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Assessment of sardinella and other small pelagics in West Africa

Progress Report 2002

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Table of Contents:

Summary.....	3
1. Introduction	4
2. Project staff and facilities in 2002.....	5
2.1 <i>RIVO project staff</i>	5
2.2 <i>IMROP staff</i>	5
2.3 <i>Project facilities</i>	6
3. Development of acoustic surveys in 2002	6
3.1 <i>Identification of echo traces</i>	6
3.2 <i>Acoustic instrumentation</i>	7
3.3 <i>Training</i>	7
3.4 <i>Acoustic stock estimates</i>	8
3.5 <i>Vessel operation</i>	8
4. Observer programme on board Dutch trawlers.....	9
5. Sardinella biology.....	10
5.1 <i>Spawning areas and seasons</i>	10
5.2 <i>Migration pattern</i>	11
5.3 <i>Stock identity</i>	12
5.4 <i>Age determination</i>	12
5.5 <i>Natural mortality</i>	12
6. Oceanographic effects on sardinella distribution.....	13
7. Working groups.....	13
7.1 <i>FAO Working Group on small pelagics in West Africa</i>	13
7.2 <i>IMROP Groupe de Travail December 2002</i>	14
8. Institutional support to IMROP	14
9. Public relations	14
10. Reports and working documents published by project staff in 2002.....	15
11. References.....	16

Summary

The co-operation between the Dutch fisheries research institute RIVO and the Mauritanian fisheries research institute IMROP (Institut Mauritanien des Recherches Océanographiques et de Pêche) in the field of pelagic stock assessment was continued in 2002. In January, a new contract was signed between RIVO and the Dutch Ministry of Agriculture, Nature Management and Fisheries (LNV) that allowed the existing co-operation to be continued and expanded for the next three years. As a consequence, RIVO project staff was increased to three scientists who worked full-time on the project.

Further development of acoustic surveys in 2002 was hampered by technical problems with the Mauritanian research vessel "Al Awam". These problems took the vessel out of operation for the first half of the year; so only one full-scale survey could be made in the second half of the year (September). To increase the efficiency of the crew in handling the new pelagic trawl, an experimental fishing trip was organised with "Al Awam" in November. A French consultant, hired by the project, trained the crew in handling the gear, and showed that the net could be used effectively in shallow waters up to 18 meters depth.

The observer programme on board the Dutch trawlers was continued in 2002 and provided detailed information on catch composition and discards. This information is of vital importance to the FAO working group on small pelagics in West Africa. An analysis of data on by-catches of large species showed that sampling of these by-catches was incomplete and that in future more attention should be paid to this part of the programme.

Biological studies on the maturation cycle of sardinella showed peak spawning periods in June/July and in September/October 2002. Spawning fish were encountered all over the Mauritanian shelf, but peak spawning seemed to occur in June/July in the northern area off Cap Blanc. Attempts to determine the age of sardinella by RIVO specialists in IJmuiden did not yet produce results, but a special FAO workshop was planned to tackle this problem. Co-operation between IMROP and RIVO was also established in the field of oceanographic research. This work is aimed at identifying oceanographic factors that are responsible for recruitment success in sardinella and horse mackerel, and that may be used to predict recruitment strength one or two years in advance.

The project contributed to two major working group meetings: the FAO working group on small pelagics in West Africa (Banjul, March 2002) and the IMROP Groupe de Travail (Nouadhibou, December 2002). Both meetings concluded that there was no evidence yet for over-exploitation of small pelagics at a regional level, but that as a precautionary measure catch levels should not be further increased. The IMROP Groupe de Travail went even further and recommended a freeze on pelagic fishing effort in the Mauritanian zone. During a survey with the Mauritanian research vessel "Al Awam" in November, large concentrations of pelagic fish were observed in the coastal waters off Nouadhibou and Cap Blanc. Especially the presence of large quantities of sardines indicated the recruitment of a strong year-class and good prospects for the sardine fishing for several years to come.

1. Introduction

The project "Assessment of sardinella and other small pelagics in West Africa" was contracted by the Dutch Ministry of Agriculture, Nature Management and Fisheries (LNV) to the Netherlands Institute for Fisheries Research (RIVO) in January 2002. The project is a continuation of joint activities between RIVO and the Mauritanian fisheries research institute IMROP (previously named CNROP) that started already in 1998. Corten (2000, 2002) has reported results of the work conducted in previous years.

