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Panama Eco-Park:

A Protected Urban Forest

Peter L. Weaver

Front cover

Top: Field trip to one of the many bunkers at Eco-Park; bottom left: gato solo (white nosed coati) feeding along the roadside; bottom right: butterfly of the Heliconidae group.

(Photos by Néstor Correa and Peter L. Weaver)

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Abstract

Eco-Park and surrounding areas located near the Pacific or southern entrance to the Panama Canal have a long history involving pre-Columbian inhabitants, Spanish conquistadors, pirates, and Panamanian natives and immigrants associated with the construction and operation of the Panama Railroad and Canal. Some major 20th century events included Panamanian independence from Colombia, building of the Balboa Naval Station (later called Rodman Naval Station), construction of the Bridge of the Americas (formerly Thatcher Bridge), the Torrijos-Carter Treaty and, subsequently, the U.S. departure from Panama. Eco-Park is dominated by a semideciduous seasonal mixed forest. A plant survey carried out in that forest type for Eco-Park and nearby military bases (i.e., Howard, Rodman, and Kobbe together called HOROKO) revealed 378 species, 97 genera, and 82 families. An animal survey carried out in the same forest type disclosed 260 species, including 40 mammals, 19 reptiles, 13 amphibians, and 188 birds (39 migratory and 149 residents). In summary, Eco-Park and surrounding areas have a fascinating history and a diverse flora and fauna. Moreover, being situated near Panama City and along the Canal route, Eco-Park and surrounding areas offer numerous outdoor recreational opportunities for Panamanian residents and Canal Area visitors. Eco-Park, beginning as a fascinating idea, was made into reality through the dedicated efforts of both local and international groups.

Keywords: Eco-Park, education, fauna, flora, historical chronology, Panama Canal.

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Introduction

Eco-Park was once part of the Rodman Naval Station or, more specifically, the Rodman Ammunition Supply Point (RASP) where munitions were stored. Eco-Park and surrounding areas are located near the Pacific entrance to the Panama Canal and have a long and interesting history (appendix table 1; fig. 1). Pre-Columbian inhabitants occupied nearby Venado Beach and Punta Brujas leaving artifacts that were uncovered during the construction of military facilities. In 1513, after discovery of the Americas by European explorers, Balboa claimed the Pacific Ocean for Spain, possibly from Punta Brujas. Subsequently, residents of Panama City and the isthmus experienced visits from pirates like Henry Morgan in 1671, activities associated with railroad construction in the 1850s, and French attempts at building the Panama Canal during the 1880s. Events during the 20th century included Panama's successful quest for independence from Colombia in 1903, completion of the Panama Canal in 1914, and construction of Balboa Naval Station between 1932 and 1937 (the Balboa Naval Station was renamed the Rodman Naval Station in 1950). In 1962, Thatcher Bridge (later renamed Bridge of the Americas) was built over the Canal completing another critical link in the PanAmerican highway between Alaska and Patagonia. In 1977, the Torrijos-Carter Treaty outlined the "reversion" of the Canal Zone (today called Canal Area) with all military and civilian buildings to Panama. In 1999, the U.S. Navy officially departed from Rodman Naval Station. Historical events within the region also have involved the Gulf of Panama, proposed canal routes through Central America, and famous naturalists who worked in or wrote about the area.

With the arrival of a new millennium, international concerns and forward-thinking Panamanians began to set aside and develop an ecological Park for the benefit of residents and visitors to the Canal Area. All those who participated considered protection, research, monitoring, recreation, ecotourism, and education to be important themes. Local and international groups promoted the design and purpose of the Park (appendix table 2). This report has been written to familiarize visitors with the Park's natural and cultural resources. Moreover, many outdoor recreational and sightseeing opportunities in and around the Park have been highlighted using photographs and expository descriptions.

Location of Eco-Park

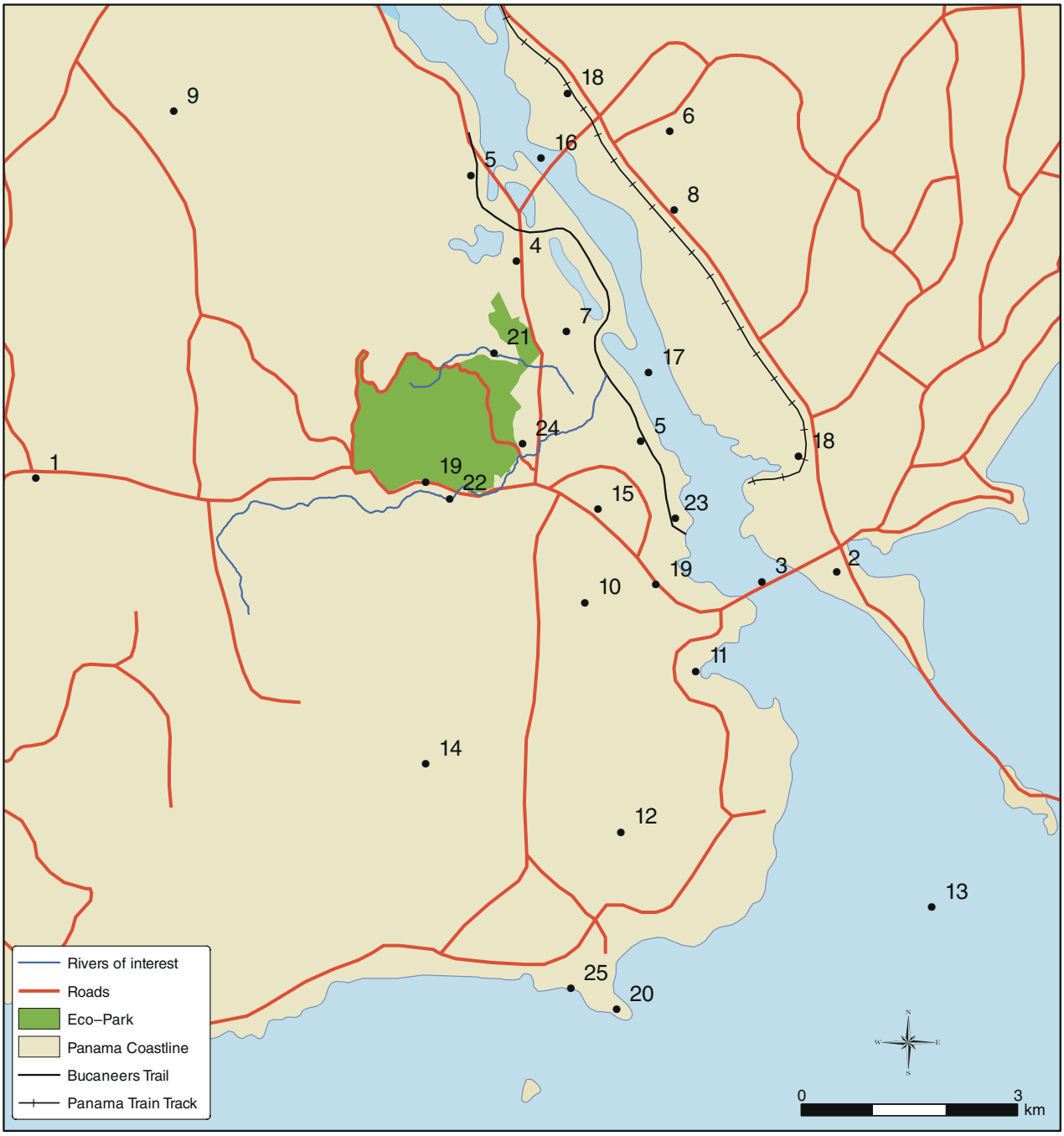
Eco-Park is bordered on the north and west by the Empire Range, on the south by the PanAmerican Highway, the Arraijan Tank Farm, and Howard Air Force Base, and on the east by Cocolí, the Tucán Resort, and the former Rodman Naval Station (fig. 1). Fort Kobbe and Farfan lie south of Rodman (Autoridad de la Región Interoceánica 1999).

Fort Kobbe, formerly Brujas Point Military Reservation, was established on 730 ha for use as a small defensive position on the Bay of Panama in 1928. In 1932, it was renamed Fort Kobbe to honor Major General William A. Kobbe, who served during the Spanish-American War (Johnson and Houle, n.d.). In 1940, Fort Kobbe was expanded to 1,600 ha; subsequent changes in 1952 resulted in reassigning Howard Field within Kobbe as part of Howard Air Force Base. Kobbe contains more than 250 housing units, a school, warehouses, and batteries built in the late 1920s. The batteries, named in honor of members of the original Joint Army-Navy Panama Canal fortifications survey group of 1910, were considered obsolete and were scrapped after World War II.

Howard Air Force Base occupies about 1,500 ha. Built in 1939 and opened in 1942, Howard was formerly part of the Bruja Point Military Reservation, but was renamed to honor Maj. Charles H. Howard who flew in Panama during the late 1920s. The nearly 2,600-m landing strip hosted fighter and bomber aircraft during World War II; and the base was the Southcom component responsible for air operations in Latin America and the Caribbean. Howard is large enough to be used as a major transport center to accommodate international cargo aircraft.

The U.S. Naval Radio Station at Farfan was constructed in 1941–42 on a 330-ha parcel during a period when naval holdings in the Canal Zone were increasing (Johnson and Houle, n.d.). Between 1947 and 1948, family housing units were built at Farfan, and it was made an annex of Balboa Naval Station.

The Cocoli housing community and related facilities began as part of the proposed project to construct a third set of locks in the Panama Canal in 1939. The project was initiated along with housing construction at Cocoli, but when the U.S. entered World War II, the lock project was abandoned



- **1** Arraijan Tank Farm
- **2** Balboa Heights Station
- **3** Bridge of The Americas
- **4** Brujas Road
- **5** Buccaneers Trail
- **6** City of Knowledge (Fort Clayton)
- **7** Cocoli
- **8** Corozal Cemetery
- **9** Empire Range
- **10** Farfán
- **11** Farfán Beach
- **12** Fort Kobbe
- **13** Gulf of Panama
- **14** Howard Air Force Base
- **15** Lacona Housing
- **16** Miraflores Locks
- **17** Panama Canal (Río Grande)
- **18** Panama Train Track
- **19** Pan American Highway
- **20** Punta Brujas
- **21** Quebrada Victoria
- **22** Río Velásquez
- **23** Rodman Naval Station
- **24** Tucán Resort
- **25** Venado Beach

Figure 1— Map of place names in and around Eco-Park.

(Johnson and Houle, n.d.). In 1951, the Panama Canal Company released Cocoli to the Navy, which in 1965 turned it over to the Army.

The Arraijan Fuel Tank Farm and the Empire Range are the other military facilities on the Canal's west bank. The Empire Range occupies about 2,270 ha and was used as a firing range dating back to World War II. The Tucán Resort, comprising a golf course, villas, condos, and a clubhouse, occupies the old HOROKO (i.e., Howard, Rodman, and Kobbe military bases) golf course. In accordance with the 1977 treaty signed by Panamanian General Omar Torrijos and President Jimmy Carter, all military facilities reverted to Panama by the end of 1999.

Eco-Park Forest

In anticipation of the Canal transfer, ecologists carried out a survey of HOROKO to identify its flora and fauna (ANCON and TNC 1996; fig. 1). The region is hilly and receives an average of 1,800 mm of rainfall per year (fig. 2). Numerous corridors (streams, drainages, roads, and trails) run through the area.

The semideciduous seasonal mixed forest occupies about 35 percent of HOROKO and is the dominant forest type in Eco-Park (ANCON and TNC 1996). During the plant survey, 378 species of plants, 97 genera, and 82 families (67 dicotyledons and 15 monocotyledons) were recognized within the forest type. Of these, 360 species were identified at least to the level of genus. Two families, Leguminosae and Rubiaceae, accounted for nearly 20 percent of the total number of species.

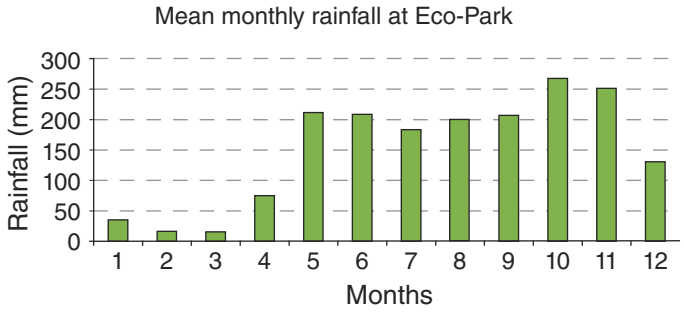


Figure 2—Mean monthly rainfall at Eco-Park.

Eco-Park Wildlife

During the animal survey in the semideciduous seasonal mixed forest, ecologists recorded 192 species, including 33 mammals, 13 reptiles, 13 amphibians, and 114 birds (ANCON and TNC 1996). Eighteen species of bats were the most common mammals. Species such as white-tailed deer, jaguarondi, coati, opossum, armadillo, rabbit, monkeys, rodents, and sloth were also recorded. Frogs (Leptodactylidae) were the most common amphibians, iguanas (Iguanidae) the most common reptiles. Tyrant flycatchers (Tyrannidae) accounted for 22 of the recorded birds species. Also common were wood warblers (Parulinae)—11 species, tanagers (Thraupinae)—9 species, and hummingbirds (Trochilidae)—8 species. These data on flora and fauna were based on a rapid ecological assessment (i.e., an intensive, short-term field survey) and represent one forest type (i.e., semideciduous seasonal mixed forest). Further monitoring in the Park will disclose additional plant and animal species.

Eco-Park Diversity

Eco-Park occupies 375 ha and is bordered by numerous properties that are used for other purposes, many of which are associated with operation of the canal and past military activities (fig. 1). Despite the array of surrounding developments, the flora and fauna are relatively diverse (table 1). The survival of secondary forest, except to the east, partially accounts for this diversity. However, major roads along the border—the PanAmerican Highway to the

Table 1—Diversity of flora and fauna in Eco-Park[1]

Flora	
Semideciduous seasonal mixed forest	
— 82 families	
— 97 genera	
— 378 species	
Fauna	
— Mammals	
— 19 families	
— 33 species (18 bat species)	
— Reptiles	
— 6 families	
—13 species	
— Amphibians	
— 4 families	
— 13 species	
— Birds	
— 29 families	
— 114 species	

[1] ANCON and TNC 1996.

south and the Brujas Road to the east (along with the Canal)—present major barriers for some species. Several plant and animal species found in the Park are considered threatened and are currently protected by Panamanian laws, or are designated in special classes by conservation organizations. The Canal Area west of the Panama Canal and south of Lake Gatún, which includes Eco-Park, has been listed as an important bird area (Angehr 2003).

Eco-Park Conservation

Mesoamerica, as a land bridge since the mid-to-late Pleistocene, permitted the dispersal of flora and fauna between the hemispheres and within the region (Bennett 1968). During the past 10,000 years or longer, humans have been a party to that dispersal. Panama was passed through and lived in hundreds of years before crops were grown. Estimated dates for the appearance of agriculture range between 250 and 5000 years B.C. At the time of the Europeans' arrival, Panama's fertile land, abundant water supply, and wildlife provided subsistence resources for at least 60 Indian chiefdoms (Helms 1979). Nombre de Dios, established by Christopher Columbus in 1502, was the earliest Spanish settlement. In 1519, Panama City was founded, and settlements on the Caribbean and Pacific coasts were connected by road and river. Panama had now established itself as the crossroads of the Americas—not only east and west, but also north and south.

At the beginning of the 20th century, 80 percent of Panama was still forested (Zon and Sparhawk 1923); however, no sawmills existed before work began on the Panama Canal (Cummings 1955). During the Canal's construction, big-leaf mahogany and Spanish-cedar were cleared locally and used for making cabinets, interior trim, railroad coaches, and furniture on ships (Braddy 1920a, 1920b). In 1947, 70 percent of the country remained forested; subsequent estimates of forest cover were 68 percent in 1950, 58 percent in 1960, 53 percent in 1970, 50 percent in 1974, 47 percent in 1980, 40 percent in 1990, and 37 percent in 1998 (Weaver and Bauer 2003).

About 65 years ago, Panama's foresters called attention to forest destruction and the need for conservation measures and management programs (Moral 1944). Forty years later, it was shown that the effects of accelerated forest destruction and colonization were causing the country serious social and environmental problems (Heckadon-Moreno and McKay 1984). Today, the call for conservation of Panama's forest resources continues, notably with regard to protection of the Canal's watershed (Condit and others 2001). The Park's development is one effort helping to protect the Canal while offering the people of Panama recreational opportunities and direct economic benefits.

Eco-Park in Photos

Introduction and Environmental Setting

1. Overview

This program of 62 photos is designed to familiarize visitors with the natural and cultural resources of the Eco-Park situated near the southern, or Pacific, entrance to the Panama Canal. The visual tour highlights the following themes:

- Panama as the crossroads of the Americas
- Cultural and historic background of Eco-Park and surrounding areas
- Fauna and flora in their natural habitat
- Famous persons and their relation to the park or Canal
- Legacy of the Canal and the importance of its protection
- Outdoor recreational and site-seeing opportunities located at Eco-Park
- Future plans for Eco-Park
- The role of collaborating agencies and groups in furthering conservation and environmental education in Panama

Eco-Park insigne. (Photo by Néstor Correa)

2. The Mesoamerican corridor—importance of Eco-Park

The Mesoamerican corridor (previously, Paseo Pantera), conceived in 1990, is an ambitious project designed to join protected areas throughout Central America by ecological corridors, or land bridges, so that the habitat necessary for migration of the region's wildlife can be protected. In June 1992, the convention for the conservation of biodiversity and protection of priority wildlife areas in Central America was created; it established a regional council on protected areas that range from the Yucatan peninsula in Mexico to the Darién in Panama (Colombian border). Goals of the international program are to promote regional peace and maintain biological diversity through sustainable economic activities such as ecotourism and agroforestry. All Central American countries agreed to protect their national heritage, adopt sustainable development programs, use natural resources optimally, control pollution, and reestablish ecological equilibrium.

Eco-Park, with its location on the Pacific side of the isthmus, where only 30 percent of Panama's remaining forests are found, would represent an important addition to the Mesoamerican corridor. The proximity of Eco-Park to Panama City and nearby suburban areas where more than one-quarter of the nation's population resides, makes it an ideal site to introduce the concept of sustainable management to residents and their children. Visitors to Panama would also benefit from an excursion to Eco-Park.

Néstor Correa Mesoamerican corridor. (Paseo Pantera Project)

3. Eco-Park—formerly Rodman Ammunition Supply Point (RASP)

In May 1932, the U.S. government granted a license for construction of the Balboa Naval Station (renamed Rodman in 1950), which was built between 1933 and 1937 (fig. 1). Originally located in a tidal marsh, the base was completed about 1937 to provide fuel, provisions, and other support to military ships passing through the Panama Canal (Enscore and Webster 1997**,** Johnson and Houle, n.d.). The naval station includes a deep draft port facility, housing units, warehouses, munitions bunkers, and other buildings. Balboa Naval Station expanded and contracted over the years to encompass other naval holdings, which included an Ordnance Department, Marine Barracks, Camp Rousseau, and the nearby Lacona and Cocoli housing communities. Additional housing was constructed in 1941 as part of a military build-up in preparation for World War II. Over the years, the Bruja Road was modified from a gravel road to a paved thoroughfare with a cloverleaf intersection at the southeast corner of the property.

Rodman Naval Station was at its peak in the 1960s when hundreds of sailors were stationed there, and it was used as a layover for U.S. ships transiting the Canal. Rodman hosted the Southern Detachment of the Atlantic Fleet (CINCLANTFLT Detachment South), the naval component of the U.S. Southern Command responsible for Southcom naval exercises. From 1963 to 1999, Rodman hosted nearly 5,400 graduates in the Navy Small Craft Instruction and Technical Training School (NAVSCIATTS). The program was mainly in Spanish for naval and coast guard personnel throughout Latin America and the Caribbean (Lindsay-Poland 2003, Nyrop 1980). Instruction included diesel motor repairs, mechanics, and navigation, among other subjects. Proposed uses for the various parts of the Rodman property after 2000 include a fuel-bunkering terminal, a third set of canal locks, and Eco-Park.

Old building at entrance. (Photo by Néstor Correa)

4. Geology, physiography, and soils

Virtually all of Eco-Park is underlain by intrusive and extrusive basalt dating to the middle and late Miocene about 15 million years ago (Stewart and others 1980, Woodring 1957). The La Boca formation, comprised of siltstone, sandstone, tuff, and limestone dating to the early Miocene, occupies less than 1 percent of the southeastern corner of the Park. "Although the canal zone has the lowest elevation on the isthmus of Panama, it is one of the most hilly parts of Central America" (Bennett 1929, page 6). This hilliness is evident within Eco-Park. The Park occupies about 375 ha and ranges in elevation from 10 m along the drainage in the east-central part of the property to about 165 m at the central summit (Díaz 2005, U.S. Army 1989). Six highpoints reach more than 100 m in elevation.

The alluvial soils bordering the larger streams and drainages in and around Eco-Park are deeper than those on hilltops. Nearly 75 years ago, the generally deep, red-clay soils in the vicinity were reported to show a remarkable resistance to erosion, even along old trails and in areas where the land had been cleared for pasture (Bennett 1929). During the survey, the alluvial areas and the rolling lower portions of hills with gentle slopes were considered well-suited to agriculture.

