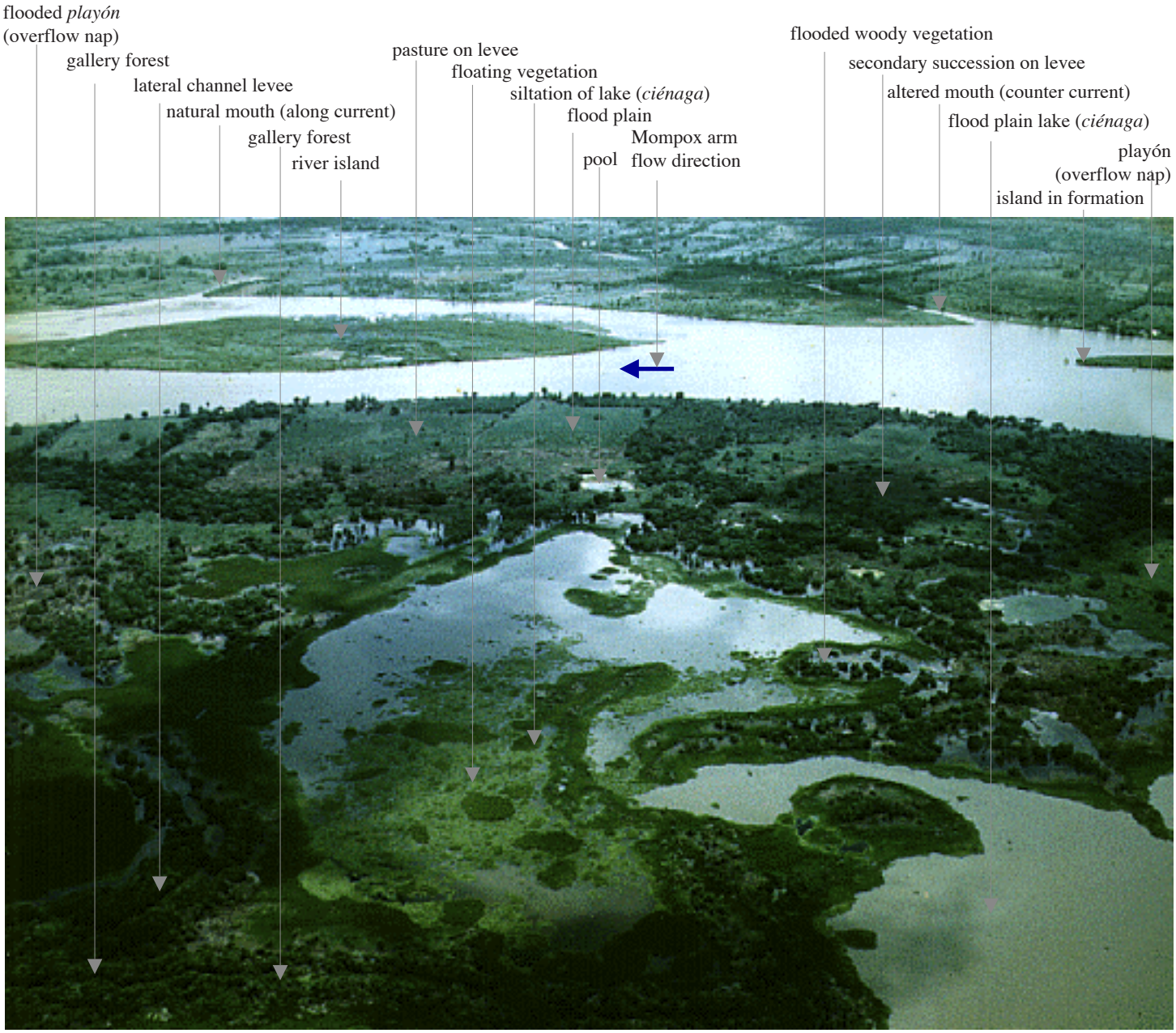
Natural and cultural restoration at El Garcero, lower Magdalena river flood plains, northern Colombia

a case study of ecological restoration, presented by Neotropicos (Medellin, Colombia) to Ecosystem Restoration joint Working Group of the Society for Ecological Restoration International and the IUCN-Commission on Ecosystem Management

March 26, 2004



Brazo de Mompox, ca. 15 km aguas abajo de El Banco. Foto Neotrópicos, mayo 1991

Operation El Dorado: a long-term, pilot project of habitat restoration in the alluvial plain of the Magdalena river in Northern Colombia

Summary

The alluvial plain at the confluence of the San Jorge, Cauca and Cesar rivers with the Magdalena, in northern Colombia, is a 35.000 km^2 subsidence area and sediment deposit, known as the *Mompox Depression*.

The region houses a very rich resource base (fisheries, game, timber, firewood, natural fibres, wild fruits, pasture- and subsistence farming land, etc.), which sustains peasant economies finely tuned to the pulsating water regime. It is characterised by a very high diversity of woody plants (153 species) and vertebrates (326 species), itself a consequence of several concurrent factors: (i) the multiplicity of aquatic, amphibian and terrestrial habitats, (ii) the complex, active fluvial dynamics, (iii) the occurrence of a transition climate, between the more humid regimes to the S and SW and xeric conditions to the N and NE, (iv) the fact that in the area come together the Chocó-Magdalena, Northern Andean and Caribbean biogeographical provinces.