The need for the project stems from the activities of a Dutch fleet in the area, consisting of 6-8 modern freezer trawlers that target small pelagics such as sardinella, sardine, horse mackerel and mackerel. These species are abundant in Mauritanian waters, but they are hardly exploited by Mauritanian fishermen. In consequence, the Mauritanian government issues licenses to foreign companies in order to benefit from the existing resources. Catches by Dutch vessels are transhipped either in Las Palmas or at sea in Mauritania, and subsequently sold in other West African countries where a large demand for these species exists.

The co-operation between RIVO and IMROP is aimed at strengthening Mauritania's capacity for pelagic research and stock assessment, thereby contributing to a rational exploitation of pelagic resources. Since the pelagic stocks migrate between different West African countries, the project also deals with stock assessment at a regional level. The emphasis of the project is on the transfer of technology that was developed by RIVO in the assessment and management of small pelagics stocks in Western Europe, and that can also be applied to similar species in West Africa

The project has a number of components, all of which are pertinent to the management of small pelagics:

- acoustic evaluation of the abundance of pelagic fish
- biological studies to establish parameters such as age and time of reproduction that are necessary for stock assessment models
- observer programme on board commercial trawlers in order to monitor catches and discards
- study of the effects of oceanographic variation on the distribution and reproduction of pelagic species
- study of migration patterns and stock identity
- study of predation and natural mortality
- contribution to working groups dealing with stock assessment of small pelagics both in Mauritania and at the West African level.

In addition to technical assistance in stock assessment of small pelagics, the project also provides institutional support to IMROP. This applies particularly to the acquisition of computer hardware and the co-operation with neighbouring countries.

The present report deals exclusively with the results of project 999-00006-05 "Assessment of sardinella and other small pelagics in West Africa". In addition to this project, RIVO has two other related projects in Mauritania. One of these (999-00006-06) is dealing with the application of satellite imagery and the other (999-00006-07) concerns the prevention of by-catches of large species. Results of these two projects are published in separate reports.

This progress report presents an overview of all activities within the framework of project 999-00006-05. Detailed results of specific studies conducted within the framework of the project are presented in separate reports and working documents, a list of which is presented in section 10.

2. Project staff and facilities in 2002

2.1 RIVO project staff

Steven Benjamins left the project at the end of 2001 to take up a PhD scholarship in Canada. Remment ter Hofstede, who arrived in Nouadhibou on the 15th of February, replaced him. Irmen Mantingh, who had been working for the project as a student since September 2001, was appointed as regular member on the project team in April. She graduated from Wageningen University in June.

The Dutch staff of the project in 2002 thus consisted of the following persons:

Ad Corten	project leader	RIVO	1 Jan - 31 Dec
Remment ter Hofstede	scientist	RIVO	15 Feb – 31 Dec
Irmen Mantingh	scientist	RIVO	1 April - 31 Dec

In addition to the permanent staff, the following experts visited the project during of the year:

Johan Müller + colleague	Engineers	Vrolijk BV	January
Dick de Haan	electronic engineer	RIVO	July
JaapJan Zeeberg	specialist remote sensing	RIVO	July, November
Joseph Douard	gear expert	Vrolijk BV	November
Cees Bakker	electronic engineer	RIVO	November
Pavel Gasyukov	mathematician	Atlantniro	December

2.2 IMROP staff

Following complaints by the project manager about a lack of co-ordination on the side of IMROP, a new Mauritanian co-ordinator, Mahfoudh Ould Taleb Sidi, was appointed as of the first of January. This co-ordinator, however, could not spend sufficient time on the project due in a PhD study in France. In July, IMROP appointed a new co-ordinator, Ebyte Ould Sidina, who subsequently left for a one-year master's course in Marseille, France. This left the project again with insufficient co-ordination on the side of IMROP.

Support from IMROP in analysing biological samples was irregular during the first half of the year. In order to remedy this situation, the project manager proposed to recruit a junior Mauritanian scientist who would be paid by the project and who would be permanently available for project activities. IMROP agreed with this proposal and the young Mauritanian scientist Abdelahhi started to work for the project by the end of November.

IMROP recruited an electronic engineer to assist in the execution of acoustic surveys. This employee was also paid entirely by the project.

RIVO financed the following foreign journeys by IMROP staff in 2002:

Wagué Abdoulaye	Dakar, Senegal	January	Co-ordination of biological studies between IMROP and CRODT (Senegal)
Ebaye Ould Sidina, Ahmedou Ould Moustapha, Magfoudh Ould Taleb Sidi	Banjul, Gambia	March	FAO working Group on small pelagics in West Africa
Ahmedou Ould Moustapha	Nantes, France	April-May	Acoustic training on board R/V "Thalassa"
Bambaye Ould Hamady	IJmuiden	October	Preparation joint publication

2.3 Project facilities

The recruitment of an additional scientist to the project necessitated the renting of a second house for the project. Furthermore, a container with furniture and a car was shipped to Nouadhibou in April.

