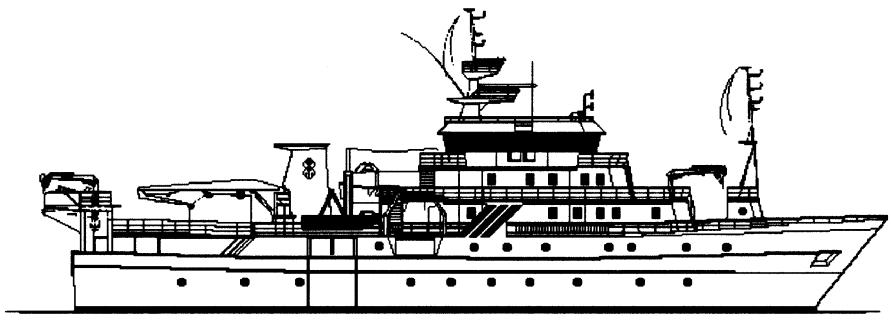

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of

SARDINELLA (*Sardinella maderensis* and *S. aurita*)

in

ANGOLAN WATERS

28 April - 13 May 1997

Instituto de Investigação
Pesqueiro
Republic of Angola

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Norway

National Marine Information
& Research Centre
Swakopmund
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CRUISE REPORT DR. FRIDTJOF NANSEN

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by

O.A. Misund[1], **N. Luyeye**[2], **D. Boyer**[3], **R. Cloete**[3], **J. Dalen**[1] and **G. Oechslin**[3]

[1]Institute of Marine Research
P.O.Box 1870 Nordnes
N-5024 Bergen, Norway

[2]Instituto de Investigação Pesqueiro
Republic of Angola

[3]National Marine Information and Research Centre
P.O.Box 912
Swakopmund, Namibia

Institute of Marine Research
Bergen, 1997

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CHAPTER 1 INTRODUCTION

1.1 Background

The sardinella stocks are a major pelagic fish resource of Angola, and are mainly managed on the basis of biomass estimates of the adult stock obtained by the standard hydro-acoustic method. To acquire reliable absolute biomass estimates by this method, the entire stock must be surveyed by a vessel carrying a calibrated echo integration system, regular sampling of the acoustic recordings must be conducted by trawling. The echo values originating from fish must be allocated to species identified by the trawling and the echo intensity scattered from individual fish of the actual species must be known. If these criteria are fulfilled, the biomass of fish stocks can be estimated by the acoustic method with an accuracy of about 25 %.

However, there are several additional possible sources of errors in acoustic abundance estimation of fish. During the last two decades most methodological and technical problems related to the methods have been investigated and solved by the introduction of reliable instruments and special procedures to calibrate the instruments. Still there are serious concerns on the effects of fish behaviour on acoustic abundance estimates. Especially if pelagic fish are schooling close to surface or performing vessel avoidance, substantial underestimation may occur.

Previous work on the sardinella stocks of Angola has shown that sardinella frequently shoal close to, and even at, the surface. Therefore considerable amounts of fish in the surface blind zone may be missed during standard hydro-acoustic biomass surveys and are also likely to actively avoid the research vessel. It has also been noted that sardinella are particularly difficult to catch in targeted mid-water trawls during day-light, indicating that this species also performs trawl avoidance behaviour.

A survey by the DR. FRIDTJOF NANSEN in July 1996 investigated some of the behavioural characteristics of sardinella which may be of importance to acoustic surveys. Acoustic observations from a transducer mounted near the surface on a small boat indicated

that the hull mounted transducer of the DR. FRIDTJOF NANSEN does indeed miss significant amounts of fish at certain times of day. Amongst other behavioural characteristics, sardinella were found to migrate to the surface in an apparently bimodal diurnal cycle; peaking at 10h00 and 16h00 local time. It was, however, found that biomass estimates of shoals positioned below the surface 'blind' zone obtained through traditional vertical echo-sounding techniques and shoal counting with a horizontally directed sonar (and assuming a constant density of shoals) produced similar results, indicating that sonar may be a useful tool for surveying surface distributions of sardinella.

Tracking of school movements using a sonar, and trawling catch rates in different depth zones, suggested that horizontal shoal movements may have a diurnally pattern, being shorewards at night.

Trawling experiment during this survey not only confirmed the ability of sardinella to avoid capture daylight, but showed that substantial amounts of fish entered the net opening during trawling, and during fast tows fell back into the belly of the net, only to swim out when the trawl slowed to begin hauling.

This current survey was conducted co-operatively between the Angolan and Namibian national fisheries research institutes and the Institute of Marine Research, Bergen and NORAD through the Nansen Programme. It was intended to further investigate the behavioural characteristics of sardinella, particularly those which may cause biases or errors in acoustically derived biomass estimates. In addition the survey was to further develop both technical and methodological solutions to alleviate these problems. These developments included the upgrading of the SA 950 sonar and installation of a new data capture and analysis programme SODAPS (Sonar Data Processing System). It was intended that any developments made during this survey should be applicable to improving the accuracy of biomass estimates derived from other surface shoaling pelagic species elsewhere.

1.2 Objectives

This survey had a number of objectives, primarily:

- Implementing and testing SODAPS (at quay in Luanda 25-29/4, and at sea 29-1/5).
- Functional testing and trials with SODAPS at sea (30/4-1/5).
- Acoustic, behaviour and catch experiments; acoustic measurements of sardinella shoals (about 50 cases), school tracking (about 15 cases), small boat experiment (1-2 per day) and pelagic trawl sampling (4 per day, 20 cases) off Palmeirinhas, 2-6/5
- Acoustic survey to compare sonar and echo sounder recordings, 7-12/5
- Cruise report production, 11-13/5

It was expected, and indeed happened, that the cruise program would need to be adjusted according to performance of acoustic equipment, fish distribution, and weather conditions.

1.3 Participation

The scientific staff consisted of :

From th Instituto de Investigação Pesqueiro in Luanda(29/4).:
N'K. Luyeye , M. F. Rafael , M. Andre

From the National Marine Information and Research Centre in Swakopmund (26/4):
D. Boyer , R. Cloete , G. Oechslin

From the Institute of Marine Research in Bergen (23/4):
O. A. Misund, J. Dalen, B. Totland, T. Haugland, R. Johannesen, O. Gullaksen

From Kongsberg Simrad AS in Horten:
E. Frønes (until 1/5)

From Christian Michelsen Research Institute in Bergen:
P. E Nordbø (until 29/4).

1.4 Schedule

The cruise started on 23/4/97 with upgrading the SA950 sonar to SF 950, including a Harbour Acceptance Test, and implementing and testing of the sonar software system SODAPS. The DR. FRIDTJOF NANSEN left Luanda on 29/4 at 10h00 to conduct sea-trials of SODAPS, returning to Luanda harbour at 10h00 on 1/5 for disembarking of Frønæs and Hansen and to receive a new power supply for the sonar. The vessel departed again at 11h00 on 2/5 and returned to Luanda again on 12/5 at 10h00 for the departure of scientific staff on 13/5 and 14/5.

The testing of SODAPS and initial behavioural work were conducted just south of Luanda near Pta. das Palmeirinhas (Figure 1). The vessel moved further south to the area offshore of the mouth of the Rio Cuanza from 4/5 to 7/5 in the hope of finding greater densities of shoals, and again southwards to just north of Lobito from 8/5 to 11/5.

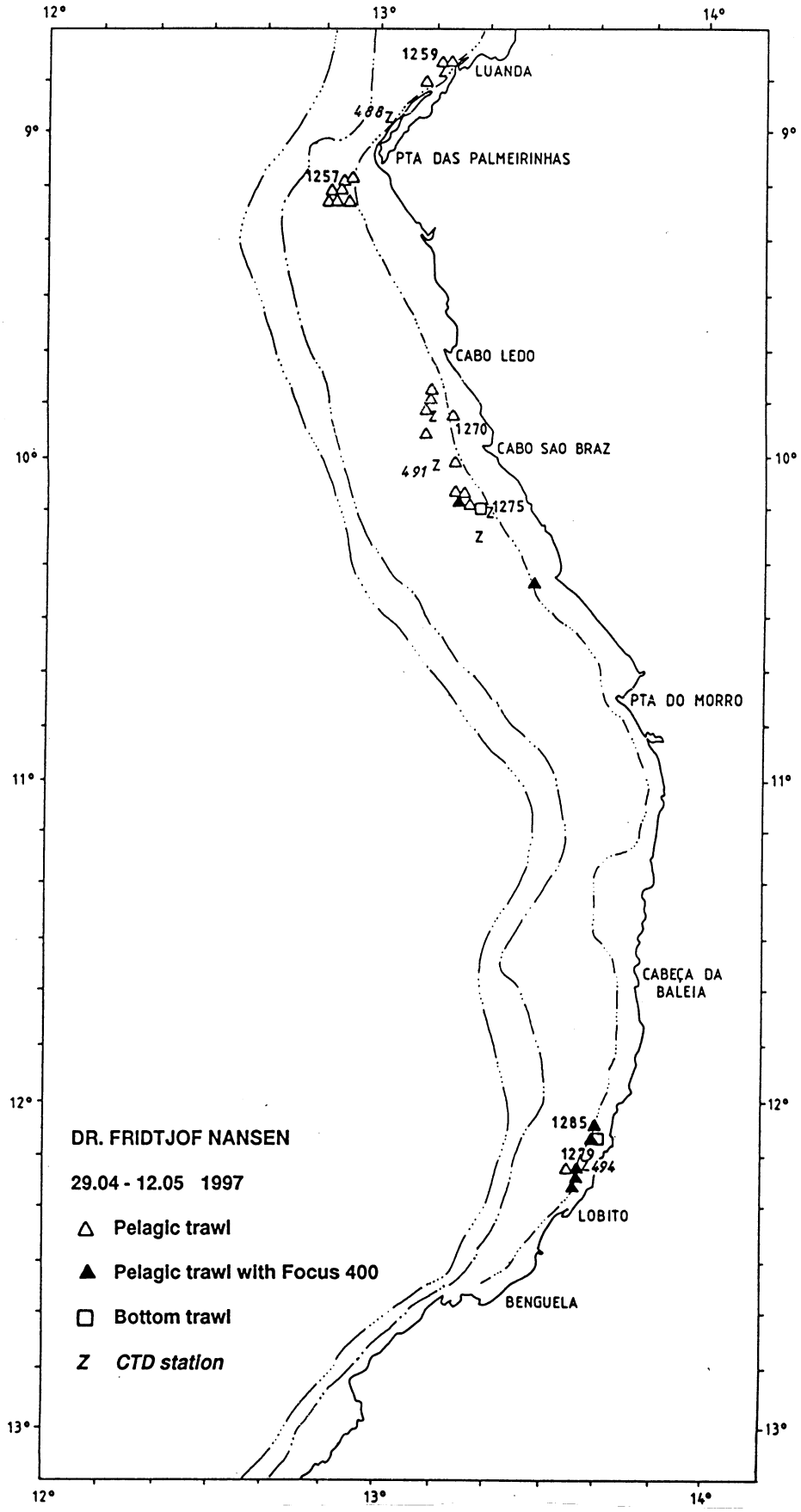


Figure 1. Pelagic, bottom trawl, and CTD stations taken during the sonar cruise off Angola 29.04-12.05 1997.

CHAPTER 2 METHODS

2.1 Upgrade of SA 950H sonar to SF 950

The SA 950H is a mine hunting sonar of the Hugin generation manufactured by Kongsberg Simrad AS, Horten, Norway. Basically the sonar had to be changed to the mine hunting sonar of the Micos generation and then specifically adapted and tuned to a fish school mapping sonar S950 which required partly new hardware (HW) and completely new software (SW). The upgrade should be performed partly ashore in Horten and during sufficient number of stays onboard DR. FRIDTJOF NANSEN by personnel from Kongsberg Simrad AS and from the Institute of Marine Research (IMR). A new operation manual should be provided during the stay onboard the ship and completed at Kongsberg Simrad AS, Horten. The handing over of the sonar from Kongsberg Simrad AS to IMR on behalf of NORAD should formally be performed during a Harbour Acceptance Test (HAT) and a Sea Acceptance Test (SAT).

2.2 Implementing, testing and tuning of SODAPS

SODAPS (Sonar Data Processing System) is a work station based software system to be connected to the SF 950 for logging, on-line monitoring and postprocessing of sonar data. The system has been systemized, modelled and coded during a co-operative R&D project between the IMR and Christian Michelsen Research AS (CMR), Bergen, Norway. The system is by its structure rather complex as well as by its performance, particularly when running in the on-line mode (under-way mode). It runs comparative tests between every sample of the backscattering coefficient to a maximum sampling frequency of 5 kHz of all 32 sonar beams and likewise between neighbouring beams - all in each ping up to a pulse repetition frequency of 175 per minute. During these detections it forms so-called echo lines and echo blocks. Thereafter it tests and compare between consecutive pings to form echo block chains or school candidates. Echo lines, echo blocks, echo block chains, and school candidates are all elements of potential schools.

The software system was to be implemented, debugged and modified where this will be required, and functionally tested on school data. A colour printer was planned to be connected to the computer with its interface, driver and specific software modules. School data should be stored on tapes for further testing and tuning at CMR and IMR.

2.3 Sonar school tracking

To study the swimming behaviour of pelagic, schooling fish off Angola, the Simrad SF 950 sonar was used to observe the speed and direction of movement of individual schools. In addition interactions with other shoals were also observed and recorded.

The sonar was set to full transmission power with gain, range and filters set to provide an optimal picture of the target school. These were usually; gain 6 - 8, display gain 8 - 9, and with the AGC, reverberation and ping-to-ping filters set to weak. The direction, range and tilt were continuously varied to track the school.

The observation strategy was to find regions where suitably distinct, but numerous, schools of sardinella occurred. The vessel approached a selected school as gently as possible until the school was at a distance of about 200 m, and then stopped carefully. The vessel was then manoeuvred carefully to keep the school within a distance of 100 to 250 m. If the school came closer then the vessel was stopped. During the tracking the sonar was trained and tilted to obtain an optimal recording of the school. When a tracking situation was established with the school in a rather stable distance from the vessel, the position and depth of an individual school was recorded at 2minute intervals for as long as possible. The tracking was stopped when the school disappeared. Any observations which lasted for less than 4 minutes (3 records) was disregarded, the longest period of observation was 64 minutes. Approaches and coalescing with other schools, or splitting of the target school, were recorded and a drawing of the outline of the school was made each time the school changed shape significantly. The sonar recordings of tracked schools will be analysed by programs written in the SAS software to visualise the swimming behaviour of the schools, and quantify the swimming speed and swimming direction of the schools.

Similar schools in the area of tracked schools were sampled by trawling to determine the species composition and size of the fish observed.

2.4 Surface school observations

Sardinella have previously been noted as occurring at the surface, even during daytime. In an attempt to determine the frequency and periodicity of this behaviour the occurrence of schools of sardinella at the surface was recorded visually from the wheelhouse of the DR. FRIDTJOF NANSEN between sunrise and sunset (06h00-18h00 local time) each day. Numbers of shoals sighted were pooled into 15 minute intervals for reporting purposes.

Solar radiation intensity was recorded automatically at 10 minute intervals by the ship-borne weather station. These data were used to investigate the relationship between surface occurrence of shoals and light intensity.

2.5 Small boat experiments

A set of five experiments using a small (5.3 m) Man-Over-Board boat equipped with a portable scientific echo sounder (Simrad EY500) were conducted to study near-surface schooling and vessel avoidance. A complete list of the boat and echo-sounder specifications and settings used is shown in Annexes I and II.

All five experiments took place in the same area (north-west of Lobito) in an area of abundant sardinella schools. Three experiments were conducted during day-light and two after dark. The first two day-light experiments were repeated several hours later at night along the reciprocal course track. Each experiment was between 7 and 10 ~~NM~~ n mi in length. During each experiment the small boat kept a parallel course with the DR. FRIDTJOF NANSEN. A constant speed of 5 knots and an inter-vessel spacing of 0.3 ~~NM~~ n mi was maintained. Synchronised intervals of equal length (1 ~~NM~~ n mi) were surveyed by both vessels. (Table 1).

Table 1 Some technical details of the small boat experiments

		RV 'Dr. Fridtjof Nansen'	M.O.B.Boat	Transect length (NM)
Expt. 1	Day	Inshore	Offshore	8
Expt. 2	Day	Inshore	Offshore	10
Expt. 3	Day	Inshore	Offshore	7
Expt. 4	Day	Offshore	Inshore	10
Expt. 1	Night	Offshore	Inshore	10
Expt. 2	Night	Inshore	Offshore	10

The EY500 was set to record from a depth of 5 m down to the bottom and the EK500 from 10 m down to the bottom. Each interval was printed out in 10 m vertical channels. The data collected were scrutinised visually, allocating total area back-scattering coefficients, or S_A values, per nautical mile to either schools or scattered targets. Schools were defined as any targets on the printed echogram which gave a jump of 10 m^2/NM^2 on the cumulative (analog) integrator line. The number of schools detected by each system was recorded in 10 metre depth channels.

2.6 Trawl sampling strategy

Trawling was conducted for several reasons during this survey; to determine the identity of suitable concentrations of fish for further observations, to identify fish observed during shoal tracking, surface sightings or small boat experiments and to observe the behaviour of sardinella in the trawl opening and cod-end with an underwater video. Details of the trawling gear used are presented in Annex III. In many cases, especially during trawling on discreet shoals, the SF 950 sonar was used to guide the vessel onto shoals. In total 29 trawls were done during the entire cruise and the objective of each, positions, catch and other relevant data are summarised in AnnexIV, while full details are presented in Annex V.

A random sample of fish representative of the total catch was taken from the trawl, the size of the sample depending largely on the species mixture of the catch. In cases where the catch was small, the total catch was sampled. To determine the catch composition of the trawl the number and weight for each species in the random sample were recorded. This sample was then raised to the total catch. A random sample of about 100 sardinella, if available, were measured to the nearest 0.5 cm below total length to obtain the size composition of the catch. Maturity stage and stomach contents of about 20 sardinella were recorded for each trawl.

The size and species composition of all trawls was pooled per area, depth and time period by simple adding. In many of the analyses the species were pooled into the following groups:

- sardinella (*Sardinella maderensis* and *S. aurita*)
- horse mackerel (*Trachurus trecae*)
- other carangids (mostly *Selene dorsalis, Trachinotus goreensis* and *Chloroscombrus chrysurus*)
- other pelagics (scombrids, barracudas, and hairtails - mostly *Sarda sarda, Scomberomorous tritor, Scomber japonicus, Sphyraena guachancho* and *Trichiurus lepturus*)

2.7 Underwater trawling observations

In order to observe the behaviour of sardinella in the trawl net, the FOCUS 400 system was used. The FOCUS 400 is a towed manoeuvrable vehicle with an electrical supply for instruments and fibre-optical transmission of data to and from the ship. It can go to a depth of 400 m and out to about 80 m on each side from the course line. It has surface or bottom lock autopilot modes. On this cruise it carried a SIT video camera and a Simrad Mesotech 3300 sonar. (Table 2).

