

Biodiversity Conservation and Human Population impacts in the Galapagos Islands, Ecuador

MacFarland, C. and M. Cifuentes. 1996. Case Study: Galapagos, Ecuador. Pages 135-188 In: Dompka, V. ed. Human Population, Biodiversity and Protected Areas: Science and Policy Issues. Report of a Workshop April 20-21, 1995, Washington, D.C. American Association for the Advancement of Science (AAAS), Washington, D.C.

The Galapagos Islands are a large and complex archipelago, lying 800 to 1100 km. west of Ecuador, straddling the equator and extending over 3 degrees East-West and 3 degrees North-South, or approximately 300 km total range in each direction (Figure 1). They include 13 major islands varying in size from 14.1 km² to 4588 km², and over 115 smaller islands, islets and rocks, the vast majority of which are vegetated (Snell, 1995). The islands total almost 8,000 km².

The islands are almost entirely volcanic in origin except for the northeast part of Santa Cruz Island and Baltra and North Seymour Islands, which are composed of uplifted marine sediments overlaid on volcanic substrata (Simkin, 1984; Jackson, 1993). There is a general age gradient of older islands to the south - southeast running to the youngest ones in the west - northwest. The oldest islands date from approximately 3 to 4.6 million years ago to the youngest, Fernandina Island, estimated to be approximately 700,000 years of age (Simkin, 1984). They are completely oceanic islands with no evidence of ever being connected to any continental land masses. There is recent evidence (Christie, 1992) suggesting that some of the earliest "Galapagos" islands have subsided below the surface of the ocean and form extinct volcanic seamounts to the east of the existing archipelago. The oldest of those seamounts dates to nine million years ago and lies approximately 600 km west of South America at 2,000 m below sea level. Thus, evolution may have been occurring in the archipelago for much longer than suggested by the age of the extant islands.

Apart from their isolation and volcanic origin, the islands have several other key physical characteristics, which are major determinants of their biodiversity and biological/evolutionary features (Jackson, 1993; Snell, 1995):

- Great size and altitudinal variation, ranging from a few dozen m² in size and a few meters altitude for the smaller islets and rocks; to small islands of 0.1 km² to almost 5 km² with altitudes of 20-350 m; to the 13 larger islands which range from 14km² up to almost 4600 km² and with altitudes ranging from less than 100 m to over 1700m.
- A complex set of major currents (Figure 2) which result in a wide variety of oceanographic conditions from very cool nutrient laden waters to warm, far less rich ones; these currents vary in position throughout the year and between years, and are part of the major worldwide El Niño circulation phenomena.
- A highly variable climate, with distinct hot and cool seasons, but major variations over the years in rainfall, most years being dry to very dry, and with less frequent wet to extremely wet years associated with moderate to major El Niño events; the climatic variation also occurs along altitudinal gradients, with the larger higher islands and volcanos having seasonally wet zones at medium to higher elevations.
- Great variation in vegetation in response to the climatic variations along altitudinal gradients; the lower, smaller islets and islands are dry and have only 1-3 vegetation zones (littoral, arid and transitional), whereas the higher, larger islands and volcanos may have up to as many as 3-5 additional zones, e.g. closed evergreen forests, mossy open evergreen forests, mossy evergreen scrub, non-wooded evergreen or summit pampas, etc.

The archipelago was discovered in 1535 by the Spanish, but never permanently settled until 1832, when Ecuador claimed possession of the archipelago and the first colony was established (Black, 1974).

BIODIVERSITY, SCIENTIFIC, EDUCATIONAL, AND ECONOMIC SIGNIFICANCE

Biodiversity Significance

The Galapagos are still one of the most unspoiled areas remaining on the planet. The Islands have a well deserved international reputation for their extraordinary natural beauty, fantastic wildlife found nowhere else on earth, spectacular examples of evolution in action and superb demonstration of how evolutionary and ecological processes work in the natural world, upon which all mankind depends.

The archipelago is known to have approximately 5500-6000 already identified species, including both terrestrial and insular marine ecosystems (Baert, 1994; James, 1991; Lawesson, et.al., 1987; Lawesson, 1990a; Loope, et.al., 1988; Peck, 1993; Porter, 1984; Snell, 1995; Weber, 1986; Weber and Gradstein, 1984; Wellington, 1984). Freshwater habitats are relatively rare in Galapagos, and what inhabits them is extremely poorly known. Many taxonomic groups are relatively well known, but a number of others, particularly among the invertebrates, have been little or not studied at all: e.g. rotifers, sipunculids, echiurids, etc., among the insects and mites; other groups in terrestrial and freshwater habitats, such as nematodes, tardigrades, copepods, and oligochaetes. Even in the invertebrate and lower plant groups which have received growing attention, much remains to be studied more thoroughly before species diversity can be more adequately assessed: e.g. insects; mites; mosses and liverworts. In various invertebrate groups such as insects and certain other arthropods, every major field collecting trip over the past several decades has resulted in the addition of numerous species. These considerations lead to the conclusion that the islands probably harbor some 7,000 to 9,000 species in all.

In terms of the species diversity level of biodiversity, the great significance of the biota is in part due to its highly unique characteristics. Endemism is extremely high, especially in the terrestrial part, but also in the insular marine area (Table 1).

These levels of endemism are even larger in many groups, if the focus is placed only on terrestrial species: e.g. 75% of all land birds are endemic (i.e. excluding sea birds); 92% of land mammals (excluding two species of pinnipeds); and, 97% of terrestrial reptiles (two species of sea turtles excluded).

Biodiversity in the Galapagos is also notable as measured by other levels, or types, in addition to species diversity. The islands' biota are particularly noted for the large number of endemic genera, especially among the plants, beetles, reptiles, land birds and mammals (Jackson, 1993; Loope, et.al., 1988; Peck, 1991).

Earlier studies on several species groups such as *Opuntia* have shown extensive between and within-population phenotypic variation, suggesting substantial underlying genetic diversity. More recently, modern (DNA-based) studies of genetic diversity among populations of the same species are showing notable genetic variation within the same species in geographically separated populations (both separated on different islands and separate populations on the same island). Examples are giant tortoises (Louis, 1995); marine iguanas and land iguanas (Rassman and Trillmich, 1995); lava lizards (Snell and Heiss, 1995); and, the so-called sunflower trees and shrubs of the genus *Scalesia* (Valdebenito and Lowery, 1994). These results are indicating that there in general probably exists considerably greater amounts of genetic diversity at the population level within species, as well as greater numbers of species in Galapagos than previously thought, based upon earlier morphological taxonomic studies.

To summarize the foregoing information on biodiversity, the main point is that the Galapagos is the largest, most complex and most diverse archipelago remaining in the world still largely in pristine condition. This fact alone makes the Galapagos the most special remaining oceanic island system in the world. Virtually all other major archipelagos and islands have suffered considerable disturbance to their biodiversity. Examples are the Hawaiian Islands, the many islands and archipelagos in the Caribbean, New Zealand and its offshore islands, Guam and many other islands in Micronesia, all of which have

suffered extinctions on the order of 25-75% of species of their major groups of organisms such as plants, reptiles, birds and mammals. In Galapagos, extinctions have totalled only approximately 30 taxa and populations, and over half of those have been subspecies, races, varieties or populations, rather than species *per se*. The only group of Galapagos animals with such levels of extinctions are the terrestrial mammals, in which eight (79%) of the original 11 species have disappeared (six extinctions caused by the introduction of exotic species by man; other two pre-historic, probably natural extinctions; Clark, 1984).

However, this does not mean that all is well and complacency can reign. Human-introduced, invasive exotic species and humans have already caused 11 of the 13 full species extinctions and the other approximately 15 extinctions of subspecies, races, varieties and populations. Major damage has occurred to habitats, communities and ecosystems on various islands, especially the five inhabited ones, but also several uninhabited ones (Hamann, 1979a, 1979b, 1981, 1984, 1991, 1993a and 1993b; Hoeck, 1984). Moreover, the greatest worry concerns future possible extinctions, which may become cascading in the not too distant future, due to the increasing rates of introductions of exotic species to the archipelago, spread of formerly introduced and new invasive species among the islands, and the rapidly growing human population and its direct pressures on biodiversity (MacFarland, 1994). Snell (1995) points out that the problem becomes much clearer if we focus upon extinctions at the population level, rather than just in terms of species diversity. He estimated in 1989 that the numbers of extinctions at population level, both definitely having occurred and impending ones, are notably greater than at species level, and are an indicator of the direction in which biodiversity conservation in Galapagos is heading (Table 2).

2.2 Scientific and Educational Significance

The scientific value of Galapagos is unchallenged. The association of the archipelago with the theory of evolution by natural selection propounded by Charles Darwin have earned the Galapagos a prominent place in the history of science. It was during a brief five week visit to the archipelago in 1835 on the voyage of the Beagle that Darwin gathered much of the information that led to his publication of *On the Origin of Species by Natural Selection* a quarter century later. In fact, it has been argued rather effectively that Darwin probably would not have arrived to his theory of evolution if he had not visited the Galapagos. Since then the Islands have become a Mecca for scientists and thousands of papers, books and other scientific works have been written based on research conducted there. The Galapagos have contributed hugely to mankind's knowledge of evolution, ecology, geology and conservation, indeed to his understanding of how natural systems function and change and man's place within and dependence upon them.

In modern times, the islands continue to contribute in a major way to our understanding of evolutionary processes. Some of the best examples of adaptive radiation are evidenced in the cases of the 13 species of Darwin's Finches, 14 species of Giant Tortoises and other species groups such as mockingbirds, lizards, beetles, ants, land snails, Opuntias, and Scalesias to name but a few. Because of the very strong selection pressures exerted by extreme climatic variation, isolation from the mainland, isolation between islands in the archipelago, and low population numbers, the pace of evolution is much faster than in the continental land masses. This characteristic is of incalculable value to science since studies of evolution can and have been conducted in Galapagos within periods of 10 to 20 years (Grant and Grant, 1986; Grant and Grant, 1989; Weiner, 1994), whereas on mainland areas these studies would be virtually impossible to carry out due to lack of reproductive isolation of the populations and the prolonged time span required (many decades to hundreds of years).

If examined in terms of the production of scientific publications, numbers of scientific missions, the training of tropical biologists, and similar such measures, over the past 35 years, Galapagos ranks as one of the three most important sites in the entire tropics of the Western Hemisphere, along with Barro Colorado Island Natural Monument (Smithsonian Tropical Research Institute) in Panama and the La Selva Biological Station and Reserve (Organization for Tropical Studies) in Costa Rica. This has especially been the case since the formation of the Charles Darwin Foundation for the Galapagos Isles

(CDF) in 1959 and the initiation of its field arm in Galapagos, the Charles Darwin Research Station (CDRS), in 1960 (CDRS, 1995) (see more details below):

- a. There have been over 700 scientific missions to Galapagos using the CDRS as a logistical base. These missions choose Galapagos, in spite of the high costs and logistical difficulties of getting to and working there, for many reasons which include its active vulcanism, relative ecological simplicity and great ecological variation within a very small geographical area, as well as largely unaltered evolutionary and ecological processes and habitats - many of these being intimately linked to biodiversity.
- b. The total number of scientific publications on Galapagos has grown exponentially since the CDRS began operations, having now surpassed 6,000.
- c. Linked to those scientific works, the extensive publications on Galapagos for the general public and the educational (natural history) materials produced, which have served to popularize the islands wildlife, uniqueness, beauty, etc., all focus on the scientific importance of the archipelago and its biodiversity, which in turn stimulates the archipelago's tourist economy. The scientific importance of Galapagos has therefore even come to manifest itself in economic terms.
- d. Over 500 Ecuadorian advanced level undergraduate university students have received training at the CDRS as volunteers and senior honors theses scholarship students. Over 100 scientists from around the world have received PhDs and masters degrees based upon their research in the Galapagos.

