INTEGRATED RESOURCE DEVELOPMENT OF THE SUNDARBANS RESERVED FOREST

FAO/UNDP PROJECT BGD/84/056

BANGLADESH

DRAFT

INTERIM REPORT
CONSULTANT MANGROVE ECOLOGY

JUNE - OCTOBER 1994

by

Dr Georges Grepin
Ecologist

United Nations Development Programme

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Khulna, October 1994

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This technical report is one of a series of reports prepared during the course of the project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

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ABSTRACT

Review of existing Work Plan

The mission on Mangrove Ecology, integrated Resource Development of the Sundarbans Reserved Forest, Khulna - Bangladesh, June 01 - October 04, 1994, was arranged in order to review the existing Work Plan in the light of new information relating to Ecology, provided by soils, sylviculture, plant physiology and botany outputs.

The goal of this review is to provide practical ecology guidelines for sustainable use of the Sundarbans.

Monitoring Ecological changes

Monitoring ecological parameters and ecological changes in the Sundarbans is the central issue and an evaluation of the inventory system is necessary in order to help the Forest Department implement an environment monitoring system, and to establish ecological monitoring stations, sampling plots and experiments.

To do so, and to be able to assess ongoing ecological changes it is essential to review the work of previous consultants, mainly that of the wildlife and fisheries biologists. This is analyzed in order to provide guidelines for complementary studies.

Validation of data

Validation of ecological information provided by terrestrial and aquatic specialists was done during fields trips on Forest Department launches during June, July, and September 1994, totaling 18 days in the forest.

North and central parts of the Sundarbans Reserved Forest (S.R.F.) were visited on 5 field tours scheduled mainly for sylvicultural purposes. However, despite restricted mobility due to lack of speed-boats and launches and unavoidable restriction in study time through being obliged to co-ordinate activities with the sylviculture team, useful ecological information was collected.

Need for Dry Season Ecological studies

Important ecological changes linked with availability of water during the peak of dry season are noticeable in the Sundarbans. It is therefore necessary to study carefully drought effects in fresh water areas of the forest.

This could be done most productively in February-April 1995, using the new project launches as scientific bases, fielding a properly coordinated ecological research team which might comprise the National Ecologist, National B.F.R.I. Botanist counterpart, University of Khulna Fisheries Specialist, University Zoologist and F.A.O. Ecologist.

Each of these specialists will be able to make the launches the centre for studying the forest using the 2 speed-boats and 1 cabin cruiser for extra mobility and greater flexibility than has ever been possible in the past. Multidisciplinary work aboard the launches will help National consultants to create links between their different institutions and with international scientific organizations by working closely with International consultants.

This practical approach to project ecological research will facilitate full completion of outputs for the I.R.M.P. and will be of great help to the Forest Department to follow up and monitor the end of the F.A.O. Project and during the succeeding of period implementation and development .

Need for Hydrological Survey and Modelling

Survival of the Sundarbans Reserved Forest (S.R.F.) is directly linked with upstream freshwater availability; in spite of this, a total lack of reliable information concerning past and recent evolution inside the Sundarbans must be reported, furthermore, no adequate modelling system of the Sundarbans water regimes was planned until recently.

The Surface Water Modeling Center (S.W.M.C.), Dhaka, was strongly interested by our proposition to include a detailed hydrological study of the Sundarbans in their programme since this would not only provide vital data by the Project but would also improve the South-West hydrological model at the National level. Part of 3 weeks work as O.I.C. a.i. conducted by the reporting officer in August was devoted to implementation of this project.

Strong support was received from the D.F.O. Sundarbans for this, who, in spite of unavailability of his main launches due to mechanical problems, generously diverted one vessel from Forest Department work to hydrological studies.

Installation of S.W.M.C. hydrological stations in 9 range offices had to be done in August in order to record monsoon data; this was successfully achieved not withstanding some technical constraints.

G.I.S. and mapping progress

Much valuable time was devoted in August to check and control the progress and accuracy of mapping work assigned to the Project Cartographer.

All future hydrological work and all other studies in S.R.F. will be able to rely on an accurate topographic map featuring precisely large and small rivers; creation of such a topo-map is one of the main goals (objectives) of this project: this will provide ultimately a useful tool to the Forest Department for sustainable management of S.R.F. through G.I.S. and database use.

The existing cyclone shelter digitized topo-map (1992) was found inaccurate by F.A.O. remote sensing experts earlier in the year; it was recommended that a new topo-map out of SPOT Satellite data using SPARRSO - Dhaka facilities and Forest Department experts should be made under the immediate supervision of the Project Cartographer.

Drawing of the 15 sheets topo-map was achieved by the end of July under supervision of the Project Cartographer who started digitization at Khulna University. unfortunately, due to unacceptable drawing errors digitization was stopped and alternatives to correct the situation were discussed in Dhaka with ISPAN. D.D.C., G.I.S. and T.H. Corporation Specialists.

To make comparison easier between Forestal (1954) and O.D.A. (1985) vegetation maps, a reduction of the Forestal map at the same scale was ordered at SPARRSO; this will enable Forestal and O.D.A. maps to be overlaid on an accurate topo-map and changes in the vegetation cover may then be calculated; ultimately further assessments may be attainable by adding the Curtis 1932 map to the overlay series.

All this essential historical information should be correlated after the December 1994 Aerial Survey. Following discussions with the Forest Department and project consultants, we made contact with T.H. Corporation's, Qasco representative in Dhaka, and it was agreed to endeavor to modify the survey appropriately, including if possible a 1/7500 transect sampling in the scheduled flights.

Careful stereoscopic studies of 1990 FIN MAP 1/30 000 aerial survey showed that comparisons between 1994 and former photographic surveys could be useful to assess general changes in the forest structure and encroachment status.

Erosion and low-land top dying areas

Low-land '"bowl-shaped" Sundri *Heritiera fomes* top dying areas and fern *Acrostichum aureum* covered raised areas, precisely located on SPOT data and O.D.A. maps using G.P.S. positioning, were visited.

Recommendations are made to assess the evolution of these areas and for the survey of bank erosion using differential G.P.S. positioning, different marking devices and aerial photography.

The impending 1994 $1/15000$ aerial photographic survey can help detailed studies of top dying areas, the ecological statuses of bowl-shaped lowlands; the evaluation of forest loss due to bank erosion and ecological aspects the *Nypa fruticans* palm inventory as recommended by the C.C.F during a strategy meeting held on 07 July 1994. Systematic photographic sampling on the whole Sundarbans at $1/7500$ transect on top dying areas, sylviculture trials, plantations and sanctuaries zones is also strongly recommended and should be altainable within the time frame and scope of the Project.

Field studies facilities

Visits to the Narayanganj shipyards in Dhaka with N.P.D., O.I.C. and F.A.O. expert were done in order to finalize equipping of project launches and to repair project speed-boats. Although such activities might be considered to be outside the TOR's collaboration this kind is essential to the successful construction of long overdue of survey vessels which will be required during next dry season for ecological data verification through field studies.

Micro light amphibian

Previous experience in coastal and wetland surveys using micro light aeroplanes in Africa led to a proposal to use a micro light amphibian aeroplane as an extremely cost effective and versatile multi-purpose tool which could be used to good advantage in the S.R.F. and other coastal area survey and forest management work.

Low altitude aerial survey

A light-plane survey was scheduled for the north and eastern border of the Forest in order to assess the effects of an accidental oil pollution incident at Mongla Port and to provide high resolution oblique photography of top-dying areas. Added to this it is evidently clear that a much better knowledge of land use, settlement patterns and physical developments on the borders of the S.R.F. is needed and low-level aerial survey is ideal for this form of assessment and long term monitoring.

Fitting of photo cameras on the plane was discussed with the chief flying instructor in Dhaka.

Data collection

Data collection in different offices and organizations was performed in Khulna and Dhaka and the author is very grateful to those members of the Forest Department and other organizations who provided advice and data for the implementation of this mission.

Links with Universities

Participation in the National Seminar on Integrated Management of the Ganges Flood Plains and Sundarbans Ecosystem July 16-18, 1994 was an opportunity to discuss further collaboration between the Project, Forest Department and Khulna and Chittagong Universities.

ACKNOWLEDGMENTS

The consultant, on behalf of the Food and Agricultural Organization of the United Nations, is greatly indebted to the members of Forest Department who provided launch facilities, advice and information for the implementation of this mission.

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Mr. A.N.M. ABDUR ROB
Conservator of Forest & National Project Director

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AND SUMMARIES OF OBSERVATION
AND RECOMMANDATION
FOR ECOLOGICAL DATA COLLECTION - JUNE TO OCTOBER 1994
(See Map of itinerary in annex p. 68)

LIST OF ACRONYMS

B.C.A.S.	Bangladesh Center for Advanced Studies
B.F.R.I	Bangladesh Forest Research Institute
C.C.F.	Chief Conservator of Forests
D.F.O.	Divisional Forest Officer
F.A.O	Food and Agricultural Organization of the United Nations
F.D.	Forest Department
G.I.S.	Geographic Information System
G.O.B.	Government of Bangladesh
G.P.S.	Global Positioning System
H.F.	Height Frequency
I.C.I.V.	Institut de la Carte Internationale de Vegetation
I.R.D.	Integrated Resource Development
I.R.M.P.	Integrated Resource Management Plan
I.S.P.A.N.	Irrigation Support Project for Asia and the Near East
I.U.C.N.	International Union for the Conservation of Nature
K.N.M	Khulna Newsprint Mill
N.G.O.	Non-Governmental Organization
N.M.E.A.	(G.P.S. Standard)
N.P.D.	National Project Director
O.D.A.	Overseas Development Administration
O.I.C.	Officer-in-Charge
P.S.P.	Permanent Sampling Plot
S.C.M.P.	Sundarbans Coastal and Marine Protected Area
S.P.A.R.R.S.O	Space Research and Remote Sensing Organization
S.P.O.T.	French Teledection Satellite
S.R.F.	Sundarbans Reserved Forest - the Project Area BGD/84/056
S.W.M.C.	Surface Water Modeling Center
T.M.	Thematic Mapper
T.O.R.	Terms of Reference
U.L.M.	Micro-light plane
U.N.E.P.	United Nations Environmental Programme
U.N.E.S.C.O.	United Nations Educational, Social & Cultural Organization

1. INTRODUCTION

Purpose of the report:

Sundarbans Mangroves and coastal wetlands are one of the most valuable components of the environment in Bangladesh.

Wise management of mangrove Forests and rivers has been performed for more than one hundred years by the Forest Department.

Unfortunately, recent changes in the hydrological situation of the Forest (S.R.F.), probable perturbation of hydroperiods and freshwater flushing of the system, have threatened the mangrove Forest.

Extension of top-dying areas of the main commercial specie of Sundri *Heriteria fomes* and recent intensification of Forest resource use has lead to a probable depletion of the stocks of some commercial species.

Assessment of ongoing ecological changes is a vital necessity in order to define future utilization of the Forest resources.

The present work is an attempt to evaluate the status of knowledge concerning ecological parameters inside the Sundarbans Forest of Bangladesh and to provide guidelines to improve this knowledge. Clearly, from findings to date, further input will be needed to achieve this objective at an acceptable standard of completeness.

The final goal will be to establish an Ecological monitoring system for the Sundarbans in order to help the Forest Department and the Government of Bangladesh implement a management policy for sustainable use of the Forest and associated riverine and marine ecosystems.

2. TERMS OF REFERENCE

The terms of reference for this study were:

2.1 To review existing information provided by previous consultants relevant to the field of ecology and formulate guideline for future ecological survey of the Forest with particular emphasis on fishery biology and wildlife management.

2.2 To evaluate the existing monitoring system and assist the planning design and monitoring of an ecological survey system.

2.3. To undertake fields studies in order to review the progress of the acquisition of ecological parameters and validate information provided by previous consultants.

2.4. To prepare a report containing findings and recommendations.

3. ECOLOGY OF THE SUNDARBANS

All mangrove Forests depend on fresh water supplies from upstream, fresh water supplies by rain, tidal flushing and fertilization by sediments. All modification of upstream or downstream water flow will result in degradation of the Forest and ultimately the mangrove will disappear.

Usually the resulting degraded mangrove has a reduced production and is reclaimed for shrimp farming.

The actual status of the Sundarbans mangrove Forest shows that the Forest is increasingly enclosed in a network of embankment (Annex: Cartography p. 95).

Lower parts of the rivers upstream are lined with embankments and those, plus numerous dams are drastically reducing fresh water inflow during the dry season on parts of the Ganges System which affect the S.R.F. (Annex map No??? Upstream Dams).

During the rainy season (April - October), sediments accumulated in the river beds are flushed to the sea through the Sundarbans rivers. Direct deposit by fresh water through the rivers entering the Sundarbans Forest occurs at this time; furthermore, a complicating factor is that sediments flushed through the Ganges System in the Bay of Bengal are probably brought back by tide currents inside the Forest.

The result is an increased rate of sedimentation and fast changes in the floristic composition of the mangrove Forest due to soil elevation.

As in other deltaic mangroves in the world, the Sundarbans Forest is a patchwork of species reflecting changes in soil elevation and draining capacity of the different areas. Sediment fertilization is a necessity as the greater part of produced biomass is exported to the sea by tides.

The usual pattern of sediment deposition in tidal areas is as follows:

a. Flat bed of sediments / emergence

b. Deposit of coarse particles on edges of the bed

c. Creation of a raised area along the shore of the sediment patch

d. The raised embankments enlarge with deposition of coarse particles, isolating a central area which becomes depressed and filled with fine particles of silt and clay. Rain water and tidal flows carve the soft sediments in a fractal arborescent pattern of small dichotomized channels reproducing the same zonation:
   Raised area: sandy, hard, well drained soil,
   Lower area: silt, clay, soft, waterlogged soil.

3.1 Plant distribution:

Plant distribution in tidal areas is conditioned by:
a. Fresh water availability
b. Capacity of the soil to retain water
c. Frequency of tidal flushing

With regard to Sundri top-dying areas in the S.R.F. it is clear that ***Heritrera fomes*** can tolerate saline areas but the full development of this species is only found in fresh water areas, as evidenced by O.D.A. (1985) and current field studies.

All mangroves species are fighting against physiological drought and sometimes even real drought of the soil at the peak of the dry season. This fight consumes a large amount of metabolic energy which is not used for growth.

The equilibrium is fragile, particularly for tall trees: as soon as the amount of energy required to pump the sap to the top of the tree is unable to compensate osmotic pressure and is not sufficient to pump fresh water out of the ground to the top of the tree, top-dying may ensue or indeed the whole tree may be killed.

3.2 Influence of soil composition:

Raised, sandy, well-drained levels are usually subject to greater drought conditions, less fresh water, less tidal flushing, and this is particularly seen on the slope opposite to river bends.

In Sundarbans, low tidal levels are encountered during dry months, increasing drought; in some places the soil is cracked at the peak of the dry season; these cracked soils are not usually on the sandy part of the level but in the centre, the so-called "bowl-shaped" areas.

3.3 The bowl-shaped areas:

The central part of these bowl-shaped areas consist of silty clay. If these soils are cracked at the peak of the dry season it means that they are completely dry in their upper layer (the depth of the dry layer is an important point which must be carefully checked).

This also means that raised embankments due to increased sedimentation tend to isolate the core of the islands from tidal flushing during the low tide season. Eventually tide water trapped inside the "bowl" after the end of rain season will evaporate without being flushed on accuount of decreasing tidal effects. The result is increasing salination of the upper layer of the soil during the dry season in these areas.

3.4 Pneumatophores and sedimentation:

Sundri trees with tall pneumatophores which need to be flooded regularly are killed by asphyxia if the pneumatophores remain sugmerged for a long time in stagnant water (or clogged with oil pollution). When the pneumatophore system is slowly buried by sediments the tree seems able to compensate by extending and creating pneumatophores (Annex: Forestry p. 89).

3.5 Result of soil level elevation:

When the level of soil is raised to such an extent that tidal flushing is reduced and even the core of the depressed area submitted to a temporary drought, the Sundri trees suffer. This condition can very quickly shift the fragile equilibrium of a whole area. Tall Sundri in bad physiological condition (eventually submitted to a peak of increased salinity in dry season) rapidly top-die and are further stressed by being unable to grow new pneumatophores to cope with sedimentation; other species with different ecological requirements (Passur *Xylocarpus mekongensis*, Baen *Avicennia officinalis*, etc.) are not disturbed at this stage but in some areas whith high level of physiological stress all the species can die. Some of these areas where all the species trees are affected and dead can be found in the Forest (R. Larsen, 1994. personal communication).

A sudden and complete burial under clay sediments lead to anoxic conditions will kill trees; however this is probably an unusual event as episodes of sedimentation able to bury tall pneumatophores up to 40 cm are presumed to be rare and probably localized to coastal areas.

Young trees of different species buried by a sudden sedimentation are usually able to recover if branches are not covered with silt (F.A.O. Report on Sedimentation).

3.6 Dead pneumatophores:

Pneumatophores of Sundri buried in sediments were excavated. These pneumatophores were found to be dead, and the silty grey sediment appeared to be covering a thin black layer of soil characteristic of ferrous sulfide deposits.

It is therefore possible that these neutral or slightly alkaline soils can develop localized top layer acidity in drought conditions; this temporary acidity developed during dry season and resulting toxic sulfur salts are washed out by rain and tide during the monsoon season. Although results of usual soil analysis do not support this hypothesis, a careful analysis of pH variation in top layers of soils showing black deposits under the surface, is needed as soon as possible. **Top layers of soils cracking during the dry season must be checked for acidity and sulfur deposition.**

3.7 Healthy pneumatophores:

It is difficult at present to link directly death of Sundri trees with burial of pneumatophores by sediments. In places where buried pneumatophores where observed dead trees had been cut but elsewhere top-dying Sundri occured with pneumatophores still alive, even when partially buried.

3.8 Soil and phenology:

Observation of the river banks at the beginning of the monsoon showed variation in phenological stages of Gewa. Gewa trees growing on the upper part of banks in the eroded side of the river loops were losing their leaves (red leaves). Gewa, ***Excoecaria agallocha,*** trees in depressed areas at the same time were without leaves and Gewa on "newly" accreted banks behind Keora, ***Sonneratia apetala,*** or along linear banks were growing new leaves; it seems that Sundri trees immediately behind the Gewa fringe on eroded sides were more intensely affected by top-dying; Gewa trees losing their leaves in early June were located on raised and more sandy soils with probably low water holding capacity. **This needs to be properly assessed.**

3.9 Grass and bare ground areas:

Grass and bare ground areas displayed in blue colour on the O.D.A. 1985 Map were located with G.P.S. fix and visited. Positioning of these areas on the O.D.A. map seems very accurate but this blue colour also encompass totally different areas.

Description of two areas:

a. Raised areas:

The first area visited was located 22° 16' 19" N / 89° 24' 44" E near KOYRA KHAL, 12.07.1994.
From the river bank to the bare ground area we crossed two narrow channels with rare short Golpatta, ***Nypa fruticans***; the soil was freshly flushed and covered by a layer of soft grey silt. Near the river in mixed Sundri-Gewa stands the Sundri are small (20 years old ?) covered with epiphytes and in bad shape with small or stunted branches or top-dying; few Sundri seeds on the trees, rare seeds on the soil, close to the bank many dying Sundri with many seeds; seedlings of Gewa; in this area banks are lined with huge quantities of Sundri seeds but no seedlings visible. No Sundri germination or seedlings between the river and "bare-ground area". Many cut Sundri (diameter 15/20 cm) with dead pneumatophores still up but easily broken.

Near the "bare ground" area there was probably a very slight rise in soil level. Many seedlings of Amor, ***Amoora cucullata,*** and Baen, ***Avicennia officinalis,*** all around the raised area but not inside. "Baela, ***Intsia bijuga,*** 5 to 8 years old spread all along the tiger fern, ***Acrostichum aureum,*** area (3 - 3,5 meter height).

The so-called "bare-ground' area is highly raised and uniformly covered with high tiger fern ***Acrostichum aureum,*** in the fern area, many "Bhaela" and some Passur, ***Xylocaspus mekongensis,*** 5-8 years old, 3-4 meters covered with climbers. On the other side of the fern area some high and well shaped Sundri and 40-60 years old Keora, ***Sonneratia apetala***, some leguminous tree, Bhaela, hibiscus seedlings ***Hibiscus tiliaceus***, and Khalshi ***Aegiceras corniculatum***, trees. (Annex: Forestry p. 89).

Survey of raised land only inundated at spring tide (unsuitable for mangrove species): the estimated extent of these areas range between 2 % (Chaffey et al 1985) O.D.A. inventory and 7 % (Anon 1960) The Forestal inventory, however, and stereoscopic examination of 1991 FINMAP Aerial Survey show that surface of degraded areas could be more important. **It is therefore necessary to make an inventory of these areas using the new 1994 survey.**

b. **Depressed area / Bowl-shaped area:**

On special recommendation of the C.C.F. we visited a depressed bowl-shaped area. This area depicted as "bare ground and grasses on the O.D.A. map (blue colour) was located during a field trip to Passur River on 28.08.94.

22° 22' 15" N / 89° 35' 50" E
Near PASSUR River close to JEPSI KHAL Compartment n° 31

To reach the area we followed a narrow outlet lined with Kewa Katta, ***Pandanus foetidus***; all along this outlet numerous young Sundri seedlings are growing (Annex: Forestry) Many ***cichlidae,*** fish larvae in shallow water. All around the Forest is tall, healthy Sundri stands mixed with some Gewa.

The small outlet drain a depressed area (location: G.P.S. fix). This irregularly shaped area (500 x 400 metres) is swampy with an outer belt of green yellow cyperaceae, Kucha grass, ***Cyperus javanicus,*** or Malia grass, ***Cyperus Sp.*** Black stems of trees cut general years ago, probably Sundri, are visible, the surrounding trees are short Gewa and Sundri. The South West side of the surrounding Forest is mainly short Sundri stands or tall top-dying Sundri. In the core part of the bowl-shaped area a dense crop of dark green Cyperus shows that this area is rich in organic matter and nitrogen salts.

Soil sampling of the bottom of this swamp area showed a black mud rich in partly decomposed ***Cyperus spp*** with the particular smell of rotting organic matter; the substratum is grey clay.

Associated vegetation: waterlily, Shapla, with small floating leaves and white flowers on open water areas, and small patches of floating dark green algae, flushed-off the bottom of the pond by bubbles of gas. These plants are characteristic of fresh water swamps.

Cyperus spp are harvested each year for matting; it is probable that the periphery of this swamp becomes dry during the dry season and that only the core area remains wet allowing dead leaves to decay: this explains the presence of the rich dark green *Cyperus* core.

The area is probably the result of normal geomorphologic evolution of the mangrove system and comparable areas can be found in other mangroves; it was however, obvious that some Sundri have been harvested on the periphery of this area.

Isolation of such areas by deposition of sediments on the periphery and creation of a trap for rain-water results in water-logged swampy soils unsuitable for mangrove species. Opening of channels allowing tidal flushing can allow mangrove plantation, however, success is improbable as the opened channel will be rapidly silted up.

Since these areas produce a valuable harvest of *Cyperus*, it seems useless to try mangrove plantations which are evidently not sustainable.

On the other hand, the periphery consists of degrated Sundri Forest with patches of top-dying. Trials to plant species more tolerant to excessive sedimentation and soil elevation could be done.

4. REVIEW OF THE PRESENT WORKPLAN ECOLOGICAL INPUTS AND QUESTIONS (A REVIEW)

For the present workplan, considering ecological inputs already done by different consultants was extensively discussed with the O.I.C.

A summary of reports is done with special emphasis on major ecological constraints:

a. Evaluation of ecological changes due to water diversion.

b. Evaluation of unofficial felling and its effect on Forest health.

c. Inventory of endangered species.

d. Evaluation of the real socio-economic value of S.R.F. for the country, including its role in the health of fisheries in the Bay of Bengal and comparison of values if reclamation proposals for shrimp cultivation were allowed.

Consultants inputs are reviewed in Annex: Summary of reports analysis p. 120.

4.1 Ecological appraisal of Sundarbans:

The aims of the F.A.O. Project is to provide the Government of Bangladesh and the Forest Department with a set of tools enabling a complete socio-economic evaluation of the Sundarbans Forest.

Findings of experts in narrow specialized fields have to be included in a full ecological appraisal of the S.R.F.

This ecological appraisal will enable the socio-economist to analyze the global value of the mangrove ecosystem for the country.

The Global Socio-Economic Valuation (and its resulting holistic orientation for the Nation) will be the "backbone" of the I.R.M.P.

4.2 Sustainable use versus conversion

Increasing pressures to convert the Sundarbans mangrove to shrimp cultivation exists (S. Huda, D.F.O. Sundarbans, 1994. Pers. Comm.). **An Economic Value must be calculated for the S.R.F. complete system, including its value for the Bay of Bengal fisheries, cyclone protection, and the cost of substitution products in case of reclamation for the shrimp culture conversion alternative.**

4.3 Present status of ecological knowledge

It will be also useful to assess the indirect cost of scheduled embankments. The present, four month consultancy on ecology shows that:

Ecology of the Bangladesh Sundarbans lacks basic scientific research studies that could only be performed by inter-disciplinary scientific teams working together over the longer term.

Inter-disciplinary research needs close collaboration between the Forest Department, Universities and other appropriate research insitutions.

4.4 Need for scientific research:

F.A.O. BGD/84/056 Project can provide the Forest Department with basic tools to improve Forest management as a whole; the future use of these tools depends on the will to allow scientific research inside the Forest by scientists from many disciplines and willingness to help the establish a research centre for ecology of the S.R.F.

The value of mangrove Forests is not only wood or wood by-products; reports of Project specialists shows the lack of reliable scientific information and ask more questions than they give answers; however, these reports, even if they are incomplete, do provide a good basis for further studies. The Project provides basic data on water diversion, showing that S.R.F. is not globally different from other mangroves around the world: similar ecology and similar sensitivity to human diversion of freshwater flow (resulting for example in top-dying), have been confirmed by field studies during the current monsoon June - September 1994..

Over harvesting: field observations confirm that this Forest is under tremendous human pressure resulting from unquantified unofficial felling, particularly of minor species, and that fisheries activities inside the Forest are probably dominated by subsistence fishering on over-harvested stocks of resident fishes.

However, in comparison with other mangrove Forests, the S.R.F. is well protected, without any direct encroachment for shrimp cultivation. It is therefore important that the Project helps the Forest Department in the long-term to maintain the ecological integrity of the Forest.

To do so, in its final stage, it will be important for the Project to provide the general public, political leaders, technical counsellors and Forest Department staff, with a comprehensive study explaining the importance of the mangrove Forest for coastal fisheries, shrimp cultivation and the National Economy. Short and striking examples of reclamation with long-term economic results will help in understanding ecological challenges and comprehension of the goals. This can be done in the ways (listed below: A, B C):

A. Brochure for the general public:

publication an attractive, well-illustrated brochure explaining the importance of mangrove preservation to assure not only sustainable wood production but it supreme relevance to sustainable fish and shrimp production in the Bay of Bengal and all areas adjacent to the Forest. This brochure will give basic economic data. The target will be the general public and non- specialists.

B. Conference for officials and managers of state companies:

This should target specificaly those promoting reclamation of mangroves for shrimp conversion: Bangladesh Small and Cottage Industries Corporation, B.S.C.I.C., Bank Regional Directors, selected private managers and others. The conference would emphasize the economic point of view and illustrate economic and technical failure stories of mangrove reclamation due to misunderstanding of ecology as in the Chakaria Sundarbans.

Attendants will receive a basic and interesting economic study with quantified examples.

C. **Training session for the Forest Department staff:**

This session will explain the environmental goals and value of the Project by giving "live" examples of modern mangrove management in other countries and the need for ecological research and collaboration with universities, especialiy Kulna University, other relevant technical departments and multi-disciplinary research scientists.

Participation of university professors should be solicited.

4.5 Mangrove Ecology:

The first report Sukardjo, F.A.O. Report Mangrove Ecologist - 1992, mainly theoretical was analyzed by Dr. A. Karim, Project sylviculturist - 1993, this analysis is valid:
Ecology is the science concerned with the inter-relationship of living organisms and their environment; this means that ecologists must rely on previous works and data collection concerning meteorology, pedology, zoology and botany of the area. These data are available for Indian Sundarbans and early description of Sundarbans flora and fauna do exist. Studies concerning vegetation, zonation and vegetation maps are available. However, detailed studies of Bangladesh Sundarbans fauna, productivity and interrelationship of living systems are scarce or absent. This means that a report on the ecology of this mangrove system consists mainly of hazardous extrapolations or is a list of questions and future research planning.

4.6 Wildlife management:

Tamang's, Wildlife - Report BGD/84/086 - 1993, deals mainly with the tiger, ***Panthera tigris,*** and other large animals; primary consumers of the Forest ecosystem are not studied; harvesting of endangered animal species is not mentioned; possible reintroduction of buffalo, ***Bubalus bubalis,*** and others former species of the Sundarbans needs a more much complete study.

4.7 Forest management / sylviculture:

This report is not yet available. Interim data would be of value to ecology and other disciplines if they are available.

4.8 Non-wood Forest Products:

A theoretical report by Shiva, Non-wood Forest Products, - BGD/84/056 (1994), needs to be completed by detailed field study in the villages surrounding the Forest; this could be done under the control of the socio-economist or by a Non Governmental Organization, with a national consultant working in this area (C.D.L., Community Development Library and other National, N.G.O (N.A.C.O.M., B.C.A.S.). working in the coastal area can be contacted). The proposed World Bank study could be of great help in improving this output.

4.9 Apiculture:

Sundarbans honey is well known and excellent as reported on by Zmarlicki, BGD/84/056 (1994); amelioration of production and harvesting techniques must be provided directly at village level with adequate technology. Attempts to promote the use of *Apis mellifera* in areas where *Apis dorsata* is predominant were not successful; improvement in the use of traditional bee hives for *Apis dorsata* inside the Forest can be done at village level and will be more useful. Further input will be needed by the National counterpart on this return from overseas studies to complete this aspect of the Project.

4.10 Soil science:

The Soil science report of Bhuiyan, BGD/84/056 (1994), provides detailed analysis of Sundarbans soil samples; unfortunately these data are not precisely located and need to be integrated in a more comprehensive survey providing complete ecological descriptions of sampling sites along vegetation transects. Information concerning improved soil sampling techniques are given in this report and a useful contribution has been made to our knowledge of S.R.F. soils.

Correlation between Forestal (1954) and O.D.A. (1985) vegetation maps and soils transect analysis in different ecological zones will provide sufficient information to extrapolate a basic soil-cum-vegetation map. This map will show the six main soil types of the Sundarbans, clay loam, silty clay, silty clay loam, loam, sand loam with indications of salinity, drainage condition and area of potentially acid sulfate soils. This will be a useful tool for the planning of new plantations.

4.11 Hydrology:

Productivity and survival of mangrove communities is directly dependent on fresh water inflow; micro-topographic changes due to deposit of sediments carried by river or tidal currents and in turn influence the condition of vegetation succession. It is therefore essential to modelize fresh water and saline water inflow inside the system; this is being done under contract with the Surface Water Modeling Center in Dhaka. Computer modelling facilitates the testing of different scenarios (increase in water diversion for example) and prediction of results; this can be a most useful asset for long-term planning of sylviculture activities via prediction of ecological changes and guiding choice of species; in pratical terms: it will be useless to plant a mangrove species, even a successful one in a top-dying area (like Passur) if the model shows a highly probable change to mesophytic conditions.

4.12 Mapping and geographic information system:

Creation of a new digitised topo map using Satellite S.P.O.T. Images will be achieved in October 1994. The O.D.A. Vegetation Map will be digitized and included in the database; photographic (colour) reproduction of the Forestal map will enable conservation in perpetuity of the unique original and future scanning will be possible if necessary. Scanning of Curtis Map originals will be also useful to assess morphological and vegetation changes on a 50 year period. The G.I.S. database is now operational, including zoological, botanical data, location of Forest stations, confluence of rivers, etc. Use of the two G.P.S. instruments in the field is a useful innovation allowing precise location of study areas, photographic sampling, zoological, botanical and hydrological sampling. Future utilization of differential G.P.S. will allow precise study of erosion dynamics.

4.13 Socio-Economics:

Probably the most important output of the project, the socio-economic study combined with the work on the National Resources Economist will provide vital information essential to evaluate the mangrove system. This study has commenced.

4.14 Fisheries Harvesting and Marketing:

Ongoing studies: preliminary results indicate predominance of subsistence fishing practices inside the river system and excessive catching of immature fishes through uncontrolled over-fishing. Fry collection for prawn ***Penaeus monodon*** cultivation is highly destructive for other fish during shrimp larval stages. Amelioration of transportation techniques could greatly improve fry survival and protect the resource.

4.15 Natural Resource Economist:

The N.R.E. will complete the Socio-Economist's work to give an estimate of the total Net Present Value (N.P.V.) of Forestry and fishery resources. Calculation of the socio-economic minimum value of Sundarbans mangrove will help implement a sustainable use policy.

In other places these values have been calculated:
Fiji mangroves have the following values Forestry.
Net benefits $164 - 217 / ha.

Fish catch 331 kg/ha,
Fishery net benefits 300 / ha / yr. ; $ 5 468 /ha
The minimum value of this mangrove was estimated $ 3000 / ha.

In Bangladesh the population directly surrounding the S.R.F. is estimated at 2 millions people in a 10 -15 km area around the Forest by Moss BGD/84/056 Tourism and Recreation, (1993). E.S.C.A.P. (1987) estimates the direct industrial employment (exploitation of the Forest resources) 10.000 permanent and 500.000 - 600.000 people in semi-permanent employment.

The Bangladesh Forestry Department revenues from the Sundarbans was Tk 140 millions in 1982/1983. The total revenues for fish catching was Tk 16 millions in 1992-1993 and Tk 21 millions in 1993-1994. Royalties collected by the Forest Department are extremely low and the revenues from the Sundarbans may be under-estimated. Market rate to royalty rate ratio can be 40 : 1 for Sundri wood and more than 136 : 1 for shrimps. If we add revenues from coastal fisheries, harvesting of Nypa palm leaves, collection of Goran fuel wood, collection of gastropods for lime, collection of grass for matting, and value of unofficial huge removal of good large wood, the figure must be completely different.

