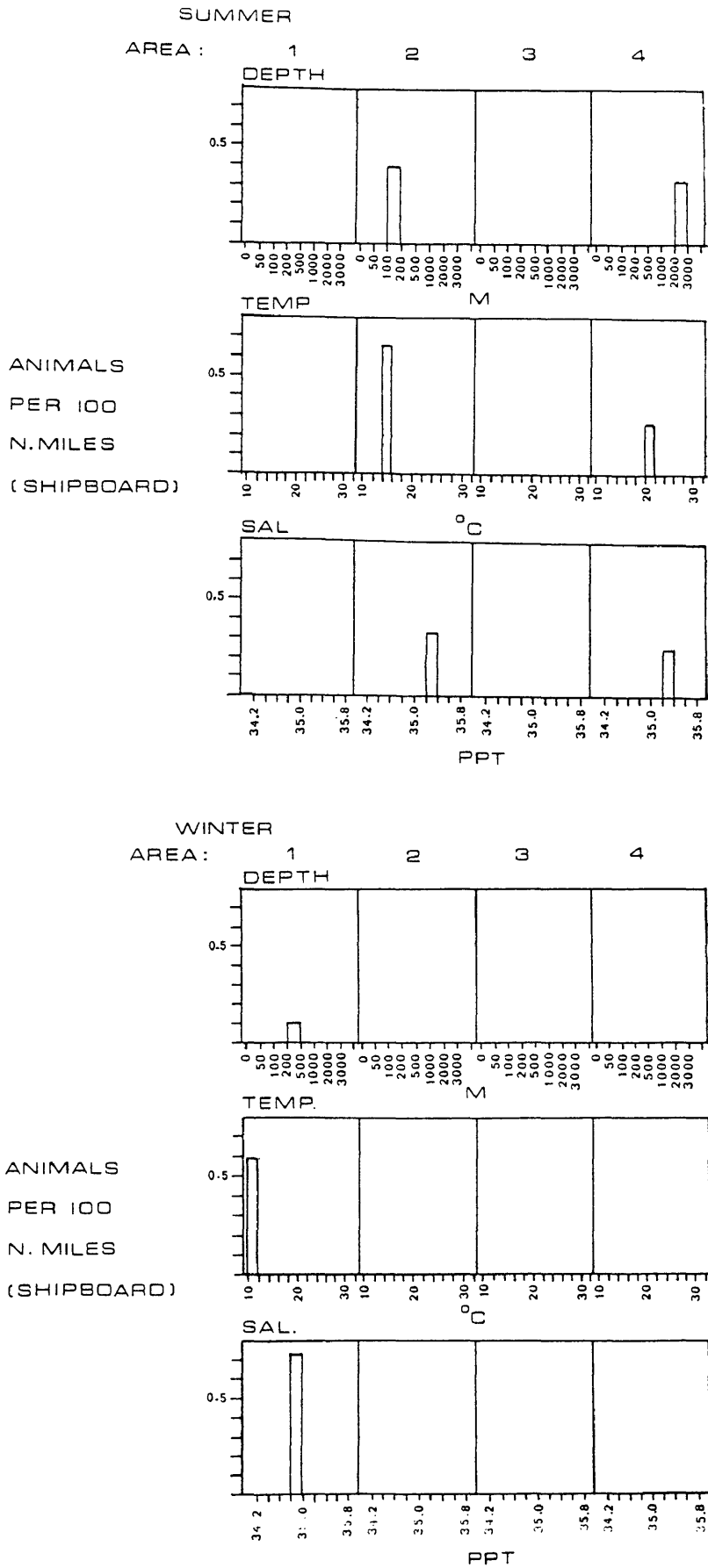


Figure 30. Densities of scientific sightings of minke and "like minke" whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Table 2. Origins of the 31 records of 33 minke whales reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	10
Dead beach cast (stranding)	1
Found floating dead at sea	3
Found dead on shore	8
Skeletal material found on shore	1
Incidental fishing mortality (including shark net mortalities)	3
Direct fishing mortalities (including scientific collection)	2
Unknown	5

Scientific sightings of minke whales were all recorded during summer in both shelf and off - shelf waters (figure 30). Similarly sightings of "like minke whales" were made both on and off the continental shelf (figure 30). Scientific sightings of minke whales were made in waters of temperatures of between 14^o and 16^o C in Area I, between 20^o and 22^o C in Area II, between 20^o and 22^o C in Area III and between 22^o and 26^o C in Area IV. "Like minke whales" were recorded in temperatures of between 14^o and 16^o C in Area II and between 20^o and 22^o C in Area IV in summer and between 10^o and 12^o C in Area I in winter (figure 30). Minke whales were recorded in a wide range of salinities (from 34.2 to 34.6 in Area IV to 35.6 to 35.8 in Area II), while "like minke whale" summer records all fell within the 35.2 to 35.4 ppt interval and the one winter record fell in the 34.8 to 35.0 ppt salinity interval.

One hundred and fifty - five groups of a sum total of 258 minke whales were sighted by commercial spotters off Durban between 1972 and 1975. Mean group size was 1.66 animals per group (sd ± 0.98). No minke whale sightings were reported off Donkergat in 1963, but this may reflect the lack of commercial interest in this species at that time. One animal was taken by the catchers in September 1963.

Minke whales only featured in the Durban whaling catches after 1968 when abundance of the other baleen species had declined (Best 1982). The seasonal abundance of catches and aerial sightings off Durban between 1968 and 1975 showed that minke whales were present between April and September with maximum abundance occurring in

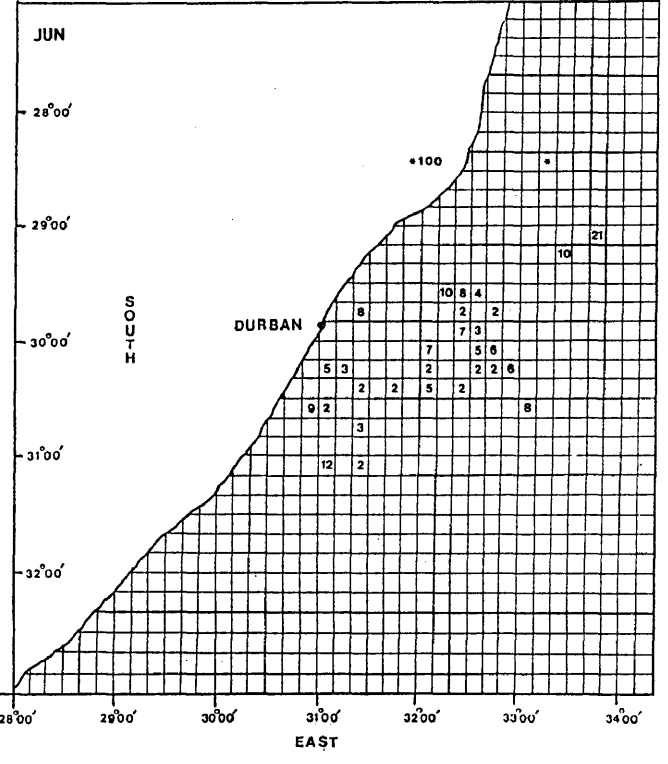
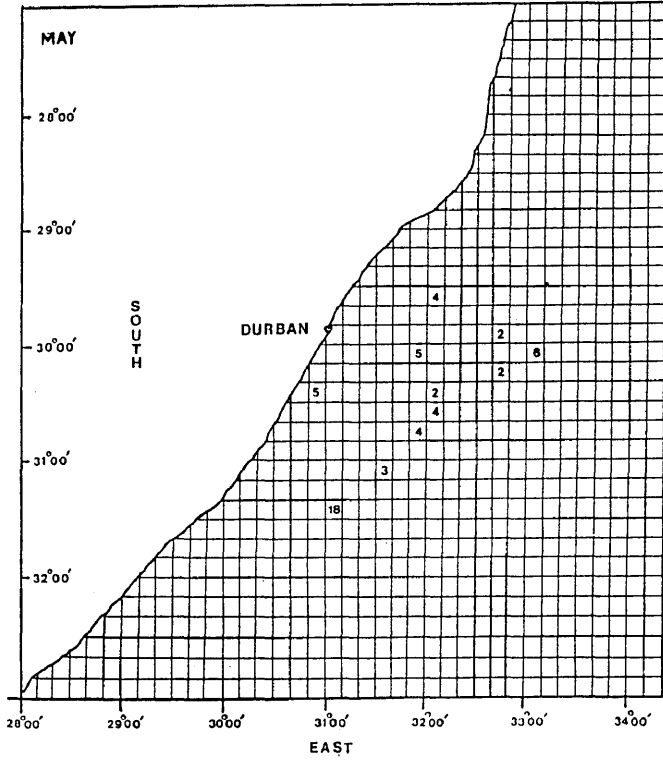
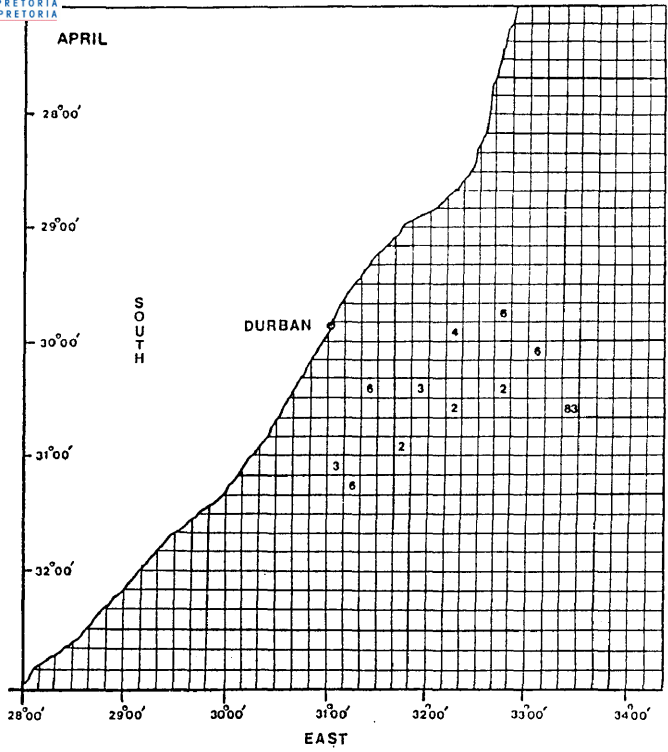
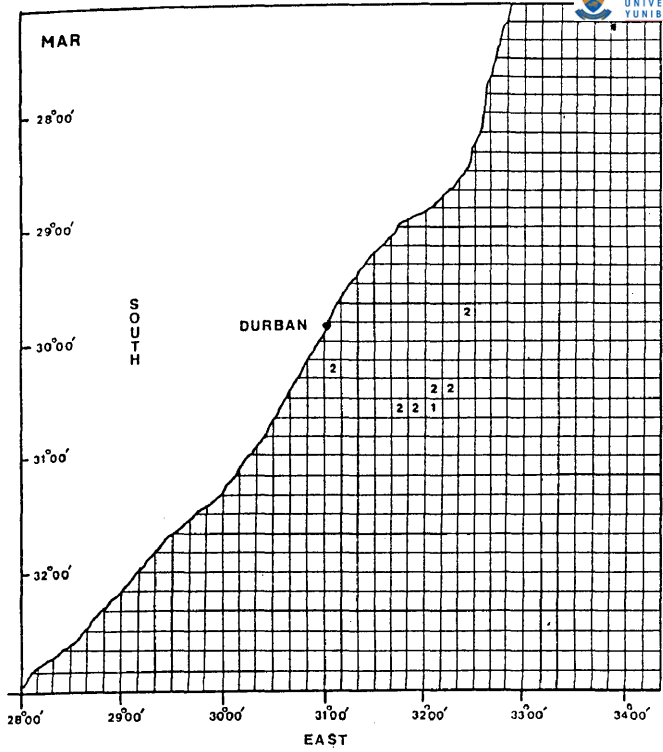


Figure 31. The distribution of minke whales sighted off Durban between 1972 and 1975.

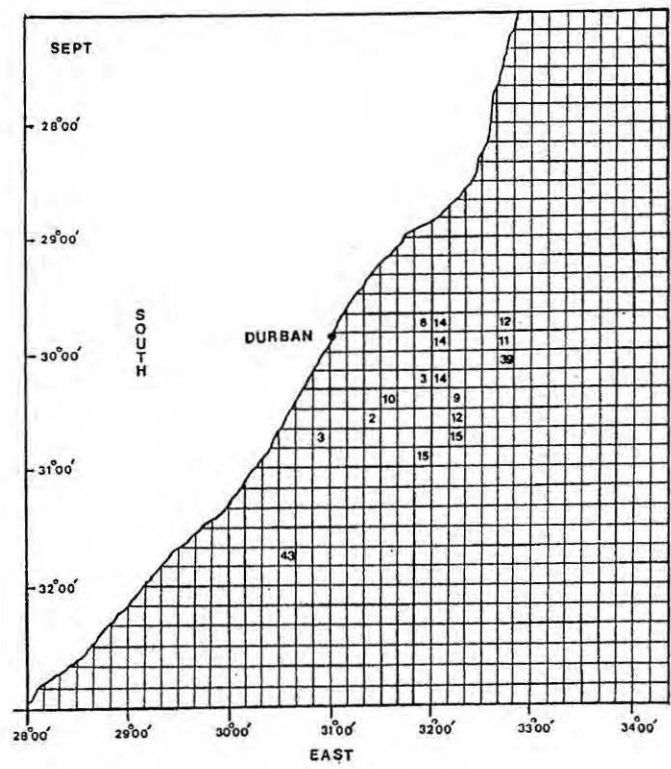
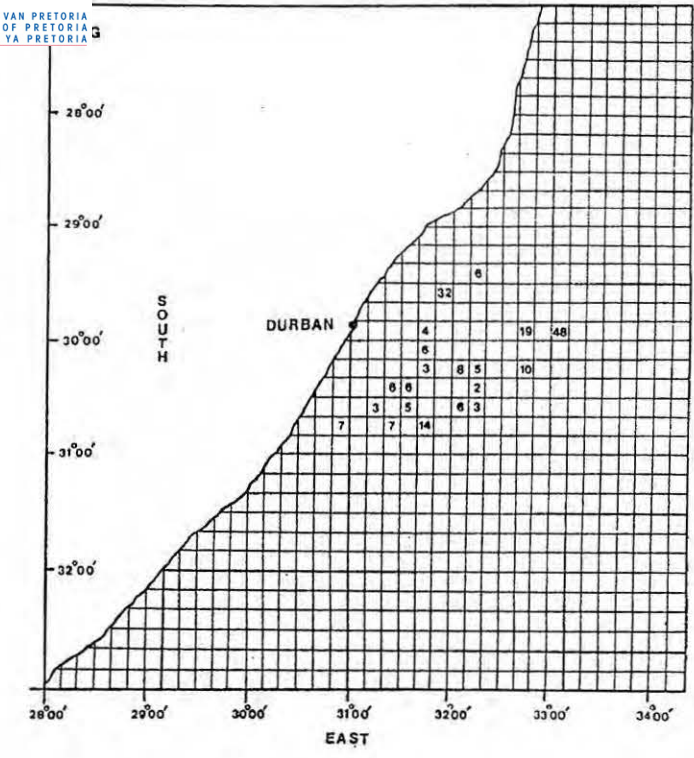
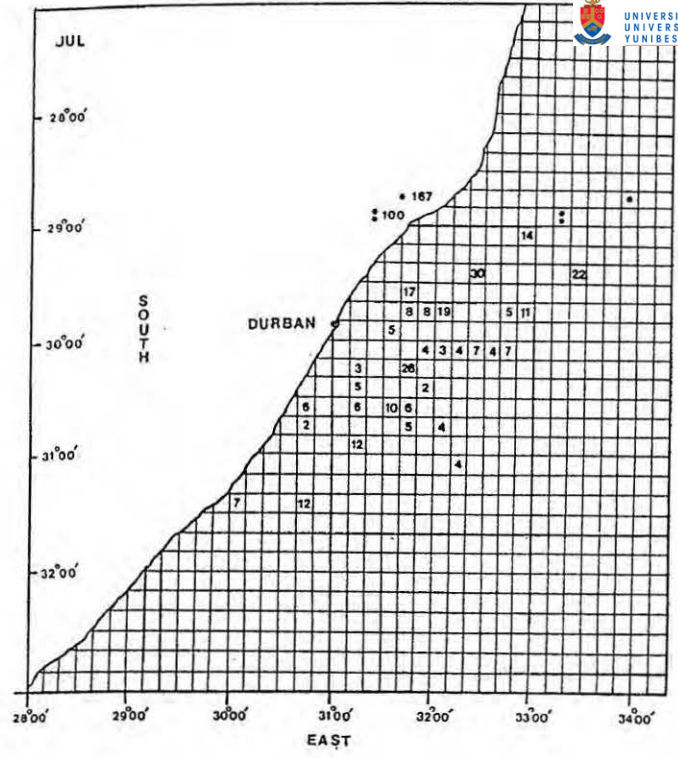


Figure 31. continued.

the departure of the southward migration is not known. The distribution of sightings of minke whales off Durban is shown in figure 31, and the general pattern shows an orientation parallel to the coast. All of these sightings of minke whales were made in water depths of over 100 metres (figure 39). It appears that the most northern distributions are found in June and July, although the peak of seasonal abundance is higher for August and September.

The scientific and incidental sighting and stranding data under review here infer that minke whales are present in southern African waters all year round. The pattern of abundance in the east coast whaling ground suggest a seasonal increase of this species in this region between July and October. Best (1982) found that the catches early in the season composed a large proportion of sexually mature animals with an increase in mature males and females from June and July respectively and that males outnumbered females by over two to one until September. The late peak of abundance found in both this study and by Best (1982) suggested that the majority of minke whales migrate southwards towards the end of the whaling season or after the season has closed. Best (1982) maintained that it was not possible to identify separate northward and southward migrations and that the incidence of whales infested with the Antarctic diatom *Cocconeis ceticola* did not show any marked peak between June and September, but remained high throughout the season. Williamson (1975) found minke whales to be present off Brazil (latitude 07° 00' S) from June and July through to December between 1969 and 1974, although maximum abundance occurred between September and November. The three summer sightings of cow and calf pairs suggest that some females with calves remain in these waters in summer. Best (1982) notes the absence of lactating females in Antarctic waters and suggests that females may either wean their calves before arriving on the feeding grounds, or remain in lower latitudes during summer.

Bryde's whale (*B. edeni*)

Olsen (1913) stated that Bryde's whale appeared to be common along the south coast in 1912 and notes the rarity of this species north of Saldanha Bay off the west coast. Cummings (1985) states that Bryde's whales do not undertake long migrations, but Tershey, Breese and Strong (in press) note that Best (1960;1977) and Valdivia, Franco and Ramirez (1981) suggest that certain groups of Bryde's whales undertake limited north south

migrations. Ohsumi (1977) reported two Bryde's whales marked just to the north of the equator (north of New Guinea) and recaptured at 30° N in the Pacific Ocean, and movements of Bryde's whales between the Bonin Islands region and the Sanriku and Wakayama whaling grounds. Best (1977) found that the southern African population of Bryde's whale consisted of two forms - a smaller neritic form and a larger pelagic form. Although it was first assumed from distribution and diet data that this species had an onshore / offshore migration (Best 1960), further data on morphology, growth and reproduction showed that in fact two forms were present (Best 1977). The inshore form appears to be more or less resident while the offshore form is believed to be migratory. Strong evidence for the migratory behaviour of the offshore form arises from a mark return of a "probable" Bryde's whale (Best 1977). This whale, originally recorded as a sei whale off Donkergat in the month of February 1963, and returned some 10 years later during July at the Equator (see Table 1), is thought by Best (1977) to have been an offshore form of Bryde's whale.

Due to the difficulty of identifying the species at sea, doubtful sightings of Bryde's whales (ie. where the head ridges were not observed) were categorised as "like Bryde's whale". Ninety-six confirmed sightings of a total of 149 Bryde's whales were made on scientific cruises, while a further 45 sightings of 73 "like Bryde's whale" were made on scientific cruises and flights (all aerial scientific sightings were recorded as "like Bryde's whale"). Group size of these sightings ranged from one to 23 animals per group. The sighting of a group of 23 animals was recorded by Best *et al* (1984) and it must be noted that this group was spread out over about 10 nautical miles and was excluded from mean group size analysis. The tendency of this species to congregate in association with schools of clupeid fish prey has been noted by Best *et al* (1984). Mean group size of the confirmed sightings of Bryde's whale was 1.64 animals per group (sd \pm 1.47) and of "like Bryde's whale" 1.66 animals per group (sd \pm 1.28). Although it is difficult to differentiate between the inshore and offshore forms of Bryde's whales at sea, a high percentage of scientific sightings of Bryde's whale and "like Bryde's whale" were made fairly close inshore between $30^{\circ} 00'$ S on the west coast and $27^{\circ} 00'$ E on the south coast of the subcontinent (figures 39 and 33), inferring that the majority are of the inshore form. Two incidental sightings of single Bryde's whales and 27 incidental sightings of a total of 44 "like Bryde's whale" were recorded (22 of these were aerial sightings). Group size of these sightings ranged from one to four animals per group (for both Bryde's and "like Bryde's" whale) with a mean of 1.5 (sd \pm 0.89) for the Bryde's whale sightings and a mean of 1.33 (sd \pm 0.57) for the "like Bryde's" whale sightings. The

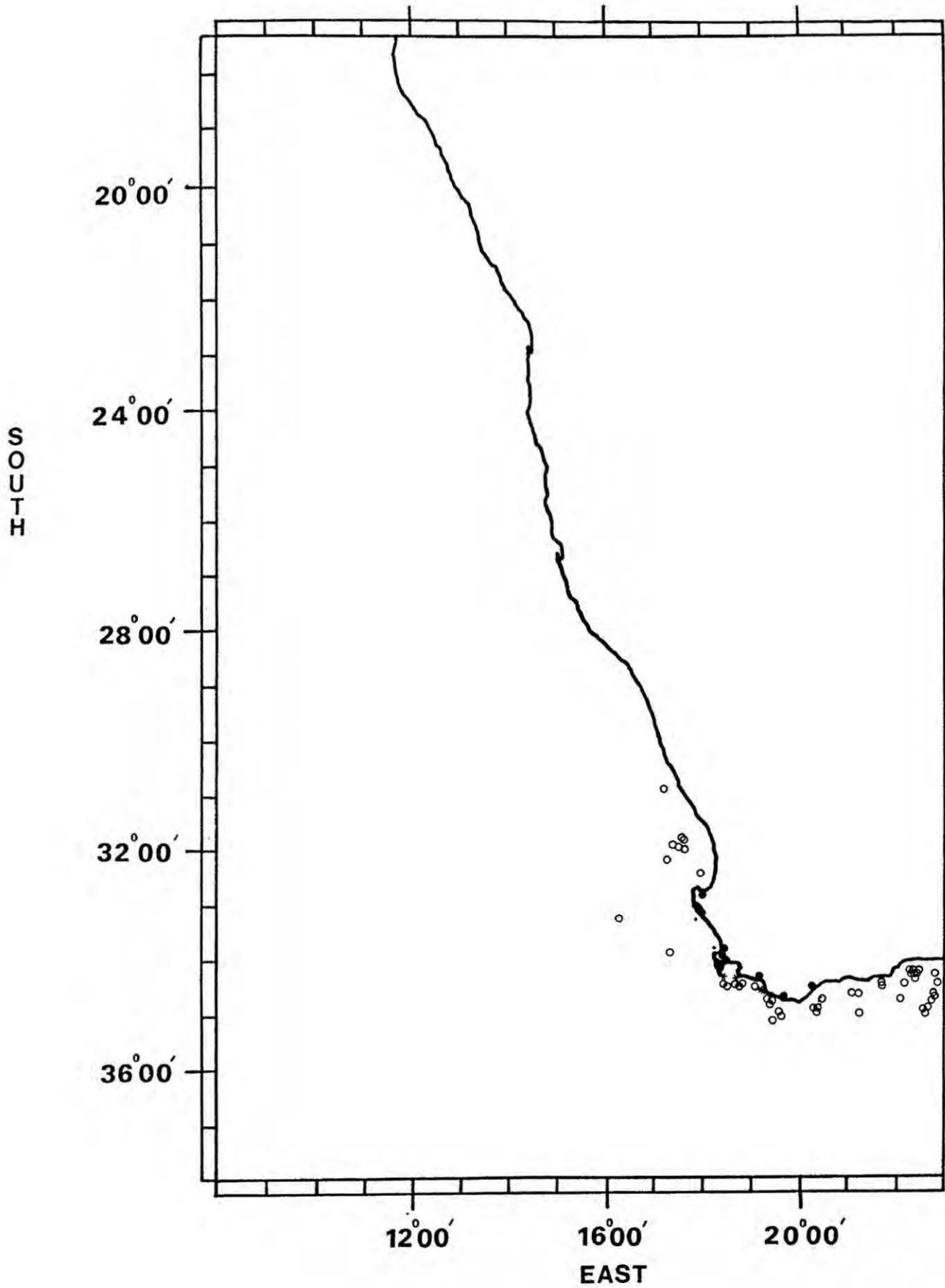


Figure 32. Scientific (o) and incidental (*) sightings and strandings (●) of Bryde's whales reviewed in this study.

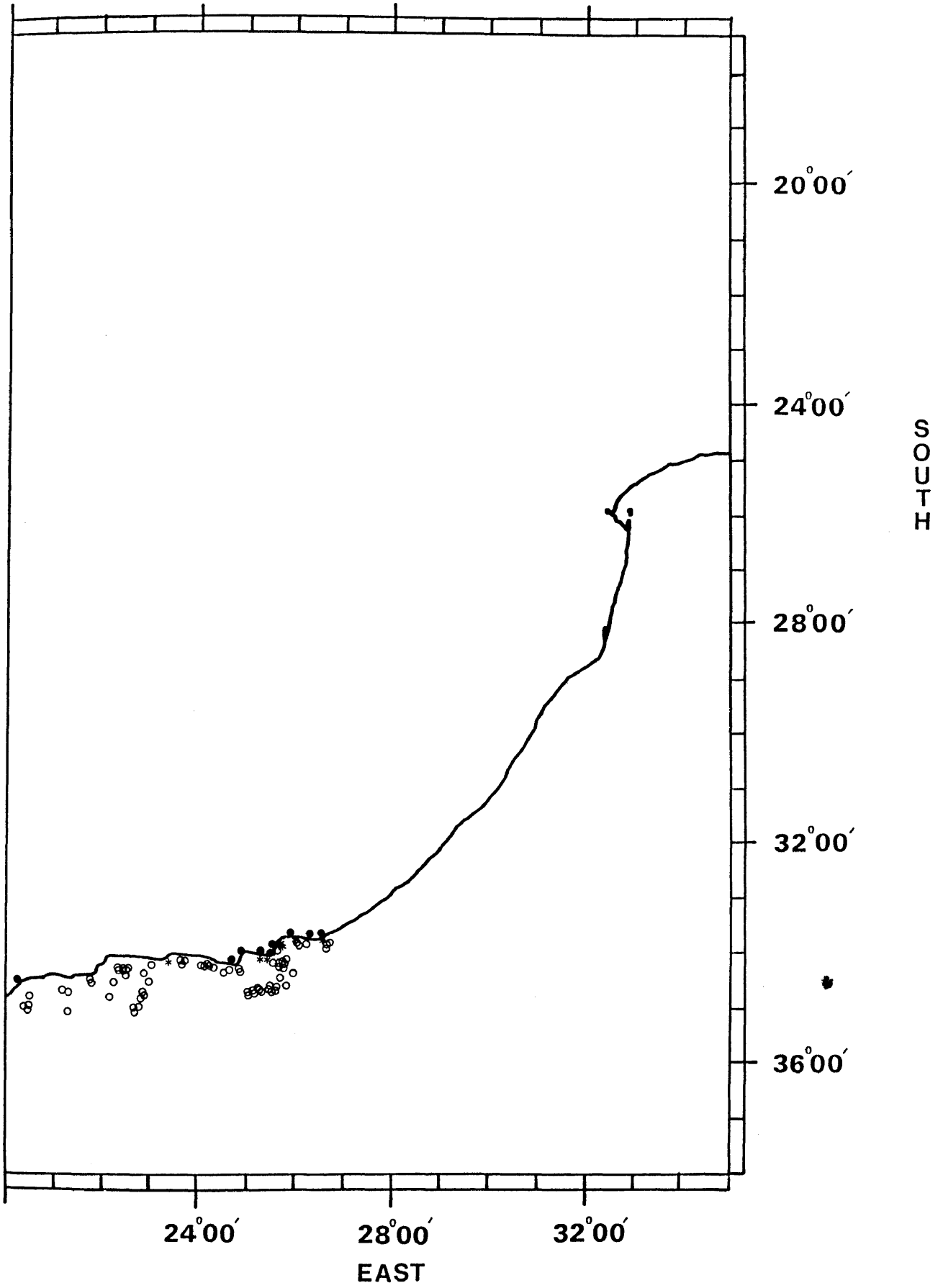


Figure 32. (continued)

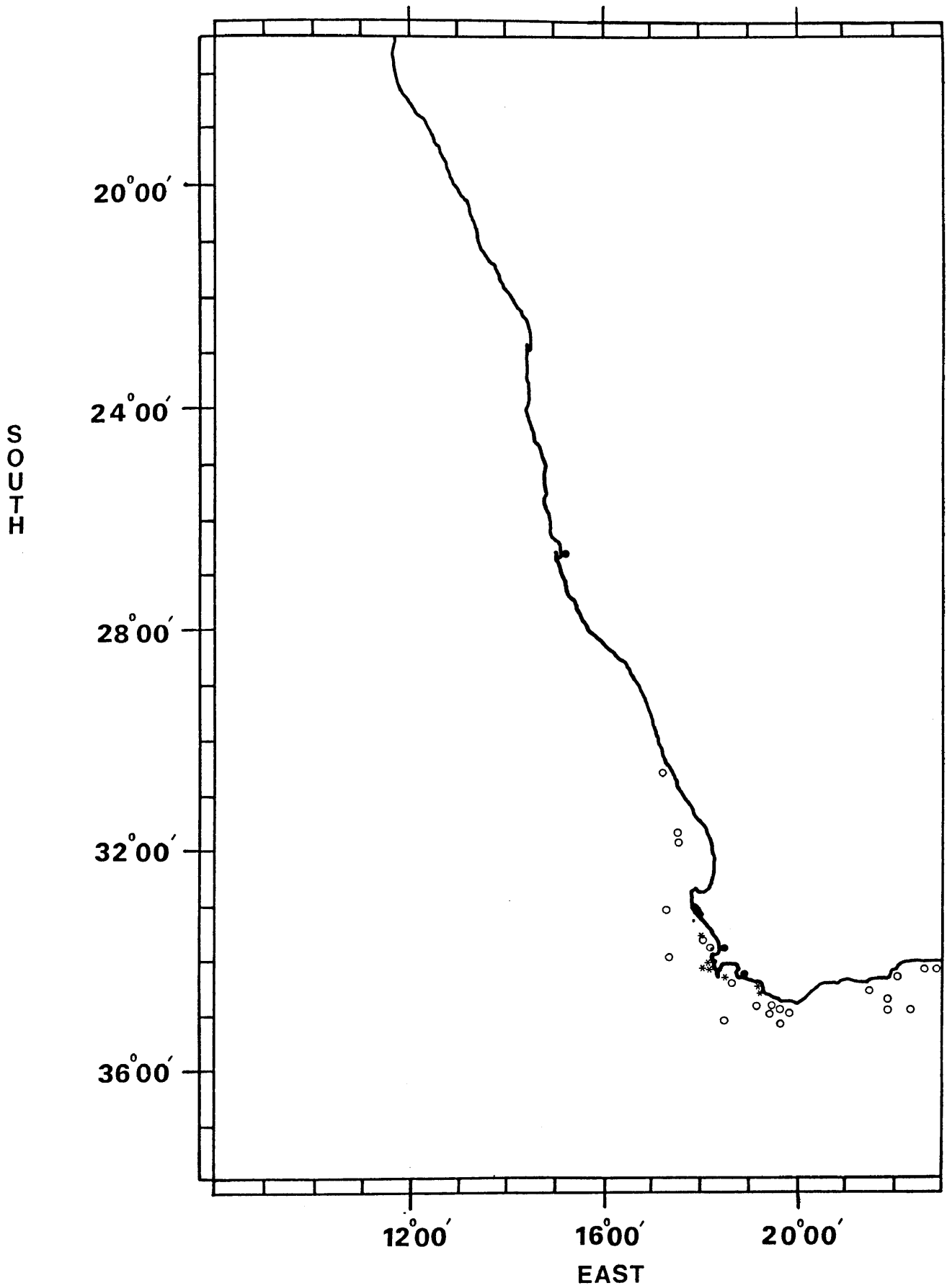


Figure 33. Scientific (○) and incidental (*) sightings and strandings (●) of "like Brydes whales" reviewed in this study.

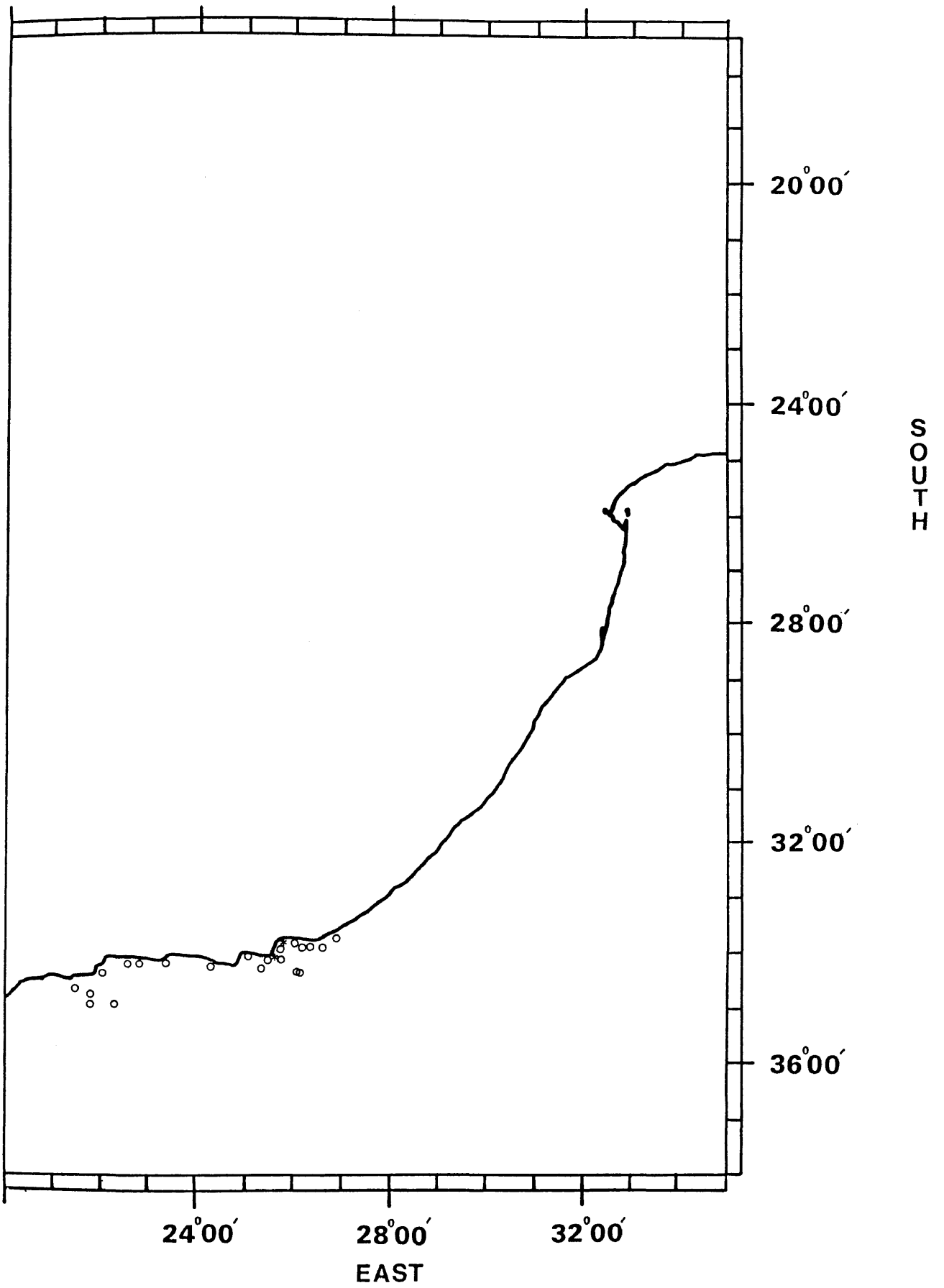


Figure 33. (continued).

incidental sightings of Bryde's and "like Bryde's whales" show similar distribution patterns (figures 32 and 33). Seventeen specimens of Bryde's whale and three specimens of "like Bryde's whale" were reviewed in this study. The provenances of these are shown in figures 32 and 33, while table 3 and figure 28 show the category and month of origin of these specimens respectively.

Table 3. Origins of the specimens of 17 Bryde's whales and 3 "like Bryde's whales" (in parentheses) reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	3
Dead beach cast (stranding)	5 (2)
Found floating dead at sea	1
Found dead on shore	6 (1)
Skeletal material found on shore	1
Unknown	1

There is a bimodal trend in the depth distribution of summer scientific sightings of Bryde's whales in Area II and a slight bimodal trend in depth distribution in Area III (figure 34). Similar bimodal trends are found in the depth distribution of "like Bryde's" sightings in Area III during summer and Area I during winter (figure 35). Sightings of Bryde's whale in Areas I and "like Bryde's whale" in Areas I during summer and Area II and III during winter are all recorded inshore of the 200 metre depth contour, while the majority of summer records of "like Bryde's" in Area II occurred in waters of over 500 metres (figure 35). Temperatures measured in waters where Bryde's whales were sighted range from 10^o to 12^o C in Area II to 26^o to 28^o C in Area III (figure 38). This occurrence in high water temperatures in Area III is assumed to arise from the temperatures not being real time measurements. The summer temperatures into which "like Bryde's" sightings fell were in the 14^o to 16^o C interval in Area I, the 14^o to 18^o C intervals in Area II and the 16^o to 20^o C intervals in Area III. Winter temperatures measured in waters in which "like Bryde's whale" were sighted ranged between 10^o to 14^o C in Area I and 12^o to 14^o C in both Area II and Area III. Tershey, Breese and Strong (in press) note that the distribution of Bryde's whales is often considered to be limited to below the 20^o C isotherm, but that the coastal form is found in temperatures as low as 12^o C and often in temperatures of between 15 and 18^o C. Salinities measured in waters in which Bryde's whale were sighted ranged from between 34.6 and 34.8 ppt (Areas I and II) to between 35.4 and 35.6 ppt (Area III).

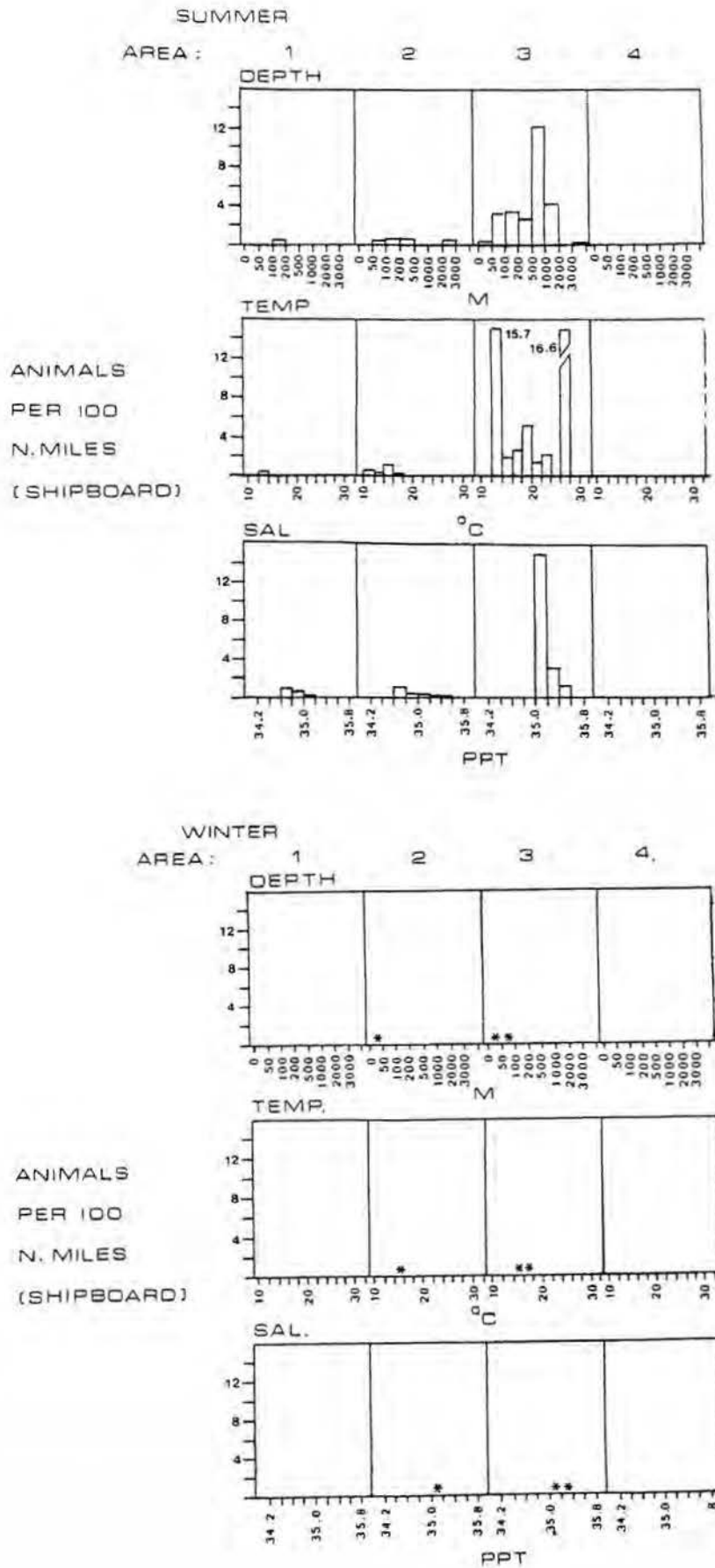


Figure 34. Densities of scientific sightings and occurrence of incidental sightings (*) of Bryde's whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

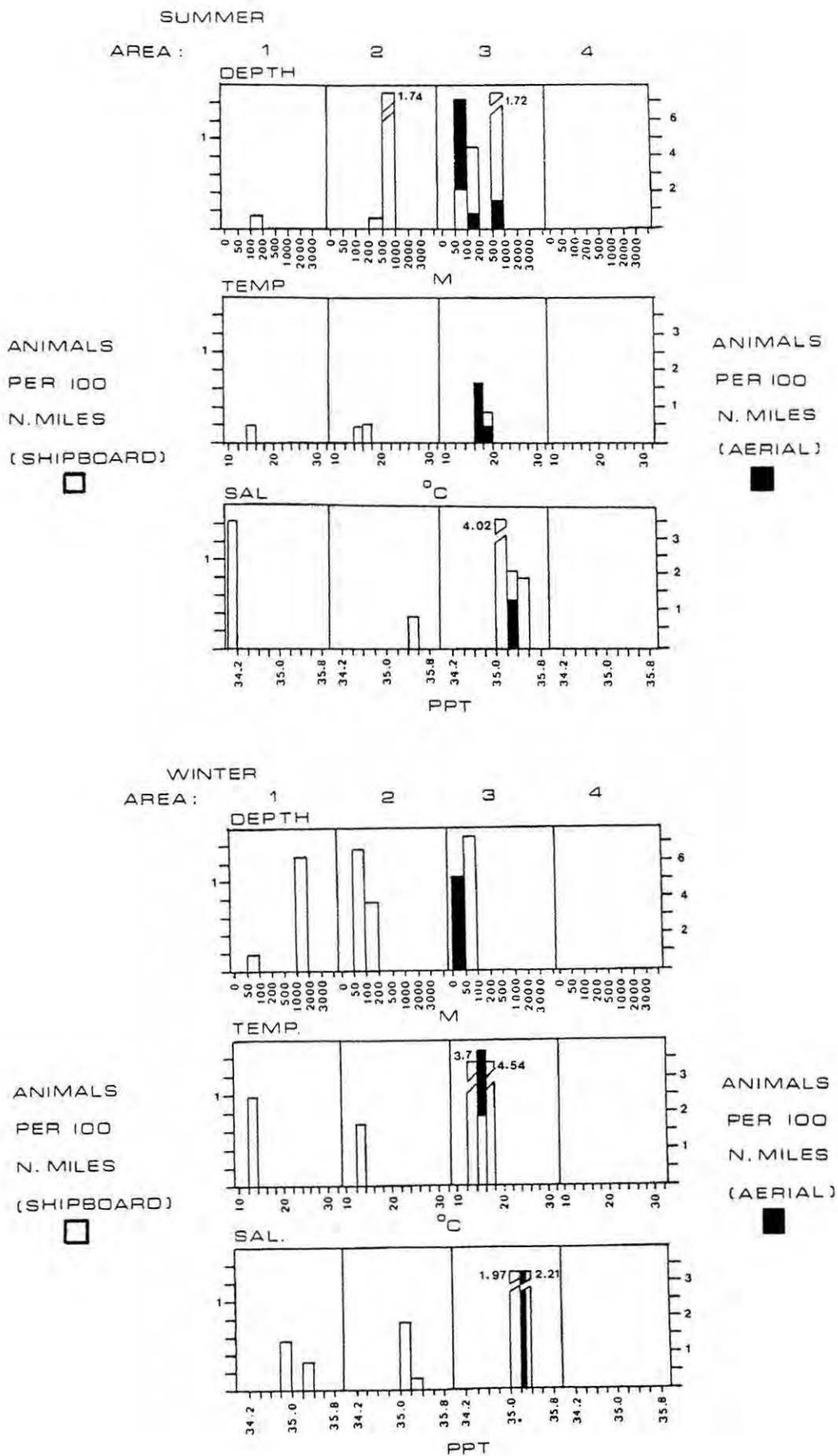


Figure 35. Densities of scientific sightings and occurrence of incidental sightings (*) of "like Bryde's whales" in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

No Bryde's whales were sighted by the spotter ~~off~~ ^{off} Durban between 1972 and 1975, although Best (1977) notes they have been taken off Durban between 1962 and 1974 in every month from April to October. Best (1977) suggests that these are the offshore form and notes that despite the annual sardine (*Sardinops ocellatus*) movement into these waters during winter, there is no increase in Bryde's whales, as might be expected from their feeding behaviour off the west coast.

Twenty - one aerial sightings of a total of 42 Bryde's whales were made off Donkergat in 1963 and a further 94 whales were taken by catchers. The sightings and catches of Bryde's whales made off Donkergat (figures 36 and 37) show some discrepancies, as catches and sightings are reported for cells in which no effort was recorded (such records are marked with a single asterisk in these figures). The majority of these catches and sightings occurred close inshore during the mid - winter months, and it is known that the catchers would search for Bryde's whales close inshore during poor weather conditions further offshore. It is possible that catches and sightings were made close inshore without effort having been recorded. Catches of Bryde's whales off Donkergat during 1963 could be identified to inshore/offshore forms on the platform (Best 1977), and the seasonal abundance of catches has been analysed as such (figure 38). No differentiation between forms could be made from sightings, and thus aerial sightings of these two forms have been analysed together. A special scientific permit (in terms of Article VIII of the International Convention of the Regulation of Whaling, 1946) was issued by the South African government for the taking of 50 sei or Bryde's whales off Donkergat during March and April 1963, and thus the high catches during these months may reflect catch selectivity. However the high sighting densities in these months would not have been subject to such selectivity and as such these densities may be real. Best (1977) maintains from catches between 1962 and 1966 that the offshore form is most abundant from March to May and in October, while the inshore form is most abundant from May to September. Catches of the offshore form are low between the months of June and August when the availability of more valuable rorquals could have resulted in less catch pressure on Bryde's whales. Best (1977) noted that the inshore form "occupied an area that is not normally fished unless the weather offshore is inclement" and the high August / September catches of this form may be due to weather having resulted in such catching. Disregarding the high early season catches shown in figure 38 it would appear that the 1963 data confirm Best's (1977) seasonality patterns. However, it should be noted that the 1963 data are included in the data analysed by Best (1977).

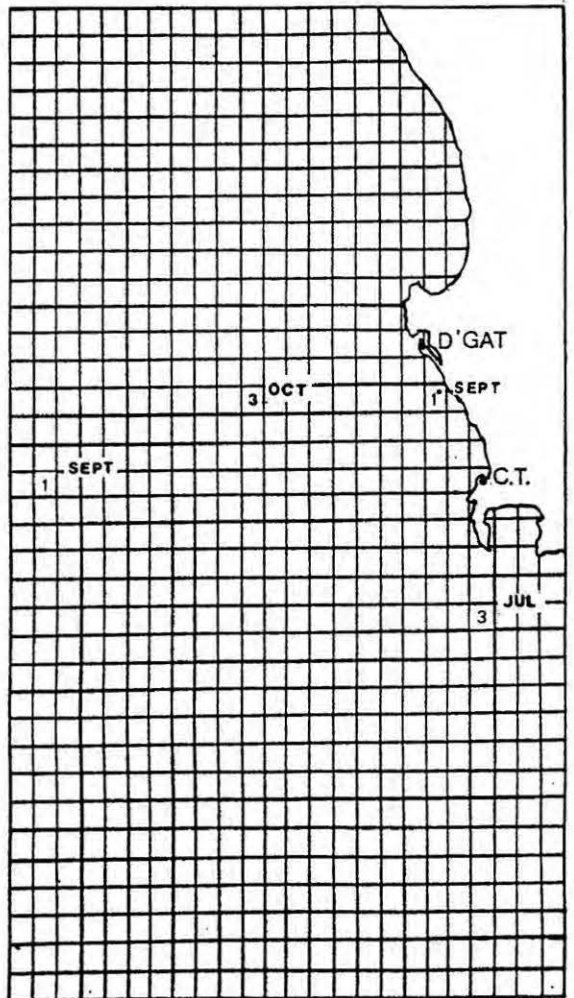
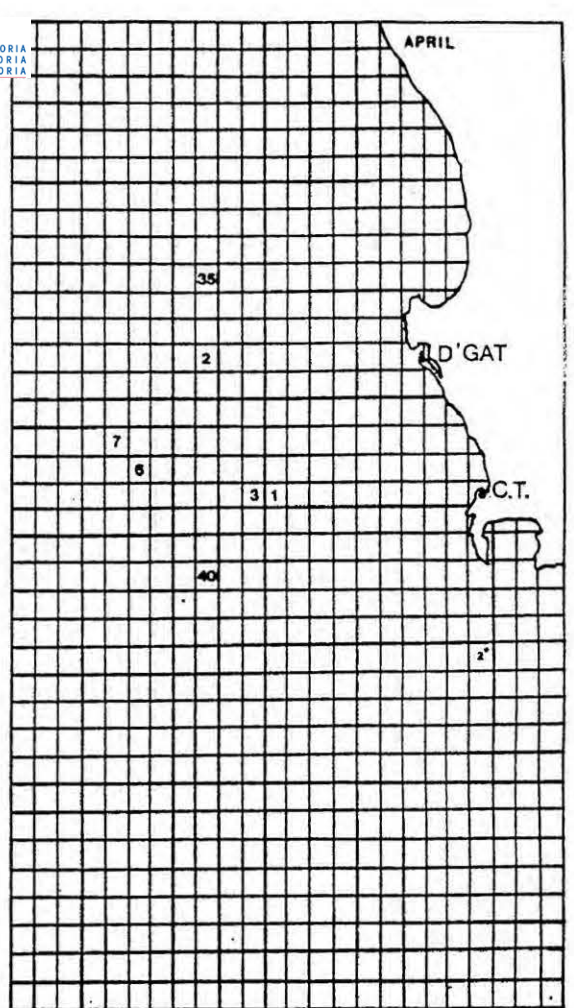
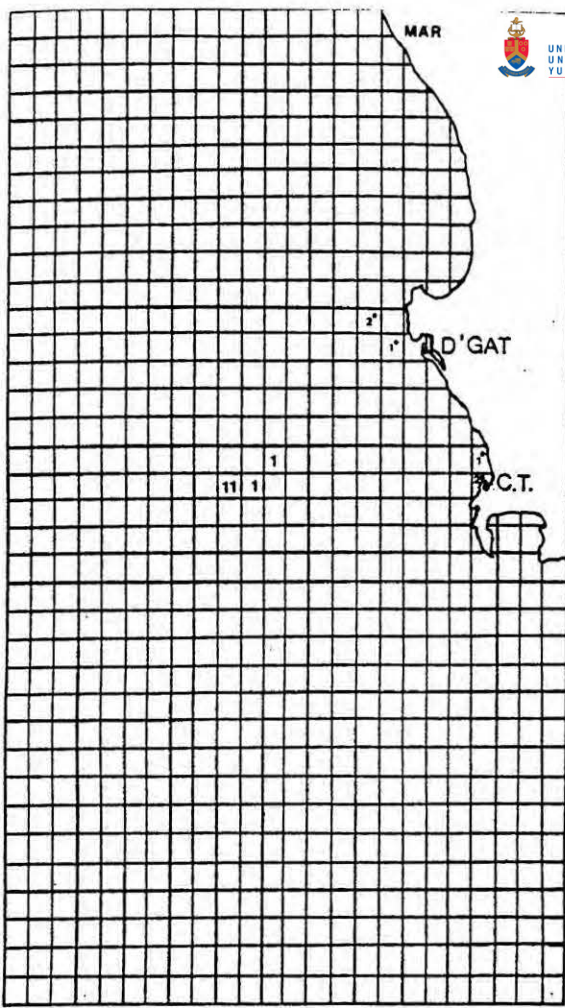


Figure 36. The distribution of Bryde's whales sighted off Donkergat during 1963.

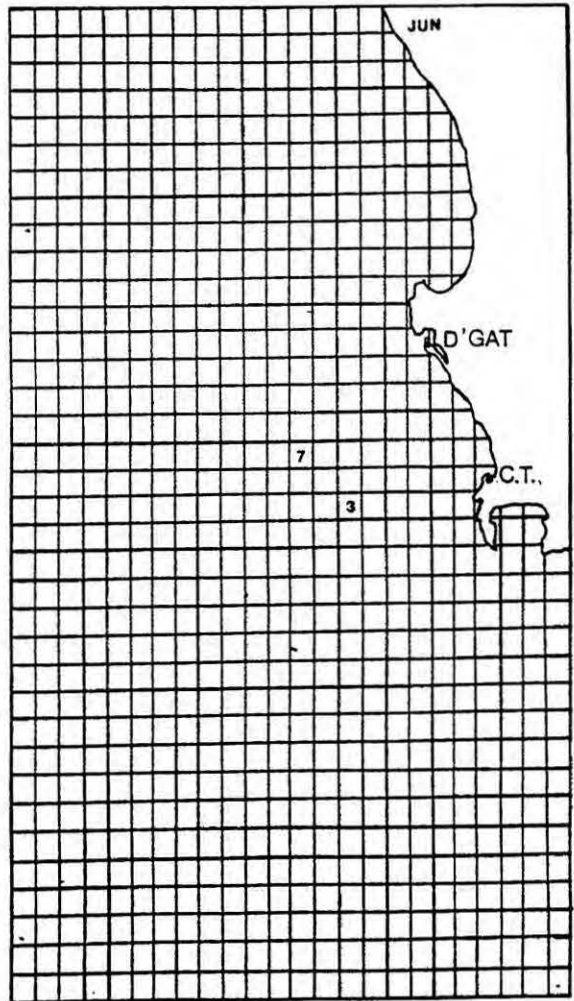
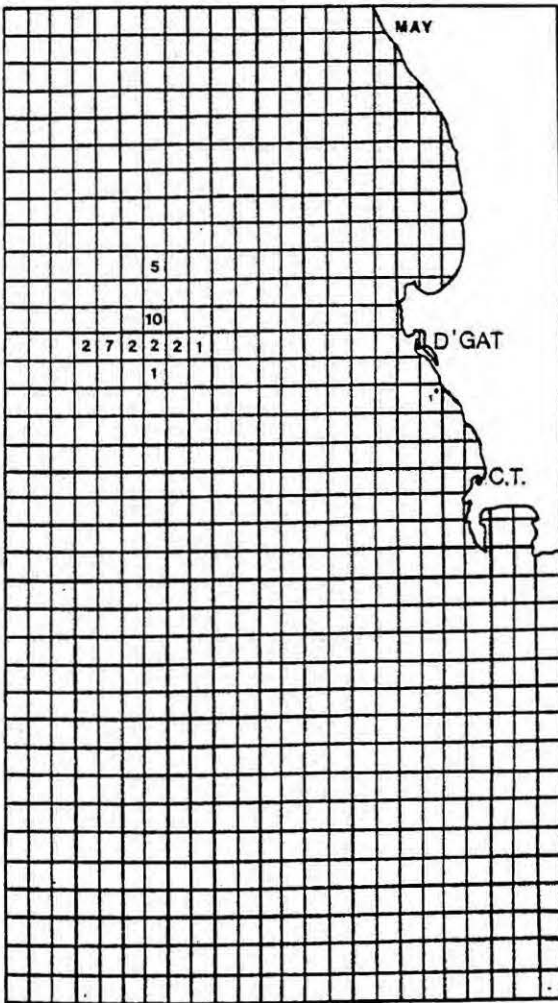
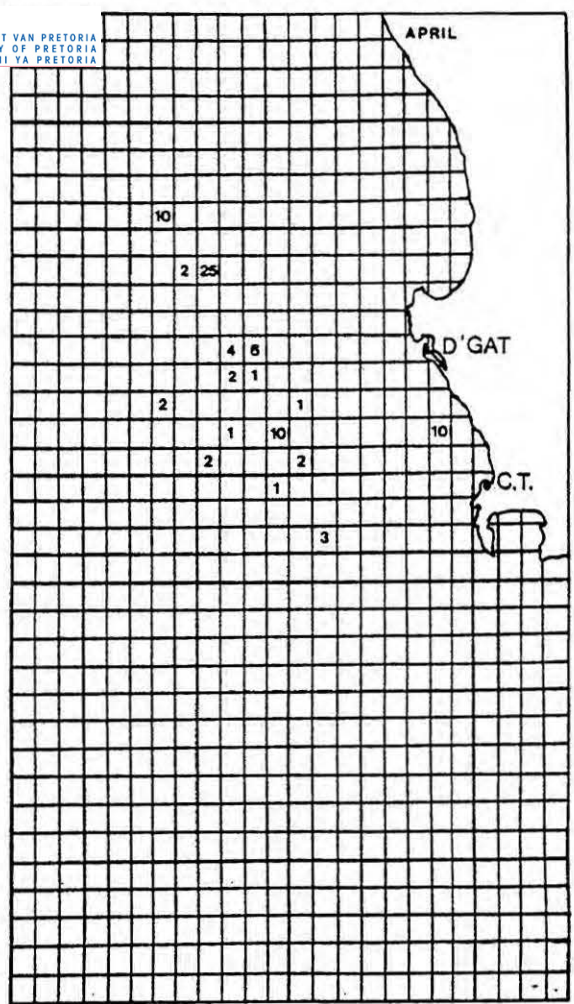
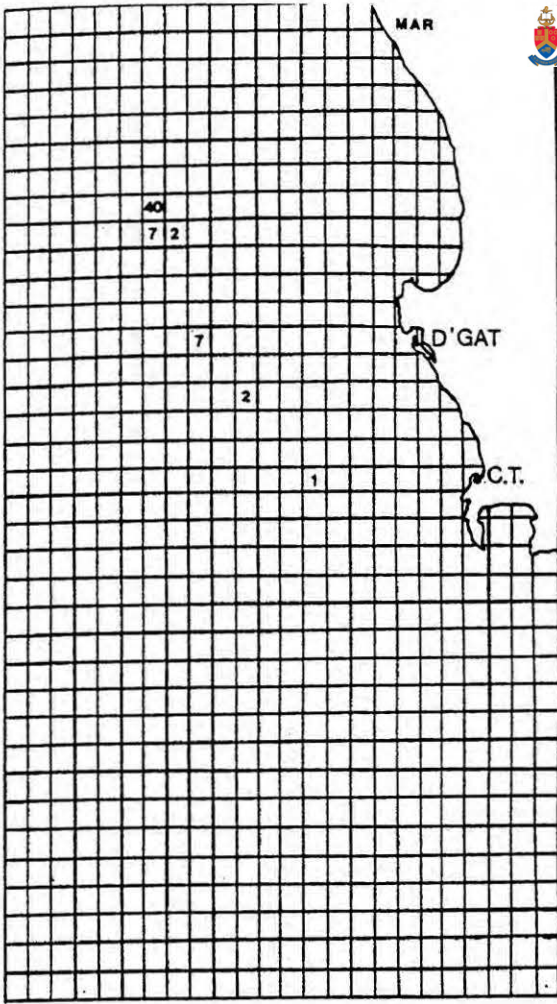


Figure 37. The distribution of Bryde's whales taken off Donkergat during 1963.

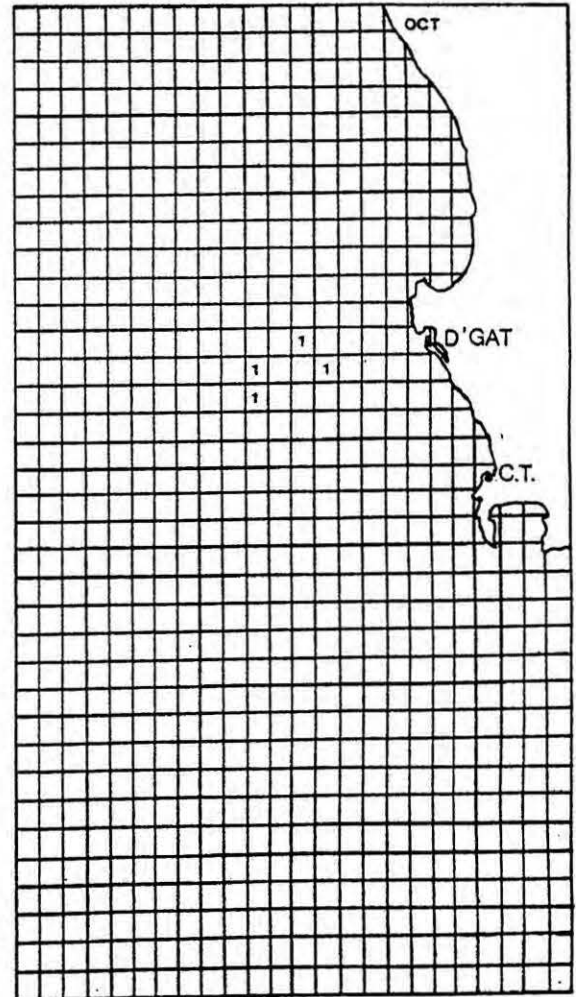
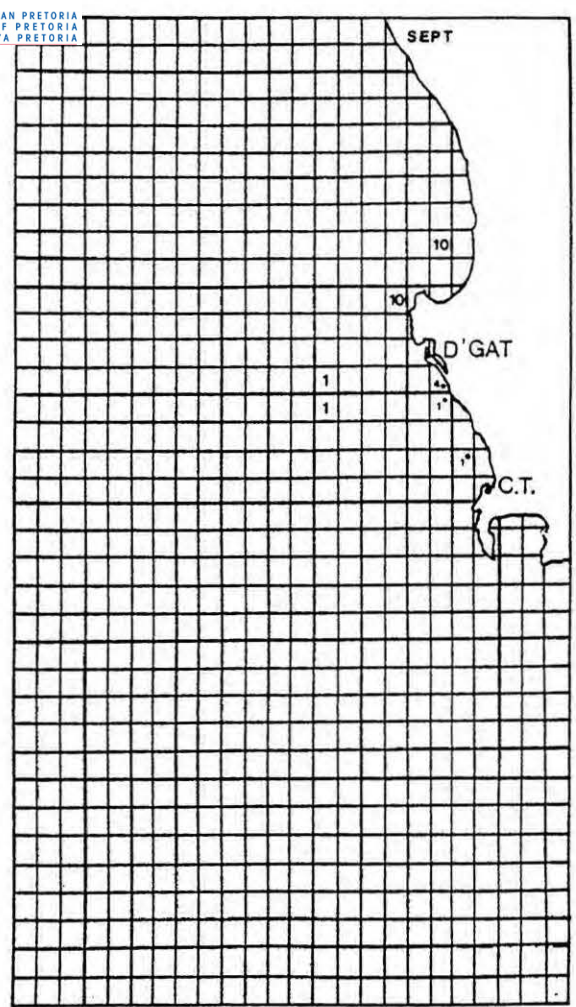
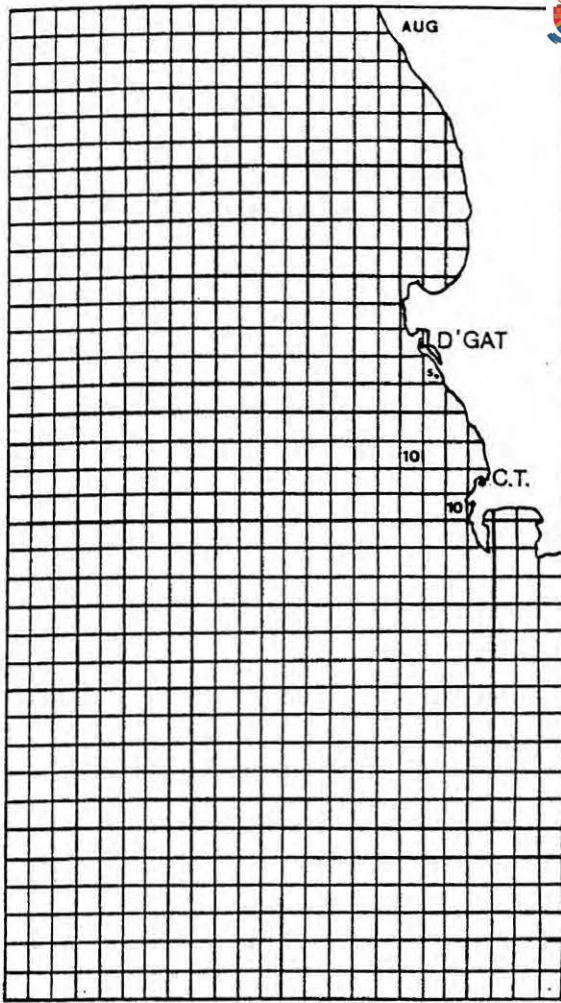


Figure 37. (continued).

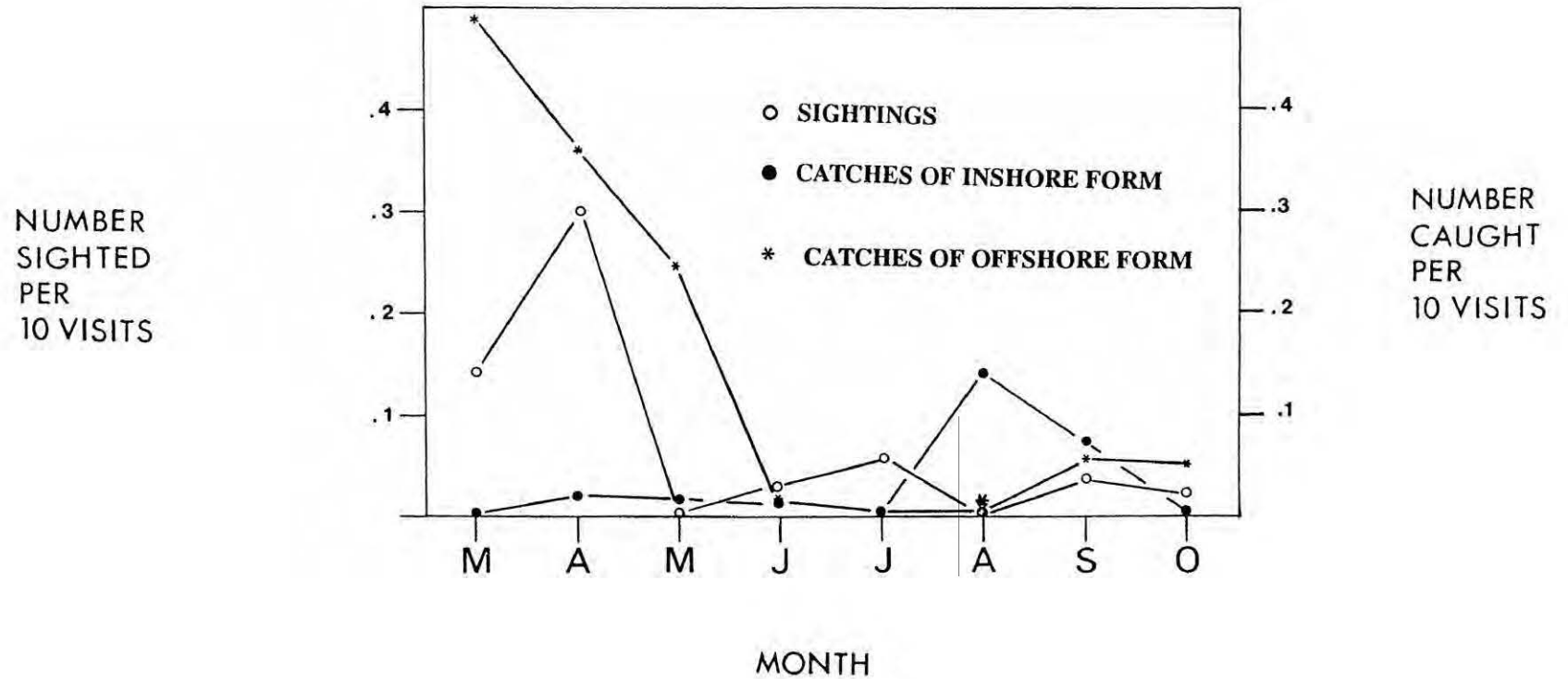


Figure 38. Seasonal abundance of sightings and catches (differentiated into inshore and offshore forms), of Bryde's whales off Donkergat during 1963.

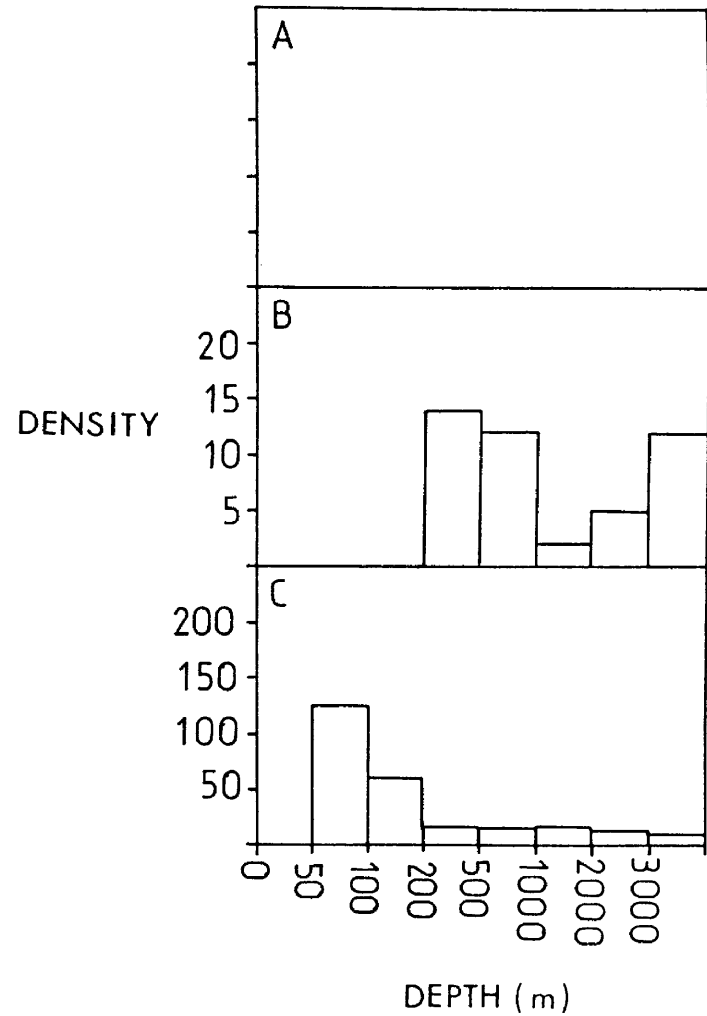
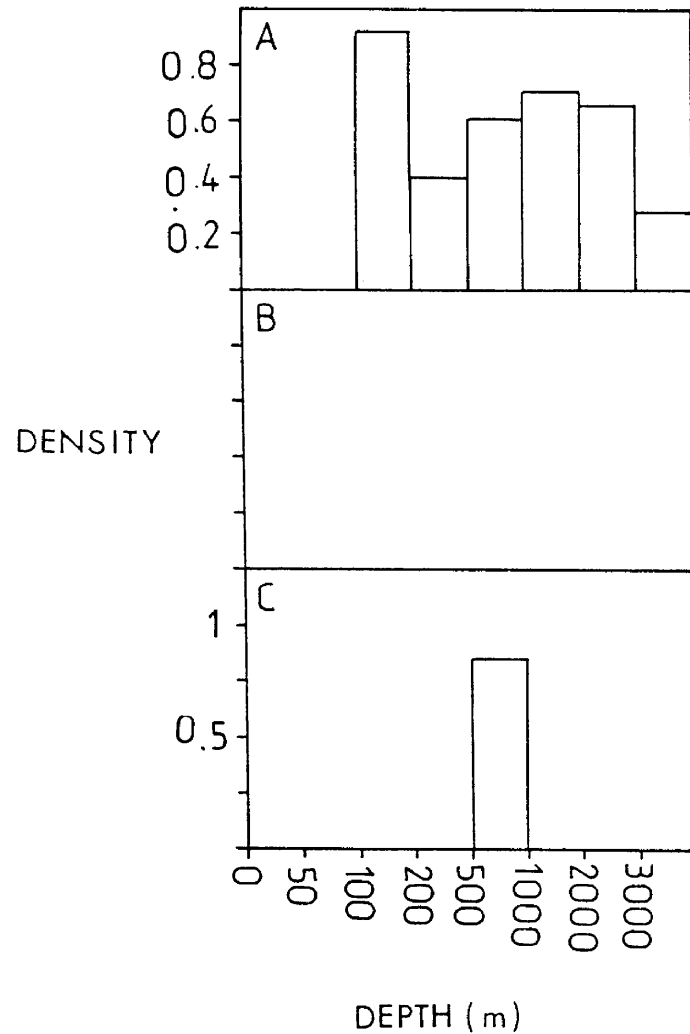


Figure 39. The depth distributions of Bryde's and minke whales recorded in the east and west coast whaling grounds.
A: East coast whaling grounds (expressed as number sighted per 1000 miles searched) and **B:** West coast whaling ground sightings and **C:** West coast whaling ground catches (both expressed as number taken per 100 visits).

The analysis of commercial sightings of Bryde's whales (figure 39) excludes those animals taken / sighted in cells in which no effort was recorded (thereby excluding most of the inshore records). Despite this, the catches were made in all depth intervals of over 50 metres and sightings were made in intervals of over 200 metres. The inshore stock of Bryde's whales appears to be resident in nearshore waters (of less than 200 m depth) in Areas II and III and the southern region of Area I all year round. Catches of the offshore form off Donkergat show that it was most abundant early in the season (until May), with low catches being made during winter and some catches being made in September and October. The low mid winter catches of the offshore form may reflect catch selectivity of the more valuable rorquals present during these months, and the high catches early in the season may reflect further catch selectivity due to the season being closed for rorquals other than Bryde's and sei whales. However the evidence from one probable mark recovery (and from mark recoveries made in the northern Pacific Ocean) suggest that the offshore form may be highly migratory, so that the apparent absence in midwinter may be real.

The humpback whale (*Megaptera novaeangliae*)

Mackintosh (1942) maintains that humpback whale distribution in the southern hemisphere is circumpolar, but that it is not as continuous as other *Balaenopteridae* due to the tendency of humpback whales to congregate in certain areas of the Antarctic. The migration routes of humpback whales are better known than those of other *Balaenopteridae* due to their coastal migratory habits in temperate to tropical waters (Matthews 1937, Mackintosh 1942, Dawbin 1966 and Winn and Reichley 1985). Dawbin (1966) found that migration routes were not consistently related to current direction, bottom topography or the physical properties of the water masses, and noted the effect that coasts lying obliquely to the routes, had in deflecting and "funneling" humpbacks along them. Matthews (1937) suggests that there is evidence for humpback whales migrating far into tropical waters as monthly catches off Natal between 1918 and 1928 show a clear bimodal distribution with peaks in June/July and September/October. Angot (1951) reported unimodal catches (between July and September) of humpbacks from Madagascar, while Townsend (1935) mapped 19th century humpback whaling grounds off Gabon and Walvis Bay on the west coast and Mozambique and Madagascar on the east coast. Olsen (1914 - 15, in

Hinton 1915) and Harmer (1931) maintained that the main west coast migration route of humpbacks strikes the sub-continent to the north of Saldanha Bay and then continues northwards while Harmer (1931) reported a bimodal trend (peaks in June and October) for Angolan catches.

Six scientific sightings of a total of 11 humpback whales are recorded. Three of these sightings were made in February, one in August, one in November and one in December. Group size ranged from one to three with a mean of 1.83 animals per group (sd \pm 0.98). Fourteen incidental sightings have been recorded throughout the year. One of these records was a sighting of approximately fifty humpbacks off the Natal coast (at 30° 15' S 30° 50' E) by a commercial fishing vessel during October. Group size for confirmed incidental sightings ranges between one and seven with a mean of 1.83 animals per group (sd \pm 1.69). Nine specimen records of humpback whale were reviewed from this coast. The provenances of these are plotted in figure 40, while categories and months of origin are shown in table 4 and figure 28 respectively.

Table 4. Origins of the 9 specimens of humpback whales reviewed in this study.

Category of provenance	Number of individuals
Dead beach cast (stranding)	3
Found dead at sea	1
Found dead on shore	2
Direct fishing mortalities (including scientific collection)	1
Unknown	2

The distributions of dedicated scientific sightings, incidental sightings and specimens of humpbacks (figure 40) show that this species occurs throughout southern African waters and the fact that the majority of the sightings have been recorded close inshore would support published findings (Olsen 1914-15 in Hinton 1915, Matthews 1937, Mackintosh 1942, Dawbin 1966) that migrations are often coastal.

A number of humpback sightings occurred in the summer months. Olsen (1914-15 in Hinton 1915) states "In the cold current off Saldanha Bay one could meet single young males, probably yearlings, throughout the whole summer". Mackintosh (1942) suggests that it is possible that some humpbacks ("especially the immature ones")

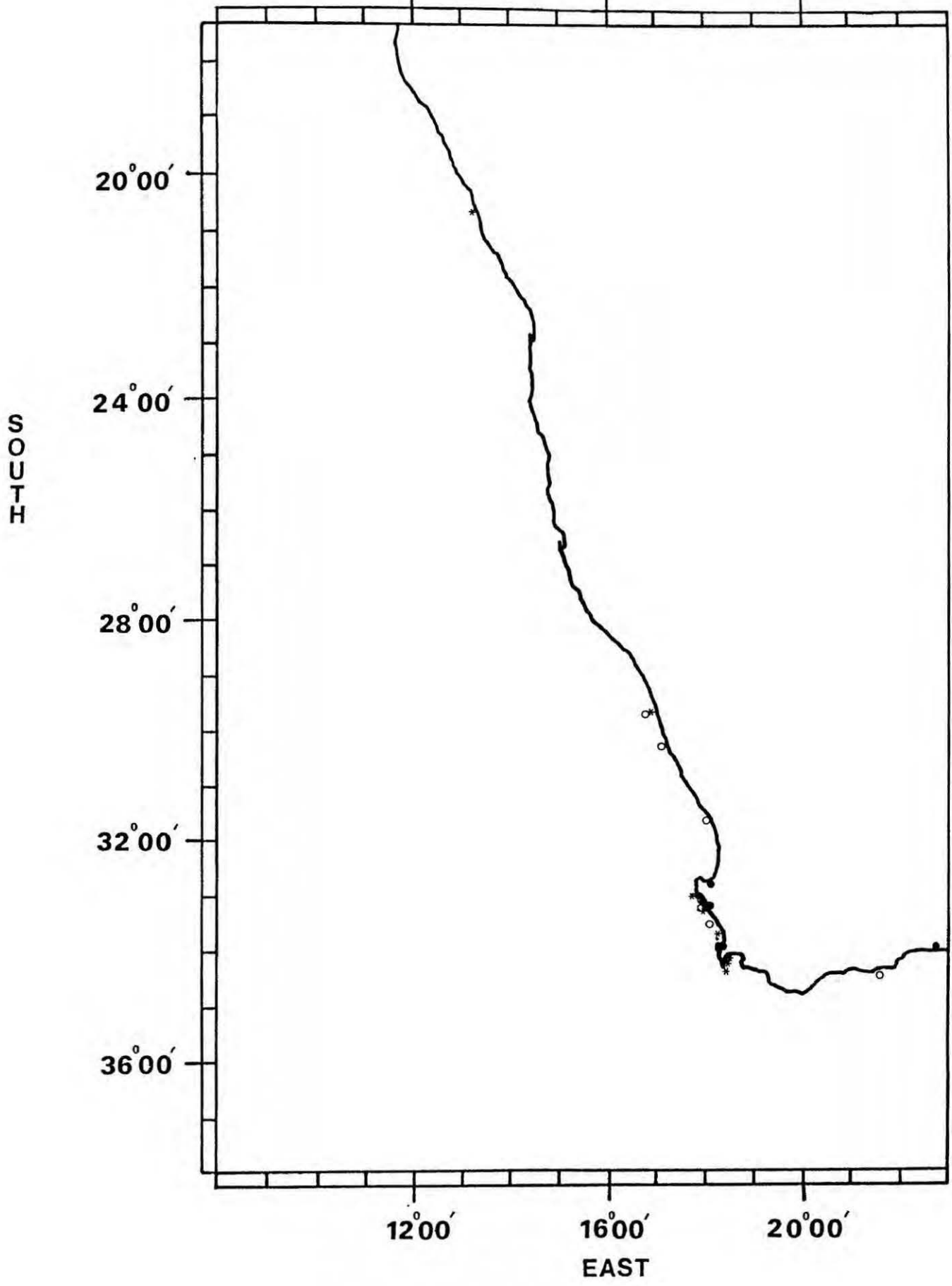


Figure 40. Scientific (o) and incidental (*) sightings and strandings (●) of humpback whales reviewed in this study.

