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Assessment of Critical Coastal Habitats of the Western Region, Ghana

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Cover Photo: Ankrobra town, at high tide. Western Region, Ghana.

Photo Credit: F. K. E. Nunoo

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Executive Summary

Introduction

The Western Region of Ghana harbors several key ecosystems with high value biodiversity. The coastal area of the region is particularly diverse in habitats many of which are unique in terms of biodiversity and provision of ecosystem goods and services. The habitats comprise of lagoon-wetland systems, mangroves estuaries, sandy beaches and rocky beaches. These habitats are considered critical because of their high vulnerability to population growth, urbanization, industrialization and climate change vulnerability. Nonetheless, the main threats to terrestrial and marine biodiversity in the Region have been identified as overexploitation of marine fisheries resources, degradation of coastal habitats, pollution from land and sea based sources, algal blooms, accelerated coastal erosion, increasing population density, weak governance, legislation and institutional framework, potential conflicts and environmental degradation from oil and gas exploitation, climate change and sea level rise, spread of invasive species and acculturation of traditional knowledge. Additionally, these critical coastal areas are often the repositories for contaminants released in coastal areas including potential of oil spills from ongoing oil exploration and production activities in the offshore environment of the region.

Objective

In line with the objectives set out in the call for proposal by CRC_URI, this study aimed to identify, document, map out and analyze key critical coastal habitats in the Western Region. The study was intended to assess the environmental conditions of these habitats deemed crucial to biodiversity and sustenance or generation of ecosystem goods and services. The findings of the assessment will afford ICFG the opportunity of priority actions to undertake geared towards preserving, restoring impaired habitats or maintain/conserve quality habitats for the long-term sustainable benefit. Assessment Methodology

Recommendations and suggestions from the ICFG Biodiversity Threats Assessment report (CRC, 2010), Coastal Wetlands in Ghana (Armah, 1993), Environmental Sensitivity Map for Coastal Areas of Ghana (2004) and expert experiences of DOF/REDO team members enabled the selection of 20 top coastal habitats in the Western Region of Ghana. In essence, the selection of these habitats were informed by their inherent potential characteristics of high ecological diversity, habitat uniqueness, economic importance, current and future anthropogenic impacts, vulnerability to climate change and geographical representation. These habitats/sites were ranked based on cumulative points gained for each of the set criteria/categories. Congruently, the final 10 coastal/marine areas selected for assessment were rearranged according to the Coastal/Marine Ecological Classification Standard, classified as Level 4.

Field studies, done within a short period of three weeks, were designed to collect primary data on key indicators of these critical habitats. For each of the selected habitats, assessments were informed by the socio-economic importance and its specific biodiversity. Primary data collected were water quality, fisheries, benthic fauna, avifauna, vegetation, mammals, socio-economic and habitat maps. Various methods and techniques employed in the acquisition of data were through

standard and accepted methods. The generated data were analyzed using basic statistics through graphical displays/plots,

Results/Findings

Water Quality

The suitability of the eight (8) selected water bodies for performing ecological and other functions have been assessed. Except for the levels of some trace metals, the water bodies are generally suitable for aquatic life. Currently, Belibangara and Amansuri-main are unsuitable for drinking without treatment. Amansuri outlet, Butre and Kpani-Nyila are suitable for recreational purposes while Ankobra estuary and Domunli lagoon are currently unsuitable for recreational purposes including bathing and swimming.

Benthic infauna

The isopoda and polychaeta were the two dominant groups of the macrobenthic infauna composition of the soft-bottom sandy intertidal habitats. *Excirolana* species is the dominant taxa, with a 66.6% frequency of occurrence (F). None of the species observed spanned the whole studied areas. There was a high proportion of rare species with about 55% of the organisms represented by one or two individuals. This indicates that the macrobenthic fauna within the studied area are in discrete communities and may be influence by a limited set of abiotic factors. The highest abundance of organisms was recorded at the Ankobra beach and Butre reported the lowest.

The polychaete, *Capitella capitata* and Chironomids were recorded mostly in Belibangara and Domunli lagoons. As *Capitella capitata* is an opportunistic polychaete, it is considered an important universal indicator of organic pollution in sediments. The presence of populations of *C. capitata* therefore represents an index of disturbance impact related to organical enrichment.

Rocky Shore Organisms

The abundance and species composition of rocky shore organisms varied between the studied sites. The epibenthic faunal diversity was highest at Cape Three Point area.

Shorebirds

Shorebirds' abundance varied among shores. The highest numerical abundance and species richness occurred at the Amansuri Estuary with a total of 1081 individuals comprising 12 species (8 waders, 2 terns and 2 'others'). Sanderlings (*Calidris alba)* dominated with 901 individuals (83.35%), which were observed feeding presumably on the isopod, *Excirolana latipes.* Shorebirds' populations at Belibangara and Kpani-Nyila were relatively low with only one individual of two species each recorded. The availability of food and good forage grounds appears to be a strong factor influencing changes in the local shorebird populations.

Terrestrial Avifauna

A total of 236 species of terrestrial birds belonging to 46 avian families were recorded in the four study habitats (i.e., Cape Three Point Forest Reserve, Amansuri Wetland, Princess Town and Akatekyi), with the highest number of 168 species recorded at the Cape Three Point Forest Reserve. Eight (8) of the species are listed on the Vulnerable, Near Threatened and Data Deficient categories of the IUCN Red List of threatened species, and observed at the Cape Three Point Forest Reserve (8 species) and the Amansuri Wetland (2 species). Environmental parameters are more likely to remain relatively unchanged over time at the Amansuri Wetland the Cape Three Point Forest Reserve than at the two off-reserve areas. It is therefore recommended that any effort at long term monitoring of changes in environmental conditions with regards to terrestrial birds, should focus on the Cape Three Points Forest reserve and the Amansuri Wetland.

Mammals

There were 45 individual captures of nine species of small mammals belonging to two orders, Rodentia (eight species) and Insectivora (one species). A total captures of 45 individuals in 360 trap-nights indicate overall trapping success of 12.5 %, which is fairly high, given the short duration of the survey. The highest diversity of small mammal species occurred at Amansuri (H' = 0.63) followed by Ankobra (H' = 0.63), and Cape Three Points (H' = 0.57) with two species each. The least diverse localities (H' = 0.00) Belibangara, Princess Town, and Butre with one species each.

Interviews conducted revealed 14 species of reptiles occurring in the study localities, represented by four species of lizards: *Agama agama* (agama/rainbow lizard), *Mabuya perottettii* (orange-flanked skink), *M. affinis* (skink), and *Varanus niloticus* (Nile monitor lizard). There were seven snake species, *Python regius* (royal python), *Philothamnus* sp. (green tree snake), *Dendroaspis viridis* (green mamba), *Grayia smythii* (water snake), *Naja melanoleuca* (black/forest cobra), *Bitis gabonica* (gaboon viper), *B. arietans* (puff adder). There was one crocodile *(Crocodylus niloticus)*, and two chelonian species.

Fisheries

The fish diversity in the studied habitats was very high, with some degree of protection due to traditional beliefs and cultural worship (e.g., Belibangara). This helps to reduce pressure on fish stocks in the lagoon. At all the habitats, the catch rate was rather low, indicating trends of decreasing abundance of fish populations. The algal bloom in the region was a major hindrance to fishing livelihoods at Domunli lagoon and Amansuri estuary. It is a financial drain on fishers who have to use precious time cleaning both fish and nets of green algae. Though providing nutrients for fish species and therefore driving productivity, it needs to be addressed before opportunistic poisonous algal species begin to bloom alongside the existing filamentous green algae.

Vegetation types

In all ecotones, there exist environmental gradients which impose limitations on the spatial distribution of flora. The estuaries of Azulenoanu, Kpani/Nyila, and Ankobra are brackish water environments with mangrove vegetation dominating the saline soils of the estuaries while freshwater swamp forest/thicket vegetation where the soils are non saline. Three main types of vegetation were recognized in the study area as follows: Wet Evergreen Forest – Cape Three Points Forest Reserve (upland); Coastal forest/thicket – rocky terrain, Ankobra and Cape three points; and Freshwater swamp (peat) forest – Amansuri.

Habitat mapping

Digitized basemaps were produced from orthophotos acquired in 2005. The maps produced at various scales between 1:5000 and 1:25000 enabled the identification of features peculiar to each critical habitat, such as the extent of rocky and sandy beaches, vegetation, settlements, etc. Detailed geomorphic assessment at Miamia and Princestown revealed that the rocky beach at Princestown offers protection to the back beach along those sections of the coast, indicating that coastal erosion is not a major issue. Nonetheless, severe erosion at Princestown beach seems to be taking place. Previous interventions using groynes appears to not protect the shoreline. Analysis of 1974 and 2005 shoreline positions indicate that the entire Western Region is eroding at a rate of about 0.35 ± 0.22 m/yr. However, there are certain hotspots (e.g. Princestown) that might be eroding at a faster rate than this and will thus require intervention.

Conclusions & Recommendations

The overall selected habitat assessment of the region indicates important management issues related biodiversity and overall ecosystem integrity/health. Cape Three Points, Ankobra and Belibangara appear to be heavily impacted by humans and require restoration of habitat quality; while the greater Amansuri (Amansuri lagoon and Amansuri outlet), Cape Three Points and Dormunli are important for ecosystem goods and services and need to be protected. As Cape Three Points falls in both categories, it has priority importance for management actions.

The assessment suggests the wider Cape Three Points areas and the Amansuri Estuary as potential biodiversity hotspot that need urgent strategic management attention. These areas have not been significantly impacted by human activities and host huge biodiversity resources including avifauna, macrobenthic organisms, important terrestrial flora and fauna and unimpaired water quality. These areas may be accorded the status of MPAs after a detailed assessment has been carried out and mechanisms put in place. In order to ensure sustainability of the resources, these areas may be developed into biodiversity parks with to generate revenue that could be used for alternate source of livelihood in the area.

The other critical habitats do not host overall huge diversity except that certain sites/areas were noted for their potentials for either one or two resources of ecological importance such as mangroves (e.g., Butre, Domunli).

Nonetheless, the undertsanding of all the issues and the related mechanisms necessitates monitoring and evaluation of key indicators, with the potential to reveal subtle adverse impacts. The available data and information is inadequate for a conclusive statement of the overall ecosystem health. Nonetheless, the data suggests a management strategy to arrest many of the issues that has potential negative impacts on the coastal biodiversity. These are mainly related to resource use patterns, issues of pollution of water bodies, harvesting of lagoonal mangrove and other forest trees for domestic purposes, collection of intertidal organisms for consumption reducing biodiversity and hence ecological services, poor enlightment of community folks on environmental sanitation/consciousness.

1 INTRODUCTION

1.1 Background

The Western Region of Ghana harbors several key ecosystems with high value biodiversity. The coastal area of the region is particularly diverse in habitats many of which are unique comprising of lagoon-wetland systems, mangroves estuaries, sandy beaches and rocky beaches. These habitats are considered critical because of their high vulnerability to population growth, urbanization, industrialization and expansion of settlements. In order to prevent further degradation of such critical habitats, it is highly desirable to determine their current status; including identifying and examining the key indicators that can be used to measure their ecological health and sustainability.

The coastal zone of Ghana spans approximately 550 km and is endowed with numerous living and non-living resources of socio-economic importance, and is characterized by sandy (70%) and rocky (30%) beaches along the entire stretch. The sandy beach stretches from the western portion close to Cote d'Ivoire to Axim and from Prampram to the border with Togo in the eastern part. It has been estimated that about 90 lagoons and associated wetlands are dotted along the entire stretch of the coastline of Ghana (Armah and Amlalo, 1998) of which many are found in the Western Region of the country. There are major rivers (e.g. Volta, Pra, Tano and Ankobra) which drain into the sea, and thus contribute to sediment replenishment in the coastal areas.

The Western Region covers about 10 per cent of Ghana's total land area (approximately 21,391 km^2) with a population of 1.92 million (Ghana Statistical Service, 2002). It is bordered on the east by the Central Region, the west by Cote d'Ivoire, the north by Ashanti and Brong-Ahafo Regions, and the south by the Gulf of Guinea. There are six coastal Districts, namely Jomoro, Ellembelle, Nzema East Municipality, Ahanta West, Sekondi-Takoradi Metropolis, and Shama.

With an average rainfall of 1,600 mm per annum, it is the wettest part of the country and thus has about 75 per cent of Ghana's high forest vegetation. The Region also has an abundance and wide diversity of coastal habitats that include rocky shorelines, sandy beaches, estuaries, lagoons, mangroves, and inland wetlands. There are many wetland systems some of which are freshwater habitats, unlike the eastern coast of the country where the lagoons are typically brackish. Lagoons of importance in the Western Region are Tano/Aby/Ehy Lagoon at the coastal border between Ghana and Ivory Coast, and Amanzule Lagoon. While five wetlands in the country are designated as Ramsar Sites, none is located in the Western Region. However, the critical habitats in the Western Region of Ghana are an integral component of the coastal ecosystem serving as essential nursery and feeding grounds for numerous marine, avian and terrestrial species of high biodiversity significance.

The main threats to terrestrial and marine biodiversity in the Region have been identified as overexploitation of marine fisheries resources, degradation of coastal habitats, pollution from land and sea based sources, algal blooms, accelerated coastal erosion, increasing population density, weak governance, legislation and institutional framework, potential conflicts and

environmental degradation from oil and gas exploitation, climate change and sea level rise, spread of invasive species and acculturation of traditional knowledge (CRC, 2010). Adding to the heightened sensitivity of coastal habitats is the fact that these areas are often the repositories for contaminants released in coastal areas.

Further, an important harbour in the Western region is the Takoradi port, which is the second largest commercial port in Ghana. The port is expected to receive very large crude carriers (VLCCs) due to development of oil and gas activities in the region. This has the potential for introducing invasive species from ballast water with associated concern of colonization and subsequent destruction of local species.

1.2 Justification

With rapidly evolving development along the coastline of the Western Region catalyzed by urban development, tourism and oil exploration, a thorough assessment of the coastal habitats is needed for both development and conservation planning purposes. This will help to reduce unplanned and chaotic development, especially in wetland areas. More information is therefore needed in the role they play in the fisheries sector, the provision of ecosystem services and functions, as well as in the sustainable development for the coastal communities.

Realizing the economic and ecological importance of the critical habitats in the Western Region and the imminent threats it faces, the Coastal Resource Centre of University of Rhode Island (CRC_URI) planned to carry out an assessment of the critical habitats of the Region among others to inventorize and map out biodiversity hot spots which will constitute an important baseline information. On 20th July 2010, the Department of Oceanography and Fisheries (DOF) in partnership with the Resource and Environment Development Organization (REDO) received a letter of award to conduct an assessment of the critical habitats of the coastal habitats of the Western Region.

In line with the objectives set out in the call for proposal by (CRC_URI), the DOF/REDO research group is to;

1. Identify and map the major terrestrial, coastal and marine habitats in the Western Region
2. Assess the condition of habitats considered to be of particular importance to the biodiversity of the region and to the sustained generation of ecosystem goods and services, and
3. Recommend courses of action that could be undertaken by the ICFG Initiative that are most likely to preserve and where possible restore the quality and functions of important habitats.

Expected outputs from the assessment included the following;
1. Report with detailed information on the current status of coastal and marine habitats
2. Base maps of the coastal habitats, including data files in formats specified in the award; and
3. Recommended planning activities for priority interventions and investments for coastal habitats during the second to fourth years of the ICFG Initiative.

1.3 Biodiversity Threats in the Western Region – A Review

In acknowledgement of the vulnerability of the coastal habitats of the Western Region of Ghana, the Biodiversity Threats Assessment (CRC, 2010) carried out an extensive review of available published and unpublished literature, supported by a few site visits and interviews with stakeholders including individuals, public institutions, non-governmental organizations. This was to assess the extent of potential threats, such that a reference point for comparisons with future changes could be made. This report is one of the most comprehensive documentations that have attempted to identify and analyze significant biological areas and their assets, in order to recommend the prioritization of future research activities. However, with the general paucity of published data on floral and faunal biodiversity along the coast of Western Region, although some data may be found in unknown institutional reports, some of the data and statistics presented were out-dated.

The report highlighted important coastal and marine ecosystems found in the six districts of the Western region, and provided a general overview of the numbers and types of predominant floral and faunal biodiversity in the terrestrial, intertidal, marine, lagoonal and estuarine, and freshwater ecosystems. Some important wetlands that are not easily accessible such as Belibangara and Domunli were, however, not given needed prominence in the report. In addition, information on the areal estimates of these ecosystems was either absent or outdated, with minimal information provided on their importance and use to the local communities. The report could have also shown areal maps to illustrate the distribution of the mentioned ecosystems. Most of the data utilized e.g., size, depth and use of habitats, in the analyses were out of date. The current status, which the present study seeks to provide, will help capture any changes that may have occurred in recent years to help inform management and conservation planning. One major contribution of the present document is the provision of updated maps on the various critical habitats and quantification of indicators of their ecological health.

A review of biodiversity assets was made of the marine ecosystems (Madreporarian corals, sandy and rocky shores) and wetland ecosystems (i.e., shallow marine water, rocky marine shores, estuarine waters, salt marshes, mangrove tidal forest, brackish/saline lagoons, coastal freshwater lagoons), which mostly described its fisheries (marine fisheries production and fish species composition). No accounts were provided for water quality status in these ecosystems, an important aspect of any ecological system.

For the terrestrial vegetation types (wet evergreen, moist evergreen, moist semi-deciduous, dry semi-deciduous) and coastal vegetation (saline grassland and evergreen shrubs and thicket, and sand dune vegetation), inadequate information was provided for terrestrial fauna such as small mammals. The focus was mainly on floral biodiversity and birds, although the report also noted major types of invasive species found the coastal waters and gave a summarized account of species of special concern in the Western Region (i.e., marine turtles, manatees, dolphins and shore birds, including important bird areas and biodiversity 'hotspots').

According to the report, the major threats to terrestrial and marine habitats and their biodiversity conservation in coastal Western Region are the over-exploitation of fisheries resources, loss of coastal habitats, pollution of the marine and coastal environments, by-catch of endangered

species, coastal erosion, changes in species composition and trophic balances, high population growth and invasive species and algal blooms. The report indicated that these threats have been further intensified by weak institutional capacity. However, the issue of weakening traditional structures (such as superstitions and laws) that supported local conservation initiatives should have been included. One of the main contributions to environmental degradation is poor education and non-committal attitude of local communities to environmental protection and conservation. The report also indicated that with the discovery of offshore oil and gas reserves, concerns are being raised about potential conflicts over the use of marine space and environmental impacts. In addition, the global threat of climate change and sea level rise is most likely to severely impact the low-lying coastal areas of Ghana.

In meeting its objectives, the report effectively provided an extensive discussion on the existing institutional arrangements for biodiversity conservation in Ghana; assessed the effectiveness of governance, protected areas and international treaties on biodiversity conservation; enumerated the current priorities for terrestrial and marine biodiversity conservation; and made recommendations for terrestrial and marine biodiversity conservation in the Western Region.

Some current priorities identified for terrestrial and marine biodiversity conservation in the Region include:

- Establishing Marine Protected Areas and Coastal Ramsar Sites at the Amanzule wetlands and Esiama beach, and the Ahunli and Belibangara lagoons, because of their special biodiversity features
- Enactment of legislation for the complete protection and conservation of the Cape Three Points Forest reserve because the "Hot Spot" is under severe threats from anthropogenic activities.
- Addressing harmful algal blooms and invasive aquatic plants in wetlands and coastal marine habitat
- Undertaking fisheries management reform to ensure compliance with fisheries regulations
- Protecting endangered species such as marine turtles, cetaceans and manatees
- Completion, adoption and implementation of Policies, and Strategies and Action Plans for biodiversity conservation

CRC (2010) concluded by making the following recommendations for biodiversity conservation in the Western Region:

- Coordinated planning and utilization of coastal zone and resources
- Improved fisheries management and conservation
- Protection of existing forest reserves
- Protection of lagoons and wetlands
- Awareness creation on habitats and biodiversity values
- Mitigation and adaptation of Climate change
- Strengthening relevant governmental and nongovernmental institutions through capacity building, and
- Building research capacity.

1.4 Macro-indicators of ecological health of coastal habitats

Coastal habitats are important in the provision of ecosystem goods and services to humans. The integrity of the ecosystem (ecological integrity) is measured by its structure and function. The concept of ecosystem health presupposes defining a normative state of natural systems and identifying limits of human intervention (e.g., Costanza *et al*., 1992). A healthy ecosystem prevents any shift toward a new mode of functioning, by reducing environmental stochasticity that could push the system away from its optimal state and cause undesirable economic or ecological effects. Also, a healthy ecosystem or community might be indicated by ranges of values considered to be normal, and by attributes that are regarded as stable and sustainable. Ostensibly, disruption/destruction of the ecosystem's health (e.g., value, stability and resilience) due to critical environmental factors (mainly anthropogenic) affects the overall functioning of the system. Ecological indicators are used as a tool to assess the effectiveness of measures to conserve and sustainably use biodiversity. They play an important role in regard to ecological status assessment of critical habitats. The ecological indicators have been shown to detect anthropogenic perturbations on biological communities in critical ecosystems.

As regard ecosystem approach, indicators should be meaningful in terms of ecosystem processes and management. They should integrate information across sectors and thematic areas and be relevant to defined policy goals, thereby providing information essential for decision making. Indicators in general serve four basic functions: simplification, quantification, standardization and communication. They summarize complex and often disparate sets of data and thereby simplify information. They usually assess trends with respect to policy goals. They should provide a clear message that can be communicated to, and used by, decision makers and the general public. Indicators link monitoring, research and policy making. Indicators are capable of tracking changes over time by comparing measured values with a baseline.

An indicator is a measurable parameter whose numeric value reflects a range of conditions or some aspect of ecosystem structure and function that is of interest to scientists and resource managers (e.g., pH, incidence of fish lesions, species diversity, and reproductive success). The best indicators of ecosystem health are measurable features of animal and plant communities and their habitats, including their interactions with human environment. Ecological indicators can be used to assess the condition of the environment, to provide an early warning signal of changes in the environment, or to diagnose the cause of an environmental problem.

Ecological indicators should meet the following criteria: i) be easily measured, ii) be sensitive to stresses on the system, iii) respond to stress in a predictable manner, iv) be anticipatory, v) predict changes that can be averted by management actions, vi) be integrative, vii) have a known response to disturbances, anthropogenic stresses, and viii) changes over time, and have low variability in response. Ideally the suite of indicators should represent key information about structure, function, and composition.

The key indicators (and their parameters or sub-indicators) that affect and define the ecological integrity and health of coastal habitats in the Western Region include biodiversity, water quality, fish and fisheries of the ecosystem. In addition, socio-economic indicators like population growth and its attendant need for greater resources tend to lead to excessive exploitation of

habitats leading to loss in biodiversity, goods and services, among others. Accurate data on the dynamics of these four macro-indicators would therefore be desirable in determining the health status of the coastal habitats. For management purposes, such information would be invaluable in providing the basis for pragmatic decisions to be made by managers and planners. In conformity with current trend in information dissipation, spatial distribution of the habitats and other key indicators and parameters determined in the study will be presented in GIS formats. These in some respects, are also tools for gauging ecological health of habitats.

1.5 Water Quality

Water quality is the overall process of the evaluation of the physical, biological and chemical nature of water. Water quality of an aquatic system is determined by the physical, chemical and biological properties and processes that occur therein. These processes may occur on micro-, meso- or macro-scales and may impact different levels of the ecosystem at different spatial and temporal scales, both positively and negatively. Water quality is critical to the proper functioning of aquatic ecosystems. The number and diversity of organisms in an aquatic ecosystem can be influenced by the overall water quality status. Water quality studies in aquatic ecosystems are an important step towards understanding the processes and conditions that could lead to an improvement of, or deleterious effects, on the ecosystem.

Water quality studies in an aquatic ecosystem usually involve measurement of a number of parameters which is used to determine the suitability of water for performing its ecological functions. These include nutrients (e.g. nitrates and phosphates), chlorophyll 'a', temperature, salinity, pH, turbidity, total dissolved solids (TDS), dissolved oxygen (DO), biochemical oxygen demand (BOD), and trace metals concentrations (As, Mn, Cd, Pd, Cu, Fe, Hg and Zn). Microbial contents of the various water bodies are examined to assess total coliform, *Escherichia coli* (*E. coli*) and heterotrophic bacteria loads to ascertain its quality for purposes of drinking.

1.6 Biodiversity

The Convention on Biological Diversity (CBD) defines biodiversity in its Article 2 to mean '*the variability among living organisms from all sources of including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this include diversity within species, between species and of ecosystem*' (UNEP, 1992). Biodiversity generally encompasses variety and variability. In other words, it refers to the differences within and between all living organisms at their different levels of biological organization – gene, individuals, species and ecosystem. It is through the myriad interactions among and between these organisms and the biotic environment that the possibility for adaptation arises. Maintaining the potential for adaptation is important because it allows organisms to adapt to modifications in the environment – such as climate change.

Biodiversity conservation is important because it helps to manage change as it provides alternatives to fall back on when other resources are absent. Knowledge of the biodiversity of an area enables the resources to be proactively adapted to better suit new conditions. . The ecological assemblage of any habitat is defined by the aggregates of fauna and flora species within the community. These aggregates in their natural settings and abundances maintain the

ecological balance of the habitat and promote biodiversity resilience over time. As development pressures grow, areas containing unique characteristics have become more vulnerable to pressures from commercial interests and local inhabitants. A good example is the rapid development anticipated in the Western Region of Ghana due to the recent oil discovery and its imminent exploitation by the end of year 2010.

1.7 Fisheries

Marine coastal waters, estuaries and coastal lagoons, as habitats, form an integral part of fisheries and provide important spawning and nursery grounds for many fish species. Fishing in the lagoons and estuaries is restricted to subsistence fishing by local residents in coastal Ghana. However, fishing pressure is high both in the offshore marine areas and in many coastal wetlands and estuaries.

Spatial and temporal gradients in fishing intensity and habitat quality have been used to demonstrate that both fishing and habitat quality are important determinants of fish abundance (Wilson *et al.,* 2008). The relative importance of these two processes is likely to depend on the extent of fishing pressure compared to changes in habitat and will vary depending on species susceptibility to fishing versus habitat degradation.

Fishing can change the size distribution of fish communities directly, by decreasing abundance of large individuals, and indirectly, by increases in small individuals. Changes in habitat can also influence the size distribution of lagoon and estuarine fish communities, resulting in a decline in abundance of small size classes, and some increases in larger sizes. A reduction in human populations and shift to alternate sources of income may result in a decline in fishing pressure. However, a prudent and sustainable management of any fishery requires analyses of its nature and dynamics.

1.8 Socio-Economic Information including Traditional Knowledge

Socio-economics basically refers to the study of the relationship between economic activity and social life. There are several methodologies involved in socio-economic research including interviews, field surveys, desk-bound research, ethnography and comparative policy analysis. There are several approaches but in practice a combination that addresses issues relating the objectives of the study seems the best, which in this case, is a critical assessment of coastal habitats in Western Ghana.

Socio-economic sub-indicators that potentially affect coastal habitats include population, education, health, culture, employment and poverty. Various guidelines have been established for socio-economic monitoring programmes, which provide a prioritized list of indicators that are useful to coastal managers. The range of indicators assessed usually depends on the objectives of the research programme. To support the objectives of the current study, indicators that described important natural resources, environmental issues and traditional beliefs/resource management in selected communities in the Western Region were assessed, which also included an overview of the socio-economic status of each of the respondents.

The knowledge that an individual has as a result of personal observations, experiences, beliefs or perceptions is known as traditional knowledge. Traditional Ecological Knowledge is generally viewed as a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. This knowledge guides an individual or community's systems of classification, environmental observations and resource use/management. It includes various types of information such as technologies, skills, practices and beliefs that contributes towards a community achieving stable livelihoods in their unique environment.

Community perceptions about, and uses of, coastal resources have serious implications on the biophysical health of coastal ecosystems. Coastal resources should not be managed from only a biophysical focus, as management also has equally significant consequences on the socioeconomic health of the community.

This information is useful in that it provides historical data and further information on environmental issues that may not be assessed by biophysical data alone. For the purposes of management, indicators of change can be established for further monitoring, scientific findings consistent with community or individual perspectives can be validated, and local observations on temporal and spatial patterns of resource use can be obtained. The engagement with community members also means community perspectives and traditions are incorporated into any decision making process.

1.9 GIS Mapping

Habitat mapping provides best estimate of habitat distribution based on field inventory of fauna flora, geophysical features, among others. Knowledge of the spatial distribution, quality and quantity of mapped coastal resources and features is fundamental to understanding of marine ecosystems and their health status. Maps have a wide range of applications in managing the coastal areas. These include base maps for spatial and strategic planning; support for the sustainable use of coastal resources; help with implementation of an ecosystem-based approach to management of the marine environment; help with protection of rare, critical and threatened habitats; planning of monitoring programs; identification of marine protected areas (MPAs); and increased understanding of marine ecosystem functioning particularly its' relationship to hydrography, water column, fish communities and climate.

1.10 Habitat classification scheme for the Western Region

1.10.1 Introduction

The complexities of coastal and marine environments lead to difficulties in making effective decisions about habitat conservation and resource management. To develop appropriate strategies for coastal and ocean resource management and evaluating conservation priorities, there is the need for a habitat classification system. Ecological classification standards are necessary to address the increasing threats to coastal/marine habitats and resources. The management of single species or the regulation of separate habitats, without reference to the ecosystem, can result in unsuccessful resource protection. Important processes such as biological life cycles, energy flows, watershed linkages, migration patterns, food requirements and trophic dynamics must be considered in the development of management plans for estuarine, coastal and marine systems.

A standardized approach will take into consideration the interactions among all habitats, their biological associations, and the larger ecosystem context. This will provide systematic organization of key information about the system, its physical and biotic components, their relationships to internal and external forces, and the scales of spatial and temporal interactions. A suitable classification scheme should also be easy to use and implemented with existing data without the need for sophisticated tools in acquiring new data.

The Coastal/Marine Ecological Classification Standard (CMECS) (Madden *et al*., 2004) is a comprehensive framework that provides a structure to characterize habitats in a standard way. This allows for standardized evaluation of information across the national landscape. The hierarchical framework contains eight levels; each containing clearly defined classes and units. The linkages between levels of the hierarchy are defined by ecosystem processes and by spatial relationships.

The hierarchy extends from ecological regions at the largest spatial scale, to habitat and associated biotopes at the smallest, within the following structure:

Level 1 - Ecological Region: *Large regions of the coasts and oceans defined by similar physical and/or biological characteristics*

Level 2- Regime: *Areas defined by the presence or absence of fresh water*

Level 3 - System: *Areas that form estuaries, estuarine- influenced areas, or marine waters of shallow, deeper, or very deep water columns*

Level 4 - Hydroform/Geoform: *Large physical structures formed by either water or solid substrate within systems*

Level 5 - Zone: T*he water column, littoral or sea bottom*

Level 6 – Macro-habitat: *Large physical structures that contain multiple habitats*

Level 7 - Habitat: *A specific combination of physical and energy characteristics that creates a suitable place for colonization or use by biota*

Level 8 - Biotope: *The characteristic biology associated with a specific habitat*

1.10.2 Methodology for assessment of condition of coastal and marine habitats

Based on the recommendations from the ICFG Biodiversity Threats Assessment report (CRC, 2010), Coastal Wetlands in Ghana (Armah, 1993), Environmental Sensitivity Map for Coastal Areas of Ghana (2004) and experiences of DOF/REDO team members, a comprehensive list of the top 20 coastal sites and habitats found in the Western Region of Ghana was generated (Table 1). Each of these sites was characterized by its ecological diversity and uniqueness, current and possible anthropogenic impacts, economic importance, and its geographical representation. Based on cumulative points gained for each of these categories, the sites were ranked.

