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Bermuda's Wetlands

written by

Dr. Martin L. H. Thomas

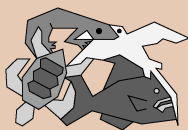


Project Nature

Field Study Guides for Bermuda Habitats

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Bermuda's Wetlands

(Fourth Edition)

Project Nature Field Study Guide

written by

Dr. Martin L. H. Thomas

Bermuda's Wetlands
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Cover photograph of Mangrove Bay, Ferry Reach
by Martin L. H. Thomas

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Foreword

'Project Nature' is an ambitious undertaking carried out by volunteers and staff of the Bermuda Aquarium, Museum and Zoo. It fills a significant gap in Bermudian Natural History literature in that it can be used and studied at home or in the classroom, and can also be taken to the habitats being described to be used as a reference for the identification and understanding of Bermuda's diverse and rich natural heritage.

Bermuda can, at first glance, appear to be somewhat sparse in its flora and fauna, which is generally the case with isolated oceanic island ecosystems where all of the indigenous species have had to overcome the formidable difficulties of transport across hundreds of miles of ocean. Those of us who have worked for years in protecting, researching and, increasingly, restoring the natural environmental features of Bermuda know however that the island is a rich treasure house of diverse habitats supporting a multitude of plants and animals, many of them unique to the island. It is also of great interest because of its location at the extreme limit of the range of many of its species; for example, the island supports some of the most northerly examples of both coral reefs and Mangrove Swamps on Earth.

This book continues this excellent series as a local field guide and reference for Bermuda's Wetlands, which are one of the least understood and most unappreciated of Bermuda's natural habitats. They have also been one of the most heavily impacted by man's activities. In the past, wetlands were usually thought of as useless, dangerous areas suitable only as garbage dumps, but now they are recognized as being among the most productive, diverse and interesting habitats of all. This book gives any reader the information and techniques for understanding and appreciating Bermuda's Wetlands, and indeed for looking at them through entirely new eyes. It is highly recommended for anyone interested in Bermuda's natural environment.

Jeremy Madeiros
Conservation Officer
Parks Department
January 2001

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The full page habitat illustrations were all drawn by Jo-Ann Stevens of the Biology Department of the University of New Brunswick, Canada while the cross section on page 2-10 was prepared by David Wingate. The illustrations of the species of plants and animals of the wetlands of Bermuda were adapted, with permission, from a variety of sources including "Marine Fauna and Flora of Bermuda" and "Bermuda's Marine Life" by W. Sterrer, "Bermuda's Seashore Plants and Seaweeds" by W. Sterrer and A. Ralph Cavaliere, R. A. R. "Joe" Smith, Michelle Pasquin, Andrew Dobson and David Wingate; others were prepared especially for this publication by Wendy Frith, Janet Percy, Martin Thomas and Tiana Harley-Thomas.

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Introduction

Organisation of this Field Guide

The guide begins with an introduction to wetlands in general, their classification, ecological importance and the ways in which they have arisen and have been colonised.

The introduction is followed by a section on the characteristics and features of the various Wetlands habitats in Bermuda. Included are freshwater marshes, freshwater ponds, freshwater swamps, salt marshes, mangrove swamps and marine ponds. Common species occurring in these habitats are listed in chapter 3. The species are sub-divided into major taxonomic groups, and are organised alphabetically within those groups. Each species has a brief description emphasising features useful in identification and stating whether the animal or plant is **endemic, native, introduced** or **naturalised**. Endemic species are those which have evolved in Bermuda and are not naturally found elsewhere. **Native species** are those which arrived here from elsewhere by natural means. **Introduced species** have been brought to Bermuda either purposely or accidentally by man. **Naturalised species** are native species which have become widespread and are now self-sustaining in Bermuda.

Both common and scientific names are used throughout to avoid confusion arising from common names being applied to more than one species. Metric and imperial measures are both given in the text and descriptions but only metric units are applied to illustrations.

Following the descriptions of the wetlands of Bermuda is a section detailing specific field trips for each wetland type. However, some locations are suitable for more than one wetland type. In this case they are presented as separate field trips. More than one field trip is described for each type of wetland, for variety and because vagaries of weather may make some sites unsuitable at times. Some locations have access problems; these are mentioned in the field trip description. Each field trip is divided into preparation, equipment, dress, location, observations and possible hazards. It is strongly advised that the field trip description is reviewed in detail prior to going into the field. In some cases a visit by the instructor, prior to the actual field trip is virtually essential. A series of field exercises suitable for younger students augments this.

The guide concludes with a glossary defining technical words and expressions used in the text. Most but not all words and expressions in bold in the text are in the glossary.

What are Wetlands?

Wetlands lie between aquatic and terrestrial systems. **Aquatic systems** are those where the environment is composed almost entirely of water and terrestrial systems are characterised by surroundings consisting mainly of sediment or rock, and air. There is always some water in **terrestrial systems** and some sediment or rock, and air in aquatic ones but they are not dominant components. Within most terrestrial systems lies what we call a water table; this is where air is replaced by water and it normally lies some distance below the surface. The **water table** might be found by digging if it is close to the surface but in most cases its location would have to be found by drilling down.

It is really the position of the water table that determines whether a system is terrestrial, wetland or aquatic. If the water table is permanently below the sediment or rock surface, the system is terrestrial; if the water table is about at the level of the sediment or rock surface, permanently or temporarily the system is a wetland; if the water table lies permanently above the sediment or rock surface, then the system is aquatic.

Another important point is that it is only when the water table rises close to the surface of the sediment or rock or lies above it that the water is colonised by significant numbers and variety of organisms. It is a rare thing to find organisms in well water, but you expect to see them in wetlands, lakes, streams and the ocean.

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Wetland and aquatic systems may be either freshwater or marine and many lie in the transition zone between marine and freshwater systems. They therefore are in places of changing biological conditions, between land and water and between marine and freshwater. Such places of great change are normally rich in species but subject to change with time. This we will see is true of wetlands.

Types of Wetland

Wetlands are primarily classified on the basis of the main type of vegetation occurring there. There are three common types of wetland, the **marsh**, the **bog** and the **swamp**.

Marshes

Marshes are wetlands dominated by grasses. Trees are absent but there may be shrubs around the edges where the sediment is drier. Marshes may be either freshwater or marine or a mixture of the two. Marine marshes are called Salt marshes. Salt marshes are characteristic of low-lying shorelines in temperate climates. They are rare or absent in the tropics. The soil in marshes may be very variable ranging from sand, through silt and clay to a very organic deposit of rotting plant remains.

Bogs

Bogs are wetlands dominated by mosses. Trees may be present, but if so they are stunted and never form a canopy that could shade a significant amount of the ground surface. They are strictly freshwater systems since very few mosses have evolved to tolerate salt water. Bogs are usually very acid environments and among the wetlands they alone can alter the position of the water table, an ability which increases their physical stability. In bogs, the dead remains of mosses absorb water and raise the water table close to the surface. For this reason they occur in areas with quite high rainfall or frequent fog. The soil in bogs is low in inorganic components.

Swamps

Swamps are wetlands dominated by trees. Like marshes they may be either freshwater or marine. Marine swamps are called mangrove

swamps and they are characterised by the presence of mangrove trees. It is important to note that **mangrove trees** have evolved from a variety of terrestrial trees rather than having originated as one type of terrestrial tree that was able to tolerate salt-water, and that then evolved to produce the various mangrove tree species. This is an example of convergence; mangrove trees are convergent species. **Mangrove swamps** are typically found in tropical or sub-tropical climates; they are replaced by salt marshes where winter frosts occur. Fresh-water swamps, found in a wide variety of climates, are also colonised by a great variety of trees ranging from deciduous hardwoods to conifers. The trees in swamps grow large and are usually dense enough so that their branches unite overhead to form a canopy. The sediments are as varied as those of marshes.

The presence of an overhead canopy in swamps adds another dimension to their complexity when compared to marshes and bogs. Thus within a swamp there is a shaded environment which reduces the frequency of plants growing on the sediment surface since light is greatly reduced. However, the canopy provides more variety to the environment within the swamp, and promotes the colonisation of the swamp by a wide variety of species giving it very high **species diversity**.

In Bermuda there are marshes, Salt marshes, freshwater and mangrove swamps, but no bogs.

Ecological Importance of Wetlands

Succession

Succession is a set of orderly predictable changes in an ecological system resulting from biological change. However, a similar series of changes may occur because of physical changes resulting from changes in physical factors in general; this is not succession. For instance climate may change and as a result vegetation may alter with time. **Succession**, on the other hand, is the result of biological change which in turn may produce physical changes. For instance, a **pond** newly created by the damming of a stream will exhibit a predictable series of changes which will eventually see it fill up with sediment and

eventually become a terrestrial system. Thus succession shows both physical and biological change, but the physical change results from the biological changes not vice-versa. In nature the processes of succession may be fast or slow depending on the situation. The creation of a new forest on a site where bare rock was exposed by a landslide, may take a thousand years or more whereas the colonisation of a sand dune created behind a sandy shore in the tropics by a hurricane, normally is accomplished in a few years.

Most examples of succession involve the accumulation of sediment or soil, starting at some point within the series of changes. It is the presence or absence of sediment which determines whether the succession is primary or secondary.

Primary Succession

If succession starts with bare rock with or without the presence of water devoid of life, then it is **primary succession**. A good example of primary succession could be seen if a volcano emerged from the ocean and then became dormant. Such situations are relatively rare.

Secondary Succession

If, on the other hand, succession starts with organic sediment devoid of life (the term organic means that there are no particles present resulting from the life processes or breakdown of organisms), with or without water devoid of life, it is an example of **secondary succession**. Commonly, such as after a severe forest fire on land, or after a landslide, inorganic sediment without life is present, and succession starts from there. This is secondary succession. Examples of secondary succession are fairly common in nature. Quite frequently, secondary succession starts in situations where some organic matter is present. In this case it proceeds more quickly.

Characteristics of Succession

Succession involves an increase in the physical complexity of the environment combined with increases in biological diversity and ecological stability. Usually none of the organisms present at the start are still present at the end. Many fairly distinct stages of succession, each with a characteristically different suite of organisms usually occur; these are **seres**.

In theory, succession ends when a stable as possible biological system is created. This is called the climax, and the community present at that time is the **climax community**. For instance never exploited forests are often called climax forests. In practice there is some doubt that true climax ever occurs, but at least, eventually, changes become imperceptibly slow.

Why is succession so important to a discussion of wetlands? All wetlands are seres in various successional processes. We can predict that wetlands will eventually become terrestrial systems by purely natural processes. They may become terrestrial more rapidly if man interferes by filling or draining them.

Typical Secondary Succession Involving Wetlands

Let us suppose that a small lake is created by a landslide which blocks the flow of a stream. The first stage of succession is characterised by the appearance of **plankton** or small aquatic organisms. Plant plankton, probably single-celled green algae, would be first and their presence would provide a food resource for animal plankton such as protozoans and small crustaceans, which would follow. Many generations of planktonic communities would result in their dead remains building up as a layer of **detritus** or organic material on the bottom. This enriches the original inorganic sediment providing a habitat for bottom dwelling animals that can eat detritus for food, such as snails, aquatic worms and other creatures. If the water is shallow, the organically enriched sediment also encourages the growth of submerged plants commonly called water-weeds. Now the community is more **diverse** and more stable than at the start and that in turn promotes the appearance of a wide variety of organisms such as fish, floating-leaved plants such as duckweed and **emergent plants** like **Cattails** (*Typha angustifolia*) with roots in the bottom and long leaves ascending into the air. This complex plant community slows water currents and promotes the relatively rapid accumulation of more sediment. When the sediment nears the surface, wetlands are born! Accumulation of sediment does not stop because floods bring material in and the remains of the plants accumulate. Therefore with further time, dry land emerges and the wetlands are gone.

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Possible Successional Events Involving Wetlands in Bermuda

The type of wetland involved would depend on the climate, the existence or extent of a freshwater table, the proximity of the sea and other factors. For example in Bermuda an inland fresh-water pond would proceed to a cattail-rush marsh then a **Sheathed Paspalum** marsh before becoming a **Saw Grass** marsh. In low areas the climax would be a **Bermuda Palmetto** forest similar to that now seen in Paget Marsh. A saltwater pond close to the sea would probably first become a **Seaside Oxeye**-paspalum marsh then a simple mangrove swamp with only one mangrove tree species and finally a fully developed climax mangrove with the **Red Mangrove** toward the water and the black further back. **Buttonwoods** would appear behind the black mangrove trees. A less likely, but possible scenario for the saltwater pond or heavily sedimented coastal bay would see the establishment of a **Marsh Samphire** and **Seaside Purslane** community, followed by a more complex salt-marsh including **Saltmarsh Oxeye**, **Paspalum**, **Seaside Heliotrope** and **Knotted Spike Rush** (*Eleocharis interstincta*). Such a location would probably see a climax of **Bermuda Cedar** and/or **Buttonwood**.

Water Clarification and Purification

Because wetlands are natural sediment traps as explained in the section on succession, they also tend to collect particles of trash introduced by man. Additionally, the large amount of organic material present in wetland soils and sediments tends to bind dissolved pollutants and deposit them in the sediments. These rich sediments support large populations of bacteria many of which are capable of breaking down a wide range of pollutants. Thus water is clarified and purified in wetlands. Of course, there are limits to the concentration of pollutants tolerated by wetland organisms and the first sign of overload is usually a decrease in bio-diversity. In other words pollution can reverse the natural processes of succession.

This ability of wetlands to act as a natural water-purification system is widely exploited throughout the world to improve the quality of surface waters. The wetland used may be a section of a natural one or one created for the purpose by the introduction of suitable plants and sediment.

Stabilisation of Shorelines

Although wetlands usually develop in reasonably sheltered locations, all shorelines, in storms, are subject to wave action which can cause erosion. Unchecked, erosion can eat back shores and destroy valuable ecosystems or developments. All wetlands are very erosion resistant; indeed as explained in the discussion of succession, they normally result in the accumulation of sediment not its removal. Wetland shorelines therefore afford great protection to the shore itself and all locations inland from them. There are many case histories where the removal of Salt marshes or mangroves has resulted in catastrophic shoreline erosion.

As an additional useful capability, wetlands have a great ability to repair themselves from storm damage. Sites of damage usually show rapid regrowth of the characteristic vegetation so that after a relatively short period damaged areas are completely healed over. For this reason coastal protection by natural means is far more effective than that involving man-made storm-barriers.

Pollution of wetlands decreases natural stability and thereby their abilities to withstand erosion. Severely polluted wetlands may need to have the pollution cleared up before they will again function well in shoreline protection.

Origin and Colonisation of Bermudian Wetlands

The Origin of Freshwater Wetlands in Bermuda

The first Freshwater Wetlands

We know that freshwater wetlands were well established when Bermuda was colonised by man; however from the geological record we also know that these wetlands were well established and of great importance long before that.

At the end of the last ice-age, some 10,000 years ago, sea levels were **far below** present levels as a result of the amount of water tied up in the immensely thick ice of the polar **ice sheets**. As a result the Bermuda land-mass was much larger than at present, stretching

from North Rock to just off the present south shore. Within this land mass were very large areas of **sand dunes**. These dunes were of two basic types: 1) **fossilised dunes** formed by the solidification of dunes formed at earlier times and 2) **coastal dunes** consisting of wind-blown sand. The extent of vegetation in these dunes, if any, is essentially unknown. There may also have been some limited areas of **mobile dunes** moving downwind from the coast into the interior. At any rate the landscape consisted of coastal tracts of dunes, probably with a varying amount of sand at the surface overlying older dunes consisting of limestone rock. Inland areas, on the other hand, were probably of more gentle topography with some large depressions within which were patches or lines of dunes. Other depressions were created by collapsing caves. These depressions would not have tended to collect rainwater because the soils and rock were so porous. Nevertheless, they would certainly have been damper than higher areas, and they served to channel freshwater into the internal freshwater lens created under the land mass. In a very dry climate, islands such as Bermuda which are composed of porous limestone would be permeated with sea water up to sea level. However, where rainfall is significant, some freshwater percolates down and as a result of its lower density floats on the saltwater. The freshwater forms a lens-shaped mass, thickest farthest from the ocean and thinning to nothing at the coast. Because freshwater is lighter than sea water, it rises up to 1 m (3 ft) higher than sea level at the centre of the lens.

It is quite possible that some marsh plants were growing in damper places in the depressions, even when the freshwater lens lay well below the surface of the soil or sand. Their remains started the accumulation of peat, however when rising sea level brought the freshwater lens to the level of the bottom of the depressions, marsh development accelerated and peat deposits thickened. The laying down of peat deposits was a critical event in wetland development. This is because a good layer of peat, particularly when compressed, will form a layer virtually impermeable to water. Thus a peat lined depression would help wetlands retain water and could tide a marsh through a short temporary reversal of sea level rise. It is known that the rise of sea level was very irregular and that reversals were common. Another aspect of peat deposits

to wetlands is also important. This is the fact that peat lowers the pH of freshwater, making it more acid. Acid marsh water overflowing marsh edges dissolved the bordering limestone with the result that a moat-like depression formed. In turn this could be lined with peat. At any rate these moat-like features are well preserved in the bottom of Harrington Sound.

Further limited rising of sea level would create lakes and ponds but large sea level rises would flood these depressions with seawater. Harrington Sound and North Lagoon are examples of low-lying marsh-pond complexes that were flooded by the ocean. Peat deposits containing the remains of freshwater organisms can be recovered from these areas today by coring. Plant remains in the bottom of Harrington Sound show that the wetland there proceeded, at least in places, to a climax **Bermuda Palmetto** (*Sabal bermudana*) forest. This shows that some early wetlands persisted for a long time.

A typical sequence of events in the creation of a freshwater wetland would be: 1) A rising sea level pushing the freshwater lens close to the surface of a low spot or depression. 2) Development of an early marsh community. 3) The laying down of a peat deposit to line the depression. 4) Development of a more diverse marsh community. 5) Expansion of the marsh laterally.

Colonisation of early Freshwater Wetlands

Colonisation was almost certainly a very slow process because there were no local sources of seeds, spores, eggs or young plants and animals adapted for life in freshwater habitats.

The organisms that initially colonised freshwater wetlands must have either been blown here as seeds, spores or eggs on the wind, or carried here by visiting waterfowl. Other birds too may have brought freshwater organisms but they were more important for terrestrial communities. The most likely source is the continent of **North America** because it is the closest landmass and the prevailing westerly winds blow in this direction. Unusual weather systems such as hurricanes, however, probably brought additional material and organisms from the **Caribbean** and **Gulf of Mexico** areas. Colonisation by organisms from Europe and Africa is much less likely because of the longer

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distances involved. However, we do occasionally get birds from those areas which might carry living material.

A Time of Change

About 6,000 years ago the global climate warmed very significantly and sea levels began a steady rise to present-day levels. Thus sea level rose above the level of the low-lying early marshes. Once sea level rose higher than that of the peat layer, seawater would flood in fairly rapidly through porous rock and sand, especially through fissures and caves dissolved out by the passage of acidic rain and swamp water. These events are recorded in the sediments in Harrington Sound by a change in **dominant organisms**. Palms gave way to marine algae and the snails showed a progression through purely freshwater ones, through brackish ones and finally to marine species. By 5,000 years ago, Harrington Sound was a saltwater environment. Similar processes were taking place in North Lagoon and in other low lying areas of Bermuda. Thus vast areas of marshland disappeared and at the same time the present-day wetlands started to develop at higher levels, but also in depressions in the limestone. As with the ancient marshes the accumulation of a layer of peat was a very important feature in making marshes more stable.

Modern Freshwater Wetlands

The relatively recent freshwater wetlands of Bermuda no doubt became established by some of the same processes as the older ones. However, the process would have been much **more rapid**, since by that time there would have been populations of bog, swamp and marsh organisms on the island to provide appropriate colonising organisms. There is one universal feature of Bermudian wetlands that is not necessarily true elsewhere in the world. This is that they lie at or just above sea level. This is because they have the same water level as that of the local lens. If topography is such that a lens is absent then the ponds will be saltwater ponds. Even some ponds well away from the sea, such as the one on the grounds of the Royal Hamilton Amateur Dinghy Club, are saltwater ponds.

The wetlands that arose varied greatly in size. The largest was the Pembroke Marsh complex

to the North and West of Hamilton. There were two low depressions in this marsh system, the **East and West basins**. The East basin lay where the old dump was located extending west to about Cedar Avenue. The West basin was more complex, starting as a marine mangrove swamp in Mill Creek and progressing through brackish to freshwater marshes to the east to finish in the area of Saltus Grammar School. At its maximum about 1837, the Pembroke Marsh complex covered some **120 acres** which was about 40% of Bermuda's total freshwater marsh area! The Pembroke Marsh complex has now been reduced to about 10 acres! There was an ill-defined **stream** running from East to West through the complex and discharging into Mill Creek; this was the only **real freshwater stream** in Bermuda. All that remains of the stream is the highly polluted **Pembroke Canal** which was created in efforts to drain the complex of marshes for building sites and agriculture. Public Works projects aimed at draining the marsh and stopping flooding at times of very high tides, began in about 1837 and continued for at least 80 years. These met with varying success. The first drainage phase consisted of a **canal** through Pembroke Marsh West to about the present site of the Bermuda Athletic Association Field. At the Western end of the old stream a **sluice gate** which allowed fresh water to drain into the sea, but did not allow seawater to flow upstream, did stop sea water flooding but also changed the marshes for ever. It is recorded that eels, shad and other fish moved inland through the canal and that early residents were able to canoe or row through much of its length. The lower banks of the stream were lined with mangrove trees at least as far inland as the present site of the BELCO electricity generating plant. The Western basin was completely filled with sediment, the displaced water drained off by 1900 and it now supports one of the largest industrial complexes in Bermuda. The Eastern basin, however, was a much bigger challenge and although the canal was extended through it, its filling and draining met with only partial success and a great deal of trouble; it became known as "Marsh Folly". The main problem was that this marsh had slowly developed over thousands of years before man colonised the islands of Bermuda. During this time a huge deposit of **peat** had accumulated below the marsh. Peat as mentioned above is just the remains of aquatic plants and not a very

stable substance. As rock, from the Blackwatch Pass, the railway right of way and other sources, was added to the marsh to raise its level and drain it, the weight merely **compressed** the peat into a thinner layer. Instead of the peat level rising, it fell and the addition of more rock only compounded the problem. It was evident that to stabilise the Eastern basin of the marsh, so much fill would have to be added that the project was totally economically unfeasible. This led to the use of the area as the country's main **garbage dump** starting in the 1930's. It remained so until 1995. Its use as a dump was not well thought out and has proved to be an **ecological disaster** which may never be cleared up. Fortunately, the peat layer which frustrated filling has been a 'blessing-in-disguise' as the trash accumulated, since it formed an impermeable layer which prevented toxic material, known as **leachates**, from entering the ground water and contaminating the water supply! Instead these leachates pass into the marsh and pond below the old dump site and then into Pembroke Canal and proceed to the sea.

Today we know that the loss of unique species from the Earth is a major problem and tragedy, part of decreasing biodiversity. Two species of animal, a freshwater limpet and a fingernail clam previously lived only in the waterways of Pembroke Marsh and are now **extinct!** In fact the **biodiversity** in the marsh-canal complex is now **exceedingly low** except in a small area inland of the dump and at the mouth in Mill Creek. This is a serious danger signal; the entire system is in grave ecological peril and has progressed from a "**National Treasure**" to a "**National Disgrace**"! In addition to the leachate from the old dump, the canal is badly contaminated by **human waste** leaking from either sewers or cesspits.

Other freshwater marshes and ponds arose by similar ecological processes and many, if not all, have been **contaminated** by the dumping of **trash** within them. The largest freshwater pond is **Warwick Pond** and the largest remaining marsh is **Devonshire Marsh**. The locations of all the larger marshes and ponds are shown in Figure 1.1. Figure 1.2 is a cross section of Bermuda showing the types of location where various wetlands may occur.

The Origin of Marine Wetlands in Bermuda

Coastal Systems

In contrast to the freshwater habitats, marine wetlands arose in a more simple and straightforward way. The main reason for this is that marine waters, principally those of the **Gulf Stream**, washing the shores of the islands would naturally contain seeds, spores and larger organisms capable of the **colonisation** of wetland areas. Thus shallow, sheltered bays could be readily colonised by **mangrove trees**, producing a swamp, which in turn would provide suitable habitats for a whole host of associated organisms. In places small Salt marshes also developed behind mangrove swamps or where freshwater marshes occurred close to the sea. There is evidence that the largest **salt marsh** in Bermuda existed in the seaward part of the Western Basin of Pembroke Marsh.

Thus **mangrove swamps** are the characteristic wetland ecosystem of coastal areas. They require some **shelter** and some **sediment** to become well established although the odd mangrove tree may be found in quite exposed areas, growing in a sediment-filled crevice in the rock. The best developed mangrove swamps are in sheltered muddy areas such as occur in bays with relatively narrow mouths. In relation to the tides, mangrove trees can colonise areas from about mid-tide level to extreme high tide level. Coastal mangrove swamps can be found as two main types. **Fringing mangrove swamps**, just a tree or two in width, are typical of fairly steep shores of fairly coarse sediment. Good examples of such systems may be found along Ferry Reach and along the shores of Mullet Bay. **Typical mangrove swamps** develop where the slope of the shore is very low; sediments vary from sand to fine mud. These mangrove swamps may be quite wide and typically show a distinct **zonation** of different mangrove tree species. In Bermuda, the best developed mangrove swamp lies in Hungry Bay, on the south shore below the Botanical Gardens. This mangrove swamp was called the "**Great Mangrove**" by early settlers. It supports very large mangrove trees of all the species found in Bermuda and has a very high diversity of **associated species**. It is the only mangrove swamp in Bermuda to show

Bermuda's Wetlands

a well developed system of **drainage channels**; additionally it is home to at least two uncommon and **endangered** marine species. It is an area that should receive more protection from human interference. Another very good concentration of well developed coastal mangroves lies in Castle Harbour between the Longbird Causeway and Walsingham Bay. This area is parkland and therefore reasonably well protected from disturbance.

In the past, shoreline mangrove swamps were much more extensive than they are today. Many have been cut to facilitate shoreline development. For example Mangrove Bay in Somerset, was formerly lined with mangroves but now supports almost none. In Hamilton Harbour, mangroves are now confined to the extreme inner end at the Foot of Crow Lane whereas formerly they were much more extensive.

Marine Ponds

There is, however, one very special marine wetland system in Bermuda which is rare elsewhere in the world. This is the ecosystem comprised of the **saltwater ponds**. As discussed above, in relation to freshwater ponds and marshes, any depression in Bermuda falling below sea level will tend to fill with seawater by percolation through porous rock, or entry through caves and fissures. In the same way inland caves are filled with seawater. Saltwater ponds with underground connections to the ocean are known as "**anchialine ponds**". They do occur elsewhere in the world, but are not common. Saltwater ponds provide a unique set of ecological habitats which support a wide variety of communities of organisms.

Anchialine ponds are always somewhat salty, but of course also receive water from **rain** and the **run-off** from surrounding land; because of this their saltiness, or **salinity**, is quite variable. The main factor controlling salinity in the saltwater ponds is the size and location of the connection to the sea. Ponds with small connections, such as Mangrove Lake the largest saltwater pond in Bermuda, tend to be less salty, whereas those with large connections, such as Walsingham Pond, tend to be almost as salty as the sea, except after very intense rain. We can get a good, quick, assessment of the size of the connection, even if we cannot see it, by checking the tidal rise and fall in the

pond. Ponds with large connections have levels which rise and fall with the ocean tides. Ponds with small connections to the sea show only a small internal tide, which may be hours later than that in the nearby ocean. Trotts Pond and Mangrove Lake with tiny connections have tides of only a few cm (an inch or so). By contrast ponds such as Lovers Lake and Walsingham Pond show internal tides of 40-50 cm (1 1/2 ft or so) compared to 75 cm (2 ft) in the ocean. It turns out that the location of the connection to the sea is also of great importance This is because the salt dissolved in seawater (3% of its weight!) makes it much **denser** than freshwater; as a result in sheltered areas such as the ponds, where winds and waves do not mix the water, freshwater tends to float on the surface of salt water. If the ocean connection is close to the surface, as in Mangrove Lake, Trotts Pond and Evans Pond, fresh water from rain tends to run to sea through the entrance. As a result, the salinity remains higher than expected. In the case of Mangrove Lake, which is very large and shallow, and should be greatly affected by rain, the water remains at about 2/3 of the salinity of the ocean. Lovers Lake is interesting in that it has a large, pipe-like, connection to the sea at its deepest spot. Sea water enters and leaves with ease, but freshwater can be trapped at the surface forming a brackish surface layer. Thus deeper waters of Lovers Lake are very like the sea whereas surface waters may be almost fresh! Such situations are called "**stratified**" or **layered**.

The exchange of seawater in the ponds also means that marine organisms will be carried in and out. Some that are capable of living in the ponds will stay and colonise them; of course some seeds such as those of mangrove trees may be too large to get in through tiny connections as are many marine animals. **Biodiversity** is tremendously variable among the ponds showing a maximum in ponds with large entrances close to the surface. The best example is Walsingham Pond, home to hundreds of marine species, some of large size. In fact Walsingham Pond is world famous for the variety of sponges it supports. By contrast Trotts Pond with its reduced salinity and tiny oceanic connection, supports only a few species including but a few sponges. However, there are a few organisms which occur in almost all marine ponds. A mangrove swamp around the edge is virtually universal.

This is interesting because the floating seeds or floating embryos of the mangroves are large and could not enter either by tiny fissures or deep tube-like holes in the rock. Evidently, they are well adapted to being carried **overland** by some means. Nevertheless, although mangrove trees are always present around saltwater ponds, one of the two common species is often absent. This will be discussed later in connection with specific saltwater ponds.

There is one large saltwater pond in Bermuda, which does not have an underground connection with the sea; this is Spittal Pond located within a bird sanctuary along the south shore. Spittal

Pond is lined with peat which effectively seals it off. However, since it is very close to the ocean it gets seawater by spillover during storms. The **salinity** of the pond averages about half that of seawater but, as one can imagine, it is very variable, ranging from almost fresh to saltier than the sea at different times, depending on the weather. It can show higher salinity than the sea if an incident of marine inundation is followed by a hot, dry period that causes high rates of evaporation. Thus Spittal Pond is very **unstable** and this makes it difficult for marine organisms to colonise it. It shows the lowest **biodiversity** among the Bermuda saltwater ponds.

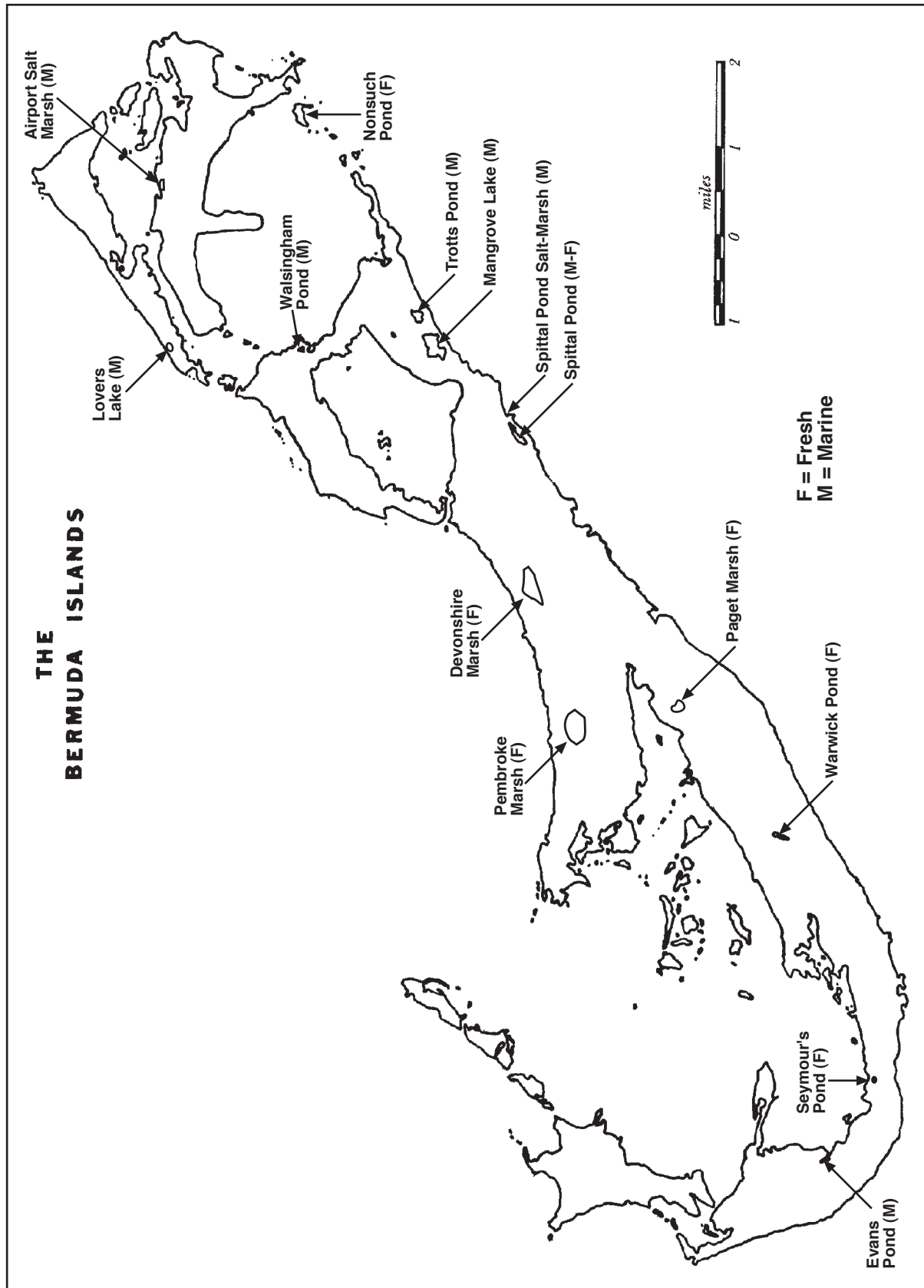


Figure 1.1. Location of all the larger freshwater and salt marshes, marine and freshwater ponds and freshwater swamps

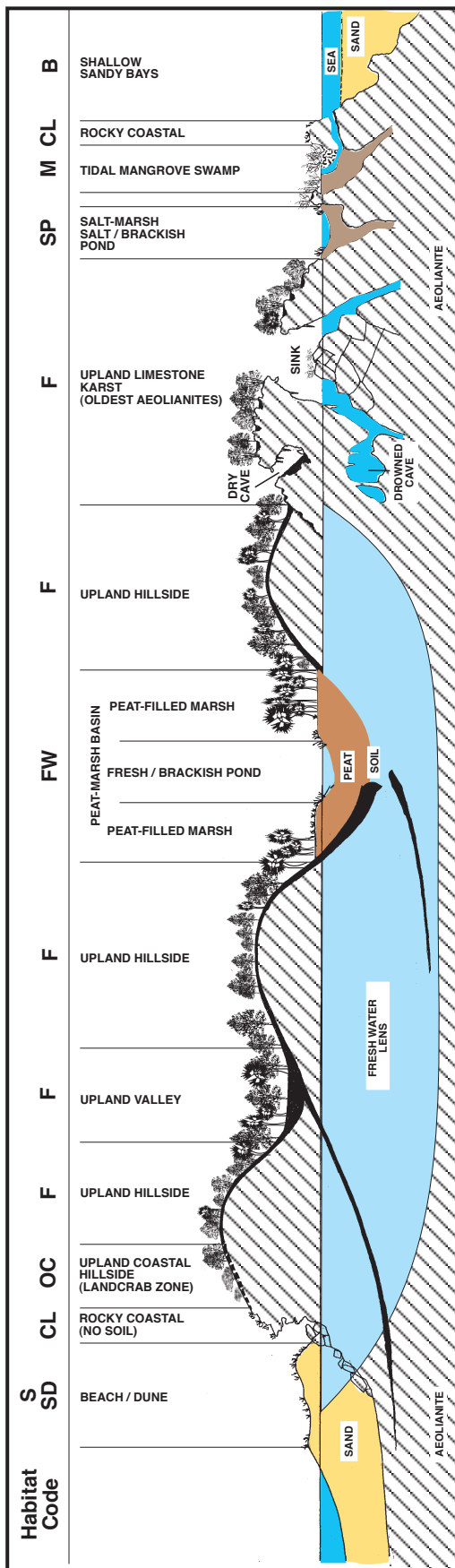


Figure 1.2. Cross-section of Bermuda showing the types of locations where various wetlands may occur.

Characteristics and Features of Wetlands Habitats in Bermuda

Freshwater Marshes

The plants and animals found in Bermuda's freshwater marshes are very similar to those of the freshwater marshes of eastern North America. The reason for this, as discussed in the general introduction, is that the original colonising organisms came from that area in the form of seeds and spores carried on the wind, and similar material plus perhaps fragments of plants and entire small animals carried on the feet and plumage of waterfowl. Of course only a relatively small number of species were able to move in this way. This group of organisms are the **native** wetland species. Since the arrival of man an additional group of wetland plants and animals has been introduced either accidentally or as ornamental plants; examples are water lilies and water hyacinths.

In wetlands as in other ecosystems, organisms tend to occur in readily recognisable communities in which one species of plant is the most important or **dominant**. Communities are normally named from the dominant species in them, and there is usually a fairly constant group of associated species. Often, different communities show the presence of slightly different ecological conditions.

Some of the marshes become quite dry during spells with low rainfall and fires have not been uncommon. Devonshire Marsh has had a history of fires. In 1914, the "great fire" destroyed its old cedar forest and changed the character of the marsh for all time. Since then it has been dominated by fire-resistant species, typically **Saw Grass**(*Cladium jamaicense*) and **Southern Bracken**(*Pteridium aquilinum*). The **Bermuda Palmetto**(*Sabal bermudana*) is also fire resistant as are plants that grow in standing water. As recently as 1996 a serious fire burned over at least 20 acres of the marsh.

Communities in Freshwater Marshes

The most widespread community of Bermudian freshwater marshes is dominated by Saw Grass, *Cladium jamaicense*, often growing with **Southern Bracken**, *Pteridium aquilinum*. Saw Grass communities are usually found where the ground is flooded only in periods of high rainfall. Where there is more permanent water on the surface, a **Narrow-leaved Cattail**, *Typha angustifolia*, community usually prevails. However, where there are no large shading plants, dense mats of **Whorled Marsh Pennywort**, *Hydrocotyle verticillata*, are common in wetter locations. Also frequent under wetter conditions, and sometimes covering quite large areas, are communities characterised by **American Great Bullrush**, *Schoenoplectus lacustris*, **Baldwin's Cyperus**, *Cyperus globulosus*, **Cape Weed**, *Phyla nodiflora*, **Bermuda Sedge**, *Carex bermudiana*, or the **Giant Fern**, *Acrostichum danaeifolium*. Wet locations that are slightly salty or brackish are usually dominated by a **Sheathed Paspalum**, *Paspalum vaginatum*, community. Where water rarely lies on the surface, marsh-edge communities dominated by **Doc-bush**, *Baccharis glomeruliflora*, **Wax Myrtle**, *Myrica cerifera*, **Bermuda Cedar**, *Juniperus bermudiana* or **Bermuda Palmetto**, *Sabal bermudana* are characteristic. These latter shrub and tree dominated communities really form a fringing swamp around the marsh.

Freshwater Ponds

Although the ponds in this category may appear to be quite fresh, most if not all have traces of salt. Bermuda is a small island and the influence of the sea is present everywhere; because of this plants and animals **tolerant of traces of salt** are characteristic of the ponds. As with those of the marshes, the organisms found in ponds mostly originated in eastern North America. Most of the organisms are **native**, meaning that they arrived naturally but are also found elsewhere. There are a few **introduced species** but so far as is known the only two **endemic** fresh water species of fresh water ponds in Bermuda are now **extinct** (See the discussion of the Pembroke Marsh complex in the general introduction.). The fact that evolution to form new species took place in Bermuda tells us that there were stable fresh-water ponds for thousands of years before the arrival of man.

Bermuda's Wetlands

However, with the arrival of man the stable era of fresh water ponds terminated. Early residents did not value the ponds and indeed saw them as breeding grounds for disease-carrying mosquitoes. Many ponds were filled, others were used for trash disposal. The introduction of the **Mosquito Fish** (*Gambusia holbrooki*) in 1928 proved a very effective control for mosquitoes and the rush to eliminate ponds slowed. In recent years the trend to eliminate ponds has fortunately been reversed. Several previous ponds have been emptied of trash and are returning to a reasonably sound ecological state. Examples are the new pond in Paget Marsh at the start of the board-walk, Somerset Long Bay pond and the pond in the Stokes Point Reserve called Bartrams Pond. An entirely new pond has been created on Nonsuch Island as have others in the Spittal Pond Bird Sanctuary.

In several locations man-made ditches function as elongate ponds. Examples are the ditch around Paget Marsh and the very upper end of Pembroke Canal at Glebe Road; they are included here with the freshwater ponds in general.

Communities in freshwater ponds

Around the edges of ponds, communities dominated by the **Narrow-leaved Cattail** (*Typha angustifolia*) are frequent as are those typified by **Joint Grass** (*Paspalum distichum*); these are fringing communities. Other plants which dominate fringing communities less commonly are the **Umbrella Sedge** (*Cyperus alternifolius*), the **White-Headed Rush** (*Rhynchospora colorata*) the **Large Marsh Rush** (*Juncus acutus*) and **Whorled Marsh Pennywort** (*Hydrocotyle verticillata*). In addition, **Sheathed Paspalum** (*Paspalum vaginatum*) is present. It will be mentioned again in relation both to salt marshes and marine ponds. In the water, **Widgeon Grass** (*Ruppia maritima*) is a common community dominant and like **Sheathed Paspalum** is an indicator of slightly salty to brackish conditions. Where the water is virtually fully fresh, **Water Smartweed** (*Polygonum punctatum*) or **Marsh Purslane** (*Ludwigia palustris*) may dominate shallow locations while **Ditchweed** or **Hornwort** (*Ceratophyllum demersum*) is a less frequent community dominant. **Marsh Eclipta** (*Eclipta alba*) and **Water Hyssop** (*Bacopa monniera*) may be scattered among the other plants. Other possible community indicators are the floating aquatic plant **Duckweed** (*Lemna minor*), **Mermaid Weed** (*Proserpinaca palustris*) and the aquatic **Water Fern** (*Salvinia oifersiana*). Very large populations of the **Mosquito Fish**, (*Gambusia holbrooki*) are often present in the water.

Freshwater Swamps

Freshwater swamps, also called swamp forests or treed swamps are not well developed in Bermuda. Mostly, they take the form of fringing or **fragmentary ecosystems** around or within the marshes. In the past, however, they were large important ecosystems. Prior to the "Great Fire" of 1914, Devonshire Marsh was a **Bermuda Cedar** (*Juniperus bermudiana*) swamp. Now the best example of a swamp is the **Bermuda Palmetto** (*Sabal bermudana*) forest in Paget Marsh. In addition to fires, introduced, invasive species such as **Strawberry Guava** (*Psidium cattleianum*), **Pittosporum** or **Mock Orange** (*Pittosporum tobira*), **Carolina Laurel Cherry** (*Laurocerasus carolinianum*) and **Ardisia** (*Ardisia polycephala*), put stress on these swamps by competing with native and endemic species. In recent years the Conservation Division of the Bermuda Government has undertaken a programme of eradication of introduced, invasive species where they have been impinging on important native communities. This programme has been remarkably successful and habitats within the swamps have returned to their original condition, fostering the return of several endangered species.

