

BERMUDA

INTRODUCTION

adapted from a report entitled "Taking Stock of Bermuda's Wetland Heritage" prepared for this Directory by David B. Wingate

Bermuda is a group of coral limestone islands and tiny islets in the western Atlantic, about 1,200 km northwest of the Turks and Caicos Islands and 1,280 km southeast of New York. It was discovered in the 16th century, settled by the British in 1609, and has been a British Crown Colony since 1684. With an area of only 55 km² and a population of some 57,000, the islands have one of the highest population densities in the world.

The islands benefit from the warming effect of the Gulf Stream but lie within the zone of the westerlies which frequently attain gale force during the winter months (December to April). Hurricanes are occasional to rare between June and November. The climate is mild with temperatures ranging from 20°C to 30°C, and moderate, fairly evenly distributed rainfall averaging 1,470 mm per annum. The Colony's chief source of income is the tourist industry; international business is also important and there is some light industry, but agriculture is relatively unimportant.

The ten largest islands, comprising over 90% of Bermuda's territory, form a narrow chain now linked by causeways and bridges. The topography of the islands is rolling, with hills rising to almost 80m. Most of the islands' native forests and swamp forest have long since disappeared and there are no permanent rivers or streams, but other wetland systems are still well represented. These include the following:

- a) Shallow marine bays. This is by far the largest wetland habitat in Bermuda, covering approximately 1,000 ha. However, the shallow bays are virtually sterile in terms of their ability to support waterfowl; they are used mainly by *Ardea herodias*, *Actitis macularia*, *Arenaria interpres* and *Ceryle alcyon*. Three species of sea grasses are common; *Thalassia testudinum*, *Cymodocea manatorum* and *Diplanthera wrightii*.
- b) Rocky coastline. Bermuda has approximately 140 km of rocky coastline, but this is relatively unimportant for waterfowl other than a few shorebirds.
- c) Sandy beaches. The 9 km of sandy beaches, with a rich beach wrack of sargasso weed and intertidal fauna, provide important feeding habitat for passage and wintering shorebirds, notably *Pluvialis squatarola*, *Arenaria interpres* and *Calidris alba*.
- d) Marine tidal mudflats. Because tidal amplitudes are small (0.5-1.3m) and intertidal gradients are typically steep, the total area of intertidal mudflat is extremely small and confined to two localities, Stoke's Harbour (0.6 ha) and Spanish Point (0.8 ha). The mudflats are used mainly by *Pluvialis squatarola* and *Numenius phaeopus*.
- e) Mangrove swamps. Bermuda is the most northerly site of mangrove distribution in the world. In 1980, there was a total of 16.7 ha of mangrove swamps scattered in small stands from one end of the islands to the other, in bays or inland peat basins. The largest surviving stand (2.9 ha) is at Hungry Bay, Paget. Most of the stands consist of a combination of Red Mangrove *Rhizophora mangle* and Black Mangrove *Avicennia germinans*. Buttonwood *Conocarpus erectus* is a common associate on the rocky margins of mangrove swamps. Although some mangrove swamps have been destroyed in the past (particularly in the 1940s), it is doubtful whether the total area of mangroves ever exceeded 25 ha. By 1984, 3.6 ha (22%) of mangroves were fully protected within managed nature reserves. The mangroves are particularly important for *Nyctanassa violacea* and *Ceryle alcyon*.
- f) Tidal salt water ponds and lagoons. There were approximately 22 ha of enclosed tidal ponds and lagoons in Bermuda in 1900, and most of these remain essentially unchanged to this day. Only one pond (Bartram's Pond) has been filled in with rubbish, and this has since been restored as a slightly tidal brackish pond. The saline ponds are used mainly by *Podilymbus podiceps*.