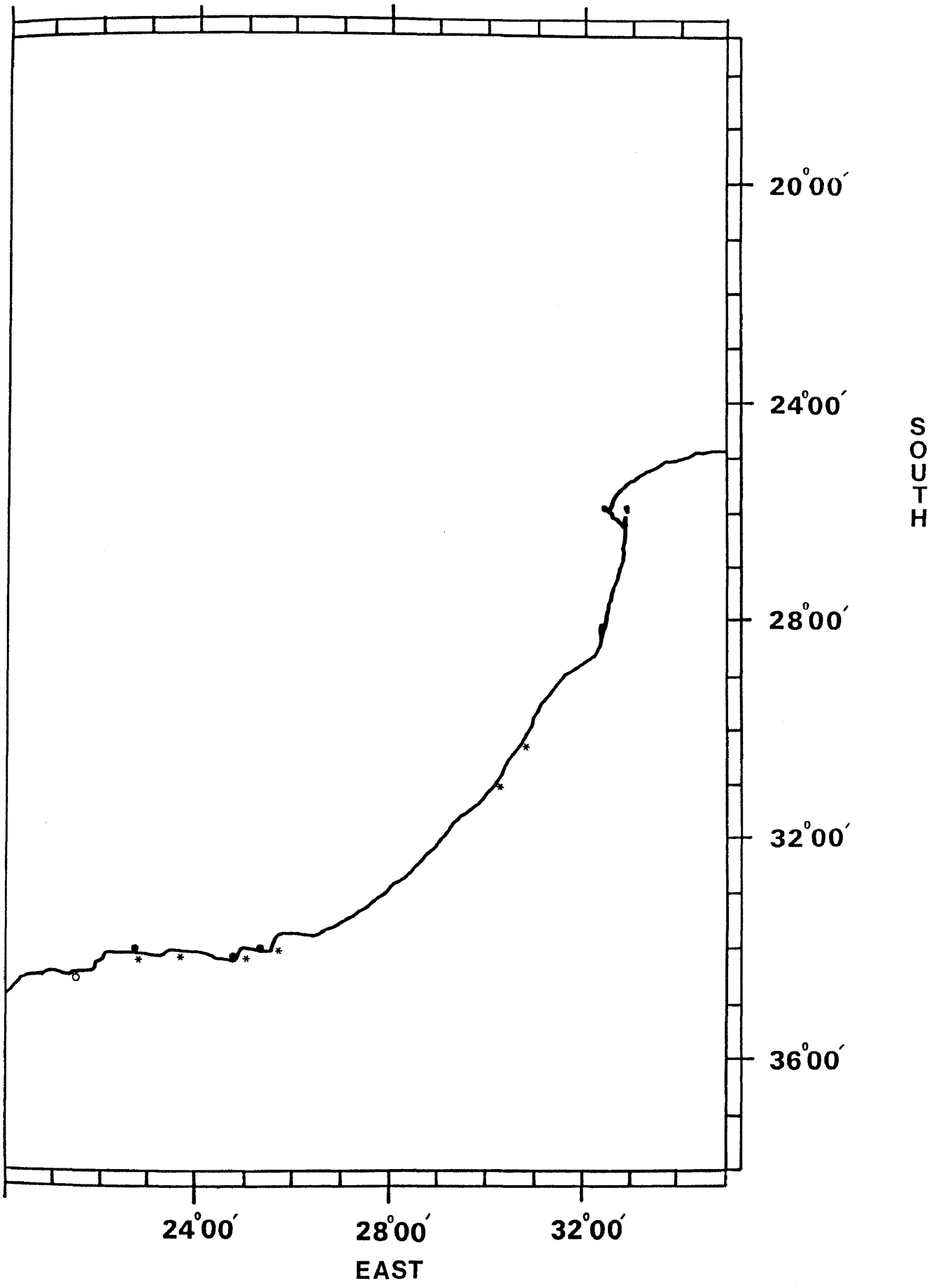


Figure 40. (continued)

remain in the lower latitudes during the summer months. (Olsen 1914 - 15 in Matthews 1937) noted that the majority of 19th century catches off Walvis Bay occurred during October, November and January and Keeler (in Best and Shaughnessy 1979) recorded a great number of humpback whales off Hollams Bird Island ($24^{\circ} 36' S$, $14^{\circ} 30' E$) during January. Olsen (1914 - 15 in Matthews 1937) notes that humpback whales arriving off the south western coast of the sub-continent are often accompanied by juveniles of the previous season which remain in the area while the adults migrate further north. The sightings of humpback whales made during the summer months were recorded off the west coast in the region of Saldanha Bay.

All humpbacks recorded during dedicated scientific censuses were sighted inshore of the 200 metre depth isobath in Areas I and II (figure 41). The temperatures measured in waters in which scientific sightings of humpbacks occurred are low, ranging between 12° to $15^{\circ} C$ in summer to 10° to $12^{\circ} C$ in winter, but these would reflect the inshore localities and not a preference for cooler waters. Unfortunately no dedicated sightings were recorded in the warm waters of the east coast which would substantiate this. The salinities associated with these summer sightings ranged between 34.8 and 35.0 ppt in Area I and II and between 35.4 and 35.6 ppt in Area III, while the one winter sighting was in a salinity interval of 34.6 to 34.8 ppt.

All incidental sightings of humpback whales were made in waters of less than 100 metres depth (figure 41). Temperatures and salinities associated with summer sightings ranged between 12° and $14^{\circ} C$ and 34.8 and 35.2 ppt respectively. Winter sightings were associated with temperatures of between 14° and $16^{\circ} C$ in Areas I and II, of between 16° and 20° in Area III and of between 16° and 24° in Area IV. Salinity values associated with winter sightings of humpback whales ranged between 34.4 to 35.4 ppt.

Twenty - one dedicated commercial sightings of a total of 38 humpbacks were made off Durban between 1972 and 1975. Group size of these sightings ranged from one to five, with a mean of 1.81 animals per group (sd \pm 0.87). Their distribution shows that although this species migrates closer inshore than other *Balaenopteridae*, there are a number of offshore sightings (figure 42). The orientation of the Natal coast to northward migrating animals results in a funnelling of animals along the coast possibly inshore of the spotter aircraft's range during the early season. The high number of offshore sightings in June may be animals migrating to breeding grounds off

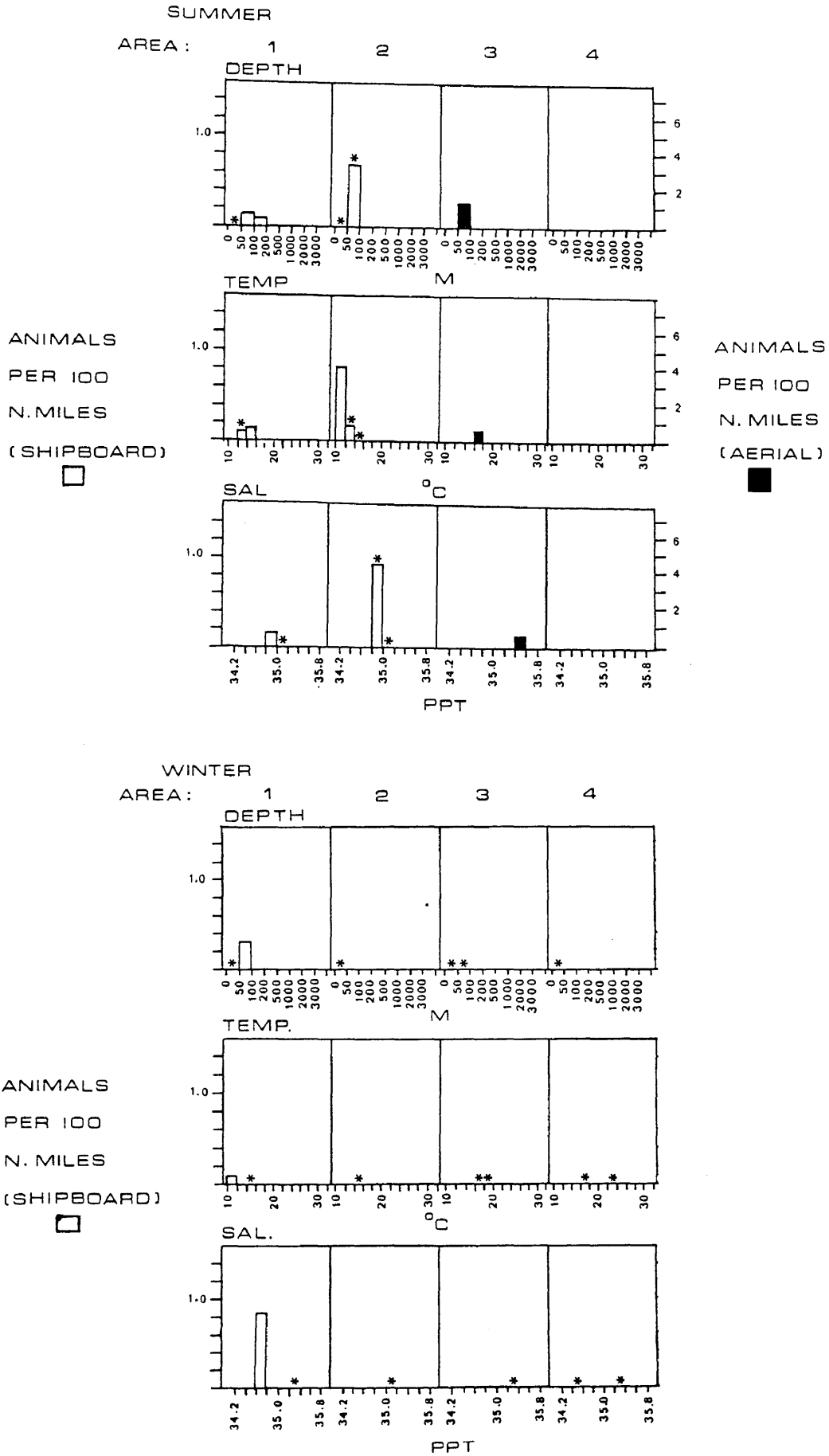


Figure 41. Densities of scientific sightings and occurrence of incidental sightings (*) of humpback whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Two humpback whales marked in Antarctica were taken in Madagascan waters (table 5) (Rayner 1940). The second of these records was marked well to the west of the east coast whaling ground longitudes which suggests that animals migrating to Madagascan breeding grounds may pass through Natal waters. Alternatively these animals may have moved between feeding grounds in Antarctic waters and migrated directly from Antarctica to Madagascar.

Table 5. Positions of humpback whales marked in Antarctic waters and recorded from Madagascan waters (after Rayner 1940).

Marked		Returned	
Date	Position	Date	Position
16.1.35	64 00 S; 54 03 E	24.8.38	25 03 S; 47 10 E
14.3.37	62 18 S; 10 41 E	17.8.38	25 36 S; 44 52 E

Olsen (1914-15, in Hinton 1915) noted two incidences of humpbacks marked by lost harpoons off the east coast. The first of these was "marked" at Durban and recovered at Linga Linga, Mozambique, while the second was "marked" at Angoche in Mozambique ($16^{\circ} 20' S$) and recovered at Durban "two to three months later". The east coast southward migration appears to be coastal in that the late season sightings were all recorded close inshore suggesting that :-

- a) the whales make use of the fast flowing Agulhas current in the southward migration, or
- b) the whales are migrating in a south - westerly direction and are linked to a feeding ground to the southwest of the east coast whaling ground.

The three catches of humpback whales off Donkergat were made in June (1) and July (2) and positions of these are shown in figure 43. Although the low catches and lack of sightings are in agreement with Olsen's (1914-15 in Hinton 1925) and Harmer's (1931) suggestions that humpback whales strike the coast to the north of Saldanha Bay

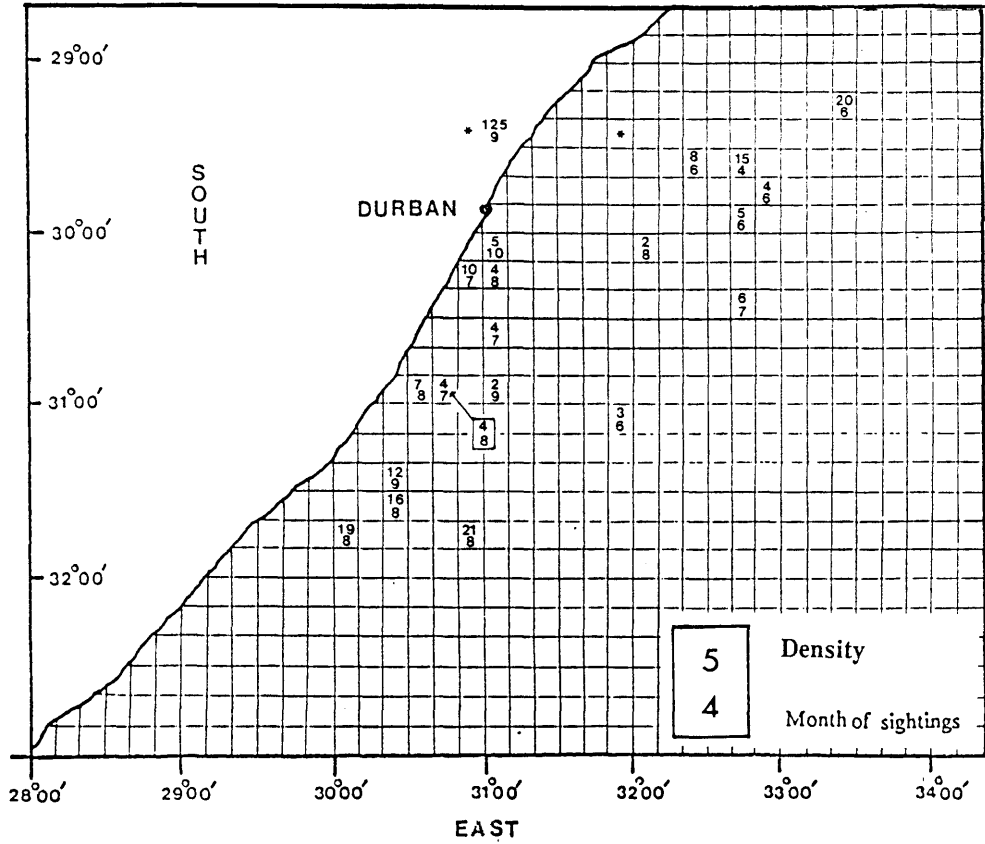


Figure 42. The distribution of humpback whales sighted off Durban between 1972 and 1975.

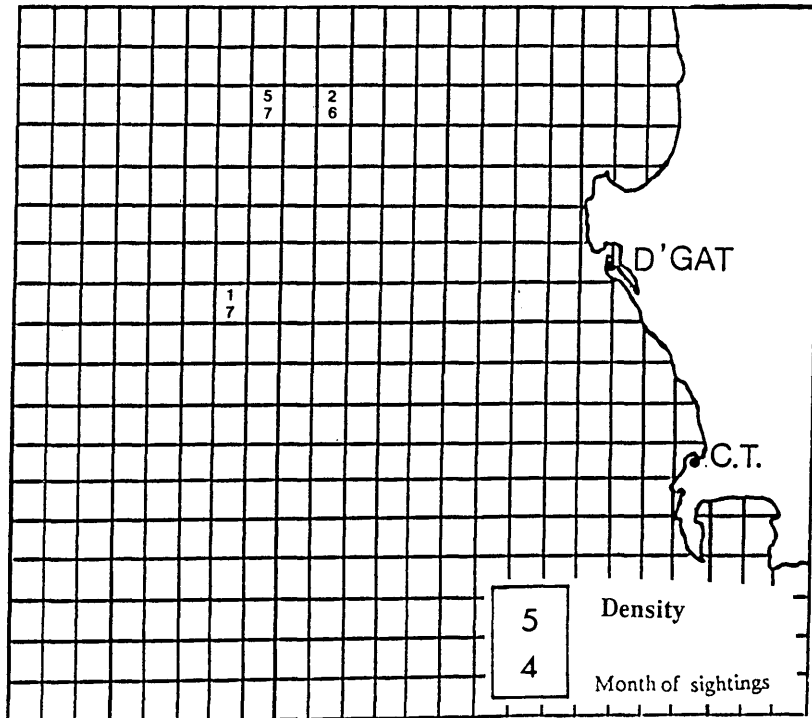



Figure 43. The distribution of humpback whales taken off Donkergat during 1963.

they possibly reflect the depletion of the spe  however the positions of these three catches are fairly far offshore (in depths of over 200 m - figure 44) on a north - south route that would presumably strike the coast to the north of Saldanha Bay. The seasonality of these catches show a marked similarity to those found by Best (1967) between 1958 and 1963, although the data sets are inclusive.

Olsen (1914-1915 in Hinton 1915) described seasonal variations in catches of humpback whales in whaling grounds off southern Africa. The season at Saldanha Bay was found to be relatively long (May to mid-December) and 1911 catches showed two maxima (one at the end of June and one in October). Catches off Port Alexander in southern Angola showed a bimodal seasonal trend with the northward migration taking place during the latter half of June and the first half of July and the southward migration in October. Harmer (1931) found a bimodal seasonal abundance of catches off Angola (maxima in July and October) in 1924 and 1925 and a unimodal abundance off French Congo (peak in July and August) in four out of five seasons and he therefore suggested that French Congo must represent the northernmost point of the migration. Olsen (1914-15 in Hinton 1915) described a shorter season off the east coast with humpbacks migrating northwards between June and July and southward in September while off Linga Linga (Mozambique) the seasonal catch trend showed one maximum in August. Matthews (1937) found a marked bimodality in the catches of humpbacks off the Natal coast between 1918 and 1928 with a July peak representing the northward migration and a September peak representing the southward migration. Townsend (1935) described the 19th century humpback ground of southern Madagascar and Angot (1951) found that the majority of catches of humpbacks in this ground were made from July to September with some catches occurring in both June and October. Bannister and Gambell (1965) showed humpbacks to be present off Natal between April and September (between 1954 and 1963) with a peak of abundance in July representing the northward migration and a slight peak representing the southward migration.

The seasonal abundance of this species from aerial sightings off Durban (figure 14) shows that it is present in April and from June to October with a peak of abundance in October. This trend is markedly different from that found in the literature in that the northward migration (June to August) was not detected, and while Bannister and Gambell (1965) found little evidence for the southward migration. Matthew's (1937) findings for 1918 to 1928 showed a distinct bimodality in catches off Natal (with peaks of abundance in July and September). It is assumed that

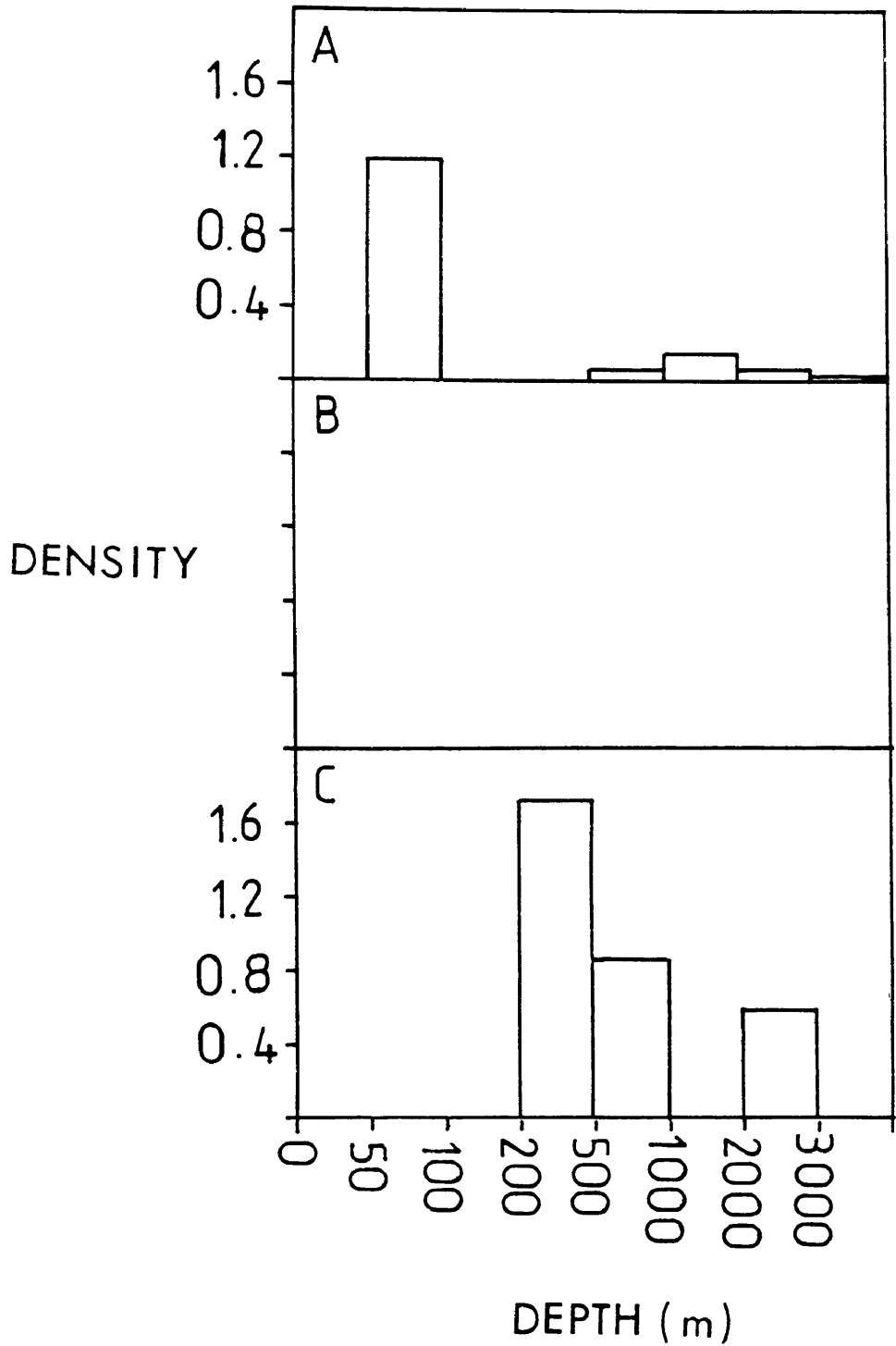


Figure 44. The depth distribution of humpback whales recorded in the east and west coast whaling grounds. A : Durban sightings (expressed as number per 1000 miles searched), B : Donkergat sightings (expressed as number per 100 visits) and C : Donkergat catches (expressed as number per 100 visits).

The seasonal abundance of humpback whales in the data in this study is largely in agreement with known migration patterns. However, the summer sightings (scientific and incidental) and specimens provide evidence for certain animals remaining in temperate waters throughout summer. The majority of these records were made off the southwestern Cape coast, where Olsen (1914 - 1915, in Hinton 1915) maintains that juveniles could be found all year round.

THE MYSTCETI (CONTINUED).**THE BALAENIDAE**

The southern right whale (*Eubalaena australis*)

Right whales were first noted off the Cape coast as early as 1654 (Best and Ross 1985) but remained largely unexploited until the 1770's when American whalers began to visit these waters. By 1775 American whalers were over-wintering in the Cape waters and in 1790 and 1791, 20 and 32 ships were operating respectively in St Helena Bay alone. Coastal land based whaling commenced in the Cape in 1792 (Best and Ross 1985) and Best (1970a) found a sharp decrease in catches in 1835. No subsequent recovery was "permitted" until 1935 when the protection of right whales came into force (although this was only promulgated in South Africa in 1940).

Eighteen scientific sightings of right whales have been recorded from these waters (figure 45). Sixteen of these sightings were made between August and December and two were made in March. Eleven were of single animals, six were of pairs of animals and one was of four animals. Four incidental sightings were recorded from the coast of South West Africa / Namibia and one offshore incidental sighting was reported from Area II. (Inshore incidental sightings from the coast of South Africa were excluded from this database).

Eighteen specimens of right whales have been recorded from the southern African coast. The provenances of these are shown in figure 45, while figure 28 and table 6 show the months and categories of origin respectively. Nine of these eighteen specimens were strandings of right whale calves.

The majority of scientific sightings were made in waters of less than 100 metres deep (figure 46), although one sighting of a single animal was made over the shelf edge in November. As in the case of the humpback whales the low temperatures associated with these sightings reflect the fact that the sightings were all made in nearshore waters in

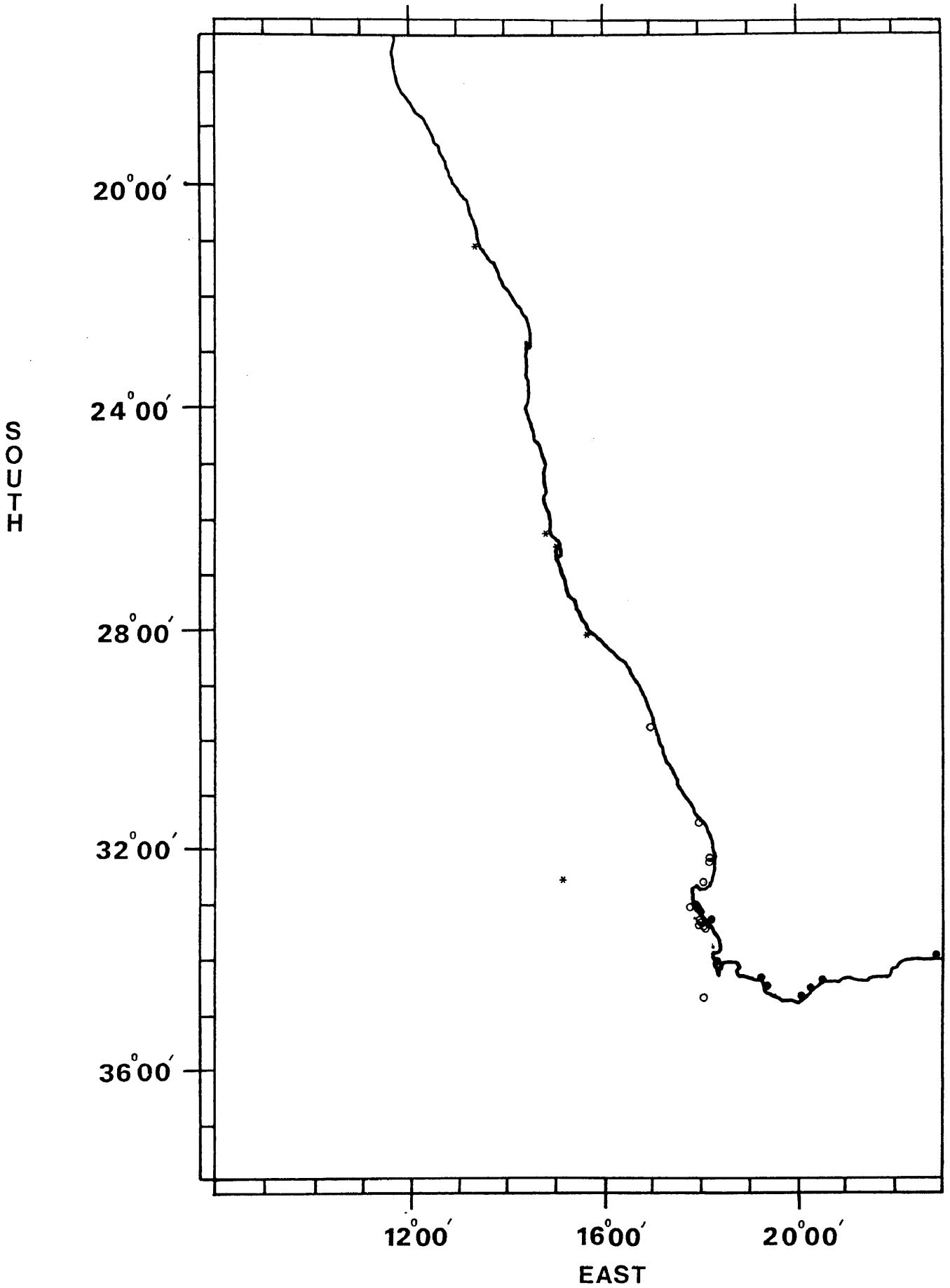


Figure 45. Scientific (o) and incidental (*) sightings and strandings (●) of southern right whales reviewed in this study.

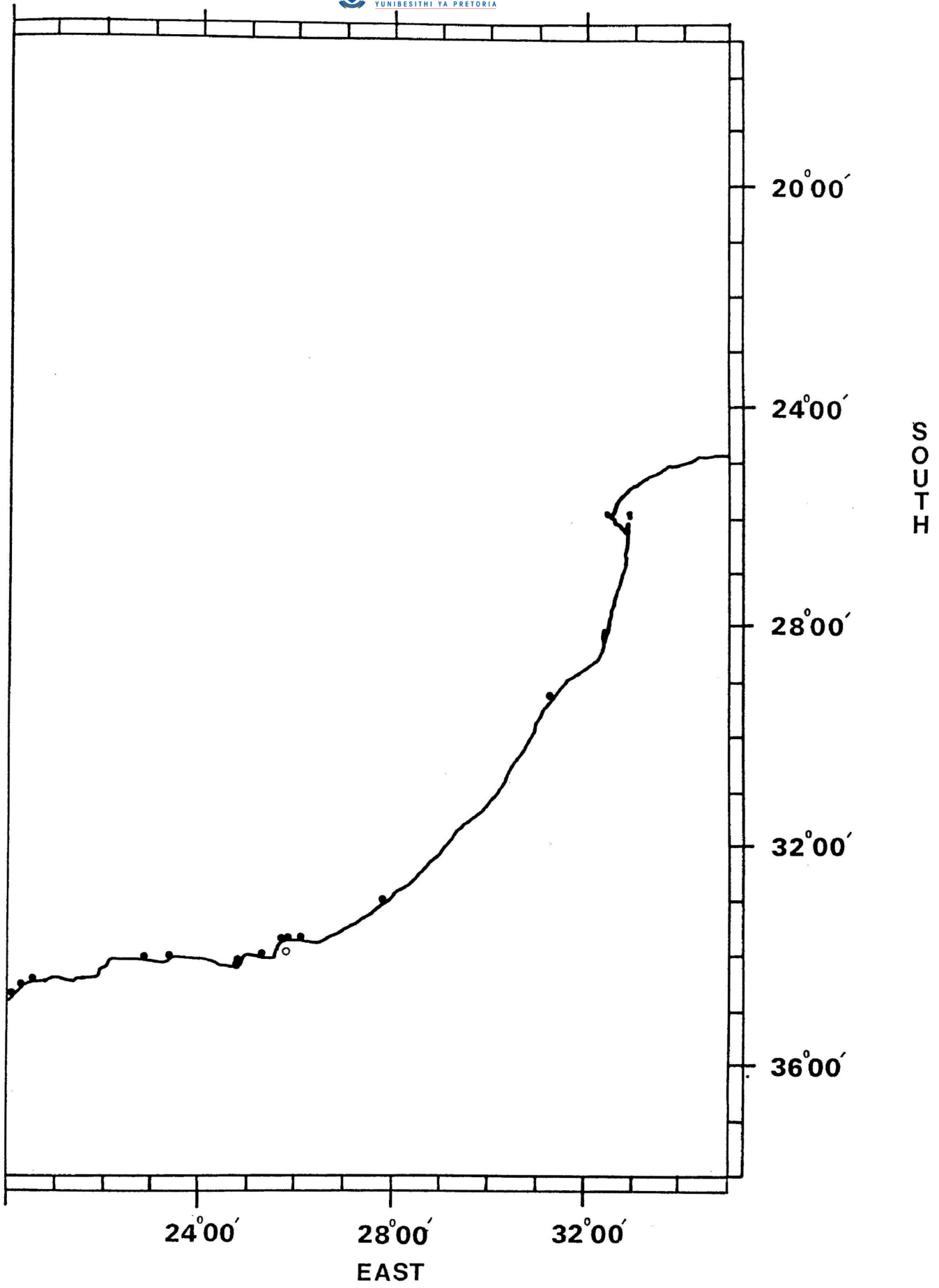


Figure 45. (continued)

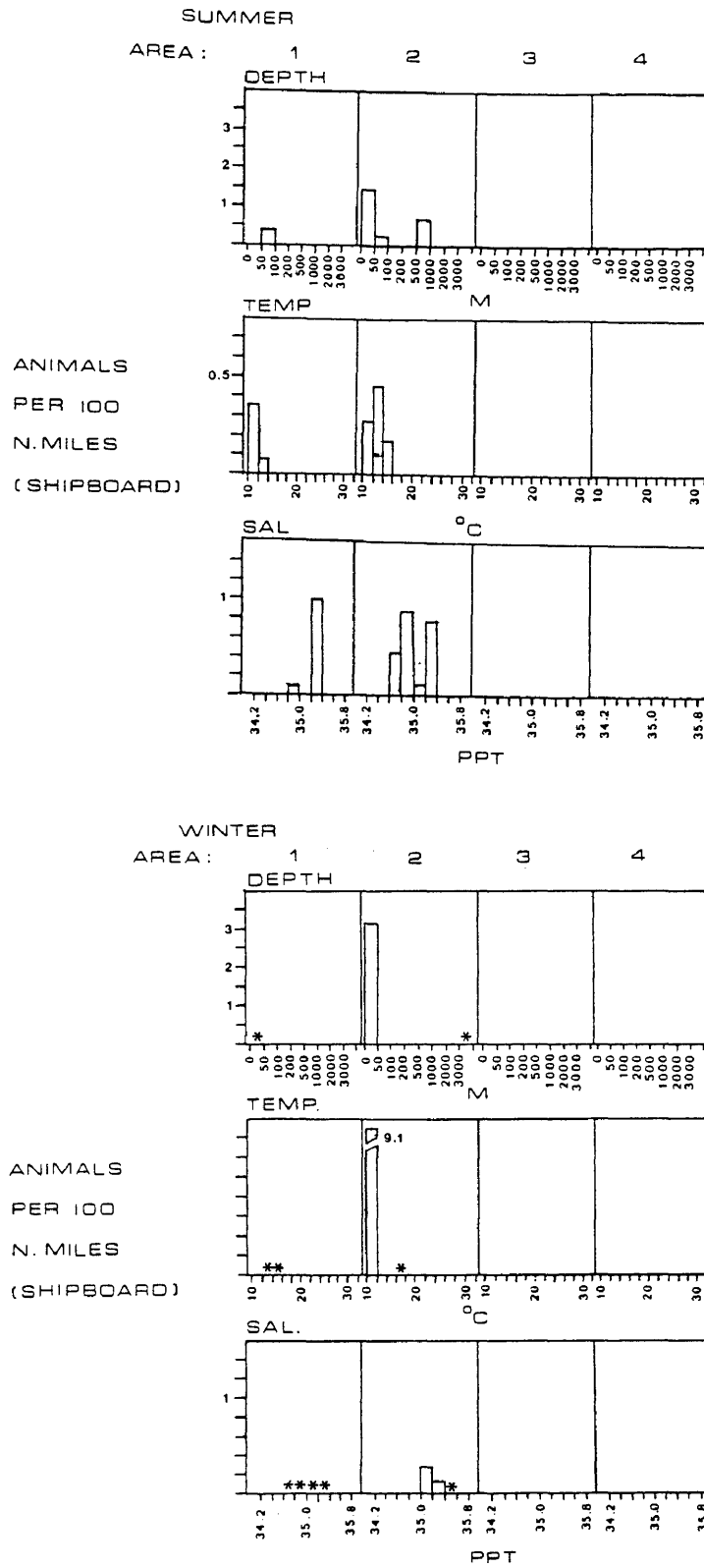


Figure 46. Densities of scientific sightings and occurrence of incidental sightings (*) of southern right whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Areas I and II. Corresponding salinity intervals were between 34.6 and 35.4 ppt in all Areas. The incidental sightings recorded off the coast of SWA / Namibia during winter, were in waters of less than 50 metres deep, low temperature intervals and all fell within the 34.6 to 35.4 ppt salinity interval. The one incidental sighting in Area II was recorded in deeper waters (over 3000 m), of higher temperatures (between 16^o and 18^o C) and of salinities of between 35.4 and 35.6 ppt).

Table 6. Origins of the 18 specimens of right whales reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	4
Dead beach cast (stranding)	2
Found dead on shore	7
Skeletal material found on shore	2
Incidental fishing mortality (including shark net mortalities)	1
Direct fishing mortalities (including scientific collection)	1
Unknown	1

Two single sightings of southern right whales were made in the East coast whaling grounds (in March 1973 and July 1974) (figure 47) and two single sightings were made in the West coast whaling grounds in October 1963 (figure 48). All of these were in water depths of over 200 metres (figure 49).

Best (1981) found that right whales were present in Walker Bay between April and January (between 1967 and 1977) and that the peak abundance was in early October. Annual aerial surveys of right whales off the southern Cape coast have been carried out since 1969 in late September or early October (Best 1981). The area surveyed has always included the area from Muizenberg (34^o 07 S; 18^o 28 E) to Woody Cape (33^o 46 S; 26^o 18 E) and in some years (1970, 1972, 1975, 1977, 1981, 1983 and 1985) has included the west coast to at least as far north as Lamberts Bay (32^o 00 S). These surveys were flown at a distance of between 300 to 600 m from the shoreline, but this was dependent on the nature of the coastline and at an altitude of 1000 ft (305 m) and a speed of approximately 100 knots (see Best 1981). Each group of whales sighted was circled until the number could be verified.

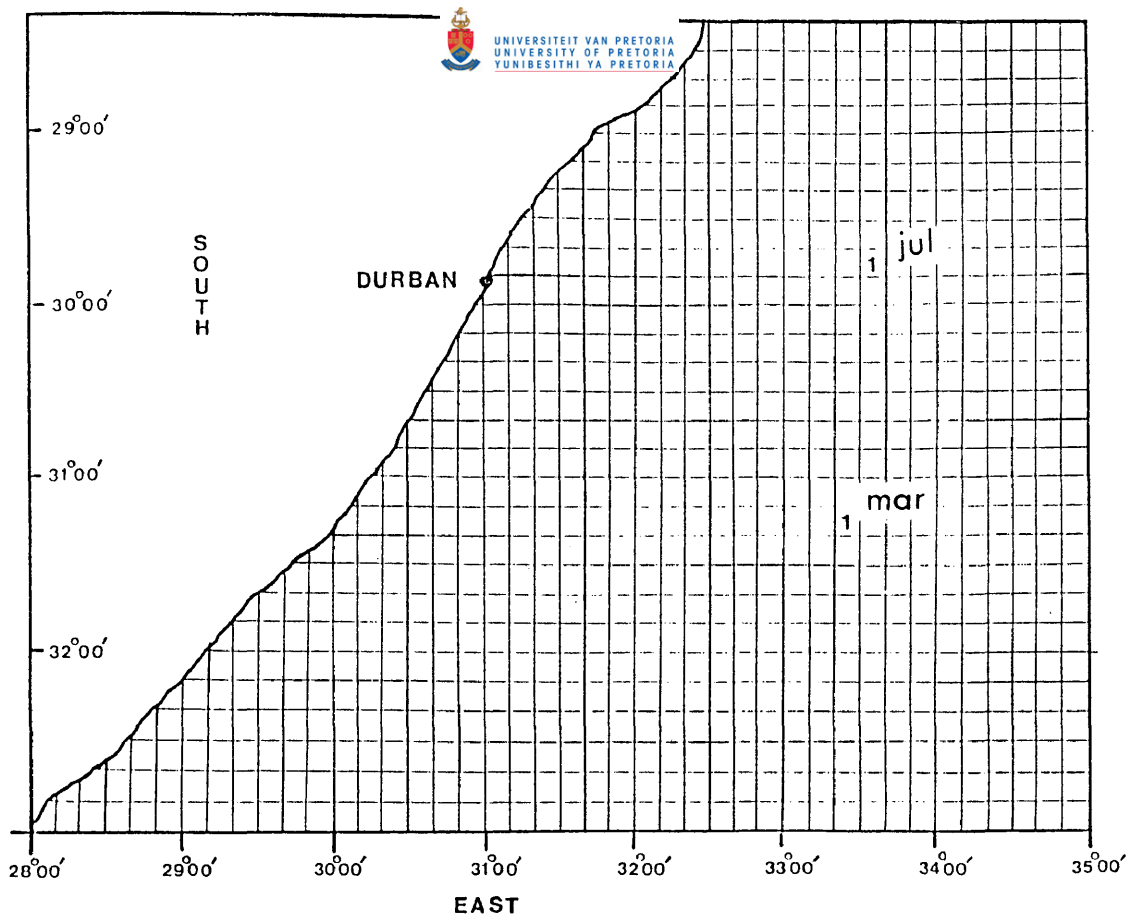


Figure 47. Positions of single right whales recorded in the east coast whaling grounds between 1972 and 1975.

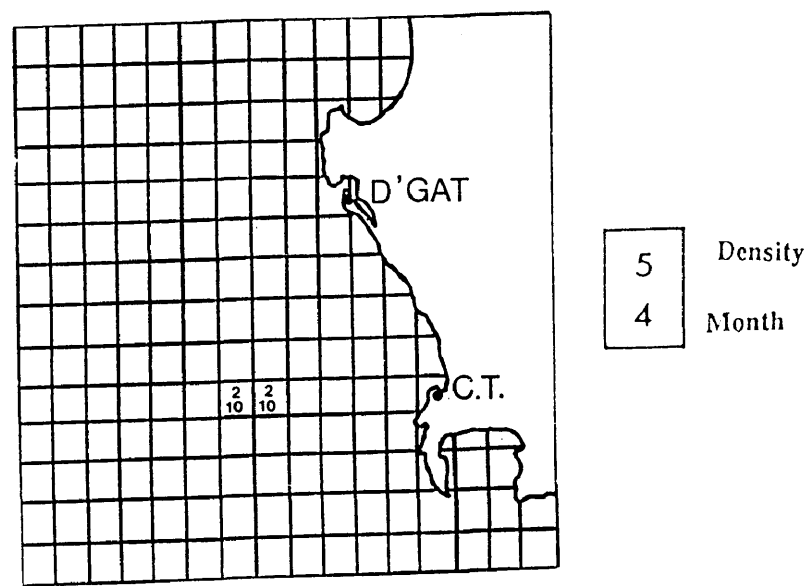


Figure 48. Densities of right whales recorded in the west coast whaling grounds.

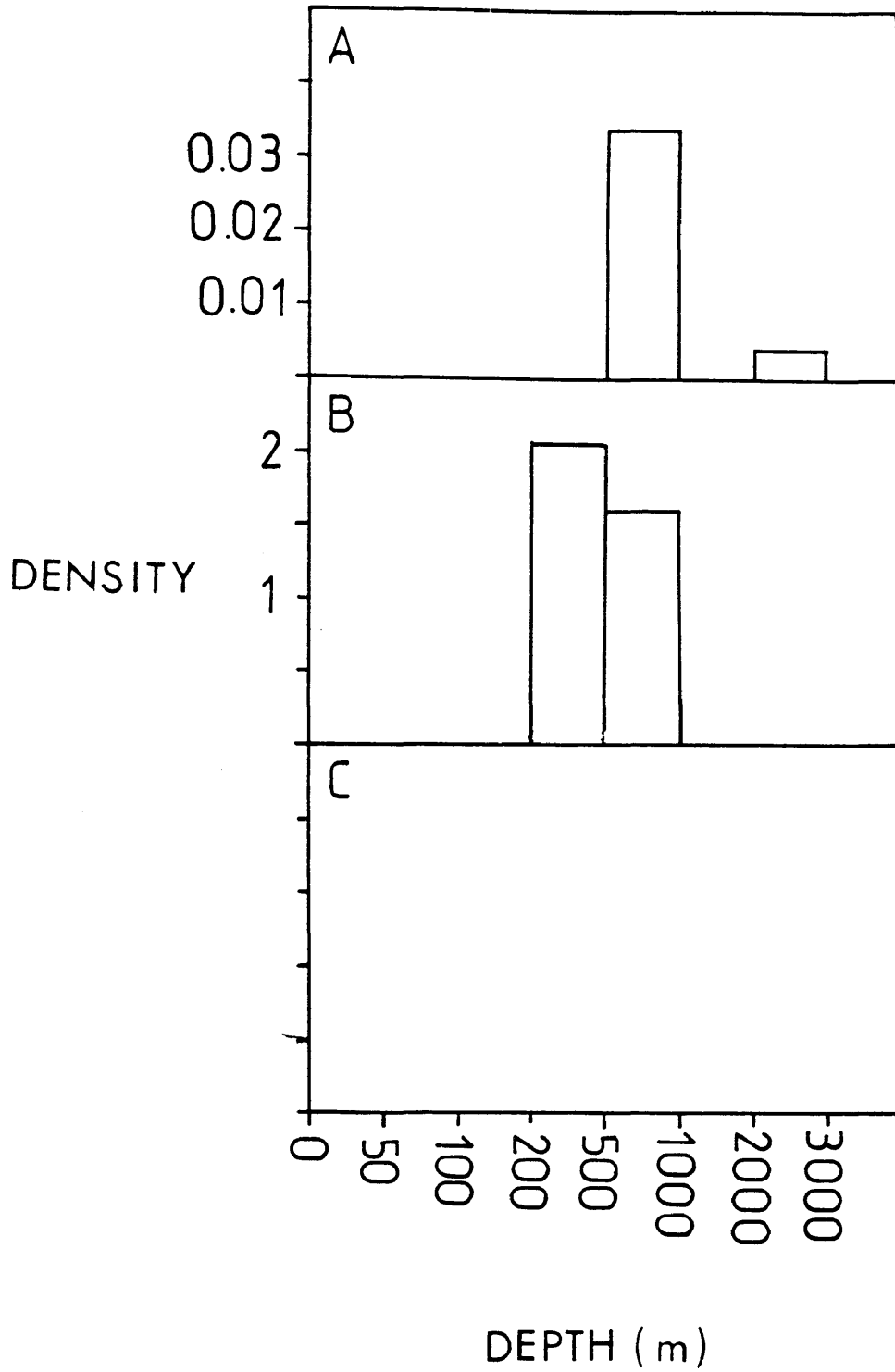


Figure 49. Depth distribution of right whales in the East and West coast whaling grounds

The densities of right whales recorded on the surveys between 1969 and 1985 in each 20 minute of longitude between Muizenberg and Woody Cape, and in each 15 minutes of latitude of the west coast (Muizenberg to Lamberts Bay) are shown in figure 50. Densities are expressed as the number of whales seen per 100 nautical miles of coastline. It can clearly be seen that certain areas of the coast are utilised by unaccompanied adults and some by cow and calf pairs. Densities of cow and calf pairs were highest in the De Hoop - San Sebastian Bay ($20^{\circ} 10' E - 21^{\circ} 10' E$), Mossel Bay ($21^{\circ} 50' E - 22^{\circ} 50' E$) and Walker Bay ($19^{\circ} 10' E - 19^{\circ} 30' E$) areas. The highest unaccompanied adult densities were centred around similar areas, although the highest density was recorded in the Walker Bay area. Best (1981) suggests that the concentration areas fall into two types, unaccompanied whales in mating areas and cow and calf pairs in calving areas and that the animals move between the areas in successive breeding seasons.

THE NEOBALAENIDAE.

The pygmy right whale (*Caperea marginata*)

Baker (1985) defines the distribution of pygmy right whales as circumpolar between about $31^{\circ} 00' S$ and $52^{\circ} 00' S$ within sea surface isotherms of $5 - 20^{\circ} C$. Ross, Best and Donnelly (1975) note that all the confirmed records of pygmy right whales are from north of the Antarctic convergence, and both they and Davies and Guiler (1957) note that the northernmost records exist near to or south of the $20^{\circ} C$ isotherm. Davies and Guiler (1957) further maintain that pygmy right whales do not undergo seasonal north - south migration and suggest that this species was present off Southern Australia and New Zealand throughout the year, while Ross *et al* (1975) show that despite the June to February occurrence off Southern Australia, the occurrence off South Africa has a strong summer seasonality, although this largely involved juveniles.

Four incidental sightings of a total of five *C. marginata* are recorded from these waters, including those published by Ross *et al* (1975). All four of these sightings were made in summer (figure 51) inshore of the 50 m isobath and in temperatures of between 14° and $16^{\circ} C$ in Area II and between 16° and 18° in Area III and salinities of 35.0 to 35.2 ppt in Area II and slightly higher (35.2 to 35.4) in Area III.

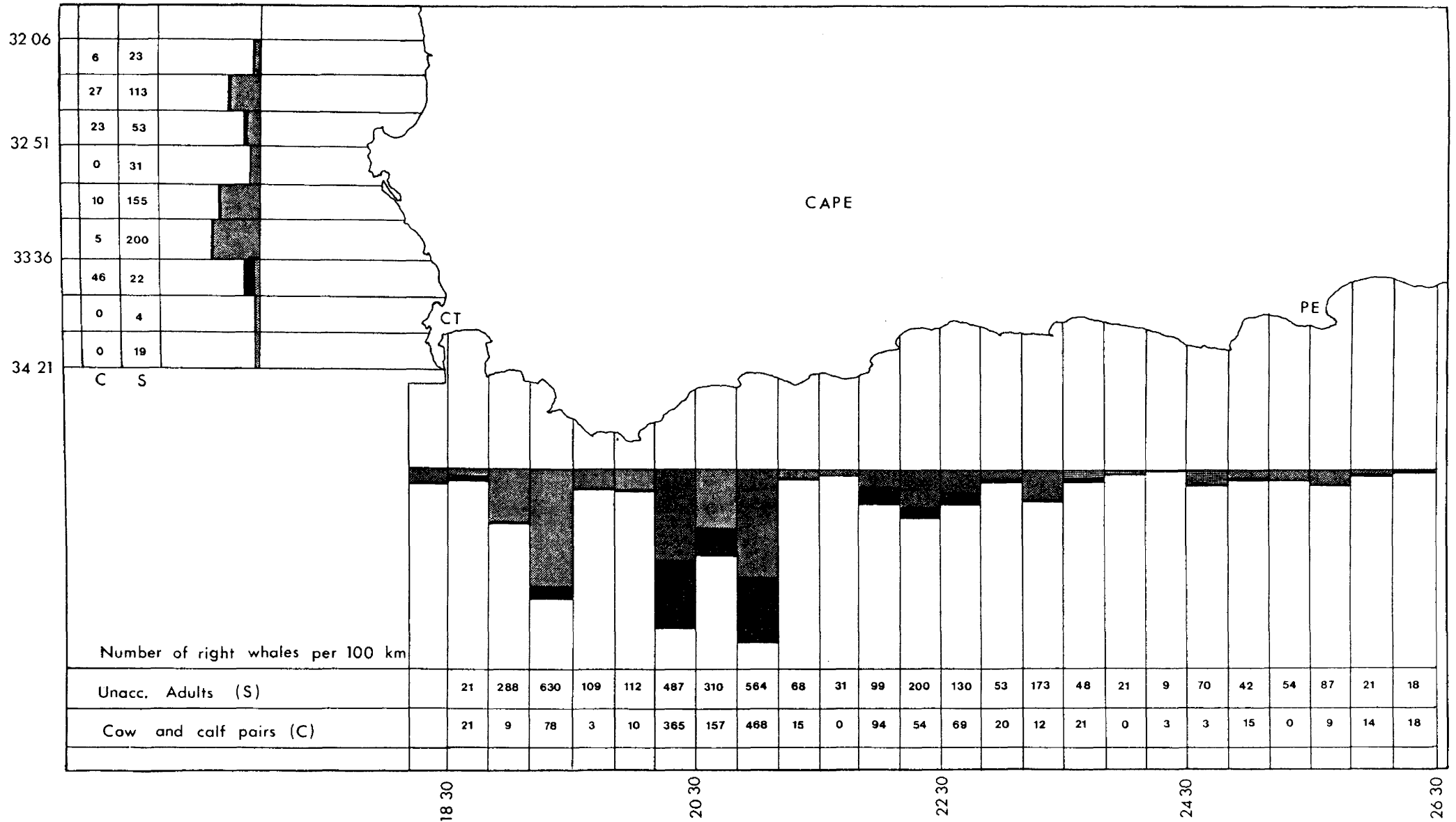


Figure 50. The distribution of southern right whales recorded on annual aerial surveys for right whales between 1969 and 1985. (Light shading = Unaccompanied adults ; Dark shading = Cow and calf pairs).

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

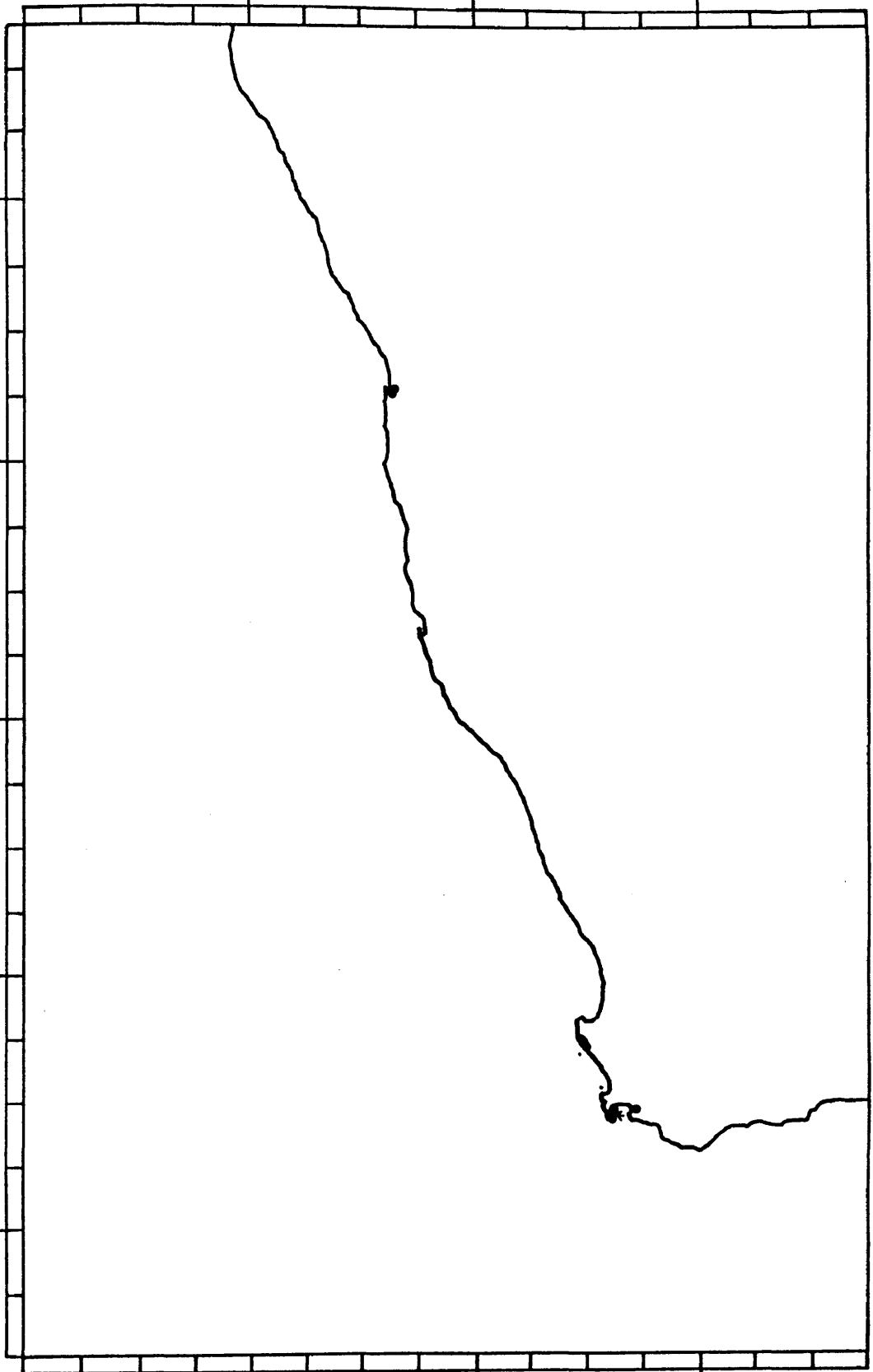


Figure 51. Scientific (○) and incidental (*) sightings and strandings (●) of pygmy right whales reviewed in this study.

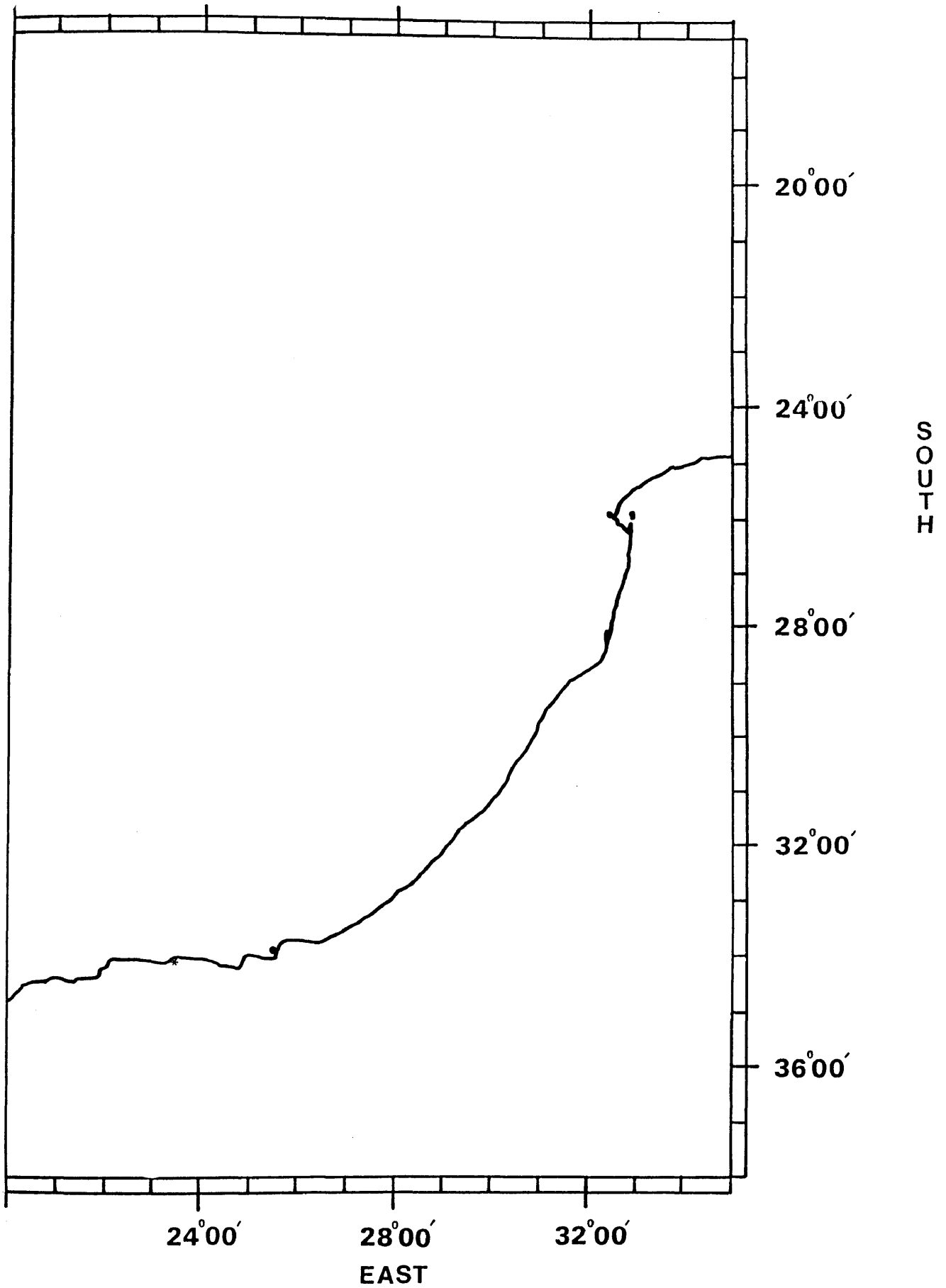


Figure 51. (continued)

A further 13 specimen records exist from the southern African coast. Provenances of these specimens are plotted in figure 51. Months and categories of origin are shown in figure 28 and table 7 respectively. Despite two specimen records from winter months, the strong summer seasonality suggested by Ross *et al* (1975) is evident in the records since their study.

Table 7. Origins of the 13 specimens of pygmy right whales reviewed in this study.

Category of provenance	Number of individuals
Dead beach cast (stranding)	1
Found floating dead at sea	3
Found dead on shore	1
Skeletal material found on shore	2
Incidental fishing mortality (including shark net mortalities)	1
Direct fishing mortalities (including scientific collection)	3
Unknown	2

Of the 17 records of this species from southern African waters, 9 originate from False Bay, Cape and the distribution of the species ranges from Walvis Bay to Algoa Bay, although Ross *et al* (1975) state that an unconfirmed specimen record exists from the east coast whaling ground. The specimens from Walvis Bay are a northern extension of the range suggested by Baker (1985), and this may result from the movement of the species into the cold waters of the Benguela Current.

RESULTS - THE *ODONTOCETI* (TOOTHED WHALES).

THE *PHYSETERIDAE*

The sperm whale (*Physeter macrocephalus*)

Best (1969) states that the major part of the global sperm whale distribution lies within tropical oceans. Small male and female sperm whales rarely venture further south than 40° S in the eastern Atlantic and further south than $45^{\circ}00'$ to $50^{\circ}00'$ S in the southwest Pacific and Indian Oceans (Best 1969), while mature males occur as far south as the pack ice. Kasamatsu *et al* (in press) found large sperm whales as far south as 74° S on IWC/IDCR minke whale assessment cruises between 1978 and 1984. These records were at the edge of the pack ice.

Best (1969) notes that there is evidence for extensive north - south migration patterns in sperm whales. Recoveries of whales marked near to and north of the equator ($06^{\circ}00'$ S and $21^{\circ}00'$ to $22^{\circ}00'$ N respectively) were made at Saldanha Bay and a further sperm whale marked at about $62^{\circ}00'$ S was taken in the East coast whaling grounds (about 30° S). Further evidence of extensive migration arises from the infestation of large and medium sperm whales from the West coast grounds with the Antarctic diatom *Cocconeis ceticola* and from the timing of seasonal abundance in whaling grounds.

Eighty - eight sightings of a total of 1442 sperm whales were recorded from the scientific flights and cruises (figure 52). These sightings occurred throughout the year and sizes of confirmed groups range from one to 115 with a mean of 15.6 animals per group (sd \pm 15.13). Despite the high numbers of dedicated sightings of sperm whales only four incidental sightings of a possible sixteen animals were recorded (figure 53). These sightings were made between February and April and group sizes were unconfirmed.

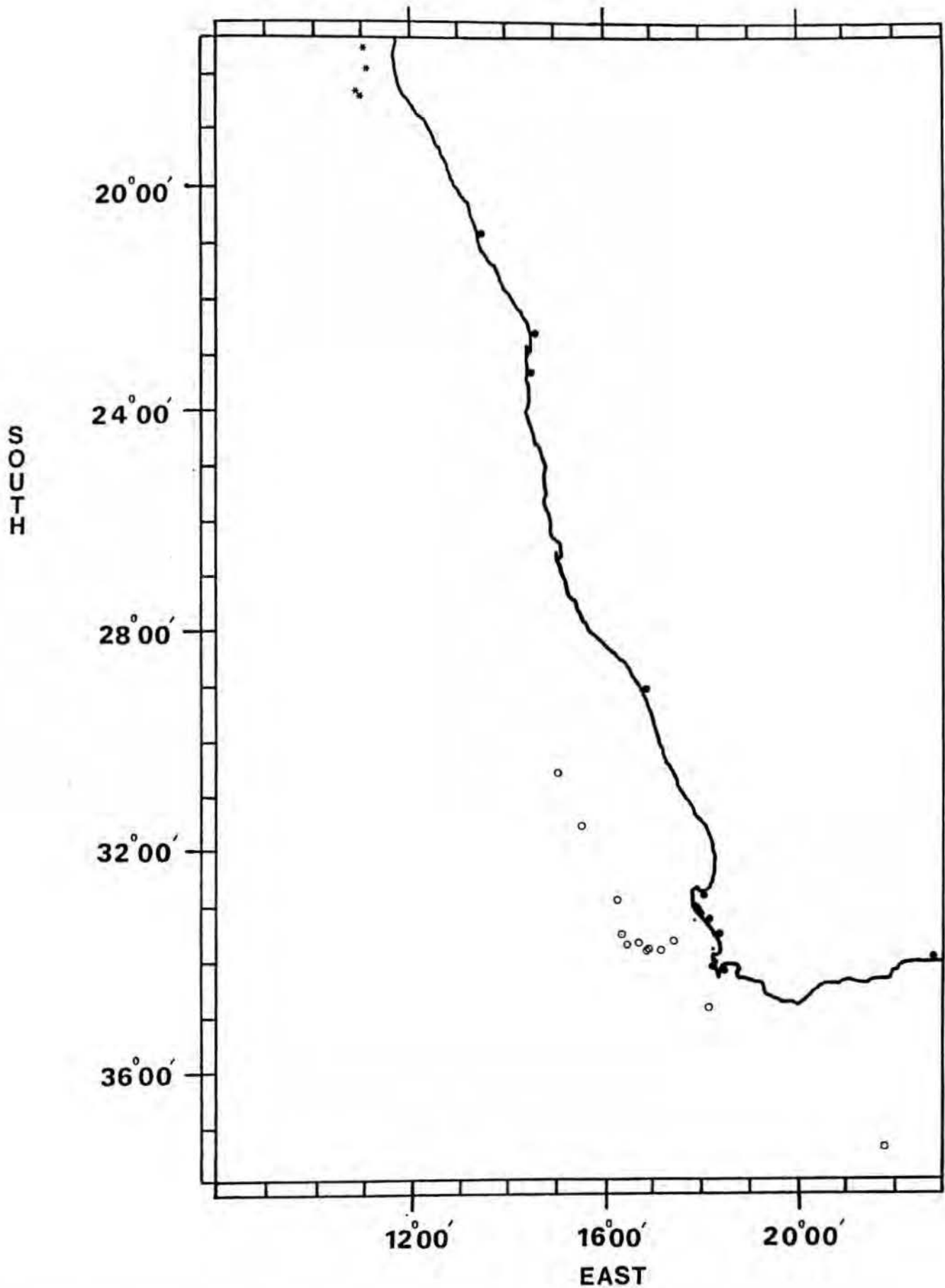


Figure 52. Scientific (o) and incidental (*) sightings and strandings (●) of sperm whales reviewed in this study.

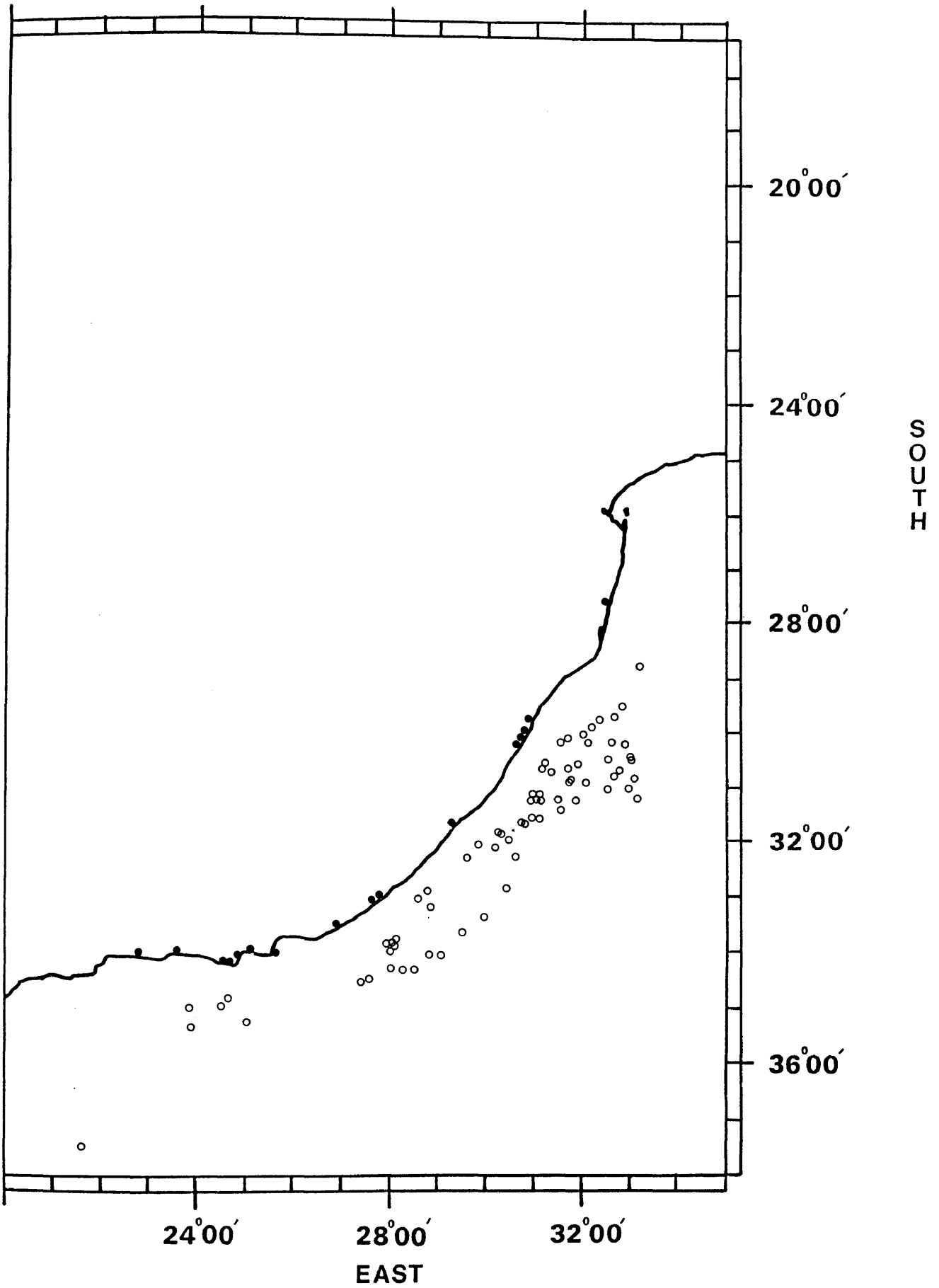


Figure 52. (continued)

The provenances of thirty eight specimen records of sperm whales are plotted in figure 52. Table 8 and figure 53 show the categories and months of origin of these specimens respectively.

Table 8. Origins of the 38 specimens of sperm whales reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	7
Dead beach cast (stranding)	3
Found floating dead at sea	1
Found dead on shore	14
Skeletal material found on shore	4
Direct fishing mortalities (including scientific collection)	1
Unknown	8

The scientific sightings and incidental sightings of sperm whales show that it occurs pelagically throughout southern African waters (figure 52). The apparent scarcity of dedicated sightings to the north of 30° 00' S on the west coast reflects the low levels of searching carried out offshore on the west coast, as incidental sightings and strandings show that this species does occur to the north of these latitudes.

All scientific sightings of sperm whales have been made in waters of over 500 metres in depth (figure 54). Temperatures in waters in which summer scientific sightings of sperm whales were made ranged between 14° and 26° C, while temperatures in waters associated with winter sightings ranged from 14° to 22° C. Kasamatsu *et al* (in press) reported sperm whales associated with temperatures of between 4.2° and - 1.7° C in Antarctic waters. All the sightings of sperm whales in this study were recorded in waters in which salinities of between 35.0 and 35.6 ppt were measured. The incidental sightings of sperm whales made in Area 1 during summer were all in waters of over 1000 m depth, and associated with temperatures of between 18° and 22° C and salinities of between 35.4 and 35.8 ppt.

The aerial spotter records for the East Coast Whaling Ground contained 168 sightings of large, 126 sightings of medium and 451 sightings of combined small and undersize sperm whales. The size categories were roughly equivalent to animals greater than 45 ft (13.7 m), between 39 ft (11.8 m) and 45 ft and less than 39 ft in length. However these classifications were made from the air without access to reference objects of

NUMBER
OF
ANIMALS
STRANDED

NUMBER
OF
ANIMALS
SIGHTED

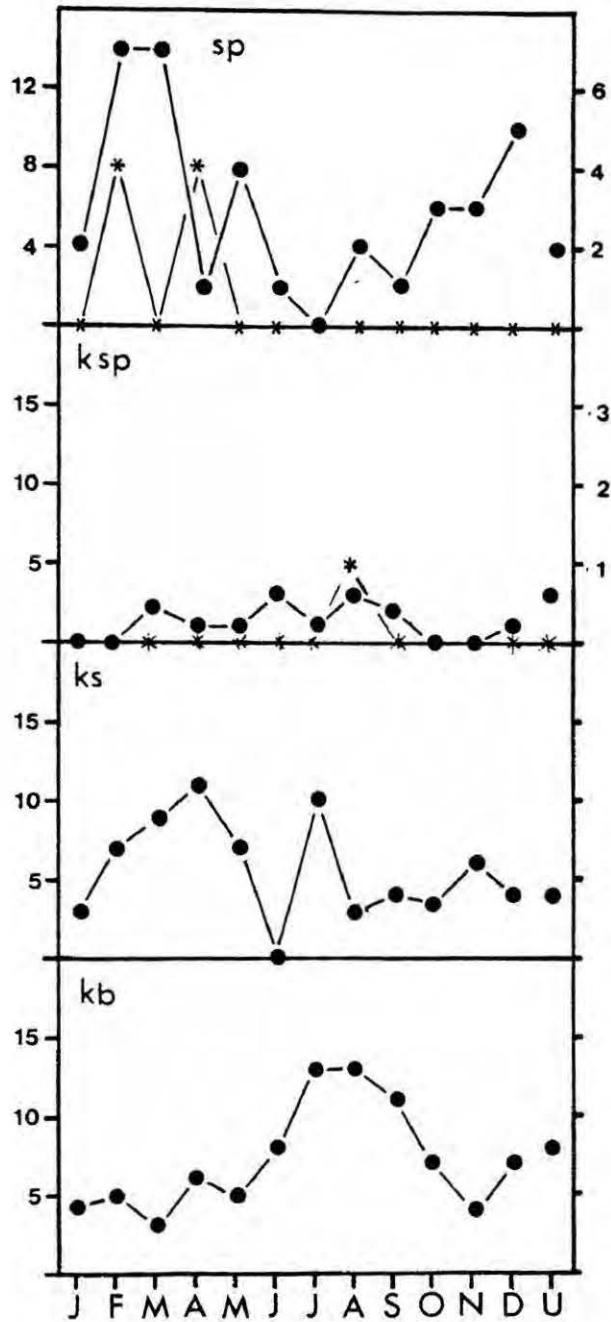


Figure 53. The seasonal abundance of specimens and incidental sightings of *Physeteridae* reviewed in this study (sp - sperm whales, k sp - unidentified *Kogia*, kb - *Kogia breviceps* and ks - *Kogia simus*).

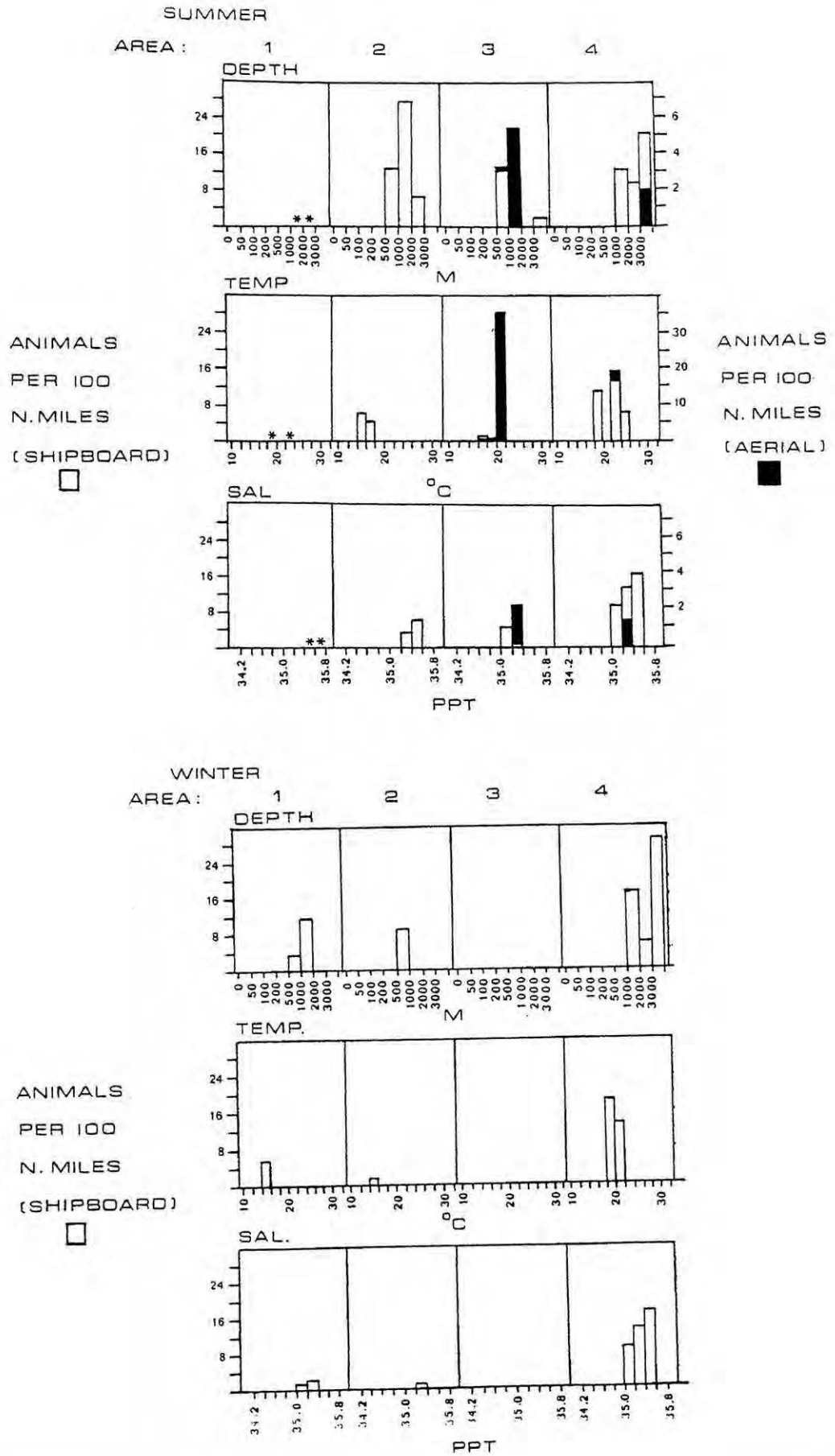


Figure 54. Densities of scientific sightings and occurrence of incidental sightings (*) of sperm whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

known size, and although there was some feedback from catcher personnel who observed the same sightings, categorisation was clearly not entirely accurate.

The group sizes ranged between :-

- i) large sperm :- one to 40 animals per group with a mean of 3.53 animals per group (sd \pm 4.36)
- ii) medium - sized sperm :- one to 31 animals with a mean of 7.22 animals per group (sd \pm 5.89)
- iii) small and under-size sperm :- one to 200 animals per group with a mean of 26.99 animals per group (sd \pm 125.02)

The seasonal abundance of large, medium and small sperm whales showed very different patterns in that the small sperm whales were most abundant early in the season with a peak in April and a smaller peak in July, while large and medium-size sperm whales showed two peaks in abundance, one in May and the other in July / August (figure 55). Thus all three size classes showed a bimodal trend centred about June which infers that some animals are passing through the whaling grounds twice during the season. However the difference in size of the two peaks of abundance in each of the large and small sperm whales suggests that the majority of small sperm arrive in the whaling grounds early in the season and do not pass through it, while the majority of the large sperm whales only reach the whaling grounds after June. Comparison of these results with the seasonal abundance of catches of sperm whales off Durban between 1954 and 1963 (Gambell 1967) shows similar trends except that the September and October peaks in the more recent sighting data are relatively lower than in the 1954 to 1963 catch per unit effort data.