2.3 Economic Significance

From the standpoint of economic value, both the immediate and long term rewards of biodiversity conservation have been clearly demonstrated in the case of Galapagos. As a gross estimate it can be stated that, in 1993, the value of Galapagos tourism to the national economy was conservatively estimated at US\$ 55 million gross income (de Miras, 1995). The attractions on which this tourist economy is based are the unique plants, animals, ecosystems and landscape features of the islands, in effect, their biodiversity. This makes tourism based on Galapagos the fourth to fifth greatest earner of foreign exchange in Ecuador in recent years.

In the longer term, consideration must also be given to the potential direct economic resources generated through the identification of usable gene resources. This value has already been demonstrated through the transfer of genes for salt tolerance and ease of breakage of the fruits from vines (making machine picking much more efficient), from an endemic Galapagos tomato species into cultivated varieties of tomatoes. Estimates are that these genetic improvements save the tomato growers industry at least an average of \$30 million per year in mid-1970s terms, i.e. considerably more now (Rick, 1977).

The intrinsic value of Galapagos cannot by definition be quantified. There are, however, basic philosophies, tenets, symbols and values held by humans such as uniqueness, rarity, tameness, beauty, ruggedness and pristineness and the will to protect endangered habitats and species, which go far beyond an appreciation in solely monetary terms. These concepts are a fundamental part of the protection of biodiversity in Galapagos. The fact that such a tiny surface area of land and its surrounding sea as the Galapagos archipelago should contain a bewildering variety of climatic and oceanographic extremes and such unique plants, animals and ecosystems, as well as being in a nearly unaltered state over much of its area, gives the islands the same magic appeal as Antarctica, yet the land area of Galapagos is infinitesimally small by comparison. Galapagos is a very small but very valuable jewel in the biodiversity crown.

2.4 Protection of the Islands

Over the past 35 years Ecuador has made notable strides to protect the Galapagos. Over 95% of the land area of over 7,800 km² of the complex archipelago was declared a National Park in 1959, on the hundredth anniversary of the publication of Darwin's seminal work on evolution. Since 1968 Ecuador has

maintained an active presence in and management of that Park, through its Galapagos National Park Service (GNPS). In 1986 Ecuador decreed the Galapagos Marine Resources Reserve (GMRR), an area of over 70,000 km² of near and offshore waters surrounding the Islands, including all the area within lines connecting points 15 nautical miles offshore from the most remote land points of the islands (Figure 3). It is the second largest marine protected area in the world, after the Great Barrier Reef of Australia. Although a management plan for the GMRR was prepared between 1986 and 1992 and approved by Presidential decree in 1992 (Ecuador Presidencia de la República, 1992b), it still remains to be implemented. Finally, in 1990 the Ecuadorian President declared the interior waters of the GMRR also as a Whale Sanctuary, during a time when Ecuador was serving as a member of the International Whaling Commission.

International recognition for Ecuador's efforts has been widespread and deservedly laudatory. The terrestrial part of the archipelago was one of the first dozen World Heritage Sites declared (1979) under that international convention. In 1984 the Islands (land portion) were also accepted as an internationally recognized Biosphere Reserve, forming part of a network of several hundred such reserves in over 100 countries, under the international Man and the Biosphere Program administered by UNESCO.

International support for Ecuador's efforts to protect the Galapagos also has developed a notable history over the past 35 years. In 1959 the international, non-profit Charles Darwin Foundation for the Galapagos Isles (CDF) was formed under the auspices of the Ecuadorian government, the International Union for Conservation of Nature and Natural Resources (IUCN, now called the World Conservation Union) and UNESCO, simultaneously with the declaration of the Galapagos National Park. The CDF operates under a long-term agreement with Ecuador, acting as the main advisor to the government on the conservation of the Island's extraordinary biodiversity and natural resources. It does that mainly by: a) operating its international field research center in the Galapagos, the Charles Darwin Research Station (CDRS), including staff-operated applied conservation research programs and promotion and facilitation of research conducted by scientists from all over the world; b) advising the Ecuadorian government on the design of appropriate policies and programs for conservation of the archipelago; c) conducting public environmental education programs at local, national and international levels; d) training of Ecuadorian scientists and resource managers; and e) seeking and channeling financial and technical support from a wide variety of international and bilateral organizations, both public and private. In practical terms this translates into major cooperative programs of the CDRS with the GNPS and numerous other governmental organizations and Ecuadorian universities in the islands, and major programs on continental Ecuador, especially in the capitol city of Quito, conducted by the CDF's General Secretariat with a wide variety of public and private institutions.

Evaluations of the CDF's history (Corley Smith, 1990) and role in Galapagos have resulted in international recognition of the unique symbiotic and productive relationship which has been forged between the key institutions involved, for the benefit of the conservation of the Galapagos (Charles Darwin Foundation, 1980; Fundación Charles Darwin, 1993). On the one hand is the GNPS, its parent organization INEFAN (Ecuadorian National Institute for Forestry, Natural Areas and Wildlife) and other governmental organizations, endowed with the legal powers necessary to conserve and manage the Galapagos National Park, the GMRR, and natural resources; and, on the other, is the CDF, an independent, international, non-governmental organization dedicated to scientific research and attracting the human and financial resources needed to provide support to conservation of the archipelago, from the international community.

POPULATION AND DEMOGRAPHIC CHARACTERISTICS

Prehistory, Discovery and Early Visitors and Colonists

Evidence clearly indicates that the Galapagos never had aboriginal peoples as residents. There is some limited evidence (Heyerdahl, 1963), rather tenuous, that the islands were visited before their discovery by Inca voyagers.

After accidental discovery by the Spanish under the then Bishop of Panamá, Fray Tomás de Berlanga, in 1535, the islands became the base for a succession of seafarers who used them as anchorages and refuges, as well as places to obtain water (in season), firewood, salt and fresh meat "on the hoof" (giant tortoises). In succession and sometimes overlapping, these seafarers included first pirates (late 1500s to early 1700s), then whalers (late 1700s to late 1800s), fur sealers (late 1700s to early 1900s), and for shorter periods military vessels during wars (e.g. War of 1812 between Great Britain and the USA). During those 300 years the islands began to suffer the first major impacts from mankind. The damage to whale populations must have been enormous, given the several hundred whaling ships from Great Britain and the USA which operated there for a century. Fur seals were driven almost to extinction. Tortoise populations were hugely diminished, and in at least one and perhaps two cases became extinct as a result of heavy direct predation by seafarers, combined with early colonists' impacts. The first known case of an introduction of domestic mammals occurred due to seafarers: goats to Santiago Island in 1813. However, it is not unlikely that rats and ants or other invertebrates may have escaped from ships to other islands during this period of several hundred years.

Ecuador officially annexed the islands in 1832 and began the first serious attempt at colonization on Floreana Island. The colony soon turned into a penal settlement for political and other prisoners. From then onwards for the next nearly 100 years the islands' history (Hickman, 1985) was characterized by repeated colonization attempts followed by the settlements usually being turned into penal colonies and the prisoners being used as virtual slave labor; most were ill-fated. During this period efforts were made to commercially exploit fisheries, salt mines, dyer's moss (a lichen) and giant tortoises (oil for cooking and for lighting of the city of Guayaquil on mainland Ecuador), all mainly for export. First dates for colonies being established on other permanently settled islands were 1847 on San Cristobal, 1893 at Villamil on southern Isabela, and 1926 at Puerto Ayora on Santa Cruz. Santiago Island was temporarily colonized during the 1930s and again the 1950s-1960s due to a salt mining operation at James Bay (Puerto Egas). The fifth island to be permanently colonized was Baltra, which initially was a US military base from 1942-45 for protection of the Panama Canal, and thereafter has continued as an Ecuadorian military facility.

By 1900 the population of the islands numbered approximately 600, having grown slowly over the previous six decades, as the colonies on San Cristobal, Isabela and Floreana gradually took hold. It was during this period that domestic and human-commensal species such as cattle, goats, pigs, dogs, cats, donkeys, horses, black rats and house mice and a whole range of plant species were introduced to the archipelago. By the time Charles Darwin visited Floreana just three years after settlement he noted feral goats and pigs to be common. Many of these species are very aggressive invasives in Galapagos (and elsewhere usually), becoming serious competitors or predators of native plant and animal communities and/or species. Most heavily impacted were the three inhabited islands, but some species were introduced more widely to uninhabited islands, both accidentally by humans in their wanderings (e.g. black rats on Pinzón Island) as well as purposefully, e.g. goats to Baltra, Española, and Santa Fé Islands (food for fishermen). This was the period when the archipelago was "seeded" with the first wave of seriously invasive and destructive exotic species.

3.2 Continuing Colonization and Population/Demographic Patterns

Figure 4 shows the overall trend in population size in the Galapagos from 1900 to the present. From 1900 to the late 1940s the net increase was almost nil. Although detailed data are not available, we know from interviews with older residents that migration to the islands was a slow steady stream during those decades, but that there was a virtually equal backflow to the continent. Galapagos presented a relatively harsh and extremely isolated environment for settlers, many of whom abandoned their efforts after attempting the largely subsistence level existence possible in those earlier times. Figure 4 also does not show that there was a notable decrease in population in 1904, after a slave/prisoner revolt resulted in the murder of Manuel J. Cobos (the so-called "Emperor of Galapagos") at the sugar plantation (virtual penal colony) on San Cristobal Island (Latorre, 1991). That outmigration after the plantation was closed was notable on that island, but by 1910 overall migration to the islands had rebuilt the population nearly to the previous level.

Beginning with the major earthquake in the Tungurahua Province of continental Ecuador in 1949, a period of population growth in Galapagos started which lasted until the early 1970s. It was characterized by waves of colonists flooding in after a series of earthquakes, droughts and similar natural disasters on continental Ecuador, and as word of the islands spread among relatives, friends and acquaintances.

Population growth was considerably reduced thereafter from the mid-1970s until the early 1980s, as the new economic activity, nature tourism, became established and started to slowly grow.

The truly major growth in the population has occurred since the early 1980s, fueled by the nature tourism industry growth boom, as shown in Figures 4, 5 and 6. This has still not abated and annual population growth rates have been variously calculated as being approximately 5.9% to 8.5% during the period 1990 - 1995 (Carrasco, Grenier and Rodríguez, 1994; de Miras, 1995). The most commonly accepted value is approximately 7.8%, of which 1.7% is estimated to be the internal annual increase rate and 6.1% that due to net immigration. At those rates (5.9 - 8.5 %) the population will double every 7 - 12 years approximately. Using even the lowest figure, that gives an increase in population from 1995 at an estimated 14,000 to 20,000 in 2003, 40,000 in 2015 and 80,000 in 2027 (de Miras, 1995).

