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Restoring Life on Earth: Private-sector Experiences in Land Reclamation and Ecosystem Recovery

With abstracts in English, French and Spanish

UNEP

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YOUNGONE

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iel
Institute for Enhanced Livelihoods

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For further information, please contact:
Secretariat of the Convention on Biological Diversity
413 St. Jacques Street, Suite 800
Montreal, Quebec, Canada H2Y 1N9
Phone: 1(514) 288 2220
Fax: 1(514) 288 6588
E-mail: secretariat@cbd.int
Website: http://www.cbd.int

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Melissa J. Mulongoy and John Fry
Editors

Foreword

Ecosystem restoration has long been recognized as an effective means of reversing the tide of land degradation that is threatening people's livelihoods and the environmental security of the planet and is a growing challenge not only in terms of biodiversity loss but also for climate change mitigation and adaptation. The question has been addressed as a matter of priority both nationally and within the framework of many international agreements and forums. Ecosystem restoration is listed under Article 8(f) of the Convention on Biological Diversity (CBD) as one of the measures to promote *in situ* conservation, and is also referred to in most national biodiversity strategies and action plans and in many key decisions of the Conference of the Parties, in particular in the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets 14 and 15. In addition, Sustainable Development Goals 14 ("Life below water") and 15 ("Life on land"), adopted by the General Assembly in 2015, address the need to protect and restore, by 2020, both water-related and terrestrial ecosystems.

There are already many restoration activities and initiatives under way or planned, but there is a general view that there is a need to scale them up and develop others to support the achievement of the relevant Aichi Biodiversity Targets and contribute to the realization of the 2030 Agenda for Sustainable Development. Against this background, the Parties to the Convention on Biological Diversity are considering adoption of a short-term action plan on ecosystem restoration at their thirteenth meeting of the Conference of the Parties to be held from 4 to 17 December 2016 in Cancun, Mexico. The plan calls for the participation of all stakeholders, including the business sector, which is often considered as a source of land degradation rather than as a potentially major player in efforts to mitigate its effects. In fact, the private sector has been carrying out many restoration activities and achieved much success and acquired a wealth of useful experience that is worth sharing with the Parties and the public at large.

The current collection of case-studies, gathered from many areas of the world and reflecting a number of vastly different ecosystems and biomes, is intended to demonstrate what can be achieved with the commitment of the private sector in the economic, social and environmental dimensions of sustainable development. The case-studies show what can be achieved on the part of the business sector if there is vision, awareness and a will to succeed. They should serve as a source of inspiration and encouragement for other ventures, particularly in the context of the action plan that the Parties to the Convention on Biological Diversity will consider and the commitments made under other multilateral environmental agreements. They are also examples of the progress being made by the private sector in mainstreaming biodiversity conservation and sustainable-use objectives in their plans and activities in order to achieve outcomes that are good for business, good for the environment and good for the broader community.

Participants in these case-studies and the contributors to this volume are hereby commended for playing their part in tackling the challenges posed by the depletion of the natural wealth around them and for the time and effort they have expended to share their experiences. They show that companies can be essential societal stakeholders in the creation of the commitment and trust needed for the implementation of ecosystem-restoration projects. It is hoped that many other members of the business sector will consider undertaking similar initiatives and share their valuable experiences in ecosystem restoration for use in communication, education and public awareness programmes for the benefit of all.

Braulio Ferreira de Souza Dias
Executive Secretary
Convention on Biological Diversity

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Ecological Rehabilitation of the Korean Export Processing Zone in Chittagong, Bangladesh

Korean Export Processing Zone Corporation (BD) Ltd., Chittagong, Bangladesh

ABSTRACT. Spread over 1,009 hectares on the left bank of Karnaphuli River in Chittagong, Bangladesh, the Korean Export Processing Zone (EPZ) was acquired in 1999 by Youngone Holdings Co. Ltd., a major Seoul-based company active in manufacturing and distribution of outdoor sportswear, shoes, backpacks and clothing apparel. At the time, the land, which had once been forest, was highly degraded. Rather than building the factories immediately after the acquisition, the company's Chief Executive Officer decided first to restore the land and revitalize its natural infrastructure. With a budget of US$ 200 million, some 17 water bodies have been established; saplings of 135 plant species have been planted every year; artificial grass has been laid down on slopes and eroded areas; and a network of roads, including a waterdrainage system to channel rainwater and control siltation, has been built around and across the facility.

The water bodies have improved the area by providing a reserve of 360 million gallons of monsoon rain that continuously recharges the aquifer and provides water for animals and plants while enhancing the aesthetic appearance of the whole landscape. The use of artificial grass, together with more traditional soil conservation measures, to cover erosion prone areas along the roads, hill slopes and the slopes between levels of buildable land, has proved to be an effective means of controlling erosion, stabilizing soils and improving soil fertility. By 2013, more than 1.7 million trees had been planted. They include many indigenous and a few exotic trees and shrubs, forest and agroforestry species, fruit and ornamental trees, and medicinal and culinary herbs. With the re-establishment of vegetation and water supply, wildlife returned. Now that it is successfully rehabilitated, the site offers a whole range of ecological services important for the well-being of the people in the region and makes for a working environment in harmony with nature. It also contributes to the achievement of Bangladesh's commitments under a number of international environmental agreements and the various United Nations resolutions on sustainable development.

Réhabilitation écologique de la zone franche d'exportation coréenne de Chittagong, Bangladesh

RÉSUMÉ. Etendue sur 1009 hectares sur la rive gauche du fleuve Karnaphuli, à Chittagong, au Bangladesh, la Zone franche d'exportation (ZFE) coréenne a été acquise en 1999 par Youngone Holdings Co. Ltd., une importante société basée à Séoul spécialisée dans la fabrication et la distribution de vêtements de sport, de chaussures, de sacs à dos et autres vêtements. Au moment de l'acquisition, la ZFE coréenne, qui etait autrefois une forêt, était un écosystème très dégradé. Plutôt que de construire les usines immédiatement après l'acquisition, le PDG de Youngone Holdings Co. Ltd.

a décidé de restaurer avant tout les terres et de revitaliser l'infrastructure naturelle. Avec un budget de 200 millions de dollars américains, dix-sept lacs ont été mis en place; des plantules de 135 espèces végétales ont été plantées chaque année, du gazon a été planté sur les pentes et les zones érodées, et un réseau de routes a été construit autour et à travers la ZFE avec un système de drainage de l'eau pour canaliser l'eau de pluie et contrôler l'envasement.

Les plans d'eau ont amélioré le système aquatique de la région en assurant une réserve de 360 millions de gallons de pluie récupérée des moussons qui recharge continuellement l'aquifère et assure ainsi un approvisionnement constant en eau souterraine et pour la flore et la faune, tout en améliorant la beauté esthétique de tout le paysage. Le fait de couvrir les zones érosives le long des routes, sur les pentes des collines et les pentes entre les niveaux de terrains bâtis avec du gazon et avec des moyens plus traditionnels de conservation des sols contribue efficacement à la lutte contre l'érosion, et la stabilisation et l'amélioration de la fertilité des sols. En 2013, plus de 1,7 million d'arbres avaient été plantés. Ils comprenaient des espèces indigènes et quelques espèces exotiques; des essences forestières et d'agroforesterie ; des arbres / arbustes fruitiers et ornementaux; des herbacées ainsi que des plantes médicinales et des plantes sources d'épices et condiments. Avec le rétablissement de la végétation et de l'eau, la faune a été restaurée. La réhabilitation réussie de l'environnement de la ZFE coréenne offre de nombreux services écologiques importants pour le bien-être des habitants de la région et qui permettent un environnement de travail en harmonie avec la nature. Elle contribue également à la réalisation de l'engagement du Bangladesh en faveur d'accords internationaux conformément aux résolutions des Nations Unies sur le développement durable.

Rehabilitación ecológica de la Zona Coreana de Procesamiento de Exportación en Chittagong, Bangladesh

RESUMEN.[1] En 1999, la Youngone Holdings Ltd. Co., una importante compañía basada en Seúl, activa en la fabricación y distribución de ropa de deportes al aire libre, zapatos, mochilas y prendas de ropa, adquirió un terreno de 1.009 hectáreas en la margen izquierda del río de Karnaphuli en Chittagong, Bangladesh, donde se estableció la Zona Coreana de procesamiento de exportación (EPZ). En ese entonces, esa tierra, que había sido bosque, estaba altamente degradada. En lugar de construir las fábricas inmediatamente después de la adquisición, el Director Ejecutivo de la compañía decidió primero restaurar el terreno y revitalizar su infraestructura natural. Con un presupuesto de US$ 200 millones, alrededor y a través de las instalaciones se establecieron 17 cuerpos de agua; cada año se implantaron plantines de 135 especies de plantas; se ha colocado césped artificial en laderas y zonas erosionadas; y se ha construido una red de carreteras, incluyendo un sistema de drenaje de agua para canalizar el agua de lluvia y controlar la sedimentación.

Los cuerpos de agua han mejorado la zona proporcionando una reserva de 360 millones de galones de lluvia de monzónes que recarga continuamente el acuífero y proporciona agua para los animales y las plantas a la vez que realza la estética de todo el paisaje. El uso de tepes de césped de gramíneas, junto con más tradicionales medidas de conservación de suelo, para cubrir áreas propensas a la erosión a lo largo de los caminos, cuestas y laderas entre los niveles de suelo edificable, ha demostrado ser un medio eficaz de control de erosión, estabilización de suelos y mejorar la fertilidad del mismo. Para 2013, más de 1,7 millones de árboles habían sido plantados, incluyendo muchas especies nativas y unos pocos árboles y arbustos exóticos, especies forestales y agroforestales, árboles frutales y ornamentales y hierbas medicinales y culinarias. Con el restablecimiento de la vegetación y el suministro de agua, la vida silvestre regresó. Ahora que está rehabilitado con éxito, el sitio ofrece una amplia gama de servicios ecosistémicos importantes para el bienestar de las personas en la región y crea un ambiente de trabajo en armonía con la naturaleza. También contribuye al logro de compromisos de Bangladesh bajo una serie de acuerdos ambientales internacionales y las distintas resoluciones de las Naciones Unidas sobre el desarrollo sostenible.

1 Translated by Professor María Elena Zaccagnini

I. INTRODUCTION

In pursuance of the Bangladesh Government's decision to set up an export processing zone (EPZ) in the private sector aimed at encouraging foreign investements, Youngone Corporation applied in May 1995 for establishing such an EPZ. The Corporation intended to use the opportunity to: (i) develop modern factories for expanding its eco-friendly manufacturing facilities; (ii) provide to interested investors a business- and environment-friendly space; (iii) create jobs and upgrade labor and management skills through the acquisition of advanced technology; and (iv) contribute to the social and economic development of Bangladesh by encouraging and promoting local and foreign investments, by increasing export of the country through the zone and by generating and diversifying the sources of foreign exchange earnings. These objectives were to be concretely translated through:

- The building of a self-contained township that has all the facilities and amenities needed for a decent well-being, in line with the principles contained in the Corporation's Environmental Policy. The township would have residences, healthcare centers, commercial offices, banks, shops, schools, recreational and sport facilities, open spaces and water bodies in addition to the factories and the road network;

- Making sure that the zone would always have enough green areas (fig. 1) not only for beauty, inspiration and spiritual purposes but also for other benefits that can be derived from nature such as soil stability, both physicochemical and biological, and the supply of wild fruits and traditional medicines; and

- The development and management of the area with the efficiency of the business sector and in full respect of national laws while putting human well-being and nature at the centre of the activities.

In response to Youngone Corporation's request, the Government of Bangladesh permitted the setting-up of an EPZ and, in 1996, the Government provided the legal framework by passing the Bangladesh Private EPZ Act, 1996. After the necessary approval, a site was identified on the left bank of the Karnaphuli river in Chittagong (fig. 2). A 1,009-hectare parcel of land was acquired and was handed over in August 1999 to the Korean EPZ Corporation (BD) Ltd. and the required operating licence was accorded in 2007.

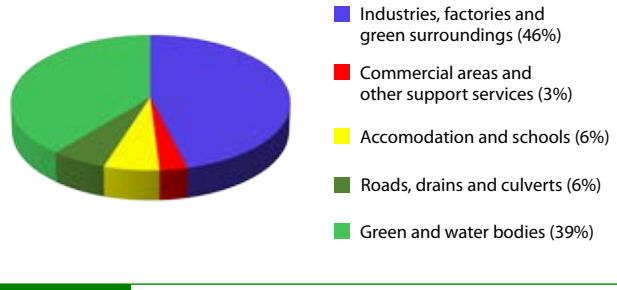

FIGURE 1 DEVELOPMENT PLAN OF THE KOREAN EXPORT PROCESSING ZONE, CHITTAGONG, BANGLADESH

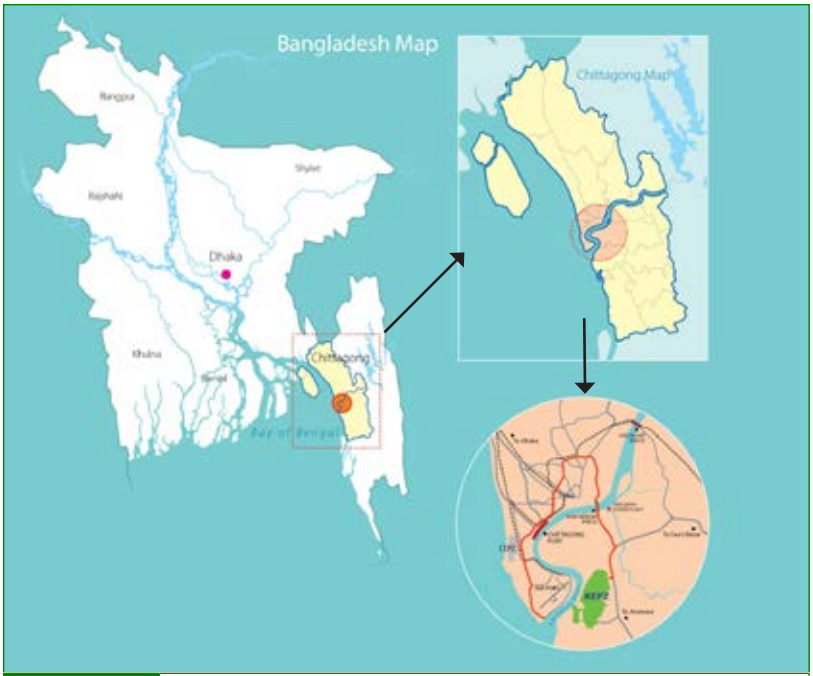

FIGURE 2 LOCATION OF THE KOREAN EXPORT PROCESSING ZONE (EPZ) IN CHITTAGONG, BANGLADESH

The Korean EPZ is located on the left bank of the Karnaphuli River in the sub-districts of Patiya, Anwara and Karnaphuli, District of Chittagong, in Bangladesh. The site is at about 21 km from Chittagong Port, and the Chittagong International Airport is opposite to the site, on the right bank of Karnaphuli River.

At the time of acquisition in 1999, the Korean EPZ was extensively degraded (fig. 3). The land, which had once been forest, had become a denuded, sandy and eroded area owing essentially to a combination of uncontrolled extraction of fuel-wood, the excavation of hills for sand used in construction and the unsustainable extraction of ground water by some companies for their operations. As noted in the 2001 national report of Bangladesh under the United Nations Convention to Combat Desertification [1]: "Deforestation leads to increased water erosion with an indirect impact on water resource development, depletion of soil fertility, disappearance of many plant and animal species, local aridification, etc. In addition, flooding, accelerated runoff, droughts, more sedimentation in rivers and reservoirs and depleted groundwater become more severe because of deforestation, with adverse consequences for agricultural production and human life." Where groundwater was being extracted for industrial uses, the decreasing water level was causing land, creating large gullies and making the area, including the paddy fields around, extremely dry with little or no productive capacity. The land was bare, dry and prone to fire, rain and wind erosion, with siltation at the outfalls and flooding during monsoon in adjoining areas. The extensive ecological degradation of the area was the major challenge that needed to be addressed to achieve the development plans for the Korean EPZ.

II. RESTORATION ACTIVITIES

Rather than filling gullies, strengthening the sandy and erosion-prone land with concrete, and building factories immediately after the acquisition of the Korean EPZ, Mr. Kihak Sung, Chairman and CEO of Youngone Holdings Co. Ltd., opted for a more eco-friendly approach starting with the rebuilding, revitalization and strengthening of the natural infrastructure on which to build. This approach was visionary of the trend in business environmental policies that came with the turning of the century, and in increased commitments of countries through the many multilateral environmental agreements they had signed. The urgency for action was felt in particular after it became clearer that climate change, biodiversity loss and land degradation were having deleterious impacts on life on Earth.

Revitalization of nature at the Korean EPZ could not succeed without: (i) the vision and determination of Youngone Holding's Chairman and CEO

FIGURE 3 STATE OF THE LAND AT THE TIME OF THE ACQUISITION OF THE KOREAN EXPORT PROCESSING ZONE IN 1999

and the resources he invested; (ii) the Korean EPZ Environmental Policy, and (iii) a thorough environmental impact assessment study and the scrupulous implementation of its recommendations.

A. Investment

With a budget of US$ 200 million to cover the cost of land, infrastructure and other development, since 1999, the Korean EPZ Corporation planted and maintained trees and turf grass, created water bodies, dressed and levelled land for the establishment of factories and other buildings. The Corporation is also using the budget for the operations of the EPZ, the creation and maintenance of roads and establishment of various buildings. Economists consider that investing in "ecological infrastructure" makes economic sense in terms of cost-effectiveness and rates of return, once the whole range of benefits provided by maintained, restored or increased ecological services are taken into account [2].

B. The Korean Export Processing Zone Environmental Policy

The Korean EPZ Corporation (BD) Ltd. adopted its environmental policy in 2002 to guide the activities and business of the Corporation so as to give proper regard to the conservation and improvement of the environment. The essence of the policy is captured in the policies about:

- Reviewing, reducing, re-using and recycling:
  - *Reviewing* by monitoring implementation of these policies and adjusting or adapting management practices;
  - *Reducing* the use of resources and energy, and the amount of waste and pollution so as to reduce the footprint of the Corporation's factories and activities on the environment;
  - *Re-using* the same resources again and again for the same or different functions so as to save money, time, energy and the resource itself that may be limited in supply; and
  - *Recycling* both renewable and nonrenewable resources into new products to prevent or reduce the waste of potentially useful materials; and
- Ensuring a positive environmental impact.

Green management is considered as a new paradigm whereby managers ensure that contribution of their products to environmental problems such as global warming, resource depletion, pollution, toxic wastes and industrial accidents are significantly reduced throughout the life cycles of their products. The Korean EPZ Environmental Policy contains these principles and goes one step further by calling for a more positive impact on the environment. The Korean EPZ Environmental Policy is well in line with the Convention on Biological Diversity as well as biodiversity-related conventions and their strategic plans, the United Nations Convention to Combat Desertification with its calls for a land degradation neutral world and the United Nations Framework Convention on Climate Change.

C. The Korean EPZ Environmental Impact Assessment Report

As stated in the fourth national report of Bangladesh under the Convention on Biological Diversity [3] and the country's national biodiversity strategy and action plan [4], environmental impact assessments are powerful tools for identifying and addressing environmental, economic and social impacts of projects, programmes and policies. Among other things, they allow to avoid and mitigate adverse environmental impacts that may be caused by the projects, programmes or policies, and ensure that alternative measures are identified and considered. In accordance with the Environmental Conservation Rules of Bangladesh, the Korean EPZ Corporation (BD) Ltd., with assistance from the Center for Environmental and Geographic Information Services (CEGIS), submitted in January 2003 an environmental impact assessment (EIA) report based on impact during the development stage between 1999 and 2003, and based on predictions of the Korean EPZ impact at full development. In October 2009 the Korean EPZ Corporation Ltd. submitted an updated version taking into account comments and observations made by the Department of Environment (DoE) between 2003 and 2009. The approved Environmental Impact Assessment Report is the guiding tool for the development of the Korean EPZ. It provides details on activities that were planned and alternatives (contingency plan) in case of unexpected negative impacts authorized by the Environmental Clearance Committee of DoE.

D. Principles Underlying the Rehabilitation of the Korean EPZ

The Korean EPZ ecosystem was rehabilitated, in line with the country's policies and priorities (e.g., the National Target 15 stating that "by 2021, initiate implementation of restoration plan for degraded ecosystems, especially, forest lands and wetlands for addressing climate change mitigation, adaptation and combating desertification") for combating land degradation as stated, for example, in the Fifth National Report to the Convention on Biological Diversity [5] and the country's National Biodiversity Strategy and Action Plan [4]. The means used were:

- Creation of water bodies to improve the aquatic system;
- Planting of sapling of different species to re-establish the lost vegetation, strengthen soil structure and restore habitats for wildlife. A passive natural recovery was not a choice because it was going to take a very long time with uncertain successes. Active interventions were necessary to 'jump-start' and accelerate the restoration process by bringing in seeds and planting trees. It was decided to use not just a few species but more than hundred tree species found in the forests in the area;
- Turfing of bare areas with grass to check erosion; and
- A road network developed with a water drainage system to channel rainwater and control siltation.

E. Water Bodies

Seventeen water bodies covering 135 acres (54.6 ha) were created (fig. 4) and have been populated with native fish. These lakes constitute a reserve of 360 million gallons of monsoon rain. They recharge continuously the aquifer and thus ensure a constant supply of groundwater for the tube wells in neighboring villages and rice paddies. Together with the seasonal floodplains, they also improve the environmental conditions of the whole area, in particular by providing water for plants (natural regrowth and newly established plants/vegetation) and animals. They are important roosting ground for waterfowls and other migratory birds. These water bodies contribute to the control of floods in neighboring settlements and the reduction of sediment flows, and are part of the aesthetic beauty of the new landscape at the Korean EPZ.