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- g) Non-tidal fresh to brackish ponds. In 1900, there were about 7.5 ha of fresh to brackish pond habitat in Bermuda. However, wetland restoration and conservation measures initiated in 1966 at Spittal Pond and the creation of two new ponds have increased this area to 9.4 ha. The ponds typically have fringing marshes of *Typha angustifolia* or *Paspalum vaginatum*, submergent *Ceratophyllum demersum* or *Ruppia maritima*, and large populations of the introduced minnow *Gambusia affinis*. They provide breeding habitat for the small surviving populations of *Gallinula chloropus* and *Fulica americana*, and support the majority of passage and wintering *Podilymbus podiceps*, Ardeidae, Anatidae and a variety of passage shorebirds.
- h) Inland peat marshes. Excluding shallow sea bays, peat marsh savannas and hammock comprise the largest portion of Bermuda's wetland habitat. This is also the habitat type which has been most extensively reduced by landfill and/or ditching. In 1900, the total area of vegetated peat marsh was 116.5 ha. Of this, 68 ha (58%) have been modified by drainage or ditching to produce arable land or wet pasture land, or destroyed completely by landfill. Although relatively poor for waterfowl, the peat marshes are of great botanical interest because the flora is almost exclusively native, in contrast to the situation elsewhere in the islands. The native flora ranges through several seral stages of development from open water ponds to peat marsh hammock. Dominant species in the early seral stages include *Typha angustifolia*, *Scirpus validus*, *Acrostichum excelsum*, *Cladium jamaicensis* and *Pteridium caudatum*. As the peat builds up, *Baccharis glomeruliflora* and *Myrica cerifera* bushes begin to appear, and finally hammock vegetation of *M. cerifera*, *Sabal bermudana* and *Juniperus bermudiana* takes over. In the early 1940s, all of the peat marshes were extensively ditched to provide better drainage into permanent water channels where *Gambusia affinis* was introduced as a biological control for mosquitos. The marshes are particularly important for *Gallinago gallinago*.
- i) Farm ponds. The two or three ephemeral farm ponds, with a maximum of 0.4 ha of open water and mudflat, are extremely rich habitats attracting a large variety of shorebirds during the migration seasons.
- j) Temporarily flooded meadows and arable land. After heavy rains, approximately 2 ha of low-lying marsh edge pastures, arable land, etc. may be subject to temporary flooding and thus provide feeding habitat for migratory shorebirds, notably *Tringa melanoleuca*, *T. flavipes*, *T. solitaria*, *Gallinago gallinago*, *Calidris minutilla* and *C. melanotos*.

The birds of Bermuda have been described by Wingate (1973). The number of species and individuals of waterfowl breeding on the islands is insignificant, and there are no surviving endemic species or subspecies. The endemic subspecies of *Nyctanassa violacea* became extinct in early colonial times, but the nominate race was successfully introduced between 1976 and 1978 (Wingate, 1982), and now numbers approximately 80 birds. The only other breeding species are *Anas platyrhynchos* (descendants of feral birds introduced in the 1950s), *Gallinula chloropus* and *Fulica americana*. *Podilymbus podiceps* was probably resident in pre-colonial times, but this century is known to have bred only in 1957 and 1985. On the other hand, a large number of species of waterfowl occur on passage and in winter. Bermuda lies under a West Atlantic flyway between North and South America, and although the vast majority of birds using the flyway overfly the islands, adverse weather conditions can ground significant numbers of birds. Some 45 species of waterfowl regularly overwinter, but except in the case of a few species of shorebirds, numbers are very small.

Institutional Base for Wetland Conservation and Research

Bermuda Government: Ministry of Planning, Agriculture and Fisheries. All Government-owned lands are vested in the Public Works Department, but management of wetland areas is carried out by the Conservation Division and (for marine habitats) the Fisheries Division of the Department of Agriculture and Fisheries. Both divisions are also involved in wetland research with the aim of enhancing this resource.

Bermuda National Trust. Nature reserves acquired and owned by the Bermuda National Trust are managed by the Open Spaces Committee with the advice and assistance of the Government Conservation Division.

Bermuda Audubon Society. Nature reserves acquired and owned by this Society are managed by the Society's Executive Committee with advice and assistance from the Conservation Division.

Bermuda Biological Station for Research. The Bermuda Biological Station does not own any wetland reserves, but supports an extensive laboratory facility and library with a resident scientific staff. It caters to visiting scientists from abroad, and has carried out environmental surveys and research on marine pollution and inshore water quality under contract from the Bermuda Government. In addition to the numerous research studies already published in its Contribution series, there is a very detailed study of Bermuda's fresh/brackish marsh and mangrove areas being undertaken at present by Martin Thomas of the University of New Brunswick, Canada.

