

THE CHARLES DARWIN RESEARCH STATION

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ABSTRACT: The Charles Darwin Foundation (CDF), founded in 1959, has been a potent force for the conservation of the unique Galapagos Islands for 35 years. The Charles Darwin Research Station (CDRS) is the operative branch of this international, non-governmental, non-profit organization, which works closely with the Galapagos National Park Service on conservation programs. Early CDRS work focused on surveys of the flora and fauna, and results of these indicated that urgent work was needed to protect threatened populations of giant tortoises. A program for captive breeding and raising tortoises was begun, which was extended to land iguanas, when some of their populations were nearly exterminated by introduced feral dogs. Research efforts have focused on the terrestrial environment, although the marine research program dates from the 1970s. New challenges have turned attention to protection of marine ecosystems and the CDRS has made marine studies a top priority. In 1986, waters within and around the Archipelago were designated a Marine Resources Reserve. Representatives from the Charles Darwin Foundation and Station staff participated in the development of a management plan for the Reserve. In 1990, at the urging of the CDF, the Ecuadorian Government declared a whale sanctuary in its territorial waters, including the Galapagos Archipelago. In 1992, a fishery for sea cucumbers started in Galapagos. Little information was available in the Station library on the biology and ecology of sea cucumbers, which made it difficult for Station scientists to provide management advice. The CDF requested help from the IUCN, which sent a group of experts in 1993 to make recommendations to the Ecuadorian Government on this issue. In 1994, the IUCN sent two experts to assess the possibility of declaring the Marine Resources Reserve a World Heritage Site. The Station is in the process of strengthening its marine studies program. Two new staff members (Ph.D. and M.S.) are expected in the second half of 1994; the Station's 43' launch is being re-fitted; and funds for marine research have been obtained from USAID and the Beneficia Foundation. With attention turning more and more to marine resources and ecosystems, researchers and students need up-to-date information on these topics. Thus, the Station must enhance its library collections in this area, so that it can effectively provide necessary background information for scientists and students on marine issues.

The Galapagos Islands have long fascinated scientists from many fields. Volcanic in origin, the Archipelago is one of the largest and most active groups of oceanic volcanoes in the world (Simkin 1984). Although on the equator, the islands are extremely arid and have a subtropical

climate, due to the influence of a complicated oceanic circulation in this part of the eastern Pacific and particularly due to cool ocean currents coming from the west and the south (Colinvaux 1984; Houvenaghel 1984). But Galapagos is probably most famous for its wildlife. Charles Darwin, who visited the Archipelago during his 5-year voyage on the *Beagle*, commented succinctly, and with great understatement, "The natural history of these islands is eminently curious, and well deserves attention" (Darwin 1960 (1860)).

Indeed there are many creatures meriting study. The Galapagos Islands consisted of barren lava when they first emerged from the sea. Today they are home to a sea-going iguana that dives to feed on algae, the only marine lizard in the world; a cormorant with turquoise eyes that has lost the ability to fly; a gull that nests on cliffs and feeds at night; and Darwin's finches, an outstanding example of adaptive radiation, in which an original ancestral species evolved into fourteen different finch species, thirteen of which are found in the Archipelago, with the fourteenth on Cocos Island.

Not only scientists, however, have been attracted to Galapagos. At the time of Darwin's visit, in 1835, whaling ships were very active in the eastern Pacific and called in at Galapagos to provision with water and giant tortoises. These animals proved to be an excellent source of fresh food on long ocean voyages, since they remained alive for up to a year even without food and water. It has been estimated that whalers removed over 100,000 tortoises between 1830 and 1860, during the period of heavy whaler visitation. From the small island of Española alone, one ship, within a period of only 5 days, took 300 tortoises (Townsend 1925). Whalers depleted the tortoise populations and ceased coming in large numbers once they had also depleted the populations of sperm whales in these waters. By the 1860s, the Galapagos whaling grounds had become, in the words of one captain, "pretty dry cruising" (Whitehead *et al.* 1988).

Without further exploitation, the tortoise populations might have been able to regain their former numbers. However, in 1832, the South American country of Ecuador claimed the Archipelago and colonists arrived to farm and fish. Settlers brought with them domestic animals - cattle, dogs, cats, pigs, goats, donkeys - as well as food crops. In clearing land for cultivation and pasture, they destroyed native habitats. These early colonies did not prosper, however, and many of the people left, abandoning their farms, along with their domestic animals, which formed feral populations. Colonists and whalers both brought accidental introductions, such as mice, black rats, insects, and weedy plants. People came and went, and other settlements grew up (Perry 1984). But the biological integrity of the islands had been broken.