At the request of the project manager, IMROP provided a new, permanent office space for the project. This office is located at the main CNROP complex, at 50 meters distance from the project manager's house. An Internet connection was installed in the office, which greatly improved working conditions. The project office increased the visibility of the project towards IMROP staff, and it improved the communication with Mauritanian colleagues.

3. Development of acoustic surveys in 2002

The acoustic programme in 2002 included further development of fishing methods and acoustic instrumentation, training of IMROP staff, and the execution of two acoustic surveys with the Mauritanian research vessel "Al Awam". These activities are described in detail below.

3.1 Identification of echo traces

An essential aspect of acoustic surveys is the ability to identify fish schools that are observed on the echo sounder. If one is unable to determine which species is observed on the echogram, one cannot make an acoustic estimate of the fish stocks either. The species of small pelagics in West Africa that are targeted by the acoustic surveys are very hard to catch. Many earlier programmes of acoustic surveys in West Africa have failed because the research vessels were unable to catch the fast swimming fish. During the current project this problem was identified at an early stage, and substantial investments were made in 2000 and 2001 to improve the capacities for pelagic fishing of the Mauritanian research vessel "Al Awam". These investments included the construction of a tailor-made pelagic trawl for the "Al Awam", the installation of a new winch for the headline transducer, and a monitor on the bridge for the headline transducer. In addition, the crew was trained by a Dutch consultant in handling the gear.

The winch for the headline transducer had broken down during the acoustic survey in October 2001. In January 2002, two experts were flown in from the Netherlands to repair the winch. These experts worked for three days on the winch and conducted a complete overhaul.

It appeared that the winch had not been properly serviced before its shipment to Mauritania in May 2001. The Mauritanian engineers of the "Al Awam" consider the winch too big and too difficult in maintenance. They foresee problem in obtaining spare parts and servicing the installation in future. Their request, therefore, is to replace the winch by a new, smaller and less complicated installation. This request will have to be seriously considered in future.

The investments and training in previous years started to produce their results in 2002. During two surveys in September and November (see below), the net performed well, and the crew demonstrated their ability to handle the trawl. During the first survey (September), a total of 6 hauls were made. This low number was partly related to the low abundance of fish during the survey, and partly to a cautious attitude among the crew. Due to a lack of experience and the absence of spare parts on board, the crew were afraid to damage the net, and they refused to fish the net in water of less than 25-meter depth. In this area, however, most of the schools were observed.

The second survey (November) was dedicated especially to the training of the crew in handling the pelagic trawl. A French consultant, Joseph Douard, participated in the cruise, and he demonstrated the crew the possibilities of the net. He showed that the net could be fished in waters up to 18 metres depth, and that it could be very well used to identify schools of fish in the shallow coastal zone. In total 15 hauls were made during this short survey, and several large catches (5-10 tonnes) of sardinella were obtained in shallow waters.

3.2 Acoustic instrumentation

Due to a lack of maintenance in the past years, the SIMRAD EK-500 scientific echo sounder on board the "Al Awam" appeared to be in poor condition, with its back panel badly corroded as a result of sea water that had come in through a leaking porthole. In order to check the condition of the EK-500 and other acoustic instruments, a specialist from RIVO (Cees Bakker) participated in the November survey. His study showed that the EK-500 was still functioning properly, and that the corrosion of the back panel had not affected the functioning of the instrument. Also the transducers (38 and 120 KHz) were still in good shape. Considering this positive outcome, it was decided that there was no need to send the EK-500 to Norway for a complete overhaul. Mr. Bakker furthermore investigated the connections between EK-500 and the auxiliary equipment, and found that most systems were working properly. The main bottleneck was found to be the stable power supply, which has to be replaced in future by a more robust system. Mr. Bakker also made recommendations for a re-arrangement of instruments in the acoustic laboratory, new fishing rods for calibrating the echo sounder, and a set of tools that should remain on board the vessel as standard equipment.

Following a recommendation from the previous survey (October 2001), IMROP had installed an air conditioning in the acoustic laboratory. This greatly improved working conditions, both for the scientists and the instruments.

3.3 Training

One of the IMROP scientists on the project, Mr. Ahmedou Ould Moustapha, took part in a 7-week acoustic survey with the French research vessel "Thalassa" in the Bay of Biscay. During this cruise he studied the use of the French computer programmes "Movies+" and "FishView"; programmes that are used to calculate the abundance of fish on the basis of acoustic data gathered with the echo sounders.