FIGURE 4 WATER BODIES IN 1999 AND IN 2012

Prior to the establishment of the water bodies, the streams present in the zone were not permanent and were dry during most part of the year

Fish were introduced in 2003, 2004 and 2011. They include among others: Rui (*Labeo rohita)*; Katla (*Catla catla),* Mrigel (*Cirrhina mrigala)*, Big head (*Hypophthalmichthys nobilis)*, Sharpunti (*Puntius* spp.), Grass carp (*Ctenopharyngodon idella),* Silver carp (*Hypophthalmichthyes molitrix)* and Tilapia (*Oreochromis niloticus)*. Populations of these fish have increased considerably and are being harvested regularly for the Korean EPZ workers (fig. 5).

FIGURE 5 FISH HARVESTED FROM ONE OF THE LAKES CREATED AT THE KOREAN EPZ.

Between 2008 and 2013, the Korean EPZ authority harvested 20,890 kg of fish from the lakes inside the zone.

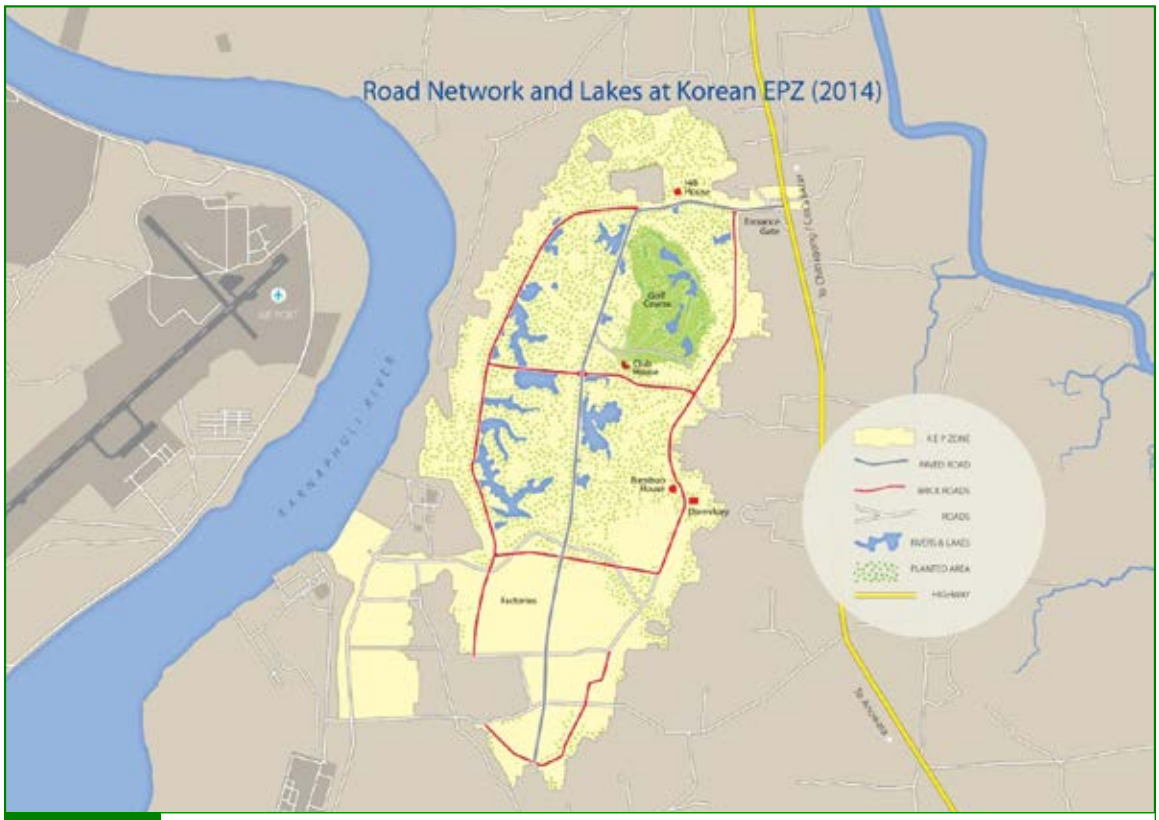

FIGURE 6 WATER BODIES AND THE ROAD NETWORK AT THE KOREAN EPZ

(Road network and waterbodies, map adapted by Prof Mohammad Eunus, 2015)

F. Establishment of a Road Network and Water Drainage System

A 26-kilometre road network has been built around and across the Korean EPZ (fig. 6). The principal roads are paved and the secondary roads are made of bricks to facilitate water infiltration (fig. 7). A drainage system was constructed to effectively channel the flow of surface water, stop siltation at the outfall and stop flooding in adjoining areas through the construction of spillways.

FIGURE 7 PAVED ROAD AND BRICK ROAD

G. Grass Turfing

In order to revitalize eroded areas, control erosion and prevent landslides and gully formation, turf grass was planted on hill slopes, on the slopes created between levels of buildable lands, and along the roads (fig. 8). Other traditional soil conservation measures such as pegging with bamboo sticks, mulching with tengra and paddy straws, and spreading seeds of bogamedula (*Tephrosia candida*), dhaincha (*Sesbania bispinosa*) and tokma (*Hyptis suaveolens*) were also used to contribute to erosion control as well as soil stabilization and organic matter improvement. These measures taken in combination with the construction of drainage channels reduced the flowing of silt down on to the water basins and cultivated areas in the downstream region.

H. Tree Planting

Every year since the acquisition of the Korean EPZ, saplings of different species are planted to restore the lost vegetation with a survival rate superior to 80 per cent in general. This planting covers a 1,500-acre area. Planting was done in various patterns: as a small-size pure stands (i.e. monoculture) of a species planted in line or in mixed stands of species planted in line or apparently at random, somehow mimicking nature. In 2013, more than 1.7 million trees representing 135 species of indigenous and a few exotic trees could be counted at the Korean EPZ. They include forest, agroforestry, fruit, ornamental tree/shrub, herbal and medicinal as well as spice and condiment species. The exotic species: teak (*Tectona grandis*), mahogany (*Swietenia mahogany*), acacia (*Acacia auriculiformis*), rain tree (*Samanea saman*) and gamary (*Gmelina arborea*) are among the most planted species. They were planted for their timber value, fast growing nature, nitrogen-fixing ability or drought tolerance and for their ability to establish in the very degraded sandy and infertile soils to provide shade and conditions favorable to indigenous undergrowth vegetation. The fruit trees include high yielding varieties of mango, guava, lime, and litchi trees grown in areas of 1 to 15 acres. Jackfruit, cashew nut trees and a few spice and condiment species are scattered within the Korean EPZ. Coconut trees are among ornamental plants along the roads. Medicinal plants, still widely prescribed by traditional medical practitioners and used in household remedies in Bangladesh, include Jamun (*Syzygium cumini*) and Aonla (*Phyllanthus emblica*), traditionally important for healing various ailments and with fruits rich in vitamins. Today, many medicinal plants are growing spontaneously under the established trees. They include for example assar (*Grewia nervosa*), menda (*Litsea glutinosa*), tokma (*Hyptis suaveolens*), leea (*Leea aequata*), kurchi (*Holarrhena antidysenterica*). The Government of Bangladesh noted in its fifth national report on biodiversity [5] that the use of multiple species in plantation programme will help restoration of biodiversity and its enhancement in the country.

FIGURE 8 GRASS TURF

III. CHARACTERISTICS OF THE SUCCESSFUL REHABILITATION OF THE KOREAN EPZ

A. Vegetation

Today, the whole planted landscape of the Korean EPZ is a luxuriant vegetation (fig. 9 and fig. 10). All the planted species have established and ornamentals embellish the surroundings of the factories and all the buildings. The shade and litter under the trees have promoted the growth of diverse vegetation of various ecological and economic values including for example edible plants or plants bearing edible fruits such as patakorolla (*Aporusa dioica*), etter banbaroi (*Ziziphus oenoplia*), jhum (*Dioscorea pentaphylla*), and kukurshunga (*Blumea lacera*).

B. Wildlife

With the re-establishment of vegetation and water, wildlife found a home where they can live and reproduce. The species richness of terrestrial and aquatic fauna has increased significantly in the past 10 years. Local inhabitants report that bird populations have increased considerably since the Korean EPZ Corporation (BD) Ltd. started planting trees and after the creation of water reservoirs. One hundred and thirty seven (137) species of local aquatic and land dependent birds (fig. 11) including migratory birds have been observed in the area. Their diversity and abundance indicate the recovered health of the whole zone. Although big mammals have already disappeared with the disappearance of the forests prior to 1999, today, various small mammals such as fishing cats (*Falis viverrina*), jungle cats (*Falis chaus*), Bengal foxes (*Vulp bengalensis*), common mongoose (*Herpestes edwardsi*) and bats as well as common lizards and monitors (*Varanus flavescens* and *Varanus bengalensis*) can be seen in the area. There is also evidence of the presence of the common otter (*Lutra lutra*), a keystone species in Chittagong.

C. Establishment of factories, buildings and recreational facilities in harmony with nature

All the buildings already established at the Korean EPZ are surrounded by luxuriant vegetation (fig. 12). Accommodation for workers and investors, and all other urban facilities such as hospitals, schools, banks,

FIGURE 9 A PIECE OF LAND THAT WAS NOT RESTORED IN THE SOUTHERN PART OF THE KOREAN EPZ CONTINUES TO DEGRADE UNDER THE COMBINED EFFECT OF WIND AND WATER EROSION.

This piece of land can be considered as a reference and a reminder of what the area would have been today if restoration activities had not taken place.

FIGURE 10 PLANTED SPECIES HAVE ESTABLISHED INTO A LUXURIANT VEGETATION

FIGURE 11 A SAMPLE OF THE 137 SPECIES OF BIRDS OBSERVABLE AT THE KOREAN EPZ, INDICATING THE SUCCESSFUL REHABILITATION OF THE AREA.

FIGURE 12 BUILDINGS ARE ESTABLISHED AMIDST A LUXURIANT VEGETATION

and recreational and other facilities required for the daily operation of an export processing zone that are in the plans will be established in harmony with nature. An 18-hole golf course maintained in an eco-friendly way is also available.

D. Various ecosystem services have been recovered

Today, the Korean EPZ environment offers a whole range of ecological services important for the well-being of the people in the region. Scientists have grouped these services derived from ecosystem and referred to as ecosystem services or nature's benefits to people, under provisioning, regulating and cultural services. Table 1 below presents some examples of ecosystem services that were recovered at the Korean EPZ.

Ecosystem services provided by the Korean EPZ are beneficial to companies, local communities, the country and the whole world. Although the economic value of these ecosystem services has not yet been assessed, their importance is well recognized not only for the people living at the Korean EPZ and in the neighborhood, but also as solid infrastructure for the factories and an environment-friendly site for the workers. The rehabilitated landscape with all the recovered ecosystem services provide the Korean EPZ Corporation an opportunity to participate in emerging markets e.g. for carbon sequestration and watershed protection, and for payment for ecosystem services.

In 2005, scientists informed the world community that ecosystems had declined extensively over the preceding 50 years and they projected "further declines over coming decades, particularly in light of population growth, economic expansion, and global climate change" [6]. Many scientists also believe that "global warming may dominate headlines today, but that ecosystem degradation will do so tomorrow." [7] In this context, the Korean EPZ rehabilitation work should be commended and be seen among business examples of proactive strategies for a positive footprint on ecosystems.

E. The Korean EPZ is now an Ecologically Resilient Landscape

In addition to the luxuriant vegetation, the beautiful lakes supplying water to the neighbouring populations and the wildlife that returned to the area,

TABLE 1: EXAMPLES OF ECOSYSTEM SERVICES RECOVERED AFTER THE REHABILITATION OF THE KOREAN EPZ

TYPES AND EXAMPLES OF ECOSYSTEM SERVICES
PROVISIONING SERVICES The Korean EPZ offers a number of goods important for the well-being of the people living in the zone and in the neighbourhood, such as:
Food Fish in lakes, fruits (e.g. mango, guava, lime, litchi, papaya and coconut) in orchards and along the roads; wild food such as patakorolla, banbaroi and many others growing under the planted trees.
Biological raw materials Timber and fuel wood (e.g. mahogany, teak, gamary, rain tree), ornamental resources (e.g. coconut and pine trees) along the roads and in lawns, although the trees were not planted primarily for harvesting timber.
Freshwater Groundwater (maintained through the water bodies created) for drinking and household as well as agricultural uses.
Biochemicals, natural medicines, and pharmaceuticals Medicinal plants (e.g. jamun, aonla, tokma, kukurshunga and many other undergrowths), food condiments.
REGULATING SERVICES The Korean EPZ, particularly through its recovered vegetation, contributes to the control of some natural processes and promotes natural processes that maintain the other ecosystem services, such as:
Air purification Plant photosynthesis is an important source of the oxygen we breathe. Also, tree and shrub leaves can trap air pollutants near roadways.
Regulation of climate Vegetation, in particular trees, captures and stores carbon dioxide, one of the most important greenhouse gases responsible for global warming. Also vegetation influences local and regional temperature, precipitation and other climatic factors.
Regulation of water flows Planted trees, grass turf and paved roads reduce the magnitude of water runoff. Some trees, in particular exotic ones, may have a higher water demand and thus impact aquifer recharge negatively. “River floodplains and wetlands retain water—which can decrease flooding— reducing the need for engineered flood control infrastructure”
Erosion control Planted vegetation (such as grass and trees) and undergrowth prevent soil loss and siltation of waterways that can be caused by rain
Improvement of soil quality Planted trees and undergrowth recycle nutrients from deep soils and promote microbial life and organic matter cycling through litter fall. Microbial and mesofaunal activity improves soil chemistry, soil structure and moisture retention.
Provision of habitat and water as well as cycling of nutrients for soil fertility and productivity The Korean EPZ is now a habitat for diverse species of fauna, in particular migratory species and other birds. Planted trees provide shade for vegetation regrowth. The whole ecosystem/landscape maintains water and promotes soil nutrient cycling while reducing and preventing soil erosion
CULTURAL SERVICES The Korean EPZ provides opportunities for recreation, education and spiritual inspiration (non-material benefits), such as:
Recreation The Korean EPZ has a 18-hole golf course maintained biologically. There are also possibilities of organizing forest trails, bird watching and recreational fishing in the zone
Spiritual values Development of the Korean EPZ ensured that some areas of spiritual and religious value such as graveyards and Muslim Eid-gah are protected. The whole Korean EPZ has gained a lot of aesthetic value, with the lush vegetation on hills and in the valleys, the many lakes, and buildings constructed in harmony with nature.
Educational and inspirational values The Korean EPZ provides opportunities for school field trips to nature and a unique environment to learn about ecosystem rehabilitation, as well as wetland restoration and development, and for conference organization.

FIGURE 13 A TUBE WELL SUPPLYING WATER THROUGHOUT THE YEAR IN A NEIGHBORING VILLAGE, THANKS TO THE WATER BODIES CREATED IN THE KOREAN EPZ.

planted plots showed in general an increase in surface soil fertility (organic matter, available phosphorous (P) and water holding capacity) (fig. 13). Planted plots also had abundant regrowth of more than 80 local species including medicinal, food and soil quality improving plants that were benefitting from improved edaphic and micro-climatic conditions. The diversity of habitats created by natural plants and more than 135 planted species forms a rich and harmonious landscape that presents the characteristics of a resilient ecosystem. Resilience is required for sustaining the success of ecological rehabilitation in face of possible anthropogenic pressures including climate change and high demand of natural resources.

F. Life is Back at the Korean EPZ and in the Neighbourhood

The Korean EPZ is bringing a lot of positive developmental and socio-economic changes in the area, in support of national development plans and policies (fig. 14). The EPZ continues to recruit hundreds of new staff every month for the shoe and apparel factories. When the EPZ will be fully developed, it is expected that over 100,000 direct jobs will be created in the zone and an additional 200,000 indirect jobs outside the zone.

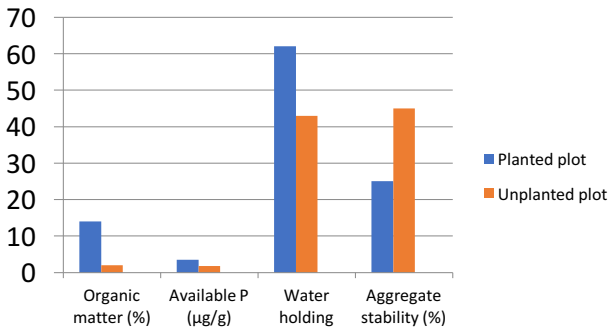

FIGURE 14 ORGANIC MATTER, PHOSPHOROUS (P), WATER-HOLDING CAPACITY AND AGGREGATE STABILITY OF SOILS COLLECTED IN PLANTED AND UNPLANTED PLOTS

G. The Korean EPZ Contributes to the Achievement of Bangladesh's Commitments Under International Agreements

Bangladesh is a party to a number of multilateral environmental agreements such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (ratified in 1982), the Convention on Wetlands of International Importance, also known as the Ramsar Convention (ratified in 1992), the Convention on Biological Diversity (ratified in 1994), the United Nations Framework Convention on Climate Change (ratified in 1994), and the United Nations Convention to Combat Desertification (signed in 1994 and effective in 1996). In addition, without being a party to the Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bangladesh is achieving some of its objectives. In line with the outcomes of the United Nations Conference on Environment and Development and related United Nations resolutions, Bangladesh is committed to sustainable development and to ensuring the promotion of an economically, socially and environmentally sustainable future for the planet and for present and future generations.

The work undertaken at the Korean EPZ contributes in many ways to the achievement of Bangladesh's commitments under these multilateral agreements and global development goals, in line with the country's Sustainable Environment Management Programme. For example, rehabilitation of the landscape and promotion of the conservation of threatened species at the Korean EPZ is a contribution to the implementation of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets, and more specifically Bangladesh's national biodiversity target to develop and implement, by 2021, a restoration plan for degraded wetlands and rivers taking into account the needs of vulnerable people and communities [4]. In addition, the successful restoration and conservation work carried out at the Korean EPZ is enhancing the resilience of the whole zone to anthropic pressures, and contributing to climate change mitigation and adaptation as well as to combating desertification in line with the national biodiversity target 15 to "initiate, by 2021, implementation of restoration plan for degraded ecosystems, especially, forest lands and wetlands for addressing climate change mitigation, adaptation and combating desertification" [4]. Restoration of the Korean EPZ is also making useful contribution to the achievement of the country's Millennium Development Goals (MDGs) in line with the 2030 Agenda for Sustainable Development adopted by the world community in 2015.

During the current United Nations Decade for Deserts and the Fight against Desertification (2010-2020), the world community recognized that land degradation is a problem worldwide and that land restoration is the solution. Rehabilitation of the Korean EPZ is thus a good example of actions that the private sector can take to support Governments in avoiding the devastating consequences of inaction.

IV. LOOKING FORWARD TO A BETTER TOMORROW

The rehabilitation of the site of the Korean EPZ built a solid natural infrastructure on which factories are being established. Mr. Kihak Sung, Chairman and CEO of Youngone Holdings Co. Ltd., noted that "the success [...] in rehabilitating the degraded land is worth replicating and upscaling, bearing in mind that the ability of the world's expanding population to thrive, let alone survive, over the coming decades will in part depend on maintaining, enhancing and investing in restoring ecological infrastructure and expanding rather than squandering the planet's natural capital. These activities are encouraged by multilateral environmental agreements and organizations caring about biodiversity and its ecosystem services".

ACKNOWLEDGEMENTS

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REFERENCES

[1] Bangladesh, Ministry of Environment and Forests, *National Report on Implementation of the United Nations Convention to Combat Desertification* (Dhaka, Ministry of Environment and Forests, Government of the Peoples Republic of Bangladesh, Bangladesh Secretariat, 2001)

[2] TEEB – The Economics of Ecosystems and Biodiversity for National and International Policy Makers (2009)

[3] Department of Environment, *Fourth National Report to the Convention on Biological Diversity* (Dhaka, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, 2010)

[4] Bangladesh, Department of Environment, *National Biodiversity Strategy and Action Plan of Bangladesh 2016–2021* (Dhaka, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, 2016)

[5] Department of Environment, *Fifth National Report to the Convention on Biological Diversity* (Dhaka, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, 2015)

[6] Rachid Hassan, Robert Scholes and Neville Ash, eds., *Ecosystems and Human Well-Being: Current State and Trends*, Volume 1, *Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment* (Washington, DC, Island Press, 2005).

