

Discovering the Coastal and Marine Environment in West Africa

Knowledge Handbook



Regional Environmental Education Programme

Regional Coastal and Marine Conservation
Programme for West Africa

The Knowledge Booklet was written by the coordination team of PREE: Frederic AIRAUD, Oumar SY, and Pierre CAMPREDON (Senior Editor).

It has benefited from comments and advice of Antonio ARAUJO, Ousmane CAMARA, Paulo CATRY, Pablo CHAVANCE, Mathieu DUCROCQ, Gora KANE and Simon MERIAUX.

Translation : Sabou de ALMEIDA, Frédéric AIRAUD

Diagrams and drawings: Luis Alberto BALATA

Bird plates : Serge NICOLLE

Maps : Emmanuel GIRAUDET, Géomer/CNRS

Also, it is a synthesis - a modest and partial one - of knowledge and wisdom collected from users of the coastal areas, protected area staff and scientists, whom we hereby thank collectively.

The Knowledge Handbook publication in four (4) languages (French, Arabic, English and Portuguese) has been made possible through the Regional Program of Environmental Education which is a component of the Regional Program for the Conservation of Coastal and Marine Area in West Africa (PRCM), generously financed by the MAVA Foundation for Nature, the Embassy of Netherlands in Dakar and the Spanish Agency of International Cooperation.


Quoted from this booklet : PRCM. 2011. Discovering the Coastal and Marine Environment in West Africa – Knowledge Handbook. Regional Program of Environmental Education : IUCN Guinea-Bissau.

The designation of geographical entities in this handbook, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

IUCN and the other participating organizations do not take any

responsibility for errors or omissions occurring in the translation into English of this document whose original version is in French.

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged. Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Copyright © 2011  International Union for Conservation of Nature



Summary

Preface	05
Foreword	06
1 Introduction	10
2 The main natural habitats	11
2.1 The Open Sea	11
2.2 The Coastline	13
2.3 The Estuaries	16
2.4 The Archipelagos	16
3 The Physical factors	19
3.1 The Tides	19
3.2 The Currents	22
4. The flora and fauna	26
4.1. Mangroves	26
4.2. Sea Grass beds	30
4.3. The Algae	31
4.4. Molluscs	32
4.5. The Crustaceans	36
4.6. The Fish	38
4.7. The Marine Mammals	46
4.8. Marine Turtles	52
4.9. Birds	56
5. The Influence of Human Activities	61
5.1. Fisheries	61
5.2. The urbanization	69
5.3. Pollution and Waste	70
5.4. The Industry	71
5.5. The Infrastructures	72
5.6. Tourism	73
5.7. Climate Change	75
5.8. The Protected Areas	77
6. Conclusion: Environmental Education should contribute to the quality of life	79
Glossary	81

Preface

Without flinching, the Regional Program for the Conservation of Coastal and Marine Area in West Africa (PRCM) welcomes with enthusiasm this Environmental Education tool which, according to its intrinsic purpose, is rightly titled “Knowledge Booklet”.

At the origin of any action, lies the knowledge that drives one’s will and power to act. This remark is even truer in the context of an Environmental Education process where the inclination to protect nature results from a work that requires patience and diligence as well as laboriously initiating and awakening consciousness by transfer of knowledge. The PRCM has therefore set itself to a real challenge through the Regional Program of Environmental Education (PREE), by betting on youth training and membership to the ideal of protecting nature: there is no other way of managing our natural resources in a sustainable and responsible manner that goes together with good citizenship.

Responsibility is primarily a collective value in so far as the populations of the PRCM countries belong to the same eco-region whose benefits and responsibilities they share. Not only for this common wealth, but also challenges and hardships, are they doomed to follow the path of solidarity by intelligently pooling their assets and experiences together. Also, the ability to respond to threats from overexploitation, pollution, coastal erosion and climate change requires a new collective culture of prevention and better management of environmental issues in a context of rapid and deep changes. To be up to these challenges, the youth must capitalize on value-based opportunities, their own know-how, culture of exchange and creative dynamism.

Hence the urging need to prepare young generations to develop the knowledge and tools that will enable them to conserve their cultural and natural heritage, which stands as the bedrock of the planet’s ecological balance and the security of its inhabitants. Clearly, conserving nature is a matter of collective survival. As such, it is therefore impossible to imagine

a culture that does not include Environmental Education or conceive a teaching model that would ignore the preservation of biodiversity.

This “Knowledge Booklet” is therefore timely in a context marked by both a public and political support to the integration of Environmental Education into school curricula in the PRCM area. By helping to fill the gap in related teaching material, this document constitutes a valuable tool for teachers in opening the children’s minds to the realities of the coastline and their duty to protect natural resources. This synthesis of knowledge on the coastal area of our sub-region will further be resourceful to everyone else, either, Members of Parliaments, local politicians, journalists or ordinary citizens, who are concerned about the future of their country and the quality of life of their populations.

Ahmed Senhoury

Director of PRCM Coordination Unit



Foreword

The Regional Program for the Conservation of Coastal and Marine Area in West Africa (PRCM II), identified Environmental Education (EE) among its strategic axes for intervention. It is within this context that the Regional Program of Education for Coastal and Marine Environment (PREE) was established to contribute to acquiring a more precise vision of the dynamics of the coastal and marine area, challenges and opportunities aiming at its long-term development.

PREE has the ambition to foster the education policies of the PRCM countries by incorporating the coastal and marine area bio-ecological and socio-cultural values as well as the risks related to their degradation. PREE has structured its activities around raising stakeholders' awareness, exchanging and sharing experiences, informing and training and developing educational tools.

It is this last component that includes the development of the "Knowledge Handbook" and the "Study Guide".

1 / Objectives and Contents of the Knowledge Booklet

The Knowledge Handbook is the first of a series of educational tools aimed at Environmental Education that PREE is making available to the academic and non-academic public to enhance their knowledge and raise their awareness of problems related to coastal and marine environment in the West African sub-region.

The Knowledge Handbook looks like a collection of basic knowledge, something minimum that any "honest person", any citizen of the coastal area should not ignore. It falls within the EE goal of contributing to the dissemination of environmental knowledge, under the first level of the Environmental Education objective of **"acquiring knowledge, skills, abilities, attitudes and values to act for the benefit of the environment."**

This booklet consists of four main chapters that present different natural sets, physical factors, flora and fauna and the influence

of human activities on the sustainable management of natural resources (urbanization, fishing, oil exploration, tourism, etc...).

The diversity of chosen themes could be useful in different academic disciplines (geography, biology, geology, speaking and writing, drawing, handwork, music, etc...) in line with the basic principle of Environmental Education: interdisciplinary.

The Knowledge Handbook is written in a lively style, using simple words, with a clear and easy-reading language accessible to all. It is supplemented by a glossary that explains some key concepts and ideas, and provides photographs, maps, sketches and did-you-know-that boxes which provide very detailed and quite unusual pieces of information on the various aspects of coastal and marine environment including curious sights of animal and plant life.

A choice for a simple and attractive tool was clearly made. It meets the need of editors for providing a didactic orientation to the "Knowledge Handbook". It is indeed essential that the work should be within the reach of the many, that it should be pleasant to read both in form and in content, and, above all, that it serves the dual dimension of education: teaching and learning.

2 / Users and potential uses of the Knowledge Handbook

The Knowledge Handbook is designed primarily as an educational tool for education professionals. They are school inspectors, curriculum writers, teachers, primary school teachers, and leaders in non-formal education (National Parks, Marine Protected Areas, training centres, NGOs, associations, youth clubs, etc.). Every one of these users will find in the booklet elements to strengthen his or her personal environmental culture and relevant information for his or her professional activities.

For education inspectors in charge of school administration, teacher training and educational control, the Knowledge

Handbook will be primarily used for capacity building in a new area of study, requiring the constant renewal of knowledge and know-how. Most school inspectors in the PRCM countries have significant academic level. They have a scientific (Life Science and Earth Science) or literary background. However, the majority does not have sufficient specific knowledge of coastal and marine environment. With this tool, they will improve their understanding of the environmental phenomena unique to this area and thus help teachers plan their lessons (make monthly or annual distributions, and choose subjects matters, sites to visit and tools and materials to use) in connection with the new curricula. They will also proceed, knowingly, to providing teaching support for teachers to perform their duties and keep track of what content is taught (for accuracy of scientific notions and concepts, semantics and vocabulary spelling, etc.). For these reasons, the Knowledge Handbook has its place in the school library next to the Treaties of pedagogy that are so dear to education inspectors!

As to curricula designers / drafters, they will use the Knowledge Handbook as a reference tool in which they will draw on the themes, sub-themes, ideas and concepts to develop the skills, learning objectives and contents that are most relevant to the new school curricula. Some countries (Senegal, Cape Verde, and Guinea-Bissau) have already made the choice to integrate EE into their new curriculum by immediately giving it a sub-domain (Education for Sustainable Development). It is up to these countries (and others which are also involved in curriculum reform) to select the appropriate contents; develop support tools such as work and / or integration books. The Knowledge Handbook will facilitate such work.

For teachers, primary school teachers, leaders of non-formal education, the Knowledge Handbook will fill knowledge gaps related to the weakness of their academic and professional training. The option taken by the education systems of countries in the sub-region to focus on the greatest number of school children having access to education over the quality of education, has led to education on the cheap in almost all PRCM countries. The needs are being expressed everywhere



for teacher training, renovation programs and available teaching aids. The Knowledge Handbook partly addresses these requirements by serving as a source of information for mental, physical and educational preparation of class. The new programs have already identified the competencies, learning objectives and related contents, whereby it is now up to classroom practitioners, leaders of ecological visits on the field, to build their own worksheets, using the provided knowledge elements, the suggested illustrations, and the values conveyed through the Knowledge Handbook. They will also have to adapt their teaching, taking into account the particular contexts of the learners' living environment, and their mental and educational levels. Hence, the activities inside and outside school related to coastal and marine environment may be better prepared, implemented and assessed with reference to this tool, which ensures the scientific credibility of the imparted knowledge.

Finally, the Knowledge Handbook, owing to its scientific and literary quality (density, accuracy, simplicity and clarity), could also be useful to a wider audience of policy-makers such as members of parliament and local authorities. They have, in some cases, a decision-making role in local communities where they are mayors or council presidents. Besides they undertake advocacy and lobbying with government officials and educate people about environmental issues. At those different levels, they need to better know the coastal and marine environment in which they live, to understand the dynamics, challenges and opportunities to build up their own opinions. The Knowledge Handbook will provide knowledge and credible environmental information on which to base their decision-making, communicate accurately with the people and build up their arguments while discussing with Government counterparts and technical and financial partners.

Still, training the different users of the Knowledge Handbook is an essential facilitating measure if we want to ensure a good ownership and an effective use of this tool.

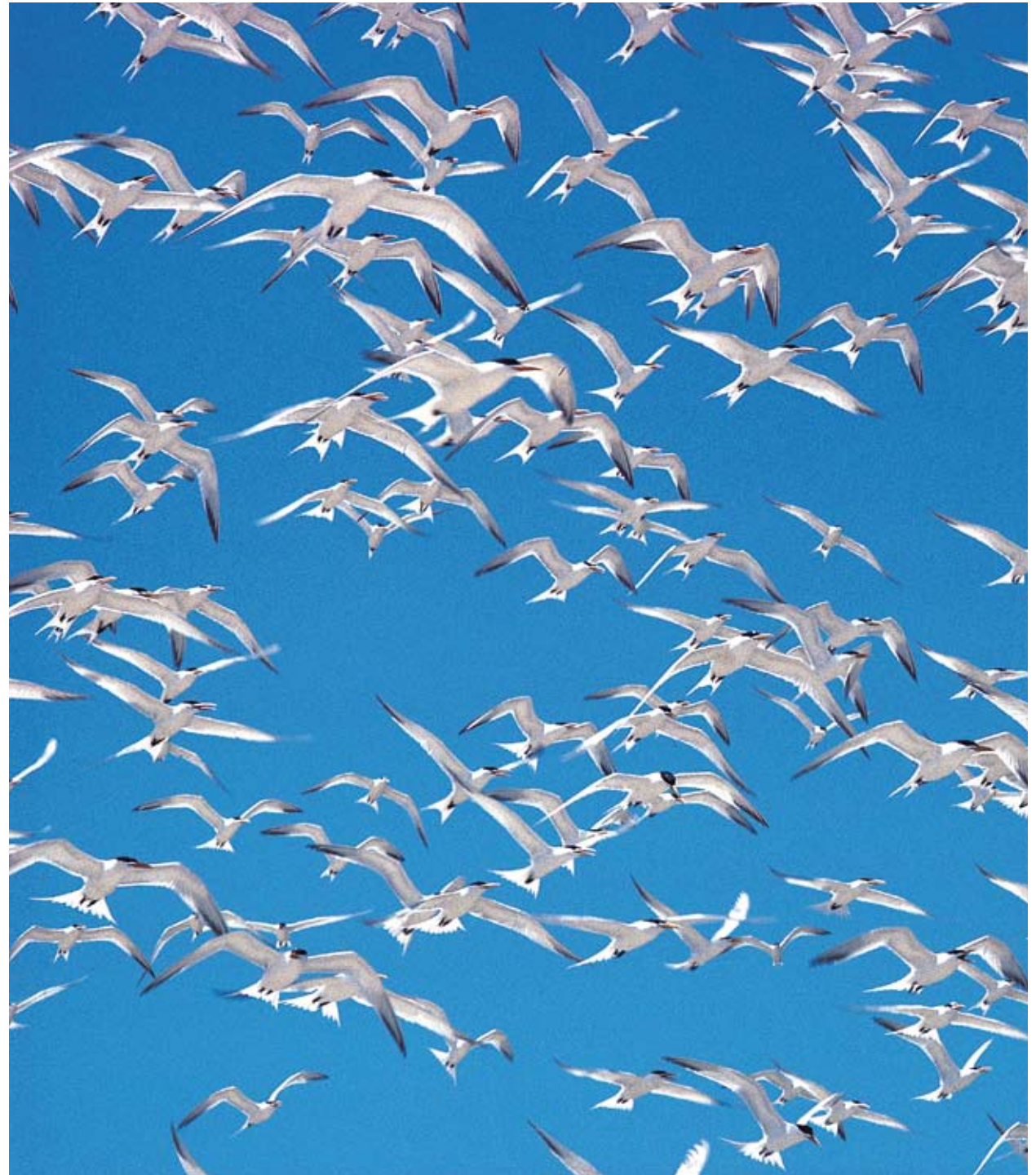
3/Recommendations for using the Knowledge Handbook

The Knowledge Handbook is a tool for teachers and others concerned with coastal and marine environment. It cannot replace the teacher or professor in his or her classroom. Instead, it supports the learning and teachers by providing scientific knowledge and illustrations for the implementation of learning sequences. Even if the Knowledge Handbook does not explicitly indicate how to proceed, it is recommended, to stay in the perspective of environmental education, to take into account the global and local, to go from the concrete to the abstract while putting emphasis each time on action to address environmental issues. The dear approach to environmental education can thus be implemented:

- ***The experimental approach*** contributes to the scientific awareness of the child using the sensitive and the entertaining to enhance better understanding and better love. Thus the natural environment (the coastline, estuaries, islands) or physical factors (tides, currents) are presented to readers in order to encourage them to learn to see, hear, feel and live with and within these elements of nature.
- ***The pragmatic approach*** is based on action, practicing learning from real-life situations. The Knowledge Booklet provides living knowledge and observable phenomena, on which one can act, and use as learning materials. The different species of flora and fauna (mangroves, sea grasses, algae, shellfish, fish, etc...) may well be observed in situ, taken into classroom, represented or reproduced by the learners.
- ***The progressive approach*** allows the educational activity to develop according to needs, rhythm and motivation of the learner. The use of the Knowledge Booklet will not be linear. Each user has the flexibility to choose what he or she wants to acquire or teach in light of his or her academic background, current interests, learning objectives, and targets.

- **The inductive approach** evolves from the bottom up: from concrete to abstract, from close to distant, from what is lived to what is conceived, from specific to general, from the individual to society. This is the very basis of our methodological options: to build the personality of the learner with him or her, starting from what he or she is and what he or she knows. The Knowledge Booklet must be used in this direction by taking as a learning foundation the concepts and notions that exist in the social and cultural environment of the child. Thus, from the study of the species quite familiar to the child like bloody cockle, mullet, grouper, green turtle, tern, etc., translated into their local languages, we can move towards learning the families of shellfish, fish, reptiles, birds, and making him or her understand the food chain, study more complex interrelationships of ecosystems, etc..

The Study Guide complements the Knowledge Handbook, providing teachers with more practical information and detail on the goals and objectives, the topics of study, progressions, learning materials, the subject matters, techniques, tools, etc.. The Knowledge Handbook and the Study Guide remain open tools, yet upgradable and therefore needing the input of all for their improvement and ownership.