However, the area has been going through a process of deterioration, initiated with the settlement of the Europeans in the early 16th century and exacerbated during the last 150 years. Presently, extensive cattle ranching, which is the main economic activity, corners the small patches of natural habitat left; road development and flood control works alter the flood-drainage pulse cycle, upon which depend the ecological processes of all the biotopes on the alluvial-plain and therefore the resources that sustain the peasant economies.

With the purpose of developing ecological and socially viable approaches for the recuperation and conservation of biodiversity in the Mompox Depression, Neotropicos acquired in 1990 two cattle ranches –*El Garcero Nature Reserve*– which together add up to more than 600 hectares of multi-habitat tract on the Mompox arm of the Magdalena river, some 50 km upstream from the homonymous city. The area is undergoing an accelerated process of succession.

Neotropicos carries out since 1990 the following pilot activities at the El Garcero: (i) *habitat restoration*, re-establishment of the natural flood pulse regime, fire, grazing and hunting control in order to accelerate natural succession, and forest repopulation with native woody species; (ii) *environmental education, and awareness*, oriented towards primary school children and illiterate adults from the El Garcero neighbouring communities, extension practices for teachers and secondary school students from schools throughout the region; these activities are carried out at Neotropicos own school, located at El Garcero; (iii) *experimental development and evaluation of schemes of sustainable utilisation of resources*, presently Neotropicos carries out a pilot project of restoration of a small, 55 ha, shallow, flood-plain lake –*cienaga*– together with a community of ca. 50 fishermen and their families, from a village upstream from El Garcero; and (iv) *basic research and documentation applied to the afore-mentioned activities*, hydrology and climate data recording, plant and animal species inventories, phenological observations (leafing, blooming, fruiting…) of woody species and associated invertebrate and vertebrate fauna (pollinators, seed dispersers and predators, herbivorous, etc.), permanent plots for succession evaluation, ecological characterisation of woody species, resource utilisation by human population throughout the region, are the main topics.

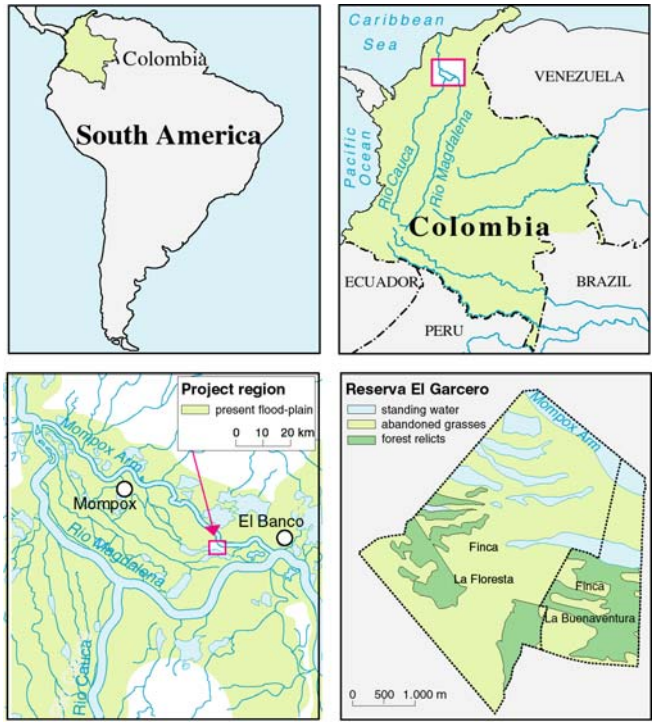


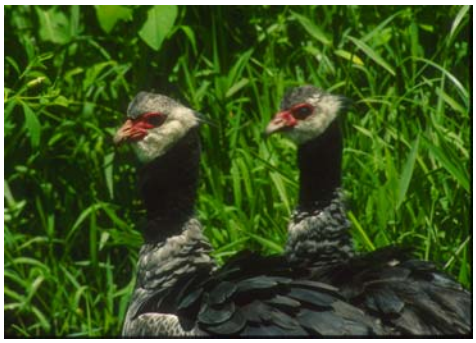
Fig 1. Project location and land cover about 1990 when OED started

2. monos aulladores, *Alouatta seniculus*

4. cariblanco, *Cebus albifrons*

marteja, *Aoutus lemurinus*

Garza real, *Casmerodius albus*



chavarrí, *Chauna chavarria*

Pato yuyo, Phalacrocorax *olivaceus*

pisingo, *Dendrocygma autumnalis*

Garcipola, *Florida caerulea*

Cucharo, *Ajaia ajaia*

babillas, *Caiman crocodilus*

Boa constrictor

Cazadora, *Leptophis* sp preyys upon Eleutherodactylus sp

Typical fauna from the Mompox alluvial plain


Low water at Mompox arm of Magdalena river


Fishermen team at ciénaga Palmarito, nearby El Garcero


Playones (overflow naps) at Las Flores


High water season, Mompox arm


Children with **babilla**, *Caiman crocodilus*


hunter with **ponche**, *Hidrochaerys hidrochaerys*


cattle raising, thr predominant activity throughout the region


El Garcero end of dry season wild fires for hunting and vandalism


Caño Caimanes, a drainage channel at El Garcero Nature Reserve


Another view of Caño Caimanes


A *playon* (overflow basin) during dry season


Secondary forest relicts at El Garcero ca. 1992


Tree nursery at El Garcero


Hydraulic restoration of ciénaga Las Flores


Treelet planting at Las Flores


Trench andf fireway along fence with *Pithecellobium lanceolatum*


Floating vegetation removal at ciénaga Las Flores


Forest canopy at El Garcero Nature Reserve, February 2001


El Garcero Nature Reserve, 2001, full view from river bank inland


hydraulic restoration of caño Raizal (Reserva Natural El Garcero)