Progress in Wetland Conservation

The destruction of wetlands began early in Bermuda's history, with the clearing of mangroves for boat anchorages and harbours, and conversion of peat marshes into arable land. In about 1900, the Government adopted a policy of reclaiming marshes completely in an attempt to control the mosquito problem, and in the 1930s, began to use wetlands for the disposal of garbage. After 1950, garbage disposal became the major factor in marsh reclamation and the pace of reclamation accelerated until by the late 1960s, many of the smaller ponds and peat marshes had been totally destroyed.

It was in order to fight this problem that the Bermuda Audubon Society became incorporated in 1960. This Society not only raised funds to purchase certain marshes and hold them in trust as nature reserves, but also began to turn around the public attitude toward wetland habitats. This change in attitude was favoured by the deliberate introduction in 1943 of the Top Minnow *Gambusia affinis* which quickly became a successful biological control for mosquitos and helped indirectly in the local extinction of the mosquito *Aedes egyptii*, a carrier of yellow fever.

By the early 1970s, the smaller outlying marshes were either filled in or secured as nature reserves, with the result that all of Bermuda's garbage had to be channelled into the remaining central garbage dump site in the east basin of Pembroke Marsh. The installation of a pulverization plant at that site and the opening of a dump at Castle Harbour finally made it possible to stop expanding into the remains of Pembroke Marsh. Lack of suitable disposal sites has now dictated a further technological refinement of garbage disposal, and plans are underway for a central incineration facility with ancillary recycling and compacting plants by 1987.

Thus, after decades of destruction, the future of wetland conservation in Bermuda looks bright. The aesthetic, scientific and economic value of wetlands is now generally recognized, and efforts are being made to save and restore them, not only by the voluntary conservation agencies, but also at Government level through protective planning legislation. Not only did the 1983 Development Plan designate all of the remaining wetland areas as Nature Reserves under the provisions of the Nature Reserve Zoning Category, but since 1970, the area of wetland habitat has actually increased as a result of deliberate restoration projects initiated by the Bermuda Audubon Society and the Bermuda National Trust.

Major Threats to Wetlands and Waterfowl

The major threat facing Bermuda's wetlands in the future will probably be eutrophication from increasing nutrient enrichment of the ground water. Bermuda already has one of the highest national population densities in the world, and yet there is only one sewage system serving Hamilton City, a few major hotels and the Hospital. Elsewhere, each housing unit has its own sewage pit excavated into the limestone bedrock. As housing densities have increased, nutrient enrichment of the groundwater from cesspits has increased correspondingly. It is possible, however, that the increasing need to exploit groundwater to augment domestic water supplies will dictate more general use of sewage collection and treatment systems before wetland pollution becomes critical.

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At Spittal Pond, the growing problem of eutrophication has been aggravated further by sheet run-off containing manure from an adjacent badly overgrazed dairy farm. By the mid 1970s, the problem had become so severe that summer die-off of the fish populations became routine. In 1979, a 30 cm diameter flushing valve was installed to deal with this problem. It is connected to the sea below low-tide level, and makes it possible to flush the pond, using the tides as the pumping mechanism, whenever this becomes necessary. Although not a solution to the problem, it has at least enabled the water quality to recover somewhat.

Hunting pressure was high in colonial times, and undoubtedly led to the rapid extinction of some unusually tame endemic species or subspecies, such as the local Yellow-crowned Night Heron *Nyctanassa violacea*. However, all hunting was prohibited in Bermuda in 1943, and a total ban on firearms, imposed in 1973 and continued with minor exceptions ever since, has put a stop to illegal hunting.

WETLANDS

Site descriptions based on data sheets provided by David B. Wingate, Conservation Officer at the Department of Agriculture and Fisheries. (For map, see Anguilla.)

Lover's Lake (1)

Location: 32°22'N, 64°42'W; Ferry Point West, St. George's Island.

Area: 0.65 ha.

Altitude: 0.1m.

Province and type: 8.38.13; 07 & 08.

Site description: A saline pond, up to 4m deep, with fringing mangrove swamps. The water level rises and falls with the tides via underground channels.

Principal vegetation: Black Mangroves *Avicennia germinans*; submergent beds of *Ruppia maritima* and *Thalassia testudinum*; some *Salicornia* sp and *Sesuvium portulacastrum*.

