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Gardenification of tropical conserved wildlands: Multitasking, multicropping, and multiusers

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ABSTRACT Tropical wildlands and their biodiversity will survive in perpetuity only through their integration into human society. One protocol for integration is to explicitly recognize conserved tropical wildlands as wildland gardens. A major way to facilitate the generation of goods and services by a wildland garden is to generate a public-domain Yellow Pages for its organisms. Such a Yellow Pages is part and parcel of high-quality search-and-delivery from wildland gardens. And, as they and their organisms become better understood, they become higher quality biodiversity storage devices than are large freezers. One obstacle to wildland garden survival is that specific goods and services, such as biodiversity prospecting, lack development protocols that automatically shunt the profits back to the source. Other obstacles are that environmental services contracts have the unappealing trait of asking for the payment of environmental credit card bills and implying delegation of centralized governmental authority to decentralized social structures. Many of the potential conflicts associated with wildland gardens may be reduced by recognizing two sets of social rules for perpetuating biodiversity and ecosystems, one set for the wildland garden and one set for the agroscape. In the former, maintaining wildland biodiversity and ecosystem survival in perpetuity through minimally damaging use is paramount, while in the agroscape, wild biodiversity and ecosystems are tools for a healthy and productive agroecosystem, and the loss of much of the original is acceptable.

The Wildland Garden

Tropical wildlands and their biodiversity will survive in perpetuity only through their integration into human society. One protocol for integration is to explicitly recognize conserved tropical wildlands as wildland gardens (1, 2). Gardens—space and circumstances for our domesticates, the engineered living extensions of our genome—are an integral part of *Homo sapiens*. Garden terminology, acceptance, perception, administration, and usefulness are deeply imbedded in our genetic and cultural codes (e.g., refs. 3 and 4). This conservation protocol is meant to explicitly apply a profound and positive portion of humanity to what has been largely viewed as “the enemy” throughout humanity’s existence.

In the domestic garden—the clothing of the agroscape—select and selected organisms are ordered and tended for perceived optimal harvestable productivity and priorities by some portion of humanity. In the wildland garden, the ordering and tending is less orderly and more non-human, and is left to run its course. However, the ordering and tending is still an investment by the species that owns Earth. The produce from the domestic garden arrives largely in predictable sacks and boxes, while the produce from the wildland garden, in keeping

with its vastly more diverse nature and its incessant revelations, comes in an ever-expanding diversity of forms and containers. And, this diverse produce is delivered, albeit often invisibly and for vastly more numerous uses, to the same array of users that receives the agroscape’s more monotonous produce.

This commentary is so generic that it may generate a “ho-hum” reaction. It is, after all, self-evident that if large blocks of self-perpetuating tropical wildland gardens can generate sufficient goods and services for local, national, and international society to be as valued and as possessed as the agroscape, we have taken a giant step toward ensuring their perpetual survival. There are proportions of land use whereby the opportunity cost of a hectare of rice field and a hectare of wildland forest are the same. And, we do not live by bread alone.

How does one facilitate nondamaging or minimally damaging development of wildland biodiversity and its ecosystems? By the generation of wildland garden goods and services, and by recognizing this generation at local, national, and international levels. We need to ask less what is the opportunity cost of a wildland and ask more what is the opportunity cost of its urban and agroscape alternatives. Hurricane Mitch’s impact on society was not only a function of the amount of rain and wind it generated.

Here, I focus on the “generation” of goods and services from the wildland garden, rather than their “recognition” on the marketplace. But by that distinction, I do not mean in any way to belittle that other major requirement for survival of a wildland garden. If there is no market for soybeans, then society grows corn.

The Wildland Yellow Pages

A major way to facilitate the generation of goods and services by a wildland garden is to generate a public domain Yellow Pages for the organisms in those wildlands (5). A Yellow Pages is a device that facilitates the use of the concentrated, diverse, and semireplicated offerings of a city. It does not itself decrease the crime rate, provide public transport, maintain the phone system, or generate a hospital or a library. However, it enormously facilitates the movement of goods and services. This leads to more goods and services, and better tracking of human desires by them. And taxes on this movement redistribute income and pay for many essential public services.

The newly blossoming internetization of the world allows many kinds of biodiversity and ecosystem Yellow Pages for the wildland garden. A Species Home Page for each species (and if you like, each ecosystem) in a wildland garden is an entry in a Yellow Pages (e.g., <http://janzen.sas.upenn.edu>). This intertwined set of processes in turn allows the emergence of the concept of the green freezer.

A Tale of Two Freezers

As we move through the age of genetic sequencing and see what can be done with a sizeable chunk of a species' code, it occurs to many to solve the "conservation problem" by plunking into a nitrogen vat a sample of each species. Such a concept generates a blizzard of concern over species ownership (what better indication that some wild things are already viewed by some as being in their gardens?). However, questions of intellectual property rights are not the focus here. I will assume that every frozen vial is unambiguously labeled with place of origin and that the place of origin owns the vial and all that derives from it (just as with my car being parked by the valet in your garage). This brown freezer leads immediately to the concern of "how do you know what was put in the vial?" Again, I will sidestep this issue by taking the futuristic view that "by thy code thy shall be known."

So now we have this immense building filled with immense vats of liquid nitrogen serviced by shivering robots, a building strategically located somewhere at the point of intersection of the superpowers and the not-so-superpowers. It contains samples of each of our 30 million wildland species. Would someone please run us a budget for this building(s)' care, feeding, insurance, backups, administration, civic civility, politics, and and and? To get more place-based and society-specific, I would like to know the real cost into the real future of the portion(s) of the brown freezer(s) that houses the "235,000" species that creep around in the particular wildland garden that I, Winnie Hallwachs, and many local, national, and international others are attempting to drag, shove, and attract into perpetual survival through nondamaging biodiversity and ecosystem development in northwestern Costa Rica (Area de Conservacion Guanacaste, ACG: <http://www.acguanacaste.ac.cr>).

