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Conservation Biology in the Galapagos Archipelago: Perspectives from Hawaii

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Five researchers from Hawaii attended the *Workshop on Botanical Research and Management in the Galapagos National Park* April 10-19, 1987 on Isla Santa Cruz, Galapagos Islands. The purpose of the meeting was to compile existing data on Galapagos flora, assess its status in the face of increasing threats, and discuss and suggest future research. Although there is some danger in the opinions of "instant experts" on any subject, it seems important to share with Hawaiian conservationists some perceptions of the successes, problems, and proposed solutions which emerged from our intense involvement in the Galapagos for a short period. That is the purpose of this paper. Some of what follows is from the extensive literature on the archipelago, some is from materials and conversations related to the workshop, and some is simply our impression of what is important based on our own experience.

PHYSICAL BACKGROUND

The Galapagos Archipelago consists of 19 oceanic islands and a number of small islets located 800 km from Ecuador (Fig. 1). The islands are young in geologic terms, the oldest being about 3 million years in age, and volcanoes are still active on Islas Isabela and Fernandina. Although the group straddles the equator, the cold Humboldt current from the southeast modifies the climate most of the time. A warm season from December to May and a cool season from June to November are usual, with most rain generally falling in the warm season. A misty "garua" season occurs in the highlands in the cool period. Islas Isabela and Fernandina have maximum elevations of 1,700 and 1,500 m; Santiago, Santa Cruz, Pinta, San Cristobal, and Floreana are over 640 m; and other islands are < 500 m in elevation (Table 1). Four of the islands (Santa Cruz, San Cristobal, Floreana, and Isabela) are inhabited by about 6,000 people, with most (ca 80%) on Santa Cruz and San Cristobal. A general comparison of physical statistics and demographics of the Galapagos and Hawaiian archipelagos is given in Table 2.

CULTURAL AND ORGANIZATIONAL BACKGROUNDS

The islands were discovered in 1535 AD by the Bishop of Panama. Explorers, pirates, whalers, and fishermen landed in the islands from the 16th century on, and in 1835 Charles Darwin made his famous visit aboard the *Beagle*. The archipelago received its first permanent settlements in the late 1800's, and the islands were declared a national park in 1959 (Ecuador's first). Boundaries for the park were established in 1968, and 96% of the land area (7,665 km^2) is now national park. In 1986, the Ecuadorian government declared an additional 80,000 km^2 a Marine Resources Reserve. The Charles Darwin Research Foundation (CDF) was established under the International Union for the Conservation of Nature and Natural Resources (IUCN) when the Park was created. The Park staff now numbers about 30, and the research staff of the Charles Darwin Research Station (CDRS) on Isla Santa Cruz (CDF supported) numbers about 50, including staff at various universities, but not including students (G. Reck, pers. comm.).

NATIVE BIOTA

A general comparison of the native biotas of the Galapagos and Hawaiian archipelagos is given in Table 3. The Galapagos Islands have far fewer species of flowering plants, arthropods, and mollusks, but more species of mammals and reptiles. Comparative isolation, time available for evolution, habitat diversity, climate, and spatial relationships of the 2 groups of islands are the major reasons for differences. Rafting, for example, is a much more important means of island colonization in the Galapagos, with mainland to island times estimated at two weeks based on ocean current speeds (Jackson 1985).

Vegetation

There are approximately 550 species of native plants on the Galapagos, of which 34% are endemic (Porter 1984). On the high islands, several of the vegetation zones listed below may be recognized.

1. *Coastal zone* - Dominated by mangrove swamps of *Rhizophora mangle, Avicennia germinans, Laguncularia racemosa,* and *Sesuvium* spp.
2. *Arid zone* - Characterized by cactus species *Jasminocereus thouarsii, Opuntia* spp. (prickly pear), and *Brachycereus* sp.; *Bursera graveolens*; and *Croton scouleri.*
3. *Humid zone* - Characterized by *Scalesia* spp., *Psidium galapageium*, and *Pisonia floribunda.* The lichens *Ramalina usnea* and *Teloschistes flavicans* and *Tillandsia insularis* often hang from trees in this zone.
4. *Miconia zone* - Dominated by the melastome *Miconia robinsoniana, Pteridium aquilinum* (bracken fern), and formerly, by the tree fern *Cyathea weatherbyana.* The pendant epiphytic liverwort *Frullania* is also characteristic.
5. *Fern-sedge zone* - Characterized by sedges, *Pteridium aquilinum* and club mosses *Lycopodium* spp.
6. *Upper zone* (on Isabela volcanoes) - *Opuntia* again appears.

Low islands exhibit plants of the coastal and arid zones.

Reptiles, Birds, and Mammals

All reptiles are endemic, except two species of marine turtles. The giant tortoise, *Geochelone elephantopus* (Fig. 2), has 11 subspecies on different islands (5 on Isabela), all of which are endangered (Jackson 1985). There are 2 species of terrestrial iguanas

