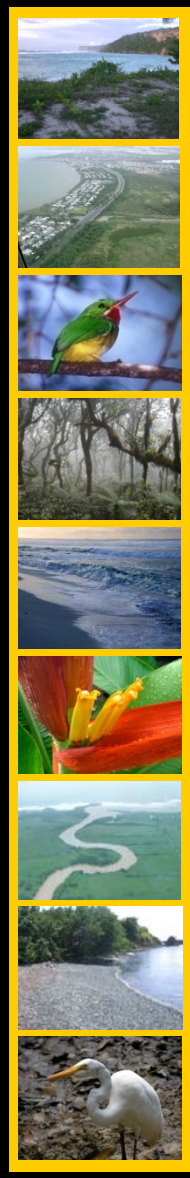
IITF GIS and Remote Sensing Laboratory

Center for Tropical Landscape Analyses



Integrated Gap Analysis Project: Assessing conservation of freshwater, estuarine, marine, and terrestrial biodiversity

Gap Team:

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Gary Potts
Yolanda Hernandez
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Jessica Castro
Patricia Rincón
Suhey Ortíz-Ramos
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Nilda Jiménez (DRNA)

William Gould, USDA Forest Service Research Ecologist

Outline

- GAP analysis: Geographic Approach to Planning
- PRGAP: Assessing terrestrial vertebrate conservation
- Integrated terrestrial aquatic GAP objectives
- Integrated terrestrial aquatic GAP components
- Collaboration

Gap Analysis Program

Initiated in the 1980s as a landscape approach to conservation planning:

1. Identify distributions of species and habitats.
2. Identify conservation areas.
3. Assess how well species and habitats are protected.

U.S. Geological Survey

- NBII: National Biological Information Infrastructure
  - Gap Analysis Program
    - Gap Aquatics Projects
      - PR-USVI Integrated Gap Project

Puerto Rico Department of Natural and Environmental Resources

- PR “Sportfish” Gap Project

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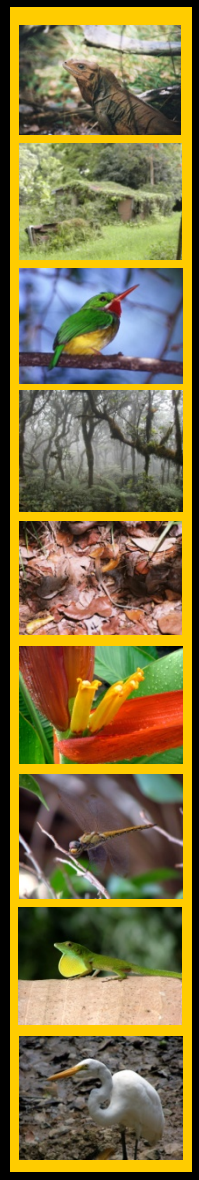
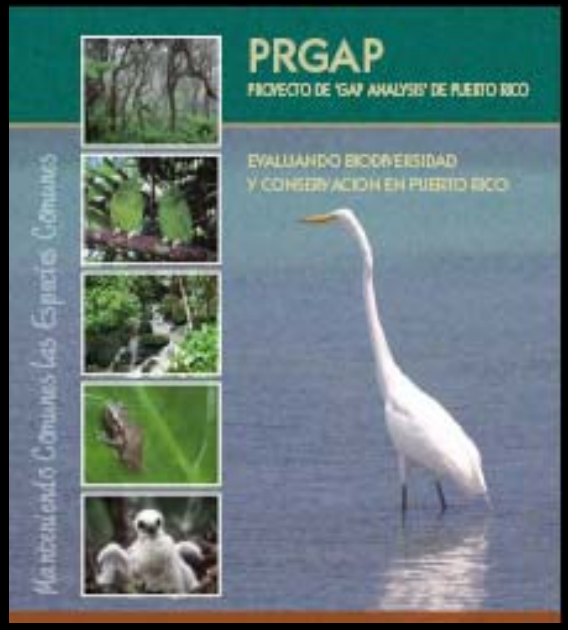


Puerto Rico Gap Analysis Project

Mission: Regional assessments of the conservation status of native terrestrial vertebrate species and natural land cover types.

Determine "Gaps" in conservation of species and habitats

"The intent of the Gap Analysis is to provide proactive…. land management activities at the community and landscape levels" (J. Michael Scott, 1995).



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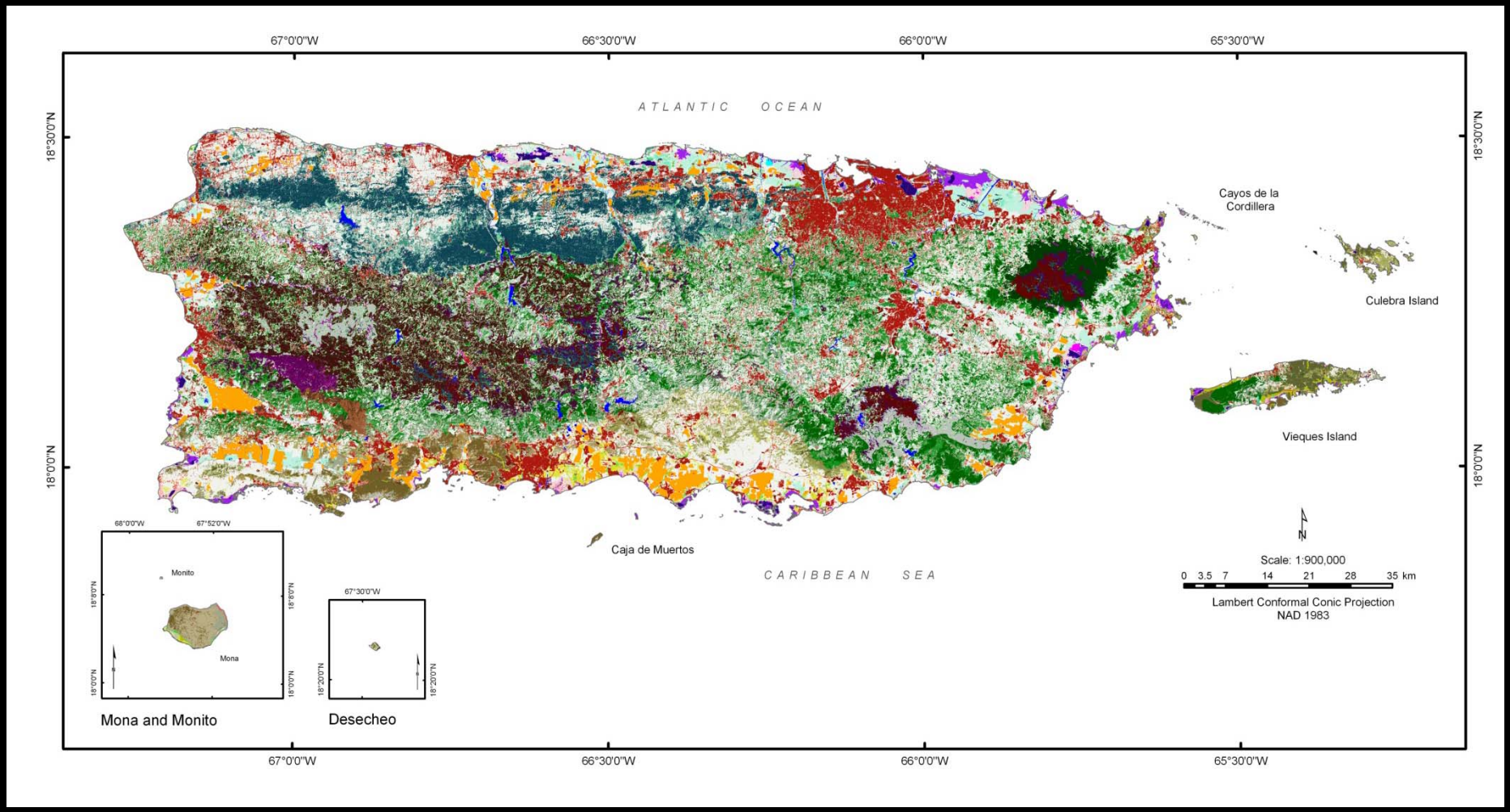
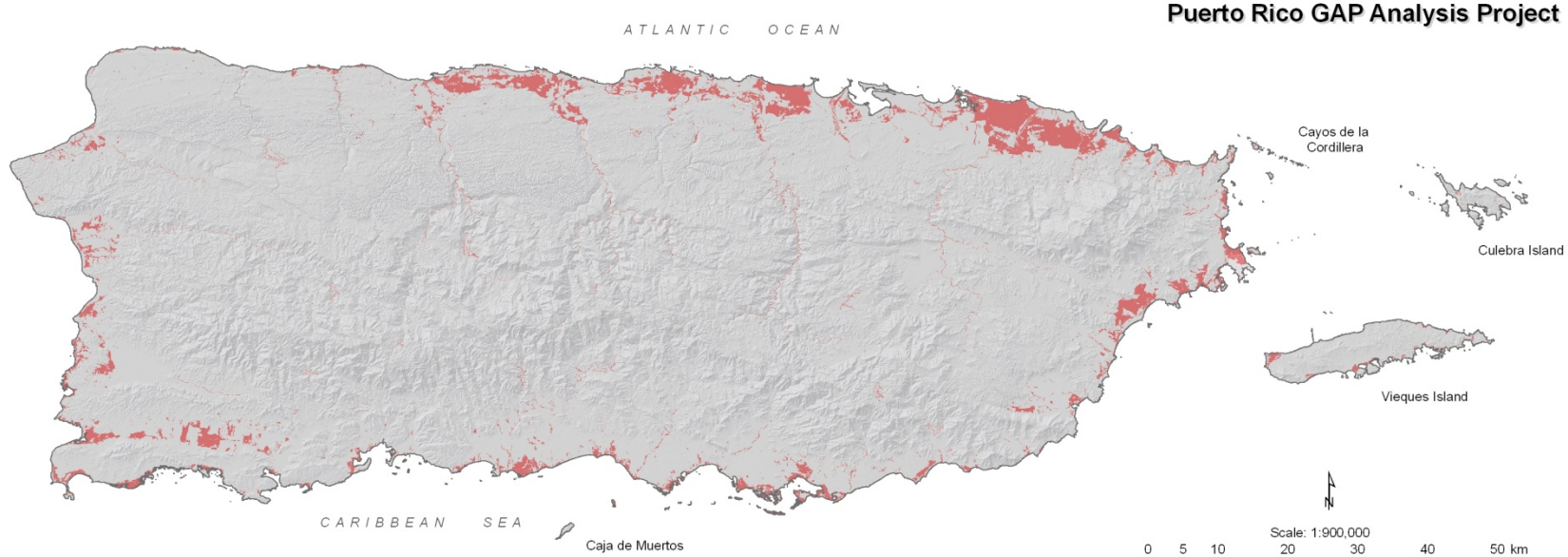


