**Biodiversity report for the 50 hectares of rain forest of parcel 11A of Sector Rincon Rain Forest of Area de Conservacion Guanacaste.**

**A report by Guanacaste Dry Forest Conservation Fund to the Pearson Group**

**10 March 2011**

**History and antecedents.**

As part of the growth and development of the portion of Area de Conservacion Guanacaste (ACG) (Fig. 1) covering the rain forest-covered northeastern side of Volcan Rincon de la Vieja in northwestern Costa Rica, the Guanacaste Dry Forest Conservation Fund (GDFCF) a California-based US 501.c.3 (http://www.gdfcf.org) that is the official international NGO for ACG, has been purchasing private forest land for ACG since 1998. Please see the description of this ten year process at the historical web site at http://janzen.bio.upenn.edu/caterpillars/RR/rincon_rainforest.htm.

In 2008, it was decided to extend the Sector Rincon Rain Forest to include the full extent of the remaining adjacent rain forest (Fig. 1), leading to the web site at http://janzen.bio.upenn.edu/saveit.html.

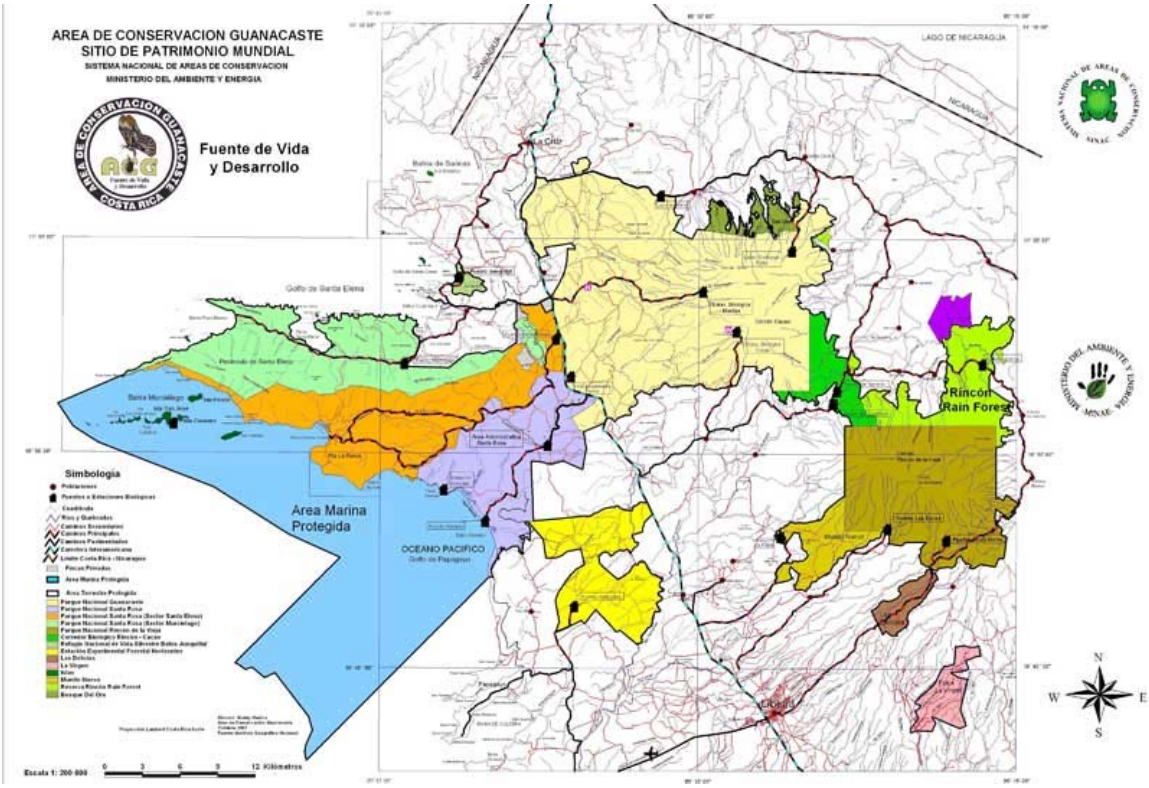

Figure 1. Area de Conservacion Guanacaste (ACG) with the anticipated Sector A expansion (dark purple) at the northern end of Sector Rincon Rainforest in 2008.

