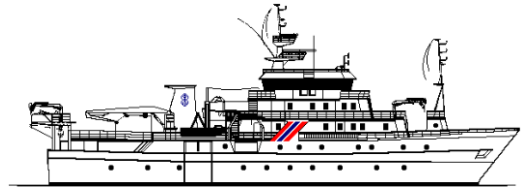


Country: Angola				
Research vessel: R/V DR. FRIDTJOF NANSEN				
Survey number: 2012402				
Number of days: 30				
General objectives: Survey to monitor the pelagic fish resources of Angola				
	Port	Date	Coverage	Specific objectives
Departure	Walvis Bay	1 March	Angola	<ul style="list-style-type: none"> To estimate the abundance and map the distribution of the main commercially important pelagic and semi-pelagic fish species in Angolan waters, including the two sardinella species <i>Sardinella aurita</i> and <i>Sardinella maderensis</i>, the Cunene horse mackerel <i>Trachurus trecae</i>, the Cape horse mackerel <i>Trachurus capensis</i>. To collect stomach samples from both horse mackerel species for analyses of diet composition. To collect stomach samples and otoliths from both sardinella species for analyses of diet composition and length-age relationships. To collect depth-stratified samples of zoo- and phytoplankton in order to continue the studies on feeding biology including relating stomach content to estimated zooplankton composition and observed density. To map the general meteorological, hydrographical and biological conditions in the survey area by means of continuous recordings of weather data, CTD-casts (Temperature, Salinity and Oxygen), ADCP measurements (Acoustic Doppler Current Profiler) and plankton sampling along acoustical and hydrographical transect lines. On-the-job training of cruise participants on the main survey routines, including using the Nansis database and scrutinizing acoustical data using IMR the post-processing system, the Large Scale Survey System (LSSS). To collect seal scats from the breeding fur seal colonies (with pups) in the Tiger Bay area in order to study their diet composition as basis for subsequent evaluations of their impacts on the fish communities in the region.
Arrival	Luanda	30 March		
Cruise leader: Aristóteles Amaro (1/3-21/3), Filomena Vaz Velho (21/3- 30/3), Knut Korsbrekke (1/3-30/3)				





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Participants:

From INIP, Angola: 01.03-21.03: Aristóteles AMARO (Co-cruise leader), Bomba Basika SANGOLAY, Fátima DELICADO, Francisco de ALMEIDA, Eusébio dos SANTOS, Geraldina SALVADOR, Tito MILAGRE, Cesaltina DIAS and João MORAIS

21.3 -30.3: Filomena VAZ VELHO (Co-cruise leader), Aristóteles AMARO, Quilanda FIDEL, Eusébio dos SANTOS, Geraldina SALVADOR, Tito MILAGRE, Cesaltina DIAS e João MORAIS and Domingos PEDRO.

From IMR, Norway: 01.03-30.03: Knut KORSBREKKE (Cruise leader), Tore MØRK and Magne OLSEN. 15.03-29.03: Knut KORSBREKKE (Líder do cruzeiro), Magne Olsen and Ole Sverre FOSSHEIM

Summary of the results:

Between the 1st and the 30 March, the survey off Angola was successfully carried out on board the R/V *Dr. Fridtjof Nansen*. A total of 49 trawl stations were carried out of which, 17 were demersal trawl and 32 pelagic. To map the oceanographic conditions 306 CTD stations were taken.

Oceanographic conditions:

Surface Distribution. Wind, sea surface temperature (SST, 5m depth), sea surface salinity (SSS, 5 depth) and sea surface fluorescence, SSF) were continuously recorded during the survey. In the Southern region the temperatures are considerably lower (3-5 °C) than in March 2011 when the front could be found just north of Baía dos Tigres. The salinity was lower close to Baía dos Tigres. In the Central region the inshore waters were considerably colder (around 26°C) than previous year and had higher salinity which is likely to be related to rainfall.

In the Northern region slight variations in temperatures at 5 meters depth were observed.

Standard Sections: The vertical distribution of temperature, salinity, oxygen and fluorescence in Cunene section shows an aspect of authentic occurrence of upwelling which was characterized by low values of all parameters inshore and higher values in offshore. The temperature ranged from 16°C to 17°C, salinity from 35.5 to 35.6 and the surface oxygen concentration was about 4.5ml/l offshore and 1ml/l near the coast. The lowest value of oxygen (0.5ml/l) was found at 70-130m layer, value usually found between 250m and 500m depth. The thermocline was located below 120m depth.

In Namibe section, it was also observed a slight effect of upwelling highlighting the area of the isotherm of 19°C throughout the continental shelf. The maximum salinity of 35.8, characteristic of tropical waters, was found above the 50m depth also with the dominance at whole continental shelf. The low of oxygen values (0.5ml/l) was located in the characteristic layer (300-450m) off the Angolan coast.