Over hundreds of thousands of years, the Galapagos flora and fauna had evolved together into a natural ecosystem. Insular ecosystems, however, are very fragile, since they lack the greater diversity and thus greater stability of continental ecosystems. The introduction of foreign organisms is usually very destructive to native island life (Carlquist 1965, 1974). Island animals that evolved with little predation cannot cope with efficient continental predators. The introduction of herbivores has proved disastrous for some native herbivores, such as the giant tortoise and the land iguana. And so, after humans arrived with their various introduced animals, dogs killed tortoises and iguanas; pigs ate the eggs of sea turtles and dark-rumped petrels; goats competed with tortoises for food (Hoeck 1984).

This was the situation confronting concerned scientists and conservationists from Ecuador and around the world, who joined forces in the 1950s to urge the Ecuadorian Government to protect these extraordinary islands. In 1959, one hundred years after the publication of Darwin's *On the Origin of Species*, Ecuador proclaimed the uninhabited portions of Galapagos, some 97% of its surface area, a National Park. The Charles Darwin Foundation, an international, non-profit organization dedicated to the conservation of the Galapagos, was also established in 1959 and its operational arm, the Charles Darwin Research Station, was built and began to work (Smith 1990).

The role of the Darwin Foundation, from its inception, has been scientific research, conservation, and education. Scientists from the Research Station conduct studies, particularly those with an application to conservation. The Station works very closely with the Galapagos National Park Service, which is the governmental body charged with the management of the National Park. The Station provides scientific advice to the Park Service, and jointly they carry out conservation programs (Smith 1984).

The training of Ecuadorian students, who will tomorrow's conservationists and policy-makers, is an important aspect of the Station's work. University students receive scholarships to carry out research under the supervision of Station scientists. Other students gain experience participating actively in Station projects or helping in the studies of visiting scientists.

Early efforts of the Station focused on surveys to determine the status of the native populations. Not surprisingly, scientists found that many tortoise populations were seriously threatened. On the small island of Pinzon, only adult tortoises could be found. Black rats, which had been introduced during the previous century, killed all hatchlings. In 1965, the Station began a program of captive rearing and repatriation of tortoises with the Pinzon population. Eggs were gathered from nests on the island and brought to the Station for incubation. The young tortoises were reared until old enough so that they were not vulnerable to rat predation. Then they could be returned to Pinzon (MacFarland *et al.* 1974a, b).

A second population of tortoises was soon added to the program. Only 13 tortoises could be found on the island of Española, where once whalers had removed 300 within 5 days! The introduction of goats to that small island had destroyed the vegetation so that the tortoises were forced to wander ever farther for food and never encountered one another for breeding. All the Española tortoises were gathered and brought to the Darwin Station, as a captive breeding population. In subsequent years, other threatened populations of tortoises were brought into the program, which is now run jointly with the Galapagos National Park Service (MacFarland *et al.* 1974a, b).

The island of Pinta had similar problems. Whalers had removed many tortoises and in the 1950s fishermen introduced a few goats, which multiplied rapidly (Thornton 1971). In 1972, what is probably the last remaining tortoise of the Pinta race was found by a group of scientists and park wardens (Cruz 1994). This old male, dubbed "Lonesome George," was also brought to the Station in the hopes that a female might be found for captive breeding. To date, however, no female has been found and "Lonesome George" remains a sad reminder of the results of human disturbance and exploitation by humans.

Land iguanas were very nearly exterminated in two areas on the islands of Santa Cruz and Isabela, when, in 1975, feral dog populations increased. Surviving iguanas were brought to the Station and thus another species joined the captive breeding program (Smith 1990).

In 1980, the iguana program was expanded to include a population that had gone extinct on its native island of Baltra, probably due to habitat destruction (Cayot & Menoscal 1992). In the 1930s, visiting scientists noted the poor condition of the Baltra iguanas, which were, apparently, suffering from the devastating effects introduced goats were having on the vegetation. The scientists decided to transfer some iguanas from Baltra to neighboring North Seymour Island, which is similar in terrain and vegetation, but had no native iguanas (Cayot & Menoscal 1992; Woram 1992). Although this is not recommended practice, it was fortunate for this population of iguanas, which survived on North Seymour, while the original population became extinct on Baltra.

Photographs taken of the highlands on Santiago Island give evidence of the devastation goats can cause. In 1972, *Zanthoxylum* trees show indications of extensive grazing by goats, and in many areas scientists could only find old individuals, virtually all young plants being eaten by goats. Almost twenty years later, even these old individuals were dead and many areas were without any surviving woody plants (Hamann 1993).

