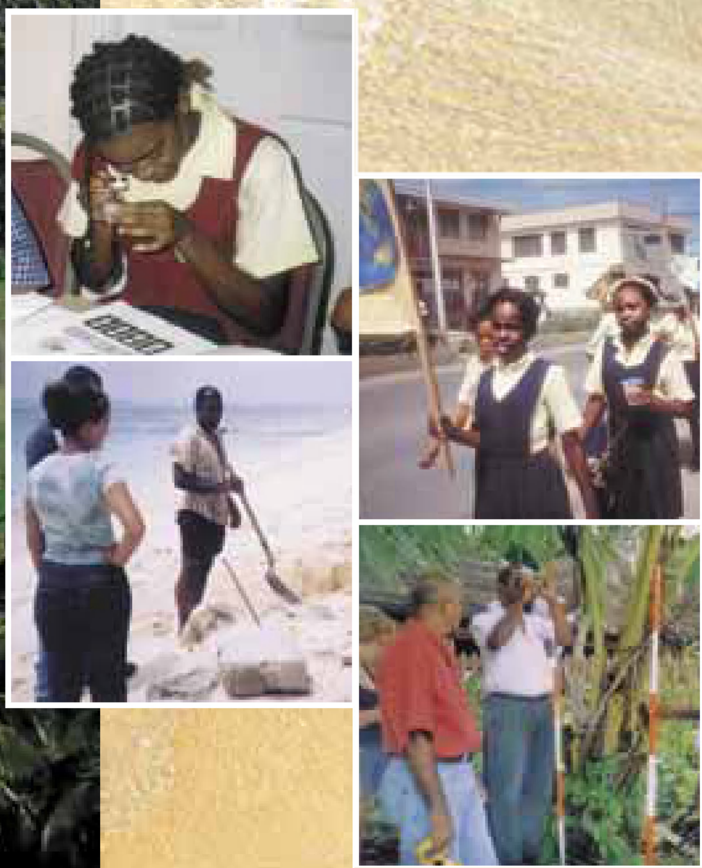
Coastal region and small island papers 19

Introduction to SANDWATCH

An educational tool for sustainable development



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Coastal region and small island papers 19

Introduction to SANDWATCH

An educational tool for sustainable development

By Gillian Cambers and Fathimath Ghina

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Foreword

Recognizing the successes of the past and integrating them into the new directions of the future is a vital part of the sustainable development learning curve. And as we enter the Decade of Education for Sustainable Development (DESD, 2005–2014) with its overall objective to empower citizens to act for positive environmental, social and economic change through a participatory and action-orientated approach, it is especially timely to discuss and review ongoing educational activities that have had and are continuing to have a measure of success in the field of sustainable development.

One such activity is Sandwatch. This had its roots in an environmental education workshop held in Trinidad and Tobago in 1998, when a group of far-sighted teachers and enthusiastic young people from UNESCO Associated Schools came together to discuss ways of thinking, planning and cooperating for a sustainable future for the Caribbean Sea region.

Sandwatch seeks to change the lifestyle and habits of youth and adults on a community-wide basis, and to develop awareness of the fragile nature of the marine and coastal environment – in particular, the beach environment – and the need to use it wisely. It is supported by the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Education Sector (Associated Schools Project Network) and Natural Sciences Sector (Environment and Development in Coastal Regions and in Small Islands, CSI), the Organization's field office in Kingston (Jamaica), as well as those in Apia (Samoa) and Dar-es-Salaam (Tanzania), and several National Commissions for UNESCO. Starting out as a Caribbean regional activity, Sandwatch is gradually expanding as islands in the Indian Ocean and Pacific regions are getting involved.

The essence of this publication, which provides step-by-step guidance for people wanting to participate in Sandwatch activities, has been in use in an unpublished form since 2001. It is now particularly appropriate at the start of the Decade of Education for Sustainable Development, and as more and more countries want to become a part of Sandwatch, to publish this document.

Special thanks are due to colleagues in the UNESCO Kingston Office for their insight and support, and to the national coordinators, teachers, students and community members who have worked so hard to make Sandwatch a success in the past five years, and whose enthusiasm, perseverance and dedication continues to inspire us all to greater heights.

Dirk G. Troost
CSI/Science

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DESD/Education

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Introduction

Sandwatch poster.

Summary

Sandwatch provides the framework for school students, with the help of their teachers and local communities, to work together to critically evaluate the problems and conflicts facing their beach environments and to develop sustainable approaches to address these issues. With a strong field monitoring component, Sandwatch tries to 'make science live', yet remains inter-disciplinary with applications ranging from biology to woodwork and from poetry to mathematics. Documenting the Sandwatch methods is the major focus of this publication. An activities-orientated approach is used to provide step-by-step instructions to cover topics such as observation and recording, erosion and accretion, beach composition, human activities, beach debris, water quality, waves, longshore currents, plants and animals. The activities are related to sustainable development issues including: beach ownership; mining beaches for construction material; conflict resolution between different beach users; preparing for global warming, sea level rise, hurricanes and tsunamis; pollution; and conservation of endangered species. Finally, two success stories of Sandwatch are presented that show how students have applied their school-based learning to everyday life, enhanced their critical thinking and conflict resolution skills and, perhaps most importantly, developed a sense of 'caring' for their beaches – their environment.

Background

A group of teachers and students met in Tobago in July 1998 for an Environmental Education workshop[1]. They saw firsthand many of the problems facing the coastal zone – problems related to erosion, pollution and development – and resolved to do something about these issues themselves. This was the beginning of what has become known as Sandwatch.

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[1] First UNESCO Associated Schools Caribbean Sea Project Regional Environmental Education Workshop, 21–26 July 1998, held in Tobago in 1998.

Among the resource persons at the Tobago workshop was Ms Bebe Ajodha, and much of the following insight about environmental education comes from her presentation (UNESCO, 1998).

Environmental education is a process aimed at developing a world population that is aware of, and concerned about, the total environment and its associated problems, and which has the knowledge, attitudes, skills, motivation and commitment to work individually and collectively towards solutions of current problems and the prevention of new ones.

More than just science, environmental education requires an understanding of economics, mathematics, geography, ethics, politics, and history. Moreover, addressing the interaction between humans and the environment is critical, making it necessary to incorporate subjects such as human ecology, philosophy, psychology and language.

It is not necessary to be a scientist or an environmental education professional to incorporate environmental education into teaching. Rather, it is a case of facilitating learning, and knowing how and when to get other teaching colleagues and experts involved. Environmental education is much more than teaching one subject; it involves decision-making, communication and creative skills – in other words, it is education for life. Venturing into unknown areas and learning about issues along with the students are other exciting aspects of environmental education.

Getting the students outside and away from the more formalized classroom surroundings helps them gain first-hand experience of their community, their natural environment and the issues facing both. In so doing, they benefit from a more 'hands on', practical or discovery learning approach.

Objectives of Sandwatch

Through Sandwatch, school students, with the help of local communities, get involved in the enhancement and wise management of their beach environments.

Vision statement

Sandwatch seeks to change the lifestyle and habits of youth and adults on a community-wide basis, and to develop awareness of the fragile nature of the marine and coastal environment and the need to use it wisely.

The beach environment was selected as the focus area for Sandwatch since beaches are much treasured by island and coastal residents and they represent areas of rapid change over short time periods.

With a strong field monitoring component, Sandwatch tries to 'make science live', yet remains inter-disciplinary with applications ranging from biology and ecology to woodwork and from poetry to mathematics. The long-term goal is to have Sandwatch activities integrated into the school curriculum so that it becomes a flagship project in this Decade of Education for Sustainable Development (2005–2014).

Sandwatch activities relate directly to topics already included in the primary and secondary school curricula. For instance at the primary level they can be incorporated directly into:

- language arts: writing, reading, comprehension, composition, poetry;
- mathematics: both mechanical and problem solving;
- social studies;
- health education;
- basic science;
- arts – music, drawing, drama.

Also, at secondary school level they can be incorporated into language studies, science (biology, chemistry, physics), mathematics, social studies, geography and others. To take just two specific examples, the Caribbean Examinations Council Secondary Education Certificate for Biology (Section A) covers living organisms in the environment – see Chapter 11 of this publication; and Section B of the Social Studies syllabus includes the development and use of resources – see particularly Chapter 5 in this publication.

Sandwatch is also about sharing information. Here a group of students in San Andres discuss how to measure beaches with a representative from CORALINA.

The specific objectives of Sandwatch are to:

- involve school students (primary and secondary school students) in the scientific observation, measurement and analysis of beaches utilizing an inter-disciplinary approach;
- assist school students, with the help of local communities, in applying their information and knowledge to the wise management and enhancement of their beaches;
- reduce the level of pollution in adjoining seas and oceans.

Above, other representatives from CORALINA talk with a beach user on how to best protect an eroding beach, 2003.

(CORALINA is the Corporation for the Sustainable Development of the Archipelago of San Andres, Old Providence and Santa Catalina.)

Sandwatch equips students with the skills to:

- make observations of the beach;
- carry out simple measurements of different beach characteristics, specifically: erosion and accretion; sand composition; waves, currents and longshore transport; biological fauna and flora; water quality; human activities; beach debris and litter;
- repeat and record these measurements accurately over time;
- compile and analyse the data;
- interpret the data, and prepare reports, graphs, stories, poems, artwork depicting the results;
- provide information to government agencies and interested parties where appropriate;
- select beach issues to address and, together with their communities, implement beach enhancement projects.

Short history and scope of Sandwatch

The concept of Sandwatch developed during the First UNESCO Associated Schools Project Network (ASPnet) Caribbean Sea Regional Environmental Education Workshop, held in Tobago, 21–26 July 1998. Thereafter, UNESCO's ASPnet joined partners with its platform for Environment and Development in Coastal Regions and in Small Islands (CSI) to prepare a proposal for a Sandwatch project. The following year, 1999, the proposal was officially endorsed at the Fourth Regional Coordinators Meeting of the UNESCO ASPnet Caribbean Sea Project, held in St Vincent and the Grenadines, 25–27 May 1999.

The project formally began in 2001 with the First Regional Workshop. With the support of the St Lucia National Commission for UNESCO, teachers from 18 Caribbean countries took part in a three-day workshop in St Lucia from 31 May to 2 June 2001 and were joined by students from seven St Lucian secondary schools. The main purpose of the workshop was to train the teachers in various beach monitoring methods relating to erosion and accretion, wave action, water quality and human beach activities. A manual was prepared prior to the workshop and was distributed to the participants. Classroom and beach sessions were integrated to demonstrate the various techniques. Sufficient equipment kits were distributed to the participating countries, so that at least three schools from each country could get involved in the monitoring activities. A project implementation plan was also prepared, which included scheduling a second workshop in Dominica in 2003 to share the results of the monitoring.

Over the next two years, the teachers who attended the St Lucia workshop shared the Sandwatch techniques and skills with their students, as well as with teachers from other schools, and together they embarked on programmes to monitor their beach environments.

Then in July 2003, with the added support of UNESCO's field offices in Kingston, Apia and Dar es Salaam, and the UNESCO National Commission for Dominica, students and teachers from 13 Caribbean countries met in Dominica to share their results and experiences (Cambers, 2003). They were joined by representatives from two islands in the Pacific and one island in the Indian Ocean. The final chapter of this publication provides a glimpse of some of the successful Sandwatch experiences presented at that workshop.

In September 2004, a competition called 'Community Sandwatch' was launched with the goal of having students plan, design, implement and evaluate a community-based beach enhancement project using the beach monitoring methods that are an integral part of Sandwatch. The winning entries were announced in the summer of 2005.

As Sandwatch continues in the Decade of Education for Sustainable Development, various initiatives are being pursued in individual countries to integrate the Sandwatch approach into the teaching environment so that students, teachers and communities can benefit and maximize their experiences. Sharing these activities and this knowledge is an important part of Sandwatch.

Outline of this publication

Documenting the Sandwatch methods is the major focus of this publication. Chapter 2 deals with how to get started, while Chapter 3 describes some simple, but nevertheless important activities – observing and recording. Thereafter the chapters describe specific activities relating to different components of the beach system:

4. Erosion and accretion
5. Beach composition
6. Human activities
7. Beach debris
8. Water quality
9. Waves
10. Longshore currents
11. Plants and animals

The final chapter (12) discusses Sandwatch in the context of Education for Sustainable Development and presents examples of how Sandwatch is working at primary and secondary school levels.

Most of the activities described in this publication can be undertaken using some basic equipment, a list of which is included in Annex 1.

A glossary at the end of this publication explains some of the terms that may be unfamiliar. Related publications, which will provide additional background material for teachers and students alike, are:

- *Coping with Beach Erosion* by G. Cambers, 1998. Coastal Management Sourcebooks 1, UNESCO Publishing.
- *Glimpses of the Blue Caribbean* by J. Rudder, 2000. Coastal region and small island papers 5 (English and Spanish versions available).

These publications are available on request (while stocks last) from Coastal Regions and Small Islands, UNESCO, 1 rue miollis, Paris Cedex 15, France (csi@unesco.org). They are also available on the web.

A Sandwatch poster is also available on request (while stocks last) from the UNESCO Kingston Office, The Towers, Dominica Road, Kingston, Jamaica.

Beaches are places to be treasured, Pigeon Island, Jamaica, 2001.

2 Getting started

Get advice from professionals

While the activities described in this manual are quite simple and straightforward, it often helps to get other teachers and environmental professionals involved in your programme. They can usually provide additional information and may be able to provide some assistance with interpreting your results. For example there may be a community college or university in your country who, as part of their outreach activities, may be willing to help. Similarly environmental and planning departments often have education programmes and may also provide additional support. Sandwatch teams in other countries are another source of assistance.

Select the beach to monitor

The key factors to consider here are:

Safety: the beach should provide a safe environment for the students, e.g. if there are very strong currents and/or very high waves, there is always the risk a student will go bathing with disastrous consequences. Safety must always be the prime concern.

Accessibility: choose a beach that is easy to get to, preferably near the school and within walking distance. In some countries private beaches exist, so make sure the beach is a public beach.

Importance of the beach to the community: try and choose a beach which is used by the residents of the area and therefore important to the local community. This will provide for local interest in the students' monitoring activities and will also be an important factor during the design and implementation of beach enhancement projects.

Small beaches enclosed by headlands, also known as bayhead beaches, and seen here at Anse Ger in St Lucia (right), are ideal for Sandwatch monitoring.

Some beaches like at Byera on the east coast of St Vincent and the Grenadines (far right) are very long, and in these cases a particular stretch should be selected for Sandwatch monitoring.

Issues of interest: particular issues such as heavy use at weekends, favourite destination for local residents, history of erosion during storms, may be another reason to select one beach location.

Size of the beach: this is another important issue. In some areas, beaches are small (less than 1 mile [1.6 km] in length) and enclosed by rocky headlands. These 'bayhead' beaches, as they are called, represent an ideal size for a monitoring project. However, in many countries there are also long beaches which extend for several miles (or several km). If one of these very long beaches has been selected as the beach to be monitored, it is recommended to determine a particular section (about 1 mile or 1.6 km) for the monitoring.

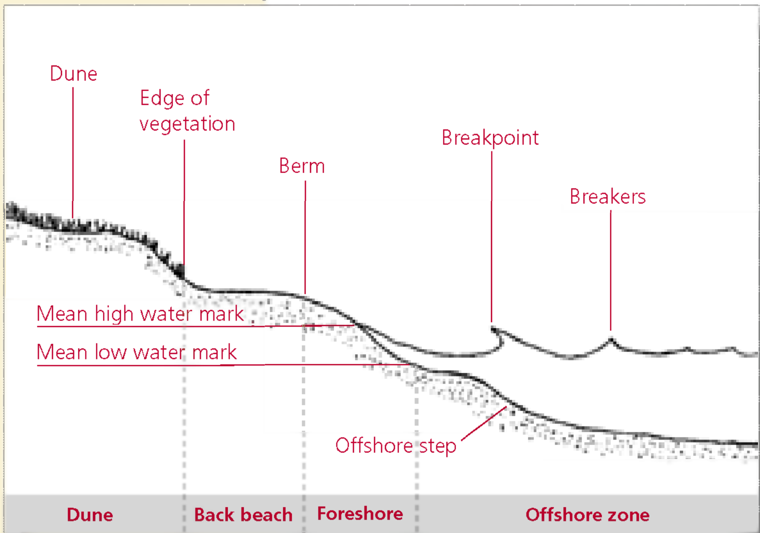
Define the boundaries of your beach

What is a beach?

> *A beach is a zone of loose material extending from the low water mark to a position landward where either the topography abruptly changes or permanent vegetation first appears.*

Applying this definition to the diagram below, which is called a cross-section, the beach extends from the low water mark to the vegetation edge.

Figure 1
Cross-section of a typical beach.



Beaches are often made up of sand particles, and in many islands the term 'beach' may be used only for sandy beaches. However, a beach may be made up of clay, silt, gravel, cobbles or boulders, or any combination of these. For instance the mud/clay deposits along the coastline of Guyana are also beaches.

Sandwatch focuses on the beach, and also the land behind the beach; this may consist of a sand dune, as shown in the cross-section, or a cliff face, a rocky area, low land with trees and other vegetation, or a built-up area.

A beach is more than just a zone of loose material found where the water meets the land; it is also a coastal ecosystem. An ecosystem is the basic unit of study of ecology and represents a community of plants, animals, and micro-organisms, linked by energy and nutrient flows, that interact with each other and with the physical environment. Ecology is the study of the relationship of living and non-living things.

Sometimes, geologists, ecologists and others look at the beach from a broader perspective, taking into account the offshore zone out to a water depth of about 40 ft (12 m). This is where seagrass beds and coral reefs are found, and these ecosystems supply sand to the beach. Much of the sand in this offshore area moves back and forth between the beach and the sea. This broader view may also include the land and slopes behind the beach, up into the watershed, since streams and rivers bring sediment and pollutants to the beach and sea. Thus, often there is a need to look at the wider perspective of the '*beach system*'.

Who to involve in Sandwatch

Sandwatch focuses on measuring changes, identifying problems and addressing issues in the beach environment. So everyone – students, teachers, community members – needs to get involved. In most countries, teachers have taken the lead, getting their students involved in observing and measuring various components of the beach over time, and analysing the information collected, in particular:

- making observations of the beach;
- carrying out simple measurements of different components of the beach;
- repeating those measurements accurately over time;
- recording the information collected;
- compiling the data;
- analysing the information;
- making conclusions;
- preparing reports, graphs, stories, poems, artwork and drama pieces depicting the results.

Students and teachers work on their data in the classroom after a morning's observations on the beach, St Lucia, May 2001.

As the students interpret their results and identify the problems that need addressing, they share their findings with their local communities. Then together they implement projects to enhance the beach environment within a framework of sustainable development.

This publication describes various activities dealing with different components of the beach. Schools can select particular monitoring activities depending on the age level, interests and school subjects. Most of the activities described in this manual can be performed by students between the ages of 8 and 18 years, although obviously with a different level of analysis. All the activities described involve work on the beach followed by work in the classroom; in most cases the work in the classroom will take considerably more time than the work on the beach (two to four times as much).

Students and teachers observing and recording at Reduit in St Lucia, May 2001.

3 Observation and recording

Background

The first and most important activity is to develop a general picture of the beach and gather as much information as possible based on simple observations. No special equipment is needed for this activity.

ACTIVITY 3.1 Observe the beach and make a map

Observe and record

Divide the students into groups, and have the students walk the length of the beach, writing down everything they see. If the beach is very varied, the student groups may be given different items to look for, e.g. one group might record buildings and roads, another group vegetation and trees, a third group might record the type of activities in which people are engaged and so on. Since the purpose of this activity is to make a map, the students should record the various items and where on the beach they are located. Items to look for include:

- beach material: size (sand, stones, rocks), colour, variation in material along different sections of the beach;
- animals, e.g. crabs, birds, domestic animals, shells of animals;
- plants and trees, e.g. seaweeds and seagrasses, grasses, plants, trees behind the beach;
- debris, litter, pollution, e.g. garbage on the beach or floating in the water;
- human activities, e.g. fishing, fishing boats on the beach, sunbathers, walkers, people jogging, sea bathers, swimmers, picnic groups;
- buildings behind the beach, beach bars and restaurants, houses and hotels, public accesses to the beach, litter bins, signs, lifeguard towers, jetties etc.;
- sea conditions, e.g. is the sea calm or rough;
- objects in the sea, e.g. mooring buoys, boats at anchor, buoyed swimming areas.

Encourage the students to make detailed observations, e.g. instead of recording three trees, encourage them to try and identify the trees, e.g. two palm trees and one sea grape tree.

Draw a map of the beach

Make a sketch map of the beach; this can be done as a class exercise, or each student or group can make their own map. An example of a sketch map is shown in Figure 2. You may wish to prepare a simple map outline on which students can record their observations, or even a copy of a topographic map, see Figure 3. The advantage of such a topographic map is that it is accurate, so the scale can be used to determine distances. Such maps can be enlarged using a copying machine (although remember to also enlarge the graphical scale).