[7] Craig Hanson, Janet Ranganathan, Charles Iceland and John Finisdore, *The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks in and Opportunities Arising from Ecosystem Change*, version 2.0 (World Resources Institute, 2012). Accessed on 3 November 2016 at http://www.wri.org/publication/corporate-ecosystem-services-review

Restoration of Banrock Station Ramsar wetlands, South Australia: over 20 years of successful involvement by a private agribusiness

Christophe Tourenq, Tim Field and Alison Searle, ***Banrock Station-Accolade Wines Australia Ltd.***

ABSTRACT. Banrock Station, in South Australia, was acquired by Hardys Wines (now Accolade Wines Australia Ltd.) in 1993. The 1,800 ha property lies on the shore of the Murray River, which with the Darling River creates one of the largest catchment basins in the world. Banrock Station's new owner developed 250 ha of wines on land previously cleared for fodder, pasture and crops. At the same time, an active restoration of wetlands and woodlands started through: (i) immediate removal of stockgrazing pressure; (ii) a feral- and weed-species control programme, including the construction of a 14 km feral-proof fence; (iii) reestablishment of a natural hydrological regime with a succession of dry and wet phases; (iv) the reintroduction of native threatened species; and (v) an annual revegetation programme. In 2000, the Banrock Station Wine and Wetland Centre opened for the public to enjoy wines and alfresco dining while looking out over the river floodplain. An 8 km self-guided walking trail network with boardwalks and bird-hides leads visitors to the heart of the wetland. For its unique biodiversity, its efforts in public awareness and natural-habitat conservation, the site was declared in 2002 as one of Australia's 65 "wetlands of international importance" under the Ramsar Convention. Because of its visible record in ontheground conservation (i.e., first birddiversity hotspot in South Australia and one of the top 100 in Australia), continuous partnership with state and federal authorities, its establishment as a prime tourist destination (with an average of 60,000 visitors a year), and its involvement in the engagement of local communities (up to two university/school class visits per month), the site has traversed successfully several changes in the company's ownership and management structures and Australia's worst recorded drought. After over 20 years of habitat-restoration efforts, Banrock Station is recognized worldwide as a successful model and demonstration site for the involvement of a private business in wetland conservation and sustainable use.

Restauration des zones humides de Ramsar de la Station Banrock, Australie Méridionale: plus de 20 années d'engagement réussi d'une agro-industrie privée

RÉSUMÉ: La station de Banrock, en Australie-Méridionale a été acquise par Hardys Wines (maintenant Accolade Wines Australia Ltd.) en 1993. La propriété de 1 800 ha repose le long de la rivière Murray, avec laquelle la rivière Darling crée un des plus grands bassins versants de monde. Le nouveau propriétaire de la station Banrock a développé 250 ha de vins sur des terres préalablement défrichées pour le fourrage, les pâturages et l'agriculture. Parallèlement, une restauration active des zones humides et boisées a été initiée par (i) l'élimination immédiate de la pression de la pression des pâturages; ; (ii) la mise en œuvre d'un programme d'éradication d'espèces introduites avec notamment la construction d'une clôture de 14 km de long; (iii) le rétablissement d'un régime hydrologique naturel des marées avec une succession de phases sèche et humide; (iv) la réintroduction d'espèces indigènes menacées; et (v) un programme annuel de revégétalisation. En 2000, le Centre des vins et des zones humides de la station de Banrock a ouvert ses

portes au public pour la dégustation des vins et apprécier les repas en plein air tout en profitant de la vue sur les marais. Un réseau de 8 km de chemins de randonnée avec pontons et observatoires conduit les visiteurs au cœur de la zone humide. Pour sa biodiversité unique, et ses efforts de sensibilisation du public et de conservation de l'habitat naturel, le site a été déclaré en 2002 comme l'une des 65 «zones humides d'importance internationale» d'Australie en vertu de la Convention de Ramsar. En raison de sa réputation en terme de conservation sur le terrain (notamment premier hotspot de la diversité des oiseaux en Australie méridionale et l'un des 100 hotspots les plus importants d'Australie), du partenariat continu avec les autorités fédérales et étatiques, de sa position comme destination touristique majeure dans le pays (avec en moyenne 60 000 visiteurs par an) et sa participation à l'engagement des communautés locales (jusqu'à deux visites de classes universitaires / scolaires par mois), le site a traversé avec succès plusieurs changements dans les structures de propriété et de gestion de l'entreprise et la pire sécheresse enregistrée en Australie. Après plus de 20 ans d'efforts de restauration de l'habitat, la station Banrock est reconnue mondialement comme un modèle et un site de démonstration réussis de l'implication d'une entreprise privée à la conservation et à l'utilisation durable des zones humides.

Restauración del Humedal Ramsar en la Estación Banrock, Australia del Sur: más de 20 años de exitosa participación de una agroindustria privada

RESUMEN.[1] La estación de Banrock, en Australia del sur, fue adquirida por los vinos Hardys (ahora Vinos Accolade Australia Ltd.) en 1993. La propiedad de 1800 hectáreas se encuentra en la orilla del río Murray, la que con el río Darling crea una de las cuencas de captación más grande del mundo. El nuevo propietario de la estación Banrock, desarrolló 250 ha de viñedos en tierras previamente transformadas para producción de forraje, pastos y cultivos. Al mismo tiempo, comenzó una restauración de los humedales y los bosques a través de: (i) la eliminación inmediata de la presión de pastoreo del ganado; (ii) un programa de control de especies salvajes y malezas, incluida la construcción de una cerca de 14 km a prueba de introducción de especies salvajes; (iii) el restablecimiento de un régimen hidrológico natural con una sucesión de fases secas y húmedas; (iv) la reintroducción de especies nativas amenazadas; y (v) un programa de revegetación anual. En el año 2000, se abrió al público la Estación de viñedos Banrock y el Centro de Humedales, para degustación de los vinos y un restaurante al aire libre, con la vista puesta hacia la llanura de inundación del río. Asimismo, se construyó una red de senderos auto-guiados para caminatas de 8 km, con paseos marítimos y estaciones de observación de aves, que conducen a los visitantes al corazón del humedal. Por su biodiversidad única, sus esfuerzos en la concienciación y conservación del hábitat natural, el sitio fue declarado en 2002 como uno de los 65 "humedales de Australia de importancia internacional" bajo la Convención de Ramsar. Debido a su historial visible en conservación en el terreno (por ejemplo, primer sitio de diversidad de aves en Australia del Sur, y uno de los primeros 100 en Australia), y su continua colaboración con autoridades estatales y federales, su establecimiento como un destino turístico de primer orden (con un promedio de 60.000 visitantes al año) y su involucramiento en el compromiso de la participación de las comunidades locales (con visitas de hasta dos clases de universidades/escuelas por mes), el sitio ha atravesado con éxito varios cambios en las estructuras de propiedad y la gestión de la empresa y la peor sequía registrada en Australia. Después de más de 20 años de esfuerzos de restauración de hábitat, la Estación de Banrock es reconocida mundialmente como un modelo exitoso y es un sitio demostrativo para la participación de una empresa privada en la conservación de los humedales y el uso sostenible.

Christophe Tourenq is Wetland and Conservation Manager, Banrock Station-Accolade Wines Ltd (email: christophe.tourenq@banrockstation.com.au).

Tim Field is Ranger Ecologist, Banrock Station-Accolade Wines Ltd (email:tim.field@banrockstation..com.au).

Alison Searle is National Environmental Manager, Accolade Wines Ltd(e-mail: alison.searle@accolade-wines.com).

1 Translated by Professor María Elena Zaccagnini

I. BANROCK STATION: CONTEXT AND HISTORY

Banrock Station is located in the Riverland, South Australia, in the far south west of the Murray Darling Basin, 430 river kilometers from the Murray Mouth (fig. 1). The Basin is formed by the Murray and the Darling rivers and their tributaries and covers one seventh of the Australian continent, approximately 1.061 million km^2 through 5 of the 8 states and territories of the mainland (the Australian Capital Territory, Queensland, New South Wales, Victoria and South Australia).

Since its discovery and European settlement, early 1800s, the environment of the Murray Darling Basin has been modified significantly. Drovers have been following the rivers and their shores as stock (sheep and cattle) routes from and to the newly established towns across the vast plains. Up to the 1930s, the use of paddle steamers as way of communication and transport of vital goods along the Murray forever modified the landscape of the Murray River banks. River red gum (*Eucalyptus camaldulensis*) and black box (*Eucalyptus largiflorens*) trees were cut and used as fuel; logs and snags in the river were removed to free the way for boats, seriously damaging fish habitats. However, the greatest impact has been the taming of the main rivers from their source to the sea with dams, weirs and locks, stabilizing flow levels enabling steamers to navigate all year round, the production of power and abstraction of water for irrigation. The impacts of these were to reduce the frequency of small to medium-sized floods, which occurred on average every 23 years.

Today, the MurrayDarling basin contains around 42% of all Australian farms, and produces wheat, cotton, wool, sheep, cattle, dairy products, rice, oil seed, fodder, wine and fruit and vegetables for the domestic and overseas markets. The waters of the River Murray are South Australia's lifeline, supplying more than 1.25 million people living in Adelaide and in regional industrial centres (Whyalla, Port Pirie and Port Augusta). Around 80% of the River Murray's flow alone is diverted for irrigation (crops, fruits, vegetables) and the Riverland produces more than 25% of Australia's total production of wine grape, about 30% of its citrus crop, 17% of stone fruits and 18% of almonds.

From the 1850s to the 1990s, land uses on the property included sheep grazing and cereal cropping on the cleared mallee and floodplain areas, pasture production for cattle grazing on the floodplain, centrepivot irrigation for vegetable production (onions, carrots and vines) on the cleared mallee highland, and recreation including fishing, camping, duck-shooting and four-wheel driving. In 1994, The then BRL Hardy Wines (now Accolade Wines Ltd) purchased the property to develop the vineyard on land previously used for cereal cropping and centrepivot irrigation.

The new owners also became involved in wetland conservation, recognizing the importance of the area and the opportunity to utilize an environmental platform

FIGURE 1 BANROCK STATION WINE AND WETLAND CENTRE, VINEYARDS AND WETLANDS

to help in the marketing of the Banrock Station wine brand. The grazing pressure was alleviated by removing the stock from the property, and a long-term wetland restoration project launched, inspiring the construction and naming of the Banrock Station Wine and Wetland Centre, which was opened in February 1999. A series of self-guided walks were opened in May 2000, with a boardwalk component to the trails completed in 2001.

In 2002, the site was listed as a "wetland of international importance" under the Ramsar Convention and, in 2004, the first Ramsar Plan of Management was completed to guide the ongoing management of the site. Nowadays, 75% of the total area of the property are dedicated to conservation, including 1,068 ha of floodplain (classified as "Wetland Complex"), and 307 ha of mallee (dry woodland).

II. PHYSICAL, ECOLOGICAL AND CULTURAL CHARACTERISTICS OF BANROCK STATION

Upstream of Banrock Station, the River Murray has cut through the Murray group limestone creating an extensive floodplain area (5-10 km wide), which narrows to a 1 km wide floodplain within the Mallee Gorge. The alluvial soils of the floodplains comprise a grey cracking clay base overlying a coarse sand aquifer. The surface soils have been shaped over thousands years by surface water processes including flooding and erosion, thereby creating a surface soil mix of sands, silts and clays of varying portions. More recent aeolian sand deposits have been blown onto the floodplain forming lunettes whose subsequent erosion has resulted in sand dispersion onto floodplain clays. Cliff face erosion has also resulted in sandy deposits over the floodplain soils.

The River Murray and its floodplains are discharge areas for regional groundwater. The groundwater is saline, and secondary salinization of areas of the floodplain has occurred in many places within the basin, including within the boundary of the Banrock Station. The Banrock Station Ramsar Wetland Complex is however a predominantly freshwater system and although salinity fluctuates (mainly reflecting changes in the River Murray source water), the system remains fresh at all times. With 251 ha combined, the Main and Eastern Lagoons make up the largest piece of water in the Wetland Complex.

The climate is relatively unpredictable with moderate to high inter-annual variation. The regional climate is characterized as semi-arid with warm to hot, dry summers and cool winters with variable rainfall. Approximately 80 % of the rainfall falls between May and October, with the highest monthly average rainfall between 17 to 21 mm per month. Total annual rainfall is approximately 260 mm per year. Temperatures are warm to hot in summer ranging from a mean minimum of 15.5˚ C to a mean maximum of 31.1˚ C. During winter, temperatures are cooler with mean maximum temperatures of 15.2˚C falling to a mean minimum of 5.3˚C. Total annual net evapotranspiration was calculated for Banrock Lagoon to be approximately 1300 mm.

III. VINEYARD OPERATIONS

The vineyard covers 426 ha, approximately 250 ha of which are planted with vines representing 17 grape varieties. Soil-moisture monitoring and efficient irrigation technology have been put in place in the Banrock Station Vineyards in order to minimize irrigation impacts and water usage on the wetlands. In the 2000s, 60 ha of vineyard were converted to subsurface irrigation, providing the first large-scale trial of this technology for grape production in the country. The vineyard uses nowadays a computerized irrigation system regulated by 22 probes (with 5 sensors each) that record soil moisture conditions along the vines root system every half an hour twenty-four hours a day. The system provides almost real-time data and allows the water to be used more effectively minimizing stress for the vines. Water is delivered in a timely manner through the network of drippers close to the root zone. In addition, recycled material from the company's winery is used as mulch, spread around the vines to reduce evaporation losses. For a couple of years now, old wines of common grapes varieties have been gradually replaced with Mediterranean varieties, which are better adapted to hot climate and consume less water. Combined with mulching and the high-tech irrigation system, these measures are estimated to save up to 30% of irrigation-water needs. For their efforts, the Banrock Station Vineyard achieved the international environmental management system accreditation, ISO 14001, which implements a systematic approach to setting environmental objectives and targets to improve its overall environmental performance.

IV. ECOLOGICAL CHARACTERISTICS

A. Flora

Over 300 species of plants have been recorded on the site, some of which are of conservation importance for the state, such as black cotton-bush (*Maireana decalvans*), the sand lily (*Corynotheca lateriflora*), the tufted burr-daisy (*Calotis scapigera*), the waterwort (*Elatine gratioloides*), and the prickly bottlebrush (*Callistemon brachyandrus*).

The dominant wetland vegetation types on the floodplain include river red gum woodland, black box woodland, lignum (*Duma florulenta*) shrubland, common reed (*Phragmites australis*) and narrow-leaf bulrush (*Typha domingensis*) sedgeland. The "Common reed (*Phragmites australis*) grassland", the "Narrow-leaf bulrush (*Typha domingensis*) sedgeland" and "Lignum shrubland" are threatened plant communities in the South Australian part of the Murray-Darling basin, due to the impacts of grazing, changes of water regimes and salinity. The "*Tecticornia (*Samphire) shrubland" vegetation association is present due to salinization of parts of the floodplain and forms an important waterbird habitat when flooded (fig. 2).

Aquatic macrophyte herbland communities with the conservation concern. including waterwort (*Elatine gratioloides*), robust milfoil (*Myriophyllum papillosum*), duckweed (*Lemna disperma*), slender knotweed (*Persicaria decipiens*) and pale knotweed (*Persicaria lapathifolia*), are present on the wetland beds an provide an important fish and frog habitat and source of food for waterbirds.

In the mallee woodland ecosystem, blue mallee (*Eucalyptus cyanophylla)*, red mallee (*Eucalyptus oleosa*), beaked red mallee (*Eucalyptus socialis*), dryland tea tree (*Melaleuca lanceolata*), umbrella bush (*Acacia ligulata*), Oswald's wattle (*Acacia oswaldii*) and bullock bush *(Alectryon oleifolius ssp. canescens*) are the dominant species with various *Maireana sp.* and other annual herbaceous and perennial grasses. The vegetation association "Blue mallee *(Eucalyptus cyanophylla),* open mallee (open scrub) with sparse sclerophyllous shrubs*"* is endemic to the mallee and restricted to far north-western Victoria and the upper Murray mallee in South Australia. This association is considered as "poorly conserved" in South Australia and of high conservation priority.

FIGURE 2 EXAMPLES OF VEGETATION ASSOCIATIONS ON BANROCK STATION.

Top to bottom: river red gum woodland, black box woodland, *Tecticornia* (Samphire) shrublands and mallee woodland.

B. Fauna

A number of species recorded on site are listed at the state level or are considered regionally important. Banrock Station is one of the only two places in the region where the once thought to be extinct River Snail (*Notopala sublineata*) has been found in Australia. The species is currently the object of a recovery program. Fourteen species of fish have been recorded within the Banrock Station Wetland Complex.

Of these, nine species are native species including one species of conservation significance: the freshwater catfish (*Tandanus tandanus*), which is "*protected*" in South Australia. The five exotic fish species include the invasive common carp (*Cyprinus carpio*), the goldfish (*Carrasius auratus*), the common carp-goldfish hybrid (*Cyprinus carpio x Carassius auratus*), the eastern gambusia (*Gambusia holbrooki*) and, more recently, the oriental weatherloach (*Misgurnus anguillicaudatus*).

Forty-eight species of reptiles, including freshwater turtles, and eight amphibians have been also been recorded on site with the Carpet Python (*Morelia spilota*), the lace monitor (*Varanus varius*) and the broad-shelled turtle (*Chelodina expansa*) listed as "rare" in South Australia, and the Southern Bell Frog (*Litoria raniformis*) listed as "*Vulnerable*" at both the national and state level.

Over 190 species of birds have been recorded at Banrock Station including several species of national and state conservation significance such as Australasian darter (*Anhinga melanogaster*), Australasian shoveler (*Anas rhynchotis*), blue-billed duck (*Oxyura australis*), the Caspian tern (*Hydroprogne caspia*), the freckled duck (*Stictonetta naevosa*), the little egret (*Egretta garzetta*), the musk duck (*Biziura lobata*) (fig.3), the sharp-tailed sandpiper (Calidris acuminate), the white-bellied sea-eagle (*Haliaeetus leucogaster*) and the regent parrot (*Polytelis anthopeplus monarchoides*). The Banrock Station Wetland Complex provides seasonal habitat for migratory waterbirds listed under JAMBA (Japan-Australia Migratory Bird Agreement), CAMBA (China-Australia Migratory Bird Agreement) and ROKAMBA (Republic of Korea-Australia Migratory Bird Agreement) agreements. At the time of writing this article, Banrock Station has become the first bird hotspot for the year and for all years (since record keeping from the1900s) in South Australia, as well as the 35th Australian hotspot for the year and the 92th for all years.

FIGURE 3 Endemic to Australia and rare in South Australia, the musk duck (Biziura lobata), breeds at Banrock Station

Seven native mammals have been recorded on site, including the Common Brush Tail Possum (*Trichosurus vulpecula*) which is considered "*Rare*" in South Australia.

V. SOCIAL AND CULTURAL VALUES

For Indigenous Australians, cultural and natural heritage materials are significant and hold social value. They also consider land and water to be intimately intertwined; therefore the whole ecosystem has social and cultural value to the Indigenous Peoples of the region not just parts of the whole.

Banrock Station Wetland Complex contains significant artefacts that suggest that the site was used and occupied by Indigenous Peoples for a diverse range of natural resource uses and strategies (*e.g.* campsites, hearth/fire places, midden, lithic artefacts and scar trees). There is strong belief that Banrock Station Wetland Complex was important for trade and access to the River Murray by Aboriginal groups, as the site is near to Overland Corner, a ration station in the 1880s, and lies probably on the past boundary of two Aboriginal groups (Erawirum and Nawait). The site is recognized for its cultural significance to Indigenous Australians.

From a more recent history perspective, European association with the site began in the 1800s. In 1851, a grazing lease was issued to Thomas Henry Wigley over the lands that are now Banrock Station. He built a small homestead on the floodplain now known as Wigley Reach and his animal yards remain. The floodplain on Banrock Station was logged to supply

firewood to power paddle-steamers from the 1850s to the 1920s as can be seen by the many old stumps that remain along the river and floodplain.

Each year, official representatives of the South Australian and inter-state polices meet by a memorial on Banrock Station on the shores of the River Murray, to attend the National Police Remembrance Day Memorial Service, in memory of police officers killed in the performance of their duty in Australia. Just three kilometres from of the memorial, on the 7 May 1847, Lance Corporal Wickham and Mounted Constable Carter policemen drowned while trying to cross the river on a canoe; they were the first casualties suffered by the South Australian Police.

The wetland restoration project inspired the construction and naming of the Banrock Station Wine and Wetland Centre which was opened in February 1999, featuring the latest environmental building developments at the time including stabilized rammed earth construction using regional soil, steel framing and timbers from sustainable sources, a building layout, orientation, materials and insulation designed to maintain comfort by natural means as much as possible and a rainwater collection to supplement water supply. The environmentally focused building features a wetland interpretative display, wine tasting area, café and conference facilities (fig. 4). The restaurant promotes local produces and native foods. Banrock Station Wetland Complex has become a popular tourist and educational destination: on average 60000 visitors (up to 100,000) have been utilizing the visitor education and wine tasting centre, restaurant facilities as well as the walking trails (opened in May 2000) and boardwalks (completed in 2001) (fig. 5), including nature information huts and bird hides.

FIGURE 4 BANROCK STATION WETLANDS FROM THE WINE AND WETLAND CENTRE DECK

FIGURE 5 ONE OF BANROCK STATION BOARDWALKS AT SUNSET.

The site hosts on average two school/university visits per month. Through a network of relationships with the state education institutions, Banrock Station has engaged children in habitat restoration and wetland monitoring and awareness programmes, longest partnerships being with the local Kingston-on-Murray Primary School and Blackforest Primary School in Adelaide since the 1990s.

The interest on Banrock Station as an environmentally educational space has gone beyond the state and even the national borders. Since 2005, the International Student Volunteers (ISV) programme has been welcoming international volunteers, who have planted thousands of trees, tracked feral animals, installed nesting boxes for birds and bats, completed construction projects, fencing, ecological monitoring and controlled infestations of serious environmental weeds throughout the property.

VI. OVER 20 YEARS OF HABITAT RESTORATION

A. Wetland Rehabilitation

At the time of its Ramsar listing (2002), the wetland, floodplain and mallee landscapes have been identified with a depleted understorey and biodiversity due to past land uses including timber cutting, sheep and

FIGURE 6 Example of significant changes in habitat at Banrock Station Wetland Complex between 1993 (start of wetland rehabilitation) and 2013 at "Blackforest DU7B site".

cattle grazing, and invasive species pressure". Some parts of the site the vegetation had significant areas of stressed mature and young river red gums and mature black box caused by raised saline groundwater levels and past grazing impacts.