This expansion to the north of property 88 was first called Sector A, and then (today) is simply known as the northern part of Sector Rincon Rain Forest (Fig. 2).

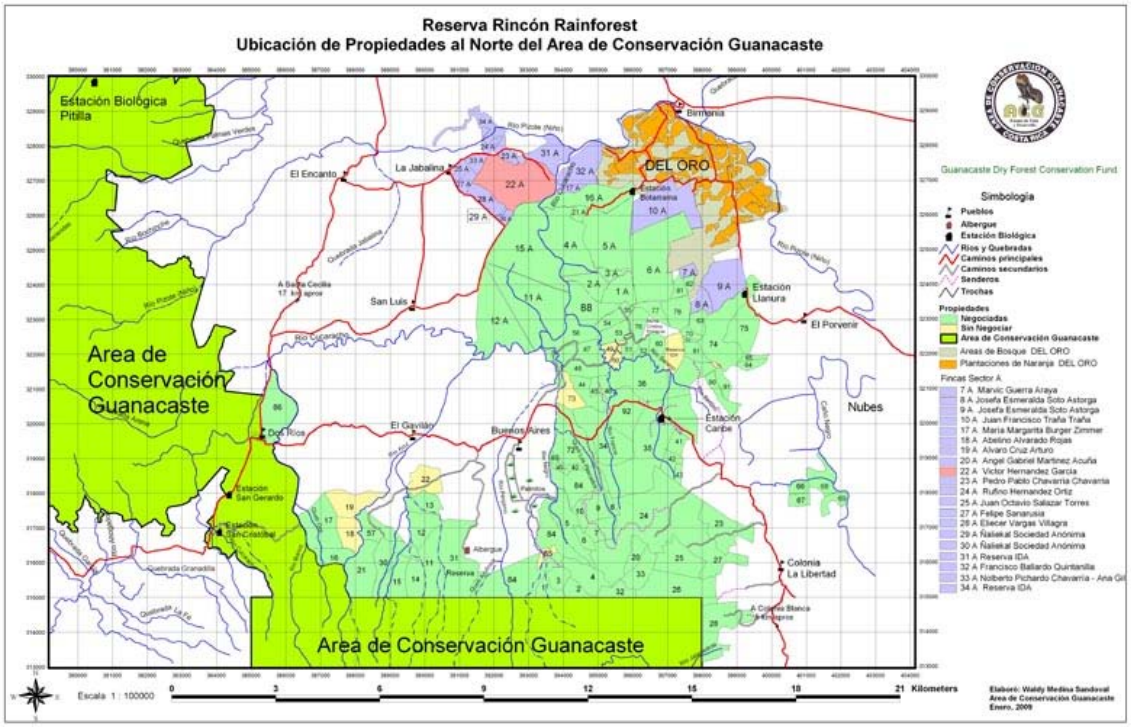


**Figure 2.** Sector Rincon Rain Forest (green with numbered individual properties) of Area de Conservacion Guanacaste. The blue and red areas are rain forest for anticipated purchase when/if funds are available. The green numbered properties have been purchased, though some are not fully paid for (purchase completed with funds borrowed from the GDFCF endowment fund. White areas are largely agroscape, with some small remaining patches of forest and isolated trees.

An aerial view of the canopy of about half of the entire Sector A portion of Sector Rincon Rain Forest is available in the web site at http://janzen.bio.upenn.edu/saveit.html, and is repeated in Figure 3 below (see further images below for understory views). This entire forest was the last large portion of relatively intact, but unprotected, rain forest when the purchase process was initiated in 2008. Parcel 11A (formerly owned by the Montero family of the town of Liberia, the socio-economic center of Guanacaste Province) lies very central to the forest in Figure 3, and appears in this image to be clothed entirely in primary forest. However, parcel is 11 A contains a gradient from once heavily logged (Figure 4-5 below) to lightly logged to primary forest (Figure 6-7 below), with this gradient beginning (most heavily impacted) at its narrowest point near the road (northwest

corner) and extending south east to its broadest point along the river (primary forest).

