STATUS OF BIOLOGICAL RESOURCES

With "sea fowle in great numbers that lyeth in little holes in the ground, like unto Coney holes", and fish….so abundant…that men were faine to get out for feare of byting".
Lefroy, 1877

Users Of Biological Resources And Extent of Use

Agriculture[1]

Agriculture was once the main industry in Bermuda, but has long been displaced by tourism and international business. In 1989, agriculture (including both commercial and hobby production of food and ornamental plant material) still satisfied 29% of Bermuda's demand for fresh and frozen agricultural products, and employed just over 100 people. Products include the production of eggs, honey, a variety of vegetables, fruit, and flowers, meat, forage crops as well as 100% of the fresh milk Bermudians consume. Moreover, agricultural land and the associated open spaces provide a buffer to the rapidly developing urban Bermuda.

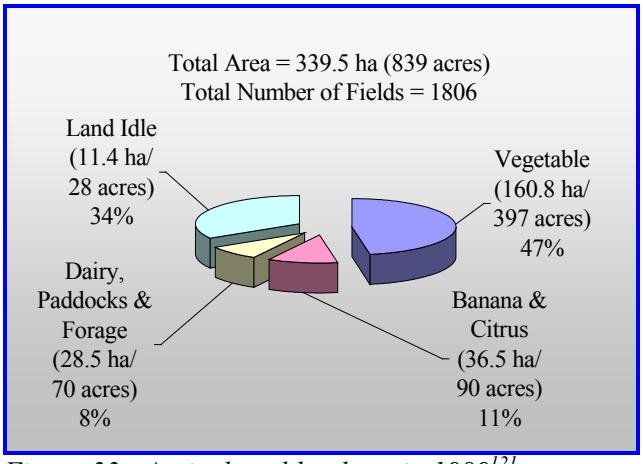

Figure 33. Agricultural land use in 1989[121].

The most recent island-wide survey of Bermuda's remaining arable land in 1989 documented 340 ha (838.93 acres) of land (1,806 parcels) set aside for agricultural purposes, with 90% of the fields less than 0.4 ha (1 acre) in size. Only 67% of the total agricultural land was being actively farmed in 1989. The extremely high real estate value of property in Bermuda creates a huge incentive for owners to develop their land, tempting many to stop production in the hope that this will lead to their property being re-zoned for development. Between 1981 and 1989 approximately 36 ha (90 acres) of agricultural land was lost to development, whilst the 1992 Development Plan reduced the zoned agricultural land from 327 ha (809 acres) to 281 ha (695 acres).

Fisheries[2]

By the beginning of the 20th Century, Bermuda's growing population exerted a huge demand for local

[1] Ministry of the Environment, Department of Agriculture, Fisheries, and Parks, Government of Bermuda. 1995. Agriculture in Bermuda. 17 pp.

[2] Ministry of the Environment, Government of Bermuda. 2000. Marine Resources and the Fishing Industry in Bermuda: A Discussion Paper. 495 pp.

fish. In the 1950's, having received an optimistic report on local fish resources, the Bermuda Government began to actively promote the fishery, and incentives were offered to encourage investment in fishing[3]. Unfortunately the projected annual catch far exceeded that which was realised, and by the 1980's landings of choice grouper species crashed. The fishermen began targeting the reef grazers such as parrotfish, and despite a series of increasingly restrictive management practices the decline continued. In 1990, the trap fishery was closed.

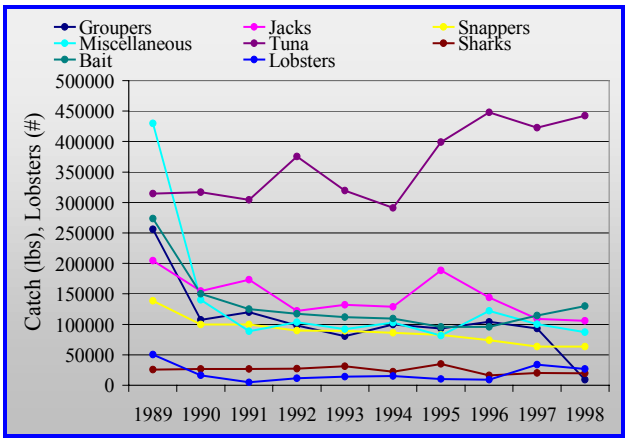

Figure 34. Annual fish and lobster landings between 1989 and 1998[4].

