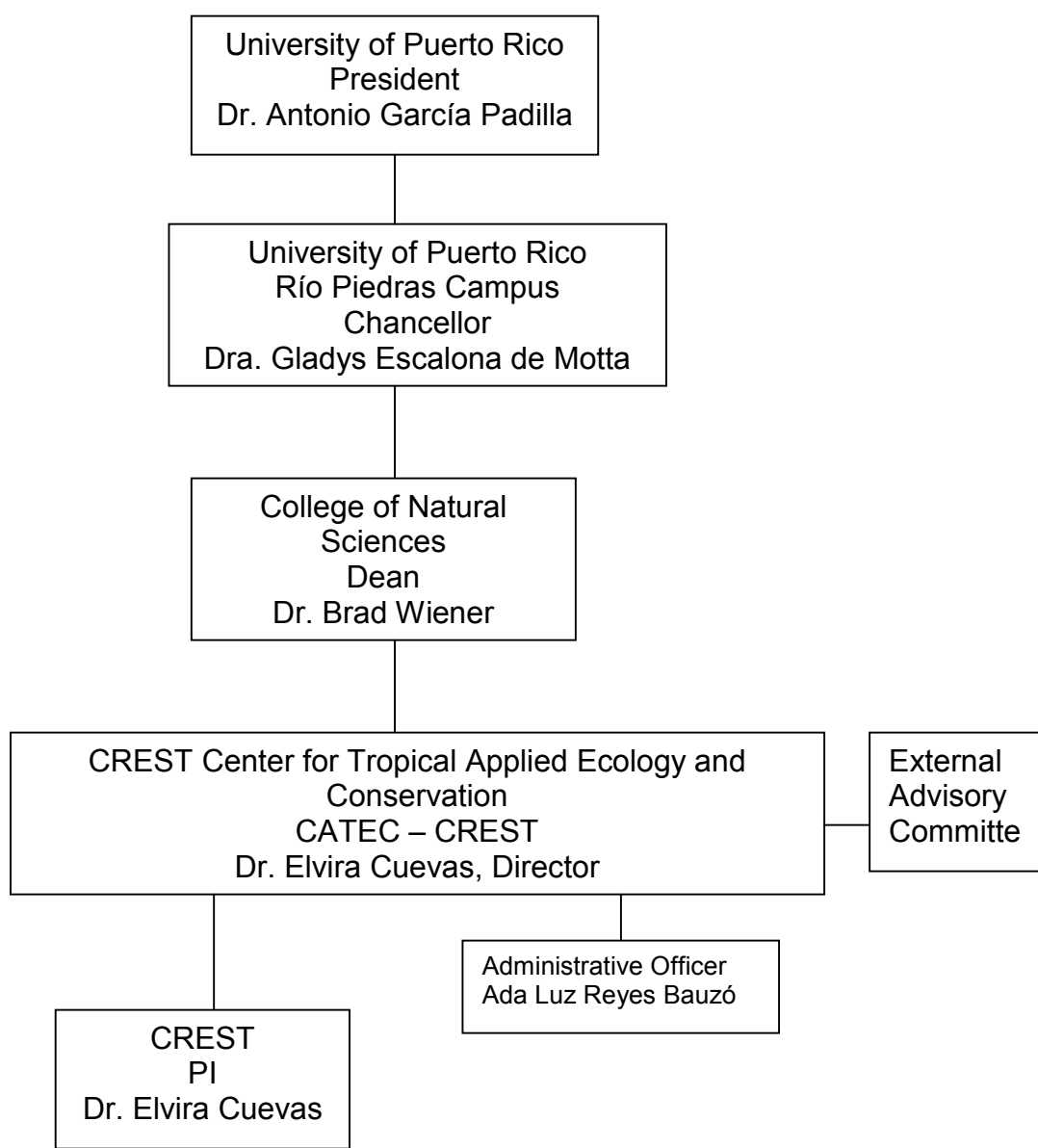


**ANNUAL REPORT OF CREST-CATEC: SEPTEMBER 1<sup>ST</sup>, 2002 – AUGUST 31<sup>ST</sup>,**

**I.PROJECT PARTICIPANTS:**

**I.1. PARTICIPANTS BY THRUST AREA: ALREADY IN PARTICIPANTS VIA FASTLANE**

**I.2. ORGANIZATIONAL CHART OF THE CENTER**



**PRESIDENT/CHANCELLOR'S STATEMENT ON CENTER:**

The President's letter will be sent by the Office of External Resources of the university before May 30<sup>th</sup> via fax and by mail.



May 13, 2003

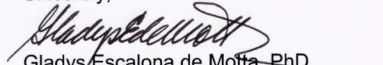
Dr. Victor Santiago  
CREST Program Director  
Division of Human resource Development  
National Science Foundation  
4201 Wilson Boulevard, Room 815  
Arlington, Virginia 22230

Dear Dr. Santiago:

I am pleased to write this letter of support for the CREST Center for Tropical Applied Ecology and Conservation (CATEC-CREST), under the direction of Dr. Elvira Cuevas. As Chancellor of the Río Piedras Campus of the University of Puerto Rico, I express my full support to the Center, which I believe has already shown excellent progress in its establishment and development.

I fully endorse the continuation of the CREST grant and will continue to allocate the established 25% of the matching funds required by NSF during the rest of the four-year duration of the grant. The Central Administration of the UPR System will contribute the other 75% of the matching funds as established in the letter of November 14, 2001.

Sincerely,

  
Gladys Escalona de Motta, PhD  
Chancellor

UNIVERSIDAD DE PUERTO RICO  
Recinto de Río Piedras  
Oficina de la Rectora

PO Box 23300  
San Juan, PR 00931-3300  
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787-764-0000, Exts. 2424, 3240  
Fax 787-764-8799

Patrón con Igualdad de Oportunidades en el Empleo M/M/V/I

### **I.3 DIRECTOR'S NARRATIVE OF THE CENTER'S MAJOR ISSUES:**

The Center started by Mid-November, 2002 as the monies from NSF and the matching funds from the UPR Central Administration and Río Piedras campus became available at that time. Ms. Ada Luz Reyes was hired as Administrative Officer so that the administrative aspects could immediately be established. The Dean's Office and the department of Biology were instrumental in providing funds on loan before November in order to proceed with the hiring of Ms Reyes, buying a computer, and providing research money to Dr. Carla Restrepo for her summer fieldwork. In the last seven months the following activities have been done:

- 1 – hiring of postdoc, students and lab technicians
- 2 - purchasing of equipment, materials and supplies
- 3 – establishing the arrangements for the payment of academic time for Dr. Tremblay and summer salary for Dr. Fernández to UPR, Humacao campus
- 4 – administrative work for field work in Mona Island
- 5 – working on establishing a memorandum of understanding between UPR – Rio Piedras and PR – Department of Environment and Natural Resources.
- 6 – gathering information on the computing and data management needs of the the CREST component in order to hire a computer data manager/system specialist
- 7 – advising and being an active part in the recruitment of researcher for the Institute of Tropical Ecosystem Studies, for which CATEC-CREST will provide the startup funds this coming August from its matching funds.
- 8 - general administrative work related to the activities of the thrust areas.