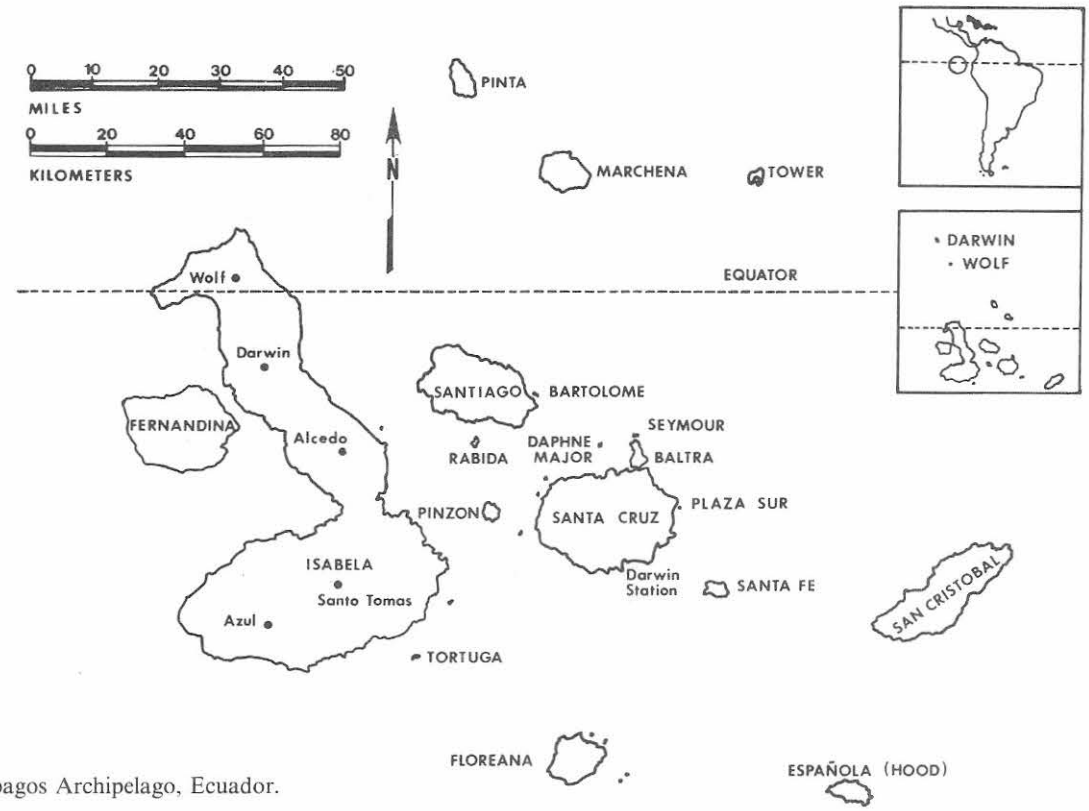

Figure 1. Galapagos Archipelago, Ecuador.

Table 1. Galapagos Island areas, maximum elevations, and populations.[1]

Common Name	Area km²	Area mi²	Max. Elevation m	Max. Elevation ft	Estimated Human Population	Agricultural Zone km²
Isabela	4588	1771	1707	5600	1000	50
Santa Cruz	986	380	864	2835	2500	113
Fernandina	642	248	1494*	4900*		
Santiago	585	226	907	2974		
San Cristobal	558	215	7308	2395*	2500	730*
Floreana	173	67	640	2100	50	3
Marchena	130	50	343	1125		
Espanola	60	23	206*	675*		
Pinta	60	23	777*	2500*		
Baltra	27	10	100*	328*		
Santa Fe	24	9.3	259*	850*		
Pinzon	18	7.0	458	1502		
Tower	14	5.4	76*	255*		
Rabida	4.9	1.9	367	1203		
Seymour	1.9	0.7	—	—		
Wolf	1.3*	0.5*	253*	830*		
Tortuga	1.2	0.5	186	610		
Bartolome	1.2	0.5	114	359		
Darwin	1.1	0.4	168*	250*		
Daphe Major	0.3	0.1	120*	366*		
Plaza Sur	0.1	0.04	25*	76*		
Totals	**7877**	**3039.34**			**6050**	**241**

*Measurement uncertain.

[1]Adapted from Jackson 1985, and Coulter, Cruz, and Curry 1985.

Table 2. Comparative physical and demographic statistics—Galapagos and Hawaii.

	Galapagos	Hawaii
Nearest continent	800 km (500 mi)	4020 km (2500 mi)
Age of oldest islands	3 million years	70 million years
Length of island chain	400 km (250 mi)	2570 km (1600 mi)
No. islands > 1 km²	19	8
Largest island	4590 km² (1770 mi²)	10,360 km² (4000 mi²)
Total area of archipelago	7850 km² (3030 mi²)	16,575 km² (6400 mi²)
National park area	6910 km² (2668 mi²) (88%)	1035 km² (400 mi²) (6%)
Highest point	1707 m (5600 ft)	4205 m (13,800 ft)
Highest rainfall	200 cm (80 in)	1270 cm (500 in)
Arrival of first humans	1500's	400's
Arrival of first Europeans	1535	1778
Resident population	6000	1,320,000
Tourists annually	27,000	5,000,000

(Conolophus subcristatus and *C. pallidus)* (Fig. 3), a marine iguana *(Amblyrhynchus cristatus),* and numerous lava lizards of the genus *Tropidurus* (Jackson 1985).

The native avifauna includes 57 resident species, of which 26 (46%) are endemic and 31 are regular migrants, and a number of accidentals also occur (Harris 1983). Endemic taxa include 13 species of Darwin's finches, a flightless cormorant *(Nannopterum harrisi),* the Galapagos Penguin *(Spheniscus mendiculus),* the Lava Heron *(Butorides sundevalli),* the nocturnal Swallow-tailed Gull *(Larus furcatus),* the Lava Gull *(Larus fulginosus),* the Galapagos Hawk *(Buteo galapagoensis),* 4 species of mockingbirds (*Nesominus* spp.), the Galapagos Rail *(Laterallus spilonotus),* the Thick-billed Flycatcher *(Myiarchus magnirostris),* the Galapagos Martin *(Progne modesta),* and the Galapagos Dove *(Zenaida galapagoensis).* The greater flamingo *(Phoenicopterus ruber)* is not endemic but is a dramatic and easily disturbed part of the avifauna (Harris 1983).

The native mammalian fauna include 7 species: the Galapagos Fur Seal *(Arctocephalus galapagoensis)* and the Galapagos Sea Lion *(Zalophus californicum wollebacki),* a small subspecies of the California Sea Lion; 2 species of rice rats, *Oryzomys bauri* on Santa Fe and *Nesoryzomys narboroughi* of Fernandina (5 rice rat species are extinct); the endemic bat *Lasiurus brachyotis,* and the hoary bat *Lasiurus cinereus* (a different subspecies from the one found in Hawaii).

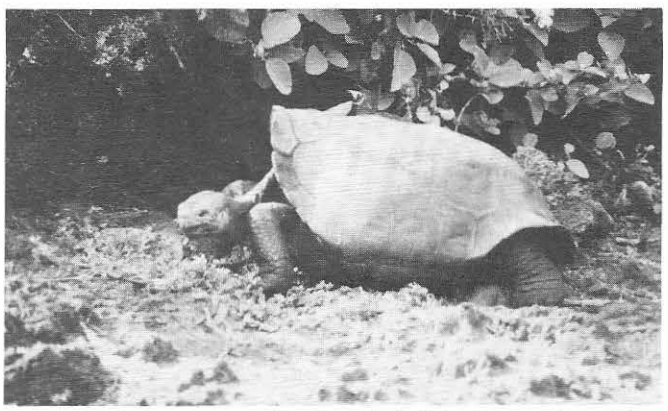

Figure 2. Galapagos tortoise from Ario Island, note the saddle-shaped carapace.

