Overview of the Minke Whale sighting survey in IWC/IDCR and SOWER Antarctic cruises from 1978/79 to 2000/01

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ABSTRACT

The IWC/Southern Hemisphere minke whale assessment cruises (IDCR or SOWER) have been conducted from 1978/79 to 2000/01 in all six IWC Antarctic baleen whale species management Areas, basically in a consistent way every year. During the 23-years history of the program a total search distance on primary effort of 70,340 n.miles has been achieved during 2,448 ship-days in the Antarctic. A total of 6,027 primary minke whale school sightings were recorded. It is concluded that the program has developed and established standard sighting procedures and has also improved the precision of whale identification standard in the Southern Ocean. However there have been two major, and some minor, modifications of survey design in relation to the development of survey procedures, which have developed as the best possible compromise between statistical needs and logistic feasibility throughout circumpolar series. This paper outlines a number of the most significant modifications that have occurred, across years, to the research equipment, protocols and data collection. Some preliminary results are included. The program was modified from a Discovery marking cruise to a rigidly structured systematic sightings cruise from the second circumpolar set (from 1985/86) after various discussions (IWC, 1986). With this as a turning point, sighting procedures had developed and strict identification guidelines for Antarctic minke and Southern bottlenose whales were established. Modification of the survey design, from the third circumpolar set (from 1991/92), to cover whole region south of latitude 60S in the Antarctic has resulted in a change in emphasis of the latitudinal coverage especially in Areas I, II, III and V, and the implications of this are discussed. Also described are the guidelines for the identification of minke whales; the methods used for assessment of duplicate status in passing mode with independent observer; the protocol used for conducting the estimated angle and distance experiment and the methods used for determining the southern boundary of the research area (ice edge). The program has also contributed to take many biopsy, photo-id, Oceanographic and acoustic samples and can be adapted to research programs in other parts of the world.

KEY WORDS: MONITORING; POPULATION ASSESSMENT; SURVEY-VESSEL; ANTARCTIC; ANTARCTIC MINKE WHALE

INTRODUCTION

This paper presents an overview of the minke whale sighting survey component and data collection during the IWC/IDCR and SOWER Antarctic cruises noting changes across years. This series of cruises, the minke whale assessment cruises, have been undertaken in the Antarctic each Austral summer for the past 23 years (since the 1978/79 summer). The cruises from 1978-79 until 1995/96 were conducted under the auspices of the International Decade of Cetacean Research programme (IDCR) of the IWC and from 1996/97 the cruises have been conducted under the Southern Ocean Whale and Ecosystem research program (SOWER) with blue whale research component . All of the Antarctic cruises were primarily minke whale assessment cruises designed for abundance estimation. During the early years there was a major change in emphasis of the cruises; with the shift from marking to sightings surveys. The sightings survey underwent an early development and standardization phases when many experiments were conducted and the current survey procedures were developed.

We have not attempted to provide a comprehensive description of all aspects of this research program. The procedures, experimental design and the equipment developed and used during the first ten cruises (1978/79 to 1987/88) are summarized in Joyce et. al. (1988). After the first ten years the survey protocol has become largely routine with no major changes to the survey procedures, however, there has been some refinement. In recent years the research has broadened in scope with the introduction of blue whale research, acoustics and oceanographic studies. These aspects of the program are not covered in this summary. The guidelines used for the identification of species, and particularly of minke whales, are described in detail as an aid to investigate the reason for the change in the proportions of minke whales and 'like minke whales' during the series of cruises.

We have drawn attention to some keys areas where changes in protocol and data recording have been made. We have also described in detail the protocol used for the Estimated angle and Distance Experiment. Since it has not been previously described in detail it may provide an insight into ways of determining if changes in distance estimation have occurred. A description of the protocol used during the Passing mode with independent observer is provided with particular emphasis on assessment of duplicate status and the recording of data, since this also has not been previously described in detail. Additionally, methods of determining the position of the southern boundary of the research area (the ice edge) are described.

SURVEY ITEM

Research area

Research area had set up as follows;

First two circumpolar series

One of the IWC Antarctic Management Areas, (Figure 1) was surveyed during each cruise in the first two circumpolar series of cruises. All six Areas were covered twice. In each Area, longitudinal coverage had taken precedence over latitudinal coverage. The northern boundary of each Area was established around 60S-61S in Areas IV and VI, and at 62-65S in Areas I, II, III and V (Figure 2a-f).

Third circumpolar series

During the third circumpolar series, on all cruises since the 1991/92 cruise, priority has been given to latitudinal coverage (from the ice-edge to 60S) instead of longitudinal coverage (i.e. the coverage was shifted to the north, compare with first two circumpolar cruises). As a consequence of this modification (the aim of which was to improve the precision of the survey for the total area south of 60S), there has been an expansion in the width of the southern stratum (Figure 2a-f).

Research vessels

A total of eight vessels have been involved in the previous cruises. Six of the ships which equipped sighting platforms have been provided by the Government of Japan (the *Kyo Maru 27* (K27), *Toshi Maru 11* (T11), the *Toshi Maru 16* and *18* (T16 and T18), and the *Shonan Maru* and *Shonan Maru 2* (SM1 and SM2)). Two vessels were provided to the program by the USSR; the *Vdumchivy 34* (V34) and the *Vderzhanny 36* (V36). Up to four vessels were used in the earlier cruises. The K27 was used in five surveys to 1986/87, the T11 in the second and third surveys, and the T16 and T18 in the first survey only. One Soviet vessel took part in each of seven of the earlier cruises; predominantly used for research in the vicinity of the ice edge and to map the ice edge. SM1 and SM2 have been engaged this program without a break for over 20 years (every survey since the 1981/82 cruise) and the bulk of the sighting data has come from theses vessels. A summary of ship deployment for each cruise is presented in Table 1. The specifications of the Japanese research vessels are shown in Appendix 6. Appendix 9 show the photographs of the research vessels.

Transit survey and homeports

On each cruise, a systematic sighting survey using the same methodology as on the cruises (except in Closing mode only) has been conducted during transits from homeport to the Antarctic research area and from Antarctic research area to the homeport. The pre- and post-cruise meetings have been held in the homeports and the ships re-fuelled and re-provisioned. The cruises have used a total of 10 homeports in 7 nations (Table 1).

Research periods

Table 1 shows the overall schedule for each cruise and the schedule of the Antarctic research (minke component only) and the transits. Table 1 also shows for each cruise, the number of research days in each calendar month. The minke research component of the 1994-95 cruise, and all subsequent cruises, was delayed by a period of two or three weeks compared with the previous cruises (The aim of the delay was to facilitate cruisetrack construction by increasing the likelihood of the ice edge receding prior to the survey to form a compact edge at a position more readily determined.

Change of the Positioning (Navigation) system

In the earlier cruises (prior to 1981/82), all vessels employed astronomical navigation as the principal technique for determining position. The Navy Navigation Satellite System (NNSS) was installed on the Japanese vessels from the 1981/82 cruise. From 1991/92 cruise, the Global Positioning System (GPS) was used on both research vessels (Table 1). These changes to the navigation system progressively improved the accuracy of the positional data recorded during the research activities. From the 1993-94 cruise, latitude and longitude on the sightings data form and on the effort data form were recorded to the nearest one hundredth of minute (instead of to the nearest minute of latitude and longitude). Additionally, the advent of GPS navigation coupled with the VDU track recorder, greatly enhanced the accuracy and ease of establishing the 3 n. mile bound on either side of the trackline and the accuracy of positions recorded during such activities as chasing, returning to the trackline procedures and during ice navigation etc. The precision of the GPS navigation also eliminated the need for 'position shifts' (corrections to the positions), which had been recorded on the weather and effort data records.

Use of Reticle binoculars

Reticle binoculars have been used routinely (after considerable experimentation and development dating back to the 1981-82 cruise) by observers in the top barrels and the Primary observers on the upper (front) bridge of the Japanese vessels since the 1984/85 cruise (Joyce et al., 1988). The reticle binoculars were also available for the independent observer (IO) platform from the 1987/88 cruise. From the 1998/99 cruise, reticle binoculars were also used for use by the researchers on the upper bridge.

Installation of Angle boards

The angle board which allows direct measurement of a whale sighting position relative to the position and heading of the vessel was introduced for the top barrel and captain in the 1983/84 cruise (Joyce et al., 1988). The angle boards were used in conjunction with a pointer on the binocular holder. Prior to this tape marks had been used as an aid; these had been placed on the wind protection screen in all platforms. The tape marks continued to be used for several years as a backup method for angle estimation. Angle boards were used routinely in the independent observer (IO) platform from the 1987/88 cruise. For the 1997-98 cruise additional angle boards with pointers were installed on the front bridge of the vessels. On the SM1, new angle boards were available for the three researchers and the engineer. On the SM2, new angle boards were available for the three researchers, the engineer and the helmsman (the other primary observer). Improved pointers on the binocular holders were installed the following year. New angle boards (used with pointers on the binocular holders) were installed in the IOP and for all upper bridge observers when the vessels were subsequently modified (SM1 prior to the 1998-99 cruise and SM2 prior to the 1999-2000 cruise.

Rebuilding of upper bridge and IOP

Independent Observer Platforms (IOP) were initially installed on SM1 and SM2 from the 1985/86 cruise. Prior to the 1998-99 cruise, extensive modifications were made to the SM1. The wheel house and front bridge were removed and replaced with an upper bridge and also a new IOP was installed. The new IOP was larger with the potential to accommodate three observers (rather than the standard one), although there was no change to the standard procedure of using one observer in this platform. The heights above sea level of the IOP or the upper bridge were not changed by the modifications. The modifications lead to an improvement in the observation platforms (upper bridge and IOP) with better wind protection and 360 degree visibility. Also at this time (prior to the 1998-99 cruise) a new larger IOP was installed on the SM2, identical to the one installed on the SM1. The following year (prior to the 1999-2000 cruise), the SM2 was extensively modified; the wheelhouse and front bridge were removed and replaced with an upper bridge. This completed the modifications and made it once again identical to the SM1.

Digital anemometers
From 1996/97 cruise, digital anemometers were installed in the wheelhouse of the SM1 and SM2 (Ensor et al., 1997, see Appendix 3). The new anemometers indicate true wind speed and direction. The previous anemometers had measured relative wind speed (from which the true wind speed was calculated by vector analysis). This modification has facilitated data recording by the ships officers and it is considered there has been no significant change to the accuracy of the measurements of wind speed and direction.

Data entry
Since the 1987-88 cruise, weather and effort data records have been entered into computer files during the cruise. For the 1990-91 cruise, new programs were developed and these facilitated the routine entry of these data in addition to input of sightings and boundary/ice edge data. The current data entry and utility programs (the Moon-Joyce Dataform and Plot programs) provide data entry, validation, summary and plotting capabilities. The data input is not in real time; the data is usually entered each evening, after the end of the research day.

SURVEY PROCEDURE

Stratification, cruise track design and coverage

The areas surveyed by each cruise are outlined in Figures 2a-f, together with the tracklines followed while on primary searching effort. It is immediately obvious that the survey design for the first six cruises differed from that in later cruises.

First circumpolar series (1978-79 to 1983-84)
During the first circumpolar series of cruises one vessel followed the ice-edge closely (the "S" strata), while another vessel alternated between latitudinal and longitudinal legs (the "N" strata), typically 60 nmiles or more north of the pack ice. An unsurveyed area ("US") generally remained between the "S" and "N" strata. The S strata were considered to cover an area twice that between the ice-edge and the vessel's trackline. From the 1983/84 cruise, vessels off the ice edge followed a zigzag cruisetrack design that was to be used in subsequent cruises (Branch and Butterworth, 2001).

Second circumpolar series (1984-85 to 1990-91)

The research areas were typically divides into four strata (East-North, East- South, West-North and West-South). Exceptions occur when there are bays in the south strata. The second circumpolar cruises followed a zigzag cruisetrack design within each stratum. A square trackline design was adopted in 1988/89 cruise but only in the southern strata. Details of the cruise track design including construction of way points were reported in the appendix of each planning report (IWC, 1988, 1989, 1990, 1991, see Appendix 1). The distribution of survey mode was changed for the 1990-91 cruise with the introduction of the option of changing survey mode (Closing or Passing mode with independent observer) at the mid-point of transects in both strata.

Third circumpolar series (from 1991-92 on)

From the 1992/93 cruise, the research area (and the cruisetrack construction) was divided into sectors of ten degrees longitude. Each sector was divided into two strata (southern and northern). The Southern Stratum extended from the estimated ice edge (or the 100 fathom line if this extends beyond the ice edge) to the southern boundary of the Northern Stratum. The Northern Stratum extended from the northern boundary of the Southern Stratum to the northern boundary of the research area (60°S). The boundary between the northern and southern strata in each sector was a line of fixed latitude. The position of the Interstratum Boundary was intended to achieve a Southern Stratum width of 60-90 n.miles, approximately. The northern waypoints are placed on the Interstratum Boundary. Details of the cruise track design including construction of waypoints were reported in the appendix of each planning report (IWC, 1991, 1992, see Appendix 1). From the 1993-94 cruise there were some additional changes in relation to coverage: The guideline for minimum coverage in the northern stratum was reduced from total coverage to 50%, The survey transects were subdivided by mode into equal-length segments restricted in length to less than 100 nmiles. For the 1995-96 cruise the guideline for minimum coverage on primary effort in the northern stratum was reduced to 46.5%. From the 1996-97 cruise the lower limit of coverage in southern stratum reduced (from total coverage) to 80%. The guideline for minimum coverage in the northern stratum was reduced to 45%. The current cruisetrack construction methods and guidelines for coverage are unchanged (IWC, 2000, see Appendix 2).

Conditions acceptable for Primary Search effort

Primary search effort is only conducted in acceptable weather conditions. These conditions were defined for the 1984-85 cruise as being able to see a minke whale blow (or other sighting cue) at a distance of at least 1.5 n.miles, with wind speed less than 25 knots and Beaufort sea state less than 6.

The conditions were redefined for the 1996-97 cruise as being able to see a minke whale blow (or other sighting cue) at a distance of at least 1.5 n.miles, with wind speed less than 25 knots (in the vicinity of the ice edge) and 20 knots (remote from the ice edge) and Beaufort sea state less than 6. These conditions are used as guidelines; in some circumstances, less severe conditions may still be inappropriate for search effort. (The assessment of acceptable conditions is subjective and depends on many other factors other than wind speed. Prior to the 1984-85 cruise, we feel that effectively the same criteria were used to define acceptable conditions. Similarly, the re-definition of acceptable wind speeds in 1996-97 did not result in any significant changes to assessments of acceptable survey conditions).

Survey mode

Since 1987-88 cruise the survey has been conducted in two primary modes:(1) Closing mode, (2) Passing with Independent Observer mode (IWC, 2000, see Appendix 2).

Closing mode (NSC)

Closing mode has been used since the first cruise. The procedure has been refined slightly over the years; most importantly with standardisation of return to trackline procedures, establishing a three nmile bound on either side of the trackline and then further refinement of return to trackline protocol following installation of the GPS.

Survey protocol

Two topmen observe from the barrel at all times; there is no observer in the IOP. There are open communications between the barrel and the upper bridge. When a sighting is made, the topman (or upper bridge observer) gives an estimate of the distance and angle to the sighting and the ship turns immediately, regardless of the angle to the sighting. The whales are approached and the species and number of animals determined. All subsequent sightings are regarded as secondary until normal search effort is resumed. If the initial sighting distance is more than 3 n.miles (perpendicular distance) from the vessel's trackline and the sighting is thought to be of minke whales, the sighting is passed; if, however, the species is thought to be a large baleen whale, closure to the sighting is attempted. In order to save valuable research time, closure to the sighting position of whales that can be positively identified as long-diving species (such as sperm whales or beaked whales) may be abandoned if it is considered that the animals have dived. The ship then changes course to the appropriate heading to approach the whale, and vessel speed is increased to 15 knots to hasten the closure. Ship speed is decreased when the group is neared, usually at a distance of 0.2-0.4 n.miles from the initial sighting position. After the whale group has been approached, the species, number of animals in the group, estimated lengths, number of calves present, and behaviour are determined and recorded. After as many data as possible have been collected, other activities might take place, such as natural marking or biopsy experiments. Until the ship resumes the transect with full search effort, any whale sightings made after the initial sighting are classified as secondary sightings.

Passing mode with independent observer (IO)

Survey protocol

Two topmen are observing from the barrel at all times and a third topman is stationed in the independent observer platform (IOP). Communications are essentially one-directional, with the topmen reporting information to the upper bridge observers, but no information being exchanged between the barrel and IOP. The observers on the upper bridge communicate with the topmen (using their independent telephone systems) only when clarification of information is required, thus avoiding disruption of the barrel and IOP's normal search procedure. Separate sighting records are completed for all standard barrel and IOP sightings. If the upper bridge makes a sighting prior to the same whale group being observed by the topmen in either the barrel or IOP, then a separate record is completed; otherwise any additional information from the resighting from the upper bridge information is added to the sighting record(s) completed for the barrel and/or IOP. The observers on the upper bridge are the first to sight a whale group, and subsequently the topmen from both the standard barrel and IOP sight the group, three sighting records will be completed for the same school, with independent estimates of angle and distance for initial sightings from each of the platforms. Immediately after a sighting is made from the barrel or IOP, the topman informs the bridge of his estimate of the distance and angle to the sighting (and also, if possible, the species, number of animals present and their swimming direction), but does not change his normal searching pattern in order to track the sighting. The topman gives no further information to the upper bridge unless the whale group happens to surface again within the normal searching pattern of the topman. The observers on the upper bridge track sightings made from that platform, and attempt to locate and track sightings made by the barrel or IOP, to confirm the species and number before the sighting passes abeam of the vessel.

Assessment of duplicate status

The researchers on the upper bridge determine which of the sightings made from the barrel, IOP and upper bridge are duplicates. There is usually discussion among the researchers and the captain (and other upper bridge observers if necessary). In almost all cases there is consensus of opinion regarding the assessments. In the rare cases of disagreement a lower 'level' of duplicate status is selected. Duplicate status is assessed in the following categories; Definite, Possible, Remotely possible, Unknown and Non-duplicate. Although the assessments are largely subjective, they are conservative and take into consideration, amongst other details, comparability of: estimated angles and distances, temporal and spatial relationship of sightings and type of cues, species, group size, swimming direction, behaviour and the compactness of the group.

- Definite – there are no fixed rules for assessing a duplicate verdict, however, the following gives an indication of the method. Simultaneous sighting (or short duration between sightings) by different platforms is not uncommon, and/or estimated angles within approximately five degrees and estimated distances within approximately ±20%, species (and group size) the same. If the sighting times are somewhat separated, the sighting has usually been tracked by the upper bridge. If not tracked then the location of the sighting is exactly as anticipated taking into account vessel movement and the whale(s) swimming direction

- Possible – the difference between the estimated angles and/or distances is just outside the threshold for Definite status but the sightings are reasonably close spatially. There may also have been difficulty tracking the sighting(s). If not resighted from the upper bridge and tracking was not possible the sightings may also have been temporally and spatially within the threshold for Definite status but the platforms indicated that the species were different

- Remotely possible – there is an 'outside chance' the sightings are Possible duplicates. Such cases may be the result of a combination of the following: not seen by upper bridge; difficulty tracking the sightings and considerable difference between the estimated angles and/or distances; the platforms indicated a difference in species

- Non-duplicate – sighting from one platform only, or if there is a candidate, the spatial/temporal or other distinction between them is obvious

- Unknown – uncertainty may exist, for example when entering a high density area

The practice of a researcher (or the captain) plotting the ships track and position of any sightings (using the estimated angles and distances) on plotting sheets (as first employed during the parallel ship experiments) has been routinely applied during survey in IO Mode. Upper bridge personnel have the option of using the plotting sheets as an aid in determining the duplicate status of sightings. In practice few sightings are plotted in this manner, and the plotting sheets are usually used only to help resolve potentially confusing situations. The plotting procedure is particularly useful as an aid for tracking sightings with a large initial sighting distance in the vicinity of the trackline (with a concomitant long time interval before the sighting comes abeam) and particularly when such groups exhibit long dive times.

Due to the subjective nature of the assessments of duplicate status there has been a slight difference in the proportion of duplicate verdicts (particularly Duplicate and Possible) between ships and between years. Between ships in any given year the difference in proportion may be due to the subjective nature of the assessments with some researchers being more conservative than others. The change in proportion of the verdicts between years is possibly a result of increased familiarity with the techniques and greater confidence of the researchers, captains and crews due to the long-term, routine nature of IO mode survey. Additionally, the most problematic cases in determining duplicate status are usually when the sighting rate is higher. In this regard it is possible there has been a decreased incidence of the use of BH mode (while conducting IO mode survey when a high sighting rate causes problems for the observers in discriminating between the same and different schools, searching mode is changed to NSP and BH mode is used in the effort record). Some factors resulting in the decreased use of BH mode may be: greater familiarity with the techniques (therefore greater confidence in tracking sightings and duplicate assessments), differences in cruisetrack design or a decrease in the incidence of encountering such areas of high sighting rate. Since the assessments always have been conservative, the issue of comparability between ships and years should not be significant.

Data record

The observers in the upper bridge, barrel or IOP (as pertinent) always give the angle, distance, cue, and (if available) their initial estimate of the species, school size and swimming direction, etc. The observer's initial data for angle, distance, cue and swimming direction are those recorded on the respective sightings data forms. With regard to species, school size and the remainder of the data, the researchers on the upper bridge (even in the case when the observers on the upper bridge never see the group) evaluate what is the most reliable and detailed information and use that to complete the sightings data form. If more information is required, or if there is conflicting information, from two or more platforms about one school, the researchers may communicate with the topmen via their independent telephone systems to request more specific information from them (usually after the sighting is estimated to have past abeam.

The following practice has been adopted as standard when completing the data forms:

- For sightings assessed as Duplicate, the data forms are completed with the SAME species and SAME numbers.
- For sightings assessed as Possible, Remotely possible, Unknown And Non duplicate, the species and numbers on the data forms may be the SAME or may be DIFFERENT.

This practice of entering the SAME species and the SAME group size information on the respective data forms for Duplicate sightings may not have always been followed exactly, however, and this may explain how there may be some (though extremely few) sightings assessed as Duplicates, where the species as recorded for the various platforms are different. Another possible explanation is that errors were made in the data records or the groups may have been composed of mixed species and the observers in the different platforms observed the separate species.

Normal passing mode (NSP)

This mode is identical to the IO mode except that there is no Independent Observer in place.

Number of the primary and secondary observers on effort

The total number of observers has not changed during the history of the cruises (apart from the additional observer used in IO mode, which became routine from the 1985/86 cruise.

The number of of observers on the front (upper) bridge has not changed, however, there has been a change in the status of one observer (the status of the helmsman was changed from secondary to Primary in 1985/86).

Top barrel	Two primary observers
IO platform	One primary observer (only IO mode, from 1985/86)
Upper (front) bridge	One primary observer (Captain, from 1978/79 to 1984/85)
	Two primary observers (Captain and helmsman from 1985/86 to present)
Upper (front) bridge	Three researchers and one Engineer

Research hours in the research area

Research has conducted as following hours (from planning reports, see Appendix 1);

First circumpolar series

1978/79 – 1983/84	0400-2000 hrs (16 hours)

Second circumpolar series

1984/85	0400-2000 hrs (16 hours)
1985-86 - 1990/91	0600-2000 hrs (14 hours)
	Reduced to 13 hours when IO mode conducted

Third circumpolar series

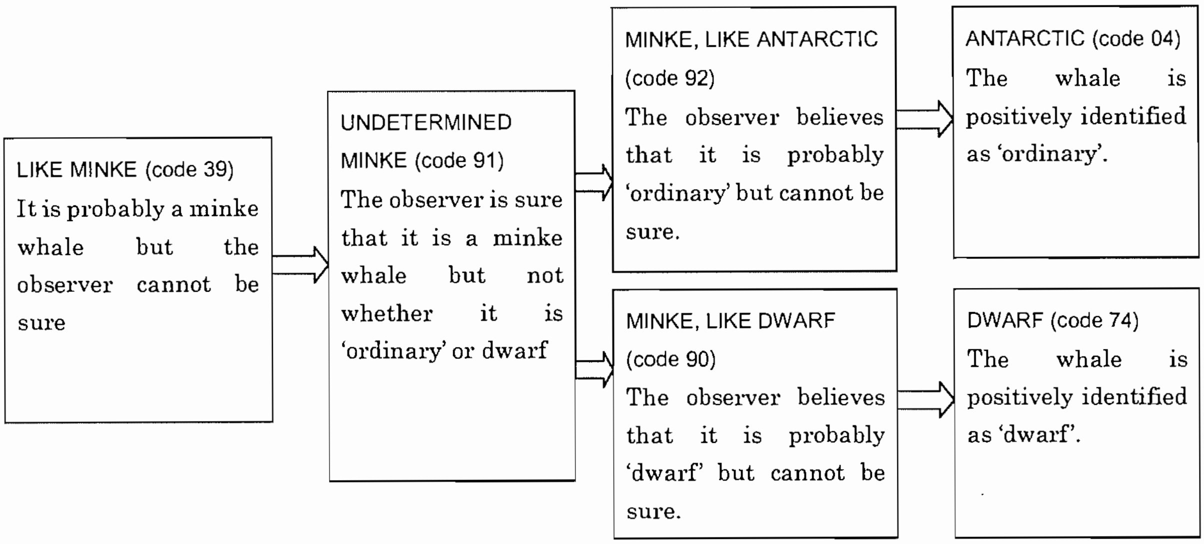
1991/92 – 1995/96	0600-2000 hrs (14 hours) Reduced to 13 hours when IO mode conducted
1996/97 – 2000/01	0600-1800 hrs (12 hours)

Standardization of species identification across years with particular reference to minke whales

The current *general* guidelines for identification on the IWC-SOWER cruises are as follows:

"Record the common or scientific name (such as "minke" or "fin") for *positively identified* species; a positively identified species is one for which the diagnostic features have been observed. Where this is not the case but the observer has seen enough to be reasonably sure of the species identity then record the qualification "like" (eg. use "like minke" if a clear view of the body was not obtained but the observer believed the sighting was *probably* a minke whale)."

For minke whales, in particular, the current identification guidelines are as shown in the following diagram (see "*Further explanation*" and " *Comparability across years*"):



Final decision of the category is made by the cruise leader/ senior scientist (or designated researcher).

<u>*Further explanation*</u>

Like minke (code 39)

The cue observed is usually the blow of the whale(s). In most cases there is no observation of the body or the view obtained is poor and insufficient to observe the diagnostic features of the species. Characteristics of the blow (small, 'baleen whale type' blow) indicate it is a probably a minke whale.

Undetermined minke (code 91)

The sighting is positively identified as a minke whale by observation of the diagnostic features of the body shape (shape of dorsal fin and head). The colouration pattern of the whale(s) body is not viewed clearly and it cannot be determined whether it is 'ordinary' or dwarf.

The distance at which a sighting can be positively identified as undetermined minke depends on many factors such as the sighting conditions, swimming direction and behaviour of the animals. Under normal conditions positive identification is possible up to about 1.5 nmiles. Under very favourable circumstances, determinations are possible up to about 3.5 nautical miles.