However Gambell (1967) found an increase in the catch of small male and female sperm whales after August between 1954 and 1963, and between 1954 and 1969 (Gambell 1972) and in the sighting data of the period between 1954 and 1958. This increase is not apparent in the sighting records between 1959 and 1963 (Gambell 1967) or between 1961 and 1969 (Gambell 1972). It is possible that the disappearance of the spring

NUMBER
SIGHTED
PER
1000
MILES
SEARCHED

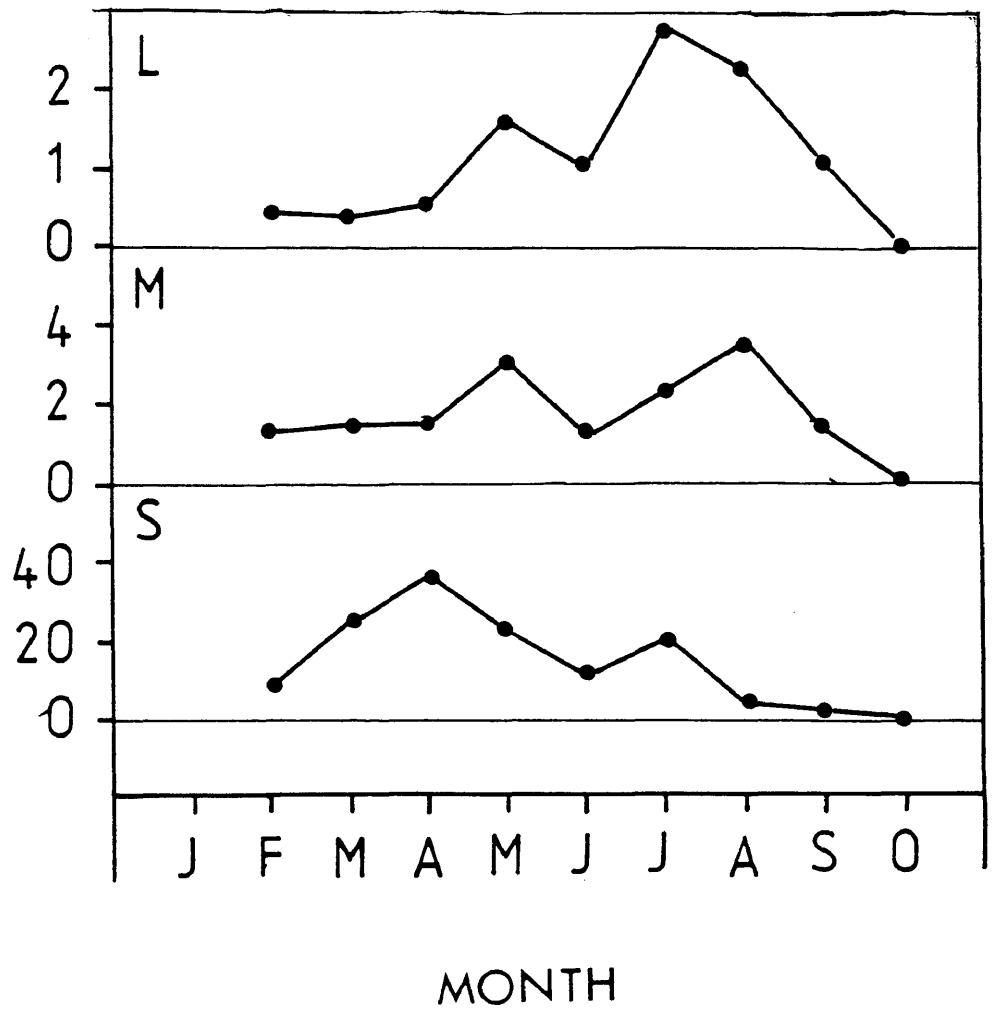


Figure 55. The seasonal abundance of sperm whales sighted off Durban between 1972 and 1975.

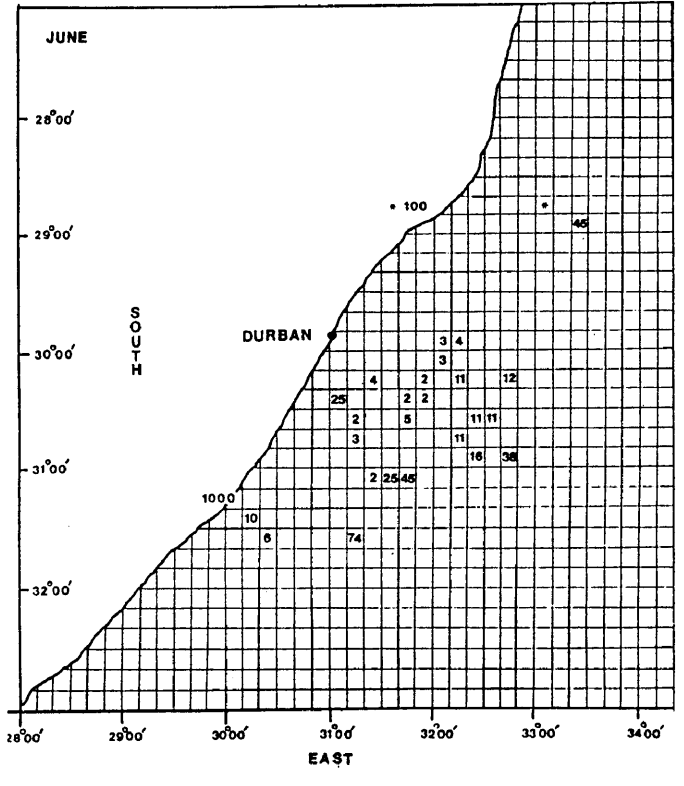
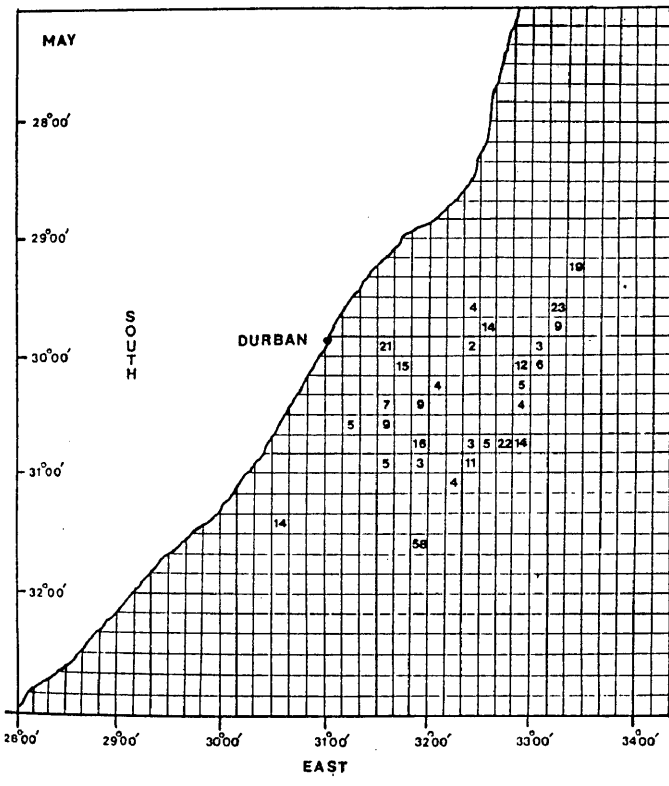
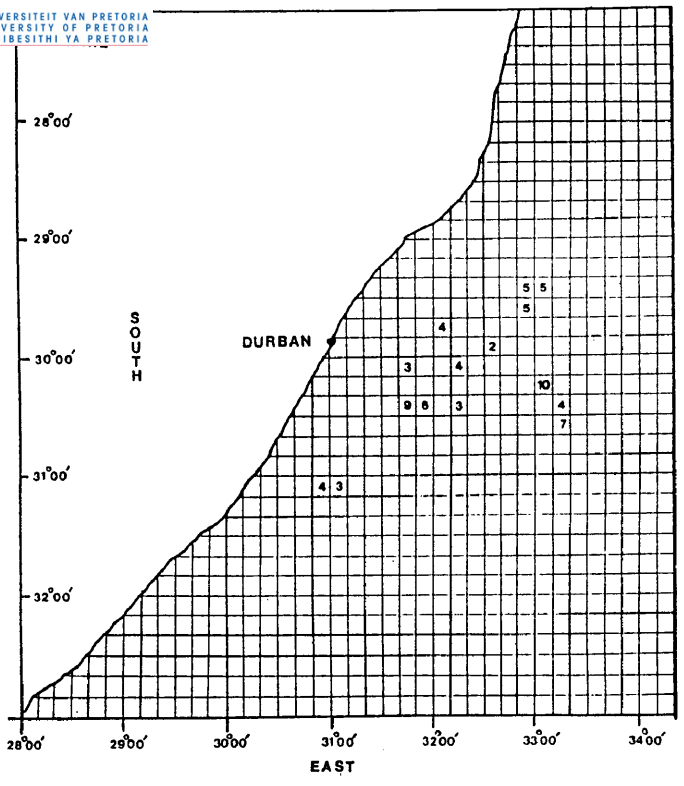
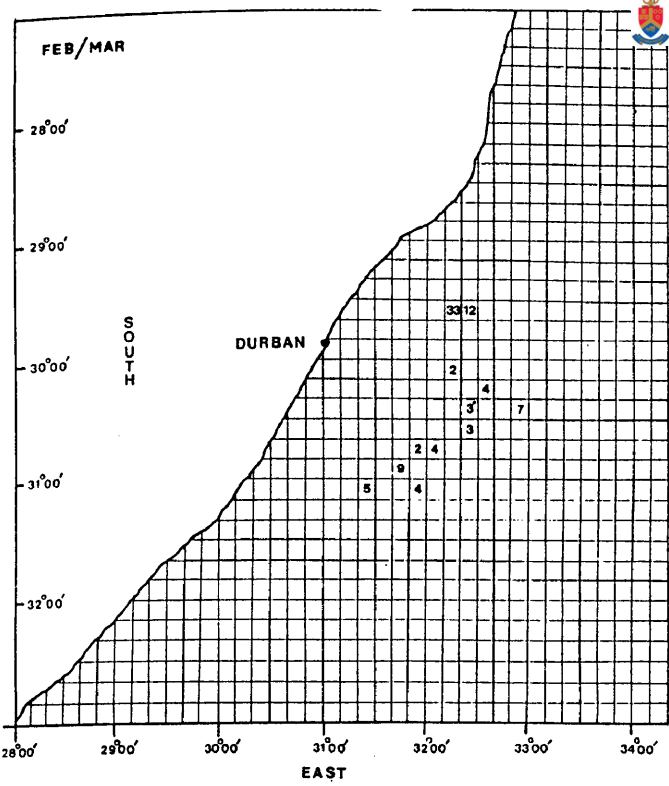


Figure 56. The distribution of large sperm whales sighted off Durban between 1972 and 1975.

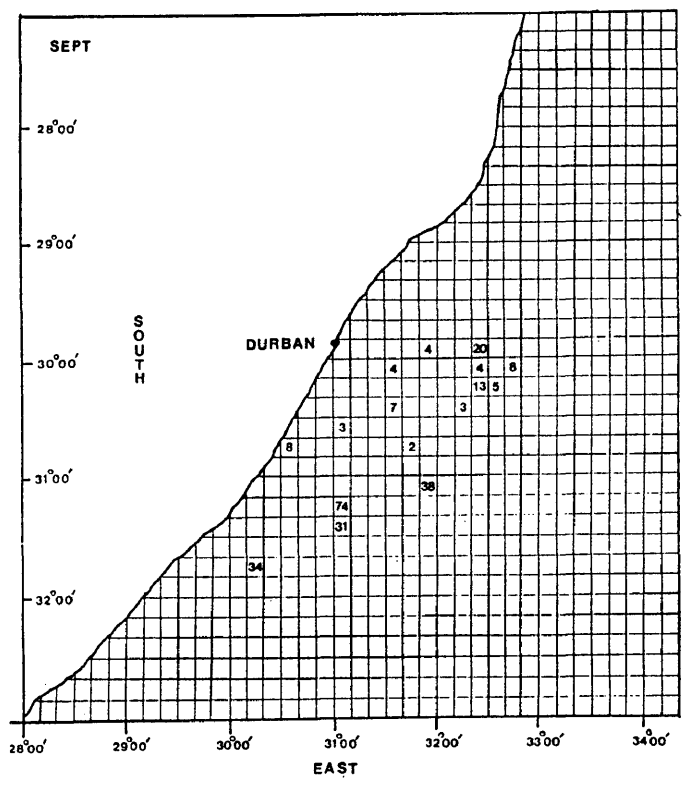
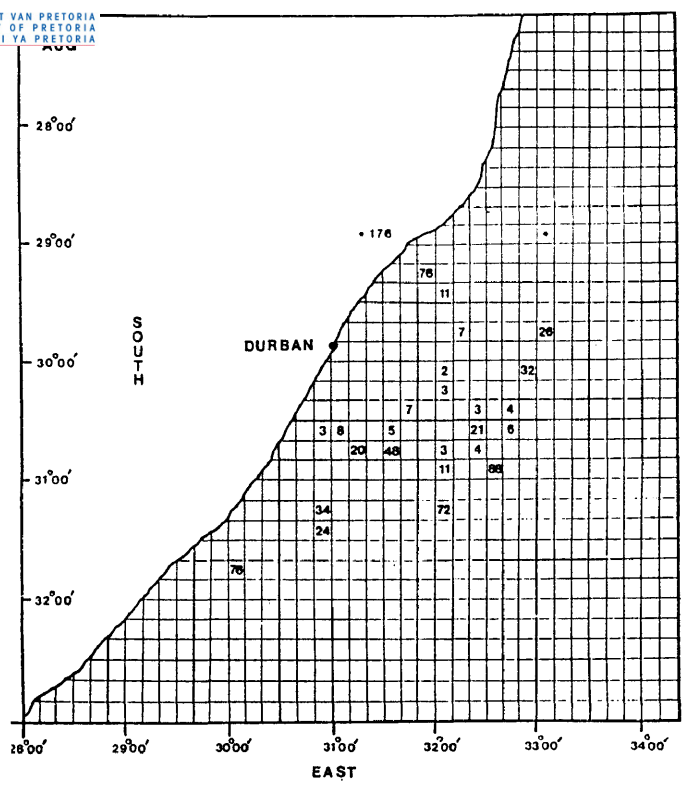
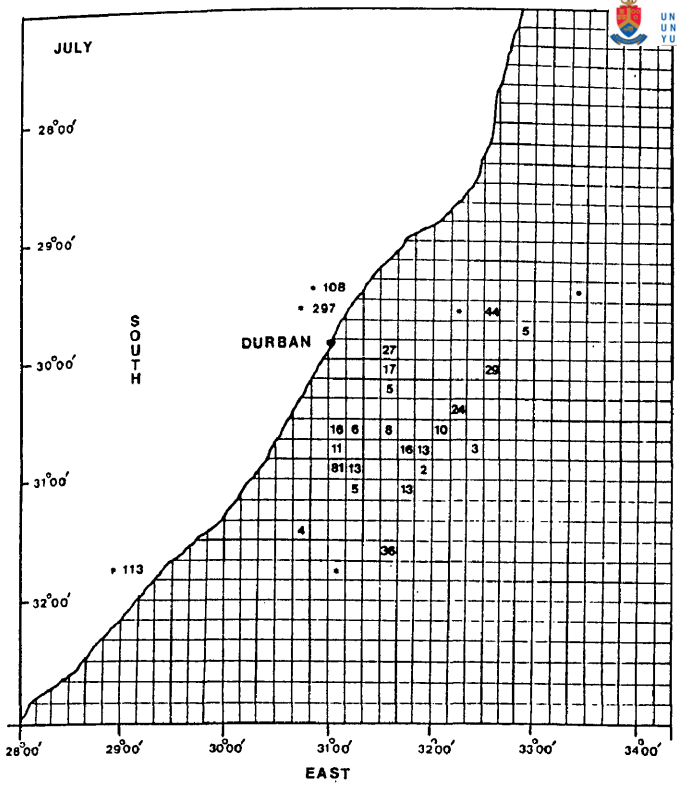


Figure 56. continued.

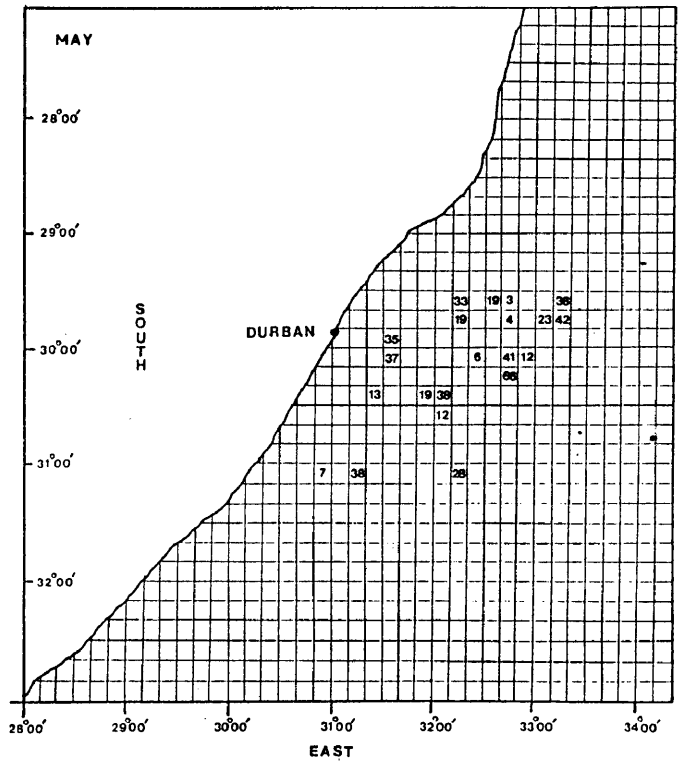
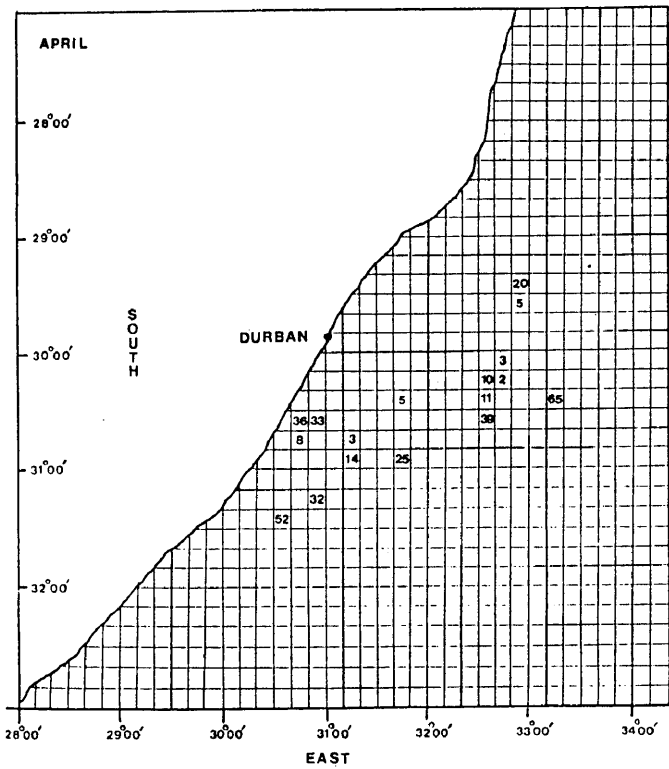
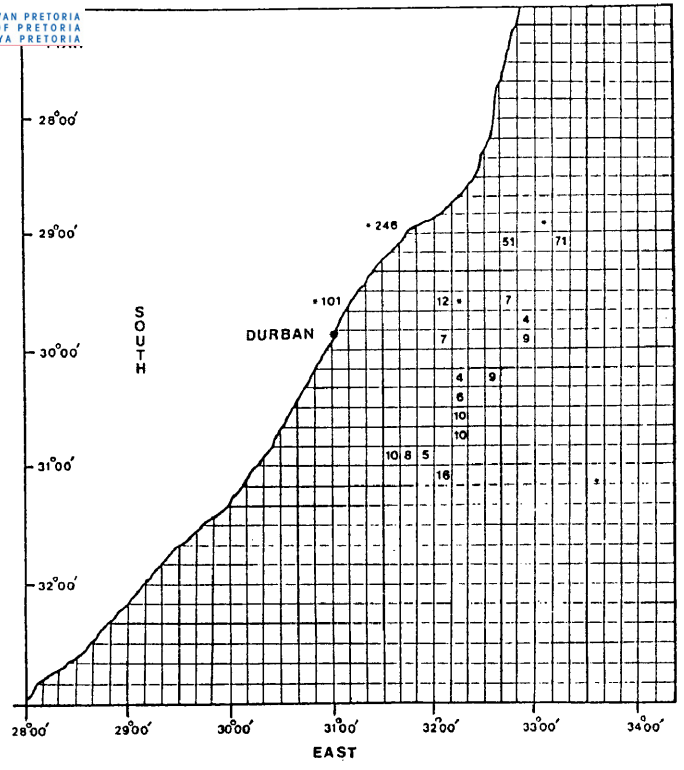
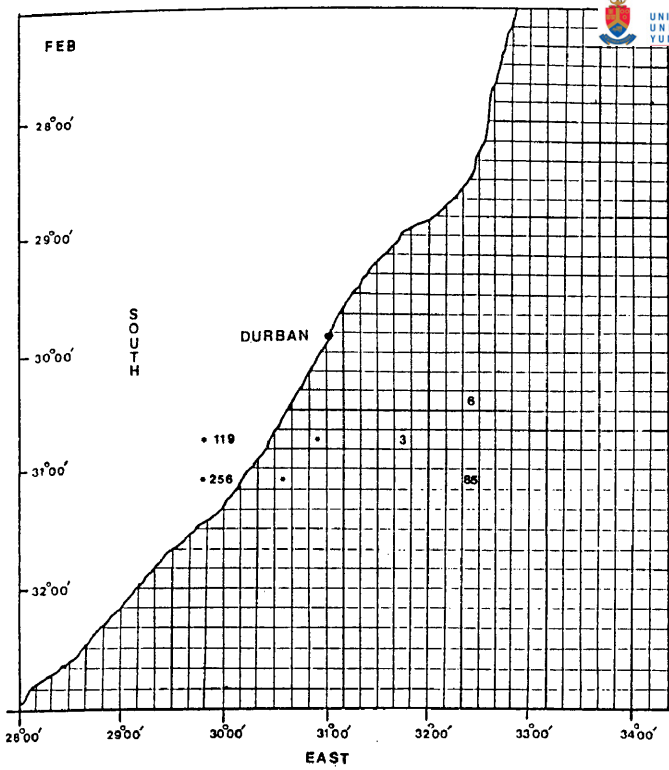


Figure 57. The distribution of medium sized sperm whales sighted off Durban between 1972 and 1975.

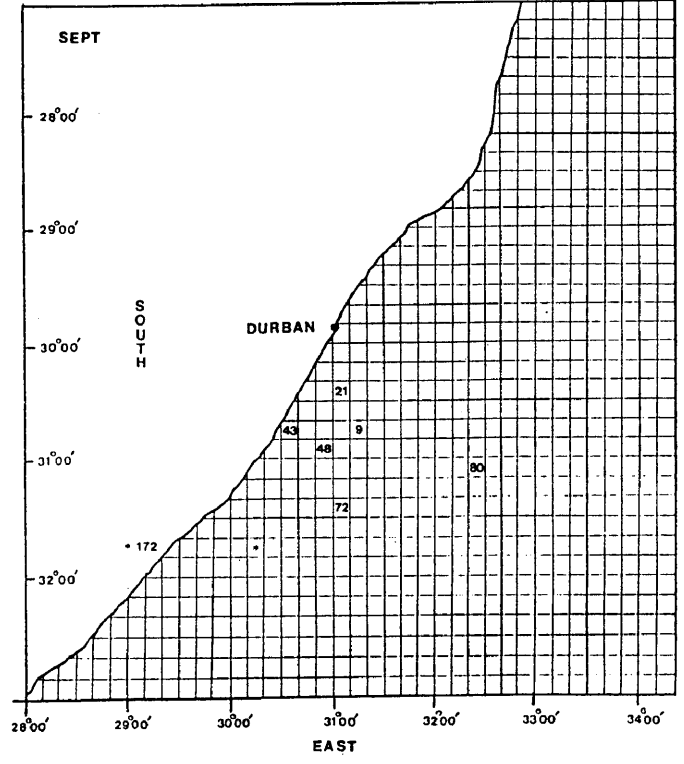
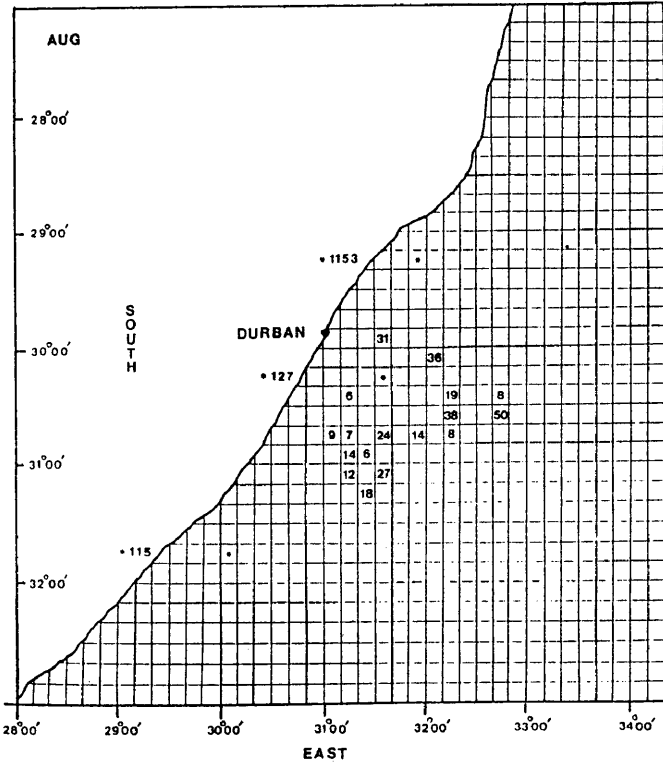
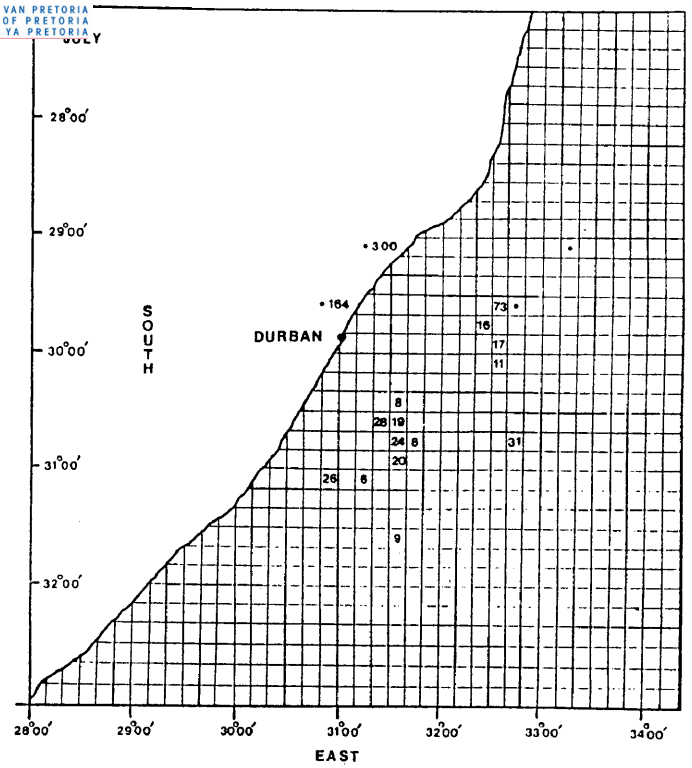
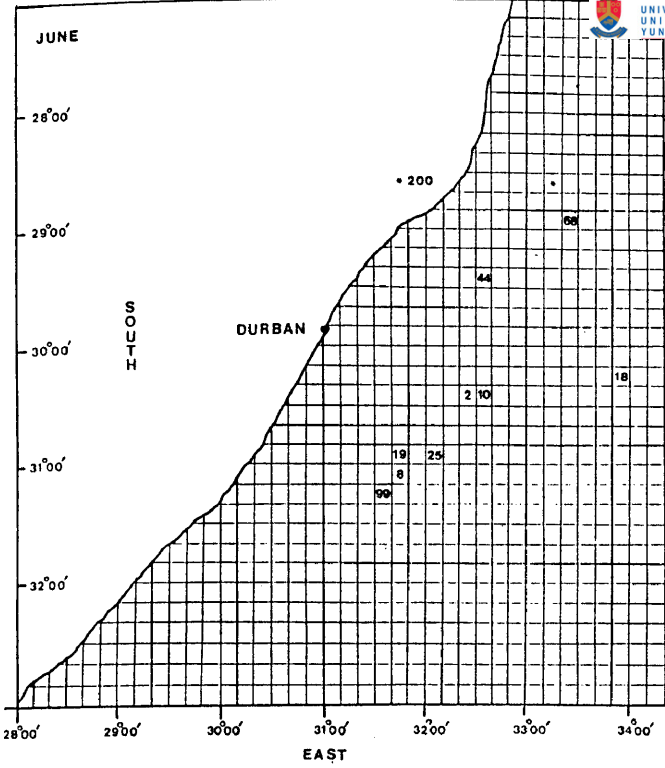


Figure 57. continued.

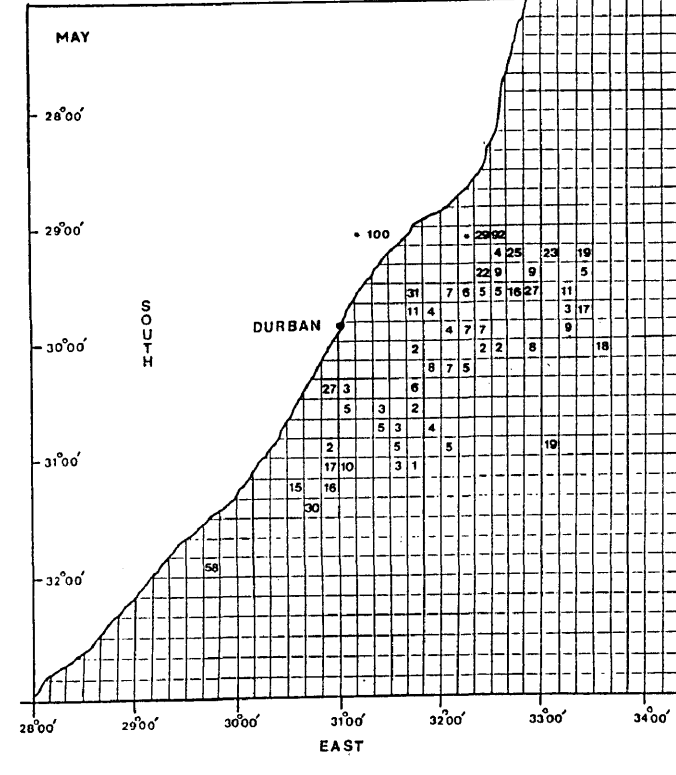
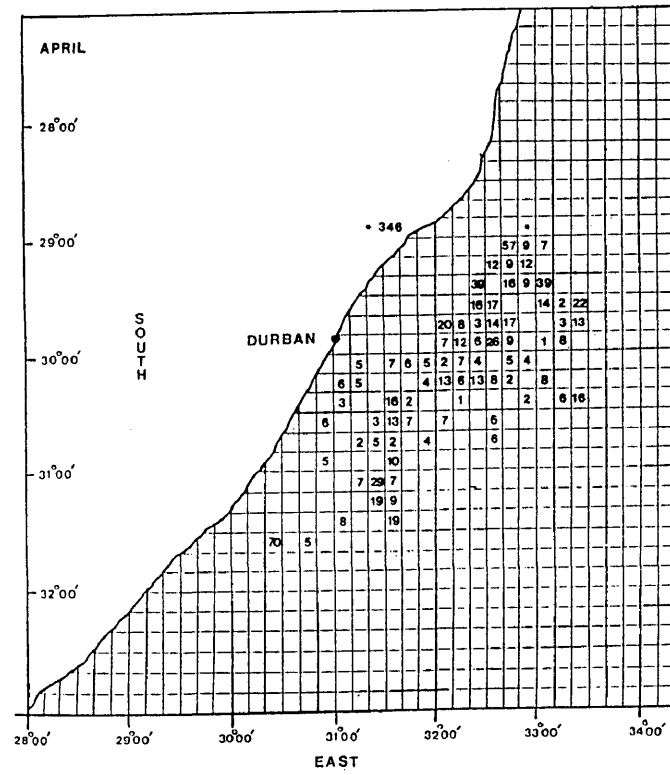
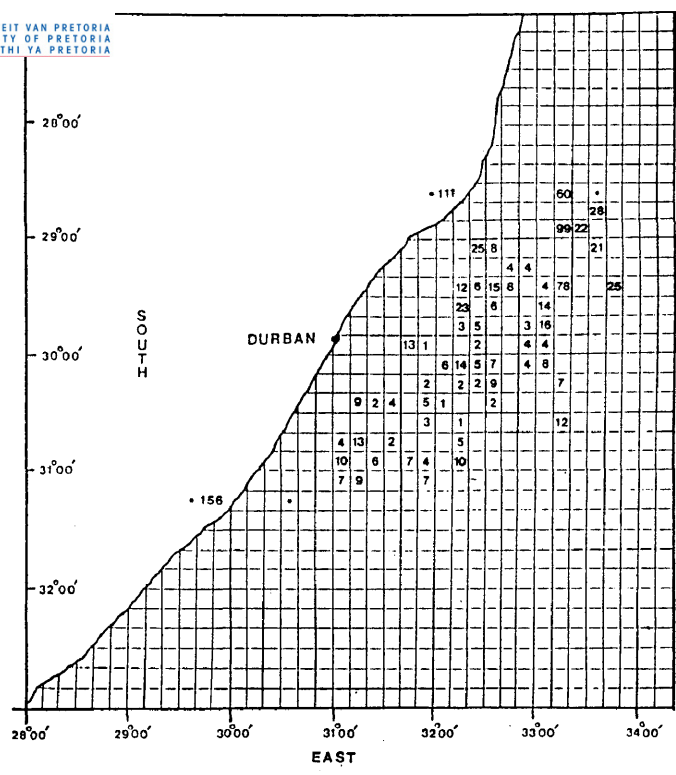
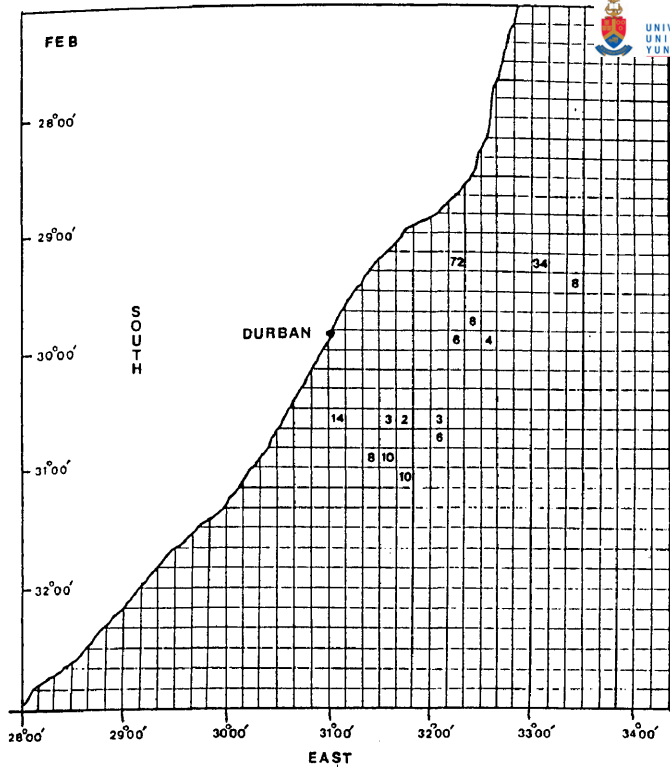


Figure 58. The distribution of small sperm whales sighted off Durban between 1972 and 1975.

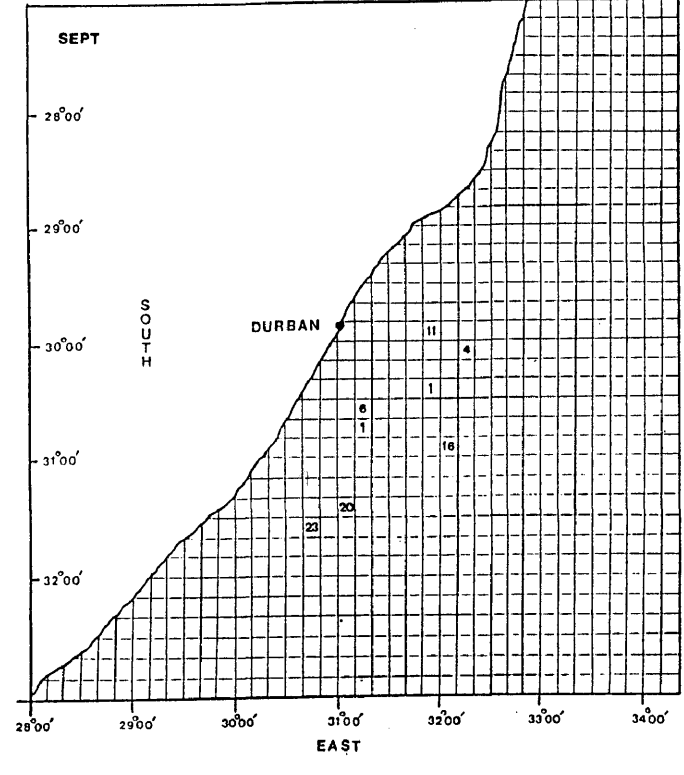
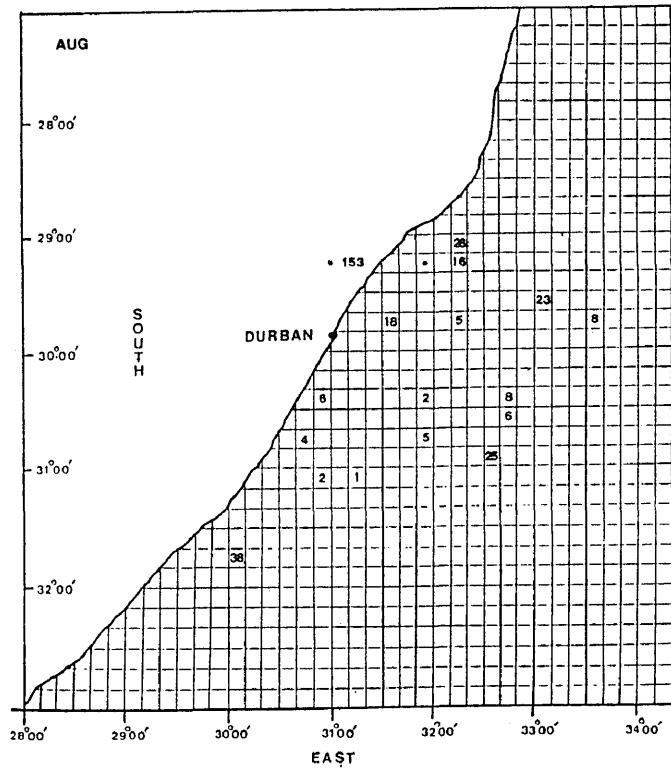
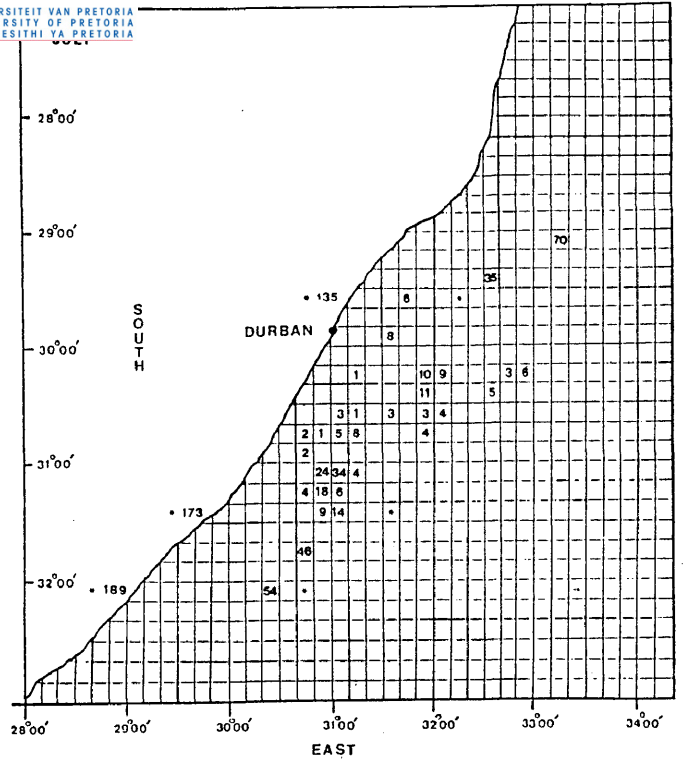
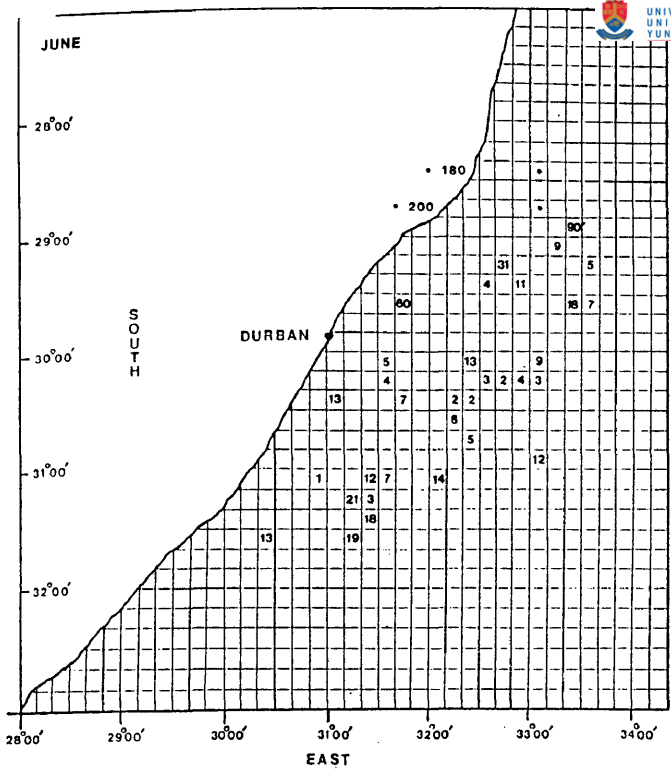


Figure 58. continued.

peak in abundance of females and small males is the result of the heavy exploitation of these classes from 1962 onwards, or alternatively the low September and October and higher July to August densities of all size classes (in this study) could reflect an earlier southward movement of sperm whales.

On the basis of abundance indices, observed directions of movement and breeding behaviour of the species, Gambell (1967) suggests that sperm whale pairing and conception take place in summer to the south of Durban. This is followed by a northward migration in autumn and a return southward migration in spring. The calving season occurs between the end of January and the beginning of August, with the majority of births in April (Gambell 1966). Thus the calving would occur in waters off Durban during the following northward migration. Gambell (1967) suggests that the large and medium sized bulls migrate into the ground after the females and small males have passed through it and suggests that the males associating with the female groups towards the end of the breeding season are the breeding males.

Fifty - nine records totalling of 1091 sperm whales were sighted off Donkergat in 1963 while a further 76 records of a total of 853 sperm whale catches exist for this ground for 1963. The distribution of these sightings and catches (figure 59 and 60) are in agreement with Best's (1969) distribution patterns in that all the sightings and catches of sperm whales in the west coast whaling grounds were in waters of over 200 metres depth (figure 61). As found by Best (1969), the greatest densities were recorded furthest offshore, which as Best suggests, infers that the industry was exploiting the distributional edge of a stock and not a narrow corridor of migrating whales. The aerial sightings in the east coast whaling grounds show a somewhat different depth distribution in that it appears that a number of sightings were made over the continental shelf. This could be due to a combination of the data being analysed by cells of 10 nautical miles square and the fact that the continental shelf is extremely narrow in this whaling ground. Figure 61 suggests that the small and medium - sized sperm whales are found closer inshore than the large sperm whales. Clarke (1980) found differences in the cephalopod diet of small and large sperm whales and suggested that this is more likely to reflect the distribution of squid species than the prey selection of sperm whales. Unfortunately data on squid vertical distribution off Durban arise largely from samples obtained from sperm whale stomachs and correlation of sperm whale and squid distributions are not feasible without independent squid depth distribution data.

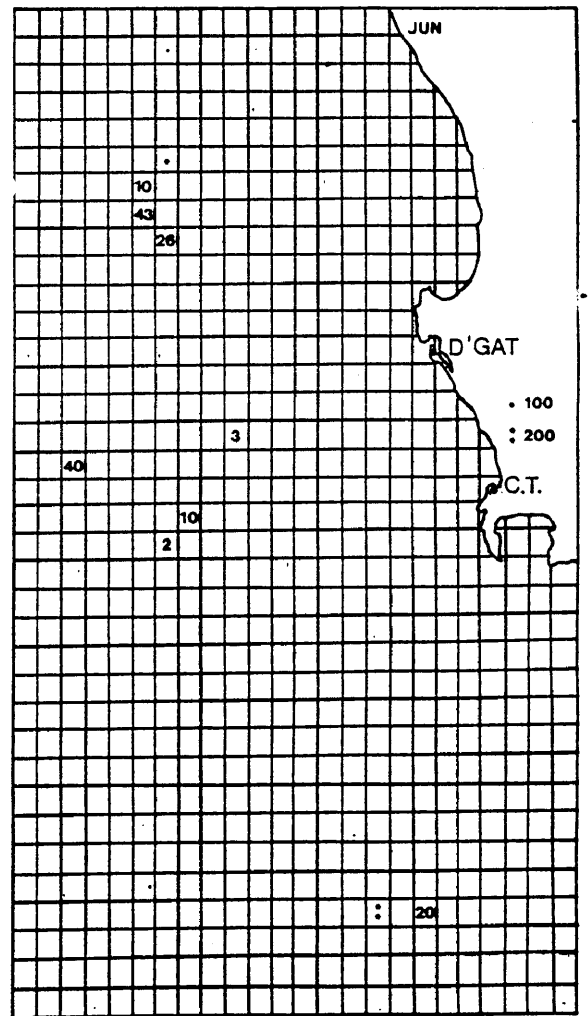
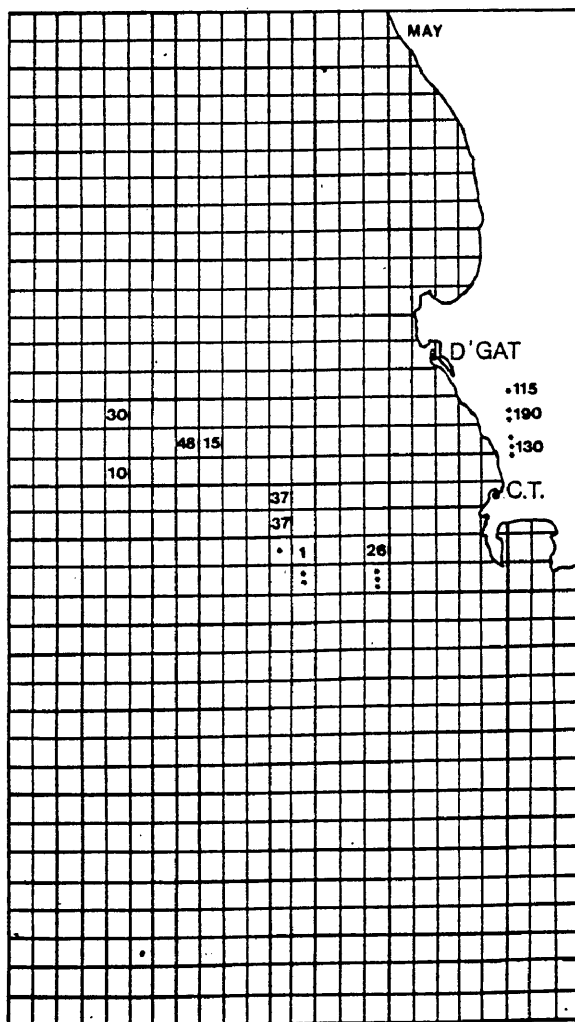
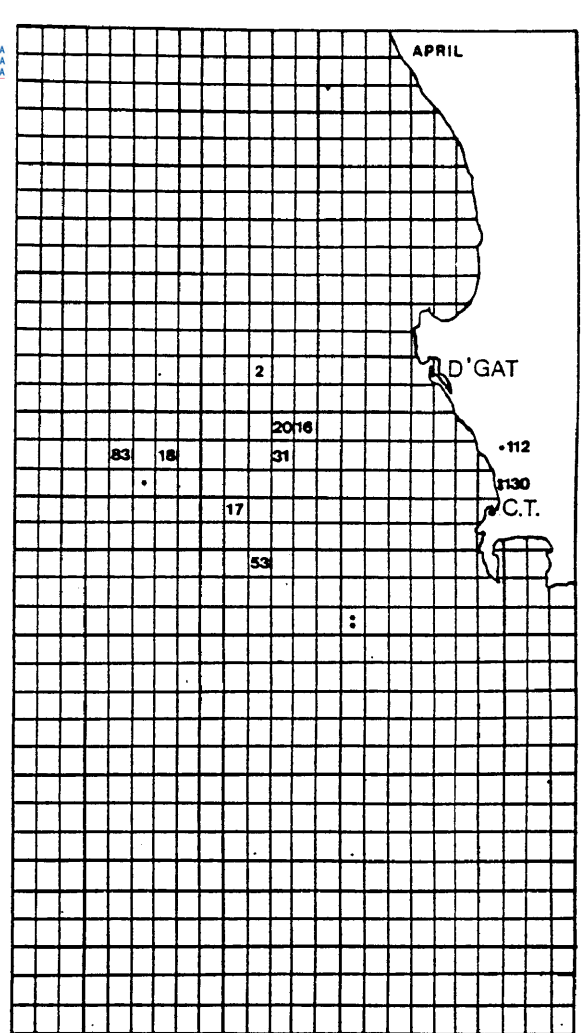
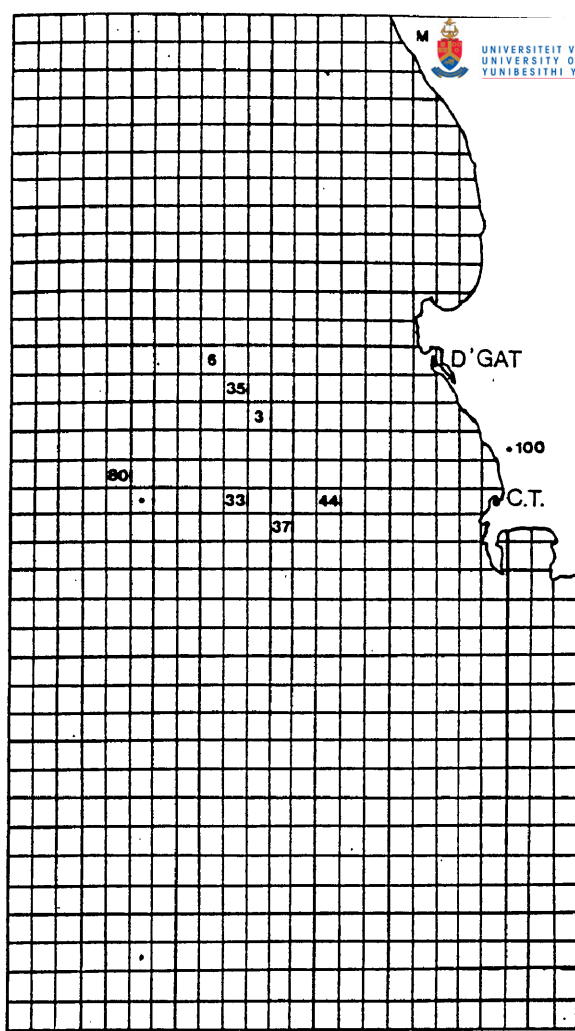


Figure 59. The distribution of sperm whales sighted off Donkergat during 1963.

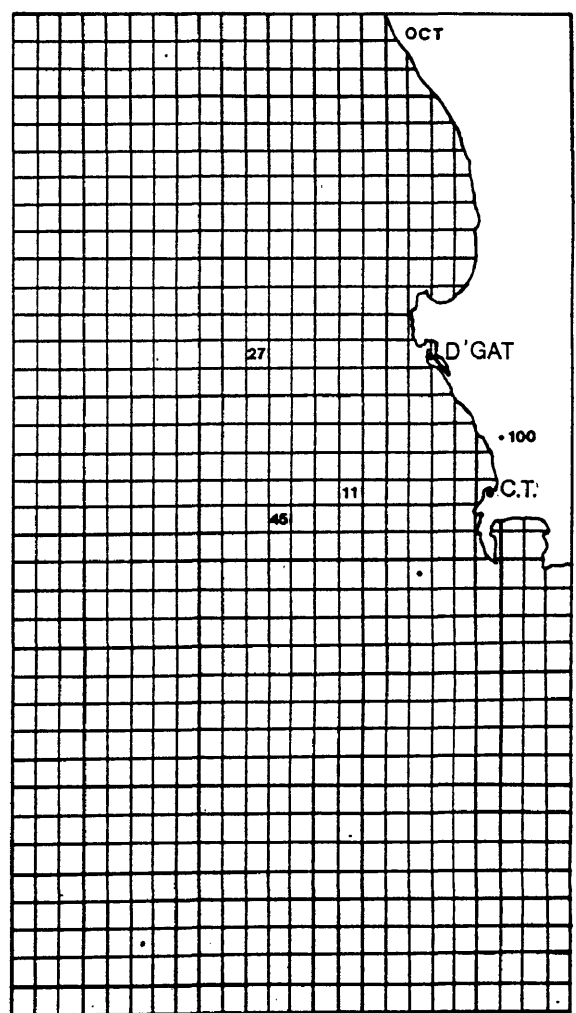
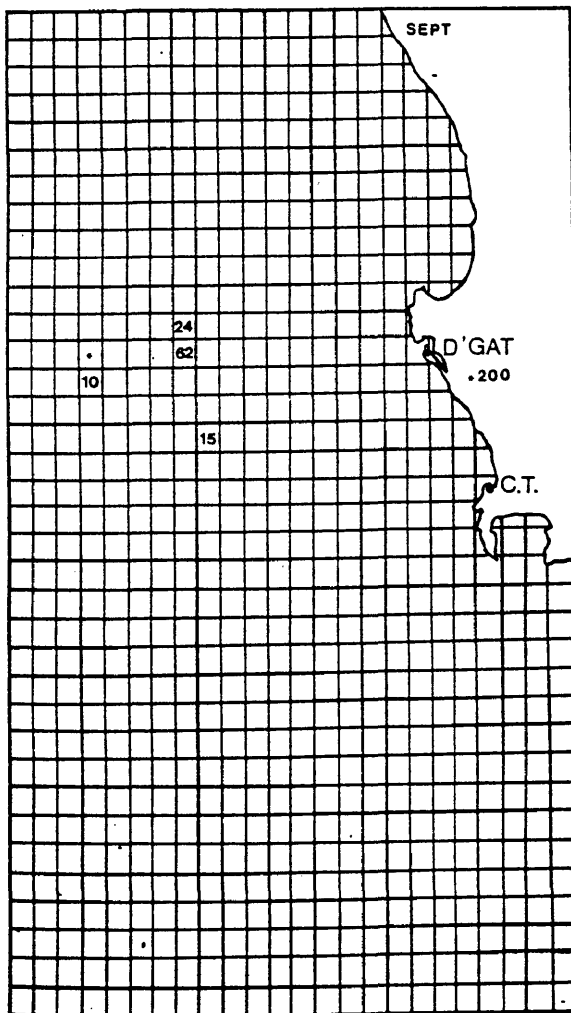
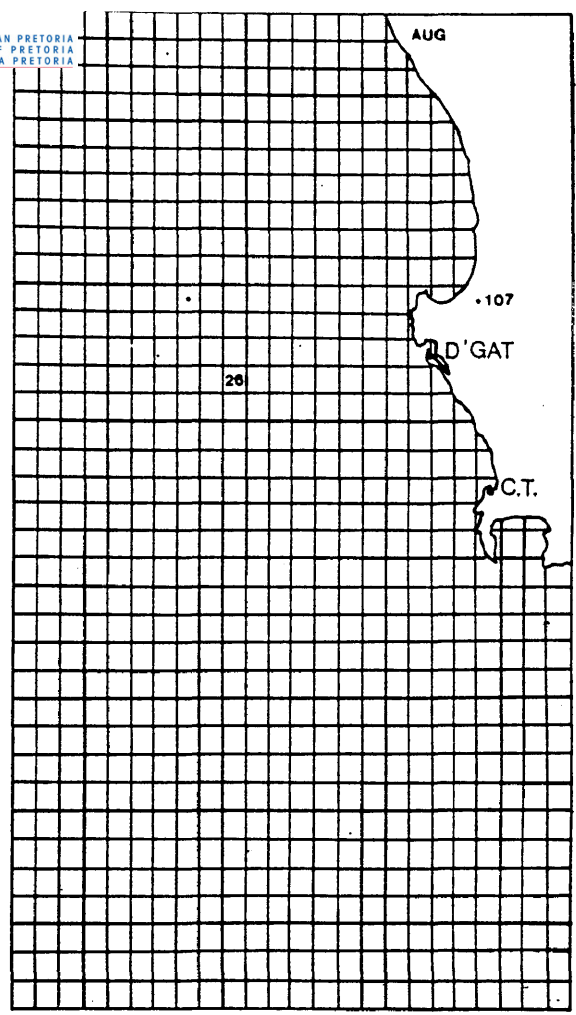
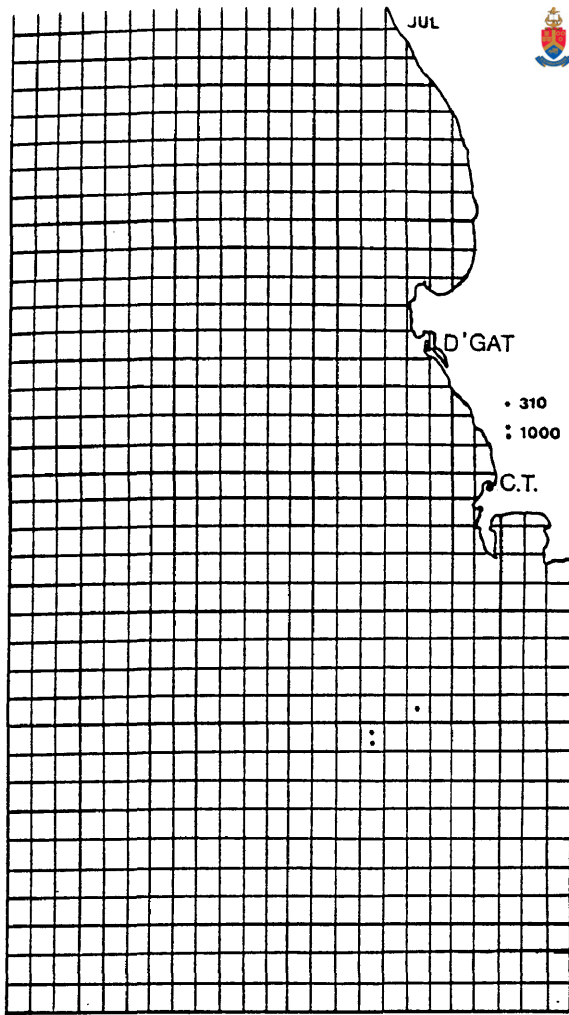


Figure 59. (continued).

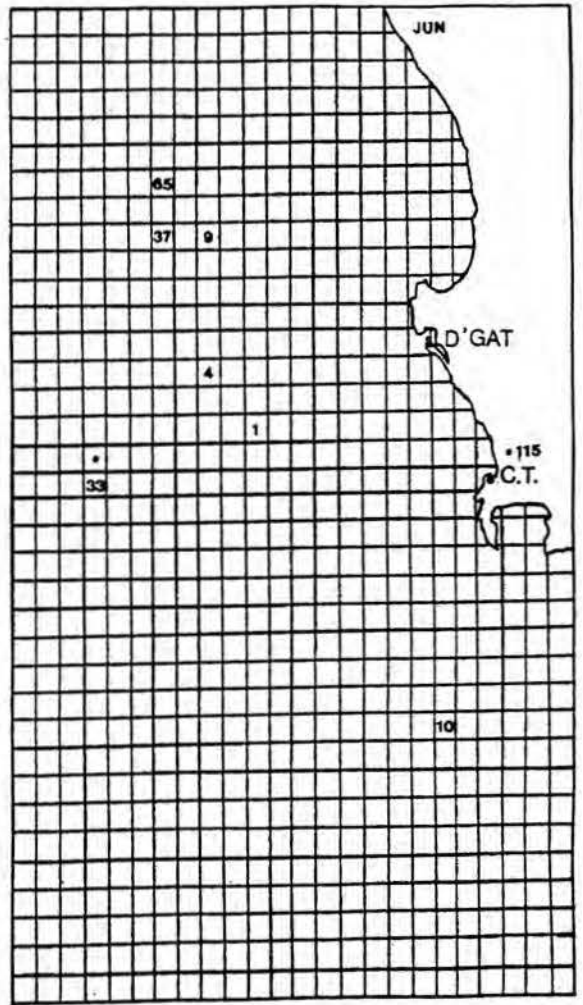
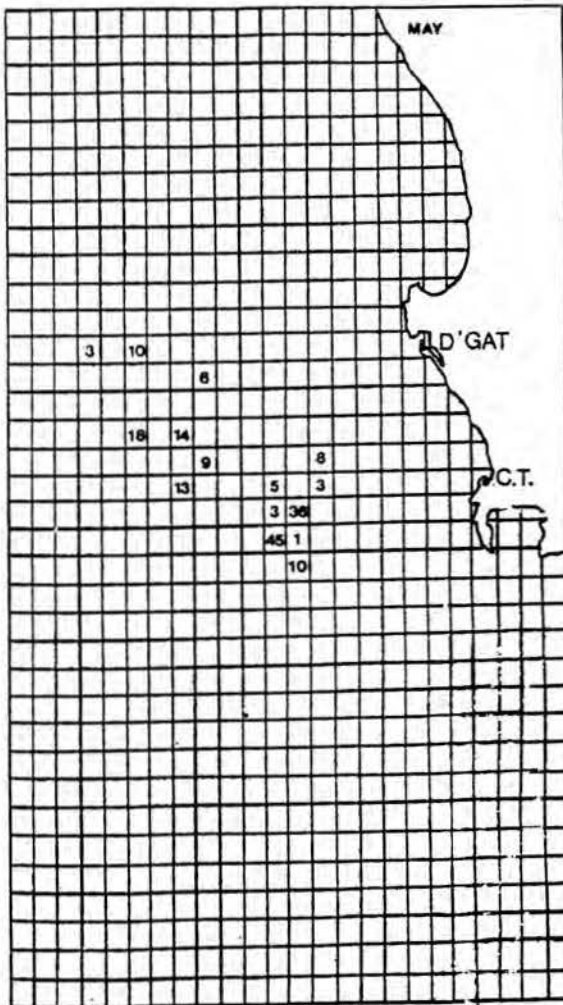
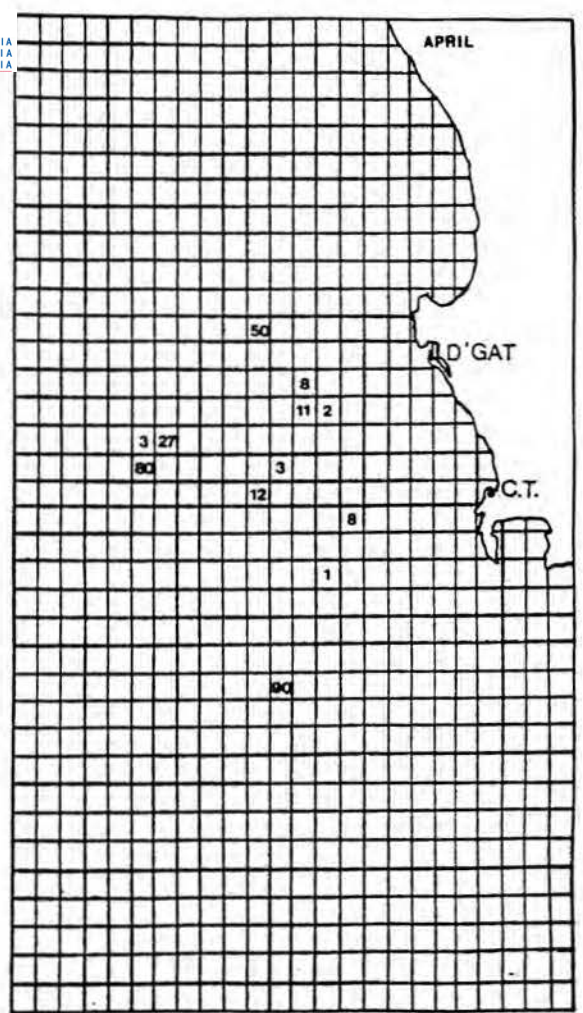
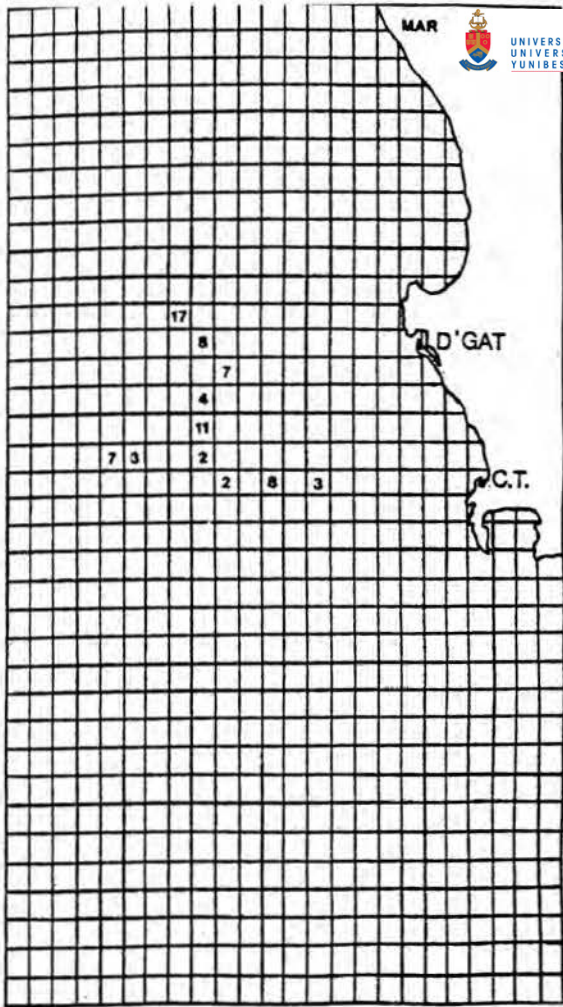


Figure 60. The distribution of sperm whales taken off Donkergat during 1963.

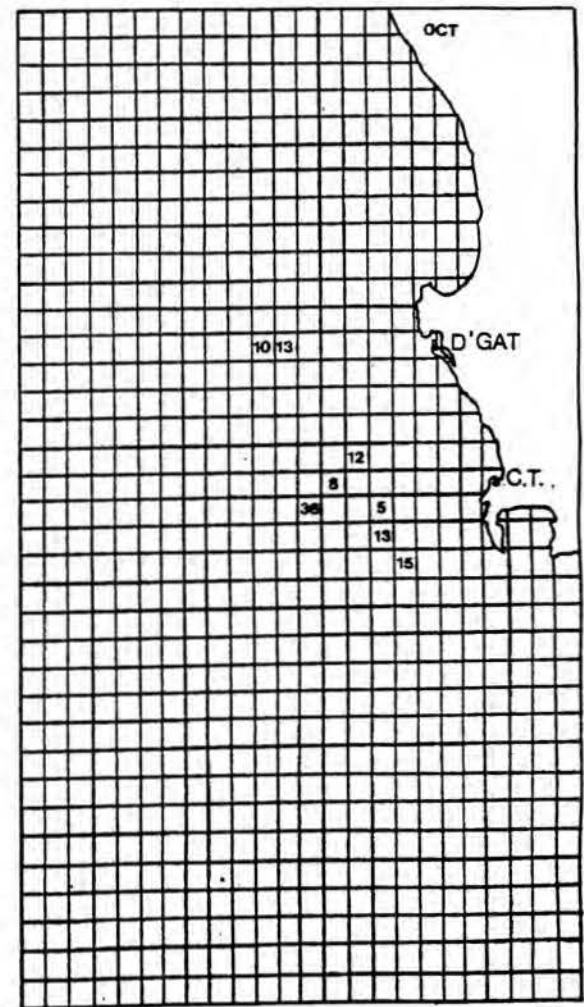
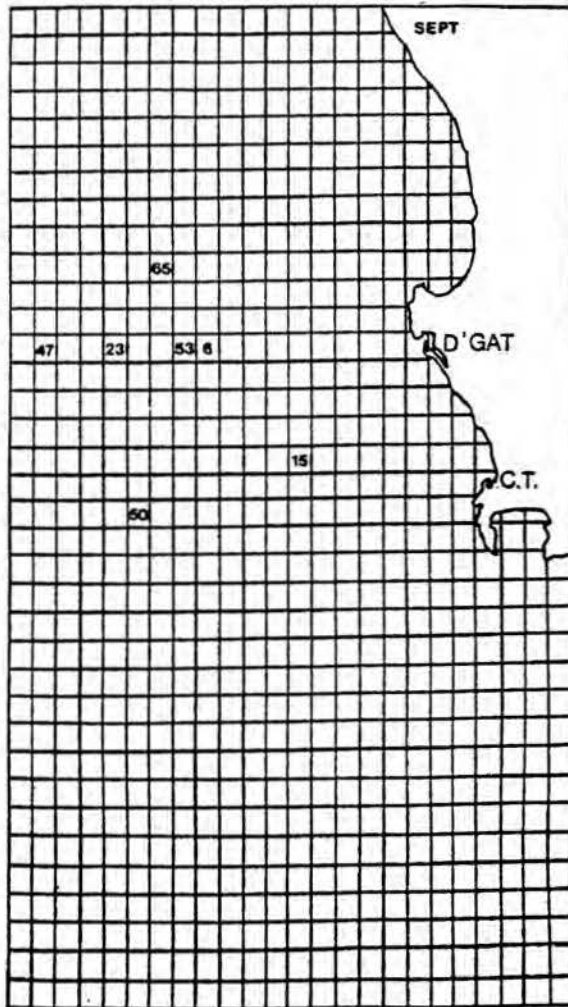
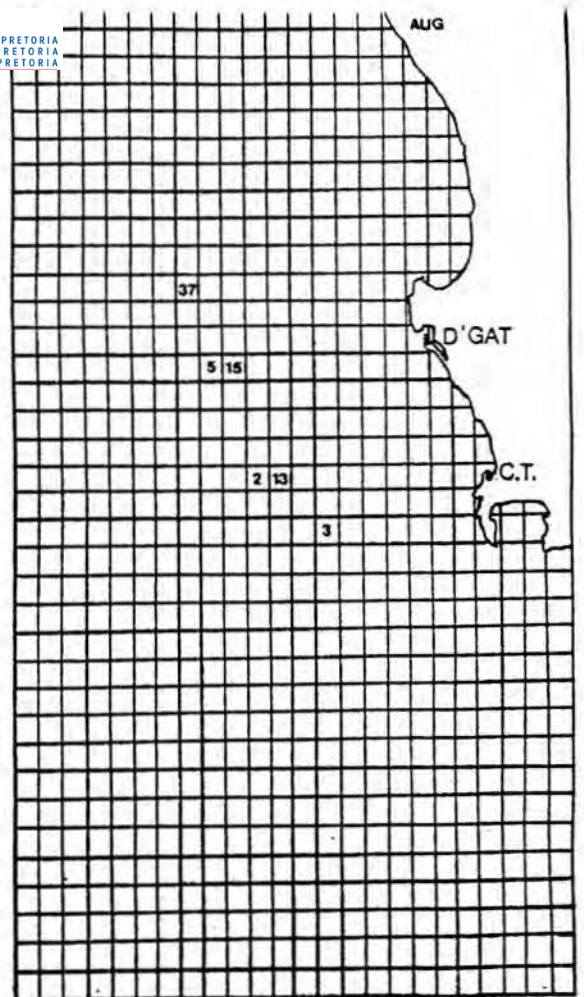
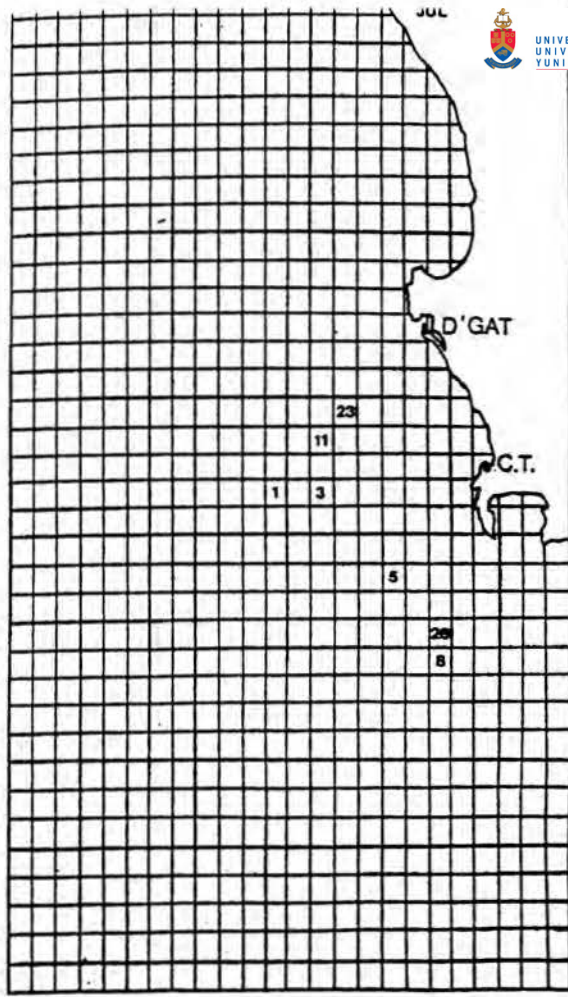
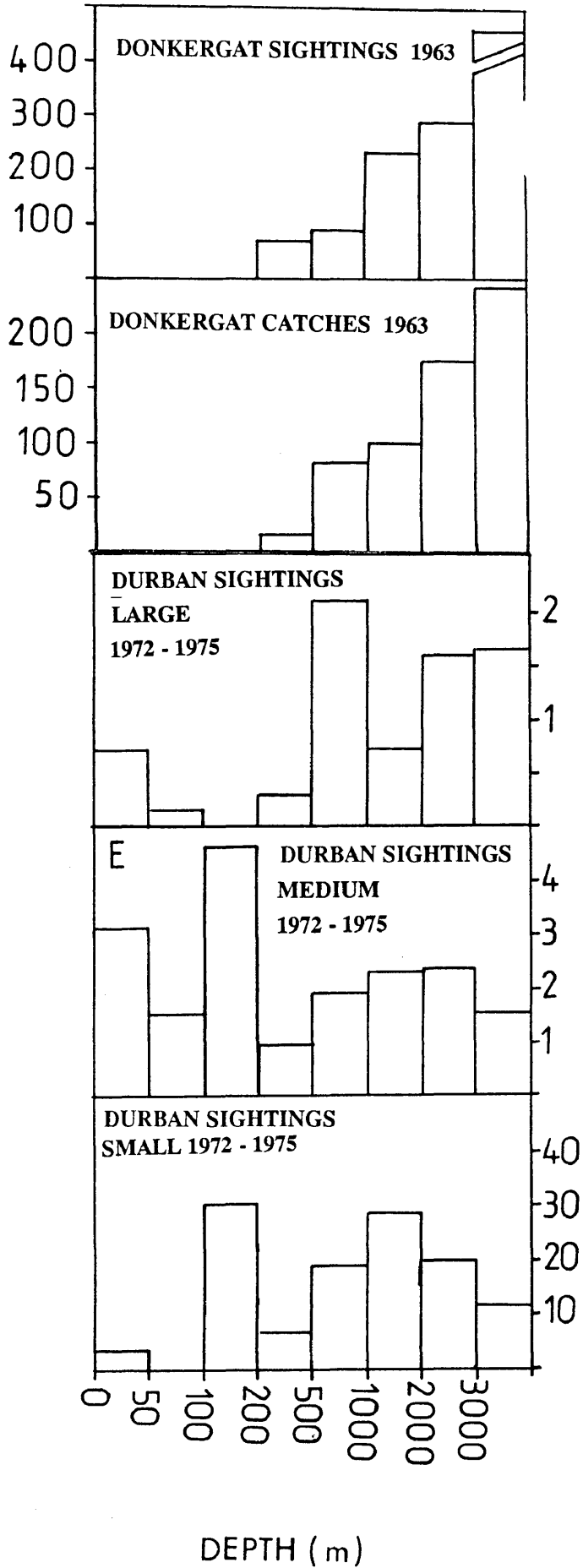


Figure 60. (continued). © University of Pretoria

DENSITY



DENSITY

DEPTH (m)

Figure 61. The depth distribution of sperm whales recorded in the east and west coast whaling grounds. Although the east coast records have been categorised into large, medium and small sized sperm, no differentiation was made for west coast records.

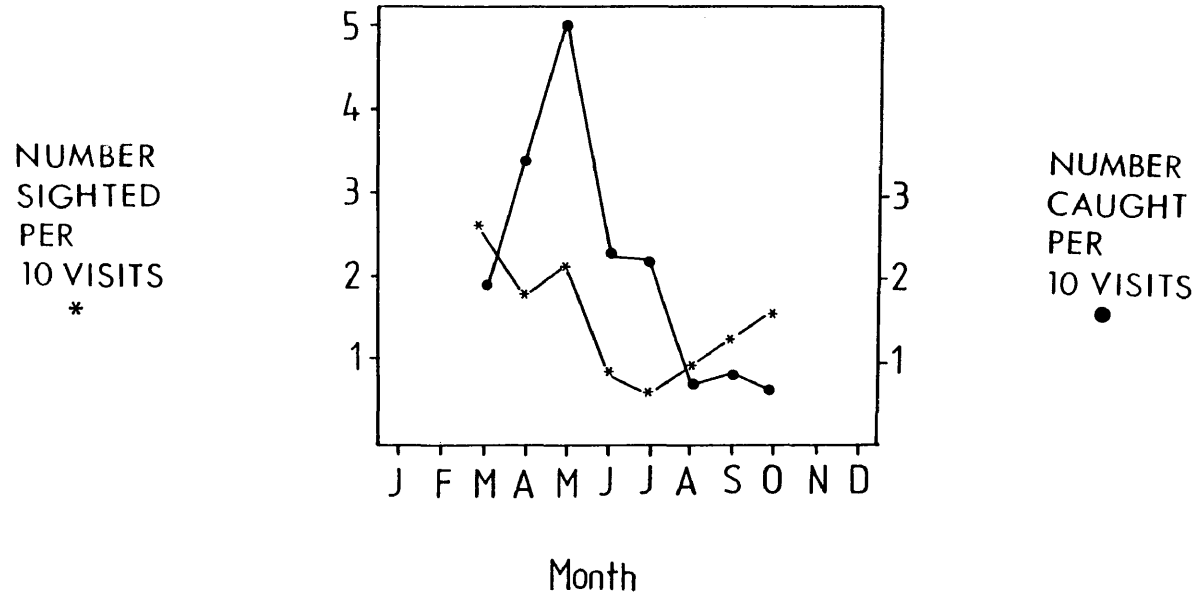




Figure 62 . Seasonal abundance of sperm whales sighted and taken off Donkergat during 1963.

Seasonal abundance based on sightings  UNIVERSITY OF PRETORIA
UNIBESITHI YA PRETORIA off Donkergat (figure 62) shows a peak of abundance in May falling to a seasonal low after August, while the seasonal abundance based on catches (figure 62) shows markedly different results in that the abundance is highest in March and declines steadily until June after which it increases slightly until the end of the season. The low catches during June, July and August could arise from catchers selecting the more valuable *Balaenopteridae* during these months, while the high March to April catches could result from the baleen whale season only opening in May. The pattern is similar to that found for catch per unit effort between 1958 and 1967 by Best (1969). Best noted the similarity between the Donkergat catch per unit effort figures and the pattern found for the East coast whaling grounds by Gambell (1967), and on the basis of the East coast lying 200 kilometres to the north of the West coast grounds concluded that sperm whales are moving north in autumn and south in spring.

The genus *Kogia*.

Nishiwaki (1967) notes that *Kogia* species are widely distributed in the tropical and temperate oceans of the world. Both the pygmy sperm whale (*Kogia breviceps*) and the dwarf sperm whale (*K. simus*) are found in southern African waters (Ross 1979). Handley (1966) stated that *K. breviceps* is confined to the warmer waters of the world and most frequently stranded on the coasts of South Africa, southeastern Australia, New Zealand and southeastern United States, and that *K. simus* has been recorded from the coasts of South Africa, India, Ceylon, Japan, Hawaii, South Australia and the east coast of the United States of America. Ross (1984) found *Kogia breviceps* distributed between Cape Cross in South West Africa / Namibia and Natal and *K. simus* distributed between Saldanha Bay and East London and suggests that the continental shelf act as a nursery area for *Kogia* off southern Africa

Due to the difficulty of identifying sightings of kogiids to species level at sea the one incidental sighting of one *Kogia* at 30° 36' S 31° 08' E in August 1971 was recorded as "*Kogia* species". This sighting was made in water depths of between 2000 and 3000 m, within a temperature interval of 20° to 22° C and salinity interval of between 35.2 and 35.4 ppt.

Specimen records of 71 *Kogia simus*, 9  and 17 unidentified kogiids were reviewed in this study. Certain of the specimens were too decomposed to be identified to species level and were recorded as unidentified kogiids.

The provenances of the 17 unidentified kogiid specimens are plotted in figure 63. Provenances of the specimen records of *K. breviceps* (plotted in figure 64) show that this species is found along the entire coastline from 22° S on the west coast to 29° 50' S on the east coast, while the provenances of the records of *K. simus* are plotted in figure 65 and suggest that the distribution of this species is limited to the south coast between Cape Columbine and approximately 28° E. Ross, Cockcroft and Cliff (1985) suggest that the one record from the northern Natal coast is a stray and that it is linked to a warm water event of 1982. Months of origin of these specimens are shown in figure 53, while categories of origin are shown in tables 9, 10 and 11. The seasonal abundance of the two species (figure 53) shows that although both are recorded throughout the year in southern African waters, *K. simus* appears (albeit from specimen records) to show some seasonal occurrence during late summer and autumn (February to June), while *K. breviceps* appears to have a seasonal peak around late winter (July to September).