Land tenure: Owned by the Government of Bermuda.

Protection: A Nature Reserve established in 1980, and an integral part of a larger National Park.

Land use: None.

Waterfowl: A wintering area for *Podilymbus podiceps* and *Nyctanassa violacea*.

Other fauna: A wintering area for *Ceryle alcyon*. The pond is an important sanctuary for the endemic Killifish *Fundulus bermudae*, and has an interesting invertebrate fauna.

Threats: None foreseen.

Research and conservation: The only inland water body in Bermuda in which the minnow *Gambusia affinis* has not been introduced. Reafforestation of the area surrounding the lake with native flora would be desirable.

Source: David B. Wingate.

Criteria for inclusion: 2a & 2b.

Trott's Pond and Mangrove Lake (2)

Location: 32°19'N, 64°42'W; adjacent to Paynter's Road, Tucker's Town.

Area: Trott's Pond 4.0 ha; Mangrove Lake 12.3 ha.

Altitude: 0.2m.

Province and type: 8.38.13; 07 & 08.

Site description: Two saline lakes, up to 2m deep, with fringing mangroves; subject to slight tidal fluctuations.

Principal vegetation: Mangroves *Avicennia germinans* and *Rhizophora mangle*; submergent beds of *Ruppia maritima*.

Land tenure: Bermuda Properties Limited (a private golf club) owns Trott's Pond and most of Mangrove Lake; the Bermuda National Trust owns the west end of Mangrove Lake.

Protection: The west end of Mangrove Lake is in a Nature Reserve; the rest of the wetland area was zoned as a nature reserve in the 1983 Development Plan, but no conservation measures have as yet been taken.

Land use: None.

Waterfowl: A wintering area for *Podilymbus podiceps*, *Nyctanassa violacea*, *Butorides virescens*, *Aythya collaris*, *A. affinis*, *Gallinula chloropus* and *Fulica americana*.

Other fauna: A wintering area for *Seiurus noveboracensis*. The lakes support the largest remaining populations of the endemic Killifish *Fundulus bermudae*. The introduced minnow *Gambusia affinis* is abundant, and there is an interesting invertebrate fauna.

Threats: Eutrophication and possible pollution from fertilizers, pesticides and herbicides used on the adjacent golf course.

Research and conservation: The lakes have been studied in connection with the geological processes of "gytt" and oil formation, and constitute an important visual amenity.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2a & 2b.

Shelly Bay Marsh (3)

Location: 32°20'N, 64°44'W; Shelly Bay, Hamilton Parish.

Area: 1.8 ha.

Altitude: 0.1m.

Province and type: 8.38.13; 07 & 08.

Site description: A small saline lagoon, up to 2.5m deep, and salt marsh with extensive mangrove swamps. The water level rises and falls with the tides via underground channels.

Principal vegetation: Red Mangroves *Rhizophora mangle*, *Salicornia* sp, *Paspalum vaginatum* and *Fimbristylis castanea*.

Land tenure: Owned by the Government of Bermuda.

Protection: A Nature Reserve, established in 1970.

Land use: In 1970, part of the marsh was filled in, and this area is now a playing field. There is still some illegal dumping of rubbish.

Waterfowl: A wintering area for Ardeidae, *Fulica americana*, *Porzana carolina* and other Rallidae.

Other fauna: A wintering area for *Ceryle alcyon* and *Seiurus noveboracensis*.

Threats: There are some minor problems from illegal dumping of rubbish and human disturbance.

Research and conservation: One of the few tidal salt marshes in Bermuda. The open water area was enlarged and deepened by dragline in 1970.

Source: David B. Wingate.

Criteria for inclusion: 3a.

Spittal Pond (4)

Location: 32°18'N, 64°43'W; South Shore, Smith's Parish.

Area: 3.9 ha.

Altitude: 0.5m.

Province and type: 8.38.13; 07 & 13.

Site description: A permanent shallow brackish lagoon with fringing mudflats and marshes. The water level fluctuates by about 75 cm with rainfall and periodic flooding from the sea, and mudflats are exposed at low water levels. Two small freshwater ponds were excavated in 1966.