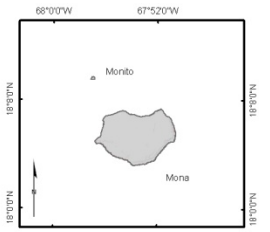
Land cover of Puerto Rico

Green Heron

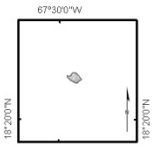
Butorides virescens Martinete

Puerto Rico GAP Analysis Project





Mona and Monito



Desecheo

Photo courtesy of Iván Vicéns

Scientific Name: ***Butorides virescens***
Common Name (ENG): **Green Heron**
Common Name (SPA): **Martinete**
Species ID: **ABNKC19110**
Taxonomic Class: **Aves**
Taxonomic Order: **Ciconiiformes**
Residency Status: **Breeding Resident**
Occurrence Status: **Common**
NatureServe Global Rank: **G5**
Federal U.S. ESA Status: **Not Listed**
PR Natural Heritage Status: **Not Listed**

Species Predicted Habitat Map Map Date: **November 7, 2006**

Species Predicted Habitat:

Predicted habitat model includes the following landcover types: Wetlands, shorelines, and water edges. This species habitat includes 4.7% (41920 ha) of the island, of which 20.6% occurs in protected areas (PRGAP Status 1 and 2).

Species Accounts Summary:

The Green Heron can be found throughout Puerto Rico[2], and also in Vieques Island[4]. It makes use of fresh and salt water marshes, Pterocarpus forests, ponds, canals, mangroves, stream borders, calm ocean shores, wet fields, and even gardens[2]. It is associated with wetlands, and it can be found in any body of water from a puddle to the border of a large lagoon[3]. It generally perches motionless on a snag low over the water awaiting for prey[3] which include "changas" or mole crickets (*Scapteriscus spp.*), small insects, small fish, toads, shrimps, and small reptile[1].

1. Biaggi, V. (1997). Las aves de Puerto Rico, Cuarta Edición. Editorial de la Universidad de Puerto Rico (EDUPR).
2. Oberle, M.W. 2000. Puerto Rico's Birds in Photographs. Second Edition. Editorial Humanitas, San Juan, Puerto Rico. 129 pp.
3. Raffaele, H.A., Wiley, J., Garrido, O., Keith, A., and Raffaele, J. 1998. A Guide to the Birds of the West Indies. Princeton Univ. Press. Princeton.
4. Sorrié, B.A. 1975. Observations on the Birds of Vieques Island, Puerto Rico. Caribbean Journal of Science, 15(1-2):89-103.

Product developed by the U.S. Forest Service, International Institute of Tropical Forestry, GIS Remote Sensing Laboratory, Puerto Rico GAP Analysis Project (PRGAP). GIS modeling and cartography by M.Jiménez, S. Martinuzzi, M. Solorzano and B. Fevold. For more information contact Team Leader, W. A. Gould; Jardin Botánico Sur, 1201 Calle Ceiba, San Juan, PR 00926. 787-766-5335; Email: wgould@fs.fed.us.

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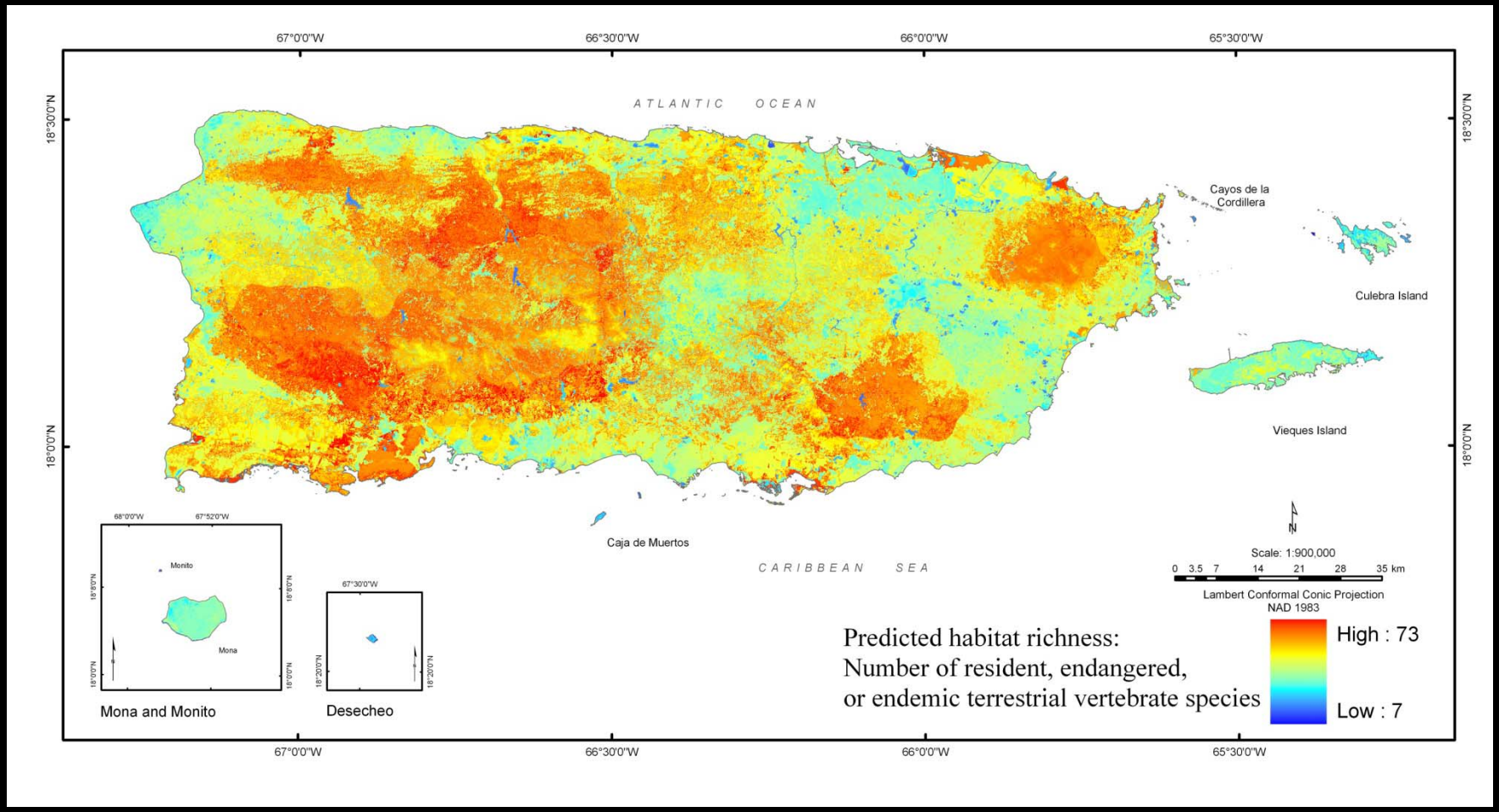
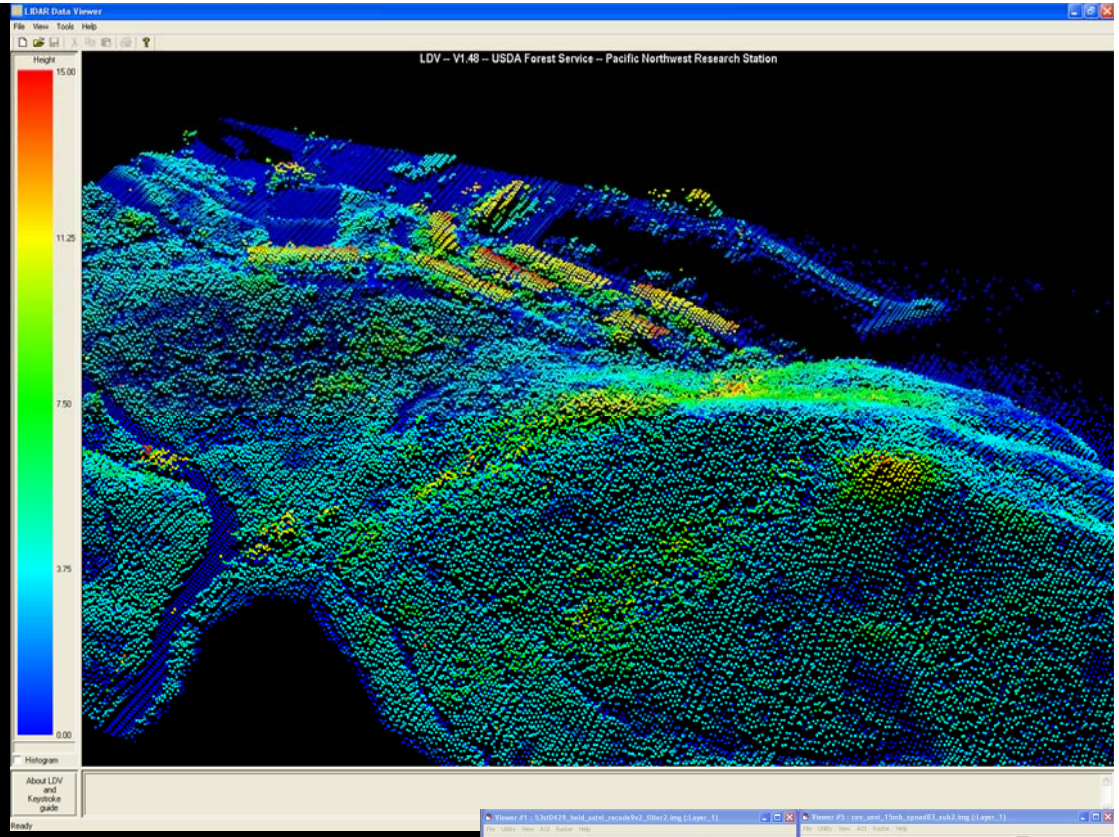
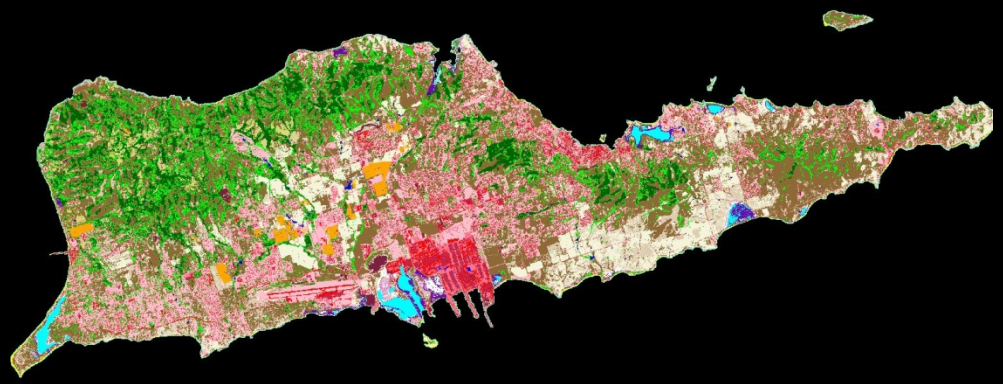
Mapping biodiversity patterns