Prior to the construction of Weir and Lock 3 on the shores of Banrock Station in 1925, the main wetland areas of the property would have exhibited a temporary water regime determined by the Murray River flooding regime which would have varied considerably from year to year but with a pronounced seasonal pattern, resulting in significant water level fluctuations and varying lengths of inundation of the wetland. The wetland and floodplain would have been mostly flooded in spring with the melting of snow cap and/or winter heavy rainfall in the western slopes of the Great Dividing Range. From time to time, monsoonal precipitations in the north of the Murray-Darling catchment basin (Queensland) during summer could as well flood the wetland. Banrock lagoons and creeks would then have undergone frequent drying in most summers and during droughts, when the Murray River levels dropped below the sill level of the wetlands inlets, and water subsequently evaporated from the wetland. The installation of Weir and Lock 3 adjacent to the wetland converted what was previously a seasonally flooded system of shallow lagoons into a permanently inundated one.

In 1992, the newly formed wetland management organization Ducks Unlimited Australia (which became later on Wetland Care Australia) commenced working with the landowners, Bruce and Teri Engel, to install water control structures on the main lagoons to enable partial drying or flooding of the wetland. The project was funded by the Murray-Darling Basin Commission and a private donor, Norman Marsh. The Banrock Station wetland was the first wetland on the River Murray to install such infrastructure to enable partial drying in the wetland and water level manipulation.

Up until 2006, the Banrock Main Lagoon retained water all year round for irrigation of the vineyard. Only after the removal of the irrigation pump from the wetland in 2007 was this wetland able to be fully dried. Since then, the wetland's water regime has returned to an intermittent inundation pattern with complete drying phases of the main wetland. The river red gum and black box woodlands, lignum shrubland, common reed and narrow-leaf bulrush sedgeland have expanded (fig. 6).

European carp were released into the Murray River in 1964. Today, they make up more than 80% of the fish in the river and have become the dominant species in many fish communities in south-eastern Australia. Locals call it the "river rabbit", because of its incredible reproduction rate, its damage to the aquatic fauna and flora and its profound impact on the whole freshwater ecosystems.

Unlike native species that have adapted to the natural seasonal fluctuation of the River Murray water levels, European Carp is a species of permanent water bodies. Along the river, carp tend move from the river main channel into the floodplain wetlands in spring-summer to spawn.

Until 2007 and the subsequent reestablishment of dry phases, the invasive European carp was thriving in Banrock Station main lagoon as it was permanently flooded. Their impact on the wetland ecosystem was considerable (fig. 7). A combination of carp screens on the wetland inlets and succession of dry phases has proven efficient in reducing the impact of the invasive alien: during the first complete dry phase (2007), 60 tonnes of carp were removed from the 120 ha main lagoon alone, during the second dry phase (2009), 6 tonnes, and in 2015, only 2 tonnes.

FIGURE 7 Banrock Station wetland dry phase revealing sedges (*Cyperus sp.*) growing within an exclosure built on the wetland bed to study the impact of invasive European Carp (inside of the pen: no access to carp).

Acid sulphate soils (ASS) are soils that either contain sulfuric acid or have the potential to form sulphuric acid if in contact with air. They can develop naturally under waterlogged conditions where anaerobic bacteria have access to sulphate, iron and organic matter. River Murray flow regulation have enhanced the formation of these ASS at Banrock Station compared to the pre-European water regime. Conversion of the Main Lagoon to permanent wetland has meant that the ASS that have formed have not been "burnt off" by frequent drying cycles to the same extent as pre-river regulation times, and are deeper and more widespread than it would have been if it had remained intermittent. Preliminary studies suggest that the return of the Banrock Station wetlands back to their original intermittent type with dry/wet cycles has prevented the expansion of ASS; hypersulphidic soils sampled in 2008 shifting to hyposulphidic soils in 2013.

In addition to return the wetlands to healthy functioning ecosystem, through removing introduced European Carp, improving soil health, encouraging the return of native fish and bird species along with native flora, the reestablishment of a dry cycle to Banrock Station Lagoon also saves precious water. An estimated 1.15 gigalitres of river water, which is the equivalent of 1,150 Olympic-sized swimming pools, is saved from evaporation over a two-year wet/dry cycle.

Because of its environmental credentials, Banrock Station has been successful to attract governmental help to improve its wetland management. During the Millennium Drought prolonged period of dry conditions that lasted from late 1996 to mid-2010 in much of southern Australia (except parts of central Western Australia), Banrock Station was guaranteed environmental water to sustain the wetland and river red gum woodlands, In 2007, the relocation of the Banrock Station vineyard irrigation pumps from the wetland to the river was initiated with funding assistance from the state government in return for water savings achieved by drying the wetland. In 2014, Banrock Station benefited from a grant from the commonwealth and the state government through the riverine recovery project (RRP) to upgrade its main outlet regulator. The RRP aims to improve and secure environmental management of wetlands and floodplains as well as ensure efficient environmental water use in the River Murray. Recognizing the economic benefits of environmental water in the tourism and wine sector, Banrock Station sought out and established an important three-year partnership with the Commonwealth Environmental Water Holder in 2015. This ongoing partnership will see Banrock Station annually deliver up to 2,004 megalitres of Commonwealth environmental water to a number of sites across the extensive 1,000 ha Ramsar floodplain.

B. Revegetation

Since 1993 and the removal of stock on the property, the company has implemented several revegetation projects on site including direct seeding using machinery for largescale areas and tube stock planting with native species. Most of the seeds and plant material for propagation have been collected on Banrock Station or acquired from local native plant nurseries. The native seed bank currently holds 53 species of mallee and floodplain habitats. Since 2012, the native plant nursery capacity on site has been dramatically increased (by 400%, in excess of 18500 seedlings) with the upgrade of the irrigation system, construction of extra benches and mixing station. Since 2013, an average of 10000 seedlings of native trees, bushes and grasses are planted annually on site, by staff and approximately 200 children and dozens of volunteers.

In 2015, Banrock Station partnered with two NGOs: Landcare Australia and Trees For Life SA to implement the Australian Department of Environment's 20 Million Trees campaign at Banrock Station with the aim of restoring previously cleared mallee (eucalypt species) habitats and restore floodplain river red gum/black box woodlands to create a habitat for species such as the regent parrot, and replacing the non-local native swamp sheoak (*Casuarina glauca*) previously planted as vineyard wind-break, which requires constant watering. In June this year, 100 kg of locally sourced seeds of 37 local species across the two vegetation communities were sown across 66 ha of mallee and 34 ha of river red gum/black box.

C. Feral and Weed Species Control

More than 50 introduced flora species have been found at Banrock Station. Of these 5 are declared as Weed of National Significance (WoNS) based on their invasiveness, potential for spread and environmental, social and economic impacts. These WoNS, and 10 others considered of local and regional importance, are the object of recurrent eradication by staff through slashing, herbicide treatment and hand-pulling.

Imported by Europeans for hunting, sport or as pets, European rabbit (*Oryctolagus cuniculus),* hare (*Lepus europaeus*), red fox (*Vulpes vulpes*) and domestic cat (*Felis catus*) have swarmed into Australia causing widespread destruction of native fauna and flora. Since early 1990s, Banrock Station has been implementing a feral species eradication programme using baiting, poisoning, trapping and shooting. In 2005, a threatened species recovery programme was launched which involved the erection of a 14 km feralanimal exclusion fence enclosing the totality of the Ramsar Wetland Complex. The rabbits and hare population at Banrock Station has been reduced through eradication and biological control (myxomatosis, rabbit hemorrhagic disease virus) and is now considered at a non-threatening level.

D. Reintroduction of Threatened Native Species

In 2005, nationally threatened brush-tailed bettong (*Betongia penicillata*) and greater bilby (*Macrotis lagotis*) were reintroduced on site as part of Banrock Station's threatened species recovery programme. The programme was a trial but showed that the operation was feasible if the impact of predation by feral species was alleviated.

Because of its environment credentials and location across the river from the last sighting of the species in 1910, Banrock Station was selected in 2013 to reintroduce the Spiny Daisy (*Acanthocladium dockeri*), a nationally threatened species considered extinct before being rediscovered in Mid-North South Australia 1999. Cuttings were collected, propagated at the Banrock Station native plant nursery and planted on site in 2014.

To date, the trial has been very successful, with a 275% increase in abundance of the translocated population. Banrock Station has become a stepping-stone to establish the species at other Murraylands sites. The project has been a great opportunity to engage the local and international community in the planting, monitoring and maintenance of the translocation sites (fig. 8). Much of the project success has been due to the unique partnership between the state environment agency, NGOs and a private business, Accolade Wines Ltd.

FIGURE 8 EXAMPLE OF NATIVE THREATENED SPECIES REINTRODUCTION AT BANROCK STATION, THE SPINY DAISY (*ACANTHOCLADIUM DOCKERI*)

Top to bottom: planting by the local community, monitoring by International Student Volunteers (ISV) and close-up of the species

VII. BEYOND BANROCK STATION WETLANDS

As a well-known, successful, ecologically sustainable business, Banrock Station has growing social significance for the region and the local community. The site has high value as a demonstration site for the Ramsar concept of "wise use" and provides for recreation, tourism, education and scientific research. It is used by private business, NGOs, and GOs as a case study for how degraded floodplains, common along the River Murray, can be restored to productive ecosystems, while maintaining a financially viable business enterprise.

For nearly 20 years, Banrock Station wines have brought the pleasure of fine Australian wine and the message of conservation to the world. Banrock Station produces full flavored, value for money Australian wines of varietal integrity, demonstrating respect from the good earth from which they came. Central to Banrock Station's success is a genuine commitment to the environment, and through the Banrock Station Environmental Trust, the company is re-investing part of its profit to supporting environment conservation projects around the world with a focus on wetland rehabilitation climate change, water conservation, ecosystem loss and species loss. Banrock Station Environmental Trust's commitment to date exceeds $6 million Australian dollars to more than 130 projects in 13 countries. Banrock Station has supported returning salmon to rivers in Canada, otter protection in Denmark, bee recovery in the United Kingdom, wetlands restoration in Hong Kong, whitebark pine preservation in the United States, etc. Recently, Banrock Station has partnered with NGOs, governmental and scientific institutions to establish a largescale monitoring scheme for sea turtles and their habitats on the Great Barrier Reef to help to better manage and protect this iconic natural heritage of Australia.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to the numerous children, students, volunteers, researchers, and past and current staff who have helped in restoring and nurturing Banrock Station habitats since 1993. This success story would not have been possible without the continuous support of Accolade Wines Ltd, the Banrock Environment Trust, and fruitful collaboration with state and national governmental environment authorities and research institutions.

REFERENCES

[1] R. Butcher, J. Hale, K. Muller, and H. Kobryn, "Ecological character description for the Banrock Station Wetland Complex", Prepared for Department for the Environment, Water, Heritage and the Arts. 2009.

[2] Constellation Wines Australia, Banrock Station Wetland Complex Wetland of International Importance. Ramsar site 1221, Management Plan 2008 to 2014. Revision June 2008.

[3] M.J. Harper, *Banrock Swamp Floodplain Management Plan, Riverland region* (Ducks Unlimited Australia Pty Ltd, 1992)

[4] Ramsar, Information Sheet on Ramsar Wetlands (RIS) 2009-2014 version, 2014, accessed 15 September 2016. https://rsis.ramsar.org/RISapp/files/RISrep/AU1221RIS_1405_en.pdf.

[5] C. Tourenq, and T. Field, Banrock Station Wetland Complex Ramsar Site Management Plan. 2014 Review and Update. Accolade Wines Australia Ltd, Reynella, SA. Australia, 2014.

BANROCK STATION-ACCOLADE WINES LTD

Accolade Wines Ltd is the 5th largest wine business globally, with operations in North America, UK, Ireland, mainland Europe, South Africa, Australia, New Zealand and Asia. Accolade Wines delivers approximately 38 million cases to more than 140 countries annually; including Australia, the UK, Mainland Europe, the US, Canada, Japan, New Zealand and China.The business is the largest wine company by volume in the UK and Australia, Its portfolio includes more than 48 wine brands including Banrock Station wines that have been produced and sold globally since 1996. Up to 4.5 Million glasses of Banrock Station are enjoyed each year in more than 60 countries.

Since 1993, Banrock Station environment has been subject to an intensive restoration project. The wetlands were included in the List of Wetlands of International Importance under the Ramsar Convention in 2002, as a demonstration site for the concept of "wise use" providing for recreation, tourism, education and scientific research. In addition to on-site conservation, the company is re-investing part of its profit through the Banrock Station Environmental Trust, into supporting environment conservation projects around the world with a focus on wetland rehabilitation climate change, water conservation, ecosystem loss and species loss. Banrock Station Environmental Trust's commitment to date exceeds AUD$6 million to more than 130 projects in 13 countries.

Restoration and Conservation of Rice-Paddy Ecosystems by a Restaurant Company

Yoshinori Hashibe, ***Aleph Inc.***

ABSTRACT. Aleph Inc. operates over 300 restaurants throughout Japan. With a view to providing customers with high-quality meals at affordable prices, Aleph restricts the use of agrochemicals and sets cultivation standards for the produce it uses. Aleph has increased the number of farmers who can sign up for its contracts. With regard to rice procurement, in 1996 Aleph started working with contracted producers to reduce the use of agrochemicals. Through trial and error, all producers succeeded in growing rice without agrochemicals, save for one application of herbicide. Since 2006, this rice (known as "Less Agrochemical Rice") has been served in all Aleph's restaurants. The company now has over 400 rice farmers under contract and procures 3,400 tonnes of rice a year. It encourages its rice producers to take into account the environmental aspects of rice paddies and related elements, such as irrigation in winter, biotopes, fishways, etc. Rice has been grown in Japan for at least 2,500 years, and rice paddies have provided one of the important ecosystems for biodiversity conservation in Asia. Over time, however, rice-paddy ecosystems have become degraded as a result of the excessive use of agrochemicals, land development, land abandonment, and so on. As a rice procurer, Aleph is involved in two restoration and conservation activities in rice-paddy ecosystems, in addition to biodiversity conservation in its rice procurement and communication, education and public awareness (CEPA) activities, namely:

(1) In 2012, Aleph started working with a local non-profit organization on the restoration of a *yatsuda* (the Japanese word for rice paddies that are located at the end of a ravine in a forest). *Yatsuda* are a hotspot of biodiversity and liable to be abandoned because they are usually small and hard to cultivate with agricultural machines. Aleph employees participate in conservation activities in the restored *yatsuda*. From a human-resources standpoint this also gives the company the added advantage of having employees educated about biodiversity; and

(2) Aleph has developed a 10-are rice paddy in Hokkaido to act as a demonstration site for a rice-paddy ecosystem. In 2006, it took up the challenge of organic rice farming, thus giving local people and company employees an opportunity to gain experience of farm work and wildlife monitoring. The newly developed rice paddy has also attracted many organisms. In particular, 30 species of dragonfly have been observed in and around the demonstration site.

Restauration de rizières abandonnées à Ibaraki, district de Kanto, Japon

RÉSUMÉ. La société Aleph Inc. exploite plus de 300 restaurants à travers le Japon. Afin de fournir à ses clients des repas de qualité à des prix abordables, Aleph limite l'utilisation de produits agrochimiques et établit des normes de culture pour les produits qu'elle utilise. Aleph a augmenté le nombre d'agriculteurs qui peuvent s'inscrire à ses contrats. En ce qui concerne l'approvisionnement en riz, Aleph a commencé en 1996 à travailler avec des producteurs sous contrat pour réduire l'utilisation de produits agrochimiques. Par tâtonnements, tous les producteurs ont réussi à cultiver du riz sans produits agrochimiques, sauf pour une application d'herbicide. Depuis 2006, ce riz (connu sous le nom de «Riz à produits agrochimiques réduits») a été servi dans tous les restaurants d'Aleph. La société a maintenant

plus de 400 riziculteurs sous contrat et fournit 3 400 tonnes de riz par an. Elle encourage ses producteurs de riz à prendre en compte les préoccupations environnementales notamment dans les rizières et les infrastructures associées comme l'irrigation en hiver, les biotopes, les passes à poissons, etc. Le riz a été cultivé au Japon pendant au moins 2 500 ans et les rizières ont fourni l'un des écosystèmes importants pour la conservation de la biodiversité en Asie. Au fil du temps, cependant, les rizières se sont dégradées en raison de l'utilisation excessive de produits agrochimiques, de l'aménagement des terres, de l'abandon des terres, etc. En tant que fournisseur de riz, Aleph participe à deux activités de restauration et de conservation dans les écosystèmes des rizières, en plus de la conservation de la biodiversité dans ses activités d'approvisionnement en riz et de communication, d'éducation et de sensibilisation du public (CESP) :

(1) En 2012, Aleph a commencé à travailler avec une organisation locale à but non lucratif sur la restauration des *yatsuda* (le nom japonais des rizières situées au bout d'un ravin dans une forêt). Les *yatsuda*s sont des points chauds (hotspot) de biodiversité et risquent d'être abandonnés parce généralement petits et difficiles à cultiver avec des machines agricoles. Les employés d'Aleph participent à des activités de conservation dans le *yatsuda* restaurés. Du point de vue des ressources humaines, cela donne également à l'entreprise l'avantage supplémentaire d'avoir des employés formés sur la biodiversité; et

(2) Aleph a développé une rizière de 10 ares à Hokkaido pour servir de site de démonstration pour un écosystème de rizières. En 2006, la société a relevé le défi de la riziculture biologique, donnant ainsi aux populations locales et aux employés de l'entreprise l'occasion d'acquérir une expérience du travail agricole et de la surveillance de la faune. La rizière nouvellement développée a également attiré de nombreux organismes. En particulier, 30 espèces de libellules ont été observées dans et autour du site de démonstration.

Restauración de campos de arrozales abandonados

RESUMEN.[1] Aleph Inc. opera en más de 300 restaurantes de todo Japón. Con el fin de ofrecer a sus clientes comidas de alta calidad a precios asequibles, Aleph restringe el uso de agroquímicos y establece estándares de cultivo para los productos que utiliza. Aleph ha incrementado el número de agricultores que pueden suscribir este tipo de contratos. Con respecto a la producción de arroz, en 1996 Aleph comenzó a trabajar con los productores contratados para reducir el uso de agroquímicos. A través de prueba y error, todos los productores tuvieron éxito en el cultivo de arroz sin agroquímicos, salvo por la aplicación de un herbicida. Desde 2006, este arroz (conocido como "Arroz con menos agroquímicos") se ha servido en todos los restaurantes. La empresa cuenta ahora con más de 400 productores de arroz bajo contrato y adquiere 3.400 toneladas de arroz al año. Aleph anima a sus productores de arroz a tener en cuenta las preocupaciones ambientales sobre los arrozales y procedimientos relacionados, como el riego en invierno, biotopos, las rutas de pesca, etc. El arroz ha sido cultivado en Japón durante al menos 2.500 años, y los campos de arroz han constituido ecosistemas importantes para la conservación de la biodiversidad en Asia. Con el tiempo, sin embargo, los ecosistemas de los arrozales se han degradado como consecuencia del uso excesivo de agroquímicos, desarrollo y abandono de la tierra, entre otros. Además de la conservación de la biodiversidad en sus actividades de producción, comunicación y concienciación del público, como productor de arroz, Aleph está involucrado en dos actividades de restauración y conservación de ecosistemas de los arrozales, Éstas son:

(1) En 2012, Aleph comenzó a trabajar con organizaciones locales sin fines de lucro en la restauración de *Yatsuda* (el nombre japonés para los campos de arroz que se encuentran al final de un barranco en un bosque). *Yatsuda* son un punto de caliente de biodiversidad [Hotspot] y susceptibles de ser abandonados, porque son generalmente pequeños y difíciles de cultivar con las máquinas de agricultura. Los empleados de Aleph participan en actividades de conservación en los *Yatsuda* restaurados. Desde el punto de vista de los recursos humanos esto da a la compañía la ventaja de tener empleados educados acerca de la biodiversidad; y

(2) Aleph ha desarrollado un campo de arroz de 10 ares en Hokkaido como un sitio de demostración de un ecosistema saludable de arrozal. En 2006, asumió el reto del cultivo de arroz orgánico, dando a la población local y a los empleados de la compañía la oportunidad de adquirir experiencia en el trabajo agrícola y monitoreo de vida silvestre. El nuevo arrozal también ha atraído a muchos organismos. En particular, 30 especies de libélula se han observado en y alrededor del sitio de demostración.

1 Translated by Daniela Cajiao

I. INTRODUCTION

Rice has been grown as a staple food for at least 2,500 years, and rice paddies have been an important component of *satoyama* landscape (traditional agricultural landscape) in Japan.

Moreover, the rice paddies are classified as a type of wetlands in the Ramsar Convention on Wetlands. According to Resolution X.31, which was adopted in 2008 at the 10th Meeting of the Conference of the Parties to Ramsar Convention, "rice paddies in many parts of the world support important wetland biodiversity such as reptiles, amphibians, fish, crustaceans, insects and molluscs, and play a significant role in waterbird flyways and the conservation of waterbird populations". For example, Kiritani [1] noted that there are 5,668 species of living things in and around rice paddies in Japan. The traditional paddy-field agriculture is sustainable as well as providing an important ecosystem for organisms, especially in Asia.

On the other hand, rice-paddy ecosystems have become degraded owing to excess agrochemical use, land improvement, abandonment and so on. As a consequence, an increasing number of species that can be seen in and around rice paddies have been added to the Red List of endangered species.