From the generated matrix, sites which fell within the Sekondi-Takoradi metropolis areas and ecosystems that have a considerable degree of research were not selected. The final 10 coastal/marine areas (Table 2) were selected to represent critical habitats found in the Western region of Ghana. Based on the Coastal/Marine Ecological Classification Standard, each of these critical areas was classified to Level 4. There was not much information on physical structures to classify further to Level 7, although a considerable amount of data was generated for Level 8, i.e., biological associations.

It is of paramount interest to protect the integrity and structure of these habitats for sustainability. Management of these habitats is deemed crucial in the light of the recent discovery of gas and oil and the expected outburst/growth in socio-economic activities. To ensure that coastal resources managers are not bereft with the requisite scientific knowhow for the management of these critical habitats, field studies were carried out to provide current information on their status. The field study aimed at inventorizing and documenting the biodiversity of these habitats. Further, assessing the abiotic environment of these habitats was made to ascertain the fitness to support the host biodiversity. Field studies were designed to collect primary data on key indicators of the habitats.

Table 1. Ranking of the various coastal areas along the Western Region of Ghana (* low, ** medium, *** high)

Rank	*Name*	*Type of ecosystem*	*Unique*	*Diversity*	*Anthropogenic*		*Economic benefits*	*District*
					Present	*Future*		
1	Amanzule	Lagoon, Estuary	***	***	***	***	Fishing/ Wildlife habitat	Jomoro
2	Wider Cape Three Points	Beach, Estuary, Forest, Lagoon,	***	***	***	*** *oil spill risk*	Expansion in amenities, wildlife habitat, Fishing	Ahanta West
3	Butre	Beach, Mangrove, Estuary, Lagoon	***	***	**	***	Source of water supply, mining	Ahanta West
5	Whin River	Beach/Estuary	**	**	***	***	Fishing/ Wildlife habitat	Sekondi-Takoradi
4	Miamia	Rocky Beach	***	**	**	***	Future supply ship docking area, rare flora and fauna, pristine environment	Ahanta West
6	Abby Lagoon	Transboundary Wetland	*	**	***	***	High productivity	Jomoro
7	Ankobra	Estuary	*	**	***	***	Mangrove/Fishing/Wildlife habitat	Nzema East
8	Dixcove	Beach	***	**	*	*** *oil spill risk*	Fish landing site for large pelagic	Ahanta West
9	Esai	Lagoon	*	**	***	***	Wildlife habitat	Sekondi-Takoradi
10	Essiama	Beach	***	***	*	**	Protected area, Shorebirds	Jomoro
11	Pra	Estuary	*	**	***	***	Fishing/Wildlife habitat/Mining	Shama
12	Ankasa	Terrestrial/ National park	***	***	*	*	Tourism	Ellembele
13	Domuli	Wetland	**	***	**	*	mangrove forest/estuary/ wildlife	Jomoro
14	Efasu	Depressional wetland	**	***	*	**	Freshwater lagoon/ Wildlife habitat	Jomoro
15	Egyambra	Beach	*	*	***	***	Future Harbor site	Ahanta West
16	Essikado	Beach	*	*	***	***	Tourism	Sekondi-Takoradi
17	Essipon	Beach	*	*	***	***	Tourism	Sekondi-Takoradi
18	Belibangara	Depressional wetland	*	**	**	**	Fishing/ Wildlife habitat	
19	Adjoa	Beach, near estuary	*	*	** *erosion*	** *erosion*	Shrimp fishing	Ahanta West
20	Busua	Beach	***	*	*	*	Tourism	Ahanta West

Table 2. Selected critical habitats in the Western Region, classified using CMECS (Madden *et al*., 2004)

Name/Locality	Level 1 – Ecoregion	Level 2 – Regime	Level 3 – Systems	Level 4 – Hydroform/ Geoform
Belibangara	Western Region of Ghana, Gulf of Guinea, Atlantic Ocean	Freshwater influenced	Estuarine system	Lagoon
Domunli		Freshwater influenced	Estuarine system	Lagoon Estuary Mangrove
Amansuri		Freshwater influenced	Estuarine system	Lagoon Estuary Swamp peat forest
Ankobra		Freshwater influenced	Estuarine system	Estuary Mangrove
Miamia		Marine	Near shore marine	Sandy and rocky beach Coastal forest
Kpani-Nyila		Freshwater	Estuarine system	Estuary Sandy beach with rocky outcrop Mangrove
Princestown		Marine	Near shore marine	Sandy and rocky beach Coastal Forest
Cape Three Points		Marine	Near shore marine	Rocky beach Coastal Forest
Butre		Freshwater	Estuarine system	Lagoon Sandy beach with rocky outcrops Mangrove

2 APPROACH AND METHODOLOGY

2.1 Water Quality

2.1.1 CTD Deployment

A CTD (model ACL 1180-PDK, Alec Elcetronics, Japan) was used in sampling *in situ* parameters (conductivity, temperature, salinity, turbidity and depth) at 3 different locations in the Belibangara and Amansuri lagoons to study the variations in conductivity, temperature, salinity and turbidity with depth in each lagoon. During deployment, the CTD was allowed to equilibrate at the surface at each station and then was lowered at a drop rate of 0.5 ms^{-1} till the CTD touched the bottom. The depth of the water was recorded with the aid of an on-board echo sounder. The data collected, which was logged in the CTD at every 0.1 m, was uploaded to a computer at the end of each sampling.

2.1.2 Water Sampling

Water samples were collected for dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) determination using the iodometric (titrimetric) method (APHA, 1995). Water samples for DO analysis were fixed in DO bottles on the field using the Winkler reagents (Winkler I and II). Both samples for DO and BOD were kept on ice and sent to the laboratory for analysis. For turbidity measurements, water samples were collected in 100ml plastic bottles and capped. For nutrients analysis, 100ml plastic bottles were filled with water samples, capped and kept on ice. For chlorophyll analysis, one litre (1L) water samples were filtered through a 0.45μm filter paper (47mm -diameter Whatman GFC) and the residue kept on ice. Water samples for trace metals (As, Cd, Cu, Pb, Hg, Fe, Mn and Zn) analysis were taken into 1L high-density polypropylene bottles previously washed and soaked in analytical grade nitric acid solution. The water samples were then fixed *in situ*with dilute analytical grade nitric acid to prevent metal oxidation and kept on ice. For microbial analysis, water samples were collected into 100ml sterile plastic containers, capped and placed on ice. All the samples were then transported to the laboratory for analysis. Prior to sampling, all sampling containers were pre-conditioned by rinsing three times with field water sample.

2.1.3 Water Analyses

2.1.3.1 pH, Temperature, Salinity and Total Dissolved Solids (TDS)

The pH, temperature, salinity and TDS of water samples were determined *in situ*. The pH was determined using a pH meter (glass electrode, automatic temperature compensation). The pH meter was first calibrated with standard pH buffers before immersing probe into the water. The water was stirred gently for the meter to equilibrate and the pH taken. Temperature was measured concurrently. Salinity was measured using a hand-held refractometer. TDS was determined using Hach portable meter and probe.

2.1.3.2 Turbidity

Turbidity in water samples were determined by the Nephelometric method (APHA, 1995).

2.1.3.3 Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD5)

In the laboratory, DO samples were analyzed immediately, whiles BOD samples were immediately incubated at a temperature of 20^{o}C for five days after which the Winkler reagents were added. Concentrated H_2SO_4 was added to both DO and BOD samples (250 ml sample: 2 ml concentrated H_2SO_4) prior to analysis in order to dissolve precipitates. For each sample, 50 ml aliquots were titrated against known concentrations of 0.025M sodium thiosulfate ($Na_2S_2O_3.5H_2O$) solution using starch as indicator. The titration was repeated two more times and the average titre value found. For a 200 ml sample, the volume of titrant added is directly proportional to the amount of DO in milligrams per litre (APHA, 1995).

2.1.3.4 Nitrates and Phosphates

Nitrates concentrations were measured using Hach DR/2010 Spectrophotometer according to the Hach Method 8039 (Hach, 2000), after sample treatment with Hach pre-packaged reagents (Nitra Ver 5 Nitrate reagent powder pillow). Phosphates concentrations were determined by the Hach DR/2010 Spectrophotometer according to the Hach method 8048, after sample treatment with Hach prepackaged reagents (Phos Ver 3 powder pillow reagent).

2.1.3.5 Chlorophyll

Chlorophyll pigments were extracted with acetone-water mixture (9:1 v/v). The extracts were then analyzed at 630 nm, 647 nm, 665 nm and 750 nm wavelengths using a Hach DR/2010 spectrophotometer. Using the appropriate formula, chlorophyll content was calculated.

2.1.3.6 Trace Metals

Fe and Pb were analyzed by flame atomic absorption spectrometry (AAS) while Mn, As, Hg, Cd, Cu, and Zn were analyzed using instrumental neutron activation analysis (INAA).

2.1.3.7 Total Coliform, E. coli and Total Heterophic Bacteria

The methods for analyses were the APHA 9222A for total coliform, APHA 9260F for *E. Coli* and APHA 9215B for total heterotrophic bacteria. Briefly, known quantities of the sample were plated onto a non-selective agar medium. After pre-incubation at 20-25^{o}C for-2 hours, a selective medium containing lactose was poured on the agar and consequently incubated at 44^{o}C for 24 hrs after which colonies with a typical or suspicious morphology were counted.

2.2 **Biodiversity**

The methodology employed for the study varied from habitat to habitats and species to species. These methods are briefly described in the following sections.

2.2.1 Rocky Shore Biota

The flora and fauna on the rocky intertidal areas of Butre, Dixcove, Axim, Princess Town, Cape Three Points, and Miamia were assessed qualitatively and semi-quantitatively during periods of low tide. The species identification was carried out using taxonomic manuals and articles (e.g., Edmunds, 1978; John *et al*., 2003).

2.2.2 Sandy Beach

Quantitatively sampling of intertidal sandy macrobenthic infauna was carried out using a 30 x 30 box corer. Three replicates were taken from each site with the interval between each replicate location approximately 100 m.

2.2.3 Shorebirds Enumeration

Observations of the shorebirds were made using a Nikon 60 mm, 7-50x zoom binoculars in the mornings (06:30 GMT). The birds were either counted (small sized flock) or estimated (large flock). The enumeration was done within the 200 m radius and ensured that double counting was avoided. The social activities of the shorebirds were observed at each site. It should be indicated that each site was visited once.

2.2.3.1 Transect Counts of Terrestrial Birds

Terrestrial birds survey in the four study areas was carried out using mainly transect counts and opportunistic observations. Transect count was carried out along footpaths, trails and other access ways within each of the four study areas. Transects were selected to cover all the identifiable habitat fragments in each of the four study areas. Counts were usually carried out between 6:00 and 10:00 am and between 3.00 and 5.30 pm when birds were most active and usually over a transect distance of 3-5 kilometers. Transect count procedure involves slow attentive walks along transects during which any bird seen or heard is identified and recorded. With the primary purpose of identifying presence of species, no distance limit was set and hence any species seen or heard anywhere in and around any of the study sites was identified and recorded. Field data for each of the four study areas was complimented with data from existing previous ornithological work. Borrow and Demey (2001) was used as the main reference for confirming the identity of species encountered.

2.2.4 Terrestrial Vegetation Assessment

Vegetation types in the study area were identified and described using the classification schemes of Hall and Swaine (1981) and Taylor (1960). The identification and classification of the

vegetation types were image-based coupled with ground-truthing. Species were surveyed within the identified vegetation types.

2.2.4.1 Field Sampling

Field sampling took place at preselected examples of each vegetation type. Selection of the units was based on unclassified polygon map produced during the initial classification of the vegetation units in the study area. Point locations in the study area were sampled to verify the vegetation type and identify dominant floristic groups. Quantitative information for plant diversity estimates was obtained by sampling in plots at a subset of these locations. The vegetation units sampled included representative examples of all vegetation types in the study site. Sampling locations or points were precisely geolocated with a GPS receiver. Species were identified out to 20 meters in a 360^{o} "sweep" around the sampling point. Plots of size 25 m x 25 m (Hall and Swaine, 1981) for forest and 10 m x 10 m for shrubs and grassland were established at sampling locations for quantifying diversity. Species of conservation concern in the vegetation types will be determined by making references to IUCN threat categories and the Star Rating system of Hawthorne, 1993.

2.2.5 Mammals

2.2.5.1 Direct/Opportunistic Observation

Direct opportunistic observation of large mammals and reptiles at the study sites, involved undertaking transect walks through walking trails or paths in various microhabitats in the seven survey sites, and recording any animal sightings or sounds (vocalizations).

2.2.5.2 Refuge Examinations

Refuge examinations/litter search involved visual scanning of terrains to record any mammals or reptiles seen hiding under rocks, in fallen logs, rotten tree stumps, and in leaf litter (litter search).

2.2.5.3 Animal Spoors

The *spoor* of animals (i.e. any sign left by a living animal, such as feeding sites, regular pathways, tracks, footprints, faecal pellets, nests, etc.) were also recorded as evidence of the existence of certain species in the survey area.

2.2.5.4 Interviews

Interviews were conducted with respondents who were mainly farmers, to obtain supplementary information on the different types of reptiles and mammals that were not encountered by the research team, as well as their perceptions and attitudes towards the various faunal species. The respondents were shown manuals with photographs of animals to guide them in the identification.

2.2.5.5 Small Mammal Live-Trapping

Small mammals were live-trapped using standard Sherman Collapsible Traps (23 cm x 9 cm x 7.5 cm). Thirty traps were laid at 10-metre intervals along 300-metre transects cut through representative vegetation in each of the seven study sites. The traps were checked twice daily, early in the morning and late afternoon for two consecutive nights at five sites (Belibangara, Amansuri, Ankobra, Axim and Cape Three Points) and one night for two sites (Butre and Princes Town). The total number of trap-nights was therefore 360 (1 trap-night = 1 trap set for one night).

Captured animals were euthanized with chloroform, identified on the spot (if possible), sexed, aged, weighed, and examined for reproductive condition. Standard measurements (body, tail, ear, and hind limb lengths) of all the animal specimens were taken. All the captured specimens were serially labelled and preserved in formalin. Specimens that could not be immediately identified in the field were later identified in the vertebrate museum of the Zoology Department, University of Ghana, and with the help of Kingdon (1997). Small mammal field handling techniques were as outlined in Wilson *et al*. (1996).

Species of international Conservation Concern (i.e., species listed by IUCN and CITES) were identified and recorded.

2.2.5.6 Analysis of Data

Relative Abundance

This is the number of individuals of a particular species in a particular habitat per 100 trap-nights. Captured small mammal species in the various habitats will be estimated as follows:

$$\textbf{\textit{Relative abundance (Ar)}} = \frac{\textbf{\textit{Ni}}}{} \textbf{\textit{ x 100 TN}}$$

Where, ***Ni*** = Number of individuals of a particular species in a particular habitat, ***TN*** = Number of trap-nights in a particular habitat (1 trap-night = one trap set for one night)

Species Diversity

Species diversities were estimated using the Shannon-Weiner index (*H*) as follows:

$$H = -\Sigma\, pi \ln pi$$

where: ***H*** = Shannon-Wiener Diversity Index, ***pi*** = proportion of the *i*th species in the total sample

2.3 Fisheries

Ten (10) fish landing ports were selected in the study area for field visits (Annex 1). These were: Belibangara, Amansuri main, Domunli lagoon, Amansuri estuary at Azulenoanu, Ankobra estuary, Butre, Dixcove, Princess Town, Axim and Miamia.

Major activities undertaken were as follows:

- Purchase of fish samples from artisanal fishers for collection of basic biological data,
- Experimental fishing using hired local fishers utilizing diverse gears at designated coastal areas,
- Inspection and identification of gears deployed and catches by the fishers at the fish landing ports in the study area
- Enumeration of active canoes to provide information on the fishing effort
- Interaction and interview of fishers.

2.4 Socio-economics including Traditional Knowledge

A one-time socio-economic assessment was carried out in the main town in selected study sites - Amansuri, Ankrobra, Butre, Cape Three Points, Dixcove, and Princestown. Data collection was based on a semi-structured questionnaire with a mix of specific and open-ended questions that allowed the respondents to expand on any other issues of importance. Individuals were approached and interviewed to assess their socio-economic status. Opinion leaders were targeted based on the fact that they would have access to more information and traditional knowledge of the area and its environs. The selected respondents were then invited to join other interviewed community members for a focal group discussion on the community's environmental and traditional practices. In each town, between 10 and 15 individuals were interviewed.

The indicators selected reflect the general objectives of the study – to assess the condition and trends in changes of critical habitats, and to obtain traditional information on resource use and management. As little information is available or accessible, this study establishes baseline information that can be monitored for changes over time. A list of indicators was created (Tables 1 and 2) based on literature for socio-economic assessments of coastal communities and upgraded with additional indicators for the specific objectives of the study.

2.4.1.1 Data analysis

Responses obtained from the individual interviews, which assessed *general information* and *socio-economic status* of the respondents were evaluated and results presented according to the pre-selected indicators below:

General Information
Sex
Age
Ethnic group
Language spoken
Religion
Marital status
Children in school
Occupation
Level of education

Status
Standard of living
Residential status
Social amenities
Environmental awareness

Notes from the semi-structures component of the focal group discussions are presented according to the themes (with selected indicators) below:

Resources
Resource collection
Farming
Fishing
Hunting
Water
Energy
Health
Flora and fauna

Environmental issues
Bush fires
Floods
Erosion
Climate change
Resource degradation
Waste disposal

Traditional beliefs and resource management
Culture
Natural/sensitive sites
Conservation practices
Regulatory measures

2.5 GIS Mapping

The methodology adopted ensured collection and mapping of reliable, high quality, current and spatially accurate information about the identified coastal habitats in the Western Region. Base maps were prepared from Environmental Protection Agency Sensitivity Mapping Program and topographic maps. The final scale for the maps was to be between 1: 5,000 and 1: 25,000. This is necessary to obtain high resolution of the selected habitats in order to map out the inventory carried out in this exercise. The base maps used in this report were those obtained from EPA and topographic sheets. Since the scales used were lower than what is required, there is still need for re-digitization of critical habitats to the appropriate scale. These would be carried out as soon as the orthophotos are released.

3 CURRENT STATE OF THE SELECTED KEY CRITICAL HABITATS OF THE WESTERN REGION

This chapter presents habitat-based findings of the field and laboratory survey. For each habitat data is presented on water quality, marine, coastal and terrestrial biodiversity, fisheries, socio-economics of adjacent coastal communities, and digital maps provided. Issues of critical conservation significance are discussed and management strategies identified for each habitat.

3.1 Introduction

The habitats are presented geographically in their order of location along the coastline from west to east (Figure 1):

1. **Belibangara**
   Coastal freshwater lagoon with no open link to the sea and serves as a wildlife habitat, fishing habitat, transportation means and for water abstraction for domestic usage.
2. **Domunli**
   A small estuary, with an intact and rich mangrove forest.
3. **Amansuri Main**
   Network of freshwater and brackish water lagoons with the only known intact swamp peat forest in Ghana
4. **Azulenoanu (Amansuri Outlet)**
   An estuary lined by mangroves with significant submerged stands of the water lily plant, *Nymphaea lotus*
5. **Ankobra**
   An estuary marked by degraded mangroves along the fringes.
6. **Miamia**
   Sandy beach with rocky boulders at the eastern side, sheltered from the impact of the open sea waves by a coastal forest.
7. **Kpani-Nyila**
   An estuary formed by the two rivers of Kpani and Nyila, has a breached sand bar and healthy mangroves on the fringes.
8. **Princestown**
   Long stretch of sandy beach with some portions interspersed with submerged rock.
9. **Cape Three Points**
   The only forest reserve of primary forest, located adjacent to a rocky beach.
10. **Butre**
    Long stretch of sandy beach, with a few rocky outcrops.

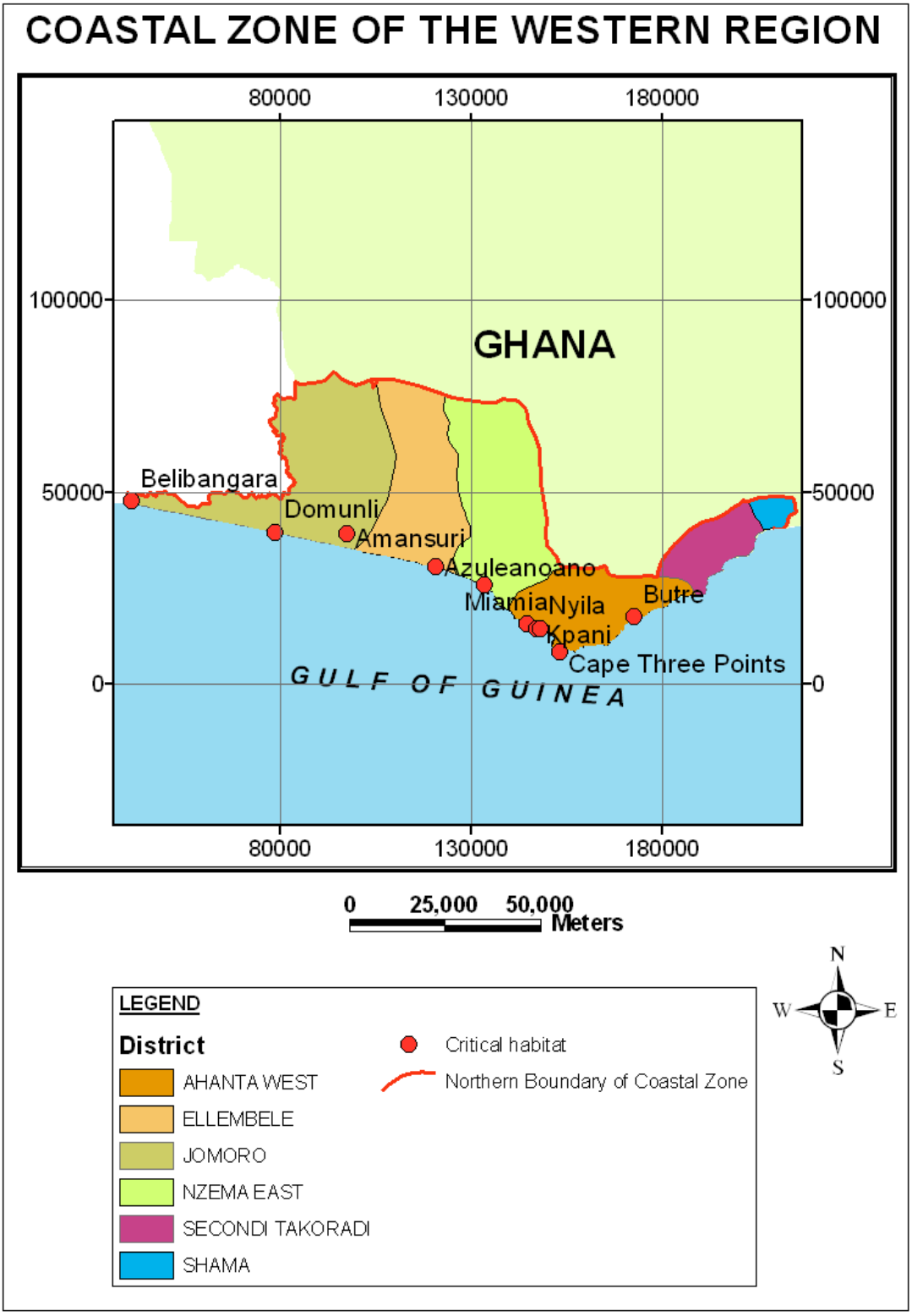

Figure 1. Map of the Western Region of Ghana

3.2 **Belibangara**

The Belibangara habitat/site is located at New Town, which is the furthermost town in the Jomoro District of the Western Region and adjacent to Cote d'Ivoire (Appendix 1). It is a coastal freshwater lagoon with no open link to the sea and serves as a wildlife habitat, fishing habitat, transportation means and for water abstraction for domestic usage.

The water body has religious and traditional values to the community as they worship it as a deity. The local community believes the spirit of the Belibangara abhors dirt and filth, as such use of outboard motors and refuse dumping are not permitted in it. Significant portions of the lagoon are covered by aquatic weeds dominated by the water lily plant *Nymphaea lotus* (Figure 2). The observed deterioration of aquatic vegetation in the lagoon has perhaps given rise to eutrophication and siltation. This is, in no small way, contributing to the reduction in size of the lagoon.

Figure 2. Eastern portion of Belibangara lagoon showing excessive growth of aquatic vegetation

3.2.1 Water quality

The details of the water quality results (Appendix 2) of the Belibangara lagoon shows that dissolved oxygen (DO), pH and phosphate levels were within internationally acceptable limits. Mean nitrate concentration, however, exceeded the NOAA/USEPA recommended range for the avoidance of algal blooms in estuaries and coastal ecosystems (Appendix 9). The N:P ratio was approximately 44:1, which far exceeded the recommended N:P ratio limit of 10:1, indicating that the system can support less species diversity (NOAA/USEPA, 1988). For trace metals, *Cd* and *Pb* concentration in the lagoon were below laboratory detection limit. However, mean levels of *Zn*, *Cu*, *Fe*, *Hg* and *As* exceeded the WHO recommended limits for aquatic life (Appendix 2).

Microbiological analyses revealed that total coliform and *E. coli* counts were within acceptable limits (Appendix 9). However, the levels of these bacteria did not conform to the Ghana

Standards GS 175 of zero tolerance for coliform bacteria. This suggests that the consumption of the water without treatment could pose serious health threats to the community who depend on the lagoon for drinking water.

3.2.2 Biodiversity

3.2.2.1 Macrobenthic fauna

The macrobenthic fauna composition within the lagoon comprised of only three taxonomic groups – Isopods, Polychaetes and 'Other' taxa (Table 3). Isopods were solely represented by *Excirolana latipes*, polychaetes by *Capitella capitata,* whilst *chironomids* constituted the *'Other'* taxa.

Table 3. Abundance of major macrobenthic faunal groups in Belibangara lagoon

Taxa	Abundance	Percent Abundance (%)
Isopods	10	71.4
Polychaetes	2	14.3
Others'	2	14.3
Total	*14*	*100*

3.2.3 Avifauna

Shorebirds' populations at Belibangara was relatively low, with only two species recorded (one bird each of *Actophilornis africanus* (Africa jackana) and *Milvus migrans* (Black kite)). This could possibly due to unreliable source of food items for these birds due to unexposed substrate as a result of high water level. Exposure of wetland substrate could lead to rapid exposure of fresh patches of unexploited feeding areas which would consequently attract foraging birds. Foraging waterbirds are uncertain about their chances of success on arrival at a patch and therefore sample their environment to get information on the presence of food so as to 'make decisions'. Since the decision on whether to keep on feeding or leave a patch depends largely on prey encounter rates. It is therefore reasonable to assume that the low numbers of birds is related to low encounter rate of prey items (e.g. invertebrates) possibly due to organic pollution as indicated by high levels of nitrate. The observation is expected due to high residence time and low flushing rate of pollutants since the water body is an enclosed system.

3.2.4 Fisheries

3.2.4.1 Fishing Effort

Fishing was the most popular profession or pastime among male adults in the community, who fished in the lagoon all year round. This made the fishing effort on the lagoon very high. The natives stated that there were about 50 commercial/subsistence set nets in the Newtown community. However, almost every family had at least one cast net which it uses to fish mainly for subsistence in support of protein needs. Because drag nets are non-selective and perceived as destructive by natives, a traditional management practice has banned its use in the lagoon. The

cast net and set nets are deployed using planked canoes that have a dual purpose of transportation and fishing. Ten of these crafts were counted at the landing site during the survey period.

3.2.4.2 Experimental Fishing

Experimental fishing using two cast nets by two fishers for one hour each, in the early hours of the morning yielded a total catch of 18 individual fishes from three families and four genera (Table 4). *Chrysicthys nigrodigitatus* was the dominant species. One of the fishermen had samples of all the genera, while the other had samples of only *Sarotherodon* and *Chrysicthys* sp. On average, the total weight of fish caught per fisherman in one hour was 653 g, at a cost of Three Ghana Cedis fifty pesewas (GH¢3.50) per fisherman per hour.

Table 4. Results of experimental fishing at Belibangara

Family	Species	TN	ASL (cm)	AW (g)
Cichlidae	*Sarotherodon melanotheron*	4	15.8	178.8
	Tilapia zillii	4	10.1	38.8
Bagridae	*Chrysicthys nigrodigitatus*	8	13.9	53.9
Mormyridae	*Mormyrus rume*	2	7.9	12.5

*(**TN** = Total number; **ASL**=Average Standard Length; **AW** = Average Weight)*

3.2.5 Fish Composition

The inhabitants noted that in the past years, the lagoon hosted rich variety of fish species that occurred in great abundance. Some of the fish species mentioned as being caught in the past were: *Tilapia zillii, Sarotherodon melanotheron, Polypterus endlicheri, Mormyrus rume, Hepsetus odoe, H. niloticus, Citharinus* spp.*, Schilbe mystus, Alestes* spp.*, Clarias* spp., *Chrysicthys* spp., *and Channa obscura.* The dominant species, according to them, in the past and in recent times, were fishes from the tilapia and catfish families. However, there has been a general decline in species richness caught in the recent years, although abundance is relatively higher during the rainy season compared to the dry season when the lagoon reduced in size. Inhabitants attributed the observed decline in fish catch and diversity mainly to excessive human pressure due to population increase and the use of small mesh sizes of nets.

3.2.6 Critical Features and Conservation Significance

The Belibangara Lagoon is important as a fresh water resource for the surrounding community for their domestic use. Various human activities (washing, bathing) near and in the lagoon, in addition to decaying vegetation, has possibly influenced the high levels of nutrients recorded. This also contributes to siltation and the growth of aquatic vegetation, which may lead to the low aquatic biodiversity observed. The distinct location of the lagoon near the country's western border with Cote d'Ivoire, and it being a unique freshwater lagoon, provides satisfactory justification for protection.

3.3 **Domunli**

The Domunli Lagoon is an open lagoon which stretches over an area of 1560 km^2. It is located in the Jomoro District of the Western Region (Appendix 2), adjacent to Old Kabensuazo. The Domunli wetland, although relatively small, has an intact and beautiful and healthy mangrove forest and estuary (Figure 3). It is inhabited by monkeys, crocodiles, marine turtles and birds. The wetland hosts significant numbers of *Tilapia* spp. due to minimal fishing in the lagoon. This is due to abundant mats of *Enteromorpha clathrata* which destroy the fishing nets and discourages large scale fishing by the community members.

Figure 3. Domunli Lagoon with fringing mangroves and coconut trees

3.3.1 Water quality

A bloom of the green algae *Enteromorpha clatharata*, previously identified as *E. flexuosa* (personal communication with Francis Seku) was observed in the lagoon during the study period. This observation was supported by high mean concentration of chlorophyll-a recorded (Appendix 9). According to the community members, the bloom was brought in from the adjacent marine environment through inflows into the lagoon.