Principal vegetation: Submergent beds of *Ruppia maritima* and fringing *Paspalum vaginatum*.

Land tenure: Owned by the Bermuda National Trust. The Bermuda Government owns and manages the surrounding land as a National Park.

Protection: A Nature Reserve established in 1954; part of a National Park.

Land use: Bird-watching and hiking; some livestock grazing.

Waterfowl: About 40 pairs of feral *Anas platyrhynchos* breed. The pond is a major refuge for passage shorebirds, notably species of *Tringa*, *Limnodromus* and *Calidris*, and a wintering area for *Podilymbus podiceps*, *Egretta caerulea*, *E. tricolor*, *E. thula*, *E. alba*, *Anas rubripes*, *A. crecca*, *A. americana*, *A. discors*, *Aythya collaris*, *A. affinis* and *Fulica americana*.

Other fauna: The introduced minnow *Gambusia affinis* is abundant, and plays an important role both in the biological control of mosquitos and as a prey species for Ardeidae. The eel *Anguilla anguilla* is common, and mullet *Mugil* sp occasionally become established after severe hurricane flooding.

Threats: There is some eutrophication from run-off from an adjacent dairy farm, and occasional botulism in summer.

Research and conservation: An important area for outdoor recreation and educational tours, with interesting geological features.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 3a.

Devonshire Marshes (5)

Location: 32°18'N, 64°45'W; between Vesey Street/Parson's Road and Middle Road/Jubilee Road, Devonshire Parish.

Area: 28.3 ha (eastern section 19.6 ha, western section 8.7 ha).

Altitude: 0.5m.

Province and type: 8.38.13; 13, 16, 18 & 19.

Site description: Two large peat marsh basins, lacking open water except in mosquito control ditches; with sawgrass swamp, bracken savanna, wet pasture and, in the western section, swamp forest. The marshes are periodically flooded by heavy rains, and the water is almost fresh (salinity 4 p.p.t.). The eastern and western sections are separated by a narrow strip of dry ground with a highway. The marsh basin lies within Bermuda's largest freshwater lens.

Principal vegetation: Extensive stands of sawgrass *Cladium jamaicensis*, bracken fern *Pteridium caudatum* and *Osmunda* ferns, with scattered *Myrica cerifera*, *Ilex vomitoria* and small patches of *Juniperus bermudiana* and *Sabal bermudana* swamp forest including the naturalized palm *Phoenix reclinata*. Marsh edge pastures are dominated by *Paspalum urvillei* and *Panicum purpureascens*.

Land tenure: The eastern section is partly privately owned and partly owned by the Bermuda Audubon Society and the Bermuda National Trust; the western section is privately owned.

Protection: Part of the eastern section has been acquired as a Nature Reserve; the rest of the wetland was zoned as a nature reserve in the 1983 Development Plan, but no other conservation measures have been taken.

Land use: Livestock grazing and the cutting of grass for fodder. Fresh water is extracted from filtration galleries around the marsh edge for domestic use.

Waterfowl: An important area for some passage and wintering waterfowl, notably *Botaurus lentiginosus*, *Bubulcus ibis*, *Butorides virescens*, *Egretta caerulea*, *Plegadis falcinellus*, *Porzana carolina* and *Gallinago gallinago*.

Other fauna: A variety of introduced species occur in the marsh, including the Orange-cheeked Waxbill *Estrilda melpada*, the toad *Bufo marinus*, and the frogs *Eleutherodactylus johnstonei* and *E. gossei*.

Threats: The future exploitation and land use of the marsh is still in dispute.

Research and conservation: The largest of the peat marsh basins in Bermuda, and one which has never been used for the dumping of rubbish. A portion of the western section retains virgin stands of the endemic Bermuda Cedar and Bermuda Palmetto forest. It is recommended that the entire marsh be acquired as a nature reserve and water conservation area.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2b & 3a.

 Pembroke Marsh East (6)

Location: 32°18'N, 64°47'W; on the north edge of Hamilton City, Pembroke Parish.

Area: 5.8 ha.

Altitude: 0.5m.

Province and type: 8.38.13; 13.

Site description: An extensive freshwater *Typha* swamp with some open water channels; up to 3m deep. There are only slight fluctuations in water level. The channels were extended by draglining in 1979.