This article introduces the restoration and conservation activities in rice-paddy ecosystems conducted by Aleph Inc., a Japanese restaurant company that procures rice for its menu. Section II briefly introduces Aleph's corporate profile, its business philosophy and its approach to environmental problems; section III recounts Aleph's biodiversityconservation efforts in its rice-procurement activities; section IV describes Aleph's communication, education, participation and awareness (CEPA) activities in rice paddy ecosystems; section V focuses on Aleph's two restoration and conservation activities for rice-paddy ecosystems, which, to some extent, may also be seen as CEPA activities; and section VI provides a brief summary of the article.

II. ALEPH INC. PROFILE

A. Corporate Profile

Aleph Inc. was established 1968 in Morioka city, Iwate prefecture, Japan. It operates over 300 restaurants throughout Japan, the mainstay being the hamburger steak restaurant chain "*Bikkuri Donkey*" (fig. 1). Aleph also operates eight factories that process ingredients to supply the restaurants.

FIGURE 1 A "*BIKKURI DONKEY*" RESTAURANT.

B. Business Philosophy

When the company was established, its founder, Akio Shoji, was strongly influenced by the spirit of the *Shogyokai* ("Commercial world") seminar. It is the seminar for merchants. Many come from around the country and have been taught how "true" business should be through axioms such as: "Shops exist for the customer", "Think first whether it will be right or wrong before thinking whether it will make loss or not" or "The *raison d'*être of the company is solving the problem of society". Although these notions have been taught for over fifty years, they are similar to the recent concept of corporate social responsibility.

At the restaurant branch of *Syogyokai*, Akio Shoji was taught as follows: the Chinese character of "food" contains the meaning of "eating" and "cuisine". The character "food" consists of two Chinese character, "human being" and "good or improve" (fig. 2). We can interpret the meaning of character "food" as "good effect for human being". Thus, we have been taught that the food industry should have a good effect on human being. Aleph's business philosophy is based on the thought expressed in this character.

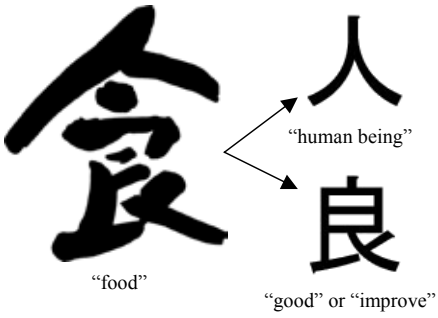

FIGURE 2 INTERPRETATION OF THE CHINESE CHARACTER FOR "FOOD".

C. Agricultural and Environmental Activities

Aiming to provide customers with high quality meals, Aleph launched an experimental farm in 1988 and started to work on sustainable agriculture.

Aleph then set out the procurement principle consisting of three guarantees and three contributions: guarantee of safety, quality and traceability; and contribution to consumer's health, to the environment and to productivity of farmers. According to the principle, Aleph set restrictions on agrochemicals and laid down cultivation standards for the crops. It then increased the number of farmers who can sign up for our contracts.

For example, we set the specification of "Aleph Natural Beef" for our procured beef. We have chosen beef from NZ and Australia. The livestock are all strictly grass-fed. All contracted producers graze them on pastures using intensive grazing methods (fig. 3). We have never used growth hormone and, after once the animals are 12 months old, no antibiotic is used. Illness associated with confinement will be prevented because of intensive grazing methods, which keeps the animals stress free.

The more deeply we got into agriculture, the more keenly we felt the importance of nature as indispensable to our business. In 1996 we started the recycling of kitchen refuse from our restaurants. Since then, we have taken a variety of environmental measures, including waste reduction, energy saving, and resource saving.

In 2003 we held "Hokkaido & New Zealand biodiversity symposium" in Sapporo city. That is the starting point for our biodiversity conservation. Through this symposium, we learned together with local residents from experts, and we considered what we were able to do as a private company.

Since then we have conserved biodiversity, mainly in farmland, through the food procurement, for example, rice procurement. In 2008, Aleph signed the Leadership Declaration of Biodiversity in Good Company Initiative at the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity in Bonn, Germany.

III. BIODIVERSITY CONSERVATION THROUGH RICE PROCUREMENT

As we think it is the best way for food-service companies like us to conserve biodiversity on its ingredients, this section first shows how Aleph has been involved in enhancing biodiversity in rice-paddy ecosystems through its rice procurement process and then proceeds to give a brief introduction to its environmental restoration and conservation activities.

FIGURE 3 ALEPH NATURAL BEEF

A. "Less Agrochemical Rice"

With regard to rice procurement, conventional rice farming in Japan typically requires between five and ten applications of agrochemicals. In 1996, Aleph started working with contracted producers to reduce agrochemical use in order to realize the procurement principle of three guarantees and three contributions mentioned in the previous section.

Through trial and error, all producers succeeded in growing rice without agrochemicals, except for one application of herbicide. Since 2006, this rice ("Less Agrochemical Rice") has been served in all of our restaurants. Now Aleph has over 400 contracted rice farmers and procures 3,400 tonnes of rice a year.

After many farmers mentioned that a large number of organisms, such as dragonflies, frogs, fish and birds, could be seen in their rice paddies, Aleph encouraged them to monitor wildlife in their rice paddies by themselves.

B. "Living-Things-Friendly" Rice-Paddy Project

As a signatory of the Leadership Declaration in 2008, and based on our activities to date, we started the "living-things-friendly" rice-paddy project in 2009. The aim of the project is to conserve the biodiversity of rice paddies through our main business with farmers and customers. There are three types of activities in this project.

Organic rice-farming: Aleph asks some farmers to grow rice without using agrochemicals, not even the single application of herbicide. Weed control without using herbicide is difficult and yields tend to be unstable. But some farmers have taken on the challenge of organic farming, and we now procure about fifty hectares of organic rice and serve it in two million dishes a year in a total of ten restaurants.

Environmental concerns: Current rice paddies are degraded as wildlife habitat because land improvement tend to dry rice paddies and to make fishes that live in drainage cannel difficult to go in and out at rice paddies. Aleph encourages farmers to produce rice with an environmental concern about rice paddies and related elements, including such aspects as irrigation in winter, biotopes (fig. 4), fishways (fig. 5), etc. in order to restore wildlife habitat to some extent into the current rice-paddy farming system. According to the report by contracted farmers, there were 800 winter-flooded rice paddies, 177 biotopes and 167 fishways that they established in 2015.

FIGURE 4 A BIOTOPE IN A RICE PADDY

FIGURE 5 FISHWAYS THAT CONNECT DRAINAGE CHANNEL TO RICE PADDIES.

Enhancement of wildlife monitoring: Aleph encourages farmers to monitor or observe wildlife not only by themselves but also with local people, customers and so on. Now many farmers' groups do wildlife observation with students of local school, consumers' groups and so on. Aleph sometimes supports them by inviting *Bikkuri Donkey* customers to the farmers' rice paddies as mentioned in the next section.

C. Further Steps

Based on our experience of "living-things-friendly" ricepaddies project, we set new target for rice procurement, so that could can say that all the rice served in *Bikkuri Donkey* restaurants is wildlife-friendly. For that reason, we reviewed our specifications for "Less Agrochemical Rice" to take effect as of 2016.

First, we set additional prohibitions that were not included from a biodiversity standpoint in the former specifications.

Secondly, we revised the list herbicides that farmers can use in growing their "Less Agrochemical Rice", and added three herbicides to the list of prohibited agrochemicals.

Thirdly, we specified some measures on the environment and wildlifemonitoring to be encouraged among non-farmers, and set a 10% target increasing over three years.

IV. COMMUNICATION, EDUCATION AND PUBLIC AWARENESS (CEPA) ACTIVITIES

A. Wildlife Observation

Our activity mentioned in the previous section aims to contribute to enhancement of biodiversity in rice paddies, mainly through rice procurement. However, it is also important to raise awareness of the value of biodiversity in rice paddies.

We therefore invite our customers to observe the wildlife at the rice paddies of our contracted farmers (fig. 6). We also invite employees of the restaurants serving the rice from these paddies. In this way, customers, farmers, and employees alike can all experience the abundance of wildlife in the rice paddies of our contracted farmers.

FIGURE 6 WILDLIFE OBSERVATION AT THE RICE PADDY OF A CONTRACTED FARMER.

B. Fuyumizu Tango (Original Song and Dance)

Furthermore, we produced original song and dance animation "*fuyumizu* tango", a play on the words *fuyumizu-tambo* (winter-flooded rice paddies), "*tambo*" meaning "rice paddy", and the pronunciation of "*tambo*" being similar to that of "tango". So we made the song to the rhythm of tango (fig. 7).

FIGURE 7 FUYUMIZU TANGO

It received the Green TV Award in the first Biodiversity Action Award Japan in 2013. It can be seen on YouTube. Customers and employees danced it together at the rice planting festival of our demonstration rice paddy that is introduced in the next section.

V. RESTORATION AND CONSERVATION ACTIVITIES OF RICE PADDY ECOSYSTEM

A. Yatsuda Restoration with a Local Non-Profit Organization (NPO)

In 2012, we started cooperation activities on *yatsuda* restoration with the non-profit organization Tsukuba Environment Forum in Ibaraki, Kanto district.

Yatsuda is the Japanese word for a certain type of rice paddy, located at the end of a ravine in a forest. Many types of wildlife species live in a *yatsuda*. However, the *yatsuda* is liable to be abandoned because it is usually small and hard to cultivate with agricultural machines. Rice paddies stay as wetlands as they are periodically cultivated by farmers. Once abandoned, however, a *yatsuda* will gradually dry out and eventually become forest, following the process of ecological succession. The wetland ecosystem will be lost. That is why a *yatsuda* is a hotspot of biodiversity.

In 2006, the Tsukuba Environment Forum became involved in the restoration and conservation of *yatsuda* located at the foot of Mt. Tsukuba. They took up the challenge of the organicfarming method of irrigating rice paddies even in winter (winter-flooded rice paddies) in order to provide a suitable habitat for certain fauna. They invited local people as annual participants in experimental programmes, such as transplanting, harvesting and wildlife observation.

In 2010, when Aleph was awarded the Minister's Prize from the Ministry of Agriculture, Forestry and Fisheries in the first Contest for Corporate Activities on Biodiversity for its project of establishing and disseminating the winter-flooded rice-farming method in Hokkaido, the Tsukuba Environment Forum won the Grand Prize for Civic Activity on Biodiversity for their *satoyama* conservation activities including *yatsuda* conservation. We became acquainted with each other and began to consider cooperation.

In 2012, we decided to have employees in Kanto district participate in activities to conserve restored *yatsuda* four times a year, such as transplanting, weeding, harvesting, maintenance and using rice straw to make traditional New Year decorations for their restaurants (fig. 8, fig. 9).

FIGURE 8 *YATSUDA* MAINTENANCE ACTIVITIES

FIGURE 9 TRANSPLANTING OF RESTORED *YATSUDA*

It is difficult for restaurant employees in Kanto district to access the rice paddies that produce the rice they serve in their restaurants because we have no contract farmers in the area. This cooperation therefore helps employees to get a feeling for the rich biodiversity of rice paddies and to understand the importance of our rice-procurement policy. This is the advantage that we have gained.

On the other hand, Tsukuba Environment Forum has gained by obtaining a stable supply of human resources, the most important factor in maintaining *yatsuda*. Some rare species as shown in table 1 and fig. 10 have been observed by their monitoring. Our financial support is only about US$ 500 a year, but I think we can also contribute to biodiversity conservation in *yatsuda* through participation.

FIGURE 10 *LETHOCERUS DEYROLLI.*

We have undertaken these activities for five years and will continue to do so in the future.

B. Demonstration Rice Paddy in Hokkaido

In order to produce a demonstration of a *satoyama* landscape including rice paddies, Aleph developed a 10-are rice paddy in Eniwa city, Hokkaido in 2006.

The site was flattened by soil- and sand-mining before, and had since been used as pastureland. But there is a spring at the site, and older residents recall rice being grown in the area sixty or seventy years ago, although it was abandoned because of the cold temperature of the water. Therefore, developing the rice paddy might be a means of restoring a pre-existing *satoyama*.

TABLE 1. RARE SPECIES OBSERVED BY YATSUDA MONITORING.

Class or Division	Scientific Name	Red List Category[a]
Pisces	*Lefua echigonia*	EN
Insecta	*Lethocerus deyrolli*	VU
Mollusca	*Cipangopaludina chinensis laeta*	VU
Insecta	*Appasus japonicus*	NT
Insecta	*Cybister brevis*	NT
Insecta	*Hydrophilus acuminatus*	NT

a. Ministry of Environment, Japan (2012, 2013)

We took up winter-flooded organic ricefarming by ourselves with the guidance of NPO experts. Almost all the work is done by hand. No agrochemicals have been used. We have continued wildlife monitoring on regular basis. Local people and employees can have an experience of farm work and wildlifemonitoring. Our activities have also paid attention to the culture behind rice-growing. We believe that the cultural aspect is one of essential factors in the wise use of wetlands.

A total of over 8,300 people have participated in these programmes over these ten years (fig. 11, fig. 12). Through this participation, we expect to achieve an educational effect, especially for children, parents, and employees.

The newly developed rice paddy has attracted many organisms. In particular, 30 species of dragonflies have been observed in and around the site over ten years (table 2). The combination of wetlands of different types—the temporarily flooded rice paddy and the permanently flooded neighbouring pond—may result in the diversity of dragonfly species because their different life cycles. It seems that our work in developing and maintaining this rice paddy has succeeded in creating a suitable ecosystem for many organisms.

FIGURE 11 RICE PLANTING FESTIVAL AT DEMONSTRATION RICE PADDY.

FIGURE 12 "*FUYUMIZU TANGO*" AT RICE PLANING FESTIVAL.

TABLE 2. DRAGONFLY SPECIES OBSERVED IN ENIWA DEMONSTRATION RICE PADDY 2006-2015

Family	Species
Lestidae	*Sympecma paedisca* (BRAUER)
	Lestes sponsa (HANSEMANN)
Platycnemididae	*Copera annulata* (SELYS)
Coenagrionidae	*Coenagrion lanceolatum* (SELYS)
	Coenagrion terue (ASAHINA)
	Coenagrion ecornutum (SELYS)
	Paracercion sieboldii (SELYS)
	Enallagma circulatum (SELYS)
	Ischnura asiatica (BRAUER)
Aeshnidae	*Aeschnophlebia longistigma* (SELYS)
	Aeshna crenata (HAGEN)
	Aeshna juncea (LINNAEUS)
	Anax parthenope julius (BRAUER)
Gomphidae	*Trigomphus melampus* (SELYS)
Corduliidae	*Somatochlora uchidai* (FORSTER)
Macromiidae	*Epophthalmia elegans* (BRAUER)
	Macromia amphigena (SELYS)

Family	Species
Libellulidae	*Sympetrum darwinianum* (SELYS)
	Sympetrum infuscatum (SELYS)
	Sympetrum frequens (SELYS)
	Sympetrum baccha matutinum (RIS)
	Sympetrum eroticum (SELYS)
	Sympetrum kunckeli (SELYS)
	Sympetrum pedemontanum elatum (SELYS)
	Sympetrum croceolum (SELYS)
	Crocothemis servilia mariannae (KIAUTA)
	Pantala flavescens (FABRICIUS)
	Orthetrum albistylum speciosum (UHLER)
	Orthetrum japonicum (UHLER)
	Libellula quadrimaculata asahinai (SCHMIDT)

Reference: Hashibe [2]

VI. CONCLUSION

Rice procurement, communication, education and public awareness and restoration activities for rice-paddy ecosystems are interrelated and, as a whole, they contribute to restoring rice-paddy ecosystems as part of our biodiversityconservation policy. We will continue our activities so as to evolve into a food industry that can be of good effect for both human beings and wildlife.

ACKNOWLEDGMENTS

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REFERENCES

[1] K. Kiritani, Ed. *List of All the Living Things Species in Rice Paddies.* Research Institute of Agriculture and Nature, 2010. (in Japanese)

[2] Y.Hashibe, "Odonata in Ecoring-Village, Eniwa city," in *Bulletin of Hokkaido Odonatological Society*, vol. 27, Hokkaido Odonatological Society, 2016, pp. 8–12. (in Japanese)

Restaurer un écosystème unique en Europe : le secteur privé comme levier de développement d'un projet de territoire fondé sur la restauration de la biodiversité Retour d'expérience sur l'opération Cossure, première expérimentation d'un dispositif de compensation par l'offre en France

L. Rouvière et Ph. Thiévent, *CDC Biodiversité*

RÉSUMÉ. Située entre le Rhône et les Alpilles, la plaine de Crau constitue la seule steppe semi-aride d'Europe occidentale. Le pâturage millénaire et les contraintes hydriques de cette plaine ont conduit à une végétation de steppe rase unique en Europe : le coussoul. Celui-ci héberge une biodiversité remarquable. Située au carrefour d'enjeux stratégiques (développement industrialo-portuaire, infrastructures, agriculture intensive,...) il ne reste aujourd'hui qu'un quart de la surface de steppe initiale, qui continue d'être menacée par l'artificialisation. Pour tenter d'enrayer cette dégradation, un projet de territoire porté par les acteurs locaux émerge au début des années 2000 après 20 ans de concertation. Il s'agit de replacer la vocation du foncier de la Crau sèche en adéquation avec ses potentialités écologiques, issues de 3000 ans de pastoralisme extensif. CDC Biodiversité, filiale du groupe Caisse des Dépôts et Consignations, acquiert alors en 2008, 357 hectares d'anciens « vergers industriels » en Crau afin d'y réhabiliter un espace favorable à l'élevage ovin et à la biodiversité. L'espace naturel restauré avec le concours de scientifiques, complète et renforce la cohérence écologique de la Réserve Naturelle Coussouls de Crau.

Forte de ses compétences écologiques et financières, CDC Biodiversité a pris l'engagement de financer (12,5M€), restaurer et gérer cet espace sur une durée de 30 ans minimum et de faire en sorte d'en maintenir la vocation écologique bien au-delà. Pour réaliser ce projet d'envergure, un mécanisme de financement s'avérait nécessaire. C'est alors que fût engagée, en concertation avec le Ministère de l'Environnement français, cette première expérimentation de constitution d'une « Réserve d'Actifs Naturels » via un dispositif de compensation par l'offre. Expérimentation pilote sur les plans à la fois scientifique, technique et économique, l'opération Cossure représente une expérience de restauration d'écosystème dégradé unique en Europe. A travers la présentation de ce projet, cet article montre le rôle de levier que peut jouer un acteur privé dans la concrétisation d'un projet de territoire fondé sur la réconciliation des activités de l'homme avec la nature.

Restoring an Ecosystem Unique in Europe: Private-Sector Leverage for a Land-Use Plan Based on the Restoration of Biodiversity: Lessons from "Opération Cossure", the First Trial of an Offset Supply Scheme in France

ABSTRACT. Located between the Rhone and the Alpilles mountains in the south of France, the Crau Plain comprises the only semi-arid steppe in western Europe. Thousands of years of use as pastureland, together with harsh hydrological conditions, have combined to create the "*coussoul*", an expanse of close-cropped steppe vegetation that is unique in

Europe and host to remarkable array of biodiversity. Located amidst a number of major strategic players (industry/port complex, infrastructure, intensive agriculture, etc.), the steppe has been reduced to one quarter of its original size, and even this area continues to be threatened by human encroachment. In an effort to stop this degradation, a new, locally developed land-use project emerged in the early 2000s after twenty years of consultations. The idea was to bring the use of the lands of the arid Crau into line with their ecological potential, itself the product of 3,000 years of low-intensity grazing. In 2008, *CDC Biodiversité*, a subsidiary of the *Caisse des Dépôts* group, acquired a 357-hectare commercial orchard on the Crau plain in order to turn it into an area favourable for sheep farming and biodiversity. Once restored with the help of scientists, this natural area would enhance and bolster the ecological integrity of the *Coussouls de Crau* Nature Reserve.

With its expertise in both finance and environmental science, *CDC Biodiversité* has undertaken to provide financing (€12.5 million), restore and manage the area for at least 30 years, and to ensure that its ecological purpose continues to be fulfilled well beyond that time. It was clear that the implementation of a project of this sort would require a financial mechanism to be put in place. This resulted in the launch, in consultation with the French Ministry of the Environment, of this first pilot "natural assets reserve" through an offset supply scheme. As a pilot trial at the scientific, technical and economic levels, *Opération Cossure* is an experiment in restoring a degraded ecosystem that is unique in Europe. In describing the project, the article underlines the leverage role that business can play in realizing a land-use plan based on reconciling human activities and nature.

La restauración de un ecosistema único en Europa: El apalancamiento del sector privado para un proyecto de uso de la tierra sobre la base de la recuperación de la biodiversidad: Lecciones de la "Operación Cossure", la primera prueba de un sistema de suministro de offsets en Francia

RESUMEN[1] - Situado entre el Rhone y las montañas Alpilles en el sur de Francia, la llanura Crau comprende la única estepa semiárida en Europa Occidental. Miles de años de uso como pastos, junto con condiciones hidrológicas adversas, se han combinado para crear el "Coussoul", una extensión de la vegetación esteparia que es única en Europa y sede de notable variedad de biodiversidad. Situada en medio de una serie de actores estratégicos importantes (industria / complejos de puertos, infraestructura, agricultura intensiva, etc.), la estepa se ha reducido a un cuarto de su tamaño original, y además esta zona sigue estando amenazada por la invasión humana. En un esfuerzo por detener esta degradación, un nuevo proyecto de uso de la tierra, desarrollado en el país surgió en la década de 2000 después de veinte años de consultas. La idea era armonizar el uso de las tierras áridas de la Crau con su potencial ecológico, a su vez producto de 3.000 años de pastoreo de baja intensidad. En 2008, los *CDC Biodiversité*, una filial del grupo *Caisse des Dépôts*, adquirió un huerto comercial de 357 hectáreas en la llanura de Crau con el fin de convertirlo en un área favorable para la cría de ovejas y la biodiversidad. Una vez restaurado con la ayuda de los científicos, este espacio natural mejoraría y reforzaría la integridad ecológica de la Reserva Natural de *Coussouls de Crau*.