Communities of freshwater swamps

Although there were Bermuda Cedar dominated swamps in the past, none exist today. The best developed modern swamp is the **Bermuda Palmetto** (*Sabal bermudana*) swamp in Paget Marsh. Since the removal of introduced, competing species, this community has returned to its original condition and is a fine example of a swamp forest that was formerly much more widespread. Conditions within this forest foster the growth of many interesting species such as the **Royal Fern** (*Osmunda regalis*), the **Cinnamon Fern** (*Osmunda cinnamomea*), **Southern Bracken** (*Pteridium*

aquilinum), **Sword Fern** (*Nephrolepis exaltata*), **Wild Bermuda Pepper** (*Peperomia septentrionalis*), **Psilotum** (*Psilotum nudum*), **Bermuda Sedge** (*Carex bermudiana*) and **White Moss** (*Leucobryum glaucum*). Two native vines, **Virginia Creeper** (*Parthenocissus quinquefolia*) and **West Indian Cissus** (*Cissus sicyoides*) climb up the trunks of the palmettos.

Other communities of the freshwater swamps are dominated by **Wax Myrtle** (*Myrica cerifera*) and **Doc-bush** (*Baccharis glomeruliflora*). In some areas the introduced **Brazil** or **Mexican Pepper** (*Schinus terebinthifolia*) seems to be establishing itself as part of the swamp.

Salt Marshes

In the North Atlantic area, salt marshes typically occur on sheltered, sedimentary shores to the north of the frost line. South of the frost line, this environment is typically occupied by mangrove swamps. It is not surprising therefore that salt marshes are not well developed in Bermuda. However, there are several areas with a good representation of salt marsh plants, and the landward fringe of many mangrove swamps has typical salt marsh plants. Formerly, as mentioned above in the description of Pembroke Marsh, salt marshes were probably much more extensive.

Communities of Salt Marshes

Although Bermudian salt marshes lack the extensive stands of salt marsh grasses (*Spartina spp.*) characteristic of mainland marshes, there are several well-defined communities present. The **Sea Rush** (*Juncus maritimus*) dominates a quite large area at Spittal Pond. The **Sheathed Paspalum** (*Paspalum vaginatum*) also dominates quite extensive areas. Smaller areas may be dominated by **Woody Glasswort** or **Marsh Samphire** (*Salicornia perennis*), particularly at the back of mangrove swamps. Very small areas at several locations may be characterised by **Seaside Heliotrope** (*Heliotropium curassavicum*), **New Zealand Spinach** (*Tetragonia tetragonioides*), **Seaside Purslane** (*Sesuvium portulacastrum*) and **Sea Lavender** (*Limonium carolinianum*).

Mangrove Swamps

Mangrove swamps are by far Bermuda's richest **wetland resource**. They are widespread, well developed, have a very high **biodiversity** and act as a very important line of **protection against coastal** erosion. Figure 2.1 shows the location of all the mangrove swamps in Bermuda. One reason that mangrove swamps are so interesting is that they form a **connecting ecosystem** between land and sea. Within the swamps there is a blending of **terrestrial** (land), **coastal** and **marine** features and organisms. Additionally, mangrove swamps are forested and therefore show typical forest features, such as a **canopy** (forest top) and **ground layer** habitats. It is therefore not surprising that they are so **diverse**.

Mangrove trees are interesting in that they are the only trees in the world that can grow with their roots immersed in salt water. Thinking about this, one would expect that perhaps one tree had evolved to tolerate salt water and had colonised the coast, then perhaps evolution had created a group of related mangrove trees from the original coloniser. However, from a study of mangrove trees worldwide we know that this is not so. Mangrove trees represent a great example of convergence. In **convergence** a group of organisms of differing origins adapt to a specific situation. Mangrove tree species are mostly **not closely related** to one another and we can expect to see **wide differences** in **structure** (how they are built) and **function** (how they operate) among them. This is true of the Bermuda mangrove trees.

Mangrove swamps (the **ecosystem** in which mangrove trees live) are typically sub-tropical and tropical systems, occurring on fairly sheltered sedimentary shores. On the mainland of North America they stop at the northern border of the State of Florida; mangrove trees are frost tender and do not cross the frost line. Bermuda's mangrove swamps are the most northerly in the Atlantic Ocean and among the most polar in the world. They are unique. Their extension to the north here is due to the **Gulf Stream**, a vast ocean current which moves north out of the Gulf

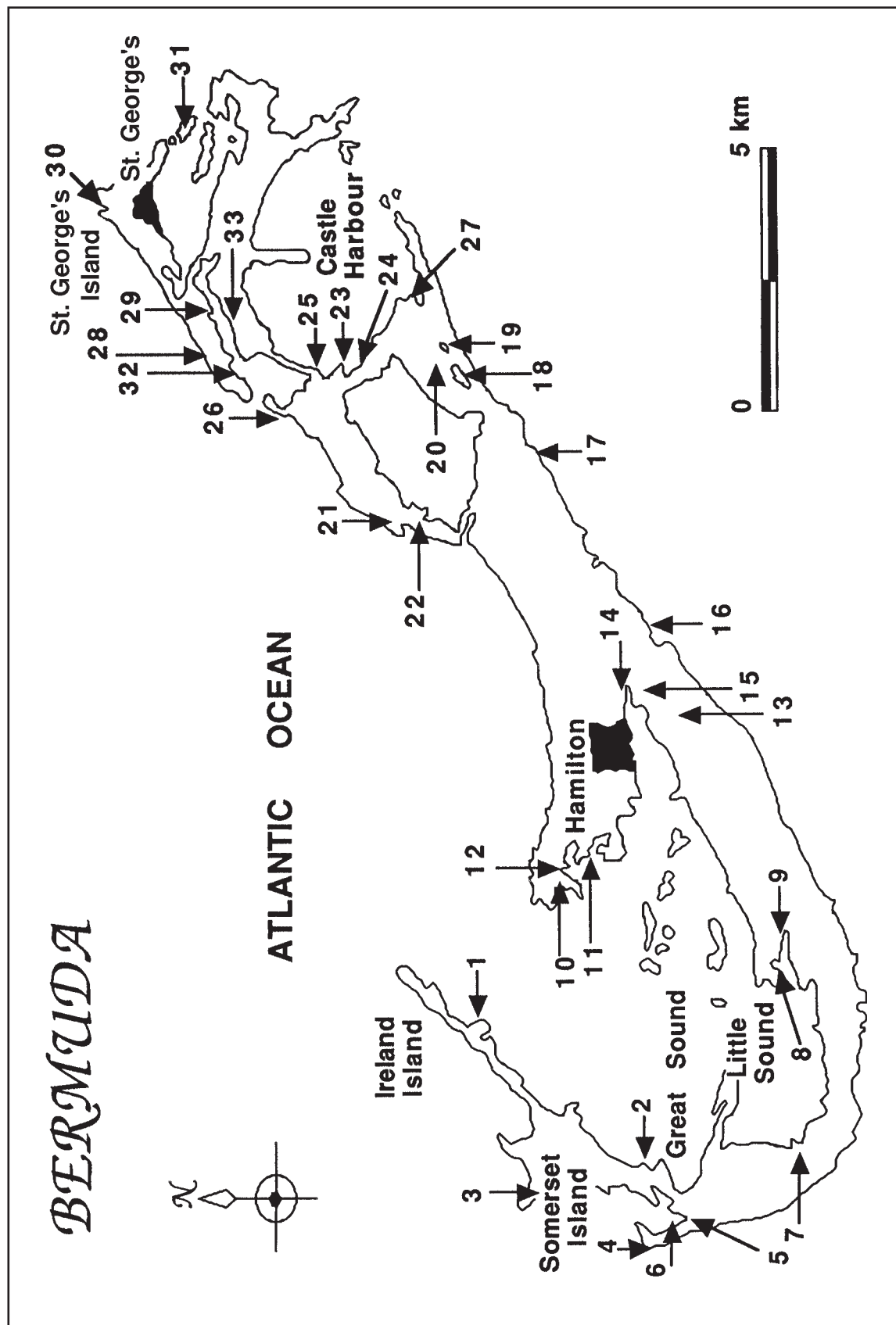


Figure 2.1. Map of Bermuda showing the location of all mangrove swamps in Bermuda.

**Characteristics and Features
of Wetlands Habitats in Bermuda**

Table 2.1. Mangrove swamps of Bermuda, mangrove tree species present, type of habitat and area occupied. R = Red Mangrove, B = Black Mangrove, BU = Buttonwood. Lagoon = marine with restricted connections with the sea. Pond = saline, non-tidal pond.

An. Pond = anchialine (tidal) pond. Land = landlocked without pond.

#	Name	Trees	Type	Area (m ²)
1	Ireland Island	R.B.BU.	Lagoon	7109
2	Head of the Scaur	R.B.BU.	Bay	189
3	Somerset Long Bay	R.B.BU.	Pond	2020
4	Ely's Harbour	R.B.	Bay	5381
5	Pilchard Bay	R.B.BU.	Bay	9141
6	Whale Island	R.B.BU.	Bay	845
7	Evans Pond	R.B.BU.	An. Pond	4432
8	Jew's Bay	R.B.BU.	Bay	800
9	Riddell's Bay	R.B.BU.	Bay	11568
10	Tom Woods Bay	R.B.BU.	Bay	1781
11	Fairyland Creek	R.B.BU.	Bay	7989
12	Mills Creek, Boss's Cove	R.B.BU.	Bay	10907
13	Paget Marsh	R.	Pond	12140
14	Foot of Crow Lane	R.B.	Bay	2336
15	Mangroville	R.B.	Pond	224
16	Hungry Bay	R.B.BU.	Bay	29717
17	Spittal Pond	B.BU.	Pond	229
18	Mangrove Lake	R.BU.	An. Pond	22597
19	Trott's Pond	R.BU.	An. Pond	8368
20	Compston Pond	R.	Pond	2900
21	Shelly Bay Mangrove	R.BU.	An. Pond	8500
22	Commonland Marsh	B.BU.	Land	800
23	Walsingham Pond	R.B.BU.	An. Pond	4933
24	Walsingham Bay	R.B.BU.	Bay	3776
25	Blue Hole	R.B.BU.	Bay	3003
26	Coney Island	R.B.BU.	Bay/Pond ¹	1755
27	Tuckers Town Bay	R.B.BU.	Bay	400
28	Lovers Lake	B.BU.	An. Pond	2288
29	Mangrove Bay	R.B.BU.	Bay	2837
30	Coot Pond	R.B.BU.	Bay	1643
31	Paget Island Pond	R.B.BU.	Bay ²	1594
32	Ferry Point	R.B.BU.	Bay	2200
33	U.S. Naval Air Base	R.B.	Pond ³	850
			TOTAL	176251
			Mean	5341

¹ Former bay, now divided into bay and pond

² Former pond, now connected to the sea

³ Former bay, now reduced to a small pond



Figure 2.2. Typical trunk and root structures of red mangrove trees.

of Mexico through the Straits of Florida. It brings both **warm sea water** and **seeds, floating embryos (propagules)** etc. of mangrove trees. However, although Bermuda has three mangrove tree species, this is less than on the mainland in the Gulf of Mexico. The more tropical species of mangrove tree have been unable to colonise Bermuda!

There are three species of mangrove tree in Bermuda; these are the **Red Mangrove** (*Rhizophora mangle*), the **Black Mangrove** (*Avicennia germinans*) and the **Buttonwood** (*Conocarpus erectus*); all are native trees. One introduced tree, the **Brazil or Mexican Pepper** tree, (*Schinus terebinthifolia*) is also found on the landward fringe of mangrove swamps. These trees all have developed adaptations to live in this marine environment. In comparison to similar land trees, the mangroves have to cope with **salty, oxygen-poor soil** which is muddy and **less stable** and supporting than soils above the water line. They also must disperse their seeds by **water borne** rather than land borne means. Some of these adaptations are visible, others are internal.

In the Red Mangrove, visible adaptations are the wide-spreading **prop roots** and the large floating **embryos** that serve to carry juvenile trees to new locations. If you look carefully at the prop roots you will see small whitish protuberances; these are called **lenticels** and function to exchange air with the inside of the roots; once inside it is carried down to the submerged roots within channels. Oxygen from air is needed for respiration within the roots and carbon dioxide must be removed. **Embryos** in plants are simply germinating seeds. In the case of the Red Mangrove the large seeds start to germinate on the tree and a large **primary root** grows down toward the water. The whole embryo is 6-8 inches in length. At this point it falls from the tree, if over water it **floats** away and if grounded elsewhere under suitable conditions, it quickly grows into a new tree. It is known that these embryos can cross the Atlantic Ocean from Africa to North America in the ocean currents!

The red mangrove is the most **highly adapted** to marine conditions of the Bermudian mangroves, excreting salt via leaf shedding. Leaves about to shed turn orange-yellow. Figure 2.2 shows the typical trunk and root structures of red mangroves.

The Black Mangrove does not have prop roots, but it does have a **wide-spreading, shallow root system** which supports the tree well. From these roots grow the most obvious of its adaptations; these are the finger-like **pneumatophores** or air breathing organs. On the pneumatophores are **lenticels** just like those in the Red Mangrove. The seeds of the Black Mangrove are large and float readily; they too are transported very long distances on ocean currents. However, they do not germinate until deposited in a suitable location. The Black Mangrove has a really neat system to get rid of excess salt within the tree body. It has **salt-secreting glands** on the backs of the leaves. These are invisible to the naked eye, but in bright sunlight the salt they secrete can be seen as shining salt crystals on the backs of the leaves.

The Buttonwood is not so well adapted as the preceding two species and consequently cannot live where its roots are submerged in oxygen-poor marine mud. It is much more like a land tree but does have medium sized **floating** seeds for **dispersal**.

All these trees have hidden **physiological adaptations** to help keep too much salt out of their living tissues.

An additional important feature of mangrove swamps is that they are very **productive**; new leaves are produced all the time and older ones are shed. Fallen leaves rot to produce a rich food source called **detritus**, for marine and coastal animals. Some of this **detritus** is carried away from the swamp at high tide and becomes an important food source elsewhere. Ecosystems that do this are called **export ecosystems**. Such systems are of great ecological importance since they have a positive influence far beyond their boundaries.

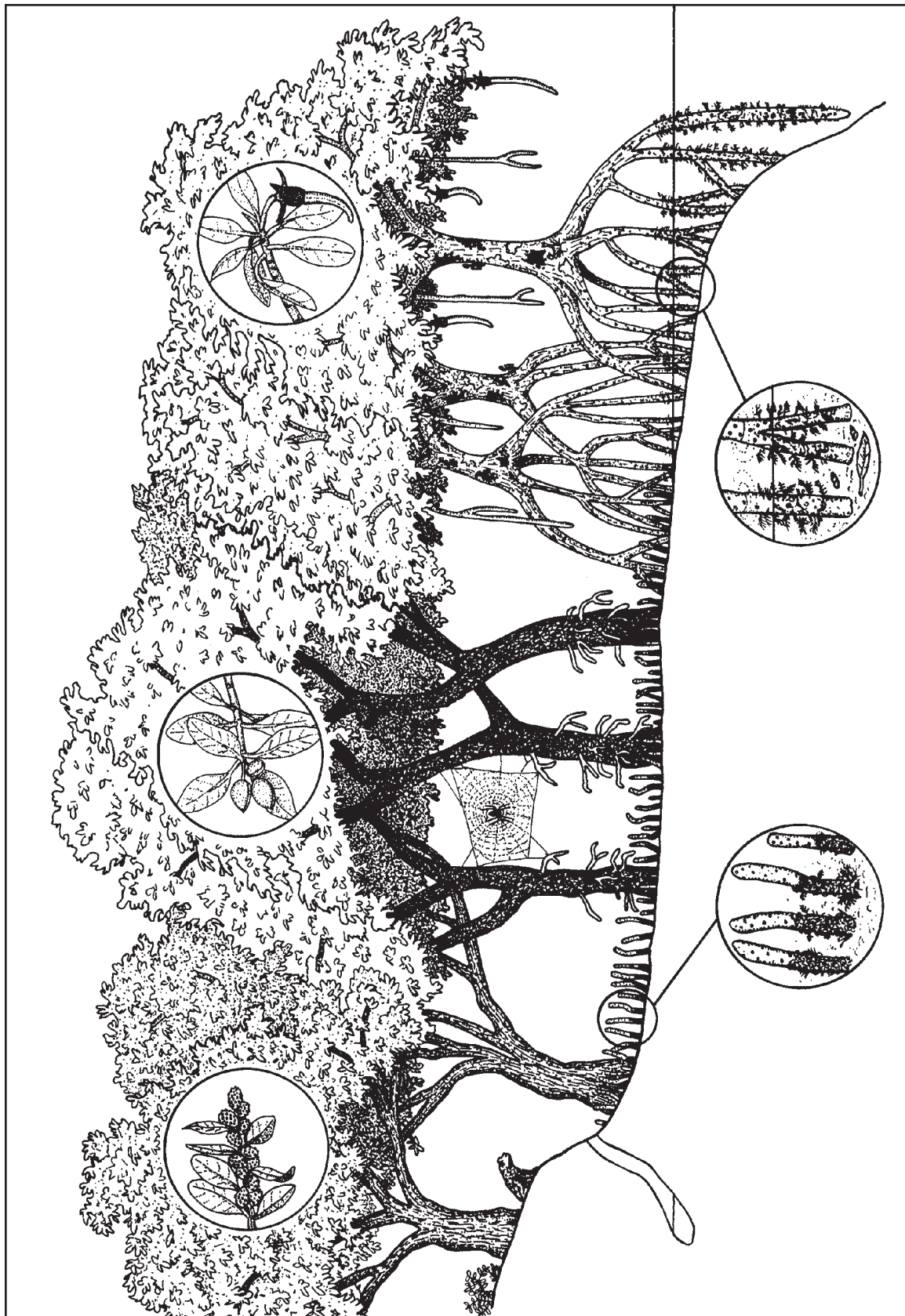


Figure 2.3. Cross section of a typical mangrove community in Bermuda

Figure 2.3. Cross section of a typical mangrove community in Bermuda, with insets showing details of main features.

Key to Figure 2.3

Buttonwood, *Conocarpus erectus*



Black Mangrove, *Avicennia germinans*



Red Mangrove, *Rhizophora mangle*



Pneumatophores of Black Mangrove



Prop roots of Red Mangrove



Giant Toad, *Bufo marinus*



Giant Land Crab burrow, *Cardisoma guanhumi*



Orb-weaver Spider, *Nephila clavipes*



Mangrove Crab, *Goniopsis cruentata*



Curly Sea Moss, *Bostrychia montagnei*,
on pneumatophores and prop roots



Mat of Crinkle Grass, *Rhizoconium* spp., on pneumatophores



Bermuda's Wetlands

Communities of Mangrove Swamps

Because of their varying degree of **adaptation** to the sea, mangrove trees tend to become zoned within the mangrove swamp. Here this **zonation** takes the form of a **seaward** band of **Red Mangrove** trees to the **landward** of which lie the **Black Mangroves**; lastly at the back of the swamp are the **Buttonwoods** and often a few **Brazil Pepper** trees. Red Mangroves can colonise further into the sea than the Black Mangrove trees both because of the prop roots and because of the large embryo which can start to grow in 10 cm (4 in) of water. By contrast, the Black Mangrove can only grow at about the water line!

The **Red Mangrove community** is situated from about low tide level to just below high tide level; it has two very different **components**. There is a component which is **submerged at high tide** and a second one in the air above this. This is called a **stratified community**. The habitat in the water is sheltered, and the prop roots give a stable surface on which attached animals and seaweeds can grow. The most prominent seaweed on the roots is the **Curly Sea Moss**, (*Bostrychia montagnei*) which is a red alga but may appear quite yellow at times. Also common on the roots are tangled patches of green filamentous seaweeds called **Crinkle Grasses**; scientifically speaking they are in the genus *Rhizoclonium*. On roots that are permanently submerged are masses of the green bushy seaweed, **Horsetail Sand Moss** (*Caulerpa verticillata*). In the aerial part of the community, a number of lichens are common. The most obvious of these is the **Fire Lichen** (*Pyrenula aurantiaca*). Just above the water there are usually small numbers of the **Mangrove Periwinkle** (*Littorina angulifera*). The **Mangrove Crab** (*Goniopsis cruentata*) may also be seen on the mangrove branches if you have quick, sharp eyes.

The Black Mangrove community is more terrestrial than the Red and consequently has more terrestrial plants and fewer seaweeds. It is situated from about 3/4 high tide level to about the level of the highest tides. However, the seaweeds noted above extend to about high tide level within the community. Where they stop they are replaced by communities dominated by a variety of flowering plants such as **Seaside Purslane**, (*Sesuvium portulacastrum*), **Woody Glasswort** or **Marsh Samphire**, (*Salicornia perennis*), **Scurvy Grass** or **Sea Rocket**, (*Cakile lanceolata*), the **Seashore Rush Grass**, (*Sporobolus virginicus*), the **Saltmarsh Oxeye** (*Borrchia frutescens*), **New Zealand Spinach**, (*Tetragonia tetragonioides*), **Fern Asparagus**, (*Asparagus densiflorus*) and the **Seaside Daisy** (*Wedelia trilobata*). Important animals are the **Coffee Bean Snail** (*Melampus coffeus*), the **Land Crab** (*Gecarcinus lateralis*) the **Giant Land Crab** (*Cardisoma guanhumi*) and the **Mangrove Crab** (*Goniopsis cruentata*).

The **Buttonwood dominated community** at the back of the swamp tends to have the same flowering plants as the landward portion of the Black Mangrove community described above, with the addition of a huge variety of native and introduced land plants. Figure 2.4 shows a profile through an average Bermudian mangrove swamp and a well zoned example at Walsingham Pond. It shows the typical location of the mangrove tree species and the areas occupied by some of the more common associated plants.

Marine Ponds

Figure 2.5 shows a diagrammatic cross section of a marine pond. Included in the diagram are typical connections to the sea and other sources of water that determine the characteristics of the pond water. Note that not all the features shown in this pond appear in each and every pond.

As explained in the general introduction to this field guide, the marine ponds are virtually all **fringed** by a **mangrove swamp**. Why then do we just not treat them as a type of mangrove swamp? The reason is that there are a whole lot of important **differences** between the ponds and the coastal mangrove swamps. This applies even to the mangrove swamps themselves which are distinctly different from those typical coastal bays. However, it must be realised that the mangrove swamps are partly responsible for many of the other unique features of the ponds themselves.

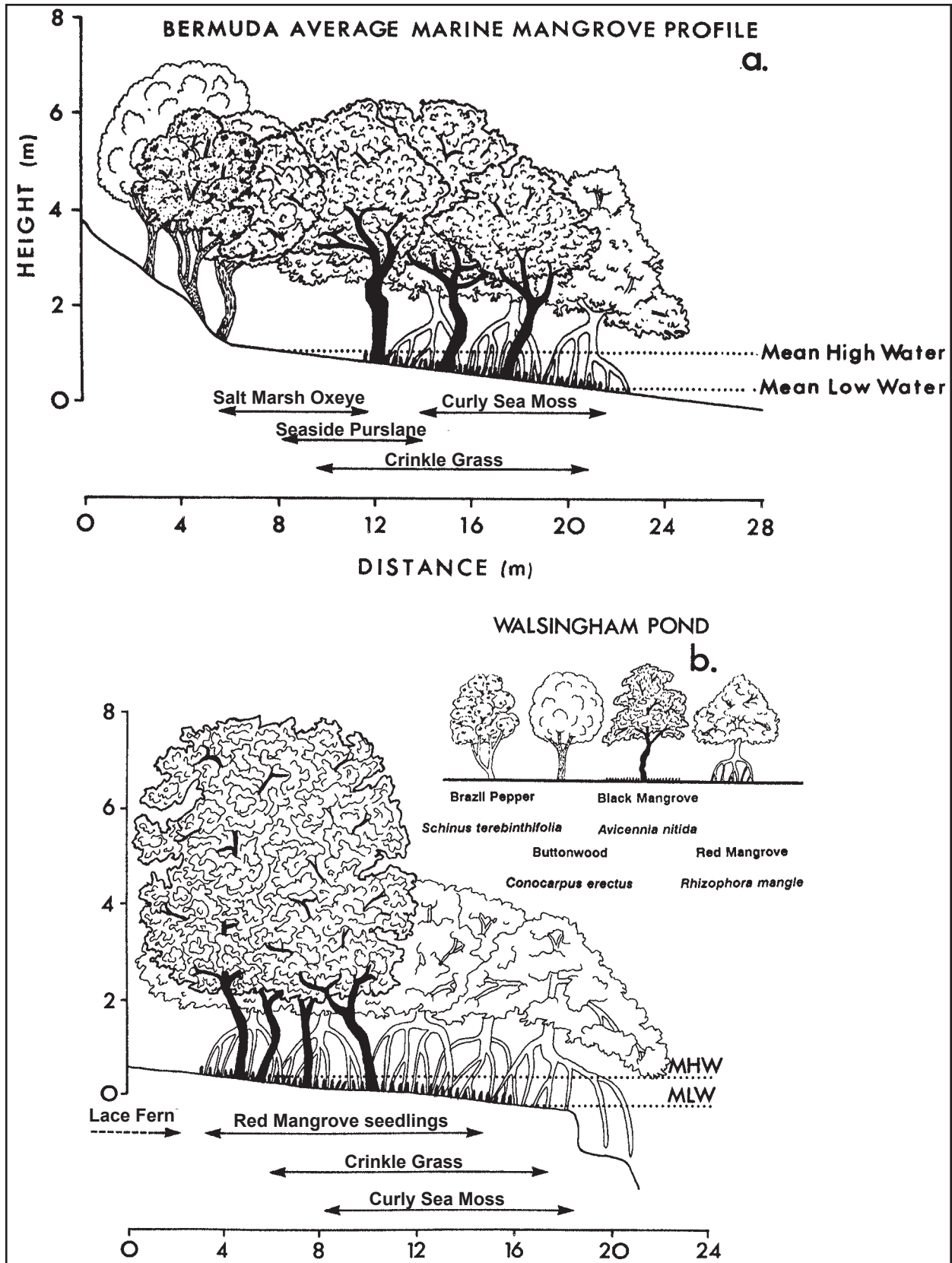


Figure 2.4. Comparison of the profiles of an average marine pond and mangrove swamp.

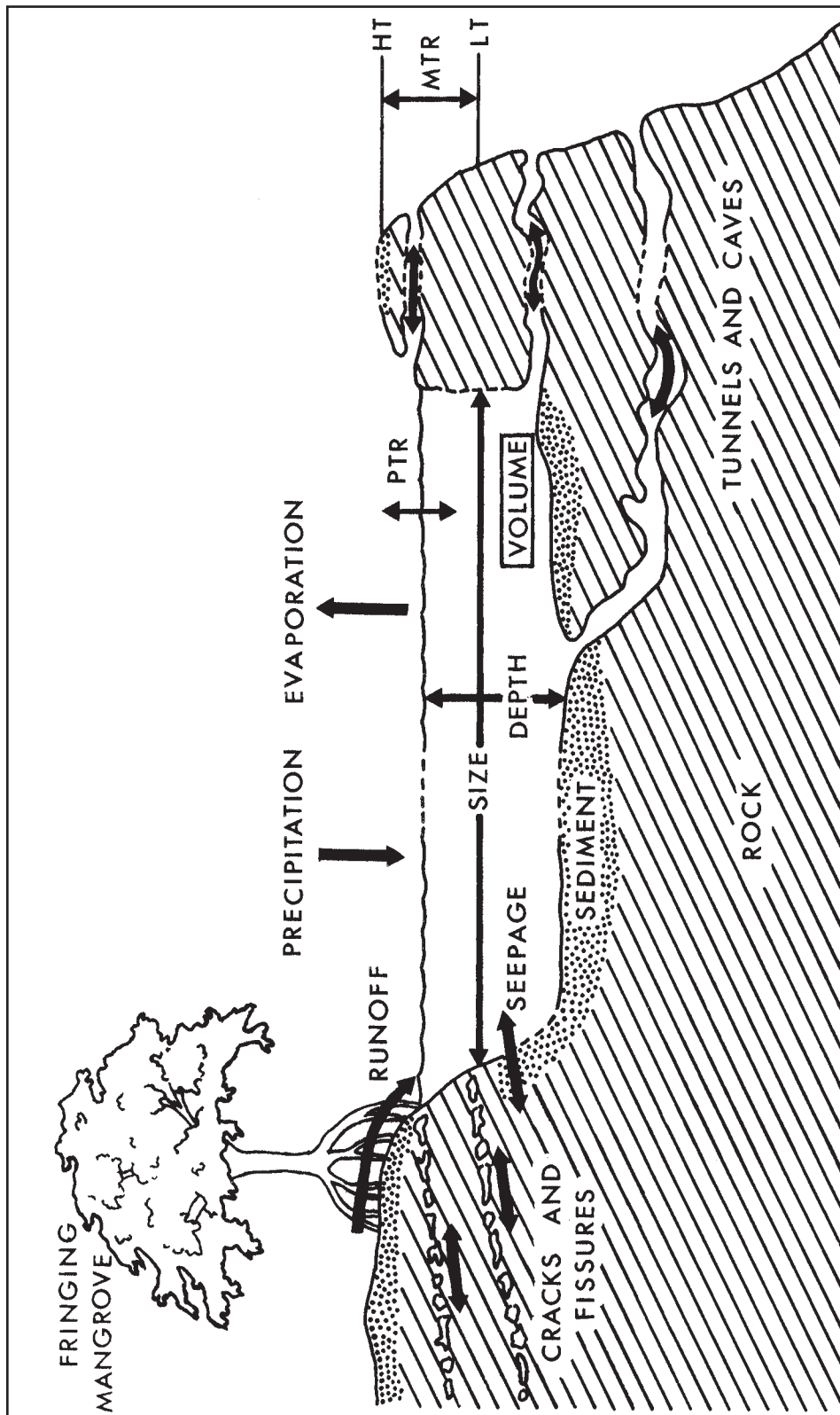


Figure 2.5. Diagrammatic cross section of a marine pond.

The ponds are special in many ways. First, they are the most **sheltered marine system** that can be seen in Bermuda. All are in **depressions**, some distance from the sea and the mangrove swamp around the edge provides an additional **shelter belt**. You will almost never see waves higher than a few inches (cm) in any pond. This allows colonisation by many delicate and beautiful marine animals and seaweed that could not exist in more open environments.

A second very important feature of ponds is that they are **rich in animal food** and **plant nutrients**. Their location in **depressions** means that surface run-off from surrounding land **transports** both plant nutrients such as nitrate, phosphate and potassium and particles of food into the water. More important, the **mangrove trees** constantly drop leaves which decay, producing **detritus** a rich food source for marine animals. Most of the food supply is in the form of small particles of detritus and because of this marine animals which obtain their food by **filtering** the water are at a great advantage. We call this group of animals **filter feeders**, and it includes such things as **sponges** (*Porifera*), **sea squirts** (*Tunicates*), **anemones** and **hydroids** (*Cnidaria*), many **molluscs** (*Mollusca*), **Tube-worms** (*Annelida*), **moss animals** (*Bryozoa*) and others. Additionally the juvenile forms and larvae of all types of marine animals feed on particles in the water. All the particulate matter in the water tends to make the pond water somewhat cloudy.

The wealth of animals feeding on **detritus** and the **lush plant growth** resulting from plant nutrients, results in a very high abundance of animals and plants in the ponds. These organisms form the basis of a **food chain** of plant and animal eating creatures. All in all the ponds have a very abundant and diverse group of organisms living in them. In many ponds with large connections to the ocean, this includes high populations of **fish** of many species. The best example of this is Walsingham Pond, but Evans Pond is also rich in fishes. The abundant food supply in ponds also attracts a wide variety of birds and others use ponds as a secure **roosting** or **nesting** location.

Although there are **mangrove swamps** associated with almost all of the marine ponds, these mangroves differ in several ways from the coastal ones. The first difference is that the distinct **zonation** of trees, with red mangroves toward the water, followed by black then Buttonwood, **does not happen** in the majority of the ponds. Many of the ponds have only either the red or the black mangrove trees; we call these **monospecific** stands. For example Lovers Lake has black mangroves only, Mangrove Lake and Trotts Pond have only red. Those that have both, for example, Evans Pond, have the trees **mixed** rather than zoned. Some like Spittal Pond have small patches of either species scattered around the edge. The reason for the lack of zonation in most of the ponds is unclear, but it is suspected that whichever species happened to **colonise first** was able to occupy the entire mangrove forest. It appears that in the absence of **competition** mangrove trees are able to occupy a broader habitat. The only pond with clear zonation is Walsingham Pond; it is separated from the sea by only a few feet (m) of land in places and seems to have the normal structure of a coastal mangrove swamp.

A second, most important difference between coastal and pond mangrove swamps is that in pond mangroves, the **prop roots** of the Red Mangrove and the **pneumatophores** of the Black Mangrove are often **permanently submerged**. This is partly due to the **reduced tides** in the ponds, and partly the result of **steeper slopes** into deeper water in the ponds. In several ponds, notably Walsingham Pond and Mangrove Lake, roots at least 1 m (3 ft) long hang into the water. These roots form an excellent, stable **attachment surface** for algae and a host of attached (sessile) marine animals such as sponges and sea squirts. Were it not for the roots there would be virtually no attachment surfaces in many ponds since they have bottoms of generally very soft mud.

The lack of water exchange (flushing) in the ponds results in both warmer, in summer, and colder, in winter, **temperatures** and more variable **salinity** than in coastal waters. A less obvious, but equally important environmental effect of low flushing is that **oxygen levels** in pond waters are very variable. This may become critical in mid-summertime when high temperature combined with maximum quantities and activity of organisms may result in **total oxygen depletion** especially at

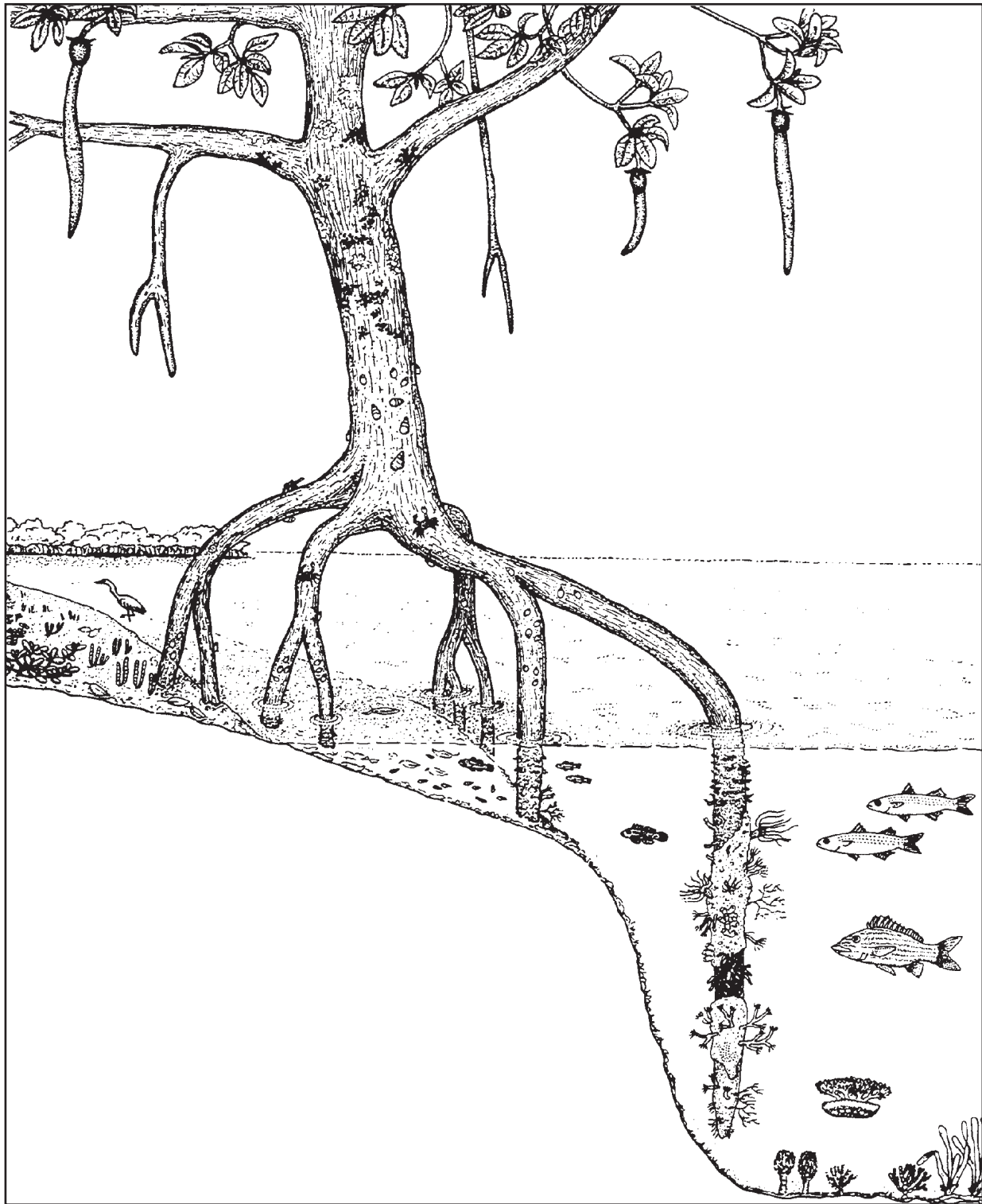












Figure 2.6. The edge of a typical anchialine pond in Bermuda showing a red mangrove (*Rhizophora mangle*) and typical examples of the biota.

Figure 2.6. The edge of a typical anchialine pond in Bermuda showing a red mangrove (*Rhizophora mangle*) and typical examples of the biota.

Key to Figure 2.6.

<i>Salicornia perennis</i> , Marsh Samphire.		
<i>Sesuvium portulacastrum</i> , Sea Purslane.		
<i>Goniopsis cruentata</i> , Mangrove Crab.		
<i>Littorina angulifera</i> , Mangrove Periwinkle.		
<i>Melampus coffeus</i> , Coffee Bean Snail.		
Lichens.		
<i>Fundulus bermudae</i> , Bermuda Killifish.		
<i>Batillaria minima</i> , False Cerith.		
<i>Lophogobius cyprinoides</i> , Crested Goby.		
Mangrove root biota.		
<i>Mugil trichodon</i> , Mullet.		
<i>Haemulon sciurus</i> , Blue-striped Grunt.		
<i>Penicillus capitatus</i> , Shaving Brush Alga.		
<i>Halimeda monile</i> .		
<i>Thalassia testudinum</i> , Turtle Grass.		
<i>Cassiopea xamachana</i> , Upside-down Jellyfish.		
<i>Egretta thula</i> , Snowy Egret.		

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night. This certainly happens in Trotts Pond and Spittal Pond, but probably occurs on a smaller scale in almost all of the ponds. Some pond creatures can survive a limited period of no dissolved oxygen, others die. Most fish are very vulnerable to this and massive fish kills have been observed in several ponds, especially **American Eels** (*Anguilla rostrata*). A few fish such as the **Mosquito Fish** (*Gambusia holbrooki*) and the **Bermuda Killifish** (*Fundulus bermudae*) are adapted to survive periods of low or no oxygen.

Communities in Marine Ponds

The **open water community** shows the least diversity in ponds. It overlies bottoms of soft mud and is usually cloudy. Plankton populations are often low but blooms (brief periods of abundant plankton) do occur in all the ponds. Large swarms of **shrimp larvae** are often common in Walsingham Pond. Most ponds, especially Walsingham, have significant **fish populations**. Several species of fish occurring in the ponds are of particular interest. The **endemic** (evolved in Bermuda) **Bermuda Killifish** (*Fundulus bermudae*) is common in most ponds as is the **Mosquito Fish** (*Gambusia holbrooki*) a species introduced to control mosquitos. **American Eels** (*Anguilla rostrata*) are present in virtually all ponds, at times, but rare or absent elsewhere in Bermuda, although they used to move inland through Pembroke Canal before it became so horribly polluted (see marsh section). Common species to be seen in the ponds are listed later. At least three ponds, Walsingham, Evans and Lovers Lake, have marine **Green Turtle** (*Chelonia mydas*) populations temporarily or permanently and Trotts Pond and Mangrove Lake support Bermuda's only populations of the **Diamondback Terrapin** (*Malaclemys terrapin*), which lay their eggs in bunkers on the Mid Ocean Golf Club course. In several of the ponds there are populations of submerged marine flowering plants. **Widgeon Grass** (*Ruppia maritima*) is common as is **Turtle Grass** (*Thalassia testudinum*); the other two sea grasses, **Manatee Grass** (*Syringodium filiforme*) and **Shoal Grass** (*Halodule wrightii*) are less common but occur. Of great interest are scattered specimens of the endemic seaweed **Sargasso Weed** (*Sargassum bermudense*) which can reach several meters in height.

The **Upside-down Jellyfish** (*Cassiopea xamachana*) which is poisonous may be abundant at times in the open-water community. Most individuals stay on the bottom but some swim up into the water. The sting is not serious but it should be avoided.

The mangrove community of the marine ponds shows a **biodiversity** unequalled perhaps anywhere else in the **world**. Because of its complexity, only the main features can be described here. For instance there are probably close to one hundred different kinds of sponges present! Other groups are almost as diverse; there are probably 50 different seaweeds, 20 different sea squirts over one hundred flowering plants and many, many other species. The total **biodiversity** is staggering. Because the community is so complex, several sub-communities will be described separately.

The **submerged mangrove root sub-community** is the most diverse of all and additionally, there is a pronounced zonation of organisms, both plant and animal, on these roots. This differs in different ponds but is most pronounced in Walsingham. There orange sponges, tube-worms, moss animals and the blue-green cyanobacterium, **Oscillatoria** (*Lyngbya lutea*), dominate the root from low tide level to about 10 cm (4 in) in depth at which point green algae, anemones and several other sponges are added including the poisonous red **Fire Sponge** (*Tedania ignis*). Do not touch any red sponges on mangrove roots! The bottom half of the root shows frequent sea squirts of several species, yet more sponges and sea squirts and frequently large clumps of the **Horsetail Sand Moss** (*Caulerpa verticillata*). Green Turtles graze this lower zone of the roots, leaving bare areas and severed root tips.

The **intertidal mangrove root sub-community**. This community only a few inches (cm) high is alternately exposed to the air and submerged in the water. It is the home to **Oscillatoria** (*Lyngbya lutea*), a blue-green cyanobacterium, **Curly Sea Moss** (*Bostrychia montagnei*) and the **Crinkle Grasses** (*Rhizoclonium spp.*).

Characteristics and Features of Wetlands Habitats in Bermuda

The **emerged mangrove root sub-community** is very similar to that in the coastal swamps and supports populations of the **Mangrove Periwinkle**, (*Littorina angulifera*), **Coffee Bean Snails**, (*Melampus coffeus*), and **Mangrove Crabs** (*Goniopsis cruentata*).

The sub-community of the **trunks, branches and leafy canopy** is characterised by such things as the Fire Lichen (*Pyrenula aurantiaca*), **Mangrove Crabs**, a few **Mangrove Periwinkles** (*Littorina angulifera*) and a host of birds, notably several species of heron, **Kiskadees** (*Pitangus sulphuratus*) and many migratory warblers and other species. The **Jamaican Anole** (*Anolis grahami*) is always abundant.

The **mangrove back sub-community** lying above high tide level is similar to that of coastal mangrove swamps. It supports populations of several salt marsh plants. Common ones are **Woody Glasswort** or **Marsh Samphire** (*Salicornia perennis*), **Saltmarsh Oxeye** (*Borrichia frutescens*), **Seaside Purslane** (*Sesuvium portulacastrum*), **Buttonwood** (*Conocarpus erectus*), **Brazil** or **Mexican Pepper tree** (*Schinus terebinthifolia*), **New Zealand Spinach** (*Tetragonia tetragonioides*), **Seashore Rush Grass** (*Sporobolus virginicus*), **Seaside Goldenrod** (*Solidago sempervirens*), **Cape Weed** (*Phyla nodiflora*), **Fern Asparagus** (*Asparagus densiflorus*), **Fennel** (*Foeniculum vulgare*), **Prickly Pear** (*Opuntia stricta*), **Seaside Daisy** (*Wedelia trilobata*), **Scurvy Grass** or **Sea Rocket** (*Cakile lanceolata*) and **Crab Grass** (**St. Augustine Grass**) (*Stenotaphrum secundatum*). A host of other species are less common.