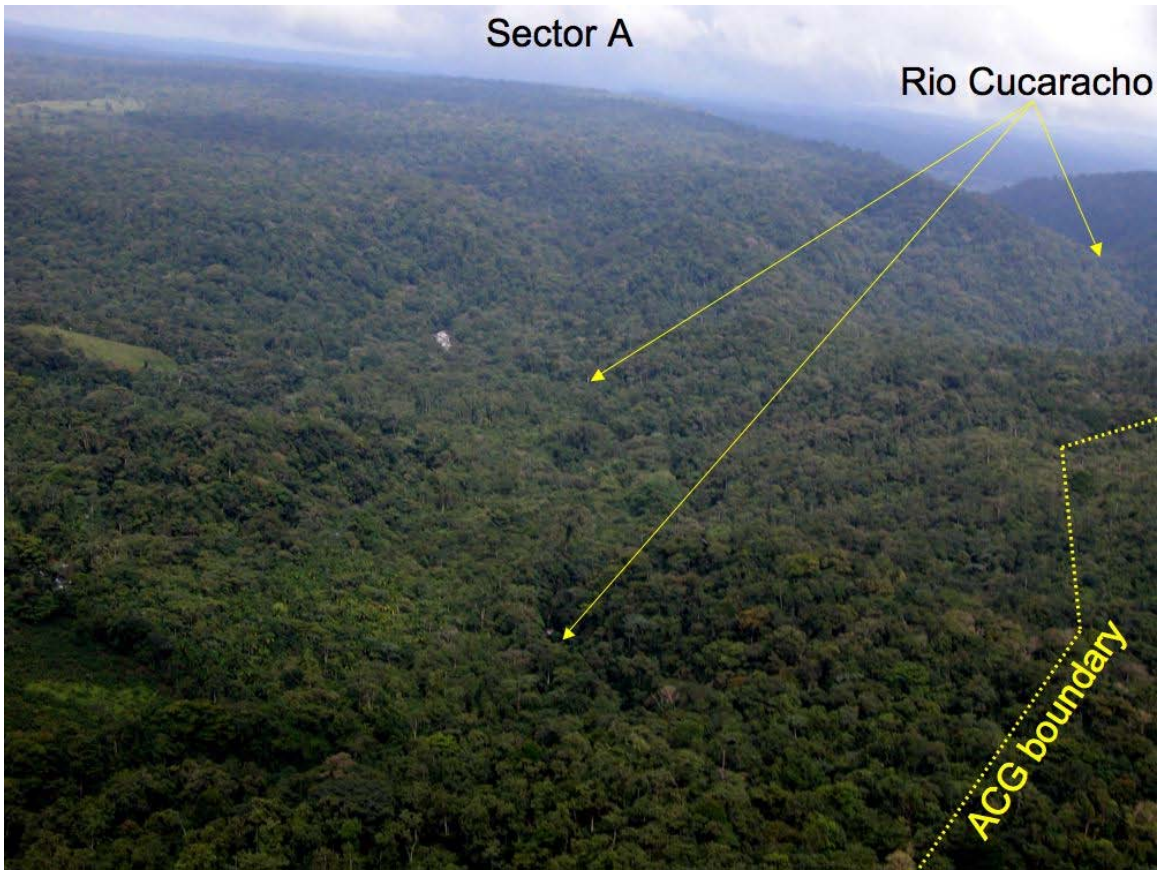


**Figure 3.** The western half of Sector A of Sector Rincon Rain Forest. The lower right corner below the words "ACG boundary" is part of parcel 88 in Figure 2. Parcel 15A and 11A lie (see detail in figure 8) to the left and above the arrowhead of the uppermost yellow arrow line. See images in figures 4-7 below and the web site at http://janzen.sas.upenn.edu/saveit.html for the appearance of the understory of this forest.

**Figure 4.** 30-year-old secondary regenerating forest at the northwestern end of the FTTF plot and GB plot (Figure 8). See Figure 5 below for the location of the howler monkey in the center of this view.