As an indication, we can calculate the subsistence catch of the dinghy registered each year, fishing inside Sundarbans Forest.
Number of boats 1992-1993: 133.198 boats
this number seems curiously overestimated, Source Forest Department, D.F.O. Sundarbans 1994).

Number of fishermen registered:	272.151
Average catch for subsistence (live fish):	350 g/day/man/estimate
Average days inside the Forest:	180
Total subsistence catch:	**17.145 ton/year**

Official figure Chantarasri, BGD/84/056 (1994), for fish catch inside the Forest average: 6.000 ton/year
and for 1992-1993 including crabs, shrimps, dried fish and Hilsha ± 5.321 tons.

Sustainability:

These data and disparities contained therein need to be carefully studied as it is possible that after 100 years of apparently sustainable use, the Sundarbans mangrove is in fact being exploited in a non-sustainable way both for wood and for fish. This worrying assertion is based on field observations concerning the size of seized wood logs and consultation with the Forest Department on unofficial logging activities which is said to occur in many places, and observation of extensive transportation of wood poles and fire wood by dinghy boats. Observation of the mangrove canopy shows patches of heterogeneity, possibly due to random unofficial logging of big trees. **A careful study of $1/15000$ aerial survey with extensive field work and a complete socio-economic study in the field can help assess the sustainability of the present utilization. This must be a major inter-disciplinary objective during the forth coming dry season.**

5. PRATICAL ECOLOGICAL GUIDELINES SAMPLING METHODS AND SCOPE

5.1 Permanent sampling plot system:

The P.S.P. system is a useful tool that gives good results data collection methodology and accuracy of measurements could be inproved however, as P.S.P.'s are submitted to a kind of special protection, at the end they will not reflect the exact status of the Forest and this bias must be taken into account.

Annual measurement of big P.S.P.'s is time consuming and allows only to survey a low number of plots not really representative of the Forest status and evolution.

5.2 Systematic survey sampling plots:

This type of sampling is discussed in Chapter 6 (Future Ecological Monitoring System). This system consists of numerous sampling plots disposed on a grid. Each plot is smaller than the usual P.S.P. and composed of small subplots in order to assess the mosaic structure of the Forest. Each systematic plot can be localized using a Satellite Global Positioning System and measurements will be faster than those of P.S.P.; however due to the increased number of plots it is necessary to have good logistic support, fast speed boats and to work methodically to avoid unnecessary cost and time consumption.

5.3 Occurrence of sampling:

With this system systematic survey sampling a complete sampling is not necessary each year and a 3 to 5 years turn-over is possible, thus reducing cost.

5.4 Necessity of a G.I.S. database:

All systematic survey sampling information must be fed into the database for future use. A qualified computer operator is necessary.

5.5 Multiple use sampling:

The systematic sampling system can be used for different types of inventory: species inventory; (example: Nypa palm); botanical inventory; zoological inventory; it is highly adaptable to the user's needs and to new research a management requirements.

5.6 Outputs:

The systematic sampling system will give quantitative data concerning recorded objects in a given area; precise evaluation of the sustainable use of the resource can be done in this way; however, the system cannot give precise location of stands and vegetation zonation; use of aerial photography and earlier vegetation maps is therefore needed.

5.7 Correlation with former data:

Scanned or digitised vegetation maps (Curtis, Forestal and O.D.A. maps) will be stored in the Project database. This will allow diachronic study of the Forest system and comparison with systematic sampling data.

5.8 Adaptation to dynamic systems:

Systematic sampling is the best choice if the system studied is susceptible to fast unpredictable changes.

6. MONITORING ECOLOGICAL CHANGES AND ECOLOGICAL PARAMETERS:

6.1. Evaluation of the existing system:

a. Existing Forest Inventory:
based on Permanent Sampling Plot System: efficient but unable to assess fast ecological changes.

b. Ecological monitoring:
ecological parameters, are not recorded in the present system; even basic meteorological information such as rainfall and temperature data are missing.

6.2. Future ecological monitoring system:

Planning and design:

An ecological monitoring system is based on an inter-disciplinary approach, this will avoid the inter-disciplinary "expert" approach resulting in fragmented understanding: The team members of the interdisciplinary Ecological Monitoring System will work together on the understanding of the whole system. They could synthesize their different knowledge using the "Holistic Resource Management" approach described by Savory (1985) and thereby attain the common central objective of integrated resources management so essential to the Forest Department in its management of the Reserved Forest.

6.3 Systematic sampling:

An alternative survey system is proposed (Systematic Survey Sampling) as a result of field observations made during June to August 1994 (See section 6.10).

6.4 Ongoing Major Ecological changes:

The Sundarbans Reserved Forest and upstream areas are constantly changing ; the occurring changes in the S.R.F. seem unavoidable in the dynamic socio-economic context of Bangladesh.

Upstream human activity, including water diversion (plus Farraka dam), for shrimp farming and agricultural purposes is already increasing and will be more drastic in the future, inevitably.

Obviously, all the biological phenomena linked with water availability, water cycle, and water salinity will be affected. All these anthropic related changes interact with the usual fast morphological accretion and erosion movements of a tidal delta.

Furthermore, official and unofficial intense removal of Forest products create a highly heterogeneous Forest and a complex mosaic of vegetation cover.

Careful comparison between former stratifications and vegetation mapping (Curtis map/Forestal/O.D.A.), recent remote sensing data (S.P.O.T. Data and FINMAP 1990 aerial photography) and field survey, show that in many parts of the Forest changes are so fast that these maps are partly outdated.

Successive field observations during 16 days of field studies inside the S.R.F. show that important phenologic changes occur at the beginning of the monsoon. Deciduous "Gewa" ***Excoecaria agallocha*** for example can be found at the same time and in adjacent areas in completely different stages: no leaves, new light-green crown, and full foliage.

The S.R.F. is a patchwork of numerous intricate Forest types with heterogeneous phenological variations. The mapping of this dynamic system seems in large areas of the Forest beyond the possibility of usual zonation mapping at a practical scale.

6.5 Limits of classical stratification and mapping applied to S.R.F.:

In the S.R.F. it appears that all future vegetation mapping based on a pre-stratification using high resolution remote sensing data and/or aerial photography will suffer the same criticism as O.D.A. and will become rapidly outdated.

6.6 High resolution aerial survey:

The use of October 1994 scheduled 1/15000 Panchromatic aerial survey will not solve the problem. The overriding need for an adequate and accurate stratification/zonation system remains in order to represent properly the characteristics of a highly dynamic system.

Reading and interpretation of vegetation on high resolution panchromatic extensive aerial survey can only be performed by specifically trained personnel who are not available stet. Training in this subject is a high priority consideration.

The use of 1/15000 and 1/7500 Aerial photography will be very useful for special cartography of Top-dying Areas, and for locating vegetation transects for research purposes (Annex: Cartogrphy p. 95).

a. Identification of Forest Stations:

A useful low-cost tool for the December 1994 aerial survey will be to clearly identify all the Forest Department permanent establishments inside the Forest by painting the roofs of the main buildings with cheap white paint; all the reference G.P.S fixes could be taken on these buildings.

b. Access to December 1994 aerial survey raw data is another important requirement for BGD/54/056:

A set of contact copies should be made available for the project Ecologist in order to finalize Ecological Guidelines (February 1995). If for some reason this aerial survey data will not be available in time, it is recommended that the Project acquires a set of enlargements of the most recent S.P.O.T. data available (1993). As these data are already processed for other purposes, the cost will be minimum; contacts have been made with French Embassy concerning this point.

c. Colour aerial photography

The December 1994 aerial survey will be done using panchromatic black and white film; it seems that this choice is rational for extensive study of coastal areas at a cheap price, but in the case of the Sundarbans Forest colour photography is a much better choice.

The value of colour photography (not infrared /false colour photography) in mangrove Forest studies is that it permits easy discrimination of tree species or even individual trees using a crown colour key.

This will help reliable calculation of average stand height, tree count / ha, crown diameter and crown cover percentage, by species, particularly for the species scattered in the Forest such as Baen and Passur and for the riverine Nypa stands inventory (differentiated from grass, etc.). Colour photography will also allow easier evaluation of the Top-Dying Areas and other interesting and important ecological parameters concerning sediment load of rivers and soil characteristics.

It is strongly recommended that, if possible, the Sundarbans Forest be surveyed using colour film during the course of the December survey. (Annex: Cartography p. 89).

6.7 G.I.S. priority:

Considering all these problems it seems more useful to concentrate initally on G.I.S. and the production of an accurate and reliable Topographic-map based on S.P.O.T. satellite imagery.

G.I.S. database is growing with addition of precise location of the Forest Department Stations (G.P.S. Fixes), Gazetteer, hydrological modelling data and biological data.

The necessity of National inputs through links with the R.I.M.S programme must be emphasized in order to easily exchange information. The G.I.S. hardware and software and the database itself will be able to be handed over to the Forest Department after termination of the Project as a complete "turn-key system" as suggested during the important G.I.S. Backstopping mission by M. Runkel, A.G.R.T., May 1994.

6.8 Digitizing:

Digitizing the topo-map is expected to start in mid-August at Khulna university under the supervision of Pr M. G. Murtaza (Rural Planning) as accuracy problems discovered on overlay coverage's drawn by SPARRSO are hopefully about to be solved.

Training of the Project Cartographer, Mr. F.I. Khan, was discussed with David J. Savory, G.I.S. specialist at ISPAN and this is teataltively proposed as soon as the G.I.S. System arrives in Dhaka (presumably September or early October).

Training will help the Cartographer to complete the base map and subsequent overlays. All the S.R.F. management information (G.P.S. location, KNM coupe maps, blocks, compartments etc.) collected by the project will be then overlaid. **An efficient G.I.S. database operator is obviously essential for the Project.**

6.9 Future vegetation and ecological mapping:

The challenge is to provide the Forest Department with a suitable set of management tools based on thematic mapping to assess the highly dynamic evolution of the S.R.F. and to be able to take suitable management decisions without delay in different fields: compartment management, coupes, planting new local species, wildlife and fisheries management, apiculture, establishment of sanctuaries, marine protected areas, ecotourism, rescue plans in case of pollution at Mongla Port, monitoring water pollution (pesticides etc.) and indeed for all future resources management.

Previous work in I.C.I.V. in the Vegetation Mapping Laboratory in Toulouse-France with mangrove mapping specialists and extensive discussions with Mr. J.W. Leech, Mangrove Inventory consultant, BGD/84/056, resulted in a new appraisal of the future S.R.F. planning and mapping.

6.10 Systematic sampling and ecological survey of the S.R.F.

The best way to assess change in as fast an evolving system as S.R.F., at multiple levels (topographic, edaphic, climatic, biotic) is to use systematic sampling and interface this with the G.I.S. facilities. This was discussed extensively with J.W. Leech.

Systematic Sampling however is usually avoided as it is often costly, in the particular case of S.R.F. this inconvenience can be overcome as discussed with Dr. A. Karim Sylviculturist (5 years sampling cycle),. J.W. Leech's proposal of a Systematic Sample System would result, if implemented, in a complete change of the mapping philosophy.

A grid of Temporary Survey Plots (T.S.P) will allow Continuous Forest Survey (C.F.I.) and post-stratification ; then multi-thematic mapping will become available allowing continuous inventory and ecological survey. In this way a new exhaustive, high resolution vegetation mapping is not a necessity ; a low resolution general mapping will be sufficient.

The overlaying of non-corrected former vegetation maps (O.D.A.) is therefore only being done as a reference to help assess changes if the Leech proposals are accepted.

6.11 Specific mapping:

The gain in time for the Project to include a further dry season's data collection will allow detailed cartography of areas of special interest, in Top-Dying Areas, sanctuaries, special zones etc., based on the impending (December 1994) aerial survey. The value of this to being able to form rationale and soundly based ecological opinions on the status of the Research Forest ecosystem, cannot be over-stated.

6.12 Morphological change evaluation:

Growing stock losses due to erosion are a real problem and Chief Conservator of Forest Mr. M. Hussain emphasized this point during a meeting in Dhaka on July 07,1994. The generally accepted method of quantification of this phenomenon requires overlays from high resolution remote sensing coverage at long intervals of time.

Precisely located control points are necessary but these are lacking in the S.R.F. Creation of control points for 1994 December survey and visible on Panchromatic high resolution S.P.O.T. data is proposed.

Precise location of these control points (5 m accuracy) by means of differential G.P.S is possible for a low extra cost (P.C. Software and N.M.E.A. function box) using the two Magellan G.P.S. already in the Project. An alternative method is to establish fixed control points near the river edge and to measure accretion and erosion rates and so develop area change models. Either way it is essential that there points are deployed as soon as possible.

6.13 Ecological field data collection:

a. Monsoon season:

Field data collections were performed during 16 days sailing in the Sundarbans in June, July ; due to monsoon constraints, timing of availability of vessels and speed boats and other data collection constraints in Khulna and Dhaka, this was a good result.

However, it is of utmost importance in future field studies (C.C.F.'s own recommendations) to have at our disposal a large, reliable speedboat with an extra security outboard engine, suitable for 8 crew members and large enough to carry 500 l petrol.

This speedboat will allow a considerable gain in time, being able to reach directly the small rivers inside the Forest, to easily survey the P.S.P.'s for Forest management and Ecological Survey purpose. Itis understood that a boat is being procured for this purpose.

b. Dry season:

Extension of ecological data collection to next dry season will allow assessment of the changes occurring on raised areas and low bowl-shaped areas (Top-Dying Areas) as required and directed by the C.C.F. during June Dhaka meeting.

6.14 Hydraulic modeling for the S.R.F.

The ecology and integrity of the S.R.F. is totally dependent on variations of water circulation inside the system. Formulation of practical ecology guidelines (T.O.R. 1) require hydrodynamic and salinity models. Without sound data on the hydrological characteristics of the system it is impossible to draw scientifically tenable conclusions about the S.R.F.

Lack of reliable data concerning the S.R.F. ecosystem is flagrant and at the moment no meteorological station is functioning inside the Sundarbans.

Two meetings initiated by P .de V. Moss - O.I.C. BGD/84/056 with Surface Water Modeling Center, Chief Technical Advisor, Mr. R. Galapatti; Mr. T. Van Kalken computational hydraulic engineer; Mr. A. Malmgreem-Hansen Environmental specialist, and a preliminary field trip resulted in a proposed intensification of the existing South-West region hydraulic model network to provide appropriate coverage for S.R.F. This activity was a direct follow-on from the valuable Backstopping mission made on hydrology by Mr. Martin Smith, May 1994.

6.14 Biotic data / wildlife:

Forest Department rangers and officers under proper direction can collect useful biotic data in different fields:

- Botany: Record of flowering, blossoming time, in each comportment in order to precise phenology i.e. the relation between climate and periodic biological phenomena, essential to Forestry, apiculture, wildlife management, etc.

- Fisheries: **Information concerning number of passes, number of fishermen, type of fisheries, fish species, etc., already collected in different point of S.R.F.could be analyzed usefully and easily by Ranges offices and Stations.**

This would provide factual information concerning evolution of fishing practices, intensity of activities, etc.

This information is not easily attainable by fisheries, ecology and socio-economy specialists at the moment but are vital to the I.R.M.P..

Transcription of theses data by range for the 10 last years will be a very useful contribution and should be given serious consideration by the Forest Department.

- **Zoological data:** Recording of all factual related to wildlife in each Range, Forest Station, Forest Coupe Station, would be of great interest and value to zoologists.

  A photocopy of the new topo-map of the range glued on a piece of thin cotton material will be provide with each wildlife notebook in order to localize the recorded observations.

  A photocopy of animals drawings with local name will be joined to the notebook for identification purpose. This must be as ongoing project for the National Ecologist and follow on from this mission. The data, if acquired over time for each compartmen, will enable an accurate picture to the formed on the status of fauna throughout the S.R.F.

Location of wildlife habitats:
Precise location of wildlife habitats will be noted on the new maps:

- Birds "Sanctuaries" with particular abundance of birds and nesting places, name of large birds usually seen.
- Oyster harvesting areas
- Location of restricted fishing Khals
- Location of main fishing areas and type of fishing gear, etc..
- Location of pristine Forest patches especially where numerous old trees are present
- Record of animals
- Presence of crocodiles directly observed, tracks, estimated size of tracks
- Seasonal presence of Ganges dolphins and estimate of numbers.
- Records of accidents due to sharks, snakes or tigers with circumstances location and date.
- Tigers directly seen, pugmaks of males - females and cubs.

Presence of carnivores and other important species:

- Tracks, barking, squeal, scats, visual records / sightings
- Python visual record. Poaching records.
- Tortoise and turtle visual record, fishing records, nesting places.

Directions for recording these data should be written in Bengali and English and included in field notebooks with identification drawings of the animals for which data are required.

One hundred of these wildlife and environment notebooks will be furnished to the Forest Department stations inside the Forest. Recording of all this information must be formalized in close collaboration with the D.F.O. Sundarbans.

6.15 Formalized records:

An attempt to keep record of wildlife is being done using a sampling card-notebook. The purpose for this works is to follow up on the wildlife specialists studies and to obtain further information on the existence and location of important wildlife species in S.R.F.

Use of cards will enable an easy input in the database.

6.16 Training course:

A earlier trial by the wildlife specialist to use record-cards had no success due to lack of motivation and training of rangers and officers. A further attempt should be made.

A training course on wildlife data recording is an absolute necessity in order to explain the value of such data for the Forest Department itself.

This training course will give the basic information to identify animals and how to record wildlife data and provide the Forest Department officers and Rangers with documents necessary for field-work: descriptions and drawings of animals, drawings of tracks, measurement of animals, keeping of skeletal material, etc.

6.17 Environment data:

The Forest Department Officers and Rangers are in permanent contact with people working inside the Forest and they are themselves well aware of environmental changes due to natural phenomenon or changes induced by man: tree loss due to erosion, storms or cyclones; sudden occurrence of top-dying; insect defoliation or animal diseases, etc.

It will be of great value to future ecological studies to record all these phenomena on a log-book in each station on a day-to-day basis; again examples of such record keeping, which is extremely valuable but not at all difficult or arduous, could be provided in the training course.

6.18 Value for the Forest Department:

The need for extensive environmental studies in order to assess the role of S.R.F. as nursery for commercial fishes and repository of so much of Bangladesh's biotic resources will require more wildlife surveys and other scientific work on biodiversity and ecology. This requirement can only increase in the future.

Demonstration of proper knowledge of the Forest environment based on accurately recorded data will be a powerful asset to convince funding agencies, wildlife N.G.O.'s, university scientists and other departments, of the Forest Department's ability to manage and supervise sustainable use and conservation of resources in the Project area. The Forest Department could thus take the lead in coordinating research activities inside the Forest. **The Project should give all help and encouragement to achieve this highly desirable goal.**

6.19 Field Ecological stations:

Three field ecological stations should be established as soon as possible (Prodoc objective 1, Output 1, Activity 2). DHANGMARI, KATKA, SUPOTI and MANDARBARIA could be possible sites. One of these stations should be equipped with basic facilities for use as a research centre. Automatic meteorological recording system should be installed in these stations.

Mobile stations: The new Project Survey launches will be used as mobile survey stations for the interdisciplinary research team; equipment should be provided with facilities to perform field sampling and study of wildlife, electricity, water, basic laboratory equipment, storage facilities, etc.

6.20 Sampling plots:

If systematic sampling is implemented the ecological inventory will use the Systematic Sampling Plot (S.S.P.) system. Identification of critical Forest, coastal, and marine habitats will be performed and Temporary Sampling Plots (T.S.P.) will be used for classification of habitats, type of environment and type of ecosystems. Areas containing remarkable ecosystems will be selected and included in a coastal and marine protected area network.

6.21 Trials:

Sylviculture trials are being performed by the Project Sylviculturist, the Forest Department and Bangladesh Forest Research Institute; these trials will be included in the ecological survey network in due course, as an output to beconsolidated in the Final Report on Ecology.

7. TOOLS FOR FUTURE SURVEY, MONITORING AND MANAGEMENT

7.1 Database / Geographie Information System (G.I.S.):

Structurating of the database is in progress with addition of the botanical and zoological data, the Gazeeter and input of meteorological data and soils data comprising diachronic soil and water salinity recorded in the periphery of S.R.F. and on Passur River for last 10 years. Contributions by Dr. Jerry Leech, BGD/84/056, August 1994, resulted in important improvements in research for the future inventory of S.R.F.. Proposal for a systematic Survey Sampling System integrated to the database was done (reported on in Section 6.10) .

Links with the Forest Department working on R.I.M.S. project have to be improved and links with other national databases are also needed.

7.2 Meteorological and environmental data collection:

Continuous meteorological data collection is essential for assessment of ecological changes.

Rain and temperature data collected at the beginning of the century in Sundarbans Forest are invaluable information for comparative purposes. Further research in the literature must be carried out.

No recent meteorological data are available concerning North West - South West centre and South East Sundarbans.

Collection of meteorological data inside the Forest is absolutely essential. Enviromental monitoring stations have a totally different role from Forestry Stations and should not be located in Range Stations. If possible automatic stations should be located as a priority on coastal areas for cyclone monitoring, etc.

7.3 Manual Data Collection:

Basic data collection could be made manually with help from Rangers (wind direction and intensity, temperatures, rainfall) working with Project staff and later other research workers.

Training of Officers and Rangers and equipping of main Range Offices with inexpensive rain gauge, thermometers,. Minima - Maxima thermometers and tide gauges could provide an inexpensive embryo-network of meteorological stations. This essential work would necessitate positive inputs by the Forest Department.

7.4 Training of officers and rangers:

Meteorological Data Collection training course: this course would comprise demonstration to read accurately and record a rain gauge, a thermometer, a minimal - maximal thermometer, a tide gauge, estimate wind speed and cloud cover and to record soil drought.

A technical field guide with illustrated examples, written in Bengali and English would be furnished to each trained Officer and Ranger.

Training of Officers must emphasize the importance of proper and accurate records for future studies and the necessity to control regularly record books and accuracy of Ranger records.

Trained Officers will be in charge of meteorological records books.

A standard basic meteorological notebook would be furnished at the end of the course with the name of the officers office; spare notebooks would be retained at the stations to avoid time wastage.

The first meteorological recording stations could be located inside the Forest and the meteorological network would be gradually extended in proportion to training and competence.

Summarized data will be collected at the D.F.O.'s office, Khulna and data will be introduced into the G.I.S. database which would be eventually transfered to the Forest Department as already noted.

All irregularity in data collection / recording could be signalled to the D.F.O. for corrective action.

7.5 Automatic weather stations

Automatic weather stations for monitoring and processing environmental information.

These systems are reliable, flexible, accurate and easy to use; they can be used for:

- Weather monitoring
  - . River height monitoring
  - . Solar radiation monitoring

Specific calibrated interchangeable sensors can be added for recording:

- temperature
- rainfall
- humidity
- solar radiation
- wind speed / direction
- leaf wetness
- soil temperatures
- barometric pressure
- water level
- soil and water electro-conductivity (salinity)
- soil moisture

7.6 Power supply:

Automatic weather are readly powered by solar panels and do not need other power supply.

7.7 Integration to a database system:

The weather stations would be supplied with full software allowing the user to configure the station, retrieve and download data. Data can be collected with a portable P. C and input directly into the database.

These stations can also be fitted with a Telecom Mobile Net Communication System, allowing automatic radio collection of data.

7.8 Number of stations needed:

Threes of these stations installed in the middle of the ecological zones of the S.R.F. would provide reliable information to monitor ecological changes. These stations could be included in Meteorological Department Network or managed directly by the Forest Department.

7.9 Importance of Environmental data collection:

Understanding of top-dying and assessment of ecological changes cannot be done without reliable climatic data collected inside the S.R.F. At least one automatic weather station must be installed in the middle of S.R.F as soon as possible.

7.10 Aerial survey and micro-light amphibian plane

Aerial survey at low level is deemed to be essential for all extensive natural resources management worldwide. Although this equipment is not listed in the PRODOC, detailed information is given in this report to help in any future Project Revision and Forest Management Policy.

An amphibian U.L.M. plane can be used with success for the following purposes:

- Aerial survey following storms or cyclonic storms and for river flooding, to monitor:
  - tree defoliation, break, felling
  - wave effects on coastal areas
  - erosion, accretion extent and area quantification of eroded areas
  - flooding of shallow areas.

- Aerial survey to monitor:
  - tree phenology
  - Sundri top-dying
  - radio tracking of rare or endangered species
  - direct counting of animals on open areas, mud flats, coastal areas
  - survey of Forest boundaries
  - illegal encroachments.

- Security links in case of accident in remote parts of the Sundarbans.

- Radio relaying service for field teams.

- Control of unofficial removal of wood and non-wood Forest products.

- Control of fisheries inside the Forest and in the future marine protected area.

All survey observations can be both visual and recorded by means of video or small size photo camera.

Apart from direct observation, video, or photo survey the amphibian plane is able to perform a wide range of administrative management and research functions due to its ability to land and take off on any river and find shelter in small khals in case of storms.

This "flying boat" can reach all the parts of Sundarbans in less than an hour, beach to collect samples, monitor tide streams in remote areas, etc.

7.11 Hydrology surveys:

Equipped with an echo sounder, electroconductivity meter and differential G.P.S. the amphibian plane can help monitoring tide and upstream river currents. Surface currents, speed and direction can be monitored by video or photography, using dye marking.

7.12 Hydrology of surrounding areas of S.R.F.

Shrimp farms, embankments and dredging of channels can be surveyed, quickly and accurately.

7.13 Cyclonic storm survey

The use of an amphibian plane allows fast upstream / downstream checking after a cyclonic storm long before any spatial remote sensing data are available due to closed coverage (up to 3 weeks after the cyclone for S.P.O.T. or T.M. Satellites).

7.14 Aerial seeding of mangrove species

Successful seeding experiments of mangrove species in Indian Sundarbans by means of a light aeroplane could be emulated in the S.R.F. For example a 150 kg carrying capacity would allow a 15 -30 ha/day seeding capacity for Baen and Keora species. This is a highly cost-effective sylvicultural technique.

7.15 Monitoring ship oil pollution at Mongla port:

Oil spills can be easily detected from air. There is no better method.

7.16 **Sampling water with precise location of sampling site:**

This is readly achieved and storage of all data effected in an acquisition solid state device; parameters: temperature; pH; salinity; electroconductivity; turbidity (current speed: on anchor); depth (transects profile).

Collection of water with an automatic sampler for pollution; analyze, biological survey of plankton, Biological Oxygen Demand (B.O.D.), etc.

Due to is manoeuverability the amphibian aeroplane can sample automatically and locate precisely with a G.P.S., many different sites (up to 30) in a single day in a range of 60 km. Up to 3 000 different data can be collected directly from the acquiring station by plugging into a P.C.

The advantage of the amphibian plane over a speed-boat is its ability to follow a fast moving phenomenon and survey it in a short period of time eg wide-spread sampling sites (example: the tide).

7.17 Type of ultra-light amphibian plane

a. **Engine:**
Very low noise reliable 2 ignition, 4 cycle aviation engine

b. **Propeller:**
4 to 6 blades low noise, low speed propeller.

c. **Security:**
combination of reliable engine and ultra low noise propeller with a non stealth plane allows secure low altitude survey of mangrove areas.

In case of a "crash" the plane is equipped with a radio beacon and a powerful flash light.

d. Amphibian capability:

The ultra light (200 kg) plane, 2 seats, 150 kg carrying extra capacity is its ability to land and take off either on land or water; it can be easily folded in a small container for storage during bad weather.

3 type of amphibian planes fulfil all the requirements for use in mangrove areas; one of them is a highly performance plane using new composite technology.

A considerable amount of experience flying these U.L.M. amphibian plane in mangrove areas, particularly in French Guyana mangrove, shows that they are more secure than small classical plane and helicopter, far more silent (allowing survey of wildlife, particularly marine birds) and highly reliable due to recent improvements in engines, propelers and frame structure.

7.18 Launches and survey equipment:

a. Laboratory equipment:

In order to conduct field verification work next dry season some additional procurement of equipment will be required. A list is provide below (a - g)

In addition to basic equipment for field-work already available to the Project, it will be necessary to purchase some additional laboratory equipment for observation and storage of larval stages of fish and shrimps.

b. Stereoscopic field microscope:

A portable stereo microscope will enable Khulna University fish biologists from whom appreciable, help is being provided to follow up on and verify the fishery biologists (Chantarasti, BGD/84/056 - 1994) findings; to study larval stages and other phenomena not adequately covered to date.

c Ice box:

A large capacity ice box 200 - 300 l is needed in order to store fish and other biological specimens.

d. Storage capacity:

Plastic leak proof containers and bottles needed to store specimens in formalin or spirit solutions; glass containers must be avoided.

e. Electroconductivity meter:

A field apparatus with automatic temperature correction is needed.

f. pH meter:

A field portable apparatus is needed.

g. Larvae collection nets:

Will be made locally under Khulna University supervision

7.19 Pollution monitoring:

Collection of animal samples is necessary in order to assess presence of pollutants in Sundarbans fish and shrimps. Deep freeze container is needed. Link with specialized laboratory is also needed. This work can be pursued by the National Ecologist.

7.20 Aerial radio tracking:

Collaboration with the cat Specialist Group, I.U.C.N., is needed if micro-light amphibian plane is acquired. In order to start this activity contacts have already been done and close linkage with the Forest Departments Wildlife Division is being maintained.

7.21 Radio network:

H.F. radio network, when fully operational will enable improved field-work and security **(PRODOC Objective 3, Output 3).**

7.22 Environment division:

Existing and proposing wildlife sanctuary:

The creation of an Environment Division within the Forest Department should enable implementation of Environment and Ecological surveys and monitoring inside the S.R.F..

Effective protection of the three existing wildlife sanctuaries and proposed extension (Wildlife Report B.G.D./54/056) should improve effective protection of highly sensitives zones for wildlife conservation. A preliminary proposal for a coastal and marine protected area is provided in this report See section 8 (Annex: Wildlife Sanctuaries p. 70)). Preliminary discussions with responsible Forest Department Environment Officers suggest an early need to establish administrative and management structuring for mutual cooperation and effective research and development between the Wildlife and Environment divisions.

7.23 Environmental team:

An environmental Team, a group of selected scientists and Forest Department Officials could be formed to further environmental understanding. This group might have the functions listed below (a - f):

a. Functions:
Implementation of environmental surveys and environmental policy inside S.R.F. as a whole with particular emphasis on Wildlife Sanctuaries and coastal and marine protected areas.

b. Links with universities:

The Environment D.F.O. and the "Environment Team" could implement and organize collaboration with University Scientists at National and International levels.

c. Field-work - the Research Centre:

Creation of a Research Centre for national and international scientists, located inside one of the coastal wildlife sanctuaries would enable the Forest Department Environment and Wildlife division to establish links with the scientific community and implement new research work, especially on endangered species: tiger, crocodile and turtles.

d. Reintroduction of wildlife:

"Hogdeer" at KATCHIAKALI,; buffalo in the North-East, S.R.F., etc..

e. Information / Publications:

Publication of an annual report and information letter, summarizing the environmental Teams activities addressed to university scientists, ecotourism organizations and international funding agencies.

f. Ecotourism:

Ecotourism activities inside wildlife sanctuaries must be strongly encouraged following recommendations of P. de V. Moss (Report Tourism and Recreation, BGD/84/056, 1994 KATKA Jungle lodge already can be used for ecotourism purposes and the team could consider ecological .aspects of tourism developments here and elsewhere.

8. SUNDARBANS COASTAL AND MARINE PROTECTED AREAS ESTABLISHING GUIDELINES

These summarized guidelines are proposed to help the Forest Department establish a network of marine protected areas around the Wildlife Sanctuaries of the Sundarbans Reserved Forest and along coastal areas of the Forest.

This network of marine and coastal protected areas would be designed primarily to protect breeding areas of endangered species along the sea facing coast.

Endangered species of sea turtles like the olive Ridleys Turtle, *Lepidochelys olivacea*, are known to nest along the coast of the Sundarbans.

Other species of marine and estuarine turtles are also greatly endangered due to excessive fishing, and disturbing of nesting sites. These species are the Coast Shell turtle, ***Pelochelys bironi*** , and the green turtle, ***Chelonia midas.***

Estuarine and fresh water soft shelled ***Tryonix spp*** turtles are commonly sold in markets around the Sundarbans Forest. Harvesting is not controlled.

All species of the marine environment animals which breed, nest or live on the beaches, or in shallow water along the coast or inside the coastal part of the Forest need special protection since it appears that they are all subject to human disturbance or harvested on unsustainable basis.

Three species of mollusks ***Crassostrea sp., Telescopium sp and Arca sp,*** are harvested for lime, for shrimp and poultry food and in most cases as human food as well. Limulus or King crab ***Carcinoscorpius rotundicauda*** must also be protected since there appears to be uncontrolled widespread exploitation of this species.

8.1 Aim of Sundarbans Coastal and Marine Protected Area (S.C.M.P.A.)

It is proposed that S.C.M.P.A.'s are needed to protect, restore and assure sustainable use of the coastal and marine ecosystem; include the protected areas in the international network of marine and coastal protected areas. There is little doubt that in areas adjacent to the Reserved Forest the coastal and marine environment and its components are under threat and without special protection are vulnerable to increasing degradation.

8.2 Definition:

The S.C.M.P.A. will encompass inter-tidal and sub-tidal seabeds, mud flats, sandy areas and beaches. The water covering these areas and the totality of associated flora and fauna should be protected..

The Forest Department should provide effective standing orders to protect partly or totally these areas during breeding or nesting periods of wildlife or over all the year, if necessary.

New policy concerning coastal and marine protected areas must consider customary use to avoid conflicts; this should be considered by the F.A.O.. Consultant on Socio-Economy.

8.3 National and International responsibilities:

At the international level, links should be established through the D.F.O. Environment with the following:

- Man and Biosphere Programme — U.N.E.S.C.O
- Marine Science Programme — U.N.E.S.C.O.
- International Marine Organization — I.M.O
- Regional Seas Programme — U.N.E.P.
- CITES
- INDIA GOVERNMENT

to collect information necessary to establish the future status of the Sundarbans Coastal and Marine Protected Area.

8.4 Objectives:

- Sustainable use of coastal and estuarine sea-facing ecosystems.
- Protection of critical habitats for the Survival of threatened or rare species.
- Protection of important habitats for the life cycle of commercially important species.
- Prevention of activities detrimental to the ecosystem
- Protection of breeding and nesting grounds in the interest of ressources needed by customary users.