As a first cut, I estimate that the annual nonsubsidized storage and retrieval cost is \$20 per vial (including amortization of the installation(s) and the costs of all that portion of society associated with it). We are then looking at a minimal annual warehouse bill of \$4.7 million.

So, now we have two warehouse options. One is a floor in the brown freezer and the other is the 88,000 ha of the ACG green freezer. A Yellow Pages can be created for each freezer (from whence, see below). In the brown freezer Yellow Pages, each species is represented by a sequence and a unique identifier for its vial(s). A few entries will have a URL to a scientific name and from there to what we are all familiar with. In the green freezer Yellow Pages, each species' entry has an interim or actual scientific name, as well as ever-increasingly, a genetic sequence. Each species has a URL to a Species Home Page that contains, and/or has pointers to, what humanity knows and comes to know about that species (including an ever-increasing number of sequences). As the days and years pass, the Species Home Pages swell and there are more pointers.

How are the brown freezer and the green freezer built? In either case, we spent \$500 per species right now getting the species in hand, determining that it is different, recording whatever information comes with the sample process, and sequencing some part of the sample. And on to the next species. Over, perhaps, 10 years, \$117,500,000 of capital investment is spread. I will assume that the cost of sequencing the contents of the vials, once in hand, is vanishingly small (which is where we appear to be headed). But in one case, we send the sample to the brown freezer and walk away, "conservation accomplished" (warehousing accomplished). In the other case, we trash the sample and settle in to increase the value of the green freezer where it stands in the wind and the rain. We set out to find out, and to organize what we find out, about the wildland garden, supported by a \$4.7 million annual budget

(which we are now not spending on a floor in the nonexistent brown freezer).

Now fast-forward several decades. You are the user. You want a sample delivered next week (tomorrow?—well, that costs a little more). From which of these two freezers would you order your sample? If you order from the brown freezer, you get a sequence, and you get the same associated information in hand as at the time it went into the freezer. And in some cases, there are some new URLs for information about that sequence, or new information about that sequence's species from some surviving population (maybe) somewhere on the globe.

If you order from the green freezer, what happens? Your e-mail is taken by one of the staff supported by the \$4.70 million annual budget, who in turn examines the Species Home Page for that species on the green freezer's web site. This indicates which staff member is "green freezer biodiversity librarian" for that taxon and/or habitat. This parataxonomist or paraecologist reads the account, puts on hip boots, climbing gear, or headlamp, and a day later has a fresh sample in hand, floating in any number of possible standard receiving preservatives. Or an e-mails comes back to you: "sorry, a fresh sample of that species is not available until the dark of the moon (within 15 days), or the beginning of the rainy season (within 11 months), or until we spend 3 days baiting the site with rotten mangos." Or, "The impossible just costs a bit more than the usual order." Incidentally, you already knew this because it was part of the Yellow Pages account for that species, part of the Species Home Page for that species.

A critical element of sample preparation in the field was that a tiny bit of the purported sample was removed and plunked into a pocket-sized gadget that took a sequence. The sequence was radioed into an internet line that carried it to a database and sent back the message that "yes, as believed, what you have in hand is in fact *Pseudomyrmex nigrocincta*" or "no, in fact it is *Manduca dilucida*, last seen 2 km NNW in 1998."

And where did this biodiversity Dewey Decimal system and librarian for the wildland garden come from? About \$3.75 million of the \$4.75 million is spent annually on systematically capturing ever more natural history, taxonomic security, trappers' rules, microgeographic locations, and interaction knowledge about those species and depositing that information in the Species Home Pages for those species. Gradually, the wildland garden moves into "more known" status, with its information creating yet more synergy with the same process in other wildland gardens/green freezers. No such synergy exists among the vials, vats, robots, and floors in the brown freezer.

Given the way society works, a diminishing percentage of the requests to the green freezer will be for a vial of species X, Y, or Z, and more will be for a sample(s) of "any (several) species" with specific traits. "I need a small annual herbaceous vine that grows on magnesium-rich phosphorus-poor soils, fruits at the end of a 6-month rainy season, has a tuber, and is fed on by caterpillars of the family Sphingidae." In other words, the search will be for suites of processes or traits, searched for through the accumulated Species Home Pages by both the machine and the human and recast through the eyes of the biodiversity librarian who makes a career at this honorable pursuit of "know thy neighbor." At one end of the chain, "let your fingers do the walking." At the other end there is a biodiversity manager/custodian who knows the beasts as does a rare book librarian or a Japanese gardener.

And whence the \$117.5 million capital investment and the annual \$4.7 million for the green freezer, the truly inventoried wildland garden? In short, the same sources as for the brown freezer, the user fees, tax base, and investors that foot the bill for all of the other major sectors of society. Wildland biodiversity, and its ecosystems, and its information, are not free goods.

I would argue that it is better business for society to invest in green freezers than brown freezers, despite the long and clumsy history of both.

Where are the real impediments to such investments? Every day exposes more "unexpected" human obstacles as well as more facilitating technologies, such as the internet and genetic sequencing, and liberating policy movements, such as blossoming of governmental decentralization and government-private interest partnerships.

Biodiversity Prospecting

Biodiversity prospecting is now a household phrase both inside and outside of the tropics, and its practice has been with us as long as we have been humans (e.g., refs. 6 and 7). We all focused on the first word of that pair and the linkage of biology with nondamaging commerce, and thought "Oh how nice." I still do. Biodiversity prospecting is a nice item to have in the menu of wildland goods and services. But look at the second word. When was the last time you encountered a gold mine that returned its profits to the maintenance in perpetuity of the soil and mineral deposit of the mine? Are mining companies famous for their contributions to national sustainable development and harmony with the environment? Are mines famous for the quality of life of their employees? Is a mine a self-supporting institution with a future and a key role in local, national, and global sustainable development? Does the old man with the pick and the mule serve as a first-class role model for our youth? Something got left out.