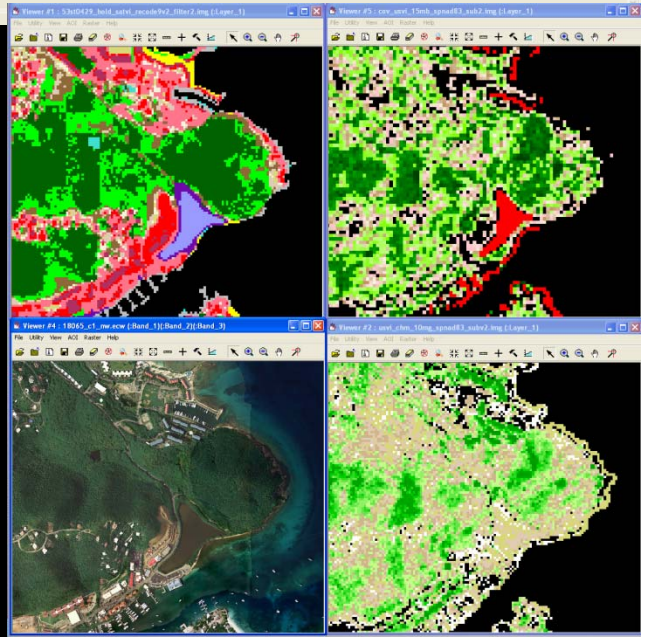


USVI Gap Analysis Project

Remote sensing and mapping vegetation composition and structure







Integrated terrestrial-aquatic gap

The goal of *Integrated Gap* is to develop a comprehensive set of databases on Puerto Rico and the US Virgin Islands' freshwater, estuarine, and marine resources – including habitat description and mapping, species distributions and conservation status, and protected areas and conservation priorities…

Integrated terrestrial-aquatic gap

….combined with existing Puerto Rico and USVI terrestrial GAP databases, to conduct integrated analyses of gaps in conservation protection for the U.S. Territories in the Caribbean.

Four tasks gathering information:

- Compile information on the natural history of selected species.
  - Taxonomic
  - Conservation status
  - Bibliography
  - Habitat affinities
- Compile information on protected areas.
  - What areas and resources are protected?
    - Parks, reserves, laws, regulations, zoning
  - How effective is that protection?

Four tasks gathering information:

- Compile information on species occurrences.
  - Point occurrences from research studies
  - Published range maps
  - Site species lists
  - Documented with date/observer/source
- Develop geospatial layers of habitat characteristics.
  - Hierarchical:
  - Related to scales of organisms and local management
  - Useful for regional and global assessments

Modeling: Species distributions based on species habitat relationships

- Inductive - Species habitat models based on data relating species occurrences to geospatial habitat data.

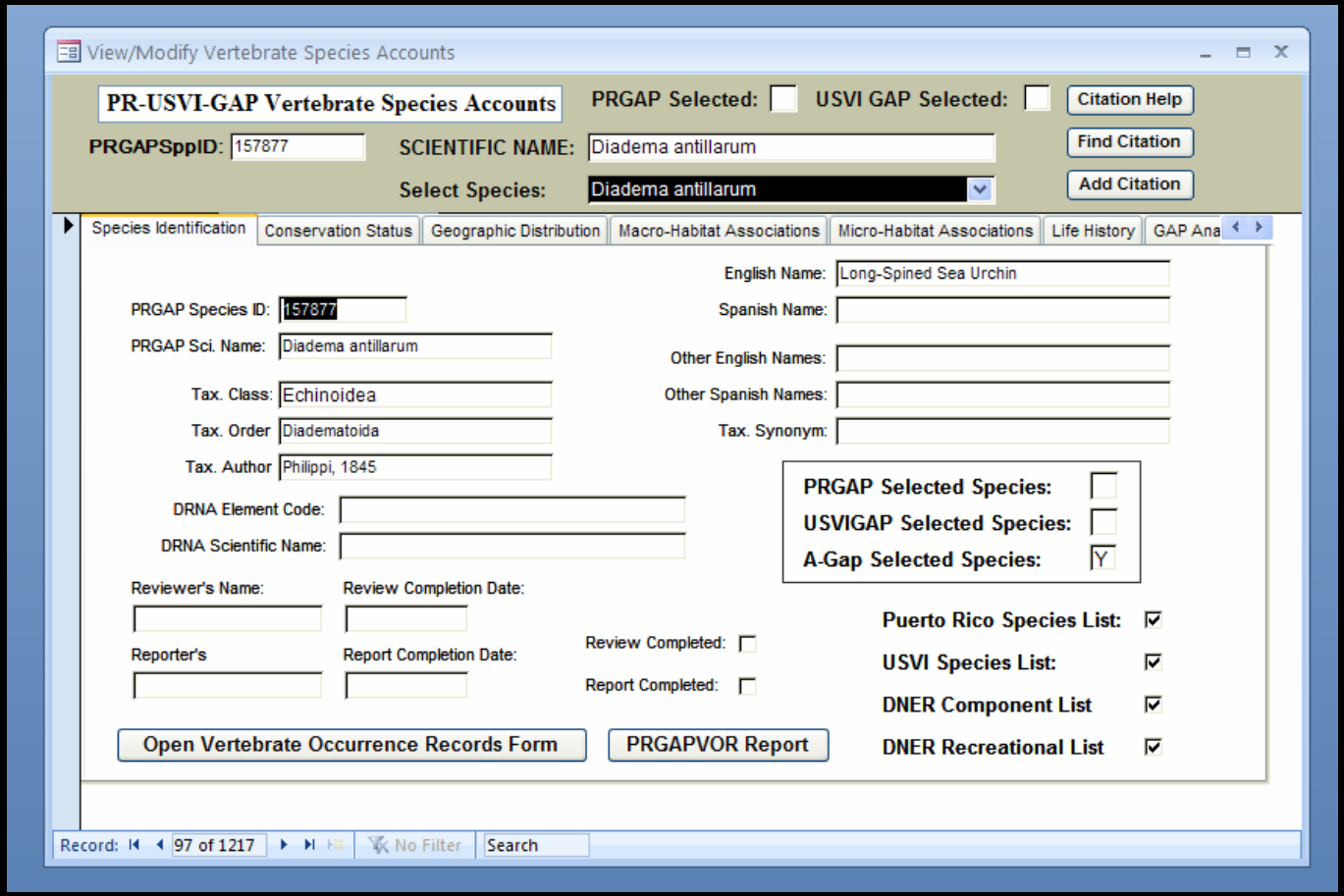
- Deductive – Species habitat models derived from literature and expert opinion based on occurrence of habitat within predicted range of species.

Gap Analysis: To what extent do protected areas overlap with species distributions, habitats of interest, concentrations of biodiversity.

Where are Gaps in conservation?