Ross (1979) concluded that *K. simus* is associated with the shelf edge of the Agulhas Bank, while *K. breviceps* is a pelagic species. However, despite the prevalence of strandings of both species, there is only one incidental sighting of *Kogia* and definition of the offshore distribution patterns is difficult without further records. The paucity of sightings could presumably reflect small school sizes (most of the strandings are of single animals), the small body size, the deep water habitat and possibly the diving behaviour of the species.

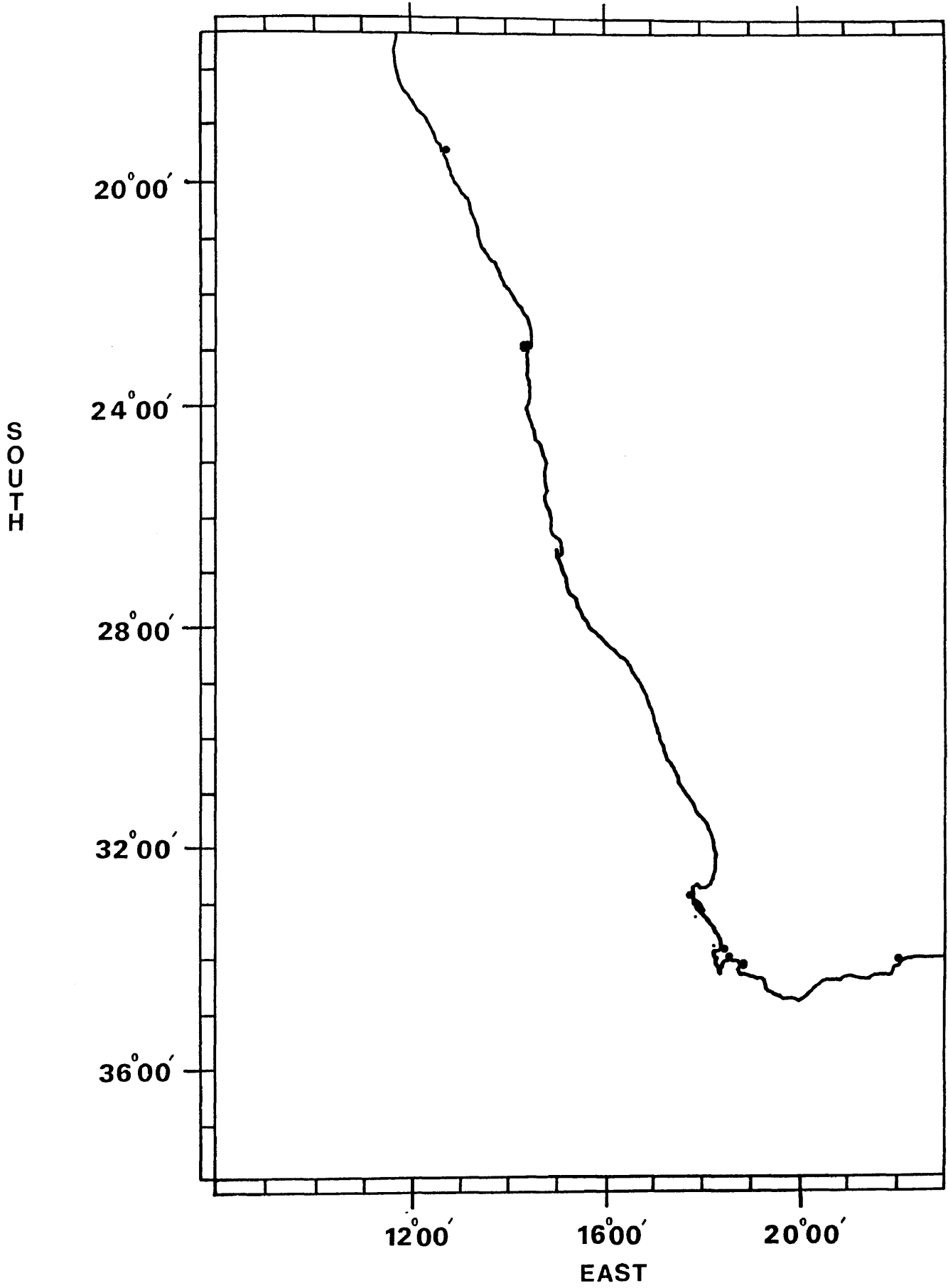


Figure 63. Incidental (*) sightings and strandings (●) of *Kogia* species reviewed in this study.

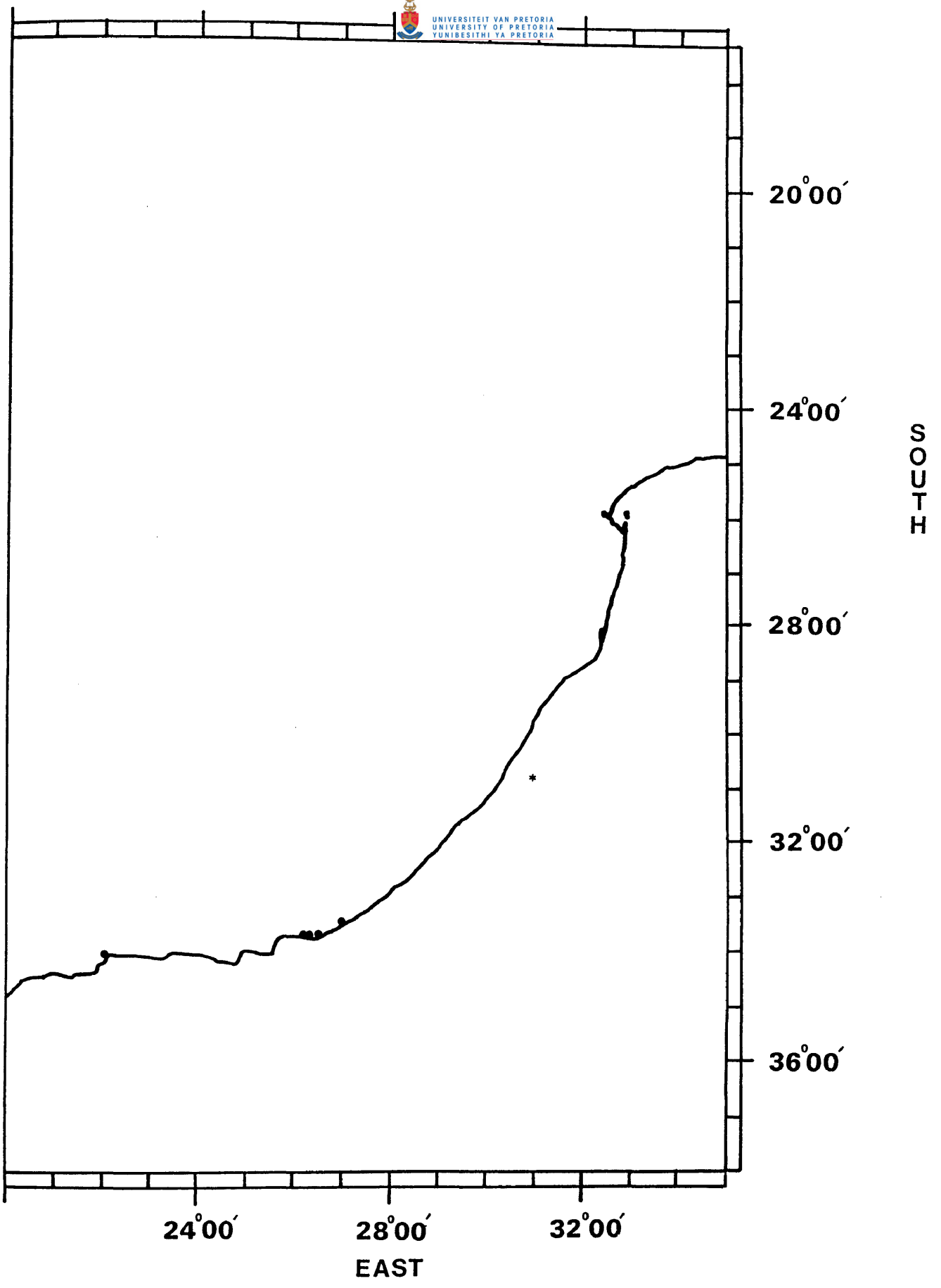


Figure 63. (continued)

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

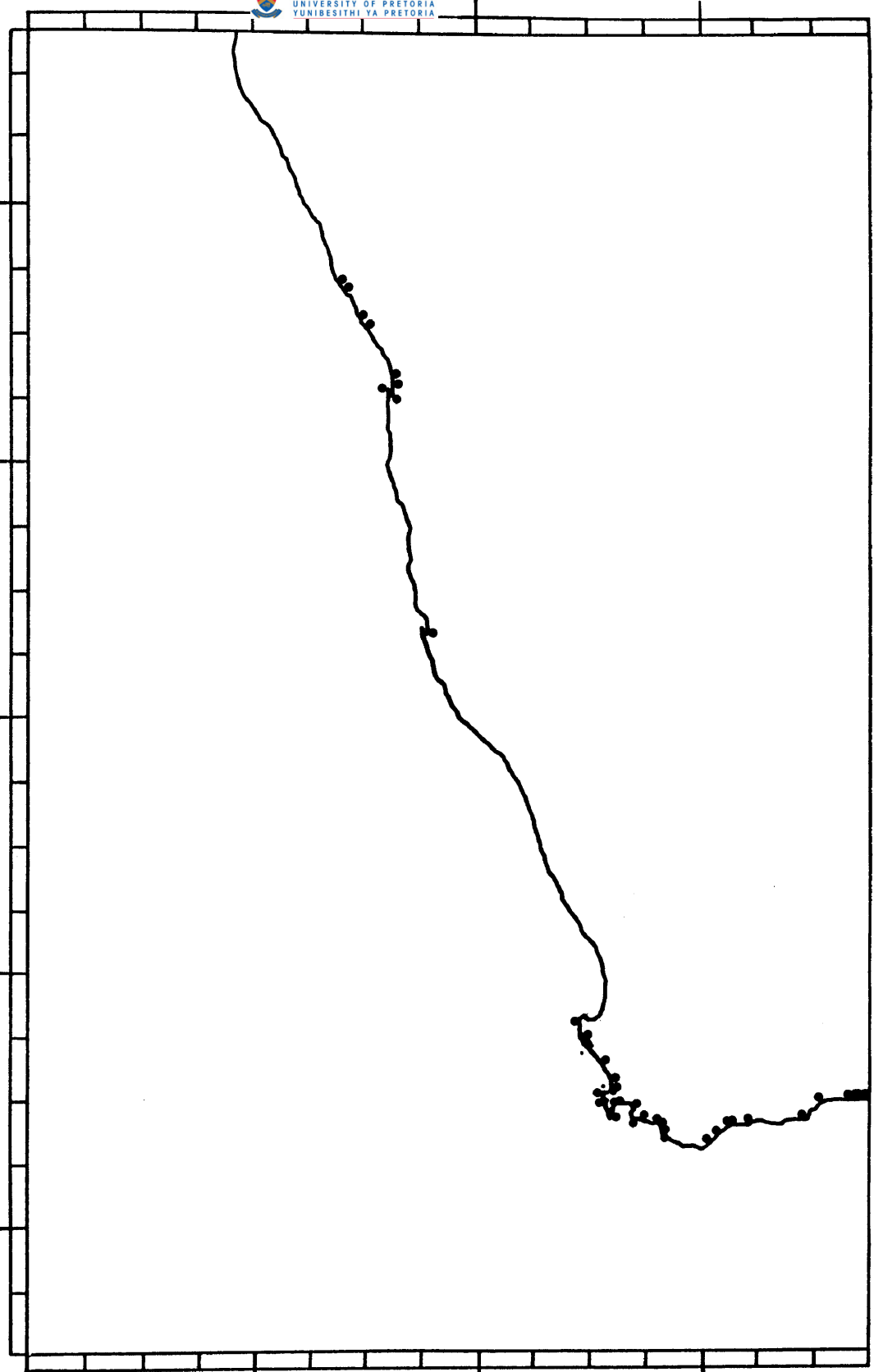


Figure 64. Provenances of specimens (●) of *Kogia breviceps* reviewed in this study.

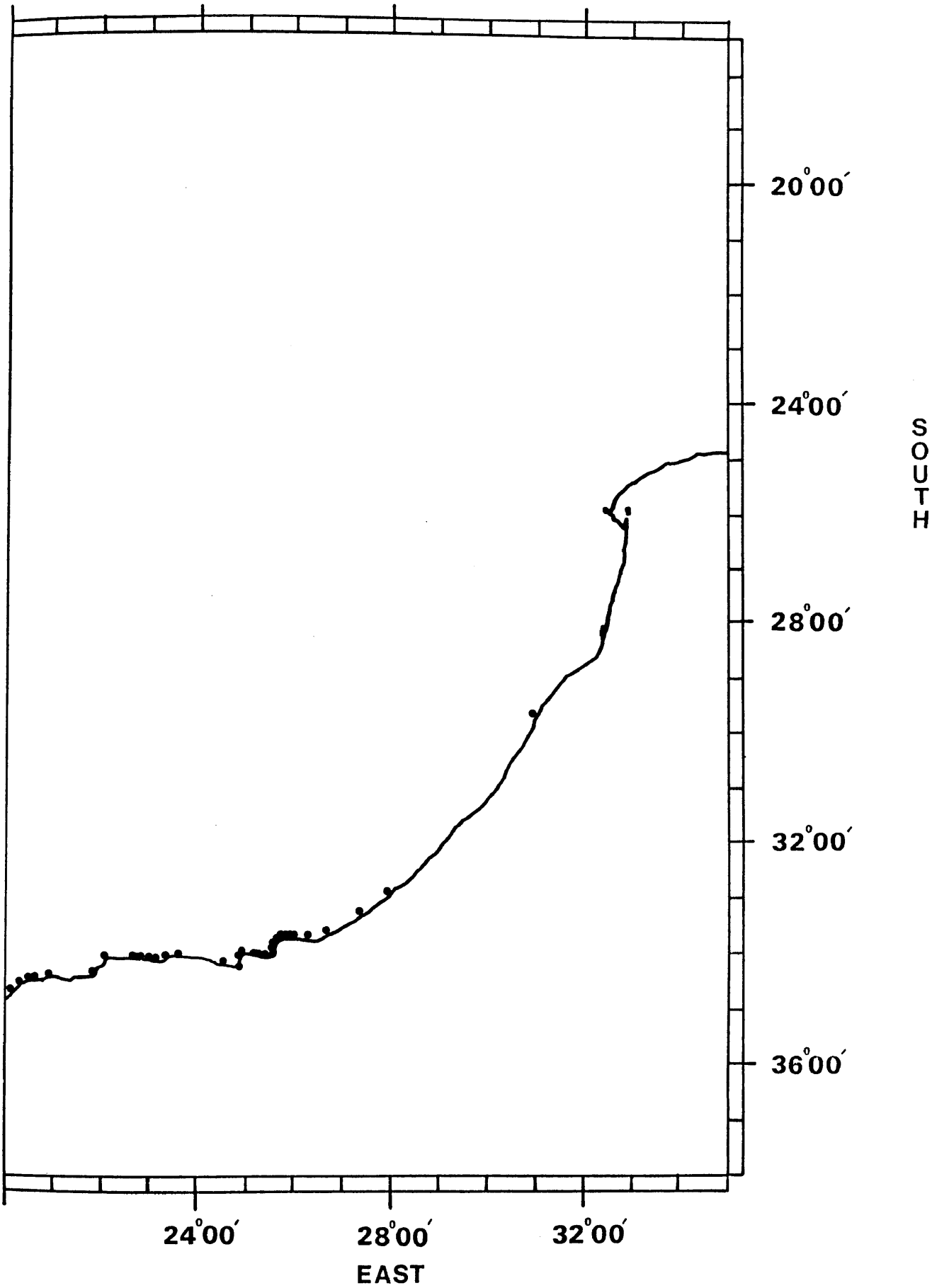


Figure 64. (continued)

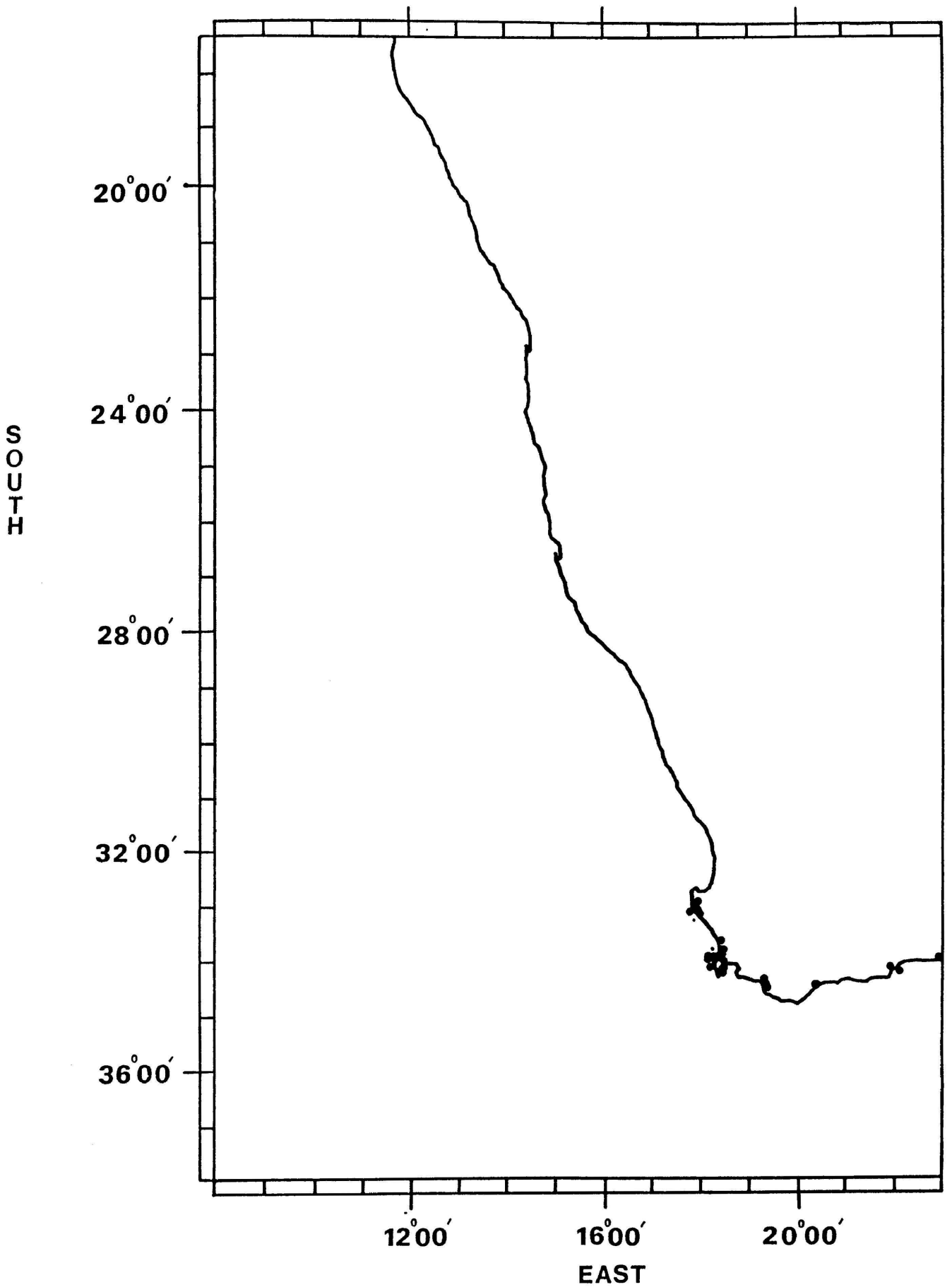


Figure 65. Provenances of specimens (●) of *Kogia simus* reviewed in this study.

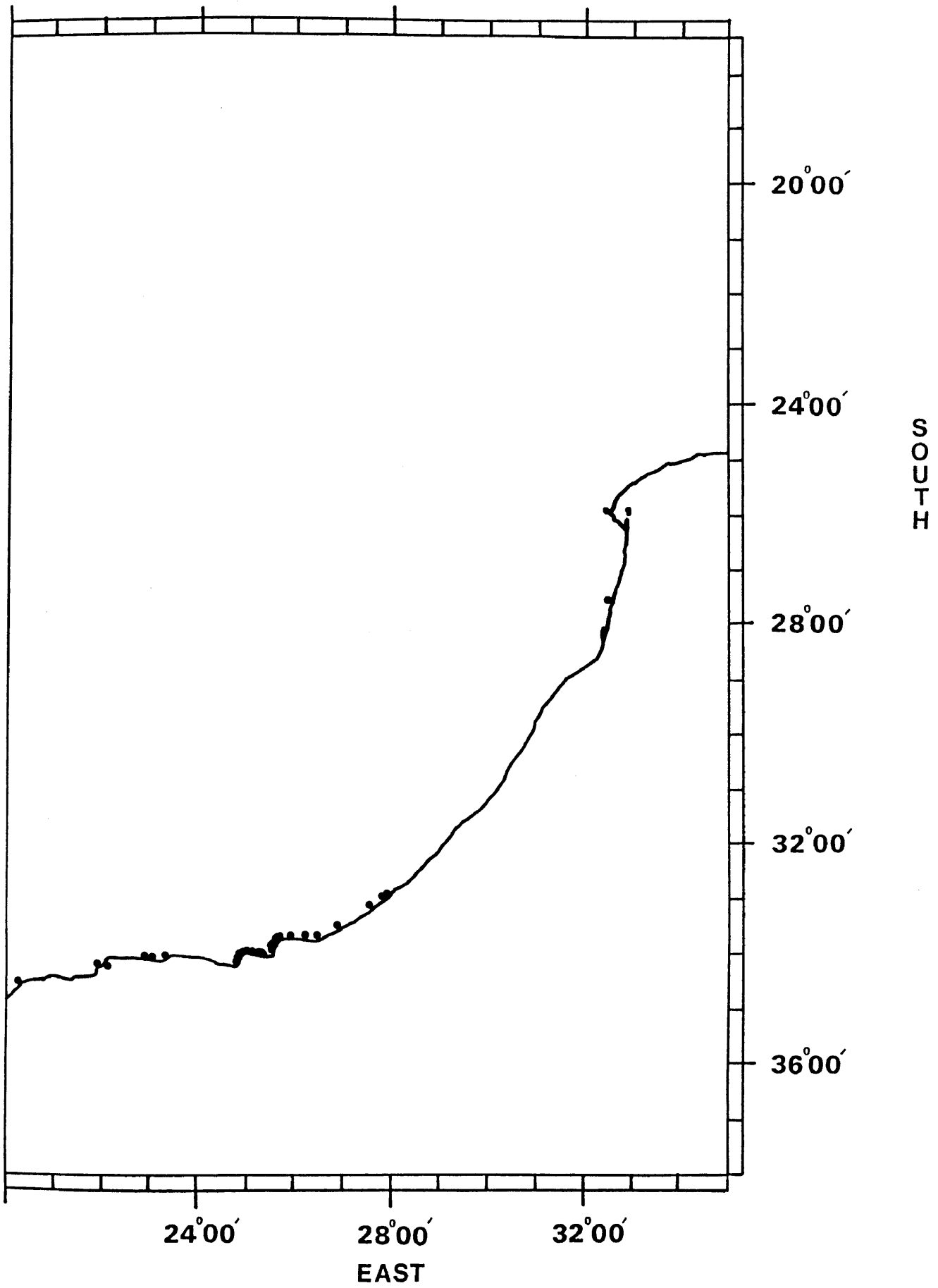


Figure 65. (continued)

Table 9. Origins of the 17 unidentified specimens of *Kogia* reviewed in this study

Category of provenance	Number of individuals
Live beach cast (stranding)	2
Found dead on shore	4
Skeletal material found on shore	1
Unknown	10

Table 10. Origins of the 94 specimens of *Kogia breviceps* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	21
Dead beach cast (stranding)	4
Found dead on shore	47
Skeletal material found on shore	7
Unknown	15

Table 11. Origins of the 71 specimens of *Kogia simus* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	16
Dead beach cast (stranding)	1
Found dead on shore	42
Skeletal material found on shore	2
Skeletal material dredged at sea (or material found in gut of predator)	2
Unknown	8

CHAPTER SEVEN

RESULTS - *ODONTOCETI* (CONTINUED)

THE *ZIPHIIDAE*

The *Ziphiidae* are a poorly known group of cetacea which is a reflection of their deep water habitat, the difficulty of identifying them at sea, and the fact that there is no fishery for most of the species so that the distribution patterns are largely derived from stranding records. Ross, Baker, Goodall, Lichter and Mead (in press) review the distributions and seasonal occurrence of beaked whales in the Southern Hemisphere and note that the majority of records are from strandings.

Cuvier's beaked whale (*Ziphius cavirostris*)

Nishiwaki (1967) suggests that this species is found in temperate waters, while Ross (1984) states that it is widely distributed in tropical and temperate oceans. Moore (1963) notes that it appears to have a worldwide distribution, but questions its occurrence in South African waters as the origin of the one specimen recorded from the Cape of Good Hope prior to Ross and Tietz (1972) is subject to controversy. Ross *et al* (in press) note that in the southern hemisphere this species is distributed from the equator southwards, and state that there are no records south of the Antarctic Convergence. Kasamatsu *et al* (in press) however report two observations of Cuvier's beaked whale south of the Antarctic Convergence.

Only one positive sighting of *Z. cavirostris* has been recorded off the coast of southern Africa. This sighting of one animal was recorded at 37° 28' S 22° 39' E during January 1975 on a scientific cruise (figure 66). Nishiwaki and Oguro (1972) state that *Z. cavirostris* occurs in waters of depths of 1000 metres or more. The one scientific sighting of *Z. cavirostris* was made in waters of over 3000 metres deep. Two of the specimens (one found floating dead off Durban and one taken off Durban at 29° 50' S, 32° 49' E (both in water depths of over 1000 m) provide further evidence on the deep water habitat of the species. The mean temperature measured in waters in which the scientific sighting was made was in the 16° to 18° C interval while the corresponding salinity value was measured between 35.2 and 35.4 ppt. Provenances of fourteen specimens of *Z. cavirostris* are plotted in figure 66 and it would appear that this species has a cosmopolitan distribution in southern African waters. The categories of origin of these specimens are shown in table 12, while figure 67 shows that, although the species is found throughout the year in southern African waters a possible peak abundance occurs in autumn.

Table 12. Origins of the 14 specimens of *Ziphius cavirostris* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	1
Dead beach cast (stranding)	2
Found floating dead at sea	1
Found dead on shore	7
Skeletal material found on shore	2
Direct fishing mortalities (including scientific collection)	1

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

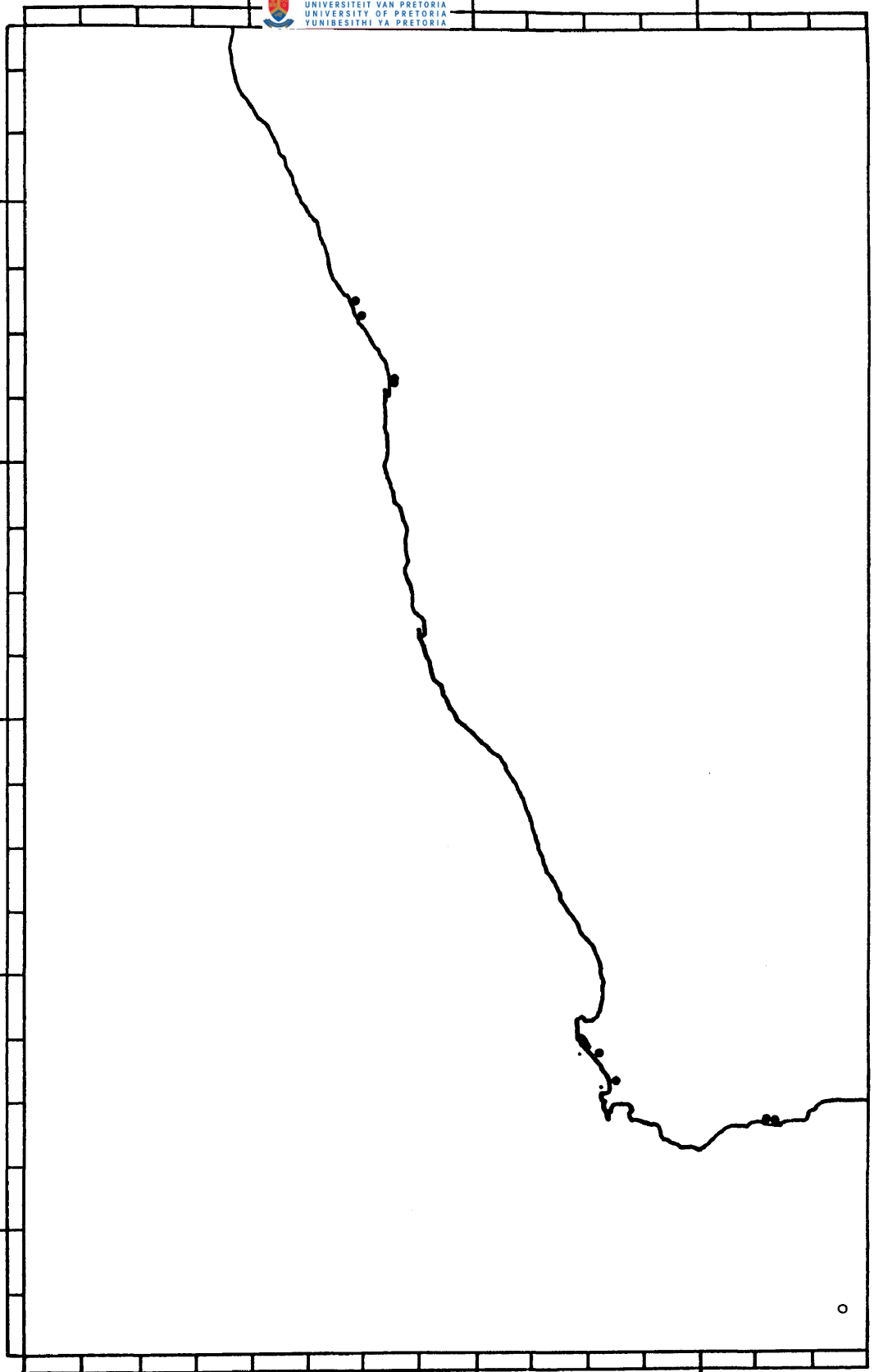


Figure 66. Scientific sightings (O) and strandings (●) of Cuvier's beaked whales reviewed in this study.

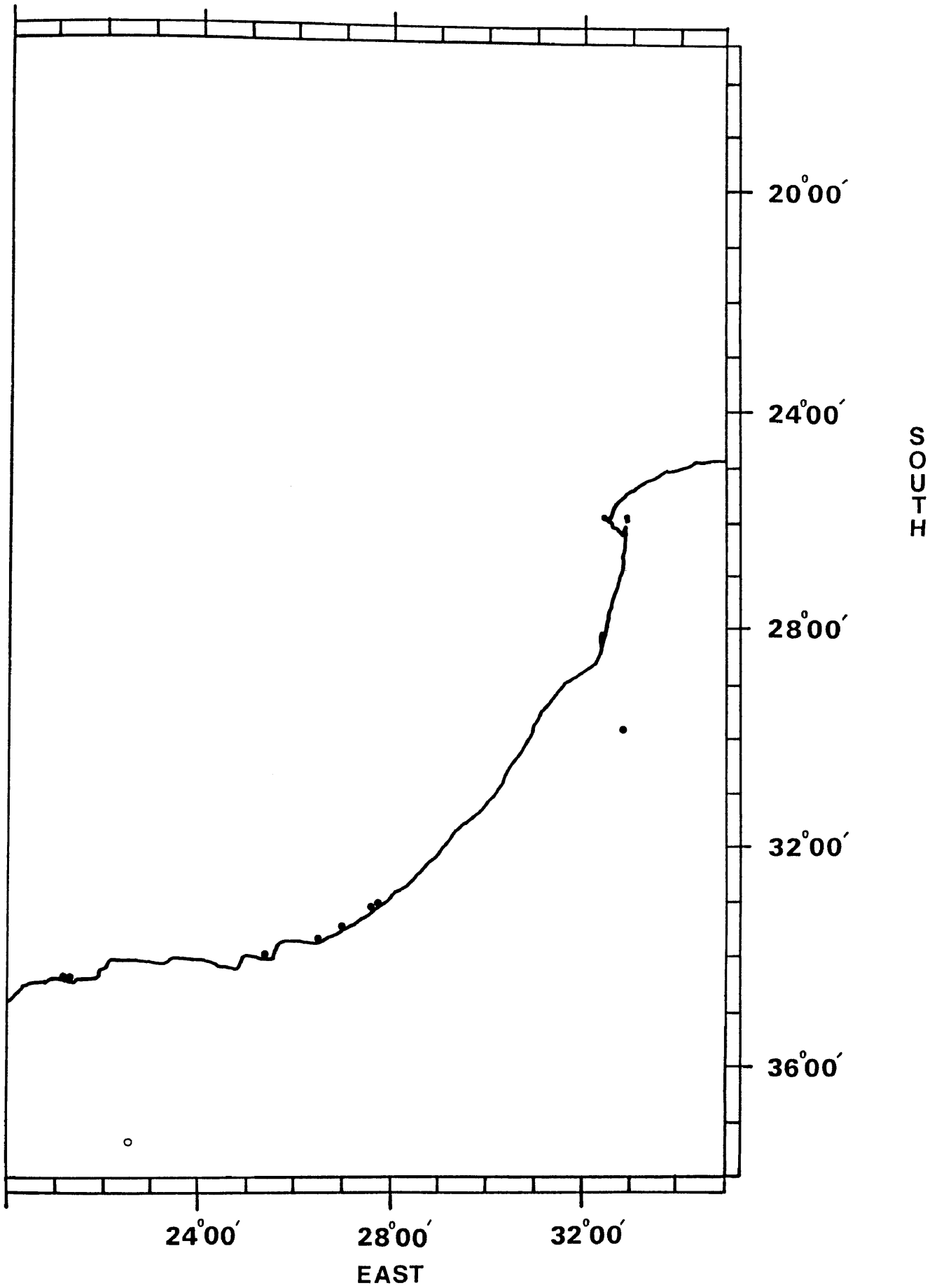


Figure 66. (continued)

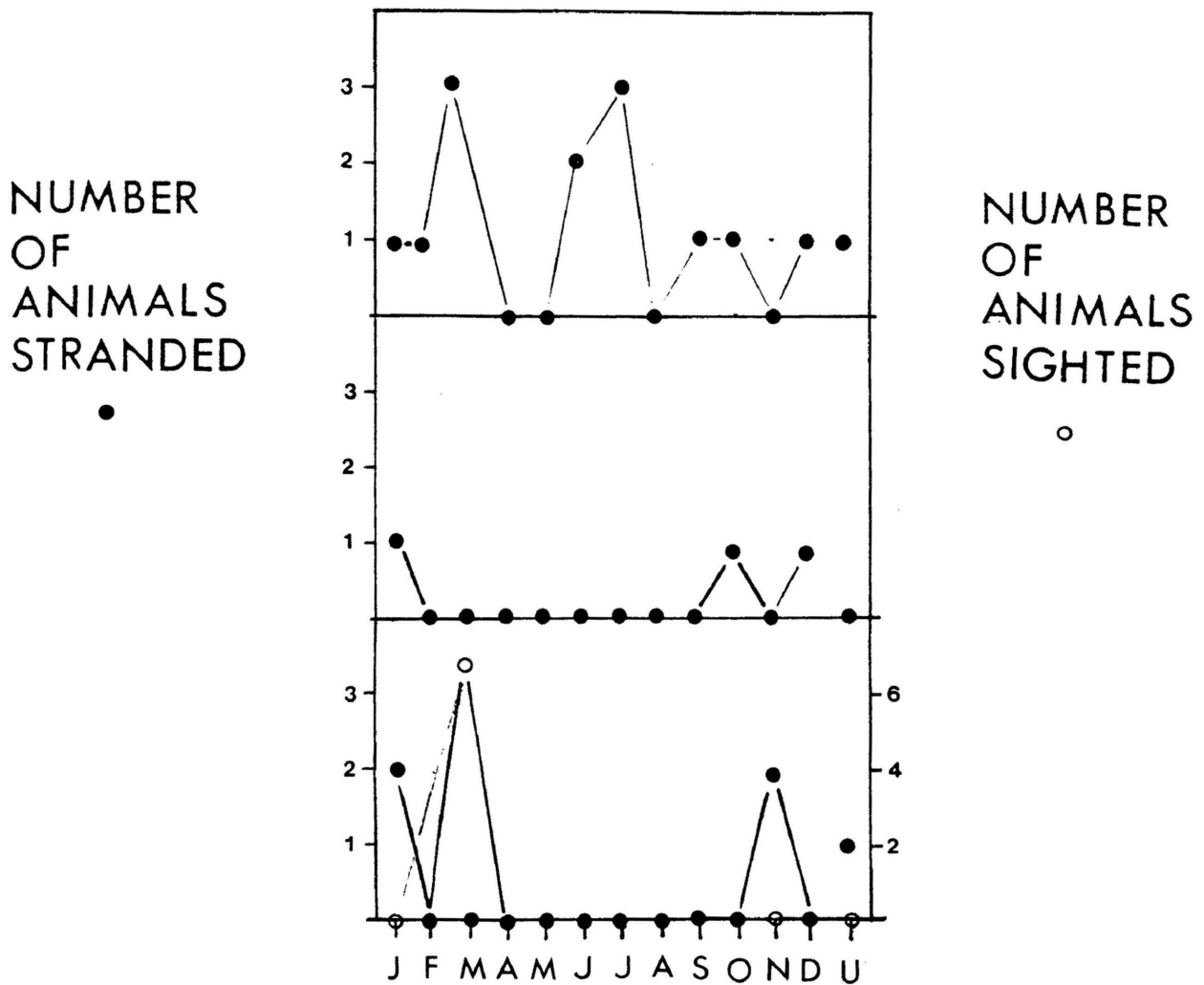


Figure 67. The seasonal abundance of incidental sightings and specimens of Cuvier's (top) and Arnoux's (middle) beaked whales and of southern bottlenose whales (bottom). (U = month of incidence unknown.)

The southern bottlenose whale (*Hyperoodon planifrons*).

The genus *Hyperoodon* has an anti-tropical distribution, with *H. planifrons* occurring in the Southern Hemisphere while *H. ampullatus* occurs in the northern Atlantic Ocean. Brownell (1974) states that *H. planifrons* is widespread in all southern oceans, occurring off the coasts of Argentina, the Falkland Islands, Chile, New Zealand, South Africa and off the coast of Antarctica in both the Indian and Pacific Oceans. Tietz (1966) records a stranding of *H. planifrons* at Humewood (33° 58' S 25° 38' E) and states that this record conforms with McCann's (1961) conclusion that the species is restricted to the Southern Hemisphere south of 20° 00' S. Ross (1984) suggests that *H. planifrons* rarely occurs north of latitude 30° 00' S and notes further that the species appears to have a summer seasonal occurrence in southern African waters. Ross *et al* (in press) find *H. planifrons* to have a range between 30° S and Antarctic waters and that the species has a regular occurrence in southern African waters.

Forty-seven sightings of a total of 161 *H. planifrons* were recorded on scientific cruises (figure 68). Of these, 23 were sighted during cruises and 24 during flights. All of these sightings were made during December, January or February. Group size range between one and 15 with a mean of 4.62 animals per group (sd₊ 2.74). Two incidental sightings were recorded from the East coast during March 1973 (figure 68). Five specimens of southern bottlenose whales have been recorded from this coast. Provenances of these specimens are shown in figure 68, while categories of origin are shown in table 13. All specimens of bottlenose whales were recorded during the summer months. The few stranding records (as compared to the abundance of sighting records) suggest that few animals strand which possibly reflects the pelagic distribution of the species.

Table 13. Origins of the 5 specimens of southern bottlenose whale reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	1
Dead beach cast (stranding)	1
Found dead on shore	1
Skeletal material found on shore	1
Direct fishing mortalities (including scientific collection)	1

The distribution of *H. planifrons* appears to be strongly associated with the Agulhas current to the east and south of the sub-continent and its western limit appears to be the eastern shelf edge of the Agulhas Bank (figure 68) to as far west as $22^{\circ} 00' E$.

All scientific sightings of bottlenose whales were made in summer in waters of over 1000 metres deep in Areas III and IV (figure 69). Temperatures measured in waters in which bottlenose whales were sighted ranged from 14° to 22° C in Area III and from 16° to 22° C in Area IV. Salinities measured in these waters ranged from 35.2 to 35.8 ppt in Area III and from 35.0 to 35.6 ppt in Area IV. All the incidental sightings of *H. planifrons* were made during the summer season in waters of over 1000 metres depth and associated with temperatures of between 22° and 24° C and salinities of between 35.2 and 35.4 ppt.

Ross (1984) notes the apparent summer seasonality of this species in southern African waters and that there are insufficient records from elsewhere to determine any migration patterns. Lichter (1986) states that there is a similar possible seasonality in the South West Atlantic, but notes there are two winter records for this region. Gianuca and Castello (1976) state that *H. planifrons* appeared to be abundant in the sub-Antarctic and Antarctic oceans in summer in the late 1800 and early 1900's, but Ross (1984) suggests that this might be a reflection of the inaccessibility of this region at other times of the year. Ross *et al* (in press) suggest that there is little latitudinal change in the seasonal distribution of specimens and that the apparent seasonality arises from the movement of animals offshore during the winter months. Nemoto, Best, Ishimaru and Takano (1980) found the skin diatom *Cocconeis ceticola* on a specimen of *H. planifrons* from southern African waters, which provides evidence of the movement from Antarctic or sub Antarctic waters. Miyashita and Balcomb (in press) found a *Hyperoodon* - like beaked whale in the central and western Pacific at 20° N in the months of July, August and September.

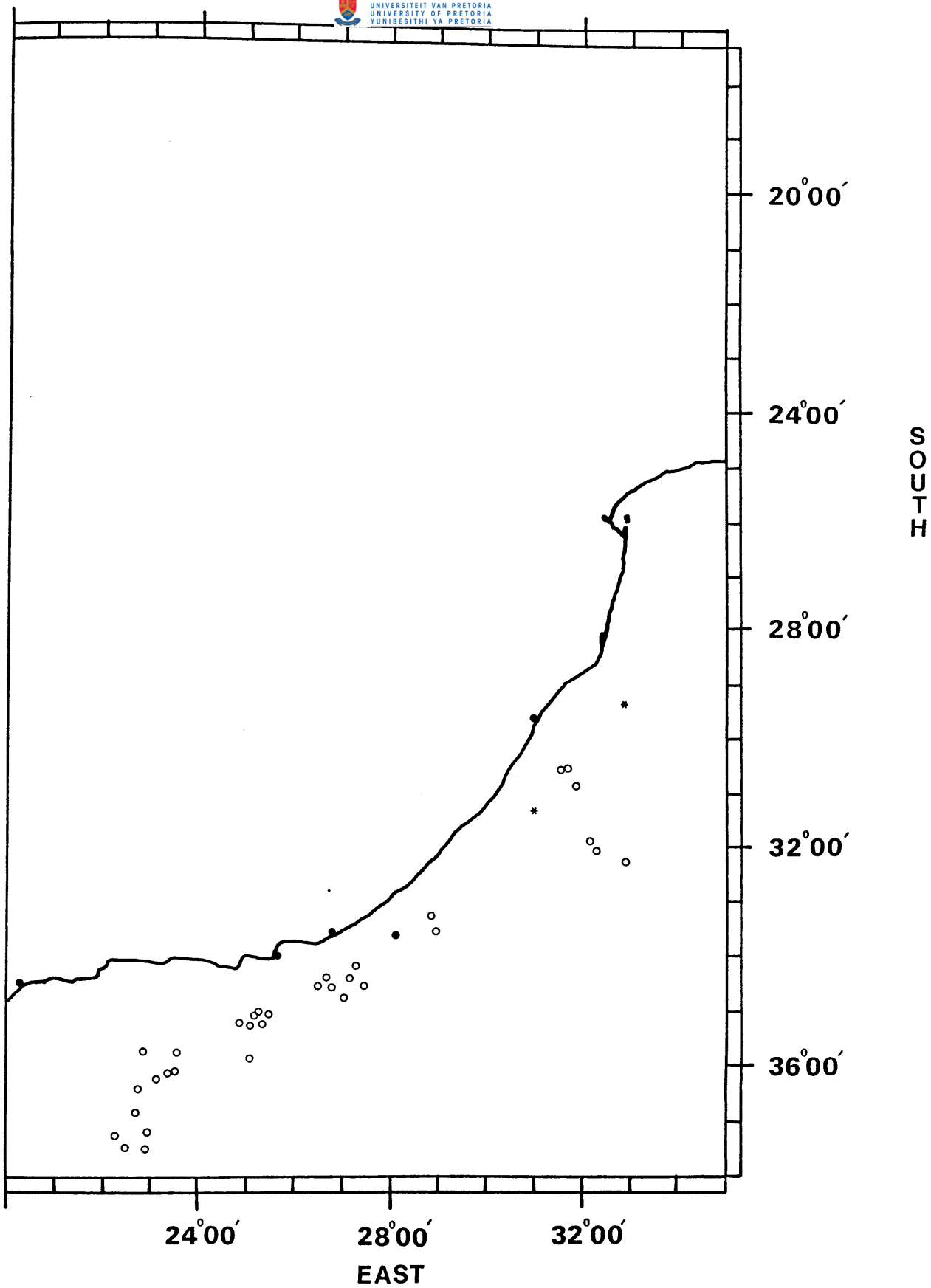


Figure 68. Scientific (o) and incidental (*) sightings and strandings (●) of southern bottlenose whales reviewed in this study.

"Like bottlenose whales"

The term "bottlenose " was frequently used by the east coast whaling crews and spotter aircraft personnel to describe any large unidentified beaked whale. Although the majority of these records probably can be ascribed to *H. planifrons*, they have been considered separately as "like bottlenose whales".

Forty - seven sightings of a total of 182 "like bottlenose whales" were sighted on scientific cruises. All of these sightings were made in summer (December (3), January (9) and February (35)). Group size ranged between one and 10 with a mean of 3.89 animals per group (sd \pm 2.41). Six incidental sightings of a total of 26 animals were made in the months of March and April and group size of these sightings ranged between two and 10 with a mean of 4.33 animals per group (sd \pm 2.94). "Like bottlenose whales" show a similar distribution pattern to that of bottlenose whales, and appear to be strongly associated with the Agulhas Current (figure 70).

Scientific sightings of "like bottlenose whales" were all recorded in summer in waters of over 1000 meters depth, of between temperatures of between 18^o and 26^o C and salinities of between 35.0 and 35.6 ppt. (figure 71). The six incidental sightings of "like bottlenose whales" were all recorded during summer in waters of over 500 m depth and associated with temperatures of between 22^o and 28^o C and salinities of between 35.0 and 35.6 ppt. (figure 71).

One hundred and thirty - eight sightings of a total of 584 "like bottlenose whales" were recorded by aerial spotters off Durban between 1972 and 1975 (figure 72). Group size of these sightings ranged between one and 12 animals with a mean of 4.34 animals (sd \pm 2.28). Abundance of sightings off Durban imply a marked seasonality between October and February (figure 73) although the lack of data for the summer months makes it unclear whether there is one or more peaks. All of these sightings in the east

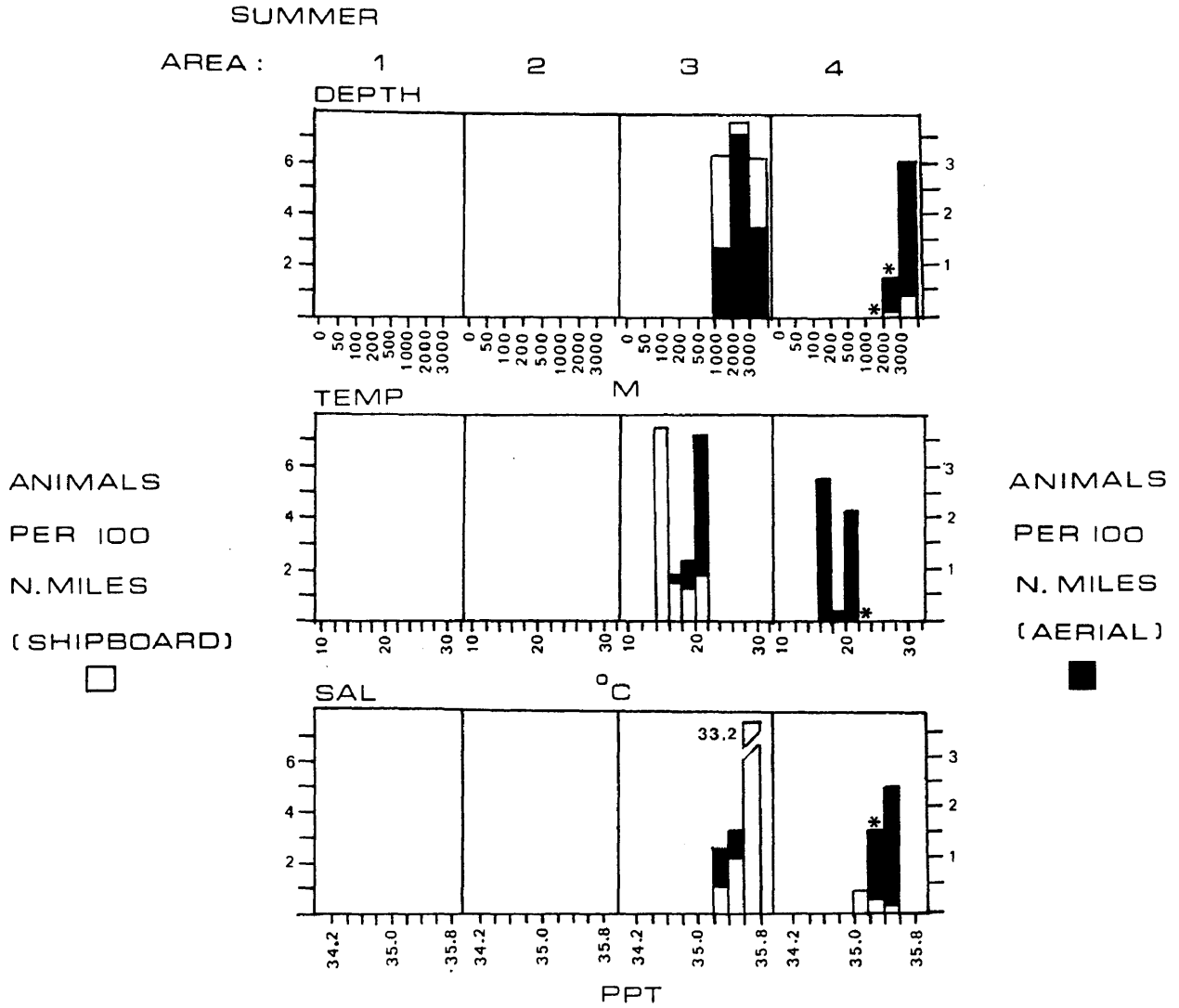


Figure 69. Densities of scientific sightings and occurrence of incidental sightings (*) of southern bottlenose whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer. No scientific sightings were made during winter.

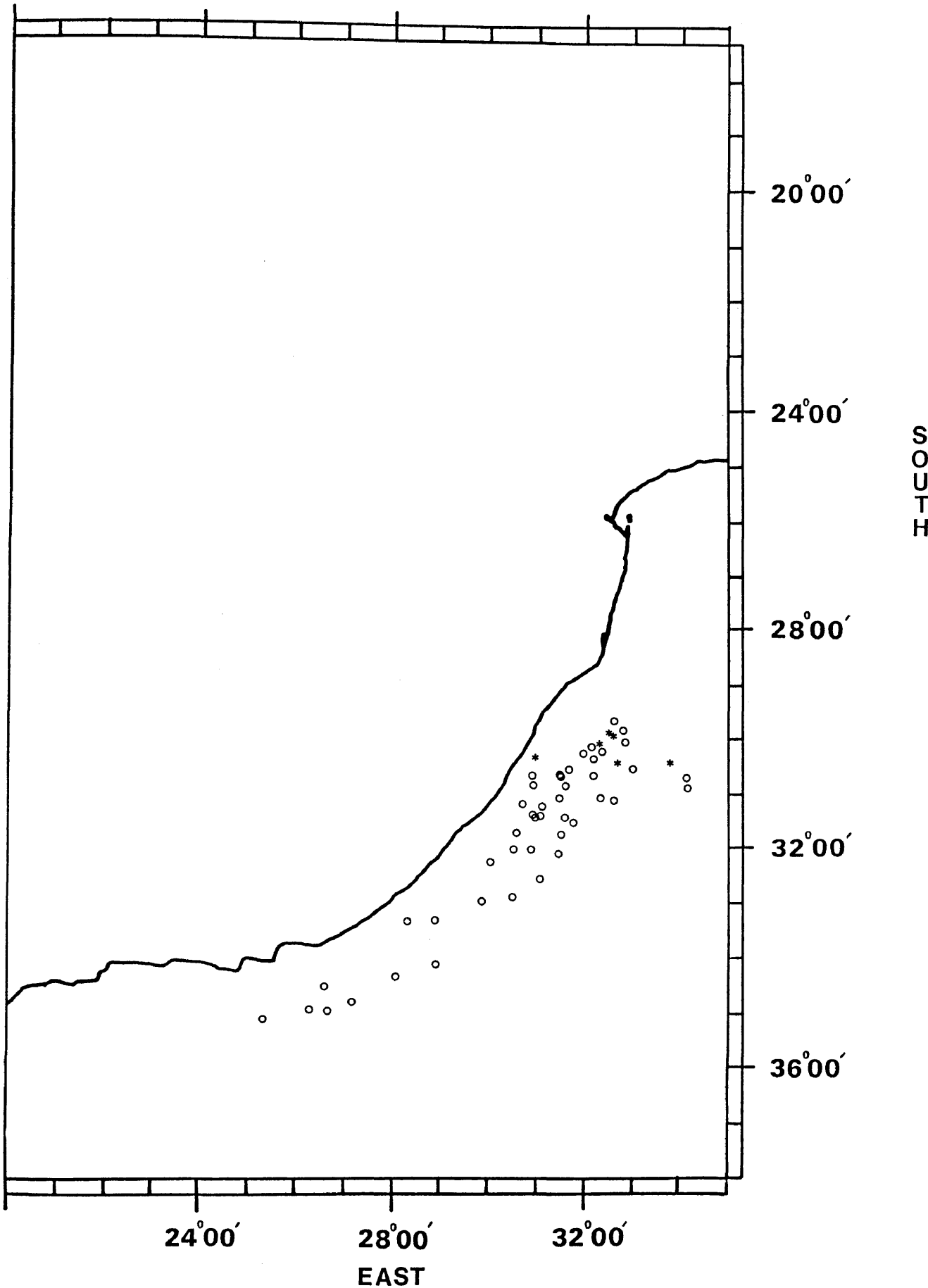


Figure 70. Scientific (O) and incidental (*) sightings of "like bottlenose whales" reviewed in this study.

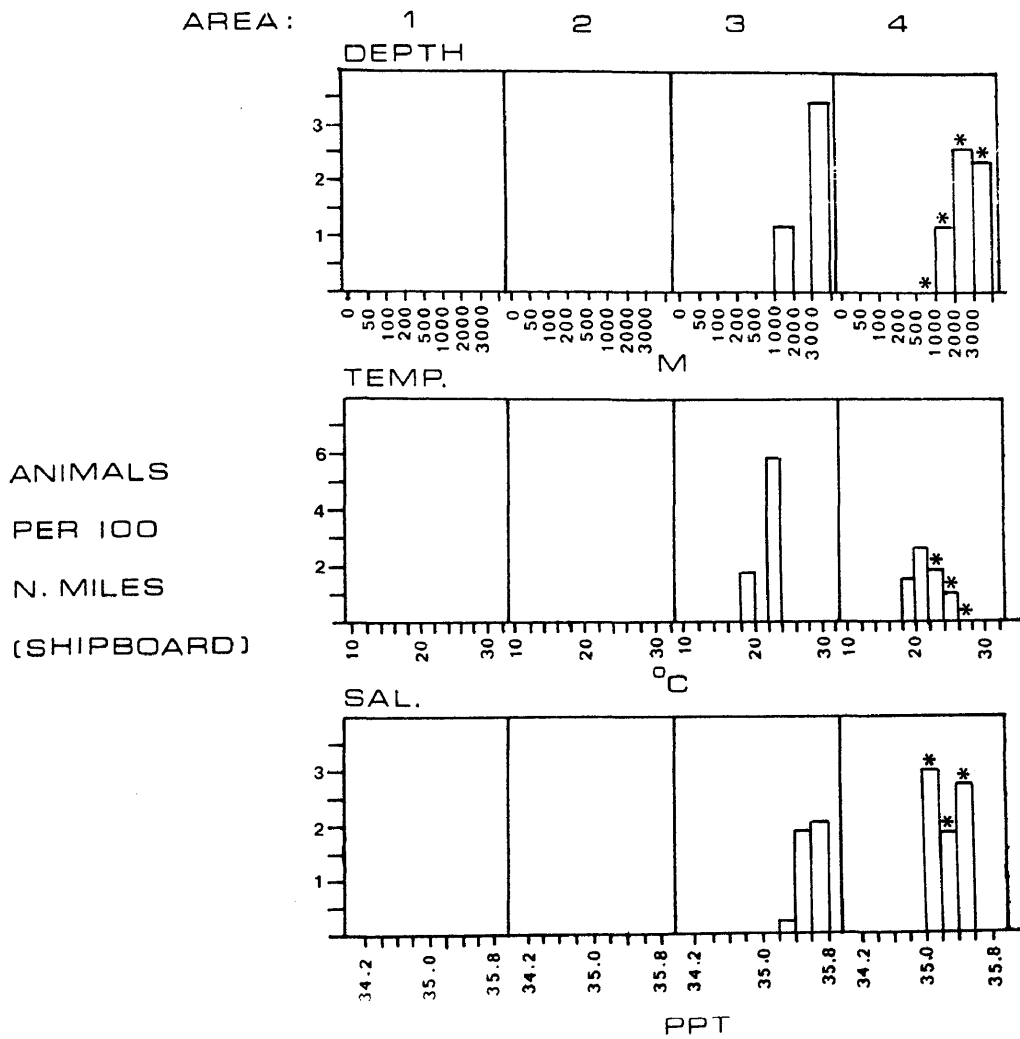


Figure 71. Densities of scientific sightings and occurrence of incidental sightings (*) of "like bottlenose whales" in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer. No sightings were made during winter.

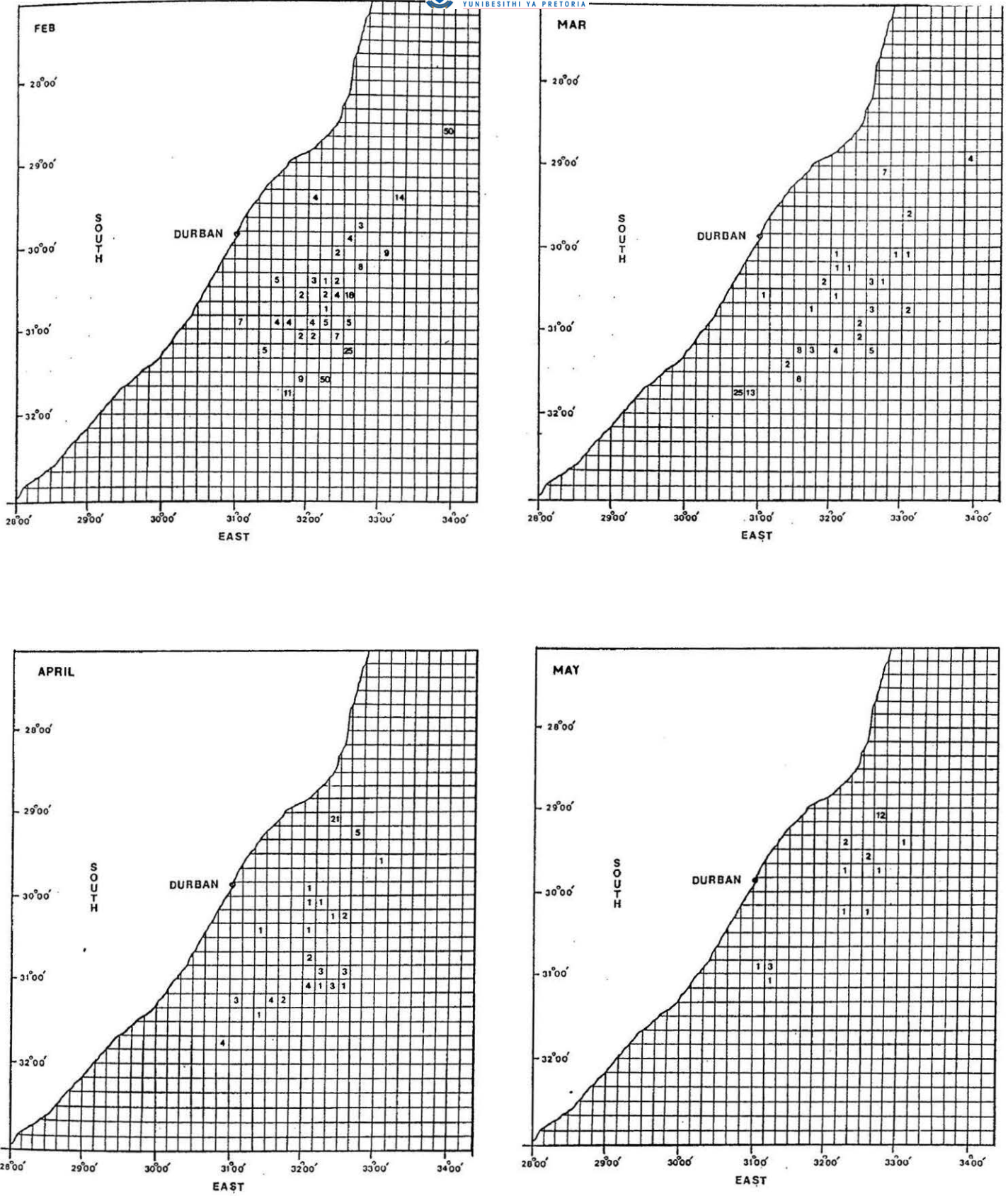


Figure 72. Distribution of "like bottlenose whales" sighted off Durban between 1972 and 1975.

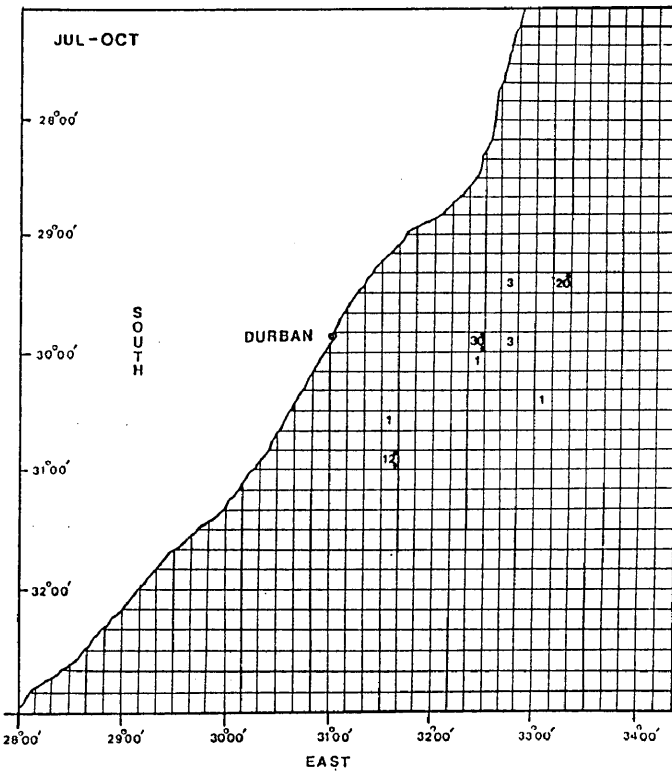
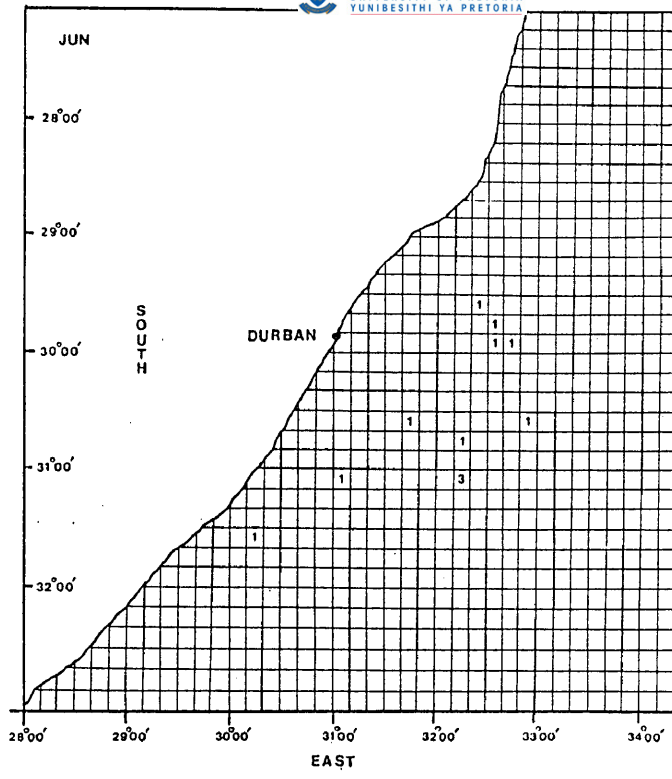


Figure 72. continued.

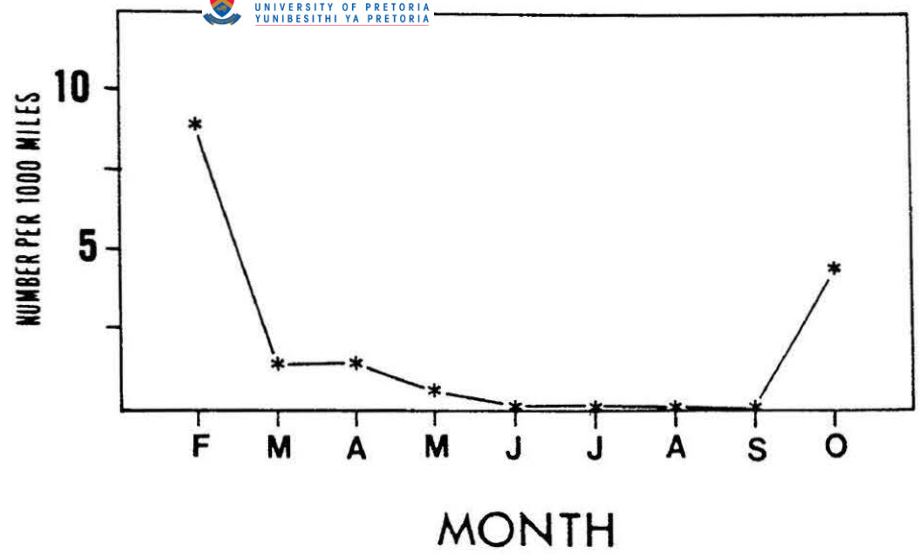


Figure 73. The seasonal abundance of bottlenose whales in the east coast whaling grounds.

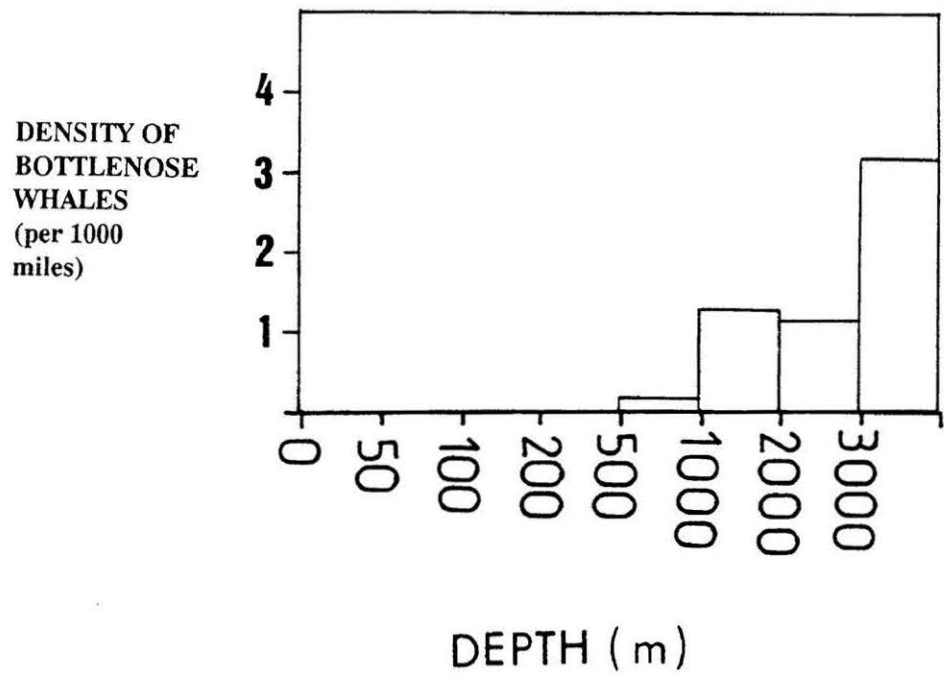


Figure 74. The densities of bottlenose whales by depth interval in the east coast whaling grounds.

coast whaling ground were in water depths  UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA (figure 74). No "like bottlenose whales" were recorded off Donkergat in 1963, but this may be because they were omitted rather than absent from the area.

Bottlenose whales of the southern African subregion appear to be confined to the temperate and sub-tropical waters of the Agulhas Current. The marked summer seasonality suggests that this species moves out of the region during winter, but too few data are available to determine the winter destination of the species.

Arnoux's beaked whale (*Berardius arnuxii*).

The genus *Berardius* has an anti-tropical pattern of distribution (Brownell 1974) with the Southern Hemisphere species *B. arnuxii* being recorded from strandings from New Zealand, Australia, South Africa, Argentina, the Falkland Islands and South Georgia and Chile (Lichter 1986). Brownell (1974) also lists records from the South Shetlands and Graham Land. Its northern hemisphere congeneric is *B. bairdii* which occurs in the Northern Pacific Ocean. McCann (1962) suggested that *B. arnuxii* winters in the Antarctic regions, but moves into warmer latitudes to calve and mate during summer, which is the reverse of the migration behaviour of southern baleen whales. Ross *et al* (in press) suggest that the distribution of *B. arnuxii* is centred around the southern Pacific between 30° 00' S and Antarctic waters. They suggest that the southern African records arise from a "sporadic occurrence" in southern African waters.

Berardius arnuxii has only been recorded in southern African waters from strandings. Three such records exist and include the record published by McLachlan, Liversidge and Tietz (1966). All of these are of single animals found on beaches during summer (one in October, one in December and one in January), and although these records are insufficient to draw any conclusions as to seasonality they would confirm McCann's (1962) suggested movement patterns. These strandings occurred at 32° 40' S, 18° 16' E; 33° 53' S, 18° 24' E and 34° 10' S, 24° 50' E respectively.

Compared to other *Ziphiidae*, *Berardius* is relatively easy to identify at sea. Thus the lack of sightings of this species infers that *Berardius* is not common in southern African waters, although the paucity of summer pelagic search effort off both the east and west coasts must be noted.

The genus *Mesoplodon*

The known distributions of the *Mesoplodon* species have undergone a considerable revision in the last twenty years. Moore (1966) stated that Blainville's beaked whale (*M. densirostris*) was the only *Mesoplodon* which appeared to normally occur in both the northern and southern hemispheres. Mead (1981), in describing the global pattern of distribution of the genus *Mesoplodon* stated that Blainville's beaked whale (*M. densirostris*) has a global distribution pattern in temperate and tropical oceans, that three species appear to be limited to tropical and warm temperate waters (Indo pacific - *M. pacificus* and *M. ginkgodens* and Atlantic - *M. europaeus*) and that two species (*M. bidens* and *M. stejnegeri*) are confined to cold temperate waters of the Atlantic and Pacific respectively. Five species (*M. hectori*, *M. grayi*, *M. mirus* and *M. bowdoini* (through, Mead suggests, its possible conspecific *M. carlhubbsii*) have general distributions in southern temperate oceans and in at least one of the northern oceans. Mead (1981) suggests that *M. layardii* should be placed in this latter group as it is likely to be recorded from the Northern Hemisphere.

Five species of *Mesoplodon* (*M. layardii*, *M. densirostris*, *M. mirus*, *M. hectori*, and *M. grayi*) are found off the southern African coast. All sighting records of these species (and possibly other *Mesoplodon* species) are analysed as "*Mesoplodon* species" due to the difficulty of differentiating positively between species at sea. Three incidental sightings of *M. layardii* were entered as such because their distinctive adult colour pattern was noted. The eleven scientific sightings of a total of 32 individuals of *Mesoplodon* species were all recorded during January and February (figure 75). Group size of the schools range from one to six animals with a mean of 2.91 animals per group (sd \pm 1.70).

Scientific sightings of *Mesoplodon* species are all limited to waters deeper than 2000 metres in Area III and 1000 metres in Area IV, confirming that the members of this genus are essentially deep water animals (figure 76). Temperatures measured in waters in which *Mesoplodon* were recorded fell into the 16^o to 18^o C and 20^o to 22^o C intervals in Area III and into the 18^o to 24^o C interval in Area IV. Salinities recorded in these waters ranged between 35.2 and 35.6 ppt in Area III and between 35.0 and 35.6 ppt in Area IV.

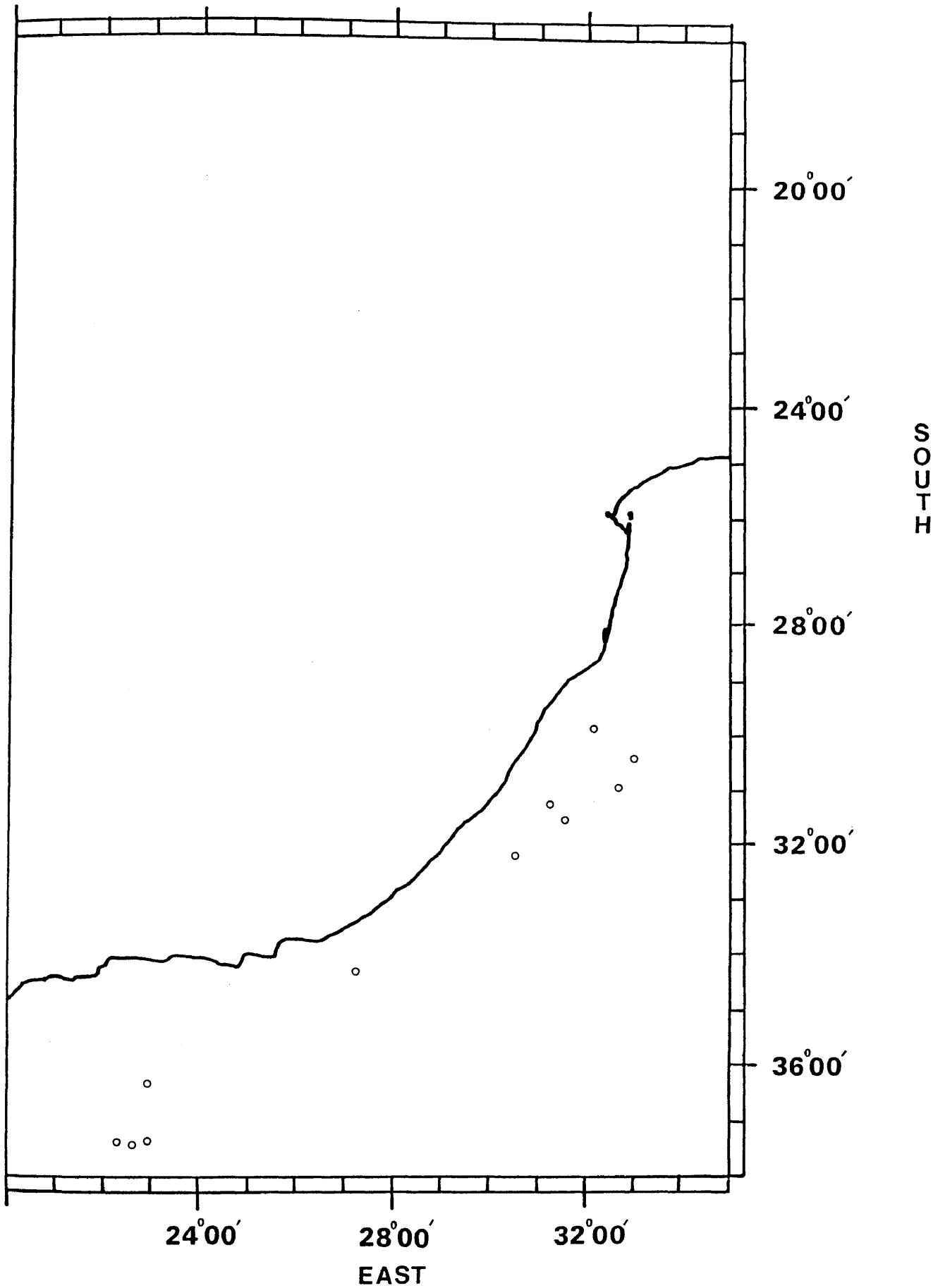


Figure 75. Scientific sightings (o) of *Mesoplodon* species reviewed in this study.

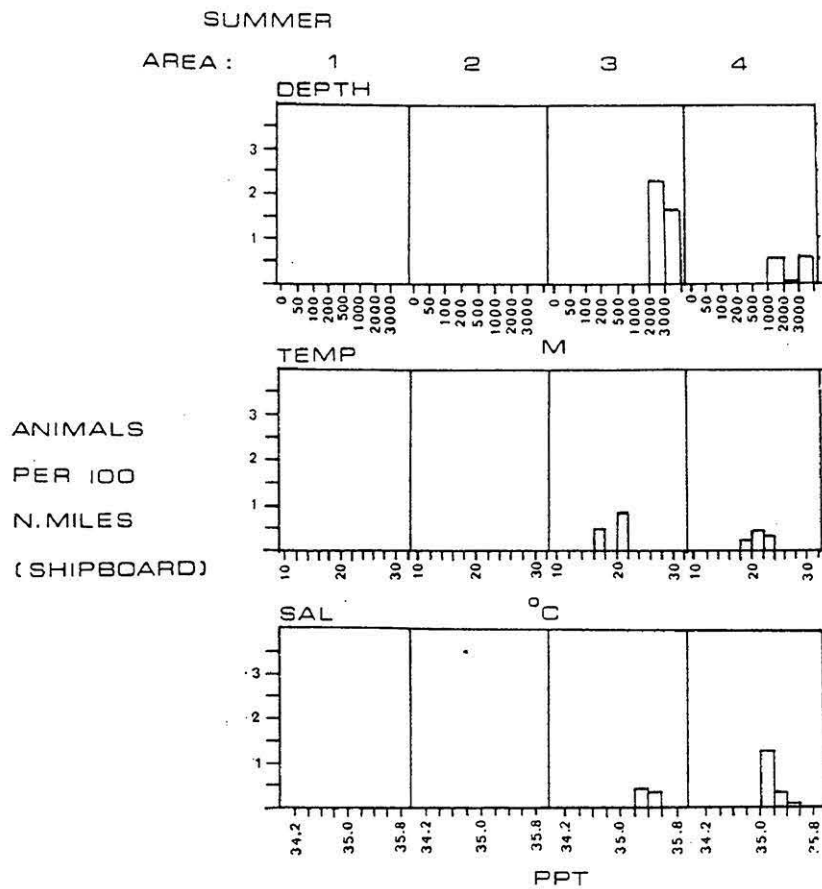


Figure 76. Densities of "*Mesoplodon* species" (recorded as scientific sightings in each of the four Areas) in relation to water depth, sea surface temperature and sea surface salinity during summer. No sightings were made during winter.