A second IMROP scientist on the project, Mr. Ebaye Ould Sidina, started a one-year study in fisheries acoustics at the University of Marseille. This study, financed by the Cooperation Française, is aimed at obtaining a Master's degree in fisheries acoustics.

3.4 Acoustic stock estimates

Two full-scale acoustic surveys of the entire Mauritanian shelf had been programmed for 2002, but the first one (scheduled for March) was cancelled due to a major technical problem with the research vessel "Al Awam". This problem, concerning the alignment of the propeller shaft with the main engine, took the vessel out of operation for the first half of the year.

The only complete coverage of the Mauritanian shelf was obtained during a survey in September. At this time, the abundance of pelagic fish in the Mauritanian zone was low, as was shown by the poor catches of Dutch pelagic trawlers in the area. The main concentrations of pelagic fish were encountered in the shallow coastal zone, where the crew did not dare to risk the pelagic trawl (see above), and hence the echo traces were not identified.

Data collected during the survey were stored for further analysis ashore. Although the responsible Mauritanian scientists had prepared a cruise report by the end of the year, final estimates of the stock biomass were not yet available. This was due to lack of experience in applying the French computer programmes on the side of the Mauritanian counterparts. Other shortcomings were the lack of a detailed cruise plan, lack of data processing during the survey, and the failure to conduct a full-scale calibration of acoustic instruments during the survey. The utilisation of the French computer software for analysing survey data is now the main bottleneck of the Mauritanian acoustic programme.

The 5-day acoustic survey in November was intended mainly for training of the crew in handling the gear. No routine acoustic data collection was conducted during this survey. Nevertheless, some interesting acoustic observations were made. Large concentrations of pelagic fish were observed in the coastal waters off Nouadhibou and off Cap Blanc, and these traces could be identified as a mixture of juvenile *Sardinella aurita*, juvenile *Sardinella maderensis*, and adult *S. maderensis*. It was known from anecdotal information that large concentrations of sardinella are usually found in coastal waters off Nouadhibou during wintertime, but the identity of these fish had never been established. Now it appeared that these fish consisted mainly of juvenile *S. aurita*, which meant that this area is a nursery for this species. So far it had been assumed that the only important nursery area for *S. aurita* existed in the waters south of Dakar. The finding of large concentrations of juvenile *S. aurita* during this survey thus threw a completely new light on the distribution of this species.

A second important observation was a large concentration of juvenile and adult sardines (*Sardina pilchardus*) in the waters between 20-40 m depth off Nouadhibou. The Norwegian research vessel "Dr. Fridtjof Nansen" had also observed this concentration two weeks earlier. Its size had been estimated at more than 1 million tonnes. The presence of such large quantities of sardine so early in winter and so far south indicates the recruitment of a strong year-class and good prospects for the sardine fishing for several years to come.

3.5 Vessel operation

During both cruises, the operation of the vessel was satisfactory and there were no major breakdowns. In September, hygienic conditions had not improved since last year, and this fact was reported after the survey to IMROP. In November, however, the crew had made a distinct effort to clean the ship, and living conditions on board had improved.

As in 2001, the vessel had insufficient crew to carry out operations both day and night, and the captain insisted that the vessel returned each night to inshore waters to drop the anchor. This practice greatly reduced the effective working time at sea. It was pointed out to IMROP that effective acoustic surveys could only be conducted with a vessel that can stay in the open sea during the night.

A further problem was the poor radio-communication with the shore, which did not allow scientists on board to consult experts ashore for technical advice. This situation also has to be remedied in future.

4. Observer programme on board Dutch trawlers

The observer programme on board Dutch trawlers was continued in 2002. In the framework of this programme, teams consisting of two Mauritanian observers join Dutch trawlers in order to collect information on catches and discards. The observers are employees of the Mauritanian fisheries research institute IMROP (both technicians and scientists) that participate in the programme on a revolving basis. The observers join the vessels either in Nouadhibou (in case of the “Maartje Theadora” and “Willem van der Zwan”) or in Las Palmas (from where the rest of the fleet operates). The RIVO project takes care of flight tickets, per diem, and material for the work on board. In addition, they make the arrangements with ship owners and captains. IMROP provides the observers with visa and their normal salary plus a sea allowance.

While at sea, the observers record the species composition of both catches and discards. They record the length composition of each species (both the preserved fraction and the discarded fraction), and a number of biological parameter for *Sardinella aurita*. These biological measurements include weight, maturity stage, fat content and stomach fullness.