I - Introduction



Countries involved in the Regional Environmental Education Program

The geographical area presented by the “Knowledge Handbook” covers the coastal and marine area of the following countries:

- Mauritania
- Cape Verde
- Senegal
- The Gambia
- Guinea-Bissau
- Guinea
- Sierra Leone

All of the above countries share to varying degrees common features of the environment and culture. Several have influences of upwelling, a current that generates high productivity of marine life. Most have a coastline lined with mangroves that provide a number of services to communities in the coastal area. The countries share common migratory species of marine mammals, birds or fish that are their common heritage. They also share ways of living and exploiting coastal resources and face common problems linked to poverty, health, education and, at another level, urban planning, pollution, degradation of natural resources and cultural heritages.

The efforts of coastal West African societies to adapt to the contexts of a changing world is a challenge to be addressed collectively by pooling together their experience and imagination as a whole. To achieve that, education is a major priority. Given the place of nature and its resources in the economy and culture of the related countries, environmental education should help prepare young generations to the effects of changes in the modern world so that they become the leading, conscious and committed agents.

II - The main natural habitats

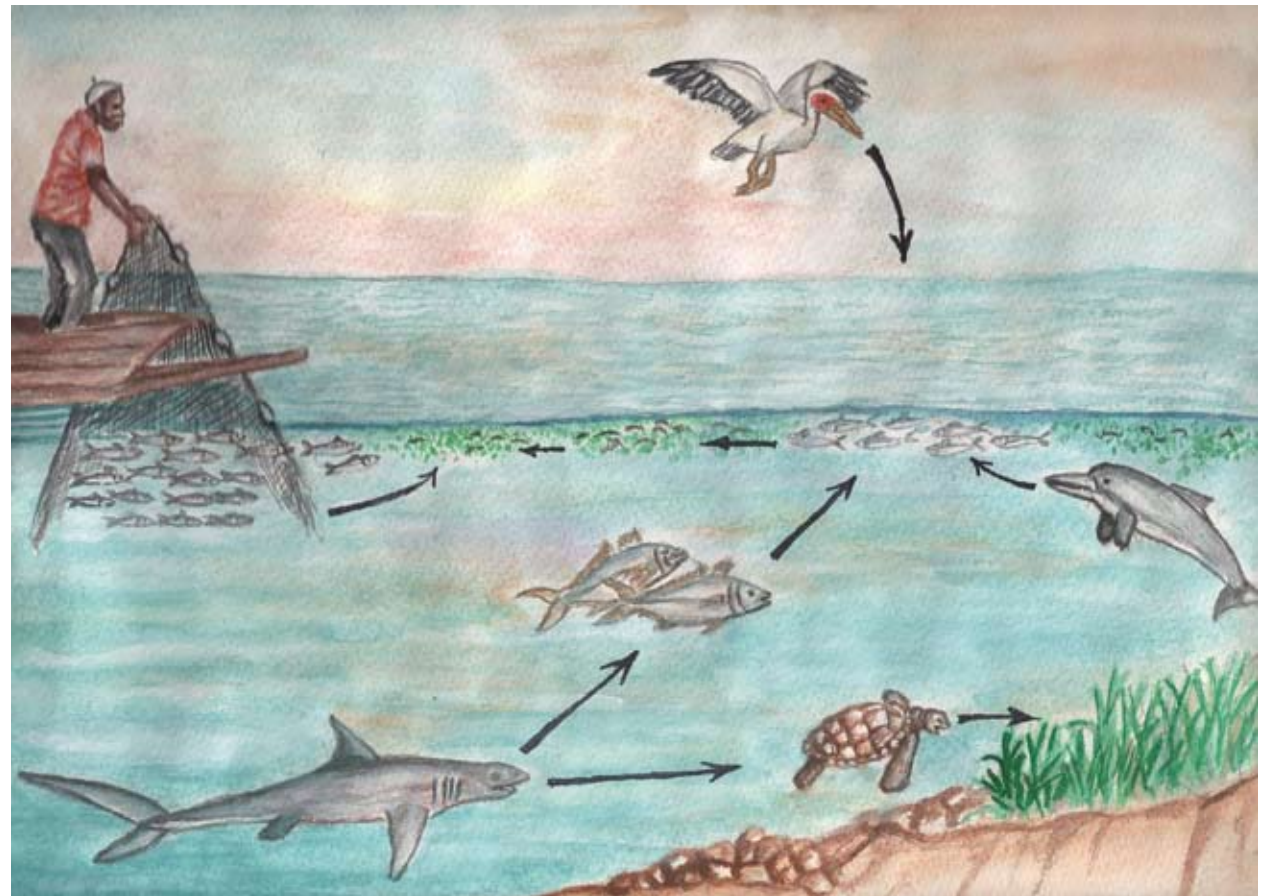
The coastal and marine area of our region is made up of different natural habitats. Among the most important ones are the open sea or ocean waters, the coastline that encompasses a marine and a terrestrial part which may consist of cliffs, beaches or mudflats, estuaries and archipelagos.

2.1 The Open Sea

The open sea begins in the bottom of the intertidal area towards the ocean at depths of several tens of meters to about 6000 meters. The levels that are closer to the surface are exposed to sunlight, with nutrients in the water, allowing the aquatic vegetation to grow through **photosynthesis**. This is where one observes the highest productivity. The deeper levels are less rich but nevertheless present a wide diversity of species adapted to darkness. Among the various forms of vegetation found in the open sea, one can distinguish phytoplankton (or vegetal **plankton**) made up of species that live in suspension and move passively with the currents. This phytoplankton serves as food for zooplankton (animal **plankton**), which is in turn the food of larger animals.

Among the species that feed on zooplankton is a large number of fish. These are especially small **pelagic** species that live in large shoals such as sardines, gilt sardine or bonga and represent a large proportion of fish catches. There are also many crustaceans such as shrimps or crabs and molluscs such as octopus or shellfish which feed on plankton. And even the largest animals on earth, the whales, feed on plankton.

Simplified food chain in the marine environment (refer to text)





These fish, molluscs and shellfish that consume plankton are the main prey of larger fish such as barracuda, kingfish, tuna or sharks considered as being predators. Marine mammals (dolphins, seals) and birds (pelicans, terns) are also important predators. Thus, schematically, there is a succession of organisms, each of them being consumed by the other, starting from the phytoplankton and animal plankton, eaten by small fish and the latter being prey for larger fish, birds and marine mammals: this sequence is what we call a food chain.

The open sea is the favoured territory of the fishermen either artisanal with smaller boats, or industrial with large vessels. Their efficiency is such that fish populations have declined significantly altering the balance between prey and predators in the food chain and leading some species, such as sawfish, to be on the verge of extinction, in other words, the final disappearance of their populations. The seabed is sometimes exploited for their resources of oil and gas becoming thus opportunities for economic development of the country though representing significant risk of pollution.

Schematic map of the main natural habitats of the coastal and marine area (cliffs, sandy coast, mangrove)

2.2 The Coastline

The coastline is the area between the sea and the land.

A coastline may appear as cliffs where the sea beats against the coast with force. In such case, the width of the coastline is small and made up of rocks. This situation is often found in the islands of Cape Verde where the cliffs plunge dramatically into the ocean characterized by the presence of waves-polished pebbles. When the rock is soft enough, the sea can dig holes in the cliffs such as along Cape Blanc, in northern Mauritania, where the caves are occupied by colonies of monk seals.

Living conditions at the foot of cliffs battered by the sea are difficult. The organisms that live there have developed special adaptations that allow them to withstand the strength of the waves. This is the case for example of barnacles, a crustacean that lives attached to rocks by the presence of a **stalk**, or lobster and some fish such as moray eels, which live in holes between the rocks. Seabirds such as cormorants, phaetons or shearwaters may breed in the cliffs or boulders, where their nests are not easily accessible.

When the depth of the sea decreases slowly while approaching the continent, the wave energy gradually is reduced and the contact with the coast is smoother. The width of the coastal strip is larger and composed of fine sediments, like sand, which form the beaches. As the water is shallow and less agitated, aquatic vegetation can grow in good conditions. In the more or less muddy sand, many organisms can burrow by digging a gallery or by hiding under the sand like flatfish. It is therefore a privileged environment for the reproduction of many species that find shelter and abundant food there. It is



Coastal cliff



Colony of long-tailed cormorants on rocky island



Tropicbird flying

believed that 60-70% of fish and shellfish spend part of their lives, especially as juveniles, in waters near the shore.

By the interplay of waves and currents, the sea provides many nutrients on the beaches: plankton, aquatic vegetation, stranded animals, etc. which constitutes what is called the high-water mark. A special wildlife has specialized in the exploitation of these resources. Examples are crustaceans like crabs, small waders or the jackal which scavenges the coastal strip by night in search of carrion. The sea also drags artificial elements (oil,

Behind the beach is a coastal sand dune that protects the shoreline from sea invasion



plastic waste) which can seriously pollute the coastline. Sea turtles also need to come to the beaches to lay their eggs in the sand. As to the sea birds, they form large colonies on islands or sandbars away from the shore.

A strong tide or a storm is enough to put the sand in suspension in the water which is then carried away by currents. Under natural conditions a balance is kept over time between the washed-away sand and brought-in sand, but this balance is easily upset by human activities: coastal sand mining for construction, building of infrastructures (harbours, dams) that interfere with the movement of sediments, etc ... We then observe the so-called coastal erosion that can lead to flooding of nearby lands. In natural conditions, the edges of beaches often present coastal dunes, which play an important role in building up reserves of sand and protecting the inner land against invasion of the sea.

The more sheltered coasts extend to the sea through **mudflats** that are exposed at low tide. They can occupy large areas like the Gulf of Arguin (Mauritania), the Saloum (Senegal) or the Bijagós Archipelago (Guinea-Bissau). They are sometimes overgrown with aquatic plant communities that make them look something like pastures and are a great source of natural productivity. Mudflats are also enriched by plankton, detritus and **organic matter** from mangroves and surrounding land. These nutrients are used by a multitude of organisms such as crabs and worms that are, again, a major food source for fish and birds. The shellfish proliferates there and are picked up by women at low tide.

The coastline is also an environment that is of high value for humans because it combines the advantages of sea and earth. It is on the coast that all of the regional capitals have developed with harbours, touristic resorts

and a few industries. The coastline thus provides a number of services. However, some human activities have the effect of transforming it, generating pollution, disturbances and overexploitation of natural resources. The most serious sources of marine pollution, such as domestic waste, sewage or toxic chemicals, mostly come from the continent. The coastline is therefore a very rich environment that creates lots of interest from mankind but which is easily affected. The coast line may be even more vulnerable with the rising of sea levels caused by climate change.



Mudflat at low tide



Urbanized and densely populated coastline

2.3 The Estuaries

Estuaries are formed by encounters between the sea and a river valley: they are the mouths of coastal rivers and water ways. They characterize the West African coast between the Saloum in Senegal and Sierra Leone where their estate gave its name to the area of “rivers of the south”, named that way by Portuguese explorers in the sixteenth century. During the dry season the salt water goes back far into the estuary, a situation that is reversed during the rainy season when freshwater influence extends to the mouth and beyond to the sea. Estuaries in the region are largely fed by rain water from the Fouta Djallon, located in Guinea, where there is an average of 4000 mm of rainfall per year (against

Aerial view of an estuary



35 mm in Nouadhibou in Mauritania and 500 mm in the Saloum in Senegal). It is this mixture of fresh and salt water, which partly explains the richness of estuaries ranking among the most productive environments. The rainy season is also in keeping with the breeding season of many species of fish, crustaceans or shellfish. Productivity is reflected in the vegetation by the presence of large tracts of mangroves that line the channels.

2.4 The Archipelagos

Archipelagos are groups of islands in the open sea. There are two major ones in our region, the archipelago of Cape Verde and Bijagos archipelago (in Guinea-Bissau). The former is a volcanic archipelago consisting of ten main islands and several islets in the middle of the Atlantic Ocean. The edges of the islands plunge steeply into the sea and therefore shallow areas are rare.

This is where can be found coral reefs, which in this case presents one of the largest diversity of species in the world. The coral is made up of marine animals living in colonies and building throughout their lives an outward skeleton from the minerals available in the ocean. Corals live in colonies (or in groups) and these colonies grow next to each other forming reefs that are homes to an extraordinary diversity of marine animals, making them one of the most diverse marine ecosystems. The coral is actually made up of small animals called polyps, which are fixed to the ground by their feet and use tentacles to capture plankton for food. One feature of the coral is the fact that the polyps contain a microscopic alga in their tissues. This is a true **sympiosis**, since the microscopic

algae provides, through **photosynthèse**, the products needed to build the exterior limestone skeleton of the coral. In contrast, the microscopic algae feed on leftover food and faeces of the polyp animal. However, if there is a stress (changes in water temperatures or other pollutions), the small algae may be expelled causing the coral to bleach and die prematurely. The coral can thus be considered as being an animal, a plant and a stone at the same time which makes of it one the most fascinating marine living creatures.

Also found in the Cape Verde archipelago are large cetaceans such as humpback whales seen regularly in the islands when it comes to give birth to their offspring during winter, and the whale shark, the largest fish of the planet. The islands are battered by trade winds and receive only small amounts of rain, which at times lead the inhabitants to harsh living conditions.



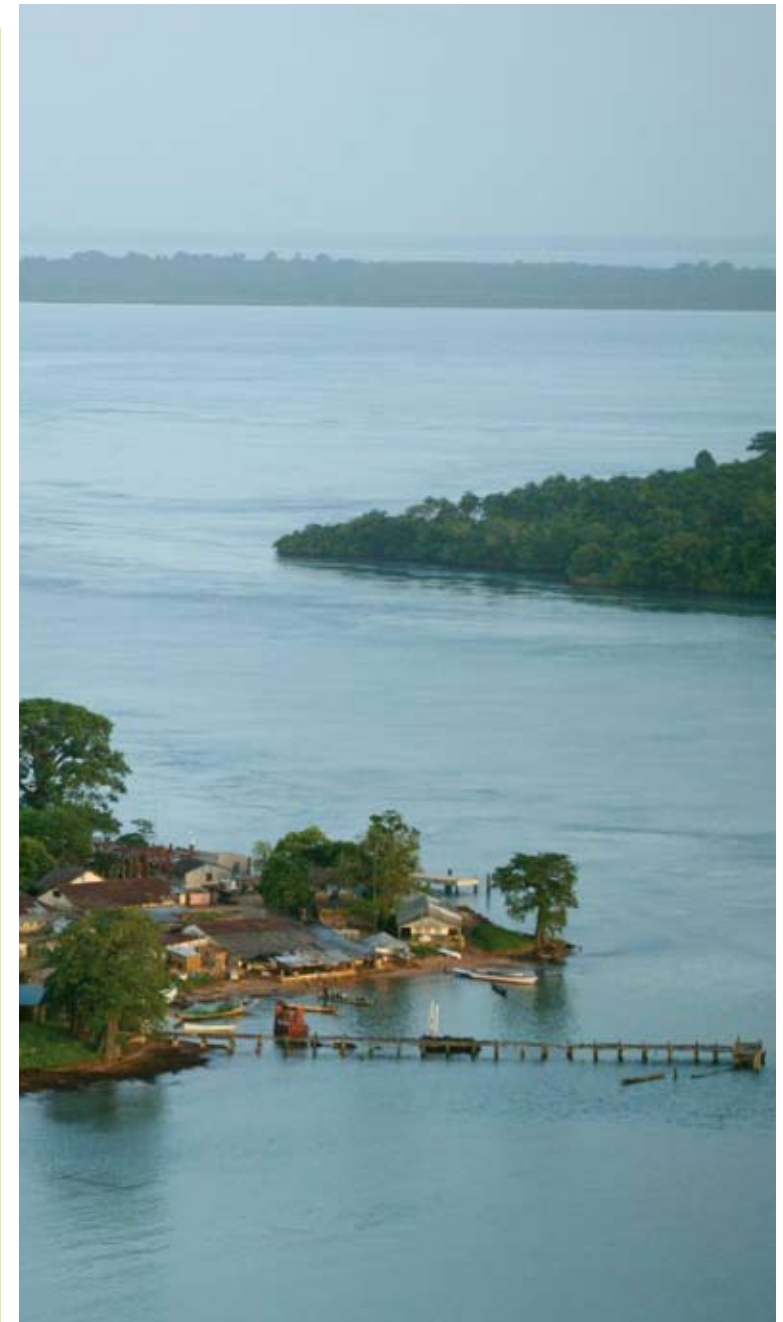
The archipelago of Cape Verde



Coral reef

The Bijagós archipelago is actually the former delta of Geba River, formed when the sea level was lower and the continent was prolonged up to hundred kilometres towards the open sea. The 88 islands and islets that compose it are low on water, surrounded by mangroves and mudflats. The aquatic environment is rich and hosts rare species such as sea turtles, manatees, dolphins, many species of sharks as well as water birds. The middle ground is mainly composed of savannas, palm groves and farmland. The inhabitants of the archipelago belong mostly to the animist Bijagós ethnic group. They see some islands as sacred, which promoted the protection of fauna and flora up to now. The archipelago is connected with the offshore waters through deep channels in between the islands where the fish reproduce and grow up in shallow waters before returning to the ocean.