El Garcero School


Aquatic biology class at El Garcero School


Natural sciences class at El Garcero Scohol


Children leaving El Garcero school for midday break

OED: long-term, pilot project of habitat restoration in the alluvial plain of the Magdalena river in Northern Colombia. Fact sheet

topic	detail
1 Status of the Work - completed, in progress, or in planning.	OED was conceived as a three phase project: - *initial land acquisition and pilot programme design*, completed in 1992 for Columbus 500 year jubileum. - *restoration implementation and development*, well under way, should end in about 3 years (2006), currently behind schedule due to finnancial difficulties. - *consolidation of protected status for lands restored*, makes reference not to the legal status which is being considered by the Ministry of Environment, but rather to the acceptance of such status by the local population, and their appropriation or adoption of the project as part of their cultural and material heritage. This is the ultimate goal and a very difficult one to attain at the present time.
2 Project site location	Project is located in a particularly habitat–rich area: shallow lakes (*ciénagas*), swamps, riparian, terrace, and hill forests, in a transition zone between Caribbean rain forests to the south and south west, and seasonal, dry forests to the north and north east, where Magdalena river enters Mompox Depression.
3 Project site size	Hydraulic/hydrologic restoration trascends the area owned or controlled by Neotropicos (ca. 700 ha), and includes the drainage network upland from El Gracero, ca. 2.000 ha. Restoration per se is limited to El Garcero. However, Neotropicos activities altogether, have direct influence over an area of some 150 km^2 and indirect on the Mompox Island and on the Mompox Depression
4 Type of ecosystem being restored,	A very small portion of recent and active alluvial plain of lower Magdalena river, within which the following biotopes can be found: major and minor natural levees, active river banks, overflow napes (playones), flood plain lakes (ciénagas), interconnecting channels (caños), low and high terraces with different degrees of drainage and hill slopes
5 The cause of degradation, damage, or destruction that prompted the restoration.	A constellation of historical and current factors: European settlement, cattle ranching, construction of improvised flood control works and dry season roadway networks, abandonment of fluvial transport and subsequent sedentariness of population and over-exploitation of wildlife resources, unusually high sediment production upstream and siltation of ciénagas, direct habitat destruction
6 Stakeholder involvement matrix (who is involved (owner, user, implementer) and at what level)	Neotropicos owns the land where we are experimenting with restoration techniques. However, between 2000 and 2003 a small restoration project was carried out at ciénaga Las Flores, up stream from El Garcero, with ample community participation; project is still under way. Results are mixed,
7 Project goals.	1. to restore or induced the restoration of a large enough, multi-habitat tract of land, such that neighbouring communities can freely use the wild life resources, without diminishing the renewability of the system; 2. to develop amongst the neighbouring communities a solid understanding of the ecological and economic processes of the flood plain; and 3. to instill amongst them a sense of ownership and territoriality over the areas thus restored, utilised and conserved
8 Who is planning and implementing?	At El Garcero, only Neotropicos; at Las Flores, a concensus amongst fishermen, peasants and Neotropicos was sought and reached;
9 Major sources and amounts of funding.	From 1991 to 1997 several donors (Artists for Nature, GTZ, Stadt Rastatt, Ehapa Verlag, etc.), through WWF-Germany Auen Institut and Neotropicos revenues from consultant work. From 1997 to-day, only Neotropicos revenues from consultant work and a yearly small stipendium from Stadt Rastatt for the El Garcero School. Las Flores restoration was partly sponsored (50%) by World Bank funds through PRONATTA, a Ministry of Agriculture grant.
10 Dates and duration of restoration activities from initiation to the expected final event.	Project is long term and pilot (example/demostration). Ecological restoration is only one half of the story, cultural restoration is the other half and the most difficult to attain. The reasons are complex and have influenced the review and rethinking of the project. The school seems to be the key factor for success, but it is running on a small recurrent budget and very little investment.
11 Actions and strategies for the long-term management of the ecosystem being restored.	Currently Neotropicos is formulating a project to obtain funding from the World Bank or other granting agencies in order to promote a co-operative effort with neighbouring land owners (large and small) for the following activities: (i) reforestation at a larger scale (15.000 ha) with native species, (ii) cienaga restoration and (iii) cattle ranching area reduction. All these activities can either capture CO_2 or reduce CO_2 emissions and threfore are elegible for CO_2 reduction certificates that could be acquired through the Protopype Carbon Fund, managed by the World Bank. These financial resources could reduce pressure over habitat and allow natural recuperation and help to finance further reforestation and restoration initiatives. The key factor is to obtain financial resources to pay for the reforestation/restoration work of the poor peasant communities.

Fact Sheet / Case Profile (brief answers / multiple choice responses)

1. Status of the Work:

____X__ completed, ___***X*** ***in progress***, ___X___ in planning.
Different componernts of OED are in different stages of development. *Ecological Restoration is in progress*

2. Project site location:
Country:: Colombia
State or province: Bolívar
City: Margarita & Hatillo de Loba
Geographical Coordinates: 76° 6' 40" W, 9° 0' 15" N

3. Project site size: 6,0-8,00 km^2 ha direct control for ecological restoration; ca. 20 km^2 area for restoration of hydraulic/hydrologic regime, mostly upland/upstream from RN El Gracero
Area covered by the project (in ha,Km2 [sic], or any other unit):ca. 150 km^2 direct influence area

4. Type of ecosystem being restored. **What was the original ecosystem, before the disturbance that now requires restoration?**
The area under restoration is an alluvial plain, *sensu stricto* is not an *ecosystem*[1] but a complex of biotopes and their communities. Alluvial plains are somewhat distinct biotopes linked by the hydraulic/hydrologic properties of the system and normally are very dynamic in nature, i. e., can change rather rapidly, within an ecological time scale, that is of tens to hundred of years. The biotopes involved in OED ecological restoration are listed below, others from the original list were removed.