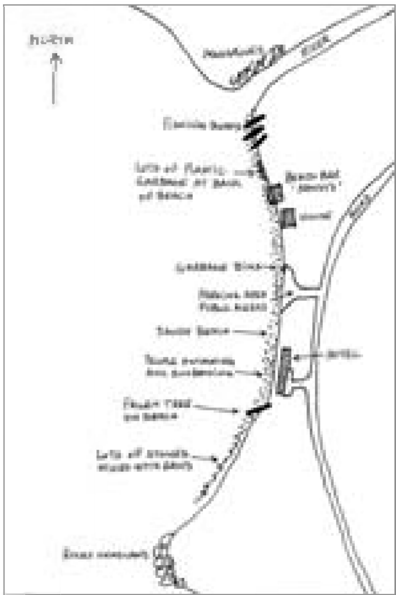


Figure 2
Sample sketch map (right).

Figure 3
Sample topographic map (far right).

Discuss the map

Discuss the map with the class. The map can become the starting point for deciding which characteristics to monitor and where to measure them.

ACTIVITY 3.2 How the beach used to look

Having drawn your sketch map of how the beach looks now, it is often useful to research information on how the beach used to look in the past.

Examine the topographic map of your beach

Topographic maps may be available in your local library, or at a bookseller, or government department responsible for lands and surveys. Look at the key to the map to find out when it was made. Compare the map with your present day sketch map and note any changes.

Look at the aerial photographs of your beach

Aerial photographs are usually kept at government departments responsible for lands and surveys, and sometimes at planning and environmental agencies. Aerial photographs are taken from a plane looking vertically downwards. They show a bird's eye view looking down at the beach from a height. You may be able to find aerial photographs of the beach taken in the 1960s or 1970s. Aerial photographs, like topographic maps, can be used quantitatively to determine the length, width and size of the beach. Compare the aerial photographs with your present day sketch map and note any changes.

Examine ordinary photographs of the beach and talk to local people who knew the beach from years back

Ordinary photographs also show how the beach used to be in the past. Sometimes postcards also show views of particular beaches. Another useful source of information is to talk to people who have lived by the particular beach for many years or have visited it regularly over a period of several years.

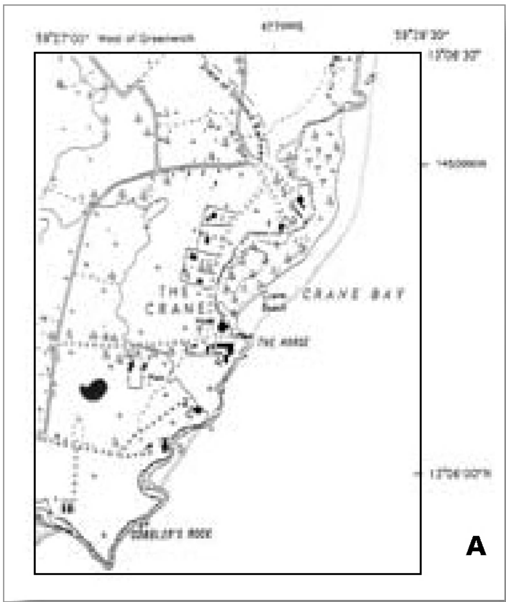


Figure 4
Different perspectives of Crane Beach, Barbados, in the 1970s. (A – a topographic map, B – an aerial photograph and C – an ordinary photograph)

Discuss how the beach used to be in the past and might be in the future

Items to discuss with the class might include:

- How has the beach changed?
- Are the changes good or bad?
- Do you prefer the beach as it was in the past or as it is now?
- How do you think the beach will look in ten years time?

The exposed tree roots and leaning palm tree are indicators of erosion at this beach in the Rock Islands, Palau, July 2002.

4 Erosion and accretion

Background

Beaches change their shape and size from day to day, month to month and year to year, mainly as a response to waves, currents and tides. Sometimes human activities also play a role in this process, such as when sand is extracted from the beach for construction, or when jetties or other structures are built on the beach.

For more information on erosion and accretion as well as waves, tides and currents, see Cambers, 1998, and other texts dealing with coastal processes.

Erosion takes place when sand or other sediment is lost from the beach and the beach gets smaller, and the opposite process – ***accretion*** – takes place when sand or other material is added to the beach, which as a result gets bigger.

ACTIVITY 4.1 Measuring erosion and accretion over time

What to measure

One very simple way to see how the beach changes over time, and whether it has eroded or accreted, is to measure the distance from a fixed object behind the beach, such as a tree or a building, to the high water mark.

The *high water mark* is the highest point to which the waves reached on that particular day. It is usually easy to identify on a beach, by a line of debris such as seaweed, shells or pieces of wood, or by differences in the colour of the sand between the part of the beach that has recently been wetted by the water and the part that remains dry.

Figure 5
Determining the high water mark, Savannah Bay, Anguilla, 1996. (The arrow shows the position of the high water mark on that date.)

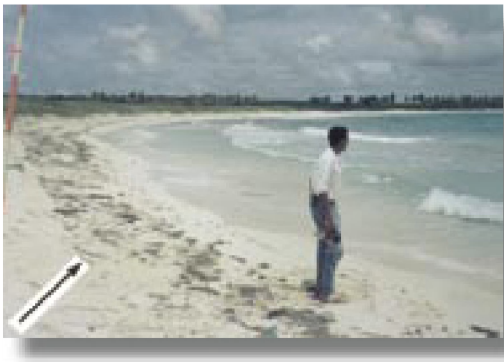


Figure 6
Plan view of a sample beach showing suggested points for measuring beach width.

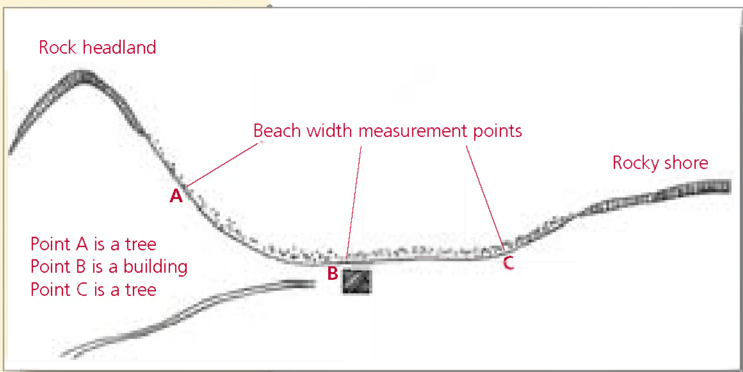


Figure 5 shows a photograph of a beach in Anguilla; the arrow shows the high water mark which, in this case, is the land-most edge of the band of seaweed.

Alternatively, in countries where tide tables are published in the local newspapers, the visit to the beach can be timed to coincide with high tide, in which case the measurement is made to the water's edge. One note of caution here, in the Caribbean the tidal range is very small, approximately 1 ft (0.3 m), so the state of the tide – whether high, mid or low tide – does not matter very much. But in the Pacific for example, the tidal range is greater, 3 ft+ (1 m+), so in this case it will be necessary to always repeat these measurements at the same tidal state, e.g. if the first measurement is done at high tide, then subsequent measurements should also be done at high tide.

Sometimes there may appear to be more than one line of debris on a beach. In such cases, take the line closest to the sea; the other debris line may well be the result of a previous storm some weeks or months ago.

Most beaches show variation in erosion and accretion, for instance, sand may move from one end to the other end. So if monitoring the physical changes in the beach, it is recommended to carry out these measurements at a minimum of three sites on the beach, one near each end and one in the middle (see Figure 6).

How to measure

At the first point, select the building or tree that you are going to use. Write down a description of the tree or building (and if possible photograph it). This will help you to return to the same point to re-measure. With two people, one standing at the building and one at the high water mark, lay the tape measure on the ground and pull the tape measure tight. Note the distance either in feet and inches, or metres and centimetres, whichever system the students are familiar with, record the measurement together with the date and the time of measurement. Then proceed to the next point and repeat the measurement. Label your three points either with physical names or a notation system (A, B, C or 1, 2, 3).

Right: Taking a photo of your reference tree or building is always advisable, Magazin Beach, Grenada, 1996.

Far right: Measuring the beach width, Sandy Beach, Puerto Rico, 1997.

If your beach or beach section is about 1 mile (1.6 km) long then a minimum of three points is recommended. However, you can always add additional points.

The measurements can be supplemented with photographs of the beach taken from the same position and angle on different dates.

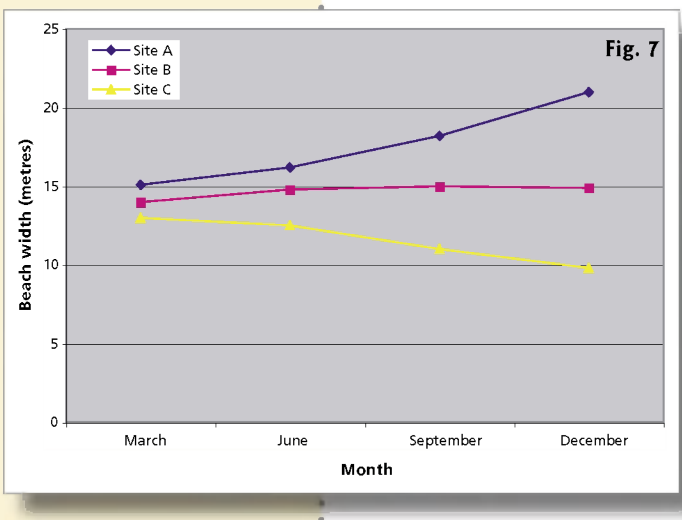
When to measure

Ideally these measurements could be repeated monthly, but even if only repeated every two or three months, they will still yield some interesting information.

What the measurements will show

The data will show how the beach has changed over the monitoring period, whether it has gained or lost sand, possibly one part of the beach has increased in size while another section has decreased in size. Figure 7 shows line graphs from three points on a sample beach, the beach at Site A accreted (it gained sand), at Site B there was very little change and at Site C the beach eroded (it became smaller).

The data may show seasonal changes in the measurements, e.g. the beach may be wider in summer than in winter. Figure 8 shows this type of seasonal pattern in a bar graph.



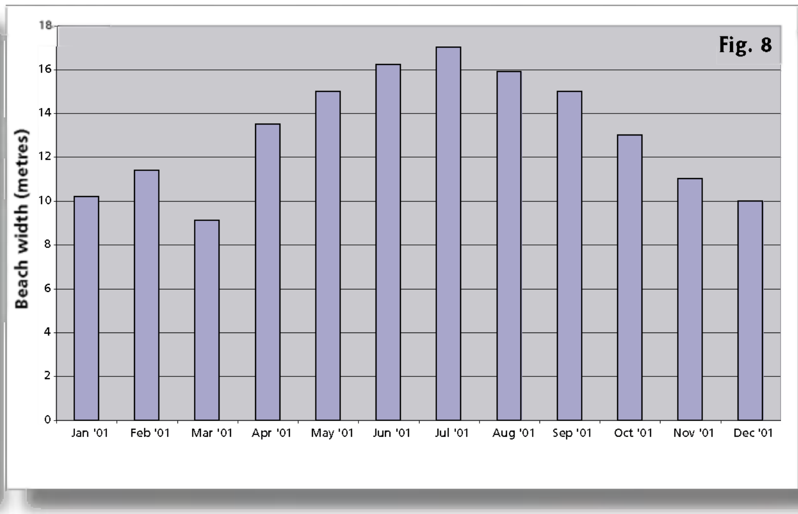
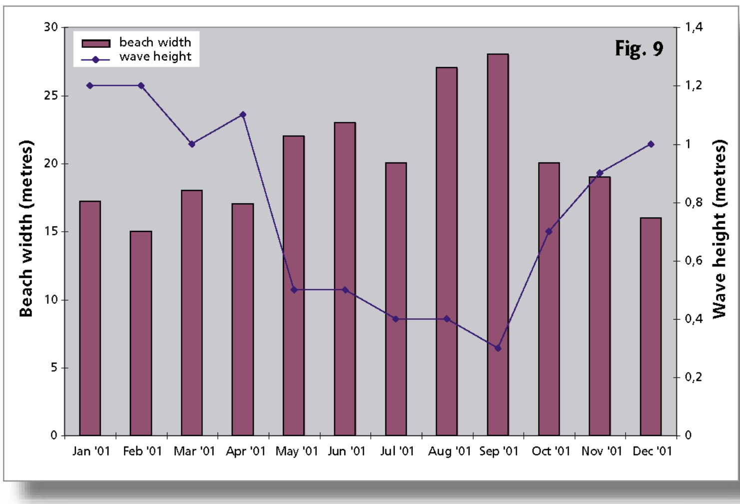


Figure 7
Line graph showing erosion and accretion changes over time.

Figure 8
Bar graph showing beach width changes over time.

Figure 9
Mixed graph showing changes in beach width and wave height.

If the students are also measuring waves (see Chapter 9), then these measurements may be related to the changes in beach width. Figure 9 shows beach width and wave height recorded on the same graph. In this case the beach width was greatest in August and September when the wave height was lowest.



ACTIVITY 4.2 Determining the effects of man-made structures on erosion and accretion

What to measure

Look for any man-made structures on the beach (also called sea defences) such as jetties, groynes, seawalls on or behind the beach. Note their numbers and where they are positioned.

If the structure is a jetty or a groyne, select a measurement point on each side of the structure, and measure the distance from a fixed object behind the beach to the high water mark, as in the previous activity (4.1).

Measuring the beach width in front of this wall, as well as in front of the grassy area to the left, could yield interesting results, Grand Mal, Grenada, 1998.

Alternatively if there is a seawall at the back of the beach, you may wish to set up a measurement point in front of the seawall as well as one on an adjacent part of the beach where there is no seawall.

How to measure

Use the same techniques as described above in the activity dealing with erosion and accretion (Activity 4.1)

What the measurements will show

Again the measurements will show how the beach changes over time. In the case of the measurements on either side of the jetty, the data may well show that the beach on one side of the structure gets bigger, while the beach on the other side gets smaller. These changes can also be related to measurements in waves and longshore currents (see Chapters 9 and 10).

Beaches in front of seawalls may also react differently to beaches where there are no seawalls. Often the beaches in front of seawalls may change very dramatically, e.g. a beach in front of a seawall may completely disappear one week, only to re-appear the following week.

ACTIVITY 4.3 Measuring beach profiles

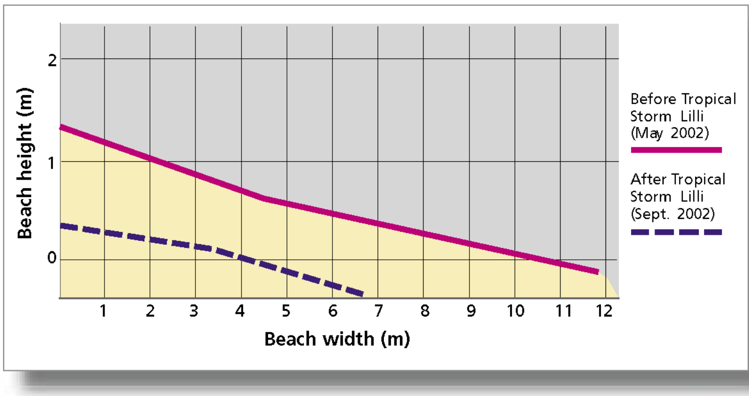
What to measure

This activity is better suited to older students in secondary school. A beach profile or cross-section is an accurate measurement of the slope and width of the beach, which when repeated over time, shows how the beach is eroding or accreting. It builds on 'Activity 4.1 Measuring erosion and accretion' and includes measurement of the slope of the beach. Figure 10 shows how a beach profile eroded as a result of a tropical storm.

How to measure

There are many different ways of measuring beach profiles, the method described in Annex 2 is one of the simpler methods, and is currently used in many small islands to determine beach changes over time. The annex describes how to measure beach profiles and also provides information on the use of a simple computer program available to analyse the data. The program is available free on request from UNESCO-CSI (csi@unesco.org).

Figure 10
Changes in a beach profile before and after Tropical Storm Lilli, Port Elizabeth, Bequia, St Vincent and the Grenadines, 2002.



Upper: Group of students measuring a beach profile at Hamilton, Bequia, St Vincent and the Grenadines, 2000.

Lower: Group learning how to measure slope with an Abney level at Beau Vallon, Mahe, Seychelles, 2003.

When to measure

Beach profiles should be repeated at three month intervals or more frequently if time permits.

What the measurements show

The measurements show how the beach profile changes over time. For instance, Figure 10 shows how the beach profile became steeper and the beach width narrower after a tropical storm. The computer program allows successive profiles to be plotted on the same graph to see the changes.

Regular measurements of profiles can show not only how a beach responds to a storm or hurricane, but also how/if it recovers afterwards and the extent of that recovery. Removing sand for construction or building a seawall also impacts a beach, and only by carefully measuring beach profiles before and after the activity is it possible to say accurately how the beach has changed. Government authorities, as well as beachfront house and hotel owners may also be interested in the information collected from beach profiles. Designing a successful tree planting project requires knowledge of how the beach changes over time. The applications are numerous. Many people think they can tell how a beach has changed simply by looking at it, but it is much more complex than that, and often people's memories are not as accurate as they like to think. Accurate data, such as beach profiles, are the basis for sound development planning.

New threats to beaches

Today, there is a new threat facing beaches – that of sea level rise. While sea levels may rise naturally in some parts of the world, this is a very slow and gradual process. However, global warming caused by excess production of greenhouse gases, notably carbon dioxide, by human activities, can greatly accelerate this process. This warming of the atmosphere is believed to cause glaciers to melt and ocean water to expand thermally. Both effects will increase the volume of the ocean, raising its surface level. This means many of our beaches may erode and disappear faster than before.

Scientists also believe that global warming may cause changes in the frequency and intensity of tropical storms, hurricanes, cyclones or typhoons. These weather systems bring extremely strong winds, torrential rain and huge waves which impact beaches, coasts and in some cases entire islands.

Related research and discussion topics might include:

- Climate change and climate variation – how do they differ?
- Research the number of hurricanes/cyclones coming within 100 miles (160 km) of your country or island in the 1970s and each following decade. Discuss the results, is there a trend?
- How many really severe hurricanes/cyclones (category 3 or higher) have come within 100 miles (160 km) of your country or island in past decades?
- Have there been changes in the climate in your country or island? Are the summers getting hotter? Or the dry season getting longer?
- What happens to beaches and dunes when hurricanes/cyclones strike?
- Has the sea level surrounding your country or region changed over the last 50 years?

The powder white sand on this beach at Vlingilli, Madives, 2003, originates from the surrounding coral reefs.

Different sizes of material on a beach in Rarotonga, Cook Islands, 2003.

5 Beach composition

Background

A beach consists of loose material, of varying sizes. The actual material itself can tell a lot about the stability of the beach.

ACTIVITY 5.1 Finding out where beach material comes from

Observe and record

Observe, describe and record the type of beach material. A beach may be composed of just one type of material, e.g. sand, or there may be a mixture of materials, e.g. sand, gravel and boulders. Beach material can be classified into different sizes (see the table below). Sand is just one size range.

Note and record the colour, size and texture of the material on the beach. A simple ruler or tape measure can be used to distinguish between the larger sizes, although obviously not for clay and silt. Use plastic bags to collect samples of material from different parts of the beach and label the location, e.g. near high water mark, beneath cliff face and so on.

SEDIMENT SIZES

Clay	Less than 0.004 mm	Less than 0.00015 inches
Silt	0.004–0.08 mm	0.00015–0.003 inches
Sand	0.08–4.6 mm	0.003–0.18 inches
Gravel	4.6–77 mm	0.18–3 inches
Cobbles	77–256 mm	3–10 inches
Boulders	Greater than 256 mm	Greater than 10 inches

Upper: This yellow-brown silica sand at Walkers Pond, Barbados, 1983, originates from the erosion of inland rocks.

Lower: This black sand at Londonderry, Dominica, 1994, is volcanic and is transported to the coast by the rivers.

What is sand?

Sand consists of small pieces of stone or shell and can be classified into three main types:

- mineral sand, which is composed of mineral grains and/or rock fragments
- biogenic sand, which is composed of coral, red-algae, crustacean skeletons, shells
- mixtures of mineral and biogenic sands

Common components of mineral sand include the following:

- Quartz grains are clear, quartz is one of the most common minerals found in sand and is extremely weather resistant
- Feldspar grains are pink, light brown to yellow
- Magnetite grains are black and strongly magnetic
- Hornblende grains are black and prism-shaped

Common components of biogenic sand include the following:

- Coral may be identified by its many rounded holes
- Shell fragments may come from scallops, mussels, clams and be a variety of colours
- Sea urchin spines appear as small rods or tubes and may be a variety of colours

Sand samples may also include some organic material.