Principal vegetation: Mainly *Typha angustifolia* with some *Ceratophyllum demersum* and *Cladium jamaicensis*.

Land tenure: Owned by the Government of Bermuda.

Protection: Zoned as a nature reserve in the 1983 Development Plan.

Land use: There is a rubbish dump on land adjacent to the marsh.

Waterfowl: A minimum of 6 pairs of *Gallinula chloropus* and 1 or 2 pairs of *Fulica americana* breed; *Podilymbus podiceps* bred in 1957. A wide variety of waterfowl have been recorded on passage and in winter, including *Podilymbus podiceps*, *Botaurus lentiginosus*, *Ixobrychus exilis*, *Nycticorax nycticorax*, *Butorides virescens*, *Ardea herodias*, *Anas crecca*, *A. discors*, *Aythya collaris*, *A. affinis*, *Porzana carolina* and *Porphyryla martinica*.

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Other fauna: The introduced minnow *Gambusia affinis* occurs.

Threats: Pollution from windblown refuse and leaching from the neighbouring rubbish dump.

Research and conservation: An important green belt and visual amenity on the boundary of Hamilton City. The future status and boundaries of the proposed nature reserve have not as yet been established. The adjacent rubbish dump could be phased out and the land used for recreational parkland and playing fields.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 3a.

Hungry Bay Mangrove Swamp (7)

Location: 32°17'N, 64°45'W; Hungry Bay, South Shore, Paget East.

Area: 2.9 ha.

Altitude: 0m.

Province and type: 8.38.13; 01 & 08.

Site description: A tidal mangrove swamp, up to 1m deep at high water, in a shallow sea bay with a relatively narrow opening to the sea.

Principal vegetation: Mangrove swamps with *Avicennia germinans*, *Conocarpus erectus* and *Rhizophora mangle*; some *Salicornia* sp.

Land tenure: The ownership is in dispute; either owned by the Government of Bermuda or by two private estates.

Protection: Zoned as a nature reserve in the 1983 Development Plan. A Tree Preservation Order protects the mangroves.

Land use: Some recreational use of the tidal channels by boat traffic.

Waterfowl: A wintering area for *Nyctanassa violacea*.

Other fauna: *Ceryle alcyon* and *Seiurus noveboracensis* are winter residents. The swamp supports the only significant surviving populations of the Giant Land Crab *Cardisoma guanhumii* and Land Hermit Crab *Cenobita* sp on Bermuda. The Mangrove Crab *Goniopsis cruentatus* also occurs.

Threats: Channels have been cut through the mangroves to enable boats to reach private properties bordering the swamp.

Research and conservation: The largest mangrove swamp in Bermuda, and one of Bermuda's largest and most interesting natural areas. It is recommended that the mangrove swamp and the peninsula of land between the swamp and the sea be acquired and managed as a nature reserve.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2b & 3a.

Paget Marsh Nature Reserve (8)

Location: 32°16'N, 64°46'W; adjacent to Middle Road, Paget Parish.

Area: 8.8 ha.

Altitude: 0.5m.

Province and type: 8.38.13; 08, 16 & 18.

Site description: A complex of swamp forest, marshy savanna and mangrove swamp with a perimeter drainage ditch; up to 1.5m deep and with a salinity of 6 p.p.t. The water level rises and falls slightly with the tides and rainfall.

Principal vegetation: Swamp forest with the endemic Bermuda Cedar *Juniperus bermudiana* and the endemic Bermuda Palmetto *Sabal bermudana*; *Myrica cerifera* bushes; marshes with *Cladium jamaicensis*, *Typha angustifolia*, *Scirpus americanus*, the endemic sedge *Carex bermudiana*, and *Acrostichum excelsum*; and mangrove swamps with *Rhizophora mangle*.

Land tenure: Owned by the Bermuda National Trust and the Bermuda Audubon Society.

Protection: A Nature Reserve, established between 1955 and 1966.

Land use: Nature-oriented recreation; there is a nature trail for educational guided tours and self-guiding tours. Some virgin forest was cut in 1983 in a timber stealing operation.

Waterfowl: Of very little importance for waterfowl. *Butorides virescens*, *Anas discors*, *Porzana carolina*, *Gallinula chloropus* and *Gallinago gallinago* occur on passage and in winter.