IV. Tropical forest
  a. Lowland rain forest√
  b. Seasonal (~~monsoonal, semi-evergreen,~~ deciduous)√
  e. Other riparian forests√
V. Wetland√
VI. Grassland
  b. Tropical
  f. Other overflow basins poorly drained
VIII. Aquatic
  a. Lakes: ciénagas, shallow lakes interconnected with others and with main river through bidirectional channels (caños)
  b. Ponds: blind small
  c. Rivers
  e. Other caños (bidirectional channels seasonal or permanent or with seasonal behaviour that interconnect ciénagas to each other and to main river.

5. State the main cause of degradation, damage, or destruction that prompted the restoration. Feel free to list peripheral causes.
Ecological status[2] The functioning of the alluvial plain and the associated resources in the Mompox Region are in an advance stage of deterioration. There are no relicts of primary forests of any size in the flood plain, the small patches of secondary forest are subjected to intense selective extraction of fire wood, and timber for fences, house and furniture construction. Forested areas are also subjected to cattle browsing that diverts secondary succession and damages soils, and are exposed to wild fires; fire is extensively utilised to manage pastures and for subsistence hunting.

[1] *Sensu stricto* ecosystems are distinct ecological units where the internal exchanges of matter and energy are more important than the fluxes through the unit. Within such a system there are multiple habitats (biotopes) and cohorts of organisms (communities o biocoenosis).

[2] Taken from: García Lozano, Luis Carlos. 2001. Mompox Region: Synthesis of regional environmental evaluation studies for the transportation sector. Summary compiled for the Subdirección del Medio Ambiente y Gestión Social, Instituto Nacional de Vías de Colombia. Medellín, November, 2001

There are practically no *ciénaga-playón-caño* complexes in natural conditions. Playones are yearly burned to stimulate green grasses growth. Most caños are obstructed with floating aquatic vegetation which is only removed to install small mesh fish nets across them during the upstream reproductive migrations that take place in the dry season. Quite often the caño-ciénaga and the caño-river mouths are diverted to open directly, counter current, cutting meanders and levees in order to accelerate siltation and thus expand pasture areas. In other occasions caños are subjected to avulsion to impede the free flow of water into a ciénaga, this slowly leads to a general impoverishment of fish species richness and fish resources. During the last 50-60 years cattle ranchers have built an extensive network of roads over dikes and embankments; bridges and culverts are purposely fewer than needed and with lower capacity in order to diminish the flood height and retard its occurrence. The pulse flood-drainage is thus altered beyond the immediate vicinity of the works: on the wet side of embankments (proximal to the river) a small increment in water level causes prolonged floods and on the dry side (flood plain side, distal from the river) water, nutrients and organisms can only reach the ciénagas and playones during extreme events, the drainage during the subsequent limnophase is thus impeded.

The main cause of this condition is the expansion of the cattle ranching activities that incorporate communal land and the partly subsequent construction of roads: This expansion brings besides a reduction of communal areas and resources, and to compensate, a more intensive utilisation of the remnants. In this sense, the *ciénaga-caño-playón* complexes are the more sensitive habitats, the ones which manifest more widespread deterioration and are likely to withstand further deleterious processes in the near future. However, the highly dynamic physical and ecological processes of these habitats allow their readily recuperation and restoration once the alteration factors are stopped or controlled.

There is very little utilisation of biocides and fertilisers to manage pastures and agricultural land in the Mompox Region; however, waters and sediments in Mompox, Loba arms of the Magdalena as well as in many ciénagas, present high concentrations of heavy metals and probably of other pollutants as well. They are still under critical levels, but likely on the increase as a consequence of population growth and industrial expansion in the upper Cauca and Magdalena watersheds.

6. Stakeholder involvement matrix[3] (who is involved (owner, user, implementer) and at what level)

Who\Phase	Planning	Design	Implementation	Evaluation	Overseeing	Other?
Neotrópicos (Owner)						
National Government						
Local Government						
Local community						
Auen Institut (until 1997)						

7. Project goals.

1. to restore or induced the restoration of a large enough, multi-habitat tract of land, such that neighbouring communities can freely use the wild life resources, without diminishing the renewability of the system;
2. to develop amongst the neighbouring communities a solid understanding of the ecological and economic processes of the flood plain; and
3. to instill amongst them a sense of ownership and territoriality over the areas thus restored, utilised and conserved

8. Who is planning and implementing? Please provide more detail than on point 6 (above)

OED was conceived in 1984 as a natural-cultural restoration project of a specific ecosystem (sensu lato), the alluvial plain of the Magdalena River at the Mompox Depresssion, and of a given people, the *amphibian cultures*[4] that there have evolved from the 1492 on. Initial planning and formulation was done at Auen-Institut in Rastatt, Germany in 1987, in Costa Rica at the 25th Anniversary of the OTS, Workshop on Ecological Rstoration, held at Guanacaste, Costa Rica in 1988 and

[3] The matrix refers only to the ecological restoration component of OED project and the documentation and scientific research to it associated. For other components (environmental education and awareness, and experimentation with tecniques for sustainable resource utilisation), the matrix is different; there is local government, environmental authority and citizen participation at various stages, from planning to ex post evaluation.