Discuss where the beach material originates

Back in the classroom, make a sketch map showing the different features (e.g. river mouth, rocky outcrop, cliff) on the beach and the different types of material. Discuss where the different types of material might originate.

Sand is composed of small pieces of stone or shell and its colour depends on its origin. Sand may come from inland rocks and be carried to the coast by rivers and streams. It may originate from nearby cliffs, or even far distant cliffs and be carried to a particular beach by longshore currents (see Chapter 10). Or the sand may have its source in the offshore coral reefs and seagrass beds.

The pure white sands of many tropical beaches are derived from coral reefs or coral reef limestone rocks. Yellow to brown silica sand found along some coasts comes from the erosion of inland rocks, while the black sand beaches of many volcanic islands consist of grains of olivine and magnetite, derived from the erosion of volcanic rocks.

Ask students to write a story about the life of a grain of sand, starting perhaps in an inland mountain and travelling to the beach by a stream, or originating on a coral reef and being moved by waves and currents to a beach. Ask them to imagine their life on a beach and what happens when a storm strikes or a sand miner moves them. A 'letter from a grain of sand' in the accompanying box provides some further ideas.

Ernesto Ardisana Santa (fourth from right) presenting 'Letter from a grain of sand', Cuba, February 2004.

Letter from a grain of sand

Hello friends!

I am a tiny grain of sand, bathed by the sea spray, created by the waves of the Caribbean Sea. I live in a marvellous place where, every morning at sunrise, I listen to the tremulous murmur of flying fish shooting out of the transparent sea water. Many birds inhabit this place, particularly the small, delicate and dark sea swallows which fly constantly in search of food.

The sea is sweet and beautiful, but it can also be cruel and can become angry all of a sudden. Perhaps you may be surprised at my referring to the sea in Spanish as if it were feminine. This is the way we, those that love her, refer to the sea. I consider her as belonging to the feminine gender and as someone who concedes or denies big favours, and if she does perverse deeds, it is because she cannot help it.

My Mom and Dad are also sand grains, already hundreds of thousands of years old, since in this beach toxic substances that could have degraded us have never been used. Those persons who visit us are sorry to tread on us, which explains their walking warily and their not leaving food leftovers behind. We are always tended by children and the young of the local beach community, who remove the plant litter that comes out of the sea.

Through this letter I wish to express my solidarity with all the suffering grains and tiny grains of sand in this world, and especially so those of the coasts of Galicia in Spain who are bearing the effects of an oil spill.

I wish to invite you all to my unpolluted world. You can find me at the following e-mail address: letstakecare@everybody.world. I will receive you with pleasure. I now say goodbye with a great marine salutation, since it is the time to go to listen to the classes given by the snail on how to recycle the trash left daily on the coasts by humans, in order that this, my small paradise, may remain clean and pure and that I may be proud to live in my blue planet, helping to make it liveable for others too.

I am looking forward to your messages. I will give you my address later, because it is difficult, very difficult to understand, since unfortunately you must find your way through the paths of dreams.

With best wishes
The happy tiny grain of sand

Source: Instituto Pre Universitario Vocacional De Ciencias Exactas,
Comandante Ernesto Che Guevara, 2004

ACTIVITY 5.2 Exploring what happens when sand and stones are removed for construction

Observe and record

Visit a beach that has been heavily mined for construction material as well as a beach that has not been mined. Observe and record the differences between the two beaches and relate them to the mining activity. Features to look for and discuss might include the following:

- How is the material being extracted – with heavy equipment or by people using spades?
- Are there vehicle tracks all over the beach?
- Are there deep holes where material has been extracted?
- Does the water reach further inland?
- Are there trees that have been undermined or vegetation that has been trampled?
- Might the deep holes affect baby turtles if they nest on this beach?
- Does the beach look like a nice place to visit?
- Are there other sources of construction material besides the beach?

Mined beach at Brighton, St Vincent and the Grenadines, 1995.

Discuss how the beach material is used in construction

Ask the students to think about the construction materials used for houses and buildings in their country. Topics to discuss might include:

- What materials were used to build houses in the past?
- Compare and contrast the differences between concrete houses and wooden houses.
- What materials are needed to make concrete?

ACTIVITY 5.3 Measuring beach sand – size, shape and sorting

What to measure

Sand samples can be collected from different parts of the beach and the size, sorting and shape of the sand grains can be measured. These characteristics are likely to vary from one part of the beach to another.

How to measure

During a visit to the beach, sand samples can be collected from different areas, e.g. from a river mouth, from the inter-tidal zone where the sea is wetting the sand, from the dry sand at the back of the beach, from a dune behind the beach, or from beneath an eroding rock face or cliff.

Place the sand samples in clean plastic bags, label each bag and keep notes on exactly where the sample was collected.

Three 'S's of sand: size, shape and sorting

Sand size depends on the origin of the sand and the wave energy. Strong wave action, such as found on exposed coasts, washes out the finer sand particles leaving only coarse sand and a steep beach profile. Often stones and boulders may be present on such beaches. However, on more sheltered coasts, finer sand is deposited and a gently sloping beach results. Near mangroves and river mouths, silt and organic material also collects.

Measuring the shape of sand grains with a magnifying glass, St Lucia, 2001.

Sorting relates to the mixture of sizes, e.g. if all the sand grains are the same size, then the sample is well sorted. If there are a lot of different size grains in the sample, then it is poorly sorted. As sand is moved about by the waves, it tends to get better sorted, in other words all the sand grains are about the same size.

The ***shape*** of the sand grains relates to whether the individual grains are angular and pointed or whether they are smooth and rounded. As the sand grains are moved about by the waves, they tend to become rounded with very few sharp points.

On return to the classroom, the samples should be spread out on a flat surface to dry (if they are wet). Then sprinkle some dry grains on to a plastic sheet. Place the plastic sheet with the sand grains on top of the size charts in Figure 11. If the sand grains are light coloured use the left hand chart, while if the grains are dark coloured use the right hand chart. With a magnifying glass, determine the size category matching most of the grains and record the results. Then compare the sand grains on the plastic sheet with the sorting chart, and with the magnifying glass determine the best-fit sorting category. Finally, compare the sand grains in the sample with the angularity charts to determine the shape.

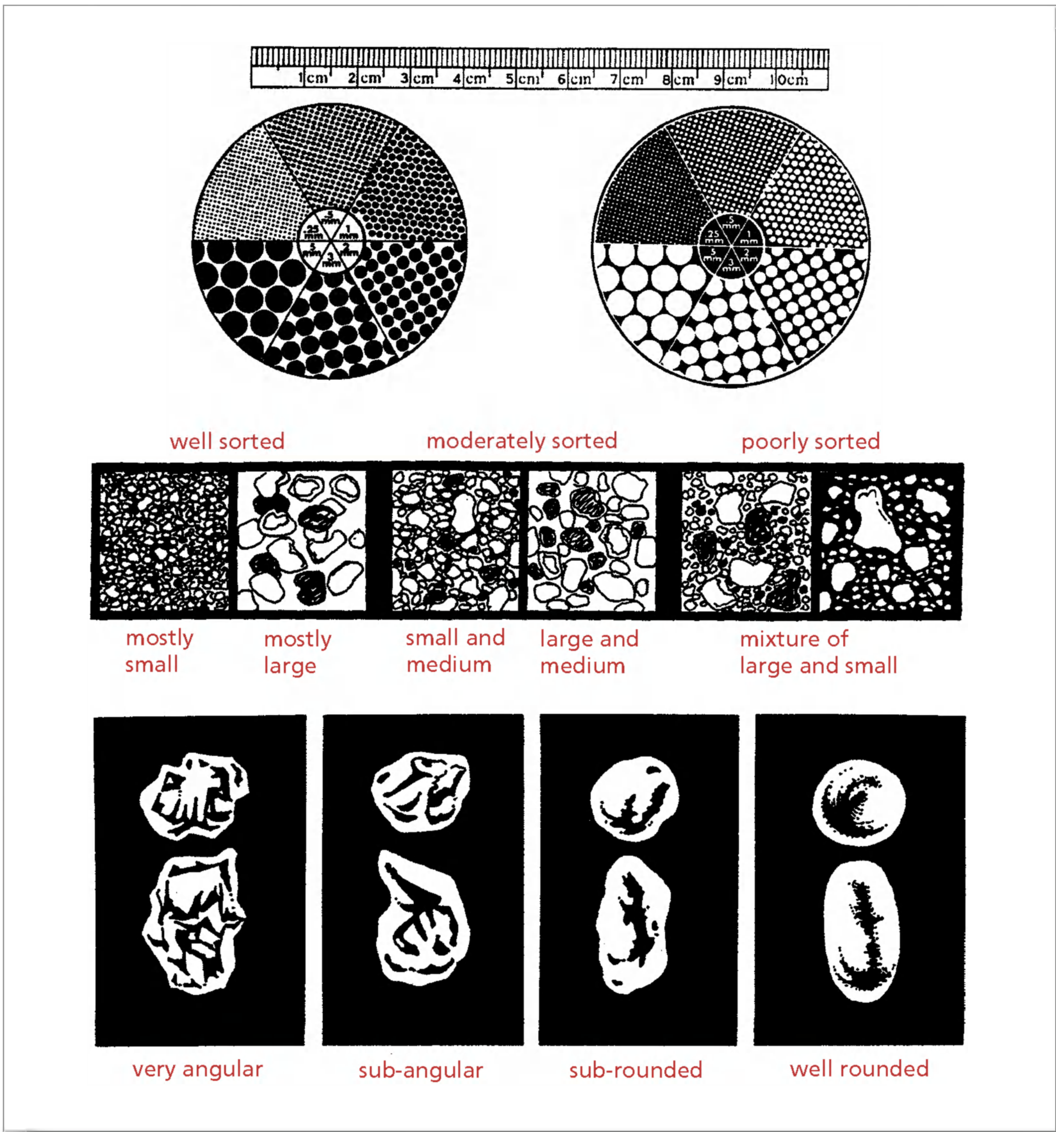
If the beach is made up of stones only, these can also be measured. Collect at least 20 stones, picking them randomly, measure the length along the longest axis and then calculate the average. The chart in Figure 11 can be used for determining the shape of the stones.

When to measure

You may wish to collect sand samples from different parts of the beach one time only, and compare the different samples.

Alternatively you may decide to collect and measure sand samples from the inter-tidal zone, at different times of the year and after different wave events, e.g. after the summer when the waves have been relatively calm and then again after a high wave event. Some beaches show marked differences in composition, having sand in the summer and stones in the winter. Size comparisons can be made and related to the wave energy (see Chapter 9).

Figure 11
Sediment analysis charts for size, sorting and shape (adapted from Kandiko and Schwartz, 1987; and Powers, 1953).



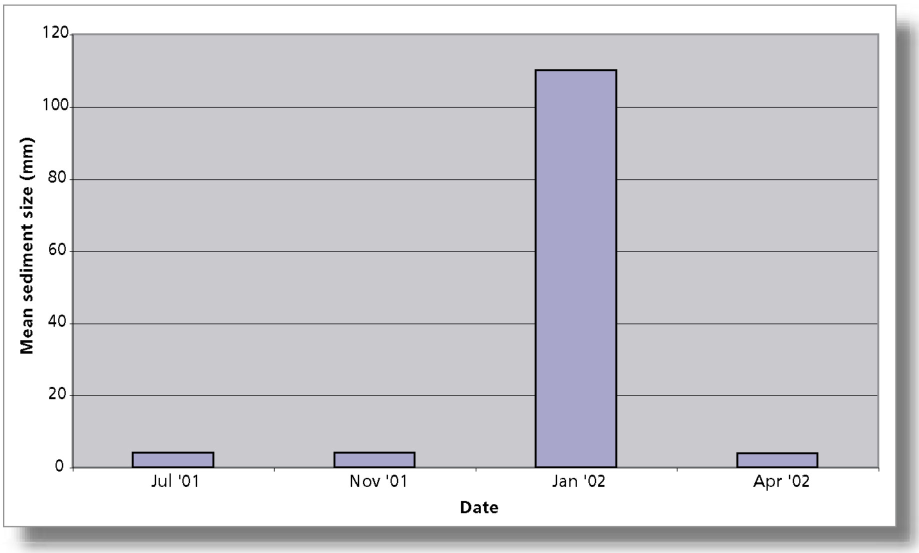
What the measurements show

Variations in size, sorting and angularity will provide information about the different zones on the beach and the processes that shape these zones. For instance, dunes are formed by the wind lifting dry sand grains and carrying them to the back of the beach. So, dune sand might be expected to be smaller in size than sand in the inter-tidal zone. Similarly, sand near a river mouth might be expected to have more organic material in it than the sand in the inter-tidal zone.

In the summer months (April to October), Bunkum Bay in Montserrat is a sandy beach; while in the winter months (December to March) the sand is replaced by stones.

Comparisons of sand size over time might be shown in a bar graph, such as is shown in Figure 12. In this example the beach consisted of black and grey stones in January 2002, while at other times of the year, the beach was made up of black sand (see also photographs of Bunkum Bay in Montserrat where similar changes take place).

Figure 12
Bar graph showing changes in sediment size.



Beaches are always popular places, especially at weekends and public holidays, Buje, Puerto Rico, 1997.

6

Human activities on the beach

Background

Human activities include anything people do on the beach, from picnicking to swimming, from mining sand to fishing. Any or all of these activities might impact the beach environment, e.g. picnickers may leave a lot of their garbage behind which might cause a bad smell and a lot of flies.

Fisherman's Day at Long Bay, Beef Island, British Virgin Islands (1992), brings a large number of people to the beach.

Careful observation of the beach environment will likely yield a list of different activities taking place, often at different times of the day, e.g. fishers might take their boats out early in the morning, the sunbathers might not appear before noon, and the sand miners might only come at night when no one else is around.

ACTIVITY 6.1 Observing different activities on the beach

What to measure

Observe and record the different activities taking place at the beach and the time of day, and draw up a time line of activities – a sample is shown opposite. The more detailed the observations, the better.

Taking this activity a little further, list all the different activities and the number of people involved in those activities to try and build up a picture of the use pattern of the particular beach. The table opposite provides an example.

Sample timeline of beach activities

6–7 am	Fishers take their boats out to sea. Early morning bathers visit the beach to bathe and swim.
7–10 am	Walkers, people with dogs.
10 am–3 pm	Sunbathers, picnickers use the beach, people bathing in the sea, children playing, people walking. Fishing boats return around 3 pm, catch is unloaded into pick-up trucks and taken into town. Fishing boats left on mooring buoys, one boat is pulled up on to the beach.
3–6 pm	Other groups of picnickers arrive, one group has a barbecue. Hotel guests playing volleyball on the beach.
6–7 pm	Few people walking the beach and watching the sun go down.

	6 am	8 am	10 am	12	2 pm	4 pm	6 pm
Number of sea bathers	2	0	4	22	19	14	4
Number of sunbathers	0	0	12	18	23	15	0
Number of walkers	5	8	10	11	13	4	9
Number of picnic groups	0	0	0	5	6	8	0
Number of fishers	7	0	0	1	2	5	1
Number of children/people playing	0	0	9	27	19	44	2
Number of windsurfers	0	0	0	0	0	2	0
Number of horse-riders	0	0	0	11	0	0	0

How to measure

This is simply a case of observing, counting and categorizing. It is best to prepare a data sheet first so that the numbers can be inserted in the appropriate column. While recording the different activities, further observations can be made such as how the different groups relate to each other, e.g. people having a party and playing loud music might disturb people trying to relax and sleep; horse and dog droppings left on the beach are not pleasant for other users; and overflowing garbage bins are unsightly and unhealthy.

Fishers may use the beach to launch and beach their boats early in the morning or late in the evening, Britannia Bay, Mustique, St Vincent and the Grenadines, 2004.

Sharing family moments, as seen here at Male in the Maldives, 2003, is another way people use the beach.

When to measure

This will depend on the depth of the investigation; however, it is always important to realize that user patterns vary according to the time of day, and whether it is a weekday, weekend or public holiday.

What will the measurements show

The measurements will show how many people use the beach on a particular day and the numbers involved in different activities.

Divide the activities into two lists:

- List A: activities that might harm the beach
- List B: activities that do not harm the beach or may be good for the beach

Have a classroom discussion about how some activities are good for the beach and do not harm it in anyway; and what can be done to stop or lessen the harmful activities.

You might also wish to compare use on a public holiday and use during a weekday, or alternatively do the same measurements on two different beaches and compare them.

ACTIVITY 6.2 Finding out the views of beach users

What to measure

Finding out what people think about their beach or a particular beach-related problem can be done by a questionnaire survey. The first step is to define your objective – what do you want to know? Try to be as specific as possible, e.g. do beach users think the beach is too crowded, or do they think the beach is clean.

Tourists are another important group of beach users, as seen here at Pinney's Beach, Nevis, 2000.

How to measure

Design your questionnaire and decide how many people you plan to survey (sample size). When deciding on sample size, also consider:

- Selection – are you going to pick people at random, e.g. every fourth person who arrives at the beach, or are you going to select persons of a certain age or gender?
- Do you want your survey to reflect all beach users or certain groups, e.g. adults or children, residents or visitors?
- How are you going to approach and introduce yourself to the people you want to question? Putting students in pairs for this activity allows one student to speak and one to record the answers.

In designing the questions, go back to your objective and prepare questions that will provide information relating to your objective. A sample is provided below.

Sample questionnaire

Objective: To find out why people use a particular beach

1.	Is the bay safe for swimming?	Yes	No	Sometimes
2.	Is the water clean?	Yes	No	Sometimes
3.	Is the beach clean?	Yes	No	Sometimes
4.	Is there good access to the beach?	Yes	No	
5.	Are the parking facilities adequate?	Yes	No	Sometimes
6.	Are the bathroom facilities well maintained?	Yes	No	Sometimes
7.	Is the beach crowded?	Yes	No	Sometimes
8.	Is there sufficient shade on the beach?	Yes	No	Sometimes

9. How would you like to improve the beach?

Note that in this sample questionnaire, questions 1–8 are very simple and direct and can be answered with a 'yes,' 'no' or 'sometimes' response. Question 9 has been inserted as an 'open-ended' question and it is expected that respondents will provide various suggestions which can be written down.

What will the measurements show

After the results of the survey are tabulated, you should be able to answer the question underlying your objective.

For example, tabulating the results of the questionnaire above might show the following:

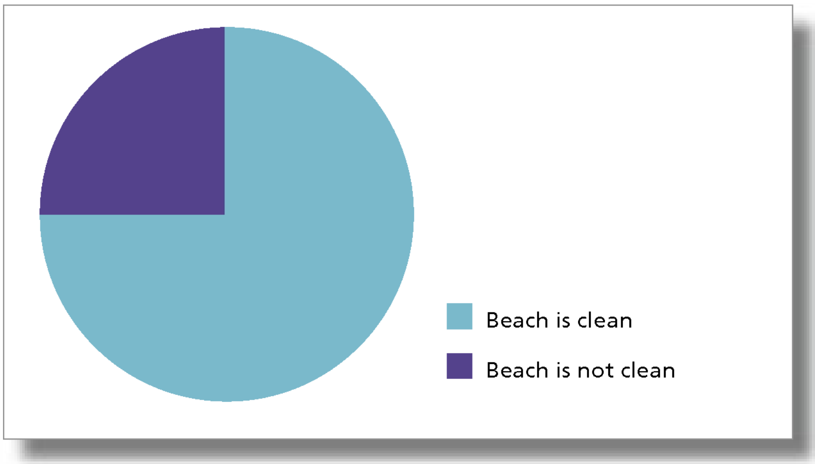
Number of people sampled = 20

Question	Yes	No	Sometimes
Bay is safe for swimming	19	0	1
Water is clean	18	1	1
Beach is clean	15	5	0
Good access	20	0	0
Adequate parking facilities	18	0	2
Bathroom facilities well maintained	9	7	4
Beach is crowded	13	3	4
There is adequate shade	10	7	3
Improvements required: More bathrooms Fewer people Less noise Plant more shade trees			

Thus, in this case the results showed quite clearly that people used this beach because they thought the water was safe and clean, that the beach itself was clean, and that there was good access and parking facilities. However, there was a need to keep the bathrooms cleaner and to provide more shade, and some people felt the beach was too crowded. Finally there were requests for improvements to the beach.

Graphs can be prepared to illustrate the answers to the different questions (see example in Figure 13 below).

Figure 13
Pie graph showing users' views on beach cleanliness.



Plastic and other debris on the beach at Petit Martinique, Grenada, 2000, looks unsightly and eventually washes into the sea and impacts marine life.