*Landscapes
from the
Bijagós
archipelago*



III - The Physical factors

3.1 The Tides

When one stands beside the sea, one can observe that the water level rises and falls periodically. This tidal phenomenon, affecting the entire West African coast and the archipelago of Cape Verde in varying proportions, leads to significant consequences on the functioning of the coastal area and the living conditions of its inhabitants.

How do tides occur ?

Tides are the result of forces of attraction of the moon and sun on the mass of ocean waters.

Did you know that? : What is a force of attraction? Gravity is a force of attraction between the earth and all living bodies or objects on its surface. We are attracted by the earth which is why our feet always touch the ground or why we always fall to the ground after a jump... It is said therefore that the earth exerts a gravitational force on us. Similarly, the earth, the sun and the moon exert attractive forces on the water bodies of the ocean causing tides...

Their position relative to the earth determines the strength of the tides. When the 3 stars and planets are aligned, forces add up and we have high tides, called spring tides:

the sea level rises and falls a lot. In contrast, when the stars and planets form a right angle, attractive forces oppose each other and we have low-amplitude tides, called neap tides. Given its proximity to the earth, the gravitational force of the moon is predominant. The high tides are therefore involved at the time of new moon and full moon, while neap tides are observed during the first and last quarter moon. In our region, as on most Atlantic coasts, we always have 2 high tides and 2 low tides each day, which means that water goes up for about 6 hours and then down for about 6 hours and again over 24 hours.

Tidal forces also depend on certain geographical factors:

- The more shallow the bottom is the stronger are the tides. The sea being deepest near the coasts of Mauritania and Senegal, the tides are of lower amplitude (about 2 meters) than in Guinea-Bissau or in Guinea, where the continental shelf extends far offshore (about 4 m amplitude in spring tides)
- The tides are higher at the bottom of the bays and estuaries than on the capes. When the depths are declining and the coasts are getting narrow, as in the Saloum Delta and in the “Rivers of the South”, the amplitude of the tide – or **marling** - increases.
- The tide rises from offshore towards the coast, i.e. a movement that goes in the West African coast from west to east: when the west wind is strong it increases the power of the rising tide.

What are the consequences of tides ?

The first visible consequence is that part of the coastal area is flooded and then drained periodically. Between the highest point reached by the sea and the lowest point reached by the tide which is also called the **foreshore** or **intertidal area**. The slope of the foreshore is greater when the coast is exposed and receives more direct impact of the **swell** and the waves. In this case surfaces influenced by the tide are less extensive and the soil is composed of heavier sediments (pebbles, coarse sand). When the coast is more sheltered from the waves, the foreshore is gently sloping and covers large areas of a substrate composed of fine particles (mud, fine sand). The landscapes are differently affected: the changes between high and low tide are barely visible on cliffy coastlines or on the volcanic islands, but they are spectacular on sheltered coastlines where sandbars and mudflats can extend beyond view at low tide.

Harbour at low tide



The mudskippers are fish able to live out of water at low tide



The foreshore is home to very specific organisms adapted to changing tidal cycles: the vegetation is capable of being submerged and to bear the salt (mangroves, sea grass beds). Invertebrates can live fixing on supports (such as oysters on the mangrove roots), on the surface of the soil (gastropods such as snails or cymbium) or dig galleries into the soil (crabs, marine worms). A species of fish, the mudskippers, has even adapted to tidal movements by developing the ability to breathe and move out of water.

The movements of the tide, moving huge volumes of water, generate currents. Current velocity depends on the strength of the tide and can reach in times of spring tides in some places up to 10 kilometres per hour. Tides are well capable of carrying living organisms (plankton: fish and crustaceans larvae, microscopic algae, for example) or even nutrients (minerals, organic matter) towards the coast to the bays or estuaries. When retreating, the descending tide carries again other elements that will enrich the sea downstream. By facilitating exchanges and transporting these nutrients, the tide plays a prominent role in the life and productivity of the coast.

Tides have a direct influence on the chronology of activities of living organisms on the coastal area. Thus, at low tide, fish are forced to retreat to the deep channels while the surrounding mudflats and sandbanks dry out. It's the favourite time for predators such as pelicans, sharks, dolphins and fishermen who benefit from the temporary concentration of fish in the channels to capture them more easily. The accessibility of mudflats at low tide allows however the birds to feed on a diet of worms, or crabs. Low tide also allows women to go and collect shellfish which are a primary source of food for coastal communities. When the tide rises and the sea covers the mudflats and mangroves the birds move toward resting places (islands, capes, mangroves), while fish can again be dispersed in search of food. Thus, the tidal rhythm largely determines the organization of life on the coast.

By their ability to move huge quantities of water over long distances, tides are also responsible for the transport of pollution. Pollution can be all solid waste

found on beaches (especially plastics) but also more diffuse pollution and sometimes very toxic wastewater from urban centres, industrial pollution or oil slicks when a tanker cleans its tanks at sea or due to accidents occurring on offshore oil drilling platforms. These toxic elements are carried by the tides to the bottom of the bays, rivers and inlets (which are the most productive environments in natural resources), covering the mudflats, entering the galleries of crabs or invertebrates, infiltrating the aerial roots of mangroves, killing aquatic vegetation and intoxicating shellfish, fish and marine mammals. Moreover, so far as water rises and falls with the tides, this pollution may affect beaches, mangroves and other areas over large distances and several meters in height.

By the currents they generate, the tides maintain channel depths, which are generally used for

navigation in coastal areas. The construction of infrastructure such as harbours and dams, slowing currents, causes a gradual silting of channels or even of the infrastructure itself. Hence the importance of measuring the tidal dynamics and conducting studies of environmental impact before carrying out works in order to prevent possible negative consequences. The study of tides and currents can also help to predict the possible directions of pollution in order to prevent and control them more efficiently.

With sea level rise and increased frequency of storms due to climate change, tides will impact the coast and human settlements more severely: increasing in salt concentration of the soil, loss of mangroves, floods and destruction of houses, etc... Again, precautionary measures are necessary in the context of developments in the coastal area.

“Did you know that?” What is plankton? Plankton is made up of living beings, animals or plants, which are carried by currents. These are usually algae and microscopic animals (so tiny that one cannot see with the naked eye) but also include larger animals such as jellyfish.

How are the activities of living-beings organized at low tide (drawing on the left side) and high tide



3.2 The Currents

Like tides, currents play a prominent role in the functioning of the coastal and marine area.

The West African coast is bathed by two main currents: the Canary Current comes from the north along the coasts of Mauritania and goes through northern Senegal before diverting its trajectory towards the archipelago of Cape Verde. During the months in which this current exerts its influence, from October to May, the water temperature is relatively cold at around 20°C. After the month of May, the Guinea Current comes from the south, from the Gulf of Guinea, gains more influence and reaches the waters of West African coast, and rising up to the Cape Blanc, in northern Mauritania. The sea temperature is then above 25° C.

The succession of both currents and their respective influence on climate determines the presence of marine species from the north and south along our coasts. One can observe plants such as spartina, a coastal plant that grows in the tidal area or marine mammals such as monk seals and porpoises, of European origin, as well as southern species such as mangroves, humpback dolphin or flying fish of African origin. The West African coast is therefore a meeting point of these two geographical areas, thus explaining the great diversity of the existing species.

There is a very special current, known as **upwelling**, which explains much of the richness of our coastal

Household waste is harmful to the health of people and natural environments



waters. This current, which name means “running upwards”, consists in deep waters rising to the surface through a mechanism that involves the strength of prevailing winds, the trade winds that blow from the northeast (that is to say, from the coast to the sea) which is added to the force caused by the rotation of the Earth. The combination of these two forces has the effect of moving the masses of the surface of coastal waters seaward, creating thus a “vacuum” near the coast. Such deficit creates a call that brings up deep waters rich in nutrients to the surface. The exposure of these rich waters from the depths to sunlight causes high production of phytoplankton which is an inexhaustible source of nutrients for huge quantities of zooplankton which are eaten by fish. It is mainly the existence of the upwelling that makes of West Africa one of the most important areas for fishing in the world.

Another type of current, which is found close to the coast, is called the coastal drift. It is caused by the echo of the waves on the coast. Swells generated by storms pound against the shoreline with a small angle of incidence. They are immediately returned to sea at an angle perpendicular to the initial angle. The successive impacts of waves and their echoes produce a current that runs southward (from Mauritania to Guinea-Bissau) or northward (from Sierra Leone to Guinea-Bissau). The two coastal drifts, north and south, meet at the latitude of the Bijagos archipelago off the coast of Guinea Bissau. These currents extend only to a few hundred meters offshore from the coast but play a fundamental role in sediment transportation and therefore in the erosion of the coastline, through their impact on coastal infrastructure and buildings, as well as the migration of certain living beings such as the larvae of some organisms, like fish or turtles.



Schematic map representing the two currents off the coast of West Africa (cold current from the Canary and warm current from Guinea)



The West African coastline is a meeting point of some species coming from temperate and tropical origins

We can also mention the surface currents that are generated by winds. These currents are generally less powerful and occur in low depths. Their strength is directly dependent on the strength and direction of the wind: if the wind blows strongly and long enough in the same direction it will generate a more significant surface current. Let's finally mention the deep currents that move very slowly from the Antarctic up on our shores at depths between 2000 m and 3000 m and gradually rise to the surface at the latitude of our **ecoregion**.

Schematic representation of the upwelling (refer to text)



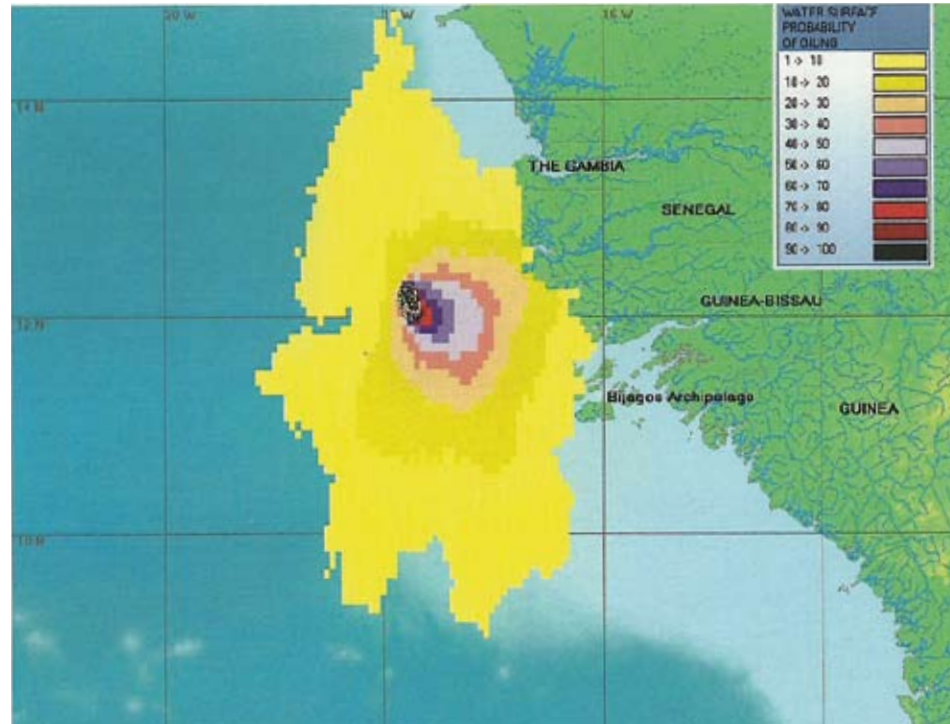
All these currents play a determinant role in several respects: they participate in the exchange of temperature between the cold and hot areas of the ocean and thus contribute to climate regulation. They participate in the movement of living organisms such as shrimp larvae, migratory fish or sea turtles that appear to perceive the currents as real underwater roads pushing and guiding them in their migrations. However, the currents are also vectors of pollution sometimes over thousands of miles and are able to generate disasters beyond the borders of their country of origin, making disaster management particularly complex, and giving crucial importance to knowing and understanding the dynamics of the currents.

“Did you know that?” What is the swell? How is the swell generated? The offshore winds stir the surface of the ocean that begins to curl. The swell created by the winds travel on the ocean surface to the coast. Approaching the coastline, the swell hits the bottom of the sea, which forms the waves.

Artisanal fishing boat fighting against coastal currents



Aerial view from the harbour of Nouakchott: one can see that the harbour, by stopping the natural flow of currents, has modified the shoreline



In case of accidental pollution, the oil slick drifts following the winds and the currents (the likelihood of surface pollution in case of accidents on the oil drilling site of Kora)

4.1. Mangroves

The mangrove is a plant community consisting in trees which have the specificity of being able to live with their roots in the sea. The 6 species of mangroves that are present on the coast of West Africa have indeed developed amazing adaptations to withstand salt water and mud. The high pressure of the sap allows mangroves to withstand sea salts, removing them at the leaves surface: one can observe salt crystals covering the upper surface of the *Avicennia* leaves. Also, all mangroves have special abilities to survive in the mud despite the lack of oxygen through root systems that allow them to breathe outside the sediment. Thus the red mangrove, *Rhizophora*, has aerial roots or prop roots directly connected to the branches or trunk. The *Avicennia* is characterized by the presence of **pneumatophores**

(or pencil roots) that emerge a few inches over the soil around the tree.

The presence of these dense root systems creates multiple effects that contribute directly to the services provided by mangroves. As a result of their grip on the ground the roots help to fix the sediments: without them the fine particles of silt would be easily washed away by currents. Also, one may realize that where mangroves have been cut down, erosion is fast eating into the shores. By their position on the coast and their flexible and dense structure mangroves absorb effectively the impacts of waves, thus protecting the land from storms. The interlacing of the roots is also a habitat difficult to penetrate and thus it provides protection to juvenile fish or shellfish from predators such as bigger fish or fishermen. Finally, the aerial roots are used to

*The two main types of mangrove observed on our coastline are *Rhizophora* (left) and *Avicennia**



support many marine creatures such as oysters that grow in clusters while feeding on nutrients carried by tidal currents. Due to their high natural productivity (mangroves produce over 10 tons of leaves per hectare per year) these characteristics make of mangroves a crucial environment for the reproduction of fish resources.

It is in the mangroves for instance that young shrimps grow up before heading out to the open sea where they are captured by industrial fishing boats. The existence of these resources explains the presence of a remarkable animal diversity with many water birds or mammals such as otters, humpback dolphins or manatees, a large herbivorous marine mammal that eat mainly mangrove leaves.

Mangroves provide many by-products that play an important role in the economy of human communities in the coastal area. Its wood is prized for many uses because of its resistance to insects such as termites. It is used as firewood but also for smoking fish, a form of exploitation that may threaten the sustainability of mangrove here and there. The bark of mangrove is used for making tannin necessary in processing leather, and the fruit of *Avicennia* is consumed in traditional cooking as a replacement of grain in the lean season. The honey produced by bees in mangroves is tasty and is a significant dietary supplement. Harvesting of salt is also a common practice in the mangroves. The traditional form is to boil sea water to obtain salt by evaporation but this technique requires a lot of firewood and is time-consuming. More and more, a new technique is used to produce salt that consist in evaporating large quantities of sea water exposed to the sun on plastic sheeting.



Aerial view of Mangroves



Some animal species associated with mangroves for food and shelter

The interlacing of mangrove roots provides shelter from predators for juvenile fish

Some ethnic groups living by the coast (Diolas, Balantas...) know how to grow rice on the saline lands of mangroves

The mangrove soils are rich and many ethnic groups of the West African coast, such as the Diola and the Balanta, have developed advanced knowledge and skills that allow them to exploit mangrove soils for rice cultivation. By building dams they stop the sea water flow that result on killing the mangroves, and their location becomes a few years later an arable land. The rainwater gradually removes the salt from the dead mangrove land and mounds are formed for transplanting rice, high enough to keep the roots away from salty soil, while the grooves are deep enough to keep rain water longer. This method of cultivation, however, is labour-intensive and requires the presence of a vigorous youth, who are not

always available given the trend of people leaving their village for town, currently called rural exodus.

Although mangroves can survive without fresh water, as it is the case on the shores of Mauritania, the northernmost point of distribution of mangroves in West Africa, the availability of freshwater is an important condition of vitality. Along our coastline, mangroves only become denser from the latitude of the Saloum Delta southward. They reach maximum development in rivers or inlets which receive large quantities of freshwater in the rainy season (it is the case of River Gambia for instance where mangroves reach great heights).