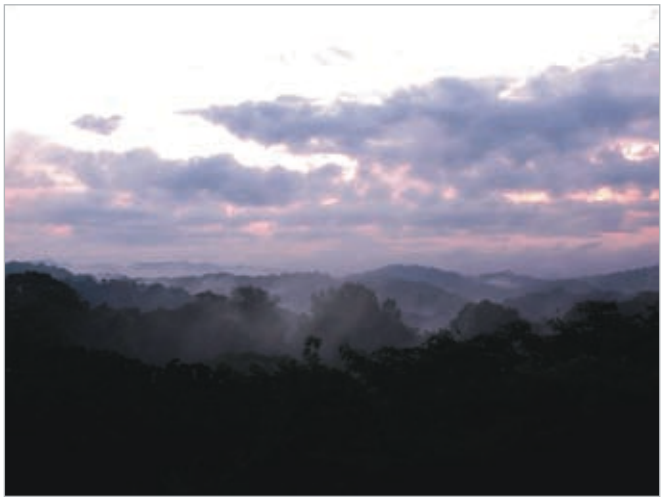
Rolling hills near Miraflores Locks. (Photo by Peter L. Weaver)

5. Climate—rainfall and drought

Estimates of rainfall for Eco-Park are available from Balboa Heights station (Type A, No. 142-004, N8°30', W79°33", 30 m elevation) located about 5 km across the Panama Canal to the east. Measurements began at Balboa Heights during construction of the Canal in 1905; the record is continuous except for the years 1974–1976 (Smithsonian Web site). The 93 years of complete annual data indicate that the mean and median rainfalls are both 1,800 mm/yr. Rainfall is seasonal: 85 percent falls during the May–November wet season, and 15 percent during the December–April dry season. The January–March period is very dry, bringing less than 4 percent of the annual rainfall. About 56 percent of the years for which records are available receive between 1,600 and 2,000 mm of rainfall; about 22 percent of the years receive less than 1,600 mm; the remaining 22 percent more than 2,000 mm. The least amount of annual rainfall, 1,288 mm, was recorded in 1980. The greatest amount of annual rainfall was recorded the following year (1981) at 2,525 mm. Mean monthly temperatures between the warmest and coolest months vary by slightly more than 1 °C (Thompson 1959). Both relative humidity and cloudiness are greatest during the wet season.

Pronounced droughts like the El Niño event in 1983 have a major impact on the Canal watershed vegetation, apparently more so in secondary growth than in mature forest (Leigh and others 1990). Moreover, mortality appeared more common for some

Rainstorm. (Photo by Néstor Correa)

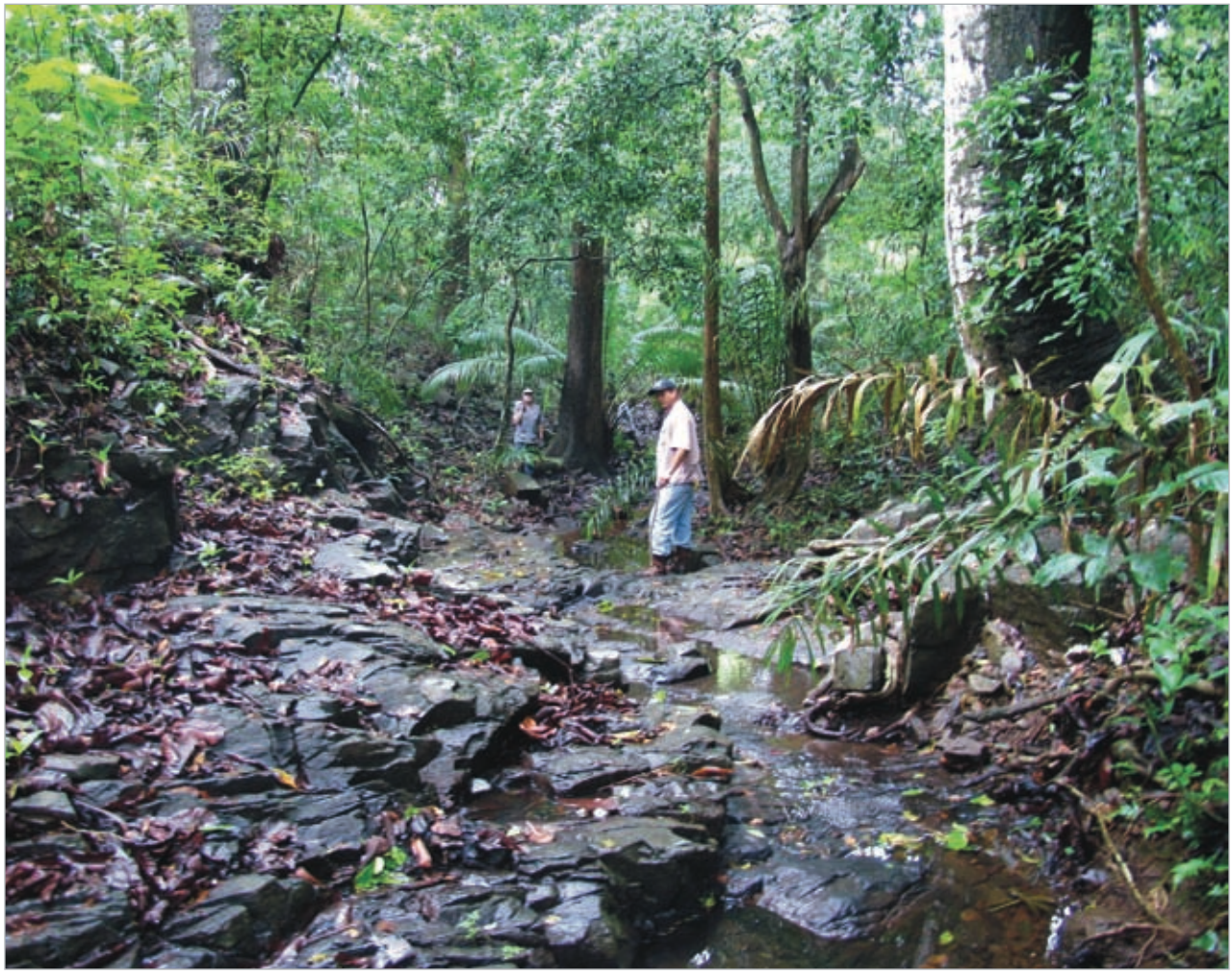


tree species and size classes than others, for trees on shallow soils as opposed to deeper ones, and for plants growing on seasonally wetter sites (i.e., along streams, drainages, and in swamps) than drier ones. Also, greater numbers of plants appeared to succumb in areas situated in clearings as opposed to those shaded by a tall forest canopy. Occasional convective thunderstorms cause local winds strong enough to topple individual trees or small patches of forest.

6. Hydrological system—ephemeral streams and drainages

Several corridors (streams, drainages, roads, and trails) run through Eco-Park. Río Velásquez, Eco-Park's only permanent waterway, parallels the southern edge of the property. Quebrada Victoria, within Eco-Park, is near the northeastern boundary. Both were tributaries of the Río Grande, which was later excavated to form the canal. In addition, numerous drainages intermittently carry runoff, the largest of these descending gently to the east and north. Isolated pools of water may remain in the drainages for extended periods after heavy rainfall. Most amphibians depend on both aquatic and terrestrial habitats to survive (Semlitsch 2003). The drainage of wetlands associated with Canal construction and related projects had a negative impact on all wildlife, notably at the Pacific terminus. The future construction of a small pond within Eco-Park might partially alleviate these negative impacts and help conserve animal diversity as surrounding areas continue to experience change. In addition, it could serve as a center for recreational activities and educational programs.

Large trees in drainage. (Photo by Yiscel S. Yángüez)



Panama City. (Photo by Néstor Correa)

7. Scenic views—Panama City skyline

The Panama City skyline, visible from a local highpoint, is a constant reminder that Eco-Park lies just outside of the country's largest city and is essentially a large urban park. Panama is often described as three cities in one—a modern capitol with skyscrapers and a business district; the Casco Viejo district with numerous buildings dating from the 17th–19th centuries; and Panama Viejo, containing the ruins of the original 16th century city. The 265-ha Metropolitan Park, which is home to numerous bird and mammal species, lies just to the north. The park also has four nature trails and a lookout point to the city and Canal.

Panama City, originally an Indian village and now the oldest surviving European City on the American mainland, was founded in 1519 by Pedro Arias Dávila, Vasco Nuñez de Balboa's successor (Panama Canal 1939). For 200 years, the city was a terminus in the transshipment route over the isthmus for Spanish colonists moving to the west coasts of Central and South America, and part of the "Camino Real," a military and treasure road, for the transfer of Peruvian gold across the isthmus, and ultimately across the Atlantic Ocean to Spain. In 1671, the buccaneer Henry Morgan sacked and burned Panama City. In 1751, Peruvian traders began to favor the route around Cape Horn and the city became a quiet, isolated appendage of New Granada (i.e., Colombia and Venezuela). In 1855, the Panama Railroad was completed across the isthmus, and the city once again became a Pacific coast terminal for travelers, most bound for California during the era of the "gold rush." In 1903, the city's leaders declared independence from Colombia and signed the Hay-Bunau-Varilla Treaty

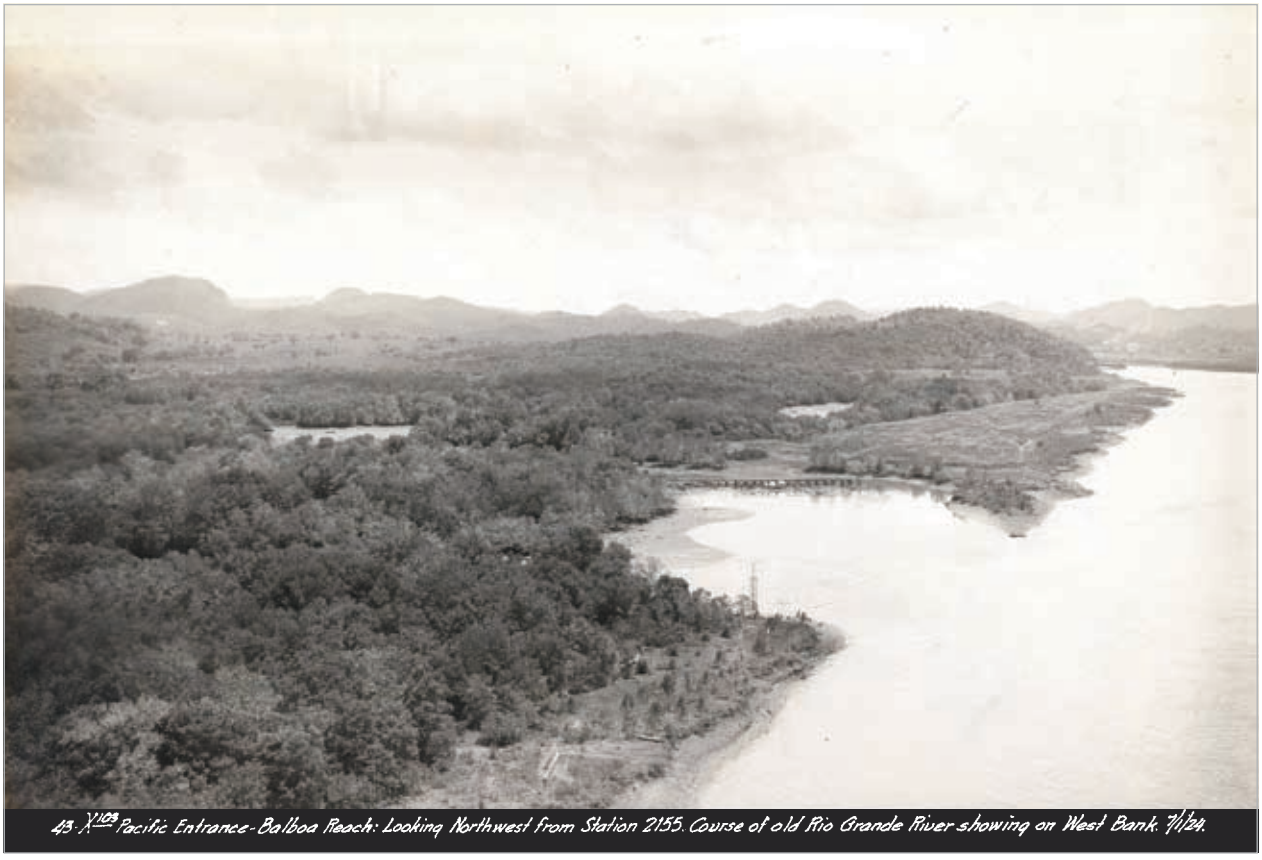
with the United States to build the Panama Canal. In 1914, the steamship Ancón made the first commercial passage from Cristóbal to Panama City, initiating cargo shipments and passenger service via the Canal, and establishing the city as a major transshipment route for all nations.

Historical Setting—Places and People

8. Eco-Park in the past

Rodman Naval Station reverted to Panama with the March 12, 1999, headline "Bandera Panameña ondea en Rodman" (Panama's flag waves over Rodman) (Delgado 1999, p. 29A). U.S. Mobil Corporation subsequently plans to use the facilities along the Canal as a fuel bunkering terminal. However, what is the history of the land today occupied by Eco-Park? Once pristine tropical forest, the land was first logged and used for agricultural production and grazing. After Panama declared its independence from Colombia, all land within 8 km of the Canal (i.e., the old Canal Zone) was granted to the United States to build and operate the Panama Canal (Gold 1999). The "Depopulation Order" of December 1912 removed all persons from the Canal Zone, paying those with valid titles. Presumably, agricultural activities in the vicinity of today's Eco-Park ceased at that time. Subsequently, secondary forest began to regenerate. Beginning in the mid-1930s, roads were developed into the area for the construction of munitions bunkers and associated facilities, including administration and storage buildings, guard posts, and parking areas. Cyclone fencing around the property was added as a security measure.

West shore before Navy Station. (Photo: ACP Archives)



9. U.S. Naval Station Panama Canal—60 years of service

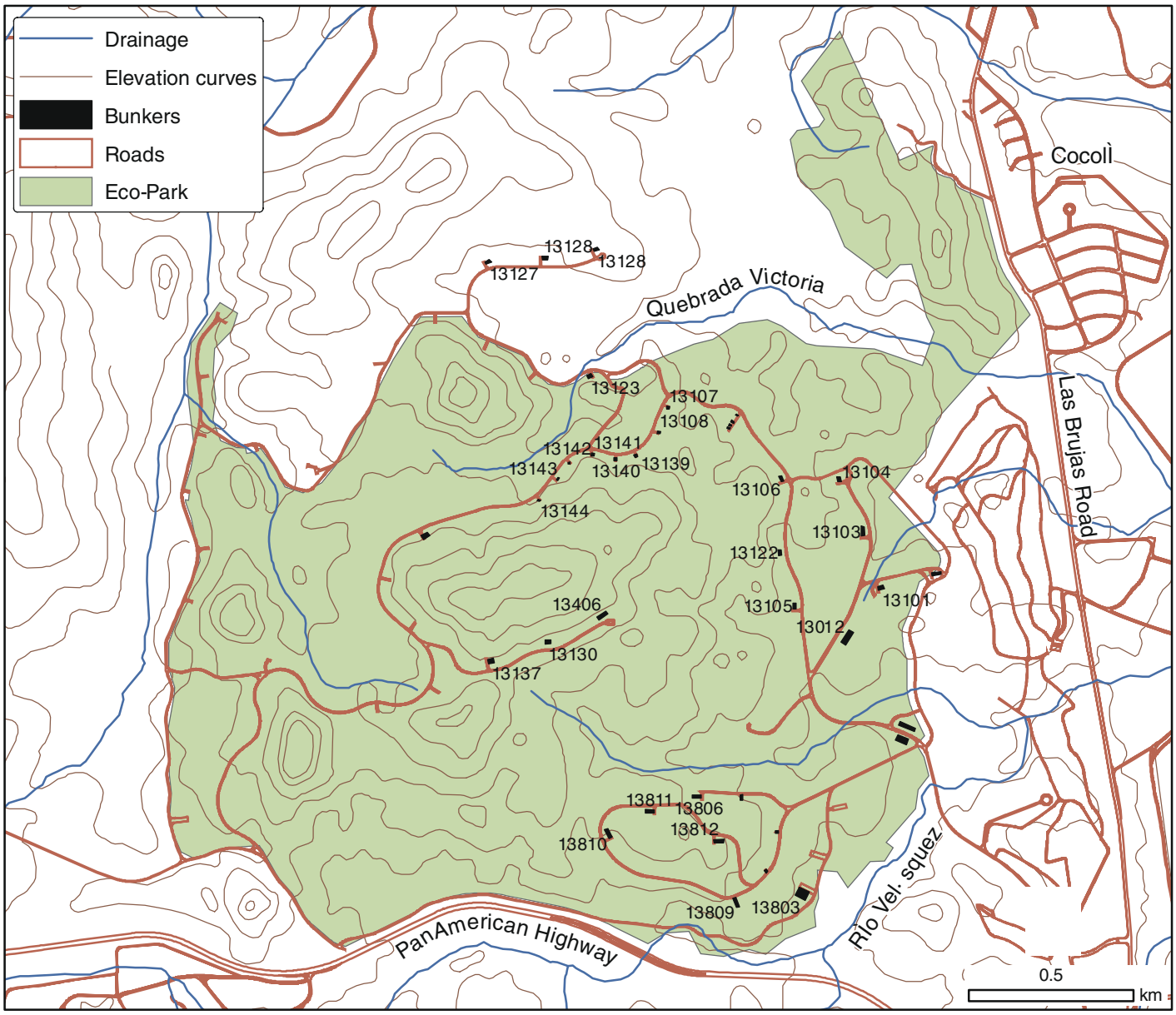
The U.S. Naval Station Panama Canal–Marine Barracks began as the Naval Ammunition Depot (NAD) at Balboa, but was soon moved to its final location across the Canal. Construction began in December 1935, and Balboa was commissioned in September 1937, when marines and sailors were on post (Enscore and Webster 1997). By 1939, the complex had about 40 buildings and structures including officers' quarters, barracks, magazines, mine storage and assembly buildings, an oil house, and an equipment building. Because of its isolation, recreational facilities were provided including an athletic field, swimming pool, bowling alleys, tennis and handball courts, movie and pool rooms, and the Canal Zone's first exchange. In September 1940, the Navy built a road to the munitions depot and additional quarters. Between 1941 and 1943, additional roads, sentry stations, temporary barracks for marine guards, an ammunition overhaul and assembly building, and a temporary mine-anchor storage building were added; also, 47 new magazines were built, 34 for the storage of high explosives.

During World War II, marines at the Naval Station served as transit guards to ensure safety, and to prevent shipboard sabotage and the gathering of intelligence. After the War, Navy troop strength was reduced significantly. The Naval Base returned to higher levels of activity during the Korean Conflict of the early 1950s, the Cuban Missile Crisis of 1962, and international incidents like the terrorist bombing in Beirut, Lebanon, and the U.S. invasion of Grenada in the 1980s. During "Operation Just Cause" in 1989, Navy Seals crossed the Canal from Rodman to Balboa Harbor to disable Manuel Noriega's yacht, the "Presidente Porras" (Flanigan 1993).

10. Rodman Ammunition Supply Point (RASP)—today, Eco-Park

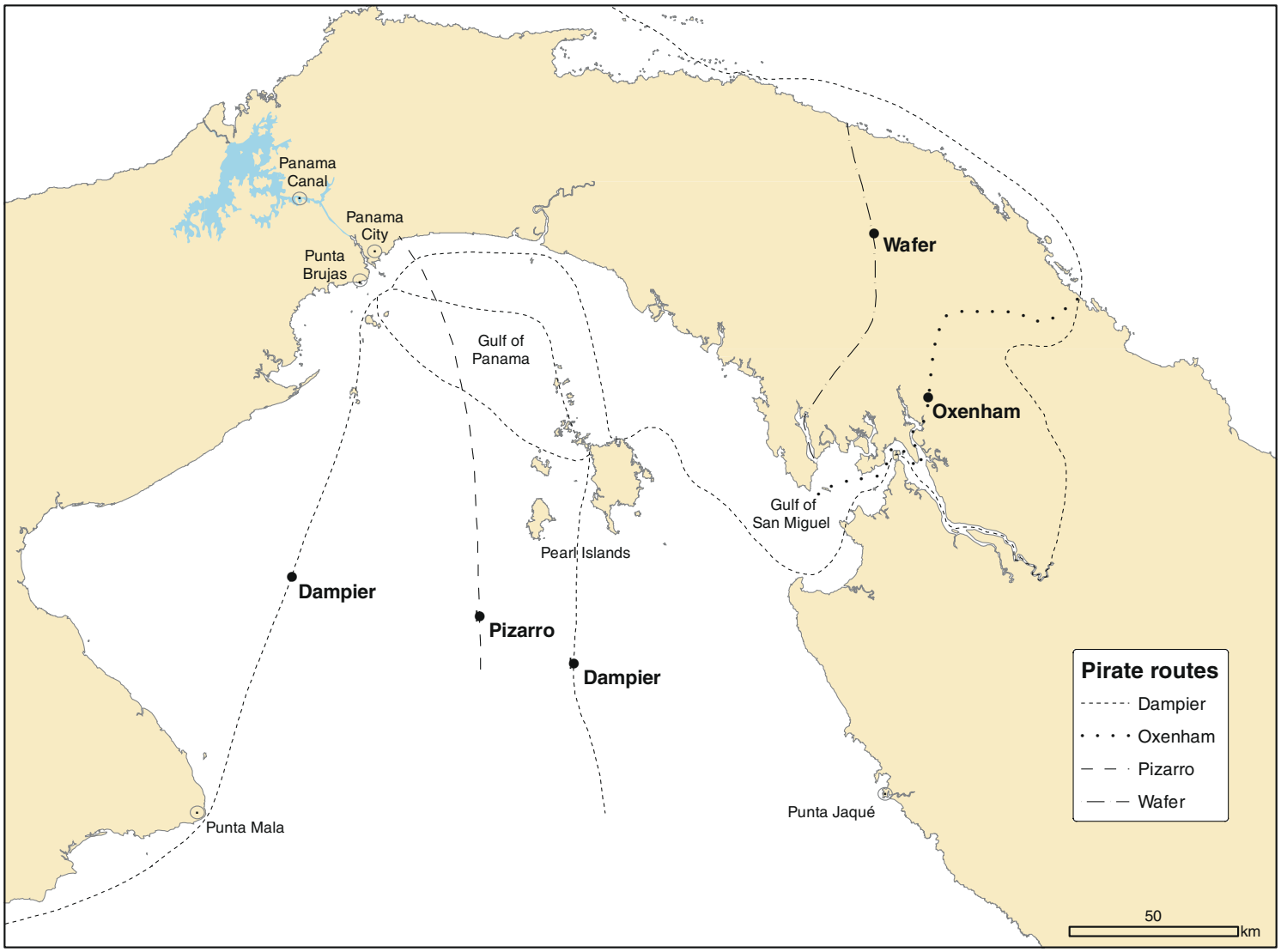
The Rodman Ammunition Supply Point (RASP) was designed and constructed to store munitions between 1933 and 1937. In 1942, the supply point was upgraded to provide additional space for materials associated with World War II. Originally, the munitions supply point was part of the Balboa Naval Complex. In 1956 it was transferred to the U.S. Air Force, and in 1976 to the U.S. Army. Today, the former RASP is Eco-Park.