What got left out is that the function of biodiversity prospecting in conserved wildlands, that thing that a lot of us have put and still put a lot of energy into, is to help the conserved wildland garden pay for its ticket at society's table. But those guilds in our society that are filled with professionals at prospecting and managing the ore onto the hardware shelf are generally inclined to put the bottom line into very different coffers than the hole in the ground. Venture capitalists love the bottom line, not the object that generates it. There are two challenges in biodiversity prospecting. First is harvesting the crop, and doing it well. We actually know how to do that and are even getting much better at it. And the biodiversity Yellow Pages is part of that prospecting. But the second is bringing home the bacon rather than paying the bar tab with it. We are way behind and getting further behind on this in biodiversity prospecting (e.g., <http://www.oneworld.org/cse/html/dte/>).

Biodiversity prospecting will not begin to realize its potential for the wildland garden until the wildland garden itself begins the prospecting process and then partners with the downriver users. The garden needs to place its own Yellow Pages on the internet, answer the call from the client, and write the contract (8, 9). This is not to say that intermediary downriver specialists at data and sample manipulation have no role. However, their role should be to act as a kind of value added rather than view the wildland garden as a mine in which to prospect or a rear patio on which to place the barbecue. The most important part of a biodiversity prospecting project document is not the technology or the intellectual property rights but the administrative protocol whereby the benefits return to the source.

"Environmental Services Contracts" Between the Wildland Garden and Society

Environmental services contracts are not new (e.g., ref. 10). Water rights and watershed access/protection have been a market commodity for millennia if not tens of millennia. Biodiversity prospecting is based on environmental services contracts, although they are not called that. Every ecotourist has a microenvironmental services contract with the national park at the gate or through the IRS intermediary. Every successful farmer has an unspoken environmental services

contract with the domestic plants and animals, paid across a multitude of counters (e.g., ref. 11). But there are still huge portions of society and major geographic regions that are living by the law of the frontier, somewhere between getting free goods and having an unpaid environmental credit card bill.

We are on the verge of environmental services contracts between the wildland garden and some social sector (e.g., *Appendices I and II*) becoming a blossoming growth area. However, when a wildland garden, as an institution, stands up tall and says, "Hey, when you eat at my restaurant you pay the bill," much of society is not so very pleased about the new kid on the block (e.g., <http://www.oneworld.org/cse/html/dte/>). At the end of the day there are at least three outstanding and deeply rooted disruptive forces.

First, a government-based wildland garden (national park, wildlife refuge, biosphere reserve, conservation area, and their multiple permutations) having the sense of self and administrative and technical skills to develop a contract with its clients, be they local, national, or international, is an act of political decentralization and government-private sector partnering that sends shock waves through the highly centralized governments characteristic of tropical "undeveloped" countries (e.g., <http://www.oneworld.org/cse/html/dte/>). These countries are not undeveloped but rather differently developed. It is quite striking that the Global Environmental Facility (GEF) of the World Bank, in its recent book "Valuing the Environment" (12), chose to locate the example of a Costa Rican environmental services contract (*Appendix I*) in a new section termed "beyond government," which it is, rather than place it in the many other parts of the book focused on environmental services contracts and the valuations in them.

Second, many occupants of the agroscape in developing countries are running agrobusinesses on very narrow profit margins, whether measured in barter or in cash. For these occupants to have to pay for environmental services (from a wildland garden or the agroscape itself), services that they currently treat as free goods, will put many out of business. The attendant sociological, economic and political consequences will be blamed on the environmental services contract (just as the impact of Hurricane Mitch is blamed on the hurricane), rather than on the act of living on an environmental credit card and not paying the monthly bill. Charging the user for irrigation and hydroelectric water, biological control agents, erosion control, worker disease prevention, technical information, firewood, biodegradation, carbon storage, seed sources, and many other currently free goods is no different than raising the costs of gasoline, refrigerators, telephones, over-the-counter drugs, barbed wire, pesticides, tractor parts, taxes or labor, or no different than lowering the market price of beef, cotton, fish, melons, or mangos. Attempting to internalize environmental costs quickly reveals that tropical agroscares established under subsistence and market economies commonplace in 1850 have today far more people on them than can be supported at the standard of living desired by those people.

When a tropical wildland garden puts the spotlight on its many services to the countryside so as to be able to directly pay its own rent and meet its own opportunity costs, the process is applauded by those of us generically aiming at sustainable healthy agroscares and those agrobusinesses that have set their sights on being in a healthy agroscape (e.g., *Appendices I and II*). However, the process is vilified with equal or more intensity by those who are still living on the "frontier" setting for their computer. The conflict between the applauders and the vilifiers may be dressed up as nationalism versus internationalism, socialism versus capitalism, upperclass versus lowerclass, indigenous versus immigrant, etc., but the real bottom line often lies in who determining who will pay the environmental bills.

Third, when a conserved wildland garden begins, it generally starts with the crudest attitudes of the "end of the frontier."

The park ranger (a.k.a., the police) attempts to prohibit what may be centuries of unrestrained predation and harvest from the wildland commons by the quick and the clever. This tends to lead to the political chaos of the “disenfranchised and their lawyer champions” flailing out at the centralized and somewhat less frontier-like national and international societies that dictated this kind of “conservationist” policy in the first place. Alternatively, there may be true open-market purchase of the conserved wildland garden for that purpose, with its indigenous occupants becoming the garden’s managers or moving on to occupy other guilds.