Photo by C.P. Stone

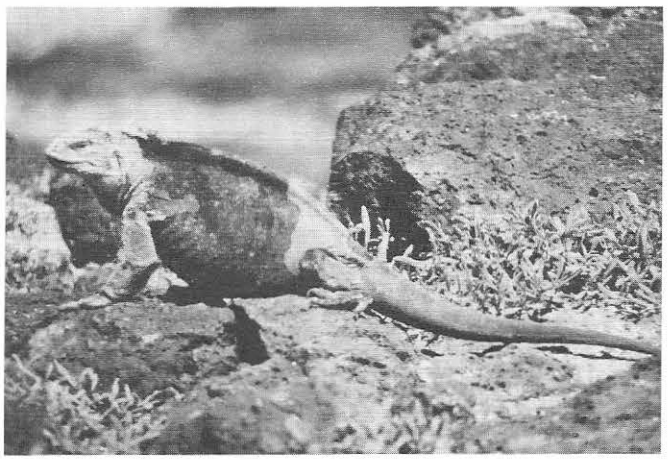

Figure 3. Land iguana on South Plaza Island near Santa Cruz Island.

Photo by C.P. Stone

Table 3.
Comparative biological statistics—Galapagos and Hawaii.

	No. Species		% Endemic	
	Galapagos*	Hawaii†	Galapagos*	Hawaii†
Flowering Plants‡	434	1200	51	97
Ferns and Allies	107	143	7	73
Resident Birds	57	56	49	79
Mammals	8	1	88	0
Amphibians	0	0	0	0
Reptiles	20	0	95	0
Arthropods	1200(?)	6000+	?	98
Mollusks	<300(?)	1000+	?	99

*Sources: Brockie *et al.* (in press); Porter (1984); Grant (1984); Patton (1984); Jackson (1985).

†Sources: Wagner *et al.* (in prep.); St. John (1973); Pyle (1983); Tomich (1984); Gagné and Christensen (1985).

‡Number of endemic angiosperm genera: 7 (Galapagos), 31 (Hawaii).

Invertebrates

There are about 1,000 species of insects, including: 2 species of scorpions (one endemic); 50 species of spiders (few endemic); and a number of centipedes (some endemic). There are also many species of small land snails, including one genus, *Bulimulus,* which includes over 60 species, some endemic to individual islands and others to vegetation zones on several islands (Jackson 1985). The aridity of most of the Galapagos provides unfavorable conditions for invertebrate establishment and survival in comparison to Hawaii.

ALIEN PROBLEMS

Ungulates

As with many island groups around the world, introduced mammals have created difficulties in ecosystems not previously exposed to them. Thirteen species currently have naturalized populations on one or more of the 19 islands, as shown in Tables 4 and 5. As in Hawaii, the depredations of feral goats *(Capra hircus)* and pigs *(Sus scrofa)* are currently the most conspicuous problems. Although feral goats were eliminated from 6 islands (Pinta, Merchena, Santa Cruz, Santa Fe, Española, and Rabida) and feral pigs from 2 (largely by the local populaces on Floreana and San Cristobal), vegetation on Islas Santiago and Isabela is still being seriously damaged by both species (F. Cruz, pers. comm.). Populations of species such as the giant tortoise and several other species are also at risk through habitat destruction by introduced mammals or man, or direct predation (Eckhardt 1972). *Opuntia* sp., once present on Floreana, now survives only on offshore islets, largely as a result of past goat foraging. Better farm management is needed on Isabela and Floreana islands especially, to reduce escape and establishment of goats. Removal of pigs prior to goats is thought necessary on Santiago and on other islands, because goats help to keep vegetation reduced for easier pig hunting. Pigs on Santiago now number about 1,500 and goats 80,000 (L. Calvopiña, pers. comm.). Shooting of goats and hunting of pigs with dogs are the currently employed removal techniques. Use of the toxicant sodium monofluoracetate (1080) on Santiago has been found to threaten the Galapagos hawk, so its use has been discontinued for this and other reasons (L. Calvopiña, pers. comm.). Fences and helicopters have not yet been used for pig and goat control in the Galapagos.

Table 4.
Distribution of naturalized ungulates in Galapagos Archipelago, 1987 (modified from Hoeck 1984).

	SPECIES				
Island	Feral Goat	Feral Pig	Feral Cow	Horse	Donkey
Isabela*	+	+	+	+	+
Santa Cruz*	+	+			+
Santiago	+	+			+
San Cristobal*	+	(+)		+	+
Floreana*	+	(+)	+		+
Pinta	(+)				

*Inhabited by humans.
(+)Thought to be reestablishing after control or eradication.

Feral cattle *(Bos taurus)* have been removed from Santa Cruz and San Cristobal, again by local people. However, herds on southern Isabela (about 3,000 animals) and Floreana (about 300) are depended upon by locals. Where farm soils are rocky, cattle use national park lands. No attempts have been made to remove horses *(Equus caballus)* or donkeys *(E. asinus)* except on northern Isabela, where eradication has not been accomplished (F. Cruz, pers. comm.).

Rodents

Black Rats *(Rattus rattus)* are present on at least 9 islands and the risk of invasion of others from unsanitary tour boats and other vessels is great. Norway rats *(R. norvegicus)* have recently been introduced to urban Santa Cruz and San Cristobal and may spread

Table 5. Distribution of introduced birds, predators, and rodents in Galapagos Archipelago, 1987 (modified from Hoeck 1984).

	SPECIES							
Island*	Black Rat	Norway Rat	House Mouse	Feral Cat	Feral Dog	Chicken	Guinea Fowl	Ani†
Isabela*	+		+	+	+			+
Santa Cruz	+	+	+	+	+	+	+	+
Fernandina								
Santiago	+		+					?
San Cristobal*	+	+	+	+		+		
Floreana*	+		+	+	+	+		+
Marchena								
Española								
Pinta								
Baltra	+		+	+	+			
Santa Fe								
Pinzon	+		+					
Tower								
Rabida	?		?					
Seymour	+		+					
Wolf								
Tortuga	?		?					
Bartolome	+		+					
Darwin								

*Inhabited by humans
†Presumed introduced

to surrounding areas. In tropical waters, black rats can swim 600 m and perhaps up to 1,600 m (I. Atkinson, pers. comm.). This species is a threat to land and marine iguana eggs, sea bird colonies (especially on small islands), and land birds, although evolution with endemic rice rats may have resulted in some avian pre-adaptation to *R. rattus* predation (Clark 1981). Black rats prevent giant tortoise recruitment only on Isla Pinzon where native rice rats never occurred (Clark 1981).

Predators

Feral cats *(Felis catus)* are abundant on populated islands. Predation on juvenile land iguanas is an important problem on northern Santa Cruz Island. A combination of trapping, poisoning with 1080 in fish baits, and hunting with rifles is used to control them (L. Calvopiña, pers. comm.). Some reduction in Galapagos dove numbers on Santa Cruz is thought by some to be related to feral cats (Harris 1983). Feral dogs *(Canis familiaris)* are a problem on Isabela and Santa Cruz, where they prey on land iguanas; dogs are also thought to hold down cattle, pig, and goat numbers to some extent. Feral dogs were eliminated by inhabitants on Floreana because they killed cattle (Coulter, Cruz, and Cruz 1985). Some farmers in remote areas apparently keep dogs in the belief that they will keep the feral dogs away. However, domestic animals also become feral.