Aquatic species

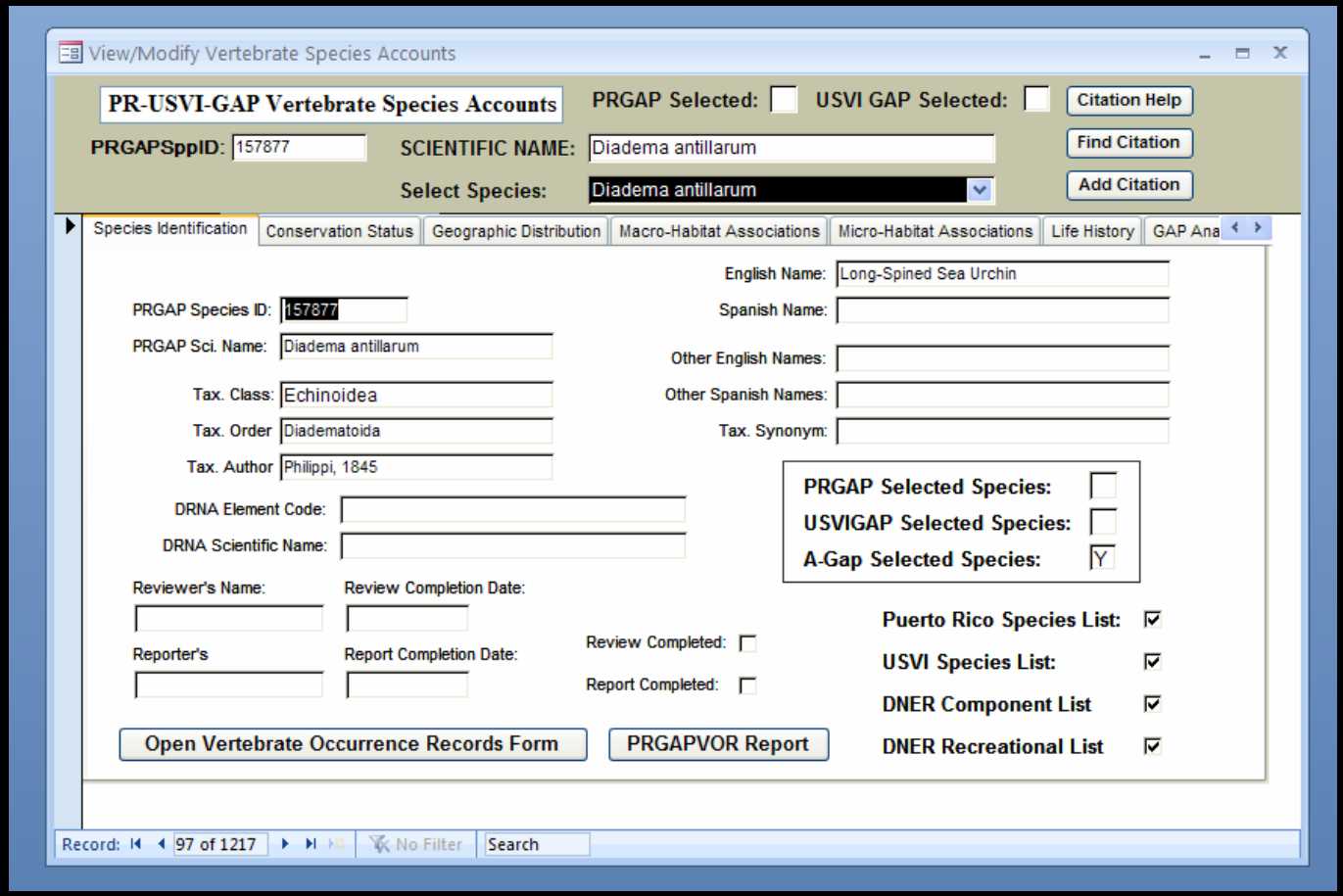
We have complied an annotated list of 846 species associated with aquatic habitats in Puerto Rico and added these to the existing Puerto Rico Gap taxonomic database, which now includes 1217 species.



The database has a number of cross walked identifiers, including scientific and common names and codes related to international biodiversity databases.

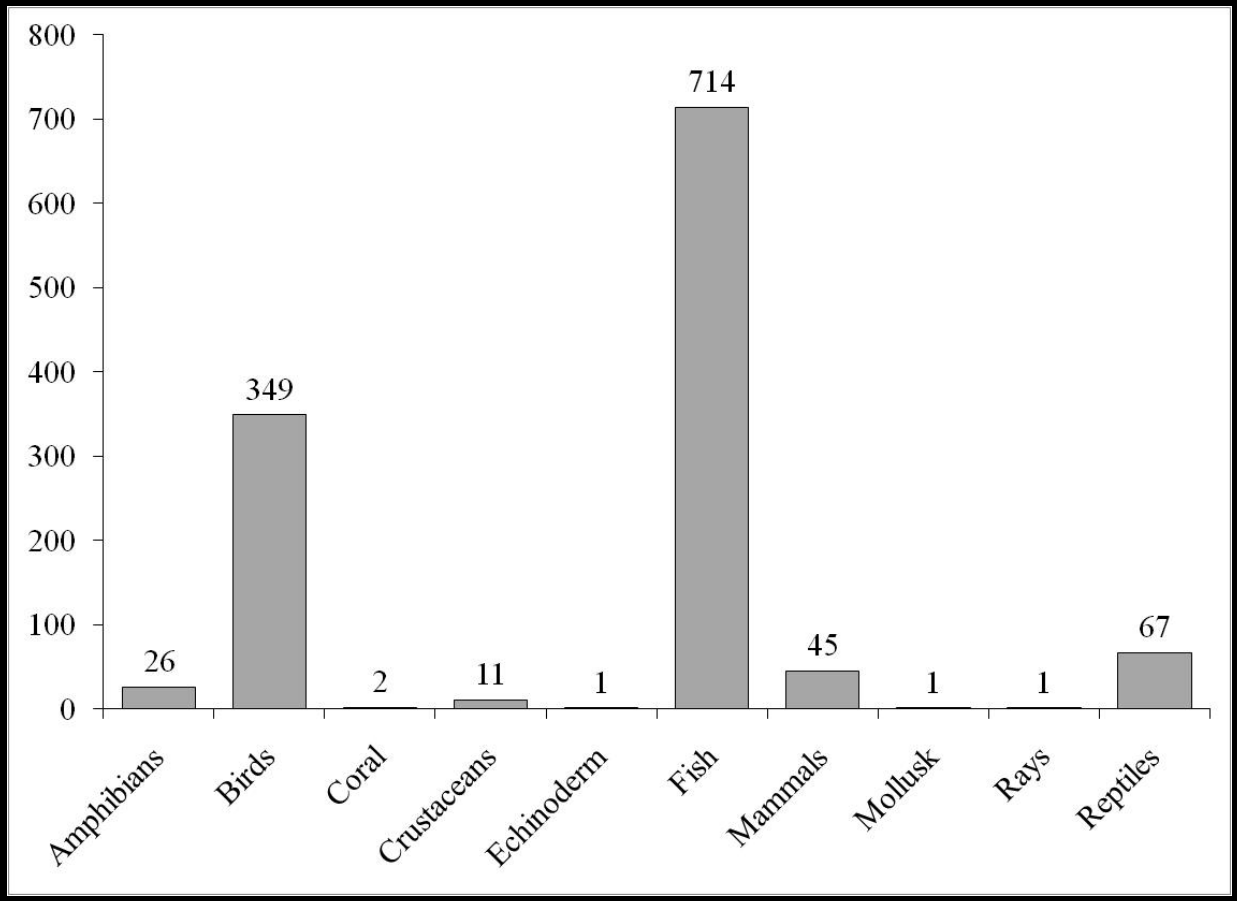
Aquatic species

We have complied an annotated list of 846 species associated with aquatic habitats in Puerto Rico and added these to the existing Puerto Rico Gap taxonomic database, which now includes 1217 species.



This database will contain information on each species taxonomy, conservation status, geographic distribution, habitat associations, life history, and specific threats to conservation.

Aquatic species

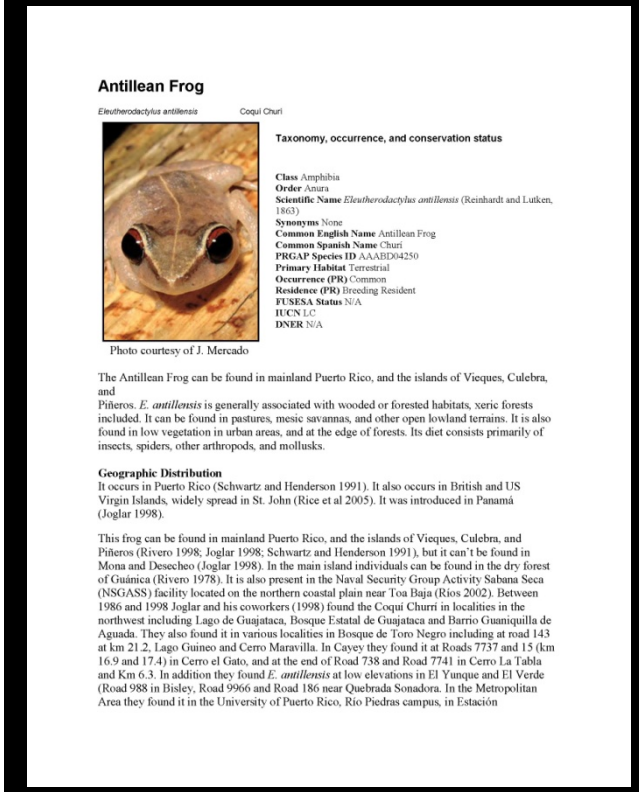


The species associated with aquatic habitats are primarily fishes (714) but include birds (100), marine mammals (9), turtles (7), rays (1), corals (2), crustaceans (11), conch (1), and sea urchins (1).

Aquatic species

From these we have a list of 57 recreational fish species of importance to the Puerto Rico Department of Natural and Environmental Resources (DNER) to include in the *Sportfish Gap* analyses and about 200 aquatic species to include in the *Integrated Gap* analyses.

Species natural history



Antillean Frog

Eleutherodactylus antillensis Coquí Churí

Taxonomy, occurrence, and conservation status

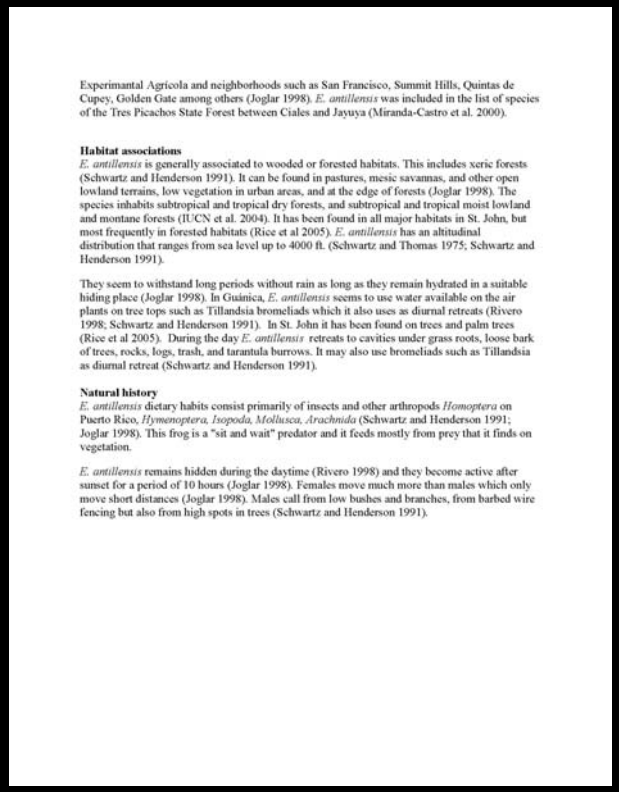
Class Amphibia
Order Anura
Scientific Name *Eleutherodactylus antillensis* (Reinhardt and Lutken, 1863)
Synonyms None
Common English Name Antillean Frog
Common Spanish Name Churí
PRGAP Species ID AAABD04250
Primary Habitat Terrestrial
Occurrence (PR) Common
Residence (PR) Breeding Resident
FUSESA Status N/A
IUCN LC
DNER N/A

Photo courtesy of J. Mercado

The Antillean Frog can be found in mainland Puerto Rico, and the islands of Vieques, Culebra, and
Piñeros. *E. antillensis* is generally associated with wooded or forested habitats, xeric forests included. It can be found in pastures, mesic savannas, and other open lowland terrains. It is also found in low vegetation in urban areas, and at the edge of forests. Its diet consists primarily of insects, spiders, other arthropods, and mollusks.