8.5 Implementation:

To implement these protected areas important preliminary work must be done:

- Determine the level of use of areas by customary users and its consequences
- Identify the breeding and nesting sites to be protected
- Determine priorities for establishment
- Determine for each area the type of protection needed, the period of time during the year were control will be useful
- Determine the necessary systems to enforce protection preferably without heightening confrontation
- Obtain the support of traditional users on a preferential basis and make provision to protect their sights.

To implement the preliminary studies the D.F.O. Environment and Wildlife Division together would establish links with Non-Governmental Organizations (N.G.O's.), universities and other organizations interested in wildlife conservation in order to select a small panel of interested scientists in conservation studies.

This panel comprising an Ecologist, a Zoologist and a Socio-Economist motivated to carry on field studies in Sundarbans coastal environment should be in charge of preliminary studies under control and with logistic help of the Forest Department Environment D.F.O and Wildlife Conservation of Forests.

To find funding for preliminary studies these scientists will submit a joint project to FLA. and to funding agencies working in the field of nature conservation.

One of the first objectives of this panel will be to establish links with Indian wildlife scientists and to visit the research centre established at SAGAR ISLAND.

As soon as the results of preliminary field work become available the Forest Department and the scientific team will prepare a report in order to contact international agencies to allocate resources for implementation of planned activities.

8.6 Choice of Coastal and Marine Protected Areas

In the present condition of Sundarbans estuaries the protected areas must not be inflexibly located but allowed to adapt to the changing environment; however, it is necessary to indicate clearly the areas in which localized temporary protected sites have to be established.

These areas will take into consideration seasonal human use and its effects on fauna and flora. All these data would be overlaid on an Ecological Map.

8.7 Criteria of choice:

a. Ecological importance

- The area should a component in important life-support systems (Bay of Bengal fishes stocks shrimps and other wildlife.
- The network of areas covers a complete ecosystem.
- Includes a variety of habitats
- Includes habitats of endangered species.
- Contains nursery juvenile feeding and breeding and resting areas for different species
- Contains rare and unique habitats
- Contain a large range of species
- Is a pristine area.

b. Socio-economic importance

Protection of the area contributes to the long-term economic value for customary users; ecotourism value; source of supply (protected reservoir) of valuable commercial species.

c. National and international scientific value:

The Sundarbans Coastal and Marine Area has the potentiality to be declared as a Biosphere Reserve and listed on the World Heritage list: its scientific value and its economic importance for aquatic resources are obvious.

8.8 Existing scenario

The Coastal and Marine Area may be already be included in an existing management regime by the Forest Department. Extension of this management regime to the legal Boundaries of the Department of Forest to encompass all the main parts of the possible protected areas (map showing legal boundaries and proposed Coastal and Marine protected areas in Annex: Wildlife Sanctuaries p. 70).

8.9 Need to improve legislation

As the Coastal and Marine protected areas will be an extension of proposed wildlife sanctuaries it is necessary to improve existing legislation starting with legallyt enable boundary descriptions.

The new legislation must consider: Scientific research, education, conservation and recreational objectives and international obligations concerning pollution or misuse of marine interconnected environments. By doing this the Forest Department can play a leading role in conservation and sustainable use of coastal areas and strengthen its position as a leader in conservation of the Sundarbans.

8.10 Multiple-use management

Sustainable multiple-use management of coastal and marine areas must be the central concept for any new legislation.

The main justification is to avoid over exploitation and degradation of interconnected terrestrial and marine ecosystems.

8.11 Planning and Management

The Sundarbans area has been successfully protected for over one hundred years by the Forest Department, this unique fact underpins the right of the Forest Department to continue to manage the area for the foreseeable future. To do so, in the face of growing threats, it will be necessary to develop capacities in the field of estuarine ecology and fisheries. Lack of this capability could entitle other departments to intrude upon the Forest Department's authority.

8.12 Planning: Coastal and Marine Sundarbans Protected Areas:

8.12.1 The present situation:

- Limited funds for management and monitoring
- Urgent need to protect endangered species
- Several seasonal pressure

8.12.2 The answers:

- a fast Socio-economic study of the area

- a general description of the ecosystem focussing on the main problems and estimates of the impact of changes on human activity

8.12.3 Sequence of decision making:

Creation of a inter-disciplinary team "nucleus" of scientist/Ecologist/Marine-Scientist/Socio-Economist under the responsibility of D.F.O. Sundarbans as per the Environmental Team (See Paragraph: 7.13) or the environmental panel.

8.12.4 Confirm legal boundaries and scope for administration:

- define the core zone areas and periphery zones. Promulgate zoning regulations. Match these against legal definitions of boundaries of the Reserved Forest (still unknown), the international boundary and the Bangladesh territorial fishing area.

- local site planning of core areas

- local site regulation of core areas and management calendar

- "retroaction system" to revise and adapt management rules to changing situations and new knowledge.

All this sequence can be achieved in a very short time (one year) even if all information are not available; adjustments would follow.

8.12.5 Main principles applying to S.C.M.P.A.

Establish boundaries for specific activities and enforce closure.

Cluster Biosphere Reserve:a Cluster Biosphere Reserve is proposed consisting of 3 core areas linked by transition and corridor zones **(PRODOC Objective 2 outputs, Activity 4)**.

8.12.6 Management Plan for S.C.M.P.A. and appropriate sections of the I.R.M.P.:

Main contents:

A. Legislative background and authority

B. Provisions and budget

C. Purpose and objectives

D. Description of the resources

1. Location and mapping
2. Main Ecological/Biological zones and habitats
3. Degree of naturalness/threats
4. Adjacent areas/Buffer zones/access routes
5. Settlement and use
6. Detailed mapping: Bathymetry/Tides/currents/land form
7. Freshwater inputs (river and rainfall)
8. Climatic data
9. Marine plants/coastal plants/phytoplankton
10. Marine fauna/coastal fauna/zooplankton

E. Management threats/potential conflicts/future use/pollution

F. Division in resource units: island / shallow water/turtle nesting beaches/sea beds/development areas/impact of human activity

G. Zoning: Seasonal closure / options

H. **Survey:** Vessel and aircraft surveillance systems

I. **Monitoring programme - Environmental monitoring system proposed**

J. **Cooperation with universities / N.G.O. 's/ Users groups**

K. **Enforcement and Education**

L. **Staff and funding - administrative structure**

M. **Data sources**

N. **Legal Boundaries and National and International status**

O. **Existing and proposed legislation**

P. **Zoological and Botanical list of species with local names**

Q. **Mapping section**

1. Copy of Curtis / Forestal / O.D.A. Maps depicting the protected area
2. Location on FAO. / S.P.O.T. Topo-Map
3. Land / Sea jurisdiction
4. Bathymetry / Tide / Topography
5. Location of animal communities / Sanctuaries
6. Vegetation map using 1994 Aerial Survey
7. Detailed map of permanent and non permanent human settlements / number of fishing / boats / anchoring areas / coastal fishing areas / logging / Forest products collection areas.
8. Plan of proposed Forest Department stations
9. Zoning map.

8.13 Over fishing in Sundarbans

Field trips in the Sundarbans and in surrounding fish markets during June to September 1994 where performed by Mr. M. S. PENA - Fisheries Marketing Specialist and Mr. G. GREPIN - Ecologist (Annex: TRIP MAP). The ecological aspects of harvesting methods are extensive and complex for the aquatic environment and its status.

Examination of catches by "dinghy" boats inside the S.R.F. shows that mainly all the fish species except migrant ***Clupeiforme*** Hilsa, ***Hilsa, ilisha*** and some resident ***Siluriformes Pangasiidae Pangasius*** (Bengali: Pangash), were composed of immature specimens; sub adult or small size adults were exceptions: usual size of a common fish of the Perciformes order: *Lates calcarifer* (Bengali: Bhetki), was twenty five centimetre and less than 600 grams. Normally this fish when caught at adult size weighs about 8 to 10 kg and specimens of more than 20 kg are not unusual..

In the case of S.R.F. and surrounding areas our own observations and previous data, Fisheries Report, p12- B.G.D. 84/056 - 1993, shows that all these small specimens have immature gonads.

All these immature fishes are caught with very small mesh nets (10 mm) and this is extremely worrying: it means that there is an over fishing of all the species and that only a very small percentage of immature fish escape the nets and are allowed to grow; the result is a huge loss in annual-catch and catch value of the fish caught.

An other major loss of fish-fry occurs during fry collection for shrimp farming; all these small fishes and shrimps are killed in the process and usually eaten by fishermen or discarded. **A careful study of the specific composition of the fry-collectors catches throughout the year in order to assess the percentage of immature of each species destroyed by this fishing practice is needed urgently. There is no doubt that pressure on species populations and fish stocks is intense.**

8.13.1 Subsistence fisheries and over fishing

Observation of the fishing practices inside the Forest shows that many people are fishing obviously operating at the subsistence level and probably over fishing by using small size mesh nets.

What can we do to achieve a normal sustainable situation ?

8.13.2 Sustainable use of fisheries resources

Subsistence fishery regulations need careful preparation and enforcement to avoid dangerous negative socio-economic consequences and conflict.

a. Protected rivers:

The first solution is to ban all fishing in different rivers throughout the Forest and carefully enforce this rule; this can be done using the experience of the Forest Department in this matter, following D.F.O. Sundarbans Office Order E memo N0 5087/18-1/11/5/1989. (Annex: Name of Khal's restricted for fishing; Annex: Fisheries p. 106).

This complete ban should allow a normal growth of remaining immature fish and creation of breeding core areas. A careful study of population changes in these areas must be done by Khulna University Fisheries Biologists with active support from the Project in 1994/95 and the Forest Department in 1995/1996. The study of the different fish species populations will help the Forest Department extend these measures to other Khal's if the initial results are good.

b. Size of the net mesh:

One of the oldest ways to regulate fisheries is to fix the size of mesh; unfortunately no regulation is applied in S.R.F.; it is extremely important that a minimum mesh size be imposed in the near future.

This can be done gradually by allowing fishermen using new large mesh nets to fish previously restricted Khals after a ban of 2 to 3 years.

c. Fry Collection:

Fry collection is highly destructive for all kinds of shrimp and fish larvae and juveniles; banning of fry collection in the restricted Khals must be strictly enforced.

Fry collection by artisanal methods and transport with "hand" oxygenation results in a very high mortality; the increasing demand by shrimp farmers of wild healthy strong fry and inefficiency of collection results in increasing price of S.R.F. fry; sometimes fry collected outside Sundarbans, in the Bay of Bengal is cheaper.

d. Reducing fry mortality:

In order to reduce fry mortality during collection and transportation to shrimp farms some easy technical improvements are used in different countries; Mr. M.S. Pena (Fishery Harvesting and Marketing, consultant) proposed that fry collectors boats should be provided with oxygenation equipement. This and temperature regulation (ice box) will result in a sharp decrease of fry mortality. Experience suggest possible improvment of about 20 - 50 %; the end result will be either a decrease in fry collection activity or a decrease in net income by poor fry collectors.

Other possible results will be to maintain the demand of fry, as this technical improvement will allow shrimp farmers to extend their activities without the need for artificial hatcheries.

In any case it is necessary to try this proposal and carefully study the socio-economic effects and the result of changes in fry-catching activities.

e. Catching fry and gravid shrimps at sea:

An increasing demand for shrimp fry is expected in the near future due to the Bangladesh policy on shrimp farming.

Increasing shrimp fry collection in the Sundarbans Forest or along the coastal area by artisanal methods will have two results:

- in the fist instance, this will allow an increased number of subsistence fry collectors to earn their money out of fry catching (up to 100 taka/day). Due to excessive mortality of collected fry an increased demand, intensive fry collection will result in depletion of the resource and will adversely affect other shrimp and fish species.

f. Fry collection at sea:

The only technical answer to this problem is to start collecting gravid shrimps at sea in shallow water, using small trawlers equipped with water aerated and temperature controlled fry-tanks.

These trawlers equipped with special nets will proceed by short trawling to bring shrimps alive and in good condition to hatching farms on the coast (the technical data and full scope of this method will be described in the report of "the Fishery Harvesting and Marketing Specialist").

g. Over-fishing of immature shrimps:

Many species of shrimp use rivers of the Sundarbans during part of their short life-cycles. Destruction of fry and early juvenile stages of other species by fry collectors of ***Penaeus monodon*** is only one part of the problem.

Careful examination of catches from July to September 1994 showed that in many cases nearly all the catches consist of mixed species. Examination of each catch showed that brown shell small shrimps are mixed with immature white shrimps; these white shrimps can reach a 8-10 cm size and have a good market value. Current practice thus fosters an unnecessary loss.

h. Need for scientific studies:

Recent field work indicates that it is necessary to study urgently the migration pattern of all shrimp species inside the Sundarbans; extensive sampling surveys during the year inside the Forest, along rivers, estuaries and coastal areas must be done to assess stocks and sustainable exploitation levels.

These studies are necessary to make new rules and a new fishery policy inside the S.R.F. and even outside its "legal" boundaries. This will apply principally to the species depending for part of their life cycles on the primary production of the Sundarbans Forest.

i. Shrimps farms versus Paddy-cum-prawn culture:

All around the Sundarbans Forest semi-industrial shrimp farms and Paddy-cum-prawn farms are extending and encompassing the border of the Forest. Forest officials daily are confronted by increasing pressure from political leaders, private contractors, and local development agencies demanding Forest land for shrimp farming. Added to this, the anticipated increase in productivity through international assistance to shrimp farming will without doubt increase the demand for fry. The pressure is relentless on the entire landward boundary of the S.R.F.

Paddy-cum-prawn farming is already extending and the need for fry results in an extensive destruction of fish and shrimp fry as already described.

Trapping fish along embankments: all along embankments, using tide currents, people are fishing with all kinds of gear, different kinds of traps many of which are devised to catch the smallest shrimps and fishes. All these catches have been seen to consist of very small fishes and prawns (See illustration photo - Annex: Fisheries p. 106).

Such unregulated activities inside and outside the Forest contribute to the depletion of fish and shrimp stocks. The pressure can only increase with the increase in the human population and increases in economic incentives.

8.14 Summaries concerning fish and shrimp ecology in the Sundarbans Forest (June to September 1994):

Catches:

- Immature fishes from the main part of catches.
- Day catch is small except for Ilsha.
- Shrimp fry collection of ***Penaeus monodon*** is highly destructive for fry of other species.
- Shrimp catches consist of mixed mature and immature specimens

Fishing practices:

- Subsistence fisheries.
- Use of small size mesh nets and traps.
- High uncontrolled fishing pressure on the resource.

Results on fish and shrimp stocks:

- Over fishing of non migratory species

Depleted stocks:

Consequences:

- Loss of commercial value due to the small size of fishes.
- Reduced global yield.
- Unsustainable use of the resource.

All these conclusions are the result of a direct studies in the field and review of available literature and data; however due to the scarcity of reliable data and precise scientific information, it is strongly recommend that a start be made as soon as possible for extra field studies with the collaboration of Khulna, Dhaka and Chittagong fishery biologists and students to confirm and augment these observations.

9. LARVAL ABUNDANCE DISTRIBUTION IN THE SUNDARBANS FOREST

Is the Sundarbans Forest a breeding and nursery area for commercial fishes and shrimps ?:

The importance of the Sundarbans Forest as a main centre for breeding and nursery sites for commercially valuable fish is usually mentioned, but new studies inside the S.R.F.must be done to quantify the real situation.

Cooperation in this field was initiated in August with Khulna University; Dr. Carl Smith, who has a good experience of larval studies of tropical fishes and a malacologist visited the Sundarbans with Project staff on "Bonokona", the Forest Department ship, sampling water sediments; mollusks, fish and larva were also collected.

Juvenile fishes were collected and preserved. All the sampling points were located with G.P.S. fixes.

9.1 Preliminary:

Early observations in June - July 1994 by the author revaled an abundance of larvae in small Khals at high tide.
Juvenile stages of Belonidae or similar species were seen hunting below the surface near Sarankhola and in several other places.

Larval and juveniles stages of Gobidae were seen and collected in shallow pools on the Forest floor between pneumatophores. Similar observations where made by the Khulna University Biologist: no larvae were collected in the main river channels. In the side channels fish activity was easily seen, and several larvae were collected. It seems that shallow side channels are used by fish larvae rather than main rivers.

9.2 Recommendations for larval studies:

As the larval stages of many species are entering the Sundarbans river network using tide currents it is necessary to know the main entry routes and to protect a complete track of river from estuaries to the smallest khal during the spawning period.

Identification of the river track to be protected and definition of the spawning, and fry migration of side channels and main channels using fine net seines and plankton ring nets must be done.

These studies, have already started, (See Paragraph 9.6: "Project on fish larval Abundance and distribution in the Sundarbans" and "Feasibility of fish larval survey in S.R.F.) are extremely important.
All support available concerning logistic (launches, speed boats) equipment, and cooperation between the university team and the Forest Department is required for these studies.

9.3 Biodiversity and "indicator" species:

During sampling tours in S.R.F. unusual or interesting animals species were collected; even if these species have no commercial use it is necessary to record carefully their spatial separation; temporal occurrence and ecological preferences.

Precise identification of preserved specimens must be performed; samples will be sent to national and international zoology centres. In cases of doubt the British Museum - London, Museum d'histoire Naturelle - Paris, etc.could be contacted. Addresses and contacts are entered in the database.

Scope:

a. All studies showing the biodiversity value of S.R.F. will help focus the attention of the international community on preservation of the S.R.F.

b. Many of these species can be "indicator" species occurring in a narrow range of ecological conditions; if their ecological range is well known their presence or absence will be a useful way to assess ongoing ecological changes.

c. Candidates to this role are mosquito larvae *Culex spp./Anophele spp.* and other insect larvae *Culicoïdes spp., Chironomus spp., Ephemeroptera spp* living in different salinity waters.

d. Some of these species families were found in shallow ponds on the Forest floor in North-East Sundarbans.

e. An unidentified species of mollusk with soft green, leaf-shaped body was also discovered at the bottom of clear water shallow ponds on the Forest floor in June; it seemed to belong to the Genus ***Aplysia*** usually found in sea water; it was collected near Kalabogi in a plantation trial.

f. An unidentified species of mollusk, bivalvia, was also discovered associated with Golpatta *Nypa fruticans* leaves.

9.4 Recommendations for larval collection:

It is recommended that general instructions to field-staff concerning collection of zoological specimens particularly small animals and larvae will be included in a sampling kit with bottles, plastic bag, magnifier, small nets, forceps, spirit , formalin and labels in order to allow non-specialists to collect and preserve samples for further studies.

This is particularly important as some stages of these species can occur rarely and in a confined area. All field trips must be the opportunity to collect all available information on animal life inside the Forest. The state of knowledge for this ecosystem - the S.R.F. - remains at this primary level.

9.5 Fungus studies:

Fungus study is a difficult field; fungus having a hidden life, and aerial parts being rarely found; however collection of specimens is of great value and importance in Forest resources management:: fungus are powerful organisms, recycling organic matter very fast.

Fungus are also parasitic organisms; Foresters are particularly aware of this point as "epidemic" fungus diseases spread sometime among trees submitted to environmental stress.

In the case of Sundarbans a quantitative study showing at what rate the wood of top-dying Sundri is invaded by fungus will perhaps enable managers to select more carefully the trees to be harvested. Harvesting criteria remain the subject of controversy among Forest management specialists - see Larsen. 1993 and Ciesla,1994.

9.6 Project on fish larval abundance and distribution in the Sundarbans

Dr. Carl Smith - Khulna University - Bangladesh

Mangrove swamps are commonly cited as important nursery areas for tropical marine fishes (Lowe-Mc Connel, 1987; Wooton, 1990). Few fish spawn in mangroves but up to 400 tropical fish species are believed to use mangroves during their early life stages.

Studies in West African lagoons and in the Indo-Pacipic have also illustrated the importance of mangroves as nursery areas for commercially valuable fish species (Philips, 1981; Por & Dor, 1984).

No recent survey of larval fishes has been carried out in the Bangladesh Sundarbans mangrove Forest and this gap in knowledge needs attention.

The proposed study, in collaboration with the Marine Biology Departement, Khluna University, would aim to describe the spatial and seasonal distribution of marine fish larvae in the Sundarbans. The specific aims of the study would be to collect larval fishes at regular intervals throughout the year. Larvae would be identified and measured to indicate larval growth rates and the size/age at which larvae enter and leave the mangroves.

Attempts would also be made to estimate larval abundance. Estimates will be either relative or absolute depending on whether larval collection methods can be calibrated. The study would also aim to establish the precise locations within the mangrove used by the various larval species; i.e. main channel, backwaters, tidal pools, and the ontogenetic (changes with age/time) use of locations within the Sundarbans. The result of this study could do much to help the Forest Department in fishery management, policy and implementation.

A. SUMMARY OF AIMS

1. Collect and identify larval fishes at various sites (to be determined) in the Sundarbans.

2. Collect age/size data for fish larvae to indicate population mean growth rates and age/size of entering and leaving mangroves.

3. Identify the precise location within the mangroves used by fish larvae.

4. Estimate seasonal larval abundance (relative or absolute).

B. SAMPLING METHODS

1. Preliminary sampling will be carried out with a small mesh seine net and plankton ring net.

2. Larval fish will be fixed in formalin and preserved in ethanol.

3. Fish will be identified and size/frequency data will be recorded and related to physical data (recorded on survey sheets).

C. EQUIPMENT NEEDED

1. Microscope (low power, binocular)

2. Identification guide to the egg/larval stage of marine fishes in the Bay of Bengal / Indo-Malayan region.

3. Formalin and ethanol.

4. 500-5-10 ml glass, stoppered bottles for storing preserved fish larvae.

a Feasibility of fish larval survey in the Sundarbans Reserved Forest:

First results:

Relatively few fish larvae were collected on the "Bonokonna" field tour, partly because the collecting gear was inappropriate and because speed boat time was divided between larvae collection, fishing survey and mollusk collection.

No larvae were collected in the main river channels, though several larvae were collected in side channels. This may represent a real distribution or may reflect the greater sampling effort in the side channels. Fish activity (fish rising, jumping) was commonly seen in side channels. Also, the river flow in the main channel appeared too great for small larvae to be able to maintain their position, whereas flow in the side channels was sluggish and more suitable for fish larvae. The initial impression is that shallow side channels are used by fish larvae rather than the main channels. This conclusion accords with previous work on fish larval distributions in salt marshes (Russell & Smith, unpublished).

aa Recommendations:

Systematic sampling of side channels using a fine mesh seine net and plankton ring net. Sampling of main channels with plankton net.

aaa Equipment required

2 x 5 cm seine nets, 1 mm mesh
1 x 50 cm plankton ring net, 1 mm mesh
1 x 50 cm bongo (double) plankton net, 1 mm mesh + 1 kg depressor.

10. CONCLUSION

Originally it had been anticipated that this mission would be able to assess all existing ecological data for the Project and provide a Workplan for the National Ecologist to make up for deficiencies. Soon after arrival it became clear that this would be impossible to accomplish to an acceptable level of completeness, firstly because little hard data was available and that which existed needed drastic revision and field verification. And secondly the National Consultant was not fielded until 08 September, less than one month before the NTE of the mission. Added to this much valuable time had to be committed to seeking fundamental data, equipment, transport and supporting other activities such as the key basemap preparation which had been assigned to the Project's Cartographer and which was only accomplished after the second attempt two days before completion of the mission (02.10.95).

It was agreed therefore that in the face of these insurmountable constraints arrangements would be made to add a further three months to this assignment to be carried out next dry season after the National Ecologist had the opportunity to follow up on desk and field studies identified in the first leg and after the Project's own survey vessels are commissioned. In this way it is anticipated that adequate hard data will be available on the gross ecology of the Sundarbans Reserved Forest, project area, to fulfil the requirements of the PRODOC and the specific needs of the Integrated Resources Management Plan.

Accordingly an Interim Report has been prepared which includes findings to date in line with the TOR's and outlines a Workplan for the period between now and the second leg which could be scheduled to start in February 1995 up to the end of the Project, currently set for NTE 30 June 1995.

The position at present is that considerable further review of the literature on basic parameters such as climate, geology, hydrology, flora and fauna still needs to be done. Past efforts have often merely recorded bibliographies without making any attempt to synthesize information relevant to the SRF and many reports are filled with unsupported conjectures. Much Project time has been input in biological fields yet fundamental data on environmental parameters, such as hydrology, have not been acquired or any attempt made at correlating such information that does exist.

However, despite these constraints and those relating to being able to access the SRF, much progress has been made as follow:

1. Existing data have been reviewed and deficiencies noted.

2. The Basemap at 1:50 000 has been prepared in digital form and input into the recently initiated Project GIS database. This will be the first accurate topo map of the Reserved Forest and will be the foundation for all future research and management.

3. Work has commenced on transferring the ODA vegetation data as an overlay as the first step in being able to make comparative studies on changes in forest types, species compositions and gross changes in the ecosystem.

4. A methology for sampling to achieve effective and accurate monitoring of the entire ecosystem has been proposed.

5. Field work has commenced to answer specific forest management question such as collation of data on the top-dying condition of Sundri, the real salinity and soils vegetation catenas and the statuses of aquatic and terrestrial wildlife including those of commercial importance and those critical to biodiversity management.

6. Recommendations have been made in the light of experience gained for rapid acquisition of vital ecological data, such as information on indicator species, over the next dry season and for the foreseeable future giving guidelines on methods and equipment.

7. Recommendations have been made on inter-disciplinary research and ways in which to augment the Forest Department's capacity to administer, manage, research and monitor the resources of the Reserved Forest.

8. Recommendations have been made to improve the conservation of endangered, vulnerable and otherwise threatened species particularly in the coastal environment (S.C.M.P.A.).

9. A Workplan to provide continuity over the remainder of the life of the Project to 30 June 1995 has been proposed. If this is followed then it can be anticipated that a valid appraisal of the ecosystem will be able to be made and that the goals of establishing "An Ecological Monitoring System" and provision of information to help the Forest Department and the Government of Bangladesh implement a management policy for sustainable use of the Forest and associated riverine and marine ecosystems" (PRODOC Immediate Objective No 1) will be attained.

At this stage of research, with 16 days of reconnaissance being possible and then during the monsoon months only, data to form scientifically tenable opinions must still be acquired. However, an effective start has been made. With extra inputs by the National Ecologist and a further period to consolidate dry season data, it is considered that the goals of the ecology component of the Project will be achieved.

11. RECOMMENDATIONS

Apart from continuing the literature review and inputting of existing data into the database the following recommendations are made as the basis of ongoing ecological work during the periods October 1994 - January 1995 and February - July 1995.

1. **CLIMATE:** complete literature review and implement data collection in the field within the S.R.F. input existing data into the database.

2. **GEOLOGY:** complete literature review and compile information.

3. **HYDROLOGY:** assist Surface Water Modeling Center complete data collection for the hydraulic model and provide guidance to the Project Hydrologist in relation to ecological issues relating to the water dynamics of the S.R.F.

4. **SOILS:** continue soils data acquisition and facilitate analysis not completed by the Soil Scientists. In particular Top layers of soils cracking during the dry season must be checked for acidity and sulfur deposition.

5. **ENVIRONMENTAL ECONOMICS AND SOCIO-ECONOMIC SURVEY:** An Economic Value must be calculated for the S.R.F. complete system, including its value for the Bay of Bengal fisheries, cyclone protection, and the cost of substitution products in case of reclamation for the shrimp culture conversion alternative.

6. **INTER-DISCIPLINARY RESEARCH:** initiate further collaboration with research institutes, universities and specialist departments,particularly with Scientits working on Indian Sundarbans.

7. **AERIAL SURVEY AND MAPPING:** ensure that all ecological and environmental data are stored correctly in the database and that GIS overlays are prepared to match the needs of the IRMP. It is strongly recommended that, if possible, the Sundarbans Forest be surveyed using colour film during the course of the December survey.

8. Assist the **FOREST DEPARTMENT** attain an independent capacity in wildlife management and ecological field research. Data collection, GPS utilization and meteorological record keeping, etc.

9. Help strengthen the links with the **FOREST DEPARTMENT's** own **FRMP/RIMS** programme with the Project's GIS and environmental database.

10. **FISHERIES:** collaborate with the Fisheries Harvesting and Marketing specialist, Natural Resources Economist and Socio-Economist to assess the values and sustainability of the aquatic resources and their utilization. Determine the true ecological statuses of the resources and the habitats which support them.

11. Help define policy guidelines for coastal environment protection zones. Wildlife and Conservation activities and functions; legislation, administration and cooperation for common goals.

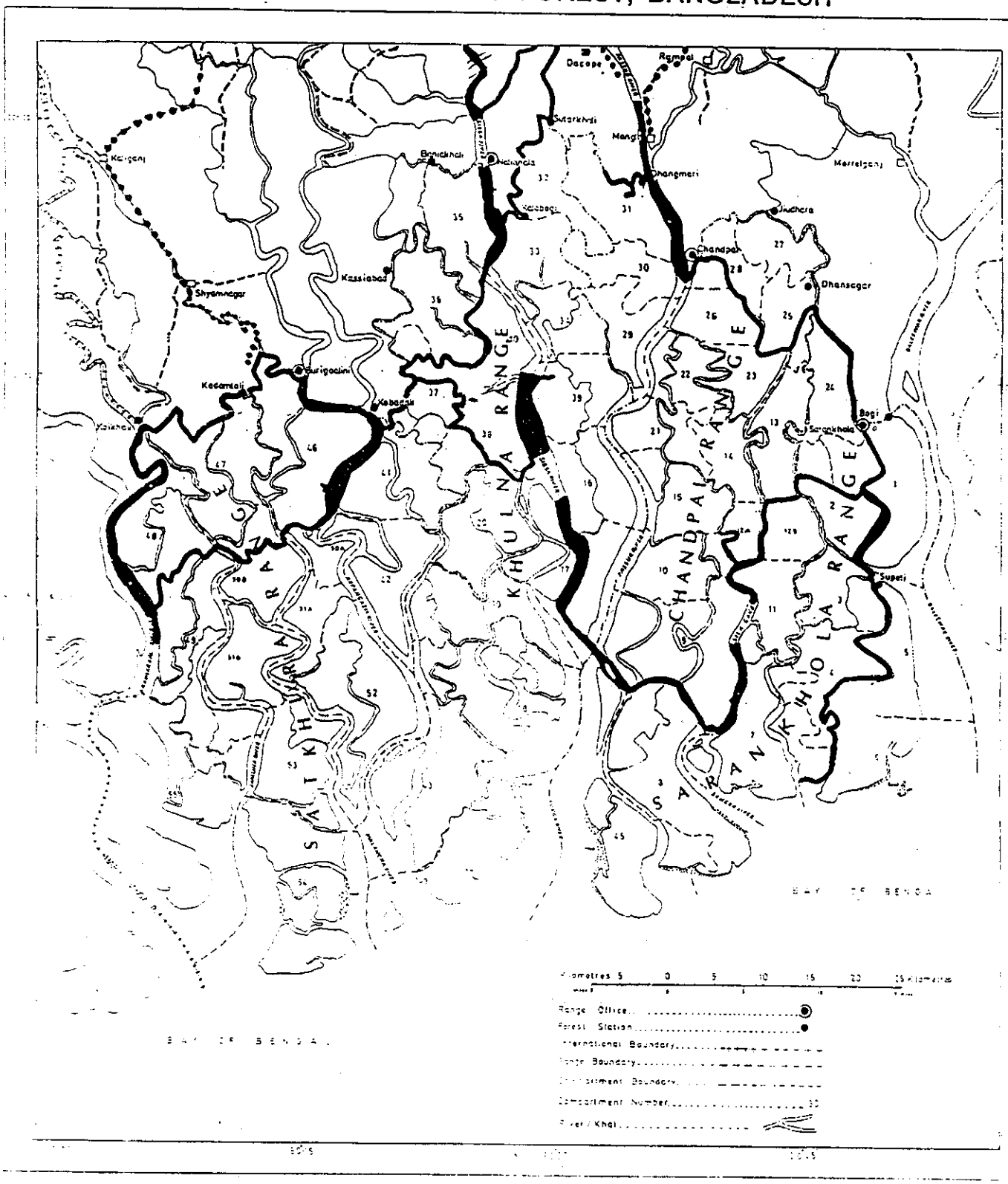
12. Synthesize data for the IRMP on all ecological and environment parameters.