[4] *Amphician Culture* is a term coined by O.Fals Borda, an anthropologist and historian born in Mompox. It makes reference to the amalgamation of European, American aboriginals and African negroes and the evolution of rather sustainable systems of resource exploitation that combine fisheries, hunting, subsistance agriculture and cattle herding in communal flood lands during the dry season and .

again at Auen-Institut in 1989-1990. Once financial sponsors were engaged, Neotropicos was stablished and this organisation continued with the detailed planning and initial implementation that started with selection of project site and land purchase in 1990. From then on there has been a close co-operation between Auen-Institut and Neotropicos for all sorts of matters related to all components of OED, from scientific discussions to financial planning, fund raising and so on. Currently, planning and implementation is solely a Neotropicos responsibility, but Auien Institut and other former sponsors are kept informed of the project progress.

9 Major sources and amounts of funding (optional).

Source	Amount (in thousands of USA dollars/year)*
National Government	
Local Government	
Local stakeholders	
Private sources (national) No private Colombian Funds haves ponsored OED	
Private sources (international)†	
International NGOs (WWF- Umwelt Stiftung Deutschland, 1990- 1997)	73.000
National NGOs (Neotropicos, from 1990 to date)	47.000
Other: (Stadt Rastatt, from 1996 to date)	6.500

* Ammounts are aproximate average values for all components; they have varied from year to year. Some occsional, minor, private donations (under US$1.000) are not listed separately, but are included in the item National NGOs.

† German and other European private funds were obtained for the OED by WWF-Deutschland and are included in the WWF total.

10. Dates and duration of restoration activities from initiation to the expected final event.

There is no final event for OED so to speak. Neotropicos team feels that there is a lot to do within the El Garcero Nature Reserve, in the immediate vicinity and in the region of influence. It is in a way like a marriage or the raising of children, there is no end in sight, although it is known that eventually other people will come and replace whoever is there. The end of OED will be the end of Neotropicos and there are a number of legal issues that have to be taken care of. Foundations in Colombia must transfer assets and patrimony either to another Foundation with analogous goals and objectives or to a state institution. In both cases the new responsible entity can alter the modus operandi of the project, but by then it will be well under way and surely beyond failure.

Project is long term and pilot (example/demonstration). Ecological restoration is only one half of the story, cultural restoration is the other half and the most difficult to attain. The reasons are complex and have influenced the review and rethinking of the project. The school seems to be the key factor for success, but it is running on a small recurrent budget and very little investment. Thus a reasonable date for project closing would be when the majority of the population in the vicinity of El Garcero is composed of adults, who are alumni from Neotropicos own school; that wound be in about 8-10 from now.

11. Actions and strategies for the long-term management of the ecosystem being restored.

Currently Neotropicos is formulating a project to obtain funding from the World Bank or other granting agencies in order to promote a co-operative effort with neighbouring land owners (large and small) for the following activities with the know how developed at El Garcero and in other research and consulting projects that the organisation has carried out: (i) reforestation at a larger scale (15.000 - 25.000 ha in Mompox Island and right bamk of Mompox arm) with the native species tried and evaluated at El Garcero, (ii) cienaga complexes restoration and (iii) cattle ranching area reduction. All these activities can either capture CO_2 or reduce CO_2 emissions and threfore are elegible for CO_2 reduction certificates that could be acquired through the Protopype Carbon Fund, managed by the World Bank. These financial resources could reduce pressure over habitat, allow natural recuperation, and help to further finance reforestation and restoration initiatives throughout the region. The key factor is to obtain financial resources to pay for the reforestation/restoration work of the poor peasant communities for whom their small land holdings (< 1 ha to 2 ha) are a critical part of their livelihood.

El Garcero restoration process, a précis[1]

The following précis addresses the main questions regarding the restoration process underway at El Garcero. Some passages of it are repetitious with what was already written above.

1. Initial conditions (around 1990)

1.1 Land cover. ca. 30% secundary forests in patches that vary from less than 1 ha to over 50 ha; in some areas the frorest is believed to be at least 70 years old as can be observed in the oldest aerial photographs available (1946), there are also some emergent individuals believed to be primary forest species.

1.2 Tree diversity in El Garcero (species of trees, sizes, abundances). There are over 90 species of trees in El Garcero region, but the great majority of adult individuals belong to a few (8-15) fast growing species. This skewed distribution of abundances has several causes difficult to separate:

- selective cutting of hardwoods for fences, stable and house construction, fire wood, etc.
- differential dispersal of seeds by natural agents (birds and native mammals, cattle, wind, water…)
- selective planting of certain valuable species
- selective grazing–browsing by cattle
- variation in fire and flooding tolerance

1.3 Canopy diversity. There are differences between canopy and understory species diversity. It seems that all of the adults (canopy individuals) are also represented in the understory as young or saplings or seedlings; but there are also seedlings and saplings from species that are not present in the canopy, some of these species are wind or water dispersed but many are presumed to be animal dispersed. As a consequence, it is expected that on the basis of natural changes, i.e., in abscence of management, there will be quantitative changes in the community (changes in the proportion of the species) as some mature individuals will be replaced by individuals from other species and qualitative changes (changes in the community composition) as new species will form part of the canopy cohort.