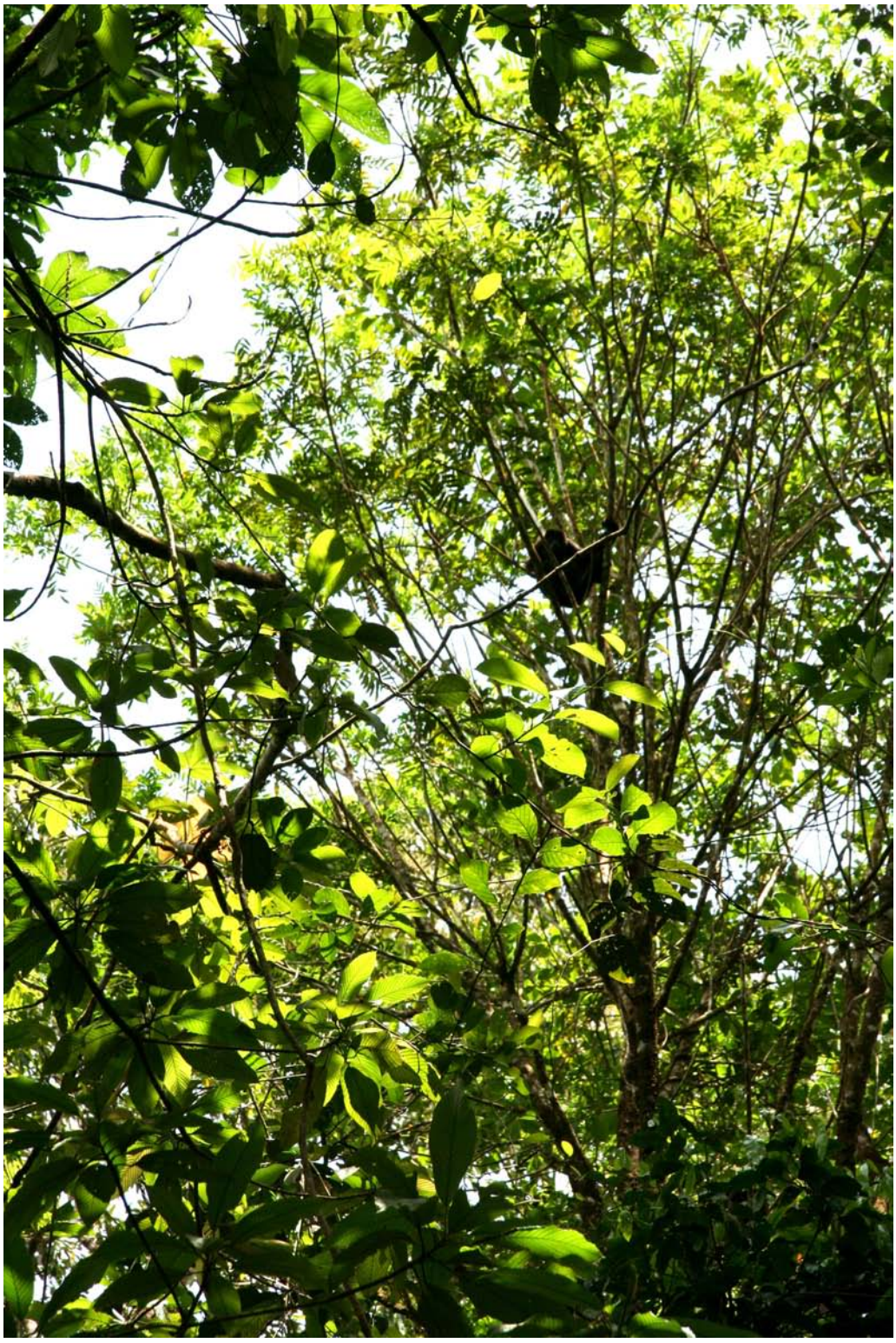

Figure 5. Resting howler monkey (*Alouatta palliata*) in center of Figure 4 (above), one of the three wild primate species that live in and circulate through parcel 11A in Sector Rincon Rain Forest of ACG.

**Figure 6.** Understory of primary forest (20 May 2008) in parcel 15A and 11A of Sector Rincon Rain Forest of ACG. This is below the canopy of the landscape view of the forest in Figure 3 above. The mature trees are 30-45 m tall.

**Figure 7.** Understory of primary forest (20 May 2008) in parcel 15A and 11A of Sector Rincon Rain Forest of ACG. This is below the canopy of the landscape view of the forest in Figure 3 above. The mature trees are 30-45 m tall.