Minke, like Antarctic (code 92)

The sighting is positively identified as a minke whale based on the diagnostic features of the body shape. The colouration pattern of the whale(s) body is not viewed in sufficient detail for the observer to be able to positively discriminate between the two forms, however, based on the details of the colouration pattern seen the observer believes that it is probably 'Antarctic' but cannot be sure.

The distance at which such determinations can be made is variable and again depends on many factors such as the sighting conditions, swimming direction and behaviour of the animals.

Minke, like dwarf (code 90)

The sighting is positively identified as a minke whale based on the diagnostic features of the body shape. The colouration pattern of the whale(s) body is not viewed in sufficient detail for the observer to be able to positively discriminate between the two forms, however, based on the details of the colouration pattern seen the observer believes that it is probably 'dwarf' but cannot be sure.

The distance at which such determinations can be made is variable and again depends on many factors such as the sighting conditions, water clarity, swimming direction and behaviour of the animals.

Antarctic minke (code 04)

The sighting is positively identified as a minke whale based on the diagnostic features of the body shape. The colouration pattern of the whale(s) body is viewed in sufficient detail for the observer to be able to positively discriminate between the two forms. The whale is positively identified as 'Antarctic'.

The distance at which such determinations can be made is variable and again depends on many factors such as the sighting conditions, water clarity, swimming direction and behaviour of the animals.

Dwarf minke (code 74)

The sighting is positively identified as a minke whale based on the diagnostic features of the body shape. The colouration pattern of the whale(s) body is viewed in sufficient detail for the observer to be able to positively discriminate between the two forms. The whale is positively identified as 'dwarf'.

The distance at which such determinations can be made is variable and again depends on many factors such as the sighting conditions, water clarity, swimming direction and behaviour of the animals.

Comparability across years

There has been an increase in the number of species codes for minke whales during the course of the cruises and, in particular, a proliferation of codes in recent years. This resulted in confusion during analyses and the codes have been reorganized as recommended in Branch and Ensor (2000). However, although there have been changes to the codes, there is consistency shown in the guidelines for identification of 'like minke' across years. At least since the 1985-86 cruise.

The identification guidelines for 'like minke' for the 1985-86 IWC-IDCR cruise as described in the usage notes are essentially the same as currently used. The guidelines for identification of 'like minkes' are shown in the section 'Probable identification' in the excerpt below. The 'Identified' category was introduced to the sightings data record for the 1985-86 cruise. This was a single cell in which was to be entered 'Y' or 'N'. The usage notes for the 1985-86 cruise have the following instructions:

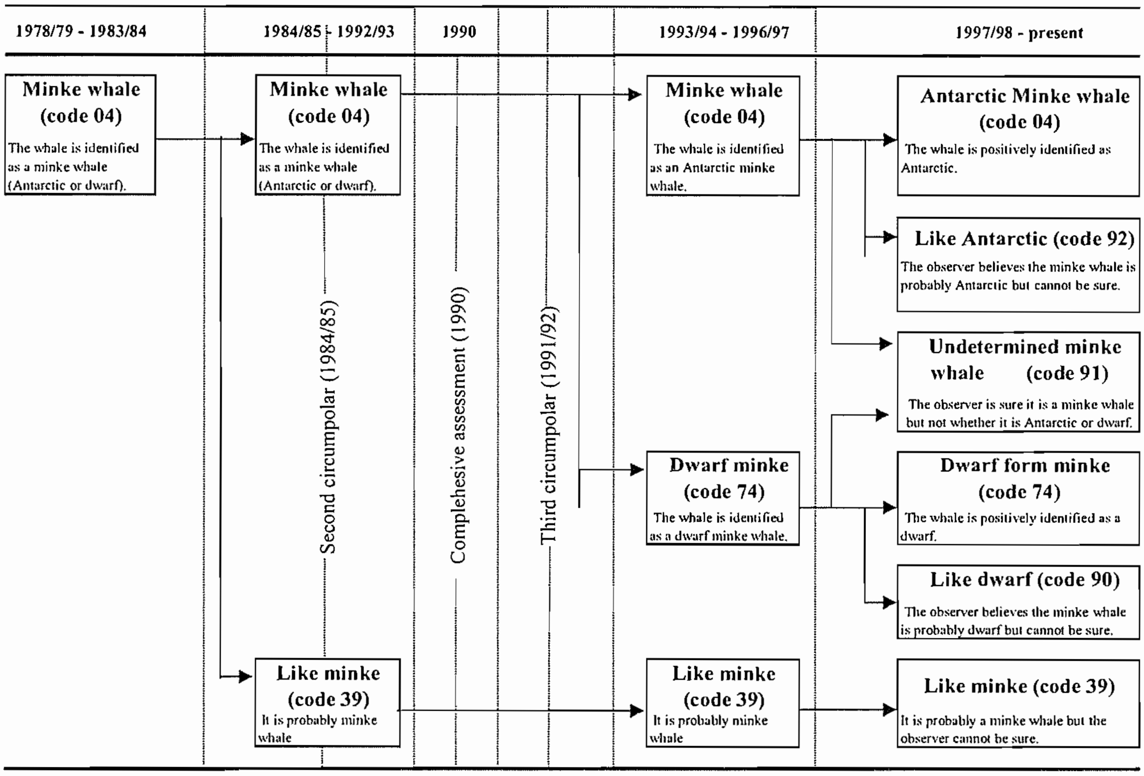
"Record as (Y) if the species (as indicated below) is 'positively' identified; otherwise record as (N) (i.e. both for 'probable' and 'unidentified' categories). Positive identification of species is based on the multiple cues and usually requires the clear observation of the whale's body. Occasionally repeated observations of the shape of the blow, surfacing and other behavioural patterns may also be sufficient: this judgement should be made only by a researcher. Positively identified whale species are recorded as such on the sighting form (e.g 'minke'). Probable identification of species is based on multiple cues but there are insufficient to be absolutely confident in identification. This usually occurs when blows are seen, the surfacing pattern is correct but the whales' body (characteristic of species) cannot be seen. Probable identifications are qualified with the term 'like' (e.g. 'like minke'). Unidentified whales should be clearly indicated. The sighting may be qualified by size (unidentified small, medium, or large whale), order (unidentified baleen or toothed whale) or suborder (unidentified ziphiid). If a species is suspected but no additional information is available to provide possible or probable identification, the species should be listed with a query, in brackets, after listing it as unidentified (e.g. 'unidentified small whale [minke?])."

A similar situation existed for the identification of southern bottlenose whales; before the 1984/85 cruise.At that time there was neither an identification standard nor a great deal of experience in identification of this species .. During this research period, whales described as "Unidentified Ziphiidae" represented "Unknown akabo" and "Like akabo". Researchers at the post-cruise meeting after 1983/84 cruise resolved that many of the unidentified Ziphiidae were probably in fact southern bottlenose whales (Nishiwaki, pers. comm). At this time, an agreed standard, between the vessels, for the identification of southern bottlenose whales had not been developed yet. Following discussions at this meeting, the identification of southern bottlenose whales became standardized, and more strict than unidentified Ziphiidae (Anon, 1986. page16: see Appendix 3).

A similar 'situation' existed at this time with identification of the minke whale, particularly when passing mode procedure was introduced There are usually poorer opportunities for positive identification in passing mode compared to in closing mode because of the difference of the approaching procedure to a sighting. Most of the sightings identified to be 'like minke' and unidentified Ziphiidae in passing mode are sightings for which the closest distance exceeds 0.6 n' miles and for which there are few sighting cues. It is possible to judgment that such a situation is not one by the search ability for the observer. It is the passing mode that was introduced to get more search efforts, but it results in increasing an unidentified species because the condition to judge the identification of the whale species and school size is worse than the closing mode.

Change of the species code

Whale species codes have proliferated over the years; increasing from 22 codes used on the 1978-79 cruise to the current total of 82 codes (Table 1). The number of codes increased due to additional species being encountered during the 23-year history of the cruises and also due to clarification of levels of identification. For change of the species code of minke whales are as shown in the following diagram:



It must be noted that code 39 (like minke) was entered in the DESS on the course of data validation even the data were prior to the introduction of the code to the field. Further information can be found in the DESS user manual Appendix S (Strindberg and Burt 2000). Code 39 has been used at field since 1984/85. Branch and Ensor (2001) described that code 39 (like minke/?minke") was used from 1978/79 to 1992/93" but the description was somewhat misleading.

Confirmation of school size

Accurate determination of the school size of all sightings is not possible. It is the responsibility of the researchers to evaluate if the school size has been accurately determined. Schools where the number of animals, or an accurate estimated range of the number of animals, is determined are classified as *confirmed* schools. The data from the confirmed schools are used in the analysis to determine a mean school size. Therefore it is critical that the schools that are confirmed are representative in size of the schools that are in the survey area. Normally, schools believed to be confirmed for school size are approached to within 0.3 n.mile, but sometimes it is possible to confirm school size at greater distances.

Ice edge determination and definition of the Southern Boundary of the Research Area

The southern boundary of the research area for the cruises has been established as either the 'ice edge' or the 100 fathom isobath, if this has extended beyond the 'ice edge'. The position of the 100 fathom isobath has been established from the navigation charts. The position of the 'ice edge' for each cruise has been established using information from a number of sources; visual and radar observations of ice from the IDCR/SOWER research vessels, satellite imagery and observations relayed from other ships and/or land bases. These sources of information have been used to construct an estimate of the 'ice edge'. This 'ice edge' has then been used in the construction of the cruisetracks. After the completion of the southern stratum of each sector, the senior scientist has used all the data to record the maximum (most northern), minimum (most southern), and best estimates of the 'ice edge'. (The best estimate may not have necessarily corresponded to the ice edge used in the construction of the cruisetracks). If there has been no evidence to suggest the 'ice edge' may be different from the best estimate, then the other estimates have not been completed.

Estimation of the position of the ice edge from the IDCR/SOWER vessels

Fundamental to determination of the position of the 'ice edge' from the IDCR/SOWER vessels is a definition of what constitutes the 'ice edge'. From these vessels, the position of the 'ice edge' has been established using visual observations (especially from the Top Barrel) and radar observations. Information from other sources (such as satellite imagery of ice concentration boundaries and bathymetric information from navigation charts) has also been used for confirmation. No single definition of what constitutes an 'ice edge' can be used for all 'ice edge' situations due to the variability in the ice concentration, ice type (e.g. sea ice, glacial ice), floe size and ice development (thickness). However, a common theme running through the estimations of all 'ice edge' boundaries is the navigational safety of the ships. The ships are not ice-strengthened and although they frequently navigate through ice, difficult ice situations are avoided. The principles involved in defining the position of the 'ice edge' and the range of difficulty involved in making that estimate is demonstrated in the following examples. When the ice/ice-free boundary is well defined and the pack ice is of high concentration (7/10-10/10) and there are no large ice-free areas inside the pack ice then estimation of the ice edge is a simple matter.

- An 'ice edge' such as this is usually obvious, visually and on radar. The ice edge waypoint is established 2.5 nmile from the 'ice edge.'

When the ice is of substantially lower concentration (3/10-4/10), or is highly variable in concentration, and/or the ice is arranged in belts separated by substantial ice-free areas (for example ice-free areas of physical dimension greater than one nautical mile), estimation of the position of the 'ice edge' is most problematic.

- In this situation the position of the 'ice edge' is determined largely by the limits of safe navigation of the ship. Attempts may be made to navigate through or around the belts of sea ice to confirm the 'ice edge' dependent on what areal extent of ice-free water is visible south of the outer limits of the ice (and depending on the relationship to other information such as bathymetry and perhaps satellite imagery). If navigation through the ice proves difficult the 'ice edge' is defined as the limit of safe navigation of the ship. The ice edge waypoint on the cruisetrack is established 2.5 nmile from this 'ice edge'.

If there are no ice-free areas to the south and when the ice is composed of small melted floes and of very low concentration (1/10-2/10) estimating the ice edge is also problematic. However, generally such scattered small ice is relatively consistent in concentration over a wide geographic area and this makes estimation of the 'ice edge' easier than the above case.

- Estimation of the ice edge is usually based on how the ice concentration and development relates to navigation of the vessels at normal searching speed (11.5 knots). The 'ice edge' is usually defined as when the ice forms a continuous visual barrier (or radar image) on the horizon or when normal searching speed cannot be maintained for majority of time without help from the Topmen to navigate through the ice. The ice edge waypoint on the cruisetrack is established 2.5 nmile from this 'ice edge'

Expansive ice-free areas or pack ice of much lower concentration may be visible inside the pack ice extending beyond the horizon south of the 'ice edge'. In such cases, the areal extent of ice-free areas extending beyond the horizon cannot be substantiated and whether the ice represents the true 'ice edge' or is separated from the main ice edge cannot be established. The position of the ice edge and details of the ice edge observations from the research vessels are indicated on the detailed cruisetrack charts produced during the cruise. Traced copies of the cruisetrack charts are sent to the IWC at the end of each cruise with the cruise data.

Estimation of the position of the ice edge from satellite information:

The vessels have received satellite information from the US Navy NOAA Joint Ice Center (JIC) and latterly the National Ice Center (NIC). Summaries of these analyses were sent to the ships by morse code from at least the 1980-81 cruise. Also at this time, an estimation of the ice edge for the entire Antarctic, based on both satellite and aerial observations, was available twice monthly (via weather chart radiofax) from the Soviet station Molodezhnaya, located in Enderby Land. More detailed information was received by facsimile after the Inmarsat system was installed on the ships for the 1991-92 cruise (and by email on recent cruises). The type of satellite information received, and its usefulness has generally remained the same across the years, with a variety of satellite methods: passive, microwave radiometers, visible and infrared sensors, synthetic aperture radar, or sometimes only estimated boundaries. The JIC/NIC ice information has been vital for estimating the position of the ice edge and has been more important in the absence (since the 1985-86 cruise) of the Soviet vessels and their dedicated ice edge role in mapping and survey.

Ice information from other ships and/or land stations

Useful ice information has been received, from time to time, from other ships and Antarctic land bases.

Consistency of estimates of the ice edge/southern boundary over years

The methods used for estimating the position of the ice edge have not changed significantly during the history of the cruises. The only major change is that the estimates for later cruises lack the precision of the earlier cruises when the position was determined by the ice edge survey and mapping vessels. Within the later cruises there has been a trend towards fewer ice edge waypoints due to changes in the cruisetrack construction methods but since the information for estimating the ice edge has come from a number of sources and uses a variety of methods it is fair to say there has been consistency over time.

The Antarctic pack ice is a highly variable, dynamic system, the distribution and characteristics of which are determined by, and strongly reflect, the underlying oceanographic processes (and on a shorter temporal scale, the meteorological conditions; particularly wind force). 'Ice edge' characteristics are not necessarily restricted to the northernmost sea ice/open water boundary. The positions of the estimated ice edges established during these cruises, based mainly on the safe navigation of the research vessels, have little biological context.

Discovery marking

From 1978/79 to 1983/84 cruises, the primary method of abundance estimation was mark-recapture method. The procedure was basically to conduct a sighting survey until an appropriate whale group was observed and then the group would pursued for marking. Minke whales at least 8.0 m in length were the primary target but sperm and humpback whales were also marked in some of the cruises. Minke whales were marked using the small .410 Discovery mark while sperm and humpback whales were marked with the more standard 12-gauge Discovery mark. Details of these activities and results are given in the cruise reports and the first ten years review paper (Joyce et. al., 1988). Discovery marking was discontinued after the 1983/84 cruise after an analysis by Cook (1986) showed that it was unlikely an adequate number of marks could be deployed to provide an accurate population estimation.

Experiments

Experiments have been conducted during the cruises to answer specific questions affecting the population estimations. Specific problems and recommendations for experiments were made at the 1980 workshop on the design of sighting surveys (IWC, 1982), and these were followed by additional recommendations formed at the annual meetings of the Scientific Committee, the Tokyo planning meetings, and especially the Specification meetings held in conjunction with the Tokyo planning meetings. Experimentation reached a peak during 1984/85 cruise when over half cruise was dedicated to conducting sighting experiments. A special workshop on minke whale sightings was held in 1985 to evaluate the results of these experiments (IWC, 1986). A list of these experiments is given in Table 1.

Experiment for Discovery marking

Mark verdict, Mark tolerance and Mark recovery experiments were conducted during first circumpolar set for development of the Discovery marking research. Joyce et. al. (1988) reported details of these results of experiments.

Experiment for development of sighting procedures

Parallel ship (1980/81-1984/85), Variable speed (1980/81-1984/85) and Dive time (1980/81, 1981/82, 1984/85, 1989/90-1992/93) experiments were conducted for estimating g(0) of minke whales. Monitoring topmen's effort experiment was conducted using VTR camera in top barrel for investigation of search effort distribution (1980/81, 1984/85-1985/86). Density gradient experiment (1980/81 and 1981/82) was conducted to determine minke whale distribution was related to the perpendicular to the ice edge. Secondary sightings type II (1985/86), length estimation (1984/85), Blow rate and Blow duration (1984/85-1986/87), Radio tracking (1986/87-1987/88), Whale reaction to the survey vessel (1986/87), swimming speed (1985/86), Cue counting (1984/85-1986/87 and 1988/89) experiments were conducted to estimate the probability of a minke whale school being spotted on the trackline and to evaluate the accuracy of these determinations. NNSS closure (1981/82-1984/85), Estimated distance and angle (1981/82-2000/01), Photographic angle measurement (1983/84-1984/85) experiments were conducted to determination of the relative position of whale groups in relation to the ship and the trackline.

Routine experiments for recent cruises

Estimated Distance and Angle Experiment

This experiment is designed to examine the precision and accuracy of distance and angle estimates to a sighting. A buoy with a radar-reflecting transponder is used as the sighting target and distance and angle estimates are made by the observers while the ship is underway at normal searching speeds. Buoys of the same design have been used for the entire history of this experiment. The mast of the buoy is 3.5-3.6 meters in height. The design of buoy is shown in the 1984-85 cruise report. At pre-determined distances and angles from the buoy, visual observations by the observers are taken simultaneously with radar readings. Six trials per observer, per sighting platform are scheduled. Primary observers should be tested from platforms where they normally conduct sighting effort and should use the same procedures and equipment used in their normal sighting procedures. It is stressed that all angle readings must be made using angle boards with pointers, both during the experiments and during sighting effort. The experiment should be conducted during weather and sea conditions representative of the conditions encountered during the survey (However, due to radar imaging problems the experiment has usually been conducted in better-than-average conditions. Additionally there is a safety aspect, since the buoy is of substantial weight, its deployment and retrieval requires a winch and the process is difficult unless conditions are calm).

It is preferable for the experiment to be scheduled for the middle of the survey period. Since sea conditions near the ice edge are usually less changeable, it is recommended that the experiment be attempted near the middle of the cruise about the time that the vessels swap strata. The cruise leader/senior scientist should select at random, distances from six of the following seven ranges (in n.miles): 0.00 - 0.25; 0.26 - 0.50; 0.51 - 1.00; 1.01 - 1.50; 1.51 - 2.00; 2.01 - 2.50; 2.51 - 3.00. Similarly the angles should be selected, at random, from six of the following seven trials (in degrees): 00 - 10 two trials; 11 - 20 two trials; 21 - 40 two trials; 41 - 60 one trial.

Any source of bias that is not existent in normal searching should be identified and avoided. To avoid known problems the following procedures should be followed:

- Observers should not know what distances and angles are being examined.
- Observers should not discuss the previous test with other observers.
- Observers should be below deck between trials.
- Observers should not look for the buoy until told to.
- Observers should not be told the results of the test until after the survey.

- Distances and angle should be over a range and not consistently a single value for all observers during a single trial.

Priority is given to the barrel and IOP trials. Trials with researchers as observers have the lowest priority. The results of the experiment are recorded on the Estimated Angle and Distance Data Record Two examples of the protocol followed while conducting the experiment on recent cruises are presented in Appendix 7.

The Estimated Angle and Distance Training Exercise.

A training exercise should be conducted on a priority basis near the beginning of the cruise to familiarise the observers with distances, angles, and the use of reticle binoculars and angleboards. The exercise uses the estimated distance and angle experiment procedures, except that several observers can make estimates at one time, and the observers are informed of the radar values in each trial. The exercise may be done with the ship underway or stationary. The number of trials conducted is at the discretion of the Cruise leader/Senior scientist. During the cruises there are usually frequent informal 'competitions' in which observers are asked to estimate the distance to icebergs and small pieces of ice. Estimates of the distance to the latter takes place particularly in calm weather when small pieces of ice can be more easily detected by radar. The observers are only informed of the radar measurement after they have made their estimates. Most frequently these 'competitions' are among the Front/Upper Bridge personnel but sometimes observers on all platforms are involved. The 'competitions' do not usually include estimates of angles.

Observers codes and experience

A list of codes for observers as used on the data forms and their relevant experience has been submitted to the IWC, for each cruise since the 1993-94 cruise. An example is shown in Appendix 8:

Changes over time

The Estimated Angle and Distance Experiment has been conducted on each ship, on each cruise, since the 1981-82 cruise and the protocol for conducting the experiment has been essentially unchanged since the 1987-88 cruise (apart from minor logistic details) as outlined below. Prior to the 1987-88 cruise, the following modifications to the experimental protocol were made: Angle boards and reticle binnoculars were used by the observers from the 1984-85 cruise. The Captain and helmsman were included in the experiment from the 1984-85 cruise. An Estimated Angle and Distance Training Exercise has been conducted on each ship since the 1985-86 cruise. The aim of the exercise is to familiarize observers with distances, angles, and the use of reticle binoculars and angleboards. Since the 1985-86 cruise researchers have also been included in the experiment (with the exception, for logistic reasons, of the senior scientists and Japanese researchers). The number of distance and angle estimates made by each observer from each platform was initially ten, this was reduced to eight from the 1986-87 cruise. The number of distance and angle estimates was further reduced, to six, from the 1987-88 cruise. From the 1987-88 cruise the experiment was conducted from the ship while it was underway at normal searching speed. Prior to this, the ship was stationary while each estimate was made. To improve the resemblance of the buoy to a whale sighting, from 1984-85 a flag on the mast of the buoy was replaced with an inverted white cone to resemble a whale blow.

Resighting

The resighting experiment is conducted during IO mode. The resighting data are to provide an additional source of information for the estimation of g(0) and for the assessment of duplicate status. This experiment has been conducted from the 1992/93 cruise. These data have not been recorded for all IO mode sightings which have been resighted during tracking, for a variety of reasons, however, resighting data exists for a large number of sightings (322 sightings for the period 1997-98 to 2000-2001).

Biopsy

This experiment started from 1988/89 cruise. Blue, right and humpback whales are targeted (low priority for killer and sperm whales). The following equipment would be available; Japanese airguns (from 1989/90); the Paxarm system (from 1995/96); the Larsen gun (from 1998/99); and crossbows (1988/89 in feasibility; from 1993/94 in earnest). During the Antarctic cruises, biopsy samples have been obtained from a total of 327 animals (minimum number only). Samples have been obtained from 14 minke whales, 34-37 true blue (field identified only), 4 pygmy blue (field identified only), 1 fin, 5 sei, 209 humpback, 4 sperm, 19 killer whales, 30 southern right, 1 pilot, 3 common dolphins and 3 hourglass dolphins.

Photo identification

This experiment started from 1987/88 cruise. Blue, right and humpback whales are targeted. 35mm SLR data back cameras equipped with 70-up to 300mm lenses and motor drives. Black and white 400 ASA film (*Kodak* T-Max or *Ilford* HP5) pushed (i.e. exposed at) to 800 ASA.

SIGHTING SURVEY RECORDS

Following records for sighting survey are completed during each cruise by ship officers or researchers throughout circumpolar series. Each record has minor changed throughout three circumpolar series. Details of each record are shown in usage-note of each cruise (see Appendix 2). Results of the experiments for other objectives also recorded in each cruise, which excepted of this section.

Weather

The weather record is maintained by the ship's officers and is completed every hour while in the research zone. Environmental conditions and data have collected using a consistent methodology throughout circumpolar series. The type of information recorded has been consistent with minor additions such as the inclusion of swell conditions from the 1995-96 cruise.

Effort

The Effort record is completed every day of the research programme. The Chief and Second Officers are responsible for the completion of the daily records. Research activities are identified by the Effort code. Effort codes are classified into four categories: On-effort, Off-effort, Experiments, and Navigation. These codes indicate the initiation or termination of full-effort sighting survey.

Sighting record

The record is completed by the researchers. A single Sightings record is used for each cetacean sighting, regardless of search effort mode or composition of the sighting. A form should be completed for each distinct aggregation of cetaceans seen, eg. a pod of whales with dolphins around them is a single sighting. If a group of animals separates when approached, all subgroups are to be considered part of the original sighting.

Ice edge

Ice edge record is used to record information on the position of the pack ice/open water boundary and should be completed by either vessel that encounters pack ice during the survey. Data for this form can come from a variety of sources: visual, satellite, and other ship observations, charts (for land boundaries), and interpolations based on these sources. The senior scientist should try to integrate the sources for the most robust estimate of the ice edge.

Glare

Glare has been recorded on a separate data record since the 1999-2000 cruise (previously glare was recorded, in a slightly different format, on the weather data record). The record has been recorded at the beginning of each on-effort period and then at any time during the research that changes in the glare are considered to significantly affect the sighting conditions.

Charts

Exact copies (tracings) of all charts developed during the cruises have been made by the ships officers. These very detailed charts show the tracklines, waypoints, the positions of all sightings (all species) the positions of all effort mode changes (such as closing and returning to trackline), and details of the ice edge etc. Copies of the charts (for all vessels and all cruises from the start of the programme) have been sent, with the cruise data, to the IWC.

RESULTS

The cruises have been conducted successfully for twenty-three years, except 1984/85 cruise (experiment cruise) with all six IWC management Areas investigated twice, and five of the Areas sampled thrice. Each cruise has utilized a standard methodology, which has contained minor modifications in the procedures dictated by the results from the previous cruises.

Searching effort and ships-day

A total of searching distance was 70,340 n.miles with 6,027 primary minke whale sightings during 2,448 ship-days in the Antarctic (Table1).

International researcher

Total 188 international researchers from 14 nations selected by the IWC have been involvedin this program (Appendix 4). Their experiences of this program are shown (Table 3). There was and additional researcher (total of four on each ship) on the 1998-99 and 1999-2000 cruises. The additional researcher was an acoustics expert and did not take part in sighting activities.

Crewmember

Total 1,093 crewmembers (217 Soviet and 876 Japanese crewmembers) have been engaged in this program (Appendix 5: only Japanese vessels at this moment). Survey experiences of Japanese crewmember in each cruise are shown (Table 2). Younger, less experienced primary observers have mainly participated from 1992/93 cruise. Since the 1998-99 cruise an additional two topmen, who have been inexperienced observers have been present on both the SM1 and SM2 (increasing the crew complement to 19). These additional observers have been on board to meet a need for crew training. While the numbers of observers in the platforms were unchanged, experienced observers were always present;inexperienced observers were either in the top barrel (under the tutelage of an experienced observer), or on the front/upper bridge. The inexperienced observers have not been assigned to the IOP.