High concentration of phosphate measured in the lagoon could possibly sustain the algal bloom. Although the sources of the phosphate into the lagoon are unclear, run-offs from the surrounding agricultural fields and from dump sites observed along the fringes of the lagoon could be contributing factors. According to the inhabitants, there are no toilets in the village and most people defecate in holes that are dug along on the beach, which are later covered. In addition,

high BOD levels indicate excessive amounts of dissolved organic matter (DOM) in the lagoon possibly from decomposing *E. Clatharata*, aquatic vegetation and organic waste discharges from the surrounding communities. Levels of *Cu, Zn* and *Fe* recorded here were also below WHO acceptable standards (Appendix 9).

3.3.2 Biodiversity

3.3.2.1 Macrobenthic fauna

A total of 105 individual macrobenthic fauna belonging to two major groups were recorded. Of this number, polychaetes constituted 79% and 'Other' taxa recorded constituted 21% (Table 5) Polychaete taxa was dominated by *Capitella capitata* indicating presence of organically-enrich pollutant, which is consistent with the observation of the water column. *Capitella capitata* is an opportunistic polychaete that has been considered an important universal indicator of organic pollution in marine sediments (e.g. Mendez *et al*., 2000). The presence of populations of C. *capitata* in the lagoon represents an index to evaluate disturbance impact related to organic load.The 'other' taxa was represented by a fish larva, a mysid and chironomids.

Table 5. Abundance of macrobenthic faunal groups in Domunli lagoon

Taxa	Abundance	Percent Abundance
Polychaetes	83	79
Others'	22	21
Total	*105*	*100*

3.3.2.2 Avifauna

There were a total of 41 individuals belonging to nine species of shorebirds were recorded at the Domunli lagoon. Of the numerical abundance, waders accounted for 32 individuals (78%) and five (5) species (56%). Shorebirds placed in the 'others' category reported 9 individuals (22%) and 4 species (54%). No terns were observed.

Table 6. Abundance of major shorebird groups recorded at Domunli lagoon.

Common name	Scientific name	Abundance
	Waders	
Whimbrel	*Numenius phaeopus*	6
Grey plover	*Pluvialis squatarola*	4
Common sandpiper	*Tringa hypoleucos*	7
Greenshank	*Tringa nebularia*	4
Sanderlings	*Calidris alba*	11
Total Waders		***32***
	OTHERS	
Pied kingfisher	*Ceryle rudis*	3
Little egret	*Egretta garzetta*	1
Africa jackana	*Actophilornis africanus*	2
Reef heron	*Egretta gularis*	4
Total Others		***9***

3.3.3 Fisheries

3.3.3.1 Fishing Effort

Although fishing is still carried out by a few members of the community, its importance has diminished over the years due to the abundance of mats of *Enteromorpha clathrata* and the recent algal bloom in the lagoon. Fishers indicated that since 2009, minimal fishing is carried out in the lagoon, although large quantities of fish have been observed. The algal bloom made catchability of fish low and contributed to the destruction of the predominant cast net used in the lagoon for fishing (Figure 4). Other organisms collected from the lagoon include fiddler crabs, periwinkles and mud skippers.

The sandy beaches adjacent to the Domunli Lagoon are important for beach seining, with extensive activities occurring from Bonyere to Elonyi. The main livelihood of the community members is crop farming, mostly of palm nuts, coconut and cassava, and livestock (pigs and sheep). According to the inhabitants, chickens were no longer reared after bird flu destroyed most of their flocks. The farms are located behind the mangroves and are accessed by a small wooden bridge across the lagoon.

Figure 4. Algae clogging the meshes of a newly constructed cast net after a bout of fishing

3.3.3.2 Experimental Fishing

An experimental fishing for one hour in the early hours of the morning, using the cast net was conducted (Table 7). The total weight of fish caught in one hour was 76 g amounting to Five Ghana Cedis (GH₵ 5.00) per hour.

Table 7. Result of experimental fishing at Domunli lagoon

Family	Species	TN	ASL (cm)	AW (g)
Cichlidae	*Sarotherodon melanotheron*	1	9.5	10.0
Mugilidae	*Mugil cephalus*	4	15.6	16.5
Elopidae	*Elops lacerta.*	2	7.9	12.5
Ostreidae	*Crassostrea tulipa*	-	-	500

*(**TN** = Total number; **ASL**=Average Standard Length; **AW** = Average Weight)*

The fish species consisted of both brackish-water (*S. melanotheron*) and typical estuarine species (*Mugil cephalus* and *Elops lacerta*). However, indications from inhabitants of the area suggested a dominance of tilapia species, fiddler crabs *Uca tangerii* and oyster. A very high average of 42 fiddler crab holes was counted per square metre at the exposed banks of the coconut lagoon. The estuarine sesarmid crab *Sesarma huzardi* was also reported to occur in the area, but not in abundance.

3.3.4 Critical Features and Conservation Significance

The Domunli lagoon appears to be pristine and highly productive with a luxuriant stretch of mangroves. The inhabitants are aware of the ecological services of the mangroves, mainly for supporting both the lagoonal and marine fisheries. However, there are no established traditional or conservation practices specifically to protect it. There are a few people who cut down the mangroves for firewood; however, inhabitants claim that most of the firewood is obtained from the farm areas. There are no sacred groves, although some grave sites were observed near the beach.

According to the community members, the mangroves have become more abundant over the past years and the stands seem to have moved closer to the community. They have observed no significant changes in water quality, despite the periodic blooms of algae they refer to as "green-green". Over time, they have observed that the lagoon has become shallower and in the last five years, clams that were once abundant have disappeared.

The mangrove vegetation and the relatively shallow nature of the lagoon support the life of shorebirds. It is envisaged that the eastern portions of the lagoon (i.e., estuary mouth) may be impacted should the plan to site a gas station from the Jubilee Field materialize. Depending on the location of the pipe, inflows between the lagoon and adjacent marine environment may be affected. There is therefore the need for a monitoring programme to be instituted in order to generate reliable data for sustainable management of the lagoon. Due to generally low fishing pressure and a small fishing community, fish abundance is high although with low diversity. The habitats look promising for aquatic biodiversity if managed due to reduced human influence. As such it is recommended for management purposes.

3.4 **Amansuri Main**

The Amansuri Lagoon is located near Beyin in the Jomoro District (Appendix 3). It is part of the Amansuri wetland (4º 55' N 20º 15' W) which comprises of a network of freshwater and brackish water lagoons. The Amansuri is the only known intact swamp peat forest in Ghana. The famous 500 years old Nzulezu village, where houses are built on stilts and traditional life adapts to the watery conditions, is built on the Amansuri Lagoon (Figure 5). The area has already been designated as an Important Bird Area based on Birdlife International criteria.

Figure 5. Amansuri wetland with Nzulezu village at the background

3.4.1 Water quality

An average pH value of 5.3 was recorded in the Amansuri Lagoon indicating moderate acidic conditions, possibly due to humic acids. The levels of *Pb* and *As* were below WHO limits. However, mean levels of *Cu, Hg, Cd, Zn* and *Fe* exceeded WHO recommended limits for aquatic life, which poses a threat to aquatic life. The low DO concentration in this lagoon can have adverse effects on fish and other organisms (ANZECC/ARMCANZ, 2000), such as immune suppression which can cause elevated susceptibility to diseases for several years (Mellergaard and Nielson, 1987).

Toxicity of trace metals such as *Zn* and *Cu* could be potentially enhanced during low DO levels in the lagoon (ANZECC/ARMCANZ, 2000). Therefore, the relatively high BOD recorded should be a matter of concern. The mean phosphate concentration was within the recommended range, the mean nitrate concentration far exceeded the NOAA/USEPA recommended range, resulting in an N:P ratio of 52:1. This exceeds the recommended N:P ratio of 10:1 for the support of high diversity (NOAA/USEPA, 1988).

The community depends on a borehole as their main source of potable water, although some members have access to pipe water or a well. The village of Amansuri could be the major source of the organic load into the lagoon, as toilet facilities are mostly unavailable, contributing to the high BOD measured. Although there is a public dump for solid waste, community members usually dispose of their liquid waste in the streets and in gutters. When interviewed, most of them believed that there were no negative environmental impacts of these activities, suggesting the need for basic environmental education towards sanitation and protection of diversity.

3.4.2 Biodiversity

3.4.2.1 Terrestrial avifauna

The terrestrial avifauna assessment of the Amansuri Wetland recorded a total of 148 bird species from 40 avian families (Appendix 10). Species recorded included two globally threatened species listed in the Near Threatened and Vulnerable Categories of the IUCN Red List of Threatened species, seven Wholly Protected species under Schedule I of the Wildlife Conservation Regulation and 76 species whose global distribution is limited to the Guinea-Congo Forest of West and Central Africa. Qualitatively, the avifauna composition of the site showed a relatively high species diversity and richness of 4.7 and 24.4, respectively.

Birds recorded in the wetland consist of species associated with primary, secondary and open woodlands, but with clear dominance of forest dependent species. The bird species composition of the wetland reflects the effect of the different habitat fragments within the wetland. The wetland is located within the wet evergreen ecozone, and although some portions of it have been degraded through various human activities, a greater proportion of it remains inaccessible and in relatively good condition. This has probably accounted for the relatively high proportion of its avifauna being forest depended. With the diversity of habitat fragments, including a relatively large area of fresh water swamp forest, the Amansuri wetland is potentially a biodiversity hot spot.

3.4.3 Fisheries

3.4.3.1 Fishing Effort

Fishing is a popular profession among members of the communities adjacent to the water body. It is more intense during the raining season when catch is good and inhabitants fish commercially with basket, wire mesh traps, set nets, and cast nets, in that order of importance. As the study visit was during the dry season, there was no active fishing activity. Fishers interviewed indicated they did not go to fishing because catches were poor during the dry season. On a trip round the water body, a few abandoned fish traps, set nets and broken down small sized wooden canoes were found at isolated places along the banks.

Fishing regulations (mainly the ban on fine and small nets) are present in the community. Decreasing fish catch has been observed over the years and the locals attribute this to the presence of algae in the water. Most of the respondents could not elaborate on any significant

changes in the Amasuri lagoon, although one person had noted increased numbers of "reddish worms" in the water.

3.4.3.2 Fish Composition

There was no experimental fishing as fishers could not be persuaded to go fishing, even for a fee. However, inhabitants indicated that catch was generally dominated by the tilapias (*S. melanotheron*, *Oreochromis niloticus*, and *Tilapia zillii*); catfishes (*Chrysichthys nigrodigitatus, Synodontis* spp., *Clarias* spp.*);* and *Alestes* spp.

3.4.4 Critical Features and Conservation Significance

There are protected sites such as the forest reserves, the lagoon and mangroves in Amansuri Main. The community has established rules about the use of these areas and members understand that these reserves are important for regular rainfall. There are conservation practices which prohibit indiscriminate cutting down of mangroves. Although traditional rules are relatively effective, locals believe that a combination of government and traditional methods will work better.

There is an ongoing bird monitoring project by the Ghana Wildlife Society in the Amanzuri wetland. Another bird monitoring project which has been completed is the Amansuri Conservation and Integrated Development project ('Apollonia Project'). Tourists are the main target of the project, which also includes visits to the Nzulezu village. More information is, however, required on tourist arrivals to assess visitor impacts on the success rates of bird breeding. Based on the information obtained, tourism should be planned or seasonal.

More data is required on solid and liquid waste products in the Nzulezu village that has grave impacts on the water quality of the wetland. This has serious implications for both ecosystem and human health. There are risks of eutrophication which contribute to the algal bloom epidemic in the western region, and can lead to the infiltration of opportunistic vegetation, especially the water hyacinth, *Eichornia crassipes*.

The overall greater Amazuri wetland with its high biodiversity, socio-economic importance deserves a Ramsar status.

3.5 **Azulenoano (Amansuri Outlet)**

The Amansuri wetland enters the sea at Azulenoanu in the Jomoro District creating the Amansuri estuary (Appendix 3). The estuary is lined by mangroves with significant submerged stands of the water lily plant, *Nymphaea lotus* (Figure 6). The water lily is usually harvested by local inhabitants of the adjacent towns as a source of fuel. The estuary mainly serves as a fishing habitat with the adjacent wetlands as the source of crabs that sustains the economy of local inhabitants.

The nearby Essiama beach is important for shorebirds with a maximum number of 10,000 birds have been recorded for the site by the Ghana Wildlife Society. The various groups of shorebirds include Terns, Foraging waders (e.g., Ringed Plover and Sanderling) and Herons.

Figure 6. Amansuri outlet with fringing mangroves and coconut palm

3.5.1 Water quality

Results of water quality parameters for the estuary (Appendix 9) show high DO levels in the estuary. This could be attributed to the mixing effects of tidal inflow into the estuary as indicated by the recorded high salinity. The BOD for this estuary was also relatively high, suggesting a high level of organic matter loading from the town of Azulenoanu. Levels of *Cu, Zn* and *Fe* recorded exceeded WHO water quality standards (Appendix 9) and therefore could have potential public health implications.

3.5.2 Biodiversity

3.5.2.1 Macrobenthic fauna

The macrobenthic fauna recorded at Amansuri sandy beach was mainly *Excirolana latipes* (Isopod). A total of 108 individuals were recorded. Ostensibly, the species may constitute the dominant food item for the numerous Sanderlings observed feeding along the swash. The *E. latipes* were observed wave-riding and quickly bored into the fine sediment during the period of the backwash. It is during the period of the back wash that the Sanderlings follow and feed on the isopod. In the main, estuarine mouth, however, only 1 species of the polychaete was observed.

3.5.2.2 Avifauna

The highest numerical abundance and species richness of the shorebirds were observed. A total of 1081 individuals comprising 12 species (8 waders, 2 terns and 2 "others") were encountered at the beach of the Amansuri Estuary (Table 8). Of the total abundance, Sanderlings, *Calidris alba* dominated with 901 individuals (83.35%l). The Sanderlings were observed feeding presumably on the isopod, *Excirolana latipes* (Figures 7 and 8).

Table 8. Abundance of shorebirds at Amansuri estuary

Common name	**Scientific name**	**Abundance**
	Waders	
Whimbrel	*Numenius phaeopus*	3
Grey plover	*Pluvialis squatarola*	25
Common sandpiper	*Tringa hypoleucos*	1
Sanderlings	*Calidris alba*	901
Black tailed godwit	*Limosa limosa*	37
Eurasian oystercatcher	*Haematopus ostralegus*	3
Little stint	*Calidris minuta*	1
Ringed plover	*Charadrius hiaticula*	16
Total Waders		***987***
	Terns	
Common tern	*Sterna hirundo*	3
Royal tern	*Sterna maxima*	84
Total Terns		***87***
	Others	
Pied kingfisher	*Ceryle rudis*	2
Reef heron	*Egretta gularis*	5
Total Others		***7***

Figure 7. Royal terns (*Sterna maxima*) in flight and Sanderlings (*Calidris alba*) feeding at the beach of Amansuri Estuarine opening.

Figure 8. Shorebirds (Sanderlings, rudy turnstones and grey plovers) feeding in the rocky intertidal beach.

3.5.3 Fisheries

3.5.3.1 Fishing Effort

Inhabitants of the local community fished more in the riverine end of the estuary using cast nets, raffia, wire mesh traps and set nets, in decreasing order of importance. Most households own at least one cast net which is used mainly for subsistence fishing. However, the fishermen indicated that with the entry of the algal bloom into the estuary, catches have remained very poor since 2009, therefore making fishing unattractive. Traditionally, there is no fishing in the estuary on both Tuesdays and Sundays as a management measure.

Because the visit to the site was on an early Sunday morning, it was not possible to undertake experimental fishing. However, beach seining was observed at the beach adjacent to the estuary. The fishers were Anlos from the adjacent town of Essiama, who drove their seine nets to the estuary using trucks. There were 6 beach seine gears from Essiama that fished here. A typical

beach seine company is made up of about 30 crew members, which may attract up to a similar number of helpers when the catch is good. When the sea conditions and past catch history were good, the beach seiners fish all week long, except Tuesdays. Fishing expeditions may last between 4 to 6 hours and the quality and amount of catch landed is variable depending on weather conditions, tidal level, and time of year. The women come in towards the time of landing of catch to purchase catch for the markets. Catch was sold primarily to women who were wives or kith and kin of the fishermen.

3.5.3.2 Fish Composition

The fish catch was mainly dominated by the tilapias and catfish. However, the land crab *Cardiosoma armatum* was very common and popular in the area. Children, youth and adults set many crab traps in the mangroves adjacent to the estuary, and the yield is abundant (Figure 9). Crab trapping is a very lucrative business in the area; crab catch which is surplus to subsistence needs are usually sold commercially on the local market as a high value product.

Figure 9. A typical crab trap found at Azulenoanu

3.5.4 Terrestrial ecosystems

The mangrove forest is dominated by *Avicennia germinans*, *Rhizophora racemosa* and *Laguncularia racemosa*. The mangrove associates *Thespesia populnea* and *Achrostichum aureum* are also well represented. The presence of *Achrostichum aureum* is indicative of degradation. The freshwater end of the spectrum has species such as *Lonchocarpus sericeus*, *Crotalaria retusa* and *Albizia adianthifolia* (Appendix 9).

3.5.5 Critical Features and Conservation Significance

This estuary appears to not be heavily impacted by human activities. The habitat is in good condition with significant biodiversity in terms of mangroves and associated vegetation, fish and crab diversity. This site is recommended for conservation measures.

3.6 **Ankobra Estuary**

The Ankobra estuary is found in the Nzema East municipality (Appendix 4; Figure 10). The estuary is marked by degraded mangroves along the fringes. Pollutants from small-scale mining activities ("galamsey") upstream have a high potential to disturb the flora and fauna in the estuary.

Figure 10. Ankobra Bay at the mouth of the estuary

3.6.1 Water quality

The brackish Ankobra estuary had a brownish water color as a result of sedimentation from upstream activities, confirmed by the high levels of TDS and turbidity recorded. Even the local community has observed the changes in the color of water and reduced levels of flow. The river is used for domestic sources although there are other sources of water available, such as rainwater, well, and borehole. There is farming along the banks of the river, of cassava, coconut, palm nuts, etc., with the application of fertilizers.

Increased sedimentation is most probably due to "galamsey", surface run-offs from agricultural farmlands upstream, and possibly erosion along the banks of the river (National Land and Water Resources Audit, 2002). Fine sediments including clays, silts and fine sands were deposited at the mouth of the estuary due to flocculation and settlement as the freshwater comes into contact with salt water. High turbidity has the potential to cause mechanical and abrasive impairment to the gills of fish and crustaceans (ANZECC/ARMCANZ, 2000). The 'galamsey' activities upstream might have contributed to the high levels of trace metals measured in the estuary, most especially *Hg* and *As* (Appendix 9). There was high BOD concentration, possibly due to high organic loading from settlements that flank the banks of the estuary.

3.6.2 Biodiversity

3.6.2.1 Macrobenthic fauna

The results of sandy bottom macrobenthic faunal biodiversity revealed two dominant groups: namely isopoda and polychaeta. Isopoda was represented solely by *Excirolana latipes* with 218 individuals, representing 85%, while polychaetes constituted 15% (38 individuals) (Table 9).

Table 9. Abundance of major macrobenthic faunal groups in Ankobra estuary

Taxa	Abundance	Percent Abundance
Isopods	218	85.15
Polychaetes	38	14.85
Total	*256*	*100*

3.6.2.2 Terrestrial avifauna

A total of 102 species of birds were recorded in the open woodland and coastal thickets between Axim and the Ankobra River estuary. This is an extensive coastal area without any widespread forest cover. With degraded farmlands and coastal thickets, the area is open to a wide variety of open wood land species. This explains the relatively high number of species and equally high species diversity (4.74) and richness (17.88) for the area.

The avifauna composition did not include any species of global conservation significance. The coastal area between Axim and the Ankobra River estuary is highly degraded without any significant presence of uncultivated habitat, except the few small patches of swamp forest along the Ankobra River. There does not appear to be much prospect for biodiversity conservation along this stretch of the south-western coastal area in view of the increasing human pressure on the land.

3.6.3 Fisheries

3.6.3.1 Fishing Effort

Fishing is also a major livelihood in the community although there are no stringent fishing regulations. The fishermen have observed changes in fish catch over the years.Fishing gears used in the estuary were baited hook and line, various traps and fine meshed drag nets. The main fish species targeted was *Sierrathrissa leonensis*. The baited hook and line was the most dominant gear that was usually deployed in shallow but sheltered areas. More than 100 fishermen were involved and targets were the relatively larger species of estuarine fishes. On the riverine side of the bridge, 5 small wooden planked canoes used for fishing were docked.

The researchers witnessed the landing of catches by two purse seine canoes at the site (Figure 11). The fishers usually come from nearby fishing communities such as Ahobre, Moree, Komenda and Half-Assini.

Figure 11. Purse seine crew about to land marine fish catch at the estuary

At the beach adjacent to the estuary, five beach seine gears were enumerated and believed to be resident fishermen who fished in the sea close to the estuary. Two of the beach seine operators were landing their catches at the time of visit to the site. They had each fished for about 6 hours. The women were at hand on landing of catch to buy fish and subsequently distribute to the markets.

Fish processing is a key income-generating activity at the mouth Ankobra estuary. A group of eight women were busy frying fish they purchased from the fishermen. About six bowls of fish being fried were largely of the smaller sized range (2 – 15 cm). They indicated that the fish catch was bought from the marine or estuarine fishermen regularly and sent to various markets in the Western and Central region after processing them. Only a small fraction of their processed fish is sold locally in the town.

3.6.3.2 Fish Composition

The catch from the estuary was dominated by *Chrysichthys nigrodigitatus, Clarias anguillaris, Tilapia zillii*. Others caught in lesser quantities are *Hemichromis bimaculatus, Hepsetus odoe, Mormyrus rume, Citharinus spp., Barbus spp., Alestes macrolepidotus, Alestes baremose, Clarotes spp*., and *Bagrus bayad*.

Under the mangrove stands at the riverine side of the estuary were large numbers of the mudskipper *Periopthalmus rouxi*. The gobid, *Gobiodes* spp. was also caught alongside the capture of *Sierrathrissa leonensis*. The estuarine crab *Sesarma huzardi* was abundant and so were the fiddler crab *Uca tangerii* (average of 15 crab holes per square metre) and the land crab *Cardiosoma armatum*. The catch from the two purse seiners were a total of 15 medium-size aluminum bowls (15 kg per bowl) of fish and two buckets of high valued shrimps each weighing 8 kg. The fish species included *Scomberomorus tritor*, *S. maderensis, Pseudotholithus senegalensis, Brachydeuterus auritus, Galeoides decadactylus, Caranx rhonchus, Decapterus*

punctatus, Chloroscombrus chrysurus, Selene dorsalis, Ilisha africana, and the shrimp *Penaeus notialis.*

The catch from the beach seine gear was high on the day of the survey, with 20 and 13 baskets of fish recorded respectively by the two gears. The fishers did not allow investigators to sample catch prior to sorting. They preferred to sort the catch by removing all bigger sized fishes to their wives before anyone could get near the catch. Investigators noted one individual specimen of the rare triple tail fish *Lobotes surinamensis* (about 100 cm in total length) landed by one of the gears while the other gear landed 4 pieces of *Pseuthololithus typus,* sizes ranged from 95 to 125 cm. The catch was dominated by the ribbon fish *Trichiurus lepturus* and *Sardinella auritus*. Other species caught in smaller quantities were *Pseudotholithus senegalensis*, *Ilisha africana*, *Galeoides decadactylus, Pentanemus quinquarius, Chloroscombrus chrysurus,* and a large quantity of jellyfish.

3.6.4 Terrestrial ecosystems

The Ankobra estuary has mangrove vegetation dominated by *Avicennia germinans* and *Rhizophora racemosa*. *Machaerium lunatum, Dalbergia escastophyllum* and *Achrostichum aureum* (mangrove associates) are also well represented (Appendix 10). In addition to *R. racemosa* and *A. germinans*, *Pterocapus santalinoides* is also listed as **Lower Risk/Least Concern** by IUCN. *Dalbergia escastophyllum*, *Achrostichum aureum* and *Machaerium lunatum* are among the mangrove associates present at the site.

3.6.5 Critical Features and Conservation Significance

The upstream mining activities, including "galamsey" and sand mining potentially impact on the water quality with elevated turbidity and total dissolved solids as well as heavy metal concentration. Turbidity may affect the estuarine fisheries that could translate into socio-economic concerns. Further, the trace metals may accumulate in the tissues/organs of fish species and other aquatic organisms with the potential transfer in the chain to humans. Impaired water quality will substantially influence aquatic biodiversity negatively and overall ecosystem health and thereby its ability to produce goods and services to humans.

One environmental issue of concern to the community members is the flooding of the Ankobra River, which has caused the loss of lives and infrastructure in the past. The locals believe that the flooding is caused by the construction of the bridge. In addition to the flooding that leads to increased breeding of mosquitoes, other critical conditions mentioned include poor sanitation and improper disposal of water. Although, there is a public dumpsite in addition to individual burning of rubbish, refuse is dumped in the river and liquid waste into the gutter, street, river or sea. There are traditional rules against dumping of refuse in water bodies and defecation at the sea shore, but community members believe thses are not as effective as before.

The biodiversity of the estuary does not indicate any conservation significance. However, the water resources support economic activities of the surrounding communities mainly in terms of fisheries.

3.7 **Miamia**

The ecological habitat of Miamia in the Ahanta West District is mainly of sandy beach and rocky boulders at the eastern side (Appendix 5; Figure 12). It site is sheltered from the impact of the open sea waves by a coastal forest. With the characteristics of a bay, the water of the beach is quite calm and clear coupled with the serene environs.

Figure 12. Rocky (cobble) beach at Eastern Side of Miamia

3.7.1 Biodiversity

3.7.1.1 Macrobenthic fauna

A total of 21 species of rocky epibenthic fauna were encountered (Table 10). These consisted of 12 gastropods, one bivalve, 4 crustaceans, 2 echinoderms and anthozoans each (Table 11). The gastropods were species rich but the barnacle, *Cthamalus dentata* and echinoderm, *Echinometra lucunter* were numerically abundant. As a result of the boulders, numerous species of mollucs and xanthic crabs were observed under the rock crevices (Figure 13; Figure 14). There were 6 macroalgal species. The low species of macroalgae might due to boulders, which are unstable substrates that limit the establishment of macroalgae spores

Table 10. Abundance of major macrobenthic faunal groups at Miamia

	Taxa	**Number of species**	**Percentage**
Fauna	Gastropods	12	57.14
	Bivalves	1	4.76
	Crustacean	4	19.05
	Enchinoderm	2	9.52
	Cnidarian	2	9.52
Total		***21***	***100***
Flora	Chlorophyta	2	33.33
	Phaeophyta	4	66.67
Total		***7***	***100***

Table 11. Inventory of rocky shore fauna and macroalgae of the Miamia rocky beach

Mollusc	Crustacean	Macroalgae
Gastropod	*Grapsus grapsus*	***Chlorophyta (Greens)***
Echinolittorina pulchella	*Cthamalus dentata*	*Bryopsis pennata*
Echinolittorina cingulifera	*Panopeus* sp.	*Chaetomorpha antennina*
Echinollitorina. granosa	Pagurus sp.	
Thais nodosa		***Phaeophyta (Browns)***
Thais heamastoma	**Echinoderm**	*Chaetomorpha linum*
Nerita atrata	*Cidaroidea* sp.	*Basispora Africana*
Patella safiana	*Echinometra lucunter*	*Rhodophyta (Reds)*
Siphonaria pectinata		Lithothamnia
Pranasis sp.		
Arca senilis	**Anthozoan**	***Algal turf***
Nudibrach	*Anthopleura* spp.	
Aplysia sp.	*Zoanthus* sp.	
Bivalvia		
Barbatia sp.		

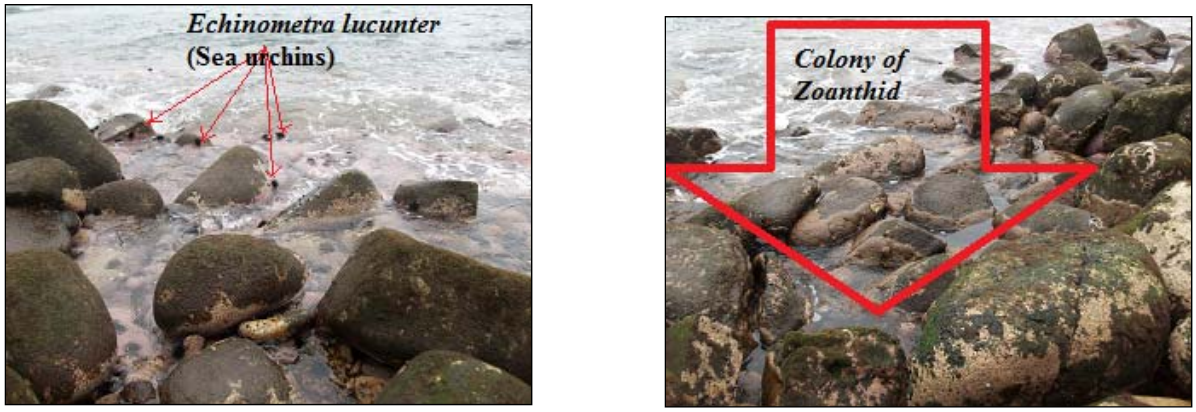

Figure 13. *Echinometra lucunter* and Zanthid colony at Miamia sheltered rocky boulders

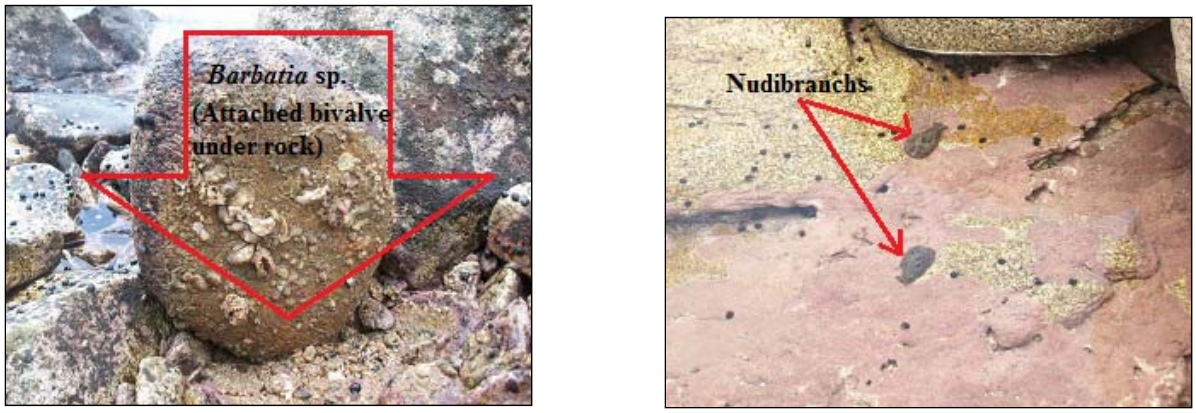

Figure 14. Under rock bivalve and Nudibrachs of the Miamia rocky beach.

3.7.2 Fisheries

No fishing activity was observed at main village beach at the time of visit. The Miamia beach is sandy and about 20 canoes were enumerated at the beach. According to the Chief-fisherman, the major fishing practice is '*watsa'* (purse seine fishing) and the main group of fish species landed was the sardinellas.

At the eastern side of the village, about 5 kilometers away, the beach is rocky. Here, four fishers were observed fishing with cast-net made from mono-filament, a net type that is proscribed for use in marine waters. One of these fishers caught about 100 individuals of *Mugil cephalus* in one throw (see Appendix 12). This is indicative of high abundance of fish in the waters. The fin and shell fish species encountered are listed in Appendix 12.