Rodman across Canal. (Photo by Gerald P. Bauer)



Eco-Park map. (Peter L. Weaver)

The structures on the Eco-Park property included 13 buildings that were used as offices, dormitories, maintenance shops, or warehouses (to store transformers, flammable materials, paints, and other items). The 87 ammunition storage magazines (bunkers) were used to store different types of ordnance, equipment, or furniture. They were designed in 14 different sizes; six were aboveground and the remainder earth-covered. The most common dimensions are: 21 bunkers measure 24.4 by 7.3 m (80 by 24 feet), 16 measure 15.2 by 7.3 m (50 by 24 feet), and 14 measure 24.4 by 6.7 m (80 by 25 feet). The remaining 38 magazines range from 2.1 by 1.8 m (7 by 6 feet) to 29.9 by 14.6 m (98 by 48 feet). Four large metal cages were also built: two 15.2 by 12.2 m (50 by 40 feet), one 14.6 by 7.3 m (48 by 24 feet), and one 12.2 by 9.1 m (40 by 30 feet). The buildings and bunkers were mostly in good to fair condition when last surveyed; some small wooden structures and abandoned magazines, however, were in poor condition. Eco-Park also has a helipad about 500 m inside its eastern boundary.



Gulf of Panama. (Pereira Jiménez)

11. Gulf of Panama—configuration, importance, and history

The Gulf of Panama, sharing the continental shelf with the isthmus, has a coastal perimeter of nearly 670 km between Punta Mala and Punta Jaqué (Rubio 1959). The Gulf, measuring 195 km at the mouth and extending 165 km to the mainland, occupies about 30,000 km^2, and contains 257 continental islands; centrally located along the coast is Panama City. With substantial tides reaching 6 m, the Gulf is shallow, rarely exceeding 60 m in depth. Realizing the existing and potential of the Gulf's natural resources, Panama, in 1946, was the first nation to incorporate the doctrine of continental shelf in its constitution by declaring the area part of the national territory.

The rich history of the Gulf of Panama began before the Spanish conquest of the native Indian populations, who had long before occupied its shores. In 1513, Balboa first sighted the Pacific Ocean (Gulf of Panama) from a peak in the Darién. After Pizarro's conquest of Peru, Panama became the portage between two oceans. From 1530 through the late 1600s, Gulf waters were frequented by Spanish vessels and pirate ships that preyed on them. Among the best known were John Oxenham in 1575, Lionel Wafer in 1681, and William Dampier in 1685 (Pereira Jiménez 1964). Oxenham, along with escaped African slaves known as Cimarrones, attacked the Pearl Islands in a vessel they had built. Wafer, a good friend of Dampier, was both a surgeon and chronicler who had served on different ships. Dampier was an extraordinary buccaneer who sailed around the

world three times, once as part of a crew that attacked ships in Panama Bay. However, he is best known as the author of three books that describe, among other topics, perceptive accounts of the Galapagos Islands, trade winds and currents, and Australia—all of which were highly regarded. During his third circumnavigation, his ship stopped at Juan Fernandez Island where he encountered a marooned sailor named Alexander Selkirk. This adventure later served as the theme for Daniel Defoe's story of Robinson Crusoe. After the attack on Pearl Harbor, Panama signed defense agreements with the United States, which included regular patrols in the Pacific Ocean, including the Gulf of Panama (Morris Brooks 2003).

12. Punta Brujas, Farfan, and Venado Beach

Indians occupied the area around Punta Brujas, Farfan beach, and Venado beach for more than a millennium, and numbered about 1 million throughout Panama at the time of the Europeans' discovery (Aráuz 1977). Moreover, in 1513, one of Balboa's three claims of the South Sea (Pacific Ocean) for the Spanish Crown may have occurred at Punta Brujas (Sauer 1966).

In the early 1940s, the U.S. military uncovered artifacts at Farfan Beach while engaged in war-hastened construction (Marshall 1949). Among the finds was a midden that contained ceramics, including dishes, bowls, and bottles. Burial sites and burial urns also were found. Later in 1948, while bulldozing near Venado Beach, the U.S. Navy discovered archaeological remains (Lothrop 1956). Soon after, groups from the Peabody Museum of Harvard and elsewhere unearthed about 370 skeletal remains that were in comparatively good condition because of unusual soil conditions.

Excavations at Venado Beach have provided a look into a past culture that occupied the site. The oldest ceramics with painted motifs from western Panama consist of black-line geometric ware (Santa Maria Polychrome) which began shortly before A.D. 300 (Stone 1972). Black line ceramics found at Venado Beach were radiocarbon dated at A.D. 227, and gold figures at about A.D. 250 (Stone 1972). The area in and around the four burial sites uncovered at Venado Beach contained other discoveries including (Bull 1958, Lothrop 1954, Sander and others 1958, Sander and Mitchell 1960, Torres de Araúz 1972):

- A single piece of worked carnelian agate without drill holes.
- Shards apparently from a large urn.

Punta Brujas. (Photo by Peter L. Weaver)

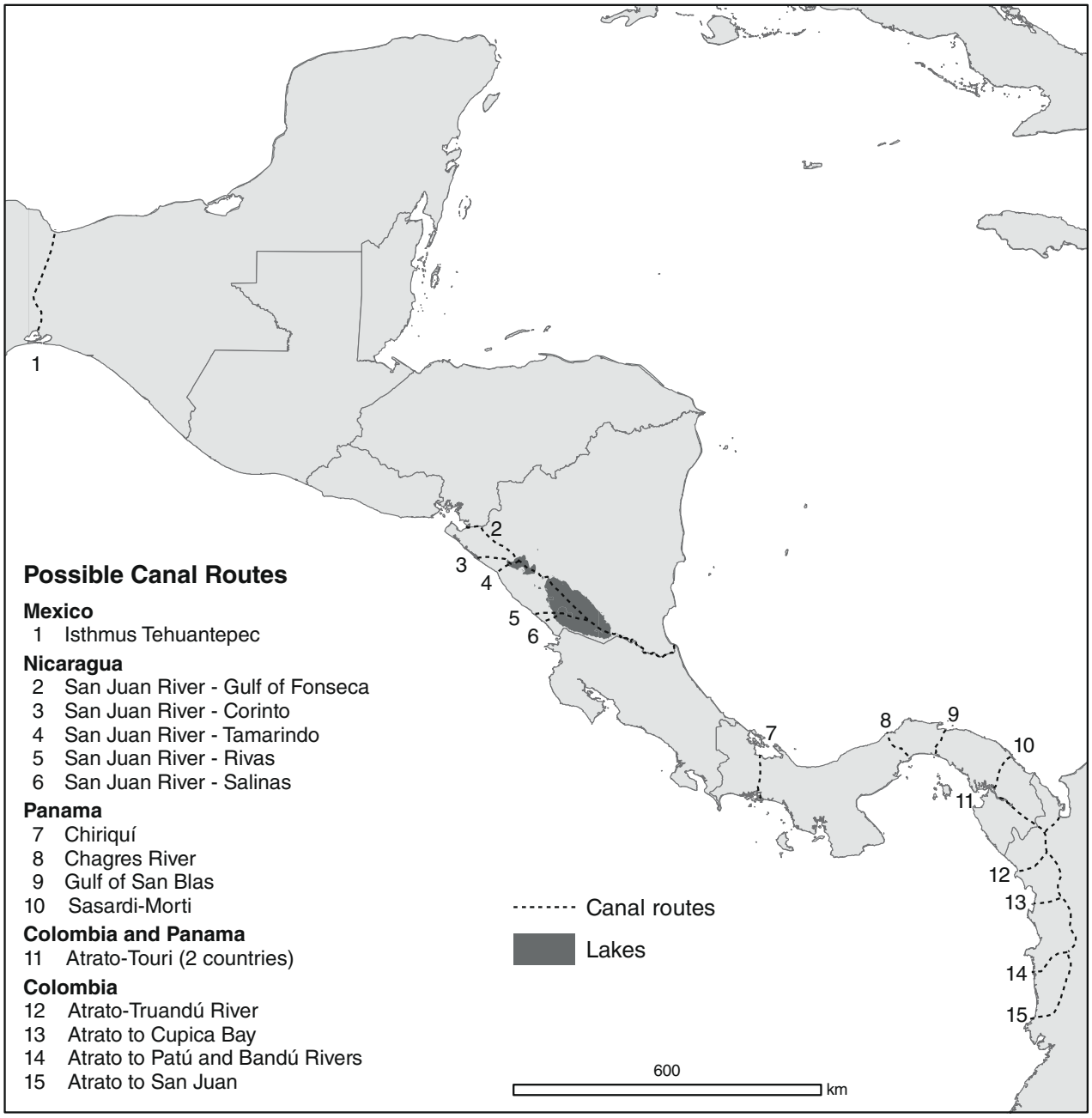
- Badly decomposed skeletal remains without cranium fragments or other large bones, and a few human teeth.
- Evidence of ordinary burials along with human sacrifice, body mutilation, and live burials.
- Forty-eight dog teeth and three pink-lipped alligator effigies, all drilled for use as necklaces, and seven pink-conch spacer beads.
- A highly polished, crudely fashioned celt (stone tool) and three shell scrapers.
- A miniature tumbaga figurine (or stylized effigy of an alligator or jaguar), along with attached pieces of fabric and cord.

Although they were advanced with regard to metal work, not a great deal is known about the people who lived at Venado Beach. The unity of style in shell fragments, pottery, and metal along with the shift from single-line patterns to a full polychrome technique in the production of wares may indicate a long presence (Lothrop 1966). The attached fabric appeared to be the oldest known from the wet tropics at that time, and suggested that the inhabitants also weaved cotton cloth. Today, Venado Beach, about 5 km distant from Eco-Park, is a pleasant area to walk while watching ships enter and depart from the Canal.

13. Buccaneers trail—Henry Morgan and the sacking of old Panama

The buccaneers trail, apparently just east of Eco-Park, was used in Morgan's 17th century attack on Panama City (Forbes 1948, Hussey 1960). Henry Morgan, born in Wales around 1635, first arrived in Barbados, later joining other buccaneers in Jamaica. After several ventures, Morgan acquired a ship and, among his exploits, raided Portobelo along the northern coast. In 1671, the buccaneers conquered San Lorenzo and then set out on a 10-day march to Panama City with few provisions and under constant harassment by the Spaniards and Indians. Old Panama, the first settlement on the Pacific shore by Europeans, was one of the largest and wealthiest in the Americas (Anderson 1914). Gold from Peru along with pearls from offshore made Panama the greatest gold and silver mart in the world. In the turmoil that followed Morgan's attack, old Panama was set on fire and continued to burn for days. After sacking Panama City, the buccaneers crossed into the Chagres River watershed, later dividing the spoils at Fort San Lorenzo, much to Morgan's favor. With discontent growing among his mutinous crew, Morgan and a select few sailed at night with the booty to Port Royal, Jamaica. Since Morgan's raid postdated the 1670 Treaty of the Americas ending hostilities between Great Britain and Spain, he was later arrested, taken to London, and imprisoned. His confinement, however, was of short duration, and he later emerged a hero for his conquests. Ultimately, Morgan was named Lieutenant-Governor of Jamaica where he died in 1688. One observer of Morgan's nefarious life labeled him as a great rogue and with little respect for the old proverb regarding honor among thieves. In 1831, George Peacock anchored the corvette Hyacinth off the Chagres River and journeyed to Panama City (Mack 1974). Based on his field observations, Peacock traced on a map a proposed canal route that is remarkably similar to the current waterway. The trace also appears to parallel the eastern boundary of Eco-Park.

Henry Morgan. (Photo by Peter L. Weaver)



Proposed canal sites. (Peter L. Weaver)

14. Proposed Canal—alternative routes through the Americas

Columbus' fourth voyage in 1502 was in quest of a passage from the Atlantic to the Indian Ocean (Bennett 1915). In 1506, Vicente Yañez Pinzon looked for a straight in the Gulf of Honduras and Yucatan, and again in 1508, as far as 40° south latitude. Magellan, in 1520, finally discovered a straight that bears his name at 53° south latitude, at the southern tip of South America. However, it was considered too distant. In 1525, Esteven Gomez, who had sailed with Magellan, searched for a passage between Florida and Newfoundland. During the 1520s, searches were also made along the Pacific coast by the Spanish, but to no avail. Man would have to supply what nature had failed to provide (Bennett 1915). Between 1517 and 1529, Álvaro de Saavedra Ceron, a follower of Balboa, made surveys and proposed four routes for a ship canal through the Central American isthmus: from the Gulf of San Miguel (Gulf of Panama) to the Gulf of Urubá; from Panama City to Nombre de Dios in Panama; through Lake Nicaragua; and finally

across Tehuantepec in Mexico. Between the 1530s and the early 19th century, several additional surveys and proposals were forwarded, including the ideas of von Humboldt.

Several events through the centuries, however, would favor the Panama route. In 1534, the Chagres River was navigable to Cruces, about two-thirds of the way across the isthmus. In 1826, President Bolivar of New Granada believed that at least a railway, and possibly a canal, were feasible between the Chagres and Panama City. That route was virtually the same as was used by the Panama Railroad in the 1850s. In 1838, a French company obtained a concession from New Granada for the construction of a canal across Panama, an effort attempted in the 1880s without success. Finally, in 1914, the United States completed the canal. In summary, at one time or another, six countries—Spain (1506 to 1820), New Granada (1826), Holland (1829), Great Britain (1838), France (1838), and the United States (as early as 1835)—showed an interest in building an interoceanic canal. Moreover, no fewer than 15 major routes ranging from Tehuantepec, Mexico to the Atrato River in Colombia (e.g., 1 in Mexico, 5 in Nicaragua, 4 each in Panama and Colombia, and 1 shared by Panama and Colombia), had been proposed to link the Atlantic and the Pacific oceans (Rubio 1964). Considering all minor variations, the number of possible routes rises to 30 (Storey and others 1970).

15. The Panama Canal—a few names and dates

Of the many names and dates associated with the Panama Canal over the past 125 years, a few stand out as memorable. On January 1, 1880, a French company headed by Ferdinand de Lesseps (famous for his involvement with the Suez Canal) began activities on a sea-level canal in Panama, completing

Theodore Roosevelt. (Photo: ACP Archives)

PRESIDENT THEODORE ROOSEVELT INSPECTING CANAL WORK FROM RAILROAD COACH

about 40 percent of the required excavation before he declared bankruptcy on January 1, 1889. Later, during the 1898 Spanish-American War, Theodore Roosevelt recognized the need for a canal in the western hemisphere and in 1901, as President, sought an agreement with Colombia. When this attempt failed, the United States supported the Panamanian separatist movement under Manual Armador Guererro, who declared Panama's independence on November 3, 1903. Three days later, the Republic of Panama was recognized by the United States. The hastily developed Canal Treaty (Hay-Bunau-Varilla Treaty) granted "in perpetuity the use, occupation, and control" of a 16-km wide strip of land across the isthmus of Panama for building, maintaining, operating, and protecting the Canal (Enscore and Webster 1997, page 12). Panama ratified the treaty on December 2, 1903, and it was approved by the U.S. Senate on February 23, 1904; however, it would always be a source of contention. Some 60 years later, the flag riots of January 1964 involved the sensitive issue of flying Panamanian flags within the Canal Zone.

On September 7, 1977, Omar Torrijos and Jimmy Carter met in Washington to sign Canal treaties in a ceremony attended by 26 nations of the Western Hemisphere. The major issues were the reversion of the Canal to Panama, and ensuring its future neutrality, operation, management, protection, and defense. In 1989, tensions between General Manual Noreiga and the U.S. government culminated in a December 20 invasion by U.S. military forces during an operation named "Just Cause." A decade later, at noon on December 31, 1999, after a century of living in a divided country, a united Panama assumed control and responsibility for its Canal.

16. Miraflores Locks—most visited tourist site in Panama

The 80-km venture through the Panama Canal, beginning from the south, takes place in eight stages: entrance through the Pacific channel and anchorage; Miraflores locks; Miraflores Lake; Pedro Miguel Locks; Gaillard Cut; Gatún Lake; Gatún locks; and departure through the Atlantic anchorage and channel.

Miraflores Locks. (Photo by Peter L. Weaver)

The Miraflores locks reach 25 m and are taller than the other locks due to the high Pacific tides in Panama Bay. The Miraflores and Pedro Miguel locks raise ships from sea level to about 26 m, the level of Gatún Lake, allowing them to travel over the continental divide; the Gatún locks then lower them into the Atlantic. Although the Canal is not straight, navigating through the canal is done in a series of straight sections called reaches connected by abrupt turns (Rowlett 2005). More than 100 range lights have been mounted at the ends of reaches to help guide ships. In 1914, 35 lighthouses were built at the ends of longer reaches. Of the 28 that remain operational today, two are located in the vicinity of Miraflores—the Balboa Northbound Front Light and the Balboa Northbound Rear Light.

Miraflores Locks are the most frequently visited tourist site in Panama. The Miraflores visitor center has a museum, theater, restaurant, snack bars, small souvenir shop, and an observation deck. The museum has four halls. The first covers the technological innovations and sanitary efforts that accompanied the construction of the Canal. The second deals with the importance of water and conservation of the Canal's natural resources. The third has a simulator that allows observers to transverse the Canal and pass through the locks. Finally, the fourth hall highlights the importance of the Canal in world commerce.

17. Corozal American Cemetery—a tribute to the past

The Corozal American Cemetery, about 5 km north of Panama City near the Miraflores Locks, is the final resting place for more than 5,300 American veterans, as well as numerous other persons representing 71 nationalities who contributed to the construction, operation, and security of the Panama Canal. Interred there are veterans of the American Civil War, the Spanish-American War, World War I, World War II, the Korean War, the Vietnam War, and military activities including Lebanon, Desert Storm, and Iraq. The cemetery is one of 24 commemorative military cemeteries maintained by the American Battle Monuments Commission (ABMC) in 10 foreign countries (American Battle Monuments Commission

Corozal Cemetery. (Photo by Peter L. Weaver)

2004, Nicolaisen 1999). The ABMC has two primary functions—to commemorate the sacrifices and achievements of the Armed Forces since 1917, and to design, construct, and operate permanent American cemeteries for war dead in foreign countries.

The Corozal Cemetery, named after a grove of palm trees that once grew on the site, has an entailed history. In 1914, the Isthmian Canal Commission reserved land within the Corozal farm where local residents had interred the dead for about 5 years. Its administration and care were assigned to the superintendent of Ancón Hospital. The cemetery was initially maintained by disabled laborers, many of whom had lost a limb. Later, the Isthmian Canal Commission became the Panama Canal Company and management was assigned to its Grounds Maintenance Division. In 1979, the Panama Canal Company transferred the Corozal cemetery to the U.S. Army. The cemetery was then separated into two parts—the Corozal cemetery and the Corozal American cemetery, a 7-ha plot of land. In 1982, the U.S. Army transferred the Corozal American Cemetery to the ABMC who, in agreement with Panama, is responsible for the administration and maintenance of the grounds in perpetuity.

18. Panama Train—first trans-continental railroad in 1855

As early as 1829, a survey of the isthmus requested by Colombian President Simón Bolivar showed that a railroad was feasible (Bennett 1915). At that time, traversing Panama took 4 or 5 days and involved travel by both water and land: riding dugout canoes between the port of Chagres on the Caribbean coast and the inland town of Cruces; and walking or riding mules on an old, rugged road between Cruces and Panama City. During the late 1840s, several critical events occurred in rapid succession:

- In 1846, Colombia gave the United States, by treaty, a right-of-way across the isthmus of Panama, by any means, present or future.
- From 1846 to 1848, the United States acquired its Pacific coastal states by treaties with Great Britain and Mexico, and sought a means of accessing those States from the eastern seaboard.
- In 1848, gold was discovered in California and the gold rush began.

Between May 1850 and January 1855, construction of the 75-km Panama Railroad was plagued by cholera, dysentery, malaria, yellow fever, and small

Tunnel at Miraflores. (Photo by Gerald P. Bauer)

pox. Moreover, at least two other notable incidents occurred—the collapse of the wooden bridge spanning the Chagres River in 1852, and mass suicide of Chinese laborers, who purportedly were denied access to opium, in 1854.

In 1909, the railroad line was relocated to higher ground during the construction of the Canal, where it served a critical role in moving laborers and equipment. In 1979, ownership was transferred to the Panamanian government as part of the Panama Canal Treaty. A 25-year concession allowed for the repair and operation of the railroad beginning in 2001. The railroad's current priority is to transport containerized freight across the isthmus. However, daily service also allows passengers and commuters a chance to enjoy a ride through rain forest, and along the Canal and former military bases.

19. Hugh Rodman—respected by his men

Rodman Naval Station was named in honor of Rear Admiral Hugh Rodman. Rodman, born in Kentucky in 1859 and graduated from the U.S. Naval Academy in 1880, witnessed the transition of ships from wood to steel and from sail to steam. He also saw the U.S. Navy assume a role of world leadership (Brats 1999). In 1898, he fought in the Philippines during the Spanish-American War, where he played a prominent role in the Battle of Manila Bay. In 1912, while in command of the U.S.S. Delaware, he convoyed President William Howard Taft from the U.S. to Panama to review construction of the Canal. In 1914 and 1915, as Superintendent of Transportation (for both the Canal and the railroad) in the Canal Zone, and later as Marine Superintendent, he drafted the rules and regulations for vessels passing through the Canal. He was aboard the Ancón when it first traversed the Canal. When the U.S. entered World War I, Rodman commanded Division 3 of the Atlantic fleet where he successfully integrated war efforts with the British (Miller 1977). At the end of the war, he convoyed President Wilson from Portland, England, to Brest, France, for the peace conferences. Retired in 1923, Rodman authored a book "Yarns of a Kentucky

SS Ancón. (Photo: ACP Archives)

SS ANCON IN UPPER WEST CHAMBER, MIRAFLORES

Admiral" in which he related many of his experiences including the transit of ships at the Culebra Cut and fishing for tarpon in the Chagres River below Gatún Dam (Rodman 1928). He received numerous decorations, many of them international, during his distinguished career and was always seen as a champion of Navy and Marine Corps personnel. The U.S.S. Rodman, a destroyer launched in 1941, was named in his honor; likewise, the name of the Balboa Naval Station was changed to Rodman Naval Station on February 19, 1950.