We have been very successful in the short time the Center has been active, however there are issues that need to be addressed. Although we have the full support of the Chancellor, Dean of natural Sciences, and the heads of the Department of Biology and ITES, the administrative part of the University is a constant source of problems. Both Ms Reyes and I have to spend a considerable amount of time just dealing with petty problems related to hiring of students,

payment of fees, and transfers of monies from one account to another. The system is outdated, and very conservative so it takes between 3-4 months, sometimes more, for the Finance Office to clear whatever orders or requests are done. That includes equipment purchase, payment of students, personnel, etc. The Chancellor is cognizant of the situation and has promised a short-term solution to it. As we have piggy-backed on research studies that have been going on for a while, there has been equipment and facilities available. However, as the Center expands and more research needs are added, the slow and excessively bureaucratic functioning of the finance and accounting office will have a deleterious effect on the short and medium term outcomes of the grants. Proposed solution: to have a person in accounting and finance offices of the University exclusively in charge of processing external funding finances, and to review and establish a more stream-lined and time and cost effective way of doing the administrative procedures.

Technically, the research groups involved are well equipped and CREST is providing extra support to improve the research facilities. We still have to develop the data base system for the Center but once the data/system manager is hired we will have a web page plus development of a database and effective interactive feedback with researchers and university web system. There are also problems in maintaining an up-to-date access of information of reference sources. The Natural Science library is well equipped and is improving the electronic access to references for students and academics. The problem lies that the scientific journals used by the newly recruited academics in ecology are not in the library and, due to financial cuts at the general administration level, the library is short of funds. Proposed solution: get supplemental funding to cover the costs of paper and electronic subscription to the journals.

Personnel-wise the Center will benefit with the hiring of an officer in charge of identifying new sources of funding, helping in grant writing and working along with the system/data manager and administrative officer. The matching funds do not provide for this person so I have to identify sources of funding for

the hiring of personnel. Proposed solution: get supplemental funding to hire this resource.

The fourth thrust area of CREST, ecosystems ecology, is still in the process of being developed. Dr. Cuevas's lab will be built and set up between the end of this year and mid 2004.

The Center is presently located in my provisional office and an extra small office where the Administrative Officer is located. It is expected that by late this year the Center will be provided with offices located in the third floor of Facundo Bueso building.

**I.4. CURRENT CENTER ADVISORS: the first external advisory committee meeting will be held after the first year of activities.**

External Advisory Committee members CATEC-CREST:

Robin Chazdon, PhD: University of Connecticut – tropical plant ecology – [chazdon@uconnvm.uconn.edu](mailto:chazdon@uconnvm.uconn.edu)

Deborah Clark, PhD: University of Missouri – St Louis – tropical forest conservation and management – [daclark@sloth.ots.ac.cr](mailto:daclark@sloth.ots.ac.cr)

Larry Gilbert, PhD: University of Texas, Austin – Evolutionary biology and economical entomology – [LGilbert@mail.utexas.edu](mailto:LGilbert@mail.utexas.edu)

Ariel A. Lugo, PhD: USDA Forest Service International Institute of Tropical Forestry – ecosystem ecology and forest restoration dynamics – [alugo@fs.fed.us](mailto:alugo@fs.fed.us)

Javier Francisco Ortega, PhD: Florida International University – molecular genetics and island biogeography – [ortgaj@fiu.edu](mailto:ortgaj@fiu.edu)

Daniel Simberloff, PhD: The University of Tennessee – [dsimberloff@utk.edu](mailto:dsimberloff@utk.edu) – Conservation biology and island biogeography

Peter Vitousek, PhD: Stanford University - ecosystem processes and island ecosystems- [vitousek@leland.stanford.edu](mailto:vitousek@leland.stanford.edu)

**I.5. BIOGRAPHICAL INFORMATION OF NEW INVESTIGATORS:** Not applicable at this moment

## I.6. Accomplishments

**Seminars, Symposia and workshops:** The faculty and students made a total of 13 presentations, of which 5 were students' presentations. They were given both in-campus, nationally and internationally. Below is a list of the seminars:

Alceste, Carla and Cuevas, Elvira. Determinación de nutrientes limitantes en un bosque secundario y una sabana secundaria del mosaico sucesional de Altos de Pipe, Venezuela. Primeras Jornadas de Divulgación Científica del Centro de Ecología del IVIC. December 5-6, 2002.

Cuervo, Andres. La fragmentación de habitat incrementa los niveles de asimetría fluctuante en aves tropicales de montaña. First Symposium of Biology Graduate Students, UPR-RP. San Juan, PR. March 2003.

Cuevas, E. Efecto de especies arbóreas en procesos biológicos de suelo. Seminario de Biología, UPR, Río Piedras. September 4, 2002.

Cuevas, Elvira. Annual Symposium on Long-term Ecological Research in Puerto Rico. January 18 - 20, 2003, Río Piedras, Puerto Rico. Plenary talk.

Cuevas, Elvira. El mosaico sucesional del IVIC: Un modelo para estudios interdisciplinarios ecológicos. Primeras Jornadas de Divulgación Científica del Centro de Ecología del IVIC. December 5-6, 2002. Plenary talk.

Delgado, Johanna. Museum collections as useful resource for assessing patterns of diversity: Amphibians and the threatened karstic region of Puerto Rico. First Symposium of Biology Graduate Students, UPR-RP. San Juan, PR. March 2003

Hanson, Timothy. Bayesian Methods with Applications to Problems in Ecology. Savannah River Ecological Lab. Aiken, SC

Hanson, Timothy. Bayesian Methods with Applications to Problems in Ecology. University of Georgia. Athens, GA.