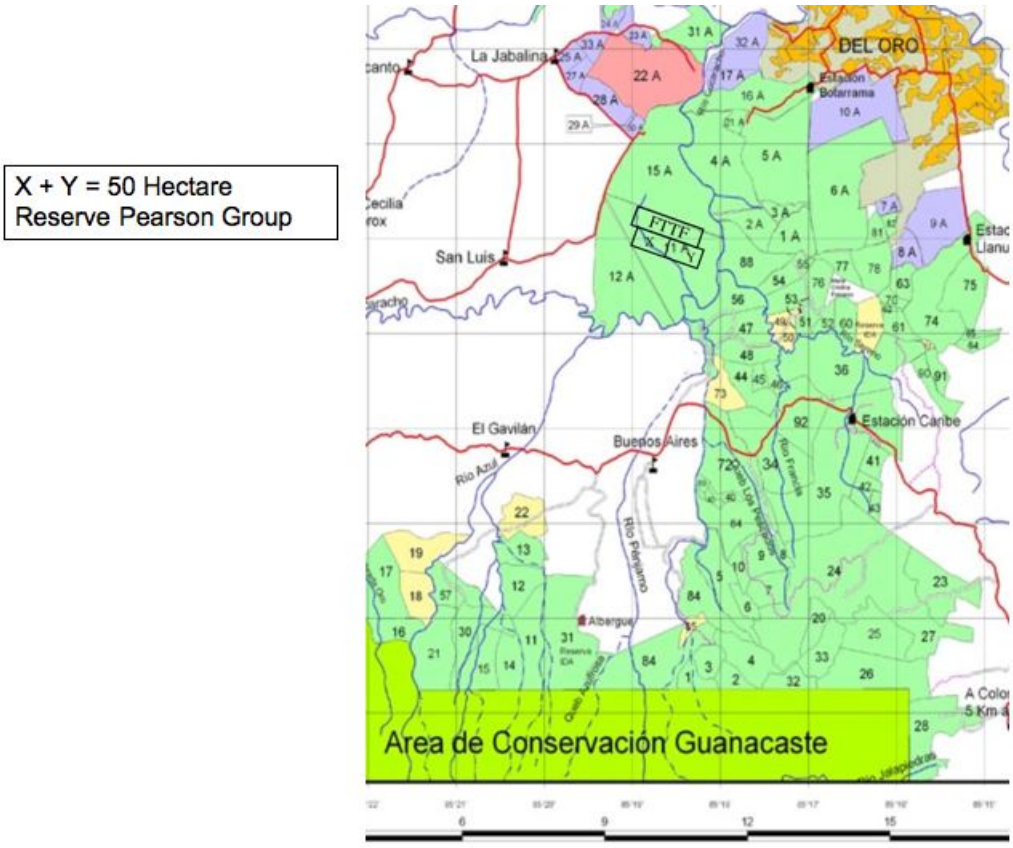


**Figure 8.** Location of the Financial Times Tropical Forest 48 hectare plot (FTTF, established in 2008) and the Pearson Group 50 ha plot (PG, established in 2010) in the forest of parcel 11A within Sector Rincon Rain Forest of ACG.

**Biodiversity content of the Pearson Group 50 ha forest plot.**

The Pearson Group (PG) 50 ha forest plot is located adjacent to the Financial Times Tropical Forest (FTTF) in parcel 11A, as mapped in figure 8. At its western end, the PG forest was heavily logged (but not pastured or cultivated) approximately 30 years ago. It is now very healthy and diverse regenerating (naturally) forest (Figure 4-5). At its eastern end, it is primary forest on a gradual slope down to the Rio Cucaracho, similar to that in Figure 6-7, which is in the forest in 15A, immediately to the north of 11A. In its middle, PG was lightly selectively logged. This gradient requires that any estimates of PG (or FTTF) will need to be an intermediate value between the values at the western and the eastern end of the parcel.