Several other key points about the demography of this population growth are the following (Andrade, 1995; Carrasco, Grenier and Rodríguez, 1994; Gylbert, 1995; de Miras, 1995; MacFarland, 1994; de Miras, Andrade and Carranza, 1995; de Miras, Grenier and Andrade, 1995a):

- a. The growth has not been equally distributed among the inhabited islands. The greatest increases have been on Santa Cruz Island, where the port village of Puerto Ayora developed into the first and only tourism support base from 1969 to 1987. It is also the home of the headquarters of the GNPS and CDRS. However, beginning in 1987, with the construction of an airport at Puerto Baquerizo Moreno, San Cristobal Island (also the official capital and governmental administrative center for the Province) became a second tourism support center and has been steadily growing in that role, and showing notable immigration and population increases. Puerto Villamil on Isabela Island has been experiencing growing immigration and population increases, especially over the past 3-4 years, due to changes in the fishing industry, from traditional fisheries for use in Galapagos and export to continental Ecuadorian markets, to export for international ones. It also is poised to become a third tourism support center, as an airport is being constructed there. Floreana Island is out of the mainstream of these changes and appears to have a steady state population. Baltra Island has a small, stable, but frequently changed, military population.
- b. As would be expected, a notable portion of the immigrants to the Galapagos have been and are skilled and semi-skilled workers directly hired by tourism operators and brought to the islands. Another notable group are small to medium-sized entrepreneurs, intent on establishing themselves via small businesses in the nature tourism industry (small tour boats, day tours, small hotels, cabins, restaurants, transportation, souvenir shops, artisans, guides, etc.) or related services and industries (construction, skilled trades and shops, etc.). Another rapidly growing sector are skilled and semi-skilled workers seeking employment in the rapidly expanding services, transport, commerce, construction and trade industries. However, also included are growing numbers of mostly unskilled urban poor and rural, landless, poor agricultural workers ("ecological refugees") from previously devastated areas of continental Ecuador. Finally, over the past few years, especially 1994, the population of fishermen has sharply increased, as indicated in point "a" (Figure 7). In short, Galapagos has become a development pole, inside a relatively poor developing country, and all types, virtually, of immigrants are flocking to the islands. The economic sector which has expanded and is expanding most rapidly is services, but notable increases in construction, transport and communications, and commerce have occurred.
- c. Recent studies indicate a sizeable "floating" population of "immigrants" to the islands, who spend part of their time in Galapagos, but much of it also on continental Ecuador. They float in and out, acting as middlemen in various resource extraction industries, including the new wave of extremely lucrative export fisheries, and/or bring goods and or services to sell in the islands, later returning to a home base elsewhere. Most appear to be trying their hand at various economic

activities, hoping to find some get-rich-quick scheme, make a sizeable amount of money and then leave.

- d. Of extremely serious consequence for the archipelago is the fact that a very large majority of the population has arrived in the past 5-10 years. One random survey of 214 households distributed among the four inhabited port towns, in 1994, showed that 73% of the persons had arrived since 1986 (Carrasco, Grenier and Rodríguez, 1994). This new population, in large part, sees the archipelago as just another place to make a living, not as a unique place in Ecuador and the world. They were not born and/or raised in the Islands with the gradual establishment and growth of the National Park Service and the idea that the archipelago must be managed for conservation goals and with very special treatment.
- e. The public educational system in Galapagos has virtually no specially designed components to adapt it to the ecological conditions, conservation needs and human reality of the islands. The curricula in use are basically those designed for continental Ecuador. The secondary and primary schools are not equipped with the human, physical plant, curricula design or other educational resources needed to attend to the needs of the rapidly growing student population. The educational system has not contributed substantially to improve the quality of life of the population, nor to articulate teaching and training to appropriate employment and careers needed in the special situation of the islands (e.g. tourism industry), nor to informal education of the family. This is a particularly disconcerting situation because one of the serious problems connected with the migration-driven population growth is that the immigrants have an extremely poor to nil understanding of conservation concepts and practices. The general attitudes range from "subsisting at whatever cost" to "making oneself rich within a few months" (Rodríguez, 1994).

One of the main factors which aggravates the rapid, mainly immigration-caused population growth is government policy (or lack thereof) on costs of basic human services in Galapagos. Virtually all key services such as potable water, electricity, solid waste disposal and air transport between the continent and Galapagos are subsidized substantially by the government, in one form or another. The prices paid by local residents (including new immigrants) are far below the real operational costs for such services. In some cases, such as air flights, costs in Galapagos are even far less than on mainland Ecuador for equivalent services. Round trip air tickets for foreign tourists cost approximately four times and for Ecuadorian (nationals) tourists twice as much as the cost for Galapagos colonists/residents (at present, April 1995, the approximate values are US\$ 400, \$220 and \$90 respectively). In this case the approximately 53,000 tourists per year visiting the islands are in effect subsidizing (unknowingly) the costs of travel between the mainland and Galapagos for residents and new colonists via this pricing scheme. This same basic scheme has been in operation since the early 1970s, not long after tourism began. Such policies offer major additional incentives to migrate to and remain in the islands, when added to the prospects of improving one's economic gains and the islands' major advantages in public and environmental health terms (absence of malaria and most other major tropical human diseases, relatively low pollution, etc.).

PROBLEMS AND TRENDS IN CONSERVATION AND DEVELOPMENT

Part A

The following sections describe and analyze the major conservation and development problems in Galapagos, all basically caused by a combination of population growth and consumptive pressures on biodiversity and scarce natural resources. For convenience and to order the ideas expressed, the analysis is divided into several major subsections, even though it is recognized that many of the themes, problems, causes and symptoms are intimately related.

4.1 Primary Economic Sector Activities

4.1.1 Agriculture and Livestock

Arable land appropriate for agricultural and related activities is extremely limited in Galapagos. Due to its relatively young geological age, the archipelago's soils are extremely superficial, interstitial and rocky. Areas with potential for agriculture are limited to a few islands with relatively high mountains receiving humid winds from the Southeast. Four of the inhabited islands (San Cristobal, Santa Cruz, Floreana and southern Isabela) have areas historically dedicated to agriculture and cattle raising, which in total cover 2.9% of the total surface area (Cifuentes, 1984). That apparently small area is almost 100% of the area potentially capable of supporting very limited agricultural development (ORSTOM-FCD, 1994, cited by Carrasco, Grenier and Rodríguez, 1994).

The major colonization waves of the 1949 - early 1970s period were mainly poor farmers and some fishermen, from mainland Ecuador, especially the Provinces of Tungurahua, Loja and Manabí. They adopted agriculture and cattle raising as their main productive activities, with fishing as a secondary main economic subsector. Many of the agricultural activities were for subsistence or extremely limited local bartering and sales, but certain activities such as cattle raising and coffee production became the main agricultural exports to continental Ecuador, and the mainstay of the economy, along with dried and salted fish for export to the mainland. In the 1960s agriculture, cattle raising and fisheries accounted for almost 60% of the economically active population, which then fell to 32 % by 1974 and 18% by 1982, as the tourism sector expanded and absorbed more and more employment, both new immigrants, as well as persons formerly active in the agricultural, cattle raising and fisheries sectors. By 1990, those three activities accounted for 20% of the economically active population, due to the resurgence of fishing in the late 1980s - early 1990s. Even now, with tourism by far the greatest production sector, cattle raising and agriculture remain as the main or only source of income for an estimated 8-10% of the population.

Agriculture and cattle raising have produced dramatic impacts upon natural areas on various islands in the Galapagos:

- a. The humid middle to higher elevation areas where those activities have been developed contain the highest biodiversity of the archipelago, and it is certain that natural communities have been drastically changed and impacted in those areas on the four islands where such colonies have developed (Hamann, 1979a, 1981, 1984, 1991, 1993a, and 1993b). Habitat loss and fragmentation have been very notable in those areas, in some cases almost obliterating entire habitats or plant communities, such as the Miconia belt on Santa Cruz Island. In total, the affected areas cover approximately 2.7% of the islands' total land area, but an estimated 60% of those humid middle and higher elevation habitats.
- b. Both productive activities require the introduction of plants and animals to the islands. Recognizing that agriculture and cattle raising are not the only human activities with which such introductions are associated and that the earliest introductions began several centuries ago, it is still true that very large numbers of introduced species have been brought in for agricultural and livestock use or accidentally in association with such, beginning with the first settlements last century and especially heavily with the waves of agriculturally-oriented settlers of the 1940s - 1970s. The most alarming trend is that the rate of introduction of foreign species has climbed dramatically over the past decade, as compared to all previous historical time in the Galapagos. For example, it required over 400 years (1535-1984) for the first approximately 200 foreign species of vascular plants to be introduced to the Islands by man (Porter, 1984) ; over the past decade it appears as if another approximately 100-150 or more species may have been introduced (Hamann, 1991; Lawesson, 1990b; Lawesson, et.al. 1987; Whelan, 1992; 1994). Studies on Santa Cruz Island alone indicate that in the period 1980-83 at least another 88 new (to that island) exotic taxa of plants were brought to that island, the majority from the South American mainland, but also from other inhabited islands in Galapagos (Aululima, 1984). The same trends appear to be occurring with invertebrates and even vertebrates such as birds and reptiles (Blanton, 1993-1995; CDRS, 1995; Peck, 1994; Whelan, 1992; 1994). Likewise, once established, many foreign species are being spread more rapidly among the Islands than ever before (Blanton, 1993-1995; CDRS, 1995; MacFarland, 1994).
- c. On most oceanic islands, visited or settled, humans have been a major destructive influence by clearing of land, polluting water and overexploiting the resources. However, by far the single most

disruptive force on oceanic islands worldwide always has been the introduction by humans, both purposefully and accidentally, of exotics or foreign species, to those isolated settings. The endemic and native fauna and flora have evolved in the absence of such predators and competitors and do not have defenses against them. That phenomenon is what has caused the major extinctions of species and massive disturbance to habitats and ecosystems on almost all oceanic archipelagos and islands of the world. The Galapagos too have been notably impacted at population, species, habitat, community and ecosystem level by such disturbance, if not yet massively at the species extinction one (Hoeck, 1984; Figure 8). However, the islands probably are approaching the verge of major cascading extinctions unless current trends are reversed.

- d. Habitat loss and fragmentation has been severe in the agricultural zones of the inhabited islands, as already explained under point "a" of this section. However, in addition there has been severe habitat modification and partial fragmentation, especially over the past century (in some cases probably starting even earlier) on a number of uninhabited islands, due to the impacts of large populations of feral herbivores - cattle, donkeys, and/or goats - and one omnivore, feral pigs. The major problem has been feral goats, and the most affected islands Española, Marchena, Pinta, Santa Fe, and Santiago. Through major campaigns over the past 30 years by the GNPS and CDRS, goats have been eradicated on the first four of those islands, as well as a couple of smaller ones (Rábida and Plazas Sur), and the habitat modification and fragmentation largely reversed through natural regeneration (Hamann, 1979a, 1984, 1993a). On Santiago Island, the largest one yet in Galapagos on which eradication campaigns are being attempted, it has been possible to decrease pig populations substantially, but not yet begin the huge, time consuming, expensive campaign needed for goats. The island has been so severely affected by the combination of those two feral species, especially the goats, that recuperation of the island's ecosystem and natural habitats, even if eradication is eventually accomplished, remains in doubt (Hamann, 1993b). A similar potential situation is developing on the central volcano, Alcedo, of the five major ones which make up the largest island in Galapagos, Isabela. An extremely large goat population has been slowly increasing in size and destructiveness over the past 1.5 decades and major damage to the communities and habitats of the volcano has now begun to occur over the last couple of years.
- e. Although most new immigrants are seeking employment in the tourism and related sectors, considerable numbers of rural poor farmers continue to arrive seeking work in agriculture and livestock raising. Most original land owners have abandoned working their ranches and farms themselves, attracted by the more lucrative tourism-related activities in the port urban areas of Santa Cruz and San Cristobal. The same phenomenon is starting to occur on Isabela as farmers abandon their land and migrate to Villamil port to work in fisheries or related activities. Many of the new immigrants are needed to manage these absentee-landlord-owned and underutilized farm and ranch lands, some arriving on their own and others invited/contracted by land owners. This growing population of landless, poor farm and ranch laborers is increasing pressure for more land. Recent studies show that 55% of the population holds the opinion that the Galapagos National Park should be opened to colonization of parts of its land area. Several different possible areas for expansion have been mentioned, including the remaining Scalesia forests on Santa Cruz, Alemania region "pampas" on southern Isabela, and El Junco lake region on San Cristobal (ORSTOM-FCD, 1994, cited by Carrasco, Grenier and Rodríguez, 1994). All of those areas contain unique communities of plants and animals, in some cases the only existing remnants of such. Moreover, even if opened to agricultural use, those would not begin to resolve the supposed land shortage problem, due to their relatively small size.
- f. In reality large areas of previously used agricultural and grazing land lie abandoned in Galapagos: estimates in 1986 ranged from 30% to 54% for the four inhabited islands (Rodríguez, 1992 and 1993; Table 3). The trend has continued and the situation is even worse as of 1995. Most of those lands could be rehabilitated for agricultural and grazing use, in fact with proper existing technology use could be greatly intensified and production made more cost efficient, effective and environmentally acceptable. That would far more than eliminate the need for additional land to be opened to colonization to satisfy new settlers' demands. The problem is one of resolving existing land tenure patterns, land use planning and implementation, proper incentives, and wiser medium-term view economics. If trends are left as is and policies not

changed, nothing will be resolved and the attack will be directed at the National Park to open up more land, while massive abandonment of "used" land continues.