Common and Important Species of Bermuda's Wetlands

List of Species Mentioned and/or Illustrated in this Guide

Key to Habitat Codes

B = Lagoons, Bays and Coastal Waters	C = Coral Reefs
CA = Caves and Cave Mouths	F = Forest
FW = Freshwater Habitats	M = Mangrove Swamps and Salt Marshes
O = Open Ocean	OC = Open Coastal
R = Rocky Shores	S = Sandy Shores
SD = Sand Dunes	SG = Seagrass Beds
SP = Saltwater Ponds	U = Urban Environments
W = Wasteland, Open Spaces, Wayside	

Note: Common names are listed in the first column except where there is no accepted common name, in these cases the scientific name is used. For each group of organisms, the common names are in alphabetical order. The habitat codes defined in the key show where the organisms are commonly found. The illustrations following the list are in the same order as the list and are also accompanied by habitat codes.

Common Name	Scientific Name	Taxonomy	Habitat Code
Beggiatoa	Beggiatoa species	Bacterium	SP
Oscillatoria	Lyngbya lutea	Blue-green Cyanobacteria	M, SP
Fire Lichen	Pyrenula aurantiaca	Lichens	M
Common Plateweed	Halimeda incrassata	Seaweeds - Green Algae	B
Crinkle Grasses	Rhizoclonium spp.	Seaweeds - Green Algae	B, M
Feather Sand Moss	Caulerpa sertularioides	Seaweeds - Green Algae	B, SP
Grape Sand Moss	Caulerpa racemosa	Seaweeds - Green Algae	B, SP
Horsetail Sand Moss	Caulerpa verticillata	Seaweeds - Green Algae	B
Light Brittle Grass	Chaetomorpha linum	Seaweeds - Green Algae	M, R
Mermaid's Wine Glass	Acetabularia crenulata	Seaweeds - Green Algae	B, SP
Merman's Shaving Brush	Penicillus capitatus	Seaweeds - Green Algae	B, SP
Mexican Sand Moss	Caulerpa mexicana	Seaweeds - Green Algae	B, M, SP
Sea Balloon	Valonia macrophysa	Seaweeds - Green Algae	B
Sea Intestines	Enteromorpha flexuosa	Seaweeds - Green Algae	B
Seathreads	Cladophora spp.	Seaweeds - Green Algae	B, R
Thin Sea Lettuce	Monostroma oxyspermum	Seaweeds - Green Algae	B, R
Bermuda Sargasso Weed	Sargassum bermudense	Seaweeds - Brown Algae	SP
Common Ribbonweed	Dictyota menstrualis	Seaweeds - Brown Algae	B, C
Jamaican Petticoat	Padina jamaicensis	Seaweeds - Brown Algae	B
Banded Threadweed	Ceramium byssoideum	Seaweeds - Red Algae	B, C
Curly Sea Moss	Bostrychia montagnei	Seaweeds - Red Algae	M
Stickweed	Wurdemannia miniata	Seaweeds - Red Algae	B
Bermuda Campylopus	Campylopus bermudiana	Mosses	F, FW
Bermuda Trichostoma	Trichostomum bermudanum	Mosses	F, FW, OC, U, W
White Moss	Leucobryum glaucum	Mosses	FW
Cinnamon Fern	Osmunda cinnamomea	Ferns	FW
Giant Fern	Acrostichum danaeifolium	Ferns	FW
Marsh Shield Fern	Thelypteris thelypteroides	Ferns	FW
Royal Fern	Osmunda regalis	Ferns	FW
Southern Bracken	Pteridium aquilinum	Ferns	FW
Sword Fern	Nephrolepis exaltata	Ferns	F
Ten-Day Fern	Polystichum adiantiforme	Ferns	FW
Virginia Chain Fern	Woodwardia virginica	Ferns	FW
Water Fern	Salvinia olerfiana	Ferns	FW
Psilotum	Psilotum nudum	Clubmosses	F, FW
Cow-cane	Arundo donax	Grasses	FW, W

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Crab Grass or St. Augustine Grass	<i>Stenotaphrum secundatum</i>	Grasses	OC, W
Joint Grass	<i>Paspalum distichum</i>	Grasses	FW, W
Para Grass	<i>Brachiaria mutica</i>	Grasses	FW, W
Saw Grass	<i>Cladium jamaicense</i>	Grasses	FW
Seashore Rush Grass	<i>Sporobolus virginicus</i>	Grasses	OC, R
Sheathed Paspalum	<i>Paspalum vaginatum</i>	Grasses	FW, SP
Switch Grass	<i>Panicum virgatum</i>	Grasses	FW, OC
American Great Bullrush	<i>Schoenoplectus lacustris</i>	Rushes	FW
Knotted Spike Rush	<i>Eleocharis interstincta</i>	Rushes	FW
Large Marsh Rush	<i>Juncus acutus</i>	Rushes	FW
Narrow-leaved Cattail	<i>Typha angustifolia</i>	Rushes	FW
Sea Rush	<i>Juncus maritimus</i>	Rushes	M
Stipitate Beaked Rush	<i>Rhynchospora stipitata</i>	Rushes	FW
White-Headed Rush	<i>Rhynchospora colorata</i>	Rushes	FW
Baldwin's Cyperus	<i>Cyperus globolus</i>	Sedges	FW
Bermuda Sedge	<i>Carex bermudiana</i>	Sedges	F
Short-leaved Kyllinga	<i>Kyllinga brevifolia</i>	Sedges	FW
Umbrella Sedge	<i>Cyperus alternifolius</i>	Sedges	FW
Bermudiana	<i>Sisyrinchium bermudiana</i>	Herbaceous Flowering Plants	OC, U, W
Blodgett's Spurge	<i>Euphorbia blodgetti</i>	Herbaceous Flowering Plants	CL, OC, W
Cape Weed	<i>Phyla nodiflora</i>	Herbaceous Flowering Plants	OC, SD, W
Common Plantain	<i>Plantago major</i>	Herbaceous Flowering Plants	U, W
Day Flower	<i>Commelina longicaulis</i>	Herbaceous Flowering Plants	FW
Ditchweed or Hornwort	<i>Ceratophyllum demersum</i>	Herbaceous Flowering Plants	FW
Dog Fennel	<i>Eupatorium capillifolium</i>	Herbaceous Flowering Plants	FW
Duckweed	<i>Lemna minor</i>	Herbaceous Flowering Plants	FW
Elephant's Ear or Eddoe	<i>Epipremnum aureum</i>	Herbaceous Flowering Plants	FW
English Plantain	<i>Plantago lanceolata</i>	Herbaceous Flowering Plants	W
False Nettle	<i>Boehmeria cylindrica</i>	Herbaceous Flowering Plants	FW
Fennel	<i>Foeniculum vulgare</i>	Herbaceous Flowering Plants	U, W
Fern Asparagus	<i>Asparagus densiflorus</i>	Herbaceous Flowering Plants	F, W
Lace Fern or Bridal Fern	<i>Asparagus setaceus</i>	Herbaceous Flowering Plants	F, W
Marsh Eclipta	<i>Eclipta alba</i>	Herbaceous Flowering Plants	FW
Marsh Purslane	<i>Ludwigia palustris</i>	Herbaceous Flowering Plants	FW
Mermaid Weed	<i>Proserpinaca palustris</i>	Herbaceous Flowering Plants	FW
Monnier's Hedge Hyssop	<i>Bramia monniera</i>	Herbaceous Flowering Plants	W
New Zealand Spinach	<i>Tetragonia tetragonioides</i>	Herbaceous Flowering Plants	M, W
Ovate Leaved Marsh Pennywort	<i>Centella asiatica</i>	Herbaceous Flowering Plants	W
Prickly Pear	<i>Opuntia stricta</i>	Herbaceous Flowering Plants	OC, W
Purslane	<i>Portulaca oleracea</i>	Herbaceous Flowering Plants	F, O
Saltmarsh Oxeye	<i>Borrchia frutescens</i>	Herbaceous Flowering Plants	M
Scurvy Grass or Sea Rocket	<i>Cakile lanceolata</i>	Herbaceous Flowering Plants	S, SD
Sea Lavender	<i>Limonium carolinianum</i>	Herbaceous Flowering Plants	M
Seaside Daisy	<i>Wedelia trilobata</i>	Herbaceous Flowering Plants	OC, SD
Seaside Goldenrod	<i>Solidago sempervirens</i>	Herbaceous Flowering Plants	OC
Seaside Heliotrope	<i>Heliotropium curassavicum</i>	Herbaceous Flowering Plants	M
Seaside Purslane	<i>Sesuvium portulacastrum</i>	Herbaceous Flowering Plants	OC, R
St. Andrew's Cross	<i>Hypericum macrosepalum</i>	Herbaceous Flowering Plants	FW, W
Turtle Grass	<i>Thalassia testudinum</i>	Herbaceous Flowering Plants	B, SG
Water Hyacinth	<i>Eichornia crassipes</i>	Herbaceous Flowering Plants	FW
Water Hyssop	<i>Bacopa monniera</i>	Herbaceous Flowering Plants	FW
Water Smartweed	<i>Polygonum punctatum</i>	Herbaceous Flowering Plants	FW
White Pellitory	<i>Parietaria officinalis</i>	Herbaceous Flowering Plants	W
Whorled Marsh Pennywort	<i>Hydrocotyle verticillata</i>	Herbaceous Flowering Plants	FW
Widgeon Grass	<i>Ruppia maritima</i>	Herbaceous Flowering Plants	FW, SP
Wild Bermuda Pepper	<i>Peperomia septentrionalis</i>	Herbaceous Flowering Plants	CA, F
Woody Glasswort or Marsh Samphire	<i>Salicornia perennis</i>	Herbaceous Flowering Plants	M

**Common and Important
Species of Bermuda's Wetlands**

Blue Dawn Flower or Morning Glory	<i>Ipomea indica</i>	Vines	F, M, W
Virginia Creeper	<i>Parthenocissus quinquefolia</i>	Vines	F, FW
West Indian Cissus	<i>Cissus sicyoides</i>	Vines	F, FW
Bermuda Holly	<i>Ilex vomitoria</i>	Shrubs	F, OC
Carolina Laurel Cherry	<i>Laurocerasus carolinianum</i>	Shrubs	F, FW
Common Sage or Lantana	<i>Lantana involucrata</i>	Shrubs	F, OC, U, W
Doc-bush	<i>Baccharis glomeruliflora</i>	Shrubs	F, FW, W
Pittosporum or Mock Orange	<i>Pittosporum tobira</i>	Shrubs	F, U, W
Poison Ivy	<i>Rhus radicans</i>	Shrubs	F, FW, W
Shrubby Fleabane	<i>Pluchea odorata</i>	Shrubs	F, FW, W
Wax Myrtle	<i>Myrica cerifera</i>	Shrubs	FW, W
Ardisia	<i>Ardisia polycephala</i>	Trees	F, FW
Bermuda Cedar	<i>Juniperus bermudiana</i>	Trees	F, OC, U, W
Bermuda Palmetto	<i>Sabal bermudana</i>	Trees	F, OC, U
Black Mangrove	<i>Avicennia germinans</i>	Trees	M
Brazil or Mexican Pepper	<i>Schinus terebinthifolia</i>	Trees	F, M, OC, W
Buttonwood	<i>Conocarpus erectus</i>	Trees	M, OC
Fiddlewood	<i>Citharexylum spinosum</i>	Trees	F
Indian Laurel	<i>Ficus retusa</i>	Trees	F, U, W
Red Mangrove	<i>Rhizophora mangle</i>	Trees	M
Strawberry Guava	<i>Psidium cattleianum</i>	Trees	F, U, W
Tamarisk	<i>Tamarix gallica</i>	Trees	F, OC
Chicken Liver Sponge	<i>Chondrilla nucula</i>	Sponges	B, SP
Dead Man's Finger (Sponge)	<i>Leucetta microraphis</i>	Sponges	B, SP
Etherial Sponge	<i>Dysidea etheria</i>	Sponges	B, SP
Fire Sponge	<i>Tedania ignis</i>	Sponges	B, SG, SP
Golf Ball Sponge	<i>Tethya actinia</i>	Sponges	B, SP
Orange Encrusting Sponge	<i>Biemna microstyla</i>	Sponges	M
Golf Ball Coral	<i>Favia fragum</i>	Corals	B, C
Small-eyed Star Coral	<i>Stephanocoenia michelinii</i>	Corals	C
Upside-down Jellyfish	<i>Cassiopea xamachana</i>	Jellyfishes	B, SP
Antillean Anemone	<i>Bunodeopsis antillensis</i>	Anemones	M
Pale Anemone	<i>Aiptasia pallida</i>	Anemones	B, SP
Ringed Anemone	<i>Bartholomea annulata</i>	Anemones	B, C, SP
Feather Duster Worm	<i>Sabella melanostigma</i>	Polychaete Worms	SP
Predacious Diving Beetle	<i>Thermonectes</i> sp.	Insects - Beetles	FW
Water Boatmen	<i>Corixa</i> spp.	Insects - Bugs	FW
Blue Dasher	<i>Pachydiplax longipenna</i>	Insects - Dragonflies	FW
Damselfly	<i>Ischnura ramburii</i>	Insects - Dragonflies	FW
Vermilion Glider	<i>Tramea abdominalis</i>	Insects - Dragonflies	FW
Salt Marsh Horse Fly	<i>Tabanus nigrovittatus</i>	Insects - Flies and Mosquitos	M
Southern House Mosquito	<i>Culex pipiens</i>	Insects - Flies and Mosquitos	FW, U
Golden Silk Spider	<i>Nephila clavipes</i>	Spiders	F, M, U
Land Hermit Crab	<i>Coenobita clypeatus</i>	Crustacea - Hermit Crabs	F, M, OC
Giant Land Crab	<i>Cardisoma guanhumi</i>	Crustacea - Crabs	M
Land Crab or Red Land Crab	<i>Gecarcinus lateralis</i>	Crustacea - Crabs	OC
Mangrove Crab	<i>Goniopsis cruentata</i>	Crustacea - Crabs	M
Wharf Louse	<i>Ligia baudiniana</i>	Crustacea - Isopods	R
Apple Snail	<i>Pomacea</i> sp.	Gastropoda - Snails	FW
Coffee Bean Snail	<i>Melampus coffeus</i>	Gastropoda - Snails	M
False Cerith	<i>Batillaria minima</i>	Gastropoda - Snails	B, M
Mangrove Periwinkle	<i>Littorina angulifera</i>	Gastropoda - Snails	M
Planorbis Snail	<i>Planorbis</i> sp.	Gastropoda - Snails	FW
Pond Snails	<i>Physa</i> spp.	Gastropoda - Snails	FW
Flat Mangrove Oyster	<i>Isognomon alatus</i>	Clams and Mussels	M
Vidovici's Amathia	<i>Amathia vidovici</i>	Moss Animals	B, SP
Spiny Sea Star	<i>Coscinasterias tenuispina</i>	Echinoderms - Starfishes	B, SP

Bermuda's Wetlands

Sticky Synaptula	Synaptula hydriformis	Echinoderms - Sea Cucumbers	SP
Lacy Sea Squirt	Botrylloides nigrum	Sea Squirts	SP
Orange Sea Squirt	Ecteinascidia turbinata	Sea Squirts	B, SP
Purple Sea Squirt	Clavelina picta	Sea Squirts	B, SP
Bonefish	Albula vulpes	Fish - Bonefishes	B, SP
American Eel	Anguilla rostrata	Fish - Eels	FW, O
Mosquito Fish	Gambusia holbrooki	Fish - Mosquito Fishes	FW, SP
Bermuda Killifish	Fundulus bermudae	Fish - Killifishes	SP
Grey Snapper	Lutjanus griseus	Fish - Snappers	B, C
Bermuda Bream	Diplodus bermudensis	Fish - Chubs and Breams	B
Queen Angelfish	Holacanthus ciliaris	Fish - Angelfishes	B, C
Sergeant Major or Cow Polly	Abudefduf saxatilis	Fish - Damselfishes	B, C
Grey Mullet	Mugil trichodon	Fish - Mulletts	B, SP
Hairy Blenny	Labrisomus nuchipinnis	Fish - Blennies	B, SP
Crested Goby	Lophogobius cyprinoides	Fish - Gobies	B, SP
Blue Parrotfish	Scarus coeruleus	Fish - Parrotfishes	B, C
Whistling Frog	Eleutherodactylus johnstoni	Frogs and Toads - Frogs	F, FW, U
Giant Toad	Bufo marinus	Frogs and Toads - Toads	F, FW, U, W
Jamaican Anole	Anolis grahami	Lizards	F, M, U, W
Green Turtle	Chelonia mydas	Turtles and Terrapins - Turtles	B, O, SG
Diamondback Terrapin	Malaclemys terrapin	Turtles and Terrapins-Terrapins	SP
Red-eared Slider	Trachemys scripta	Turtles and Terrapins-Terrapins	FW
American Coot	Fulica americana	Birds - Coots and Moorhens	FW
Moorhen or Common Gallinule	Gallinula chloropus	Birds - Coots and Moorhens	FW
Mourning Dove	Zenaida macroura	Birds - Doves	F, W
Blue-winged Teal	Anas discors	Birds - Ducks and Geese	FW
Green-winged Teal	Anas carolinensis	Birds - Ducks and Geese	FW
Mallard	Anas platyrhynchos	Birds - Ducks and Geese	FW
European Goldfinch	Carduelis carduelis	Birds - Finches	F, U, W
Great Kiskadee	Pitangus sulphuratus	Birds - Flycatchers	F, U, W
Pied-billed Grebe	Podilymbus podiceps	Birds - Grebes	FW
Cattle Egret	Bubulcus ibis	Birds - Herons	FW, SP
Great Blue Heron	Ardea herodias	Birds - Herons	FW
Great Egret	Casmerodius albus	Birds - Herons	FW, M
Green Heron	Butorides virescens	Birds - Herons	FW, SP
Little Blue Heron	Florida coerulea	Birds - Herons	FW
Yellow-crowned Night Heron	Nyctanassa violacea	Birds - Herons	F, M, SP
Belted Kingfisher	Ceryle alcyon	Birds - Kingfishers	FW
Catbird	Dumatella carolinensis	Birds - Mockingbirds	F, U
Barn Owl	Tyto alba	Birds - Owls	F, U
Sora	Porzana carolina	Birds - Rails	FW
Common Snipe	Gallinago gallinago	Birds - Snipes	FW
Starling	Sturnus vulgaris	Birds - Starlings	F, U, W
Northern Waterthrush	Seiurus noveboracensis	Birds - Thrushes	F, FW
Bermuda White-eyed Vireo or Chick-of-the-village	Vireo griseus bermudianus	Birds - Vireos	F, U
Black and White Warbler	Mniotilta varia	Birds - Warblers	F, M
Common Yellowthroat	Goethlypsis trichas	Birds - Warblers	F, M
Palm Warbler	Dendroica palmarum	Birds - Warblers	F, FW, M, W
Prothonotary Warbler	Protonotaria citrea	Birds - Warblers	F, M
Worm-eating Warbler	Helmintheros vermivorus	Birds - Warblers	F, FW, M
Yellow-rumped (Myrtle) Warbler	Dendroica coronata	Birds - Warblers	F, FW, M
Black Rat	Rattus rattus	Land Mammals	F, U
Brown Rat or Norway Rat	Rattus norvegicus	Land Mammals	F, U

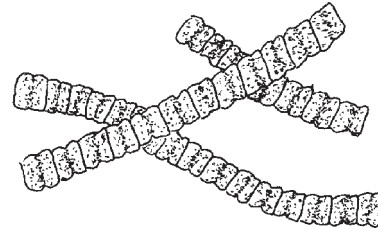
Species Illustrations and Descriptions

Bacterium

Beggiatoa

Beggiatoa species

Beggiatoa is a sulphur oxidising bacterium found in polluted water with very low oxygen present. It forms patches at the water surface which range from black, through grey to white. When *Beggiatoa* is present the water usually smells foul. The individual bacteria are filamentous and microscopic but the patches may reach 50 cm (1.6 ft) across. **Native.**



SP

Blue-green Cyanobacteria

Oscillatoria

Lyngbya lutea

A variable species but most often appearing as purple patches at about high tide level on mangrove roots. Microscopically, it consists of fine filaments which constantly slide back and forth. 1-8 cm (1/2-3 in) high. **Native.**



M, SP

Lichens

Fire Lichen

Pyrenula aurantiaca

The fire lichen forms bright orange patches on the trunks and branches of the Red Mangrove tree. 2-10 cm (3/4-4 in) across. **Native.**



M

Seaweeds

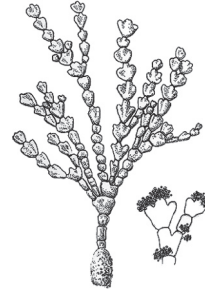
Green Algae

Common Plateweed

Halimeda incrassata

This green alga commonly about 10 cm (4 in) high consists of a series of small, three ridged plates, jointed together. It is a green seaweed but it incorporates calcium carbonate into its tissues, giving it a hard texture and whitish-green colour.

Native.



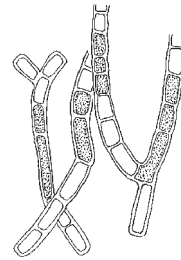
B

Crinkle Grasses

Rhizoclonium spp.

A group of wiry, bright green thread-like seaweeds which form tangled masses on mangrove roots or on the surface of the mud in mangrove swamps. 2-15 cm (3/4-6 in) long.

Native.



B, M

Feather Sand Moss

Caulerpa sertularioides

This lovely bright green seaweed about 10- 15 cm (4-6 in) high, grows in shallow, still places such as ponds, sometimes forming huge mats. Each plant body is shaped like an elongate, delicate feather.

Native.

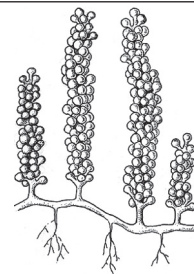


B, SP

Grape Sand Moss

Caulerpa racemosa

This very common seaweed has a stem that hugs the bottom from which arise branches bearing small grape-like branchlets. Common on lagoonal and inshore reefs. Up to 50 cm (1.5 ft) long and 10-15 cm (4-6 in) high. **Native.**



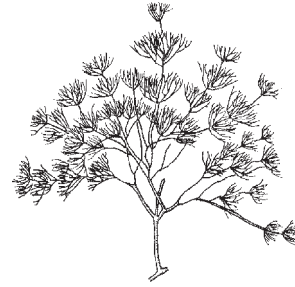
B, SP

Horsetail Sand Moss

Caulerpa verticillata

A very beautiful small, bright green alga of quiet places, such as the marine ponds. Very common on mangrove roots, forming masses up to 15 cm (6 in) across. The individual plants up to 2.5 cm (1 in) wide have a very finely divided appearance.

Native.



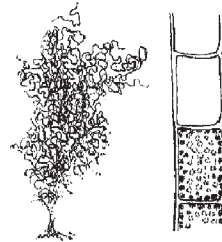
B

Light Brittle Grass

Chaetomorpha linum

For a green filamentous seaweed this one is quite robust and the stiff filaments can easily be seen with the naked eye being up to at least 1 mm (1/32 in) wide. On mud among mangrove trees.

Native.



M, R

Mermaid's Wine Glass

Acetabularia crenulata

A charming little green seaweed only 5 cm (2 in) high, consisting of a slender stalk on which are one or more curved green discs with radial bands. In quiet waters. **Native.**



B, SP

Merman's Shaving Brush

Penicillus capitatus

A robust greenish white alga, anchored in soft bottoms by root-like organs. The plant is 10-15 cm (4-6 in) high and consists of a stout stalk surmounted by a brush-like array of greenish filaments. Widely distributed. **Native.**



B, SP

Mexican Sand Moss

Caulerpa mexicana

Bright green in colour and with a pretty frond about 10 cm (4 in) high shaped like a very coarse feather. On mangrove roots, rocks etc. in still waters. Common in saltwater ponds. **Native.**

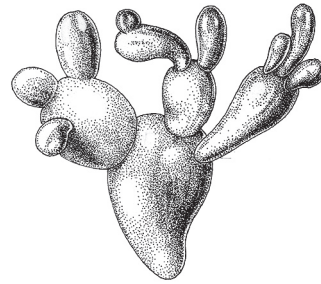


B, M, SP

Sea Balloon

Valonia macrophysa

This seaweed is well named as it consists of one or more somewhat elongated tiny, shiny balloon-like fronds, quite stiff to the touch. It is highly resistant to wave action and common on Boiler Reefs and Bioconstructional Lips. 1-2 cm (1/4-3/4 in) high. **Native.**



B

Sea Intestines

Enteromorpha flexuosa

The name is unattractive but the seaweed is distinctive as it consists of a group of green tubes about 4 mm (1/8 in) in diameter and 10-15 cm (4-6 in) long. There are often bubbles within the tubes. On rocks or roots. **Native.**

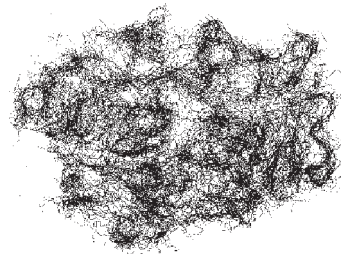


B

Seathreads

Cladophora spp.

When you see slimy green masses of tangled very fine filaments it is probably one of the Cladophoras. These weeds in masses from a few cm (in) to a few metres (ft) across are common in fresh, brackish and salt waters. **Native.**

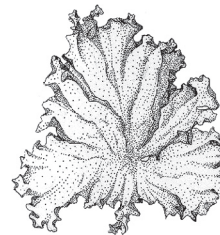


B, R

Thin Sea Lettuce

Monostroma oxyspermum

This alga consists of a very thin film of dark green tissue up to 10 cm (4 in) across. Delicate and easily torn it is a plant of very sheltered saltwater locations such as the ponds. **Native.**



B, R

Brown Algae

Bermuda Sargasso Weed

Sargassum bermudense

A large seaweed, of which there are at least a dozen different forms, it is often found washed up on the rocky shoreline. Most often free-floating, it has "leafy" branches, often with spine-like projections and spherical float bladders. It commonly harbours small marine animals such as shrimps and crabs. Up to at least 2 m (6 ft) high. **Endemic.**

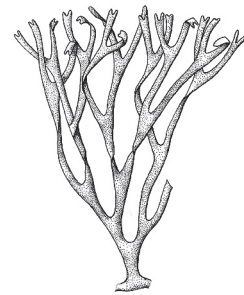


SP

Common Ribbonweed

Dictyota menstrualis

A light brown seaweed that forms clumps of fronds that divide repeatedly into two similar branches. On reefs the clumps are commonly about 10 cm (4 in) high but in other locations it can be much bigger. Common on inner lagoonal and inshore reefs. **Native.**

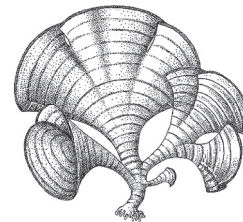


B, C

Jamaican Petticoat

Padina jamaicensis

This is a brown, fan shaped seaweed about 10-15 cm (4-6 in) high. The fan is generally banded with lighter zones reflecting the light calcification present. Widely common. **Native.**



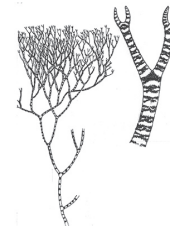
B

Red Algae

Banded Threadweed

Ceramium byssoideum

A small red, threadlike seaweed, generally looking like pink turf or small clumps. Microscopically, the characteristic red-banded appearance shows up. Grows to 10 cm (4 in) high. **Native.**



B, C

Bermuda's Wetlands

Curly Sea Moss

Bostrychia montagnei

A small red seaweed, usually appearing as a very dark reddish brown mass. Most easily identified from the habitat which is exclusively on mangrove roots at high tide level. About 8 cm (3 in) tall. **Native.**

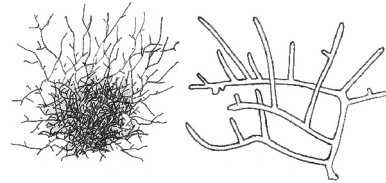


M

Stickweed

Wurdemannia miniata

A tiny, red seaweed forming mats up to 3 cm (1 1/3 in) deep. Consisting of entangled clumps of dividing filaments. Dull red in shady places to light pink if exposed to sun. On rocks or roots. **Native.**



B

Mosses

Bermuda Campylopus

Campylopus bermudiana

A rare moss found at the bases of Bermuda Palmetto trees in Paget Marsh. The moss is dark green in colour, about 6 cm (2.5 in) high and has bunches of leaves along the stem. **Endemic.**

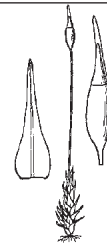


F, FW

Bermuda Trichostoma

Trichostomum bermudanum

A very common moss only about 2.5 cm (1 in) high, occurring in bright green to yellowish green patches on rocks, walls and in marshes. **Endemic.**



F, FW, OC, U, W

White Moss

Leucobryum glaucum

This moss is found in compact pale green cushions in marshes and swamps. It is medium sized for a moss at about 5 cm (2 in) high and has very numerous tiny leaves. **Native.**



FW

Ferns

Cinnamon Fern

Osmunda cinnamomea

A medium sized fern up to about 1 m (3 ft) high. The leaves arise from a compact centre at the ground surface. This fern derives its name from the fruiting bodies on a central stalk with masses of cinnamon-brown sporangia for the top 15 cm (6 in). In freshwater swamps and marshes.

Native.

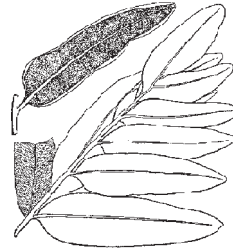


FW

Giant Fern

Acrostichum danaeifolium

This is a simply huge fern often growing in near-pure stands of about 2.6 m (8 ft) in height. The leaves are fairly simple and leathery. Common around the edge of Paget Marsh and in N. Devonshire Marsh. **Native.**



FW

Marsh Shield Fern

Thelypteris thelypteroides

A fern with slender creeping, brown to black roots from which arise 35-100 cm (1-3 ft) long leaves. The leaves are quite complex and widest in the centre, tapering slowly to the tip. **Native.**



FW

Royal Fern

Osmunda regalis

A medium to fairly large fern up to 1.7 m (5 ft) in height and of very graceful appearance. The leaves are simpler than in most ferns with the leaflets along the leaf-stalk undivided, all arising as a central, compact clump at the surface of the ground. In freshwater swamps and marshes.

Native.

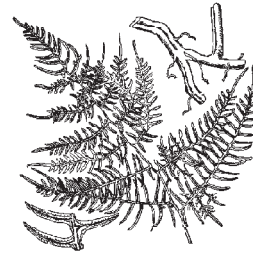


FW

Southern Bracken

Pteridium aquilinum

Bracken differs from the ferns in that the leaves arise singly from the ground. The leaves are stiff with medium-fine sub-divisions and about 1 m (3 ft) high. Bracken dies back in winter. Common in swamps and marshes. **Native.**



FW

Sword Fern

Nephrolepis exaltata

The Sword Fern has a simpler leaf than most ferns with the leaflets along the leaf stalk being undivided. It is a medium to small fern up to about 70 cm (2 ft) high. In marshes and drier ground. **Native.**



F

Ten-Day Fern

Polystichum adiantiforme

The ten day fern is medium in size and has a creeping root from which arise groups of a few leaves 35-135 cm (1-4 ft) long. The leaflets arising from the central leaf stalk have smoothly toothed lobes and are quite wide. Very rare, found in Devonshire Marsh only. **Native.**



FW

Virginia Chain Fern

Woodwardia virginica

This small fern has a stout horizontal root which is shiny and purplish brown in colour; black where it starts. The leaves are quite short being 30-50 cm (1-1 1/2 ft) long; there are about 20 leaflets along the leaf stalk, each leaflet divided into about 20 lobes. Marshes and swamps. Common only in Devonshire. **Native.**



FW

Water Fern

Salvinia olfersiana

The only floating water fern. This species is quite small with several simple leaves about 1 cm (3/8 in) long from a central stem creeping along the water surface. Short roots hang down into the water. Droplets on the leaves often shine in the sun. **Naturalised.**



FW

Clubmosses

Psilotum

Psilotum nudum

Psilotom is an exceedingly interesting plant of great antiquity. Psilotum is a small, stiff, leafless plant with green stems, Not common except in Paget Marsh. About 15-20 cm (6-8 in) high.

Native.



F, FW

Grasses

Cow-cane

Arundo donax

This one is hard to confuse with others as it towers 3-9 m (9-25 ft) tall and has a very large flower 50-100 cm (1 1/2-3 ft) long. When present, as in Pembroke Marsh East it forms large prominent stands along the banks of the waterways but not in the water itself. **Introduced** from the Mediterranean.



FW, W

Crab Grass or St. Augustine Grass

Stenotaphrum secundatum

This is one of several Bermuda grasses called crab grass. This one lives in partly salty environments such as the back of mangrove swamps. This grass tends to form springy beds about 30 cm (1 ft) deep. The stems are stiff and wiry, and the leaves bend sharply as they leave the stem. **Native.**



OC, W

Joint Grass

Paspalum distichum

A large, hairy grass 75-130 cm (2-4 ft) tall. Like all the Paspalums it has prominent leaf sheaths where the leaves join the stem. The leaves are quite narrow less than 7 mm (1/2 in). The flower head is V shaped. Often in quite dense stands with few associated species in moderately wet locations. **Native.**



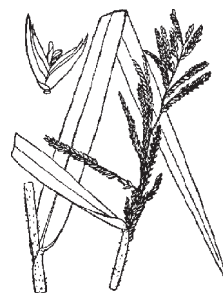
FW, W

Bermuda's Wetlands

Para Grass

Brachiaria mutica

A grass with creeping stems 1-2 m (3-6 ft) long with upright portions 65-100 cm (2-3 ft) high. Flowers 10-12 cm (6-8 in) long. A good recognition feature are the wide leaves, up to 1 cm (3/4 in) across. In damp places. **Naturalized** from South and Central America.



FW, W

Saw Grass

Cladium jamaicense

A very large grass which can form large, dense stands. It has long leaves with saw-tooth edges which give it its name. It is the only marsh grass to show this feature. The flower is a diffuse spray. 1-3m (3-9ft) high. **Native.**



FW

Seashore Rush Grass

Sporobolus virginicus

This is a fairly low trailing grass of partly salty places. The stems are stout, firm and scaly rising above the soil. The narrow 4 mm (1/8 in) wide leaves are numerous, and their basal sheaths overlap. About 40 cm (15 in) high. **Native.**

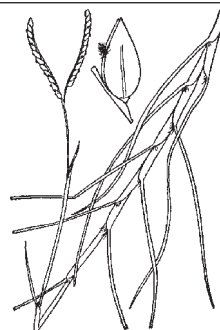


OC, R

Sheathed Paspalum

Paspalum vaginatum

A grass of quite wet places, often spreading out into the water. It forms dense, springy, pure stands 12-65 cm (8-24 in) thick, which are difficult to walk through. The leaf sheaths, where the leaves join the stem, are crowded and often overlapping. Tolerant of considerable salinity. The flower is V-shaped. **Native.**



FW, SP

Switch Grass

Panicum virgatum

A grass of coastal areas and marsh borders. It grows in prominent clumps that may reach 2 m (6 ft) in height. The delicate flower sprays change from purple to brown as the season progresses. The leaves are long and strap-like, brown, dead ones persist into the next season. **Native.**



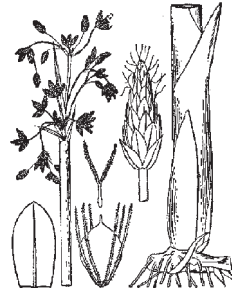
F, W, OC

Rushes

American Great Bullrush

Schoenoplectus lacustris

A large rush, 1-3 m (3-9 ft) tall with a robust, round solid stem up to 1 1/2 cm (3/4 in) in diameter at the base and a spray flowers at the tip. Leaves small or absent. Common in freshwater marshes either scattered or in distinct communities. **Native.**

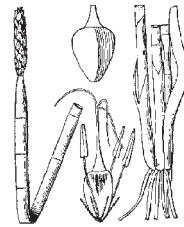


FW

Knotted Spike Rush

Eleocharis interstincta

A sturdy rush up to 1m (3 ft) high. Leaves with a sharp point. Flower like a slender elongated cone at the tip of the stem. Common in marshes. **Native.**

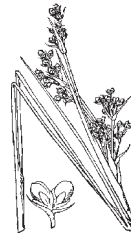


FW

Large Marsh Rush

Juncus acutus

Recognisable from the round stems and leaves both about 85-125 cm (2 1/2-3 1/2 ft) long. The leaves having sharp ends. In marshes. **Naturalized.**

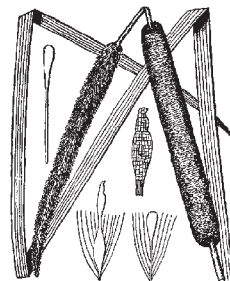


FW

Narrow-leaved Cattail

Typha angustifolia

A well known rush 1.3-2.5 m (4-10 ft) tall. The flowering stems are very characteristic with a very large, dark-brown, compact, club-shaped flower up to 15 cm (10 in) long and long strap-shaped leaves. In quite wet places and often forming large, virtually pure stands. **Native.**



FW

Sea Rush

Juncus maritimus

Common in eastern North America but confined to a few locations in Bermuda. Most easily observed at the East end of Spittal Pond. This rush has spiky, round, hollow leaves up to about 1 m (3 ft) high in dense clumps. The flowers are in inconspicuous greenish sprays. **Native.**



M

Bermuda's Wetlands

Stipitate Beaked Rush

Rhynchospora stipitata

A medium sized rush 80-120 cm (2 1/2-3 1/2 ft) high with triangular stems and flat leaves. The flowers are borne in clumps at the tip of the stems. Found only in Devonshire Marsh.

Native.



FW

White-Headed Rush

Rhynchospora colorata

A smallish rush with triangular stems about 1 50-75 cm (1/2-2 ft) tall. the distinctive feature is the group of white bracts around the flower at the top of the stem. Grows in quite wet locations.

Native.



FW

Sedges

Baldwin's Cyperus

Cyperus globulosus

A medium sized rush up to about 70 cm (2 ft) high with a cluster of star-like flowers surrounded by leaves at the tip of the round, solid stalk. Other leaves arise at the base of the stalk. Occasional in the drier parts of freshwater marshes. **Native.**



FW

Bermuda Sedge

Carex bermudiana

This sedge has triangular stems and flat leaves as long as the stems. Fertile stems have several compact flower clusters at the tip. 50-85 cm (1.5-2.5 ft) high. Endemic. **Native.**

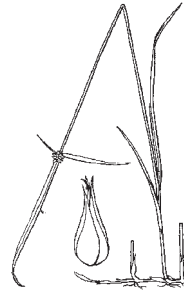


F

Short-leaved Kyllinga

Kyllinga brevifolia

One of the smallest of the rushes about 6-40 cm (4-15 in) tall. The stems are round and slender and the leaves fairly short and narrow. The small dense flower at the tip of the stem has several scales of varying length below it forming a rough star shape. Common along the drier borders of marshes. **Native.**



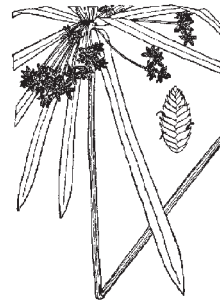
FW

Umbrella Sedge

Cyperus alternifolius

This sedge has triangular stems that are 100-150 cm (3-4 1/2 ft) tall. At the top of the stem is a very characteristic whorl of leaves forming the umbrella shape that gives this sedge its name. Just above the whorl of leaves is the spreading flower adding to the striking appearance.

Introduced as an ornamental from Africa.



FW

Herbaceous Flowering Plants

Bermudiana

Sisyrinchium bermudiana

Often called the National Flower of Bermuda, Bermudiana grows from a bulb and bears blue flowers in spring. The plant has strap-like leaves. Very common. 15-30 cm (6-12 in) high.

Endemic.



OC, U, W

Blodgett's Spurge

Euphorbia blodgettii

This is a small, tough plant that grows almost in contact with the ground, never rising more than a few millimeters (1/8 in), however, it may spread at least 20 cm (8 in). The leaves are small and rounded, well spaced out along the branching stem. The flowers are small and insignificant. **Native.**



CL, OC, W

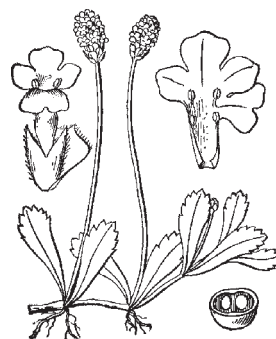
Cape Weed

Phyla nodiflora

This very widespread herb grows in a variety of habitats, including swamps and marshes, and may be mixed with other plants, for example in lawns, or grow in pure mats 15-25 cm (6-10 in) deep. The leaves are small up to 5 cm (1 3/4 in) long and have about 7 teeth on each side on the broad end. The flowers are like small buttons and very pale pink in colour. Originally from the African tropics the plant arrived naturally.

Native.

OC, SD, W



Common Plantain

Plantago major

The plantains have a basal rosette of broad leaves, tapering to a point at the tip. In the Common Plantain these leaves are up to 15 cm (6 in) long and have prominent veins. The flowers are spike-like on a 15-25 cm (6-10 in) stalk and a dull purple in colour. Lives in a variety of habitats. **Introduced.**

U, W



Day Flower

Commelina longicaulis

This is a creeping flower with small leaves streaked with lighter green, pointed at the tip and broadest near the base, which are attached directly to the stem without stalks. The small blue flower, less than 1 cm (1/2 in) across, has two petals larger than the others. Very common in wet areas such as swamps, the banks of Pembroke Canal etc. **Naturalized.**

FW

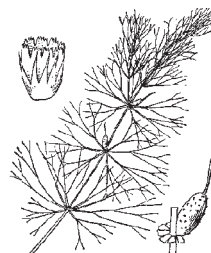


Ditchweed or Hornwort

Ceratophyllum demersum

A fully aquatic plant which floats freely in the water. The stems are long and bear many whorls of 7-10 very finely divided leaves giving a delicate appearance; there are no roots at any time. Up to 30 cm (1 ft) long. **Native.**

FW



Dog Fennel

Eupatorium capillifolium

This strangely named plant looks little like Fennel and has no particular attraction to dogs. Usually found on rubble fill areas in marshes. Up to about 70 cm (4 ft) high, the herb has a tough, thick stem and masses of thread shaped leaves. The flowers are small white daisies. **Native.**

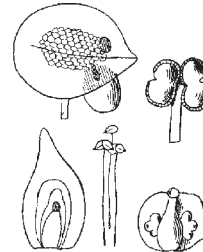


FW

Duckweed

Lemna minor

A very small floating plant consisting of up to three floating green discs which resemble leaves. A few very short roots hang in the water. The plant body is 4 mm (1/4 in) or less in diameter. **Native.**



FW

Elephant's Ear or Eddoe

Epipremnum aureum

Eddoe, sometimes called Elephant Ears, is a plant that lines the upper part of Pembroke Canal. The large leaves are shaped like an elongated heart and are dark green often with contrasting light, prominent veins. The flowers are insignificant. Up to 1.1m (3.5 ft) high.

Introduced.