In either path to a wildland garden, the institution is confronted with an angry social force that potentially may be appeased by biodiversity and ecosystem development of the wildland site. Development means budgets, salaries, and training; it means setting up an industry, a green freezer based on skilled labor, a sort of biological Silicon Valley and Library of Congress rolled up into one. And this wildland industry has enormous local growth potential. Why is it generally not welcomed with open arms by even the “local populace?” Because in great part, unless very explicit steps are taken to counter this, the new employees in the factory are neither the newly disenfranchised previous harvesters from that wildland nor their sons and daughters. Ironically, the people most likely to be chosen by virtually any style of job search—the quick, the flexible, the alert, the educated, the curious, the driven—are the least likely to have been those previous harvesters, even if they were born there.

Some very explicit affirmative action for “local hiring” (e.g., in the construction of parataxonomists and paraecologists and other kinds of staff; ref. 13) can to some degree restore the balance. However, this in turn is viewed dimly by the centralized portions of national societies, those who themselves see their sons and daughters competing for an ever-shrinking contemporary national resource base. This shrinking is inevitable as a society winds off the frontier and is confronted with a monstrous environmental credit card bill, as well as having few remaining still-mineable (usually unrenewable) natural resources (such as the massive old-growth forests that were liquidated to bankroll the agroscape and urbanity during the past several centuries). And we even revisit the first problem mentioned above: a complex resident staff in charge of its own wildland garden and knowing best how to treat it brings the threat of wresting power of decision and action from the centralized government.

Be Positive

How can one design for intrinsic permanence of wildland gardens, a permanence that “just happens?” Human societies are adept at lowering the overhead on the manipulation of individuals and guilds through microgeographic design. Good fences make good neighbors. Stoplights live at intersections. We certainly do not now have design of conserved wildlands for permanence. And I think that a major reason we do not have it now is because the conservationists and the spoilers are both trying to have it all.

We need twin philosophies operating on big landscapes. On the one hand, there should be wildland gardens within a generic goal-oriented framework for wildland permanence and on which are hung place-based regulations for a specific garden. These wildland gardens should be as large and as complex as absolutely possible. One framework commandment is that we (society) formally agree to be happy with what survives in them, and to some degree give up on what is outside of them. Another is that they are forever—no bankruptcy allowed. Another is that we recognize that they are ecological islands in a sea of agroscape and always will be. Now let’s get on with making them high-quality islands.

On the other hand there is the agroscape, a habitat in which biodiversity is simply one of the tools in the toolbox—albeit a very important one—but not *the* priority. The priorities are humans and their happiness. Whatever biodiversity and ecosystem traits survive, survive. We are all happy that they do, but biodiversity survival *per se* is not the driving/shaping force except where that biodiversity is the best tool for a happy agroscape and the people in it, where it is as much a part of the agroscape as a road or cotton plant. Now let’s get on with making it a high-quality agroscape.

We have had 10,000-plus years of trial and error “successful” agroscares but only a few decades of practice with the explicit wildland garden. However, when it comes to creating sustainable agroscares occupied by happy clients, both major kinds of land use are still in kindergarten.

Such a landuse macrodichotomy means that we will be happy saving a high percent of, but not all, wild biodiversity for perpetuity. Yes, such a land-use plan is triage. And if something appears in the agroscape that we desperately want to save, the option is very clear. We go out on the real estate market, buy its home, and put it in the wildland garden. Society understands that you get what you pay for.

A broad-brush wildland garden protocol such as discussed here will be more applicable to some current landscapes than others. And it means that many small populations will disappear. But I cannot think of any tropical society where the application of such an attitude would not have a calming effect on the contemporary border wars between society and wildland conservation. Second, its application, slow and steady, holds out far more hope to large amounts of extant tropical biodiversity and its ecosystems than does continuation of a cops-and-robbers mindset. If you want to keep the gold under your bed from being stolen, put it to work on the marketplace and diversify your portfolio.

I have long believed (3, 14) that conservation of wildland biodiversity and its ecosystems, and their integration with society, are unavoidably and inextricably place-based. The only generic formula is the goal of conservation by means of nondamaging integration with society. The world as a whole will achieve far more wildland conservation in perpetuity by diminishing the planning and pursuit of the “conservation model” and conservation assessment and by putting the very considerable resources currently spent on these stratospheric activities into the specific nondamaging integration of specific large wildlands with specific parts of their societies throughout the tropics. We are not alone in this observation (15).

Appendix I

(Translated from the Spanish original.)

Environmental Services Cooperative Agreement between the Ministerio del Ambiente y Energía, and Grupo Del Oro, S. A., a subsidiary of CDC, in northwestern Costa Rica.

Between us, Carlos Manuel Rodríguez Echandi, of legal age, married, attorney at law, identification card number 1529682, resident of San Jose, Costa Rica, in my position as acting Minister of the Ministerio del Ambiente y Energía (MINAE), according to nomination decree 26850-P in the Gaceta No. 88, 8 May 1998 and from here on termed “MINAE”, and Norman Justin Braithwaite, of age, married, businessman, U.K. passport 740050714, in his position as President of the Board of Directors of Grupo Del Oro, S. A., we agree to the following:

GIVEN THAT:

1. The Area de Conservación Guanacaste (ACG) is a decentralized institution of the National System of Conservation Areas (SINAC) of the Ministry of the Environment and Energy (MINAE), and has the responsibility of continuing its efforts to conserve the biodiversity and ecosystems of its lands into perpetuity.,

2. The Fundacion de Parques Nacionales (FPN) functions as a non-profit institution with the legal capacity to manage funds, including those of the ACG.