Data collected by the observers are used both by IMROP and by RIVO scientists. IMROP uses the data to follow the activities of the Dutch fleet and to obtain an idea of the actual catches of this fleet. RIVO scientists use the data to estimate total annual landings and discards of the EU fleet (excluding the Irish vessels “Veronica” and “Atlantic Dawn”). These data are subsequently used for stock assessment by the FAO working group on small pelagics in West Africa.

Special activities in 2002 included the preparation of a set of standard materials for the observers at sea, and the preparation of a new, completely revised manual in three languages (French, English and Dutch). This revision was also prompted by the intended extension of the observer programme to Angolan waters. Also the methodology of the observer programme was reviewed, and some procedures such as sampling methods, data recording, and data storage were improved.

There was a lack of supervision of the observer programme by IMROP. This was due to a change of IMROP co-ordinator, and to the prolonged absence of the new co-ordinator. The lack of supervision on the side of IMROP necessitated extra supervision on the side of the responsible RIVO scientist, Remment ter Hofstede. This scientist supervised the work of the observers during three voyages on board Dutch trawlers (“Franziska”, “Carolien” and “Willem van der Zwan”).

Discussions were held at RIVO, IJmuiden, to consider the possibility of harmonising the existing observer programme in Mauritania with the newly created observer programme in Western Europe. The EU finances this programme. However, the differences between the two systems were too large to reach agreement on a common system.

In November, Remment ter Hofstede participated in the International Fisheries Observers Conference (NOAA/DFO) in New Orleans, Louisiana, USA. This allowed him to compare the existing observer programme in Mauritania with systems in the rest of the world. In many parts of the world, observer programmes are compulsory and the observers also have an inspection task. The situation is rather different from the scheme in Mauritania, where vessels co-operate on a voluntary basis.

A total of 8 voyages were made in the framework of the observer programme in 2002. This constituted 14% of all fishing trips made by EU-vessels in Mauritanian waters. In general the results were considered satisfactory, although the quality of the observations (and the amount of work performed) differed greatly between the different teams of observers. A general weakness of the programme was the lack of attention for by-catches of large species. As the observers concentrated on the sampling of commercial species on the processing deck, they tended to overlook the by-catches of sharks, dolphins etc. that were not taken below deck. The conclusion of the report on incidental by-catches of large species in 2001 was that the current observer data are of insufficient reliability, and that a special effort has to be made in 2003 in order to increase the accuracy of the collected data.

The analysis of data collected in 1999-2001 resulted in the production of a number of reports (see section 10). These reports dealt with the catch composition in 1999-2001 and the by-catches of large species in those years. At the request of IMROP, a report was produced with a summary of all data collected on mullets (*Mugil* spp.) in the course of the observer programme. The geographical distribution of sardinella catches in 1999-2001 was analysed for the Groupe de Travail in December 2002.

5. Sardinella biology

The target species for the Dutch fishery in Mauritania is sardinella. One of the main objectives of the current project, therefore, is to make an assessment of this resource. To apply conventional stock assessment models, a number of biological parameters are required which are presently unknown. A first step towards stock assessment of sardinella, therefore, is to establish these unknown biological parameters. These are spawning area and season, migration pattern, stock identity, age composition and growth rate, and natural mortality.

Two species of sardinella occur in the West African region: the round sardinella (*Sardinella aurita*) and the flat sardinella (*S. maderensis*). The industrial fishery targets the round sardinella, which is the most abundant species and which has a more offshore distribution. Biological studies conducted in the framework of the current project are aimed primarily at this species.

Progress in the study of sardinella biology in 2002 is further described below.

5.1 Spawning areas and seasons

The spatial and temporal distribution of spawning in the Mauritanian zone was studied on the basis of samples of sardinella obtained from the commercial fishery. The sampling programmes initiated for this purpose in 2001 were continued in 2002. Samples were obtained from the Dutch industrial fishery and from the Mauritanian artisanal fishery.

Sardinellas taken by Dutch vessels were sampled both at sea and in the laboratory. Mauritanian observers on board of the Dutch trawlers conducted sampling at sea. They took length and weight measurements of the fish, and recorded maturity stages. Weighing gonads at sea still presented a technical problem, and therefore gonads were frozen at sea and taken ashore for weighing afterwards in the laboratory.

In addition to the observations taken at sea, samples of frozen fish were analysed ashore. Two Dutch trawlers that regularly transhipped their catches off Nouadhibou "Maartje Theadora" and "Willem van der Zwan" provided these samples. The crew of these vessels was very co-operative in collecting the samples and taking them ashore. Irmen Mantingh, the responsible scientist for this study, made two voyages on board these vessels to instruct the crew how to take the samples, and also to study fresh samples on board.

