ECOLOGY AND FISHERY IN THE CROSS RIVER ESTUARY - A RESEARCH PROJECT

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ABSTRACT

The research proposal results from the requirements for nature conservation and fishery development. A literature review of 50 titles including nearly all relevant publications ensures adequate basis on the present level of knowledge. The proposal includes (a) the determination of the biozonosis and selected environmental factors, and (b) of fishery and stock data of the main fish and shellfish species. The ecological research studies physical and chemical variables of the estuarine waters (flow velocity and direction, water temperature, conductivity, pH, dissolved oxygen, salinity, nutrients such as ammonium, nitrite, nitrate, phosphate, silicate, pollutants such as hydrocarbons, pesticides and heavy metals, biochemical oxygen demand, chemical oxygen demand), plankton (bacterio-phyto- and zooplankton), benthos, sediment. The fishery biological and fishery investigations include: number of villages and fishermen, number of boats and gears by type, length and weight data of the main fishery objects with concentration on the shrimps, species and numbers of fish parasites. The ecological variables will be monitored at fixed stations on sections in the Cross-River Estuary, Calabar and Great Kwara Rivers two times per month during spring and neap tides. The fishery biological and fishery variables will be obtained in selected fishing villages two times per month during spring and neap tide too. For the determination of the detailed methodology the ecological and fishery part of the programme should be started with frame surveys based on a larger number of stations. These frame surveys should be repeated from time to time. Both parts of the programme are based on three years duration. It seems already appropriate to continue the work with selected representative stations, villages and variables in form of a long-term data chain. With such time series it should be possible to differentiate between natural, fishery and other anthropogenic impacts on the ecosystem.

INTRODUCTION

The Cross River Estuary situated in the South-East of Nigeria has an area of about 1500 km², the tidal flood plains included. About 50% of this area is free water, the other half is occupied by the amphilboius mangrove species Rhizophora racemose and Avicenna africana. The Cross River Estuary is connected with the neighbouring estuarine waters in the South-West of Cameroon. Both, together form the biggest mangrove system of the West African coast and probably the most untouched in the world.

The mangrove system serves as spawning and feeding ground for shrimps, crabs, periwinkles and fish. Important fish species are, for example, bonga, Ethmalosa fibriata and the estuarine catfish, Chrysichthys nigrodigitatus. The main shrimp species are probably, in the inner estuary Macrobrachium macrobrachion, Macrobrachium vollenhovenii and Peneaus notialis (post larval stages), and in the outer estuary, Nematopaemon hastatus, Parapenaeopsis atlantica and Exhippolysmata hastatoides.

The fishermen live since time immemorial in equilibrium with the mangrove which serves as firewood for drying or smoking of fish and shrimps, for construction of huts and for sale. They also live until recent time in equilibrium with the aquatic and terrestrial animals of the mangrove which they use as food and for sale.

Recently, obvious indications exist for an over-exploitation of the mangrove trees of the neighbouring Niger Delta. That means the deforestation is faster than the natural reproduction.
This process should be avoided in the Cross River Estuary.

Another anthropogenic factor is the increasing stock of the nipa palm, *Nipa fruticans*. It is assumed that this palm species was imported from Singapore in 1904 in order to strengthen the banks of the waterways. Their large leaves are used by the inhabitants as roofing material for their huts; but the value of the nipa palm for the ecosystem in comparison with the mangrove trees is likely to be much lower, these species have for example no fertilizing leaf fall.

It can be assessed that anthropogenic influences in the Cross River Estuary were, so far, small, when compared to other estuaries. It is not too late to accumulate more know-how for its regulated exploitation and for the protection of the mangrove ecosystem. This know-how should be used for the development of a National Park "Cross River Mangrove" in a selected area of the Cross River Estuary similar to the National Park "Cross River Rainforest" which is already in the state of realization with funds from the European Community.

An important part of the research equipment for the intended project has been realized by European development aid organizations and institutes, as for example by the Institute of Baltic Research in Rostock-Warnemünde/Germany. We appreciate their kind donations and call for more sponsors, so for mechanical current meters for example. Especially we need financial help for the running costs of the project.

**LITERATURE REVIEW**

Akpan (1993, 1994) processed the seasonal variability of the phytoplankton biomass in relation to physico-chemical changes in the Cross River Estuary. Akpan and Offem (1993) provided data on the seasonal variations in temperature, salinity, dissolved oxygen, biochemical oxygen demand, ammonium, nitrite, nitrate, phosphate, silicate, pH and Secchi disc transparency. Both publications give explanations for the annual changes in the water quality of the estuary. The main influencing factor is the seasonal variation of rainfall, but biological cycles may play a significant role on chemical variables. Former investigations on phytoplankton (Moses 1979; Nwa 1982) and on the abiotic environmental factors (Moses 1979; Nwa 1982; Asuquo 1989; Lowsen and Künzel 1992) contributed some results.