20. Famous naturalists—their relation to the Canal

Friedrich Heinrich Alexander Baron von Humboldt (1769-1859), born in Berlin, Germany, was an explorer, artist, author, cartographer, botanist, zoologist, and sociologist. Between 1799 and 1804, at a time when travel was long and arduous, Humboldt and his colleague Aimé Bonpland mapped the Orinoco River in Venezuela and substantiated the existence of the Casiquiare Canal, a natural link between the Orinoco and the Negro River, a tributary of the Amazon (Wilcox 1977). He traveled nearly 10,000 km through rain forests and mountain ranges, keeping a diary with geological, zoological, and botanical notes and sketches. Humboldt collected 60,000 plant specimens representing 6,000 species, more than one-half new to science. He described experiences with the preparation of curare arrow poison, the cinchona plant which produces quinine used to cure malaria, and the electric eel. In Ecuador, he attempted to climb to the summit of the 6,270-m Mt. Chimborazo, and in Peru, he sketched Inca ruins and described the ocean current which bears his name. In 1804, on his return to Europe, Humboldt passed through the United States and discussed the issue of a canal with President Thomas Jefferson. When his travels were over, he lectured in Berlin and wrote everything he knew about the earth in a multi-volume book called "Cosmos." Although he never visited Panama, Humboldt suggested the construction of an interoceanic canal across the Central American isthmus, mentioning possible sites in Mexico, Nicaragua, Colombia, and of course, Panama (Rubio 1964). Panama's "high" mountains and Nicaragua's abundant water supplies were the reasons that Humboldt favored a Nicaraguan route (Enscore and Webster 1997). Simon Bolivar was so impressed with Humboldt's accomplishments that he once stated that "Baron Humboldt did more for the Americas than all of the conquistadors" (von Hagen 1948, page 145). Moreover, another source was quoted as saying that he was "the greatest man since Aristotle" (von Hagen 1948, page 145).

Two other renowned naturalists actually spent considerable time working in Panama and probably walked through the hills of Eco-Park at one time or another. Paul Carpenter Standley (1884-1963), a native of Missouri, entered Panama in 1923 to prepare a book on the vegetation along the Canal (Heckadon-Moreno 1998). He collected 7,500 specimens of plants and wrote "The Flora of Barro Colorado Island" and "Flora of the Panama Canal Zone," both published by the Smithsonian. After working in Panama, Standley studied the floras of the Yucatan (1930), Lancetilla Valley in Honduras (1931), British Honduras (1936), Costa Rica (1937-38), and Guatemala (1946). During his field activities in Central America and Mexico, he collected more than 130,000 plant specimens.

Alexander Wetmore (1886-1978), born in Wisconsin, was one of the most famous ornithologists in the world (Heckadon-Moreno 1998). His initial studies were in Puerto Rico (1911). In 1920, he traveled to South America where he published a book on the birds of Argentina, Chile, Paraguay,

Von Humboldt. (Photo: Wikipedia 2009)

A portrait of Humboldt by Friedrich Georg Weitsch, 1806

and Uruguay (1926). He also worked Haiti and the Dominican Republic (1927), Guatemala (1936), and Venezuela (1937), and traveled through Mexico (1939), Costa Rica (1940), and Colombia (1941). From 1944 to 1966, Wetmore studied the avifauna of Panama. His work entitled "The Birds of the Republic of Panama" was published in four volumes dated 1965, 1968, 1972, and posthumously in 1984 (Wetmore 1965-1984). During his travels, Wetmore collected more than 26,000 specimens of birds, 55 percent of them during his long period of research throughout Panama.

21. The PanAmerican Highway—Alaska to Patagonia

The PanAmerican Highway stretches nearly 48,000 km from Fairbanks, Alaska, to Quellón, Chile (some say Ushuaia, Argentina). Along its route, the highway traverses 14 countries—three in North America (Canada, the United States, and Mexico), six in Central America (Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama), and five in South America (Colombia, Ecuador, Peru, Chile, and Argentina). The highway passes through several regions with dramatically different climates including Alaska's frozen north, the temperate latitudes, the tropics, and finally the cold, windswept cone of South America. To those who drive along that route numerous ecosystems are visible—ranging from snow-covered landscapes through majestic temperate rain forest, mid-latitude prairies, mountainous cloud forests, tropical lowland rain forest, savannas, and desert. Along the way, the road ascends high mountain passes and descends into seemingly endless coastal lowlands. The road is discontinuous at only one point, the Darién Gap in eastern Panama and northwestern Colombia, where dense lowland rainforest and swamp lands remain as an obstacle. Somewhere near the middle of its transcontinental length, this international network of roads—"the PanAmerican Highway, a system so vast, so incomplete, and so incomprehensible it is not so much a road as it is the idea of Pan-Americanism itself" (Silverstein 2006, page 70)—traverses the Panama Canal at the Bridge of the Americas (formerly Thatcher Bridge) and passes within 100 m of the south edge of Eco-Park. Some might say that the highway achieved Simón Bolívar's dream to unite the Americas, at least to some extent.

Pan-Am Highway. (Photo by Peter L. Weaver)

Thatcher Bridge. (Photo by Peter L. Weaver)

22. Bridge of the Americas (Thatcher Bridge)—connecting the continents

The history of the "Bridge of the Americas" began in 1909 when bridges or tunnels were being considered to cross the Panama Canal at Empire, Culebra, Gold Hill, or Paraiso (Anonymous 1962). In 1942, the Miraflores swing bridge was completed. Although never intended as a substitute, its existence, along with the Canal ferry, delayed the building of a permanent structure. The bridge was a major stipulation in the 1955 Remón-Eisenhower Treaty, which also concerned annual payments for the Canal and proposed U.S. military uses of other lands in Panama. Construction began in December 1958 and was finished in time for inauguration on October 12, 1962 (Columbus Day), thus completing another link in the PanAmerican Highway, which then extended from Alaska to Patagonia (Noriega 1987). Maurice H. Thatcher, a member of the original group of Canal administrators that included such well-known figures as Gaillard, Goethals, and Gorgas, among others, was present at the inauguration. After service in Panama, Thatcher, as a member of the U.S. House of Representatives, was instrumental in developing a ferry service across the Canal, and in building a road between the western terminal of the ferry and the town of Arraijan. Thatcher's enthusiasm earned him the unofficial title as the "First Governor of the Canal Zone" (Anonymous 1962, page 3) and later tied his name to the ferry, highway, and bridge.

At a maximum height of 117 m above sea level and 61 m clearance over water at mean high tide, the bridge stretches 1670 m over Panama Bay at the Pacific entrance to the Panama Canal (Stevens 1962). The main spans are a combination cantilever-tied arch, and the approaches are combination cantilever-simple spans. In 1962, the bridge's main span was less than two-thirds of the world's largest cantilever bridge across the St. Lawrence River at Quebec, Canada. It's height above high water, however, dictated by shipping requirements, ranked it among the highest in the world.

Seasonal mixed forest. (Photo by Peter L. Weaver)

Panama's Flora—A Diverse Botanical Heritage

23. Flora of Panama, western Canal Area, and HOROKO

Panama has one of the most diverse floras in the world; in the early 1990s, the total number of plants (flowering plants, conifers, and ferns and fern-allies) within the country was estimated at nearly 9,400 (Correa and Valdespino 1998, Hampshire 1989). Of the nearly 200 families that were identified, five contained nearly one-quarter of the total species: Orchidaceae, Leguminosae, Rubiaceae, Graminae, and Compositae (D'Arcy 1987, Woodson and Schery 1943-80). A total of 571 plant species were found during the rapid survey carried out in the mid-1990s in the western Canal Area (i.e., HOROKO, composed of the Howard, Rodman, and Kobbe military bases, and the Empire Range and Balboa West Range) (ANCON and TNC 1996). The main vegetation types that characterize the 17,360 ha in the western Canal Area are: semideciduous seasonal mixed forest (36 percent), semideciduous seasonal low forest (38 percent), and grassland (15 percent). The remainder of the area is covered by five less common vegetation types (5 percent), and urban infrastructure, associated developments, and water (6 percent). The western Canal Area has been heavily disturbed by past human activities. Within the entire Canal Area, only 3,000 ha of old-growth forest remain (Ibañez and others 2002).

Eco-Park is at the drier end of a climatic gradient that extends across the Canal Area (Pyke and others 2001). The vegetation in and around Eco-Park is classified as part of the Tropical dry forest life zone according to the ecological life zone system used widely throughout Latin America (Holdridge 1967, Tosi 1971). In the 4,900 ha that comprise HOROKO, the rapid survey of the vegetation identified eight vegetation types (ANCON and TNC 1996):

- Deciduous forest, where virtually all of the canopy trees lose their leaves during the dry season.
- Semi-deciduous seasonal forest, where limited water during the dry season (two months with less than 100 mm of rainfall) causes many of the trees to lose their leaves. Three forest types were recognized on the basis of age and height: tall forest, reaching 30–40 m; mixed forest, reaching 25–35 m; and low forest, growing to heights between 10 and 20 m.
- Mangrove swamp forest, where trees grow in soils that have a high salt content on lands that are periodically flooded by ocean waters.

- Shrubland, where small trees and shrubs (3- to 10-m tall) cover about three-quarters of the surface area.
- Grassland, where the area is dominated by grass with dispersed trees and shrubs.
- Marsh, where the soils are regularly subjected to flooding.

The semideciduous seasonal mixed forest occupies about 35 percent of HOROKO, and is the dominant forest type at Eco-Park (ANCON and TNC 1996). In general, this forest type is characterized by wide-crown trees with a mixture of small-crown trees and three strata (vegetation levels within the forest). Underbrush is more common where the forest is lower. The forest type is disturbed, containing both mature and secondary tree species. The most prominent tree species in the mixed forest type are: yellow plum (*Spondias mombin*), guácimo colorado (*Luehea seemannii*), wild cashew (*Anacardium excelsum*), along with ear tree (*Enterolobium cyclocarpum*), West Indian locust (*Hymenaea courbaril*), Spanish-elm (*Cordia alliodora*), amarillo (*Terminalia amazonica*), cagajón (*Zuelania guidonia*), maquenque palm (*Oenocarpus mapora*), wild fig (*Ficus insipida*), and zorro (*Astronium graveolens*). Within the mixed forest type, the maximum canopy height is between 25 and 35 m. Tree species composition and structure (height and diameter), however, vary according to past use, time since agriculture or other disturbance was abandoned, and topography (for example, hilltops, side slopes, and drainages).

Other vegetation types occur to a limited extent within Eco-Park. These include areas of semideciduous seasonal low forest, open fields covered by native grasses and herbs, roadside strips of grasses and herbs, and patches of wild sugarcane (*Saccharum spontaneum*).

24. Big-leaf mahogany—virtually absent from Eco-Park's landscape

Big-leaf mahogany (*Swietenia macrophylla*), the most valuable timber in the western hemisphere, has been heavily exploited throughout its natural range, which extends from southern Mexico through Central America including southern Panama, western South America, and the Brazilian Amazon, to Bolivia. The species is so highly prized that during the mid-1930s, nearly 200 tree species in 35 families were known as some type of mahogany (Weaver and Sabido 1997). During the 20th century, Panama's forests were logged for valuable timbers and cleared for farming. The forests, which originally covered virtually all of Panama, declined to 86 percent of the country in 1900, and to 37 percent in 1998 (Weaver and Bauer 2003). With construction of the Canal, timber harvest resulted in a general decline, and often a local loss of valued construction and furniture timbers, among them big-leaf mahogany in and around Eco-Park.

Panama was first used by the Indians as a bridge between the continents. Soon after European discovery, New World explorers recognized it as

Big-leaf mahogany. (Photo by Peter L. Weaver)

an important bridge between two oceans and two continents. Likewise, Panama is the natural bridge that connects northern and southern populations of big-leaf mahogany, a species of major concern to both timber-producing countries and conservation groups. Moreover, some big-leaf mahogany has been planted in the narrowest part of that natural bridge—Panama City, and areas surrounding Eco-Park. Recently, big-leaf mahogany was listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), largely through the concern and efforts of countries that maintain native populations of the species (Grogan and Barreto 2005).

25. Espavé, Cuipo, and Corotú—three forest giants in Eco-Park

Espavé (*Anacardium excelsum*), a member of the mango or poison ivy family, is a large, deciduous tree that reaches a 45-m height and a 2-m diameter, often with a clear bole for 15 m or more (Angehr and others 1985, Carrasquilla R. 2005, Chudnoff 1984, Janzen 1983, Wong and Ventocilla 1995). The species flowers from January to June, and fruits ripen from March onward. Ranging from Guatemala to northern South America (Colombia, Venezuela, the Guianas, and Ecuador), espavé frequently grows on well-drained soils. It is common as a riparian tree in the Tropical dry forest life zone and occurs in other life zones, where it is found in coastal flood plains and gallery forests up to nearly 1000-m elevation. The fruits are eaten by bats, coatis, white-faced monkeys, and other animals. The raw seeds are highly toxic but may be consumed after roasting. The light-weight timber can be used for a variety of purposes including furniture, veneer, plywood, pulp and paper products, wood trays, wood frames for houses, and boxes. Indians and farmers used the trunks to make boats (cayucos). The well-known cashew (*Anacardium occidentale*) is a close relative.

Cuipo (*Cavanillesia platanifolia*) reaches a 45-m height and a 2-m diameter. The species is distinguished by its smooth bark and straight, unbranched, swollen trunks with rings that resemble belts. The crown is round on top and flat on the base, and extends above surrounding trees as an emergent (Carrasquilla 2005, International Science and Technology Institute 1980). Ranging from Mexico through Panama to Peru in humid to wet forests, cuipo

Espavé. (Photo by Peter L. Weaver)

is deciduous, losing its leaves during the dry season. The species flowers in March and April, with fruits beginning to ripen in April. The wood is very weak and light. The seeds, with a flavor similar to peanuts, are usually eaten after roasting. The species is fast growing and may invade open areas after logging. With no commercial value, some botanists have considered the cuipo to be "a giant vegetable." Harpy eagles (*Harpia harpyja*) frequently select cuipo trees as nesting sites.

Corotú (*Enterolobium cyclocarpum*), a large deciduous tree, losing its leaves during the dry season, reaches a 30-m height and a 2-m diameter (Angehr and others 1985, Carrasquilla 2005, Little and others

Corotú. (Photo by Néstor Correa)

1974). The species flowers from December to May with the fruits maturing during the following dry season. The trunk branches low and forms a broad, spreading crown. Native to savannas, Corotú ranges from Mexico through Central America south to Venezuela, Trinidad, Guyana, and Brazil. The tree grows rapidly in the open, perhaps as much as 1 m in trunk diameter in 60 years. The wood, generally light in weight, is used for furniture, veneer, carpentry, and construction. The seed-bearing pods are round and the seeds are apparently edible when roasted. In the past, Indians made dugout canoes from the large trunks. Today, the tree is planted for shade and ornament in large, open spaces and parks.

26. Amate in Eco-Park—and figs in general

The genus *Ficus* contains about 800 species of trees, shrubs, and vines that grow throughout the tropics with a few species native to the warm temperate zone (Carrasquilla 2005, Wikipedia 2006, Britannica Student Encyclopedia 2006). In general, figs are evergreen but those growing in the temperate zone or areas with long dry seasons are deciduous. Amate (*Ficus obtusifolia*), which grows in Eco-Park, is one of the 150 American fig species, most of which are "stranglers." It ranges from Mexico to Bolivia and is found in the Canal Area and Eco-Park. The life cycle of figs typically begins when their sticky seeds are deposited by birds, bats, or possibly mammals high in the canopy of a host tree. The species grows initially as an epiphyte, deriving its nutrients from the rain and litter found on the host plant. Roots then descend to the ground where they proliferate in the soil to absorb water and nutrients. Other fig roots grow laterally around the trunk of the host tree, gradually grafting together into an intertwined lattice. Ultimately, the leaves and roots of the fig prove to be better competitors for light, water, and nutrients than those of the host tree, gradually strangling it. Each fig species is pollinated by a particular small wasp that crawls through an opening into the fruit. The flowers are clustered inside the fruit, a fact that led some to believe that fig trees did not form flowers. Tropical figs are considered a keystone species because they bear continuously, providing food for fruit-eating animals during periods of scarcity.

Ficus *sp.* (Photo by Peter L. Weaver)

Some figs growing elsewhere are renowned. The common fig (*Ficus carica*) is sold commercially worldwide. Moreover, it may have been the first domesticated crop, because its use can be traced back about 10,000 years in the Middle-East. Another species, *Ficus religiosa*, is considered as sacred in Burma, Ceylon (Sri Lanka) and India. Apparently, Buddha was enlightened while contemplating in its shade. Yet another species, *Ficus bengalensis*, is reputed to have a specimen designated as the largest tree in the world—a tree in India with 1,000 prop roots that extend over an area of 1.6 ha.

27. Royal palm—palma corozo in Eco-Park

Although species of palm grow naturally between 44 degrees north and south latitude (i.e., southern France to Chatam Island, New Zealand), about 95 percent of the species are found in the tropics, predominantly in forested conditions. The palm family, with its 6 subfamilies, 200 genera, and about 2,500 species, is one of the most useful in the world. Some species are harvested for their fruits (i.e., dates and coconuts), oil, or as vegetables (i.e., palm hearts). Rattan is the raw material for making furniture or baskets, and palm fiber is used to make brushes and rope. Palms are also planted as ornamentals; moreover, their leaves are harvested for thatch roofing, to make articles of clothing, and to use in floral arrangements or religious ceremonies (i.e., Palm Sunday).

Palma corozo (*Attalea butyracea*, formerly known as *Sheelea zonensis*) grows in Eco-Park. The species is widespread in Central America and also ranges from Venezuela and Colombia through the Amazon of Peru and western Brazil to northwestern Bolivia, where it attains a 20- to 30-m height and 50-cm diameter (Angehr and others 1985, Henderson and others 1995). Corozo grows in seasonal and humid forest areas, usually below 300 m, but occasionally reaches a 1,000-m elevation. It is common along rivers, open savannas, disturbed or secondary forests, and pastures. The red squirrel (*Sciurus granatensis*), also found in Eco-Park, commonly consumes the seeds.

Palma corozo. (Photo by Peter L. Weaver)

28. Heliconias—Eco-Park's popular garden plants growing wild

Heliconias (family Helicaoniaceae) are large upright herbs with banana-like leaves. Noted for their colorful inflorescenses, heliconias are native to the American tropics from Central Mexico to Brazil and Bolivia, and to some South Pacific Islands (Berry and Kress 1991, Janzen 1983). The group is common along forest streams, in small forest gaps, and in shady secondary vegetation. About 250 species occur naturally, but with hybrids and varieties, the total number of recognizable heliconias may approach 500. Nectar-feeding hummingbirds are the only pollinators in the American tropics. The branch bracts of heliconias often contain water that supports numerous aquatic insects including larvae of beetles, flies, and mosquitoes. The fruit is fleshy (drupe) and is eaten by several species of birds with the seeds subsequently being dispersed. Heliconia leaves have been traditionally used by native peoples for thatching roofs and wrapping food. Currently, the bright colors and large size of heliconias make them popular as ornamentals throughout the tropics. Two species are common in Eco-Park: *Heliconia latispatha* and *H. platystachys*.

Heliconia *sp*. (Photo by Néstor Correa)

29. Epiphytes, Climbing Plants, and Parasites

Epiphytes include a host of different plants (lichens, fungi, bryophytes, ferns, orchids, bromeliads, vines, and seedlings of many forest trees, notably strangler figs) that commonly grow in the forest canopy. The death and decomposition of these aerial plants forms a soil-like substance that gradually accumulates on branches providing habitat and food for soil microorganisms, numerous insects, small amphibians and reptiles, birds, and mammals. Moreover, epiphytes affect the movement and chemistry of water in the canopy, and in the case of bromeliads, collect water in miniature reservoirs providing elevated breeding sites and refuges during dry periods. Among the plant families with the greatest number of climbing plants are milkweed (Asclepidaceae), morning glory (Convolvulaceae), sunflower (Compositae), aroid (Araceae), bigonia (Bignoniaceae), and legume (Leguminosae) (Gentry 1991). Vines and lianas climb high into the canopy where they produce flowers and often shed leaves during the dry season. Both may compete with trees for light, water, and nutrients, and at times may contribute to tree mortality. At the same time, however, they provide food and shelter for many animals, including roosting sites and hiding places for different species of bats. Another group, the mistletoes (Loranthaceae), including *Phoradendron* spp., grow as parasites on 42 different families of plants, ranging from primitive to advanced (Janzen 1983). Mistletoes may be entirely parasitic or in some instances, partly parasitic (i.e., capable of photosynthesis to some extent).

Climber. (Photo by Peter L. Weaver)

30. Wild sugarcane—an invasive species

Wild sugarcane (*Saccharum spontaneum*), a grass that grows naturally in eastern and northern Africa, the Middle East, India, China, Southeast Asia, and New Guinea, now occupies large areas in the Canal Area, including isolated patches within Eco-Park (Hammond 1999, Hooper and others 2005, Jones and others 2004). Some forms of the species can grow to heights of 8 m or more. Wild sugarcane was introduced into the Canal Zone but the date is uncertain. Some conjecture that the introduction was made in the mid-20th century to protect the Canal Zone from erosion and sedimentation; however, others say it was introduced accidentally in the1970s when a ship from Thailand traversed the canal during a rain storm and plant fragments were washed into the water. Since its arrival, the species has spread throughout the Canal Area and elsewhere in Panama from Costa Rica to Colombia, absent only from areas with dense forest cover. Adapted to hot, sunny environments, wild sugarcane can attain very high rates of photosynthesis, and reduce water loss during periods of low rainfall or drought. Rapid growth allows it to dominate other weedy species, eliminating competition through shading. Capable of reproduction by layering, vegetative growth, and seeding, wild sugarcane develops a dense root mat that competes intensively with other vegetation, allowing the species to control large areas and prevent the regeneration and growth of native species, including trees. In the Canal watershed, wild sugarcane dominates lands previously used in migratory agriculture. Of little use agriculturally or to native wildlife, the species poses serious problems for reclamation of the Canal Area. Cutting wild sugarcane and planting fast growing fruit or native timber species could alter sites sufficiently to favor recovery of native forest on areas currently dominated by these grasslands.