Medina, Ernesto and Cuevas, Elvira. Bosques tropicales sobre suelos calcáreos: Ecofisiología de la nutrición y el balance hídrico de especies arbóreas.

Primer simposio de investigaciones en el Karso. September 2002,  
Bayamón, Puerto Rico.

Sustache, José, Carla Cortés, Elvia Meléndez-Ackerman, Susan Aragón, Mariely Morales, Denny Fernández and Miguel García. Characterization of the plant diet of introduced pigs and goats in Mona Island Reserve, Puerto Rico. -Annual Symposium of Flora and Fauna of Puerto Rico, University of Puerto Rico – Humacao. May, 2003.

Sustache, José , Carla Cortés, Elvia Meléndez-Ackerman, Susan Aragón, Mariely Morales, Denny Fernández and Miguel García. Characterization of the plant diet of introduced pigs and goats in Mona Island Reserve, Puerto Rico. Botanical Society of America -July 2003.

Tremblay, Raymond and Durrell Kapan. Dispersal in an Orchid metapopulation. Dispersal in fragmented landscapes, Université catholique de Louvain, Louvain-la-Neuve Belgium. March 2003.

Rodríguez, Rodney. Diversidad de mariposas en la cuenca de la quebrada La Tula, Puerto Rico: Diversidad morfológica y heterogeneidad especial. First Symposium of Biology Graduate Students, UPR-RP. San Juan, PR. March 2003

Elvira Cuevas, the Center Director, also participated as Discussion leader of the Forest and savanna ecosystems group in the Workshop on Nitrogen fluxes and processes in tropical and temperate systems held in Ubatuba, Sao Paulo, Brazil on March 15-18, 2003.

Drs. Denny Fernandez and Elvia Melendez-Ackerman each attended technique-oriented workshops this semester in their specialty areas. Dr. Fernandez attended the workshop titled 'Molecular Techniques in Microbial Ecology', offered by the RUI-Microbial Observatory at the University of Puerto Rico at Humacao; and Dr. Melendez-Ackerman attended the workshop 'Molecular markers: microsatellites and AFLP' offered by the ICBR Core Facilities at the University of Florida Gainesville.

### **I.7. International activities**

Elvira Cuevas has ongoing collaboration with Drs. Francisco Herrera and Ernesto Medina, Centro de Ecología, Venezuelan Institute for Scientific Research (IVIC) in Caracas, Venezuela. This collaboration encompasses research activities in Venezuela as well as development of new research in the Karst region of Puerto Rico. In this last effort the USDA Forest Service International Institute of Tropical Forestry will also be involved, with the participation of Drs. Ariel Lugo, Ernesto Medina (adjunct scientist) and Grizzelle González. The Center will be developing international activities during the next years and the plans are to be able to establish collaborations, student and faculty exchanges, publications and short courses. The Center Director will be attending a scientific Congress in Salvador, Brazil during the week of June 19 where contacts will be made with faculty from the Universities of Sao Paulo and Rio de Janeiro for this purpose. We are also in conversations with Dr. Sandra Diaz from Universidad de Cordoba in Argentina and Dr. Holm Tiessen from Gottingen University in Germany.

Dr. Eugenio Santiago has also established collaborations with the National Botanical Garden of the Dominican Republic. *Goetzea* is also found in Hispaniola, where it is very rare. Colleagues of this institution are collaborating with Dr. E. Santiago in a project to determine the taxonomic boundaries of the species in this genus.

### **I.8 Description of Shared facilities within the CREST framework.**

The Sequencing and Genotyping Facility, under the supervision of Dr. Owen McMillan, is a core research facility designed to allow students and researchers access to state-of-the-art sequencing and genotyping equipment. In addition, the facility is charged with creating essential infrastructure for archiving, manipulating and analyzing large molecular data sets. The facility was recently upgraded with the arrival of a new capillary-based automated DNA sequencer (MegaBACE™ 1000) and Li-Cor NEN Global DNA Analyzer System and Odyssey Infrared Imaging System. The MegaBACE is a high throughput



sequencer and genotyper and will be instrumental in the characterization and development of the microsatellite loci that are cornerstone of the core MEEG projects. The Li-Cor DNA Analyzer and Imaging systems was purchased specifically for our genotyping needs. The Li-Cor software and LIMs support for analysis of microsatellite or Amplified Fragment Length Polymorphisms (AFLP) data is excellent and will allow researchers to easily manage the large molecular datasets generated over the course of this proposal.

One of the most important contributions to research infrastructure of this proposal was continued growth and development of core genomic facilities at the University of Puerto Rico, Rio Piedras. Specifically, we were able to use this project as leverage to secure additional funds for growing and integrating the UPR-RP's Genotyping and Sequencing Facility. We have recently (2003) added a high-throughput DNA Sequencer and additional genotyping equipment that greatly increases our ability to collect high-resolution molecular data. In addition, we have secured funding to purchase key computer hardware and software to better manage and analyze large molecular genetic projects. Both these expansions are essential for the success of the CATEC's Molecular Ecology, Genetics, and Evolution Program. Although NIH provide the primary funding, NSF-CREST computational support will be essential for integrating and managing hardware and software components of the facility. In addition to allowing CREST researchers to collect high-resolution molecular data, the expanded Sequencing and Genotyping Facility is critical for attracting new researchers and new research funding.

### **1.9 Plans for future collaborations with other Centers.**

There are plans for collaboration with CEA-CREST in California State University, Los Angeles. We have identified common research interests and will develop ways to come together via students, research, symposia and workshops.

## **II. ACTIVITIES AND FINDINGS**

## II.1. ACTIVITIES:

Thrust area 1: Molecular ecology, evolution and genetics. Component 1:  
Demography and population biology of Hawksbill turtles.

Research activities at this stage have mainly focused on preparing for the August-January 2003 field seasons. Preparations have including (1) developing a database of tissue and blood samples, (2) perfecting genomic DNA extraction techniques, (3) testing and optimizing available microsatellite resources for hawksbill turtles, (4) in collaboration with DNER establishing a volunteer program help with “in-water” and “nesting” surveys, and (5) purchasing key research equipment, including satellite transmitters, for field research.