- g. Abandonment of farm and grazing lands causes other serious interrelated impacts:
 1. Existing farms have never adequately produced enough to cover local market needs for many products (beef is an exception), mainly because land use practices are so poor; abandonment exacerbates the problem. Dependency on basic foodstuffs from mainland Ecuador is heavy. In addition, because local farmers lack the technology, training and organization to provide high quality products and regular goods and services on a guaranteed basis, the tourism industry imports virtually all of its food and supplies from the mainland (Ecuador, Presidencia de la República, 1992a). Increased frequency of cargo transport increases the risk of foreign species introductions, which impact nature, agricultural areas (pests) and human health. Introduced rats and fire ants, for example, which have huge impacts on natural communities, also greatly decrease production from basic grain and vegetable fields and home gardens, and fire ants make adequate harvesting of coffee plantations very difficult. Imported products cost more in almost all cases than those produced locally, and economic impact is widespread on many residents.
 2. Abandoned farms are reservoirs for introduced species and have become serious sources of major problematical invasive plant and animal species which affect the National Park, crops in the agricultural zones and even urban areas. Examples are the massive areas of abandoned farms on Santa Cruz and San Cristobal which are covered with species such as guava (*Psidium guajaba*), pomarosa (*Eugenia jambos*), quinine tree (*Chinchona succirubra*), blackberry (*Ribes* sp.) and many other smaller plant pests.
 3. In 1974 still 42% of the Galapagos population lived in rural farming and ranching areas. That number in 1990 had dropped to 19% and certainly is even lower now (Carrasco, Grenier and Rodríguez, 1994). Only 1.4% of the land area is set aside for urban communities on the four inhabited islands (Cifuentes, 1984). Increasing population densities in the small urban areas are producing problems difficult to solve. Demands for electricity, potable water, solid waste disposal, sewage management and transportation services have surpassed the supply capacity. Until 15 years ago individual property holdings had a minimum size required to guarantee a proper human environment. However, now small areas of land have been subdivided so much that in some portions of the urban areas, especially on Santa Cruz and San Cristobal, conditions of crowding are similar to marginal neighborhoods in large cities of continental South America. Crime, violence, prostitution, alcoholism, drug addiction, delinquency, juvenile vagrancy and similar urban ills are on the increase in Galapagos. Municipal and national governmental capacity has been greatly exceeded by unplanned urban growth. Plans have been prepared in the past, but no technically based zoning or incentives have ever been implemented. Galapagos inhabitants are becoming extremely concerned about the future of their communities. Only 3.6% of the population sampled think that the future will bring equal or better conditions, and that only if strict immigration controls are imposed by the authorities; 66.4% are convinced that the future will bring ever worsening conditions to their communities (Carrasco, Grenier and Rodríguez, 1994).

4.1.2 Fisheries

The information in this section is based upon Andrade, 1995; Carrasco, Grenier y Rodríguez, 1994; CDRS, 1995; Ecuador, Presidencia de la República, 1992b; MacFarland, 1994; de Miras, Andrade y Carranza, 1995; Reck, 1986; and Reck and Rodríguez, 1978, plus personal communications by C. MacFarland with many of those same authors, CDRS personnel and other reliable sources.

Fishing was one of the main economic activities in the islands ever since settlement last century, and was maintained for over 100 years as a traditional, artisanal activity. Until some 50 years ago fishing was largely a subsistence activity. The multi-species, so called "whitefish fishery" based on the "Galapagos bacalao", a grouper, and other species of Serranidae (sea bass family) started in approximately 1940. The fishery is to produce dried and salted fish for export to continental Ecuador for the Lenten season. For several decades it made up 100% of the fisheries catch exported out of the islands. By 1973 whitefish made up only 76% of the total annual catch in Galapagos, in 1978 it was approximately 45% and by 1989

it had fallen to only 20% of the total. Even though effort has been increased and equipment improved somewhat, total catch has systematically declined, which suggests that populations have been overfished (Ecuador, Presidencia de la República, 1992b).

Lobstering for local use and export to the continent and internationally developed slowly in the mid-1960s to 1970s. As lobster populations dwindled in the mid-to-late 1970s, the Navy banned international export for five years which resulted in the 12 vessel fleet being reduced to one boat within a month. It was a semi-industrial activity with only one large ship and numerous small local ones operating in 1982 when international export opened again. Annual catch up to then in the early 1980s was approximately 32 metric tons/year. From 1982 - 1986 lobstering developed rapidly and annual capture increased 300%. By 1987 it had become clear that considerably greater effort was needed to capture similar quantities to four years before, average size of individuals was considerably smaller, and greater diving depths were required, meaning that the populations were being overexploited. Lobstering attracted new immigrants, 90% of the lobster fishermen coming from mainland Ecuador and most settling permanently in Galapagos. At present it is clear that lobster fishing is extremely difficult and requires more sophisticated equipment, more effort per person per day and deeper immersion, because of the major reduction of the populations caused by overfishing .

Fisheries in Galapagos are presently in a totally chaotic situation. The marine area of Galapagos is under assault from three types of fishing. First, large international fishing vessels, mostly from Asiatic countries, are fishing around the Galapagos in pelagic zones, and often inside the GMRR. Most of this fishing is illegal and involves devastating, modern, high-technology methods such as large seines and long-lining. Second, some modern ships from the Ecuadorian mainland and foreign ships (mainly Asian) with Ecuadorian permissions and/or flying the Ecuadorian flag are also fishing both pelagically and nearer to shore. This fishing is legal, but there are reasons to question to what extent they obey the rules laid down by Ecuadorian fisheries laws and regulations. Third, with increased migration to Galapagos, one of the fallouts has been growing interest from mainland Ecuadorian fishing companies and middlemen buyers in what resources could be extracted and sold on the international market. This has been fueled by Asian markets for many of these products as well as capital from those countries. These interests have moved into Galapagos from the mainland and are using the local traditional fisherman of Galapagos as their labor source, and loaning them money or arranging bank loans to purchase boats and equipment. The local fishermen are abandoning their traditional fisheries in favor of these new short-term, rapid economic gain, export product ones. Likewise, these lucrative operations are causing a rapid influx of poor fishermen from the mainland of Ecuador as new migrants (Figure 7).

This interest in making rapid profits from massive extraction of certain marine species for export to specialized foreign markets has reached Galapagos precisely because of the condition of fisheries worldwide. Demand is voracious and supplies are dwindling. Worldwide fisheries are collapsing almost everywhere because of severe overexploitation and the use of inappropriate high-technology approaches. Except in extremely rare, very localized cases, fisheries worldwide are not whatsoever sustainable: market demands can not be satisfied with supply on a self-sustaining basis. Those few apparent exceptions ("apparent" because most have not been studied over a long enough time to prove that they truly are examples of sound sustained yield use and management) are cases of local fishermen using truly simple traditional techniques to fish not easily caught species, or cases of sea "farming" of certain species such as conchs, other molluscs, algae, sea urchins, sea cucumbers in two rare cases (one in Japan and one in China), etc. Examples of collapses are the total failure of the fisheries of eastern Canada in the 1990s, of the "anchoveta" fishery of Peru in the early 1980s, the virtually dead Jamaican fisheries (1970s) and the coming collapse of fisheries on the west coast of Canada and both east and west coasts of mainland USA and Alaska. Of course, the Asian countries long ago fished out their own waters of many commercial species, and they have been gradually and inexorably marching across the rest of the world destroying those fisheries also, through short-term, maximum economic gain, massive overexploitation.

Not surprisingly, that wave of destruction hit the South American mainland in the 1970s and 1980s and has more recently spread to offshore islands, as the mainland fisheries have been fished down to anti-

economic levels. That pattern, clearly demonstrated in the cases of Peru and Chile, also has proven to be true in Ecuador: first a given new export fishery is developed rapidly on the mainland and then driven to virtual extinction within only a few years, by overfishing; then the companies search for a new fishery and repeat the same process with another species or group of species (e.g. lobster, sea turtles, sharks, sea cucumbers, moray eels, sea urchins). Eventually, depending on short-term economic gain market forces, some of those same fisheries move on to the Galapagos, especially as fewer and fewer opportunities for fishing are available on continental Ecuador (e.g. this has already happened with lobsters, sharks and sea cucumbers; the next likely cases to arrive to Galapagos will be fisheries of sea urchins and moray eels; even perhaps an attack on the long protected sea turtles, and, even sea lions, in the last case for their penises and baccula for the Asiatic aphrodisiac trade). Interested parties from mainland Ecuador and their foreign market contacts already are looking for new species to exploit in massive fashion in Galapagos: e.g. samples of sea urchins and sea lion penises taken in recent months (CDRS, 1995).

These are true rape and pillage fisheries. The end result is that a small number of companies and individuals end up considerably more wealthy. The poor fishermen who are involved in the process experience a brief increase in living standards, but most of them fall back into poverty once again when the resources are reduced to economically (and, almost always, biologically) unsustainable levels. The intermediary buyers and companies abandon the fishermen. The government is left with another group of poor for whom it must somehow look for alternatives. The pressure is even greater than before because many migrants have flooded into the area and brought their families and even relatives, when the fishery was expanding. The marine environment is ever more impoverished in terms of its biodiversity, with far reaching consequences in terms of long-term destruction of ecosystem structure, functions and dynamics, and, therefore, elimination or severe reduction of the country's future potential and options for economic and social development.

The process described is already well underway in the Galapagos. Lobsters already have been reduced to a level in which it will take considerable time for their populations to recover. Sea cucumbers, which are strictly for export to foreign Asiatic markets (both in Asia and elsewhere), have been heavily fished since 1992 and are well on the way to being rapidly fished out, by local Galapagos fishermen and a wave of new immigrants to the islands. Shark populations are being severely damaged by illegal longline fishing by large vessels (not local fishermen), but in two past outbreaks of this fishery (1989 and 1991) some local fishermen also became involved. All this is happening despite the fact that the GMRR has an officially government approved (by Presidential decree) management plan which expressly prohibits these types of fisheries and that since 1991 shark fishing has been banned. Unless major steps are taken the process will simply continue, species group by species group, until the GMRR becomes a totally fictitious "protected area on paper".