The third source of information was the sampling programme of artisanal catches on the beach of Nouakchott. A technician of IMROP in Nouakchott was instructed to collect two samples a week and analyse these in the small laboratory adjacent to the fish market. This technician was visited once months to check his work, to collect information on the fishery, and arrange the financial aspects of the sampling programme.

Irmen Mantingh visited the Senegalese institute CRODT in September to discuss further standardisation of sardinella sampling between Mauritania and Senegal.

All data collected in 2002 were analysed in co-operation with a Mauritanian counterpart scientist. The results were summarised in a working document for the "Groupe de Travail" at IMROP in December 2002.

The results so far show that fish in spawning condition may be found at any time of the year and at any place in the Mauritanian waters. However, there are peaks in spawning activity in some months of the year. These peaks occurred in 2001 in January/February and June/July, and in 2002 in June/July and September/October. The difference between the two years may be related to differences in temperature regime between the two years. However, some of the differences may also be due to sampling errors, due to the different level of experience of the observers that conducted the sampling at sea.

Work on the classification of maturity stages was continued in 2002. Histological slides of ovaries in different stages of maturity were prepared by the CEFAS laboratory in Lowestoft, and studied in consultation with RIVO experts in IJmuiden. The results allowed a better interpretation of the actual stage of development of an ovary on the basis of macroscopic inspection. This work will be continued in 2003, and it will lead to a better key for macroscopic classification of maturity stages in sardinella.

5.2 Migration pattern

The distribution of commercial catches may provide clues as to the migration pattern of sardinella. Therefore, catch positions of the Dutch trawlers were plotted by month to see whether there was a shift in distribution of catches from one month to the next. These results were made available to the "Groupe de Travail" in December.

There was no clear pattern in the distribution during the first half of the year, with catches originating from all over the Mauritanian shelf. From June to August, the fishery shifted towards the Moroccan border, indicating a northward migration of the fish. After the main part of the population had crossed the Moroccan border, catches in Mauritania declined during the last four months of the year.

It is assumed that the fish return from Morocco via Mauritania to Senegal during the winter months. However, the path of this return migration is unknown. The few Dutch trawlers that remain in Mauritania do not detect large quantities of sardinella bound southwards. In the past it has been assumed that adult sardinella follow a route close to shore, and thereby remain out of range of the industrial fleet. The earlier observation of large numbers of sardinella schools in coastal waters off Nouadhibou supported this hypothesis. However, in November 2002, the "Al Awam" found that these inshore concentrations consisted only of juvenile *S. aurita* (in addition to *S. maderensis*).

The absence of adult *S. aurita* from coastal waters in November reduces support for the hypothesis of an inshore return migration of these fish during winter. It now seems more likely that the fish follow an offshore route for their return migration, also out of reach for the industrial fleet.

5.3 Stock identity

Although the current hypothesis is that *S. aurita* in West Africa constitute one population, migrating back and forth between Morocco, Mauritania and Senegal, there is a possibility that local populations exist in each of these countries. This hypothesis can only be tested by genetic studies or by a tagging experiment.

A genetic study has been planned in the framework of the current project and is scheduled for 2003 and 2004. In preparation of this study, advice was sought from professor Jeanine Olsen from the Rijks Universiteit Groningen (RUG) in The Netherlands. In consultation with her, a number of options for the genetic programme are considered.

5.4 Age determination

In order to apply conventional stock assessment models, the age composition of the fish in the catches has to be known. So far, there has been no consensus on age reading of sardinella, and experts generally consider age reading of sardinella to be a major problem. Despite these difficulties, the FAO working group on small pelagics in March 2002 recommended that efforts should be undertaken to solve the problem of age reading in sardinella. This group recommended that a workshop on age reading of sardinella should be organised in the autumn of 2002, and that this workshop should be preceded by an exchange of otoliths between the countries in the region.

IMROP participated in this programme and the Mauritanian experts tried to read the otoliths that were circulated among the various research institutes. In the meantime, RIVO scientist Irmen Mantingh asked RIVO colleagues in IJmuiden to try and read a sample of sardinella otoliths. Despite the application of a number of staining and preservation techniques, RIVO experts were unable to read the otoliths.

During her visit to Senegal in September, Irmen Mantingh also discussed the problems of age determination in sardinella with her French colleague Jacques Panfili, an expert on age reading of tropical fish, who works for the French organisation "Institut de Recherche pour le Développement" (IRD).

Due to the unavailability of Russian experts (the only scientists that claim they can read sardinella otoliths), the international workshop scheduled for late 2002 had to be postponed until early 2003.