ITINERARY OF FIELD TRIPS TO SUNDARBANS

1 annex

ITINERARY OF FIELD TRIPS TO SUNDARBANS

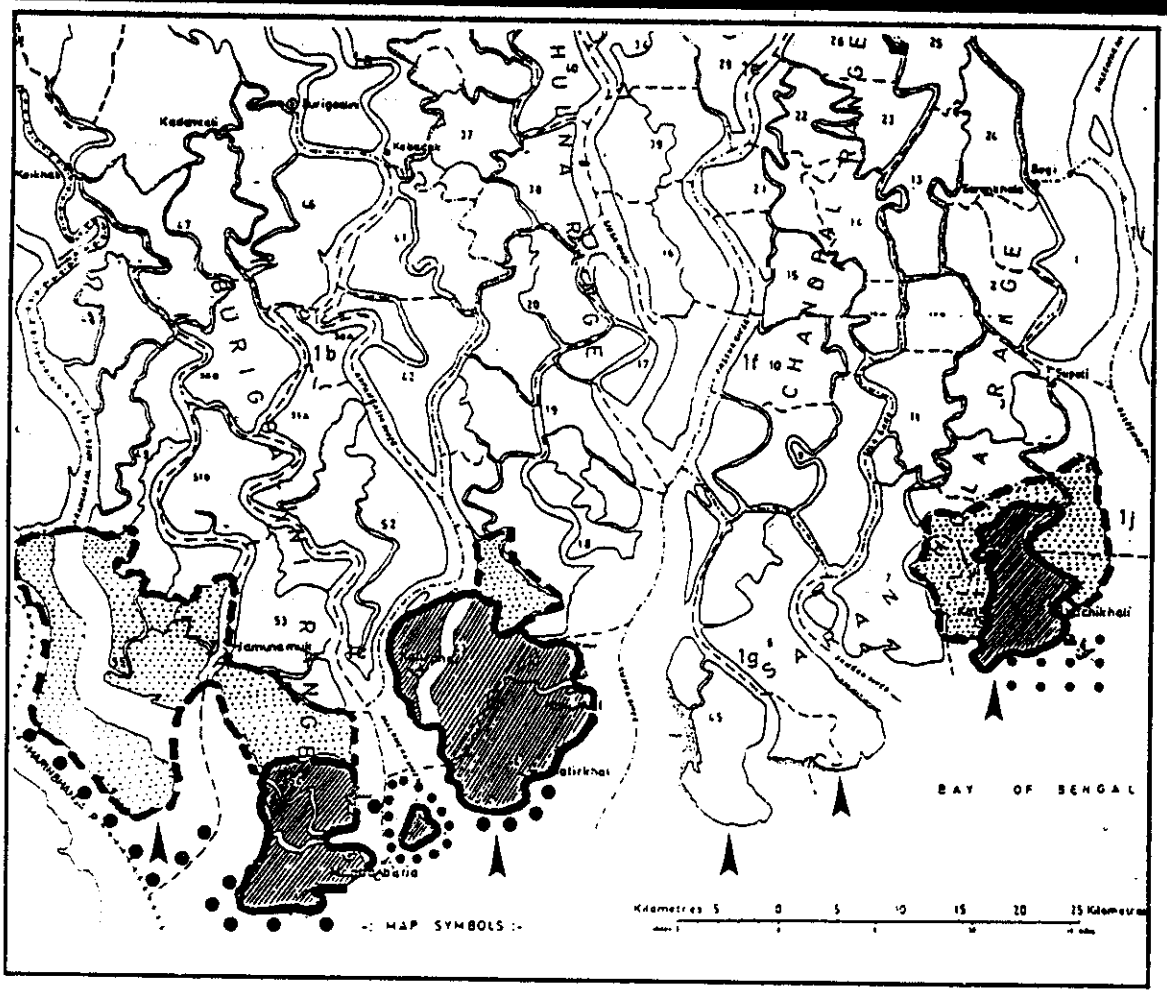
MAP OF SUNDARBANS FOREST, BANGLADESH



WILDLIFE SANCTUARIES
&
PROPOSED MARINE PROTECTED AREAS

7 annex

WILDLIFE SANCTUARIES
&
PROPOSED MARINE PROTECTEDS AREAS



Costal and Marine Protected Area (proposal) are displayed with black dots. Arrows indicate temporary restriction strictly enforced for turtle nesting (areas must be defined by specialists)

Sundarbans

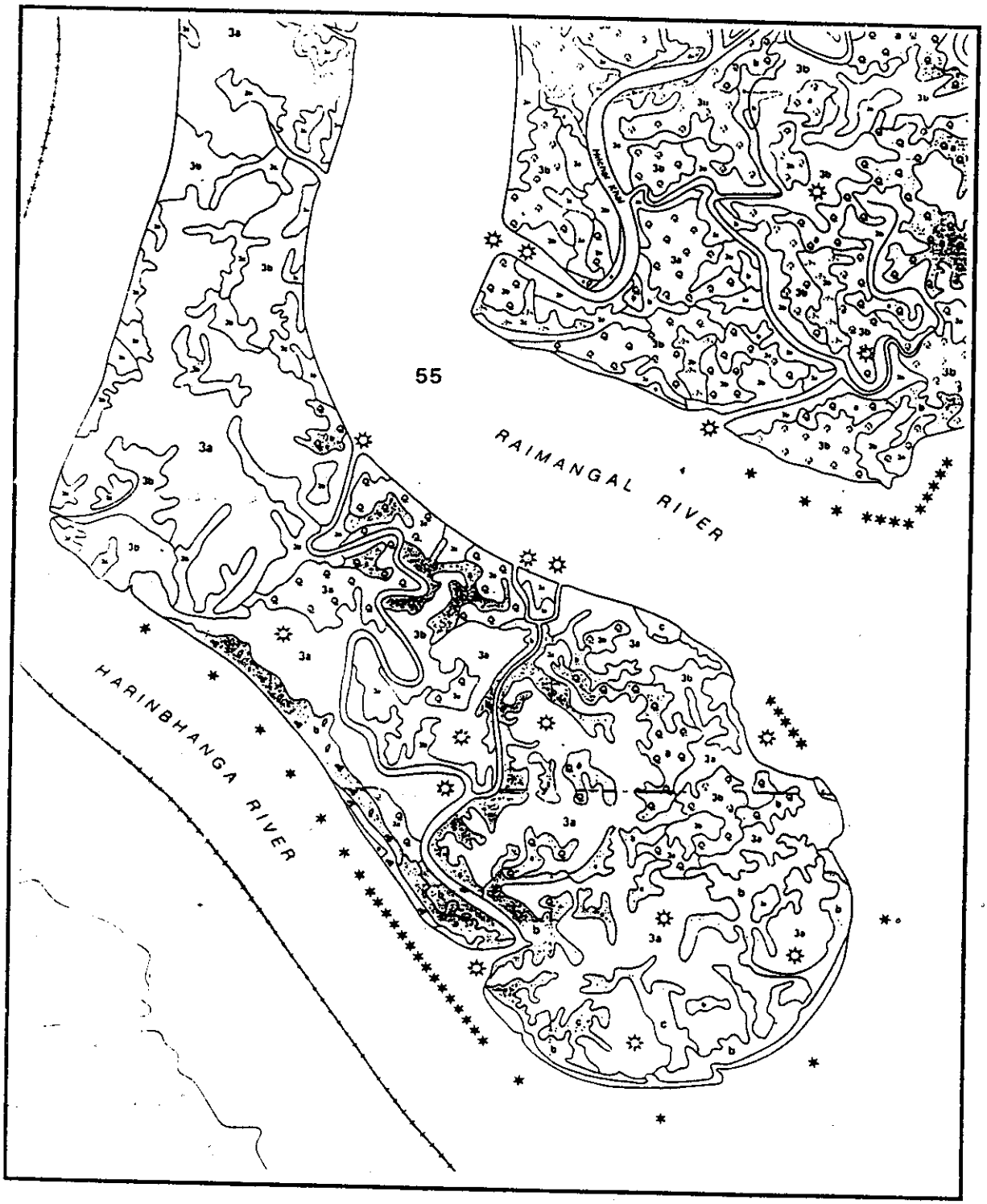
.....FOREST DIVISION.

Register of Reserved Forests--(continued).

Date of Entry.	Description of Boundaries.
15-7-1939	**Area.** 5971.07 Km² 1,470,368 acres = 2,297.45 square miles. **Boundaries:** North- From a wooden post No.1 on the east bank of the Kalindri Gang situated at a point 684 feet north of an artificial channel joining the Kalindri Gang and the Jamuna or Madar river, a demarcated line with an embankment 843 feet long and bearing 72°-30' along the south boundary of lot No.164, locally known as Koikhaliabad, to a wooden post No.2 on the Jamuna river ; thence southwards along the Jamuna river to its junction with the Golkhali Khal , and along this khal to its junction with the Dhaji khal ; thence the Dhaji khal to a wooden post marked No.3; thence an artificial channel with an embankment having a general bearing of 1°-30' for 2,400 feet to a wooden post No.4; thence an embankment being generally 62° for a distance of 88 feet to its junction with the Mirgang at wooden post No.5; thence the Mirgang, Churkuni khal, Dumkoli khal, Kadamtoli khal and Chaur Gang to its junction with the Arpangasia river; thence the Arpangasia river the Singlagolkhali khal, the Sakbaria khal or Koira Gang, Moisadali khal, Harda khal, the Sipsa river, the Sutar khal, the Bhnddar Gang, Ladobi khal, the Dhangar khal, the Passur river, the Chachan Gang up to a small khal near Chandpai revenue station, demarcated by wooden posts No.6 to 21; and thence the Khurma khal to its junction with the Bhola Gang. East- The Bhola Gang to a wooden post No. 22 on its eastern bank; thence an artificial line demarcated by posts Nos.22 to 26 forming part of the south boundary of lot No.G; thence the Bogi khal to its junction with the Haringhata or Balenwar river and thence the Haringhata river to the Bay of Bengal. South- The Bay of Bengal from the Haringhata river to the Raimangal river. West- The Raimangal river from the Bay of Bengal to its junction with the Kalindri Gang ; and thence the Kalindri Gang to post No. 1. J.H.Kerr. Secy. to the Govt. of Bengal. Vide Calcutta Gazette , dated the 10th February, 1915 Part I page 236.

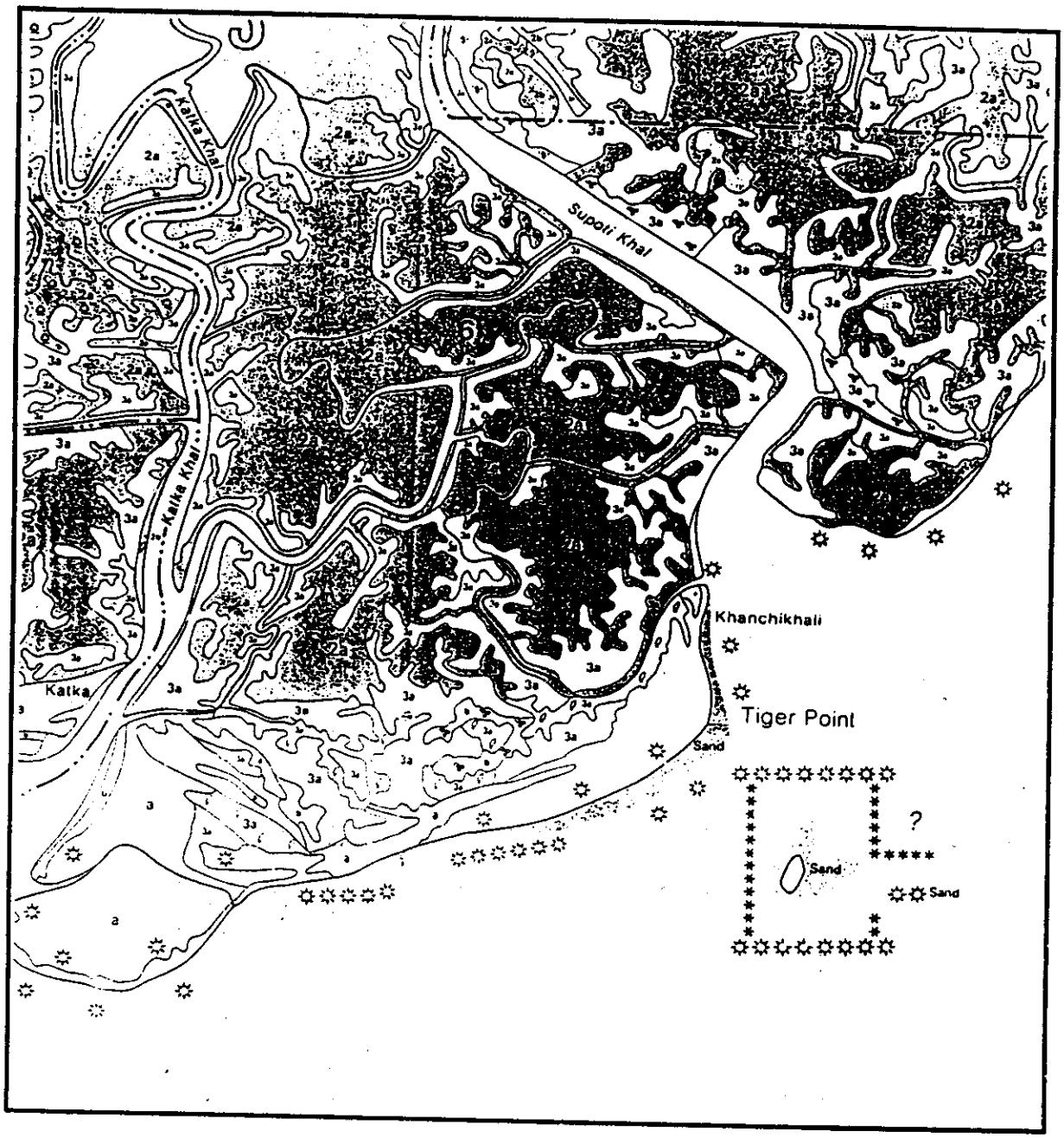
DEFINITION OF BOUNDARIES: 1915

Precise definition of the legal boundaries of the Sundarbans Reserved Forest is needed, including Marine boundaries



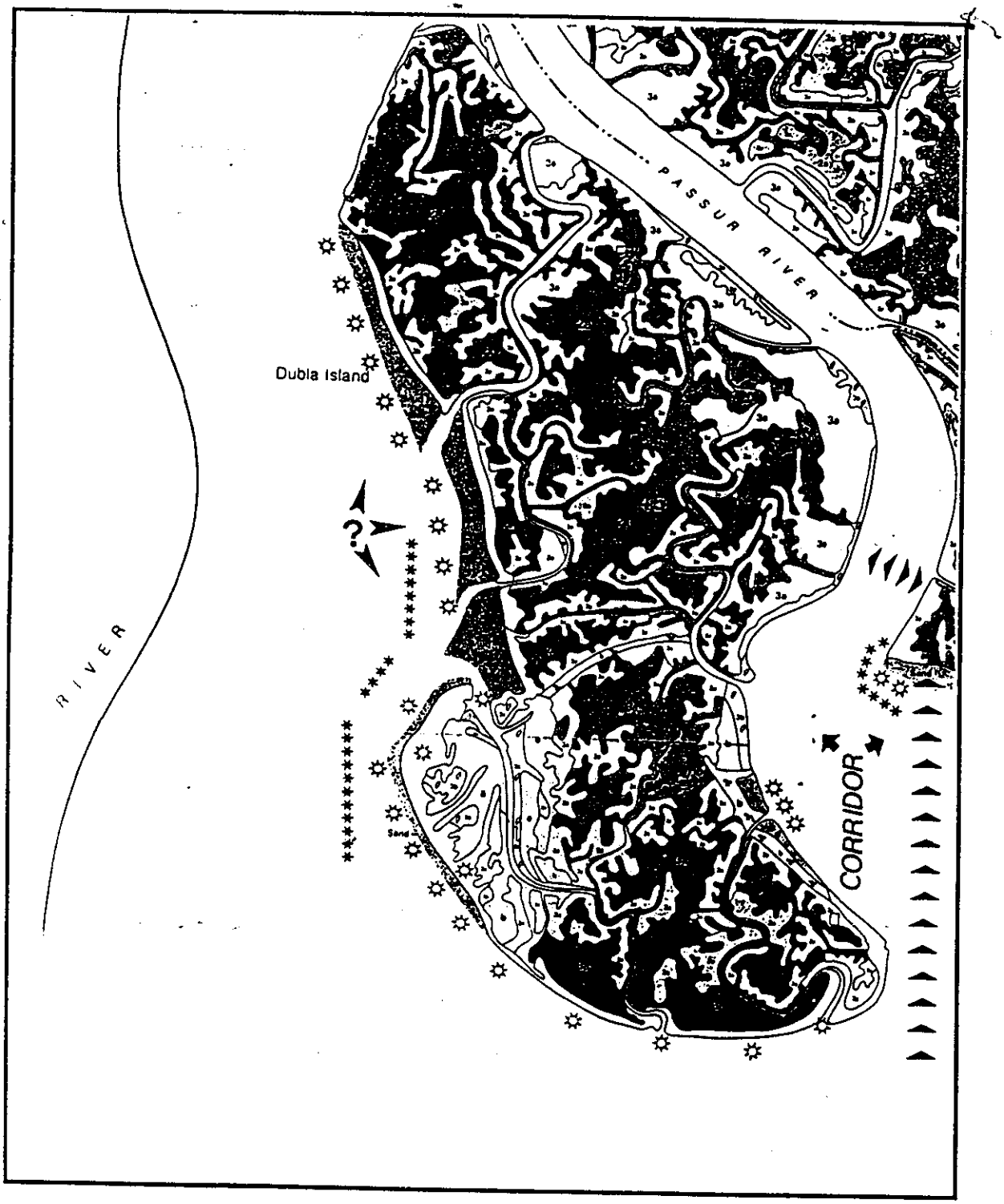
PROPOSED COSTAL & MARINE PROTECTED AREAS 1
TURTLE NESTING SURVEY

Open stars indicate survey areas. Black stars indicate possible sanctuary



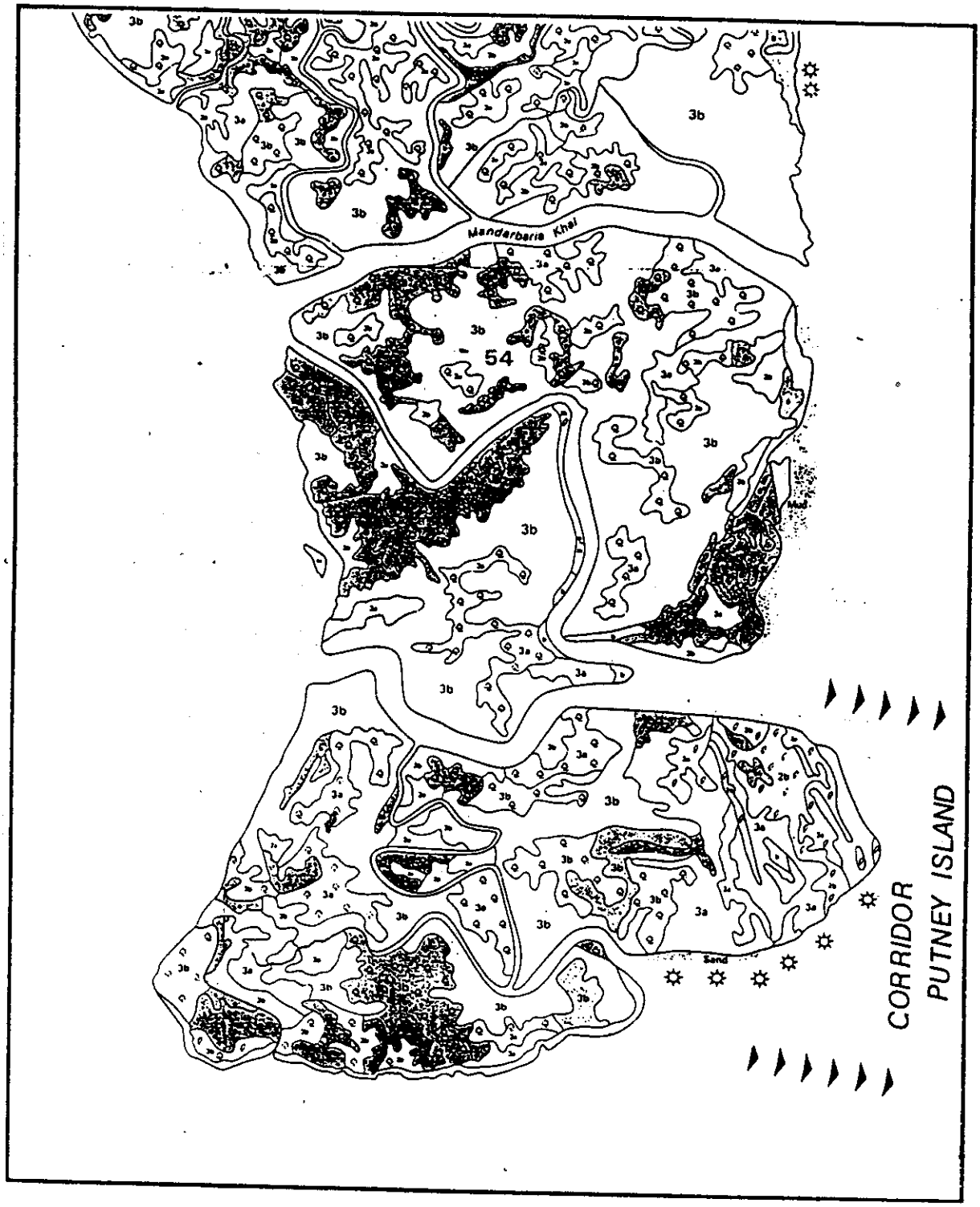
PROPOSED COSTAL & MARINE PROTECTED AREAS 2
TURTLE NESTING SURVEY

Open stars indicate survey areas. Black stars indicate possible sanctuary



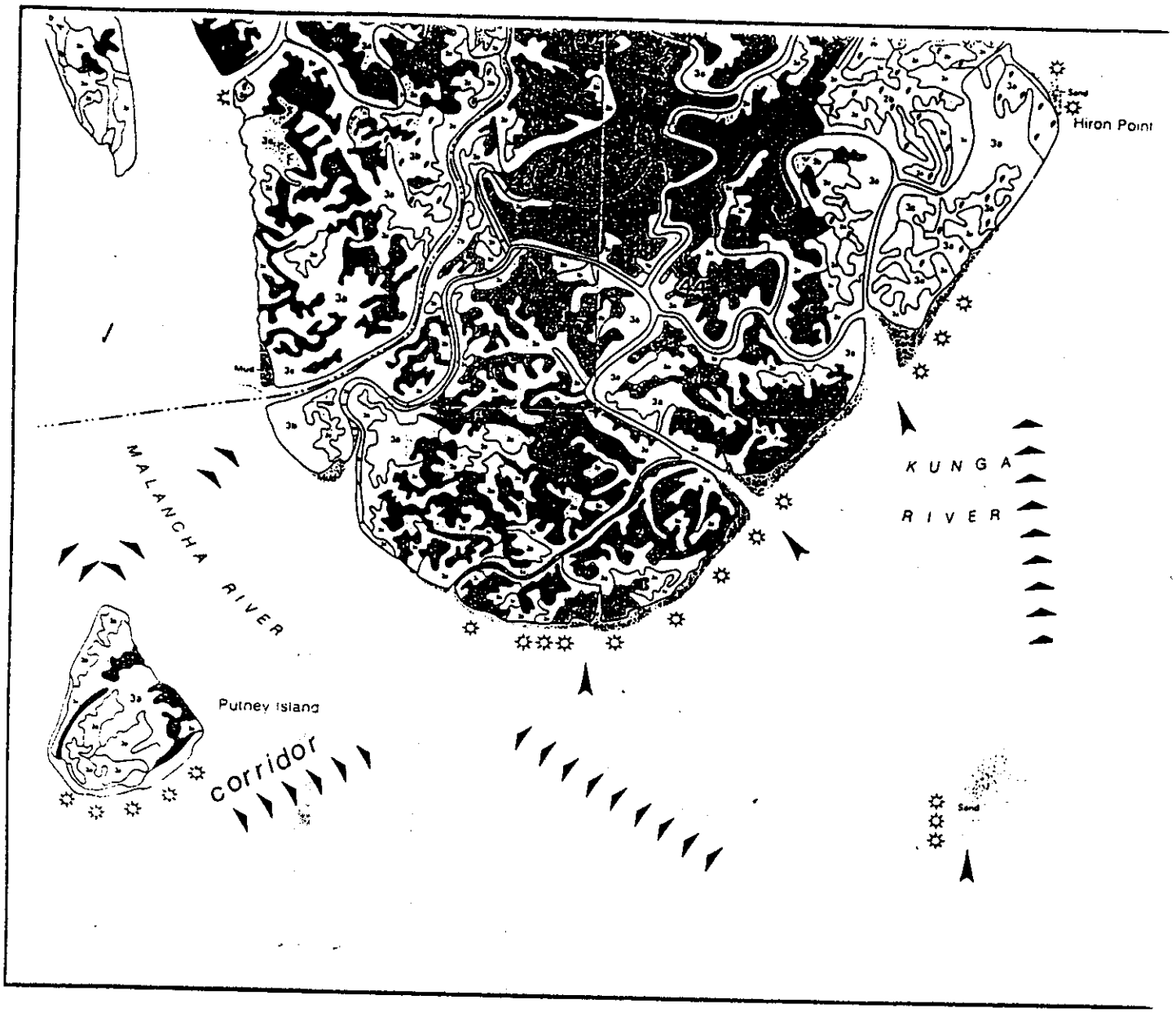
PROPOSED COSTAL & MARINE PROTECTED AREAS 3
TURTLE NESTING SURVEY

Open stars indicate survey areas. Black stars indicate possible sanctuary



PROPOSED COSTAL & MARINE PROTECTED AREAS 5
TURTLE NESTING SURVEY

Open stars indicate survey areas. Black stars indicate possible sanctuary



PROPOSED COSTAL & MARINE PROTECTED AREAS 4
TURTLE NESTING SURVEY

Open stars indicate survey areas. Black stars indicate possible sanctuary

TIGER AUTPOSY RECORD

7 annex

ANNEX

TIGER AUTOPSY RECORD

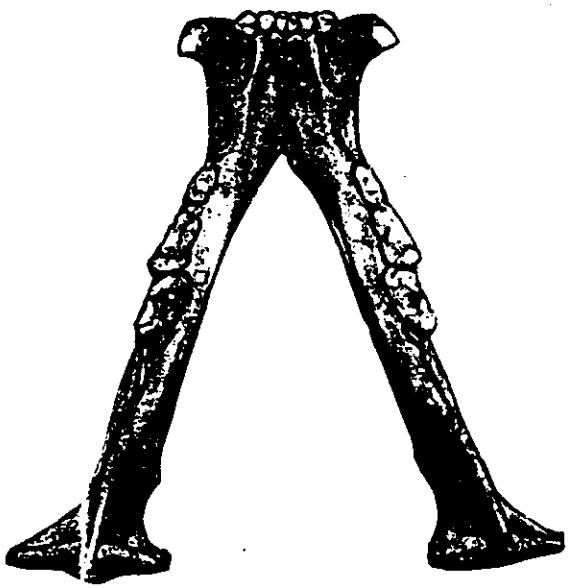
02.08.1994

The body of a young tiger beaten to death by villagers after an attack on a man near the forest.

DESCRIPTION:

Male: 60 -70 kg (estimated)
- meagre thin body
- small genitalia
- eroded pugs on 4 legs
- no open wound

DISSECTION:



- Stomach full of meat (2 -3 kg) animal with brown fur, short air (goat-dog-monkey ?) half digested.
Sample of the food consisted of a piece of prey intestine.

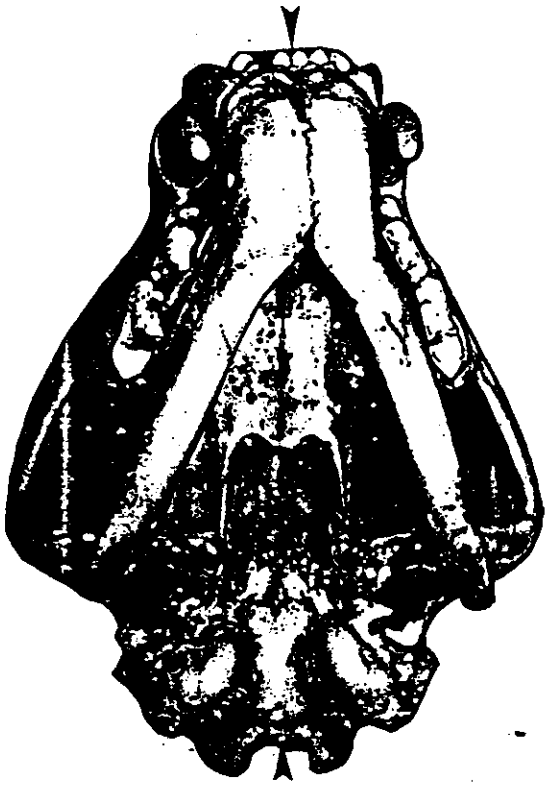
- Blood and organ sampling:
Lung: Oedematous with clear spots superficially
Liver: red brown with numerous white spots superficially

Food sample, blood, lung and liver were collected, one part was stored in formalin solution the other part was deep freezed

- Parasitic study needed due to the unhealthy appearance of this young tiger and abnormal aspect of organs.

- Head: the head was cut and boiled for teeth and skull studies. Numerous bone fracture and breaking open were repaired with plaster.

MENSURATION:



Upper main teethes
from jaw bone to tip: 51 mm left / 51 mm right
from collar to tip: 48 mm left / 47 mm right

Skull: from front upper teeth to occipital hole 225 mm

Lower main teeth
from jaw bone to tip: 44 mm left / 44 mm right
from collar to tip: 41 mm left / 41 mm right

Number of teeth mobile jaw	14
skull jaw	16

Teeth status: Central lower incisive
From view from left to right number 4 is eroded, all other teeth are new sharp teeth

- a complete set of close up photography of skull and teeth feature was done and attached.

Conclusion: Skull and teeth examination by a specialist is necessary in order to assess age of the animal; first examination confirm that this tiger is a young specimen.

TIGER RECORDS

PHOTO 1:
PUG MARKS

Recording Pug Marks and encounter of tiger in the database is an efficient way to survey tiger population

TIGER RECORS

PHOTO 2:
WILDLIFE NOTEBOOK

Rangers record informations an endangered species, tiger, crocodile,etc. on a field notebook.

Informations collected monthly and inputted in G.I.S. database allow continuous surveys of these populations.

TIGER AUTOPSY

PHOTO 1:
SKULL

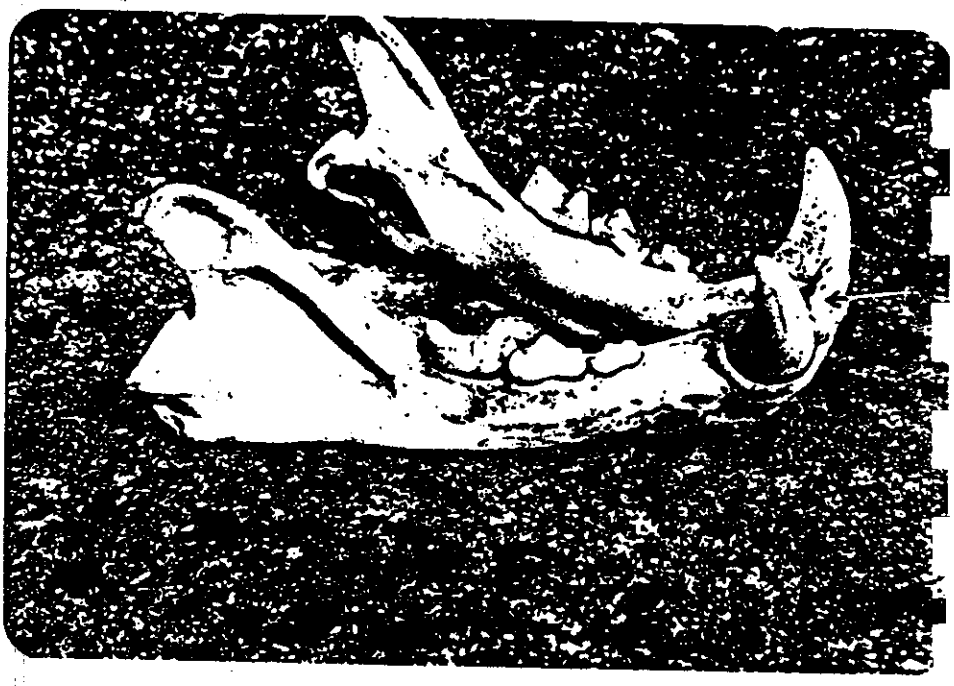
Teeth are in good shape, sharp, without erosion

TIGER AUTOPSY

PHOTO 2:
SKULL

After boiling the skull lower jaw display sharp teeth of young male tiger.

The central right canine teeth is slighly eroded (carie ?)



TIGER AUTOPSY

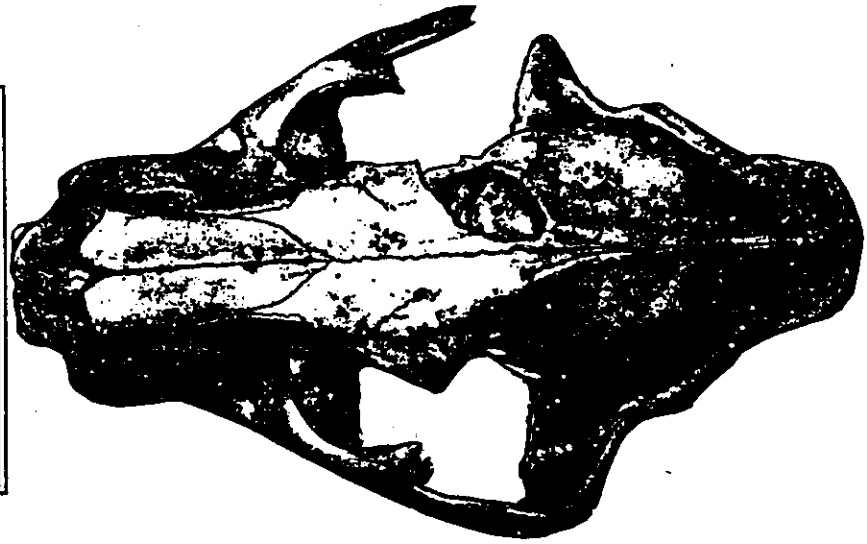
PHOTO 3:
PADS EROSION

The cushioned thickening of underside of the toes are bearing white round-shaped ulcerations

TIGER AUTOPSY

PHOTO 4:
SKULL

Top view displaying fractures



TIGER AUTOPSY

PHOTO 5:
SKULL

Lef side view displaying sharp canine teeth

TIGER AUTOPSY

PHOTO 6:
SKULL

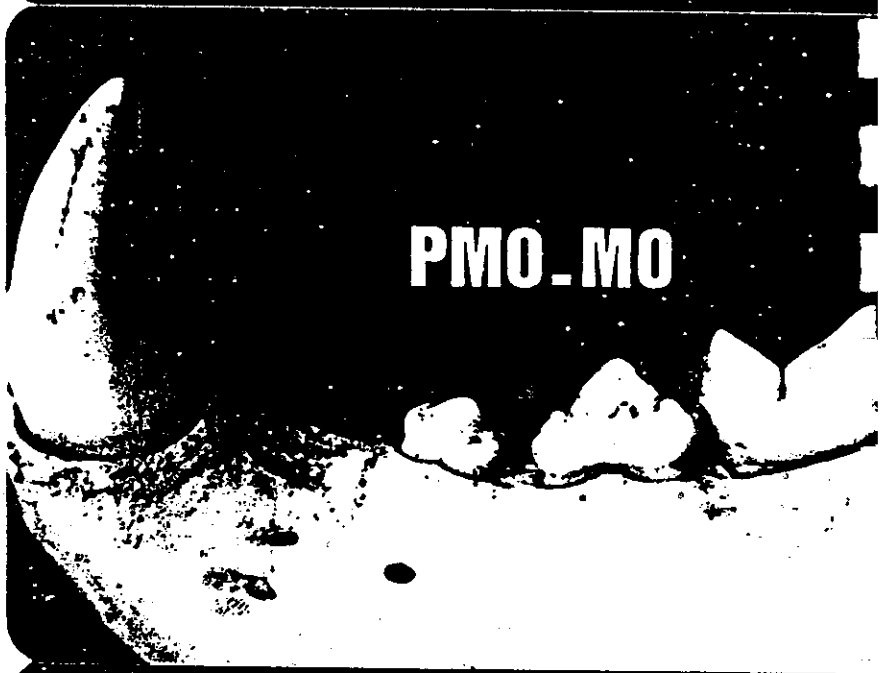
Jaws widely open

Panthera tigris

INC
Short sharp incisors

CAN
Long canine

PMO
Premolar & molar
Cheek teeth - largest top and bottom known as carnassials



TIGER KILLED IN 1994

26.03.1994 CHANDPAI RANGE near NANDABALA CAMP
A tigress attacked a man in the jungle. People killed the tigress by beating.