The sea cucumber fishery in Galapagos illustrates the above points well. Sea cucumbers began to be exploited in mid-1992. In addition to being a totally illegal type of export fishery according to the zoning and management scheme approved in the GMRR Management Plan (Ecuador, Presidencia de la República, 1993), the fishermen were making large camps on land in totally off-limits areas of the Galapagos National Park, e.g. on Fernandina and western Isabela islands. In August, 1992 an additional specific total ban on the fishing of sea cucumbers was issued via Presidential decree. A small number of middlemen buyers interested in the very lucrative sea cucumber trade then continued to manipulate the situation with both the poor local and migrant fishermen in Galapagos as well as with some governmental fisheries management authorities. They were increasingly successful over the next 20 months in creating both extensive social unrest and major interest from some fisheries authorities in opening up a legal sea cucumber harvest. The official arguments were based upon some totally dubious biological data, but the real driving force behind the scene was the extremely lucrative nature of this fishery. Despite major warnings based on studies and information (UICN, 1993) at international level and surveys of sea cucumbers in the Galapagos, which emphatically demonstrate that nowhere in the world has there ever been a sustained yield sea cucumber fishery of tropical species (instead most of Asia, Micronesia and other areas of the world are rife with areas from which sea cucumbers have been either totally extirpated or reduced to levels that may never permit recovery), the Fisheries Development Council in Ecuador proceeded in June 1994 to authorize a three month long "experimental" fishery. That set a limit of

550,000 sea cucumbers to be allowed to be taken between October 15, 1994 and January 14, 1995. Far less than thirty days into the fishery season the limit was reached and by December 15, 1994 it was estimated that the catch in reality was in the range of 8-12 million. Only some 420 fishermen had legal permission to participate yet by mid-November an estimated 850-900 were involved, many having migrated to the islands in the previous weeks. Estimates also show that some 70-80 boats and 130-150 dinghies were operating at the height of the fishery. An inspection in early December, 1994 by National Park authorities and the Fisheries Administrator in Galapagos demonstrated dozens of violations, with virtually every boat involved: fishermen without legal papers; boats without legal permissions; illegal taking of many other species (horse conchs, sea horses, sea turtles); badly substandard health and living conditions on the vessels; illegal, poor quality equipment,). The situation became so scandalously intolerable by mid-December that the Vice Minister for Fisheries stopped the season one month short. There followed in early 1995 a takeover of the GNPS and CDRS facilities and threats by the fishermen to sabotage conservation programs in the islands, interrupt tourism operations, and harm both CDRS staff and unique endangered species, unless the fishery were reopened and other demands met. Some authorities wavered and gave in to the demands, at least in part. This just encouraged further lack of respect for authority. In the end the matter was temporarily settled by a combination of a promised two month evaluation of the impacts of the "experimental" fishery, after which a decision on whether to reopen it or not would be made, and the sending of troops to Galapagos to protect public facilities, the GNPS and the CDRS. As of this writing the ban is still in force; the official evaluation supposedly has been done by the National Fisheries Institute (under orders from the Fisheries authorities) but the results are being withheld from public scrutiny; the fishermen have received overfished (10 tons allowed in total; over 30 tons taken in less than two months); and, sea cucumbers continue to be fished illegally and smuggled out of the islands, but at a rate of probably only 20-30% of what was happening during the legal fishery in October-December 1994. Since sea cucumbers are sedentary animals, extremely easy to collect and process, and fetch extremely high prices in Asian markets in Asia and elsewhere, it is not difficult to predict to what point this process will lead. Throughout this entire process, 1992 to the present, there has been only extremely limited action by authorities to stop such.

In the meantime ongoing studies of the species specific and broader ecological impacts (CDRS, 1995) and of the social and economic effects of the fishery (de Miras, Andrade y Carranza, 1995), both give extremely solid reasons as to why the entire "experimental" fishery was a total ecological, social, and economic failure and should never have been permitted in the first place. Those also indicate that much of the area of the densest sea cucumber populations has already been heavily impacted by the three years of fishing, thus decreasing its economic attraction for the middlemen buyers, and increasing the probabilities that other species soon will become the new focus of massive export fisheries. Likewise, a major social problem has been created: there are now over 800 poor fishermen in the islands, over four times the population of just a few years ago (Fig. 7).

Finally, these types of "gold rush" fisheries also bring with them other not so immediately obvious threats to the unique and fragile Galapagos environment. Fernandina is one of the largest undisturbed islands in the world, devoid of introduced species, an extremely rare condition in the world. Sea cucumber fishermen have been illegally camping on shore, cutting protected mangroves for firewood, and bringing fresh food and other products on shore, with an extremely high danger that they will introduce rats, ants, other insects and/or seeds into one of the most pristine areas remaining on earth. Moreover, the scarce forests of tall mangroves on western Isabela and Fernandina islands are the only habitat of the rarest species of Darwin's finch, the tool-using Mangrove Finch. Cutting those heretofore undisturbed forests directly endangers that bird species.

4.2 Secondary Economic Sector Activities

The main activities in this economic sector for which data are available are construction, commerce, transportation and communications, manufacturing industries, financial establishments, electricity/gas/water, and mining and quarrying. The last of those is miniscule in Galapagos and the three before that one are all very small still, but slowly growing. Construction, commerce and transportation and communications have all been growing rather rapidly in the periods 1974-1982 and 1982-1990, since

those are intimately related to growth in the tourism sector and to the general increase in population, especially because of migration. As measured by changes in the Economically Active Population, those three sectors increased by annual growth rates of approximately 20%, 19% and 15%, respectively, over that 17 year period (INEC, 1974, 1982 and 1990).

The impacts of these activities are mainly seen in the following areas:

- Increasing pressures on both endemic and native tree species for construction materials for tourism and fishing boats and dinghies, housing, and other facilities. This has reached the point that the endemic tree species *Piscidia carthagenensis* (matarsano) is being seriously overexploited within the National Park (both in Special Use zones legally and illegally in other areas) on inhabited islands. That slow growing species will eventually become threatened unless adequate replacement species are found. The CDRS and GNPS have an agroforestry program which is working towards those solutions at an experimental level with a number of farmers on Santa Cruz island.
- Increasing mining of sand from beaches and a variety of types of volcanic products (scoria) from inland areas of the inhabited islands, for construction purposes. This has gone to the point that the once abundant sandy beaches in and for many kilometers around the main ports have disappeared (Puerto Ayora, Santa Cruz and Puerto Baquerizo Moreno, San Cristobal). The mining of scoria is not a problem generally, as long as it is done in a manner to avoid visual impacts and confined to a very few source sites.
- The steady increase in commerce and transportation between mainland Ecuador and Galapagos and among the inhabited islands results in gradually increasing probabilities of introductions and spreading of exotic species to and within the archipelago.

4.3.1 Tourism

Tourism has been the main economic activity in the Galapagos since the mid-1970s, not long after it began in an organized fashion in 1969. As measured by Economically Active Population, tourism is by far the single greatest employer in Galapagos, directly employing approximately 40% of all those economically active (Carrasco, Grenier y Rodríguez, 1994). From 1974 to 1991, census figures show that the increase in Economically Active Population in the "Services" sector has averaged approximately 9.5% per year (INEC, 1974; 1982; 1991), and the vast majority of that is specifically in the tourism sector. Figures 5 and 6 express this rapid growth, especially since the mid-1980s, in terms of numbers of tourists and number of tourism vessels operating.

Except for some pollution (see section 4.4.3), the tourism industry so far has produced very little direct impact, i.e. by visitors, crews and vessels, upon the biodiversity and environment in Galapagos. Much of this is due to a very well-designed tourism management system established in the early 1970s, which includes:

- Marked trails (in most visitor sites) or marked areas (a few less fragile visitor sites) within which visitors must stay, but which allow them excellent proximity to and views of wildlife and habitats;
- A system of trained, licensed (by the GNPS) naturalist guides who must accompany tourists on all visitor site visits, with a maximum of 20 persons to one guide;
- Only day use in the vast majority of visitor sites and camping/overnighting at only a few less fragile sites in designated, primitive camp sites, with pack-it-in/pack-it-out regulations and trained, licensed guides required to accompany groups in some cases;
- Itineraries programmed well in advance for all the large and medium-sized tourism vessels (approximately 15) to distribute use and avoid crowding at visitor sites; smaller vessels (total approximately 80) are allowed to organize their own itineraries, but within a designated maximum set of visitor sites assigned to each, among the 55+ sites now in operation.

Monitoring shows that there has been some limited damage to geological features in a few sites; slight, acceptable, normal trail wear at most sites; and, varying degrees of erosion (mostly slight) at a few others. However, overall impacts have been very minimum and the few problem areas have been corrected by use of raised platform trails, stairs, or similar simple wooden structures (GNPS, 1975-1995). Likewise, impacts on vegetation have been absolutely minimum due to the system described above. In the case of animals, long-term monitoring studies on the impacts of visitors' presence and activities along trails have been conducted since the early 1970s on a variety of colonial nesting sea birds, by comparing visited sites and non-visited similar control colonies. Results show no detectable impacts whatsoever on bird populations' distributions, reproductive success, and other similar measures (Tindle, 1983).

Except for some pollution problems, tourism's major real impacts in the Galapagos have been the indirect by products of that industry's growth boom, especially over the past ten years. The constantly increasing damage and threats from exotic species introductions, human population growth, extraction of resources for export markets, direct impacts on biodiversity and resources for direct local consumption, and increasing human consumption patterns in general, all have their origin in the economic boom brought by tourism. These aspects are covered in other sections of this report. It is worth pointing out that the economic boom in the case of Galapagos happens to be tourism-based. It could have been based on some other industry, and most of the by product outcomes and trends probably would have been largely the same, probably far worse had they involved major agricultural settlement programs, directly polluting industries, massive extractive fisheries or similar uses.

There is no doubt that the model of nature-oriented, educational, tightly controlled tourism established in Galapagos 25 years ago has contributed significantly to the conservation of most of the archipelago's ecosystems. However, that well-designed tourism and visitor management system which functioned so well from the early 1970s until the mid-1980s has begun to show major signs of considerable strain over the past 8-10 years. Some of the key causes and symptoms of this ever-worsening strain are as follows:

- A partially outdated and inadequate zoning scheme for protection and use of the Galapagos National Park; a GMRR zoning scheme in need of improvements; and, lack of a refined zoning scheme to integrate rural and urban areas with the protected areas;
- Congestion and overuse of some visitor sites and underuse of others;
- The unplanned appearance of new modalities of tourism, such as day tours which use local hotels as a base, bay tours near port villages, diving tours, and sport fishing tours; these severely disrupt the limited, existing tourism and visitor management capacity of the GNPS and other agencies;
- Considerable pressure from some economic interests to introduce large scale foreign flag tourism vessels as a new modality;
- Growing numbers of newer operators with less experience and less sensitivity to the unique conservation values of the archipelago;
- A notable and growing proportion of guides with lower guiding capacity and quality and lesser sensitivity to conservation concepts, needs and practices;
- The almost total absence in Ecuador of a well-designed and appropriately applied and government controlled concessions system; a superficial look indicates some government control of such, but in reality there is little true control;
- Uncontrolled growth which has produced a tourism supply capacity well beyond existing demands (extremely economically unsound in the medium-term);
- Lack of cohesiveness and collaboration within the tourism industry and among the industry and all other key actors (industry, government agencies, conservation NGOs, research institutions, etc.), to resolve conflicts and build consensus for a truly sustainable tourism and visitor management system and process;
- A tendency for economic displacement of small local operators by larger outside sources of investment; and, spiraling inflation which causes local communities considerable disadvantages compared to larger operators with outside funding sources;

- Growing competition and conflict for certain basic services and supplies in the tourism support centers (Puerto Ayora and Puerto Baquerizo Moreno) between the tourism industry and local populations;
- Lack of an adequate planning, monitoring and evaluation process to determine when and how to adjust the tourism and visitor management system and tourism supply and demand, based upon sound ecological, social and economic principles and methods (true sustainability), such as the Limits of Acceptable Change (LAC) planning and monitoring process (Stankey, et.al., 1985) and the use of quotas based upon carrying capacity determinations at specific visitor sites (Cifuentes, 1992).