Con su experiencia en la financiación y ciencias ambientales, los *CDC Biodiversité* se hab comprometido a proporcionar financiación (€12,5 millones), restaurar y manejar la zona durante al menos 30 años, y asegurar que su finalidad ecológica se mantenga más allá de este periodo de tiempo. Es claro que la aplicación de un proyecto de esta importancia requeriría de la implementación de un mecanismo financiero. Esto dio lugar a la puesta en marcha, en consulta con el Ministerio de Medio Ambiente Francés, de este primer piloto de "Reserva de Activos *[assets]* Naturales" a través de un sistema de suministro de offsets. A modo de prueba piloto en los niveles científico, técnico y económico, *Operación Cossure* es un experimento en la restauración de un ecosistema degradado que es único en Europa. En la descripción del proyecto, el artículo subraya el papel apalancamiento que las empresas pueden desempeñar en la realización de un plan de uso de la tierra basado en la conciliación de las actividades humanas y la naturaleza.

Lôra Rouvière est Chargée d'études et des publications à CDC Biodiversité

Philippe Thiévent est Directeur de CDC Biodiversité

1 Translated from English by Daniela Cajiao

INTRODUCTION

CDC Biodiversité a initié en 2008, avec le ministère français de l'Ecologie, une opération pilote de création de Réserve d'Actifs Naturels sur le site de Cossure afin de réhabiliter et de restaurer, sur 357 hectares, un écosystème unique en Europe : les coussouls de la plaine de Crau (Bouches du Rhône). L'opération Cossure concrétise un projet imaginé par les acteurs clés du territoire. Collectivités locales, agriculteurs, naturalistes, scientifiques et administrations en charge de l'agriculture et de l'environnement ont fait le choix d'une réhabilitation écologique et pastorale du site de Cossure, qui permet de renforcer la cohérence écologique de la Réserve Naturelle Coussouls de Crau adjacente. Forte de ses compétences à la croisée des ingénieries financières et écologiques, CDC Biodiversité a pris l'engagement de mener l'opération sur un premier pas de temps de 30 ans, par la mise en place d'un dispositif de compensation par l'offre, première expérimentation en France, et de faire intervenir des spécialistes locaux. Après une description de l'opération et de ses enjeux à la fois écologiques et territoriaux, cet article mettra en avant les deux volets expérimentaux qui constituent le socle de cette action de restauration et qui ont rendu possible cette opération : l'expérimentation d'un mécanisme de de compensation par l'offre à l'origine du projet et l'expérimentation scientifique et technique. Enfin, les premiers résultats écologiques et économiques seront exposés.

I. LES COUSSOULS DE LA PLAINE DE CRAU : UN ÉCOSYSTÈME, UN TERRITOIRE

A. Un écosystème unique et menacé

Située entre le Rhône et les Alpilles, au carrefour des communes d'Arles, de Salon-de-Provence et de Fos-sur-Mer, dans le département des Bouches-du-Rhône, la plaine de Crau constitue la seule steppe semi-aride d'Europe occidentale. Vaste étendue de galets déposés par la Durance durant plusieurs millions d'années, jusqu'à ce que son cours change il y a quelques 30 000 ans, il s'agit d'une plaine à sol pauvre, sec et caillouteux, dénudée et battue par les vents [2]. L'existence d'une couche de poudingue très peu perméable et proche de la surface explique en partie le développement d'un milieu de type steppique. Depuis plus de 3 000 ans, la plaine de Crau est pâturée par des troupeaux de moutons. Ce pâturage multimillénaire et les conditions très sèches ont conduit à une végétation de steppe rase, unique en Europe, à croissance printanière : le coussoul[2] (fig 1). Cet habitat, très contraignant du point de vue hydrique, a entrainé la vie à développer une grande diversification de stratégies pour y survivre, formant ainsi cette végétation unique et un réservoir de biodiversité. La flore y est très riche. Certains botanistes l'ont d'ailleurs considéré comme l'association végétale la plus riche de Provence [2]. On y dénombre aujourd'hui plus de 70 espèces de plantes à fleurs par m² [2]. En ce qui concerne la faune, cet écosystème abrite des espèces rares en France et en Europe, dont certaines endémiques, telles que le Criquet rhodanien (*Prionotropis hystrix rhodanica*) ou le Bupreste de Crau (*Acmaeoderella cyanipennis perroti*). La plaine de Crau est essentielle en France pour les espèces des milieux pierreux ouverts : elle accueille la seule population française de Ganga cata (*Pterocles alchata*) et des populations remarquables d'Œdicnème criard (*Burhinus oedicnemus*), d'alouettes et de Lézard ocellé (*Timon lepidus*). Elle constitue un refuge vital pour la population méditerranéenne d'Outarde canepetière (*Tetrax tetrax*), tant en nidification qu'en hivernage. Ces éléments remarquables de la biodiversité sont menacés par l'artificialisation et la destruction progressive de cet écosystème.

FIGURE 1 PHOTO DES COUSSOULS DE LA PLAINE DE CRAU

En effet, sur les 40 000 ha existants au 17ème siècle il ne restait plus que 11 500 ha de coussouls en 1990, en partie fragmentés. En cause notamment, le développement de l'agriculture irriguée traditionnelle à partir de la fin du XIXème siècle et l'émergence de l'agriculture intensive moderne, principalement le foin de Crau, les cultures de melons et les vergers industriels. En effet, l'arrivée de l'irrigation a permis

2 Coussoul, du bas latin cursorium signifiant parcours (trace de la vocation de parcours à moutons du site).

d'envisager cet espace, longtemps perçu par les pouvoirs publics et les acteurs locaux comme stérile, hostile et sans intérêt paysager, comme un lieu fertile pour y développer l'agriculture. L'aménagement de canaux d'irrigation dès le XVIème siècle avait déjà marqué un tournant : la fin possible de l'aridité. Cette mise en culture a également été facilitée par la richesse en limons de la rivière, formant, après quelques années d'irrigation, un sol riche qui profite principalement au foin de Crau, transformant la plaine en prairie irriguée pour la culture du foin sur plus de 13 500 ha[3], dont 8 500 ha classés AOP/AOC[4] renommés mondialement. Le maraîchage, initié dans les années 60 grâce au pompage de la nappe phréatique, et le développement de l'arboriculture intensive sur les coussouls de Crau à la fin des années 70, va continuer à grignoter un peu plus cet écosystème [4]. Plus récemment, l'implantation d'importantes infrastructures, notamment industrielles et logistiques, a entrainé l'arrivé de nouvelles activités. En outre, son positionnement géographique au sein d'une zone de développement attractive qui relie de grands axes d'échange et le Grand Port Maritime de Marseille, soumet cet écosystème à de fortes pressions. Ces facteurs d'impacts multiples et anciens ont transformé la plaine de Crau. Il ne reste actuellement qu'un quart des quelques 400 km² de végétation rase pâturée, dont une partie est aujourd'hui protégée par la Réserve Naturelle Nationale Coussouls de Crau (RNCC) (fig. 2).

B. Un contexte territorial historiquement conflictuel : quelle vocation pour la Crau sèche ?

La volonté de redonner à la Crau sèche sa vocation écologique, via l'adaptation de l'activité de la zone aux conditions du milieu, résulte d'un long processus de concertation entre les acteurs du territoire. Ce territoire

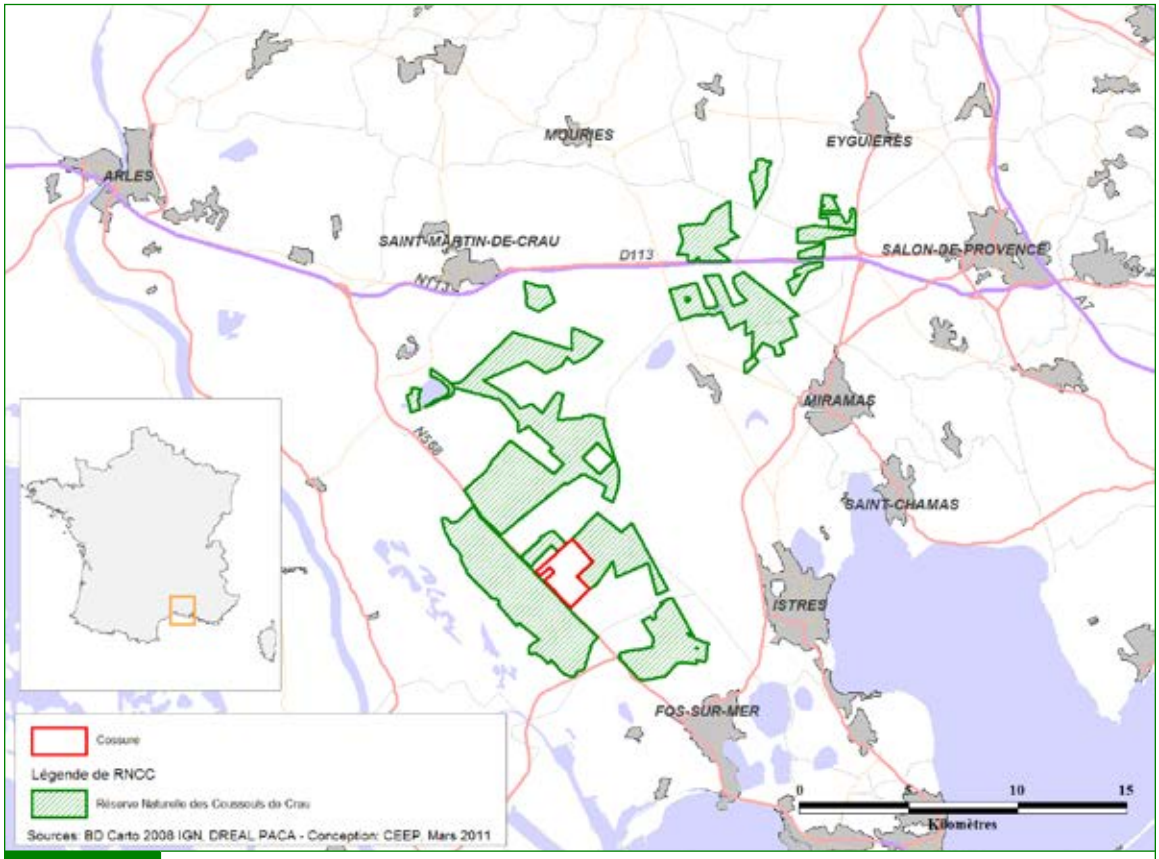

FIGURE 2 LOCALISATION GÉOGRAPHIQUE DU SITE DE COSSURE

3 Source : Comité du foin de Crau http://foindecrau.com/

4 Le foin de Crau est la seule production labélisée AOP/AOC qui ne soit pas destinée à la consommation humaine, ce qui en fait sa renommée internationale.

était confronté à un conflit historique opposant d'un côté les naturalistes, partisans de la restauration et de la préservation du milieu pour soutenir la richesse écologique de cet écosystème unique, et de l'autre, aménageurs, agriculteurs et chasseurs qui, pour une grande majorité, l'envisageait comme un territoire offrant de nombreuses opportunités d'aménagement. En effet, le secteur agricole, poussé par l'arrivée de l'irrigation, appréhendait déjà le fort potentiel de développement de la zone à l'origine des grands projets d'agriculture intensive sur la plaine. Parallèlement, le positionnement géographique stratégique de celle-ci vis-à-vis des grandes infrastructures alentours (pétrolières, aéroportuaires, maritimes,...), attirait de nombreux aménageurs désireux de développer des infrastructures ou d'étendre les zones urbaines. Au cœur d'enjeux stratégiques antagonistes, ce territoire a été le terrain pendant plus de 20 ans d'un désaccord entre les acteurs du territoire, confrontés à ce qui était perçu à l'époque comme une dichotomie : développer le territoire économiquement et préserver la biodiversité.

Après des rapports difficiles dans les années 80, la Crau devient le cadre d'un dialogue fécond entre agriculteurs et protecteurs de la nature. En effet, la préservation de ce biotope est conditionnée par le maintien du pastoralisme. La reconnaissance de cette interaction entre la nature, l'homme et le mouton sur la plaine de Crau est à l'origine du consensus entre les acteurs du territoire, qui en fait un véritable socio-écosystème. La Réserve Naturelle Nationale Coussouls de Crau (RNCC) est créée le 8 octobre 2001 afin de protéger 7 500 ha de coussouls sur les 10 000 ha restants. La mise en place en 2004 d'une cogestion de cette réserve entre le Conservatoire d'Espaces Naturels de Provence-Alpes-Côte d'Azur (CEN PACA) et la Chambre d'Agriculture des Bouches du Rhône (CA 13) est venue officialiser et donner une visibilité à ce travail conjoint. Il repose sur le partage des savoirs et d'expériences dans les domaines pastoraux et écologiques ainsi que sur la mise en commun d'objectifs, à savoir : défendre la viabilité de ce système pastoral [4]. C'est la première fois qu'une association de protection de la nature et un organisme professionnel agricole s'associent pour gérer une réserve naturelle. L'opération de réhabilitation et de restauration que CDC Biodiversité a portée est la conséquence de ce contexte local favorable.

II. L'OPÉRATION COSSURE : UN LEVIER DE DÉVELOPPEMENT DU PROJET DE TERRITOIRE

A. Naissance d'une opération inscrite dans le territoire

En 2006, 357 ha de vergers situés à Saint-Martin-de-Crau, au cœur de la Crau sèche, sont mis en vente dans le cadre d'une liquidation de biens suite à la faillite du propriétaire. Les pouvoirs publics, sous le pilotage des directions Régionale et Départementale de l'Agriculture et de la Forêt (DRAF et DDAF) et de la Direction Régionale de l'Environnement (DIREN), se mobilisent pour trouver une solution d'acquisition foncière des parcelles en position stratégique, avec pour objectif d'améliorer la cohérence écologique de la réserve naturelle et d'augmenter la connectivité écologique entre la Crau à l'Est et la Camargue à l'Ouest. Un comité de pilotage est mis en place impliquant de nombreux partenaires territoriaux (collectivités, profession agricole, naturalistes, pouvoirs publics et scientifiques)[5]. Ce comité réunit, via certains partenaires, les moyens d'acquérir un cinquième des surfaces en vente. Il s'agit donc de choisir la partie apte à offrir la meilleure cohérence écologique avec la réserve. En 2007, la DIREN PACA sollicite CDC Biodiversité[6] pour examiner les possibilités d'intervention en tant qu'opérateur de la restauration éco-pastorale de ces parcelles de vergers. Sous réserve d'une pertinence écologique démontrée adossée à un modèle économique, celle-ci propose d'acquérir l'ensemble (357 ha). En concertation avec le Ministère de l'Ecologie, dans le cadre des réflexions communes menées en parallèle sur l'expérimentation d'un dispositif de compensation écologique par l'offre en France (cf. III – A), CDC Biodiversité acquiert en 2008 les 357 ha d'anciens vergers afin d'y réhabiliter un milieu favorable à l'élevage ovin et à la biodiversité, en conformité avec le projet de territoire.

Depuis 2006, le verger n'était plus exploité ni entretenu, les arbres n'étaient plus irrigués et avaient perdu leurs capacités de production. La moitié avait été arrachée pour prévenir l'extension d'un virus,

5 L'Etat avec la DRAF, la DDAF et la DIREN ; le Conseil régional de PACA ; le Conseil général des Bouches du Rhône ; la Chambre d'agriculture des Bouches du Rhône ; l'Etablissement public foncier de PACA ; la Fédération Départementale des Syndicats d'Exploitants Agricoles (FDSEA) des bouches du Rhône ; le Syndicat du foin de Crau ; la SAFER de PACA ; le Conservatoire des Espaces Littoraux et des Rivages Lacustres (CELRL) ; le CEN PACA.

6 Alors en cours de constitution et ayant pour projet de monter des opérations pilotes de « Réserves d'Actifs Naturels »

mais laissée sur place. Les réseaux d'irrigation subsistaient en surface sur l'ensemble du site ainsi que les canalisations enterrées d'eau et d'air comprimé.

CDC Biodiversité s'engage, sur le site acquis très dégradé et artificialisé, à reconstituer une végétation de pelouse sèche rase, composée majoritairement d'espèces sauvages communes en Crau sèche (engagement sur le résultat), sur la totalité des parcelles pour une durée de 30 ans. L'objectif est d'offrir un habitat convenable à plusieurs espèces emblématiques identifiées de la Crau sèche : Outarde canepetière, Ganga cata, Oedicnème crirard, Alouette calandre, Alouette calandrelle, notamment. Ceci en réinstallant un pastoralisme traditionnel, en faisant appel à des éleveurs locaux, comme les coussouls traditionnels de la Crau sèche (engagement sur les moyens). CDC Biodiversité se donne également des objectifs complémentaires de restauration à moyen ou long terme, ne comportant pas d'engagement de résultat en raison des incertitudes et des méconnaissances scientifiques actuelles, ajoutant ainsi un volet recherche à l'opération (cf. III.B.). L'opération Cossure constitue véritablement l'aboutissement d'un consensus entre la profession agricole locale et les acteurs de l'environnement autour d'un projet de territoire partagé.

B. Mise en œuvre du projet de réhabilitation et restauration des habitats

Cette opération représente un budget total de 12,5 millions d'euros répartis en trois postes principaux : achat du foncier, réalisation des travaux de réhabilitation et de restauration écologique, et enfin gestion et suivi sur 30 ans. La mise en œuvre de ce projet comporte quatre étapes clés. Tout d'abord la sécurisation foncière avec l'acquisition par CDC Biodiversité des 357 ha de vergers en 2008 et la réalisation d'un état initial. Puis CDC Biodiversité réalise les travaux de réhabilitation du site en 2009 et 2010. Ces travaux conséquents ont consisté en premier lieu au nettoyage du site ainsi qu'à la résorption d'une décharge en contact avec la nappe. Puis, l'enlèvement des arbres et de leurs souches, valorisés en bois énergie, ainsi que l'enlèvement du réseau d'irrigation, valorisé dans les filières de fabrication de mobilier urbain. Puis, la remise en état du sol, du fait des ados créés pour la plantation d'arbres, afin de restaurer la surface plane originelle. Enfin, la dernière étape de réhabilitation a été la revégétalisation du site favorable au cortège faunistique emblématique de la Crau sèche, faisant appel à plusieurs techniques expérimentales (cf. III.B.). Afin de garantir la démarche de développement durable, caractéristique de l'ensemble de cette opération, une grande place a été accordée au recyclage des matériaux et à la traçabilité de l'ensemble des produits exportés.

La dernière étape de l'opération concerne la gestion conservatoire. Cette gestion écologique des milieux est essentiellement fondée sur l'écopastoralisme, à la genèse de ces formations, couplée à une mission de surveillance et de suivi confiée aux co-gestionnaires de la RNCC. Deux unités à vocation pastorale ont ainsi été créées, pâturées au printemps. Cette réhabilitation a nécessité la réalisation des aménagements pastoraux (bergeries et abreuvoirs). Elle vise la mise en place d'une gestion courante durable du site, qui puisse offrir une garantie d'accès aux ressources pour les éleveurs dans la durée et qui aide à pérenniser localement l'élevage ovin transhumant (aide à des éleveurs déjà installés et en manque de surfaces ou aide à l'installation de jeunes éleveurs). L'objectif est donc à la fois la réhabilitation d'une fonction de l'écosystème, c'est-à-dire la capacité d'accueil des oiseaux steppiques, et d'une « fonction socio-territoriale » via l'élevage ovin traditionnel multimillénaire [3].

Le suivi de l'opération implique deux comités de suivi réunissant les différentes parties prenantes (fig. 3). D'un côté, un comité local de montage technique et méthodologique de l'opération, piloté par CDC Biodiversité, qui réunit le CEN PACA, la chambre d'agriculture, le Conseil Scientifique Régional du Patrimoine Naturel (CSRPN), la Direction Départementale des Territoires et de la Mer (DDTM 13) , la Directions Régionales de l'Environnement, de l'Aménagement et du Logement (DREAL) , et l'Institut Méditerranéen de Biodiversité et d'Ecologie marine et continentale (IMBE) . Celui-ci joue un rôle central dans la conduite technique des opérations et notamment sur les décisions relatives à la gestion et au suivi écologique de l'opération. De l'autre, un comité national piloté par le ministère, qui réunit le CGDD, la DGALN, les DREAL intéressées, les opérateurs de compensation écologique invités et le CNPN, se concentre sur les volets liés à l'expérimentation du dispositif de compensation écologique par l'offre : la Réserve d'Actifs Naturels de Cossure (cf. III -A.).