The complex of FTTF and PG are of course the same forest as all of 11A and in general terms, the same forest that is all of the 9,000+ ha of Sector Rincon Rain Forest. This is, in general terminology, mid-elevation to lowland Caribbean rain forest, and biologically extends from the mid-elevations to lowlands of Veracruz, Mexico, south to Bolivia. Literally hundreds of thousands of species share this rain

forest distribution. More specifically, the Sector Rincon Rain Forest contains at least 50% of the estimated 300,000 species found in Area de Conservacion as a whole. All of these 150,000 species circulate through and have parts of their populations contained in, the 9,000+ ha of Sector Rincon Rain Forest (SRRF). Over a stretch of years to decades, all of these species actually live in and/or circulate through parcel 11A - with the animal species being more dynamic than the plant species.

**Vertebrates.** The with a few notable exceptions, the community of large vertebrates occupying SRRF -- and therefore FTTF and PG -- contains members of all of the expected endangered rain forest species (tapir (see images at http://janzen.bio.upenn.edu/saveit.html), jaguar, mountain lion, ocelot, jaguarundi, caucel, tayra, otter, collared peccary, agouti, paca (tepisquintle), white-tailed deer, coyote, howler monkey (Fig. 4-5 above), white-faced monkey, spider monkey, bushmaster, fer-d'lance, boa constrictor). The severely threatened white-lipped peccary (Fig. 9 below) is present as healthy populations on ACG's Volcan Cacao and Volcan Rincon de la Vieja, and is now making its way back into SRRF. The giant anteater was extinguished in Costa Rica in the 1960's and will always be gone unless re-introduced from South America. These large animals are accompanied by

Figure 9. A portion of the Volcan Cacao (ACG) white-lipped peccary 100+member herd that will circulate once again into the protected Sector Rincon Rain Forest of ACG. Here they are foraging on the forest edge at Estacion Cacao (27nov2003).

Another 500 species of small vertebrates - mice, birds, snakes and frogs.

The birds are the easiest to census and document, and the most recent bird survey of SRRF, and therefore in parcel 11A and 15A adjacent. Please see pp. 4-5 of the attached project description written for the US Fish & Wildlife Service. The bottom line is "The combined efforts of a 1996-2001 bird survey of the Rincon Rainforest area (Cooper 1997) and the observations of other professional birders (F. Joyce, C. Henderson, D. Causey, G. Stiles, J. Woodcock, W. Hallwachs) have recorded 309 species of birds in the 400-900 m sweep of the Rincon Rain Forest. This is 35% of Costa Rica's 878 species of birds (Stiles and Skutch 1989, Principe 1984, Cooper 1997, Henderson pers. com). At least 66% of Costa Rica's birds occur in the ACG." Among this very large array of birds (compare 309 species in 9,000+ ha as compared with 574 species in the entire UK and about 700 species in Europe) there is a healthy population of the endangered Great Curassow (*Crax rubra*), Fig. 10 below, and

**Figure 10.** Female Great Curassow (*Crax rubra*) incubating two eggs in ACG (July 2000). There is a healthy and growing portion of the population of this turkey-sized bird in SRRF now that hunting has been terminated.

Penelope (Crested Guan, *Penelope purpurascens* (Fig. 11 below). All of these species of birds are a mix of migrants and residents, and a mix of deep rain forest birds with

edge birds. As the SRRF itself returns to primary forest, the rain forest species will regain their original natural population density and structure, at least as best as can be hoped for in a preserved ecosystem the size of ACG (163,000 ha), but there will always be an array of the forest edge species on the join between ACG and the surrounding agroscape. Climate change (in this area, more erratic seasonality, and perhaps somewhat reduced total annual rainfall) will also re-organize, restructure their density and community relationships, just as is occurring with all other species in ACG.

**Figure 11.** A Crested Guan (*Penelope purpurascens*), a turkey sized bird, dives into flight off a vine attached to a *Cecropia* tree branch in the canopy in the center of parcel 15A of SRRF (8aug2009). These large fruit-eating seed dispersers are found throughout SRRF now that hunting has been eliminated.

The small mammal, frog, snake and lizard diversity of parcel 11A-15A will gradually become known through intense inventory efforts by the parataxonmists of SRRF. For the moment, three images (Fig. 12-14) below emphasize just three of the anticipated 200+ hundred species that will be found there. Almost none of these populations would be able to maintain themselves into perpetuity in just an island of parcel 11A all by itself (and certainly not the small area of FTTF+PG), but 11A is a significant portion of SRRF as a whole, and especially because its eastern half contains at least 50 ha of the extremely scarce untouched original primary forest, which in turn contains large adults of hundreds of tree species (see below), which in

turn generate large quantities of seeds and fruits as food for the vertebrate (as well as insect populations) of SRRF.