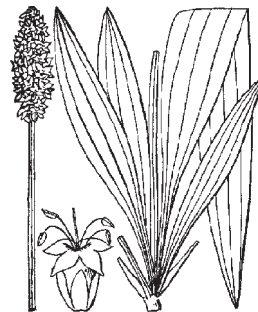


FW

English Plantain

Plantago lanceolata

The plantains have a basal rosette of fairly broad leaves, tapering to a point at the tip. In this species the leaves are fairly slender and about 12 cm (4 1/2 in) long; they have prominent parallel veins. The flower is a brownish-blue spike on a 15 cm (6 in) stalk. A plant of waste places and marshes. **Introduced.**



W

False Nettle

Boehmeria cylindrica

Common in marsh and wasteland habitats, this 70 cm (2 ft) plant has long, thin, sprays of very inconspicuous flowers arising from the leaf axils. The fairly broad leaves are coarsely toothed and arise in pairs from stem nodes. **Native.**

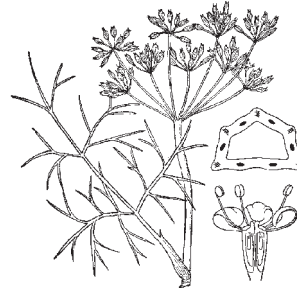


FW

Fennel

Foeniculum vulgare

This well known aromatic herb is used in cooking. The stout stems rise up to 1.3 m (4 ft) or occasionally more and bear the large, flat flower heads with small yellow flowers. The leaves are very finely divided but quite large, up to 30 cm (1 ft) long. **Introduced** from Europe.



U, W

Fern Asparagus

Asparagus densiflorus

This is not a true fern (true ferns never have flowers). The roots are tuberous while the older stems are woody with some spines and can grow to 1 m (3 ft). Foliage is yellow-green and resembles pine tree needles. The minute flowers are white or pale pink and the mature fruit are bright red berries. This is a sprawling, invasive plant found everywhere. **Introduced** and **naturalized.**

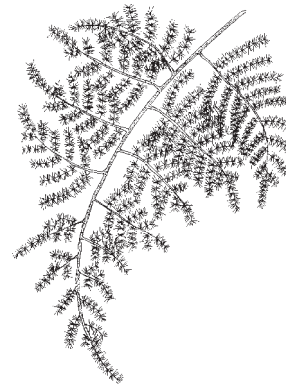


F, W

Lace Fern or Bridal Fern

Asparagus setaceus

An evergreen plant with woody climbing stems, this more delicate looking asparagus fern has pale to lime-green foliage in flat sprays. The tiny white flowers bloom throughout the foliage creating a lovely lace like appearance. The fruit is a purple-black berry. It is a native of South Africa. Like its relative, *A. densiflorus*, this plant can be found everywhere. Again, like its relative, this is not a true fern. Up to 90 cm (3 ft) high. **Introduced** and **naturalized.**



F, W

Marsh Eclipta

Eclipta alba

This herb reaching about 70 cm (2 ft) high has fluffy white flowers about 1.5 cm (1/2 in) in diameter. The leaves are elongated and coarsely toothed, pointed at the tip arising without stalks from the stem nodes. Common in marshes.

Native.

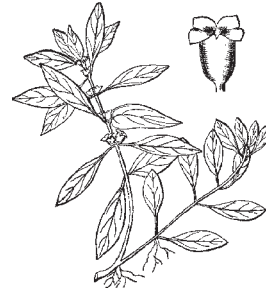


FW

Marsh Purslane

Ludwigia palustris

This aquatic plant has long trailing stems and smooth edged leaves 25 mm wide by 12 mm long (1 in by 1/2 in), widest at the middle. The flowers are tiny in the leaf axils. Submerged and emerged leaves are identical. May be in the water or on mud. **Native.**



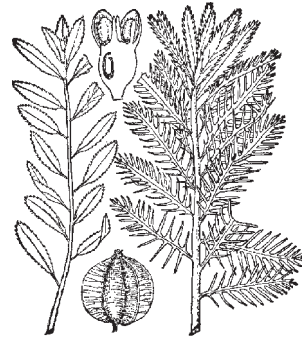
FW

Mermaid Weed

Proserpinaca palustris

An aquatic plant which may be partly emergent from the water. The submerged leaves are feathery but the emergent leaves on stems up to 30 cm (1 ft) tall are simple, quite long and widest in the centre. The flowers are inconspicuous in the axils of the emergent leaves. Found in Devonshire Marsh only and rare there.

Naturalized.



FW

Monnier's Hedge Hyssop

Bramia monniera

A prostrate fleshy-stemmed plant with small spatulate leaves and small star-shaped yellow flowers on the leaf axils. 8-50 cm (3-20 in) long.

Native.



W

New Zealand Spinach

Tetragonia tetragonioides

This plant has a trailing, soft stem from which branches about 45 cm (18 in) tall ascend. The branches have numerous quite large leaves up to 10 cm (4 in) long and rather triangular in shape. The small, yellow flowers appear in the leaf axils. Highly edible. Common in dryish mangrove swamps. **Introduced.**

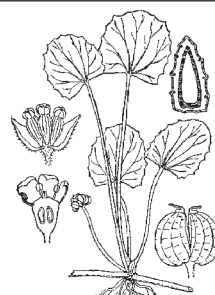


M, W

Ovate Leaved Marsh Pennywort

Centella asiatica

This small herb growing close to water and also on hillsides, has long creeping stems from which arise small heart-shaped leaves on short stalks. The leaves are about 2 cm (3/4 in) in diameter. The small and insignificant flowers are in the axils of the leaves. **Native.**

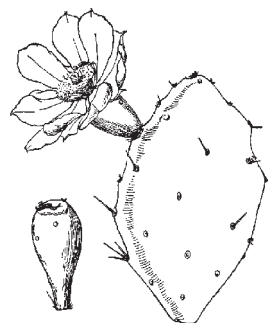


W

Prickly Pear

Opuntia stricta

This cactus with oval pads can hardly be mistaken for anything else. The pads up to 12 cm (5 in) long form bushes or clumps up to 1 m (3 ft) high. The spines are stout and sharp and the flowers a showy yellow. The pear-like fruits are a magenta-red when mature and very tasty. **Native.**



OC, W

Purslane

Portulaca oleracea

This is a succulent plant, having fleshy leaves. It is common in damp places even quite close to the sea. The rounded leaves are often a bright red in winter. Purslane can be distinguished from the closely related Seaside Purslane by its more rounded leaves and yellow flowers rather than pink. Up to about 10 cm (4 in) high but may spread 35 cm (14 in). **Native.**



F, OC

Saltmarsh Oxeye

Borrichia frutescens

A herb with thick, fleshy leaves and stout stems. It occurs in salt-marshes and the back of mangrove swamps. The flowers are daisy-like and yellow about 2.5 cm (1 in) across. The outer whorl of petals is somewhat irregular, with occasional gaps. Up to 1.5 m (4.5 ft) high.

Native.



M

Scurvy Grass or Sea Rocket

Cakile lanceolata

This is a fleshy plant most typical of the strand-line of sandy shores, but also occurring in mangrove swamps and salt-marshes. The plant grows up to 70 cm (24 in) high. The 2-7 cm (1-2 1/2 in) long leaves are somewhat dish-shaped and the edges wavy. The 4-petaled flowers are white in a terminal spike.

Native.



S

Sea Lavender

Limonium carolinianum

This rare salt-marsh plant has a basal rosette of leaves up to 15 cm (6 in) long which taper very gradually away from the base and then become broad near to the tip. The tall flower has small but pretty blue flowers arranged along vertical thin stalks. About 30-60 cm (12-24 in) high when in flower.

Native.



M

Seaside Daisy

Wedelia trilobata

This is a very invasive plant which covers waste ground and can be very common in marshes. The light green leaves arise from a trailing stem and are coarsely toothed on the edges, broader at the base. The yellow flowers about 2 cm (1/2 in) in diameter appear in summer and fall.

Introduced.



OC, SD

Seaside Goldenrod

Solidago sempervirens

This herbaceous plant has an exceedingly wide geographic distribution and occupies a wide range of habitats. The stem is stout with the long leaves closely arranged around the stem. The stem is crowned by a long flower head with very numerous, small yellow flowers, each daisy-like in appearance. Flowers in summer and autumn. About 70-100 cm (2-3 ft) high. **Native.**

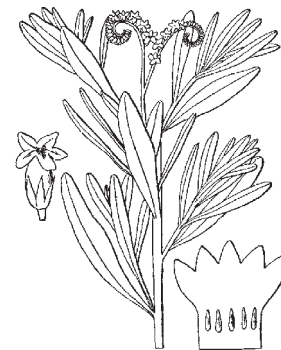


OC

Seaside Heliotrope

Heliotropium curassavicum

This salt-marsh plant is common only at a few locations such as Spittal Pond; it flowers in spring. The leaves are somewhat fleshy and about 5 cm long (2 in). The stems, about 25 cm (10 in) tall, culminate in a very characteristic flower head. This collection of flowers is divided into two equal elongate halves, each of which spirals away from the other. The individual flowers are small and light purple. **Native.**



M

Seaside Purslane

Sesuvium portulacastrum

Seaside Purslane has a fleshy, creeping stem on which very fleshy leaves are borne in opposite pairs. The whole plant rises no more than about 5 cm (2 in) above the ground. The blunt-tipped leaves are broadest about 2/3 of the way along and are often tinged with a reddish colour. The pretty flowers are solitary and pink. Frequent at the backs of mangrove swamps. **Native.**



OC, R

St. Andrew's Cross

Hypericum macrosepalum

Plant about 45-70 cm (18-24 in) high. Leaves narrow and without stalks, arising in whorls from the stem. Flowers single, showy and yellow, about 1.5 cm (3/4 in) across, with 4 petals. Rare. **Endemic.**



FW, W

Turtle Grass

Thalassia testudinum

The largest and most common of the common seagrasses. Leaves flat and up to 1 m (3 ft) long and 5 mm (1/4 in) wide and commonly encrusted with epiphytes. Grows in clumps of leaves arising from a buried rhizome. Forms extensive beds. Important in sediment stabilisation and as food for turtles. **Native.**



B, SG

Water Hyacinth

Eichornia crassipes

This is a large freshwater, floating plant with very attractive spires of pale blue flowers. The leaves are unique having an inflated base which acts as a float from which the leaf stalk arises supporting a broad, shiny leaf with a blunt tip. Roots hang in the water. About 25 cm (10 in) high. **Introduced.**

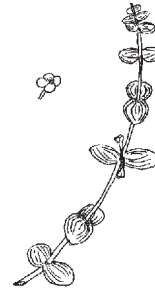


FW

Water Hyssop

Bacopa monniera

A sprawling or creeping water plant with small, opposite, nearly round leaves, up to about 20 cm (8 in) high. The plant may float or root at the nodes. The flowers are tiny, yellow and on short stalks in the leaf axils. Frequent in all marshes. **Native.**



FW

Water Smartweed

Polygonum punctatum

A small aquatic plant with stems emerging from the water. Leaves delicate and pointed about 4 cm (1 1/2 in) long. Flowers above the water in spikes of numerous, small white flowers. **Native.**



FW

White Pellitory

Parietaria officinalis

A somewhat floppy herb about 30 cm (1 ft) in height, with hairy stems and leaves. The leaves are thin and 1-5 cm (1/2-2 in) long. The inconspicuous flowers are in whorls around the axils of the stems where the leaves originate. Flowering in all seasons. **Naturalized.**

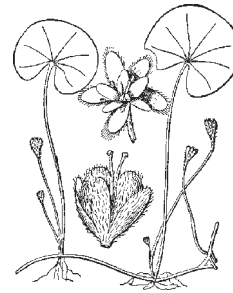


W

Whorled Marsh Pennywort

Hydrocotyle verticillata

A low growing marsh herb up to about 15 cm (6 in) high common in open wet areas such as channel banks. Often forming a dense mat, this plant has round, shiny leaves about 2 cm (3/4 in) across and small insignificant flowers. **Native.**



FW

Widgeon Grass

Ruppia maritima

An aquatic plant typical of slightly salty (brackish) waters. Despite its name this is not a grass but a flowering plant. The leaves are long and thin, arising from a submerged stem. The flowers rise to the water surface on twisted stalks and are quite small. Typical of both brackish and saltwater ponds. Up to 60 cm (2 ft) long. **Native.**



FW, SP

Wild Bermuda Pepper

Peperomia septentrionalis

This plant lives in shaded areas and cave mouths. It is only locally common. It has rather fleshy leaves broadest close to the tip but with a slight indentation there. The flower spike is very characteristic, being brown and pencil shaped with very minute blossoms. About 15 cm (6 in) high. **Endemic.**



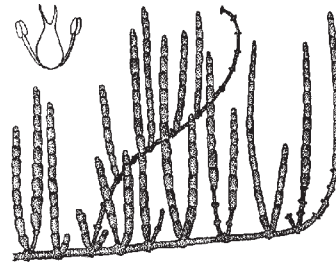
CA, F

Woody Glasswort or Marsh Samphire

Salicornia perennis

This most interesting plant of the backs of mangrove swamps is often called samphire and is quite edible. The plant is leafless but the stalks are fleshy and green and rise up to about 50 cm (18 in) above the mud. The flowers are minute.

Native.



M

Vines

Blue Dawn Flower or Morning Glory

Ipomoea indica

The Blue Dawn Flower is one of the Morning Glories. The plant is a vine up to several yards (m) long that trails over ground and up other foliage. The very pretty, trumpet-shaped, blue flowers appear in the morning and fade later. This plant can be a pest. Up to 10 m (30 ft) long.

Native.



F, M, W

Virginia Creeper

Parthenocissus quinquefolia

A tall-growing clinging vine. Easily recognised by the vine habit and the leaves with five prominent leaflets. The leaves turn red in autumn. Common in swamps. Up to at least 10 m (30 ft) high.

Native.



F, FW

West Indian Cissus

Cissus sicyoides

A tall, clinging vine of the swamps and marshes. May completely cover small trees with its foliage. It has characteristic heart-shaped, shiny, light green leaves about 6 cm (2.5 in) long. Up to 7 m (20 ft) high. **Native.**



F, FW

Shrubs

Bermuda Holly

Ilex vomitoria

As suggested by the scientific name the berries have been used as a purgative. Holly is a shrub about 2 m (6 ft) high with simple leaves, that bears bright red berries in autumn. Survives in Devonshire Marsh. **Naturalized.**



F, OC

Carolina Laurel Cherry

Laurocerasus carolinianum

A small tree up to 12 m (40 ft) high with a slender trunk. The 6-10 cm (3-4 in) long leaves are leathery, oblong and pointed on a short stalk. The flowers are white and small, borne in the leaf axils. The fruit is black and plum-like 3 cm (3/4 in) long. Invading swamp-forests. **Introduced.**



F, FW

Common Sage or Lantana

Lantana involucrata

This is the common very fragrant sagebush of Bermuda. A relatively small shrub up to 1.3 m (4 ft) high it is common in many habitats as well as in cultivation. The leaves about 2.5 cm (1 in) long are oval in shape with a scalloped edge. The flowers vary somewhat in colour as they mature but are basically reddish-purple. **Native.**



F, OC, U, W

Doc-bush

Baccharis glomeruliflora

A shrub reaching 3 m (10 ft) high that is common in most peat marshes and uplands. It is evergreen and the light greenish-yellow leaves about 8 cm (3 in) long have a few coarse teeth near to the pointed tip. The fruits have hairy tufts. **Native.**



F, FW, W

Pittosporum or Mock Orange

Pittosporum tobira

A shrub or small tree. The leaves, which can grow to 10 cm (4 in) long, are egg shaped with the broader end above the middle. They are dark green, shiny and leathery in texture. The edges of the leaf are rolled toward the underside of the leaf. The leaves have quite a distinctive smell when crushed. Five-petaled flowers are white to lemon-yellow. The half inch long flowers grow in fragrant clusters. The fruit is a green capsule which splits into three segments containing attractive, red, sticky seeds. Can grow to 6.5 m (18 ft). **Introduced.**

F, U, W



Poison Ivy

Rhus radicans

This nasty little shrub or low vine, up to 1 m (3 ft) high is common both in swamps and marshes and also occurs at the back of mangrove swamps and around ponds. The three-lobed leaves are shiny, but varied in shades of green, and sometimes exude a black liquid. The whole leaf is about 7-10 cm (3-4 in) across. About 1 m (3 ft) high. Very poisonous. **Probably native.**

F, FW, W



Shrubby Fleabane

Pluchea odorata

This is an aptly named shrub with typical fleabane character. The leaves are oblong from 8-16 cm (3-6 in) long. White flowers are small and daisylike. Numerous flowers are arranged in flat topped clusters. Growing from 1-2.5 m (3-8 ft) tall. **Native.**

F, FW, W



Wax Myrtle

Myrica cerifera

Wax Myrtle is a large shrub that may form almost pure stands in some marsh-swamp habitats, such as parts of Devonshire Marsh. The leaves are quite long, pointed at the end, with 2-3 large teeth on the outer part of each leaf-edge, and leathery in texture. The flowers are rather inconspicuous. Up to 6.5 m (20 ft) high. **Native.**

FW, W



Trees

Ardisia

Ardisia polycephala

An invading shrub of the swamp-forests. The leaves are 10-15 cm (4-6 in) long and pointed. The greenish-purple flowers are in flat groups at the end of branches or on side shoots. Up to about 3-3.5 m (9-10 ft) high. **Introduced.**



F, FW

Bermuda Cedar

Juniperus bermudiana

Bermuda Cedar was a dominant upland tree when the islands were colonised but has since been decimated by exploitation and insect damage. The wood is highly aromatic. Cedar is a large tree with scale-like foliage and purple-black berries. Up to 13 m (40 ft) high. **Endemic.**

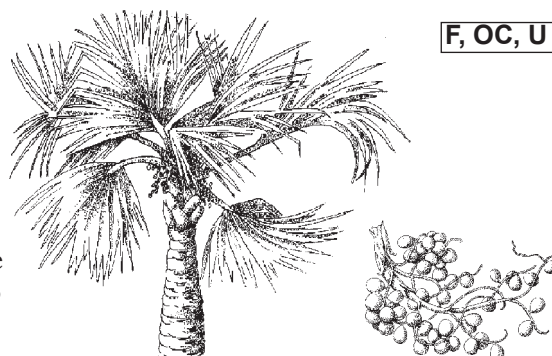


F, OC, U, W

Bermuda Palmetto

Sabal bermudana

Bermuda Palmettos were once the dominant lowland tree of Bermuda. They have been exploited quite heavily in the past and are out-competed by some introduced fan-palms. The trunks are stout with numerous leaf-scars and the fan-shaped fronds emerge in a mass from the top. Fruit black in large clusters. Up to 8.5 m (25 ft) high. **Endemic.**



F, OC, U

Black Mangrove

Avicennia germinans

The characteristic tree of the back of mangrove swamps. The size is very variable but it can be a big tree. The trunk is scaly black and the leaves are leathery elongate oval, blunt at the tip and a greyish-green in colour. A definitive diagnostic character are the pencil-like pneumatophores or air breathing roots, rising out of the sediment. Up to 17 m (50 ft) high. **Native.**



M

Brazil or Mexican Pepper

Schinus terebinthifolia

This tree has occupied a huge variety of habitats in Bermuda. It competes with native trees in mangroves and swamps and is encroaching in marshes. The leaves are compound and pungent if crushed. The large groups of small berries borne in winter ripen to a deep red. Up to 7 m (20 ft) high. **Introduced.**



F, M, OC, W

Buttonwood

Conocarpus erectus

A tree which does not live up to its "erectus" name since some specimens in exposed places are sprawling or even ground hugging. A tree of very varied height. Sometimes considered a mangrove, it is common as the rear tree of mangrove swamps or forming fringing stands along sheltered coasts. The leaves are oval, fairly broad and leathery and have two little keels on either side of the leaf stalk. The flowers are white fuzz-balls and the fruit small cone-like structures, turning red when mature. Height from a few cm (in) to 6.5 m (20 ft). **Native.**



M, OC

Fiddlewood

Citharexylum spinosum

A tree up to 15 m (50 ft) high and with a trunk up to 1 m (3 ft) in diameter. The large leaves are shaped like an elongated heart and are unique in that they turn yellow and fall in early summer. The white flowers borne in long strings are small and fragrant. Common. **Naturalized.**



F

Indian Laurel

Ficus retusa

A real pest tree that has become established in a wide variety of habitats. Up to 50 ft (16 m) high it has small leaves and gives dense shade. **Introduced.**



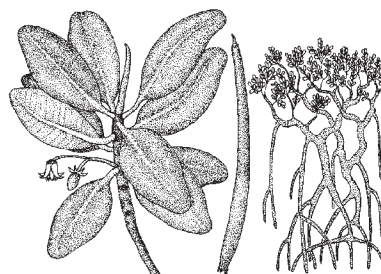
F, U, W

Red Mangrove

Rhizophora mangle

This is the most highly adapted of the Bermuda mangroves to a salt-water existence. The diagnostic features are the wide-spreading prop roots arching into the water. Adventitious roots dropping from the branches are also present. The leaves are dark green, large, broad and shiny; the flowers are yellowish-white and fragrant. A second unique feature is the large embryos. Commonly 3-5 m (15-25 ft) high but it can be much larger. **Native.**

M



Strawberry Guava

Psidium cattleianum

An evergreen shrub or small tree up to 10 m (30 ft) high with blunt, oval leaves 6 cm (2 1/2 in) long. The yellow fruits are spherical and about 3.5 cm (1 1/2 in) across. A useful identification feature is that the bark sheds in patches, leaving areas of varying colour on the trunk. **Introduced.**

F, U, W



Tamarisk

Tamarix gallica

A small tough tree or large shrub, typical of windswept shorelines and very common along the North shore. It is also found bordering ponds and scattered in other habitats. The branches are arching and the leaves small and scale-like. The attractive pink flowers appear in sprays. It is often called "spruce". Up to about 5 m (15 ft) high. **Introduced.**

F, OC



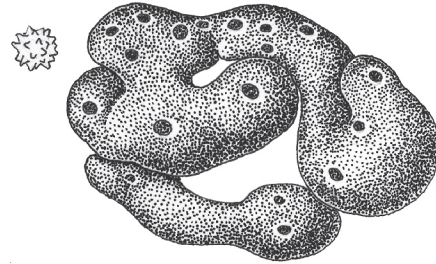
Sponges

Chicken Liver Sponge

Chondrilla nucula

This sponge varies greatly in size but is commonly up to 15 cm (6 in) in size. It consists of groups of rounded oblong extensions, which are closely attached to the rock. The colour is greenish to brownish and the texture very smooth, hence its common name. This sponge also has plants within its body in a symbiotic relationship but in this case they are Blue-green cyanobacteria (formerly called Blue-green Algae). Common in many environments including all types of reef. **Native.**

B, SP

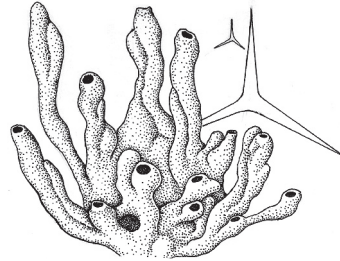


Dead Man's Fingers (Sponge)

Leucetta microraphis

A well named sponge as the upright finger-like lobes with a hole at the top are a deathly white colour. Common in the notch as well as in caves. A medium sized sponge up to 50 cm (20 in) high. **Native.**

B, SP

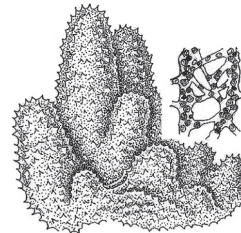


Ethereal Sponge

Dysidea etheria

This sponge is hard to mistake for any other as it is a clear sky blue. It is a small sponge, consisting of rounded lobes rarely over 5 cm (2 in) high in sheltered places. **Native.**

B, SP

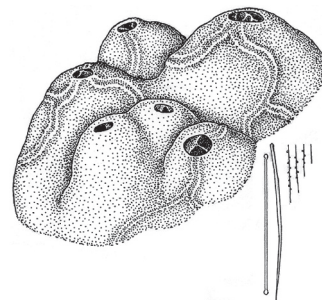


Fire Sponge

Tedania ignis

This sponge up to about 10 cm (4 in) high may be found attached to both seagrasses and Thicket Weed. It is generally shaped like a thumb but may have several lobes. The main distinguishing feature is its red colour. This sponge can inflict a sting, so do not touch any red sponges. **Native.**

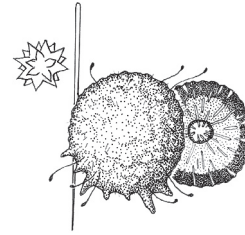
B, SG, SP



Golf Ball Sponge

Tethya actinia

This is a small round, yellow sponge of quiet waters, just about the size of a golf ball 4 cm (1 3/4 in). It is fastened to rock with yellow threads. Common in Walsingham Pond. **Native.**



SP, B

Orange Encrusting Sponge

Biemna microstyla

This bright orange sponge forms thin films on mangrove roots, 5 cm (2 in) or so in extent, but very variable. No structure is visible. **Native.**



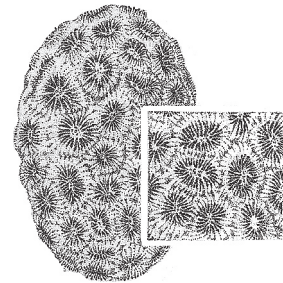
M

Corals

Golf Ball Coral

Favia fragum

While this coral is not very common it is easy to spot, because in this case the common name is very descriptive. The coral colony takes the form of a ball like structure 2.5-5 cm (1-2 in) across. It has comparatively large polyps and may be found on reef flanks or shallow cavities. **Native.**

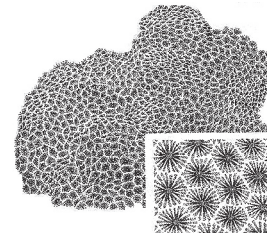


B, C

Small-eyed Star Coral

Stephanocoenia michelinii

Occurs as irregular patches up to 10 cm (4 in) across in quiet inshore waters, including ponds. The colour is whitish-grey with dark marks where the polyps are. **Native.**



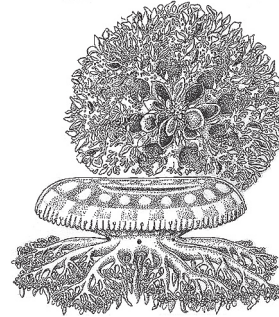
C

Jellyfishes

Upside-down Jellyfish (Poisonous)

Cassiopea xamachana

This jellyfish is quite poisonous and has the unusual habit of lying upside-down on the bottom, with the greenish tentacles waving up in the water. Small individuals and occasionally large ones swim up into the water. Up to 25 cm (10 in) in diameter, they should be avoided. Very common in the ponds. **Native.**



B, SP

Anemones

Antillean Anemone (Poisonous)

Bunodeopsis antillensis

This poisonous anemone is bright purple in colour and lives on mangrove roots. Up to 2.5 cm (1 in) long, it can walk around on the tips of its tentacles. **Native.**

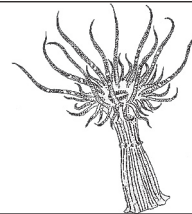


M

Pale Anemone

Aiptasia pallida

This is a small, light brown anemone up to 4 cm (1 1/2 in) long, common in masses on mangrove roots and rocks in quiet places. **Native.**

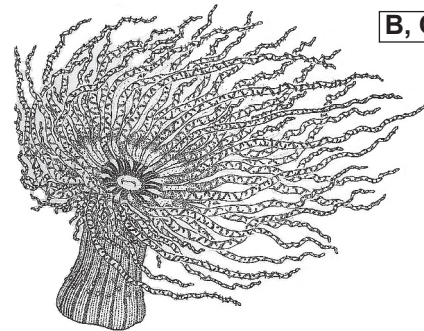


B, SP

Ringed Anemone

Bartholomea annulata

This medium sized, common, pale brown anemone has numerous tentacles which have distinctive lighter rings around them. Normally about 6 cm (2 1/4 in) in diameter including the tentacles it is found in an amazing variety of habitats from mangrove swamps to the outer reefs. **Native.**



B, C, SP

Polychaete Worms

Feather Duster Worm

Sabella melanostigma

This worm has a leathery tube within which it can withdraw. When undisturbed it expands a circle of brightly banded tentacles about 1.3 cm (1 in) in diameter. Most commonly found on mangrove roots. **Native.**



SP

Insects

Beetles

Predacious Diving Beetle

Thermonectes sp.

These beetles have aquatic larvae and the adults are winged so that they can move among freshwater locations. These blackish beetles 1 cm (3/8 in) long feed in the water by diving for their prey, but breathe at the surface. **Native.**



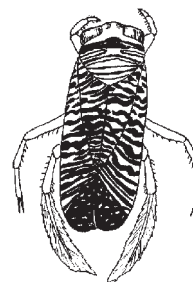
FW

Bugs

Water Boatmen

Corixa spp.

These insects live in the water but readily fly from water body to water body. They vary in size from about 5-20 mm (1/8-1/2 in) and are readily recognised by the long, oar-like back pair of legs used for swimming. They hang at the surface to breed or rest. Some swim upside-down. **Native.**



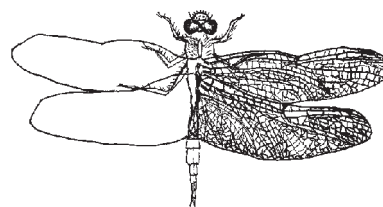
FW

Dragonflies

Blue Dasher

Pachydiplax longipenna

These are the classic dragonflies about 8 cm (3 in) long with a wingspan somewhat greater than this. The body is red and the wings black-veined. The larvae are predatory and aquatic. Around ponds and fresh waterways. **Native.**



FW

Damselfly

Ischnura ramburii

The damselflies are smaller, more slender members of the dragonfly group. The larvae are predatory and aquatic; the adults bluish in colour are about 5 cm (2 in) long, with prominent paired wings. Around freshwater ponds and waterways. **Native.**

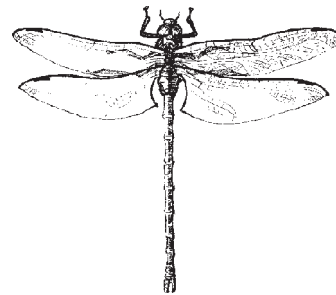


FW

Vermilion Glider

Tramea abdominalis

A fairly common dragonfly 14-15 cm (1.7-2.0 in) long with red body and clear wings with reddish patches at the base of the rear pair. It flies constantly, is island-wide in distribution and can be spotted hovering over ponds. It hunts, eats, mates and lays eggs 'on the wing' (whilst in flight). Eggs hatch into creatures that are voracious feeders and spend their life existence below the surface of the water. This nymphal stage lasts about a year, at which point the insect climbs out of the water and a final moult occurs and the dragonfly emerges. **Native.**



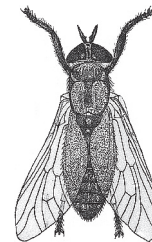
FW

Flies and Mosquitos

Salt Marsh Horse Fly

Tabanus nigrovittatus

These large, blackish, biting, two-winged flies are about 1 cm (3/8 in) long. They are silent fliers and can bite without warning. The larvae are grub-like creatures burrowing in salt-marsh muds. **Native.**

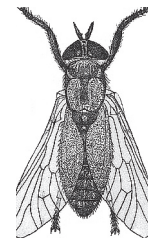


M

Southern House Mosquito

Culex pipiens

Mosquitos were formerly much more common than they are today. They were carriers of diseases such as malaria, and it was to control them that the Mosquito Fish was introduced. The larvae are about 4 mm (1/8 in) long comma shaped creatures which hang at the water surface. The adults are small, biting flies about 8 mm (1/4 in) long. **Native.**



FW, U

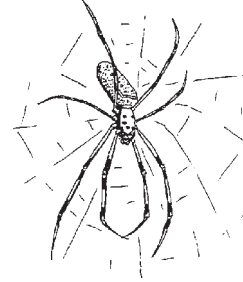
Spiders

Golden Silk Spider

Nephila clavipes

The females of this species are the largest spiders in Bermuda and the very large net may be many metres (feet) across. The female spider may be 15 cm (6 in) across including the legs.

The body is banana-shaped and the colour yellow with brown bands. **Native.**



F, M, U

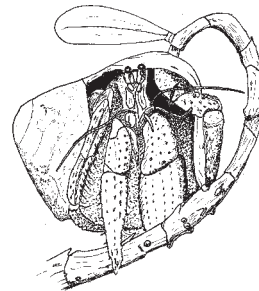
Crustacea

Hermit Crabs

Land Hermit Crab

Coenobita clypeatus

This now rare crab is present at only a few locations on the south shore and declining rapidly. It occupies the black-and-white shells of the West Indian Top Shell, *Cittarium pica*. The crab's front, large claws are a bright purple in colour. The shells housing the crab may be up to 8 cm (3 in) wide. **Native.**



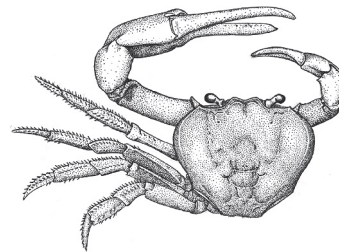
F, M, OC

Crabs

Giant Land Crab

Cardisoma guanhumii

This is one of Bermuda's endangered species. The habitat of this crab is the landward part of mangrove swamps, where they live in large burrows, excavated to just below the water level. The adult males have one very large claw. These are big crabs with a body at least 10 cm (4 in) across and long legs. They are brown in colour, omnivorous and nocturnal. **Native.**



M

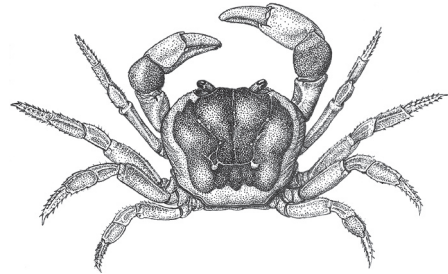
Land Crab or Red Land Crab

OC

Gecarcinus lateralis

The most common land crab in Bermuda, this species inhabits burrows in the treed and grassy areas of the shoreline. The carapace is oval in shape, wider rather than long. It is coloured dark, reddish brown. The chelipeds are red or purple and are large and unequal in the male. The legs are paler and narrow at the tips, making them unsuitable for swimming. To 4.5 cm.

Native.

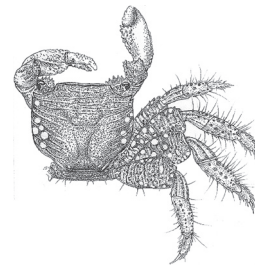


Mangrove Crab

M

Goniopsis cruentata

These crabs are really fast and you have to be alert to catch sight of them in the mangrove swamp. They will climb the trees but have burrows in the mud. The shells are about 5 cm (2 in) across and brownish green. **Native.**



Isopods

Wharf Louse

R

Ligia baudiniana

A very active, dark grey, flattened crustacean about 2 cm (3/4 in) long, very common along sheltered shores and around ponds, just above the water-line. It hides rapidly when disturbed.

Native.



Gastropoda

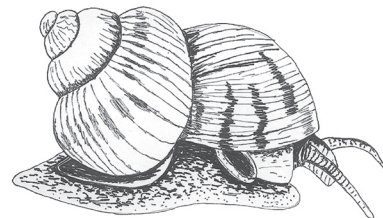
Snails

Apple Snail

FW

Pomacea sp.

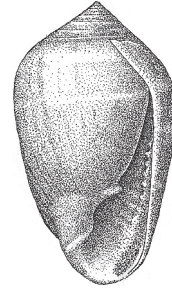
The Apple Snail was brought to Bermuda for use in aquariums. Predictably it got free and is now much more common than native water snails. A large, banded snail, with a very large aperture, up to 6 cm (2 1/2 in) long, it lays masses of bright pink-orange eggs above the water. Now widely distributed in warm climates of the world, Apple Snails are among the most destructive of invasive species, eating both plant life and small animals including other snails. **Introduced.**



Coffee Bean Snail

Melampus coffeus

These snails living on mangrove roots are aptly named being about the size and shape of a coffee bean. About 1 cm (3/8 in) long, they come in a great variety of colours from solid brown, through various brown and beige bandings to a light colour. **Native.**



M

False Cerith

Batillaria minima

These little shells often occur in almost countless profusion on sheltered shores, particularly where there is both rock and sediment. Reaching only 15 mm (5/8 in) in length, the shell is very tall and slender with numerous whorls of ridges and small bumps. **Native.**

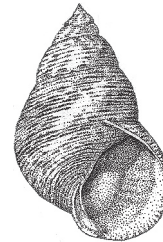


B, M

Mangrove Periwinkle

Littorina angulifera

This snail is larger than its close relatives on the rocky shore with a shell up to 3 cm (1 1/4 in) long. Found crawling on mangrove prop roots, it is herbivorous. The colour is streaked brown. **Native.**



M

Planorbis Snail

Planorbis sp.

This freshwater planorbid is a flat discoid snail to 1 cm (1/2 in) in diameter. **Native.**



FW

Pond Snails

Physa spp.

The pond snails vary considerably in size but most are in the order of 1 cm (1/2 in) long. The spiral shells are elongate and pointed at the tip. The aperture is oval. Pond snails are herbivorous. **Native.**



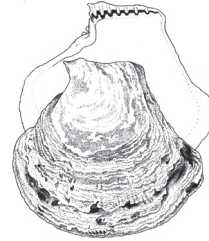
FW

Clams and Mussels

Flat Mangrove Oyster

Isognomon alatus

Found on red mangrove prop roots, under the water, these oysters can be exceedingly numerous. While the shells may be 5 cm (2 in) long, they are very thin. The colour is blackish. Now restricted to a few locations. **Native.**



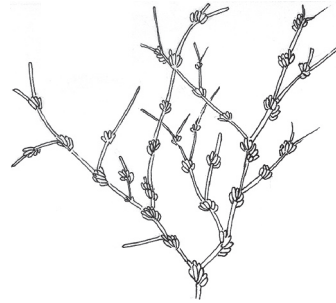
M

Moss Animals

Vidovici's Amathia

Amathia vidovici

This is a quite unusual moss animal. In the water it appears as a mass of long clear stalk-like strings with bumps at intervals. The strings may be 50 cm (20 in) long and dangle down in the water. Common in Walsingham Pond. **Native.**



B, SP

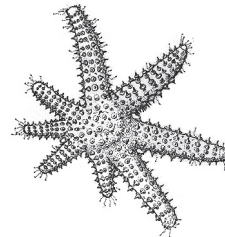
Echinoderms

Starfishes

Spiny Sea Star

Coscinasterias tenuispina

This is a small starfish with cylindrical arms, often found in Walsingham Pond. Often one or more of the five arms is missing. The starfish is up to 8 cm (3 in) in diameter, and a dirty brown in colour. **Native.**



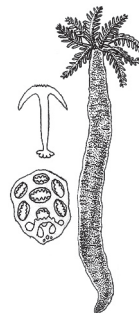
B, SP

Sea Cucumbers

Sticky Synaptula

Synaptula hydriformis

A tiny, almost colourless sea cucumber found clinging to vegetation in some marine ponds. Usually, 1 cm (1/2 in) or less in length, but can be larger, it feels sticky to the touch as it has numerous hooked spines. It can stand quite low salinity, an unusual feature for a sea cucumber. **Native.**



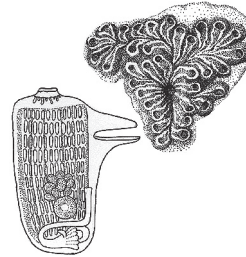
SP

Sea Squirts

Lacy Sea Squirt

Botrylloides nigrum

The Lacy Sea Squirt is really a colony of small sea squirts. The whole colony may be 5 cm (2 in) across, but quite thin. The colour is a very striking bright orange. Common in marine ponds on roots. **Native.**

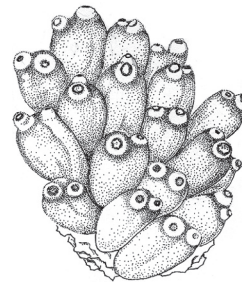


SP

Orange Sea Squirt

Ecteinascidia turbinata

This species lives in just the same habitats as the Purple Sea Squirt but the individuals are a little smaller as are the colonies reaching only about 15 cm (6 in) across. The colour is a fairly uniform soft orange with a darker ring at the apex. Sea squirts are filter feeders. **Native.**

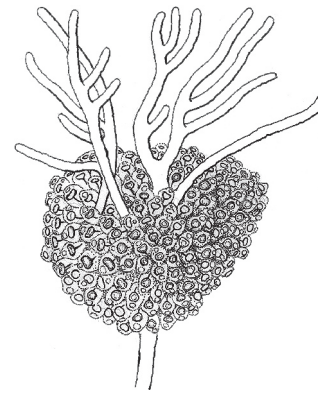


B, SP

Purple Sea Squirt

Clavelina picta

This sea squirt and the preceding species may often be found in colonies on the stalks of soft corals as well as on rocks and mangrove roots. Each individual is of great beauty, consisting of an almost transparent sack about 1 cm (3/8 in) in length, through which can be seen the internal organs. The colonies can reach 40 cm (15 in) across. At the top of the sack a brilliantly iridescent purple ring, with an inner margin of white is very obvious around the larger of the two openings. **Native.**



B, SP

Fish

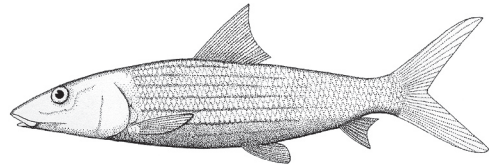
Bonefishes

Bonefish

Albula vulpes

This fairly large fish growing up to 1 m (3 ft) long often feeds in shallow water. It is silvery in colour with several thin horizontal lines on the front half of the body, and a good swimmer. Common in the ponds, they often jump considerable distances. **Native.**

B, SP



Eels

American Eel

Anguilla rostrata

The American Eel, up to 1.5 m (4.5 ft) in length is an oceanic spawner. It lays its eggs in the Sargasso Sea and the larvae travel in ocean currents until they are ready to swim ashore. Spawning has never been observed but newly laid eggs have been taken in nets. Found in saltwater ponds only. **Native.**

FW, O



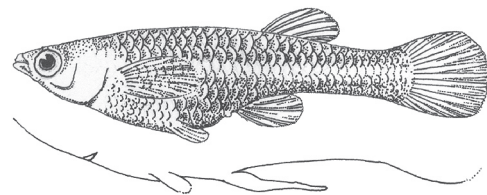
Mosquito Fishes

Mosquito Fish

Gambusia holbrooki

A tiny but important fish. Mosquito Fish can live in water of very poor quality because they are able to breathe atmospheric air. Introduced to control mosquitos. They are in virtually all ponds and ditches and mass at the surface when water quality is very bad. Often called "Guppies" they can grow up to 7 cm (2.5 in) long but are commonly only half this length. Female above, male below. **Introduced.**

FW, SP



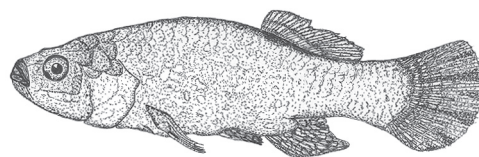
Killifishes

Bermuda Killifish

Fundulus bermudae

The Killifish is a small fish up to about 4 in (10 cm) in length. The colour varies from light brown to pale greenish-yellow. The body is rather cylindrical in shape and the tail rounded. Very common in saltwater ponds. **Endemic.**

SP



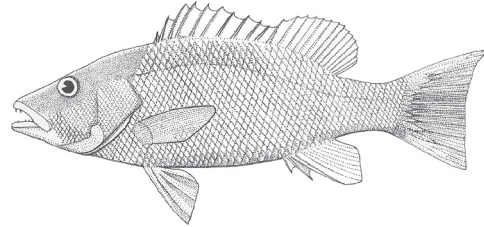
Snappers

Grey Snapper

Lutjanus griseus

The Grey Snapper can reach 61 cm (2 ft) in length but the ones commonly seen in small groups along shores, around wharves, in grass beds, mangroves and some saltwater ponds are much smaller. Large specimens of this grey-coloured fish are common on reefs and beyond. Young specimens have an oblique dark line through the eye. **Native.**

B, C



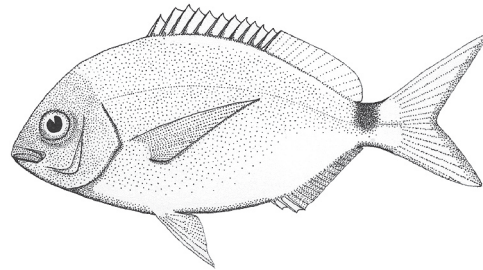
Chubs and Breams

Bermuda Bream

Diplodus bermudensis

The Bermuda Bream is similar to but smaller than the Bermuda Chub growing to 40 cm (16 in). Bermuda Bream have relatively small heads and eyes, and are a dull silvery-grey in colour. The Bermuda Bream and the Bermuda Chub are easily told apart by the presence on the Bermuda Bream of a large dark spot, just above the base of the tail. **Endemic.**

B



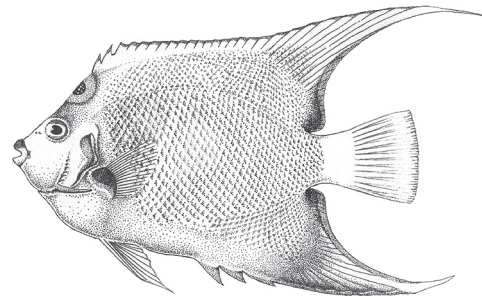
Angelfishes

Queen Angelfish

Holocanthus ciliaris

The Queen Angelfish is boldly coloured, the body being blue with yellow edges to the scales, while the tail is bright yellow and the head has blue, yellow and green areas. The large trailing dorsal and anal fins are orange-yellow with blue edges. The distinctive feature is a black patch with a bright blue border on the forehead. Juvenile specimens show much more yellow on the body, and have bold narrow, blue vertical stripes. Large adults reach 45 cm (18 in) long. **Native.**

B, C

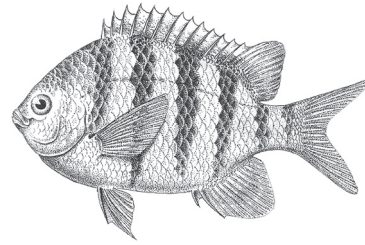


Damselfishes

Sergeant Major or Cow Polly

Abudefduf saxatilis

The Sergeant Major is one of the damselfishes, and is strikingly coloured with a blue head, and with vertical dark bars on a yellow background along its back, grading to light blue beneath. It is a very active small fish, up to 15 cm (6 in) long. **Native.**



B, C

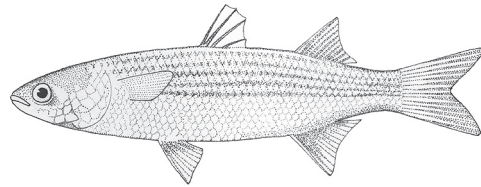
Mullet

Grey Mullet

Mugil trichodon

The Grey or Fan-tailed Mullet is a fish of quiet waters often seen in groups sunning themselves at the surface. A slow swimmer, the mullet can survive in water of poor quality and it is unusual in being herbivorous. The colour is a dull grey and the length up to about 40 cm (16 in).