7 Beach debris

Background

Beach debris includes garbage left behind by beach users, as well as materials – both natural and man-made – washed onto the beach by the waves or transported by rivers. Such materials may include tree trunks or branches; seaweed and seagrass; tarballs, which are large or small pieces of tar (solidified oil) and are usually soft to touch; pieces of boat; plastic oil containers etc. The presence of litter such as plastic bottles, snack wrappers and sewage-related debris on beaches and in the water is unattractive, has health and economic impacts on beach users and local communities, and is potentially harmful to marine wildlife through entanglement and ingestion.

Bobbins of thread washed up from a container onto the beaches of Anegada, British Virgin Islands, in 1990. When unravelled, the thread made thick underwater mats endangering some marine life.

ACTIVITY 7.1 Measuring beach debris

What and how to measure

Select a point behind the beach and mark off a straight line across the beach towards the sea; this is called a transect line. Collect all the debris found 5 yds (5 m) on each side of this line. Sort the debris into different groups using the categories listed in Figure 14. This figure shows the Beach cleanup data card used by the Ocean Conservancy in their International Beach Clean-ups. Record, count and measure all the debris found within 5 yds (5 m) of the transect line. If you do not have a set of weighing scales available, then count the number of items.

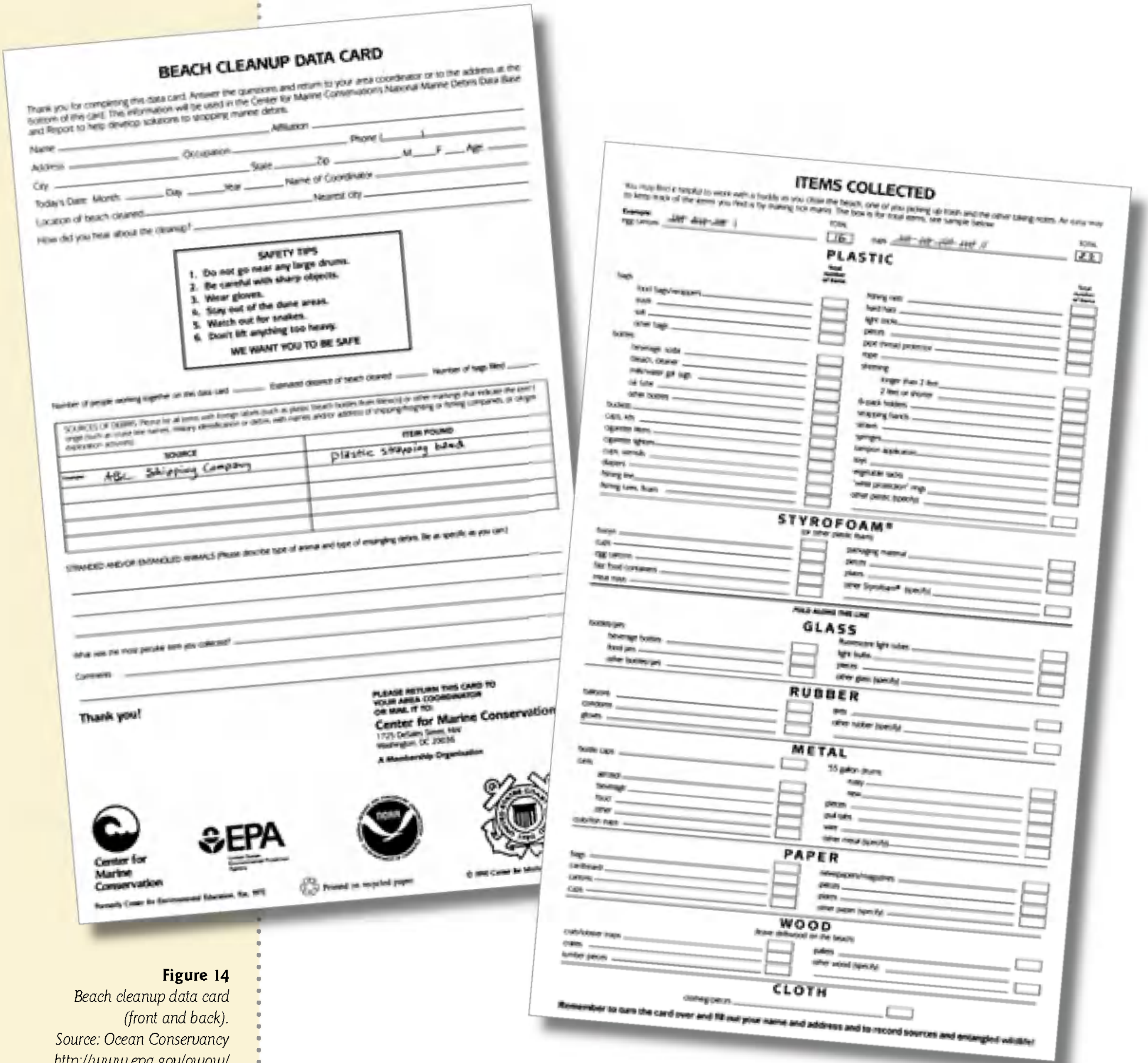


Figure 14
Beach cleanup data card (front and back). Source: Ocean Conservancy http://www.epa.gov/owow/oceans/debris/floatingdebris/append-d2.pdf

(See also Annex 3, to reproduce for classroom purposes.)

You may also wish to add tarballs to the list of items since these are often numerous on exposed ocean beaches. Tarballs can be recorded in the same way as other debris items, and if these are of particular interest, or they represent a special problem at the beach, they can be counted and the diameter along the longest axis measured.

Record the location of the transect so as to be able to return to the same point at a future date. Several transects may be set up on one beach.

It is important to take adequate safety precautions when conducting marine debris surveys. Gloves should be used, and students should be cautioned not to touch anything they may be suspicious about, e.g. any container marked with poison, or syringes.

Once the debris has been recorded, be sure to dispose of it in a proper garbage receptacle.

When to measure

The surveys can be done just once, or they can be repeated and done at different beaches to provide comparative data. They can also be combined with beach cleanups – see the next activity.

What will the measurements show

The measurements will show first of all the total amounts and different types of debris at a particular beach, and if repeated at different times of the year, they will show variations over time.

Discuss the possible origins of the materials collected. Divide the materials into three groups:

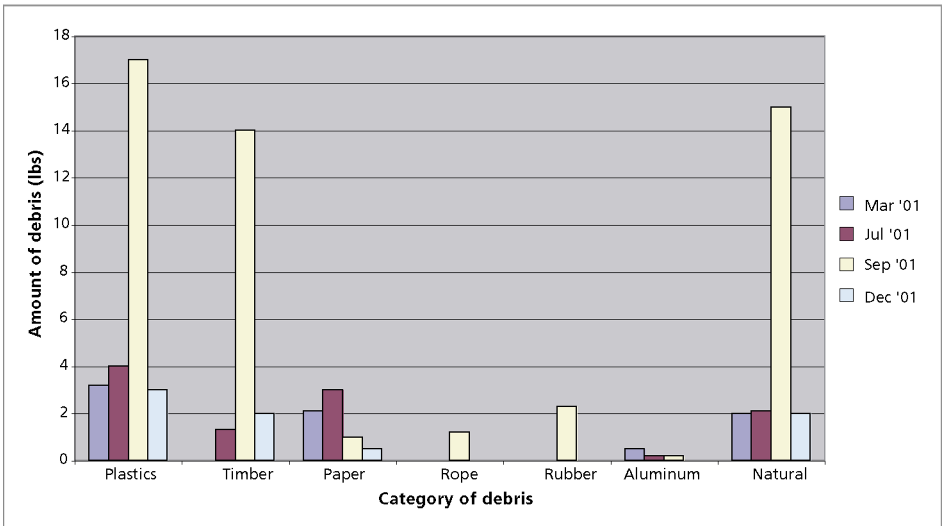
- group 1: debris that came from the sea, e.g. fishing floats, plastics with labels showing they were made in a different country;
- group 2: debris that came from careless beach users or nearby communities, e.g. cigarette filters, styrofoam containers;
- group 3: debris that might have come from either group 1 or 2, e.g. pieces of rope and timber, packing material.

Discuss which group is largest and why.

Patches of oil on the beach at Long Bay, Beef Island, British Virgin Islands, 1991.

If you measure debris at different times of the year you might be able to relate the amounts of various categories of debris to weather events. Again it might be possible to relate the amount of debris and the various categories of debris to wave and weather conditions (see Chapter 9). For instance, tarballs might only appear at certain times of the year. Figure 15 shows a sample graph of some debris surveys conducted at different times of the year and the graph shows large increases in the volume of debris after a hurricane passed over the island in September.

Figure 15
Bar graph showing beach debris changes.



You can also discuss how to inform beach users and the rest of the community about the negative impacts of littering and to encourage them to keep the beaches clean. Chapter 12 describes some actions taken by a primary school in Dominica after undertaking a debris survey.

ACTIVITY 7.2 Conducting a beach cleanup

Beach cleanups can be done at any time of the year. You might also want to consider taking part in the International Beach Cleanup organized by the Ocean Conservancy (formerly the Center for Marine Conservation). They organize beach cleanups in many parts of the world in September each year. The activity focuses on educating and empowering people to become a part of the marine debris solution and consists of data collection (see the data cards referred to in Figure 14) as well as cleaning the beach.

Debris piled up at the back of the beach at Morne Rouge, Grenada, 1999.

Some points you might want to keep in mind when doing a clean-up activity are the following:

- Take photos of the beach before and after the cleanup.
- Combine data collection with the cleanup – see activity 7.1.
- Try and involve students, their parents and nearby communities in the cleanup.
- Encourage everyone to wear gloves and not to touch any potentially dangerous items.
- Provide food and drink.
- Take into account the temperature at the beach; it may be best to conduct a cleanup early in the day when it is cooler.
- Ensure there are sufficient garbage bags.
- Make arrangements in advance for the garbage and debris to be removed to a proper waste disposal site.
- Inform the press to get maximum publicity.
- Make the activity fun.

A clear, blue sea does not necessarily indicate clean water, South Friar's Bay, St Kitts, 2002.

Runoff from coastal development and discharges from boats are among the potential sources of pollution in coastal waters, Cane Garden Bay, Tortola, British Virgin Islands, 1990.

8 Water quality

Background

The condition or quality of coastal waters is very important for health and safety reasons and also for visual impact. Disease-carrying bacteria and viruses (or pathogens) associated with human and animal wastes pose threats to humans by contaminating seafood, drinking water and swimming areas. Eating seafood and even swimming can result in hepatitis, gastrointestinal disorders, and infections. There are several sources of bacterial contamination in coastal waters, e.g. leaking septic tanks, poorly maintained sewage treatment plants, discharges from boats, and runoff from the land during heavy rains and storms.

Water quality also depends on the level of nutrients. These are dissolved organic and inorganic substances that organisms need to live. The most important nutrients of concern in coastal waters are nitrates and phosphates. In excessive quantities these can cause the rapid growth of marine plants, and result in algal blooms. Sewage discharges, and household and commercial waste that is carried to the sea by storm runoff, add excess nutrients to coastal waters. Detergents and fertilizers supply high quantities of nutrients to streams and rivers and ultimately the marine environment.

The visual quality of the water is also important; a beach environment is much more attractive when the water is clear and one can see the sea bottom. However, even clear water may sometimes be polluted. Rivers and streams often carry a heavy load of sediment (soil particles) to the sea, and in many countries, the nearshore waters may turn a brown colour after heavy rainfall.

ACTIVITY 8.1 **Measuring water quality**

What to measure

There are a number of simple indicators which can be used to measure water quality. These are:

- Faecal coliform bacteria: naturally present in the human digestive tract, but rare or absent in unpolluted water;
- Dissolved oxygen: needed by all aquatic organisms for respiration and their survival;
- Biochemical oxygen demand: a measure of the quantity of dissolved oxygen used by bacteria as they break down organic wastes in the water;
- Nitrate: a nutrient needed by all aquatic plants and animals to build protein;
- Phosphate: also a nutrient, and needed for plant and animal growth;
- pH: a measure of the acidic or alkaline properties of the water;
- Temperature;
- Turbidity: a measure of the amount of suspended matter and plankton in the water.

How to measure

There are many sophisticated field and laboratory methods to measure water quality, and there are also simple kits that can be purchased which measure quantitatively the various indicators described above. One such kit referred to in Annex 1 is designed for testing salt and brackish waters for coliform bacteria, salinity, dissolved oxygen, biochemical oxygen demand, nitrate, phosphate, pH and turbidity. The kit comes with all reagents and components to test 10 water samples together with complete instructions, colour charts and safety information. Similar kits are also available for freshwater. Since the kits vary with different manufacturers, no attempt is made here to describe the step by step instructions – rather the reader is referred to the detailed instructions that come with the kit. These kits are designed for schools and citizen monitoring groups and are very easy to use.

Measuring water quality at Old Point Regional Mangrove Park in San Andres.

Collecting the water sample properly is very important to ensure that correct results are obtained. Collect the water sample in a sterile, wide mouthed jar or container (approximately 1 litre) that has a cap. If possible, boil the sample container and cap for several minutes to sterilize it and avoid touching the inside of the container or the cap with your hands. The container should be filled completely with your water sample and capped to prevent the loss of dissolved gases. Test each sample as soon as possible within one hour of collection. When possible, perform the dissolved oxygen and biochemical oxygen demand procedures at the monitoring site immediately after collecting the water sample.

The collection procedure is as follows:

- Remove the cap of the sampling container.
- Wear protective gloves and rinse the bottle 2–3 times with the seawater.
- Hold the container near the bottom and plunge it (opening downward) below the water surface.
- Turn the submerged container into the current or waves and away from you.
- Allow the water to flow into the container for 30 seconds.
- Cap the full container while it is still submerged; remove it from the sea immediately.

When to measure

The kits only have a limited supply of tests; however, there are some indicators such as temperature and turbidity which do not require specific reagents or chemicals and can be measured as many times as desired. It is important to design the monitoring programme based on the number of tests/kits available, e.g. if one kit only has enough materials for 10 phosphate tests, and two samples are measured each time, then this will allow five tests over the monitoring period. When measuring water samples, it is advisable to collect two sets of water samples and duplicate each test. This way more students can be involved and sample duplication also provides for added reliability of the results.

What will the measurements show

The measurements will show variation in the water quality indicators over a period of time. The accompanying box gives some ideas on interpreting what the indicators signify. It is not necessary to measure all the indicators described; a school group may wish to select just two or three.

Understanding water quality indicators

Faecal coliform bacteria themselves are not harmful; however, they occur with intestinal pathogens (bacteria or viruses) that are dangerous to human health. Hence, their presence in water serves as a reliable indicator of sewage or faecal contamination. These organisms may enter waters through a number of routes, including inadequately treated sewage, stormwater drains, septic tanks, runoff from animal grazing land, animal processing plants and from wildlife living in and around water bodies.

Dissolved oxygen is an important indicator of water quality and is measured as percentage saturation. Much of the dissolved oxygen in water comes from the atmosphere. After dissolving at the surface, oxygen is distributed throughout the water column by currents and mixing. Algae and rooted aquatic plants also deliver oxygen to water through photosynthesis. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen. For instance, cold water can hold more oxygen than warm water, and high levels of bacteria from sewage pollution can cause the percentage saturation to decrease.

Using a kit to measure water quality, St Lucia, 2001.

Biochemical oxygen demand – in general, the higher the biochemical oxygen demand, the worse the quality of the water. Natural sources of organic matter include dead and decaying organisms. However, human activities can greatly increase the available organic matter through pollution from sewage, fertilizers or other types of organic wastes. The decomposition of organic wastes consumes the oxygen dissolved in the water – the same oxygen that is needed by fish and shellfish.

Nitrate – excess nitrate will cause increased plant growth and algal blooms, which may then out-compete with the native submerged aquatic vegetation. The excess algae and plants may smother the habitat used by the aquatic fauna and their decomposition can lead to oxygen depletion. Sources of nitrate in coastal waters include runoff containing animal wastes and fertilizers from agriculture, and the discharge of sewage or waste effluents.

Phosphate is a fundamental element in metabolic reactions. Sources and effects of excess phosphates are similar to those of nitrates. High levels may cause overgrowth of plants and increased bacterial activity and decreased dissolved oxygen levels.

pH – the pH scale ranges from 0–14. 0 is very acidic and 14 is very alkaline; freshwater usually has pH values between 6.5 and 8.2. Most organisms have adapted to life in water of a specific pH and may die if it changes even slightly. The pH level can be affected by industrial waste, agricultural runoff or drainage from unmanaged mining operations.

Temperature affects many physical, biological and chemical processes, e.g. the amount of oxygen that can be dissolved in water, the rate of photosynthesis of plants, metabolic rates of animals, and the sensitivity of organisms to toxic wastes, parasites and diseases. It is most often measured in degrees Celsius. Many factors affect water temperature. These include changes in air temperature, cloudiness and currents. Wastes discharged into water can also affect temperature if the effluent processing or treatment temperature is substantially different to the background water temperature. For example, discharges of water used for cooling in industrial processes can be considerably warmer than the water into which they are discharged.

Turbidity is often measured in arbitrary units called Jackson Turbidity Units (JTU). Suspended matter usually consists of organic debris, plankton and inorganic matter, e.g. clay, soil and rock particles. Turbidity should not be confused with colour, since darkly coloured water can still be clear, not turbid. High turbidity affects the aesthetic appeal of waters, and in the case of recreational areas may obscure hazards for swimmers and boaters. Its environmental effects include a reduction in light penetration which reduces plant growth, and in turn reduces the food source for invertebrates and fish. If turbidity is largely caused by organic particles, their microbial breakdown can lead to oxygen depletion.

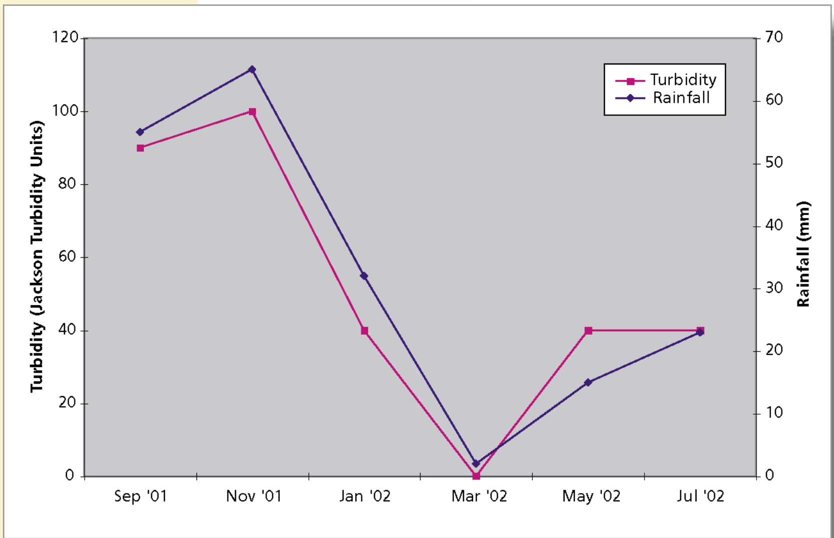


Figure 16
Line graph showing turbidity and rainfall changes over time.

One example might be to see how turbidity conditions vary between the rainy season and the dry season, e.g. the turbidity may be higher during the rainy season when storm runoff is high and excess organic and inorganic materials are carried into the sea. Such a case is shown in Figure 16. Rainfall records can be obtained from the local/national meteorological office.

It is important to realize that water quality measurements often show considerable variation, and tests need to be repeated to verify the results. Furthermore, if water quality problems such as high coliform bacteria readings are found at a local beach, the first step should be to contact the local environmental and health authorities.

High waves at Rincón, Puerto Rico, December 2004.

9

Wave characteristics

Background

Waves are the main source of energy that causes beaches to change in size, shape and sediment type. They also move marine debris between the beach and offshore zone. Waves are generated by the wind blowing over water. Waves formed where the wind is blowing are often irregular and are called ***wind waves***. As these waves move away from the area where the wind is blowing, they sort themselves out into groups with similar speeds and form a regular pattern known as *swell*.

ACTIVITY 9.1 **Measuring waves**

What to measure

The three main characteristics of waves are the height, the wavelength and the direction from which they approach. Figure 17 shows a diagram of a simple wave. Wave height is the vertical distance from the crest of the wave to the trough. Wave period is the time measured in seconds between two successive wave crests. Wave direction is the direction from which the waves approach.