In 1999, there were 300 registered fishermen in Bermuda, 213 licensed fishing vessels, 23 charter fishing vessels, and 485 recreational lobster divers. The mainstays of the fishery today are the offshore pelagic species; Yellowfin and Blackfin tunas and Wahoo.

Prior to the fish pot ban Caribbean Spiny Lobster landings were consistent. However, with the fish pot ban, the commercial harvesting of lobsters was also curtailed. To address this, a lobster-specific trap was developed for use by commercial fishermen. The commercial harvest of Guinea Chick Lobsters was re-introduced in 1998.

An experimental pelagic fishery to target shark and tuna species began in June 1981 and has continued on and off. There are 3 vessels currently licensed and suitably geared for this activity. However, there is some concern that this fishery may deplete local shark stocks, which are considered ecologically important.

There was a commercial Turkey Wing Mussel fishery in Harrington Sound up until 1994 when the policy of not allowing new participants to enter led to closure of the fishery by attrition. This closure is supported by the results of an ecological survey of the benthos of Harrington Sound, which uncovered a massive loss of branching corals, presumably the result of long-term dredging for mussels[5]. Small quantities of mussels continue to be harvested by swimmers and skin divers.

[3] Ward, J. A. 1996. Coral Reef Conservation at Bermuda: A Case Study. Regional Proceedings of the American Zoo and Aquarium Association Conference, Hawaii, September 1996. 370-375.

[4] Ministry of the Environment, Government of Bermuda. 2000. Marine Resources and the Fishing Industry in Bermuda: A Discussion Paper. 495 pp.

[5] Thomas, M. L. H. 1996. The Marine Ecology of Harrington Sound, Bermuda. Unpublished report. 46 pp.

A deep-water fishery for snappers and Wreckfish was conducted during the 1980's using vertical longlines. Although initial landings were high the fishery soon crashed and interest declined. It is now clear that the relatively narrow band of productive habitat that rings the Island cannot sustain heavy fishing pressure.

Seine nets have traditionally been used inshore for taking bait, jacks and Little Tunny. Offshore netting is not presently in use, although some research has demonstrated that it can be an effective method for taking flying fish.

Sportfishing[6]

Sportfishing is popular with both Bermudians and tourists alike. This activity rarely targets the vulnerable reef species but is mainly directed to offshore pelagic fish. There are 24 charter fishing vessels licensed, which provide crew, gear, and bait for an average fee of $650-$1100 per person per day. A study conducted in 1999 estimated that recreational pelagic fisheries accounted for 17% of the overall extraction of pelagic stocks, although this varied significantly by species, with up to 42% for yellow fin tuna[7].

Lobster diving is a popular recreational activity, with licences issued from September to April. Restrictions limit both catch and gear, and prevent the sale or barter of the catch. For the past few years the number of licences issued has levelled at just under 500, although there is currently no limit.

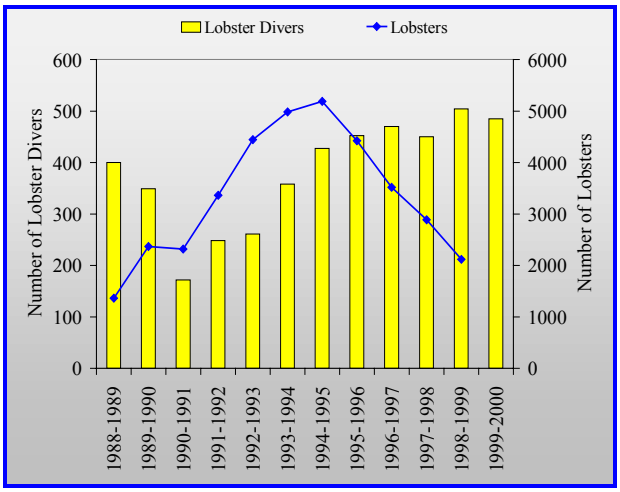

Figure 35. The number of licensed lobster divers and the number of lobsters caught between 1988-2000[126].