Wild sugarcane. (Photo by Christian Ziegler)

Kapok tree. (Photo by Peter L. Weaver)

31. Plant uses—medicine, fibers, dyes, and toxins

Of the nearly 11,000 species of plants that exist in Panama, about 400 have popular uses (Sasaki 1996, Zapata 1998). Many of these species grow in the semi-deciduous seasonal mixed forest at Eco-Park. For example, the leaves of marañón (*Anacardium occidentale*) produce a tea that is used to alleviate stomach pains and diarrhea. Several other plants provide fibers for personal, home, or agricultural uses, including maquenca (*Oenocarpus mapara*), matumba (*Desmoncus isthmius*), and trema (*Trema micanthra*). Kapok (*Ceiba pentandra*) has short fibers that are used for stuffing in upholstry, mattresses, life preservers, and saddles. Pita (*Aechmea magdalenae*) is versatile and provides fibers to make hammocks, shoulder bags, and traveling gear, and cortezo (*Apeiba tibourbou*) is used for ropes and handbags. Balsa (*Ochroma pyramidale*) is a very light wood first used to make rafts and later insulation products. Today it is used to make carved novelties. Nance (*Byrsonima crassifolia*) and leaves of the liana (*Arrabidaea chica*) provide dyes to color hats and other articles. Certain indigenous groups also use the latter to paint their skin. Furthermore, nance is used in tanning hides and for various folk remedies, and its fruits are sold to make beverages (Janzen 1983). Boca de vieja (*Posoqueria latifolia*) is occasionally planted as an ornamental.

Several species recorded at Eco-Park are recognized commercial timber species. At the time of Panama's settlement and later during the construction of the Canal, caoba (*Swietenia macrophylla*) was the most famous. Today, cedro (*Cedrela odorata*), laurel (*Cordia alliodora*), and guayacan (*Tabebuia guayacan*) are among the most prized timber species. Also, the species guayabillo blanco (*Terminalia oblonga*) produces a heavy lumber with good physical and mechanical properties, which is renowned for flooring and paneling. Another tree is níspero (*Manilkara zapota*), a source of timber, fruit, and latex, the latter formerly used to make chewing gum before the age of synthetics. In addition to the aforementioned useful plants, several species in Panama's flora are toxic or poisonous to humans and animals (Allen 1942, Escobar 1972). Indeed, there are numerous recognized uses of Panama's flora, many handed down among the local folks for centuries.

Fauna—Among the Most Conspicuous in Eco-Park

32. Panamanian tamarin—titi monkey

The titi monkey (*Saguinus oedipus geoffroyi*) is currently found almost entirely within the boundaries of Panama, notably in the vicinity of the Panama Canal and in the San Blas and Darien provenances. Historically its range extended to the Río Atrato region of northwestern Colombia and the Coto region of southern Costa Rica (Eisenberg 1989, Emmons and Feer 1997). The monkeys feed on insects, small lizards, flowers, fruits, and nectar. The fruits of *Cecropia* spp., guayava (*Psidium guajava*), mango (*Mangifera indica*), monkey's apple (*Annona spraguei*), Yellow mombin (*Spondias mombin*), and the gums and resins of wild cashew (*Anacardium excelsum*), also appear to be favorite food items.

Titi monkeys roam in small groups averaging about 7 individuals and range within an area of forest that covers about 25–30 ha. Titi monkeys usually bear twins both of which rarely survive in the wild. Tending the young is predominantly an activity carried out by one adult male. Panamanian tamarins are territorial, visiting boundaries and marking trees with their scent glands. Interactions include chasing, flicking tongues, and fighting, particularly during the main breeding period from November through February. Sometimes combatants fall or are injured during the fights. Titi monkeys sleep in the trees, often using nests made by other animals, or formed by the accumulation of debris. "Sleeping trees" tend to be somewhat isolated from others and provide a viewpoint to detect approaching nocturnal predators. The most frequent predators apparently are raptors. Other potential predators are tayras (*Eira barbara*), ocelots (*Leopardus pardalis*), margays (*Leopardus wiedii*), jaguarundis (*Herpailurus yagouroundi*), coatimundis (*Nasua narica*), and large boas (*Boa constrictor*).

The monkeys prefer secondary vegetation, suggesting they have lived in close association with humans for centuries. Alternatives for management of Eco-Park might consider the maintenance of some areas of secondary vegetation and the protection of favored fruit species to ensure their survival. Titi monkeys currently are listed as threatened by CITES.

Titi monkey. (Photo by Gerald P. Bauer)

33. Central American agouti—ñeque

The Central American agouti (*Dasyprocta punctata*) is orange-brown in color, with a rounded back and slender legs (Eisenberg 1989, Emmons and Feer 1997, Janzen 1983, Reid 1997). Agoutis are diurnal and terrestrial, often feeding on seeds and fruits in an upright position. When seeds are abundant, they will carry them off for burial at different sites. Because only a portion of seeds are recovered, many germinate and grow into trees or shrubs. At night, agoutis sleep in hollow logs, buttressed trees, vegetative debris, or burrows. Agoutis live permanently in stable pairs but are often seen individually in the field. The pairs are territorial, each defending an area. Adult males protect as large an area as possible; females, in turn, tolerate other agoutis when food is abundant. The areas, usually 2–3 ha in size, contain trails and sites used regularly to feed and sleep. When chased by predators, agoutis will run in circles but will not leave their relatively small territory—a behavior that often leads to their demise. Females give birth to one or two young that are then led to a nest hole or

Agouti. (Photo by Néstor Correa)

crevice, where they remain until called by the female for nursing. Later, as they grow, they move to another, slightly larger nest hole. Gradually they spend more time in the open, and after 4–5 months, become independent. Agoutis range from Mexico through Central America to Bolivia and Argentina where they are found in deciduous and evergreen forests, and plantations. Although common in parks and reserves, the species is heavily hunted for its meat; subsequently, populations have dwindled in many areas that have suitable habitat. In contrast, in areas where large predators have disappeared, the agouti may be abundant.

34. White-nosed coati—gato solo

The white-nosed coati (*Nasua narica*), ranging in color from dark to yellowish brown, is often seen with its head down and long tail, equal in length to the body, in an upright position (Eisenberg 1989, Emmons and Feer 1997, Janzen 1983, Reid 1997). Coatis range from the Southwestern United States and Mexico through Central America, including Panama, to northern Colombia where they are common in the lowlands up to 3000-m elevation. Coatis inhabit deciduous and evergreen forests, secondary vegetation, and arid scrub. Mainly diurnal, they are omnivorous, digging for invertebrates in leaf litter and in rotting logs, sometimes to 1-m deep. They also may climb into the tallest fruiting trees when production is abundant, remaining for days. At night, they climb into roost trees to sleep. Pregnant females also use trees to make nests where litters of two to five are born. Males are solitary except during the breeding season; females and the young, however, often roam in stable groups of 10–20 individuals. Mutual grooming among group members is common. In tropical forests, the groups have home ranges of 30–50 ha within which are territories of smaller size that are used constantly. Boas, raptors, cats, and humans are among the major predators of white-nosed coatis.

Coati. (Photo by Néstor Correa)

35. Three-toed sloth—perico ligero

Three-toed sloths (*Bradypus variegates*), perhaps best known for their "cute, smiling" face (Reid 1997, page 58), are most frequently seen hanging below branches or curled-up sleeping in the canopy (Eisenberg 1989, Emmons and Feer 1997). Their legendary slow movements are accompanied by limited use of resources and low body temperatures, which vary from near ambient at night to near normal for mammals during the day. Sloths reach sexual maturity slowly for their body size, reproduce slowly, and live for a long time—possibly 20–30 years. The species is common in lowland evergreen forest and secondary vegetation, where it may be seen sunning itself in open-canopy trees like *Cecropia*. Adults occupy a home range of nearly 2 ha, are arboreal, solitary, rarely share trees with other individuals, and are most active at night. Several arthropods live as adults on their bodies.

Sloths may feed on the leaves of about 50 trees, including 30 different species. They spend an average of 1.5 days in a tree before passing to an adjacent crown, often via lianas. Sloths accumulate feces and urine for about one week. Then they descend to the ground to relieve themselves, a process that takes about one-half an hour and exposes them to various predators. Sloths cannot support their weight on the ground but swim well. Females give birth to a single individual per year which is carried on the mother's chest continuously for about 6 months. She then departs leaving the collage of feeding trees in her home range to the offspring. Mortality at this point is high for the young. The species ranges from Honduras south to eastern Peru and northwestern Argentina. Sloth populations in Panama's forests are often high, averaging 5–8 per hectare.

Sloth. (Photo by Néstor Correa)

Toucan and puffbird. (Photo by Néstor Correa)

36. Keel-billed Toucan—and associates

The toucans (Ramphastidae) have enlarged, multicolored bills, making them easy to recognize. Three species are common in Eco-Park, often seen traveling in groups and perching high in open canopies. Toucans nest in trees and are gregarious, often feeding as groups in fruiting trees. Their diet also includes large insects, small reptiles and amphibians, nestling birds, and the eggs of other bird species. In a rare photograph, the Keel-billed toucan (*Ramphastos sulfuratus*) is seen perched along with a White-necked puffbird (*Bucco macrorhynchos*). The Keel-billed toucan ranges from southern Mexico to northern Colombia and northwestern Venezuela (Ponce and Muschett 2006, Ridgely and Gwynne 1989, Stiles and Skutch 1989). The remaining common toucan species are the Collared Aracari (*Pteroglossus torquatus*) and the Chestnut-mandibled toucan (*Ramphastos swainsonii*). The former ranges from southern Mexico to western Ecuador, and the latter from Honduras to western Ecuador. Toucans have decreased in recent years due to the loss of habitat and hunting. The White-necked puffbird, ranging from southern Mexico through western Ecuador to northeastern Argentina, occupies lowlands mainly below 600-m elevation. It frequents the forest canopy, often in second growth vegetation, where it perches for extended periods on high branches or snags. From this vantage point, the puffbird sallies to capture large insects or small lizards, carrying its prey back to the perch.

37. Oropendula—swinging high in the treetops

The Chestnut-headed Oropendulas (*Psarocolius wagleri*) is a gregarious icterid that ranges from southeastern Mexico to western Ecuador. The species is resident in Panama's lowland to mid-elevation (i.e., 1,200 to 1,700 m) forests, secondary growth, woodland borders, and open areas that have trees suitable for nesting (Janzen 1983, Ridgely and Gwynne 1989, Stiles and Skutch 1989, Wetmore 1965-84). The species has been reported as particularly common in the Canal Area. The birds are often first seen near their globular pouches (nests) that hang down about 1 m from isolated trees. The nests are woven out of roots, tendrils, and fibers found within wooded areas or pilfered from other birds. The species often nests in colonies that number 25–50 birds, although some may reach 100 birds. Colony sites are frequently used by the same birds in subsequent years. The species forages high in trees, frequently moving in noisy groups, where it feeds on small frogs and lizards, insects, fruits, seeds, and occasionally nectar from large flowers. Oropendulas are most notable during the breeding season from January through June. At other times, the birds disperse and wander in monospecific flocks searching for fruit in trees. Oropendulas are highly vocal with numerous calls described as croaks and gurgling notes. Giant cowbirds (*Scaphindura oryzivora*) sometimes deposit their eggs in oropendula nests. This relationship, known as brood parasitism, is actually beneficial, because cowbird chicks remove the eggs and larvae of botflies from their nest mates.

Oropendula and nest. (Photo by Néstor Correa)

Violet-bellied hummingbird. (Photo by Christian Ziegler)

38. Hummingbirds and parakeets—part of the diversity

Hummingbirds (Trochilidae) are confined to the Americas and reach their greatest diversity in northern South America. Panama has about 60 of the hemisphere's 340 species. The birds are renowned for their small size, brilliant iridescent colors, and their unique capacity to hover and even move backwards in flight. With wing beats of some species averaging 80 per minute, hummingbirds move rapidly and may change direction abruptly. In general, hummingbirds feed on nectar, small insects, and spiders. Nests are constructed of plant materials and spider webs and situated in branch forks, or underneath large leaves. The Violet-bellied hummingbird (*Damophila julie*), small and not very conspicuous, ranges from central Panama to western Ecuador where it is found along forest borders and secondary woodlands (Stiles and Skutch 1989). The species is common in the Canal Area and ranges locally into the foothills of Cerro Campana. In Eco-Park, it is frequently seen close to the ground along the numerous fence lines overgrown with flowering legumes, although it sometimes ventures into taller flowering trees.

Another easily recognized resident is the Orange-chinned Parakeet (*Brotogeris jugalaris*), which ranges in lowlands from southern Mexico to northern Colombia and Venezuela (Janzen 1983, Stiles and Skutch 1989). Common in the Canal Area, including Eco-Park, parakeets prefer forest edges and open areas with scattered trees. The birds breed during the dry season and frequently nest in woodpecker holes carved in dead trees or holes dug into termitaries. The parakeets often fly in large flocks except during the breeding season when pairs or small groups are common. The birds are often noisy in flight or when feeding on the fruits, seeds, flowers, and nectar of several tree species. Known as "pericos" in Panama, the parakeets are often kept in cages where they make affectionate pets, surviving well on assorted table leftovers and birdseed.

Migratory raptors above Canal. (Photo by Gerald P. Bauer)

39. Migratory raptors—avian clouds soar over Eco-Park

Broad-winged hawks (*Buteo platypterus*), Swainson's hawks (*Buteo swainsoni*), and turkey vultures (*Cathartes aura*) pass through Panama in large flocks, many crossing the Canal in the vicinity of Eco-Park and Ancón Hill (Smith 1980). In 1972, nearly 960,000 of these three species were counted using photographs, and in 1973, slightly more than 870,000—and these figures represent only a fraction of the total migratory population in each year. Fall migrations take place mainly in October and November, and return spring migrations in March and April. The fall migration begins in North America when broad-winged hawks cross the Gulf states flying to southeastern Texas and into the lowlands of Mexico where they are joined by Swainson's hawks and turkey vultures from the western part of the continent. Once in the tropics, the birds use thermal soaring to fly much of the distance. Differential heating of the earth's surface creates parcels of hot air which rise more rapidly than surrounding air. Migratory species use these air parcels to ascend through the thermal area, departing as the air cools and gliding downward until they encounter the next ascending hot air parcel. Pilots departing from Howard Base reported that some birds may rise as high as 4,000 m on days of favorable thermal activity. Swainson's hawks spend 4 months completing their 20,000 km round-trip migrations between Argentina and the Rocky Mountains of Canada and the United States.

40. Green iguana (Iguana iguana)

Panama has 228 species of reptiles (10 percent endemic, or native to Panama alone) including 127 species of snakes, 81 lizards or iguanas, 15 marine and freshwater turtles, 3 worm lizards, a crocodile, and a caiman. Of these, Eco-Park contains at least 26 species, or 11 percent of Panama's total. The green iguana, native to tropical America, is among the most conspicuous species to be seen in a variety of sites less than 1,000 m in elevation, where it favors wooded areas near water. The iguana, predominantly a vegetarian, may grow to 1.8-m long. Early in the dry season, the green iguana lays about 30 eggs. About 3 months later, at the beginning of the wet season, the young emerge. Humans are the iguana's major enemy, principally through habitat destruction, egg stealing, and hunting. Large felines, birds of prey, alligators, crocodiles, and snakes are also included among its predators. The iguana, favored in the diets of native peoples and rural populations of Panama, is also a popular animal in the pet trade. Historically it was transported by native groups during excursions; today, it is often discarded in alien habitats by unsatisfied owners. The dramatic decline of Panama's iguana populations has been counteracted by legislation, educational programs, reforestation, and by breeding in captivity for later release.

Green iguana. (Photo by Néstor Correa)

Vine snake. (Photo by Néstor Correa)

41. Brown vine snake (Oxybelis aenus)

Oxybelis aenus (Colubridae, Squamata), one of more than 2,500 known species of snakes, ranges in dry habitats from southern Arizona to central Bolivia and southeastern Brazil. Vine snakes are common in the lowlands, but occasionally occur at intermediate to relatively high elevations, giving them one of the largest distributions of any neotropical snake (Ibañez and Solis 1991, Janzen 1983, Keiser 1974). Mature individuals are slender, sometimes approaching 2 m in length. Vine snakes are primarily diurnal and inject their prey with immobilizing venom. They feed largely on lizards, although frogs, small birds, and insects are also part of their diet. Vine snakes are good climbers and spend considerable time in trees and shrubs. Their elongate bodies allow them to crawl on small branches with relative ease. Resembling a vine, they are often difficult to see (i.e., camouflaged) when motionless. During the dry season vine snakes may remain quiet, occupying hollow trees and other moist sites. Snakes from northern localities reproduce during the late spring or early summer months, laying up to five eggs in an underground den. The species is relatively common in the secondary vegetation of the Canal Area, including Eco-Park. When disturbed, it will hold its mouth open, exposing the dark lining of its throat.

42. Amphibians and fish

Panama has 170 species of amphibians, including 141 frogs and toads, 21 salamanders, and 8 cecilias. One of the most famous is shown here—the Red-eyed tree frog (*Agalychnis callidryas*), a favorite among photographers. The frog has bright markings on its sides and limbs, and when moving presents a kaleidoscope of patterns and colors, helping to reduce predation. The species ranges from Colombia to Mexico along the Caribbean slopes, and from Colombia to Nicaragua along the Pacific slopes; it is absent from dry lowland sites (Guyer and Donnelly 2004, Janzen 1983). The frog is arboreal and nocturnal, moving in a hand-over-hand fashion, grasping thin twigs and vines with its opposable thumb. Breeding occurs during the rainy season, often after heavy downpours. Most eggs are laid and fertilized on the undersurface of leaves that overhang ponds or water bodies (Holland 2006). Subsequently, the eggs hatch in about 1 week and the tadpoles fall into water where they feed on plankton. Metamorphosis takes about 80 days. Mature frogs live in tree canopies, often spending daylight hours in bromeliads or affixed to leaves. Their diet is presumably composed of invertebrates (beetles, crickets, grasshoppers, flies, and moths) and other small frogs. Their major enemies are snakes that may consume entire egg clutches and wasps that carry off individual embryos. Interestingly, the embryos can respond to a threat by immediately hatching—up to two days prematurely—and falling into the safety of the water below.

Without permanent streams or water bodies, Eco-Park cannot support a diverse population of fish throughout the year as in other parts of the Canal Area (Hildebrand 1938). Undoubtedly, some fish species survive in streams like the Río Velazquez just south of Eco-Park. The dry season leaves most of the ephemeral streams in Eco-Park without flowing water, although a few scattered pools are apparent in most years. A likely species to survive such conditions is the common guppy (*Poecilia reticulata*), a popular, live-bearing, freshwater aquarium fish.

Red-eyed tree frog. (Photo by Néstor Correa)

Kite swallowtail. (Photo by Peter L. Weaver)

43. Panama—the land of butterflies

One possible Indian meaning for the name Panama is the abundance of butterflies (Hedrick and Hedrick 1970). Butterflies, numbering about 18,000 species worldwide, are more abundant in the American tropics than anywhere else. Panama has at least 550 species (DeVries 1987). The butterfly life cycle includes four stages (metamorphosis): the egg, larva or caterpillar (growing stage), pupa or chrysalis (transformation stage), and adult butterfly (reproductive stage). The stages vary in length with caterpillars surviving months, pupa perhaps 15 days, and butterflies from 2 weeks to more than 1 year for species that migrate like the monarch (*Danaus plexippus*). During the caterpillar stage, these insects eat plant materials (mostly leaves, but also seeds, pods, or flowers); during the adult stage, most sip nectar from flowers with their tongues. Butterflies vary in size with wingspans ranging from 1.5 cm for some small species to about 30 cm for the Queen Alexandra's birdwing (*Ornithoptera alexandrae*) of New Guinea.

Among Panama's most attractive butterflies are the kite swallowtails (tribe Leptocircini) in swallowtail family (Papilionidae) and the longwings (subfamily Heliconiinae) of the brush-footed butterflies (family Nymphalidae). The swallowtails, renowned for their coloration, are found worldwide. In contrast, the longwings, known for their elongated forewing, are confined almost exclusively to the American tropics. Both kite swallowtail (*Eurytides anaxilaus*) and the crimson-patched longwing (*Heliconius erato*) are occasionally seen on flowering shrubs in the secondary forests at Eco-Park. Planting select shrubs like lantana (*Lantana camara*) and heliconias along roadsides would help attract both butterflies and hummingbirds to the attention of Eco-Park visitors (Tufts 1995). Lantana flowers bloom for long periods and provide a landing platform, which increases the visitation rate of many butterflies, notably the larger ones (Janzen 1983). In addition, the floral nectaries of the wild passion flower vine (*Passiflora vitifolia*) provide the larva and adults of Heliconiinae butterflies with a source of food.