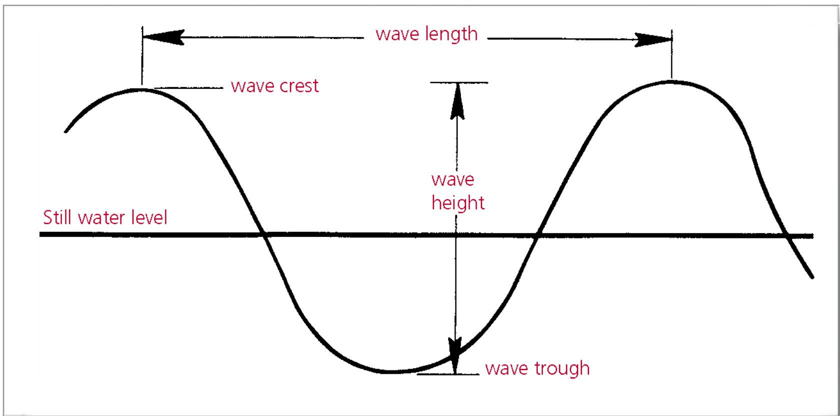
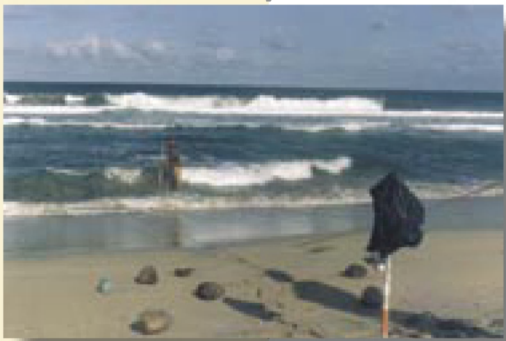


Figure 17
Characteristics of a wave (adapted from US Army Corps of Engineers, 1981a).

How to measure

Wave height is measured by having an observer with a graduated staff or a ranging pole (pole with measured sections in red and white) walk out into the sea to just seaward of where the waves are breaking, and then to have the observer record where the wave crest and the following wave trough cut the staff; the difference between the two is the wave height. Alternatively, an estimate may be made of the wave height. Such estimates can be made in imperial or metric units, whichever the observer feels most comfortable with. Often it is best to have two observers independently estimate wave height and then to compare their results. The height of at least five separate waves should be estimated and the average taken.



Measuring wave height at Grande Anse, St Lucia, 1990.

Wave period is the time in seconds for eleven wave crests to pass a fixed object, or if no such object exists, the time for eleven waves to break on the beach. Use a stopwatch if available, or a wristwatch with a seconds hand. Start the timing when the first wave passes the object or breaks on the beach, and stop it on the eleventh. Divide the total number of seconds by ten to get the wave period.

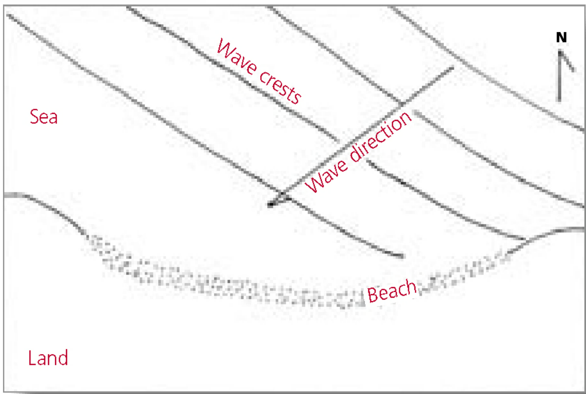


Figure 18
Wave direction.

Wave direction is the direction from which the waves approach and is measured in degrees. This can be measured with a compass, standing high up on the beach and sighting the compass along the direction from which the waves are coming, which will be at right angles to the wave crests (see Figure 18).

When to measure

This will depend on the time available and the nature of the monitoring activity. Waves change from day to day, so daily measurements are the most useful. However, if time is not available for daily measurements, weekly measurements or even twice-monthly measurements can still provide useful data.

What will the measurements show

The measurements will show how the wave characteristics change over time. Depending on how often the data are collected, the measurements can be averaged over weeks or months and plotted on graphs. If beach width or marine debris is also being measured, it may be possible to correlate changes in the width of the beach or the amount of debris with the wave height. It may also be possible to pick out seasonal changes from the data such as the time of year when the waves are highest (see Figure 19).

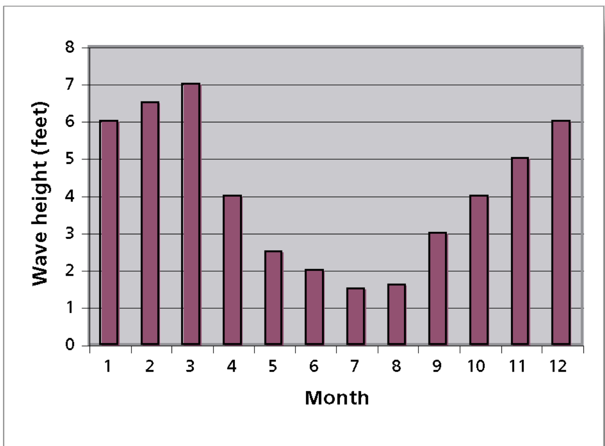
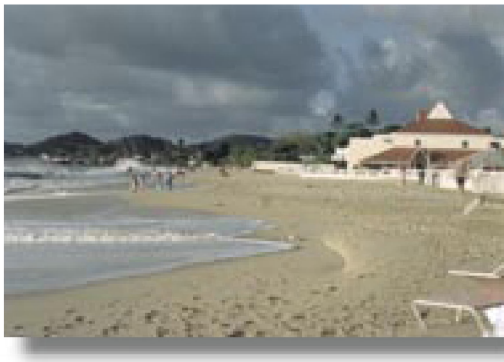


Figure 19
Bar graph showing wave height variations over time.

Waves vary according to the time of year. Small low waves were observed at Reduit, St Lucia, in May 2001 (right), while higher waves were observed in February 1990 (far right).



ACTIVITY 9.2 Watching out for a tsunami

Learning about tsunamis

In the aftermath of the Indian Ocean tsunami that occurred on 26 December 2004, most people are now aware of these phenomena. Tsunamis are extremely high waves (sometimes referred to as tidal waves) that are caused by earthquakes or huge undersea landslides. They are rare events. They occur most frequently in the Pacific Ocean where a tsunami warning system has been established. However, they have also been recorded in historic times in the Atlantic and Indian Oceans and in the Caribbean Sea. There are now plans to install tsunami warning systems in these areas.

Tsunami warning sign, Rincón, Puerto Rico, June 2004. (Translation: Danger zone, earthquake/tsunami. In case of an earthquake, move to a high place or move away from the coast.)

During tsunamis, low-lying coastal areas, those below 20 ft (6 m) in height, may be flooded. However, because of the speed at which tsunami waves travel (500 mph or 800 km/hr) an earthquake off the Venezuelan coast might result in a tsunami reaching some Caribbean islands within minutes. Thus, knowing the warning signs could result in saving lives. One of the best warning signs is the earthquake itself, though it should be noted that not every earthquake generates a tsunami. A second warning sign is when the sea recedes – before the arrival of the tsunami wave(s), the sea recedes a considerable distance leaving a significant portion of the seabed dry. If you are at the beach or near the shore, and you see either or both of these warning signs, run inland for higher ground and alert as many people as possible.

Discussion topics and beach activities

- Get the students to research tsunamis that have affected their country within historic times.
- When was the last tsunami to affect your country and was there any damage or loss of life?
- Discuss whether there has been a lot of coastal development in your country since the last tsunami.
- Ask the students if they know the tsunami warning signs and ask them to find out if their parents are aware of these signs.
- Visit the beach and determine how far inland a tsunami wave, such as occurred in the Indian Ocean on 26 December 2004, might reach; how many buildings might be flooded; how many people would be at risk.

Measuring longshore currents with fluorescent dye, St Lucia, 2001.

10 Currents

Background

While waves are the most important process moving sediment particles on a beach, currents also have a role to play.

ACTIVITY 10.1 Measuring longshore currents

What to measure

When the waves approach the beach at an angle, they generate a longshore current which moves parallel to the beach (see Figure 20). While this current is not in itself strong enough to pick up sediment particles from the sea bottom, it can move material that has already been stirred up by the waves.

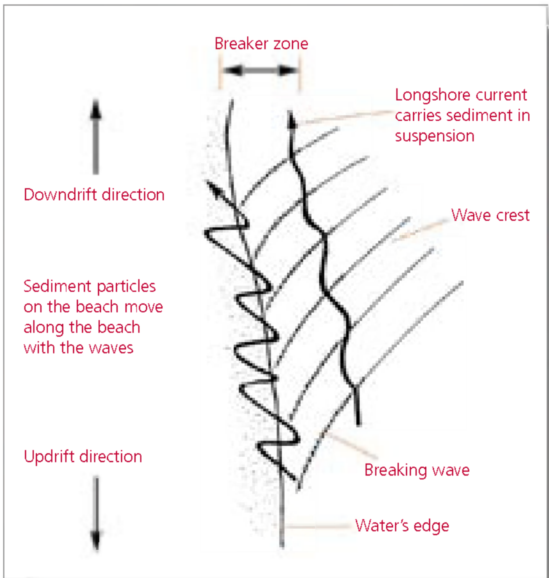
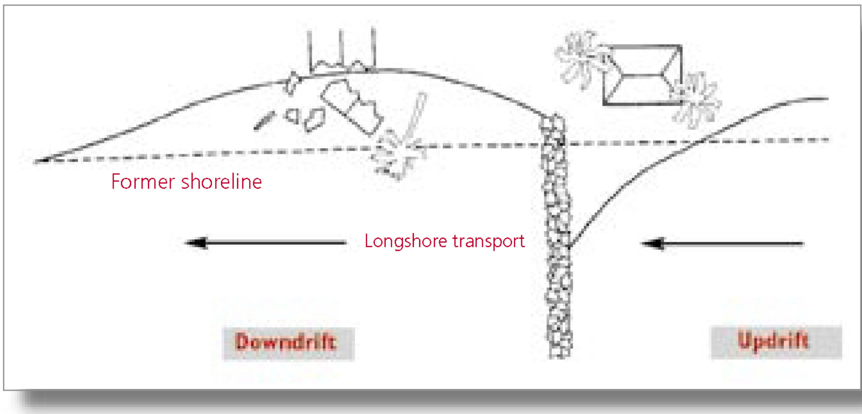


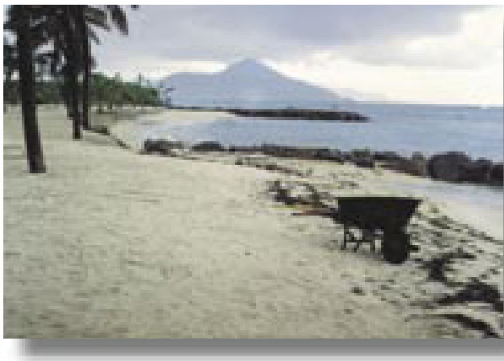
Figure 20
Longshore currents (adapted from US Army Corps of Engineers, 1981b).

The longshore current is responsible for moving material from one part of the beach to another. When a structure such as a jetty or groyne is built out into the sea, this longshore current results in sand building up on one side of the structure (see Figure 21).

Figure 21
Effect of a groyne on longshore transport (adapted from Bush et al., 1995).

Photo: Groyne at Nisbett Plantation, Nevis, 1992. The sand has built up on the updrift side of the groyne in the foreground, while the waves reach further inland on the downdrift side as a result of erosion.





Measurements of longshore currents are best combined with wave measurements. So if longshore currents are being monitored, then waves should also be measured (see Chapter 9). Together, these provide a picture of the processes moving sand around on the beach.

The longshore current flows in a direction roughly parallel to the beach, near where the waves break. The current speed and direction can be measured. Current speeds are recorded in feet per second or cm per second. Current direction is recorded in degrees and is the direction towards which the current is going. So if a current is going from north to south, the current direction is recorded as south or south-going; similarly, a current going from east to west is recorded as west or west-going. (This is opposite to wind and wave direction, which are recorded as the direction from which the wind is blowing or the waves are coming.)

How to measure

Place a stick in the sand near the water's edge. One observer walks into the water from the stick and places the dye tablet in the water, as near as possible to where the waves are breaking. The observers on the beach stand by the stick, watch the coloured water and observe the direction in which it moves. After one minute, the maximum distance the coloured water has moved is measured along the beach starting from the stick. This is recorded. The measurement is made again after 2 minutes and after 5 minutes.

The distance moved after five minutes is used to determine the current speed in ft/second or cm/second. The direction in which the dye moved must also be recorded.

These measurements can be repeated at several different places along the beach to see if the current speed and direction is the same or whether it varies.

If the dye does not move much, but just remains in a pool near the stick, then this means there is no longshore current on that day.

When to measure

As with the wave measurements, this will depend on the nature of the monitoring and the time available. While the time is not likely to be available for daily measurements, weekly or twice monthly measurements will yield some interesting information.

What will the measurements show

The measurements will show how the longshore current varies over time, and how it changes with the wave height and direction. For instance, if the waves usually approach a beach from the south, and it is only during winter storms that the waves come from the north, then monitoring currents and waves during the normal southerly wave regime and the less frequent northerly storm wave regime, will yield some interesting results. It may be possible also to relate these variations to visual changes in the sand build-up on the beach or measurements of beach width (see Chapter 4).

Figure 22 shows current speed and direction based on once/month measurements in 2000. The speed was highest in the winter months when the current direction was south-going. While in the middle months of the year, the current speed was lower and the direction of current movement was north-going.

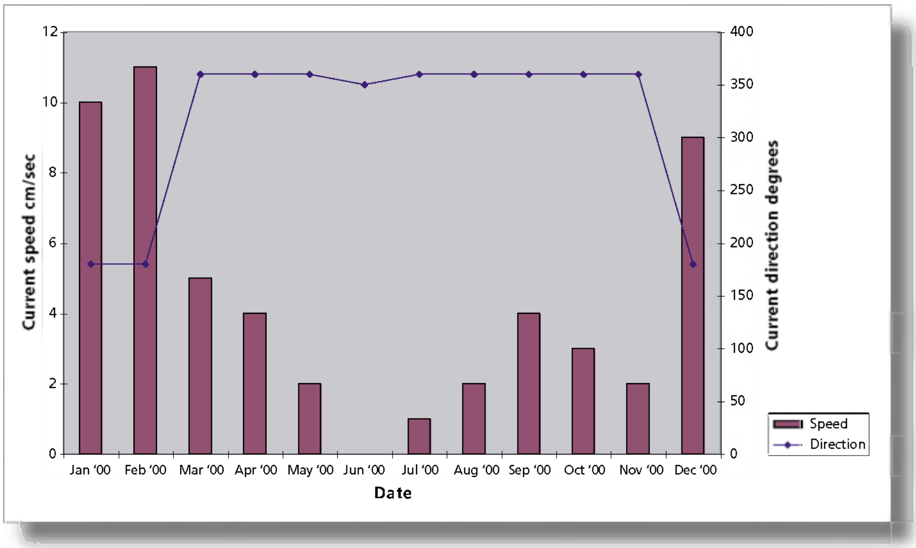


Figure 22
Mixed graph showing current speed and direction.

Further activities

Relate the direction of the longshore current to the source of beach material (see also Chapter 5); possibly some of the material at the monitored beach originates from an adjacent beach or coral reef.

Discuss the impact of groynes and jetties in your area and the role of longshore currents. Often beachfront home owners build such structures to try and protect their homes, but sometimes homeowners on the other side of the groyne or jetty may experience erosion as a result of the structure. Discuss such measures in the context of the entire beach, not just the affected homeowners.

Suggest the students carry out research into who owns the beach in your country. What does the law say? Are there any particular building restrictions near beaches so as to protect the public's right to use the beach?

*Green turtle (*Chelonian mydas*) returning to the sea after nesting, English Bay, Ascension Island, February 2004.*

11 Plants and animals

Background

While at a glance beaches may appear as barren stretches of sand, in reality they are diverse and productive transitional ecosystems that serve as a critical link between marine and terrestrial environments.

The sandy beach is an unstable environment for plants and animals, largely because the surface layers of the beach are in constant motion as a result of waves and wind. This also means that organisms that live there are specially adapted to survive well in this type of environment. Many burrow in the sand for protection from waves or to prevent drying out during low tide. Others are just visitors, such as birds and fishes. While different animals are found in different zones, they often move up and down the beach with tides. Hence, zonation patterns along sandy shores are not as clearly defined as on rocky shores.

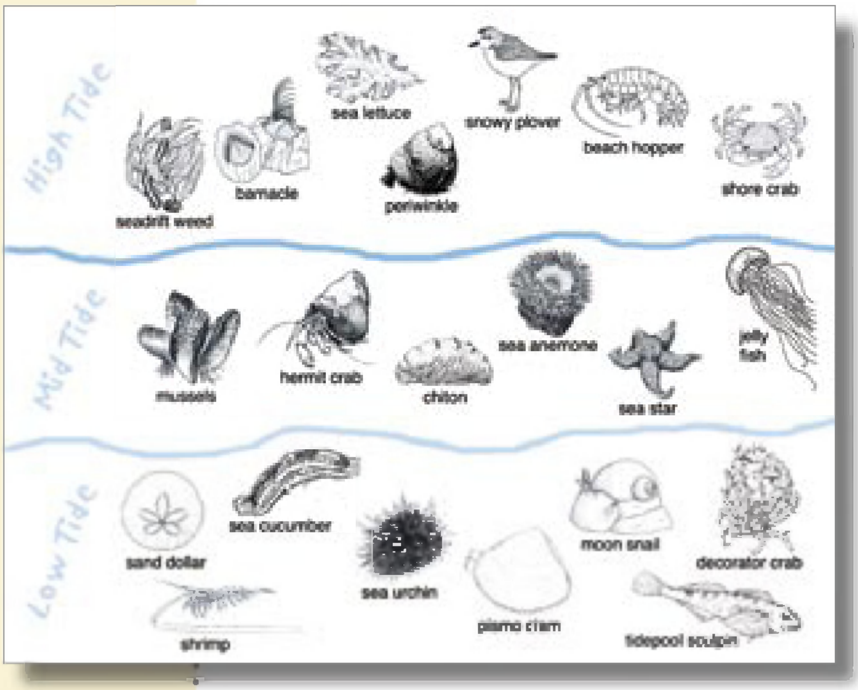


Figure 23 *Common plants and animals found between the high and low water mark. (Illustration compiled by Aurèle Clemencin)*

ACTIVITY 11.1 Observing and recording plants and animals on the beach

Collect, observe and record

For this activity, give the students plastic bags and ask each of them to collect ten different objects from the beach and to record where on the beach each object was found. In addition you may also ask them to record five different plants they see and five different animals; if they cannot identify a particular plant or animal, suggest they make a sketch.

Identify the collected items

Back in the classroom, get the students to separate biological from non-biological items, and plants from animals. Then ask them to identify the items in their collections. Once this has been completed and discussed, ask each student to select one of the plants or animals they collected and to describe it – shape, colour, size – and draw a picture of it. As a further activity, ask the students to research its habits – diet, movement, reproduction, protection – and note any unusual or interesting features. Include ways in which it might be affected by humans and how it might be protected.

Understand the beach ecosystem

The beach ecosystem represents the interaction between the biological organisms and the physical environment in the beach area. Thus the birds and the crabs are as much a part of the ecosystem as the sand and the waves. Learning how the different components interact and depend on each other is the study of ecology.

Use the organisms collected on the beach to build a food chain to show how the various plants and animals interact within the ecosystem and how energy passes from one organism to another. Figure 24 shows a simple food chain.

Figure 24
Simple food chain.

Sun	Sun
↓	↓
Plants (producers)	Algae in coral and seagrass
↓	↓
Plant eaters (herbivores)	Parrot fish, Green turtle
↓	↓
Meat eaters (carnivores)	Sharks, Barracuda

ACTIVITY 11.2 Understanding the role of coastal vegetation

What to measure

Vegetation on the beach and behind the beach plays an important role in helping to stabilize the beach and prevent erosion.

Landward of the highest high water mark, vines and grass predominate and the sand runner or goat-foot (*Ipomoea pes-caprae*), a long trailing vine, is often found colonizing the sand surface. Other species of vines, herbs and shrubs occur in a landward direction. Further inland there are coastal trees, such as seagrape (*Cocoloba uvifera*), seaside mahoe (*Thespesia populnea*), coconut palms (*Cocos nucifera*), manchineel (*Hippomane mancinella*) and the West Indian almond (*Terminalia catappa*). The change from low vines and grasses to mature trees is known as a vegetation succession.

How to measure

Identify the vegetation succession at the beach. Lay out the tape measure starting at the seaward edge of the vegetation and, at 2 yd (2 m) intervals, note down the number of plant species present and identify them or describe them if names are not known. Note particularly if any plants appear to be stressed, e.g. roots exposed or brown leaves.

When to measure

This activity may be carried out once only, or perhaps repeated after a severe storm.

What the measurements will show

Use the data collected to try and develop a vegetation succession. A typical coastal succession is shown in Figure 25. Discuss the environmental conditions in the different zones, e.g. the frontal zone may be subject to wave action during storms and will receive the full force of the salt spray (or sea blast), while the forest zone may be more protected from the salt spray and the wind, and the soil and nutrient conditions may be better.