We are making good progress. Our database is finished and extraction techniques are robust for all but the toughest tissue. We have tested 8 turtle loci previously identified, all of which work well on our samples and show varying levels of polymorphism within the Mona aggregation. We are currently using them to test for evidence of multipaternity in 18 nests. In addition, we are developing a volunteer program using some of the available CREST resources, including outreach activities targeting other PR universities, PR-based conservation organizations, and mainland US universities. Importantly, we have attracted a new graduate student, Ms. Ximena Vélez, who will begin research next fall. She is a key addition to the project and will coordinate field and lab components of the project.

In the coming year, we will:

- 1) Tag and collect tissue and blood samples for genetic analysis from a large proportion of the juvenile and male hawksbill populations.
- 2) Tag and collect tissue and blood samples for genetic analysis from a large proportion of nesting females.
- 3) Collect tissue and blood samples from a series of focal nests.
- 4) Use satellite telemetry to track residence males throughout the year.
- 5) Finish paternity analysis and begin large-scale genotyping of breeding males
- 6) Submit grants to state, federal, and NGO conservation organizations for continued research support.

Thrust area 1: Molecular ecology, evolution and genetics. Component 2: Reproductive Biology of the Mona Rock Iguana.

Research activities to date have focused on (1) radio telemetry & sample collection (in the field), (2) development of a database of tissue & blood samples, and (3) perfecting genomic DNA extraction techniques in the lab.

Since late February PhD. Student Nestor Pérez spearheaded 5 weeks of fieldwork on Mona with three assistants from UPR and critical support from Department of Natural Resources and Environment (DNER). To date he has captured 17 adult iguanas (5 males & 12 females). Twelve animals were fitted with external radios. All of animals were weighed & measured (SVL, length tail). In addition, we injected subcutaneous pit-tags in the tail. Blood samples (2 ml) and tissue samples (dorsal spines and nails) were collected from each individual and preserved in appropriate buffer solutions. In March, we collected the first ecological data of the radio marked iguanas. Specifically, we measured the home range and made behavioral observations of the radio-marked individuals interacting with their neighbors. Finally, we have already established a group of students from UPR that will help us in the most critical field period on July and October.

For our fieldwork in the coming field season we will:

- 1) Tag and collect tissue and blood samples for genetic analysis from a large proportion of the iguana populations on the focal study sites, to establish individual genotypes of focal females & their potential mates.
- 2) Radio-mark of 30 more iguanas to
  - a) facilitate identification of marked females and their nesting sites
  - b) map home range and social associations between males & females
  - c) monitor habitat use of the radio-marked individuals across seasons
- 3) Collect blood and/or tissue of the offspring of females to determine their microsatellite fingerprints for paternity analysis.
- 4) Submit grants to state, federal, and NGO conservation organizations for continued research support

In laboratory during this spring we have cataloged our blood & tissue collection and have successfully optimized our DNA isolation protocol from blood samples (put numbers here) and soon we expect to have collected enough DNA to build the iguana microsatellite library (initial tests will begin with our Microsatellite Enrichment Workshop this summer) further work will continue with the library constructed at the workshop or with Genetic Identification Services if the workshop library does not produce sufficient variable loci.

Our lab work for the next six months will include

- 1) continued extraction, quality assessment & archiving of DNA from individual iguana blood & tissue collections.
- 2) We will begin & finish the development and sequencing of the microsatellite library (see Microsatellite procedures).
- 3) Once this library is completed we will begin to determine individual genotypes at several to many microsatellite loci for all individuals in the study area.

Thrust area 1: Molecular ecology, evolution and genetics. Component 3: Metapopulation Biology of Riperian Orchids: Laboratory work over this period was focused on the development of an enriched microsatellite library. Genomic Identification Services has recently completed the library and we proceed with the development of highly polymorphic markers. These markers will be key for estimating gene flow among focal populations. We have continued to collect data in the field on the dynamics of the metapopulation, including extinction and recolonization and population dynamics and recolonization. We have now completed four years of field research. Drs. Kapan, Tremblay and Melendez-Ackerman presented a poster on colonization and extinction rates at an international conference. With four years of data on metapopulation dynamics we are starting to get stabilization and consistency in the parameters and patterns appear to be consistent consequently we can feel confident that we have true metapopulation.

In the coming year, we will

- 1) Develop a database of plant tissue

- 2) Perfect genomic DNA extraction techniques
- 3) Test and optimize available microsatellite resources for the orchid
- 4) Continued data collecting of population dynamics in the field
- 5) Collect data on the spatial distribution of the metapopulation structure
- 6) Collect data on light environment of the individual populations
- 7) Collect data on ecological parameters of all populations (moss cover, aspects, etc).

We finished and published a draft of our laboratories web page (McMillan's Lab Web Page). The page includes, as part of our major research focus the CREST Molecular Ecology, Evolution, and Genetics Program and associated projects. It was designed to advertise research and training opportunities associated with the MEEG program.

Thrust area 2: POPULATION ECOLOGY: Effects of exotic species on native insular biotas. Component 1: Effects of exotic ungulates on the native vegetation of Mona Island Reserve, Puerto Rico

This particular project is on track to achieve the goals it set up for the first year:

1. Biological reference collections of Mona Island vegetation for Plant Ecology studies. These collections include: a) a voucher collection of dry specimens of all Mona Island species to be deposited at the University of Puerto Rico Rio Piedras Herbarium (UPRRP). To date 74 have been collected and processed; b) a digital replica of the voucher collection to be worked through the digitalization project of the UPRRP-Herbarium which is part of 'The Virtual Herbarium Project' of the New York Botanical Garden and is funded by the Mellon Foundation. To date 350 have been processed (522 expected). Processed data has been delivered to NYBG information system staff for publication at their web site; c) a digital collection of epidermal tissue of all species in Mona Island. This collection will be helpful at identifying microscopic samples of plant tissue in ongoing studies of ungulate diets. To date, the collection has 120 micrographs for 20 species (a total of 60 species

will be done by this summer). d) a collection of digital photos of seeds/fruits of all plant species of Mona. The need of this collection was not determined a priori but rather preliminary results from one of the studies pointed out to the need of such collection. A new undergraduate student will be hired for this purpose this summer.