44. Beetles—30 million of them on the planet?

The Smithsonian Tropical Research Institute has mounted cranes supporting a gondola in secondary dry forest at Metropolitan Park on the Pacific side of the Canal and in tropical rain forest in the San Lorenzo National Park on the Atlantic side. The cranes allow instant access to the most interesting part of the forest—the exposed branches and leaves in the canopy—through a cylindrical space 30-m high and 70-m across (Joyce 1991). Among the major benefits is that researchers can return several times to the same position in the canopy without disturbing the trees. The crane allows a variety of studies dealing with climate, leaf production, photosynthesis, water movement, carbon dynamics, and plant (epiphytes and vines) and animal (invertebrates and vertebrates) species that live in or pass through the canopy. Many arthropods appear to be host-specific (i.e., feeding on a single plant species). One estimate placed their number at 30 million species, fewer than 2 million of which have been described (Allen 1996). Another point of interest is the amount of vegetation that is consumed (herbivory) annually by insects, vertebrates, and pathogens. Most studies have based their estimates on portions of foliage eaten over a period of time and do not account for the complete loss of leaves. Differences in leaf consumption are apparent among species and between the canopy and understory of trees. Future investigations will explore these differences which may be related to canopy climate, defensive plant compounds,

Cerambycid beatle. (Photo by Néstor Correa)

predation on plant herbivores, or a combination of factors. *Ptychodes niveisparsus* (Cerambycidae), common in the understory of Eco-Park, is seen here on a leaf surface.

45. Spiders … some walk, jump, swim, or fly

Spiders are animals in the phylum Arthropoda (class Arachnida) that have a fused head and thorax, an abdomen, eight legs (most have eight eyes as well), and spinnerets to make silk (Foelix 1996). There are about 37,000 known species of spiders grouped into about 100 families. Depending on their predatory habit and appearance, they have been labeled as web, wolf, crab, jumping, button, widow, or pirate spiders, among other names. They are voracious predators that digest their food by injecting enzymes into their prey. Most are solitary, active throughout the day, and feed on insects. Larger spiders, however, may consume small snakes, birds, and even mammals. Spiders are found worldwide in every type of ecosystem ranging from tundra through chilly alpine habitats to tropical rain forests and deserts. All spiders have venom but few are harmful to humans. All make silk but some have evolved distinct uses for it. Most use it to make egg sacs and webs. Others fabricate retreats for hiding, lassos and traps to capture prey, wraps to confine females during mating, bubbles to hold air while submerged under water, and strands or "balloons" of silk to migrate long distances in the wind. Sailors have often encountered small "flying spiders" far out to sea. Though feared by many, spiders benefit humans by controlling insect pests. Some estimates have placed their numbers at 100 per square meter, or 1 million spiders per hectare (Coleman and Crossley 1996).

With regard to records, the Earth's largest spider is the goliath bird-eating spider (*Theraphosa biondi*) that has a leg span of 28 cm and weighs around 170 g (Guinness World Records 2006). The species inhabits the coastal rain forests of French Guiana, Guyana, and Surinam (also recorded in Venezuela and Brazil) where it dwells underground and occasionally feeds on rodents and frogs. Another interesting fact is that the genus of jumping spiders called *Portia* has a cognitive ability used during hunting that has been described as "versatile and clever" (Russell-Robertson 2004, page 6). Eco-Park has several species of interesting spiders, including *Nephila clavipes* shown here.

Nephila *spider*. (Photo by Néstor Correa)

46. Acacia trees and their ants—mutualism with a nasty bite

The total number of ants has been estimated at 10 trillion and their total weight at approximately that of mankind itself (Wilson 2006). The 12,000 different ant species are major predators on invertebrates as well as scavengers of dead bodies; moreover, ants are found everywhere except on ice-covered mountain peaks and near the North and South Poles. Some Amazon tribes use soldier ants with their large mandibles to suture wounds by cutting off their bodies and leaving their heads in place.

Elsewhere in the tropics, certain acacia trees lack chemical defenses to deter insects or browsing mammals. Over time, acacia ants (species in the subfamily Pseudomyrmecinae) evolved along with swollen-thorn acacia species in a symbiotic relationship (mutualism) that benefits both organisms (Holldobler and Wilson 1990, Janzen 1983). The acacia species (*Acacia chiapensis*, *A. collinisii*, *A. cornigera*, *A. hindsii*, and *A. sphaerocephala*) range from Mexico to South America and occupy different habitats in association with the ants. The acacias provide ants with "room and board" and the ants defend against intruders. The acacia "rooms" are the hollow thorns located at the base of leaves where the ants bore holes to inhabit. The "board" includes two food sources that the ants harvest—the Beltian bodies (tiny structures on the leaf tips with proteins and lipids) and petiolar nectar at the leaf bases. The ants clear a circle around the base of the host acacia killing vegetation that touches it, including epiphytic vines. Sometimes they even extend their territories to adjacent acacias. When disturbed, the ants produce a substance (pheromone) which stimulates the remaining ants of the colony to attack or drive away the intruder. An earlier author suggested that the ants were "kept by the *Acacia* as a standing army" (Belt 1874, Chapter 12). Eco-Park has both the Acacia ant *Pseudomymex ferruginea* and host *Acacia collinsii*. Caution should be taken when near the ant-Acacia trees. Alerted by the smell of approaching intruders, the "ant army" will quickly swarm over and sting unwary individuals should they touch the tree. Other social insects are also present at Eco-Park, including species of leaf cutter ants, bees, wasps, and termites.

Acacia *sp. with ants*. (Photos by Peter L. Weaver)

City of Knowledge from Miraflores. (Photo by Peter L. Weaver)

Conservation – Protection, Research, and Education

47. City of Knowledge—a Panamanian initiative

The master plan for the Canal Area presented to Panama's Interoceanic Authority (ARI) included provisions for both public and private ownership of the transferred lands, and assumed that a third set of locks would be constructed within 20 years. One of the most ambitious proposals was the "City of Knowledge," an international university and research complex to be located at Fort Clayton, the U.S. Army unit responsible for defense of the Canal (DeMena 1996, Woodard 1997). Fort Clayton had nearly 1,400 family housing units, 1,750 dormitory spaces, and 500 offices along with libraries, auditoriums, swimming pools, and other facilities appropriate for a major university. In 1998, a private foundation was created to transform Fort Clayton into a center of excellence for science and technology (Jackson 2003). The key components of the project included a 4-year liberal arts university, a community college campus (i.e., continuing education programs, worker training, and industrial contract services), branch campuses for several foreign universities, foreign and domestic research institutes, and an industrial park where private companies could conduct research and development activities. Cooperating international institutions were eligible for mission status easing many of the requirements associated with overseas ventures. Moreover, many activities benefited from tax incentives or exemptions, including the importation of equipment and supplies duty-free. The City of Knowledge became "an academic free-trade zone" where Panama provided the infrastructure and cooperators brought programs and resources. Most of the City's income is derived from being the landlord for numerous international groups. In summary, the City of Knowledge is an international, multi-institutional, and multi-cultural environment whose occupants pursue research, development, management, and educational activities aimed at sustainable development.

48. New facilities—the reception center

Currently, some perceptions of Eco-Park's future lie on the architect's table. Managers foresee a park highlighting activities oriented toward Panama's youth, nearby residents, and tourists (Amend and others 2001, Botanic Gardens Conservation

Sketch of reception center. (Photo by Néstor Correa)

International 1994, Correa and Carver 2004). Among the many envisioned structures and facilities are:

- A reception-interpretative center and resource library.
- An amphitheater.
- A botanical garden.
- A children's science laboratory.
- An animal rescue service.
- A butterfly compound and garden.
- Picnic and camping areas.
- Numerous hiking and interpretative nature trails.
- Bicycle pathways.
- Permanent plots for study of the forest.
- A cable excursion through forest canopy.
- A plant nursery.
- A recreational lagoon.

Once completed, Eco-Park will mitigate the effects of Canal expansion, protect fauna and flora, and provide needed recreational and educational opportunities for residents and tourists alike. Direct economic benefits will include employment associated with the construction and maintenance of the area, as well as increased tourism.

49. Roads and trails—hiking and bicycling

Eco-Park has about 16 km of roads. The largest road encircles the property for about 8 km. The interior road, extending from the western boundary to the middle of the property, climbs to about 120-m elevation. Eco-Park currently has four trails totaling about 2.75 km. They range in length between 0.25 and 1.35 km. Two descend drainages, one in the north and the other in the east. Two ascend hilltops, one in the center of the property and the other in the southeastern corner. The future design and layout of trails will continue to highlight the park's natural and cultural resources and will include stretches of varying length and difficulty.

There are plans to limit vehicular traffic to parking areas near the entrance in order to maintain an outdoor ambiance, reduce congestion, and protect wildlife. An open trolley will move visitors within the park. Bicycles will be allowed to traverse the roads and hikers will have free use of the roads and trails. Road signs will indicate special attractions—facilities, scenic views, interpretative trails, and interesting vegetation.

Main road. (Photo by Peter L. Weaver)

50. A fairy tale—the lily of the Indian princess

Once upon a time there was an Indian tribe that lived deep in the mountains of Veraguas where they worked happily and adored their gods (Aguilera 1991). Their chief was old yet renowned for his capacity to overcome difficulties. His only daughter was young and pure as lilies of the field. Many warriors sought her but she would marry her lover within a few moons. The tribe prepared for the event unaware that pale faces with red hair had arrived from afar. Then one day a column of Spaniards marched into the village, conquering the helpless tribe. "What do you want?" said the chief. "Gold," replied the haughty Spanish leader. Immediately, the tribe surrendered all of the gold. About to leave, the arrogant Spaniard leader saw the chief's beautiful daughter and demanded that she accompany him, allowing her only a couple of days to consider his proposition and threatening mayhem if she refused. Perplexed, the young maiden sought help from her wise father. Listening to the Spaniard's threat and

Grave site of Little Princess. (Photo by Peter L. Weaver)

knowing the brutal nature of the invaders, her father devised a plan to save all involved. The chief, his daughter, and her loved one would depart from the tribe's settlement for a distant land where nobody would find them. The agonizing journey, however, would last weeks and was filled with hazards. Once underway, the maiden soon fell ill and realized that the gods were calling her. Placed in a tranquil spot near a small stream, she did not survive the night. In the early morning hours, her companions buried her. For three days they deeply grieved their loss and on the fourth day, about to depart, their eyes fixed on a beautiful white lily of pleasant aroma that had opened its flower at the base of the maiden's grave. The chief stared at it commenting that he had never before seen such a flower in the region. That must be my daughter—she has kept her promise to return to us. This fascinating tale and many others from Panamanian folklore may stimulate the younger generation to better appreciate the outdoors and its wildlife.

51. Another tale—Johnny and his mahogany bureau

Once upon a time there was a very young boy named Johnny who was left alone one day at home (Tejeira de Venegas 1995). While intently admiring a sturdy and attractive bureau, he exclaimed aloud if somebody might tell him the name of the wood and where it came from. It seemed that instantly the bureau replied telling Johnny that its life began as a seed that was plucked by a bird and dropped to the ground in a forest opening. Within a few days he emerged as a thin stem to first glimpse daylight. Seeing tall trees all around he soon realized that with force from mother earth, the sun, and rain, he would grow into a towering giant of the forest. Time passed and many years later on a pleasant December day, a bunch of men carrying tools approached what was now a magnificent mahogany tree shouting that they had found just what they needed. Using nearby trees to make a ladder, they climbed the great mahogany, cutting off its foliage and branches with sharp axes. The loggers soon felled the mahogany using a saw with big teeth. Once on the ground, they cut the trunk into logs, and then they sliced the logs into several boards. Finally, they carried the boards to a cabinet maker who transformed the wood into a beautiful, strong, and useful piece of furniture. Hearing the story, little Johnny told his friend (the bureau) that he was thrilled to own such a beautiful piece of furniture although his experience had been very painful. To express his appreciation, Johnny promised to plant mahogany trees with his father and teachers to assure that his friend's lineage would live on. Little Johnny's fascination with an attractive and sturdy bureau tells a story about the most valuable timber in the world and sustainable forest management.

Little Johnny and bureau. (Julie Hernández)

Deer seen by remote camera. (Photo by Néstor Correa)

52. Conservation issues—poachers and management

Informed sources said that poaching began the moment that the military departed from Rodman. Among the principal species being shot are the white-tailed deer (*Odocoiles virginianus*) and the agouti (*Dasyprocta punctata*). Other wildlife species likely to be shot, whether for meat or sport, include virtually any of Eco-Park's larger mammals or bird species. Commercial or sport hunting is illegal in Panama, but laws regarding subsistence hunting are confusing and contradictory (Ibáñez and others 2002). Some is allowed, even in national parks, by indigenous groups; however, despite the laws, many residents near national parks hunt in them. The unauthorized exploitation of natural resources (e.g., wildlife, trees, or attractive plants) threatens the one major benefit that Eco-Park offers the residents of downtown Panama City—exposure to natural forest and typical wildlife just across the Bridge of the Americas. The main management concerns for Eco-Park are:

- Immediate law enforcement, boundary patrol, trespass posting, and repair of damaged fences.
- The development of a comprehensive management plan dealing with natural and cultural resources and existing structures (mainly bunkers and roads).
- Education of the surrounding communities regarding the objectives and benefits of Eco-Park.
- Continuous monitoring to estimate wildlife diversity and population sizes (applied research).

53. Monitoring—fauna and flora

Mounting cameras in the field provides an inexpensive and efficient method of observing wildlife without harming the animals. In December 2005, remote control cameras were installed at 22 sites in Eco-Park to monitor the movements and foraging of mammals both day and night (Díaz 2005). The monitoring program, operated by personnel from Eco-Park, the Institute for Neotropical Conservation, and four professors from the Forestry and Zoology Departments at Southern Illinois University, was carried out until early May 2006. The sites, visited every 2 weeks, were distributed throughout the Park and included areas near water and food as well as trails where evidence of animal use was apparent. The cameras, programmed to photograph each minute once activated by animals, were to permit an analysis of wildlife resource use and movements within Eco-Park. Among the early surprises was a photograph of an ocelot (*Leopardis pardalis*), a species not previously recorded at Eco-Park. Other species recorded during the first 4 months included

Remote camera. (Photo by Néstor Correa)

agouti (*Dasyprocta punctata*), coati (*Nasua narica*), collared peccary (*Pecari tajacu*), jaguaroundi (*Herpailurus yaguarondi*), nine-banded armadillo (*Dasypus novemcinctus*), northern tamandua anteater (*Tamandua mexicana*), paca (*Agouti paca*), Virginia opossum (*Didelphis virginiana*), and white-tailed deer (*Odocoileus virginianus*). Future monitoring is planned at other sites and during different seasons to learn more about the mammals at Eco-Park.

The staff of Eco-Park will also establish permanent plots within the forest to monitor vegetation and familiarize visitors with the field techniques. Plot monitoring will provide information on species composition, tree size, and spatial distributions, as well as forest dynamics, including tree growth and development, ingrowth, mortality, and changes in species composition over time. Forest responses to severe climatic events such as major windstorms or prolonged droughts will also be evident. Plot monitoring also provides the basis for specialized ecological studies such as tree life histories, and flowering and fruiting patterns. Sufficient data will allow researchers to model changes over time and compare the results with monitored forests elsewhere.

54. Wild animal rescue service—hawk-eagle and margay

Until quite recently, Panama had no center for the rehabilitation of injured or abandoned wild animals. In December 2005, a wild animal rescue service was begun at Eco-Park, where limited facilities are now available for the temporary confinement and care of some wildlife. Among the first animals to be admitted were a titi monkey (*Saguinus oedipus geoffroyi*), a northern tamandua anteater (*Tamandua mexicana*), two-toed sloths (*Choloepus didaytylis*), a small boa

Hawk-eagle rescue. (Photo by Peter L. Weaver)

constrictor (*Boa constrictor*), a black-and-white hawk-eagle (*Spizastur melanoleucus*), and a margay (*Leopardus weidii*).

The hawk-eagle, ranging from Mexico to northern Bolivia, is still fairly common in secondary forests near the Canal, often seen flying high even at mid-day (Ridgely and Gwynne 1989). The margay, sometimes called "tree ocelot," ranges from Mexico to east and central Brazil, and northern Argentina. Dwelling mainly in trees, their flexible ankle joints allow them to run head first down tree trunks. Future plans for the animal rescue program call for improved facilities and the regular assignment of a veterinarian. The main goal will be to prepare all animals for release back into the wild as soon as convenient.

55. Bats and bunkers—a possible student adventure

Bats, comprising about 1,000 species worldwide, constitute nearly one quarter of all known mammals; moreover, tropical America has the greatest ecological diversity of bats and probably the greatest bat densities and biomass as well (Findley 1993). A few years ago, the white bat (*Declidurus albus*), a species that feeds in the forest canopy and has been found only seven times in Panama during the past 100 years, was reported at Eco-Park, (Tejera and others 1999). Bats forage at night using echolocation to find food. They are voracious predators of night flying insects as some examples will illustrate. A single little brown bat (*Myotis luciferus*), a species native to the state of Michigan in the United States, can catch as many as 600 mosquito-sized insects in an hour (Tuttle and Taylor 1994). In Arizona, a colony of 25 million Mexican free-tailed bats (*Tadarinda brasiliensis*) inhabiting caves consume between 100 and 200 tons of agricultural pests each night. Other bat species are believed to be important as pollinators and seed dispersers for as many as 60 species of agave plants. Recently it was discovered that the giant noctule bat (*Nyctalus lasiopterus*) not only feeds on insects but also birds that migrate across the Mediterranean Sea (Milius 2007). Hawks, owls, and snakes, prey on bats, often as they enter and leave their roosts. The Jamaican fruit-eating bat (*Artibeus jamaicensis*) and Seba's short-tailed bat (*Carollia perspicillata*) are the most common species at Eco-Park (Fleming and others 1972). Bats would be inconspicuous to Eco-Park visitors during the day when they roost in hollow logs, on the undersurfaces of branches and leaves, or on the ceilings of the bunkers. This latter habit provides an opportunity for Eco-Park managers to convert one or more of the many bunkers into small observatories where bat colonies could be easily seen by visitors or students.

Bunkers. (Photo by Néstor Correa)

56. Ecotourism—the master plan and Panama's future

Historically, Panama's tourist industry has not benefited from its greatest resource—the Panama Canal—a point vividly shown by the fact that as of 2001, none of the cruise ships that annually traverse the Canal stop at Panamanian ports (Casado 2001). This lack of tourism has been due in part to the Nation's heavy dependence on income generated directly or indirectly by an American presence. As part of the master plan for the development of tourism, the Panamanian government directed all entities to develop new attractions and destinations, and a new infrastructure and workforce to handle the anticipated demands. The nine new tourism areas range from La Amistad along the Costa Rican border to San Blas and the Daríen near the Colombian border. An area designated as "Metropolitana" will highlight attractions in Panama City and the Canal corridor. Eco-Park, with its location just across the Canal from Panama City, is an integral part of the plan, designed mainly to satisfy some of the Nation's internal demand for tourism but also to attract foreign visitors. The park's objectives are compatible with ecotourism that aims to promote conservation, enhance community development, and generate a national economic benefit (Lieberknecht and others 1999). The strategy includes determining

Eco-Park's carrying capacity, monitoring both the program and physical environment, using the existing infrastructure in innovative ways, working with the domestic workforce and local communities, reinvesting a portion of the profits in the park's natural resources, and cooperating with interested entities (the government, NGOs, community organizations, academic institutions, and students).

57. Native handicrafts—baskets, wood carvings, molas, and taguas

Nearly 10 percent of Panama's total population is composed of indigenous groups, some of whom are renowned as artisans. Perhaps the most famous artisans are the Emberá-Wounan of the Darién, a group once collectively known as Chocó, who make baskets, wood carvings, and taguas; and the Kuna along the Caribbean coast who produce molas. All of these handicrafts are prized worldwide for their intricate detail.

Baskets. Hard and durable hand-woven baskets originated in the Darién province where they were apparently used for storing curative plants and objects of value. The baskets are fashioned using the fine fibers of the black palm (*Astrocarpum standleyanum*), which are sewn over coils of the palm-like Naguala (*Carludovica palmata*). Traditionally, the baskets contained little adornment. About 25 years ago, the artisans began using dyes to produce baskets with more elaborate and colorful designs that soon caught the attention of collectors in the United States and Europe. The weaving tradition, handed down from mother to daughter, has today made the Wounaan women famous as Panama's most gifted basket weavers.

Carvings. Wood carvings, many depicting animal species, are fashioned from Rosewood (*Dalbergia retusa*), a tree species locally called Cocobolo. The wood is prized for its highly figured grain as well as

Birdwatchers in Eco-Park. (Photo by Néstor Correa)

Baskets.

Wood carvings. (Photos by Gerald P. Bauer and Peter L. Weaver)

its rich, orange-red color which diminishes after exposure to air and sunlight. Rosewood's natural oils help to waterproof the wood and give it a waxy appearance when rubbed. The species also provides dark dyes used in staining the fine fibers of the black palm for basket making.

Tagua.

Tagua. "Vegetable ivory" is another name for the palm seed known as tagua (*Phytelepus seemanii*). Artisans carve the hard and durable seeds with hand tools into buttons and various figurines of plants and animals typical of the tropical forest. The figurines are often painted. Tagua harvests are sustainable because the seeds are easily collected at the base of the trees where they fall.

Molas. A traditional costume of Kuna women, molas are cloth panels with complex designs that are made into clothing (blouses, scarves, or skirts), or sewn onto other fabrics, or perhaps even displayed as art. Handmade molas highlight animals, mountains, and traditional themes from Kuna legends and culture. An individual mola, mainly in black, orange, and red colors, may take up to 6 months to produce.

Mola.