Table 2 Details of trawls when the FOCUS system was used

Trawl No.	Trawl depth (m)	Speed (knots)	Length (mins.)	Total Catch (kg)
1262*	0	3,52	126	376
1264*	0	3,23	262	70
1277	25	3,75	106	354
1278	12	3,63	76	106
1279	10	4,17	92	8847
1280	10	3,67	86	7131
1282	10	2,74	98	437
1283	5	3,00	48	233
1284	5	3,20	106	400

* These trawls were to practice manoeuvring the FOCUS platform close to a trawl net

Standard mid-water trawls were conducted in regions where schools of sardinella had previously been recorded. These experiments were only conducted during day-light as it was necessary to watch the vehicle during deployment and retrieval. The water clarity was such that artificial light was not required. For safety reasons trawls had to be at a constant depth, direction and speed and it was

therefore not possible to actively target on individual schools. The vehicle was positioned between 1 and 3 metres above the net, at a distance where individual fish could be clearly seen.

The swimming speed in relation to the net was observed at different trawling speeds for periods ranging from several minutes to more than half an hour. Video recordings were taken to IMR for qualitative analysis.

2.8 Environmental characteristics

Wind (direction and speed), air temperature, global radiation and sea surface temperature (5 m) data were collected throughout the survey area and logged automatically every nautical mile using an Aanderaa meteorological station. In addition, a Seabird 911 CTD Plus Sonde was used to obtain a general overview of temperature, salinity and oxygen at 7 stations. The profiles were taken from the surface down to within a few metres of the bottom. Current measurements were also made at these stations with the use of the ship-born Acoustic Doppler Current Profiler (ADCP) from RD Instruments. All measurements were made at depths greater than 20 m and where bottom tracking was obtainable, i.e., at bottom depths less than 350 m. The ADCP was set to ping every 8 seconds, the depth cell was set to 4 m and the number of cells to 40. Transducer misalignment was kept at 0° and averaging time was 300 seconds. Only processed data files were stored to disk and current vectors were plotted for each data point.

CHAPTER 3 RESULTS

3.1 Upgrade of the sonar SA 950H to SF 950

Upgrading of the sonar was performed onboard DR. FRIDTJOF NANSEN in two periods: the first period (P1) was in Las Palmas and in Moroccan waters during 30 Nov to 11 Dec 1996 when the new hardware was installed and tested. Furthermore, a considerable part of the new software was developed, implemented and partly tested.

The second period (P2) coincides with this survey (23 April to 1 May 1997). The hardware was further tested, and new software developed, implemented and tested.

During both periods a lot of effort was used into developing the new operator manual. The manual - version 0- was brought back to Kongsberg Simrad AS for completion.

The Harbour Acceptance Test was performed on 25 April while the Sea Acceptance Test took place on 29 April.

For sake of completeness, an overview all the performed sub-tasks is listed below:

Hardware

- changed to Micos Transceiver Unit (TRU) and additional electronics (P1).
- increased the number of signal processors from 2 to 3 in the TRU (P1).
- installed an Ethernet interface (I) with an extra transceiver interface board for the Raw DataLine (RDL) which is a dedicated Ethernet line between the sonar and SODAPS (P1).
- installed an Ethernet interface (II) with an extra DEC-board for the System Data Line (SDL) which is the ship`s Ethernet network (P2).
- installed and tuned a replaced section of the sonar power supply (P2).

Software

- changed to Micos SW in the Control and Display Unit (CDU) (P1).
  linked the CDU to the original (electric) transducer control in the original Motion Stabilisation Processor (MSP) (P1).
- developed SW-driver in processor 2 for the RDL (P1).
- shifted the filter programs from processor 2 to 3 in the TRU (P1).
- established the pulse log and ship`s motion sensor connection (P1).
- developed logging of complex echo envelope to the RDL (P1).
- presenting target data on the sonar display (P1 and 2).
- provided logging of target data to RDL (P1).
- developed SW-driver in processor x for the SDL (P2).
- corrected compensation for gain in the RDL data (P2).
- established the remote sonar function control (RSFC) over the SDL (P2).
  enabled navigation data reading (time, ship position and speed) over the SDL and added support for additional input telegram types (P2).
- provided logging of echo intensity to RDL (P2).
  developed target detection and target tracking in processor 3 (P2) ("tracking is not completed").
- adapted the sonar performance test system to the new HW-configuration (P2).
  established a RS422-driver for the trigger pulse to enable a master function of the sonar in relation to the echo sounder EK500 (P2).

Documentation and system testing

- writing and editing the revised and partly new operator manual (P1 and 2).
  performed the HAT and the SAT (P2).

3.2 Implementing, testing and tuning of SODAPS

Testing of SODAPS took place over two periods: the first period (P1) was in Moroccan waters (7 to 13 Dec 1996) when the first testing and tuning of the system took place, including the development of software modules for storing school data and some data storing.

The second period (P2) was during this survey, from 25 April to 13 May. The SODAPS was again implemented, debugged and modified where this was required, and functionally tested on school data. A colour printer was connected to the computer with its interface, driver and specific software modules. Figure 2 displays a rather preliminary version of the printout where the sonar has a constant bearing of 90° relative to the ship's bow. School data were stored on tapes for further testing, debugging and tuning in Bergen to prepare SODAPS to be applied during ordinary surveys.

As for the upgrade of the sonar the performed sub-tasks are listed below:

- established connection between SODAPS and the sonar (RDL); verifying data transmission, testing, debugging and modifying (P1).
- established and tested module for storing sonar data (P1).
- performed sonar data storing (P1 and 2).
- established connection to SDL, verifying data transmission; testing, debugging and modifying (P2).
- established and verified the remote sonar parameter control; testing, debugging and modifying (P2).
- developed logging program for colour tuning parameters to monitor beam data after correcting echo pressure to echo intensity transmission and correction of gain compensation (P2).
- established connection to a Hewlett-Packard PaintJet printer, developed and tested basic parts of the echo-gram printer software; verifying data transmission, debugging and modifying (P2).

- established and tuned new algorithm to relate selected echo intensity intervals to a colour palette for the printer (P2).
- corrected module for calculating school positions, added clean up on terminating the logging program to properly close the last set of data files (P2).
- developed and tested report program for school data (P2).
- developed and tested report program for tracked schools (P2).
- recorded school data versus different parameter settings of the sonar (P2) (reduced program due to unfavourable school behaviour).

Other issues

- not able to establish SDL-connection with the "Navtonet" PC (broadcasts SEAPATH data i. e. navigation data and ship`s speed and motion) due to malfunctioning of the mouse when including the NFS communication protocol .

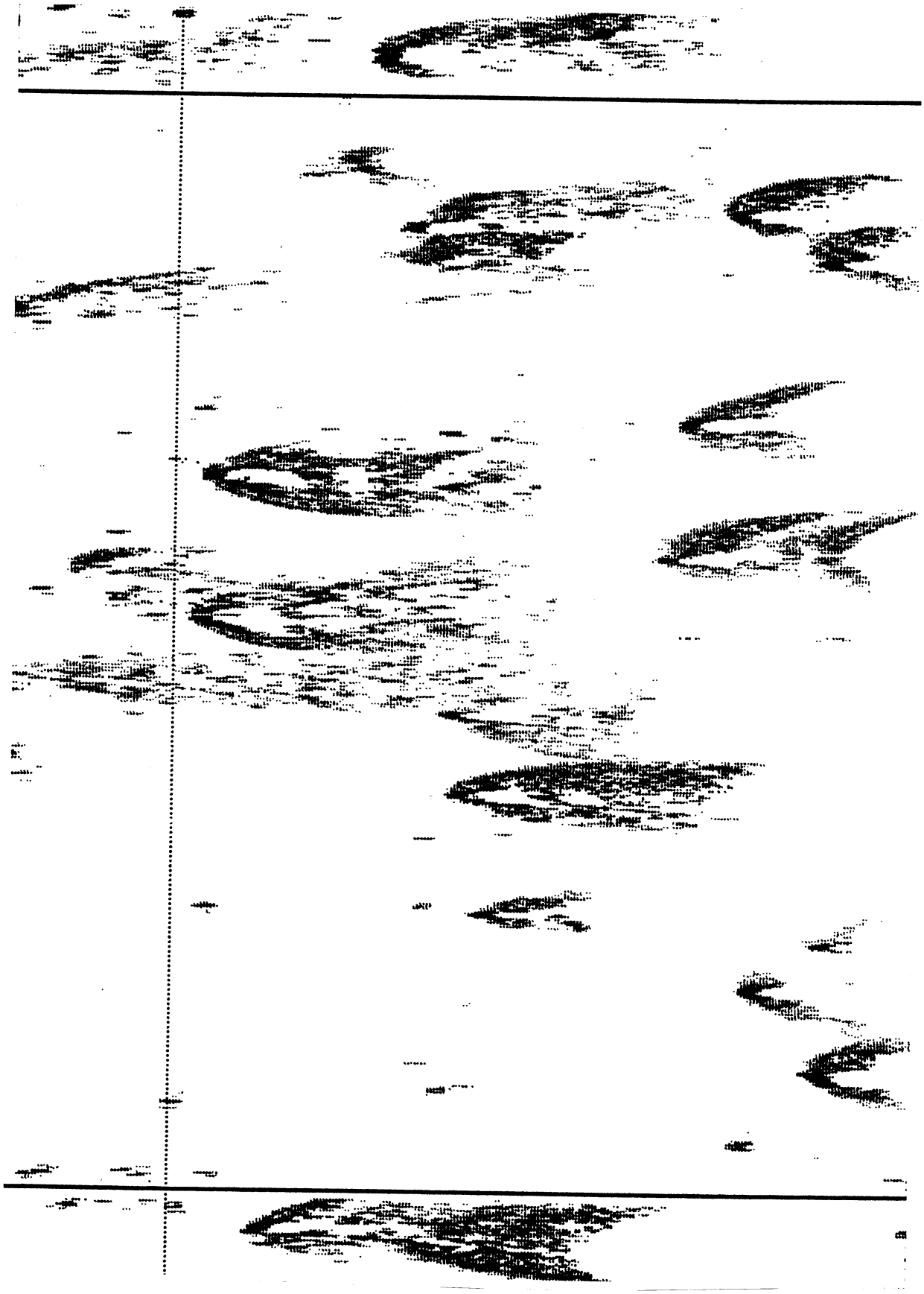


Figure 2. A preliminary version of a printout from the SODAPS echogram printer.

3.3 School tracking

During the cruise, 26 schools were tracked for 6 - 64 min. In many cases the tracking was initiated on schools that appeared at the surface, and that also could be recorded by the sonar. Some schools appeared in midwater so that the recorded schools were distributed from average depths in the range 1 - 33 m. The schools were swimming at horizontal speeds of 0.66 - 3.37 m/s, and moving in the direction of migration at speeds of 0.28 - 2.27 m/s.

The schools were rather dynamic, and splitting, joining, change of shape, and fragmentation occurred rather frequently. In many cases the rather short duration of the tracking was caused by fragmentation or dispersion of the schools so that the school echo on the sonar display became too small or too weak to perform further tracking. Intra-school events such as change of shape, reorganizing, and splitting occurred at an average rate of 0.33 per min which means that an intra-school event occurred each 3rd min. Most schools adopted a rod-like or fragmented shape, but circles and ovals were also quite frequent. Ring-shaped schools were rather rare. Interactions between neighboring schools as approach and join occurred at rates of 0.06 per min which means that such events occurred on average at time intervals of 16 min 40 sec.

The schools seemed little disturbed by nearby predators. Seabirds were remarkably absent when considering the large number of surface schools. Two gannets were observed in the Lobito area, but they were only once observed to attack the sardinella schools. Fish predators as barracuda were caught during aimed trawling on sardinella schools, especially in the Palmeirinhas area. Sharks were observed at surface both off Cabo Ledo and Lobito. However, it was not observed that schools were chased by fish predators during the trackings. Several seals were also observed in the Lobito region. Nevertheless, a distinct, noisy, and water splashing flash could occasionally be seen to be performed in sardinella schools at surface. This flash is probably an antipredator manoeuvre which can be effective to scare and confuse both bird and fish predators (Figure 3).

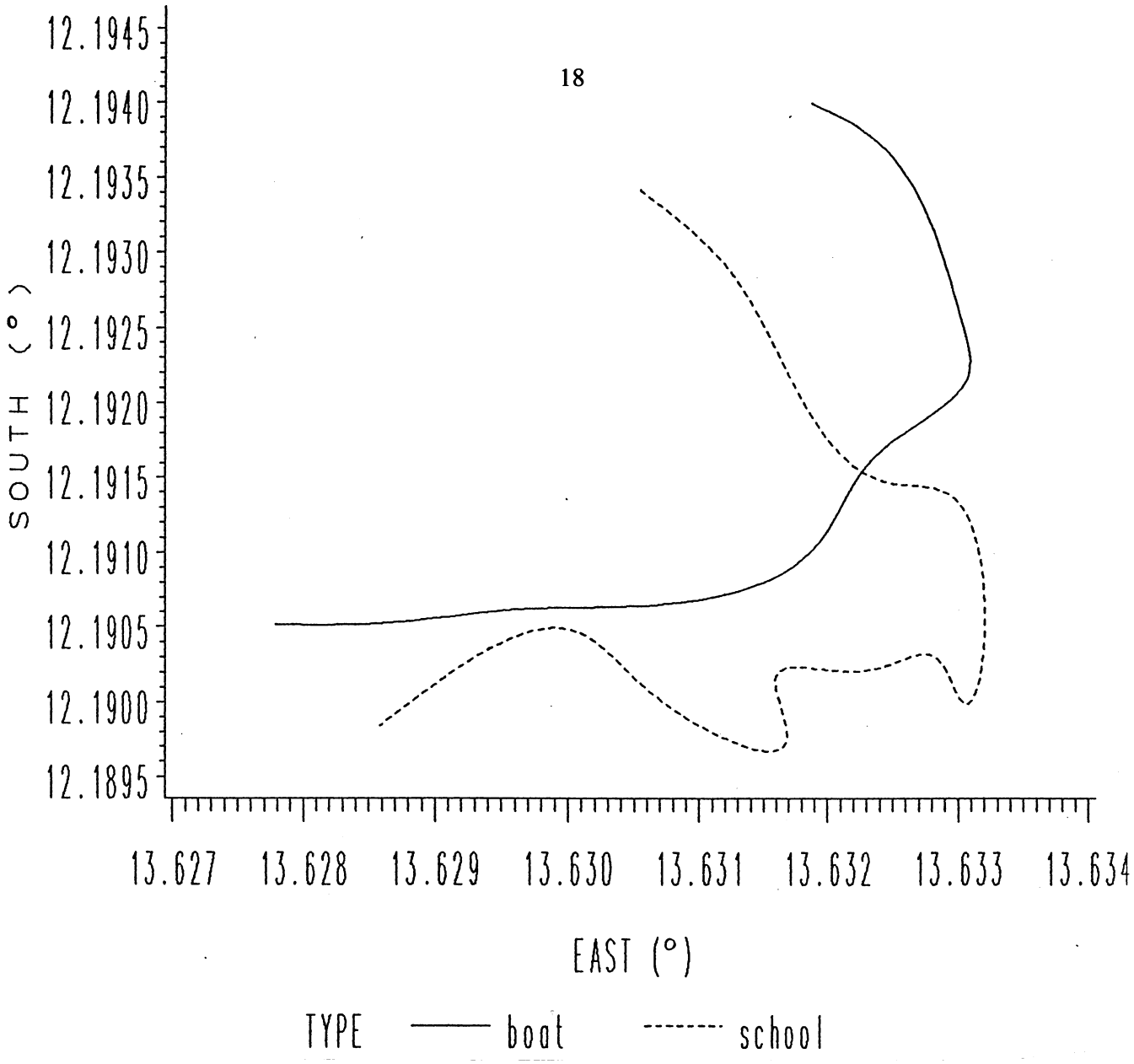


Figure 3. Treacking of sardinella school no. 23 during the cruise off Angola 1997. The school was migrating southwards in a direction of 208° at a speed of 0.47 m/s, and was tracked for 25 minutes.

A difficulty for proper school tracking was the performance of the SF 950 sonar. It was clearly seen in several cases that the school image tended to fade when the sonar beam was trained to have the school recording in the center beams. This occurred even when the sonar beam was trained 90° to port or starboard and when tilted - 5° downwards. Probably several of the school trackings, especially in the beginning of the survey, were ended because the school image faded when the school recording was positioned in the center of the beam fan. In later cases more distinct school images were obtained when the sonar beam was trained so that the school recording appeared in the beams at the edges.

Several of the cruise participants have experience in recording school with the SA 950, and it was generally agreed that the images of school recordings on the SF 950 seem different from the school images displayed at the SA 950. On the SF 950 the 32 sonar beams are clearly visible. This induce a seemingly coarser resolution of the school images on the SF 950 than on the SA 950. However, this is probably not the case, but it seems that "functions" to smooth images are not operating on SF 950 as on the SA 950. Nevertheless, the SF 950 has high resolution, and the images displayed seem to reflect the natural shape of the schools. This was confirmed in many cases when the schools could be seen at the surface and recorded by the sonar simultaneously.

3.4 Surface school observations

Surface school counts performed in the same area during 4 days of survey in 1996 (Figure 4) revealed that shoals were seen clearly bimodally from 08h00 to 11h00 and from 14h00 to 18h00 in the evening. The same task was repeated in 1997 in three different areas during 13 days of survey. Shoals were seen throughout the day (with a complicated pattern) at the surface in large numbers from 06h00 in the morning (sunrise) to 11h00. In the middle of the day from 11h00 to 14h00 shoals seemed to be diving but returned to the surface from 14h00 to 18h00 although with a lower frequency than in the morning. Generally the data recorded during these two surveys showed that the best time for school sightings is in the early morning (sunrise) and at the end of the day (sunset).

The shoal counts at the surface have shown a relationship between a number of shoals and solar radiation intensity (Figure 4). It is presumed that solar radiation can affect the behavior of fish schooling at the surface (e.g. sardinella) throughout the day. Daily recordings indicate that from 06h00 to 10h00 a large numbers of schools are seen at the surface. In contrast, when it is bright from 11h00 to 13h00 less shoals are observed at the surface. On days when the solar radiation intensity was below about 700 W/m^2 during the middle part of the day, the number of shoals at surface seems to be considerably more than during brighter days.