3. At the present time the lowland tropical Costa Rican forests that represent the transition between the dry forests of Guanacaste and the Caribbean rainforests are almost totally extinguished, and very poorly represented in Costa Rica's conserved wildlands, including the ACG,

4. Approximately 1200 ha of the dry-wet transition forests mentioned above still exist in the form of wide peninsulas of forest extending into the Del Oro plantations, and these peninsulas of forest are contiguous with the ACG forests at the southern boundary of Del Oro with the northern limit of the ACG,

5. Del Oro recognizes that the ACG offers a variety of biodiversity and ecosystem services (in sum, known as environmental services) to the Del Oro plantations and its juice production industry,

6. Del Oro supports the concept of purchasing these biodiversity and ecosystem services from the ACG, following the schema proposed below, and

Del Oro, MINAE (ACG) and the FPN agree to:

1. Segregate the above-mentioned lands of 1200 ha of dry-wet transitional forest and set their value at \$400/ha, and pass them permanently to the FPN/ACG, in payment for the services summarized in Article 9 below. The ACG will conduct this topographic segregation with its own topographer and carry out the passing of these lands to the FPN/ACG, and assume the associated costs, which will be paid by the ACG with its own resources.

2. Value the services of biological control agents coming from the ACG forests (primarily parasitic wasps and flies of importance to Integrated Pest Control) at \$1/ha per year for the 1685 ha of adjacent Del Oro orange plantations for the 20 years of the contract, for a total of \$1,685/year.

3. Value the technical services of the ACG at \$500/day for international consultants and \$200/day for national consultants. Del Oro will pay for a minimum of 3 days and 10 days, respectively, per year, for the 20 years of this contract, for a minimum of \$3,500 of consultant services, irrespective of whether Del Oro uses these services or not. Additional days will be charged at these same rates but are not included within this contract.

4. Value the provision of water to the Del Oro farms at \$5/ha/year for the 1169 ha of the drainage basin of the Rio Mena that lies in the ACG, for a total of \$5,885/year for the 20 years of this contract. It is understood that other minor water sources draining from the ACG into the Del Oro farms at no cost are not included in this valuation.

5. Value the biodegradation of the orange peels from Del Oro on ACG lands at \$11.93/truckload, for a minimum payment of 1000 truckloads per year, whether used or not, for a minimum of \$11,930/year for the 20 years of the contract. The ACG will design a 20 ha Biodiversity Processing Ground (PBG) to the east of Del Oro, at some point in Sector El Hacha to receive the orange peels. Del Oro agrees to visit the site at the end of the deposition period (end of May) and level the peels to generate an approximately flat layer. The ACG will select another 20 adjacent hectares for the peels in the next year, and continue doing this in four year rotation cycles for a given PBG. Del Oro agrees to maintain the access road and its bridges to the PBGs passable at Del Oro's cost for these 20 years. Del Oro agrees to maintain a registry of the number of truckloads of peel that are deposited at a PBG each year.

6. Value at \$1000/year the rent for the use of a hectare of old pasture within the ACG wildlands but far from any orange plantation or other citrus trees, where Del Oro may plant an arboretum of citrus trees free of diseases, from which they can obtain material for grafts. This environmental service to Del Oro is protection from pests via isolation. Del Oro will pay for and continue any maintenance associated with this hectare for protection against any kind of threat. Del Oro agrees to not apply pesticides or other chemicals that are toxic to biodiversity to this hectare without first having written permission from the ACG. The ACG has full authority to deny such permission without affecting this agreement.

7. If the ACG uses these 1200 ha of land in a carbon fixation program during the 20 year duration of the contract, the carbon credits generated will be divided evenly between Del Oro and the ACG.

8. Del Oro will maintain good agricultural practices in its plantations according to the standards and legislation of Costa Rica and the US FDA. As long as Del Oro complies with these standards, the ACG will not interfere with Del Oro's agricultural activities, thereby explicitly recognizing the legitimacy of agriculture on Del Oro's private lands.

9. The biodiversity services and ecosystem services (environmental services) described above in articles 2–6 are worth \$1,685 + \$3,500 + \$5,885 + \$11,930 + \$1,000 = \$24,000/year. The 1200 ha are worth \$480,000. This means that the land that the FPN will receive permanently from Del Oro for the ACG/MINAE is worth 20 years of environmental services from the ACG/MINAE, as are described in articles 1–9. This contract applies for 20 years beginning one year before the date of its signing. The passage of the lands from Del Oro to the FPN/ACG will occur within six months after of the signing date.

Being in agreement with all said above, we sign in San Jose, 24 August 1998.

CARLOS MANUEL RODRIGUEZ ECHANDI

MINISTRO A. I. DE MINAE

NORMAN JUSTIN BRAITHWAITE

GRUPO DEL ORO, S. A.

HONOR WITNESS

MIGUEL ANGEL RODRIGUEZ

PRESIDENTE DE LA REPUBLICA

WITNESSES:

MICHAEL BAX

GRUPO DEL ORO, S. A.

SIGIFREDO MARIN ZUNIGA

DIRECTOR AREA DE CONSERVACION GUANACASTE

more information about the ACG: <http://www.acguanacaste.ac.cr>.

Appendix II

(Translated from the Spanish original.)

NUMBER NINE HUNDRED NINETY-NINE.

Before me, Marco Vinicio Retana Mora, public notary, with an office in San Jose [COSTA RICA], the following people are present: Johnny Enrique Rosales Cordoba, adult, married, agricultural economist, resident of Monteverde, Puntarenas, identity card number 1–484–951, acting as representative of the entity, the Monteverde Conservation League, and Fernando Sanchez Sirias, adult, married, business administrator, resident of San Jose, identity card number 3–230–568, acting as representative of the entity, Inversiones La Manguera Sociedad Anonima, and these parties declare the following: that in fulfillment of the pre-contract signed by these same parties present here, on 11 March 1998 they come to celebrate this Environmental Services Contract, that will be governed by the following clauses: CHAPTER ONE. SUBJECTS: ONE. THE PARTIES: the parties of this contract are: a-) the Monteverde Conservation League, operating license number 3–002-075864 (which will be known as the "MCL" herein, for the purposes of this contract), and b-) Inversiones La Manguera Sociedad Anonima (which will be known as the "INMAN" herein, for the purposes of this contract). TWO. REPRESENTATION: The MCL is represented here by its Executive Director, with unlimited power of attorney, Mr. Johnny Enrique Rosales Cordoba, adult, married, agricultural economist, resident of Monteverde, Puntarenas, identity card number 1–484–951, representation inscribed in the Register of Associations of the Public Register, record 1983, title 136 and following. The INMAN is represented here by the President of the Board of Directors, Mr. Fernando Sanchez Sirias, adult, married, business administrator, resident of San Jose, identity card number 3–230–568, representation inscribed in the Mercantile Section of the Public Register, at volumes 747 and 1078, titles 269 and 150, sites 475 and 152. THREE. CONTRACTUAL DOMICILES: The parties name the following places as their contractual domiciles, for the effects of article four of Law Number 7637 of 4 November 1996: MCL: their offices located in front of the Gasoline Station in Cerro Plano, Monteverde, Puntarenas. INMAN, 9 Avenue, 13 & 15 Streets,