Other fauna: A variety of introduced species occur, including the Orange-cheeked Waxbill *Estrilda melpoda*, the toad *Bufo marinus*, and the frogs *Eleutherodactylus johnstonei* and *E. gossei*.

Threats: The threat of timber theft continues as living and dead cedars within the reserve are of great value.

Research and conservation: The largest surviving remnant of Bermuda's pre-colonial swamp forest, and of primary importance as a reserve for native marsh flora. It is the most important locality for the endemic Bermuda Sedge *Carex bermudiana*, and is rich in fungi. All non-native species of flora are being culled to preserve this remnant of forest in its natural condition. The ditch surrounding the marsh could be widened in places to form ponds without any damage to the native flora.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2a, 2b & 3a.

Warwick Pond (9)

Location: 32°16'N, 64°48'W; adjacent to Middle Road, Warwick Parish.

Area: 2.3 ha.

Altitude: 0.5m.

Province and type: 8.38.13; 13.

Site description: A shallow freshwater pond, up to 20 cm deep, with mudflats at the north end and a broad fringing marsh. There are slight fluctuations in water level associated with the tides.

Principal vegetation: Mainly *Paspalum vaginatum* with some *Scirpus americanus* and *Fimbristylis castanea*.

Land tenure: Privately owned (Graham Powell Estate).

Protection: Zoned as a nature reserve in the 1983 Development Plan.

Land use: Livestock grazing on the edge of the marsh.

Waterfowl: *Gallinula chloropus* bred in 1984. The mudflats at the north end of the pond are an important feeding area for passage shorebirds, notably *Charadrius semipalmatus*, *Tringa melanoleuca*, *T. flavipes*, *Calidris pusilla*, *C. minutilla*, *C. fuscicollis*, *C. melanotos* and *Micropalama himantopus*. Wintering birds include *Podilymbus podiceps*, various Ardeidae, *Anas discors*, *Porzana carolina* and *Fulica americana*.

Other fauna: The endemic Killifish *Fundulus bermudae* occurs. Warwick Pond is the only freshwater pond in which this species occurs and it is likely that the form occurring here is unique to the pond.

Threats: None known.

Research and conservation: M. Thomas is conducting a detailed study of the pond. It is recommended that the area be acquired by the Bermuda National Trust or Government for a nature reserve. Possible management could include deepening of the south end of the pond by dredging, and introduction of *Ruppia maritima*.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2a, 2b & 3a.

Somerset Long Bay Pond (10)

Location: 32°18'N, 64°52'W; Long Bay Lane, Somerset Island, Sandy's Parish.

Area: 0.4 ha.

Altitude: 0.5m.

Province and type: 8.38.13; 13.

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Site description: A freshwater pond, up to 2m deep, with three small islands and scattered mangroves. The pond was recreated in 1973 by dredging on the site of an old rubbish dump, and deepened in 1980. There are slight changes in water level with rainfall, and the salinity is 4 p.p.t.

Principal vegetation: Scattered Black Mangroves *Avicennia germinans* on the islets, fringing *Paspalum vaginatum*, and submergent beds of *Ruppia maritima*.

Land tenure: Acquired by the Bermuda Audubon Society in 1970.

Protection: Protected as a Nature Reserve by the Bermuda Audubon Society since 1970.

Land use: Recreation on the adjacent public beach. The grass around the pond is periodically cut for cattle fodder.

Waterfowl: Long Bay Pond and the nearby private Pitman's Pond are becoming the most important breeding area for *Gallinula chloropus* and *Fulica americana* in Bermuda, and *Podilymbus podiceps* bred in 1985. A variety of waterfowl occur in winter, including *P. podiceps*, several Ardeidae, *Anas discors*, *Aythya collaris* and *Porzana carolina*.

Other fauna: The minnow *Gambusia affinis* was introduced in 1973 and is now abundant.

Threats: There is some minor disturbance from people using the adjacent beach. The area has been fenced off to reduce public disturbance, but the fencing and boundary hedges should be improved.

Research and conservation: Long Bay Pond forms an integral part of a public beach and park area. It lies in the Somerset freshwater lens, and is particularly rich because of the exceptional freshness of its water.

References: Hayward *et al* (1981).