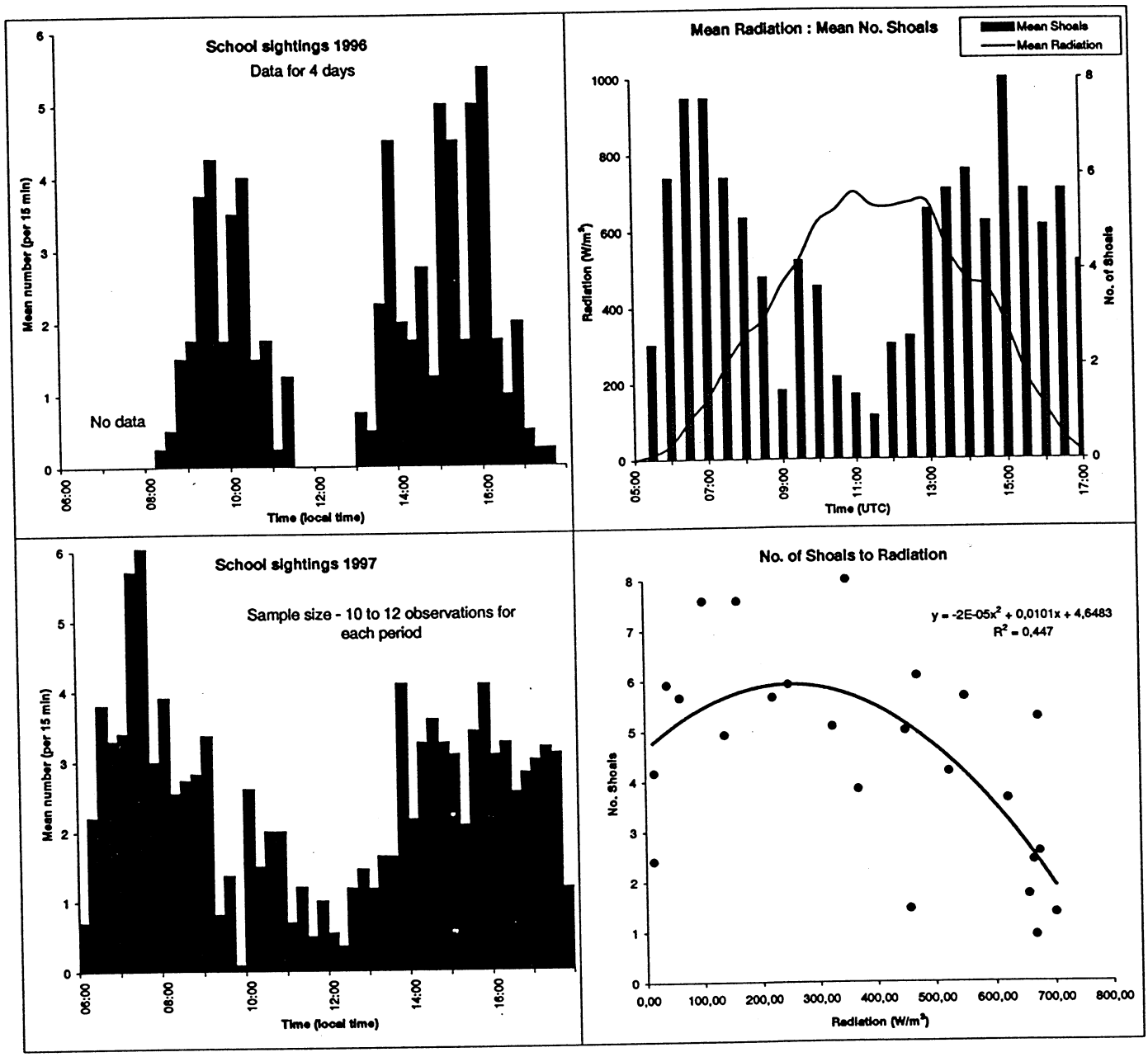


Figure 4a. Mean number of schools sighted in 1996 and 1997

Figure 4b. Mean number of shools sighted in 1997 compared to solar radiation levels

These data and analyses must be treated with some care as the probability of detecting shoals was likely to be greatly influenced by the time of day, wind (and hence wave formation), direction in relation to the sun and observer. In addition counting continued throughout the survey, including in some areas where, in hind-sight, it proved that there were few sardinella present.

3.5 Small boat experiments

The total s_A values per nautical mile attributable to shoals and scattered targets are presented in Annex XI. Table 3 summarizes these results. The conditions for conducting such experiments were excellent. As the weather was fine and calm and during most of the experiments there was considerable near-surface schooling activity.

Table 3 s_A value and number of shoals per nautical mile for each experiment

		DR. FRIDTJOF NANSEN			M.O.B.boat			
		S_A of shoals	No. of shoals	S_A of scatters	S_A of shoals	No. of shoals	S_A of scatters	Transect length
Expt. 1	Day	803	2,0	5285	1317	5,4	3721	8
Expt. 2	Day	814	2,9	3897	947	4,0	3863	10
Expt. 3	Day	1275	2,0	441	445	2,5	569	7
Expt. 4	Day	1600	5,7	525	1391	5,0	329	10
Expt. 1	Night	62	0,2	3582	1416	1,6	1875	10
Expt. 2	Night	66	1,2	5852	50	0,8	5037	10
Mean		766	2,3	3156	912	3,1	2453	55

A preliminary analysis shows a remarkable similarity in the echo-recordings of each vessel. The total S_A values/NM recorded from shoals were, as expected, rather variable. Of the six experiments, the small M.O.B. boat recorded a higher s_A in two, while three values were very similar and the DR. FRIDTJOF NANSEN gave the highest value in one. Overall values recorded by the M.O.B. boat were 20% higher.

The M.O.B. boat also recorded 35% more shoals, including 36 shoals in the upper 5-10 m channel; a depth range not covered by DR. FRIDTJOF NANSEN s transducer (Table 4). If shoals had performed a diving avoidance reaction it may be expected that the RV 'Dr. Fridtjof Nansen' would have detected a higher number of shoals in the next channel. The number of shoals recorded in the 10-30 m range were very similar, indicating that there may have been little diving. Paradoxically the M.O.B. boat did record considerably more shoals at depths below 30 m. Further analysis of the data are required to investigate these anomalies.

Table 4 Number of shoals recorded per depth range

	5-10	10-20	20-30	30-40	40-50	Total
DR. FRIDTJOF NANSEN	n.a.	49	69	9	0	127
M.O.B.boat	36	51	56	24	3	170

Overall the experiments do not indicate that vessel avoidance by near-surface shoals is a problem for the DR. FRIDTJOF NANSEN, although a fairly large number of shoals may be missed in the surface "blind" zone. Further more detailed analysis of the data is required.

The mean s_A values from scattered targets came mainly from the demersal fish community. On average the DR. FRIDTJOF NANSEN recorded 30% higher values, possibly caused by some systematic orientation of these near-bottom fish in response to the DR. FRIDTJOF NANSEN, resulting in a higher individual TS, which did not occur with the smaller M.O.B. boat.

3.6 Trawling

A total of 29 trawls were conducted during the survey; two to test the underwater camera system (FOCUS), seven with the FOCUS to study the behavior and swimming speed of sardinella under trawling conditions and the rest of the trawls for target identification, species composition and the collection of biological data. A summary of the technical details of the trawls are presented in Annex IV.

As the sardinella shoals were generally found close inshore, the trawls were conducted between 30 and 50 m bottom depth. The trawls were mainly midwater trawls at or close to the surface. Catches were divided into four main groups: Sardinellas, Trachurids, other Carangids and other pelagics. During this survey sardinellas were more abundant in the trawls compared to the survey conducted in June/July 1996. There appeared to be no major changes in the species composition between day and night trawls (Figure 5). The highest catches of sardinella were made in the Lobito area. No sardinella were caught in the bottom trawls.

Comparing the total catch of sardinella obtained during the day with the average speed of the trawl, the general trend appeared to be that catches increased with an increase in the towing speed (Figure 6). However, the data were influenced by two very big catches made in the Lobito area. The trend was also reversed during night time, but as there were only a few data points, this relationship needs further investigation before any conclusions can be made.

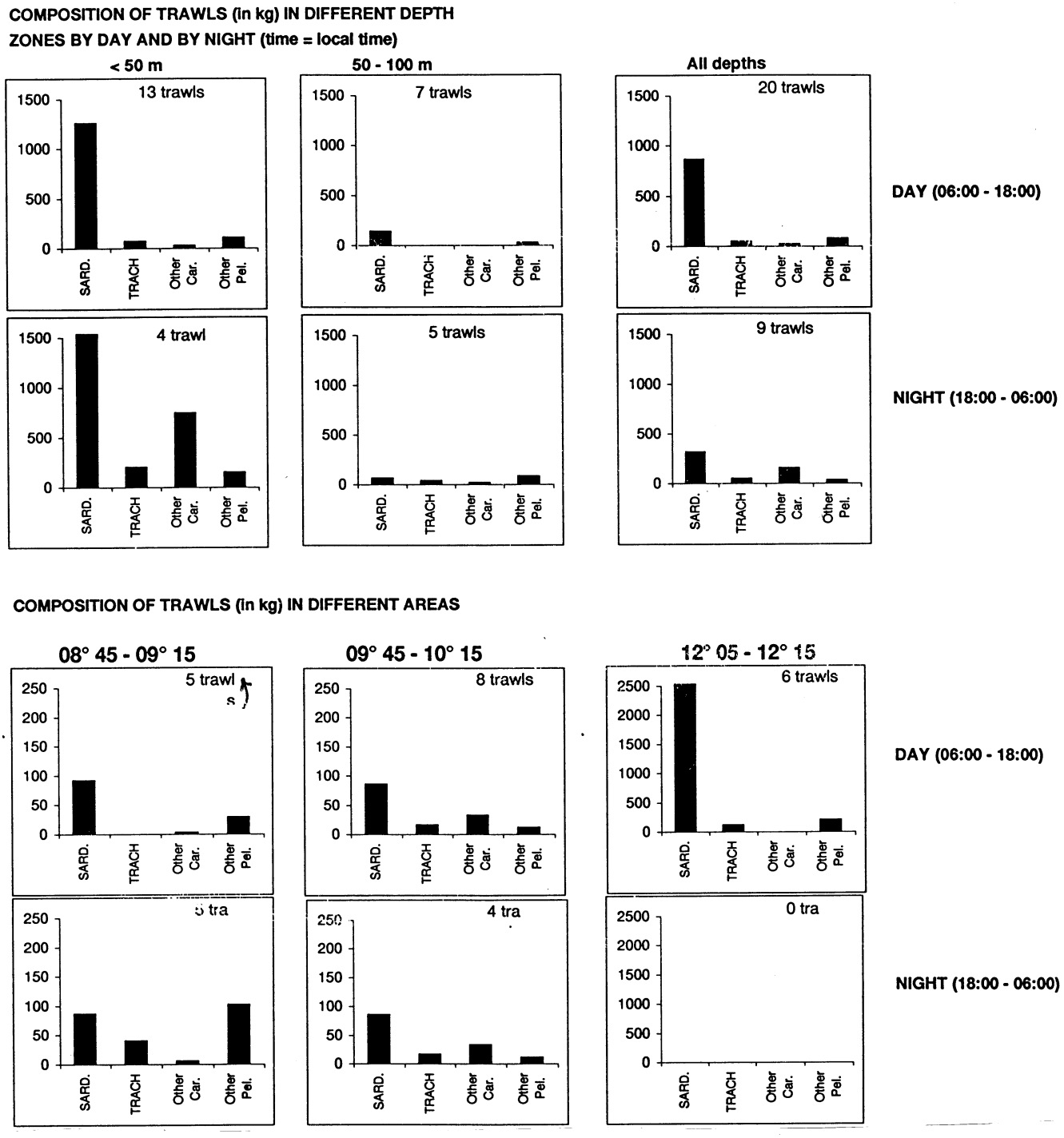


Figure 5. Analysis of trawl catch data by species, time of day, depth and area.

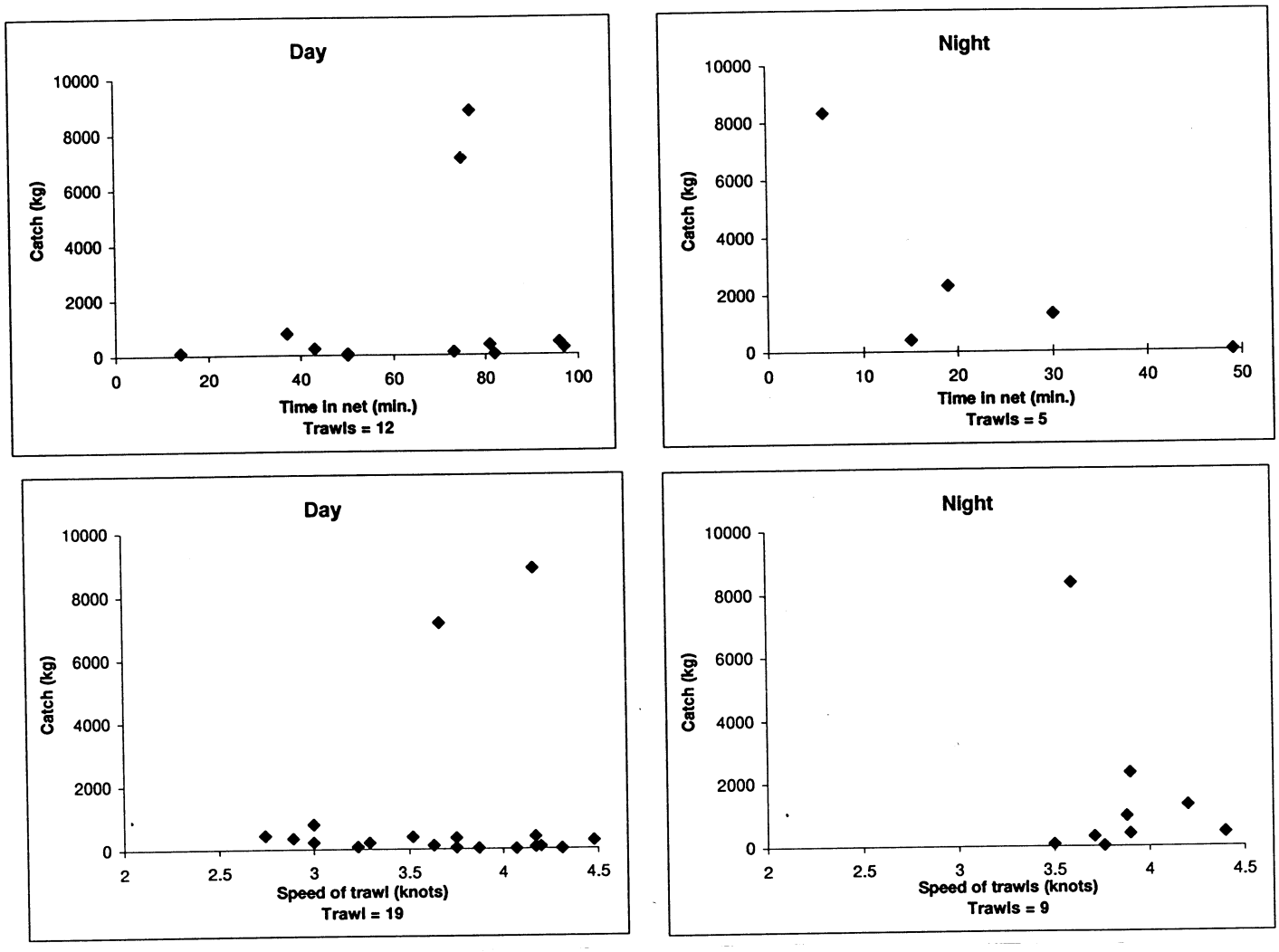


Figure 6. Comparison of Sardinella catches vs. Time in net and vs. Speed of trawl.

The sardinella catches were also compared with the amount of time that the shoals spent within the net during trawling. The time from when the shoal enters the opening of the net until the end of the trawl was recorded. The idea was that by increasing the duration of the trawl it will tire the sardinella preventing them from swimming out of the net when the vessel slows down to haul in the net. However, conflicting trends between day and night were obtained when comparing the size of the catch with the time that the fish were in the net (Figure 6).

3.7 Underwater trawling observations

During nine pelagic trawl hauls, the underwater towed vehicle FOCUS 400 was used to record swimming behaviour of sardinella in the trawl belly. Stations PT1292 and PT1264 were conducted to train the crew in deploying and retrieving the underwater towed vehicle (UTV), and to train the operator to manoeuvre the UTV in the vicinity of the trawl. PT1292 and PT1294 were conducted with floats with no extension, and the UTV was manoeuvred below the trawl and backwards to the trawl belly, and with the camera looking upwards and into the trawl belly. There were no recordings of fish on the camera during these trawl stations.

During the seven other pelagic trawl hauls, the trawl was rigged with floats of 5 or 10 m extension and light weighs. This enabled manoeuvring the UTV backwards between the floats to position the UTV on top of the trawl belly within about 20 min. The towing speed during these trawl stations varied from 2.8 knots during PT1282 to 4.3 knots during PT1277.

Camera recordings of sardinella in the trawl belly (20 cm stretched mesh section) were obtained on PT1277 (towing speed 4.3 knots), PT1278 (towing speed 3.0 knots), PT1279 (towing speed 2.9 - 3.6 knots), PT1280 (towing speed 3.8 knots), and PT1282 (towing speed 2.8 knots). During these 5 pelagic trawl stations we obtained catches from a few hundred kilos to about 8 tonnes of sardinella (PT1297). The Secchi disk visibility in the areas where these hauls were conducted was 8 - 9.5 m. During PT1283 and PT1285 north of Lobito, the Secchi disk visibility had decreased to just 2.5 m, and even if fish were recorded in the trawl belly on the FS3300 sonar, there were no recordings on the SIT camera.

Sardinella schools that were recorded in the trawl mouth by the Scanmar trawleye, seem to appear in the 20 cm stretched mesh section of the trawl within about 10 minutes when towing at 3.6 knots This was observed both during PT1279 and PT1280. This indicated that the sardinella were able to swim in the trawl opening for about 10 minutes, and this thereby confirms net sound recordings during the first trawl hauls during this cruise and those during the 1996 cruise that sardinella is capable of swimming in the trawl opening for a remarkably long time.

When in the trawl belly, the vertical position of the sardinella in relation to the trawl as recorded by the FS3300 sonar seem dependent on visibility. During the hauls with moderate visibility (PT1277, PT1278, PT1279, PT1280, PT1282) when the sardinella was recorded by the SIT camera, the sardinella seemed to take up positions all over the trawl tunnel, even close to the upper panel. During the two hauls with low visibility (PT1283 and PT1285), the sardinella seem to concentrate in the lower part of the trawl tunnel.

In the tunnel of the trawl belly, the swimming behaviour of the sardinella seem determined by the optomotor response so that the fish were trying to maintain position alongside the diamond patterns of the meshes of the trawl net. At a speed of 2.8 knots the sardinella seem capable of swimming slowly forward in the trawl, at a speed of 3.3 knots the fish were observed to lose position slowly and fade backwards in the trawl tunnel, and at a speed of 3.7 knots the fish seem to lose position faster and fade backwards in the trawl tunnel.