2. Permanent transects for biodiversity studies at Depression Forest sites in Mona Island. Three 250 m transects were established between November 2002 and January of 2003 and baseline data has been collected for a number of parameters including 1) tree species at fixed points (GIS marked) along the transect, plant species composition and herbivory detection at the understory, reproductive and herbivory phenology at the canopy level around these points, canopy light environment by analysis hemispherical digital photos of canopy cover, continuous measurements of temperature and relative humidity and presence and absence of feces of the three large herbivore species (goats, pigs, endemic iguana). Two studies are currently have been developed around these transects. The first one directed by Dr. Denny Fernandez looks at the extent of spatial heterogeneity in plant diversity, canopy structure and two environmental parameters (temperature and relative humidity). To finish data collection in the first study we are planning to establish a fourth transect at a different forest site (outside the depressions) to serve as control. We expect this transect to be completed by the end of August 2003. The second project directed by Dr. Elvia Melendez-Ackerman looks at the relationship between indicators of herbivory (vertebrates and insects) activity with spatial and temporal vegetation traits at the understory and canopy levels through monthly censuses that are expected to take place for at least a year and a lower frequency census scheme on the second year depending on the data results. Data collected includes plant diversity and density at the understory level at permanent points, vertebrate activity through presence and absence of fecal samples at these points, plant phenology, herbivory (vertebrates and insects), recruitment, leafing, fruiting and flowering. Both studies will provide a

general characterization of the forest habitat of depression forest sites, information on the potential interplay between microclimate parameters and herbivore activity on plant density, composition as well as information on which plant species (native and otherwise) may be more susceptible to the action of herbivores at this site. See abstracts below for preliminary results. An additional study on the relationship between herbivore diversity and plant composition is expected to commence in July 2003 under the direction of Dr. Alonzo Ramirez (ITES) when we expect to have completed all the necessary purchases for this study. A study of soil characteristics is also expected to start by September of 2003 under the direction of Dr. Grizzelle González (IITF).

3. Stomach samples of feral ungulates for diet studies. We have finished this year's collection of stomach samples of exotic ungulates for studies of the plant diets of these animals. The work was done in coordination with the DNRE and taking advantage of their hunting season that lasted from January to March of 2003. Sample size was more than adequate for goats (N = 92) but not for pigs (N = 18). Therefore, future efforts on this regard will concentrate on increasing stomach sample size for pigs during the 2004 hunting season. We are currently processing samples for identification of plant species and preliminary results will be presented by Jose Sustache at the Annual Symposium of Flora and Fauna of Puerto Rico at the University of Puerto Rico, Humacao and was submitted to the Botanical Society of America meeting to be held in Mobile, Alabama in July 2003 by Carla Cortes (see abstracts below). This has truly been a team effort and most participants of the projects are co-authors in all this as well as the previously described projects.

4. Study on differential nutritive values of plant species. Data results of previously described studies is critical to the initial identification of those species that may be susceptible to consumption by these animals. Once we have accomplished this goal, we can begin to explore if and why some species may be more susceptible than others to animal consumption. One way to accomplish that this is by performing bromatological studies of different

focal plant species to determine potential differences in nutritive values among them. This study is expected to begin in August of 2003 when we should have enough data to guide us as to which species may be more suitable for analysis. This study will be led by Dr. Denny Fernandez. The nutrient analyses will be done in collaboration with Dr. Francisco Herrera of the Plant eco-physiology laboratory, Instituto Venezolano de Investigaciones Cientificas in Caracas, Venezuela.

5. Purchasing and Set up of Meterological Station. We are in the process of purchasing a state-of-the-art meteorological station for the Island of Mona with satellite-mediated data access. The station should provide continuous data on temperature, precipitation, relative humidity, solar radiation, and wind speed and direction as experienced in the center of the Island. These data will be invaluable for determining the extent by which variability in climate is related to our focal biological responses. CREST researchers as well as the scientific community in general will be able to access these data through our web page (currently under construction). We expect purchasing of the station to be completed by July 2003.

Thrust Area 2: Population Ecology, Component 2: Effects of an introduced visitor, Africanized bee, on reproductive success of the endangered tree species *Goetzea elegans*.

All areas where *Goetzea elegans* populations exist has been sampled for presence of Africanized bees. The Africanization has been assessed by use of mtDNA haplotypes based on RFLP of PCR products determined on agarose gels. We also have determined defensiveness of 12 of samples 25 colonies, after establishing these colonies in standard commercial hive boxes, and bringing them to an estimated colony size of 20K bees.

Thrust area 3: Landscape ecology: Multimodality in body size: an integrative approach to understand the effect of land-use change on tropical animal assemblages.



The proposed research had three main components: 1) the collection of field data on birds (Colombia) and amphibians (Puerto Rico) in order to obtain estimates on fluctuating asymmetry and body size. 2) the consolidation of two databases through literature reviews on body size of Colombian birds and Caribbean amphibians. Through the development of the project, a third group of organisms was included, represented by butterflies of the Caribbean, and Puerto Rico in particular. 3) the development of quantitative tools to detect multimodal patterns in the distribution of biological variables and to describe landscape complexity. The first component is almost completed (75%), remaining some few visits to the field in Puerto Rico and also lab measurements based on specimens/structures collected in the field or housed in collections worldwide. The second component is mostly completed (80%) and we need to undertake a last literature review to identify endangered species in both regions. The third component is underway (30%). The UNM team has identified some tests and approaches that could be used to statistically identify multimodal distributions in biological variables. The UPR-RP team is working towards rewriting the code of a program that used an alternative method for identifying multimodal distributions in body size of organisms. This is in collaboration with Dr. Paul Marples. In addition, the UPR-RP team is writing the code to analyze digital elevation models (and other kind of surface data) to describe landscape structure. This is in collaboration with Dr. Fernando Lozano at the Universidad de Los Andes, Colombia.

In addition to the research goals, subproject III will serve as the seed to establish the Large-Scale Ecology Lab at UPR-RP. Three important components include having a GIS Specialist, establishing minimum computer facilities, and the renovation of the Lab. Of these, two and three are supported through CREST. The GIS Specialist was hired. The computer facilities involve mostly the help of a system administrator to establish an intranet network that makes use of a server obtained through setup funds. As the CREST system administrator is hired the computer related facilities will be up and running. Meanwhile, we are getting help from other sources within the University.

## **FINDINGS:**

Thrust area 2, component 1: “Effects of exotic ungulates on the native vegetation of Mona Island Reserve, Puerto Rico”

The following abstracts of presentations summarize preliminary results up to-date.