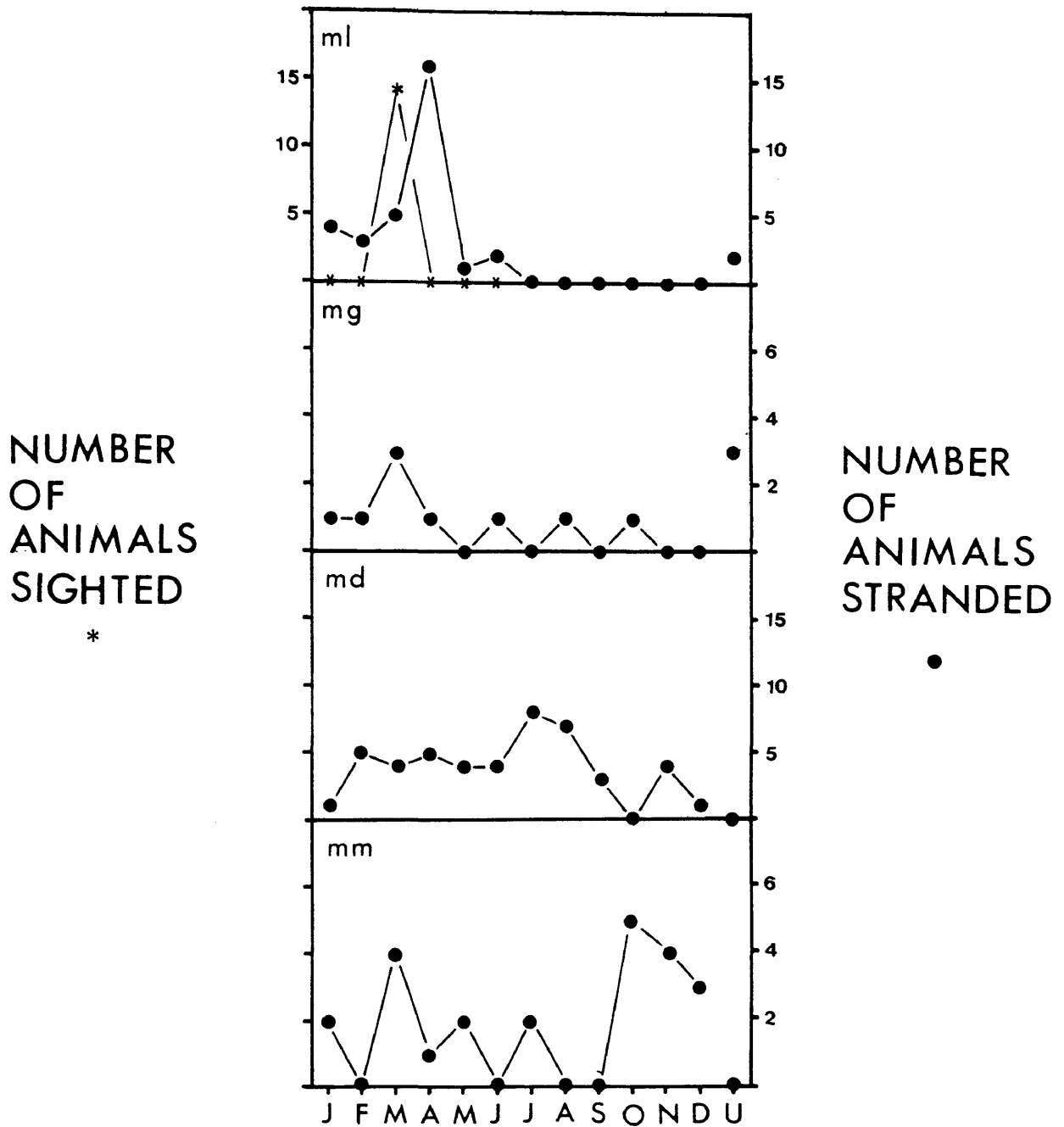


Figure 77. The seasonal abundance of specimens of species of *Mesoplodon* (m sp - unidentified *Mesoplodon* species, ml - *M. layardi*, mg - *M. grayi*, md - *M. densirostris*, mm - *M. mirus*).

(U = month of incidence unknown.)

Layard's beaked whale (*M. layardii*)

This species is recorded from Australia, New Zealand, South Africa, Uruguay, Argentina and Chile and its distribution has been described by Goodall (1978), Sheffield (1979), Ross (1984) and Lichter (1986). Ross *et al* (in press) maintain that *M. layardii* has a circumpolar distribution in cold temperate waters of the Southern Hemisphere between 30° S and 53° S, and the only records to the north of these latitudes are from the cold Benguela Current. Three incidental sightings of *M. layardii* are recorded off the Natal coast during a whaling cruise in March 1973 (figure 77). Two of these groups were of four animals and one was of six animals. These sightings were in waters of over 2000 metres depth and associated with temperatures of 24° to 28° C and salinities of between 35.2 and 35.4 ppt.

Provenances of thirty three specimens of *M. layardii* are plotted in figure 78 and their categories of origin are presented in table 14. The distribution of incidental sightings and strandings suggests that the species has a cosmopolitan distribution, although strandings were not recorded to the east of 28° E in these waters. Figure 77 shows the months of origin of these stranding records which suggests that *M. layardii* has marked seasonal occurrence in these waters during autumn. Ross *et al* (in press) find a marked increase in specimens during summer and autumn and suggest this results from a onshore movement during these months. They further suggest a possible northward shift in distribution during winter.

Table 14. Origins of the 33 specimens of *M. layardii* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	12
Dead beach cast (stranding)	2
Found floating dead at sea	1
Found dead on shore	15
Skeletal material found on shore	1
Unknown	2

SOUTH

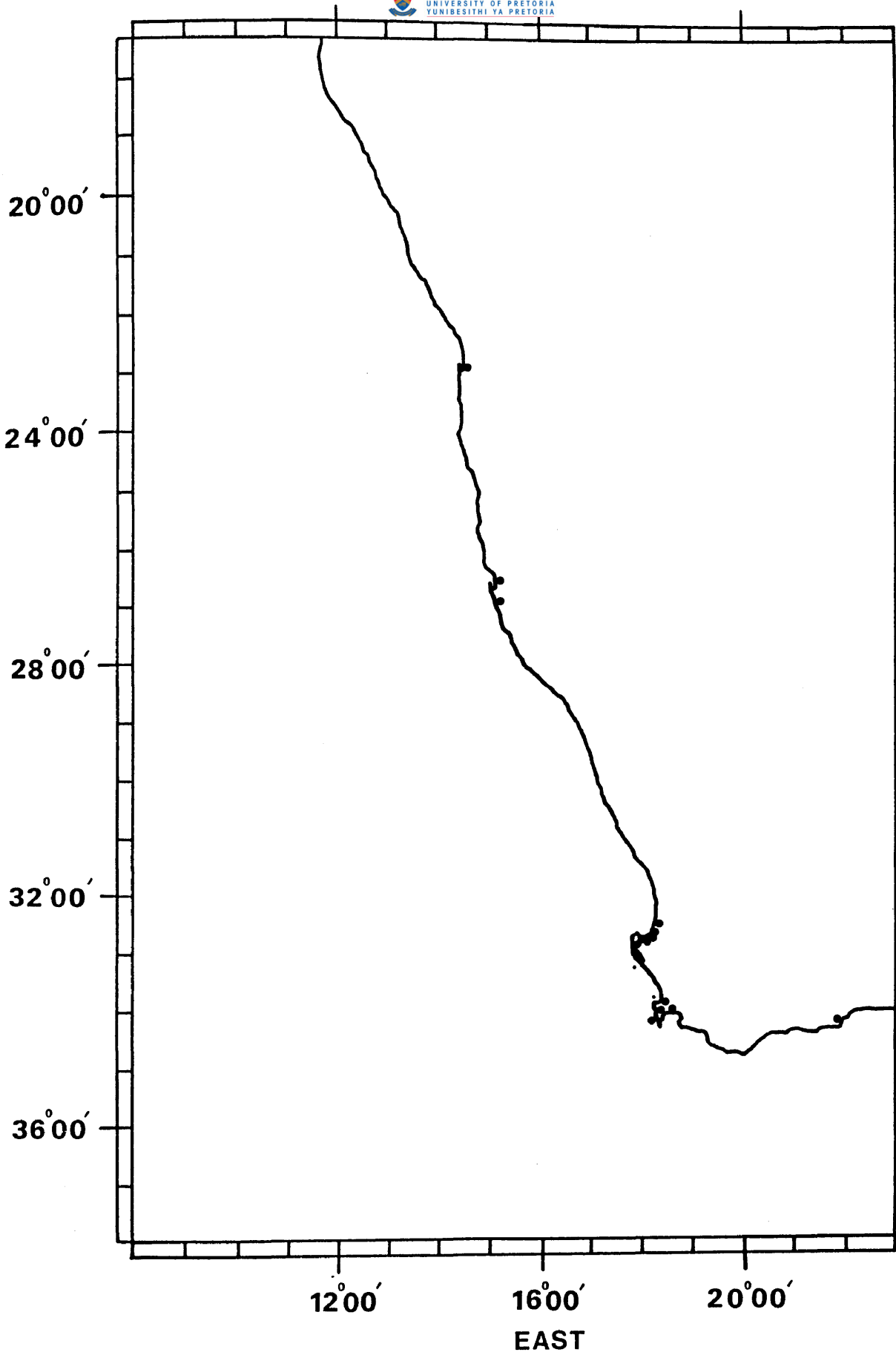


Figure 78. Incidental sightings (*) and specimens (●) of *M. layardii* reviewed in this study.

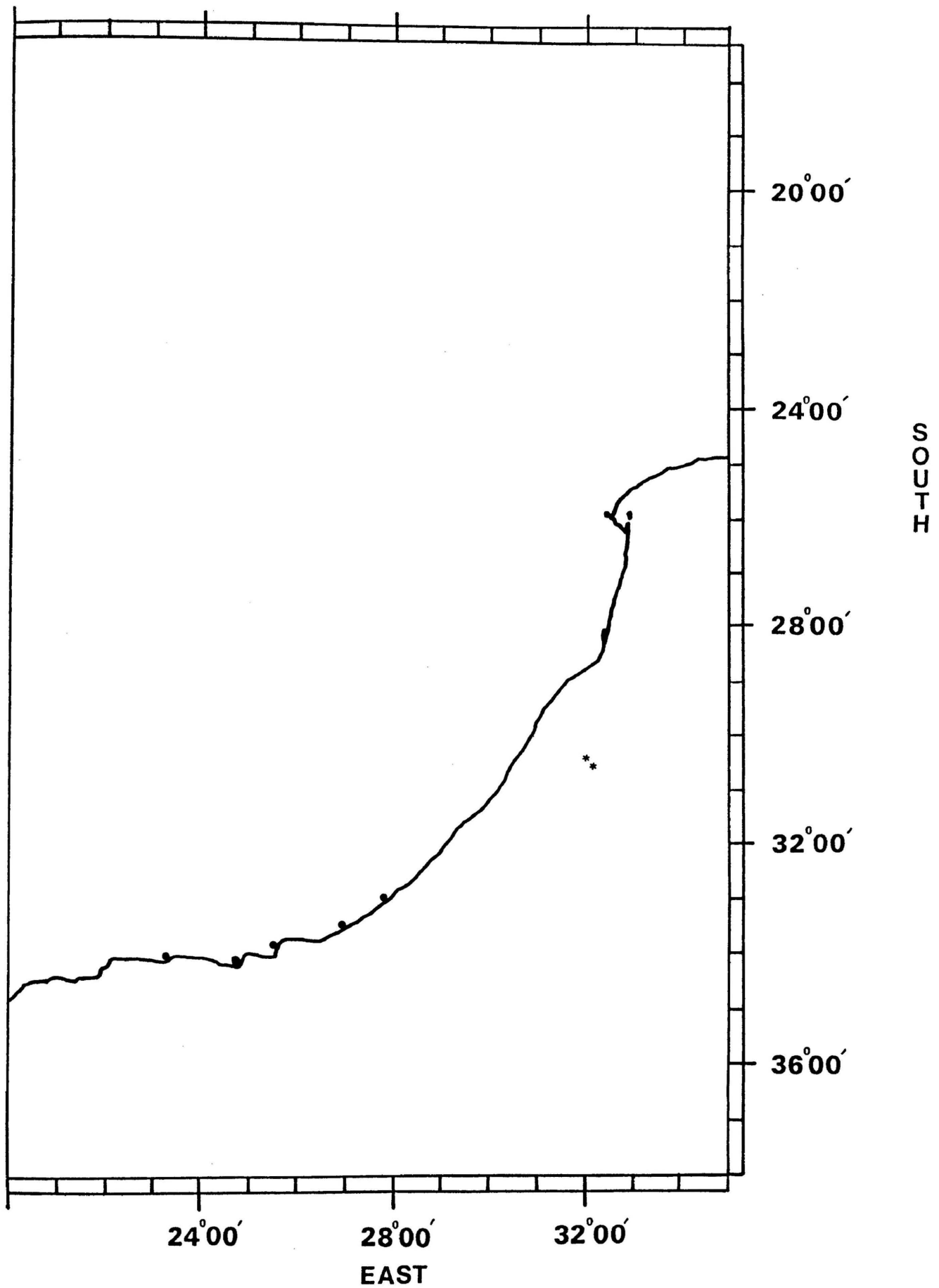


Figure 78. continued.

Blainville's beaked whale *M. densirostris*

Moore (1958) notes that of the 11 records at that time, ten were from the tropics or from the coasts having warm oceanic currents. Ross (1984) states that *M. densirostris* is a widely distributed species and notes records from the northern and southern Atlantic Oceans, from the northern Pacific and Indian Oceans and from the Australasian seas. He suggests that the animals found in southern African waters either inhabit the warm water of the Agulhas current or that the animals are transported by it. Ross *et al* (in press) find *M. densirostris* to be distributed in tropical waters to the north of 35° S and the large sample from Southern Africa may arise from the warm Agulhas Current extending tropical conditions into higher latitudes.

Provenances of 48 specimen records of *M. densirostris* (plotted in figure 79) suggest that this species is limited to the warm temperate waters of the south coast and the mixed waters of the south west coast. The species is recorded elsewhere from the tropical waters of the Indian Ocean, and the lack of specimens from the Natal coast is surprising as it is thought that the specimens from the southern Cape coast have their origin in the Agulhas Current. Table 15 and figure 77 show the categories and months of origin of these specimens respectively. As found by Ross *et al*, there was no evidence of seasonal occurrence in this sample of specimens.

Table 15. Origins of the 48 specimens of *M. densirostris* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	10
Dead beach cast (stranding)	4
Found floating dead at sea	1
Found dead on shore	30
Skeletal material found on shore	1

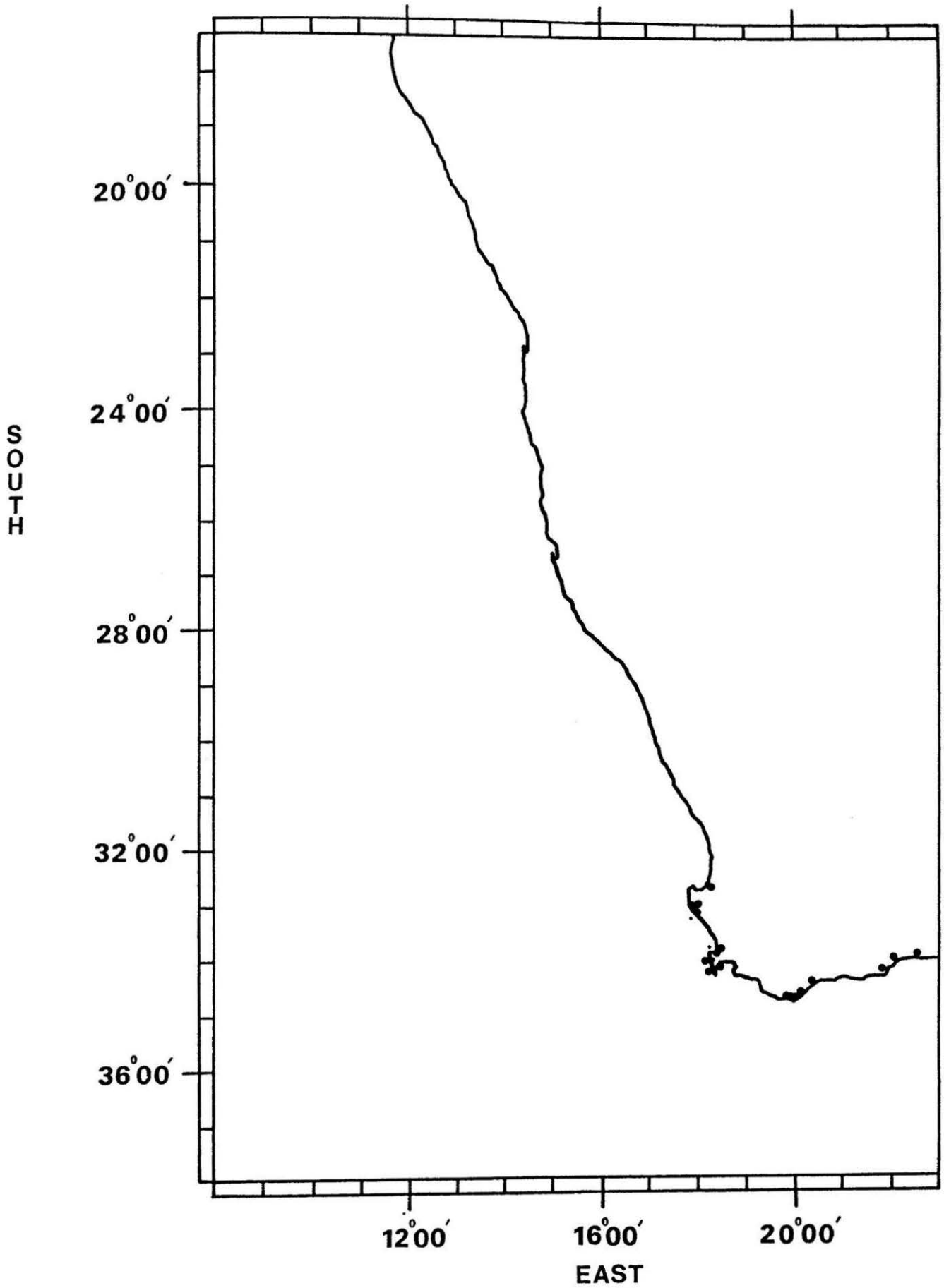


Figure 79. Provenances of specimen records of *M. densirostris* reviewed in this study. © University of Pretoria

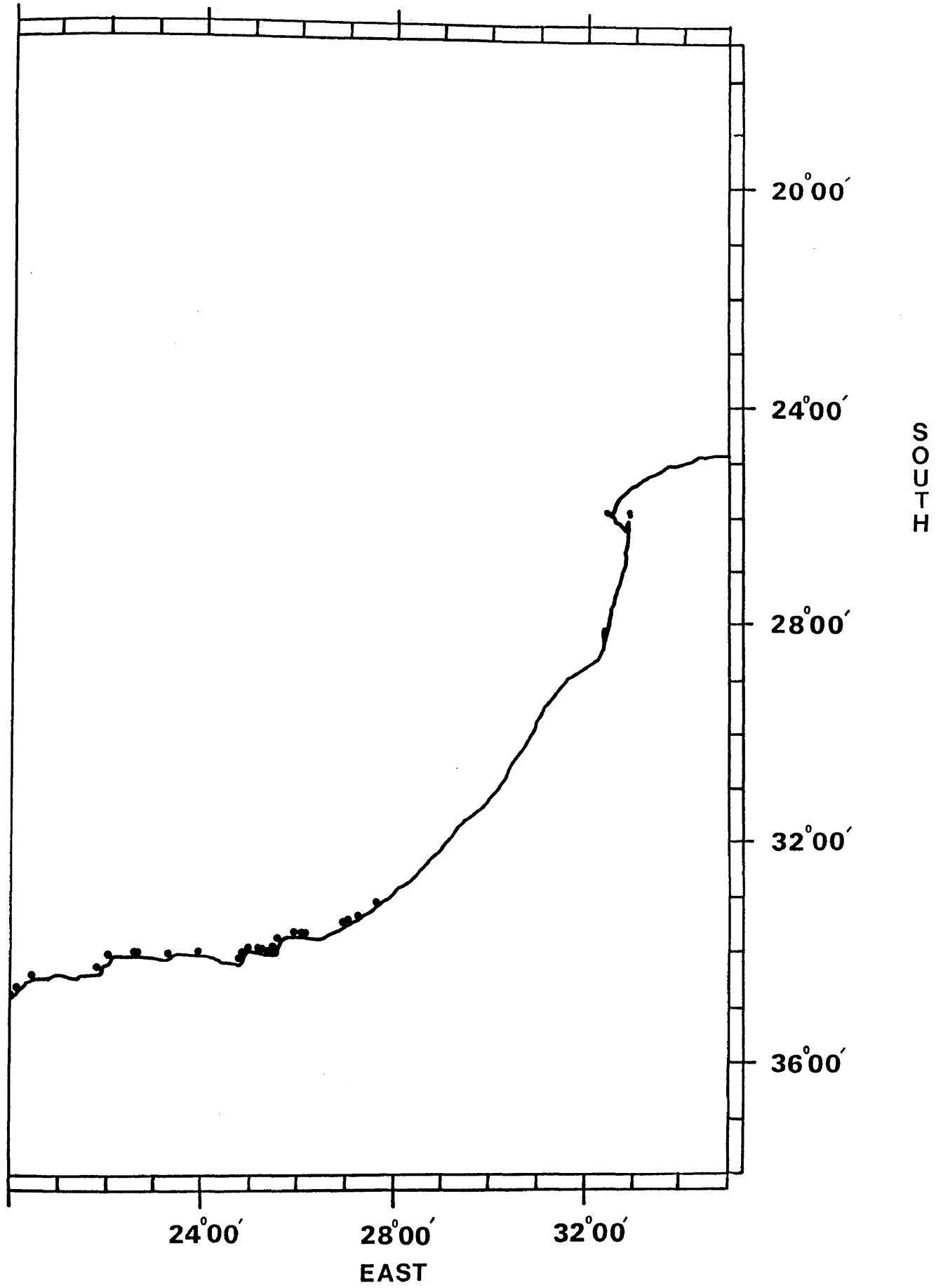


Figure 79. continued.

True's beaked whale (*M. mirus*)

Talbot (1960) published a stranding record of *M. mirus* from Wilderness (34° 00' S, 22° 34' E) in May 1959. Moore (1966) considered this record to be "curious" and defined the distribution as the Northern Atlantic. A stranding of a pregnant cow and a calf at Maitland River Mouth (33° 58' S, 25° 17' E) in 1969 (Ross 1969) gave evidence of the existence of a breeding population in the Southern Hemisphere. A further twenty specimens of *M. mirus* have been recorded from the South African coast. Localities of all known specimens are plotted in figure 80, while the months and categories of origin are given in figure 77 and table 16 respectively. Specimens were distributed between St Helena Bay (approximately 33° S) and the northern Natal coast. Ross, Cockcroft and Cliff (1985) note that the stranding record of PEMN 1010 at 28° 29' S, 32° 25' E extends the eastern limit of the species, but that this may be due to the anomalous high water temperatures recorded around the coast of southern Africa in 1982. The majority of the specimens were recorded as far east as Algoa Bay. No seasonality was apparent in these specimen records.

Table 16. Origins of the 23 specimens of *M. mirus* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	2
Dead beach cast (stranding)	2
Dead beach cast (stranding)	2
Found dead on shore	18
Unknown	1

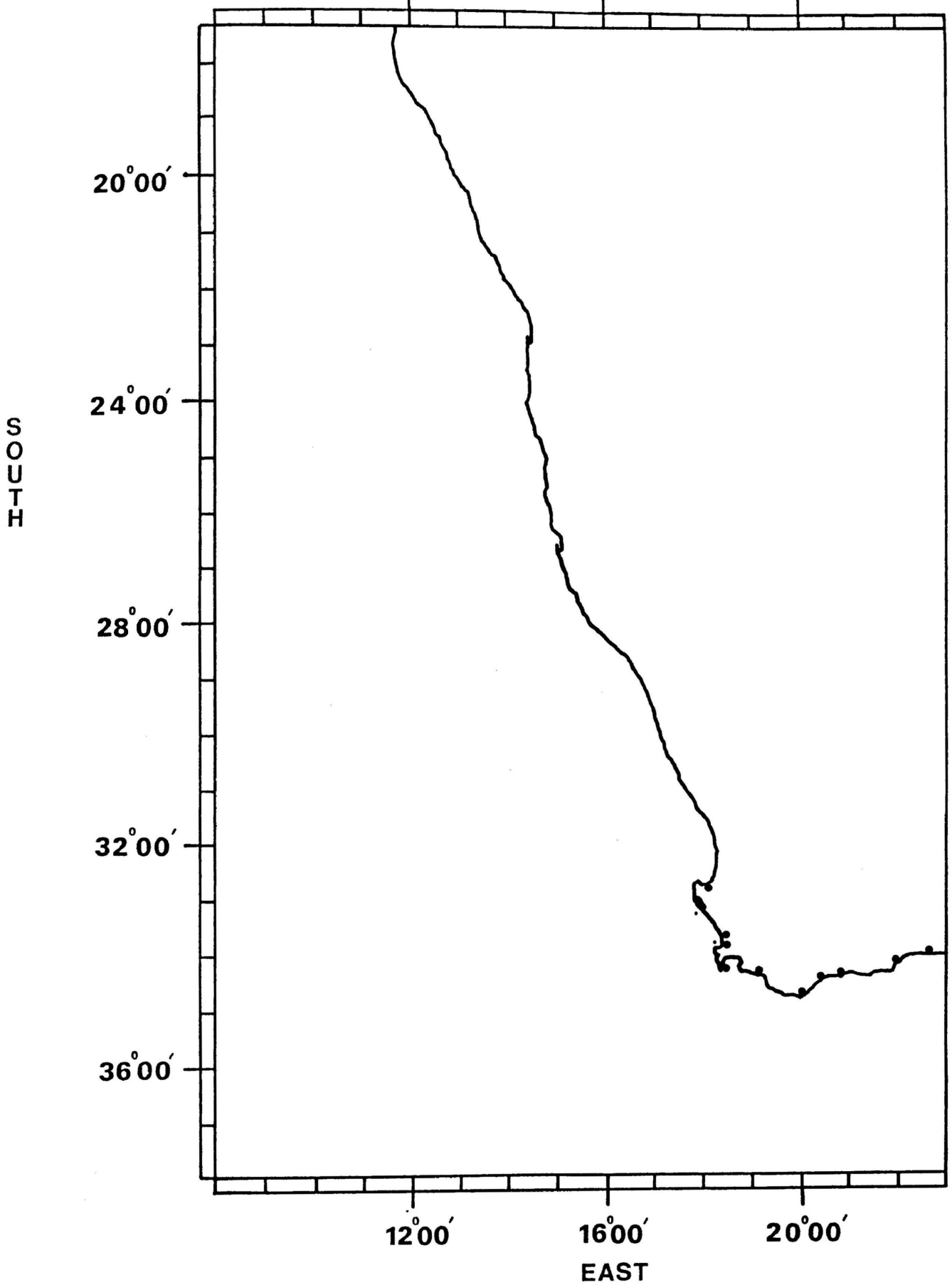


Figure 80. Provenances of specimen records of *M. mirus* reviewed in this study.

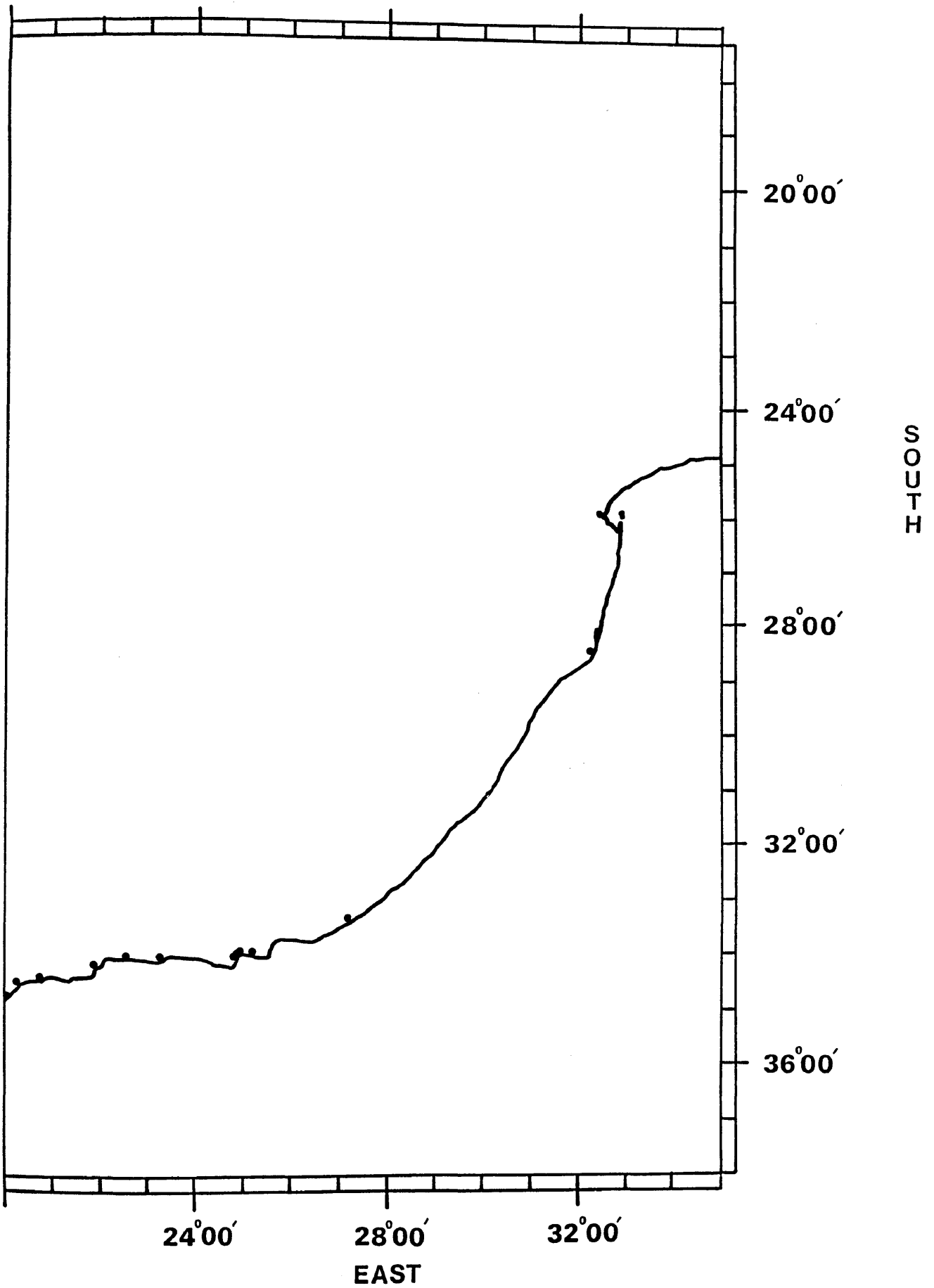


Figure 80. continued.

Gray's beaked whale (*M. grayi*)

Southern hemisphere records of *M. grayi* exist for Australia, New Zealand, the Chatham Islands, South Africa, Argentina, Uruguay and Chile. Ross *et al* (in press) find *M. grayi* to have a circumpolar distribution in cold temperate waters of the south Atlantic, south Indian and south Pacific Oceans between 30° and 53° S except for records to the north of these latitudes in the cold Benguela Current.

Provenances of twelve specimens of *M. grayi* recorded on the southern African coast are plotted in figure 81, and it would appear that this species is restricted to the west coast and the southern Cape coast. All of these were single strandings except one group of three animals "found dead" on the coast near Stilbaai (34° 24' S 21° 12' E) and the categories of origin are shown in table 17. These strandings occurred between January and October (figure 77). Ross *et al* (in press) found no evidence of seasonal movement between latitudes.

Table 17. Origins of the 12 specimens of *M. grayi* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	1
Found dead on shore	5
Skeletal material found on shore	1
Unknown	5

Hector's beaked whale (*Mesoplodon hectori*)

Twenty specimens of *M. hectori* are known from Tasmania, New Zealand, South Africa, the Falklands, Argentina, Chile and California (Lichter 1986), and Mead (1981) reports two probable sightings off the coast of California. Ross *et al* (in press) find that this species has a circumpolar distribution in cold temperate waters. One stranding record of two juvenile *M. hectori* exists for the Southern Cape coast at 34° 00' S 23° 45' E (Ross 1970). This very decomposed stranding was

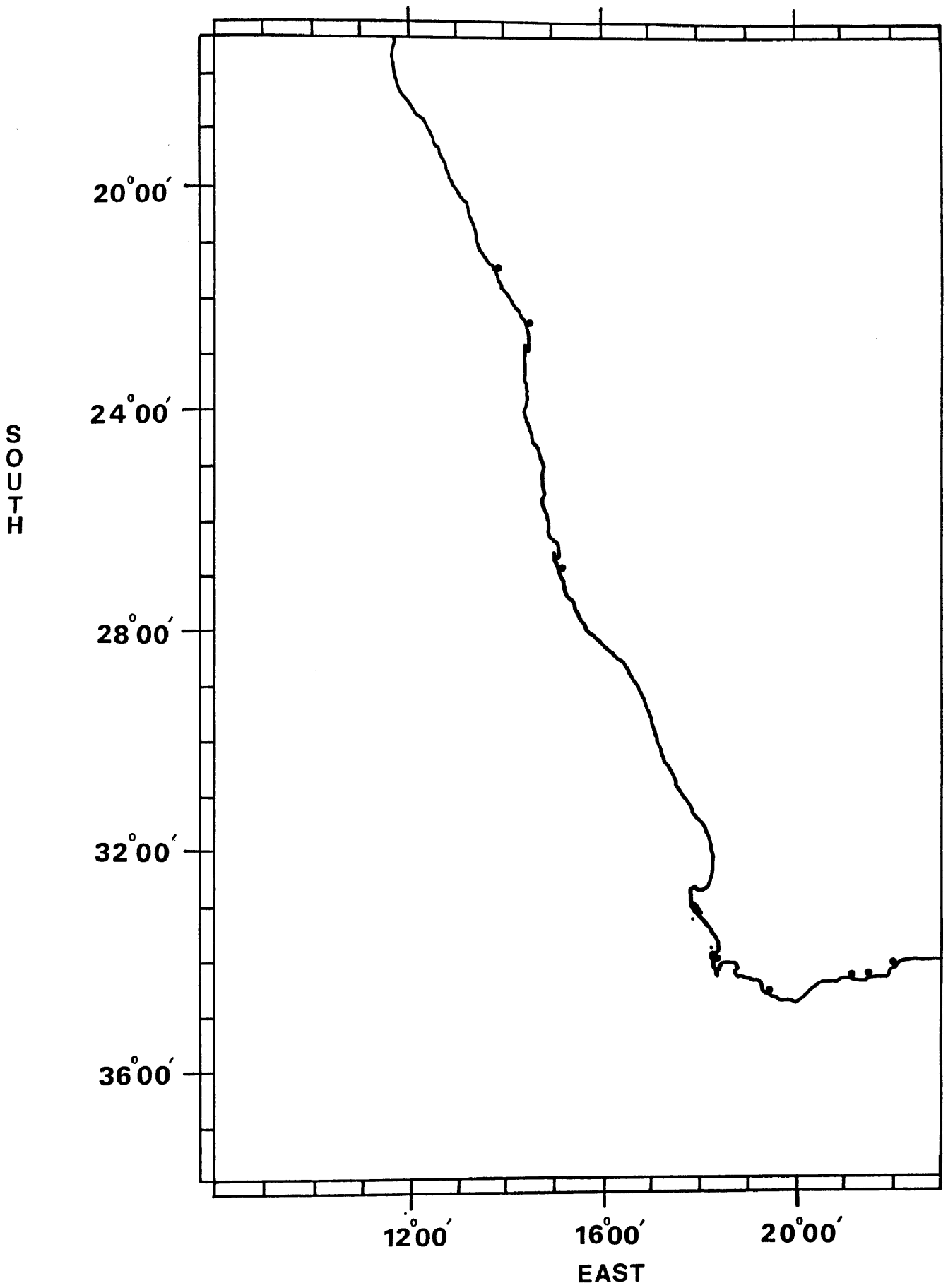


Figure 81. Provenances of specimen records of *M. grayi* reviewed in this study.

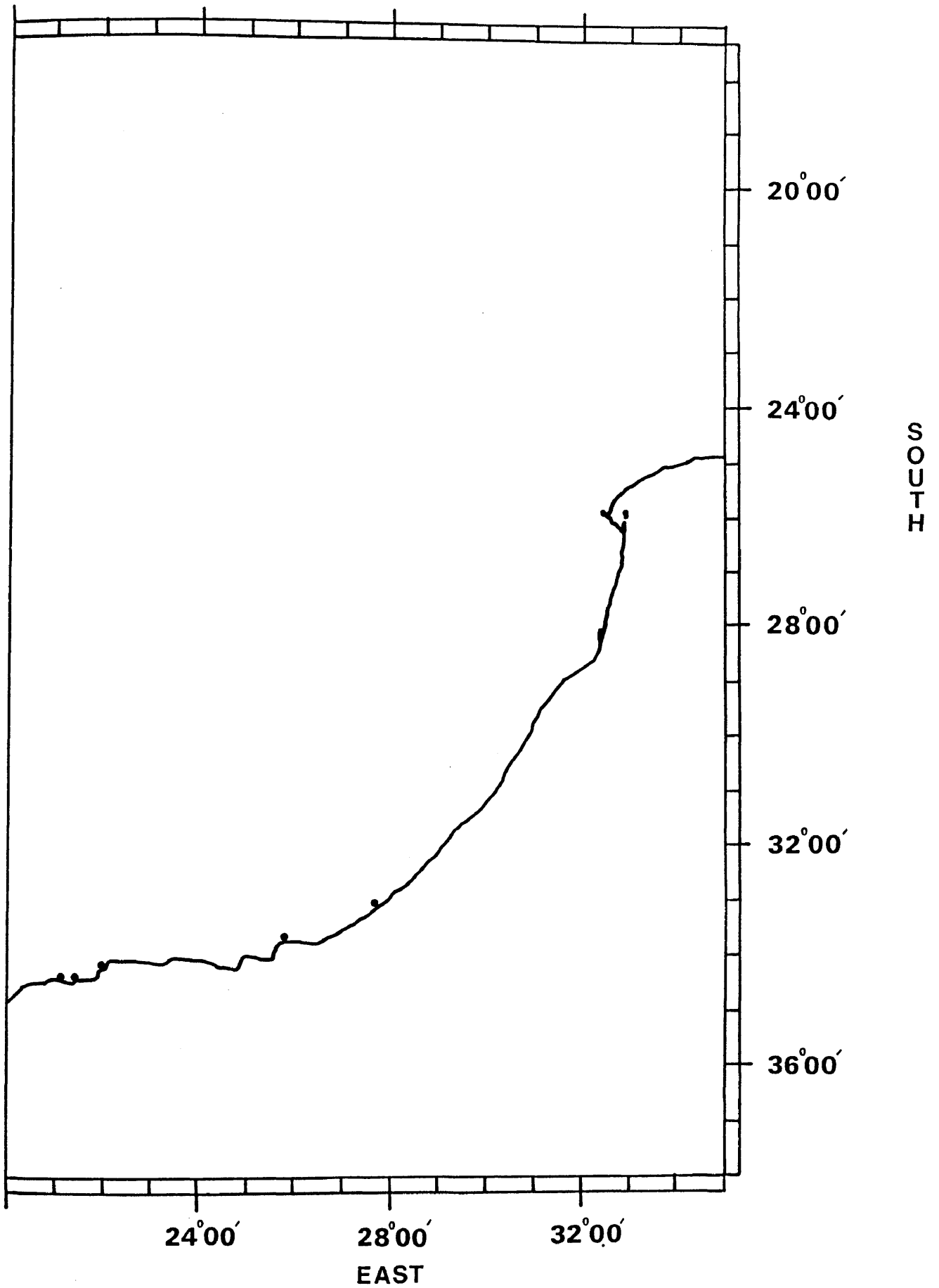



Figure 81. continued.

recorded during March 1967. Ross *et al* (in press)  ded specimens of *M. hectori* are strongly seasonal between December and March, suggesting an onshore movement during the summer months. Ross *et al* (in press) record a second South African stranding of *M. hectori* at 34° 03'S 22° 50'E which is not included in this database as it occurred after June 1986.

RESULTS - ODONTOCETI (CONTINUED)

THE DELPHINIDAE

Killer whale (*Orcinus orca*)

Orcinus orca has been described as a cosmopolitan species occurring in all major oceans of the world (Budylenko 1981). Ross (1984) defines the species as cosmopolitan occurring throughout the year off the south east coast of southern Africa and Dalheim (1981) notes that it appears to be most prevalent in colder waters of both hemispheres with "centres of abundance within 800 km of major continents". However, there are references to migratory habits of killer whales. Mikhalev, Ivashin, Savusin and Zelenaya (1981) suggest that southern killer whales are distributed in the low latitudes during winter and migrate to the high latitudes during summer and that the southward migrations begin in September / October and end by January, while the northern migrations begin in February / March. Bigg, Ellis, Ford and Balcomb (1987) found two forms ("resident" and "transient") of killer whales in Puget Sound on the west coast of the United States.

There are nine confirmed dedicated scientific sightings of a total of 48 *O. orca* from the study area (figure 82). Group size of these confirmed sightings ranged from three to 11 with a mean of 5.33 (sd \pm 3.24). Sightings occurred during January (2), February (3), April (1), May (1) and August (2). Forty - six incidental sightings of killer whales are recorded from the region (figure 82). These sightings occurred throughout the year (figure 83) and group size ranged from one to twelve with a mean of 4.54 animals per group (sd \pm 3.03). Figure 82 shows the provenances of 41 specimens of killer whales reviewed in this study. The months and categories of origin are shown in figure 83 and table 18 respectively. The large number of fishing mortalities in these records are catches by the commercial whaling industries off Durban and Donkergat during the whaling season, and thus may give a false impression of a seasonal abundance during the winter months.

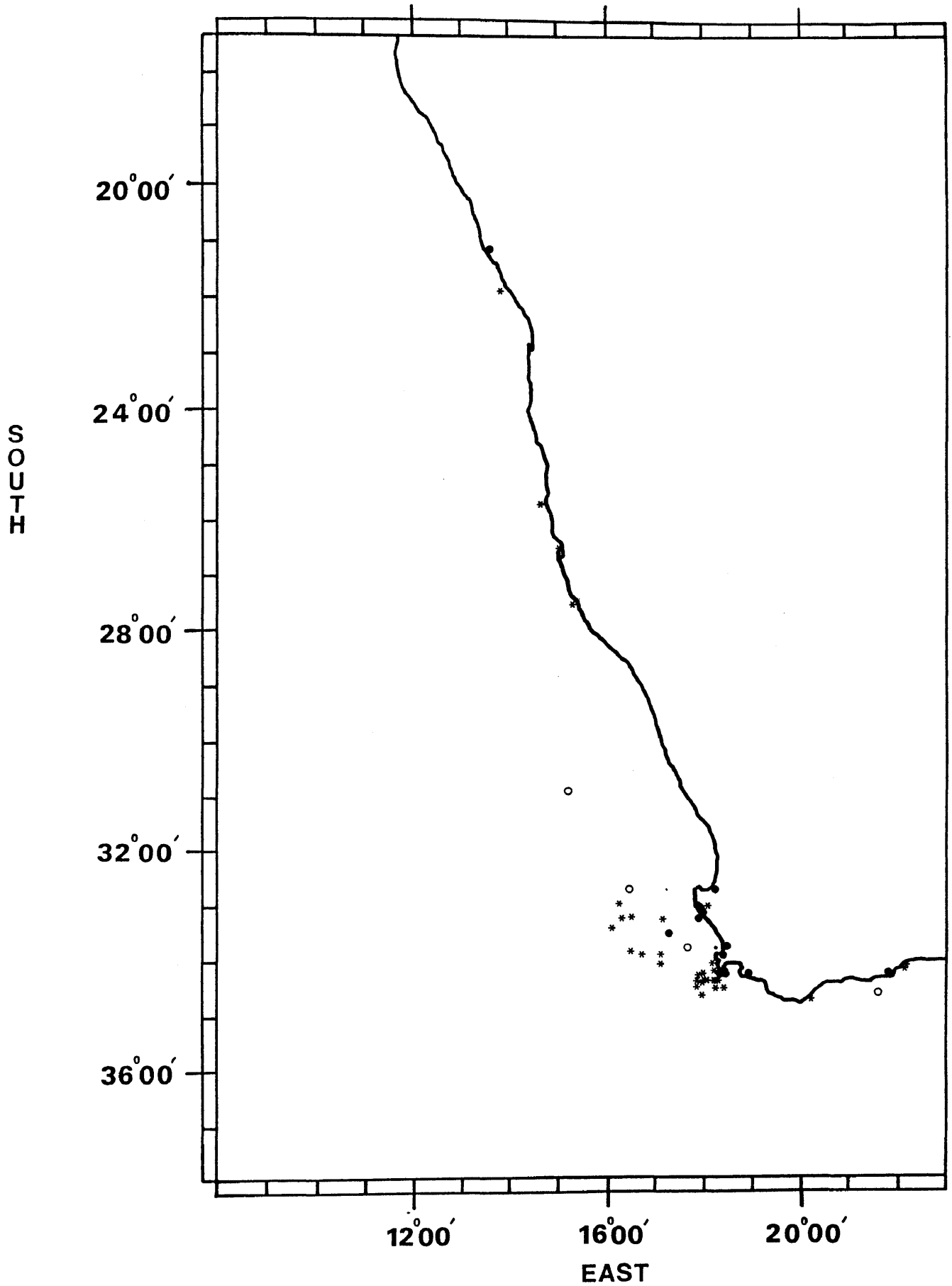


Figure 82. Scientific (○) and incidental (*) sightings and strandings (●) of killer whales reviewed in this study.

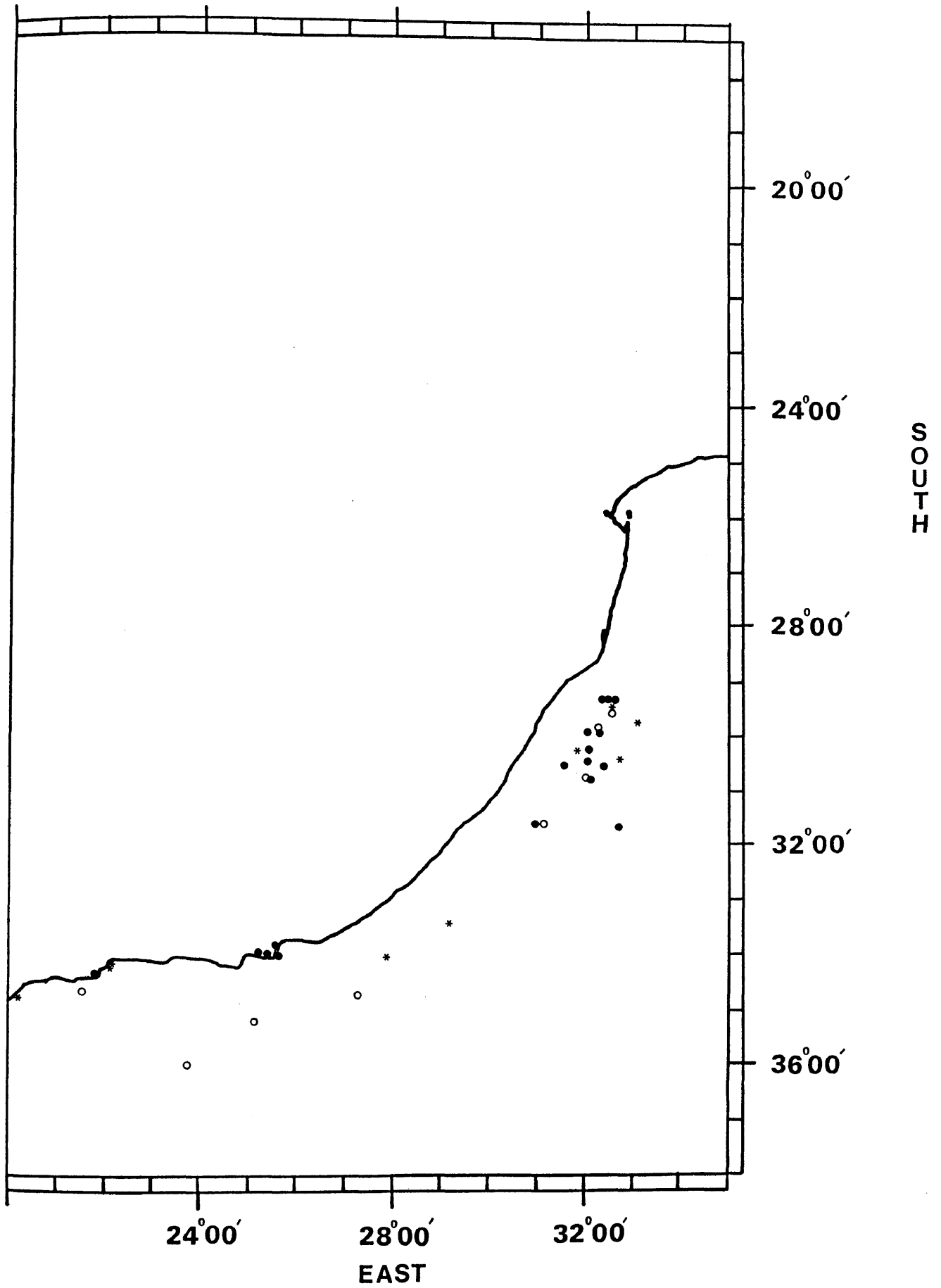


Figure 82. (continued)

NUMBER
OF
ANIMALS
SIGHTED
○

NUMBER
OF
SPECIMENS
●

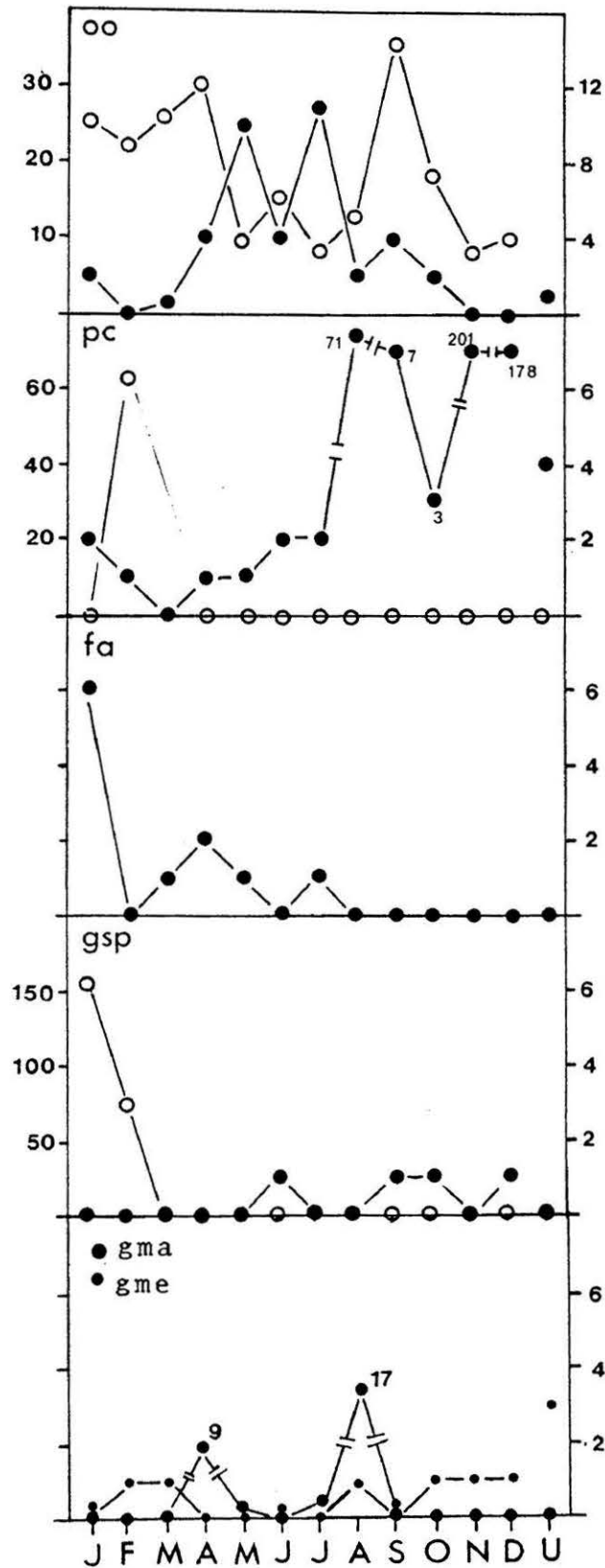


Figure 83. The seasonal abundance of incidental sightings and specimens of killer whales (oo), false killer whales (pc), pygmy killer whales (fa), *Globicephala* species (gsp), and *Globicephala meleana* (gme) and *G. macrorhynchus* (gma) reviewed in this study. (U = month of incidence unknown.)

give a false impression of a seasonal abundance during the winter months.

Table 18. Origins of the 41 specimens of killer whales reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	1
Dead beach cast (stranding)	1
Found dead on shore	6
Skeletal material found on shore	2
Direct fishing mortalities (including scientific collection)	31

The scientific and incidental sightings and specimen records show that the killer whale is found throughout southern African waters (figure 82) and the clump of incidental sightings to the west of Cape Peninsula results from reports from ski-boat anglers. In the latter case it is possible that the whales are attracted to the boats (where they have been reported to take fish off lines) or that both anglers and whales are attracted to frontal areas where game fish occur.

All scientific sightings of killer whales have occurred in water depths of 200 metres or greater in all four Areas. Temperatures and salinities associated with waters in which these sightings fell were the 12^o to 24^o C and 35.0 to 35.8 ppt intervals respectively (figure 84). Kasamatsu *et al* (in press) found killer whales in Antarctic waters to be associated with temperatures of between 5.6^o and -1.7^o C.

The incidental sightings of killer whales were made over a wide range of environmental conditions (figure 84). Sightings in Area I were all in shallow waters (inshore of the 100 m isobath) associated with temperatures of between 12^o and 16^o C and salinities of between 34.8 and 35.2 ppt. Summer sightings in Area II occurred in all depth intervals, while winter sightings were recorded in the 0 to 100 m and all of the 200 to 3000 m depth intervals. Temperatures associated with these Area II sightings ranged between 12^o and 20^o (for summer sightings) and between 12^o and 18^o C (for winter sightings). Corresponding salinity values ranged between 34.8 and 35.6 ppt for

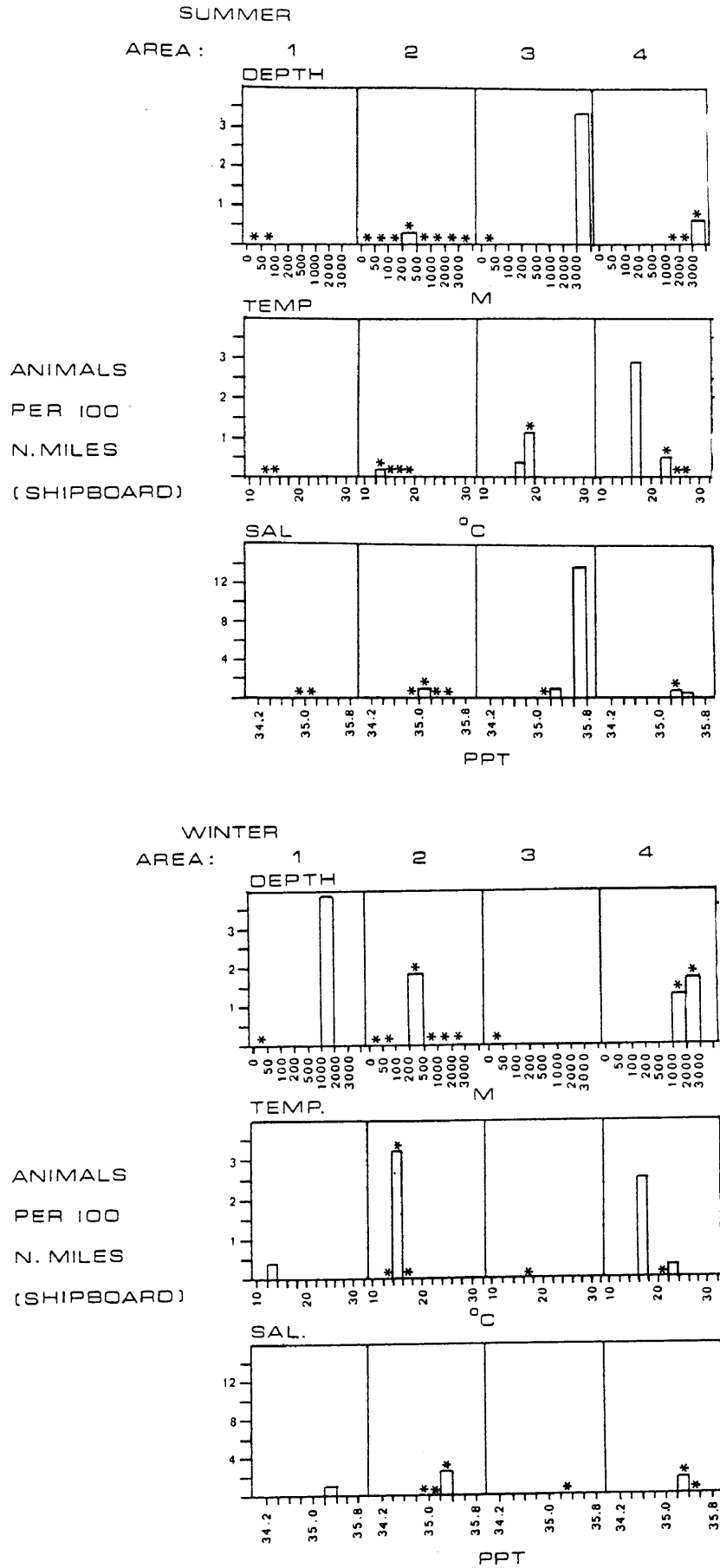


Figure 84. Densities of scientific sightings and occurrence of incidental sightings (*) of killer whales in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

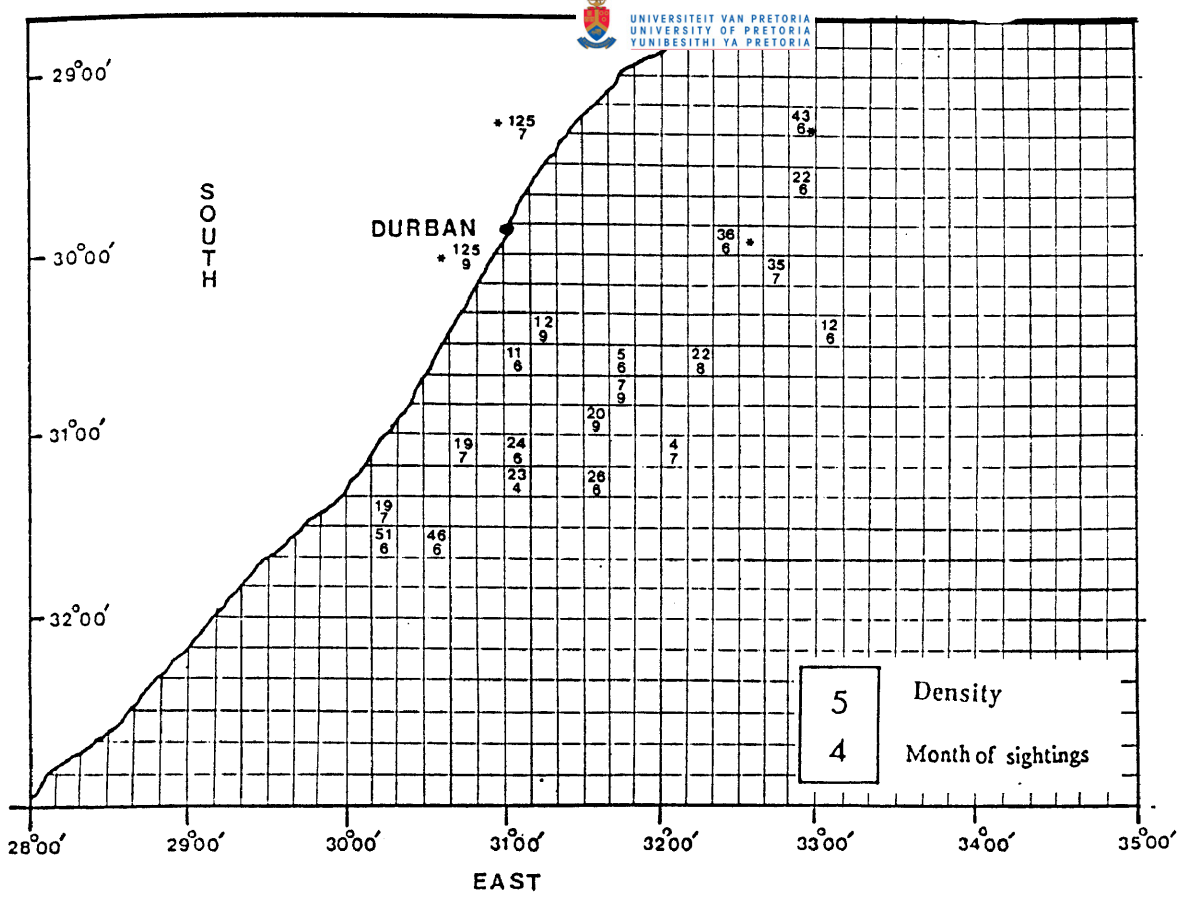


Figure 85. Distribution of killer whales sighted off Durban between 1972 and 1975.

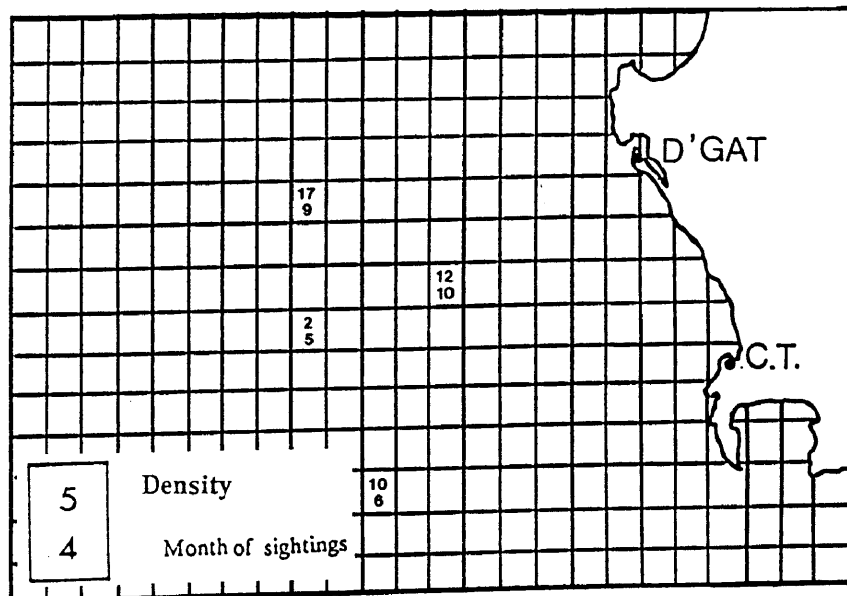


Figure 86. Distribution of killer whales sighted off Donkergat during 1963.

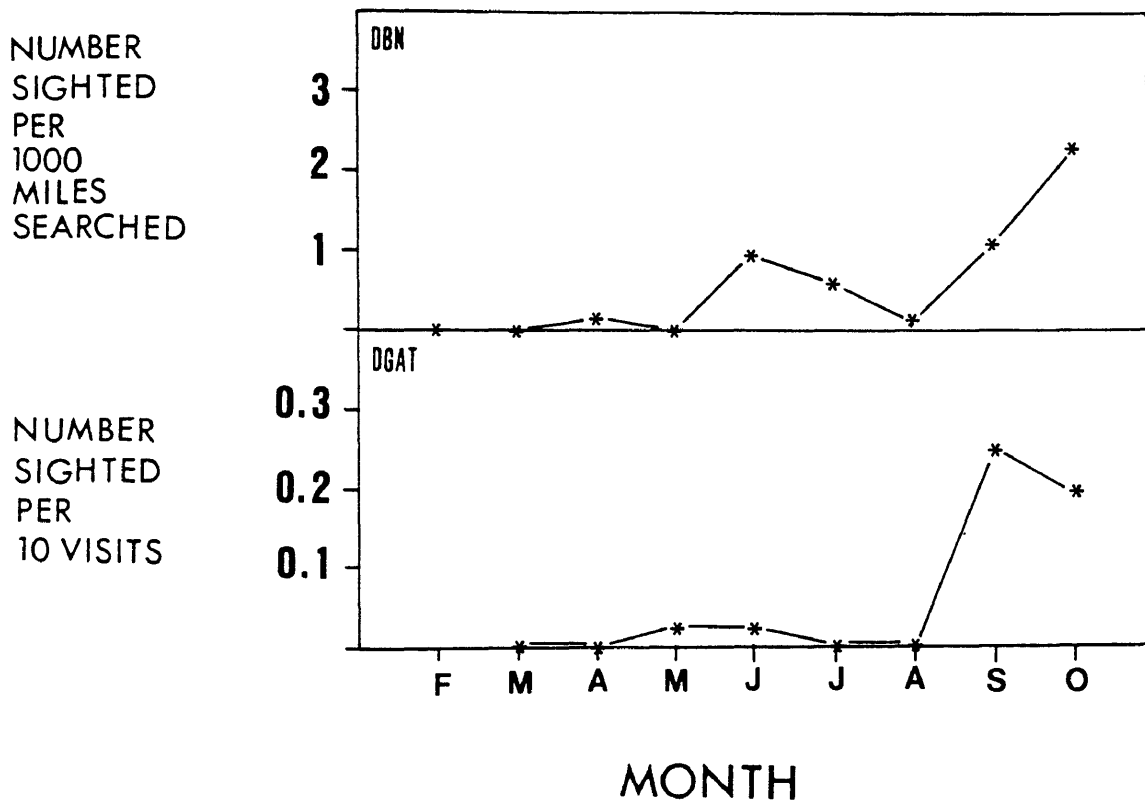


Figure 87. Seasonal occurrence of killer whales in the east (DBN) and west (DGAT) coast whaling grounds.

summer sightings and between 34.8 and 35.6 ppt. All incidental sightings in Area III were in waters inshore of the 50 metre isobath and associated with temperatures of between 18^o and 20^o C (summer) and 16^o and 18^o (winter). Salinities associated with these sightings fell into the 35.0 to 35.2 ppt range (summer sightings) and 35.2 to 35.4 ppt range (winter sightings). Area IV incidental sightings were all in waters of over 1000 m depth. Temperatures associated with waters in which summer sightings were made ranged between 22^o and 28^o and waters in which winter sightings were made between 20^o and 22^o. Corresponding salinity values ranged between 35.2 and 35.4 ppt (for both summer and winter sightings).

Twenty - two aerial sightings of a total of 161 killer whales were recorded off Durban between 1972 and 1975 (figure 85). Group size ranged between one and 25 animals with a mean of 7.32 animals per group (sd \pm 4.68). Four sightings of a total of 22 killer whales were made by aerial spotters over the west coast whaling grounds during 1963 (figure 86). Seasonal abundance of sightings off Durban and Donkergat both show slight bimodal trends with maximum abundance towards the end of the season (September to October) with lesser maxima earlier in the season (June to July off Durban and May to June off Donkergat) (figure 87). These patterns are similar to seasonal patterns for rorquals off both Durban and Donkergat, especially that of sei whales off Donkergat (figure 15). Mikhalev *et al* (1981) found that migrations of Southern Hemisphere killer whales appeared to co-incide with rorquals and particular that of the minke whale.

It appears possible that both resident and transient groups of killer whales are found in these waters. The occurrence of the remains of at least three elephant seals in the stomach of a killer whale taken at Durban (some 1000 nautical miles from the nearest rookery) and the seasonality of killer whales in the whaling grounds suggest that some at least of the animals are highly migratory. However, the cosmopolitan year - round occurrence of killer whales in these waters infer a resident component of the population. However, without morpho-logical or behavioural evidence of either form it is impossible to define these forms.

Ross (1984) states that the false killer whale is an oceanic species found in tropical and temperate waters of all oceans. Six dedicated scientific sightings of a total of 100 *Pseudorca crassidens* are recorded from southern African waters. These sightings were all made during summer (one in January and five in February). Group size ranged from one to 50 with a mean of 16.0 animals per group ($sd \pm 22.9$). One incidental sighting of approximately 68 animals was reported off the Cape Peninsula ($33^{\circ} 53'$; $18^{\circ} 03' E$) from a private fishing vessel during February 1985. Strandings of false killer whales are recorded from just south of Luderitz on the west coast to East London on the east coast (figure 88) and the categories and months of origin are presented in table 19 and figure 83 respectively.

Table 19. Origins of the 472 specimens of false killer whales reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	386
Found dead on shore	72
Skeletal material found on shore	2
Incidental fishing mortality (including shark net mortalities)	2
Direct fishing mortalities (including scientific collection)	1
Unknown	9

Five of the stranding incidents of *P. crassidens* have involved mass strandings of five, 65, 120, 200 and 58 individuals respectively. A further mass stranding of four individuals was recorded, but no information was available as to the category of stranding. All of these mass strandings have occurred over a limited area of coastline in the southwestern Cape, while two mass strandings have occurred on the same stretch of beach at St Helena Bay ($32^{\circ} 50' S$, $18^{\circ} 05' E$). These mass strandings are marked with arrows in figure 88.

Scientific sightings of false killer whales were all recorded in Area IV in waters deeper than 1000

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

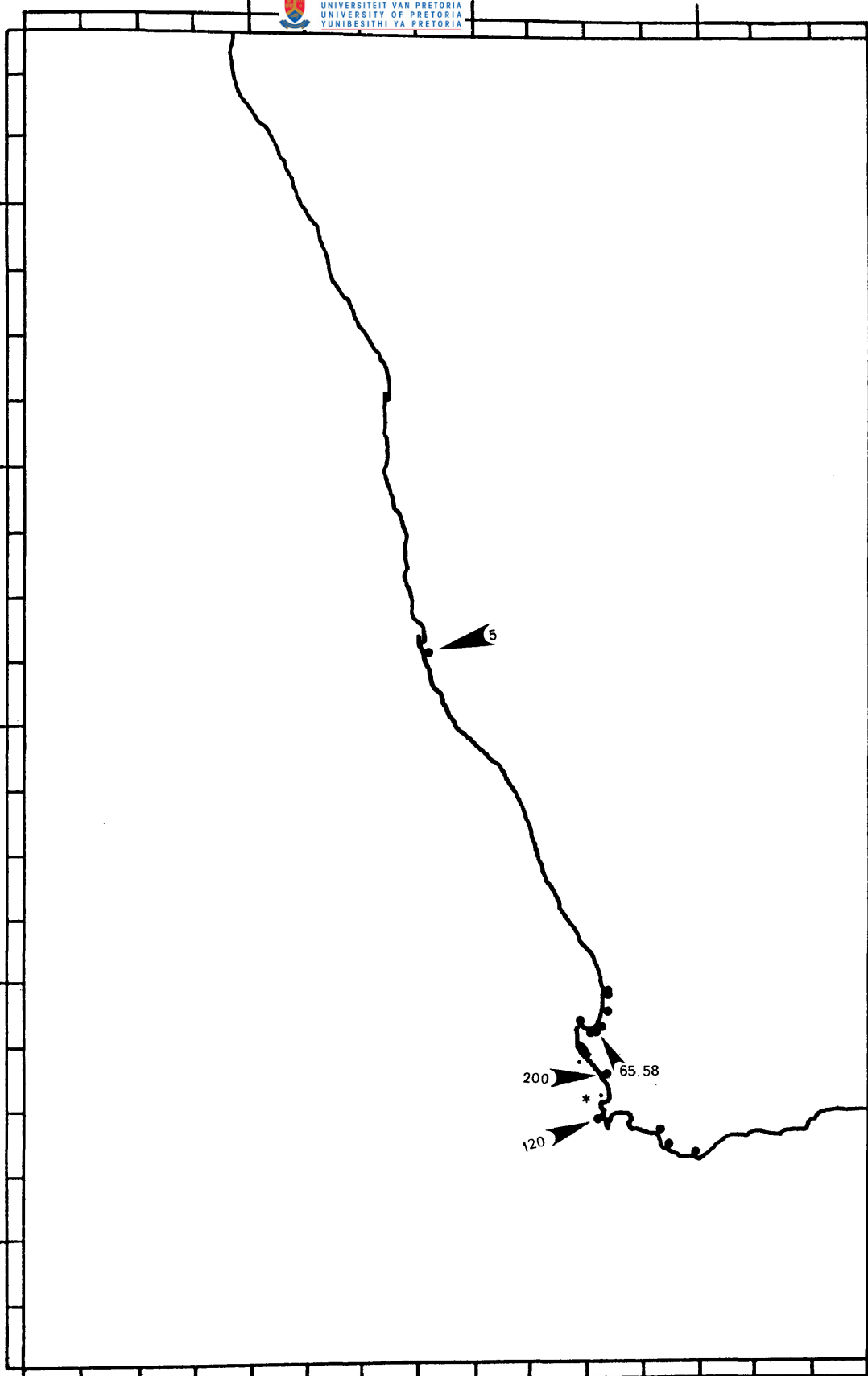


Figure 88. Scientific (o) and incidental (*) sightings and strandings (●) of false killer whales reviewed in this study. Arrows indicate provenances of mass strandings.

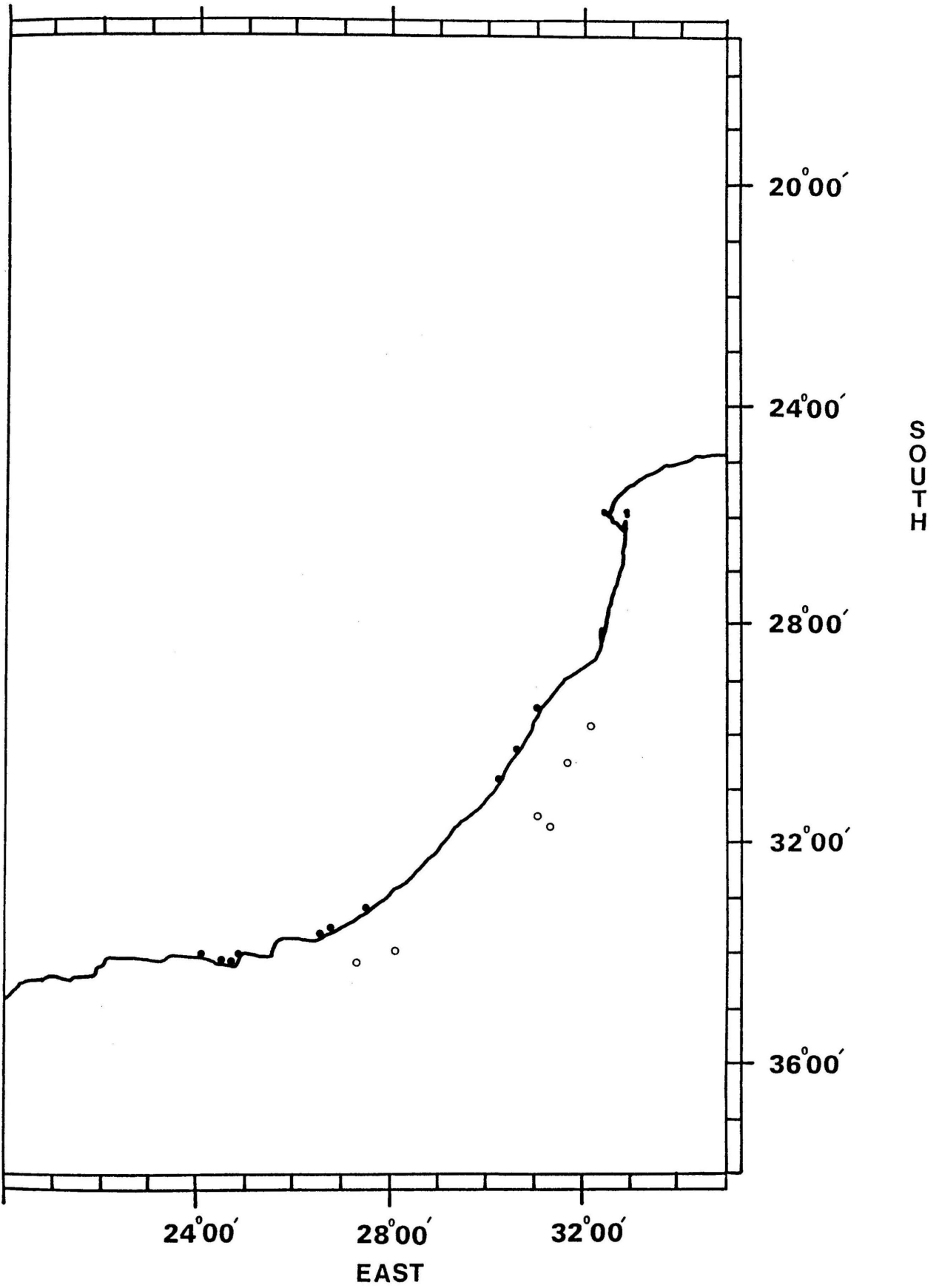


Figure 88. (continued).

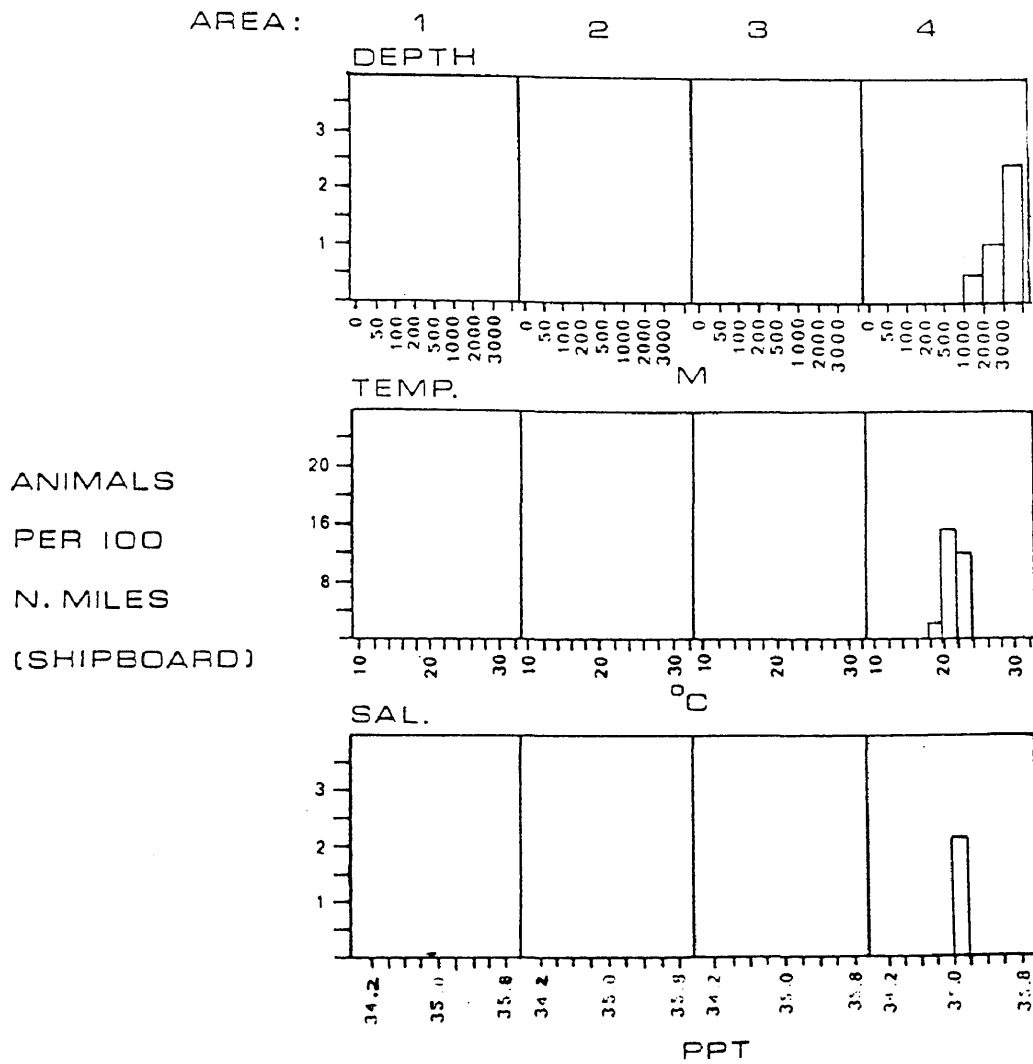


Figure 89 . The distribution of scientific and incidental sightings of false killer whales by depth, sea surface temperature, and sea surface salinity during summer. No sightings were made during winter.

metres (figure 89). Temperatures measured in these waters ranged from 18^o to 24^o C while salinities measured in corresponding waters ranged from 35.0 to 35.6 ppt (figure 89). The one incidental sighting of *P. crassidens* was made in waters of 100 to 200 metres depth and associated with temperatures of between 12^o and 14^o C and salinities of between 34.8 and 35.0 ppt.

It would appear from scientific sightings that this species occurs seasonally in southern African waters. However, little search effort was carried out off the east coast during winter months (apart from whaling ground data in which most small cetaceans were not recorded) and little search effort was made in pelagic waters off the west coast and this may explain the paucity of winter records. All the mass strandings were recorded between the months of August and December.

Pygmy killer whale (*Feresa attenuata*).

This species appears to be confined to tropical, sub-tropical and warmer temperate waters of the world. Perrin and Hubbs (1969) note that the distribution remained almost undetermined until Yamada (1954) described a specimen from Japan and Fraser (1960) reported a specimen from Senegal. Best (1970b) notes that Nishiwaki *et al* (1965) reported a further 14 specimens captured in Japan, while Pryor *et al* (1965) described a specimen caught from Hawaii. Van Waerebeek and Reyes (1988) reported two records of *Feresa attenuata* from the coast of Peru in the Humboldt Current.

One dedicated scientific sighting of 11 *Feresa attenuata* was made off the Natal coast (31^o 00'S, 29^o 00'E) in August 1969 (Best 1970a). This sighting was made in waters of between 1000 and 2000 metres depth and associated with temperatures of between 20^o and 22^o C and salinities of between 35.2 and 35.4 ppt. Eleven strandings of *F. attenuata* appeared widespread along the coast (figure 90). However there is an absence of strandings between the Cape Peninsula and Algoa Bay, possibly caused by the greater width of the continental shelf in this area. The records from SWA / Namibia as far north as 23^o 00' S are surprising given the species reputed preference for warm temperate waters.

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

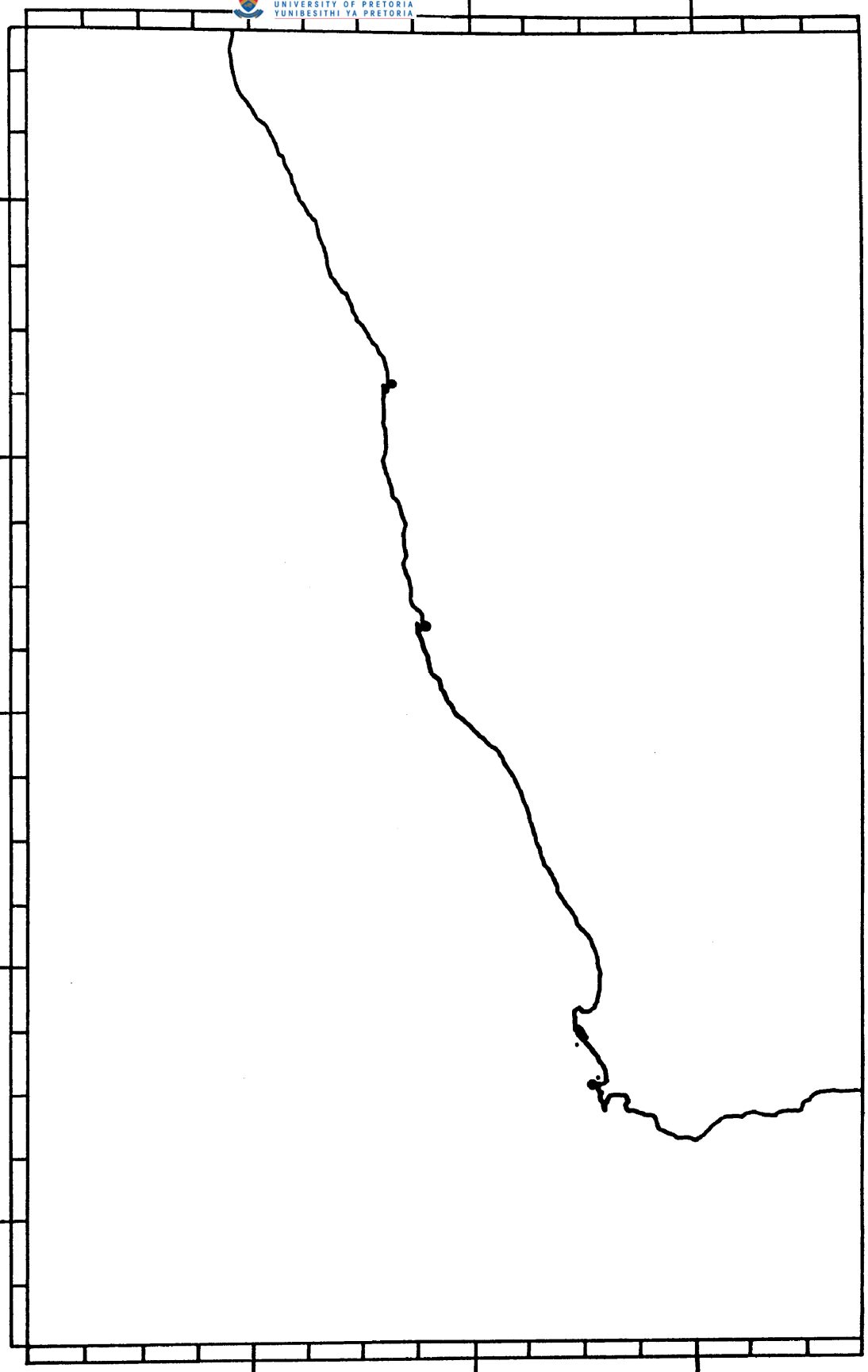


Figure 90. Scientific (⊙) sightings and strandings ● of *Feresia attenuata* reviewed in this study.

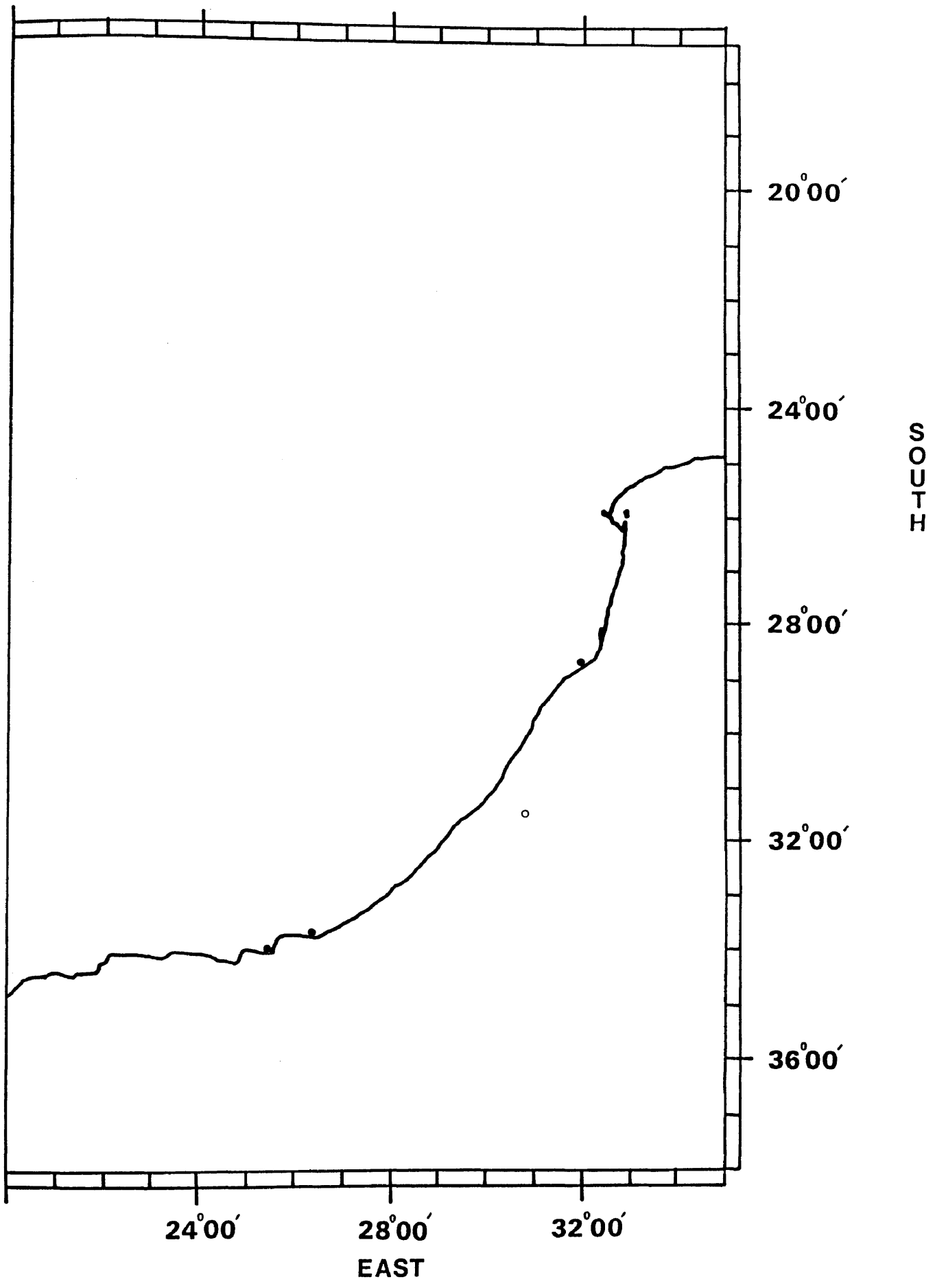


Figure 90. continued.

However these animals probably originate offshore waters. Table 20 lists the categories of origin of the specimens.

Table 20. Origins of the specimens of *Feresa attenuata* reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	1
Found dead on shore	10

The seasonal abundance of these specimens (figure 83) would suggest that this species has a summer - autumn seasonality in these waters. However the one dedicated sighting was later in the year in August.

The melonheaded whale (*Peponocephala electra*)

P. electra is a tropical pelagic species and Perrin (1976) summarised its worldwide tropical distribution.

Only one stranding of this species has been recorded from this coast. This was a single animal that stranded alive at Hout Bay (34° 04'S ; 18° 21'E) in July 1976. Best and Shaughnessy (1981) note that as this species is usually found in tropical and sub tropical waters, this specimen must represent the extreme southern limit of its range. The only other Atlantic Ocean records were made to the north of the equator (van Bree and Cadenat 1968) and a recent report of a mass stranding of 240 individuals in Brazil (Siciliano, Lodi, Capistrano, Thebald and de Andrade 1987).

The genus *Globicephala*.

Both the long - finned (*G. melaena*) and short - finned (*G. macrorhynchus*) pilot whales are found off the coast of southern Africa. Van Bree, Best and Ross (1978) found that *G. macrorhynchus*

appears to be the predominant east coast species, and they describe an area of overlap from strandings between East London and Mossel Bay. A specimen of *G. macrorhynchus* has been recorded from the Mossel Bay Area, but no accurate provenance is available. Nores and Perez (1988) found that the two species existed allopatrically off the coast of Spain with *G. melaena* inhabiting cooler waters than *G. macrorhynchus*.

Due to the difficulty of distinguishing between the two species at sea, scientific sightings have been recorded simply as *Globicephala* species. Thirteen such records of dedicated scientific sightings of animals have been reported (figure 91). Two of these sightings were of unconfirmed group sizes and excluding these, group size ranged from two to 25 animals per group with a mean of 7.33 per group (sd \pm 4.61). Seven incidental sightings were made in southern African waters. Group sizes ranged between one and approximately 120 animals per group.

Figures 92 and 93 show the provenances of nine specimens of *G. melaena* and 29 specimens of *G. macrorhynchus* respectively. Months and categories of origin of the two species are presented in figures 83 and table 21 respectively.

Table 21. Origins of the 9 specimens of *G. melaena* (*G. mel*) and 29 specimens of *G. macrorhynchus* (*G. mac*) reviewed in this study.

Category of provenance	Number of individuals	
	<i>G. mel</i>	<i>G. mac</i>
Live beach cast (stranding)		26
Dead beach cast (stranding)		1
Found dead on shore	5	2
Skeletal material dredged at sea	1	
Skeletal material found on shore	1	
Direct fishing mortality (including scientific collection)	1	
Unknown	1	

Scientific sightings of *Globicephala* appeared to be associated with the shelf edge or in waters of over 1000 metres (figure 94). Temperatures associated with these sightings were within the 12^o to 16^o C

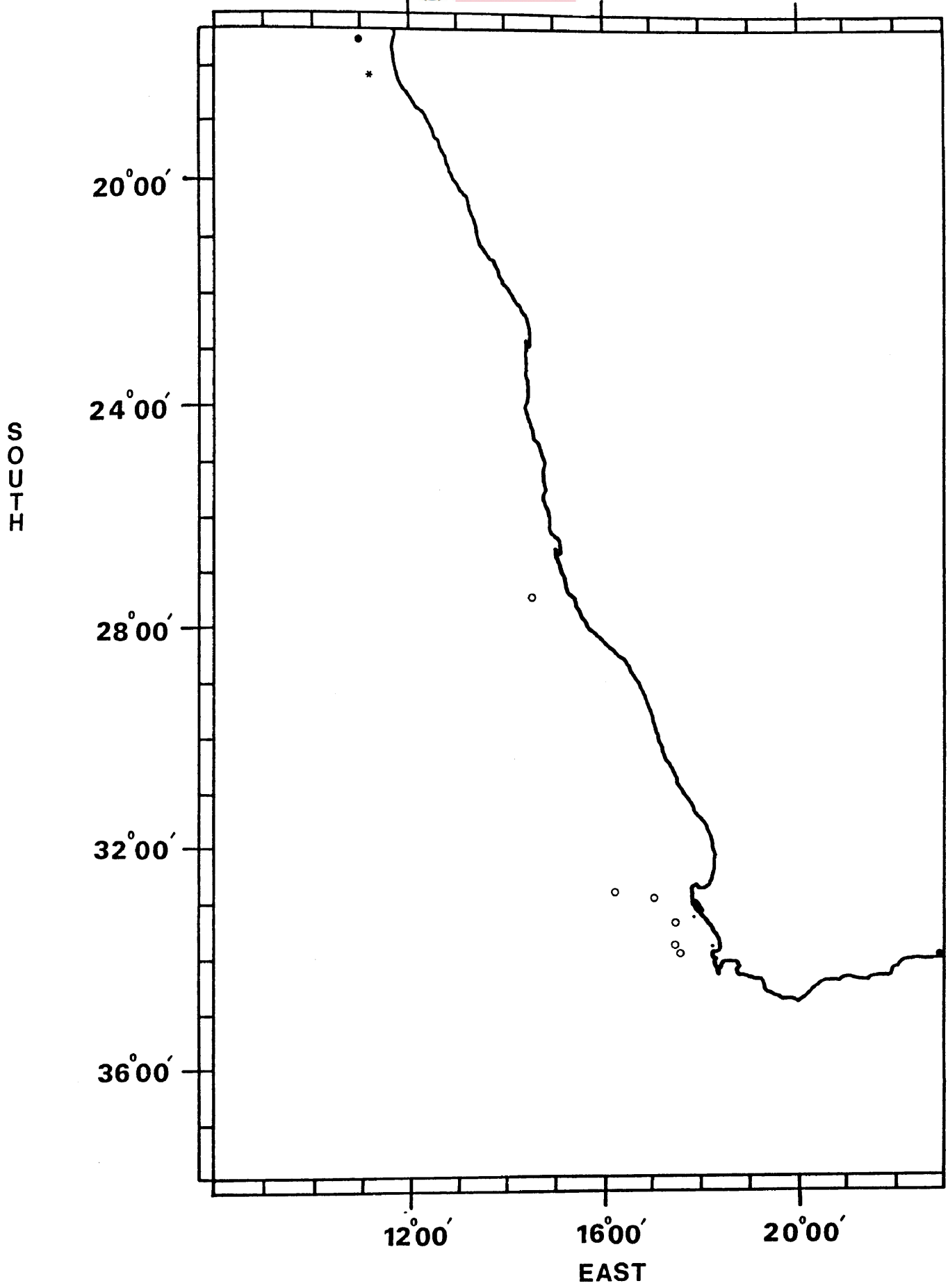


Figure 91. Scientific (o) and incidental (*) sightings and strandings (●) of "*Globicephala* species" reviewed in this study.

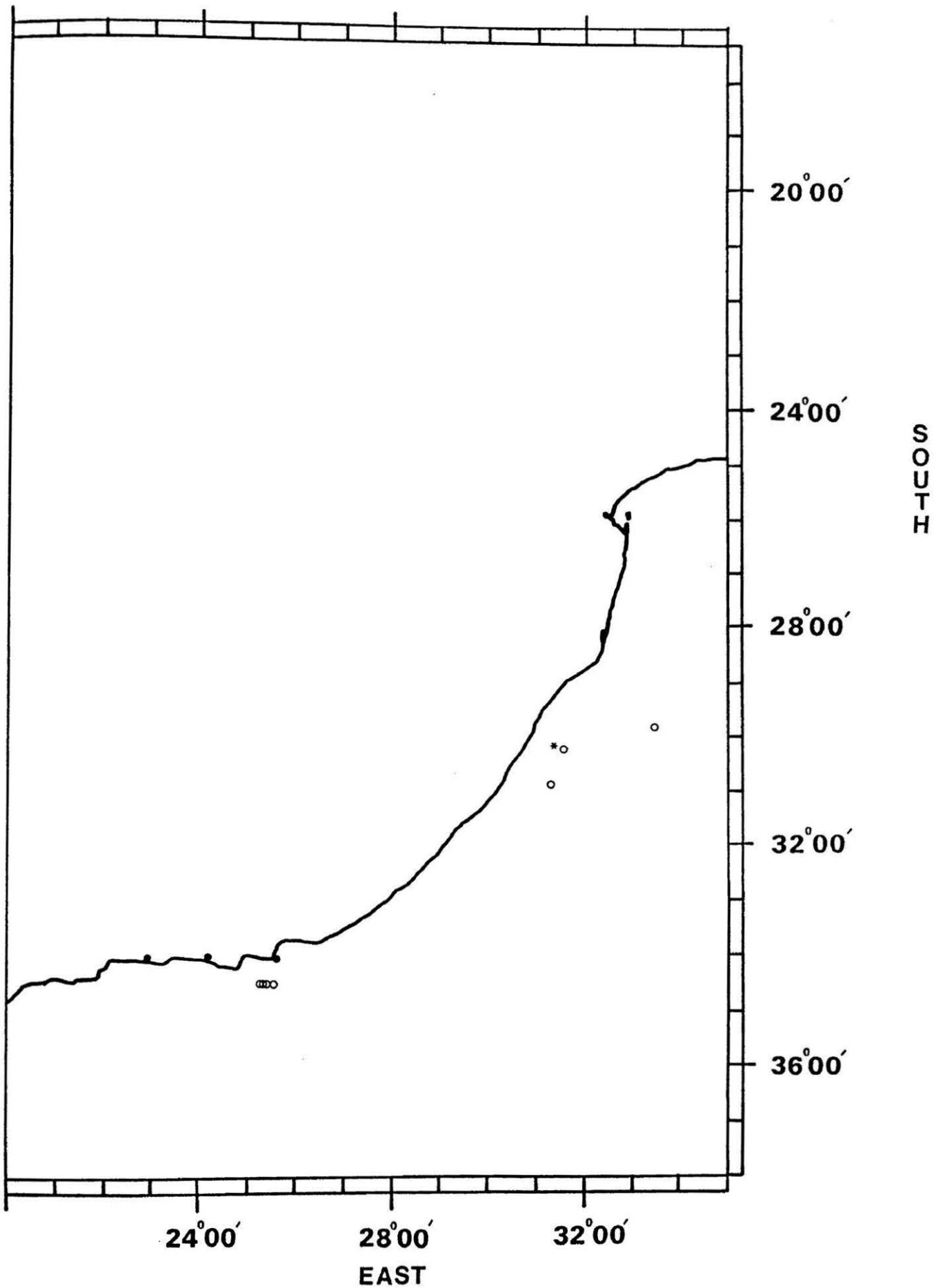


Figure 91. continued

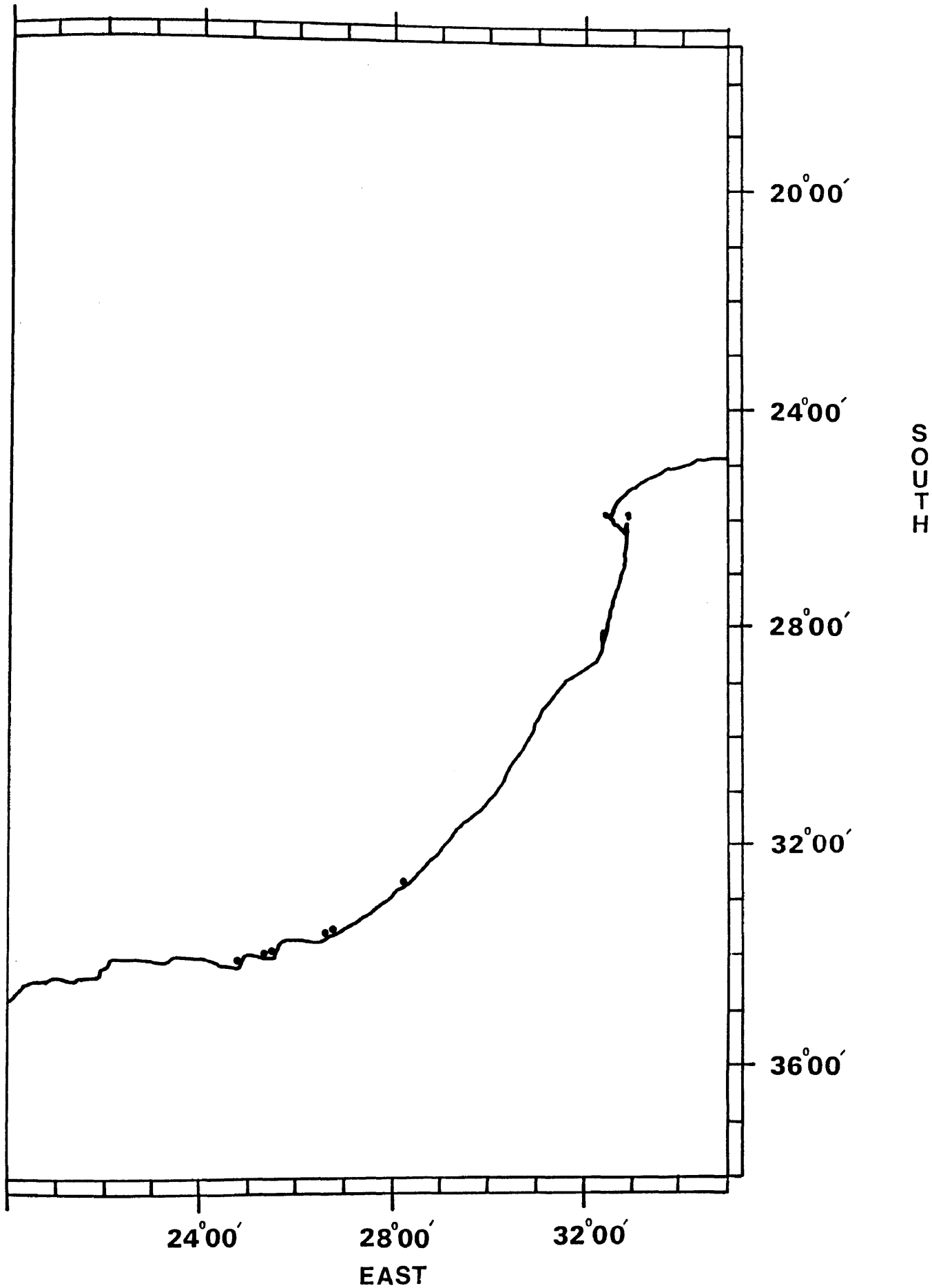


Figure 92. Provenances of specimens (●) of short -finned pilot whales reviewed in this study.

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

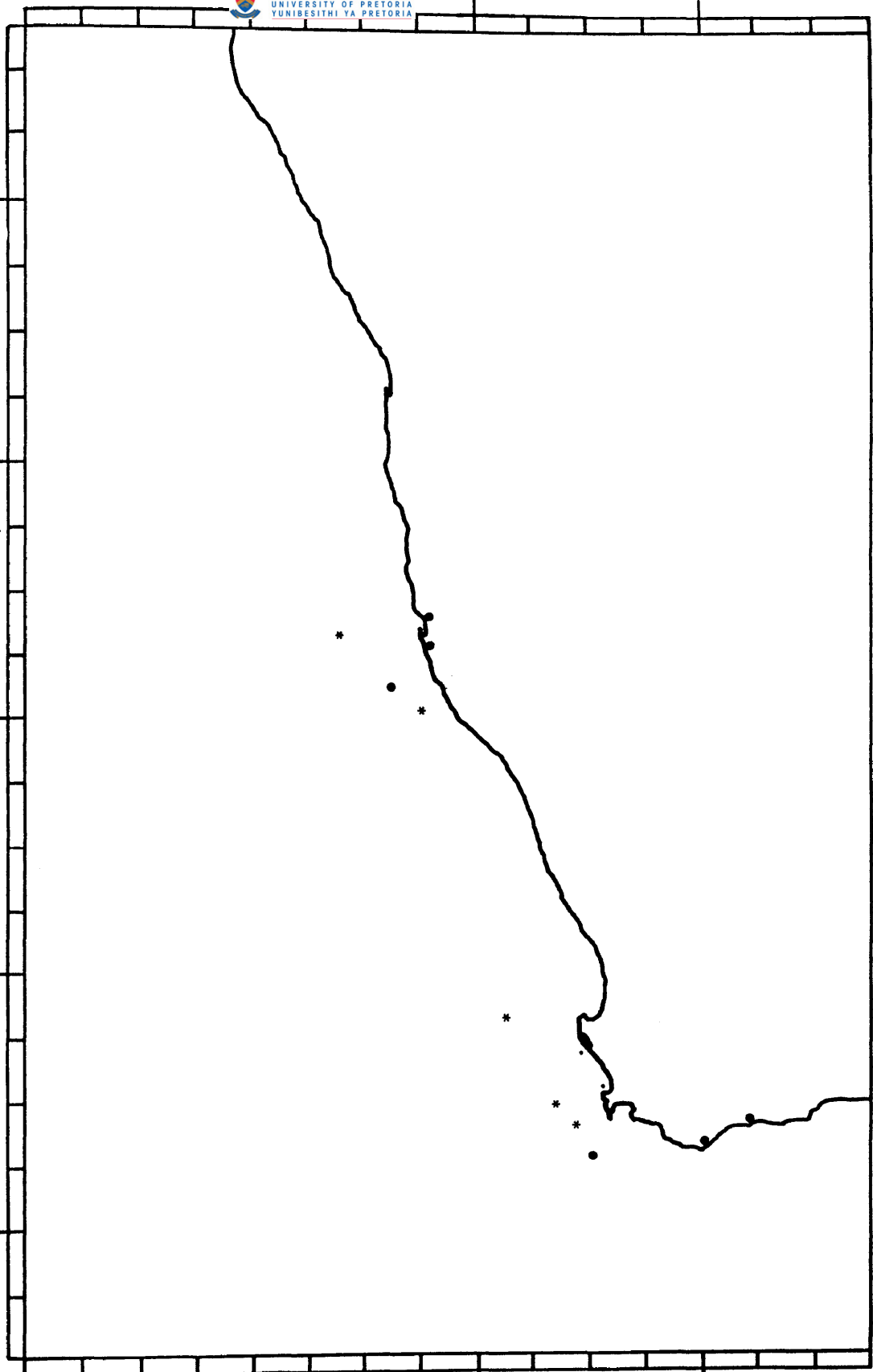


Figure 93. Incidental sightings (*) and specimens (●) of long - finned pilot whales reviewed in this study. © University of Pretoria

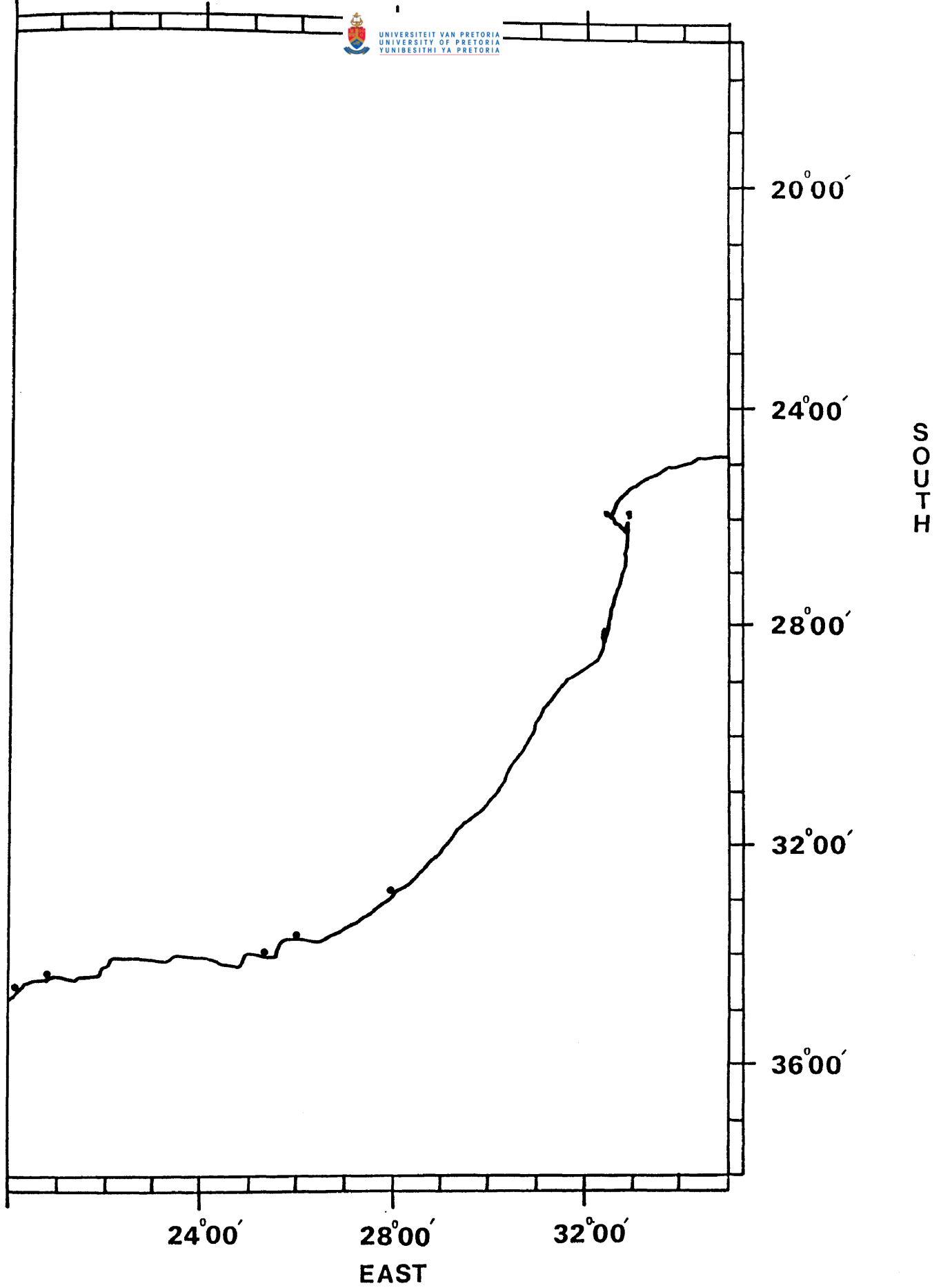


Figure 93. continued.

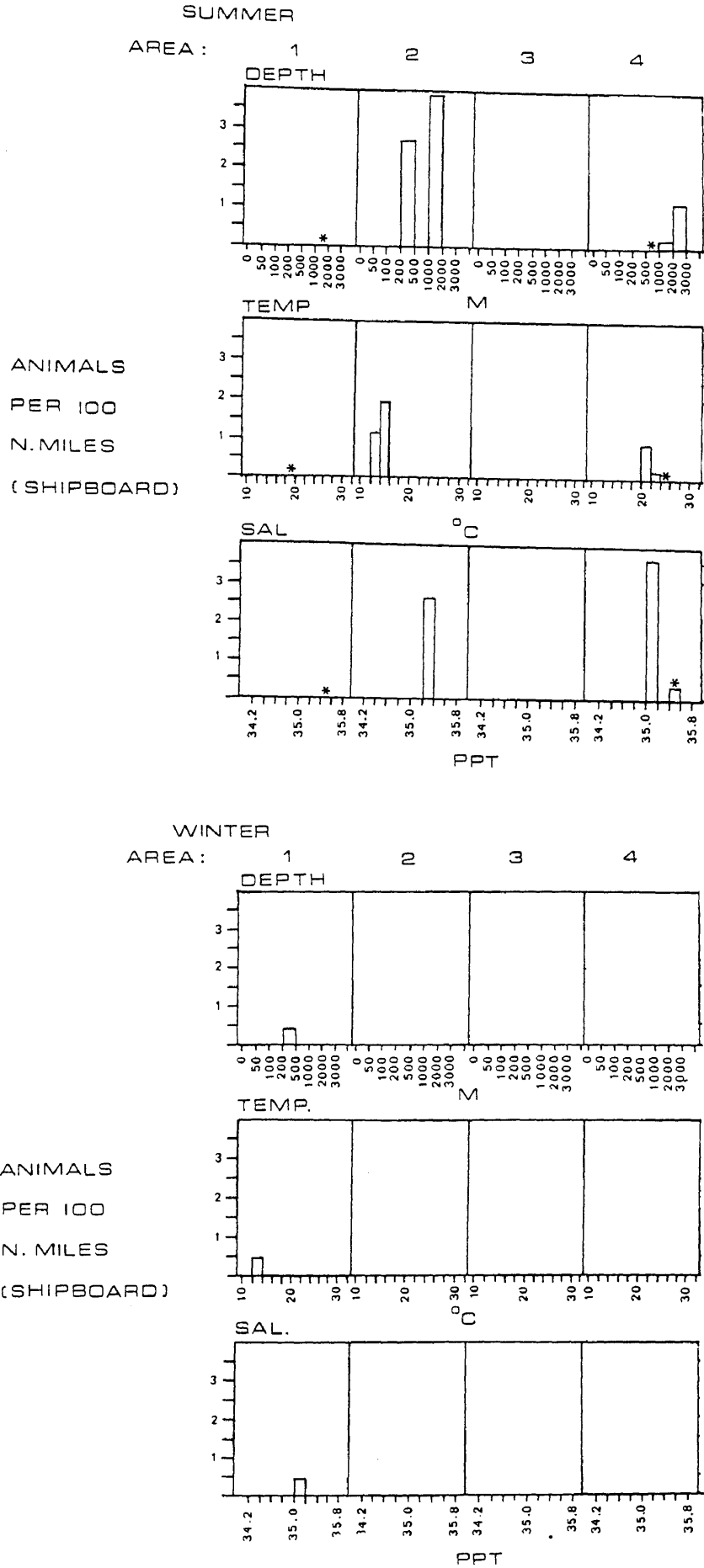


Figure 94. Densities of scientific sightings and occurrence of incidental sightings (*) of pilot whales in each of four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

range in Area II (possibly *G. melaena*) and 24^o C in Area IV (possibly *G. macrorhynchus*). Salinities measured in waters in which these sightings were made ranged between 35.0 and 35.6 ppt.

A number of the schools of *Globicephala* were associated with schools of *Tursiops*. Four dedicated sightings of schools of pilot whales were made in the same localised area as three sightings of bottlenose dolphins on one day, and two incidental sightings of school of *Globicephala* was made with *Tursiops*.

Sightings of *Globicephala* have been made throughout southern African waters (figure 91), and although these cannot be entirely differentiated into the two species, the pattern of strandings of the two species and the distribution of the genus in relation to temperature appear to confirm the distribution patterns put forward by van Bree *et al* (1978), that *G. melaena* is a cold water west and south coast species, while *G. macrorhynchus* is a warm water east coast species. The area of overlap of the two species (between 25^o and 28^o E) apparent from the stranding records would reflect the movement of *G. macrorhynchus* westwards with the Agulhas Current and the eastward movement of *G. melaena* in cooler waters inshore of this current system.

Risso's dolphin (*Grampus griseus*)

Leatherwood, Perrin, Kirby, Hubbs and Dalheim (1980) state that Risso's dolphin is widely distributed in tropical and temperate waters around the world while Davies (1963) defines the distribution as largely tropical extending its range poleward to overlap with temperate forms. Kruse, Leatherwood, Prematunga, Mendes and Gamage (in press) found *G. griseus* to be distributed throughout the central and northern Indian Ocean and "particularly along and seaward of the continental shelf". Ross (1984) found that on the south - east coast *G. griseus* occurred well offshore, but that there was some possible association with the 1000 metre isobath.

these sightings ranged from one to 80 with a mean of 11.09 animals per group (sd ± 13.37). The majority (37) of these sightings occurred in summer. Twenty five incidental sightings of Risso's dolphin have been recorded (figure 95) and mean group size of these groups was 10.36 animals per group (sd ± 8.70).

The localities of 100 specimens of Risso's dolphin are shown in figure 95. The categories and months of origin of these specimens are presented in table 22 and figure 96 respectively. No seasonality was apparent from these specimen data. The sightings of *G. griseus* were recorded from 31° 00' S on the west coast to 29° 00' S on the east coast. The lack of sightings off the west coast is probably an artefact due to the low search effort offshore on this coast, as three stranding incidents are recorded as far north as 21° 35' S.

Table 22. Origins of the 100 specimens of Risso's dolphins reviewed in this study.

Category of provenance	Number of individuals
Live stranding	37
Dead stranding	1
Found floating dead at sea	2
Found dead on shore	44
Skeletal material found on shore	7
Incidental fishing mortality (including shark net mortalities)	2
Unknown	7

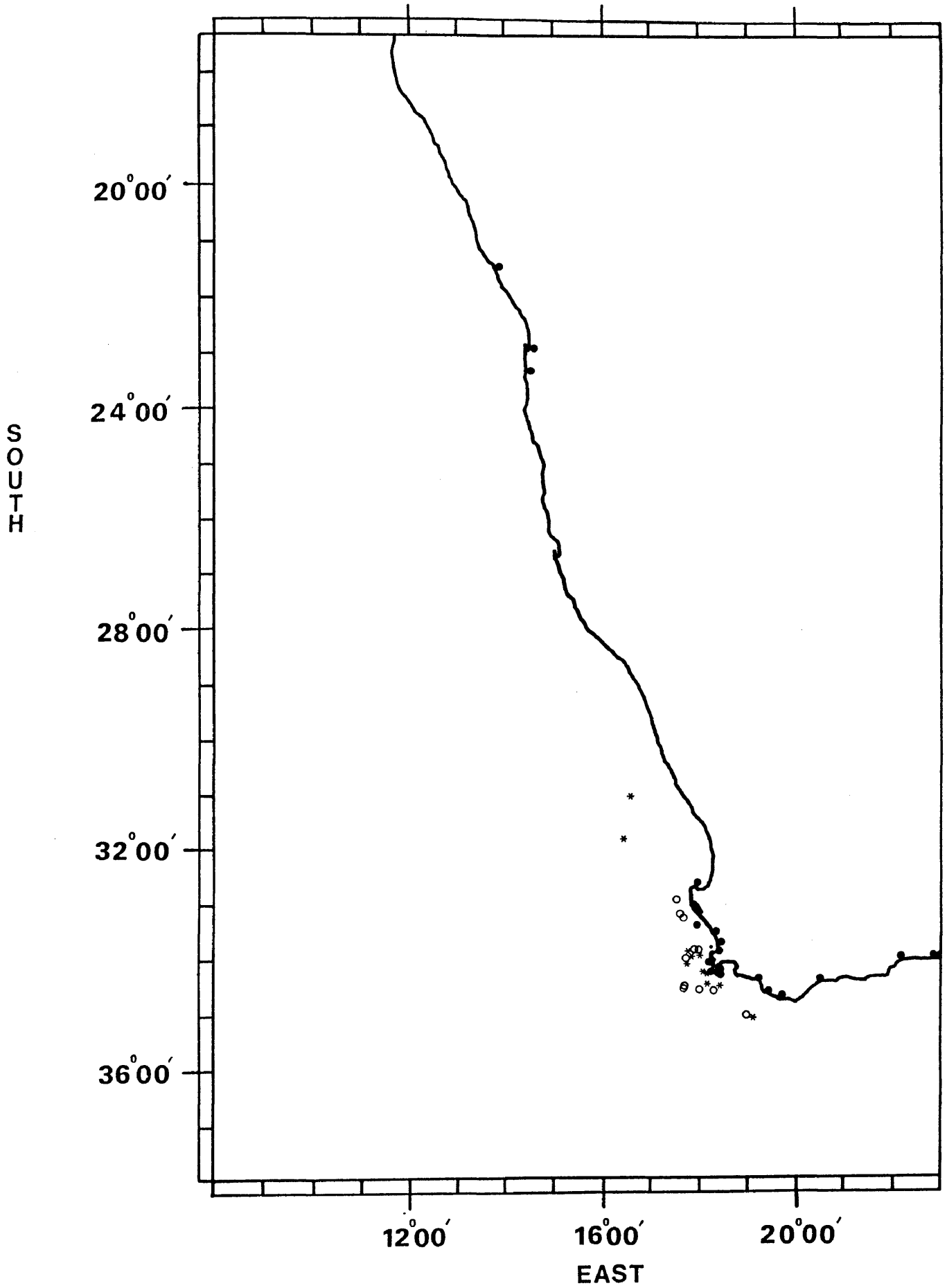


Figure 95. Scientific (○) and incidental (*) sightings and specimens (●) of Risso's dolphins reviewed in this study.

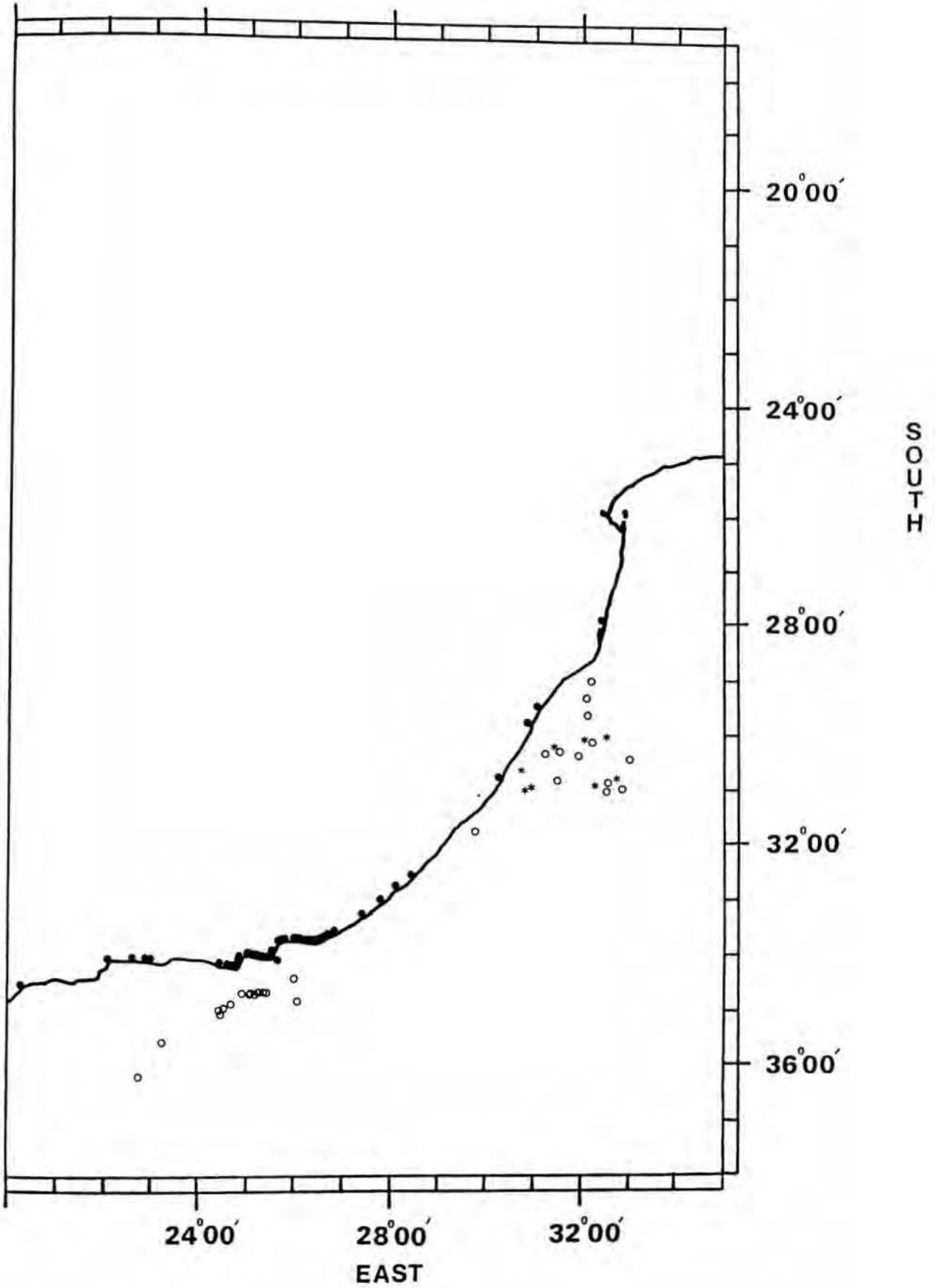
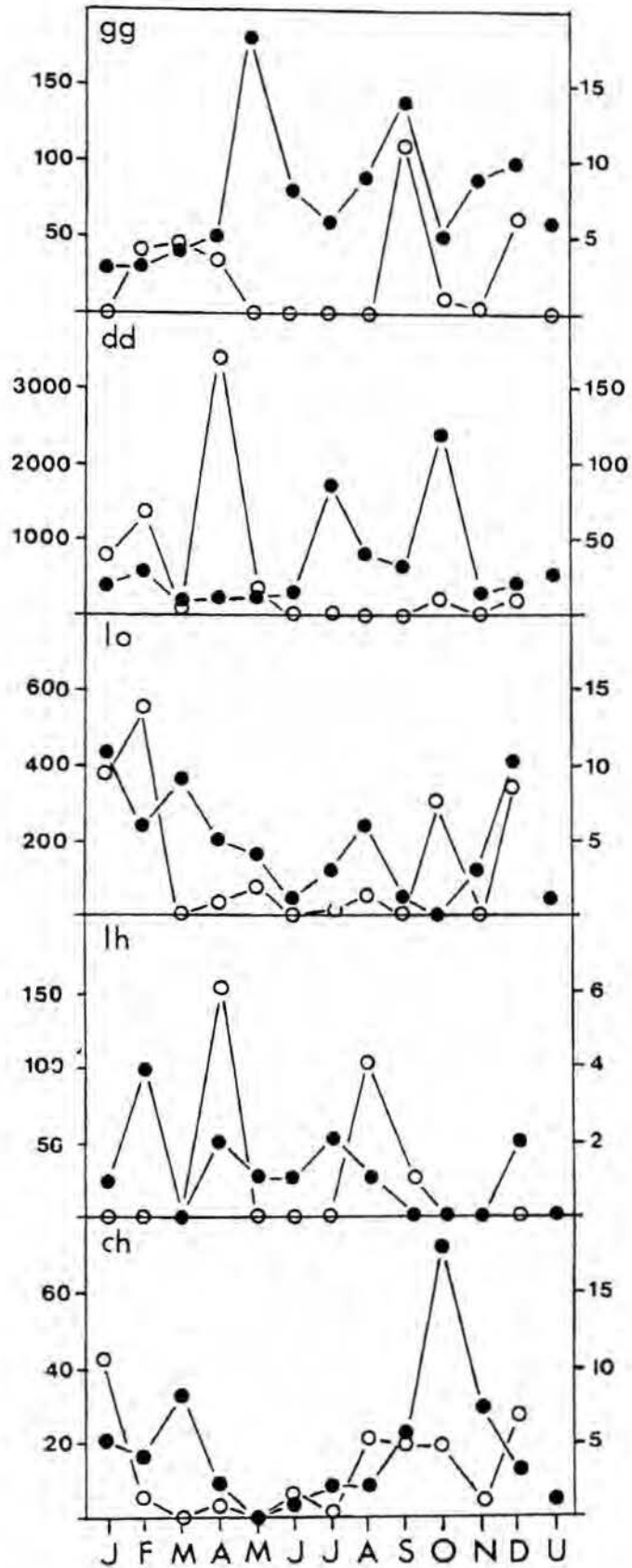


Figure 95. (continued)

NUMBER
OF
ANIMALS
SIGHTED
○



NUMBER
OF
ANIMALS
STRANDED
●

Figure 96. The seasonal abundance of incidental sightings and specimens of Risso's dolphin (gg), common dolphin (dd), Fraser's dolphin (lh), dusky dolphin (lo) and Heaviside's dolphin (ch). (U = month of incidence unknown.)

The scientific sightings of *G. griseus* were strongly associated with the shelf edge and pelagic waters (figure 97). Temperatures associated with summer sightings of this species ranged between 14 and 18^o C in Area II, 16^o and 22^o C in Area III and 18^o and 24^o C in Area IV. Summer salinities measured in these waters ranged between 35.0 and 35.8 ppt. Temperatures associated with winter sightings of *G. griseus* ranged between 12^o and 16^o C in Area II and 18^o and 20^o C in Area IV. Corresponding winter salinities ranged from 35.0 to 35.4 ppt in Area II and from 35.2 to 35.4 ppt in Area IV. The incidental sightings of Risso's dolphin were made in a wide range of water depths, temperatures and salinities and did not appear to be associated with any particular depth temperature or salinity intervals (figure 97). However the one incidental sighting of Risso's dolphin made in nearshore waters was made in the vicinity of Simonstown harbour and it is presumed that this individual was about to strand and its distribution must be considered anomalous.

Thus Risso's dolphins are found throughout southern African pelagic waters all year round, but as suggested by Leatherwood *et al* (in press) the species appears to have some association with the shelf edge.

Common dolphin (*Delphinus delphis*)

Evans (1982) notes that *D. delphis* is a highly mobile species distributed over a wide range of water temperatures (10^o - 28^o C) and that it appears to adapt to a wide range of habitats from enclosed waters (the Black Sea) to a pelagic existence. Gaskin (1968) states that in the Southern Hemisphere *D. delphis* appear to be confined to north of the Subtropical Convergence, and suggests a minimum surface temperature of about 14^o C. Dohl *et al* (1986) found that *D. delphis* off the coast of California follows features of bottom topography in response to seasonally fluctuating water temperature, while Hui (1979) found *D. delphis* distribution to be related to regions of high topographical relief and that ocean floor plains are avoided. Hui (1979) notes however that this

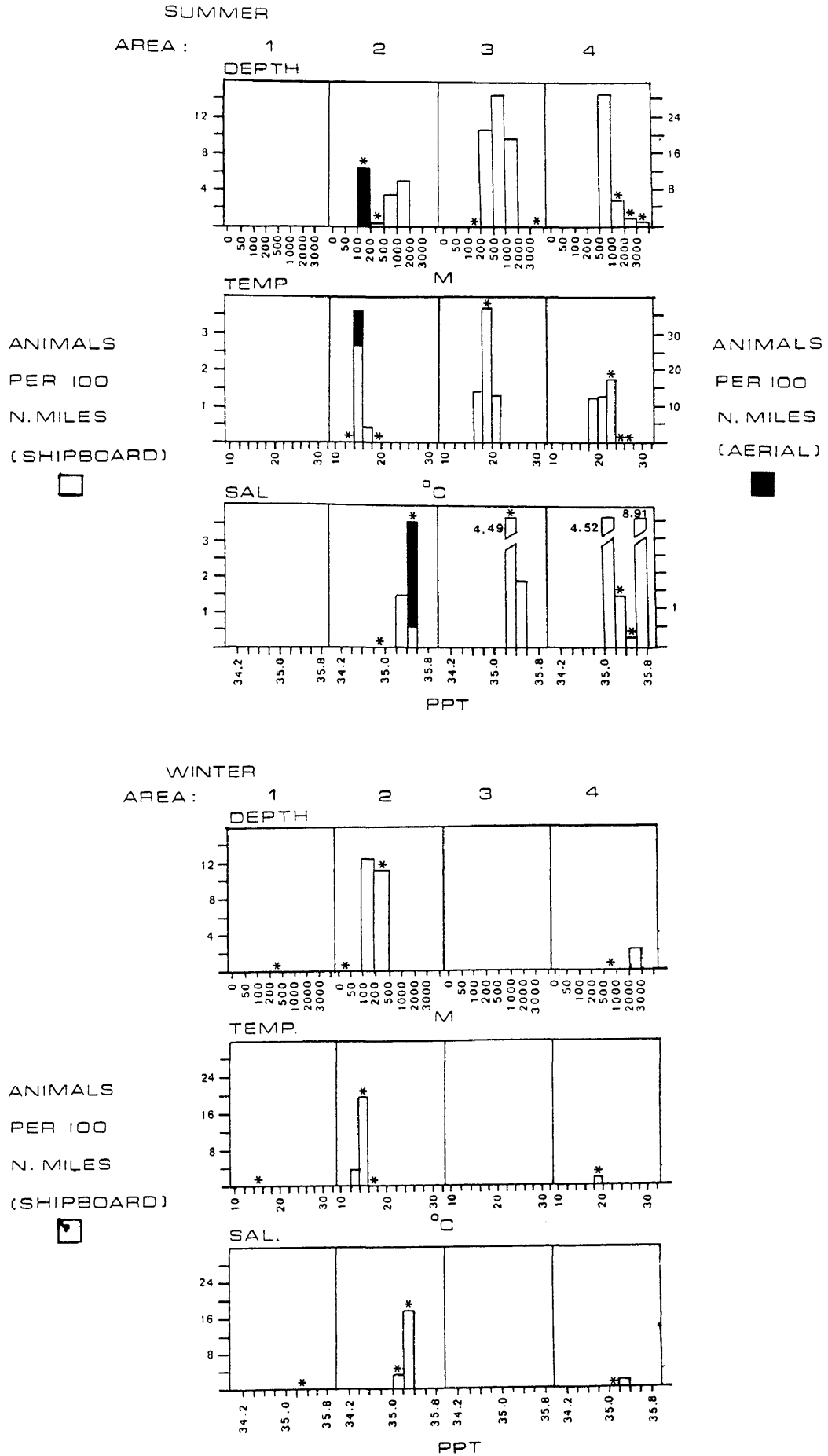


Figure 97. Densities of scientific sightings and occurrence of incidental sightings (*) of Risso's dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

utilisation of areas of high topographical relief is probably related to prey distributions, as these areas are regions of upwelling, and concludes that as upwelling (and therefore productivity) is not related to ocean depth that *D. delphis* should be distributed without regard to depth. Norris and Prescott (1961) found a seasonal offshore movement of *D. delphis* off California in that animals moved inshore in autumn and winter and moved further offshore in spring and summer and they suggest this to be food related, while Evans (1982) found a southward movement of this species in Californian waters between December and June. Ross (1984) suggests that the presence of *D. delphis* in Natal waters during winter is associated with the winter "sardine run".

Fifty - two scientific sightings of common dolphins were made off this coast (figure 98). Group size of these sightings ranged between one and approximately 1000 animals per group with a mean of 267 animals per group (sd \pm 287.2). Seasonal frequencies of group sizes are shown in figure 99. Group sizes were significantly larger in autumn (March to May) and winter (June to August) than other seasons ($F = 14.176, p < 0.05$). The majority of these sightings were made during summer, but this appears to be a reflection of timing of effort in areas where common dolphins occur. Twenty - one incidental sightings of common dolphins have been reported (figure 98) of which the largest school recorded was estimated to be between 1000 and 5000 individuals (Ross 1984). The mean group size for these confirmed incidental sightings was 174.3 animals per group (sd \pm 206.9). The provenances of 431 specimens of common dolphin are shown in figure 98, while months and category of origin are shown in figure 96 and table 24 respectively.

SOUTH

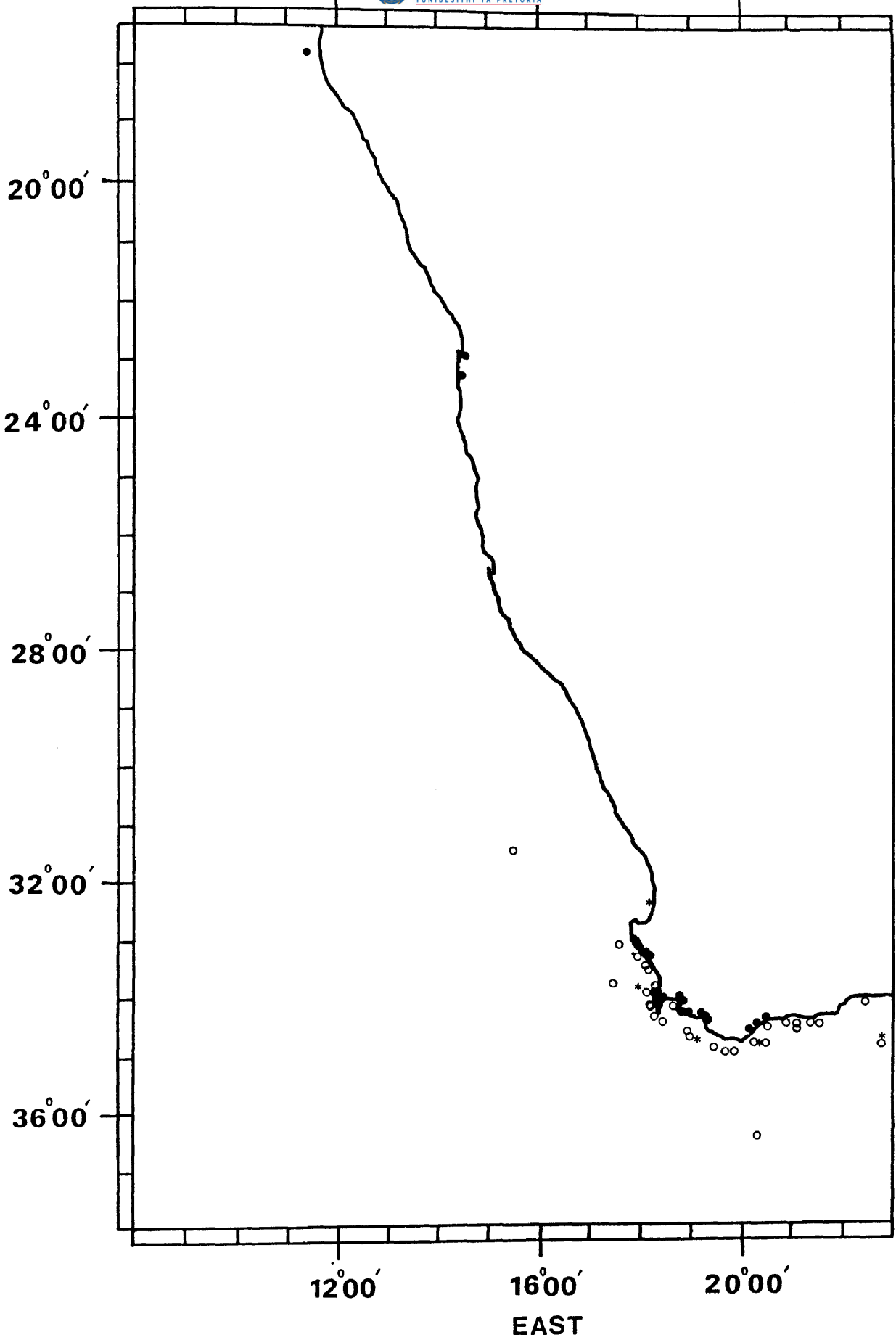


Figure 98. Scientific (o) and incidental (*) sightings and strandings (●) of common dolphins reviewed in this study.

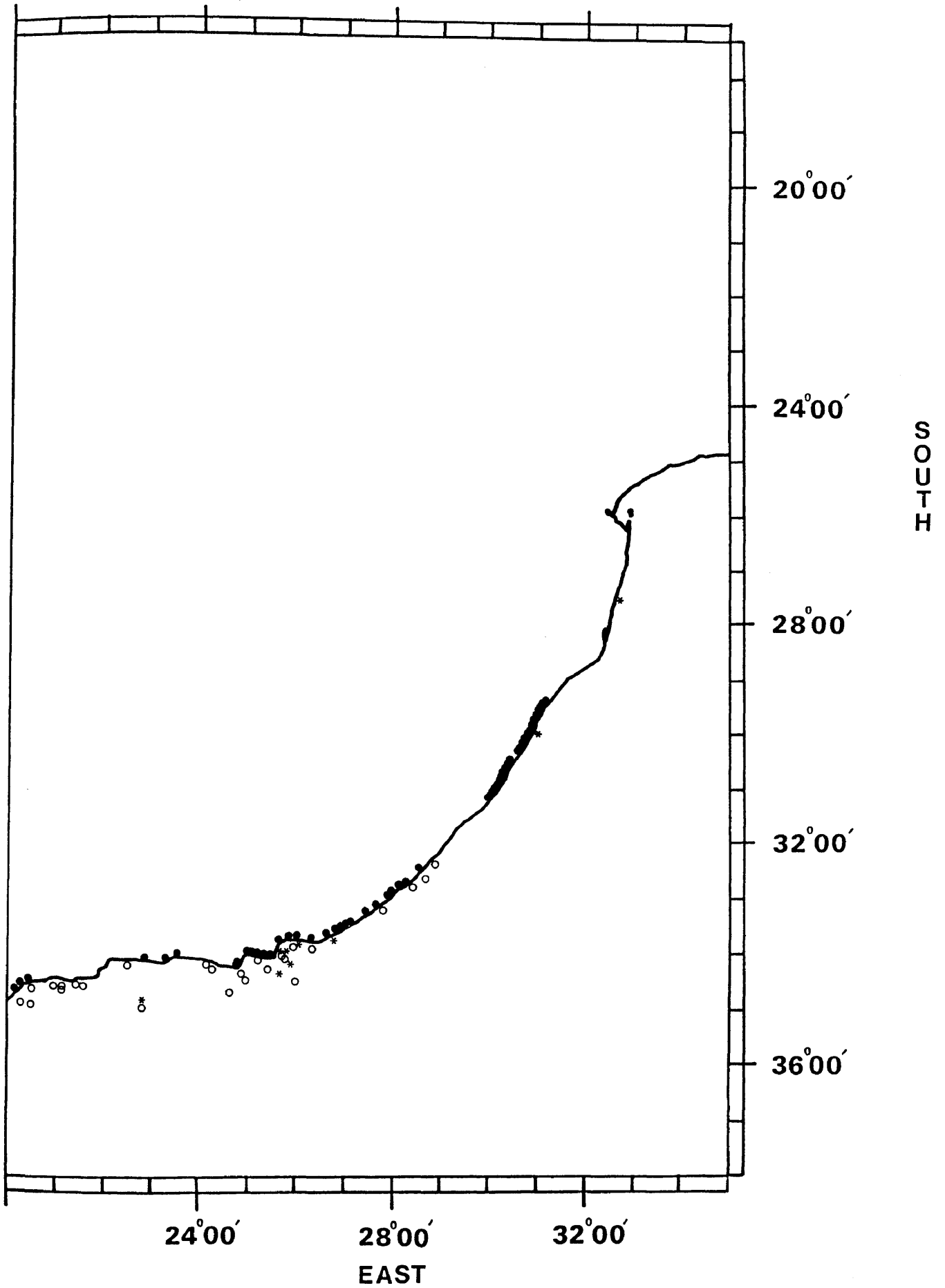


Figure 98. (continued)

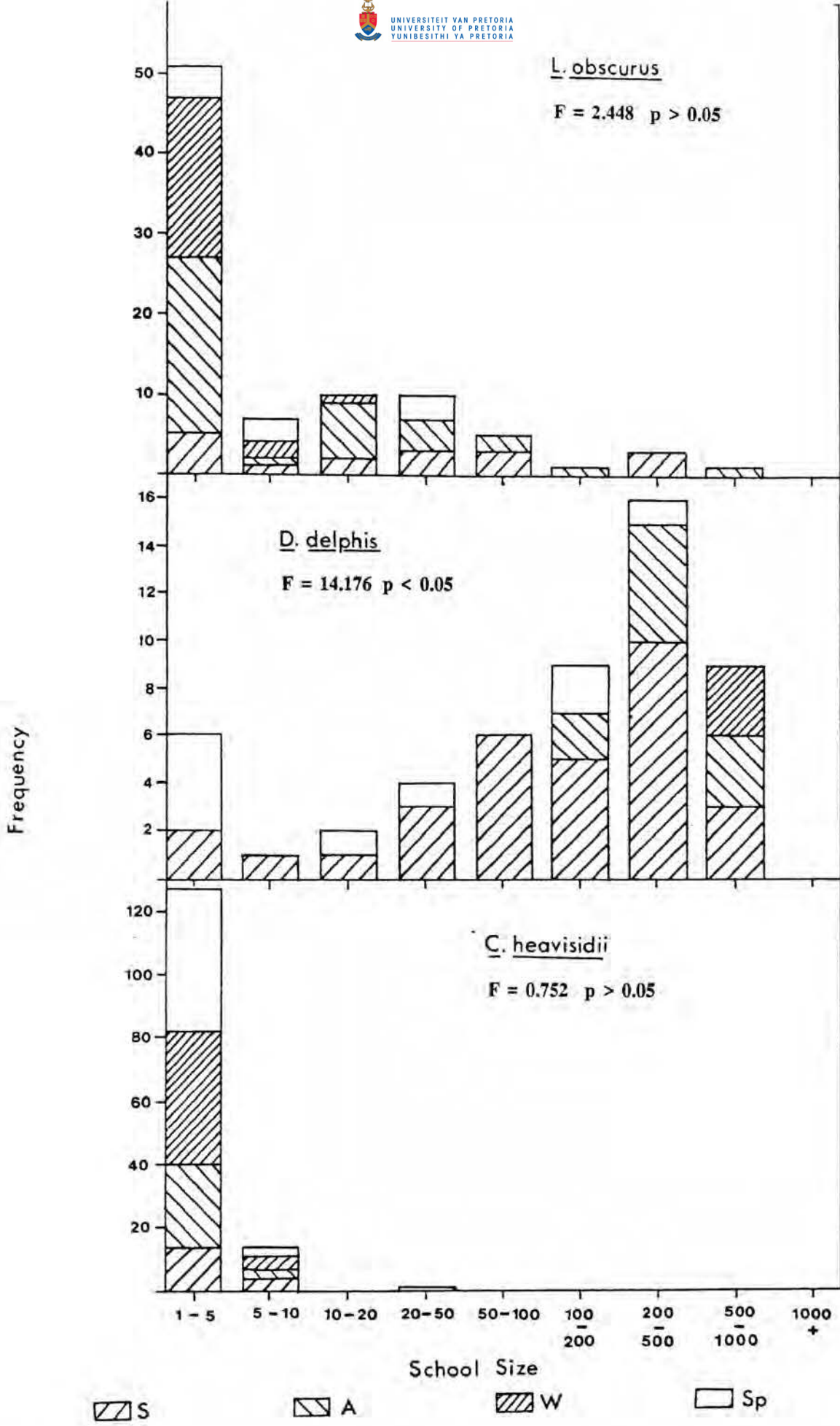


Figure 99. Frequencies of school sizes of common dolphin, dusky dolphin and Heaviside's dolphin sighted on dedicated scientific cruises during December to February (S), March to May (A), June to August (W) and September to November (Sp).

Table 24 Origins of the 431 specimens of common dolphin reviewed in this study.

Category of provenance	Number of individuals
Live stranding	20
Found floating dead at sea	3
Found dead on shore	54
Skeletal material found on shore	5
Skeletal material dredged at sea (or material found in gut of predator)	4
Incidental fishing mortality (including shark net mortalities)	298
Direct fishing mortalities (including scientific collection)	29
Unknown	14

The pattern of sightings of common dolphins infers that this species is distributed from about 31° 00' S on the west coast to north of 28° 00' S on the east coast (figure 98). However strandings as far north as Walvis Bay and an incidental capture at 18° 00' S confirm the occurrence of common dolphin off the South West African / Namibian coast. The lack of sightings on dedicated searches on this coast infer that the distribution is largely off-shore where no search effort was undertaken, and it appears that common dolphins occur in the warmer deep waters off the west coast and avoid the colder inshore waters. Evans (1982) found two separate stocks of common dolphin in the north east Pacific Ocean. These were a long snouted neritic form and a short snouted pelagic form and it may be that two stocks of common dolphin are found in southern African waters, although no morphological have yet been demonstrated. However without studies on the onshore / offshore movements of this species, this is impossible to ascertain.

The one dedicated sighting of *D. delphis* in Area I was made in waters of 500 to 1000 m deep (further confirming a deep water presence off the west coast) and associated with temperatures of between 14° and 16° C and salinities of between 35.2 and 35.4 ppt (figure 100). The majority of sightings in the remaining three areas were in waters of less than 500 m depth, although one sighting to the south of the Agulhas Bank was in waters of between 1000 and 2000 m depth.

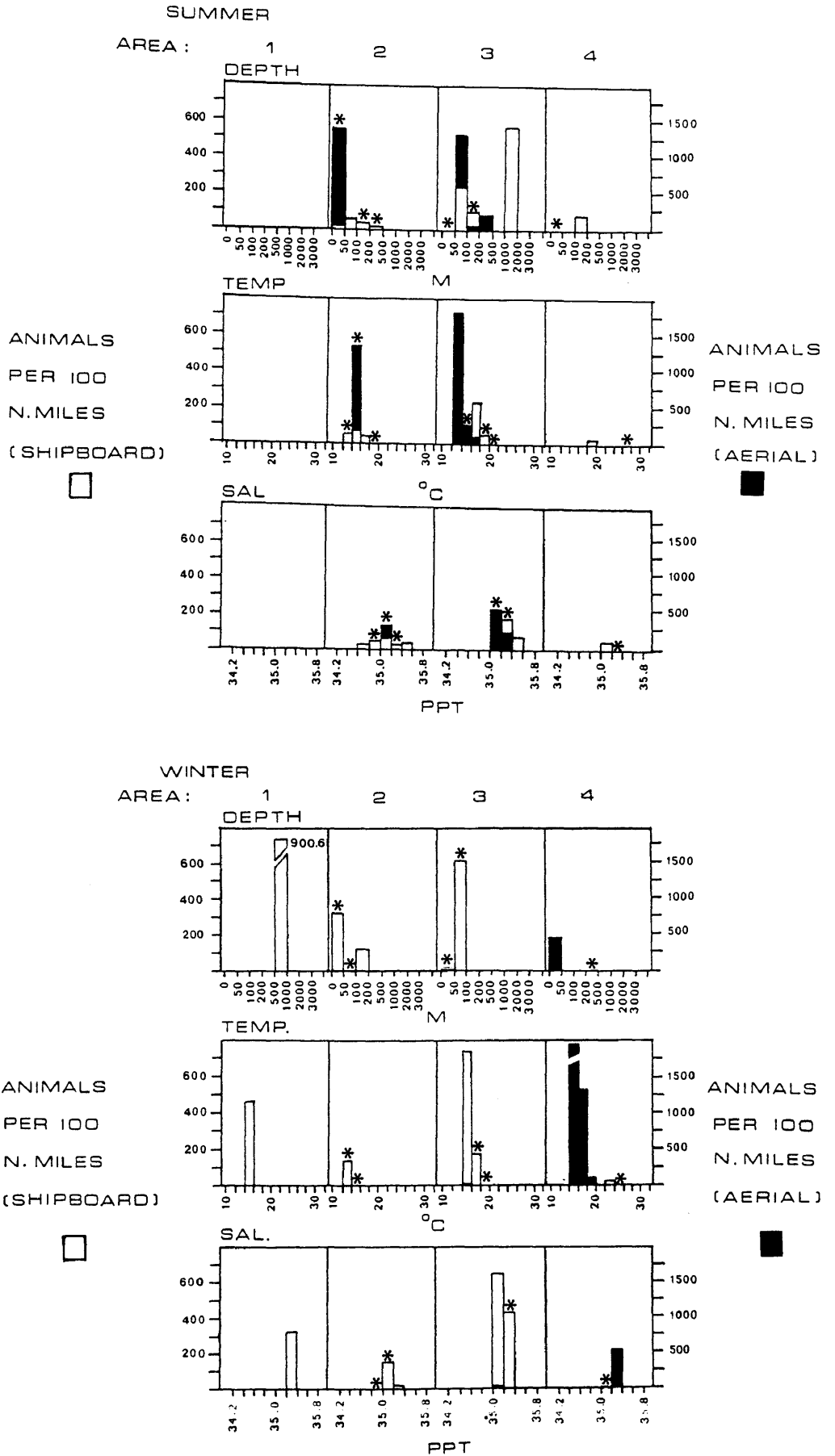


Figure 100. Densities of scientific sightings and occurrence of incidental sightings (*) of common dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Temperatures associated with waters in which the Area II - IV sightings were made ranged between 12^o and 24^o C, although the majority of these sightings were in waters associated with temperatures of less than 20^o C. Evans (1982) suggested that temperatures of above 28^o C could form an upper thermal barrier to *D. delphis* distributions and noted the species' preference for temperate to sub tropical waters. Salinity intervals in which *D. delphis* were recorded ranged from 34.6 to 35.6 ppt, but most of these sightings were in waters associated with salinities of 35.0 to 35.4 ppt.

All incidental sightings of *D. delphis* were made inshore of the 500 metre depth isobath (figure 100). Temperatures associated with these sightings ranged between 12^o (Area II) and 26^o C (Area IV) for both the summer and winter sightings. Salinities associated with these sightings ranged between 34.8 ppt (Area II) and 35.4 ppt (Area IV).

Common dolphins were found in Area II and III throughout the year. Ross (1984) suggested that this species follows the winter "sardine run" into Natal (Area IV) waters. The seasonal catches of common dolphins in shark nets on this coast substantiates this (figure 99), but it must be noted that common dolphins were sighted (as both dedicated and incidental sightings) in Area IV during both summer and winter. Only one sighting of common dolphins was made offshore (in waters of over 500m depth) to the north of 32^o 00 S on the west coast and this sighting was made in winter.

Specimens of common dolphin were recorded in Area I during both summer and winter, but it is not known if these originate from inshore or offshore populations.

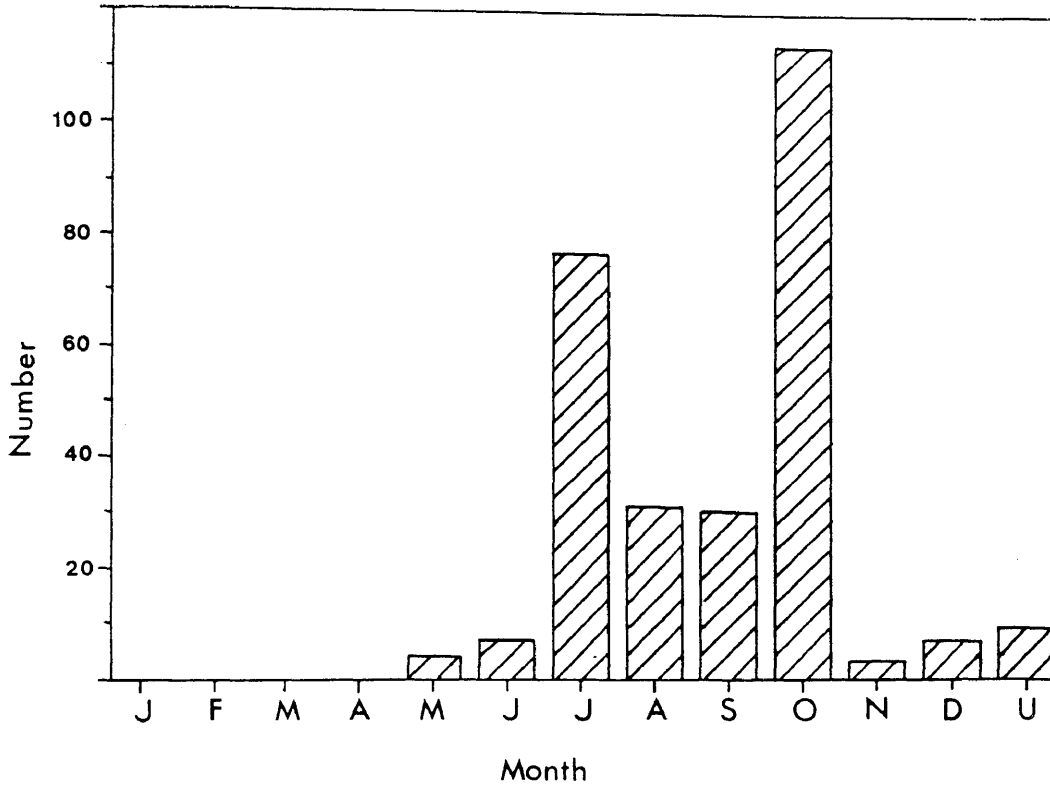


Figure 101. The seasonal abundance of incidental catches of common dolphins in anti - shark nets off the coast of Natal.

Dusky dolphin (*Lagenorhynchus obscurus*)

Wursig and Wursig (1980) note that *L. obscurus* populations are distributed in coastal waters of the Southern Hemisphere and most notably found off the coasts of New Zealand, South Africa and South America. Brownell (1965) states that *L. obscurus* has a circumpolar distribution north to approximately 30° 00' S, but Gaskin (1968) however regards this distribution with caution and maintains that there is no evidence that the species occurs east of the Chatham Islands in the South Pacific. Gaskin (1968) further suggests that the *L. obscurus* population off New Zealand is associated with the subtropical convergence and rapidly disappears to the north and south of it.

One hundred sightings of dusky dolphin were made on scientific cruises (figure 102). These sightings occurred throughout the year and confirmed school size ranged from 2 to 800 animals with a mean of 35.32 animals per group (sd \pm 104.46). The seasonal frequency of group sizes is shown in figure 99 and no significant differences were found in log transformed group sizes between seasons ($F = 2.448$, $p > 0.05$). Seventy - one incidental sightings of dusky dolphins have been reported including forty - one during live - capture attempts of animals for oceanaria. Mean group size of the confirmed incidental sightings was 29.2 animals per group (sd \pm 48.3). Sixty - two specimens of dusky dolphin are recorded from the west coast. Provenances of these records are plotted in figure 101, while months and categories of origin are presented in figure 95 and table 24 respectively.

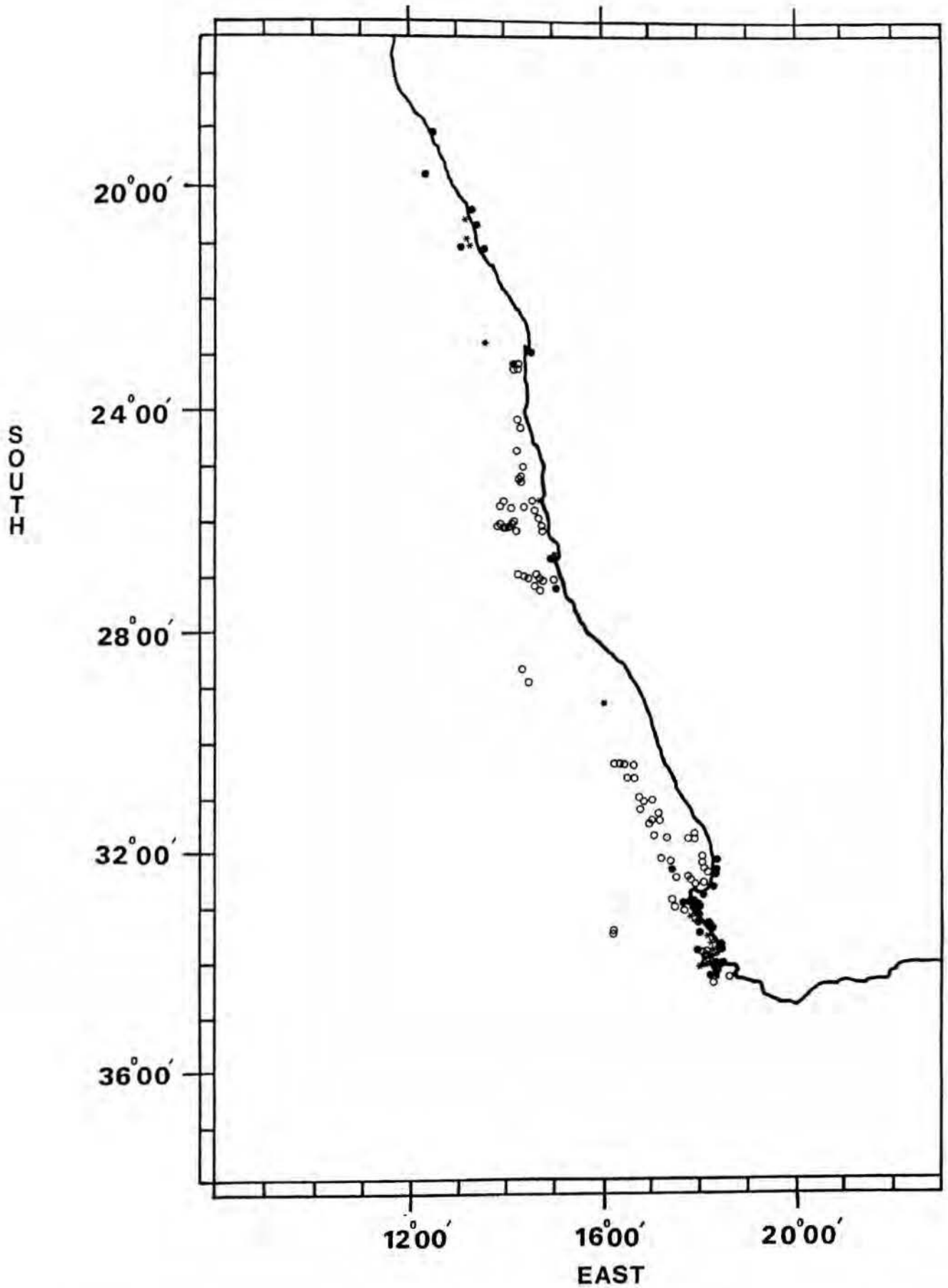


Figure 102. Scientific (○) and incidental (*) sightings and specimens (●) of dusky dolphins reviewed in this study.

Table 24. Origins of specimens of *L. obscurus* reviewed in this study.

Category of provenance	Number of individuals
Live stranding	6
Dead stranding	1
Found floating dead at sea	2
Found dead on shore	17
Skeletal material found on shore	5
Skeletal material dredged at sea (or material found in gut of predator)	1
Incidental fishing mortality (including shark net mortalities)	3
Direct fishing mortalities (including scientific collection)	26
Unknown	1

All sightings of *L. obscurus* were made to the west of 19° 00' E (figure 102). Brownell (1974) maps *L. obscurus* as occurring along the south coast as far east as Algoa Bay. This is based on a misinterpretation of a statement made by Saayman and Tayler (1972) and on a personal communication by Prescott (in Brownell 1974). Prescott has no knowledge of this personal communication (Prescott in litt). A hiatus in the distribution is apparent between about 27° 00' S and 30° 00' S on the west coast, as only two sightings are recorded between these latitudes (these sightings were made slightly further offshore than the majority of other sightings), despite substantial search effort in this region. A further smaller hiatus is apparent between 21° and 23° S. Although the distribution of *L. obscurus* overlaps the upwelling cells (noted by Shannon (1985)) off the Cape Peninsula, Cape Columbine and Luderitz, the larger southern hiatus overlaps the Hondeklipbaai upwelling cell.

The furthest northern record known from the west coast is from Lobito Bay, Angola (12° 00 S) (Kramer 1961), but this may not be the northernmost limit of the distribution. Read, Van Waerebeek, Reyes, Mckinnon and Lehman (1988) record catches of dusky dolphins as far north as Huacho (approximately 11° S) on the coast of Peru.