Native.



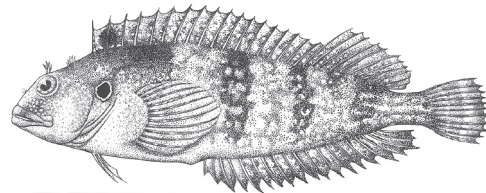
B, SP

Blennies

Hairy Blenny

Labrisomus nuchipinnis

This fish, up to 20 cm (8 in) long, but usually smaller is typical of shallow waters in algal or seagrass beds. The colour varies with the habitat from near-white to near-black, but males are dark with red fringed fins and there is a spot on the gill cover. The head is large. **Native.**



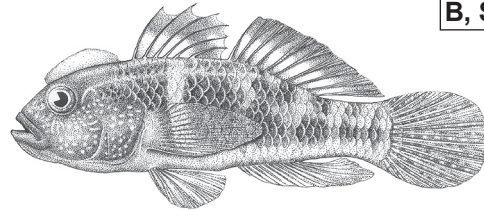
B, SP

Gobies

Crested Goby

Lophogobius cyprinoides

A small, dark fish with a very large head and a lot of character. Up to 10 cm (4 in) long the fish is dark-brown to olive and lives in the mangrove root habitat. **Native.**



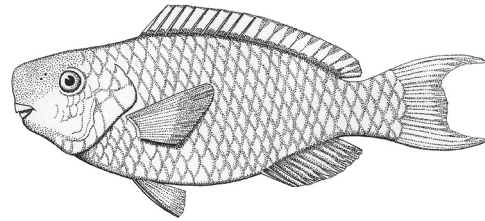
B, SP

Parrotfishes

Blue Parrotfish

Scarus coeruleus

The Parrotfishes are quite distinctive with their blunt heads, stocky bodies and indented tails. The Blue Parrotfish, up to 1 m (3 ft) long, is a fairly uniform medium blue, whether immature or adult. They are important algal grazers on the reef, but also penetrate into mangrove swamps at high tide and are in larger ponds. **Native.**



B, C

Frogs and Toads

Frogs

Whistling Frog

Eleutherodactylus johnstoni

This is a tree frog of small size. The length is about 2 cm (1 in) and the body is pinkish brown. There are suckers on the feet. This frog along with other amphibians is on the decline in Bermuda. **Introduced.**



F, FW, U

Toads

Giant Toad

Bufo marinus

The Giant Toad can be quite large measuring up to 23 cm (9 in) long. It is brown with darker blotches and has poison secreting glands behind the head. The only amphibian that can stand quite salt water. Breeds in ponds but lives in a wide variety of habitats. **Introduced.**



F, FW, U, W

Lizards

Jamaican Anole

Anolis grahami

The common lizard of Bermuda. The colour is a blueish green but some males are a chocolate brown. In virtually all habitats. The length with tail is up to about 17 cm (7 in). **Introduced.**



F, M, U, W

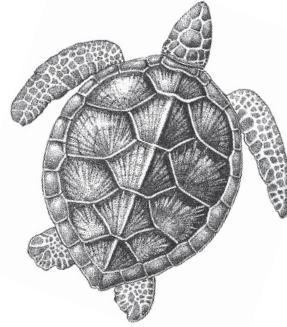
Turtles and Terrapins

Turtles

Green Turtle

Chelonia mydas

The Green Turtle is the commonest of the marine turtles seen in Bermuda and used to breed here. Up to at least 1 m (3 ft) long, they may be any shade of colour between dull, dark green and virtually black. The adults feed on sea-grasses and seaweeds and the occasional sessile invertebrate. Always present in Walsingham Pond and occasionally seen in others. **Native.**



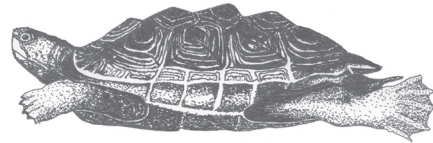
B, O, SG

Terrapins

Diamondback Terrapin

Malaclemys terrapin

A small brackish water terrapin found only in Mangrove Lake and Trott's Pond. It is a shy species that nests in golf club bunkers. The brown top shell has striking plates each with a bold polygonal pattern. About 23 cm (9 in) long. **Native.**



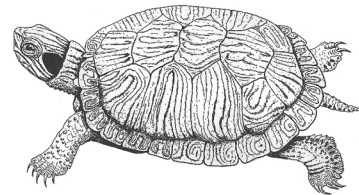
SP

Red-eared Slider

Trachemys scripta

A freshwater terrapin which resulted from escape or liberation of pets. A terrapin of the southern USA. This terrapin is omnivorous and now a great pest in all standing freshwater environments. Up to 24 cm (9 in) long.

Introduced.



FW

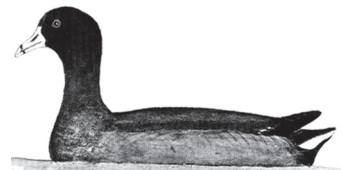
Birds

Coots and Moorhens

American Coot

Fulica americana

This 38 cm (15 in) long bird is dark grey, with a white beak and white shield above the beak ending in a red swelling on the forehead. The toes are lobed. **Native.**

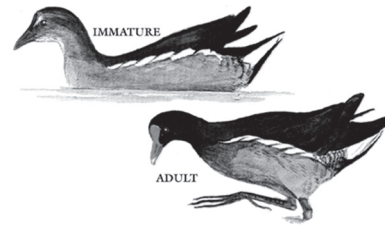


FW

Moorhen or Common Galinule

Gallinula chloropus

Also called the "Common Galinule" this 33 cm (13 in) long duck-like bird lives in fresh water ponds. It constantly bobs its head while swimming and is slate-grey with a yellow-tipped, red beak. **Native.**



FW

Doves

Mourning Dove

Zenaida macroura

This common dove reaches a length of 30 cm (12 in). The Mourning Dove is slender and long-tailed. They are an attractive brownish-grey with darker spots on the wings and black tips to the major wing feathers. They are usually seen in pairs and the name comes from the somewhat mournful but pleasant song. **Native.**



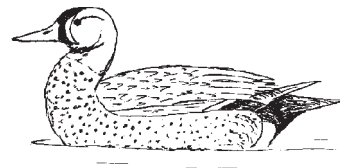
F, U, W

Ducks and Geese

Blue-winged Teal

Anas discors

This small duck is almost always seen in small flocks on freshwater ponds and very occasionally on salt water. It does not breed in Bermuda and is absent in mid-summer. It is a brown duck, both sexes having a pale blue area on the front of the wing. The male has a pale crescent in front of the eye. About 28 cm (11 in) long. **Native.**



FW

Green-winged Teal

Anas carolinensis

A small duck 30-41 cm (12-16 in) long. It is a generally dark duck, but the male has a chestnut head, a green ear patch and a green patch on the wing. A pond duck. **Native.**



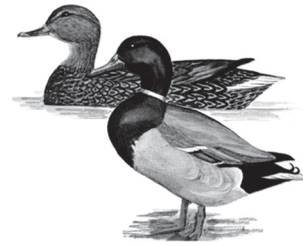
FW

Mallard

Anas platyrhynchos

The commonest of the ducks, quite large in size, measuring 49-69 cm (18-27 in) long. The male has a green head and a white neck ring, chestnut breast and greyish body. The female is mottled brown with a white tail. Common.

Native.



FW

Finches

European Goldfinch

Carduelis carduelis

A seed-eater, found in parks, gardens, woodland (especially casuarina trees) and overgrown fields. The goldfinch is about 13 cm (5 in) long bird. It is basically brown but with striking red face and yellow on the wings. **Naturalized.**



F, U, W

Flycatchers

Great Kiskadee

Pitangus sulphuratus

This is a large, basically yellow flycatcher with a black and white striped head and a raucous call. It is 27 cm (10 1/2 in) long and has a broad black beak. The back is browner than the underparts. **Introduced** to control lizards.



F, U, W

Grebes

Pied-billed Grebe

Podilymbus podiceps

A pigeon-sized bird measuring 30-38 cm (12-15 in) in length. It is a stocky, uniformly brownish water bird with a stout, whitish beak. The beak has a white ring in spring. **Native.**



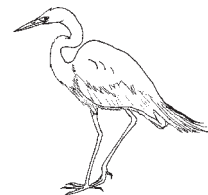
FW

Hérons

Cattle Egret

Bubulcus ibis

A small, stocky, white heron 51 cm (20 in) long. The legs are pale yellow or orange in adults. Common around ponds. **Native.**



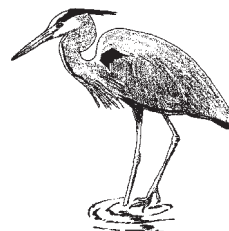
FW, SP

Great Blue Heron

Ardea herodias

This large heron measures 99-132 cm (39-52 in) in length. It is mainly pale grey in colour with a pale or yellow beak. The crown is white with a black streak below. Flies with its neck folded.

Native.



FW

Great Egret

Casmerodius albus

Regular vagrant from eastern North America. The Egret is a large long-necked white heron with yellow bill and black legs. Seen throughout the year walking in ones or twos and small flocks usually with other species of herons, around the edges of ponds. Can also be seen in fields. About 1-1 1/2 m (3-4 1/2 ft) high. **Native.**

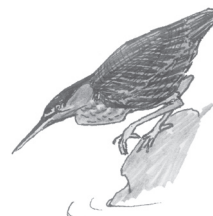


FW, M

Green Heron

Butorides virescens

A small heron 41-56 cm (16-22 in) long. Crown black, back and wings dark greyish green. Beak dark, legs bright orange. Nests in Trott's Pond and Mangrove Lake mangroves. **Native.**

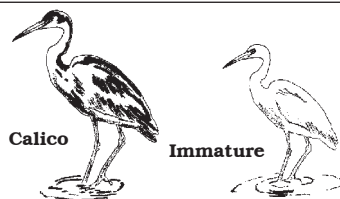


FW, SP

Little Blue Heron

Florida coerulea

A medium-sized heron 64-76 cm (25-30 in) long which is slate-blue with a maroon neck. The beak is greyish and the legs greenish. **Native.**



FW

Yellow-crowned Night Heron

Nyctanassa violacea

A rather small heron. The adult is slate-grey with a black head capped with a yellowish crown and plumes. The beak is black and the legs yellow to orange. Has become very common after its introduction in 1976-8. Eats mainly land crabs. 56-69 cm (22-27 in) long. **Introduced.**



F, M, SP

Kingfishers

Belted Kingfisher

Ceryle alcyon

A common migrant and winter visitor, arriving in August and departing in April. This bird has a large head with bushy crest and a dagger-like bill. It is blue-grey above and white below with a broad blue-grey chestband. The female has an additional rusty-brown breastband. 28-35 cm (11-14 in) long. **Native.**



FW

Mockingbirds

Catbird

Dumetella carolinensis

Very visible in spring and summer but at other times hidden in dense thickets, hedges and woodland. The catbird is a slender dark grey bird with a black cap. It imitates the calls of other birds. 20-22 cm (8-9 in) long. **Native.**



F, U

Owls

Barn Owl

Tyto alba

A resident and rare migrant, this owl is crow-sized. It is tan above and white below with a pronounced heart-shaped white face and dark brown eyes. Feeds over marshes and golf courses in Bermuda. 46 cm (18 in).

Introduced.



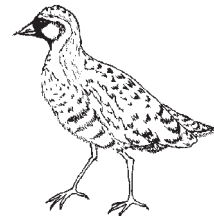
F, U

Rails

Sora

Porzana carolina

This rail is a bird of the marshes. It measures 20-25 cm (8-10 in) long. It has a short yellow beak and a black face. The upper body is mottled brown and the belly black. **Native.**



FW

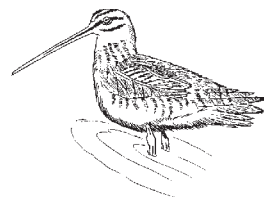
Snipes

Common Snipe

Gallinago gallinago

This long-beaked marsh bird is 27 cm (10 1/2 in) long and streaked brown in colour. The belly is white. The snipe has a fast and erratic flight.

Native.



FW

Starlings

Starling

Sturnus vulgaris

Abundant and widespread throughout Bermuda. The Starling measures 20 cm (8 in) long. This iridescent blackish bird has a short tail and a long yellow beak. **Introduced** from Europe to the US, from where it extended its range to Bermuda. **Naturalized.**



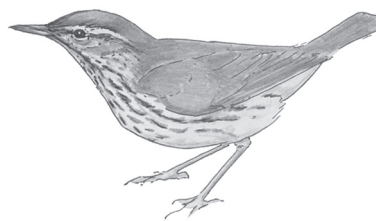
F, U, W

Thrushes

Northern Waterthrush

Seiurus noveboracensis

A common migrant from northern North America seen in the spring, fall and winter walking on the edges of ponds, tidal flats and rain pools. This bird has a dark brown back, bright eyebrow, streaked below. The underparts and eyebrow are usually tinged yellow, sometimes more white. Most spend the winter in the mangroves but they can also be seen in woods and parks. Usually solitary and secretive but rather noisy. About 20 cm (8 in) long. **Native.**



F, FW

Vireos

Bermuda White-eyed Vireo or Chick-of-the-village

Vireo griseus bermudianus

The "Chick of the Village" is a small vireo measuring 13 cm (5 in) long. It is olive green above and white below with yellow sides. The adult has a white eye but more distinctive is the yellow eye-ring and double wing-bar. The Bermuda sub-species is **endemic.**



F, U

Warblers

Black-and-white Warbler

F, M

Mniotilta varia

A bold stripe, black streaks on back and sides. The adult male has a black throat and cheeks. This bird is a common vagrant from eastern North America seen in the fall and spring in gardens, woods, orchards and mangroves feeding on the trunks and branches of trees. 13 cm (5 in) long. **Native.**



Common Yellowthroat

F, M

Geothlypis trichas

A brilliant yellow throat contrasts with white neck spot, black face and black stripes on sides. Grey back with white wing bars. This bird is a common vagrant from North America seen in the fall, spring and winter foraging for food in weedy wastelands, hedgerows, dunes and golf courses, dumps, aquatic vegetation around ponds. 13 cm (5 in) long. **Native.**



Palm Warbler

F, FW, M, W

Dendroica palmarum

A medium sized warbler 14 cm (5.5 in) long which is olive-brown on the back and yellow, streaked with chestnut below. There is a dark eye stripe. This warbler has a habit of wagging its tail while feeding on the ground. This bird is a common vagrant in Bermuda and may be seen in a variety of habitats including woodland, gardens and open spaces. **Native.**



Prothonotary Warbler

F, M

Protonotaria citrea

A regular, fairly common migrant from southeastern North America. Golden yellow head and chest, white under tail, blue-grey wings and tail with white tail spots. Female duller than the male. Most abundant in the early fall but can also be spotted in the spring and winter. Beautiful golden-yellow colour. Can be seen foraging in foliage in ones, twos and small flocks with other warblers. 12 cm (4 3/4 in) long. **Native.**

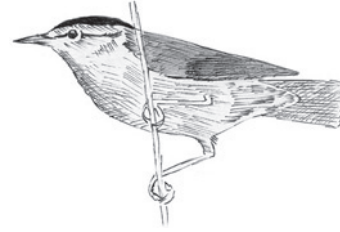


Bermuda's Wetlands

Worm-eating Warbler

Helminthos vermivorus

This small warbler measures 12-14 cm (5 - 5 1/2 in) long. The body is a dull olive-green with alternating black and creamy stripes on the head. A stripe runs through each eye. Its habitat is shady woodlands where it feeds on hanging dead foliage. A regular migrant and winter visitor in small numbers. **Native.**



F, FW, M

Yellow-rumped (Myrtle) Warbler

Dendroica coronata

A regular migrant from northern North America, abundant in the fall and spring and seen occasionally in the winter. This bird has a bright yellow rump patch, white spots in its tail, and small yellow patch at the side of its chest. It has a white throat and well-defined cheek patch. The yellow-rump patch is obvious as the bird flies away. Usually seen in flocks with other land birds feeding on the ground on golf courses, farm land, parks, gardens and fields. 12-14 cm (5- 5 1/2 in) long. **Native.**



F, FW, M

Land Mammals

Black Rat

Rattus rattus

The species is said to have been introduced into Bermuda on a captured Spanish grain ship towed into St. Georges by the privateer Frith in 1613. Blackish-grey in colour, the tail is always longer than the body. The eyes and ears are relatively large and the nose pointed. Adult body size, 17-23 cm (7-9 in). **Introduced.**

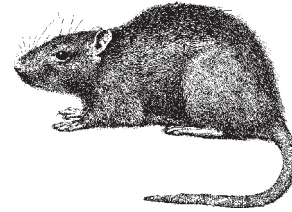


F, U

Brown Rat or Norway Rat

Rattus norvegicus

The Norway rat probably reached the island on ships about the mid 18th Century. The tail is always shorter than the body and the nose blunt. Eyes and ears are relatively small. The pelt is rough and brownish and the underside grey. Adult body size, 20-28 cm (8-11 in). **Introduced.**



F, U

Field Trips

Examples of Locations for the Study of Wetlands with Field Trip Exercises and Suggestions.

Preliminary Note

Freshwater wetland systems are very limited in extent in Bermuda and many of those that exist have very poor or no ready access. Additionally, conditions in the freshwater wetlands vary greatly with the weather. After heavy rain many of them may be inaccessible. Others are so limited in useful study areas that it is impractical to take large classes. In many cases only observation is possible, because either access is limited or the system is delicate and trampling by a group of students quite out of the question. In all cases great care should be taken not to disturb the natural ecosystem. Students must be warned about this in advance and prompt disciplinary action taken if problems arise.

Bermuda is a tiny country and many of its natural systems are under severe stress. One aim of this guide is to raise the level of awareness and appreciation for the wetland systems of Bermuda. It is a privilege to visit and study them and a duty to try to preserve what is left of them.

Please play your part.

Restrictions on the use of each area are noted below if applicable.

Please bear in mind that the locations listed were useful as study locations at the time this guide was written. This may not continue to be the case, or locations may temporarily become unsuitable due to storm damage or other unforeseen factors. **It is strongly recommended that instructors check sites out before taking classes to them.**

Freshwater Marshes

Devonshire Marsh

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and ponds. Find out anything else that you can on Bermudian marshes.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but would be an advantage particularly if there has been much rain in the recent past.

Location. Field exercise Map 1 shows the area of the field trip. You will enter the marsh from behind the grocery store called the Howard's on Middle Road. Here an old causeway stretches to the middle of the marsh. The causeway provides reasonably firm, dry footing and the marsh on either side can easily be observed. In this area the marsh varies from quite wet to dry and there are several drainage ditches, with access into the marsh along their banks, as shown in the map.

As with most marsh locations in Bermuda, Devonshire marsh has been altered by man and has come under severe stress at times. Catastrophic fires have occurred in parts of the marsh. Other parts have been drained. All these things affect the natural fauna and flora. Be aware that what you observe may not be what was there before man arrived in Bermuda. Nevertheless, what you see will be principally native species with a few endemic ones and several introductions.

Observations. Examine the marsh on both sides of the causeway and also along the margins of the drainage ditches.

1. Look for examples of the following communities. Note that for it to be a real community the main plant must be the most important one there. Importance is really a combination of size and abundance. But at any rate the most important species should stand out.

Whorled Marsh Pennywort
Narrow-leaved Cattail
Saw-grass
Great American Bullrush
Wax Myrtle

2. For each community, identify and list the other species found there in order of decreasing importance.
3. For a section of marsh starting at a drainage ditch bank, sketch a section of the marsh surface showing where different communities occur. Probably a section about 10 m (30 ft) square should do, put a rough scale on the sketch map. Use different shading or colour to indicate different communities. Be aware that the low grass community along the drainage channels is artificially maintained by mowing.
4. List as many species of plant and animal (other than birds) as you can identify and state their habitat.

Eg. **Jamaican Anole** in **Doc Bush**

Use the list of common species found in freshwater marshes as a guide together with the pictures of each common species included with this field guide.

5. Look for evidence of pollution in the form of trash or other material left by people. Make a list of what you see and say what the effect on the marsh might be.
6. This area was once a Bermuda Cedar swamp-forest. Repeated fires have altered the marsh so that fire-resistant species now dominate. List at least 3 fire-resistant species.
7. Do you see any plants or animals here that suggest that the site might be somewhat salty? What grass, in particular, is an indicator of somewhat salty conditions?
8. Look for and list all the **birds** that you see. If you see what habitat or community they are in, or go into, write that down. If they just fly over also note that. If you know whether the birds that you see are native, introduced or endemic, add that information to your list.
9. This marsh and others in Bermuda has man made drainage ditches. Why were these ditches dug and what species of fish has been introduced into them? The ditches would change ecological conditions in the marsh. Name two species that would decrease after ditching and two that would increase.
10. This marsh is now the largest in Bermuda but when the island was settled another was larger. Which marsh was formerly larger than Devonshire Marsh? Name one other marsh that still exists.
11. Pick one community and measure the approximate height of ten specimens of the most important species. Try to count the stalks (abundance) of the most important plant in a square yard (square metre) of the community.

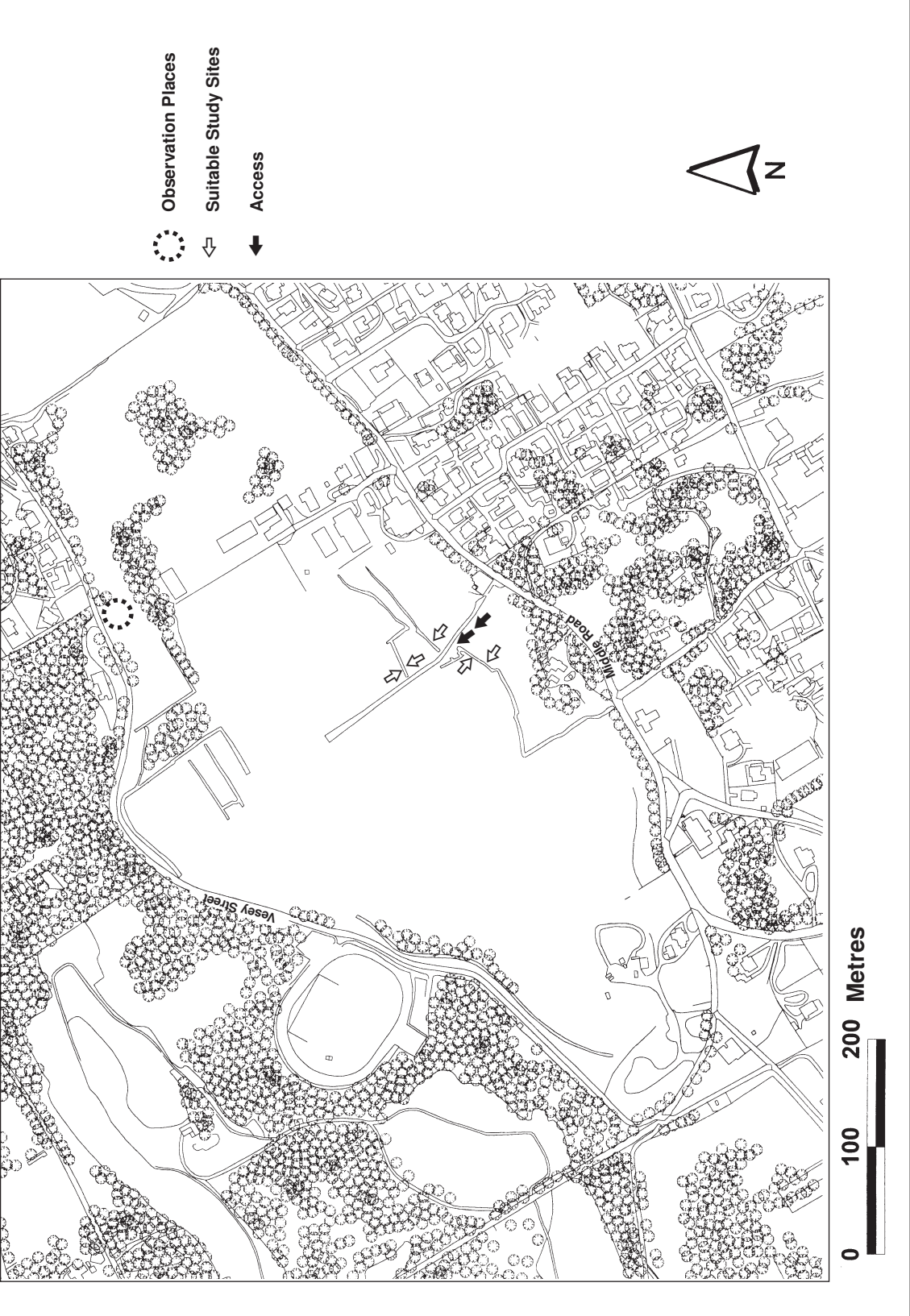
Possible Hazards

1. Poison Ivy is present but not common in the part of the marsh you will visit. Your instructor will point it out if present. Do not touch poison ivy even if you think you are immune. Every touch lowers your resistance. If in contact with poison ivy wash the area of contact off with rubbing alcohol (carried by instructor). Do not go beyond the more open part of the causeway near to the drainage ditches because large plants of poison ivy become very common and are concealed in other high vegetation.
2. Watch out for trash, especially broken glass and rusting metal.

Observations around the edge of Devonshire Marsh

To get a better idea of the total diversity in Devonshire Marsh, drive around to the north side along Vesey Street. There are several places where vehicles can stop and the marsh be observed. The Winifred Gibbons Nature Reserve and the Freer Cox Nature Reserve are very good sites. Along the N. side of the marsh there are some fine stands of the **Giant Fern**, (*Acrosticum danaeifolium*). Look also for stands of **Wax Myrtle**, (*Myrica cerifera*), and good specimens of the **Bermuda Cedar** (*Juniperus bermudiana*) and the **Bermuda Palmetto** (*Sabal bermudana*).

Map 1 - Devonshire Marsh



Paget Marsh

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and ponds. Find out anything else that you can on Bermudian marshes.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or meter sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Map 2 shows the location of Paget Marsh and where freshwater marshes are located within it. Paget Marsh is a Nature Reserve administered jointly by the Bermuda National Trust and the Bermuda Audubon Society. Paget Marsh lies in a depression in the central part of the main island. It is very important because it supports a great variety of natural wetland systems. The centre of the marsh lies just below sea level and is flooded with very diluted seawater making it an anchialine pond. The pond is surrounded by a **Red Mangrove** swamp. As the ground rises away from the saltwater flooded area, it quickly becomes quite fresh at the surface and the mangroves are replaced by a freshwater swamp forest dominated by **Bermuda Palmetto** with **Bermuda Cedar** as a sub-dominant. This swamp-forest is very close to the original, typical lowland forest of Bermuda, particularly where invading species have been cleared out. There are also significant areas of freshwater marsh where **Saw-grass** and **Narrow-leaved Cattail** predominate and which show all the typical features of Bermudian freshwater marshes. Although there is no true freshwater pond, drainage ditches dug around the outer edge of the depression have pond like character and show abundant **Duckweed** and **Water Fern**. Thus virtually all the wetland types discussed in this field guide could be studied at this one location.

Observations

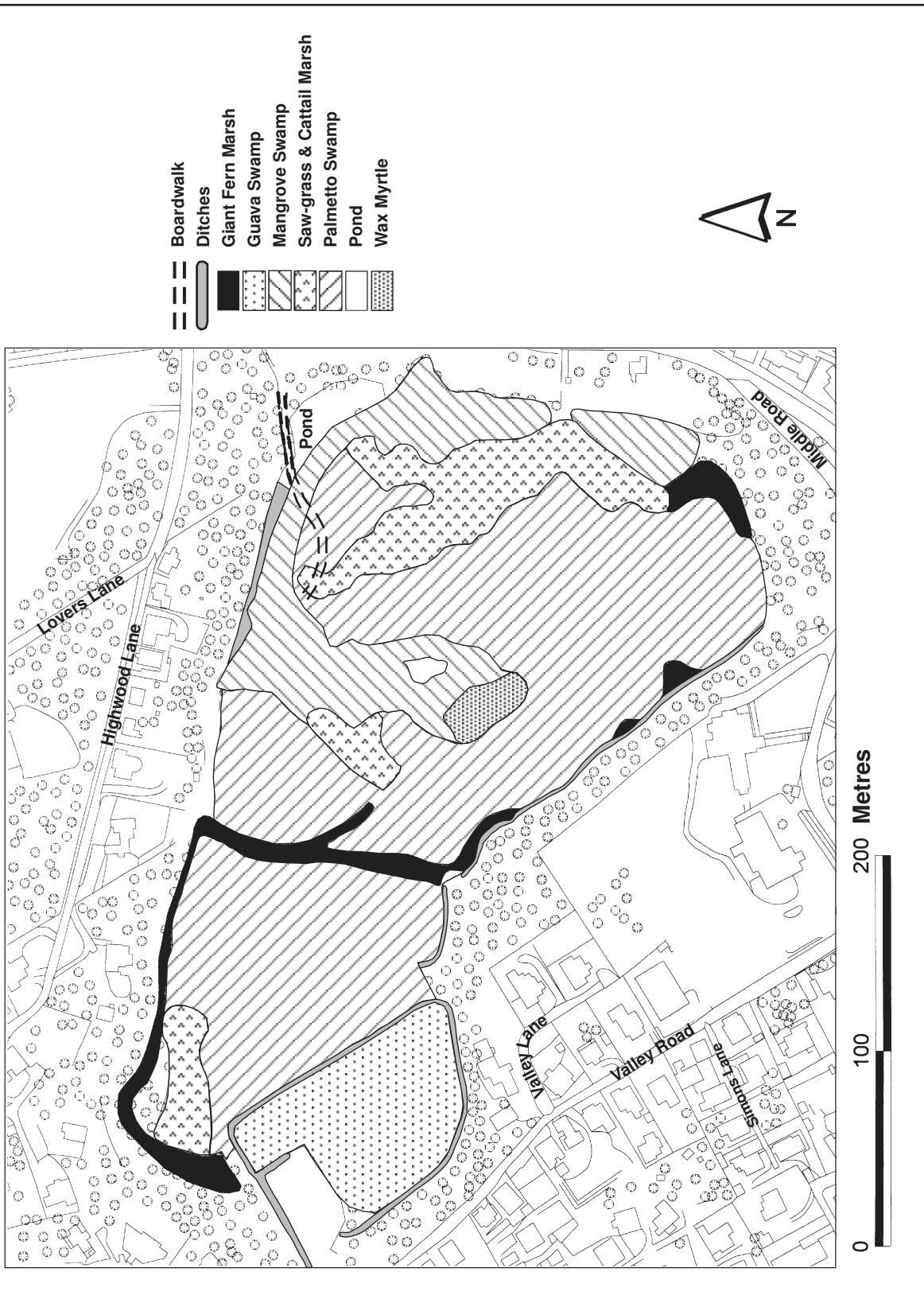
1. All work at this location will be done from the boardwalk to avoid trampling this very important ecological site. Walk along the boardwalk and identify the various ecosystems described above. The freshwater marshes will stand out as grass dominated areas.
2. From the boardwalk look at the marsh area. Locate the dominant grasses or grass like plants, **Narrow-leaved Cattail** and **Saw-grass**. Are these interspersed with each other or in discrete patches? Make a judgement about which one is most important (dominant) and which comes second (sub-dominant). If you think they are of equal importance call them co-dominants.
3. Look for and identify any other plants found in this marsh. Try to identify them from the pictures included in this field guide. Examples of ferns, herbs and other grasses, sedges or rushes may be seen. List all those you find and note where they were growing.
4. Walk to where the marsh grades in to surrounding systems. At this point grasses will cease to be dominant and trees will become important. This change-over zone is called an ecotone. Look carefully at this area. All ecotones have special features, one of which is increased biodiversity. Biodiversity can most simply be judged by counting the number of different species present. Take no notice of the abundance of each species. Pick reasonable areas of marsh, ecotone and woodland. About 4 square metres or 4 square yards would be about right. Judge this as the area enclosed by a square of 8 metre or yard sticks, laid two to a side. You can lay out such an area on the boardwalk if it will help and then mentally transfer this area to the ground. Note the biodiversity, expressed as number of different species, in each of the three areas. For added detail list all the species that you find.

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5. Write a list of marsh plants with the one that penetrates furthest into the trees at the top and the one that penetrates least at the bottom. Such a list is a heirarchy. It gives a good idea of the adaptability of the plants you are observing.
6. Observe or list all the birds that you see and add information on the habitat in which they were observed most frequently. You may also see **Giant Toads** in the marsh or swamp, perhaps even in the mangrove. They are a very adaptable species.

Potential Hazards. There are none if you stick to the board-walk.

Map 2 - Paget Marsh Palmetto Forest Swamp



Warwick Pond Marsh

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and ponds. Find out anything else that you can on Bermudian marshes.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but will be a distinct advantage.

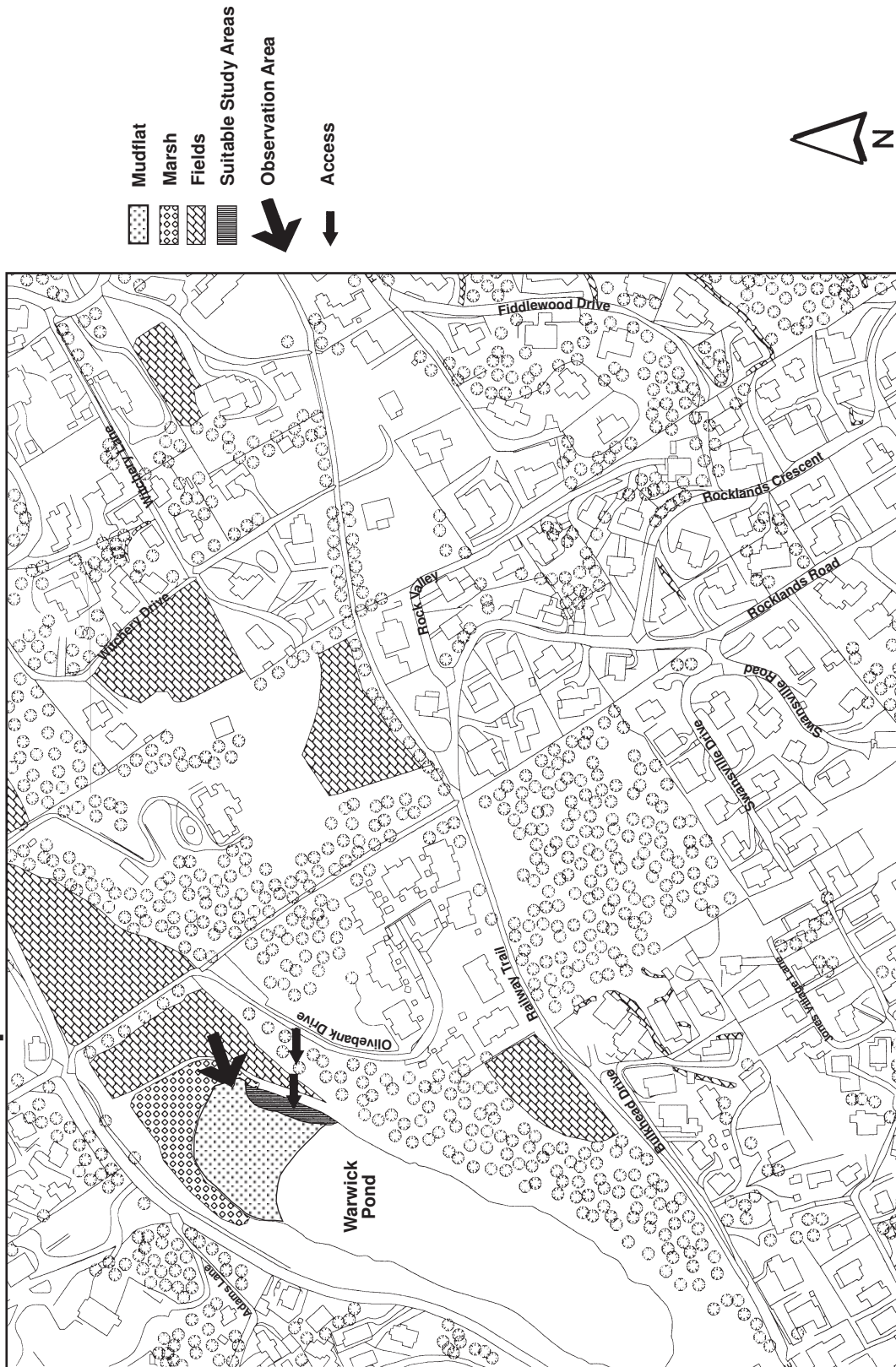
Location. Warwick Pond is the largest of Bermuda's freshwater ponds but the whole location has very low biodiversity, an indication of a stressed environment. The water gets very hot in summer and there are large deposits of organic material. Some pollution also enters from surrounding properties. At the North end of the pond there is quite a good marsh area accessible by turning off Middle Road up Olivebank Road. About 100 yards up is an opening to agricultural land at the back of the marsh. Map 3 shows this location.

Observations

1. Look at the East end of the pond generally before you approach the marsh. Note that there are good stands (plant communities) of **Narrow-leaved Cattail** and **Great American Bullrush**. Along the SE shore is a very extensive community of **Sheathed Paspalum** next to the water. **Joint Grass** is the taller grass behind the mat of **Sheathed Paspalum**. Draw a sketch map showing the East end of the pond and the approximate location of the plant communities mentioned above.
2. Proceed down to the flat land around the pond and approach the SE shore where the **Sheathed Paspalum** community is well developed. Lay a 10 m or 30 ft tape at approximately right angles to the shore with zero at the outer water edge of the **Sheathed Paspalum**. Measure to the most inland part of each plant community. Remember that the community boundary is where dominance changes to another species. Then find the upper and lower limit of every species present, including the dominant ones. Also note the measurement of the water's edge and the depth of the water at the zero point. If marsh species continue back beyond the end of the tape, move the tape back and continue measurements. This data will allow you to draw a profile of the freshwater marsh community around the edge of Warwick Pond.
3. Observe any birds in the area and list them with notes saying where they were seen. During summer droughts a mudflat habitat forms at the North end. This is used by migrant Sandpipers and Plovers in July, August and September. If you see any invertebrates in the water or in the marsh also make a list of those. **Giant Toads** may also be present.
4. Look for physical and biological evidence of stress on the system including pollution. In this location agricultural chemicals are quite likely used at times.
5. Look at the woodland edge behind the transect area. Identify the dominant tree species. Determine from what you know or have read whether this is endemic, native or introduced. If introduced, is it having a positive or negative influence on wetlands in Bermuda?

Potential Hazards. There are no major hazards on land, but do not step into the pond, the bottom is soft and muddy and will not support your weight

Map 3 - Warwick Pond Marsh



Freshwater Ponds

Seymours Pond

Restrictions. The available study area on the West bank of the pond is quite small. No more than 12-15 students should be taken there at any one time. This is a Nature Reserve and care must be taken to disturb nothing.

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and ponds. Find out anything else that you can on Bermudian ponds.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. Sampling or dip nets (If you don't have dip nets available, the skimming nets used for swimming pools make a good substitute.) Plastic buckets or basins. If available, kits for testing the water for oxygen, pH, phosphate and nitrate would be helpful. At least one pair of binoculars for the group would be a minimum, one pair per 3 students would be better.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but are a very great advantage. At least some students should have them particularly if the weather has been wet lately

Location. Field exercise Map 4 shows the area where the field trip will be run. You will approach the pond from a track off Middle Road; 10 m or so down the track a path descends steeply to the bank of the pond. Walk down the slope towards the pond but do not go into the water, the bottom is very soft and muddy and even rubber boots would not stop you from getting wet and dirty. Try not to disturb the area; freshwater ponds are few and far between in Bermuda and can be considered quite fragile. However, as you approach the pond look around at the surrounding countryside and observe any wildlife that you may be disturbing and that will therefore be absent when you list things later.

Observations.