There is little data regarding the effects of recreational fishing on Bermuda's marine environment, although some concern has been expressed for party boat fishing, where fishing pressure is intensified due to the number of people participating from one boat.

Small-scale harvesting of ornamental fish and invertebrates for display in personal aquaria does occur and is not regulated. Fisheries regulations allow for the collection of fish for private aquarium displays; use of SCUBA gear for collecting is not permitted and a special permit is required for hand nets or barrier nets.

[6] Ministry of the Environment, Government of Bermuda. 2000. Marine Resources and the Fishing Industry in Bermuda: A Discussion Paper. 495 pp.
[7] Hellin, D.C. 1999. An assessment of recreational fishing in Bermuda. Unpublished M.Sc. Thesis. University of Newcastle.

Ecotourism[8]

Ecotourism is a relatively new industry for Bermuda and one that is hindered by the limited availability of undisturbed natural areas. With the specific objective of studying, admiring, and enjoying the scenery and wild plants and animals, ecotourism is largely restricted to the parks system on land but has room to expand in the marine environment.

In Bermuda, there are several marine operations including dive and snorkel boats, glass-bottom boat tours and cruises, and a few terrestrial ecotourism guides. However, the philosophy of ecotourism is poorly integrated into local operations. Few of the tour operators truly focus on the impact and responsibilities of both the tourist and the tourism industry on the environment. They do not subscribe to any consistent code of practice and, at present, there are no regulations governing ecotour operators in Bermuda.

The development of the Daniel's Head Village with an ecotourism theme represents the first major formal effort to establish ecotourism locally. However, it is widely feared that the intensive development of this site and the lack of significant undisturbed natural habitats nearby will greatly limit the success of this venture.

[8] Ministry of the Environment, Government of Bermuda. 2000. Marine Resources and the Fishing Industry in Bermuda: A Discussion Paper. 495 pp.

Recreation[132]

In addition to sportfishing, Bermuda's waters are used for a variety of recreational purposes, including swimming, boating (for pleasure as well as competition), sailing, SCUBA and skin diving, water-skiing, para-sailing and jet skiing. There are over 9,500 locally registered pleasure craft.

Plate 23. Snorkelers enjoying a trip to a shallow reef. (Photo from BAMZ slide collection).

Use Of Bio-Technology And Genetic Extraction

In October 1999, the Bermuda Biological Station for Research Inc. (BBSR), a U.S. not-for-profit, Bermuda-based institution began a three-year collaborative bioprospecting effort with Diversa Corp. Genetic extraction techniques are being used to isolate microbial nucleic acids from symbiotic bacteria living within a variety of marine invertebrates (such as sponges and tunicates) collected from local waters. The research is directed towards the development of improved drugs for

cancer, arthritis and osteoporosis, as well as for the development of anti- fouling for boats.

Access To Genetic Resources

At present, there is unrestricted access to genetic resources in Bermuda, although access to species that are locally or internationally protected does require a collecting permit. To date, access has been limited to scientific research by local and overseas researchers, and to the bio-prospecting effort between the Bermuda Biological Station for Research Inc, (BBSR) and Diversa Corp. There is currently no legislation governing such activity, but the Ministry of the Environment, Development and Opportunity has expressed some concern over this effort, as one of the objectives of the Convention on Biological Diversity is the "equitable sharing of benefits arising out of the utilisation of genetic resources,"…."taking into account all rights over those resources"[9].

Assessments Of Sustainability

By any reasonable measure of production, Bermuda's standard of living is not sustainable. Bermuda's population has grown so large and affluent that we are totally dependent upon outside imports for all manufactured goods and even such basic commodities as food. There is no integrated economic plan for the Island that defines target population levels, identifies sectors for expansion that build on the skills of the resident population, or that charts a course for necessary skill development in order to minimise the need to import specialised labour. In short, private enterprise continues to define the levels of immigration into Bermuda despite the fact that the population currently exceeds the carrying capacity of the environment.