Number 1350, Office 7, San Jose. CHAPTER TWO FOUR. OBJECT: The MCL is the founder, promoter and administrator of the private reserve, the "Children's Eternal Rain Forest" (Bosque Eterno de los Niños), in which a part of the Esperanza River watershed is enclosed; the part owned by the MCL within the larger watershed area is a land extension close to 3800 hectares. And so, the object of this contract will be environmental services that the MCL will offer to the Esperanza Hydro-electric Project (property of INMAN), environmental services that are carried out across its conservation activities within the Children's Eternal Rain Forest. FIVE. DEFINED AREA OF ACTION. In spite of what was mentioned in the aforementioned fourth clause, the parties have established and accepted that INMAN will receive a direct benefit via environmental services, provided by the MCL, specifically for the protection and conservation of forest, in a land extension of 3000 hectares, and for that, this last extension of land is what is subjected to environmental services stipulated here, that consequently is and always will be the taxable base of rent for environmental services, that is established later on, even and when, by future purchases or donations of land, the extension of the reserve protected by the MCL would be able to be increased. This determination of three thousand hectares, only can be varied by mutual agreement by both parties, in a public document. Both parties renounce judicial complaints and any other type of complaint, to increase or reduce the extension of land subjected to environmental services. SIX. DEFINITION OF ENVIRONMENTAL SERVICES: For the purposes of this contract, environmental services are understood as those goods or services that, in direct or indirect form, are obtained thanks to the existence of an eco-system like that which is natural forest. The benefits derived from the existence of forest are varied: stabilization of land, soil protection, humidity and nutrient retention, water protection, protection of species biodiversity, protection of genetic biodiversity, scenic beauty, regulation of local and regional climate, and mitigation of gases that produce the greenhouse effect, among others. Environmental services, as yet recognized in Costa Rica, through the Forestry Law Number 7575 of 13 February 1996, are the following: carbon fixation (mitigation of greenhouse-effect gases), protection of water, protection of biodiversity, protection of eco-systems and natural beauty. According to its activities and conservation mission, the MCL promises to protect that part of the Esperanza River watershed that is part of its property, according to what has been defined in this clause. This terrain is completely covered by forest, which offers, among other things, the environmental service of retaining and capturing water, which assure the maintenance of the water flow of the Esperanza River throughout the year. The vegetation cover also maintains the quality of water and prevents landslides and soil erosion, particularly in this steeply inclined terrain, which is the subject of environmental services in this contract. To such effect, the MCL commits itself, within the referred area, to the following: i)- to conserve and protect the existing forest, ii)- to watch for and reject land invasion, iii)- to administer the forest and forest guards and iv)- to attain the economic means to fulfill its commitment, in accord to its absolute discretion, according to its statutes. SEVEN. RELATING TO THE TAX OR PAYMENT FOR ENVIRONMENTAL SERVICES: the environmental services to which the previous clause referred have a return favor (quid pro quo) charged to the INMAN, and it is precisely the payment of a price or tax, as was defined in the pre-contract and is retaken in this agreement. The offering of environmental services and the payment of the corresponding tax are independent of the granting of the surface right that is established later on; in case the surface right would be extinguished or would not already be usable to the INMAN, for example due to the confusion with that business's property, the INMAN's obligation to the MCL, for paying the tax for environmental services established here, would remain invariable, valid and effective, given that the reasons for the existence of this tax are environmental services and the protection that the MCL offers to the part of the watershed that is on its property and the non-access and use of land that is indicated further on. EIGHT. QUANTIFYING THE TAX: The price that INMAN will pay to the MCL, always calculated for three thousand hectares, as defined in the aforementioned fifth clause, is the following: a)- DURING THE