Geographic Distribution
It occurs in Puerto Rico (Schwartz and Henderson 1991). It also occurs in British and US Virgin Islands, widely spread in St. John (Rice et al 2005). It was introduced in Panamá (Joglar 1998).

This frog can be found in mainland Puerto Rico, and the islands of Vieques, Culebra, and Piñeros (Rivero 1998; Joglar 1998; Schwartz and Henderson 1991), but it can't be found in Mona and Desecheo (Joglar 1998). In the main island individuals can be found in the dry forest of Guánica (Rivero 1978). It is also present in the Naval Security Group Activity Sabana Seca (NSGASS) facility located on the northern coastal plain near Toa Baja (Ríos 2002). Between 1986 and 1998 Joglar and his coworkers (1998) found the Coquí Churri in localities in the northwest including Lago de Guajataca, Bosque Estatal de Guajataca and Barrio Guaniquilla de Aguada. They also found it in various localities in Bosque de Toro Negro including at road 143 at km 21.2, Lago Guineo and Cerro Maravilla. In Cayey they found it at Roads 7737 and 15 (km 16.9 and 17.4) in Cerro el Gato, and at the end of Road 738 and Road 7741 in Cerro La Tabla and Km 6.3. In addition they found *E. antillensis* at low elevations in El Yunque and El Verde (Road 988 in Bisley, Road 9966 and Road 186 near Quebrada Sonadora. In the Metropolitan Area they found it in the University of Puerto Rico, Río Piedras campus, in Estación



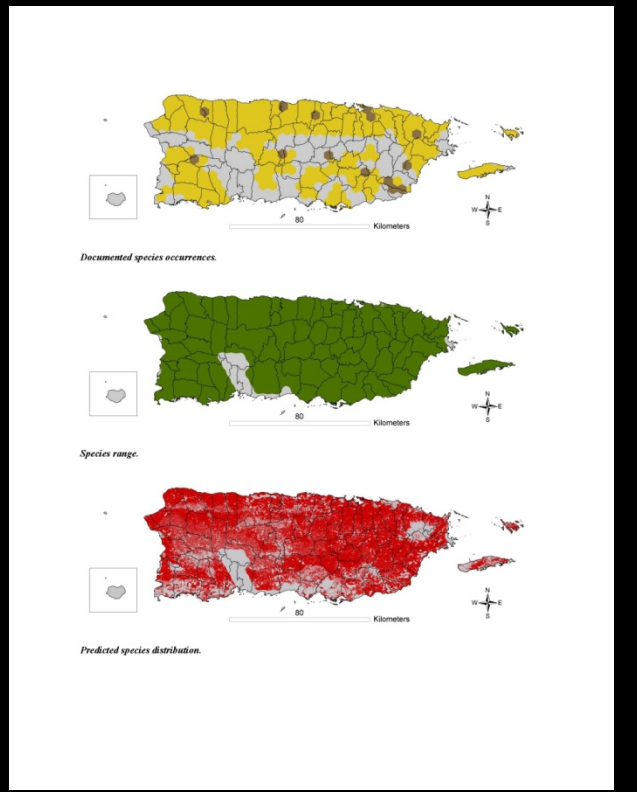
Experimantal Agrícola and neighborhoods such as San Francisco, Summit Hills, Quintas de Cupey, Golden Gate among others (Joglar 1998). *E. antillensis* was included in the list of species of the Tres Picachos State Forest between Ciales and Jayuya (Miranda-Castro et al. 2000).

Habitat associations
E. antillensis is generally associated to wooded or forested habitats. This includes xeric forests (Schwartz and Henderson 1991). It can be found in pastures, mesic savannas, and other open lowland terrains, low vegetation in urban areas, and at the edge of forests (Joglar 1998). The species inhabits subtropical and tropical dry forests, and subtropical and tropical moist lowland and montane forests (IUCN et al. 2004). It has been found in all major habitats in St. John, but most frequently in forested habitats (Rice et al 2005). *E. antillensis* has an altitudinal distribution that ranges from sea level up to 4000 ft. (Schwartz and Thomas 1975; Schwartz and Henderson 1991).

They seem to withstand long periods without rain as long as they remain hydrated in a suitable hiding place (Joglar 1998). In Guánica, *E. antillensis* seems to use water available on the air plants on tree tops such as Tillandsia bromeliads which it also uses as diurnal retreats (Rivero 1998; Schwartz and Henderson 1991). In St. John it has been found on trees and palm trees (Rice et al 2005). During the day *E. antillensis* retreats to cavities under grass roots, loose bark of trees, rocks, logs, trash, and tarantula burrows. It may also use bromeliads such as Tillandsia as diurnal retreat (Schwartz and Henderson 1991).

Natural history
E. antillensis dietary habits consist primarily of insects and other arthropods *Homoptera* on Puerto Rico, *Hymenoptera, Isopoda, Mollusca, Arachnida* (Schwartz and Henderson 1991; Joglar 1998). This frog is a "sit and wait" predator and it feeds mostly from prey that it finds on vegetation.

E. antillensis remains hidden during the daytime (Rivero 1998) and they become active after sunset for a period of 10 hours (Joglar 1998). Females move much more than males which only move short distances (Joglar 1998). Males call from low bushes and branches, from barbed wire fencing but also from high spots in trees (Schwartz and Henderson 1991).



Documented species occurrences.

Species range.

Predicted species distribution.

Compiled in Access database

Used for developing species-habitat models

Available as individual reports

Protected areas

We have identified 201 protected areas (8% of Puerto Rico) that have an aquatic component and developed a database of the attributes of these protected areas.

Protected areas

We have identified 201 protected areas (8% of Puerto Rico) that have an aquatic component and developed a database of the attributes of these protected areas.

Virtually all of the terrestrial protected areas identified in the Puerto Rico Gap project have streams, reservoirs, estuarine, or coastal components so these have been included in addition to marine reserves.

Protected Natural Areas of Puerto Rico

William A. Gould, Maya Quiñones, Mariano Solórzano, Caryl Alarcón, and Michael E. Jiménez
U.S. Department of Agriculture (USDA) Forest Service International Institute of Tropical Forestry (IITF)

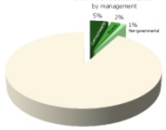
PRGAP ANALYSIS PROJECT
IITF GIS and Remote Sensing Lab
A center for tropical landscape analysis

The protection of natural areas and their ecosystems is an essential step in the conservation of biodiversity and natural resources. These are important elements for a healthy environment and a sustainable future. Protected areas improve the quality of life by providing green spaces for society to enjoy. The effective planning and management of protected areas must attend to local, regional, and global concerns, based on a sound scientific base, provided by research. The conservation of natural resources is a balance of protection, managed use, restoration, and sustainable development.

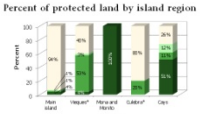
In this map we portray those public and private lands designated for biodiversity conservation in Puerto Rico. The areas have been identified according to ownership and management (not always the same entity) and in terms of the priority of protection given to biodiversity by the management entity. The map is a product of the Puerto Rico Gap Analysis Project, a component of the United States Geological Survey National Gap Analysis Program. The information was primarily gathered through interviews with the protected area management officials and through literature review.

Puerto Rico has an extent of 8938 km^2, and a population of just under 4 million people, which makes the population density approximately 447 people per km^2. Eight percent of Puerto Rico (721 km^2) has some protection for biodiversity conservation. We have identified 114 terrestrial and marine protected areas in Puerto Rico with 13 of them being exclusively marine. Eleven of the 101 protected land areas are divided into 2 or 3 distinct management areas that are managed or owned by different agencies or entities, and may have different levels of protection. The commonwealth of Puerto Rico owns and manages the greatest area of protected lands (58 percent and 57 percent respectively), followed by the federal government (28 percent in both categories) and non-governmental organizations or other private entities (14 and 15 percent respectively). However, non-governmental organizations manage more individual protected land areas than the federal government (38 vs. 7). Just over 1 percent of the island has strong biodiversity protection (e.g., federally designated wilderness areas), 7 percent of the island has an intermediate level of biodiversity protection (e.g., state forests and reserves), less than 1 percent of the island has weak biodiversity protection (e.g., areas of low intensity resource extraction), and nearly 92 percent of the island has no biodiversity protection. Protected areas are concentrated on the high peaks of the Central and Luquillo Mountains, the wetlands of the coastal plains, and the lesser islands and cays of the Puerto Rican Archipelago. These areas are relatively well-protected. Under protected areas include non wetlands of the coastal plain, the karst limestone hills in northwestern Puerto Rico, and the coastal hills and lower slopes. These form an important hydrological and ecological link between the upper mountains, the coastal wetlands, and the near shore marine areas. Connectivity between protected areas is non-existent, making our protected landscape a series of isolated spaces. The lack of ecological corridors weakens the conservation of biodiversity by undermining the movement of species, water resources, and other natural resources.