Discovery marking

Discovery marking was conducted during 1978/79 to 1983/84 cruises and 2,716 minke whales, 25 sperm whales and 7 humpback whales were successfully marked. Details of this experiment were reported by Joyce et al., (1988).

Surveyed Area (A)

Figure 3 shows the comparison, by strata, of the research area surveyed (A, n.miles^2) in each cruise by Area from 1978/79 to 1997/98. In Areas I, II and III, the area of the northern stratum is larger in the 3rd circumpolar cruise. Although comparable data are still being calculated for Area IV, and for the 2000/01cruise in Area VI), it appears the same tendency is to be expected.

Searching distance (L)

Figure 4 shows for each cruise the comparison of the distance searched on primary effort (L, n.miles) by survey mode (Closing mode; black, and IO mode; white) from 1978/79 to 2000/01. In Areas I, II, III and VI, the northern stratum component of L is higher in the 3rd circumpolar cruise with the expansion of research area in the northern stratum. Northern part of the L is decreased in Areas IV in 3rd circumpolar cruise.

Number of primary sightings of minke whales (n_s)

Figure 5 shows the comparison of the number of the primary sightings of minke whales (n_s) in each cruise by survey mode (Closing mode; black, and IO mode; white) from 1978/79 to 2000/01.

In Areas I, II, III and VI, the northern stratum component of the n_s is higher in the 3rd circumpolar cruise (with the expansion of research area in the northern stratum). Northern part of the n_s is decreased in Areas IV in 3rd circumpolar cruise.

Encounter rate of the primary school of minke whales (n/L)

Figure 6 shows the comparison of the number of primary sightings of minke whales (n/L; schools/ 100 n.miles) with CV in each cruise by survey mode (Closing mode; black, and IO mode; white) from 1978/79 to 1997/98 (from Branch and Butterworth, 2001).

Effective search half width of minke whales (ESW)

Effective search half widths of the primary minke whale schools, (as analyzed by Branch and Butterworth 2001) are shown, with CVs, in Figure 7.

Estimated mean school size of minke whales (E)

The estimated mean school size of minke whales (E) of the primary minke whale schools(from Branch and Butterworth 2001) are shown, with CVs, in Figure 8.

Number of the primary sighting of "like minke"

The identification category "Like minke" was first used during the 1985/86 cruise in Area V. Figure 9 shows the comparison of the number of the primary sighting of the "like minke" in each cruise by survey mode (Closing mode; black, and IO mode; white) from 1978/79 to 2000/01. The number of sightings identified as "like minke" has increased in Areas III, IV and VI through the circumpolar series. More "like minke" sightings tended to be recorded during IO mode (Figure 9).

Sighting compositions of each Area

Figure 10 show that the compositions of the primary school sightings in each circumpolar set by Area, except 1984/85 experiment cruise (from DESS (Strindberg, S. and Burt,L. 2000) and cruise reports (Ensor et. al., 1999, 2000, 2001)). Blue, fin, sei, minke, humpback, sperm, killer, pilot, cruciger, southern bottlenose, Ziphiidae and unidentified whales are analyzed. Minke whale which include codes "04; Minke", " 91; Undetermined minke", " 92; Minke, like Antarctic form" and " 90; Minke, like Dwarf form" and "39; like minke".

For third circumpolar series, two cruises are combined in Area I (1993/94 + 1999/2000), Area II (1996/97 + 1997/98), Area III (1992/93 + 1994/95), Area VI (1995/96 + 2000/01). Although Area V was already surveyed in the third set, the coverage of the far north of the northern strata was inadequate.

The proportion of minke whale schools is consistent in Area II, III and V, however they tend to reduce in proportion (with a corresponding increase of humpback and fin whales) in Area I and IV, throughout of three circumpolar series. In Area VI, minke whale school composition is tended to increase throughout of three circumpolar series. The proportion of humpback whales has apparently tended to increase in Areas I and IV, and fin whales have apparently increased in proportion somewhat in Areas I, II, IV and VI (Figure 3).

Ziphiid (code 11) and unidentified whales are tended to reduce, in proportion to increase of southern bottlenose whales (code 24) from second circumpolar set after established of whale identification standard (See above, the section of the change of the whale species identification standard). Unidentified whales which include code 09; unidentified whale, 64; unidentified large baleen whales, 73; unidentified large whale, 63; unidentified small whale, 76; unidentified small cetacean (Figure10).

DISCUSSION

Overview of data collection

It is concluded that the program has conducted in a consistent way of the sighting survey with developing of standard procedures that are the best possible compromise between statistical needs and logistic feasibility throughout circumpolar series. Over 23 cruises experience has also improved the precision of whale identification standard in the Antarctic and Southern Ocean.

Noting changes over time

Change of survey priority

The program has been modified from a Discovery marking cruise to a rigidly structured sightings cruise from the second circumpolar set (from 1985/86) after various discussions (IWC, 1986). With this as a turning point, rigid sighting survey procedures (especially strata design and cruise track design) and strict whale identification standards have been established for the line transect abundance estimations.

Change of coverage of the northern stratum

From third circumpolar series, the survey design was further modified, to ensure complete coverage south of latitude 60S. The latitudinal coverage (from ice-edge to 60S) has taken precedence over the longitudinal coverage (cruise track is shifted to the north especially in Areas I, II, III and V, compared with for first two circumpolar cruises). Also the width of the southern stratum has been expanded. An outcome of this change is that the distribution of effort within the overall research area has not been consistent; not only in the southern part (where minke density is expected to be the higher) but also in the northern part (Figure 2a-f and 3). As a result, the distance searched on primary effort in the northern stratum has increased to over 30%-50 % its previous amount in Areas I, II, III and VI (Figure 4). These effects possible lead to a decrease in the encounter rate in the northern stratum in third circumpolar series (Figure 6).

Change of whale identification standard

The systematic sighting procedures were developed and strict rules for identification of Antarctic minke, like minke, Southern bottlenose and Ziphiid whales were established from 1985/86 cruise, along with increasing expertise of observers and researchers in identification of the species previously lumped as 'akabo'. As a result of these progresses, the number of school of "unidentified whale" and "unid. Ziphiid" have decreased and "like minke" and "southern bottlenose" whales have increased through three circumpolar series (Figure 9 and 10). In relation to the standardization of identification and research procedures, we can see no reason to account for the change in proportion, across years, of minke identifications and 'like minke' identifications. Plausible explanations may include:

1) Changes in the distribution of survey coverage (northwards) may have increased the likelihood of encountering smaller group sizes of minke whales, particularly solitary animals (an increase in solitary animals would lead to a decrease in the success rate of closures and identification in closing mode and increased difficulty tracking and identification in IO mode). There may also have been changes to the clustering pattern of minke whales (towards a more dispersed distribution) or a change in age structure (smaller animals are generally more difficult to identify) or change in school size or distribution of prey species (Euphaisia).

2) Areas of higher sighting rate of minke whales may have been encountered in some years and not in other years. In both survey modes (and particularly in IO mode), when the sighting rate is high there is greater likelihood that the increased time spent assessing duplicate status means that not all groups will be tracked and identified.

3) The introduction of younger, less experienced observers into the program.

4) Researchers may have had different levels of strictness, across years, in assigning identifications

Change of research schedule

The two- to three-week delay in the schedule for the cruises since the 1994-95 cruise may have had some subtle effects on the results of the sighting survey. Prior to, and after the changes to the schedule there was a significant difference in effective half width between the ships. Consistently on all recent cruises, the SM1 has had a significantly greater effective half width, than SM2, (Borchers, 1993; Burt and Borchers, 1996; Burt and Borchers, 1999), except for the 1992-93 cruise (when SM2 went to the Southern Stratum first (Borchers and Cameron, 1995)) and excluding the 1997-98 cruise results when strata were pooled, (Burt and Stahl, 2000).

By speculation, it is possible there is a difference in minke whale sightability between the strata between early–season and late-season. The methods and equipment used for distance estimation are the same between the ships; the sighting ability of the crews should not differ significantly as the crews are rostered 'randomly' to the ships for each cruise. The standards used for acceptable sighting conditions should also be the same on each ship. This may point to a difference in minke whale sightability between the strata, early and late season. Factors affecting sightability may be the result of differences in weather conditions (in sightability conditions) or differences in group size, behaviour, body size (and related cue size). For example, a proportion of the 'larger?, behaviourally more obvious?' animals (for which closing/tracking are completed more easily, thereby aiding identification) may change their clustering pattern and/or behaviour during the season, or move further south into the pack ice and be inaccessible for survey. This may also have implications for the identification of species, particularly the change in proportion of minke and 'like minke' identifications.

Change of research hours

The reduction of research hours per day from 16 hours per day for the earlier cruises, to the current 12 hours per day may have had an impact on the sighting efficiency of observers. Although the observers have always had scheduled 'rest' periods, they have always had additional ship maintenance and management tasks to complete. The reduction in working hours would have reduced the fatique of the observers and it is possible there has been a related increase in their sighting efficiency, while total distance searched during a cruise had decreased. In this regard, Branch and Butterworth (2000a) indicate that the shape of the detection function for minke whales (and humpback and sperm whales) has changed over the three circumpolar series, with broadening of the shoulder (see Branch and Butterworth, 2000a Figure 2) implying that we are now making sightings of these whales at greater distances.

Distance estimation across years

We have described the Estimated Angle and Distance Experiment protocol in detail. Since it has been conducted in a consistent manner using the same equipment for many cruises, and because several observers have taken part on several different cruises it may be possible to test if there has been any trend in distance estimation over time. This may also help explain the change in the shape of the detection function for minke whales as indicated in Branch and Butterworth, 2000a .

ACKNOWLEDGEMENTS

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Appendix 2

Usage notes:

Usage notes of each cruise were prepared by the IWC (International Whaling Commission), and were unpublished but available from the secretariat of the IWC, Cambridge, England. Usage note of 1978/79 cruise was written with hand-written amendments that were incorporated for the 1979/80 cruise, so this should be ignored (Peter Best, pers., com.). Usage note of 1979/80 cruise was included in the planning report of this cruise. Usage note of 1992/92 cruise was used of 1991/92-usage note (Nishiwaki, pers. Com).

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Appendix 4. List of international researcher of the IWC/IDCR and SOWER cruises during 1978/79-2000/01.

Antarctic Minke Cruise

SEASON	VESSEL	RESEARCHERS				
1978-79	Toshimaru No.16	Peter B.Best* (SA)	Durant Hembree (AUS)	Kazuo Yamamura (JPN)		
	Toshimaru No.18	L.Tsunoda# (USA)	Hidehiro Kato (JPN)	J.K.O'Leary (USA)		
1979-80	Kyo Maru No.27	J.Horwood* (UK)	Hidehiro Kato (JPN)	L.Tsunoda (USA)		
	Toshi Maru No.11	Durant Hembree# (AUS)	Fujio Kasamatsu (JPN)	M.Meyer (SA)		
1980-81	Kyo Maru No.27	Peter B.Best* (SA)	Gerald G.Joyce (USA)	Fujio Kasamatsu (JPN)		
	Toshi Maru No.11	L.Tsunoda# (USA)	Paul Ensor (NZ)	Nobuyuki Miyazaki (JPN)		
	Vdumchiviy 34	Durant Hembree# (AUS)	Richard A.Rowlett (USA)	A.Rovnin (USSR)	Hidehiro Kato (JPN)	
1981-82	Shonan Maru	Durant Hembree* (AUS)	C.Potter (USA)	Fujio Kasamatsu (JPN)		
	Shonan Maru No.2	Gerald G.Joyce# (USA)	M.Meyer (SA)	S.Nagata (JPN)	T.Waters (UK)	
	Vdumchiviy 34	Richard A.Rowlett# (USA)	M.Baylon (Brazil)	A.Karpenko (USSR)	P.Lourega (Brazil)	A.Sazhinov (USSR)
1982-83	Shonan Maru	Durant Hembree* (AUS)	Jorge F.Mermoz (ARG)	Tomio Miyashita (JPN)		
	Shonan Maru No.2	Gerald G.Joyce# (USA)	Fujio Kasamatsu (JPN)	W.Church (USA)		
	Vdumchiviy 34	Richard A.Rowlett# (USA)	Paul Ensor (NZ)	A.Galeazzi (ARG)	A.Karpenko (USSR)	
1983-84	Vdumchiviy 34	Richard A.Rowlett# (USA)	A.Karpenko (USSR)	Jorge F.Mermoz (ARG)	Shannon Fitzgerald (USA)	
	Shonan Maru	Paul Ensor# (NZ)	Tomio Miyashita (JPN)	C.Edward Bowlby (USA)		
	Shonan Maru No.2	Gerald G.Joyce* (USA)	Toshio Hata (JPN)	Luis A.Pastene (Chile)		
	Kyo Maru No.27	Fujio Kasamatsu# (JPN)	David Thompson (UK)	Barry Troutman (USA)		
1984-85	Shonan Maru	Durant Hembree# (AUS)	Katsuji Kawaura (JPN)	Alan Ward (UK)		
	Shonan Maru No.2	Gerald G.Joyce* (USA)	C.Edward Bowlby (USA)	Shigetoshi Nishiwaki (JPN)		
	Kyo Maru No.27	Fujio Kasamatsu# (JPN)	Paul Ensor (NZ)	Luis A.Pastene (Chile)		
	Vdumchiviy 34	Richard A.Rowlett# (USA)	Jorge F.Mermoz (ARG)	V.Yukhov (USSR)		
1985-86	Shonan Maru	Gerald G.Joyce* (USA)	Katsuji Kawaura (JPN)	Shigetoshi Nishiwaki (JPN)		
	Shonan Maru No.2	Fujio Kasamatsu# (JPN)	Barry Troutman (USA)	Kanneth C.Balcomb (USA)		
	Kyo Maru No.27	Jorge F.Mermoz# (ARG)	Larry Tsunoda (USA)	Hirohisa Shigemune (JPN)		
	Vyderzhannyi 36	Richard A.Rowlett# (USA)	Allan Ward (UK)	V.Yukhov (USSR)		
1986-87	Shonan Maru	Gerald G.Joyce* (USA)	C.Edward Bowlby (USA)	Katsuji Kawaura (JPN)		
	Shonan Maru No.2	Richard A.Rowlett# (USA)	Jorge F.Mermoz (ARG)	Allan Ward (UK)	Hirohisa Shigemune (JPN)	
	Kyo Maru No.27	Fujio Kasamatsu# (JPN)	Mike Meyer (SA)	Barry Troutman (USA)		
	Vdumchiviy 34	Durant Hembree# (AUS)	Shigetoshi Nishiwaki (JPN)	Nikolay Doroshenko (USSR)	Alexander Zorin (USSR)	
1987-88	Shonan Maru	Gerald G.Joyce* (USA)	Hirohisa Shigemune (JPN)	Barry Troutman (USA)		
	Shonan Maru No.2	Fujio Kasamatsu# (JPN)	Paul Ensor (NZ)	Richard A.Rowlett (USA)		
1988-89	Shonan Maru	Fujio Kasamatsu* (JPN)	Jorge F.Mermoz (ARG)	Alexander Zorin (USSR)	Vera da Silva (Brazil)	
	Shonan Maru No.2	Paul Ensor# (NZ)	Hirohisa Shigemune (JPN)	Michael Newcomer (USA)		
1989-90	Shonan Maru	Gerald G.Joyce (USA)	Shigetoshi Nishiwaki (JPN)	Carolina Sanpera (Spain)		
	Shonan Maru No.2	Paul Ensor# (NZ)	Jorge F.Mermoz (ARG)	Hiroshi Tsutsumi (JPN)		
1990-91	Shonan Maru	Gerald G.Joyce* (USA)	Shigetoshi Nishiwaki (JPN)	Genevieve Desportes (Denmark)		
	Shonan Maru No.2	Paul Ensor# (NZ)	Jorge F.Mermoz (ARG)	Hiroshi Ohizumi (JPN)	Finn Danielsen## (Denmark)	
1991-92	Shonan Maru	Paul Ensor* (NZ)	Shigetoshi Nishiwaki (JPN)	Michael Newcomer (USA)		
	Shonan Maru No.2	Richard A.Rowlett# (USA)	Jorge F.Mermoz (ARG)	Hiroyuki Shimada (JPN)	Jimmy Hansen## (Denmark)	
1992-93	Shonan Maru	Shigetoshi Nisiwaki# (JPN)	Ken Findlay (SA)	B.Abernethy (SA)		
	Shonan Maru No.2	Richard A.Rowlett* (USA)	Hiroyuki Shimada (JPN)	Genevieve Desportes (Denmark)		
1993-94	Shonan Maru	Paul Ensor* (NZ)	Luis A.Pastene (JPN)	Micheline-Nicole Janner (AUS)		
	Shonan Maru No.2	Hiroyuki Shimada# (JPN)	Jorge F.Mermoz (ARG)	Robert Pitman (USA)		
1994-95	Shonan Maru	Paul Ensor* (NZ)	Miranda Brown (AUS)	Masahiro Kawasaki (JPN)		
	Shonan Maru No.2	Hiroyuki Shimada# (JPN)	Martin Cawthorn (NZ)	Ken Findlay (SA)		
1995-96	Shonan Maru	Paul Ensor* (NZ)	Peter Corkeron (AUS)	Koji Matsuoka (JPN)		
	Shonan Maru No.2	Martin Cawthorn# (NZ)	Robert Pitman (USA)	Keiko Sekiguchi (JPN)		
1996-97	Shonan Maru	Paul Ensor* (NZ)	Sharon Hedley (UK)	Daishiro Yamagiwa (JPN)		
	Shonan Maru No.2	Ken Findlay# (SA)	Robert Pitman (USA)	Keiko Sekiguchi (JPN)		
1997-98	Shonan Maru	Paul Ensor* (NZ)	Sharon Hedley** (UK)	Hiroshi Iwakami (JPN)	Robert Pitman (USA)	
	Shonan Maru No.2	Luis A.Pastene# (JPN)	Martin Cawthorn (NZ)	Ken Findlay** (SA)	Lars Kleivane (Norway)	
1998-99	Shonan Maru	Paul Ensor* (NZ)	Janet Doherty** (USA)	Lars Kleivane (Norway)	Koji Matsuoka (JPN)	
	Shonan Maru No.2	Keiko Sekiguchi# (JPN)	Donald Ljungblad** (USA)	Fernanda Marques (Brazil)	Robert Pitman (USA)	
1999-00	Shonan Maru	Paul Ensor* (NZ)	Lars Kleivane (Norway)	Donald Ljungblad** (USA)	Keiko Sekiguchi (JPN)	
	Shonan Maru No.2	Ken Findlay# (SA)	Rodrigo Hucke-Gaete (Chile)	Fernanda Marques (Brazil)	Hiroyuki Shimada** (JPN)	
2000-01	Shonan Maru	Paul Ensor* (NZ)	Hiroto Murase (JPN)	Van Waerebeek (Peru)		
	Shonan Maru No.2	Koji Matsuoka# (JPN)	Fernanda Marques (Brazil)	Robert Pitman (USA)		

*Cruis Leader and Senior Scientist #Senior Scientist ##Seabird Researcher **Acoustic Researcher

Appendix 5. List of Japanese crewmembers of the IWC/IDCR and SOWER 1978/79-2000/01 cruises.

1978/79

TOSHI MARU No.16

No.	Rank	Family Name	Given Name
1	Captain	Kitayama	Kazuo
2	Chief Officer	Sakai	Kazushi
3	Second Officer	Yamashita	Tomiya
4	Chief Engineer	Nakajima	Takeshi
5	First Engineer	Fujimoto	Ichiro
6	Second Engineer	Yamauchi	Nobuo
7	Chief Operator	Arai	Hiroshi
8	Boatswain	Hayashida	Genzo
9	Quartermaster	Yamashita	Yoshizo
10	Quartermaster	Nakahama	Eiji
11	Second Officer	Takemura	Toshiyuki
12	Sailor	Hirose	Kiyoji
13	No.1 Oiler	Togashi	Masamitsu
14	Oiler	Hamamura	Katsuo
15	Oiler	Horinaga	Masaya
16	Oiler	Okita	Mitsuaki
17	Chief Steward	Masekuchi	Toshio
18	Steward	Sato	Kimio

TOSHI MARU No.18

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Saito	Teruo
3	Second Officer	Owada	Atsushi
4	Chief Engineer	Ohama	Saburo
5	First Engineer	Yokosuka	Yozo
6	Second Engineer	Mukai	Takehiko
7	Chief Operator	Abe	Kiyomi
8	Boatswain	Yamanaka	Kenji
9	Quartermaster	Ishida	Yoshihiro
10	Quartermaster	Yamashita	Norihiro
11	Quartermaster	Oki	Tukasa
12	Sailor	Nakamichi	Setsuo
13	No.1 Oiler	Abe	Kokichi
14	Oiler	Tomi	Tsunemi
15	Oiler	Matsunaga	Mitsuhiro
16	Fireman	Kikuchi	Kosei
17	Chief Steward	Ueki	Hideaki
18	Steward	Yasunaga	Kenichi

1979/80

KYO MARU No.27

No.	Rank	Family Name	Given Name
1	Captain	Nagata	Shoji
2	Chief Officer	Suzuki	Shigeo
3	Second Officer	Otani	Shigeru
4	Chief Engineer	Usuda	Shigetada
5	First Engineer	Okayama	Itaru
6	Second Engineer	Yoshinaga	Yoshihito
7	Chief Operator	Chiba	Seichi
8	Boatswain	Murata	Takamura
9	Quartermaster	Takaizumi	Yoneo
10	Quartermaster	Okumura	Tomohiro
11	Quartermaster	Oguni	Seichi
12	Quartermaster	Kasai	Norihiko
13	No.1 Oiler	Matsumoto	Shozo
14	Oiler	Hamamura	Katsuo
15	Oiler	Abe	Toshiji
16	Fireman	Abe	Syouetsu
17	Chief Steward	Konno	Tokio
18	Steward	Kawasaki	Kazuhiko

TOSHI MARU No.11

No.	Rank	Family Name	Given Name
1	Captain	Suzuki	Shigeru
2	Chief Officer	Tsurui	Toshinori
3	Second Officer	Matsusaka	Kiyoshi
4	Chief Engineer	Kaji	Kosaku
5	First Engineer	Terao	Yoshiteru
6	Second Engineer	Sakurada	Hiromi
7	Chief Operator	Arai	Hiroshi
8	Boatswain	Sakae	Masaru
9	Quartermaster	Sakaguchi	Tatsuo
10	Quartermaster	Okumura	Toshiki
11	Quartermaster	Terao	Makoto
12	Quartermaster	Tanaka	Yoshiki
13	No.1 Oiler	Nakao	Masaaki
14	Oiler	Okita	Mitsuaki
15	Oiler	Sato	Sueo
16	Fireman	Yanagiuchi	Hidetoshi
17	Chief Steward	Urusitani	Hiroshi
18	Steward	Urasaki	Jisao

1980/81

KYO MARU No.27

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Nakano	Kikumi
3	Second Officer	Masuda	Motoo
4	Chief Engineer	Hirakata	Sadaharu
5	First Engineer	Shimazaki	Shigeji
6	Second Engineer	Kanesaka	Masao
7	Chief Operator	Abe	Shigeo
8	Boatswain	Washizuka	Rinma
9	Quartermaster	Chiba	Hikotaro
10	Quartermaster	Ishida	Yoshihiro
11	Quartermaster	Miyazaki	Tomeo
12	Quartermaster	Murata	Goro
13	No.1 Oiler	Sakurai	Kaniji
14	Oiler	Hamaguchi	Norio
15	Oiler	Okaya	Katsuhiro
16	Fireman	Abe	Syouetsu
17	Chief Steward	Kaino	Takumi
18	Steward	Yamashita	Katsushi

TOSHI MARU No.11

No.	Rank	Family Name	Given Name
1	Captain	Uchiike	Ikuo
2	Chief Officer	Saito	Teruo
3	Second Officer	Gomi	Katsuji
4	Chief Engineer	Yamada	Etsuo
5	First Engineer	Murono	Yoshihisa
6	Second Engineer	Takeyama	Kazuo
7	Chief Operator	Abe	Kunio
8	Boatswain	Hayashida	Genzo
9	Quartermaster	Takeuchi	Ryo
10	Quartermaster	Morino	Kaneo
11	Quartermaster	Kobayashi	Tomeo
12	Quartermaster	Oki	Tukasa
13	No.1 Oiler	Abe	Kichio
14	Oiler	Kaji	Masahisa
15	Oiler	Yabu	Kitoshi
16	Fireman	Sasaki	Kazuaki
17	Chief Steward	Mahama	Kazuo
18	Steward	Kuramoto	Akira

Appendix 5. (Continued).