21.07.1994 SATKHIRA RANGE - KOIKHALI STATION - CPT No 48
near MAHMUDA RIVER
A tiger (old ?) was found dying (back legs paralyzed ?)

02.08.1994 BAIDYAMARI CAMP / BAIDYAMARI AREA
One tiger attacked people; villagers beat the tiger to death. Probably sub-adult (See attached report)

06.05.1994 SATKHIRA RANGE - KOIKHALI STATION
Village near MORGANG PATROL CAMP; one tiger attacked village animals and was killed by beating.

WIDLIFE SURVEY

5 annex

সংরক্ষিত সুন্দরবনে আবশ্যকীয় প্রানীবিন্যাস

তারিখ :	স্থান :	শুধু দেখা প্রানী	শুধু বাঘের পদচিহ্ন বড়	শুধু বাঘের পদচিহ্ন ছোট	কুমীরের বাসা শুধু দেখা	কুমীরের ডিম শুধু দেখা
কম্পার্টমেন্ট নং :						
দর্শকের নাম :						
প্রানী						
বাঘ						
চিত্রা হরিন						
মায়া হরিন						
বন্য শুকর						
বানর						
কুমীর						
কচ্ছপ						

WILDLIFE SURVEY CARDS:
A usefull tool to assess fauna repartition

A-4435

কেবলমাত্র একটি স্থানের এবং একটি প্রানীর জন্য একটি তথ্য
সংগ্রাহকের সরাসরি দেখা তথ্য = শোনা তথ্য নয়।

এই কাজের উদ্দেশ্য হচ্ছে সুন্দরবনের অত্যাবশ্যকীয় বন্য প্রানীদের উপস্থিতির উপর তথ্য সংগ্রহ করা। যদি সম্ভব হয় তবে এই ফর্ম প্রত্যেক পর্যবেক্ষনের জন্য পুরন করতে হবে এবং যদি একই তথ্য একাধিকবার আসে তবে এতে কোন অসুবিধা নেই। যা জানা প্রয়োজন তা হলো প্রানীদের উপস্থিতি ও অনুপস্থিতি।

আপনার সাহায্যের জন্য ধন্যবাদ।

সুন্দরবনের সমন্বিত সম্পদের উন্নয়ন প্রকল্প,

WILDLIFE SURVEY CARDS:
A usefull tool to assess fauna reparition

IMPORTANT ANIMALS : DISTRIBUTION IN SUNDARBANS RESERVED FOREST

DATE : COMPARTMENT NUMBER : NAME OF OBSERVER :	PLACE	ANIMAL ONLY SEEN	TIGER PUG MARK only Large	TIGER PUG MARK only Small	CROCODILE NEST (seen only)	CROCODILE EGGS (seen only)
ANIMAL						
TIGER						
SPOTTED DEER						
BARKING DEER						
WILD BOAR						
MONKEY						
CROCODILE						
TURTLE						

ONE RECORD PER PLACE FOR EACH ANIMAL
DIRECT OBSERVATIONS BY RECORDER ONLY = NO HEARSAY

The purpose for this work is to obtain information on the EXISTENCE of important wildlife species in Sundarbans. The forms should be completed on every patrol if possible and IT DOES NOT MATTER IF INFORMATION IS REPEATED. We need to know the presence and absence of species only.

Thank your for your help.

INTEGRATED RESOURCE DEVELOPMENT PROJECT OF THE SUNDARBANS RESERVED BGD/84/056, KHULNA

Crocodylus porosus

Skull in the collection of the former Raja of Kanika, Orissa

Photo: R. Whitaker

R. WHITAKER

The story of the killing of this particular crocodile is quoted from a letter to J. C. Daniel from the Raja of Kanika and is published in the Society's Journal Vol. [illegible]: 309. It reads thus: 'This crocodile was about 23 to 24 ft and was known as Kalia. It was very dark skinned. It was very notorious. It had a range of 10 miles in the Dhamra river. It eluded shikaris for about 50 years. My grandfather, my father's elder brother and my father tried to shoot it. Nobody succeeded. The story goes that it was shot by the Captain of a ship which was on its run from Chandbali to Calcutta. Previously small coasting tramps had regular sailing between Chandbali and Calcutta. The crocodile after being hit and wounded went into the bank where there was a lot of reed and dry grass. The villagers set fire to the grass and the crocodile died. This crocodile was well known to every boatman and every villager.' — EDS

Larges specimens of Crocodylus have diseapared but some 3 - 4 meters specimens still exist.

GANGETIC DOLPHIN RECORDS

JULY - SEPTEMBER 1994

The Gangetic dolphin *Platanista gangetica*, locally named "Susu" is adapted to riverine life. They are easily seen near Khulna and were observed many time inside the Sundarbans Forest between July and September 1994. Many observations where done near fishing nets or confluence of river; recorded diving time were one to two minutes; on two occasions 2 and 3 Susu where seen breathing at the same time.

Severed heads and dried parts of dolphin (probably Susu) were sold in Dhaka near river market in May- June 1994 (as reported by a truthful witness).

22° 48' 57" N / 89° 34' 25" E
12.06.94 Khulna KAZIBACHA Confluence (seems from July to October)

22° 43' 33" N / 89° 31' 31" E
KAZIBACHA River downstream Khulna

22° 25' 43" N / 89° 32' 49" E
22.06.94 upstream DANGMARI near a "Set Bagnet" net

22° 26' 18" N / 89° 35' 21" E
22.06.94 DANGMARI Confluence (seems from July to October fishing near fishermen "Set Bagnet" nets

22° 04' 30" N / 89° 48' 31" E
15.06.94 PATURIA RIVER Confluence 2 Susu

22° 05' 21" N / 89° 46' 42" E
Confluence 1 Susu seen two time near DUTMUKI

22° 24' 10" N / 89° 28' 11" E
16.06.94 "Resident" susu near Forest camp KALABOGI. 8 - 10 susu are fishing there at high tide during monsoon near the confluence (information give by the Forest Department Division)

NOLIHAN Station
17.06.94 3 Susu together

KHULNA
17.06.94 4 - 5 miles downstream 2 Susu together

22° 30' 04" N / 89° 28' 59" E
30-08-94 Near SHUTARKALI 1 susu

Confluence KALABOGI SIBSA River
30-08-94 2 Susu

22° 25' xx" N / 89° 36' xx" E
30-08-94 KARAMJAL Patrol Post - PASSUR River 1 Susu at confluence

ANIMAL THREATENED ANIMAL SPECIES OF THE SUNDARBANS:

SUMMARIES OF OBSERVATIONS DURING FIELDS TRIP FROM JUNE TO SEPTEMBER 1994

I. FISHES

Mainly all the catches inside the Forest consisted of immature resident fish (Expert Pangasius p).

II. TURTLES

Only two turtles were observed crossing a river. Questions to fishermen showed that all turtles are caught alive and sold in different markets around the Forest. 4 estuarine river terrapin ***Batagur baska*** were sold alive by a fishermen in September 1994 at CHADNA market; 4 breastplate freshly slaughtered were also in the boat (size ranging from 30 to 50 centimeters).

III. CROCODILES

Location of crocodile observations:

22° 06' 01" N / 89° 46' 15" E
(size estimate 3 - 3,5 metre) in June at DUTMUKI observed by rangers.

22° 03' 31" N / 89° 06' 58" E
(size estimate about 3 metre) Near RAIMANGAL Confluence / K.N.M. camp in June observed by K.N.M. people.

22° 22' 24" N / 89° 36' 09" E
(size 3 - 3,5 metre) Tracks on mudflat

22° 25' xx" N / 89° 36' xx" E
KORONJAL Patrol Post confluence a big crocodile 3,5 - 4 metre is observed 40 minutes around the boats.

September 94
A K.N.M. employee was killed, probably by a crocodile, on PASSUR River downstream from MONGLA.

IV. MONITOR LIZARD

7 specimens of monitor lizard were seen inside the S.R.F. between July and September 1994.

V. OTTERS

One family of otters was sighted at DUTMUKI

VI. ILLEGAL TRADE OF ENDANGERED SPECIES OF SUNDARBANS AREA

The level of illegal trade of endangered species of S.R.F. particularly birds, turtles and reptile skins should be assessed. Contact with "Traffic international" specialists could be helpful in this regard.

FORESTRY
&
SUNDRI TOP-DYING

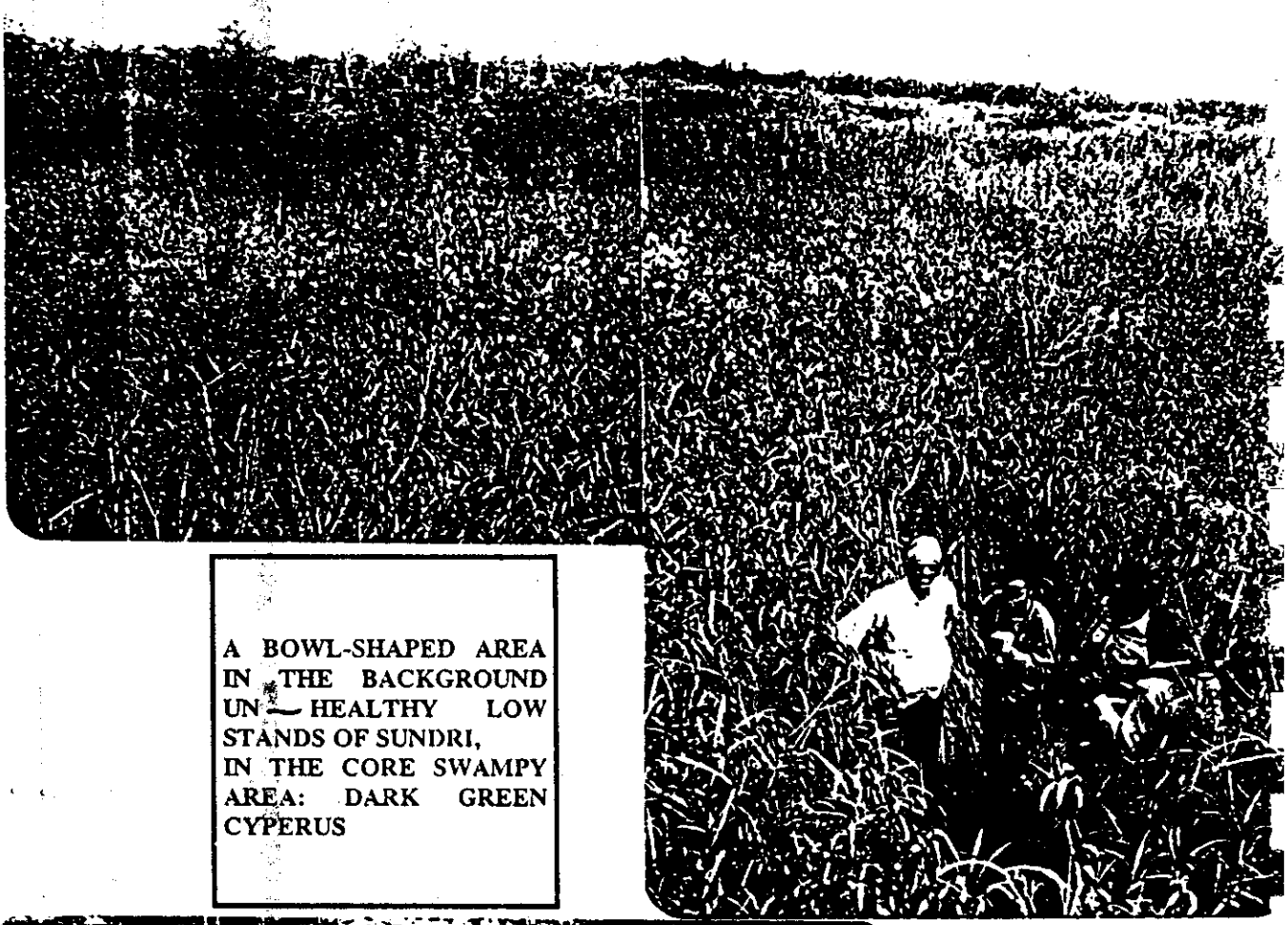
5 annex

HARVEST OF ERODED TREES

Eroding forces initiated upstream are a normal part of estuary dynamics; trying to slow erosion by keeping eroded trees in place is generally of little value. Thus from a technical point of view all the completely eroded trees (on an active erosion area and without any chance of rerouting (fallen trees)) can be harvested. This is the case when the cause of erosion is a strong current along the bank due to meanders and silt deposit on the bottom of the river.

Erosion due to waves during a big storm or cyclone must be treated differently. Large plots of Gewa eroded by wave action on the banks of RAIMANGAL River near KACHI KATTA Khal were see in July. All these areas had been harvested (presumably by K.N.M.); fallen trees but also bare-rooted trees still stand up had been harvested; the presence of some new small branches and leaves on these stems showed that many of these trees were able to survive and root again; in this case only the fallen trees had to be harvested. It is therefore necessary before harvesting eroded tree to assess two things: is the erosion localized and accidental or related to the general dynamics of the river. In the first case only fallen trees must be harvested; in the second case all the eroded and eroding trees can be harvested but clearly this must be done under strict control to avoid excessive logging of non-eroded trees.

Sometimes the erosion / accretion phenomenon is acting very fast and an eroded bank showing falling Gewa can be already reaccreted at the bottom of the bank and eventually, presence of pioneer vegetation or seedlings can be found; in this case only the falling trees should be harvested.



A BOWL-SHAPED AREA IN THE BACKGROUND UNHEALTHY LOW STANDS OF SUNDRI, IN THE CORE SWAMPY AREA: DARK GREEN CYPERUS

SEDDLINGS OF SUNDRI ALONG THE NARROW OUTLET DREDGING A BOWL-SHAPED AREA

Pneumatophores of a dead Sundri burried in silt.

Note the black layer, two centimetre under the surface

TOP LEFT:
Silted area; an unhealthy suffering Sundri covered with seeds

TOP RIGHT:
Cankers on small branches of an unhealthy tree

PNEUMATOPHORES
GREEN ALGAE

NEW DEPOSITS OF
SEDIMENTS

LATERAL ROOTS ARE
VISIBLE

TWO SPECIES OF ALGAE

PNEUMATOPHORES
PARTLY BURRIED
BROW ALGAE
AREA USUALLY FLUSHED BY
TIDE

Wouds on pneumatophores during logging work can have negative results on the respiration of trees trought lenticels (L.E.)

Badly distorded pneumatophores probably due to previous logging operation are common in some place of the forest

PNEUMATOPHORES

are vital conponent of mangroves trees; Sundri trees have tall fragile pneumatophores easly wounded during logging operations. Proposal to use a sledge to ease unladding was done. If a sledge is used in the Sundarbans, large flat runners must be avoided: a dinghy shaped sledge designed to part and bent the pneumatophores without cracking them will be much more efficient

CARTOGRAPHY
&
AERIAL PHOTOGRAPHY

10 annex

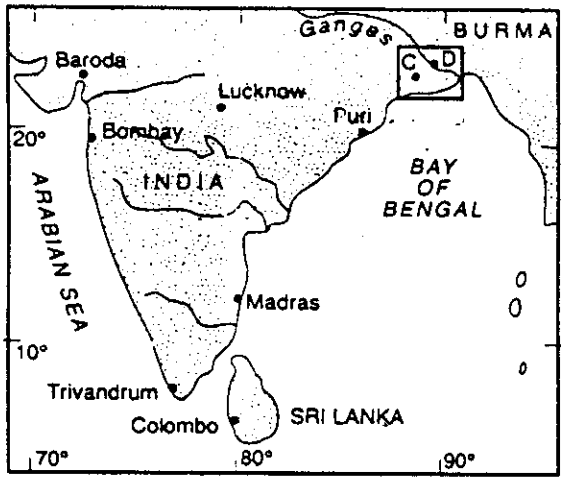


Figure 1 - Location of the mouth of the Ganges.
C : Calcutta
D : Dakha

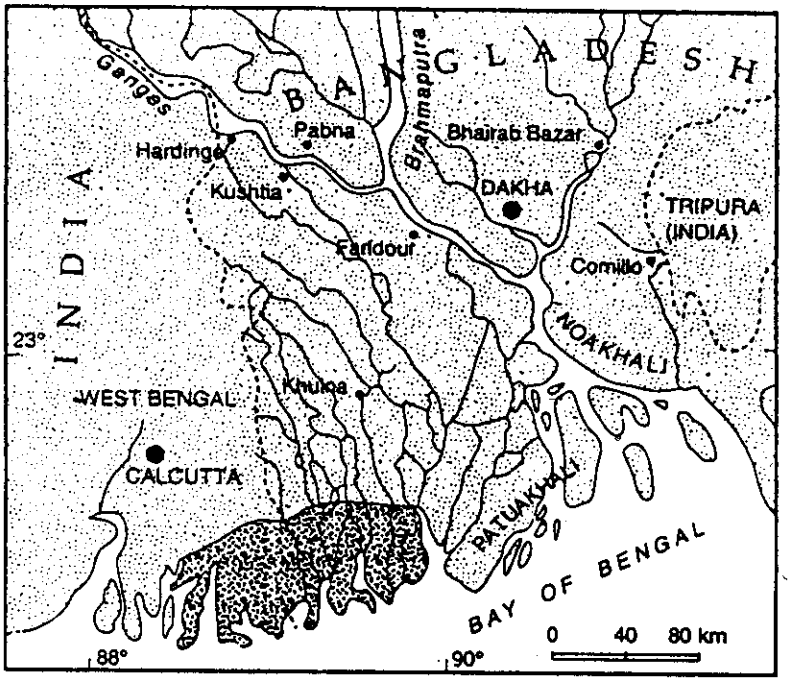
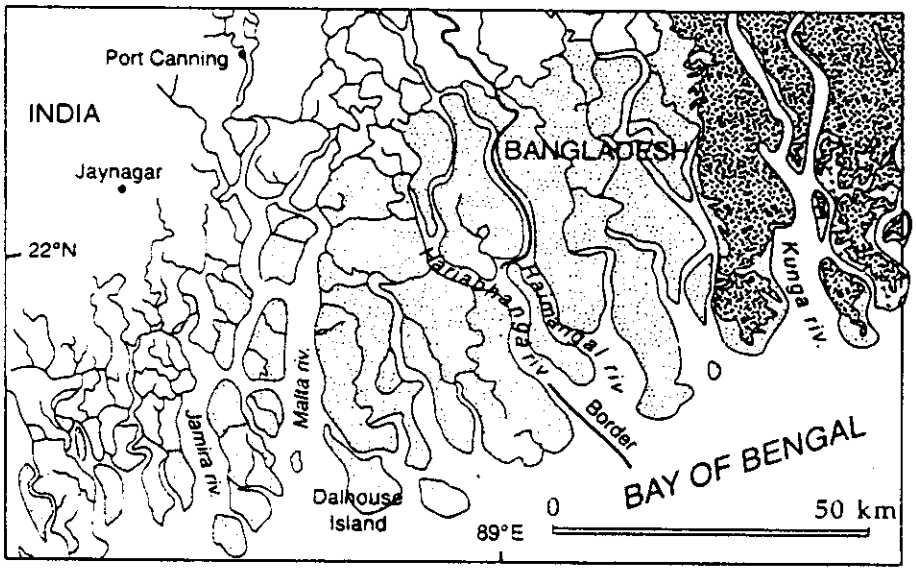


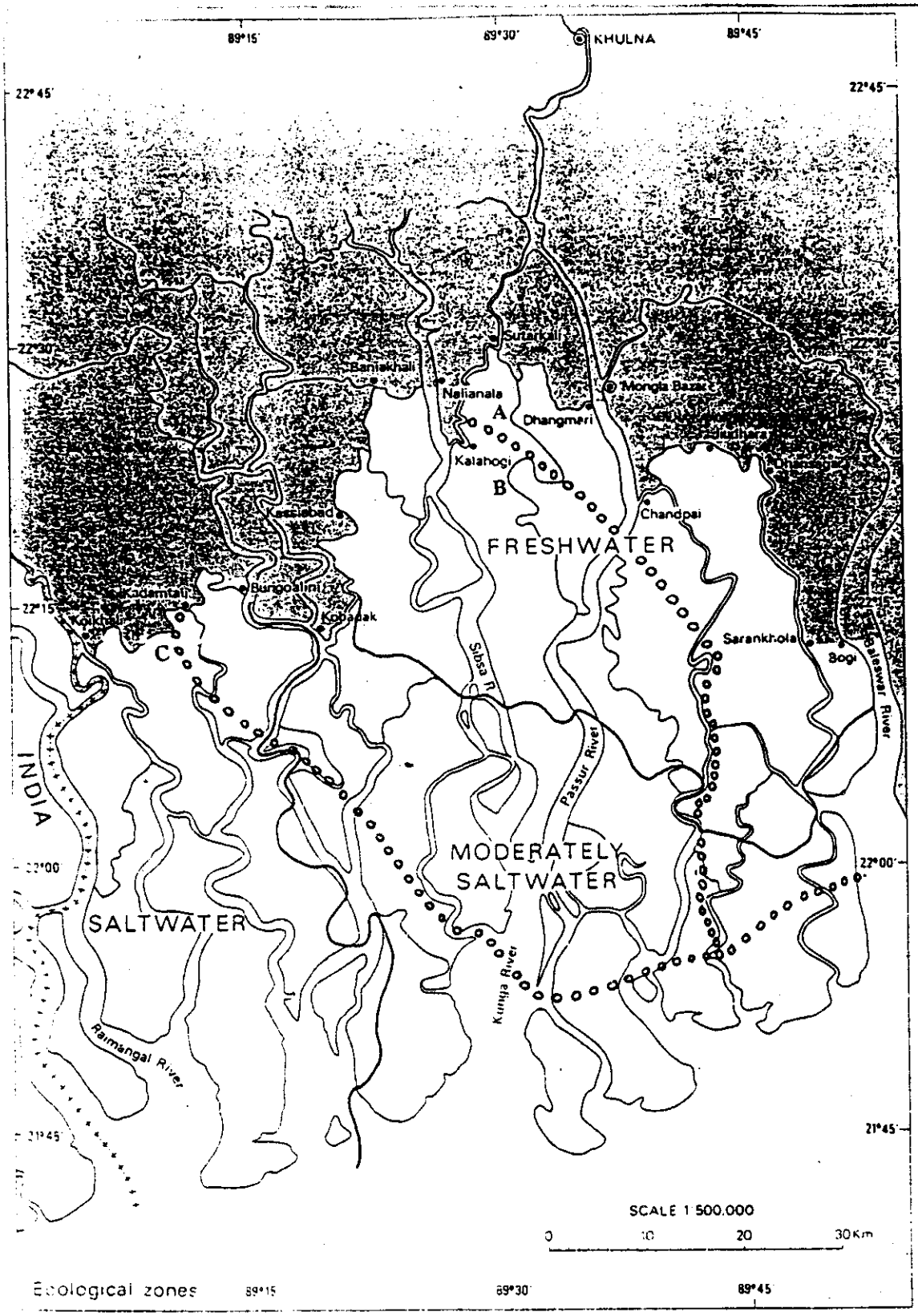
Figure 2 - Location of the study area (fig. 3).

Approximative distribution of the "Sunderbans", the largest mangroves in the world (6,000 km^2)



Low mangrove stands on highly saltish soils
High mangrove stands on less saltish soils

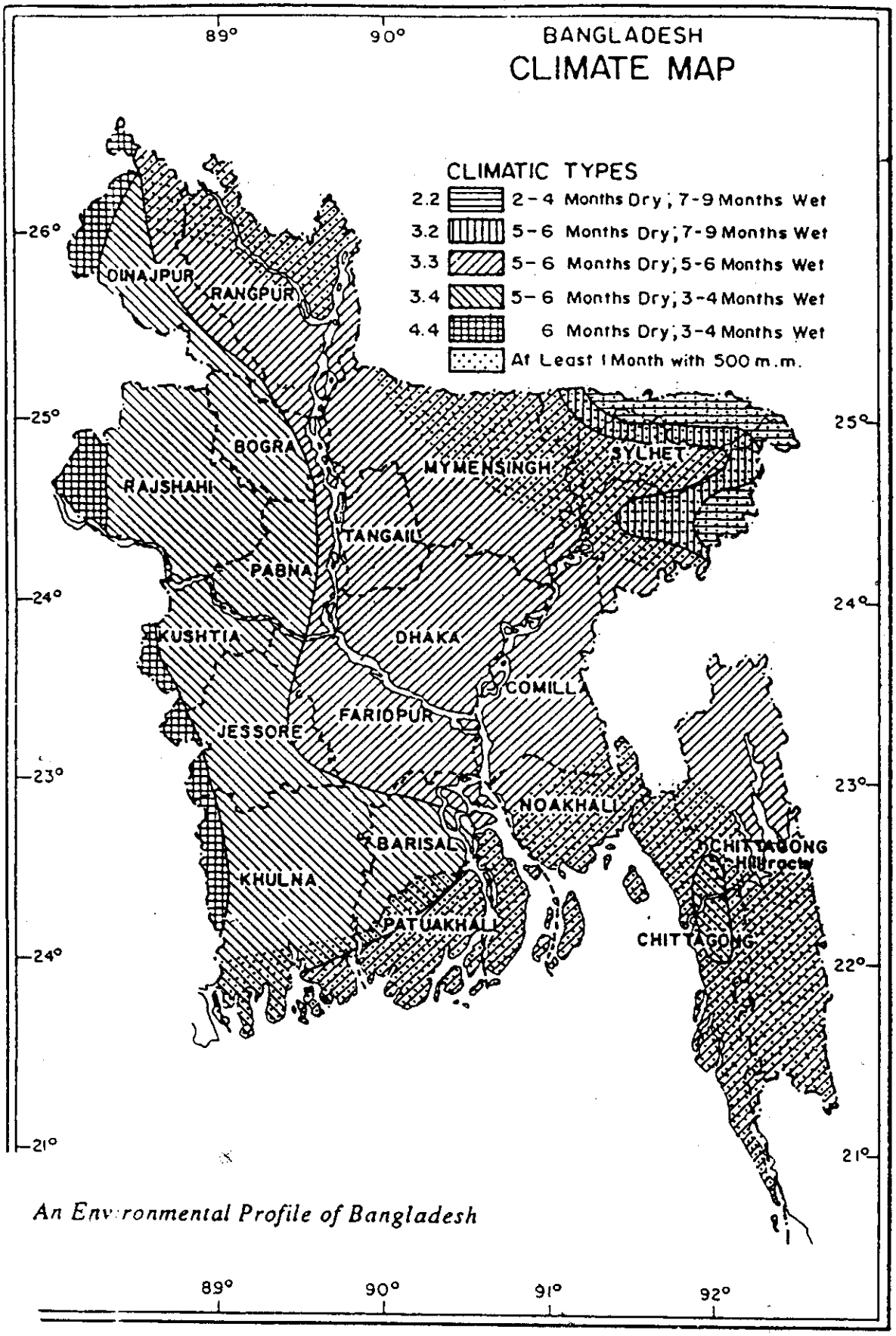
- Evolution of the delta of the Ganges seen from satellite (Landsat MSS n° 148/45). The western part of the delta is much more saltish than the eastern part due to the tilting of the delta. Less halotolerant species (*Heritiera, Nypa, Sonneratia*) are mainly found in Bangladesh (East).



COMPARISON OF SALINITY ZONES INSIDE THE SUNDARBANS FOREST SHOWING SIGNIFICANT DIFFERENCES

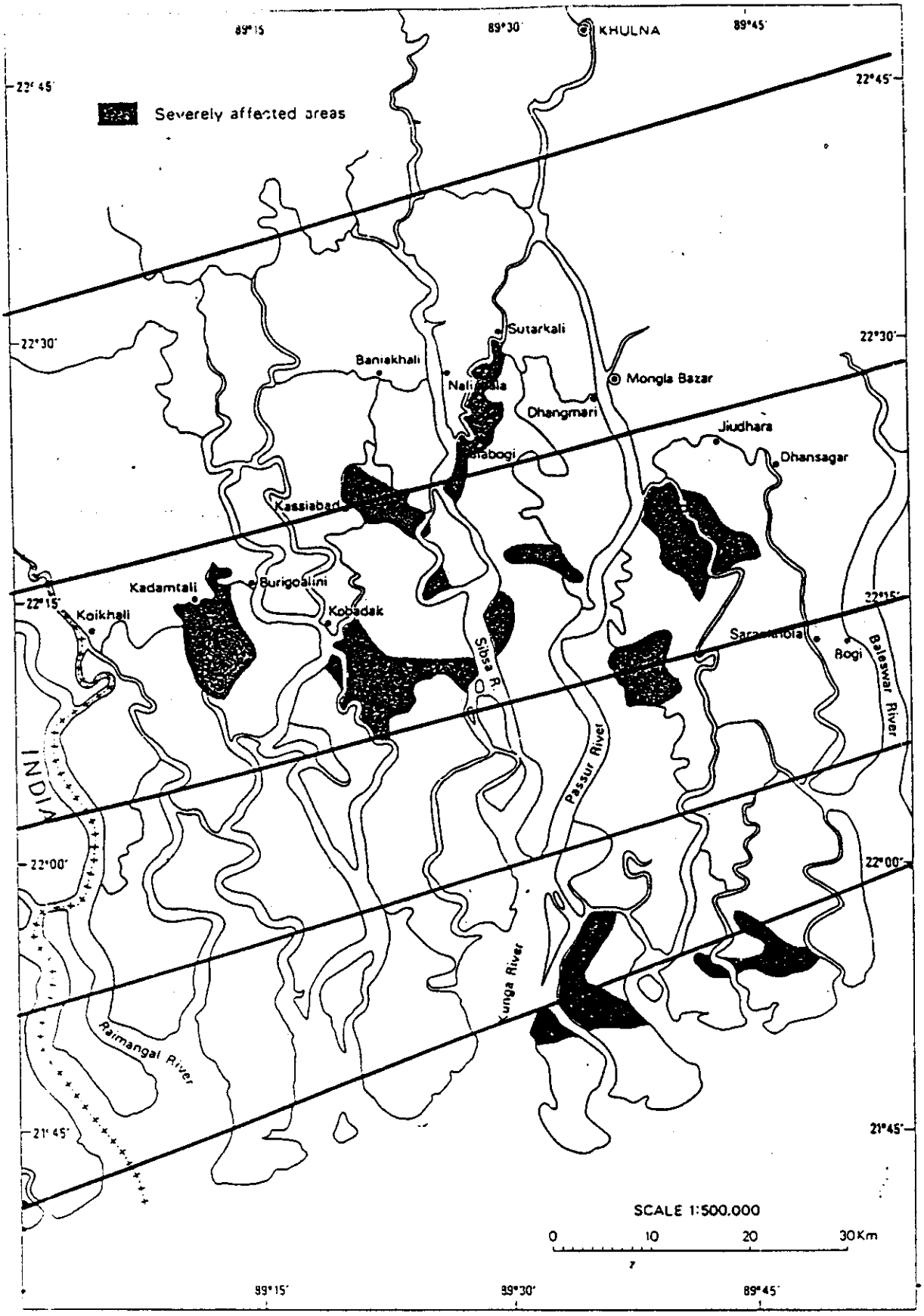
Salinity zones A / B/ C /• • • •
(Bangladesh Forest institute) N. A. Siddiqui

A - Less saline zone / B - Moderately saline zone
C - Strongly saline zone / O.D.A. salinity zones

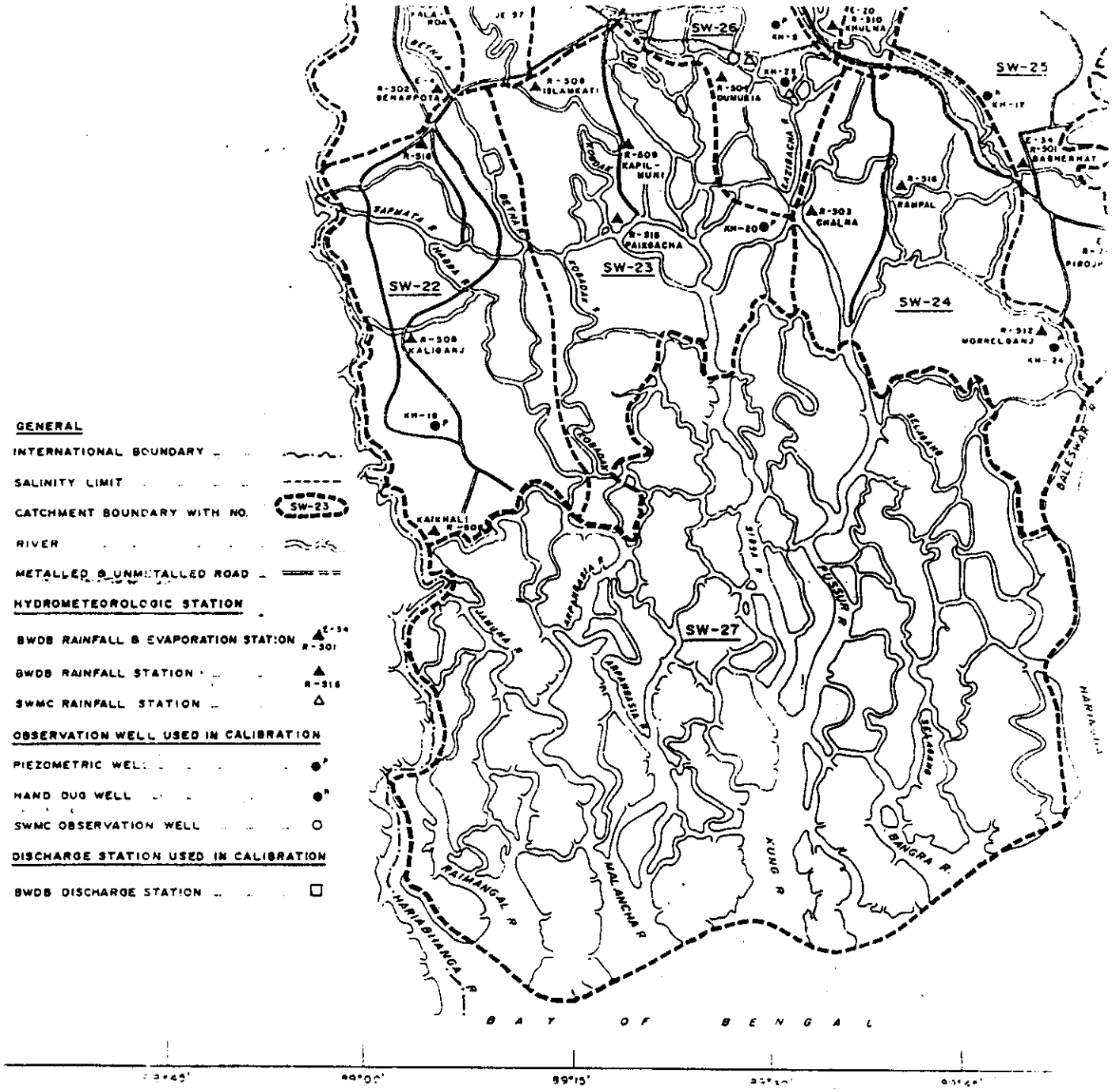


An Environmental Profile of Bangladesh

The upper part of Sundarbans mangroves is submitted to a 5 - 6 month drought accentuating effect of water diversion.