Source: David B. Wingate.

Criteria for inclusion: 2b.

Other significant wetlands

Other significant wetlands in Bermuda include the following:

Bartram's Pond, St. George's Island (0.4 ha): a brackish pond, up to 2m deep, with two islets excavated in 1983, submergent *Ruppia maritima* and fringing *Paspalum vaginatum*. Owned and managed as a Nature Reserve by the Bermuda Audubon Society.

Cloverdale Marsh, Devonshire East (0.25 ha): a man-made, slightly brackish pond, up to 1.5m deep, excavated within a peat marsh; with *Typha angustifolia*, *Cladium jamaicensis* and *Conocarpus erectus*. Owned by the Cloverdale Condominium Owners Association, and managed as a Water Garden and private Nature Reserve. *Gallinula chloropus* breeds.

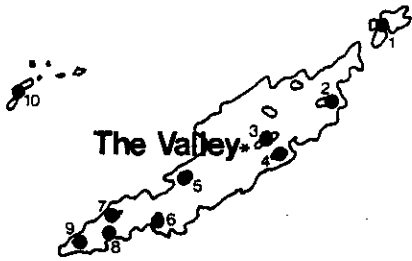
Edmund Gibbons Nature Reserve, Devonshire East (1.8 ha): a slightly brackish swamp, up to 2m deep, with native swamp "hammock" flora including *Juniperus bermudiana*, *Sabal bermudana*, *Myrica cerifera*, *Typha angustifolia*, *Cladium jamaicensis* and *Conocarpus erectus*. Owned by the Bermuda National Trust and managed as a Nature Reserve. *Gallinula chloropus* breeds.

Seymour's Pond, Southampton Parish (0.2 ha): a shallow, slightly brackish pond, up to 0.5m deep, with submergent *Ruppia maritima* and fringing *Paspalum vaginatum*. Owned by the Bermuda Audubon Society and managed as a Nature Reserve since 1963. *Gallinula chloropus* breeds.

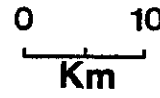
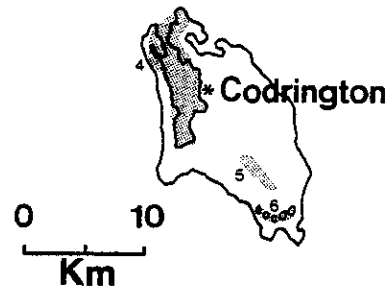
Evan's Pond, Southampton West (1.8 ha): an enclosed saline pond, up to 3m deep, with fringe of mangroves *Avicennia germinans* and *Rhizophora mangle*. Owned by the Government of Bermuda and two private estates; zoned as a nature reserve in the 1983 Development Plan. A roosting site for Ardeidae.

Ireland Island Lagoon, Ireland Island South (2.4 ha): a saline lagoon with fringing mangroves *Avicennia germinans* and *Rhizophora mangle*, and Turtle Grass *Thalassia testudinum*; connected with the sea by a channel and subject to tidal influence. Owned by the Government of Bermuda (West End Development Corporation), and zoned as a nature reserve in the 1983 Development Plan. A roosting site for Ardeidae.

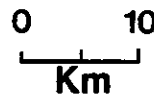
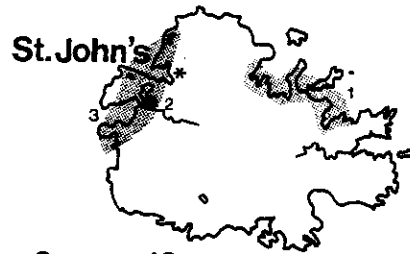
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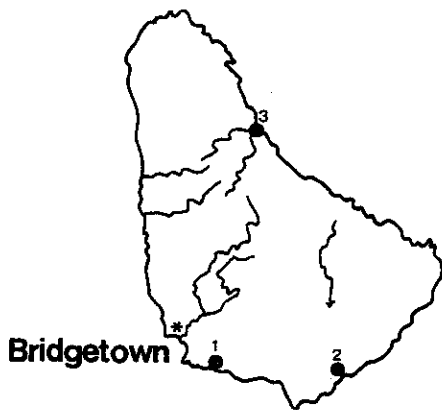
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