3.7.3 Critical Features and Conservation Significance

The Miamia site host unique rocky shore fauna that may present high biodiversity value (ecologically and economically). The calm and relatively clear water due to its sheltered nature from the waves support the unique rocky shore fauna. The area present high scientific interest and could be conserved/managed to protect its rich fauna. Due to its semblance of a bay, the habitat may suffer significantly from any human disturbance such as oil spill or climate change. This is because the resident time for any pollutant will be high and will increase the severity of the disturbance.

3.8 **Kpani-Nyila**

Kpani-Nyila estuary is formed by the two rivers of Kpani and Nyila in the Ahanta West District, which empties its content into the sea via a breached sand bar (Appendix 6). The fringes of the water body consist of healthy mangroves. The main activities observed on the lagoon were transportation of humans from one end of the lagoon to another. The rivers are usually separated from the sea by approximately 40 m sand bar. East of the mouth of the estuary, there are few rocky outcrops interspersed with sand (Figure 15). Further east of the Kpani-Nyila, there is a cemetery covered by coastal vegetation including coconut and cactus.

Figure 15. (Left) Kpani-Nyila Estuary. (Right) Adjacent rocky beach (right).

3.8.1 Water quality

The physico-chemical and bacteriological conditions in the Kpani and Nyila estuaries were generally within water quality standards (Appendix 9). Unlike the other studied sites, there was no *E. coli* found in these estuaries during the sampling period. However, the concentrations of *Cu, Zn* and *Fe* are of concern as they exceeded the WHO recommended limits for aquatic life. *Hg*, *As*, *Cd* and *Pb* levels were not detected.

3.8.2 Biodiversity

3.8.2.1 Macrobenthic fauna

Eight intertidal rocky shore epibenthic fauna were recorded, comprising five gastropods and one each of bivalves, crustacean and anthozoans (Table 12; Table 13). The community was visibly dominated by the barnacle, *Chthamalus dentata* and the upper shore littorinid, *Echinolittorina pulchella* (Figure 16).

There was low diversity of macroalgae was dominated by the brown alga, *Bachelotia antillarum* (Figure 17). Other phaeophytes recorded were the *Chnoospora minima* and *Ralfsia expansa* as well as a chlorophyte, *Chaetomorpha linum*. The low species may possibly be attributable to the nature of the rocks and also exposed conditions of the rocky not being able to facilitate attachment.

Table 12. Number of species of fauna and macroalgae at Kpani-Nyila

Taxa		No. of species	Percentage
Fauna	Gastropods	5	62.5
	Bivalves	1	12.5
	Crustaceans	1	12.5
	Echinoderms	0	0.0
	Cnidarian	1	12.5
Total		*8*	*100.00*
Macroalgae	Chlorophyta	1	25.0
	Phaeophyta	3	75.0
	Rhodophyta	0	0.0
Total		*4*	*100.00*

Table 13. Inventory of rocky shore fauna and macroalgae of the Kpani-Nyila rocky outcrops

Mollusc	Crustacean	Macroalgae
Gastropod	*Chthamalus dentata*	***Chlorophyta (Greens)***
Echinolittorina pulchella		*Chaetomorpha linum*
Echinollitorina. granosa	***Cnidarian***	
Thais heamastoma	*Anthopleura* sp.	***Phaeophyta (Browns)***
Nerita atrata		Chnoospora minima
Siphonaria pectinata		*Bachelotia antillarum*
		Ralfsia expansa
Bivalvia		
Ostea tulipa		

Figure 16. Dominance of *Echinolittorina pulchella* (periwinkles) and *Chthamalus dentate* (barnacles)

Figure 17. Dominance of *Choospora minima* of rocky outcrop of Kpani-Nyila outlet

3.8.2.2 Avifauna

At Kpani-Nyila, only two species were observed. Six individuals of the Whimbrel, *Numenius phaeopus,* and two individuals of the Pied kingfisher, *Ceryle rudis*.

3.8.3 Fisheries

An hour of fishing at the confluence of the rivers using cast-net did not yielded two species, *Callinectes* sp. and *Sarotherodon melanotheron.* According to the natives, fishing was not normally carried out at the estuary. The inhabitants appeared to be mainly farmers who cross the estuary in canoes to their farms at the other bank. One hour of fishing with cast net at the rocky beach *(*East of Princestown), resulted in the following fishes: *Mugil cephalus*, *Brachydeuterus auritus*, *Pseudupeneus* sp., *Trachinotus ovatus* and the rare *Diplodus cervinus cervinus* (Table 14). The biological data is indicated in Table 14.

Table 14. Results of experimental fishing west of Kpani-Nyila

Family	Species	TN	ASL (cm)	AW (g)
Mugilidae	*Mugil cephalus*	6	11.1	25.1
Carangidae	T*rachinotus ovtus*	5	9.3	14.6
Haemulidae	*Brachydeuterus auritus*	1	7.8	12.0
Sparidae	*Diplodus cervinus cervinus*	1	8.0	34.0

*(**TN** = Total number; **ASL**=Average Standard Length; **AW** = Average Weight)*

3.8.4 Terrestrial ecosystems

The confluence of the Kpani and Nyila Rivers has a mangrove swamp with *Avicennia germinans* and *Conocarpus erectus* and thicket vegetation. The mangrove vegetation is poorly developed and is dominated by *Thespesia populnea* (a mangrove associate) and the grass *Imperata cylindrica*.

The thicket vegetation is composed largely of shrubs and climbers *Lantana camara*, *Flagellaria guineensis*, *Chromolaena odorata*, *Waltheria indica* and *Tetracera alnifolia*. *Avicennia germinans* and *Conocarpus erectus* are classified as **Least Concern** under the IUCN threatened species categories.

3.8.5 Critical Features and Conservation Significance

The Cape Three Points Forest Reserve has been designated as a Globally Significant Biodiversity in view of its high conservation value. This designation needs to be extended to adjacent areas such as Kpani Nyila and Princestown beaches due to the biodiversity of fauna and flora at the beach, and unique habitat in the small marine islands in the nearshore area,. Attention should be given to restoring degraded mangroves of the area. The conservation can be strengthened by promoting tourism and relevant infrastructural development in the area.

3.9 Princestown

Princestown is located 5km east of Fort St. Antonio on Manfro Hill in the Ahanta West District of the Western Region of Ghana (Appendix 6). It lies between Axim, to the west, and Takoradi to the east. This locality exemplifies a sandy and rocky beach with adjoining forest biotope (see Table 12). There is a densely populated settlement very close to the beach (Figure 18).

Figure 18. View of beach at Princestown with settlement in background

3.9.1 Biodiversity

3.9.1.1 Terrestrial avifauna

Although this portion of the south-western coastal area of Ghana is without any widespread area of undisturbed habitat, the number of bird species recorded was quite appreciable. With a total of 130 species from 38 avian families, the site recorded species diversity and richness of 22.20 and 4.55, respectively. The area appears to be under the influence of the Cape Three Points Forest Reserve, which is the only extensive uncultivated natural habitat in the vicinity. The presence of the forest reserve, along with the dominance of the oil palm, coconut and rubber plantations, has retained some forest dependent bird species in the face of massive habitat degradation. None of the bird species recorded in this area is, however, of global conservation concern.

In spite of the proximity to the Cape Three Points Forest Reserve, bird species composition at the Princess Town–Akatekyi area did not share much similarity. The obvious reason is the difference in the state of the habitat at the two sites, with the off-reserve area losing all of its original forest

habitat and consequently the species that were closely associated with it. According to Thiollay (1986), bird species distribution patterns associated with succession from primary forest to various forms of secondary and degraded forest show a rapid decrease in species composition and considerable change in population structure. Whenever bird species closely associated with dense forests disappear due to extensive habitat degradation, edge and open woodland species appear and dominate the avifauna.

3.9.2 Fisheries

The closest fishing village is Aketekyi (about 3 km from Princess town). The village has two beaches, the Anlo beach, where beach seine is the main fishing practice and the second one where '*watsa*' is mostly practiced (23 canoes were counted). The beach seine practice is, however, in the minority (about 10 canoes involved). One sizeable fish, a croaker, *Pseudotolithus senegalensis* was caught by '*watsa*' beach seine fishers at the beach at the time of study (Figure 19). This might be largely due to known seasonality patterns in occurrence of fish in nearshore waters. The fish might have been caught while on their normal spawning or foraging activity. There were about 33 '*watsa*' canoes which were all operational and sardinellas are the major fish group landed.

Figure 19. A *Pseudotolithus senegalensis* (Val. 1833) landed at Aketekyi beach

3.9.3 Critical Features and Conservation Significance

According to the community members, important areas protected by traditional rules and regulations include the forest reserve, lagoon, and the mangroves. The inhabitants were aware of the ecological significance of the forest reserve and believed that these rules, in addition to forest guards, were very effective.

In Princess town, the change of forests and farmlands into rubber plantations, has affected the availability of agricultural lands, reducing fallow periods and leading to reduced crop yields. A

decrease in the numbers of wild animals has also been attributed to the change in land use over the years. There is charcoal production, but it is believed that there are no impacts on the forest because the trees used are from logged rubbers trees that are cut down during land clearing. Other changes observed include decreasing fish yields, which has been blamed on light fishing by foreign fishermen.

When interviewed about issues of concern, the inhabitants indicated that there has been increased flooding in the past years due to sand winning and bad drainage. The collection of stones and sand from the beach as construction material has led to erosion, destroyed vegetation and caused loss of property. In addition, poor regulations controlling sanitation, especially with the dumping of liquid waste into gutter and streets, has led to increased breeding of mosquitoes and health hazards.

3.10 **Cape Three Points**

The Cape Three Points Forest Reserve, located in the Ahanta West District, occupies a total area of 51,102 km^2 is the only primary forest in Ghana located very close to the sea (Appendix 7; Figure 20). Though now at risk from encroachment and poaching, the reserve has a wide variety of tree species, butterflies, monkeys and birds. It is a designated Important Bird Area (IBA).

Figure 20. Rocky shore at Cape Three Points

3.10.1 Biodiversity

3.10.1.1 Macrobenthic fauna

The epibenthic fauna richness and abundance at Cape Three Points was relatively high compared to the other studied sites. 29 macrobenthic epifauna were enumerated, made up of 14 gastropods, three bivalves, five crustaceans, two echinoderms and six Cnidarians of the class Anthozoa (Table 15). The dominant species encountered were the sea urchin, *Echinometra lucunter*, *Thais nodosa*, and *Thais haemastoma* (Figure 21). These are species normally found in lower intertidal zones and such occurrence in most of the intertidal stretch is an indication of narrowness of the intertidal zone and also availability of numerous microabitats (e.g. many crevices. Many of these epibenthic fauna are indicators of ecological healthiness and also constitute an important food resource for marine organisms (e.g., fishes) and also humans (Fig. 21). Higher the species diversity of these epibenthic organism is an indication lack of ecological disturbance (natural and anthropogenic), albeit most ecologist correlate moderate disturbance with higher species diversity.

Table 15. Inventory of rocky shore fauna and macroalgae of the Cape Three Point rocky beach

Mollusc	Crustacean	Macroalgae
Gastropod	*Grapsus grapsus*	***Chlorophyta (Greens)***
Echinolittorina pulchella	*Cthamalus dentata*	*Bryopsis pennata*
Echinolittorina cingulifera	*Panopeus* sp.	*Chaetomorpha linum*
Echinollitorina. granosa	*Pagurus* sp.	*Chaetomorpha antennina*
Thais nodosa		*Ulva fasciata*
Thais heamastoma	**Echinoderm:**	
Cyprae sp.	*Cidaroidea* sp.	***Phaeophyta (Browns)***
Nerita atrata	*Echinometra lucunter*	*Basispora africana*
Patella safiana		*Chnoospora minima*
Siphonaria pectinata	**Cnidarian**	*Ralfsia expansa*
Nudibranchs sp.	*Sea anemone (Indet. 1)*	
Clanculus sp.	*Sea anemone (Indet. 2)*	***Rhodophyta (Reds)***
Arca senilis	*Palythoa* sp.	Lithothamnia
Murex sp.	*Anthopleura* spp.	*Botrisia radicans*
Fissurella nebecule	*Sea anemone (Indet. 3)*	
	Zoanthus sp.	
Bivalvia		
Ostea tulipa		
Brachydontes sp.		
Perna perna		

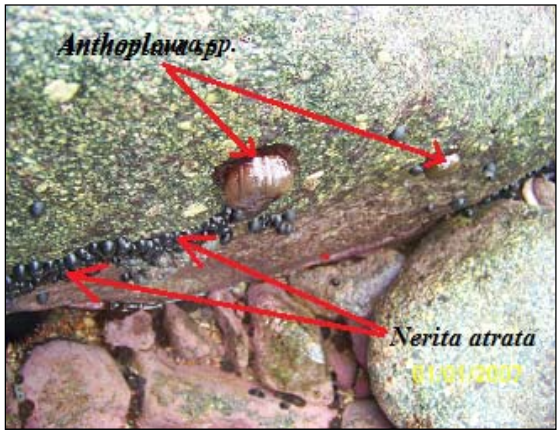

Figure 21. Epibenthic fauna (left) and samples of *Thais* spp. collected by the locals at Cape Three Points (right)

There was relatively few macroalgae species, although the three main taxonomic groups were represented. In all, nine species of macroalgae were observed and these were made up four species of chlorophyta, three species of phaeophytes and two of rhodophytes (Table 16).

Table 16. Number of species of fauna and macroalgae at Cape Three Points

Taxa		No. of species	Percentage
Fauna	Gastropods	14	48.28
	Bivalves	3	10.34
	Crustacean	4	13.79
	Enchinoderm	2	6.90
	Cnidarian	6	20.69
Total		*29*	*100.00*
Macroalgae	Chlorophyta	4	44.44
	Phaeophyta	3	33.33
	Rhodophyta	2	22.22
Total		*9*	*100.00*

3.10.1.2 Terrestrial Avifauna

A total of 168 species of birds from 38 avian families were identified and recorded for the Cape Three Points Forest Reserve and surrounding areas. The species recorded included eight globally threatened species in the Vulnerable, Near Threatened and Data Deficient categories on the IUCN Red List of Threatened species. Also included are 10 wholly protected species under Schedule I of the Wildlife Conservation Regulation as well as 123 species whose global distribution is limited to the Guinea-Congo Forest of West and Central Africa and six Upper Guinea Endemics. Qualitative analysis of species composition showed a relative high species diversity and richness of 4.84 and 27.13, respectively.

Birds recorded in the Cape Three Points and surrounding areas comprised primarily of species closely associated with forest. Habitat preference analysis showed that a significantly high proportion (67%) of the species recorded is closely associated with primary and secondary forests, with the rest being largely forest edge species. The Cape Three Point Forest Reserve and surrounding areas are, therefore, in good condition in terms of avifauna, giving a good representation of the species associated within ecozone.

3.10.2 Fisheries

3.10.2.1 Fish Composition

The Atenkyi town at Cape Three Points is mainly a fishing village, although there is farming of mainly palm fruit, coconut and cassava, and gari processing. During the study period, landing of fish occured in the early morning before all the catch could be assessed. Nonetheless, fishes on display included *Sphyraena sphyraena* (Linn. 1758), *Sepia officinalis* (Rong 1831), *Trachurus trachurus* (1758), *Sardinella maderensis*, and *Sardinella aurita* (Figure 22) shows some *Sardinella* species observed). Highly migratory fish species like sharks were landed alongside dolphins, sword fishes and blue marlins using the Drift Gill Net (DGN) (Figure 23).

Figure 22. *Sardinella* sp.

Figure 23. (Left) Clymene dolphin (*Stenella clymene*); (Right) Long-beaked common dolphin (*Delphinus capensis*) and hammer-head shark (*Sphyrna* spp)

3.10.3 Critical Features and Conservation Significance

The Cape Three Points Forest Reserve has been designated as Globally Significant Biodiversity in view of its high conservation value. This designation need to be extended to its adjacent areas such as Kpani Nyila, Ehunli lagoon and Princesstown beaches due to the biodiversity in the small marine islands in the nearshore area, fauna and flora at the beach, and unique habitat.

There are internationally threatened bird species occurring in the area whose food source and ecology could be affected by the global climate change; potential oil spills from oil production in the region. The forest reserve, in addition to traditional rules regulations, is properly protected by forest guards. They are known locally as Community Biodivertsity Advisory Group (CBAGS) who patrol on the look out for offenders and are also responsible for tourists interested in exploring the forest and its biodiversity. Traditionally, the 'Offior', a type of black and white monkey, is used as a totem. The community rules also include bans on visiting the forest on certain days. These bans are considered to be quite effective by the community members. At Cape Three Points, there is a lighthouse that serves as a site for tourists.

The commercial tuna fishery industry contends that only negligible numbers of dolphins are killed in purse-seine set nets. However, informal interviews with fishers suggest that this association may be more common, and that dolphins and birds are used as guides to locate tuna. Fisheries Officers have shown that dolphins are taken with high frequency along the Cape Three Points, including Axim and Dixcove. The dolphins are cut up and sold for human consumption in these fish landing ports. Unfortunately, landed marine mammals, although a local product like any other, are not reported by national fisheries observers, unless a specific research programme becomes operational. As a result marine mammal mortality remains to be verified.

The conservation value of Cape Three Points can be strengthened by promoting tourism and infrastructural development in the area.

3.11 **Butre**

The Butre beach is located east of Dixcove in the Ahanta West District (Appendix 8). The beach is mainly sandy one with few rocky outcrops (Figure 24). The beach is also a landing site for the fishers.

The Butre lagoon is an open lagoon and relatively long. The rocky outcrops are largely located at the mouth where the lagoon enters the sea. Of scientific interest were the mats of the bivalve, *Brachydontes* sp. and the algae *Enteromorpha flexuosa* at the entrance of the lagoon. The lagoon is flanked by extensive mangrove species and associates as well as other coastal scrubs including *Sessuvium portulacastrum*. Portions of the mangrove have been degraded through cutting for firewood. Numerous species including crabs, gastropods, lizards (e.g., monitor lizard), fishes inhabit the rooting system of the mangroves. The northwestern side of the lagoon has an extensive forest with numerous vultures.

Figure 24. (Left) Butre estuary entering into the sea (Right) Rocky outcrops at the mouth of the estuary at low tide.

3.11.1 Water quality

Levels of water quality parameters measured in the Butre estuary were generally within acceptable levels (Appendix 9). Of concern, however, was the very low DO levels recorded in the estuary. It was observed that the fringes of the lagoon along the scrubs were used by the community as places of convenience. These levels could impact adversely on aquatic life in the estuary.

Hg, Cd and *Pb* were not detected in the estuary. The levels of *Zn, Cu, Fe* and *As*, however, exceeded the WHO recommended limits for aquatic life and pose a potential threat to aquatic life.

3.11.2 Biodiversity

3.11.2.1 Macrobenthic fauna

The organisms found on both the outcrops and boulders constitute the rocky shore fauna of the area (Table 17). In all, a total of 16 individual epibenthic taxa were encountered. These consisted seven gastropods, two bivalves, and seven crustaceans (Table 17). The gastropods dominated the fauna numerically especially the upper shore littorinid, *Echinolittorina pulchella*.

The macroalgal species observed included five chlorophytes, four phaeophytes and five rhodophytes (Table 17). There was no clear dominance macroalgae except that *Ulva fasciata* and *Enteromorpha flexuosa* were comparatively abundant.

An important observation was the cluster of *Brachydontes* sp. found in the inlet/open of the lagoon to the sea (Figure 25). Appreciable numbers of *Ostea tulipa* were also observed in the inlet. These species possibly preferred marine environments with sea water slightly diluted by fresh water from land drainages for their survival.

Table 17. Inventory of rocky shore fauna and macroalgae of the Butre rocky beach

Mollusc	Crustacean	Macroalgae
Gastropod	*Xanthid* sp.	***Chlorophyta (Greens)***
Echinolittorina pulchella	*Cthamalus dentata*	*Boodlea composita*
Echinolittorina cingulifera	*Panopeus* sp.	*Boodlea psispusila*
Echinollitorina. granosa	*Callinectes* sp.	*Cladophora prolifera*
Thais haemastoma	*Uca tangeri*	*Enteromorpha flexuosa*
Nerita atrata	*Grapsus grapsus*	*Ulva fasciata*
Patella safiana	*Pagurus* sp.	
Siphonaria pectinata		***Phaeophyta (Browns)***
		Padina durvilea
Bivalvia		*Ralfsia expansa*
Ostea tulipa		*Chnoospora minima*
Brachydontes sp.		*Basispora africana*
		Rhodophyta (Reds)
		Centrocera clavulatum
		Bostrychia radicans hapteromanica
		Gelidium corneum
		Gymnogongrus nigricans
		Lithothamnia sp.

Table 18. Number of species of fauna and macroalgae at Butre

Taxa		No. of species	Percentage
Fauna	Gastropods	7	43.75
	Bivalves	2	12.50
	Crustacean	7	43.75
Total		*16*	*100.00*
Macroalgae	Chlorophyta	5	35.71
	Phaeophyta	4	28.57
	Rhodophyta	5	35.71
Total		14	100.00

Figure 25. Mouth of Butre estuary depicting populations of *Brachydontes* sp. and *Ostrea tulipa*

3.11.3 Critical Features and Conservation Significance

The existing traditional conservation measures should be strengthened to help protect biodiversity of the area. This can be achieved by educating community to raise awareness on values of habitat and biodiversity of the area thereby providing understanding for enforcement of traditional conservation measures.

4 COMPARATIVE ASSESSMENT OF KEY CRITICAL HABITATS AND RECOMMENDATIONS FOR MANAGEMENT

4.1 Overview of ecosystems of the Western Regions

This chapter presents a comparative discussion of the critical habitats assessed based on the different indicators measured. This is to categorize the habitats in terms of the quality and healthiness of the systems. Where rankings are presented, they are based purely on the quality of the habitats drawing on existing scientific concepts. Section 4.1.2., however, provides a detailed description of findings from terrestrial faunal survey covering seven out of ten studied habitats. The essence of these comparative analyses was to help derive recommendations for future management.

4.1.1 Water quality

In terms of water quality indicators, levels of dissolved oxygen (DO), and biochemical oxygen demand (BOD), nutrients (e.g nitrates and phosphates), temperature, total dissolved solids, and trace metals are crucial. Water quality standards may be set for these water indicators depending on the purpose for which the water is required. For instance, a water body with BOD of less than 2 mg l^{-1} is generally regarded as unpolluted, while one with a BOD of more than 10 mg l^{-1} is considered as grossly polluted (Clark, 2003). Although BOD level of up to 7 mg l^{-1} may be considered acceptable for drinking water (Clark, 2003), the overall suitability of water for consumption may depend on many other factors such as levels of bacteria, nitrates and other chemical contaminants.

Among the water bodies studied, Belibangara and Amansuri main were purely freshwater while the others were saline. Thus, Belibangara and Amansuri- main serve as sources of drinking water for the local inhabitants. For water to be considered fit for human consumption, it should have no fecal coliform units or zero CFU/100 ml (WHO, 1987). The detection of total and fecal coliform levels of 504 and 163 CFU/100 ml respectively for Belibangara and 428 and 194 CFU/100 ml respectively for Amansuri-main therefore suggests fecal pollution. In the light of the observed levels of fecal coliform in these two water bodies, consumption of these waters could pose as human health risk, especially if general sanitary conditions deteriorates. At Belibangara, the residents bath in the freshwater lagoon, while at Amansuri- main, it was obvious that domestic waste water and human excreta could be easily discharged into the water body without treatment. Wild and domestic animals seeking water can also contaminate these two water bodies through direct defecation and urination. These two water bodies are therefore not suitable for drinking without treatment. The levels of trace metals such as Zn, Cu, Fe, Hg and As detected in the selected water bodies exceeded their acceptable limits for aquatic life and could therefore impact negatively on aquatic life.

The Ankobra estuary had high turbidity and high levels of toxic elements such as Hg and As. High turbidity indicates the presence of suspended organic materials which promotes the growth of microorganisms (WRC, 1993). It recorded the highest heterotrophic bacteria counts of 1540 CFU/100 ml indicating the generally poor biological quality of the estuary. Although the total

and fecal coliform counts were within limits, this water body is not recommended for recreation, swimming or bathing due to the current state of pollution.

Domunli is saline and colonised by the green algae *Enteromorpha clathrata*. Not surprisingly, it recorded the highest level of chlorophyll-a. Levels of BOD and bacteriological load were within acceptable limits and could be useful for tourism if the issue of *Enteromorpha* bloom is dealt with permanently. By far, Amansuri outlet, Butre and Kpani-Nyila are among the best lagoons for recreation, especially swimming. This is because the water quality indicators are generally within acceptable limits with zero fecal /100 ml being recorded for Kpani-Nyila.

4.1.2 Biodiversity

4.1.2.1 Macrobenthic fauna

The results of the macrobenthic fauna composition within the studied areas, revealed two dominant groups: isopoda and polychaeta. A total of 539 individuals (mean=59.8) belonging to 11 species/taxa were identified during the study across the various areas. Of this number, isopods constituted 72%, polychaetes 23% and other taxa recorded constituted 5%. The dominant taxa encountered during the study was *Excirolana* sp with a 66.6% frequency of occurrence (F) (Guille 1970) >20%. However none of the species spanned the whole studied areas. There was a high proportion of rare species with about 55 % of the organisms represented by one or two individuals. This indicates that the macrobenthic fauna within the studied area are in discrete communities and may be influence by a limited set of abiotic factors. The highest abundance of organisms was recorded at the Ankobra beach (256 ind.) whilst no organism was recorded at Butre. The polychaete, *Capitella capitata* and Chironomids were restricted to the two coastal lagoons; Belibangara and Domuli.

4.1.2.2 Sandy Shore Infauna

The results of the macrobenthic fauna composition within the beaches (Amansuri, Ankobra, Princess Town, Cape Three Points, Miamia, Butre) revealed two dominant groups: isopoda and polychaeta. Isopoda was the most dominant group in terms of number of individuals, contributing over 89 % to the total macrofaunal population (Table 19). Their abundance varied from 0 to 218 individuals with a mean of 63 individuals. *Scolelepis squamata* and *Glycera* sp. were the main constituents of Polychaeta and together formed 9% of macrofaunal abundance. Isopoda was represented by *Excirolana latipes* whilst caridea (benthic prawns) formed the 'Other' group. In general, the density values were higher in the western sector compared to the eastern sector and there was a gradual decrease in the density from west to east.

In a bid to determine the abundance pattern of the macrobenthic infauna from the mouth of the estuaries and distance away from the mouth, the replicate data were compared. The analysis showed a steady increase in numerical abundance with distance from the mouth of the estuary (westwards) especially for Amansuri outlet. The pattern was clear for the Ankobra except peaks and troughs. The site located approximately 300 m from the mouth of the estuary recorded the highest abundance compared to the farthest point 400 m away. Within-site differences in macrobenthic abundance at Ankobra beach revealed contrasting trends to that observed at

Amansuri beach. High abundance was recorded close to the mouth of the estuary (westwards) and this decreased with increasing distance away from the estuary.

This possibly suggests that food supply (nutrients) is one of the main factors controlling macrobenthic fauna distribution. Input of food to the beach is in the form of autochtonous and allochtonous materials. In addition, there may be other localized factors controlling the distribution and abundance of the macrobenthic fauna within the two beaches since both show contrasting trend away from the mouth of the estuary.

Table 19. Abundance of the major macrobenthic fauna groups recorded along the six beaches in the western region. Cape T. Pts= Cape Three Points

Taxa	Amansuri	Ankobra	Princess Town	Cape 3 Pts	Miamia	Butre
Isopoda	108	218	47	4	0	0
Polychaeta	0	38	0	0	1	0
Other'	0	0	0	0	3	0

4.1.2.3 Avifauna

Most lagoons and wetlands are important stop-over sites for most migratory avifauna as Ghana is on the boundary of two flyways of water-birds (the East Atlantic and Mediterranean Flyways). Changes in water level and availability of food in lagoons have been suggested as the main ecological factors that determine the abundance and distribution of water-bird species in most wetlands in Ghana. Conditions such as large exposed areas of land of suitable sediment texture, low water depth, flooding regimes, climatic conditions and time of day are important controlling factors influencing the diversity and abundance of birds in lagoon at any given time. These factors combine to determine usage of specific sites within a lagoon/wetland by avifauna and are responsible for the short-term changes in local populations.

The abundance of shorebirds recorded from the study shores varied from one another. The highest numerical abundance and species richness of the shorebirds were reported at the Amansuri Estuary. A total of 1081 individuals comprising 12 species (8 waders, 2 terns and 2 ‘others”) were encountered at Amansuri. Of the total abundance, Sanderlings, *Calidris alba* dominated with 901 individuals (83.35% of the total). The Sanderlings were observed feeding presumably on the isopod, *Excirolana latipes.* Shorebirds’ populations at Belibangara and Kpani-Nyila were relatively low. Only one individual of two species each were recorded at these sites.

The availability of food appears to be a strong factor influencing changes in the local bird populations. The common species found in the study sites were the Whimbrel (*Numenius phaeopus)* and Pied kingfisher (*Ceryle rudis)* with 75% frequency of occurrence. Four other species namely Africa Jackana (*Actophilornis africanus)*, Sanderlings (*Calidris alba*), Grey plover (*Pluvialis squatarola),* Common sand piper *(Tringa hypoleucos)* and Western Reef herons *(Egretta gularis)* showed 50% frequency of occurrence. In general, the waterbirds recorded were observed feeding at the water-edge more than any of the other locations. The Pied Kingfisher (*Ceryle rudis*) was often observed flying and diving (using aerial plunging) for possible fishes in the shallow areas of the open water, and often perching on the branches of mangrove trees.

The Cape Three Point Forest Reserve and the Amansuri Wetland are the only areas with some amount of conservation value with respect to avifauna. The other two areas are highly degraded and completely devoid of any natural intact habitat. The Amansuri Wetlands currently been managed by the Ghana Wildlife Society under the Amansuri Conservation and Integrated Development project, has succeeded in securing community support for the conservation of the wetland. The ecological and aesthetic values of the wetland are being promoted through sustainable tourism. It is envisaged that this initiative would help ensure long-term conservation of the wetland and its fauna and flora diversity.

Cape Three Points Forest Reserve has been designated as a Globally Significant Biodiversity in view of its high conservation value. This designation gives the reserve a much higher protection status with complete exclusion of logging. High hunting pressure from inhabitants of the numerous fringe communities still persists in the reserve. This notwithstanding the condition of the reserve is not expected to deteriorate.

The land use pattern in the two other areas which is basically slash-and-burn agriculture is not likely to change with time and this constitutes the main environmental threat in the area. This practice has depleted all the patches of secondary forests that existed in the area. There were patches of pristine mangrove forest and secondary forest surrounding the two lagoons in Princess Town and Akatekyi but these have recently been cleared for farming, leaving a narrow strip of mangrove vegetation around the lagoons. There is the need for intervention measures that would reverse the trend and ensure sustainable utilization of environmental resources as this project seeks to achieve.

Environmental parameters are more likely to remain relatively unchanged over time at the Amansuri Wetland the Cape Three Point Forest Reserve than at the two off-reserve areas. It is therefore recommended that any effort at long term monitoring of changes in environmental conditions with regards to terrestrial birds, should focus on the Cape Three Points Forest reserve and the Amansuri Wetland.