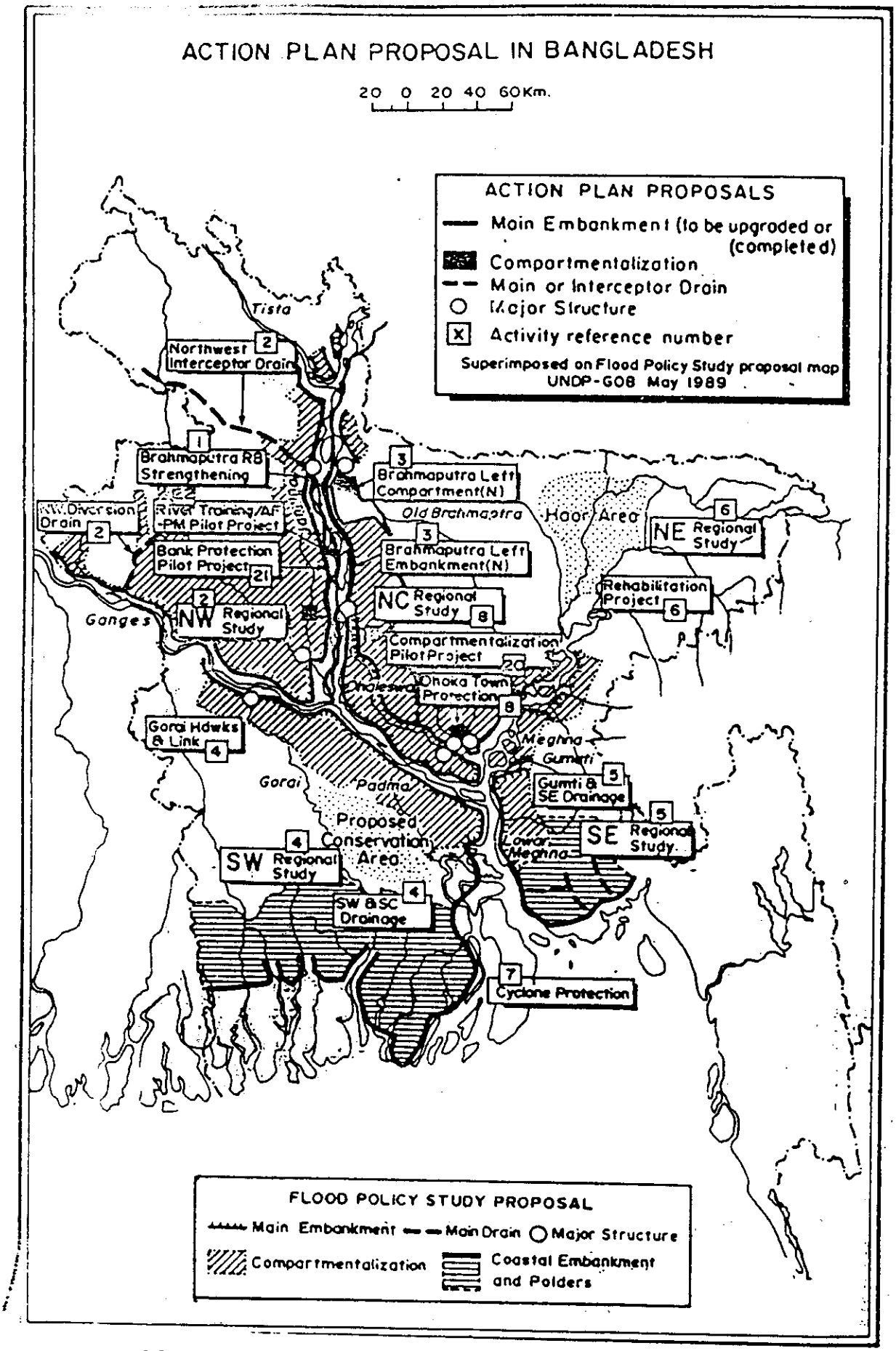


MEAN ANNUAL RAINFALL / SUNDRI DYING
FROM BANGLADESH 1991 H.e. RAHSID
in centimeters:
17 / 200 / 225 / 250 (5 - 6 month dry, 3-4 month wet) / 275



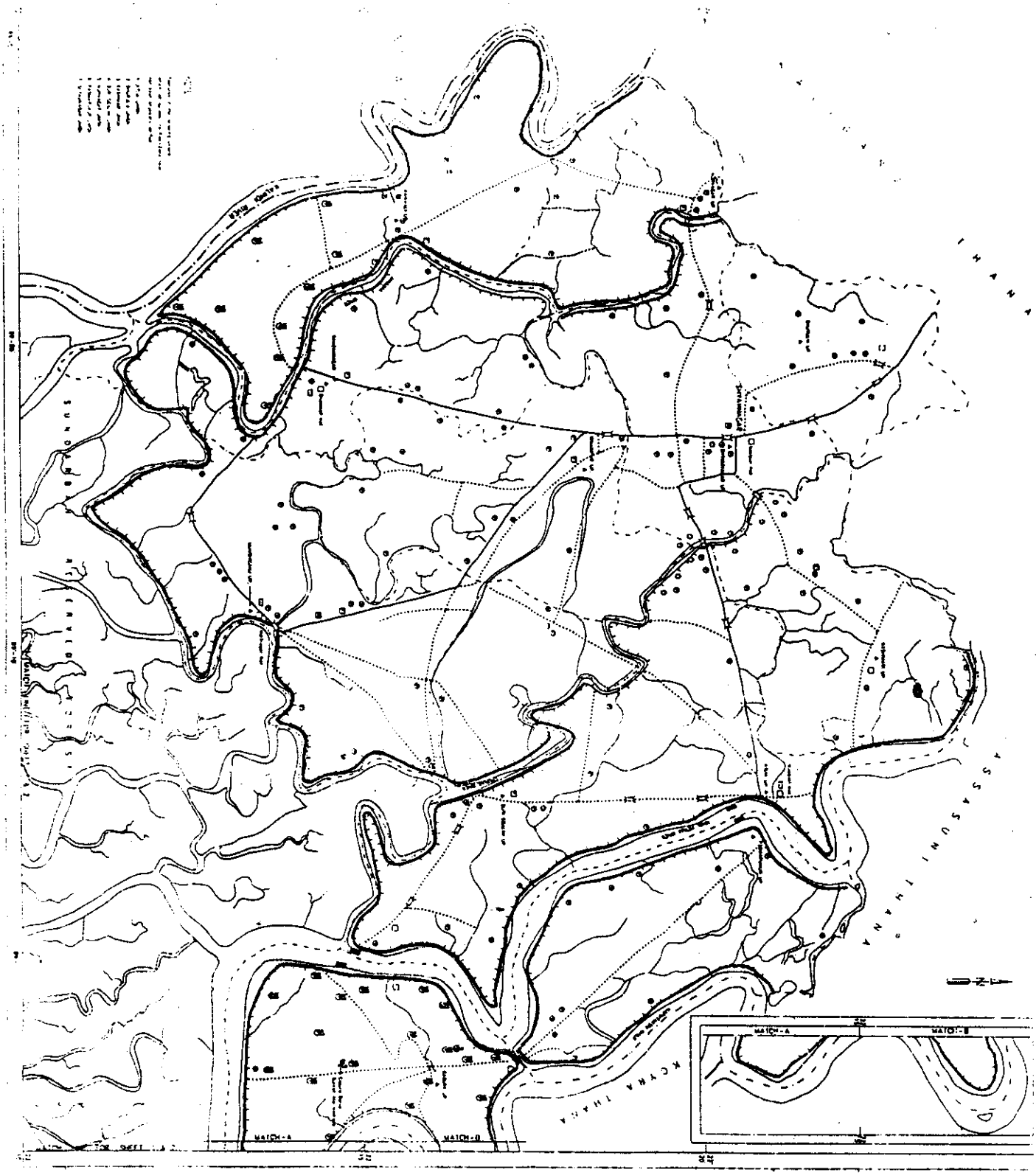
UPPER CATCHMENTS OF THE SUNDARBANS FOREST SHOWING:

- The dependency of the forest to freshwater inflow from these areas.
- Freshwater diversion, building of embankments and shrimp farm extensions are drastically changing the hydrology of this area.



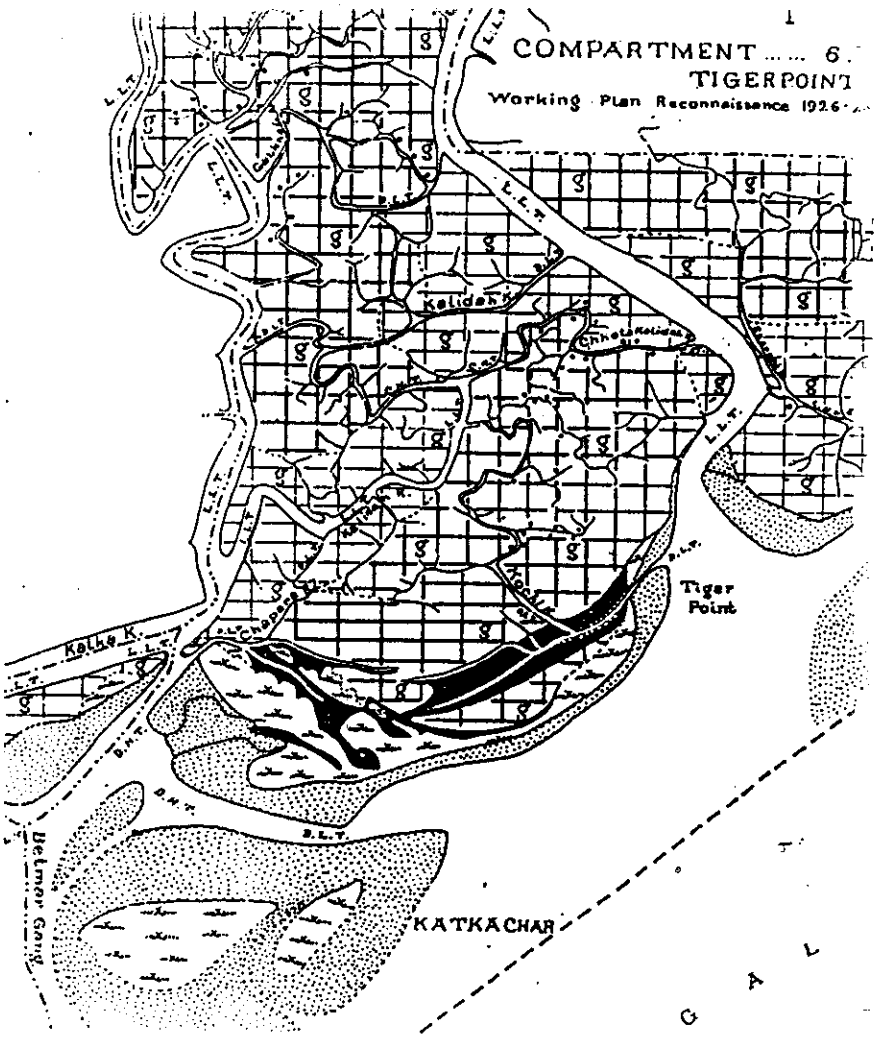
SCHEDULED REDUCTION OF FRESHWATER INFLOW

Freshwater diversion will drastically reduce productivity of the mangrove ecosystem and catches of fishes in the Bay of Bengal

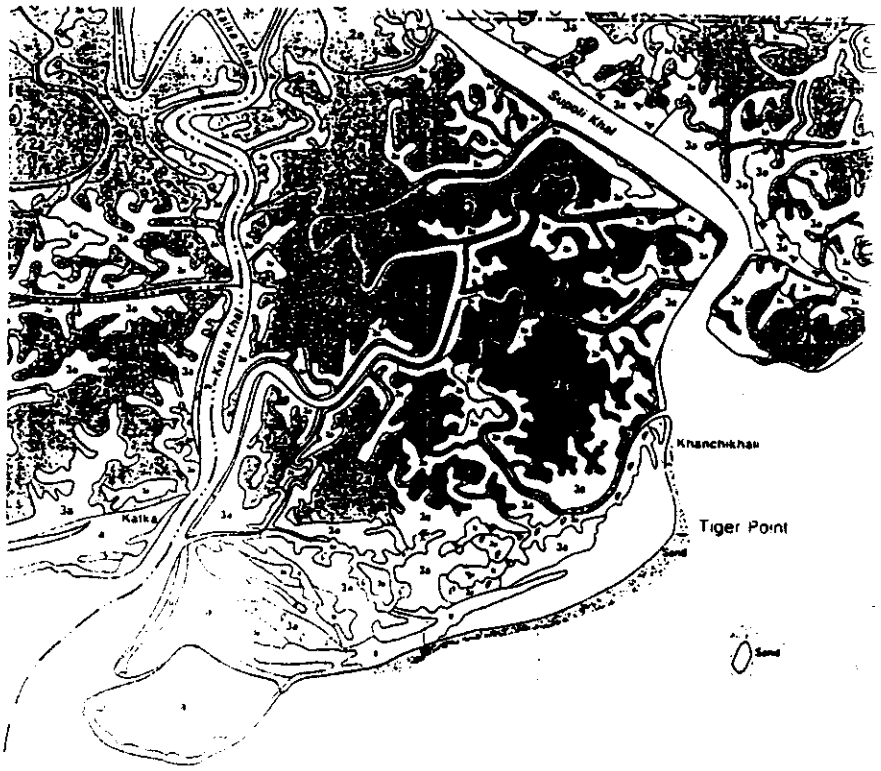


PART OF THE SUNDARBANS FOREST SHOWING THE EXTEND OF EMBANKMENTS:
SUCH EMBANKMENTS _____ ALL THE NORTH BORDER OF THE FOREST IS LINED WITH

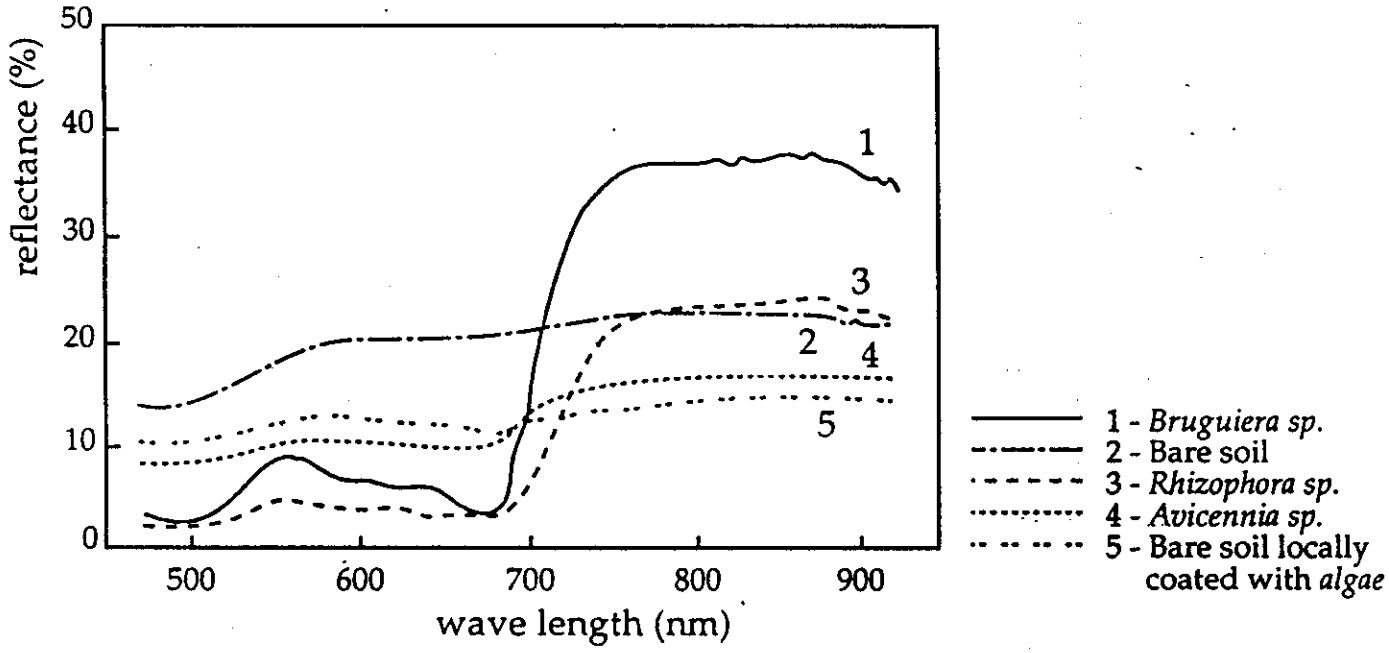
CURTIS FOREST MAP
SURVEY 1926



O.D.A. FORES MAP-
SURVEY 1984



Spectral signature of some conspicuous mangrove units (Loubersac, 1988)



CHOICE OF COLOR FILM FOR AERIAL SURVEY

- Many mangroves species can be easily descrimined using usual "visible" color photography.
- Survey of top-dying Sundri caracterised by a green greyich foliage using low altitude aerial photography will be more efficient if color film is used in place of panchromatic film.
- Use of infraced, false color film will not improve discrimination at 1/15000 scale.

History of the Aerial photograph

Sl No	year	type	owner	done by	area	scale	available at
1.	1952	B&W	SOB	Hunting Aero surveys ltd.	not known	1:30,000	SOB
2.	1963	B&W	SOB	Pak Airforce	not known	1:50,000	SOB
3.	1975	B&W	SOB	Capital air survey, Canada	All Bangladesh	1:30,000	SOB
4.	1983/84	B&W Infrared color	SOB SPARRSO	IGN, France	All Bangladesh	1:50,000	SOB SPARRSO
5.	1980/81	B&W	Forest Dept.	J.A. Story, England	Coastal area of Bangladesh	1:30,000	SOB
6.	1981/82	B&W	Forest Dept.	J.A. Story, England	Chittagong forest/Sundarbans forest	1:30,000	SOB
7.	1987	B&W	BWDB	Finnmap	Naogaon,Jessore, Brahmanbaria(FCD III area of BWDB)	1:30,000	SOB
8.	1987	B&W	Jamuna bridge authority	Finnmap	Padma/Jamuna confluence & Jamuna bridge corridor area	1:20,000	SOB
9.	1990	B&W Color	BIWTA	Finnmap	Coastal area of Bangladesh	1:30,000 1:50,000	SOB SPARRSO

AERIAL SURVEYS EXISTING FOR DIACHRONIC STUDIES OF THE SUNDARBANS AREAS

Numerous survey exist; official demand to obtain copy of the Sundarbans area was done; a new survey is scheduled December 1994

FISHERIES

5 annex

NUMBER OF BOAT
NUMBER OF FISHERMEN
REGISTERED 1992 – 1993

RANGES	BOAT	FISHERMEN
SHATKIRA	61,735	102,566
SARANKHOLA	10,598	56,121
KHULNA	42,592	79,169
CHANGPAI	18,273	34,295
TOTAL	133,198	272,151

THE AMOUNT OF FISH
NO OF PERMIT – NO OF FISHERMEN
AND FINALLY AMOUNT OF MONEY
COLLECT DURING 1992 – 1994

1992 – 1993

	1992 – 1993 JULY – JUNE
1. NUMBER OF PERMIT	107035
2. NUMBER OF PEOPLE	264339

	AMOUNT MAUNDS	REVENUE TAKA
OTHERS FISHS	82,724	3,840,039
BIG SHRIMP	8,232	2,470,508
SMALL SHRIMP	4,886	244,323
DRIED FISH	21,205	1,378,332
HILSA FISH	13,368	1,002,631
CRABS	13,167	526,699
WASTE PRODUCTS	2,916	5,831
BABY BAGDA SHRIMPS / No	127,968,100	5,225,151
REVENUE FOR FISH CATCHING		1,516,985
TOTAL		**16,210,499**

1993 – 1994

	1993 – 1994 JULY – JUNE
1. NUMBER OF PERMIT	401157
2. NUMBER OF PEOPLE	430878

	AMOUNT MAUNDS	REVENUE TAKA
OTHERS FISHS	67,668.06	3,383,692.37
BIG SHRIMP	7,348.00	2,206,303.90
SMALL SHRIMP	4,999.16	249,882.50
HILSHA FISH	11,575.29	873,881.28
CRABS	14,112.37	562,979.00
DRIED FISH	229,111.32	873,881.28
WASTE PRODUCTS	5,049.16	122,170.25
BABY BAGDA SHRIMPS / No	209,635,300.00	10,555,915.00
MISCELLINEOUS	125.00	2,798.25
REVENUE FOR FISH CATCHING		1,751,050.70
TOTAL		**20,582,554.53**

THE NAME OF DIFFERENT KHAL AND RIVERS RESTRICTED FOR FISHING (PRESERVED AS BREEDING CENTRE)

KHALS AND RIVERS	COMPARTMENT
A. KHULNA RANGE:	
1. BHADRA	No 32
2. SHARBAT	No 32
3. MORA BHADRA	No 33
4. HADDORA	No 33
B. SHARANKHOLA RANGE:	
1. ALI BANDA	No 01
2. CHANDESWAR	No 15
3. DASHE BASI	No 24
4. KATKA	No 04
5. KACHIKHALI	No 06
C. CHANDPAI RANGE:	
1. KARAMJOL	No 31
2. JONGRA	No 31
3. MORA PASSUR	No 30
4. JHAPSI	No 29 & 30
5. NANDA BALA	No 26
D. SATKSHIRA RANGE:	
1. CHUTO KOYAKHALI	No 46
2. BONO KAYA KHALI	No 46
3. KHALISH BANIA	No 46
4. SAPKHALI	No 46

D.F.O. SUNDARBANS OFFICE ORDER AND MEMO No 5087/18–1 AT 11–05–1989

PHOTO 1

Different species of penaeid prawns caught inside the Sundarbans:

1. Immature of *P. indicus* (?)

2. *Metapenaeus spp* (tchingri)

3. *Penaeus indicus* (chaga)

4. *Penaeus monodon* (tiger bagda)

Immatures stages of *P. indicus* are often mixed with other species

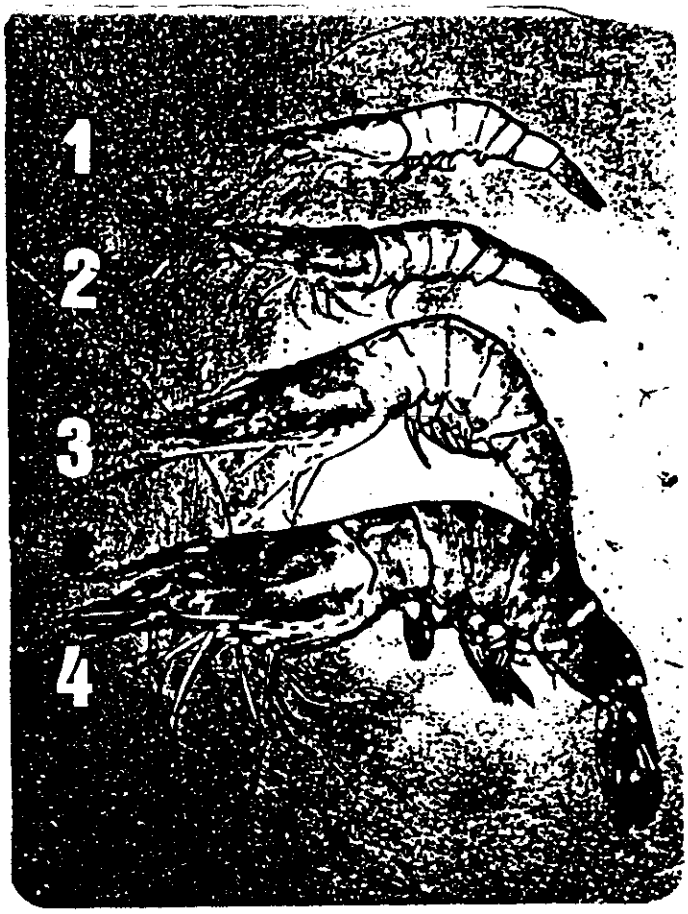
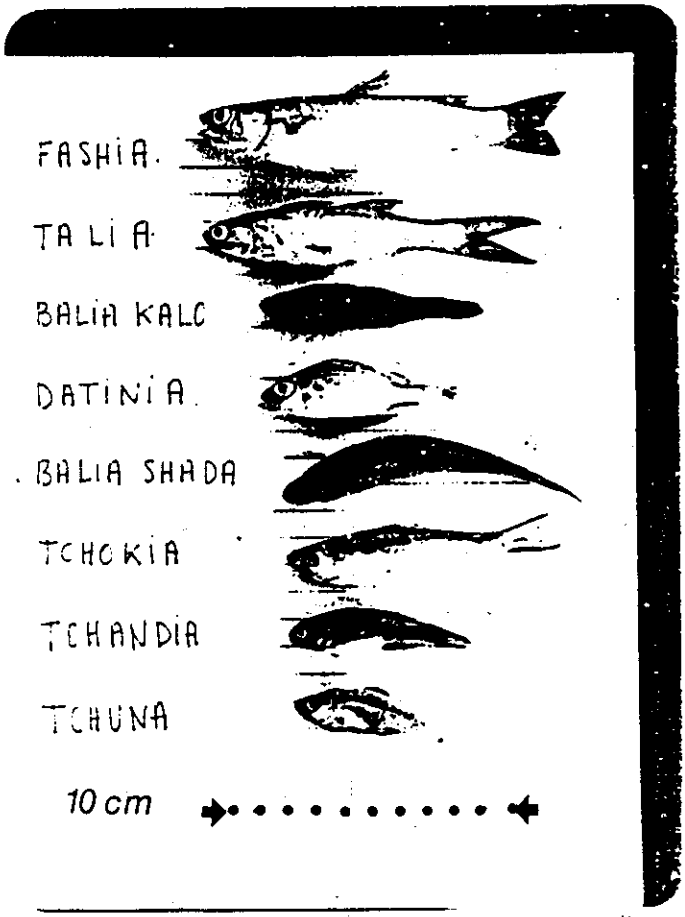


PHOTO 2

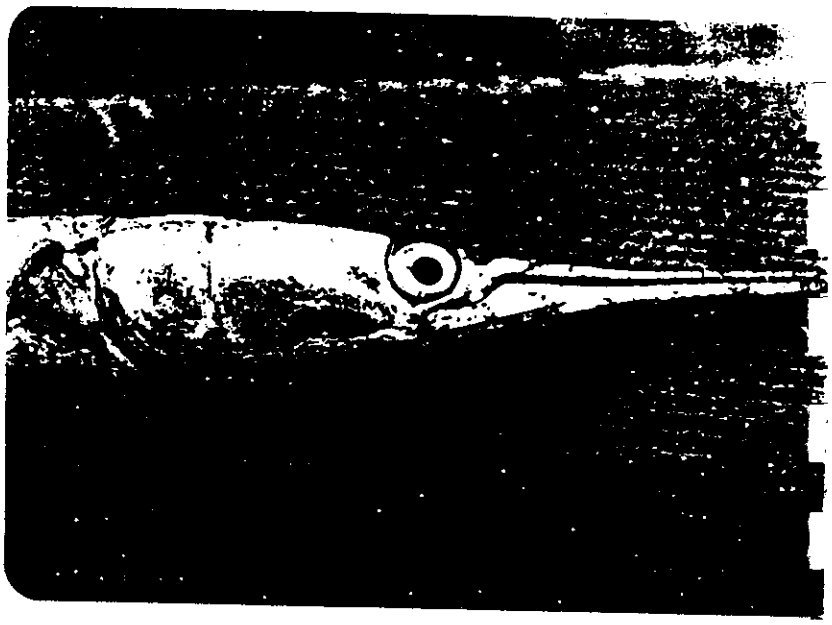
All these fishes were caught at the same time by a dinghy boat.

Nearly all are immature; use of small mesh nets is highly destructive

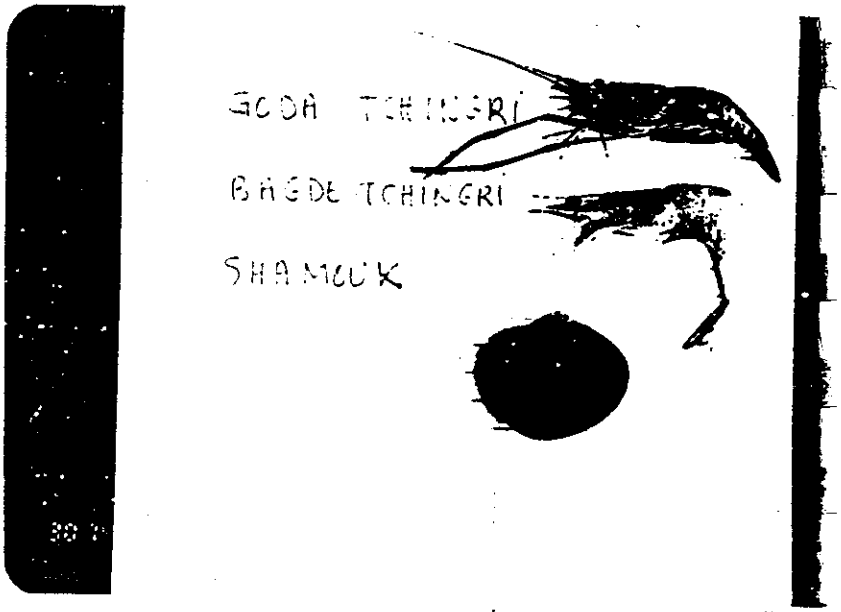


BREEDING AND NURSERY GROUNDS IN SHALLOW WATER

JUVENILE STAGE OF FISH



SHRIMPS AND BIVALV MOLLUSK SPECIES FOUND IN THE MANGROVES

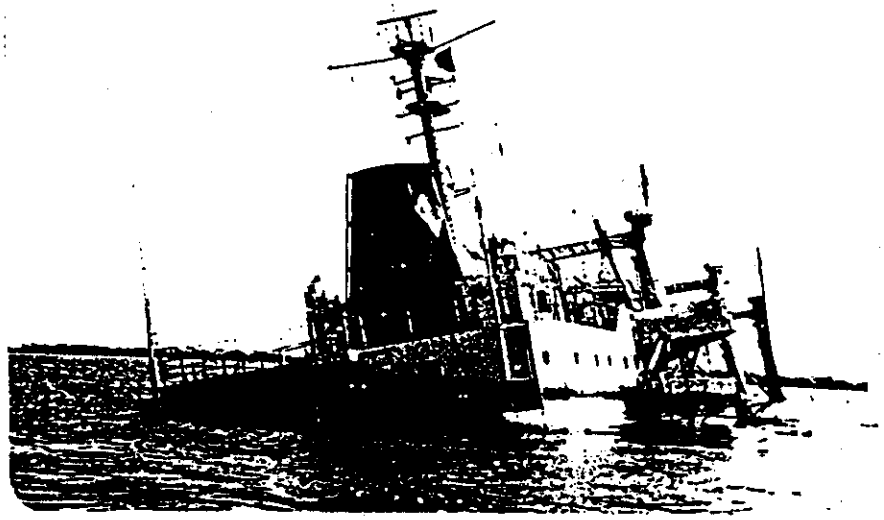


POLLUTION

2 annex

OIL POLLUTION

Passur River near MONGLA harbore: burn and sunk vessel; oil is pourring out of the tanks



OIL POLLUTION

A black layer of oil line the vegetation/ Trees roots and herbs are covered with oil

OIL POLLUTION

Oil is flushed throug an outlet, down to Passur River at low tide near DANGMARI - August 1994

Oil slick from sunken ship in Pasur

Threat to eco-system

KHULNA, Aug 19 : As the sunken ship in the Chalna Port continues to leak huge fuel oil in river Pasur, experts have warned of a disastrous impact on mangrove eco-system in the Sundarbans besides a havoc on fish and animals, Reports UNB.

They said shrimp fry as well as saplings would be the worst victims of the poisonous effect of the spilling diesel and furnace oil which, till today, spread 50 sq miles deep into the Sundarbans.

Eggs of hilsa" and other species of fish in the Pasur and its tributaries would be threatened seriously, endangering their reproduction, while the smell of the leaking oil would drive away the hilsa population, said Mosharraf hossain, Deputy Deputy Director of the Department of Environment in Khulna division.

"Diesel is very dangerous for fish. It will certainly cause serious respiratory problem for floating fishes," said divisional Fisheries Officer Rafiqul Islam Chowdhury.