1981/82

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Suzuki	Shigeo
3	Second Officer	Matsusaka	Kiyoshi
4	Chief Engineer	Murata	Mitsuhiro
5	First Engineer	Nakamura	Kazuo
6	Second Engineer	Sakurada	Hiromi
7	Chief Operator	Abe	Satoru
8	Boatswain	Hazehata	Yosao
9	Quartermaster	Takayama	Shinji
10	Quartermaster	Urayoshi	Tomoyuki
11	Quartermaster	Emoto	Satoru
12	Sailor	Sasaki	Yasuaki
13	No.1 Oiler	Kon	Zennosuke
14	Oiler	Hiratsuka	Katsuo
15	Oiler	Okubo	Shigeharu
16	Fireman	Miura	Takeaki
17	Chief Steward	Okumura	Hideo
18	Steward	Nakanisi	Miyuki

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Suzuki	Shigeru
2	Chief Officer	Sumihara	Tokuya
3	Second Officer	Hmaguchi	Yatsuo
4	Chief Engineer	Usuda	Shigetada
5	First Engineer	Okayama	Itaru
6	Second Engineer	Matsushita	Mitsuo
7	Chief Operator	Ujiie	Ryo
8	Boatswain	Yamauchi	Sokichi
9	Quartermaster	Miyata	Kanji
10	Quartermaster	Dezaki	Iseo
11	Quartermaster	Takemura	Toshiyuki
12	Sailor	Kashiwa	Hiromi
13	No.1 Oiler	Nakao	Masaaki
14	Oiler	Kaji	Masahisa
15	Oiler	Kikuchi	Sakae
16	Fireman	Yamauchi	Nobuo
17	Chief Steward	Inoue	Hitoshi
18	Steward	Kawasaki	Kazuhiko

1982/83

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Saito	Teruo
3	Second Officer	Yasunaga	Norikatsu
4	Chief Engineer	Masuda	Satoru
5	First Engineer	Moromoto	Etsuo
6	Second Engineer	Mukai	Takehiko
7	Chief Operator	Abe	Kunio
8	Boatswain	Hiratsuka	Tomigoro
9	Quartermaster	Ishida	Yoshihiro
10	Quartermaster	Murata	Nobutaka
11	Quartermaster	Nakahama	Eiji
12	Quartermaster	Fujiwara	Genzaburo
13	No.1 Oiler	Matsumoto	Makoto
14	Oiler	Tateda	Hiroshi
15	Oiler	Kakiuchi	Rikiharu
16	Oiler	Yanagiuchi	Hidetoshi
17	Chief Steward	Masekuchi	Toshio
18	Steward	Asano	Shizuka

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Uchiike	Ikuo
2	Chief Officer	Fukui	Rintaro
3	Second Officer	Kamei	Hideharu
4	Chief Engineer	Takami	Junichi
5	First Engineer	Fujimoto	Ichiro
6	Second Engineer	Kimura	Isamu
7	Chief Operator	Tsuda	Katsumasa
8	Boatswain	Takezaki	Hideo
9	Quartermaster	Yamashita	Yoshizo
10	Quartermaster	Maruishi	Toshiharu
11	Quartermaster	Sakurai	Tadashi
12	Quartermaster	Nagayoshi	Makoto
13	No.1 Oiler	Hashiba	Saburo
14	Oiler	Kikuchi	Sakae
15	Oiler	Murata	Tadashi
16	Oiler	Yamashita	Taketoshi
17	Chief Steward	Ueki	Hideaki
18	Steward	Emoto	Tanemi

1983/84

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Suzuki	Shigeru
2	Chief Officer	Sumihara	Tokuya
3	Second Officer	Otani	Shigeru
4	Chief Engineer	Nakajima	Takeshi
5	First Engineer	Sawa	Naofumi
6	Second Engineer	Yoshinaga	Yoshihito
7	Chief Operator	Abe	Satoru
8	Boatswain	Murata	Takamura
9	Quartermaster	Sakaguchi	Tatsuo
10	Quartermaster	Ishida	Yoshihiro
11	Quartermaster	Yoshino	Yosinori
12	Quartermaster	Ohmura	Haruyoshi
13	No.1 Oiler	Higashi	Akira
14	Oiler	Hamaguchi	Norio
15	Oiler	Sato	Sueo
16	Fireman	Nemoto	Fukuji
17	Chief Steward	Kaino	Takumi
18	Steward	Hatai	Keiji

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Suzuki	Shigeo
3	Second Officer	Kimura	Isamu
4	Chief Engineer	Sawai	Hajime
5	First Engineer	Hidaka	Isamu
6	Second Engineer	Ikehata	Yoshihiko
7	Chief Operator	Abe	Shigeo
8	Boatswain	Hazehata	Yosao
9	Quartermaster	Ryono	Hirohisa
10	Quartermaster	Uematsu	Shigeru
11	Quartermaster	Okumura	Toshiki
12	Sailor	Hirose	Kiyoji
13	No.1 Oiler	Nakao	Masaaki
14	Oiler	Horinaga	Masaya
15	Oiler	Okita	Mitsuaki
16	Fireman	Yanagiuchi	Hidetoshi
16	Chief Steward	Endo	Masanori
17	Steward	Urasaki	Jisao

Appendix 5. (continued).

KYO MARU No.27

No.	Rank	Family Name	Given Name
1	Captain	Yokota	Fumio
2	Chief Officer	Tsurui	Toshinori
3	Second Officer	Yamashita	Tomiya
4	Chief Engineer	Kaji	Kosaku
5	First Engineer	Shimazaki	Shigeji
6	Second Engineer	Kawase	Yoshitake
7	Chief Operator	Yamamoto	Naotoshi
8	Boatswain	Yamanaka	Kenji
9	Quartermaster	Endo	Ryoichi
10	Quartermaster	Iwamoto	Manabu
11	Quartermaster	Tanaka	Yoshiki
12	Sailor	Nakamichi	Setsuo
13	No.1 Oiler	Ohi	Fumio
14	Oiler	Yamakawa	Yoshifumi
15	Oiler	Okaya	Katsuhiro
16	Fireman	Maruyama	Tatsuzo
17	Chief Steward	Konno	Tokio
18	Steward	Hamashita	Seichi

1984/85

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Gomi	Katsuji
3	Second Officer	Takemura	Toshiyuki
4	Chief Engineer	Kimura	Risao
5	First Engineer	Sodeyama	Shoji
6	Second Engineer	Mukai	Takehiko
7	Chief Operator	Abe	Kunio
8	Boatswain	Hazehata	Yosao
9	Quartermaster	Iwamoto	Manabu
10	Quartermaster	Miyazaki	Tomeo
11	Quartermaster	Yoshino	Yosinori
12	Sailor	Abe	Nobuo
13	No.1 Oiler	Higashi	Akira
14	Oiler	Abe	Toshiji
15	Oiler	Sato	Sueo
16	Chief Steward	Kaino	Takumi
17	Steward	Asano	Shizuka

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Suzuki	Shigeru
2	Chief Officer	Hara	Tetsuo
3	Second Officer	Maiya	Yukihiro
4	Chief Engineer	Yamada	Hiroshi
5	First Engineer	Hatano	Hisashi
6	Second Engineer	Komaki	Yoshiyuki
7	Chief Operator	Chiba	Yuji
8	Boatswain	Hiratsuka	Tomigoro
9	Quartermaster	Tsujiyama	Hideo
10	Quartermaster	Abe	Tsutomu
11	Quartermaster	Kawasaki	Yoshihiro
12	Sailor	Kashiwa	Hiromi
13	No.1 Oiler	Goto	Toshio
14	Oiler	Kaji	Masahisa
15	Fireman	Yasunaga	Haruyuki
16	Chief Steward	Mahama	Kazuo
17	Steward	Dezaki	Iseo

KYO MARU No.27

No.	Rank	Family Name	Given Name
1	Captain	Yokota	Fumio
2	Chief Officer	Tsurui	Toshinori
3	Second Officer	Yamada	Masamitsu
4	Chief Engineer	Kurosaki	Yoshiaki
5	First Engineer	Sanyoshi	Kaneshige
6	Second Engineer	Ito	Kimio
7	Chief Operator	Yoshida	Yuji
8	Boatswain	Hatakeyama	Tyozaburo
9	Quartermaster	Sakaguchi	Tatsuo
10	Quartermaster	Nozaki	Tsutomu
11	Quartermaster	Fujiwara	Genzaburo
12	Sailor	Hirose	Kiyoji
13	No.1 Oiler	Okamoto	Tetsuhito
14	Oiler	Hamaguchi	Norio
15	Oiler	Okubo	Shigeharu
16	Fireman	Maruyama	Tatsuzo
17	Chief Steward	Eto	Kusumi
18	Steward	Nakanisi	Miyuki

Appendix 5. (continued).

1985/86

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Isobe	Sadao
3	Second Officer	Otani	Shigeru
4	Chief Engineer	Murata	Mitsuhiro
5	First Engineer	Oide	Akihide
6	Second Engineer	Sato	Norio
7	Chief Operator	Ujiie	Ryo
8	Boatswain	Hatakeyama	Tyozaburo
9	Quartermaster	Fukuda	Toshifumi
10	Quartermaster	Shimizu	Teiji
11	Quartermaster	Yoshino	Yosinori
12	Quartermaster	Oki	Tukasa
13	No.1 Oiler	Kaji	Masahisa
14	Oiler	Okita	Mitsuaki
15	Oiler	Yoshida	Hachirou
16	Chief Steward	Konno	Tokio
17	Steward	Dezaki	Iseo

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Uchiike	Ikuo
2	Chief Officer	Onuki	Masayuki
3	Second Officer	Yamashita	Tomiya
4	Chief Engineer	Hidaka	Isamu
5	First Engineer	Sodeyama	Shoji
6	Second Engineer	Sakurada	Hiromi
7	Chief Operator	Yoshimura	Haruo
8	Boatswain	Miyata	Kanji
9	Quartermaster	Iwamoto	Manabu
10	Quartermaster	Sakurai	Tadashi
11	Quartermaster	Nakahama	Eiji
12	Quartermaster	Sato	Shouzou
13	No.1 Oiler	Nakao	Masaaki
14	Oiler	Kakiuchi	Rikiharu
15	Oiler	Ishii	Terumi
16	Chief Steward	Endo	Masanori
17	Steward	Hatai	Keiji

KYO MARU No.27

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Owada	Atsushi
3	Second Officer	Kimura	Isamu
4	Chief Engineer	Nakajima	Takeshi
5	First Engineer	Hatano	Hisashi
6	Second Engineer	Yamauchi	Nobuo
7	Chief Operator	Tsuda	Katsumasa
8	Boatswain	Ryono	Hirohisa
9	Quartermaster	Sakaguchi	Tatsuo
10	Quartermaster	Tsujiyama	Hideo
11	Quartermaster	Yoshinaga	Makoto
12	Quartermaster	Hiratsuka	Kunizo
13	No.1 Oiler	Sakurai	Kaniji
14	Oiler	Yamashita	Tomihisa
15	Oiler	Matsuda	Yoshio
16	Oiler	Iizawa	Tadao
17	Chief Steward	Ueki	Hideaki
18	Steward	Kawasaki	Kazuhiko

1986/87

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Suzuki	Shigeru
2	Chief Officer	Onuki	Masayuki
3	Second Officer	Takeda	Masao
4	Chief Engineer	Atsumi	Hiroaki
5	First Engineer	Okayama	Itaru
6	Second Engineer	Mukai	Takehiko
7	Chief Operator	Abe	Shigeo
8	Boatswain	Takeuchi	Ryo
9	Quartermaster	Takaizumi	Yoneo
10	Quartermaster	Tsujiyama	Hideo
11	Quartermaster	Hara	Yasuhei
12	Quartermaster	Oki	Tukasa
13	No.1 Oiler	Matsumoto	Makoto
14	Oiler	Kakiuchi	Rikiharu
15	Oiler	Chyubachi	Tamao
16	Chief Steward	Tanabe	Yoshikazu
17	Steward	Yasunaga	Kenichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Yokota	Fumio
2	Chief Officer	Yasunaga	Norikatsu
3	Second Officer	Masuda	Motoo
4	Chief Engineer	Hirakata	Sadaharu
5	First Engineer	Sawa	Naofumi
6	Second Engineer	Hiratsuka	Katsuo
7	Chief Operator	Abe	Satoru
8	Boatswain	Hiratsuka	Tomigoro
9	Quartermaster	Nishimura	Michio
10	Quartermaster	Terao	Makoto
11	Quartermaster	Oguni	Seichi
12	Quartermaster	Nakamichi	Setsuo
13	No.1 Oiler	Koba	Tsuneyoshi
14	Oiler	Horinaga	Masaya
15	Oiler	Ido	Minoru
16	Chief Steward	Imasaki	Tadamitsu
17	Steward	Hamashita	Seichi

Appendix 5. (continued).

KYO MARU No.27

No.	Family Name	Given Name	Date of Birth
1	Captain	Kira	Masatoshi
2	Chief Officer	Takekawa	Reiichi
3	Second Officer	Takemura	Toshiyuki
4	Chief Engineer	Shimazaki	Shigeji
5	First Engineer	Yokosuka	Yozo
6	Second Engineer	Abe	Syouetsu
7	Chief Operator	Abe	Kiyomi
8	Boatswain	Hatakeyama	Tyozaburo
9	Quartermaster	Takayama	Shinji
10	Quartermaster	Chiba	Hikotaro
11	Quartermaster	Yoshino	Yosinori
12	Quartermaster	Hiratsuka	Kunizo
13	No.1 Oiler	Matsumoto	Shozo
14	Oiler	Okita	Mitsuaki
15	Oiler	Ishii	Tsutomu
16	Oiler	Kikuchi	Kosei
17	Chief Steward	Masekuchi	Toshio
18	Steward	Urasaki	Jisao

1987/88

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Yamashita	Kazuhiko
2	Chief Officer	Saito	Teruo
3	Second Officer	Hirose	Kiyoji
4	Chief Engineer	Nakamura	Kazuo
5	First Engineer	Abe	Toshiji
6	Second Engineer	Yoshinaga	Yoshihito
7	Chief Operator	Chiba	Seichi
8	Boatswain	Fukuda	Toshifumi
9	Quartermaster	Mori	Osamu
10	Boatswain	Kawasaki	Yoshihiro
11	Boatswain	Endo	Kenichi
12	Boatswain	Ohmura	Haruyoshi
13	No.1 Oiler	Nakao	Masaaki
14	Oiler	Koba	Hiroyuki
15	Oiler	Yamane	Katsuro
16	Chief Steward	Okumura	Hideo
17	Steward	Kuramoto	Akira

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Yasunaga	Norikatsu
3	Second Officer	Kimura	Isamu
4	Chief Engineer	Hidaka	Isamu
5	First Engineer	Mori	Yutaka
6	Second Engineer	Hiratsuka	Katsuo
7	Chief Operator	Tsuda	Katsumasa
8	Boatswain	Miyata	Kanji
9	Quartermaster	Okumura	Toshiki
10	Quartermaster	Miyazaki	Tomeo
11	Quartermaster	Nitta	Takiji
12	Quartermaster	Omoto	Okinori
13	No.1 Oiler	Mori	Isamu
14	Oiler	Abe	Kokichi
15	Oiler	Matsuda	Yoshio
16	Chief Steward	Konno	Tokio
17	Steward	Kawasaki	Kazuhiko

1988/89

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Takeda	Masao
3	Second Officer	Masuda	Motoo
4	Chief Engineer	Komaki	Yoshiyuki
5	First Engineer	Yokosuka	Yozo
6	Second Engineer	Fukushima	Koji
7	Chief Operator	Abe	Kiyomi
8	Boatswain	Kubo	Tadayuki
9	Quartermaster	Uematsu	Shigeru
10	Quartermaster	Nakahama	Eiji
11	Quartermaster	Nitta	Takiji
12	Quartermaster	Kasai	Norihiko
13	No.1 Oiler	Tateda	Hiroshi
14	Oiler	Sakihata	Kiyoki
15	Oiler	Ito	Kazuo
16	Chief Steward	Emoto	Tanemi
17	Steward	Hamashita	Seichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Owada	Atsushi
2	Chief Officer	Maiya	Yukihiro
3	Second Officer	Takemura	Toshiyuki
4	Chief Engineer	Atsumi	Hiroaki
5	First Engineer	Takeyama	Kazuo
6	Second Engineer	Ikehata	Yoshihiko
7	Chief Operator	Arai	Hiroshi
8	Boatswain	Chiba	Hikotaro
9	Quartermaster	Tsujiyama	Hideo
10	Quartermaster	Kawasaki	Yoshihiro
11	Quartermaster	Okumura	Toshiki
12	Quartermaster	Terao	Makoto
13	No.1 Oiler	Yokoo	Kiyoto
14	Oiler	Murakami	Hiroshi
15	Oiler	Iizawa	Tadao
16	Chief Steward	Ueki	Hideaki
17	Steward	Ishimori	Shigenobu

Appendix 5. (continued).

1989/90

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Kira	Masatoshi
2	Chief Officer	Yasunaga	Norikatsu
3	Second Officer	Hirose	Kiyoji
4	Chief Engineer	Hidaka	Isamu
5	First Engineer	Yokosuka	Yozo
6	Second Engineer	Oeda	Masanobu
7	Chief Operator	Abe	Kiyomi
8	Boatswain	Nishimura	Michio
9	Quartermaster	Miyazaki	Tomeo
10	Quartermaster	Murata	Goro
11	Quartermaster	Fujiwara	Genzaburo
12	Quartermaster	Ohmura	Haruyoshi
13	No.1 Oiler	Yamashita	Tomihisa
14	Oiler	Abe	Kokichi
15	Oiler	Maeda	Sumihide
16	Chief Steward	Dezaki	Iseo
17	Steward	Ishimori	Shigenobu

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Hara	Tetsuo
2	Chief Officer	Takeda	Masao
3	Second Officer	Yamashita	Norihiro
4	Chief Engineer	Murata	Mitsuhiro
5	First Engineer	Oide	Akihide
6	Second Engineer	Hamaguchi	Norio
7	Chief Operator	Chiba	Seichi
8	Boatswain	Hamayoshi	Yoshio
9	Quartermaster	Morino	Kaneo
10	Boatswain	Kobayashi	Tomeo
11	Quartermaster	Emoto	Satoru
12	Quartermaster	Omoto	Okinori
13	No.1 Oiler	Tsuchiyama	Yoshihiro
14	Oiler	Yamane	Katsuro
15	Fireman	Maruyama	Tatsuzo
16	Chief Steward	Endo	Masanori
17	Steward	Muranaka	Mitsuji

1990/91

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Nakanishi	Sanji
2	Chief Officer	Gomi	Katsuji
3	Second Officer	Takemura	Toshiyuki
4	Chief Engineer	Nakamura	Kazuo
5	First Engineer	Yamauchi	Nobuo
6	Second Engineer	Endo	Yoshiya
7	Chief Operator	Arai	Hiroshi
8	Boatswain	Nozaki	Tsutomu
9	Quartermaster	Uematsu	Shigeru
10	Quartermaster	Okumura	Toshiki
11	Quartermaster	Nakahama	Eiji
12	Quartermaster	Shibata	Tadao
13	No.1 Oiler	Yokoo	Kiyoto
14	Oiler	Yabu	Kitoshi
15	Oiler	Yoshimura	Kazuhisa
16	Chief Steward	Emoto	Tanemi
17	Steward	Yasunaga	Kenichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Tsurui	Toshinori
2	Chief Officer	Ryono	Tameo
3	Second Officer	Masuda	Motoo
4	Chief Engineer	Shimazaki	Shigeji
5	First Engineer	Kimura	Isamu
6	Second Engineer	Yoshinaga	Yoshihito
7	Chief Operator	Oishi	Katsuichi
8	Boatswain	Iwamoto	Manabu
9	Quartermaster	Hara	Yasuhei
10	Quartermaster	Miyazaki	Tomeo
11	Quartermaster	Okumura	Tomohiro
12	Quartermaster	Murata	Goro
13	No.1 Oiler	Tsuchiyama	Yoshihiro
14	Oiler	Okaya	Katsuhiro
15	Oiler	Yanagiuchi	Hidetoshi
16	Chief Steward	Kawasaki	Kazuhiko
17	Steward	Muranaka	Mitsuji

1991/92

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Kira	Masatoshi
2	Chief Officer	Takeda	Masao
3	Second Officer	Urayoshi	Tomoyuki
4	Chief Engineer	Komaki	Yoshiyuki
5	First Engineer	Yamauchi	Nobuo
6	Second Engineer	Nakamura	Shinichi
7	Chief Operator	Chiba	Seichi
8	Boatswain	Mori	Osamu
9	Quartermaster	Terao	Makoto
10	Quartermaster	Kobayashi	Tomeo
11	Quartermaster	Hashimoto	Kyozo
12	Quartermaster	Kasai	Norihiko
13	No.1 Oiler	Yamashita	Tomihisa
14	Oiler	Iizawa	Tadao
15	Oiler	Shiraishi	Motofusa
16	Chief Steward	Konno	Tokio
17	Steward	Hodokuma	Hironobu

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Onodera	Eigo
2	Chief Officer	Yamashita	Tomiya
3	Second Officer	Yamashita	Norihiro
4	Chief Engineer	Tabata	Nobuichi
5	First Engineer	Kimura	Isamu
6	Second Engineer	Sato	Norio
7	Chief Operator	Matsuda	Kiyotada
8	Boatswain	Hamayoshi	Yoshio
9	Quartermaster	Murata	Goro
10	Quartermaster	Oguni	Seichi
11	Quartermaster	Fujiwara	Genzaburo
12	Quartermaster	Suzuki	Zenetsu
13	No.1 Oiler	Kurokawa	Minoru
14	Oiler	Horinaga	Masaya
15	Oiler	Maeda	Sumihide
16	Chief Steward	Imasaki	Tadamitsu
17	Steward	Mae	Kanzi

Appendix 5. (continued).

1992/93

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Kira	Masatoshi
2	Chief Officer	Yamashita	Tomiya
3	Second Officer	Komiya	Hiroyuki
4	Probationary Officer	Kanzaki	Masahiko
5	Chief Engineer	Shimazaki	Shigeji
6	First Engineer	Mori	Yutaka
7	Second Engineer	Oeda	Masanobu
8	Chief Operator	Matsuda	Kiyotada
9	Boatswain	Nishimura	Michio
10	Quartermaster	Kobayashi	Tomeo
11	Quartermaster	Shibata	Tadao
12	Sailor	Ogasawara	Dairo
13	No.1 Oiler	Morishita	Hideyuki
14	Oiler	Yabu	Kitoshi
15	Oiler	Nakamura	Motomi
16	Chief Steward	Hirai	Yojiro
17	Steward	Kuramoto	Akira

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Owada	Atsushi
2	Chief Officer	Ryono	Tameo
3	Second Officer	Kimura	Takumi
4	Probationary Officer	Maki	Kouji
5	Chief Engineer	Atsumi	Hiroaki
6	First Engineer	Abe	Toshiji
7	Second Engineer	Goto	Yoshihito
8	Probationary Engineer	Sugiyama	Yoshinori
9	Chief Operator	Arai	Hiroshi
10	Boatswain	Uematsu	Shigeru
11	Quartermaster	Endo	Kenichi
12	Quartermaster	Emoto	Satoru
13	Sailor	Shina	Yoshiaki
14	No.1 Oiler	Mori	Isamu
15	Oiler	Maeda	Kazuyoshi
16	Chief Steward	Miura	Yoshimi
17	Steward	Urasaki	Jisao

1993/94

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Yasunaga	Norikatsu
2	Chief Officer	Ryono	Tameo
3	Second Officer	Miura	Toshiyuki
4	Chief Engineer	Hidaka	Isamu
5	First Engineer	Nakamura	Shinichi
6	Second Engineer	Kikuchi	Kosei
7	Probationary Engineer	Kabeya	Kazuhisa
8	Chief Operator	Suzuki	Yoshio
9	Boatswain	Nozaki	Tsutomu
10	Quartermaster	Nitta	Takiji
11	Quartermaster	Abe	Takuichi
12	Sailor	Sasaki	Kenichi
13	Sailor	Hirai	Tomoya
14	No.1 Oiler	Mori	Isamu
15	Oiler	Sakata	Masaru
16	Chief Steward	Endo	Tsutomu
17	Steward	Kuramoto	Akira

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Gomi	Katsuji
2	Chief Officer	Maiya	Yukihiro
3	Second Officer	Kasai	Hidenori
4	Chief Engineer	Nakamura	Kazuo
5	First Engineer	Kimura	Isamu
6	Second Engineer	Yasunaga	Haruyuki
7	Probationary Engineer	Miyamoto	Shigeki
8	Chief Operator	Chiba	Seichi
9	Boatswain	Hamayoshi	Yoshio
10	Quartermaster	Morino	Kaneo
11	Quartermaster	Fujiwara	Genzaburo
12	Sailor	Hashimoto	Yoshiro
13	Sailor	Nishi	Yoshiyuki
14	No.1 Oiler	Horinaga	Masaya
15	Oiler	Kumagaya	Yoshio
16	Chief Steward	Dezaki	Iseo
17	Steward	Yasunaga	Kenichi

1994/95

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Hara	Tetsuo
2	Chief Officer	Miura	Toshiyuki
3	Second Officer	Fujiwara	Tsukasa
4	Chief Engineer	Ono	Kazuo
5	First Engineer	Yamauchi	Nobuo
6	Second Engineer	Hiratsuka	Katsuo
7	Probationary Engineer	Miyamoto	Ryuta
8	Chief Operator	Tsuda	Yasunari
9	Boatswain	Okumura	Toshiki
10	Quartermaster	Endo	Kenichi
11	Quartermaster	Omoto	Okinori
12	Sailor	Abe	Masahiko
13	Sailor	Abe	Yasuhisa
14	No.1 Oiler	Okaya	Katsuhiro
15	Oiler	Nakamura	Motomi
16	Chief Steward	Endo	Tsutomu
17	Steward	Matsushita	Tomonori

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Gomi	Katsuji
2	Chief Officer	Narita	Hidenori
3	Second Officer	Takemura	Toshiyuki
4	Chief Engineer	Ageno	Kazuhiro
5	First Engineer	Takeyama	Kazuo
6	Second Engineer	Endo	Yoshiya
7	Third Engineer	Miura	Takayuki
8	Chief Operator	Arai	Hiroshi
9	Boatswain	Okumura	Tomohiro
10	Quartermaster	Miyazaki	Tomeo
11	Quartermaster	Abe	Takuichi
12	Sailor	Katase	Hisashi
13	Sailor	Suzuki	Katsushi
14	No.1 Oiler	Abe	Kokichi
15	Oiler	Iwabuchi	Akio
16	Chief Steward	Emoto	Tanemi
17	Steward	Yamashita	Katsushi

Appendix 5. (continued).

1995/96

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Sumihara	Tokuya
2	Chief Officer	Yamashita	Norihiro
3	Second Officer	Eguchi	Hiroshi
4	Third Officer	Maki	Kouji
5	Chief Engineer	Tabata	Nobuichi
6	First Engineer	Sato	Sueo
7	Second Engineer	Murai	Yasunari
8	Third Engineer	Ohura	Yoshihiro
9	Chief Operator	Arai	Hiroshi
10	Boatswain	Okumura	Tomohiro
11	Quartermaster	Omoto	Okinori
12	Quartermaster	Omura	Takao
13	Sailor	Takahashi	Dai
14	No.1 Oiler	Tateda	Hiroshi
15	Oiler	Ishimori	Tadashi
16	Chief Steward	Endo	Masanori
17	Steward	Mae	Kanzi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Narita	Hidenori
2	Chief Officer	Ebisui	Tadashi
3	Second Officer	Sato	Shouzou
4	Jr.Second Officer	Yamauchi	Yoshiyuki
5	Chief Engineer	Atsumi	Hiroaki
6	First Engineer	Saito	Hidetoshi
7	Second Engineer	Oeda	Masanobu
8	Third Engineer	Sakamoto	Seiji
9	Chief Operator	Tsuda	Yasunari
10	Boatswain	Kasai	Norihiko
11	Quartermaster	Maeda	Koji
12	Quartermaster	Shibata	Tadao
13	Sailor	Hirai	Tomoya
14	No.1 Oiler	Yokoo	Kiyoto
15	Fireman	Nishimura	Yusaku
16	Chief Steward	Miura	Yoshimi
17	Steward	Emoto	Tanemi

1996/97

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Hara	Tetsuo
2	Chief Officer	Hirose	Kiyoji
3	Second Officer	Watanabe	Masaki
4	Chief Engineer	Shimazaki	Shigeji
5	First Engineer	Nakamura	Shinichi
6	Second Engineer	Horinaga	Fujio
7	Third Engineer	Miyamoto	Shigeki
8	Chief Operator	Ikuta	Ryoji
9	Boatswain	Nitta	Takiji
10	Quartermaster	Suzuki	Zenetsu
11	Quartermaster	Kamiyama	Hideo
12	Sailor	Takei	Hiroshi
13	Sailor	Kato	Syota
14	No.1 Oiler	Okaya	Katsuhiro
15	Fireman	Nakashima	Kazunori
16	Chief Steward	Hirai	Yojiro
17	Steward	Watanabe	Kenichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Tsurui	Toshinori
2	Chief Officer	Yamashiro	Kenji
3	Second Officer	Okoshi	Chikamasa
4	Probationary Officer	Saito	Takayuki
5	Chief Engineer	Komaki	Yoshiyuki
6	First Engineer	Kimura	Isamu
7	Second Engineer	Murai	Yasunari
8	Third Engineer	Koga	Yoshimasa
9	Chief Operator	Arai	Hiroshi
10	Boatswain	Endo	Kenichi
11	Quartermaster	Shibata	Tadao
12	Sailor	Abe	Yasuhisa
13	Sailor	Kawaragi	Yoshiyuki
14	No.1 Oiler	Oki	Kunimori
15	Fireman	Koyama	Kazuhiro
16	Chief Steward	Kawasaki	Kazuhiko
17	Steward	Eguchi	Kiyoshi

1997/98

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Tsurui	Toshinori
2	Chief Officer	Ebisui	Tadashi
3	Second Officer	Kasai	Hidenori
4	Chief Engineer	Nakamura	Kazuo
5	First Engineer	Kimura	Isamu
6	Second Engineer	Miyamoto	Ryuta
7	Third Engineer	Takata	Takuya
8	Chief Operator	Arai	Hiroshi
9	Boatswain	Miyazaki	Tomeo
10	Quartermaster	Omoto	Okinori
11	Quartermaster	Shibata	Tadao
12	Sailor	Hasebe	Kozo
13	Sailor	Maeda	Hajime
14	No.1 Oiler	Yabu	Kitoshi
15	Fireman	Yamasaki	Yasuo
16	Chief Steward	Ogawa	Teruo
17	Steward	Yasunaga	Kenichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Sakai	Kazushi
2	Chief Officer	Komiya	Hiroyuki
3	Second Officer	Fujiwara	Tsukasa
4	Chief Engineer	Atsumi	Hiroaki
5	First Engineer	Yamauchi	Nobuo
6	Second Engineer	Sato	Norio
7	Third Engineer	Kawamoto	Kenji
8	Chief Operator	Kobayashi	Yasuji
9	Boatswain	Okumura	Tomohiro
10	Quartermaster	Abe	Takuichi
11	Sailor	Nakamura	Norihiko
12	Sailor	Utashiro	Jun-ya
13	Sailor	Matsuzawa	Kazuya
14	No.1 Oiler	Ishimori	Tadashi
15	Fireman	Kawasaki	Yoji
16	Chief Steward	Hamada	Norio
17	Steward	Kinoshita	Hirohumi

Appendix 5. (continued).