4.1.2.4 Terrestrial avifauna

A total of 236 species of birds belonging to 46 avian families were recorded in the four study habitats. The highest number of 168 species was recorded at Cape Three Point Forest Reserve and the surrounding areas. This was closely followed by the Amansuri Wetland with a total of 148 species. Princess Town, Akatekyi and surrounding coastal communities and the stretch of land between Axim and the Ankobra estuary recorded a total of 130 and 102 species of birds respectively. The species list for the area as presented in this report comprises of species recorded in the field survey as well as those from previous baseline report for the areas.

Included in the birds recorded at the four study areas are eight (8) species which are listed on the Vulnerable, Near Threatened and Data Deficient categories of the IUCN Red List of threatened species. The threatened species were only recorded at the Cape Three Point Forest Reserve (8 species) and the Amansuri Wetland (2 species). A significantly high proportion (57%) of the species recorded at the four study sites are species whose global distribution is limited to the Guinea-Congo forest Biome of West and Central Africa. This could be attributed to the overwhelming influence of the Cape Three Point Forest Reserve, the Amansuri Wetland and the

few isolated patches of secondary forest in the swamps associated with the streams and rivers in the south-western coastal areas of Ghana.

A number of bird species that are habitat sensitive and highly dependent on pristine forest condition were recorded at Cape Three Points Forest Reserve and the Amansuri Wetland. These species include the Congo Serpent Eagle, Crowned Eagle, Long-tailed Hawk, Crested Guinea fowl, Lemon Dove, Western Bronze-naped Pigeon, Great Blue Turaco, Dusky Long-tailed Cuckoo, Olive Long-tailed Cuckoo, Yellow-throated Cuckoo, Chocolate-backed kingfisher, Shining-blue Kingfisher, Shinning Drongo, Green-tailed Bristlebill, Yellow-bearded Greenbul and several marked **'F'** in the preferred habitat column in Appendix 3. The species in the Princess Town - Akatekyi area and the Axim – Ankobra estuary comprised mainly of habitat generalist, which usually persist and thrives well in areas with intense human disturbances.

4.1.2.5 Terrestrial Fauna

4.1.2.5.1 Small Mammal Distribution, Abundance and Diversity

There were 45 individual captures of nine species of small mammals belonging to two orders, Rodentia (eight species) and Insectivora (one species). The rodent species captured were *Praomys natalensis* (soft-furred rat), *P. tullbergi* (Tullberg's soft-furred rat), *Mastomys erythroleucus* (multimammate mouse), *Lophuromys sikapusi* (rusty-bellied mouse), *Acomys cahirinus* (spiny mouse), *Malacomys longipes* (long-footed rat), *Mus minutoides* (pygmy mouse), and *Myomys* sp. (meadow rat). *Crocidura* sp. (white-toothed shrew) was the only insectivore species captured. The two commonest species were *P. natalensis* (10 captures, 22.2%) and *P. tullbergi* (nine captures, 20.0%), followed by *M. erythroleucus* (eight captures, 17.8%) and *L. sikapusi* (seven captures, 15.6%). The least abundant species was *Myomys* sp. (one capture, 2.2%) (Table 20, Figures 26, 27, 28 and 29)

Table 20. Small Mammal Capture Data from Seven Localities in the Western Region (Relative Abundance in Brackets)

Survey Localities		**Be**	**Am**	**An**	**Ax**	**C3P**	**PT**	**Bu**	**Total**	**%**
Species	**Common Name**									
Praomys natalensis	Soft-furred Rat	10 (16.7)	0	0	0	0	0	0	10	**22.2**
Praomys tullbergi	Tullberg's Soft-furred Rat	0	0	0	0	9	0	0	9	**20.0**
Mastomys erythroleucus	Multimammate Mouse	0	0	0	3 (5.0)	0	0	5 (16.7)	8	**17.8**
Lophuromys sikapusi	Rusty-bellied Mouse	0	2 (3.3)	0	2 (3.3)	3 (5.0)	0	0	7	**15.6**
Acomys cahirinus	Spiny Mouse	0	0	4 (6.7)	0	0	0	0	4	**8.9**
Malacomys longipes	Long-footed Rat	0	0	2	0	0	0	0	2	**4.4**
Mus minutoides	Pygmy Mouse	0	0	0	0	0	2	0	2	**4.4**

Survey Localities		Be	Am	An	Ax	C3P	PT	Bu	Total	%
							(6.7)			
Crocidura sp.	White-toothed Shrew	0	1 (1.7)	0	1 (1.7)	0	0	0	2	**4.4**
Myomys sp.	Meadow Rat	0	0	0	1 (1.7)	0	0	0	1	**2.2**
Total Captures		**10**	**3**	**6**	**7**	**12**	**2**	**5**	**45**	
Capture %		**22.2**	**6.7**	**13.4**	**15.6**	**26.7**	**4.4**	**11.1**		
No. of Species		**1**	**2**	**2**	**4**	**2**	**1**	**1**		
No. of Trap-Nights		**60**	**60**	**60**	**60**	**60**	**30**	**30**	**360**	
Trapping Success (%)		**16.7**	**5.0**	**10.0**	**11.7**	**20.0**	**6.7**	**16.7**	**12.5**	
Species Diversity		**0.0**	**0.63**	**0.63**	**1.28**	**0.57**	**0.0**	**0.0**	**1.65**	

Legend:

Be = Belibangara **Am = Amansuri** **An = Ankobra**
Ax = Axim **C3P = Cape Three Points** **PT = Princess Town**
Bu = Butre

Figure 26. *Mastomys* sp. (Axim)

Figure 27. *Acomys* sp. (Ankobra)

Figure 28. *Crocidura* sp. (Axim)

Figure 29. *Lophuromys* sp. (Axim)

With total captures of 45 individuals in 360 trap-nights, overall trapping success was 12.5 %, which is fairly high, given the short duration of the survey. Trapping success at three of the sites, Belibangara (16.7 %), Cape Three Points (20.0 %) and Butre (16.7 %) were higher than the overall trapping success (Table 20). The highest diversity of small mammal species occurred at Axim (H' = 1.28) with four out of the nine species, followed by Amanzuri (H' = 0.63), Ankobra (H' = 0.63), and Cape Three Points (H' = 0.57) with two species each. The least diverse localities (H' = 0.00) Belibangara, Princes Town, and Butre with one species each (Table 20). *Lophuromys sikapusi* was the most widely-distributed species, occurring at three sites (Amanzuri, Axim and Cape Three Points) which were far from each other in different districts. Two other species (*M. erythroleucus* – Axim and Belibangara, and *Crocidura* sp. – Amanzuri and Axim) occurred at two sites. The six other species occurred at only one site each (Table 20).

Of all the nine species captured, *P. tullbergi, P. natalensis, M. longipes, Myomys* sp. and *Acomys cahirinus*, are known forest inhabitants. *Mastomys erythroleucus* and *Crocidura* sp. occur nationwide, while *L. sikapusi* and *M. minutoides* are savanna penetrants into forest. The presence of these two species in the study localities may indicate some level of degradation or fragmentation of habitat for agricultural and other human activities. Five other small mammal species were identified through the interviews, as occurring in the various localities surveyed: *Euxerus erythropus* (striped ground squirrel), *Cricetomys gambianus* (giant pouched rat), *Thryonomys swinderianus* (grasscutter/cane rat), *Hystrix cristata* (crested porcupine), and *Eidolon helvum* (straw-coloured fruit bat) (Table 21).

Table 21. Checklist of Small Mammals Recorded using Other Methods (Interviews, Refuge Examination and Direct Observation) at Seven Localities in the Western Region

Survey Localities/ Species	Common Name	Be	Am	An	Ax	CP	PT	Bu	Total	Perception Attitudes
Euxerus erythropus	Striped Ground Squirrel	0*	3*	1*	1*	1*	1*	2*	9	Food
Cricetomys gambianus	Giant Pouched Rat	*	*	*	*	*	*	*		Food
Thryonomys swinderianus	Grasscutter	*	*	*	*	*	*	*		Food
Hystrix cristata	Crested Porcupine	*	*	*		*	*	*		Food
Eidolon helvum	Straw-coloured Fruit Bat	3*	0*	0*	0*	0*	0*	1*	4	Food

**Presence (based on interviews) /Figures represent number of sightings.*

4.1.2.5.2 Large Mammal Occurrence

There were also five large mammal species identified, namely *Phataginus tricuspis* (pangolin), *Cercopithecus patas* (patas/red monkey), *Colobus vellerosus* (pied colobus monkey), *Phacochoerus africanus* (common warthog), and *Cephalophus maxwelli* (Maxwell's duiker) (Table 22).

Table 22. Checklist of Large Mammals Recorded from Interviews at Seven Localities in the Western Region

Survey Localities/ Species	Common Name	Be	Am	An	Ax	CP	PT	Bu	Total	Perception Attitudes
Phataginus tricuspis	Tree Pangolin	*	*	*		*	*	*		Food
Cercopithecus patas	Patas/Red Monkey		*			*	*			Food
Colobus vellerosus	Pied Colobus					*	*			Food
Phacochoerus africanus	Common Warthog		*							Food
Cephalophus maxwelli	Maxwell's Duiker		*			*	*			Food

**Presence (based on interviews) /Figures represent number of sightings.*

4.1.2.6 Reptile Distribution, Abundance and Diversity

The interviews revealed 14 species of reptiles occurring in the study localities, represented by four species of lizards (Table 23). These were *Agama agama* (agama/rainbow lizard), *Mabuya perottettii* (orange-flanked skink), *M. affinis* (skink), and *Varanus niloticus* (Nile monitor lizard).

Based on the number of sightings, *A. agama* was the commonest species, followed by the skink (*M. affinis*). There were no sightings of *V. niloticus*, but the interviews revealed its presence. In terms of distribution, all the species were present in all the habitats. There were seven snake species, notably *Python regius* (royal python), *Philothamnus* sp. (green tree snake), *Dendroaspis viridis* (green mamba), *Grayia smythii* (water snake), *Naja melanoleuca* (black/forest cobra), *Bitis gabonica* (gaboon viper), *B. arietans* (puff adder). Only one individual of *Philothamnus* sp. was sighted. The other snake species were recorded from the interviews. There was one crocodile *(Crocodylus niloticus)*, and two chelonian species also revealed through the interviews.

Table 23. Checklist of Reptiles Recorded Using Interviews from Seven Localities in the Western Region

Survey Localities/ Species	Common Name	Be	Am	An	Ax	CP	PT	Bu	Total	Perceptions/ Attitudes
Lizards										
Agama agama	Agama (Rainbow) Lizard	16*	32*	2*	13*	2*	16*	7*	**88**	
Mabuya perotteti	Orange-flanked Skink	0*	0*	0*	2*	1*	0*	0*	**3**	
M. affinis	Skink	5*	4*	2*	3*	10*	22*	3*	**49**	
Varanus niloticus	Nile Monitor Lizard	*	*	*	*	*	*	*		
Snakes										
Python regius	Royal Python	*	*	*	*	*	*	*		Dangerous attacker
Philothamnus sp.	Green Tree Snake	0*	0*	0*	0*	0*	1*	0*	**1**	Fear, Poisonous
Dendroaspis viridis	Green Mamba	*	*	*	*	*	*	*		Fear, Very Poisonous
Grayia smythi	Water Snake		*	*		*	*	*		
Naja melanoleuca	Black Cobra	*	*	*	*	*	*	*		Fear, Very Poisonous
Bitis gabonica	Gaboon Viper	*	*		*	*	*	*		Fear, Very Poisonous
Bitis arietans	Puff Adder	*	*		*	*	*	*		Fear, Very Poisonous
Crocodiles										
Crocodylus niloticus	Nile Crocodile	*	*	*	*	*	*	*		Dangerous attacker
Chelonians										
Kinixys sp.	Hinged Tortoise	*	*	*	*	*	*	*		Food
Dermochelys coriacea	Leatherback Sea Turtle	*	*	*	*	*	*	*		Food

**Presence (based on interviews) /Figures represent number of sightings.*

4.1.2.7 Conservation Significance

Of all the recorded species, six were of global conservation significance, comprising one mammal and five reptile species. The crested porcupine *(Hystrix cristata)* is categorized as **LR/nt** (Lower Risk/Near Threatened) by the IUCN. The leatherback turtle *(Dermochelys coriacea)* and hinged turtle *(Kinixys* sp.) are IUCN-categorized as **CR** (Critically Endangered) and **DD** (Data Deficient) respectively, as well as CITES-categorized in **Appendix 3** and **Appendix II** respectively. Three other reptile species are CITES-categorized: Nile crocodile -

Crocodylus niloticus (**Appendix I**), Nile monitor lizard - *Varanus niloticus* **(Appendix II)**, and royal python -*Python regius* **(Appendix II)** (Table 24).

Table 24. Checklist of All Faunal Species Recorded and their Conservation Significance

Species	Common Name	Recording Methods	Conservation Significance	
			IUCN	CITES
MAMMALIA	**Mammals**			
Rodentia	**Rodents**			
Muridae				
Praomys natalensis	Soft-furred Rat	Tr		
Praomys tullbergi	Tullberg's Soft-furred Rat	Tr		
Mastomys erythroleucus	Multimammate Mouse	Tr		
Lophuromys sikapusi	Rusty-bellied Mouse	Tr		
Acomys cahirinus	Spiny Mouse	Tr		
Malacomys longipes	Long-footed Rat	Tr		
Mus minutoides	Pygmy Mouse	Tr		
Crocidura sp.	White-toothed Shrew	Tr		
Myomys sp.	Meadow Rat	Tr		
Cricetomys gambianus	Giant Rat	Int		
Hystricidae		Int		
Hystrix cristata	Crested Porcupine	Int	LR/nt	
Thryonomyidae				
Thryonomys swinderianus	Grasscutter	Int		
Sciuridae				
Euxerus erythropus	Ground Squirrel	Int		
Chiroptera	**Bats**			
Eidolon helvum	Straw-coloured Fruit Bat	Int		
Pholidota	**Pangolins**			
Phataginus tricuspis	Tree Pangolin	Int		
Primates	**Primates**			
Cercopithecus patas	Patas/Red Monkey	Int		
Colobus vellerosus	Pied Colobus	Int		
Artiodactyla	**Herbivores**			
Phacochoerus africanus	Common Warthog	Int		
Cephalophus maxwelli	Maxwell's Duiker	Int		
REPTILIA	**Reptiles**			
Chelonia	**Tortoises/Terrapins**			
Kinixys sp.	Hinged Tortoise	Int	DD	II
Dermochelys coriacea	Leatherback Sea Turtle	Int	CE	I
Squamata: *Lacertilia*	**Lizards**			
Agama agama	Agama Lizard	DO		
Hemidactylus brookii	Common Gecko	DO		
Mabuya perrotetii	Orange-flanked Skink	DO		
M. affinis	Skink	DO		
Varanus nilotocus	Nile Monitor	Int		II
Crocodylus niloticus	Nile Crocodile	Int		I
Squamata: *Serpentes*	**Snakes**			
Python regius	Royal Python	Int		II
Philothamnus sp.	Green Tree Snake	DO/Int		
Dendroaspis viridis	Green Mamba	Int		
Grayia smythii	Water Snake	DO/Int		
Naja melanoleuca	Black (Forest) Cobra	Int		
Bitis gabonica	Gaboon Viper	Int		

Species	Common Name	Recording Methods	Conservation Significance
B. arietans	Puff Adder	Int	

Legend

Conservation Significance
Species of global Conservation Concern (i.e., species listed by IUCN and CITES) within the survey area were identified and recorded as follows:

IUCN

The IUCN (International Union for the Conservation of Nature) publishes a Threatened Species List *(Red List of Threatened Animals, 2000)* which categorises globally-threatened animals as follows:

- ***Critically Endangered (CE)***: A taxon which is facing an extremely high risk of extinction in the wild in the immediate future

- ***Data Deficient (DD):*** A taxon on which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well-studied, and its biology well-known, but appropriate data on abundance and/or distribution is lacking

- ***Lower Risk (LR):*** Taxa which have been evaluated but do not satisfy the criteria for any of the categories of *Critically Endangered (CE), Endangered (E), Vulnerable (V)* or *Rare (R)*

- ***Near Threatened (nt):*** Sub-category of taxa which are close to qualifying for *Vulnerable (V).*

CITES

CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) publishes a list of three Appendices (*CITES Appendices, 1975*) which limits global trade of certain categories of animal species.

- ***Appendix I*** species are threatened species which cannot be traded in
- ***Appendix II*** species are species for which levels of trade are limited.

4.1.2.8 Perceptions and Attitudes

All the small and large mammal species as well as the two chelonian species recorded from the interviews were perceived as sources of food (bushmeat). There were no significant perceptions about lizards, but the crocodile unsurprisingly was perceived to be a dangerous, attacking animal. All the snakes, including non-venomous specie like the green tree snake (*Philothamnus* sp.). This is one of the common misconceptions or myths about snakes, that all of them are venomous and dangerous.

4.1.3 Fisheries

All the ten sites were very important fish habitats of both ecological and socio-economic importance. The fish diversity in the habitats was very diverse. The two lagoons Belibangara and Domunli experienced eutrophication and some amount of pollution from human sources. Belibangara enjoys some amount of protection because the people of Newtown worshipped it as a deity. This therefore helps to reduce undue pressure on fish stocks in the lagoon. However, during the dry season it can get heavily polluted since it does not have an opening directly into the sea. Under such situations, it is not surprising that only hardy species such as *Tilapia and Clarias* are able to survive therein.

At all the habitats, the catch rate was rather low indicating trends of decreasing abundance of fish populations. The algal bloom in the region was a major hindrance to fishing livelihoods at Domunli lagoon and Amansuri estuary. It is a financial drain on fishers who have to use precious time cleaning both fish and nets of green algae. Fish tainted with green algae is of lesser value on the market (Nunoo & Ameka, 2005). Though providing nutrients for fish species and therefore driving productivity, it needs to be addressed before opportunistic poisonous algal species could begin to bloom alongside the existing filamentous green algae. The huge diversity of fish species and the large number of juveniles caught in beach seines are threatened if the situation continues to persist (Nunoo *et al*., 2006). Further, the Domunli lagoon appears very productive but pristine and must be considered for protection as a Ramsar site.

The main reasons for poor catches according to fishers were:

- Poor rainfall in the area during the period
- Use of illegal fishing practices and chemicals: use of illegal mesh sizes, DDT, Ground mosquito coil, dynamite, carbide.
- Some serious and holistic attempts have to be made towards revitalizing the fishing in these habitats and the region as a whole with a view to supporting the socio-economic livelihood of inhabitants.
- This should include efforts to enforce new Fisheries Regulations 2010 in the Western region as well as the entire coast of Ghana.
- A year-long study using the simple methodologies outlined in this study would give a better picture of the situation of these habitats.
- Efforts must be made to especially monitor this site from the effects of the upcoming siting of gas plants near it.

4.1.4 Aquatic mammals

In Ghana, pressures from rapid population growth and declining fish catches are turning marine mammals to immediate food need. In the Western Region, there are captures of small cetaceans (dolphins and whales), mainly using drift gill nets (DGN). Catches have been documented periodically from two fish landing port (Axim and Dixcove), albeit on a limited scale, since 1995. The species most frequently by-caught are the *Clymene dolphin* (about 24.5%), pantropical spotted dolphin and the common bottle nose dolphin.

Although aquatic mammals are on the first schedule of Ghana's 1971 Wildlife Conservation Regulations (Legal Instrument 685) and are protected by law, there are no explicit regulations concerning the use of cetaceans killed in nets. As a result, the use of dolphin meat as bait in shark fisheries and for human consumption is not considered illegal, which means that catch statistics can be obtained (i.e. catches are not concealed for fear of sanctions) and thus makes it feasible to study trends and carry out biological studies based on carcass sampling protocols (e.g. morphology, growth and reproduction, feeding ecology, stock identification, genetics, parasitology, contaminant loads and pathology).

Any estimate of catches of the aquatic mammals is premature, but will not be less than hundreds annually. As a result, the diversity and abundance of dolphins are under threat. There is urgent need for enforcement of Wildlife Conservation Legislature and adoption of new measures to address the protection of small cetaceans, including increased community-based education and monitoring nation-wide. Knowledge of spatial and temporal distribution of the cetaceans could provide the base for local dolphin-watching ventures.

4.1.5 Floral ecosystems

The estuaries of Azulenoanu, Kpani/Nyila, and Ankobra are brackish water environments. As with all ecotones, there exist environmental gradients which impose limitations on the spatial distribution of the flora. Towards the marine (seaward) side of the spectrum are more salt tolerant species, whilst towards the freshwater end, the flora is less tolerant of saline soils. Mangrove vegetation dominates the saline soils of the estuaries while freshwater swamp forest/thicket vegetation exists where the soils are non saline.

Three main types of vegetation were recognized in the study area as follows:

1. Wet Evergreen Forest – Cape Three Points Forest Reserve (upland)
2. Coastal forest/thicket – rocky terrain, Ankobra and Cape three points
3. Freshwater swamp (peat) forest – Amasuri

1. The wet evergreen forest at Cape Three Points

This is a floristically rich forest which may reach a height of 40 m in some places.

The Cape Three Point forest reserve is a repository of several vulnerable plant species. These species are heavily exploited for timber. Seven of the species recorded during the survey are listed as **Vulnerable** under the IUCN threatened species categories while one is Lower Risk/Near Threatened.

2. Coastal forest/thicket (Cape Three Points and Ankobra)

Thicket vegetation occurs on rocky terrains that do not have soil deep enough to carry forest vegetation. The flora of the thicket at Cape Three points and Ankobra have species of conservation concern as Ghana is concerned, though these are not listed by IUCN, (Hawthorne

1993) Appendices 5 and 6. *Elytraria ivorensis* (Black star) and *Ehretia trachyphylla* (Gold Star) are endangered in Ghana and require urgent conservation attention.

3. Freshwater Swamp Forest/Peat Forest (Amansuri)

This vegetation appears to be an extension of the Amansuri mangrove since it has *Avicennia germinans, Rhizophora racemosa* and *Achrostichum aureum*. It is poor in species. *Pierreodendron kerstingii*, which occurs here, is listed as Vulnerable under the IUCN threatened species categories and as a Black star species by Hawthorne (1993). Thus this vegetation type is critical and needs to be further studied.

Key to Star Rating System

Star Rating system adopted in the Forest of Ghana Geographic Information Exhibitor manual (Hawthorne, 1993):

1. Black Star species - Species rare internationally and at least uncommon in Ghana; urgent attention to conservation of populations needed
2. Gold Star species - Fairly rare internationally and/or locally
3. Blue star species - Widespread internationally but rare in Ghana or vice-versa
4. Scarlet star species - Common, but under serious pressure from heavy exploitation
5. Red Star species - Common, but under pressure from exploitation
6. Pink Star species - Common and moderately exploited. Also non-abundant species of high potential value
7. Green Star species- No particular conservation concern, common in Ghana.

4.1.6 Socio-economics

In the ecological assessment of critical habitats of the Western Region, discussions with community members were also carried out to establish the specifics of their relationship with the environment. This section provides an overview of their socio-economic status, including various activities that utilize natural resources and traditional beliefs or conservation practices to protect these resources. .

In the Western Region, there are five major ethnic groups: Ahantas (6%), Nzemas including the Evalue (11%), Wassa (12%), Sefwis (11%) and Aowins (3%) (ERM, 2009). Through discussion with community members, the majority of the respondents were Nzema, with other ethnic groups such as Ahanta and Fante in the minority (Figure 30). A greater part of those interviewed currently lived in the town they were interviewed in (96.2%). Two-thirds (63.8%) said the town they were interviewed in was their place of birth, whilst the remaining was from other areas such as:

- Agona West
- Egyambra
- Ahanta
- Ahanta East
- Cape Coast
- Ellembele
- Evalue Dwira
- Larteh
- Mankessim
- Moree
- Nkroful
- Nsuaem

- Shama
- Takoradi
- Tikobo
- Nigeria

The age distribution of the respondents is shown in Figure 31. Of those interviewed, the largest proportion was within the 20 – 29 age groups. Low numbers of the older age groups could mean that they were at work and not available. The population of the Western Regions is relatively young, with 43% of the population falling between the ages of 0 – 15 years. This age structure follows the trends of developing countries, where numbers of young people are high but gradually dwindles off with increasing age. 62% of respondents have had some form of formal education with the remaining 38% respondents having none (32). The relatively higher basic level of literacy can be attributed to the National Education Strategy Plan of the government which led to about 64% of the population in primary school and 21% in secondary school, in 2000 (ERM, 2009).

Fishing and farming are the main livelihoods (Figure 33), although trading is the preferred form of secondary occupation for most of the women interviewed. Coconut and oil palm are cultivated on a large scale for commercial purposes, with subsistence farming of cassava, maize, rice, and other crops. Respondents were either home owners (43%) or stayed in family houses with other relatives (37%) (Figure 34). Houses were either built with cement blocks or mud, but there is use of other materials such as bamboo, raffia and bricks (Figure 35). The roofing material is mainly of asbestos, aluminum and thatch.

Only 25% of the respondents interviewed have places of convenience in their homes. The remaining 75% either use the public toilets or resort to the use of open places such as the bush or the beaches.

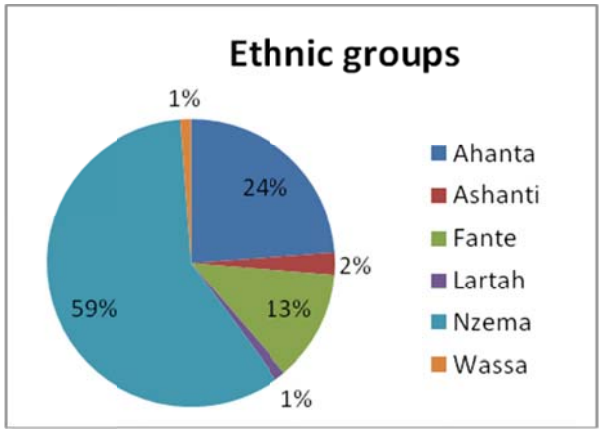

Figure 30. Percentage composition of ethnic groups

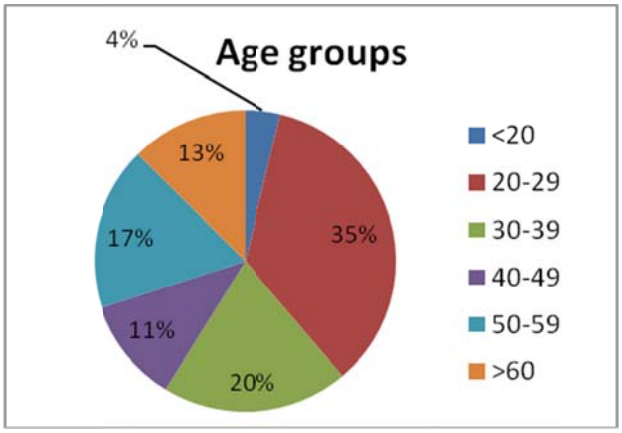

Figure 31. Percentage composition of respondents' age groups

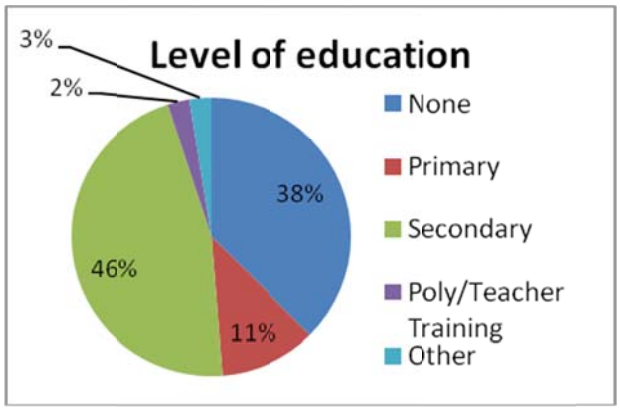

Figure 32. Percentage composition of respondents' levels of education

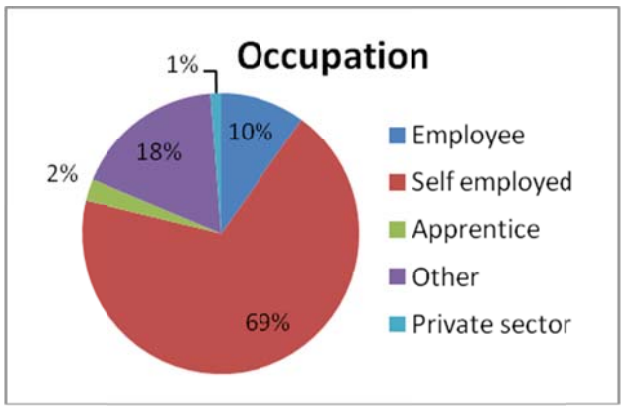

Figure 33. Percentage composition of respondents' occupations

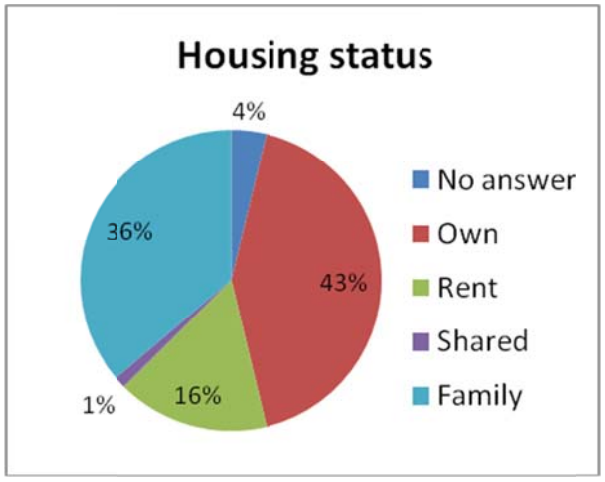

Figure 34. Percentage composition of respondents' housing status

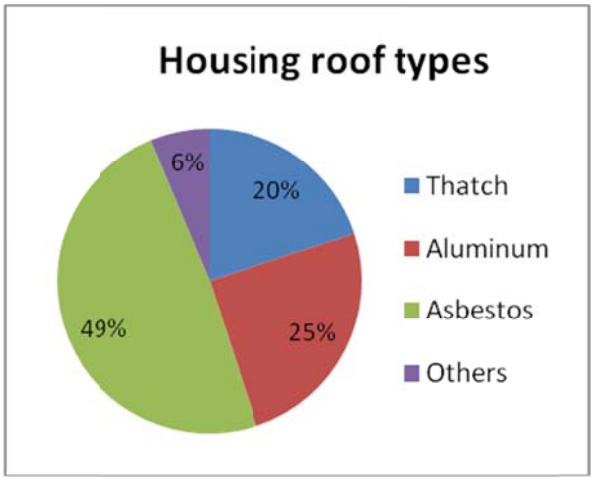

Figure 35. Percentage composition of types of housing roofs

4.1.7 Resource Use

In addition to the collection of natural resources from the wild, communities in the Western Region depend on activities such as farming, fishing, and hunting for food. The following sections provide an overview of how the community members depend on their environment for their livelihood, including access to other amenities such as water, energy and health care.

4.1.7.1 Natural resource collection

There are different types of natural resources collected by the respondents. Coconut, palm fruits, cassava, plantain, maize, tomatoes, pepper, garden eggs fish, crab, snails, fire wood, herbal medicine, etc. were some of the natural resources that found in the communities visited. Collection of natural resources was the responsibility of both male and female with children also helping in the collection. These are for both domestic consumption and for sale. The type and time of resource varies depending on the season.

