

ANNEX III INSTRUMENTS AND FISHING GEAR USED

ACOUSTIC INSTRUMENTS

A SIMRAD scientific echo sounder, EK 500/38kHz, was used during the survey for estimation of fish density.

Based on a calibration experiment using a standard copper sphere in Baia dos Tigres on 26th November 1991, the following settings were used:

Absorption Coeff.	10 dB/km
Pulse length	Medium
Bandwidth	Wide
Max. Power	2000 W
Angle sensitivity	21.9
2-way Beam Angle	-21.0 dB
Sv Transd. Gain	28.0 dB
Ts Transd. Gain	28.0 dB
3 dB Beamwidth	6.9°
Along-ship Offset	0°
Athwart-ship	0°

FISHING GEAR

Bottom trawl: High opening shrimp and fish trawl with net headline 31 m (floatline), foot-rope 47m, gear with 12 cm diameter roller disks, 40 m sweeps, estimated headline height 6m and distance between wings during towing 18-20m. This gear was also used for some of the mid-water trawls.

Pelagic trawl: Swedish type mid-water trawl with a vertical opening of 20-25m.

Cod ends of trawls with fine meshed inner lining.

ANNEX IV INTERCALIBRATION OF HYDROACOUSTIC INSTRUMENTS

In order to compare the hydroacoustic systems onboard R/V "BENGUELA" and R/V "DR. FRIDTJOF NANSEN", an intercalibration was carried out between the two vessels on the 15th June between 17 50'S and 18 10'S. The total sailed distance was 105 nautical miles, and the bottom depth varied from 50 metres down to approximately 1000 metres. Different courses were used. Weather conditions were good with calm seas and practically no wind. The two vessels sailed on a parallel course with "DR. FRIDTJOF NANSEN" 0.3 nautical miles to the side of and 0.3 nautical miles ahead of "BENGUELA".

The instrument settings were in accordance with the most recent calibration with standard copper sphere, and corresponded to those used during a normal survey. Tables 1 and 2 show instrument settings for the two vessels during the intercalibration.

The recordings consisted of layers of plankton, fish or a mixture of plankton and fish, and were grouped correspondingly.

These grouped data indicated that "DR. FRIDTJOF NANSEN" obtained higher S_A values than "BENGUELA" when the recordings were plankton or very small fish in deeper waters (myctophids), while there was good similarity between the vessels when commercial fish was recorded. This corresponds to the observations made during the intercalibration between the two vessels in November 1991, and is explained by the higher performance and lower threshold settings in the EK500 system.

The intercalibration also indicated that "BENGUELA's" bottom signal is frequently integrated and contributes to the S_A value in the bottom channel. Experiments should be done to find a proper setting to minimize this bottom detection problem in the future.

It was also found that "BENGUELA" recorded noise at depths of approximately 400 metres and downwards, increasing with TVG. This interference is also integrated and will disturb data obtained from those depths. No certain explanation was found to this problem.

On the basis of these observations it was concluded that the S_A -values obtained from fish in the pelagic zone by the two vessels were similar and could be used without correction.

R/V "Dr. Fridtjof Nansen 18.06.92

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Table 1. Instrument settings onboard R/V "DR. FRIDTJOF NANSEN" during the intercalibration.

Echo sounder:	EK500
Frequency:	38 kHz
Transducer:	ES38B (6.9° circular split beam)
Transmit power:	2000 Watts nom
Noise margin:	0 dB
Pulse length:	Medium
Bandwidth:	Wide
2-way beam angle:	-21.0 dB
SV transducer gain:	27.9 dB
TS transducer gain:	28.0 dB
SA threshold:	-80 dB

Table 2. Instrument settings onboard R/V "BENGUELA" during the intercalibration.

Echo sounder:	EK400
Frequency:	38 kHz
Transducer:	8°x8° split beam
Transmit power:	2500 Watts nom
Pulse length:	1.0 ms
Bandwidth:	3.3 kHz
Attenuator:	20 dB
Performance (SL + VR):	131.6 dB
Integrator:	QD
Integrator gain:	-40.2 dB
SA threshold:	10 mV

ANNEX V EVALUATION OF BIOMASS ESTIMATES OBTAINED BY *R.V. Dr. Fridtjof Nansen* and *R.V. Benguela* IN MAY-JUNE 1992

A number of sources of error are causing variability in the biomass estimates of Namibian pelagic fish. The main sources of error are:

- 1 Fish distribution is outside of the transducer range
 - a Surface shoaling fish above transducer range
 - b Fish on bottom in "dead zone"
 - c Fish in waters shallower than 20 m
- 2 A highly clumped distribution when fish are in few scattered and very dense shoals
- 3 Migration during the survey period

During this survey several areas were covered more than once by either one or both vessels and the individual estimates of each area as assessed by the *R.V. Benguela* and *R.V. Dr. Fridtjof Nansen* are presented in Tables 1 and 2 respectively. An attempt is made below to present the best assessment of each area.