Wallace (1993) also points out a number of other detailed problems associated with and ways in which the tourism system, zoning scheme and visitor management design and practices in Galapagos could be improved, by using LAC and various other specific concepts, methods and techniques.

The key point is that if the trends indicated above are not corrected soon, a breakdown in the entire tourism system could easily occur. Uncontrolled, unmonitored growth in tourism will threaten the ecological integrity of the islands, the quality of visitor experience, and the economic viability of the industry itself. Everyone will lose in that case. The islands themselves and none of the actors involved in their use can afford for the present primitive capitalistic system to continue.

The Galapagos experience offers a unique visit to an isolated, fragile and largely untouched natural place, and many visitors relish the opportunity to become "modern-day Darwins" as they step from their vessels onto the islands. Conservation of marine and terrestrial biodiversity and resources must become a central tenet and primary commitment of the nature-oriented tourism sector if their own existence in Galapagos is to be assured and sustainable. Nature-oriented tourism still appears to be the best economic alternative for Galapagos and should remain as its central economic activity. All other economic activities should be linked tightly to it, with a substantial, long-term, steady flow of benefits to Ecuador as a whole and to the local Galapagos communities in particular. The emphasis must be upon long-term, steady benefits and not short-term, "gold rush" approaches which exhaust resources and destroy healthy social development.

4.3.1 Other Services

Numerous other services exist, but virtually all are tightly linked to and depend upon tourism as the central economic motor. Virtually all are growing in the same pattern as tourism.

4.4 Other Related Impacts

4.4.1 Habitat Loss and Fragmentation

This topic was basically covered in section 4.1.1 on the impacts of agriculture and livestock. The same types of fragmentation and loss processes occur in urban areas and around their perimeters. This has happened and continues to occur in and around villages, especially the ports, with the loss and fragmentation of mangroves, elimination of sandy beaches and similar changes. These changes still have not reached such sizeable proportions, as in the rural agricultural and grazing areas.

4.4.2 Direct Human Impacts on Resources

Many examples have already been given in other sections where they fit in well. A few other cases not yet indicated are:

- Intertidal organisms such as chitons, gastropods (snails), crabs, and others are being exploited heavily for several kilometers along shore lines around the growing population centers of the

ports on Santa Cruz, San Cristobal and Isabela. These are basically subsistence and artisanal hunting and gathering activities of the poorer economic groups, but they may be having major effects on those natural shoreline and intertidal communities.

- Open garbage dumps near most of the port towns are major sources of pollution for water supplies in some cases, as well as foci for some introduced animal species.

4.4.3 Pollution

This is one area in which the tourism industry, as well as the fisheries sector, may be having major impacts in the islands. There is no question that qualitatively and quantitatively the amount of solid waste in the islands has been increasing rapidly, especially that thrown into the sea from vessels. The other is that accumulating on land from local communities and the relatively few more conscientious tourism vessels which bring solid waste to Santa Cruz for incineration or disposal in "land fills".

No quantitative studies have been done, but there is unquestionably ever larger amounts of solid waste accumulating on beaches in the islands compared to just 1-2 decades ago. Disposable containers and plastics have come of age in Galapagos over the past 15 years, and are the root cause of much of the problem. They likewise make up much of what goes into the "land fills" (open garbage dumps on lava fields).

Impacts have not been studied, but visual impacts are obvious in numerous places that 10-20 years ago never had any notable accumulated solid waste. Other impacts are unknown quantitatively and qualitatively, except that individual animals are known to be killed or severely injured in a variety of ways by solid waste: sea turtles eat plastic bags; sea lions are lacerated by metal cans and strangled by items like pulley or fan belts.

This entire area needs to be explored, studies done and plans made for ameliorating trends if any of them are determined to be serious environmental threats, either biophysical or aesthetic.

4.5 Summary of Key Population Impacts, Conservation Problems and Potential Solutions

This paper was intended and attempts to describe and analyze human population and biodiversity/environmental impact relationships in the Galapagos Islands. It was not intended to cover in any substantial way actions underway or being planned to try to confront those problems. What follows is a brief summary of some solutions and actions which have been used in the past and others which are now being tried, just to inform the reader of some of the major ones.

4.5.1 Stabilizing the Human Population (Controlling Immigration and Population Growth)

The Ecuadorian government (Congress) is currently in the process of considering a set of reforms to the national Constitution. The President has included in that a proposed reform which would declare Galapagos as a "Provincia Especial" (Special Province), which would in turn allow establishment of a special set of laws for governing the Islands, including immigration controls. Experience in other parts of the world, e.g the states of Vermont and Oregon in the USA, San Andrés Island (Colombia) and the Bahamas, has demonstrated that such controls are difficult to legislate and even more problematic to enforce. Nevertheless, a special set of economic, legal and other incentives and disincentives to help slow and control immigration would be an extremely important part of a overall strategy to limit negative impacts in the Galapagos.

4.5.2 Loss of Isolation: Preventing Species Introductions and Containing the Spread of Invasive Species

Galapagos has suffered much from the loss of isolation problem. However conservation efforts beginning in the 1960s had begun to reverse many of those trends. Programs to protect and repopulate areas with

endangered species such as giant tortoises, land iguanas, dark-rumped petrels and some plants, and to protect the last remnants of entire threatened plant communities on some islands, were combined with campaigns to eliminate feral goats and pigs from some islands and control feral dogs, cats, rats and some introduced plants on several islands. Notable successes were achieved in the 1960s to 1980s.

However, a rapidly growing human population means a corresponding increase in human traffic from the continent to the archipelago and between the islands: more supply ships making more frequent trips, ever increasing numbers of air flights, more travel on local boats among the islands. In biological terms that translates into ever increasing opportunities for foreign species to be introduced to the archipelago by man, or, spread among the islands once established on one of them, be it purposefully for agricultural, domestic or ornamental uses, or accidentally as stowaways. The most alarming trend is that the rate of introduction of foreign species has climbed dramatically over the past decade as already explained in section 4.1.1.

Once foreign species have become established and spread it is far more difficult, costly and time consuming to control or eradicate them, than to prevent their introduction in the first place. In fact in many, probably most, cases such elimination or control are impossible, because the technology does not exist to do so, or it can not be adequately marshalled to cover large areas. That is especially true of most invertebrates (e.g. wasps, ants) and plants, but is even true of many vertebrates such as rats, cats, anis, geckoes, snakes, etc.

Even species which it has been possible to completely remove from small and medium-sized islands, e.g. feral goats, or to control in specific limited areas of other islands, e.g. dogs and rats, have so far been impossible to remove completely from the larger islands. In fact those species have spread gradually to new areas on those larger islands, or reinvaded cleared areas as soon as the control efforts have been relaxed even slightly due to budget or manpower shortages. Recent alarming examples are:

- Feral goat populations have spread from the south to the central volcano (Alcedo) of the largest island, Isabela, devastating the vegetation and threatening food shortages and major potential population collapse of the largest giant tortoise population remaining in Galapagos. The goats have now reached Volcan Darwin, one volcano further north and probably will move on to Volcan Wolf, the northernmost on Isabela, unless a major long-term removal and control effort is mounted very soon.
- Recent reports indicate that feral dogs may have returned to the Cartago Bay area of Isabela, where dogs had previously been controlled and a large land iguana population reintroduced in the late 1980s, after almost being eliminated by dogs in the mid-1970s and after years of painstaking work with a captive breeding and raising program to enable the reestablishment of the land iguana population.

With technical and scientific support from the Charles Darwin Foundation and other organizations, the government of Ecuador has drawn up new draft laws and regulations and is preparing plans for a Quarantine and Control program, emphasizing both inspection/control and education, to hopefully greatly reduce the introduction of foreign species to the islands and the spread of those already established in the archipelago (Whelan, 1994; 1995). This program needs to be initially established and then fully implemented as soon as possible and will require international technical, training and financial support because of its major cost and technical complexity.

Funds are urgently needed to attack the problem of feral goat control and gradual eradication on northern Isabela, to improve feral dog control, and to take on the huge task of finishing the clearing of feral pigs from Santiago, followed by removal of the more than 100,000 goats on that same Island. Santiago has been almost totally devastated ecologically by feral pigs and goats over the past century, but it could still be saved because 16 total hectares of native vegetation have been fenced in various plots at several elevations during the 1970s-1990s, to serve as seed sources for its eventual recuperation.

PROBLEMS AND TRENDS IN CONSERVATION AND DEVELOPMENT

Part B

4.5.3 Stopping "Gold Rush" Export Fisheries

In September 1994 a 5-day workshop was held in Galapagos on how to implement the GMRR, in which all relevant national and local government agencies, resource user groups and conservation NGOs participated. Substantial progress was made on discussing key issues and seeking negotiated agreements in order to be able to make recommendations to the government. But far more needs to be done to continue that positive process. The workshop was an excellent first step, but will require concerted follow-up action.

The President of Ecuador last Fall courageously ordered that Naval sea and air patrols be initiated in the GMRR and adjacent areas and has ordered that the possibility of a decree be explored which would expand the GMRR from 15 to 40 nautical miles around the Islands and banning all fishing of sharks within the GMRR. The President has also ordered that only local fishermen, who can prove residence and fishing activities of at least five years in the Galapagos, be allowed to fish in the GMRR and that the fisheries only be artisanal and strictly controlled. These points also probably would be considered for the potential new decree being considered. These are fine ideas, but require closer examination. For example:

- If it has not been possible to implement the GMRR Management Plan for the 15 nautical mile reserve and truly protect and manage that area, how will an expanded GMRR boundary of 40 nautical miles be protected and managed? What are the concrete plans for implementing the Management Plan, for following up on the September 1994 workshop? What types of support does the government require from the international community to help implement the reserve and the Management Plan?
- The ban on shark fishing is excellent, but local fishermen have already made clear that they are not interested in fishing sharks: it is too difficult; they do not possess the right types of equipment and boats in large part; they would rather be able to fish sea cucumbers, sea urchins and similar easily exploited, lucrative export species. Sharks are mainly being taken by long-lining by larger ships, not Galapagos fishermen. Enforcement of the ban will be difficult, unless the capacity to manage the entire reserve is installed and sustained.
- The terms "artisanal fishery" and "artisanal fishermen" are meaningless in the Galapagos context. With species which are sedentary or sessile, or otherwise easy to catch, and which feed into lucrative export markets controlled by middlemen in Ecuador and foreign buyers (e.g. sea cucumbers, sea urchins, sea turtles, etc.) it does not matter if the fishing technology used is simple, "artisanal" or "primitive". The end result is industrial level overexploitation and exportation, leading to eventual economic and biological extinction.
- How will the five year residence and fishing activities rules be applied? It is common knowledge in Galapagos that such residency identification cards can be bought easily, by anyone, regardless of time of residency and previous activities.
- How are the fisheries going to be controlled when the fisheries authorities do not have the infrastructure, equipment and manpower needed to do so?

Much more is needed or the GMRR will never be implemented.

Moreover, be it 15 or 40 nautical miles, the GMRR is a huge area, which will be extremely difficult to patrol and control adequately. Ecuador, being a third world country with all that implies, should be supported strongly by the industrialized countries via financial and technical cooperation support to enable it to seriously take on the task of protection and control. That implies long-range rapid vessels, patrol aircraft, much increased numbers and training of specialized protection staff, improved land-based

facilities for such equipment and staff, operational costs for a number of years to allow consolidation of the protection system, etc.