The problems are enormous, but the conservation efforts of the Darwin Station and the National Park Service have been remarkably successful. Park wardens have conducted goat eradication campaigns and goats have now been eliminated from six small islands, including Española and Pinta (Smith 1990). Extensive areas on Santiago have now been fenced against goats and regeneration of native plants is occurring (Cruz 1993, Hamann 1993).

The captive breeding program for tortoises and land iguanas has been so successful that the problem now is to find space to house all the hatchlings until they can be repatriated! Over 1000 tortoises have been returned to their islands of origin (Smith 1990). The young tortoises on Española, which were hatched in captivity, have now begun breeding on their native island (Márquez *et al.* 1991). Land iguanas bred in captivity have also been returned to their native islands (Cayot & Menoscal 1992).

Unfortunately, in the world of conservation, one can never rest. Although some battles are won, the war never ends. New threats are facing the Galapagos.

Tourism on a large scale began in Galapagos in the 1970s and has increased from about 7000 visitors annually in the early 1970s to over 40,000 today. The increase in tourism over the years has increased the prosperity of the Galapagos inhabitants, and this has brought a wave of immigration from mainland Ecuador. A larger human population puts more pressure on the Galapagos ecosystem: there is greater demand for the scarce water supplies; most fresh produce and all canned and bottled goods are imported from mainland Ecuador; removal of sand for construction has destroyed some beaches; the amount of garbage is exceeding the capacity of dump sites; sewage disposal is also inadequate. Social problems have also increased, since the new immigrants are not always able to find employment (Rodríguez 1993).

With increased traffic from the mainland, in people and materials, the danger of introductions of alien organisms also increases. In 1989, a new wasp was accidentally introduced to Floreana Island, probably in a stalk of bananas brought from the mainland. Today it is found throughout the Archipelago (Abedrabbo 1991). Earlier this year, another species of wasp was found, this time on Santa Cruz.

Recently, concern has arisen about the status of marine iguana populations. In 1983, a scientist studying the iguanas suggested that they were severely endangered in some areas where introduced cats preyed heavily on juvenile iguanas (Laurie 1983). This worry was echoed in 1993 by scientists collecting blood samples from marine iguanas throughout the Archipelago as part of a genetics study (Cayot *et al.* 1994). Only on islands free of introduced predators did the scientists find juvenile marine iguanas in abundance. Earlier this year, the Station began a study, conducted by an Ecuadorian university student on scholarship, to determine the threat posed by cats and to suggest control measures.

Threats to the Galapagos marine environment have also increased greatly in recent years. Old-time residents talk of the ease with which lobster was caught many years ago. For a long time, the lobster fishery was at a relatively low level, with mainly local consumption. Within the last ten years, moratoria on lobster fishing have been declared both in Galapagos and on the mainland, due to low stocks. Initially, the prohibition was for two months annually; this was then increased to four months, and finally in 1992 lobster fishing was banned entirely until the year 2000 (Merlen, in press).

Other fishery resources have also diminished. Fishermen taking whitefish have to seek farther and farther away from their former near shore haunts and are fishing deeper for the Galapagos grouper that is so prized for a special Easter-season soup popular in Galapagos and mainland Ecuador.

Fishing of sharks for their fins has occurred on the open sea near the Galapagos for decades (Merlen, in press). This trade, which is for export, began in Galapagos, but was banned by the government in 1989 once it was learned that fishermen killed sea lions to use as bait to attract sharks. This fishery is allowed 80 nautical miles from the Archipelago, with the restriction that the whole animal, not merely the fins, must be used. Nevertheless, fishermen still take sharks illegally within the Archipelago, using nets, which are highly indiscriminate and may catch sea turtles, marine iguanas, sea lions, penguins, cormorants, and of course other non-target fish. In January of this year, a group of tourists SCUBA diving by the far northern island of Wenman, famous for its large schools of hammerhead sharks, discovered a gill net containing some 40 dead hammerhead sharks. This has once again focused attention on problems in the marine environment.

Tuna fishing also occurs on the high seas near Galapagos. Although it is prohibited for industrial tuna boats to work within the Archipelago, they are often seen, sometimes fishing with their enormous purse seine nets (Merlen, in press).

An even more worrying threat has arisen with the recent development of new fisheries that are intended entirely for export, rather than for local or mainland consumption. A trade in sea cucumbers for export to Asia began on mainland Ecuador in 1988. By 1992, stocks there had

been so reduced that entrepreneurs started to look for new areas to exploit. Attention naturally turned to Galapagos. Fishermen from the continent arrived and were joined by local fishermen, who found the trade in sea cucumbers much more remunerative than any other. Unfortunately, the highest concentrations of sea cucumbers were to be found in the western part of the Archipelago, in the Bolivar Channel between the two westernmost islands of Isabela and Fernandina.