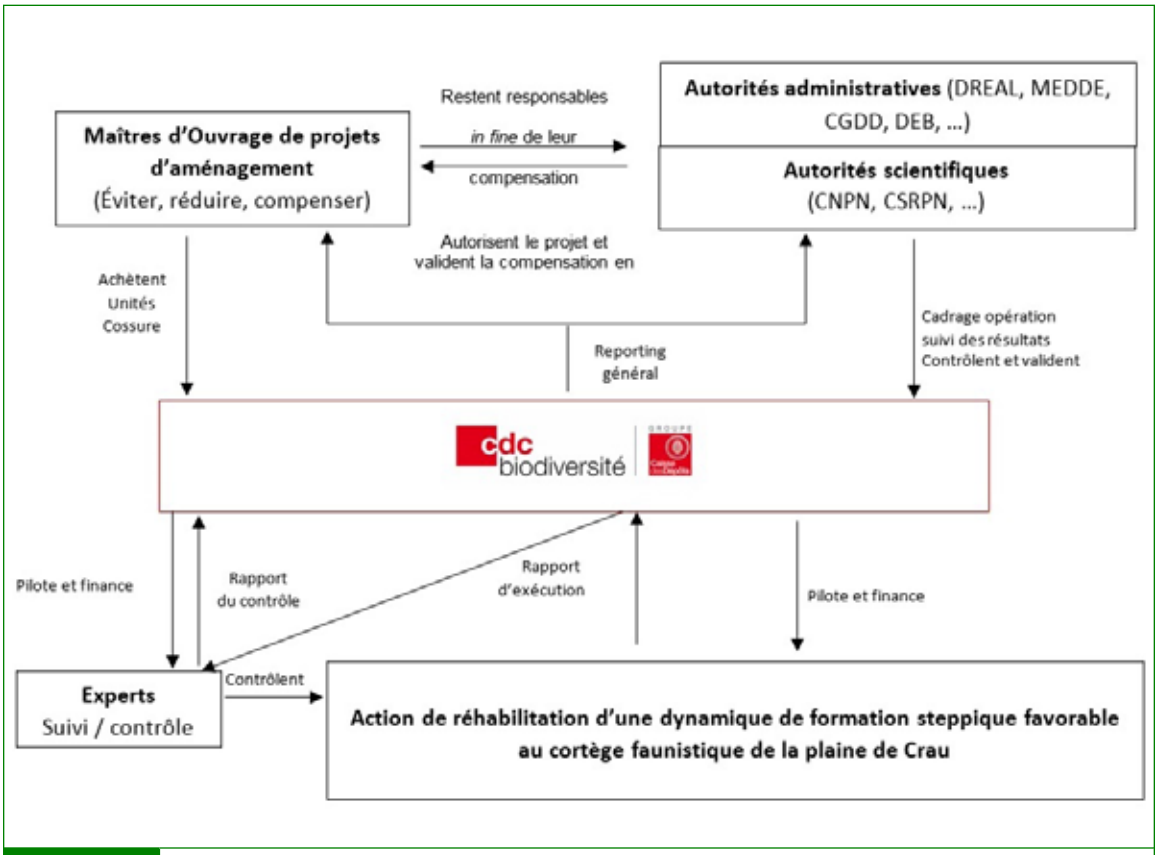

FIGURE 3 SCHÉMA DE LA MISE EN ŒUVRE DE L'OPÉRATION COSSURE

Ce projet représente l'une des plus grosses opérations en Europe de reconquête d'espaces naturels artificiellement dégradés.

III. LES CLÉS DE L'EXPÉRIMENTATION ÉCONOMIQUE, SCIENTIFIQUE ET TECHNIQUE : SOCLE D'UNE MISE EN ŒUVRE RÉUSSIE

A. Développer un mécanisme de financement nécessaire à la mise en œuvre et à la pérennité des objectifs écologiques : création de la première Réserve d'Actifs Naturels en France

Prévue en France dès 1976[7] et réaffirmée quarante ans plus tard par la loi pour la reconquête de la biodiversité, de la nature et des paysages[8], la compensation écologique fait partie intégrante du cadre réglementaire français relatif à la réparation des dommages causés à la biodiversité, suivant la séquence Eviter-Réduire-Compenser. Elle cible les impacts résiduels significatifs d'un projet d'aménagement, c'est-à-dire les impacts qui n'ont pu être ni évités ni suffisamment réduits. Dans ce contexte, compenser signifie réaliser une action positive et additionnelle pour la biodiversité. En complétant les mesures d'évitement et de réduction, elle doit permettre de viser une logique de non perte nette de biodiversité, en s'appuyant sur la notion d'équivalence écologique. La responsabilité juridique des mesures compensatoires incombe l'aménageur.

L'appui aux politiques publiques dans le domaine de l'environnement entre dans les champs de compétences de la Caisse des Dépôts et Consignations[9]. Dans ce cadre, elle s'intéresse

7 Loi n°76-629 du 10 juillet 1976 relative à la protection de la nature

8 Loi n°2016-1087 du 8 août 2016

9 Caisse des Dépôts is a public group serving the public interest and the country's economic development. The Group carries out missions of public interest in support of the public policies implemented by the State and local government bodies, and may also exercise competitive activities. Caisse des Dépôts is a long-term investor and contributes to the development of enterprises in line with its own proprietorial interests.

au début des années 2000 à la question du financement de la biodiversité et lance en 2006 la Mission Biodiversité[10] afin d'étudier la faisabilité de financement de la biodiversité à partir des mécanismes de compensation écologique. En parallèle, face aux défaillances de l'application de la séquence Eviter-Réduire-Compenser en France, et ce, malgré son inscription dans la loi depuis 1976, des réflexions sont menées au niveau du ministère français de l'Ecologie pour limiter l'érosion de la biodiversité entrainée par la non-application de cette réglementation et, plus largement, pour mobiliser des financements additionnels et innovants pour la préservation de la biodiversité. Des discussions sont alors engagées entre la Caisse des Dépôts et Consignations et le ministère de l'Ecologie pour la mise en œuvre de mécanismes de compensation écologique par l'offre.

La démarche de compensation écologique par l'offre consiste, pour un opérateur de compensation, à anticiper des besoins potentiels de compensation d'un ou plusieurs maîtres d'ouvrage en procédant à la restauration, la réhabilitation et/ou la création de milieux naturels sur des sites préalablement acquis. Cette action permet de constituer des unités de compensation. L'opérateur finance à l'avance l'ensemble de l'action. Les unités de compensation ainsi créées pourront servir aux aménageurs pour leurs besoins futurs de compensation dès lors qu'elles correspondent aux impacts à compenser.

En juin 2007, la faisabilité réelle de l'opération Cossure est établie et quelques mois plus tard, le ministère de l'Ecologie reconnait l'intérêt de cette opération pilote pour expérimenter la mise en œuvre d'un dispositif de compensation par l'offre en région PACA avec CDC Biodiversité nouvellement créée. Ce qui aboutira, un an plus tard, à la création de la première Réserve d'Actifs Naturels en France. Cette opération permet à des aménageurs redevables d'actions de compensation en plaine de Crau de souscrire l'acquisition d'« actifs naturels Cossure ». L'achat de ces actifs, ou unités de compensation, par un maître d'ouvrage doit être préalablement validé en tant que mesure compensatoire par les autorités administratives compétentes. La mise en place de ce mécanisme a permis la réalisation de cette opération de restauration écologique de grande ampleur portée par un opérateur doté d'une robustesse économique apte à porter une telle opération dans la durée.

Cette approche présente plusieurs avantages :

- Elle permet d'une part de répondre à des enjeux écologiques nécessitant une intervention rapide sans laquelle les terrains pourraient être le lieu d'aménagements non compatibles avec des objectifs de préservation de la biodiversité.

- La mutualisation des obligations de compensation visant le même habitat permet à la fois d'éviter la dispersion des mesures de faible ampleur et par conséquent de réaliser des actions de grande envergure, écologiquement plus efficaces et cohérentes, et moins coûteuses.

- L'action anticipée permet de garantir qu'au moment de l'impact, la mesure compensatoire soit déjà engagée.

- Enfin, cette approche permet d'optimiser le contrôle par les services de l'Etat ainsi que le suivi des mesures compensatoire sur le long terme.

Il est encore à noter que la création de la Réserve d'Actifs Naturels de Cossure n'a pas attiré de projets d'aménagement qui n'auraient pas vu le jour sans elle. En outre, la mobilisation de fonds privés a permis de conduire une expérimentation à grand échelle qui n'aurait pas pu être réalisée avec le seul concours des budgets de l'Etat et des collectivités [3].

B. Développer la connaissance de la dynamique des formations de coussouls et de sa restauration : une opération de génie écologique de grande ampleur

Dans le cadre de la réalisation de cette opération, CDC Biodiversité s'est donné des objectifs complémentaires de restauration à long terme, sans engagement chiffré ou daté en raison des incertitudes et méconnaissances scientifiques actuelles. Cela concerne la réduction, voire la disparition, des adventices ainsi que la reconstitution des conditions oligotrophes semblables à celles des coussouls d'une part, et la reconstitution de cortèges végétaux composés principalement d'espèces caractéristiques végétales et animales remarquables de ce milieu d'autre part. Ces objectifs complémentaires apportent une dimension expérimentale de premier ordre à l'opération Cossure et renforcent les gains écologiques attendus. Ils orientent les protocoles de

10 Mission de recherche qui a précédé la création de CDC Biodiversité

remise en état du site, de végétalisation et de gestion courante, dans un cadre scientifique expérimental de grande ampleur. De plus, ils rendent nécessaires la définition d'indicateurs biologiques supplémentaires et la réalisation de suivis plus précis et plus poussés, permettant ainsi de développer des techniques de génie écologique et d'améliorer les connaissances relatives à la restauration des coussouls de Crau. C'est dans ce cadre expérimental que s'est inscrit de 2009 à 2012 la réalisation d'une thèse de doctorat sur la restauration du cortège végétal de coussouls[11] ainsi qu'une thèse sur le peuplement entomologique.

Les opérations de végétalisation se sont déroulées en expérimentant plusieurs techniques de restauration [2] :

- Des expérimentations de semis d'espèces nurses visant à empêcher la prolifération d'adventices et à faciliter l'installation des espèces typiques des coussouls (60 ha);
- Des expérimentations d'épandage de foins récoltés dans des coussouls puis épandus sur les surfaces réhabilitées du verger (24 ha) ; et
- Des expérimentations d'inoculum de sol permettant à la fois l'apport de graines d'espèces typiques des coussouls et l'apport de parties végétatives et de constituants biologiques des sols (3 ha).

L'objectif des transferts est ainsi d'apporter des graines d'espèces de la communauté végétale de référence et celui de l'étrépage du sol, de diminuer la quantité de graines d'espèces adventices et de résidus d'engrais apportés durant la phase de culture.

L'ensemble des traitements ont bien permis la création d'une végétation dominée par des espèces herbacées. Très peu d'espèces arbustives proliférantes (ronces) ou envahissantes (micocouliers) ont pu s'installer. De même, les espèces domestiques plantées lors de la période d'exploitation (pêchers, abricotiers, peupliers) sont actuellement maîtrisées par le pâturage ovin. Les résultats les plus probants concernent le transfert de sol comme le montre la figure 4.

Les résultats encourageants concernant ce traitement ont incité d'autres acteurs à utiliser cette technique, notamment dans le cadre de restauration d'habitats suite à une pollution accidentelle.

Par ailleurs, l'ampleur du projet a également nécessité le développement de techniques d'ingénierie écologique et induit des innovations (mise au point de machine, développement de nouveaux procédés,...). D'un point de vue scientifique, l'expérimentation à grande échelle est une occasion unique pour le développement de la connaissance sur la formation de ces milieux.

IV. PREMIERS RÉSULTATS : POINT D'ÉTAPE SUR LA PÉRIODE 2009-2015

Du point de vue écologique, après cinq années de mise en œuvre du premier plan de gestion, suite à une évaluation intermédiaire réalisée par le CEN PACA en septembre 2015, les principaux objectifs de gestion et de conservation du patrimoine naturel visés par l'opération ont été accomplis [1]. Le site présente une physionomie de pelouse sèche, globalement favorable à la faune steppique (fig, 5 et 6), et a été recolonisé par la grande majorité des espèces animales visées, notamment l'Outarde

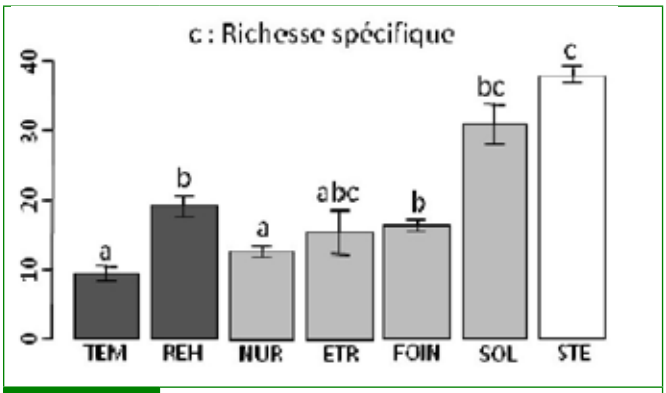

FIGURE 4 RICHESSE SPÉCIFIQUE EN FONCTION DES TRAITEMENTS DE RESTAURATION

zone témoin (TEM), zone réhabilitée (REH), Semis d'espèces nurses (NUR), étrépage de sol (ETR), Trasfert de foin (FOIN), transfert de sol (SOL) et zone de steppe de référence (STE). Au sein de chaque graphique, deux barres surmontées par une lettre identique ne présentent pas de différences significatives.

11 Thèse intitulée « Dynamique et restauration d'une steppe méditerranéenne après changements d'usages (La Crau, Bouches-du-Rhône, France) » (16 sept. 2016), réalisée en partenariat avec l'Institut Méditerranéen de Biodiversité et d'Ecologie (IMBE) et l'Université d'Avignon, cofinancé par CDC Biodiversité, le Conseil régional PACA et le CNRS. Disponible en ligne sur : https://tel.archives-ouvertes.fr/tel-00862398

FIGURE 5 VUE AÉRIENNE EN 2008 AVANT MISE EN ŒUVRE DE L'OPÉRATION

FIGURE 6 VUE AÉRIENNE 2012 APRÈS TRAVAUX DE RÉHABILITATION DU SITE

canepetière et l'Alouette calandre. Les densités d'outardes observées en période de reproduction sont très satisfaisantes et le site assure également de bonnes conditions d'hivernage de l'espèce. L'une des principales gageures au démarrage du programme était de parvenir à instaurer une gestion adaptative permettant de répondre à la principale inconnue : la dynamique de la végétation. Cette gestion adaptative a été conduite grâce au dialogue mis en place avec les éleveurs et les modifications apportées à la gestion pastorale qui ont largement contribué au maintien durable de la physionomie de pelouse sèche. Bien que certains paramètres restent à surveiller, notamment la hauteur et la densité de la pelouse, la dynamique des milieux naturels sur le site reste sous contrôle. La ressource pastorale disponible sur le domaine ainsi que les bonnes conditions d'accueil des troupeaux font que le site de Cossure répond aux objectifs zootechniques et économiques des éleveurs qui l'utilisent. Les premières années de gestion ont montré la bonne compatibilité entre les objectifs de conservation du patrimoine naturel et les objectifs d'élevage, tout en mobilisant une gestion adaptative et concertée.

D'un point de vue économique, à ce jour, l'opération a permis à 6 aménageurs de réaliser effectivement leur compensation, en mobilisant au total près de la moitié des unités de compensation de la Réserve d'Actifs Naturels de Cossure. Ce résultat est en décalage avec les prévisions initiales du modèle économique réalisé en 2008. Cela s'explique en partie par la non-réalisation de certains projets, se traduisant donc par une non dégradation des milieux ; ce qui est un point positif pour la nature. Mais aussi par le fait que les actions de compensation de quelques projets, initialement destinées à l'opération Cossure, ont été orientées vers d'autres destinées telles que l'acquisition de coussouls en bon état écologique ne nécessitant pas de restauration ; ce qui pose la question de l'additionnalité relative d'une action correspondant à la « simple » acquisition/conservation de milieux naturels.

Si le résultat écologique et scientifique est tout à fait encourageant, le fait est de constater qu'un véritable projet d'offre de compensation nécessite un portage financier impliquant, sous peine d'échec, une grande robustesse économique de l'opérateur de compensation. Le statut de CDC Biodiversité, filiale de premier rang de la Caisse des Dépôts et Consignations est déterminant dans le soutien à long terme de cette opération. Notons toutefois, qu'en cas de réalisation des hypothèses de départ, c'est-à-dire l'utilisation des unités de compensation de la Réserve d'Actifs Naturels de Cossure pour l'ensemble des aménagements réalisés et prévus dans le scénario initial (en dehors des projets qui n'ont pas vus le jour), le taux d'utilisation des unités de compensation serait à ce jour de près de 90 %.

La nouvelle loi pour la reconquête de la biodiversité, de la nature et des paysages, promulguée le 8 août 2016, a inscrit dans le cadre français la possibilité de recourir à des « sites naturels de compensation » (dénommés jusque-là « Réserve d'Actifs Naturels ») pour remplir les obligations des maîtres d'ouvrage. Ce renforcement du cadre laisse présager une mise en œuvre effective de ce mécanisme dotée d'un contrôle adapté pour contribuer à limiter l'érosion de la biodiversité en France.

V. CONCLUSION

La réalisation de cette opération permet de tirer plusieurs enseignements. Tout d'abord, elle démontre le potentiel des acteurs socio-économiques comme levier de déploiement d'un projet de territoire à vocation écologique. C'est pourquoi, le positionnement de l'opérateur en tant qu'acteur parmi les acteurs du territoire est une condition de réussite d'un projet d'une telle ampleur. Mais, cette opération a été rendue possible grâce à la mise en place d'un mécanisme de financement permettant de tenir des objectifs sur le long terme. Cet engagement sur le long terme qui reste une nécessité écologique pour la restauration d'écosystèmes dégradés, est fortement tributaire de la solidité financière de l'opérateur. CDC Biodiversité, en tant que filiale du groupe Caisse des Dépôts - institution financière d'investissement sur le long terme au service de l'intérêt général - a pu agir comme un tiers de confiance disposant d'une capacité d'ingénierie et d'une solidité financière adaptée à la conduite de cette opération. Enfin, la question des incertitudes scientifiques et du manque de connaissances sur le fonctionnement et la dynamique de certains milieux est un paramètre nécessaire à prendre en compte qui, s'il ne doit pas être un frein pour l'action, nécessite une approche par l'expérimentation, une gestion adaptative, ainsi qu'un accompagnement par la communauté scientifique.

REFERENCES

[1] CDC Biodiversité, DREAL PACA, CEN PACA, IMBE, INRA et CA13, « Réserve d'Actifs Naturels de Cossure. Evaluation Intermédiaire », Rapport, juin 2016.

[2] T. Dutoit, « Pèr memori l'ermas de Crau ? in memoroam le coussoul de Crau ? », *Courrier de l'environnement de l'INRA*, no. 58, pp. 37-44, Mars 2010.

[3] T. Dutoit, C. Calvet, R. Jaunatre, J.-F. Alignan, A. Wolff, F. Sauguet, A. Bulot, E. Buisson, J.-F. Debras, E. Provost et C. Napoléone, « Première expérimentation de compensation par l'offre : bilan et perspective », *Revue L'ingénierie écologique au service de l'aménagement du territoire*, no. 16, p. 69-69, 2015.

[4] P.Fabre, F. Sauguet et A.Wolff, « La réserve naturelle des coussouls de Crau : pastoralisme et biodiversité », in *Le Merinos d'Arles. Passion de bergers*, Dir. P. Fabre et G. Lebaudy, Marseille : Images en Manœuvres Editions et Maison de la Transhumance, 2010, pp.468-477.

[5] H. Levrel, N. Frascaria-Lacoste, J.Hay, G.Martin et S. Pioch, *Restaurer la nature pour atténuer les impacts du développement. Analyse des mesures compensatoires pour la biodiversité*, Chap. 12 « La réserve d'actifs naturels. Une nouvelle forme d'organisation pour la préservation de la biodiversité en France ? », Peronnas : Editions Quae, 2015, p.139 – 156

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Business and Biodiversity in Brazil: Why Private Restoration is an Important Issue against the Reality of Climate Change and Environmental Pressure

André V. Ramalho, Raquel L. Bonelli, Luan Santos, ***Brazilian Business Council for Sustainable Development (CEBDS)***

ABSTRACT. Brazil is a megadiverse country with forests covering more than 54% of its territory. Nevertheless, some ecosystems are threatened and reduced to some 7% of their original area, as in the case of the Atlantic Forest. Deforestation has historically been the major issue in Brazil in terms of both greenhouse-gas (GHG) emissions and pressure on biodiversity, with the main cause being land-use changes for the expansion of agriculture and cattle-ranching. To address these issues, the Brazilian Government makes use of several legal norms, such as the Forest Code. The Code calls for setting aside 20-80 per cent of the area of each rural property for the preservation of native forest and it underpins the Brazilian intended Nationally Determined Contribution (iNDC) of restoring 12 million hectares of forests set out at the twenty-first meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change. Even with all the legal requirements, which also include mitigation projects and offset compensation, Brazil is seeing a growth in voluntary restoration efforts by businesses. Several companies are currently collaborating on natural infrastructure development, payment for ecosystem services and carbon-neutrality projects, all using restoration as a tool. The results of these projects are practical and, in addition to the traditional environmental and social impacts, they have clear operational benefits for businesses. This agenda is being advanced through risk and dependency analysis, operational security, new business opportunities, financial and investment requirements and by a positive socio environmental agenda. The country's recent droughts have clearly helped, for example, in the expansion and development of natural infrastructure projects. The time is ripe for mobilizing and engaging business in conservation and restoration projects, especially when the multiple benefits of this agenda are linked to climate change and water issues.