Scores of shrimp farms, stretching along the Pasur, are also threatened by the oilslick. The Panamian flag carrier MV Pavlina has been leaking oil since it sank on August 14 near the west bank of Chalna Port following a fire accident. The engine room of the ship had 195 metric tons of furnace oil and 28 tons of diesel, enough to cause a large-scale pollution. Grasses and small plants along river Pasur are already seen covered with the oil. Hossain reported that some cattle in the Mongla area had died after eating the oil-soaked grass.

Divisional Forest Officer in Khulna M Shamsul Huda said the oil-soaked grass and water might also poison the deer and tiger population of the Sundarbans. Already hit by high salinity, apart from young plants and saplings, Huda said the oil, with low tide, has already spread 50 sq miles deep into the forest, threatening its flora and fauna.

The oil leakage will add to the crisis of salinity in the Sundarbans which has threatened the Sundari and other mangrove tree population. Meanwhile, the port authorities and the Department of Environment have asked the local agent of the sunken ship to take immediate measures to stop the oil leakage.

The Port Authority is also trying to use an indigenous technique, wrapping jute rags around bamboo, to stop the oil from spreading, which, according to experts, would work a little.

Most sea ports around the world have modern technology floating oil arostol and oil bomb to stop spread of spilled oil which Bangladesh does not have.

Meanwhile, people in the shipping business here did not rule out a conspiracy behind the capsize of the ship to gain from insurance. The ship was an old one and was to be sold as scrap after the voyage, they said.

Six of the ship's airconditioned machines and three of the cranes were inoperative.

The wrecked ship that had been loaded with 6485 metric tons of raw jute and jute goods before it caught fire was destined for Abidjan port in West Africa.

Pollution and Erosion are serious theats to Sundarbans Ecosystems. They are regularly recorded in the press.

Erosion takes serious turn in C'nawabganj

From Our Correspondent

CHAPAINAWABGANJ, Aug 19 : Wide spread erosion of river Padma has turned about 6000 thousand people homeless during the recent flood as the water started swelling in the river Mohananda and Padma. About 16 unions of the district partly or fully have been inundated due to onrush of water released from upper region of the country.

The erosion of these rivers intensified since July 29 which took serious turn in the last week. Within last few days about 8,000 acres of Panka Union 7,000 acres of Narayanpur Union about 500 acres of Alatuly Union Parisad cultivatle lands, homestead, and educational institutions have been washed away by the surging water left the areas as hiors.

One Saiful Islam (10) of Bhutpukuria of Panka union has drowned in flood water. Erosion is still grave in some areas. Large chunks of river bank are being washed away daily by the surging water.

The homeless people took shelter at different places and are passing days in great miseries for want of food and work. Many of them have migrated to different town and other villages. The river Padma is now flowing 3 centimeter and the river Mohananda is flowing 1 and half centimeter above of danger level. The flood situation of the district is quite grave. New areas of the district are being inundated inundating huge acres of Aus paddy Chapainawabganj—Dhaka high way may be inundated any moment by flood waters.

Over eighty thousand children have been suffering from malnutrition for want of proper nutritions food in the district, confirmed sources said. It is learnt that the parents of these children cannot provide nutritive food due to their poverty.

It is further gathered that at least 80 per cent families of the rural areas of the district depend on agriculture and earnings.

Besides a concerned sources said, natural calamities and other problems such as unprecedented drought and increasing price of goods, fertilizers, insecticides have been hampering crop cultivation and production since last few years. As a result most of the manual labourers, landless families are deprived of the cost of their labour.

Moreover 90 per cent of cultivators in this district use plough lands belonging to others. Children of those farmers have to remain unfed for most part of the days.

These children are being affected with various diseases including, polio, blindness, skin diseases.

Besides most of the children of the district die of diarrhoea, dysentery, Diphtheria and other water or air born diseases every year. According to physicians many families of the rural areas of district do not maintain rules of health and cleanliness. Elites of the district, however, feel that government should take up schemes to distribute rice, wheat, vegetable and other essential nutritive foods amon

WORKING PLAN

ECOLOGY

2 annex

Ecology Guidelines for the dry season 1994/95 Workplan

This report contains the main recommendations for a working plan and basic technical data appropriate to field sampling for ecological studies . All these studies must be performed during the 1994/1995 sampling campaign in order to complete all the ecological studies before end of June 1995.

- The National Ecologist will collect information during the dry season from October 1994 to April 1995 following the recommendations of this report.

- The FAO Ecologist will complete the dry season sampling from February to April/May 1995.

All these points have been discussed and agreed during the 1st October 1994 meeting between National and Consultant Ecologist and subsequently with the OIC.

Sampling methodology

- Review of sampling methodology:
- A systematic survey system grid : 1 minute longitude/1 minute latitude was chosen to form the framework for data collection in the field.

1. **Sampling methodology** : Systematic Sampling Points are located on the field using GPS and GPS facilities (Go to system).

2. **S.S.P. Sampling** : each SSP is divided in Sub plots of 5 X 5 metres disposed along 100 m lines
   each Sub plot can be devised is necessary in sub-sub plot of 1 X 1 metre for precise ecological studies.

3. **Comparative Study of Top-Dying and non Top-Dying areas.**

3a. Profile drawing - Ecological comparative study of two adjacent areas will comprise a precise drawing of the profile, between two GPS fixes located with (concrete/steel) poles;

3b. Deposit of brick powder (1 kg) near each pole will allow further study on sediment deposition.

3c. Soil sampling : Soil sampling along the transect will be performed in all different ecological zones

- technical procedure
- acquisition of a good shovel.
- collection of soil profiles in plastic bag if necessary
- photos of sampling points with scale
- complete ecological description of the profile including detailed description of the status of regeneration surrounding each sampling point; description of the surface of the soil, animal activity and biological activity in the soil and all other relevant physical and biological information (size and aspect of pneumatopheres etc.) Presence in the soil profile of a thin layer of black soil must be carefully recorded and an horizontal slice of this particular soil must always be collected.

3d. **Identification and labelling of samples**

- It is a crucial point and field notebooks must be kept carefully; use of strong plastic bags, large markers or graphite pens is essential.

4. **Use of Maps and Aerial Photography**

- Choice of sampling points and transacts must be carefully done using enlargements of the new topo map and FINMAP aerial infra red photography - all GPS way-points will be input in the GPS memory before leaving Khulna in order to use the Go-to system to easily find them in the field.

- All field work and information must be recorded on a enlargement (photocopy) of the new topo map.

5. **Nypa Palm inventory**

Nypa Palm inventory along river banks can be performed in precisely located areas using GPS. Choose a stand; count stems/choose a stem; count leaves; cut leaves leaflets/fruits/ etc. This will be a useful tool as it will help photo interpretation of Nypa stands using supporting data from the new aerial survey in December 1994. This can be performed easily during liaison trips with the speed boats.

Step-wise sampling: (a) Count the stands in the sample
(b) Make a clump count - count the number of stems
(c) Take a stem and count the number of leaves/count leaves/leaflets/fruits/flowers.

1995 _____ F.A.O. ECOLOGIST _____ END OF PROJECT

NATIONAL ECOLOGIST _____

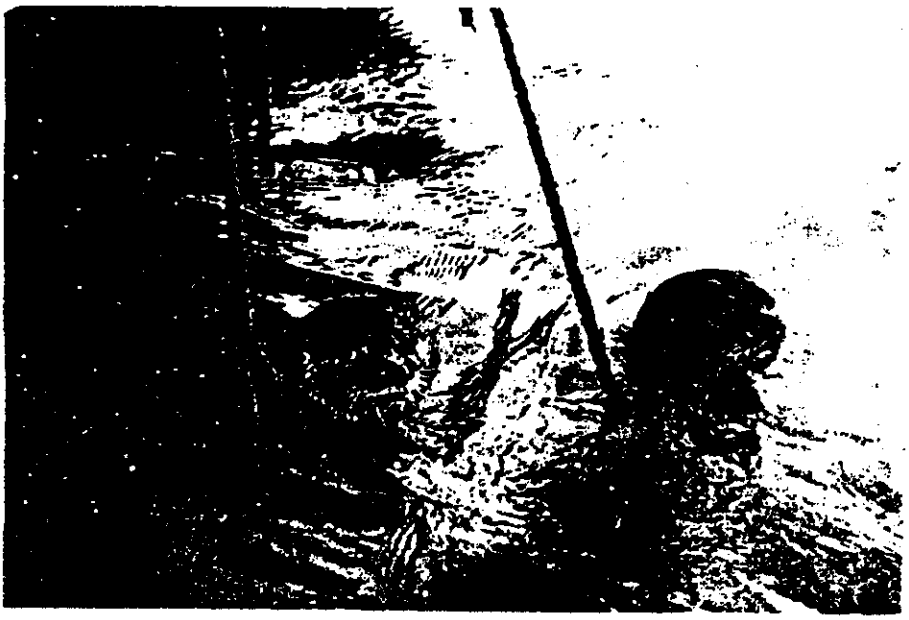
J	F.	M.	A.	M.	J.	J	A.	S.	O.	N.	D.	ACTIVITIES
												LARVAE STUDIES SHALLOW WATER
												INSECTS LARVAE AND IMAGO
												DOBSOAE SURVEY / MUDFLAT FAUNA
												MOSQUITO LARVAE
												SOIL SAMPLE COLLECTION G.P.S LOCATION + MAP LOCATION
												G.P.S. LOCATION OF F.D. OFFICES AND SAMPLING POINTS
												SOIL SALINITY DATA IN TOP DYING AREAS
												SOIL DROUGH ASSESSMENT IN TT DYING AREA
												WATER SALINITY WITH G.P.S LOCATION AND HOUR
												AQUATIC LIFE RIVERS FISH
												AQUATIC LIFE RIVERS
												SWAMPS LIFE
												PLANKTON / SEA / RIVERS
												SURVEY MIGRATING FISH
												REED AN FLOWERS COLLECTION HERBARIUM
												TREE PHENOLOGY
												FOREST TRANSECT
												TIGER AND LARGE ANIMALS RECORDS NOTEBOOK
												BIRDS
												COSTAL AREA TURTLE NETTING
												CROCODILE NESTING
												MOLITOR SURVEY
												BEER SURVEY
												PIG SURVEY
												BARKING DEER
												AMPHIBIANS TADTOLES
												CYCLONE PERIOD
												MONSOON
												SEEDLINGS
												LOW ALTITUDE AERIAL
												TRANSECT PERMANENT SAMPLING PLOTS TEMPORY SAMPLING PLOTS SEDIMENTATION SURVEY WATER LEVEL PROFILES

WORKING PLAN: ECOLOGIST

ECOTOURISM

1 annex

AN INTACT POTENTIAL FOR ECOTOURISM



SUMMARY OF REPORTS ANALYSIS

1 annex

ACTIVITY	DONE	ONGOING	TO BE BY PROJECT	FOLLOWED BY F.D.
WILDLIFE MANAGEMENT*	XXX	–	–	X
FOREST HEALTH INVENTORY	–	XX	–	X
SYLVICULTURE*	–	XXX	X	X
FOREST PRODUCTS	XX	–	–	–
APICULTURE*	XXXX	–	–	–
SOIL SCIENCE*	XXX	–	–	–
HYDROLOGY	XX	XXX*	X	–
MAPPING / G.I.S.	–	XXX	–	–
DATABASE	–	XXX	X	–
SOCIO–ECONOMICS	–	XXX	X	–
FISHERIES HARVESTING AND MARKETING	–	XXX	X	–
NATURAL RESOURCE ECONOMIST	–	–	X	–
MECHANICAL ENGINEER SURVEY VESSELS	–	XXX	X	–
STATISTICIAN	–	XXX	X	–
MANGROVE ECOLOGIST	XX	XXX	X	X data collection ?
ECOLOGICAL INVENTORY OF ENANGERED SPECIES	XX	–	X	X data collection ?
EVALUATION OF ECOLOGICAL CHANGES DUE TO WATER DIVERSION	–	XXX	X	–
GLOBAL SOCIO–ECONOMIC VALUATION VERSUS CONVERSION	–	–	X	–
I.R.M.P. PREPARATION	–	XXX	X	–

LEGEND

FULLY COMPLETED:	XXXX
PARTLY COMPLETED:	XXX
UNCOMPLETE:	XX
TO BE COMPLETED:	X
SPECIAL COMMENTS:	* 4.1 to 4.11

APPENDIX

ITINERARY OF FIELD TRIPS TO SUNDARBANS

AND SUMMARIES OF OBSERVATIONS AND RECOMMENDATIONS FOR ECOLOGICAL DATA COLLECTION

JUNE TO OCTOBER 1994

NOTE:

The itinerary log-books contain all information collected during these trips concerning vegetation, fauna, water and soil. The following notes are only an abstract of the most relevant observations and G.P.S. locations.

All G.P.S fixes recorded are to be included in the database. G.P.S. fixes of the stations were recorded on the jetty of the Forest Department Station or if the boat did not stop, abeam perpendicular to of the jetty.

G.P.S. fixes of the small lateral Khals were recorded abeam middle of opening (the river month).

G.P.S. fixes of big confluences are more imprecise and usually recorded with a drawing on the log book indicating bearing of morphological features (point of land, etc.).

Many G.P.S. fixes are not recorded in these notes as they apply to localized field observations and are recorded in the log-book or field notebooks.

Bad quality G.P.S. fixes (GG < 7) are not recorded.

SUMMARIES OF OBSERVATIONS AND RECOMMENDATIONS

FIELD TRIP N° 1 - 12.06.94 TO 17.06.94

1. STRUCTURE OF THE FOREST AND TOP DYING:

As expected with previous readings and exam of S.P.O.T. remote sensing data in France the structure of the forest is complex.

1.1 A complex mosaic structure

The forest seems constituted of small size mosaic units, narrow bands or patches of Nypa palm, Hantal palm and others species along small rivers.

Elevation of river banks and correlated water capacity retention of the soil seems to govern Gewa and Sundri distribution

1.2 Use of remote sensing data

Discrimination of such small mosaic units, sometime less than 5 metres wide, and of scattered trees will be difficult or impossible on available remote sensing data (10 -15 metres pixel S.P.O.T. data).

However, this method may have to be used it necessary to assess morphological changes of the rivers (erosion, accretion) encroachment and official and unofficial felling.

1.3 Aerial survey of top-dying areas

An aerial survey, at low altitude and using low-oblique colour stereo photography and 1/3000 vertical stereo photography of T.D. area with G.P.S. localization will help to understand and to check the natural or anthropic evolution of these area in the future.

1.4 Needs for diachronic data

Information concerning official or unofficial felling will be useful: it seems that in many places the structure of the canopy of the Sundri forest is highly heterogeneous due to selective felling.

1.5 Phenology

Local variation in phenological stages of deciduous "Gewa" seems linked with edaphic changes and with Sundri top dying in some places.

This needs to be assessed or refuted by careful phenological observations correlated with soil water holding capacity along transects precisely located with G.P.S.

1.6 Soil moisture and top dying

Soil water or moisture content and tidal flushing patterns along transects through top dying and reference healthy plots will be useful information.

The most interesting period will be the peak of dry season and low tidal level, January to April. Sediment gauges and marks will be establishment at this time all along the transects for future investigation. Second observation could be done by aerial low altitude survey of these transects during May - June to assess Gewa phenological changes. Third observations should be done just after rainy season in October to assess sediment deposits.

1.7 Analysis of foliage

Top dying Sundri have gray green unhealthy leaves; a comparative study of these leaves for micro structural changes using scanning election microscopy and for chemical changes could be done in Toulouse University Laboratory - France.

1.8 Different kind of top dying

Presence of top dead Sundri with healthy dense foliage on lower branches in some places of the forest shows that top dying has different causes, it is therefore necessary to define clearly the symptoms and categories to avoid misunderstanding; description of these different categories of top dying or top dead trees could be done by the Sylviculture team on a representative sample. This will be used to make a standard record card used by field teams; associated top dying of others species will be also recorded with description of characteristic features.

2. SOIL AND WATER:

2.1 Water salinity

It is recommended to effect during each field trip a control of water salinity with a refractometer and/or a good electroconductivity meter.

This will be done recording hour and G.P.S. fix at each sampling point and before and after each large confluence. It is recommended to buy a second hand refractometer and an electroconductivimeter specially designed for field use with automatic temperature correction (the project Ec meter is inadequate).

2.2 Sedimentation assessment

Presence at high tide of "clouds" or "cauliflower" of sediments shows that episodes of heavy sedimentation occurs.

Presence of thick sticky layer of silt on forest floor, filling tracks of animals and partially decaying roots shows that deposition is fast.

Two questions have to be answered:

a. What is the physical increase in height of the soil surface after one rainy season ?

b. What is the origin of these sediments ?

Mainly upstream silt, mainly silt brought from sea by tide or both.

Study of sedimentation process and sediment origin is not only "pure science"; it will help us understand the nature of ongoing changes concerning fresh water upstream flow effects inside the S.R.F..

Choices concerning the future of management of top dying or unproductive (from the forester's angle) areas of the forest will depend on these data: it is useless to recommend costly plantation of alternative indigenous mangrove species (Passur or others) to replace Sundri if:

a. Upstream fresh water diversion is increasing with resulting drought episodes in the dry season.

b. Increased siltation of the Sundarbans rivers due to upstream embankments or due to Ganges sediments brought from the sea by the tide result in an intolerable rise in soil level for these species.

2.3 Micro-topography and soil water-holding capacity

Stereoscopic examination of aerial photography of the Sundarbans shows that there is a raised area (white or narrow) along each bank of large and small rivers; this is a general feature of estuarine mangroves with high level of silt / sand sediments. Curtis, Forestal and O.D.A. maps show zonation of vegetation along these levels.

All these raised areas are covered with a specific type of forest depending on:

South North increasing drought gradient.
North South increasing salt gradient

3. ECOLOGICAL ZONES:

3.1 O.D.A. zonation

We are very cautionus concerning the boundaries of the so-called fresh water, moderate salt-water and salt water zones described in O.D.A. and other reports. This O.D.A. zonation was defined using the Curtis definition and distribution of Sundri, Gewa and Goran. In the Curtis definition we find a North-East fresh water zone and a South-West moderately salt water zone; the salt water zone was west of Raimangal river.

The O.D.A. report added a salt water zone arguing a change in species composition. Such change occurring in less than sixty years do not seem obvious when Curtis map is carefully studied. Presence of Golpatta, which is precisely recorded on the Curtis map gives a good indication of low, frequently flushed areas: Golpatta are recorded on 1926-28 reconnaissance down to Tiger Point; these Golpatta stands are still there (compartment n° 6); this point needs to be confirmed. Study of the distribution of indicator species (***Sonneratia spp and Bruguiera spp***) with well known salinity tolerance threshold preferences will be helpful to our understanding proper cause and effects for the S.R.F.'s plant ecology.

The O.D.A. zonation reflects not only the salt gradient but the combination of salt and "drought" gradient.

3.2 Drought gradient and rainfall

Observation of Mean Annual Rainfall map (Haroun Er Rashid: Geography of Bangladesh. 1991, University Press) shows that the upper catchment of S.R.F. receives between 150 and 175 centimetres of rain; on the other hand western coastal area of the forest receive more than 275 cm of rain (100 cm difference) per annum.

Rain variation from West to East at 22° North is less than 225 cm; near Raimangal river, to more than 275 cm near Baleswar river. It means than the North part of the forest is drier than the coastal area, it means also that this drought is more intense on the North West of the forest and that fresh water in flow from the upper catchment is low in the North west area.

In contrast with the Eastern area, the Western area is characterized by less fresh water in flow from up stream, less rain and a strong marine influence through large tidal river mouths.

3.3 Vegetation zones

The distribution of vegetation inside the S.R.F. is not only dependent on the salinity zones. The saline gradient is compensated near the coast by prolonged and intense rainfall explaining the presence of short but healthy Sundri trees. Golpatta and eventually beautiful Rain tree and Borassus palm trees can be seen at KOTKA (probably using a thin fresh water table in sandy sediments).

The slight but gradual drought from East to West, reduced rainfall on the upper catchment of this area and strong marine influence due to large estuaries explains the changes in vegetation, accentuated probably by the presence of sand.

3.4 Need for metreological data

These assertions are based on extrapolated rain curves as they are no meteorological records inside the Forest, hence the necessity to assess rainfall inside the Forest and to record at least rainfall along the coast and in the middle of the Forest. Proposed rain recording stations are: Mandarbaria, Gewakhali, Dangmari, Katka or Kochikhali. This an urgent activity for the Project.

4. BOTANY:

Good indication of mangrove species distribution are given by A. Karim (1988 Thesis). Distribution of trees species along transects in relation to edaphic factors and tidal occurrence is studied in this work.

Percentage of distribution of mangrove species including non tree species and definition of different phyto-association and phyto-succession along transects will be a good tool to assess future ecological changes.

Algae distribution: Algae distribution on tree trunks, roots (and soils) can be studied and used to quickly assess tidal influence. This fieldwork should commence immediately and be carried on throughout next dry season.

5. ZOOLOGY:

5.1 Larval stages in shallow waters

During early trips in June numerous larval forms of insects, fish, crustacea and mollusks were noticed in shallow clear water on the forest floor in North East and Central parts of the forest.

5.2 Insects larvae as bio indicator of salinity

Larval stages of *Culex spp, Anopheles ssp* and other unidentified Diptera were recorded in shallow (2-5 cm) clear water on forest floor. A careful study of the salt tolerance of the larval stages of these species and period of occurrence can be used as bioindicator of low salinity areas.

Collection of these species with fine mosquito net, preservation in alcohol 60° spirit and collection of adults stages is necessary; identification would need to be carried out by Diptera specialists.

5.3 Crustacea specie

Numerous larvae of crustacea were seen in muddy, tidal, shallow waters on the Forest floor. Decapods, unidentified shrimp species, ispods and amphipods were recorded. Identification of the differents stages of these species can only be made by specialists; hence the necessity to carefully sample, collect and preserve the specimens in each field trip.

5.1 Larval collection and preservation

- Tools needed:

Plankton nets, fine mesh scoop, mosquito net scoop, different size of nets (2 m up to 6 m) made of fine mosquito net.

- Containers:

White plactic or metal basin and bowls small plastic bags; label and waterproof pen, big plastic bags, big plastic pots large opening small plastic tubes with watertlight screw caps (2-4 cubic centimetre "NUNC" tube).

- Low magnification stereoscopic microscope:

With low voltage light and pocket microscope, cupels, microscopes slides, small forceps / syringes / fine paintbrush

- Preservation:

Small aquatic larvae of insects and arthropods up to 5 mm are preserved in small plastic tubes using 60° C spirit; to avoid destruction of thin fragile structures air bubbles must be removed and a cotton tip plunged in the spirit to immobilize the specimens.

Fish larvae, small immature fish up to 20 millimetres can be preserved in 4-6 % formalin neutral solution in plastic bags.

Bigger specimens must be opened with scissors and preserved in 8 - 10 % formalin solution in small water-light, plastic bottles. Label on paper with graphite pencil must indicate hour/day/G.P.S. location/biotope code.

- Training:

Each field team must be trained to collect specimens for other specialists particularly with regard to larval species; a collecting and preserving set with basic information must be included as standard on each speed-boat. This is a most important aspect of training in ecological techniques for Forest Department staff as an input of the Project.

5.1 Soil sampling

Due to imprecise location and site descriptions many of the soils data available are of little use for precise ecological studies; future soil sampling must record the followings:

a. Site description:

- Location: precise G.P.S. location must be completed on a site description card including distance from the river, position on the transect, estimated height, bearing of the transect line, surrounding vegetation, proximity to big trees.

b. Soil description:

Surface, status, dry, flushed, hard, soft, top-soil biological activity, litter, algae, macro structure, colour; must be noted on a card with a code system.

c. Soil profile

Indicating micro structure, colour, horizons, particularly black thin horizons, cracks, humidity, animal activity at different heights, plant roots at different heights and status of roots (dead/alive/coated with colored deposits)

d. Tools:

A special shovel with narrow long strong sharp blade is needed to perform this work. Flat slices of soil are collected from top to bottom in plastic bags labeled with a waterproof marker.

e. Fast assessment of soil profile:

A light small size auger made of a narrow steel tube opened along one side can be used to rapidly check a soil profile.

6. PHOTOGRAPHY "SAMPLING":

It is recommended to provide field teams with a good 24 x 36 small camera with data back to record on negative 200 iso films all site descriptions and include enlargements in the field log book; year/month/day will be recorded on pictures using the camera data back.

Stereophotographic pairs of forest structure can be done by hand using if possible a scale and G.P.S. location.

Linear photographic records of bank vegetation between two G.P.S. fixes can be done to assess future changes of bank vegetation, etc.

Example:
on a 36 exposure film record first the G.P.S. screen giving fix/hour/date. Set your camera data back on year/month/day and record 16 contiguous, adjacent picture (or stereo-pairs) then record the last G.P.S. fix (picture 17) and turn back: do the same on the others side of the river.

The result is a linear "panorama" of the river bank precisely located. The boat must maintain a constant distance form the bank if possible. Comparison between panoramas taken at different dates can show floristic changes etc. on a long period of time and will be a useful tool for future research studies.

FIELD TRIP N° 2 - 22.06.94

Note 1:

Use of G.P.S. in narrow Khal. Surrounded by high dense forest: start the G.P.S. before entering the forest and do not stop it until you are back as it is difficult to get a first fix inside the forest

Note 2:

Temperature data germination and growing data were not recorded correctly. A training workshop is necessary in order to explain the importance of correct data recording

Note 3:

Wildlife: presence of annelids and fish larvae in nursery plots; green filamentons algae, brahaminy kite, large woodpecker, little pond heron *Ardeola Grayii*.

Note 4:

Necessity for a detachable canvas canopy on the speed boats and anchors.

FIELD TRIP N° 3 - 11-12-13 July 1994

1. SEDIMENTATION:

Observations and discussions with Surface Water Modeling Center (S.W.M.C.) people confirm the great value of these hydrological studies both to the Project and the Forest Department.

Evaluation of freshwater inflow from upper catchment inside the Sundarbans system will enable us to understand and estimate the effect of embankments on the rivers and the forest.

It seems that part of East-West rivers along the boundaries of the forest are silted or heavily silting up (Churkumi Khal, Khadamtali Khal, Khasma Khal); in many places we observed the presence of heavy "clouds" of sediment in the water.

It is possible that fresh water in flow from upstream is reduced to a short period of time in the monsoon season, flushing sediments inside the S.R.F. system and silting border rivers; sediments rich in organic matter, bacteria and protein mixed with silty clay are ionised and highly cohesive. These ionised sticky sediments deposit in thin layers and are not easily washed out by tide and rain.

Heavy sedimentation occurs when salt water and fresh water mix (sediment flocculation).

Part of the deposited sediments are probably brought into the S.R.F. from the Bay of Bengal by tide currents (Anders Malmgree Hansen personal communication).

2. FRY COLLECTION

The destructive effect of fry collection practices on juvenile stages of shrimps and fishes is confirmed. Thousand of people are involved; many are not fishermen but farm workers encouraged by the possibility to earn 100 takas day or more at peak of fry production. They are collecting with hand nets along the river banks; other collectors are using big conical reversible nets in the river current.

Many young and children are working the whole day from 5 a.m. to 7 p.m. to collect sometimes less than 100 fry larvae of ***Penaeus monodon***. The fry are manipulated with a shell, in white basins, stored in clay pots in shade and collected in aluminium pots; fry mortality is high.

3. FISHING:

Use of fishing nets up to 200 metres length with 10 millimetre mesh tied along the mangrove banks on wooden poles is a common practice. The result of a morning catch for a dinghy was very poor: many small immature fishes of different species, some big blue legged shrimps and smaller white shrimps; the total amount was probably less than 4 kg of mainly immature fishes. 2 other observations in the previous field trip showed the same result; it means that overfishing is probably occurring in these areas. This is a matter of great concern and must be throughly researched.

4. SUNDRI SEEDLINGS:

Sundri seeds collected in the river and on the river banks near Maragang Patrol camp were put in a net jute bag for germination assay. 80 % germination was ultimately obtained on these seeds.

FIELD TRIP N° 4 - 25 July 1994

1. NYPA PALM:

Nypa palm are rare in this area and they are overcut with only one leaf or half a leaf in some places. This practice is contrary to Forest Department rules and should be investigated.

2. PASHUR AND BAEN:

Many old Baen exist, sometime hollow; old Pashur are quite common near Kalagashi and rare near Kholpetua, it is necessary to check the seedling of Pashur in this area and if necessary to make some plantations.

ITINERARY OF FIELD TRIPS TO SUNDARBANS

FIELD TRIP N° 1 12.06.94 TO 17.06.94

Boat 110 feet the Forest Department launch: *Bonokanna*

Members:

1) Dr. G. GREPIN, Mangrove Ecologist BGD/84/056
2) Dr. A. KARIM, Mangrove Sylviculturist BGD/84/056
3) Mr. SHIDULLAH, , COUNTERPART, Mangrove Ecologist, B.F.R.I.
4) Dr. M.R. BHUIYAN, Soil Scientist, BGD/84/056

Itinerary:

12 June 1994: Leave Khulna for the Sundarbans
12-14 June 1994: Sylviculture studies at compartments 27, 28, 1, 10
15-16 June 1994: Sylviculture studies at compartments 32, 33, 35,
17 June 1994: Back to Khulna

Objective:

This trip was initially scheduled for sylviculture purposes; as only one speed boat was available, it was decided to work together on sylviculture field studies areas. Examination of top dying areas was one of the main objectives.

Observation:

Departure from Khulna, going down KAJIBACHA River to PASSUR River

G.P.S. FIX 1 22° 48' 57 N / 89° 34' 25 E
Khulna: start 10h55 Rain/Ganges dolphin breathing in 3 different places, average diving time 120'. Rain 11h20.

G.P.S. FIX 2 22° 42' 31 N / 89° 31' 51 E
Small Hindu temple, numerous people fishing prawn fry, "tchingri", all along the banks.

G.P.S. FIX 3 22° 3' 36 N / 89° 31' 23 E
PANKALI River / Dry collectors

G.P.S. FIX 4 22° 31' 01 N / 89° 35' 08 E
Abeam Mongla Cement Factory

G.P.S. FIX 5 22° 29' 25 N / 89° 35' 27 E
Abeam Mongla Harbour first shed control on S.P.O.T. Imagery

G.P.S. FIX 6 22° 28' 18 N / 89° 35' 34 E
Abeam Katakali channel hilsha nets and dinghy: 30 -40 boats fry fishing all along the banks.

G.P.S. FIX 7 22° 21' 04 N / 89° 38' 32 E
CHECHANG

G.P.S. FIX 8 22° 21' 08 N / 89° 38' 29 E
Sundarbans "border": the old "Khorma" river, now silted up and partly reclaimed by farmers.

G.P.S. FIX 9 22° 21' 05 N / 89° 38' 59 E
200 m after branching KHORMA River

G.P.S. FIX 10 22° 22' 00 N / 89° 39' 32 E
MIRGAMARI River, fishermen with other. Suave smell of Avicenia flowers

G.P.S. FIX 11 22° 21' 53 N / 89° 40' 09 E
Mirgamari coup Forest Office / wooden wharf.

G.P.S. FIX 12 22° 18' 30 N / 89° 42' 19 E
Confluence with SELA GANG

G.P.S. FIX 13 22° 16' 52 N / 89° 43' 53 E
Entering ARWABAR KHAL. Rain; all along this transect between G.P.S. Fix 11 and 13: 40 dinghy with crew of 2 to 4 young fry collectors; turbid water; banks lined by Nypa palms, numerous seeds of Sundri floating; no water birds, no shorebirds. Rain.

G.P.S. FIX 14 22° 12' ?? N / 89° 48' 48 E
SARANKHOLA Range / Headquarters 8h15 / 13.06.94. Many bee-eaters *Merops philipinus* (?) along the banks / Brahminy kite / one fishing eagle. Along the main river on 5 km we have seen 20 dinghy fishing hilsha, 65 fry catchers dinghy, 20-25 big wood carrying launches empty, lay up.

DHANSAGAR FOREST STATION: Visit of plantation of Sundri trees on newly accreted land. Clear fresh water shallow pools on the soil, numerous larvae of ulicoides, culex, ostracodes crustacean, other unidentified crustacean larvae, shrimp larvae, gastropods on trees.
Along the banks typical riverine fresh water succession. Monitor lizard young seedlings are browsed by spotted deers and bark is removed in some places; (seen: tracks, droppings, antler marks on trees); monkey tracks.

G.P.S. FIX 15 22° 12' 57 N / 89° 50' 35 E
Plantation of exotic species

G.P.S. FIX 16 22° 12' 58 N / 89° 50' 37 E
BOGI FOREST CAMP / Forestry station Office. Numerous fishing boats (hilsha nets) on the opposite side. Nypa and Phoenix palm ; freshwater riverine plants
- Soil sampling
- Morning visit of plantation area. Afternoon: visit to exotic species plantation.

14.06.94
Speed boat visit to Tambulbunia office / examine logging maps.
Note: all this area is highly used by fishermen and harvested for Nypa palm; Brugeria have been harvested for poles near Bogi. Wildlife: spotted deer tracks / 2 long tailed green parrots / duck water fowl quacking / numerous gastropods ("shanouk") on trees / fish larvae wandering on top layer of the water in small Khal. No fixes due to G.P.S battery problems.

15.06.94
Morning: leaving SARANKHOLA Range down stream. BHOLA River / numerous fixes on small rivers on each side / description of riverine vegetation.

G.P.S. FIX 17 22° 09' 52" N / 89° 50' 03" E
Abeam small river, left (downstream)

G.P.S. FIX 18 22° 09' 33" N / 89° 50' 03" E
Abeam small river, right (downstream)

G.P.S. FIX 19 22° 09' 14" N / 89° 49' 45" E
Abeam very narrow Khal, right

G.P.S. FIX 20 **22° 09' 04" N / 89° 49' 30" E**
Abeam very narrow Khal, left
Going down to SUPOTI RANGE OFFICE

G.P.S. FIX 21 **22° 08' 33" N / 89° 48' 58" E**
Confluence / Nypa palms / low grasses

G.P.S. FIX 22 **22° 07' 50" N / 89° 49' 35" E**
Abeam small river right side. Heterogeneous forest background, some big trees.