A simple and extremely conservative assessment serves to highlight the degree to which the local population exceeds the carrying capacity of the Island. It has been estimated that approximately 0.4 ha (1 acre) of productive land is required to provide a high meat diet for one human. In Bermuda we have a population density of 11.45 people/ha (4.6 people/acre). Thus assuming that all of Bermuda's land is highly productive farm land (which it is not), and that all Bermudians eat a high meat diet (which in general is probably not far from true) we have exceeded our carrying capacity for food production alone, by a factor of more than 4.5. In other words, we would have to reduce our population from approximately 62,000 to less than 14,000 in order to feed ourselves without imports.

Without defined population targets it appears inevitable that overseas labour will continue to be recruited to work on the Island and, in order to make immigration sufficiently appealing to attract qualified personnel, many of these people will require high quality housing. The clear results of this trend are the ongoing political pressure to develop affordable housing for Bermudians, the continued

[9] Earth Summit. 1992. The Convention on Biological Diversity. Rio de Janeiro, Brazil.

destruction of Bermuda's limited open spaces, and the displacement of native species.

On a species level, with the exception of limited modelling of fisheries yields, there have been few attempts to assess population sustainability. Those species for which accurate population information exists are generally limited to critically endangered organisms with such small populations that it is clear that their survival is in peril. Ironically the clear exceptions to this rule are those invasive species that are in no danger and which will sustain or increase their present population unless dramatic action is taken to control their numbers.

Economic Value of Biological Resources

Economic valuation is measured from the perspective of humans and inherently misses much of the value that closely evolved interactions between species bring to natural systems. This value includes the products and services provided by natural systems along with any income derived from activities that rely on natural environmental amenities, such as tourism. Although it is relatively easy to provide a value for fisheries landings, to adequately measure the economic value of all of Bermuda's biological resources will demand a great deal of information and sophisticated techniques. Although such a valuation is beyond the scope of this report, the following information is presented to provoke consideration of the issues and provide a framework for discussion.