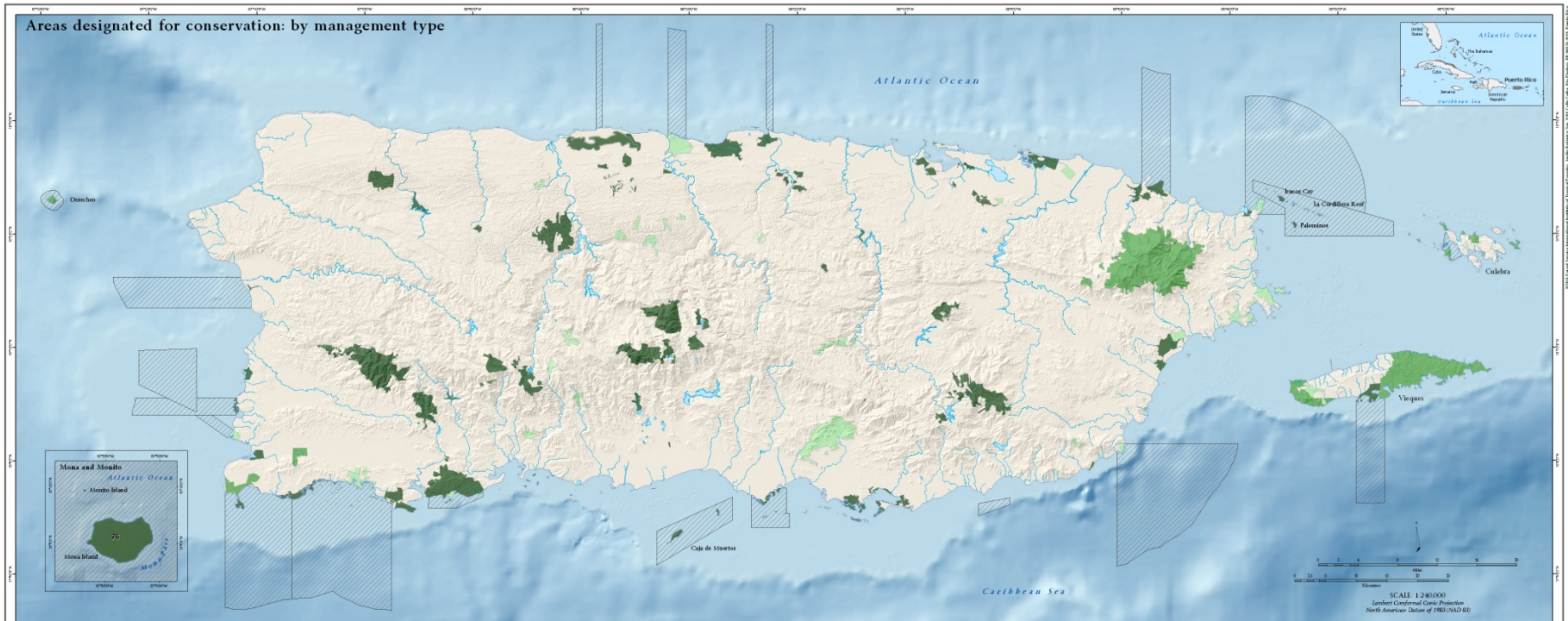
Distribution of protected lands in Puerto Rico



Percent of protected land by island region



Areas designated for conservation: by management type



Protected Areas

1 Adjuntas People's Forest
2 Agricultural Experimental Station
3 Aguas Buenas Caverns and Cave Systems Natural Reserve
4 Aguirre State Forest
5 Belvedere Natural Reserve
6 Belvedere Natural Reserve Marine Extent
7 Boquerón State Forest
8 Boquerón State Forest Marine Extent
9 Boquerón Wildlife Refuge
10 Cabo Rojo National Wildlife Refuge
11 Caja de Muertos Island Natural Reserve
12 Cambalache State Forest
13 Camp Santiago U.S. Military Reservation
14 Camuy River Caves Park
15 Caño La Boquilla Natural Reserve
16 Caño La Boquilla Natural Reserve Marine Extent
17 Caño Martín Peña Natural Reserve
18 Caño Tiburones Buffer Zone
19 Caño Tiburones Natural Reserve
20 Carite State Forest
21 Cartagena Lagoon National Wildlife Refuge
22 Ceiba State Forest
23 Cerrillos State Forest
24 Cibuco Swamp Natural Reserve
25 Cibuco Swamp Natural Reserve Marine Extent
26 Conservation Easement El Rabanal
27 Conservation Easement El Tambor
28 Conservation Easement Foreman
29 Conservation Easement Montes Oscuros
30 Conservation Easement Palmas del Mar Tropical Forest
31 Cueva del Indio Natural Reserve
32 Cueva del Indio Natural Reserve Marine Extent
33 Culebra National Wildlife Refuge
34 Desecheo Island Coastal Waters Natural Marine Reserve
35 Desecheo National Wildlife Refuge
36 Doña Inés Mendoza Urban Forest
37 El Buey National Wildlife Refuge
38 El Convento Caves Natural Protected Area
39 El Tallonal
40 El Yunque National Forest
41 Encantado River Natural Protected Area
42 Espíritu Santo River Natural Reserve
43 Espíritu Santo River Natural Reserve Marine Extent
44 Guajataca State Forest
45 Guánica State Forest
46 Guánica State Forest Marine Extent
47 Guayama Reef Natural Reserve
48 Guaynabo River Natural Protected Area
49 Guillermeti property
50 Hacienda Buena Vista Natural Protected Area
51 Hacienda La Esperanza Buffer Zone
52 Hacienda La Esperanza Natural Reserve
53 Hacienda La Esperanza Natural Reserve Marine Extent
54 Inés María Mendoza (Punta Yeguas) Nature Reserve
55 Jobos Bay Estuary National Research Reserve
56 Jorge Sotomayor del Toro Natural Protected Area
57 Joyuda Lagoon Natural Reserve
58 La Ciénaga Las Cucharillas Natural Reserve
59 La Cordillera Reef Natural Reserve
60 La Olimpia Forest
61 La Parguera Natural Reserve
62 La Parguera Natural Reserve Marine Extent
63 Lago Guajataca Wildlife Refuge
64 Lago La Plata Wildlife Refuge
65 Lago Luchetti Wildlife Refuge
66 Las Cabezas de San Juan Natural Reserve
67 Las Cabezas de San Juan Natural Reserve Marine Extent
68 Las Mesas Peak
69 Las Piedras del Collado Natural Reserve
70 Los Frailes property
71 Luis Peña Channel Natural Reserve
72 Maricao River Natural Protected Area
73 Maricao State Forest
74 Mata de Plátano Field Station Natural Reserve
75 Medio Mundo y Daguao Natural Protected Area
76 Mona and Monito Island Natural Reserve
77 Monte Choca State Forest
78 Monte Guilarte State Forest
79 Nuevo Milenio Urban Forest
80 Old San Juan Aquaduct
81 Pandura Range Natural Protected Area
82 Paraíso de las Lunas Natural Protected Area
83 Piñones State Forest
84 Pterocarpus Forest Natural Protected Area
85 Pterocarpus Forest Nature Reserve
86 Pterocarpus Swamp Forest and Mandry and Santa - Teresa Lakes Natural Reserve
87 Punta Ballenas Natural Reserve
88 Punta Guaniquilla Natural Reserve
89 Punta Guaniquilla Natural Reserve Marine Extent
90 Punta Petrona Natural Reserve
91 Punta Petrona Natural Reserve Marine Extent
92 Punta Tuna Natural Mangrove Reserve
93 Punta Yeguas Natural Reserve Marine Extent
94 Ratones Cay Natural Reserve
95 Río Abajo State Forest
96 Roosevelt Roads transferred lands
97 San Cristóbal Canyon Natural Protected Area
98 San Juan Ecological Corridor
99 San Juan National Historic Site
100 San Patricio Urban Forest
101 Seven Seas Natural Reserve
102 Shapiro property
103 Sun Bay National Park
104 Susúa State Forest
105 Toro Negro State Forest
106 Tortuguero Lagoon Natural Reserve
107 Tourmaline Reef Natural Reserve
108 Tres Palmas Natural Marine Reserve
109 Tres Picachos State Forest
110 University of Puerto Rico Botanical Garden
111 Vega State Forest
112 Vieques Bioluminescent Bay Natural Reserve
113 Vieques Bioluminescent Bay Natural Reserve Marine Extent
114 Vieques National Wildlife Refuge

Administrative: Marine protected areas
Hydrography: Lakes / Reservoirs; Rivers / Streams
Bathymetry (m below sea surface): High : 0; Low : 4608

Protected Land Management in Puerto Rico

Commonwealth
Lands managed by Puerto Rican Government agencies (i.e., Department of Natural and Environmental Resources, Land Administration, National Parks Company of Puerto Rico, and University of Puerto Rico) and municipalities.

Federal
Lands managed by United States federal government agencies (i.e., US Fish and Wildlife Service, US Forest Service, and US National Park Service).

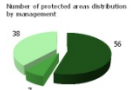
Non-governmental
Lands managed by non-governmental entities (e.g., Casa Pueblo Foundation, Ciudadanos del Karso, Conservation Trust of Puerto Rico, Luis Muñoz Marín Foundation, among other non-profit and private organizations).

Unprotected areas
Lands with no known current legal protection for conservation.

Management classes	Hectares	Percent of protected lands	Percent of island	Number of protected areas
Commonwealth	40,799	57%	5%	56
Federal	20,520	28%	2%	7
Non-Governmental	10,759	15%	1%	38
Protected	72,078		8%	
Unprotected	821,684		92%	

Protected land distribution by management

Number of protected areas distribution by management



Data sources:

Bathymetry: The bathymetric data were derived from the National Oceanic and Atmospheric Administration, National Geophysical Data Center (NGDC), Digital Elevation Model of Puerto Rico, Integrating Bathymetric and Topographic Datasets published in 2006, Boulder, Colorado. The NGDC compiled and integrated high resolution bathymetric, topographic, and shoreline data for selected U.S. coastal regions from various sources, including NGDC, the U.S. National Ocean Service, the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, the Federal Emergency Management Agency, and other federal, state, and local government agencies, academic institutions, and private companies.

Coastline: The coastline data set is mainly based on 2007 digital aerial photographs, with small areas based on 2004 digital aerial photographs, IKONOS and the USGS topographic maps due to geometric errors or range issues in the 2007 photos. The data set was developed by a collaborative effort between the Conservation Trust of Puerto Rico (CTPR) and the International Institute of Tropical Forestry (IITF) GIS and Remote Sensing Lab.