G.P.S. FIX 23 **22° 07' 34" N / 89° 50' 06" E**
On left bank dense background heterogeneous high trees, Sundri in bad shape

G.P.S. FIX 24 **22° 04' 30" N / 89° 48' 31" E**
Going right on a river confluence. Going inside DUDHMUKHI GANG (Paturia River ?). All this forest along the bank looks like a complex "patchwork" of at least 5 species of trees ; water hyacinth between Bhola and Dudhmukhi Gang ; Numerous Nypa on accreted soft sides. Gangetic dolphins at Fix 24.
SUPOTI RANGE

G.P.S. FIX 25 **22° 03' 01" N / 89° 49' 40" E**
Abeam office middle of the rivers crossing 31 hilsha fishing dinghy in BALESWAR River confluence / size of 8 hilsha 40-45 cm / top dying of Sundri trees: in this area top dying of Sundri started in 1978 and the maximum of top dying problem was in 1989/90. A the present all this area contains a mixture of top dying and non top dying zones.

3 h P.M. starting

G.P.S. FIX 26 **22° 03' 02" N / 89° 48' 22" E**
Abeam a river on left side

G.P.S. FIX 27 **22° 04' 10" N / 89° 48' 11" E**
Abeam a river on left side, we enter this river; all the left forest lined with Nypa; right bank is also lined with Nypa. Beautiful stands of Keora an accreted side. Many Gewa trees with mixed new light green leaves and old dying red leaves: Gewa with red leaves are found in patches, those with no leaves or new leaves are also in patches.
Mixed with Gewa near the river and growing more densely behind the Gewa line we found Sundri trees in bad shape; gray green foliage mixed with healthy, thick dark green Passur trees; Nypa all along the banks with harvested leaves. Green / orange bee-eater birds.

G.P.S. FIX 28 **22° 04' 54" N / 89° 47' 30" E / 3h19 p.m.**
Abeam a river right side, we enter this river low grass on each side; no Nypa

G.P.S. FIX 29 **22° 05' 21" N / 89° 46' 42" E**
Confluence with BETMAR River

G.P.S. FIX 30 **22° 06' 01" N / 89° 46' 15" E**
DUTMUKI COUPE OFFICE
Presence of a Gangetic dolphin; and a group of others ("Dharial").
The man in charge showed us a big crocodile ("oumir") 3 - 3,5 metres in length

G.P.S. FIX 31 **22° 03' 01" N / 89° 49' 40" E**
2 tributary right

G.P.S. FIX 32 **22° 07' 12" N / 89° 45' 55" E**
Abeam left, 30 metres wide river. Low forest (6 - 8 metres), highly turbid water; one white breasted eagle, one swallow; numerous epiphytes and climbing ferns, singing cicadas

G.P.S. FIX 33 **22° 07' 58" N / 89° 44' 35" E**
1 Tributary left side, 20 metres wide

G.P.S. FIX 34 **22° 08' 02" N / 89° 44' 40" E**
Taking left branch of confluent rivers, middle of the embankment; beautiful stand of Keora trees

G.P.S. FIX 35 **22° 07' 57" N / 89° 43' 49" E**
small tributary left side

Note: from Supoti to Dutmuki and to fix n°35 no visible logging or fishing activities. The Gewa - Sundri forest gets shorter with a slight decrease in incidence of top dying areas.

G.P.S. FIX 36 **22° 07' 56" N / 89° 43' 45" E**
Tributary right side narrow tributary less than 7 metres are closed by the forest canopy and probably not visible on S.P.O.T. Imagery

G.P.S. FIX 37 **22° 07' 45" N / 89° 42' 56" E**
Abeam land point, river on right side

G.P.S. FIX 38 **22° 07' 16" N / 89° 42' 48" E**
Tributary right

G.P.S. FIX 39 22° 06' 33" N / 89° 42' 51" E
Branch river

All along this transect from Fix 36 to fix 39 the forest is lower, we cannot see top dying sundry in this area; Sundry stand is low (6-7 metres) with groups of healthy tall Sundri (9-10 metres). After fix 39 from roof of the launch we can see over the first line of trees 95-6 metres).

Many Gewa trees without leaves or with red and yellow leaves, scattered along the banks (20-50 metres), on the eroded side of the river: a closed line of Keora trees and Gewa trees without red leaves.

Note: The difference in the phenological stages of Gewa trees closely linked with the nature of soil and elevation of the bank: Gewa on eroded side are losing leaves. Their leaves are red in colour; in many places erosion of the banks has eroded and killed Gewa and sometimes Sundri trees.

15.06.1994 to 16.06.1994
Waiting for tide; we cross at night PASSAR River. Going from PASSAR to SIPSAH. "Bonnokanna" launch give her full speed on a rough river and front wind in a dark night.

G.P.S. FIX 40 22° 08' 46" N / 89° 28' 58" E
SUNAKHAL River fix entering the river; river water salinity, refractometer reading: 23 o/oo. Top dying area

G.P.S. FIX 41 22° 15' 32" N / 89° 30' 35" E
Mixed forest Gewa trees near the bank and Gewa Sundri inside. Some Sundri are top dying, others are in bad shape. 1st soil sampling on fix 41

1st soil sampling: near the bank (20 metres inside), we dig a hole 100 cm depth: no visible horizon; gray sticky clay; crab holes; Gewa (?) rotted roots, showed brown red colour at 60-80 cm depth, roots alive down to 100 cm, going deeper.

G.P.S. FIX 42 22° 15' 34" N / 89° 30' 33" E
2d Soil sampling: Near a freshly cut "Top dying" Sundri (?) the trunk is cut at 1 metre height; diametre at cut height 24 cm; all pneumatophores are alive, not rotted, full of sap non silted and well above ground level all around many others Sundri top dying or cut; in this area Gewa have no leaves on top or yellow red leaves and some new small leaves.

G.P.S. FIX 43 22° 09' 24" N / 89° 27' 01" E
Took stereo pair photographes of left and right banks: on our right, mixed Gewa Sundri top dying forest: on our left Keora, Gewa, Sundri non top dying.

G.P.S. FIX 44 22° 09' 36" N / 89° 26' 49" E
Big Baen, small Goran all around and in background top dying Sundri

G.P.S. FIX 45 22° 09' 36" N / 89° 25' 39" E

Note: in all these areas top dying is linked with eroded sides near the river and associated with Gewa losing their leaves

G.P.S. FIX 46 22° 09' 23" N / 89° 25' 01" E
GEWAKALI CAMP Refractometer / water salinity: 25 o/oo. A big area of dead and cut Sundri all around the camp; Poshur mixed with Sundri 2 wood launches / 35 fishermen (fry collectors dinghy)

G.P.S. FIX 47 22° 15' 29" N / 89° 24' 54" E
On BOSBOLA River, just before confluence with SHIPSHA RIVER / ARVASHIPSHA in front of BOSBOLA River: long line of red Gewa and top dying Sundri. Due to scarcity of branches and leaves epiphytes seems more abundant (clearly visible) on T.D. Sundri.
Drawing made of vegetation pattern on river. Banks with G.P.S. localization is done in log-book, all along this trip.

G.P.S. FIX 48 22° 20' 45" N / 89° 25' 31" E
Abeam steamer signal near confluence

G.P.S. FIX 49 22° 21' 25" N / 89° 26' 07" E
Steamer signal on a point, all this area is top dying

Note:

It will be interesting to check the intensity of tidal flooding and soil drought during December to February: it is possible that the raised areas or more sandy areas near the bank are submitted to a prolonged drought. The most sensitive species to drought in salty conditions is Sundri; Keora and Baen can excrete salt and extract soil water more easily (check with plant physiologist the root system and water requirement of these species).

Gewa, Kakra are found in "Moderately saline" areas.

Goran, Pashur, Gargan are associated with small Gewa and small Sundri in saline areas if there is regular tidal flushing. ***Rhyzophora mucronata*** and ***R. epiculata*** are found in strongly saline areas.

Presence of Sundri trees in saline areas, shows that this species, if regularly flushed by the tide, can survive without top dying and may not be affected by dry season stress.

A careful comparative study of tidal flushing during dry season inside top dying areas and adjacent non top dying areas is necessary. Measurement of soil drought down to the wet area must be done.

<u>17.06.1994</u>

G.P.S. FIX 50 22° 24' 10" N / 89° 28' 11" E

KALABOGI Forest office: many Gangetic dolphin are living there; the guard tells us that sometime they are ten; we have seen one.

Sediments: Heavy "clouds" of silt in the tide stream (6h45 am). 7h45: tide going down, no more "clouds".

Note: This observation concerning "clouds" of sediments at high tide seems correlated with a heavy load of clay and silt deposited and flushed alternatively in fresh and salt water mixing areas.

River salinity 0,5 o/oo (refractometer), the mangrove is completely covered by water at high tide.

Note Top Dying: Visit to a plantation: dead or dying Sundri are surrounded by new Sundri seedlings, some Sundri are top dying; top dead with few branches, growing poor foliage and numerous epiphytes; others are top dead but the lower branches are healthy with green dark dense foliage; all around 2 and 4 years (± 2 metres) Sundri, some already with seeds. Mixed with these Sundri: big old Keora, young Gewa with flowers, fruits, new leaves, and red leaves (strange phenology !); old Pashur, beautiful with fruits. **It seems that in this area we are in presence of a special phenomenon: some Sundri seems to have recovered from a top dying episode few years ago.**

Back to Khulna 11h05
Rain / turbid area 10 metres wide along the bank right side, many muddy rivulets, heavy erosion and eroded trees.

Nolian Station 13 h **Khulna end of afternoon.**

FIELD TRIP N° 2 22.06.1994

Boats: Speed boat 16 feet / 55 hp

Members:

1) Dr. G. GREPIN, Mangrove Ecologist BGD/84/056
2) Dr. A. KARIM, Mangrove Sylviculturist BGD/84/056

Itinerary:

22 June 1994: Khulna - Dangmari - Khulna

Object:

Sylviculture purpose, survey of tree nursery in Dangmari / observation of top dying areas upstream Dangmari / Sundri germination assay.

Observation:

Numerous boats carrying different kinds of wood from S.R.F. and one carrying Nypa palm leaves; very few birds. White breasted eagle. Rain. Sudden storms. Numerous fry collectors on river banks.

G.P.S. FIX 51 22° 26' 18" N / 89° 35' 21" E
GG9 DANGMARI Office
Observation of mangrove nursery of different species.

Control of Sundri seeds germination inside Jute bags (seeds were collected on a previous trip)

Visit of top dying mangrove area upstream.

G.P.S. FIX 52 22° 26' 23" N / 89° 33' 09" E
CAGRAMARI Office (abeam)

G.P.S. FIX 53 22° 26' 18" N / 89° 35' 55" E
CAGRAMARI Confluent

G.P.S. FIX 54 22° 25' 43" N / 89° 32' 49" E
Top dying area

FIELD TRIP N° 3 11 - 12 13 July 1994

Boats: BANOKANYA

Members:

1)	Anders MALMGREN HANSEN	Surface Water Modeling Center (SWMC)
2)	Terry VAN KALKEN	SWMC
3)	Dr. MANOUAR HUSSEIN	Socio Economist
4)	Peter de V. MOSS	Officer-in-Charge F.A.O. B.G.D./84/056
5	Dr. G. GREPIN	Mangrove Ecologist F.A.O. BGD/84/056

Itinerary:

Khulna / Passur river / Dacope / Badra river
Sutherkali / Kalabogui / Noliana
Baniakhali / Kasiabad / Kobadak
Burigoalini / Muntchigang / Kadamtala / Koykhali / India border

Object:

Surface Water Modeling Center first
Survey tour / Ecological studies

KHULNA - KALABOGUI 11.07.1994 - evening night
Fry collection along the banks and dinghy with Hilsha nets.

KALABOGUI 12.07.1994 - 5h15 a.m.

SIBSA CAMP TAHOLPARI 5h40 a.m.
Crossing SIBSA River, numerous seedlings of Sundri.
Clouds of sediments
Entering Aura SIBSA 6 h a.m.

G.P.S. FIX 55 22° 19' 21" N / 89° 25' 21" E
6 h 20 abeam KOYRA River - white buoy (bad fix)

G.P.S. FIX 56 **22° 16' 19" N / 89° 24' 44" E**
Bare ground raised area near TCHALKI Khal

We visit a bare ground area, located on O.D.A. Map using G.P.S. positioning: all the area is slightly raised and covered with "Hoda" fern *Acrostichum aureum*. Some short "Amur" *Amoora Cucullata*, and young "Passur" *Xylocarpus mekongensis* are growing at the periphery; inside the fern area some small "Khalshi" *Hibiscus tiliaceus* seedlings and young shrubs and "Bhaela" *Intsia bijuga* 5 - 8 years old small tree are growing muddy soil inundated at high tide. Many climbers covering 5 -6 years Pussur are seen.

All around old beautiful Sundri 30 -40 years old, and big " Baen" and some Keora. Between the fern area and the river many cut Sundri with dead pneumatophores easily broken (these trees were cut probably 2 years ago). Fresh sticky mud with vermicular excretats. Spotted deer tracks; no seedlings of Sundri; near the river the Sundri are small (± 20 years old) and unhealthy, mixed with young Sundri (± 5 years old) unhealthy with dying branches, without seeds. Near the bank dying Sundri (15 - 20 years old) with many seeds and seedlings of Gewa. Mudflats covered with Sundri seeds.

G.P.S. FIX 57 **22° 15' 45" N / 89° 21' 14" E**
Confluent SAKBARIA River; BOZBOZA Camp (meaning: always net place)

G.P.S. FIX 58 **22° 13' 15" N / 89° 20' 45" E**
KACHITANA Patrol Camp

G.P.S. FIX 59 **22° 13' 00" N / 89° 20' 42" E**
HANGTI HARA (meaning: lost ring) Tide Gauge

G.P.S. FIX 60 **22° 10' 52" N / 89° 19' 26" E**
More than 320 dingly (hilsha) fishing between HANGTI HARA and this fix.
Down ARPANGASIA River to MALANCHA River going to JAMUNA River.
Through KUBLAKALI (?).

G.P.S. FIX 61 **22° 04' 48" N / 89° 12' 47" E**
Very low mangrove (5 - 6 m) Gewa / *Phoenix sp* / some beautiful Passur

G.P.S. FIX 62 **22° 04' 18" N / 89° 10' 35" E**
JAMUNA River confluence 35 fishing dinghy (Hilsha)

G.P.S. FIX 63 **22° 04' 29" N / 89° 08' 56" E - 2h59 p.m.**
K.N.M. extraction camp: Gewa rafts

G.P.S. FIX 64 **22° 03' 58" N / 89° 08' 30" E**
Confluence KACHI KATTAKHAL - 5 fishing dinghies (hilsha)

G.P.S. FIX 65 **22° 04' 17" N / 89° 07' 33" E**
Gewa felling

G.P.S. FIX 66 **22° 04' 04" N / 89° 07' 17" E**
Gewa felling. Numerous ***Phoenix paludosa*** mixed with few patches of ***Nypa fruticans***

G.P.S. FIX 67 **22° 03' 31" N / 89° 06' 58" E**
K.N.M. logging camp; 15 people, one tiger and a big crocodile are seen in this area.

Entry on RAIMANGAL River going downstream observation of an eroded Passur with two successive root layers on the bank.

All around very low mangrove Gewa, Goran and one big Keora.

A fishing camp on the bank with about 60 fishermen, dinghies; in this place many trees had been cut by K.N.M. in 1993.

Some of these cut stems have new small branches with leaves.

This camp has been held up and robbed by 6 armed dacoïts, a day ago. The dacoïts robbed more than 3 000 takas (name of the place "KATCHIKATA" cut rope). An other fishing camp with numerous dinghies; one old fishermen brought meaning all the "passes" to the Forest Department launch. Traveling with the speed boat along the eroded banks, failure of the two outboard engines. Recovered by Banokanya Launch.

7h p.m. Ship aground on a sand flat. Journey up RAIMANGAL terminated

7h40 p.m. Going upstream RAIMANGAL River and KALINDI River. Anchor at KOIKHALI River.

13 July 1994

Socio-economist and Ecologist are collecting information near young fishermen: Young boys / young girls / women / young men: 4 of them are interviewed; they are all new to this job and usually work as farm workers.
Catch content: the first one had caught less than 20 fry larva in about 3 hours and 250 -300 grams of others juveniles shrimps, white small shrimps and juvenile fishes less than 3 cm length: all these fish and shrimps were being carefully colleeted for food.

10h a.m.: going upstream CHURKUMI Khal and KADAMTALI Khal; a lot of accretion on each side of this Khal which seems silted up along the forest side; mainly Colchi / Baen / Goran and Keora on accreted land. A huge quantity of Sundri seeds in the river and on river banks; all along the banks plenty of Gewa seedlings; in some places pure stands of big or young Keora and under Colchi and Goran seedlings in lines, but no Sundri seedlings.

Many small shrimp farms along the bank with Gewa on the embankments; clouds of sediments in the river; rain.

G.P.S. FIX 68 22° 11' 55" N / 89° 08' 37" E
MOURGANG (MARANGANG ?) Forest Patrol Camp 600 metres down stream location of this fix.
Gangetic dolphin; Dalbergia plantation; plenty of Sundri seeds but no germination or seedlings; low forest. Sediments are washed out of the mangrove by small outlet rivulets.

G.P.S. FIX 69 22° 12' 18" N / 89° 09' 37" E
Confluence (abeam) all banks covered with Sundri seeds; surface water looked oily, a thin layer of organic matter covering the surface, in some place pink colour foam out of forest outlets in this place we collect 4 kg of Sundri seeds in the water and on the bank for germination assays.

G.P.S. FIX 70 22° 12' 55" N / 89° 10' 00" E
100 metres upstream CHUNKURI Patrol Camp and confluence point.
All around about 2 hectares cleared for "safety". It would be interesting to know the rules which cover, these random clearances and how vulnerable fragile buildings become to effects of resulting open exposure to wind and rain.

The forest consists of small trees (5 - 6 metres) mainly Gewa and Goran with some scattered high Baen and patches of Hantal *Phoenix paludosa* along the banks; rare dark green Kakra were also observed. Rare Sundri, small. thin, few branches and grey-green colour of the foliage. Many Gewa are parasitised by mistletoe, Viscum sp. *lorantacee*. Rare Pashur with dense dark green foliage.

G.P.S. FIX 71 22° 13' 37" N / 89° 11' 01" E
Abeam KADAMTALI or KODUMTALA Forest Station middle of confluence. Going to MUNSHIGANJ.

All along Churkumi and Kadamtali Khal, many fuelwood big boats are aground.

G.P.S. FIX 72 22° 16' 07" N / 89° 12' 03" E
MUNTCHIGANJ or MUNSHIGANJ

Near MUNSHIGANJ a bird sanctuary (Kurigali ?) with 3 species of egrets: Large Egret ***Ardea alba***, little Egret ***Egretta garzetta)*** Cattle Egret ***Bubulcus ibis***.

Note:

CHURKUMI Khal and KADAMTALI Khal are lined with embankments and shrimp farms; the river is heavily silted up; all along the banks seedlings are browsed by goats. In the river fishermen catch blue legged "Bagda" shrimps (1 kg = 4 big Badga !), "Golda" shrimps are raised in sweet / brackish water; other small species of salt water shrimps are fished in this area (Tchaka / Goura / Tchingri). Before reaching Burigoalini we passed adjacent to a big shrimp farm.

G.P.S. FIX 73 22° 15' 02" N / 89° 14' 00" E
BURIGOALINI Forest Station and Range Office (Burigoalini: meaning the old Daisy women) SATKIRA Range.

Big boats loaded with dark Goran wood and with high orange Antal wood. (KHOLPETUA River means: "play the drum river") ; (BONOBIARINI, launch means: the girl wandering in the forest).

This forest station is issuing fishing passes (10 000 passes per month: average !) for 3 000 / 4 000 Tchingri fry fishermen for 1993 it means 800 000 takas for a total of 12 comparunents. The second income is Goran wood; until 1984 income are increasing (x 3,5) and expenditures have doubled. In this post, we give a wildlife notebook for fauna inventory experiment.

Gewa and Goran felling: an harvesting map, (3 years operation map), exists for Goran but not for Gewa; the other maps are in Khulna; Gewa is harvested in compartment 48 and last year in compartment 49; a proposal for a Goran working plan was discussed. A five year working plan exists for Gewa (K.N.M.).

Note:

All the information concerning Gewa, Goran, Kolchi, Antal and other wood harvests are very difficult to understand without working maps. These data should be acquired by the wood harvesting and forest management specialists.

Radio equipment:
Frequence 1: 6.985.0 H.F.
Frequence 2: 8.030.0 H.F.
Frequence 3: 7.325.0 H.F.
Best link with Khulna on Frequence 3
Battery charger ICOM PS 60.

The complete list and location of the Forest Department buildings inside the S.R.F. is available at Khulna.

Setting sail to KATERSHWAR (KATESHOR) Camp (the God of timber)

G.P.S. FIX 74 22° 12' 52" N / 89° 16' 29" E
KATESHWAR
Sailing SAKBARIA River (meaning: the river full of leafy vegetables (?), aquatic plants (?). The water is less turbid on this river; 12 dinghies with big conical fishing nets. Patches of organic matter and seeds on water.

KHASHITANA Patrol Post (meaning: pull the goat !) no top dying in this area.

G.P.S. FIX 75 22° 16' 02" N / 89° 22' 05" E
Top dying area; these mangrove forests are growing taller and the first symptoms of top dying appears on tall Sundri; near this place a big patch (± 6 ha) of Gewa without leaves just before a branching of rivers. Intense top dying near the branching, muddy water with clouds of sediments; numerous birds for the first time.

G.P.S. FIX 76 22° 16' 02" N / 89° 23' 18" E
On accreted side of this loop, all along, *Acanthus ilicifolius* with blue flowers and tall healthy trees.

G.P.S. FIX 77 22° 16' 01" N / 89° 23' 19" E
Collection of Keora leaves for spotted deers; tall, healthy, Sundri mixed with some top dying in patches; in many cases small branches at the top are bearing new yellow green leaves; branches are covered with hairy lichen (*usnea sp* ?) in spite of some top dying in the area the forest is beautiful. Tide is going down and narrow rivulets are pouring muddy water with scum, leaves and Sundri seeds into the river.

G.P.S. FIX 78 22° 15' 29" N / 89° 24' 30" E
This fix at the end of a long wide loop of the river, turning left; before this fix on 500 - 600 metres on left bank accreted side: regularly spaced patches of Nypa palm in front of Sundri forest, on the other side Nypa, ***Phoenix p. Acanthus.***

G.P.S. FIX 79 22° 15' 28" N / 89° 24' 56" E
12.07.1994. Confluence Aura Sibsa. Abeam steamer signal. In front on Aura Sibsa bank, all the Gewa which were red and losing leaves last time have new light green leaves.

SIBSA River to KHULNA at night.
KHULNA anchoring 13.07.94.

FIELD TRIP N° 4 25 July 1994

Boats: BONO MARONCHO - F.D. Trawler

Members:

1) M. SHAIDULLA Bangladesh Forest Research Institute (B.F.R.I.)
2) Dr. G. GREPIN Mangrove Ecologist F.A.O. BGD/84/056

Itinerary:

KHULNA TO MUNSIGANJ

Object:

Ecology

G.P.S. FIX 80 22° 14' 04" N / 89° 11' 27" E
MUNSIGANJ - 10h42 a.m. ; rain
Going down to KADAMTALA; rain
On the left side low mangrove (6-7 metres); on right side shrimp farms and embankments. Mangrove forest is mainly Gewa on the banks. Scattered Keora on new accreted lands.

G.P.S. FIX 81 22° 15' 39" N / 89° 11' 52" E
Water electro conductivity 21,6 MVS . "Clouds" of silt; Sundri seeds

G.P.S. FIX 82 22° 14' 28" N / 89° 12' 01" E
Low mangrove 6 - 7 metres, no Nypa, no *Phoenix paludosa*; mainly Gewa with scattered Passur and Baen, few fishermen; rain.

G.P.S. FIX 83 22° 13' 37" N / 89° 11' 18" E
Sylviculture plantations; five hundred Pashur and Sundri planted after removing part of Gewa trees 5 - 6 metres mangrove, with scattered small Golpatta heavily cut, some with only one leaf. Strange sharp noise unidentified: "ponc", "ponc"; it is not a bird but from the bank; one hour before high tide we walk first in 20 cm of water for 15 - 20 metres then down to 1 metre of water for 30 - 50 metres and again on a raised area climbing to 20 cm of water.

The forest is mainly Gewa mixed with Sundri and scattered Pashur and Goran. A big Pashur height :12 - 15 m trees (40 years old ?) located 22° 13' 33" N / 89° 11' 17" E. 11h50 on raised area.

Tidal level marks on trees is about 80 cm; more huge quantity of fish larvae are seen in water, and quantity of organic debris; big old "Baen" 2 metre circumference at breast height; small Sundri are holding many cankers and leaves are covered with Fungus. Young fishermen selling big mud crabs. Rain.

G.P.S. FIX 84 22° 13' 59" N / 89° 11' 15" E
Abeam narrow Khal

G.P.S. FIX 85 22° 13' 43" N / 89° 11' 04" E
KADAMTALA Camp

G.P.S. FIX 86 22° 13' 49" N / 89° 44' 14" E
Raised area with fern; rain, soil sampling numerous S.P.O.T. with "Naked" Gewa banks.

G.P.S. FIX 87 22° 12' 27" N / 89° 12' 06" E
Abeam narrow Khal
Along the banks, low mangrove with tall "Baens" and some scattered Pashur; banks covered with nearly pure Gewa; in some places near the banks on the eroded side, the Gewa trees are without leaves; on the opposite side they are covered with new leaves; on eroded banks the eroded trees are dying.

G.P.S. FIX 88 22° 12' 49" N / 89° 14' 33" E
KOLAKASI Patrol Camp.
Strong rain, all around the camp beautiful Keora and big Baen, rare Pashur and mumerous Gewa; one ranger told us the story of an old male tiger, who died recently: this tiger was paralyzed and only able to swim with fore legs, he died after two days of agony. Near this camp 30 dinghy fishing boats were operating.

From KALAGASHI Khal we reach KHOLPETUA River; all the Pashur have been cut here.

BURIGOALINI Forest Station and Range Office, going up to Munshiganj we enter a small Khal: young girls with fry nets are waiting during high tide sitting together in the trees. A small patch of mangrove trees outside the forest in a sharp loop, big shrimp farms, "Hargoza" with blue flowers along the banks on mudflats 6 BRAHMINY kite.

G.P.S. FIX 89 22° 15' 04" N / 89° 13' 29" E
3h25 p.m. Water electroconductivity: 20,7 M.V.S. Cloudy sediments.

G.P.S. FIX 90 22° 15' 25" N / 89° 12' 57" E
Near a narrow Khal; tide going down, water electroconductivity: 21,3 M.V.S.

MUNSHIGANJ 4h15 p.m. Water electroconductivity: 20,4 M.V.S.

KALIGANJ Ferry 5h40 p.m. Water electroconductivity: 8,4 M.V.S.

KADJIRAD Paddy field on the right side of the road. Going to Khulna: water electroconductivity: 0,2 M.V.S.. On the opposite side of the road: shrimp pond with thousands of shrimp fry along the side: electroconductivity: 3,6 M.V.S.

Back to KHULNA

FIELD TRIP N° 5 02.08.94 TO 03.08.94

Boat 110 feet the Forest Department launches: *Bonokanna*

Members:

1) Dr. A. KARIM Mangrove Sylviculturist - F.A.O. BGD/84/056
2) Dr. J. LEECH Forest Inventory Specialist - F.A.O. BGD/84/056
3) Dr. G. GREPIN Mangrove Ecologist - F.A.O. BGD/84/056

Itinerary:

KHULNA / SIBSA RIVER / SUNAKHAL / GEWAKALI / SAKBARIA RIVER / AURAJIBSA / KHULNA

Object:

This trip was the occasion to discuss directly on the field forest inventory and measurement procedures. The value of systematic sampling applied to S.R.F. was discussed extensively and will be developed in the interim report (FUTURE ECOLOGICAL SAMPLING SYSTEM).

FIELD TRIP N° 6 05 August 1994

Boats: BONOKANNA - Forest Department launch

Members:

1) Dr. J. W. LEECH Consultant Forestry - F.A.O. BGD/84/056
2) Dr. A. KARIM Consultant Sylvicuture - F.A.O. BGD/84/056
3) Mr. P. de V. MOSS O.I.C. - F.A.O. BGD/84/056
4) Dr. G. GREPIN Mangrove Ecologist F.A.O. BGD/84/056

Itinerary:

KHULNA / SIBSA RIVER / SUNA KHAL / GEWAKALI /
SAKBRIA RIVER / AURA SIBSA / BACK TO KHULNA

Object and results:

- This very short trip was intended for sylviculture and inventory purposes Dr. J. W. Leech, inventory specialist, discussed extensively with ecology and sylviculture consultant on the actual inventory system.
- Proposals, based on practical field examples, were made to improve the P.S.P. measurement system.
- Quantification of trees removal by erosion processes was discussed in detail.
- Inventory of Nypa palm and a new approach to the forest inventory based on systematic sampling was compared with the Permanent Sampling Plot System.
- A G.P.S. fixes was taken on the concrete G.P.S. plot at GEWAKALI: 22° 09' 15" N / 89° 24' 58" E
- Back to Khulna during the night, we proceed to make the autopsy of a dead tiger at D.F.O. Office Khulna.

FIELD TRIP N° 7 28- 29 -30 August 1994

Boats: BONOKANNA - Forest Department launch

Members:

1)	Dr. A. KARIM	Consultant Sylvicuture - F.A.O. BGD/84/056
3)	Dr. M. PENA	Consultant Fisheries Marketing
4)	Dr. G. GREPIN.	Mangrove Ecologist F.A.O. BGD/84/056
5)	Mr. S. HUDHA	D.F.O. Sundarbans - Khulna - Part of the transect

Itinerary:

KHULNA / DANGMARI Patrol Camp / CHALNA RIVER / SHUTARKALI / KALABOGUI / SIPSA /ARUA SIPSA / BOSBAZA KHAL / CPT 36 -37 / 22° 16' 01" N - 89° 21' 36" E Plantation / GEWAKALI
Total 331 miles / 31 hours

Object and results:

- During this trip we visited a low lying bowl shaped area located downstream DANGMARI near PASSUR River (JEPSI Khal) 22° 22' 15" N - 89° 35' 50" E.
- So called a "burned area" (GEPSI BARANI ?) (KARAMJOL)
- KARAMGANG Patrol Camp, this place is breeding centre for spotted dear: 3 females, 1 male, 2 young females, 1 young born there.
- Observation on fisheries practices and catches.
- Electroconductivity measurements
- Observation of top-dying and coupes near SHUTARKALI
- Botanical and zoological samplings (sole fish were found in nearly freshwater - 22° 12' 08" N - 89° 23' 14" E

Note:
Due to logistic problems (1 speed boat, broken engine....) sample collection and field studies were reduced.

- KORMA River, this silted river was cruised by a 9 feed draught launch in 1989, actually even a speed boat is stopped.
- *Crocodlus porosus*: 3 - 3,5 m specimen of *Crocodlus porosus*: was observed 40 minutes during around the boats on PASSUR River near KARAMGANG; tracks were seen on a mud flat along JUNGRAKHAL.

FIELD TRIP N° 8 21.09.1994

Car: Pick-up TOYOTA

Members:

1) Dr. M. PENA Consultant Fisheries Harvesting and Marketing
2) Dr. G. GREPIN Mangrove Ecologist F.A.O. BGD/84/056

Itinerary:

KHULNA / CHALNA - KHULNA

Object: **Fisheries**

Observation and result:

Extension of shrimp farming and Paddy cum shrimp farming was observed in this area. Different king of fishing gears are used along the river, between the embankments, on each outlet of paddy fields.

The sluices gates along the road are open. Examination of main catches and collection point along the road confirm the previous observation: size of ***P. monodon*** is normal, other catches of ***Penaeid*** shrimps are mixed matures and probably immature species ***Penaeus indicus*** and ***Penaeus sp. (semisculatus ?).***

Fish catches consist mainly of small immature fishes. This observation is confirmed in CHALNA Market.

Turtles: Freshwater and estuarine turtles are openly sold at Chalna Market. 4 living estuarine Terrapin ***Batagur baska*** and 4 fleshly slaughtered Terrapin (25 to 60 cm shell length) were seen on a dinghy boat. Fishermen told us that this meat was highly appreciated.

FIELD TRIP N° 9 23- 24 -September 1994

Boats: BONOKANNA - Forest Department launch

Members:

1) Surface Water Modeling Center team and project hydrologist (5 people)
2) Mr. P. de V. MOSS O.I.C. - F.A.O. BGD/84/056
3) Dr. M. PENA Consultant Fisheries Harvesting and Marketing
5) Dr. G. GREPIN Mangrove Ecologist F.A.O. BGD/84/056
6) Mme. B. BONI U.N.D.P./F.A.O. Programme Officer

Joined this trip 25.09.94 to 29.09.94 to HIRON Point
7) Dr. C. SMITH Fisheries Zoologist - Khulna University
8) Dr. SMITH Malacologist

Itinerary:

KHULNA / SUPOTI 22° 02' 46" N - 89° 50' 15" E / SUNDURI KHAL 300 m after confluence 22° 52' 58" N - 89° 47' 12" E / KOTKA Station 21° 51' 12" N - 89° 46' 37" E / KOTCHIKALI 21° 52' 07" N - 89° 50' 12" E / SUPOTI 22° 02' 50" N - 89° 50' 09" E / DAMGMARI / KHULNA

Object and results:

Botanical, zoological and fisheries information were collected with the end of the monsoon observations of wildlife was more easy; many birds, a river terrapin and spotted deers were observed. The healthy Sundri forest in this area considered as moderately to highly saline, is noticeable. The zoologist team continue the trip to Hiron Point and collected numerous samples of fish, shrimp larvae and juvenile stages. M. S. Pena collected valuable information on fisheries practices and marketing.

NOTE CONCERNING LAUNCHES AND SPEED BOATS

Lack of launches and speed boats due to mechanical problems strongly reduced the field work capacity of Ecology and Fisheries specialists. Two speed boats are needed for future field work, with back-up facilities.

New Project launches and equipment must include a working area to work on biological specimens with canvas canopy; a 200 - 400 l ice box and a small deep-freezer. A small crane situated at the stern will help mollusk dredging operations.

Despite generous cooperation of the Forest Department the work of the Ecologist was seriously hampered throughout this mission due to the inability to access the S.R.F. Independant and reliable water transportation is not available and is an ongoing serious constraint to the Project.