Cape Frio to Cunene River

As most of the pelagic type-1 fish occurred between Cape Frio and Cunene River, this area was covered a number of times by both vessels. The estimates were extremely variable. The high value obtained by the *R.V. Dr. Fridtjof Nansen* of over 850 000 tonnes during 4th to 7th June rests on two extremely high S_A values. The *R.V. Benguela* obtained a similarly high estimate of 830 000 tonnes on 8th June, but this also comes largely from several dense shoals. These results must be considered unreliable because of the few data points contributing such a high part of the total biomass, although their similarity suggests some accuracy.

This variability is highlighted by the two simultaneous coverages on 8th June, when the *R.V. Benguela* obtained the very high estimate of 830 000 tonnes, while the *R.V. Dr. Fridtjof Nansen* recorded 260 000 tonnes.

This high variance should be reduced by increasing the transect density and therefore the combined results of the joint survey, estimated at 500 000 tonnes, are presented as the most reliable assessment of this region. This joint survey also gave a synoptic coverage of the area removing the error caused by fish migration during an extended survey period. Some of the integration values obtained by the *R.V. Benguela* were above of the range accepted by the

acoustic equipment and were lost. Minimum values have been inserted, which means that the 500 000 tonnes is a minimum estimate.

Pelagic fish are known to become unavailable to the research vessels at certain times when surface shoaling or migration into shallow waters occurs. The calm weather and full moon during the surveys conducted towards the end of the cruise are suspected to have resulted in the fish moving inshore during the day, and possibly night also, while surface shoaling was noted during both day and night times. It is assumed that the much smaller biomass estimates obtained in this region after the joint survey on the 8th June are due to the fish being distributed outside of the transducer range.

Cunene River to Tombua

Several estimates, ranging from 25 000 tonnes to 80 000 tonnes, were obtained for the fish in southern Angola. The sources of error reported for the fish to the south of the Cunene River are assumed to have also caused this variability. It is therefore likely that the joint survey has given the most accurate estimate. This gave a total of about 50 000 tonnes.

Ambrose to Rocky Point

The shoals briefly surveyed by both vessels on the first part of the survey at Dune Point and near Rocky Bay were reported to be moving southwards by the fishermen working in this region. The area of fish at Dune Point was poorly covered by both vessels due to the activities of these fishermen in the densest part of the shoal. The *R.V. Dr. Fridtjof Nansen* estimated the fish to be 23 000 tonnes, while the *R.V. Benguela* found only 8 000 tonnes.

The fish at Rocky Point was only found by the *R.V. Dr. Fridtjof Nansen* and was surveyed on 5th June with a widely spaced grid. The *R.V. Dr. Fridtjof Nansen* returned to this area on 10th and 15th June, but the fish could not be found. This further suggested that the fish was migrating southwards.

During the southward journey at the end of the cruise the *R.V. Dr. Fridtjof Nansen* found fish at Dune Point with a similar length-frequency to the fish recorded earlier at Rocky Point. This was assumed to be the same fish which had moved some 60 nm southwards in the intervening 12 days. A dense survey grid gave an estimated biomass of 110 000 tonnes.

Pelagic fish were recorded around Ambrose Bay by the *R.V. Dr. Fridtjof Nansen* at the end of the cruise and the area was surveyed intensively. From the length-frequency characteristics, these fish are assumed to be the same as those recorded at Dune Point 14 days earlier, some 60 nm further north. The fishermen working in this area confirmed that they had been following this fish from Dune Point. The estimate for these fish was 20 000 tonnes.

The two values obtained during this southward part of the cruise are used as the most accurate assessment of these two areas of fish. The last estimate of the southern group of

shoals gave a lower estimate than that recorded 12 days earlier. This is assumed to be due to the effects of the fishing fleet.

Dolphin Head to Ambrose Bay

The only estimate of fish abundance for this area was made by the *R.V. Dr. Fridtjof Nansen* and gives about 70 000 tonnes of juvenile fish, mainly anchovy. Surface shoaling of these fish and dense layers of plankton may render this estimate unreliable and, if so, it is likely an underestimate.

The *R.V. Dr. Fridtjof Nansen* surveyed a small area of anchovy to the north of Cape Cross at the end of the cruise. The resulting estimate was 5 000 tonnes.

The species composition was determined from the trawl samples taken in each area and from the judged values of the echo traces (Table 3). On the basis of these proportions the fraction of each species occurring in each area has been calculated (Table 4) and these data are presented as the best estimates of abundance obtained during this cruise.

Table 1 Biomass estimates of Namibian pelagic fish of *R.V. Benguela*.

AREA	Day survey 4-7 June	Joint survey 8-10 June	North 13-14 June	
			North	South
Cunene-Baia dos Tigres		51 500	25 200	80 600
18°00' - Cunene		454 000	47 700	52 600
18°40' - 18°00'	239 300	375 200		
18°40' - Dune Pt.	17 500			

Table 2 Biomass estimates of Namibian pelagic fish of *R.V. Benguela*.

AREA	DAY	DAY	DAY	DAY	NIGHT	DAY	DAY+N	DAY
	27-29/5	3/6	4/6	5-7/6	6-7/6	8/6	8-11/6	14-20/6
Cunene- B.d.Tigres						52 000		
18°20' - Cunene				855 000	131 000	262 000	71 000	
Rocky Point			23 000					
Dune Point		23 000						110 000
Ambrose Bay								20 000
Cape Cross								5 000
Easter Pt. Walvis Bay	72 000							