1998/99

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Sakai	Kazushi
2	Chief Officer	Yamauchi	Yoshiyuki
3	Second Officer	Nojima	Shigeru
4	Chief Engineer	Matsushita	Mitsuo
5	First Engineer	Yamauchi	Nobuo
6	Second Engineer	Oeda	Masanobu
7	Third Engineer	Kodama	Shuji
8	Chief Operator	Arai	Hiroshi
9	Boatswain	Nitta	Takiji
10	Quartermaster	Wakazuki	Kenji
11	Quartermaster	Abe	Masahiko
12	Sailor	Kurogi	Takashi
13	Sailor	Kurisu	Kazumitsu
14	Sailor	Sakimukai	Shinichi
15	No.1 Oiler	Iizawa	Tadao
16	Fireman	Mizobuchi	Keisuke
17	Fireman	Aman	Keita
18	Chief Steward	Ishimori	Shigenobu
19	Steward	Hamashita	Seichi

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Narita	Hidenori
2	Chief Officer	Minami	Kiyokuni
3	Second Officer	Taguchi	Futoshi
4	Chief Engineer	Shimazaki	Shigeji
5	First Engineer	Tokuda	Motoo
6	Second Engineer	Ohura	Yoshihiro
7	Third Engineer	Mizoguchi	Takahide
8	Chief Operator	Tsuda	Yasunari
9	Boatswain	Kasai	Norihiko
10	Quartermaster	Shibata	Tadao
11	Sailor	Abe	Yasuhisa
12	Sailor	Machida	Sumito
13	Sailor	Adachi	Hironori
14	Sailor	Fukutoyama	Junji
15	Sailor	Shinohe	Akira
16	No.1 Oiler	Oki	Kunimori
17	Fireman	Shiotsuki	Ryooji
18	Chief Steward	Endo	Masanori
19	Steward	Sugimoto	Kiyoharu

1999/2000

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Miura	Toshiyuki
2	Chief Officer	Taguchi	Futoshi
3	Second Officer	Kasai	Hidenori
4	Chief Engineer	Komaki	Yoshiyuki
5	First Engineer	Mori	Yutaka
6	Second Engineer	Murai	Yasunari
7	Third Engineer	Mizobuchi	Keisuke
8	Chief Operator	Inomata	Toshitaka
9	Boatswain	Suzuki	Zenetsu
10	Quartermaster	Omura	Takao
11	Sailor	Nakamura	Norihiko
12	Sailor	Utashiro	Jun-ya
13	Sailor	Kurisu	Kazumitsu
14	Sailor	Tsuda	Kenji
15	No.1 Oiler	Iwabuchi	Akio
16	Fireman	Takahashi	Yuya
17	Fireman	Osamu	Takashi
18	Chief Steward	Ogawa	Teruo
19	Steward	Sasaki	Tadayuki

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Komiya	Hiroyuki
2	Chief Officer	Ebisui	Tadashi
3	Second Officer	Takeda	Shintaro
4	Chief Engineer	Ono	Kazuo
5	First Engineer	Kimura	Isamu
6	Second Engineer	Yamashita	Taketoshi
7	Third Engineer	Nojima	Tomo
8	Chief Operator	Tsuda	Yasunari
9	Boatswain	Nitta	Takiji
10	Quartermaster	Omoto	Okinori
11	Sailor	Maekawa	Kentaro
12	Sailor	Honma	Hideto
13	Sailor	Narita	Oomi
14	Sailor	Teraoka	Takuya
15	No.1 Oiler	Ishimori	Tadashi
16	Fireman	Shirasaki	Hajime
17	Chief Steward	Okumura	Hideo
18	Steward	Mae	Kanzi

2000/01

SHONAN MARU

No.	Rank	Family Name	Given Name
1	Captain	Sakai	Kazushi
2	Chief Officer	Eguchi	Hiroshi
3	Second Officer	Konagai	Takahiro
4	Chief Engineer	Tokuda	Motoo
5	First Engineer	Saito	Hidetoshi
6	Second Engineer	Narazaki	Ikuo
7	Third Engineer	Nishiyama	Futoshi
8	Chief Operator	Tsuda	Yasunari
9	Boatswain	Suzuki	Zenetsu
10	Quartermaster	Nishi	Yoshiyuki
11	Sailor	Nakamura	Norihiko
12	Sailor	Kawaragi	Yoshiyuki
13	Sailor	Fukutome	Kazuki
14	Sailor	Nakato	Tetsuya
15	Sailor	Takada	Takahiro
16	No.1Oiler	Ishimori	Tadashi
17	Fireman	Yamagishi	Yoshinori
18	Chief Steward	Emoto	Tanemi
19	Steward	Oki	Kei

SHONAN MARU No.2

No.	Rank	Family Name	Given Name
1	Captain	Miura	Toshiyuki
2	Chief Officer	Yamauchi	Yoshiyuki
3	Second Officer	Oshima	Takuro
4	Chief Engineer	Nakamura	Kazuo
5	First Engineer	Tanno	Hiroshi
6	Second Engineer	Murai	Yasunari
7	Third Engineer	Kawamoto	Kenji
8	Chief Operator	Ogawa	Kazuhiro
9	Boatswain	Nitta	Takiji
10	Quartermaster	Hirai	Tomoya
11	Sailor	Maeda	Hajime
12	Sailor	Sawabe	Takato
13	Sailor	Sakimukai	Shinichi
14	Sailor	Nagai	Takahiro
15	Sailor	Yamaguchi	Koichi
16	No.1 Oiler	Ido	Minoru
17	Fireman	Watari	Takahiro
18	Chief Steward	Iida	Yukiharu
19	Steward	Yamashita	Katsushi

Appendix 6. Specifications of the Japanese research vessel in IWC/IDCR and SOWER cruises.

	Shonan-Maru	Shonan-Maru No.2	Kyo-Maru No.27	Toshi-Maru No.11	Toshi-Maru No.18	Toshi-Maru No.16
Call sign	JFBW	JFCF	JBOT	JNOL	JPMQ	JPLG
Register length (m)	64.80	64.80	63.50	63.20	63.20	63.20
Molded breadth (m)	10.20	10.20	9.90	9.90	9.90	9.90
Gross register tonnage	709	710	729.55	740.37	758.33	758.33
Barrel height (m)	20	20	17	17	17	17
IOP height (m)	14	14	-	-	-	-
Upper bridge height (m)	11.8	11.8	10	10	10	10
Bow height (m)	6.5	6.5	6.5	6.2	6.2	6.2
Maximum continuous output	5,280	5,280	3,600	3,500	3,500	3500
Main sailing technique NNSS from 1981, GPS from 1991.	GPS	GPS	Astronomical	Astronomical	Astronomical	Astronomical

Appendix 7

Examples of the Protocol used for the Estimated Distance and Angle Experiment

Example 1.

1998-99 IWC-SOWER Antarctic Cruise *Shonan Maru*
The Estimated Angle and Distance Experiment was conducted on the *Shonan Maru* on 30 January 1998.
Selected target distances and angles were:

Distance (nmile)	Angle
2.87	P 004°
2.38	S 015°
1.73	P 034°
1.44	S 028°
0.78	P 011°
0.41	S 007°

Persons taking part in the experiment were divided into five teams (A-E). The members of the teams and their allocation to the platforms are shown in Table 1.

Table 1. IWC-SOWER Antarctic Cruise 1998-99. Estimated Angle and Distance Experiment *Shonan Maru.*

	A	B	C	D	E
BARREL	NITTA	ABE & SAKIMUKAI	WAKAZUKI	KUROGI	KURISU
IOP	KURISU	NITTA	ABE	WAKAZUKI	KUROGI
UPPER BRIDGE	KUROGI &CAPTAIN	KURISU	SAKIMUKAI & KLEIVANE	ABE & DOHERTY	WAKAZUKI

The observers undertook the Experiment only from platforms where they normally conducted sighting effort.

For example: Nitta (the Boatswain) did not normally conduct sighting effort from the Upper Bridge therefore did not undertake the Experiment from that platform.

Similarly, Sakimukai (a young sailor with no previous Antarctic sighting survey experience) did not conduct sighting effort from the IOP and therefore did not undertake the Experiment from the IOP. (this was the first IDCR/SOWER cruise with participation of a young sailor with no previous Antarctic sighting survey experience and it had been agreed at the Planning Meeting that the observer rotation schedules would be arranged to ensure that the least experienced crewman would not be assigned to the IOP).

The teams were selected for the angle and distance estimates in a random order. The order of selection of teams and the target angles and distances for each trial are shown in Table 2.

Note as shown in Table 2. that the tested angle and distance usually differ from the target angle and distance.

Table 2. IWC-SOWER Antarctic Cruise 1998-99.

Estimated Angle and Distance Experiment *Shonan Maru*

Trial Number	Team	Target dist./angle	Time	Compass	Radar angle	Radar distance
1	A	2.87 P 004°	132514	089	P003	2.70
2	C	2.38 S 015°	132827	068	S018	2.16
3	E	1.73 P 034°	133144	118	P035	1.60
4	B	1.44 S 028°	133445	057	P028	1.16
5	D	0.78 P 011°	133801	093	P014	0.62
6	A	0.41 S 007°	134002	068	S007	0.28
7	E	2.87 P 004°	135448	078	P004	2.72
8	B	2.38 S 015°	135803	059	S015	2.13
9	C	1.73 P 034°	140032	110	P036	1.73
10	A	1.44 S 028°	140257	047	S027	1.34
11	E	0.78 P 011°	140543	085	P013	0.87
12	B	0.41 S 007°	140749	061	S005	0.48
13	D	2.87 P 004°	142207	096	P006	2.71
14	A	2.38 S 015°	142451	074	S015	2.25
15	B	1.73 P 034°	142723	125	P035	1.77
16	D	1.44 S 028°	143011	065	S025	1.28
17	C	0.78 P 011°	143200	099	P011	0.74
18	E	0.41 S 007°	143445	080	S006	0.43
19	B	2.87 P 004°	144939	095	P006	2.81
20	D	2.38 S 015°	145204	073	S014	2.34
21	A	1.73 P 034°	145510	118	P035	1.82
22	C	1.44 S 028°	145734	048	S033	1.41
23	B	0.78 P 011°	150136	096	P012	0.67
24	D	0.41 S 007°	150343	068	S011	0.26
25	C	2.87 P 004°	151820	088	P003	2.76
26	E	2.38 S 015°	152055	070	S015	2.32
27	D	1.73 P 034°	152413	118	P035	1.70
28	E	1.44 S 028°	152626	049	S031	1.30
29	A	0.78 P 011°	152939	092	P009	0.71
30	C	0.41 S 007°	153134	069	S012	0.33

Example 2.

2000-2001 IWC-SOWER Circumpolar Cruise, *Shonan Maru*

The estimated angle and distance experiment was conducted on the *Shonan Maru* on 25 January 2001

Selected target distances and angles were:

Distance (nmile)	Angle
2.67	P 009°
2.25	P 001°
1.63	S 027°
0.71	S 018°
0.32	P 014°
0.24	S 058°

Persons taking part in the experiment were divided into six teams (A-F). The members of the teams and their allocation to the platforms are shown in Table 1.

For all trials, (on both ships), the GPS position of the ship was recorded simultaneously with each trial of observers' estimates. Also on both ships, the GPS position of the buoy was recorded at the end of each set of six trials when the ship passed within a few meters of the buoy (thus the set and drift of the buoy could be determined). The aim of this was to provide verification of the GPS distances calculated from the results of the GPS Experiment.

Table 1. Estimated Angle and Distance Experiment *Shonan Maru*. IWC-SOWER Circumpolar Cruise 2000-2001.

	A	B	C	D	E	F
Barrel	SUZUKI	NISHI	NAKAMURA	KAWARAGI	FUKITOME & TAKADA	NAKATO
IOP	NAKATO	SUZUKI	NISHI	NAKAMURA	KAWARAGI	
Front Bridge	CAPTAIN SAKAI	NAKATO	VAN WAEREBEEK & FUKITOME	TAKADA	NAKAMURA	KAWARAGI

Note that observers undertook the Experiment only from platforms where they normally conducted sighting effort.

For example: Suzuki (the Boatswain) did not normally conduct sighting effort from the Upper Bridge therefore did not undertake the Experiment from that platform.

Similarly, Takada and Fukutome (observers with no previous Antarctic sighting survey experience) did not conduct sighting effort from the IOP and therefore did not undertake the Experiment from the IOP.

The teams were selected for the angle and distance estimates in a random order. The order of selection of teams and the target angles and distances for each trial are shown in Table 2.

Table 2. IWC-SOWER Circumpolar Cruise 2000-2001

Estimated Angle and Distance Experiment *Shonan Maru*

Trial number	Team	Target dist./angle	Time	Compass	Radar angle	Radar distance	Ship GPS position	Ship GPS position
BUOY	XXX	XXX		XXX	XXX	0.00	6811.42S	12846.05W
1	A	2.67 P 009°	08:25	293	S010	2.65	6812.70S	12840.43W
2	E	2.25 P 001°	08:30	309	P002	2.04	6812.36S	12842.05W
3	C	1.63 S 027°	08:37	278	S025	1.56	6812.01S	12843.11W
4	F	0.71 S 018°	08:43	300	S018	0.71	6811.66S	12845.19W
5	D	0.32 P 014°	08:50	336	P014	0.32	6811.36S	12845.93W
6	B	0.24 S 058°	08:58	299	S061	0.24	6811.29S	12846.48W
BUOY	XXX	XXX	09:01	XXX	XXX	0.00	6811.05S	12846.66W

Table 2. Cont.

7	D	2.67 P 009°	09:22	339	P007	2.63	6813.05S	12843.02W
8	B	2.25 P 001°	09:25	335	P003	2.27	6812.73S	12843.46W
9	D	1.63 S 027°	09:29	310	S026	1.63	6812.22S	12844.65W
10	A	0.71 S 018°	09:35	331	S018	0.68	6811.40S	12846.45W
11	F	0.32 P 014°	09:44	305	P012	0.32	6810.86S	12846.15W
12	C	0.24 S 058°	09:49	238	S060	0.19	6810.82S	12846.55W
BUOY	XXX	XXX	09:51	XXX	XXX	0.00	6810.71S	12847.05W
13	E	2.67 P 009°	10:14	339	P007	2.67	6812.80S	12843.59W
14	D	2.25 P 001°	10:17	334	P002	2.27	6812.41S	12844.18W
15	F	1.63 S 027°	10:21	310	S026	1.63	6811.88S	12845.33W
16	B	0.71 S 018°	10:26	330	S016	0.72	6811.09S	12846.90W
17	E	0.32 P 014°	10:29	005	P013	0.32	6810.72S	12847.32W
18	A	0.24 S 058°	10:35	290	S063	0.19	6810.58S	12847.50W
BUOY	XXX	XXX	10:37	XXX	XXX	0.00	6810.38S	12847.59W
19	F	2.67 P 009°	10:57	341	P008	2.70	6812.58S	12844.44W
20	C	2.25 P 001°	10:59	336	P003	2.25	6812.13S	12845.06W
21	B	1.63 S 027°	11:03	310	S024	1.62	6811.58S	12845.97W
22	E	0.71 S 018°	11:09	329	S016	0.71	6810.78S	12847.61W
23	A	0.32 P 014°	11:11	004	P014	0.30	6810.40S	12847.97W
24	D	0.24 S 058°	11:16	290	S070	0.13	6810.24S	12848.24W
BUOY	XXX	XXX	11:18	XXX	XXX	0.00	6810.06S	12848.29W
25	C	2.67 P 009°	11:49	340	P007	2.67	6812.12S	12845.17W
26	A	2.25 P 001°	11:51	335	P003	2.25	6811.72S	12845.73W
27	E	1.63 S 027°	11:55	312	S025	1.63	6811.23S	12846.92W
28	C	0.71 S 018°	12:00	330	S015	0.71	6810.41S	12848.31W
29	B	0.32 P 014°	12:03	360	P017	0.29	6810.01S	12848.57W
30	E	0.24 S 058°	12:08	292	S058	0.24	6809.94S	12848.74W
BUOY	XXX	XXX	12:10	XXX	XXX	0.00	6809.70S	12848.90W
31	B	2.67 P 009°	12:33	037	P009	2.70	6811.57S	12844.79W
32	F	2.25 P 001°	12:36	328	P001	2.24	6811.19S	12845.49W
33	A	1.63 S 027°	12:40	300	S029	1.60	6910.79S	12846.99W
34	D	0.71 S 018°	12:45	318	S019	0.70	6810.06S	12848.69W
35	C	0.32 P 014°	12:48	004	P014	0.27	6809.68S	12849.26W
36	F	0.24 S 058°	12:55	330	S082	0.23	6809.54S	12850.03W
BUOY	XXX	XXX	12:58	XXX	XXX	0.00	6809.38S	12849.63W

Appendix 8

Example of list of observer codes and details of previous IDCR/SOWER experience

IWC-SOWER Circumpolar Cruise 2000-2001

For the purposes of data validation the codes used to identify observers on the data records are listed below.

Code	Name	Experience (years)	
		IDCR/SOWER	JARPA/JARPN
Shonan Maru			
1	SUZUKI	4	8/5
2	NISHI	2	6/4
3	NAKAMURA	3	3/4
4	KAWARAGI	2	2/2
5	NAKATO	1	1/1
6	TAKADA	1	0/0
7	FUKUTOME	1	0/0
8	CAPTAIN SAKAI	5	5/3
C	CREW (and when no researchers present)		
E	ENSOR		
M	MURASE		
K	VAN WAEREBEEK		

Shonan Maru No.2

1	NITTA	7	7/7
2	HIRAI	3	6/6
3	MAEDA	3	3/3
4	SAWABE	1	3/2
5	SAKIMUKAI	2	2/1
6	NAGAI	1	2/2
7	YAMAGUCHI	1	0/0
C	CAPTAIN MIURA	4	5/3
S	CREW (and when no researchers present)		
M	MATSUOKA		
P	PITMAN		
F	MARQUES		

Table1. Summary of the IWC/IDCR or SOWER cruises from 1978/79 to 2000/01.

Season	Area	longitudinal range	(degree)	latitudinal range (average)	Research vessel	home port	home port	Research period Period 1 home port to home port		Period 2 Antarctic period *		Number of research days Transit to	from	Total	Antarctic Dec.	Jan.	Feb.	Total
1978/79	**Ⅳ**	70E-130E	60	ice-61S	T16,T18	Fremantle	Fremantle	1978/12/12	1979/2/14	1978/12/28	1979/2/7	16	7	**23**	4	31	7	**42**
1979/80	**Ⅲ**	0-70E	70	ice-63S	K27,T11	Cape Town	Cape Town	1979/12/20	1980/2/21	1979/12/27	1980/2/14	7	7	**14**	5	31	14	**50**
1980/81	**Ⅴ**	130E-170W	60	ice-62S	K27,T11,V34	Wellington	Wellington	1980/12/17	1981/2/12	1980/12/22	1981/2/6	5	6	**11**	10	31	6	**47**
1981/82	**Ⅱ**	60W-0	60	ice-63S	SM1,SM2,V34	Buenos Aires	Cape Town	1981/12/19	1982/2/14	1981/12/27	1982/2/6	8	8	**16**	5	31	6	**42**
1982/83	**Ⅰ**	120W-60W	60	ice-64S	SM1,SM2,V34	Ushuaia	Wellington	1982/12/30	1983/2/26	1983/1/2	1983/2/15	3	11	**14**	-	30	15	**45**
1983/84	**Ⅵ**	170W-120W	50	ice-61S	SM1,SM2,K27,V34	Wellington	Wellington	1983/12/29	1984/3/1	1984/1/4	1984/2/19	6	11	**17**	-	28	19	**47**
1984/85	**Ⅳ**	70E-130E	60	ice-61S	SM1,SM2,K27,V34	Fremantle	Fremantle	1984/12/21	1985/3/1	1984/12/29	1985/2/19	8	10	**18**	3	31	19	**53**
1985/86	**Ⅴ**	130E-170W	60	ice-63S	SM1,SM2,K27,V36	Wellington	Wellington	1985/12/18	1986/2/24	1985/12/22	1986/2/18	4	6	**10**	10	31	18	**59**
1986/87	**Ⅱ**	60W-0	60	ice-63S	SM1,SM2,K27,V34	Ushuaia	Port Luis	1986/12/27	1987/2/20	1986/12/28	1987/2/4	1	16	**17**	4	31	**4**	**39**
1987/88	**Ⅲ**	0-70E	70	ice-63S	SM1,SM2	Fremantle	Port Luis	1987/12/11	1988/2/8	1987/12/20	1988/1/25	9	14	**23**	12	25	-	**37**
1988/89	**Ⅳ**	70E-130E	60	ice-61S	SM1,SM2	Fremantle	Fremantle	1988/12/21	1989/2/20	1988/12/29	1989/2/11	8	9	**17**	3	31	11	**45**
1989/90	**Ⅰ**	120W-60W	60	ice-64S	SM1,SM2	Ushuaia	Wellington	1989/12/26	1990/2/19	1989/12/28	1990/2/10	2	9	**11**	4	31	10	**45**
1990/91	**Ⅵ**	170W-120W	50	ice-61S	SM1,SM2	Wellington	Wellington	1990/12/29	1991/2/23	1991/1/3	1991/2/11	5	12	**17**	-	29	11	**40**
1991/92	**Ⅴ**	130E-170W	60	ice-63S	SM1,SM2	Wellington	Wellington	1991/12/21	1992/2/17	1991/12/31	1992/2/8	10	9	**19**	1	31	8	**40**
1992/93	**ⅢW**	0-40E	40	ice-60S	SM1,SM2	Cape Town	Fremantle	1992/12/17	1993/2/16	1992/12/25	1993/2/4	8	12	**20**	7	31	4	**42**
1993/94	**Ⅰ**	110W-60W	30	ice-60S	SM1,SM2	Wellington	Valparaiso	1993/12/23	1994/2/21	1994/1/3	1994/2/14	11	7	**18**	-	29	14	**43**
1994/95	**ⅢE, Ⅳ W**	40E-80E	40	ice-60S	SM1,SM2	Cape Town	Fremantle	1995/1/5	1995/3/6	1995/1/13	1995/2/25	8	9	**17**	-	19	25	**44**
1995/96	**ⅥW**	170W-140W	30	ice-60S	SM1,SM2	Hobart	Wellington	1996/1/6	1996/3/4	1996/1/14	1996/2/21	8	12	**20**	-	18	21	**39**
1996/97	**Ⅱ E**	30W-0	30	ice-60S	SM1,SM2	Cape Town	Cape Town	1997/1/7	1997/2/26	1997/1/16	1997/2/14	9	12	**21**	-	16	14	**30**
1997/98	**Ⅱ W**	60W-25W	35	ice-60S	SM1,SM2	Punta Arenas	Cape Town	1998/1/14	1998/2/26	1998/1/18	1998/2/14	4	12	**16**	-	14	14	**28**
1998/99	**Ⅳ**	80E-130E	50	ice-60S	SM1,SM2	Cape Town	Hobart	1998/12/31	1999/3/1	1999/1/20	1999/2/22	20	7	**27**	-	12	22	**34**
1999/00	**IE, IIW**	80W-55W	25	ice-60S	SM1,SM2	Valparaiso	Punta Arenas	2000/1/6	2000/2/18	2000/1/15	2000/2/13	9	5	**14**	-	17	13	**30**
2000/01	**VIE, IW**	140W-110W	30	ice-60S	SM1,SM2	Wellington	Papeete	2001/1/5	2001/3/5	2001/1/16	2001/2/22	11	11	**22**	-	16	22	**38**

Abbreviation ; SM1: Shonanmaru, SM2: Shonanmaru No.2, T16: Toshimaru No.16, T18: Toshimaru No.18, K27: Kyomaru No.27, V34: Vdumchivyi No.34, V36: Vyderzhanny No.36,

*: For minke whale component.

Table1. (Continued.)