Cruise ship in Panama Canal. (Photo by Gerald P. Bauer)

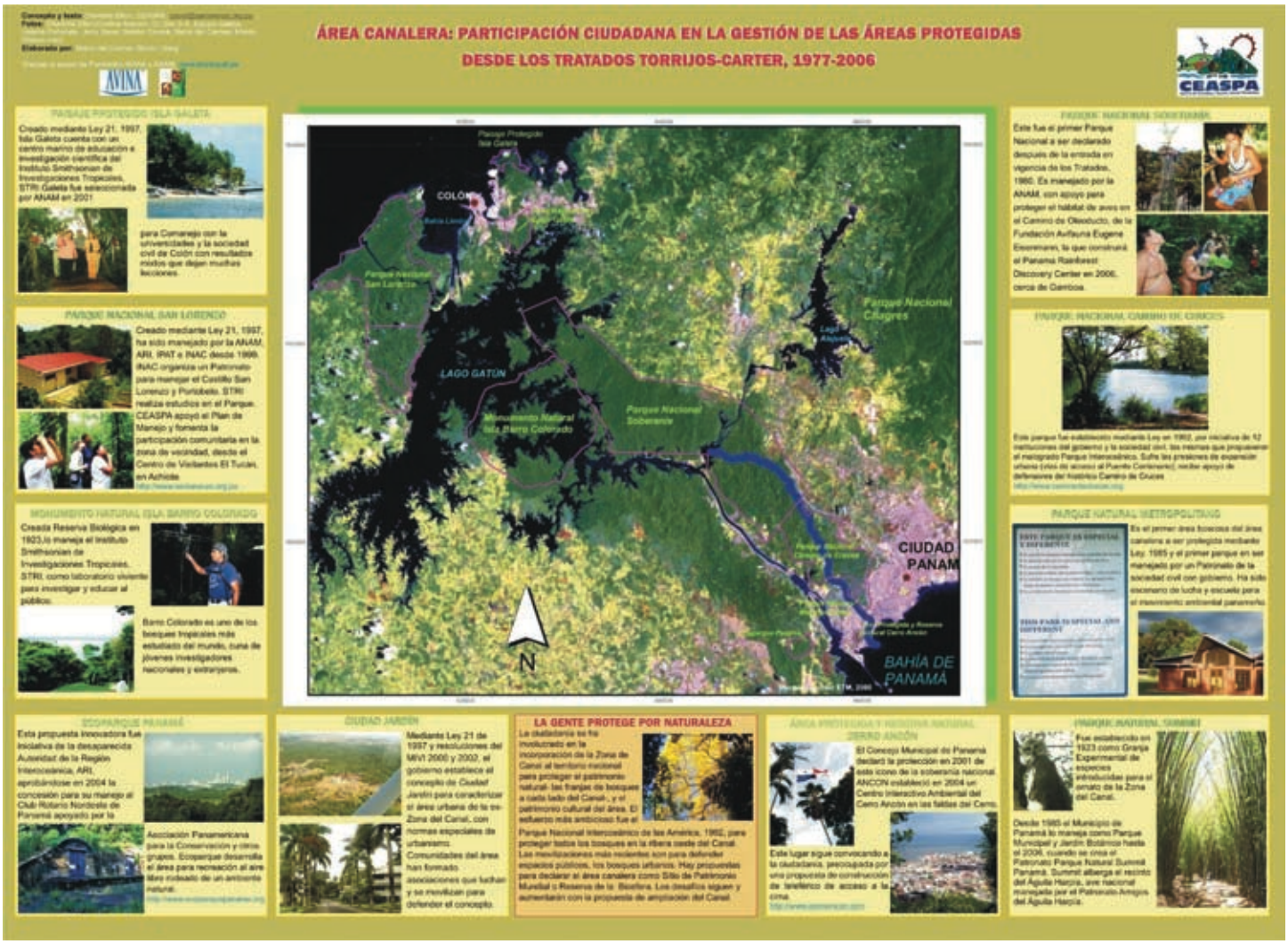
58. Cruise ship tourists and the Panama Canal watershed

At the beginning of the 21st century, tourism worldwide represented about 6 percent of the global gross national product and employed more than 130 million people (Thurau 2004). In addition to economic benefits, the tourism industry has helped increase environmental awareness, and promoted the conservation of forest and wildlife natural areas. The Panama Canal and its watershed encompass nearly 290,000 ha, about one-half of which are protected in heavily-forested national parks. At the northwestern entrance is San Lorenzo National Park with its diverse flora and fauna, and legacy of Spanish conquest, fortune seekers, pirates, and building of the Panama Railroad and Canal (Weaver and Bauer 2004, Weaver and others 2003). At the southwestern entrance is Eco-Park with its diverse flora and fauna, family-oriented outdoor activities, and proximity to much of Panama's urban population.

Cruise ship tourists passing through the Panama Canal recently indicated several key motivations for their travel—among them exposure to cultural and historical experiences, tours of historical sites, outdoor sports, wildlife viewing and bird watching, and security during family travel (Thurau 2004). Eco-Park with its past military history, and proposed facilities such as a visitors information center, butterfly garden, numerous trails for walking and bicycling, picnic and recreation areas, and animal rescue center, all surrounded by tropical forest, can be an adventurous stop for many of the Canal's short-term visitors.

59. Status of the Panama Canal watershed in the new millennium

The forests of the Panama Canal watershed are critical from the standpoint of the flora and fauna that they protect and the water resources that they provide. The canal watershed covers about 2,900 km^2 (Condit and others 2001). In 1998, 54 percent of the total area was in forest and 43 percent in pasture or shrubs. The difference is important because the natural forests generally don't burn, and degraded areas are subject to fires. Tree diversity along the Canal gradient from the dry Pacific shores to the humid Atlantic coast is as rich as any place in the world, and the Canal watershed—with 1,700 to 2,300 species—appears to contain about 60–70 percent of the total recorded for the entire country. Bird species in the Canal watershed total about 650, an amazing two-thirds of the entire Panamanian avifauna. The number was tallied in an area of only 1000 km^2, making the Canal Area one of



Canal watershed poster. (STRI Files)

the richest in the world (Robinson an others 2004). Moreover, 93 species of amphibians, or slightly more than one-half of the country's total, have been reported in the Canal watershed. The total runoff from the Canal watershed is 4.4 billion cubic meters of water per year. About 60 percent of the total runoff is used annually to fill the locks as ships pass through the Canal—37 times each day, or about 13,500 times per year. An additional 27 percent is used to generate electricity, and about 0.6 percent is purified for drinking water.

60. Major partners of Eco-Park—domestic and international

Eco-Park has numerous friends and supporters interested in ensuring the protection and sustainable use of its natural and cultural resources. The National Environmental Authority (ANAM) is responsible for Panama's system of protected areas through an inter-institutional agreement with the Interoceanic Regional Authority (ARI), the Panamanian Institute of Culture (INAC), and the Panamanian Tourist Institute (IPAT). The staff is working in cooperation with the

Cooperators. (Photo by Néstor Correa)

Panamanian Rotary Club (Northeast), whose mission is to serve the community through development of social programs and projects (Carver and others 2007). Animal monitoring is carried out with the help of the Panamanian Association for Conservation and Southern Illinois University's Institute for Neotropical Conservation. Other international cooperators include Spain's Association GAIA for the Conservation and Management of Biodiversity, Southern Illinois University's Forestry Geo-Spatial and Economic Analysis Lab, and the Forest Service, U.S. Department of Agriculture's International Institute of Tropical Forestry in Puerto Rico. Cooperative activities with numerous local groups, including NGOs, the University of Panama, high schools, museums, and others, will be developed over time.

61. Protecting the Canal—every Panamanian's job

Statements made regarding the importance of forest conservation within the Canal watershed are poignant. The title of one article reads, "Deforestation: death to the Panama Canal" (Wadsworth 1978, page 22). Another article states that, "Panama is a small Central American country but it operates a big Canal and the world keeps an eye on developments there. Problems with the Canal or ecological disasters in its watershed would attract a lot of attention." (Condit and others 2001, page 389). Extensive forests are still found within the Canal watershed, largely because of past military and shipping interests; however, at the same time, the watershed is adjacent to a large and growing metropolitan area. The population of the Panama Canal watershed, 22,000 in 1950, grew to 77,000 in 1980, and 113,000 in 1990 (Ibáñez and others 2002).

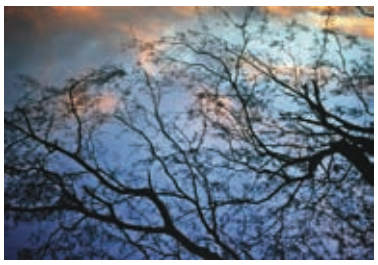
Signing the Canal Treaty. (ACP Archives)

Similarly, in 1980 there were 43 communities with 1,100 residents living inside national parks; by 1990, that population had increased to 2,800, due in large part to immigration.

Forest within the Canal watershed won't be destroyed over night. Rather, the fear is that population pressures will remove the forest a few trees at a time—a clearing here, a road there, and buildings someplace else. The Canal watershed is not the place for agriculture or urban expansion. Such activities will have negative impacts within the Canal watershed by increasing sediment loads, reducing the water holding capacity of the soil and reservoirs, and altering the flow of water over time. These impacts would be noticeable during the dry season, and could become critical during periods of prolonged drought. Uncontrolled activity would also have a negative impact on Panama's future options for management within the Canal watershed.

62. Future of Eco-Park and the Panama Canal

The Canal is Panama's treasure and every Panamanian benefits from it. Likewise, protecting the Canal watershed is a national concern (Heckadon-Moreno and others 1999).



Sunset through branches.
(Photo by Néstor Correa)

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Literature Cited

Anon. 1962. Dedicated—to Service: Free, permanent transit; Dream of years now reality. The Panama Canal Review. 13(10): 3-6, 19.

Aguilera P., Luisita. 1991. Tradiciones y leyendas Pamaneñas. Cuidad de Panamá, Panamá: Editorial Manfer, S.A. 230 p.

American Battle Monuments Commission. 2004. Fiscal year 2004 Annual Report. Arlington, VA: American Battle Monuments Commission. 47 p.

Allen, P.H. 1942. Poisonous and injurious plants of Panama. Panama City, Panama: Smithsonian Tropical Research Institute. 141 p.

Allen, W.H. 1996. Traveling across the treetops. Bioscience. 46(11): 796-799.

Amend, T.; Spalding, A.; Hinojosa, M.; Espinosa, A. (Grupo Aprender con la Naturaleza). 2001. Un día de aventura en el bosque: actividades ambientales para areas protegidas, Panama. Cuidad de Panamá, Panamá: Autoridad nacional del Ambiente. 412 p.

ANCON (Asociación Nacional para la Conservación de la Naturaleza); TNC (The Nature Conservancy). 1996. Ecological survey of the U.S. Department of Defense lands in Panama, phase III: HOROKO, Empire Range and Balboa West Range. Panama City, Panama: [Name of publisher unknown]. 282 p.

Anderson, C.L.G. 1914. Old Panama and Castilla del Oro. Boston, MA: The Page Company. 557 p.

Angehr, G. 2003. Directorio de áreas importantes para aves en Panamá. Cuidad de Panamá, Panamá: Socieded Audubon de Panamá. 342 p.

Angehr, G.; Coley, P.; Worthington, A. 1985. A picture guide to trees of the Gamboa area, Republic of Panama. U.S. Army Tropic Test Center (USATTC) Report No. 851001. Balboa, Panama: USATTC. 109 p.

Aráuz, R.T. de. 1977. Las culturas indígenas Panameñas en el momento de la conquista. Hombre y Cultura 3: 69-96.

Autoridad de la Región Interoceánica. 1999. Inventario de los bienes revertidos, 1979–1999. Cuidad de Panamá, Panamá: Autoridad de la Región Interoceánica. 293 p.

Belt, T. 1874. The naturalist in Nicaragua. 1985 ed. Chicago, IL: The University of Chicago Press. 403 p.

Bennett, C.F. 1968. Human influences on the zoogeography of Panama. Ibero-Americana 51: 1-24. Los Angeles, CA: University of California Press. 112 p.

Bennett, H.H. 1929. Soil reconnaissance of the Panama Canal Zone and contiguous territory. Tech. Bull. 94. Washington, DC: Bureau of Chemistry of Soils, U.S. Government Printing Office: 1-46.

Bennett, I.E. 1915. History of the Panama Canal: its construction and builders. Washington, DC: Historical Publishing Company. 543 p.

Berry, F.; Kress, W.J. 1991. Heliconia: an identification guide. Washington, DC: Smithsonian Institution Press. 334 p.

Botanic Gardens Conservation International. 1994. Environmental education in botanic gardens: guidelines for developing individual strategies. Richmond Surrey, UK: Descanso House. 32 p.

Braddy, T.W. 1920a. Commercial woods, native of the Canal Zone and Republic of Panama. Southern Lumberman. 98: 145-146.

Braddy, T.W. 1920b. Native woods used by Panama Canal. Lumber Trade Journal. 77: 11, 16.

Brats, C.Z. 1999. Admiral Hugh Rodman. Washington, DC: Department of Naval History. 4 p. http://www.czbrats.com/Builders/Rodman.htm [Date accessed: January 2, 2005].

Britannica Student Encyclopedia. 2006. Strangler fig. http://www.britannica.com/ebi/article-9109656. [Date accessed: October 9, 2006].

Bull, T. 1958. Excavations at Venado Beach, Canal Zone: Preliminary report on archaeological site, District of Chame, Province of Panama. Panama Archeologist. 1: 6-14 and 2: 91-146.

Carrasquilla, R., Luís G. 2005. Árboles y arbustos de Panamá. Cuidad de Panamá, Panamá. Universidad de Panamá. 479 p.

Carver, A.D.; Correa, N.J.; Bauer, G.P.; Weaver, P.L. 2007. Public and private partnerships for idle land utilization: case studies from the midwestern United States and Panama. In: Proceedings of the thirteenth meeting of Caribbean Foresters in Jamaica, June 12-16, 2006. Río Piedras, PR: U.S. Department of Agriculture Forest Service, International Institute of Tropical Forestry: 35-39.

Casado, M.A. 2001. Overview of Panama's tourism in the aftermath of the turnover of the Canal Zone. Journal of Travel Research. 40(1): 88-93.

Chong, N.S. 1984. A history of the Panama Canal from construction days to the present. Balboa Heights, Panama Canal Zone: Panama Canal Commission, Community Services Division, Library Services Branch. 85 p.

Chudnoff, M. 1984. Tropical timbers of the world. Agricultural Handbook 607. Washington, DC: U.S. Department of Agriculture Forest Service. 464 p.

Condit, R.; Robinson, W. D.; Ibañez, R.; Aguilar, S.; Sanjur, A.; Martínez, R.; Stallard, R.F.; García, T.; Angehr, G.R.; Petit, L.; Wright, S.J.; Robinson, T.R.; Heckadon, S. 2001. The status of the Panama Canal watershed and its biodiversity at the beginning of the 21st century. Bioscience. 51(5): 389-398.

Coleman, D.C.; Crossley, Jr., D.A. 1996. Fundamentals of soil ecology. New York: Academic Press. 205 p.

Congressional Research Service Library of Congress. 1977. Vol. 1. A chronology of events relating to Panama Canal. Washington, DC: U.S. Government Printing Office. 734 p.

Conte-Porras, J.; Castillero L., Eduardo E. 1998. Historia de Panamá y sus protagonistas: una vision de la historia nacional desde el período precolombina hasta finales del siglo XX. Cuidad de Panamá, Panamá: Distribuidora Lewis. 340 p.

Correa, M.D.; Valdespino, L.A. 1998. Flora de Panamá: una de las más ricas y diversas del mundo. Ancón. 5(1): 16-23.

Correa, N.; Carver, A. 2004. Area recreativa y educativa del bosque tropical. Proposal presented to La Autoridad de la Región Interoceánica. Panama City, Panama: Club Rotario Panamá Nordeste; Asociación GAIA para la Conservación y Gestión de la Biodiversidad; Southern Illinois University, Department of Forestry. 28 p.

Cummings, L.J. 1955. Forestry in Panama. Panama City, Panama: Ministerio de Agricultura, Comercio e Industrias: Institute of Inter-American Affairs. 28 p.

D'Arcy, W.G. 1987. Flora of Panama: checklist and index. Parts I and II. Introduction and checklist; index. St. Louis, Missouri Botanical Garden. 995 p.

Delgado, T.E. 1999. Bandera panameña ondea en Rodman. La Prensa. (viernes, 12 de marzo): 29 A.

DeMena, D. (comp.). 1996. The era of U.S. Army installations in Panama. Fort Clayton, Panama Headquarters, U.S. Army South, History Office. 216 p.

Díaz, J.M. 2005. Captarán movilización de fauna en cuenca del Canal. Panamá América. Diciembre 21.

DeVries, P.J. 1987. The butterflies of Costa Rica and their natural history: Papillonidae, Pieridae, Nymphalidae. Princeton, NJ: Princeton University Press. 327 p.

Eisenberg, J.F. 1989. Mammals of the neotropics, the northern neotropics. Vol. 1. Panama, Colombia, Venezuela, Guyana, Suriname, French Guiana. Chicago, IL: University of Chicago Press. 449 p.

Emmons, L.H.; Feer, F. 1997. Neotropical rainforest mammals: a field guide. Chicago, IL: University of Chicago Press. 307 p.

Enscore, S.I.; Webster, J.L. 1997. Marine barracks, Panama Canal. HABS No. CZ-12. Denver, CO: U.S. Department of the Interior, National Park Service, Rocky Mountain Regional Office (Historic American Building Survey). 47 p.

Escobar A., Novencido. 1972. Flora tóxica de Panamá. Cuidad de Panamá, Panamá: Universidad de Panamá, Editorial Universitaria. 279 p.

Findley, J.S. 1993. Bats: a community perspective. New York: Cambridge University Press. 167 p.

Flanigan, E.M., Jr. 1993. Battle for Panama: inside operation just cause. New York, NY: Brassey's (US), Inc. 251 p.

Fleming, T.H.; Hooper, E.T.; Wilson, D.E. 1972. Three Central American bat communities: structure, reproductive cycles, and movement patterns. Ecology. 53(4): 555-569.

Foelix, R.F. 1996. Biology of spiders. 2d ed. Oxford, UK: Oxford University Press. 330 p.

Forbes, R. 1948. Sir Henry Morgan: pirate and pioneer. Toronto, Canada: Cassel & Co., Ltd. 296 p.

Gentry, A.H. 1991. The distribution and evolution of climbing plants. In: Putz, F.E.; Mooney, H.A., eds. The biology of vines. Cambridge, UK: Cambridge University Press: 1-49.

Gold, S.D. 1999. The Panama Canal transfer: controversy at the crossroads. Austin, TX: Raintree Steck-Vaughn Publishers. 128 p.

Grogan, J.; Barreto, P. 2005. Big-leaf mahogany on CITES Appendix II: big challenge, big opportunity. Conservation Biology. 19(3): 973-976.

Guinness World Records. 2006. Natural world/creepy crawlies/ largest spider. http://guinnessworldrecords.com/content_pages/record.asp?recordid=51536. [Date accessed: October 9, 2006].

Guyer, C.; Donnelly, M.A. 2004. Amphibians and reptiles of La Selva, Costa Rica, and the Caribbean slope: a comprehensive guide. Berkeley, CA: University of California Press. 299 p.

Hammond, B.W. 1999. *Saccharum spontaneum* (Graminae) in Panama: the physiology and ecology of invasion. Journal of Sustainable Forestry. 8 (3/4): 23-38.

Hampshire, R.J. 1989. Panama. In: Campbell, D.G.; Hammond, H.D., eds. Floristic inventory of tropical countries. The status of plant systematics, collections, and vegetation, plus recommendations for the future. New York, NY: New York Botanical Garden; Arnold Arboretum; Missouri Botanical Garden; World Wildlife Fund: 309-312.

Heckadon-Moreno, S. 1998. Naturalistas del Istmo de Panamá: un siglo de historia natural sobre el puente biológico de las Américas. Cuidad de Panamá, Panamá: Instituto Smithsonian de Investigaciones. 215 p.

Heckadon-Moreno, S.; McKay, A. 1984. Colonización y destrucción de bosques en Panamá: ensayos sobre un grave problema ecológico. Cuidad de Panamá, Panamá: Asociación Panameña de Antropolía. 174 p.

Heckadon-Moreno, S.; Ibáñez D., Roberto; Condit, R. 1999. La cuenca del canal: deforestación, contaminación y urbanización. Instituto Smithsonian de Investigaciones Tropicales. 120 p.

Hedrick, B.C.; Hedrick, A.K. 1970. Historical dictionary of Panama. Metuchen, NJ: The Scarecrow Press, Inc. 105 p.

Helms, M.W. 1979. Ancient Panama: chiefs in search of power. Austin, TX: University of Texas Press. 228 p.

Henderson, A.; Galeano, G.; Bernal, R. 1995. Field guide to the palms of the Americas. Princeton, NJ: Princeton University Press. 352 p. + plates.

Holland, J.S. 2006. It's a frog's life. National Geographic. 210(5): 136-147.

Hooper, E.; Legendre, P.; Condit, R. 2005. Barriers to forest regeneration of deforested abandoned land in Panama. Journal of Applied Ecology. 42: 1165-1174.

Hildebrand, S.F. 1938. A new catalogue of the fresh-water fishes of Panama. Publ. 435. Zoological Series: 22(4). Chicago, IL: Field Museum of Natural History. 1-359.

Holdridge, L.R. 1967. Life zone ecology. San José, Costa Rica: Tropical Science Center. 206 p.

Holldobler, B.; Wilson, E.O. 1990. The ants. Cambridge, MA: Belnap Press of Harvard University Press. 732 p.

Hussey, R.D. 1960. Caminos coloniales en Panamá. Lotería No. 60: 104-121. [translated by Eva E. Escala V.].

Ibáñez, R.; Condit, R.; Angehr, G.; Aguilar, S.; García, T.; Martínez, R.; Sanjur, A.; Stallard, R.; Wright, S.J.; Rand, A.S.; Heckadon, S. 2002. An ecosystem report on the Panama Canal: monitoring the status of the forest communities and the watershed. Environmental monitoring and assessment. 80: 65-95.

Ibáñez, R.; Solis, F.A. 1991. Los serpientes de Panamá: lista de especies, comentarios taxonómicos y bibliografía. Scientia (Panamá). 6(2): 27-52.

International Science and Technology Institute. 1980. Panamá: perfil ambiental del pais. Washington, DC: International Science and Technology Institute. 162 p.

Jackson, E. 2003. City of Knowledge goals, successes outlined. The Panama News 9(13): 3. http://www.thepanamanews.com/pn/v_09/issue_13/business_03.html. [Date accessed: October 4, 2006].

Janzen, D.H., ed. 1983. Costa Rican natural history. Chicago, IL: University of Chicago Press. 816 p.

Jones, E.R.; Wishnie, M.H.; Deago, J.; Sautu, A.; Cerezo, A. 2004. Facilitating natural regeneration in *Saccharum spontaneum* (L.) grasslands within the Panama Canal Watershed: effects of tree species and tree structure on vegetation recruitment patterns. Forest Ecology and Management. 191(1): 171-183.