The majority of scientific sightings of *L. obscurus* were made in waters of less than 500 metres depth (figure 103). This may reflect some bias towards the nearshore in that there is little off-shore effort on the West Coast, and the species was recorded in over 2000 metres water depth in Area II during the *Terrier III* cruise of 1963. However *L. obscurus* appears to be most strongly associated with the 0 to 50 metre depth interval. Wursig and Bastida (1986) found that of nine dusky dolphins marked off Argentina, eight kept within 20 km of the shore while one moved up to 50 km from the shore. Temperatures measured in the waters in which dusky dolphins were sighted in summer ranged from 10° to 16° C in both Areas I and II. Winter temperatures in which April to September sightings of *L. obscurus* were made fell between 10° and 12° C in Area I and 12 and 14° C in Area II. Wursig and Wursig (1980) suggest that *L. obscurus* observed in the Golfo San Jose' may have been avoiding summer temperatures of over 18 C°, but did not avoid low ($\pm 10^{\circ}\text{C}$) winter temperatures. Salinities measured in waters in which *L. obscurus* were sighted ranged between 34.6 and 35.4 ppt in summer and between 34.8 and 35.4 ppt in winter. All incidental sightings of *L. obscurus* were made in waters of less than 500 metres depth (figure 103). Summer sightings were associated with temperatures of between 12° and 16° C and salinities of between 34.8 and 35.2 ppt. Winter sightings were associated with temperatures of between 12° and 14° C and salinities of between 34.8 and 35.2 ppt.

Thus *L. obscurus* is a year - round resident of the west coast of southern Africa and occurs predominantly over the shelf in the 0 - 50 m depth interval, with some of the population occurring off the shelf edge. Unfortunately insufficient search effort was made in deep waters off the west coast to establish densities more accurately.

Heaviside's dolphin (*Cephalorhynchus heavisidii*)

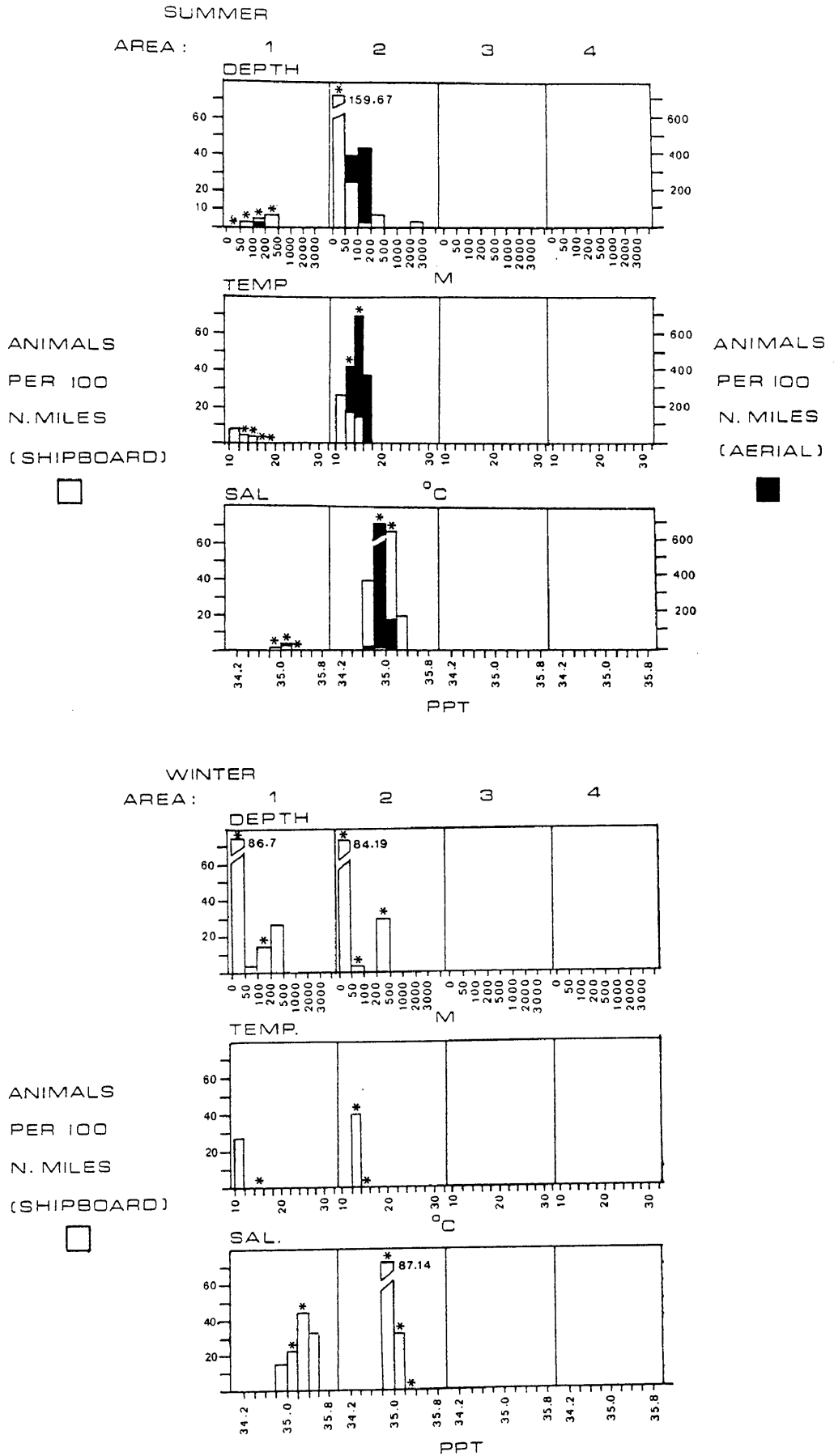


Figure 103. Densities of scientific sightings and occurrence of incidental sightings (*) of dusky dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Marcuzzi and Pilleri (1971) erroneously map *C. heavisidii* as occurring in Natal and Southern Cape waters and as occurring in an trans - oceanic band into the south western Atlantic (where it is mapped as occurring sympatrically with *C. commersoni* off the Argentinian coast). Best (pers. comm. in Mitchell 1975) defines the distribution as from Cape Cross to Cape Town on the west coast of the African sub-continent, while Watkins, Schevill and Best (1977) state that it is found in coastal waters off the West coast of southern Africa from about 18⁰ 00' S to the Cape of Good Hope.

One hundred and forty - nine scientific sightings of a total of 482 individuals of Heaviside's dolphin are recorded off the West coast. Group size ranged from one individual to 30 individuals with a mean group size of 3.15 animals per group (sd \pm 3.07). The seasonal frequencies of group sizes are shown in figure 99 and no significant differences in log transformed group sizes were found between seasons ($F = 0.752, p > 0.05$). Forty incidental sightings of Heaviside's dolphin have been reported. These sightings also range between one and 30 animals per group (with a mean group size of 3.97 (sd \pm 4.92) animals per group). The provenances of fifty - nine specimens of Heaviside's dolphin are plotted in figure 104, while the seasonality and categories of origin are presented in figure 96 and table 25 respectively. The low winter abundance of Heavisides dolphins apparent in figure 96 may result from uneven reporting effort as human coastal utilisation would be higher in summer than winter.

Table 25. Origins of the 59 specimens of Heaviside's dolphins reviewed in this study.

Category of origin	Number
Found floating dead at sea	1
Found dead on shore	32
Skeletal material found on shore	8
Skeletal material dredged at sea (or material found in gut of predator)	1
Incidental fishing mortality (including shark net mortalities)	4
Direct fishing mortalities (including scientific collection)	13

SOUTH

20°00'

24°00'

28°00'

32°00'

36°00'

12°00'

16°00'

20°00'

EAST

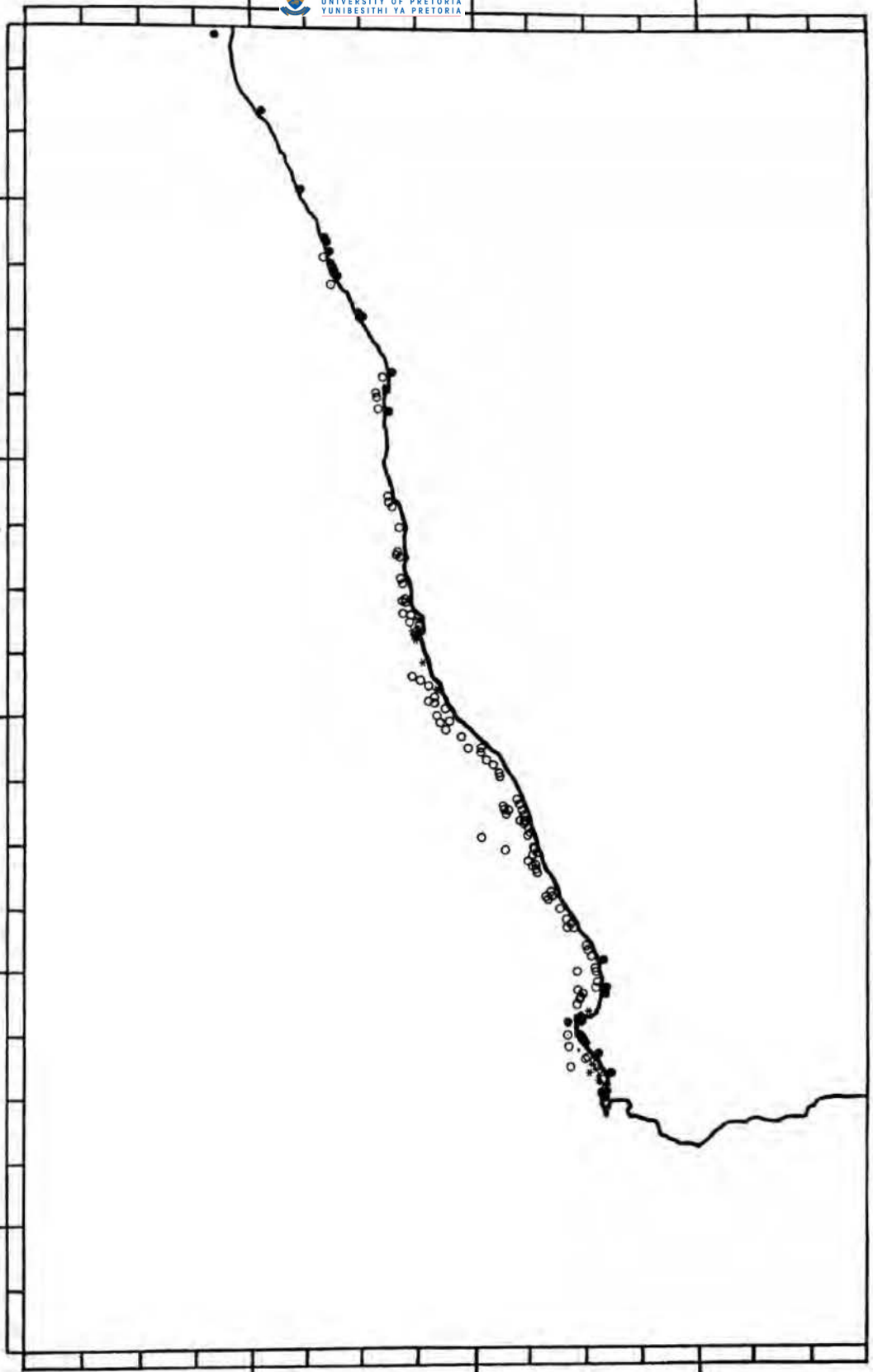


Figure 104. Scientific (○) and incidental (*) sightings and strandings (●) of Heaviside's dolphins reviewed in this study.

All records of Heaviside's dolphin have been recorded to the west of Cape Point (figure 104) although one unconfirmed incidental sighting was reported from approximately one mile east of Cape Point. The furthest north that this species was recorded was $17^{\circ} 09' S$, but the accuracy of this position is uncertain. No data were available from Angola.

All sightings of *C. heavisidii* were in waters of less than 200 m depth and associated with temperatures of less than $18^{\circ} C$ and a wide range of salinities (34.0 to 35.4 ppt for summer sightings and 34.6 to 35.2 ppt for winter sightings) (figure 105).

Thus *C. heavisidii* is a year - round resident of nearshore waters of the west coast and tends to favour waters of between 0 and 100 m depth. One dolphin (tagged on the 11 May 1986 at $25^{\circ} 21' S$, $14^{\circ} 43' E$) was caught in a purse seine on the 27 October 1987 in the region of Conception Bay ($23^{\circ} 50' S$, $14^{\circ} 30' E$), and repeated sightings of recognisable albino individuals between Table Bay and Yserfontein ($33^{\circ} 22' S$, $18^{\circ} 09' E$) over a 3 year period (Rice and Saayman 1984) would suggest that their home ranges may be quite small.

Fraser's dolphin (*Lagenodelphis hosei*)

Prior to 1971, Fraser's dolphin was only known from a skeleton collected in 1895 from Sarawak, Borneo. Perrin, Best, Dawbin, Gambell and Ross (1973) recorded at - sea sightings of the species off the coast of southern Africa, as well as specimens from the tropical Eastern Pacific, off Durban and from New South Wales, Australia. Robinson and Craddock (1983) suggest that the species has a pan tropical distribution. Ross (1984) notes that the species has been recorded from widespread localities in the tropical waters of the Pacific and the Atlantic and states that despite sightings and strandings occurring at the same time of the year on the S.E. coast, the data are insufficient to show seasonality.

Fourteen dedicated scientific sightings of *L. hosei* have been made off the coast of South Africa. It

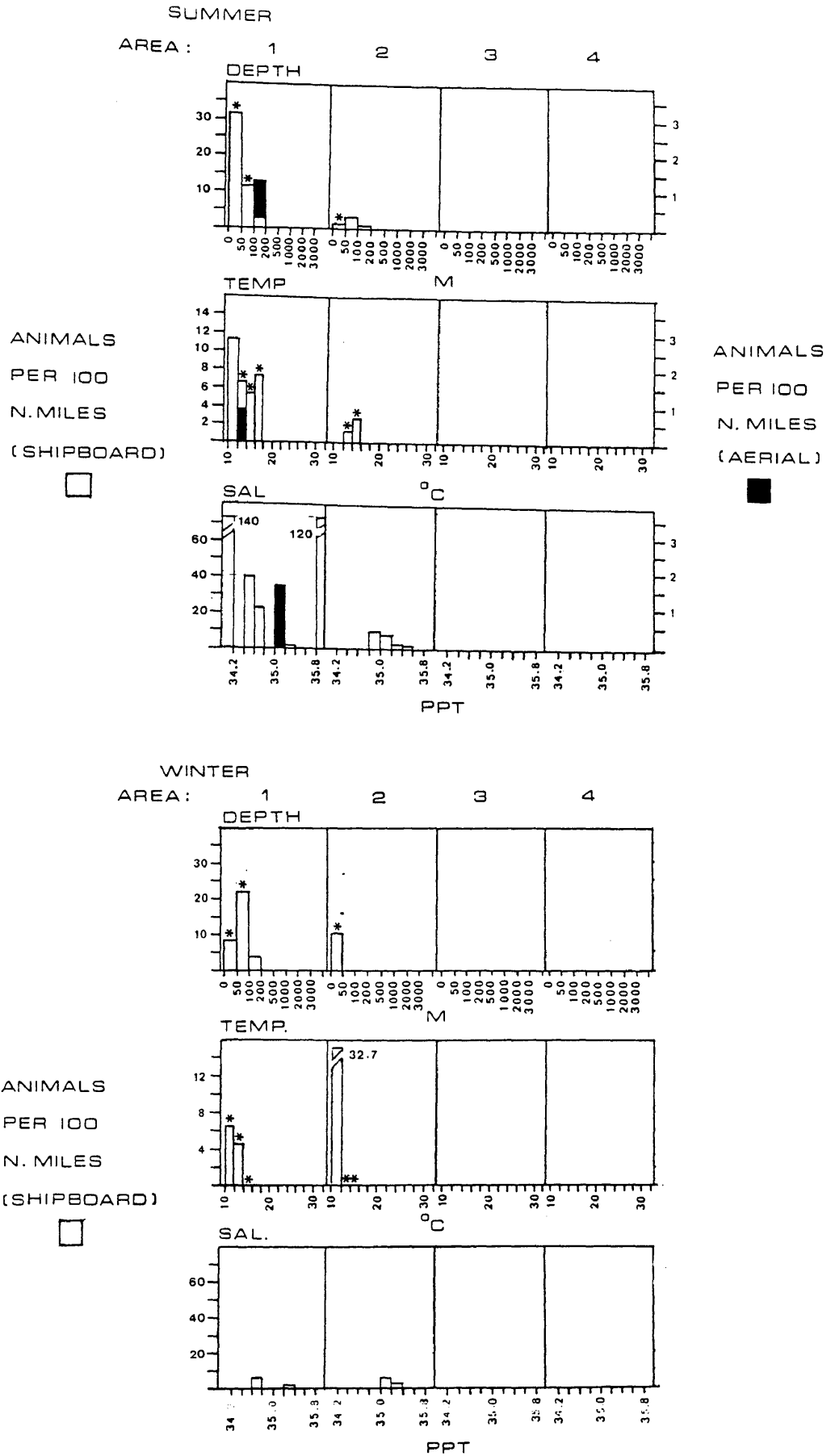


Figure 105. Densities of scientific sightings and occurrence of incidental sightings (*) of Heaviside's dolphin in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

must be noted that a number of these sightings were made prior to Perrin *et al* (1973)'s report and subsequent identifications of these particular individuals were made from field notes and sketches given the greater knowledge of the animal's appearance. The majority (13) of the sightings are recorded in summer (the one winter sighting was made during August). Group size ranges from seven to 1000 animals with a mean of 183.1 animals per group (sd \pm 277.1). Incidental sightings of *L. hosei* have been reported for April (150 animals) and August (about 100 animals) and September (25 animals).

Figure 106 shows the provenances of fourteen specimens of *L. hosei*, while table 26 and figure 96 show the categories and months of origin of these specimens. No seasonality is apparent from these incidental sighting or specimen data.

Table 26. Origins of the 14 specimens of Fraser's dolphin reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	2
Found dead on shore	6
Incidental fishing mortality (including shark net mortalities)	1
Direct fishing mortalities (including scientific collection)	4
Unknown	1

It would appear from the pattern of sightings and specimens that the distribution of *L. hosei* is strongly associated with the sub-tropical component of the Agulhas current (figure 106). Only one sighting is recorded to the west of 27° 00' E (at 26° 50' E). All scientific sightings of *L. hosei* have been made in waters of depths of over 500 metres in Areas III and IV (figure 107). Summer temperatures measured in these waters were between 20° and 22° C in Area III and between 20° and 24° C in Area IV. The temperature associated with the winter sighting in Area IV was between 18° and 20° C. Summer salinities recorded in these waters were between 35.4 and 35.6 ppt (in Area III) and 35.0 and 35.8 ppt (in Area IV). The incidental sightings of *L. hosei* were made in waters of between 1000 and 2000 metres depth. The summer sightings were in waters associated with temperatures of between 24° and 26° C and salinities of between 34.4 and 34.6 ppt. The winter sightings were made in waters associated with temperatures of between 20° and 24° C and salinities of between 35.2 and 35.4 ppt.

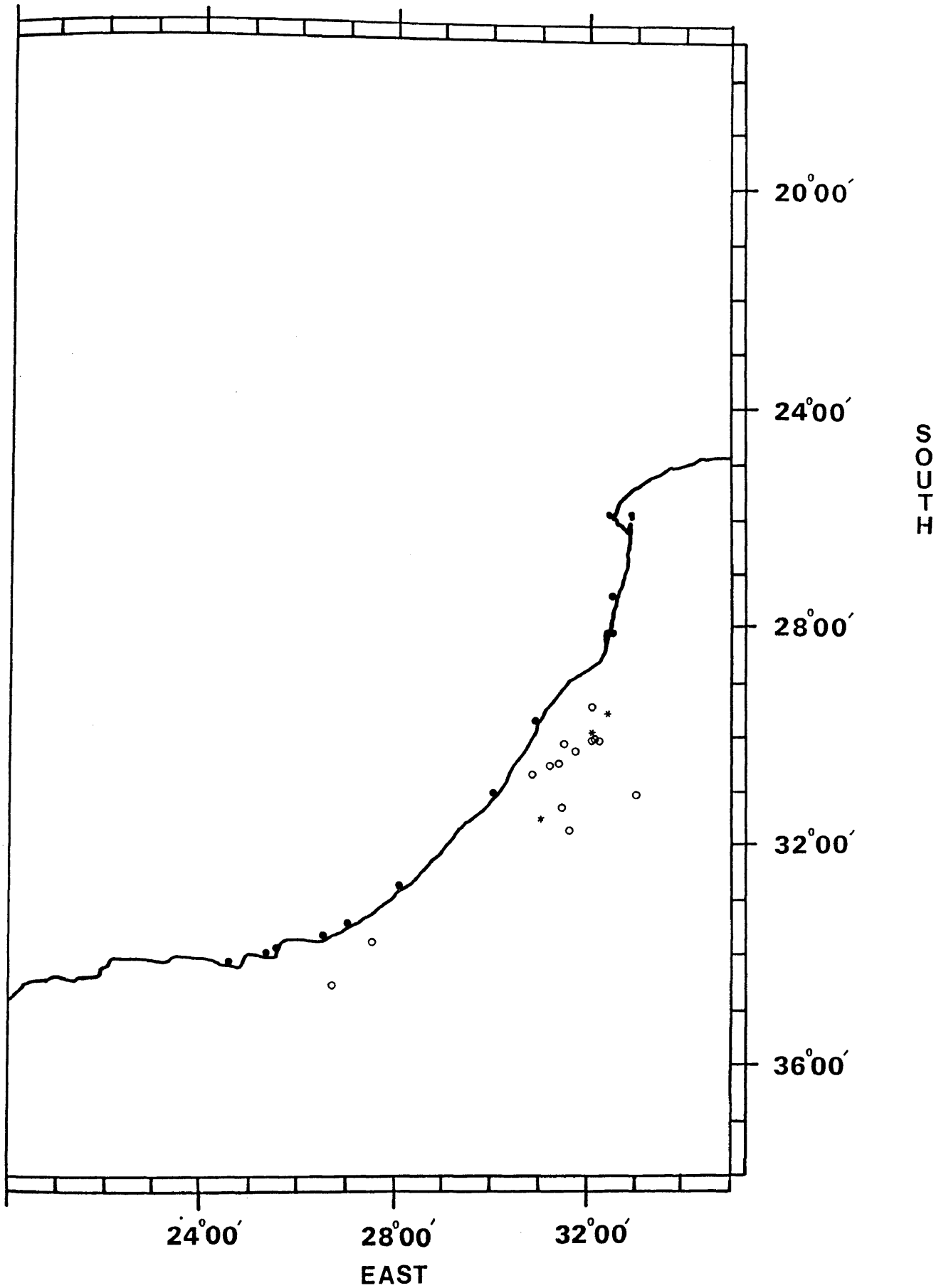


Figure 106. Scientific (o) and incidental (*) sightings and strandings (●) of Fraser's dolphins reviewed in this study

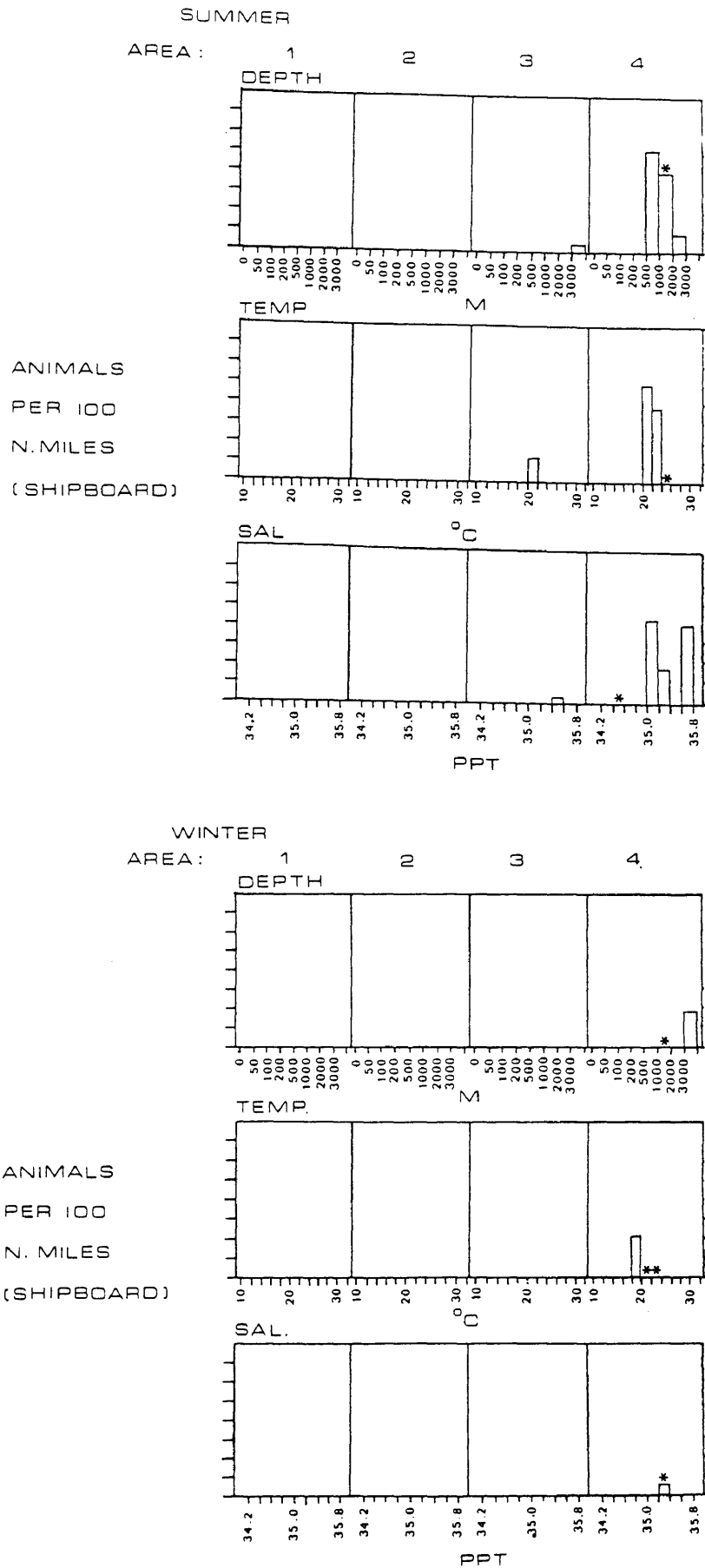


Figure 107. Densities of scientific sightings and occurrence of incidental sightings (*) of Fraser's dolphin in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

L. hosei was found year - round off the shelf edge off the east coast and may well have a localised occurrence in this area. No sightings of this species further offshore (outside the study area) were made on the 1973 / 74 whale marking cruise that covered a large part of the south eastern Indian Ocean (Gambell, Best and Rice 1975).

Southern right whale dolphin (*Lissodelphis peronii*)

The recorded distribution of this species is limited to the cooler waters of the Southern Hemisphere (Gaskin 1968, Brown 1973). It has been recorded from 58° 00' S to 64° 00' S off the coast of South America (Fraser 1955) and Brownell (1974) notes that all observations except two are from the S.W. Atlantic, South Pacific and Australian waters. Gaskin (1968) states that the presence of this species in water of surface temperatures between 9° and 15° C suggests that it is distributed south of the Subtropical Convergence but north of the Antarctic Convergence. Fraser (1955) maintains that *L. peronii* probably has a circumpolar distribution in the Southern Hemisphere and that it has a "predelection" for the West Wind Drift, as records to the north are close to the Subtropical Convergence and there is only one sight record for the Antarctic Ocean. Kasamatsu *et. al* (in press) found three sightings of *L. peronii* to the south of 58° S and these sightings were associated with temperatures of between 1.4° and 13.8° C. Barnard (1954) suggested it might well occur off the coast of South Africa and Brown (1973) on the basis of sea surface temperature and the records in the Peru Current as far north as 19° 00' S suggested that it may be found in the Benguela Current. Brownell (1974) states that *L. peronii* is an epipelagic species whereas Aguayo (1975) defines it as a pelagic and coastal species.

There are no recorded scientific sightings of this species from southern Africa. Twelve incidental sightings of *L. peronii* have been recorded (figure 108) including those published by Cruikshank and Brown (1981). A further record is published by Brown (1982) but no accurate locality is given. Group size ranged between three and 250 with a mean of 52.25 animals per group (sd \pm 82.59). Eight of the sightings were made in summer (January (3), February (3), November (1) and December (1)) and two in autumn and winter (April (2) and August (2)) (figure 110).

SOUTH

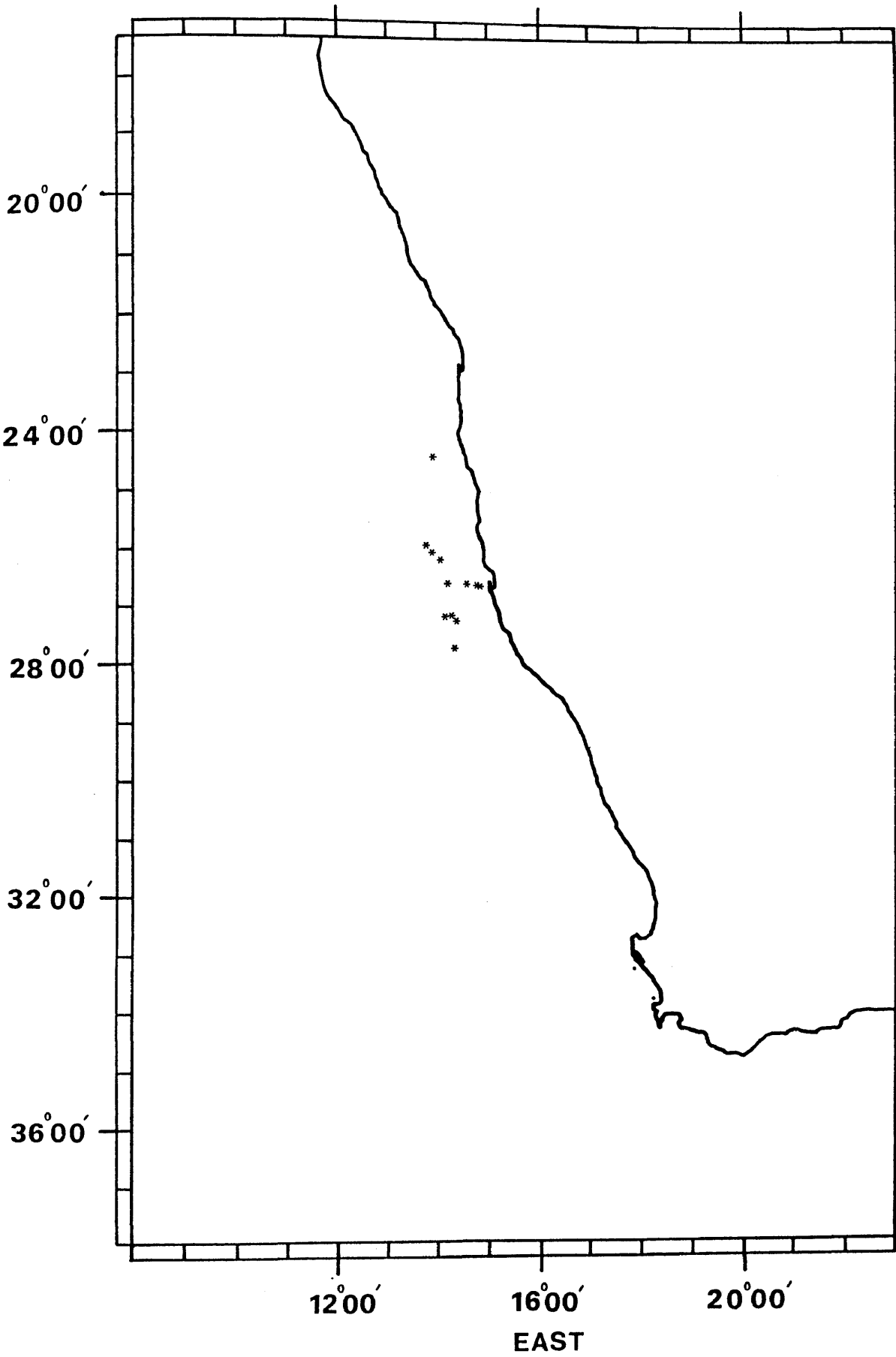


Figure 108. Localities of incidental sightings of southern right - whale dolphin reviewed in this study.

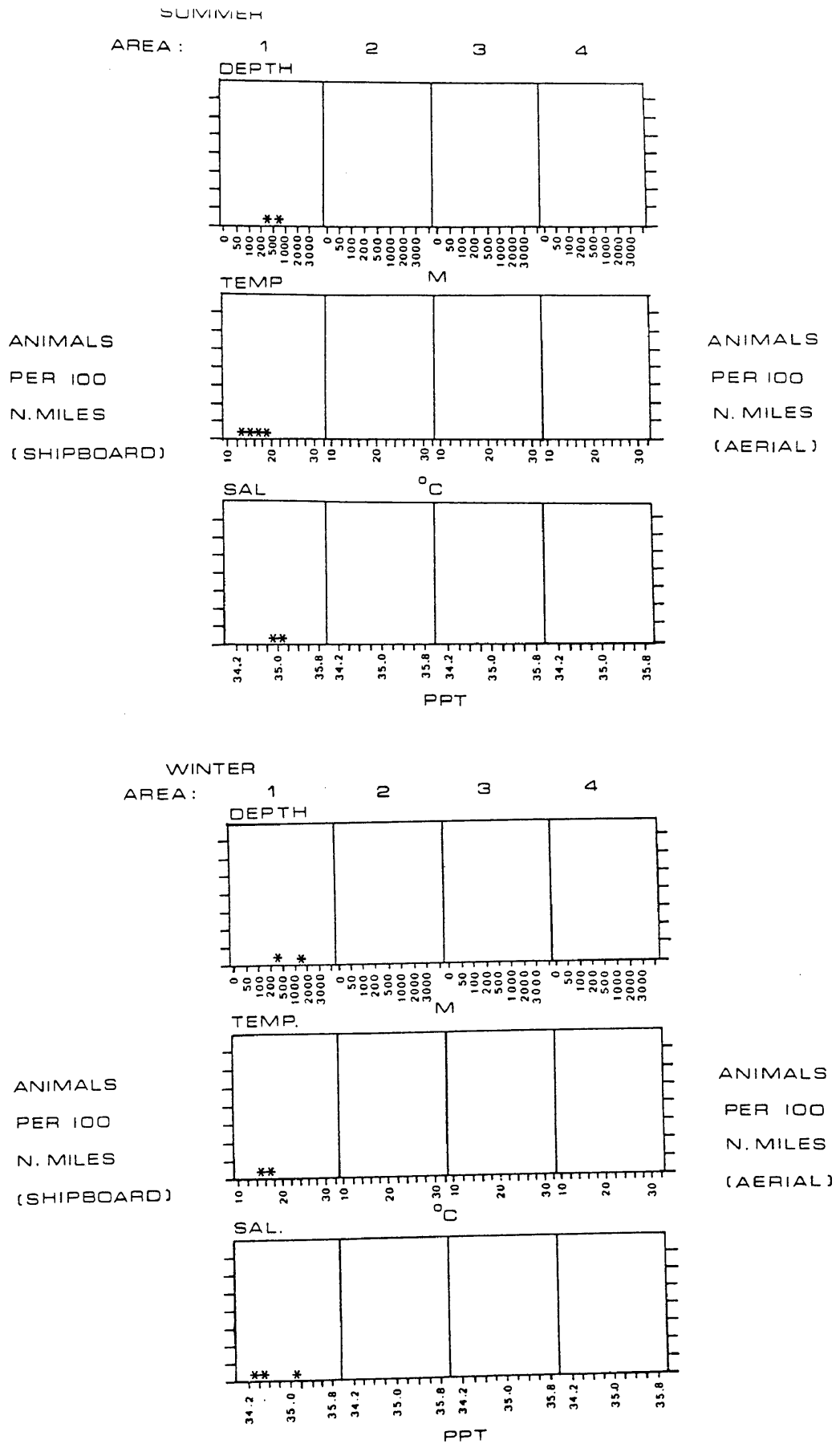


Figure 109. The distribution of incidental sightings of southern right - whale dolphins by depth, sea surface temperature, and sea surface salinity during summer and winter.

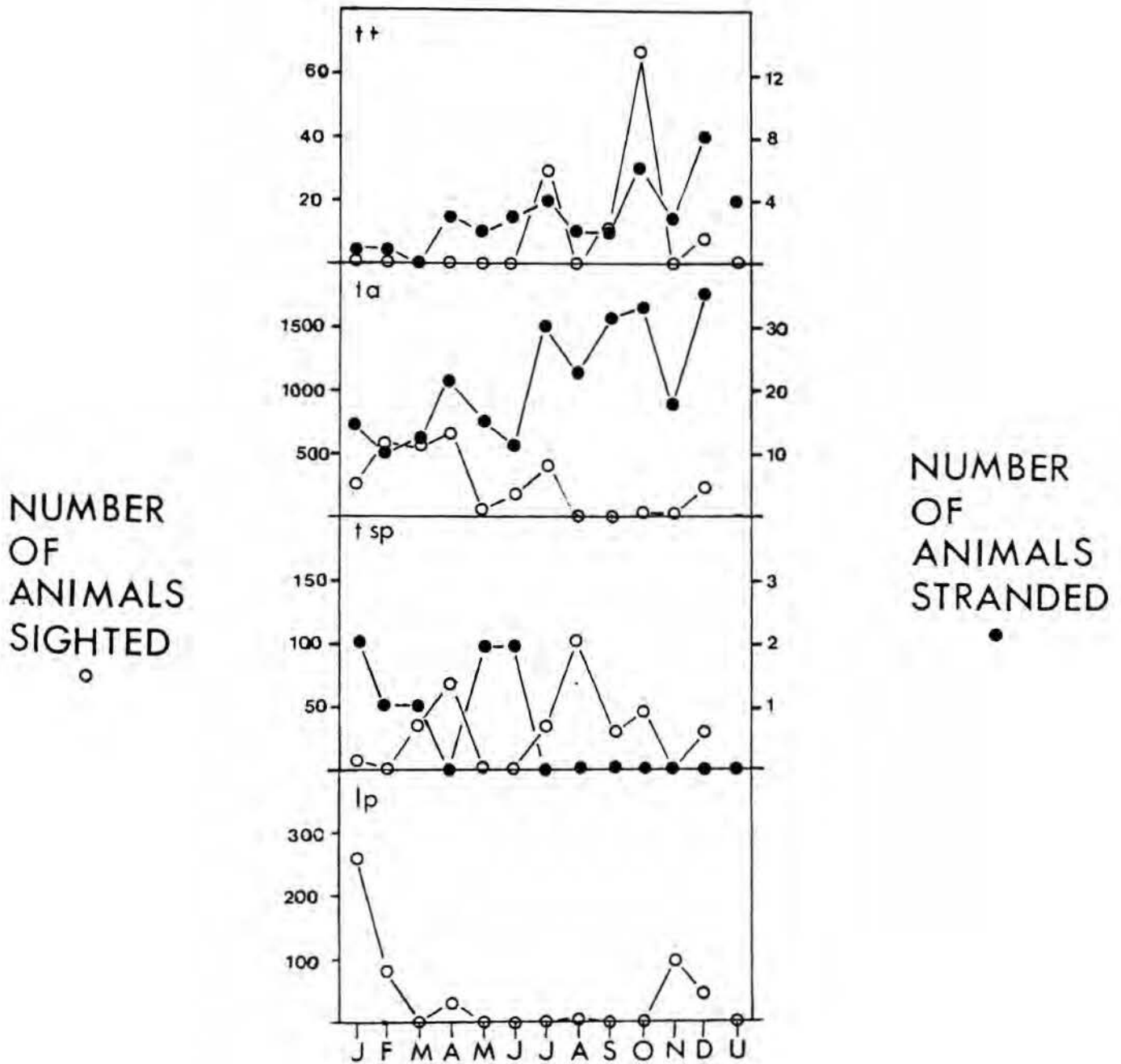



Figure 110. The seasonal abundance of incidental sightings and specimens of southern right - whale and bottlenose dolphins. lp - southern right whale dolphins, ts, tt and ta - unidentified form and *truncatus* and *aduncus* forms of bottlenose dolphins respectively. (U = month of incidence unknown.)

Cruikshank and Brown (1981) note that the  sightings were made in waters with surface temperatures between 15.5^o and 20.1^o C and of depths of between 300 and 500 metres. However the position given for the group of 200 - 300 animals sighted on the 24-1-79 (26^o 40' S 14^o 49' E) lies in waters less than 200 metres deep. Water depths of the remaining five sightings range from between 100 and 200 metres to between 1000 and 2000 metres. Temperatures associated with the incidental sightings ranged between 12 and 20^o (summer sightings) and 14 and 18^o (winter sightings). Salinities associated with these sightings ranged between 34.8 and 35.2 ppt (summer) and 34.2 and 35.2 ppt (winter).

Thus it would appear that *L. peronii* has a year - round occurrence in a localised area off the west coast of SWA / Namibia. The distribution appears to be associated with the Luderitz upwelling cell region and the lack of sightings in South African waters infers that this population is resident in a localised area off South West Africa / Namibia.

Bottlenose dolphins (Genus *Tursiops*)

There is some doubt over the taxonomic position within the genus *Tursiops*. Ross (1977) identified two species of *Tursiops* off the coast of southern Africa, namely *T. truncatus* and *T. aduncus*, and maintained that these species exist allopatrically, but that there is no evidence that this is due to competitive exclusion. Ross (1984) stated that the smaller *T. aduncus* is widely distributed in Indian Ocean coastal waters, but was uncertain of the western limit of this distribution. It was found inshore off the S.E. coast of South Africa, while the larger *T. truncatus* was found off shore on the south and south eastern coasts and inshore on the West Coast. Ross, Cockcroft and Butterworth (1987) found that all the *T. aduncus* sighted on an aerial census off the east coast of South Africa were inshore of the fifty metre depth isobath, while on boat censuses in Algoa Bay *T. aduncus* was rarely seen outside of the 40 metre isobath.

Ross (pers. comm.) maintains that recent evidence suggests that these two species are in fact two distinct forms of *Tursiops truncatus* and this approach has been followed in this study. All sightings of *Tursiops*, however, have been entered into the data base as *Tursiops* species due to the difficulty in

Eighty - six dedicated sightings of *Tursiops* have been made throughout the year (figure 111). Seventy - three of these were confirmed sightings of a total of 2434 animals and mean group size was 33.34 animals per group (sd± 52.68). Excluding the localised capture attempts for oceanaria (in which the form has been identified) twenty - three incidental sightings of a total of 682 *Tursiops* species were made throughout the year. Mean group size was 29.62 animals per group (sd ± 36.43). Eight specimen records of bottlenose dolphins could not be identified to *truncatus* or *aduncus* forms. The provenances and months and categories of origin of these specimens are presented in figure 111, figure 110 and table 27 respectively.

Table 27. Origins of the 8 specimens of *T.truncatus* that could not be attributed to "form" reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	2
Found dead on shore	3
Incidental fishing mortality (including shark net mortalities)	3

These sighting and specimen records were distributed throughout southern African waters (figure 111).

The *truncatus* form

Eleven live capture attempts of the *truncatus* form occurred in Walvis Bay (22⁰ 52' S; 14⁰ 33' E) in 1975, 1976 and 1983, while a further thirty - nine records of specimens of this form could be identified. Provenances of specimens are shown in figure 112. Categories and months of origin of these specimens are presented in table 28 and figure 110 respectively.

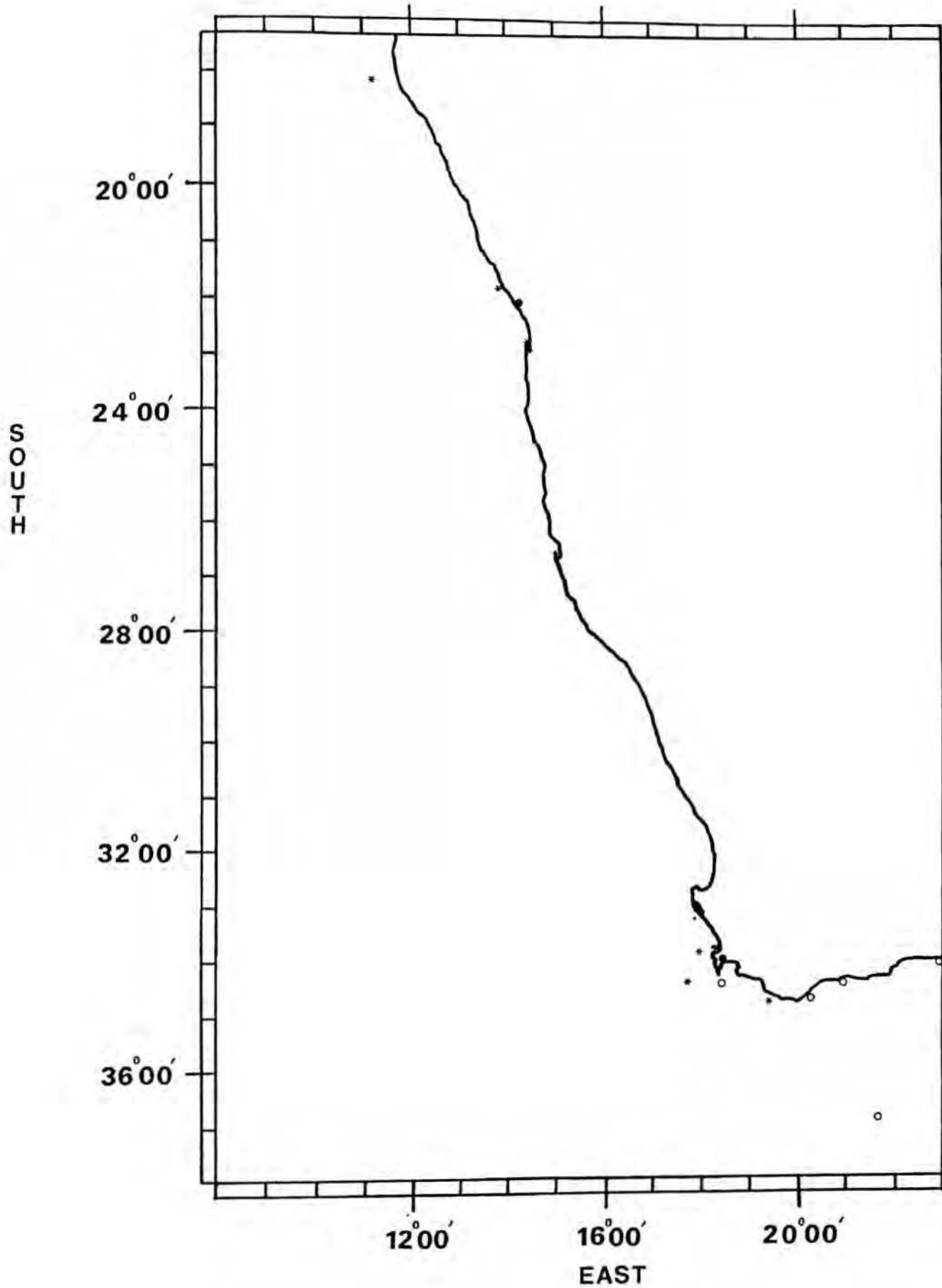


Figure 111. Scientific (○) and incidental (*) sightings and specimens (●) of "*Tursiops* species" (not identified to form) reviewed in this study.

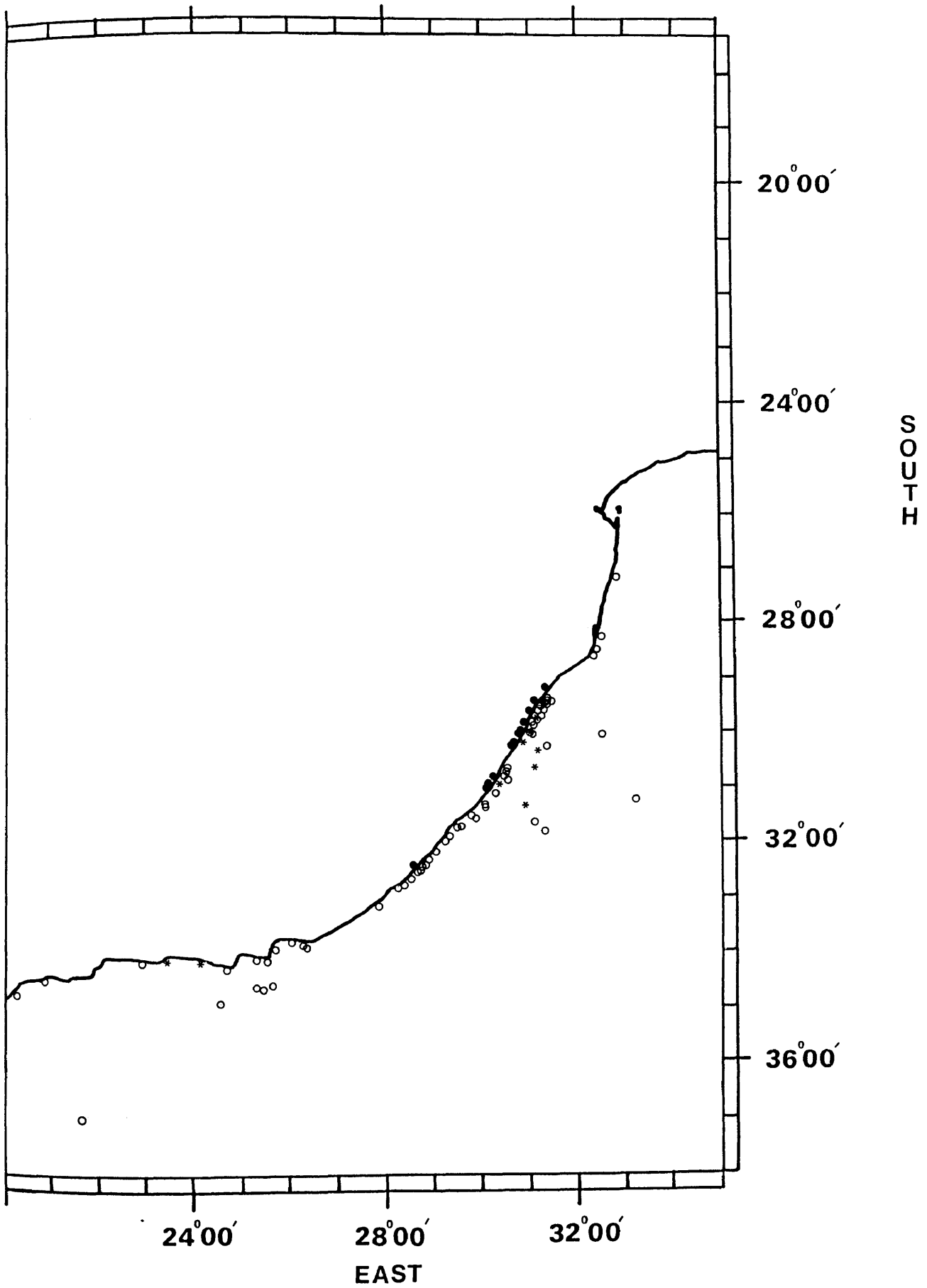


Figure 111. continued.

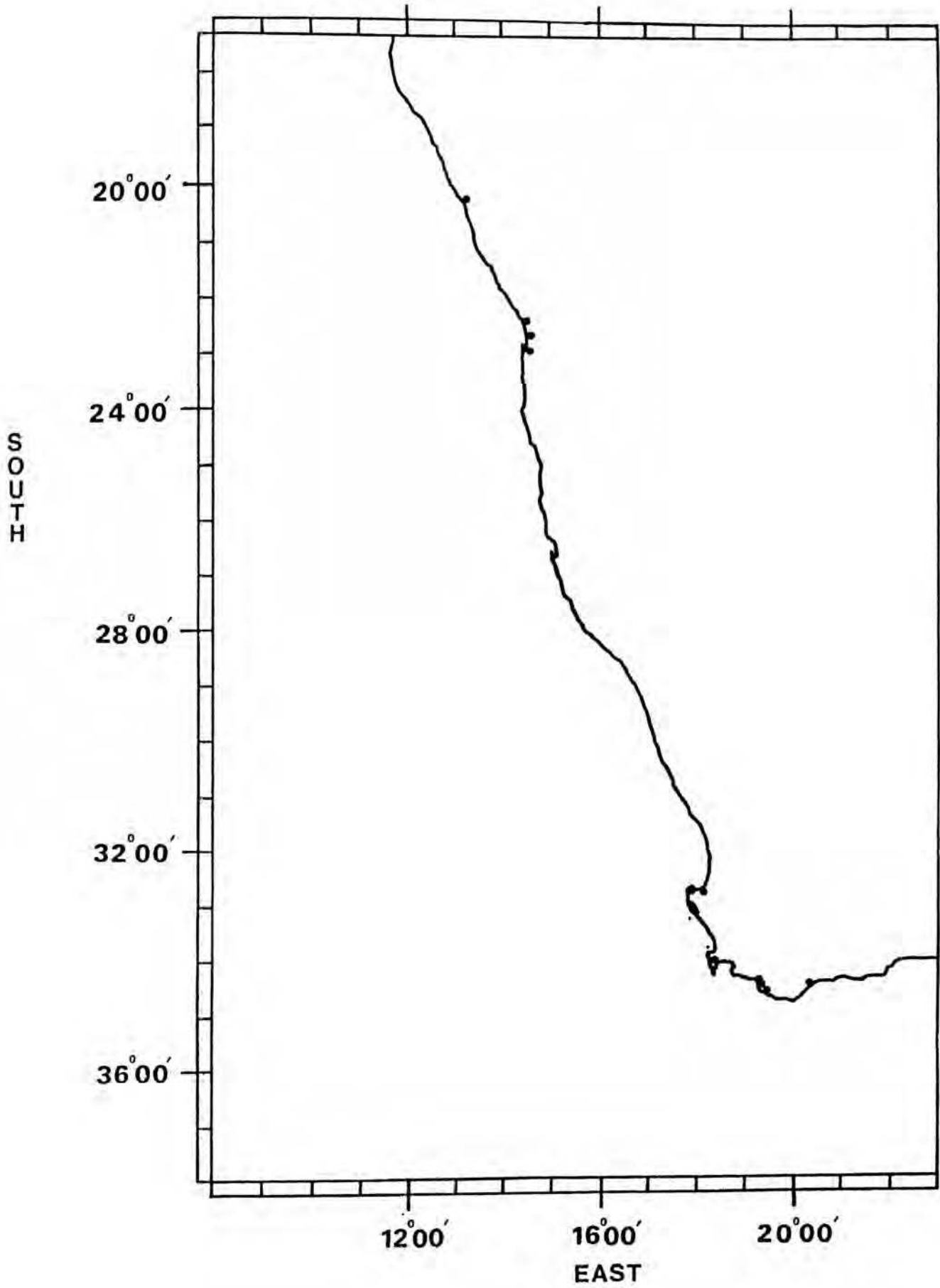


Figure 112. Scientific (○) and incidental (*) sightings and specimens (●) of *Tursiops (truncatus) to form* reviewed in this study.

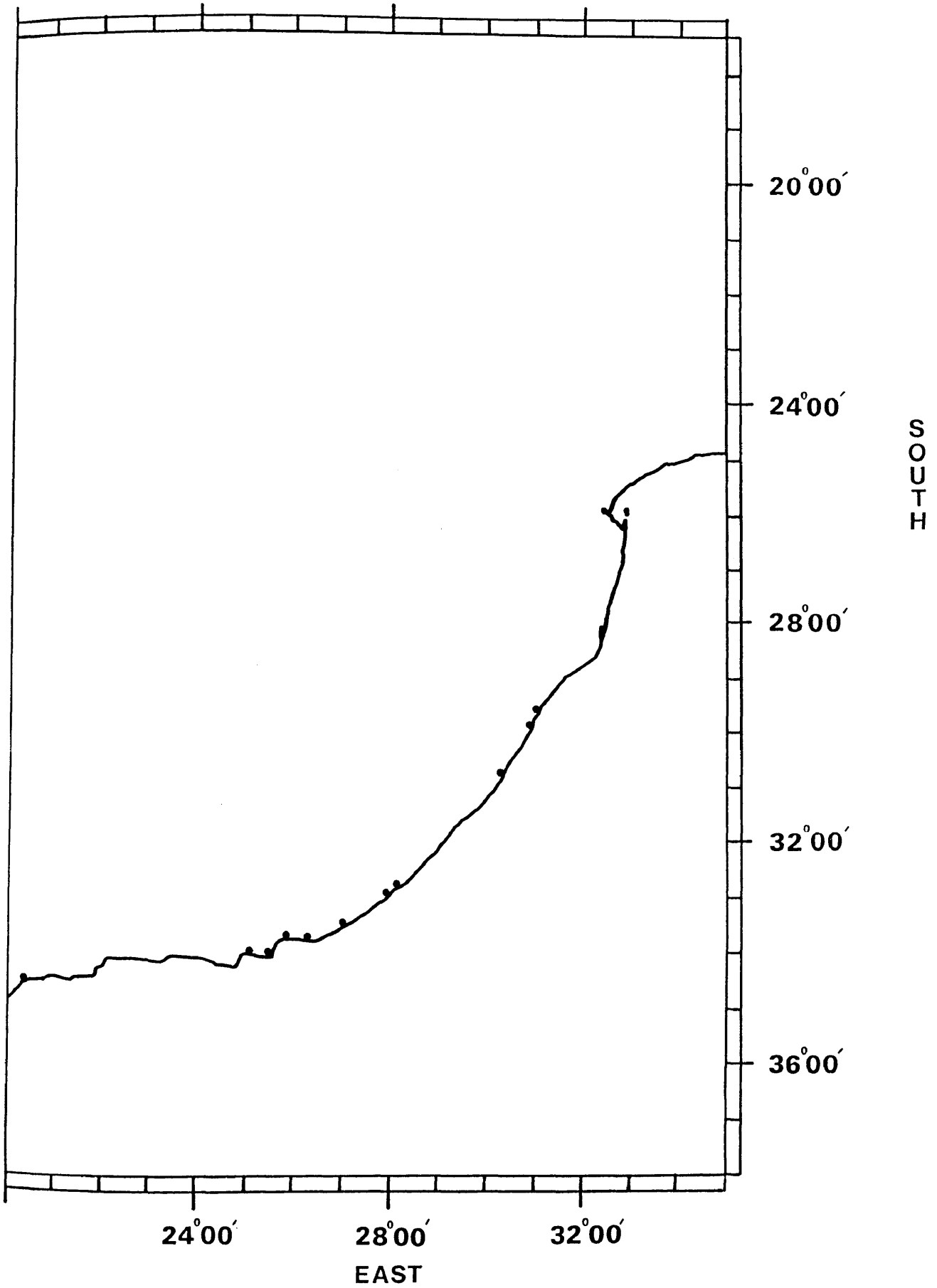


Figure 112. continued.

Table 28. Origins of the 33 specimens of bottlenose dolphins (*truncatus* form) reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	12
Dead beach cast (stranding)	1
Found floating dead at sea	1
Found dead on shore	14
Skeletal material found on shore	2
Skeletal material dredged at sea (or material found in gut of predator)	1
Incidental fishing mortality (including shark net mortalities)	1
Direct fishing mortalities (including scientific collection)	3
Unknown	4

Records of this form occurred from 30° S on the east coast to the region of 33° S on the west coast and then again in the vicinity of Cape Cross and Walvis Bay, Namibia (20° to 23° S) (figure 112). With the exception of the Walvis Bay live capture attempts, the remainder of the records are strandings. As there is no reliable way of establishing the origin of the stranded *truncatus* specimens, it is impossible to definitely establish whether the inshore *truncatus* form exists on the west coast, south of the Walvis Bay region. As there are no incidental or dedicated sightings of *Tursiops* inshore between the Walvis Bay region and the Cape Peninsula, it is possible that the majority of strandings in this region originate from the offshore population. It is assumed that all the specimens of the *truncatus* form recorded to the east of Cape Point are in fact from the offshore population described by Ross (1984).

The *aduncus* form

Twenty capture attempts of the *aduncus* form were made of which seventeen were from Algoa Bay while the other three were recorded from Durban (figure 113). Twenty six published sightings of *T. aduncus* from the Tsitsikamma National Park (Saayman, Bower and Tayler (1972) - original data supplied by D. Bower) are included as incidental sightings. School size of these sightings ranged from 1 to 1500 per group with a mean of confirmed sightings of 76.2 (sd ± 84.98) animals per group. The group of 1500

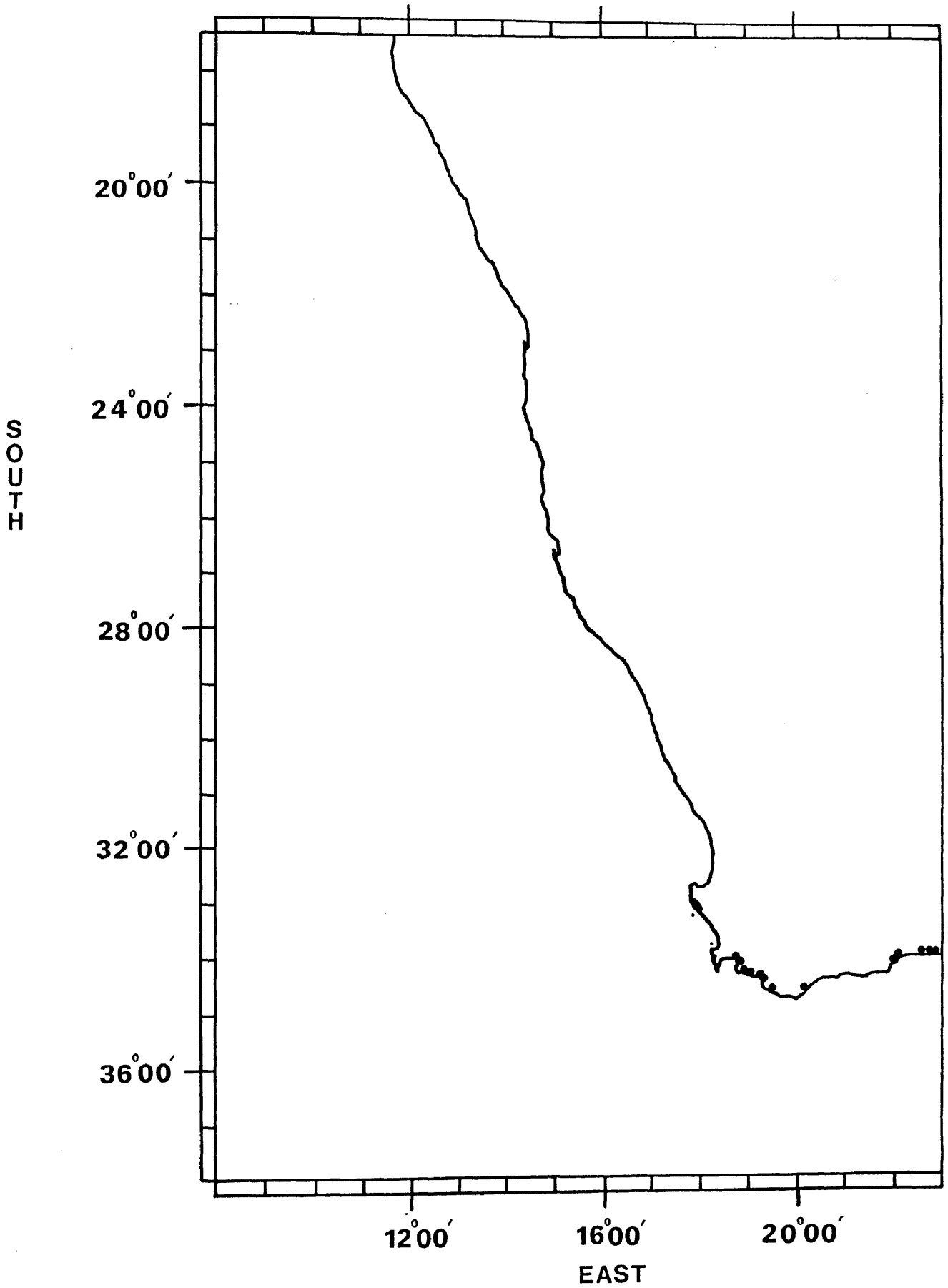


Figure 113. Provenances of specimens of the *aduncus* form of bottlenose dolphins reviewed in this study.

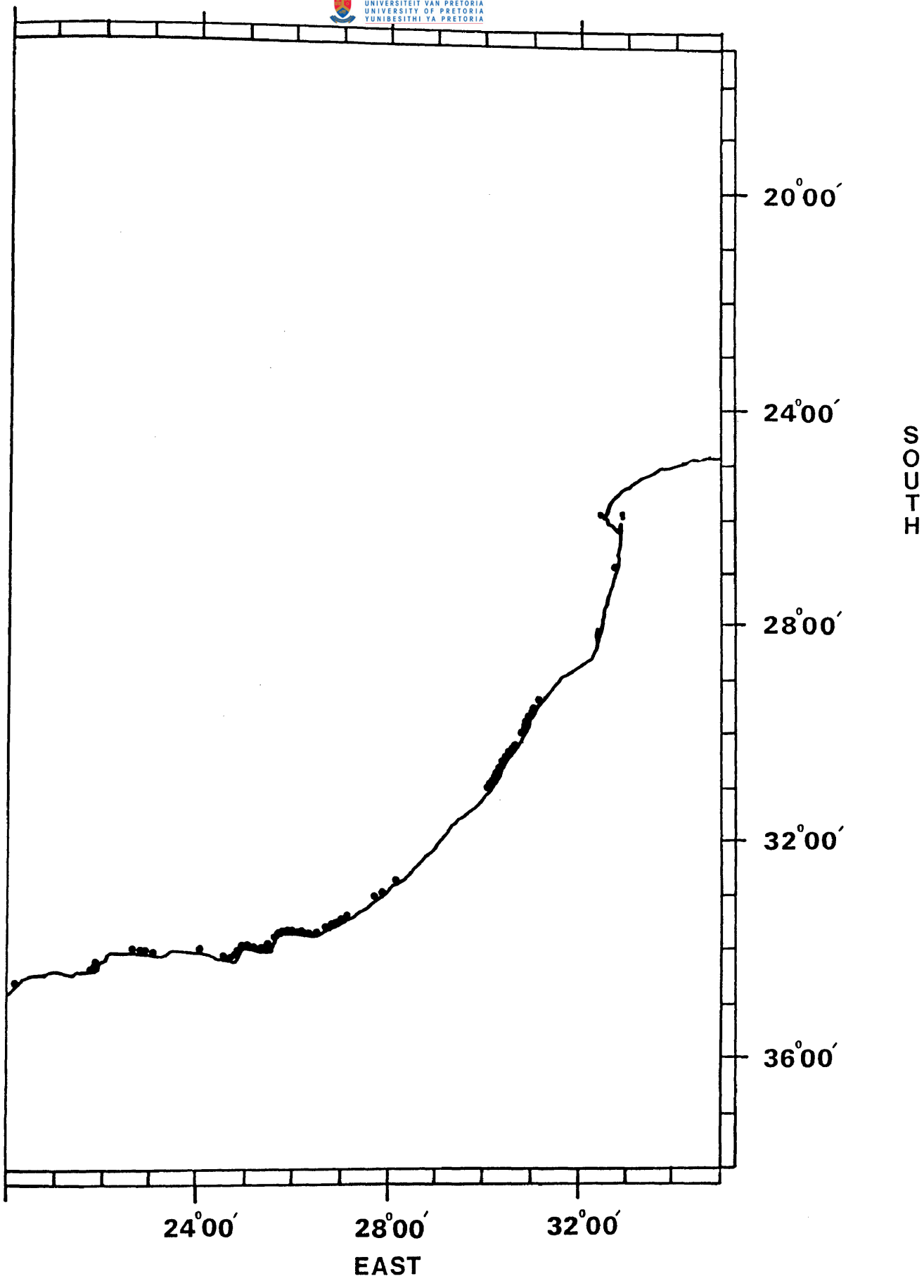


Figure 113. (continued)
.pa

animals actually comprised three groups, but no individual group sizes were noted and this group has not been included in the calculation of mean group size.

The provenances and months and categories of origin of 267 specimen records of the *aduncus* form are shown in figures 113 and 110 and table 29 respectively. Ross (1984) states that the western limit of this form's distribution is uncertain as only three records were available west of Cape Agulhas. The western most record under review in this study is a stranding from Strand ($34^{\circ} 08'$, $18^{\circ} 25' E$) and inshore sightings of *Tursiops* extend as far west as Gansbaai ($34^{\circ} 35' S$, $19^{\circ} 20' E$).

Table 29. Origins of the 267 specimens of bottlenose dolphins (*aduncus* form) reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	13
Dead beach cast (stranding)	3
Found dead on shore	68
Skeletal material found on shore	7
Incidental fishing mortality (including shark net mortalities)	152
Direct fishing mortalities (including scientific collection)	11
Unknown	13

Figure 114 shows the distribution of "bottlenose dolphins" (both forms) by depth, salinity and temperature for scientific cruises in summer and winter respectively. The marked neritic and pelagic peaks of occurrence in Area IV are clearly evident. Comparison of the shipboard results for Area III with the results from the aerial surveys for Area III show similar trends of neritic and pelagic peaks of occurrence. These would presumably correspond to the allopatric existence of the two forms of *Tursiops* identified by Ross (1977) as species. Sightings of *Tursiops* in Area II were in waters associated with temperatures of between 12° and 14° C and salinities of 35.0 and 35.2 ppt, while sightings in Area III were in waters with temperatures of between 16° and 20° C and salinities of between 35.2 and 35.6 ppt. Both summer and winter sightings in Area IV were in waters associated with temperatures of between 18° and 22° C and salinities of between 35.0 and 35.6 ppt.

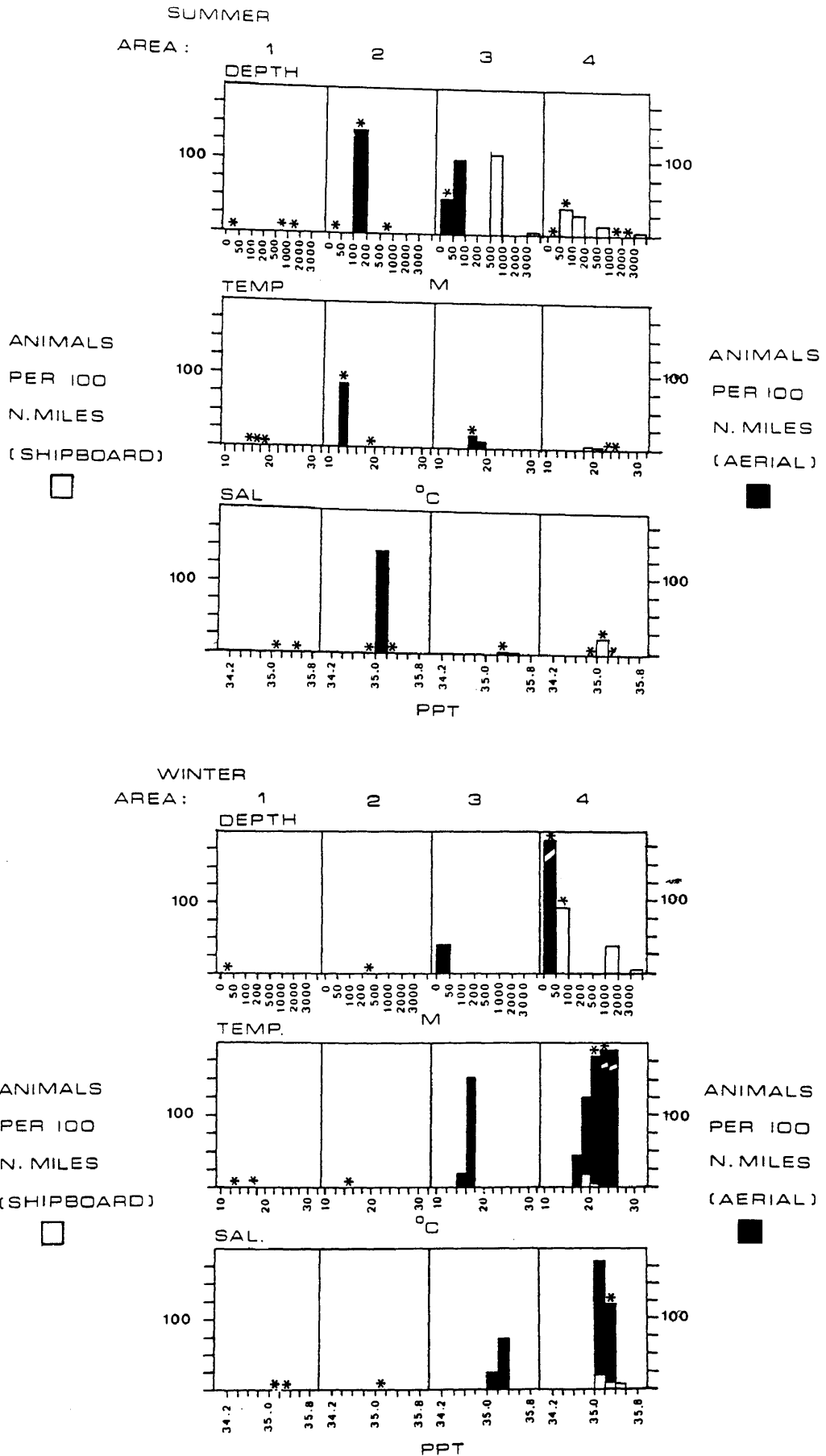


Figure 114. Densities of scientific sightings and occurrence of incidental sightings (*) of bottlenose dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Ross and Cockcroft (in press) found that water temperature played a significant part in defining the distribution of the two forms in Australian waters, but that sea surface temperature did not appear to define the distribution of the two forms off the east coast of southern Africa (as suggested in the data analysed in this study). However, they note that the temperatures decline rapidly with depth on the east coast and that the offshore *truncatus* form could be feeding at lower temperatures than at the sea surface.

The distribution of the neritic *aduncus* form extends from the east coast westwards as far as False Bay, while the distribution of the neritic *truncatus* form appears to extend from Walvis Bay northwards. An offshore *truncatus* form occurs off the east coast and may have a continuous offshore distribution around the whole coast, although the origin of stranded *truncatus* forms on the west coast are unknown.

The Indian Ocean humpback dolphin (*Sousa plumbea*)

Ross (1984) lists *S. plumbea* as occurring in the western and northern Indian Ocean, between the Gulf of Siam and South Africa. In southern African waters *S. plumbea* occurs in the coastal waters of Natal and the eastern and southern Cape. Ross (1984) states that the western limit is uncertain and that excluding the skull found at Muizenberg ($34^{\circ} 07' S 18^{\circ} 28' E$) in 1866 (Tietz 1963) which is presumed to be a vagrant there are no records west of the Gouritz River Mouth ($21^{\circ} 53' E$). Saayman and Tayler (1979) found that humpback dolphins ranged within one kilometre of the coast and foraged in the vicinity of reefs, and suggested that reef fish formed a major portion of the diet.

Six dedicated scientific sightings of a total of 41 *S. plumbea* have been made during the dolphin aerial surveys carried out by Port Elizabeth Museum (figure 115). Group size ranged between five and 10 with a mean of 6.83 animals per group (sd \pm 1.94). Twelve incidental sightings of *S. plumbea* have been reported. Group size of these sightings ranged from one to 10 with an average of 4.83 animals per group (sd \pm 3.04) and no seasonality was apparent in these sightings. Three sighting records exist to the west of the Gouritz River mouth, with the furthest west sighting being recorded off De Hoop ($20^{\circ} 30' E$).

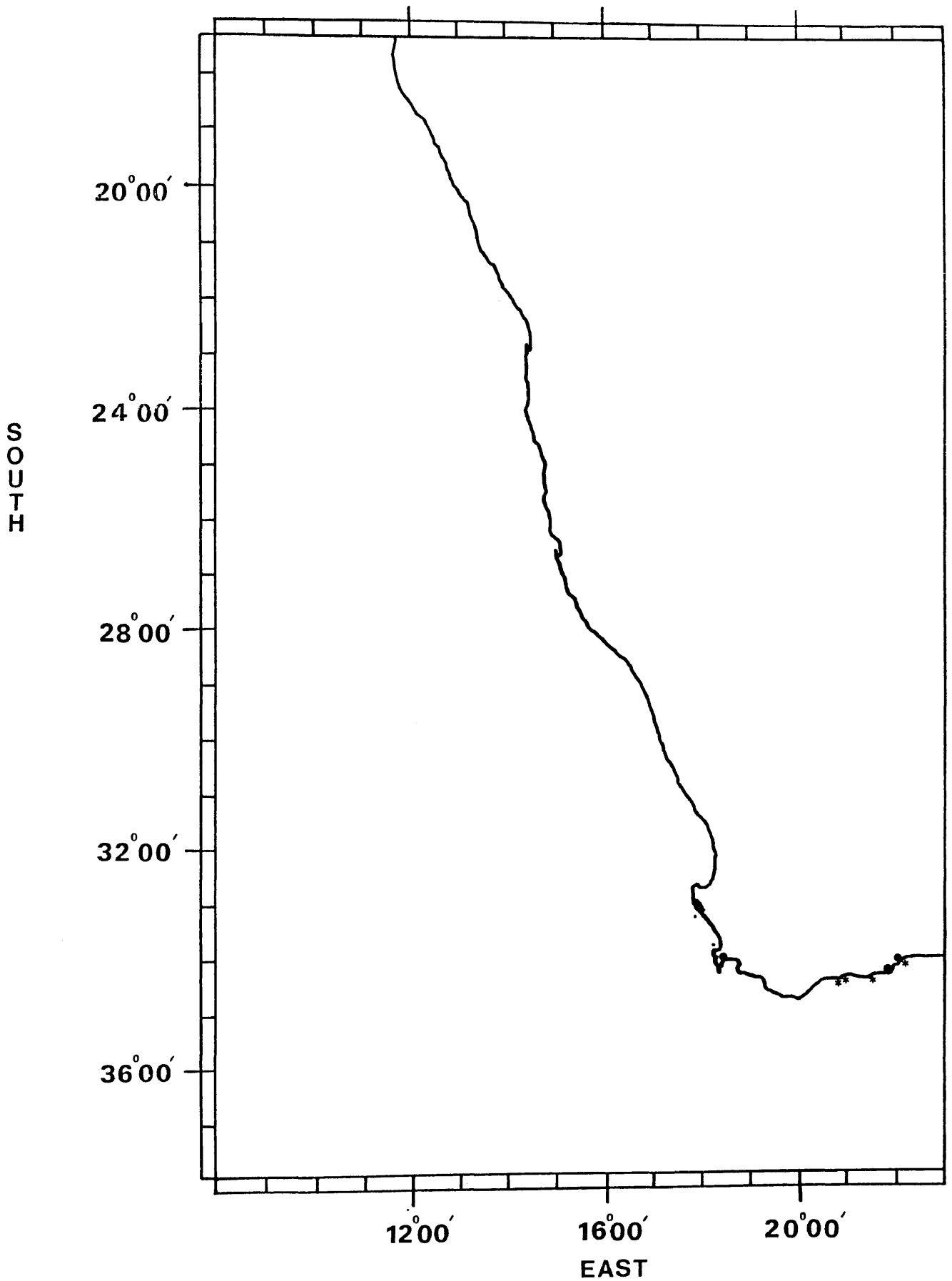


Figure 115. Scientific (o) and incidental (*) sightings and strandings (●) of humpback dolphins reviewed in this study.

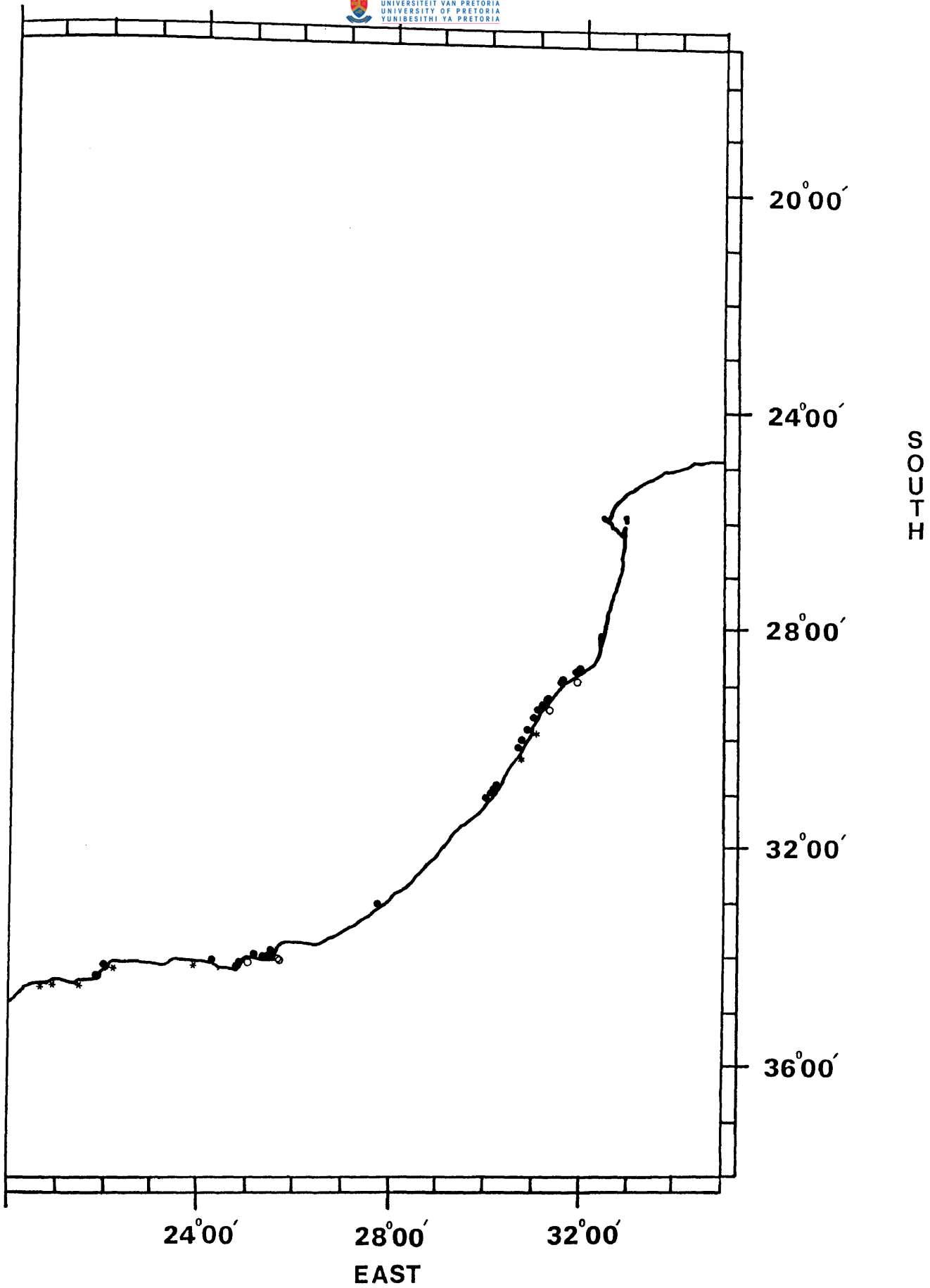


Figure 115. (continued)

Fifty - seven specimen records of *S. plumbea* from this coast, the localities of which are plotted in figure 115. From table 30 it can be seen that a high percentage of these records arise from incidental capture of animals in shark nets, while the months of origin of these specimens (figure 117) show the species to be found throughout the year in these waters. Figure 116 shows that all *S. plumbea* sightings were made in waters of less than 50 m depth. The lack of dedicated cruise sightings presumably reflects the fact that the vessels used for dedicated searches were too large to adequately survey such shallow depths, as well as the vessel avoidance behaviour of this species. Mean salinities recorded for the waters in which *S. plumbea* were sighted ranged from 35.0 to 35.4 ppt while mean temperatures for these waters ranged between 14^o to 20^o C (figure 116). Saayman, Bower and Tayler (1972) found that the occurrence of humpback dolphins in Plettenberg Bay was not affected by variation in sea surface temperature as the species was present in the bay all the year round.