Season	Area	Positioning system			Ice information		Experiments																												
							Marking				Sighting																				Enviroment				
		Ast-ronomical	NNSS	GPS	Vessel	JIC /NIC	Marking	Mffe	Mft	Mvt	Pls	Vs	Dive	DG	MTE	NNSS	D&A	Hz	SP	BD	PAM	Cue	LE	Pid	SS	Rd	RWV	SI	Biop	Rsight	Md	Poll	Ac	CTD	XBT
1978/79	IV	Y	-	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1979/80	III	Y	-	-	Y	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1980/81	V	Y	-	-	Y	Y	Y	-	-	-	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981/82	II	Y	Y	-	Y	Y	Y	-	-	-	Y	Y	Y	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982/83	I	Y	Y	-	Y	Y	Y	-	-	Y	Y	Y	-	-	-	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983/84	VI	-	Y	-	Y	Y	Y	-	Y	Y	Y	Y	-	-	-	-	Y	Y	-	-	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1984/85	IV	-	Y	-	Y	Y	-	-	-	-	Y	Y	Y	-	Y	Y	Y	-	-	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-
1985/86	V	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	Y	-	Y	-	-	Y	-	Y	-	-	Y	-	-	-	-	-	-	-	-	-	-
1986/87	II	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	Y	-	Y	-	Y	-	Y	Y	-	-	-	-	-	-	-	-
1987/88	III	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	Y	-	-	-	-	Y	-	-	-	-
1988/89	IV	-	Y	-	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	-	-	-	Y	Y	-	Y	-	-	-	-
1989/90	I	-	Y	-	Y	Y	-	-	-	-	-	-	Y	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	-	-	-	-
1990/91	VI	-	Y	-	Y	Y	-	-	-	-	-	-	Y	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	-	-	-	-
1991/92	V	-	-	Y	Y	Y	-	-	-	-	-	-	Y	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	-	-	-	-
1992/93	III W	-	-	Y	Y	Y	-	-	-	-	-	-	Y	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	-	-	-
1993/94	I	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	Y	-	Y	-
1994/95	III E, IV W	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	-	Y	Y	Y	Y	-
1995/96	VI W	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	Y	-	Y	Y
1996/97	II E	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	-	Y	Y
1997/98	II W	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	Y	-	-
1998/99	IV	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	Y	-	-
1999/00	IE, IIW	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	Y	-	-
2000/01	VIE, IW	-	-	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	Y	-	-	-	-

Abbreviation ; Mffe: Mark-recapture efficiency, Mft: Trial-firing for dart modification and appropriate place sould be fired, Mvt: Mark verdict experiment using VTR,
Pls: Parallel ship experiment for g(0), Vs: Variable speed experiment for estimating g(0), Dive: dive time experiment for estimating g(0), DG: Density gradient ex., MTE: Monitoring topmen effort,
MTE: Monitoring topmen effort.
NNSS: Trial for closing distance by Satellite Navigation System, D&A: Accuracy in angle and distance estimation, Hz: Hazard rate experiment, SP: Swimming speed experiment,
BD: Blow duration or blow rate experiment, PAM: Photographic angle measurement, Cue: cue counting, LE: Length estimate ex., Pid: Photoidentification or natural marking,
SS: Secondary sighting ex., Rd: Pilot study on radio tagging, RWV: Reaction of whales to vessel, SI: School identify ex., Biop: Biopsy. Rsight: Re-sighting experiment in IO mode.
Md: Marin debris observation. Poll: Air an sea water pollutants. Ac: Acoustic survey.

Table1. (Continued.)

Season	Area	Sighting Survey mode Closing	IO	No. of Species code *	code Zipphid	code like minke	code s.bottle -nose	Area number of strata	(n.mile^2)	Searching distance (n.mile) ** Closing	IO	total	Minke whale primary school ***	D (whales /100n.m^2)	P **** (ind.)	CV	C.A.***** Abundance (whales)	CV
1978/79	IV	Y	-	35	-	-	-	9	427,496	7,764.1	-	7,764.1	498.3	22.7	97,027	0.218	-	-
1979/80	III	Y	-	35	-	-	-	6	493,908	6,966.3	-	6,966.3	419	16.5	81,587	0.242	-	-
1980/81	V	Y	-	35	-	-	-	5	480,280	5,299.9	-	5,299.9	545	37.0	177,606	0.264	-	-
1981/82	II	Y	-	35	-	-	-	7	398,021	6,581.8	-	6,581.8	447	12.5	49,675	0.262	-	-
1982/83	I	Y	-	35	-	-	-	6	372,005	4,823.3	-	4,823.3	576	19.7	73,302	0.254	73,302	0.254
1983/84	VI	Y	-	35	-	-	-	6	725,179	4,190.6	-	4,190.6	190	14.7	106,901	0.277	106,901	0.277
1984/85	IV	Y	-	39	Y	-	-	6	-	-	-	-	-	-	-	-	-	-
1985/86	V	Y	Y	58	Y	Y	-	6	963,468	3,485.3	4,227.9	7,713.2	1,056	29.2	281,158	0.231	294,610	0.138
1986/87	II	Y	Y	59	Y	Y	Y	10	495,208	3,329.6	3,650.7	6,980.3	781	24.8	122,655	0.256	122,156	0.190
1987/88	III	Y	Y	59	Y	Y	Y	4	479,730	2,069.5	3,329.6	5,399.1	300.4	14.4	69,001	0.543	88,735	0.273
1988/89	IV	Y	Y	59	Y	Y	Y	6	577,099	2,067.2	2,378.5	4,445.7	422.7	14.9	85,756	0.375	74,692	0.257
1989/90	I	Y	Y	62	Y	Y	Y	4	429,512	2,430.2	2,980.9	5,411.1	487.5	12.4	53,236	0.258	-	-
1990/91	VI	Y	Y	73	Y	Y	Y	4	557,424	1,453.4	2,159.5	3,612.9	146.6	8.6	47,955	0.399	-	-
1991/92	V	Y	Y	73	Y	Y	Y	4	443,845	1,702.8	2,029.0	3,731.8	535.9	21.0	93,000	0.200	-	-
1992/93	III W	Y	Y	73	Y	Y	Y	4	445,316	2,540.9	2,748.6	5,289.5	325.6	3.2	14,204	0.183	-	-
1993/94	I	Y	Y	83	Y	Y	Y	4	667,776	2,362.1	2,477.4	4,839.5	224.3	4.0	26,687	0.220	-	-
1994/95	III E, IV W	Y	Y	83	Y	Y	Y	5	428,564	2,052.3	2,248.0	4,300.3	216.1	5.8	24,900	0.210	-	-
1995/96	VI W	Y	Y	75	Y	Y	Y	4	446,418	1,647.4	1,733.8	3,381.2	174	8.6	38,300	0.223	-	-
1996/97	II E	Y	Y	75	Y	Y	Y	4	445,715	1,568.6	1,769.4	3,338.0	131.2	6.3	28,140	0.241	-	-
1997/98	II W	Y	Y	80	Y	Y	Y	6	306,981	1,377.2	1,688.1	3,065.3	114	3.2	9,750	0.325	-	-
1998/99	IV	Y	Y	80	Y	Y	Y	4	387,581	1,734.8	2,098.4	3,833.2	390		-	-	-	-
1999/00	IE, IIW	Y	Y	80	Y	Y	Y	4	-	1,022.8	790.9	1,813.7	108					
2000/01	VIE, IW	Y	Y	80	Y	Y	Y	4	-	1,629.6	1,556.5	3,186.1	614					

* from DESS.
**: from cruise reports
*** From 1978/79 to 1997/98 :Branch and Butterworth (2001),
from 1998/99 to 2000/01: Ensor et. al., (1999, 2000 and 2001).
**** 1978/79-1990/91(IWC,1991).
1991/92-1993/94 (Borchers, 1993, Boachers and Cameron, 1995, Borchers and Burt, 1996).
1994/95-1997/98 (Burt and Borchers, 1996, 1997, 1999, 2000).
***** IWC,1991.

Table 2. Survey experiences of primary observers in each cruise.
Darta included in Antarctic commercial whaling experience.
Data from Kyodo Senpaku, Kaisha, Ltd., for Japanese vessels.

Survey	1-5	6-9	10-
1978/79	0	1	11
1979/80	0	0	12
1980/81	0	0	12
1981/82	0	2	10
1982/83	0	0	12
1983/84	0	0	18
1984/85	1	0	18
1985/86	0	0	18
1986/87	0	0	18
1987/88	0	0	12
1988/89	0	0	12
1989/90	0	0	12
1990/91	0	0	12
1991/92	1	0	11
1992/93	4	1	7
1993/94	5	0	7
1994/95	5	0	7
1995/96	6	1	5
1996/97	6	0	6
1997/98	5	0	7
1998/99	8	2	5
1999/00	4	5	5

Table 3. Survey experiences (IWC/IDCR or SOWER Antarctic minke cruise) of international researchers.

RESEARCHER / SEASON	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	Total
A.Galeazzi					1																			1
A.Karpenko				1	2	3																		3
A.Rovnin			1																					1
A.Sazhinov				1																				1
Alan Ward							1																	1
Alexander Zorin									1		2													2
Allan Ward								1	2															2
B.Abernethy															1									1
Barry Troutman						1		2	3	4														4
C.Edward Bowlby						1	2		3															3
C.Potter				1																				1
Carolina Sanpera												1												1
Daishiro Yamagiwa																			1					1
David Thompson						1																		1
Donald Ljungblad																					1	2		2
Durant Hembree	1	2	3	4	5		6		7															7
Fernanda Marques																					1	2	3	3
Finn Danielsen													1											1
Fujio Kasamatsu		1	2	3	4	5	6	7	8	9	10													10
Genevieve Desportes													1		2									2
Gerald G.Joyce			1	2	3	4	5	6	7	8		9	10											10
Hidehiro Kato	1	2	3																					3
Hirohisa Shigemune								1	2	3	4													4
Hiroshi Iwakami																				1				1
Hiroshi Ohizumi													1											1
Hiroshi Tsutsumi												1												1
Hiroto Murase																							1	1
Hiroyuki Shimada														1	2	3	4					5		5
J.Horwood*		1																						1
J.K.O'Leary	1																							1
Janet Doherty																					1			1
Jimmy Hansen														1										1
Jorge F.Mermoz					1	2	3	4	5		6	7	8	9		10								10
Kanneth C.Balcomb								1																1
Katsuji Kawaura							1	2	3															3
Kazuo Yamamura	1																							1
Keiko Sekiguchi																		1	2		3	4		4
Ken Findlay															1		2		3	4		5		5
Koji Matsuoka																		1			2		3	3
L.Tsunoda	1	2	3					4																4
Lars Kleivane																				1	2	3		3
Luis A.Pastene						1	2									3				4				4
M.Baylon				1																				1
Mayer		1		2					3															3
Martin Cawthorn																	1	2		3				3
Masahiro Kawasaki																	1							1
Michael Newcomer											1			2										2
Micheline-Nicole Janner																1								1
Miranda Brown																	1							1
Nikolay Doroshenko									1															1
Nobuyuki Miyazaki			1																					1
P.Lourega				1																				1
Paul Ensor			1		2	3	4			5	6	7	8	9		10	11	12	13	14	15	16	17	17
Peter B.Best	1		2																					2
Peter Corkeron																		1						1
Richard A.Rowlett			1	2	3	4	5	6	7	8				9	10									10
Robert Pitman																1		2	3	4	5		6	6
Rodrigo Hucke-Gaete																						1		1
S.Nagata				1																				1
Shannon Fitzgerald						1																		1
Sharon Headley																			1	2				2
Shigetoshi Nishiwaki							1	2	3			4	5	6	7									7
T.Waters				1																				1
Tomio Miyashita					1	2																		2
Toshio Hata						1																		1
V.Yukhov							1	2																2
Van Waerebeek																							1	1
Vera da Silva											1													1
W.Church					1																			1
Number of researchers	6	6	10	12	10	13	12	12	14	6	7	6	7	7	6	6	6	6	6	8	8	8	6	8
Average of the survey experiences of researcher	1.0	1.5	1.8	1.7	2.3	2.2	3.1	3.2	3.9	6.2	4.3	4.8	4.9	5.3	3.8	4.7	3.3	3.2	3.8	4.1	3.8	4.8	5.2	3.6
A balance of previous cruise		0.5	0.3	-0.1	0.6	-0.1	0.9	0.1	0.8	2.2	-1.9	0.5	0.0	0.4	-1.5	0.8	-1.3	-0.2	0.7	0.3	-0.4	1.0	0.4	
Number of researcher who have over 5 cruises experience.					1	1	4	3	5	4	3	3	4	4	2	2	1	1	1	1	2	3	2	

Average

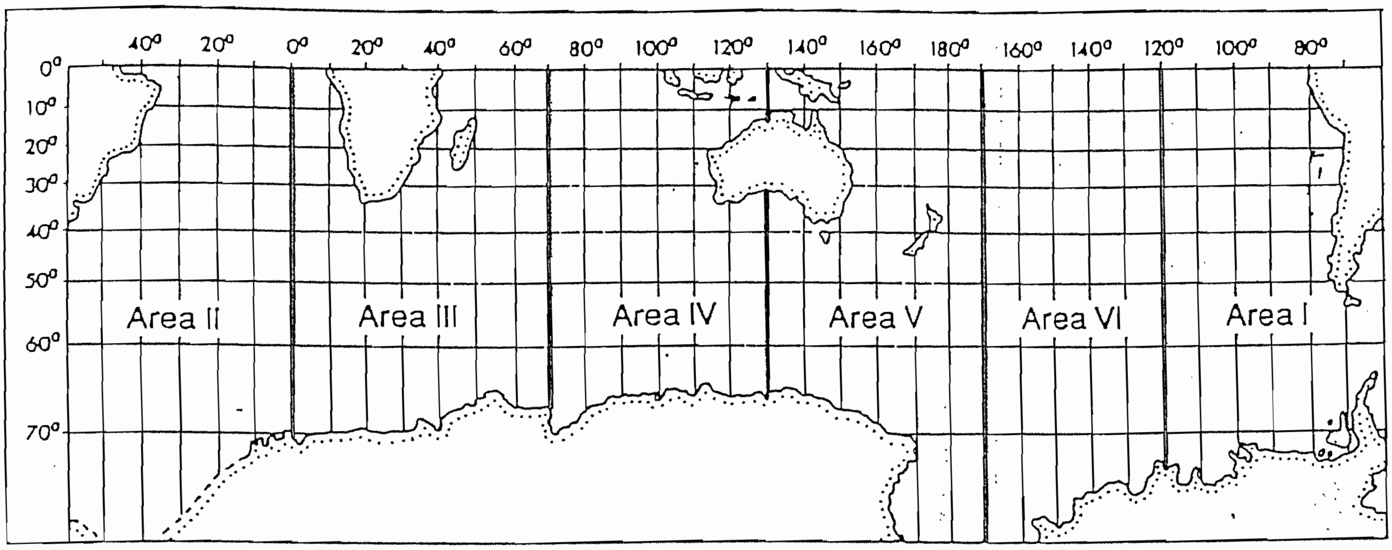


Figure 1: IWC Antarctic Areas for the management of baleen whale species (except Bryde's whale).