CURRENT PERIOD OF CONSTRUCTION, that was estimated as approximately one year. The INMAN will pay to the MCL the sum of three dollars, the monetary unit of the United States of America, per hectare, per year, for an annual total of nine thousand dollars. The INMAN has remitted this sum for the period covering 11 March 1998 to 10 March 1999. In case the construction period would exceed this limit, the INMAN will have to pay an additional sum of six hundred fifty dollars per month. This payment will take place on the 11th day of the month before, in the MCL offices located in Barrio San José de La Tigra, San Carlos. b)- DURING THE FIRST YEAR OF PRODUCTION: The INMAN will pay in advance to the MCL eight dollars per hectare, per year, for an annual total of twenty-four thousand dollars. c)- DURING THE SECOND YEAR OF PRODUCTION: The INMAN will pay in advance to the MCL nine dollars per hectare, for an annual total of twenty-seven thousand dollars. d)- DURING THE THIRD and FOURTH YEAR OF PRODUCTION: The INMAN will pay in advance to the MCL, ten dollars per hectare, per year, for an annual total of thirty thousand dollars. e)- BEGINNING FROM THE FIFTH YEAR OF PRODUCTION: The INMAN will pay to the MCL a tax that will be calculated every six months with the following formula: tax in dollars for each six-month period = three thousand hectares multiplied by 10 dollars per hectare [per year], multiplied: i) - by the resulting factor derived from dividing the real six-month period generation (Note #1: the real generation for each six-month period will be established according to the billing for the total sale of energy that INMAN produces during this period), by the projected annual generation of the hydro-electric plant (Note #2: The projected generation, accepted by ICE at the time of signing of this contract and according to the figures of the Hydro-electric Plant feasibility study provided by INMAN is 28.82 GwH [per year]. However, considering the change in the location of the engine room, there is a new projection of production, that in the case of being approved by ICE, would change this number to 31.70 GwH [per year], which would represent a 10% increase.), according to the feasibility study by INMAN and ii)- by the resulting factor derived from dividing the tariff for Kw/h charged by INMAN during the six-month period, by the tariff for Kw/h that ICE should pay to INMAN at the date in which the project should initiate the sale of energy. In case the INMAN will pay with the energy production, whatever service of ICE or of other public or private business, this payment in kind will be included as part of the real generation that the formula indicates. NINE. CALCULATION OF THE TAX: The estimated annual generation and the tariff at the initiation of the production, indicated in the formula, point "e" of the previous clause, will be established as constants, at the moment in which the project should initiate the sale of energy. This information will be incorporated in this contract by means of an addendum. The six-month period generation will be established against the billing for the sale of energy by the INMAN to ICE and/or any other future buyer. The valid tariff during the six-month period will be established against the data offered by ICE, the INMAN or any other buyer. In this act, the INMAN authorizes the MCL to solicit that information from the respective source. These data will be supplied by INMAN to the fiduciary that will be named, with a copy to the MCL. The calculation of the six-month tax, beginning at the time when this formula should be duly applied, will be done by the fiduciary in charge of the payment, according to what is established in clause eleven. When the MCL will require as such, across one of its representatives the INMAN will provide the necessary information to corroborate the calculations made by the fiduciary. TEN. THE TAX IN CASE OF UNPRODUCTIVITY: It is understood that in the case that the hydro-electric plant would suspend its operation, the amount of the tax will be decreased by the same proportion, as is implied in the formula. Nevertheless, during the first four years of production of the plant, in which a fixed tariff is applied, this circumstance of unproductivity of the plant will be taken in to account to diminished the tax, in the following way: The amount of the annual tax will be divided into 365 (days in a year) to obtain the payment factor for each day, and will be multiplied by the days or fraction of day in which the production has been suspended. By that amount the amount of payment tax will be decreased. ELEVEN. FORM OF PAYMENT OF

THE TAX: In the first four years of production, the payment of the tax will be made one year in advance. Beginning from the fifth year, the payment of the tax will be made payable every six-months. The initial year will be computed beginning from the day in which the hydro-electric plant enters operation. The payment of the tax will be payable on demand, thirty days after the date on which the hydro-electric plant enters operation and thus successively during the first four years. Beginning >from the fifth year, the payment of the tax will be payable thirty days after the expiration of the six-month period which is addressed. The payment of the tax will be made in dollars, the monetary unit of the United States of America or the equivalent amount in colones, determined by the banking exchange rate. The payment will be made across an ad-hoc trust fund that will be established with the Coperacion Privada de Inversiones, with one of its subsidiaries or with a state bank, as fiduciaries, with the exception that unless that another mechanism should be negotiated that is satisfactory to both parties, which necessarily will be made in writing and through an addendum to this contract. From the establishment of the trust fund, the INMAN, in the capacity of the fiduciary's client, will give the specific and unconditional order to the fiduciary for the calculation and payment of the tax to the Monteverde Conservation League. In all cases, the INMAN remains obliged to communicate to the Costa Rican Institute of Electricity (ICE) or any other business, public or private, that may become a purchaser of its energy, an order so that the amount of the tax will be drawn on this ad-hoc trust fund on the appropriate months, to fulfill the payments established in this contract. The conditions indicated here will be duly incorporated to the resulting ad-hoc trust fund.

CHAPTER THREE: LAND CONFLICT ISSUE: TWELVE. RELATING TO THE LAND IN CONFLICT: In addition, between the two parties there exists a land conflict that appears in the overlap of land register plan number A9609431-91 (from the MCL) and number A-7405816-88 (from INMAN). The overlap appears exactly in the place where INMAN needs to construct a dam and water intake structure for the Esperanza River Hydroelectric Project. This overlap has an extension of approximately five thousand five hundred squared meters.

THIRTEEN. RELATING TO THE POSITION OF THE PARTIES WITH RESPECT TO THE LAND: Neither of the parties accept any other position except that the land is their own property; nevertheless, both parties have accepted that currently the MCL finds itself in possession of the land described in the previous clause and that it has boundary lines marking the border in accordance to the land register plan number A-9609431-91. Since the past May 11, INMAN has come soliciting and obtaining from the MCL permits for the use of the aforementioned land, to carry out the work described in the construction plans of the Esperanza River Hydro-electric Project (which was attached to the pre-contract), work that began execution this past 16 April.

FOURTEEN. JOINT ACTION FOR THE JUDICIAL SOLUTION OVER THE PROPERTY: The parties mutually recognize the right of making use of the pertinent judicial action to clarify the definitive property of the land referred to in the previous clause. In the measurement of what is possible they will attempt to initiate a joint action in this sense. Further, the parties will hire a topographical engineer, with the purpose of registering a plan of the area of overlap. The MCL promises to establish homesteading rights proceedings, with the purpose of obtaining a valid title in the National Registry of Real Estate, of the land described in land register plan number A-9609431-91, and further, to register, on behalf of INMAN the part of this land that corresponds to the surface right that is indicated in the following clause.