4.1.7.2 Farming

Land preparation usually involves slash and burn techniques, with mixed/continuous cropping. Crops grown are mainly cassava, oil palm and vegetables, with other crops such as plantain, cocoyam, rice, coconuts and in some cases, rubber. Farmers have all observed decreasing yields due to poor soil fertility; however, three communities indicated that they have recently started using fertilizers (Ankrobra, Butre and Cape Three Points). It was also noted that many farmlands have been transformed to rubber plantations, which reduce available land.

4.1.7.3 Fishing

Both inland and sea fishing is a common activity in the Western Region, characterized by the use of canoes. There are regulations such as bans of fine and small mesh nets, with traditional regulations where fishing is not allowed on specific days. These days range depending on the area, and include Tuesdays, Thursdays or Fridays. Fishermen complain of decreasing yields and blame light fishing by Chinese fishermen for the depleted stocks. In Amansuri, the proliferation of green algae has been noted as the cause of lower fish harvests.

4.1.7.4 Hunting

With the exception of the Amansuri community, communities in the assessed communities supplement their diets with hunted animals. This includes the commonly known grasscutter, antelope, and rats; and in some cases, duikers and monkey. Hunting techniques are usually by guns, traps and dogs. Respondents have observed declining numbers in hunted animals and attribute this to the migration of animals deeper into the forests, the result of increased population and numbers in hunters, exploitation and extinction of animals, and change in land use from forest to rubber plantations.

4.1.7.5 Water

In the Western Region, only 32% of the houses have access to treated pipe-borne water, with 8.5% in their homes. Sources of potable water in the studied areas include rainwater, boreholes, well, pipe and nearby streams and rivers. In many areas, the inhabitants depend on a borehole for potable water, mostly without any payments. With increased activities along the aquatic systems, i.e., farms and dumping of refuse, communities have observed 'reddish worms' in the water. The majority of respondents commented on the deteriorating water quality that has affected its color and taste. Respondents also commented on the changes in the perennial nature of the river and that the river now dries up in the dry season.

4.1.7.6 Sources of energy

About 60% of respondents are connected to the national grid through a rural electrification programme, and the remaining percentage (26.2%) use kerosene. The main sources of energy for cooking are fire wood and charcoal. The use of gas was not common among those interviewed. Charcoal production takes place in most of the communities. In Ankobra and Butre, respondents have observed that it causes destruction to vegetation and various species. However in Princestown, the impact of charcoal production on the environment were considered to be

negligible since the wood used is normally obtained from logged rubber trees and other trees already cut down during land clearing.

4.1.7.7 Health

Malaria and fever were the most common ailments reported in the various communities. Other health issues included water borne diseases such as Guinea worm, Buruli ulcer, diarrhoea, elephantiasis, itchy skin, and cholera. Orthodox and herbal treatments are the forms of treatments that are used for treating persons who fall sick. There was general agreement about the usefulness of herbal plants found in the vicinity of the community. Some of the plants mentioned (with local names and/or parts of the plant used) include:

- *Acacia* species (Acacia leaves)
- *Azadirachta indica* (Neem Tree)
- *Chromoleana odorata* ("Ghana Afofo"; "Abafro"; "Acheampong")
- *Cocos nucifera* (leaves of coconut)
- *Kyaha* species (parts of the Mahogany tree)
- *Musa* species (leaves of plantain)
- *Ocimum gratissimum* ("Nunum")
- *Persea americana* (Avocado leaves)
- *Rauvolfia vomitoria* ("Kakapenpen")
- *Theobroma cacao* (leaves of Cocoa)

4.1.7.8 Flora and fauna

In guided discussions for more precise information about common and important types of flora and fauna in the communities, the respondents seemed unsure about what was being asked for exactly and indicated that the elders would know more. Most of the information on specific floral and faunal groups is provided in the reports of the various field surveys.

4.1.8 Environmental issues

There has been observed changes in the environment over the past years, which has led to poorer crop and fishing yields, lesser numbers of wild animals, and deteriorating quality of water and soil. In Ankobra, Butre and Cape Three Points, respondents indicated that critical environmental issues were arising because people lacked education and did not respect authority anymore. This has resulted in poor sanitation and inappropriate waste disposal systems that are causing increased breeding of mosquitoes and outbreaks of diseases.

In the Western Region, 40% of the homes have no toilet facilities. Solid waste is usually dumped at public refuse dumps in the vicinity of the towns, where it is sometimes burnt or buried. In some cases, the location of these dumpsites is near surrounding water bodies. Liquid waste is dumped directly into gutters and when not available, into the streets or available spaces in the environs of the community. In some instances, it is taken to the nearest water body such as the river or sea. The respondents all expressed concern about the impacts of indiscriminate disposal

of waste that has resulted in poor sanitation and breeding of mosquitoes. They agreed on the need for more effective enforcement of rules and regulations.

On some beaches a proliferation of plastic poly ethane bags and human excreta were observed. However, with the national beach clean up efforts by Zoil Ghana Ltd, the communities showed efforts at cleaning the beach on a daily basis, with the rubbish collected buried in deep holes in the sand.

Other impacts to the environment include uncontrolled bushfires, especially in Ankrobra and Butre. Here, bush fires are common occurrences since fire belts are not normally constructed before fires are set. The impacts of erosion were ranked high in almost all the communities, which respondents explained was caused by sand/stone winning from the shore. For example, in Princestown, gully erosion was observed around the school and on the road to Castle. In Amansuri, however, sand winning and erosion was not an environmental issue. All the communities have been affected by flooding as a result of sea erosion, deforestation and destruction of mangroves. Impacts of flooding included loss of property, further erosion, destroyed vegetation and loss of lives.

All those interviewed recognized the changes in the weather conditions over the past years, especially decreasing rainfall and warmer weather. The respondents suggested various factors which ranged from human activities such as deforestation, depletion of the ozone layer and bush burning, to reasons indicating natural process of a changing world and the will of God.

4.1.9 Traditional beliefs and resource management

The Western Region has a high number and extent of pristine tropical beaches, with reserves of tropical rainforest, inland lakes and rivers. The region also has seven of the country's fifteen selected tourist forts. In general, cultural practices include traditional rules and regulations to help protect and manage the environment. However, in some villages such as Amansuri and Butre, the respondents complained that these methods are no longer effective and there is the need for additional governmental regulation. For example, it was observed that in Butre the sacred grove was being used as a place of convenience. In Princestown, it was observed that the public toilet exits near to the beach and cemetery. In Ankobra, there were no regulations that the respondents were even aware of. However, in Cape Three Points, the traditional rules and superstitions were considered to still be effective.

Many of the traditional regulations have similar themes. In Butre and Princestown, entry into sacred groves and reserve areas is restricted on Sundays or when there has been a death in the community. Similar taboos include no fishing and no farming days. There are also restrictions against women who are in the bleeding phase of their menstrual cycle or who are post-natal. In the case of post-natal women, purification rites are required before she is allowed to enter again. Purification rites include the sacrifice of an animal (goat) or of food (e.g., plantain, eggs, yam, onions, etc.).

The use of the Offior (black and white monkey) as a totem in Cape Three Points is used in the protection of natural resources. Many of the communities in the study areas are aware of

protected natural and sensitive sites, such as the forest reserve, mangrove and lagoon areas. These also include also sacred groves and the Castle Del. Similar restrictions that exist for sacred areas are applied for reserves and protected areas. In Cape Three Points and Princestown, patrols by forest guards also support the traditional methods.

On an individual basis, the majority of respondents were aware of their role in managing the natural resources and the environment. Overall, individual contributions included: following rules and regulations, being involved in communal labor, contribution of money towards various activities, and the protection of the forest and planting of trees, among others. 75% of the respondents agreed that traditional and festive occasions were good platforms for educating communities on environmental issues. For discussions on conservation issues, 45% discussed this at the household level (34% did not), and only 26% of those who belonged to various organizations (36% of respondents) discussed this at the organizational level (i.e., those belonging to recreational, religious, political or interest groups).

4.2 Management Issues and Recommendations

Marine resource use is an important component of the local economy in many tropical coastal areas. The importance of marine resources to a community depends on the geographic and economic situation of the area: the level of development, the role of tourism and the availability of alternative sources of income. Biological resources in many of low intensity managed habitats represent a significant contribution to economic activity. However, many traditional low-intensity managed habitats are threatened by development – a change in land use management due to the prospect of increased private returns.

Conservation of all components of biodiversity within a framework of 'irreplaceability' relative to 'vulnerability' is central to conservation planning theory (Margules and Pressey, 2000) of biodiversity representation'. Representation identifies everything that biodiversity conservation aims to preserve, whereas prioritization identifies what it aims to preserve first (Ginsberg, 1999). Importantly, in the conservation context, prioritization is quite distinct from, and should not be confused with, triage. Prioritization provides a means of scheduling responses within such an overall framework (Mittermeier *et al*., 2003a). Triage, by contrast, has been interpreted as writing threatened biodiversity off the conservation agenda as beyond hope (Pimm, 2000) – discounting the high vulnerability components of the framework.

The most common measure of irreplaceability is plant (WWF and IUCN, 1994–97; Mittermeier *et al*., 1997, 2003b; Myers *et al*., 2000) or bird (Stattersfield *et al*., 1998) endemism, often supported by terrestrial vertebrate endemism overall (Mittermeier *et al*., 1997, 2003b; Myers *et al*., 2000). The logic for this is that the more endemics a region holds, the more biodiversity is lost if that region is loss other aspects of irreplaceability have been proposed including taxonomic uniqueness, unusual phenomena and global rarity of major habitat types (Olson and Dinerstein, 1998), but these remain difficult to quantify.

Prioritization identifies what needs to be preserved first (Ginsberg, 1999). Despite the fact that species richness within a given area is sometimes assumed to be important in prioritization (Prendergast *et al*., 1993), none of the approaches rely on species richness alone. This is because species richness is driven by common, widespread species, thus strategies focused on species richness tend to miss exactly those biodiversity features most in need of conservation (Orme *et al*., 2005; Possingham and Wilson, 2005; Lamoreux *et al*., 2006).

One very instructive way of prioritizing management action for habitats is to determine the relative importance of the habitats through a determination of human impacts as well as the importance of ecosystem goods and services. Impacts can be quantified using indications of magnitude, frequency and likelihood of occurrence; while ecosystem goods and services can be broadly grouped and quantified under biodiversity, water quality and socio-economic importance. This method of relative quantification was applied to all the ten habitats assessed and given a score each of: 1 for low; 2 for medium; and 3 for high impact, or importance using findings from this study and supported by experience of the researchers. The total score for human impacts and that of ecosystem goods and services was subsequently summed up (Table 4.7)

Table 25. Habitat Rankings

	HUMAN IMPACT (PRESENT AND FUTURE)				**GOODS AND SERVICES**			
Habitat	*Magnitude*	*Frequency*	*Likelihood Of Occurrence*	***Total Score***	*Biodiversity*	*Water Quality*	*Social*	***Total Score***
BELIBANGARA	2	3	3	**8**	2	1	3	**6**
DORMUNLI	1	1	3	**5**	3	2	2	**7**
AMANSURI LAGOON	2	2	3	**7**	3	2	3	**8**
AMANSURI OUTLET	1	2	2	**5**	3	2	2	**8**
ANKOBRA	3	3	3	**9**	3	1	3	**7**
MIAMIA	1	1	1	**3**	2	2	1	**5**
KPANI-NYILA	1	1	2	**4**	2	2	2	**6**
PRINCESTOWN	1	1	2	**4**	3	2	2	**7**
CAPE THREE POINTS	3	3	3	**9**	3	2	3	**8**
BUTRE	1	1	1	**3**	3	2	2	**7**

Legend
Low = 1
Medium = 2
High = 3

As a result of their high score from human impact, Cape Three Points, Ankobra and Belibangara appear to be the most adversely impacted habitats. Conversely, greater Amansuri (Amansuri lagoon and Amansuri outlet), Cape Three Points and Dormunli ranked highest in terms of ecosystem goods and services. The study, therefore, recommends that the three most impacted habitats by humans require urgent management actions for restoration of habitat quality, whiles the three most important habitats for ecosystem goods and services need to be protected. Cape Three Points falls in both categories and hence has priority for management actions, especially with the oil and gas activities offshore.

4.3 Strategic Environmental Monitoring Methods of Critical Habitats

Management of marine/coastal resources requires the assessment of the ecological status of the habitats and organisms that are being exploited. It is also important to assess how local people use the resources and their role in the local economy. As the socioeconomic structures of coastal communities develop and change, the intensity with which the resources are exploited also changes. The assessment of the selected critical habitats of the Western Region reveal important management issues, which call for measures that will reduce the concerns. Mechanistic understanding of the issues and subsequent mitigating measures call for monitoring and evaluation of key indicators that will measure the ecosystem health. Monitoring and research is therefore needed into the sustainability of the resource use methods and potential alternative use of resources as well as the direction of change of the resource use habitats.

The following are proposed simple monitoring indicators of ecosystem health of the critical habitats. The indicators are targeted at monitoring each biotic component, water quality and socio-economics of the critical habitats assessed.

Proposed indicators for monitoring the health of the Critical Habitats in Western Region

Water Quality

- Surface water quality: Nitrogen, Dissolved oxygen, pH, pesticides, heavy metals, temperature
- Dissolved oxygen concentration
- Phosphorus concentration
- *E. coli* counts and nutrient levels as % of baseline levels
- Suspended solids
- Changes in vegetation type along water courses
- Density of opportunistic species

Macrobenthos

- Species richness (number, number per unit area, number per habitat area)
- Integrity of habitats for terrestrial fauna
- Species diversity and abundance
- Functional diversity of macrobenthos
- Geographical range of species
- Biomass
- Change in number and/or distribution of keystone or indicator species
- Percentage of intertidal area under intensive collection

Avifauna

- Composition & diversity of avifauna
- Number of endangered/threatened avifaunal species
- Change in presence, location, area, numbers of resident species

Fisheries

- Abundance of fish species landed
- Diversity of landed fish
- Dominance of fish species
- Fish family diversity
- Size of fish species
- Changes in fish catches by species per specific season
- Threatened fish species as a percentage of total fish species known
- Catch Per Unit Effort (CPUE)
- Number of gear types

Terrestrial Fauna

- Integrity of habitats for terrestrial fauna
- Composition & diversity of fauna species
- Spatial extent of fauna
- Number of endangered/threatened faunal species
- Diversity of native fauna
- Species richness (number, number per unit area, number per habitat area)
- Change in presence, location, area, numbers of invasive animal species

Mangroves

- Percentage of planted mangrove
- Number of species in mangrove forest
- Spatial extent of mangrove coverage
- Height of mangrove plants
- Thickness of mangrove forest
- Number of endangered/threatened species within mangrove forest
- Alternative means of firewood in community
- Number of mangroves forests converted into aquaculture
- Number of educational seminars of mangrove benefits

Terrestrial Vegetation

- Percentage of cover of vegetation or canopy cover
- Number of species in mangrove forest
- Number of exotic or alien plant species
- Spatial extent of dominant species
- Height of plants species
- Thickness of forest

- Number of extinct, endangered, threatened, vulnerable and endemic forest dependent species by group (e.g. birds, mammals, vertebrates, invertebrates)
- Percentage of planted plant species
- Percentage primary and secondary forests
- ratio dead-living wood
- Change in presence, location, area, numbers of invasive plant species
- Total forest area as a percentage of total land area
- Number and size of forest fires
- Change in land use, conversion of forest land to other land uses (deforestation rate)

Socio-economics*

- Types of community infrastructure (to assess development and wealth)
- Identify coastal and marine activities (to assess use of coastal and marine resources)
- Types of coastal resources
- Perception of degree and type of impact of activities on coastal and marine resources
- Informal rules, customs, and traditions for resource management
- Traditional conservation measures
- Enforcement and compliance to management and rules

**The categories listed are not specific but can be expanded into qualitative or quantitative elements.*

4.4 Weaknesses and Shortcomings of Survey

This study has shortcomings that cannot be swept under the carpet. There is generally a paucity of information on the coastal habitats of the Western Region. A few notable ones like the Amansuri and Cape Three Points are well documented but that cannot be said for many others in the region. Therefore the background information to support the assessment was limiting. It should be noted herein that CRC (2010) which focused on the threats to biodiversity of the region was a useful source of background information for the present study. Further, the timing of the study in the dry season of the year provided information for that is relevant more for that period of the year which cannot be extended for the rainy season. In recent years, however, due largely to climatic changes, there has been shifts of the timing of these two seasons in the year thereby confounding notable general trends. It would have been more instructive and useful to extend these studies over the entire year or more and to cover many more habitats. Data gathering for a longer period could have afforded opportunity to help model impacts of climate change on the conditions of these habitats as well as capture any intra- and inter-seasonal variability in habitat quality. Obviously, there is a need for follow up studies in these habitats and this can be done by monitoring the simple indicators outlined in Section 4.3.

Field studies were carried out within a short period of three weeks. One-off spot sampling field surveys could be undertaken for each of the habitats due to budgetary constraints. These assessments were guided by the socio-economic importance and its specific biodiversity. Findings therefore are indicative only but can be useful to guide future follow up studies and management actions. The low budgetary provisions persisted within the broad objective of the call for proposals. The expected outputs are way beyond the budgetary provisions of the call. Lots of sacrifice of manpower and other resources has gone to ensure successful completion of this study. The most expensive part of the study was the cost of acquiring digital maps, interviewing human subjects that require incentives before providing information. Other challenges were long travel times in between and within the various habitats, due to poor road network to many locations and expensive and scarce accommodation in many parts of the region.

Constraints faced by two thematic areas, socio-economics and GIS mapping have been discussed below to illustrate difficulties under which the study was conducted. Socio-economic sub-indicators that potentially affect coastal habitats include population, education, health, culture, employment and poverty; require quantitative study to provide reliable information on densities to inform the choice of sites for designation as marine protected sites. One of the difficulties with qualitative data is assessing its accuracy. Due to the limited time frame of the study, the research team could not spend a substantial amount of time in the various communities that are located in the vicinity of the selected critical habitats. Although respondents lived in the main townships evaluated, overall responses presented in the report are representative of only a small sub-section of the communities that live around the habitats. In addition, information provided could not be verified through observation. For a more comprehensive socio-economic survey, there is the need for a wider range for evaluation and more time spent interacting with the community members.

For GIS mapping, the methodology adopted ensured collection and mapping of reliable, high quality, current and spatially accurate information on the identified coastal habitats in the

Western Region. Base maps were prepared from topographic maps and orthophotographs of the coastal area provided by the Survey Department. Raster maps used in the document were produced at scale of between 1:5,000 and 1:50,000 depending on the habitat under consideration. In view of the fact that shape files have been re-digitized for the area, it is possible to view to higher resolution with appropriate GIS software.

4.5 Conclusions

This study has assessed 10 identified critical habitats in the Western Region of Ghana. The assessment covered terrestrial, coastal and marine habitats of major importance in the region. Each of the habitats have been mapped and surveyed for its water quality, biodiversity and socio-economics that affected their continued survival and provision of ecosystem goods and services. Despite the fact that information gathered was from one season only with some variability, overall, adequate data has been generated on the critical habitats which should provide reliable initial basis for further monitoring towards a more comprehensive database and understanding of the dynamics of the systems and the goods and services they provide. Specific indicators have been provided under the various thematic areas for monitoring purposes and can be used for other habitats in the region in future.

Cape Three Points, Ankobra and Belibangara appear to be heavily impacted by humans and require restoration of habitat quality; while the greater Amansuri (Amansuri lagoon and Amansuri outlet), Cape Three Points and Dormunli are important for ecosystem goods and services and need to be protected. As Cape Three Points falls in both categories, it has priority importance for management actions. The assessment suggests the wider Cape Three Points areas and the Amansuri Estuary as potential biodiversity hotspots that need urgent strategic management attention. Conservation measures at the Cape Three Points area including Princestown, Ehunli and Kpani Nyila should be strengthened with the promotion of ecotourism to help support the economies of the local communities. The marine nearshore and beach at Miamia is worth instituting measures to protect as a site of scientific interest.

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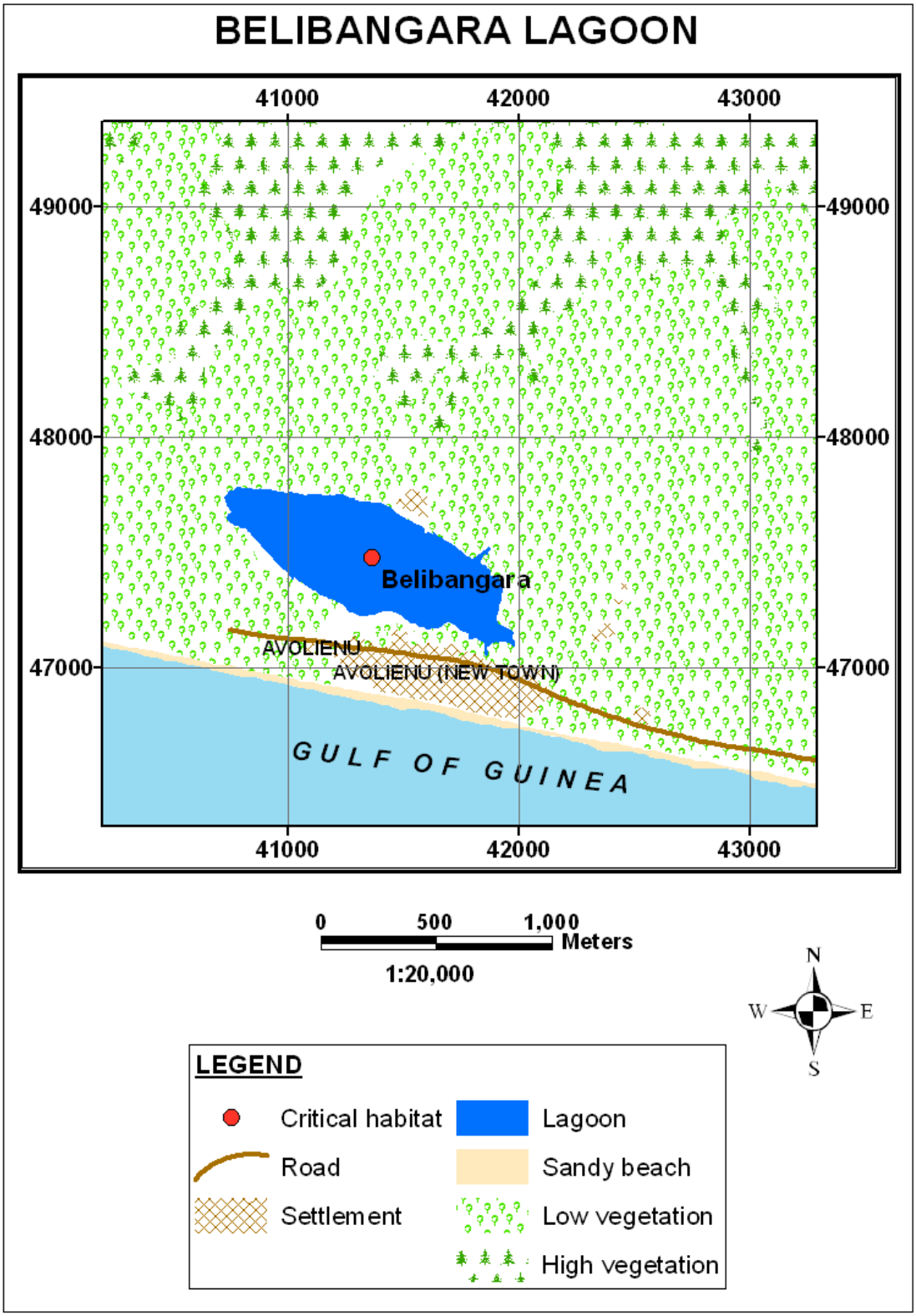
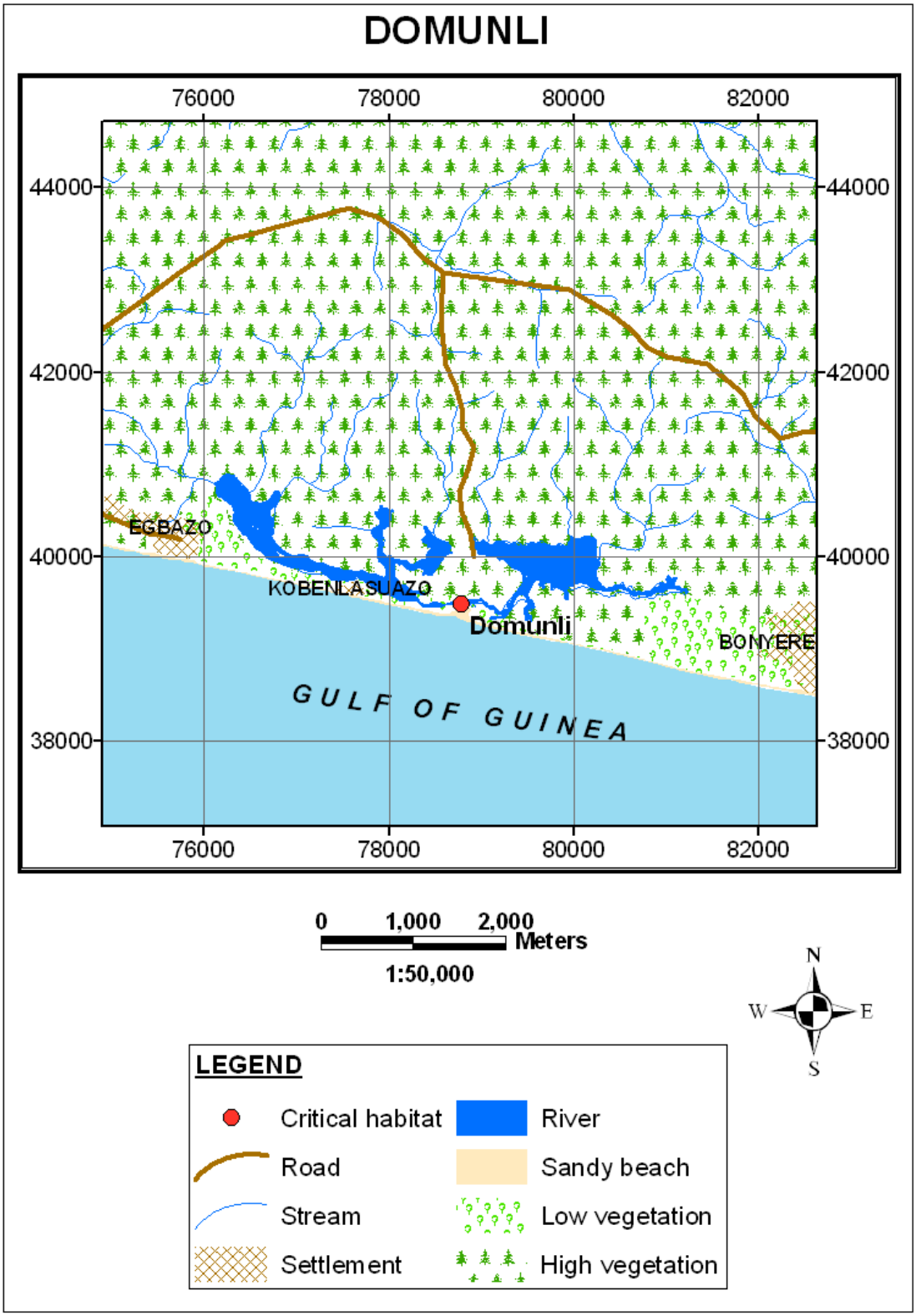
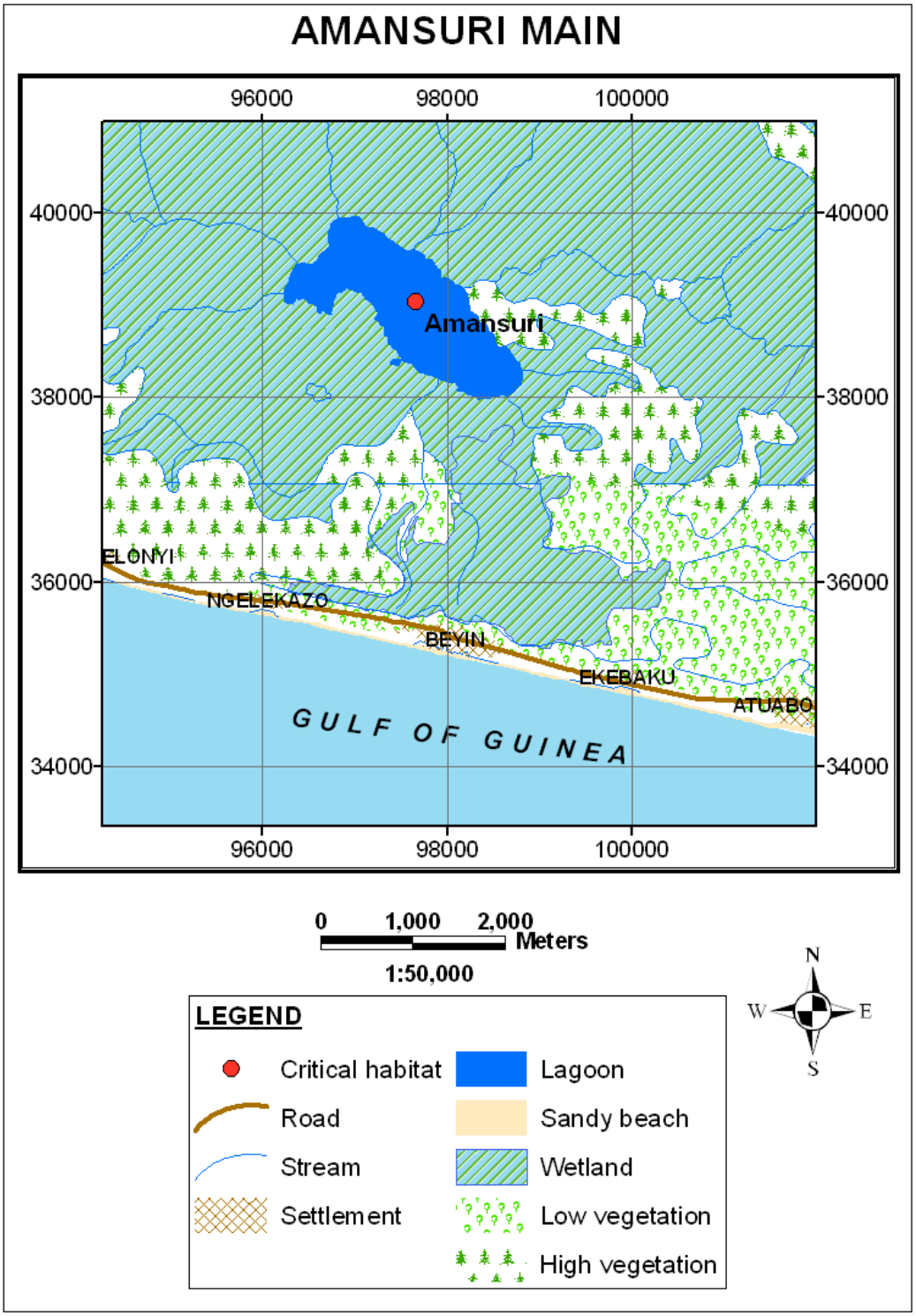
Appendix 1. Map of Belibangara Lagoon