Akpan and Offem (1993) compared Chlorophyll a and carotenoids and tried to use them as predictors of phytoplankton biomass. The correlation coefficient (r) between phytoplankton cell density and chlorophyll a was higher ($r^2 = 0.85$) than between cell density and carotenoids ($r^2 = 0.47$).

Akpan (1993) investigated the influence of grazing activity on zooplankton on phytoplankton on an annual cycle. He came to the conclusion that hydrographic factors may be dominant for the biomass of phytoplankton but grazing activity may contribute significantly to the timing and intensity of algal blooms. Concerning epibenthos the only available results are from the neighbouring Niger Delta mangrove on the seasonal variations and community structure of epibenthic algae on the roots of the mangrove *Rhizophora mangle* (Ewa and Abby-Kalilo, 1993). The maximum ash free dry weight with 0.33 mg cm was found in the dry season between November and January.

The molluscs (clams, periwinkles and other snails) of the Cross River Estuary are, until now, insufficiently investigated. In the past the activities were concentrated on the semi-estuarine clam species *Egeria radiata* settling on the lower reaches of the Cross River. Several papers were published about the annual cycle of reproduction, growth and condition index (Etim and Enyenili 1990; Etim 1990, 1991; Etim and Unoh 1991; Etim and Taegé, 1993). The seasonal variation of biochemical composition was provided by Etim (1990, 1991 and 1993). The seasonal variations of heavy metals in the tissue were investigated by Etim and Akpan (1991) and the temporal trends by Etim et al. (1991). Moses (1990 b) provided data on abundance, mortality, biological production and potential yield based on length-structured relative age. Etim and Brey (1994) used tagging-recapture data for assessment of population dynamics and found out a Von Bertalanffy growth function with $L_0 = 98.9$ m and $K = 0.828$ y a natural mortality $M$ and a fishery mortality $F$ of 1.10 Y and 0.93 y , an exploitation rate of 0.45 and a maximum sustainable yield of 600 tons wet weight.

Only sporadic investigations on the crabs in the
Cross River estuary are available. Ewa (1988, 1994) worked on the influence of simulated crude oil spills on the mangrove swamps of Bonny Estuary (Niger Delta), especially on the crabs *Uca tangeri* and *Tympanotonus fuscata*. Three days after the spill the bigger individuals disappeared, but two weeks after they returned.

Ewa (1993) described the substratum preference of the estuarine burrowing crabs *Orcypode cursor* and *Uca tangeri* (*Orcypodidae*) in the Bonny Estuary.

Anda (1989) investigated the activity of the burrowing crabs *Orcypoda africana* and *Orcypoda cursor* on the sandy beach where the estuary borders on the Atlantic Ocean and compared the distribution with the coast morphology. High burrow densities were observed along cusp horns compared with those of the adjacent bays.

The so-called fresh water crayfish *Macrobrachium vollenhovenii* lives in the brackish waters of the estuary as larva and in fresh water of the rivers as adult animal. This shrimp species is the largest in West Africa and therefore a potential candidate for aquaculture. Udo and Taege (1989, 1991) compared the body size with the metabolic rate and the respiratory responses to various salinities. Udo and Ekpe (1991) found a fecundity between 1,100 and 170,000 eggs. Willfiihr-Nast et al. (1993) studied the influence of the salinity on the larval development.

Moses (1985), Nsentip (1985), Enin et al. (1991) and Enin (1994) investigated the artisanal shrimp fishery in the outer Cross River Estuary. Enin (1994) found in the catches by weight 81.5% *Nematopalaemon hastatus*, 8.2% *Parapeneaepohippus atlantica* and 81% *Exhippolysmata hastatoides*. For the main species *Nematopalaemon hastatus* the natural mortality (M) was 2.92, the fishing mortality (F) 2.61 and the exploitation rate (E) 0.47.

Some large-scale surveys provided an oversight on the marine fish fauna of West Africa (Longhurst 1965; Domain 1980). Schneider (1990) summarized the knowledge about the marine fisheries of the Gulf of Guinea in a field guide. Furthermore some surveys and fishery statistical estimations of the coastal waters in the southern and southeastern part of Nigeria are available. (Ssentonga et al. 1986; Moses 1993; Enin 1993).

The fish fauna of the Cross River estuary is poorly investigated. Some statistical data sampling and stock assessments have been done by Bissong (1994) and by Löwenberg and Künzler (1991) based on landings from the bottom trial fishery in the outer Cross River Estuary and adjacent region. The catch consisted of 65 fish species representing 30 families, mainly *Clupeidae*, *Mugilidae*, *Lutjanidae*, *Carangidae*, *Sciaenidae*, *Polynemidae*, *Pomadasidae*, *Sphyraenidae* and *Bagridae*. Künzler et al. (1986) worked on the genus *Pellonula* along the Cross River. Moses (1990b) contributed to the growth, mortality and potential yield of the bonga, *Ethmalosa fimbriata*. Nawa (1982) studied the growth of the croaker, *Pseudolothus elongatus*, of the estuarine catfish, *Chrysichthys nigrodigitatus* and of the sole, *Cynoglossus goreensis*.