The oceanographic conditions of the section off Santa Marta indicated a stable condition. Parallel stratification isolines of all the parameters occurred indicating the absence of a vertical mixing process of water bodies in this region. It was also found that higher values of temperature (24°C), salinity ($S \geq 35.8$), oxygen (4.5ml/l) and fluorescence (0.2µg/l) dominated along the entire continental shelf.

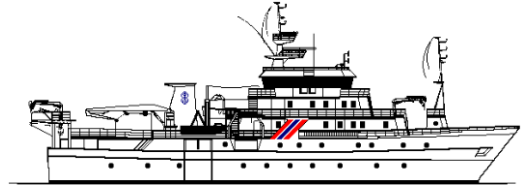
The environmental parameters of the section off Lobito described totally a different scenario regarding all transects in the southern region. The result revealed an aspect of the sinking/downwelling of the waters near the coast with emphasis on a deeper thermocline. In the two coastal stations the presence of low salinity levels observed, possibly due the outflow of Catumbela River. As noted in the Namibe section, the low oxygen content was located between 400 and 500m depth at Lobito transect.

In the section of section of Pta do Morro, the layer of 0 to 30m was characterized by high values of





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all parameters. In this layer, the temperature varied between 28°C and 21°C, salinity dominated by less saline water showed a range of values from 34.2 to 35.6, the concentration of oxygen ranged from 4.5ml/l to 3ml/l and then fluorescence ranged between 0.1µg/l and 0.2µg/l being the maximum of the fluorescence has been recorded close the coast. The minimum oxygen content was found at 320m depth and the maximum value of salinity ($S \geq 35.8$) was located at 50 - 100m layer.

Distribution, Size composition and biomass estimates:

Cunene River – Benguela:

Sardinella: The *S. aurita* was the dominate species throughout the southern region from Baía dos Tigres to south of Baía dos Elephants. *Sardinella maderensis* was caught only in the one station and was not enough to estimate the proportion *S. maderensis* in the region.

The distribution *S. aurita* was patch with small areas with high density acoustic densities inside of Baía dos Tigres and north and south of Pta. Albina. Two areas with very acoustics densities ($sA > 10\ 000\ m^2/NM^2$) were recorded off Tombwa at 23 e 43 meters depths. From Cabo de Santa Marta to Baía dos Elefantes de *S. aurita* were found in very low acoustic densities.

S. aurita shows a unimodal distribution with a modal peak at around 19cm found at shallow waters. The few large *S. aurita* recorded in the area were found offshore. The length frequency of *S. maderensis* is dominated by the fish greater than 24cm.

The estimated total biomass for the two sardinella species was 353000 tons and *S. aurita* contributes more than 95% of the total.

Horse mackerel: Like in previous surveys both species of horse mackerel of horse mackerel were found in the area. Cunene horse mackerel *Trachurus trecae* a species that distributes in most of the Angolan continental shelf and the Cape horse mackerel *Trachurus capensis* a species associated with cold waters of the Benguela current.

Cunene horse mackerel presented a continuous from Cunene river to north of Tombwa. The highest acoustics densities were recorded offshore from Cunene River to Baía dos Tigres. From Namibe to the limit of southern region the horse mackerel distribution is patch with low acoustic densities. Cape horse mackerel was caught only up to 16° S.

The size distribution of size of Cunene horse mackerel covers wider size range (5-33cm). Although the distribution of Cunene horse mackerel is dominated by a group of modal peak around 16cm, the group of fish larger than 21cm contributes more than 50% of the total biomass in the southern region. The Cape horse mackerel shows a unimodal distribution with modal peak around 17cm. Few fish of both species below 10cm were caught in the southern area.

The biomass for both horse mackerel was estimated at 239 000 tonnes which is 76% higher than the biomass estimate last year in this season. The biomass of Cunene horse mackerel was estimated at 162 000 tonnes and the Cape horse mackerel was 67 000 tonnes.

Although the present biomass for Cunene horse mackerel is estimated at some level of the 1998 summer season biomass (163 000) the length distribution in 1998 was dominated by the adult fish ($> 23cm\ LT$).

Sardine: The distribution of *Sardine ocellatus* was between Baía dos Tigres and Cunene River with highest acoustic densities south of Baía dos Tigres.

Other species: Species belonging to the pelagic 1 group (e.g. round herring, *Etrumeus whiteheadi*, and anchovy, *Engraulis encrasicolus*) were found scattered in low densities ($0 > sA > 300$) along the southern region and therefore no biomass was estimated for this group.