Birds

Domestic chickens *(Gallus gallus)* and Guinea Fowl *(Numida melagris)* may eventually establish feral populations on islands inhabited by people. The greatest risk is thought to be that, even when domestic, these species serve as reservoirs for avian pox virus and other disease agents which can be transmitted to native birds. Pox has been reported from Galapagos Doves, Darwin's finches, and mockingbirds (Stafford and Harmon 1982), but not at epizootic levels to date (F. Cruz, pers. comm.). However, the experience with pox and malaria in Hawaii suggests that disease reservoirs in domestic birds are important (van Riper *et al.* 1986). Whether the overall aridity or recency of evolution of some taxa will protect Galapagos birds from serious avian diseases is unknown. However, the Galapagos birds lack high-elevation refugia which Hawaiian birds have. Rock Doves *(Columba livia)* are known carriers to *Trichomonas gallinae,* a protozoan pathogen which has so far been found in Galapagos Doves only in the vicinity of villages where Rock Doves are present (Harmon *et al.*, in press).

Ani (probably Smooth-billed, *Crotophaga ani*) may have reached the Islands on their own but may have been brought to the archipelago in the 1980's by man to remove ticks from cattle. Unfortunately, the population expanded considerably during the 1982-83 El Niño event, and it is now thought that the bird eats native insects (F. Cruz, pers. comm.).

Invertebrates

The most conspicuous invertebrate invader is the little fire ant *(Wasmannia auropunctata).* This species is present on 4 islands; it is a pest around human settlements and is spreading in native ecosystems, especially along transportation corridors (Lubin 1985). High densities are associated with reduced diversity of other invertebrates including ants and a native scorpion, *(Hadruroides maculata galapagoensis)* (Lubin 1985). The Argentine ant *(Iridomyrmex humilis)* produces similar effects in Hawaii (Medeiros, Loope, and Cole 1986).

Plants

Alien plants in the archipelago have increased from 77 known species in 1971 (Wiggins and Porter 1971) to about 260 in 1987, a rate of about 10 per year (J. Lawesson, pers. comm.). The rapid increase is presumably due to an increasing human population and needs for agriculture, and ornamental and medicinal purposes, as well as increasing accidental introductions (J. Lawesson, pers. comm.). About 50 of the introductions are thought to be invading natural areas (Hamann 1984). A number of species have naturalized over large areas and form monospecific stands which replace native species. About 100 native species may be threatened, especially on the four inhabited islands. Some invaders threaten entire vegetation zones (e.g. *Scalesia* forests and *Miconia* shrublands) with extinction on one or more islands. *Pennisetum purpureum* (elephant grass) is known to prevent both endemic *Eugenia* and *Scalesia* reproduction, for example. (The last species exhibits cohort dieback in which large areas of dead trees are subject to invasion by alien plants similar to the situation with 'ohi'a *(Metrosideros polymorpha)* in Hawaii.) Alien plant species of special importance include (J. Lawesson, pers. comm.):

Psidium guajava (common guava)—41,000 ha on 4 islands;
Pennisetum purpureum (elephant grass)—5,150 ha on at least 2 islands;
Cinchona succirubra (quinine tree)—4,000 ha on one island;
Lantana camara (lantana)—2,000+ ha, largely on one island;
Rubus sp. (raspberry)—100+ ha on 2 islands;
Kalanchoe pinnata (airplant)—70+ ha on 4 islands;
Eugenia jambos (java plum)—57 ha on 4 islands;
Furcraea hexapetala—31 ha on 4 islands.

To date, no significant weed control has been achieved, restrictions on importation and transportation are minimal, and only a few tests with herbicides have been undertaken. There is no biocontrol of alien plants in the islands and no research being conducted there on that subject. One of the problems in this regard is the presence of native species *(Lantana peduncularis, Psidium galapagenium)* which are closely related to the alien species.

CONSERVATION ISSUES AND PROGRAMS

There are a number of important conservation issues in the Galapagos, some related to problems with aliens and some to rare species management. Many issues are similar to those in Hawaii. Some issues will now be briefly highlighted.

Human Populations and Development

The resident human population, although comparatively small, has to meet its needs for survival. Houses and boats must be built, food grown, and income generated. Tourism, agriculture, and fishing are key methods of providing income both for island residents and others in the Galapagos. All of these human activities aggravate the problem of alien species introduction and spread, and destruction of native ecosystems.

Efforts to manage timber species needed for building are being made. Teak *(Tectonia grandis),* a non-dispersing alien tree, is being grown on agricultural lands for timber production. The Charles Darwin Research Station is participating in studies of this species and 2 native trees, *Hippomane mancinella* (poison apple) and *Piscidia carthagenesis* (matazarno). If these species can be grown economically in plantations for commercial purposes, destruction of native forests may diminish. Watershed problems in the agricultural zone may also be reduced.

Tourism and the associated infrastructure are rapidly increasing in the Galapagos. Over 27,000 tourists arrived in 1986, and the rate in the first half of 1987 was alarming (C. MacFarland, pers. comm.). Each visitor is required to have a guide when he/she

arrives, and the Galapagos National Park Service offers two training courses for guides each year. However, the risk of alien introductions, especially to uninhabited islands, remains great. Visitors need to be controlled, directed, and supported, and the Galapagos Islands have limited economic resources for this. Disturbance of wildlife and plants, litter (including ubiquitous plastic which ensnares sea birds and sea lions and is eaten by wildlife), pollution, souvenirs made from plants or animals, and vandalism are dangers (Mountfort 1970).

At present, tour guides help in monitoring remote areas, policing tourists under their charge, and providing a tremendous educational service. A key issue is how to limit numbers and control visitors as demand increases to prevent damage to the natural resources in an economically poor country. The current use of 45 designated visitor sites and marked trails from which tourists are not to stray is an excellent approach. Questions of size and frequency of tour groups, effects of infrastructure development, scrupulousness and knowledgeability of tour guides, and quality of the Galapagos experience are all relevant. Increased resource monitoring and enforcement programs, and better educational programs all seem critical.