A) Characterization of the plant diet of introduced pigs and goats in Mona Island Reserve, Puerto Rico. José Sustache, Carla Cortés, Sofía Olivero, Elvia Meléndez-Ackerman, Susan Aragón, Mariely Morales, Denny S. Fernández, Miguel García. 2003.

The introduction of feral ungulates (i.e. goats and pigs) is one of the most common and impending threats to the biodiversity of island biotas around the world. Introduction of these animals to Mona Island, a dry forest Reserve located between the islands of Puerto Rico and Hispaniola occurred 500 years ago by Spanish settlers. While some data suggests that these animals may regulate some plant communities in the island, a detailed characterization of the diet of these animals is lacking. Current management of populations of these animals include a three month hunting season coordinated by the Department of Natural Resources and the Environment (DNRE) of Puerto Rico. We used this management strategy as an opportunity to directly characterize the plant species that make up the diet of these animals. This information could be valuable in identifying those species that might be most susceptible to herbivory by these animals. Preliminary results indicate that many plant species do appear in the stomach of these animals including species highly toxic secondary compounds (e.g. *Euphorbia petiolaris*) and an endangered cactus endemic to the island (*Harrisia portorricensis*). Surprisingly “toxic” species were found in unusually high frequencies in stomach samples (47 %) suggesting that perhaps these animal populations may have evolved mechanisms to deal with the presence of such compounds in their plant diets. Additional studies will be needed to test this hypothesis.

B) Spatial Ecology: Spatial pattern analysis and related ecological processes.

Denny S. Fernández. 2003. Plant Biology Symposium, University of Puerto Rico at Utuado

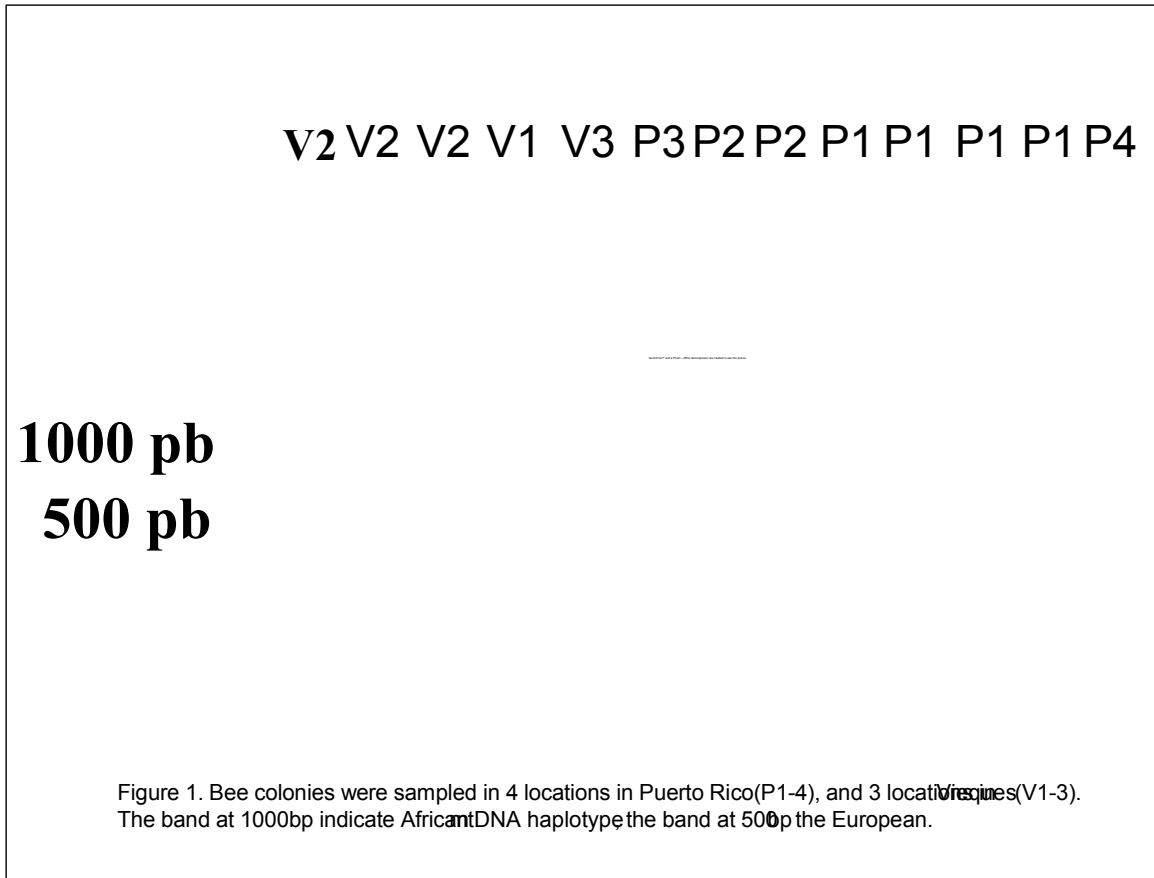
The first set of data from the permanent transects have been analyzed using geostatistics procedures (semivariance) in order to detect spatial patterns on several community related variables (number of plant species, density of shrub and tree individuals, density of animal feces). The variograms indicate that the number of plant species and individuals reach their maximum differences between points at distances above 50 m. With these results we can determine the minimum distances to establish independent vegetation study areas (i. e. enclosures) within each depression forest. The presence of animal feces seems to be independent at distances as short as the minimum distance between measuring points within the transects (15 m). However the density of animal feces are usually very low or nil, affecting the power of the analysis. Pooled data from several visits will be analyzed to verify this preliminary results. Moreover, information from new visits and more variables (canopy characteristics and light environment, seedling density, leaf, flower and fruit production, herbivory damage) will be used to complete the analysis of spatial patterns to reach more solid conclusions.

Thrust area 2, component 2: Effects of an introduced visitor, africanized bee, on reproductive success of the endangered endemic tree species *Goetzea elegans*.

1. Determined that the bird *C. flaveola* is not a robber of nectar, and is a pollinator of the rare tree *Goetzea elegans*,
2. *Apis mellifera* carries out some pollination, this being the first documentation of the exotic Honeybee pollinating an endangered species in Puerto Rico.
3. THRUST AREA: Population Ecology. Component 2: Effects of an introduced visitor, Africanized bee, on reproductive success of the endangered tree species *Goetzea elegans*.