1.4 Seedling/sapling diversity in El Garcero vs. other forest remnants in the region. The research on this topic is not complete, but the general impression is that grazing and browsing by cattle has a negative effect on the diversity of the mature forest. In forest patches located outside from El Garcero the diversity of understory species is lower than the diversity of the canopy and than that of the understory of forest patches in El Garcero. Perhaps the low canopy diversity of El Garcero is a consequence of successional development of forest cover under grazing–browsing conditions.

1.5 Habitat diversity. Besides the differences in age and composition outlined, there are also other factors, not altogether independent, that account for habitat diversity in El Garcero.

1.5.1 Differences in flooding frequency and intensity. The flood process is not totally natural; El Garcero is criss-crossed by a number of channels (caños) some of which are seasonal and some of which are activated only during extreme high waters which have a recurrent cycle of long period (between 5 and 8 years). This situation is obviously partly due to the location of the areas along the toposequence but also due to the manipulation of levels by two main processes: highwater dam construction along the channel's banks and obstruction of drainage along the road Mompox–Hatillo de Loba that cuts El Garcero in two. The flooding from Mompox arm occurs in El Garcero in an upstream direction from ciénaga de Morón, in pulses defined by the height of the dams in finca El Paraiso. These structures function as barriers to water movement both during the flow and ebb parts of the inundation cycle and when flooding occurs due to increased rain fall. To date no flooding in downstream direction from La Ribona has taken place in El Garcero. This situation makes the areas between the playón on the south side of the road artificially drier.

1.5.2 Differences in soils. There is a general gradient in permeability/drainage capacity in a direction away fom river and channels, so that sites proximal to the river are more easily drained than the distal ones, also distal sites are relatively lower therefore more subjected to floods.

[1] Modified from a 1995 Neotropicos internal report, by Luis Carlos García Lozano

1.5.3 Stratification. Depends on age. Young forest patches or patches with large natural or artificial clearings are not clearly stratified; there is a great abundance of herbaceous and woody vines and lianas that slow down the growth of seedlings and saplings. Older sites have 3 strata: a closed canopy, between 8-12 m height, with some taller individuals with emergent crowns; a understory stratum, up to 6 m high, composed mostly by juveniles from the canopy, although there are some species only present in this layer. Finally there is a herbaceous/schrubby layer where seedlings from understory or canopy species are also found. This general pattern is not by any means uniform; very often there are gaps in the canopy, several m in diameter, where the unstratified secundary forest type develops.

2. Objectives of restoration

The aims of a restoration processs are twofold: to re–establish the dynamic conditions of the flood plain i.e., to facilitate a suitable habitat for the stablishment of populations of flood plain animals and plants and second to reinstate the structural conditions of the habitats within, i.e., increase the present day diversity.

2.1 To speed up forest cover development. Given the initial status of the area it is of utmost importance to speed up the development of a woody cover, in order to:

- drive out african and native grasses that are prone to fire and slow down succession;
- generate suitable microclimates that allow the accumulation and slow decomposition of litter, reduce the ammount of solar radiation that reaches the ground, increase air and soil humidity levels, etc.
- provide nesting and feeding grounds for forest animals (rodents, bats, birds…) that can bring seeds and accelerate succession

2.2 To increase diversity of woody species.

2.3 To rehabilitate flood dynamics. As was stated earlier, the existence of flood control structures in neighboring properties up and down stream from El Garcero impedes that this objective to be totally accomplished without the aquisition of additional land.

3. Approach

3.1 Active restoration. Refers mostly to the objective of tree diversity increasing within El Garcero

3.1.1 Seed/propagule collection. There are a number of remnants of primary forest and old secundary forest in the vicinity from El Garcero. Their composition is in general similar to that of El Garcero's relicts (predominance of a few fast growing wind or large herbivore dispersed species). However there are many species that are not found in El Garcero; therefore a permanent program for seed/propagule collection was early established. To complement it a program was organised in cooperation with the elementary schools from the region by which children bring seeds and receive seedlings, books, school or other type of materials in exchange. The list of potential species for planting has expanded to ca. 80, including 49 that are found in El Garcero. Some 20 species are reproduced not from seeds but from root cuttings.

3.1.2 Tree nursery. The new facilities have a capacity of ca. 30.000 seedlings/year. There are two deep wells that provides water year around. Seeds are planted directly in plastic bags. There are no special beds for germination. Information about germination of seeds of the large majority of the species is not available; when germination, or leafing and root formation in the case of cuttings, does not readily occur the seeds are inmersed in warm water or diluted HCl, and the cuttins sprayed with hormones. Positive results have been obtained in most cases, although there are some 12 species for which no seedlings are available. There are ca. 10-15 species that have been collected as seedlings in the forest floor. No records of rate of success are yet available.

3.1.3 Seedling planting. Initially mixed cohorts of seedlings from as many different species as possible were planted directly in pastureland; the survival rates varied (5-75%) with the species and the sites of planting, but in general were low due to one or more of the following causes:

- Severe drought since December 1991 until December 1992 followed by long lasting inundation that began in May 1993 and prolongued until the end of october 1993.
- Saplings were outcompeted by grasses or growth was arrested by fast growing herbaceous vines which impeded light penetration

• Undetermined insect herbivory in some species. Cicadas, grasshoppers and many other generalist herbivores are very abundant in pasture lands. On the other hand, the plantings along the road that cuts through El Garcero were severely damaged by free roaming cattle in the 1992-93 drought.