Hydrography: The hydrography dataset was derived and generalized from The National Hydrography Dataset (NHD) published in 2006, Reston, Virginia. The NHD was originated by the USGS in cooperation with the U.S. Environmental Protection Agency, U.S. Department of Agriculture Forest Service (USDA), and other Federal, State and local partners. This data set is presented as vector digital data generally developed at 1:24,000/1:12,000 scale.

Protected areas: Updated from Gould, W.A.; Alarcón C.; Fevold B.; Jiménez M.E.; Martinuzzi S.; Potts G.; Solórzano M.; Ventosa E. 2007. Puerto Rico Gap Analysis Project – Final Report. USGS, Moscow, ID and the USDA Forest Service International Institute of Tropical Forestry, Río Piedras, PR. 159 pp. and 8 appendices. Marine reserves were added from data provided by the Department of Natural and Environmental Resources of Puerto Rico. Some boundaries were updated with more recent data provided by the agency or organization responsible for said areas, while other areas that were missing in the original file were added. The coastline of the original data was updated to match a newer coastline based primarily on 2007 digital ortho-rectified aerial photographs, developed by the IITF GIS and Remote Sensing Lab.

Topography: The elevation data were derived from the USGS National Elevation Dataset (NED) digital elevation model (DEM). This data set is a raster product assembled by the USGS. The NED is designed to provide national elevation data in a seamless form with a consistent datum, elevation unit, and projection. Data corrections are made in the NED assembly process to minimize, but not eliminate artifacts, perform edge matching, and fill sliver areas of missing data. NED has a resolution of one arc-second (approximately 30 meters) for the contiguous United States, Hawaii, and Puerto Rico and a resolution of two arc-seconds for Alaska. The hillshade was calculated using ArcGIS 9.2 and the spatial analyst extension.

Urban centers: This data set was developed by the IITF GIS and Remote Sensing Lab using visual interpretation of existing maps. Each point in the data set represents the approximate urban center for each municipality.

References:

Suggested citation: Gould, W.A.; Quiñones, M.; Solórzano M.; Alarcón C.; Jiménez, M.E. 2010. Protected areas of Puerto Rico. Scale 1:240,000. IITF-RMAP-02. Río Piedras, PR: US Department of Agriculture Forest Service, International Institute of Tropical Forestry.

Acknowledgements: This research was supported by the USGS Biological Resources Division National Gap Program cooperative agreement No. 01HQPG0031 (01-IA-11120101-002), the Puerto Rico GAP Analysis Program, the IITF GIS and Remote Sensing Laboratory and the USDA Forest Service International Institute of Tropical Forestry. Special thanks to Brick Fevold and the Conservation Trust of Puerto Rico, the Puerto Rico Department of Natural and Environmental Resources, William Hernández and the Fish and Wildlife Service, and reviewers for information and critical reviews of this map. This research was conducted in collaboration with the University of Puerto Rico.

Areas designated for conservation: by ownership type

Protected Land Ownership in Puerto Rico

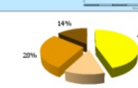
Commonwealth Forests, Parks, Reserves
Protected lands for conservation owned by Puerto Rican government agencies (i.e., DNER, National Parks Company of Puerto Rico).

Commonwealth Institutions, Counties, Utilities
Protected lands for conservation owned by Puerto Rican government institutions, municipalities, and utility companies.

Federal Agencies, Forests, Parks, Reserves
Protected lands for conservation owned by United States government federal agencies.

Non-governmental Organizations
Protected lands for conservation owned by non-profit and private organizations.

Unprotected areas
Lands with no known current legal protection for conservation.



Ownership	Hectares	Percent	Protected areas owned or co-owned
Commonwealth Forest, Reserves and Parks	32,439	45%	40
Commonwealth Utilities	9,242	13%	28
Federal Agencies, Forests, Reserves and Parks	20,308	28%	8
Non-Governmental	10,089	14%	34
Total	72,078	100%	

Protected natural land in Puerto Rico

Preliminary map. This space is going to change

Protected areas designated for conservation
Agriculture reserves
Agriculture valleys

PR Land Use Plan 2006 draft
Suelo Rustico Especialmente Protegido
Other classifications
Especially protected rustic terrain: definition

Wetlands and mangroves
Emergent herbaceous nonsaline wetlands
Emergent herbaceous saline wetlands
Freshwater Pterocarpus swamp
Mangrove forest and shrubland
Salt and mudflats
Seasonally flooded herbaceous nonsaline wetlands
Seasonally flooded herbaceous saline wetlands

Wetlands and mangroves are protected by various local and federal laws. Main law is the Federal law Clean Water Act... etc.

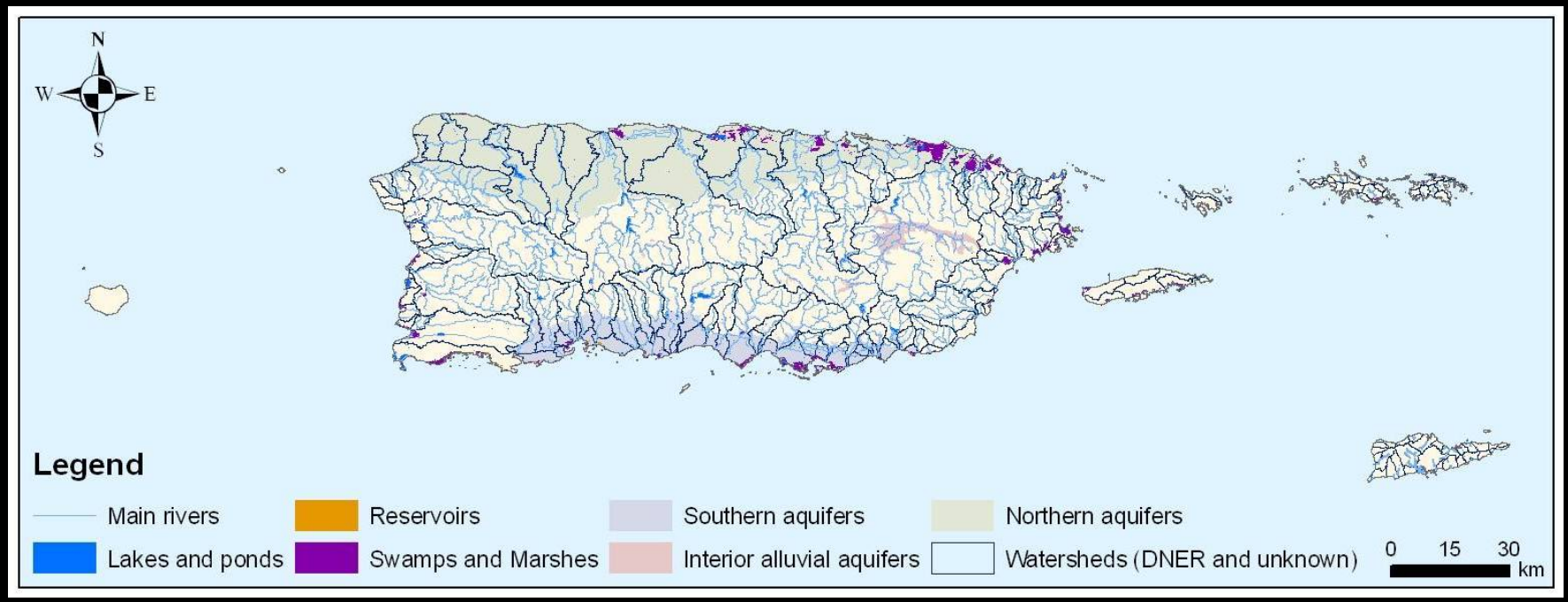
Publication date: Revised Draft August 2010

Aquatic habitats

Goal - Identify habitats from simple to complex classification, capture spatial and temporal variation.

Three main aquatic systems:
Marine, estuarine, freshwater

Aquatic habitats: Freshwater



Main freshwater habitats for Puerto Rico and the USVI. Feature source: Main rivers (Lopez and Villanueva 2007), watersheds of Puerto Rico (delineated by the Department of Natural and Environmental Resources of Puerto Rico), watershed of the USVI (Santiago et al. 1998), lakes, ponds, reservoir, swamps, marshes (USEPA and USGS, 2000).