5.5 Natural mortality

Estimates of natural mortality in sardinella are necessary for the application of Ecopath models; an activity that has been programmed for 2003-2004. In order to arrive at these estimates, predation on sardinella by various other fish species has to be estimated. This work requires the collection and analysis of a large number of stomachs of different potential predator species. Plans were formulated to start this work in early 2003.

6. Oceanographic effects on sardinella distribution

Variations in oceanographic conditions may have a number of effects on pelagic fish. Firstly, the variations may affect the distribution of adult fish, either by a direct response of the fish to high or low temperatures, or indirectly by an effect of temperature and or wind on food abundance. A second effect of oceanography on pelagic fish may occur at the juvenile stage. Temperature, currents and nutrient levels will affect survival of eggs, larvae and juveniles, and will therefore influence year-class strength.

The study of environmental effects is conducted mainly in the framework of project 999-00006-06 "Remote sensing: using satellite data to predict the distribution of pelagic fish", and the results of this project are presented in a separate report (RIVO C008/03). However, environmental data collected in the context of the remote sensing project are also used in the assessment project. In addition, the data are made available to IMROP and it is attempted to establish a co-operation in this field between IMROP hydrographers and RIVO staff.

RIVO oceanographer JaapJan Zeeberg visited IMROP twice (in July and in November) to promote joint activities between IMROP and RIVO. A complete set of all satellite images bought by RIVO from the University of Las Palmas was made available to IMROP. In return, RIVO received a set of oceanographic data for Mauritanian waters collected by IMROP. Plans were drafted for a joint presentation of IMROP and RIVO during the Groupe de Travail in December. In October, the Mauritanian oceanographer Bambaye Ould Hamady visited RIVO to further discuss this joint presentation. However, the joint presentation was later cancelled by IMROP with the argument that the publication of Mauritanian data was not appropriate at this moment.

Jaap Jan Zeeberg also participated at a meeting of the NATfish project at IMROP. NATfish is an EU-funded project, aimed at utilising oceanographic data in a study of environmental effects on recruitment of pelagic fish at Northwest Africa. Although RIVO is not a contractor to this project, it participates as member of the Mauritanian team.

7. Working groups

7.1 FAO Working Group on small pelagics in West Africa

This working group has been created in order to co-ordinate biological research on small pelagics in West Africa, conduct joint evaluations, and provide unanimous management advice to the various countries in the region. The RIVO project has contributed to the establishment of this working group in the period 1999-2000 and to its operation starting from 2001. It contributes 25% of the costs of the annual meetings of this group.

The first official meeting of the FAO working group had been held the previous year in Nouadhibou, Mauritania (FAO 2001). In March 2002, the second annual meeting of the working group was held in Banjul, The Gambia. The RIVO project leader and three Mauritanian counterparts participated in the meeting. A considerable part of the meeting was devoted to the training of participants in modern methods of stock assessment. Separate assessments were made (or attempted) for each of the main pelagic species, and management recommendations were provided.

The group concluded that in general there was no evidence of over-exploitation of pelagic fish in the region, but it recommended taking a precautionary approach and not increasing catches above the average level of the preceding five years.

The report of the meeting was published as FAO paper later in the year (FAO 2002).

7.2 IMROP Groupe de Travail December 2002

This IMROP meeting was one in a series of meetings that are held at intervals of 4 years. The objective of the meeting was to evaluate all fish stocks in Mauritania, to consider possible management options, and to discuss these options with the industry and administration. The meeting was a major event in which about 80 Mauritanian scientists, administrators and industry representatives participated and about 30 foreign experts. The RIVO project contributed to the meeting by presenting two working documents; one dealing with information on catch distribution and catch per unit of effort in the Dutch fleet, and one dealing with the biology of sardinella. In addition, the project assisted IMROP to bring a Russian expert on stock assessment to the meeting. This expert, Pavel Gasyokov, arrived one week prior to the meeting in order to do preparatory analyses, and he subsequently participated in the meeting.

The scientists dealing with small pelagics in this meeting were broadly the same as those that had participated in the FAO meeting in Banjul in March. However, the Mauritanian scientists had produced a new set of data on catches per unit of effort in the industrial fleet, and the Russian expert Gasyokov applied new stock assessment models. Despite these new data and new methods, the final conclusions of the meeting were almost the same as those in Banjul: there was no evidence for over-exploitation at a regional level, but the declining catch rates of sardinella in the Dutch fishery in Mauritania were a cause of concern. The working group therefore recommended, as a precautionary measure, to freeze fishing effort for sardinella in the industrial fishery in Mauritanian waters. Because fishing for sardinella could not be separated of those for other species, the freeze on fishing effort should apply to the total pelagic fleet in the Mauritanian zone. This recommendation was a major change from the previous working group meeting (December 1998) when it was concluded that small pelagics in Mauritania were under-exploited and that fishing effort could still be increased.