3.8 Environmental characteristics

The environmental characteristics in the areas where the sardinella schools were sighted and tracked, and where the pelagic trawl hauls and small boat experiments were conducted are summarised in Table 5. The sea temperatures at 5 m depth in the respective areas varied by 2.0° - 3.3° C. As several of the CTD stations were taken at nearby positions within these areas, the substantial temperature variations at 5 m depth probably reflected internal waves influencing of the surface layer. At 20 m depth, the sea temperature varied by less than 2° C, and was about 19° - 21° C in the respective areas. The salinity was within 35.6 - 35.8 ‰ in

all depths of the respective areas. In the Palmeirinhas area, the Secchi depth varied two-fold from 8 to 15 m. In the Lobito area the Secchi depth varied five-fold from 2.5 to 9.5 m.

Table 5. Environmental characteristics in the areas where the school studies and pelagic trawl hauls were conducted.

Area	Temperature (°C)		Salinity (‰)		Secchi -depth
	5 m	20 m	5 m	20 m	(m)
Palmeirinhas	20.7 - 22.7	19.3 - 20.2	35.6 - 35.7	35.8	8 - 15
Cabo Sao Braz	20.7 - 24.0	19.2 - 21.0	35.8	35.6 - 35.8	7

CHAPTER 4 CONCLUDING REMARKS

The first part of the cruise was devoted to upgrading of the SF 950 sonar (at quay in Luanda 23 - 29/4, and at sea 29/4 - 1/5) and implementation and testing of the SODAPS software (at quay in Luanda 26 - 29/4, and at sea during the rest of the cruise). As described in chapter 3.1, substantial hardware and software changes have been made to change the SA 950 sonar to an SF 950 sonar, and to enable the SF 950 sonar to communicate with and deliver specified data to the SODAPS system. However, at the present state the SF 950 is not functioning satisfactorily. School images appear 'weaker' than before and tend to fade in the centre of the beam fan. A cosmetic detail is that images appear somewhat coarser, and the tracking function is not implemented. The SODAPS system was not functioning at all during the cruise. Because of these limitations, we were not able to do any proper school measurements or conduct a comparative sonar/echo-sounder survey as planned in the cruise programme. It is recommended that further modifications, implementations and testing of the SF 950 and SODAPS are conducted on cruises with DR. FRIDTJOF NANSEN this year, and where the objectives of the cruises do not require use of the sonar system for quantitative purposes.

Twenty-six schools were tracked manually during the cruise. The schools were rather dynamic, and intra- and interschool events occurred at average rates of 0.33 and 0.06 per min respectively. This means that intra-school events such as change of shape, reorganising and splitting occurred each 3rd minute on average, and that interschool events such as joining and approaching occurred at time intervals of 16 min 40 sec on average. The schools were moving at horizontal speeds of 0.66 - 3.37 m/s in average, and the speed in the direction of migration varied from 0.28 to 2.27 m/s in average.

A large number of surface schools were sighted during the cruise. The schools seem most active at the surface during early morning and in the afternoon, and with a minimum of surface school activity during mid-day. The number of surface schools seem inversely related to the level of solar radiation.

A total of 29 pelagic trawl stations were conducted during the cruise. Compared to the 1996 sonar survey, sardinella were more abundant in the trawl catches during this cruise. There were no differences in species composition between day and night trawl catches. In most daytime stations catches of sardinella were obtained if sardinella schools were recorded by the sonar or at surface during the trawling. Daytime catches of up to 8 tonnes of sardinella were obtained in the Lobito area.

The FOCUS 400 UTV was used to record the behaviour of sardinella in the trawl mouth and in the tunnel of the trawl belly during 7 pelagic trawl stations. These observations confirmed that the sardinella were capable of swimming along in the trawl mouth for a remarkably long time. In the tunnel of the trawl belly, the sardinella were recorded by camera, and seemed to perform the optomotor response in trying to swim along with the diamond shaped patterns of the trawl net. The sardinella seemed to maintain position in the trawl belly when the towing speed was less than 3 knots, but lost position slowly and faded backwards in the trawl tunnel when the towing speed exceeded 3.3 knots.

To compare the echo integration recordings of sardinella obtained by a small and large vessel, six experiments were conducted by running the man-overboard vessel equipped with a EY500 in parallel and 600 m to the side of DR. FRIDTJOF NANSEN steaming at 5 knots. During these experiments the average back scattering strength of sardinella was about 25 % higher and the number of schools recorded about 35 % higher on the M.O.B. boat than on DR. FRIDTJOF NANSEN, respectively. There were also substantial differences in the vertical distribution of the schools recorded by the m.o.b. boat and DR. FRIDTJOF NANSEN.

With respect to the objectives of the cruise, these were definitely met with regard to visual school sightings, school tracking, pelagic trawl stations with UTV observations, and the small boat experiments. For these tasks substantial amounts of data were collected, and further analysis is required to justify significant conclusions. The data for these tasks will be analysed with respect to the influence of the schooling behaviour of sardinella in relation to acoustic abundance estimation, and the results are intended to be reported in referee-based scientific journals.

Annex I EK500 settings

The Simrad scientific echo sounder EK 500/38 kHz was used to observe fish distributions and densities during the survey. The details of the settings of the 38 kHz echo sounder were as follows:

Transceiver-1 menu

Transducer depth	5 m
Absorption coeff.	10 dB/km
Pulse length	medium
Bandwidth	wide
Max. power	2 000 W
Angle sensitivity	21.9
2-way beam angle	-21.0 dB
SV transducer gain	27.7 dB
TS transducer gain	27.8 dB
3 dB Beamwidth	6.8 deg
Alongship offset	0.00 deg
Athwartship offset	0.04 deg

Display menu

Echogram	1
Bottom range	13 m
Bottom start	10 m
TVG	20 log R
SV Colour minimum	-67 dB
TS Colour minimum	-60 dB

Printer settings

Range	0-100 m
TVG	20 log R
SV Colour minimum	-67 dB

Bottom detection menu

Minimum level	-45 dB

Annex II Small boat specifications and portable echo-sounder settings

The Simrad EY500/38 kHz portable scientific echo sounder fitted with a split beam transducer was operated from a small boat during several exercises to study fish schooling behaviour. All raw data were stored to tape and a colour printout of echograms was generated. The details of the settings of the portable 38 kHz echo sounder were as follows:

Transceiver menu

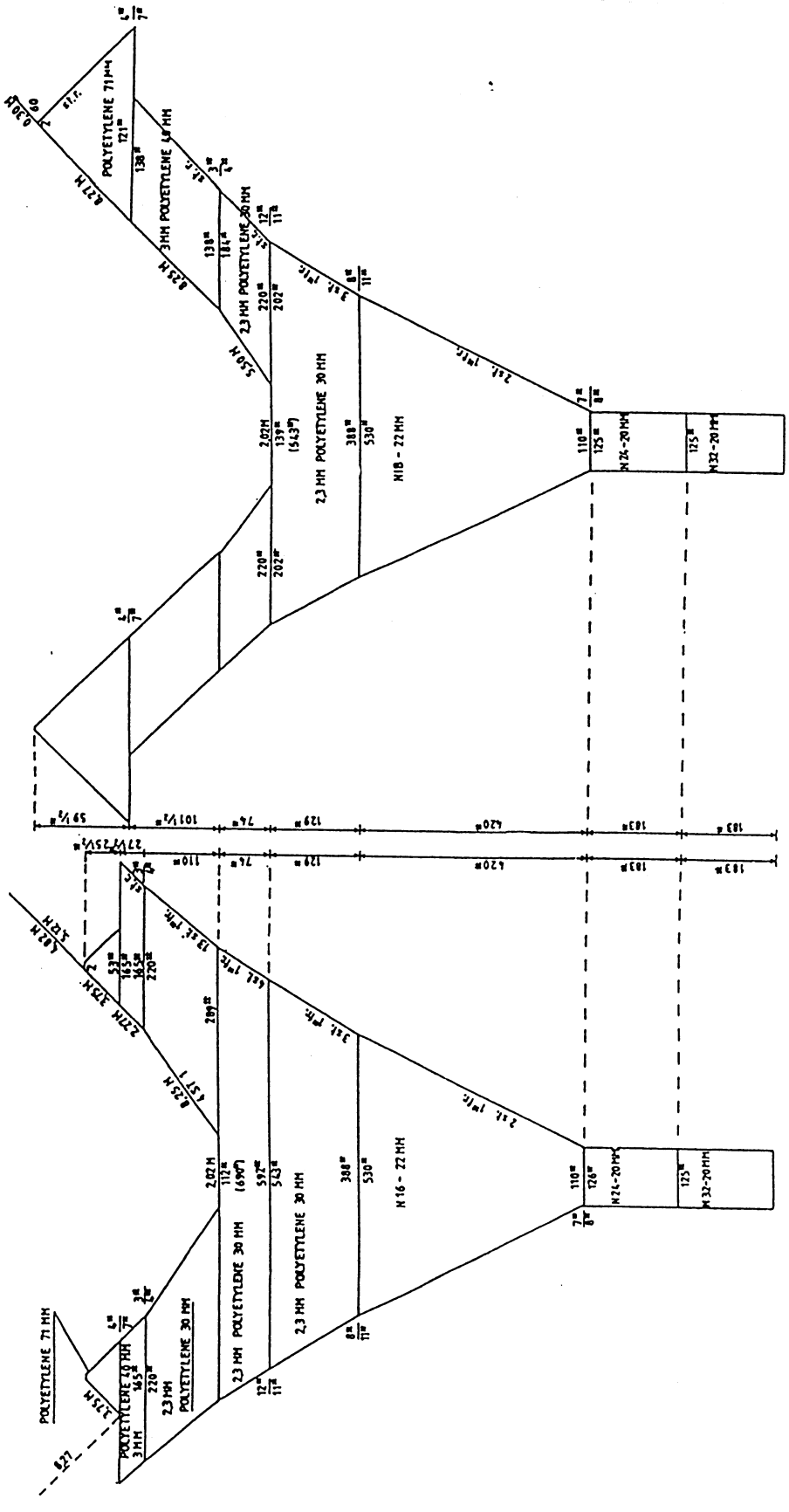
Transducer type	ES38-12
Transducer depth	0 m
Absorption coeff.	10 dB/km
Pulse length	medium
Max. power	125W
2-way beam angle	-15.8 deg
SV transducer gain	22.7 dB
TS transducer gain	22.7 dB
3 dB Beamwidth along.	11.9 deg
3 dB Beamwidth athw.ship	11.7
Alongship offset	0.01 deg
Athwartship offset	-0.02 deg

Man-Over-Board boat

Length	5.3 m
Width	2.1 m
Power	40 Hp
Draught	1.2 m
Weight	2000 kg

Annex III Fishing gear

The small "Åkrehamn" pelagic trawl and "Gisund super" bottom trawl was used for sampling pelagic fish. Tyborøn, 7.8 (1670 kg) trawl doors were used for both trawls.



Bottom trawl: High opening shrimp and fish trawl with net headline 31m (floatline), foot-rope 47m, gear with 12 cm diameter roller disks, 40 m sweeps, estimated headline hight 6m and distance between wings during towing 18-20m.

F/F Dr. Fridtjof Nansen

OVER/UNDER/SIDER

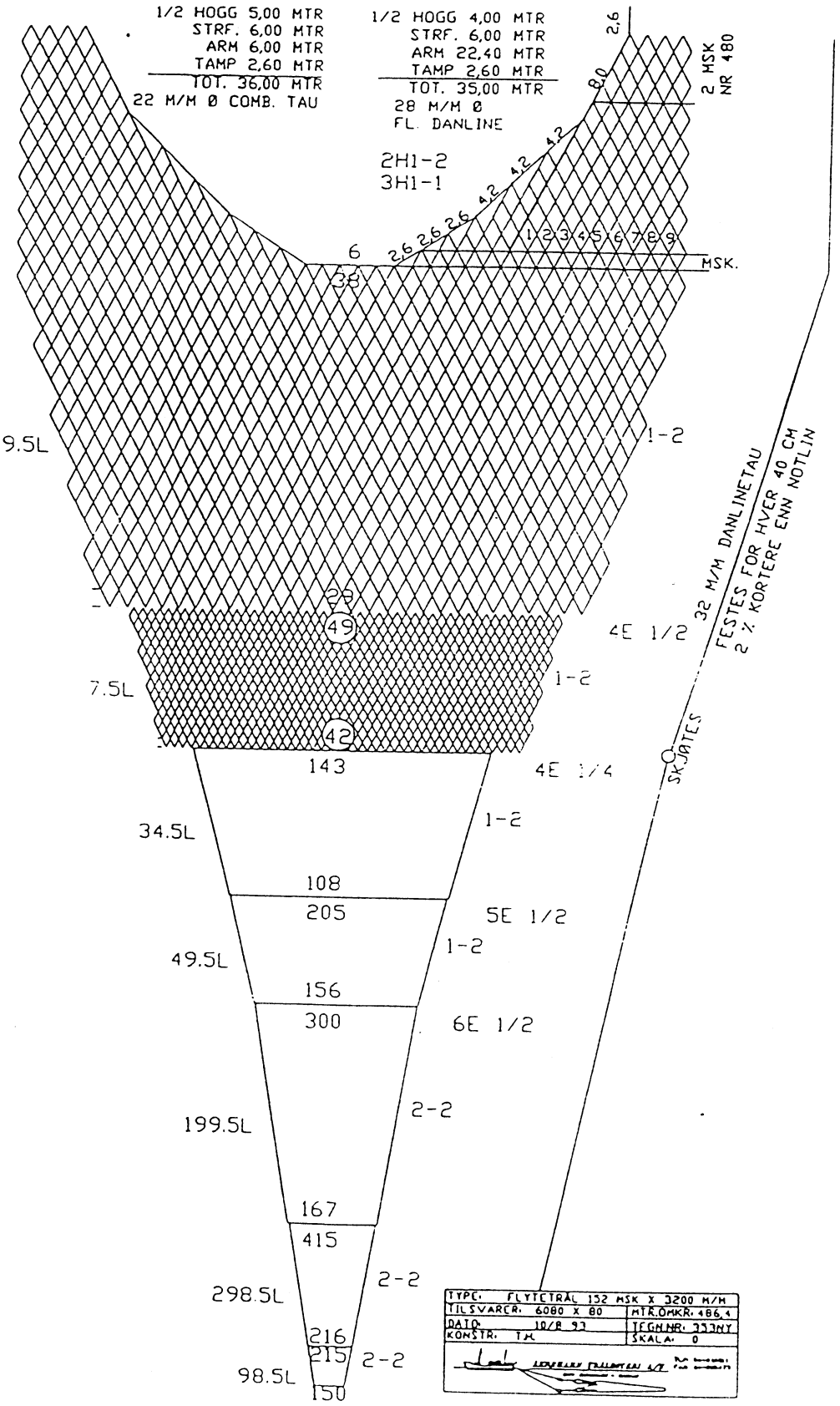
OVERDEL:
50 STK 11" PLASTKULER

UNDERDEL
14 M/M WIRE OMSP. MED
14 M/M BLYTAU
+ KJETTING.
TOTAL VEKT UNDER 400 KG.

1/2 HOGG 5,00 MTR
STRF. 6,00 MTR
ARM 6,00 MTR
TAMP 2,60 MTR
TOT. 36,00 MTR
22 M/M Ø COMB. TAU

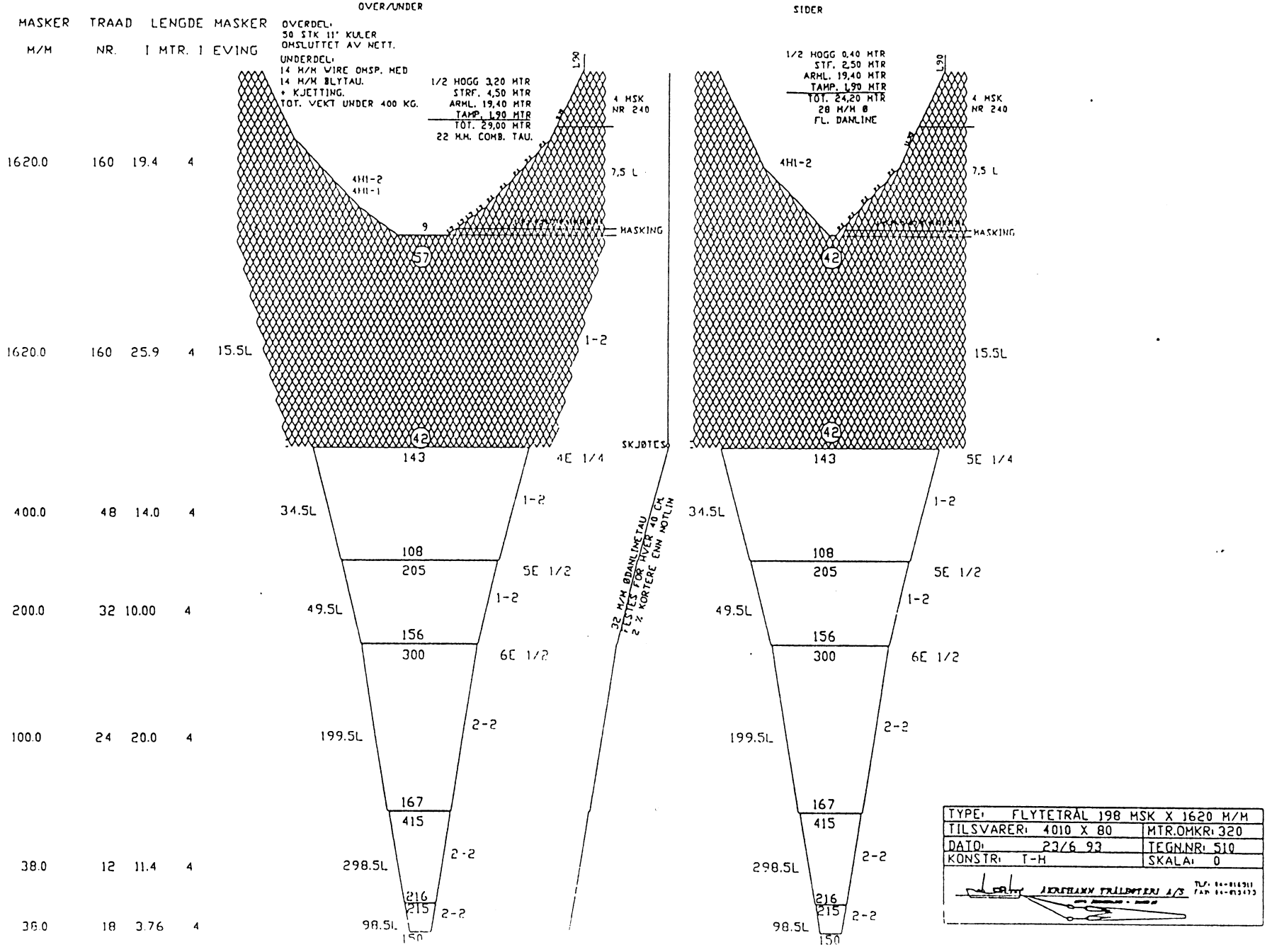
SIDER.
1/2 HOGG 4,00 MTR
STRF. 6,00 MTR
ARM 22,40 MTR
TAMP 2,60 MTR
TOT. 35,00 MTR
28 M/M Ø
FL. DANLINE