Then ask the students to forecast what would happen to the beach environment if all the vegetation was removed for a new development project such as a 100+ room hotel complex.

Vegetation succession, Rarotonga, Cook Islands, 2003. Here the grasses and vines give way almost immediately to the coastal woodland.

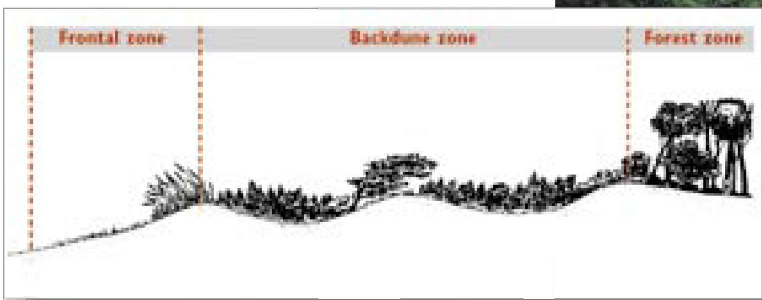


Figure 25
Vegetation succession: The frontal zone is covered with grasses and vines, which gives way to shrubs and herbaceous plants and eventually the coastal woodland (adapted from Craig, 1984).

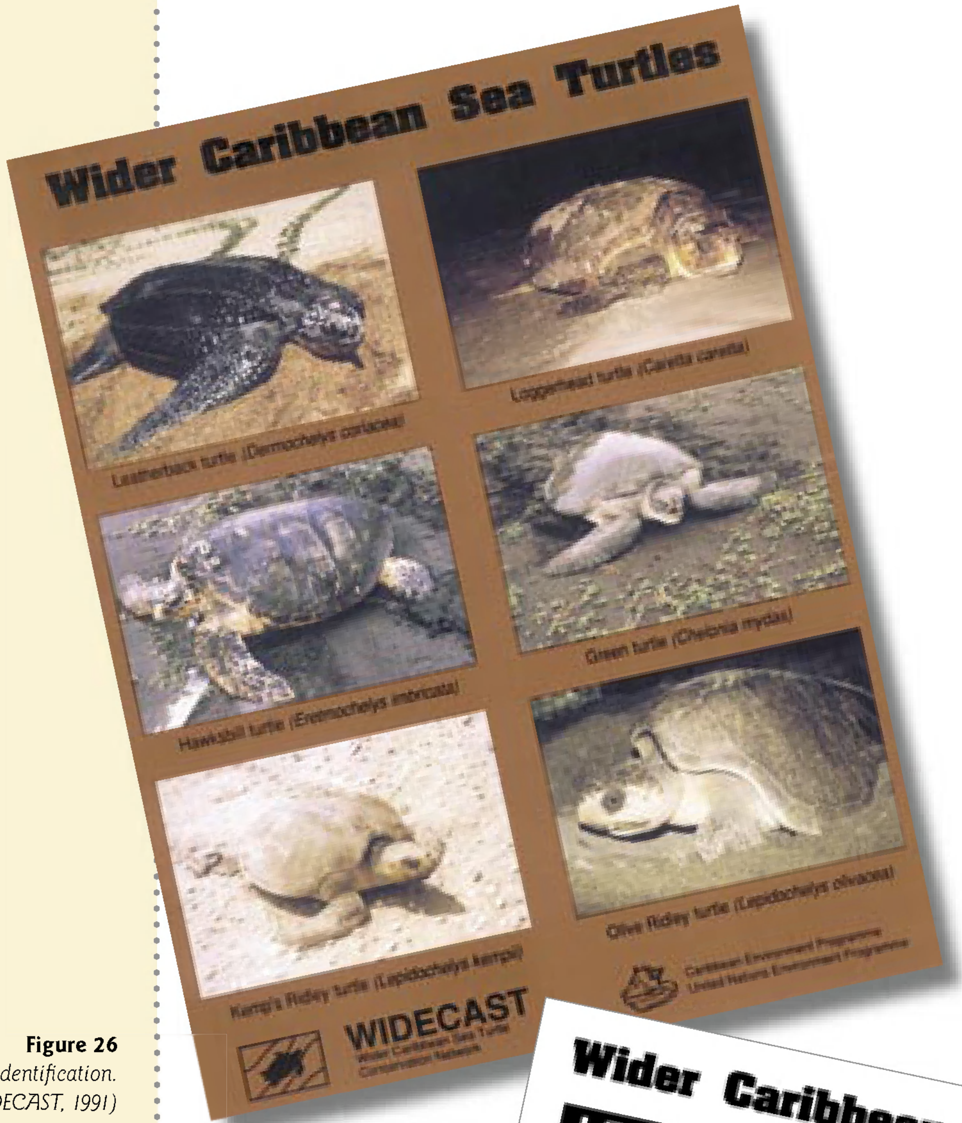
ACTIVITY 11.3 Monitoring beaches for nesting turtles

What to measure

Many tropical sandy beaches are used for nesting by sea turtles. The most common species are:

Leatherback turtle (*Dermochelys coriacea*)
Hawksbill turtle (*Eretmochelys imbricata*)
Green turtle (*Chelonia mydas*)
Loggerhead turtle (*Caretta caretta*)
Kemp's Ridley turtle (*Lepidochelys kempii*)
Olive Ridley turtle (*Lepidochelys olivacea*)

At night-time, female turtles come up onto the beach, make nests at the back of the beach or in the vegetation behind the beach and lay their eggs in the sand. The period for nesting differs according to the species and the geographical area of the world. After the eggs have been laid, the female covers the nest with sand and returns to the sea. Between 55 and 72 days later the hatchlings emerge and make their perilous journey down the beach to the sea.



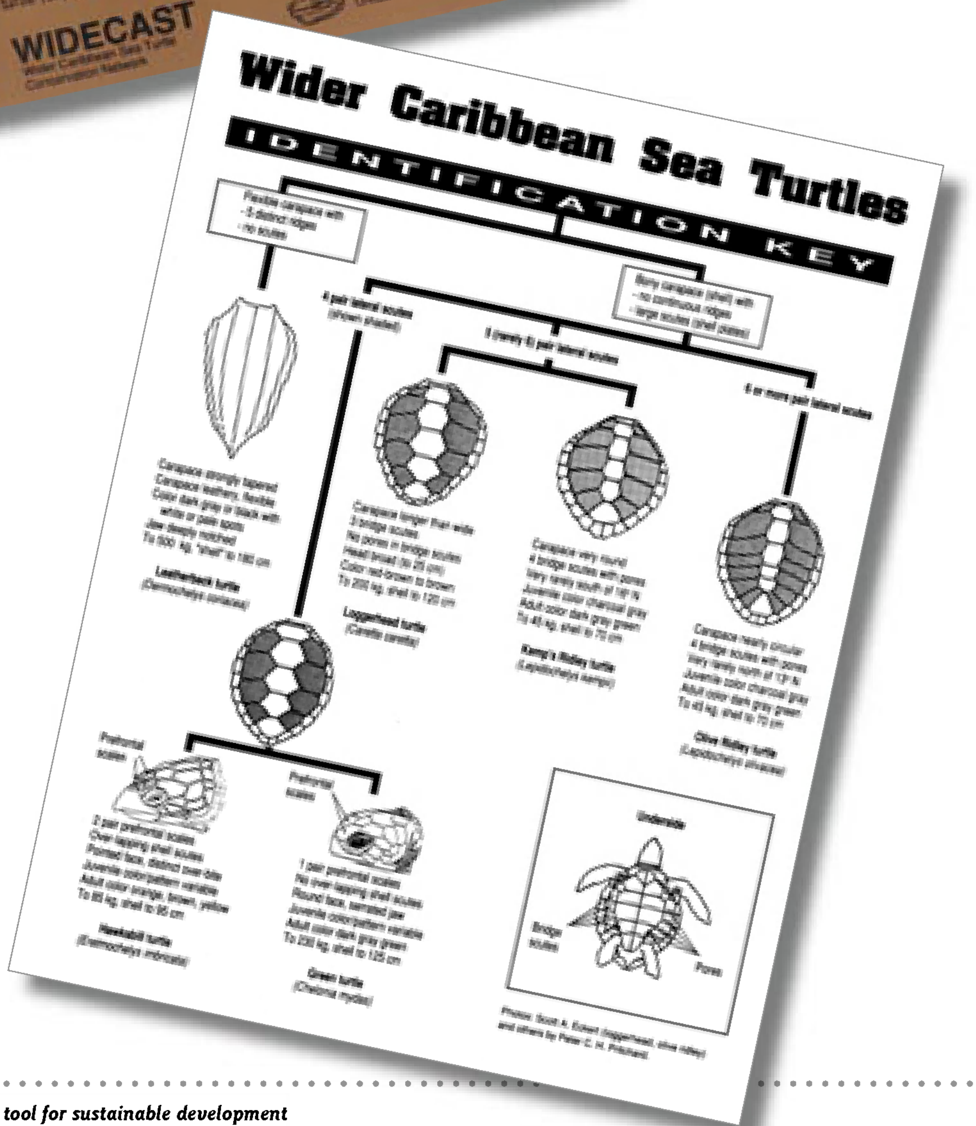


Figure 26
Sea turtle identification. (Source: WIDECAST, 1991)

(See also Annex 4, to reproduce for classroom purposes.)

Right: Turtle tracks at Long Beach, Ascension Island, February 2004.

Far right: Safeguarding a turtle nest on a busy tourist beach, Bayibe, Dominican Republic, 2000.

Many of these turtles are endangered because of over-harvesting in the past, and many countries have programmes to conserve marine turtles and their eggs.

Monitoring may consist of night-time watches at key nesting beaches, monitoring beaches early in the morning for evidence of turtle tracks and monitoring nesting activity for emerging hatchlings.

How to get involved in monitoring

Check with your environmental agency or local conservation organization if there is a special beach in your country where turtles nest, and what programmes they have to monitor and conserve turtles.

Observing turtle nesting at night, from a safe distance so as not to disturb the female turtle, can be a very exciting experience; as is monitoring the nest to see the hatchlings emerge and make their journey to the sea.

In some areas, key turtle nesting beaches are monitored during the turtle nesting season to observe and record turtle tracks and evidence of successful nesting.

Follow-up activities

If students take part in any aspect of turtle monitoring, there are many areas where they can conduct further work and research; here are just a few ideas:

- Conduct research to find out which turtle species nest in your country and how many successful nests are laid. Compare these figures with historical information.
- Why are sea turtles endangered and what threats do they face?
- What can you do to help conserve marine sea turtles?

Marches and demonstrations help make people aware of environmental issues, as seen here in the British Virgin Islands, in 1992.

12 Sandwatch as a tool for education for sustainable development

Education for sustainable development

The United Nations General Assembly adopted a resolution in December 2002 establishing a Decade of Education for Sustainable Development. The resolution designates the ten-year period 2005–2014, and names UNESCO as the lead agency to promote this decade.

Education for sustainable development (ESD) is a dynamic concept that encompasses a new vision of education that seeks to empower people of all ages to assume responsibility for creating and enjoying a sustainable future. The overall aim of ESD is to empower citizens to act for positive environmental and social change, implying a participatory and action-orientated approach.

ESD integrates concepts and analytical tools from a variety of disciplines to help people better understand the world in which they live. Pursuing sustainable development through education requires educators and learners to reflect critically on their own communities, identify non-viable elements in their lives, and explore tensions among conflicting values and goals. ESD brings a new motivation to learning as people become empowered to develop and evaluate alternative visions of a sustainable future and to work to collectively fulfil these visions (UNESCO, 2003).

During a Sandwatch workshop in Dominica (Cambers, 2003), several islands shared experiences of how they were trying to change the lifestyle and habits of youth and adults on a community-wide basis, and to develop awareness of the fragile nature of the marine and coastal environment and the need to use it wisely. Two of these experiences, which illustrate ways in which Sandwatch is providing examples of ESD in action, are described here.

Community Sandwatch case study from Dominica

The students from Dublanc Primary School in Dominica started Sandwatch monitoring activities in 2003. There were 22 students involved in this project with ages ranging from 8 to 11 years.

Four key questions were put to the students:
1. What are the factors that affect the beach?
2. How do human activities affect the beach?
3. What are the negative impacts these factors have on human life?
4. What can be done to reduce the level of pollution on the beach?

Questionnaire survey – Dublanc Primary School

1. What kind of beach do you enjoy visiting?
2. Why do you enjoy visiting this kind of beach?
3. Do you like going to a beach that is dirty?
4. Where do you think materials used to pollute the beach come from?
5. Have you polluted the beach?
6. How have you polluted the beach?
7. How do you feel when you see someone polluting the beach?
8. Have you encouraged them not to do so?
9. How do they respond?
10. What can you do to help have a better beach?

Messages displayed on placards

- Our beach was great. Now it's a disgrace.
- Do not dump garbage on the beach.
- Beach safety is better than being dirty.
- Protect the beach.
- Faeces make our beach unsafe.
- Now is the time to start taking care of the beach.
- Dispose of your garbage properly, not on the beach.
- Be wise, stop the pollution.
- Keep our beach clean and safe.
- Make our beach a better place.
- Wise up! Come out and clean up.

Students from Dublanc Primary School displaying some of their beach artwork at a Sandwatch workshop in 2003.

Students were taken out to observe the beach, after which they then recorded their observations by drawing pictures of the beach, writing stories and poems.

They conducted a survey of the debris and garbage on the beach, collecting and counting different items. Then a one-on-one interview survey was undertaken with people using the beach.

All survey respondents stated that they appreciated visiting a clean, safe beach. Yet some stated that they had contributed to the appearance of the beach by throwing leftovers, snack wrappers, styrofoam cups and lunch boxes, and bottles. In addition, some people urinated and passed their faeces on the beach. The students said that on several occasions they had seen people disposing of garbage and passing faeces on the beach. Some students tried to influence the polluters, who on occasion responded negatively by swearing and rejecting advice.

The students felt there was a need to sensitize and educate the community about the appearance of the beach and the effects of a polluted beach. So they made placards showing what they had learnt in the project.

Right: Some of the students who took part in the march and their teachers, June 2004.

Far right: Ms Vernessa Hilton standing by a garbage can recently painted by the students.

In March 2003, the entire student body along with the Principal and teachers marched through the community of Dublanc holding their placards and chanting their slogan 'Listen and get it right.' They stopped in areas where people were gathered, such as by the restaurant, health centre, pre-school, fisheries building, and on the street near the homes of villagers. Many community members left their homes and came to find out what was happening.

It was a successful march. The following day community members voluntarily cleaned the beach.

A year later, the school and students were still busy with related activities such as painting garbage cans for the school and community. Furthermore, their efforts had had a lasting impact in that now the community has taken over responsibility for keeping the beach clean and for planting and caring for trees behind the beach.

Community Sandwatch case study from St Vincent and the Grenadines

Students and teachers at Bequia Community High School in St Vincent and the Grenadines have been actively involved in Sandwatch activities for several years.

Most of the teachers at the school are involved in Sandwatch which is integrated into the curriculum – into science and social science, into practical subjects such as woodworking, into mathematics and English, and into information technology. Sandwatch activities have been the subject of recent School-Based Assessments, e.g. measuring coastal erosion was the subject of one assessment for geography, and designing a crushing device for discarded glass bottles was the topic of an assessment for drawing and design.

Through their information technology classes, and in their own after-school time, the Sandwatch students share their activities with other students around the world through the Small Islands Voice Youth Internet forum (www.sivyouth.org with username *view* and password *only*). They have also travelled to other schools in the Grenadines and in mainland St Vincent to share their experiences and train other students in Sandwatch.

Language, drama and arts are other areas where Sandwatch has been incorporated into school subjects. In 2004 a poetry competition focusing on Sandwatch and environmental action encouraged several students to write inspiring poems, nearly all of them with action-orientated messages.

Be environmentally friendly

By Trachia Simmons, Bequia Community High School
First prize winner

Have you ever thought of the things we need in life?
Things to support our children,
Husband and wife?
These things are found above,
Below, before and behind us.
Yes, my friends, the sea and our
Surroundings should be our main focus.

From the land to the sea and wherever land may be,
The environment should be cared for by you and me.
So, we must be sure that we do not indulge in any harmful actions,
Cause little do we know, it would cause serious repercussions.

We spoil the calm, sapphire blue waters we call the Caribbean Sea,
And allow our air to be filled with smoke until it's impossible to see.
We agree everyday to let our natural resources go to waste,
And then feelings of regret will one day take its place.

Advanced countries are only concerned with their industrial economies
They build blast furnaces releasing poisons and they do as they please.
Chemicals of all sorts pour into our lakes and seas,
Destroying our marine life and stunting our trees.
With feelings of these, do you think Mother Nature will be pleased?
How can one relax at home and their mind be at ease?

The ozone layer will soon disappear as quickly as the trees.
Listen good, cause you'll forget where you last heard the buzzing of bees
Think about losing the country's unspoilt beauty
And losing the calmness, quietness and its serenity.

Soon there'll be nowhere left to laugh, walk and talk,
Cause pollution would have removed even our natural parks.
Then it would seem that even the trees don't care
Cause they'll cease to produce blossoms and the fruits that they bear.

So my plea, friends, is that we take matters into our own hands
To stop air, water and land pollution.
Let's put our minds together and come up with useful plans
That would prevent the environment's soon extinction.

Not content with poetry, they have also turned to drama. During a Sandwatch workshop in Dominica in 2003, they presented an inspiring dramatic monologue 'Up from the deep' which was performed to drums. This portrays the ocean responding to decades and centuries of misuse by humans.

Up from the deep

Extract from a dramatic monologue
by Vernette Ollivierre

Written for presentation by Racquel Phillips and Michael Penniston
of the Bequia Community High School, St Vincent and the Grenadines,
at the Second Regional Sandwatch Project Workshop, Dominica 7–9 July 2003

Racquel Phillips and Michael Penniston performing 'Up from the Deep', Dominica, July 2003.

Up from the deep I come, I rise in protest
look at me, I was here at the
beginning of time, that was before time
created at
    the firmament
        above and below
Keeper of the deep
holder of myriad secrets
provider of needs
I've kept the faith
and now, your actions
    will decide my fate

    And so I've come up
        up, up, up
        from the deep
        from your shores
        from the river mouths

To confront you
Caution you
Plead with you
Pardon me if I am no longer
as beautiful as before
But I am adorned with the artefacts
of your generosity

I remember how I cushioned
your budding islands
in my warmth
and nourished your natives
with the richness of my store

Can't we work together?
It is time we work together
in harmony
in rhythm of my water
    lapping your shores
You need to protect me
As I have sustained you

You need to promote conservation
    And cut down on pollution
We need to develop cooperation
In the preservation of marine life
For all generations

Look at me,
    Keeper of the deep
    holder of myriad secrets
    sustainer....provider of needs
I am keeping the faith
Now by your actions reverse my fate

Love me as I love you
    Conserve me
    Preserve me
    Sandwatch me
In all generations to come

Sandwatch does not, however, remain limited to the school environment in Bequia. In 2003, the school won the Commonwealth Youth Award for their efforts to monitor the changes in Bequia's beaches and their role in protecting the environment. Having monitored beach changes for several years now, the Sandwatch group are at times consulted by authorities such as the Planning Department relating to their observations and knowledge about certain beaches. They monitored beaches in the Tobago Cays before and after the filming of the movie 'Pirates of the Caribbean' in order to determine the extent of human impact. They have also voiced their environmental concerns at meetings with the Hotel and Tourism Association.

Other activities have included stabilizing a hillside at Park Bay so the sediment does not wash onto the nearby coral reef, beach cleanups, and glass recycling – making their Sandwatch a real community initiative.

Final comments

These two case studies provide a glimpse of Sandwatch in practice and they also provide examples of community involvement in environmental management initiatives. The case studies are based on detailed observations of beaches, accurate measurements repeated over time, careful recording of the data, and analysis and sharing of the results, all of which lead to a greater scientific understanding of the environment. These same steps are also the basis of environmental management, which is founded on scientific knowledge (both natural and human sciences), and has as its goal, the sustainable use of resources. So that we use those resources wisely, taking what we need for today, whilst always ensuring that sufficient remain for the generations still to come.

Sandwatch provides the potential for students, teachers and community members to work together to critically evaluate the problems and conflicts facing their beach environments, and to develop sustainable approaches for addressing some of these problems. It teaches students to apply their school-based learning to everyday life, to develop skills relating to critical thinking and conflict resolution, and perhaps most importantly instils a sense of 'caring' for their beaches – their environment.

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Glossary

Accretion: accumulation of sand or other beach material due to the natural action of waves, currents and wind; a build-up of sand.
Algae: class of almost exclusively aquatic plants including seaweeds and their fresh-water allies. They range in size from single cell forms to giant seaweeds several metres long.
Algal bloom: an over-growth of algae in water that shade out other aquatic plants and use up the water's oxygen supply; blooms are often caused by pollution from excessive nutrient input.