Some publications are available concerning the parasites of commercially important fish species of the estuarine and coastal water of Nigeria (Obiekezie, Möller and Anders, 1988; Obiekezie et al., 1992; Obiekezie and Holzlöhner, 1995).

Antai et al. (1993) and Enyenih et al. (1990) performed surveys in the fishing villages of the Akwa Ibom, Cross River and Rivers State for sampling of information on the population structure and fishery. Alone in the Cross River system they counted 59,714 artisanal fishermen in a population of 246,011 dwellers in 232 fishing settlements exploiting with 17,706 canoes the fish and shrimp stocks of the Cross River Estuary.

Sporadic papers are available about the ecology of the mangrove including the fishery resources. Odum and Heald (1972) gave a tropical analysis of an estuarine mangrove community. Adebegbin and Nwaigho (1990) discussed the uses and management perspectives of the mangrove. Enyenih et al. (1987) presented the ecological parameters of the mangrove swamps of the Cross River State. The only paper which concentrates on the ecology of the Cross River Estuary is that from Nawa (1982). The mangrove ecosystem provides nursery grounds for post-larval stages and young individuals from crustaceans and marine fish and also feeding grounds for adult individuals of several marine fish species during high tide.
Holzlöhner (1996) derived the objective demands for short- and long-term biological-oceanological and fishery investigations in the Cross River Estuary and environs to the Institute of Oceanography of the University of Calabar. Antia and Holzlöhner (1986) produced a bibliography of a decade (1975-1985) of coastal studies in the Cross River Estuary and environs by the Institute of Oceanography, University of Calabar.

Research Proposal
The research results from the requirement of nature conservation and fishery under consideration of past research corresponding to the literature review. The main research objectives include (a) the determination of the biozoenosis with selected environmental factors and (b) the determination of fishery and stock data concerning the main fish and shellfish species.

(a) Determination of the biozoenosis and selected environmental factors.
It is intended to start the work with a frame survey in the estuary with a research boat. In combination with research objective (b), we hope to organize additionally an airplane and water and the registration of the composition of the mangrove forest. The available topographic maps are outdated. The frame survey with the boat should be repeated at least after each year.

The data sampling concerning (a) should include:
- biomass of bacterio-, phyto- and zooplankton
- species composition of plankton under special consideration of fish and shrimp larvae and planktonic stages of fish parasites
- biomass of benthos
- species composition of benthos
- physical environmental factors (velocity of flow, temperature, conductivity, pH, turbidity)
- Chemical environmental factors (oxygen, salinity, micronutrients, biochemical oxygen demand, chemical oxygen demand
- selected pollutants (phenol, hydrocarbons, heavy metals, pesticides) of water and sediment samples.

The data should be sampled on stations each along the main water ways or flows in the Cross River, Calabar River and Great Kwara River Basin on the frame survey some transverse sections are designated. They should include the water body near to the mangrove. The sampling should be planned twice in a month during spring and neap tide.

The biozoenosis and environment project should be planned in the first instance for 3 years parallel to the fish and stock assessment project mentioned under (b).

It seems appropriate to continue the work with selected stations and parameters after this period as a time series (monitoring). That is the only way to distinguish anthropogenic impacts on the biozoenosis and the whole ecosystem from natural influence.

b) Determinations of fish and shellfish fishery and stock data.
Analogous to the environmental part of the programme it is intended to start a frame survey with the research boat. Additionally should be of interest the use of an airplane survey to get an overview concerning the number and distribution of the fishing villages, number of boats and main places of the fishery. The frame survey with the boat should be repeated after each year.

The data sampling concerning (b) should include:
- number of fishing villages and their geographical position
- number of fishermen
- number of boats by type
- number of fishing gear by type (gillnet, line, trap etc.)
- fishing effort
- species composition
- catch per unit effort by species (by one gillnet or by 20 hooks per day)
- value of the catch
- length and weight of the main species.

The duration of the project should be planned for three years parallel to the biozoenosis and environment project mentioned under (a). The programme should be concentrated on the inner Cross River Estuary because of the lower level of knowledge in comparison to the outer one, especially what concerns the shrimps as important target objects of the project. In the first and second year is incorporated a survey of the fishing villages in the inner estuary and in the associated creeks (area 1 in figure 1); there are at least 50 fishing
villages. In the third year the survey should be performed in the outer estuary, where we expect at least 50 fishing villages too.

REFERENCES