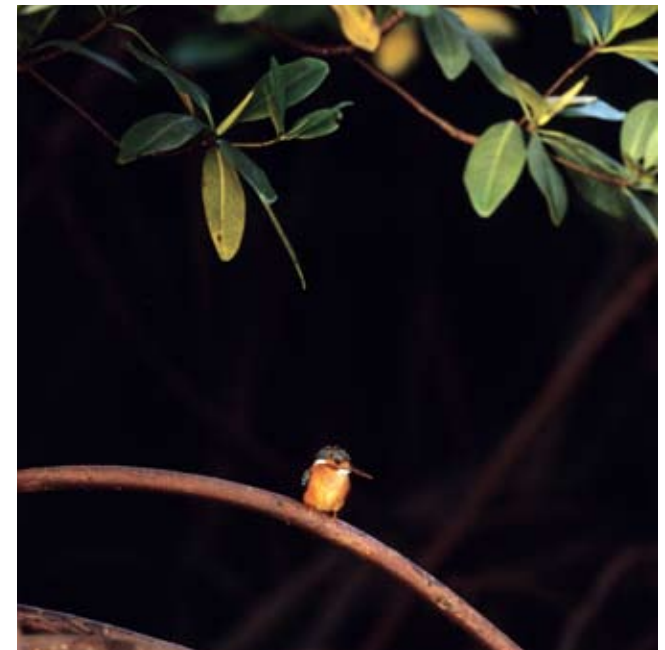




Distribution of mangroves along the coast from Mauritania to Sierra Leone



Where mangroves are deteriorated, some communities plant new mangrove trees



Kingfisher on a mangrove root

4.2. Sea Grass beds

Sometimes the mudflats and shallow environments are covered with aquatic vegetation which makes them look like grazing lands under water. Some species that make up these fields are able to survive outside water during low tides, while others, with longer and wider leaves, live under water permanently. Apart from sea turtles, manatees and a few fish, there are few creatures that directly consume such vegetation. In contrast this is colonized by algae that stick to the leaves, as well as tiny organisms such as bacteria and fungi, or by small gastropods. This micro-fauna, that fragments and decomposes plant matter for food, is in turn eaten by predatory fauna consisting mainly of crabs and shrimps, which themselves serve as prey for fish. At low tide when

mudflats are left uncovered by the sea, these animals will seek shelter in deeper grass-beds. The diversity and quantity of fish in sea grass beds is particularly high.

Besides their role as habitat and food, the sea grass beds have an influence on the ecological conditions prevailing on the mudflats. On the one hand, by slowing down the water flow, they provide a sheltered environment, where suspended solids deposit and where water remains clear. On the other hand, the system of roots and **rhizomes** of sea grass beds plays the role of a sediment trap and contributes to a good stability of the mudflats. The entire sea grass bed produces a large amount of oxygen used by all organisms that live there.

*Sea grass beds
at low tide*



4.3. The Algae

Marine algae that can be observed by the sea side are very different from terrestrial plants that we know: we see neither roots, nor stems or leaves that usually allow us to distinguish the species. No flowers, fruits or seeds to help one imagine the reproductive mechanisms, which are also very diverse.

The algae use sunlight to live and reproduce, which is why they are found mostly in shallow depths. From 200 meters deep, the amount of light entering under water is almost zero and there are no more plants. The distribution of different species is mainly determined by the depth and the agitation of the water. Much of the algae living in the intertidal area develop various adaptations to resist **desiccation**, such as the secretion of mucus.



A guitarfish in a flooded sea grass bed



Marine algae (Sargasso)

When the coastal area receives input of artificial fertilizers, such as from wastewater discharged into the sea, algae can grow significantly. When large amounts of algae die they decompose, producing **bacteria** that consume the oxygen in the water, which causes the disappearance of many animals and spreads into the environment toxic and smelly substances.

Fresh or dried, the algae provide a range of wide use. They are found in medicine (rheumatism, vermifuge), agriculture (fertilizer) or even as food for humans and animals. Algae are sometimes cultivated to meet those uses, but that requires special precautions. Thus, to feed his chickens, a breeder located along the Senegal River has attempted to introduce a species called salvinia, known for its ability to double surface every 2 to 3 days. By accident, the species has reached the river, where it became invasive. It is fought today by mechanical means, but also organic means with the introduction of a small insect consumer of salvinia and equally able to multiply rapidly.

“Did you know that?” These species are invading us! It is considered that both plant and animal species are invasive when they appear and grow dramatically in an area where they were not found originally and cause deep changes in the functioning and balance of ecosystems. The presence of species sometimes takes such proportions that they become uncontrollable. Plant and animal species can become dangerous when they take the place of other natural resources of economic importance, as in the case of the salvinia algae: by invading the waters of the Senegal Delta River, the salvinia algae undermines the development of fisheries, slows down water circulation - thus creating conditions for the development of certain diseases such as bilharzias - and hindering the movement of boats.

4.4. Molluscs

Apart from cephalopods (octopus, cuttlefish...) which are targeted by the commercial fisheries, the main species of molluscs that play a role in coastal communities' source of food are the shellfish. For some communities, they even represent their main source of animal protein.

The major collectable species are:

- The Bloody Cockle (called 'pagne' in Senegal and 'combe' in Guinea-Bissau) is a **bivalve** that lives buried near the surface of mudflats, in such densities that they represent the main species of shellfish consumed by man.

- The mangrove oyster is also a bivalve that lives hanging in clusters on the roots of mangrove trees located along the channels. There are also oysters on the bottom of waters, set on rocks.
- The scroll or cymbium (called 'yët' in Senegal and 'contchurbedja' in Guinea-Bissau) is a large **snail** that lives on the mudflat surface but also up to 90 meters deep. Biggest species of scroll can reach 35 cm in length.
- The melongena (is called 'toufa' in Senegal and 'gandim' in Guinea-Bissau); the murex and conus snails are also found on mudflats, but in smaller quantities.

Bloody Cockles are the most commonly consumed shellfish by coastal communities

Oysters growing on mangrove roots



Bivalves feed by filtering food particles from water. A single oyster can filter about 250 litres of water per day. That explains their importance in maintaining the water quality and their sensitivity to pollution. Snails feed on aquatic vegetation or are carnivorous. The volute feeds by wrapping other shellfish inside its fleshy mass of body to digest them, while the murex and conus pierce the shell of other shellfish, inject powerful venom and kill them before consumption. Other shellfish predators (besides humans) are the rays, sawfish or the oystercatcher bird which, as its name suggests, is a water bird able to insert its long and compressed beak in bivalves to feed.

The exploitation of shellfish

Usually women are responsible for collecting, processing and marketing shellfish. They go in groups at low tide on mudflats or along small channels (or bolons) to pick them up. The Bloody Cockle is searched with bare hands or simple tools like spoons. Oysters are detached from their support (mangrove roots) with machetes. Depending on areas, women developed mangrove-friendly collecting techniques whereby they take only the oysters, while in other areas, especially where the oysters are traded, sometimes women cut the roots of mangrove to go faster, causing adverse damage to the survival of mangroves.

When the tide rises and begins to cover the collection sites, women move away, carrying the shells in a bowl on their heads. They must sometimes walk several kilometres with a load between 20 and 30 kg.

Either for bloody cockles or oysters, women's work does not stop there. They should collect firewood to

cook large quantities of shellfish until their shells open, and then remove the fleshy part and put it on racks to dry in the sun. Bags of dried shellfish are then retrieved by traders to be sold at fairs and market places



Women harvesting shellfish



Bivalves cockles are boiled, cracked open and then dried in the sun

around. Oysters are sometimes sold alive, mostly in big towns or at hotels. The sale price (350 CFA for hundred dried bloody cockles) seems ridiculously low when one realizes the energy it requires to collect them: the energy from the natural environment that produced the shells and firewood added to the energy developed by the women to collect, transport and process shellfish, besides the energy spend on their evacuation to the markets and from the work of traders. When a resident of Dakar enjoys rice with seafood, he probably doesn't realize the amount of efforts it took to fill his plate ... or the fact that it is women and the environment that pay the heaviest price for that dish.

There are several ways of preparing and eating shellfish. The most classic one is to boil them in a saucepan then crack them open to mix with rice, sometimes with palm oil. Oysters can be grilled on embers and eaten with a sauce of lemon and spices. Yët or scrolls undergo special treatment of fermentation (they are buried under sand for a few days, sometimes

stored in a plastic bag prior to drying them); then cut into small pieces, yet serves as a condiment for 'Ceebu Diene' (rice with fish sauce).

How do we manage shellfish resources ?

In areas where shellfish are traded and economic alternatives are few, the pressure on resources is sometimes much larger than their capacity for renewal. Shells become less numerous or smaller in size as a result. Solutions have been experienced to face this problem, particularly in the context of the project "Women and shells" in the Saloum:

- For breeding oysters or farming oysters, one installs in the mangrove lines of empty shells on which oyster-larvae (spat) will hang on and grow.
- To reseed depleted areas using young bloody cockles taken from areas of high density.
- Leaving portions of mudflats untouched for a certain period to give time for the bloody cockles to relocate and grow.
- Restricting the exploitation of areas of mudflats for a longer period to protect adults and therefore promote full breeding, the larvae can thus be dispersed by currents to the sites of exploitation.

In other coastal sites, as in the Bijagós archipelago, the problem of lower shell production has been partly solved by the collective decision on some islands not to sell them and to keep them for the livelihoods of local communities. In fact, this source of food is essential for survival at the lean



Oyster farming

time, when rice stocks are depleted and the harvests of the year have not been made yet.

Overexploitation is not the only threat to shellfish. Another danger coming from people is that they sometimes cut roots of mangrove trees to collect larger quantities of oysters and that practice impoverishes the stock of oysters. Still, one of the most worrying threats remains in the pollution of water. Much of human sewage from urban areas are discharged directly into the sea, and knowing that most species feed by filtering water, one can understand why the environmental conditions are nowadays less favourable to the development of shellfish. Besides sewage there are sometimes industrial pollutions, or pollutions caused by hydrocarbons. Furthermore, these forms of pollution are likely to poison shellfish consumers, either human populations or other shellfish predators.

Other uses of shellfish

Besides food, the shells have many other uses:

- The deposits of shells, which sometimes form mounds of several meters high, were once used to bury important people, such as wizards or warriors. This kind of tomb-mounds known as tumulus is sometimes topped by large holy baobab trees in the Saloum Delta. Such traditions as covering graves with seashells are preserved, like in the cemetery of Fadiouth where Muslims and Christians are buried side by side.
- Remains of shells are sometimes used to gain ground on sea shores (polders) or protect certain shores from marine erosion. Again, the Fadiouth Island, which is partly based on shell-mounds, is one example.

- Some shells like cowry shells used to be used as currency for trade.
- Several species of shellfish are used as jewellery by women: cowries, bloody cockles or porcelains are crafted and worn as necklaces, bracelets, and hair-adornment or even sewn onto certain types of clothing.
- Cowry-shells are often used to make amulets but also to predict the future.
- Shellfish, including oysters, are involved in performing other specific ceremonies as presents. Still in

Shell-covered graves



the Bijagós archipelago for instance, the bivalve called lingron (*Tagellus adamsonii*) is used by a woman as a present when she wants to let a man know that she wishes him to marry her. The conus are used by men around the neck with a protecting witchcraft inside.

- Shells of gastropods such as scrolls and murex are sold as souvenirs to foreign tourists.
- Shells of bloody cockles are mixed with sand and cement to build houses. They can be used as well to produce lime.

Jewels made out of cawries

Houses decorations

*Shells for sale to tourists
(from left to right and from
bottom to top: conus, volute
or cymbium, murex and, at
the bottom right, melongena)*

4.5. The Crustaceans

Crustaceans also occupy a prominent place in the marine environment and in food and fisheries economics. Shrimps are among the most popular crustaceans. Generally, they live in sea grass beds or estuaries populated by mangroves, where they

undergo a complex life cycle. Some species of juvenile shrimp live in mangroves until they become adults before heading to the sea to lay their eggs. Shrimp-eggs become larvae that currents carry to mangroves and sea grass beds, where they become juveniles, completing thus the reproduction cycle.

Like shrimps, lobsters and crabs are among the most targeted crustaceans. Typically, lobsters eat detritus at the bottom of the sea. While green lobsters live near rocky shores and in the area of surf waves, spiny lobsters are found at depths of up to 300 meters in colder waters.

Among crab species that are most visible and abundant are fiddler crabs. They are so called because of the males' generally immobile large claw coupled with an animated smaller claw for food-intake through a rapid back-and-forth movement like a bow on a violin. Fiddler crabs feed on plant particles they extract from mud or sand. They live in dense colonies, often up



to tens of thousands of individuals, each occupying a gallery from which they feed. There is another crab species called ghost crabs because of their nearly transparent bodies. They also live on beaches but maintain a diet mostly based on carrion and detritus brought in by the tide, or, occasionally, on preys such as hatching young sea turtles. Other species live in deep waters like the blue crab, a swimmer crab that catches live preys.



Shrimps



Ghost crab



Fiddler crabs

4.6. The Fish

Of over 24,000 species, fish makes up the largest group of vertebrates. There are more than 14,000 species living in the sea while others live in lakes and rivers around the world. Because fish is known to have appeared 500 million years ago, it is therefore considered as being the first vertebrate inhabiting the planet. Fish species are set into two major groups: the cartilaginous fish (sharks, rays) and the bony fish (largest group). The bony fish has a backbone made up of bones, while the cartilaginous fish, such as any ray or shark, has a skeleton made of cartilage.

One of the special features of fish is its ability to breathe underwater. To do so, fish swallow in water and let flow out through its gills that look like tiny combs and that allow fish to capture the oxygen dissolved in water. Fish breathes through these blood-vessel-rich lamellae located on either side of its head. When water enters the gills, the oxygen goes in the bloodstream which then

distributes it to all organs. The oxygen-depleted water goes out through the slots located behind fish gills. Also, some types of fish have adapted to the tidal changes of sea level and have developed the ability to breathe outside water. This is the case of mudskippers that can be observed in the mangroves.

Legless, fish moves through water using fins. These are made of small bones called rays that give fins their rigidity and allow them to remain deployed. One distinguishes between pectoral and pelvic fins located on the sides of the body, dorsal fins on the back, anal fins below and caudal fins at the rear end of the body. In general, the caudal fin (tail) is used to provide the propulsion that allows fish to move forward. The other fins are used primarily to manoeuvre and stabilize.

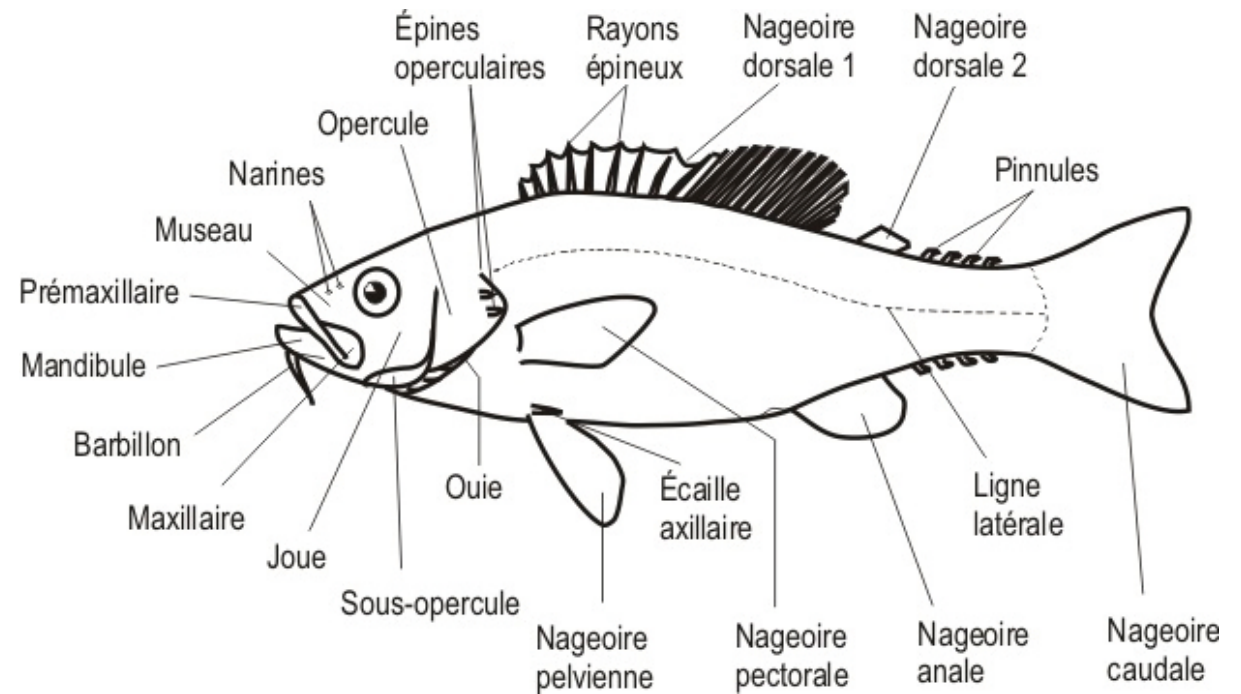
Not all types of fish have the same diet. Depending on the species, fish can eat plankton, aquatic plants, molluscs (shellfish and cephalopods), crustaceans (crabs, shrimp ...) or other fish. Some types of fish

Some species of bony fish (from left to right): tilapia, sardinellas, groupers, barracudas, grunts, mullets



are active and fast predators, armed with sharp teeth, while others, such as flat fish, hide in the bottom of the sea and wait for preys to swim past within their reach in order to capture them.

To reproduce, in general, female fish release in water a large number of eggs that the male turns fertile with its milt. Again, depending on the species, the eggs may float on the surface of water, settle at the bottom or cling to some vegetation. When these eggs hatch, tiny larvae spring off but many of them end up being eaten by other animals. At early stage of development eggs and fish (called fry) are easy preys; very few of them will reach maturity. Nonetheless, the balance of species is maintained by the enormous quantity of eggs laid. A mullet for instance can produce several million eggs in one spawning. Young fish from eggs which survive become juveniles before reaching adulthood. Fish age and size at sexual maturity (i.e. when fish can breed for the first time) vary greatly from one species to another.