Introduction of Aliens

There are presently no restrictions on importing plants or animals from other parts of Ecuador into the Galapagos or transferring biota from island to island. Information on what is alien and what is not is sometimes a problem. Education about the damage caused by alien species is improving; however, there are numerous obvious examples of problems [e.g. the use of *Erythrina* from the Ecuadorian mainland with its associated insect fauna for living fences; use of invasive species such as *Pennisetum purpureum* for livestock forage; importing of *Rubus* spp. for economic uses; use of fruit trees such as avocado *(Persea americana)*; and loose husbandry of pigs, cattle, goats, dogs, and cats on inhabited islands]. Again, increased efforts in education, monitoring, and enforcement seem necessary.

***Ex Situ* Conservation**

Preservation of species gene pools through captive propagation programs for animals and botanical garden populations for plants is an increasingly important aspect of the conservation biology of rare species. Whether the intent is to use *ex situ* biota for repatriation or simply to ensure survival of significant genetic material, however, *ex situ* conservation is not in itself conservation biology. Attention must be paid to the natural habitat. The goal of the *ex situ* programs at CDRS is to repatriate the natural habitat, which may involve removal of rats, cats, dogs, or pigs as well as successful captive propagation.

In Galapagos, *ex situ* conservation of giant (up to 250 kg) tortoise subspecies and land iguanas from several islands are important emphases of CDRS. After hatching, tortoises, which are sexually mature at about 40 years, are separated according to subspecies and raised in pens for 5 years, whereupon they are reintroduced to their home island habitat. The tortoise reserve on Isla Santa Cruz and the remote Alcedo Volcano on Isla Isabela are the main places to see wild tortoises today (Jackson 1985). Land iguanas (weights up to 6 kg), which breed at 6 years, are also propagated in captivity and repatriated as juveniles. On northern Santa Cruz island the initial effort to reestablish the land iguana, *C. subscristatus,* is now being made, subsequent to a campaign to control feral cats with trapping, 1080, and hunting. Wild land iguanas may be seen on Fernandina, Santa Fe, and South Plaza (Jackson 1985). A workshop on reptile conservation is planned for next year in the Galapagos.

Dark-rumped Petrel

The Dark-rumped Petrel *(Pterodroma phaeopygia phaeopygia)* nests on 5 islands in the archipelago. The population was estimated at 10,000 pairs on Santa Cruz and Floreana in 1980 (Coulter, Cruz, and Cruz 1985). In Hawaii, about 430 pairs of the same species (subspecies *P.p. sandwichensis*) nest largely in Haleakala National Park, according to Simons (1985). Cats, dogs, ungulates, rats, and even fire ants threaten the colonies. The largest colony (ca 2,000 nests—F. Cruz, pers. comm.), on Isla Floreana, is threatened by lantana growth and cat and black rat predation. Predators have been controlled there by CDRS since 1982. Ginn traps are used for cats; and an anticoagulant, Racumen, is used in PVC (plastic) tubes for rats. Since mammal control began, reproductive success of the petrels has increased from 30% to 72% (about 28% is considered unavoidable loss through infertility, desertion, etc.). The colony is visited every other month for monitoring of petrel nest sites and control. It is hoped that the Galapagos National Park Service will take over the program next year and expand it to other islands (F. Cruz, pers. comm.). (See Simons 1985 and Stone and Keith 1987 for descriptions of mammal control efforts in petrel colonies in Haleakala National Park.)

El Niño

Failure of the southeast trade winds and a shifting of the Humboldt Current allow warm equatorial currents to predominate in Galapagos waters periodically. The effect, called El Niño, can be devastating, as records show for the 1982-83 event (Robinson and del Pino 1985). The dramatic consequences of such periodic events are not under the control of man but must be considered in any program in conservation biology. As stated by Kramer (1985), "Populations and biotic communities must be sufficiently protected and large enough to be safe not only when average environmental conditions previal, but also during time of climatic extremes and stress." The potential role of El Niño-like events such as hurricanes, droughts, and other abnormal weather in affecting evolutionary processes of small and localized populations in Hawaii should be obvious.

The documented effects of El Niño in the Galapagos in 1982-83 are worth noting. As a general rule, animals dependent on marine ecosystems were affected negatively, but terrestrial animals and plants prospered. During the 1982-83 event, near-surface ocean temperatures increased 2-5° C, nutrient-rich cooler water declined, and precipitation increased dramatically. Phytoplankton biomass in the upper 25 m of water was reduced to 30% of normal (Kogelshatz *et al.* 1985), invertebrates and endemic fishes were reduced (Robinson 1985), and other species dependent on these forms suffered dramatically. Marine iguanas declined 30-55% (Laurie 1985); flightless cormorants 45%; and Galapagos Penguins 78% (Castillo 1985). Waved Albatrosses *(Diomedea irrorata)* did not breed successfully (Rechten 1985); Dark-rumped Petrel reproductive failure was offset by the predator control program (Cruz and Cruz 1985); and young fur seal mortality of Fernandina was nearly complete (Limberger 1985).

On the land, soils became waterlogged and runoff increased. Root systems of plants often collapsed and shallow-rooted species such as tree ferns *(Cyathea weatherbyana)* were washed away (Hamannn 1985). Lichens and mosses rotted or were washed away. Some herbs and vines and common highland bryophytes flourished (Weber and Beck 1985). Some forest species such as the endemic tree

sunflower *Scalesia* were thinned dramatically, while other species flowered and produced seeds repeatedly in response to moisture. Mockingbirds and Darwin's finches (Curry 1985; Grant and Grant 1985) nested repeatedly, while giant tortoises seemed to "wait out" the event (Cayot 1985). Feral pig populations apparently suffered large declines in the subsequent drought (Calvopiña, pers. comm.). Effects at that time in other parts of the world included an unprecendented drought in Hawaii, fires in Australia, and the abandonment of Christmas Island (Pacific Ocean) by seabirds.

THE FUTURE

Some of the recommendations from the work groups in the plenary session at the workshop included renewed emphasis on fundraising and education inside and outside the Galapagos; increased monitoring and research and better use and protection of the data generated; control of tourism and alien importations; more emphasis on both inventories (including mapping) and long-term studies; focus on important ecological areas and uninhabited islands which are most intact; *in situ* protection of the biota through removal of alien influences and exclusion by fencing; and *ex situ* conservation through expansion of programs in the Galapagos Islands and elsewhere. Priorities identified for alien species research included identifying plants to be controlled by herbicides and increasing research on different chemicals to control them; management of uninhabited islands for weeds and introduced animals; mapping of weeds; and biocontrol introductions. Use of outside expertise for alien animal and plant control (especially ungulate control campaigns, biocontrol, and herbicidal control) and for short-term research and *ex situ* programs was recommended. The international community could also be involved in more systematic training of Galapagos National Park Service personnel in principles and practices of conservation biology under the auspices of CDRS or the Agency for International Development, for example. The information generated at the meeting will be used to plan for a better future and to seek further funding for conservation biology in the Galapagos. Those of us fortunate enough to have visited the "Enchanted Isles" for a short time and interchange ideas with specialists there are better prepared to work toward effective conservation biology in Hawaii and elsewhere.