All areas where *Goetzea elegans* populations exist has been sampled for

presence of Africanized bees. The Africanization has been assessed by use of mtDNA haplotypes based on RFLP of PCR products determined on agarose gels. The results indicate 100% matrilineal Africanization in feral colonies (See Figure 1 and Table 1).



	VIEQUES	PUERTO RICO
A	13	25
E	3	0

Table 1. Numbers of Africanized (A) and European (E) bee colonies in samples from Vieques and Puerto Rico. The European bee colonies are from a commercial beekeeper in Vieques. Other samples are from feral colonies.

We also determined defensiveness of 12 of sampled 25 colonies, after establishing these colonies in standard commercial hive boxes, and bringing

them to an estimated colony size of 20K bees. This study demonstrated that in Puerto Rico the undesired highly defensive behavior of Africanized bees is less frequent. Only 2 of 12 colonies tested exhibited high defensiveness characteristic of Africanized bees (See Table 2). Should Goetzea population management strategies be based on using introduced Africanized bees as pollinators defensiveness may not present a large problem.

	High defensiveness	Varroa
+	2	15
-	10	0

Table 2. Presence of high defensiveness as determined in standard colony manipulation, and presence of Varroa mites, a natural enemy of the honey bee, as determined by capture on sticky traps.

Future research is to examine the reasons behind reduced defensiveness of Africanized bees in Puerto Rico. Alternative hypotheses are that 1) there is genomic introgression of European alleles into the Africanized bees, altering their defensiveness, and 2) africanization in Puerto Rico may represent a more restricted representation of African genotypes due to a more severe "bottle-neck" during invasion of the island. These hypotheses lead to different predictions in relation to population genetic structure. We will test these predictions by means of established genomic population markers (microsatellites), and demonstrate presence or absence of European genomic introgression. Also African gene diversity will be directly compared to published results from continental populations.

**Summarize outstanding accomplishments  
(nuggets for general public use).**

We have demonstrated Africanization of honey bees in Puerto Rico to be complete, and extending into the Island of Vieques. However, we also demonstrated that only a small fraction of Africanized colonies in Puerto Rico exhibit the high defensiveness associated with Africanized bees in other places.

### II.3. TRAINING AND DEVELOPMENT

#### Thrust area 1:

Curriculum Development: Developed new graduate courses to teach students important concepts/techniques in population biology and genetics. These courses included Metapopulation Dynamics (Spring, 2003), taught by Dr. R. Tremblay and Landscape Genetics (planned, Fall 2003) taught by Drs. W. O. McMillan and D. Kapan. Both courses were designed to train students in emerging concepts and methods in population biology and conservation. The Landscape Genetics course, in particular, has been conceived as a hands-on course on how to integrate high-resolution molecular and ecological datasets and will include workshops the generation and analysis of microsatellite data within the context of landscape dynamics.

We will run a two-week summer workshop on microsatellite enrichment strategies in June 2003. The two-week workshop is designed to 1) teach students how to make genomic libraries enriched for microsatellite repeats, 2) how to screen these libraries, and 3) how to select and optimize microsatellite loci. The workshop will utilize new core equipment within UPR's Sequencing and Genotyping Facility.

#### Thrust area 2

1. Diversity of faculty and senior personnel. This project so far has involved a large number of senior personnel (i.e. faculty and specialists) that belong to underrepresented groups. Five of seven senior personnel involved in the project are Puerto Ricans (two females, three males), one is Venezuelan and one is Peruvian.

2. Students. Carla Cortes was funded through REU funds to an REU site Grant (DEB-991234) from Jan 2003-April 2003 after which she began funding with this grant. Her undergraduate research collaboration has resulted in one presentation at a regional meeting and her abstract has been submitted for a poster in national meeting this summer. She has applied to the program

"Increasing diversity at the annual Botanical Society of America meeting," for travel funds. The program is supported by the National Science Foundation (Undergraduate Mentoring in Environmental Biology (UMEB)).

3. Student recruitment. We currently support two graduate and five undergraduate students with funds from this project. Both graduate students (Susan Aragon, Mariely Morales) are graduating in May 2003. Mariely will be hired as the project technician starting in July 2003. Susan will be replaced by Jose Fumero, a graduate student that will be starting in the Biology Ph. D. Program in August 2003. We are currently recruiting for a second graduate student. We are in the process of hiring additional undergraduates for the summer which will elevate the total of undergraduates to 7 during the summer period. Seven of the eight students currently supported are Puerto Ricans.

4. Collaboration with program that promote the participation of women in science. Dr. Denny Fernandez is a collaborator as mentor of the NSF-ADVANCE Institutional Transformation program in UPR-Humacao. This program promote the participation and advancement of women in natural and social sciences. Next semester Drs. Cuevas and Melendez-Ackerman will participate as speakers in seminars for the program's participants (faculty and students).

5. Incorporation of research information in undergraduate courses. Dr. Denny Fernández is part of the Wildlife Management program in UPR-Humacao and teaches regularly General Ecology and ecology related courses for undergraduates, and beginning this semester he has incorporated in his courses information on the background, design and results of this project. For next semester he plans to develop course-context activities about the main theme of this project: the effect of exotic species in native biota.

Thrust area 2, component 2:

1. Two undergraduate students has been integrated to the molecular population genetics component of our project. Charito Orengo and Gabriel Lugo have been trained in DNA extraction, PCR, RFLP, AFLP,

electrophoresis techniques in analysis of *Goetzea* populations and honey bee populations. Charito Orengo has applied successfully to the Master's program at the University of Puerto Rico Department of Biology.

2. This project is providing professional development for Mr. Marcos Caraballo. Part of this project will be Mr. Caraballo's Masters thesis project. We anticipate that Mr. Caraballo will be presenting his work in public meetings during next year. Next year, we intend to have two undergraduate students of the PRLS-AMP Program assisting in the project. This will provide an opportunity to learn different aspects of the research process.

3. Dr. David Ziegler from the University of Illinois at Urbana-Champaign, has been invited to offer a summer field course in plant ecology to the graduate students in the CREST-CATEC program. The course will be offered in English, however students will be able to interact with the prominent researcher in Spanish. The co-PI, Dr. Giray will organize and host the activity.