Names of the different fish fins



Some particularities of fish behaviour

To protect themselves from predators, some species have developed specific strategies. For example, most fish species have the back darker than the belly: this is called the reversed shadow. This dual complexion allows the fish to be less easily spotted by hovering birds (as from the sky, the dark colour blends with the blue of sea) while also keeping the fish less easily identifiable by bottom-dwelling predators (as from below, the light colour of fish-belly shines; and is easily confused for sunlight).

According to their lifestyles and behaviour, fish species can be classified into two main categories: the pelagics and the demersals. The pelagics live in open waters and often in large groups called shoals of fish. This gathering lifestyle has the advantage of enabling them to escape more easily to attacks from predators (the more numerous they are, the easier it is for them to detect a predator and the greater the chance of each

Rays and sharks are cartilaginous fish (hammerhead shark and stingray)



individual not to be eaten) and facilitates the search for food. Conversely, they become more vulnerable to fishing methods developed by man of using a net to encircle a large part of fish shoals. Pelagic species may live near the coast (mullet) or in the open ocean (gilt sardine) be small (sardine) or large (meagre), feed on plankton (Bonga) or be top predators (tuna). The pelagics perform large migrations during the annual cycle. Hence, the yellow mullet goes to the estuary of River Senegal to lay eggs and then migrates northward into the Gulf of Arguin, where the presence of large areas of mudflats and sea grass beds allows it to rebuild its strength before returning to the river to spawn. Gilt Sardines also perform migrations between a spawning area located off the Mauritanian coast and a scattering area that leads to Senegal, The Gambia and Guinea-Bissau.

Demersal species are rather solitary, living near the coast, near the bottom and remaining attached to their territory. These characteristics turn them vulnerable to fishing or habitat destruction. Among the best known demersals are groupers or 'thiof' but, because they are subject to overfishing, their populations are in danger just like captains and flatfish species such as the sole or even sea bream. Their vulnerability is increased by a relatively slow rate of reproduction or by their hermaphroditic characteristic: a 'thiof' is first a female during the initial 6 or 7 years of life and then becomes a male. If fishing pressure prevents individuals from living beyond this first stage of life, gender imbalance becomes a constraint on reproduction.



Small pelagic fish: the bongas



Large pelagic fish: the tunas

The specific case of sharks and rays

Sharks and rays form the class of cartilaginous fish species. The 350 species recorded worldwide share a number of common characteristics. Their cartilaginous skeleton sets them apart from all other fish (so-called bony fish) and their elongated body allows them to swim swiftly, combining speed and agility, which is crucial for a predator. Their senses are highly developed, including the sense of smell that enables them to perceive the presence of blood or meat at great distances. Like other fish species, they have a lateral line comprising cells with a sensory organ of touch like a remote controller which allows them to perceive the peculiarity of electric fields and detect even a hidden prey (such as a prey buried in the sand).

Sharks have many forms of dietary specializations. In the case of sharks such as the giant whale shark, the teeth are atrophied, giving way to a filtering device developed from the gills. Species that are equipped with such devices feed on plankton or small fish they harvest while swallowing rapidly tons of seawater.

The teeth of other species like the tiger shark are well developed for slicing flesh from larger preys. These triangular and serrated teeth, which also possess the ability to renew by themselves when they wear, allow them to

smash even the shells of sea turtles. Other species that live at the bottom of the sea, including rays, have teeth like a grinding stone that they use to chew up shellfish or crustaceans. Sharks also have the ability to capture preys that hide in holes in the rocks cupping their meaty lips around the hole and deploying a considerable suction force that draws the prey out of hiding. While sharks have a bad reputation, attacks on swimmers are very rare. Only

a few species such as tiger sharks and hammerhead sharks can provoke attacks in very specific conditions. Better avoid swimming in the open sea, even more if you have scratches that bleed even a little bit.

Compared with other fish, rays and sharks have a particular mode of reproduction rather similar to that of mammals. Unlike most marine animals though, which produce large quantities of eggs for external fertilization, sharks have internal fertilization. Most sharks are **viviparous** or **ovoviviparous**, meaning that the egg turns into a young animal inside the female. This gives birth to a limited number of offsprings (one every two years to one hundred at each breeding cycle, depending on species) after a gestation period of several months to more than 12 months for large species. Young sharks are able to swim right after their birth, but their growth is very slow and often occurs in different environments from those colonized by adults. It takes 4 to 16 years before a shark reaches sexual maturity.

Delayed sexual maturity and small number of young at birth determine a very slow rate of reproduction, offset by a long life expectancy under natural conditions. Unfortunately these conditions are jeopardized with the development of shark-targeted fishing. Formerly little sought, sharks have been in the last thirty years the subject of strong demand from Asian markets to satisfy fin-soup consumers. With prices of around \$ 100 per kg of fin (and up to \$ 500 for more desirable species), many fishermen have turned to





The marine protected area of Santa Luzia, Branco and Razo islands (Cape Verde)

Nurse shark

catching rays and sharks, of which they only keep the fins. The rest of the body, with low commercial value, is thrown overboard, contributing to pollute the sea. In some cases the body is preserved, salted and dried or processed into fish-meal flour for poultry farms.

Bulldog shark (notice that its fin was cut) and its offspring

Most species subject to the above commercial fishing practice are now threatened. Indeed, given the sharks particularly slow rate of reproduction, their populations are not being renewed fast enough to cope with such pressure.



For instance, the sawfish, which appears on coins of the Central Bank of West African States as a former symbol of power and wealth, is now considered close to extinction. Its peculiar morphology, a rostrum with teeth extending the nose used to chase shoals of fish or dig shells out of mud, made the sawfish especially vulnerable to fishing nets. There are now only a few specimens in Guinea-Bissau, where they are venerated by the Bijago ethnic group and represented in the form of masks the young men wear during ceremonial dances.



The partial disappearance of sharks has also an impact on the balance of the marine food chain. Besides their function of eliminating weak or sick individuals, the role of large predators is indeed to maintain a balanced level of the population numbers of different species of the preys they eat. With the disappearance of predators, these species tend to proliferate, destabilizing in turn other segments of the food chain. Thus, in some parts of the world, the disappearance of sharks has led to the proliferation of seals on which they feed. The increase in the number of seals has led to a decrease in fish populations to the detriment of the fishermen. Another example mentioned by the fishermen in the Bijagós archipelago, recalls the dramatic increase in

the number of stingrays caused by overfishing of hammerhead sharks, their major predator. The abundance of stingrays has multiplied the risks of extremely painful stings that affect not only the fishermen, but also collectors of shellfish and such other beach-users as tourists. It also appears that overfishing local catfish has resulted in the overpopulation of sea urchins that are their usual preys. Beyond a certain point, these summing effects make it difficult to return to a steady state of balance, despite all conservation efforts that can be deployed.

Shark fins drying in the sun



Load cell stylized in a form of sawfish, nowadays symbol of the Central Bank of West African States (BCEAO)





*Shoal of juvenile mullets
in the mangrove*

4.7. The Marine Mammals

While belonging to different families marine mammals share a number of common characteristics. The architecture of their bodies is similar to that of terrestrial mammals that have adapted to aquatic life later. They have lungs to breathe, and reproduce like other mammals, usually delivering a single young after a gestation period of 8 to 16 months, depending on the species. The offspring is able to swim from birth and is breastfed under water by the mother with a milk rich in fat ejected under pressure. They spend their entire lives

in water, with the only exception, in West Africa, of the Mediterranean monk seal which gives birth to her pups and spends part of its life on the beach. They live either solitary or in small groups, apart from some small species of dolphins that remain far away from shore and can form gatherings of hundreds of individuals.

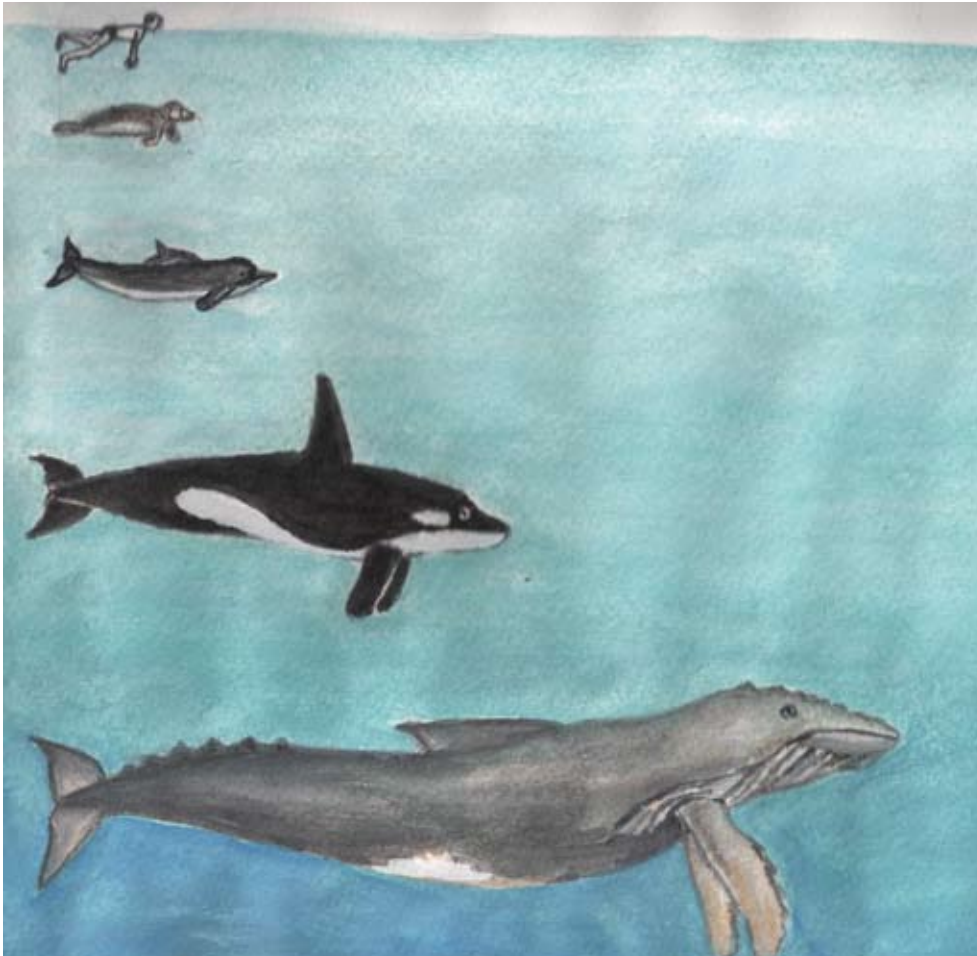
Marine mammals are large animals but with large variations between species. The smallest ones, such as dolphins, porpoises and seals, measure between 1 and 3 meters, the largest ones, the whales, are also the largest living animals on earth and can reach 30 meters and weigh up to 150 tons. Those that are observed near the coast are small species, with the exception of the killer whale that measures 7 to 10 meters in adulthood and can get close to beaches or into channels in search for its prey. Marine mammals observed on our coasts belong to the Cetaceans order with the exception of monk seals and manatees.



Monk seal

The Cetaceans

The most commonly seen cetacean species is the bottlenose dolphin, found in all temperate seas around the globe. It sometimes manifests itself by its exuberant behaviour, making spectacular jumps out of the water or accompanying vessels. If it can be seen almost everywhere along the coast, it is regularly present in a



Size comparison of man and some marine mammals (seal, dolphin, killer whale, humpback whale)

few special sites, characterized by an abundance of shoals of fish such as sardines or mullets. Their method of fishing is to encircle the shoal all together, preferably at low tide when contained in the channels. They can also attract shoals of fish close to shore where shallow water makes them more vulnerable. A few decades ago, in Mauritania, the Imraguen fishermen used to call dolphins by tapping the water with sticks imitating the sound of mullets leaping and falling to the surface, hoping dolphins to attract migratory fish shoals near the coast to catch them in their nets.

The Atlantic humpback dolphin is a rare species, considered as being threatened of extinction, and has a distribution limited to the tropical West African coast. This species lives close to shores, where



Bottlenose dolphin

it enters channels located in the middle of mangroves and lagoons. Much more discreet than its predecessor, the humpback dolphin usually prospects the falling channels slowly at low tide in search for sedentary fish such as snapper or grouper to feed on.

Other species of cetaceans that live along our coast is the killer whale of which large size, black body and white-spotted dorsal fin can be distinguished from other species. The killer whale is known for its ruthlessly efficient hunts, whereby family groups venture as far as attacking whales. Whales and sperm whales are also present but further offshore in deep waters. The humpback whales are regularly observed in the archipelago of Cape Verde where the females come to give birth to their young during the winter, before migrating to the Arctic waters to spend the summer.

While the toothed whales (dolphins, killer whales or sperm whales) feed on fish and cephalopods (squid, octopus etc...), **baleen** whales such as Sei whale have a diet mainly based on plankton. To eat, they swallow tons of water that they suck with their tongue (note that a tongue of whale is as big as an elephant) by closing the mouth partly and filtering through their baleens the organisms they then swallow.

Some species like the humpback whale may also feed on small fish and have developed a unique method of fishing by encircling the shoals with a bubble curtain in the middle of which they dive on their prey with the mouth

Main cetaceans observed off the West African coasts



wide open. To feed, these giants consume considerable amounts of food, about 4 tons of plankton per day for an adult blue whale, while a calf fed by his mother receives nearly 600 litres of milk daily.

Even with good vision, cetaceans do only use their sight marginally to move around and locate preys, because of the lack of light or low water transparency. The sperm whale for instance, fishing up to 3000 m deep, moves in total darkness. Hearing is instead the most important of all senses and is used on the principle of echolocation or **sonar** : the animal emits sounds that are echoed by the obstacles facing it. The nature, direction and strength of the return signal provide information on the distance and nature of the object: shoals of fish, boat, channel side, etc. They also hear the sounds produced by other organisms as well as their congeners, denying thus the belief that the underwater world is the “world of silence.” Research on sounds produced by cetaceans show the existence of a vocabulary specific to each species. There are nearly thirty different sounds for the bottlenose dolphin for example, and “dialects» have even been identified in distinct groups of killer whales. Knowing that water is an efficient vector for the transmission of sound, we also discovered that some whales can communicate

by infrasound to several hundreds of kilometres away.

The acoustic sensitivity of cetaceans makes them vulnerable to the proliferation of sounds due to increasing human activities at sea. It is known for example that the sonar used by ships emits loud sounds. Exploration of hydrocarbon resources in the sea, realized in the form of seismic surveys during which powerful ultra sounds are sent under the sea with air guns, is another source of noise pollution that disturbs marine mammals up to causing fatal internal injuries. It was noted that cetaceans diving to great depths ascended abruptly at the surface or were stranded on the coasts where these sources of noise became too powerful. These noise pollutions are in any case one plausible hypothesis to explain the mass stranding of dozens of individuals seen occasionally on the coasts of the region.

The other causes of threat to the cetacean populations appear first in the fishery. We know that most West African waters are overfished and one can easily imagine that the depletion of resources affects the feeding conditions of cetaceans. Fishing activity is also a source of direct mortality; marine mammals are routinely caught in the nets of artisanal or industrial fishing.

A species threatened of extinction, the humpback dolphin



Monk Seals

As a single species of tropical seal, the monk seal is also one of the mammals most threatened of extinction in the world. They were once abundant as evidenced by stories of the fifteenth century that describe the extermination of thousands of monk seals for their skin and oil from their fat. Today the world population is between 400 to 500 individuals. The colony living along the peninsula of Cap Blanc, in the north of Mauritania, is the largest in the world - and perhaps the only one viable in the long term - with nearly 190 individuals only. They are distributed on the ocean front of the peninsula, with a marked preference for areas with cliffs. They occupy some caves carved by sea erosion. In these caves accompanied by their mother the young monk seals find shelter from the

Monk seals on a beach



swell and men. Further offshore there is an essential productive environment for feeding these animals weighing from 250 to 300 kg and consuming every day about a tenth of their weight in cephalopods, fish and shellfish.

A few years ago the colony has experienced a dramatic decline in its numbers down to one hundred individuals. Among the factors behind this fall should be reported a massive mortality in 1997 caused probably by a toxic algae. Another factor is the continued development of artisanal fisheries in waters frequented by seals, which results in the presence of nets that clutter their living space and in increasing the competition as far as the access to food resources is concerned. Another constraint to the expansion of the species is the limited availability of caves, which tend to collapse from time to time.

Protection efforts undertaken in collaboration with the fishermen helped to redress the situation of population of seals. A protection area has been delimited within which the fishermen no longer use their nets and where disturbance is reduced. As a result of these efforts, the population rebounded with an annual birth rate of



nearly 50 pups. Finally, thanks to protection efforts, seals seek less shelter under caves and use more and more open beaches to rest, give birth and raise their pups, a behaviour that had not been seen for long.