LITERATURE CITED

Brockie, R.E., L.L. Loope, M.B. Usher, and O. Hamann. In press. Biological invasions of island native reserves. Biol. Conserv.

Castillo, C.A.V. 1985. Alteracion en las publaciones del cormoran no volador, el penguino y otras aves marinas en Galapagos por efecto de El Niño 1982-83 y su subsecuente recuperacion. Pp. 245-258, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Cayot, L.J. 1985. Effects of El Niño on giant tortoises and their environment. Pp. 363-398, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Clark, D.A. 1981. Foraging patterns of black rats across a desert-montane forest gradient in the Galapagos Islands. Biotropica 13(3):182-194.

Coulter, M.C., F. Cruz, and J. Cruz. 1985. A programme to save the Dark-rumped Petrel, *Pterodroma phaeopygia,* on Floreana Island, Galapagos, Ecuador. Internatl. Comm. Bird Preserv., Tech. Publ. 3.

Cruz, F., and J. Cruz. 1985. The effect of El Niño on the breeding of the Dark-rumped Petrel on Cerro Pagos, Floreana. Pp. 259-273, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Curry, R.L. 1985. Breeding and survival of Galapagos mockingbirds during El Niño. Pp. 449-471, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Eckhardt. R.C. 1972. Introduced plants and animals in the Galapagos Islands. Bioscience 22(10):585-590.

Gagné, W.C., and C.C. Christensen. 1985. Conservation status of native terrestrial invertebrates in Hawaii. Pp. 105-126, *in:* Stone, C.P. and J.M. Scott (eds.), Hawaii's terrestrial ecosystems: preservation and management. Honolulu, Hawaii: Univ. Hawaii Press for Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit.

Grant, P.R. 1984. Recent research on the evolution of land birds on the Galapagos. Biol. J. Linnaean Soc. 21:113-136.

Grant, P.R., and B.R. Grant. 1985. Responses of Darwin's finches to unusual rainfall. Pp. 417-447, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Hamann, O. 1984. Changes and threats to the vegetation. Pp. 115-132, *in:* Perry, R. (ed.), Key environments: Galapagos. New York: Pergamon Press.

Hamann, O. 1985. The El Niño influence and the Galapagos vegetation. Pp. 299-230, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Harmon, W., W. Clark, M. Stafford, and A. Hawbecker. In press. *Trichomonas gallinae* in Galapagos columbiform birds. J. Wildl. Diseases.

Harris, M. 1983. A field guide to the birds of Galapagos. Collins. 160 pp.

Hoeck, H.M. 1984. Introduced fauna. Pp. 233-245, *in:* Perry, R. (ed.), Key environments: Galapagos. Pergamon Press, New York.

Jackson, M.H. 1985. Galapagos: a natural history guide. Calgary, Canada: Univ. Calgary Press.

Kramer, P. 1985. Foreword. Pp. xviii-xxi, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Kogelschatz, J., L. Solorzano, R. Barber, and P. Mendoza. 1985. Oceanographic conditions in the Galapagos Islands during the 1982-1983 El Niño. Pp. 91-123, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Laurie, A. 1985. The effects of the 1982-1983 El Niño on marine iguanas. Pp. 199-209, *in:* Robinson and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Limberger, D. 1985. El Niño on Fernandina. Pp. 211-225, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Lubin, Y.D. 1985. Studies of the little fire ant, *Wasmannia auropunctata,* in a Niño year. Pp. 473-493, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Medeiros, A.C., L.L., Loope, and F.R. Cole. 1986. Distribution of ants and their effects on endemic biota of Haleakala and Hawaii Volcanoes National Parks: a preliminary assessment. Proc. 6th Hawaii Volcanoes Natl. Park Nat. Sci. Conf.: 39-51. Honolulu: Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit.

Mountfort, G. 1970. The problems of tourism to island reserves. Noticias de Galapagos 15 en 16:11-13.

Patton, J.L. 1984. Genetical processes in the Galapagos. Biol. J. Linnaean Soc. 21:97-111.

Porter, D.M. 1984. Relationships of the Galapagos flora. Biol. J. Linnaean Soc. 21:243-251.

Pyle, R.L. 1983. Checklist of the birds of Hawaii. 'Elepaio 44:47-58.

Rechten, C. 1985. The waved albatross in 1983: El Niño leads to complete breeding failure. Pp. 227-237, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Robinson, G. 1985. Influence of the 1982-1983 El Niño on Galapagos marine life. Pp. 153-190, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Robinson, G., and E.M. del Pino (eds.). 1985 El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

St. John, H. 1973. List and summary of the flowering plants in the Hawaiian Islands. Pacific Trop. Botan. Garden Mem. 1. Lawai, Kauai, Hawaii.

Simons, T.R. 1983. Biology and behavior of the endangered Hawaiian Dark-rumped Petrel. Condor 87:229-245.

Stafford, M., and W. Harmon. 1982. A survey for blood parasites in the Galapagos Islands. Informe Anual 1982, Estacion Cientifica Charles Darwin 273:278.

Stone, C.P., and J.O. Keith. 1987. Control of feral ungulates and small mammals in Hawaii's national parks: research and management. Pp. 277-287, *in:* Richards, C.G.J. and J.Y. Ku (eds.). Control of mammal pests. Suppl. 1, Trop. Pest Manage. 32. London: Torgen and Francis, Ltd.

Tomich, P. Q. 1986. Mammals in Hawaii: A synopsis and notational bibliography, 2nd ed. Bishop Mus. Publ. 76, B.P. Bishop Mus. Press, Honolulu.

van Riper, C. III, S.G. van Riper, M.L. Goff, and M. Laird. 1986. The epizootiology and ecological significance of malaria in Hawaiian land birds. Ecol. Monogr. 56(4): 327-344.

Wagner, W.L., D.R. Herbst, and S.H. Sohner. In prep. Manual of the flowering plants of Hawaii. B.P. Bishop Mus., Honolulu.

Weber, W.A., and H.T. Beck. 1985. Effects on cryptogamic vegetation (lichens, mosses and liverworts). Pp. 343-361, *in:* Robinson, G. and E.M. del Pino (eds.), El Niño in the Galapagos Islands: the 1982-1983 event. Quito, Ecuador: Charles Darwin Found.

Wiggins, I.L., and D.M. Porter. 1971. Flora of the Galapagos Islands. Stanford, Calif.: Stanford Univ. Press.