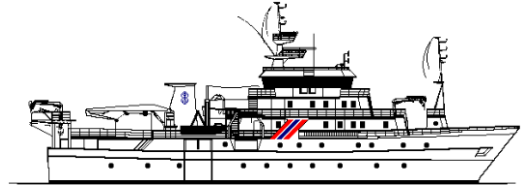
Benguela-Pta. das Palmerinhas

Sardinella: Like in previous summer survey sardinella was found in the area with continuous distribution north of Lobito to Cabo São Braz. In the area around Benguela and Lobito was





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recorded in low acoustics densities. The highest acoustics densities in the central region were recorded south of Cabeça da Cobra and off Ponta da Moita Seca.

The distribution of *S. maderensis* was dominated by adults (>21 cm TL) with a modal peak at around 26 cm TL. The length distribution of *S. aurita* shows two clear at 9 and 23cm.

However, the small fish between 6 and 10cm dominated the size spectrum of *S.aurita* the fish larger than 20cm has the highest contribution for the biomass of the species. .

The biomass for both sardinellas was estimated at 230 tonnes, where *S. maderensis* dominating and contributing with 65% (149 000 tonnes) of proportion of the biomass and *S. aurita* with 35% (81 000 tonnes). These figures are less than those estimated during the 1998 summer survey, when the total Sardinella biomass was calculated in 389 000 tonnes (106 000 for *S. aurita* and 283 000 for *S. maderensis*).

Horse mackerel: The only species of horse mackerel found in this region was the Cunene horse mackerel (*T. trecae*). It was found throughout the area in low acoustics densities. Offshore south off Ponta da Moita Seca and the Novo Redondo Depression was recorded in two small areas with high densities. The population has three well defined modal peaks around 7, 14 and 29 cm TL, which may be represent different cohorts.

The biomass of Cunene horse mackerel was estimated at 135 000. This biomass is higher than the estimated last year for this season (68 000 tonnes) and 34% lower compared with biomass estimated in the warmer season in 1998.

Pta. Palmerinhas - Congo River

Sardinella: *Sardinella* was found in continuous from Luanda to Nzeto. Small areas with high acoustic densities were recorded offshore Cabeça da Cobra, Ambriz and Luanda. For both species of sardinella the length distribution shows three clear modal lengths. For *S.aurita* peaking at around 7, 17 and 24cm and for *S. maderensis* at 9, 16 and 25cm. The estimated biomass for this region was 156 000 tonnes, with *S. maderensis* representing around 60% of the total biomass, while *S. aurita* contributed with 40%. These figure is lower than the biomass estimated in 1998 (79 000 tonnes), where 71% of the total biomass was estimated in central region.

Horse mackerel: In northern region Cunene horse mackerel, *T. trecae*, was found in low- acoustics densities areas ($0 < SA < 300 \text{ m}^2/\text{NM}^2$) between Cabeça da cobra to Luanda. The Cunene horse mackerel was primarily caught in bottom trawls mixed with demersal species. The size distribution of Cunene horse mackerel showed two length modes, one at about 10cm TL and another at 17 cm TL. The biomass of horse mackerel was estimated at 30 000 tonnes, which half of the biomass estimated in 1998 in summer season.

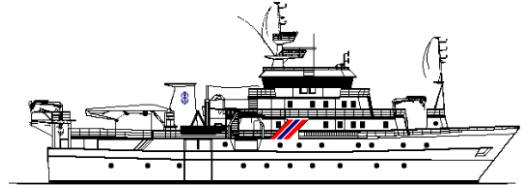
Summary of Survey results:

The overall high temperatures and low salinity observed in March 2011 was replaced with more “normal” conditions this year. Last year’s report included a hypothesis that the rather modest observations of target species abundance could be explained by them being more dispersed and thus less available to acoustic estimation. This year’s results show considerable higher biomass of the target species, but we would like to point out the acoustic survey is only covering a fraction of the resources. Considerable amounts can be distributed in more shallow waters (less than 20 meters) and closer to the surface. In particular is this a problem for the sardinella species. In such circumstances it is common to view estimates as conservative, but we would like to remind the reader that the choice of single fish target strength may have introduced a bias in the estimate. More research is needed to gain more insight into the fraction of the stocks not covered by the survey and into single fish target strength (possibly being dependent on depth and/or diurnal migrations).





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Report status final References:

NORAD - FAO PROJECT: CCP/INT/003/NOR, Cruise reports "Dr. Fridtjof Nansen" EAF - N/2012/1. K. Korsbrekke, M. Olsen, A. Amaro, F. Vaz Velho, Q. Fidel and B. Sangolay. **Survey of the pelagic resources. Angola. 1-30 March 2012.** Institute of Marine Research, Bergen and Instituto Nacional de Investigação Pesqueira, Angola. 2012

Constraints/Comments:

