WINSTON CHURCHILL MEMORIAL TRUST

Exploring World Class Landscape Restoration

Travelling Fellowship Report

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The Winston Churchill Memorial Trust

The Winston Churchill Memorial Trust was established in 1965 when the great man died. As a mark of respect and gratitude for the man and his legendary leadership, thousands of people from the UK and overseas generously donated £3 million so that a living memorial to him could benefit future generations of British people.

The fund supports annually around 100 Travelling Fellowships and ten bursaries at Churchill College, University of Cambridge. The objective of the Travelling Fellowships is to enable British citizens to travel overseas on a worthwhile enterprise of the own choosing, with the aim of enriching their lives by the skills they gain and, on their return, enhancing the life of their community by their example and the dissemination of the benefit of their travels. These opportunities are provided to people of any age, gender, ethnicity, or religion, with or without educational qualifications and in any occupation or none.

Travelling Fellowships allow travel to almost anywhere in the world under a diverse range of project themes. The purpose of such a fellowship is to widen an individual's experience in such a way that he or she grows in confidence, knowledge, authority and ambition, and to bring benefit to others in the UK through sharing the results of the experience. This is achieved through:

- The inspiration provided by the individual's example – his or her subsequent performance and achievements, and
- The dissemination and application of new knowledge, different perspectives and innovative solutions.

Since 1966 some 4,450 fellowships have been awarded. In 2011, 105 fellowships were awarded for projects of between four and eight weeks.

For more details about the Trust and its work, and for information on how to apply, visit www.wcmt.org.uk.

Front cover photo: The road west to Estancia Menelik, thence the distant Andes of Argentine Patagonia.

SUMMARY

Combating land degradation is one of global society's major environmental challenges; the decay of our terrestrial resource directly affects the lives and futures of countless millions of people around the world. Restoring degraded landscapes is, therefore, a powerful way to rebuild ecological integrity and enhance the lives and livelihoods of people connected with them, for the long term.

In 2011 I received a Travelling Fellowship from the UK's Winston Churchill Memorial Trust to **Explore World Class Landscape Restoration**; so, between 16 October and 15 December 2011 I travelled through the Americas visiting the people, projects and places of some of the world's most significant landscape restoration projects. This report is the story of those projects.

At the outset, I define landscape restoration as:

The improvement of degraded land on a large scale that rebuilds ecological integrity and enhances people's lives.

This definition is deliberately and conveniently broad in order to encompass a diverse range of ambitions, activities, scales, environments and societies and end-uses.

Landscape restoration, as defined above, should aim to reconcile economic, social and environmental concerns within a holistic framework; the best projects utilise environmental improvements as drivers for socio-economic regeneration; less commonly, but more effectively, socio-economic development can be used to generate enduring environmental improvements.

My fellowship aimed to:

1. Identify and understand the main challenges to delivering world class landscape restoration projects.
2. Identify and understand the elements of success required to deliver world class landscape restoration projects.
3. Develop a set of generic recommendations that should apply to almost any project almost anywhere.

I took a pragmatic rather an academic or philosophical approach to meeting these objectives, which involved visiting the projects, meeting the people behind them and reviewing relevant literature before, during and after the visits.

At all times I was concerned with relating my findings back to Cornwall's china clay mining district in south-west England – an area dogged by diverse political interests, social decline and environmental degradation, but now on the cusp of a once-in-a-generation regeneration opportunity.

My fellowship involved visiting a range of scales and types of landscape restoration projects and meeting the people behind them. The approach focused primarily on what could be learned from first-hand, on-the-ground experiences that would be of use to other groups in other places struggling to deliver their own projects.

The places and projects that I visited were:

- **The Appalachian Regional Reforestation Initiative and allied projects of the eastern USA's central Appalachian coalfields** – an initiative that aims to restore the region's diverse temperate forest after extensive denudation by mountaintop removal mining.

- **The Comprehensive Everglades Restoration Plan and allied projects of Florida's Everglades** – a multi-billion dollar programme to restore a more natural hydrology to the Everglades to ensure water supplies for people, industry and the ecosystem's unique ecology.
- **Costa Rica's Area de Conservacion Guanacaste** where the restoration of **dry tropical forests** on degraded farmland has been underway for decades, alongside the simultaneous encouragement of a new economy based on conservation and eco-tourism.
- **Tropical island restoration in Ecuador's Galapagos Islands**, which aims to reverse the damage caused by introduced species and poorly-planned development.
- The **REGUA, Serra da Concordia Wildlife Sanctuary, SOS Mata Atlantica and Atlantic Forest Restoration Pact projects of Brazil's eastern seaboard**, all working towards **restoring the Atlantic Rainforest** – one of the most important and degraded forests in the world.
- **Three enormous mines in Brazil's Amazon Rainforest, namely: Carajas iron mine and Trombetas and Juruti aluminium mines**, all concerned with **re-growing the Amazon rainforest** after its land has been mined, and incorporating forest-derived socio-economic opportunities for local people in the future.
- **Pumalin Park, future Patagonia National Park and Estancia Menelik in Chilean and Argentine Patagonia**, which are creating, through restoration, **new regional economies** based on conservation, responsible farming practices and eco-tourism.

The fellowship focused mainly on projects in Latin America because:

- Environmental awareness is arguably at an earlier stage than in Europe and North America;
- Social and economic development are prime objectives of Latin American governments and societies, implying that landscape restoration projects there really need to incorporate these issues at the outset; and
- I was told that there is nothing interesting happening in terms of landscape restoration in Latin America!

This report is structured simply by destination in visit order, in which each project is described with associated conclusions and lessons. The final section, "Making Sense of it All", attempts to draw lessons from the experience and derive generic recommendations of broad applicability.

The report is intended neither as an academic treatise nor a formal consultancy document, but as a personal, practical account and analysis of my findings on the ground. It is aimed at anyone with an interest in landscape restoration and learning from the experiences of others. I have briefly included in the final section a summary of the key stages in an "ideal" landscape restoration a project, which could be used as a starting point for others contemplating pursuing their own projects. Ultimately, the report aims to inform, stimulate and inspire thinking on landscape restoration possibilities and opportunities elsewhere.

Complementing this report is the separate story of the journey itself, which has been written-up as a travel blog, available at www.petewa.blogspot.com, with many photographs of the above projects and locations.

Based on my fellowship and other experiences, I have attempted to draw out the key challenges likely to be experienced by landscape restoration projects and briefly discuss how these have been overcome in real situations. It goes without saying that all these challenges have been overcome somewhere at some time by a combination of creative thinking, collaboration, trust, necessity and

dedication. The following challenges have been identified and are discussed in detail in the body of the report:

- **Controlling the land**,
- **Funding**,
- **Project goals**,
- **Local community participation and development**,
- **Empowerment and capacity building**,
- **Constituency building**,
- **Scaling**,
- **Alien species**,
- **Changing perceptions**,
- **Reinventing the wheel**,
- **Institutional barriers**, and
- **Policy and legislation**.

In particular I have attempted to explain the main issues likely to arise under each theme and suggest generic, pragmatically-derived recommendations for overcoming them.

That said, delivering a world class landscape restoration project is about more than just ticking a check-list of stages and processes. In many ways it is an organic thing built on human relationships and evolving over years and decades with changing personal circumstances, societal expectations and the personalities involved. Inevitably, in all long-term projects, unpredictable events and opportunities occur that will need to be carefully considered and reacted to. The more flexibility and adaptability that a project has engrained into its modus operandi and collective philosophy, the more durable and ultimately successful it will be.

I am convinced that absolutely critical to every aspect of every successful project everywhere are several cross-cutting themes without which a project will fail and that I call, for want of a better term, **"the oil in the machine"**. They are:

- **Leadership**,
- **Communication,**
- **Collaboration,**
- **Knowledge,**
- **Creativity and beauty,** and
- **Culture.**

These are also discussed in detail in the report, particularly in relation to developing the means for maximising their effectiveness – again generic and practically-based recommendations are suggested for each theme.

Ultimately, the Cornish Claylands provided the inspiration for my original application for a Winston Churchill Memorial Trust Travelling Fellowship. Unbeknown to me at the time, this presented a once-in-a-lifetime opportunity to become inspired by ordinary people doing extraordinary things in some of the world's most challenging places. Not all were millionaires – far from it; not all were ecologists or environmentalists; but all set out on a selfless journey of their own, not quite knowing how they would reach their destination or even where it was, but driven by a passion to make a difference, set an example and leave a legacy.

In most of the people I met I sensed a frustration that they wished they could do more, but that a human lifetime is inevitably limiting. We may not know all the answers, but we know enough now to make substantial improvements to degraded lands and their people so, quoting directly many colleagues mentioned in this document:

“Just do it!”

ACKNOWLEDGEMENTS

My Winston Churchill Memorial Trust Travelling Fellowship was a life-changing experience, enabling me to visit places, meet people and learn things that I had only previously dreamed of. I am indebted to the Trust for their support and assistance in making this possible.

I would also like to thank my former and current employers, the Eden Project (Tim Smit and Dr. Tony Kendle) and Wardell Armstrong International (Nick Coppin) respectively, for their support in allowing me to undertake this adventure.

My journey required months of planning and correspondence with people on the ground in the different areas that I visited. They, and their teams, kindly and generously helped with logistics and hospitality, sparing time, imparting knowledge and kindly commenting on drafts of sections of this report. They are, in order of destination:

- **Central Appalachian Coalfields, USA:** Dr. Patrick Angel and Jim Holliday, US Office of Surface Mining Reclamation and Enforcement;
- **Everglades, USA:** Erica Robbins and Jennifer Domashevich, US Army Corps of Engineers;
- **Area de Conservacion Guanacaste, Costa Rica:** Professor Dan Janzen and Dr. Winnie Hallwachs, University of Pennsylvania, USA;
- **Galapagos Islands, Ecuador:** Dr. Mark Gardener, Charles Darwin Foundation and Mandy Trueman, Charles Darwin Foundation and the University of Western Australia;
- **Mata Atlantica, Brazil:** Nicholas and Raquel Locke and Jorge Bizzaro, REGUA; Roberto Lamego, Serra da Concordia Wildlife Sanctuary; Rafael Bitante Fernandes, SOS Mata Atlantica; Pedro Castro, Atlantic Forest Restoration Pact;
- **Amazon, Brazil:** Alexandre Castilho, Vale; Domingos Campos and Volnei Tenfen, ALCOA; and
- **Patagonia, Chile and Argentina:** Doug and Kris Tompkins, Conservation Land Trust; Carolina Morgado and Carlos Zambrano, Pumalin Park; Kate Farthing and Dagoberto Guzman, Conservacion Patagonica; Rafael Smart, Cielos Patagonicos.

During the Patagonia section of my journey I had the good fortune to spend 10 days in the company of two American ladies, Lisi Krall and Jane Philips. I would like to thank them for their generosity, patience and fascinating discussions – particularly during days of seemingly endless driving through Patagonia.

I reserve the biggest thank you to my wonderful, long-suffering family – my patient and understanding wife, Maxine, and my two beautiful daughters, Alice and Katie – who allowed me to leave home for a two-month adventure, while they manned the fort back home and prepared for Christmas.

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1 INTRODUCTION

Combating land degradation is one of global society's major environmental challenges; the decay of our terrestrial resource directly affects the lives and futures of countless millions of people around the world. Restoring degraded landscapes is, therefore, a powerful way to rebuild ecological integrity and enhance the lives and livelihoods of people connected with them, for the long term.

In 2011 I received a Travelling Fellowship from the UK's Winston Churchill Memorial Trust to Explore World Class Landscape Restoration; so, between 16 October and 15 December 2011 I travelled through the Americas visiting the people, projects and places of some of the world's most significant landscape restoration projects. This report is the story of those projects.

1.1 DEFINING LANDSCAPE RESTORATION

I define landscape restoration as:

The improvement of degraded land on a large scale that rebuilds ecological integrity and enhances people's lives.

This definition is deliberately and conveniently broad in order to encompass a diverse range of ambitions, activities, scales, environments and societies and end-uses. Key aspects of the definition are that landscape restoration activities should:

- **Improve degraded environments by rebuilding ecological integrity by:**
  - Reducing/ reversing the pressure that is causing the decline;
  - Reintroducing biodiversity that is missing or has declined;
  - Connecting now disconnected landscape elements;
  - Involving a mosaic of ecological habitats, communities, land-uses and interest groups;
  - Ensuring that existing communities and habitats are enhanced by the restoration programme; and
  - Enhancing ecosystem functions ultimately aiming towards a self-sustaining system.
- **Operate on a large (temporal or areal) scale by**:
  - Recognizing that large-scale projects consist of smaller projects on the ground and they should be encouraged as they are easier to conceptualise and deliver;
  - Encouraging the smaller projects to collaborate so that the beneficial impacts are scaled up and synergy is encouraged;
  - Considering the landscape beyond its geographical confines to offer new opportunities for communities and habitats outside the immediate scope of the restoration programme in question;
  - Considering trends in ecological and socio-economic systems, including climate change impacts, human migration patterns, changes in land-use, etc.;
  - Working within a holistic, sustainable development framework such that environmental, socio-economic and cultural issues are given due consideration before a balanced outcome is reached; and
  - Taking a long-term perspective – generations, decades, centuries.
- **Enhance people's lives** by**:**
  - Creating employment opportunities related to the restored landscape in question;

- Developing opportunities for enhancing knowledge and/or skills;
- Improving the quality of life for local people;
- Incorporating the hopes and aspirations of local people into a landscape vision, and work towards achieving that vision; and
- Developing/ continuing the human narrative as told through a landscape by engendering a sense of place and reaffirming cultural identity.

Central to my definition above is the consideration that too often, social development programmes ignore the fact that the natural environment may provide a source of on-going future livelihoods after rehabilitation and, similarly, environmentally-focussed rehabilitation programmes do not necessarily consider the needs of people and communities when determining final land use options. Landscape restoration, as defined above, should aim to reconcile economic, social and environmental concerns within a holistic framework; the best projects utilise environmental improvements as drivers for socio-economic regeneration; less commonly, but more effectively, socio-economic development can be used to generate enduring environmental improvements.

Such considerations are fundamental to many aspects of the sustainable development paradigm although it is understood that most landscape restoration projects will satisfy only some of the above criteria within one project.

1.2 APPROACH

Every landscape restoration project is a unique response to a specific set of challenges and opportunities, yet there are common generic challenges addressed in all of them. My fellowship, including the travel, project visits and research before and since, has attempted to unpick various projects to identify the generic elements critical to delivering landscape restoration success.

1.2.1 AIMS

My fellowship aimed to:

1. Identify and understand the main challenges to delivering world class landscape restoration projects.
2. Identify and understand the elements of success required to deliver world class landscape restoration projects.
3. Develop a set of generic recommendations that should apply to almost any project almost anywhere.

At all times I was concerned with relating my findings back to Cornwall's china clay mining district in south-west England – an area dogged by diverse political interests, social decline and environmental degradation, but now on the cusp of a once-in-a-generation regeneration opportunity.

1.2.2 METHOD

My fellowship involved visiting a range of scales and types of landscape restoration projects and meeting the people behind them. A pragmatic approach was central and focused primarily on what could be learned from first-hand, on-the-ground experiences that would be of use to other groups in other places struggling to deliver their own projects.

I did not examine to deeply the philosophies behind such work, although I recognize that this is a subject ripe for analysing man's relationship with the planet, nor did I pursue any particularly academic avenues. My "what worked and what didn't" approach considered the following generic aspects:

- Overcoming the barriers of institutional politics, funding, technology/ knowledge and communication.
- Funding models.
- Building a broad, multi-stakeholder project team:
    - The different roles and disciplines involved, including leadership;
    - Multi-stakeholder collaboration and management over the long term; and
    - Moulding different motivations towards a common objective.
- Approaches to project governance.
- The technical aspects of:
    - Restoring biodiversity; and
    - Restoring ecosystem functions and services.
- The role of education.
- Improving local lives and livelihoods:
    - Encouraging community participation;
    - Capacity building;
    - Creating new livelihoods;
    - Delivering socio-economic benefits from ecological improvements and vice versa; and
    - Creating viable environmental and socio-economic connections between the project area and surrounding landscapes and communities.

Project information was gleaned from site visits and tours, personal observations, presentations, background reading, assisting with fieldwork and, mainly, through informal discussions with project personnel (Photo 1.1).

Photo 1.1. In conversation with ARRI's Patrick Angel, on a reclaimed mountaintop removal site.

1.2.3 PROJECTS AND LOCATIONS

I deliberately selected a diverse range of restoration projects that varied in scale, type and location, the intention being that this would aid the identification of generic aspects of wider applicability. The destinations and projects selected are identified in Table 1.21 and 1.2 and Figure 1.1.

I have been aware of the two North American projects for several years and, finally, through the award of my fellowship, had the opportunity to visit them. They are interesting because of their vast geographic, financial and temporal scales; however, I focused mainly on projects in Latin America because:

- Environmental awareness is arguably at an earlier stage than in Europe and North America;
- Social and economic development are prime objectives of Latin American governments and societies, implying that landscape restoration projects there really need to incorporate these issues at the outset; and
- I was told that there is nothing interesting happening in terms of landscape restoration in Latin America!

Table 1.1. Summary of the locations visited during my fellowship and brief project details.

Location	Projects
Central Appalachia, USA	**Appalachian Regional Reforestation Initiative and allied projects** Temperate forest restoration after extensive denudation by mountaintop removal mining.
Everglades, USA	**Comprehensive Everglades Restoration Plan and allied projects** Restoring a more natural hydrology to the Everglades by combination of civil engineering and applied ecology.
Area de Conservacion Guanacaste, Costa Rica	**Tropical dry forest restoration in Santa Rose National Park** Restoring tropical forests from old farmland and encouraging a new regional economy based on conservation and eco-tourism.
Galapagos Islands, Ecuador	**Tropical island restoration** Reversing the extensive damage caused by alien species of plants and animals.
Mata Atlantic, Brazil	**REGUA, Serra da Concordia Wildlife Sanctuary, SOS Mata Atlantica, Atlantic Forest Restoration Pact** Different approaches to restoring one of the most important rainforests in the world in east Brazil.
Amazon, Brazil	**Carajas iron mine, Trombetas and Juruti aluminium mines** Regrowing the Amazon rainforest after its extensive removal for large-scale mining.
Patagonia, Chile and Argentina	**Pumalin Park, future Patagonia National Park, Estancia Menelik** Creating, through restoration, new regional economies based on conservation and eco-tourism that work with the grain of nature rather than against it.

My itinerary is provided in Table 1.2 and further details of each project, including key findings, are provided in subsequent sections of the report.

Table 1.2. My itinerary.

Dates	Location/ activity
16-17 Oct	Transfer from home in Cornwall, UK, to Wise, Virginia, USA, via Washington, D.C.
18-21 Oct	Drive to Hazard, Kentucky. Visit Appalachian Regional Reforestation Initiative sites
22 Oct	Transfer to Florida Everglades
23-26 Oct	Visit Comprehensive Everglades Restoration Plan sites and allied projects
27-29 Oct	Transfer to, and visit, Area de Conservacion Guanacaste, Costa Rica
29-31 Oct	Transfer to San Jose, via Playa Hermosa
1 Nov	Visit Poas Volcano National Park
2-3 Nov	Transfer to Santa Cruz Island, Galapagos, via Quito, Ecuador
4-9 Nov	Visit island ecological restoration projects, Galapagos
10-11 Nov	Transfer to Rio de Janeiro, Brazil
12-13 Nov	Bus to, and visit, REGUA project
14 Nov	Bus to, and visit, Serra da Concordia Wildlife Sanctuary
15-16 Nov	Bus to Sao Paulo. Intended meeting with Atlantic Forest Restoration Pact, Sao Paulo
17 Nov	Bus to SOS Mata Atlantica and return
18-19 Nov	Transfer to, and visit, Carajas iron mine, Amazon
20 Nov	Transfer to Belem
21-23 Nov	Transfer to, and visit, Trombetas and Juruti aluminium mines. Transfer to Santarem
24-26 Nov	Transfer to Puerto Montt and bus to Caleta Gonzalo, Pumalin Park, Patagonia, Chile
27-28 Nov	Visit Pumalin Park
29-30 Nov	Drive to future Patagonia National Park
1-3 Dec	Visit future Patagonia National Park
3 Dec	Drive to, and visit, Estancia Menelik, Patagonia, Argentina
4 Dec	Visit Estancia Menelik and Perito Moreno National Park, then drive to El Calafate
5 Dec	Visit Glaciers National Park
6-7 Dec	Bus to Ushuaia, Tierra del Fuego, Argentina
8-10 Dec	Visit Ushuaia and environs
11-13 Dec	Transfer to, and visit, Buenos Aires
14-15 Dec	Transfer to home, Cornwall, UK

Figure 1.1. The locations visited. A Google map of the journey is available at petewa.blogspot.com.

1.3 ABOUT THIS REPORT

This report is structured simply by destination in visit order, in which each project is described with associated conclusions and lessons. The final section attempts to make sense of the whole experience and draws out generic recommendations of broad applicability.

The report is intended neither as an academic treatise nor a formal consultancy document, but as a practical account and analysis of my findings on the ground. It is aimed at anyone with an interest in landscape restoration and learning from the experiences of others. Ultimately, it aims to inform, stimulate and inspire thinking on landscape restoration possibilities and opportunities elsewhere.

To offer a more personal context, I have included brief extracts from my travel journal at relevant places in the narrative, and the report is written largely in the first person. It contains fewer images than I would have liked owing to the need to limit the size of the electronic version of the document for the Winston Churchill Memorial Trust website. A second version of the report is also available containing the same text but with many more photographs, and is available from my blog (www.petewa.blogspot.com). All financial figures are given in US dollars and standard international units are used throughout.

Complementing this report is the separate story of the journey itself, which has been written-up as a web-based, picture-rich, travel blog, entitled Chasing the Sun, which is also available at the above web address that also contains my contact details. The fascinating place histories and human stories that I encountered on my journey, and briefly touch on here and there throughout this report, will provide extra material for a book of the overall experience at some later date.

Fall

2 CENTRAL APPALACHIAN COALFIELDS, USA

ARRIVING…

My first destination was central Appalachia's vast coal-mining region, around the nexus of the three US states of Kentucky, Virginia and West Virginia. The drive there from Washington DC, through mid-October's Autumnal gold, was spectacular:

Organic gold leaf shimmers in the breeze and scatters across my path - a natural signpost to a new seasonal direction. I drive south, the sun in my face, for hour after hour, on a black ribbon through the golden heart of Virginia. Scratch beneath the tarmac and you'll glimpse the soul of a nation born in forest and forged in war. Forest hems in roads and farms, defining their geography, while every road sign seems to indicate another Civil War battlefield, or memorial to veterans. Despite initial trepidation the drive has been straight-forward, until the last couple of miles that is, when I take a slight detour: as dusk descends the road narrows, traffic thins, trees grow more intimidating and roadside shacks become more unkempt. Dirt tracks lead off into the woods - strangely inviting, yet tempting Deliverance.

The primary objective of my Appalachian journey was to meet the people and visit the sites of the Appalachian Regional Reforestation Initiative (ARRI), which is restoring native hardwood forests on the extensive coal-mining-damaged landscapes of this part of the USA. My key contacts were Patrick Angel and Jim Holliday of the federal Office of Surface Mining Reclamation and Enforcement (OSM) based in London, Kentucky.

2.1 CONTEXT

The eastern United States region of Appalachia is formally recognized as a distinct cultural region of the USA that derives from its mountainous geography hindering communications and fomenting isolation, a unique natural history of diverse, temperate forests and a human history of industrial exploitation of abundant coal reserves and logging. The region stretches along the Appalachian mountain chain, from north-east Mississippi to south-west New York State. Covering over 528,000 km^2, it is home to over 25 million people[1].

Coal was discovered in here in the mid-18th century. The Appalachian Coal Basin covers 163,200 km^2 and, today, is one of the most important coal-producing regions of the US and one of the biggest in the world. Since 1830 an estimated 32 billion tonnes of bituminous coal has been mined with an estimated potential reserves of 60-90 billion tonnes remaining[2].

Mining is concentrated around a few centres in the region – particularly in the central Appalachia area that encompasses eastern Kentucky, south-western Virginia and West Virginia– the focus of my visit to the Appalachian coalfields (

Figure 2.1). The geography of this area is dominated by the Cumberland Plateau. The predominant landscape is a deeply dissected plateau with a typical relief of about 120 metres, characterised by narrow valley floors and hill tops and steep valley sides (Photo 2.1).

The natural vegetation is dominated by forests of predominantly deciduous, broadleaf, hardwood trees. These forests are some of the most biologically diverse temperate forests on the planet owing largely to the fact that much of the area acted as ice age refugia, escaping glaciation during recent

ice ages. Alongside the high plant diversity, the region is enriched in birds and amphibians, particularly salamanders – an Appalachian speciality. The myriad rivers and streams contain uniquely high biodiversity, particularly of freshwater fish and shellfish species.

Photo 2.1. Typical topography and forest of central Appalachia.

This ecosystem is considered to be endangered with 95% regarded as being degraded due to coal mining, logging, plantation forestry and the depredations of increasing deer populations. Rivers are also impacted by damming and the effects of coal mining.

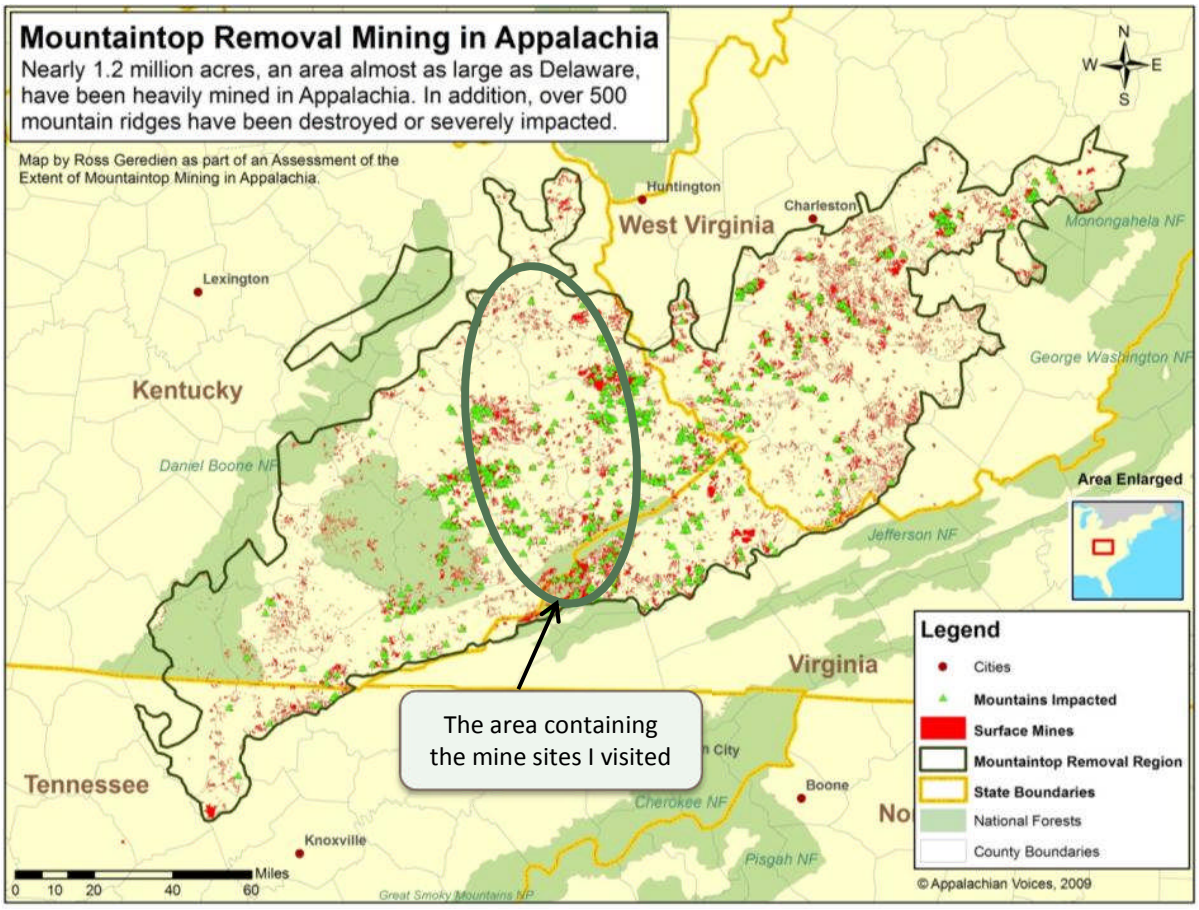


Figure 2.1. Central Appalachia showing mountaintop removal sites and the area of interest[3].

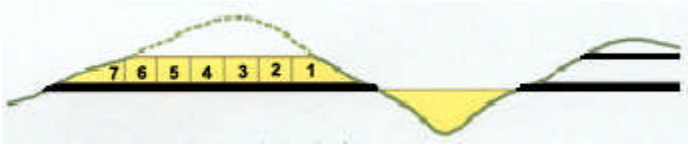
With increasing coal mine mechanisation during the mid- to late-20th century came large-scale unemployment in the coalfields. Many of the Appalachian counties of eastern Kentucky are the

poorest in the whole Appalachia region, including Perry County, where I spent some time exploring landscape restoration work.

2.1.1 MOUNTAINTOP REMOVAL MINING

Appalachian coal mining has utilised a variety of underground and surface mining techniques. The relatively new practice of mountaintop removal (MTR) mining is particularly controversial and is concentrated in central Appalachia (Figure 2.1). Compared to other mining techniques practiced in these coalfields, MTR is an economically effective and safer way to remove entire coal seams within 150 metres of a mountain top. The sheer scale of mining is breath-taking with eastern Kentucky alone estimated to use 1,000 tonnes of explosive daily in surface mining operations.

Step 1. Rock (overburden) above the coal seams is removed



Step 2. Upper coal seams are removed and rock waste is placed in an adjacent valley.

Step 3. Draglines excavate the lower coal seams, placing the waste rock in spoil piles.

Step 4. Regrading begins as coal excavation continues.

Step 5. Once the coal has been removed, the area is given a final regrade and then revegetated.

Figure 2.2. The process of mountain top removal mining[4].

After deforesting the land to be mined, the lumber being either sold or burned, the overburden overlying the seams is extracted with explosives and machinery to expose the coal, which is removed by enormous, dinosaur-like drag-line machines. The overburden is restacked back on the ridge to

mimic the approximate original mountain contour. Excess overburden is tipped into neighbouring valleys, filling them in the process, known colloquially as “holler fills” (valley fills). The scale is enormous – a single operation can cover thousands of hectares and involve the translocation of tens of millions of tonnes of rock. The development of the new post-mining landscape is illustrated in Figure 2.2 and the scale of the operations can be seen in Photo 2.2.

Photo 2.2. Buffalo Mountain mountaintop removal site, Logan County, West Virginia[5].

Surface mining for central Appalachian coal began in the first half of the 20th century when environmental regulation was non-existent. The process involved simply blasting then pushing the rock waste downhill letting gravity do the rest resulting in loose, unstable piles of rock that were susceptible to erosion with a high potential for mass instability leading to landslides. These could and did endanger down-gradient dwellings and communities and, frequently, people were killed in their homes. Such accidents encouraged the growth of the anti-mining movement and “the law of the Winchester”, but “the trees grew like hell!” Today, timber, including the most valuable

hardwood trees – yellow poplar, black walnut, and white oak, is being cut commercially on old strip mined land where trees naturally recolonized mined sites in the 1940s, '50s and '60s. The highest site index of these trees in the region is found on old strip mine sites.

SMCRA

The 1977 federal Surface Mining Control and Reclamation Act (SMCRA) legislation mandates the reclamation practices of surface mines in the US and put an end to the down-slope, loose-tipping of mineral wastes and required a mine site to be graded/ compacted as tightly as possible to the approximate original contours[6]. SMCRA also required that reclamation must create "a level plateau or a gently rolling contour with no highwalls remaining". However, regulatory agencies can waive such requirements to allow MTR.

Typically, during the preparation of a site for mining, after deforestation topsoils should be removed and stored appropriately for future use. After the final emplacement and grading of the overburden, topsoil or a substitute is spread over the surface. Grass seed is then spread as a mixture of seed, fertilizer and mulch. Tree-planting then occurs if the pre-approved post-mining land use is forest. The land owner can request alternative post-mining land uses, such as pasture land and economic development, or other uses specified by SMCRA.

Traditionally, the reclamation of MTR sites has focused on land stabilisation and the control of erosion, including heavy compaction and the planting of quick-growing, non-native grasses such as *Lespedeza cuneata* to protect the new surface and reduced dust blow.

ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACTS

The sheer scale of MTR mining means that its impacts are correspondingly large. Physically, a new landscape of grassy, upland plateaus has been created where once there was continuous forest covering the narrow ridge tops and valleys and steep valley sides. More than 450 mountains and summits in Appalachia have already been destroyed by MTR[7]. Other significant statistics that illustrate the impressive scale of landscape damage were released by the EPA in 2005[8]:

- 5,700 km^2 of Appalachian forests were predicted to have been cleared by MTR by this year (2012);
- More than 7% of Appalachian forests were cut down between 1985 and 2001;
- Over 2,000 km^2 of mountains are estimated to be already destroyed (equal to a 400-metre swathe of destruction from New York to San Francisco).

For years SMCRA-mandated reclamation objectives controlled erosion and maintained slope stability by means of compaction and re-vegetating with fast-growing, exotic herbaceous species. Excessive compaction promotes surface run-off rather than infiltration, compared to the natural system. Compaction and ecological competition from the herbaceous vegetation cover interact to severely restrict natural colonisation by native woody species, and also creates a fire risk. Consequently, the expansive, compacted, upland plateaus have been described as a "biological desert" – particularly pertinent considering the vast ecological wealth of the precursor natural forest system (Photo 2.3).

Equally devastating, and on a similar scale, has been the impact of the valley fills and enhanced run-off on surface water quality. The EPA's 2005 report highlighted that over 1,900 kilometres of streams across the region were directly impacted by MTR activities between 1992 and 2002, and an estimated 1,160 stream kilometres were buried under valley fills from 1985 to 2001.

Photo 2.3. “Biological desert”.

The combination of altered surface drainage, high surface run-off and large expanses of upland water-capturing plateaus have increased the risks of flash flooding during extreme rainfall events, which have damaged some valley floor communities. Conversely, wells that supply potable water to some communities have dried up or have become contaminated and, consequently, undrinkable.

The burial of river headwaters has had substantial and significant detrimental effects on water chemistry (including elevated sulphates, metal ions, pH, conductivity, total dissolved solids, declining river biodiversity and water quality). This has knock-on effects on central Appalachia’s renowned aquatic biodiversity and on surface water users.

Central Appalachian communities in the vicinity of the MTR mining areas have been affected in numerous ways. Significantly, over the years, unemployment has risen sharply as the increased mechanisation of MTR means more coal can be mined by fewer people. For instance, underground mining used to provide the majority of US coal. MTR allows two and a half times as much coal to be mined per worker per hour[9]. In Kentucky, between 1979 and 2006, the number of mine workers declined from 47,190 to 17,959 (a drop of 60%)[10]. In West Virginia in the 1950s there were an estimated 125,000-145,000 coal miners, today there are about 16,000, while during that time coal production has increased[11].

Direct unemployment creates knock-on effects down the supply chain, in a region dominated by this one industry. Ultimately this leads to high unemployment, out-migration of the skilled and young, family break-up, social problems and declining communities. This negatively affects the reputation of the region and, combined with the degraded landscape and negative media stereotyping, detracts external investment and the attraction of new talent.

Recent years have seen an intense focus on the issue of MTR and its negative effects by a vast array of groups, from government, to private sector, community and non-governmental organisations. Academic research is analysing and proving the negative effects. There have been several legal challenges to practices of MTR by government agencies and environmental groups.

2.1.2 RESTORATION ISSUES

Since its implementation SMCRA has obligated coal mine operators, through the use of reclamation bonds based on a levy per tonne mined, to restore their mined land in a way that encourages future land use. An element of these funds is allocated to restoring abandoned – or legacy – surface mine sites. The legislation requires detailed reclamation plans before mining takes place followed by assessments of vegetation progress till the bond is released five years after mining ends. The coal operators do not usually own the land and are primarily interested in meeting the terms of the bond

release, satisfying the regulators and moving on. Such revegetation traditionally has been to "hayland/ pasture" - intended as suitable for grazing, while much of the rest is designated as unmanaged forest land. Aesthetically such sites look better when compared to analogous sites pre-SMCRA, but it does nothing to ensure the most appropriate land use will be implemented in the long run. These older, bond-released mine sites are characterized by excessive soil compaction and a thick herbaceous cover and are typically in a state of **arrested natural succession**. Grazing in such areas is often poor and better economic returns for landowners could be developed from alternative land uses. Ecological succession to hardwood forests will occur naturally over decades/ centuries, but both landowners and society have a more immediate interest in initiating a longer term return from the land.

Appropriate reforestation provides an environmentally and economically viable post-mining land-use option for both the landowner and the mining company. Environmental benefits include:

- Increased biodiversity of native species;
- Rapid development of ecological processes: succession, decomposition, nutrient cycles, etc.;
- Ecosystem services: soil and water conservation, water quality improvement; and
- Carbon sequestration.

Socio-economic benefits include:

- Increased timber value;
- Landowner tax reductions;
- Enhanced recreational opportunities;
- Local employment;
- Local tax revenue; and
- Aesthetic improvement.

2.2 THE APPALACHIAN REGIONAL REFORESTATION INITIATIVE

In the mid-1990s, University of Kentucky scientists began raising concerns about poor natural forest recovery on reclaimed sites. Eventually they persuaded the OSM that the physical issue of surface stability and the ecological issue of forest recovery could be solved.

In response, in 2004, the Appalachian Regional Reforestation Initiative (ARRI) was created from the bottom-up as foresters and soil scientists started listening in earnest to the environmental scientists and forest ecologists.

2.2.1 ARRI'S APPROACH

ARRI is the biggest tree-planting scheme in North America and aims to encourage the restoration of high quality, native, hardwood forests on reclaimed coal mines in the eastern USA, i.e. to re-establish the forests that existed prior to mining. The initiative in ambitious; in December 2008, it pledged to plant 38 million trees over three years on mined lands as part of the United Nations Environment Programme's Billion Tree Campaign[12]. This builds on impressive tree planting performances in previous years, such as 2007, when 12.7 million trees were planted.

ARRI, through people like Patrick Angel and his colleague Scott Eggerud, has managed to encourage current coal mining operations to take a more progressive approach to post-mining reclamation, by

planting native trees during their reclamation schemes. To date, over 70 million trees have been planted on sites that would otherwise have been reclaimed to the ecologically-pointless herbaceous seed mix.

However, there is a legacy of between 304,000 and 405,000 hectares (750,000 - 1 million acres) of reclaimed surface mine sites that complied with the regulatory regime at the time of their rehabilitation. The issue of restoring forests on such sites boils down to confronting the technical issue of relieving compaction and funding the operations.

TECHNICAL PRACTICES

On a small scale, ARRI needed first to prove that trees could be successfully established in these conditions. They did this by:

1. Alleviating compaction by ripping the soil with a 1.3 metre ripping shank on the back of a D9 bulldozer;
2. Sourcing native trees from commercial nurseries; and
3. Engaging people to plant the trees.

With little money, they relied on in-kind donations of a D9 and driver from a mining company and the tree-planting efforts of local Sierra Club volunteers.

Planting trees over just one hectare of this post-mining terrain costs about $1,500, including dozer hire, trees, planting, etc. Incidentally, the alleviation of compaction by ripping reduces surface water run-off during rain fall by increasing its filtration into the substrate, thus moderating the risks of soil erosion and flash flooding.

Based on sound science and demonstration, ARRI has developed a simple bespoke methodology for overcoming the technical barriers to planting trees on these post-mining landscapes, known as the **Forestry Reclamation Approach (FRA)**. The FRA's strategic goals include:

- Planting more high-value, hardwood trees on reclaimed surface mined lands in Appalachia;
- Increasing the survival rates of planted trees;
- Increasing the growth rates and productivity of the surviving trees; and
- Expediting the establishment of forest habitat through natural succession.

Several FRA demonstration projects exist to showcase the techniques involved. **Forest Reclamation Advisories**, prepared by the ARRI Science Team, describe practices that can be used to create productive, diverse forests on reclaimed coal mine sites and explain the rationale for recommending the use of such practices. This advice is aimed at the stakeholders who conduct and influence coal mine reclamation and reforestation practices such as: coal company staff, contractors, land owners and natural resource agency personnel.

Some regulatory barriers have been overcome as state regulations have been modified to facilitate the FRA technique for establishing forests as a post-mining land-use, such as in the states of Tennessee and Virginia, to allow a reduction in ground cover vegetation requirements to improve restoration success with trees.

The benefits of collaborative approaches between regulators, practitioners and researchers, and the use of successful demonstration projects enables cultural barriers to be addressed, enabling the over-turning of widely accepted, but outdated, methods of mine site restoration. A fringe benefit

has been the encouragement of mutual understanding between previously opposing groups, such as miners and conservationists, during tree-planting exercises.

The progress of planting trees on legacy mine sites has advanced slowly but surely, with increasing confidence by the organisers:

- **2009;** 28,800 trees on 16 ha across 10 sites by 500 volunteers. No funding.
- **2010;** 140,000 trees on 80 ha across 17 sites by 2,000 volunteers. A little funding.
- **2011;** 500,000 trees on 275 ha across 18 sites by 1,700 volunteers. More funding.

These small-scale plots have been critical in raising awareness and proving the concept. Refinements to the tree-planting process are always being researched to try and reduce costs and improve results.

On a grey day, pouring incessantly with rain, Patrick and I were accompanied by Professor Chris Barton of the University of Kentucky's Department of Forestry. We drove through another devastated, east Kentuckian, MTR landscape to visit some of Chris's long term tree planting demonstration sites at the Star Fire Complex – the very ones that were used to persuade Patrick and others of the efficacy of planting native hardwoods on these seemingly impossible mountaintop removal sites.

The first site was planted in 1996. The critical role of compaction in hindering successful tree establishment was realised when, after 11 years, tree survival was less than 10% and those that remained were severely stunted. The berms that surrounded the planting sites had been planted at the same time and now these trees are eight metres high – the stunted companions in the main site were a maximum of 1.5 metres.

Photo 2.4. Patrick's "tree cookies" of 17-year-old white pine trees on different mining substrates. The left-hand example is from a tree grown on loose-graded mine waste.

A new set of experiments was established to investigate how to avoid compaction in the first place during the reclamation of working mine sites. They found that simply end-dumping waste rock, including coarse boulders, from the back of a truck over the compacted, post-mining substrate, followed by loose-grading by one or two passes with a small bulldozer to strike-off the tops of the piles, provided a much better substrate for the establishment and growth of trees. In fact the native trees chosen grew better than equivalent trees in normal soils (Photo 2.4). This approach is not favoured by purists, who prefer a smooth, flat, post-mining surface, but tree-planters prefer it as it is easier to plant trees in the loose, soft substrate. The end results speak for themselves.

Further research is underway to determine the best types of rock waste for growing trees, particularly in terms of the substrate chemistry that they produce.

SPECIES CHOICE, PLANTING AND AFTERCARE

Species choice is based on the ability to cope with the infertile, compacted terrain, the value to overall biodiversity and long term economic value, with the intention of encouraging the growth of employment in forest industries over the long term (as a means of diversifying the economy from a primary coal-mining focus). An important species is the black locust (*Robinia pseudoacacia*) which, as a leguminous tree, fixes atmospheric nitrogen in root nodules and naturally fertilises the soil. It is well adapted to grow in infertile soils.

Some sites require some limited aftercare, usually spot spraying with herbicide to control weeds until the trees have become established, which normally takes two to three years. On undisturbed native soils, canopy closure generally occurs after 15 to 20 years.

On one 27-year-old site, black cherry trees were planted over 10 hectares with a survival rate of 85-90%. Their economic value as timber is $500 per 1,000 board feet. Commercial foresters would be satisfied with a survival of 70% on secondary forests growing on old fields.

ORGANISATION AND VOLUNTEERING

Organisationally, ARRI is structure like the layers in an onion. The first, inner layer is the Core Team, consisting of 25 federal (OSM) and state government employees from the seven states. The second layer is the Science Team, comprising 25 to 35 research scientists from 12 to 14 universities across Appalachia, OSM, the US Forest Service, US Geological Survey and the American Chestnut Foundation, who have voluntarily signed up to the ARRI concept.

Until very recently ARRI had just two full-time employees, one of whom was Patrick. In response to the growing interest in planting trees on legacy mine sites, the ARRI Science Team set-up a non-profit organization called **Green Forests Work (GFW)**. The GFW programme offers an economic development plan for Appalachia styled after the US's Civilian Conservation Corps of the 1930s and will focus on restoring ecosystem services on mine-scarred lands and creating jobs in the process. Successful re-establishment of the hardwood forests will provide a renewable, sustainable multi-use resource that will create economic opportunities while enhancing the local and global environment. The jobs will include everything from employment in tree nurseries, equipment operators, tree planters, forest managers and wildlife biologists to those that may manage these sites for renewable energy and climate change mitigation. At the time of writing a recent grant success has enabled the recruitment of the following staff: a full-time, MBA-qualified administrator to manage ARRI; two

foresters to work with GFW and another to work with The American Chestnut Foundation; and a community liaison officer with the Appalachian Coal Country Team.

The core and science team members contribute to the reforestation initiative above and beyond their normal duties with state and federal agencies and universities. Tree planting on active mine sites is funded by the coal industry as part of their reclamation obligations and most of the tree planting each spring is by migrant labour. On the legacy sites, however, a great deal of effort is expended in engaging watershed groups and communities through tree-planting activities on previously mined land by volunteers and students from local schools, OSM employees, state government staff and other community groups. A range of watershed and conservation volunteer groups, often organized by OSM/ Volunteers in Service to America (VISTA), take responsibility for tree-planting in their locales, raising publicity and encouraging community buy-in[13].

In the spring of 2009, ARRI collaborated with the Appalachian Coal Country Watershed Team – now known as the Appalachian Coal Country Team (ACCT) – on 11 tree planting projects in five states. The ACCT is an innovative partnership between OSM, concerned with environmental reclamation and safety, and AmeriCorps*VISTA, concerned with poverty, currently consists of 33 OSM/ VISTA volunteers. It was founded in response to requests from small, community volunteer-based, watershed groups throughout coal country to target problems associated with the legacy of pre-regulatory coal mining in Appalachian watersheds. The 11 tree planting projects are being considered prototypes or pilot projects for a larger regional effort that could develop as an economic package creating green jobs. The projects involved 533 volunteers planting nearly 30,000 trees on mine sites. Evolving from these efforts, in summer 2009, ARRI announced the Green Forests Work for Appalachia proposal to create 2,000 rural jobs in coalfield communities planting 125 million trees on over 70,000 hectares by 2014, and funded the project in 2011. ARRI is seeking $422 million of federal economic stimulus funding for the programme.[14]

In the past couple of years between four and five thousand volunteers have been engaged in tree-planting projects. Cultural barriers have been breached, in some cases, with volunteers from the Sierra Club (a conservation non-governmental organisation (NGO)) and the James River Coal Company working alongside one another – two groups of people that don't always see eye to eye – but "there were no dramas and everyone got on".

Volunteers include people of all ages, from school children to retirees. Working with volunteers is not easy and they need to be trained and managed constantly, with a regime employed that does not exhaust people who are not used to this kind of work. They start at 1000, work for two hours, then lunch, then another hour or two, and then home. Their training is constant and is applied in three stages:

1. Show them, in a large group, how to plant trees;
2. Equip them and show them in a small group; and then
3. Give one-on-one training as part of a group of six to eight volunteers assigned to a forester.

Public (and specialist) interest is also maintained through a host of meetings, talks and tours. Schools involvement is also encouraged through the production of curriculum-linked teaching resources about the initiative.

FUNDING

ARRI receives no direct public funding, just goodwill and commitment. The reclamation of active mine sites to trees is funded by the mining companies themselves. Re-foresting the legacy areas, though, requires funding from other sources. In-kind support, such as the loan of bulldozers by mining companies to rip compacted substrates, is important and helps build goodwill.

In the couple of weeks before my visit, the Appalachian Regional Commission had granted $300,000 to ARRI and the GFW programme, with the University of Kentucky offering an additional $90,126 of in-kind support, primarily to hire project personnel that will develop the business plan, develop the organisation and begin fund-raising in earnest.

COLLABORATION

ARRI is a co-operative reforestation initiative between OSM and seven Appalachian coal-mining states and also includes coal mining companies, landowners, academics, and watershed and environmental groups in the partnership. To date, public organisational support has been formally committed through the signing of a Statement of Mutual Intent in which they pledge to work together to encourage the restoration of high-value, hardwood forests on coal mined lands in Appalachia using the FRA. (In practice, there is no formal obligation attached to signing the statement to do anything other than agree with the approach being used.) At the time of writing, the 1136 signatories collected represented 200 different organisations including: environmental groups, industry organisations, watershed/ citizen groups, government agencies, academic institutions, conservation groups and international organisations[15].

Nine Appalachian states, from Pennsylvania to Alabama have formally committed to planting native trees on active and legacy mine sites and, most importantly, to raising public awareness of the replanting of their Appalachian forests – a “reforestation renaissance”, as described by Patrick.

ARRI has recently developed a major strategic partnership with **The American Chestnut Foundation**. The American chestnut (*Castanea dentata*) is a culturally-iconic tree of the eastern US forests, although it is considered to be ecologically extinct – wiped out by the mid-20th century by the introduced, airborne Asian bark fungus (*Cryphonectria parasitica*). It is estimated that there were three billion American chestnut trees in the eastern US and that they comprised up to 25% of all the trees in the Appalachian forests[16]. It survives as sprouts from old stumps and continues to grow until these sprouts are killed by the blight, consequently it no longer plays the same important role in the ecosystem as it once did. An economic corner-stone of the region, the fast-growing tree produced edible nuts prolifically and its excellent wood was used to construct “everything from cradles to graves [coffins]."

Patrick explained that the tree was the “magic bean” of the region: “Every family in central Appalachia has an American chestnut story”. The partnership with The American Chestnut Foundation therefore provides an important cultural strand, which connects many people to the restoration of the Appalachian forests who may not have a major interest in conservation or restoration *per se*. This is a key element in raising broad public awareness of the forest restoration issue in the region.

A new backcrossed American chestnut tree has been bred that is 15/16 genetic native North American stock and 1/16 of a closely-related Chinese species that is resistant to the otherwise deadly fungus, and is now being planted widely in ARRI projects.

2.3 OTHER PROJECTS

During my visit to central Appalachia, I was also taken to visit other coal landscape restoration projects by Patrick, Jim and colleagues. Not all were ecologically-focused, but all were aimed at improving people's lives. They are summarised briefly below.

2.3.1 PAINTSVILLE PROJECT

OSM's Jim Holliday oversees a range of publicly-funded, primarily civil engineering projects working to correct the inherent instabilities in the old, post-mining landscapes of central Appalachia's difficult terrain. He kindly took me to visit a $1 million slope stabilisation and mine drainage control project on a slope of made-ground behind a small community of poor quality housing on the edge of Paintsville (population 5,300).

There are many thousands of old, abandoned, small-scale coal mines hidden in the forests of central Appalachia. Not all are mapped or known of until the ground starts to give away. The term "abandoned" is defined by SMCRA as any mine site that was worked prior to 1977, the effective date of the federal law. This means that an "abandoned" mine site is any mining operation where the mine operator has walked away leaving no-one legally responsible for it. All abandoned mine sites are owned by someone, or some entity, but that does not necessarily make them legally responsible.

The Paintsville project is making-safe the slope behind the community (Photo 2.5). Originally the coal was extracted from underground through a mine adit (a horizontal tunnel driven into the hillside). A small surface mine nearby subsequently deposited mine waste over the slope, burying the adit. Over decades the forest naturally re-colonised and the area was largely forgotten as a mine site. Cracks occurring in the slope, indicating ground movement, were noticed by local residents who called the OSM.

Photo 2.5. Slope stabilisation behind a Paintsville community.

Jim Holliday from the OSM and his contractors moved in. The thick spoil layer had been mobilised by water seeping from the buried adit and was in danger of collapsing over the houses at the base of the slope. The reclamation work involved excavating the loose material, installing drains into the

adit, constructing slope retaining walls and pulling back and regrading the slope. Eventually trees will be planted to make the surface of the slope more resilient.

Some people ask how the government can justify spending such money to protect houses worth less than a half this amount in total. Jim's well-prepared answer is that it should be considered as returning the money (via SMCRA) that would have been taken out of the region altogether by "the men from the North-East", and using it to pay digger drivers, architects, equipment hire companies, fuel companies, etc., in the local restoration economy.

2.3.2 POWELL RIVER PROJECT

Back across the border in Virginia, Amy Fannon-Osborne, a research assistant at Virginia Tech gave me a tour of the Powell River Project[17]. For over 30 years the enormous Powell River coal mining site, which is still operational, has been used as a research and educational facility to explore various options for environmental and economic after-uses of coal mine sites, in fact some of the Powell River Project's tree planting trials were the first to use ARRI principles. The project's set-up with the close involvement of an academic situation has enabled long term studies to be undertaken into a wide range of post-mining land-use opportunities. A summary of the various trials investigated over the years is provided below:

- Investigating use of soil amendments and rock types, particularly bio-solids, to improve post-mining soil productivity and studies of soil profile development;
- Investigating options for livestock raising, such as cattle, on the flatter areas of the land (Photo 2.6);
- Biomass cropping for energy, e.g., *Miscanthus*, switch grass (native), willow and poplar coppice;
- Agricultural crops, e.g. a range of vegetables, maize, etc.;
- Tree-planting trials, including exotic conifers, for the timber industry; and
- Ecosystem development, including biodiversity surveys for nematodes, birds, salamanders, etc.

The soils of the sites are the subject of on-going research activities. Over the years, from a disorganised mixture of coal mine waste rock fragments, plus soil-ameliorating amendments, a rough B-horizon has started developing.

There is also an environmental research/ education station on the site. The research really took off in the late 1970s and '80s after the implementation of the SMCRA legislation, as there were serious gaps in knowledge in relation to developing good practice in the restoration of coal mining landscapes.

As landscape-orientated thinking has developed, the EPA now wants land-owners to return mined land to the approximate original contours. This has upset some in the region as many land-holders would prefer flat land for agriculture and other types of economic development, such as the land on which my hotel in the town of Wise sits and the nearby airport.

Photo 2.6. Cattle farming on former mine land, Powell River Project.

2.3.3 CRANE'S NEST GOB PILE REMOVAL PROJECT

Amy Fannon-Osborne introduced me to Richard Davis, the abandoned mine land projects co-ordinator of the Department of Mines, Minerals and Energy of the Commonwealth of Virginia. He has been interacting at a state/ commonwealth level with ARRI; for example National Arbor Day was celebrated locally by planting native hardwoods on mined land, and currently, his department is encouraging sixth-graders to get involved with tree planting projects. In 2010 in Virginia the mining industry planted two million trees; the AML planted 10,000 on abandoned mines.

In 1748 the first commercial US coal mine was developed outside Richmond, Virginia. Although long since closed, such mines still cause subsidence issues there. The AML receives SMCRA funding from the OSM in order to reclaim abandoned mines, based on an inventory of the sites in the Commonwealth. For each of the last couple of years the AML has received $9 million. Most of this has been spent in replacing public water supplies that have been impacted by old mine sites. Other major issues include making safe mine portals and restricting access to them.

Coal mine waste rock piles are locally referred to as gob piles. Old gob piles may contain residual coal which, using modern technology, can be removed economically. This has enabled the AML to develop a way of working with private sector companies to clean up (sometimes very) old mine sites. A company can re-mine the waste and extract the coal (for which they do not need a permit, which would otherwise cost $100,000). The residual waste rock is then piled against the mine's high walls

to reduce the risk to public safety and the visual impact. The AML then plants trees over the rock waste and the cleared site, restoring any waterways in the process (Photo 2.7).

Photo 2.7. Restored stream, once buried under a gob pile.

The Crane's Nest Gob Pile Removal Project removed a waste rock pile covering 3.25 hectares and restored a 300-metre stream that had been buried for 60 years. The mine waste rock had been impacting the Clinch River watershed. The project began in August 2007 employing about ten people and was completed by September 2008. As part of ARRI, community volunteers from the OSM/ VISTA and ARRI programmes and county jail inmates working with a tree-planting contractor planted native hardwoods over the site into non-competitive herbaceous vegetation, and finished in April 2009. Meanwhile, the new stream development required a permit from the US Army Corp of Engineers.

A key part of the project's success was the interest shown by the company, GOBCO LLC. The project cost the state only US$3,600 as the rest of the cost was met by the company selling the reclaimed coal. The project won national recognition when it received a prestigious OSM Abandoned Mine Land Reclamation Award.

2.3.4 MOUNTAIN ROSE VINEYARD

Wise County Virginia's first ever vineyard, the Mountain Rose Vineyard, was developed on a reclaimed surface mine[18]. The first vines were planted in 1996 and it opened in 2004. It currently employs around five people. The well-drained, deep and relatively infertile substrate and the cool temperatures and low humidity of the local microclimate have turned out to be ideal for growing grapevines (Photo 2.8). The vineyard is the brain-child of David Lawson – a friend of Amy Fannon-Osborne's from Virginia Tech. Sustainable viticultural practices are employed wherever possible; for example, rows of Caliente Mustard grow between the vines to help control the damaging nematodes that have affected some of his crop. Many of the wines are named after the coal seams that once existed on this site, such as: Jawbone and Pardee.

Photo 2.8. Mountain Rose Vineyard.

2.4 CONCLUSIONS AND LESSONS

The scale of ARRI's ambition and scope are enormous – precisely what is required for landscape restoration to enhance ecological integrity and improve people's lives in areas like central Appalachia, with its complexity of environmental, social and economic challenges and its enormous geographical and temporal scales. There are many transferable lessons, many of which are summarised below.

2.4.1 OVERCOMING BARRIERS

ARRI has been successful in identifying and dismantling the barriers to implementing their ambition. These barriers are technical, regulatory, institutional and cultural:

- **Technical:** develop new and simple reforestation practices based on sound science;
- **Regulatory:** effect regulatory change;
- **Institutional:** encourage collaboration between state and federal institutions, towards a common aim, by all sharing in the limelight of success; and
- **Cultural:** encourage groups and people with different perspective, such as conservation groups and industry, to work together towards a simple and worthwhile common aim.

2.4.2 SCIENTIFIC APPROACH

- **Listen to the advice of technical experts** – in this case scientists – who develop solutions to vexing issues.
- The importance of **rigorous science converted into simple practical principles** for implementation to contribute to effecting a new culture of practice.
- There is a need for **on-going research** – it is a mistake to think that all the problems are solved, particularly when social and economic outcomes are expected as part of the landscape restoration effort.
- For long term success and value in perpetuity, the eventual project outcome must be ecologically appropriate and valuable, but also offer **long term economic prospects**.

2.4.3 DEMONSTRATION, COMMUNICATION AND ENGAGEMENT

- **Create an exemplar that proves the concept** and can demonstrate the activities required for success (e.g. Star Fire Complex) or the Powell River Project. This is a powerful tool to indicate the promise of future success, if the project can be backed.
- **A simple message and objectives** that are easy to communicate to a wide audience and that encourage public support.
- **Engage** with the full range of stakeholders and encourage formal buy-in that doesn't cost anything, i.e. showing support by signing the statement of mutual intent

2.4.4 ORGANISATION AND LEADERSHIP

- **Leadership**, in this case from OSM and the state governments, has unlocked wider involvement and action on the ground.
- The **involvement and leadership of federal and state government** was critical in effecting changes in legislation to improve practice going forward (e.g., the local interpretation of SMCRA reclamation requirements).
- **Break down institutional barriers** between by developing an easily understood common purpose where each institution has a valuable role.
- **Encourage voluntary buy-in initially** to prove the concept and develop momentum, then seek funding for paid employees of the right calibre to deliver a step change in the organisation.
- A **multi-stakeholder partnership** has been developed encompassing all the relevant groups, such as government (federal and state), conservation, industry, government, communities and academic.

2.4.5 CULTURAL IDENTITY

- Forests are part of the **cultural foundation** upon which Appalachian society has been built. People here instinctively understand the forest. ARRI builds on this sensitivity and offers ordinary people a chance to make a positive contribution to the forests of the future.
- Build in a strong element of **cultural identity**, e.g., the use of the **American chestnut** as a flagship species to raise broad public awareness and attract a new range of partners and open access to new funding opportunities.

- Encouraging those of **different cultural backgrounds** – actually on opposite sides of the mining debate – to work together as volunteers for a common, worthwhile aim – planting trees to restore the forest.

DEPARTING…

After a symmetrical 777 miles of driving through Appalachian splendour I arrive at the small, but perfectly-formed, Tri-Cities Regional Airport in Tennessee. My final Appalachian drive had started well, although I'd had to scrape the frost from my windscreen with my fingernails. The shadows were long, the sun summoning just enough energy to lift the early morning mist, swirling smoke-like from the increasingly skeletal trees.

Everglades

3 EVERGLADES, FLORIDA, USA

ARRIVING…

From the ridges, valleys and forests of central Appalachia, the next point on my journey south was the Everglades of southern Florida marking a complete change in landscape and climate.

On the plane, descending into Fort Lauderdale, I am amazed at the amount of water weaving its way between endless estates and houses. On leaving the airport, the humid heat hits. My Haitian taxi driver drives me through a flat land of palm trees, closely cropped lawns, manicured shrubs and concrete. This place feels very different to where I have just come from.

The purpose of my Florida visit was to explore the fascinating and impressive work of the Comprehensive Everglades Restoration Plan. I was kindly hosted by the hard-working duo of Erica Robbins and Jennifer Domashevich of the US Army Corps of Engineers (USACE) – one of the lead organisations of the restoration effort.

3.1 CONTEXT

Everything about the spectacularly flat geography of south Florida implies a system naturally dominated by water. Over the 240 kilometres between Lake Okeechobee and the southern tip of Florida the land falls by only 4.2 metres. The original natural ecosystem was dominated by the retention and slow mass flow of surface water. During the rainy season rain falls in intense, heavy downpours leading to localised flooding; during the dry season, droughts are the norm. Originally sheets of water would move slowly down the state starting from Florida's upper chain of lakes, along the Kissimmee River to Lake Okeechobee, then south to the southern tip of Florida, largely through mass surface flow, the process taking several months (Figure 3.1).

The original waters of the Everglades were characterised by their extremely low nutrient content; today, agricultural and urban run-off lead to increased nutrients, particularly phosphates, in the system resulting in changes to the vegetation.

South Florida's geology, topography, climate, geographical location between the temperate and tropical zones and the high humidity from the proximity of sub-tropical seas on three sides are the foundations for the unique Everglades ecosystem – one of the USA's wildest and most inaccessible regions. Approximately 3,500 plant species occur here, with many endemic plant and animal species.

Far from being a never-ending swamp, the Everglades today covers approximately 10,400 square kilometres of a complex, interdependent patchwork of sub-tropical wetland and upland habitats that mark slight differences in the underlying topography and geology. They include sawgrass (*Cladium jamaicense*) marshes, sloughs, marl- and peat-based wet prairies, tree islands, cypress swamp, tropical hardwood hammocks, pinelands and, along the southern coast, critically important mangrove swamps. The diversity of animals includes alligators, American crocodiles, panthers, snail kites, apple snails, wood storks, bald eagles, manatees, and more. Almost 350 species of birds have been recorded in the region.

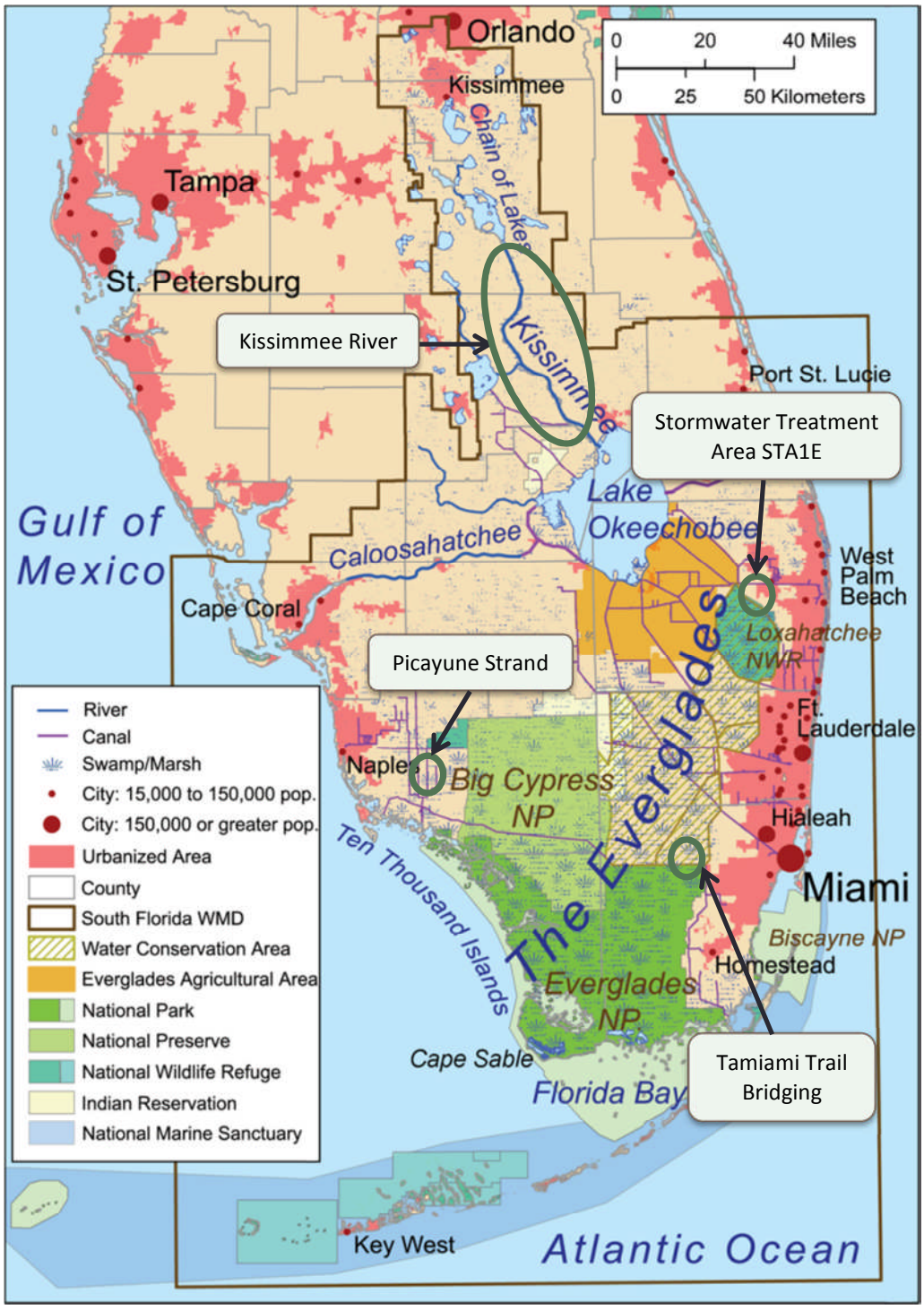


Figure 3.1. Everglades geography showing the restoration projects visited[19].

Florida was colonized and developed rather late when compared with much of the eastern USA and even then the wet interior confined the development of communities to the slightly higher ground of the coastal and central Florida ridges. As well as being a globally unique natural feature, the Everglades ecosystem is critical to the society and economy of Florida for the following reasons:

- It supplies water to agriculture and the resident and tourism populations;
- It supports valuable freshwater fisheries;
- It enables agriculture – particularly sugar cane and fruit;

- It attracts tourism for its wildlife and wilderness; and
- It is the backdrop to indigenous peoples' heritage.

The Everglades watershed is a completely rain-fed system, which must store and sustain the freshwater supplies for about nine million people. The value of the annual ecosystem products and services provided by the Everglades has been calculated as $82.1 billion.[20] Based on data from 2006 it has been calculated that recreational freshwater and saltwater fisheries in the Everglades region generated an estimated $722 million directly, rising to $1.2 billion when indirect revenues are included, and supported a conservatively estimated 12,400 full-time equivalent jobs[21]. In 2007, direct tourism expenditure connected with Everglades recreation was estimated at $935 million with a further $912 million indirectly[22].

3.1.1 THE CENTRAL AND SOUTH FLORIDA PROJECT

Florida was affected by particularly devastating hurricanes in the late 1920s and the late 1940s and the resulting flooding killed thousands and caused tens of millions of dollars-worth of damage. A public outcry led to Congress passing the Central and Southern Florida Project (C&SF Project) in 1948, mandating the USACE (federal) and South Florida Water Management District (SFWMD) (state) to construct one the most elaborate, effective and expensive water management systems anywhere. Its 1,600 kilometres of levees, 1,160 kilometres of canals and 200 water control structures aimed to control flooding, prevent salt water intrusion, supply water to the Everglades National Park and protect fish and wildlife resources.

Since the major drainage canals were dug, a key area of the Everglades known as the Sawgrass Plain has lost six metres of elevation as the peat dried and blew away. Such a large expanse of sodden peat created substantial hydrostatic pressure over the underlying aquifers to the extent that freshwater used to upwell beneath the sea and was useful to sailors of old. Today, this loss of hydrostatic pressure is a major contributing factor to the ingress of seawater into the aquifers.

The C&SF Project has been highly effective in reducing the impacts of extreme flooding events, but it has had severe deleterious effects on many aspects of the natural hydrological and hydrogeological system and the ecosystem that evolved to cope with it, and many of these effects are likely to be exacerbated by climate change in the future.

RESTORATION ISSUES

The main negative environmental and socio-economic impacts inherited from the C&SF Project are:

- A slowly **desiccating ecosystem** leading to:
  - increased erosion and infertility of agricultural soils,
  - invasion by exotic plant and animal species leading to vegetation and subsequently ecosystem change, and
  - an enhanced risk of fires.
- **Diminished freshwater recharge** of, and **seawater intrusion** into, the important Florida and Biscayne aquifers, which supply drinking water to Florida's millions and agriculture;
- **Failing freshwater fisheries** as the annual flooding pulse through the system fails to clear channels as it once did, leading to a changing aquatic ecology and the decline of economic freshwater fisheries; and

- **Pollution**, particularly of **phosphorus**, in stormwater run-off from urban areas and agricultural land, resulting in wholesale changes to large areas of vegetation leading to a loss in biodiversity.

Today, about 50% of the original Everglades ecosystem has been destroyed for agriculture and urban development. Alongside the impending threat of climate change, the burgeoning population of Florida is continuing to increase the stresses on the Everglades. Currently 7.7 million people call south Florida home, a number that is projected to double in the next 50 years. It became apparent in the 1970s that the status quo was no longer sustainable and that, eventually, the ecosystem collapse of the Everglades would lead to a socio-economic crisis.

3.2 COMPREHENSIVE EVERGLADES RESTORATION PLAN

There are myriad projects, large and small, throughout the Everglades related to the restoration of its damaged landscapes. The lead programme is a joint initiative between state (primarily South Florida Water Management District (SFWMD)) and federal (primarily USACE) institutions. Together, and with a range of other national, state and local partners, they developed the Comprehensive Everglades Restoration Plan (CERP), which was approved by Congress in 2000. USACE's involvement in large-scale restoration projects is very recent and has required a change of perspective institutionally and in the contractors they employed, such as training to reduce the environmental impacts of their work in such a critical ecosystem.

CERP provides a framework and guide for restoring, protecting and preserving the water resources of central and southern Florida over 46,000 km^2 and derives from substantial revisions and updates to the C&SF Project, known as the Restudy.

Approved in 2000, CERP includes more than 60 elements over 30 years and will cost about $10 billion dollars. The overall aim of CERP is to increase the amount of water flowing through the entire ecosystem by capturing much of the fresh water that is currently diverted unused to the sea, with the aim of reviving the ecosystem and benefiting farmers and city dwellers (Figure 3.2).

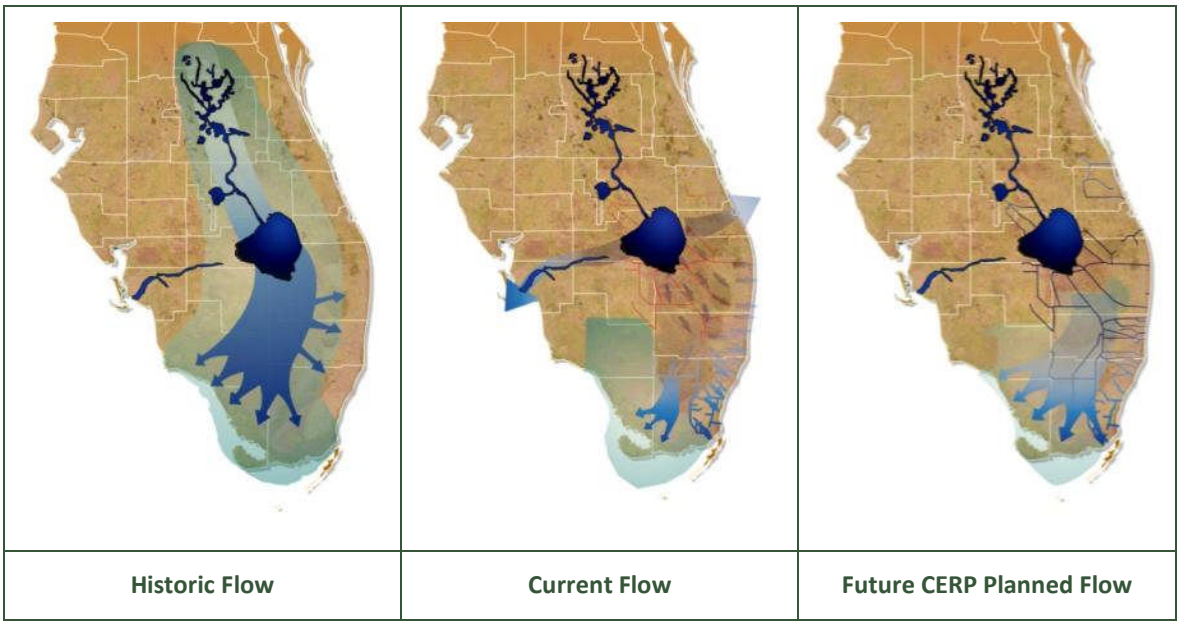


Figure 3.2. Past, current and planned water flows through the Everglades ecosystem[23]

CERP is probably the largest and most ambitious ecosystem restoration project in the world. It aims to provide a framework and guide to restoring, protecting and preserving the water resources of Florida's Everglades ecosystem. CERP was founded on the following guiding principles:

- The restoration, preservation and protection of the south Florida ecosystem while providing for other water-related needs of the region;
- To be based on the best available science - independent scientific review is an integral part of its development and implementation;
- To follow an inclusive and open process that engages all stakeholders and interest groups;
- To be inclusive: federal, tribal, state and local agencies are full partners and their views are considered fully; and
- To be flexible and based on the concept of adaptive assessment, recognizing that modifications will be made in the future based on new information.[24]

Approximately 6.5 billion litres of water drain from the Everglades to the coast each day. The plan aims to capture most of this water and store it at the surface and in aquifers until it is needed for urban and agricultural needs – particularly during the challenging dry season. This will require the construction of enormous surface water storage structures and increasing the hydrological connectivity between natural areas, which will involve the removal of approximately 390 kilometres of levees and canals. The restored natural sheet flow will then encourage the return of the natural vegetation and the animals that rely on it. It is estimated that only 20% of the new water storage will be required for human uses, the remaining 80% will benefit the environment. The key components of CERP are:

1. Surface water storage areas,
2. Water preserve areas,
3. Management of Lake Okeechobee as an ecological resource,
4. Improved water deliveries to the estuaries,
5. Underground water storage,
6. Water treatment wetlands,
7. Improved water delivery to the Everglades,
8. Removal of barriers to sheetflow,
9. Storage of water in existing quarries,
10. Reuse of wastewater,
11. Pilot projects,
12. Improved water conservation, and
13. Additional feasibility studies.

The plans and work of CERP are reviewed quarterly by an independent multi-stakeholder body consisting of some of the country's leading scientists, who act as oversight and advisers to the project. The group is known as RECOVER (Restoration Coordination and Verification) whose role is evaluation, assessment and planning.

There is currently relatively little interaction between CERP and more general Everglades restoration work and other landscape restoration projects, particularly overseas. However, this is slowly changing, particularly in North America as, since 2004, there has been a biennial National Conference on Ecosystem Restoration. This conference brings together many of the major landscape restoration projects nationally, such as Chesapeake Bay, the Gulf Coast, the Great Lakes, etc. It is

likely that collaboration between such large-scale, transformational projects will increase in the future as the socio-economic benefits come to be more widely recognized.

Not everyone has been in favour as indigenous people and special interest groups, such as fishermen, fan-boaters, recreational cross-country drivers, worry about changes to the hydrological regime that will affect their ways of life. Carefully, most of these minority groups have been engaged and reassured and plans have been modified in some circumstances to account for such activities and livelihoods. Legal recourse has also been used where some land-uses have been illegal.

3.2.1 EVERGLADES ECONOMICS

According to the Everglades Foundation, investing $11.5 billion in Everglades restoration will result in $46.5 billion in economic gains to the state and create over 440,000 jobs over the next 50 years; for every dollar invested in Everglades restoration, $4 are generated in economic benefits – as broken down in Figure 3.3.

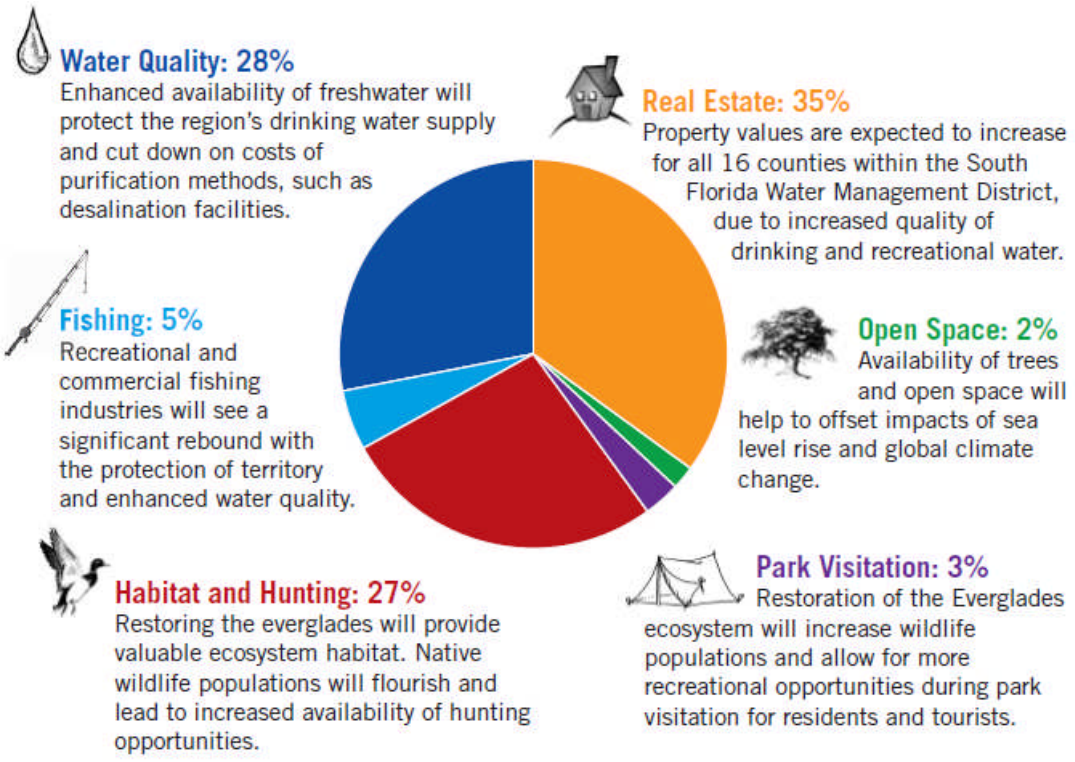


Figure 3.3. Predicted economic gains by sector from Everglades restoration[25].

The main objectives and features of several Everglades ecosystem restoration projects visited on my tour are described below.

3.3 OTHER PROJECTS

CERP is a programme of over 200 separate projects, but also accounts for projects developed by other organisations outside of the CERP. I was taken to several CERP-constituent and non-constituent projects in the Everglades and these are described below, organised as if travelling from north (Kissimmee River) to south (Everglades National Park) (Figure 3.1). It should be borne in mind that these visits constituted only a small introduction to the breadth and complexity of Everglades ecosystem restoration and some aspects, such as the control of invasive species, public consultation,

etc., were not included in the itinerary, but their omission here is no reflection of their importance in the greater scheme of things.

3.3.1 KISSIMMEE RIVER RESTORATION PROJECT

Erica kindly arranged for an early-morning ride over the Kissimmee River floodplain in a SFWMD helicopter – the only way to get a coherent picture of the scale and dynamics of the Everglades ecosystem. The river is a key element of the northern Everglades system and drains the Kissimmee Chain of Lakes (Figure 3.1).

Originally the river was 166 kilometres long – a meandering, shallow complex of river channels, wetlands and ox-bow lakes, brimming with fish and bird populations. On average 50% of the river is inundated 80% of the time. The natural system experienced a seasonal flooding pulse during the wet season, which converts into an ecological productivity pulse as the flooding river recedes into the main channel, bringing with it nutrients that substantially increase productivity, with associated environmental, social and economic benefits.

Public outcries over the mid-20th century's severe flooding disasters demanded that the natural flooding cycle of the river be controlled to protect lives and property. Channelization by USACE as part of the C&SF Project, between 1962 and 1971, replaced the river with the 90-kilometre-long, nine-metre-deep and 91-metre-wide, steep- and straight-sided C-38 canal, cutting off meanders, but highly effective at rapidly channelling water away during high rainfall events. Two-thirds of the historical floodplain was drained to create larges areas of land for agriculture, ranching or other kinds of development.

Ecosystem decline was noticed within five years as 90% of the wintering waterfowl and wading birds were lost and game fish plummeted. The underlying reason for the decline was the removal of the seasonal flood pulse, followed by recession and drying. The ecosystem began shifting towards a dry land regime as terrestrial plants invaded, water birds decreased and the highly productive floodplain habitats were lost. The much reduced flow in the remnants of the river caused increases in floating vegetation with concomitant increases in organic matter decomposition, lower dissolved oxygen levels and changes in aquatic animal communities, and the bird life that depended on them.

From the mid-1970s advocates worked tirelessly to raise the profile of the decline and gradually, over 20 years, state and then federal legislation – particularly the 1992 Water Resources Development Act – enabled the damage to be reversed while retaining existing levels of flood protection to surrounding communities. Ecological and hydrological restoration experiments and demonstration projects determined the most appropriate mechanisms, while a formal collaborative approach was mandated in 1994 when a Project Cooperative Agreement between USACE and SFWMD agreed a 50/50 cost-share for the work. A two-pronged restoration approach was developed:

- Reconstruct the river's physical form through back-filling of the C-38 flood control canal;
- Modify headwater inflows to mimic historic hydrological patterns; and
- The original channelization cost $32 million; the cost of restoration to date totals about $900 million.

A crucial aspect of the project was the early and on-going public engagement at local and county level, including public town hall meetings, etc. There was a minority of people with vested interests

in the in the status quo, some of who had become quite vocal forming the pressure group, Realists Opposed to Alleged Restoration, who were against changing the course of the river.

The restoration began in 1999 and has been implemented in four phases and is due to be completed in 2012. Much of the original river template remained within the floodplain although much degraded. To date, 35 kilometres of the canal have been backfilled using the original spoil material extracted during its construction, which had been piled in an embankment – which also acts as a barrier to water flows – alongside the canal, and meanders reconnected and channels dug to create 69 kilometres of meandering river. SFWMD has also acquired 41,300 hectares of land and modified canals, demolished/ built water control structures and other parts of the system in the upper basin to provide water storage for the restoration downstream. In all 104 km^2 of river and floodplain habitats will be restored and 10,930 hectares of wetlands will be rehydrated (Photo 3.1).

Photo 3.1. The flooded valley of the Kissimmee River.

The river and its floodplain have shown promising and rapid recoveries of dissolved oxygen levels, reductions in accumulated organic sediments, regrowth of wetlands, and increasing populations of bird and fish populations, auguring well for the future.

3.3.2 STORMWATER TREATMENT AREA 1 EAST

Eutrophication, particularly of phosphorus in stormwater run-off from agricultural and urban land, is a major problem in the Everglades ecosystem. The original system evolved in adaptation to oligotrophic (low nutrient) conditions; the introduction of excessive nutrients causes a rapid decline in biodiversity as the vegetation becomes dominated by a few, fast-growing species, such as cattails

(*Typha* spp.). As they come to dominate, physical impacts include the impedance of sheet flow and out-competition of the original vegetation with severe knock-on effects for the entire ecosystem.

In the 1990s a science-based approach, involving local universities and the SFWMD, developed a system for the large-scale collection and subsequent biological treatment of stormwater run-off, before releasing the cleaned water to the Everglades. Today, more than 150 km^2 of stormwater treatment areas have already been constructed around the Everglades agricultural area to collect phosphorus-rich, stormwater run-off and remove the dissolved phosphate.

I was shown Stormwater Treatment Area 1 East (STA1E), just west of West Palm Beach. STA1E is a 2,165-hectare constructed wetland stretching to the horizon, ringed by levees and canals and internally divided into distribution cells (Photo 3.2). The cells progressively strip phosphate from the water as it flows slowly through the system. STA1E became operational in 1994. The area had been farmland prior to its construction by USACE.

Photo 3.2. North-east corner of the vast STA1E.

Water containing 100-200 parts per billion (ppb) phosphorus enters STA1E from adjacent urban and agricultural areas. The aim is to achieve a maximum discharge phosphorus concentration of 10 ppb on leaving the STA, through bio-chemical processes produced by the growth of plants and the accumulation of peat. Emergent vegetation, particularly cattails, removes 75% of the phosphorus in the first stage. Water containing 25-45 ppb phosphorus then enters part of the system containing submerged aquatic vegetation. Water of 20-30 ppb phosphorus (currently too high) leaves this system and enters a third stage containing periphyton – mat-like assemblages of microorganisms that cover the wetland bed – to reduce concentrations below 10 ppb. On leaving the STAs, water is discharged into Water Conservation Areas and finally is pumped into the Everglades ecosystem proper (Figure 3.1). Regular water monitoring measures water quality, depths, flow rates and the developing ecology of the STA1E system.

STA1E was constructed on intensively-farmed agricultural land. Within the space of a very few years, it is already teaming with wildlife, including over 90 species of birds, including – as I observed – fishing ospreys, alligators, and thousands of wading and water birds. Public access is permitted to the area for hiking, bicycling, bird-watching, and bank-side catch and release fishing.

Agencies are also working with farmers on programmes to reduce the amount of phosphorus emanating from farmland in run-off and entering the Everglades. Already, over 2,000 tonnes of phosphorus have been prevented from entering the Everglades by the STAs and improvements in farming practices.

3.3.3 PICAYUNE STRAND RESTORATION PROJECT

The 22,300 hectares of mainly shallow cypress swamp that form the Picayune Strand are located to the southwest of Naples in southwest Florida, between the I-75 Everglades Parkway and the US41 Tamiami Trail – the only two highways that cross southern Florida. It is surrounded by sensitive protected areas, including the Florida Panther National Wildlife Refuge, the Fakahatchee Strand Preserve State Park and the Big Cypress National Preserve, amongst others. The area is prime habitat for the endangered Florida panther – the last subspecies of puma still extant in the eastern USA, with only one breeding population of about 100 adults in south Florida. The Picayune Strand restoration project will, like a jigsaw piece, connect other areas of publicly-conserved lands to create an enormous area of contiguous panther habitat.

The Strand is criss-crossed with a network of roads and tracks and drained by four major canals – see Photo 3.3– that were constructed in the 1970s as part of a real estate project that ultimately failed. The land became acquired by the state of Florida – a huge piece of work involving negotiations with 20,000 individual landowners. The elevation of roads, even the gravel ones that are just a few centimetres above the surrounding land, restricts the sheet flow of water and, along with the canals, cause the land to dry out, promoting the influx of dry land vegetation – particularly the sable/ cabbage palm, increasing the risk of fire. As cypress trees are more sensitive to fire damage than the palms, burning removes the former from the system – changing the habitat and reducing its biodiversity value. Although the project area is 22,300 hectares, the total area impacted is over 29,000 hectares owing to the wider effects of draw-down by the altered hydrology of the system. The original diffuse freshwater discharge to the marine ecosystem to the south is now a point discharge of the canals' freshwater, which is damaging the sensitive ecology of the Ten Thousand Islands National Wildlife Refuge to the south.

The objectives of the Picayune Strand Restoration Project are:

- To **restore the original hydrology** of the wetlands (historic flow ways, sheet flow, and hydro periods);
- To **reduce point discharges** to improve the health of downstream estuaries;
- To **improve aquifer recharge** to improve water supplies and prevent salt water ingress; and
- To **maintain flood control** for the developed areas to the north.

The project was jump-started early when, in 2009, the American Recovery and Reinvestment Act (2009) enabled USACE to begin work with $40 million towards the $53 million for the first phase of canal work.

The project aims to undo the damage by plugging 64 kilometres of canals and removing 365 kilometres of roads to re-create a fully-functioning wetland, while ensuring flood protection for nearby residential areas. This is one of the first CERP projects and, to date, 12 kilometres of canals have been back-filled and 105 kilometres of roads and 140 structures (including houses) have been removed, enabling the gradual natural restoration of 5,260 hectares of forest. Pumping stations are also being constructed alongside spreader swales to enhance flooding.

Photo 3.3. One of the main north-south drainage canals through Picayune Strand.

During the original road construction, low banks of excess material were left along the roadsides, which have now become overgrown. Along with only a few inches of road elevation, these banks provide a linear obstacle to the recreating the natural surface hydrology. Roads are removed by scraping their surfaces down to the surrounding land level and removing the linear banks (Photo 3.4). The extracted material is then used to plug the canals. Any trees removed during the road removal process – particularly of unwanted species – are burned and also used to back-fill. The canal is plugged rather than completely back-filled because there is a lack of available material to complete the job.

Photo 3.4. Stages of road removal process (with Mike Duever).

The bare ground that remains is ideal for the colonisation of unwanted invasive species, so a watchful eye is kept on these areas, with chemical spraying of a 15-metre strip either side of the removed road in an effort to decrease the seed rain. This treatment continues for six years. Helicopter spraying is also used on large stands of invasive Brazilian pepper.

Cypress trees are very slow growing thus necessitating a long-term approach to measuring the success or otherwise of the project. Indeed, it is thought that the now extinct Carolina Parakeet was a major agent in the dispersal of the trees' seeds, making recovery of this habitat even longer without intervention by human seed dispersers or tree planters. Ecology often/ usually works outside a human time-frame, although human hubris is driven by the need for observable results within a typical professional career. The Everglades restoration programme is changing such perspectives. Mike Duever, a consultant ecologist working on the project as environmental quality assurance, has been working on Everglades ecology since the 1970s and, with an expert's eye, has watched the decline in his precious ecosystem first hand. He regards this work as the culmination of his long career (Photo 3.4).

Before the project started, and occasionally still, the area was popular for (illegal) recreational activities, such as off-road driving. Once the work began, such activities were prevented, causing media/ public relations issues that are still being addressed. Around $3 million has been spent on this work. However, the proportion of the people/ groups in support of the work vastly out-numbers those with an axe to grind and they pull together to support the project when a negative news story hits the headlines.

3.3.4 TAMIAMI TRAIL BRIDGING PROJECT

The Tamiami Trail is the name given to the 425 kilometre section of U.S. Highway 41 between Tampa and Miami (hence Ta-Miami) in southern Florida. It is the southern-most highway between Florida's east and west coasts and has existed since 1928. Although a considerable feat of engineering considering the waterlogged terrain, the road and its adjacent east-west canal have long been recognized as a major barrier – in effect a dam – to southwards sheet flow into the southern Everglades (Photo 3.5). The 57 culverts built under the road have proved, to all intents and purposes, useless as means for ensuring hydrological continuity across the barrier. Its detrimental effect on the River of Grass has been measurable as reduced flow damaged fish reproduction, wading bird nesting sites, and other important Everglades species. Habitats have changed to drier end-points – particularly the important sawgrass marshes and tree islands. The freshwater recharge of the underlying aquifers has also been compromised allowing the inflow of saltwater further damaging related habitats and freshwater wells.

In 2005 USACE submitted a plan to erect the Everglades Skyway – an 18-kilometre bridge – to replace part of the road to the west of Miami and allow unimpeded water flow from north to south. However, in 2008 Congress allocated only enough funds to construct a 1.6-kilometre stretch costing $81 million and work began in December 2009 (Photo 3.6). The completion date is anticipated to be June 2013.

The Tamiami Trail Bridging Project is regarded as a CERP foundation project, i.e. an early piece of engineering required to be in place before other projects upstream are commissioned that will enable more water to flow southwards. It is now hoped that further funding will be forthcoming to enable an additional 8.9 kilometres of bridge to be built, costing about $400 million.

Operations on the construction site itself are environmentally very sensitive with turbidity curtains in the adjacent water to inhibit the spread of suspended sediment. Once complete, the bridge will have two six-metre-deep concreted boxes at each end to intercept bridge run-off and filter out any oils or other pollutants within, before it enters the Everglades.

Photo 3.5. Damming effect of the Tamiami Trail and canal[26].

Photo 3.6. Tamiami Trail bridging project underway.

There is a general feeling around Miami and, more widely, southern Florida, that citizens do not appreciate the uniqueness or fragility of the Everglades, nor that they are surrounded by one of the world's biggest ecosystem restoration schemes. It is hoped that the elevated section of the new bridge will offer drivers along this popular route a new perspective on their local environment enabling uninterrupted views across the River of Grass, encouraging a new local environmental consciousness to arise.

3.4 CONCLUSIONS AND LESSONS

In the short period I spent in Florida, it was only possible to get a small taste of the complexity and impressive ambition of the Everglades restoration projects. On a project as enormous as CERP and its allied Everglades restoration projects, there is inevitably a long list of prospective lessons that could apply to other landscape restoration projects. They are summarised below.

3.4.1 APPROACH

- To restore the ecological function of a system as complex and large as the Everglades requires ambitious, well-coordinated and well-funded thinking. At this **scale** step changes are possible over the medium term, environmentally, socially and economically.
- Restoring landscapes is about much, much more than ecological restoration; in order to restore the Everglades, for example, large-scale engineering is essential.
- From the outset a **science-based approach** based on objective and fact-driven investigations, constructive debate and peer review have provided the foundation for the whole enormous exercise.
- The complexity, scale and range of disciplines involved have required an **inclusive and multi-stakeholder approach** requiring, importantly, listening, learning and compromise.
- Well-researched **economic statistics** of the benefits of the yet-to-happen restoration are powerful persuaders for policy/ decision-makers and wider opinion.
- Everglades' restoration ultimately focuses on the importance of **ecosystem services** as a driver for restoration on a large scale and requires a consideration of ecosystem processes and function, which in the case of the Everglades, means the water supply for south Florida, wildlife and wild landscapes for tourism and productive fisheries.
- Ecosystem services can only effectively be restored when restoration activities are **scaled up** to enable the re-functioning of the system. This engenders **multi-disciplinary planning**, for the long term and, ultimately, an obligation to see the job through. Inevitably this requires a **large-scale programmatic approach** to co-ordinate and schedule restoration activities appropriately, increasing effectiveness and value for money.
- A **long-term perspective**, beyond the life-spans of many of the people currently involved and the usual political cycles, requires significant change in attitude and perspective, amongst all stakeholders. Ultimately the benefits from this work will accrue to future generations – the essence of that elusive paradigm, sustainable development.

3.4.2 DELIVERY

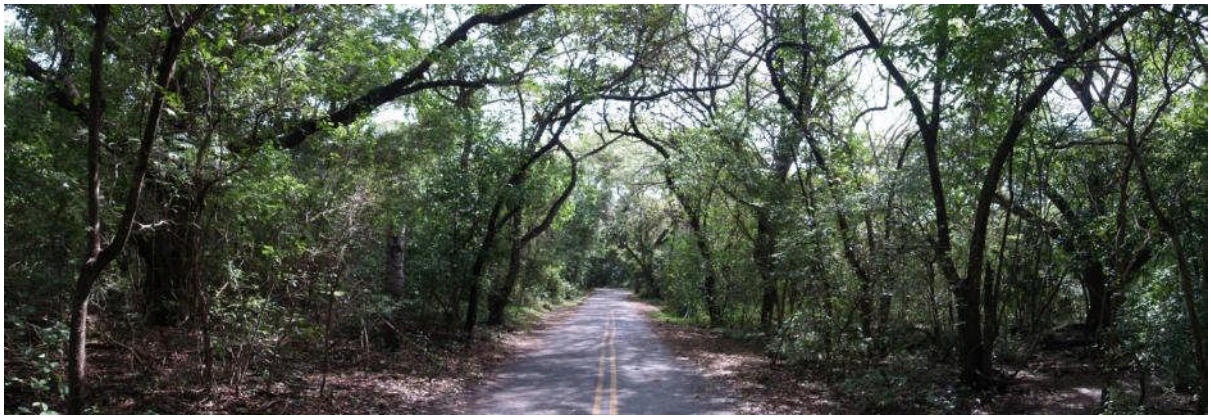
- All the groups/ individuals involved are **learning and applying new knowledge**; for example, USACE has always been a public civil engineering/ construction organisation, but this is the first restoration project it has been involved in. A whole new language, discipline and way of working have had to be learned/ developed. The same goes for all the other groups involved.
- This requires **strong, open-minded, considerate and adaptable leadership** – essential for projects so large and so political (with both a large 'P' and a small 'p').
- Such work is unique and new to almost all the organisations and individuals involved. The sense of excitement, mixture of ages and experiences and the **positive attitude** is infectious.
- Strong, **delivery-focused managers in critical key positions** on the ground are essential to ensure time-frames and budgets are met – it is worth the extra expense to employ such people.
- The involvement of major federal and state public bodies assists the development of **supportive regulatory change** if, and when, necessary.

3.4.3 ENGAGEMENT AND COMMUNICATION

- **Clear and simple objectives** were developed that are easy to articulate and easy to understand.
- It is inevitable with such a large project that not everybody will be pleased. It is important that everyone's **grievances are aired** and considered, but it is also important that if a majority does agree with a course of action that they voice their support.
- **Widespread, in-depth and on-going public engagement and communication** is essential when such large sums of public money are involved and when so many people will be affected by the outcome. This requires the employment of competent, professional public education specialists, such as USACE's Erica Robbins and Jennifer Domashevich, with whom I spent time in Florida.

DEPARTING…

All the people I have met, from a range of organisations involved in Everglades restoration projects, are on steep learning curves. Institutional dogma and doctrine has had to be overcome. And the range of organisations working in partnership is very impressive. The evidence of listening, learning and compromise oozes out of this project like water through the Everglades. It's inspiring to see and provides a valuable benchmark for other landscape restoration projects in other places.



Green season

4 AREA DE CONSERVACION GUANACASTE, COSTA RICA

ARRIVING…

Flying from the Everglades' flatlands took me over Caribbean tropical islands with a spectacular descent over Lake Nicaragua's impressive volcanoes into Liberia, Costa Rica.

They call it the "green season" in Costa Rica – a clever marketing moniker dreamt up to paint a tourist-friendly gloss on the conventional "wet season". However, it is quite appropriate as much of the tropical forest here is deciduous – the trees lose their leaves, turning the landscape brown in the dry season. Dry tropical forests are some of the most threatened forest ecosystems in the world. This forest is the focus of my visit to north-west Costa Rica and, now, in the green season, the place is a vibrant, steaming jungle.

I was en route to Area de Conservacion Guanacaste (ACG) and, more specifically, its Sector Santa Rosa, to visit a forest restoration project that I'd first heard about in the tropical ecology lectures of my undergraduate years at Cambridge, and to meet the person behind the project, Dan Janzen.

4.1 CONTEXT

Dry tropical forests are the most threated forest ecosystems in the world. In Central America there were an estimated 550,000 km^2 of dry tropical forests in the early 16th century compared to today's 440 km^2 (0.08% of the original). Much of the area has been cleared, burned and farmed for cattle pastures and crops and much, today, remains in this state. These forests house about 4% of the world's known biodiversity and the ACG is at the hottest part of this biodiversity hot-spot.

The Area Silvestre Protegido (ASP) of ACG consists formally of several different national parks, a forest reserve, several wildlife refuges and land held by the NGO, Guanacaste Dry Forest Conservation Fund in north-western Costa Rica (Figure 4.1) [27], and formally oversees agro-landscape areas (*agropaisaje* in Figure 4.1) that surround the ASP. In reality the ASP is the ACG and has a single management, budget and conservation philosophy (which does not include agriculture or other forms of destructive harvest). The various areas became joined over time as properties were purchased to form a continuous conservation area of 120,000 terrestrial hectares and 70,000 marine hectares. The ASP of ACG includes a continuous range of Costa Rican ecosystems and forest habitats from Pacific coastal and marine environments through mangroves to dry tropical forest, rain forest and cloud forest on the flanks of the area's two volcanoes. ACG is home to almost a quarter of a million species – 65% of the Costa Rican total. In 1999 it was inscribed as a World Heritage Site for its unique biodiversity, yet only four decades ago this would have seemed a very unlikely dream given the area's intense agricultural and ranching (and burning, logging and hunting) history throughout the previous four centuries.

Founded as the Santa Rosa National Park in 1971, the Sector Santa Rosa is culturally important to the Costa Rican national identity. Dating from the late 16th century, Hacienda Santa Rosa (or Santa Rosa Estate), one of the oldest in Central America, was established as a mule production farm for one of the important international trade routes across the Central American isthmus, plied by mule trains in the centuries before the Panama Canal. From then till 1971, when the hacienda was expropriated to become part of the germinal Parque Nacional Santa Rosa, it was involved in agriculture and cattle ranching activities and much of its 100,000 hectares were converted from dry tropical forest to pastureland for mules, and then cattle for the indigo trade, the hide and tallow

trade and for meat. The hacienda was also logged and farmed, much of the land being burned annually during the dry season to discourage forest regrowth. During the 1940s the Pan-American Highway was pushed through with the simultaneous introduction of jaragua (*Hyparrhenia rufa*) pasture grass from East Africa.

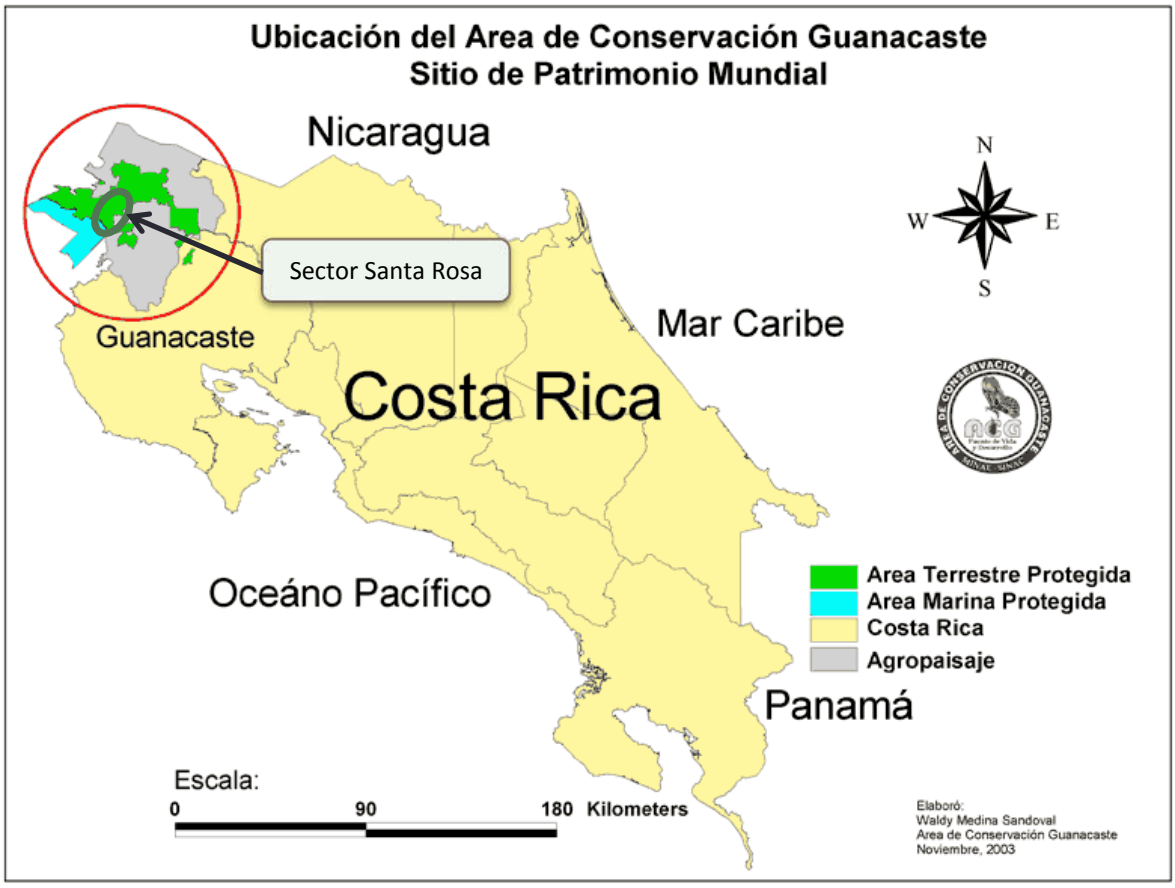


Figure 4.1. Location of ACG, Costa Rica[28].

The current Casona (– large house –) building, now a national museum, achieved its size and appearance in the late 19th and early 20th centuries and was rebuilt for a second time in 1985 after it was razed by fire (Photo 4.1). The site and the surrounding area have provided the stage for three important battles for Costa Rican independence in 1856 and again in 1919 and 1955.

The Parque Nacional Santa Rosa was established in 1971 for its national cultural importance, but also to protect the sensitive natural history of the area, including several threatened and endangered large mammals – cougar, jaguar, three species of monkey, coyotes, Baird's Tapirs, over 500 species of birds and four species of nesting marine turtles.

Today's international image of Costa Rica as a conservation success story and an eco-tourism ideal belies its not-too-distant environmental history. In 1940 the country was 85% forested, declining to around 35% today[29]. During the early 1990s it had one of the highest deforestation rates in Latin America. Most of the land was cleared for agriculture, typically coffee, bananas and cattle pastures. As beef export markets declined – rapidly in the case of the USA – Costa Rica was left with vast areas of cleared land and a national cattle herd that was almost worthless. Today tourism, much of it eco-tourism, is the country's biggest earner of foreign exchange, worth more than the combined income from coffee, pineapples, bananas, cattle-rearing, etc. Tourism exploded in the 1990s and has never

looked back, rising from 329,000 in 1988, through 1.03 million in 1999 to a record 2.2 million in 2011[30]. Insensitive tourism development is now a major issue in some parts of the country.

Photo 4.1. The Casona of Sector Santa Rosa in ACG.

4.2 TROPICAL FOREST "CULTIVATION" IN THE ACG

ACG is home to the world's largest tropical forest restoration project. Currently, its landscape is a mosaic of successional stages; most mid-elevation (200-500 metres above sea level) areas remain as open pasturelands or "savannas" now covered with young forest, while other areas have developed older, successional forests. The goal is to re-establish a continuous dry tropical forest from remnants of forest and restored pasturelands. The impressive scale of this regeneration work offers a range of opportunities for research and innovative practice relating to biodiversity recovery and conservation, natural resource management, sensitive economic development and social justice.

The main driver behind the successful ecosystem regeneration work is the University of Pennsylvania's Professor Dan Janzen, a tropical ecologist of world renown and inspiration for thousands of environmental scientists around the world. He began as a self-proclaimed "esoteric ecologist" researching Costa Rican tropical forests in 1963. The remaining fragments of degraded forest and the intervening and surrounding agroscape (agricultural landscape) were saved, not by Dan, but by many other motivated people (e.g., Kenton Miller, Alvaro Ugalde Mario Boza, Alvaro Umaña, Rodrigo Gamez, Oscar Arias and Pedro Leon) and conservation organisations (such as IUCN, WWF and TNC, Fundacion de Parques Nacionales and Fundacion Neotropica), nurturing the early Costa Rican national park service. In conversation and correspondence he gives due acknowledgement to the wider team and institutions that have ensured the success of this work.

Dan's perspective changed in the '80s after experiences in other parts of Costa Rica and Australia when he realized that the ownership of land needs to be psychologically and socially visible if conservation is to work over the long term – meaning that outsiders need to physically see and understand that an area of land earmarked for conservation is actually being used by people doing something. This revelation coincided with a severe decline in the Costa Rican agro-economy, including a fall in cattle production. Their removal from Santa Rosa in 1978 caused the jaragua grass to grow rapidly to two metres high, creating an ideal fuel source for fires that threatened to destroy what little forest remained in the area[31].

In 1985 Dan and Winnie Hallwachs, his field biologist wife, developed a strategy for the conservation and restoration of ACG. He prefers the term "cultivation" to "reforestation" for much of the forest regeneration work that is underway in the ACG, as it better serves his view of a large, conserved wild land as a "somewhat disorderly garden, one that is multi-cropped, multitasked and has multiusers, and that produces its crops in unconventional kinds of sacks and boxes. And, it requires the same intensity of care and thinking as does any highly successful agroscape or urban centre"[32].

The conservation/ restoration imperative for tropical dry forests, particularly those in Latin America, has usually been eclipsed by the more glamorous, but no more tragic tale of the tropical rainforests. This translated into significant gaps in knowledge and ecology that required addressing to enable dry forest restoration on large scale to be successful.

Dan has identified five biological reasons to restore and protect tropical dry forests on a large scale[33]:

1. Dry season water scarcity magnifies habitat differences between wet and dry places, so a large park provides a functional heterogeneous environment for a large variety of species.
2. The ACG is home to many large vertebrate species, which require large areas to maintain healthy breeding populations.
3. Animal migration to moist areas during the dry season means that both migration routes and refuge habitats need protecting.
4. Detrimental edge effects (wind, light, temperature and humidity fluctuations, etc.) when forest meets open agricultural land can penetrate up to two kilometres into the forest. Large continuous areas of forest avoid this.
5. Large areas allow replicate habitats for multiple uses such as research, eco-tourism and conservation and enable the intense protection of particularly sensitive areas.

Another major reason for restoration and conservation on such a large scale is that only at the ecosystem scale are the products and services useful to humans produced in sufficient quantities; for example, in the case of the ACG, the availability of water for irrigation and potables uses is critical.

There was some resistance from some conservation NGOs when they believed the restoration message expounded by Dan and Winnie confused their more "pure" hands-off conservation mantra. However, these groups have, over many years, slowly been won over.

4.2.1 APPROACH

Typically, local ranchers clear their land every year by burning, removing the dead and dry material and invading forest plants. The invasive, jaragua grass, colonizes the nutrient rich, bare soil and is grazed by cattle.

In a 1980s' experiment Dan protected a couple of hectares of pasture from fire and the competitive jaragua and found that the area returned to forest within a few years as colonizing tree seeds arrived wind-blown from the forest 150-metre distant (Photo 4.2). With the developing trees came increasing shade and habitat for animals, which introduce seeds of different species. This led to the development of the basic strategy for the "cultivation" of the forest on a large scale: fires are suppressed, hunting is prohibited and trees are (rarely) planted and/or (usually) seed naturally. Simultaneously, the regeneration message is reinforced by employing only Guanacaste residents and

outreach educational activities, such as conducting all the basic science and natural history education in the field for 4th, 5th and 6th grade students in all ACG and surrounding schools.

CONTROLLING FIRES

The dry forest cannot be restored by simply planting trees; the key factor preventing forest regeneration is fire. The ACG's dry season fires are anthropogenic and the dense, one- to two-metre tall stands of jaragua burn the hottest and are the most damaging. A great deal of effort and money was initially expended in employing and equipping local people to become fire-fighters; the same people who also worked the land and had been manipulating fire and vegetation for most of their lives. The fire control strategy aims to prevent the spread of jaragua and to allow tree re-colonisation of the pastures. Park staff use fire control techniques, such as clearing fire breaks, maintaining fire access tracks, and rushing quickly to any fires as soon as they are spotted by look-outs on a nearby volcanic peak. Cattle were also employed in the early stages to keep fuel loads low so that any occasional fire could be more easily dealt with.

FOREST RECOLONISATION

Tree species with wind-dispersed seeds are the first to colonize the pasturelands and can move several hundred metres into an old pasture in a decade. 25% of the 215 tree species in Sector Santa Rosa produce such seeds. The resulting habitat is, initially, not ideal for animals as most of the wind-dependent trees do not bear succulent, animal-attracting fruits. An occasional nuclear tree may appear on its own in the middle of a pasture, having been carried there in the gut of an animal. If the seed germinates and establishes successfully, it creates a micro-habitat attracting other animals eventually developing as an "island" of trees spreading slowly across the pasture, eventually to join, hopefully, with other forest fragments. Apparently, the significance of animal dispersal is in moving the seeds to sunny places and not in scarification (i.e., breaking seed dormancy). Consequently animal populations require protection from hunting if the new forest is to develop into a healthy ecosystem. In 1986, at the beginning of the concerted restoration effort, some seedlings were produced and planted, but it quickly became obvious that this was wasting funds that would be better spent on the combination of fire suppression, resident employment and biological education in the neighbouring schools.

Photo 4.2. Before (left) and after (right): jaragua pasture superseded by forest.

During a short tour with Dan along the Sector Santa Rosa access road, he showed me a couple of hectares of tall grass where forest should be. Although it is in the restoration area, it is kept as grass by deliberate burning to prevent tree colonisation as a reminder to others, especially to those who are too young to know, of what the thousands of surrounding hectares once looked like (Photo 4.2).

PEOPLE

It is Dan's and others' philosophy that "conservation into perpetuity demands the abandonment of the model of society fenced out and passive institutional custody"[34], urging the environmental movement and society to consider and implement conservation strategies where people benefit directly – particularly those people most local to the areas of concern. The receipt of local benefits fosters a dependence on the area by local people so that they are motivated to act in ways that are sympathetic to the conservation objectives. A range of initiatives have been carried out to this end. They are summarised here:

- Only local residents are employed by ACG, including those who control fires and manage sites. Sector caretakers are responsible for between 1,000 and 10,000 hectares of land each. They are provided with on-the-job training and the necessary equipment to carry out this work.
- ACG employs only Costa Ricans and promotes from within the park staff, fostering a sense of ownership and responsibility for restoration and conservation. 100% of about 135 employees come from neighbouring communities, of which 45% are women.
- ACG supports basic biology education to all school children in a 20-30 kilometre radius, equating to about 2,200 children from over 50 schools. All related activities are inside ACG and are the core of this educational initiative in biology and environmental science.
- National and international universities conduct ecological and taxonomic research through 13 ecological research stations located in ACG's different ecosystems.
- Local people are trained as parataxonomists to identify and catalogue ACG species, including those of the marine and coastal areas of the park. The parataxonomists coordinate with the Instituto Nacional de Biodiversidad (INBio) in the outskirts of the capital, San Jose.
- Other Costa Ricans trained on-site survey species for potential pharmaceutical products of the future (known as bio-prospecting).
- The Horizontes Forest Experiment Station (previously a 7,000 hectare cattle ranch) in ACG employs local staff to research the recovering ecosystem. It also works to develop silvicultural practices for native dry tropical forest timber species. Its nursery produces 40,000 seedlings per year which are sold to others for reforestation projects and timber and fruit production. The silvicultural programme provides funding and develops new technical knowledge for selling to industry. The station includes lodging and dining facilities and an auditorium.

To date about 6,000 hectares of forest in ACG have been restored to young forest. As well as serving as a platform for esoteric and applied biodiversity research, there is an on-going process of monitoring and evaluation of the reforestation success and its derived benefits. Such work includes the investigation of "conservation through non-damaging use", i.e., developing novel socio-economic outcomes from innovative use of the forest or its land.

The pastureland is achieving young canopy closure within one to four decades. It appears that the regenerating forest will meet the goals of a fully-functioning, mature, dry tropical forest, but when

that will be depends on how one defines mature. Many of the forest's trees have a life expectancy of centuries, so the real measure of success may be delayed until sometime in the 24th century! And to be considered as old growth forest may take another six centuries or so beyond this.

ORGANISATION

The politics behind the ACG and its administration has been a journey of constituency-building to develop a bespoke system of decentralized governance, at odds with the conventional centralized and hierarchical structures. Originally the diversity of land designations and ownerships that became joined to form ACG each had their own formal owners and multiple administrations: the state-owned lands, the newly-purchased lands between the three national parks, the forest reserve and a wildlife refuge. These interests were eventually united under a central administrative structure as a non-governmental/ governmental hybrid to manage ACG. However, this model has still not gained universal acceptance despite other conservation areas in Costa Rica hankering after something similar.

FUNDING AND SUPPORT

A fund-raising initiative was started simultaneously with ACG's launch in 1986 to provide sufficient financial resources to enable the project to develop and expand. Alongside the requirement for hard cash was a substantial need for in-kind support by people of a range of skills and disciplines to develop ideas, generate political support, the administrative structure, technical programmes, etc. The money comes from four key sources[35]:

1. Interest payments from the **ACG Endowment Fund**, consisting of specific donations and maintained since 1988. The Endowment Fund enables the ACG to manage itself with a certain degree of financial autonomy of the vested interests of many external funders be they corporate, government or trust funds, and allows the development of long term approaches.
2. A variety of **specific donations**, either economic or in a technical advisory capacity, from governments, agencies, foundations, corporations and private individuals, both nationally and internationally.
3. **Income generated by services**, e.g. park entrance fees, the activities of the silvicultural programme, the work of the parataxonomists, etc.
4. **Funds from SINAC** (the Sistema Nacional de Areas de Conservacion, or National System of Conservation Areas) as part of its obligation under law to disseminate public funds from central government to the Costa Rican regions for conservation work.

Since the launch of the ACG in 1986, $83 million has been spent in getting the park to where it is today, consisting of $53 million raised by Dan and colleagues plus another $30 million plus from the Costa Rican government. The ACG manages 2% of Costa Rica at almost no cost to taxpayers. Of course, this has taken an enormous personal effort by Dan and Winnie – 25 years' each of dedication, plus uncounted years of many hundreds of other colleagues, including over 200 Costa Ricans.

Dan describes himself as an "esoteric ecologist" and still loves doing ecology. However, much of his time is involved in ensuring that ACG remains viable into the future, although he really does not want to be an administrator, but administration is what he and Winnie spend most of their time doing. The park employs 135 people of which the government pays for 85 from the gate fees of

about 60,000 annual visitors. Dan, Winnie and colleagues raise the money to pay the difference and are also trying to raise $30 million for the Endowment Fund to secure ACG's future indefinitely.

PHILOSOPHY

The germinal ACG team recognized early on that the local history of the last few centuries was at least as much social as it was natural and that to try and separate the two by building a fence between people and conservation would ultimately fail. The solution had to be "**conservation through non-damaging use**". The major success of the ACG to date has been combining the two in a pragmatic and current realization that the long-term future depends on implementing this vision. Other parks in Costa Rica have learned from the ACG's example and are now employing the principle in other of the country's parks.

When I asked why landscape restoration of this philosophy is not more widespread around the world, the surprisingly honest response was, "Lack of landscape restoration in place x and y is generally not because the technical way to do it is unknown or non-obvious. It is because the controlling parts of society have no interest in seeing it restored (or no interest great enough to outweigh the costs to them, be they political, financial, ego or whatever).

"All we did was have the personal desire to expend/ invest the energy in purchasing and otherwise gaining control over management, shared with the government in many ways, of a large and badly trashed really crappy real estate very far from the centre of Costa Rican policy and economic power, and on the edge of a war zone. What we then farm is wildland, rather than rice and cows."

4.3 CONCLUSIONS AND LESSONS

According to Dan, "There are no new ideas here; what's new is doing it." I have tried to identify the following lessons from the restoration experiences in ACG that could apply more widely.

4.3.1 APPROACH

- **Acquire/ control the land**; the simplest and best solution is by raising the money to buy it. Land can also be donated or controlled by entering long term agreements to manage land under the ownership of others.
- **Occupy the land** – being actually, socially and intellectually visible to those outside that people are physically on the land and using it for a return, which could be economic, social, and/or intellectual. It is difficult trying to convince people, especially poor people, not to use adjacent land that isn't theirs when they perceive it as being unused.
- Determine what the key issues are and work out how to deal with them; don't worry about the n^{th} degree of detail – **don't let the perfect become the enemy of the good**.
- **People are central** to the future of large scale ecosystem restoration. Conservation for conservation's sake probably isn't sustainable in perpetuity; people, especially local people, need to see a return for their social stake in a progressive restoration message.
- Others, such as the NGO community, are **changing their perceptions** as they see biodiversity benefiting while local farmers and ranchers gain value from biodiversity conscious agroscape management.
- **Develop local support** for the project by ensuring direct benefits from the project to the local people.

- **Build national capacity** in the key conservation/ restoration disciplines in way that appreciates the limitations and requirements of the national need

4.3.2 ORGANISATION AND FUNDING

- Create a **decentralised, bespoke organisational structure** with high level political support and significant local representation. The organisation should, ideally, have executive powers for activities over the land it manages.
- Create an **independent, autonomous source of funding**, such as the ACG Endowment Fund, owned by the Guanacaste Dry Forest Conservation Fund, which will provide significant income indefinitely.

4.3.3 GENERAL PHILOSOPHY

- Accept that **pristine nature**, in perhaps the majority of landscape situations, is an unachievable/ unattainable/ at times even undesirable goal for landscape restoration activities.
- **Develop a pragmatic and realistic approach** based on the needs of the environment and the local economic and social situation – the two work hand in hand.
- Develop a model of a conserved wild land area as a "**rural social institution**" that can negotiate as an equal across the cross-cultural table in a time of increasing urbanisation.
- Understand the **perceptions** of others about what you are trying to achieve. In challenging them, be flexible and adaptable with your approach to communication to begin the slow journey to mutual understanding. This is not easy when organisations are institutionally expected and organised to think in a certain way, or individuals sit most comfortably within their own intellectual silos. The real wins from landscape restoration (and sustainable development for that matter) are to be had in the intellectual space where different disciplines and different opportunities overlap, but this space is uncomfortable, at least initially, for those who have been trained to think within conventional arenas.
- **Just do it!**

DEPARTING…

I fly out of Costa Rica heading for the Galapagos Islands via Quito. I have seen some impressive work and met a couple of extraordinary people in Costa Rica, as well as exorcised a few personal ghosts. It is a fantastically beautiful country with a well-marketed and well-resourced environmental conservation movement. The work of Dan and others in restoring their degraded landscapes and showing what can be done by just doing it is a valuable lesson for everyone – and not just the environmental movement.

Galapagos

5 GALAPAGOS ISLANDS, ECUADOR

ARRIVING…

The fourth destination of my Churchill travels were those ecological jewels of the Pacific, the Galapagos Islands.

Excitement crackles like electricity through the plane as we near our destination, after a drawn-out stopover in Ecuador's Guayaquil airport. The plane is packed with a broad selection of nationalities, including many Eucadorians too. Peeking through scant holes in the cloud blanket below, the first of the Galapagos Islands comes into sight – everyone cranes and strains for a better view. I'm in an aisle seat so give up trying.

The purpose of my time in the Galapagos was to explore and understand better the local issues that threaten this globally unique place and the tremendous efforts that are being made to reverse some of this damage. My host for the week was Mark Gardener, Coordinator of the Ecological Restoration Group of the Charles Darwin Foundation, based at the Charles Darwin Research Station where I was also accommodated.

5.1 CONTEXT

The oceanic islands of the Galapagos straddle the Pacific Ocean equator 972 kilometres from the coast of mainland Ecuador (Figure 5.1). Their unique ecology is a function not only of their isolation enabling evolutionary diversification of animals and plants, but also of the islands' fluctuating seasons owing to their geographic location on the Humboldt Current and the periodic influence of El Niño events, and their range of micro-climates. The 128 islands' total land area is 7,856 km^2, ranging in altitude from near sea level to 1,700 metres.

In 1959 the government of Ecuador declared 97.5% of the islands as the **Galapagos National Park**. The **Charles Darwin Foundation** (CDF) was established the same year. Constituted in Belgium as an international NGO, its core responsibility is to conduct research and advise the government on the effective management for conservation of the Galapagos. CDF founded the **Charles Darwin Research Station** in 1964, which implemented some of the environmental management practices on the ground until this became the responsibility of the national park service. The CDF, who Mark works for, now advises the Galapagos National Park Service (GNPS) and other Ecuadorian government agencies on conservation methodologies, particularly for the control of introduced invasive species. In 1978 UNESCO inscribed the islands as a World Heritage Site and in 1985 as a Biosphere Reserve.

The Galapagos Islands are economically the richest part of Ecuador and the national government has a vested interest in assuring/ allowing the economic development of the islands for the benefit of the whole country. Galapagos tourism earns a large proportion of Ecuador's Gross Domestic Product. In 2009 it generated $418 million, of which $63 million stayed in the local economy[36]. The islands' economy is based almost entirely on eco-tourism, which is apparent everywhere around Puerto Ayora (the islands' capital) in the iconography of the natural treasures on murals and shop designs, boating tours, and the historical association with Charles Darwin, who is, ironically, awarded almost god-like/ revolutionary status in many lurid public depictions.

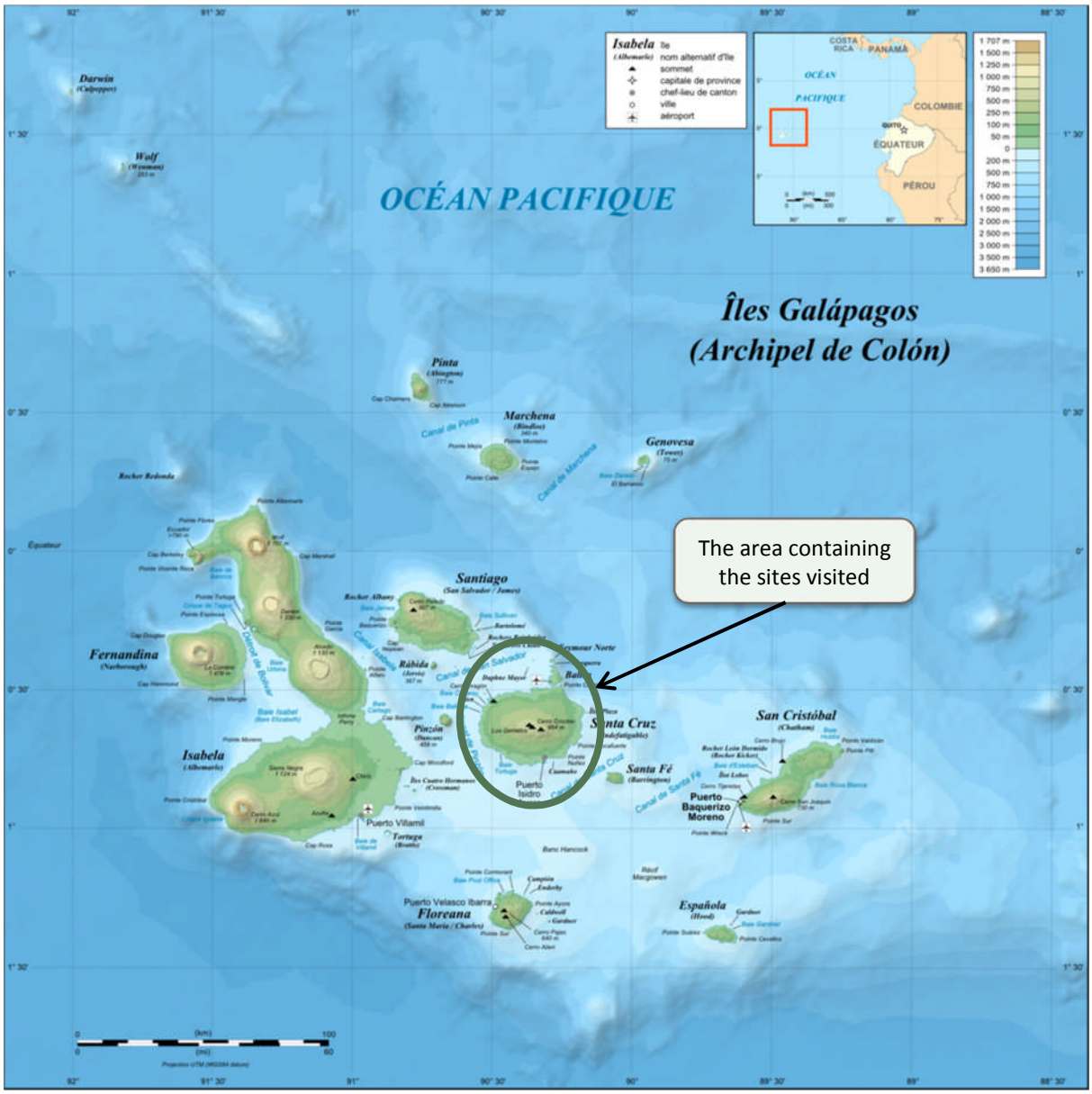


Figure 5.1. Geography of the Galapagos archipelago[37].

5.1.1 THREATS

The islands' flagship natural history needs no introduction, but the threats to it and the important restoration activities trying to reverse them are much less well-known, but critically important to the future of Galapagos. These threats include increasing population and development, invasive species and climate change. The environmental situation in the islands polarises opinion about what to do about the threats and encapsulates locally the international debate between two opposing conservation philosophies: people versus the environment, or people and the environment. However, despite the growing problems, the islands' biodiversity remains in relatively good condition with 95% of their pre-human biodiversity remaining intact[38]. Human impacts have been comparatively low key until the latter part of the 20th century because of the islands' relatively recent colonisation, the islands' aridity precluding human settlement in most areas, and the early designation and protection as a national park.

Several issues combine in the islands that could inhibit long term conservation progress, which have been articulated well by scientists working there[39]. In 2007 the President of Ecuador declared the Galapagos "at risk" and mandated its conservation as a national priority. This was reinforced in 2007 when UNESCO formally listed the islands as *World Heritage in Danger*, although this designation was removed in 2010[40]. The main challenges have been identified by Watkins and Cruz and are outlined below[41].

LEADERSHIP AND GOVERNANCE

Since the implementation of the 1998 Special Law of Galapagos, local administration has become much more independent through receipt of 40% of the $100 national park entrance fee payable by every adult foreign visitor to the islands. This swift increase in income has enabled the rapid development of infrastructure to support the arrival of yet more tourists. The national government, however, still maintains control over the islands' education, health, tourism and conservation policies. The local political difficulties engendered by this state of affairs have been exacerbated by high turnovers of local and national leaders, with implications for the local institutions charged with conservation and sustainable development. The Galapagos Regional Plan in 2001 sought to address the coordination of leadership and governance, but has, so far, been found wanting. At present over 70 local, regional and national institutions play a role in Galapagos decision making, which is further hampered by poor coordination and a lack of transparency.

CHANGE IN TOURISM POLICY

Despite early attempts to control tourism numbers and reduce land-based impacts by confining them to boat-based tourism, since the early 1990s there has been no official restriction in on tourist numbers, which have quadrupled in the ensuing years. This has produced related effects on the expansion of invasive species and development for agriculture and accommodation. The islands are now served by three airports and, since 2007, cruise ships. There is a direct link between the increase in the resident population, mainly by in-migration from the mainland, and the rapid rise in tourist numbers. In the 1970s there were around 5,000 people living in the Galapagos with about 3,000 – mainly high end, foreign – tourists per year (although growing rapidly); in 2009 there were around 30,000 inhabitants and 175,000 tourists annually[42]. The environmental pressures on the islands, such as water and food supply, waste management, housing and tourism accommodation and all the associated infrastructural paraphernalia – particularly on the main island of Santa Cruz, are increasing in step with the human population and the inability of the natural environment and local society to deal with the consequences.

SUSTAINABLE ENTERPRISE DEVELOPMENT

Water availability, soil quality and dense plant invasions are environmental limiters to agricultural development, alongside the economic constraint of high labour costs. These constraints can be overcome usually by importing more, as shown in Figure 5.2, but with negative impacts on the local environment. During the late 20th century the explosive development of the tourism industry increasingly benefited foreign interests, creating social unrest on the islands, which targeted the conservation institutions. The 1998 Special Law of Galapagos sought to address this situation to enable more direct local benefits to flow from fisheries and tourism with more direct local accountability, although the application of the law to tourism has never really been implemented, which still causes some disillusionment.

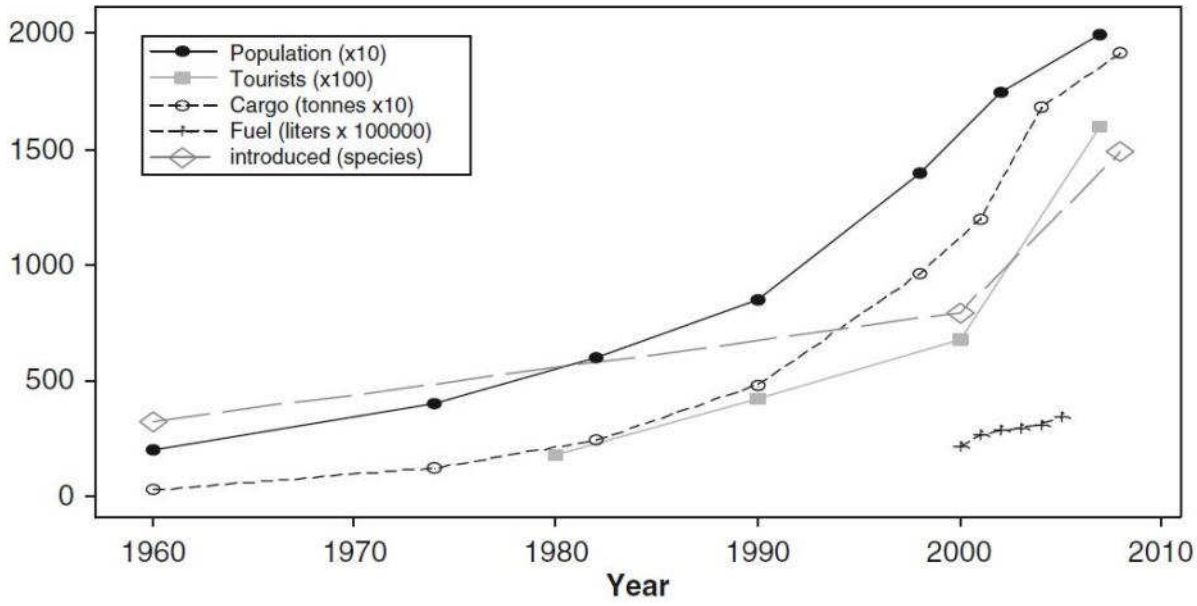


Figure 5.2. Development in the Galapagos, 1960 to 2007[43].

EDUCATIONAL REFORM

The conservation and development issues are exacerbated by poor quality education in the islands. School programmes are poorly aligned with the particularities of life in the islands and teachers are poorly paid and are inadequately qualified. The Special Law sought to broach education as key to a sustainable society and included a framework to fundamentally overhaul the education system. This has still not happened. Alongside this is a lack of opportunity for vocational and tertiary education leading to a local population without sufficient skills or knowledge to prepare them for employment in the local tourism or conservation sectors; therefore, local employers often employ workers from outside the islands. Managers in these jobs are often "Galápagueños" – permanent residents – who lack the necessary professional qualifications that would be expected elsewhere. Residents with sufficient wealth and motivation regularly leave the islands for better quality education and often do not return, having found employment on the mainland.

GROWING ENVIRONMENTAL PROBLEMS: INVASIVE SPECIES

As more people move to or through the islands, the environmental risks of pollution and the introduction of more alien species increase. The direct impacts on the islands of a growing tourism economy are still limited as tourism is now tightly regulated in the national park and there is (quite) strict inter-island quarantine; but indirect impacts have had the greatest impact on the biodiversity of the islands, including the introduction of invasive species, including diseases, and pollution (Figure 5.2). Almost 1,500 species have been introduced into the Galapagos in the past 40 years and, once naturalized they are almost impossible to eradicate – this is particularly true of invasive plant species (Table 5.1). Expensive and perennial control is necessary to reduce the negative impacts of such species on local biodiversity, so it is financially preferable and more effective to reduce the risk of entry in the first place, hence the establishment of the Special Law's Inspection and Quarantine Service in 1999. It aims to:

1. **Intercept new species** on arrival in the Galapagos;
2. **Detect introduced species** before they become naturalised; and
3. **Educate** the community.

The government approved the Total Control Plan in 2006 in support of these aims, but it remains under-funded and lacks strong leadership. That said, there are examples of successful eradication projects, one of which is outlined below.

Table 5.1. Native and introduced Galapagos species numbers by taxonomic group[44].

Taxonomic group	Native species	Of which endemics	Introduced species
Vertebrates (exc. fish)	117	69	55
Fish	396	51	2?
Terrestrial invertebrates	3,000	1,560	543
Marine invertebrates	1,384	362	?
Vascular plants	378	238	888
Non-vascular plants (excluding fungi)	986	184	?

These issues are increasingly understood by decision-makers at local, regional and national levels and some activities and policy instruments have been implemented recently to begin addressing them. Some recent proposals for a radical policy approach have included:

1. Slowing economic growth and the flow of people and goods;
2. Stabilising population growth in the islands; and
3. Investing in the livelihood, education and future of the existing resident community.

The invasive alien species threat is especially serious in the moister upland parts of the main islands, where ideal growing conditions allow any rapidly growing introduced plant species to takeover rapidly.

The realisation is slowly growing that alien species could undermine the economic foundation of the islands by the death of a thousand cuts to their famous ecology. A great deal of effort is being expended on attempting to reverse the impacts of invasive species, with mixed results to date. Two specific examples are discussed below.

5.2 PROJECT ISABELA

The introduced animals of most concern to conservationists are: goats, pigs, dogs, rats, cats, mice, sheep, horses, donkeys, cows, ants, parasitic flies, scale insects, African snails and wasps. Dogs and cats attack tame birds and destroy the nests of birds, tortoises, iguanas and marine turtles and may also kill small tortoises and iguanas. Pigs also destroy reptile nests for eggs, eat their native food and destroy vegetation while searching for food. Cattle, donkeys and, especially, goats, eat all the available vegetation and disperse introduced plants.

On some islands feral goats are by far the most damaging introduced species as they breed rapidly, eat almost all the vegetation and cause soil erosion (Photo 5.1). Goats were originally introduced to the islands in the 1800s and early 1900s by fishermen, pirates and whalers to ensure a fresh supply of meat on future visits to the islands, and by settlers as livestock.

Goat control programmes are easier to implement on islands with no settlements. Where goats are associated with people, for example around farms, control programmes are socio-economically less acceptable. Northern Isabela was goat free until the early 1970s; by 1998, the population was estimated at 75,000 to 125,000 goats. Formerly pristine forests were reduced to closely-clipped grasslands or bare soil, and the loss of forests on hill slopes increased soil erosion. This part of Isabela Island is also home to the largest giant tortoise population in Galapagos, estimated at around 15,000. The goats were affecting tortoises by:

- Out-competing them for grazing;
- Reducing the number of suitable nesting sites;
- Altering island microclimates essential for tortoise survival; for example, hill-top forests trap the thick *garúa* mists. The water then drips to the ground keeping it damp and collects in hollows known as drip pools. These pools disappear as the forest becomes sparser because of over-grazing.

Photo 5.1. Goats on Isabela Island[45].

Other endemic species were also suffering, with a real risk of habitat degradation-related species and sub-species extinctions.

The situation was deemed critical to the ecological and evolutionary integrity of the island and the islands could not be ecologically restored until the goats had been removed. Project Isabela was initiated as a key part of an ambitious, long-term ecological restoration programme under the auspices of the Galapagos National Park Service and the Charles Darwin Foundation/ Charles Darwin Research Station. The Global Environment Facility and other funders provided $43.3 million to fund a project entitled, “Control of Invasive Species in the Galapagos Archipelago”. This ambitious programme had a number of elements including: baseline inventories, quarantine development, research on invasions, pilot eradications, awareness and participation programmes, capacity building and development of a Galapagos-wide planning and policy framework.

The flagship pilot eradication programme was Project Isabela[46]. It is the world’s largest island restoration programme to date and has removed over 140,000 goats from over 500,000 hectares at a cost of $10.5 million. It aimed to permanently remove goats, feral pigs and donkeys from the islands and ensure the re-establishment of the native vegetation and evolutionary processes. It ran from 1997 till 2006 and eradicated the animals from the islands of Pinta (5,940 ha), Santiago (58,465 ha), the northern part of Isabela Island (approximately 250,000 ha of the total island area of 458,812 ha) and Floreana island.

The isolated and remote nature of the locations required a huge and expensive logistical exercise and organisational ability and finding people with the appropriate hunting skills. Field trials on smaller islands provided the test-bed before the main part of the project on the extensive, difficult terrain of Isabela. A range of advance surveying, tracking and hunting techniques were used, based on experiences of goat eradication on islands in other countries. Methods included:

- Ground hunters with trained dogs;
- Aerial hunting from helicopters; and
- "Judas goats" fitted with tracking collars. (As goats are gregarious, live-captured, sterilised and released animals fitted with radio collars will naturally seek out remaining goats, leading hunters to them.)

Since 2006 when the eradication programme ended, there has been a remarkable ecosystem recovery of native plants and birds. Vegetation is regenerating from:

- The native seed bank in many areas as goats were removed before it became too diminished; and
- Tree stumps that are still viable despite being heavily grazed.

Many species that had become rare or uncommon are now returning, including the endangered Galapagos rail (*Laterallus spilonotus)*. Currently, the control of feral goats, pigs and donkeys is being implemented in the trickier social environments of the inhabited islands. The lessons learned from Project Isabela are also being applied to the control of other mammals, particularly introduced rodents. Despite the success, a few local residents have deliberately re-introduced goats to the "goat-free" islands to make a political point. This emphasises the need for the participation and education of local people to reduce the risk of reversing the eradication efforts, but also to ensure that they benefit from the restoration work.

Complete ecosystem recovery will take decades and will require on-going management to ensure the re-growing vegetation does not become dominated by introduced species; although, for a range of ecological, climatological and socio-economic reasons, it is unlikely ever to return to something that would be recognizable by the 1835 Darwin.

5.3 INVASIVE PLANT CONTROL ON SANTA CRUZ

The islands are located within the Pacific Dry Zone which results in a very low annual rainfall. Consequently, much of the islands are covered in characteristic desert or semi-desert type vegetation; however, the high volcanic peaks intercept the south-east trade winds resulting in higher rainfall than would otherwise be expected. The extreme difference in the availability of moisture causes a very marked zonation in the vegetation as one gains altitude. Generally five vegetation zones, with their approximate altitudinal ranges, are recognised[47]:

1. **Coastal or Littoral Zone.** This is a narrow belt immediately on the coast line. It most commonly appears as bare lava flows or lava with a coastal scrub cover. Lichens may occur in damper dewfall areas. Mangroves grow in flatter, more sheltered areas, in accumulations of silt.
2. **Dry Zone.** The endemic lava cactus (*Brachycereus nesioticus)* is often the only sign of plant life that can survive the harsh, hot and extremely dry lava substrate. Palo Santo (*Bursera graveolens*) forms a light, open woodland, often mixed with tree-like *Opuntia* or other cacti.
3. **Transition Zone.** Stands of *Bursera* trees become denser and the diversity of tree species increases and the forest gets taller. Epiphytic lichens commonly hang like beards from the trees.

4. **Humid Zone.** This consists of very diverse, lush forest vegetation. Dense scrubland, ferns and grasslands are common. On several islands the forests are dominated by trees of the endemic genus *Scalesia*. Trees may be festooned in ferns, mosses and liverworts.
5. **High Altitude Dry Zone.** This zone only occurs on the islands with the highest peaks that reach beyond the cloud layer and therefore experience little rainfall.

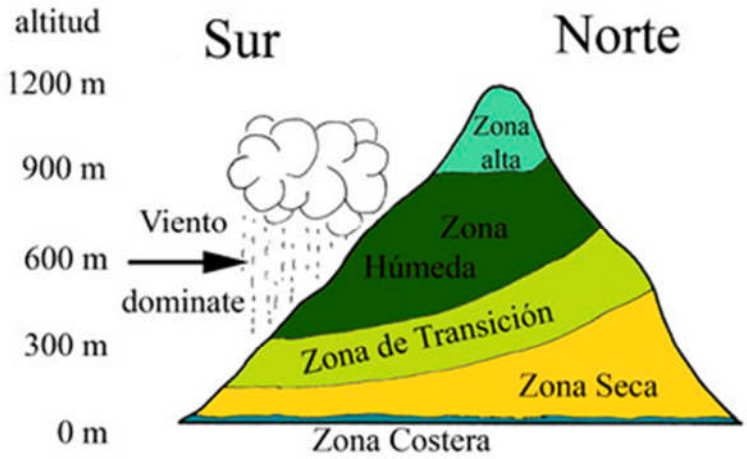


Figure 5.3. Galapagos vegetation zones.

The vegetation zonation is particularly evident on the island of Santa Cruz on the north-south drive between the airport and Puerto Ayora, over the extinct volcano.

While the success of the large mammal eradication programmes should be applauded, they are relatively straightforward in comparison to reducing the impacts of invasive alien insects and plants. Much of my time on the Galapagos Islands was spent in the humid, green uplands of Santa Cruz, wearing waterproofs against the mist and drizzle and dripping trees, while Mark explained the various issues and described some solutions to the problems posed by introduced plant species. Humid zone vegetation is the most impacted by invasive plants as growing conditions here are ideal.

The humid uplands of the main island of Santa Cruz are clothed by native, humid tropical forest, originally dominated by the endemic *Scalesia* – or daisy tree – and its associated unique natural ecology. I spent a day in this cool, damp environment assisting Mandy Trueman of the University of Western Australia with her PhD research, surveying the humid zone vegetation in the vicinity of the small, extinct volcanic cone of Media Luna (Photo 5.2). Her project is to investigate and map the spread of invasive species in this part of Santa Cruz.

Like Darwin's finches, the endemic *Scalesia* genus has adaptively radiated into 15 species and five subspecies that exist as shrubs and trees ideally adapted to a range of habitats and islands. The largest species, *S. pedunculata* may reach 10 metres in height and its stronghold is on Santa Cruz. It has become endangered as significant sections of the humid zone were converted into agricultural land thus fragmenting the forest. Grazing and browsing mammals (goats, pigs and donkeys) have also had a serious impact and the species is also susceptible to competition from introduced plant species. The main introduced plant threats are[48]:

- **Trees:** Cuban cedar (*Cedrela odorata*), guava (*Psidium guajava*), sauco (*Cestrum auriculatum*) and red quinine (*Cinchona pubescens*).
- **Shrubs:** blackberry or mora (*Rubus niveus*).

- **Vines:** passionfruit (*Passiflora edulis*)
- **Herbaceous species:** some grasses, e.g. elephant grass (*Pennisetum purpureum*).

Photo 5.2. Fieldwork with Mandy Trueman in Santa Cruz's *Scalesia* forest and the garúa mist.

CDF, and Mark's group in particular, have been studying how best to save the unique *Scalesia* forests by developing a management matrix that promotes native species and reduces the vigour of invasive species. I consider the control of just two introduced plant species below.

5.3.1 MORA

An area of 25 hectares near Los Gemelos, on the main road from the airport to the islands' main population centre at Puerto Ayora, has received intensive management of invasive species, particularly of Cuban cedar, red quinine and mora, which are threatening to dominate the forest. The control regime involves the regular hacking and spraying of mora and the girdling of non-native trees. At first sight this appears effective; however, walk inland from the road beneath the *Scalesia* canopy and after 100 metres or so one hits an impenetrable, thorny wall of smothering mora (Photo 5.3).

Mora is particularly difficult to eradicate. Introduced in the 1980s, it emanates from the Himalayas and is fast-growing and thorny, forming dense, impenetrable thickets below which little grows. It currently infests an estimated 30,000 hectares of the humid zone and the potential distribution could reach 90,000 hectares. It is prolific, producing sweet, fleshy fruits throughout the year, each containing hundreds of seeds that are dispersed widely by rodents, birds and tortoises. The seeds remain viable in the soil for years, accumulating to form a large seed bank of 7,000 to 22,800 seeds

per square metre. As well as damaging native forests, it also increases the cost of local agricultural produce.

Current control methods include thorough searching on the ground followed by the application of herbicides on new growth some weeks after the plant has been cut back. Tests with herbicides that kill the seeds in the seed bank are promising, but must be accompanied by re-planting with natives species, otherwise introduced species will move in. A recent, intensive, five-year experiment to manage mora on Santiago Island proved that, using conventional techniques, it is extremely difficult to eradicate mora. It concluded that even if the financial and human resources were found to enable this, then the detrimental off-target effects and disturbances on native species would outweigh the effects of the control[49].

Photo 5.3. Mark Gardener by a "wall of mora" in the *Scalesia* forest.

The use of bio-control agents, particularly pathogenic fungal agents, is being researched by the Charles Darwin Foundation, but this is a long-term solution. The cost of the research alone will be around $800,000 over five years. Their routine use in the field is likely to be controversial, at least initially, against the backdrop of the damage that has been done to the islands' fragile ecology by introduced/ alien species.

5.3.2 CUBAN CEDAR

There are two native timber species in the Galapagos although, since 1995, it has been illegal to fell them. Cuban cedar (*Cedrela odorata*), a member of the mahogany family, was introduced to the islands in the 1960s, along with several other tree species, as an ideal timber provider for local

economic needs. Most of the islands' buildings and furniture are fashioned from the tree to the extent that an artisanal village has developed to supply the islanders' needs. The tree has spread into the *Scalesia* forest where it is taking over in many areas.

Owing to the slow growth rates of trees, the Cuban cedar and other invasive trees species are relatively easier to control than, for example, mora. It is controlled by girdling near ground level then spraying the cuts with herbicide. A key issue, however, is more socio-economic than environmental. Without the introduced timber trees, wood would need to be imported at high expense from the mainland. For decades local people have been able to log such trees, effectively at will, providing a cheap, raw material for creating value-added products, such as furniture and construction. There is some resistance to the destruction of the trees, which will need to be addressed as the control programme becomes increasingly successful.

5.4 OTHER PROJECTS

During my tour of the islands in the informative company of Mark, we talked for hours about all aspects of the life in the islands and its ecological and socio-economic challenges. I was also shown a range of different projects and issues that relate to landscape restoration. These are summarised very briefly below.

- **Native Gardens for Galapagos** is a CDF project, begun in 2007, to encourage residents to plant native species in their gardens rather than introduced ones, with the aim of reducing the risk from new introduced garden plants. There are three key project components:
    - **Increasing participation** by planting new public gardens in Puerto Ayora with native species, including around the research station;
    - **Increasing knowledge** by providing information about the species planted to the public and producing an illustrated guide to garden plants that are safe for local biodiversity; and
    - **Increasing the availability** of native garden species and related knowledge by developing a nursery for producing and selling these species for people's gardens[50].
- **Native species nursery** – a new nursery, less than three years' old, has been set-up on about 100 hectares of old farmland at Sala-saca, which was land given to the national park in a swap for new development land on the edge of Puerto Ayora. Three full-time nursery workers and two volunteers, with and assistance from local youth clubs, have helped grow 22,000 native and endemic species for reforesting the farmland surrounding the nursery. The nursery takes a "learning as you go" approach to determining how best to grow these native species.
- **Mining for aggregates** – two small quarries, Mina Granillo Negro and Mina Granillo Rojo, on the north side of Santa Cruz mine volcanic rock for use in road building, the preparation of new building plots, etc. The islands need their own sources of aggregates for such purposes because the cost of importing the quantities required from the mainland is prohibitive. The worked out areas are progressively replanted with native canopy tree species, planted directly into the waste rock material to control erosion on the bare substrate. The young saplings are drip-watered by bespoke plastic drink cartons filled with water (Photo 5.4).

Photo 5.4. Drip irrigation of young trees at the Mina Granillo Negra.

- **Charles Darwin Research Station**, Puerto Ayora – is the nerve centre of research and science on the biology and conservation of the islands species and their restoration. A large area of the station is allocated as an educational visitor attraction, which is one of the main built attractions for tourists – and locals – in the Galapagos. It also doubles as a breeding centre for giant tortoises and land iguanas. A small nursery, which is also open to the public, cultivates endemic species. Throughout, various public education displays highlight, among other things, the important restoration work underway on the islands. Such a facility helps build local and international awareness of the unique ecology, but also the environmental threats and restoration challenges facing the Galapagos. Local guides are employed to show visitors around the site.
- **Rancho Primicias** is located on the edge of Santa Cruz's agricultural area. Its 150 hectares was previously used for cattle. Since then the owner has pulled down the fences that separated pasture from forest, dug some shallow ponds and allows wild tortoises to wander in to wallow in the muddy ponds or graze the grass (Photo 5.5). The farm, now with a restaurant, is on the tourist route and is proving more lucrative than farming cows.

Photo 5.5. Galapagos giant tortoises at the Rancho Primicias.

5.5 NOVEL AND HYBRID ECOSYSTEMS

The two main examples of invasive alien plant species control described above illustrate that it is probably not possible, nor even desirable, to covert the inhabited Galapagos Islands back to the pristine state of the early 19th century. Cultural and socio-economic drivers are as important to the islands and the nation of Ecuador now as its ecological interests and must be factored into large-scale restoration efforts. Similarly, despite the relatively pristine nature of Galapagos' biodiversity compared to other island systems, the ecological impact of invasive and introduced plant species (in particular) is probably too far advanced now to reverse completely, with current technology; Mark stated that between 2001 and 2007 CDF carried out 29 plant eradication projects on 23 invasive species focusing on those still limited to small areas. Only four of the projects succeed in eradication and none covered areas of more than one hectare. The conclusion: given current and likely future resources, eradicating plants is a practical impossibility.

Furthermore, there are so many different invasive species and ecological impacts that the removal of one species is likely to result in replacement by another invasive. Another perspective offers a more pragmatic, but currently more controversial approach, where the goal would be to maintain as much native biodiversity as possible together with original functionality, and undertake management interventions that maximise benefits over the total area of intervention and not focus solely on the invasive species. Here, the pre-human state is unattainable given realistically available resources. Such hybrid and novel ecosystems, those that have new species combinations arising

through either species invasions or environmental change, are now widespread and could become objects of conservation for their own sake.

This hybrid and novel ecosystems approach also frees up resources for the conservation of important native species in areas currently less impacted by invasive exotics and allows for the supply of basic cultural and socio-economic needs. After all, it could be argued that the original ecosystem was a novel, hybrid affair comprising an ensemble of species that arrived by luck, rather than design, which was augmented by subsequent natural invasions – some successful, some not – and natural extinctions of the incumbents.

5.6 CONCLUSIONS AND LESSONS

The impact, both current and potential, of invasive plants, animals and diseases on the unique ecology of the islands is hard to take in initially. And that's before the impacts of rapid development are considered. Taken at face value, the small population and lack of capacity make the situation seem hopeless, yet the international ecological icon that is the Galapagos Islands ensures that corrective action will be funded to some degree.

Much of the ecological restoration research that is underway is world class. However, the Galapagos shows that dealing with landscape restoration, as defined in Section 1.1, goes beyond purely ecological considerations – human issues are critical to success. Some Galapagos scientists have recognised this and have written well-informed papers relating to the governance and socio-economic development imperative as it influences ecological considerations on the ground. And this is simultaneously illuminating and encouraging. I have summarised the following generic transferable lessons from my Galapagos experience.

- As the development of evolutionary theory challenged the philosophy of human origins and our place in the world, contemporary Galapagos also prompts us to **examine our responsibilities** for reducing the environmental (and ensuing socio-economic) damage caused by human activity. What do we mean by landscape/ ecological restoration? Is a new paradigm of hybrid or novel ecological systems acceptable? How far should intervention go? Why are we doing it – what it is the goal, and who benefits? The lessons learned in relation to these issues in places like the Galapagos will resonate around our world and well into the future.
- The importance of **good governance** – the development of strong policies and legislation that are properly implemented on the ground.
- **Local autonomy in governance** with proper participation by local people in decision-making.
- The Galapagos Islands face a series of environmental threats that will directly and indirectly impinge on its people and those who live further away on the Ecuadorian mainland. Project Isabela shows that a **long-term, multi-faceted strategic approach** is required that addresses all the threats to the unique and income-generating environment – determining who leads it, and how, are critical issues.
- The importance of **good leadership** – ideally one organisation or individual that is recognized as being the final decision-maker by all the contributor organisations and individuals – is essential. The leading group should also be an open-minded listener working in the best interests for the long term future of the Galapagos, avoiding local, short-term vested interests.

- **Good quality science** is essential and the bedrock of restoration activities. They should ensure that money and resources are spent in the most appropriate and effective ways to reduce risks to the environment and decision-makers should act appropriately on such information.
- The **importance of public awareness**. This works at two levels in the Galapagos: the **resident public** and the **tourist public**. Local communities are central to conservation in mixed land use areas and must be fully involved in management planning and implementation. Residents are now being taught local environmental education in schools, but resident adults and new in-comers need also to be targeted because of the influence they have on the present. Tourists are generally not aware of the restoration efforts or imperatives, and a more coordinated approach could raise awareness of (and funding?) from 170,000 captive, wealthy international visitors per year. They present an opportunity for public education around more general sustainable development issues.
- Despite the myriad international organisations involved in Galapagos conservation and the relative availability of funding, conservation and restoration activities in the islands are generally hampered by: lack of a coherent, long-term strategy, lack of capacity, reinvention of the wheel, little means to encourage ground-up initiatives, lack of strong leadership and dilution of effort. This experience is by no means unique and is very common with restoration projects around the world. Improved international collaboration and knowledge-sharing between areas that are working on similar issues would build capacity, avoid wasting resources and produce a louder voice for support of restoration activities, either financially or in policy terms.

A great deal can be learned about the social and environmental challenges facing society on a global scale by studying these issues in microcosm on island systems. For two centuries the Galapagos Islands have been at the forefront of knowledge and philosophy on man's place in the world and his interaction with the environment. The islands are famed for their critical role in inspiring, through Darwin, a revolutionary perspective of man's place in nature. Today they could provide an evolutionary lesson relating to how man can live globally in nature in way that takes into account the impossibility of returning to a state of pristine wilderness when there are over seven billion people sharing the planet.

DEPARTING…

I'm an optimist and after only a week in the Galapagos I can see the germinal environmental awareness (yes, including recycling) allied to an appreciation of the basis for the tourism that is the mainstay of the islanders' existence. The constant, international, environmental spotlight on the islands adds a third dimension. There is a government strategy for the Galapagos Islands to become completely sustainable by 2060. I would love to be able to come back in 50 years (at the age of 94) to see if it really has.

Rio

6 MATA ATLANTICA, BRAZIL

ARRIVING…

On leaving the Galapagos Islands, a tortuous series of overnight flights brought me to Rio de Janeiro in the heart of what was once one of Latin America's greatest forests.

Scalped and flayed, torrents of pink blood erode gaping wounds exposing geological bones as tears fall from a sombre sky. Sterile grassy hillsides and naked soil are sad substitutes for one of the planet's most spell-binding forests. In 1832, this spectacular forest had captivated Charles Darwin. If he had visited today, perhaps his work on evolution would have taken rather longer.

My over-long journey ends in a 30-minute ride in a rickety, old bus along a dirt road, heading into the mountains. The rivers are now clean and bordered by trees and green pastures. The driver indicates with a hand gesture that I have reached my destination, so I duly jump off. The bus trundles on trailing a cloud of dust, and then I am in the quiet zone, suddenly alone, in the middle of apparently nowhere.

I was visiting three projects, all different, that are working to restore the land where once the great Atlantic Rainforest grew. These projects are located in the south-east of Brazil and not that far from the sprawling conurbations of Rio de Janeiro and Sao Paulo. They are:

- **REGUA,**
- **Serra da Concordia Wildlife Sanctuary,** and
- **SOS Mata Atlantica.**

Unfortunately a pre-arranged meeting with the **Atlantic Forest Restoration Pact** (Pacto Mata Atlantica) did not happen. However, I have collated the information discussed below through subsequent correspondence and have, therefore, included reference to their work below.

6.1 CONTEXT

The demise of the once great Atlantic Rainforest, or Mata Atlantica as it is called in Brazil, is an environmental and human tragedy. Once one of the world's most ecologically-rich forests, it covered nearly 1.5 million square kilometres of the eastern side of tropical and sub-tropical South America, extending 4,500 kilometres northwards from present day northern Argentina, Paraguay and the extreme south of Brazil (Figure 6.1). Today just 7% remains in highly fragmented patches mostly less than 50 hectares in size. Yet, even these scant fragments provide the ecological back-drop to some of the most remarkable scenery in Latin America, such as the Iguaçu Falls on the border of Argentina, Brazil and Paraguay, and the city of Rio de Janeiro, and retain some of the richest life on earth, comparable to the Amazon rainforest[51]. The remains of the forest contain almost twice as many animal and plant species as the whole of Europe. It ranges from sea level to 2,000 metres and receives 2,200 millimetres of rain and supplies fresh water, clean air and climate moderation for 130 million Brazilians. It is one of the top five conservation priorities in the world[52].

Forest clearing by Portuguese, Spanish and French colonialists began in earnest in the 16th century as they established settlements along the coast. The harvested hardwoods, mainly Brazilian redwood (*Manilkara bidentata*) and Pau Brazil (*Caesalpina echinata*), were sent to Europe, while the land was turned over to sugar cane plantations. By the early 19th century land around Rio de Janeiro, Sao

Paulo and Minas Gerais was being cleared for coffee plantations, with most of the wood simply burnt. This early period of clearance was done by African and indigenous slaves. As the cleared land degraded and the plantations became uneconomical, the land was turned over to cattle pastures, which persist over millions of hectares today.

Figure 6.1. Original extent of the Atlantic Rainforest and the locations of the three projects I visited[53].

Rapid industrialisation and urban expansion in south-east Brazil in the second part of the 20th century destroyed much of the remaining forest; today, 70% of Brazilians – over 130 million people – now live within the Atlantic Rainforest domain, including in the enormous cities of Sao Paulo and Rio de Janeiro. Deforestation over the last 50 years has been as severe as that of the previous three centuries and the destruction continues as areas of remaining forest are cleared for sugarcane, pines and eucalyptus plantations, livestock farming, illegal timber and urban expansion[54].

The remaining Atlantic Rainforest areas contain over 20,000 plant species, including some of the highest tree biodiversity on earth, and 2,200 species of vertebrates of which 800 are endemic. 60% of Brazil's endangered species are found in the forest, including flagship, endangered primate endemics such as the four species of lion tamarins and two species of spider monkeys.

The main threats to the remaining forest include:

- **Clearance for pasture**;
- **Clearance for agriculture**, including coffee, tea, sugarcane, tobacco and, more recently, soybean and biofuel crops;
- **Urban expansion**;
- **Hunting** has had a large impact until quite recently. There is much less hunting today as people are afraid of police enforcement of environmental laws. Also, there is much less prey to be hunted than there once was;
- **Logging**; and
- **Fire** –Atlantic Rainforest species have not evolved to cope with fire, so it is particularly destructive to the ecosystem.

The conservation community and many decision-makers in south-east Brazil realise the severity of the situation, particularly in terms of the lost and declining ecosystems services in the face of impending climate change. Increasingly protected areas of forest are being created and obligations are being legally place on land-owners to conserve and restore forest on their land.

6.2 REGUA

The Reserva Ecológica de Guapiaçu (REGUA) project is located 80 kilometres north-east of Rio de Janeiro in the upper watershed of the Guapiaçu river – an area of 30,000 hectares ranging in altitude from 30 to 2,000 metres above sea level. REGUA is strategically located between the protected forest areas of Parque Nacional da Serra dos Orgaos to the west and the Parque Estadual dos Tres Picos to the east. REGUA sits within the Serra do Mar mountain range and offers a complete gradient of forest cover from near sea level to its rocky summits.

The San Jose Farm has been owned by the English Locke family since 1907. Nicholas Locke arrived from the UK in 1979 to farm it and rapidly developed an interest in conservation by busily planting trees. In 1996, after the visit of a UK naturalist, this interest developed into the beginning of a serious eco-tourism project. The project became an NGO, now known as the REGUA project, and later acquired a substantial part of the original San Jose Farm. A few administrators later the project invited Nicholas and his wife, Raquel to manage the project. Both kindly hosted me and patiently answered my tedious questions.

Photo 6.1. Volunteer accommodation in converted farm buildings at REGUA.

A key part of the success of the REGUA project is derived from the conversion of the old San Jose Farm buildings to provide: comfortable accommodation for tourists in the old farmhouse, accommodation for staff and volunteers (I stayed in what used to be the calf shed!), a native tree nursery and a developing conservation centre in the farm's refurbished workshop area – the focal

point of the estate that now houses facilities for catering, teaching, computing and research (Photo 6.1). An impressive effort has gone into this conversion and you can see it has been a labour of love.

REGUA has several streams of work in its Atlantic Rainforest conservation programme, namely:

- **Land acquisition and protection**,
- **Education**,
- **Research**,
- **Habitat restoration**, and
- **Tourism**.

6.2.1 LAND ACQUISITION AND PROTECTION

Land is protected by purchasing key areas when they become available to expand the size of the reserve or to connect existing conserved areas. The REGUA project now owns 4,500 hectares with management agreements over a further 2,700. The largest management agreement is with the Brazilian beverages company, Schincariol, which owns 2,500 hectares in the centre of the reserve, from which they pipe water to a reservoir for a bottling plant near Cachoeiras do Macacau[55].

Areas of REGUA that lie outside the Tres Picos park are to be protected by RPPN (Private Reserve for the Patrimony of Nature) status – the first such designation in the Cachoeiras de Macacau municipality. Nicholas explained that the country is still developing and it is difficult for many Brazilians to understand the concept of conservation and why an NGO should want to own and protect land rather than sell it for profit or develop it.

The forest is also protected by 10 rangers employed and trained by REGUA to patrol the area – equivalent to one ranger per 700 hectares – each costing $7,200 per annum. They protect the reserve against hunting, illegal logging and the collection of rare plants.

A key strand of REGUA's protection activities is the building of public awareness in, and integration with, the local community through on-site activities and ensuring a constant and visible presence on the land, for example REGUA recently organised an Upper Guapiaçu River Basin cycling event that attracted 40 local participants.

6.2.2 EDUCATION

Since 2006 there has been a weekly school visit schedule. Children arrive by school bus on Saturdays and participate in forest nature trails and other activities in which they learn about the forest, biodiversity, landscapes and restoration.

As well as hosting hundreds of school children, REGUA has a permanent education programme, including a Young Ranger Programme for 10-16 year olds now entering its seventh year. Participants from surrounding villages are given informal lessons on the environment, with an emphasis on creative approaches such as arts and crafts and theatrical workshops. They have become involved in raising trees in the nursery and planting them, bird-watching and other educational activities around the reserve. The programme includes a periodic Green Bulletin to keep its members up-to-date with REGUA happenings and conservation news in their local area of the Atlantic Rainforest.

6.2.3 RESEARCH

REGUA's resident scientific research coordinator, Jorge Bizzaro, related the contemporary and historical context of the project, explaining much of the ecological wonder of the place. He is an interesting and intellectual character; trained as a medical doctor, then re-trained as an entomologist, and now assists with the scientific development and credibility of the project.

In partnership with local universities, a range of research activities are underway including monitoring the newly planted forest and recovery of the new wetland. The combination of easy access, accommodation and research facilities also attracts biodiversity researchers as regular visitors who are particularly interested in REGUA's birds, charismatic mammals like pumas and the rare woolly spider monkey (*Brachyteles arachnoides*), and other vertebrate groups such as amphibians and reptiles, sloths, caimans and invertebrates. In spite of past selective logging the forests are in a good state and ecologists are also researching regrowth, carbon stocks and plant communities. An orchid survey has been conducted, although orchids are best known from the high cloud forests of the Serra do Mar mountains.

6.2.4 HABITAT RESTORATION

Natural forest regeneration was inhibited on many parts of the farm by the highly competitive grass species, *Imperator cylindrica*. Since 2005 REGUA has planted 130,000 trees of which 85% were supplied by the in-house nursery (Photo 6.2). Trees were planted at a density of 1,000 to 1,600 trees per hectare, with up to 70 different species per hectare of which 40% are pioneer species. The grass is killed with herbicide prior to planting, which is done by hand on the hillsides. An intensive aftercare regime ensures that the grass and leaf-cutter ants are controlled and water is provided during droughts. To date there has been 95% tree survival. REGUA's native tree nursery was supported with a grant from SOS Mata Atlantica (Section 6.4). The nursery grows between 40 and 50 mainly pioneer tree species and produces 45,000 trees per year – the maximum that can be produced with the current facilities and staff; further expansion will require significant investment in staff, facilities and equipment. The nursery and planting strategy was developed by a forester based at the Federal Rural University of Rio de Janeiro. Two staff are employed to run the nursery: a manager and an assistant. The REGUA driver, Alcenir, works voluntarily in the nursery in his spare time with his family.

A recent wetland restoration project has been very successful. An original wetland existed on the farm, which was drained in the 1970s by a past Locke family member and converted to pasture. Between 2004 and 2010 Nicholas and team returned 12 hectares of this grassland to wetland. The bird species count has risen from 90 to 220 species, including the rare black-legged dacnis (*Dacnis nigripes*), in a very short time and the lake and its environs are now populated by capybaras and caimans. Before this project, wetland recreation in Rio de Janeiro state was largely unheard of – wetlands were regarded as something that had to be drained and developed.

Adjacent to the wetland, a hillside has been re-planted with native trees to connect the restored wetland to some remaining forest fragments. Another 40 hectares of land is due to be reforested adjacent to REGUA, the purchase of which was helped by the UK-based World Land Trust.

Photo 6.2. Raquel Locke at REGUA's tree nursery.

REGUA has also been working with the Crax Institute of Belo Horizonte to re-introduce the endangered, endemic, red-billed curassow (*Crax blumenbachi*) to the local area. Its wild population had declined to an estimated 250 birds. Twenty birds, equipped with radio transmitters, were released at REGUA in 2006, with a further 20 released the following year.

6.2.5 TOURISM

REGUA offers high quality accommodation to tourists, primarily bird-watchers from Europe and North America, who are attracted by the renowned endemic birdlife of south-east Brazil. They are taken on guided bird-watching tours through the forest and into the mountains and can observe birds from hides around the new wetland area (Photo 6.3). This eco-tourism venture is promoted by participating in events such as the annual UK Bird Fair.

Tourist activities are supported by eight paid guides and volunteers from the around the world, including professional birders from the UK's Royal Society for the Protection of Birds (RSPB). Nicholas and Raquel have an enlightened and brave policy of employing and training up local people to work on their project – the main thing they look for in potential employees is the "right attitude". A fascinating case in point is offered by the guides employed to lead wildlife-watching trips into the forest. Each of them originally worked illegally in the forest as hunters/ poachers. Nicholas offered them the first formal employment of their lives as guides. They learned on-the-job and by informal teaching by national park staff. Adilei is one of those inspiring guides. He had learned all the calls and behaviours of the local birds and was able to recognize them by the call, and even to imitate most of

them, drawing the birds closer for better viewing by bird-watching tourists. He had little formal education, but told me he was now learning English in his spare time so that he could interact better with his tourist charges.

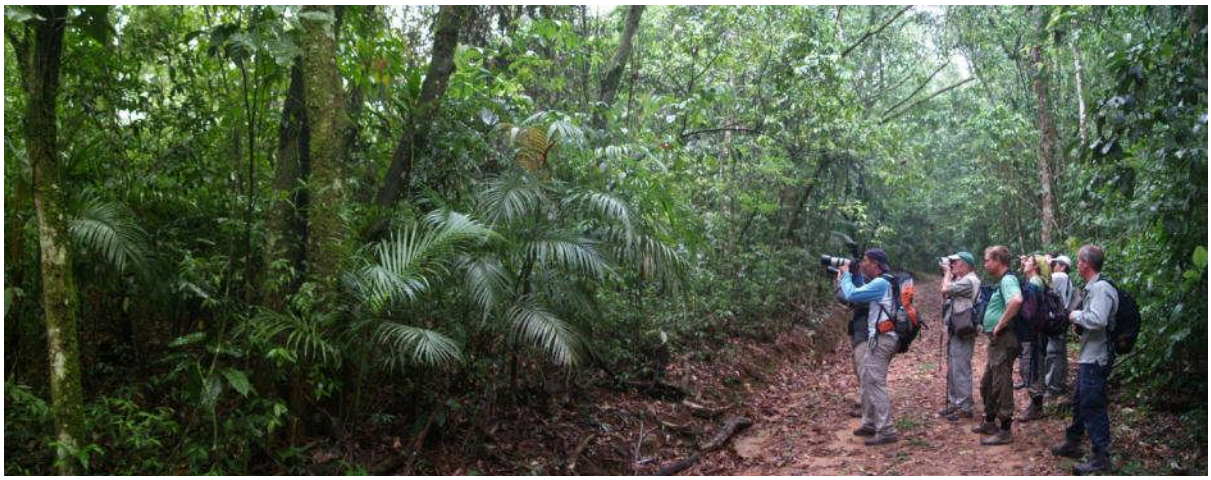


Photo 6.3. Bird-watching tourism at REGUA.

6.2.6 IMPACTS

REGUA is supported financially by two UK-based NGOs – the World Land Trust and BART (British Atlantic Rainforest Trust) and various US-based, private donors. The organisation also collaborates with many local and regional Brazilian groups including the state universities of Sao Paulo and Rio de Janeiro, research organisations and local government.

Since 2001 REGUA has delivered the following beneficial impacts:

- The number of employees has increased from three to 23;
- There are now 15 formal research projects underway;
- From an unknown number of bird species in 2001, last year 456 were spotted;
- Visitor bed nights have increased from 30 to 1,300 per annum;
- 130,000 trees have been planted;
- Two habitats have been restored;
- From zero school visitors in 2001, last year there were 3,250;
- 70 local youths have passed through the Young Rangers Programme;
- There are four formal land owner members of REGUA;
- Volunteer numbers have increased from zero to 40 per year;
- Paying day visitor numbers have increased from zero to 250 per year; and
- Local day visitors have increased from zero to 1,000 per year.

REGUA's exciting future plans include acquiring more land and further development of the conservation centre to integrate coursework in applied biology and conservation at local universities. It also intends to create/ restore more habitats on its land to increase local biodiversity and enhance the potential for more eco-tourism.

6.3 SERRA DA CONCORDIA WILDLIFE SANCTUARY

Located a three hour, 160-kilometre bus ride to the north-west of Rio de Janeiro, the Concordia Wildlife Sanctuary is effectively an island of upland forest surrounded by a sea of grassland and eroding red soil. The sanctuary is owned by Roberto Lamego, a highly-respected former vet, who kindly agreed to show me around his projects and discuss at length the destruction, and subsequent restoration, of the once mighty Atlantic Rainforest.

The original deforestation in the Paraiba do Sul river valley and surrounding areas was carried out by slaves in the late 18th and 19th centuries to create coffee plantations. The plantations lasted only five or six decades until the soil fertility declined to the point where coffee growing became uneconomic. Most of the coffee plantations were then converted to cattle pasture. The land has become so degraded that even this low intensity land use is now barely economic over large parts of this region (Photo 6.4). Most of the landscape is dominated by introduced African pasture grass species growing almost in subsoil as the topsoil is very thin and highly eroded. The grass burns regularly in the dry season killing any tree seedlings that have managed to gain a foothold. During the wet season the barely protected soil washes into surface water courses. Many of these same streams and rivers were permanent under the forest, now many are ephemeral and their unstable valley sides regularly collapse (witness the horrendous, deadly landslides around Sao Paulo and Rio de Janeiro in recent years).

Photo 6.4. Degraded land of the Paraiba do Sul river valley.

The area is economically very poor with farmers locked into a system of cattle pasture land management that offers them very little financial return and their land holds very little value as farmland, so they are not able to sell. Such farmers are also not convinced that replanting their land with trees is the answer; their needs are immediate, yet a forest will not give an economic return for many years (under the current system of funding such projects anyway). Some farms are being bought (cheaply) by rich city dwellers from Rio de Janeiro or Sao Paulo as weekend retreats, which do little to help reverse the socio-economic decline related to increasingly degraded land.

It is also believed that the local climate has changed markedly over the past two centuries, mainly due to the degree of deforestation. Roberto explained that recent academic research has shown that forest removal has extended the length of the dry season from an average of one month in 1830 to six months today, implicating the loss of the forest as the main factor for the marked decline in rainfall.

Roberto inherited the land, which was bought by his grandfather in the early 20th century. He now devotes his time to conservation and raising awareness of new approaches to managing the Atlantic Rainforest's land. He is converting his 200 hectares of forest into a largely self-funded demonstration project of how keeping the land as forest can enable a viable economic return. He is convinced that the only way of gaining long term value from this degraded land on a large scale is to reforest – the only way to protect the soil – and develop ways of creating a financial return from the land. He employs two people to help him work his land. Roberto used to work in Brasilia, but returned to the area to occupy/ work on his land to prevent it becoming destroyed by illegal loggers and hunters. His neighbours think he is crazy!

Despite the relatively small size of this forest fragment, biodiversity researchers from the State University of Rio de Janeiro working on-site have identified at least 197 species of birds and 70 species of mammal including about 30 bat species, one of which was previously thought to have been extinct.

He is particularly interested in raising the issue of **ecosystem services**, particularly water supply, as a prime reason for conserving/ restoring the environment. He uses his land for education and awareness, agroforestry demonstration, eco-tourism and, he hopes soon, payments for ecosystem services provision – particularly the provision of water from forested systems.

6.3.1 AGROFORESTRY DEMONSTRATION

Largely by his own efforts, Roberto is developing **agroforestry demonstration projects** on this land that show how this biodiversity can be conserved while simultaneously enabling people to have viable, land-based livelihoods. Under the existing forest canopy he is experimenting with various agroforestry techniques involving many different species of Atlantic Rainforest trees, including palmetto palms (the source of the delicacy, heart of palm) and other palm species, a range of vegetables and fruits and shade-grown coffee (Photo 6.5). The Brazilian Agricultural Research Institute (EMBRAPA) has been conducting agroforestry trials on five hectares of Roberto's land to investigate the economic potential of 30 native tree species. There are now about 25 hectares planted in this trial. Roberto believes that we know how to plant trees on this land, maybe without the finer details of technical accuracy, but they grow and protect it, so it is imperative to get on with planting on a large scale as soon as possible, i.e. "Don't let the perfect be the enemy of the good".

6.3.2 EDUCATION AND AWARENESS-RAISING

The site is also used in education and awareness raising and, eventually, eco-tourism. Roberto is concerned that most of the current generation are ignorant of environmental issues, even of the importance of the local environment to their daily lives. Over recent years more than 3,000 school children and college students have visited his Serra da Concordia Wildlife Sanctuary and are shown around his land, discussing the history of the Atlantic Rainforest and how it resonates with the degraded environment today.

The field operation runs from a collection of small buildings on the only piece of flat land in the sanctuary. Currently, good quality buildings are under construction to house visiting researchers and eco-tourists.

This effort is largely self-funded with the help of a small grant from the web-based charity GlobalGiving. Roberto has also recently won a Neutrogena award worth $70,000 for his work. He

works tirelessly publicising his passion and is something of a local media celebrity for it. But, like many such small restoration projects, I am coming to learn that they often operate independently and are generally not well connected with one another.

Photo 6.5. Roberto's palmetto palm demonstration plot.

Roberto is a fascinating and driven man. He is very concerned about the future, particularly about the large proportion of people who "don't know, don't care, or don't listen", and is passionate that **current adults need to be educated as well as the children** – to wait a generation will be too late! He sees the story of the Atlantic Rainforest as a lesson for the world.

6.4 SOS MATA ATLANTICA

The Centro de Experimentos Florestais - the headquarters of the Atlantic Rainforest conservation NGO, SOS Mata Atlantica (SOSMA) – symbolically occupies the renovated buildings of the old Sao Luiz coffee, then cattle, farm, just outside the town of Itu, 90 minutes' bus ride northwest of Sao Paulo. Their overly large concrete car-park used to be the coffee drying area.

My host was Rafael Bitante Fernandes, SOSMA's Coordinator of Forest Restoration (Photo 6.6). The organisation is 25 years old and has been working with farmers and other landholders in the region to plant Atlantic Rainforest trees since 2000. It currently employs 55 people.

6.4.1 FUND-RAISING

SOSMA really took off in the late 1990s with the rapid growth of the internet in Brazil. It started as a website called “Clickarvore” (“Click a Tree”), where the simple act of clicking on a website enabled the purchase and planting of one native Atlantic Rainforest tree. The initiative was jointly organised by SOSMA and Vidagua and was sponsored by the Brazilian bank, Bradesco S.A. As part of its corporate social responsibility programme, Bradesco continues to generously fund 70% of SOSMA’s annual financial requirement. The trees were given to farmers to grow and protect to maturity to help them protect their water supplies. However, the project became too successful for its own good resulting in too many clicks and not enough farmers. Despite this, the initiative planted 24 million trees in 10 years.

Photo 6.6. Rafael Bitante Fernandes of SOS Mata Atlantica at the tree nursery in Itu.

SOSMA is now running with a new format for the Clickarvore project in which areas of land of relevance to the conservation of the biome are selected by SOSMA technical staff. Public internet voting on these areas then determines the number of tree seedlings that each region will receive. SOSMA purchases the seedlings and transfers them to producers in the selected areas, monitoring each restored area for three years. After three years, or when restoration goals for an area have been achieved, the owner receives a loan for applying to the property.

Another recent initiative, “Floresto do Futuro” (“Forest of the Future”) plants and cares for trees for five years on farmers’ land. To date, this programme has developed 190 projects covering a total area of 2,500 hectares. Farmers who become part of the scheme must sign a legal contract in which they agree to fence and protect the planted area and plant 30 metre-wide belts either side of surface water courses and ensure that, even if the land is sold, the trees are legally protected against

damage by the new owner. Lists of suitable tree species for different areas have been developed by the University of Sao Paulo's Laboratory of Ecology and Forest Restoration. As well as working with farmers, SOSMA also assists tree-planting of public-owned lands with government bodies and local communities.

6.4.2 TREE NURSERY AND FARM RESTORATION

Rafael took me on a tour of the SOSMA HQ, including their impressive tree nursery and the outlying old coffee/ pasture fields that are now sprouting new segments of Atlantic Rainforest.

SOSMA's focus is on the restoration of high diversity, native forest. The on-site nursery grows between 80 and 100 different species of native tree, with capacity for 400,000 trees per year. Production capacity is in the process of being doubled – a reflection of the increasing demand for native trees and enabling cheaper unit production through increased economies of scale.

The nursery currently employs four people, which will increase to seven when it expands. Nursery workers are local people usually with five to ten years of formal education, so SOSMA provides on-the-job training for improving technical skills, health and safety knowledge and practices, and environmental education. Rafael reiterates that it is important for all SOSMA employees to understand why they are involved in this work. Research students also work at the HQ investigating relevant aspects of the Atlantic Rainforest's wider ecology, such as the ecology of birds and fish, etc.

Photo 6.7. Trees shading-out the grass that used to inhibit natural colonisation.

Tree seeds are collected locally by specialist contractors and taken to nearby tree nurseries. There are several private nurseries in different parts of the Atlantic Rainforest biome from which SOSMA takes seedlings to apply to their projects. Seeds are planted into a coconut or rice fibre growing media with an addition of fertilizer. Most species spend six months in the nursery, although some are there for up to a year. They are typically 20-30 centimetres tall on planting. Locally collected seeds grow into saplings which are then planted locally ensuring the genetic diversity of the restored forest.

Rafael drives me into the farm's old fields, which are now a rapidly growing forest demonstration and experimental centre. The first step in tree planting is to control the ants, using insecticide as ants strip the leaves of the young plants. Then the grass is controlled either mechanically or with herbicide. Soil compaction must then be relieved by ripping, either by tractor or, if the terrain is too steep, by hand using a pick-axe. SOSMA policy is to avoid the use of pesticides where possible and rely instead on the high diversity of tree species planted to mitigate pest-induced tree loss. Invasive trees are controlled by girdling. There are two different mixes of tree species for planting: a shade-inducing mix to kill the grass and promote shade grown seedlings; and a mix that grows in the shade of other trees that will eventually become the canopy (Photo 6.7). Trees are planted three metres apart in rows with two metres between the rows, with contour planting on slopes.

In planted areas grass is controlled by a combination of chemical and manual means around individual trees during a 24-month aftercare period. This costs $5,000 to $8,000 per hectare, including the cost of the trees, and delivers a survival rate of 90% after the same period. Planting one hectare with forest creates three to four full-time equivalent jobs over two years, which includes the inputs from the nursery, planting, administration, aftercare, etc.

6.4.3 PUBLIC EDUCATION

Rafael explains that a prime objective for conserving and restoring the forest is raising public awareness of its importance – the degree of knowledge is directly related to involvement. However, communication of these issues is hampered by competition in the media with popular obsessions with celebrity, sport, pop music, etc. The web-based fund-raising activities described above also have a strong public education element. Alongside this, the HQ also includes a well laid out public education centre relating to the importance of restoring the Atlantic Rainforest. Last year over 4,000 school children visited for formal environmental education sessions. This year, a new programme will be introduced that works more closely with teachers.

SOSMA works with a range of other conservation organisations in trying to restore the forest, including the North American NGO, The Nature Conservancy, which has a very ambitious programme of tree planting in the region and the new Brazilian Atlantic Rainforest restoration organisation, Pacto Mata Atlantica (Atlantic Forest Restoration Pact).

6.5 ATLANTIC FOREST RESTORATION PACT

Created out of a spirit of cooperation and mobilisation, the Atlantic Forest Restoration Pact (AFRP) (or Pacto pela Restauraçâo da Mata Atlântica) was established as an umbrella organisation with the mission to create an integrated and holistic strategic approach to the activities of a diverse range of forest restoration projects through the Brazilian Atlantic Rainforest area, to achieve the rapid restoration that is required. It aims to rebuild forest integrity over large areas by reconnecting the

remaining fragments, which will lead to the re-development of forest ecosystem function and services upon which millions of people rely.

After failing to meet in Sao Paulo, the Pact's Executive Secretary, Pedro Castro, and I talked on the phone and have corresponded by email. He explained that coordinating and scaling up existing restoration efforts began in 2006 and, after much hard work, the Pact was launched in April 2009. Its ambitious goal is to restore 15 million hectares of forest by 2050, equating to at least 30% of the original forest biome's Brazilian footprint. To achieve this, the organisation promotes[56]:

- The **conservation of biodiversity**;
- The **generation of jobs and income**;
- The **maintenance of payment for ecosystem services**; and
- **Supporting farmers' compliance with state and national laws**.

The Pact is a young organisation and still developing its remit and practices. It currently operates through the following bodies:

- A **steering committee** to determine how the organisation will run and manage the operations and procedures;
- An **executive office** that coordinates, supervises and provides technical and logistical support to AFRP activities; and
- Five **working groups** focussing on:
    - **Fundraising**;
    - **Technical aspects and science**;
    - **Communications and marketing**;
    - **Public policy**; and
    - **Information and knowledge**.

The executive secretariat is hosted by the NGO, Instituto Amigos da Reserva da Biosfera da Mata Atlantica (IA-RBMA) (Atlantic Forest Biosphere Reserve – recognised by UNESCO), which includes administrative and financial support.

At the time of writing, the Pact boasts 216 members including national and international NGOs, government (local, regional, national), private companies and research institutions.

Now that the vision, key relationships and organisational structures have been created, the long-term and large-scale objective is setting-up the collaborative network of practitioners and suppliers, including associations, projects, seed and seedling producers, communities and individuals committed to the restoration of the forest.

In its short life, the Pact has begun to have an impact. Achievements to date include:

1. **An online project registry system.** This currently includes over 50 restoration projects covering 20,000 hectares.
2. **An update of the Pact's first book**, the *Reference Concepts and Actions of Forest Restoration,* which soon sold out, so the State of Sao Paulo's Environment Secretary paid for an additional 3,000 copies, of which half were distributed to Pact members and collaborators.
3. **A preliminary assessment of current and future restoration projects by Pact members**, including restoration methodologies, costs and successes, with details to be made available online.

4. **The identification and mobilisation of funding for forest restoration projects**. In 2010, the National Development Bank (BNDES) funded 25 projects covering 4,000 hectares – the first time the bank had funded Atlantic Rainforest restoration. It will soon be launching a second call for proposals with the technical support of the Pact. The National Fund for Biodiversity (FUNBIO) also launched a call to support projects focusing on ecosystem services in the Atlantic Rainforest region, with the support of the German government. The Pact and others are engaged in the approval of the Debt Swap/ *Tropical Forest Conservation Act (TFCA)* – a bilateral negotiation between the Brazilian government and the US Agency for International Development (USAID). The Pact has also been working with the national government to divert some of the $20 million of the TFCA to restoring the forest.
5. **The implementation and replication of innovative restoration projects**. Learning from Pact members' project partnership activities to develop large scale restoration programmes. A monitoring protocol is being developed to assess the results and disseminate them.
6. **The promotion of the Pact in national and international events and forums and to the international scientific community**. Individual Pact members have attended and presented on the Pact's activities and the restoration of the forest to national and international scientific communities and through publications in scientific journals.
7. **The engagement of new members**. Building the multi-stakeholder partnership continues and includes international partners such as a European ecological research laboratory and a prominent American botanical garden.
8. **The development and implementation of a monitoring protocol**. A group of 80 restoration experts met over three days to develop a monitoring protocol based on social, ecological, economic and management indicators. This protocol is currently being tested by several projects.

6.6 CONCLUSIONS AND LESSONS

The story of the demise of the Atlantic Rainforest is a salutary lesson that resonates today as forests around the world continue to be destroyed. There are many projects throughout the region working towards restoring it. From the three I visited, the following lessons can be drawn:

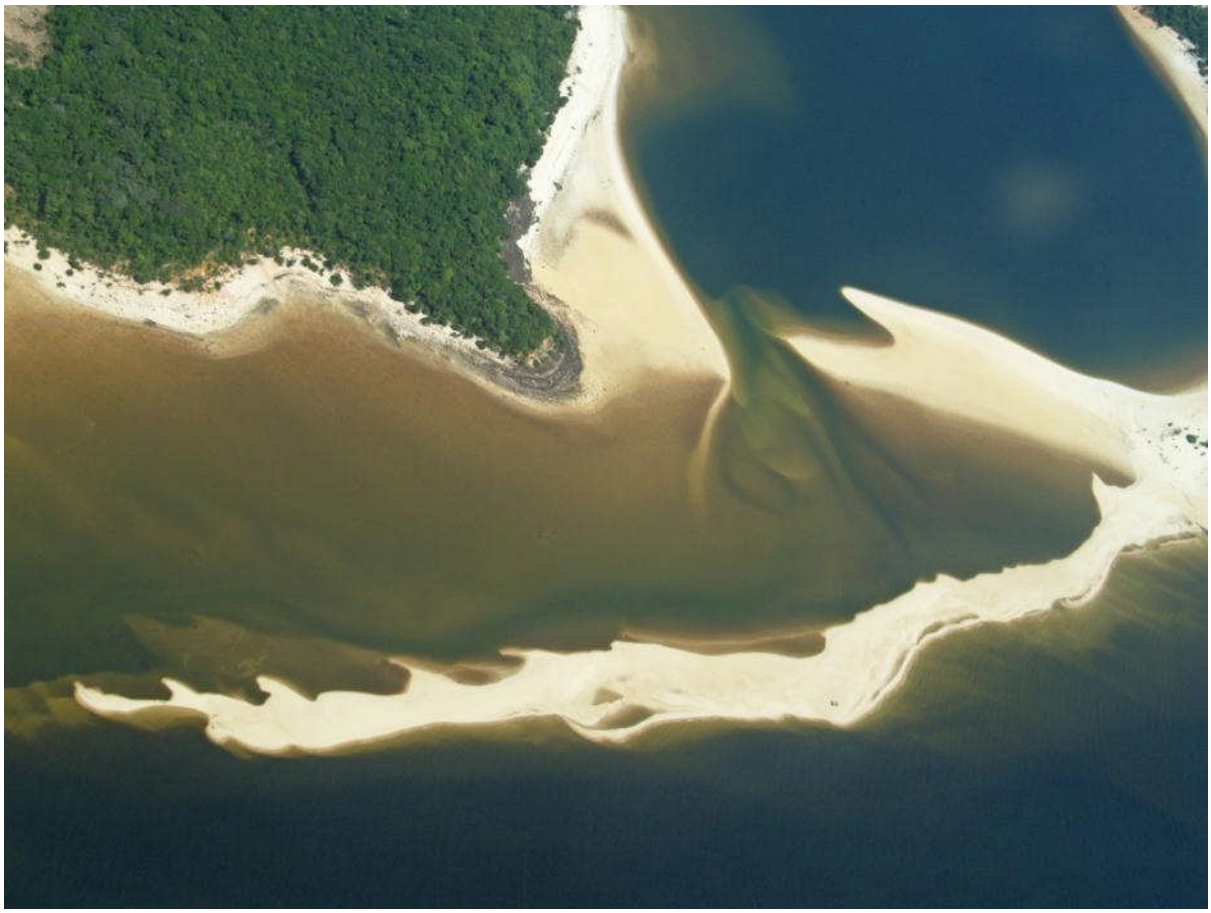
- The importance of a **constant and visible presence** on the land is critical in dissuading opportunistic exploiters of the forest from entering the area in question.
- **Physical demonstration** of alternative, forest-friendly land management is critical, particularly in a society where environmental awareness remains relatively low and the priority is national development almost at all costs. It takes **individual and organisational leadership and courage** to go against the convention and showcase a new direction.
- Finding ways for conserving and restoring the forest to **create viable livelihoods** for local people for the long term.
- **On-going research** raises the profile of the forest nationally and internationally and illustrates its unique nature and the necessity for its conservation.
- The importance of **monitoring and feeding back** to improve practices improves success and efficiency over the long term.
- **Raising public awareness for people of all ages** about the importance of the local environment is an essential step for unlocking their direct involvement in the future.
- **Employing staff locally** and training them as required encourages local community buy-in to the restoration effort. Local employees also know the land and its associated culture,

particularly if they have been involved in land-related activities previously, so can offer an extra element of cultural interest. Such new opportunities in areas traditionally lacking them helps inspire people to learn, particularly if they regularly meet people from outside their local area or from overseas.

- Employing local staff is an important opportunity for **changing the perspectives of local people** regarding the importance of, and their interaction with, their local environment. However, this also requires sustained effort and education in variety of ways aimed at different audiences.
- Just **one person with sufficient vision, ambition and drive to change things** can have an important impact. When several such people working in the same area become connected, step changes are possible. Making these connections between people working independently is a scaling challenge.
- **Building project momentum** to create a step change is difficult for small, individual projects. It requires collaboration and a coordinating body to rapidly build profile and awareness to attract the big funding.
- **Scaling** the efforts of small projects to create a step change is critical. It needs a co-ordinating body. Other benefits of scaling include a bigger voice for politicking and public education and enhanced funding opportunities.
- Initiatives run by just one or two people are, however, at risk once the leaders move on. Building in **continuity** is critical to ensuring project sustainability and long-term success.
- **Ecosystem services**, particularly for water, are an important driver for large-scale restoration and offer a source of possible future revenues for the restoration and conservation of watersheds.
- **Don't let the perfect be the enemy of the good** – where enough is known to make a positive impact, just get on with it!
- Ideally, project **finance** is best derived from more than one source to avoid dependency; however, too much funding diversity can mean effort is wasted on managing individual funder expectations.

DEPARTING…

These projects and many others like them will not recreate a once great forest overnight. The new forest that is created will be different to its progenitor – the world is a changed place now and environmental concerns need to work within this new context. But nothing will happen without the likes of the generous, inspiring, dedicated people that I have met on this journey through the Mata Atlantica.



Amazon

7 AMAZON RAINFOREST, BRAZIL

ARRIVING…

It's an early start – a very early start! Planes are used around the Amazon much like the British use buses. To reach your intended destination typically entails a 4 a.m. take-off and three or four stops en route, while various people get on and off. The flights always appear to be full and the planes always appear to be new. I'm flitting around the Amazon basin like a house fly in a hot kitchen to visit three mines to see for myself their forest restoration work.

The three mines were:

- **Carajas iron mine**, run by the Brazilian multinational Vale;
- **Trombetas aluminium mine**, managed by Mineração Rio do Norte (MRN); and
- **Juruti aluminium mine**, run by ALCOA.

Where these huge mines are once was Amazon rainforest and they remain surrounded by it (Figure 7.1). The operational imperative is to restore it, on a large scale, in areas with important biodiversity and socio-economic development imperatives.

Figure 7.1. The Amazon Basin indicating the mine sites visited.

7.1 CONTEXT

The Amazon is a region of contrasts and surprises. Everyone knows it is the largest remaining tropical rainforest on earth and that this globally-important ecosystem is under a range of threats. However, outside the Amazon, fewer realize that it is home to millions of people who live and work there. Its three largest cities (Belem, Santarem and Manaus) house over 3.5 million people.

As a developing country Brazil has determined that its vast natural resources should be exploited in an attempt to lift its citizens out of poverty. It has a very active and rapidly growing mining industry exploiting some the country's rich and diverse mineral potential and operates across the Amazon to extract metals and minerals for Brazilian and global society. The typical image of mining in the Amazon is of thousands of artisanal miners (*garimpeiros*) scraping a subsistence from mining gold and gemstones with few environmental or health and safety controls and widespread environmental and human damage. While such scenes do exist, the real national wealth from Brazilian mining is produced by some of the biggest mines in the world, with respectable reputations for their corporate responsibility agendas. Brazil is the world's largest iron ore exporter with annual production of over 200 Mt per year and much of this is produced from the Amazon region.

7.2 CARAJAS IRON MINE

Discovered by accident in the late 1960s in the state of Para, since the 1970s the Carajas iron ore deposit has been home to the world's largest iron ore mine with reserves of 7.2 billion tonnes of ore (Photo 7.1). The mine produced 301.7 million tonnes of ore in 2008 and 237.9 million tonnes in 2009. It is located within the 411,000 hectare Carajas National Forest Reserve, in the hills of the Serra dos Carajas, alongside the Parauapebas River and near the rapidly-growing city of Parauapebas.

Photo 7.1. Carajas iron mine.

The enormous forest reserve surrounding the mine is easily identifiable on Google Earth, as deforestation – mainly for agriculture – around the reserve has left this biologically-rich expanse of forest isolated from the rest of the Amazon forest in this frontier part of Para State, the edge of the rainforest gradually receding to the west. The forest reserve is "typical" jungle and still contains roaming jaguars.

At Carajas mine I was kindly hosted by Alexandre Castilho of the mine's environment and permitting department, whose job is to ensure regulatory compliance with IBAMA, the Brazilian environmental protection agency. Alexandre gave me a tour of the Carajas mining operations, with an emphasis on its environmental and restoration issues. It is one of the world's biggest mining complexes covering

an area of 10 km by 6 km, heavily automated and very efficient. The ore is mined from three deep, open pits by drilling and blasting and loading and hauling through to crushing, screening and subsequent processing, before being stockpiled and railed out.

Vale has explored a total of 15,000 hectares in the area over a period of 20 years for mineral riches. Of this, 4,000 hectares have been impacted by mining or related activities. The restoration challenge will be enormous when the mine eventually closes, but it is likely to be operating well into the foreseeable future – possibly up to 80 years or more. However, progressive restoration is underway on areas around the mine once mining has ended in that area.

7.2.1 THE NURSERY AND RESTORATION STRATEGY

Alexandre first showed me the nursery that he is developing, which will include a laboratory for studying plant and soil materials. The nursery includes local plant species being grown for re-planting around the mine site during its progressive restoration activities, and individual plants – particularly epiphytes and understorey specimens – rescued before the advancement of new mining activity. He employs ten local people at the nursery, who learn their trade on the job. Alexandre also sources plants as required from commercial nurseries in Belem. His plants spend between two to three months and two years being cared for in the nursery. The restoration plan includes economically important tree species to provide some socio-economic value to the future forest without the need to cut it down. Such species include the Brazil nut (or castanheira) tree (*Bertholletia excelsea*) and jaborandi (*Pilocarpus microphyllus*), which contains chemical compounds extracted by the pharmaceutical company Merck to produce a medicine for the treatment of glaucoma. Local people harvest and dry the leaves before selling them to the company.

The mine area is, topographically, a complex of slopes with very few flat areas. Current replanting around the mine aims to satisfy three main objectives:

1. Dust reduction by reducing the amount of exposed surfaces and trapping some from the air;
2. Control of erosion on the slopes; and
3. The restoration of the original forest habitat.

Re-establishing the typical forest vegetation is relatively straight-forward, once the appropriate framework species are identified and planted and have received appropriate aftercare. Approximately 50 tree species are used in the restoration schemes, which are soon enhanced by natural arrivals from the surrounding forest. Trees are planted into a sward of nitrogen-fixing, herbaceous legume species grown from previously sown seed to quickly stabilise the naked soil surface, in order to reduce soil erosion and dust generation.

7.2.2 CANGA

Then we arrived at another Amazon surprise; the rainforest is not just a continuous blanket of tall trees but, particularly around the iron-rich hills being in mined in Para, contains extensive hill-top areas of very different vegetation to the surrounding jungle. These ironstone outcrops can be considered as upland islands with a range of xerophytic plant communities of high – and some unique – biodiversity, closely associated with mineral reserves[57]. This range of habitats is locally called canga and consists of, possibly, 12 recognizably different types, according to Alexandre (Photo 7.2). Our altitude of 750 metres was approximately level with the other plateaus surrounding the mine. The plants grow in a very dry, red, iron-rich substrate as hard as concrete, possibly with

naturally elevated concentrations of potentially toxic elements such as nickel and chromium. The plants are deciduous in the dry season. Canga covers 15,000 hectares in the Carajas area and is rare, poorly studied and under threat of destruction as mining advances.

Photo 7.2. Alexandre Castilho in the natural canga vegetation of the Amazon Rainforest, Carajas iron mine.

IBAMA requires the canga to be restored; however, because so little is known about these habitats this is proving difficult. Of the 300 or so canga species, approximately 70 are planted during restoration. The current restoration strategy involves planting them around the mine on the assumption that rainforest plants will re-colonize naturally in areas that are suitable, leaving the canga species in the areas that are unsuitable. This strategy is easier than trying to predict and manage the soil and planting at the outset. Although many of the appropriate canga species grow well, but slowly, on the typical post-mining substrates (usually some type of crushed-rock), they are soon overtaken by the more vigorous species of the surrounding rainforest. Ultimately, the key to success is likely to be reproducing the particular substrate conditions and flat terrain which canga species have evolved to cope with. And this is a challenge that causes Alexandre some anxiety and requires on-going research in partnership with several Brazilian research institutions, including EMBRAPA-CNPAB (Empresa Brasileira de Pesquisa-Centro Nacional de agrobiologia), Universidade Federal de Viçosa (UFV), Universidade Federal Rural do Pará (UFRA), Universidade Federal do Rio de Janeiro (UFRA), Museu Paraense Emilio-Goeldi, and others. Eleven different research groups are studying the ecology of the Carajas mine and its vicinity.

7.3 TROMBETAS ALUMINIUM MINE

MRN's Trombetas aluminium mine is located on the Trombetas River – a tributary of the Amazon – in Para state (Figure 7.1). Internationally, it is generally regarded as an exemplar of good practice for its forest restoration work.

Before the mine and its necessary infrastructure were created over 30 years ago, there was little there but forest and small, scattered communities. Today there is a large surface mine and a mining town of a few thousand people. During its life the mine has generated billions of dollars for the Brazilian economy. MRN owns the mining rights for 25,000 hectares of land of which over 7,000 hectares have been mined to date. In 2010 the mine produced 17 million tonnes of bauxite (aluminium ore)[58].

Bauxite, or aluminium ore, is usually red-brown and, at Trombetas, occurs just a few metres below the surface in expanses covering hundreds of square kilometres, which is very easy to mine. First, commercially valuable timber trees are identified, felled and stockpiled until authorisation is received for its transportation. The remaining forest is then cleared by bulldozer, with the remaining vegetation augmenting the fertility of the underlying topsoil. The topsoil (about 50 centimetres thick) and overlying rock (8-12 metres thick) are then scraped off and stored for later use in reclamation. Now the red bauxite ore is exposed and excavated and taken for subsequent treatment. Each activity occurs in separate strips, hence the name strip mining, in which the overburden is removed from the strip being mined and then deposited on the previous strip from which the ore has already been extracted (Photo 7.3). This is then covered with the topsoil to be followed by tree-planting. From the air, the mining area forms a perfect red rectangle cut from the green forest blanket.

Photo 7.3. Bauxite mining at Trombetas mine.

At Trombetas mine I met ALCOA's environment, health and safety director for Brazil, Domingos Campos, and Milena, a forestry engineer, who, along with other members of their talented team, showed me their work.

7.3.1 THE FOREST RESTORATION PROCESS

Trombetas mine started production in 1979 and, as the mine is located in the Saracá-Taquera National Forest protected area, there is a legal requirement to restore the forest. Forest restoration activities began in 1984. By 2011, 4,500 hectares of forest had been planted.

The process of restoring the rainforest in the mining areas begins before the actual mining starts. Wildlife monitoring is set-up two-years before and continues during forest clearance. Immediately before clearance a wildlife rescue team, employing trained local contractors, is sent in to a

demarked area of forest to rescue slow-moving animals such as sloths and tortoises, important plant species such as orchids and the nests of stingless bees, which are vital for the pollination of many forest plants, including trees. The bee hives also provide an income for the surrounding local communities. The nursery acts as the repository for collected epiphytes; since 2001, over 63,000 epiphytes of 123 species have been collected, including orchids, bromeliads and Araceae. These are translocated to previously restored forest areas years later. Any animals that are injured in the clearance process are treated in a dedicated animal hospital adjacent to the nursery in Porto Trombetas.

The goal of the forest restoration team is to regrow the jungle as close as possible to the original. They have made steady progress in this over the past 30 plus years, based on careful research and experimentation. Of the 180 tree species found in the diverse local forest, 100 are chosen for replanting, based on their speed of growth for soil protection, their ability to attract fauna (through fruit and flower production) importing seeds from outside area, and use to people – fruit and nut production, medicinal use, timber, etc. A favourite, for economic reasons, is the Brazil nut tree (Photo 7.4). Twelve local village families equating to about 120 local people assist in collecting seeds and raising seedlings to augment the half a million produced every year by MRN's own nursery. Around 70 local people are employed to plant the trees during the wet season.

Photo 7.4. Brazil nut tree in a forest planted in the 1980s.

I was shown every stage of the mining and restoration activity and all my questions were generously answered. Within a couple of years the trees are above head height and the canopy is closing, shading out light-loving weeds and offering forest understorey plants an ecological toe-hold. New

trees re-colonize naturally, spread in the guts of animals attracted to the newly planted forest areas. Artificial bird perches are also included among the newly planted trees to encourage seed dispersal by birds.

Since 1981 when reforestation began MRN's people have planted over nine million trees on 4,500 previously-mined hectares. To the casual observer the oldest planted areas are becoming indistinguishable from the rest of the forest, although Milena and her team are not satisfied; their numerous indicators of success indicate that the forest is around 70% restored (although it looks pretty authentic to me!). I was taken around the very first forest planted in the early 1980s where the translocated stingless bee beehives have been relocated to, epiphytes have been reintroduced from recently cleared areas and a planted Brazil nut is already a 40-metre giant (Photo 7.4). Tree species are also chosen that will provide an economic return for local communities from non-timber forest products, including fruits and nuts, etc.

The restoration work is subject to on-going scientific research. Since 1997 about 50 Masters' theses and 25 PhD theses have investigated the developing ecology of the new forests. Despite the documented and obvious (to my eyes) success of the restoration work, the team continues to look for ways to improve the restoration process still further.

7.4 JURUTI ALUMINIUM MINE

The quiet, old town of Juruti, population 35,000, sits on the south bank of the Amazon in western Para state. It has a very new and soon to be very large aluminium mine developing at the very heart of the Amazon rainforest.

ALCOA's Juruti mining concession extends over 250,000 hectares of almost unbroken, impressive Amazon rainforest. It is currently estimated that the Juruti bauxite reserve is 700 million tonnes, buried just a few metres beneath the forest. The mine life is estimated at 70 years. Bauxite production is slowly ramping up: at the time of my visit it was around four million tonnes per year, which will increase to about six million this year, expanding to eight or nine million tonnes. Construction of the mine infrastructure, including a 55-kilometre, sealed access road through the jungle, processing plant, rail line and river port capable of handling 75,000 tonne ships, ended in 2008. Currently 2,000 people work at the mine.

I was generously hosted by Volnei Tenfen, Superintendent – Environmental Management and his team responsible for the mine's environmental and community work. His team, including Ellie and Susie, showed me around their early, ambitious work, in the scorching Amazon heat.

ALCOA aims to make the Juruti mine an exemplar of corporate social responsibility and mining-driven sustainable development. For example, unlike the much older mines at Carajas and Trombetas it is now company policy for ALCOA workers to live in the local community, rather than in purpose-built mining camps isolated from the pre-existing towns. In 2006, the Sustainable Juruti Project was developed by the Getúlio Vargas Foundation (FGV) and the Brazilian Biodiversity Fund (FUNBIO), with the support of ALCOA. It presents a proposal for the long-term, sustainable development of Juruti and the surrounding region based on the so-called sustainability tripod:

1. The Sustainable Juruti Council;
2. A system of sustainability indicators; and
3. The Sustainable Juruti Fund.

An essential part of ALCOA's social and environmental responsibility is restoring the forest after the bauxite has been mined – the reason why I was visiting this part of the Amazon.

The bauxite mining process is very similar to that of Trombetas mine, just across the Amazon (Section 7.3; Photo 7.3), including the wildlife rescue teams sent in prior to forest clearance[59]; a team enters the demarked 20 hectares of forest five days before it is due to be cleared (Photo 7.5). The forest restoration process is also similar, with the aim of restoring the forest within two years of a strip of land being mined.

Photo 7.5. Forest clearance at Juruti.

7.4.1 A NEW METHOD OF FOREST RESTORATION

Conventionally, after an area has been mined, stockpiled topsoil is spread over the replaced overburden and then ripped to alleviate compaction before planting trees. Although generally successful, aerial views of the developing forest showed occasional gaps relating to poor soil conditions, possibly due to compaction. In order to address this, a new rehabilitation methodology known as **nucleation** is currently being trialed at both Trombetas and Juruti mines, and was developed by Ademir Reis at the University of Santa Catarina.

Volnei's team at Juruti intend to use the new nucleation restoration process from the outset. They are constructing 50 metre x 50 metre reclamation cells, bounded by two- to three- metre-high earth embankments, to enhance water retention. Within the cells topsoil is loose-tipped from trucks to create mounds at roughly two metre intervals. The high average annual rainfall soon washes the soil from the mounds to create an almost continuous soil cover that varies in thickness above the overburden, enhancing the range of ecological niches available, into which trees are then planted.

This method has the following benefits over the previous method:

- It **reduces topsoil compaction**;
- It **holds more water** as the soil depth is, on average, thicker than the old method;

- **Propagules in the topsoil are not buried or destroyed** by heavy machinery;
- **Fuel use and related CO_2 emissions are reduced** because there is no need ripping by heavy machinery;
- The **heterogeneous topography offers more niches** for the development of ecological complexity; and
- Waste brush from recent forest clearance can be placed between the soil mounds, **increasing physical heterogeneity, improving soil fertility and kick-starting ecosystem processes**.

An early nine-hectare nucleation trial area was planted in 2009 and, when I visited, the trees were already several metres tall and the canopy was starting to close (Photo 7.6). A couple of climax species, including Brazil nut, are due to be planted in this trial area. The first phase of mine restoration planting began in January 2012 during the wet season.

Photo 7.6. Tree growth after 30 months in the 2009 nucleation trial, and Susie.

The local rainforest contains 460 tree species, but only 30 – mainly pioneer – species are planted in the restoration scheme at a rate of approximately 350 trees per reclamation cell. The later

successional species are planted two to three years later. A monitoring system will begin this year and cover a range of indicators such as plant and animal species, soil biomass, tree growth, etc. to follow the progress of the forest restoration.

7.4.2 THE NURSERY

The Brazil nut is one of the later successional species of particular importance to the forest's economy. However, it can take 18 months for a seed to germinate naturally, so Ellie, one of Volnei's team, is researching ways to scarify the seed to speed up germination and restoration success. Such experiments are part of the purpose of the nursery that is currently under development, which I visited on another scorching day with Ellie, Susie and Liliane. The 1.8 hectare nursery is located near the mine's new railhead and port. Previously the nursery site had been a smallholding, so some nursery infrastructure was already present. An orchid house is under construction to store wild orchid plants rescued from areas of forest about to be cleared. The old farmhouse is being renovated to create a new nursery administration building and other existing buildings will be renovated accordingly to provide new nursery facilities, such as changing rooms and classrooms. The Viveiro do Saber – the Nursery of Knowledge – will also be used to host children's educational groups.

An important archaeological site – a 6,000 year old oven – has been discovered at the heart of the nursery, believed to have been created by the ancient Konduri people. This will be preserved as a feature of the nursery and open to visitors.

The nursery employs 10 people, eight of whom will be from local communities. They already have experience of plant growing, having worked on farms, and are provided with specific on-the-job training.

Nursery tree production was running at about 3,000 per month, which will increase dramatically as mining activities ramp up. This will be augmented by tree production from nurseries in local communities, which are being encouraged to supply trees to the mine. They are shown how to collect seeds from the forest and nurture them, according to the mine's requirements. Currently 33 communities are involved in the tree propagation process with 29 small community nurseries in development.

7.5 CONCLUSIONS AND LESSONS

Wealthy corporate organisations, like the mining companies Vale, MRN and ALCOA, are able to resource high-quality research and develop a landscape restoration infrastructure and team that can produce world class results at a very large scale compared to some of the projects I experienced on my journey. Their work is certainly impressive; however, even they do not possess all the answers to the challenges that arise. Findings from this leg of my journey are summarised below.

- There is an **on-going need for ecological research** for this kind of work, for example:
    - **To improve practices** – loose-tipping of soil rather than spreading,
    - **Determining how to restore tricky, critical habitats** such as canga,
    - **Changing practices to identify more economical restoration methods**, and
    - **Determining how to germinate particular species** of ecological and socio-economic importance.

- Take a **long term approach** – don't be afraid to try new techniques even when the previous ones may have been successful for decades;
- Pursue **on-going monitoring** after tree-planting, which may need to last decades, to assist adaptive management during the post-planting period, and the adaptive restoration of new areas, and to help determine what success looks like;
- **Develop indicators of success** to determine when you have achieved the restoration goal;
- **Restoring the forest to what was there before may be:**
    - **Neither technically feasible**, for example if some species are too difficult to propagate, or the restored soil conditions differ too much from the original,
    - **Nor desirable**, as a changing socio-economic scene during the life of the mine may require the restored forest to return more or different on-going socio-economic benefits than before, such as an increase in the need for trees that can deliver non-timber forest products, e.g. fruits, nuts, honey, etc.
- **Reinventing the wheel**: during this journey there have been many instances where similar problems faced by individual problems are being approached independently over and over again, wasting time and resources and indicating a lack of communication between projects and organisations beyond a particular ecosystem of interest;
- **Collaboration** between organisations is essential to building overall capacity for a particular restoration project, for example the numerous relationships between each of the mines and research institutions; and
- **Public participation** has been essential, particularly in the case of Juruti - the newest mine I visited. Appropriate, transparent and open communication between the different groups involved has produced a commendable sustainable development plan for the future, involving nothing less than the creation of a new regional economy. The restored forest will be a significant part of that forest and public participation in the future will be an important factor toward its overall success.

DEPARTING…

The small, propeller-driven plane takes off over the Amazon River. Again I have views over the pilot's shoulder as we parallel the mighty river en route for Santarem. It will take me the best part of three days and numerous flights, but I am now leaving the rainforest of my boyhood dreams and chasing the sun south to Patagonia.

Patagonia

8 PATAGONIA, CHILE AND ARGENTINA

ARRIVING…

My final destination was southern Latin America's Patagonian wilderness where I explored the landscape restoration work of some of the most significant and large-scale conservation projects in the world.

In less than eight hours I am on the road again, the sun just rising and burning through the early sea mist releasing the distant mountains to view. After departing Puerto Montt bus station, the paved road soon mutates to gravel and stays that way for the next few hundred kilometres, winding through forests and snow-capped mountains. A fluffy, yellow, toy duck swings in the windscreen, in my line of sight, designed to test my good humour. Our road – the Carretera Austral – is renowned in the lore of Latin American travel and over the next 10 days or so I am to become very well-acquainted with it. Penetrating deeper into Patagonia, around every turn is a new vista of whatever combination of mountains, fjords, snow, forest, sea and isolated wooden shacks you can imagine, and it's all mind-blowing – views spoilt only by the incessantly swinging fluffy duck!

I visited three landscape restoration projects in Patagonia (Figure 8.1). The first two, in Chilean Patagonia, had been long in the planning; they were Pumalin Park and the future Patagonia National Park. They are ultimately the fruits of two charitable trusts: the Conservation Land Trust and Conservacion Patagonica established by the American philanthropists Doug and Kris Tompkins. I happened upon the third project serendipitously, as often happens on journeys like this – it is the ecological and economic restoration of the Estancia Menelik on the Argentine side of Patagonia, the brainchild of Rafa Smart and his company, Cielos Patagonicos.

8.1 CONTEXT

Patagonia is a geological contortion of immense proportions – a union of geo-forces that contrive a unique landscape – tectonics, volcanoes, wind, rain, sea, ice and snow, and biology. It's raw, wild, isolated, and spectacular and the people who live here remain at the mercy of these elements, despite their attempts to civilize the land.

The Chilean side is mountainous with permanent ice-fields in the south and a tortuous fjord coastline of forested islands. The climate is particularly wet with up to six metres of precipitation in some areas! The predominant natural vegetation system of this part of the Andes is the Valdivian temperate rainforest – a globally unique forest ecosystem stretching along a very wet, narrow strip between 37^{o} and 48^{o} south latitude. The rainforest's combination of temperate broadleaf and mixed forests, together with the Magellanic forests further south, form the second largest temperate rainforest system in the world. Characteristic plant species include two southern beech species (*Nothofagus alpina* and *N. oblique*) and the forest giant – similar to the North American giant sequoia – the alerce (*Fitzroya cupressoides*), which at 3,622 years vies with the Californian bristlecone pine as being the oldest living trees[60]. The forests and mountains are also home to some spectacular animals, such as the puma, but also the endangered south Andean deer, the huemul (*Hippocamelus bisulcus*) and the guanaco – a wild relative of the llama, and the Andean condor.

Some distance to the east through the cordillera, the Patagonian Steppes of Argentina stretch to the Atlantic. Being in the rain shadow of the Andes they are dry and very windy, with ecological transitions into semi-desert and desert in some areas. Vegetation is generally of dwarf and cushion

shrubs and hardy, tussock grasses. There is a high degree of endemic plant and animal species, including the characteristic, flightless, ostrich-like rheas.

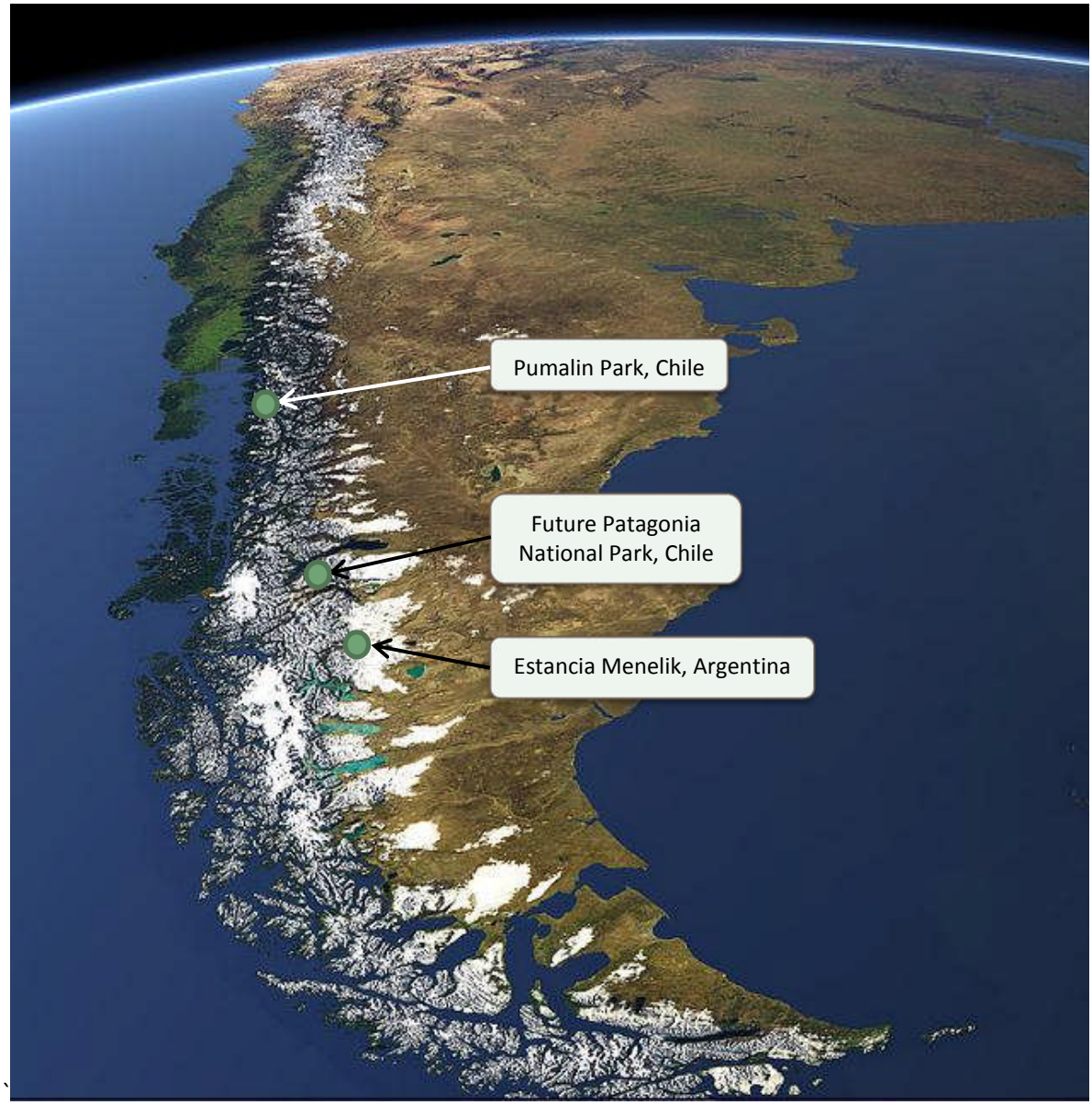


Figure 8.1. Patagonia showing the main project locations visited[61].

8.1.1 ENVIRONMENTAL ISSUES

In Latin American terms, Patagonia was colonized relatively recently as settlers were discouraged by fierce indigenous trips, harsh terrain and a challenging climate. The recent human history of the region is primarily one of exploitation and low intensity pasture agriculture.

During the late 19th and early 20th centuries, settlement of the region by displaced indigenous peoples and pioneers of European descent began the destruction of the (mainly) Chilean forests. During the 1940s government programmes encouraged settlers to “clean” their land in order to gain title to it; loggers removed the valuable timber trees such as alerce, cypress (*Pilgerodendron uvifera*), manio (*Podocarpus nubigena*) and others, while prospective livestock farmers burned the

forest out of existence – some fires burning out of control for months across the mountainsides, destroying millions of hectares. The results of this devastation are readily apparent even today as one travels through the region as denuded hillsides and countless bleached, fallen, wooden skeletons grazed around by sheep and cows. The extreme rainfall coupled with steep slopes, unprotected thin soils and inappropriate farming practices taken from different climates and topographies, resulted in catastrophic soil erosion and a poor quality pasture resulting in farms covering huge areas in order to be able to graze sufficient livestock to make a viable economic return. By the end of the twentieth century much of this system of agriculture had collapsed. Reforestation with exotic tree species was encouraged with government incentives in the 1970s, preventing natural re-colonisation by the forest. Finally, in the 1980s, the driving of the Carretera Austral through Chilean Patagonia increased access for people wanting land, leading to further deforestation.

And the exploitation and destruction has not stopped; the southern Aysen region of Chile has recently been selected for the production of hydroelectricity, with plans by HidroAysen to construct one of the world's largest hydroelectric schemes. This will involve five dams on the spectacular, wild Baker and Pascua rivers and the construction of thousands of kilometres of transmission lines through protected landscapes to transport the energy to Santiago and further north to the serve the mining industry. Needless to say, national and international opposition to this scheme has been very vocal and very active with the formation of the several pressure groups including Patagonia Chilena ¡Sin Represas! (Chilean Patagonia Without Dams) leading the way[62].

Patagonia is the least densely populated part of Chile and modern life and communications are difficult. Despite General Pinochet's dreams of developing this part of Chile, it is still a convincing wilderness. The main communication artery for hundreds of kilometres is the mainly gravel, often single-track, road – the Carretera Austral – that winds through the mountains, fjords, forests and lakes (Photo 8.1). The limiting communications are gradually being improved and this, coupled with awesome scenic beauty, are a strengthening magnet for tens of thousands of tourists annually –a figure that is increasing.

Despite the low human population density of Argentine Patagonia, enormous areas of its seemingly endless expanses are ecologically degraded – a situation which is generally worsening. Over-grazing of the slow-growing vegetation, mainly by sheep and cattle roaming over estancias covering tens of thousands of hectares, exposes the highly fragile soil to erosion – particularly by wind. Competition with wild, native herbivores and the hunting or poisoning of large predators, such as the puma and birds of prey, including the iconic Andean condor, are related pressures caused by farming. Hunting other animals for skins and feathers is also a major problem in some areas[63].

8.2 THE TOMPKINS' APPROACH

The life stories of Doug and Kris Tompkins are fascinating and well-known[64]. They have lived in Chilean Patagonia, in Pumalin Park, since the early 1990s and have dedicated their "retired" lives and philanthropic activities to the conservation of wild lands in South America and, particularly, in Patagonia. They have established numerous charitable foundations, including, in chronological order, the Foundation for Deep Ecology, the Conservation Land Trust, Conservacion Patagonica and Fundacion Pumalin. Their main, on-the-ground, work priorities are:

Photo 8.1. The Carretera Austral south of Pumalin Park, Chile.

1. **Restoring and preserving wild habitat by creating new protected areas** (the top priority), especially national parks. To date, by working through their foundations and with partners, they have permanently conserved over 810,000 hectares of land and have created two national parks, with more on the way.
2. **Developing well-managed agricultural lands** in areas adjacent to wild areas, to act as an ecological buffer and expand wildlife habitat in the non-productive areas. The farms also act as de facto park ranger stations helping to protect against poaching and intruders.
3. **Landscape restoration:** they and their teams have become experts in restoration, particularly of agricultural land, grasslands and forests. They see this activity as the "favourite activity among all the things we do".

Not all of the Tompkins' activities have been straight-forward or trouble-free. As committed conservationists from a tradition of American philanthropic conservation working in a country with a relatively new environmental consciousness, there have been many tussles with some in Chilean society unused to this tradition, which became manifested as distrust, scepticism and political opposition to the Tompkins' efforts. Such sentiments have been gradually won over by persistence, "walking the talk", winning the arguments fairly and by slowly building confidence and a constituency of support in the locale and region. There are still a few nay-sayers – I met one or two in the wilderness – but they are in decline.

The Tompkins' "empire" runs many conservation activities in many locations across Argentina and Chile. Many of these possess a critical element of landscape restoration attached to improving the

conservation value of the land and in promoting jobs and product supply chains from sensitive land management practices, particularly related to eco-tourism and agriculture. This chapter focuses on their activities in Chile's Pumalin and future Patagonia National Parks.

8.3 PUMALIN PARK, CHILE

My Latin America travel book describes Pumalin Park as being "seen by many as one of the most important conservation projects in the world"[65]. It covers 3,250 km^2 of mountains, forests, rivers and farms in Chile's Lakes Region and is the country's largest private reserve. The park and its neighbouring protected areas form a total, almost continuous, protected area of the Valdivian temperate rainforest covering many thousands of square kilometres. Pumalin aims to:

- Conserve almost pristine rainforest for posterity;
- Maintain limited access to, and accommodation for, about 10,000 tourists per year;
- Create local employment;
- Demonstrate how a sympathetic agrarian economy can sustain biodiversity and create economic opportunity;
- Develop a market for local farm products provided by farms in and around the park, several of which have been bought by the Conservation Land Trust or sympathetic land owners;
- Develop a broad-based cultural appreciation of conservation; and
- Act as "a model for other private conservation initiatives, large and small"[66].

Overall Pumalin directly contributes about $700,000 to the local economy plus an unknown amount of value-added from indirect tourist spending activities. Such figures are not insignificant given the sparse population of the region. The park has been developed by Tompkins-led teams to its current spectacular status, through a combination of opportunism, careful planning and good fortune.

The land has been acquired in stages as described by Doug:

"The first farm was 17,000 acres [6,900 hectares], the second piece was 75,000 acres [30,300 hectares]. 98% was bought from absentee landlords who did not live anywhere close to the land, many in Santiago, and abroad. Only 2% was owned by small settlers who either were traded for land they chose somewhere else or, if they did not want to trade because they wanted to live close to their children and grandchildren and wanted to be in towns or cities, tired of rural life, then they were paid in money and not land trade. The plan behind the land trades was that no-one who wanted to have land, and better productive land in most cases, would not have to worry about being left with cash only and not land. This was a program that we started, it is unusual, but it foresaw social problems and helped to avoid them. We know of many successful examples coming out of this process." The key stages in the evolution of Pumalin Park are summarised in Table 8.1.

8.3.1 LANDSCAPE RESTORATION IN PUMALIN PARK

Creating Pumalin Park has required much more than simply acquiring land. Much of the land was degraded by poor farming activities; parts of the forest had been logged; and there was neither infrastructure for tourists, nor local supply chains connecting visitors with producers to enable sustainable economic development (all of which are implicit in my broad definition of landscape restoration (Section 1.1)).

The guide for my time in Pumalin was its head park guard, Carlos Zambrano, who kindly drove me through the park, stopping at points of interest; accompanied me on boats across fjords and on an open trailer pulled by a tractor in torrential rain, and on walks into the forest. During the Pumalin journey, it became apparent that a great deal of thought has gone into creating a coherent design language throughout the disparate sites of the park, giving a sense of an identifiable purpose and of a place where people care for their surroundings, and for other people. I have summarised below the main landscape restoration activities I experienced in Pumalin Park.

Table 8.1. Key events in the development of Pumalin Park.

Year	Development
1991	Doug Tompkins buys a derelict farm in Renihue Valley to protect its forests. Begins buying adjacent land as it becomes available.
1992	He moves in to live in Renihue Farm and begins restoring the farmland. The Conservation Land Trust, endowed by Doug, is created in California to acquire land for the park.
1993	Doug Tompkins marries Kris McDivitt and they combine their conservation work.
1996	The Trust continues acquiring land for the park – a process which lasts almost a decade, resulting in a total area of 289,000 hectares.
2005	Fundacion Pumalin, a Chilean NGO, is incorporated to preserve Pumalin Park. On 19 August, President Ricardo Lagos visits the park as it becomes declared an official Nature Sanctuary under the protection of Chilean Law.
2007	The Conservation Land Trust donates Pumalin Park's 294,000 hectares of land to Fundacion Pumalin.
2012	Pumalin Park now extends over 3,250 km^2.

FARMS

In Chilean Patagonia the traditional economic activities for the past century or more have been logging and sheep and cattle farming. Farm landholdings may cover tens or hundreds of thousands of hectares, although much of this is mountain and forestry, with the prime farming activities concentrated on the narrow valley floors.

Through the Conservation Land Trust the Tompkins have been acquiring degraded, strategically-located farms around Pumalin and restoring and converting them to provide opportunities for developing a new regional economy based on conservation, tourism and responsible farming. The innovation has been in developing multi-use and organic farms that:

- **Simultaneously act as park stations**, including offices and meeting rooms, that also house the (non-uniformed) park rangers;
- **Act as visitor centres and accommodation providers**;
- Act as **plant nurseries** for the production of native forest plants;
- **Improve animal husbandry** (mainly sheep) and related (mainly wool) products;
- **Produce fruit and vegetables** for local consumption by visitors or for local sale;
- **Employ local people**; and
- **Produce honey and jams** from local bees.

This new model of farming in Chilean Patagonia is being developed through trial and error – those involved do not have all the answers. The important message is that the farms are demonstrating a

new model for sustainable agriculture that recognizes the limitations imposed by the region's climate, topography and poor road infrastructure.

Doug's ultimate aim "is to play the tourism card, which is a way to diversify the local economy and reduce dependence on forestry and farming on unsuitable land". Supplemental income through tourism helps alleviate the pressure for over-grazing or even over-fishing.

Carlos took me to several of Pumalin's beautiful farms. I describe three of them – Caleta Gonzalo, Pillan and Vodudahue – below.

CALETA GONZALO FARM

The Caleta Gonzalo farm, on the southern shore of Renihue Fjord, was once an isolated, 186-hectare sheep farm with little more than a wharf, a few fields and a lot of forest (Photo 8.2). Today, owing to its strategic position on the Carretera Austral, it forms part of the main entry point into Pumalin Park and is visited by 10,000 tourists annually. This number is rising rapidly with the all-year ferry service that links the land sections of the Carretera Austral and Doug hopes that it could be triple in 10 to 15 years' time.

Photo 8.2. Caleta Gonzalo – entrance to Pumalin Park on Renihue Fjord.

The farm has been extensively, but sensitively, improved since it was acquired in 1993. Farm buildings have been modernised, productive vegetable gardens have been created, fences and gates have been improved in the prevalent design motif, improved sheep breeds have been introduced, the runway has been upgraded (small bush planes are the easiest way to get around for key park staff), a carefully designed campsite has been built and cabins for tourists have been constructed.

New tourism infrastructure has also been developed, such as a park visitor centre and a superb café and gift shop selling high quality, locally-produced offerings of honey, jams, wool products, etc. All the buildings are sensitively designed in a rustic fashion with high quality construction and craftsmanship using locally-sourced materials and labour. The buildings and furniture are crafted from locally-sourced, salvaged wood. Power is provided by a micro-hydroelectric generator in a nearby mountain stream and wood is the heat source. The buildings and visitor areas are offset by

beautifully planted gardens showcasing native plants from the Valdivian rainforest. The total package is unexpected, surprising and beautiful, and it works.

PILLAN FARM

Located between Comau and Renihue fjords at the geographical centre of Pumalin Park, the 492-hectare Pillan Farm was acquired by the Tompkins in 1994. It serves as the administrative headquarters for the park and several local farms and includes the ubiquitous grass airstrip and a school for the children of farm and park workers (Photo 8.3). The surrounding landscape is awesome, with uninterrupted views of the almost 2,440-metre Michimahuida volcano (when it isn't raining!).

Photo 8.3. Pumalin Park offices at the restored Pillan Farm.

When they first arrived at the farm in the early '90s, it was an environmental disaster area. Its salmon farm, in the Renihue fjord, was damaging the local marine environment and the shabby salmon processing plant was polluting the surrounding land; the pasture was scrubby and

unproductive; the farm tracks and the short section of the Carretera Austral through the farm were overgrown and poorly maintained.

Several years of restoration work have regraded and restored the fields to high quality, productive pasture for cattle and sheep bordered by characteristic, locally-inspired fencing. Given the high rainfall averaging six metres per year, careful pasture management is required – too high a density of grazers will soon destroy the soft fields leading to their decline. Most of the productive land has been concentrated in the middle of the farm, leaving 80% of the area to nature. Simultaneously, the roads and tracks, including the Carretera, were upgraded and are now properly maintained.

Eleven people are employed at the farm, including eight park workers. Three people run the farm, while park-related activities include the school, machine shops, park administration, etc.

Two new farm-based enterprises have been established – organic honey and organic jam production. Bee hives are constructed on the farm in the carpentry workshop. The bees pollinate the farm's berry bushes and surrounding forest trees, which are festooned in flowers at certain times of the year. Honey and berries are also imported from other Pumalin farms and processed and packaged at Pillan, before being distributed to outlets around Chilean Patagonia under the brand name Pillan Organics. A range of nine different jams is produced, including strawberry, blueberry, raspberry, gooseberry, murta and red currant. Beeswax is also produced and processed on-site and similarly marketed. Production runs at 30-40 tonnes of honey per year and about 8,000-10,000 jars of jam.

All the farm's buildings, including homes for farm and park workers, are of the local style, high quality and fabricated from locally-sourced and recycled materials, where possible.

VODUDAHUE FARM

Vodudahue Farm's 1,502 hectares are spectacularly squeezed between vertical mountainsides soaring from sea level at the Comau fjord into the rain clouds! Only accessible by air or sea, it has been built up by purchasing separate but adjacent farms as they became available, between 1994 and 1999. As well as operating as a working farm, it serves as a park ranger station watching over the Vodudahue and neighbouring river valleys.

When they were acquired, the farms that now constitute Vodudahue consisted of ramshackle, decaying buildings, heavily degraded pastures, forests extensively damaged by fires and poor logging practices.

The Vodudahue experience of building and pasture restoration is similar to Pillan's. I ask about the colours of the buildings – the red roofs and dark wooden walls also make a design statement. Carlos explains that this derives from Doug's interpretation of two key colours of the rainforest and underlines Doug's active interest in the architecture of the park's buildings, designing many of them himself (Photo 8.4).

This farm also produces vegetables and fresh fruits, including berries, and honey. The fruit and honey are taken to Pillan Farm for the production of Pillan Organics' honey and jams.

A key component of the Vodudahue Farm is the native tree nursery, which began in 1998. The seeds of alerce and almost two dozen native tree species are collected from the forest, germinated and nurtured into saplings in the nursery before being planted in the same valleys from which the seeds were collected. Forestry student interns are offered hands-on work here while gaining an insight into

the importance of forest conservation. Over 25,000 plants are produced annually by seed germination and a further 50,000 by vegetative propagation.

The Tompkins' policy is to acquire degraded farms like Vodudahue, restore them and sell them on to new conservation-minded owners. The money raised is used to buy and restore more "beaten-up" farms.

Photo 8.4. Carlos Zambrano above Vodudahue Farm.

FOREST RESTORATION – ALERCE 3000

Alerce is the spectacular flagship tree species of the Valdivian rainforest, occurring across 52,000 hectares of Pumalin's forests – a fraction of its former range. Just a few miles south of Caleta Gonzalo, along the Carretera Austral, Carlos showed me a riverside stand of enormous alerce trees (Photo 8.5). Each hosts a world of its own, dripping with epiphytes and, occasionally, even young trees growing in its branches.

Most of the world's remaining alerce stands occur within Pumalin Park. Although this endangered endemic tree is protected by law from felling, its wood can still be milled and worked. This loop-hole and poor law enforcement mean that the alerce, even in some areas of the park, remains threatened, although the network of farms/ park ranger stations acts as a deterrent to illegal logging. Doug assures me that over the last few years there have been no records of wood poaching.

Photo 8.5. Alerce trees on the Sendero Alerce, Pumalin Park.

The focus on the spectacular alerce is a useful means of raising awareness of the need for forest conservation. Carlos described a new initiative to market nursery-grown alerce and its conservation message to visitors who, for $10, will be able to plant the tree around the park's camp-sites. The park has been collaborating with the University of Chile on the Alerce 3000 programme since the year 2000, researching how to restore the forest, including how best to germinate and nurture trees, including the Alerce, from seed at the Vodudahue Farm tree nursery. The name of the project implies the length of time it will take for the slow-growing alerce to return the rainforest to its former glory. The range of sites requiring planting include: gravel borrow pits from the construction of tracks and the Carretera Austral, burned out forest areas, pasture fields, steep slopes, rock slide areas, frequently flooded areas, wetlands and river banks. Planting programmes are carefully designed to reflect the ecological requirements of individual species and are considered "as much art as science".

Other important forest trees being raised as part of the Alerce 3000 project include: cypress, ulmo (*Eucryphia cordifolia*), canelo (*Drimys winteri*), tepa (*Laurelia philippiana*) and manio. Many of these are sold to other projects that are restoring the forest.

The nursery has been vital in restoring Pumalin's forests over the last 15 years and, if other markets for its trees cannot be found, it is likely that the nursery will close. If this happens then another nursery may be opened in El Amarillo to employ the skills and knowledge acquired over years of research and practice. El Amarillo at the southern end of the park is better connected logistically to other parts of the region, which will provide better market opportunities for restoration projects in the province or elsewhere.

CHAITEN VOLCANO

In 2008 the Chaiten Volcano erupted after 9,000 years of inactivity. The eruption created a 20-kilometre-high mushroom cloud of ash and devastated the town of Chaiten, 60 kilometres south of Caleta Gonzalo, with ash and flooding (Photo 8.6). Air traffic across the southern cone of Latin America was disrupted for days; however, no-one was killed – the Chileans are very used to dealing with such natural disasters. The Carretera Austral was closed by ash till just before my arrival in December 2011.

Photo 8.6. Chaiten town - still recovering from the 2008 eruption.

The southern – El Amarillo – sector of Pumalin Park was badly affected and had to be closed, allowing park staff to restore the damaged sections of the park (Photo 8.7). It was due to fully re-open to visitors shortly after my visit. Two campsites had been affected, including one that had only just been created, now buried under metres of ash. They have been restored by removing ash by repeated disking allowing the rain to wash it away. Once there was only a small amount remaining, this was ploughed in and re-seeded.

Photo 8.7. Chaiten volcano and its damage to Pumalin Park's forest.

Hundreds of hectares of forest have also died, which are already starting to regenerate naturally. In one area of the forest of skeletons it is possible to walk along a new trail through the ash and devastated forest to a vantage point from where the still steaming volcano angrily dominates the skyline. The plan is to take the trail right up to the edge of the volcanic peak, in due course.

The whole park was due to re-open on 15 December 2011, shortly after I left. Since then Doug has informed me that it is fully restored and open and the visitors are flooding in.

ROADS AND BORROW PITS

For most of its length the Carretera Austral is little more than a narrow gravel road. It was pushed through under the Pinochet regime in the 1980s and is owned and maintained by the state, although it passes over privately-owned land in Pumalin Park. Two things became very apparent as Carlos drove me along it:

1. As the road passes through the park it imparts the illusion of a wide footpath winding through a lush garden with the large, rhubarb-like nalca (*Gunnera tinctoria*), red-flowering fuchsia – both found in my Cornish garden – and southern beech trees lining the road's edge, casting shade and a sense of wildness; but, outside the park, the road is lined for miles with scars of rocky earth dug carelessly into roadside banks, undermining trees causing them to collapse into the road, and creating a sense of disrespect for the spectacular surroundings;
2. Mild-mannered Carlos became visibly angry and explained that the lack of care shown by the road repairers offers a regular source of irritation to a park team obsessed with quality, a passion for environmental care and attention to detail.

Such geological scars are also apparent wherever gravel has been extracted from roadside borrow pits or river reds to provide material for road repairs. The unnatural mess is simply left.

The Pumalin team has taken the initiative in repairing this damage, to great effect, on the park's land. Through learning by experience they have developed expertise in roadside restoration that is now offered to road-building contractors; the team's work in Pumalin setting a standard for contractors to follow. Pumalin is also funding a staff position to work exclusively on the roads issue with Chile's Ministry of Public Works, advocating that they follow similar standards of care and aesthetics in their work. There are longer term plans for the Conservation Land Trust and Conservacion Patagonica, working alongside conservationists and local business leaders, to develop a campaign to call for the Chilean government to designate the entire 1,200 kilometre Carretera Austral as a National Scenic Highway, with obvious positive economic and landscape effects. Doug

believes that this would become a world famous road (and, for what it's worth, so do I). They have succeeded in getting the 75-kilometre Pumalin Park section of the Carretera thus designated. At the time of writing, a new exhibition format book on the road is being printed, which will be the lead piece for the campaign.

VILLAGES

Landscape restoration, based on my definition in section 1.1, recognizes that people and their activities and communities constitute important aspects of a functioning landscape. This is evident on the ground both within the environs of Pumalin Park and those areas bordering it.

The 2008 eruption of the Chaiten volcano destroyed the eponymously named town, which also housed the Pumalin Park offices and visitor centre, hotels and tourism infrastructure and the main route into the southern part of the park. After the eruption the park's offices were relocated 24 kilometres along the Carretera Austral to the small village of El Amarillo.

Photo 8.8. El Amarillo village beautification – improved appearances to housing, for example.

A Pumalin Park El Amarillo restoration team is working with the people of the village to enhance its appearance and build "house pride" by improving buildings, gardens, public spaces and infrastructure – including a new petrol station, grocery shop and bus stop (Photo 8.8). This informal social experiment has developed from the farm restoration experiences. When the farms were restored and beautified, park staff found that the farm workers became very proud of their homes and the surrounding working landscape, which became manifested as more considerate farm management and improved productivity. By working with the village the team is trying to develop

this approach further with people who do not work for the park. The team of architects, designers and builders collaborates with local home-owners in taking the first step, which is subsidizing the exterior renovation of their homes (they have to do the interior) and help with landscaping, fences and painting. The park is also upgrading the village's public spaces in line with the spectacular surrounding natural geography. The team does not yet know if this approach will work, but the response from locals so far has been "extremely enthusiastic" and community pride appears to be building. It is planned to finish the project by 2015, after when it is hoped that the initiative will make the community more attractive to residents and visitors and provide a fitting focus for the southern entrance to Pumalin Park.

8.4 FUTURE PATAGONIA NATIONAL PARK, CHILE

Two days' drive south of Pumalin Park on the Carretera Austral and deeper into the isolation and wilderness of Chile's Aysen Region, is the Chacabuco Valley – home to another spectacular attempt to create a new national park (Photo 8.9). The future Patagonia National Park project is the brain-child of Kris Tompkins' charity, Conservacion Patagonica. The major steps in developing the park to date are outlined in Table 8.2.

Photo 8.9. Chacabuco Valley – the estancia buildings are in the centre of the picture.

The 87,000-hectare proto-park is strategically located between pre-existing protected areas, namely: the Jeinimeni National Reserve and the Tamango National Reserve, and is one of few east-west valleys that connect the Valdivian temperate rainforest with the substantially drier steppe ecosystem of Argentine Patagonia. The broad valley contains an array of ecosystems including southern beech forests, grasslands, high mountains, rivers and wetlands (Photo 8.10). Consequently the valley's biodiversity is very rich and a critical conservation target in the region. Charismatic species include the guanaco, the endangered huemul deer, the puma and the Andean condor.

The Estancia Valle Chacabuco was established in 1915 by Lucas Bridges, the famous Patagonian pioneer. In the 1920s he drove 80,000 sheep onto the valley's 70,000 hectares. The land rapidly became degraded to the point, before it was acquired by the Tompkins, where it could not support even 10% of that population. In 2004 the estancia was bought by Conservacion Patagonica and a

new era in the development of the valley and southern Patagonia began. Conservacion Patagonica currently owns 87,000 hectares with more being added as opportunities arise.

Photo 8.10. Chacabuco valley mountains and wetlands.

The goal of Conservacion Patagonica's work in the Chacabuco Valley is to create the tourism anchor for a much larger new national park, to be called the Patagonia National Park, as the Chacabuco Valley combines with the two adjacent national reserves to create one 263,000 hectare wilderness national park. The new park will eventually belong to the Chilean nation. Although the Chacabuco Valley has long been a top conservation priority of the Chilean government, for decades, it has lacked the necessary financial ability to acquire the land. The arrangement with Conservacion Patagonica will create a world class national park to rival, it is hoped, the likes of California's Yosemite and Chile's Torres del Paine. Indeed Bruce Babbitt (ex-US Secretary of the Interior for eight years under Bill Clinton) has said, "It will be the Yellowstone of South America". Doug is given to saying it will be the "Torres del Paine of Aysen". Within eight to ten years he expects between 150,000 and 200,000 visitors to the park. His ambition is that, "There will be no park in Latin America with the public access infrastructure of the calibre of this park, that much I can guarantee!"

Converting a run-down estancia into a world class national park inevitably requires a great deal of work and creative thinking. Tourism-related infrastructure is required, including utilities, buildings, trails, etc. The organisation has developed a construction programme to build the essential buildings of any major national park, namely: staff accommodation, visitor accommodation, offices, visitor centre, workshops, etc. At the time of my visit these were almost complete – and at first site appear rather odd after hours of driving through wilderness seeing little but wooden shacks (Photo 8.11,

Photo 8.12). The park's buildings are of superlative quality, built with local stone and Chilean copper roofs, purveying a statement that they are here to stay. Their style is taken from the English influence in the southern cone of Patagonia, for example buildings in the centre of Punta Arenas, Chile and the train station in Puerto Deseado, Argentina. The old wooden estancia buildings remain, for the moment, as interesting comparators. The objective is to hand over the land to the government, as part of the national park, with infrastructure that is built to last.

Table 8.2. Key events in the development of the future Patagonia National Park.

Year	Development
2000	Kris Tompkins founds the Patagonia Land Trust, a charity dedicated to preserving biodiversity and creating parklands in southern Chile and Argentina. The organisation's name is later changed to Conservacion Patagonica.
2004	Conservacion Patagonica buys Estancia Valle Chacabuco – a 70,800 hectare sheep ranch in Aysen Province, and launches the Patagonia National Park project.
2007	Construction of The Lodge at Valle Chacabuco begins – the first public access infrastructure for the new park.
2008	Conservacion Patagonica buys 8,500 hectares of land for the future Patagonia National Park. Research begins on huemul deer – puma interaction (the first study of its kind in Chile). Construction of park buildings, including employee housing, continues.
2010	Ground-broken on the park's new trail system and first campground.
2011	Future Patagonia National Park pre-opens to the public.

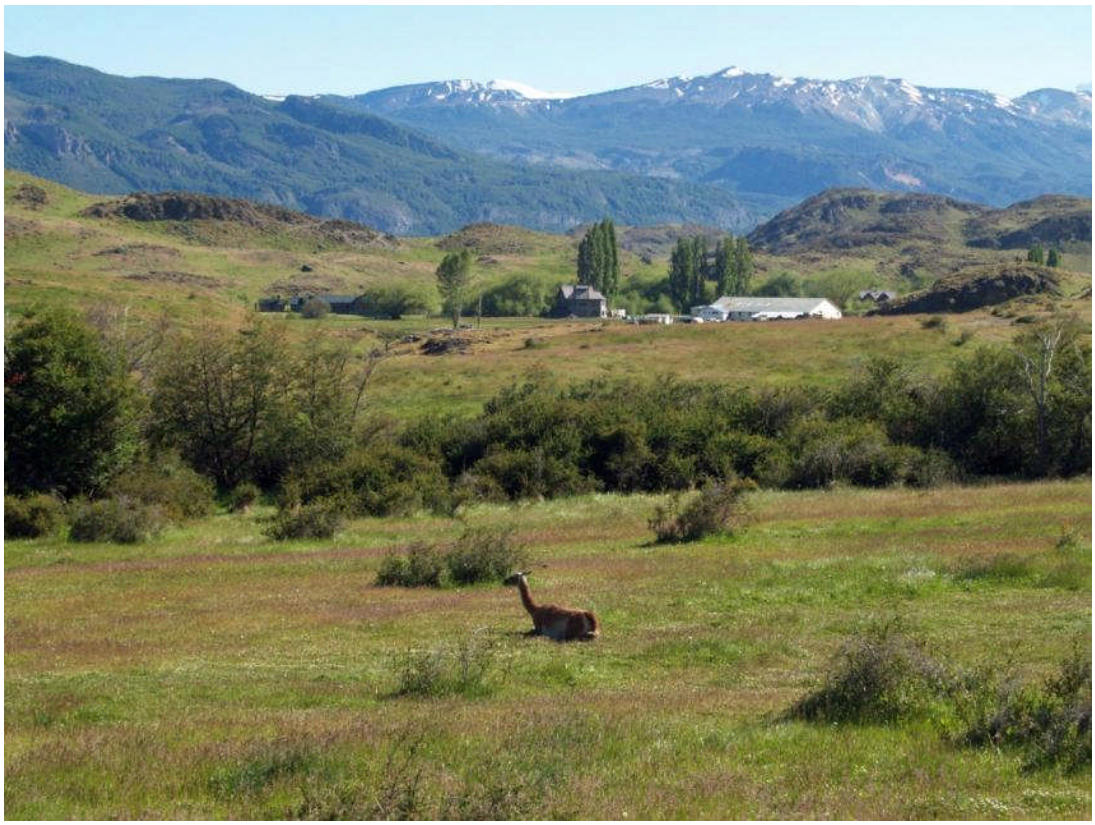


Photo 8.11. Estancia Valle Chacabuco in context, with guanaco.

Other park development activities have included creating hiking trails, capacity building among staff, community education programmes, scholarships, etc. There is a policy of local employment, including many of the staff who worked the land when it was an estancia who are now engaged in conservation activities. Other manpower is provided by an active international volunteer and intern programme, many of whom I met during my sojourn. My visit, however, was primarily concerned with the landscape-restoration activities and these are described in more detail below.

Photo 8.12. The new Lodge at Patagonia Park with estancia buildings in the background.

Within the next few years, Conservacion Patagonica intend to hand-over the valley to the Chilean government as a national park, with stipulations to protect the park's integrity and staff. Doug believes that there is at least another seven to ten years of park infrastructure to be built and, although the government could declare this as a national park, this is not a priority for him until the entire project is finished and coherent.

Simultaneously, Argentine NGOs are working on developing a similarly ambitious, adjacent Patagonian national park for the future, which would create a truly enormous continuous protected area of global importance and would be a first for this part of the world.

8.4.1 LANDSCAPE RESTORATION IN THE CHACABUCO VALLEY[67]

During my stay at the park I met with its new superintendent, Dagoberto Guzman – formerly of Pumalin Park, who explained the rationale for the park and its valuable work. The Chacabuco Valley is the focus for a range of restoration activities seeking to maximise the ecological potential of the valley and some of these activities are summarised below.

INFRASTRUCTURE

In order to restore a more coherent landscape aesthetic, derelict ranch buildings and infrastructure have been removed, including barns, sheds and corrals. Poorly planned and constructed roadways and tracks have been restored, or improved, to minimise their visual impact or reduce further erosion.

Beyond the aesthetic, over 600 kilometres of barbed wire fencing divided the landscape, fragmenting habitats and hindering the movement of wild animals, many of which were killed, their corpses hanging from the wire. Most of the fences have now been removed, allowing the guanacos and other animals to freely roam the valley once more.

GRASSLANDS

Despite its degraded environment the valley still retains the full range of native wildlife, including the guanaco and puma, although a couple of species are hanging on by a thread, such as the endangered huemul deer and mountain vizcacha (a relative of the chinchilla). The long term viability of their populations depends on the quality of their grassland habitat, which is currently being restored.

The important first step in restoring the grassland was to rapidly reduce the number of grazing sheep and cattle. Over a four-year period from 2004, most of the estancia's 30,000 sheep, 3,800 cattle and 1,000 horses were sold, gradually and further north, to avoid distorting the local livestock market and affecting other farmers. About 1,000 sheep remain in the valley and are managed for local consumption.

A restoration ecologist was employed from 2005 to begin the grassland restoration process. This involved a soil sampling programme and the establishment of grassland monitoring plots to test reseeding and erosion control practices. Staff were also employed to manually collect seeds from native grassland species, which are used to reseed denuded areas. I also witnessed the transplantation of some species from areas of high density to bare ground. Exotic plant species are removed by hand when they are found.

RESTORING FORESTS

The western end of the valley possesses thousands of hectares of southern beech forest; however, it once covered thousands of hectares more. The fallen, bleached skeletons of tens of thousands of trees narrate destruction by fire – fires set deliberately to clear the land and left to burn for weeks (Photo 8.13).

Photo 8.13. Destroyed forest, Chacabuco valley.

Since the valley has been owned by Conservacion Patagonica, fires have been actively discouraged and grazing livestock have been removed. On mountain hikes I witnessed thickets of fresh, young beech trees growing among the detritus of their fallen elders, but there remain extensive, continuous areas of dead trees with little natural regeneration underway (Photo 8.14). Currently there is no active forest restoration planned as the main *Nothofagus* species are notoriously difficult to germinate from seed and planting has to be very carefully considered. It is readily apparent, though, that natural regeneration is rapidly restoring the forest over large areas and it is estimated that mature, functioning forests will return within a century or two at the most.

Photo 8.14. Natural recolonisation by *Nothofagus* trees.

Many of the countless fallen trees have been deliberately broken up with chainsaws and axes in an attempt to accelerate their decomposition and natural removal from the landscape. Some standing dead trees (or snags) have been felled to enable their organic matter to become incorporated into the soil rather than wastefully decomposing in the air. This policy raises slight controversy among some staff as many feel that the fallen trees should be kept as part of the landscape's cultural narrative – an important part of the foundation for building the next, positive chapter in the human story of the Chacabuco Valley.

RESTORING ENDANGERED ANIMALS

While the activities described above seek to restore a viable ecosystem, many key animal species remain at low populations. For much of the past century the combination of livestock fencing, hunting and attacks by estancia dogs had a drastic effect on the populations of guanacos and Chile's

iconic huemul deer. These animals form a major part of the diet of the puma and, as their population has declined, puma's increasingly hunted the livestock bringing conflict with farmers. This story has been, and is being, played out across much of western Patagonia and Conservacion Patagonica is developing species reintroduction research of value right across the region

Restoration of a viable population of the celebrated and endangered huemul deer is a top priority for the organisation. Fewer than 2,000 individuals remain and almost 10% occur within the footprint of the future Patagonia National Park. Conservacion Patagonica is funding essential research into the ecology of the species to determine its social behaviour, migration routes, population trends, etc., using technologies like radio telemetry to feed into a long term restoration programme across Patagonia.

The puma is the top predator in Patagonia playing a crucial role in regulating the numbers of herbivores and mid-sized carnivores – an essential component of an ecosystem functioning to its full potential. The removal of sheep in the Chacabuco Valley could mean that more predation pressure is exerted by pumas on the guanaco and huemul deer populations, which would be a cause for concern, or that pumas may move into neighbouring estancias to predate their livestock causing accusations of sheep-killing by "Tompkins' pumas" (Figure 8.2). To assist the understanding of puma hunting habits and dynamics, a puma tracking research programme is underway to understand how they utilise the landscape. The aim is to address this conflict by determining whether or not it is a real issue, or is borne out of more traditional cultural concerns. The head tracker was, previously, a professional puma hunter employed by estancias to kill pumas. He is now using his hunting skills in the cause of puma conservation.

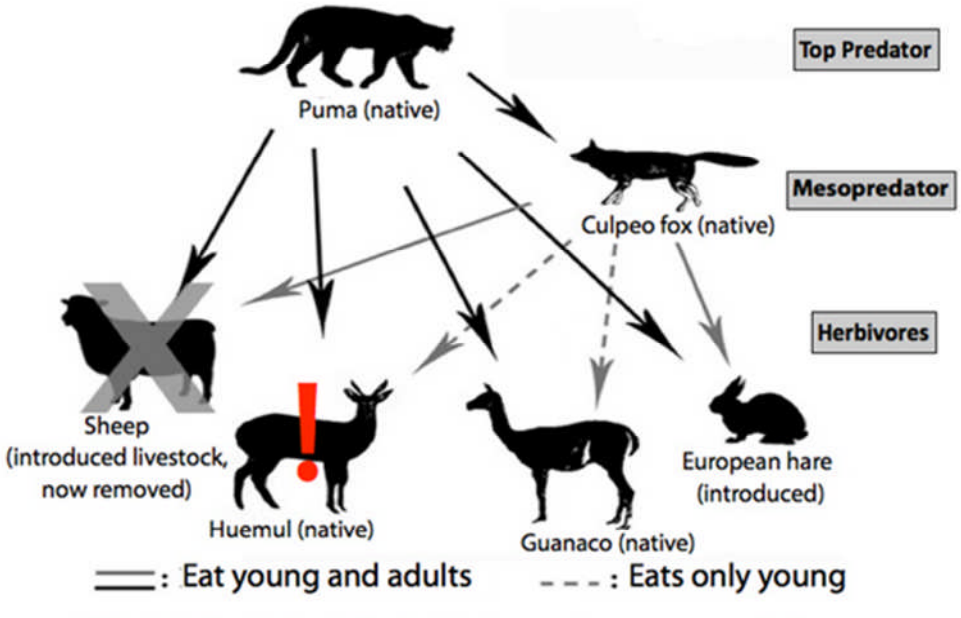


Figure 8.2. Puma prey options in an ecosystem in transition. Which way will it go?[68]

Simultaneously, the puma-livestock conflict is being addressed physically with a Conservacion Patagonica-funded Livestock Guardian Dog Programme to train dogs to guard livestock against pumas and foxes. Although new to Patagonia, this system has been a traditional livestock management technique for thousands of years in Europe, Asia and North America, using dogs such

as Pyrenean mountain dogs. The Chacabuco Valley provides the experimental test-site for this work and, if successful, the charity will work with local farmers to roll out the programme.

Other endangered Patagonian species are currently the subjects of actual or planned research, including: the austral mountain vizcacha; the lesser or Darwin's rhea – a large, ostrich-like bird of Patagonia's grasslands; Geoffroy's cat and the pampas cat; several species of threatened freshwater fish and waterfowl.

ENVIRONMENTAL EDUCATION AND COMMUNITY ENGAGEMENT

Engaging local people so that they come to understand the economic and ecological transition that is occurring in their neighbouring landscape is essential, so that they are better placed to benefit from it and are less likely to negatively impact it. The future Patagonia National Park is no exception as it creates the impetus for change from a livestock farming tradition to a conservation/ eco-tourism economy.

Such a transition involves working beyond the immediate footprint of the future park with local communities and neighbouring estancias to raise awareness and inspire dedication. Examples of such activities underway include:

- **Retraining former estancia gauchos as park rangers** – all former estancia workers have been offered jobs in the park. The original Estancia Valle Chacabuco employed around 20 to 30 workers. Today, Conservacion Patagonica employs around 60 people plus a further 75 to 90 construction workers and cabinet makers, excluding over 100 volunteers and interns. Almost all the original estancia workers have been re-employed in the park;
- Project biologists are working with park rangers to provide **on-the-job training** in wildlife tracking and animal behaviour. One former gaucho is a puma researcher, another is working on the huemul deer programme;
- Park workers are offered **English language classes**;
- A **school outreach programme** brings local school children into the park to learn about the huemul deer and the conservation work of the park;
- **Environmental education** specialists regularly take school children on nature walks and encourage their involvement in ecological restoration activities;
- The park hosts the annual **Huemul Festival** and two-day hike, sharing a huge roast lamb dinner (asado) at the end;
- Approximately 50 **scholarships** are given to local students to assist with their studies in the hope of attracting them back to the region to assist in developing the new sustainable development paradigm.

FROM CHILE TO ARGENTINA…

Mid-morning and we set off in our Nissan four-wheel drive east through the broad valley of the Rio Chacabuco in Chile's Andes. The densely-wooded mountains diminish in the rear view mirror to be replaced, in the space of a few miles, with sparse grasses and low mounds of muted shrubs. The ripio track is forced ever closer to the bubbling, turquoise river by brooding mountains casting a menacing shade. The valley funnels us towards the eastern promise of Argentina through a gorge occupied solely by the river and the track. Re-born, we emerge from the claustrophobic confines of the gorge into the brightness of expansive, dramatic skies and an unexpected, tortured Tokienian geography of impossible pinnacles, rugged terraces, and emptiness filled only with the sound of the incessant wind.

8.5 ESTANCIA MENELIK, ARGENTINA

Argentine Patagonia is a cultural landscape inhabited and worked by the legendary gaucho on estancias covering many thousands of hectares. Despite its wild and empty wilderness appearance, enormous expanses, thousands of square kilometres have been degraded by over-grazing, a lack of water and the hunting of livestock-killing predators. The region is becoming increasingly arid and many areas are borderline desert. Poor farming practices over the past century have led to an ecosystem too degraded to support the livestock it once did, so other means are being sought to generate an income from the land.

8.5.1 CIELOS PATAGONICOS S.A.

Cielos Patagonicos SA (Patagonian Skies Inc.) is an Argentine company established by the Argentine entrepreneur Rafael Smart (Rafa), who I met briefly in Pumalin Park and who invited me and my travelling colleagues, Lisi and Jane, to stay at the their Estancia Menelik after leaving Chile's future Patagonia National Park.

Cielos Patagonicos was founded in 1998 and is dedicated to the sensitive development of real estate and tourism in southern Patagonia, Argentina. It operates by acquiring estancias and land in areas of high eco-tourism potential and, taking a pragmatic and considered approach, increases the value of the property gradually by sustainably restructuring the estancia's activities towards low intensity, high value tourism. The company's main corporate principle is to "conserve the natural, historic and cultural heritage of its lands".

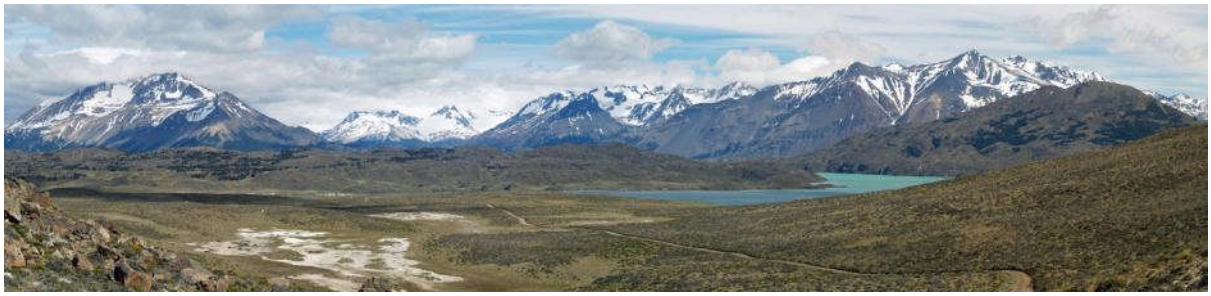


Photo 8.15. Perito Moreno National Park.

We spent a night on the 10,000-hectare Estancia Menelik, 10-hours dusty driving time on a gravel road from Chile's Chacabuco Valley (see front cover photo). This isolated estancia is located just a few kilometres from the spectacular mountains and lakes unspoilt wilderness of the Perito Moreno National Park – Argentina's least visited national park (Photo 8.15).

8.5.2 A BRIEF HISTORY OF ESTANCIA MENELIK

The early 20th century saw the Argentine government offering incentives to settlers to populate the empty wilderness of Patagonia and the development tool of choice was livestock ranching. Johannes Martin Broedner, a young German immigrant, acquired a couple of thousand hectares of land from the government and, in 1918, began construction of the estancia's buildings. The estancia became known as Estancia Menelik after the resemblance of Broedner to Emperor Menelik II of Ethiopia. The family owned and ran the sheep ranch until the late 20th century. Broedner died in Buenos Aires in 1971, followed by his wife in 1979. His son-in-law managed the property until his death 1987.

In 1998, Cielos Patagonica purchased the closed, derelict, degraded estancia from Juana Broedner (sister) living in Buenos Aires. The company, today, remains in contact with Broedner's grand-daughter who is pleased with the approach that the company is taking in restoring the estancia and respectfully valuing its human story (Photo 8.16).

Photo 8.16. Estancia Menelik.

Such human tales are unique to the place and the land and together they comprise a Patagonian cultural history. The estancia's history is the story in microcosm of the settlement of Argentine Patagonia encompassing pioneering spirits, two continents and an ocean and two world wars, including the German battleship Graf Spee! However, it is a story for another time and place.

8.5.3 NATURAL HISTORY

Estancia Menelik's land is representative of the environments that characterize the transition between the Andes' foothills, dominated by grass and trees, and the central arid highlands of Santa Cruz that are characterized by shrubs and stunted plants.

The topography is dominated by the glaciations of the Quaternary period as well as contemporary fluvial processes derived from the Belgrano River and its tributary streams that flow through the property, meaning the estancia is well supplied with water all year round despite the semi-arid climate.

The local vegetation consists of:

- **Coirón grass steppe** on valley floors and slightly rocky flatter areas;
- Intermediate s**hrub-grass steppes** occupying rocky soils such as the old lateral moraines of valley glaciers;
- **Shrub steppes** on basaltic slopes between 950 and 1,400 metres and on hilltops and high slopes;
- **Meadows** in the permanently damp, low-lying areas;
- **Wasteland and dunes** with a characteristically sparse vegetation cover resulting from soil erosion; and
- **Barren areas** occurring in very rocky and windy locations as wind-eroded, rocky pavements, with very low shrub vegetation coverage of less than 15%.

Of the animals, 53 bird species – a large proportion of those found on the province of Santa Cruz's vast steppe – have been recorded on the estancia and includes water birds, grassland birds –

including rheas – and many birds of prey species, including the Andean condor, which surprised us one day by swooping low over our car. There are also many mammal species on the property including puma, guanaco, foxes and the Patagonian skunk.

There are some 2,000-year-old archaeological remains believed to have been a temporary settlement as the indigenous people followed the migration of guanaco herds between the high Andean forests and the steppe plateau.

8.5.4 CURRENT LAND MANAGEMENT AND ECO-TOURISM

Historically Estancia Menelik was home to 8,000 sheep. When Cielos Patagonicos bought it in 1998 the buildings were not in use, but the land had been leased out and was being grazed by 5,000 sheep. It had become degraded through over-grazing and soil erosion.

Owing to the vicinity of the precious Perito Moreno National Park the company did not return sheep to the land except for 60 ewes for local consumption, the reason being that a large flock of sheep would have attracted pumas and foxes from the national park, which would have had to be hunted. They decided to try cattle ranching instead.

In 2001, University of Buenos Aires researchers determined that the land had a carrying capacity of 160 cows. Between 2002 and 2007 further research visits were made by various experts in agronomy and pasture management to consider the state of the land. As the environment has slowly improved, so has the carrying capacity which, since 2008, has risen to 220 head of cattle.

In 2000 the company bought an adjacent 4,000 hectare summer pasture where, between December and April, the cattle were to be taken to graze. However, they have not done so because this land is too sensitive for this level of grazing and also neighbours the national park, so the summer pastures are used only for fattening cattle. In Patagonia such concerns over the land are quite unusual. Also, wire fencing between the park and the estancia is being improved so that cattle do not stray into the park.

ECO-TOURISM

Estancia Menelik, as well as being a working estancia, also operates as an eco-tourism venture with capacity for 26 visitors in two converted estancia buildings. Activities on offer include multi-day wilderness horse-riding and trekking – simply immersing oneself in one of the finest landscapes anywhere – while experiencing a very special way of life. Food is provided if required, and produced on the farm, with greenhouse-grown vegetables.

Being so close to the national park, Estancia Menelik is gambling on eco-tourism; but, currently, the park only attracts about 600 visitors per year, which is much fewer than visited 10 years ago. Rafa believes that this is partly because the park management actually discourages visitors.

Rafa has found the conversion of the estancia's economic activities away from livestock ranching to ecotourism as, "an uphill struggle (and still is) and was not what was expected at the outset". Today 70% of the estancia's income derives from livestock (cattle) ranching with 30% from tourism, with plenty of capacity for more.

FUTURE OPPORTUNITIES

Argentina's Ruta Cuarenta (Route 40) or RN40 – the main arterial highway through western Argentine Patagonia – is assuming the legendary status of a Latin American Route 66. It is a wide, empty, gravel road with no traffic and very few petrol stations connecting the widely-separated lives of everyone in this part of the world. It is evidently the focus of a major national upgrade as, section by disparate section over hundreds of kilometres, it is slowly being converted to a tarmac road to attract much-needed economic development and tourism to this part of Argentina (Photo 8.17).

Photo 8.17. The gravel Ruta Cuarenta alongside a section of black-top upgrade.

The Perito Moreno National Park, on the door-step of the Estancia Menelik, is the least visited national park in the country (indeed, part of its attraction is the isolation – I feel) (Photo 8.15). There are rumours that, in the long term, a new, expanded protected area on this side of the border and incorporating Perito Moreno National Park will connect with the Chilean future Patagonia National Park producing one enormous, contiguous protected area.

If and when both these happen, the Estancia Menelik, and others like it, will be ideally placed physically, philosophically and ecologically to capitalise on the new tourism opportunities that arise, and will offer a welcome model for others to aspire to.

8.6 CONCLUSIONS AND LESSONS

Like all landscape restoration projects, the ones I visited in Patagonia were unique. The two Tompkins projects, Pumalin Park and the future Patagonia National Park, in particular outline the variety of individual elements necessary for holistic landscape regeneration.

Cielos Patagonicos' work with Estancia Menelik takes a simpler, more subtle approach that understands that people need to make a living from ranching, but that the land requires more sensitive management over the long term. The tourism infrastructure of the region does not support large scale tourism – yet – and the key is promoting the natural wealth of a sensitively managed, isolated estancia immersed in empty splendour, while celebrating the unique cultural back-drop.

All the projects recognized that the future ecological integrity of the region relies on finding a new economic direction that works with rather than against the grain of nature. I have identified some generic attributes and lessons from the Patagonian leg of my journey.

8.6.1 LEADERSHIP AND AMBITION

- **Leaders as project champions are almost always self-selecting**. They are similar in several ways, namely: they are ambitious in recognizing the scale that is required to make a significant difference, they are highly motivated and persuasive and usually charismatic, but at the outset may not clearly know how they will achieve their ambition.
- **Unusual suspects** – strangely, the leaders of such large-scale projects are commonly from beyond the conservation world, at least initially, and often from a business background.
- **Perseverance is a key attribute**, particularly in the face of opposition.
- **Walk the talk/ lead by example**, gradually winning over doubters and building a constituency of support.

8.6.2 APPROACH

- **Acquiring the land** is fundamental to everything else that happens. **Creating large continuous areas** is essential when the ambition is to protect and restore ecosystems and develop new regional economies based on sensitive land-use and eco-tourism. Scaling up also maximises the potential for realizing the economies of scale. Land acquisition often requires an opportunistic approach.
- **Controlling and occupying the land** – demonstrating to others that the land is being used by people who gain a livelihood and enjoyment from it will discourage those who may damagingly exploit the land and its resources.
- Recognize that the **land and communities beyond the immediate project footprint are, nevertheless, an integral part of the project** in relation to maximising environmental and socio-economic benefits and opportunities and shifting a cultural mind-set.
- **Develop a functioning, protected landscape with its own viable economy** and culture then, at the appropriate time, hand this over to the nation in the tradition of North American philanthropy.
- **Developing bespoke approaches by learning by doing** – there is no rule book for this kind of work. Listen to the best advice on offer, following gut instincts, make a decision, and then see what happens.

- Recognizing that, **although landscapes may appear wild and spectacular, they may also be severely degraded**, which will ultimately affect the lives of the people who live on and from the land.
- **Instil a concept of beauty** – although this is subjective and influenced by culture, it is important; most people have a basic appreciation of beautiful versus ugly.
- **Be innovative and creative** – tear up the rule book and return to first principles in developing restoration approaches that will link the current situation to the one being aspired to, e.g. restore degraded farms to ones that more sensitively use the land, but also double as park guard stations and offices.

8.6.3 KNOWLEDGE, EDUCATION AND AWARENESS

- **Employing local people often requires them to acquire new knowledge and skills.** Projects should support this, which will improve local understanding of the project, building a local constituency of support and engendering loyalty.
- **Develop a demonstration model** that signifies the seriousness of the intent to opinion-formers, decision-makers, local people and employees. The model will also act as a focus for inspiration and aspiration.
- **F**und new, **pragmatic research from first principles** to investigate particular issues and improve the management of the changing landscape. A research element also engages with the academic community, which assists in building credibility. Furthermore, it contributes to the perception of land being occupied and used (see above).
- **Identify threatened iconic species** that can be used as flagships for raising public awareness and funds for the restoration and conservation of the entire ecosystem. In the case of Chilean Patagonia, these include alerces and huemul deer.

DEPARTING…

After breakfast and goodbyes, Lisi, Jane and I – still bewildered with the remote new world we have discovered – drive the 20 or so miles west to the Perito Moreno National Park on just the fumes in our petrol tank, along the dirt road from nowhere to nowhere. Early morning rheas, presumably after early morning worms, scatter as we approach the mountains.

The park is a heady, geological cocktail of wild mountains and stunning lakes dominated by the imposing peak of Monte San Lorenzo guarding the Chile-Argentina border. We keep pushing, like surfers promising themselves the next wave will be their last of the day, for the best view, limited by our time and fuel situation. Eventually we stop for a few minutes on the dirt road, take our obligatory snaps then head east, the Andes diminishing in our rear view mirror for the second time in two days.

9 MAKING SENSE OF IT ALL!

The purpose of my Winston Churchill Memorial Trust Travelling Fellowship was to explore a range of landscape restoration projects in the Americas and, from first-hand experience, attempt to define common challenges to project development and implementation and generic, pragmatically-based recommendations for overcoming them that would apply broadly to other landscape restoration projects in other places. This section endeavours to do this after, first, summarising the main aspects of the fellowship.

9.1 SYNOPSIS

At the outset I defined landscape restoration as:

The improvement of degraded land on a large scale that rebuilds ecological integrity and enhances people's lives.

During my travelling fellowship I purposefully visited a wide range of project types, locations, ambitions and scales in an attempt to draw generic conclusions in response to the following project aims:

1. Identify and understand the main challenges to delivering world class landscape restoration projects.
2. Identify and understand the elements of success required to deliver world class landscape restoration projects.
3. Develop a set of generic recommendations that should apply to almost any project almost anywhere.

I took a practical rather an academic or philosophical approach to meeting these objectives, which involved visiting the projects, meeting the people behind them and reviewing relevant literature before, during and after the visits. The recommendations, outlined in the next section have been deduced from this approach. The projects and locations I visited are listed in Table 9.1.

Table 9.1. Summary of the projects and locations visited during my fellowship.

Location	Projects
Central Appalachia, USA	Appalachian Regional Reforestation Initiative and allied projects
Everglades, USA	Comprehensive Everglades Restoration Plan and allied projects
Area de Conservacion Guanacaste, Costa Rica	Tropical dry forest restoration in Santa Rose National Park
Galapagos Islands, Ecuador	Tropical island restoration
Mata Atlantic, Brazil	REGUA, Serra da Concordia Wildlife Sanctuary, SOS Mata Atlantica, Atlantic Forest Restoration Pact
Amazon, Brazil	Carajas iron mine, Trombetas and Juruti aluminium mines
Patagonia, Chile and Argentina	Pumalin Park, future Patagonia National Park, Estancia Menelik

9.2 KEY STAGES IN AN "IDEAL" LANDSCAPE RESTORATION PROJECT

All landscape restoration projects result from a unique combination of geographical, environmental, cultural, socio-economic and personal circumstances – no two projects are the same. Although each

has cut its own path through this forest of circumstances, some similarities between them can be drawn that can help in defining the key developmental stages of an "ideal", generic landscape restoration project.

I have briefly included below a summary of the key stages in such a project, which could be used as a starting point for others contemplating pursuing their own landscape restoration projects (Figure 9.1)[69]. I recognise that in the real world these steps are not necessarily discrete or mutually exclusive, some may be missing and several may continue throughout the life of the project, but it provides an idea of key stages to be considered at the outset.

9.3 COMMON CHALLENGES AND RECOMMENDATIONS

No one project, person or organisation has all the answers to delivering a perfect landscape restoration effort but, to paraphrase Voltaire, "Don't let the perfect be the enemy of the good". All the projects I visited, including the many I have visited over the years outside of the fellowship, offer something of value for others to learn from and I believe that this is probably typical of all projects everywhere.

Every project will inevitably face external or internal challenges and there is no guidebook to navigating them, but if such challenges could be anticipated, a degree of preparation should be possible. I have attempted to highlight below the key challenges likely to be experienced by landscape restoration projects and briefly discuss how these have been overcome in real situations. They have all been informed by my fellowship experiences (and, inevitably, the two decades that I have been working in this field). It goes without saying that all these challenges have been overcome somewhere at some time by a combination of creative thinking, collaboration, trust, necessity and dedication. The following challenges have been identified and are discussed in more detail below:

- **Controlling the land**,
- **Funding**,
- **Project goals**,
- **Local community participation and development**,
- **Empowerment and capacity building**,
- **Constituency building**,
- **Scaling**,
- **Alien species**,
- **Changing perceptions**,
- **Reinventing the wheel**,
- **Institutional barriers**, and
- **Policy and legislation**.

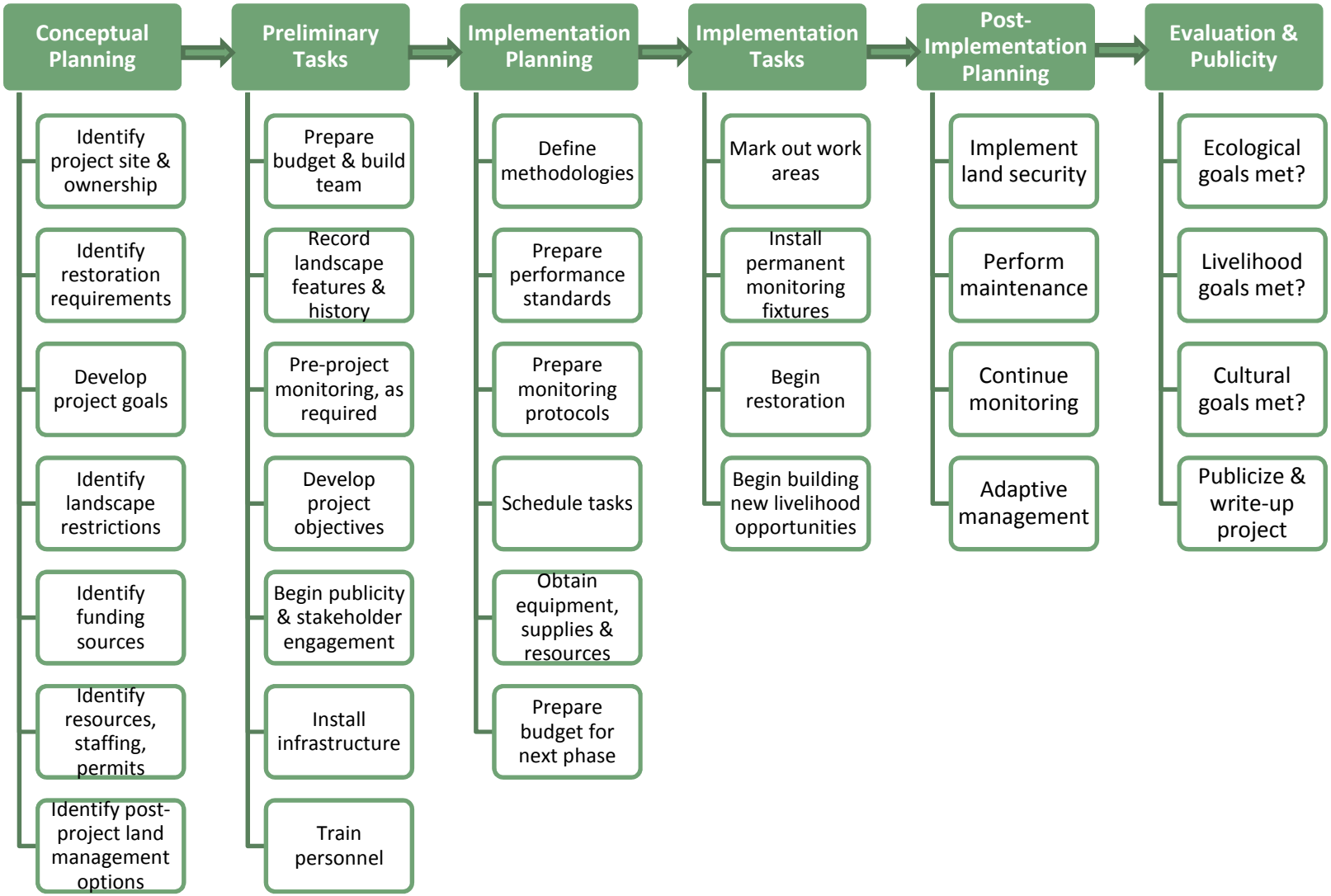


Figure 9.1. Key stages in an "ideal" landscape restoration project.

9.3.1 CONTROLLING THE LAND

Success in landscape restoration cannot be achieved without significant influence or control over the land in question. Most of the people behind the projects I visited viewed this as critical to project success. It is often the case that the people with the motivation and vision to restore degraded land have no ownership or control over it yet, frustratingly, they can see the huge potential that exists. Therefore, the critical first step for many landscape restoration schemes is to gain a foothold on the land.

The most straight-forward way to control the land is to simply buy it, e.g. Everglades, USA; Pumalin Park and future Patagonia Park, Chile; Estancia Menelik, Argentina, thus enabling the owner to have the greatest influence over what happens on it. However, acquiring land on a scale sufficient to make a significant positive impact can be prohibitively expensive depending on the landscape's complexity, scale, land-use type and intensity and/ or degree of degradation. A case in point is the acquisition by the state of Florida of the Picayune Strand from its 20,000 individual landowners spread across the world, to enable the hydrological restoration of this critical area of the Everglades. Land may also carry public or pollution liabilities, for example, that may transfer with any change of land ownership, further complicating the restoration aims.

If the land is already owned by a benevolent land-owner, then they may be persuaded to donate it to the project or to adopt less damaging land management practices towards the restoration objectives by means of land management agreements, and many of the projects I visited have taken such approaches.

Whether the land is owned, leased or managed appropriately in some other way, it is critical for those external to the project to observe the land being regularly used, with people on it, thus dissuading illegal access, occupation and damaging exploitation of it. Such uses cover a range of possible activities such as:

- **Restoration activities**, e.g., Everglades, Florida and future Patagonia National Park
- **Field research** e.g. ACG, Costa Rica; Serra da Concordia Wildlife Sanctuary and REGUA, Brazil;
- **Tourism**, e.g. Galapagos National Park, Ecuador; REGUA, Brazil; Pumalin Park and future Patagonia National Park, Chile; Estancia Menelik, Argentina; and
- **Sustainable farming practices,** e.g. Everglades, USA; ACG, Costa Rica; REGUA, Serra da Concordia Wildlife Sanctuary, SOS Mata Atlantica, Brazil; Pumalin Park and future Patagonia National Park, Chile; Estancia Menelik, Argentina.

GOVERNANCE

Governance of the project and its land should be straight-forward if the land is owned outright, but this is often not the case. When the parcel of land associated with a project is adjacent to other parcels owned by other people of a like-minded restoration ethic, the coordinated governance over the whole is the best approach for achieving scaling.

Whatever the model of governance chosen, and despite the complexities of the land ownership, ideally a single, over-arching, accountable organisation should be set-up to oversee delivery of the project goals and subsequent management of the landscape, e.g. ACG, Costa Rica. If necessary the organisation should be given a legal mandate by the relevant authorities to facilitate their role in the

landscape. The governing organisation should also include representation from local communities and other stakeholder groups.

RECOMMENDATIONS

- If possible, buy the land outright.
- Or enter into leasing or land management agreements.
- Dissuade illegal occupation of and damaging activities on the land, by generating activity land-based activities to give the signal that it is being used and is providing benefit.
- Create a single, accountable governance body to control the restoration activity and the land that includes representation by local communities and other key stakeholders.
- If necessary, support the work of this group with a legal mandate.
- Be clear about the liabilities – keep your eyes open!

9.3.2 FUNDING

The requirement for funding is as critical as owning, controlling and occupying the land. Funding is evidently essential for buying or renting land, paying workers, buying materials, equipment and services and for marketing and communications and derives from either of both of two fundamental sources: private or public. Private sources include:

- **A bond or fund from previous activity** (e.g. mining),
- **The corporate sector,**
- **Philanthropy,**
- **Personal wealth,**
- **Donor foundations, trusts and international NGOs,** and
- **Project-instigated enterprise.**

Public funding sources include:

- **International development aid** from foreign governments, e.g. Galapagos, Ecuador,
- **National/ regional/ local government**, e.g. ARRI and Everglades, USA; ACG, Costa Rica; Galapagos, Ecuador,
- **Arrivals taxes,** e.g. Galapagos, Ecuador, and
- **Lottery revenues**.

In many countries where environmental awareness and concerns lag behind more immediate socio-economic considerations, public funding for conventional ecologically-focussed restoration activities may not be forthcoming unless direct socio-economic benefits can be identified.

Apart from a common lack of available funding for restoration activities, other funding challenges are that:

- Funding priorities and sources at project start-up are usually different to the requirements for on-going project activities;
- Raising external finance for conventional land protection is generally easier;
- Changing political priorities and election cycles can make funding for long term projects difficult to raise;
- It is generally easier to attract funds from donor organisations for one-off schemes, rather than for on-going management;

- Projects typically have to concur with a donor's funding or political cycle and time limits may not fit with the practical requirements of restoration; and
- Systems that integrate restoration costs with landscape-related payments, such as tourism, water supply, forest products, etc., could provide sustainable funding long term. This assumes that the costs and benefits can be measured accurately and that the necessary political and economic factors are in place to realise this.

It is important to realise that restoration is not just a "one-off" activity, i.e. that it is a process and not an outcome. It is generally easier to attract capital funding for project development and harder to bring in recurrent funding for on-going operational/ management/ maintenance activities. Both are required to make the project ultimately sustainable.

Ideally, degraded landscapes should be restored in ways that provide long term economic opportunities to people and communities, ultimately returning more than the short term cost of the initial regeneration. Almost all the projects that I visited had obtained funding from a combination of public and private sources, with most being funded from a very wide range of organisations and individuals.

Once the restoration is underway a range of landscape-derived revenues may be generated from, for example, tourism and ecosystem services and products. In Pumalin Park, Chile, degraded farms are bought and restored back to economic viability, but with a new, more sensitive approach to land management, and then put up for sale to like-minded prospective buyers. The money-raised is then used in acquiring and restoring more degraded farms. Brazil's SOS Mata Altantica was successful in raising project finance through a web-site that also doubled as a public awareness-raising campaign.

RECOMMENDATIONS

- Try **many different funding avenues** – avoid focussing on just one or two.
- Take a **creative approach** – sometimes funding from unconventional sources or for non-landscape related activities can be attracted by taking an adaptable and flexible interpretation of project objectives.
- **Employ an experienced fund-raiser** with good local connections and at least some understanding of landscape restoration issues.
- Consider the **surrounding** local and regional environmental, social, economic and cultural situation as an **integrated aspect of any funding application**.
- Develop landscape restoration plans to **leverage funds from existing programmes** and plans of industry, government or civil society.
- A **combination of funds** from a range government, industry and philanthropic sources should be pursued to ensure a consistent and dependable stream of funding over the medium to long term.
- Try to develop an **independent, autonomous funding source**.
- Even in very large restoration programmes, consider tapping into **smaller grants** for specific aspects of the programme.
- Consider **in-kind contributions** by the corporate sector for machinery, man-power, logistics, etc. In some cases, these contributions may be tax-deductible.
- Use the **restoration project as a stimulus for socio-economic activities** such as education and training, skills development, job creation, the generation of alternative energies, etc.

- Under the right combination of circumstances, pursue a goal of payment for the ecosystem services provided by the restored landscape.

9.3.3 PROJECT GOALS

A landscape restoration project is usually born in an individual's mind who, in order to deliver it, must engage with others. The development of mutually-acceptable project goals is central to encouraging involvement and collaboration to enable the project to happen. Setting clear, long-term goals at the outset assists project planning, fund-raising, capacity-building and awareness-raising. However, these goals must be **realistic** and should be **easy to understand** for those beyond the project team; it is very easy to get carried away after initial successes and become unprepared for the inevitable set-backs that will occur over the long term.

Project advocates commonly aim towards recreating the original habitat/ ecosystem, and such goals may even be didactically written into regulation, for example, concerning the mining industry. However, it is important to recognize that "**You can't step in the same ecosystem twice**"[70], in other words this re-creation approach is often/ usually neither possible nor ideal, as at least some of the external factors that degraded the environment in the first place are likely to remain in the system. "Beneficial after-use" is a more constructive mantra for most situations than the more conventional replacement of what was there before. A restored landscape should take this new socio-economic setting into account and give birth to a system that works with the new circumstances.

Large projects require broad goals, the geographical and temporal scope of which can seem impossible to sell. Yet, all major landscape restoration projects are built of smaller projects working towards more directly achievable objectives that fit within the overall goals. Various project goals derived from the projects I visited would include:

- Improve water supplies, e.g. Everglades, USA;
- Eradicate/ manage invasive species, Galapagos, Ecuador; Everglades, USA
- Showcase agroforestry systems, e.g. Serra do Concordia Wildlife Sanctuary, Brazil;
- Restore native hardwood forests, e.g. ARRI, USA;
- Restore a functional tropical forest, e.g. ACG, Costa Rica; Galapagos, Ecuador; all the Atlantic forest projects, Brazil; Carajas iron mine and Trombetas and Juruti aluminium mines, Brazil;
- Develop sustainable farming practices, e.g. Pumalin Park, Chile;
- Enhance eco-tourism to protect the natural landscape, e.g. ACG, Costa Rica; REGUA, Brazil; Pumalin Park and the future Patagonia National Park, Chile; Estancia Menelik, Argentina; and
- Restore endangered species; ARRI and Everglades, USA; Costa Rica; Galapagos, Ecuador; Pumalin Park and the future Patagonia National Park, Chile.

RECOMMENDATIONS

- The amount of **time** required to build realistic project goals and persuade the necessary stakeholders to collaborate should not be underestimated. When setting project goals, ask the questions:
    - What is the restoration starting point?
    - What is the project aiming to restoring to (look forward to where the landscape should be rather than back to where it has come from)?
    - How will this restoration point be recognised?

  - For whom is the restoration project being undertaken?
  - Who should be involved in determining the project goals?
  - What livelihood opportunities are possible?
  - What cultural opportunities are possible?
  - Who determines the correct approach?
  - Where are the potential clashes of interest?
- There are obvious ways to make ambitious goals achievable and not too overwhelming, such as breaking them down into smaller achievable steps and resourcing each step accordingly as constituent projects of the overall restoration plan.

9.3.4 LOCAL COMMUNITY PARTICIPATION AND DEVELOPMENT

The people local to a landscape restoration project are absolutely critical to its success and every effort must be made to pay more than lip service to "community consultation" by encouraging active and meaningful participation in decision-making and project delivery. Get it wrong, and the project will fail. Fundamentally, protecting or restoring a degraded landscape will not be enough to guarantee its long term survival without engaging the socio-economic reasons for its demise in the first place. This requires more long term thinking beyond the conventional and purely ecological, e.g. for example the use of Costa Rican farmers in ACG to control fires for forest regeneration rather than clearance.

Engaging communities is not always easy; they may be isolated geographically and independently-minded, or may have been over-looked by politicians and businessmen because they are too thinly dispersed to warrant the external effort, or may be blamed for environmental destruction to satisfy their pressing needs when wider society offers no alternative. Such communities can end-up feeling disenfranchised, apathetic, insular, independent and wary of outsiders; poor previous consultation experiences persist in the collective memory leading to distrust and a lack of constructive engagement; and cultural and language differences and poor education are further barriers to engagement. All these reasons may be compounded by a lack of capacity. Such hard-to-reach communities are common in degraded landscapes.

Not engaging local communities should not be an option; there are options, however, in the way they are engaged. The conventional suit and clipboard approach with presentations and focus groups can go so far, but often miss difficult to reach groups, such as youth, women, the disabled, nomadic groups, etc., and largely ignore the hidden, unlocked potential that exists within communities. These groups require special consideration as they will have important and different perspectives that may prove invaluable. Indeed, contrary to the initial assumptions of some, there are examples of successful projects instigated and delivered by local people illustrating that innovation and motivation – often born of necessity – exist in such communities – if they don't help themselves.

Creative approaches to community participation take more organisation and resources, but when done well deliver information and benefits in terms of understanding and trust that would be difficult to replicate using more conventional approaches. They are especially useful in engaging and building relationships with those hard to reach groups. Creative approaches could involve culturally appropriate musical or theatrical performances or build on a local festival tradition – very often such traditions derive from historical associations with the land, for example. Participation events should be fun and immersive and should encourage mixed ages and family groups to attend, with a possible

focus on leaving something physical and positive about their community – a piece of art, a film, etc. They should leave the event with a positive sense of themselves and their communities having planted a stake for a positive future. Pumalin Park's El Amarillo village restoration illustrates what is possible in this vein, as does the future Patagonia National Park's Huemul Festival.

RECOMMENDATIONS

- A major aim of community consultation is **building trust between local people and external parties**. There are several facets to doing this effectively, including:
    - Making a genuine, **high level commitment** to engage by those in positions of power;
    - Engaging **early** in a **neutral space** or on the terms of the community;
    - Communicating openly with **free, prior-informed consent**;
    - Making information **freely-accessible** (physically, intellectually and linguistically) as a means of empowering local people with the knowledge of events that will be happening in their area; Giving sufficient time to **relationship building**;
    - Developing detailed **social baseline studies** of the affected communities to identify the needs and structures that have contributed to its viability so that these can be used as a basis for development. These will include social networks and cultural values and should be captured as the information will facilitate the mitigation and monitoring of social impacts;
    - **Pro-actively involving the community in setting the agenda** of the restoration project (too often the major decisions have already been made by others and the local community's response is inevitably reactive and often not that useful); and
    - Identifying a **local champion** who should be/ become a leader of the local stakeholder group.
- **Sufficient time and effort needs to be expended early on** to ensure that the community knows enough about the subject that they are able to **know what questions to ask**.
- **Consider the restoration area as an education and training ground** for the development of skills, knowledge and qualifications to local people, relevant to the wider aims of the restoration project that will be useful to them beyond the life of the project.
- Circumvent issues of distrust by **commissioning a third party** to engage with a community and begin brokering a solution.
- **Employ creative and participative approaches** – they may be harder work and require more resources, but ultimately produce better results.

9.3.5 EMPOWERMENT AND CAPACITY BUILDING

Landscape restoration projects can be very complex, requiring a large and complex multi-disciplinary team spread over a wide area and often with limited communications. It is essential for a project to have good quality people with the appropriate skills and that take responsibility for decision-making when communications are difficult or higher management does not possess the necessary level of knowledge. Many project leaders look to employ "the right kind of person" as opposed to simply seeking a specific skill-set, reflecting the need for people to get on on difficult projects in often challenging conditions. This may fly against policies of local employment to promote socio-economic development in local communities. In this case, the project organisation may implement a policy of intensive training and education when employing local people to improve their job worthiness, as the add-on benefits of local employment could be very valuable, e.g. the employment of ex-hunters

of wildlife as birding guides at REGUA, Brazil and as puma researchers in future Patagonia National Park, Chile, and training university leavers as parataxonomists in Costa Rica's ACG.

Some of the key requirements are likely to be in the following fields: marketing, horticultural, ecology, taxonomy, soil science, field guiding, small enterprise development, project management, social engagement, formal education, construction, crafts, lobbying, legal, contract negotiation, etc. These capacity requirements can be met by direct employment, collaborating with other institutions, providing training and personal development opportunities to existing staff, taking on volunteers and interns and buying in expertise.

VOLUNTEERS

A common way of increasing capacity is to use volunteers, who can be either specialists or generalists. In central Appalachia's ARRI, for example, they include people of all ages, from school children to retirees.

Among the projects visited on my journey, there were mixed opinions on the use of volunteers which, I feel, is based as much on personal experiences – good and bad – as on any corporate policy. ARRI's experience is that working with volunteers is not easy. They need to be trained and managed constantly, with a regime employed that does not exhaust people who are not used to this kind of work. However, the benefit of using them has proved critical to the early success of the initiative.

Very generally, it seems that when volunteers can be employed en masse as unskilled labour there are relatively few problems; but when they are relied on for specific roles they may be found wanting as organisational reliance on the individual is greater, yet organisational control is limited.

RECOMMENDATIONS

- **Good interpersonal skills** are essential in such projects as their success is inevitably and always built on a foundation of strong human relationships both within the project and between it and other organisations.
- **Employ locally** wherever possible – the peripheral benefits are invaluable, but bear in mind there may be a significant requirement for education and training.
- **Education and training** should play a key role in filling in gaps in knowledge and should be properly resourced.
- Consider **seconding staff** from collaborating organisations to assist in building mutual inter-organisational understanding.
- **Use staff to train other staff**, creating professional bonds and organisational understanding between different levels and disciplines within the organisation.
- **Volunteers**, especially for unskilled manual tasks, can be invaluable. For specific roles, consider carefully and explore an individual's motivations before committing.

9.3.6 CONSTITUENCY BUILDING

A committed individual or small team working independently will have a local positive effect at best, but scaling will only be achieved by convincing others, particularly those with influence – local people, politicians, businesses and conservation organisations – to support the landscape restoration initiative.

All the projects that I visited are actively involved in constituency building. Essentially the process aims to build momentum for a project to develop, so project leadership, communication and collaboration are essential. As much effort should be applied to building the constituency of support as to raising the money, controlling the land and implementing the restoration activities – indeed they are not mutually exclusive. Publicity and marketing are important, but equally important are encouraging others to sing the project's praises in their own peer groups and disciplines, doing one's publicity by proxy: large projects will inevitably displease some people and it is important that grievances are aired, but it is also important that if a majority does agree with a course of action that they voice their support; for example, pro-restoration groups publicly supporting the Everglades' Picayune Strand project when illegal and damaging land-users have agitated media trouble.

It is important to be aware that an individual's or organisation's objectives may well be different to those of the project and the key to building a constituency is therefore to develop a common agenda that satisfies a range of expectations.

Getting to this stage takes a tremendous effort, particularly during the project development phase, and means travelling the miles, giving the presentations, and enduring politeness and patience. Once successfully built, there will still some requirement for on-going constituency building, but to a large extent it will sustain itself. When successful, such approaches by successive generations of restoration leadership should have created platforms for future accomplishment over decades.

RECOMMENDATIONS

- Take the time and effort to **understand local politics and vested interests**.
- **Spare no effort** in engaging influential stakeholders, particularly during the early project development phases, including using the media, going out to meet and present to local people and stakeholders, travel the miles.
- Make full use of the **media.**
- **Encourage others to sing one's praises.**
- **Keep communication channels open** and transparent and be available.
- Develop a **common agenda**.
- **Share the success** by giving credit to others for their support and involvement.

9.3.7 SCALING

The 18th century Irish statesman, Edmund Burke, wrote: **"Nobody makes a greater mistake than he who did nothing because he could only do a little."** This sentiment, as it applies to landscape restoration, implies that often the challenges can seem too big or too complex or too depressing for one person to make a difference. However, during my journey I met several people running projects that were small-scale in terms of the landscapes and the problems that needed addressing, but such example and approaches are vital in delivering larger goals. Large projects are built from smaller constituent projects, without the latter, the former cannot happen.

In terms of ecosystem services or benefits to large numbers of people, generally the scale of the project needs to be large – both geographically and temporally. Taking an **ecosystem services** approach from the start forces the development and delivery of an over-arching programmatic approach that involves high level politics, large amounts of funding, working across institutional barriers and policy and regulatory support, such has been developed in the Everglades by SFWMD

and USACE and is as much engineering as it is ecological. Ecosystem service delivery is likely to remain impaired if only a part of a degraded ecosystem is restored; therefore, a critical mass, or area, of restoration will be required to make a significant positive impact. That said, it can only be delivered through smaller projects on the ground involved in planting the trees, engaging the communities, training the workers, removing invasive species, etc.

Another aspect of scaling is **time** – natural systems tick on a different clock to political cycles or a human lifespan. To deliver enduring benefits beyond a human life-time a restoration project must plan for well beyond the expiration of the people involved at its outset. For many this will require significant changes in attitude and perspective amongst all stakeholders. Ultimately the benefits from this work will accrue to future generations. Such long-term thinking can be stymied by the understandable hubris of those who want to make a recognizably significant change within their own life-times.

A step change in scaling can be achieved by increasing connectivity between neighbouring, possibly independent, projects, including perhaps across national borders. This is starting to happen in Brazil's Atlantic Rainforest and in the Galapagos and, maybe, between neighbouring future Patagonian national parks either side of Chile-Argentina border. Unfortunately, many restoration projects, good though they may be in many other respects, may not possess the necessary footprint or long-term planning to create a step-change improvement at a landscape level, which requires a range of other factors to be in place. Externally these include political will, public support, funding, manpower, etc.; internally, vital factors include leadership and technical capacity.

Beyond degraded landscapes and their associated communities projects should, by default, consider how to connect with the lands and wider communities surrounding such areas – a key to unlocking scaling success. If degraded environments can be considered within regional sustainable development frameworks that fit with the priorities of the local/ regional authorities, then individual site regeneration would be much more relevant and useful; good examples are provided here by the Galapagos Islands, ACG, Costa Rica and the Trombetas and Juruti aluminium mines in the Amazon.

RECOMMENDATIONS

- **Encourage the development of smaller projects** that are more intellectually and physically accessible for ordinary people to get involved, alongside the broader programmatic approach.
- **Developing an ecosystem services approach** at the start requires a joined up, multi-disciplinary approach and the involvement of a range of key stakeholders.
- **Engage with similar projects** in the same area or in the same ecosystem, and explore collaborative approaches to build broader success.
- **Connect with landscapes and communities** neighbouring the footprint of the project in question to encourage spill-over benefits to maximise project effects.
- **Work with government** to determine how a project can assist in delivering their **sustainable development objectives**.
- Implement **succession planning** to build an inter-generational project and enhance scaling in time.

9.3.8 ALIEN SPECIES

The term invasive species and its many allied terms, such as exotic species and invasive species, etc. are emotive to many ecologists, yet the subject is overburdened with definitions and descriptions. For the sake of this section I have used the definitions of alien and invasive alien species as defined by the EU[71]:

- **Alien species** are species which are introduced outside their natural past or present distribution area and succeed in surviving and subsequently reproducing.
- **Invasive alien species** are alien species whose introduction and/or spread threaten biological diversity.

Although they can be a serious threat to ecosystem integrity, it is important to remember that not all alien species cause significant ecological damage and in many cases ecosystem functions and services can remain relatively intact even under an exotics regime. Where a problematic alien species can be readily controlled easily and cheaply, then it should be; however; there are instances in which the eradication of an alien species may have become intertwined with socio-economic issues, such as the supply of timber from the introduced Cuban cedar in the Galapagos Islands taking the pressure off of native tree species. In others, the biology of the plant may make it simply too difficult to eradicate successfully with current technology and practices, without spending enormous sums of money or irreversibly damaging the ecosystem in the process, an example being the control of mora, again in the Galapagos Islands. In the lands that were once covered with Atlantic Rainforest, there are large tracts planted with alien species for timber and paper pulp. Although exotic, these trees also reduce erosion, increase water infiltration and increase soil organic matter – and protecting the land in this way is better as a temporary or socio-economic method than no trees at all. In such instances, more pragmatic approaches to managing alien species in landscape restoration schemes are required.

NOVEL AND HYBRID ECOSYSTEMS

In some cases landscapes may be impacted by so many different invasive species that the removal of one species is likely to result in replacement by another invasive, such as the scenario with mora control in the Galapagos. Here, another perspective offers a more pragmatic, but currently more controversial approach, where the goal would be to maintain as much native biodiversity as possible, together with the original functionality, and undertake management interventions that maximise benefits over the total area of intervention and not focus solely on the invasive species. Here, the pre-human state is unattainable given realistically available resources. Novel ecosystems, those that have new species combinations arising through either species invasions or environmental change, are now widespread and could become objects of conservation for their own sake in the future. This hybrid/ novel ecosystems approach also frees up resources for the conservation of important native species in areas currently less impacted by invasives and also allows for the supply of basic cultural and socio-economic needs.

Even the most committed restorationists will need to accept that for some places in a world of massive environmental degradation, social stress and economic necessity and with current technology, restoring a landscape to a previous pristineness is unrealistic. This paradigm emerges from a social and economic landscape that overlays the natural one, and should aim towards essential ecosystem function, products and services, but also build direct in-pocket benefit to the surrounding people – improving lives and livelihoods. This means understanding that, increasingly

around the world, people will be living in hybrid or novel ecosystems that have never existed before and will require changing conventional socio-economic and policy approaches.

RECOMMENDATIONS

- **Objectively consider the risk** from alien species in the landscape and determine whether any cause significant problems.
- Determine if any of these species are used for **economic or cultural purposes** by local people.
- Determine if they can be **controlled naturally** by, for example, shade cast by native planted trees as part of a forest restoration programme.
- Where possible **control invasive alien species** if this can be done **without excessive cost or irreversibly damaging the environment**.
- If normal control measures are inadequate, consider funding research into the use of more exotic controls such as the use of **biocontrol agents**.
- **Implement quarantine procedures**, if feasible.
- In the interim, or if not possible, **develop a landscape management regime that protects and restores the degraded areas** where it is feasible to do this and **concentrate on containing the most heavily infested areas by on-going management**.
- **Ensure all staff receive adequate training** as to the threat from alien species and how to manage it.
- **Co-operate with other organisations** involved with similar problems with similar species, sharing knowledge and communicating regularly.

9.3.9 CHANGING PERCEPTIONS

Often central to restoring landscapes is changing the way people view them, particularly local people and people outside the area with influence over the land, such as politicians and business people.

Some players in the land-based industries; for example forestry, agriculture and mining, may see restoration as a convenient excuse to allow exploitation without realising (either cynically or through ignorance) that a restored system can never the same as the original, even after decades with all the specialists and resources that such businesses can provide. Non-specialists, such as decision-makers in government, may not possess the necessary knowledge to be able to ask the right questions to achieve the best solution, taking the business case at face value.

Perspectives need to change from exploitation or resignation with the degraded status quo to ones of restoration and conservation, possibility, cultural value and personal worth. Local people are the lynch-pins as they are usually those who were involved in the exploitation of the same landscape that they are now expected to restore and protect. I witnessed many, many examples where local people had been re-employed by restoration projects when previously they had been poachers, farmers or loggers responsible for the demise of the landscape. Inevitably, necessity for work is the ultimate driver, but once involved and appreciated, they gain a new self-esteem that opens new doors for them – in particular I think of Adilei, the REGUA bird guide in Brazil's Atlantic Rainforest. It may be feasible, if risky, to encourage groups and people with different/ conflicting perspectives to work together towards a simple and worthwhile common aim while each influences – hopefully in a positive direction – the other's perceptions. There are two important lessons here:

1. **The status quo is not viable** – they have watched their farms producing less as the soil washes away and their land values decline, or their quarry diminishing because of over-hunting and habitat loss, and have appreciated the opportunity of a new start in the old place.
2. Create **the opportunity for a worthwhile alternative livelihood** that allows them to live constructively in the landscape to which they are rooted.

It seems that almost all the project leaders I met had, at some stage, dramatically changed their own perspectives and professions, from farming, big business, medicine, academia, or entertainment to one of committed restorers of degraded landscapes. Each had a different kind of epiphany and all are equally fascinating (– but these are stories for a different time!). Having made the leap they become passionate about making a positive difference.

DEMONSTRATION

The **physical demonstration** of an idea at a pilot scale can be a very powerful persuader for changing perceptions, particularly of potential funders and decision-makers. Not only does this prove that the technology works, it shows that the project team is serious in delivering and has the knowledge and will to make it so. ARRI in Central Appalachia, USA, illustrated this principle perfectly by proving that it is possible to recreate a native hardwood forest on compacted mine sites; and the demonstration of a range of agroforestry possibilities in Roberto Lamego's Serra da Concordia Wildlife Sanctuary in Brazil's Atlantic Rainforest.

Allied to demonstration are the basic **human qualities of trust and passion**. As relationships build between project leaders and stakeholders, innate wariness subsides and minds open. The importance of communication and leadership here should not be underestimated.

RECOMMENDATIONS

- Positive **personal relationships** are the foundation for persuading others to believe in an alternative way of behaving, particularly when ambitions are grand, costs are high and the scale is enormous.
- The **value of physical demonstration** is essential and the resources should be found to enable them, particularly in the early days of an ambitious project.
- Create meaningful new **employment opportunities** connected to the old land,
- then facilitate opportunities for further, **personal development**.
- In the early days in particular, but also through the life of the project, **share the credit** for any successes that happen. This builds wider confidence and appreciation in your effort, but also reflects the actual collaborative nature of the achievement.

9.3.10 REINVENTING THE WHEEL

During my journey I found it surprising how little interaction there was between some projects and similar projects elsewhere. Around the world, and even within countries, similar problems of environmental degradation are faced by different communities. While there are many forums – real and virtual – for exchanging ideas and developing knowledge open to industry, governments and academics, much of the creativity and innovation derives from committed individuals and groups in communities with limited resources, motivated by necessity and developed from first principles.

Such groups are often using all of their limited capacity acting locally to be able to share their experiences more widely. Consequently much of this work goes unknown, only surfacing through word of mouth, personal contacts and serendipity. These projects potentially offer an enormous pool of practical experience that is rarely tapped beyond their locally-focused activity.

There are other – more attitudinal – reasons for this frustrating state of affairs in which the people involved may consider that:

- Their problem or situation is unique;
- It is not worth looking elsewhere for a solution;
- It is not worth looking back in time to previous research; or
- It is just not worth looking!

This means that the wheel is regularly reinvented at different locations, wasting time and resources, with potential for disillusionment and prolonged projects with unsatisfactory outcomes. The success stories arising from such projects have huge potential for inspiring others and for improving practice on the ground elsewhere.

There are also other reasons causing the wheel to be reinvented, including, depressingly, egos and hubris, apathy and institutional barriers. This lack of interaction is even found between groups and individuals sharing similar challenges in very similar ecosystems but, for what are sometimes issues to do with personal relationships, interaction is stymied.

There have been moves in recent years, particularly in North America, to convene national landscape restoration conferences to share knowledge and build a continent-wide constituency for facilitating more landscape restoration activities to happen. The Everglades restoration programme, as one of the continent's flagship restoration schemes, has been involved in these events.

RECOMMENDATIONS

- At the outset of a landscape restoration project, **task knowledgeable individuals to research projects** elsewhere in similar ecosystems, and/or suffering similar types of degradation, and the successful restoration approaches they employed. Make contact with individuals involved in these projects.
- **Ensure that one's own project records the successful processes and procedures** that could be useful to others elsewhere. Important aspects of such communications should include details of:
    - how the project was conceived and implemented,
    - who did what,
    - particular challenges and how they were overcome, and
    - the outcomes and how success was measured.
- Such information should then be made **freely available and disseminated** to other groups. The information thus gained can be used in a variety of ways to build and reinforce trust among stakeholders and improve practice on the ground.
- Encourage an **open organisational mentality** of assisting others.
- Attend forums and **promote one's work**.
- **Get involved!**

9.3.11 INSTITUTIONAL BARRIERS

Institutional barriers within and between organisations, particularly governments, academia and NGOs, create bottlenecks and hinder effective involvement with landscape restoration projects and, unfortunately, commonly revolve around vested interests. Government departments regularly initiate partnerships for delivery as they often provide funding or address liability, but do not always possess the specific expertise or capacity required. In countries with a federal – state/ province government system, issues of institutional barriers can be particularly problematic. Limiting factors to project delivery include:

- **Bureaucratic rules and procedures** that limit effective involvement;
- **Paranoia** over accountability for public funding;
- **No clear delegated authority**;
- **Institutional politics**, when two or more organisations vie for control and stymieing progress as, often, landscape restoration projects may (and arguably should) cut across the remits of more than one organisation, each of which is putting in resources and expects an element of control;
- **Attitude** – "It's not our job!";
- **Lack of capacity** means that the availability of people to make decisions, or assist in some other way, can be limiting;
- Different elements of a coherent restoration project are often the **responsibility of different departments** and/or levels of government, **hindering final decision making**; and
- Some projects may **cross jurisdictions** or even national borders adding obvious political and/or cultural complexity.

Successful projects have identified ways to surmount these barriers ensuring that project implementation is easier, that also delivering wider institutional benefits such as improved mutual understanding and trust-building – if a trans-boundary Patagonian conservation involving the governments of both Chile and Argentina can be made a reality, wider political benefits will undoubtedly accrue. In Florida, SFWMD (state) and USACE (federal) are finding a new institutional freedom in working together towards the common aim of restoring the Everglades. In the central Appalachian coalfields, not only are state and federal institutions collaborating, but the seven Appalachian coal states are simultaneously adapting coal mine restoration regulations to assist ARRI. Even the Galapagos, which for a small community has a plethora of national and international conservation organisations involved, is finding ways to deliver effective programmes on the ground, such as Project Isabela. A possible model is provided by Costa Rica's ACG, which is governed by a deliberately **bespoke system of decentralised governance** as a hybrid government-NGO organisation.

RECOMMENDATIONS

- Work with relevant stakeholders to **identify institutional barriers** to project delivery.
- When institutional barriers are identified **allocate small teams to focus on surmounting the barrier**.
- **Create project delivery teams that cut across institutional boundaries**, building understanding through common working and information-sharing.
- **Promote the inter-institutional development of personal relationships**.

- Consider developing a **bespoke system of decentralised governance** for management of the land.

9.3.12 POLICY AND LEGISLATION

Poor legislation and enforcement and the implementation of inappropriate government or corporate policy may have created the degraded landscape and its related social problems in the first place. Initially, at least, there may be reluctance to assist in a restoration programme for fear of **adverse public reaction** or the legal reality of **assuming liability** for the damage. Such policies include usually well-meaning historic programmes for: creating new livelihoods for settlers, e.g. Patagonia and Costa Rica; post-mining restoration regulation that addressed physical problems, but exacerbated ecological damage (ARRI, USA); solving major flooding at the expense future water provision for agriculture, cities and wildlife in the Everglades; or replacing native forest with plantations for timber or paper pulp, e.g. Brazil's Atlantic Rainforest and Chilean Patagonia.

Many government institutions, particularly in developing countries, may lack the technical capacity to understand the wider ecological implications of their policies on the ground or, even if they do, socio-economic development is the over-riding priority and can and does lead to a situation of almost irredeemably damaged landscapes which are costly to rectify.

There are, however, some recent examples where government policy has altered in favour of restoration such as the support by the Costa Rican government for the forest restoration efforts in the ACG after the considerable life-time efforts of Dan Janzen and his impressive colleagues; government-supported island restoration in the Galapagos; state-level flexibility in regulation the restoration of coal mining sites in Appalachia and the monumental efforts been taken by the US and Florida governments to reverse decades of environmentally-damaging flood control policy in the Everglades. Also, enlightened corporate policies, such as at Trombetas and Juruti aluminium mines, now drive some of the most ambitious and best implemented landscape restoration projects anywhere.

Such changes in policy, whether in the public or private sectors, come about through a combination of public pressure for change, improved technical knowledge and demonstration of the benefits.

RECOMMENDATIONS

- **Build influence** with policy advisors and makers by creating strong personal relationships with key project personal. Communicate regularly in an open and honest fashion and make them feel part of the project.
- If necessary, give government an **element of control** over an aspect of the project that assists rather than hinders overall project aims.
- **Use pilot scale projects to demonstrate** the success of the restoration scheme and to show that new, restoration-friendly technical approaches can deliver the aims of existing policy and regulation with added benefits.
- Apply well-informed and appropriately targeted **external pressure** and lobbying to influence insensitive government and corporate policies.

9.4 "THE OIL IN THE MACHINE"

Delivering a world class landscape restoration project is about more than just ticking a check-list of stages and processes. In many ways it is an organic thing built on human relationships and evolving over years and decades with changing personal circumstances, societal expectations and the personalities involved. Inevitably, in all long-term projects, unpredictable events and opportunities occur that will need to be carefully considered and reacted to. The more flexibility and adaptability that a project has engrained into its modus operandi and collective philosophy, the more durable and ultimately successful it will be.

I am convinced that absolutely critical to every aspect of every successful project everywhere are several cross-cutting themes without which a project will fail, that I call, for want of a better term, "the oil in the machine". They are:

- **Leadership**,
- **Communication,**
- **Collaboration,**
- **Knowledge,**
- **Creativity and beauty, and**
- **Culture.**

Each of these is discussed briefly below with recommendations to assist in making them happen.

9.4.1 LEADERSHIP

Good leadership is essential to the success of any project. Many of the projects I visited had been set-up by motivated individuals, usually from outside of the conservation world – at least initially, who saw an opportunity and changed their life's course to seize an opportunity. The projects that have since developed around them are still largely led by these self-selecting individuals, e.g. ARRI, USA; ACG, Costa Rica; REGUA and Serra da Concordia Wildlife Sanctuary, Brazil; Pumalin and future Patagonia National Parks, Chile; and Estancia Menelik, Argentina. Such motivated individuals use their own resources in working towards their restoration ambitions. For some this includes personal wealth, but for all this includes their intellectual, organisational, creative and motivational skills to get the job done; many of these individuals do not possess large personal wealth and are achieving their ambitions by influencing how others manage their land. The important leadership quality here is the ability to persuade others to follow a course of action – usually organisational and managerial skills are secondary concerns that can be picked up by others in the team.

The large scale of many landscape restoration projects means that there is often significant public interest in their progress, with attendant media attention. Also, their complexity requires a range of skills and organisations to collaborate towards a common goal. The task facing the leader of such a project is tricky: they must be simultaneously engaging, strong and confident, focused and committed, and articulate and respected. Such people are hard to find, though thankfully they are usually self-selecting!

As with all restoration projects, all leaders are not perfect. A project leader can be simultaneously an asset and a threat to the project as they become its public totem and, in the eyes of the public, the project and the people who work on it are coloured by the strengths and weaknesses of the leading person. It is a fact of life that a person cannot get on with everybody, inevitably there will be clashes,

but in terms of leadership such clashes can reflect on the whole project team. If a project is successful, there may be charges of arrogance, either real or imagined, by project watchers, which can also damage external perceptions and harm internal morale.

Ideally, a single organisation should control the restoration project and its land. In complex landscape restoration projects, a number of different organisation bring key attributes to the table, but **organisational leadership** can be diluted and ineffective as each may want an element of control, resulting in a poorly delivered project and wasted resources. This is where a strong, charismatic, respected individual is required to take control. Not all projects have them, but they all need them.

There is a risk with collaborative approaches that some of the individuals/ institutions involved may vie for leadership in attempting to assert overall control over a project, and that the organisation itself can dilute the media profile of the frontman – the project leader. This is a mistake; people naturally connect with other people, not faceless organisations, or organisations with too many faces. Unplanned leadership contests can be defused by a clear delineation of responsibilities, strong sole leadership and a project approach that everyone understands and formally agrees with.

Ultimately, on projects of sufficiently ambitious scale, a leader is succeeded. With some, an intense sense of ownership over a project may mean that they are unable to relinquish control to others at the most appropriate time, or when a project grows or diversifies into areas where others with more appropriate skills are required.

RECOMMENDATIONS

- **Respected leaders are essential** for a project, but are not that easy to find.
- The leader should be a **confident media performer** (and have a thick skin!).
- In many projects the leader may be self-selecting having driven the project from a personal dream to reality. Inevitably there will be negative attributes, so an **adaptable and supportive team** will be indispensable to achieving something amazing. This requires recruitment of the “right kind of people”.
- **Succession planning** is essential, especially for projects spanning several years or decades.
- A **single organisation** should run the project and, ideally be the same organisation that controls the land.
- Don’t let the organisation **dilute the visibility** of the leading person.
- Organisational in-fighting can be diffused by strong leadership and **formally agreed roles** and responsibilities within an overall project delivery programme.

9.4.2 COMMUNICATION

Good communication is the essential foundation of any project, both within the project team and in external engagement with stakeholders, collaborators, local people and the media. Good personal relationships cannot be built without it. Important aspects of communication for a project to consider include:

- **Who is responsible** for corporate communications?
- **What is the engagement strategy** – and who will take which roles?
- How will project information be **disseminated and to whom**?
- **Language:**

  - **Translation issues** - does the project have the capacity for engaging in the necessary languages?
  - Availability of information in the **relevant languages**,
  - Language-related **cultural sensitivities**, and
  - Comprehension of **technical language** by the audience.
- **Information issues**:
  - Is the information provided of sufficiently **good quality** in terms of presentation and substance?
  - Does it come from a **reputable source**?
  - Could it be **conceived to be biased** towards a particular outcome, particularly when political organisations are involved?

It is important for project leaders to be proficient and engaging communicators and this applies, ideally, to much of the project team. Large, complex landscape restoration projects should employ a competent communications team capable of engaging the necessary audiences with the appropriate information. I witnessed at first hand the importance of this with the excellent work of the Everglade's CERP in Florida, and also in Chile's Pumalin Park and future Patagonia National Park.

The value of physical demonstration of the project on a pilot scale as a proof of concept (Section 9.3.9), is a valuable and often overlooked communication tool, particularly when trying to convince important stakeholders and local communities at the start of a project of the potential benefits.

More broadly, most of the world's public, including people who live within the footprint of enormous projects such as the Everglades restoration are blissfully unaware of the world class projects on their door-step that are literally changing their worlds (I met a few people there that reinforced this point). Ideally, every landscape restoration project should take the role of promoting the general concept of landscape restoration more broadly – the more people who are aware, the easier it should be to do more of it.

Two-way communication – listening as well as broadcasting – is essential. A network of informal and formal feedback mechanisms involving the surrounding communities and stakeholder groups can help reduce the risk of small issues running out of control.

Poor inter-project communication – for a variety of reasons (lack of time or capacity, hubris, personality clashes, ignorance) – is a very common trait; different landscape restoration projects don't communicate as well as they should. At the very least within the same ecosystem type it should be expected that communications should occur between projects to share knowledge and build public awareness. Much can also be learned from very different landscape restoration projects communicating on a common high level agenda. Thankfully, this is starting to happen albeit sporadically.

RECOMMENDATIONS

- Communication with all audiences is helped by having clear and **easily understandable project objectives**.
- At the start of a project there is unlikely to be a reference to show what the restoration will entail, or how the restored landscape will appear. Use a **range of visual tools**, particularly physical **demonstration models**, to **showcase the plans**. Invite **constructive feedback** and adapt plans as necessary.

- Make **full and creative use** of all the communication opportunities available – publications, websites, local media, face-to-face, etc.
- **Be accessible and transparent**.
- **Build communications with restoration projects in similar ecosystems elsewhere** to share knowledge and build public awareness more broadly.
- **Establish forums** with stakeholders and local communities and meet regularly on neutral ground, if necessary.

9.4.3 COLLABORATION

No one group or individual has all the answers to delivering a successful landscape restoration project. The skill sets, political jurisdictions, finances and scales involved mean that collaboration between organisations is essential and almost all the success stories demonstrate the value of collaboration of some kind. Each party brings different experiences and skill sets to the project, making the collaboration stronger, more integrated and more creative. A primary purpose of collaboration is to **encourage synergy** – the development of new ideas that would otherwise not have occurred. It is important to remember that relationships between institutions are ultimately built on **relationships between individuals**, and that the basis of human relationships is **trust** and **respect**. Key to building trust is **open, transparent and regular two-way communication**.

A typical landscape restoration project will involve the following stakeholder groups:

- Government departments and agencies;
- Public/ private sector and other groups;
- Local government;
- Local community; and
- Possibly, indigenous people's groups

Collaboration needs to happen at different scales and with different types of organisation depending on the nature of the project, such as:

- **Locally-focused partnerships** consisting of the relevant skills focused on developing a particular solution;
- **Between geographically discrete projects** to share know-how, increase resource efficiency and scale up the impacts;
- **Between restoration projects of different landscape types** to share and compare approaches; and
- **Between the public and private sectors** to encourage lasting socio-economic benefits within and beyond the immediate geography.

The time required to build effective collaboration should not be underestimated – along with an understanding that the partners will need to be willing to share knowledge and experiences, be generous in providing support and have commitment from the top of their organisations.

The deepest collaborations are those where knowledge is the currency of exchange and the development of a common agenda is central to positive action, although individual motivations may well differ.

RECOMMENDATIONS

- **Begin relationship-building early** in the planning process, particularly if there are significant trust issues to overcome.
- Allow **sufficient time for building personal relationships** – the basis of any institutional collaboration.
- Develop a **common agenda and goals** that encompass the sometimes disparate motivations of the individual players.
- Collaborative approaches can be **incentivised through legislation or catalytic funding**.
- Develop the stakeholder group to include representation from **all relevant parties**, including funding groups.
- The group should move forward on a **consensus** basis if at all possible.
- Involve **technical experts** who can give candid and regular advice.
- Ensure that "champions" for particular issues are **respected** within their realm of influence (e.g. community engagement, science, business knowledge and government).
- Giving **equal voice** to all stakeholders in providing different yet valid perspectives on the same issue.
- All involved, including stakeholders and the project delivery team, should develop a **shared understanding of the project's challenges** whilst engaged in the consultation. This may include an **education** function and the development of a **common language**.
- **Progress on the ground** is a key element in developing mutual understanding and building trust.
- **Continuity of project team staffing**, with due consideration given to succession planning with a smooth transition (nothing frustrates stakeholders more than having to tell and re-tell their story as the personnel involved in a project change).

9.4.4 KNOWLEDGE

Knowledge and how it is sourced, developed and applied runs through all projects like electricity – invisible but essential. Alongside applying pre-existing knowledge during project delivery, a good landscape restoration project also generates new beneficial knowledge (research), applies knowledge to measure project progress and assist management (monitoring and evaluation) and creates opportunities for knowledge to be imparted to others to assist personal development (education and training). There are several different modes of knowledge interaction all of which are essential to project success, namely:

- **Research**,
- **Monitoring and evaluation**, and
- **Education and training**.

All of these will require the involvement of willing local educational institutions capable of delivering a high quality, knowledge-based service. In some instances this may be assisted by the rationale of the institution being to support local economic development as well as education and research, as is the case of Cornwall, UK's, Combined Universities in Cornwall initiative, with its state-of-the-art geography, mining and conservation biology departments – ideal for application to the landscape restoration challenges of the county's clay mining district.

All landscape restoration projects are unique. It is important and valuable to record the project's story for posterity, because this is soon forgotten with time as project personnel move on. Every project offers lessons to be learned, which can only happen if there is a combination of the easy accessibility of appropriate information and enquiring minds.

RESEARCH

There is a common impression that, for most landscape restoration schemes, we know enough about ecology and managing land to develop a reasonably successful restored landscape, without researching to the n^{th} degree every precise unknown, i.e. "Don't let the perfect become the enemy of the good".

As expressed by many of the people I met on my journey, basic research at the outset is often sufficient to determine the cause of the environmental degradation in the first instance, which can then be acted upon immediately, e.g. ACG, Costa Rica; Estancia Menelik, Argentina. Less straight-forward is the research into the socio-economic and cultural aspects of changing a land-use to predict what the impacts, either positive or negative will be.

There may be particular ecological issues in important habitats, such as the restoration of the canga habitat at Brazil's Carajas iron mine, which requires substantial research to determine how such unique ecologies can be restored after they have been mined out. In other examples, applied research has shown that Amazon rainforest restoration at Trombetas and Juruti aluminium mines can be improved and made cheaper and more climate-friendly by using loose-tipping soil application and planting methods. This is despite very successful restoration processes over the 30-year life-time of the Trombetas mine, showing that research into restoration techniques should be an on-going process and respond to changes in economic and societal expectations as well as ecological necessity.

Not all research is, or should be, academically-orientated. The agroforestry research being carried out at Serra da Concordia Wildlife Sanctuary takes a largely practical approach to determine which approaches work and which do not, and also serves as a useful demonstration project. Also, the training of young Costa Rican graduates as parataxonomists has been important in taxonomic research in the ACG.

Ecological research on both degraded and restored landscapes also serve as a land-use visible to external audiences that may otherwise occupy the land for more damaging purposes. Biodiversity and taxonomic research at REGUA in Brazil's Atlantic rainforest and Costa Rica's ACG has been a useful tool to this end. Research in the Galapagos on a range of ecological/ evolutionary aspects has helped establish the islands' international reputation as a unique natural research laboratory, with associated high level attention from international government organisations, academic institutions and NGOs, with obvious down-stream benefits.

Good quality research into the socio-economic and cultural effects of a landscape restoration project is often lacking and is an area requiring considerable improvement. This is particularly important when engaging the potential public funders of a project who may be interested in job creation and improvements to the local quality of life. The Everglades' CERP, USA, have produced statistics to this end predicting the economic benefit to the restoration work several years hence, showing that the project will far outweigh the costs to the public purse of the restoration work itself (Figure 3.3). Such approaches need to be more widely used.

MONITORING AND EVALUATION

Decision-makers crave hard facts on which to base decisions, but projects would often rather spend resources on restoring than monitoring. Monitoring and evaluation are very important in long term, large-scale projects as the findings should feed into **adaptive management**, and **link successive generations of restoration workers**. Appropriate monitoring/ evaluation tools are required for any project to improve success over the (very) long term and to be able to determine when project goals have been achieved, and this should include the monitoring of socio-economic and cultural indicators as much as ecological ones.

EDUCATION AND TRAINING

The role of education and training in building capacity has already been introduced. While this is obvious, the benefits can be significantly enhanced if the perspective on the landscape restoration project can be shifted slightly. For example, while the ecological and ecosystem service benefits should be borne in mind, the project could be viewed as opportunity to impart new transferable skills and knowledge through on-the-job training, especially for local, often socio-economically depressed local communities. Such projects could offer knowledge-enhancing opportunities beyond ecological skills including training in catering, landscape design, construction, teaching, public education, marketing, hospitality, etc. Delivering such opportunities is enhanced by collaborating with local educational establishments who may be able to assist with adult education facilities and training.

RECOMMENDATIONS

- **Record the project story** and make the information **accessible**.
- **Basic, early research at the outset of a project** is often sufficient to begin restoration activities. Be wary of increasing costs and time by striving for **unnecessary perfection**.
- **Focus detailed research** on important and specific ecological issues without which the project will be compromised, or on developing new restoration methods that save time and resources or to respond to changing local circumstances.
- **Research does not have to be academically orientated**, but it does need to produce useful results on which **valued judgements** can be made.
- **Collaborate with institutions** that can assist the research, monitoring and education and training.
- Commission research on the **potential socio-economic and cultural impacts** of the project that can be used to assist the lobbying of public funders and decision-makers in particular.
- **Monitor socio-economic and cultural indicators**, as well as ecological ones during project development and afterwards.
- Alter perspectives from ecological concerns to viewing the project as a **long-term education and training opportunity** for local people in particular.

9.4.5 CREATIVITY AND BEAUTY

Restoring landscapes is a creative process and is known by some as **Creative Conservation**[72]. Creativity, either consciously or sub-consciously, is critical to landscape restoration success – something new is being created, no matter how hard one tries to emulate/ imitate what went

before. The opportunity, if not the will, exists in many circumstances to create beauty simultaneously with restoring functionality, adding a deliberate cultural element beyond the purely natural and reflecting the new system for what it is.

Practitioners and planners have a large degree of control over what happens on the ground. In many instances, opportunities to introduce creative elements into a project, rather than dogmatically follow a strictly, pragmatic ecological restoration approach, can add socio-economic, cultural and even ecological value to the land that did not exist before. Creativity is closely allied to human values of responsibility, respect, trust and empathy and, in my opinion, much, much more should be made of this kind of approach.

Creativity through art – visual or performance – can and should be used to offer new perspectives on the familiar – and this applies to the landscape one may have known for a lifetime as much as to a temporary visitor. Such changes in perspective may lead to overcoming previous prejudices and encourage others to dig deeper into why they are there, what the land means, who and why it became damaged and who and why gave it a new life, i.e. it can be used as a successful means of public education. Such methods enrich the landscape, bind people to it and attract people in.

In many instances, particularly where tourism or access to the land is a project goal, creative ideas can be used to instil an **emotional connection** additional to that experienced from simply being in a natural landscape. Such emotional ties can persist for a human lifetime engendering possible on-going, indefinite support for a project beyond the landscape in question, both geographically and temporally.

There is an important role for beauty – natural or man-made – and this is a tenet of the work of the Tompkins in Chile, witness the work of the Pumalin Park team in ensuring the Carretera Austral respects the natural beauty of the surroundings, or the El Amarillo village beautification project. People innately value beauty more than disrepair; the presence of man-made beauty shows that others care for and respect the local environment, which is more likely to instil a sense of responsibility and respect in others for the restored landscape.

Creative approaches can and should be used much more widely in the critical work of engaging local communities, as suggested in Section 9.3.4 by developing **participative, immersive methods** that build on local traditions of music, performance, craftwork, story-telling, etc., offering opportunities for local cultural reinforcement and a role in education and training.

RECOMMENDATIONS

- **Employ artists** to contribute to designs and planning.
- **Encourage all staff to develop a creative edge** to their thinking and work.
- **Use creative approaches to engage key audiences** – offer an **emotional experience**.
- **Build on and market the creative aspects of the local landscape and community** – strive to enhance local culture as a means of encouraging local community participation and generate visitors thus enhancing socio-economic opportunities.
- **Strive for beauty**.

9.4.6 CULTURE

All of the landscapes in this report are a manifestation of the interaction of people with the natural world – the story of the land is inevitably the story of its people and this narrative may have

continued unbroken for millennia. The events leading to the landscape's degradation are as much a part of this cultural narrative as what happened centuries before – indeed, it may be argued that they are more relevant as the people involved may still be in the locale; so, a concerted restoration effort could be regarded as only another chapter in this story. It is, therefore, important that a restoration project should respect even the degraded aspects of the landscape as they tell real stories of real people and offer a valuable lesson to others. This may become manifested during the project by leaving some areas unrestored and managing them to keep them this way, e.g. the fields of jaragua grass in Costa Rica's ACG – they tell a story that could otherwise be forgotten, given the stunning success of the restoration. These continuing landscape narratives are particularly well-respected in other projects like ARRI in the central Appalachian coalfields, USA; the Serra da Concordia Wildlife Sanctuary, Brazil and Argentine Patagonia's Estancia Menelik.

It is also possible for a restoration project to assist the recovery of dormant cultural practices by instilling new pride in old traditions and, by a combination of education and creativity, enhance local cultural practices with associated opportunities for wider socio-economic benefits.

RECOMMENDATIONS

- **View the restoration project as a new chapter** in the long, fascinating narrative of the land.
- Ensure, during project development, that the cultural history and traditions of the landscape and its communities are **properly researched and understood by the whole project team**.
- Develop restoration-related activities that **enhance local traditions and practices** and explore **potential socio-economic benefits**.

9.5 FINAL WORDS

Ultimately, the Cornish Claylands provided the inspiration for my original application for a Winston Churchill Memorial Trust Travelling Fellowship. Unbeknown to me at the time this presented a once-in-a-lifetime opportunity to become inspired by ordinary people doing extraordinary things in some of the world's most challenging places. Not all were millionaires – far from it; not all were ecologists or environmentalists; but all set out on a selfless journey of their own, not quite knowing how they would reach their destination or even where it was, but driven by a passion to make a difference, set an example and leave a legacy.

In a 21st century climate-changing world of over seven billion people, we need to be cleverer than thinking that landscape restoration is just about planting trees and walking away; the people of my journey are showing the way by seeing the potential of a landscape and its people and altering their own perceptions and lives accordingly to achieve this potential.

In most of the people I met I sensed a frustration that they wished they could do more, but that a human lifetime is inevitably limiting. We may not know all the answers, but we know enough now to make substantial improvements to degraded lands and their people so, quoting directly many colleagues mentioned in this document:

"Just do it!"

10 ENDNOTES AND REFERENCES

[1] Pollard, K., Jacobsen, L.A. and Population Reference Bureau. (2011). *The Appalachian Region in 2010: A Census Data Overview*. Chartbook. Prepared for the Appalachian Regional Commission Under Contract #CO-16506-09. September 2011
[2] Milici, R.C., and Dennen, K.O., 2009, Production and depletion of Appalachian and Illinois Basin coal resources, *in* Pierce, B.S., and Dennen, K.O., eds., The National Coal Resource Assessment Overview: U.S. Geological Survey Professional Paper 1625–F, Chapter H, 18 p.
[3] Sourced from www.ilovemountains.org. Retrieved 4 April 2012.
[4] Images produced by the US EPA and sourced from http://en.wikipedia.org/wiki/Mountaintop_removal_mining
[5] Sourced from www.ilovemountains.org. Retrieved 4 April 2012.
[6] www.osmre.gov/topic/SMCRA/SMCRA.shtm. Retrieved 19 February 2012.
[7] http://ilovemountains.org/resources#mtreconomy. Retrieved 22 February 2012.
[8] USEPA (2005). Final Programmatic Environmental Impact Statement on Mountaintop Mining/Valley Fills in Appalachia – 2005. www.epa.gov/region03/mtntop/eis2005.htm. Retrieved 19 February 2012.
[9] Most Requested Statistics - U.S. Coal Industry" (PDF). National Mining Association. www.nma.org/pdf/c_most_requested.pdf. Retrieved 19 February 2012.
[10] www.coaleducation.org/Ky_Coal_Facts/default.htm. Retrieved 19 February 2012.
[11] US Bureau of Labor figures quoted at http://ilovemountains.org/resources#mtrenvironment. Retrieved 2 March 2012.
[12] www.unep.org/billiontreecampaign
[13] For example: Pytak, SJ (2009). Replanting coal lands. Republicanherald.com. 2 May 2009. At: www.republicanherald.com/articles/2009/05/02/news/local_news/pr_republican.20090502.a.pg3.pr02trees_s1.2491270_loc.txt
[14] Estep, Bill. (2009). The Plan: Plant 125 Million Trees. Lexington Kentucky Herald – Leader. Sunday, 16 August, 2009; and Alford, R. (2009). Reforestation proposal considered. Bristol Herald Courier. Friday, 14 August 2009, Associated Press.
[15] http://arri.osmre.gov/SMI/SMI.shtm
[16] http://en.wikipedia.org/wiki/American_chestnut#cite_note-2. Retrieved 9 March 2012.
[17] http://www.prp.cses.vt.edu/. Retrieved 15 April 2012.
[18] www.mountainrosevineyard.com. Retrieved 5 March 2012.
[19] http://en.wikipedia.org/wiki/Everglades. Retrieved 17 March 2012
[20] Center for Urban and Environmental Solutions at Florida Atlantic University. (2009). The Economics of the Everglades Watershed and Estuaries. Prepared for the Everglades Foundation.
[21] Fedler, T. (2009). The Economic Impact of Recreational Fishing in the Everglades Region. Prepared for The Everglades Foundation.
[22] Center for Urban and Environmental Solutions at Florida Atlantic University. (2009). The Economics of the Everglades Watershed and Estuaries. Prepared for the Everglades Foundation.
[23] www.evergladesplan.org/education/flowmaps.html. Retrieved 17 March 2012
[24] www.evergladesplan.org/facts_info/faqs_cerp.aspx#1. Retrieved 17 March 2012
[25] Mather Economics. (2010). Measuring the Economic Benefits of America's Everglades Restoration. Prepared for the Everglades Foundation.
[26] Image from http3.bp.blogspot.com-rxJBrcRrqq8T5hoI5b3d1IAAAAAAAAABIRqjGwYE5tBIs1600Picture3.jpg
[27] See http://www.gdfcf.org
[28] Map sourced from the Stroud Water Research Center website (www.stroudcenter.org). Retrieved 27 March 2012.
[29] http://rainforests.mongabay.com/20costarica.htm. Retrieved 27 March 2012.
[30] Tourism in Costa Rica. http://en.wikipedia.org/wiki/Tourism_in_Costa_Rica
[31] Janzen, D. H. (2000). Costa Rica's Area de Conservacion Guanacaste: a long march to survival through non-damaging biodiversity and ecosystem development. In: *Norway/ UN Conference on the Ecosystem Approach for Sustainable Use of Biological Diversity*. Norwegian Directorate for Nature Research and Norwegian Institute for Nature Research, Trondheim, Norway. pp. 122-132.

[32] Janzen, D. H. (2000). Costa Rica's Area de Conservacion Guanacaste: a long march to survival through non-damaging biodiversity and ecosystem development. In: *Norway/ UN Conference on the Ecosystem Approach for Sustainable Use of Biological Diversity*. Norwegian Directorate for Nature Research and Norwegian Institute for Nature Research, Trondheim, Norway. pp. 122-132.
[33] Janzen, D.H. (1988). Guanacaste National Park: Tropical ecological and biocultural restoration. In: *Rehabilitating Damaged Ecosystems*. Edited by J. Cairnes Jr.
[34] Janzen, D. H. (2000). Costa Rica's Area de Conservacion Guanacaste: a long march to survival through non-damaging biodiversity and ecosystem development. In: *Norway/ UN Conference on the Ecosystem Approach for Sustainable Use of Biological Diversity*. Norwegian Directorate for Nature Research and Norwegian Institute for Nature Research, Trondheim, Norway. pp. 122-132.
[35] http://www.acguanacaste.ac.cr/1997/manejo_admin/estr_adming.html
[36] Watkins, G. and Cruz, P. (2007). Galapagos at risk: a socioeconomic analysis of the situation in the archipelago. Charles Darwin Foundation. http://wwww.Galapagos.org/pdf/GalapagosAtRisk2007.pdf
[37] http://en.wikipedia.org/wiki/File:Galapagos_Islands_topographic_map-en.svg
[38] Charles Darwin Foundation and World Wildlife Fund. (2002). *A Biodiversity Vision for the Galapagos Islands.* Ed. by R. Bensten-Smith. CDF, Puerto Ayora, Galapagos.
[39] Gardener, M.R and Grenier, C. (2011). Linking livelihoods and conservation: challenges facing the Galapagos Islands. Chapter 6 in: *Islands Futures: Conservation and Development Across the Asia-Pacific Region.* Springer 2011; Watkins, G. and Cruz, P. (2007). Galapagos at risk: a socioeconomic analysis of the situation in the archipelago. Charles Darwin Foundation. http://wwww.Galapagos.org/pdf/GalapagosAtRisk2007.pdf
[40] UNESCO (2010). List of World Heritage in Danger. http://whc.unesco.org/en/danger; http://whc.unesco.org/en/news/636
[41] Watkins, G. and Cruz, P. (2007). Galapagos at risk: a socioeconomic analysis of the situation in the archipelago. Charles Darwin Foundation. http://wwww.Galapagos.org/pdf/GalapagosAtRisk2007.pdf
[42] Wolf, M. and Gardener, M. (20??). Towards a self-sustained Galapagos?
[43] Gardener, M.R and Grenier, C. (2011). Linking livelihoods and conservation: challenges facing the Galapagos Islands. Chapter 6 in: *Islands Futures: Conservation and Development Across the Asia-Pacific Region.* Springer 2011;
[44] Gardener, M.R and Grenier, C. (2011). Linking livelihoods and conservation: challenges facing the Galapagos Islands. Chapter 6 in: *Islands Futures: Conservation and Development Across the Asia-Pacific Region.* Springer 2011
[45] Sourced from www.galapagos.org.
[46] Lavoie, C., Cruz, F., Carrion, G.V., Campbell, K., Donlan, C.J., Harcourt, S., Moya, M. (2007). *The Thematic Atlas of Project Isabela: An illustrative document describing, step-by-step, the biggest successful goat eradication project on the Galapagos Islands, 1998-2006.* Puerto Ayora, Galapagos: Charles Darwin Foundation. 60 pp.; Goats in Galapagos, http://galapedia.darwinfoundation.org/Goats_in_Galapagos, retrieved 1 April 2012; Project Isabela, http://www.galapagos.org/2008/index.php?id=48, retrieved 1 April 2012.
[47] http://galapedia.darwinfoundation.org/Vegetation. Retrieved 2 April 2012.
[48] http://galapedia.darwinfoundation.org/Scalesia. Retrieved 2 April 2012.
[49] Renteria, J.L., Gardener, M.R., Panetta, F.D. and Crawley, M.J. (2012). Management of the invasive hill raspberry (*Rubus niveus*) on Santiago Island, Galapagos: eradication or indefinite control? Invasive Plant Science Management, 5. In press.
[50] www.darwinfoundation.org/english/pages/intern.php?txtCodiInfo=22. Retrieved 7 April 2012.
[51] www.pactomataatlantica.org.br. Retrieved 8 April 2012.
[52] Atlantic Forest Restoration Pact. Concept document. March 2011.
[53] Image from the Critical Ecosystem Partnership Fund, at: http://www.cepf.net/SiteCollectionImages/Maps/482_atlantic_forest_map.jpg. Retrieved 8 April 2012.
[54] www.eoearth/article/Biological_diversity_in_the_Atlantic_Forest. Retrieved 8 April 2012.
[55] www.regua.co.uk. Retrieved 17 April 2012.
[56] www.pactomataatlantica.org.br. Retrieved 2 March 2012.
[57] Garcia, L.C., Barrios, F.V. and Lemos-Filho, J.P. (2009). Fructification phenology as an important tool in the recovery of iron mining areas in Minas Gerais, Brazil. Brazilian Journal of Biology, 69 (3).
[58] www.mbendi.com/indy/ming/baux/sa/br/p0005.htm. Retrieved 13 March 2012.

[59] See my blog for details of one particular wildlife rescue experience: http://petewa.blogspot.co.uk/2011/12/amazon-aluminium-part-2-snake-in-a-box.html.
[60] http://en.wikipedia.org/wiki/Fitzroya. Retrieved 21 April 2012.
[61] Copyright 2006, Christoph Hormann, http://earth.imagico.de
[62] www.patagoniasinrepresas.cl
[63] www.eoearth.org/article.Patagonia_steppe?topic=49597. Retrieved 25 March 2012.
[64] http://en.wikipedia.org/wiki/Douglas_Tompkins and http://en.wikipedia.org/wiki/Kris_Tompkins.
[65] Ben Box. (2010). *Footprint South American Handbook 2011*. 87th edition. Footprint. p.835.
[66] Foundation for Deep Ecology (2010). *Work in Progress. A Twenty-Year Retrospective, 1990-2010*. Ed. By Tom Butler.
[67] www.conservactionpatagonica.org and Foundation for Deep Ecology (2010). *Work in Progress. A Twenty-Year Retrospective, 1990-2010*. Ed. By Tom Butler.
[68] Image from www.conservacionpatagonica.org/buildingthepark_wr_puma.htm. Retrieved 2 April 2012.
[69] This section has been adapted from: Clewell, A., Rieger, J. and Munro, J. (2005). Society for Ecological Restoration International: Guidelines for Developing and Managing Ecological Restoration Projects. 2nd edition. At: www.ser.org/content/guidelines_ecological_restoration.asp.
[70] Hobbs, R.J., Hallett, L.M., Ehrlich, R., and Mooney, H.A. (2011). Intervention ecology: applying ecological science in the twenty-first century. Bioscience, 61, no. 6, pp. 442-450.
[71] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Towards an EU Strategy on Invasive Species. Impact Assessment – Executive Summary. Commission of the European Communities. Brussels 3/12/2008. http://ec.europa.eu/environment/nature/invasivealien/docs/1_EN_resume_impact_assesment_part1_v3.pdf. Retrieved 20 March 2012.
[72] See the work of Landlife, the UK-based urban conservation and restoration charity, http://www.wildflower.co.uk/