Manatees

The manatee is another species of marine mammals found in West Africa. Its body is massive (adults weigh up to 750 kg), cylindrical, elongated and extended by a very broad and round tail. The Manatee's head is round, provided with a nose and thick lips with which it licks up the vegetation that forms the basis of its diet.

It is a very secret species, almost invisible, which lives in the unclear waters of mangroves, estuaries and rivers. It lives alone or in small groups, of which concentration of more than a dozen individuals is exceptional, and only come to the surface for breathing. These features have given rise to the legend of mermaids and a particularly rich mythology. In several countries of our region people tell the origins of the manatee: a young woman bathing in the river, having been surprised by a hunter, decided to take the plunge to hide her nakedness. She then



turned into a manatee, singing her songs of despair.

The manatee lives in freshwater and brackish rivers and estuaries where it mainly feeds on aquatic plants and mangrove leaves, but also sometimes shellfish. It happens that they enter into rice fields committing damage complained by peasants. It is also found in marine environments, as in the Saloum Delta and the Bijagos archipelago, where its presence is linked to the availability of freshwater sources underwater. These locations, where the manatees come to drink, are also sought after by hunters.

The hunt for manatees is still practiced despite the ban, either for trading their meat or for using different parts of their body for traditional medicine. The oil, bones, certain organs or the skin are used to treat a

Manatees



wide range of illnesses (ear infections, asthma, skin diseases, etc...). Among many ethnic groups, this hunt can be practiced only by initiated persons, according to specific rituals and special ceremonies.

Apart from the greed of hunters, the manatee is often caught by fishermen, especially when they close the inlets with their nets, sometimes trapping an individual. It suffers from habitat degradation particularly the loss of mangroves, pollution of water and constructions made on rivers such as dams or dikes that constitute real walls preventing the manatees to move freely in their environment. Manatees are very sensitive to disturbances such as those caused by motor boats, of which propellers can fatally wound them. These reasons make the manatee a species threatened of extinction, especially since its capabilities of reproduction are limited, in that adult females deliver only one young every two to three years.

Imraguen fishing with the help of dolphins



4.8. Marine Turtles

The ancestors of current turtles appeared about 200 million years ago during the dinosaur era. These ancestors were not like the turtles that still live today: it is to defend themselves from predators that their shell has grown. The turtles were then adapted to different environments in which they lived, forming over 300 different species divided into three broad groups: land turtles, freshwater tortoises and sea turtles.

Turtles are reptiles like snakes and crocodiles. They therefore have morphological characteristics typical of this group such as their dry skin with scales. Sea turtles are mostly recognizable by their shell which is actually composed of two parts: the carapace (the back), and plastron (the belly).

The first turtles certainly appeared on earth. Turtle species found in the ocean today conquered the marine environment adapting slowly to the new habitat. Coming



Green turtle digging its nest

originally from land, sea turtles have lungs. They cannot breathe under water and must return to the surface to catch their breath. Sea turtles are excellent divers, since some of them are able to dive up to 1000 meters deep and spend several tens of minutes under water. To facilitate their movement in water, feet of sea turtles are different from those of their terrestrial cousins. The front legs turned into fins long and powerful allowing them to swim very quickly in water, they are flippers. Conversely, the rear legs are smaller but very rigid and mainly used to guide and stabilize the turtles in their movements, much like the rudder of a boat.

Worldwide, there are seven species of sea turtles. Among them, six species can be found in the West African waters. They are the green turtle, olive ridley, loggerhead, hawksbill, leatherback and Kemp turtle. Each species of turtle has a different diet. Green turtles feed mostly on algae and sea grass, and are therefore **herbivorous**. The hawksbill turtle is **omnivorous** but the sponges (marine invertebrate animals) are its favourite dish. The Loggerhead turtle feeds mainly on crustaceans and molluscs. Leatherbacks turtles mainly eat jellyfish. And the olive ridley turtle eats a lot of different things but prefers crustaceans, molluscs and jellyfish.

Marine turtles are very great travellers: they do migrations between feeding grounds, mating areas and nesting sites. Scientists have discovered for instance that some green turtles that come to nest on the Bijagos islands in Guinea-Bissau then travel to the Banc d'Arguin in Mauritania to feed on the vast underwater sea grass beds (which represent several hundred kilometres of travelling). The loggerhead turtles of Cape Verde, after laying eggs on the coast of the island of Boa Vista, move close to the continent to reach the area from Senegal to Sierra Leone. Some species such as leatherback turtles are able to cross the Atlantic Ocean following the currents.



Loggerhead turtle

Sea turtles are among the few marine animals that leave the ocean to breed, and this is unfortunately increasing dangers on them. During the same spawning season, each female may rise several times on the beach to lay eggs. After the spawning season, sea turtles return to feeding areas to rest and gather strength before returning to the same beach to lay eggs one or several years later.

During the spawning season, when it gets dark, female sea turtles leave the sea and ascend to the top of the beach. Turtles live 99% of time in the ocean, they therefore move slowly and painfully on the beach, which makes them vulnerable to natural predators and humans. They leave visible traces on the sand that can help to identify which species came over to spawn. After a search-time for the most appropriate place (somewhere

closer or not to the vegetation, depending on the species), the sea turtle sweeps the location clean where she intends to dig her nest. Then, using her rear legs, she digs a hole in the sand. The nest can measure between 40 to 70 cm deep and receive 80 to 130 eggs, depending on the species. After laying her eggs inside, she fills the hole with sand and then blurs the top to hide her nest. Exhausted by all this work, she finds her way back to the sea abandoning the eggs to

providence. Apart from humans, many predators such as crabs and monitor-lizards can devastate her nest. The nests may also be wiped out by high tides and waves as a result of severe erosion.

Almost two months after spawning, the young turtles hatch and climb out of the nest all together, usually at night. Once on the beach, they run towards the ocean attracted by the



Young turtles going to sea after birth

glittering of the water and the brightness of the horizon. Between leaving the nest and reaching the ocean, many dangers await them: birds, crabs or roaming dogs are there to enjoy the feast. Even in the water, they can be eaten by many fish. As they grow up, predators become fewer: mainly large sharks (like the tiger shark) and killer whales are able to break their shells. Depending on the species, 10 to 20 years elapse before young sea turtles become adults and return, as if by magic, to lay their eggs on the same beach as where they were born.

Many dangers threaten sea turtles throughout their lifetime: incidental capture by fishing gear, sickness sometimes lethal by chemical pollution, being choked by floating plastic bags they take for jellyfish, or being captured on the beach when they come out to lay their eggs. Turtles are often captured for their eggs, meat or shell. Moreover, other threats rely in the fact that feeding areas or nesting areas are ruined by near-beach town and village constructions.

Sea turtles have a very complex life cycle (migration between feeding and breeding areas and spawning on beaches) and very late sexual maturity (between 10 to 20 years before laying eggs for the first time). Considering all these threats on marine turtles, it is estimated that only one or two out of one thousand hatchlings leaving the nest may reach adulthood. All species of sea turtles are endangered of extinction and it is urgent to protect marine areas where they come to feed and beaches where they lay their eggs. Technical solutions exist to reduce the incidental catch by fishing gears (including trawls or hooks). **Ecotourism** based on observation of turtles during nesting can create significant revenues, if properly organized, and be an alternative to catching these animals when they come to life.



Young green turtle a few minutes after its birth



Green turtle going back to the sea after spawning

4.9. Birds

Several families of birds can be observed in the coastal and marine area. The most conspicuous, precisely because of their size, are large wading birds such as herons and egrets, flamingos, ibises, spoonbills, distinguished by the size of their legs, their necks or their beaks that allow them to move or eat in relative deep water. They may be solitary as herons or in large groups such as flamingos.

Waders are smaller with a colour that blends with mud, their favourite environment: curlews, godwits, plovers or sandpipers stand in large groups which can be seen most often when flying in a form of compact clouds with

iridescent effects. Waders move mostly by walking and their legs are long enough compared to their size, while their beaks are of variable sizes and shapes.

A third category consists of seabirds, the most common of which are terns, gulls, cormorants or pelicans. Moving more by swimming or flying, their legs are short and webbed. Their size varies considerably from the little tern (30 grams) to white pelicans (10 kg). Either fishing or resting, seabirds usually flock together in small groups.

Some seabirds can be rarely observed near the coast. These are shearwaters, petrels and boobies which approach the shores only in times of spawning.

Various species of birds gathering to feed on fish



Other species that can be seen on the seafront include birds of prey that have specialized in fishing as the fish eagle or osprey, kingfishers and even bee-eaters and other insect-eating birds that live in mangroves.

The organization of birds' activities on shore varies a lot among species. Some, like the majority of waders and flamingos have their rhythm of activity determined by the tides: they feed at low tide by day and at night. When tides cover the mudflats, they gather and fly to high tide roosts. Other species such as seabirds, herons or ospreys, that need to see to catch their prey, feed during the day and rest at night.

Different families of birds have specialized in their diet, so as to limit competition among them. No species feeds exactly like the others: the preys they seek are distinct and selected through behaviours or morphologies. Pelicans fish in groups to block the way to fish in small channels at low tide. Terns soar and dive to catch fish on the surface while swimming cormorants dive deeper for food. The prey-weight may exceed one kilogram for the former and only weight a few grams for terns. Some egrets create shadow by spreading their wings above the water surface to attract the fish they catch, while herons progress at a slow rhythm to surprise and catch their prey with their beak acting as a spear.

The existing fifteen wader species share resources by choosing different preys (crabs, worms, snails, carrion, etc...). Some species like godwits have very long beaks that allow them to search into mud, using nerve endings located at the tip of their beak to feel worms or small shells, while others such as turnstones or plovers which rely more on their sight than their sense of touch, have short beaks. Flamingos have beaks with mandibles between which their filter food organisms from the water they swallow.



Main species of waders present on our shores. Plate 1 (left to right and from top to bottom): Red Knot, Little Stint, Dunlin, Sanderling, Curlew Sandpiper, Turnstone, Kentish plover, ringed plover



Main species of waders present on our shores. Plate 2 (left to right and top to bottom): oystercatchers, grey plover, black-tailed godwit, bar-tailed godwit, curlew, whimbrel, greenshank, and redshank

All year round, birds follow a cycle consisting of a breeding season, followed by migration to their wintering grounds, after which they return to their breeding grounds. Depending on the species, the distance between the breeding sites and wintering grounds may vary a lot. Waders that we see on our shores start migrating in March towards northern Europe, Siberia and Greenland then travel over 6000 km to their egg-laying site and fly the same distance back to Africa around October. Along the journey they stop by intermediate locations comparable as “filling-station” to build up reserves of fat they use as fuel for the long journey.

Between April and October, most of the water birds we observe on our coastline are breeding. Sea bird colonies gather sometimes thousands of pairs. Breeding sites are located on islands or islets devoid of terrestrial predators (i.e. jackals, hyenas and dogs) where they can lay eggs on the ground or in the nests they build in trees. During the nesting period, one parent must stand by the nest to protect it from harsh weather and predators.



Waders in flight



Colony of breeding sea birds (Royal terns)

This constraint reduces the amount of time available for feeding all the more since of chicks multiplies food needs: a family of pelicans consumes about 500 kg of fish during the breeding season. Breeding birds are therefore very demanding both in terms of safety and nutrition, requirements that only certain well protected sites can offer.

The vulnerability of sea bird colonies can arise from various causes:

- Direct stealing of eggs or chicks
- Disturbance caused by visitors either fishermen landing on the island to clean their nets or tourists wishing to approach nests : adult birds may fly away in panic jeopardizing their chicks that can die from sunstroke or drown in the sea.



Colonial birds breeding on west-african coast (left to right from top to bottom): slender-billed gull, grey-headed gull, gull-billed tern, little tern, royal tern, Caspian tern, common tern, bridled tern.



Bee-eaters, feeding on insects, are commonly observed in the mangrove

- Presence of terrestrial predators such as jackals, able to swim from the coast to nearby islands.
- Unusual high tides that flood nests: rising sea levels resulting from climate change substantially increase the risk for species like terns nesting on the ground.
- Reduction of food resources. As a result of overfishing, fish and other fishery resources are becoming increasingly scarce making the risk more

real. Seemingly, the warming of the sea due to climate change is driving fish away from water surface making them less accessible to birds.

Most colonies of birds are now being protected within national parks in West Africa such as Banc d'Arguin and Diawling in Mauritania, Saloum Delta and Djoudj in Senegal, the Bijol Islands in The Gambia, the Bijagós archipelago in Guinea-Bissau, Naufrage and Alcatraz islands in Guinea.

Colony of greater flamingos



V - The Influence of Human Activities

5.1. Fisheries

Traditional fishing

For centuries artisanal fishing was limited to fishing grounds near villages. Each village had a fishing area of its own allocated under traditional rules. Fishing was restricted to mere subsistence and practised only to feed families in the village. Fishing was practised on foot either with cast nets, spears or using different traps to enclose fish in pools or small channels at low tide. Men were mostly engaged in fishing and women in collecting shellfish. Fishing was mainly practiced in the dry season and agriculture in the rainy season. Marine resources were left undisturbed throughout their reproduction period. In the Cape Verde islands, artisanal fishing is practised throughout the year, but only when sea conditions are favourable, given the relative scarcity of sheltered fishing areas and the low rainfall that limits farming opportunities.

Along the African coast, the fishermen have been using traditional dugout canoes – i.e. a pirogue carved out of tree trunk – for ages. These canoes are propelled by oars, but as soon as the 17th century these traditional canoes were equipped with sails. These boats allow sailing further away from the coast, extending the fishing territories. Even if the majority of fishing boats is now equipped with outboard engines, fishing by sailing is still practiced in the Banc d'Arguin national park in Mauritania as well as in Senegal, The Gambia, Sierra Leone and the archipelago of Cape Verde. The



Sailing fishing boats

depletion of fish resources and the cost of engines and fuel influence the revival of using sails as opposed to motorized boats.

Among fishing gears commonly used traditionally are gillnets tied to the bottom, beach seines for catching fish near the shore by encircling them with a team of men at each end of the net, or even fishing lines with hooks that were formerly manufactured by local

Dugout canoe





Fish processing by women

blacksmiths. Communities also produce different kinds of traps or snares. Some consisting of rows of piles, driven into the mud, that channel the fish into a determined place of capture. Others look like ponds made out of stones where fish come at high tide and are trapped when the tide is low. These forms of catching fish, primarily implemented in collective fishing for ceremonial purposes, tend to disappear with the decrease in fish abundance.

Once caught and landed, fish are purchased by women who are responsible for processing and marketing. When fish is not eaten fresh, it is treated according to methods of conservation which vary depending on

weather conditions. In areas where rainfall is scarce, fishery products are simply dried. When the humidity is higher other techniques are observed including the drying-and-salting (fish is salted before drying), the drying-salting-and-spicing, drying-and-fermenting (fish is soaked in water one or two days before being allowed to dry) or smoking (fish is placed on top of a wood source of smoke for several hours). Some by-products of fish are subject to special treatment. Thus the yellow mullet eggs are dried for several days to make the famous “poutargue”, considered as being a luxury product in European markets. The Imraguen women also boil heads of fish to extract oil. Fish oil is eaten with dried fish or drunk directly because of its supposed curative properties against diabetes, tuberculosis and rheumatism. The central fishbone, once incinerated and crushed, is used as a cataplasm to treat muscle aches. As one can see, according to traditional practices, every part of fish can be used leaving out no waste.

The simplicity of fishing gear, the modest craft, the limited capacity of fish conservation or the lack of transport contribute to moderate catches by traditional fishing and therefore maintaining abundant fish stocks.