Bacteria: mostly microscopic and unicellular organisms with a relatively simple cell structure and lacking a nucleus.
Beach: zone of loose material extending from the low water mark or a point landward where either the topography abruptly changes or permanent vegetation first appears.
Biogenic: originating from living forms.
Breaker: a wave as it collapses on a shore.
Breaker zone: area in the sea where the waves break.

Coliform bacteria: widely distributed micro-organisms found in the intestinal tract of humans and other animals, and in soils.
Coral reef: complex tropical marine ecosystem dominated by soft and stony (hard) corals, anemones and sea fans. Stony corals are microscopic animals with an outer skeleton of calcium carbonate that form colonies and are responsible for reef building.
Cliff: high steep bank at the water's edge, often used to refer to a bank composed primarily of rock.
Crustacean: animal, usually aquatic, with two pairs of antennae on the head, jointed legs and a hard shell.
Current: flow of air or water in a given direction.

Dune: accumulation of wind-blown sand in ridges or mounds that lie landward of the beach and usually parallel to the shoreline.

Ecology: study of the relationships between organisms and their environments.
Ecosystem: represents a community of plants, animals and micro-organisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment.
Erosion: wearing away of the land, usually by the action of natural forces.

Feldspar: mineral, mixture of calcium, potassium, alumino-silicates.
Fertilizer: substance added to the soil to increase its productivity.
Food chain: shows how each living thing gets its food and how energy is transferred from one organism to another.

Geology: scientific study of the composition, history and structure of the earth's crust.
Global warming: refers to an average increase in the earth's temperature, which in turn causes changes in climate.
Greenhouse gases: Any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, halogenated fluorocarbons, ozone, perfluorinated carbons, and hydrofluorocarbons.
Groyne: shore protection structure built perpendicular to the shore; designed to trap sediment.

Headland: cliff or rock promontory jutting out into the sea.
Hepatitis: disease of the liver.
High water mark: the highest reach of the water at high tide. It is sometimes marked by a line of debris, e.g. seagrass, pieces of wood, line of shells.
Human ecology: an academic discipline that deals with the interrelationship between humans and the entire environment; it is an interdisciplinary applied field that uses a holistic approach to address human-environment-development issues.
Hurricane: intense low-pressure weather system with maximum surface wind speeds that exceed 118 km/hr (74 mph).

Inorganic: not organic; composed of lifeless matter.

Jetty: structure projecting into the sea for the purpose of mooring boats; also solid structure projecting into the sea for the purpose of protecting a navigational channel.

Limestone: sedimentary rock consisting essentially of calcium carbonate.
Longshore current: a movement of water parallel to the shore, caused by waves.
Low water mark: the highest reach of the water at low tide.

Magnetite: black mineral composed of iron oxide.
Mineral: natural inorganic substance of specific composition found in the earth.
Monitoring: systematic recording over time.

Nitrate: a salt of nitric acid.
Northeast Trade Winds: dominant wind regime in the Caribbean region; the winds blow from directions between north and southeast.
Nutrient: any substance assimilated by living things for bodily maintenance or to promote growth; the term is often applied to nitrogen and phosphorus, but may also be applied to other essential and trace elements such as carbon and silica.

Offshore zone: extends from the low water mark to a water depth of about 15 m (49 ft) and is permanently covered with water.
Olivine: green, yellow or brown mineral composed of iron and magnesium.

Pathogen: organism causing disease.
Phosphate: a salt of phosphoric acid.
Pollution: the action of contaminating (an environment) especially with man-made waste.

Quartz: a mineral, oxide of silica, often white.

Sand: rock particles, 0.08–4.6 mm (0.003–0.18 inches) in diameter.
Sand mining: removal of large or small quantities of sand from the beach, by machine or by hand, usually for building purposes.
Saturation: state of containing as much solute as can be dissolved.
Sediment: particles of rock covering a size range from clay to boulders.
Seagrass bed: area of the offshore sea-bottom colonized by seagrasses.
Septic tank: outdoor tank in which sewage is broken down by bacteria.
Shore: narrow strip of land in immediate contact with the sea.
Shrub: plant with woody stems branching from the root.
Silica: hard white or colourless mineral with a high melting point.
Silt: fine rock particles, 0.004–0.08 mm (0.00015–0.003 inches) in diameter.
Surf zone: area between the water's edge and the wave breakpoint.

Suspended matter: particles moving in suspension in the water.
Swell: waves that have travelled out of the area in which they were generated.

Tar: thick, black sticky material obtained from the destructive distillation of coal.
Tar balls: small pieces of tar, often shaped like balls.
Tide: periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography: configuration of a surface including its relief and the position of its natural and man-made features.
Transect: a line cut across (a beach).
Translucent: permitting partial passage of light; not completely transparent.
Tropical storm: low-pressure weather system with maximum surface wind speeds between 61 km/hr and 118 km/hr (38 mph and 73 mph).
Tsunami: a series of giant waves generated by submarine volcanic eruptions, earthquakes and landslides that can rise to great heights and catastrophically inundate low-lying coastal areas.
Turbidity: reduced water clarity resulting from the presence of suspended matter.

Vegetation edge: place where the vegetation (e.g. grasses, vines) meets the bare sand area of the back beach.
Vine: slender stemmed plant that climbs or trails.
Virus: organism smaller than bacteria, causing infectious diseases in plants and animals.

Watershed: geographically defined region within which all water drains through a particular system of rivers, streams or other water bodies.
Wave breakpoint: the point where the waves break.
Wave direction: direction from which the waves approach the shore.
Wave height: the vertical distance between the wave crest and the following wave trough.
Wave period: time period of the passage of two successive crests (or troughs) of a wave past a specific point.
Wind waves: waves formed in the area in which the wind is blowing.

Annex 1
Sandwatch equipment

The items listed below are available from large international environmental equipment suppliers, such as those that exist in the USA and other large countries. Prices are approximate, in US$ and relate to 2005 costs.

1. Water quality kits suitable for use by students and community groups to measure temperature, salinity, dissolved oxygen, biochemical oxygen demand, pH, nitrates, phosphates, coliform bacteria in brackish and salt water.
   For example, a GREEN Program Estuary Monitoring kit is offered by Forestry Suppliers – www.forestry-suppliers.com – with enough chemicals and reagents for 10 samples.
   Cost approx US$40

2. Dye tablets to measure currents
   Cost for 200 tablets US$40

3. Folding pocket magnifying glass
   Cost US$3

4. Tape measure, 30 m, fibreglass
   Cost US$30

5. Hand-held compass
   Cost US$15

6. Digital stop watch
   Cost US$20

7. Hardboard clipboard
   Cost US$2

ANNEX 2
Method for measuring and analysing beach profiles

Measuring beach profiles is an ideal activity for science-based assessments and science fair projects. Beach size often changes so quickly – in a matter of days – that interesting results can be guaranteed in a short time period. Furthermore, the information gathered may also be useful for environmental management and planning authorities who need such information when planning new development, but rarely have the resources themselves to collect the data.

Field methods

The monitoring consists of surveying the beach profile from a fixed point set up behind the beach. The fixed point is called the reference mark and is the starting point for the measurement. The reference mark is usually a painted square on a wall or tree. (Ultimately permanent surveying monuments may be constructed which should withstand hurricanes better than the trees or buildings.) It is essential to always start the beach profile measurement at the reference mark. The profiles run at right angles across the beach and in most cases specific orientations for the beach profiles are determined. Photographs should be taken of the reference points.

When to measure

The beach profile at each location should be measured every three months. This will give four data sets a year and will adequately cover seasonal changes. However, this is only a guide, and depending on the time available, the frequency of monitoring can be increased or decreased. If the profiles are set up in May 2001, subsequent measurements are due in August, November 2001, February and May 2002, and so on. In addition, the beach profiles should be re-measured as soon as possible after a major event such as a tropical storm or hurricane.

Preparations for going in the field

- Prepare data sheets; a standard data form is shown in Figure A.
- Gather together the equipment: data sheets, clipboard, pencils, Abney level, tape measure, ranging poles, masking tape, camera loaded with film, spray paint.
- Prepare a plan for which beaches are to be measured on that day and in which order.
- Arrange transport for the field work.

Field measurements

a) On arrival at the beach site, locate the reference mark.

b) Lay out the profile in segments, place a ranging pole at each break of slope, ensure the line of the profile follows the fixed orientation. The end point of the profile is the offshore step (see Figure 1, page 14). This is near where the waves break and there is usually a marked downward step. If no offshore step exists at that location or time, and/or the wave conditions are too rough, just continue the profile as far into the sea ***as safety permits***.

c) Write the beach name and date on the data form, also the names of the field personnel. (If using a number system for the sites, it helps to add a location, e.g. 'Grand Bay #1, southern site'.) This reduces the possibility of error when the data are entered on computer.

Figure A
Beach monitoring programme and profile data sheet.

BEACH MONITORING PROGRAMME

BEACH PROFILE DATA SHEET

Site Name:

Date: Surveyors:

Observations:

Measurement down from the top of the reference mark: metres

Beach segment	Length of segment (metres)	Slope angle (degrees & minutes)
A – B		
B – C		
C – D		
D – E		
E – F		
F – G		
G – H		
H – I		
I – J		
J – K		
K – L		
L – M		
M – N		
N – O		
O – P		
P – Q		
Q – R		
R – S		

d) Measure the vertical distance from the ***top*** of the reference mark to the ground level with the tape measure. Measure to the nearest cm. Record all measurements in metric units. Write the measurement down on the form.

e) Measure the observer's eye level on both ranging poles, making sure that the surface of the sand just covers the black tip of the pole.

f) Place the ranging pole at the first break of slope always making sure the surface of the sand just covers the black metal tip of the pole. Check the profile alignment and re-position the pole if necessary. Always ensure the pole is vertical.

g) The observer stands by the reference mark and uses the Abney level to sight onto his/her eye level on the ranging pole.

h) To read the Abney level, refer to Figure B. As can be seen from Figure B a), the Abney level is divided into degrees, every 10 degrees is numbered. Readings to the left of the zero are negative or downhill; readings to the right of the zero are positive or uphill. To read the angle, determine where the arrow intersects the degrees scale. In the example – Figure B b), the arrow falls midway between -5 and -6 degrees. So the degrees would be recorded as -5 degrees. Since the arrow falls approximately midway between -5 and -6 degrees, it is likely that the minutes reading is about 30 minutes. To check the minutes, use the vernier scale – see Figure B c). For a downhill slope use the vernier lines to the left of the arrow. They are at 10-minute intervals and the 30- and 60-minute lines are numbered. Determine which of the vernier lines most closely intersects one of the degree lines below. In this case the 30-minute vernier line almost exactly lines up with the degree line below, so the vernier reading will be 30 minutes. So this reading will be recorded as -5 degrees 30 minutes.

i) Record the segment slope in degrees and minutes, to the nearest ten minutes on the data sheet. Always remember to record whether it is a plus or a minus slope (plus is an uphill slope, minus is a downhill slope).

j) Measure the ground distance from the base of the reference point to the first ranging pole with the tape measure, to the nearest cm; record this measurement on the data form. Measure along the slope, not the horizontal distance.

k) The observer then proceeds to the ranging pole at the first break of slope and sights onto the ranging pole which has been placed at the second break of slope – remember to check for profile alignment – and repeats steps g) through j). This is continued until the endpoint of the profile, see step b).

l) Ensure all measurements are recorded clearly. Figure C shows a completed data form.

Figure B
Reading the Abney level.

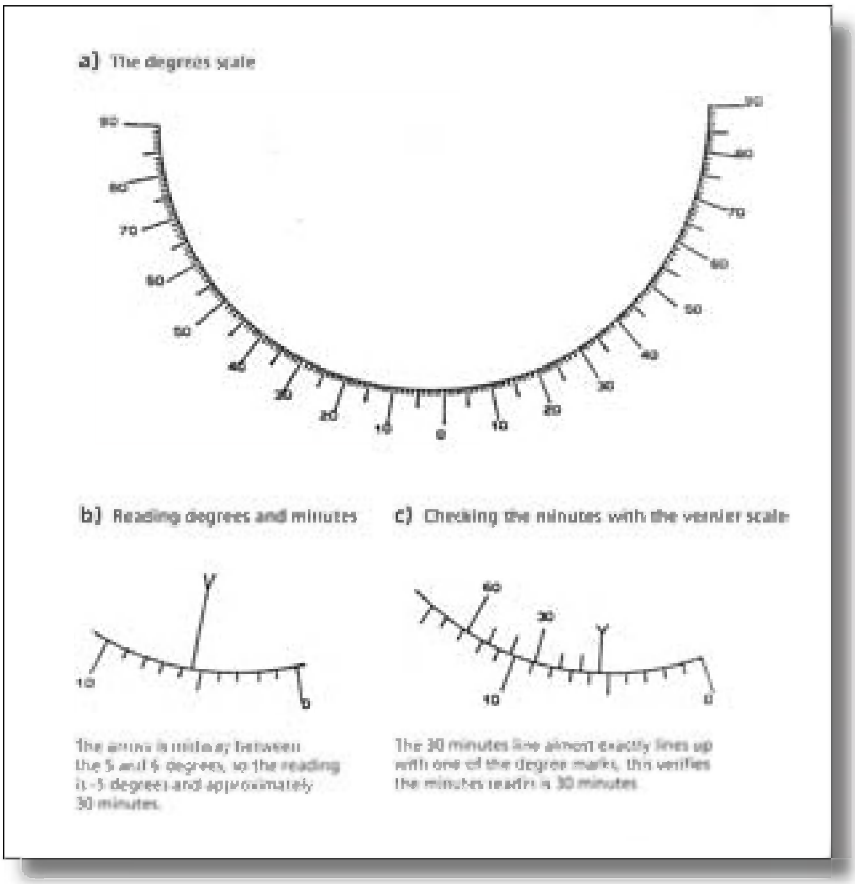


Figure C
Completed data form.

BEACH MONITORING PROGRAMME
BEACH PROFILE DATA SHEET

Site Name: Grand Bay #1 (south site)

Date: 24.03.99 Surveyors: Mr Delusca, Mr Altidor, Mr Baptiste

Observations: Lot of debris on the beach washed up from last week's storm

Measurement down from the top of the reference mark: 1.01 metres

Beach segment	Length of segment (metres)	Slope angle (degrees & minutes)
A – B	5.73	-7° 00′
B – C	4.29	-4° 00′
C – D	1.25	+3° 00′
D – E	1.85	-1° 30′
E – F	6.98	-8° 00′
F – G		
G – H		
H – I		
I – J		
J – K		
K – L		
L – M		
M – N		
N – O		
O – P		
P – Q		
Q – R		
R – S		

m) Record on the data sheet under 'Observations' anything else of interest, e.g. recent sand mining pits, evidence of recent storms etc.; take photographs if possible.

n) As the paint squares (reference marks) begin to fade, touch them up with spray paint.

o) Collect up all equipment and return to vehicle and proceed onto the next site.

p) Should a reference mark be lost due to a particularly severe storm or due to man's action in cutting down a tree etc., establish a new reference mark as near as possible to the old one.

q) If there have been very significant changes at a beach, perhaps due to heavy seas or human activity, then take photographs of the beach.

On return from the field

- Check each data sheet, make sure it is complete, and place in binder or folder. It is advisable to set up a binder/folder for each site. Keep the binders/folders safely.
- Wash sand out of the tape measure in fresh water, leave to dry and rewind.
- Check on the Abney level; if it has any sand on it, wipe it carefully with a soft cloth.
- Store equipment carefully for future use.

Data analysis

This methodology and computer program was prepared by Gillian Cambers and David F. Gray, with the support of the University of Puerto Rico Sea Grant College Program (MRPD-11-75-1-98), November 1999, and is available free on request to UNESCO-CSI (csi@unesco.org).

This section describes the main routines of the computer program, Beach Profile Analysis (*Profile*). It draws the beach profile to scale and then determines the cross-sectional area and beach width. The program can display and print graphs of the profiles and superimpose up to eight profiles on top of each other. Tables showing changes in beach size over time can also be prepared and graphs plotted showing the resulting trends.

The computer program has been written for the Windows operating system and works on Windows 95 and newer versions. It contains fully compiled 'Help' files. This manual refers to Version 3.2, January 2000, and outlines the main routines. (For more detailed information use the 'Help' file.)

Getting started

Enter the data promptly: It is always recommended that field data be entered on computer as soon as possible after the field measurements. This avoids the possibility of losing data sheets and personal memory of the beach conditions is clearer. In addition, the team can see the results and perhaps make changes to the monitoring programme in a timely manner, e.g. if a particular beach is showing very significant changes it may be advisable to add another site where profiles are to be measured, or increase the frequency of measurement.

Each site has its own data file: Each beach site has its data entered in a separate file. So the site at Grand Bay North will have its own data file and the site at Grand Bay Central will have a separate data file.

Furthermore, if the reference point is lost at Grand Bay North (file name Grand Bay North 1), possibly as the result of a hurricane, and a new reference point is selected, then a new file will have to be established; this will then have the file name Grand Bay North 2.

The main parameters – profile area and profile width: First of all, a note about what the parameters really measure. The program draws the beach profile to scale and then determines the area under the profile mathematically in m^2. The program also determines the profile width in metres (m).

Starting the program: Go to '*My Computer*' and select the drive where the program (*Profile*) has been installed. Select *Profile* and you will see an opening screen and at the top left hand corner, a ***main menu*** with four selections as follows:

Site File	Profile	Selection	Help
New	New	By year	Contents
Open	Delete		Index
Save	Uncheck all profiles		About
Save As	Fix all drops		
Close			
Options			
Print			
Printer Set-up			
Exit			

The sub-menu: As you work through the routines in the main menu, you will see a sub-menu appear about a third of the way down the screen on the left hand side. (To see this sub-menu, select '*Site file*' from the main menu, select '*New*', then select '*Profile*' from the main menu, and select '*New*'.) This sub-menu has four options:

- Profile sub-menu: this is where the data is entered and quality control functions are performed.
- Profile graphs sub-menu: this is where the graphs for each profile are displayed and can be printed or transferred to other programs.
- Table sub-menu: this is where the values for profile area and profile width are listed in a table and annual mean values calculated.
- Table graphs sub-menu: this is where the values for profile area and width are shown graphically over time, either as actual values (in line graphs) or mean values (in bar graphs).

Profile sub-menu – entering data and quality control

Establishing a new site: At the opening screen, select '*Site File*' from the main menu and then select '*New*'. In the box by '*Description*', type the name of the beach site, e.g. Grand Bay South 1. Then select '*Profile*' from the main menu, and select '*New*'. The screen will show a blank spreadsheet where the data for the first profile for a new site, e.g. Grand Bay South 1, can be entered.

Entering the data for the first profile: Start by entering the date when the first profile at the site was measured. The box by '*Profile date*' shows today's date. To enter the date the profile was measured, click on the figures in the box by '*Profile date*' and enter the appropriate date (month/day/year). Alternatively, select the arrow by the side of the '*Profile date*' box, a calendar will then be displayed. The month and year can be changed by selecting the arrows at the top left or right on the calendar; the day can be selected by just clicking on the correct day.

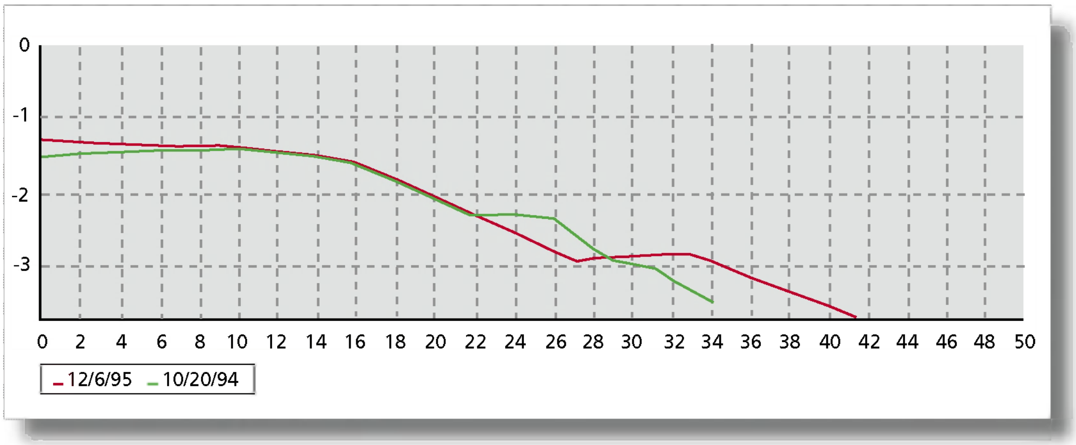
Enter the distance down from the top of the reference point to the ground surface: Next, go the box below '*Profile date*' labelled '*Distance – reference point to surface*.' Enter the distance down from the top of the reference point to the surface that was recorded on the field sheet.