Johnson, S.P.; Houle, R.M. (N.d.). An American legacy in Panama. 75 p. https:www.denix.ods.mil/denix/Public/Library/NCR/note8.html

Joyce, C. 1991. A crane's eye view of tropical forests. New Scientist. 131(1787): 40-42.

Keiser, E.D., Jr. 1974. A systematic study of the neotropical vine snake *Oxybelis aeneus* (Wagler). Bulletin Texas Memorial Museum. 22: 1-51.

Lieberknecht, K.; Papazian, J.; McQuay, A. 1999. Balancing conservation and economics: the development of an ecotourism plan for Panama. Journal of Sustainable Forestry. 8(3-4): 107-126.

Leigh, E.G.; Windsor, D.M.; Rand, A.S.; Foster, R.B. 1990. The impact of the El Niño drought of 1982-83 on Panamanian semideciduous forest. In: Glynn, P.W., ed. Global ecological consequences of the 1982-83 el Niño-southern oscillation. Amsterdam, Holland: Elsevier Scientific: 473-483.

Lindsay-Poland, J. 2003. Emperors in the jungle: the hidden history of the U.S. in Panama. Durham, NC: Duke University Press. 266 p.

Little, E.L., Jr.; Woodbury, R.O.; Wadsworth, F.H. 1974. Trees of Puerto Rico and the Virgin Islands, second volume. Agricultural Handbook 449. Washington, DC: U.S. Department of Agriculture Forest Service. 1024 p.

Lothrop, S.K. 1954. Suicide, sacrifice, and mutilations in burials at Venado Beach, Panama. American Antiquity. 19(3): 226-234.

Lothrop, S.K. 1956. Jewelry from the Panama Canal Zone. Archaeology. IX(1): 34-40.

Lothrop, S.K.; Bergsøe, P. 1960. Aboriginal gilding in Panama. American Antiquity. 26(1): 106-108.

Lothrop, S.K. 1966. Archaeology of Lower Central America. In: Wauchope, R., ed. Handbook of Middle American Indians, Vol. 4, Archaeological Frontiers and External Connections. Austin, TX: University of Texas Press: 180-208.

Mack, G. 1974. The land divided: a history of the Panama Canal and other isthmian canal projects. New York, NY: Octagon Books. 684 p.

Marshall, D.S. 1949. Archaeology of Farfan Beach, Panama, Canal Zone. American Antiquity. 15(2): 124-132.

Milius, S. 2007. Perils of migration. Science News. 171(7): 102.

Miller, N. 1977. The U.S. Navy: an illustrated history. New York, NY: Annapolis, MD: United States Naval Institute Press. 416 p.

Moral, Camilo del. 1944. La silvicultura y las industrias bases. Revista de Agricultura y Comercio (Panamá). 3(36): 2-56.

Morris Brooks, C. 2003. Guarding the crossroads: security and defense of the Panama Canal. Bogotá, Colombia: Imprelibros S.A. 283 p.

Nicolaisen, E.A. 1999. Corozal cemeteries. Panama City, Panama: American Embassy. 4 p. + information sources (unpublished). Available from: Corozal American Cemetery, American Embassy Unit 0945, APO AA 34002.

Noriega, J.O. 1987. Puentes sobre el Canal de Panamá. S.L., S.N. 60 p.

Nyrop, R.F. 1980. Panama, a country study. Washington, DC: American University, Foreign Area Studies. 276 p.

Panama Canal. 1939. Historical map of the canal zone and vicinity showing various routes, settlements, etc., between 1502 to 1855. Panama City, Panama: Tommy Guardia. 1 p. Available from Instituto Geográfico Nacional "Tommy Guardia."

Pereira Jiménez, B. 1964. Biografía de Río Chagres (segunda edición) Cuidad de Panamá, Panamá: Imprenta Nacional (orden 11368). 283 p.

Ponce, E.; Muschett, G. 2006. An illustrated field guide to the birds of Panama. Madrid, Spain: Ediciones San Marcos S.L. 551 p.

Preston-Mafham, R.; Preston-Mafham, K. 1984. Spiders of the New World. New York, NY: Blanford Press, Ltd. 191 p.

Pyke, C.R.; Condit, R.; Aguilar, S.; Lao, S. 2001. Floristic composition across a climatic gradient in a neotropical lowland forest. Journal of Vegetation Science. 12: 553-566.

Reid, F.A. 1997. A field guide to the mammals of Central America & southeast Mexico. New York, NY: Oxford University Press. 334 p.

Ridgely, R.S.; Gwynne, J.A., Jr. 1989. Birds of Panama with Costa Rica, Nicaragua, and Honduras. Princeton, NJ: Princeton University Press. 534 p.

Robinson, W.D.; Angehr, G.R.; Robinson, T.R.; Petit, L.J.; Petit, D.R.; Brawn, J.D. 2004. Distribution of bird diversity in a vulnerable neotropical landscape. Conservation Biology. 18(2): 510-518.

Rodman, H. 1928. Yarns of a Kentucky admiral. Indianapolis, IN: Bobbs-Merril Company. 320 p.

Rubio, Á. 1959. El golfo de Panamá, bahía historica. Lotería No. 41: 17-46.

Rubio, Á. 1964. Rutas posibles de un nuevo canal. Lotería No. 107: 54-71.

Russell-Robertson, M. 2004. Surprising spiders. http://nationalzoo.si.edu/publications/zoogoer/2004/3/spiders.cfm [Date accessed: October 9, 2006].

Rowlett, R. 2005. Lighthouses of the Panama Canal. http://www.unc.edu/~rowlett/lighthouse/PanamaCanal/ [Date accessed: October 9, 2006].

Sander, D.; Mitchell, R.H. 1960. Report on fabric and figurine, Venado Beach, Canal Zone. Panama Archeologist. 3: 52-54.

Sander, D.; Mitchell, R.H.; Turner, R. 1958. Report on Venado Beach, excavations. Panama Archeologist. 1: 26-28.

Sasaki, J. 1996. Plantas de uso medicinal comunes en la provincias de Panamá y Colón. Cuidad de Panamá, Panamá: Ancón. 38 p.

Sauer, C.O. 1966. The early Spanish main. Berkeley, CA: University of California Press. 306 p.

Semlitsch, R.D. 2003. Amphibian Conservation. Washington, DC: Smithsonian Institution. 323 p.

Silverstein, J. 2006. Highway run: touring Mexico in a death-race revival. Harper's Magazine. (July 2006): 70-80.

Smith, N.G. 1980. Hawk and vulture migrations in the neotropics. In: Keast, A.; Morton, E.S., eds. Migrant birds in the neotropics: ecology, behavior, distribution, and conservation, a symposium held at the Conservation and Research Center, National Zoological Park, Smithsonian Institution, October 27-29, 1977. Washington, DC: Smithsonian Press: 51-65.

Smithsonian web site: Tropical Research Institute. ACP Physical Monitoring Downloads. http://striweb.si.edu/esp/physical_monitoring/download_acp.htm [Date accessed: October 9, 2006].

Stevens, E.B. 1962. The land reunited. The Panama Canal Review. 13(10): 7-11.

Stewart, R.H.; Stewart, J.L.; Woodring, W.P. (comps). 1980. Geologic map of the Panama Canal and vicinity, Republic of Panama. Arlington, VI: U.S. Geological Survey. 1 p. (map).

Stiles, F.G.; Skutch, A.F. 1989. A guide to the birds of Costa Rica. Ithaca, NY: Comstock Publishing Associates (Division of Cornell University Press) and External Connections. Austin, Texas: University of Texas Press. 511 p.

Stone, D. 1972. Pre-columbian man finds Central America. Cambridge, MA: Harvard University, Peabody Museum Press. 231 p.

Storey, R.G.; Eisenhower, M.S.; Fields, K.E.; Hill, R.A.; Anderson, R.B. 1970. Interoceanic canal studies 1970. Washington, DC: Atlantic-Pacific Interoceanic Canal Study Commission. 129 p. + annexes.

Tejera, V.H.; Araúz, J.G.; Ramos, C.; Rodríguez, A.R. 1999. Nuevos registros del murciélago blanco, *Declidurus albus* (Chiroptera: Emballonuridae) en Panamá. Scientia (Panamá). 14(2): 95-101.

Tejera de Venegas, C. 1995. Juanito y tu mueble de caoba. Cuidad de Panamá, Panamá: Universidad de Panamá, Editorial Universitaria. 8 p.

Thompson, W.F. 1959. Canal Zone analogs VII: Analogs of Canal Zone climate in Indonesia, the Philippines, and Borneo. Technical Report EP-116. Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station. 22 p. + 15 figures.

Thurau, B. 2004. Travel motivations of cruise ship tourists visiting the Panama Canal watershed: an ecotourism-market segmentation approach. M.S. thesis. Carbondale, IL: Southern Illinois University, Department of Forestry. 80 p.

Torres de Araúz, R. 1972. Arte precolombino de Panamá. Cuidad de Panamá, Panamá: Editora de la Nación. 95 p. + photographs.

Tosi, J.A., Jr. 1971. Zonas de vida: una base ecológica para investigaciones silvícolas e inventariación en la República de Panamá. Rome, Italy: Organización de las Naciones Unidas para la Agricultura y Alimentación FAO/FO: SF/PAN 6. Informe técnico 2. 123 p.

Tufts, C. 1995. The National Wildlife Federation's guide to gardening for wildlife: how to create a beautiful backyard habitat for birds, butterflies, and other wildlife. Emmaus, PA: Rodale Press. 192 p.

Tuttle, M.D.; Taylor, D.A.R. 1994. Bats and mines. Resource Publication No. 3. Austin, TX: Bat Conservation International, Inc. 41 p.

U.S. Army. 1989. Topographical survey for the design of improvements to ASP, Rodman, Panama. Drawing –3265. Fort Clayton, Panama: Headquarters, United States Army Garrison—Panama, Directorate of Engineering and Housing; Holzer-Narbona-Bond y Asociados, S.A. 1 p. (map).

Von Hagen, V.W. 1948. The green world of the naturalists: a treasury of five centuries of natural history in South America. New York, NY: Greenberg. 392 p.

Wadsworth, F.H. 1978. Deforestation: death to the Panama Canal. In: Proceedings of the U.S. strategy conference on tropical deforestation. Washington, DC: U.S. Department of State, U.S. Agency for International Development: 22-24.

Weaver, P.L.; Bauer, G.P. 2003. Big-leaf mahogany in Panama: historical perspective. GTR-IITF-24. Río Piedras, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. 29 p.

Weaver, P.L.; Bauer, G.P. 2004. The San Lorenzo Protected Area: a summary of cultural and natural resources. Gen. Tech. Rep. IITF-25. Río Piedras, PR: U.S. Department of Agriculture Forest Service, International Institute of Tropical Forestry. 89 p.

Weaver, P.L.; Bauer, G.P.; Jiménez, B. 2003. The San Lorenzo Protected Area: Panama's Caribbean Treasure. Gen. Tech. Rep. IITF-23. Río Piedras, PR: U.S. Department of Agriculture Forest Service, International Institute of Tropical Forestry. 60 p.

Weaver, P.L.; Sabido, O.A. 1997. Mahogany in Belize: a historical perspective. GTR-IITF-2. Río Piedras, PR: U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry. 31 p.

Wetmore, A. 1965-84. The birds of the Republic of Panama. Parts 1-4. Washington, DC: Smithsonian Institute Press. 2389 p.

Wikipedia. 2006. Ficus. http://en.wikipedia.org/wiki/fig. [Date accessed October 9, 2006].

Wikipedia. 2009. Alexander von Humboldt. http://en.wikipedia.org/wiki/Alexander_von_humboldt. [Date accessed August 25, 2009].

Wilcox, D. 1977. Ten who dared. Boston, MA: Little, Brown and Company. 336 p.

Wilson, E.O. 2006. The civilized insect. National Geographic. 210(2): 136-149.

Wong, M.; Ventocilla, J. 1995. Un día en la isla de Barro Colorado. Cuidad de Panamá, Panamá: Instituto Smithsonian de Investigaciones Tropicales. 199 p.

Woodard, C. 1997. Panama hopes to create a "City of Knowledge" where U.S. forces once ran the Canal Zone. Panamá Update No. 20. 3p. http://www.forusa.org/programs/panama/archives/0797-2.htm. [Date accessed October 4, 2006].

Woodring, W.P. 1957. Geology and paleontology of Canal Zone and adjoining parts of Panama: geology and description of tertiary mollusks (Gastropods: Trochidae and Turritellidae). U.S. Geological Survey Professional Paper No. 306: A contribution to the history of the Panama land bridge. Washington, DC: United States Government Printing Office. 145 p. + 23 plates.

Woodson, R.E.; Schery, R.W. 1943-80. Flora of Panama. Annals of the Missouri Botanical Garden. St. Louis, MO: Missouri Botanical Garden Press. Vols. 30 through 67 [Various Issues].

Zapata Q., Alvin. 1998. Algunos usos tradicionales de las plantas de Panamá. Ancón. 5(1): 12-13, 15.

Zon, R.; Sparhawk, W.N. 1923. Forest resources of the world, Panama. New York, NY: McGraw Hill Book Company. 585-594. Vol. 2.

Appendix A

Chronology of events associated with Eco-Park (formerly Rodman Ammunition Supply Point) and surrounding areas in Panama[1]

Year	Event
300	Indians occupy nearby shoreline (Venado Beach, Far Fan, and Punta Brujas).
1492	Panama is occupied by 60 Indian groups totaling about 1 million.
1513	Balboa claims the South Sea (Pacific Ocean) from a headland (possibly Punta Brujas) for Spain.
1514	Spanish settlers first arrived in Panama.
1518	Balboa discovers the Pearl Islands in the Gulf of Panama.
1519	First European settlement on the Pacific coast of the Americas is founded in 1519 at old Panama (Panama la Vieja).
1530s	Pizarro conquers Peru and Panama becomes the portage between the oceans. Las Cruces Trail from Panama City to the Chagres River and on to San Lorenzo is first established and its use continues through the days of the 1849 California gold rush.
1671	The buccaneer Henry Morgan sacks Panama City and returns to Fort San Lorenzo on a route just east of Eco-Park (formerly Rodman Munitions Depot).
1673	Panama City (Casco Antiguo) is rebuilt at a new site closer to the current canal and Eco-Park
1848	California “gold rush” attracts first isthmian transients between Chagres and Panama City
1849	Steamboat service begins from Panama City to San Francisco
1855	The railroad across the isthmus of Panama, started in 1850, is completed.
1870s	Baron Godin de Lepinay proposes a lock canal for Panama, including dams on the Rio Chagres (Atlantic) and Rio Grande (Pacific), a scheme that would reduce excavation, construction costs, and time.
1880	Construction of Panama Canal begins under Ferdinand de Lesseps (French) but the effort is abandoned in 1889.
1898	Spanish-American War highlights the inability of the United States to move ships from the Pacific to the Atlantic rapidly.
1903	Panama declares independence from Colombia on November 3 and the United States recognizes the new Republic on November 6.
1904	In May, the United States begins to build the Panama Canal.
1904	William Crawford Gorgas begins work as chief sanitary officer in the Canal Zone.
1905	John F. Stevens allows William C. Gorgas to implement a campaign to eradicate mosquitoes, known vectors in the transmission of yellow fever and malaria.
1906	On November 9, President Theodore Roosevelt visits Panama to inspect progress on the construction of the Panama Canal.
1909	Construction of bridge or tunnel across the Panama Canal is first considered, and the topic surfaces again in 1913, 1929, 1937, and between 1942 and 1954.
1914	On August 15, Admiral Hugh Rodman traverses the canal aboard the Ancon.
1920	Construction on Fort Clayton (today called Cuidad del Saber) begins.
1920s	Navy begins looking for land at the Pacific terminus of the Canal to build an operating base.

continued

Appendix A (continued)

Chronology of events associated with Eco-Park (formerly Rodman Ammunition Supply Point) and surrounding areas in Panama[1]

Year	Event
1923	Paul Carpenter Standley collects plants in the Canal Zone, and in 1927 and 1928 publishes books on the flora of Barro Colorado Island and the Canal Zone.
1932	On May 19, license is granted to Navy Department for the construction of west bank navy facilities, work which is started in 1935 and is completed around 1937.
1932	Ferry service at Pedro Miguel locks is transferred to Balboa at the Pacific entrance of the canal, and a short stretch of road designated as Thatcher Highway is built from the western ferry slip (called Thatcher Ferry) to the western Canal Zone boundary, where it connects with Panama's national highway.
1932	Isthmian Canal Commission reserves the Corozal cemetery for veterans and others associated with the construction and operation of the Panama Canal.
1939	A third set of canal locks is begun along with the development of large military installations (later part of Rodman) on the west bank of the Canal.
1940	Ferry service is initiated across Miraflores Lake and continues through mid-1942.
1942	The Miraflores swing bridge over the Canal opens and continues to serve until 1962.
1943	Balboa Navy Base is built to provide fuel, provisions, and maintenance to military ships that traverse the Canal.
1944	Alexander Wetmore begins 22 years of studies on the avifauna of Panama resulting in the publication of four volumes on Panama's bird species between 1965 and 1984.
1948	Navy bulldozers uncover archaeological remains at Venado Beach.
1950	In February, Balboa Navy Base is renamed Rodman to honor Admiral Hugh Rodman.
1955	The Remon-Eisenhower Treaty includes the construction of a bridge over the Canal.
1962	On October 12, the Thatcher Ferry Bridge (today, the Bridge of the Americas) is dedicated, replacing the Miraflores swing bridge.
1962	In October, personnel at Rodman cooperate with the U.S. fleet during the Cuban missile crisis.
1977	Torrijos-Carter Treaty, signed on September 7, outlines reversion of the Canal Zone to Panama, including 7,000 military and civilian buildings.
1980s	The government of Panama adopts numerous environmental measures to protect the Panama Canal watershed.
1989	On December 20, "Operation Just Cause" is launched and frogmen depart from Rodman to cross the Panama Canal and incapacitate Noriega's yacht.
1990	On January 31, 1990, "Just Cause" ends.
1992-3	The Bruja Road is widened and a cloverleaf intersection is built just west of the Bridge of the Americas.
1998	A law creates a private foundation to transform part of Fort Clayton into a center of excellence in science, technology, and innovation—the City of Knowledge.

continued

Appendix A (continued)

Chronology of events associated with Eco-Park (formerly Rodman Ammunition Supply Point) and surrounding areas in Panama[1]

Year	Event
1999	On March 11, the symbolic key to Rodman Base is given to Panamanian President Ernesto Perez Ballardes by Navy Fleet Admiral Paul Reason.
1999	In April, the U.S. Navy officially departs from Rodman.
2001	The Panama Canal Railway begins coast to coast service.
2004	Eco-Park is created by two resolutions of the Interoceanic Regional Authority (ARI); ARI selects the Rotary Club (Nordeste), a local civic organization, to serve as trustee of the land; the Rotary Club, in turn, enlists the PanAmerican Conservation Association (APPC), the International Institute of Tropical Forestry (IITF), and the Institute for Neotropical Conservation to assist in conservation land management.
2005	Eco-Park press releases inform the public regarding park objectives and activities.
2006	From January to May, mounted remote cameras detect the presence of mammals previously unknown from Eco-Park.
2006	Panamanian public votes to enlarge the Panama Canal.

[1]Sources: Chong 1984, Congressional Research Service Library of Congress 1997, Conte-Porras and Castillero L. 1998, Enscore and Webster 1997, Weaver and others 2003.

Appendix B

Various groups associated with Eco-Park in Panama

Groups from Panama

Autoridad del Canal de Panamá (ACP) … The Panama Canal Authority

Autoridad Maritima de Panamá (AMP) … National Maritime Authority

Autoridad Nacional del Ambiente (ANAM) … National Environmental Authority

Autoridad de la Región Interoceánica (ARI) … Interoceanic Regional Authority

Club Rotario Panamá Nordeste … Panama Rotary Club (Northeast)

Fundación Natura … Natura Foundation

Instituto Panameño de Turismo (IPAT) … Panamanian Tourism Institute

La Asociación Panamericana para la Conservación … Panamerican Conservation Association

Sociedad Audubón de Panama … Panama Audubon Society

Tucán Country Club

Groups from Spain

La Asociación GAIA para la Conservación y Gestión de la Biodiversidad

Groups from the United States

Institute for Neotropical Conservation (Southern Illinois University)

Smithsonian Tropical Research Institute (STRI)

U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry (IITF)

U.S. Peace Corps

Weaver, Peter L. 2009. Panama Eco-Park: a protected urban forest. Gen. Tech.Rep. IITF-41. San Juan, PR: U.S. Department of Agriculture Forest Service, International Institute of Tropical Forestry. 66 p.

Eco-Park and surrounding areas located near the Pacific or southern entrance to the Panama Canal have a long history involving pre-Columbian inhabitants, Spanish conquistadors, pirates, and Panamanian natives and immigrants associated with the construction and operation of the Panama Railroad and Canal. Some major 20th century events included Panamanian independence from Colombia, building of the Balboa Naval Station (later called Rodman Naval Station), construction of the Bridge of the Americas (formerly Thatcher Bridge), the Torrijos-Carter Treaty and, subsequently, the U.S. departure from Panama. Eco-Park is dominated by a semideciduous seasonal mixed forest. A plant survey carried out in that forest type for Eco-Park and nearby military bases (i.e., Howard, Rodman, and Kobbe together called HOROKO) revealed 378 species, 97 genera, and 82 families. An animal survey carried out in the same forest type disclosed 260 species, including 40 mammals, 19 reptiles, 13 amphibians, and 188 birds (39 migratory and 149 residents). In summary, Eco-Park and surrounding areas have a fascinating history and a diverse flora and fauna. Moreover, being situated near Panama City and along the Canal route, Eco-Park and surrounding areas offer numerous outdoor recreational opportunities for Panamanian residents and Canal Area visitors. Eco-Park, beginning as a fascinating idea, was made into reality through the dedicated efforts of both local and international groups.

Keywords: Eco-Park, education, fauna, flora, historical chronology, Panama Canal.

The Forest Service, U.S. Department of Agriculture (USDA), is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.