Fernandina is a genuine treasure. It is one of the very few oceanic islands in the world with no introduced vertebrates. Elsewhere in the Galapagos, endemic rice rat species have gone extinct with the introduction of black rats. On Fernandina, rice rats still survive. Marine iguanas can be found sunning in immense colonies and going to sea to feed on the rich algae beds in this area. The mangrove finch, one of the 13 species of Darwin's finches in the Archipelago, is found only in mangrove areas on Fernandina and Isabela. Two flightless birds, both endemic to Galapagos, the flightless cormorant and the Galapagos penguin, have their population centers around Fernandina. Fur seals, which were hunted nearly to extinction during the last century, also have colonies on the harsh rocky shores of Fernandina.

It was to this jewel of an island that fishermen came to hunt sea cucumbers. The processing of sea cucumbers requires boiling and subsequent drying. Lacking room on their small boats for such processing, the fishermen camped illegally, within the National Park, on the shores of Fernandina and neighboring Isabela. They cut mangroves for firewood, left garbage behind, and took out great quantities of sea cucumbers in areas where marine iguanas, flightless cormorants, and penguins nest and feed. Their presence on the land on Fernandina enormously increased the risk of introductions, of mice or rats, not to mention fire ants, cockroaches, and other invertebrates. It was this abuse of the National Park that led the government to ban sea cucumber fishing in 1992 (Merlen, in press).

But, there have been successes in the conservation of the Galapagos marine environment, too. In 1986, the Government of Ecuador declared the Galapagos Marine Resources Reserve, which encompasses all the internal waters of the Archipelago, plus a buffer area of 15 nautical miles from the extreme points of land (Sevilla 1987). Representatives from the Darwin Foundation, as well as Station personnel, participated in the development of a management plan for the Reserve. In 1990, at the urging of the Foundation, the Ecuadorian Government declared a whale sanctuary in its territorial waters, including the Galapagos Archipelago (Merlen 1992). When the sea cucumber fishery began in 1992, little information was available in the Station library on the biology and ecology of these animals, which made it difficult for Station scientists to provide management advice. The Darwin Foundation requested help from the IUCN, which sent a group of experts in 1993 to make recommendations to the Ecuadorian Government on this issue. In 1994, the IUCN sent two experts to assess the possibility of declaring the Marine Resources Reserve a World Heritage Site. At the end of September, a workshop was held on the Marine Resources Reserve to promote the conservation and integrated management of the marine and terrestrial environments, as well as to encourage inter-institutional cooperation. The workshop was attended by representatives from a number of governmental agencies involved with fisheries, representatives from the Darwin Station and the Foundation, National Park Service officials, local fishermen, and representatives from tourism organizations.

Although the Station's marine research program dates from the 1970s, for many years research efforts focused on the terrestrial environment. The new challenges have turned attention to protection of marine ecosystems, and the Station is making marine studies a high priority. Two new staff members have joined the Station in the Area of Marine Research. The Station's 43' launch is being re-fitted and funds for marine research have been obtained from USAID and the Beneficia Foundation.

With attention turning more and more to marine resources and ecosystems, researchers and students need up-to-date information on these topics, on which wise management decisions depend. Thus, the Station must enhance its library collections in this area, so that it can effectively provide necessary background information for scientists and students on marine issues.

The Darwin Station Library houses what is undoubtedly the world's most complete collection on Galapagos, with some 600 books and 4000 reprints on the Islands, as well as a collection of Galapagos maps. In addition, the Library has a collection of 8,000 books and reprints on non-Galapagos subjects and over 200 different journal titles. Students from Ecuadorian universities receive training at the Darwin Station through scholarship and volunteer programs. These students, as well as local high school students and teachers, Darwin Station and Park Service personnel, and even professors from continental universities use the Station Library, which thus provides unique opportunities for a wide variety of professionals and students, offering a service that is basically not available elsewhere in the country. On average, the Library registers about 200 users per month.

However, new demands on its resources are proving challenging. As human pressure on marine resources increases, information on management of the marine environment, as well as pure science on marine topics, will become vital for a sustainable future. The Darwin Station Library must continue to act as a channel for the flow of information from outside the country.

Contacts with other libraries, through such meetings as the IAMSLIC conferences and e-mail lists, will be of considerable benefit in expanding the collections, learning of new technologies that can be brought into use, choosing data management software, and attempting to obtain funding for library automation and expansion.

The Darwin Station Library is a new member to IAMSLIC this year, but we look forward to a long and fruitful relationship.

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