MASKER M/M	TRAAD NR.	LENGDE I MTR.	MASKER I EVING	
3200.0	240	22.4	4	
3200.0	240	32.0	4	9.5L
1620.0	160	13.0	4	7.5L
400.0	48	14.0	4	34.5L
200.0	32	10.00	4	49.5L
100.0	24	20.0	4	199.5L
38.0	12	11.4	4	298.5L
38.0	18	3.76	4	98.5L



TYPE: FLYTETRÅL 132 MSK X 3200 M/M	
TILSVARER: 6080 X 80	MTR.OMKR. 486,4
DATO: 10/8 93	TEGN.NR: 333NY
KONSTR: TH	SKALA: 0

F/F Dr. Fridtjof Nansen



TYPE:	FLYTETRÅL 198 MSK X 1620 M/M		
TILSVARER:	4010 X 80	MTR.OMKR:	320
DATO:	23/6 93	TEGN.NR:	510
KONSTR:	T-H	SKALA:	0

JOSTEINN TRILDTEIN A/S

Annex IV Summary of trawls

Summary of technical details of trawls (Day=05h00-17H00 UTC)

DAY TRAWLS			Position		Time UTC		B.Depth	Wire out	Speed	Gear depth	Vert.open	Net S.Rec	First rec.	TOTAL	Catch composition (kg)			
Station No.	Gear	Objective	South	East	start	end	m	m	kn	m	m	min.	min.	CATCH	SARD.	TRACH	Other Car.	Other Pel.
1257	PT 6		09° 09	12° 53	16:03	16:41	53	200	4.17	0				390.27	110.55	0.00	4.80	74.70
1259	PT		08° 47	13° 21	07:10	08:10	77	190	3.75	0				38.72	38.45	0.00	0.10	0.00
1262	PT 2	FOCUS	09° 10	12° 52	15:53	17:59	59	210	3.52	0				375.51	268.95	0.57	2.76	60.37
1264	PT 2	FOCUS	09° 10	12° 53	07:29	11:51	44	150	3.23	0				69.69	32.7	0	1.97	2.87
1265	PT		09° 11	12° 54	15:38	16:22	44	220	4.31	0				1.11	0.23	0	0.01	0
1267	PT		09° 48	13° 09	13:40	15:12	43	200	3.87	0	18	19	10	25.28	0	0	22.4	2.45
1270	PT 2		09° 52	13° 13	12:52	13:52	28	250	4.17	0	16	11	10	47.23	0.00	0.00	1.08	5.35
1271	PT 5		09° 56	13° 08	15:12	16:19	58	160	4.07	20	14	2	17	0.01	0.00	0.00	0.00	0.00
1273	PT 5		10° 08	13° 15	07:35	08:36	57	180	4.20	25	12	4	47	76.48	73.13	0.00	0.00	3.35
1274	PT 5		10° 08	13° 15	12:08	14:09	45	160	4.48	25	10	1.5	24	258.36	165.69	9.75	29.10	13.51
1275	BT 1		10° 10	13° 18	15:12	15:52	43	160	3.00	43	10	11	3	780.02	0.00	99.67	197.17	45.16
1277	PT 2	FOCUS	10° 08	13° 14	09:00	10:46	57	170	3.75	25			25	354.20	354.20	0.00	0.00	0.00
1278	PT 1	FOCUS	10° 24	13° 28	16:09	17:25	51	175	3.63	12			3	106.05	80.55	10.85	2.35	11.45
1279	PT 2	FOCUS	12° 13	13° 36	09:06	10:38	39	180	4.17	10			16	8846.80	8102.42	79.52	0.00	664.86
1280	PT 2	FOCUS	12° 13	13° 36	12:43	14:09	39	170	3.67	10			11	7131.63	6667.67	402.96	0.00	59.13
1281	PT 1		12° 14	13° 36	09:28	09:58	42	175	3.29	10				203.56	100.29	5.95	2.01	89.15
1282	PT 2	FOCUS	12° 15	13° 36	12:58	14:36	45	175	2.74	10			2	437.22	212.38	120.60	1.80	23.82
1283	PT 2	FOCUS	12° 07	13° 39	08:37	09:25	35	175	3.00	5			5	223.36	6.75	0.00	0.69	214.04
1284	BT 1		12° 07	13° 40	10:27	10:53	33	160	2.89	33				344.70	0.00	39.75	8.25	98.75
1285	PT 2	FOCUS	12°04	13°40	12:08	13:56	38	175	3.20	5				400.06	211.05	0.00	23.35	163.07
NIGHT TRAWLS																		
1258	PT 1		09° 09	12° 53	19:31	20:01	66	190	4.40	0				435.35	42.25	46.20	0.98	138.35
1260	PT		08° 48	13° 11	19:20	20:20	75	190	3.71	0				318.44	24.48	94.50	3.48	141.18
1261	PT		08° 50	13° 08	06:19	07:18	80	190	3.76	0	18	27	10	19.10	13.15	0.00	4.17	0.00
1263	PT 5		09° 09	12° 53	18:54	19:31	44	190	3.88	0				955.20	343.98	44.70	11.04	185.58
1266	PT 2		09° 11	12° 54	18:31	19:33	60	190	3.50	0				81.17	1.61	10.75	2.24	36.49
1268	PT		09° 51	13° 08	17:30	18:10	47	190	4.2	0	16	12	10	1302.98	950.04	36.29	46.28	86.41
1269	PT 2		09° 49	13° 09	19:56	20:16	43	190	3.90	5	12	10	5	405.77	209.76	0.00	53.50	62.51
1272	PT 6		10° 01	13° 13	19:18	19:38	43	190	3.60	5	18	1	14	8335.94	3868.16	504.32	1946.11	151.11
1276	PT 2		10° 09	13° 17	17:34	17:54	43	180	3.90	5	19	20	1	2311.11	998.46	188.89	959.04	142.09

Annex V Record of fishing stations

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1257
DATE:29/ 4/97 GEAR TYPE: PT No:6 POSITION:Lat S 909
start stop duration Long E 1253
TIME :16:03:50 16:41:29 38 (min) Purpose code: 1
LOG :4341.65 4344.29 0.12 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 53 52 Validity code:
Towing dir: 325° Wire out: 230 m Speed: 50 kn*10

Sorted: 390 Kg Total catch: 390.27 CATCH/HOUR: 616.22

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Manta birostris	RAYMO21	315.79	8	51.25	
Sardinella maderensis	CLUSL02	153.71	542	24.94	2786
Sphyraena guachancho	SPHSP01	114.63	8	18.60	
Sardinella aurita	CLUSL01	20.84	76	3.38	2787
Caranx crysos	CARCA02	7.58	22	1.23	2785
Scomberomorus tritor	SCMSM01	3.32	2	0.54	
Echeneis naucrates	ECNEC01	0.17	8	0.03	
Naucrates ductor	CARNA01	0.17	2	0.03	
Total		616.21		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1258
DATE:29/ 4/97 GEAR TYPE: PT No:1 POSITION:Lat S 909
start stop duration Long E 1253
TIME :19:32:26 20:03:46 31 (min) Purpose code: 1
LOG :4346.60 4348.79 1.17 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 63 65 Validity code:
Towing dir: 325° Wire out: 190 m Speed: 40 kn*10

Sorted: 435 Kg Total catch: 435.35 CATCH/HOUR: 842.61

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Manta birostris	RAYMO21	387.10	10	45.94	
Trichiurus lepturus	TRITR01	153.58	250	18.23	
Sphyraena guachancho	SPHSP01	114.10	17	13.54	
Trachurus trecae	CARTR02	89.42	203	10.61	2790
Sardinella maderensis	CLUSL02	70.74	246	8.40	2788
Stromateus fiatola	STRST01	11.67	12	1.38	
Sardinella aurita	CLUSL01	11.03	54	1.31	2789
Sepia officinalis hierredda	SQUSE11	1.92	8	0.23	
Selene dorsalis	CARSL01	1.90	4	0.23	
Alloteuthis africana	SQULO11	1.16	116	0.14	
Total		842.62		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1259
DATE:30/ 4/97 GEAR TYPE: PT No:1 POSITION:Lat S 847
start stop duration Long E 1312
TIME :06:40:31 06:40:45 60 (min) Purpose code: 1
LOG :4382.12 4385.87 3.36 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 62 87 Validity code:
Towing dir: 325° Wire out: 190 m Speed: 40 kn*10

Sorted: 38 Kg Total catch: 38.72 CATCH/HOUR: 38.72

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	32.30	113	83.42	2791
Sardinella aurita	CLUSL01	6.15	19	15.88	2792
Echeneis naucrates	ECNEC01	0.09	1	0.23	
Trachinotus ovatus	CARTC03	0.09	1	0.23	
Sepiella ornata	SQUSE21	0.06	3	0.15	
Lagocephalus laevigatus	TETLA01	0.02	1	0.05	
Selene dorsalis	CARSL01	0.01	1	0.03	
Total		38.72		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1260
DATE:30/ 4/97 GEAR TYPE: PT No:1 POSITION:Lat S 847
start stop duration Long E 1312
TIME :19:20:31 20:20:17 60 (min) Purpose code: 1
LOG :4460.59 4464.24 3.67 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 63 85 Validity code:
Towing dir: 225° Wire out: 190 m Speed: 40 kn*10

Sorted: 159 Kg Total catch: 318.44 CATCH/HOUR: 318.44

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	TRITR01	116.60	256	36.62	
Trachurus trecae	CARTR02	94.50	743	29.68	2793
Brachydeuterus auritus	PODBR01	50.50	397	15.86	2794
Sardinella maderensis	CLUSL02	23.40	112	7.35	2795
Sarda sarda	SCMSA01	12.10	10	3.80	
Euthynnus alletteratus	SCMEU01	6.30	14	1.98	
Sepia officinalis hierredda	SQUSE11	4.30	10	1.35	
Chloroscombrus chrysurus	CARCH01	3.48	152	1.09	
Sphyraena guachancho	SPHSP01	2.78	4	0.87	
Engraulis encrasicolus	ENGEN01	1.90	340	0.60	
Scomber japonicus	SCMSC01	1.50	6	0.47	
Sardinella aurita	CLUSL01	1.08	6	0.34	
Total		318.44		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1261
DATE: 1/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 850
start stop duration Long E 1308
TIME :06:19:00 07:18:17 59 (min) Purpose code: 1
LOG :4475.27 4478.99 2.81 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 84 75 Validity code:
Towing dir: 55° Wire out: 190 m Speed: 40 kn*10

Sorted: 19 Kg Total catch: 19.10 CATCH/HOUR: 19.42

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	13.37	44	68.85	2796
Trachinotus ovatus	CARTC03	4.24	9	21.83	
Lagocephalus laevigatus	TETLA01	1.76	3	9.06	
Sepiella ornata	SQUSE21	0.05	1	0.26	
Total		19.42		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1262
DATE: 2/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 912
start stop duration Long E 1254
TIME :15:53:37 17:59:43 126 (min) Purpose code: 1
LOG :4536.95 4544.29 5.64 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 32 91 Validity code:
Towing dir: 350° Wire out: 210 m Speed: 40 kn*10

Sorted: 125 Kg Total catch: 375.51 CATCH/HOUR: 178.81

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	105.21	370	58.84	2797
Sardinella aurita	CLUSL01	22.86	68	12.78	2798
Trichiurus lepturus	TRITR01	15.86	60	8.87	
Isurus oxyrinchus	SHALA21	9.52		5.32	
J E L L Y F I S H	JELLY00	7.36		4.12	
Euthynnus alletteratus	SCMEU01	5.17	4	2.89	
Sarda sarda	SCMSA01	3.86	3	2.16	
Sphyraena guachancho	SPHSP01	2.84	1	1.59	
Sepiella ornata	SQUSE21	1.41	49	0.79	
Trachinotus goreensis	CARTC02	1.31	3	0.73	
Lagocephalus laevigatus	TETLA01	1.11	3	0.62	
Scomberomorus tritor	SCMSM01	1.02		0.57	
Echeneis naucrates	ECNEC01	1.00	4	0.56	
Trachurus trecae	CARTR02	0.27	6	0.15	
Total		178.80		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1263
DATE: 2/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 910
start stop duration Long E 1253
TIME :18:54:36 19:31:37 37 (min) Purpose code: 1
LOG :4549.10 4551.49 1.31 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 45 43 Validity code:
Towing dir: 5° Wire out: 190 m Speed: 40 kn*10

Sorted: 159 Kg Total catch: 955.20 CATCH/HOUR: 1548.97

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	PODBR01	579.89	5612	37.44	
Sardinella maderensis	CLUSL02	549.73	6331	35.49	2799
Trichiurus lepturus	TRITR01	215.51	662	13.91	
Trachurus trecae	CARTR02	72.49	720	4.68	2800
Sphyraena guachancho	SPHSP01	64.22	78	4.15	
Sarda sarda	SCMSA01	20.24	10	1.31	
Caranx crysos	CARCA02	17.90	19	1.16	
SHACA19		16.54	10	1.07	
Sardinella aurita	CLUSL01	8.08	68	0.52	
Priacanthus arenatus	PRIPR01	2.34	10	0.15	
Engraulis encrasicolus	ENGEN01	0.97	204	0.06	
Echeneis naucrates	ECNEC01	0.78	10	0.05	
Sepiella ornata	SQUSE21	0.29	10	0.02	
Total		1548.98		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1264
DATE: 3/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 910
start stop duration Long E 1253
TIME :07:29:00 11:51:58 263 (min) Purpose code: 1
LOG :4572.54 4586.64 0.45 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 46 43 Validity code:
Towing dir: 160° Wire out: 150 m Speed: 35 kn*10

Sorted: 69 Kg Total catch: 69.69 CATCH/HOUR: 15.90

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	7.05	25	44.34	2801
Lepidochelys olivacea	TURCH11	6.84		43.02	
Scomberomorus tritor	SCMSM01	0.60		3.77	
Trachinotus goreensis	CARTC02	0.45	1	2.83	
Sardinella aurita	CLUSL01	0.41	1	2.58	
Octopus sp.	SQUOC10	0.28	1	1.76	
BELAB01		0.16	1	1.01	
Echeneis naucrates	ECNEC01	0.05		0.31	
Auxis thazard	SCMAU01	0.05		0.31	
Total		15.89		99.93	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1265
DATE: 3/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 911
start stop duration Long E 1254
TIME :15:38:48 16:22:30 44 (min) Purpose code: 1
LOG :4594.27 4597.43 1.25 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 39 49 Validity code:
Towing dir: 180° Wire out: 220 m Speed: 45 kn*10

Sorted: 1 Kg Total catch: 1.11 CATCH/HOUR: 1.51

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	JELLY00	0.68		45.03	
Echeneis naucrates	ECNEC01	0.50	3	33.11	
Sardinella maderensis	CLUSL02	0.31	1	20.53	
Selene dorsalis, juveniles	CARSL91	0.01	14	0.66	
Total		1.50		99.33	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1266
DATE: 3/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 911
start stop duration Long E 1254
TIME :18:31:42 19:33:03 61 (min) Purpose code: 1
LOG :4604.37 4608.03 4.17 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 42 77 Validity code:
Towing dir: 225° Wire out: 190 m Speed: 40 kn*10

Sorted: 81 Kg Total catch: 81.17 CATCH/HOUR: 79.84

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	TRITR01	22.77	35	28.52	
Brachydeuterus auritus	PODBR01	20.95	210	26.24	
Trachurus trecae	CARTR02	10.57	178	13.24	2802
Miscellaneous fishes	MISFI00	5.86		7.34	
Sphyraena guachancho	SPHSP01	5.85	7	7.33	
Rhinoprionodon acutus	SNACA51	5.46	3	6.84	
Galeorhinus galeus	SHATR51	2.95	1	3.69	
Sardinella maderensis	CLUSL02	1.58	5	1.98	
Scomber japonicus	SCMSC01	1.22	2	1.53	
Selene dorsalis	CARSL01	1.11	4	1.39	
Trachinotus goreensis	CARTC02	1.09	2	1.37	
Sepia officinalis hierredda	SQUSE11	0.19	5	0.24	
Engraulis encrasicolus	ENGEN01	0.19	29	0.24	
Saurida brasiliensis	SYNSA01	0.04	7	0.05	
Total		79.83		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1267
DATE: 4/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 948
start stop duration Long E 1309
TIME :13:39:46 15:12:41 93 (min) Purpose code: 1
LOG :4696.80 4702.74 3.65 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 42 44 Validity code:
Towing dir: ° Wire out: 220 m Speed: 40 kn*10

Sorted: 25 Kg Total catch: 25.28 CATCH/HOUR: 16.31

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachinotus goreensis	CARTC02	14.45	22	88.60	
Scomberomorus tritor	SCMSM01	1.58	1	9.69	
Echeneis naucrates	ECNEC01	0.22	1	1.35	
Sepiella ornata	SQUSE21	0.04	2	0.25	
Lagocephalus laevigatus	TETLA01	0.02	1	0.12	
J E L L Y F I S H	JELLY00	0.00	6		
Total		16.31		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1268
DATE: 4/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 951
start stop duration Long E 1308
TIME :17:30:29 18:10:12 40 (min) Purpose code: 1
LOG :4705.78 4708.57 2.69 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 47 48 Validity code:
Towing dir: 360° Wire out: 190 m Speed: 45 kn*10

Sorted: 182 Kg Total catch: 1302.98 CATCH/HOUR: 1954.47

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	1143.45	4206	58.50	2804
Sardinella aurita	CLUSL01	281.61	933	14.41	2803
Brachydeuterus auritus	PODBR01	275.94	2243	14.12	
Sphyraena guachancho	SPHSP01	59.10	63	3.02	
Trachurus trecae	CARTR02	54.44	152	2.79	
Sphyraena afra	SPHSP03	46.58	2	2.38	
Chloroscombrus chrysurus	CARCH01	42.84	264	2.19	
Selene dorsalis	CARSL01	26.58	51	1.36	
Scomber japonicus	SCMSC01	23.94	51	1.22	
Total		1954.48		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1269
DATE: 4/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 949
start stop duration Long E 1309
TIME :19:56:08 20:15:40 20 (min) Purpose code: 1
LOG :4710.67 4712.03 1.47 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 43 42 Validity code:
Towing dir: 180° Wire out: 190 m Speed: 40 kn*10