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BOOK REVIEW

Mammals in Hawaii: A Synopsis and Notational Bibliography. Second Edition. P. Quentin Tomich. Bishop Museum Special Publication 76, Bishop Museum Press, Honolulu, 375 pp., 1 table, frontispiece + 80 figs., 1986. $42.95 (hardbound).

Prior to 1986, three books devoted exclusively to the mammalian fauna of Hawaii had been published: *Hawaiian Land Mammals* (Kramer, C. E. Tuttle Co., Rutland, Vermont, 347 pp., 1971), , *A Field Guide to the Mammals in Hawaii* (van Riper and van Riper, Oriental Publ. Co., Honolulu, 68 pp., 1982), and the first edition of the Tomich book being reviewed here (Bishop Museum Press, Honolulu, 238 pp., 1969).

The Kramer work, which did not cover cetaceans, has been out of print for a number of years. The van Ripers' paperback, still in print and covering both land and sea mammals, is excellent but is primarily a quick reference publication. Tomich's first edition was an admirable blend of scientific and popular information on mammals in Hawaii and its surrounding waters, supported by background information on both mammalogy in general and specific biological conditions here in Hawaii, and enhanced by an imposing annotated bibliography of approximately 700 text-cited entries. As in the case of Kramer's book, however, the first edition of this work has been unavailable for some years.

Fortunately, a moderately revised and extensively updated second edition of Dr. Tomich's book is now available. The author primarily intends this new version of *Mammals in Hawaii* "to continue the story and bring it once again up-to-date." The result is a book of at least the same--if not even greater--high caliber, value, and interest as its predecessor.

This edition is composed of the same six major sections as the first: Introduction, Checklist, Species Accounts, Some Perspectives in Hawaiian Mammalogy, Bibliography, and Index. The earlier 45 text figures, almost exclusively photographs of land mammals and terrestrial habitats, have been augmented by 35 others, mostly whales and dolphins. Pencil sketches (by Marcia Tomich Rose, the author's daughter) of all cetaceans recorded from Hawaiian waters have been added to the front and back end papers.

The spelling of Hawaiian words now includes the 'okina, or glottal stop, and the macron, or vowel accentuator. Total page number has been increased significantly: from 238 to 375. Author and editorial staff have also done a good job in proofing, as extremely few typographical errors were noticed. The price is high but perhaps not excessive for an extensively illustrated book of this length and quality.

The 10-page Introduction includes a concise explanation of scientific nomenclature and classification, and a new discussion titled Trends, which details the generally encouraging expansion of biological and environmental protection work primarily in Hawaii, since 1969.

This is followed by a scientific- and common-name Checklist of the mammals that at one time or another have maintained (significantly sized) wild or feral populations in and around the State, noting the method by which each species came to be found here. There are, still extant in the wild, one bat, two seals, at least 22 whales and dolphins, and 19 terrestrial forms, for a total of 44 species, the Domestic Horse not being included in this number as all of its former feral populations have apparently disappeared. The Black-tailed Prairie Dog, *Cynomys ludovicianus*, a "flourishing colony" of which Tomich notes (p. 188) was found (and soon extirpated) during 1981 in a Kauai pasture is not included in the Checklist or Species Accounts. Past and present occurrence of wild and feral populations of the non-cetacean Checklist mammals on the Main Islands and a few of their offshore islets, as well as on a

number of the Northwestern Hawaiian Islands, are recorded in an accompanying chart. A convenient addition to the Checklist would have been the page number of the Species Account for each animal, because this information is not recorded in the Table of Contents.

Changes since the 1969 Checklist consist of the addition of five species of larger whales and three of smaller whales and dolphins, while three species of dolphins have been deleted. The Northern Elephant Seal, *Mirounga angustirostris,* which breeds on islands off California and northern Mexico, is added to the state inventory on the basis of three sightings at or near Midway Islands. The house mouse found here is now considered to be a derivative of the southwest European *Mus domesticus* rather than of *M. musculus* from northeastern Europe, and the pilot whale of Hawaiian waters is now said, without explanation, to be *Globicephala macrorhynchus* rather than *G. melaena.*

Some confusion may result from the variety of (unexplained) status terms used in the Checklist: "immigrant," "introduced," "escape," "vagrant," "hypothetical," "indigenous," and "endemic." For all of the non-native species, at least, it might have been better simply to call them "alien" and rely on the Species Accounts to provide more-detailed information.

The Species Accounts now occupy 152 pages, up from a first-edition length of 103. The discussion of each taxon remains headed by a citation of the original scientific description and type locality, and brief statements giving the native range and the range in Hawaii. In most instances, the 1969 account has been repeated with little or no change, but is followed by a significant amount of newer information. Especially interesting and informative are the description of the continuing work of Dr. Tomich and a few other researchers on the Hawaiian Hoary Bat, as well as the greatly expanded cetacean accounts.

The next section, Some Perspectives in Hawaiian Mammalogy, completes the narrative portion of the text and consists of 10 essays, ranging from one to six pages long. Most of these, like the Species Accounts, are essentially repeats of the first-edition work updated with post-1969 information. They include such diverse topics as Hawaiian Names for Mammals, Biological Aspects of the Rodents, Animal Quarantine, and The Fate of Kahoolawe.

Apparently, the primary purpose in writing these essays was to provide a vehicle for utilization of all references not used in writing the Species Accounts. Some of the included data do, however, seem rather specific to certain Hawaiian species but, being more or less hidden in the essays, may escape the notice of many users. In the essay Whales and Dolphins, the illustrated Johnny Hart *B.C.* cartoon (p. 177; duly referenced and annotated in the Bibliography) relating to the possible effect of a horse meat diet on methods of communication in humans seems inappropriate in more ways than one.

The Bibliography is almost doubled in length from the earlier 86 pages to the current 163, thus becoming the longest section of the book. All of the 700 or so 1969-edition references have been purposely retained, and the numerous post-1969 titles that have been added (including publications from well into 1985) bring the present total to over 1500 entries. Each of these references is accompanied by a notation of from one to, usually, two or three sentences summarizing the content. This Bibliography and its annotations are a virtual gold mine for students of Hawaiian natural history and, taken alone, could be considered almost as great a contribution to knowledge as the entire rest of the volume.

To assemble and analyze this vast number of references, Dr. Tomich obviously searched long and hard through a great variety of published and unpublished sources, many of which would have remained undiscovered or unsearched by any less conscientious and dedicated a worker.

It is, however, around just this startlingly long and truly diverse Bibliography that my only significant negative criticism of the book revolves. It is true that the wide-ranging discussions of the Introduction and Perspectives sections require a certain level of bibliographical variety, but, for less than 200 pages of preceding text, a reference list of 163 fine-printed pages is inordinately long.