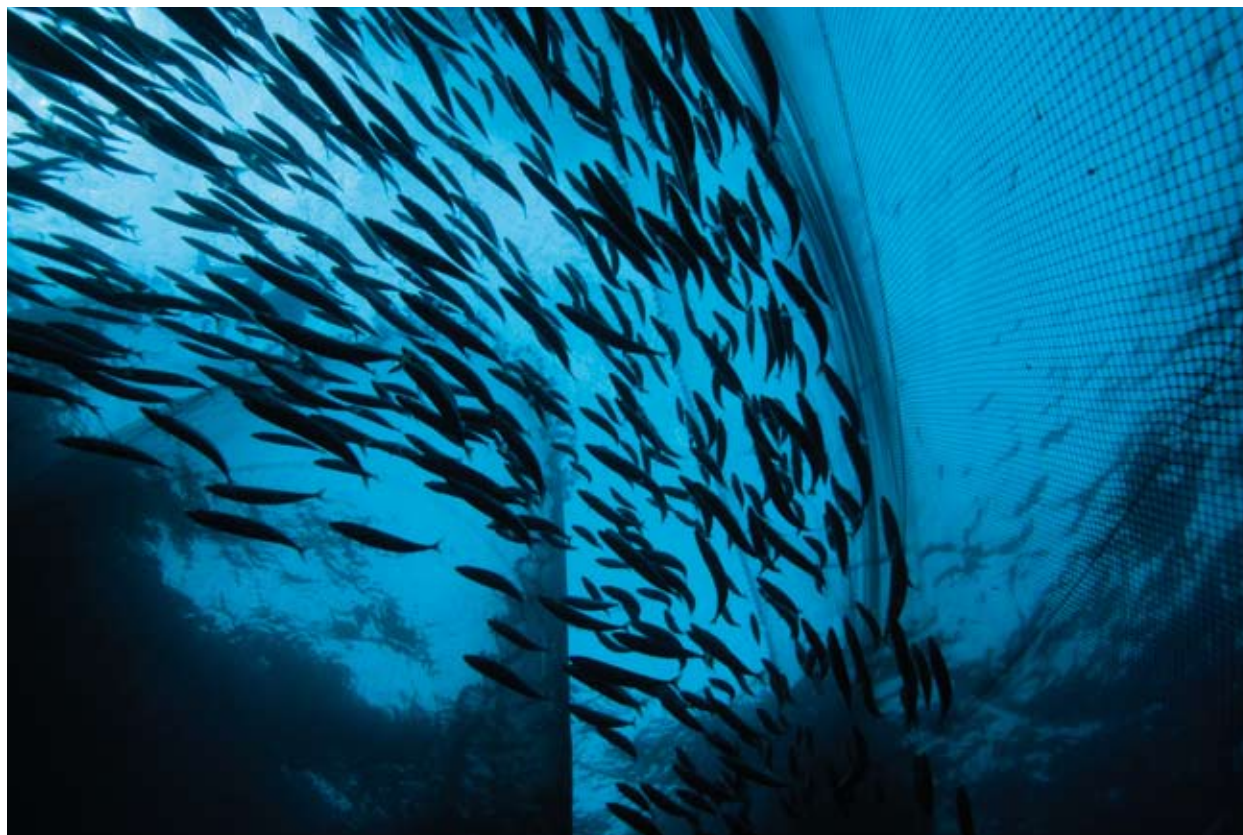
Moreover, traditional fishery management is based on certain rules which take into account the need for preserving the reproduction of species. Hence, the way Imraguen fish mullets was run by periods of access (called Itani), defined according to the moon cycle, in order not to disturb fish at time of producing eggs. Similarly, in most coastal communities, all forms of fishing are prohibited during the rainy season and a number of channels, considered sacred are also protected. These traditional practices limit the pressure on fish populations during the critical period of reproduction and thus ensure the renewal of stocks.

Artisanal commercial fishing

The characteristics of traditional fishing still exist here and there nowadays, but are replaced by new forms of fishing to increase the efficiency of catch and income. Accordingly, fishery products, once primarily used as food by communities, are now marketed and exported. Villages have moved in a few decades from a subsistence economy to a market driven economy. In this new logic, the resources of the sea (and natural resources in general) are now considered as commodities and therefore as a means of enrichment. The fishermen will try to exploit the largest possible quantities. Consequently, they will rely on more modern technology. Larger and more solid vessels are capable of going offshore or of migrating along the coast. The introduction of outboard engines in the 1950s, and later the availability of ice allowed the fishermen to go farther and stay longer at sea without damaging fish. Nets were improved and are now able, as with purse seines or drift nets, to capture large quantities of fish, sometimes several tons per day per boat. The decrease in the fish abundance has led the fishermen to use nets with smaller mesh size to capture smaller fish, which has accelerated the depletion of fish stocks. These quantities of fish are easily transported in refrigerated trucks to urban centres, and then shipped by boat or aircraft to foreign countries.

Increased fishing pressure has also been caused by people leaving the inlands for the coast. For these people, who were facing droughts and declining agricultural crop yields, fishing was deemed a promising activity especially as access to fishing grounds were open to everyone. The number of boats has increased in significant proportions (12 700 units in Senegal, 3000 in Mauritania, 1500 in The Gambia and Guinea-Bissau) accelerating the overfishing of resources.

The rise of commercial artisanal fishing has enhanced the development of new employment opportunities with significant economic and social benefits: boatbuilding, net making, sale and repair of engines, ice making, processing, transport and trade of



Fishing net catching a shoal of fish

products. Jobs created for studying and monitoring fishery resources (researchers, investigators), training of fishermen, fishery surveillance and so on have to be taken into account as well. In a country like Senegal, it is generally considered that the artisanal fishing sector created about 600,000 jobs directly and indirectly.

Nowadays many species of fish considered as high commercial value fish (mostly demersal species that live at the bottom) have become rare. Artisanal fishermen mainly catch small pelagic fish such as sardines or bonga of which nutritional value is high but have relatively low commercial value. Even species that do not raise much interest for food, such as sharks, are now targeted by fishermen. Asians have actually developed a particular demand for fins of rays and sharks with which they make soup. They buy fins at so high a price (about 100 000 FCFA per kilo) that fishermen began to catch sharks in so large quantities

Senegalese pirogues



that their population tend to fall and even some species seem to have disappeared locally. Even more absurd is that shark fishing is not intended for food: still many fishermen throw bodies of sharks overboard once the fins are cut off, a waste that contrasts with the systematic valorisation of all parts of fish in the logic of traditional fishery.

At the same time, most traditional rules are no more respected. Part of the catch is still bought by women processors on the landing sites to be sold in urban centres of the region. Nevertheless, the bulk of the catch is marketed either frozen for small pelagics towards Nigeria and China, or fresh for the high commercial value species. The dominant emerging trend is that fish available for people in the region is decreasing. This trend is even clearer when one considers the high commercial value fish that are preferably sold in Europe due to the benefit one can expect from the sale (close to 20 000 FCFA per kg of grouper in a European fish shop).

The above trend is likely to affect the health of human populations knowing that fish provides high nutritional qualities and is an important part of human diet. Moreover, it increases their dependence on external sources of supply for food alternatives, such as frozen chicken, with less nutritional value, from Europe. If one considers that gastronomy is a major form of any people's cultural expression, we can only deplore the predicted disappearance of certain species such as groupers, which for instance are an important part of regional heritage that might be lost.



Artisanal fishing harbour

Industrial fishing

The fish stocks of West Africa are also exploited by industrial fishing vessels. Among the types of industrial fishing most commonly practiced in the region are bottom trawls and pelagic trawls. The former type looks for shrimps, octopus and demersal fish. The latter type captures in turn small pelagic fish or blue fish such as sardines, anchovies or horse mackerels. Small pelagics constitute the main catches made by the fishing industry in the area, while shrimps and octopus have higher commercial values.

The industrial fishing fleets belong mostly to foreign owners who buy fishing licenses or permits from States of the region. These licenses may be obtained in the framework of agreements signed by West African countries with States or communities of States encompassing several ships for a period of several years. In addition to these foreign fleets, are ships flying the national flag. These fishing licenses and agreements are generating important financial returns for the benefit of African countries, sometimes reaching significant proportions of the national budget.

As pointed out by certain agreements, including those signed with the European Union, foreign vessels are expected to take the extra resources that national fishermen are not able to capture. Indeed, in some countries of the region, national industrial fleets are poorly developed. There is therefore a surplus of resources to exploit, especially further from the coast



Industrial trawler

or at depths that artisanal fishing cannot reach. There are also, in all countries, the regulatory measures that define specific areas of access to industrial fishing. These rules, which are part of a series of regulatory measures on fishing gear, fishing areas and periods, protected species, etc... are intended to manage resources sustainably while protecting the specific interests of artisanal fishermen.

However, experience has shown that the practice of industrial fishing rises many problems:

- Nowadays-vessels have very sophisticated and powerful technologies that enable them to make catches that, in aggregate, exceed the capacity of renewal of targeted species. Even the small pelagics which offer several hundred thousand tons of fishing potential see their numbers decreasing.
- Trawlers that drag their nets on the bottom of the sea destroy the habitat of many species living near the bottom. Observations made in connection with oil exploration show that almost all sea beds are disturbed up to depths of 800 meters.
- Of the fish, crustaceans and molluscs brought by the trawl nets on to the deck of the ship, not all species have a commercial interest to fishermen. They only keep those with the most value and throw overboard all the others, mostly dead (which is a huge waste). On shrimp vessels, often up to 80% of the catches are thrown overboard. Among the discarded catches are often protected species like sea turtles or dolphins (these accidental catches are seriously threatening many marine species).

- These industrial vessels fishing offshore require sophisticated and expensive surveillance capabilities which States in the region do not always have. For this reason illegal fishing is still widespread and many vessels without license still come to fish at night in waters reserved for artisanal fishing.

- Trawlers are often in competition with artisanal fisheries either by capturing species that could be accessible to the latter, or destroying their fishing gear. Cases of shipwrecked canoes caused by illegal encroachment of industrial fishing vessels in coastal waters are unfortunately fairly frequently deplored.

- Crews of industrial vessels are mostly foreigners and their catches are rarely landed in the region. Therefore the economies of West African countries only indirectly benefit from the industrial fishing sector.

Whatever the causes of resource depletion, it is the people of the region who suffer most directly from it. Besides the economic and social impacts caused by the fall in catch, it is the nutritional health and food security of people that are at risk.

Towards more responsible fishing

To reverse this trend of depleting fish resources, it is necessary to be careful not to fish faster than the sea is able to produce. Overfishing is caused when the catches are becoming more important than the natural production of the oceans: fish no longer have time to reproduce and their populations can then disappear. In consultation with the fishermen, it would be necessary in some cases to seek to limit the number of boats and fishing gears in certain areas to reduce fishing pressure

on fish populations.

For the future, fishing should be banned or more tightly regulated in the sensitive sites where fish come to breed and grow. It is for these and other reasons that in our region several marine protected areas were created. Furthermore, to allow fish populations to renew, a minimum size at first capture should be respected. By regulating the size of the mesh, it is possible to enforce the minimum size of fish captured. Some fishing gears such as monofilament nets have destructive effects on marine life because they break easily while having a long life: once abandoned in the water by their owners, they continue to capture and kill marine animals for years without any benefit for humans.

Aquaculture

To address the decline in fishing yields, great hopes are placed in the development of aquaculture, an activity which involves raising fish or marine organisms in floating cages at sea or in ponds built on the coast and supplied by sea water. In some cases, aquaculture can



Compared features of industrial fishing and artisanal fishing (by IUCN)

Industrial fishing boat passing by pirogues

	Industrial fisheries	Artisanal fisheries
Number of fishermen employed	 About 500 000	 About 12 000 000
Annual marine fish catch for human consumption	 About 29 000 000 Tons	 About 24 000 000 Tons
Initial investment for each working position on the fishing boats	\$ 30 000 \$ - 300 000 \$	\$ 250 \$ - 2 500 \$
Annual marine fish catch industrially processed into fish meal and fish oil	 About 22 000 000 Tons	 Almost nothing
Annual consumption of fuel	 Between 14 and 19 million Tons	 Between 1,4 and 1,9 million Tons
Quantity of fish captured for each ton of fuel consumed	 2 à 5 Tons	 10 à 20 Tons
Number of fishermen employed for each million of dollars invested in fishing boats	 5 - 30	 500 - 4 000
Fish destroyed every year due to accidental catch by the shrimp fisheries	 15 million Tons	Zero

indeed be an interesting addition to fishing to provide local populations with fresh fish and provide farmers or fishermen with additional income (as is the case of tilapia farms in fresh or brackish water in association with breeding of chickens or pigs for example).

Nevertheless, it is worth making the right technical choices when seeking to develop an aquaculture project so as not to jeopardize investments while minimizing environmental impacts. A fundamental rule is to never raise species that are not naturally present in the environment. Otherwise, we run the risk of genetic pollution (in the case of introduced species to breed with local wildlife) and other consequences can be devastating and difficult to predict. Fish escaped from cages can compete with native species for food or habitat, eventually settling in and profoundly upsetting the balance of the ecosystem. Another constraint is the control of the reproductive cycle of the species in breeding. If the farmed fish species does not have reproduction conditions in confined spaces, it becomes necessary to remove the larvae or juveniles

from the natural environment for them to grow in ponds, which can lead to serious consequences on the wild fish resources: hence, to collect a few hundreds of shrimp larvae along the beaches, millions of fish larvae and other crustaceans larvae are often destroyed.

In general, it is best to choose a planktivorous or an herbivorous species (which feeds on plankton and plants) because in the case of carnivorous or piscivorous species (feeding on other animals) they often require the use of 2 to 3 kg of fish meal and litres of oil to successfully produce 1 kg of farmed fish. By choosing to raise carnivorous and fish-eating species of fish, the risk is then to increase even more the pressure on the resource of wild fish caught to be processed into meat flour for farmed fish. Finally, aquaculture farms can be a source of pollution caused by fish faeces and food residues that can accumulate under the cages and kill all forms of life in the area. The use of chemical treatments and antibiotics for fish is also problematic and may create pollution affecting the health, quality of water and abundance of marine life.

5.2. The urbanization

For reasons related to difficulties of living in rural areas, we can see in our region, as in other parts of the world, a population exodus to cities and coastal areas. This migration is sometimes determined by ecological reasons, namely in response to drought or poor soils that have severe impact on agriculture and livestock. This rural exodus is sometimes determined by the instability of political and military conditions in some areas pushing people to migrate to more quiet areas. It is further caused by the desire, most often among young people, to live in a big city where opportunities seem more numerous and varied especially in education, employment, meeting people or entertainment. The consequence of these population movements is the increase in the number of inhabitants in cities of which the majority, including all capital cities, are located on the coast.

The presence of these millions of people and characteristics of their lifestyle will have repercussions on the environment. The construction of a large number of houses will require raw materials such as sand or wood. The sand is often taken on the beaches which accelerates erosion of the coastline and on occasion leads to the actual loss of beaches. The needs for wood accelerates the degradation of forests and some species, such as Palmyra tree (known for its resistance to termites), tend to disappear. With the expansion of cities, the soil surface covered by houses or paved roads prevents rainwater from infiltrating into the permeable soil, consequently creating frequent floods.



All capitals from the countries of the sub-region are located on the coast

Coastal sand mining stresses coastal erosion



5.3. Pollution and waste

The steady deterioration of the quality of water is a threat of particular concern. Towns on the coastal area discharge their wastewater (water from toilets, laundry and other uses) and a portion of their waste at sea, plus industrial effluents and other pollution from offshore. Today, we consider that marine areas located near these major cities are mostly dead zones.

All forms of domestic waste are discharged into the environment. While some waste such as kitchen scraps, paper and cardboard is biodegradable, others such as plastic can take a hundred years to

decompose. They are carried by wind and water runoff to the sea and contribute to destroy the living conditions. They eventually cover the bottom of the water making it become sterile. Animals like sea turtles that eat jellyfish swallow plastic bags by mistake and die of intestinal obstruction. Marine mammals ingest such plastic waste accidentally and die smothered. The plastic gradually fragments into tiny particles that living organisms such as fish are unable to filter. The absorption of these tiny plastic particles by all marine animals finally causes diseases that can be lethal.

Waste disposal also affects more and more rural areas. Number of food products of basic need are packed

in plastic bags and packaging. Some products such as batteries contain highly toxic components that, if dropped on the ground, reach freshwater aquifers and pollute wells and other sources of drinking water.

It also happens that livestock (especially sheep and goats) try to eat plastic packaging that causes bowel obstruction. The presence of plastic waste or used batteries in the soil, which may accumulate over decades, affects the productive capacity of land for agriculture and livestock. Too often, urban and rural populations have no way to treat their waste without risk to their health or their environment.

By throwing our plastic or toxic waste to the soil or the sea, we endanger our environment and our own health. We need to stop discarding waste just anywhere and together seek solutions to address

Waste disposal



waste disposal. To fight against waste-generated pollution, we must try:

- to **Reduce** the amount of waste we produce (for example by limiting the number of plastic bags used when going to the market),
- to **Reuse** the packaging instead of throwing them (washing and reusing plastic bags or bottles) and
- to **Recycle** used objects by giving them a new function rather than throwing them away (many useful items can be manufactured from plastic bags, bottles or metal cans).

With this rule of 3Rs "**Reduce, Reuse and Recycle**", each of us can contribute daily to maintain a cleaner, more healthy and productive environment.



5.4. The Industry

Industries (chemical, refineries, mines, concrete plants etc...) are often located on the coast either to facilitate discharge of their wastewater or to transport their goods by sea. Although very useful, indeed essential, in most cases, these industries generate quantities and qualities of products that are particularly toxic to the environment, taking advantage of some lax regulations and insufficient enforcement capacity.

The discovery of oil and gas off the coast causes also a number of risks despite all the precautions that are taken. These risks appear in various stages of the process: in prospecting hydrocarbon deposits offshore seismic surveys consist of sending loud sounds underwater that cause explosions capable of destroying the larvae of fish or disturbing marine mammals which in consequence wash up on beaches

in groups where they die. During the operational and transport phases there are risks related to the discharge into the sea of toxic chemicals or oil spills that are likely to drift over large distances and cover all the coastline with oil. The conditions of storage and transportation by sea also have their risks in case of bad weather or collision between ships. All these risks, if not coped with properly, address threats to marine resources and environments upon which they depend on, particularly mangroves, sea grass beds, mudflats or corals that are at the same time more fragile and more productive. Of major accidents (such as oil spill in the Gulf of Mexico in 2010) some may have lasting effects on coastal

*"Did you know that?" How long does it take to decompose?
Paper and cardboard can take up to 6 weeks to perish
Cigarette filters up to 3 years
Metal cans up to 50 years
Bottles and plastic bags up to 450 years
Nylon fishing nets up to 600 years
The glass ... its time of decomposition is unknown ...
When we throw an object that we used for a short time, we should always consider the consequences and time that it will take to decompose.*

Floating production and oil storage unit

ecosystems with severe consequences on such economic activities associated with them as fishing or tourism.