Enter the distance and slope measurements: Now, enter the profile data – the distance and slope measurements for each segment. To move around the spreadsheet use the arrow or Tab keys. For the first segment, a–b, enter the distance measurement in the column with the heading '*Distance metres*', enter the degrees in the column with the heading '*Angle degrees*' and enter the minutes in the column with the heading '*Angle minutes*.' The program assumes the numbers are positive, so if a negative slope was recorded, e.g. -7° 30', enter -7 in the '*degrees*' column and 30 in the '*minutes*' column. If the slope measurement is -0° 30', mathematically minus zero does not exist, so enter 0 in the degrees column and -30 in the minutes column. Enter all the data for that profile.

Computation of the area and width values: As you enter the data, the program will calculate the cumulative horizontal and vertical values, so you will notice the figures in the columns labelled '*Cumulative Horizontal*' and '*Cumulative Drop*' change. You do not have to enter any values in these columns. The spreadsheet shows the profile area and profile width in two boxes at the bottom left of the screen labelled '*Area*' and '*Width*.'

Fixing the standard total vertical drop: The 'standard total vertical drop' finalizes the end point of the profile. A particular profile always has the same starting point – the reference point or paint square. However, profiles end in the sea by the 'offshore step', this is a variable point which changes with the wave conditions. Reference to Figure D shows a hypothetical first profile measurement (green line) with a total vertical drop of 3.5 m. However, during the second measurement of the profile (red line) three months later, the offshore step had moved and the total vertical drop was 3.7 m. To compare the two profiles mathematically, the starting point and the end point of the profile have to be the same. In order to do this, the total vertical drop of the first profile at a site becomes the standard and the program will adjust all subsequent measurements at the site to the standard either by adding or deleting a section to the final slope segment.

Figure D
Finalizing the profile end point.



The first profile (green line) had a total drop of 3.5 m. This value of 3.5 m becomes the standard total vertical drop for this site. The second profile at this site (red line) had a total drop of 3.7 m. So when 'Fix Drop' is selected, the program will cut off a small portion of the bottom of the second graph (red line), so that the total drop remains 3.5 m.

Setting the standard vertical drop: Once the data for the first profile at a site have been entered, it is necessary to set the standard total vertical drop. If the final segment of the first profile is f–g, ***move the cursor down to the next line***, g–h, and note the value in the column with the heading '*Cumulative Drop*'. Enter this value in the box labelled

'*Standard total vertical drop*'. (This box is located near the top of the screen below the box labelled '*Description*').

Adjusting the drop for subsequent profile measurements: For subsequent profile measurements at this site, the program will standardize the total vertical drop (profile end point) when the '*Fix Drop*' box is selected. For example, when entering the data for the second profile measurement at a site, after the data are all entered, click on the '*Fix Drop*' box (located below the '*Distance – reference point to surface*' box). The program will adjust the distance measurement of the final segment accordingly, and also make the necessary adjustments to the profile area and profile width values.

Saving the file for the first time: From the main menu, select '*Site File*', select '*Save As*'. In the box by '*File Name*', type the name of the file (e.g. Grand Bay South 1 in our example) and select '*Save*'. Before doing this, you may wish to set up a separate folder to store all your beach data files.

Closing the site file: From the main menu, select '*Site File*', select '*Close File*', the program returns to the opening screen. If you have not saved your data or changes, the program will ask you whether you want to save them, select '*Yes*' or '*No*' accordingly.

Exit the program: From the main menu, select '*Site File*', select '*Exit*'. If you select '*Exit*' without saving your changes, the program will ask you if you want to change your changes, select '*Yes*' or '*No*' accordingly.

Entering the data for the second profile: From the main menu '*Site File*', select '*Open*'. Select the folder where the beach data is stored. The program will list the files; select the appropriate file and select '*Open*'. The screen will show the spreadsheet for the most recent measurement at this site. From the main menu, select '*Profile*', and then select '*New*'. The screen will show a blank spreadsheet. Enter the data for the second profile as described earlier. Once all the data have been entered, select '*Fix Drop*', this will standardize the profile endpoint.

Select '*Site File*' from the main menu and '*Save*' to save the second set of measurements. However, if you try to close the file or exit the program without saving the data, a check box will automatically appear asking if you want to save the changes.

When you have finished entering the data for second profile measurements, a box may appear on screen telling you to check the data.

Displaying spreadsheet data for different dates: From the main menu '*Site File*', select '*Open*'. Select the folder where the beach data is stored. The program will list the files; select the appropriate file and select '*Open*'. Go to the box at the top right-hand side of the screen showing the dates of the profile measurements. Click on the date you wish to display (use the up/down arrows to see further dates) and the screen will display the spreadsheet for that date.

Deleting a profile spreadsheet: To delete a profile spreadsheet, first of all display the spreadsheet you wish to delete on the screen. Once it is displayed on the screen, select '*Profile*' from the main menu, then select '*Delete*'.

Printing the spreadsheet: To print a spreadsheet, select '*Site File*' from the main menu, select '*Print*'. Click on the box by '*Include profiles*' a tick mark will appear, then select '*All*' (to print all the profile spreadsheets in the file), '*Current*' (to print the profile spreadsheet displayed) or '*Selected*' (to print the profile spreadsheets you have selected by ticking the boxes to the left of the dates – displayed at the top right of the screen), click on '*OK*' and the spreadsheet(s) will be printed.

Data quality control: After the data for a new profile at a particular site have been entered, then as you select '*Fix Drop*', a box may come on the screen warning you that the new data set is significantly different to the average for the previous twelve months. Select '*OK*' and ***then check your data entries*** making sure the data are entered accurately, correct any mistakes. Especially check whether you have entered negative slopes correctly.

The quality control has been set at 20%, i.e. if the profile measurement varies by more than 20% from the average of the measurements for the previous twelve months, the quality control check box will appear. At most sites there are only small changes from profile to profile, so 20% is reasonable. However, at some high energy beaches, changes may be of considerable magnitude from one measurement date to the next, so it may be advisable to change the quality control percentage setting for the data files for these sites.

To change the quality control percentage setting, select '*Site File*' from the main menu, select '*Options*' and change the percentage value accordingly in the box by '*Check percent for area and width*'.

Establishing an actual datum height for the reference point: If an absolute height is established for the reference point (using surveying techniques to tie in the reference point to a known datum), this can be displayed on the profile graph. Select '*Site File*', '*Options*', '*Have datum height for reference point*', '*OK*'. A box will appear under '*Standard total vertical drop*' named '*Datum height for reference point*'. Enter the actual height in this box. The spreadsheet will then show another column under '*Cumulative*' named '*Height*'. When the '*Profile Graphs*' sub-menu is selected, the profile will be displayed with the absolute height of the reference point.

Profile graphs sub-menu – display and print the graphs

After opening a data file, from the program sub-menu select '*Profile graphs*'. The screen will show the graph for the current spreadsheet. The following section describes how to display, alter, save and print the graphs.

'Max. horizontal for the graph': This box is located in the top mid-section of the screen below and to the right of the box for '*Standard total vertical drop*'. This sets the maximum distance for the 'X' axis on the graph. To change the setting, delete the figures displayed in the box and substitute a new value.

'Current': This is the box at the bottom left of the screen and allows you to display the graph for the current spreadsheet.

'Selected': This box is to the right of '*Current*' and allows you to select up to a maximum of eight profiles to show on one graph. To select the profiles you want, go to the box at the top right-hand corner of the screen where the dates of the profile measurements are listed. Check the profile dates you wish to display on the screen by clicking on the box next to the desired date; a tick mark will appear in the box. (To uncheck a date, click on the tick mark. To uncheck all the profiles, select '*Profile*' from the main menu and select '*Uncheck all profiles*'.)

'Top': This box is to the right of '*Selected*' and next to it is a box with a number and an up/down arrow. This allows you to select the top (up to a maximum of eight) profiles to show on the graph. By changing the number in the box you can select the top 2, 3, 4, etc. profiles to display on the graph.

'Print': The program will print the graph displayed on the screen.

'Copy': This copies the displayed graph to the clipboard; you can then paste it into a word processing program such as Microsoft Word.

'Save': This saves the graph as a BITMAP (BMP) file. A box appears on the screen asking you to confirm the file name. This file can then be inserted as a picture in a word processing program, e.g. Microsoft Word.

'Markers': This box to the right of '*Save*' inserts markers onto the displayed profiles.

'B & W': This box, below '*Markers*' allows you to display the graph in colour or in black and white.

'Adjust scale': This box to the right of '*B & W*' has two boxes to the right, '*Vert*' and '*Hor*'. These allow you to adjust the vertical exaggeration of the graph and the size of the graph.

Table sub-menu – list values and annual means for profile area and width

For each profile, the profile area and width are displayed on the spreadsheet screen. It is also possible to display a table showing the profile area and profile width for each measurement date. To do this, select '*Table*' from the sub-menu. This table shows the profile area and width value for each date as well as the mean value for each year. This enables determination of long term trends where seasonal changes are averaged out.

To print the table, select '*Site File*' from the main menu, select '*Print*'. Click on the box by 'Include table', a tick mark will appear, then click on '*OK*' and the table will be printed. (Make sure to uncheck the '*Include profiles*' box.)

Table graphs sub-menu – graphs showing changes over time

This function graphs the values of profile area and/or width over time.

'Profiles': This shows a line graph of the values for profile area and/or width over time. To select profile area only, put a tick in the '*Areas*' box, to select profile width only, take out the tick marks in the '*Areas*' box and tick the '*Widths*' box. To display both profile area and profile width values on the same graph, place a tick in the '*Areas*' box and in the '*Widths*' box.

'Means': This shows a bar graph of the mean annual values for profile area and/or profile width over time. To display profile area or profile width mean values separately, tick the '*Areas*' or '*Widths*' box accordingly.

'Show only selected years': This allows you to show a line graph or a bar graph for selected years only. Go to '*Selection*' on the main menu, select '*By year*', enter the first and last years of your selection in the boxes by '*Show*', click on '*Select profiles*' and '*OK*', then click on the box below the graph by '*Show only selected years*'. The graph will then display the values for the time period you have selected.

'Print': The program will print the graph displayed on the screen.

'Copy': This copies the displayed graph to the clipboard, you can then paste it into a word processing program.

'Save': This saves the graph as a BITMAP (BMP) file. A box appears on the screen asking you to confirm the file name. This file can then be inserted as a picture in a word processing program, e.g. Microsoft Word.

'Markers': This box to the right of '*Save*' inserts markers onto the displayed profiles.

'B & W': This box, below '*Markers*', allows you to display the graph in colour or in black and white.

ANNEX 3

BEACH CLEANUP DATA CARD

Thank you for completing this data card. Answer the questions and return to your area coordinator or to the address at the bottom of this card. This information will be used in the Center for Marine Conservation's National Marine Debris Data Base and Report to help develop solutions to stopping marine debris.

Name ______________________ Affiliation ______________________

Address ____________ Occupation ____________ Phone (____) ____________

City ______________________ State ______ Zip ______ M___F___ Age ______

Today's Date: Month: ______ Day ______ Year ______ Name of Coordinator ______________

Location of beach cleaned ______________________ Nearest city ______________

How did you hear about the cleanup? ______________________________

SAFETY TIPS

1. Do not go near any large drums.
2. Be careful with sharp objects.
3. Wear gloves.
4. Stay out of the dune areas.
5. Watch out for snakes.
6. Don't lift anything too heavy.

WE WANT YOU TO BE SAFE

Number of people working together on this data card ______ Estimated distance of beach cleaned ______ Number of bags filled ______

SOURCES OF DEBRIS. Please list all items with foreign labels (such as plastic bleach bottles from Mexico) or other markings that indicate the item's origin (such as cruise line names, military identification or debris with names and/or address of shipping/freighting or fishing companies, or oil/gas exploration activities).

SOURCE	ITEM FOUND
Example: ABC Shipping Company	plastic strapping band

STRANDED AND/OR ENTANGLED ANIMALS (Please describe type of animal and type of entangling debris. Be as specific as you can.)

____

____

____

What was the most peculiar item you collected? ______________________________

Comments ______________________________

____

Thank you!

PLEASE RETURN THIS CARD TO YOUR AREA COORDINATOR OR MAIL IT TO:

Center for Marine Conservation
1725 DeSales Street, NW
Washington, DC 20036

A Membership Organization

Center for Marine Conservation

Formerly Center for Environmental Education, Est. 1972

Printed on recycled paper.

© 1990 Center for Marine Conservation

ITEMS COLLECTED

You may find it helpful to work with a buddy as you clean the beach, one of you picking up trash and the other taking notes. An easy way to keep track of the items you find is by making tick marks. The box is for total items, see sample below.

Example:
egg cartons ~~||||~~ ~~||||~~ ~~||||~~ | — TOTAL 16
cups ~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ || — TOTAL 22

PLASTIC

Total number of items

- bags
  - food bags/wrappers
  - trash
  - salt
  - other bags
- bottles
  - beverage, soda
  - bleach, cleaner
  - milk/water gallon jugs
  - oil, lube
  - other bottles
- buckets
- caps, lids
- cigarette filters
- cigarette lighters
- cups, utensils
- diapers
- fishing line
- fishing lures, floats
- fishing nets
- hard hats
- light sticks
- pieces
- pipe thread protector
- rope
- sheeting
  - longer than 2 feet
  - 2 feet or shorter
- 6-pack holders
- strapping bands
- straws
- syringes
- tampon applicators
- toys
- vegetable sacks
- "write protection" rings
- other plastic (specify)

STYROFOAM®

(or other plastic foam)

- buoys
- cups
- egg cartons
- fast food containers
- meat trays
- packaging material
- pieces
- plates
- other Styrofoam® (specify)

FOLD ALONG THIS LINE

GLASS

- bottles/jars
  - beverage bottles
  - food jars
  - other bottles/jars
- fluorescent light tubes
- light bulbs
- pieces
- other glass (specify)

RUBBER

- balloons
- condoms
- gloves
- tires
- other rubber (specify)

METAL

- bottle caps
- cans
  - aerosol
  - beverage
  - food
  - other
- crab/fish traps
- 55 gallon drums
  - rusty
  - new
- pieces
- pull tabs
- wire
- other metal (specify)

PAPER

- bags
- cardboard
- cartons
- cups
- newspapers/magazines
- pieces
- plates
- other paper (specify)

WOOD

(leave driftwood on the beach)

- crab/lobster traps
- crates
- lumber pieces
- pallets
- other wood (specify)

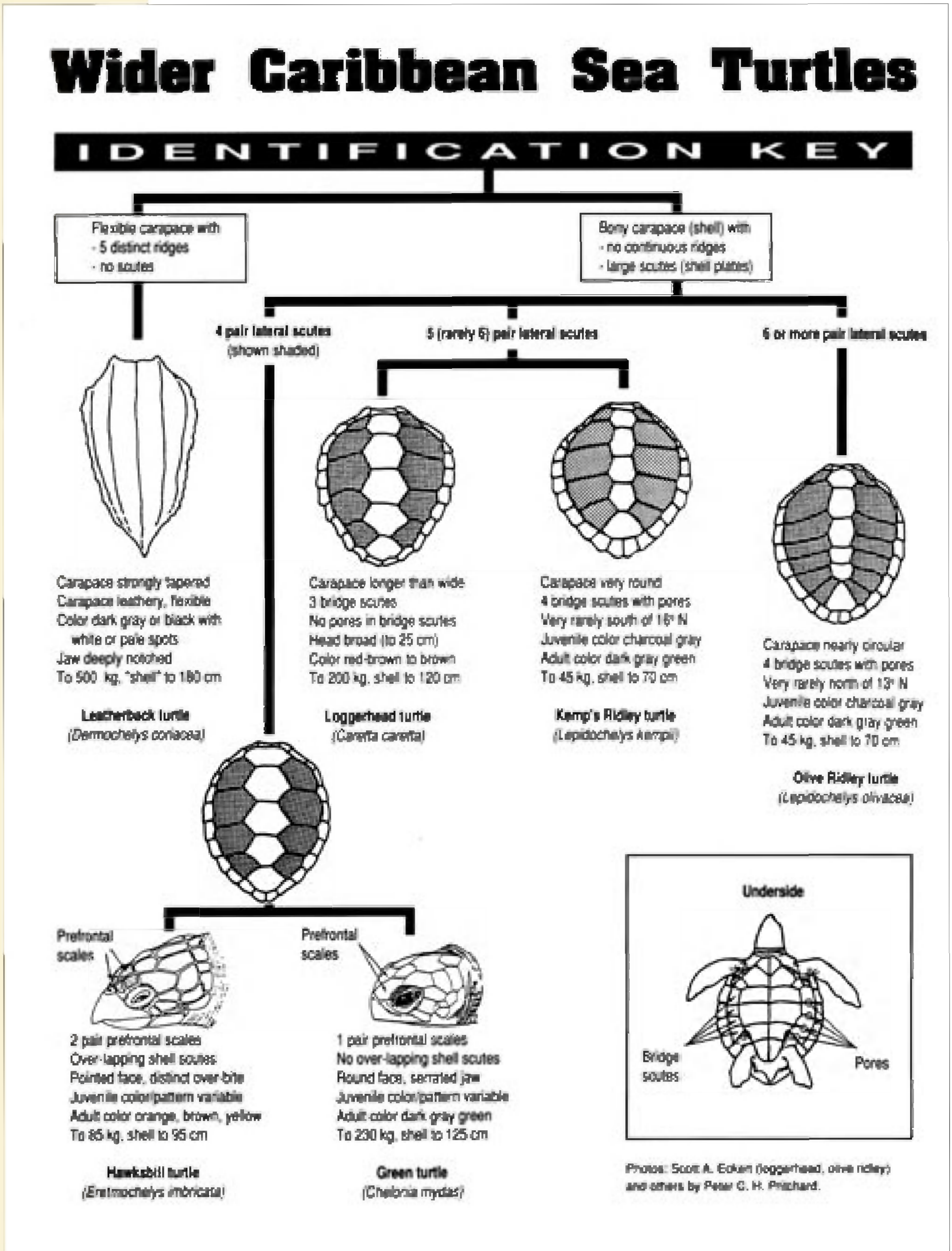
CLOTH

- clothing/pieces

Remember to turn the card over and fill out your name and address and to record sources and entangled wildlife!

ANNEX 4


Wider Caribbean Sea Turtles
Leatherback turtle (Dermochelys coriacea)
Loggerhead turtle (Caretta caretta)
Hawksbill turtle (Eretmochelys imbricata)
Green turtle (Chelonia mydas)
Kemp's Ridley turtle (Lepidochelys kempii)
Olive Ridley turtle (Lepidochelys olivacea)
WIDECAST
Wider Caribbean Sea Turtle
Conservation Network
Caribbean Environment Programme
United Nations Environment Programme


Wider Caribbean Sea Turtles
IDENTIFICATION KEY
Flexible carapace with
- 5 distinct ridges
- no scutes
Bony carapace (shell) with
- no continuous ridges
- large scutes (shell plates)
4 pair lateral scutes
(shown shaded)
5 (rarely 6) pair lateral scutes
6 or more pair lateral scutes
Carapace strongly tapered
Carapace leathery, flexible
Color dark gray or black with
white or pale spots
Jaw deeply notched
To 500 kg, "shell" to 180 cm
Leatherback turtle
(Dermochelys coriacea)
Carapace longer than wide
3 bridge scutes
No pores in bridge scutes
Head broad (to 25 cm)
Color red-brown to brown
To 200 kg, shell to 120 cm
Loggerhead turtle
(Caretta caretta)
Carapace very round
4 bridge scutes with pores
Very rarely south of 18° N
Juvenile color charcoal gray
Adult color dark gray green
To 45 kg, shell to 70 cm
Kemp's Ridley turtle
(Lepidochelys kempii)
Carapace nearly circular
4 bridge scutes with pores
Very rarely north of 13° N
Juvenile color charcoal gray
Adult color dark gray green
To 45 kg, shell to 70 cm
Olive Ridley turtle
(Lepidochelys olivacea)
Prefrontal scales
2 pair prefrontal scales
Over-lapping shell scutes
Pointed face, distinct over-bite
Juvenile color/pattern variable
Adult color orange, brown, yellow
To 85 kg, shell to 95 cm
Hawksbill turtle
(Eretmochelys imbricata)
Prefrontal scales
1 pair prefrontal scales
No over-lapping shell scutes
Round face, serrated jaw
Juvenile color/pattern variable
Adult color dark gray green
To 230 kg, shell to 125 cm
Green turtle
(Chelonia mydas)
Underside
Bridge scutes
Pores
Photos: Scott A. Eckert (loggerhead, olive ridley) and others by Peter C. H. Pritchard.

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Environment and development
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