4. Field technician Manuel Mercado was sent to a training course on climbing trees in Germany. This will facilitate collection of population samples of bees in this project. Technician J. Manuel Mercado, a member of a minority group, is now better equipped for future employment or education in ecology and conservation.

5. Our current molecular technician, Alberto Galindo, decided to apply for Ph.D. program in order to be involved in *Goetzea* molecular genetic work. Alberto Galindo has been accepted by the graduate program at the Department of Biology, he will start his Ph.D. work in August 2003.

Thrust area 3.

1. Development of new courses:

Carla Restrepo, UPR-RP developed one new course and one new seminar to foster cross-scale thinking among UPR-RP students and faculty. The 6 credit graduate course (Large-Scale Ecology: Landscapes, Processes, and Diversity) was taught in the Fall of 2002 and included weekly lectures and labs. The labs emphasized the use of large databases (in addition to field work to



gather data) to address ecological questions and of GIS and remote sensing techniques. The 3 credit graduate seminar (Conservation, Allometry, and Fluctuating Asymmetry) involved directed discussion of topics that would provide the foundations for writing two review papers. In both instances, the PI at UPR-RP put special attention in developing the oral and written skills of the students, and their creativity. This has led to good class projects that will be presented at meetings and/or submitted for publication in the near future.

2. Contributions to the development of human resources at the postdoctoral, graduate, undergraduate, and pre-college levels.

Currently, there is (1) Ph. D. and (3) M. Sc. being supported directly through CREST-III. One of the M. Sc. students will complete her degree in the Fall of 2003. I am using an Independent Study course (Rotacion) to identify entering graduate students that potentially represent a good match for the lab. There are plans to integrate up to 2 undergraduate students into the research during the new academic year pending the renewal of the lab.

#### **II. 4. OUTREACH ACTIVITIES**

1. Cooperative Agreement between UPR-Rio Piedras and the DNRE – We are establishing a formal cooperative agreement between the University of Puerto Rico-Rio Piedras and the Department of Natural Resources and the Environment (DNRE) that will facilitate research at the Mona Island Site for this project, foster training of local students in areas related to Wildlife Management and Conservation and encourage collaborations between researchers at these Institutions. The document has been drafted by CREST PI Dr. Elvira Cuevas, UPR-Rio Piedras Chancellor and is pending for signature by the Secretary of DNRE.

2. Puerto Rico Department of Natural and Environmental Resources/U.S. Fish & Wildlife Service: Dr. Santiago's main research project under CREST revolves

around the reproduction and genetics of a Federally Endangered species, *Goetzea elegans*. After performing the experimental phase on pollination, plant material propagated will be used for recovery activities outlined by the Fish & Wildlife Service. Some of the the activities will include the establishment of ex situ populations of *G. elegans* in protected lands. In addition, the proposed research on genetic diversity of *G. elegans* will provide these agencies baseline data on genotypes that of top conservation priority.

## II. 5. Awards

Students:

Andres Cuervo, Society for Conservation Biology ,Travel Award ca \$1200,  
04/01/03

Johanna Delgado, EPSCoR, Fellowship, 08/01/02-12/31/02

## II.6. Summary of minutes of external advisory group meetings:

There have been no meetings yet as the Center started on September 1<sup>st</sup> 2002.

## III. Publication and Products

Not applicable at the moment

## IV. 1-3. Development of human resources; submitted directly to CREST

### IV.4.

NSF support by thrust area and other activities

Thrust area	Current year	9/1/03 – 8/31/04
1 -MMEG	320,638.00	333,524.00
2 -PEG	303,239.00	280,360.00
3 - LEG	327,062.00	318,080.00
4 - ECG	-	-

### IV.5 Level of complementary support for this year from collaborating institutions: estimated dollar equivalent

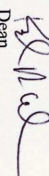
DNRE	USDAFS IITF	STCB	IVIC
\$15,000	\$1,000	N/A	\$2,000

**V. Cost-share certification and statement of funds to remain un-obligated at the end of the current CREST project year.**

UNIVERSITY OF PUERTO RICO - RIO PIEDRAS  
 CENTER OF RESEARCH EXCELLENCE IN SCIENCE AND TECHNOLOGY (CREST)  
 FORECASTS (SEPTEMBER 1, 2002 TO AUGUST 31, 2003)

	NSF FUNDS		FORECAST		BALANCE AVAILABLE	UPR FUNDS		FORECAST		BALANCE AVAILABLE
	NSF FUNDS	SPENT TO MAY 15, 2003	FROM 5/16/03-8/31/03	AVAILABLE		UPR FUNDS	SPENT TO MAY 15, 2003	FROM 5/16/03-8/31/03	AVAILABLE	
PERSONNEL										
A. SENIOR PERSONNEL/YEAR	28,247	0	28,247	0	0	27,303	9,994	17,309	0	
B. OTHER PERSONNEL	106,880	29,331	56,173	21,376	21,376	50,010	10,244	8,791	30,975	
C. RESEARCH ASSISTANSHIP AND STIPEND	95,856	25,009	51,676	19,171	19,171	59,500	4,723	12,000	42,777	
FRINGE BENEFITS	55,316	6,233	38,020	11,063	11,063	28,743	4,028		24,715	
EQUIPMENT	11,000	9,301		1,699	1,699	5,500	9,812		(4,312)	
TRAVEL	36,300	6,682	22,338	7,260	7,260	3,000	0		3,000	
PARTICIPANT COST	23,484	0	18,788	4,696	4,696	25,845	0		25,845	
MATERIALS AND SUPPLIES	189,476	60,692	90,889	37,895	37,895	40,000	2,190		37,810	
PUBLICATION COSTS	12,000	0	9,600	2,400	2,400	0	0		0	
CONSULTANT SERVICES	46,227	0	36,982	9,245	9,245	0	0		0	
SUBAWARDS	85,213	26,932	41,239	17,042	17,042	0	0		0	
OTHER	24,900	0	19,920	4,980	4,980	0	0		0	
INDIRECT COSTS	285,101	32,496	195,585	57,020	57,020	0	0		0	
TOTAL	1,000,000	196,676	609,777	193,547	193,547	239,901	40,991	38,100	160,810	

  
 Director CA TEC-CREST

  
 Dean  
 College of Natural Sciences

The budget for the coming year stays the same as specified in the proposal. Supplemental funding will be discussed with Dr. Santiago, NSF CREST Program Director.