Some of the key actions needed are:

- Formally placing the GMRR within the National Protected Areas System of Ecuador via a decree classifying it as part of that system (it does not currently have such status);
- Placing the management of the reserve under the authority of a single government agency and requiring the cooperation of other agencies to support and aid that single agency in the management and implementation of the reserve (the current institutional jurisdictional status is vague);
- Strengthening that single agency with a specialized department or program aimed specifically to manage the GMRR, which implies special new personnel with appropriate training and a specific, substantial budget;
- Truly implement the existing, approved (in 1992 by Presidential decree) GMRR Management Plan, including the zoning scheme described in the plan which would establish zones for total protection; zones for nature-oriented, non-exploitative tourism use; and zones for traditional fishing of species not easy to capture (bacalao and other white fish and lobsters) using appropriate traditional technology and following improved, stricter regulations on sizes, sexes, fishing seasons, etc.
- Export fisheries, whether to foreign markets or mainland Ecuador, should be banned. Only Galapagos fishermen should be allowed to fish in the Islands and that artisanal industry should be tightly linked to the tourism industry, with regulations and incentives to insure that the tourism industry stops importing seafood to the Islands, and instead buys from local fisherman. This must be accompanied by studies to determine if sustainable fisheries for "white fish" (bacalao and related Serranid species) and lobster, by local fishermen for the tourism and local population markets, would be feasible; how many fishermen would that support and what would be the regulations to ensure viability of the fishery? Since such fisheries would probably not support more than 100-200 fishermen, if that number, ways to retrain and reinsert others into the tourism economy must be explored. Many others will have to simply return to the continent.
- Work with local fishermen to help them organize and unify their cooperatives, to train them in product preparation, quality control, and marketing requirements and operations to guarantee appropriate supplies to the tourism industry, and to eliminate middlemen and buyers from the outside.
- The international community must support Ecuador's efforts with major financial and technical cooperation support for the implementation of the GMRR Management Plan, because such an area of national and international importance can not be expected to be financed solely by its sovereign, owner country.

4.6 Institutional Management Problems

For over two decades the principal institutions charged with nature conservation in the Galapagos (GNPS and CDF) were also the most dominant and outstanding organizations in the islands in terms of their effective and efficient programs, local economic importance and influence, international and national prestige, and leadership of local public affairs. As happens in almost all cases worldwide, some normal conflicts between national park managers/CDRS scientists and conservationists and the local population occurred in the earlier years after the GNP was established. However almost 20 years of environmental education programs, involvement of local people in the process of national park management, participation of the GNPS and CDRS in local community affairs, and provision of new opportunities for economic improvement based on the National Park (nature tourism), created a population which was overall positive and supportive of the Galapagos National Park. However, charged with the extremely difficult responsibility of protecting the biodiversity, ecosystems and natural resources of the Galapagos, the two conservation organizations did not or were not able to give enough attention to the human system in Galapagos, with its development related problems and needs.

While scientific and conservation knowledge and practice were being rather well developed by the two organizations, both the conservationists and long-term Galapagos residents had confidence that other sectors related to human system development would be attended to by the proper national, regional and local governmental institutions. Unfortunately that did not happen in large part, and dissatisfaction has been slowly growing for several decades. Now both old and newer expectations have been raised again. The population is demanding attention and solutions to its problems, which are now more than ever difficult to attend to, due to rapid population growth.

Galapagos institutions, at all levels (national, regional and local), do not have the capacity to absorb the demand for services, nor to provide adequate advisory, planning and management guidance and leadership for local development (Ecuador, Presidencia de la República, 1992). Municipalities are not capable of providing adequate potable water, electricity, sewage, solid waste and land use/zoning services, nor to produce and enforce proper urbanization plans and policies. National and regional institutions have failed to accomplish their objectives in Galapagos because of lack of clear development and conservation policies, deficient technical capacity and, in some cases, lack of funding. The GNPS does not have adequate capacity to patrol and control the GNP nor the GMRR, in order to avoid problems of increasing pressures of biodiversity and natural resources exploitation. The CDF and its research station do not have adequate enough programs, staffing, and funding to address the full range of fundamental questions related to biodiversity conservation and natural resources limits of use, nor to fully advise local, regional and national agencies and organizations on those aspects.

The rapid population growth rate, heavy influx of migrants, lack of understanding of the uniqueness of the archipelago by most residents, absence of sufficiently clear governmental policies and their inadequate application, and weak institutional capacity of government agencies at all levels are producing a slow but steady abandonment of the rule of law in Galapagos. A general atmosphere of disrespect for authority is growing in the islands, due to the actions of (apparently) small numbers of persons. Those attitudes will continue to spread easily and inexorably, if the situation does not change, in which few infractors are ever found and in most cases they have never suffered any penalties even when caught. No solid, consistent legal and other follow-up actions to punish infractors occur in most cases. Indirect and direct evidence and rumors indicate that corruption may exist at many levels in various agencies. The GNPS and other authorities in Galapagos badly need increased human resources, training, and financial and other support in order to be able to more effectively protect the islands through a combination of patrolling and other physical and moral presence, full legal processing of infractors, widespread education campaigns, and similar actions. True solid authority over the use of the Galapagos National Park and biodiversity and natural resources in general in the archipelago -- by local people, the tourism industry, visitors, and other user groups -- won during years of effort under difficult conditions during the 1960s to early 1980s, needs to once again be substantially strengthened. or the growing chaos will increase.

Discussion of Galapagos conservation and management has been fundamentally from the nature protection point of view. It is now necessary to recognize that it is as much an economic as a nature conservation dialogue. It is unfortunate that the Galapagos archipelago is no longer an absolutely pristine place, but that fact must be explicitly recognized. The key issue for the future is how to manage human presence and use with as minimum an impact as possible on natural systems (de Miras, 1995).

4.3.1 Tourism

Tourism has been the main economic activity in the Galapagos since the mid-1970s, not long after it began in an organized fashion in 1969. As measured by Economically Active Population, tourism is by far the single greatest employer in Galapagos, directly employing approximately 40% of all those economically active (Carrasco, Grenier y Rodríguez, 1994). From 1974 to 1991, census figures show that the increase in Economically Active Population in the "Services" sector has averaged approximately 9.5% per year (INEC, 1974; 1982; 1991), and the vast majority of that is specifically in the tourism sector. Figures 5 and 6 express this rapid growth, especially since the mid-1980s, in terms of numbers of tourists and number of tourism vessels operating.

Except for some pollution (see section 4.4.3), the tourism industry so far has produced very little direct impact, i.e. by visitors, crews and vessels, upon the biodiversity and environment in Galapagos. Much of this is due to a very well-designed tourism management system established in the early 1970s, which includes:

- Marked trails (in most visitor sites) or marked areas (a few less fragile visitor sites) within which visitors must stay, but which allow them excellent proximity to and views of wildlife and habitats;
- A system of trained, licensed (by the GNPS) naturalist guides who must accompany tourists on all visitor site visits, with a maximum of 20 persons to one guide;
- Only day use in the vast majority of visitor sites and camping/overnighting at only a few less fragile sites in designated, primitive camp sites, with pack-it-in/pack-it-out regulations and trained, licensed guides required to accompany groups in some cases;
- Itineraries programmed well in advance for all the large and medium-sized tourism vessels (approximately 15) to distribute use and avoid crowding at visitor sites; smaller vessels (total approximately 80) are allowed to organize their own itineraries, but within a designated maximum set of visitor sites assigned to each, among the 55+ sites now in operation.

Monitoring shows that there has been some limited damage to geological features in a few sites; slight, acceptable, normal trail wear at most sites; and, varying degrees of erosion (mostly slight) at a few others. However, overall impacts have been very minimum and the few problem areas have been corrected by use of raised platform trails, stairs, or similar simple wooden structures (GNPS, 1975-1995). Likewise, impacts on vegetation have been absolutely minimum due to the system described above. In the case of animals, long-term monitoring studies on the impacts of visitors' presence and activities along trails have been conducted since the early 1970s on a variety of colonial nesting sea birds, by comparing visited sites and non-visited similar control colonies. Results show no detectable impacts whatsoever on bird populations' distributions, reproductive success, and other similar measures (Tindle, 1983).

Except for some pollution problems, tourism's major real impacts in the Galapagos have been the indirect by products of that industry's growth boom, especially over the past ten years. The constantly increasing damage and threats from exotic species introductions, human population growth, extraction of resources for export markets, direct impacts on biodiversity and resources for direct local consumption, and increasing human consumption patterns in general, all have their origin in the economic boom brought by tourism. These aspects are covered in other sections of this report. It is worth pointing out that the economic boom in the case of Galapagos happens to be tourism-based. It could have been based on some other industry, and most of the by product outcomes and trends probably would have been largely the same, probably far worse had they involved major agricultural settlement programs, directly polluting industries, massive extractive fisheries or similar uses.

There is no doubt that the model of nature-oriented, educational, tightly controlled tourism established in Galapagos 25 years ago has contributed significantly to the conservation of most of the archipelago's ecosystems. However, that well-designed tourism and visitor management system which functioned so well from the early 1970s until the mid-1980s has begun to show major signs of considerable strain over the past 8-10 years. Some of the key causes and symptoms of this ever-worsening strain are as follows:

- A partially outdated and inadequate zoning scheme for protection and use of the Galapagos National Park; a GMRR zoning scheme in need of improvements; and, lack of a refined zoning scheme to integrate rural and urban areas with the protected areas;
- Congestion and overuse of some visitor sites and underuse of others;
- The unplanned appearance of new modalities of tourism, such as day tours which use local hotels as a base, bay tours near port villages, diving tours, and sport fishing tours; these severely disrupt the limited, existing tourism and visitor management capacity of the GNPS and other agencies;
- Considerable pressure from some economic interests to introduce large scale foreign flag tourism vessels as a new modality;

- Growing numbers of newer operators with less experience and less sensitivity to the unique conservation values of the archipelago;
- A notable and growing proportion of guides with lower guiding capacity and quality and lesser sensitivity to conservation concepts, needs and practices;
- The almost total absence in Ecuador of a well-designed and appropriately applied and government controlled concessions system; a superficial look indicates some government control of such, but in reality there is little true control;
- Uncontrolled growth which has produced a tourism supply capacity well beyond existing demands (extremely economically unsound in the medium-term);
- Lack of cohesiveness and collaboration within the tourism industry and among the industry and all other key actors (industry, government agencies, conservation NGOs, research institutions, etc.), to resolve conflicts and build consensus for a truly sustainable tourism and visitor management system and process;
- A tendency for economic displacement of small local operators by larger outside sources of investment; and, spiraling inflation which causes local communities considerable disadvantages compared to larger operators with outside funding sources;
- Growing competition and conflict for certain basic services and supplies in the tourism support centers (Puerto Ayora and Puerto Baquerizo Moreno) between the tourism industry and local populations;
- Lack of an adequate planning, monitoring and evaluation process to determine when and how to adjust the tourism and visitor management system and tourism supply and demand, based upon sound ecological, social and economic principles and methods (true sustainability), such as the Limits of Acceptable Change (LAC) planning and monitoring process (Stankey, et.al., 1985) and the use of quotas based upon carrying capacity determinations at specific visitor sites (Cifuentes, 1992).

Wallace (1993) also points out a number of other detailed problems associated with and ways in which the tourism system, zoning scheme and visitor management design and practices in Galapagos could be improved, by using LAC and various other specific concepts, methods and techniques.