Table 30. Origins of the 57 specimens of humpback dolphin reviewed in this study.

Category of provenance	Number of individuals
Found dead on shore	9
Skeletal material found on shore	4
Indirect fishing mortalities (including shark nets)	47
Direct fishing mortalities (including scientific collection)	3
Unknown	6

The genus *Stenella*

The taxonomy of the genus *Stenella* is complex. Three groups or superspecies can be distinguished (Rice and Sheffer 1966, Rice 1977). These are

- 1) the spinner dolphins, occurring in all three oceans and including *S. longirostris* from the Pacific, Indian and Atlantic and *S. clymene* occurring allopatrically with *S. longirostris* in the Atlantic (Perrin, Mitchell, Mead, Caldwell, and Van Bree 1981)

WINTER

AREA:

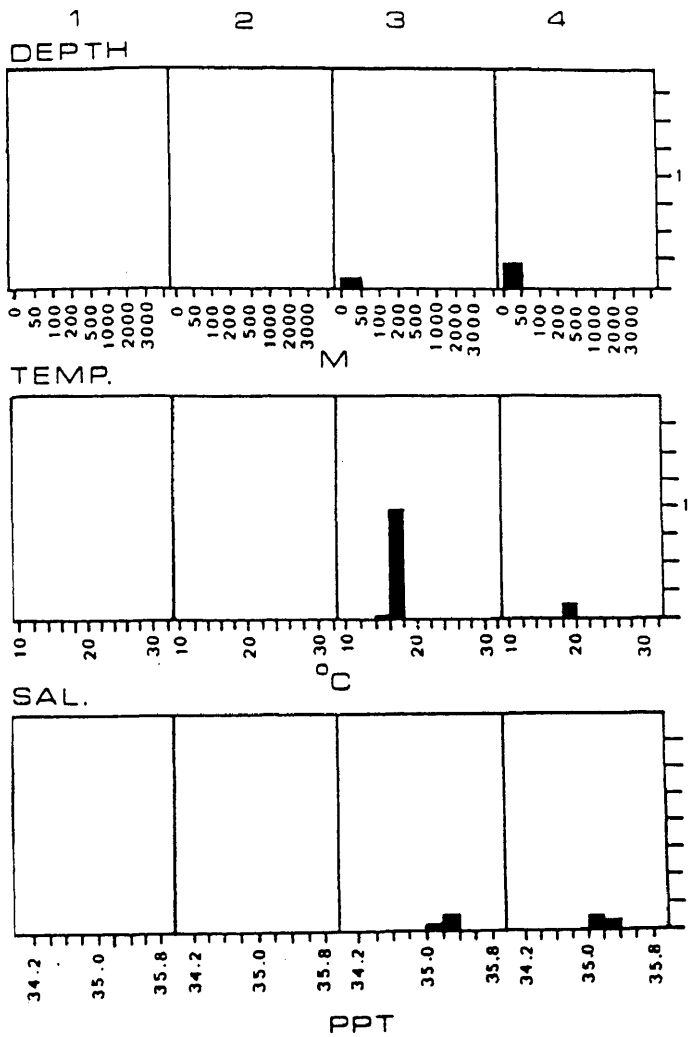
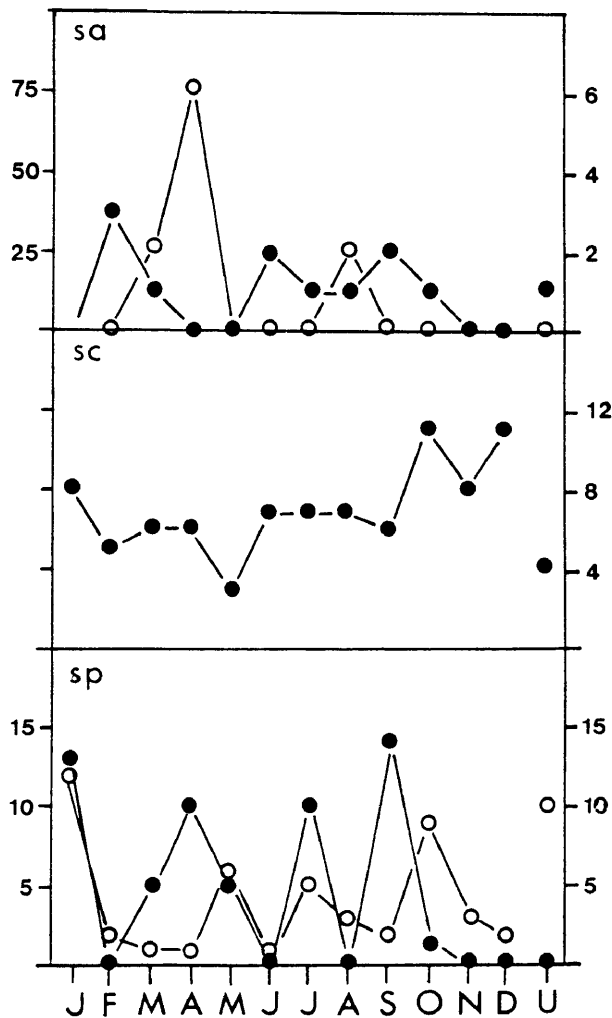


Figure 116. Densities of scientific sightings of humpback dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during winter.

NUMBER
OF
ANIMALS
SIGHTED
○



NUMBER
OF
ANIMALS
STRANDED
●

Figure 117 The seasonal abundance of incidental sightings and specimens of humpback (sp), spotted (sa) and striped (sc) dolphins reviewed in this study.
(U = month of incidence unknown.)

2) the spotted dolphins including the pantropical *S. attenuata* and *S. frontalis* which is restricted to the Atlantic (Perrin, Mitchell, Mead, Caldwell, Caldwell, Van Bree and Dawbin 1987) and

3) the striped dolphin of which there is one species *S. coeruleoalba*.

All spotted dolphins from the study area have so far been referred to the pantropical species *S. attenuata*, and there are no records of the short - snouted spinner dolphins *S. clymene*.

Perrin *et al* (1978) suggest that the high *Stenella* diversity in the Atlantic may have resulted from movements of this genus from the Indian Ocean around the African sub-continent via the Agulhas Current into the Atlantic Ocean. Miyazaki, Kasuya and Nishiwaki (1974) found that *S. attenuata* is distributed in slightly warmer waters than *S. coeruleoalba* off Japan, while Perrin, Scott, Walker, Ralston and Au (1983) state that *S. longirostris* may be more restricted to tropical conditions than *S. attenuata* in the eastern Tropical Pacific.

Spotted dolphin (*Stenella attenuata*)

There are eight dedicated scientific sightings of a total of 663 *S. attenuata*. All of these sightings occurred east of 27° 00' E (figure 118). The large bias towards summer sightings presumably reflects the lack of winter search effort off the Natal coast. Mean group size of confirmed sightings was 93.86 animals per group (sd ± 92.4). Three incidental sightings of a total of 125 animals were made in the same Area (Figure 118).

The provenances of twelve specimens of *S. attenuata* are plotted in figure 118, while figure 117 and table 31 show the months and categories of origin of 13 specimens. One specimen was recorded (as a live stranding) at 34° 40' S 19° 30' E, which is well to the west of the distribution of the species from sightings or any other strandings and so is not illustrated in figure 118 and it is possible that this specimen was a stray.

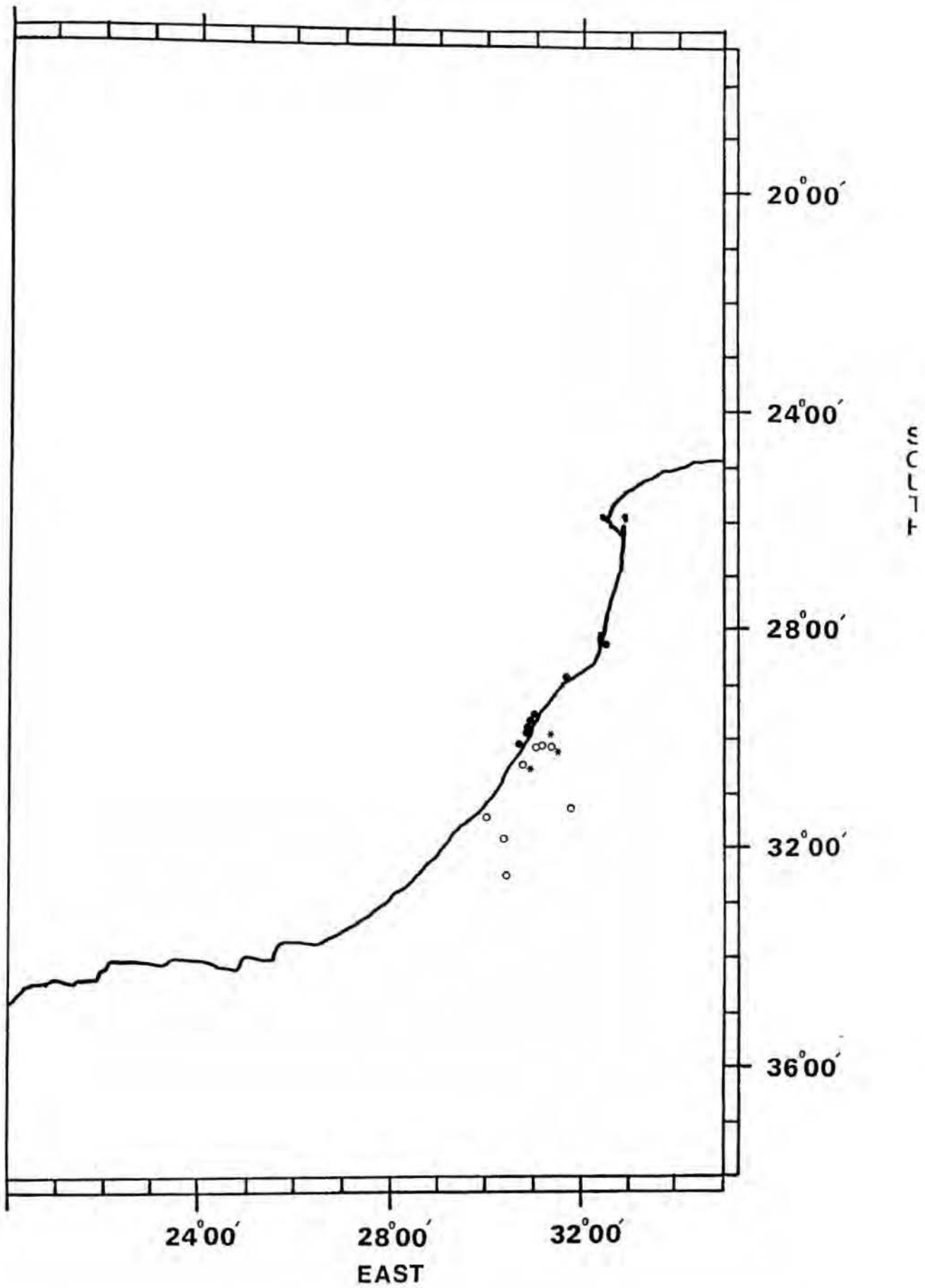


Figure 118. Scientific (o) and incidental (*) sightings and strandings (●) of spotted dolphins reviewed in this study.

Table 31. Origins of the 15 specimens of spotted dolphins reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	4
Found dead on shore	4
Incidental fishing mortality (including shark net mortalities)	1
Direct fishing mortalities (including scientific collection)	2
Unknown	2

Scientific sightings of *S. attenuata* were all made in Area IV in waters of over 200 metres deep. Ross, Cockcroft and Butterworth (1987) suggest that *S. attenuata* may be feeding closer inshore than the 200 metre isobath. Associated temperatures ranged between 18^o and 26^o C in summer and between 18^o and 20^o C in winter. Salinities measured in these waters were between 35.0 and 35.6 ppt in summer and between 35.4 and 35.6 ppt in winter (figure 119).

The summer incidental sightings of *S. attenuata* were made in waters of between 500 and 1000 metres depth and associated with temperatures of between 24^o and 26^o C and salinities of between 34.8 and 35.4 ppt. The one winter incidental sighting of *S. attenuata* was made in deeper waters of between 2000 and 3000 metres and associated with temperatures of between 20 and 22^o C and salinities of between 35.2 and 35.4 ppt (figure 119).

Striped dolphin (*Stenella coeruleoalba*)

There are twelve dedicated scientific sightings of a total of 1020 *S. coeruleoalba*. All sightings occurred during summer (December (1) January (9) and February (2)). Mean group size of these sightings was 74.5 animals per group (sd ± 57.2). Three scientific sightings of "like striped dolphin" were made. Two of these sightings were made in August (of 100 and of four animals per group) and one in February (22 animals).

No incidental sightings of striped or "like striped dolphins" were recorded.

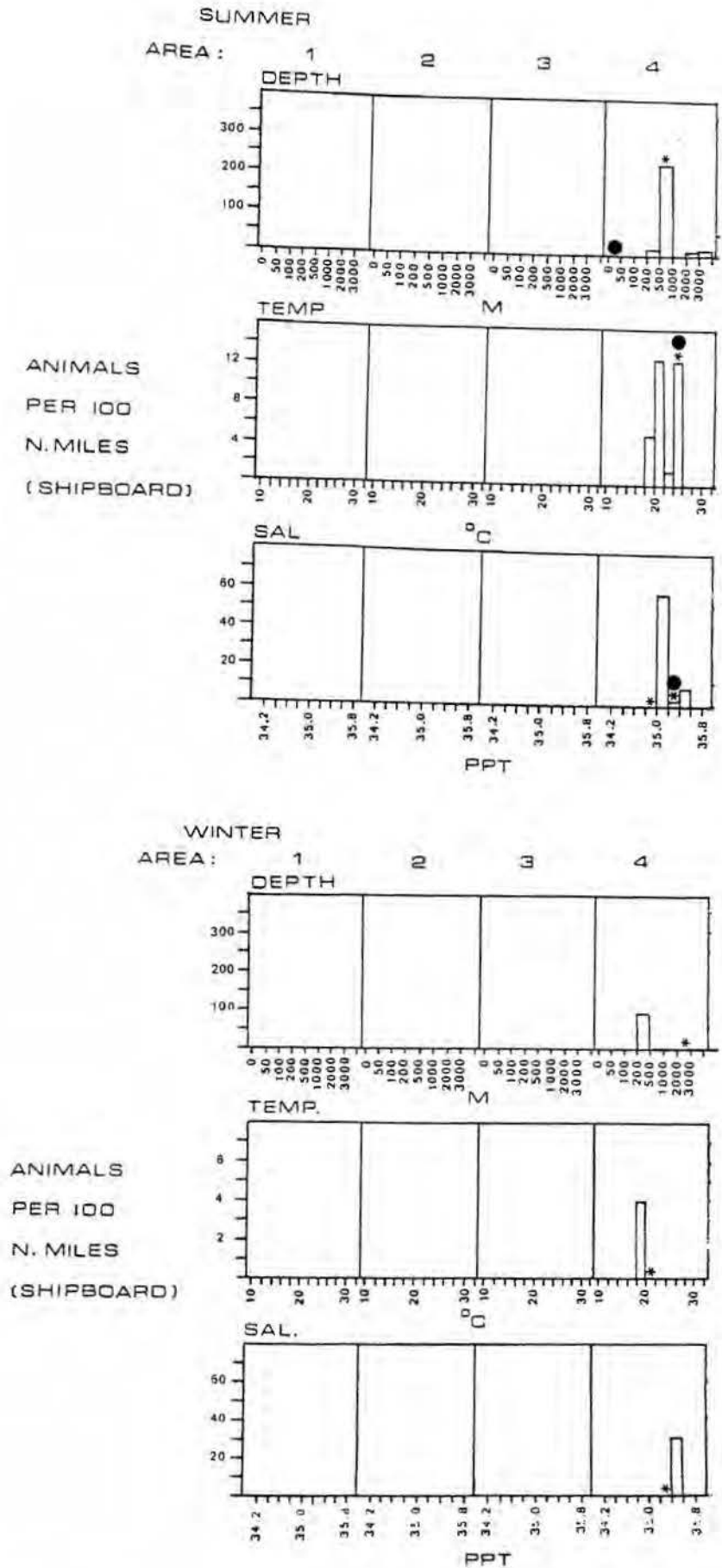


Figure 119. Densities of scientific sightings of spotted dolphins and occurrence of incidental sightings of spotted (*) and spinner (●) dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter. © University of Pretoria


Eighty - seven specimens of striped dolphin  and localities of these are plotted in figure 120. Months and categories of origin of these specimens are presented in figure 117 and table 32 respectively. No seasonality was apparent in the timing of specimens.

Table 32. Origins of the 87 specimens of striped dolphin reviewed in this study.

Category of provenance	Number of individuals
Live beach cast (stranding)	22
Dead beach cast (stranding)	2
Found floating dead at sea	2
Found dead on shore	46
Skeletal material found on shore	5
Direct fishing mortalities (including scientific collection)	1
Unknown	9

The distribution of *S. coeruleoalba* appears to be strongly associated with the Agulhas current system (figure 120). As with the distribution of *H. planifrons* the western boundary appears to be determined by the shelf edge of the Agulhas Bank. The strandings of striped dolphins around the Cape Peninsula and as far west as Yserfontein (33° 22' S ; 18° 09' E) on the west coast suggest that individuals may move around the Cape Peninsula into the Benguela system with eddies of Agulhas current water, or alternatively that *S. coeruleoalba* also occurs pelagically off the west coast (where there has been relatively little search effort).

All scientific sightings of *S. coeruleoalba* were recorded in water depths of over 500 metres in Area III and over 2000 metres in Area IV. Temperatures measured in these waters ranged between 16° and 20° C in Area III and between 18° and 22° C in Area IV (figure 121). All of the sightings of "like striped dolphin" were made in waters of over 500 metres depth. The one summer sighting was made in waters of temperatures of between 20° and 22° C and salinities of between 35.0 and 35.2 ppt. Both of the winter sightings were recorded in waters of temperatures of between 18° and 20° C and salinities of between 35.2 and 35.4 ppt. (figure 122).

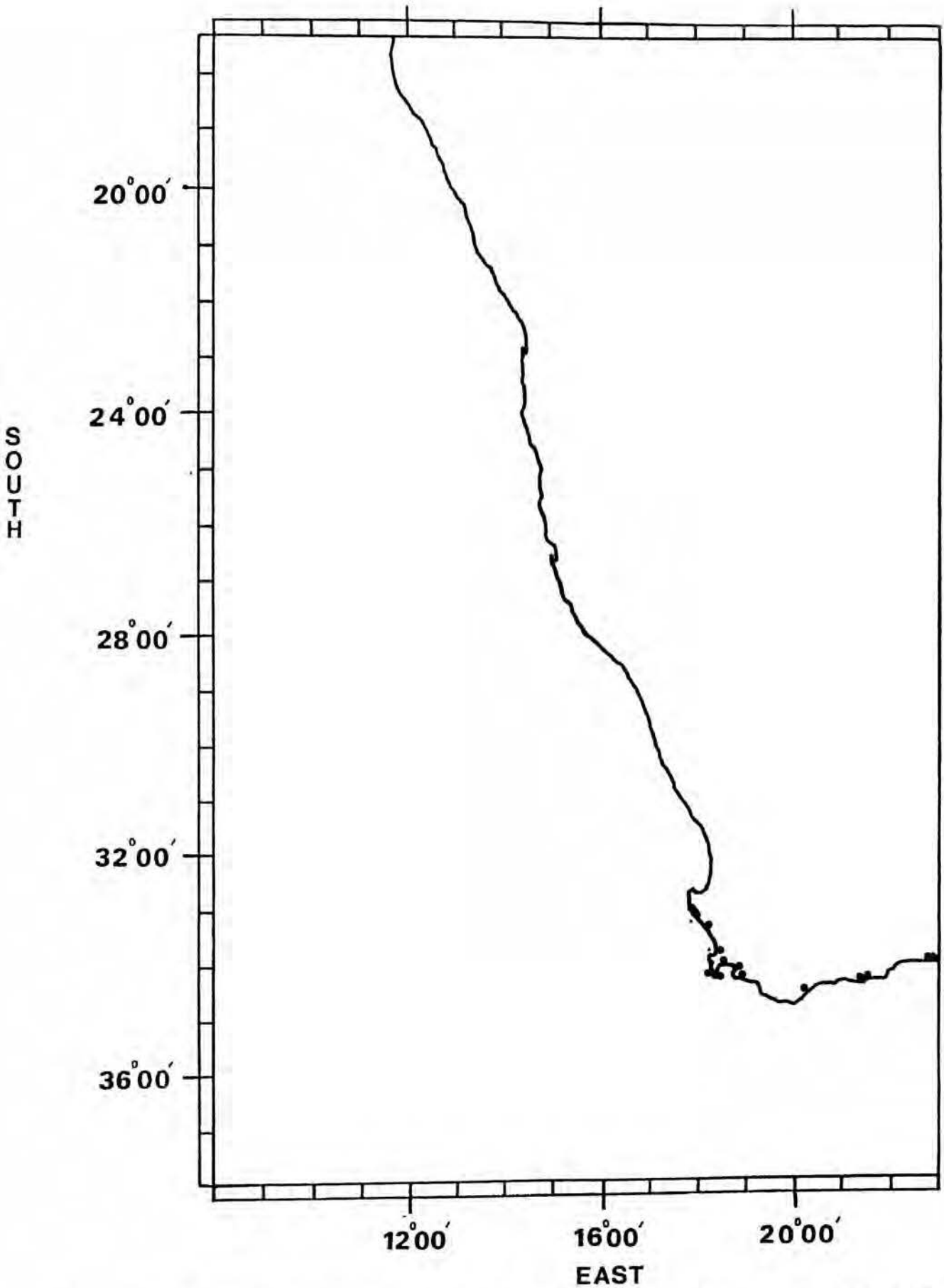


Figure 120. The distribution of scientific (O) and incidental (*) sightings and specimens of striped dolphins and "like striped dolphins" reviewed in this study.

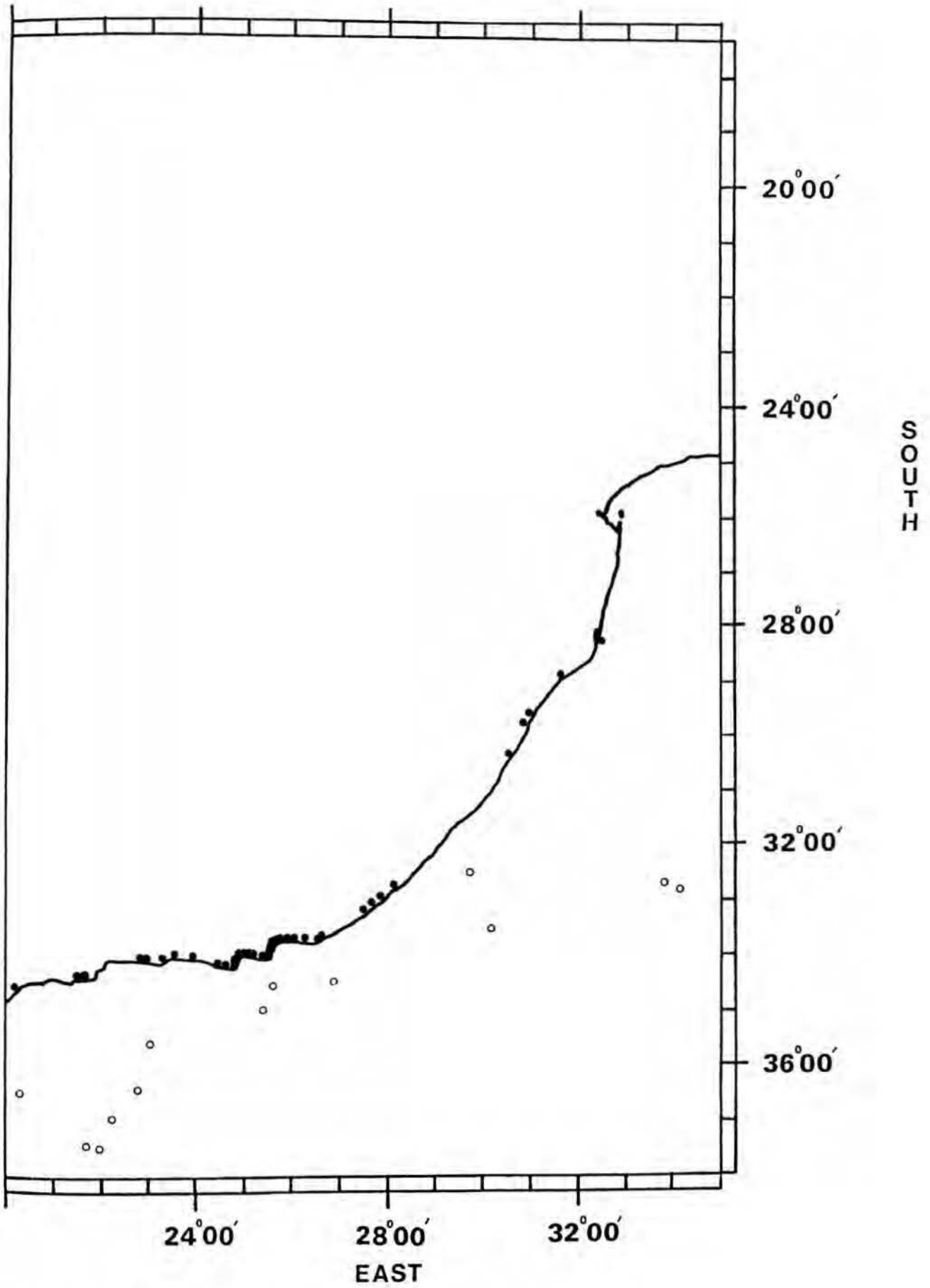


Figure 120. continued.

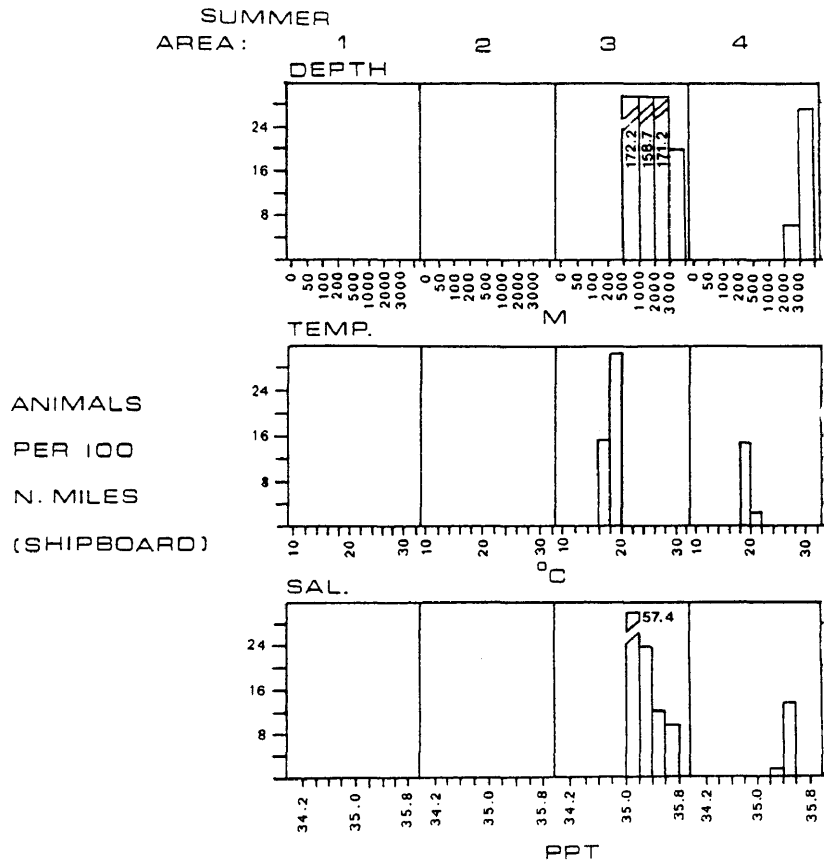


Figure 121. Densities of scientific sightings of striped dolphins in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer. No sightings were made during winter.

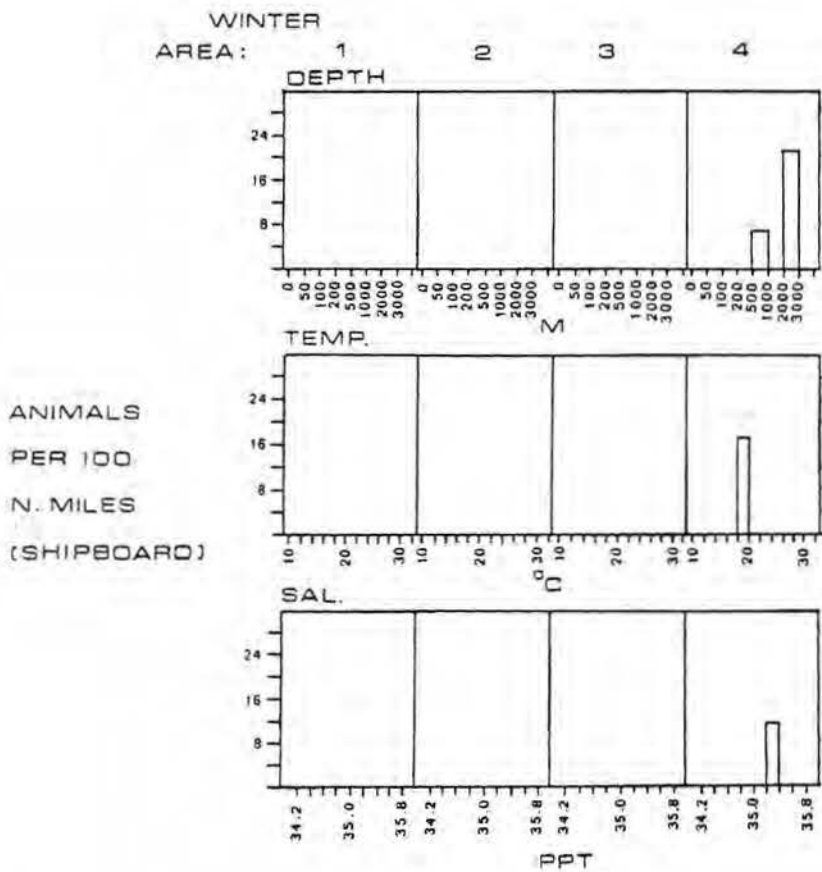
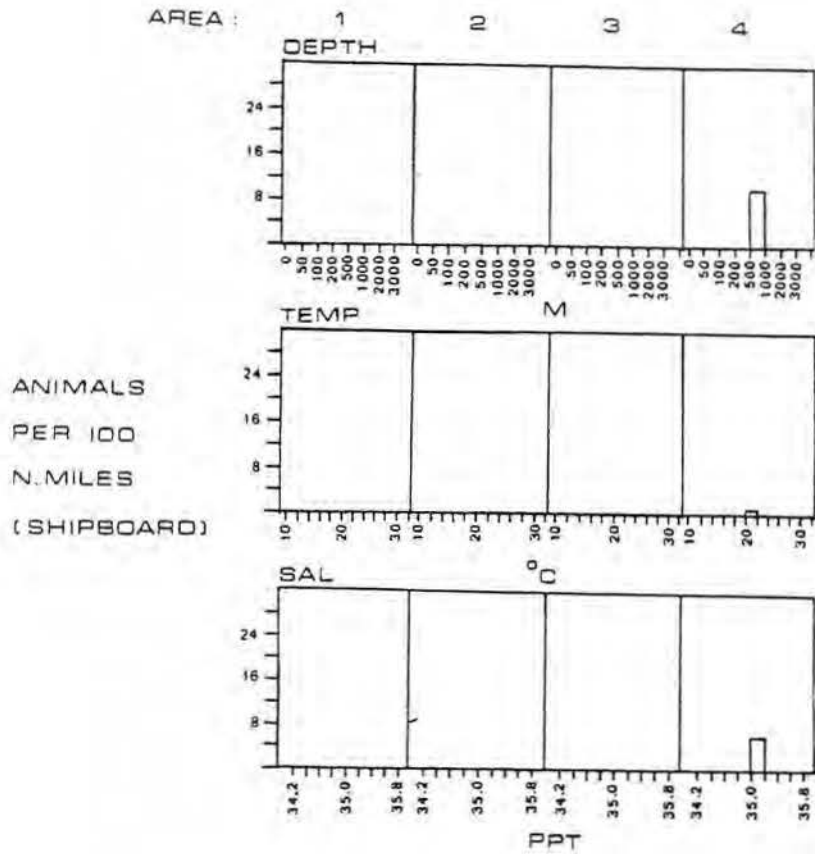


Figure 122. Densities of scientific sightings of "like striped dolphins" in each of the four Areas in relation to water depth, sea surface temperature and sea surface salinity during summer and winter.

Two incidental sightings of *S. longirostris* have been published by Ross, Cockcroft and Cliff (1985). Both of these sightings were made close inshore on the northern Natal coast and no school size are published. Ross (1984) notes that there are three other possible records of *S. longirostris* from southern African waters, but none of the localities of these animals can be accurately verified and as such were omitted from this database. These incidental sightings were both made inshore of the 50 m isobath. Temperatures and salinities associated with these waters ranged between 24^o and 26^o C and 35.0 and 35.2 ppt respectively. No records of spinner dolphin have been recorded further south in the east coast whaling grounds (despite much search effort within the area). Thus the northern Natal area may represent the southernmost limit of the distribution of spinner dolphin in the western Indian Ocean. The nearshore distribution of these records may reflect the closeness of the tropical Agulhas Current to the coast in this region, or the species' behaviour of resting in shallow waters as recorded off Hawaii (Norris and Dohl 1980). Alternatively, as both of the records are incidental sightings, the distribution may reflect biased distribution of search effort.

Rough-toothed dolphin (*Steno bredanensis*).

Two confirmed specimen records of *S. bredanensis* were recorded for the subregion. The provenance of the one of these specimens was 1 km to the north of Sheffield Beach (29^o 28' S; 31^o 16' E) (Ross, Cockcroft and Cliff 1985), while a second specimen (whose exact provenance is unknown) was found in a collection at Mowe Bay, SWA / Namibia (19^o 20 S, 12^o 35' E) in 1986 (Best, pers. comm.). Ross, Cockcroft and Cliff (1985) note that historically a further three specimens were attributed to the Cape but that two of these may have been collected elsewhere by a vessel *en route* to England via the Cape and mistakenly "attributed" to South Africa, while the third has been reidentified as the "*aduncus*" form of *Tursiops truncatus*. There have been no sightings of this species in South African waters, and the single records from Natal and SWA / Namibia may represent individuals at the extreme southern limits of their range, as the rough-toothed dolphin is generally considered a tropical and warm temperate species occurring in waters of over 25^o (Leatherwood and Reeves 1983).

RESULTS - CORRESPONDENCE ANALYSIS

The use of multivariate analysis to analyse interrelationships between animals and their habitats has been carried out by a number of authors (e.g. Hirst 1975, Beardall, Joubert and Retief 1984, Polacheck 1987 and Ben Shahr 1987). Beardall *et al* (1984) and Ben Shahr (1987) both used correspondence analysis to determine the interrelationship between herbivores and the environment.

Correspondence analysis is a technique for displaying rows and columns of a two way contingency table of variables and objects as points in corresponding low dimensional vector spaces (Greenacre 1981).

The method can briefly be described as defining :-

- a) firstly a cloud of points in a multi-dimensional vector space,
- b) secondly the metric structure of that space,
- c) thirdly the fit of this cloud to a variable low dimensional subspace onto which the points are projected for display and interpolation.

Hill (1979) notes that correspondence analysis is in fact reciprocal averaging and suggests the use of detrended correspondence over simple correspondence analysis (or reciprocal averaging). Gauch (in Hill 1979) maintains that detrended correspondence analysis is a substantial improvement over reciprocal averaging as it avoids both the dependency of the second axis on the first and the compression of the axis ends. Beardall *et al* (1984) note that there is no interpretation of distances between variables and objects, but that angles formed when joining elements through the origin give a good indication of their "correlation" (small angles indicating a high "correlation" and large angles indicating a low "correlation").

Data matrices of encounter rates (sightings per 100 miles searched) of cetaceans in relation to different environmental parameters were created for both the cruise and the aerial data. The cetacean species sighted (see table 33) were represented by the columns and the environmental and seasonal parameters against which these were tested (see table 34) were represented by the rows. A detrended correspondence analysis package (DECORANA, Hill 1973) was run on these matrices and results of the scientific cruise data are presented below in table 35 and figure 123. As axis one and two accounted for 90% of the total inertia (table 35) only these axes were plotted in figure 123. The environmental data show close associations between Areas I and II and low temperatures, between Area III and intermediate temperatures and between Area IV and high temperatures and salinities. Although the low salinities appear to be associated with low temperatures along the first axis, there is a spread of the low salinities along the second axis which presumably reflects the wide range of salinities recorded in Area I. The associations between Areas I and II and the neritic environment and between Area IV and the pelagic environment are strongly evident and these presumably reflect the lack of searching offshore on the west coast and the lack of searching inshore and the narrowness of the continental shelf on the east coast.

Table 33. Species sighted on dedicated cruises and analysed by correspondence analysis.

Species	Code (figure 123)
Blue whale	bm
Fin whale	bp
Sei whale	bb
Minke whale	ba
Like minke whale	lba
Humpback whale	mn
Bryde's whale	be
Like Bryde's whale	lbe
Right whale	ea
Sperm whale	pm
Bottlenose whale	hp
"Akabo"	ak
<i>Mesoplodon</i> sp.	ms
Killer whale	oo
False killer whale	pc
Common dolphin	dd
Dusky dolphin	lo
<i>Tursiops</i> sp.	tt
Fraser's dolphin	lh
Striped dolphin	sc
Like striped dolphin	lsc
Risso's dolphin	gg
Heaviside's dolphin	ch
Spotted dolphin	sa
<i>Globicephala</i> sp.	gs
Cuvier's beaked whale	zc
Pygmy killer whale	fa

Table 34. Environmental variables tested by correspondence analysis.

Variable	Range	Code (figure 123)
Depth 1	0 - 200 m	1
Depth 2	201 - 500 m	2
Depth 3	501 m +	3
Temperature 1	10 ^o - 14 ^o	4
Temperature 2	14 ^o - 18 ^o	5
Temperature 3	18 ^o - 22 ^o	6
Temperature 4	22 ^o - 26 ^o	7
Salinity 1	34.4 - 34.8 ppt	8
Salinity 2	34.8 - 35.2 ppt	9
Salinity 3	35.2 - 35.6 ppt	10
Salinity 4	35.6 - 36.0 ppt	11
Area 1	As defined in text	12
Area 2		13
Area 3		14
Area 4		15
Summer	Oct - Mar	16
Winter	Apr - Sep	17

Table 35. Inertias of axes 1 and 2 of the correspondence analysis performed on the scientific cruise data.

Axis	Inertia	Cumulative inertia
1	0.574	0.574
2	0.326	0.900
3	0.072	0.972
4	0.024	0.996

Despite the limitations of using mean data, rather than real time data, four major groups of species were apparent in the results (figure 123) :-

- 1) group 1 including dusky dolphins, Heaviside's dolphins, humpback whales, right whales and "like minke whales". These were all nearshore species or occur in nearshore waters. The inclusion of humpback, right and "like minke" whales in this group result from them having only been sighted within Area I and II on scientific cruises.
- 2) group 2 including common dolphins, Bryde's whales and the *Globicephala* species. The inclusion of *Globicephala* species with the two "Agulhas Bank" species presumably results from the two *Globicephala* species occurring in warm and cold water habitats.
- 3) group 3 including the blue whale, fin whale, Cuvier's beaked whale, Risso's dolphins, the Mesoplodon species, striped dolphins (and "like striped dolphin") and spotted dolphins
- 4) and group 4 including sei whales, sperm whales, killer whales, bottlenose whales,(and "like bottlenose whales"), false killer whales and Fraser's dolphins. Both group 3 and group 4 comprise species found in deep waters off the south and east coasts.

These four groups are arranged along axis one with group 1 associated with low temperatures and salinities (and thus Areas I and II) and group 4 "correlated" with higher temperatures and salinities and Area IV. Offshore species were not associated with Area I and II and nor were inshore species associated with Area IV (reflecting the distribution of search in these Areas). The arrangement of minke whales and "like Bryde's" whales along axis 2 result from the association of these species with low salinities in Area 1.

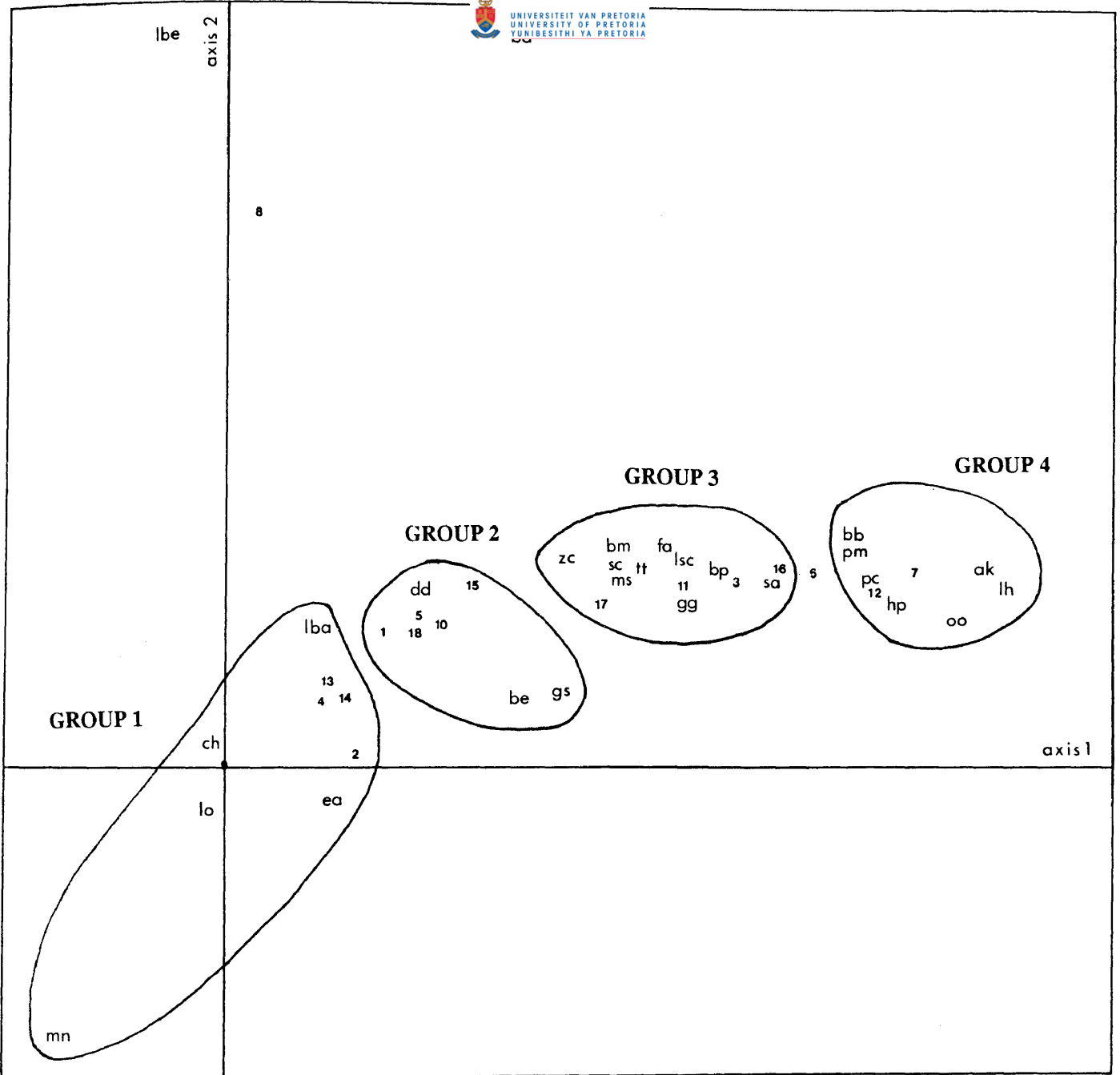


Figure 123. Results of correspondence analysis of sightings of cetacean species on dedicated scientific cruises versus environmental, seasonal and distributional factors.

CHAPTER TEN

DISCUSSION

Thirty - seven cetacean species are found in the southern Africa sub-region. Of these, the distribution and seasonal abundance patterns of 33 species could be defined and these fell into four groups.

a) "Migratory species". Five species (*Balaenoptera musculus*, *B. physalus*, *B. borealis*, *Eubalaena australis* and *Hyperoodon planifrons*) showed strong patterns of overall seasonal abundance in the dedicated data and were defined as "migrators".

b) "Possible migratory species". A further three species (defined as "possible migrators") that were not recorded in the dedicated data showed patterns of seasonal occurrence in the incidental sighting and specimen databases (namely *Caperea marginata*, *Mesoplodon layardii*, and *Berardius amuxii*), although it must be realised that the search effort cannot be assumed to be uniform throughout the year.

c) "Resident species". Twenty species (*Ziphius cavirostris*, *Mesoplodon minus*, *M. densirostris*, and *M. grayi*, *Pseudorca crassidens*, *Feresa attenuata*, *Globicephala melaena* and *G. macrorhynchus*, *Grampus griseus*, *Lagenorhynchus obscurus*, *Delphinus delphis*, *Cephalorhynchus heavisidii*, *Stenella attenuata* and *S. coeruleoalba*, *Lagenodelphis hosei*, *Tursiops truncatus*, *Sousa plumbea*, *Lissodelphis peronii*, *Kogia breviceps* and *K. simus*) were defined as "resident" in southern African waters.

d) "Semi - resident species". A further five species (*Balaenoptera edeni*, *Balaenoptera acutorostrata*, *Physeter macrocephalus*, *Orcinus orca* and *Megaptera novaeangliae*) were defined as "semi - resident" in that it appeared that the population was segregated by form or reproductive component and although some individuals were present all year round, a marked seasonality was found in other components or forms. Humpback whales were included in this group because of the historical summer records of Townsend (1935) and Keller (in Best and Shaughnessy 1979).

The distribution patterns of a further four species (*reponocephala electra*, *Mesoplodon hectori*, *Steno bredanensis* and *Stenella longirostris*) are impossible to determine due to insufficient records, and at least three of these may be species for which Southern African waters represent the extreme limit of their distribution.

The distribution and seasonal abundance patterns of these 38 species will be discussed separately.

Seasonal abundance of migratory and semi resident species

All of the rorqual whales (with the exception of Bryde's whale) undertake migrations from the summer Antarctic feeding grounds to the winter breeding grounds in temperate and tropical waters. Mackintosh (1942) notes that various authors have suggested that the best evidence for seasonal migrations in blue and fin whales is that whalers have never found it profitable to operate in the Antarctic waters in winter or in the temperate / tropical waters in summer. Brown (1962) notes that it is not known to which Antarctic stock the blue whales found on this coast are related, although Harmer (1931) links the timing of the departures of blue and fin whales from the Cape coast to the arrivals and abundance of the two species off South Georgia.

The seasonal occurrences of these species in whaling grounds provide good evidence of the migration patterns, with unimodal trends inferring migrations to the vicinity of the grounds and bimodal trends inferring migrations to the north of the grounds. Unimodal trends may also result from one migration taking place outside of the whaling grounds or season, while Harmer (1931) suggests that the bimodal trends may arise from :-

- 1) uneven catch effort due to poor weather conditions (not of consequence in this study due to effort being taken into consideration).
- 2) the main migration stream passing the ground on two occasions per season.

3) the segregation of migration into age, size or reproductive classes.

Unfortunately, many of the larger mysticetes are now severely depleted through over-exploitation, so that not only are the available data limited in scope (especially for humpback, blue, fin and right whales), but there must also be some doubt over how representative they are of the original distribution and seasonality of the species.

Table 36 shows a synopsis of published literature on the seasonal abundance of rorqual species in the southern African whaling grounds. Although the records of blue whales are too few to adequately determine migration patterns, the seasonal pattern of sightings of blue whales in the east coast whaling grounds would infer that the migrations of this species precede those of other rorquals (as suggested by Bannister and Gambell 1965). Migrations of fin and minke whales through these waters occur late in the season (between June and September) although minke whales were recorded in southern African waters all year round as scientific and incidental sightings and strandings. Extreme segregation of minke whales by age and reproductive condition makes it difficult to interpret the migratory patterns of this species. Both published literature and the records reviewed in this study infer that sei whales migrate to the north of both the east and west coast whaling grounds, despite the fact that a number of authors (eg. Matthews 1938, Bannister and Gambell 1965 and Best 1967) have recorded unimodal trends in abundance in these whaling grounds. Such unimodal peaks were recorded for both aerial sightings and catches in the west coast whaling grounds in 1963 (as analysed in this study) and it is assumed from the timing of these unimodal peaks (which coincide with the timing of either northward or southward migration peaks when bimodal trends were recorded) and their prominence that one migration path has occurred outside the whaling ground. The seasonality of sightings of humpback whales in the east coast whaling grounds reviewed in this study show a unimodal trend, and comparison of this result with the published trends from this whaling ground (Olsen 1914 - 15, in Hinton 1915, Harmer 1931, Matthews 1937 and Bannister and Gambell 1965) would suggest that the northward migration during the July to August period has gone undetected. It is assumed that the major part of this migration has occurred

inshore of the area in which the spotter aircraft was operating. Both Harmer (1931) and Olsen (1914 - 15, in Hinton 1915) suggest that a high proportion of the humpbacks migrating up the west coast, struck the coast to the north of the west coast whaling ground, and the low densities of catches and the lack of sightings of humpback whales in this study result from this behaviour and the depletion of the stock earlier this century. The inclusion of this species in the semi - resident group results from the fact that historically humpback whales may have remained in the waters off the west coast the whole year round. Townsend (1935) and Keller (in Best and Shaughnessy 1979) maintained that humpbacks were present off the west coast of South West Africa / Namibia during summer, and Olsen (1914 - 15, in Hinton 1915) stated that humpbacks could be taken off Saldanha Bay all year round. All of the summer dedicated and incidental sightings and strandings were recorded off the west coast, apart from one stranding recorded at Cape St Francis ($34^{\circ} 12' S, 24^{\circ} 52' E$) during November. The possibility exists that these humpback whales were feeding on pelagic fish which would have been abundant all year round in this region.

Conclusions on the migration patterns of the offshore form of Bryde's whale are difficult to draw due to the possible catch selectivity in the west coast whaling ground data, but the paucity of catches during June, July and August suggests that it moves out of the whaling grounds during the winter months. Unpublished data (in the possession of P B Best) on the catch positions of "sei whales" (probably the offshore form of Bryde's whale) taken by the catcher / factory ship "Sierra" that operated in the South Atlantic, suggest a seasonal shift from latitudes of the Cape Peninsula in summer to the tropics in winter.

Table 36. Synopsis of published migration trends of rorqual whales in southern African whaling grounds. U = unimodal trend; B = bimodal trend. Months of maxima are presented in parentheses where given in the source literature. The offshore form of Bryde's whale has not been included due to possible catch selectivity or movement out of these grounds during the winter months.

SPECIES	SOURCE	CAPE	WALVIS BAY	ANGOLA	GABON	NATAL	LINGA LINGA	MADAGASCAR
BLUE	Olsen (1914)	U				Scarce	None (Prior to 1913)	
	Harmer (1931) Bannister and Gambell (1965)	U / B	U (Aug)	U (Jul-Aug)		U (Jun-Aug) U (Apr-Jun)		
FIN	Olsen (1914)	Throughout season				Scarce		
	Harmer (1931)	B (May-Jul; Oct/Nov)				U		
	Bannister and Gambell (1965) Best (1967)	U				U (Jul)		
SEI	Olsen (1914)							
	Harmer (1931)	B				B		
	Matthews (1938)	B (May; Aug-Oct)	U	U		U		
	Bannister and Gambell (1965)					B (Jun; Sep)		
	Best (1967)	U (1958-1962) (max-Sep/Oct) B (1963) (max-May/Jun; Sep)						
HUMPBACK	Olsen (1914)	B				B (Jun/Jul; Sep)	U (Aug)	
	Harmer (1931)	"Touch coast to north of Cape Town"		B (Jul; Oct)	U (Jul/Aug)	B (Jul; Sep)		
	Matthews (1937) Angot (1951)					B (Jul; Sep)		
	Bannister and Gambell (1965)					B (Jul; Sep)		U (Jul-Sep)
MINKE	Best (1982)					U (present throughout season, max - Sep)		

The seasonal abundance of sperm whales suggested that they were moving northwards in autumn and southwards in spring, although marked differences in seasonality were found between large, medium and small sperm whales. Best (1974) found that females predominated in the summer catches off Durban between 1946 and 1951 when year round catches were made. Few large or medium sized sperm whales were taken during the summer months of this period, and it appears that these size classes only move into the study area during winter months.

The marked summer seasonality of bottlenose whales and "like bottlenose whales" is apparent in the scientific and commercial databases. However Ross (1984) notes that there is little evidence of the winter destination of this species.

Bigg *et al* (1978) note the presence of two races (resident and transient) of killer whales in Puget Sound, USA, while Mikhalev *et al* (1981) found that southern killer whales are distributed in low latitudes during winter and migrate to high latitudes during summer. The seasonality of killer whales in the commercial data and the year round presence in the scientific and incidental sighting and stranding data suggest that possibly both resident and migratory groups of killer whales are found in southern African waters. Alternatively the "resident" killer whales may move into the whaling grounds as the migrating whales are passing through the region. However this is difficult to determine without some study on the movements of individually recognisable whales (as carried out in Puget Sound).

Although the incidental sighting and specimen records possibly reflect biased seasonal effort, records of certain species (not recorded as dedicated sightings and defined as "possible migrators") provide evidence of seasonal occurrence in these waters. This group includes :

a) pygmy right whales

Despite two strandings of *Caperea marginata* (University of Pretoria logo) in May and June) the species appear to have a strong summer seasonality in this region. The records on the coast of South West Africa / Namibia are a northern extension of the range suggested by Baker (1985) as regards latitude, but temperatures recorded in these waters are within the species temperature range put forward by him.

b) Layard's beaked whale

Although Ross *et al* (in prep) find that this species has an onshore movement during summer and a northward shift in latitude during winter, the stranding data presented here suggest that *M. layardii* moves into these waters during autumn.

c) Arnoux's beaked whale.

All three specimens of *Berardius arnuxii* were recorded during the summer which, as McCann (1961) suggests, infers a movement into temperate waters during summer. Ross *et al* (in prep) found all *B. arnuxii* specimens in the southern Hemisphere to have occurred between October and March.

Distribution.

The migratory species have a transient occurrence in this region and thus the distribution patterns largely reflect seasonal migratory corridors through the area. Harmer (1931) has suggested that the difference in the surface temperatures on the east and west coast results in certain large whale species migrating to lower latitudes off the cold west coast than off the warmer east coast. Unfortunately the SADCO temperature database is inadequate for correlation with the dedicated commercial abundance data. The mean temperatures recorded in the east and west coast whaling grounds between April and September (the major part of the whaling season) were 22.22^o C and 16.7^o C respectively, and comparisons of seasonal trends in abundance in the whaling grounds recorded in this study and from published literature with these temperatures would suggest that blue,

fin and minke whales do not migrate to waters those found off Durban in the Indian Ocean, while humpback and sei whales migrate to tropical waters to the north of these. However records of fin whales at 20° S in the central Atlantic (Wheeler 1946), catches of fin whales off Gabon (Budker and Collignon 1952) and of minke whales at 07° S off Brazil (Williamson 1975, Da Rocha 1980) suggest that these species migrate well to the north of 30° S in the Atlantic.

Analysis of the distribution of blue, fin and sei whales by depth shows that they do not migrate through nearshore waters and the distribution of these species must reflect their transient occurrence to or through deep off - shelf waters to their "breeding grounds". Although it is not known where the breeding grounds of these species are, it can confidently be said that they lie outside "coastal waters". The distributions of both humpback and right whales show that both species were found in nearshore and offshore waters. Humpback whales largely have a coastal transitory occurrence in southern African waters *en route* to and from breeding grounds in tropical waters and individuals found in deep waters are assumed to be *en route* to coastal waters to the north of this region. Right whales utilise the large sheltered bays of the southern Cape coast for calving and the majority of sightings recorded on right whale surveys were recorded within 1km from the coast. Mating grounds for right whales are unknown, but may occur in the mid - oceanic whaling grounds of the 19th century (Townsend 1935). Individuals observed in deeper waters in this study may be *en route* to or from these areas.

Ekman (1947) noted the wide spectrum of zoogeographic components in southern African oceans and stated that faunistic boundaries are complex due to the oceanographic conditions. He maintained further that the zoogeography can only be understood if the faunistic regions are defined by water characteristics and not by geographical boundaries.

The high species diversity of cetaceans in southern African waters arises largely from these complex oceanographic conditions. The mixing of the tropical / sub tropical waters brought in from the east by the Agulhas current with the cold temperate waters of the west coast results in the formation of a

descending cline of surface water temperatures from east to west (figure 124). Certain species appearing to be strongly confined to particular temperature ranges and faunistic boundaries appear to coincide with temperature fronts. Within this temperature cline the distribution patterns of certain species are strongly associated with water depth. Thus the non - migratory cetacean fauna (including the "possible migrators") of the region can be divided into species occurring in ten different habitats which are largely defined by water temperatures and depth (figure 125). These are :-

Cosmopolitan species (11 on figure 125)

Orcinus orca and *Balaenoptera acutorostrata* appear to be the only two species which have cosmopolitan distributions in these waters. The depth distributions of minke whales show that they are found in all water depth intervals from less than 50 metres (incidental sighting) to over 3000 metres (dedicated scientific and commercial sightings). Best (1982) noted the presence of dwarf minke in southern African waters and that these were often found closer inshore than other minke whales.

Although *Pseudorca crassidens*, *Grampus griseus* and *Physeter macrocephalus* appear to have cosmopolitan distribution patterns, they are largely confined to pelagic waters (although *G. griseus* also appears to be strongly associated with the shelf edge). It would appear from the specimen records that *Ziphius cavirostris*, *Feresa attenuata* and *Kogia breviceps* should be grouped as pelagic cosmopolitan, but the paucity of sightings make confirmation of these distribution patterns difficult. Two further species (*Delphinus delphis* and *Tursiops truncatus*) appear to be found throughout southern African waters, but as different forms (in the case of *Tursiops*) or possible forms (in the case of *Delphinus*) are found at different depths off the west, south and east coasts they cannot be considered cosmopolitan. *Delphinus delphis* occurs over the Agulhas Bank on the south coast (inshore of the 500 m isobath) and in similar water depths off the east coast. The records of common dolphin off the continental shelf off both the south and west coasts would suggest that an offshore population of this species does occur in these waters. Further evidence of an offshore population off the west coast is inferred by the records of strandings, but the lack of sightings in inshore

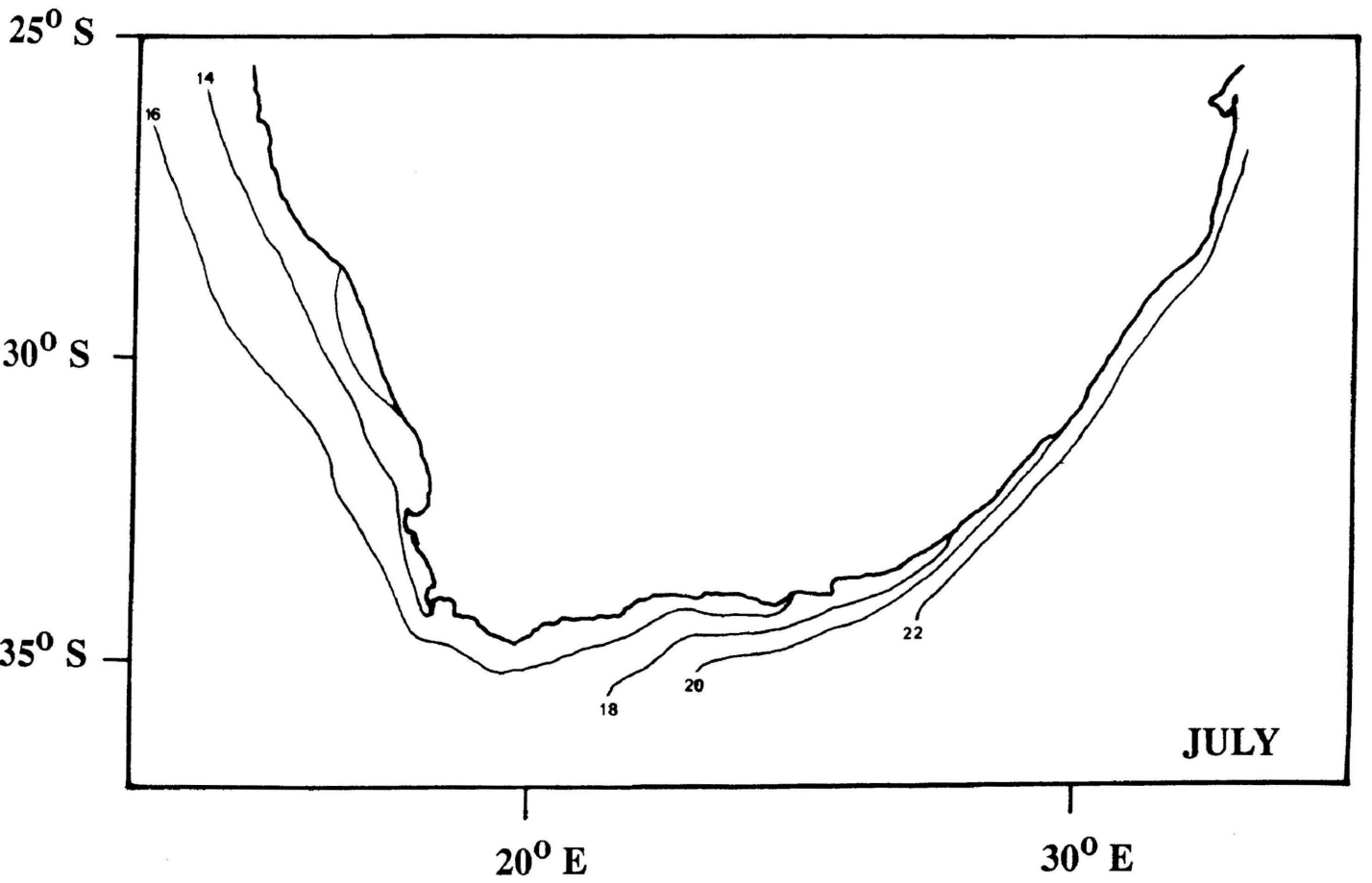
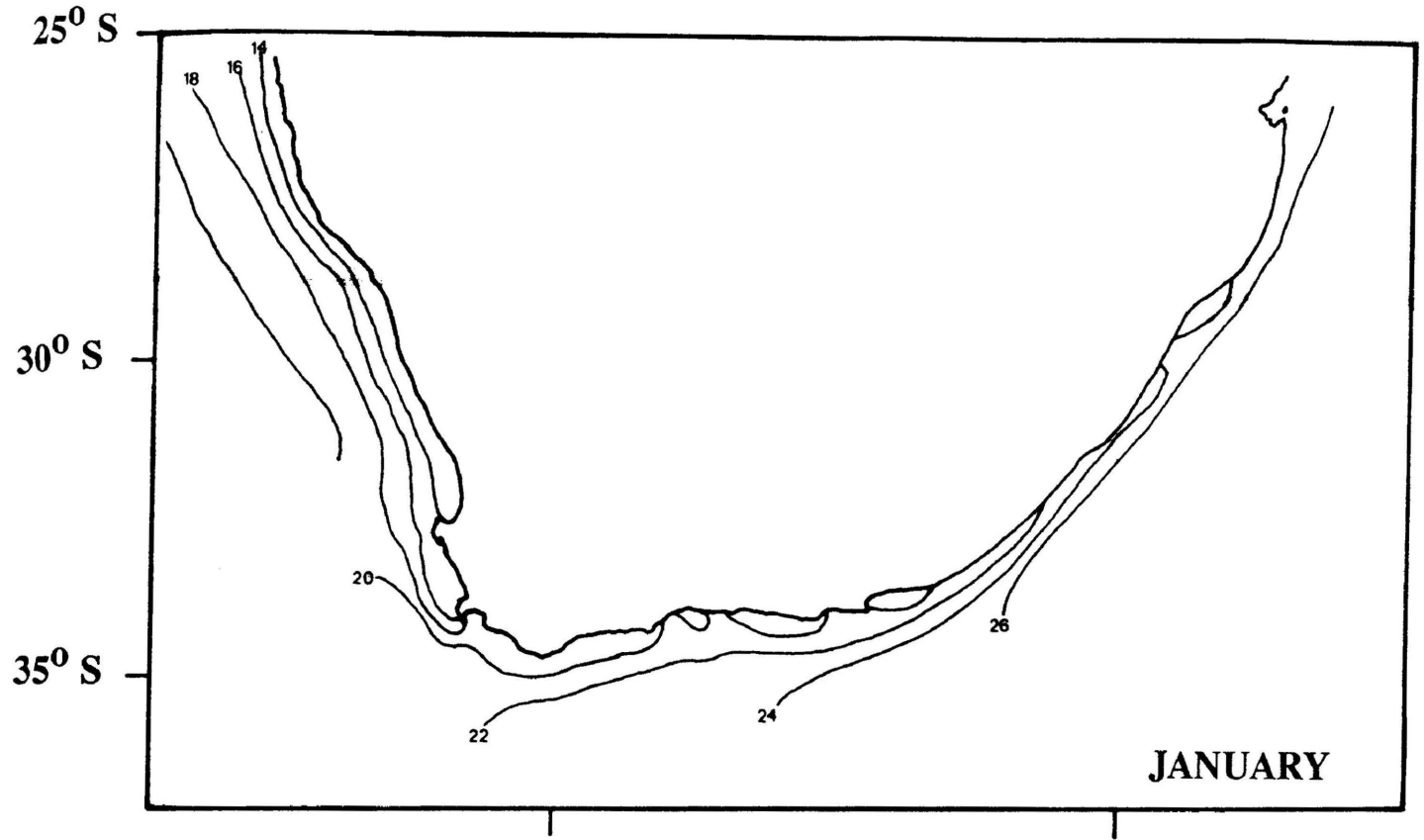


Figure 124. January and July sea surface temperature patterns measured in southern African waters (after Christensen 1980).

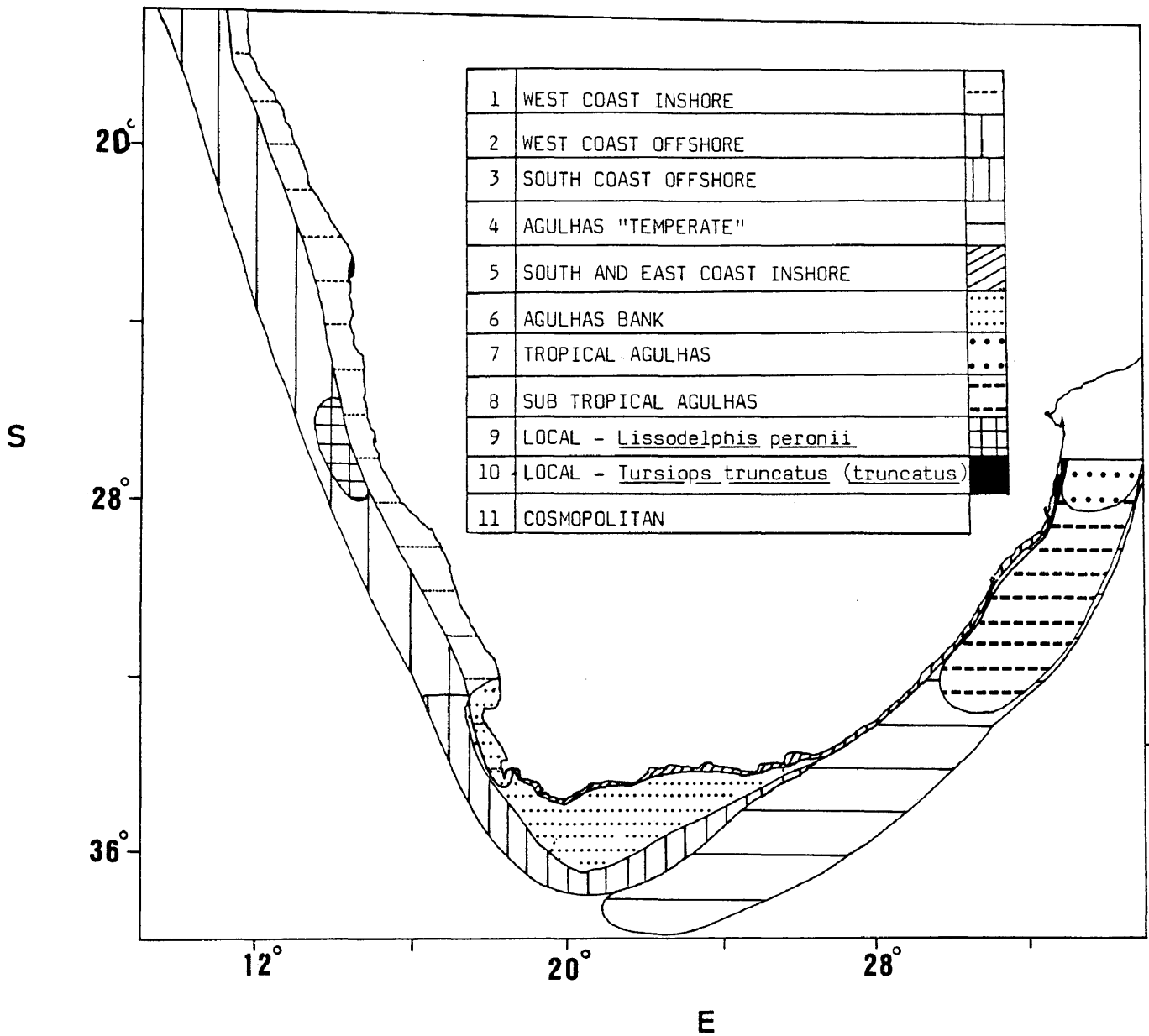


Figure 125. Diagrammatic representation of the distribution patterns of resident and semi - resident cetaceans in southern African waters.

waters of this coast. Bottlenose dolphins are found in both inshore waters (the *aduncus* form) and offshore waters (the *truncatus* form) of the east and south coasts, and in both inshore and offshore waters of the west coast (the *truncatus* form). Ross and Cockcroft (in press) suggest that the larger *truncatus* form is found in cooler waters than the smaller *aduncus* form. These temperature associations are not apparent in these data as :-

- a) the west coast *truncatus* form was not recorded on dedicated surveys and
- b) the east coast *truncatus* form was found in deeper waters than the *aduncus* form. The analyses performed in this thesis were carried out using sea surface temperatures, and it is suggested by Ross and Cockcroft (in press) that the offshore *truncatus* form is utilising deeper cooler waters of similar temperatures to the west coast.

Species associated with the Agulhas Current system (7, 8, 4 and 5 on figure 125).

The northern-most species associated with the Agulhas Current is *Stenella longirostris* which has been sighted in inshore waters off the Northern Natal coast, although the data are too few to define a distribution pattern or to comment on seasonality within the study area. This species has been recorded from the tropical Indian Ocean (Howell and Pearson 1977) and its occurrence off northern Natal is linked to the tropical component of the Agulhas Current. The one specimen of *Steno bredanensis* from the northern Natal coast would suggest that this region might also represent the extreme southern limit of the distribution of this tropical species in the Indian Ocean.

Smith (1965) determined that the southern limit of sub-tropical fish and invertebrate fauna on the east coast was in the region of the Great Kei river mouth ($32^{\circ} 45'S$, $28^{\circ} 30' E$). Ekman (1947) found that Algoa Bay represents a region of discontinuity of the inshore fauna, presumably caused by the Agulhas current's movement offshore. Certain of the pelagic species associated with the Agulhas current system are confined to the east of this region, namely *Lagenodelphis hosei* and

Stenella attenuata, while other species (*Hyperoodon planifrons* (and "like bottlenose whales") and *Stenella coeruleoalba*) appear to also tolerate the more temperate conditions to the south of the sub-continent. The western limits of these latter two species appear to be defined by the eastern shelf edge of the Agulhas Bank (which in itself plays an important role in defining the path of the Agulhas Current). Two further pelagic species (*Mesoplodon densirostris* and *Globicephala macrorhynchus*) are recorded from the east and south coast regions as strandings. Sightings of both of these species have only been recorded to genus level, and distribution patterns are difficult to define. It is possible that due to the prevailing currents of the south coast, strandings of these species may occur to the west of their normal range and as such the western limit of the distribution ranges of these species should be determined from sightings and not from strandings.

Gaskin (1982) states that continental Africa has functioned as a barrier to some warm water cetacean species, and the extent of this barrier has depended on their varying abilities to penetrate the cool waters of the southern Cape region. Certain pan-tropical genera have penetrated this barrier and have both Atlantic and Indo-Pacific distributions and these genera include *Sousa*, *Feresa*, *Steno*, *Peponocephala*, *Lagenodelphis* and *Stenella*. Perrin *et al* (1980) have suggested that the high diversity of *Stenella* species in the Atlantic Ocean has resulted from the Cape acting as a "variable one way filter" in the movement of *Stenella* into the Atlantic Ocean. Strandings of both *Stenella attenuata* and *coeruleoalba* well to the west of the distribution ranges determined from sightings suggest that these species may move around the Cape Peninsula in cells of Agulhas current water moving into the Benguela system. Furthermore similar events during interglacial temperature maxima may have facilitated the east to west dispersal of present pan-tropical species through the Cape cold water barrier.

Three species are found inshore of the Agulhas Current on the east coast. Both *Tursiops truncatus* (*aduncus* form) and *Sousa plumbea* are found from the northern Natal coast to the south coast west of Algoa Bay, while *D. delphis* moves into Natal inshore waters from the south following the annual winter sardine run (Ross 1984).

Both Ekman (1947) and Stephensen (1944) define the south coast as a warm temperate region and Ekman notes that the inshore waters are cooler than the more offshore Agulhas current and defines this region as an independent zoogeographical province. Ross (1984) maintains that cool waters intrude westwards inshore of the Agulhas current on the south coast.

The Algoa Bay region does not determine the western boundaries of the neritic species *Sousa plumbea* and *T. truncatus* (*aduncus* form). Ross (1984) suggests that this is due to the presence of sheltered shallow bays along the south coast which provide warm water close inshore. However it does appear to determine the eastern limit of three groups :-

- a) the south coast neritic forms both of *Delphinus delphis* and *Balaenoptera edeni*, although *D. delphis* follows the winter movement of pilchards *Sardinops ocellatus* into Natal waters. Although summer records of *D. delphis* do occur to the east of this discontinuity, the majority of records are to the west of it.
- b) a group of pelagic species (recorded from strandings only), distributed from the region of Cape Columbine to the Eastern Cape including *Mesoplodon mirus*, *Berardius arnuxii* and *Kogia simus*.

Ross (1984) maintains that both *K. simus* and *M. mirus* are closely associated with regions of highly mixed waters and notes that Moore (1966) suggests an association between *M. mirus* and the deeper waters of the continental shelf of the eastern seaboard of the USA. Ross however argues that *M. mirus* is an oceanic species and therefore probably not associated with the Agulhas Bank and that it appears to be confined to the area of overlap between "the allopatric" *M. densirostris* and *M. layardii*. Ross (1979) suggested that there may be some association between the Agulhas Bank and the distribution of *K. simus*. The longshore distribution of strandings of *Kogia breviceps* overlaps that of *K. simus*, and unless the two species are confined to different depth intervals, they must be considered

c) a second group of pelagic species which appear to tolerate the cooler waters between SWA / Namibia and the eastern Cape (where they intrude eastwards inshore of the Agulhas Current) and includes *Globicephala melaena*, *Mesoplodon grayi* and *Mesoplodon layardii*. Ross (1984) states that the south coast distribution of *Mesoplodon layardii* is associated with the cool waters inshore of the Agulhas Current. Although the present study presents incidental sightings records from the east coast, the majority of the the stranding records are all west of the south eastern Cape distribution limit suggested by Ross (1984).

All pygmy right whales records are confined to this region, although it is suggested that the species has a seasonal occurrence in these waters. One possible pygmy right whale was taken in the east coast whaling grounds in 1969 (Ross *et al* 1975), but this record is not confirmed and therefore has not been included in this database.

The inshore west coast region (1 on figure 125).

Ekman (1947) suggests that the Cape of Good Hope forms a boundary between two temperate regions, and the distribution patterns of the neritic cetaceans appear to confirm this. Two neritic species (*Lagenorhynchus obscurus* and *Cephalorhynchus heavisidii*) are associated with the cold temperate waters of the west coast and have not been recorded to the east of False Bay and Cape Point respectively. Conversely *Sousa plumbea* and the *aduncus* form of *Tursiops truncatus* have not been recorded further west than strandings at Muizenberg (34° 07' S, 18° 28' E) and Strand (34° 08' S, 18° 25' E) respectively. (The definition of the western limit of the distribution range of *Sousa plumbea* from this stranding, however must be regarded with caution as no recent sightings are recorded to the west of Cape Agulhas.) Inshore distributions of both *Delphinus delphis* and


Balaenoptera edeni do not extend much further north than about 32° 00' S on the west coast (although offshore distributions of these species occur to the north of this). The longshore distribution pattern of *Cephalorhynchus heavisidii* (the cool temperate inshore waters of the west coast) corresponds to Ekman's (1947) "Namaqua zone" between Cape Point and 18° 00' S, while *Lagenorhynchus obscurus* tolerates slightly warmer and deeper waters and has been recorded as far north as 12° 00' S. The reason for the hiatus in the distribution of *L. obscurus* in the region of the Orange River Bight is unknown. The distribution of the species overlaps both regions of upwelling cells and regions where upwelling is not as prevalent, while the hiatus overlaps both the Hondklipbaai upwelling cell (Shannon 1985) and the region to the north of this. Although a hiatus in the distribution of clupeid fish is recorded off the west coast, it occurs further to the north between Luderitz and the Orange River Mouth.

The extreme nearshore distribution of bottlenose dolphins (*truncatus* form) off the west coast appears to be confined to the waters in the vicinity of Walvis Bay and further north, one nearshore incidental sighting at Cape Cross having been reported. No dedicated sightings of this nearshore population have been recorded, but this is probably due to the lack of search effort in their habitat, the waters being too shallow for survey vessels.

Historical records of humpback whales occurring in this area throughout the year (Olsen 1914 - 15, in Hinton 1915; Townsend 1935 and Keller, in Best and Shaughnessy 1987) and summer sightings and strandings from the west coast reviewed in this study, suggest that some individuals remain in temperate waters throughout summer. Olsen found that humpback whales taken in this region during summer had been feeding on fish and it is suggested that these individuals prey on pelagic fish.

The offshore west coast region (2 on fig 125).

The offshore distributions off the west coast are difficult to define due to the lack of search effort

off the shelf and in a number of cases are randings, the lack of sightings over the shelf, and the pelagic habits of these species off other coasts. These species include the pelagic cosmopolitan species, *Globicephala melaena*, *Mesoplodon grayi* (both recorded between the SWA / Namibia coastline and the eastern Cape) and the pelagic forms of common dolphin and Bryde's whale. The distribution of *Tursiops truncatus* (*truncatus* form) in pelagic waters of this coast is uncertain. The occurrence of this form in extreme nearshore waters of the northern west coast has been noted, and all strandings in the region have been attributed to *truncatus*. However, it is not known if the stranding records from this coast originate from this nearshore population or from the offshore population apparent from incidental sightings. The extremely localised occurrence of *Lissodelphis peronii* off Luderitz is associated with the shelf edge and possibly with the Luderitz upwelling region and the year round presence suggests that the population is resident. The fact that the majority of sightings of this species were made in summer must be regarded with caution as all sightings were incidental. The possible record of *Steno bredanensis* on this coast probably arises from a population to the north of SWA / Namibia in tropical waters of the eastern Atlantic. Unfortunately little data are available as to the distribution of small cetacea off Angola and further north.

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