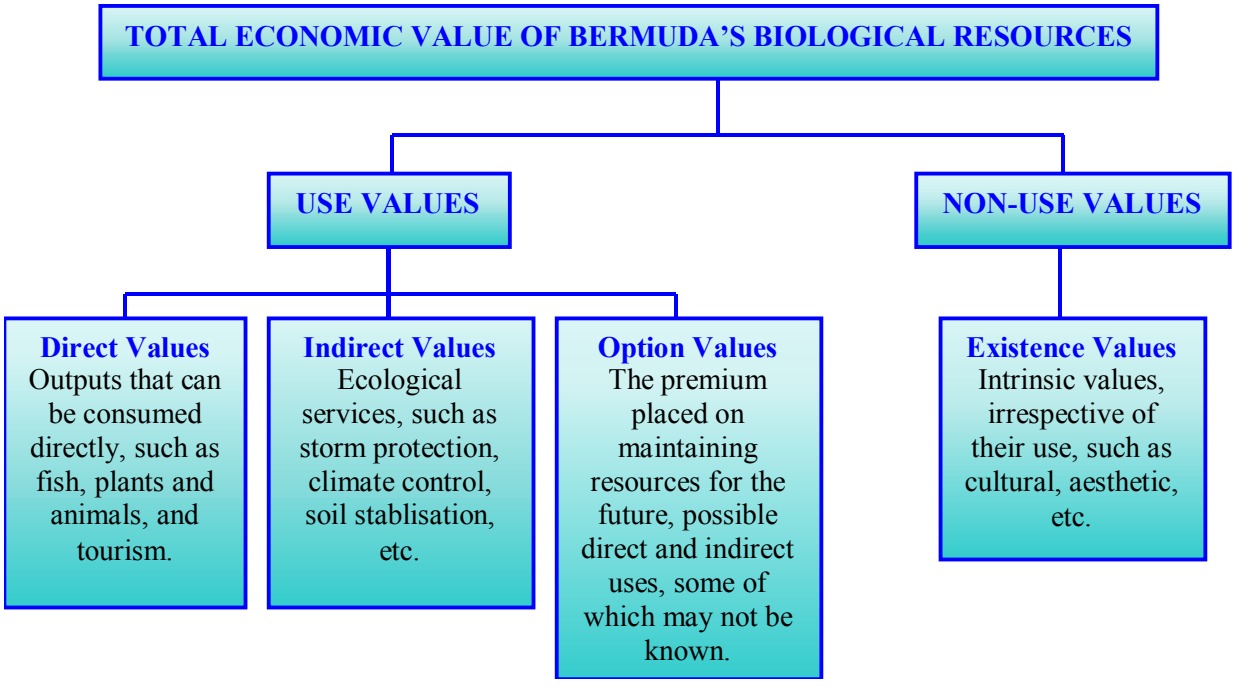

Figure 36. Adapted from Seychelles Biodiversity Strategy and Action Plan, 1997.

Biological Resource	Direct Use		Indirect Use	Option Value	Existence Value
	Extractive	Non-Extractive			
Coral Reef System	- Fishing - Bioprospecting	- Recreation - Scientific - Tourism - Education	- Shoreline protection - Sand production - Habitat	- Bioprospecting - Potential future supply of goods and services	- Intrinsic (northernmost) - Aesthetic - Cultural
Mangrove System	- Bioprospecting	- Education - Scientific	- Fish and invert production - Erosion protection - Bird sanctuary - Runoff mitigation - Habitat	- Bioprospecting	- Intrinsic (northernmost) - Aesthetic
Cedar Tree	- Timber	- Education - Scientific	- Bird habitat - Nitrogen-fixing - Soil conservation	- Seed production - Future furniture products	- Cultural - Aesthetic
Upland Hillside		- Scientific - Recreation (birdwatching)	- Climate control - Soil production - Habitat	- Bioprospecting - Timber - Medicinal uses - Ecotourism	- Cultural - Spiritual regeneration

Table 8. Examples of the economic value of Bermuda's biological resources and biodiversity.

Fisheries[10]

In 1988, the capture fishery (including lobster and offshore pelagic fish) generated a gross earning of around $6 million. Despite the closure of the trap fishery in 1990, this value rose to more than $6.5 million in 1998. A survey of restaurants, hotels, and grocery stores found that local fish accounted for 20-25% of fish utilised. However, despite the dominance of imported fish and perhaps because of price and seasonal availability, these outlets handled only approximately 30% of the catch.

Marine Tourism[134]

A survey of the marine tourist-related industry conducted in 1989 revealed that this sector of the economy grossed in excess of $9 million *per annum*. Despite significant investment in this industry since then, the decline in tourism has had a negative affect on income levels. It is worthy of note that, unlike the capture fishery, properly executed marine tourism does not damage the resource.

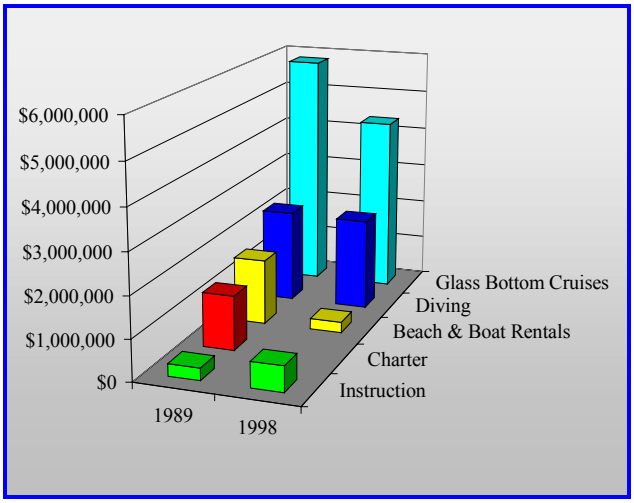

Figure 37. The total gross income of commercial marine operations in 1989 and 1998 (minus charter data in 1998)[134].

[10] Ministry of the Environment, Government of Bermuda. 2000. Marine Resources and the Fishing Industry in Bermuda: A Discussion Paper. 495 pp.