Sorted: 210 Kg Total catch: 405.77 CATCH/HOUR: 1217.31

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	395.64	1377	32.50	2805
Manta birostris	RAYMO21	240.00	6	19.72	
Sardinella aurita	CLUSL01	233.64	816	19.19	2806
Decapterus rhonchus	CARDE02	160.50	2775	13.18	
Engraulis encrasicolus	ENGEN01	108.39	14844	8.90	
Sphyraena guachancho	SPHSP01	30.45	45	2.50	
Ilisha africana	CLUIL01	19.44	279	1.60	
Scomberomorus tritor	SCMSM01	17.85	9	1.47	
Scomber japonicus	SCMSC01	11.40	24	0.94	
Total		1317.31		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1270
DATE: 5/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 952
start stop duration Long E 1313
TIME :12:52:48 13:52:17 59 (min) Purpose code: 1
LOG :4761.72 4765.89 2.79 Area code : 1
FDEPTH: 0 0 GearCond.code:
BDEPTH: 22 33 Validity code:
Towing dir: ° Wire out: 250 m Speed: 4 kn*10

Sorted: 47 Kg Total catch: 47.23 CATCH/HOUR: 48.03

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Manta birostris	RAYMO21	40.68	1	84.70	
Scomberomorus tritor	SCMSM01	5.44	3	11.33	
Trachinotus goreensis	CARTC02	1.10	2	2.29	
BELA801		0.61	3	1.27	
Echeneis naucrates	ECNEC01	0.20	1	0.42	
Total		48.03		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1271
DATE: 5/ 5/97 GEAR TYPE: PT No:5 POSITION:Lat S 956
start stop duration Long E 1308
TIME :15:12:02 16:19:02 67 (min) Purpose code: 1
LOG :4773.37 4777.91 0.48 Area code : 1
FDEPTH: 20 20 GearCond.code:
BDEPTH: 60 56 Validity code:
Towing dir: 180° Wire out: 160 m Speed: 40 kn*10

Sorted: Kg Total catch: 0.01 CATCH/HOUR: 0.01

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis, juveniles	CARSL91	0.01	2	100.00	
Total		0.01		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1272
DATE: 5/ 5/97 GEAR TYPE: PT No:6 POSITION:Lat S 1001
start stop duration Long E 1313
TIME :19:17:56 19:38:28 21 (min) Purpose code: 1
LOG :4793.16 4794.36 0.99 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 38 47 Validity code:
Towing dir: 300° Wire out: 190 m Speed: 40 kn*10

Sorted: 239 Kg Total catch: 8335.94 CATCH/HOUR: 23816.97

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	11051.89	56477	46.40	2809
Brachydeuterus auritus	PODBR01	4622.63	48909	19.41	
Chloroscombrus chrysurus	CARCH01	4461.71	33603	18.73	
Trachurus trecae	CARTR02	1440.91	16823	6.05	2807
Selene dorsalis	CARSL01	459.34	3803	1.93	
Galeorhinus galeus	SHATR51	380.34	146	1.60	
Alectis alexandrinus	CARAL01	346.69	146	1.46	
Sardinella aurita	CLUSL01	329.14	1903	1.38	2808
Decapterus rhonchus	CARDE02	292.57	440	1.23	
Sphyraena afra	SPHSP03	222.57	11	0.93	
Sphyraena guachancho	SPHSP01	98.00	146	0.41	
Engraulis encrasicolus	ENGEN01	74.60	12434	0.31	
Ilisha africana	CLUIL01	36.57	440	0.15	
Total		23816.96		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1273
DATE: 6/ 5/97 GEAR TYPE: PT No:5 POSITION:Lat S 1008
start stop duration Long E 1315
TIME :07:35:04 08:36:33 61 (min) Purpose code: 1
LOG :4821.75 4826.02 3.55 Area code : 1
FDEPTH: 20 30 GearCond.code:
BDEPTH: 55 59 Validity code:
Towing dir: 150° Wire out: 177 m Speed: 40 kn*10

Sorted: 76 Kg Total catch: 76.48 CATCH/HOUR: 75.23

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	71.31	272	94.79	2810
Euthynnus alletteratus	SCMEU01	2.20	1	2.92	
Sarda sarda	SCMSA01	1.09	1	1.45	
Sardinella aurita	CLUSL01	0.62	3	0.82	
Total		75.22		99.98	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1274
DATE: 6/ 5/97 GEAR TYPE: PT No:5 POSITION:Lat S 1008
start stop duration Long E 1315
TIME :12:07:45 14:08:58 121 (min) Purpose code: 1
LOG :4834.88 4843.85 2.92 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 50 39 Validity code:
Towing dir: 320° Wire out: 280 m Speed: 40 kn*10

Sorted: 258 Kg Total catch: 258.36 CATCH/HOUR: 128.11

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	81.35	274	63.50	2812
Stromateus fiatola	STRST01	10.36	10	8.09	
Brachydeuterus auritus	PODBR01	8.98	87	7.01	
Chloroscombrus chrysurus	CARCH01	8.11	56	6.33	
Selene dorsalis	CARSL01	6.27	46	4.89	
Sphyraena guachancho	SPHSP01	5.45	6	4.25	
Trachurus trecae	CARTR02	4.83	17	3.77	2811
Sardinella aurita	CLUSL01	0.81	4	0.63	
Pagellus bellottii	SPAPA02	0.64	5	0.50	
Trichiurus lepturus	TRITR01	0.58	1	0.45	
Auxis thazard	SCHAU01	0.51	1	0.40	
Scomber japonicus	SCMSC01	0.16		0.12	
Trachinotus ovatus	CARTC03	0.05		0.04	
Fistularia petimba	FISFI01	0.00			
Total		128.10		99.98	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1275
DATE: 6/ 5/97 GEAR TYPE: BT No:1 POSITION:Lat S 1010
start stop duration Long E 1318
TIME :15:12:31 15:52:53 40 (min) Purpose code: 1
LOG :4847.01 4848.98 2.16 Area code : 1
FDEPTH: 38 49 GearCond.code:
BDEPTH: 38 49 Validity code:
Towing dir: 300° Wire out: 160 m Speed: 31 kn*10

Sorted: 90 Kg Total catch: 780.02 CATCH/HOUR: 1170.03

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	PODBR01	330.86	4953	28.28	
Selene dorsalis	CARSL01	211.91	1899	18.11	
Trachurus trecae	CARTR02	149.51	1650	12.78	2813
Chloroscombrus chrysurus	CARCH01	83.85	585	7.17	
Sphyraena guachancho	SPHSP01	67.61	78	5.78	
Stromateus fiatola	STRST01	65.00	65	5.56	
Trichiurus lepturus	TRITR01	53.30	143	4.56	
Pagellus bellottii	SPAPA02	45.50	248	3.89	
Dentex barnardi	SPADE06	35.10	611	3.00	
Galeoides decadactylus	PLNGA01	34.32	65	2.93	
Raja miraletus	RAYRA11	33.29	53	2.85	
Pomadasys incisus	PODPO02	26.66	287	2.28	
Pseudotolithus typus	SCIPS03	11.45	26	0.98	
Citharus linguatula	CITCI01	6.24	209	0.53	
Umbrina canariensis	SCIUM01	5.60	53	0.48	
Penaeus notialis	SHRPE61	4.43	156	0.38	
Boops boops	SPABO01	2.60	14	0.22	
Torpedo torpedo	RAYTO11	1.43	14	0.12	
Sepia officinalis hierredda	SQUSE11	1.31	14	0.11	
Engraulis encrasicolus	ENGEN01	0.14	39	0.01 *	
Total		1170.11		100.02	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1276
DATE: 6/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1009
start stop duration Long E 1317
TIME :17:34:34 17:54:03 19 (min) Purpose code: 1
LOG :4852.60 4853.95 1.23 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 45 41 Validity code:
Towing dir: 170° Wire out: 180 m Speed: 40 kn*10

Sorted: 215 Kg Total catch: 2311.11 CATCH/HOUR: 7298.24

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	3123.63	12764	42.80	2814
Chloroscombrus chrysurus	CARCH01	2204.40	16279	30.20	
Selene dorsalis	CARSL01	824.15	3559	11.29	
Trachurus trecae	CARTR02	596.49		8.17	2815
Sphyraena afra	SPHSP03	293.68	13	4.02	
Scomberomorus tritor	SCMSM01	78.95	57	1.08	
Sarda sarda	SCMSA01	74.34	57	1.02	
Sphyraena guachancho	SPHSP01	53.59	117	0.73	
Sardinella aurita	CLUSL01	29.40	174	0.40	
Brachydeuterus auritus	PODBR01	17.87	174	0.24	
Engraulis encrasicolus	ENGEN01	1.74	174	0.02	
Total		7298.24		99.97	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1277
DATE: 7/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1008
start stop duration Long E 1314
TIME :09:00:37 10:46:20 106 (min) Purpose code: 1
LOG :4888.85 4895.47 6.39 Area code : 1
FDEPTH: 25 25 GearCond.code:
BDEPTH: 56 59 Validity code:
Towing dir: 150° Wire out: 180 m Speed: 44 kn*10

Sorted: 96 Kg Total catch: 354.20 CATCH/HOUR: 200.49

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	200.49	1411	100.00	2816
Total		200.49		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1278
DATE: 7/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 1024
start stop duration Long E 1328
TIME :16:09:09 17:25:00 76 (min) Purpose code: 1
LOG :4935.47 4940.10 5.09 Area code : 1
FDEPTH: 12 12 GearCond.code:
BDEPTH: 39 63 Validity code:
Towing dir: 290° Wire out: 180 m Speed: 45 kn*10

Sorted: 106 Kg Total catch: 106.05 CATCH/HOUR: 83.72

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	62.80	186	75.01	2818
Trachurus trecae	CARTR02	8.57	26	10.24	2817
Trichiurus lepturus	TRITR01	7.89	28	9.42	
Scomberomorus tritor	SCMSW01	1.14	1	1.36	
Selene dorsalis	CARSL01	0.87	2	1.04	
Sardinella aurita	CLUSL01	0.79	2	0.94	
Brachydeuterus auritus	PODBR01	0.67	6	0.80	
Trachinotus goreensis	CARTC02	0.51	1	0.61	
Chloroscombrus chrysurus	CARCH01	0.47	2	0.56	
Total		83.71		99.98	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1279
DATE: 8/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1213
start stop duration Long E 1336
TIME :09:06:03 10:38:04 92 (min) Purpose code: 1
LOG :5090.24 5095.16 4.96 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 42 35 Validity code:
Towing dir: 25° Wire out: 180 m Speed: 38 kn*10

Sorted: 159 Kg Total catch: 8846.80 CATCH/HOUR: 5769.65

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	5269.11	15112	91.32	2819
Trichiurus lepturus	TRITR01	432.20	989	7.49	
Trachurus trecae	CARTR02	51.86	110	0.90	
Sardinella aurita	CLUSL01	15.08	37	0.26	
Sarda sarda	SCMSA01	1.41	1	0.02	
Total		5769.66		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1280
DATE: 8/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1213
start stop duration Long E 1336
TIME :12:43:43 14:09:56 86 (min) Purpose code: 1
LOG :5102.21 5107.47 5.16 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 42 36 Validity code:
Towing dir: 25° Wire out: 175 m Speed: 38 kn*10

Sorted: 165 Kg Total catch: 7131.63 CATCH/HOUR: 4975.55

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	4635.67	13656	93.17	2821
Trachurus trecae	CARTR02	281.13	703	5.65	2820
Trichiurus lepturus	TRITR01	41.25	91	0.83	
Sardinella aurita	CLUSL01	16.19	31	0.33	
Mugil cephalus	MUGMU02	1.30	1	0.03	
Total		4975.54		100.01	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1281
DATE: 9/ 5/97 GEAR TYPE: PT No:1 POSITION:Lat S 1214
start stop duration Long E 1336
TIME :09:28:26 09:59:04 31 (min) Purpose code: 1
LOG :5163.93 5165.55 1.53 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 41 43 Validity code:
Towing dir: 15° Wire out: 175 m Speed: 30 kn*10

Sorted: 203 Kg Total catch: 203.56 CATCH/HOUR: 393.99

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	193.35	565	49.07	2823
Trichiurus lepturus	TRITR01	172.55	418	43.80	
Trachurus trecae	CARTR02	11.52	31	2.92	2822
Pomadasys jubelini	PODPO01	8.42	12	2.14	
Selene dorsalis	CARSL01	3.89	12	0.99	
Sepia officinalis hierredda	SQUSE11	3.27	2	0.83	
Sardinella aurita	CLUSL01	0.75	2	0.19	
Pagellus bellottii	SPAPA02	0.23	2	0.06	
Total		393.98		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1282
DATE: 9/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1215
start stop duration Long E 1336
TIME :12:58:13 14:36:07 98 (min) Purpose code: 1
LOG :5172.51 5176.98 4.25 Area code : 1
FDEPTH: 10 10 GearCond.code:
BDEPTH: 42 48 Validity code:
Towing dir: 9° Wire out: 175 m Speed: 28 kn*10

Sorted: 218 Kg Total catch: 437.22 CATCH/HOUR: 267.69

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	128.94	363	48.17	2825
Trachurus trecae	CARTR02	73.84	183	27.58	2824
Pomadasys jubelini	PODPO01	44.39	58	16.58	
Trichiurus lepturus	TRITR01	14.27	39	5.33	
Lithognathus mormyrus	SPALI01	1.46	2	0.55	
Atractoscion aequidens	SCIAT01	1.18	1	0.44	
Brachydeuterus auritus	PODBR01	1.11	6	0.41	
Selene dorsalis	CARSL01	1.10	4	0.41	
Sardinella aurita	CLUSL01	1.09	2	0.41	
Scomber japonicus	SCMSC01	0.32	1	0.12	
Total		267.70		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1283
DATE:10/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1207
start stop duration Long E 1339
TIME :08:37:38 09:25:12 48 (min) Purpose code: 1
LOG :5222.62 5224.98 2.47 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 34 36 Validity code:
Towing dir: 15° Wire out: 175 m Speed: 30 kn*10

Sorted: 223 Kg Total catch: 223.36 CATCH/HOUR: 279.20

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	TRITR01	266.63	635	95.50	
Sardinella maderensis	CLUSL02	8.44	24	3.02	2826
Trachinotus ovatus	CARTC03	1.66	4	0.59	
Sphyraena guachancho	SPHSP01	0.93	1	0.33	
Chloroscombrus chrysurus	CARCH01	0.86	4	0.31	
Selene dorsalis	CARSL01	0.50	1	0.18	
Brachydeuterus auritus	PODBR01	0.19	1	0.07	
Total		279.21		100.00	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1284
DATE:10/ 5/97 GEAR TYPE: BT No:1 POSITION:Lat S 1207
start stop duration Long E 1340
TIME :10:27:03 10:53:38 27 (min) Purpose code: 1
LOG :5229.02 5230.29 1.51 Area code : 1
FDEPTH: 33 32 GearCond.code:
BDEPTH: 33 32 Validity code:
Towing dir: 200° Wire out: 160 m Speed: 30 kn*10

Sorted: 74 Kg Total catch: 344.70 CATCH/HOUR: 766.00

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Brachydeuterus auritus	PODBR01	247.22	3036	32.27	
Trichiurus lepturus	TRITR01	196.11	344	25.60	
Trachurus trecae	CARTR02	88.33	6456	11.53	2827
Pomadasys incisus	PODPO02	39.44	644	5.15	
Dentex barnardi	SPADE06	33.33	456	4.35	
Sphyraena guachancho	SPHSP01	23.33	56	3.05	
Selene dorsalis	CARSL01	18.33	56	2.39	
Umbrina canariensis	SCIUM01	17.56	211	2.29	
Balistes capriscus	BALBA01	16.22	33	2.12	
Mugil cephalus	MUGMU02	14.44	11	1.89	
Pontinus accraensis	SCRPO10	13.33	22	1.74	
Lithognathus mormyrus	SPALI01	13.33	33	1.74	
Octopus vulgaris	SQUOC11	10.22	2	1.33	
Pagellus bellottii	SPAPA02	7.89	111	1.03	
Pomadasys rogeri	PODPO04	6.11	11	0.80	
Cynoglossus senegalensis	CYGCY08	5.78	33	0.75	
Rhinobatos albomaculatus	RAYRB16	5.11	2	0.67	
Chaetodon hoefleri	CHACH01	3.67	33	0.48	
Citharus linguatula	CITCI01	3.00	22	0.39	
Penaeus notialis	SHRPE61	1.89	56	0.25	
Pseudupeneus prayensis	MULPS01	1.22	11	0.16	
Chaetodon marcellae	CHACH02	0.11	11	0.01	
Total		765.97		99.99	

DR. FRIDTJOF NANSEN PROJECT:A4 PROJECT STATION:1285
DATE:11/ 5/97 GEAR TYPE: PT No:2 POSITION:Lat S 1204
start stop duration Long E 1340
TIME :12:08:58 13:56:09 107 (min) Purpose code: 1
LOG :5266.28 5272.10 6.25 Area code : 1
FDEPTH: 5 5 GearCond.code:
BDEPTH: 38 37 Validity code:
Towing dir: 5° Wire out: 175 m Speed: 33 kn*10

Sorted: 115 Kg Total catch: 400.06 CATCH/HOUR: 224.33

SPECIES		CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	CLUSL02	118.35	341	52.76	2828
Trichiurus lepturus	TRITR01	89.01	191	39.68	
Trachinotus ovatus	CARTC03	7.99	20	3.56	
Chloroscombrus chrysurus	CARCH01	5.10	26	2.27	
Sphyraena guachancho	SPHSP01	1.83	2	0.82	
Pagellus bellottii	SPAPA02	0.79	2	0.35	
Sarda sarda	SCMSA01	0.61	1	0.27	
Brachydeuterus auritus	PODBR01	0.59	4	0.26	
Lagocephalus laevigatus	TETLA01	0.08	10	0.04	
Total		224.35		100.01	

Annex VI Shoal tracking data for 1996 and 1997

Shoal Tracking Angola 1996

	Speed (m/s)	SD (m/s)	N speed (m/s)	E speed (m/s)	M speed (m/s)	Heading (°)	Depth (m)	Area (m²)	Time	South (°)	East (°)	N (Observ.)
School 1	0,67	0,68	0,03	0,17	0,17	80	11	153	8,49	9,17	12,91	107
School 2	0,69	0,52	0,01	0,11	0,11	85	9	110	9,8	9,19	12,91	72
School 3	0,74	0,28	0,55	0,22	0,59	202	3	22	14,87	9,19	12,92	11
School 4	0,85	0,7	0,03	0,17	0,17	80	8	145	15,4	9,19	12,91	19
School 5	0,51	0,32	0,03	0,35	0,35	275	4	181	15,51	9,19	12,91	8
School 6	2,3	0,4	1,16	0,39	1,22	199	1	19	15,8	9,18	12,91	5
School 7	0,95	0,57	0,11	0,05	0,12	205	5	89	16,13	9,17	12,91	43
School 8	1,04	0,67	0,22	0,02	0,22	185	11	95	16,14	9,17	12,91	37
School 9	0,67	0,63	0,1	0,02	0,1	169	3	114	17,02	9,17	12,91	27
School 10	0,97	0,91	0,05	0,16	0,17	287	9	93	8,78	9,75	13,08	14
School 11	1,99		0,69	1,86	1,98	250	22	73	12,07	9,28	12,95	2
School 12	0,73	0,64	0,09	0,03	0,09	345	7	261	13,01	9,23	12,92	30
School 13	1,11	0,68	0,17	0,08	0,19	335	9	240	13,46	9,24	12,92	37
School 14	1	0,6	0,04	0,01	0,04	166	5	176	14,6	9,18	12,91	63
School 15	1,32	0,74	0,73	0,42	0,84	30	5	206	15,57	9,15	12,89	9
School 16												
School 17	1,2	0,7	0,49	0,21	0,53	247	11	375	6,8	9,08	12,91	99