Stream habitats: Watershed-segment-reach

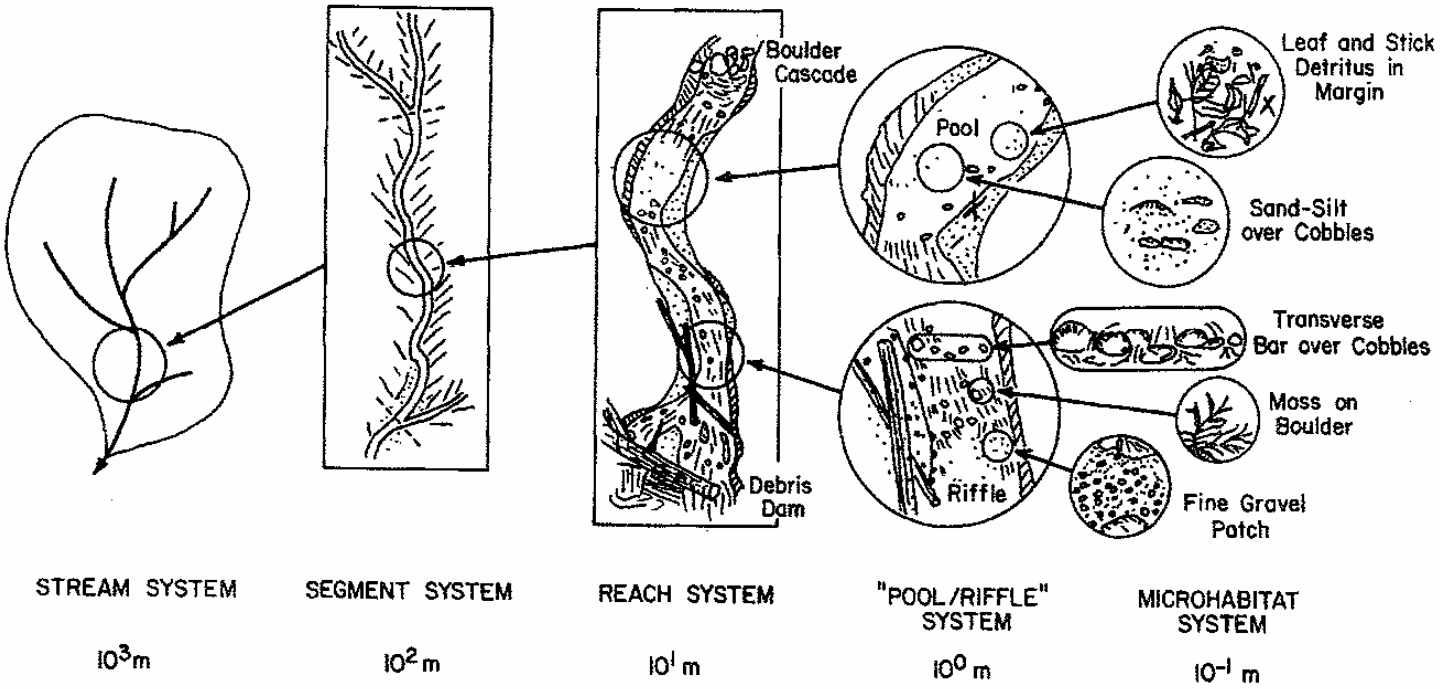


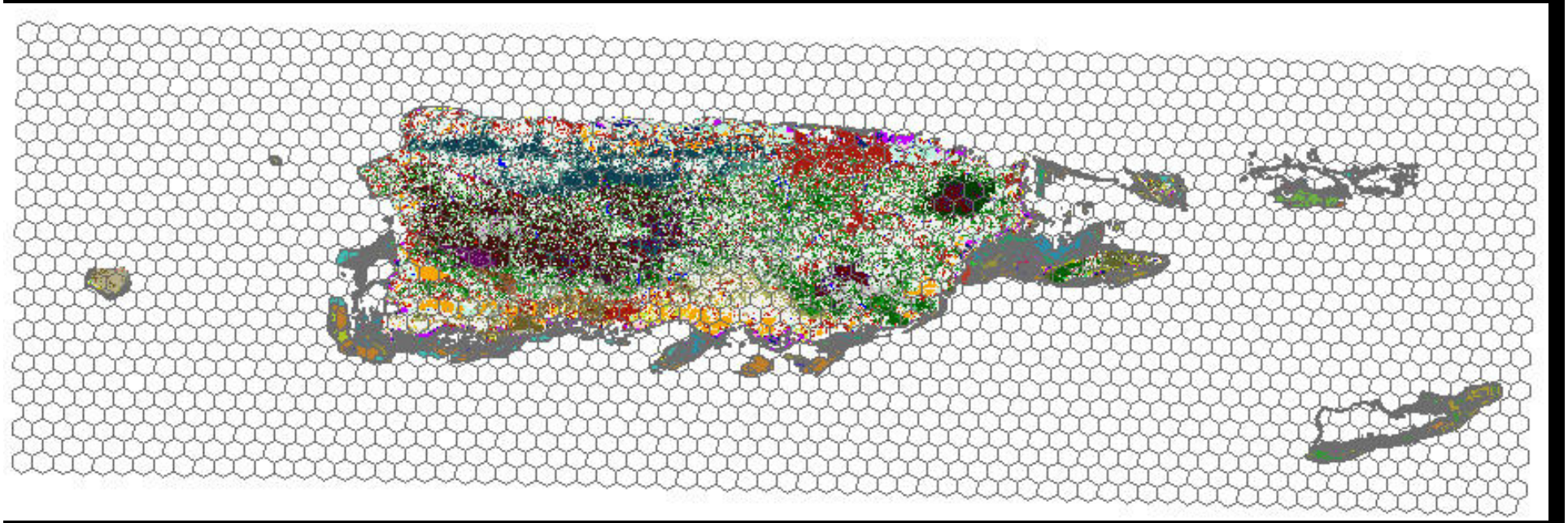
Figure 2. Hierarchical organization of a stream system and its habitat subsystems. Approximate linear spatial scale, appropriate to second- or third-order mountain stream, is indicated.

Frissell et al. 1986: A hierarchical framework for stream classification: viewing streams in a watershed context

Marine habitats

Modeling challenge: Combine geospatial layers that consistently cover the extent of the study with higher resolution information available for specific sites.

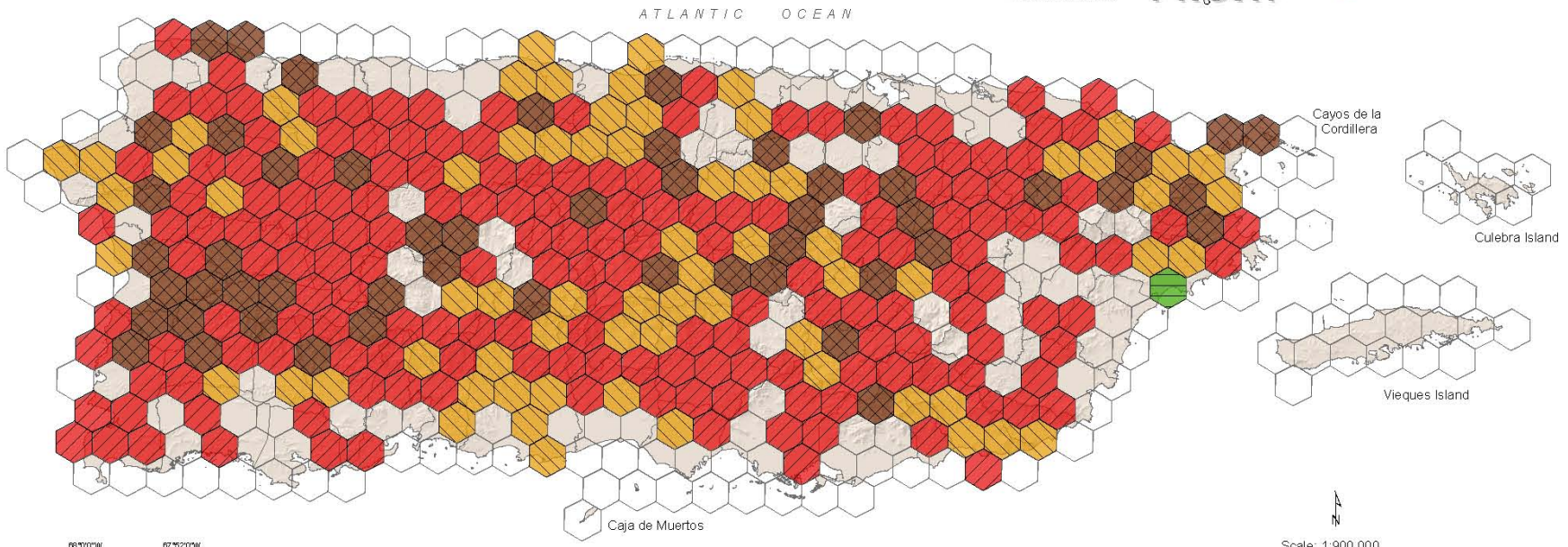
Occurrence data

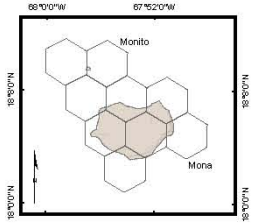


Within hexagon/watershed
Point occurrences from research studies
Published range maps
Site species lists
Documented with date/observer/source

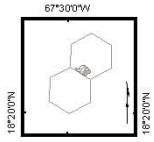
Greater Antillean Oriole

Icterus portoricensis — Calandria Capuchinegra





Mona and Monito



Desecheo

Scientific Name: ***Icterus portoricensis***
Common Name (ENG): **Greater Antillean Oriole**
Common Name (SPA): **Calandria Capuchinegra**
BANDCODE: **GAOR**
Taxonomic Class: **Aves**
Taxonomic Order: **Passeriformes**
Residency Status: **Endemic**
Occurrence Status: **Common**
NatureServe Global Rank: **G4**
Federal U.S. ESA Status: **Not Listed**
PR Natural Heritage Status: **Data Deficient (DD)**

Photo courtesy of Javier Mercado

Confirmed: Confidently assumed or known to be breeding in the hexagon. It includes the following categories: (CN), (NB), (DD), (UN), (NE), (ON), (IP), (NY), (CF), (FL), and (BG).

Probable: Probable breeding based on a set of criteria including a breeding behavior, substatial male singing, couples in breeding habitat, courting and other. Categories included are: (7), (P), (T), (C), (A) and (N).

Possible: Indicates possibility of breeding based on a combination of suitable breeding habitat and occurrence record. Territorial singing is also taken into account. It includes categories: (X) and (H).

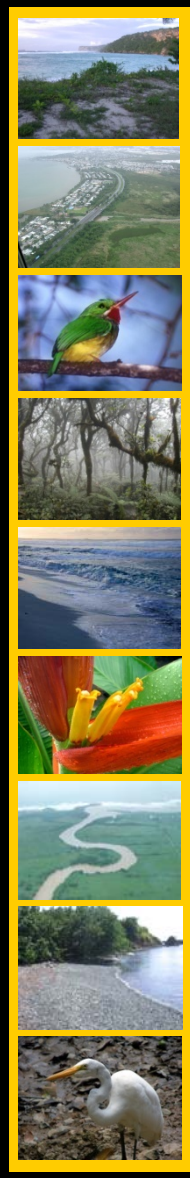
Observed: Species occurrence outside their breeding habitat including independent juveniles. Categories included are: (O), and (J).

Draft product developed by the Breeding Bird Atlas Project in collaboration with the Puerto Rico Gap Analysis Project, U.S. Forest Service, International Institute of Tropical Forestry, GIS Remote Sensing Laboratory. Contact Joe Wunderle at (787) 888-3673, William Gould or Mariano Solórzano at (787) 766-5335, or José Salguero at (787) 853-4617.

Breeding Bird Atlas Map — Map Date: **July 9, 2009**

IITF GIS and Remote Sensing Laboratory

Center for Tropical Landscape Analyses



Collaborations needed

Occurrence data

Reviews

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