8. Institutional support to IMROP

In the framework of the project, RIVO provided 7 high performance laptop computers to IMROP.

The project supported the participation of IMROP's librarian, Mr. Amadi Sow, to the international conference of librarians of fisheries institutes (IAMSLIC) in Mazatlan, Mexico. This participation was considered useful for the exchange of ideas and publications between IMROP and foreign fisheries institutes.

9. Public relations

To increase public awareness of the project in Mauritania, a poster in French was prepared, giving an overview of the project activities. This poster was distributed among the various IMROP departments, the Mauritanian ministry and other interested parties.

Remment ter Hofstede prepared an English poster on the observer programme for his presentation at the International Fisheries Observers Conference (NOAA/DFO) in New Orleans, Louisiana, USA.

A special page at the RIVO-Biology & Ecology website (www.rivo.dlo.nl/specialprojects/index.htm), dealing with project activities in Mauritania further disseminated information on the project.

On the 27th of December, project staff held a series of presentations for Dutch ship owners and fishermen at RIVO, IJmuiden. This meeting was organised to exchange information and to present the industry with some results of the project. The meeting was also intended to show the appreciation of project staff for the co-operation they receive from the Dutch fleet in Mauritania.

Finally, a number of short articles were written for the Dutch fisheries journal "Visserijnieuws" and various other Dutch magazines.

10. Reports and working documents published by project staff in 2002

Benjamins, S., 2002a. Catch composition of the EU pelagic fleet in Mauritania in 1999. RIVO report C042/02.

Benjamins, S., 2002b. Catch composition of the EU pelagic fleet in Mauritania. Results of the scientific observer programme 2000. RIVO report C035/02.

Benjamins, S., 2002c. Incidental catches of pelagic megafauna by pelagic trawlers from the European Union in Mauritanian waters during 1999-2000. RIVO report C036/02.

Corten, A., 2002. Assessment of Small Pelagics in Mauritania. Report of Activities in 2001. RIVO report nr. C046/02.

Corten, A., 2002. Changements dans la pêche des sardinelles en Mauritanie: effets de l'exploitation? Working document presented to the IMROP Groupe de Travail in December 2002.

Mantingh, I.T. 2002. The reproductive cycle of *Sardinella aurita* in the Eastern Atlantic Ocean off North-West Africa. Student report Wageningen University.

Ter Hofstede, R., 2002. Catch composition of the EU pelagic fleet in the Mauritanian Exclusive Economic Zone during the year 2001. RIVO report C052/02

Ter Hofstede, R., 2002. Catches of Mugilidae (mulletts) by Dutch pelagic trawlers in the Mauritanian Exclusive Economic Zone during the years 1999-2001. Working document provided to IMROP.

Ter Hofstede, R., 2002. Directive pour le travail des observateurs scientifiques à bord des chalutiers du PFA. RIVO internal report 03.004.

Ter Hofstede, R., 2002. Incidental catches of pelagic megafauna by the EU fleet in the mauritanian Exclusive Economic Zone in 2001. Results extracted from the scientific observer programme. RIVO report C007/03.

Troost, T., 2002. The distribution of sardinella catches in Mauritania compared to sea surface temperature (SST) data obtained by satellite. RIVO report C045/02.

Wagué, A. and Mantingh, I.T., 2002. Le cycle de reproduction de *Sardinella aurita* dans les eaux mauritaniennes. Working document presented to the IMROP Groupe de Travail in December 2002.

11. References

- Corten, A., 2000. Biological research on pelagic fish stocks in West Africa. Pelagic Freezer Trawler Association, IJmuiden, The Netherlands.
- Corten, A., 2002. Assessment of small pelagics in Mauritania; Reports of activities in 2001. RIVO report C046/02.
- FAO, 2001. Report of the FAO Working Group on the assessment of small pelagic fish off northwest Africa. Nouadhibou, Mauritania, 24-31 March 2001. FAO Fisheries Report No.657.
- FAO, 2002. Report of the FAO Working Group on the assessment of small pelagic fish off northwest Africa. Banjul, Republic of the Gambia, 5-12 April 2002. FAO Fisheries Report No.686.

Al Awam met vangst sardinella



Groupe de travail IMROP



Irmen met Abdelahhi