Shoal Tracking Angola 1997

	Speed (m/s)	SD (m/s)	N speed (m/s)	E speed (m/s)	M speed (m/s)	Heading (°)	Depth (m)	Area (m²)	Time	South (°)	East (°)	N (Observ.)
School 1							6		13,5	9,18	12,89	0
School 2	1,05		0,46	1,24	1,32	70	26		13,67	9,18	12,89	1
School 3	0,82		0,48	0,83	0,96	60	38		13,87	9,18	12,9	1
School 4	3,37		-0,63	0,71	0,95	131	22		14,03	9,18	12,9	1
School 5	1,32	0,26	0,34	1,01	1,06	72	9		14,28	9,19	12,9	6
School 6	2,27		0	2,27	2,27	90	33		14,47	9,19	12,9	1
School 7	0,95	0,19	0,38	-0,7	0,8	298	6		14,77	9,18	12,9	5
School 8	1,54	0,58	0,61	-1,13	1,28	298	3		12,35	9,82	13,16	10
School 9	0,56		-0,45	0,13	0,47	164	1		16,63	9,87	13,14	1
School 10	2,06	0,47	-0,91	-1,56	1,8	240	1		16,8	9,87	13,13	3
School 11	1,49	0,73	-0,07	0,66	0,66	96	4		17,16	9,86	13,13	8
School 12	0,66		0,56	0,33	0,65	30	2		10,5	9,86	13,23	1
School 13	1,26	0,32	1,09	-0,01	1,09	1	4		10,68	9,86	13,23	4
School 14	1,16	0,64	-0,19	-0,21	0,28	228	8		12,24	9,85	13,24	10
School 15	0,42	0,23	-0,08	-0,42	0,42	101	27		7,92	10,16	13,26	4
School 16	1,3	0,6	0,14	0,95	0,96	82	28		10,18	10,18	13,26	8
School 17	1,3	0,44	-0,69	0,24	0,73	44	10		16,73	10,15	13,29	8
School 18	1,03	0,65	0,47	0,46	0,66	45	17		8,35	10,18	13,27	4
School 19	1,69	0,82	-0,3	1,39	1,42	103	8		8,6	10,18	13,27	5
School 20	1,67		1,23	-1,28	1,77	314	10		8,33	12,13	13,62	1
School 21	0,99	0,43	0,34	0,27	0,43	39	15		8,56	12,16	13,62	6
School 22	1,5	0,49	0,94	-1,06	1,42	311	6		9,18	12,16	13,61	3
School 23	0,73	0,7	-0,41	-0,22	0,47	208	4		11,87	12,19	13,63	11
School 24	1,45	0,29	-0,21	1,07	1,09	101	4		6,91	12,09	13,67	4
School 25	1,09	0,46	0,04	0,8	0,84	87	5		7,3	12,09	13,67	13

Annex VII Shoal behaviour events for 1996 and 1997

Shoal Behaviour Angola 1996

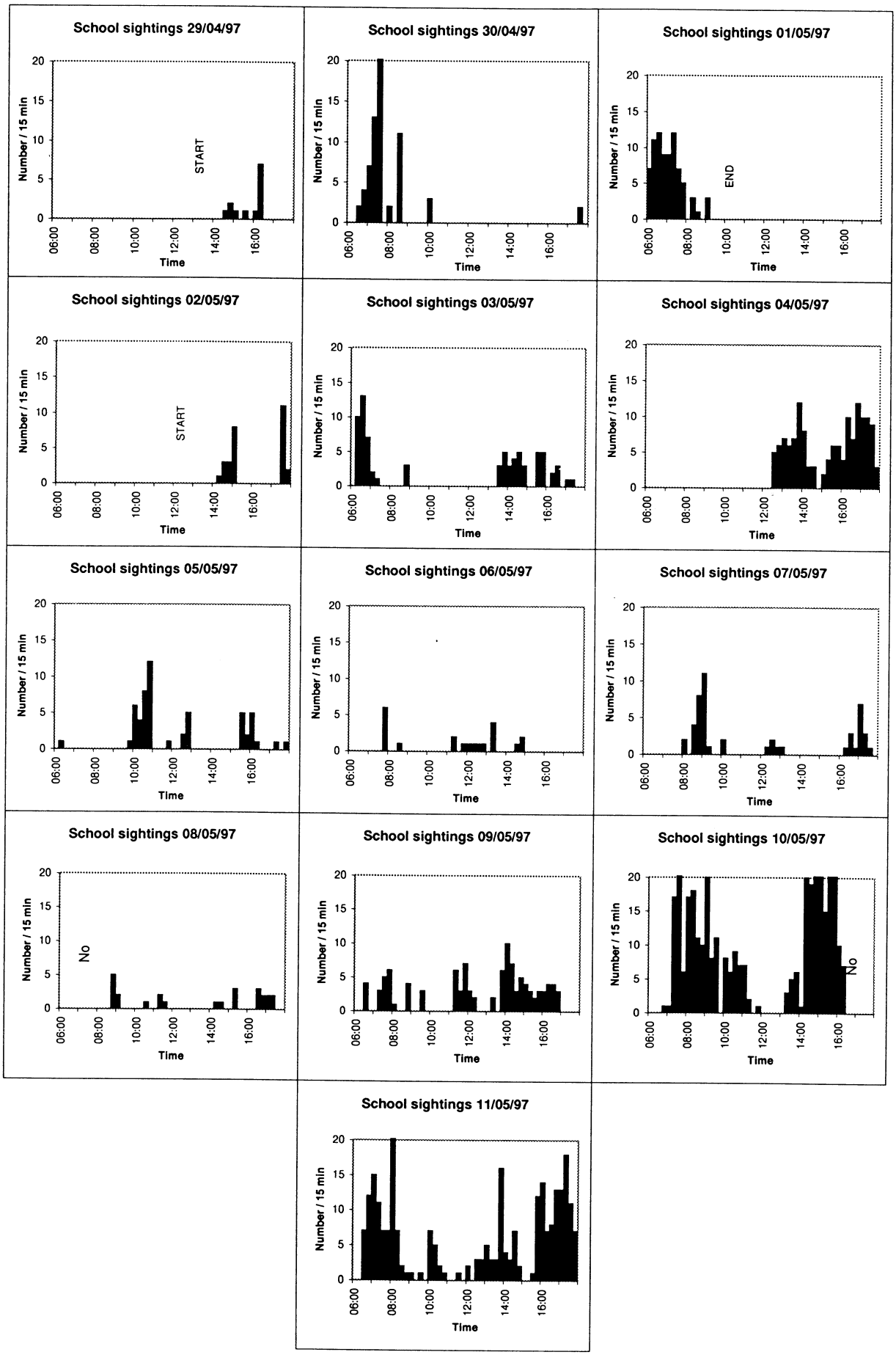
			SHAPE							INTRASCHOOL EVENTS					INTERSCHOOL EVENTS		
	Time	Duration	Circle	Oval	Rod	Crescent	Ring	Amorph	Fragmented	Change of shape	Re- organising	Splitting	Leaving	No. of events	Join	Approach	No. of events
School 1	07:58	60	1	6	3	3	1	4	23	36	1	6	1	44	5	-	5
School 2	09:20	41	3	7	-	6	-	-	8	22	-	7	-	28	6	-	6
School 3	14:44	6	-	1	1	2	-	-	1	3	-	1	-	4	-	-	-
School 4	15:14	5	1	-	-	-	-	-	2	1	-	1	-	2	1	-	1
School 5	15:22	5	1	2	-	1	-	-	1	1	-	1	-	2	1	-	1
School 6	15:41	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
School 7	15:48	18	-	7	2	4	-	-	3	3	-	2	2	7	1	1	2
School 8	16:08	7	-	2	5	-	-	-	-	2	-	-	1	3	-	-	-
School 9	16:48	14	-	2	-	-	-	1	3	5	-	-	1	6	1	-	1
School 10	08:36	8	-	3	-	-	-	1	3	4	-	2	-	6	1	-	1
School 11	11:58	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
School 12	12:46	18	-	5	-	-	-	-	8	12	2	-	4	18	1	-	1
School 13	13:14	19	-	7	-	2	-	-	5	11	1	2	2	16	1	-	1
School 14	14:13	16	-	2	5	-	-	5	1	9	-	1	2	12	1	-	1
School 15	14:30	61	-	13	2	4	4	-	6	21	-	4	1	26	4	-	4
School 16	15:28	3	-	-	-	1	-	1	2	4	-	-	1	5	1	-	1
School 17	06:03	72	8	21	5	9	-	4	13	72	1	9	2	84	6	4	10
TOTAL	**-**	**356**	**14**	**80**	**24**	**31**	**1**	**16**	**79**	**206**	**5**	**36**	**17**	**263**	**30**	**5**	**35**

Shoal Behaviour Angola 1997

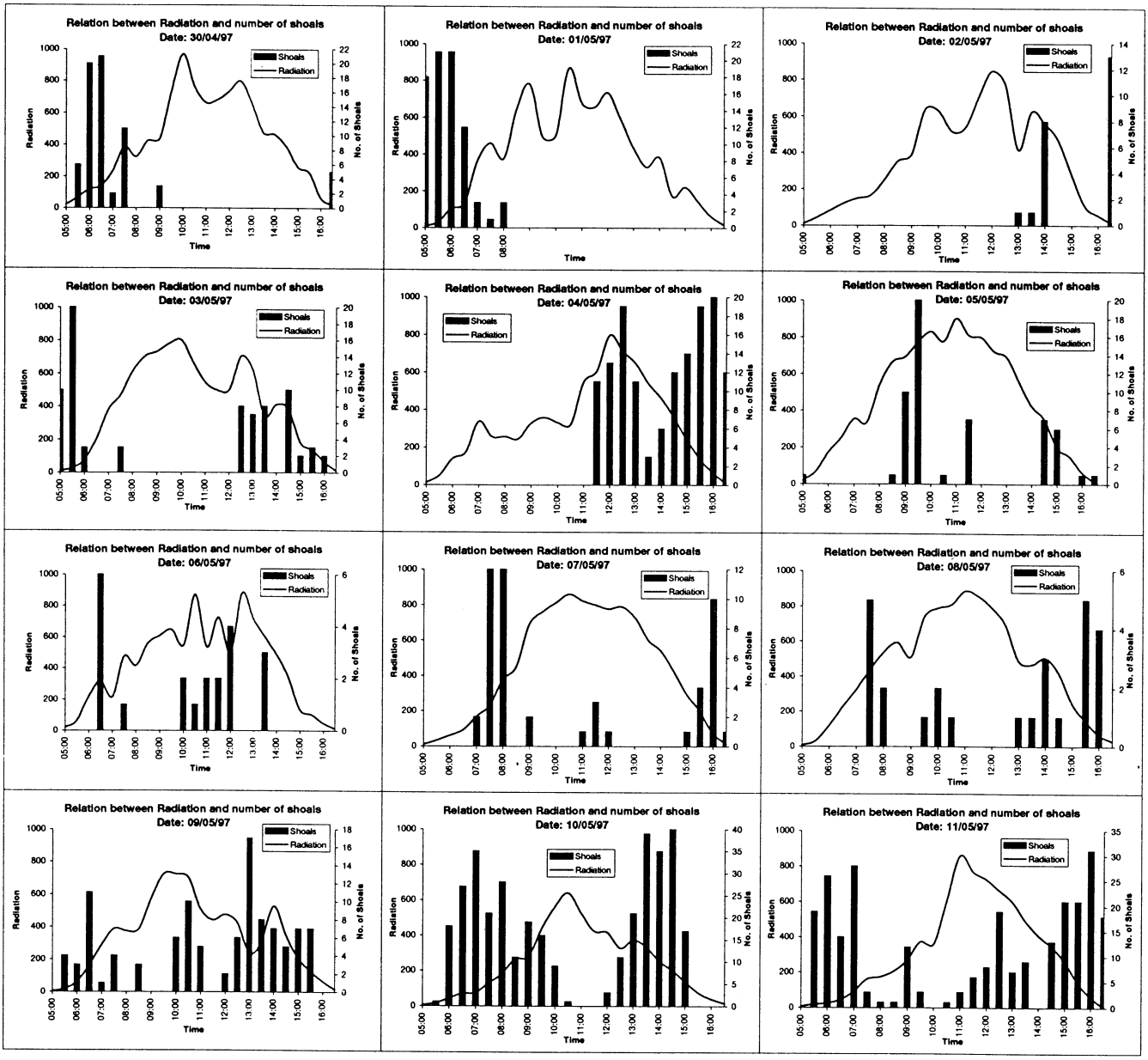
			SHAPE							INTRASCHOOL EVENTS					INTERSCHOOL EVENTS		
	Time	Duration	Circle	Oval	Rod	Crescent	Ring	Amorph	Fragmented	Change of shape	Re- organising	Splitting	Leaving	No. of events	Join	Approach	No. of events
School 1	13:30	6	-	-	-	-	-	-	2	2	1	1	-	5	-	-	-
School 2	13:38	6	-	-	-	-	-	-	1	1	-	1	-	2	-	1	1
School 3	13:51	6	-	-	-	-	-	-	2	2	-	-	-	2	-	-	-
School 4	14:00	10	-	-	1	-	-	-	3	4	1	-	-	5	-	-	-
School 5	14:10	16	-	-	-	-	-	-	4	4	-	-	-	4	-	-	-
School 6	14:26	6	-	-	-	-	-	-	3	3	-	-	-	3	-	-	-
School 7	14:40	14	-	-	-	-	-	-	3	3	-	-	-	3	-	-	-
School 8	12:06	32	-	3	5	-	-	3	-	11	1	3	-	15	1	-	1
School 9	16:36	6	1	-	4	-	-	-	1	6	1	-	-	6	2	1	3
School 10	16:44	10	-	-	5	-	-	-	-	5	-	1	-	5	1	1	2
School 11	17:00	30	3	-	1	4	-	-	2	10	-	2	-	12	2	-	2
School 12	10:28	8	1	1	-	-	-	-	-	2	-	-	-	2	-	-	-
School 13	10:36	12	-	2	2	1	1	-	-	6	-	-	-	6	-	-	-
School 14	11:56	68	3	-	2	-	-	-	-	5	-	3	-	8	2	4	6
School 15	07:50	12	2	1	-	-	-	-	2	5	1	-	-	6	-	1	1
School 16	10:02	20	1	1	1	-	-	-	-	3	2	1	-	6	-	1	1
School 17	16:27	34	-	1	-	-	-	-	2	3	-	1	-	4	-	1	1
School 18	08:16	12	2	1	2	-	-	-	-	5	-	2	-	7	-	1	1
School 19	08:28	20	1	-	1	-	-	-	1	3	-	-	-	3	-	1	1
School 20	08:18	6	1	-	-	-	-	-	1	2	-	-	-	2	-	-	-
School 21	08:24	24	-	2	4	1	-	1	2	10	1	1	-	12	-	-	1
School 22	09:07	10	-	1	-	-	-	1	1	3	-	-	-	3	-	-	1
School 23	11:41	25	-	3	6	2	-	1	2	14	-	1	-	15	3	-	3
School 24	06:49	12	-	-	2	-	-	-	-	2	-	1	-	3	-	-	-
School 25	07:02	33	1	1	-	-	1	-	1	4	-	1	-	5	-	2	2
School 26	16:10	6	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-
TOTAL	**-**	**444**	**16**	**17**	**36**	**8**	**2**	**6**	**34**	**119**	**8**	**19**	**0**	**145**	**11**	**14**	**27**

Annex VIII Daily records of shoal sightings and solar radiation levels

Annex VIIIa Number of schools sighted at surface (local time)



Annex VIII B: Relation between radiation and number of shoals at surface (Times in UTC)



Annex IX Record of frequency of occurrence of species in trawls

(* no. of trawls present in)

BONY FISH

BALISTIDAE	*Nalistes capriscus*	*
BELONIDAE	*Ablennes hians*	**
CARANGIDAE	*Alectis alexandrinus*	*
	Caranx chrysos	**
	Chloroscombrus chrysurus	***** ***
	Decapturus rhonchus	**
	Naucrates ductor	*
	Selene dorsalis	***** ***** *****
	Trachinotus goreensis	***** *
	Trachinotus ovatus	*****
	Trachurus trecae	***** ***** ***** *
CHAETODONTIDAE	*Chaetodon hoefleri*	*
	Chaetodon marcellae	*
CITHARIDAE	*Citharus linguatula*	***
CLUPEIDAE	*Ilisha africana*	**
	Sardinella maderensis	***** ***** ***** ***** ****
	Sardinella aurita	***** ***** ***** ***
CYNOGLOSSIDAE	*Cynoglossus senegalensis*	*
ECHENEIDAE	*Echeneis naucrates*	***** ***
ENGRAULIDAE	*Engraulis encrasicolus*	***** **
FISTULARIIDAE	*Fistularia petimba*	*
HAEMULIDAE	*Brachydeuterus auritus*	***** ***** ***
	Pomadasys incisus	**
	Pomadasys jubelini	**
	Pomadsys rogeri	*
MUGILIDAE	*Mugil cephalus*	**
MULLIDAE	*Pseudupeneus prayensis*	*
POLYNEMIDAE	*Galeoides decadactylus*	*
PTERADONTIDAE	*Lagocephalus laevigatus*	*****
PRIACANTHIDAE	*Priacanthus arenatus*	*
SCIAENIDAE	*Pseudotolithus typus*	*
	Umbrina canariensis	**
	Atractoscion aequidens	*
SCOMBRIDAE	*Sarda sarda*	***** **
	Auxis thazard	**
	Scomberomorus tritor	***** ***
	Euthynnus alletteratus	***
	Scomber japonicus	***** *
SCORPAENIDAE	*Pontinus accraensis*	*
SPARIDAE	*Boops boops*	*
	Dentex barnardi	**
	Lythognathus mormyrus	*
	Pagellus bellottii	******
SPHYRAENIDAE	*Sphyraena afra*	***
	Sphyraena guachancho	***** ***** *****
STROMATEIDAE	*Stromateus fiatola*	***
SYNODONTIDAE	*Saurida braziliensis*	*
TRICHIURIDAE	*Trichiurus lepturus*	***** ****