Before the development of these industries, studies on possible impacts on the natural environment should be conducted and solutions sought to mitigate the negative consequences for both local populations and natural ecosystems. Also, measures to prevent and contain potential accidents should be planned and ready to be activated quickly in the event of a serious accident (population evacuation in case of danger to health or setting up floating dams to contain oil spills in case of leakage ...). To prevent risks and negative repercussions of these industries, local populations should always be informed, consulted and involved in decision making through a transparent and continuous dialogue with government and private companies.

*Diama anti-salt Dam,
River Senegal lower
delta*



5.5. The Infrastructures

To meet the needs of development, men must build infrastructure like roads, bridges, dams, and ports. These infrastructures are often useful for the population and for the development of trade. However, these huge projects generally create impact on the environment. On the one hand, roads can fight isolation of rural communities but on the other hand they may facilitate the entry of new users, such as poachers, charcoal producers, etc... who are not always conscious of the damage they may cause to these areas of which they are not native. When people do not plan free circulation of water or wildlife, roads can divide habitats and affect biodiversity. Some ports, especially the poorly designed ones, may speed up coastal erosion.

If people do not take care of the functioning of the natural environment - especially the fragile and productive estuaries - and communities that depend on them while building dams, entire coastal areas may be sterilized by drought or salinization. Dams slow down the flow of rivers and facilitate the development of invasive aquatic vegetation harmful to fisheries and biodiversity. It increases the risks to health, particularly malaria and bilharzias. Finally, dams tend to trap sediment and silt, which contributes so essentially to maintaining soil fertility. Sediment trapping by dams deprives the coasts of their raw material and accelerates coastal erosion.

For the above reason, it is essential before building a new infrastructure, to conduct an assessment of potential impacts on the environment and provide measures and arrangements to mitigate and reduce the adverse effects on ecosystems and local

populations, or even enhance positive impacts as appropriate. In most countries of our region, studies on the environmental impact are now mandatory as well as the need for local residents to be informed, consulted and involved in decision-making long before the infrastructure is built.

5.6. Tourism

The region has a good potential for tourism with a favourable climate during the dry season, a long coastline of beautiful beaches, friendly people and, in general, a rich and diverse natural and cultural heritage. The development of tourism brings some advantages in providing job opportunities, marketing of food or handicrafts.

However, the model of tourism generally practiced in West Africa also creates drawbacks. The resorts are often built on the coast and produce pollution by discharge of sewage or domestic waste directly into the sea. Sometimes they are built on sites that may have an important function for traditional communities, such as initiation sites or sacred sites, causing conflicts that are as bad for tourism as for the populations. The complexes can be built on areas important for biodiversity, for example near nesting sites of sea turtles, or on stretches of coastline vulnerable to erosion, threatening the very feasibility of the facility.

Tourism activities are not always environmentally friendly. Speed boats and jet skis for instance are often responsible for fatal injuries to marine mammals or sea turtles already threatened by accidental fishing and habitat degradation. Every so often sport-fishing targets species in danger such as sharks and swordfish. This situation is comparable to the hunting safari which may cause interference or excessive harvesting of species.

The degradation of social and cultural environment of local people, however, is the major risk. Tourists have in fact financial resources that enable them sometimes to abuse the economic vulnerability of the people they encounter. There is as a result a worrying increase in prostitution and pedophilia nearby touristic sites.

Despite the efforts being done by most States to promote a more sustainable tourism in a form of equitable tourism or ecotourism, we note that most of the profits generated by this sector still remain in the tourists' origin countries. It is there where the costs of transport and most services

The city of Saint Louis in Senegal, World Heritage site, and the several neighbouring protected areas constitute a touristic destination by excellence



provided on site are paid. Whatever the pros and cons, the tourism sector is fragile because of its volatility and sensitivity to local contexts: just a political unrest or terrorist threats may cause disaffection of a touristic destination, at times for several years, dipping entire sectors of the country's economy in doldrums.

For the benefit of people and the environment, it is worth encouraging and promoting tourism with minimum impact

on the environment (especially through the recycling of waste and wastewater), which may contribute to improving the living conditions of local populations and conservation efforts of endangered species and habitats. Such tourism should above all be respectful of local people in preventing the development of practices such as the trivialization of culture, begging or prostitution, and ensuring a fairer distribution of profits between the private company and local residents.

Tourist resort on the coast



5.7. Climate Change

Climate change is the result of human activity booming economy worldwide. This expansion, mainly due to industrial activity and transport, has the effect of releasing gases (such as carbon dioxide) into the atmosphere from burning oil, gas, wood or coal. This change in the composition of the atmosphere traps the rays of the sun in the atmosphere and causes a rise in global temperature of the planet and other climate-related changes.

This results in several phenomena:

- A change in amounts of rainfall and their distribution in time and space. It is believed that rainy countries will experience more rainfalls and dry countries will experience more severe droughts. The rains will fall on a more irregular and less predictable basis, which is not necessarily suited to the needs of crops, pastures or forests. In a region where much of agriculture depends on rain, these climate changes will have serious consequences on food availability and on the economy. However, West Africa is one of the regions in the world where scientists find it most difficult to predict these changes over the long term.
- With the melting of ice near the poles, sea levels will probably rise between 20 cm and 80 cm by the end of the century. The warming of the sea itself would result in the oceans expansion further increasing the phenomenon of rising waters. Hence, some coastal cities in the region such as Nouakchott, Saint Louis, Rufisque, Banjul, and Conakry risk experiencing flooding. Coastal infrastructure, buildings, tourist resorts located on the seafont will be affected either



Coastal villages are particularly vulnerable to sea level rise



by the acceleration of coastal erosion, or by flooding during periods of high tides or during storms.

- Likewise, some natural environments along the coast will be brought to disappear in part. Mangroves will in consequence struggle to survive with a higher level of sea waters. Low islands which sometimes play an important role for people, particularly the fishing villages, or biodiversity will be covered by the sea. Certain bird colonies and nesting sites of sea turtles may disappear. As to turtles, of which sex is determined by the temperature of the sand where the eggs are laid, increased temperatures will result in a disproportionate increase in female and therefore a reduced capacity to reproduce for these already threatened species.

- An increase in ground temperatures between 1.4 ° C and 5.8 ° C will be registered by 2100. That will have a significant impact on crop productivity, livestock health and the quality of water. Coupled with less rainfall, these factors may affect agriculture and prices of agricultural products which will tend to increase. As a consequence, the occurrence of famine in poor countries will be higher.

- The risks of diseases associated with global warming will be greater (malaria, cholera, meningitis).

- Climate change will induce many other phenomena that we do not yet know very well how to measure, such as movements of people leaving the most affected areas. The impact of these phenomena will depend largely on efforts that will be done by developed countries to reduce their emissions of gas. What is almost certain is that people in poor countries,

especially those living on the coastal area, will in all cases be mostly affected by these changes.



Impact of coastal erosion

The sex-ratio of marine turtle depends on the sand temperature during the embryo development in the nest and is therefore influenced by climate change

5.8. The Protected Areas

Some areas have a particular cultural or natural value. Communities set measures to protect these areas such as making them undisturbed by external pressures that are likely to deteriorate them. This protection strategy is old as shown by the existence of sacred sites (forests, islands, rivers) created by traditional communities over the centuries.

In more recent times (since 1970) several States have decided to protect areas that have special natural features. On our regional coastal area, these are places like breeding grounds for fish, crustaceans and molluscs, nesting sites for sea turtles and birds, sensitive areas that provide valuable services to communities such as mangroves, or coral reefs that are particularly rich in biodiversity.

There are several categories of protected areas. Some are fully protected and no human activity is actually authorized. Others are open to tourism. In some national parks only resident populations have the right to exploit natural resources following specific rules. In others, it is mainly the landscapes that are safeguarded. Finally, some protect both the culture and traditional rights of some indigenous peoples along with their natural environment.

The protection scheme may be based on traditional practices when it comes to areas which have been protected for ages as sacred sites, often used for conducting initiations or ceremonies of a religious nature. Other areas may be protected by communities in an attempt to protect some of their traditional territory, land or sea (community-based protected areas). When it comes to large extensions of territory, it



Map of the Protected Marine Areas Network in West Africa

Women on pirogues in the Natural Park of the mangroves of the River Cacheu

Marine protected areas foster fishing resources reproduction

is up to States to decide on protection. State protected territories are known as national nature reserves or national parks.

In our eco-region, there are (in 2010) 26 official State-protected marine areas. These areas have different characteristics, particularly related to their size, the presence or absence of people living inside, the proportion of marine and terrestrial area and the types of more or less strict rules applied inside. These protected areas are organized into a regional

network, meaning that States work together protecting a sample of the main natural environment features of the eco-region. They further work together to conserve migratory species belonging to the concerned States as a whole. Protected areas have also been created on the borders between two countries to protect the integrity of a shared natural area (the delta of the Senegal River between Mauritania and Senegal, the Saloum delta between Senegal and The Gambia) and to promote peaceful relationships among people.



VI - Environmental Education should contribute to the quality of life

One of the major objectives of Environmental Education is to contribute to a better understanding, and therefore a better control, of factors that constitute the quality of life. This concept incorporates a set of values that everyone can adjust as suitable to their context. Schematically, values that are attached to the quality of life relate to the necessary satisfaction of the basic needs of mankind. These values do not always have a direct relationship with the environment but are the elements of an overall build-up from which one cannot exclude the environmental dimension.

The first of vital needs mentioned above is related to drinking water and a diversified balanced diet. Satisfying these needs depends largely on well-being and health quality. It is therefore easy to understand the importance of maintaining a healthy environment and abundant natural resources that can regenerate on an ongoing basis to hopefully meet the needs of future generations.

The social dimension is also important to ensure the quality of life. It implies protecting children against vulnerabilities such as hard labour, begging and, in some extreme cases, social deviance (theft, drugs, prostitution). This dimension also refers to all factors likely to affect the harmony in families or communities, such as respect for elders, respect of community rules and mechanisms for conflict resolution, in short, everything that sustains security and peace. The promotion of

social infrastructure of collective interest (education, health, sports, recreation, etc...) and shared governance approaches similar to those developed in community-based protected areas contribute significantly to meeting those needs.

The economic dimension is also essential in that it allows fulfilling needs related to health, education, food, entertainment, etc... It implicitly refers to the need for solidarity, justice and fairness as needed to improve the situation of people belonging in the poorest and most disadvantaged social strata. The ways to achieve these needs are manifold. They should necessitate for instance better utilization of natural or agricultural resources, on which rural communities depend either directly or by rights of a more equitable and sustainable access to fishery resources.

The quality of life naturally incorporates the cultural dimension. Culture is indeed the set of values and knowledge shared by communities. It is essential to maintain the vitality of the heritage and traditions, recognizing their need of evolution to adapt them to the constant changes of our societies and to maintain a living link between generations. This cultural dimension, which affects the fields of arts as well as music, dance, poetry, theatre, or even the gastronomy, is an identity factor of vital importance in our globalized world, where landmarks and values tend to fade away.

Finally, there can be no quality of life without the spiritual dimension which implies respect for religions and beliefs and related areas such as places of worship or sacred places.

Bijagós dance with masks of sharks (here hammerhead shark and sawfish) illustrating the vital link between nature and culture



Glossary

Bacterium: a living being made up of a single cell considered as being neither an animal nor a plant

Baleen: a kind of brushes that adorn the lower jaw of some whales, acting as a filter that allows the water to flow through while retaining the solid nutrients

Bivalve: a mollusc characterized by a shell in two parts joined by a hinge (oyster, cockle)

Cephalopod: a mollusc characterized by arms with tentacles and suckers (the octopus is a cephalopod)

Delta: mouth of a river flowing out of several branches of which shape recalls a triangle (which is also the shape of the Greek letter delta)

Desiccation: a drying phenomenon; operation by which some elements are deprived of the moisture they contain

Ecoregion: a geographical area presenting similarities and links to particular ecology and culture which defines a coherent entity. The Sub-Regional Fisheries Commission and the Regional Conservation Program for the Marine and Coastal Area in West Africa consider the area from Mauritania to Sierra Leone including Cape Verde as an Ecoregion

Ecotourism: a form of tourism focused on the discovery of cultural and natural heritage and committed to respecting the environment while contributing to the well-being of local people

Gastropod: mollusc with a large fleshy foot that allows it to move (the snails are gastropods)

Hydrocarbons: oil, petroleum, natural gas

Intertidal area: part of the coastline between the lowest and the highest tide levels

Mollusc: soft-bodied invertebrate animal

Mudflats: coastal natural habitat composed of fine sediment being the habitat for some species that live on top of or in the mud (worms, shellfish, crabs, and waders)

Organic matter: remains of vegetal (food waste, leaves, wood, etc...) or animal matter (dead animals) that can decompose. Some animals feed on organic matter by decomposing it (e.g. shrimps)

Ovoviviparous: refers to a species of which eggs incubate and hatch in the belly of the mother but without being fed in by the mother (less developed strategy than that of the viviparous)

Peduncle: cord uniting two parts of organs (stalk). In the case of barnacles the peduncle is a kind of flexible foot that allows the organism to attach to rocks

Pelagic: living in the open sea. By extension, pelagic fish are those which live in shoals, swim in the open sea and are mostly migratory. In contrast, demersal fish live near the bottom of the sea or rocks; alone or in small groups and do not make large migrations

Photosynthesis: use of organic matter by plants through light

Plankton: microscopic animals (zooplankton) and microscopic plants (phytoplankton), living suspended in the sea water

Pneumatophores: outgrowths of roots (pencil roots) protruding from the surface of the ground to facilitate the supply of oxygen to mangroves

Rhizomes: underground stems of certain plants

Roost: locations used by birds outside feeding periods. These are sites occupied during the high tide by species that feed on the mudflats or at night by birds that feed only during daytime

Sonar: equipment that propagates sound in water to detect objects by echo. Marine mammals, but also bats, locate things using the same process.

Swell: undulating movement that stirs the sea, produced by the force of wind on the surface of water

Symbiosis : mutually beneficial association between two living beings

Upwelling : upward movement of deep waters upwelled with nutrients (from the decomposition of organic matter) towards the ocean surface. The combination of these nutrients and sunlight promotes the development of phytoplankton, a food source for

animal species. There are 4 major upwelling on the planet, including one in West Africa. Together, they cover only 3% of fishing grounds, but represent 25% of the global fish catch

Viviparous: describes an animal whose eggs develop entirely within the mother that feeds them until they hatch inside and are delivered as newborns.



Regional Coastal and Marine Conservation Programme for West Africa – PRCM was created at the initiative of the International Union for Conservation of Nature – IUCN, the International Foundation of the Banc d’Arguin – FIBA, the World Wild Fund – WWF, Wetlands International – WI and in partnership with the Sub-Regional Commission on Fisheries – CSRP.

It now stands for a coalition of almost 90 partner institutions with the objective to coordinate efforts towards conservation of the coastal zone of the countries of the sub-region, Mauritania, Senegal, Cape Verde, The Gambia, Guinea Bissau, Guinea and Sierra Leone.

This knowledge handbook was produced by the Regional Environmental Education Programme implemented by the IUCN office in Guinea Bissau for the PRCM with the financial support of the Embassy of Netherlands in Dakar, the Foundation MAVA for Nature and the Spanish Agency for International Cooperation.



Photo contributors

All pictures are from *Hellio & Van Ingen* © that we acknowledge, except from

Pierre Campredon: 9, 13 a et b, 18 a, 20 a, 22, 25 a, 26 b, 30 b, 31 a, 33, 34, 36 b et c, 38 c, e et f, 42, 43 b, 45 b et c, 47, 49, 52 a, 55 b, 59, 60 b, 61 a, 62, 65 b, 67, 78 a, 80

Antonio Araujo: 30 a, 76

Saleck/CBD-Habitat: 50

Toba aquarium: 51 b

Design and printing:  mandarine

The adaption efforts of West African coastal societies to a changing world form a challenge to be addressed collectively gathering experiences and imagination of everyone. To achieve such a goal, education is a major priority. Taking into account the role of nature and its resources in the economy and the culture of the countries involved, environmental education must contribute to prepare young generations to the effects of the changes of a modern world in order to turn them into active, conscious and engaged elements.

This knowledge handbook, produced in the framework of the Regional Environmental Education Programme of PRCM, describes the coastal and marine environment of the countries involved in this programme (Mauritania, Senegal, Cape Verde, The Gambia, Guinea Bissau, Guinea and Sierra Leone). It is mainly directed to teachers so as to help them transmit to the youth the great value of their common heritage and the necessity to conserve it for future generations.

For more information: iucngb@iucn.org

www.prcmarine.org

www.iucn.org

ISBN : 978-2-8317-1328-1