The key point is that if the trends indicated above are not corrected soon, a breakdown in the entire tourism system could easily occur. Uncontrolled, unmonitored growth in tourism will threaten the ecological integrity of the islands, the quality of visitor experience, and the economic viability of the industry itself. Everyone will lose in that case. The islands themselves and none of the actors involved in their use can afford for the present primitive capitalistic system to continue.

The Galapagos experience offers a unique visit to an isolated, fragile and largely untouched natural place, and many visitors relish the opportunity to become "modern-day Darwins" as they step from their vessels onto the islands. Conservation of marine and terrestrial biodiversity and resources must become a central tenet and primary commitment of the nature-oriented tourism sector if their own existence in Galapagos is to be assured and sustainable. Nature-oriented tourism still appears to be the best economic alternative for Galapagos and should remain as its central economic activity. All other economic activities should be linked tightly to it, with a substantial, long-term, steady flow of benefits to Ecuador as a whole and to the local Galapagos communities in particular. The emphasis must be upon long-term, steady benefits and not short-term, "gold rush" approaches which exhaust resources and destroy healthy social development.

4.3.1 Other Services

Numerous other services exist, but virtually all are tightly linked to and depend upon tourism as the central economic motor. Virtually all are growing in the same pattern as tourism.

4.4 Other Related Impacts

4.4.1 Habitat Loss and Fragmentation

This topic was basically covered in section 4.1.1 on the impacts of agriculture and livestock. The same types of fragmentation and loss processes occur in urban areas and around their perimeters. This has happened and continues to occur in and around villages, especially the ports, with the loss and fragmentation of mangroves, elimination of sandy beaches and similar changes. These changes still have not reached such sizeable proportions, as in the rural agricultural and grazing areas.

4.4.2 Direct Human Impacts on Resources

Many examples have already been given in other sections where they fit in well. A few other cases not yet indicated are:

- Intertidal organisms such as chitons, gastropods (snails), crabs, and others are being exploited heavily for several kilometers along shore lines around the growing population centers of the ports on Santa Cruz, San Cristobal and Isabela. These are basically subsistence and artisanal hunting and gathering activities of the poorer economic groups, but they may be having major effects on those natural shoreline and intertidal communities.

Open garbage dumps near most of the port towns are major sources of pollution for water supplies in some cases, as well as foci for some introduced animal species.

4.4.3 Pollution

This is one area in which the tourism industry, as well as the fisheries sector, may be having major impacts in the islands. There is no question that qualitatively and quantitatively the amount of solid waste in the islands has been increasing rapidly, especially that thrown into the sea from vessels. The other is that accumulating on land from local communities and the relatively few more conscientious tourism vessels which bring solid waste to Santa Cruz for incineration or disposal in "land fills".

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- If it has not been possible to implement the GMRR Management Plan for the 15 nautical mile reserve and truly protect and manage that area, how will an expanded GMRR boundary of 40 nautical miles be protected and managed? What are the concrete plans for implementing the Management Plan, for following up on the September 1994 workshop? What types of support does the government require from the international community to help implement the reserve and the Management Plan?
- The ban on shark fishing is excellent, but local fishermen have already made clear that they are not interested in fishing sharks: it is too difficult; they do not possess the right types of equipment and boats in large part; they would rather be able to fish sea cucumbers, sea urchins and similar easily exploited, lucrative export species. Sharks are mainly being taken by long-lining by larger ships, not Galapagos fishermen. Enforcement of the ban will be difficult, unless the capacity to manage the entire reserve is installed and sustained.
- The terms "artisanal fishery" and "artisanal fishermen" are meaningless in the Galapagos context. With species which are sedentary or sessile, or otherwise easy to catch, and which feed into lucrative export markets controlled by middlemen in Ecuador and foreign buyers (e.g. sea cucumbers, sea urchins, sea turtles, etc.) it does not matter if the fishing technology used is simple, "artisanal" or "primitive". The end result is industrial level overexploitation and exportation, leading to eventual economic and biological extinction.
- How will the five year residence and fishing activities rules be applied? It is common knowledge in Galapagos that such residency identification cards can be bought easily, by anyone, regardless of time of residency and previous activities.
- How are the fisheries going to be controlled when the fisheries authorities do not have the infrastructure, equipment and manpower needed to do so?

Much more is needed or the GMRR will never be implemented.

Moreover, be it 15 or 40 nautical miles, the GMRR is a huge area, which will be extremely difficult to patrol and control adequately. Ecuador, being a third world country with all that implies, should be supported strongly by the industrialized countries via financial and technical cooperation support to enable it to seriously take on the task of protection and control. That implies long-range rapid vessels, patrol aircraft, much increased numbers and training of specialized protection staff, improved land-based facilities for such equipment and staff, operational costs for a number of years to allow consolidation of the protection system, etc.

Some of the key actions needed are:

- Formally placing the GMRR within the National Protected Areas System of Ecuador via a decree classifying it as part of that system (it does not currently have such status);
- Placing the management of the reserve under the authority of a single government agency and requiring the cooperation of other agencies to support and aid that single agency in the management and implementation of the reserve (the current institutional jurisdictional status is vague);
- Strengthening that single agency with a specialized department or program aimed specifically to manage the GMRR, which implies special new personnel with appropriate training and a specific, substantial budget;
- Truly implement the existing, approved (in 1992 by Presidential decree) GMRR Management Plan, including the zoning scheme described in the plan which would establish zones for total protection; zones for nature-oriented, non-exploitative tourism use; and zones for traditional fishing of species not easy to capture (bacalao and other white fish and lobsters) using appropriate traditional technology and following improved, stricter regulations on sizes, sexes, fishing seasons, etc.
- Export fisheries, whether to foreign markets or mainland Ecuador, should be banned. Only Galapagos fishermen should be allowed to fish in the Islands and that artisanal industry should be tightly linked to the tourism industry, with regulations and incentives to insure that the tourism industry stops importing seafood to the Islands, and instead buys from local fisherman. This must be accompanied by studies to determine if sustainable fisheries for "white fish" (bacalao and related Serranid species) and lobster, by local fishermen for the tourism and local population markets, would be feasible; how many fishermen would that support and what would be the regulations to ensure viability of the fishery? Since such fisheries would probably not support more than 100-200 fishermen, if that number, ways to retrain and reinsert others into the tourism economy must be explored. Many others will have to simply return to the continent.
- Work with local fishermen to help them organize and unify their cooperatives, to train them in product preparation, quality control, and marketing requirements and operations to guarantee appropriate supplies to the tourism industry, and to eliminate middlemen and buyers from the outside.
- The international community must support Ecuador's efforts with major financial and technical cooperation support for the implementation of the GMRR Management Plan, because such an area of national and international importance can not be expected to be financed solely by its sovereign, owner country.

4.6 Institutional Management Problems

For over two decades the principal institutions charged with nature conservation in the Galapagos (GNPS and CDF) were also the most dominant and outstanding organizations in the islands in terms of their effective and efficient programs, local economic importance and influence, international and national prestige, and leadership of local public affairs. As happens in almost all cases worldwide, some normal conflicts between national park managers/CDRS scientists and conservationists and the local population occurred in the earlier years after the GNP was established. However almost 20 years of environmental

education programs, involvement of local people in the process of national park management, participation of the GNPS and CDRS in local community affairs, and provision of new opportunities for economic improvement based on the National Park (nature tourism), created a population which was overall positive and supportive of the Galapagos National Park.

However, charged with the extremely difficult responsibility of protecting the biodiversity, ecosystems and natural resources of the Galapagos, the two conservation organizations did not or were not able to give enough attention to the human system in Galapagos, with its development related problems and needs.

While scientific and conservation knowledge and practice were being rather well developed by the two organizations, both the conservationists and long-term Galapagos residents had confidence that other sectors related to human system development would be attended to by the proper national, regional and local governmental institutions. Unfortunately that did not happen in large part, and dissatisfaction has been slowly growing for several decades. Now both old and newer expectations have been raised again. The population is demanding attention and solutions to its problems, which are now more than ever difficult to attend to, due to rapid population growth.

Galapagos institutions, at all levels (national, regional and local), do not have the capacity to absorb the demand for services, nor to provide adequate advisory, planning and management guidance and leadership for local development (Ecuador, Presidencia de la República, 1992). Municipalities are not capable of providing adequate potable water, electricity, sewage, solid waste and land use/zoning services, nor to produce and enforce proper urbanization plans and policies. National and regional institutions have failed to accomplish their objectives in Galapagos because of lack of clear development and conservation policies, deficient technical capacity and, in some cases, lack of funding. The GNPS does not have adequate capacity to patrol and control the GNP nor the GMRR, in order to avoid problems of increasing pressures of biodiversity and natural resources exploitation. The CDF and its research station do not have adequate enough programs, staffing, and funding to address the full range of fundamental questions related to biodiversity conservation and natural resources limits of use, nor to fully advise local, regional and national agencies and organizations on those aspects.

The rapid population growth rate, heavy influx of migrants, lack of understanding of the uniqueness of the archipelago by most residents, absence of sufficiently clear governmental policies and their inadequate application, and weak institutional capacity of government agencies at all levels are producing a slow but steady abandonment of the rule of law in Galapagos. A general atmosphere of disrespect for authority is growing in the islands, due to the actions of (apparently) small numbers of persons. Those attitudes will continue to spread easily and inexorably, if the situation does not change, in which few infractors are ever found and in most cases they have never suffered any penalties even when caught. No solid, consistent legal and other follow-up actions to punish infractors occur in most cases. Indirect and direct evidence and rumors indicate that corruption may exist at many levels in various agencies. The GNPS and other authorities in Galapagos badly need increased human resources, training, and financial and other support in order to be able to more effectively protect the islands through a combination of patrolling and other physical and moral presence, full legal processing of infractors, widespread education campaigns, and similar actions. True solid authority over the use of the Galapagos National Park and biodiversity and natural resources in general in the archipelago -- by local people, the tourism industry, visitors, and other user groups -- won during years of effort under difficult conditions during the 1960s to early 1980s, needs to once again be substantially strengthened. or the growing chaos will increase.

Discussion of Galapagos conservation and management has been fundamentally from the nature protection point of view. It is now necessary to recognize that it is as much an economic as a nature conservation dialogue. It is unfortunate that the Galapagos archipelago is no longer an absolutely pristine place, but that fact must be explicitly recognized. The key issue for the future is how to manage human presence and use with as minimum an impact as possible on natural systems (de Miras, 1995).

Research priorities

Some major areas for future research are as follows:

- a. A quantitative model of the human system in relation to the natural system in Galapagos is badly needed in order to establish a baseline, permit quantification of trends and try to develop predictive scenarios for the future. This must include components to measure the direct and indirect (e.g. via introduced species) impacts of humans on the biodiversity and natural systems of Galapagos. Initial studies of direct and indirect human impacts on biodiversity are underway (Snell, 1995). These studies also would involve a basic GIS system. Such a model should include involving local communities and other key stakeholders in generating scenarios as a basis for making or supporting informed choices in the future, based upon those alternatives.
- b. Long-term economic and social development projections based upon different policy options, e.g. nature tourism versus export fisheries.
- c. Can local fisheries be wed to nature tourism and local village markets and be sustainable? Studies on the biology, ecology, fisheries management, marketing and related aspects are needed.
- d. Immigration dynamics and potential policies and their impacts, including controls, incentives, institutional reforms, etc.
- e. Design, operations and policies for nature tourism in the Galapagos in the National Park, Marine Reserve and non-protected areas portions of the islands, in order to ensure its ecological, economic and social sustainability.

There are many other areas requiring research, but these are some of the most urgent requiring attention.