Nonetheless, some experimental plots are maintained, there is a good number of individuals (mainly from Ceiba pentandra, Hura crepitans, Samanea saman, Enterolobium cyclocarpum) over 4 m high after 19 months of being planted. No new massive planting experiments in open pastureland are conducted.

3.1.3.1 Connecting of forest patches. Early on was found that seedlings planted on the edges of forest patches survived and throve better because the shadow allowed for a better establishment of young trees and the competition with grasses was not so strong. Thus, some experiments were started in 1993 to connect forest patches; wood frameworks 1,50 m height x 1 m width, covered with palm leaves were built in the open areas between patches in order to provide suitable perching sites for birds, support for vines and overshadow the grasses; after 8 months they seem to function properly.

3.1.3.2 Plantings inside forest patches. The light, humidity and soil conditions inside a forest patch are ideal for the planting of seedlings. Planting is limited to some 15 species that are rather scarce in secondary forests in the region; often the sedling/sapling is outrooted from some areas where they are abundant and replanted in El Garcero. The process is very time consuming but has proven worthwhile, for instances with garceros (Licanea arborea, Neotrópicos logo tree) which mast fruited last year and we had been unable to get seeds to germinate or root cuttings to leaf.

3.1.4 Follow up of plantings. Two detailed surveys of plantings have been done so far. The first one in February–March 1993 and the second in December 1993. Surveys included species, site, age, size (height and diameter), health status and comments about the conditions of the treelets. Data are being recorded in a computer data base in Mompox. J. G. Ramírez (former botanists at El Garcero) has a copy of the records for the first survey and should produce a report shortly. The comments here included about mortalities and survivorship are taken from these surveys.

3.2 Passive restoration. It is passive because does not imply the direct planting of trees. However, it requires the implementation of management activities oriented towards:

• acceleration of succession,
• erradication of grasses
• animal population build up

3.2.1 Grazing control. In the region fences are not usually needed to establish property boundaries, they are rather utilized to keep cattle restricted to a given pasture while others are left to recover from grazing, or to separate young animals or females with calves from the rest of the herd; therefore outer fences, if they exist at all, are not normally well kept. That was the situation in both fincas when they were acquired. Because La Buenaventura had not had cattle for over a year the inner fences were in poor condition. New fences (posts and barbed wire) were constructed in 1992, even in the boundary with La Floresta which had over 500 animals until it was received from the former owners in late August, 1992. The fences of this latter finca were in better shape; the materials were utilized to rebuild in part the boundary fences. The playón boundary was completed with new materials early this year. Along the perimeter from El Garcero (ca. 12 km) some 2.500 fast growing trees were planted as live posts. The most commun species is *Spondias pulcherrima*, but after the long 1992–93 dry season it was noted the convenience of planting the following fire resistent species: *Guazuma ulmifolia*, *Pithecellobium lanceolatum* and *Cassia grandis*. Eventhough expensive in terms of time and money the fencing of El Garcero has proven worthwhile.

3.2.2 Poaching control. The correct concept is perhaps hunting control as wild life was, and to–date is not considered for the exclusive use of the owners of the land, eventhough from the legal stand point it could be so. On the other hand, most of the species which are regularly hunted are endangered species or with reduced populations at least in the region. However the local environmental authorities have neither the way nor the interest of enforcing regulations. Hunting is a year around activity but occurs mostly during the dry season, when it is easier as animals congregate around the water pools and more humid areas. Hunting is in a very real sense a survival activity, not something done to acquire prestige or gain ascendancy before one's peers; nonetheless, there are "proffesional" hunters who sell their preys. There are two types of prey: those for direct consumtion (turtles, capybaras, rabbits, deer, tapir, etc.) and those taken for their skins (boas, caiman, iguanas…) for which an ilegal export market exists, many a time with the compliance of the local environmental authorities. Hunting has been never overtly prohibited for outsiders in El Gar-

cero; the permanent and temporary workers are informed that they themselves cannot take animals and that they should politely discourage people from hunting in the premises. During the dry season patrols for fire control, there have been encounters with hunters who allegedly said that they were not informed about the project or that they are not hunting in El Garcero but going through to some other hunting ground, etc. and leave the area without further complaints. There has never been an incident or misunderstanding with hunters that we should regret, the encounters have always been friendly; but it is true that we cannot control the area all the time and certainly there has been poaching activities as we have found animal rests, mainly from caimans and iguanas. Small fires in the vicinity from ciénagas and ponds are most likely started by terrapin and turtle hunters who take the animals alive to market. It is paradoxical but altogether logical that the El Garcero restoration processes have successfully increased the density of many flood plain vertebrate species, but by doing so have also increased the pressure from hunters. This is a relationship whose complexity in Neotrópicos we are only beginning to appreciate; there is a conflict between the restoration goal, the need to allow resources to be utilized and the development and furthering of trust with the neighbors. An answer to this could be the development of a buffer zone around El Garcero whereby Neotrópicos and the community can together experiment with new ways to increase animal densities, determine hunting times and intensities.