Area I

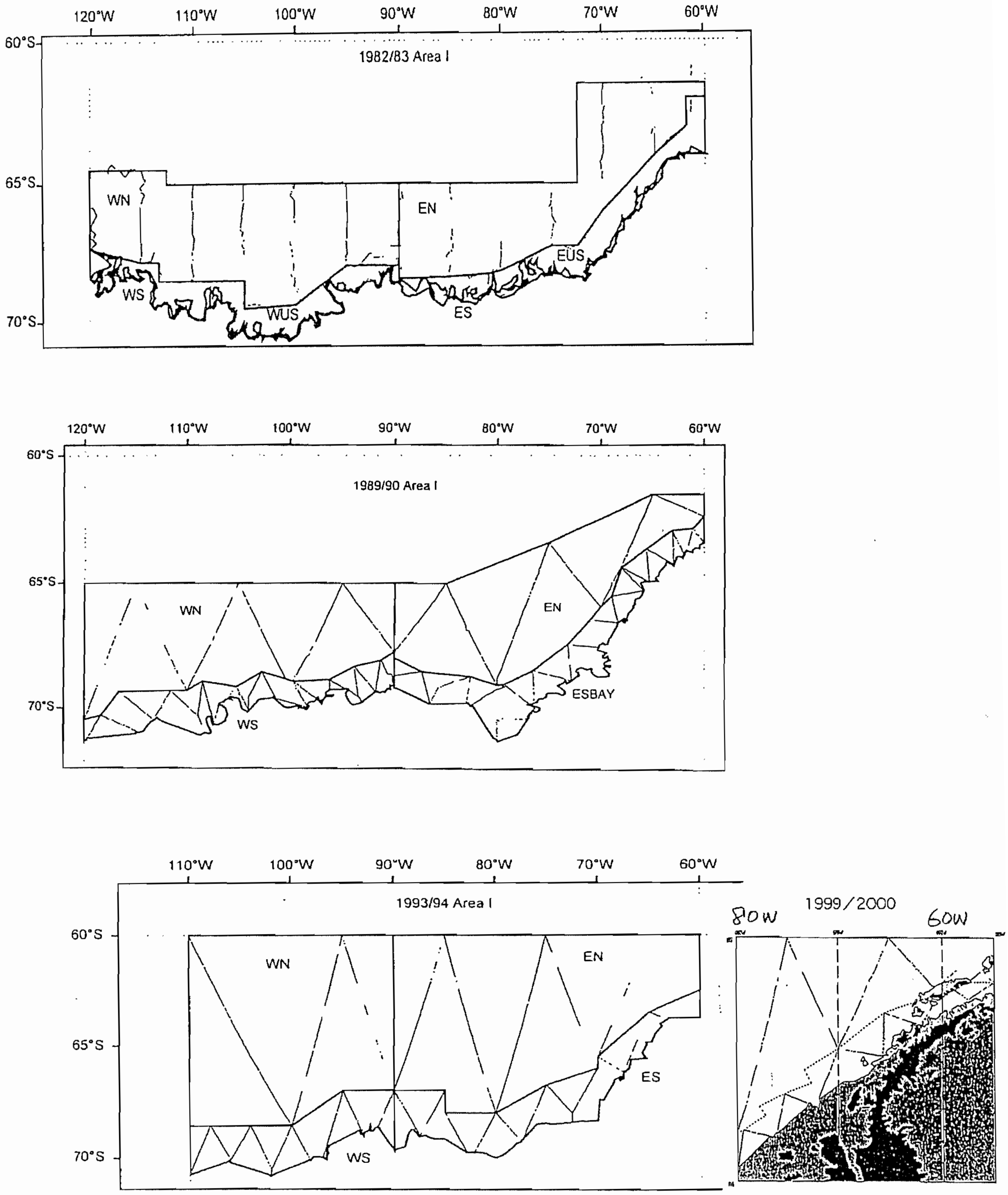


Figure 2a. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

Area II

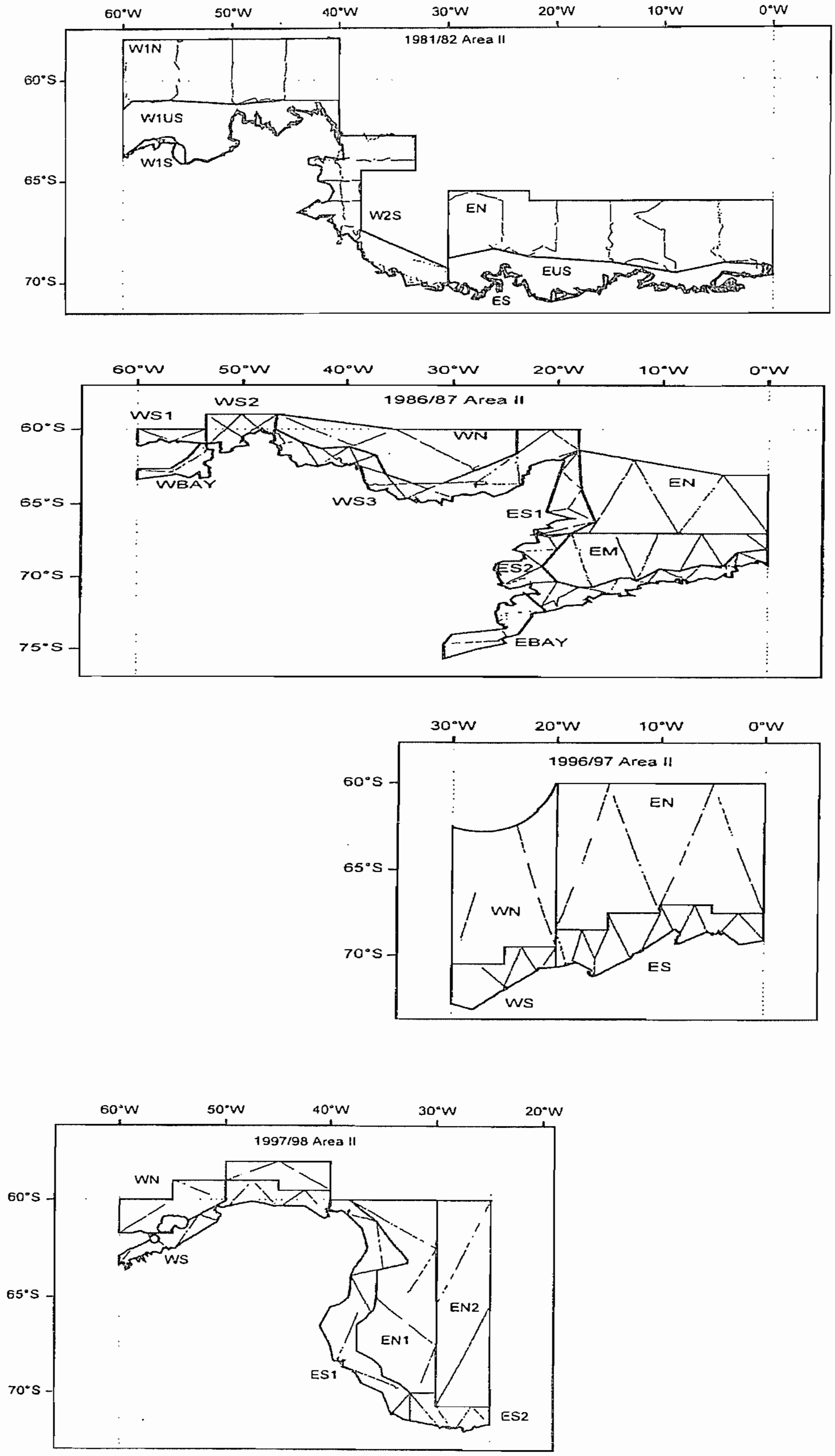


Figure 2b. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

Area III

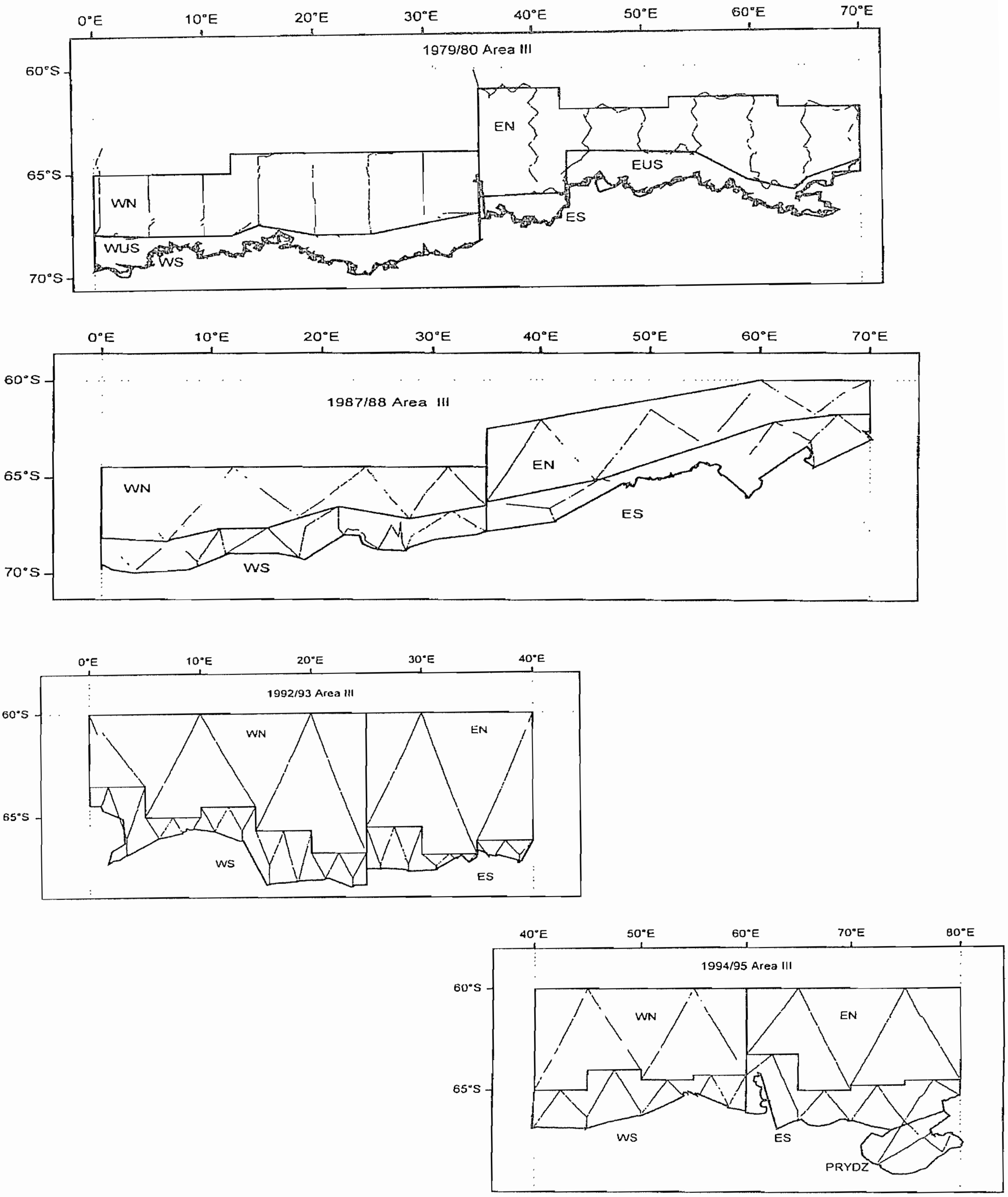


Figure 2. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

Area IV

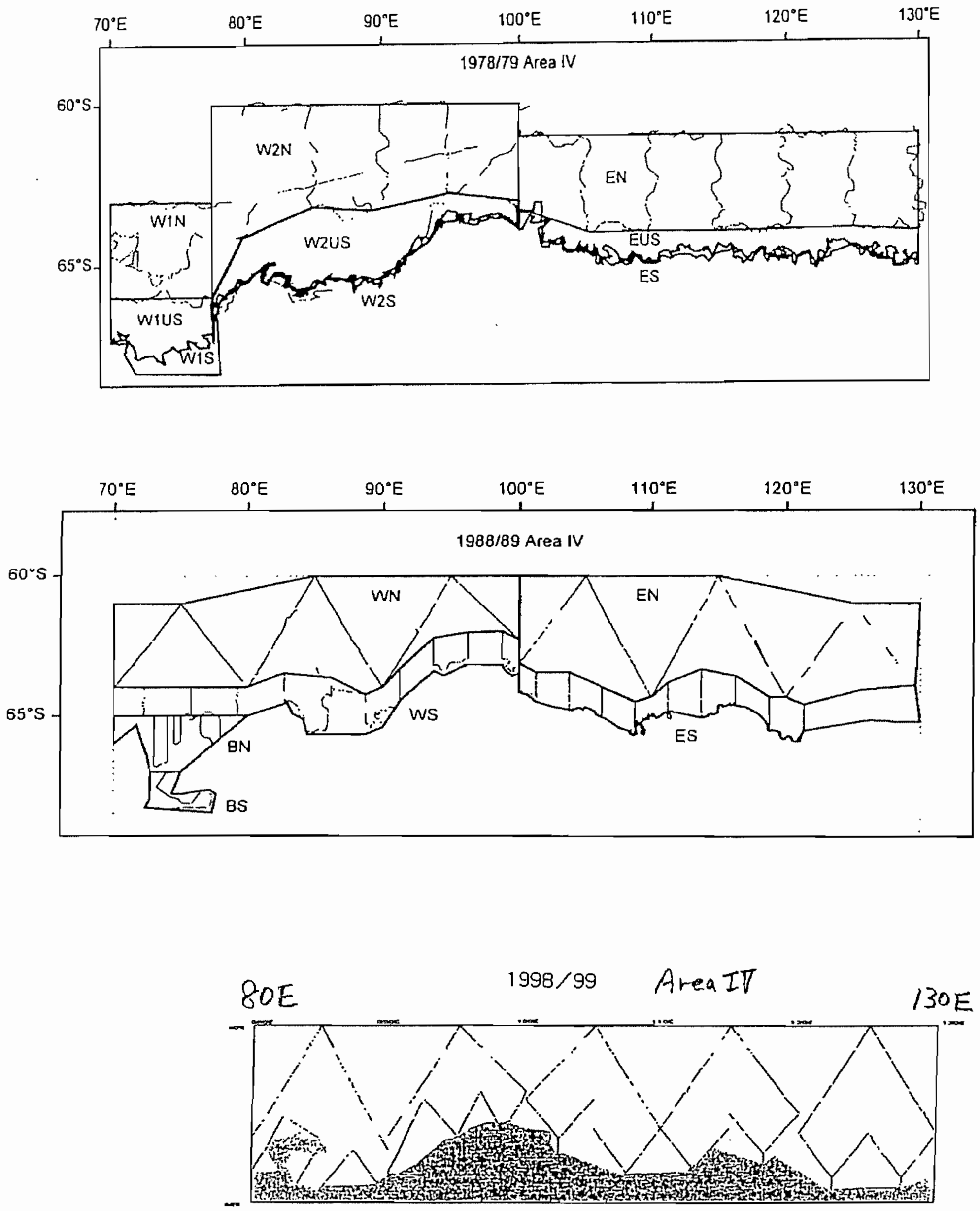


Figure 2. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

Area V

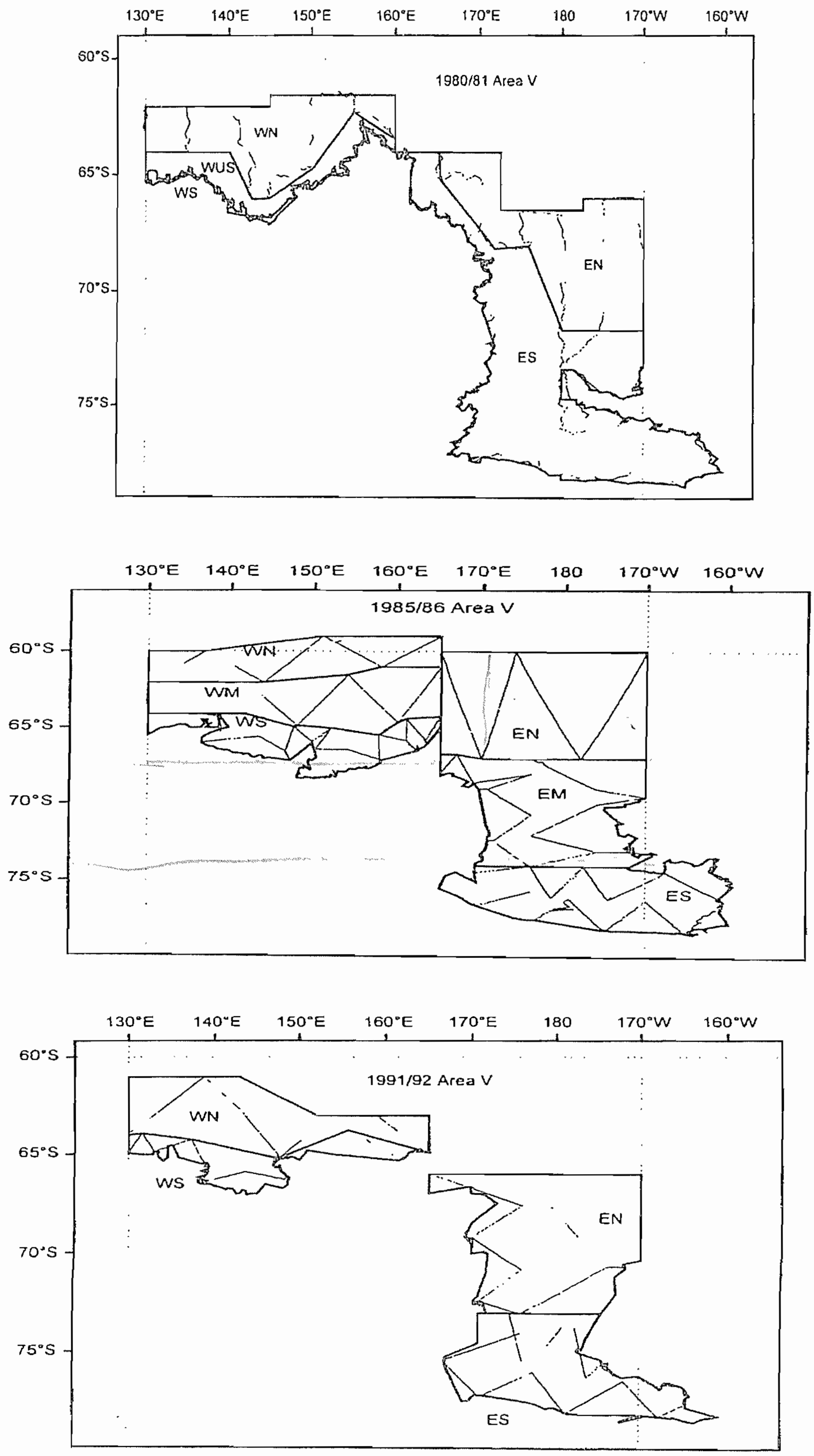


Figure 2. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

Area VI

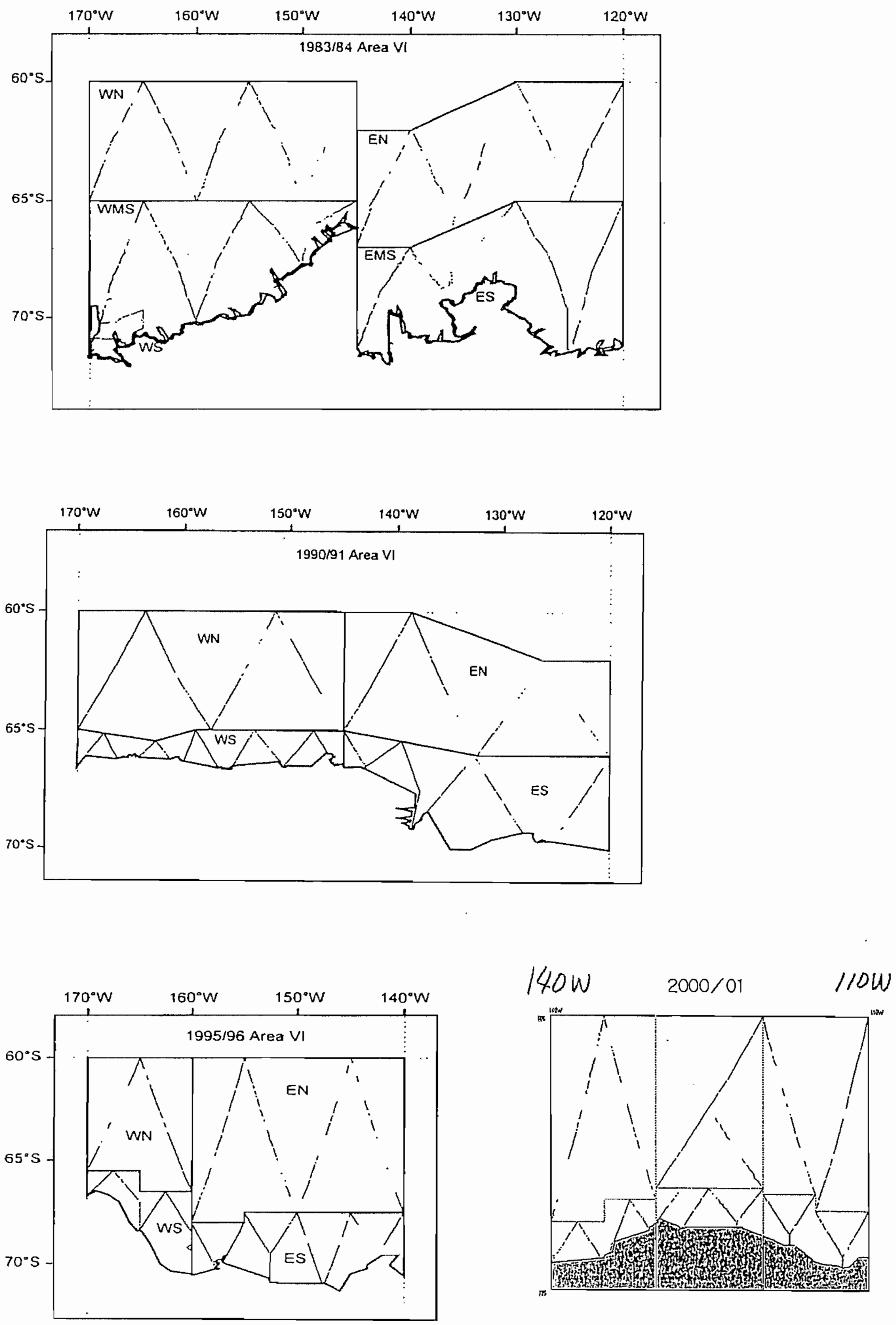


Figure 2. Strata surveyed in each Area throughout circumpolar sets from 1978/79 to 2000/01 (alter Branch and Butterworth, 2001).

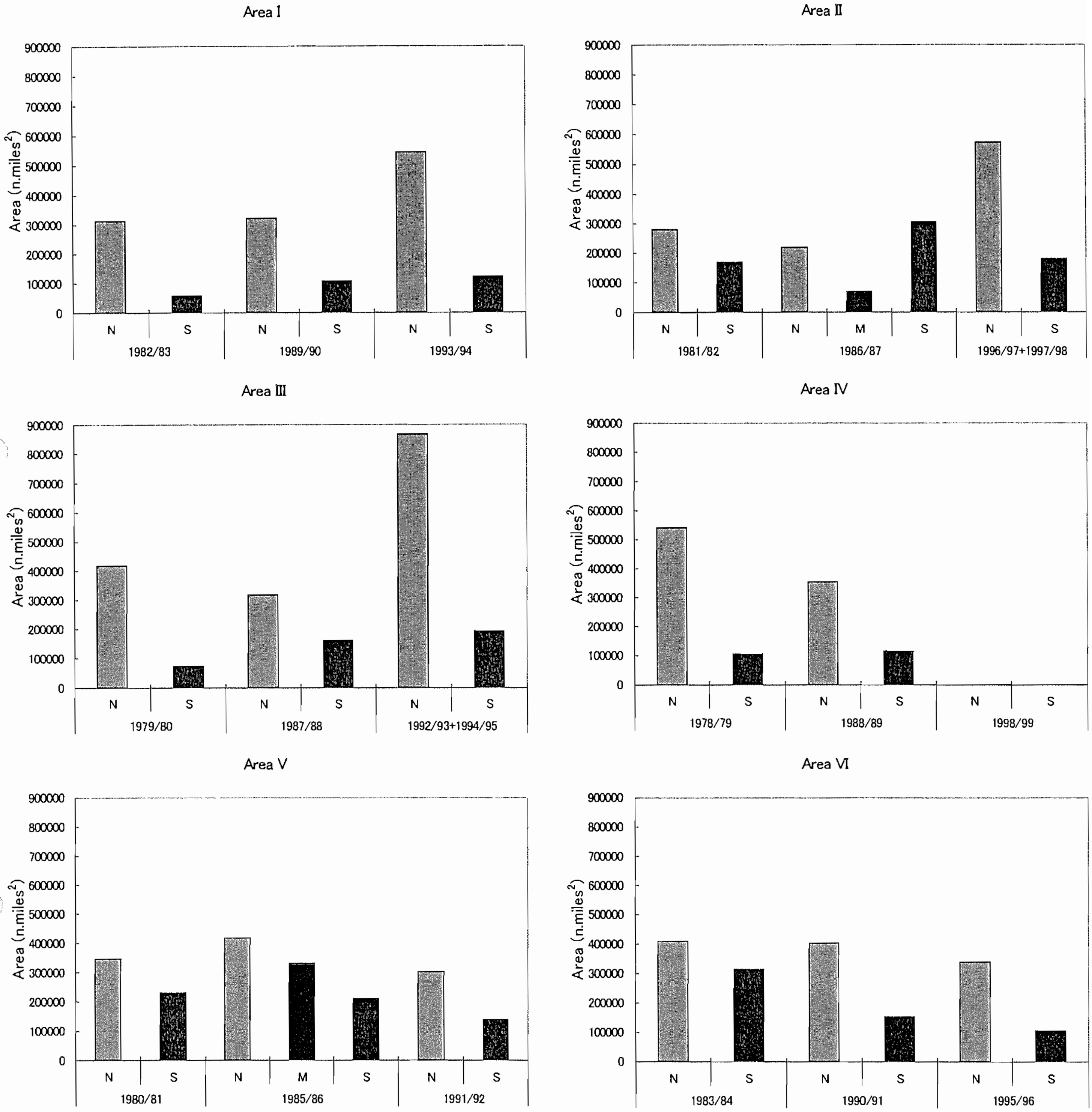


Figure 3. Comparison of the research area surveyed (A, n.miles^2) in each cruise by Area from 1978/79 to 1997/98. In Areas I, II and III, the northern part of the A are increased in 3rd circumpolar cruise. Although Areas IV and VI (2000/01) are still calculating, it seemed that they expected same tendency. N; northern strata, M; middle strata, S; southern strata. Each stratum was established in different latitude by each circumpolar cruise.

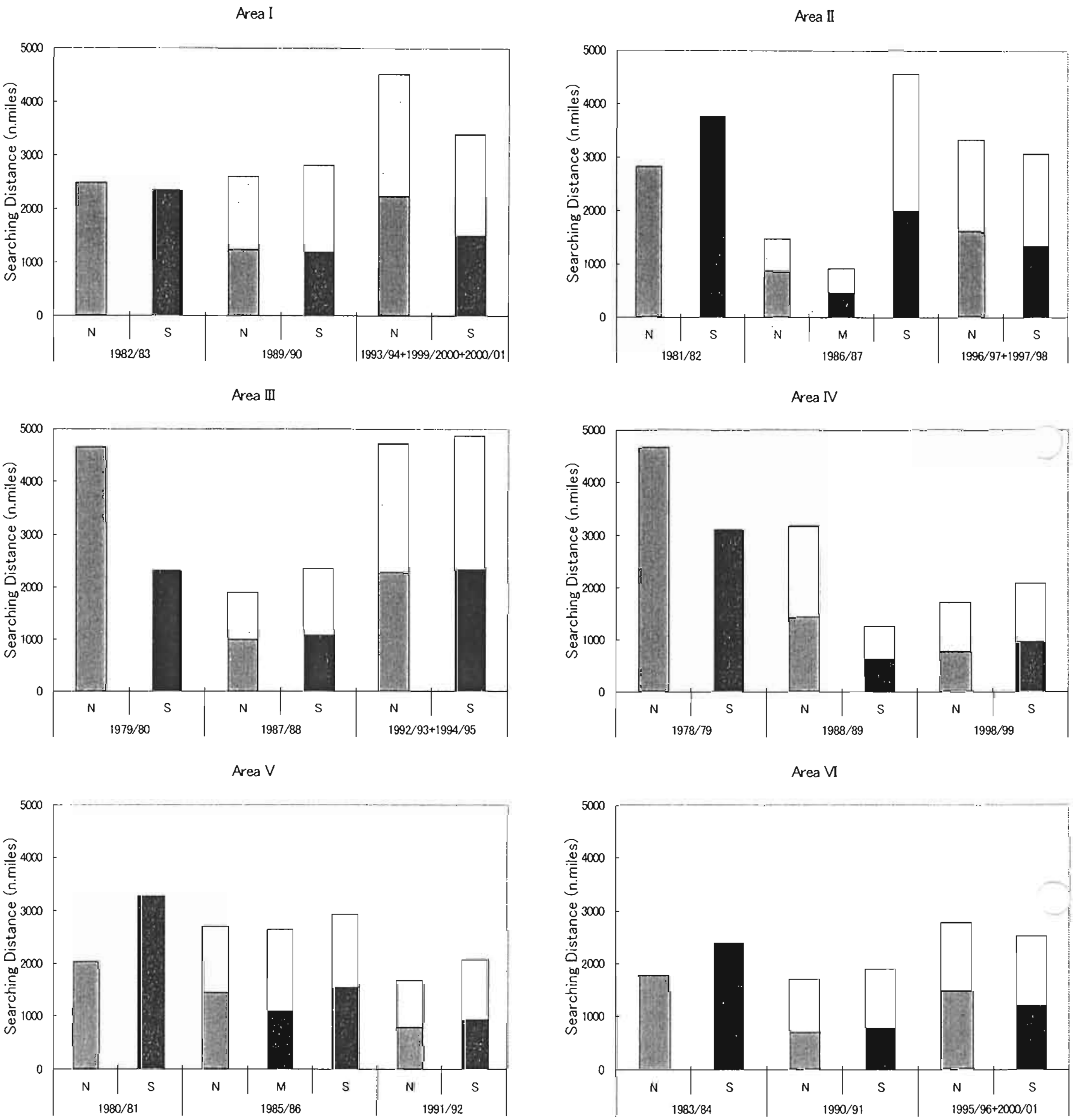


Figure 4. Comparison of the Searching distance (L, n.miles) in each cruise by survey mode (Closing mode; black and IO mode; white) from 1978/79 to 2000/01. In Areas II, III and VI, the northern part of the L are increased in 3rd circumpolar cruise with the expanding of research area in northern stratum. N; northern strata, M; middle strata, S; southern strata. Each stratum was established in different latitude by each circumpolar cruise.

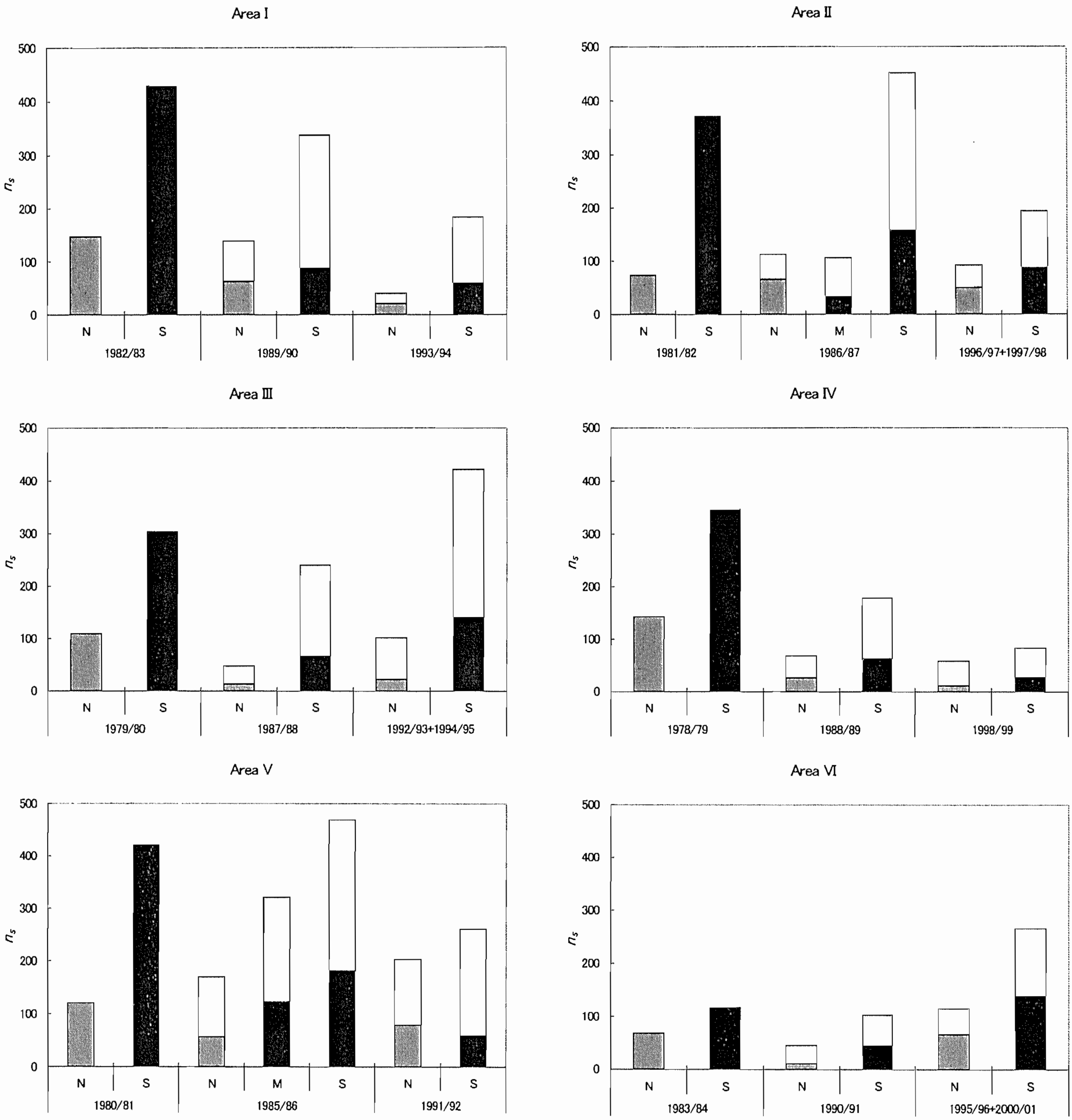


Figure 5. Comparison of number of the primary sighting of minke whale sighted (n_s) in each cruise by survey mode (Closing mode; gray and IO mode; white colored) from 1978/79 to 2000/01 cruise. N; northern strata, M; middle strata, S; southern strata. Each stratum was established in different latitude by each circumpolar cruise.

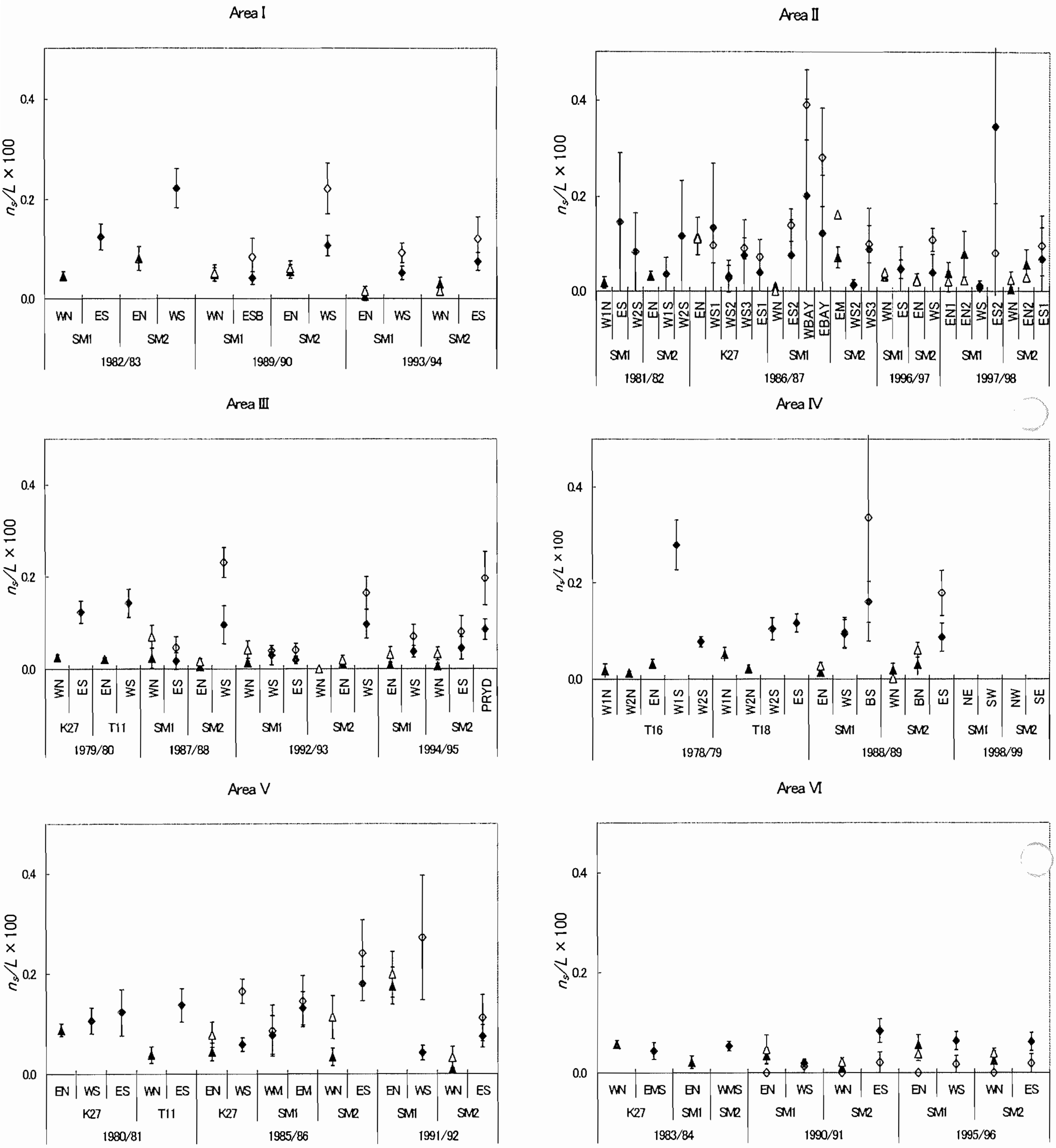


Figure 6. Comparison of the number of the primary sighting of minke whale (n/L; schools/ 100 n.miles) with CV in each cruise by survey mode during 1978/79 to 1997/98 cruise. Closing mode; filled symbols, IO mode; unfilled symbols, Northern stratum; triangle, southern stratum; circle. Each stratum was established in different latitude by each circumpolar cruise.