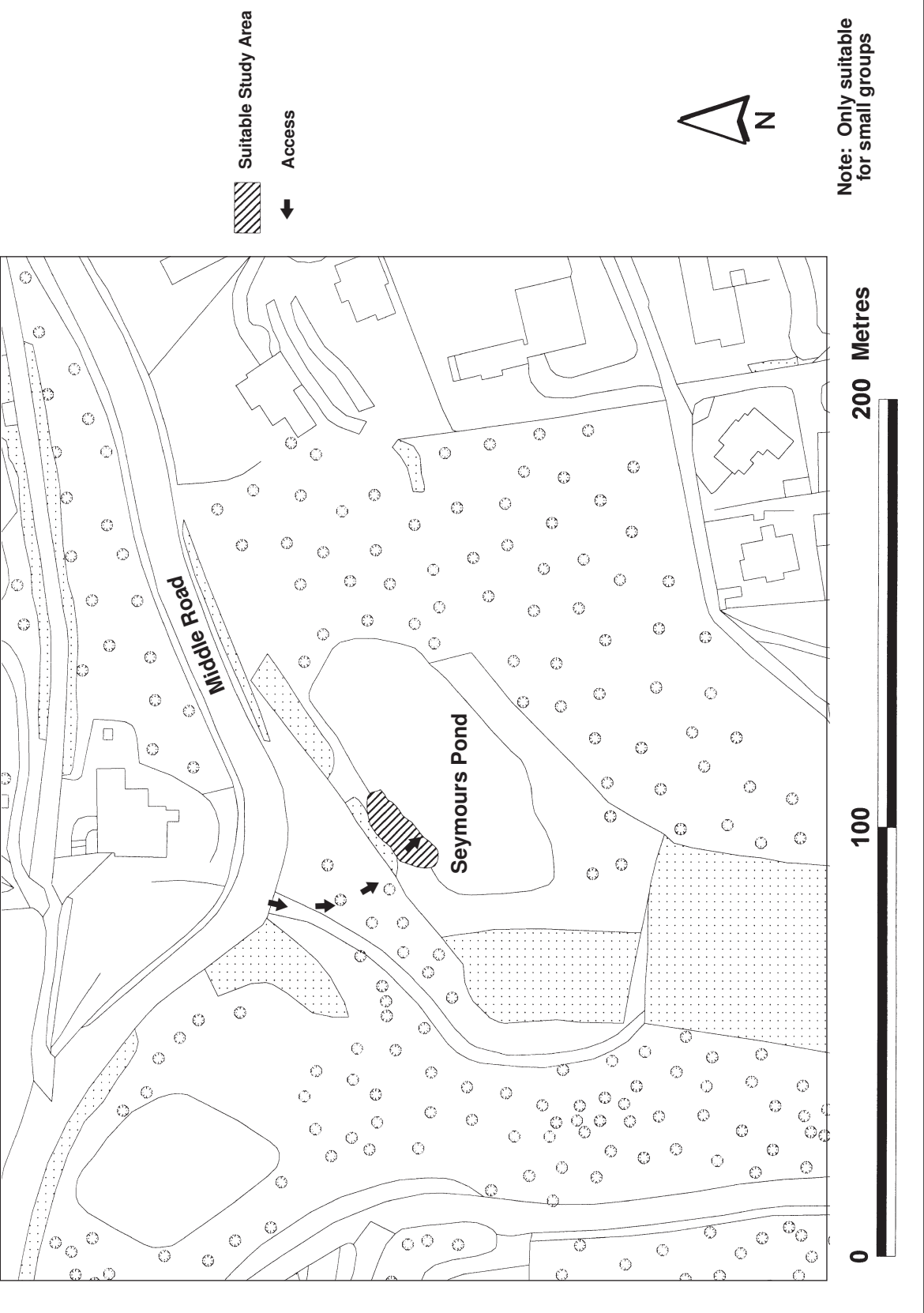
1. Before you start any detailed work, observe the pond area and list any wildlife that you can see now or that you disturbed as you approached. In the water you might see **Pied-billed Grebes**, **Coots**, Common Galinules or a variety of **ducks**, depending on the season. Around the water look for **herons** and **egrets**. These long necked wading predators could be wading in the water, in the vegetation surrounding the pool or even perching in the trees around the pond. Additionally, look for birds not closely tied to water that have a broad enough habitat range to use pond-side environments. **Kiskadees** and **Starlings** are likely to be present and others may be.
2. Briefly describe the surroundings of the pond. Is it woodland or agricultural fields. If it is woodland, what are the main trees present, if cultivated, what is being grown there? At the South end of the pond the water ends in a fringe of **Tamarisk** shrubs; this is an unusual habitat for this salt tolerant tree or small shrub more commonly seen along the North Shore.
3. Lay out a tape or tapes (students can be grouped for this exercise) with zero at the waters edge and running at right angles to the shoreline, up the slope, back towards the woods or fields. If the tape reaches woods or fields, stop there. Working along the tape from either end, determine where different types of vegetation start and stop, and where they are most

abundant. Generally classify each thing that you look at as rare, common or abundant. For instance, where do grasses occur? What herbs can you find and where along the tape are they situated? How common are they. Communities are normally named on a basis of the most abundant plant. Can you distinguish any plant communities around the pond? It is likely that there will be a grass community close to the water, composed of **Sheathed Paspalum**, followed by a second grass community characterised by **Para Grass** or **Joint Grass** and a herb community farther back. Identify as many plants as you can from the pictures in this field guide. For those you know the identity of, make sure you have recorded where they were along the tape and how common they were.

4. From where you have been working, look to both sides of the tape and on around the pond. Decide if any communities form distinct zones or bands around the pond. If they do, draw a sketch map of the pond area showing the pond itself and the zones of vegetation around it. This can also be done if the vegetation forms patches rather than distinct zones. Both patches and zones show changing environmental conditions where they start and stop.
5. Remain in groups and turn your attention to the pond itself. Try to determine what water weeds are present. **Widgeon Grass** is the most likely but look for others. Thread-like green algae will also very likely be there. If you see any fish try to determine what they are. **Mosquito Fish** are likely to be found. List what you find.
6. Take a bowl or other container and fill it with pond water from the edge of the pond. **Do not step into the water**. Using a net with a handle, sweep it gently through the water weeds and open spaces. Try not to catch masses of weed. Shake the catch into the bowl of water. If clumps of weed are in the net they can be shaken over the water too. Some animals may cling to the weed and will need to be gently dislodged. Observe what you have caught and identify as many things as possible from the pictures in this guide. Some interesting things may be very small. Depending on season, much of what you get may be larvae or immature stages of aquatic insects that spend their adult lives out of the water. Others may be insects that spend all or most of their lives in water. Some of these, such as **Water Boatmen** can fly and may decide to leave the bowl. Try to distinguish between larvae and adults. When you have finished observing the pond creatures, it is important that you return your catch to the water.
7. If you have any water test kits, use samples of clean pond water to test for oxygen, pH, phosphate and nitrate. For a pond in good condition, oxygen should be high (5ppm or more), pH should be between 5 and 8 and phosphate and nitrate should be very low. Any deviation from these ranges could indicate pollution or other environmental problems.

Possible Hazards. The area is generally free of hazards but on no account should anyone step into the pond itself. The mud is deep and soft and will not support your weight. However, be aware that you are a hazard to the pond and this small nature reserve. Try to disturb nothing and to leave it as you found it. The only exception to this rule is that trash can be removed and placed in proper disposal containers.

Map 4 - Seymours Pond

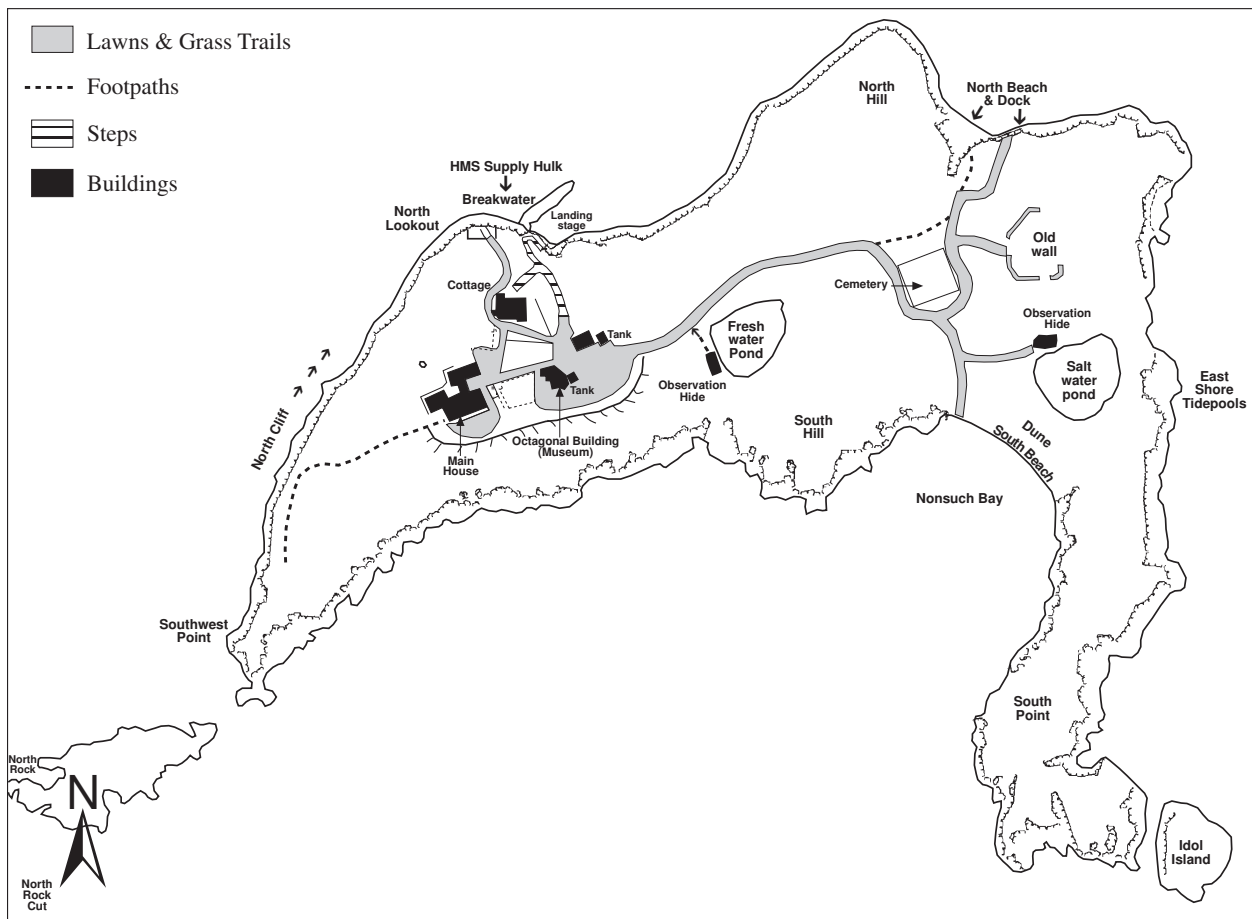


Freshwater Pond on Nonsuch Island

This pond is a special man-made one to diversify the range of habitats found on Nonsuch Island. It is an observation-only location and sampling or trampling are not permitted. A visit to it should be combined with visits to other locations available for observation and learning on the island. However, as a fresh water pond, it is worth a visit as every effort has been made to include the common fresh-water plants of Bermuda. For instance, around the pond are large growths of **Narrow-leaved Cattails** and **Great American Bullrushes**. Neither of these were common at the first two locations described above although both are present in Devonshire Marsh.

The Nonsuch pond is also a good place to observe various birds such as herons, egrets and sometimes ducks and coots.

Map 5 - Nonsuch Island



Freshwater Swamps

Paget Marsh Palmetto Forest Swamp

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and swamps. Find out anything else that you can on Bermudian swamps or lowland forests.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. If the drainage ditch were to be waded in dry weather, rubber boots would be required. Knee high rubber boots are not essential but may be an advantage if walking down the ditch side.

Location. Map 6 shows the location of Paget Marsh and where swamp forests are located within it. Paget Marsh is a Nature Reserve administered jointly by the Bermuda National Trust and the Bermuda Audubon Society. Paget Marsh lies in a depression in the central part of the main island. It is very important because it supports a great variety of natural wetland systems. The center of the marsh lies just below sea level and is flooded with seawater making it an anchialine pond. The pond is surrounded by a **Red Mangrove** swamp which also extends along the eastern edge of the marsh. As the ground rises away from the saltwater flooded area, it quickly becomes quite fresh at the surface and the mangroves are replaced by a freshwater swamp forest dominated by **Bermuda Palmetto** with **Bermuda Cedar** as a sub-dominant. This swamp-forest is very close to the original, typical lowland forest of Bermuda, particularly where invading species have been cleared out. There are also significant areas of freshwater marsh where **Saw-grass** and **Narrow-leaved Cattail** predominate and which show all the typical features of Bermudian freshwater marshes. Although there is no true freshwater pond, drainage ditches dug around the outer edge of the depression have pond like character and show abundant **Duckweed** and **Water Fern**. Thus virtually all the wetland types discussed in this field guide could be studied at this one location.

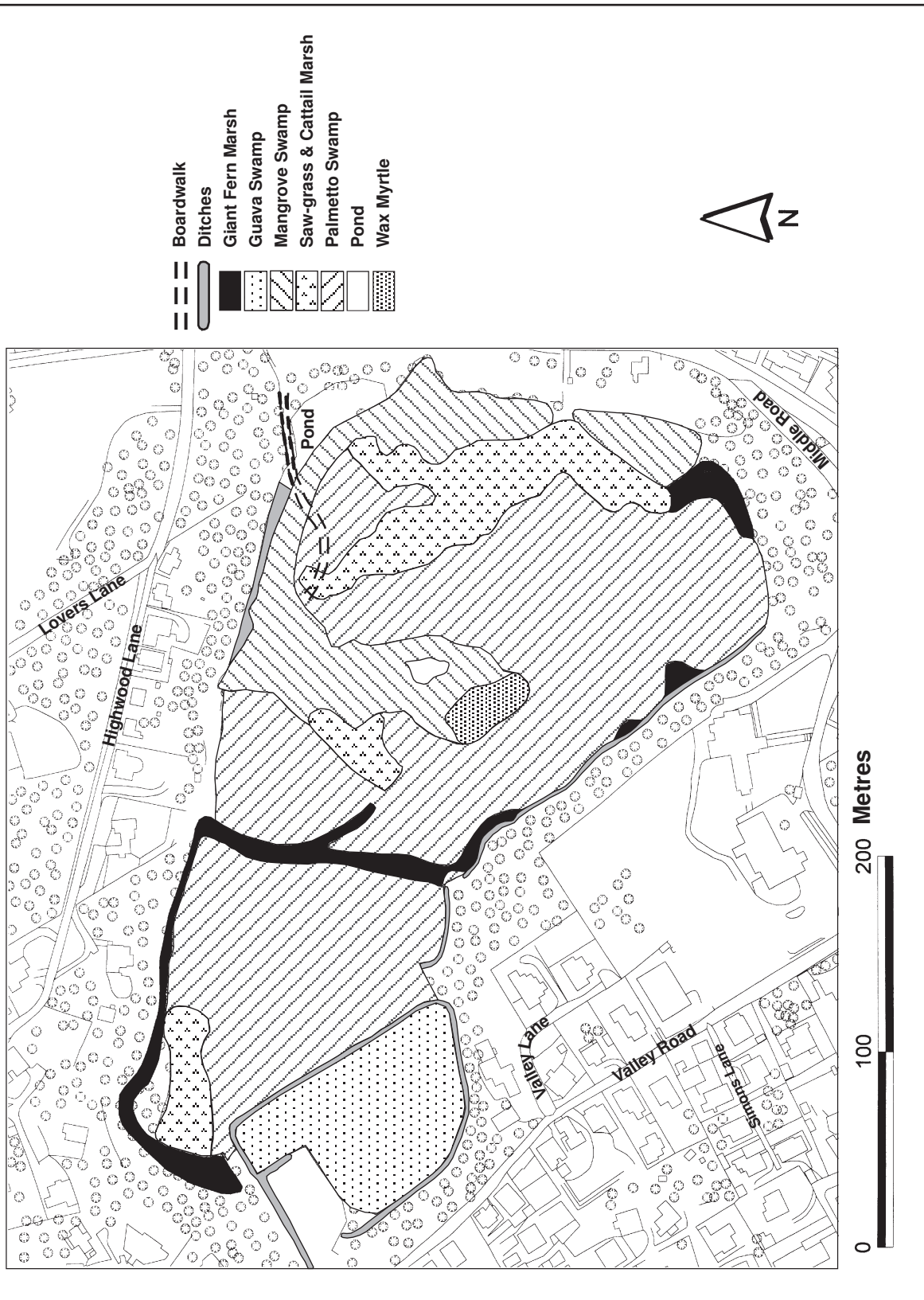
Observations

1. All work at this location will be done from the boardwalk to avoid trampling within this very important ecological site. Walk along the boardwalk and identify the various ecosystems described above.
2. In the Bermuda Palmetto-Bermuda Cedar swamp-forest, identify these two trees and as many associated species as you can see. Two vines cling to the trunks these are **Virginia Creeper** and **West Indian Cissus**. Under the trees you should be able to see ferns such as **Southern Bracken**, **Cinnamon Fern**, **Sword Fern** and **Royal Fern**. Also look for the clubmoss, **Psilotum** a very ancient species. The White Moss should also be visible. Several other plants are possible. List everything that you identify.
3. A swamp is a wetland forest. Forests are one of the best examples of a stratified or vertically layered ecosystem. The topmost layer containing the crown of the trees and the bulk of their leaves is the canopy. Look up to the canopy and estimate the height above the ground of the top and bottom of this stratum. A metre or yard stick can be used to help make this estimate, just imagine how many sticks would have to be placed end-to-end to reach the heights you are estimating. Estimation is a valuable scientific method and with practice it can be reasonably

accurate. Below the canopy, the sub-canopy, a quite open area extends down to the top of the ground layer. Add an estimate of the height of the canopy bottom to your data. The ground layer may be almost devoid of plants where the canopy is thick, but have a diverse flora of shrubs and/or herbs where there is a reasonable amount of light. Ferns are often dominant or quite common in this layer.

4. Using your height estimates draw a sketch of the vertical structure of the forest.
5. Look for animal life. List any birds that you see. Also look for **Giant Toads** and **Jamaican Anoles**. Look for insects and other invertebrates. Make a list of everything that you can identify.
6. The biological structure of the forest modifies the climate of the location. If it is windy note that the highest wind velocity is at the top of the canopy. Wind strength drops rapidly moving down into the canopy, but may rise somewhat again in the more open sub-canopy. Within the ground layer the wind speed drops almost to zero at the ground surface. Notice that light intensity is much lower within the swamp. If the canopy shades out more than 90% of sunlight, the ground layer will be very poorly developed. Another physical change to look for on a sunny day is a lower air temperature in the shade of the trees than outside (at night the opposite effect would occur). All these changes increase the physical stability of the forest. Summarise your observations on the modification of local climate by the forest.

Map 6 - Paget Marsh Palmetto Forest Swamp



North Devonshire Marsh

Restrictions. The access to these sites is very difficult especially when there has been a good deal of rain. A drainage ditch follows the road most of the way, and is present at the best sites off The Bermuda National Equestrian Centre and the Freer Cox and Winifred Gibbons Nature Reserves. An actual on-site visit may be impractical in this area except in very dry weather. There is access down drainage ditch edges further to the East, but there the swamp-forest is fragmentary at best. A trip along the road with observations across the ditch may be the only practical approach. Instructions for work within the forest are included in case this is a possibility. Some of this work can be done by observation from the road edge.

Preparation. Read the general introduction to this field guide and the specific sections on freshwater marshes and swamps. Find out anything else that you can on Bermudian swamps or lowland forests.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. If the drainage ditch were to be waded in dry weather, rubber boots would be required. Knee high rubber boots are not essential but may be an advantage if walking down the ditch side.

Location. Map 7 shows this location. Although there are no longer any really well developed freshwater swamps in Bermuda, an idea of what they were like can be obtained by the examination of fringing (narrow) swamps along the North edge of Devonshire Marsh. The best swamps are in the Freer Cox and Winifred Gibbons Nature Reserves toward the West end of Vesey Street but there access is made difficult by a wide, water-filled drainage ditch. Less well developed fringing swamps are accessible from several locations along the more eastern portion of Vesey Street. Pick a place where a creek-pond with a mowed border heads into the swamp, since such locations provide the most convenient access. There are other locations where the band of trees can be reached by a quite short, if bumpy and overgrown, walk through a grassy area from the road.

Observations. Find an area in which trees are the dominant organisms and which is at least damp underfoot.

1. Look at the general character of the ecosystem. Note particularly that it is dominated by relatively few but very large organisms. Contrast this to the open marsh where there are abundant small to medium-sized plants dominating the plant community. Identify the kinds of trees in the forest and decide which one is dominant (forming a majority of the tree community).
2. A swamp is a wetland forest. Forests are one of the best examples of a stratified or vertically layered ecosystem. The topmost layer containing the crown of the trees and the bulk of their leaves is the canopy. Look up to the canopy and estimate the height above the ground of the top and bottom of this stratum. A metre or yard stick can be used to help make this estimate, just imagine how many would have to be placed end-to-end to reach the heights you are estimating. Estimation is a valuable scientific method and with practice it can be reasonably accurate. Below the canopy, the sub-canopy, a quite open area extends down to the top of the ground layer. Add an estimate of the height of the canopy bottom to your data. The ground layer may be almost devoid of plants where the canopy is thick, but have a diverse flora of shrubs and/or herbs where there is a reasonable amount of light. Ferns

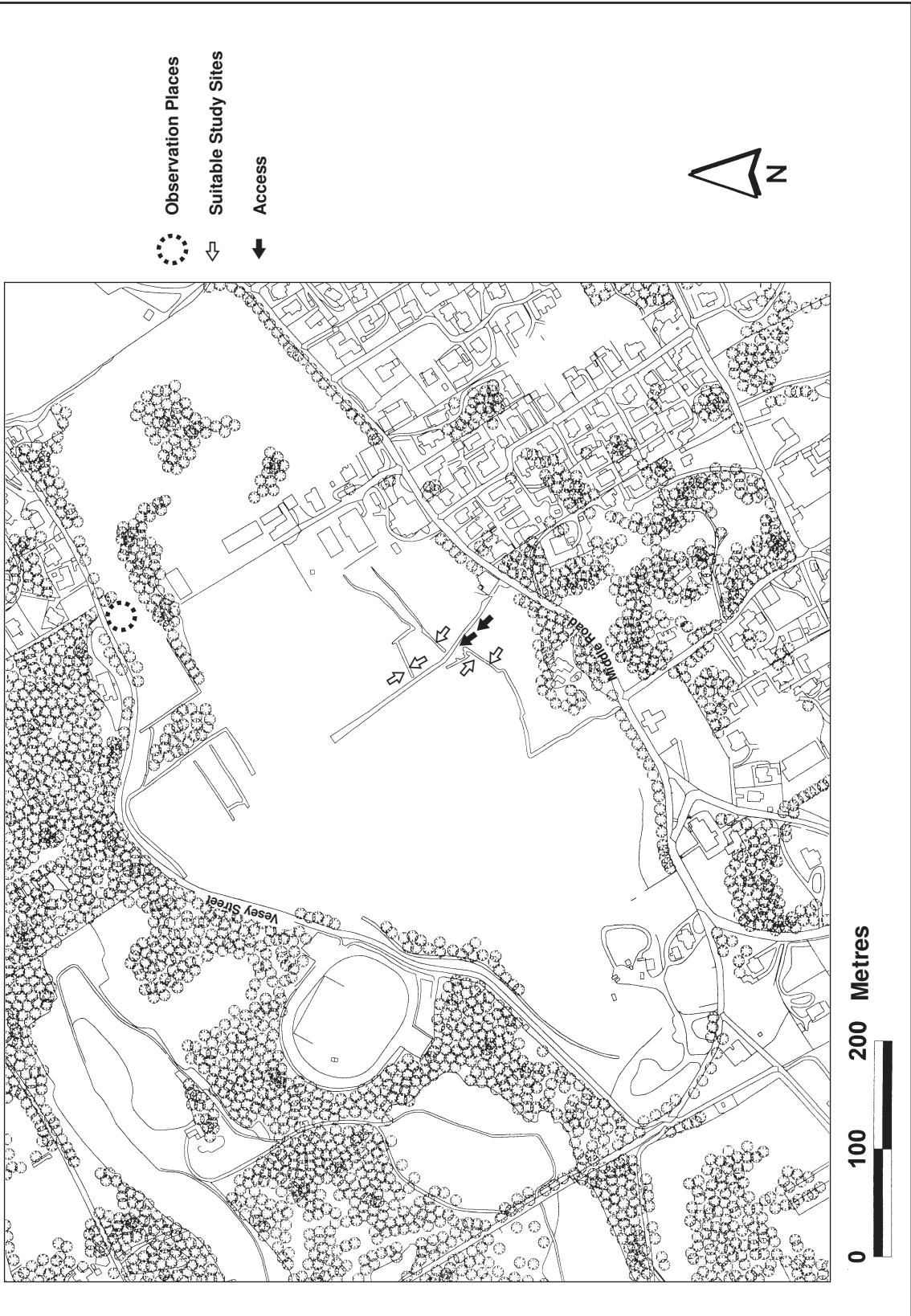
Bermuda's Wetlands

are often quite common in this layer. Try to identify as many as possible of the plants seen here. If any endemic species are seen make a special note of this fact.

3. Using your height estimates draw a sketch of the vertical structure of the forest.
4. Look for animal life. List any birds that you see. Also look for **Giant Toads** and **Jamaican Anoles**. Look for insects and other invertebrates. Make a list of everything that you can identify.
5. The biological structure of the forest modifies the climate of the location. If it is windy note that the highest wind velocity is at the top of the canopy. Wind strength drops rapidly moving down into the canopy, but may rise somewhat again in the more open sub-canopy. Within the ground layer the wind speed drops almost to zero at the ground surface. Notice that light intensity is much lower within the swamp. If the canopy shades out more than 90% of sunlight, the ground layer will be very poorly developed. Another physical change to look for on a sunny day is a lower air temperature in the shade of the trees than outside (at night the opposite effect would occur). All these changes increase the physical stability of the forest. Summarise your observations on the modification of local climate by the forest.

Possible Hazards. Keep a careful lookout for Poison Ivy and avoid any area where it occurs. It is quite common in and around Devonshire Marsh.

Map 7 - Devonshire Marsh



Salt Marshes

As with the freshwater swamps, salt marshes are now reduced to small remnants of their former extent in Bermuda.

Spittal Pond Salt Marsh

Preparation. Read the general introduction to this field guide and the specific sections on salt marshes and mangrove swamps. Find out anything else that you can on Bermudian salt marshes.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

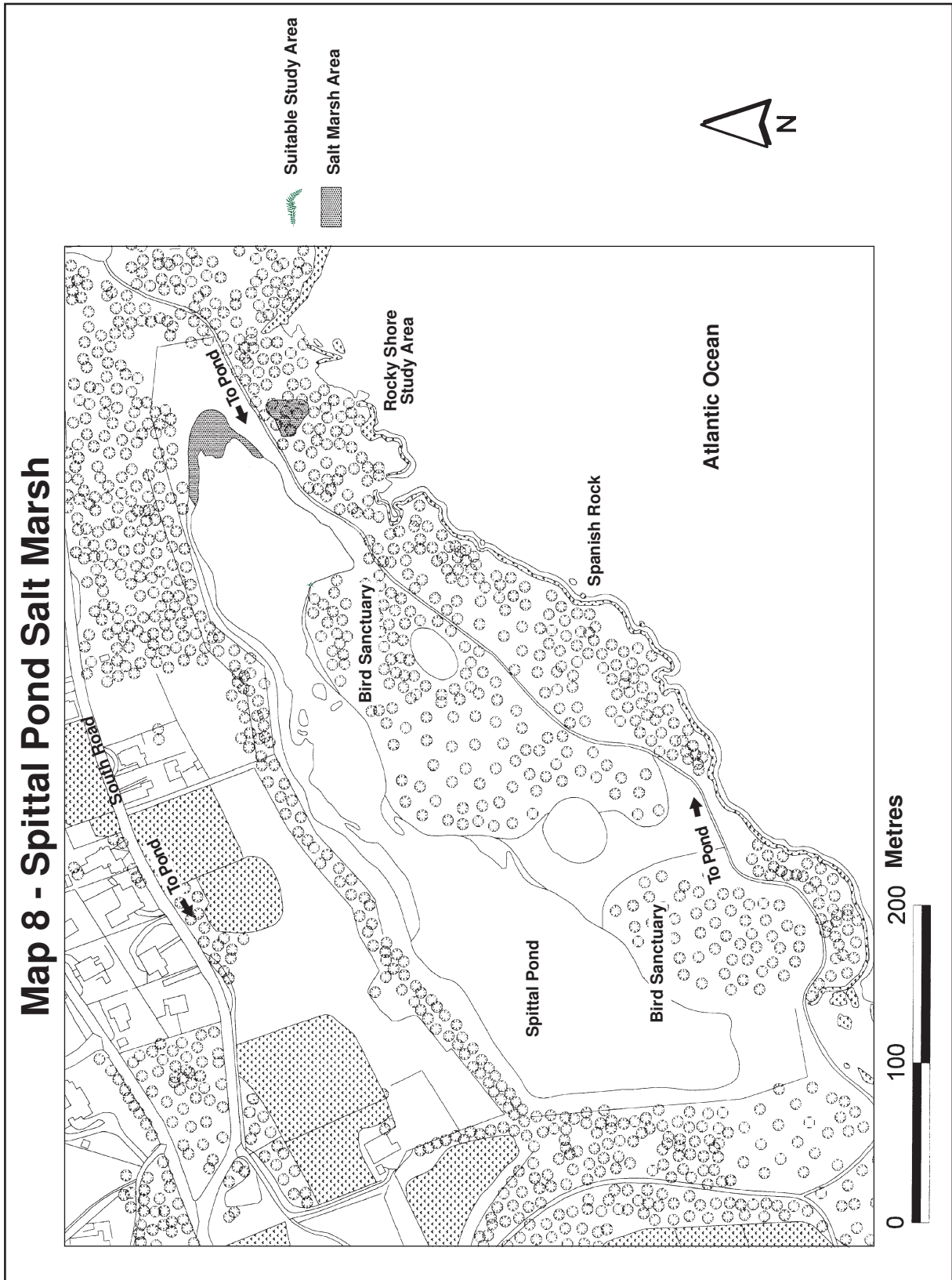
Location. The salt marsh lies at the West end of the Spittal Pond Nature Reserve. Its location is shown in Map 8. Take the trail from the West parking lot through the gate in the fence and head towards the pond. The salt marsh lies to the right and extends from the pond edge back at least 30 m or 100 ft. Remember that this is a nature reserve and that you are working in a delicate and, now rare, ecosystem. Try not to disturb anything.

Observations

1. Look at the general nature of the salt marsh. This one is typical in that it is grass dominated (grasses, including rushes are the most important plants present by far!). It is also typical in that it is very flat and only moderately wet. There are two plant species that dominate two clearly different areas of the salt marsh. These are the **Sea Rush** and **Sheathed Paspalum**. Find the pictures of both of these and then note where each dominates. Draw a sketch map of the West end of the pond showing the general location of each of these communities and that of the tiny mangrove swamp (area dominated by Black Mangrove trees) at the West end of Spittal Pond. Lay a tape along the path so that you can get a rough idea of scale and add information on scale to your sketch map.
2. Look at each of the two salt marsh communities and note that they are typically almost mono-specific (Composed almost entirely of a single species). This is not a very common situation in nature but tends to occur in stressed or unstable environments. Think about how these two communities may come under stress here. (Hint! Think about flooding at times of storms and possible lack of water in drought. If you have visited Spittal pond often before you might also realise that the water in the pond is of very poor quality at times. Sulphurous smells at times suggest this.) (Look at the field trip outline for the pond itself later in this field guide.)
3. Look for the presence of other salt marsh species, particularly along the edges of the path and between the path and the sea. You should be able to find **Saltmarsh Oxeye**, **Seaside Purslane**, **Seaside Goldenrod** and **Seaside Heliotrope**. For those you find, note the habitat (the particular place where they occur.). Do you see any evidence that the trail fosters the growth of these less common species? If you do, try to think why this may be so.
4. Lay a tape from the main path edge toward the sea. Along this tape note the distribution of each kind of plant in a belt no wider than 1 yard or 1 metre, centred on the tape. Think

about ways to best show your results and think about how this area differs from that closer to the pond. (Laying a tape in the main part of the salt marsh would give little in the way of results!)

5. Explore this area in general and note the great wealth of natural systems in such a small area. Describe this in a paragraph or so.



Mangrove Swamps

General note concerning tides.

Whenever you are working along coasts it is easier if you go to the location at low tide. Times of low tide are given in the newspaper. However, time restrictions for field trips may not permit this; fortunately the tidal range in Bermuda is only about 75 cm or 2 1/2 ft on the average, at full high tide you may therefore have to do a bit of wading. Figure 3.3 is a diagram of a cross section through a typical Bermudian mangrove swamp. It shows the most common trees and a few other plants and animals.

Blue Hole Mangrove Swamp

Preparation. Read the general introduction to this field guide and the specific sections on mangrove swamps. Find out anything else that you can on Bermudian mangrove swamps.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. A length of strong fine cord and a line level. A minimum of a 10 m or 30 ft measuring tape, 10 m or 100 ft would be better. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage. This site is primarily sandy rather than muddy.

Location. This is the best location in Bermuda for a basic study of a mangrove swamp and lying within a national park it is protected from interference by man. The location of the study site is shown in Map 9. However, the actual entrance to the swamp is a little difficult to spot but lies close to where the path from the parking lot joins the paved road. Note: In 2003 Hurricane Fabian damaged this site but it is recovering.

Observations

1. General features. First look at the area in general and learn its typical and unusual features. The mangrove swamp at Blue Hole is a very fine example of a well formed coastal or bay mangrove swamp, it has well grown **Black Mangrove** trees at the landward end and a long stretch of **Red Mangrove** trees ending in the water of Castle Harbour. The **Black Mangrove** trees are larger, have thicker, darker trunks than the red and have more elongated leaves. The most obvious feature of the **Red Mangroves** is the spreading prop-roots going down into the sediment (see Figure 3.2). However another very noticeable feature are the large embryos (germinated seeds) hanging from the trees. These are often called propagules since this term can be applied to seeds as well.

Blue Hole mangrove swamp is unusual in that, although it is a very sheltered location, the sediment is sandy rather than muddy. This is good from a point of view of study, but quite atypical. A result of this is that the pneumatophore roots of the Black Mangrove, a very useful aid to identification, are absent. These roots are an adaptation to provide oxygen to roots in mud, and not needed here since the sand is well aerated.

This mangrove swamp is beautifully zoned. The seaward part is dominated by **Red Mangroves** which give way to **Black Mangroves** above high tide line and at the back is a zone of diverse coastal trees. Smaller plants such as algae and herbs also show zonation and details will be explored in the study.

Bermuda's Wetlands

2. This site is excellent to demonstrate the use of the transect technique very widely used in ecology to describe a rapidly changing biological system. The transect described here can be carried out in whole or in part at various stages of complexity depending on the age and experience of the students and instructor.
- 2A. Basic transect work. Lay a tape on the ground with the zero mark at the back of the transect and the tape running at right angles to the shoreline. At this location there is a convenient gap in the mangrove swamp down which the tape can be laid. The zero point must be slightly within the terrestrial zone at the back. There is a small limestone outcrop there which will be a good start point. Fasten the tape firmly there with a stick or by jamming the end in a crevice. If debris is present clear it so that the tape lies on the ground.

A 30 m or 100 ft tape will reach the water, if only shorter tapes are available, the transect will have to be done in sections as the tape is moved down.

- 2B. Physical features. Note the nature of the sediment along the tape. Look at such things as detritus (rotting leaves etc.) content, particle size and the presence or absence of identifiable shells.

This part can be omitted in a simple study. Using a strong cord on which a line level is hung, find the drop in elevation at intervals along the transect line. To do this stretch the cord from the ground level at the high end, to a yard or metre stick at the lower end so that the bubble in the level is centered. The cord must be tight. Read off the height difference on the ruler. If anything interferes with the line, clear it away, or if it more practical, raise the line at the higher end and subtract the height raised from that shown on the stick (ruler) at the lower end. You can either do this at regular intervals or do it wherever there is an appreciable change of slope at the ground surface. In any case note the horizontal tape reading where heights are determined. When you look at the data collected, remember the heights are increments and they must be summed sequentially from the start to give total drop in elevation at each point. If you just want total elevation drop from start to finish just sum the increments. Note unless the tide is very low, you will reach the water before you reach the end of the swamp. In this case note the distance to the waterline, then take depths with the metre or yard stick at regular intervals. But remember these depth are total not increments and must be treated accordingly if you graph the results.

- 2C. Biological features. In this part various stages of complexity are possible. At a minimum find the zones occupied by as many species as you can handle, but certainly include the mangrove trees. Just get a measurement for the most seaward and most landward individuals of each species. Include a reasonable distance to either side of the transect line, for herbs and grasses a foot or so either side of the line but for the trees look several yards or metres.

To get more information include more species such as algae and **Mangrove Periwinkles** on mangrove roots and herbs and grasses at higher parts.

To get a better idea of the mangroves themselves, get similar measurements for the lowest (seaward) and highest (landward) prop roots, trunks and leaves of the **Red Mangrove** and the lowest and highest trunks and leaves of the **Black Mangrove**. The lowest and highest leaf measurements are giving you the extent of the canopy of each mangrove species. This can be extended to other trees and shrubs present if desired.

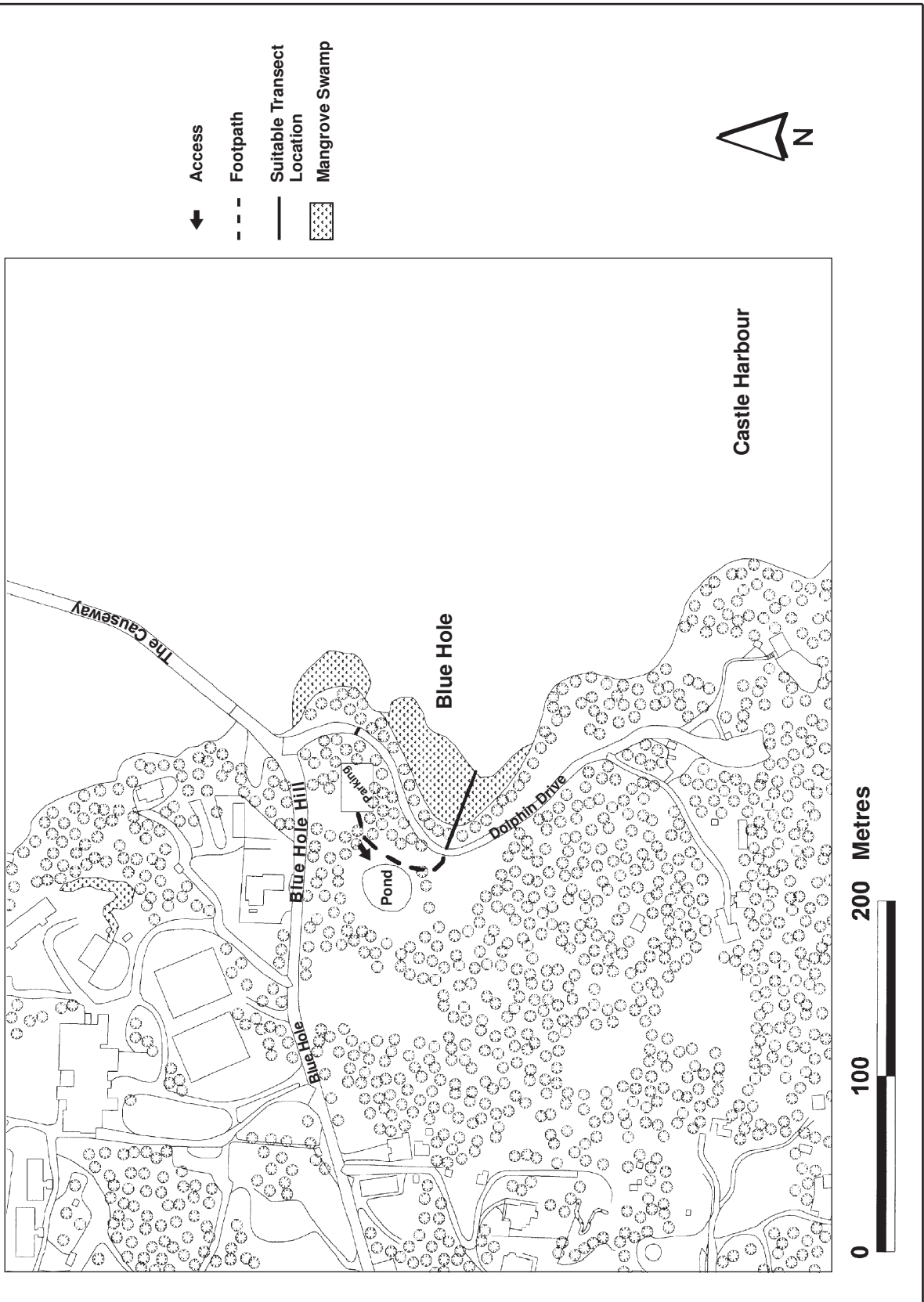
- 2D. Forest structure. If time is available, another dimension can be added to the study by looking at the heights of important forest features above the transect line. As a minimum estimate the height of the bottom and top of the canopy of each tree species at metre or 5 yard intervals. The base of the canopy can usually be measured; estimate the top by reference to two yard or

metre sticks put one on top of the other. This will give reasonably accurate results if done thoughtfully but do it only to the nearest foot or half metre. Naturally other features can be added if time permits.

3. According to the complexity of your study, the results can be shown in various graphs and diagrams. If you have done everything suggested, then a cross section of the mangrove forest can be drawn to scale showing its basic structure and where different species live.
4. While at the mangrove swamp note any birds or other wildlife seen and make a list of them. Also look for any signs of pollution in the form of trash. Even though this location is within a park, floating trash can come in.

Possible Hazards. This location is virtually free of hazard but shards of broken glass are always possible.

Map 9 - Blue Hole Mangrove Swamp



Mill Creek Mangrove Swamp

Preparation. Read the general introduction to this field guide and the specific sections on mangrove swamps. Find out anything else that you can on Bermudian mangrove swamps.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. A bottle of isopropyl rubbing alcohol and paper towel. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. The location of this mangrove swamp is shown in Map 10. It lies at the bottom of Mill Creek Lane adjacent to the Mill's Creek Marina. This mangrove swamp is an example of a mangrove swamp under stress. There is heavy boat traffic to the marina and some chemical pollution is inevitable. Additionally the wash from boat wakes results in some erosion along the shoreline. The worst source of pollution, however, is Pembroke Canal which discharges into Mill Creek through the sluice gate at the bottom of Mill Creek Lane. Pembroke Canal carries a heavy load of industrial and domestic waste. Pollutants in this waterway include oils and other hydrocarbons, heavy metals and contaminants such as coliform bacteria derived from sewage. Because of the level of pollution, work at this area is best confined to observation.

Mangrove swamps are very good at dealing with quite high levels of pollution but the effect shows in a reduced diversity of associated animals and plants.

A good view of the mangrove is available from the roadway along the landward edge of the swamp. A path down the N. side of the swamp allows further observation points but is very trash ridden.

This mangrove swamp is the only one in Bermuda within an estuary. Mill Creek (Pembroke Canal) is the only fresh water stream in Bermuda and a small estuary is formed where it meets and mixes with the sea.

Observations

1. First look at the area in general and learn its typical and unusual features. The mangrove swamp at Mill Creek is an example of a well formed coastal or bay mangrove swamp that is under stress from pollution. It has well grown **Black Mangrove** trees particularly at the landward end but also scattered through the swamp, and many **Red Mangrove** trees especially along the waterfront. The **Black Mangrove** trees are larger, have thicker, darker trunks than the red and have more elongated leaves. The most obvious feature of the **Red Mangroves** is the spreading prop-roots going down into the sediment. However another very noticeable feature are the large embryos (germinated seeds) hanging from the trees. These are often called **propagules** since this term can be applied to seeds. Find both types of mangrove tree and look for other distinguishing features.
2. This is not a distinctly zoned mangrove swamp, but rather one where red and black mangroves intermingle. However, if you look critically you should see that **Red Mangroves** are commoner towards the sea and **Black Mangroves** towards the land. This is an example of zonation. If you see any other indication of biological zonation within the swamp note it down.
3. Look for evidence of pollution. List all the pollutants you can see and try to estimate from where they may have come. What other things also suggest this as a polluted location?