How many and which of these species should be termed "endangered" is an academic exercise of not much practical significance. If rain forest habitats such as those in SRRF, and therefore parcel 11A and 15A are converted to agroscape (orange plantations, pineapple, palmito, pasture, manihot, oil palm, etc.), easily 80% of these vertebrate species are eliminated and the remaining survivors then exist in population densities and relationships that are extremely anthropomorphic in their dynamics and future evolutionary histories.

**Figure 12.** Large adult "mano de piedra" or jumping viper (*Atropoides nummifer*) sunning (digesting prey) in a small clearing in parcel 15A rain forest understory. This snake species occurs throughout SRRF as a healthy population of small predators. There are at least 8 other species of pit vipers and coral snakes living in this forest.

**Figure 13.** A medium-aged boa (Boa constrictor) at the moment of swallowing a newly-captured ground-foraging bird in parcel 11A of SRRF. Such acts of predation are a normal part of the community relationships in these predator-rich rain forest habitats (12jul2010).

**Figure 14.** This adult forest-floor rain forest frog (*Eleutherodactylus mimus*) in the understory of parcel 15A (2jun2010) illustrates well why it is difficult to inventory these small vertebrates, of which there are many tens of species in just a single hectare of rain forest.

**Non-vertebrates.**

It is straightforward to estimate that at least half of the 200,000+ species of ACG insects (e.g., Fig. 14), mites, spiders, snails (e.g., Fig. 15 and other invertebrates circulate through and live in SRRF, which means that they also live in and circulate through the FTTF+PG forest plot.

The ACG caterpillar inventory (see http://janzen.bio.upenn.edu/caterpillars/database.lasso) has been intensively surveying the caterpillars (larval moths and butterflies) of SRRF for 6 years, and has recorded 4,230 species so far (and anticipates thousands more, since the total ACG Lepidoptera inventory is estimated to be 15,000). To put these 4,230 species in context, there are less than 3,000 species of Lepidoptera in the UK. In this last year (2010), the adult moths have also been inventoried with light traps by the ACG BioLep project, and their tally stands at 2,314 species of moths collected at lights on the forest edge of parcel 11A+15A in just one year. Just as with the vertebrates, if the ACG in general, and SRRF more specifically, are allowed to survive as intact forest, easily 90% of these species will survive both the insularization of ACG (in the

ocean of agroscape) and the climate changes. The latter survival will be importantly due to moving of entire populations upslope as the area gradually becomes warmer, which makes the 70 m to 2000 m elevation transect of SRRF particularily important. The particular forest of 11A and 15A (from about 100 to 450 m of that transect) is directly in the anticipated path of that movement.

**Figure 14**. This large day-flying moth (*Xanthocastnia evalthetica*) in the family Castniidae is known in Costa Rica only from the primary forest of parcel 11A and 15A in SRRF, though it is suspected to occur throughout SRRF. The unknown caterpillar is probably a miner in the stems of Heliconiaceae or orchids. Were this to be a bird, with its rarity it would long ago be put on the list of endangered species protected by ACG.

**Figure 15.** This 10 cm long predator snail on the rain forest floor in parcel 15A was found exactly at the moment of preying on a second (herbivorous) rain forest snail, which can be seen as the clearly helical object enveloped by the foot of the large predaceous snail. Snail species diversity is extremely high in this rain forest, but each species occurs at such low density that it is only very rarely encountered.