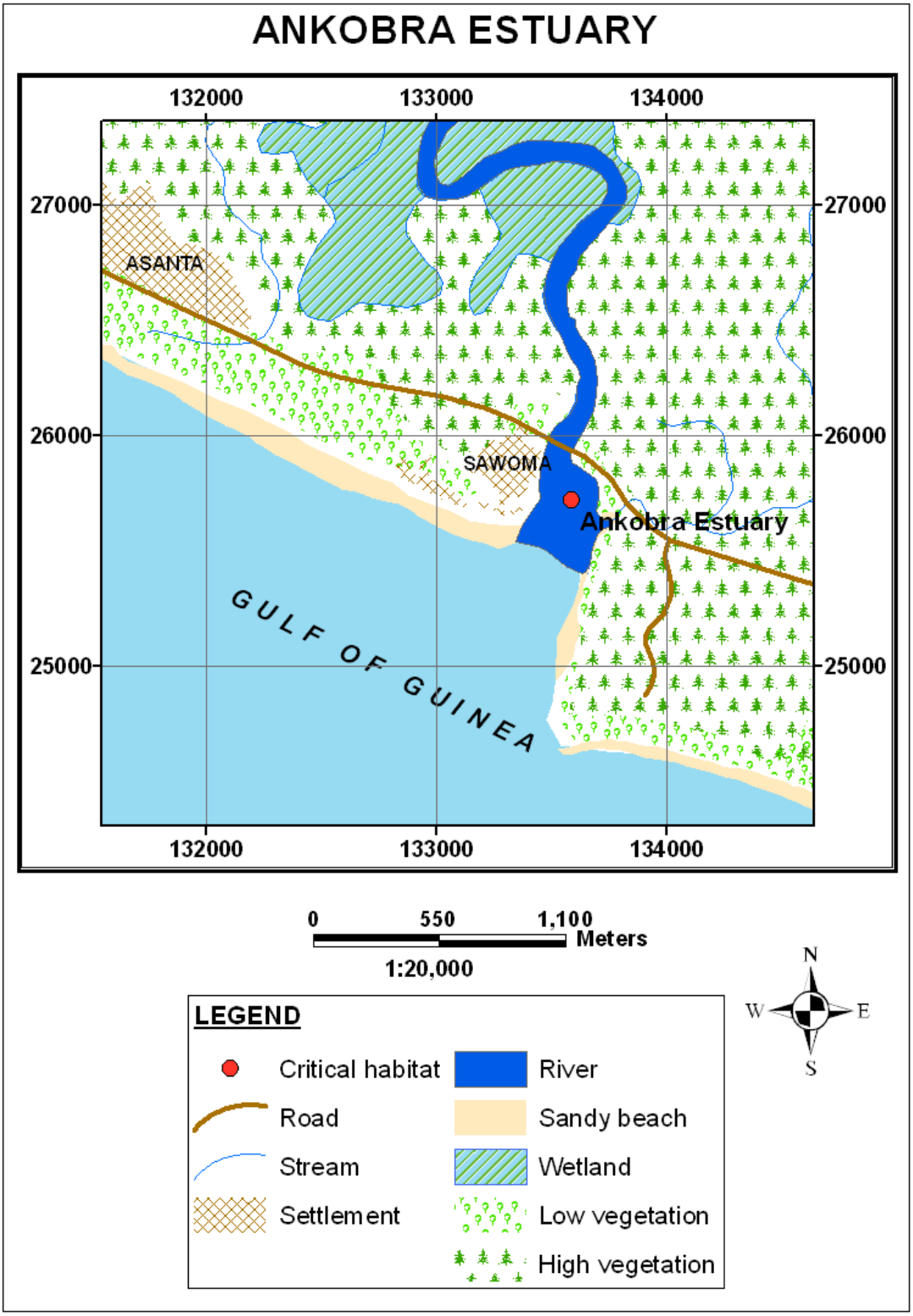
Appendix 2. Map of Domunli Lagoon



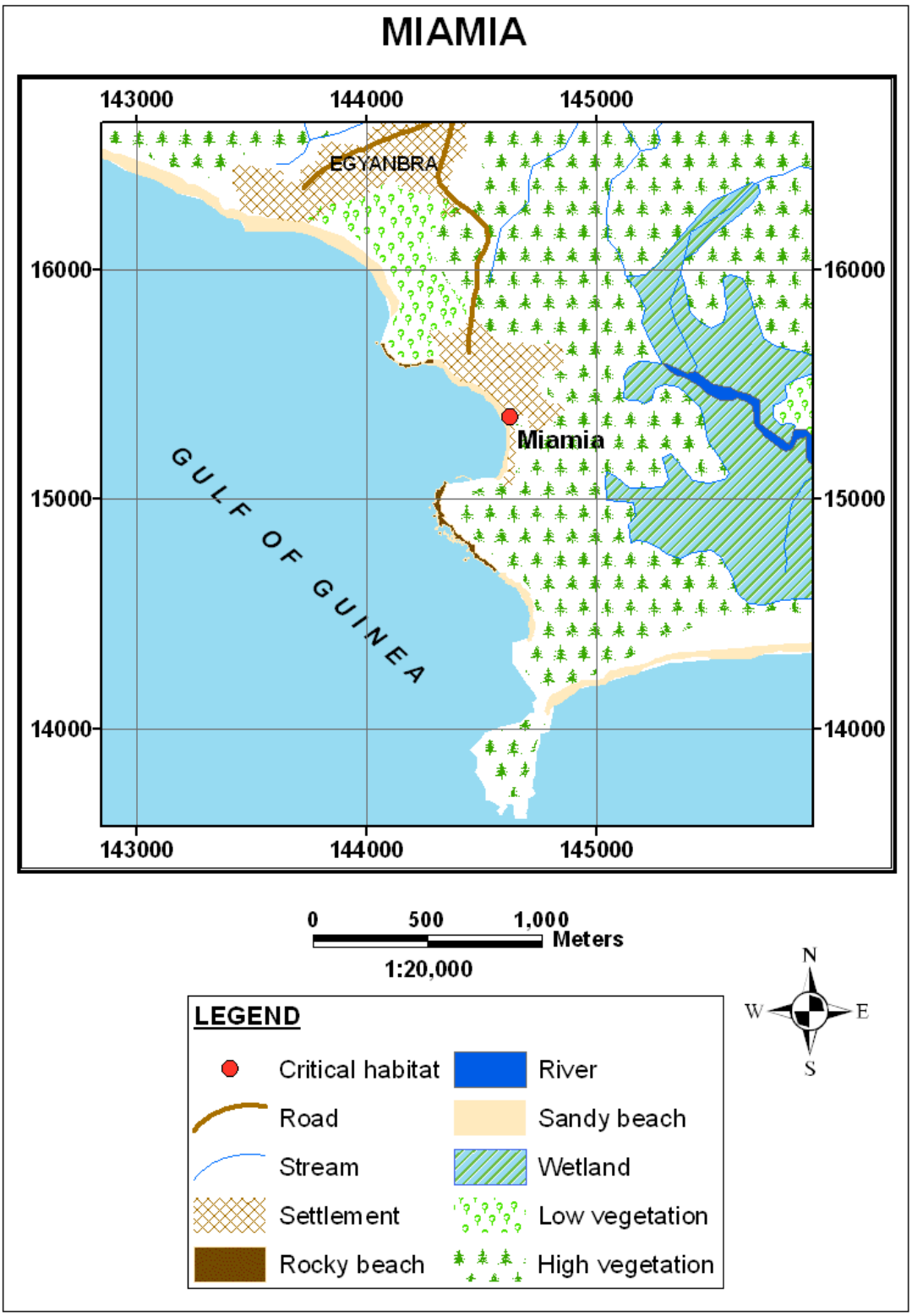
Appendix 3. Map of Amansuri Main and Azulenoanu (Amansuri Outlet)



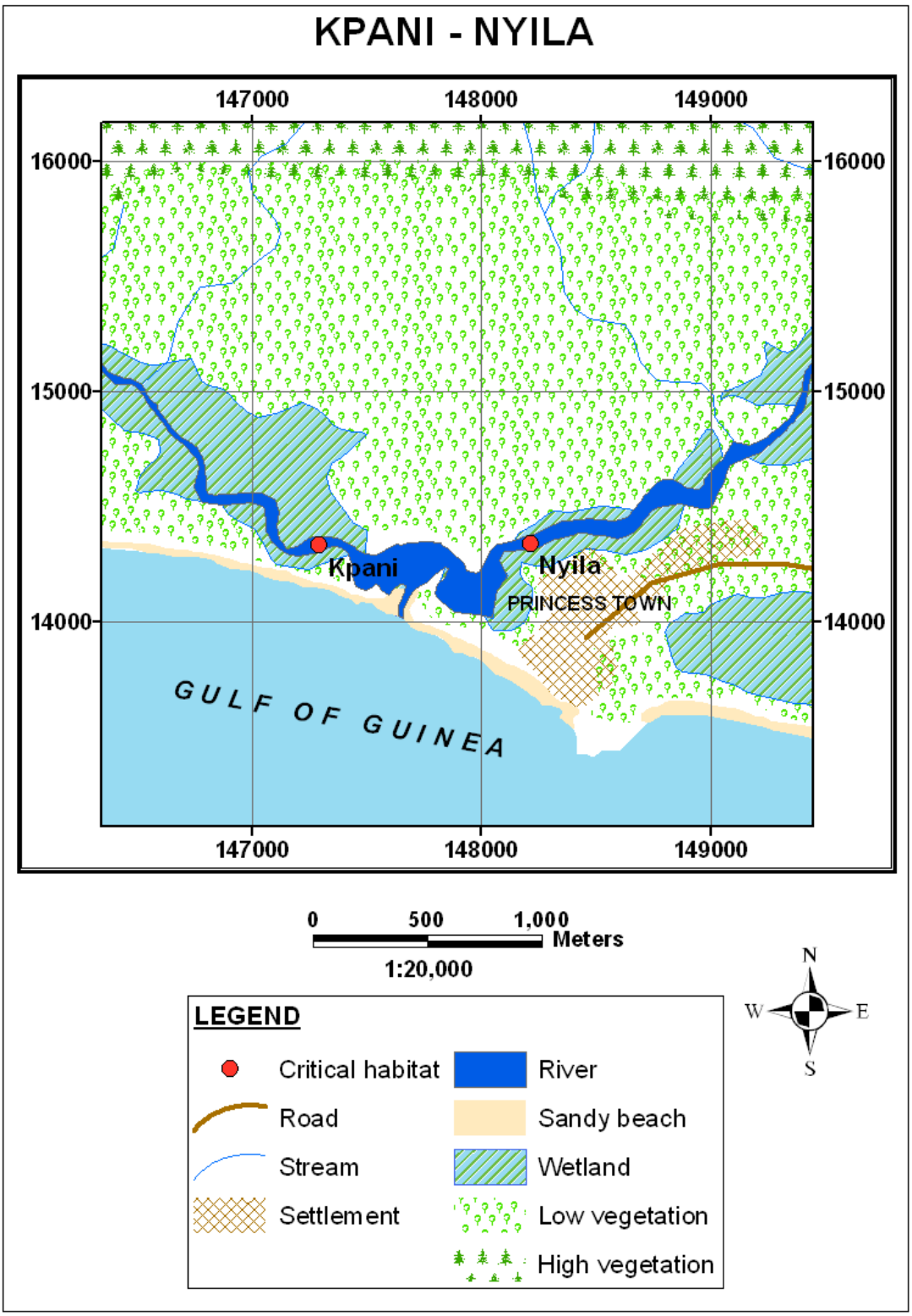
Appendix 4. Map of Ankobra Estuary



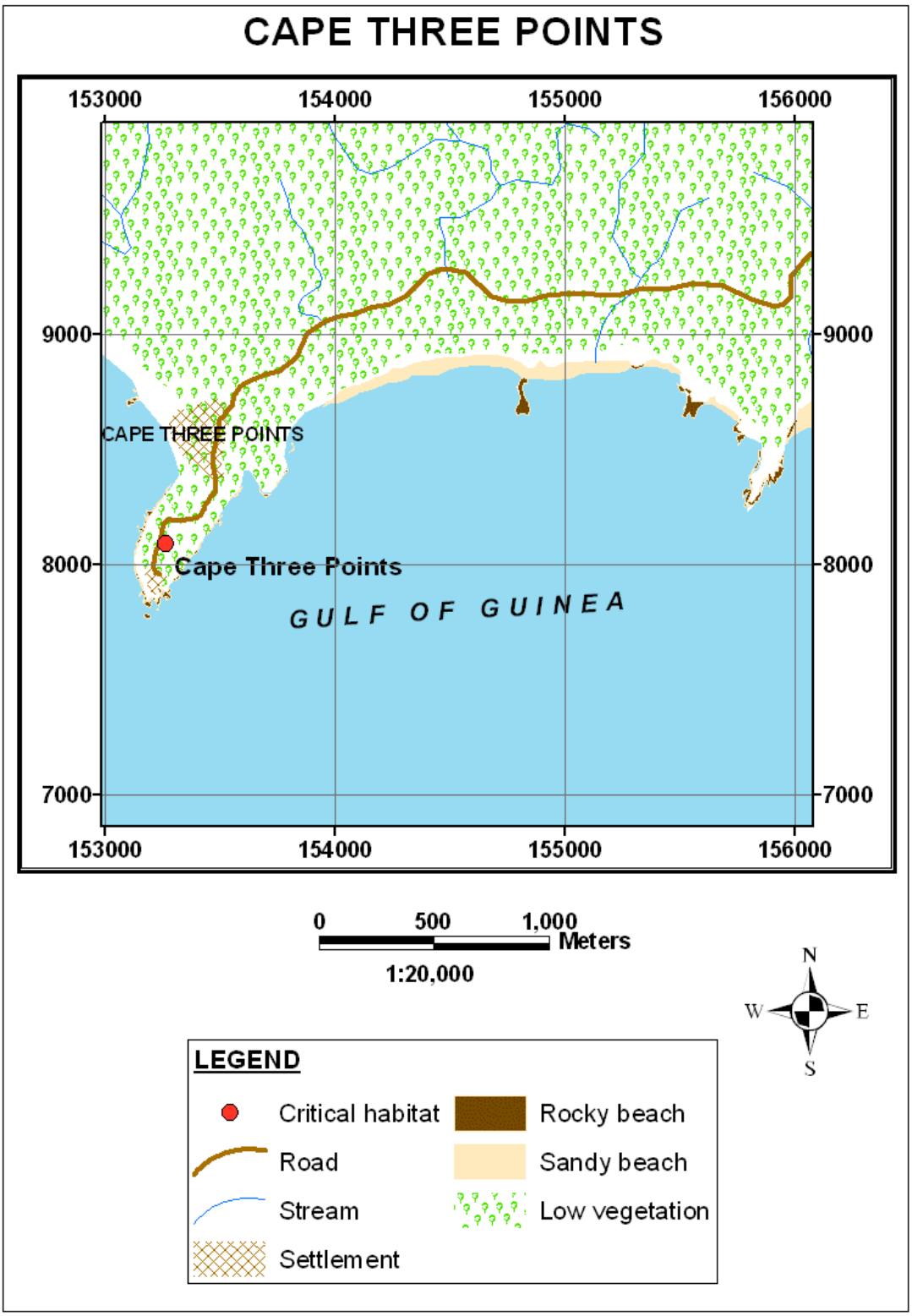
Appendix 5. Map of Miamia Beach



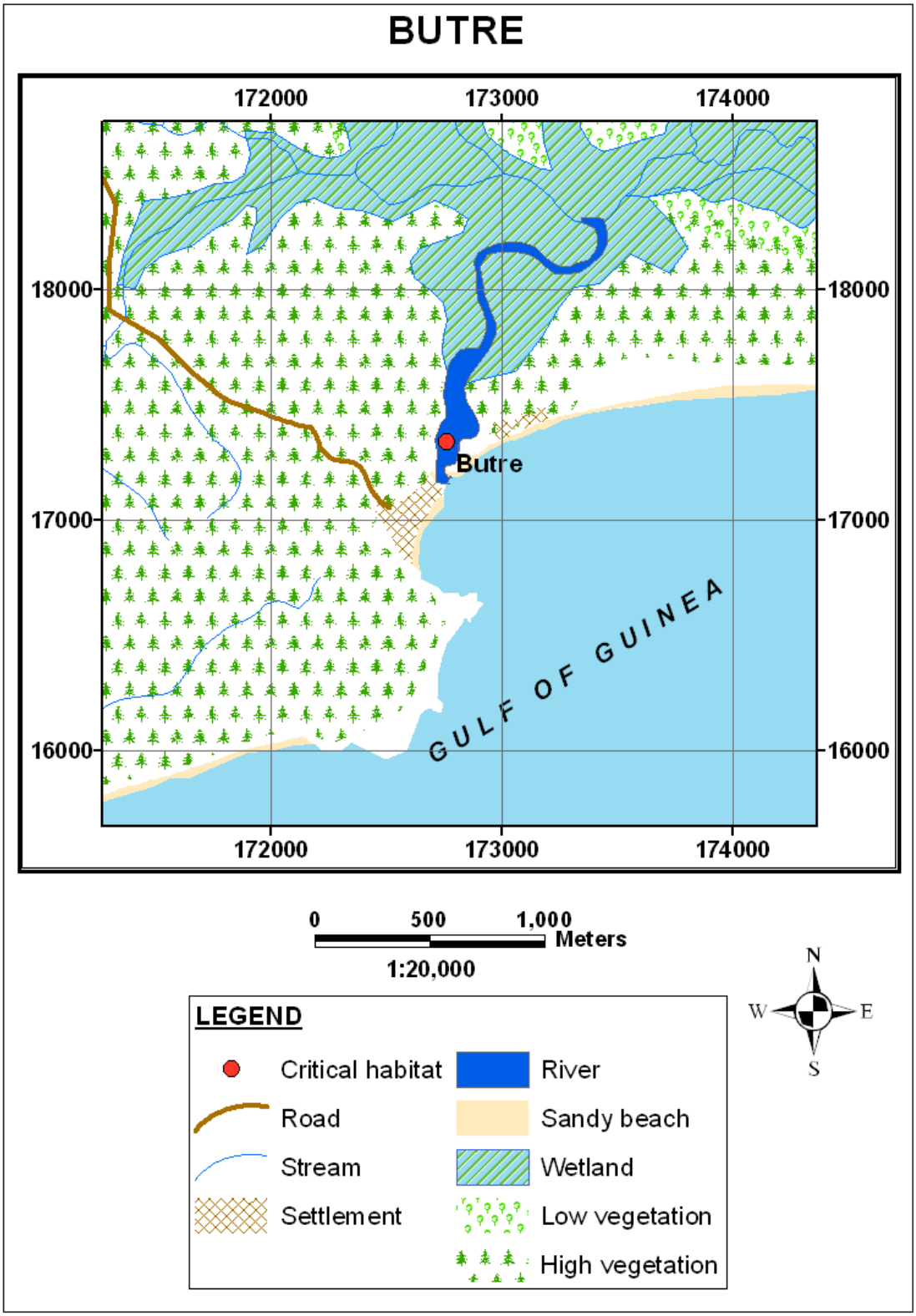
Appendix 6. Map of Kpani-Nyila and Princess Town beach



Appendix 7. Map of Cape Three Points



Appendix 8. Map of Butre



Appendix 9. Results of water quality parameters measured at the various sites

Parameter	Belibangara	Amansuri Main	Amansuri Outlet	Domunli	Ankobra	Kpani	Nyila	Butre	Acceptable levels	Reference
Temperature (^{o}C)	23.2 ± 0.05	27.6 ± 1.50	24.4 ± 1.2	29.6 ± 0.92	26.4 ± 0.1	26.3 ± 0.54	26.2 ± 0.60	24.2 ± 1.2	-	
Salinity (‰)	0	2 ± 0.8	38.0 ± 1.0	33.0 ± 2.6	9.0 ± 1.0	28.0 ± 2.0	30.0 ± 3.0	15.0 ± 5.0	-	
pH	7.7± 0.7	5.3 ± 1.1	8.6 ± 1.0	8.8 ± 0.2	8.1 ± 0.1	7.6 ± 0.4	7.5 ± 0.6	6.9 ± 0.2	6.5 – 8.5[a]	Chapman (1996)
Total Dissolved Solids (g l^{-1})	39.78 ± 0.97	28.13 ± 5.49	29.58 ± 3.00	17.55 ± 0.80	8.07 ± 1.00	4.73 ± 0.75	3.35 ± 0.80	2.71 ± 1.30	1[a]	Chapman (1996)
Turbidity (NTU)	4.28 ± 0.38	1.24 ± 0.38	3.70 ± 0.50	1.13 ± 0.06	32.50 ± 3.54	2.20 ± 0.30	2.80 ± 0.80	5.20 ± 3.41	5[a]	Chapman (1996)
Dissolved Oxygen (mg l^{-1})	7.20 ± 0.44	4.77 ± 0.73	8.64 ± 0.56	8.64 ± 0.84	7.92 ± 0.20	6.12 ± 0.42	7.92 ± 0.60	3.48 ± 0.10	9.5 [a]	Chapman (1996)
Biological Oxygen Demand (mg l^{-1})	6.85 ± 0.97	4.54 ± 1.11	8.14 ± 0.40	8.30 ± 1.49	7.52 ± 0.50	2.88 ± 0.70	4.32 ± 0.30	1.08 ± 0.12	-	
Chlorophyll-a (mg l^{-1})	0.015 ± 0.003	0.008 ± 0.005	0.003 ± 0.001	0.106 ± 0.017	0.002 ± 0.001	0.013 ± 0.005	0.024 ± 0.005	0.009 ± 0.007	-	
Total Coliform (cfu 100 ml^{-1})	504	428	655	258	820	840	745	775	10000[b]	
E. coli (cfu 100 ml^{-1})	163	194	298	30	425	0	0	71	2000[b]	
Heterotrophic Bacteria	435	564	100	218	1540	60	120	903	-	

Parameter	Belibangara	Amansuri Main	Amansuri Outlet	Domunli	Ankobra	Kpani	Nyila	Butre	Acceptable levels	Reference
(cfu 100 ml^{-1})										
NO_3 (mg l^{-1})	2.28 ± 0.48	2.85 ± 0.63	1.00 ± 0.02	0.80 ± 0.17	0.70 ± 0.14	0.40 ± 0.08	0.20 ± 0.05	0.37 ± 0.06	0.1 - 1[c]	NOAA/USEPA (1998)
PO_4 (mg l^{-1})	0.05 ± 0.01	0.06 ± 0.04	0.07 ± 0.01	0.36 ± 0.09	0.15 ± 0.02	0.07 ± 0.01	0.11 ± 0.05	0.21 ± 0.13	0.01 - 0.1[c]	NOAA/USEPA (1998)
Fe (mg l^{-1})	0.72 ± 0.15	1.63 ± 0.36	0.78 ± 0.03	1.04 ± 0.52	1.16 ± 0.20	0.51 ± 0.02	1.42 ± 0.30	0.33 ± 0.01	0.3[a]	Chapman (1996)
Hg (mg l^{-1})	1.06 ± 0.05	0.38 ± 0.07	ND	ND	1.95 ± 0.32	ND	ND	ND	0.001[a]	Chapman (1996)
As (mg l^{-1})	0.10 ± 0.02	0.17 ± 0.04	ND	ND	1.03 ± 0.10	ND	ND	0.32 ± 0.05	0.34[a]	Chapman (1996)
Cu (mg l^{-1})	2.78 ± 0.13	2.11 ± 0.15	2.76 ± 0.72	5.05 ± 0.38	2.89 ± 0.54	0.42 ± 0.02	0.35 ± .04	1.56 ± 0.05	0.005[a]	Chapman (1996)
Mn (mg l^{-1})	0.50 ± 0.23	0.65 ± 0.11	ND	3.77 ± 0.45	0.29 ± 0.02	1.12 ± 0.22	0.23 ± 0.01	0.48 ± 0.06	-	
Cd (mg l^{-1})	ND	0.09 ± 0.05	ND	ND	ND	ND	ND	ND	0.002[a]	Chapman (1996)
Pb (mg l^{-1})	ND	ND	ND	ND	ND	ND	ND	ND	0.001[a]	Chapman (1996)
Zn (mg l^{-1})	0.36 ± 0.12	0.25 ± 0.07	0.25 ± 0.01	0.18± 0.03	0.21 ± 0.03	0.46 ± 0.05	0.11 ± 0.02	0.37 ± 0.02	0.03[a]	Chapman (1996)

ND = not detected i.e. below the instrument detection limit of 0.01 mg/l.
a = WHO maximum recommended limit for aquatic life.
b = EU standard for estuary water.
c = NOAA/USEPA recommended range for the avoidance of algal blooms in estuaries and coastal ecosystems.

Appendix 10. List of Terrestrial Avifauna

Legend: E/S – open habitat, F – primary forest, f – secondary forest, Co – cosmopolitan, SA-Savannah, C – common, U – uncommon, R – rare, BR – Biome Restricted, RR – Range Restricted,

Species	***Common name***	***P. Habitat***	***Rarity***	***C. Status***	***Cape 3 Pts***	***Amanzuri Wetland***	***Princess T***	***Axim-Ankobra***	
ACCIPITRIDAE									
Accipiter erythropus	Red-thighed Sparrowhawk	f	U	WP BR	1				1
Black-shouldered Kite	*Elanus caeruleus*					1	1	1	1
Accipiter melanoleucus	Black Sparrowhawk	f	C	WP	1				1
Accipiter tachiro	African Goshawk	E/S	C	WP	1	1	1	1	1
Aviceda cuculoides	African Cuckoo Hawk	E/S	U	WP	1				1
Buteo auguralis	Red-necked Buzzard	E/S	C	WP		1	1	1	1
Dryotriorchis spectabilis	Congo Serpent Eagle	F	R	WP BR	1				1
Gypohierax angolensis	Palm-nut Vulture	E/S	C	WP	1		1	1	1
Necrosyrtes monachus	Hooded Vulture			WP		1	1	1	1
Kaupifalco monogrammicus	Lizard Buzzard	E/S	C	WP				1	1
Macheiramphus alcinus	Bat Hawk	E/S	U	WP		1			1
Milvus migrans	Black Kite	Co	C	WP	1	1	1	1	1
Pernis apivorus	European Honey Buzzard			WP		1			1
Polyboroides typus	African Harrier Hawk	E/S	C	WP	1	1			1
Stephanoaetus coronatus	Crowned Eagle	F	C	WP	1				1
Urotriorchis macrourus	Long-tailed Hawk	F	U	WP BR	1				1
FALCONIDAE									
Falco ardosiaceus	Grey Kestrel	E/S	C	WP		1	1	1	1
Falco cuvierii	African Hobby	E/S	U	WP			1		1
PHASIANIDAE									
Francolinus ahantensis	Ahanta Francolin	f	C	BR		1	1	1	1
Francolinus lathami	Latham's Forest Francolin	f	U	BR	1	1			1
NUMIDIDAE									
Guttera pucherani	Crested Guineafowl	F	C	BR RR	1				1
RALLIDAE									
Himantornis haematopus	Nkulengu Rail	f	U	BR	1	1			1
Porzana porzana	Spotted Crake	SA	f						
Sarothrura pulchra	White-spotted Flufftail	f	C	BR	1	1	1	1	1
COLUMBIDAE									

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
Aplopelia larvata	Lemon Dove	F	R	BR	1				1
Columba iriditorques	Bronze-naped Pigeon	F	U	BR	1	1			1
Columba unicincta	Alep's Pigeon	F	C	BR	1				1
Streptopelia semitorquata	Red-eyed Dove	SA	C		1	1	1	1	1
Streptopelia senegalensis	Laughing Dove	SA	C			1	1	1	1
Treron calva	African Green Pigeon	E/S	C		1	1	1		1
Turtur afer	Blue-spotted Wood Dove	E/S	C		1	1	1	1	1
Turtur brehmeri	Blue-headed Wood Dove	F	C	BR	1	1			1
Turtur tympanistria	Tambourine Dove	E/S	C		1	1	1		1
PSITTACIDAE									
Agapornis pullarius	Red-headed Lovebird	SA	C				1		1
Poicephalus gulielmi	Red-fronted Parrot	f	R		1	1			1
Psittacus erithacus	Grey Parrot	f	C	NT BR	1	1			1
MUSOPHAGIDAE									
Corythaeola cristata	Great Blue Turaco	F	C		1				1
Tauraco macrorhynchus	Yellow-billed Turaco	F	U	BR	1	1			1
Tauraco persa	Green Turaco	f	C	BR			1	1	1
Crinifer piscator	Western Grey Plantain-eater						1	1	1
CUCULIDAE									
Centropus leucogaster	Black-throated Coucal	f	C	BR	1	1			1
Centropus monachus	Blue-headed Coucal	f	U	BR	1	1	1		1
Centropus senegalensis	Senegal Coucal	E/S	C			1	1	1	1
Cercococcyx mechowi	Dusky Long-tailed Cuckoo	F	U	BR	1				1
Cercococcyx olivinus	Olive Long-tailed Cuckoo	F	R	BR	1				1
Clamator glandarius	Great Spotted Cuckoo	E/S	C				1	1	1
Cuculus gularis	African Cuckoo	E/S	U			1	1	1	1
Ceuthmochares aereus	Yellowbill	E/S	C		1	1	1	1	1
Chrysococcyx caprius	Didric Cuckoo	SA	C				1	1	1
Chrysococcyx cupreus	African Emerald Cuckoo	f	C		1	1	1		1
Chrysococcyx flavigularis	Yellow-throated Cuckoo	F	R	BR	1				1
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	f			1	1	1		1
Chrysococcyx klaas	Klaas's Cuckoo	SA	C			1	1	1	1
Cuculus clamosus	Black Cuckoo	f	U		1	1			1
Cuculus solitarius	Red-chested Cuckoo	f	C		1	1			1
TYTONIDAE									
Tyto alba	Barn Owl	E/S	U			1	1	1	1

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
STRIGIDAE									
Bubo leucostictus	Akun Eagle Owl	E/S	R	BR	1	1			1
Bubo poensis	Fraser's Eagle Owl	E/S	U	BR	1				1
Glaucidium tephronotum	Red-chested Owlet	E/S	R	BR	1				1
APODIDAE									
Apus affinis	Little Swift	E/S	C			1	1	1	1
Cypsiurus parvus	African Palm Swift		U		1	1	1	1	1
Neafrapus cassini	Cassin's Spinetail		C	BR	1	1			1
Rhaphidura Sabini	Sabine's Spinetail			BR	1		1		1
Telacanthura melanopygia	Black Spinetail		C	BR		1	1	1	1
CAPRIMULGIDAE									
Caprimulgus binotatus	Brown Nightjar	E/S	R	BR		1	1	1	1
Caprimulgus climacurus	Long-tailed Nightjar				1	1	1	1	1
Macrodipteryx longipennis	Standard-winged Nightjar					1			1
TROGONIDAE									
Apaloderma narina	Narina's Trogon	f	U		1				1
ALCEDINIDAE									
Halcyon badia	Chocolate-backed Kingfisher	F	U	BR	1				1
Halcyon malimbica	Blue-breasted Kingfisher	f	U		1	1	1	1	1
Halcyon senegalensis	Woodland Kingfisher	SA	C		1	1	1		1
Ceyx lecontei	African Dwarf Kingfisher	F	R	BR	1				1
Ceyx pictus	African Pygmy Kingfisher	E/S	C		1	1	1	1	1
Alcedo leucogaster	White-bellied Kingfisher	F	U		1				1
Alcedo cristata	Malachite Kingfisher	SA	C		1	1	1		1
Alcedo quadribrachys	Shining-blue Kingfisher	F	U		1				1
Ceryle rudis	Pied Kingfisher					1	1	1	1
Megaceryle ma1ima	Giant Kingfisher					1	1		1
MEROPIDAE									
Merops gularis	Black Bee-eater	E/S	R	BR	1	1	1		1
Merops pusillus	Little Bee-eater					1	1	1	1
Merops albicollis	White-throated Bee-eater				1	1	1	1	1
CORACIIDAE									
Eurystomus gularis	Blue-throated Roller	E/S	U	BR	1	1		1	1
Eurystomus glaucurus	Broad-billed Roller	E/S	C			1	1		1
Coracias cyanogaster	Blue-bellied Roller	E/S	U				1	1	1
PHOENICULIDAE									
Phoeniculus castaneiceps	Forest Wood-hoopoe	F	R	BR	1				1