FIFTEEN. RELATING TO THE SURFACE RIGHT IN FAVOR OF INMAN: The parties recognized that, while there should be no judicial rulings that would establish the contrary, the MCL is the title holder of the domain and it exercises in effective form the right of possession over the overlapping land. In such state, the MCL grants in this act the surface right in favor of INMAN, over the land that has been named as the conflict zone. The surface right consists of the right to build on the land and utilize the land and the infrastructure that may be constructed there, in exclusive and autonomous form, the MCL retaining the rights to any infrastructure built on this land. The work to create infrastructure on this land will be that for the dam and water

intake structure for the Esperanza River Hydro-electric Project (in accord with the specification of the plans that were attached to the pre-contract). The term of this surface right is 99 years, counted from today. This term will be deferrable by written agreement from both parties, in public documentation. The INMAN acknowledges to the benefit of the MCL an annual tax as a return favor of the surface right, established here. This annual tax corresponds to one percent of the value of the infrastructure constructed on the land, in such a way that at the end of the term of the surface right, the infrastructure will have been paid-off and will be the exclusive property of the MCL, without the INMAN being able to reclaim any indemnification for improvement to the land, or, moreover, to the co-property for the infrastructure access to the land. The tax established in this clause will not be paid in money or any other denomination, rather only in the paying-off of the infrastructure in favor of the MCL. In case of the proration of the surface right, the tax for the use of the dam and water intake structure will be maintained in one percent of the annual value of the infrastructure existing on the land referenced in this clause. This tax will be paid in cash by the INMAN to the MCL one year in advance. The parties, aware that the surface right cannot be registered over the MCL's property because even that property itself is not registered, promise at this moment to effect the titling of the land in the name of the MCL, in such a way that the registration of the surface right is given together with the registration of the title for the property in question. Due to the surface right being treated as an atypical right in real Costa Rican law, in the case the Registrar or courts were to impose an obstacle to the registration of the surface right, the parties promise to formalize another type of contract, starting with a usufruct contract, that may assure the real rights of use for INMAN over the land where the structure for the dam and water intake of the hydro-electric project is located, until completing the same aforementioned 99 years for the surface right and under the same conditions or that the contract may not be more onerous for the INMAN. In any case, it is agreed that the surface right remains contingent on the payment of the tax for environmental services for the protection of the hydro-electric watershed, established in the contract. The surface right or eventual usufruct right is subject to the resolution condition in such a way that the INMAN will be left to carry out at least one of the tax payments for environmental services within one month following its liability, the surface right will be dissolved and the MCL will recover the full domain of the land, together with the infrastructure by way of the damages and losses for the non-fulfillment of the contract. On the other hand, it is established that the surface right will be extinguished for the following reasons: a)- The enactment of the resolution condition for non-fulfillment of the tax payment for environmental services, in accord with what is established in clauses seven, eight, nine, ten, eleven and sixteen, although it may be reiterated here that the nature of that tax is like a return favor for the environmental services, not as a return favor for the surface right that is constituted here. b)- Confusion, in case it would come to be determined, judicially or extra-judicially, that the land in dispute is the property of the INMAN, and c)- the expiration of the term. Finally, the land over which the surface right is located is graphically represented in the attached plan, which the parties sign and incorporate as a document to this contract.

SIXTEEN. DETERMINATION OF NON-FULFILLMENT OF THE PAYMENT OF THE TAX. Just as it is indicated in the pre-contract, the figure established here will be utilized to objectively determine an eventual non-fulfillment of the payment of the tax by the INMAN. In case there may be differences to what is agreed here, the INMAN and the MCL accept that they will be resolved by means of arbitration, conforming to the Rule of Arbitration of the Center of Reconciliation and Arbitration of the Chamber of Commerce of Costa Rica, to whose norms the parties will submit unconditionally. The procedure will be the following: when the MCL should consider that the INMAN has defaulted on the tax payment, it will solicit action from the Center of Reconciliation, so that they may become aware of the case. The INMAN will have to present its defense within 15 working days following notification and, further, it will have to pay-off half of the fees corresponding to the Center of Reconciliation's action, in the adverse case, it will not listen to its defense. In principle the

expense incurred for the hiring of the Center of Reconciliation will be paid equally by both parties, the MCL and the INMAN. The MCL will pay its half when it presents its motion for action. In the case that it should be determined that indeed there was default on the payment of the tax, the INMAN will have to reimburse the MCL the money it paid to the Center of Reconciliation. If it should be determined that there was no default on the payment of the tax, the INMAN will be able to deduct from the tax for environmental services that which it paid to the Center of Reconciliation. In any case, if the Center of Reconciliation establishes that there was a default on the tax payment, the resolution condition will apply and the surface right will be extinguished. The MCL will keep the improvements to the land, by way of damages and losses, being absolved from covering any amount for them. SEVENTEEN. RELATING TO THE USE OF THE MCL NAME: As part of this agreement, it is established that it is prohibited for the INMAN to make use of the name of the MCL or the Children's Eternal Rain Forest (Bosque Eterno de los Niños), without prior, written authorization. This is all. The following people serve as honorary witnesses to the signing of the contract: Joyce Mary Zurcher Blen, adult, married, Doctorate of Philosophy, resident of Alajuela, who carries identity card number 1-286-801, Ex-Ombudsman of the People; Francis John Joyce Hammil, adult, married, biologist, resident of Monteverde, Puntarenas, USA citizen with passport number Z7047463, as President of the Board of Directors of the MCL; Miguel Ruperto Cifuentes Arias, adult, married, biologist, resident of Turrialba, Cartago, citizen of Ecuador with international mission identity card number 4231, as the Central American regional representative of the World Wide Fund for Nature (World Wildlife Fund); and Martha Eugenia Marin Malandez, adult, single, biologist, resident of Sabanilla de Montes de Oca, who carries identity card number 1-584-656, as the Executive Director of the Costa Rican Network of Nature Reserves. I issue the two first testimonies. The aforementioned read to the parties, it is in agreement to them, they approve it and we all sign it

in San Jose [COSTA RICA], at sixteen hundred hours on the 28th of October 1998.

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