Just a few examples of the present overuse of references might be cited here. Such publications as *Weeds Manual for the Hawaiian Sugar Industry* (Anon. 1963a) and "The Mechanics of the Explosive Eruption of Kilauea in 1924" (Finch 1947) along with dozens of similar entries, are extremely marginal to the subject of mammals in Hawaii, to say the least. Perusing the Bibliography, it is intriguing to consider just what circumstances necessitated text use of the *Hot Rod* magazine article "Mauna Kea Hillclimb" (Brock 1963) that, according to its notation, "[d]escribes early failures, and final conquest of Mauna Kea by an automobile on January 30, 1963. Driver, Jimmy Pfleuger, used a Willys Jeep powered by a Chevrolet Corvette engine and equipped with modified Firestone Duplex tires. Seven photos."

The Guinea Pig, *Cavia porcellus,* existed wild in the State for about 10 years, was found only on Laysan Island, and has been gone for 75 years. In the first-edition account of the species, a not-unreasonable six references were devoted to the species, but in the present edition these are all retained and four post-1969 citations have been added; only one of the latter four being truly pertinent. Finally, in an essay (p. 179), the Greenpeace Foundation is noted as an example of effective activist "Save the Whale" groups; but the text does not require three reference citations to the organization, when any one of them would have been completely adequate.

In summary, I would suggest that the current Bibliography could have been shortened by at least a third -- perhaps even by a half -- without significantly diminishing the amount of specific information on Hawaiian mammals available in the volume. The many obscure but valuable pre-1969 references that the author has diligently uncovered and reviewed through the years are, after all, already permanently recorded in the first edition. The bibliographical task in the second edition should have been to streamline the book (and, coincidentally, minimize its price) by judiciously culling all non-essential older references, and exercising a modicum of restraint in adding new ones.

A 13-page, generally well-detailed, Index concludes the book. Discrete entries appear for most individual terrestrial mammal species; islands, islets, and atolls; most persons; and organizations, but the user should note that a number of other potential entries are simply grouped under such collective headings as "Birds," "Diseases," "Plants," "Ships," and the like. Spot checks indicated a few Index omissions and apparent discrepancies, particularly in the case of scientific names of mammal species mentioned only once or a few times in the text.

Overall, however, Dr. Tomich can certainly be justifiably proud of this new contribution to our knowledge, understanding, and appreciation, of the mammals in Hawaii. His book will stand as *the* work of this subject for many years to come!

Alan C. Ziegler
45-636 Liula Place
Kaneohe, Hawaii 96744

NOVEMBER FIELD TRIP REPORT KOKO HEAD REEF WALK

The November 21st HAS field trip was a night-time reef walk along a Koko Head lava and coral bench that contained hundreds of tidal pools. Fifty-three people participated in the outing which began at 7:45 PM. Miraculously, the heavy rains which had been showering Oahu during most of the day stopped as soon as we all parked our cars and began the reef walk. The tide was extremely low, the ocean was calm, and the tidal pools were teeming with marine life. Participants encountered octopus, nudibranchs, "7-11" crabs and nama crabs, brittle stars, sea squirts, sea cucumbers, sea anemones, moray eels, goat fish, butterfly fish, aholehole, mullet, damselfish, scorpion fish, squirrel fish, manini, cardinal fish, trumpet fish, banded coral-shrimp, spiny sea urchins, hermit crabs, sea hares, polychetes, many colorful sea shells, limu, and the list goes on and on. Due to the success of this trip, the field activities committee will be re-scheduling this trip during the coming new year.

Bruce Eilerts

JANUARY FIELD TRIP TO HOOMALUHIA PARK

The January 16th field trip will be held at Hoomaluhia Park and led by Patrick Ching. Participants will be given a tour of the park's botanical gardens and will have the opportunity to observe native waterbirds, migratory shorebirds, and a wide variety of introduced birds. Bring along a lunch, binoculars, rain gear, and some insect repellant. Meet at the State Library on Punchbowl Street at 8:30 AM. or at Hoomaluhia Park's visitor center at 9:15 AM. Contact Patrick Ching at 839-2866 or Bruce and Robin Eilerts at 941-5974 for more information.

FREE ICE CREAM!

Ice cream will again be served to those volunteering for paste up of the *'Elepaio* at Thane Pratt's house on Saturday, 23 January 1988, beginning at 1:00 PM. I thank Sheila Conant and Bruce and Robin Eilerts for help with paste up of the current issue. For more information, call me at 524-8464.

TKP

NOTICE TO AUTHORS

The *'ELEPAIO*, Journal of the Hawaii Audubon Society, invites authors to submit scientific articles on natural history of Hawaii and the Pacific. Scientific articles are subject to peer review. The *'ELEPAIO* also serves as a newsletter to inform members of conservation issues, Society events, and other subjects of interest to members. Manuscripts of articles and newsletter items may be sent to Thane Pratt at 1022 Prospect St., Apt. 1103, Honolulu, HI 96822. Articles not subject to peer review MUST BE RECEIVED BY THE 15TH OF THE MONTH to be considered for publication in the next month's issue.

SCIENTIFIC ARTICLES should be typewritten and double-spaced scientific, and three copies should be submitted. Any photographs should be submitted as photographic prints, in color or black and white (they will appear in black and white). The prints should be 3.5 X 5 inches, or larger, and should be adequately cropped if cropping is required. Original copies of figures (e.g., maps, graphs) should be clear and clean, with lettering large enough to remain legible upon reduction to fit the newsletter format. Authors are advised to design their illustrations with the 'Elepaio's columnar format and size in mind (please look at a copy of the journal).

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FIELD CHECKLIST OF BIRDS OF HAWAII by R. L. Pyle and A. Engilis, J. (1987). Pocket-sized card listing 125 species, with space for field notes. Post paid. $0.25 or $0.10 for 10 or more. **(NEW!)**

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CALENDAR OF EVENTS

Jan. ?? Board Meeting and pot luck at Sheila Conant's house. Date & time to be determined; call Sheila, 948-8241 (wk).

Jan. 16 (Sat.) Field trip to Hoomaluhia Park. Meet at State Library on Punchbowl St. at 7:30 AM. Announcement on p. 10.

Jan. 18. (Mon.) General Meeting at Atherton Halau, Bishop Museum at 7:30 PM. Program: *New Guinea Wildlife* by Allen Allison.

Jan. 23 (Sat.) *'Elepaio* paste up at Thane Pratt's house, 1:00 PM. Call 524-8464.

TABLE OF CONTENTS

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