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
BUCEROTIDAE									
Tropicranus albocristatus	White-crested Hornbill	F	C	BR	1	1	1		1
Tockus hartlaubi	Black Dwarf Hornbill	E/S	U	BR	1				1
Tockus camurus	Red-billed Dwarf Hornbill	E/S	C	BR	1	1			1
Tockus fasciatus	African Pied Hornbill	f	C	BR	1	1	1	1	1
Bycanistes fistulator	Piping Hornbill	E/S	C	BR	1	1	1	1	1
Bycanistes cylindricus	Brown-cheeked Hornbill	F	U	BR RR NT	1				1
Ceratogymna atrata	Black-casqued Hornbill	F	U	BR	1				1
CAPITONIDAE									
Gymnobucco peli	Bristle-nosed Barbet	f	U	BR	1				1
Gymnobucco calvus	Naked-faced Barbet	f	C	BR	1	1	1		1
Pogoniulus scolopaceus	Speckled Tinkerbird	E/S	C	BR	1	1	1	1	1
Pogoniulus atroflavus	Red-rumped Tinkerbird	E/S	U	BR	1	1	1		1
Pogoniulus subsulphureus	Yellow-throated Tinkerbird	f	C	BR	1	1	1		1
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	f	C			1	1	1	1
Buccanodon duchaillui	Yellow-spotted Barbet	f	C	BR	1				1
Tricholaema hirsuta	Hairy-breasted Barbet	E/S	C	BR	1	1	1	1	1
Lybius vieilloti	Vieillot's Barbet	SA	C				1	1	1
Trachylaemus purpuratus	Yellow-billed Barbet	F	C	BR	1				1
Lybius vieilloti	Vieillot's Barbet					1	1	1	1
Lybius bidentatus	Double-toothed Barbet						1	1	1
INDICATORIDAE									
Prodotiscus insignis	Cassin's Honeybird	F	R	BR	1	1			1
Melichneutes robustus	Lyre-tailed Honeyguide	f	R	BR	1				1
Melignomon eisentrauti	Yellow-footed Honeyguide	F	R	BR	1				1
Indicator maculatus	Spotted Honeyguide	f	U	BR	1				1
Indicator conirostris	Thick-billed Honeyguide	f	U		1	1			1
PICIDAE									
Campethera caroli	Brown-eared Woodpecker	F	C	BR	1				1
Campethera maculosa	Little Green Woodpecker	E/S	U	BR	1		1		1
Campethera nivosa	Buff-spotted Woodpecker	F	C	BR	1	1	1	1	1
Dendropicos gabonensis	Gabon Woodpecker	F	U	BR	1	1			1
Dendropicos goertae	Grey Woodpecker	SA	C				1	1	1
Dendropicos pyrrhogaster	Fire-bellied Woodpecker	f	C	BR	1	1			1
Sasia africana	African Piculet	F	R	BR	1				1

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
EURYLAIMIDAE									
Smithornis rufolateralis	Rufous-sided Broadbill	F	U	BR	1	1			1
HIRUNDINIDAE									
Psalidoprocne nitens	Square-tailed Saw-wing	f	C	BR		1	1	1	1
Psalidoprocne obscura	Fanti Saw-wing	E/S	C	BR	1	1	1		1
Hirundo abyssinica	Lesser Striped Swallow	E/S	C			1	1		1
Hirundo rustica	Barn Swallow	Co	P M		1	1	1	1	1
Hirundo aethiopica	Ethiopian Swallow						1		1
Hirundo daurica	Red-rumped Swallow	E/S	N U			1		1	1
Hirundo semirufa	Rufous-chested Swallow					1	1		1
MOTACILLIDAE									
Motacilla aguimp	African Pied Wagtail	SA	C			1	1	1	1
CAMPEPHAGIDAE									
Coracina azurea	Blue Cuckoo-shrike	F	U	BR	1				1
Campephaga phoenicea	Red-shouldered Cuckoo-shrike						1	1	1
PYCNONOTIDAE									
Andropadus virens	Little Greenbul	E/S	C		1	1	1	1	1
Andropadus gracilis	Little Grey Greenbul	f	C	BR	1	1	1	1	1
Andropadus ansorgei	Ansorge's Greenbul	F	U	BR	1	1			1
Andropadus curvirostris	Cameroon Sombre Greenbul	f	C	BR	1		1		1
Andropadus gracilirostris	Slender-billed Greenbul	f	C	BR	1	1	1		1
Andropadus latirostris	Yellow-whiskered Greenbul	f	C		1	1	1	1	1
Calyptocichla serina	Golden Greenbul	F	R	BR	1				1
Baeopogon indicator	Honeyguide Greenbul	f	C	BR	1	1			1
Ixonotus guttatus	Spotted Greenbul	F	C	BR	1				1
Chlorocichla simplex	Simple Leaflove	E/S	C	BR	1	1	1	1	1
Thescelocichla leucopleura	Swamp Palm Bulbul	f	C	BR	1	1	1	1	1
Phyllastrephus icterinus	Icterine Greenbul	F	C	BR	1	1			1
Phyllastrephus albigularis	White-throated Greenbul	F	R	BR					
Bleda syndactyla	Red-tailed Bristlebill	F	R	BR	1				1
Bleda eximia	Green-tailed Bristlebill	F	R	BR RR VU	1	1			1
Bleda canicapilla	Grey-headed Bristlebill	E/S	C	BR	1	1	1	1	1

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
Criniger barbatus	Western Bearded Greenbul	f	C	BR	1	1			1
Criniger calurus	Red-tailed Greenbul	F	C	BR	1	1			1
Criniger olivaceus	Yellow-bearded Greenbul	F	R	BR RR VU	1				1
Pycnonotus barbatus	Common Bulbul	f	C			1	1	1	1
Nicator chloris	Western Nicator	f	C	BR	1	1	1	1	1
TURDIDAE									
Stiphrornis erythrothorax	Forest Robin	f	C	BR	1	1			1
Cossypha cyanocampter	Blue-shouldered Robin Chat	f	U	BR	1				1
Alethe diademata	White-tailed Alethe	F	C	BR	1	1			1
Neocossyphus poensis	White-tailed Ant Thrush	f	U	BR	1	1			1
Stizorhina finschi	Finsch's Flycatcher Thrush	f	C	BR	1	1			1
Turdus pelios	African Thrush	SA	C			1	1	1	1
SYLVIIDAE									
Apalis nigriceps	Black-capped Apalis	f	C	BR	1				1
Apalis sharpii	Sharpe's Apalis	f	C	RR BR	1	1			1
Camaroptera brachyura	Grey-backed Cameroptera	E/S	C		1	1	1	1	1
Camaroptera chloronota	Olive-green Camaroptera	E/S	C	BR	1	1	1	1	1
Camaroptera superciliaris	Yellow-browed Cameroptera	E/S	U	BR	1	1	1	1	1
Cisticola lateralis	Whistling Cisticola	SA	C			1	1	1	1
Cisticola galactotes	Winding Cisticola	SA	C			1	1	1	1
Cisticola natalensis	Croaking Cisticola	SA	C				1	1	1
Hypergerus atriceps	Oriole Warbler	f	C	GS			1		1
Prinia subflava	Tawny-flanked Prinia	E/S	C				1	1	1
Eremomela badiceps	Rufous-crowned Erememela	f	C	BR	1				1
Heliolais erythroptera	Red-winged Warbler	SA	C				1	1	1
Hylia prasina	Green Hylia	f	C	BR	1	1	1	1	1
Macrosphenus concolor	Grey Longbill	E/S	C	BR	1	1	1		1
Macrosphenus kempi	Kemp's Longbill	E/S	U	BR	1	1	1		1
Sylvietta virens	Green Crombec	E/S	C	BR	1	1	1	1	1
MUSCICAPIDAE									
Fraseria cinerascens	White-browed Forest Flycatcher	F	U	BR	1				1
Fraseria ocreata	Fraser's Forest Flycatcher	F	U	BR	1	1			1
Muscicapa caerulescens	Ashy Flycatcher	E/S	U						

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
Muscicapa cassini	Cassin's Flycatcher	f	C	BR	1				1
Muscicapa comitata	Dusky-blue Flycatcher	E/S	C	BR		1	1		1
Muscicapa epulata	Little Grey Flycatcher	f	R	BR	1	1	1		1
Muscicapa olivascens	Olivaceous Flycatcher	f	R	BR	1				1
Muscicapa tessmanni	Tessmann's Flycatcher	F	R	BR DD	1				1
Muscicapa ussheri	Ussher's Flycatcher	E/S	C	BR	1	1			1
Myioparus plumbeus	Lead-coloured Flycatcher	SA	U				1	1	1
MONARCHIDAE									
Erythrocercus mccallii	Chestnut-capped Flycatcher	f	C	BR	1				1
Elminia nigromitrata	Dusky Crested Flycatcher	f	U	BR		1			1
Trochocercus nitens	Blue-headed Crested Flycatcher	f	R	BR	1	1	1		1
Terpsiphone rufiventer	Red-bellied Paradise Flycatcher	f	C	BR	1	1	1	1	1
PLATYSTEIRIDAE									
Bias musicus	Black-and-white Flycatcher	E/S	U		1	1	1	1	1
Platysteira cyanea	Common Wattle-eye						1	1	1
Dyaphorophyia castanea	Chestnut Wattle-eye	F	C	BR	1	1			1
TIMALIIDAE									
Illadopsis fulvescens	Brown Illadopsis	f	C	BR	1	1	1		1
Illadopsis cleaveri	Blackcap Illadposis	F	C	BR	1				1
Illadopsis rufescens	Rufous-winged Illadopsis	f	U	BR RR NT	1				1
Turdoides plebejus	Brown Babbler	f	C				1	1	1
REMIZIDAE									
Anthoscopus flavifrons	Forest Penduline Tit	F	R	BR	1				1
Pholidornis rushiae	Tit-hylia	F	U	BR	1				1
NECTARINIIDAE									
Anthreptes gabonicus	Brown Sunbird	E/S	U	BR		1		1	1
Anthreptes rectirostris	Green Sunbird	E/S	U	BR	1		1		1
Deleornis fraseri	Fraser's Sunbird	F	U	BR	1				
Cyanomitra cyanolaema	Blue-throated Brown Sunbird	F	C	BR	1	1			1
Cyanomitra obscura	Western Olive Sunbird	E/S	C		1	1	1	1	1
Chalcomitra adelberti	Buff-throated Sunbird	E/S	C	BR	1				1
Hedydipna collaris	Collared Sunbird	E/S	C		1		1		1
Cinnyris cupreus	Copper Sunbird					1	1	1	

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
Cinnyris chloropygius	Olive-bellied Sunbird	E/S	C		1	1	1	1	1
Anabathmis reichenbachii	Reichenbach's Sunbird	E/S	R			1		1	1
Cinnyris superbus	Superb Sunbird	E/S	C	BR	1				1
Cinnyris coccinigaster	Splendid Sunbird	SA	C	GS		1	1	1	1
ZOSTEROPIDAE									
Zosterops senegalensis	Yellow White-eye	SA	C				1	1	1
LANIIDAE (5)									
Lanius collaris	Common Fiscal					1	1	1	1
MALACONOTIDAE									
Dryoscopus gambensis	Northern Puffback	SA	C			1	1	1	1
Dryoscopus Sabini	Sabine's Puffback	f	C	BR	1				1
Laniarius aethiopicus	Tropical Boubou	E/S	C				`	1	1
Malaconotus cruentus	Fiery-breasted Bush-shrike	f	U	BR	1				1
Tchagra australis	Brown-crowned Tchagra	E/S	C		1	1	1	1	1
Antichromus minutus	Marsh Tchagra							1	1
PRIONOPIDAE									
Prionops caniceps	Red-billed Helmet-shrike	f	C	BR	1	1			1
ORIOLIDAE									
Oriolus brachyrhynchus	Western Black-headed Oriole	f		BR	1	1	1		1
DICRURIDAE									
Dicrurus atripennis	Shining Drongo	F	U	BR	1				1
Dicrurus modestus	Velvet-mantled Drongo	f	C		1	1	1	1	1
CORVIDAE									
Corvus albus	Pied Crow	Co	C			1	1	1	
STURNIDAE									
Onychognathus fulgidus	Chestnut-winged Starling	f	C	BR	1		1		1
Lamprotornis cupreocauda	Copper-tailed Glossy Starling	f	C	BR RR VU	1				1
Lamprotornis splendidus	Splendid Glossy Starling	f	C		1	1	1	1	1
PLOCEIDAE									
Malimbus malimbicus	Crested Malimbe	f	C	BR		1			1
Malimbus nitens	Blue-billed Malimbe	E/S	C	BR	1	1	1	1	1
Malimbus rubricollis	Red-headed Malimbe	E/S	C	BR	1	1	1	1	1
Malimbus scutatus	Red-vented Malimbe	E/S	C	BR	1				1
Ploceus albinucha	Maxwell's Black Weaver	f	U	BR	1				1
Ploceus aurantius	Orange Weaver			BR	1	1	1	1	1
Ploceus nigerrimus	Vieillot's Black Weaver			BR		1	1	1	1
Ploceus cucullatus	Village Weaver	SA	C			1	1	1	1

Species	*Common name*	*P. Habitat*	*Rarity*	*C. Status*	*Cape 3 Pts*	*Amanzuri Wetland*	*Princess T*	*Axim-Ankobra*	
Ploceus nigricollis	Black-necked Weaver	E/S	C		1	1	1	1	1
Ploceus tricolor	Yellow-mantled Weaver	E/S	C	BR	1				1
ESTRILDIDAE									
Estrilda melpoda	Orange-cheeked Waxbill	SA	C			1	1	1	1
Lagonosticta senegala	Red-billed Firefinch	E/S	C			1	1	1	1
Lonchura bicolor	Black-and-white Mannikin	E/S	C		1				1
Lonchura cucullata	Bronze Mannikin	E/S	C			1	1	1	1
Nigrita bicolor	Chestnut-breasted Negrofinch	f	C	BR	1	1			1
Nigrita canicapilla	Grey-crowned Negrofinch	E/S	C		1	1	1	1	1
Parmoptila rubrifrons	Red-fronted Antpecker	F	R	DD BR	1				1
Pyrenestes ostrinus	Black-bellied Seedcracker	E/S	U		1	1	1	1	1
Spermophaga haematina	Western Bluebill	E/S	C	BR	1	1	1	1	1
VIDUIDAE									
Vidua macroura	Pin-tailed Whydah	SA	C			1	1	1	1
Vidua chalybeata	Village Indigobird					1	1	1	1
					168	**148**	**130**	**102**	**236**

Appendix 11. Photo Gallery of Common Waterbirds

The following photo gallery is few of the water-birds that are likely to be observed or seen at wetlands and coastal lagoons/wetlands in the Western Region.

Black-tailed godwit

Greenshank

Sanderling

Whimbrel

Ringed plover

Little stint

Spur winged plover

Ruddy turnstone

Little egret

Western reef heron

Appendix 12. Results from Experimental Fishing

Belibangara

Species composition	*Sarotherodon melanotheron*			*Tilapia zillii*			*Chrysicthys nigrodigitatus*			*Mormyrus rume*			Catch rate (g/hr.)	GH ¢
Fish Size	*TL*	*SL*	*Wt*	*TL*	*SL*	*Wt*	*TL*	*SL*	*Wt*	*TL*	*SL*	*Wt*		
Fisherman1 (11 pieces)	196	160	150	171	130	60	182	138	50	106	82	15	675	4.0
	182	135	130	125	95	40	195	145	60	97	75	10		
				124	95	35	175	143	40					
				110	85	20	200	150	65					
Fisherman2 (6 pieces)	202	175	235				170	130	60				631	3.0
	196	162	180				196	150	70					
							161	124	30					
							165	128	56					

Domunli

Species composition	*Sarotherodon melanotheron*		*Mugil cephalus*		Catch rate (g/hr.)	GH ¢
Fish Size	*TL*	*Wt*	*TL*	*Wt*		
Fisherman 1 (7 pieces)	95	10	13.3	9	76	5.0
			14.2	12		
			21.0	35		
			13.9	10		

Butre

Marine Fisheries (Sample)	**S. L.** (cm)	**Weight**(g)	**Total No.**	**Total Wt** (g)	(kg)
Selene dorsalis (Gill 1863) (African moonfish)	15.50	30.80	21	646.80	0.65
	14.00	38.90	10	389.00	0.49
Cypselurus lutkeni	24.00	23.29	12	279.48	0.28
	24.00	23.44	8	187.52	0.12
Sardinella maderensis	20.50	13.70	15	205.50	0.21
	13.50	15.50	12	186.00	0.19
*Illisha africana (*Bloch. 1795*)*	15.50	52.20	10	522.00	0.52
	14.50	36.90	12	442.80	0.44
Brachydeutarus aritus (Val. 1831)	13.80	56.30	16	900.80	0.90
	13.5	55.40	11	609.40	0.61
Trachinotus ovatus	22.10	110.90	12	1330.80	1.33
Cynoglossus senegelensis	8.00	6.00	4	24.00	0.02
Ethmalosa fimbriata (Bowdich, 1825)	5.00	7.00	3	35.00	0.04
Lagoon Fisheries					
Mugil cephalus	5.00	20.00	4	80.00	0.08
	8.00	25.00	2	50.00	0.05
	10.00	35.00	3	105.00	0.11

Marine Fisheries (Sample)	**S. L.** (cm)	**Weight**(g)	**Total No.**	**Total Wt** (g)	(kg)
Dixcove					
Makaira indicus					
Thunus sp		DISPLAYED IN FOR SALE, NO BIOLOGICAL DATA TAKEN			
Rays					
Cuttlefish					

Princess Town (Cast-net catches at the rocky beach, east of the village)

FISH	**Morphometric data**				
	S. L.	Weight (sample)	Total No.	Total Wt g	kg
Marine Fisheries					
Mugil cephalus	14.20	38.00	10	251.17	0.25
	13.90	36.80			
	11.00	21.30			
	11.50	22.80			
	10.50	16.80			
	10.40	15.00			
T*rachinotus ovtus*	10.50	19.00	5	73.00	0.073
	11.00	22.60			
	8.00	9.80			
	9.60	15.30			
	7.20	6.30			
Brachydeuterus auritus (Val. 1831)	7.80	12.10	1	12.00	0.012
Diplodus cervinus cervinus	8.00	24.10	1	24.10	0.024

Family	**Genus**	**Species**
Marine and Lagoon fish species		
Mugilidae	*Mugil*	*cephalus*
Elopidae	*Elops*	*lacerta*
Clupeidae	*Illisha*	*africana*
Clupeidae	*Sardinella*	*aurita*
“	*Ethmalosa*	*fimbriata*
“	*Sardinella*	*maderensis*
Sciaenidae	*Pseudotholithus*	*senegalensis*
“	“	*typus*
“	*Agyrosomus*	*regius*
Polynemidae	*Galeoides*	*decadactylus*
“	*Pentanemus*	*quinquarius*
“	*Polydactylus*	*quadrifilis*
Carangidae	*Caranx*	*hippos*
Carangidae	*Decapterus*	*punctatus*

Family	Genus	Species
“	*Selene*	*dorsalis*
“	*Trachinotus*	*ovatus*
“	*Caranx*	*rhonchus*
“	*Chloromscombus*	*chrysurus*
“	*Selene*	*dorsalis*
Scombridae	*Scomber*	*japonicus*
“	*Thunnus*	*spp*
“	*Scomberomorus*	*tritor*
Penaeidae	*Penaeus*	*notialis*
Pomadasyidae	*Brachydeuterus*	*auritus*
Cynoglossidae	*Cynoglossus*	*senegalensis*
Istiophoridae	*Makaira*	*indicus*
Sepiidae	*Sepia*	*officinalis*
Rajidae	*Raja*	*miraletus*
	Raja	*straeleni*
Sparridae	*Diplodus*	*cervinus cervinus*
	Cypselurus	*lutkeni*
Trichiuridae	*Trichiurus*	*lepturus*
Periophthalmidae	*Periopthalmus*	*rouxi*
Ocypodidae	*Uca*	*tangerii*
Lobotidae	*Lobotes*	*surinamensis*
Freshwater fish species		
Cichlidae	*Tilapia*	*zilli*
	Sarotherodon	*melanotheron*
	Hemichromis	*bimaculatus*
Polypteridae	*Polypterus*	*endlicheri*
Mormyridae	*Mormyrus*	*rume*
Hepsetiae	*Hepsetus*	*odoe*
	“	*niloticus*
Cithrinidae	*Citharinus*	*spp*
Schilbeidae	*Schilbe*	*mystus*
Characidae	*Alestes*	*spp*
	Alestes	*macrolepidotus*
Caridae	*Clarias*	*spp*
	Clarias	*anguillaris*
Bagridae	*Chrysicthys*	*Spp*
	Bagrus	*bayad*
	Chrysichthys	*nigrodigitatus*
Channidae	*Chana*	*obscura*
Portunidae (blue crab)	*Callinectes*	*spp*
Gecarcinidae (land crab)	*Cardiosoma*	*armatum*

Appendix 13. Selected Results from Socio-Economic Survey

A. Resource use

		Amansuri			*Ankrobra*			*Butre*			*Cape Three Points*			*Dixcove*			*Princestown*		
Resource type	**Use**	**m**	**w**	**c**	**m**	**w**	**c**	**m**	**w**	**c**	**m**	**w**	**c**	**m**	**w**	**c**	**m**	**w**	**c**
Cassava	**d**	*	*	*	*	*	*					*					*	*	*
	s	*	*	*	*	*	*					*					*	*	*
Cocoyam	**d**				*	*	*												
	s				*	*	*												
Mushroom	**d**							*	*	*	*	*	*	*	*	*			
	s							*	*	*	*	*	*	*	*	*			
Pepper	**d**													*	*	*			
	s													*	*	*			
Plantain	**d**	*	*	*	*	*	*	*	*	*				*	*	*			
	s	*	*	*	*	*	*	*	*	*				*	*	*			
Tomatoes	**d**														*				
	s														*				
Vegetables	**d**				*	*	*												
	s				*	*	*												
Yam	**d**				*	*	*												
	s				*	*	*												
Medicinal herbs	**d**	*	*	*															
	s	*	*	*															
Coconut	**d**	*	*	*	*	*	*	*	*	*							*		
	s	*	*	*	*	*	*	*	*	*							*		
Orange	**d**								*										
	s								*										
Palm nuts	**d**								*						*				
	s								*						*				
Fish	**d**	*			*			*			*			*			*		
	s				*			*			*			*			*		
Crab	**d**	*		*										*					
	s	*		*										*					
Lobster	**d**													*					
	s													*					
Bushmeat	**d**																*		
	s																*		
Grasscutter	**d**										*								
	s										*								
Snail	**d**							*	*	*	*	*	*	*	*	*	*	*	*
	s							*	*	*				*	*	*	*	*	*
Tortoise	**d**																*		
	s																		

(d = domestic; s = sale; m = men; w = women; c = children)

B: Environment

		Amansuri	*Ankrobra*	*Butre*	*Cape Three Points*	*Dixcove*	*Princestown*
Energy source	*Sources*	Firewood, charcoal	Firewood, charcoal	firewood, charcoal, gas, kerosene stove	Firewood, charcoal	NA	Firewood, charcoal and gas (mainly firewood)
	Charcoal production	Yes	Yes	Yes	NA		Yes
	Impacts of charcoal production	None observed	Destroys vegetation	Destroyed various species	NA		None - trees used come from logged rubber plants and trees already cut down during land clearing
Health	*Main sickness*	Malaria, fever	Malaria, fever	Malaria, elephantiasis, chicken pox, skin rashes	NA	NA	Malaria, fever
	Water borne diseases	Not known	Not known	Worms, guinea worm	Buruli ulcer, diarrhea, elephantiasis, itchy skin	cholera	None known
	Medicinal herbs	pear leaves, acacia leaves, emanko, abusanya	plantain leaves, coconut leaves, cocoa leaves, gnara leaves,	Nunum, abafro (achempong), kakapenpen, bodwoni	Acheampong, brusuo leaves, nunum	aborda, sikyerama, ghana afofo - Acheampong, nunum	Nim tee, Abura koo, Acheampong, Gyeka, Acacia, Mahogany
Waste Disposal	*Solid waste*	Public dump	Public dump but also in bush	Public dump but also in/near water bodies	Public dump but also in/near water	Public dump near water bodies	Public dump
	Liquid waste	Gutter and street	Gutter, street, river, seas	In vicinity of community	Streets, river, sea	Gutter, river, sea	Gutter, street,
	Regulations		Traditional rules, but not effective	None, but offenders should be punished	None, need toilet facilities	-	Need for regulations
	Impacts observed	None	Poor sanitation	Disease and unhealthy environment	Disease	Sanitation issues	Breeding of mosquitoes

B. Environmental issues

Environmental Activity		*Amansuri*	*Ankrobra*	*Butre*	*Cape Three Points*	*Dixcove*	*Princestown*
Farming	*Crops*	cassava, cocoyam, coconuts, rice, palm, vegetables	coconut, cassava, palm nuts	Cassava, plantain, vegetables	Cassava, vegetables	cassava, palm, plantain	cassava, oil palm, rubber, coconut, plantain, vegetables
		Slash and burn, continuous cropping	Slash and burn, continuous cropping	Mixed cropping and continuous cropping	-	Slash and burn and continuous cropping	Slash and burn and continuous cropping
	Changes	Negative - decreasing yields	NA	Negative - decreasing yields	Negative - decreasing yields	Negative - decreasing yields	Negative - decreasing yields
	Reasons						Change from forest, and farmlands to rubber plantation
	Fertilizer application	None	Yes	Yes, depending on crop cultivated	Recently started used fertilizer	NA	NA
Fishing	*Fishing*	Yes	Yes	Yes	Yes	Yes	Yes
	Regulations	Ban on fine and small mesh nets	No specific regulations	Taboo – no fishing on Tuesdays	Taboo – no fishing on specific days	no fishing regulations but now being put into place	Taboo – no fishing on specific days
	Trends	Decreasing yields	Decreasing yields	Decreasing yields	Decreasing yields	Decreasing yields	Decreasing yields
	Reason	Algae in water	NA	light fishing by the Chinese	light fishing by the Chinese; increased population	light fishing by the Chinese	light fishing by the Chinese
Hunting		No hunting	grasscutter, antelope and rats	grasscutter, antelope and rats	Antelope; rats; duiker	rat, antelopes, grasscutter	grasscutter, antelope and rats
	Methods	-	Guns, traps, dog hunting	Guns, traps,		guns, traps, dog hunting	guns, traps, dog hunting
	Change in trends	-	Decrease in animals	Decrease in animals	Decrease in animals	Decrease in animals	Decrease in animals
	Reason	-	Animals moved deeper into the	Animals moved deeper into the	Increased numbers of	over killing, over population, and the	Change in land use from forest to

Environmental Activity		***Amansuri***	***Ankrobra***	***Butre***	***Cape Three Points***	***Dixcove***	***Princestown***
			forest	forest	hunters	extinction of the animals	rubber plantations
Bush fires	*Occurrence*	None	Common	Common	NA	No knowledge	Not common
	Reasons	-	During processes of smoking or drying fish	No fire belts; poor education	NA	Effective rules and regulations	Fire belts used
	Regulations	-	none	None	NA	-	Forbidden to create bush fires without fire belt
	Prevention	-	Fire belts	None	NA	-	Fire belts
	Major incidents	-	none	Yes	NA	-	none
Floods	*Occurrence*	?	Yes – the Ankobra River	Yes – sea erosion	Yes – sea erosion	Yes	Yes
	Reasons	-	Construction of bridge	Sand winning from sea shores	Sand winning from sea shores	Deforestation, destruction of mangroves	Sand winning
	Impacts	-	Destroys infrastructure and loss of lives	Destroys infrastructure and loss of lives	NA	Loss of property	loss of property, erosion and destroyed vegetation
Erosion	*Sand/stone winning*	-	Along shores	Along shores	Along shores	Currently no more	From the beach and specific sites
	Intensity of erosion	-	High	High	Very high	Previously high	High
	Impacts	-		destruction of houses, and breeding of mosquitoes	Destruction of property	Led to erosion and flooding	Erosion on road to the castle
Water quality	*Source of potable water*	Borehole	Rainwater, well, borehole, river	rainwater, river	Rainwater, well, borehole	pipe, rainwater, borehole, well	NA
	Changing aquatic system		Color changes and perennial frequency	Increasing pollution	Color changes and abnormal taste of water	Decreasing quality of water	NA
	Activities by aquatic system		Farming	Farming	Farming	Farming and dumping of refuse	Farming

Environmental Activity		***Amansuri***	***Ankrobra***	***Butre***	***Cape Three Points***	***Dixcove***	***Princestown***
Climate change	*Observed changes*	Decrease rainfall, warmer weather	Decrease rainfall, increased sun intensity	Decrease rainfall, increased sun intensity	Decrease rainfall, increased sun intensity	Decrease rainfall, increased sun intensity	Decrease rainfall, increased sun intensity
	Reasons	Unknown, "the world is changing"	Don't know	Natural processes, human activities	Politics and 'god'	depletion of ozone layer and deforestation	clearing of forest, bush burning leading to ozone depletion
Critical environmental conditions	*Issues*		Poor sanitation and improper disposal of waste	Sanitation and flooding	Improper disposal of waste	NA	None
	Reasons			Refusal to follow rules and regulations; lack of education	Lack of public dumping sites and waste bins	-	-
	Impacts		Flooding of river, breeding of mosquitoes	Increase in diseases; reduced fish catch	Outbreak of diseases	-	

C. **Traditional beliefs and resource management**

Tradition		***Amansuri***	***Ankrobra***	***Butre***	***Cape Three Points***	***Dixcove***	***Princestown***
Cultural practices		NA		sacred groves	Offior (black and white monkey) as a totem		Lagoon and forest reserve
	Regulations			No visits when there is a death in the community; no visits on Sundays, Women do not go there when in their menses or after giving birth, (only after purification)			No visits when there is a death in the community; no visits on Sundays
	Pacification			Sacrifices, include goat, plantain, eggs, yam, onions			
Natural/sensitive sites	Ecosystems	forest reserves, lagoon and mangroves		Sacred groves, mangrove, (Castle Del) , forest reserve	Forest reserve, (light house Del),	Forest reserve, (cemetery DEL),	Forest reserves, lagoon, mangroves, (castle DEL)
	Understanding of importance	reserves are important for regular rainfall		Abode of gods, according to the chief students come and study the ecology of the forests		Increase in rainfall	Reserves ecologically significant
	Regulations			No entry by post-natal women unless purified; no entry by menstruating women	No entry on specific days; Protection by forest guards	Traditional laws and superstitions	rules and regulations and forest guards
Conservation practices		indiscriminate mangrove cutting		Various taboos			Not going to forest on specific days; forest guards
Regulatory measures	Opinion on effectiveness No	Traditional measures not effective; need governmental regulation	NA	Traditional measures no longer effective	Traditional rules considered to be effective	Traditional rules and superstitions considered effective	Effective especially the patrolling by forest guards