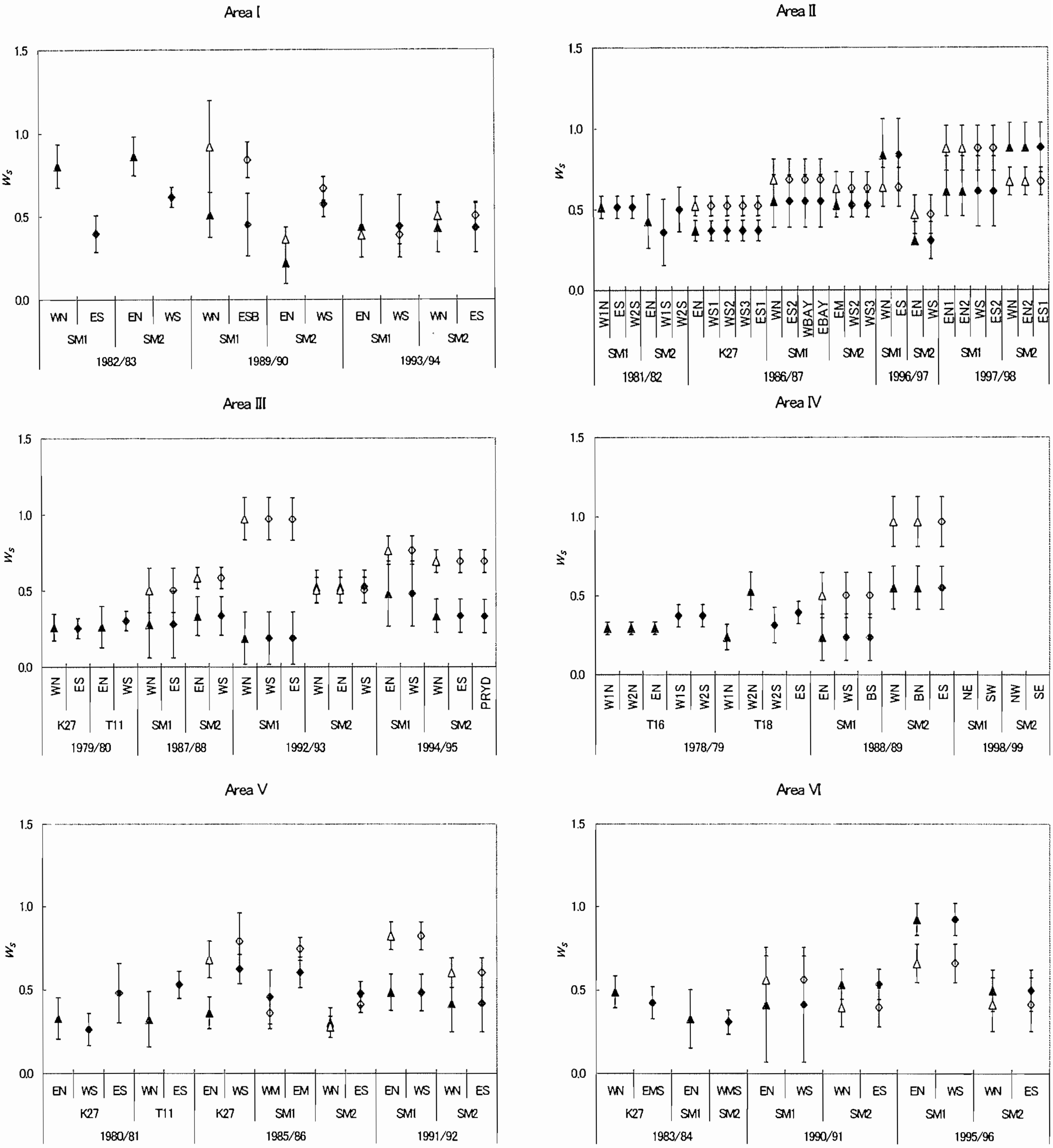


Figure 7. Effective search half width (ESW) of the primary minke whale schools with CV (data from Branch and Butterworth, 2001). The ESW were pooled by each vessel in 3rd circumpolar series. Northern stratum; triangle, southern stratum; circle. Closing mode; filled in symbols, IO mode; unfilled. Each stratum was established in different latitude by each circumpolar cruise.

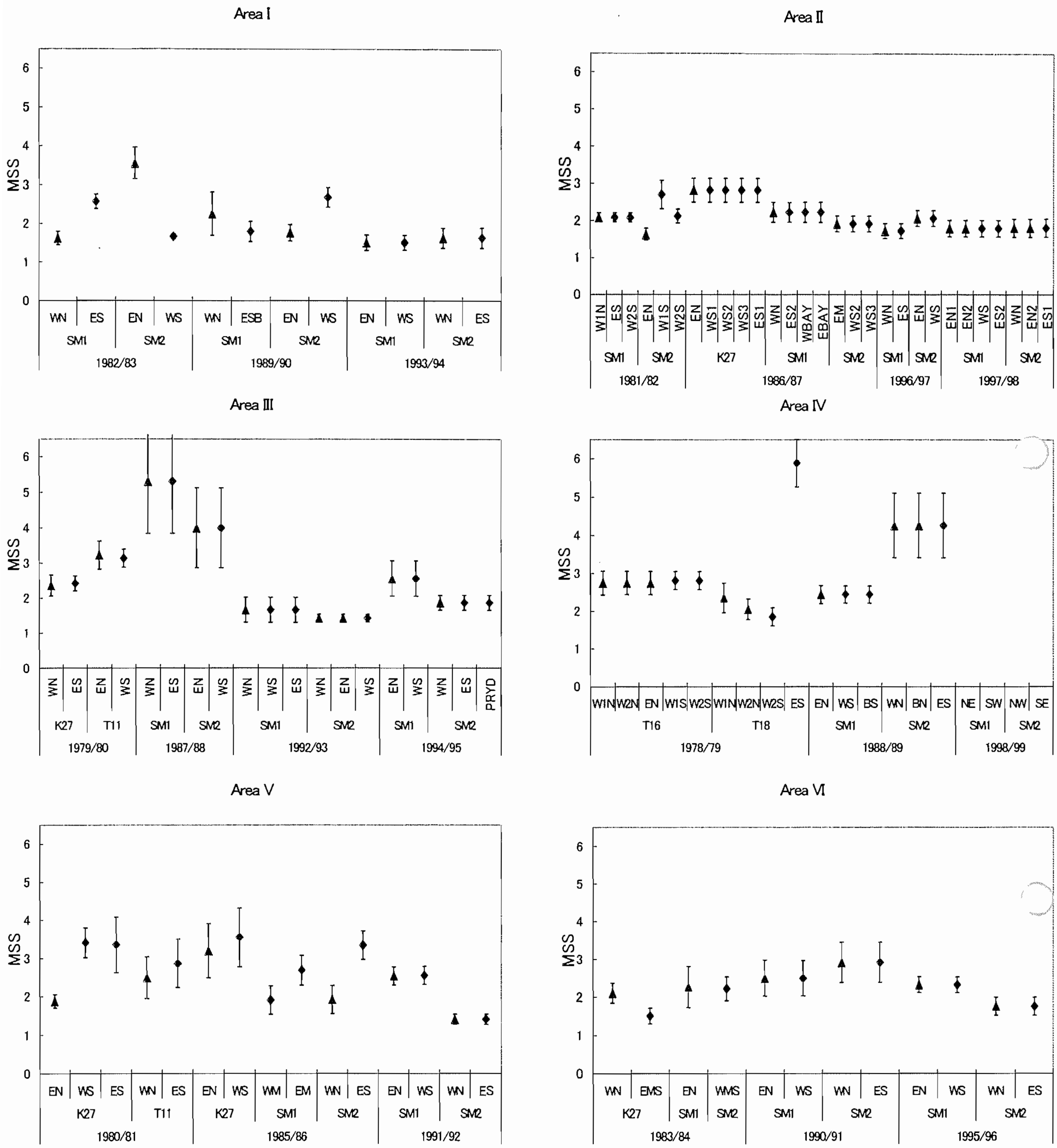


Figure 8. Estimated mean school size of minke whales (E) of the primary minke whale schools with CV (data from Branch and Butterworth, 2001). The E were also pooled by each vessel in 3rd circumpolar series. Northern stratum; triangle, southern stratum; circle. Closing mode; filled in symbols, IO mode; unfilled. Each stratum was established in different latitude by each circumpolar cruise.

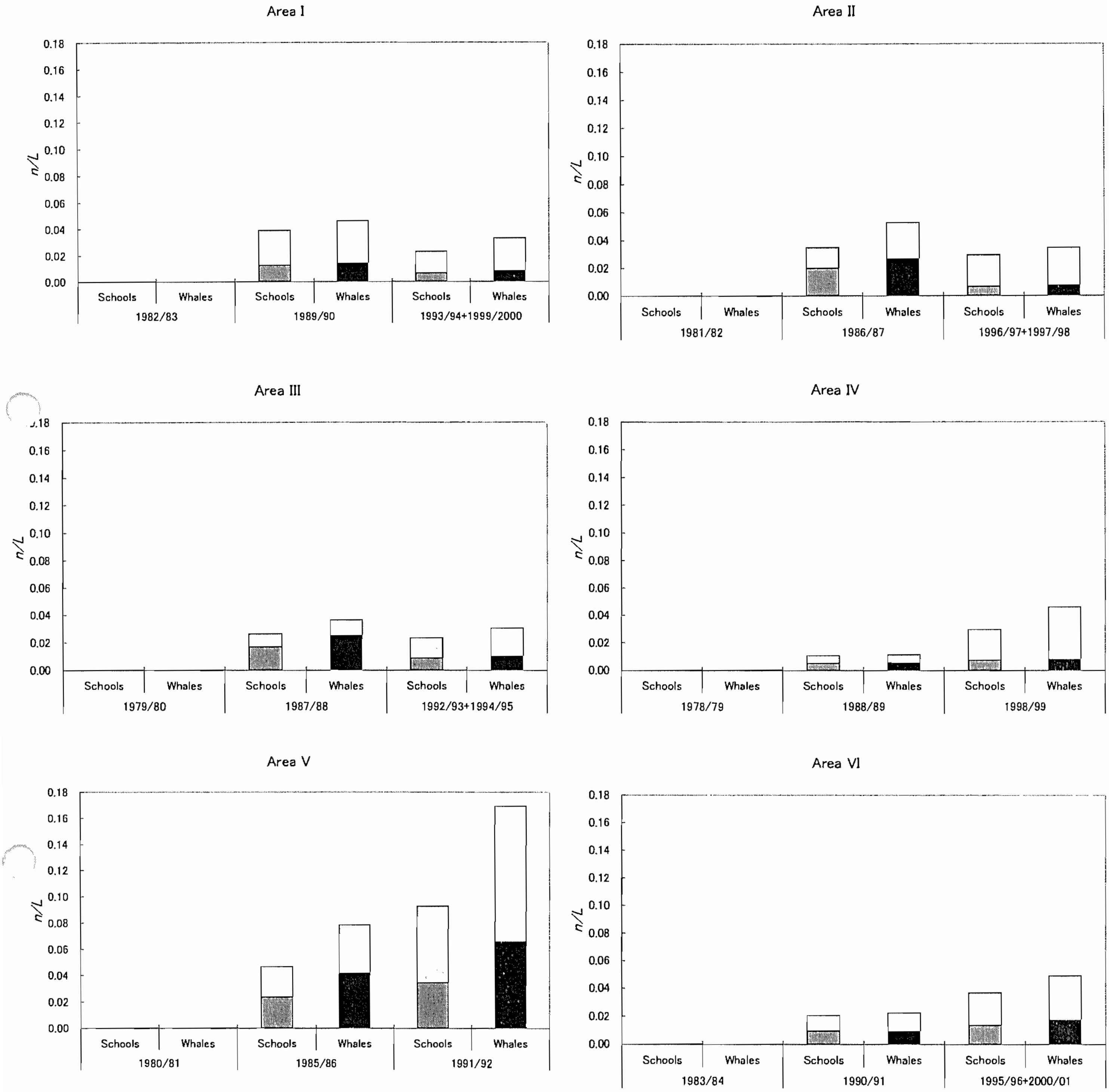


Figure 9. Comparison of the encounter rate (n/L) of "like minke" (primary schools and whales) by each Area during 1978/79 to 2000/01 cruises (Closing mode; lower, IO mode; upper). More "like minke" sightings tended to be recorded during IO mode. Each stratum was established in different latitude by each circumpolar cruise.

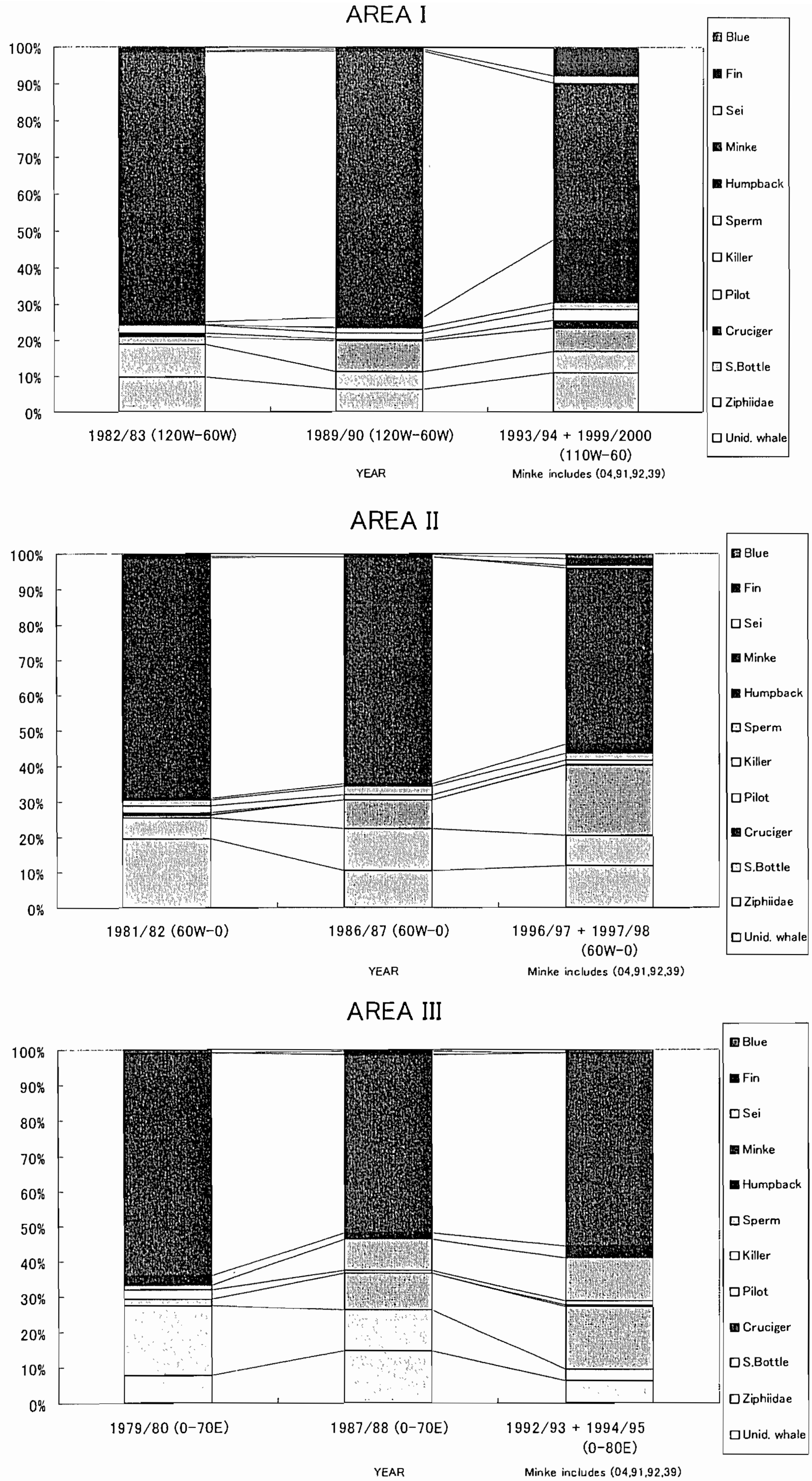


Figure 10. Compositions of the primary school sightings in each circumpolar set by Area, during 1978/79 to 2000/01. Blue, fin, sei, minke, humpback, sperm, killer, pilot, cruciger, southern bottlenose, Ziphiidae and unidentified whales are analyzed. Minke whale which include codes "04; Minke", " 91; Undetermined minke", " 92; like Antarctic form" and " 90; like Dwarf form" and "39; like minke". (see text).

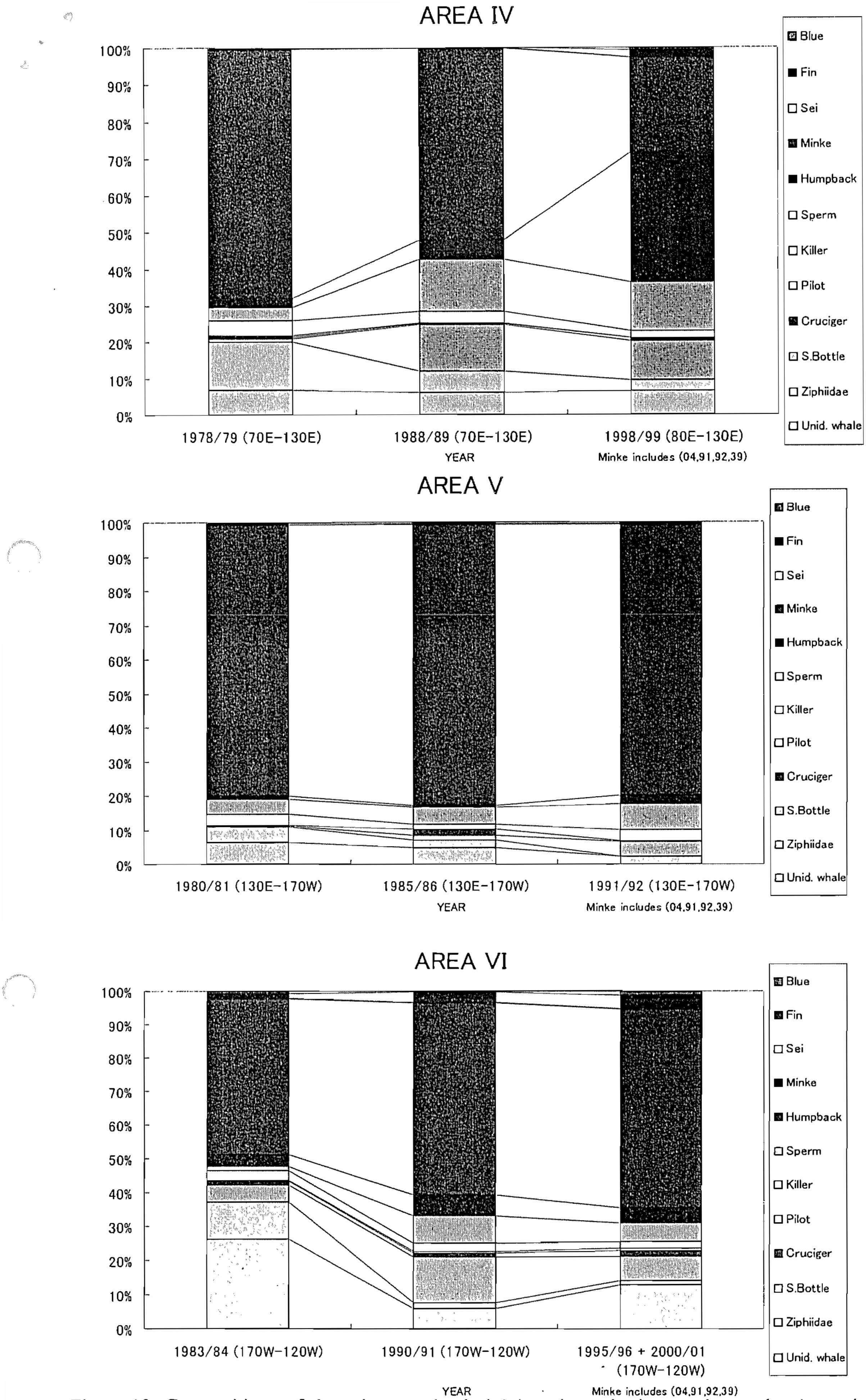
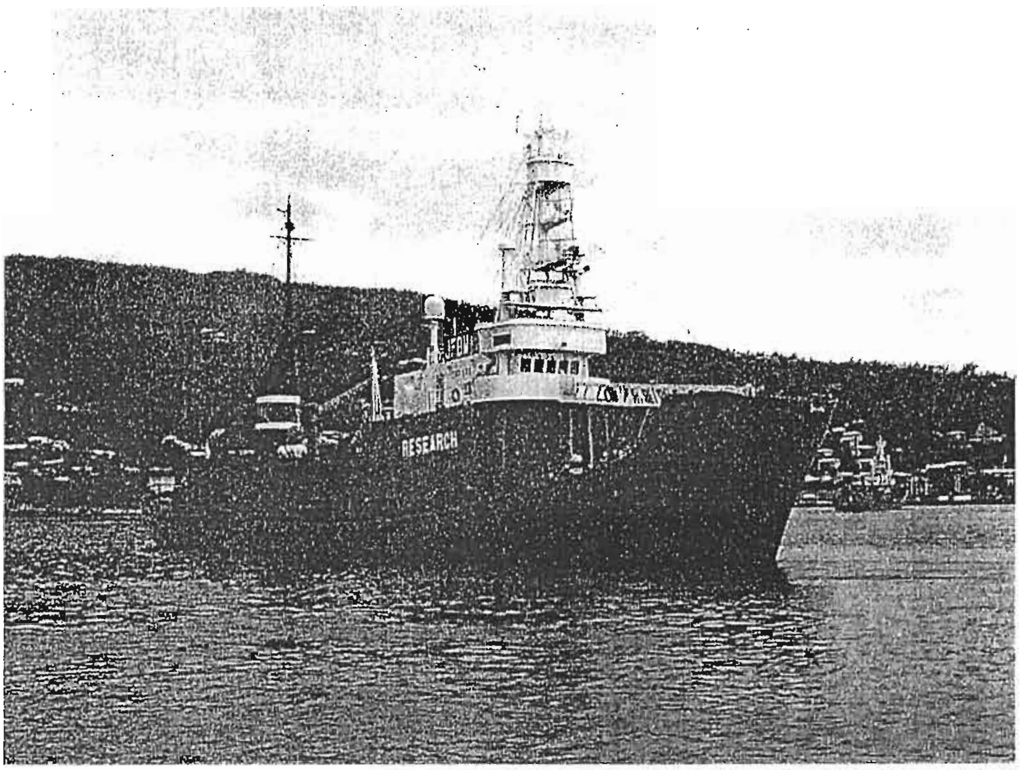
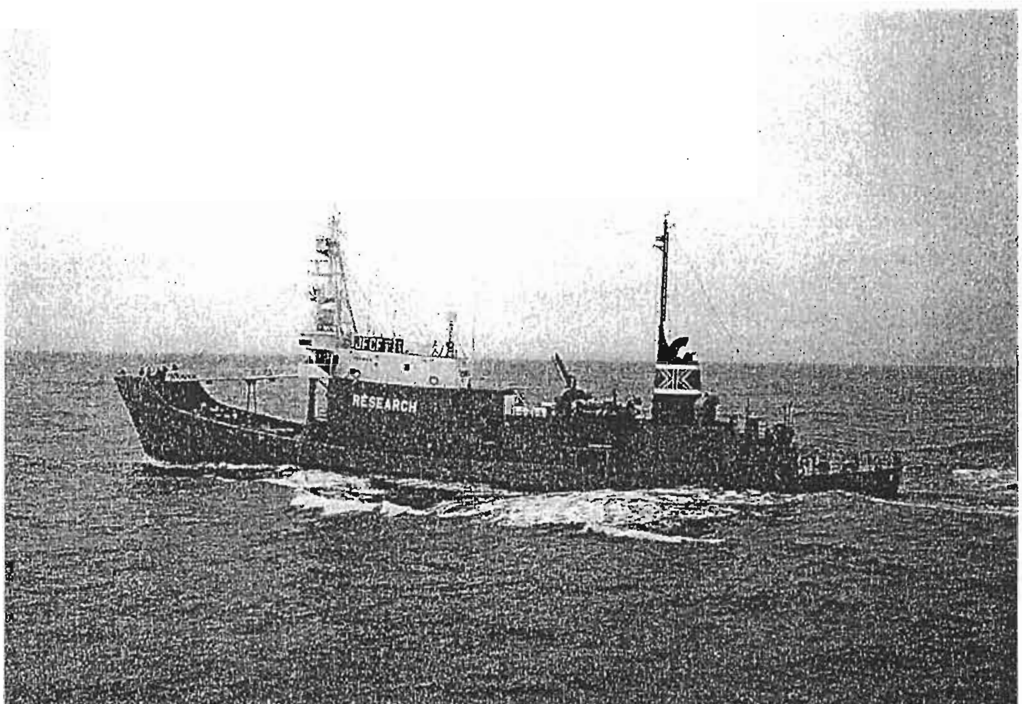


Figure 10. Compositions of the primary school sightings in each circumpolar set by Area, during 1978/79 to 2000/01. Blue, fin, sei, minke, humpback, sperm, killer, pilot, cruciger, southern bottlenose, Ziphiidae and unidentified whales are analyzed. Minke whale which include codes "04; Minke", " 91; Undetermined minke", " 92; like Antarctic form" and " 90; like Dwarf form" and "39; like minke". (see text).

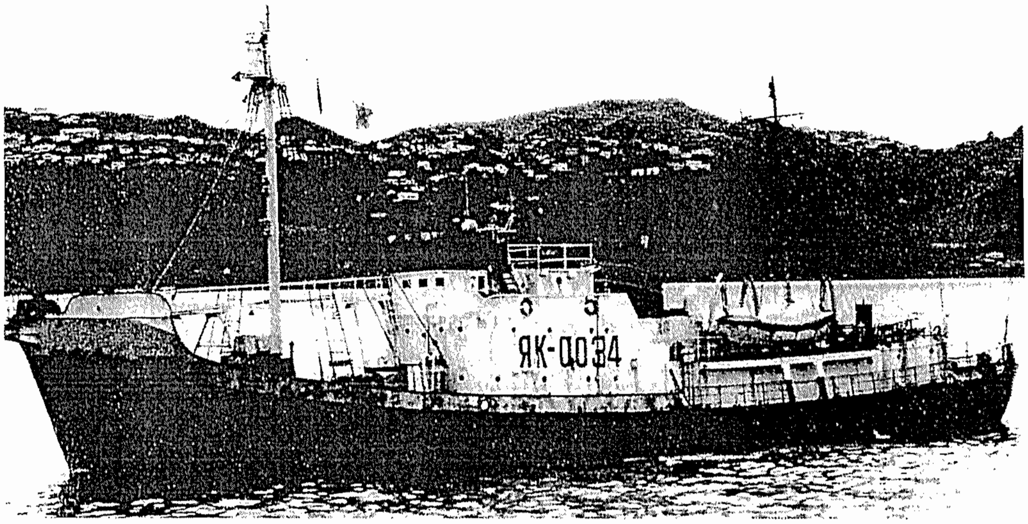


Shonan Maru



Shonan Maru No.2

Figure 11. Photograph of the typical research vessel types engaged in IWC/IDCR and SOWER cruises between 1978/79 and 2000/01.



Vdumchivy 34.

Figure 11 (continued). Photograph of the typical research vessel types engaged in IWC/IDCR and SOWER cruises between 1978/79 and 2000/01.