**Plants.**

It will be at least five years before a reasonably complete inventory of the species of plants in SRRF is completed. The current inventory effort is focused on the 11A+15A area, the area that contains the FTTF and PG, and the Estacion Caribe area (slightly closer to the base of the volcano, see Figure 8 above). With respect to endangered species of plants, of course the great majority of species are not formally called "endangered" (there are way too many thousands for that) but the simple fact is that if this forest is converted to agroscape, easily 95% of them will be gone from here (as well as from the neighboring agroscape, where they have already been extinguished). There are 9 species of rain forest trees explicitly listed as untouchable by Costa Rican legislation, and all but one (*Dipteryx panamensis* or almendro), have breeding populations in SRRF of ACG - *Dipteryx* occurs at lower elevations). But the general problem is reflected in Fig. 16 below. While there are literally thousands of species of plants in SRRF (more than 2,000 of them have been collected and deposited in herbaria), the great majority cannot be readily identified in their vegetative state, which is the usual state that they are encountered. Over

time, the ACG staff and parataxonmists are gradually learning them one by (painful) one, but real detailed inventory will not be possible until the bulk of the species have been DNA barcoded and therefore can be identified in the field from just a chip of leaf. This DNA barcoding process is ongoing for SRRF as well as the remainder of ACG (which contains at least 6,000 species of plants).

**Figure 16.** Forest understory in parcel 11A of Sector Rincon Rain Forest (SRRF). There are at least 50 species of plants in this photograph, each one of which has very likely had a scientific name for 50-150 years. However, there is no one on the planet who can identify more than a very few on-site, because they are not reproducing at the time of the visit.

The region of SRRF that contains parcel 11A and 15A is particularly noteworthy for containing about 1,000 ha of primary forest. This forest is of very great conservation importance not only for its great species diversity, but because it contains the last remaining truly large adults (e.g., Figure 17) of many species of trees that were very thoroughly harvested for their timber during the past 100 years of European occupation of this landscape. These few large adults are fortunate to often be surrounded by a small cloud of juveniles, as is the case with the large *Dialium* in Fig. 17, which gives hope that once again, as the forest area restores itself, these species of very large tree will once again have a healthy population.

Figure 17. A large adult Dia*lium guianensis* (Fabaceae) in parcel 15A next to parcel 11A of Sector Rincon Rain Forest (SRRF). This is the only known surviving large adult of this species of threatened rain forest tree in the entire area of eastern ACG.

An outstanding characteristic of the 11A and 15A forests is that each species of plant occurs at a nearly unimaginably low density. For example, the adult of the

orchid *Cochleanthes aromatica* in Fig. 18 appears to be the only individual of this species in the western end of parcel 11A, in the FTTF plot. It would probably not even have been noticed if it had not produced its single flower and that would not have been noticed and found except for the very sweet and intense odor that it produces (presumably to attract a night-flying moth). This plant is a fine example of the situation with very many tropical plant species - each hectare contains only one or fraction of an individual, and that individual is dependent on a complex and probably host-specific interaction with one or more species that also occurs at a very low density. In these circumstances, even a small shrinkage of habitat area conserved will eliminate many species, and their loss then promote the further loss of other species -- for a downward spiral. On the other hand, because of this, the addition of even quite small areas, such as the FTTF and PG 95 hectares, will keep many species in the game.

Figure 18. The single flower of the single individual of the orchid *Cochleanthes aromatica* that flowered on 24 October 2010 in the FTTF in parcel 11A. Growing epiphytically in deep shade on a 20 cm diameter tree trunk about 1.5 m above the gound, this large orchid flower will be found by its pollinator (probably a night-flying moth) through its itensely sweet odor that will be perceptible for hundreds of meters in all directions (which is how we found it).

I**n conclusion.** The biodiversity value of parcel 11A and adjacent 15A, and in turn for the Sector Rincon Rain Forest in which they are embedded, is not that they would be able to survive as tiny and species-rich protected islands themselves. Rather, it is that their additional hectares greatly increase the total area of protected

ACG rain forest on its north and eastern (wetter) side. Additionally, the animal (and more slowly, plant) populations circulate throughout the wetter side of ACG, and another large set of mobile species (birds, dragonflies, moths, butterflies, wasps, flies, etc.) circulate back and forth seasonally between the ACG dry forest on the Pacific side and this Caribbean rain forest on the east and northern side of ACG. Finally, as the changes in climate that are being thrust on us sort themselves out, what we know for certain is that with the drying and warming that is happening to ACG, the populations will shift and re-assemble themselves. Every hectare of rain forest available for that shift, and every meter of elevational transect available for that shift, will increase the chances of one to many species and their interactions surviving.

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