SHARKS

CARCHRHINIDAE	*Carcharhinus brachyrus*	*
	Rhizorionodon acutus	*
LAMNIDAE	*Isurus paucus*	*
MOBULIDAE	*Manta birostris*	****
RAJIDAE	*Raja miraleus*	*
RHINOBATIDAE	*Rhinobatos albomaculatus*	*
TORPEDINIDAE	*Torpedo torpedo*	*
TRIAKIDAE	*Galeorhinchus galeus*	**

SHRIMPS

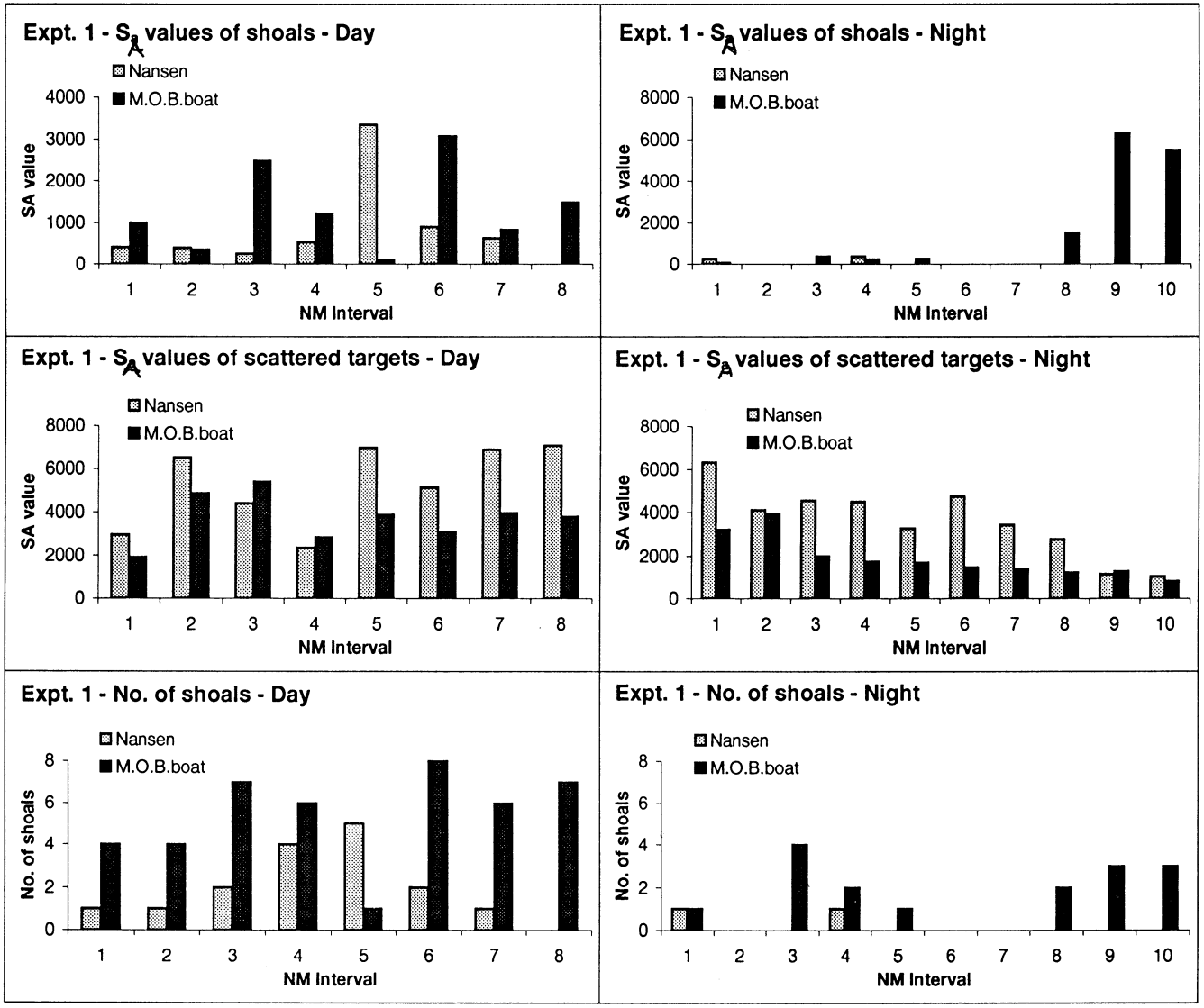
PENAEIDAE	*Penaus notialis*	**

CEPHALOPODS

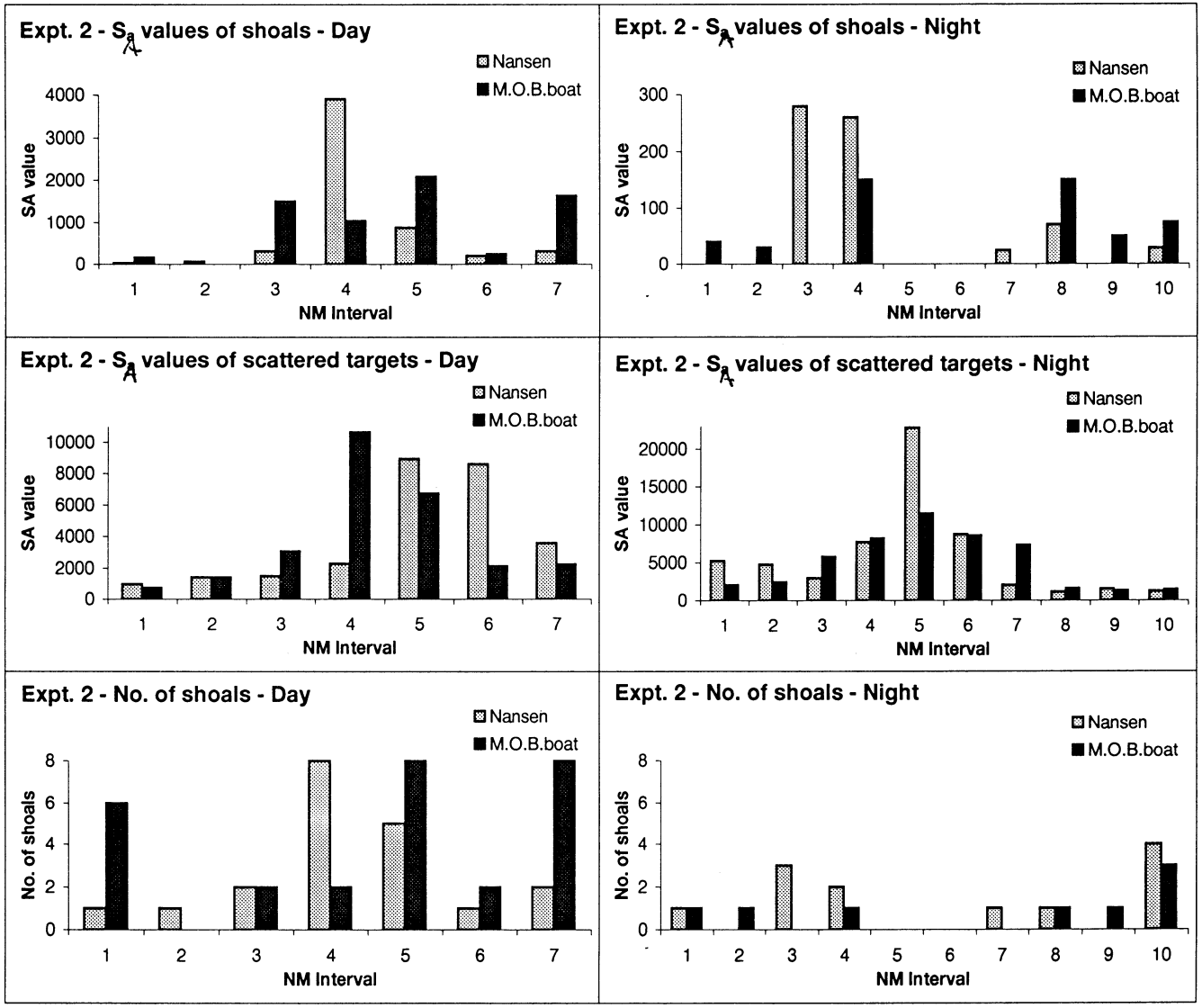
LOLIGINIDAE	*Alloteuthis africana*	*
OCTOPODIDAE	*Octopus sp.*	*
	Octopus vulragis	*
SEPIIDAE	*Sepia officinalis*	*****
	Sepiella ornata	*****

Annex XI S_a values of shoals and scattered fish and number of shoals for each small boat experiment

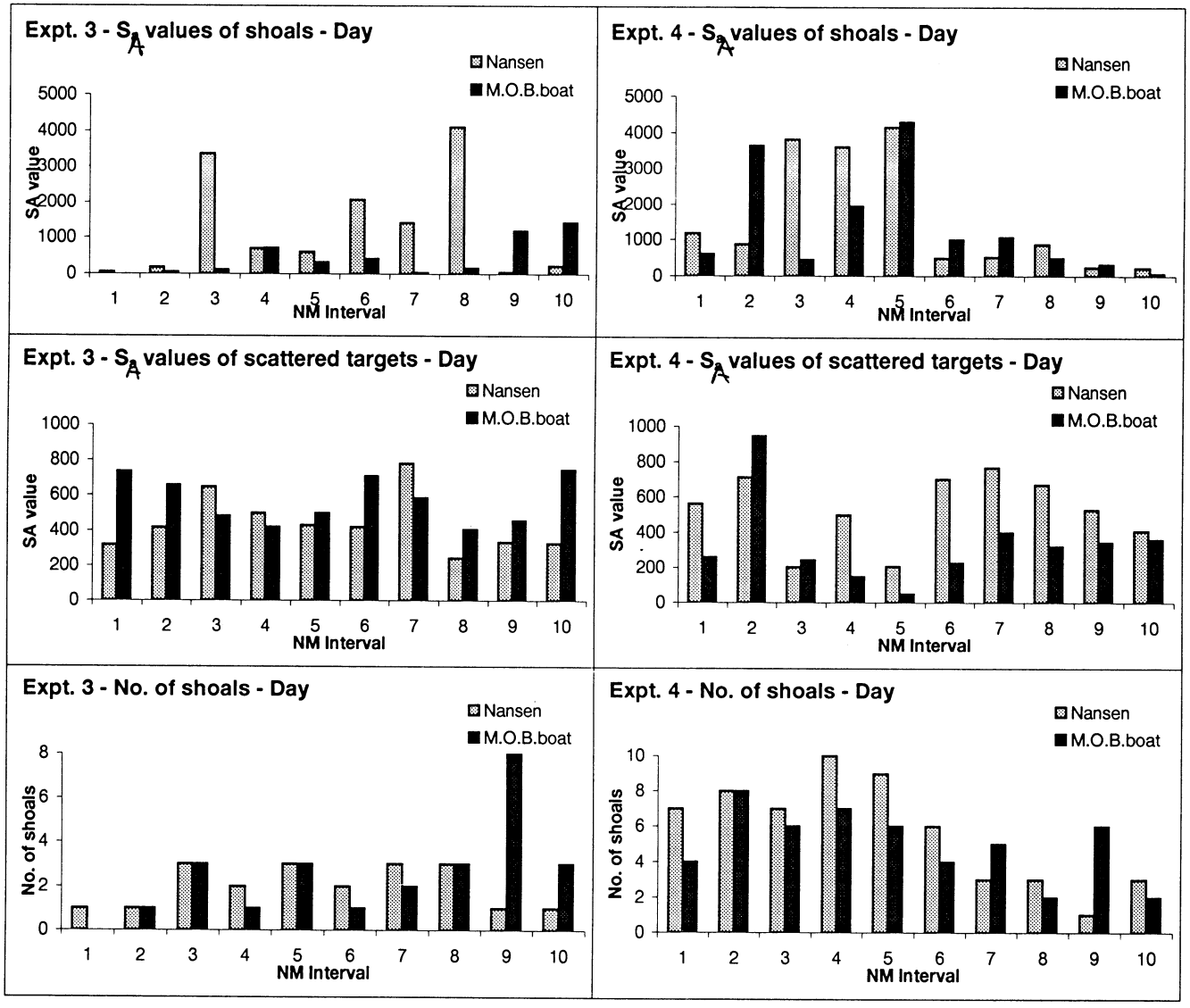
Results of the small boat experiments - 1



Results of the small boat experiments - 2



Results of the small boat experiments - 3 & 4



ANNEX XII Record of daily activity

23/4

J. Dalen, HI, and E. Frønes and T. W. Hansen, SIMRAD arriving and starting implementation and testing of SODAPS.

24/4

Working on SODAPS in Luanda harbour.

25/4

O.A.Misund and B. Totland, IMR, and P.E. Nordbø, CMR, arriving at about 10:00. Ole Gullaksen arriving at about 21:00, without local agent (Hull Blyth) or captain being informed. J. Coetzee not arriving because visa was given to late. Working on SODAPS in Luanda harbour.

26/4

D. Boyer, R. Cloete and G. Oechslin, MFMR, arriving. Working on SODAPS in Luanda harbour.

27/4

Working on SODAPS in Luanda harbour. Tour to the beach organized by Norwegian Embassy and A. Sangolt and family.

28/4

Working on SODAPS in Luanda harbour. Cruise meeting at 10:00 to discuss objectives and tasks of the cruise. Prepared ICES abstract from results obtained on pelagic trawl sampling during last years survey, and hopefully new results this year. P.E. Nordbø departing to Norway.

29/4

N'Kosi Luyeye and his two assistants onboard 10:00, departure from Luanda 11:00, steaming southwards to Palmeirinhas area, cruise meeting 12:30 about cruise programme and organization of work. Recorded several school at surface at about 16:30, sonar source level 6 dB lower than usual because of lab. Power supply only, still sonar seem weak, and uncertain school recordings, T.W. Hansen therefore adjusted colour threshold of sonar display. PT1297 at surface, speed 5 knots, trawl manoeuvred through surface school, large recording on net sonde that lasted for about 5 minutes, catch 100 kg Sardinella, two holes in the trawl which fish probably have escaped through. PT1298 in darkness at 20:00, catch Sardinella, horse mackerel, Tricurus lepturus, and barracuda. Vessel drifting from 22:30.

30/4

PT1259 off Luanda, 08:00, catch two buckets of Sardinella, surface trawling, substantial recordings on net sonde in trawl mouth, seem to swim forward and out of the trawl during hauling. Going southward to Palmeirinhas during the morning to produce fresh water and adjust the sonar and SODAPS. School tracking function not working, SODAPS not functioning, not detecting any schools. Sailing north to Luanda area again and taking PT1260 in the evening at 20:00 in darkness. Discussion about what data being delivered from the sonar to SODAPS, envelope amplitude being sent as mean back scattering ratio/m^3, this suggested changed to envelope intensity as mean back scattering ratio/m^3. J. D. Phone to P.E.Nordbø about SODAPS and possibilities to get it functioning. Printer mounted on net-sonde.

1/5

PT1261 off Luanda, catch ¾ bucket of Sardinella, recording of fish in trawl opening on net sonde, seem that the fish swam forward and out of the net when hauling. Arriving Luanda harbour at 10:30 for disembarking of Frønæs and Hansen from Simrad, and get the new sonar power supply onboard. Sonar power supply not at agency, national holiday in Angola, decided to wait for tomorrow. Handling and function test of FOCUS 400 in Luanda harbour.

2/5

Sonar power supply delivered by agent 10:30. Investigation possibility to get Jerry-can for petrol without success. Leaving Luanda 11:00. Operation trial with FOCUS400 when cruising at slow speed. O.Misund sick.

3/5

Operation trial with FOCUS400 when pelagic trawling in surface. FOCUS400 manoeuvred gently back to and underneath trawl mouth. Groundrope and wings visible. School tracking off Palmeirinhas. O. Misund still sick.

4/5

Searching southwards to Cabo Ledo for area with more fish. School tracking and PT1267 - 1269 in area. Good catches of Sardinella in PT1268 and 1269 at night, but nothing in PT1267 when towing through 3 surface schools during daytime. Fish escaping out when hauling back the net.

5/5

Working south of Cabo Ledo. School sighting, school tracking and pelagic trawling. Set up for small boat experiment at 11:00, but no response from transceiver. Cable connection failure localized in the evening, and start to prepare a new connection. No catches on two trawl stations during daytime, 8 ton catch of sardinella in the evening.

6/5

School tracking and school sighting south of Cabo Ledo in area with many schools. Pelagic trawl sampling.

7/5

School tracking south of Cabo Ledo. PT1277 with Focus400, recorded sardinella in trawl belly by FS3300, and also on camera. PT1278 with Focus400, to low visibility just before sunset to see fish in trawl by camera. Steaming southwards to Lobito area during night.

8/5

Arrived Lobito-area at about 10:00. PT 1279 with Focus400, good FS3300 and camera recordings of sardinella in the trawl belly. Catch 9 tonnes. PT1280 with Focus400, again good camera and FS3300 recordings of sardinella in the trawl belly. Small boat experiment 1 (16:15 - 17:50, 8 n.miles) and 2 (20:15 - 22:30, 10 n. Miles). In both experiments more recordings on EY500 on small boat than on EK500 on large vessel.

9/5

Working in Lobito area, schools sighting started 6:00 as on all other days during the cruise, school tracking, PT1281, catch 200 kg sardinella, trawl rigged with 10 m extension on floats, light weights, Scamnar trawleye as during PT1279 and 1280 yesterday, attempted Focus400 but camera control out of function, loose card in underwater housing detected during error searching after about 2 hours, PT1282 in same area and with same rigging, and with Focus400, some entrance of fish in the beginning of the haul, towing speed 2.8 knots, saw just a few fish on camera, catch ca. 200 kg sardinella and horse mackerel. Small boat experiment 3 (daylight) and 4 (darkness). Stopped experimenting at about 22:00.

10/5

On Lobito north - transect, school sighting from 06:00, school tracking, PT1283 with Focus400, no fish seen on camera in the trawl, catch. ca. 200 kg. *Trichopterus ? lepturus*. BT1284, catch mixture of bottom species. Small boat experiment 5, cruising with 5 knot speed north along Lobito north - transect. M.O.B. on port side in deepest waters, seemingly better recordings on D.F.N. than on M.O.B. Experiment finished 14:55. Steaming east for 15 min. to shores of Egito Praia for anchoring and grill - party.

11/5

Last day for experimenting and data collection, working on Lobito north transect. Small boat experiment no. 6, PT1285 with FOCUS400, no fish recording on camera because of low visibility, Secci-depth 2.5 m. School tracking and school sighting. Washing trawl. Steaming towards Luanda at 18:00. Cruise report production.

12/5

Arriving Luanda at 10:30, cruise report production.