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4. Look for organisms associated with the mangrove swamp and also those that may just visit. List as many as you can. If you have visited other mangrove swamps, suggest what may be missing here due to the high level of pollution.
5. Think about this situation. How might this area be improved? What can be done to make it a better site for educational visits such as this one?

Possible Hazards. This location is rife with potential hazards but there is no real danger if you follow the guidelines. Treat this visit as an observation only one. Do not handle any of the organisms, pollutants or trash. If you accidentally touch polluted material, rub the contaminated skin immediately with rubbing alcohol on a paper towel and wash thoroughly with soap and water as soon as you can after the field trip. Do not attempt to penetrate into the swamp. You can see all that you need to without doing this.

Ferry Point Mangrove Swamp

Preparation. Read the general introduction to this field guide and the specific sections on mangrove swamps. Find out anything else that you can on Bermudian mangrove swamps.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape; a 30 m or 100 ft tape would be better. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. This location is another coastal or bay mangrove swamp but it differs from the one at Blue Hole in that it is somewhat narrower and a lot more muddy. Access to the site is easy as it is in Ferry Reach Park but penetration of the mangrove swamp is more difficult due to the mud and the absence of a gap in the swamp; nevertheless a full mangrove transect study is possible here. The swamp lies in the East end of Ferry Reach to the left of the end of the road into the park. Map 11 shows the location.

Observations

1. **General features.** First look at the area in general and learn its typical and unusual features. The mangrove swamp at Ferry Point is a good example of a well formed coastal or bay mangrove swamp; it has well grown **Black Mangrove** trees at the landward edge and a band of **Red Mangrove** trees ending in the water of Ferry Reach. The **Black Mangrove** trees are larger, have thicker, darker trunks than the red and have more elongated leaves. The most obvious feature of the **Red Mangroves** is the spreading prop-roots going down into the sediment. However another very noticeable feature are the large embryos (germinated seeds) hanging from the trees. These are often called propagules since this term can be applied to seeds as well.

This mangrove swamp is quite well zoned. The seaward part is dominated by **Red Mangroves** which give way to **Black Mangroves** above high tide line and at the back is a zone of coastal trees the most common of which are **Buttonwood** and **Mexican (Brazil) Pepper**. Smaller plants such as algae and herbs also show zonation and details will be explored in the study.

2. This site is reasonably good to demonstrate the use of the transect technique very widely used in ecology to describe a rapidly changing biological system. The transect described here can be carried out on whole or in part at various stages of complexity depending on the age and experience of the students and instructor.
- 2A. **Basic transect work.** Lay a tape on the ground with the zero mark at the back of the transect and the tape running at right angles to the shoreline. The zero point must be within the terrestrial zone at the back, preferably at the back of the trees. Fasten the tape firmly there with a stick. If debris is present clear it so that the tape lies close to or on the ground.

A 30 m or 100 ft tape will reach the water, if only shorter tapes are available, the transect will have to be done in sections as the tape is moved down.

- 2B. **Physical features.** Note the nature of the sediment along the tape. Look at such things as detritus (rotting leaves etc.) content, particle size and the presence or absence of identifiable shells.

This part can be omitted in a simple study. Using a strong cord on which a line level is hung, find the drop in elevation at intervals along the transect line. To do this stretch the cord from the ground level at the high end, to a yard or metre stick at the lower end so that the bubble in the level is centered. The cord must be tight. Read off the height difference on the ruler. If anything interferes with the line, clear it away, or if more practical, raise the line at the higher end and subtract the height raised from that shown on the stick (ruler) at the lower end. You can either do this at regular intervals or do it wherever there is an appreciable change of slope at the ground surface. In any case note the horizontal tape reading where heights are determined. When you look at the data collected, remember the heights are increments; they must be summed sequentially from the start to give total drop in elevation at each point. If you just want total elevation drop from start to finish just sum the increments. Note: Unless the tide is very low, you will reach the water before you reach the end of the swamp. In this case note the distance to the waterline, then take depths with the metre or yard stick at regular intervals. But remember these depth are total not increments and must be treated accordingly if you graph the results.

- 2C. **Biological features.** In this part various stages of complexity are possible. At a minimum find the zones occupied by as many species as you can handle, but certainly include the mangrove trees. Just get a measurement for the most seaward and most landward individuals of each species. Include a reasonable distance to either side of the transect line; for herbs and grasses a foot or so either side of the line but for the trees look several yards or meters.

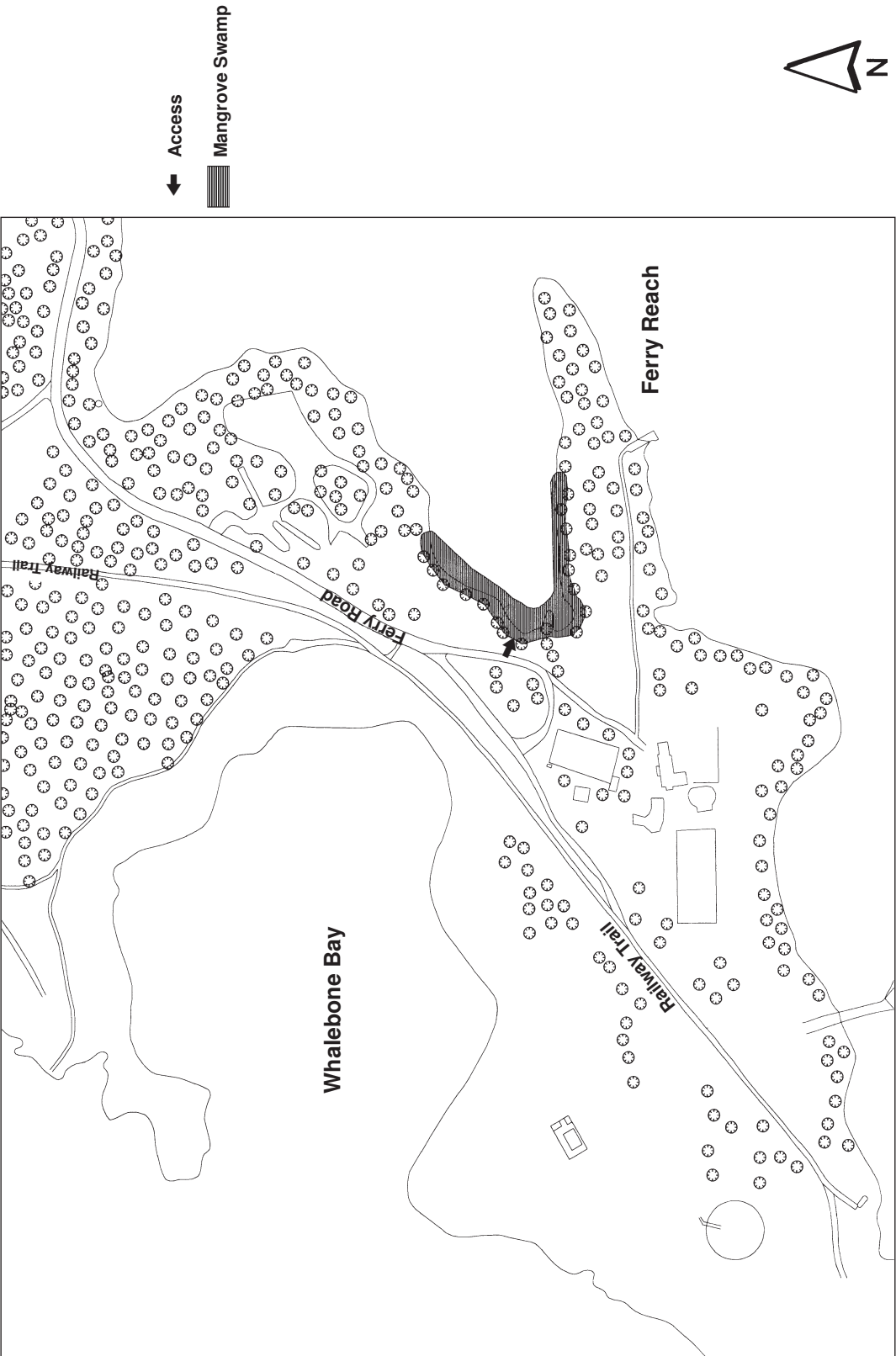
To get more information include more species such as algae and **Mangrove Periwinkles** on mangrove roots and herbs and grasses at higher parts.

To get a better idea of the mangroves themselves, get similar measurements for the lowest (seaward) and highest (landward) prop roots, trunks and leaves of the **Red Mangrove** and the lowest and highest trunks and leaves of the **Black Mangrove**. The lowest and highest leaf measurements are giving you the extent of the canopy of each mangrove species. This can be extended to other trees and shrubs present if desired.

- 2D. **Forest structure.** If time is available, another dimension can be added to the study by looking at the heights of important forest features above the transect line. As a minimum estimate the height of the bottom and top of the canopy of each tree species at meter or 5 yard intervals. The base of the canopy can usually be measured; estimate the top by reference to two yard or meter sticks put one on top of the other. This will give reasonably accurate results if done thoughtfully but do it only to the nearest foot or half meter. Naturally other features can be added if time permits.
3. According to the complexity of your study, the results can be shown in various graphs and diagrams. If you have done everything suggested, then a cross section of the mangrove forest can be drawn to scale showing its basic structure and where different species live.
4. While at the mangrove swamp note any birds or other wildlife seen and make a list of them. Also look for any signs of pollution in the form of trash. Even though this location is within a park, floating trash can come in.

Possible Hazards. The worst hazard at this location is trash. Even though it is located within a park there are lots of discarded items such as broken bottles. Be very careful.

Map 11 - Ferry Point Mangrove Swamp



Marine Ponds

Figure 3.6 shows a mangrove tree and the underwater creatures found with it at the edge of a Bermudian marine pond.

Walsingham Pond

Preparation. Read the general introduction to this field guide and the specific sections on marine ponds and pond mangrove swamps. Find out anything else that you can on Bermudian inland saltwater (anchialine) ponds.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. 10 m or 30 ft measuring tape. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Walsingham Pond is surrounded by parks and nature reserves and is therefore quite well protected from the adverse effects of human development. The best point of access is from the parking lot of Tom Moore's Tavern. The location is shown in Map 12. This pond lies in the oldest limestone formation in Bermuda (The Walsingham Formation) and the limestone within the ground has been heavily eroded over thousands of years. There are many caves in this vicinity and the surface of the rock tends to be sharp and jagged. This is termed "Karst" topography. Many examples of this will be seen on this field trip.

Walsingham Pond is one of Bermuda's natural treasures; it is a very diverse area and many studies and observations can be carried out. Time will dictate which of the following suggested activities can be fitted in.

Possible Activities

1. **General Saltwater Pond Features.** From the parking lot jetty area look into and across the pond. Salt water ponds in Bermuda are commonly formed either in low areas or where large, water-filled caverns have collapsed. Walsingham Pond combines these two. The side of the pond to the right and forward of where you are has a gentle shoreline and is quite shallow. This was probably a low area among small dunes. If you look forward and to the left, however, the pond margin is characterised by cliffs and rocky outcrops. The water is also deeper. This part of the pond was once an immense water filled cavern. At places stalactites still cling to the cliff overhangs and in the water are large limestone blocks from the cave roof!

Make sure you can see both areas and note the differences between them. Saltwater ponds such as this one are characterised by having underground connections to the sea. Walk ahead from the end of the parking lot, between the tavern and the pond, then bear left along the trail into the upland forest. A little way in a channel from the lake nears the path and stops abruptly. At the landward end of this channel is a hole going straight down into the ground. Sea water may be either entering or leaving here according to the state of the tide. There are several other connections from the pond to the sea. Return to the parking lot.

Because of the wealth of connections to the sea from the pond, Walsingham Pond is quite tidal with a change in level of about 38 cm (1 1/4 ft) between high and low tide. This compares

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with about 75 cm (2 1/2 ft) in the ocean. Because of this you will only see small changes in level as the tide changes. Compare the level in the pond at Tom Moore's Tavern with that in Walsingham Bay only a stones throw away. Explain your observations.

The first part of the path is also excellent for general observations on pond mangrove swamps but some features can also be seen from the little jetty. The mangrove swamp that surrounds Walsingham Pond supports both kinds of Mangrove tree found in Bermuda; it has well grown **Black Mangrove** trees at the landward edge and a band of **Red Mangrove** trees ending in the waters of the pond. The **Black Mangrove** trees are larger, have thicker, darker trunks than the red and have more elongated leaves; they also exhibit quill-like "pneumatophore" roots extending up from the mud like large pencils. The most obvious feature of the **Red Mangroves** is the spreading prop-roots going down into the sediment. However another very noticeable feature are the large embryos (germinated seeds) hanging from the trees. These are often called propagules since this term can be applied to seeds as well.

This mangrove swamp is quite well zoned. The pondward part being dominated by **Red Mangroves** which give way to **Black Mangroves** above about half way back in the swamp. At the back is a zone of coastal trees the most common of which are **Buttonwood** and **Mexican (Brazil) Pepper**. Smaller plants such as algae and herbs also show zonation within the swamp.

Identify as many plants including trees as you can and also look for any animals in the swamp and birds that may be using the area.

2. **Snorkelling in The Pond.** A great many more pond features can be seen by snorkelling around the pond. However, this is an activity for a small senior class with plenty of snorkelling practice. A light wet-suit is a great advantage here.

Enter the water carefully from the jetty at Tom Moore's Tavern. Keep horizontal in the water and try not to stir up the bottom. If you do stir it up visibility will be greatly reduced. Also be aware that this pond supports a population of the **Upside-Down Jellyfish** which can inflict a painful, but not dangerous sting. These jellyfish are normally lying on the bottom upside down, hence its name. The greenish tentacles extend up into the water. This is a second reason why it is not advisable to kick up the bottom with your flippers!

Swim slowly and carefully to the left from the jetty observing the long prop roots of the **Red Mangrove**, extending vertically down into the water; some are 2 m or 6 ft long! These prop roots provide a hard surface to which myriad marine invertebrate animals and algae can attach. Most common are sponges, sea squirts, anemones, tube worms, moss animals etc. but there are lots of others. Marine plants include green and red algae and cyanobacteria. Look carefully at these roots and observe that the organisms on them are zoned so that they differ with depth. These roots exhibit one of the greatest examples of biodiversity in the world. You are privileged to be able to observe it.

Proceeding further to the left, the mangroves give way to sheer rock walls. The organisms attached to them are similar to those on the roots but differ in that they are less clearly zoned and include larger sponges and even the odd coral. Try to remember what you see and when you get back, you can identify a few of the species seen from the pictures in this field guide.

At the far end of this shore of the pond, look up at the stalactites on the cliff overhang. These are cave features and give evidence that this part of the pond was once a large cave.

From this point you can either return the way you came, cross the pond to the opposite shore or continue around the edge. You will see more examples of pond features and organisms whatever you do.

If you are very lucky you may see large Green Turtles which inhabit the pond; they are harmless. A large variety of fish are also present; you may be able to recognise some of them.

3. Walsingham Pond can also be used as a site to run a mangrove swamp transect such as that described for Blue Hole mangrove above. However, the mangrove is thicker and wetter so the project is really only suited to senior, dedicated, students.
4. Proceed along the path described in (1) above keeping bearing left until you emerge from the **Surinam Cherry** thickets into a more open grassy area at the far end of the pond. Bear to the right here until you come to a small blue pond. This is an example of a small saltwater pond. It has subterranean exits and entrances for water which you should be able to spot as you look around. There are usually a good variety of fish in this pond. List as many as you can.

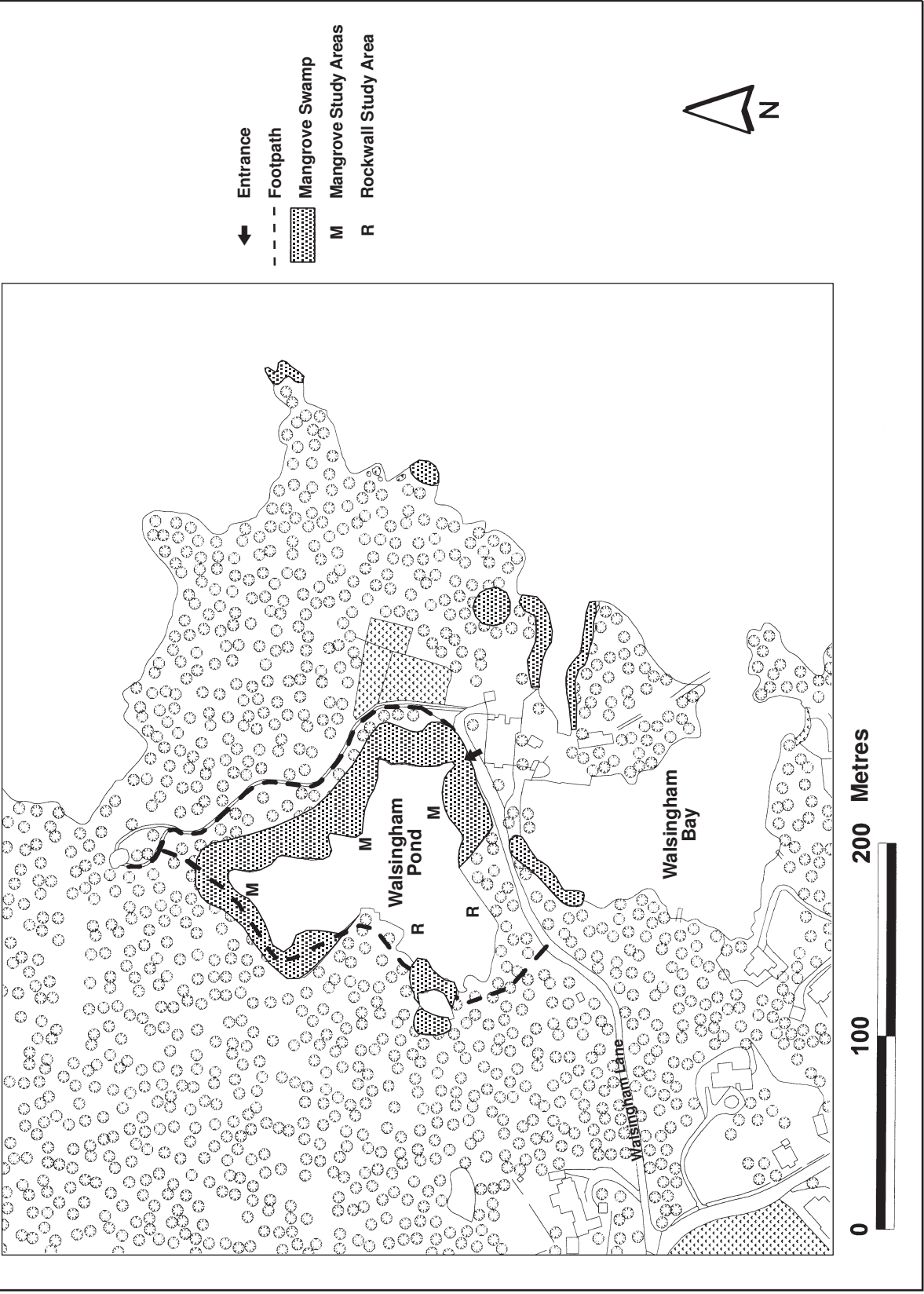
Return to where the main path entered this grassy area, but go straight on. In this forest glade there are the entrances to two marine water filled caves; observe these and appreciate that they penetrate far into the rock of the Walsingham Formation.

Look around here at the very jagged Karst topography of the area and see if you can spot any endemic trees. From here return to the way you came and go back to Tom Moore's Tavern.

5. Write an account of the unique features that you saw on this field trip emphasising those of particular importance and those seen nowhere else.

Potential Hazards. A general hazard in this area are exposed, sharp pieces of limestone rock. Avoid them. The paths may also be quite slippery after rain. In the water avoid any contact with **Upside-Down Jellyfish** or with any purple anemones seen on the mangrove roots. Both can inflict a painful sting. Also on the roots are red coloured sponges called **Fire Sponges** which can give you a mild but fairly long-lasting sting. In the water it is a good rule to observe but not to touch.

Map 12 - Walsingham Pond



Mangrove Lake

Preparation. Read the general introduction to this field guide and the specific sections on marine ponds and pond mangrove swamps. Find out anything else that you can on Bermudian saltwater (anchialine) ponds.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Mangrove Lake is the largest saltwater pond in Bermuda; however, even in the centre it is only a few feet deep. It connects to the sea off the south shore by small passages in the rock. Because the connection is so small, the tidal range in the pond is but a few centimetres (ins) and the water can get quite diluted at times of heavy rain. It therefore is quite physically unstable and because of this has a reduced biodiversity. The best place to observe the pond is from a clearing on the shore along Judkin Lane. Map 13 shows the location. Good views are also available from South Shore Road.

Since work at Mangrove Lake is limited to observation, it is best visited for comparative purposes, after looking at Walsingham Pond

Observations

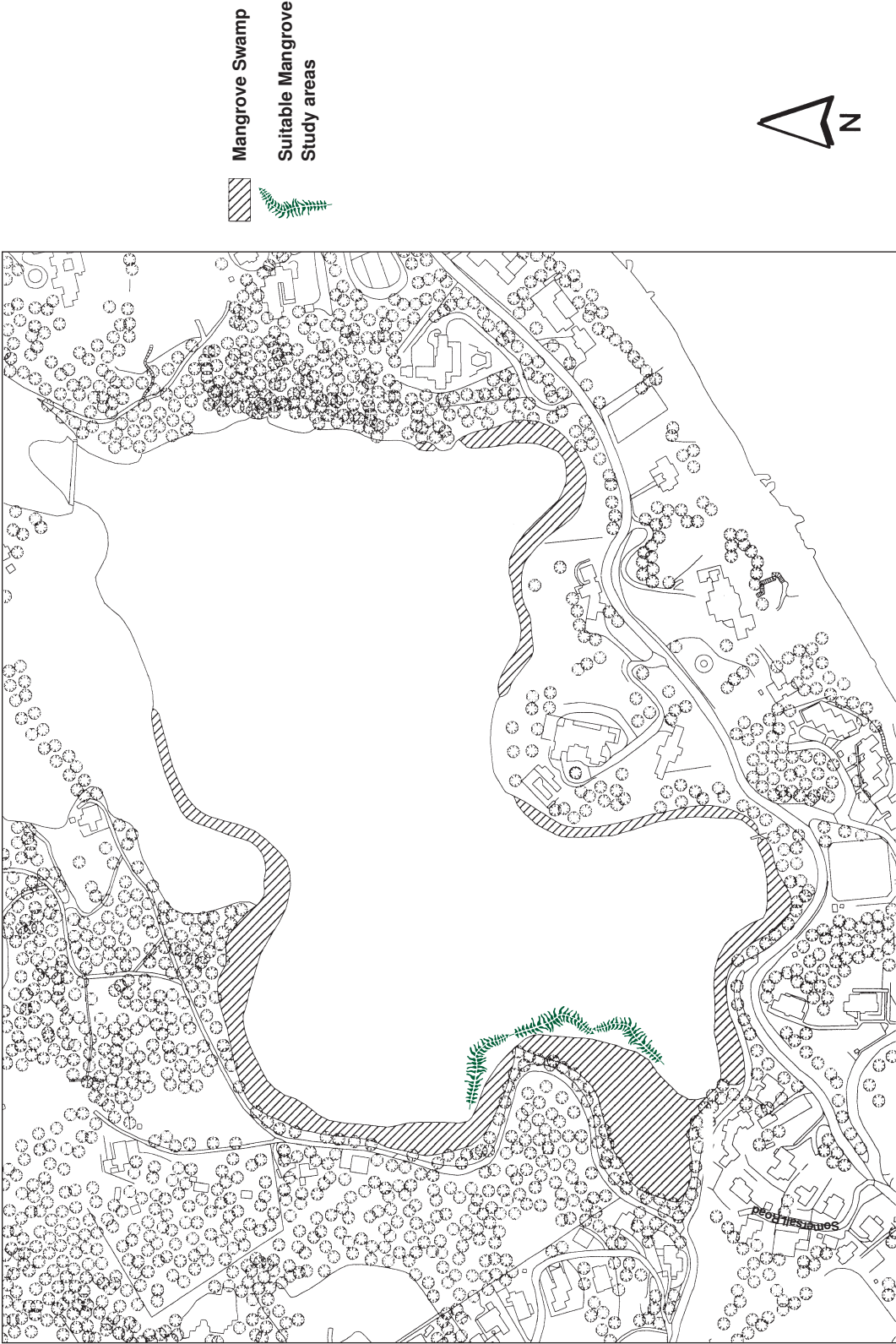
1. From the shore look at the extent of the pond. It has an area of 12 hectares (30 acres) but remember it is very shallow. The deepest parts are just offshore, but never more than 220 cm (7 ft). The bottom is of soft, very deep mud, very high in organic content. Mangrove Lake has been used by scientists as a model for oil production. Observe the water, it is usually quite murky from stirred up bottom deposits. It may be quite fresh if there has been recent heavy rainfall.
2. Look at the fringing mangrove swamp. It differs from coastal mangroves and those of Walsingham Pond in that only one species of mangrove tree is present. It is the **Red Mangrove**, characterised by arching prop roots, wide shiny leaves and by large embryos or propagules formed by seeds that have germinated while still attached to the parent tree. These propagules are an efficient method of dispersal of the reproductive products.

If the water is fairly clear, you should be able to see large clumps of **Flat Mangrove Oysters** attached to the roots in the water. These oysters occur abundantly in only two of the ponds, Trott's Pond being the other and are rare elsewhere in Bermuda. They are very tolerant of low oxygen levels and high temperatures which occur in these ponds in summer.

Several fish are present including the endemic **Bermuda Killifish**. You may be lucky enough to see specimens from the shore.

Potential Hazards. This is an essentially hazard free location provided you stay out of the pond. The mud therein is very soft and deep.

Map 13 - Mangrove Lake



Spittal Pond

Preparation. Read the general introduction to this field guide and the specific sections on marine and freshwater ponds. Find out anything else that you can on Bermudian ponds in general.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. At least one pair of binoculars for the group would be good, more are a definite advantage.

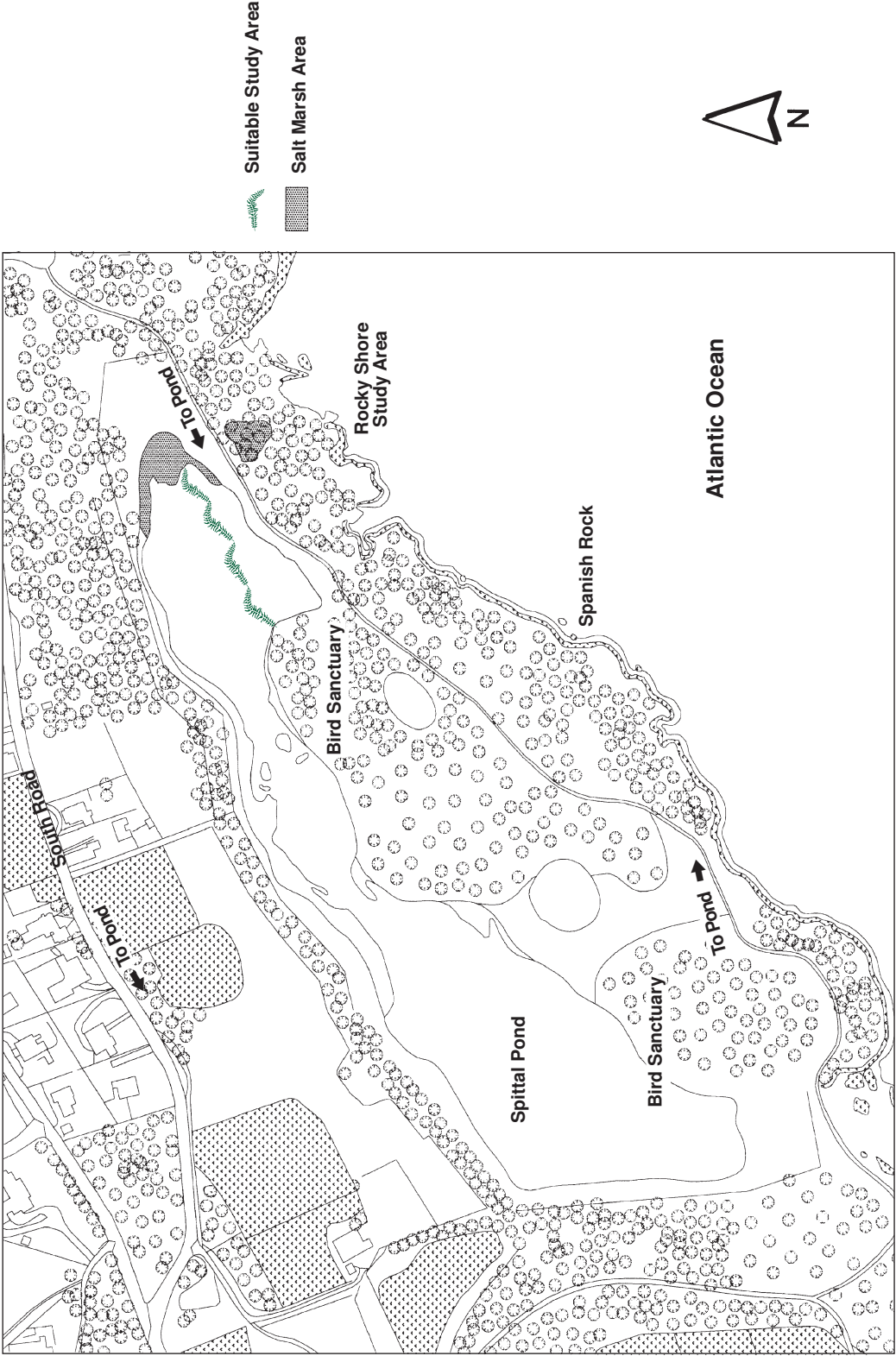
Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Spittal Pond differs from the other pond locations in that it is not anchialine. That is to say that it is not currently connected to the sea by subterranean passages. It really is intermediate between fresh and saltwater ponds and is called a “brackish pond”. However, the amount of salt (salinity) in the water is immensely variable. In storms or hurricanes sea water floods the pond from the south shore; by contrast during very heavy rain, the pond fills with virtually fresh water. If a long dry spell follows saltwater inundation, evaporation can raise the salt content to very high levels indeed. On top of this variability, is stress from organic pollution derived from the dairy farm along the pond’s north shore. Spittal Pond is a very unstable, stressed location and in consequence its biodiversity is very low indeed and mass mortalities of some resident organisms are common. Because it is so polluted work at this location must be observation only. The location is shown in Map 14.

1. Approach the pond from the East parking lot of the Spittal Pond Nature Reserve. You can get quite close to the shore at several locations. In the water are masses of **Widgeon Grass**, a flowering plant typical of brackish water. You may also see large numbers of **Mosquito Fish** which were introduced into Bermuda to combat the mosquito population which had spread malaria. Little else in the way of higher organisms can be seen although **American Eels** are present in winter and the odd snail may be found. However, in warm weather large pink, grey or black patches of the **Sulphur Reducing Bacteria** (*Beggiatoa*) are very common and a sulphurous smell may be present. Whenever you detect a sulphurous smell in nature, you can safely assume that the oxygen content in that environment is very low. Since almost all living organisms need oxygen, this makes life difficult. **Mosquito Fish** can handle this situation because they can breathe atmospheric air. Sulphur Reducing Bacteria are an example of a life-form that do not require oxygen (They use anaerobic respiration.)
2. Although the pond is an unsavoury biological environment, it is Bermuda’s main refuge for migratory waterfowl and is therefore very important. Depending on season, a very wide variety of aquatic birds may be observed there. Look for both ducks and wading birds as well as other non-aquatic birds. Use binoculars to observe any birds and try to identify them. Quite often escapee **Flamingoes** from the aquarium are present. Make a list of all the birds that you see at Spittal Pond.

Potential Hazards. Stay out of the pond and do not wander away from study areas and the location is virtually hazard free. The coastline at Spittal Pond is quite precipitous in places.

Map 14 - Spittal Pond Salt Marsh



Lovers Lake

Preparation. Read the general introduction to this field guide and the specific sections on marine ponds (anchialine ponds.) Find out anything else that you can on Bermudian salt water ponds.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Yard or metre sticks. Isopropyl rubbing alcohol. Paper towel. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Lovers Lake is in the Ferry Point Park and easily accessible from the Railway Trail. Map 15 shows the lake and its environs. Lovers Lake is a good pond to visit to appreciate how ponds arose in the past. The pond area is a series of ancient sand dunes now hardened into limestone hills. These are very visible from the Railway Trail since the original upland **Bermuda Cedar** forest was decimated by disease. The pond can be clearly seen as being in an old inter-dunal low area. This pond is connected to the sea, probably in North Lagoon by a quite large pipe-like opening entering at its deepest part near to the West end of the pond. This large connection to the sea results in tides within the pond which are two thirds as large as those in North Lagoon. Lovers Lake has the highest tidal range of all the Bermuda anchialine ponds. This means that seawater within the pond is thoroughly mixed with fresh seawater on every tide.

However, the location of the connection in the deepest location at about 4 m (12 ft) has an interesting and important consequence. Any freshwater entering the pond tends to lie on top of the saltwater because of its lower density. Since the pond is very sheltered from wind and waves never develop; there is little tendency for the two water layers to mix. Thus after heavy rain, a freshwater layer can lie on the surface of the pond and remain virtually undisturbed as the deeper saltwater is exchanged with the sea by tides twice a day. This results in Lovers Lake being very sharply layered at times. This situation is referred to as stratification and the meeting depth of the two layers of water is a halocline.

The surface water of Lovers Lake ranges from fresh through brackish to fully saline, depending on the weather and are therefore physically quite unstable. This is a difficult situation for many plants and animals to cope with and so the surface layer has quite low biodiversity.

Another interesting feature of Lovers Lake is that it is fringed by a mangrove swamp composed entirely of **Black Mangrove** trees. This is in contrast to Mangrove Lake, described above, where the mangrove swamp consists only of **Red Mangrove** trees. Walsingham Pond also described above supports both species of mangrove tree. It is therefore useful to compare these three locations since they cover a wide range of various possible pond situations.

Observations

1. Starting on the Railway Trail, look at the pond and observe its setting among the ancient dunes. Note that the connection to the sea lies in the deeper West end. Also observe that it is completely surrounded by a fringing mangrove swamp.
2. Walk down the slope to the edge of the pond and look first at the mangrove swamp. Here the **Black Mangroves** can be seen better than elsewhere in Bermuda. Observe the main features of dark trunks, elongated leaves and especially the hundreds of pencil-shaped, air-breathing roots called pneumatophores which stick up out of the mud at low tide or up through the water at high. Look for other associated fauna and flora. **Golden Orb Web Spiders** are often common in the mangrove canopy and Jamaican Anoles hunt along the branches.

Bermuda's Wetlands

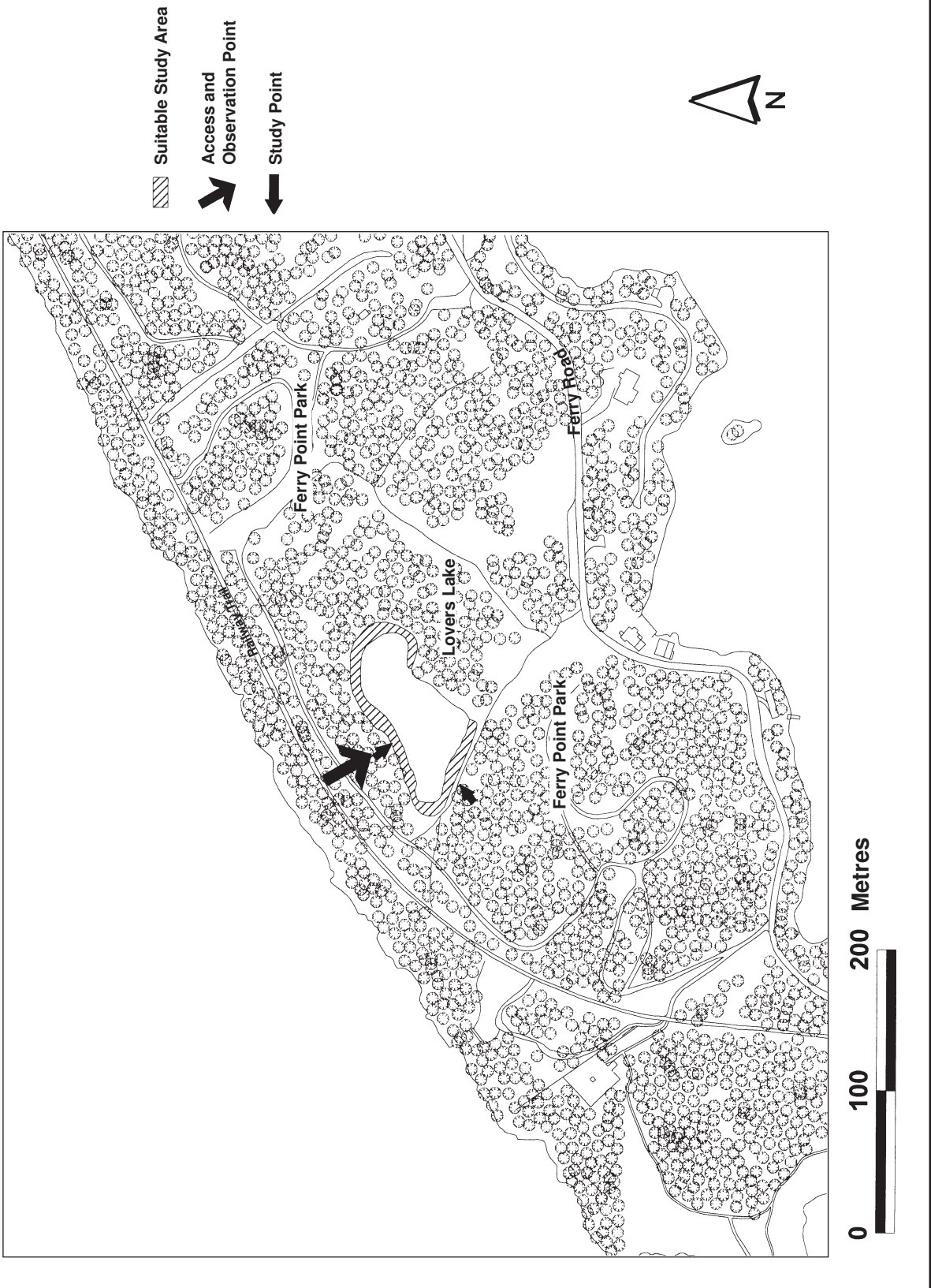
3. In the water there are usually large patches of **Widgeon Grass**, an aquatic flowering plant that is typical of brackish water, but tolerant of wide salinity (salt content) changes. It is therefore a biological indicator that the surface waters tend to be greatly diluted by rain at times. Interestingly, in these patches of **Widgeon Grass** are population of a small sea cucumber the **Sticky (Hydriform) Synaptula**. As a group, the sea cucumbers are generally intolerant of reduced salt content (salinity) sea water so it seems strange that one should inhabit this habitat. Try to get a clump of **Widgeon Grass** and observe this unique creature. Also reasonably common in the water are the **Bermuda Killifish**, one of Bermuda's endemic fishes.
4. While at the pond watch for birds such as herons and egrets which feed in shallow water and roost in the mangrove trees. List these together with any other birds that you see in the area.

Potential Hazards. The main problem in the Lovers Lake area is Poison Ivy. It is particularly common at the East end of the Pond. Look out for it and avoid it. If you do touch it the effect can be neutralised by wiping areas of skin that came in contact with the leaves with isopropyl rubbing alcohol.

Comparing the Ponds

Detailed field work is difficult in the ponds since access is difficult, the bottoms generally muddy and the water quite deep. Because of this the suggested work in the ponds has been mainly observational. If you have a chance to visit several ponds it is instructive to compare and contrast them. They all tend to be quite different from one another in origin, physical character and the creatures and plants found there. Think of these things for ponds you have visited and write a brief comparison, strive to explain the differences you observed or have read about.

Map 15 - Lovers Lake



Polluted Freshwater System

Pembroke Canal at Canal Road

Preparation. Read the general introduction to this field guide and the specific sections on freshwater ponds and marshes. Find out anything else that you can on the history of Mill Creek and the Pembroke Canal.

Equipment. Copy of Wetlands of Bermuda (Project Nature). Clip board and pencil. Isopropyl rubbing alcohol. Paper towel. At least one pair of binoculars for the group would be good, more are a definite advantage.

Dress. Wear long pants and waterproof footwear. Knee high rubber boots are not essential but may be an advantage.

Location. Although this location is now a dangerously polluted eyesore, it was once a unique and very important part of the ecological mosaic of Bermuda. When man first colonised the Bermuda Islands, Pembroke Canal did not exist but near its present location, the only freshwater stream in Bermuda, Mill Creek, flowed toward the sea from its origin in Pembroke Marsh East. Shortly below the present Canal Road, it entered the large Pembroke Marsh West and from there flowed into Mill Creek Bay, here forming the only estuary in Bermuda. Refer to Map 16 for this field trip.

Pembroke Marsh East was a very large freshwater marsh with some open ponds; it was first partially filled with sediment and waste rock, then it became a huge garbage dump. Only recently have these abuses stopped and the area is being rehabilitated. However, a vast storehouse of rotting trash still lies under the surface and toxic material from this leaches into the top of Pembroke Canal.

Pembroke Marsh West was more varied than its eastern counterpart. It consisted of large areas of salt-marsh, some freshwater marsh and some mangrove swamp. Mangrove trees lined the creek at least as far as the present location of the Bermuda Athletic Club. This has all been filled with sediment and waste rock to form building sites for industry.

Pembroke Canal itself was dug to drain the area and a sluice gate was installed at its mouth to prevent the flow of seawater upstream. Unfortunately, the canal also carries liquid wastes for industries in the area. A particular problem is oil from the BELCO electricity generating plant. Although efforts are under way to lower waste addition to the canal, there is so much old oil and other material in sediment along its banks that it will leach out for years to come. Another serious pollutant in the canal is derived from sewage as shown by the high levels of coliform bacteria present at times. The exact source of this water is under investigation. Additionally, the old garbage dump upstream will also supply toxic leachates into the future. Clean-up of this area is difficult but absolutely essential.

Because of the condition of the canal, this field exercise is observation only.