3.2.3 Fire control. Fire is a pasture management tool in El Garcero region, actually in all agricultural societies. Even in the more humid areas fire is used to prepare land for planting or to stimulate the production of tender regrowth of grasses. In El Garcero region fire is also used as a hunting tool, a practice probably learned from the precolumbian inhabitants; today is habitual in regions of the neotropics, with seasonal environments and where indian cultures are relatively intact, such as the savanna regions of eastern Colombia and western Venezuela (llanos). Contrary to hunting/poaching, fires should not be a problem inside El Garcero, except for those that are started outside the reserve and spread accidentally windward to it. However, fires do occur inside El Garcero, some times quite a ways from our boundaries; certainy some could be related as was mentioned above to hunting practices, but there are some that are definitely arson. To understand the reasons behind this, we have to go back to the history of the properties. Prior to the acquisition of the La Buenaventura and La Floresta by the former owners (who later sold them to Neotrópicos), both fincas had been abandoned for sevaral years as their owners had difficulties paying back money borrowed on them; some landless or small ownwers in the vecinity slowly increased their control over parts of both fincas in the border with the communal pastures (playón) without complains from the owners who were parhaps unware of what was happening. This situation was changed when El Garcero was established; for the first time in many years, property rights are not excercised by absentee owners; naturally the afected members of the community were discontent, but they could not legally make anay claims, so they express their unhappiness by interfering with our work in a way that could be righteously interpreted as an accident or otherwise not easily prosecuted. It would be very simple, but very wrong, to inform the authorities of the situation and deal with the problem in a straight forward manner. We must take into account that our neighbors form a very tightly woven traditional society, with a very high degree of familial relationship. To them, including the landworkers of OED, we are simple outsiders, there today but tomorrow maybe somewhere else, who cannot be trusted and who do not deserve fidelity. Therefore we have to keep in mind our number one rule: i.e., the most important short term goal of OED is to gain the confidence, trust and support of our neighbors, without it we are doom to failure. It is clear from what have been said, that fire control requires very well tuned ways to deal with the social and cultural aspects of the practice as well. The strategy has been so far to concentrate in preventing the occurrence of fires an putting out those that eventually spread. We simple ignore the mediate causes and concentrate in the inmediate ones. But in the near future this approach will change; an scheme is being designed to involve directly the two neighbors with whom we share the longest boundaries in the playón (see future approaches below)

3.2.3.1 Fire ways. There has been a evolution in the characteristics and efectiveness of fire ways. Initially they were cleared too soon before the dry season was well onset and required expensive maintenance if a small rain or a cool spell happened; they were narrow, about 1 m, at each side of the outer fences, this proved to be insufficient, with large fires they failed to protect even the fence posts. Later on they were widened up to 4-6 m and more timely prepared, but again the costs of labor and time were outrageous. In December a portable, motor driven grass cutter was bought and the work was speeded up. However the timing of clearing is something that we have nor been able to master.

3.2.3.2 Patrolling and control. Involves activities inside the reserve and its inmediate boundaries in order to spot fires, wind direction and velocity, distance appreciate degree of risk and decide on the required actions. All workers and visitors are required to inform if they see a risk situation and to cooperate with the fire brigade if needed. Recently, following the example of Guanacaste fire control program the monitoring is complemented with fire damage evaluation; a data base is being developed to record all reports, incidents, damages etc., in order to improve the forecasting capacity and the design and implemetation of preventive or corrective measurements.

3.2.3.3 Trenches. To counter the poor timing that has plagued our fire control program, it was decided to dig trenches in the areas more prone to be afected, i.e., the fences along the playón. They are ca. 50 cm wide by 30 cm deep trenches, dug 2,5–3 m away and along the fences. Their purpose is to retain water that would slow down the spread of fire and to feed a water pump to put them out in case they spread any way. They work properly but are very expensive to build in terms of time and man power.

3.2.3.4 Fire resistant trees. As was noted above, the evaluation of fire damage permitted the identification of fire–resistant trees. Live–posts in the fences are being currently planted.

3.2.3.5 Future approaches. A cooperation program with the Guanacaste Nature Conservation District in Costa Rica was established earlier this year. Within the framework of this program, a workshop on habitat restoration and fire control was held in Costa Rica from 30.4.94 to 8.5.94, with the participation of 5 members from Neotrópicos. The ample experience of Guanacaste cannot be totally transferred to El Dorado; there are differences in the natural, socio–cultural and political–administrative conditions of the two regions, as well as in the size of the projects. However, there are many basic similarities that are definitely profitable for El Dorado. The report about the workshop has not come out yet, however some ideas were already discussed and will be tried out later this year. As was mentioned above it is almost certain that some fires last year were started by our neighbors from the playón. They basically resent that our fences denied them access to pastures which they could use before and that today are being let fallow. Well, the Paloverde reserve in Guanacaste in the alluvial plain of Tempisco river uses controlled cattle grazing before the end of the rainy season and on to the onset of the dry season to clear the fire ways. The land is rented out to cattle ranchers who have the compromise of building fences, driving the herds and in general of keeping their animals under control. The plan is to try a variation of this with one of our neighbors, by which we will allow free use of a corridor of 2,6 km x 30 m (7,9 ha). The main problem is how to control the cattle without the construction of a second inner fence, which will not be worthwhile to him because of the length. A possibility is to install a solar energy powered electrical fence wich requires very little labor and can be easily transported to where is needed. Some conversations along the lines of this experiment took place with our neighbor before I came to Germany, and the results were encouraging. However we want to take all precautions before launching this experiment; a failure due to misunderstandings could set back our work and have grave unforeseeable consequences. In Guanacaste controlled grazing is also utilized to accelerate succesion of open pastures, this process requires very delicate manipulation of intensities and timing in the movement of herds. While we are not ready to try this out yet, we have started to document the diversity of plants in pastures subjected to different instensities of grazing in El Paraiso, one of the neighboring fincas.