1. Look at the canal at this site. Look at the condition of the water for visible evidence of pollution; list any pollutants that you can identify and speculate as to their possible source. How does it differ now from the original clear creek flowing near this site? Does the creek smell normal? If not is the main smell sulphurous, sewagey, oily, or a combination of these?
2. Despite the extremely high level of pollution, life is present in and along the banks of the creek. Look for life in the water. You may see a few **Mosquito Fish**, these are tough little fish

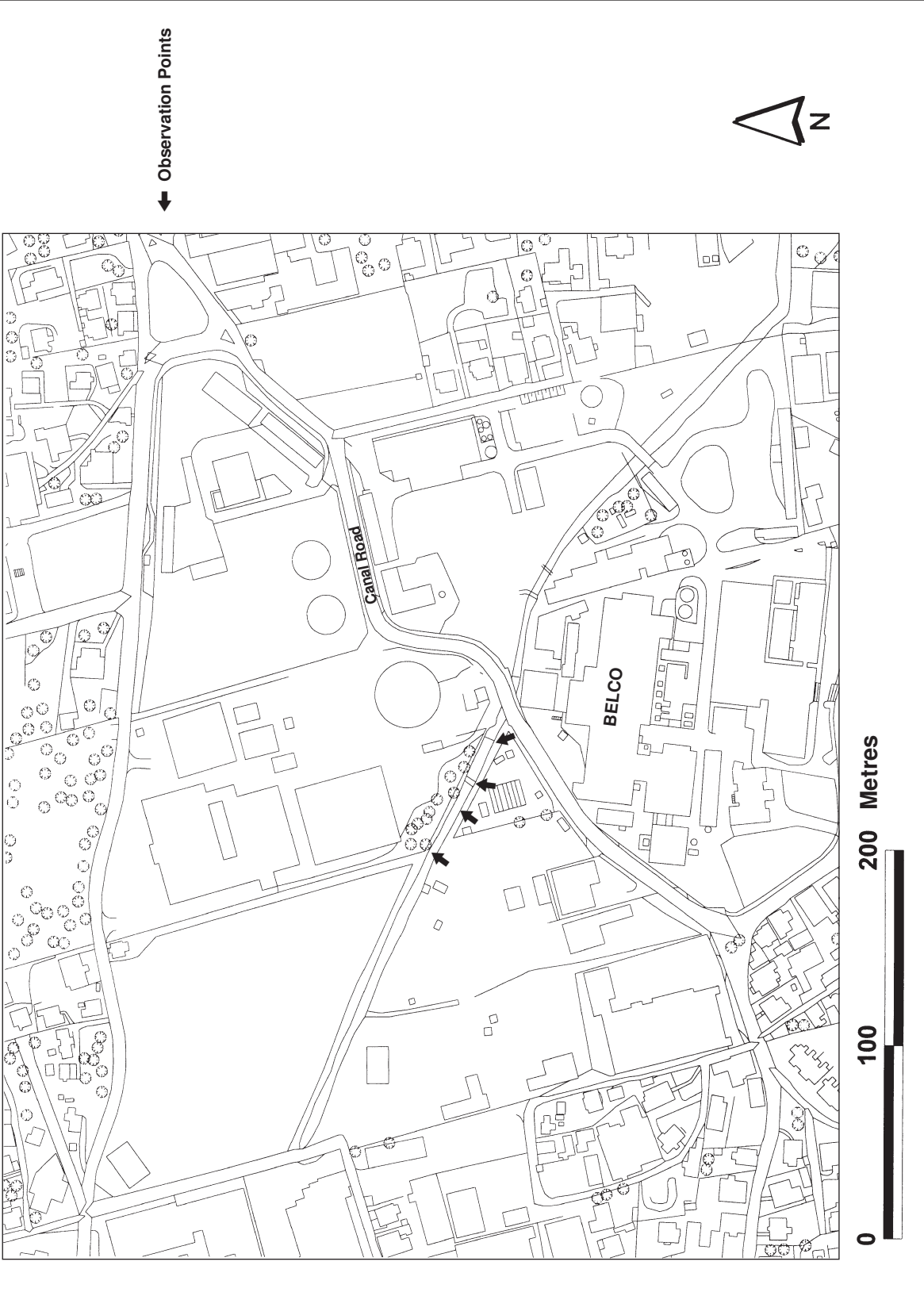
and have the advantage that they do not have to extract the oxygen they need from the water, because they can breath air at the surface. The odd duck may also appear and sometimes birds of the heron family are present. List any that you see.

The banks support what we could call a “fringing salt marsh community”. Note the marsh characteristic of domination by grasses. **Sheathed Paspalum** and **Para Grass** are common. However, also note that the biodiversity in the water and along the banks is very low, a sure sign of a stressed environment. Just look at a few yards of creek-side and count how many different kinds (not how many individuals) of plant that you see. Note this result down and compare it mentally with any unpolluted location.

3. Think about this whole situation. How has it arisen? Can it be cleaned up? Does it have educational value? If we were to return in 10 years could we expect to see an improved situation? Do you have a role in the clean up of situations like this?

Potential Hazards. Keep everything observation only. Do not touch soiled material around the canal or the water itself. If you accidentally do so, wipe contamination off with a paper towel moistened with isopropyl rubbing alcohol.

Map 16 - Pembroke Canal at Canal Road



Additional pre-visit, on-site and post-visit activities for a variety of age groups follow.

FIELD STUDY

Group Name: _____

Location: _____

Description of Area to be Studied:

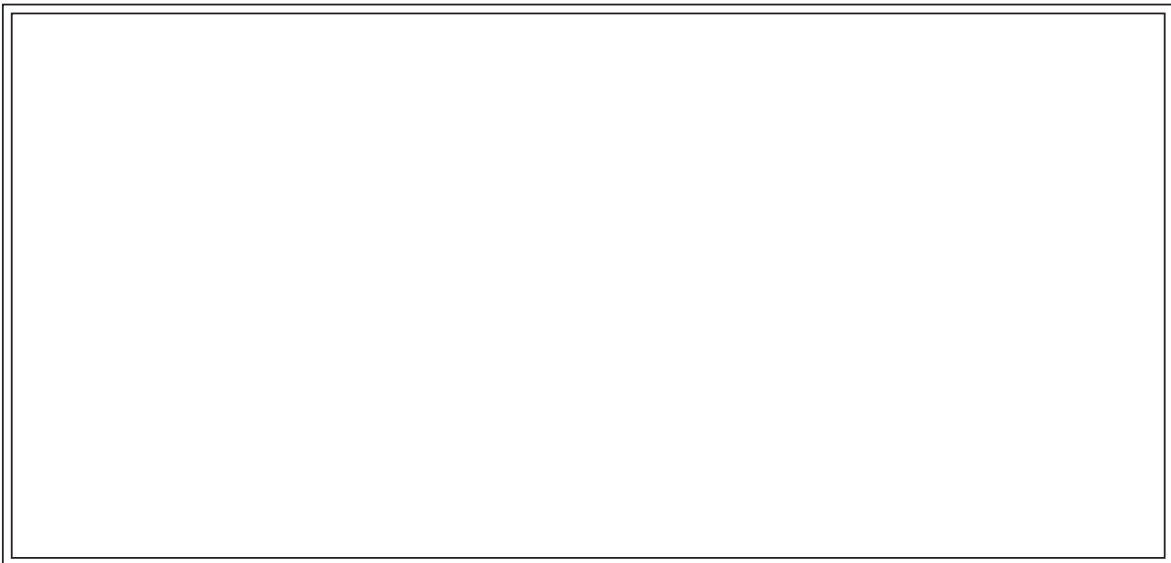
Date: _____ Time: _____

Weather Conditions: _____

Survey Details:

- i) Length of transect _____
- ii) Intervals of sampling _____
- iii) Other relevant information _____

Sketch map to show area sampled:



Any other information: _____

Continued on next page

Transect # _____ Group Name: _____

Species Name:	Type of Organism:	Presence (please <input type="checkbox"/> applicable)			Other Comments (eg. dominance)
		Rare	Common	Abundant	

Bermuda's Wetlands

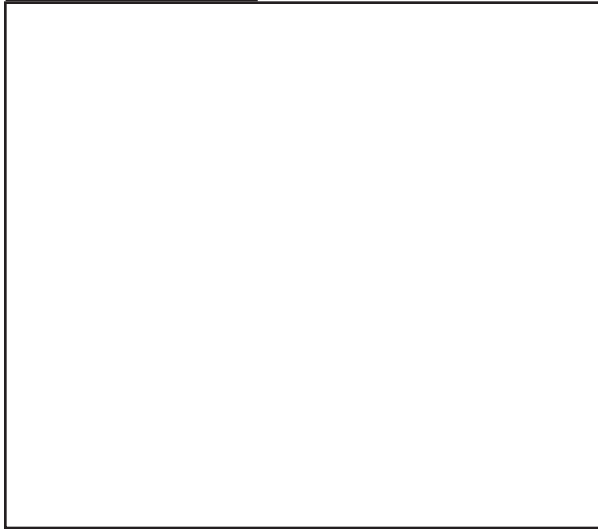
Plants of the Wetlands

Name: _____ **Date:** _____

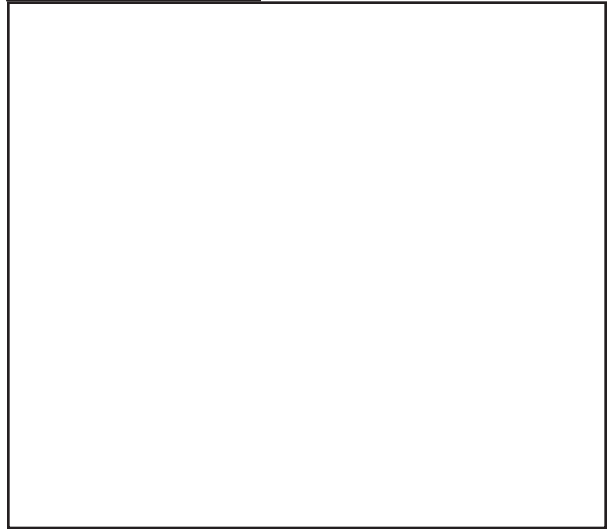
Procedure:

Choose 2 plants which grow in the wetlands. Make well observed drawings of the plants in the boxes below.

Name of Plant



Name of Plant



Comment on the following features for each plant:

1) Height of plant

2) Texture and thickness of leaves

3) Growth pattern of plant (is it bushy or thin etc.)?

4) Is the plant in a sheltered or exposed area?

5) How deep and damp is the soil?

6) Is the ground rocky, sandy, hilly or flat?

Conclusions:

What features are common to plants which grow in Bermuda's wetlands?

Bermuda's Wetlands

Plant Life In the Wetlands

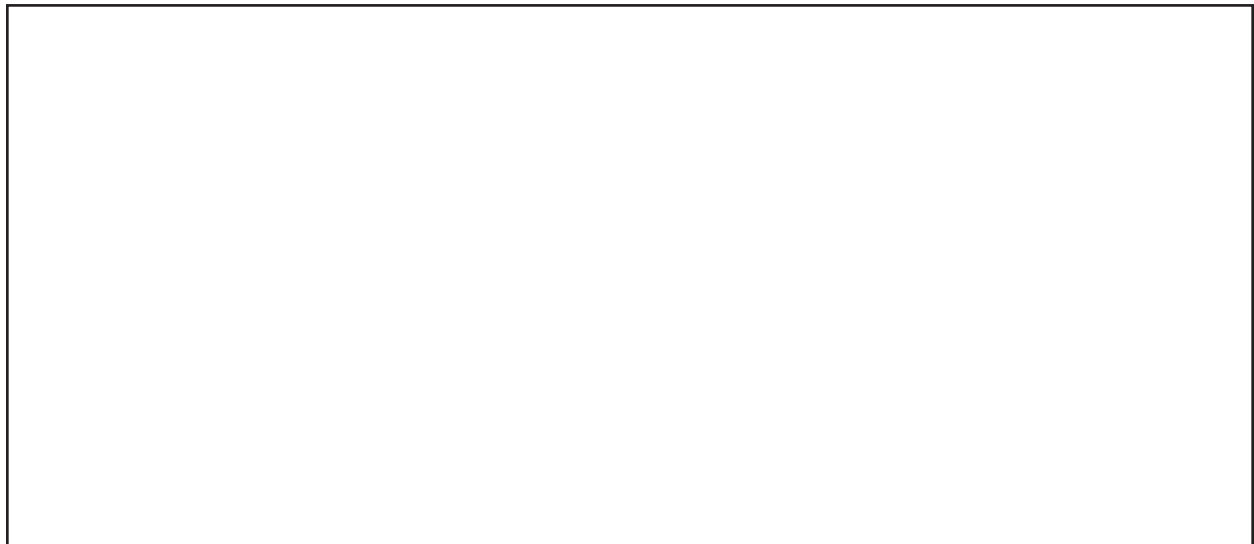
Name: _____ **Date:** _____

Materials:

- Clipboards
- Flat crayon
- Extra paper for plant rubbings

Procedure:

In the box below, draw and name one plant you find in the wetlands. Label all adaptations that enable it to survive its habitat.



Are there any creatures living under/on the plant you found? Describe them and where you found them.

Plant Rubbing:

Place plant part between board and paper - use flat side of crayon and rub gently.

Discussion:

- What inter-relationship might exist between plants and animals?
- Are these plants beneficial or a nuisance? (*oxygen suppliers/wind break/shelter/home/food*)
- What would plants in the wetlands do over a period of time? (*erode rocks/build up soil/reclaim?*)
- Which plants are native/naturalised?

Wetlands Observations _____

Name: _____ **Date:** _____

Draw and describe examples of the following Wetlands organisms:

Invertebrates	Plants
Birds	Pond Creatures

Bermuda's Wetlands

Bird Watching _____

Name: _____ **Date:** _____

Materials:

Binoculars
Field guides

Procedure:

- Look for local birds and visiting migratory birds. (Try not to disturb them.)
- Observe their shape, size, colour, location and behaviour.
- Record your observations below.

See Eco File document BIR-01, Birdwatching in Bermuda, for more information.

* The ECO FILE is a collection of information documents on Bermuda natural history topics. It can be found in all school and public libraries in Bermuda.

Test Wind Speed and Direction _____

Name: _____ **Date:** _____

Materials:

Paper streamer or anemometer
Compass

Procedure:

Use the anemometer or hold a paper streamer at arm's length and pretend that it is the arm of a clock. If it hangs vertically, it is six o'clock and there is no wind. Record below the wind speed on the anemometer or whether the streamer stayed at six o'clock, or moved to seven, or eight, or nine o'clock.

_____ Holding paper streamer/anemometer over your head

_____ Holding paper streamer/anemometer at your waist

_____ Holding paper streamer/anemometer down near the ground

- Use the compass and record the wind direction.
- Record wind speed during your visit, e.g. every 15 minutes.
- Write your conclusions:

Extension:

Compare your results with the weather report in the newspaper.

Notes:

Bermuda's Wetlands

Temperature Recording

Name: _____ **Date:** _____

Materials:

Thermometer

Put the thermometer in each position listed below for about a minute. Read each temperature and record it below.

_____ At shoulder height (hold thermometer carefully; keep your fingers off the bulb)

_____ At the surface of the soil

_____ 3" into the soil

Points to think about:

- Has it been sunny, cloudy or raining?
- How would the above factors possibly change your results?
- Write your observations and conclusions:

Notes:

Wetlands Creature Card Game

Materials:

Index Cards
Pencils etc.
Glue

Students should make pairs of cards; one showing only the organism's name and the other showing only an illustration of that organism. (You may wish to laminate the cards.) You should make enough pairs to play the game below.

Possible Cards :

Algae	Red Mangrove	Crab
Toad	Black Mangrove	Oyster
Heron	Fern	Brazil Pepper
Palmetto	Golden Silk Spider	Damselfly
Mosquito	Pond Snail	

(or any of the plants illustrated in this book)

Procedure:

The student will try to obtain the most pairs of cards in the card game "FISH". Deal four cards to each player. In rotating order, one player selects one other player to ask for a card to match the one in his/her hand. If the player does not have the card, he/she tells the "requesting player" to "fish" (to pick a card from the deck.) If the player is given the card that was requested, he/she puts the pair face down in front of him/her and is allowed to request another card from another player. As pairs are accumulated and the game has ended, players count their pairs. The player with the most pairs wins.

Extension:

Cards could be used on future field trips for a "locating" game.

Notes:

Animal Life Amongst the Mangroves _____

Name: _____ **Date:** _____

Procedure:
Observe animals in the mangroves and fill in the table below.

Picture and/or description	Where does it live?	General observations:- Animal activity, colour, size, texture, etc.	How many are there?

Reminder:
Do not collect live specimens.

Which is Which? Red or Black _____

Name: _____ **Date:** _____

Procedure:

- Study both a red and a black mangrove tree. Concentrate on their roots, leaves, seeds and position.
- Produce a list of similarities and differences. Make sketches to show differences if you wish.

Similarities	Differences

Discussion:

- The Red Mangrove (*Rhizophora mangal*) is not related to the black mangrove (*Avicennia nitida*), what accounts for the similarities?

The Seeds of the Red Mangrove Tree _____

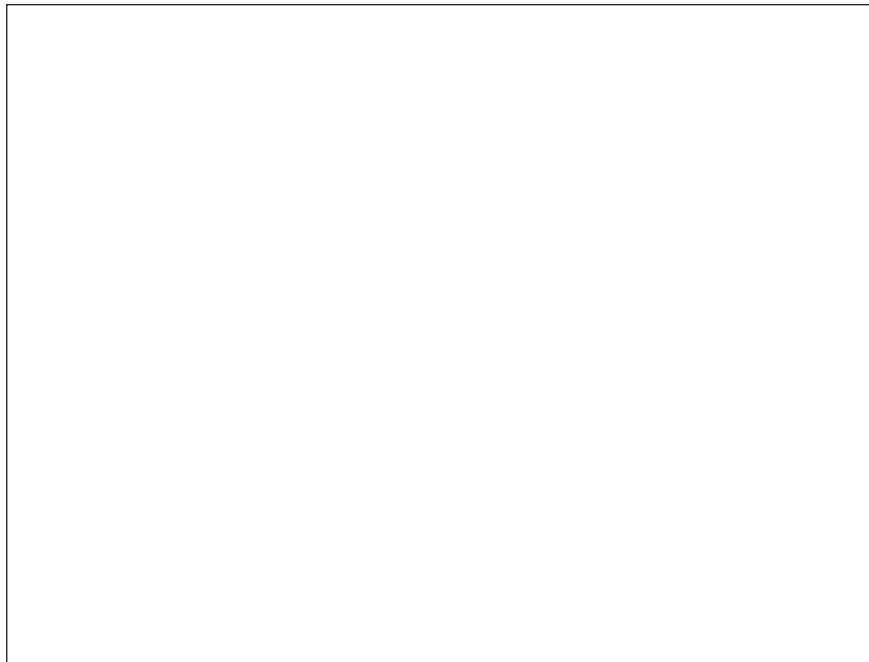
Name: _____ **Date:** _____

Materials:

1 red mangrove seed per class (the red mangrove seed is called a propagule)
container of water
Plant pot and soil

Procedure:

- Locate and observe seeds on the tree. How many seeds are there? _____
- Find a seed that is floating in the water.
- Draw and label the seed in the box below.
- Observe how the seed floats.
- Place the seed in a container of water. How many days did it float? _____
- Plant the seed and watch it grow.



Discussion:

- What is unique about the seeds of the red mangrove tree?
- What does the word 'viviporous' mean?
- Why do you think the seeds always float the same way?

Pneumato-whats?? _____

Name: _____ **Date:** _____

Materials:

Dictionary.

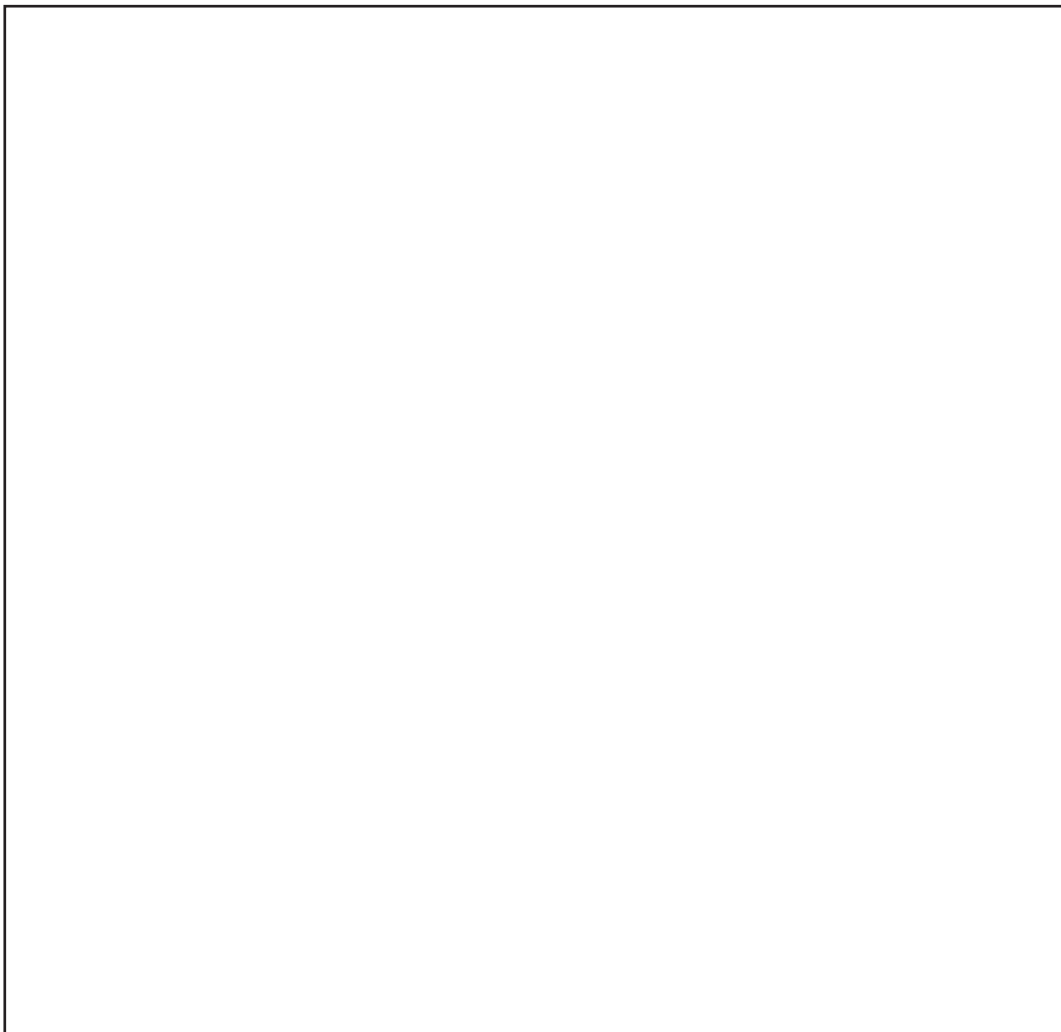
Procedure:

Look up the root 'pneuma' in the dictionary - what does it mean?

Look up the words: pneumonia and pneumatic.

Discussion:

- What is a pneumatophore?
- Which type of mangrove tree has pneumatophores?
- Why might the length of the pneumatophores vary at different locations?
- Draw some pneumatophores.

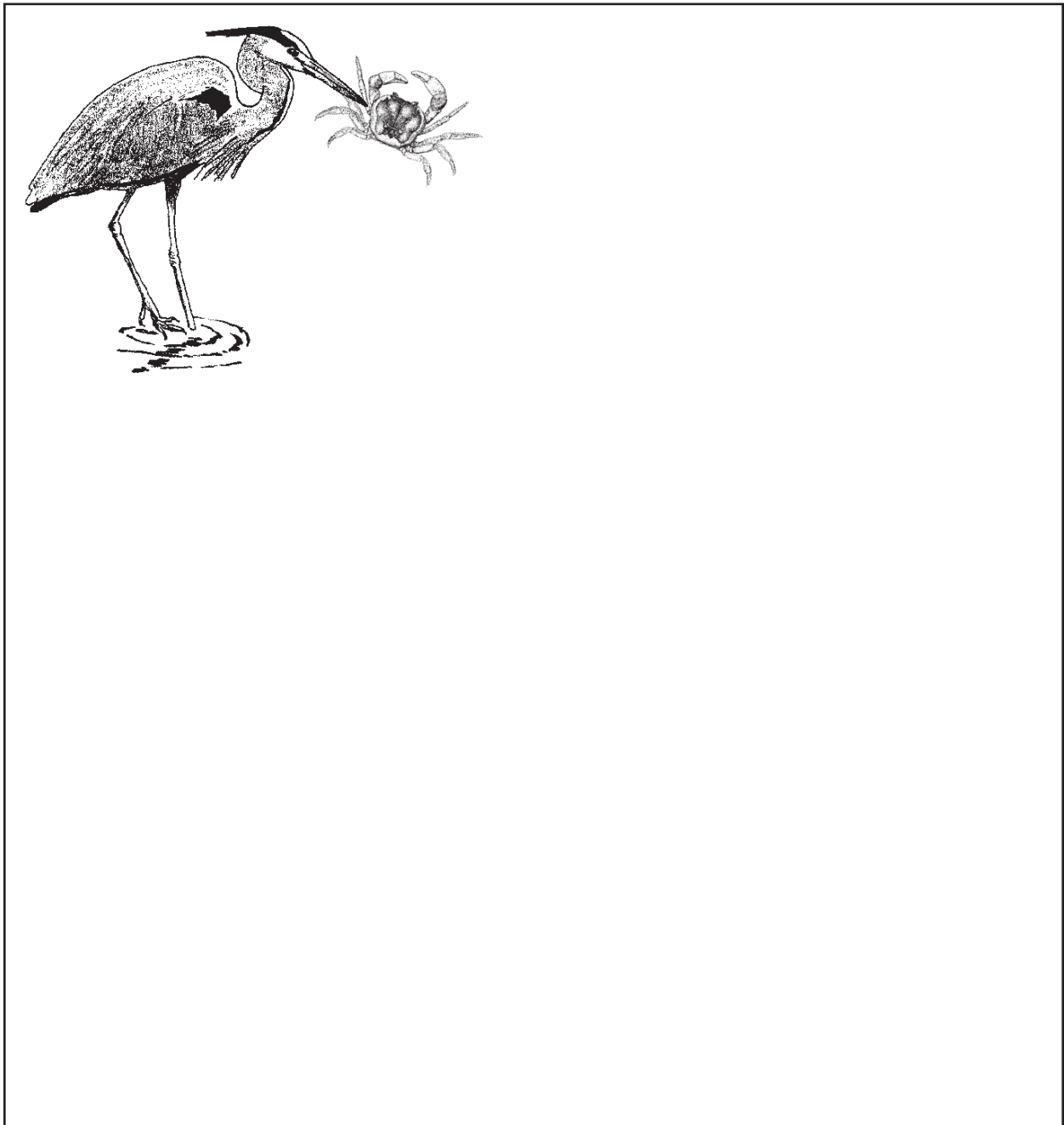


Bermuda's Wetlands

Nursery of the Sea _____

Name: _____ **Date:** _____

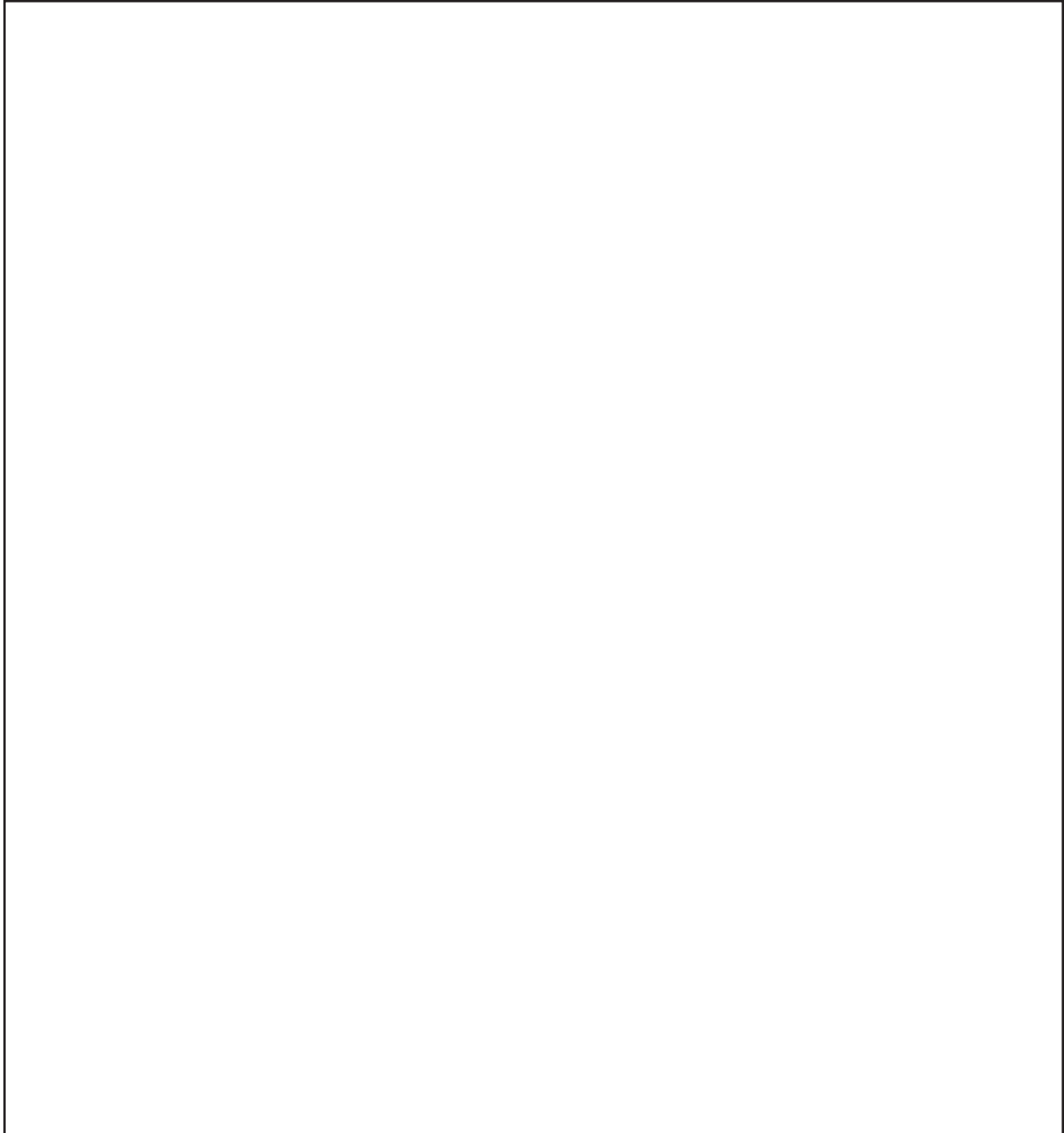
Create a picture, mural or collage showing a mangrove habitat. Draw/place pictures of all of the animals which start their lives in this sheltered habitat. We have started the picture for you.



Design a Wetland _____

Name: _____ **Date:** _____

- In the box below draw your ideal wetland. Show the ground features and the access paths.
- List and/or illustrate the plants (including trees) and animals found in your Wetland.



Bermuda's Wetlands

Environment-picture Problems _____

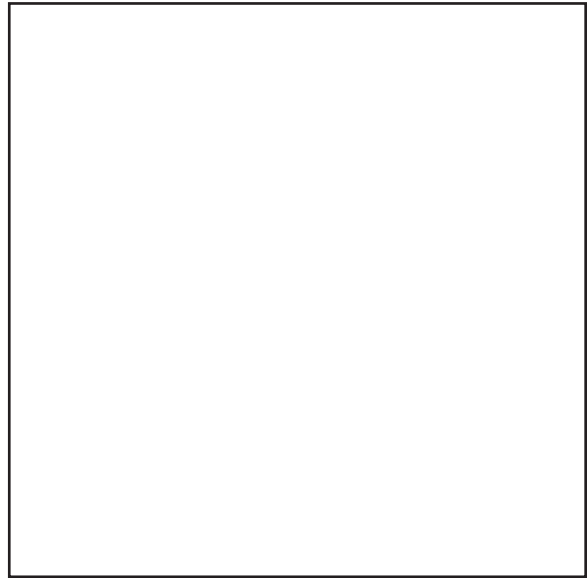
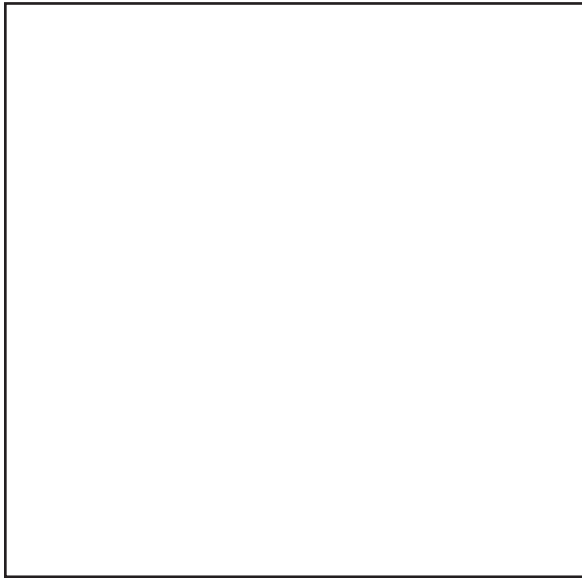
Name: _____ **Date:** _____

Materials:

Find some pictures or do drawings in the boxes below to make up environment-picture problem cards.

Procedure:

- Discuss environment problems found in Bermuda's Wetlands.
- Have students make environment-picture problem cards.



Notes:

The Composition of Soil _____

Name: _____ **Date:** _____

Materials:

Dry soil samples
Microscope
Slides or petri dish
Needles

Procedure:

- Place a small sample of soil on the slide or petri dish. Examine the soil sample under the microscope.
- Use the needle to separate the soil. Record your observations.
- List any materials that you can recognise.
- Draw a sample of the soil.

Discussion:

- Do your observations provide any clues to how soil is formed?
- Can you recognise any soil components?
- What colour is the soil sample?
- Do samples of different colours have different components?

The Composition of Soil _____

Name: _____ **Date:** _____

Materials:

Soil sample(s)

A tall transparent container of uniform thickness, e.g. measuring cylinder or tennis ball container

Water

Procedure:

- Half-fill the container with a soil sample.
- Fill the container with water.
- Carefully shake the soil and water to distribute the soil.
- Wait for approximately 5 minutes until the sample has settled.
- Observe and draw the various layers which the soil has settled into.

Discussion:

- The contents settle according to their mass.
- What layers were observed?
- Were the layers the same for all samples?
- Can this experiment predict how fertile a soil may be?

The Permeability of Soils

Name: _____ **Date:** _____
Materials:

Tin can with one end removed
 Tin can with both ends removed
 Metric ruler
 Piece of wood
 Watch with a second hand
 Water

Procedure:

- Choose an area on-site to be tested.
- Use the piece of wood to press the can with both ends removed into the ground a few centimeters.
- Place the ruler against the inside of the can.
- Pour water into the can to a depth of 10cm.
- Record how many seconds it took for the first 5cm of water to be absorbed.
- Record how many seconds it took for the next 5cm of water to be absorbed.
- Move to a different location close by the first one and repeat the procedure.
- Take 5 locations and average the results.

Results:

Trial #	# seconds for 1st 5 cm to absorb	# seconds for 2nd 5 cm to absorb
1		
2		
3		
4		
5		
Total		
Average		

Discussion:

- Was there a difference in the absorption rate for the first and second 5cm samples? If so, can you explain this?
- What does the term permeability mean?
- How do you think the rate of permeability affects plant growth?

The Porosity of Soils

Name: _____ **Date:** _____

Materials:

- Sand
- Clay
- Gravel
- Top soil
- Graduated cylinder
- Water
- 5 paper cups

Procedure:

- Fill one cup 3/4 full of sand.
- Fill one cup 3/4 full of clay.
- Fill one cup 3/4 full of top soil
- Fill one cup 3/4 full of gravel
- Fill one cup 3/4 full of a mixture of sand, clay, topsoil and gravel.
- Fill the graduated cylinder with water and record the volume.
- Slowly pour water into the cup of sand until a very small amount of water can be seen above the surface of the sand, allow time for settling.
- Record the amount of water added to the sand.
- Repeat the above procedure adding water to each sample in turn.

Record Results:

Soil Type	ml of water held
sand	
clay	
topsoil	
gravel	
mixture	

Discussion:

- Which type of soil held the most water?
- Which type of soil held the least water?

Growing Plants _____

Name: _____ **Date:** _____

Materials:

250ml (1 cup) sand
250ml (1 cup) soil sample(s) taken from different locations
Paper cups
Foam meat trays
Seeds (radish or alfalfa)
Measuring cup
Water

Procedure:

- Poke a hole in the bottom of each paper cup and place it on a foam tray.
- Place the measured sample of sand into a cup, place each soil sample into a different cup.
- Place 8 seeds in each cup and cover lightly.
- Pour 60ml (1/4 cup) water into each cup, continue to water each cup approximately every 2 days.
- Examine the cups every day for 2 weeks and record your observations.

Discussion:

- Did all of the soil samples produce plants?
- Did the time for germination differ between samples?
- Were there any differences in the plants in different samples?

Every Litter Bit Helps _____

Name: _____ **Date:** _____

Materials:

Trash bag
Worksheet

Procedure:

- Collect debris (leave potentially hazardous items where you find them and report them to The Parks Department, Agriculture & Fisheries.)
- Sort debris (on site or in classroom)
- Record your findings on the worksheet below. Recycle all you can.

Worksheet				
Type	Degradable	Man Made	Quantity Found	Recyclable
<i>e.g. Bottles</i>	<i>No</i>	<i>Yes</i>	<i>10, various types</i>	<i>Yes</i>
Soda Cans				
Bottles				
Shoes				
Rope				
Plastic Bits				
Paper				
Styrofoam				
Metal				
Wood				
Cloth				
Cigarette Butts				
Other				

- Make a pie or bar graph to illustrate your results.
- Can you use your graph to answer these questions?
- How many kinds of litter did you find?
- Which type of litter do you predict a friend would find if you sent him/her to the area where you found your litter?
- What other inferences could you make from your graph?
- Prepare a list of suggestions for reducing the amount and type of litter you collected.

Discussion:

- Is any of this litter harmful to creatures?
- In what ways is the litter a nuisance to humans?

Notes:

Species Variation Maths

Name: _____ **Date:** _____

Materials:

Rulers

Paper

Procedure:

- Locate several plants of the same kind.
- Measure and record their height and width.
- Carefully measure and record the length and breadth of several leaves on each plant.
- Compute the average plant height, width and leaf size.
- Can you think of any explanation for the variations?

	Plant 1	Plant 2	Averages
Height			
Width			
Leaf 1 - Length			
Leaf 1 - Breadth			
Leaf 2 - Length			
Leaf 2 - Width			

Conclusions: _____

Extension:

Many other features can also be measured; size of flowers, length of stem etc. The students may be surprised at the variations within the species.

How Salty is Pond Water?

Materials:

You will need to make a hydrometer for this activity (see next page)

Sea water sample

Pond water sample

Distilled or low sodium bottled fresh water

Measuring cups

Measuring Spoons

Pot

Stove

Procedure:

Measure an amount of sea water, put it in the pot and boil it until evaporation has left the salts, a very small amount of which will be trace elements. Measure the amount of these solids, find the ratio between these solids and the original amount of sea water.

Extension:

- *Is there any difference between water in a tide pool and water from the sea?*
- *If water is really salty an egg will float on it - try it!*

Make a Hydrometer

Materials for the hydrometer:

Clear plastic straw

Melted sealing wax

Metric ruler

Waterproof marker

Large graduated cylinder or clear bottle

Water

Ball bearings (and sand if necessary)

Procedure:

Fill the end of a clear plastic straw with melted sealing wax. Using a metric ruler and a waterproof marker, mark the straw in centimetre and half-centimetre units. Place some BB's, plus sand if necessary, in the bottom of the clear plastic straw.

Notes:

Comparing Densities with your Hydrometer

Materials:

Large graduated cylinder or clear bottle filled with fresh water
Bottles containing field trip pond water samples
Bottle containing sea water
Hydrometer

Procedure:

Put the weighted straw (hydrometer) in the fresh water. Adjust the ball bearings and sand so that the straw floats upright in the liquid. Mark the level of the water on the straw, labeling it 1. This will be the density reference point for fresh water.

What does it mean if "1" is clearly visible above the liquid level when the straw is floating in a liquid other than fresh water?

When the number 1 is below the surface of another liquid?

Using other containers filled with the salt and pond water samples, check the level of the hydrometer compared to the reference point when in fresh water. Which type of water has the highest density?

Extension:

Try distilled water. Compare warm water with ice-cold water. Do they all have the same densities?

Try colouring salt water with food colouring. Pour it over the back of a spoon into a glass of fresh water, very gently, and see where it settles in the glass.

Glossary

Word	Description
Aquatic Sytems	Natural systems where the environment is composed almost entirely of water.
Anchialine Ponds	Marine inland saltwater ponds connected to the sea by subterranean passages.
Associated Species	A species normally found with another species.
Biodiversity	In its simplest form the number of different species present at a location. More complex measures of diversity also incorporate relative abundance or biomass.
Bog	Freshwater wetland dominated by mosses.
Canopy	The upper stratum, or layer, of a forest community, dominated by leafy branches.
Climax Community	The natural end point of succession, which, in theory, is stable and has the highest possible biodiversity for those conditions.
Community	A naturally occurring assemblage of organisms typical of a particular environment.
Convergent Species	Species that are not closely related that have come to live in a particular natural system.
Depression	An enclosed low area of land caused by cave collapse or erosion.
Detritus	Partially rotted remains of dead animals and plants.
Ecotone	The natural boundary zone between two communities or ecosystems.
Embryos	Early developmental form of an animal or plant.
Emergent Plants	Aquatic plants in which part of the plant body extends up into the air.
Endemic Species	A species which evolves to a new species after colonisation of a new area.
Export Ecosystems	Ecosystems in which part of the products of primary production are exported beyond it boundaries.
Extirpated Species	A species which has been wiped out of a discrete part of its range.
Extinct Species	A species which has been wiped out from its entire range.

Bermuda's Wetlands

Filter Feeders	Animals which obtain their food by filtering either living or dead organic material from water.
Flushing	Exchange of water from one water body to an adjacent one.
Food Chain	A group of organisms linked by directly feeding on one another. Normally starting with a primary producer and ending in a top carnivore.
Fragmentary Ecosystems	Ecosystems, formerly large, now reduced to small patches.
Fringing Mangrove Swamps	Narrow bands of mangrove trees growing along the edges of marine waterways.
Ground Layer	The layer, or stratum, of a forest community growing on the soil but excluding the mature trees.
Gulf Stream	A very large ocean current flowing NE out of the Gulf of Mexico and passing between Bermuda and the East coast of North America.
Introduced	A species transferred to a new location by man, either accidentally or on purpose.
Invasive	An introduced plant which has become naturalised and grows and reproduces aggressively, displacing native and endemic plants. (e.g. Mexican Pepper).
Leachate	Water borne pollutant flowing from accumulations of trash and garbage.
Lenticels	Air breathing organs found on the roots of mangrove trees.
Mangrove Tree	A tree adapted to life in a marine coastal swamp.
Mangrove Swamp	A marine coastal wetland dominated by trees.
Marsh	Wetland dominated by grasses or grass-like plants.
Native Species	A species which arrived in a new area by natural means and subsequently reproduced and survived.
Naturalised Species	A species introduced by man. Not endemic or native but self propagating and firmly established.
Peat	The partially decomposed remains of bog, swamp or marsh vegetation. Usually very acidic in nature.
Plankton	Small animals or plants that are suspended in the water column and that cannot swim against natural water currents.
Pneumatophores	Vertical, quill or pencil-like air breathing roots.

Pond	A relatively small, relatively shallow body of water.
Primary Succession	A predictable and orderly change in an ecosystem starting with rock.
Propagules	Any part or reproductive product of a plant which can serve to produce a new individual.
Prop Roots	Spreading secondary roots of swamp trees. An adaptation to provide support in soft mud.
Run-off	Water derived from rainfall draining on the surface into low areas.
Salinity	The total dissolved salt content of sea water. About 3.5% in coastal waters.
Salt Marsh	A grass dominated wetland on a marine coast.
Saltwater Ponds	Relatively small and shallow ponds close to coastlines, filled with sea water.
Secondary Succession	A predictable and orderly change in an ecosystem where sediment is already present.
Species Diversity	The number of different species of organism within a habitat or natural system.
Stratified Community	A community in which there are distinct horizontal layers differing in either physical, chemical or biological characteristics.
Succession	A predictable and orderly change in an ecosystem with time.
Swamp	Wetland dominated by trees.
Terrestrial Systems	Natural systems where the water table lies significantly below the surface of the ground.
Tides	The regular and predictable rise and fall of sea level resulting principally from the gravitational pull of the moon.
Water Table	The level at which water lies with respect to the surface of the ground.
Wetland	Ecosystem where the water table lies close to the ground surface.
Zonation	Regular banding of communities within an ecosystem in response to changing environmental conditions.

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