Entreprises et biodiversité au Brésil: pourquoi la restauration par le secteur privé est un enjeu important dans un contexte de changement climatique et de pression sur l'environnement

RÉSUMÉ. Le Brésil est un pays mégadivers avec des forêts couvrant plus de 54% de son territoire. Cependant, certains écosystèmes sont menacés et réduits à quelque 7% de leur superficie d'origine, comme dans le cas de la Forêt atlantique. Le déboisement a toujours été le principal problème au Brésil en termes d'émissions de gaz à effet

de serre (GES) et de pression sur la biodiversité. Ce sont les changements d'affectation des terres pour l'expansion de l'agriculture et de l'élevage qui en sont la principale cause. Pour faire face à ces problèmes, le gouvernement brésilien utilise plusieurs normes juridiques, comme le Code forestier. Ce Code prévoit la mise de côté de 20 à 80 pour cent de la superficie de chaque propriété rurale pour la préservation de la forêt indigène et sous-tend la Contribution prévue du Brésil déterminée au niveau national de restaurer 12 millions d'hectares de forêts. Cette contribution avait été annoncée à la vingt et unième Réunion de la Conférence des Parties à la Convention-cadre des Nations Unies sur les changements climatiques. Même avec toutes les exigences légales, qui incluent également des projets d'atténuation et de compensation, le Brésil constate une croissance des efforts de restauration volontaire des entreprises. Plusieurs entreprises collaborent actuellement au développement des infrastructures naturelles, au paiement des services écosystémiques et aux projets neutres en carbone, en utilisant la restauration comme outil. Les résultats de ces projets sont pratiques et, en plus des impacts environnementaux et sociaux habituels, ils ont des avantages opérationnels clairs pour les entreprises. Des progrès sont en train d'être réalisés dans ce domaine grâce à l'analyse des risques et des dépendances, à la sécurité opérationnelle, aux nouvelles opportunités d'affaires, aux besoins financiers et d'investissement et à un programme socio-environnemental positif. Les récentes sécheresses qui ont frappé le pays ont clairement contribué, par exemple, à l'expansion et au développement de projets d'infrastructure naturelle. Le moment est venu de mobiliser et d'engager les entreprises dans les projets de conservation et de restauration, surtout lorsque les multiples avantages de ce programme sont liés aux changements climatiques et aux problèmes de l'eau.

Negocios y Biodiversidad en Brasil: por qué la restauración privada es un tema importante para el cambio climático y una realidad ambientalmente bajo presión

RESUMEN.[1] Brasil es un país megadiverso con bosques que cubren más del 54% de su territorio. Sin embargo, algunos ecosistemas están amenazados, reducidos a cerca del 7% de su área original, como en el caso de la Mata Atlántica. La deforestación ha sido históricamente el principal problema en Brasil para las emisiones de gases de efecto invernadero (GHG) y presión sobre la biodiversidad, con la principal causa siendo los cambios en el uso de la tierra para la expansión de la agricultura y la ganadería. Para abordar estas problemáticas, el Gobierno brasileño hace uso de varias normas jurídicas, como el Código Forestal. El Código establece dejar de lado entre 20-80% del área de cada propiedad rural para la preservación del bosque nativo, sustentando así la Contribución Prevista y Determinada Nacional de Brasil (iNDC) de restaurar 12 millones de hectáreas de bosques, establecido en la vigésima primer reunión de la Conferencia de las Partes en el Marco de la Convención de las Naciones Unidas sobre el Cambio Climático. Incluso con todos los requisitos legales, que también incluyen proyectos de mitigación y compensación, Brasil está viendo un crecimiento en los esfuerzos de restauración voluntaria por parte de las empresas. Varias empresas están colaborando actualmente en el desarrollo de la infraestructura natural, el pago de los servicios ambientales y proyectos de carbono neutralidad, todos utilizando la restauración como herramienta. Los resultados de estos proyectos son prácticos y, además los impactos ambientales y sociales tradicionales, tienen claros beneficios operacionales para las empresas. Esta agenda está avanzando a través de análisis de riesgo y dependencia, seguridad operativa, nuevas oportunidades de negocio, necesidades financieras e inversiones y una agenda socio ambiental positiva. Las recientes sequías del país han ayudado claramente, por ejemplo, en la expansión y desarrollo de proyectos de infraestructura natural. Es hora de movilizar e involucrar a los negocios en proyectos de conservación y restauración, especialmente cuando los múltiples beneficios de esta agenda están vinculados al cambio climático y a los problemas del agua.

A. V. Ramalho is Technical Advisor on Biodiversity and Water, CEBDS (e-mail: andre.ramalho@ cebds.org).

R. L. Bonelli is Technical Assistant, CEBDS (e-mail: Raquel.bonelli@cebds.org).

L. Santos is Technical Advisor of CEBDS (e-mail: luan.santos@cebds.org).

1 Translated by Sofia Calvo

I. INTRODUCTION

In recent years, the private sector has developed a series of improvements in their business focusing on efficiency and the reduction of greenhouse-gas emissions. However, despite of these efforts, climate change continues to be an ongoing process, a new reality that forces the private sector to adapt constantly to the environmental risks, but it also allows the more engaged companies to adapt and explore new opportunities and it is even becoming a competition advantage.

According to the Brazilian Panel on Climate Change, several regions of Brazil have seen shifts on temperature and rainfall patterns, for instance, the Amazon savannization of the Amazon, heavy rainfall and floods in the south and south-east of the country and drought in north and north-east that affects, for example, hydroelectricity generation.[1] These environmental risks have become a major concern for business, with 83% of Brazilian companies reporting climate risks and the subsequent incorporation of risk management into their business.[2] In addition, ecosystem services provided "free of charge" by nature and the bottom line of almost every business are being affected by climate change as well. Since ecosystems are responsible for providing raw material and water needed to produce goods, natural capital losses will affect companies' growth, development and, most importantly, profits. If no investment is made to conserve and restore the natural capital, impacts on businesses may force them to change composition of products, relocate facilities and face conflicts of interest with local society. Fortunately, several companies are realizing how much they depend on nature and are transforming the established relationship.

The Brazilian Business Council for Sustainable Development (CEBDS), part of the global network of the World Business Council for Sustainable Development, is responsible for supporting and connecting the private sector with the best and more advanced concepts, projects, cases and solutions for improving sustainability and the existing relationship between business and nature. CEBDS operates through its working groups, two of which are directly linked to the restoration agenda, the Biodiversity and the Water Working Groups.

This article focuses on the current status of the restoration scenario in Brazil and what is being done by the private sector in his regard. To illustrate restoration and biodiversity conservation efforts, some initiatives that being promoted by large companies in Brazil will be presented.

II. OVERVIEW

Brazil is the fifth-largest country in the world and holds the major part of the largest forest, the Amazon rainforest, which includes the greatest amount of biodiversity in the world. Forest cover 54.4% of the country, an area of approximately 463 million hectares, distributed into six biomes – Amazonia, Cerrado, Caatinga,

Atlantic Forest, Pampas and Pantanal,[3] two of them, Cerrado and Atlantic forest, being considered world hotspots for conservation.[4] The distribution is unequal though, the Atlantic Forest for example has about 7% of its original area. An important data to highlight is that, from the existing native forests cover, 53% are inside private property, stocking about 105±21 million $GtCO_2e$ (billion tonnes of carbon dioxide equivalents).[5] The importance of engaging business in restoration and conservation is clear.

Currently, the most challenging issue in Brazil, in terms of climate change and environment is deforestation, the result mainly of landuse changes for agriculture and cattleranching. Both the agriculture and livestock sectors are important for Brazilian economy, since they provide the country's main export commodities. From 1990, the agricultural sector has undergone a boom, with scaled up investments that turned Brazil into the largest food producer and exporter of raw materials in the world.[6] In order to become a massive producer and exporter, in 2010, grazing lands were being settled over an area of 182.8 million hectares,[7] and Amazon rainforest deforestation has endured. Despite a 79% decrease in the Amazon deforestation between 2004 and 2015, in 2015 alone, 5,831 square km of forests were lost, with the resultant emission of 282.8 million tCO_2e.[8] For this reason, deforestation and land use are the main drivers of Brazil's greenhouse-gas emissions, which makes so important to emphasize how restoration and conservation can help and coexist with agriculture and cattle ranching.

In fact, Brazil has committed itself, during the twenty-first meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change, of its intended Nationally Determined Contribution (iNDC) of restoring 12 million hectares of forests. Much will need to be done to address this challenge. Firstly, an estimated investment between R$31 million to R$52 million up to 2030 will be needed.[9] Secondly, it will need to finish mapping the areas that need restoration, in accordance with the Brazilian Forest Code. Then, there will be the need to increase and provide incentives for the development of nativeforest nurseries to meet the demand for young plants, among other complementary actions.

For years, the Brazilian Government has been advancing the nativeforest agenda with the intention of protecting and restoring forests for conservation purposes and safeguarding the natural resources needed by the private sector, especially considering that the contribution of the agriculture and livestock sectors, the main users of these resources, to the gross national product is over 20%, or approximately 70 billion dollars.[10]

One of the most important environmental legal norms in Brazil is the Forest Code. With a first version dating from 1965, the norm was revisited and relaunched in 2012. At that time, two mechanisms—the Legal Reserve (LR) and Areas of Permanent Preservation (APPs)—remained with some modifications. Under the former, a landowner should maintain 80% of the property under native vegetation, if the land is in the Amazon biome; otherwise, the percentage falls to at least 20%.[11] The main aim of the latter is to conserve water resources and thus protect the soil from erosion. The size of area preserved is variable and depends on factors such as the type of ecosystem, the width of the river, the presence of a water spring, etc. As an example, for a river 10 metres wide must have at least 30 metres of forest throughout its length.

If both mechanisms are effectively enforced, they are capable of protecting 193 ± 5 million hectares.[5] The Forest Code is an important tool to promote private restoration with environmental benefits. The Code also includes the Environmental Reserve Quota (CRA), a market for forest land whereby, should a property have protected native vegetation in excess the amount required by the Code, the landowner can receive compensation by "selling" it to another landowner who has fallen short of the amount required, provided that both properties are located in the same biome.

Therefore, effective implementation is essential. Once that is assured, an area of about 23.4 million hectares will be recovered in areas used for agriculture and grazing, with particular consideration given to areas with degraded and low productive pastures.[7] The potential of the private sector to contribute to restoration efforts in Brazil depends upon strong enforcement and government support to make sure that agribusinesses are able to adhere to the Code. An example of government support is the development of a plan to help fund this restoration, as in fact is the purpose of the National Native Vegetation Recovery Plan (Planaveg).[12] Brazil will also need to improve its native forest sector to support this restoration effort.

Finally, the Warsaw Framework for Reducing Emissions from Deforestation and Forest Degradation

(REDD+) and Payment for Ecosystem Services (PES) are two initiatives that need to be highlighted. REDD+ was created under the Convention on Climate Change in order to create opportunities for developing countries to follow a sustainable economic pathway. It was instituted in Brazil in 2013, with the intention of mitigating climate change by combating illegal deforestation. Subsequently, its scope was amplified to include restoration and other actions. Likewise, PES is an economic incentive that includes payments beyond carbon and focuses on ecosystems services.[13] Those two instruments are under discussion by the Brazilian Government in the context of policies and strategies. It is also worth noting that, besides the environment impact, these measures can provide an income supplement, especially for smallholders and native people, thus generating a positive social impact.

It is important to emphasize that despite the existence of a large number of legal obligations that go beyond many of current commitments in the world, Brazilian companies are willing to invest even more in restoration and conservation. They have come to see restoration efforts and climate change mitigation and adaptation as vital to their own business, since they provide operational security, thus decreasing risks and liabilities, and an improved image and also serve as an additional contribution to society.

III. BUSINESS CASE

There follow some examples of conservation and restoration initiatives that have been promoted by the business sector, including those in other major biomes outside the Amazon, such as the Cerrado and the Atlantic Forest, where the level of protection is below the 17% required in the framework of the Convention on Biological Diversity.[5]

The Green-Blue Water Coalition, an initiative of The Nature Conservancy (TNC), is a collaboration of the private sector and the civil society and local government in order to promote water security to hydric stress basins. The main goal of this Coalition, formed by companies such as AmBev, Coca-Cola, Klabin and having Faber Castell, McDonalds, Unilever, Pepsico and the Bank of America as collaborators, is to reach 12 metropolitan areas, restoring and conserving forests in up to 21 watersheds, capable of supplying water to almost 63 million citizens.[14]

In each watershed, this natural infrastructure initiative will make use of several tools to support restoration, such as creating a local water fund, mapping better areas for restoration, develop a payment for ecosystem services program, and create a local governance, among others. As an example of expected results, TNC studies indicate that the restoration of just 3% of forests could reduce siltation by up to 50% in the watersheds responsible for 64% of the water supplied to the Greater São Paulo area.

In order to create an improved model for watershed collaborative actions, which could reach even more companies looking to invest in natural infrastructure by associating with CEBDS, a new chapter of the Green-Blue Water Coalition—the Guandu River Basin chapter—is under way. This project is expected to restore 2,250 and preserve 11,750 hectares in five years at a basin that is responsible for 80% of the Rio de Janeiro water supply.

Supported by Brasil Kirin in partnership with SOS Mata Atlântica, the SOS Mata Atlântica Forest Experiment Centre (*Centro de Experimentos Florestais SOS Mata Atlântica*) aims to produce native trees for forest restoration in the Atlantic Forest. This initiative is currently producing over 750 thousand plants representing 110 native species from this biome per year to be used in restoration areas in the surroundings. In addition, they have a programme of environmental awareness and education for the community.[15] This centre also hosts two projects, one called ClickÁrvore and the other Forests of the Future, which account for more than 30 million young trees donated or sponsored for the restoration of the Atlantic Forest over the years.

Coca-Cola has also contributed to Sustainable Amazon Foundation - FAS Permanent Fund, which uses to defray the family forest grant at the 16 conservation areas where the forest grant programme currently operates.[16] It makes use of several mechanisms, including one of the first structured payment-for-ecosystem-services project in Brazil. It has a social development goal of developing a value chain of forest products. The families included the project then became forest guardians.

Syngenta in partnership with Coopavel has created the Água Viva Project, with the intention to revitalize water springs by using methods such as restoring forest cover aside from providing environmental

awareness to the local community. In the 12 years since it was launched, the Project has restored 1,000 freshwater springs, generating 160 million litres of good quality water, with benefits reaching 12,000 families from 70 cities across 11 states.[17]

Legado das Águas (Water Legacy) is a project developed under Votorantim leadership to guarantee hydro availability through the River Juquiá and to protect the local biodiversity. The main goal is to ensure ecological stability in this particular region of the Atlantic Forest, by conserving an area of approximately 31,000 hectares.[18] There are several ongoing projects at the site, including the construction and operation of a greenhouse to produce young native Atlantic Forest trees to be used for forest restoration at the site and its surroundings. Other example are projects relating to the access and benefit sharing with regard to biodiversity, all aiming at making this private conservation area self-sustainable.

SPVS, Fauna and Flora International and Souza Cruz launched Partnership for Biodiversity (*Parcerias Pela Biodiversidade*) in 2012. This initiative aims to protect the local biodiversity and to foster a sustainable family agriculture, which includes biodiversity as a critical asset.[19] The actions include forest restoration and enrichment and pollinator management aiming to improve and conserve ecosystem services while generating benefits for local agriculture. A pilot phase was carried out on 17 small farms and it is now expanding.

The Strategic Forest Restoration Plan (PERF) was deployed at one of the biggest agrarian region, the Alto Teles Pires in Mato Grosso. This Plan, developed by The Nature Conservancy, has as its main actions to map degraded areas, identify stakeholder initiatives, and structures already developed at the region to organize productive chains for restoration, including seed production, plant nursery and workforce, as well as create restoration schedules and priorities. This initiative is supported by Syngenta, Fiagril, Amaggi, among others.[20]

Conservation International in partnership with Monsanto has been developing a project based on the concept of sustainable agricultural landscape. It has been involved in the protection of natural capital, sustainable food production and territorial governance. This initiative takes into account the vital role played by the agricultural sector, thus looking to integrate between agriculture and the protection of environmental services.[21]

Through its Foundation, the Boticário Group has two very interesting initiatives that should be mentioned: one, called Araucária+, that aims to conserve a highly

threatened ecosystem that has as its main species a tree called Araucaria. To help protect the Araucaria forest, they are developing ways for the local smallholders to explore products derived from the forest in a sustainable way. The second is a payment for ecosystem services and conservation initiative that became a model for several others named Oasis. In ten years of operation, Oasis engaged 434 landowners, and protected an area of 3,500 hectares.[22]

Natura is also giving an example of a commitment that can benefit forest conservation and/or restoration that is the *Programa Carbono Neutro* (Carbon Neutrality Programme). Through this commitment, Natura quantifies all its greenhouse-gas emissions, including in its value chain, an then it offsets those emissions by buying carbon credits from forest restoration projects in degraded lands, and for switching from oil-based fuels to renewables and those associated with waste treatment.[23]

One thing that is important to say about all these projects is how they relate conservation and/or restoration with positive impacts to not only nature and society but also a clear benefit for the companies. And, when results are clear, companies are willing to invest.

IV. CURRENT AND FUTURE PERSPECTIVES

The business perception of nature has been changing in the past few years, both globally and in Brazil, and not only motivated by legal requirements. As an institution that has being working with more than 60 of the major companies in Brazil in the field of sustainability, CEBDS cannot help but notice the advances made by companies in the country in terms of awareness, investments, and commitments.

These advances are encouraged by several factors such as the creation and adoption of sustainability indexes, as is the case of Dow Jones Sustainability Index; transparency and reporting of social and environmental impacts, initiatives and corporate responsibility actions, those compiled in documents following standards such as the Global Reporting Initiative. Advances are also made as a result of a better understanding of naturalcapital risks, dependencies and opportunities, supported by ever evolving tools such as the recently launched Natural Capital Protocol.[24] The financial sector is also getting involved into advancing the environmental and climate agenda by creating risk methodologies and requirements for companies seeking investment capital.

The Brazilian financial sector engagement in the natural-capital agenda is duly noticed when they commend studies on naturalcapital risks for the main business sectors in the country, such as the Natural Capital Risk Exposure of the Financial Sector in Brazil,[1] or when they calculate the financial impact of recent droughts that affected both the population and business production in the southeastern region of Brazil, including major industrial areas such as São Paulo.[25] There is also a very positive discussion going on in Brazil that involves the regulation and issuance of Green Bonds. The Bank Federation of Brazil (FEBRABAN) and CEBDS are working together on a guide for green bonds issuance. This is a helpful tool to support company's climate adaptation and environmental conservation/ restoration investments.

Several actions complementary to the legal requirements on restoration have been in place in the country, all contributing to protecting and restoring the ecosystems. Voluntary commitments are helping changing the way we relate to nature. Walmart and Carrefour, for example, have made a commitment not to buy cattle meat from deforested areas, leading to the creation of a tracking process by its suppliers. Commitments such as this force the hand of producers and distributors into legalizing farms, checking and promoting changes in their value chain, in order to avoid the risk of suffering economic losses.

Another important commitment that is producing a great impact on Brazilian landscape is the Soy Moratorium, a zerodeforestation voluntary commitment. Since its adoption by several major producers, the deforestation rates declined by 86% in the states where it has influence. At the same time and in the same areas, the soy production rose 200% without land expansion,[26] proving that it is possible to increase production while protecting the ecosystems.

Recently Brazil debated, revisited and issued its new biodiversity access and benefit-sharing legal norm and it is being pressured by society to ratify the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. In a megadiverse country, exploring biodiversity can be a very effective way to stimulate conservation

and even increase restoration investments. A recent research from the National Industry Confederation (CNI) found interesting results as to company investments in biodiversity. Results from an interview with 120 chief executive officers (CEOs) and executives showed that for 86.7% of them the importance of biodiversity has increased to the company, and that more than half (52.2%) invested in products derived from biodiversity use. In addition, 78.3% invest in actions and processes for exploring biodiversity sustainably, and half of them invest in voluntary conservation projects, with most of them being developed by the largest companies.[27]

As indicated in the business-case section above, natural infrastructure is gaining strength in the country. Many practical examples are being developed and partnerships with local governments being made, which is of great significance, given that its basis is forest restoration. According to the World Resources Institute (WRI) (2016), two elements can help pushing this agenda even further: the first is a clear understanding of the economic benefits arising from these projects; and the second is the sharing of knowledge related to managing natural-infrastructure projects to which we can add building capacity. As for the economic benefits, the recent water crisis affected great industrial regions in Brazil producing enough awareness to help companies start considering natural infrastructure as a viable preventive solution to help keep water security levels at a safe margin.

Opportunities are clearly arising in the country, projects and initiatives that for years were considered mostly as philanthropic, now are starting to be considered strategic. As the perception of risks and dependencies of ecosystem services become clearer, the trend is to see an increase in these projects.

V. CONCLUSION

When we go back to Rio 1992 and Rio +20 conferences, we can see how Brazil evolved in its environmental agenda. Now, the country has a greater awareness in keeping with the importance of biodiversity. There is a noticeable increase in the number of social and environmental projects and initiatives. We see many voluntary commitments being made despite all the demanding legal requirements. All these combined with an international agenda such as Paris Agreement on Climate and the Sustainable Development Goals, contribute to a better outlook for nature, and thus for all of us.

The level of involvement from society and business in the conservation of our natural resources is expanding. Consumers increasingly check how "green" a company or its products are; sustainability has become an index that investors look into it. The business sector, through the concept of natural capital, is now understanding how investing in conserving/restoring nature adds to its productivity and income.

It is in this context that governments and nongovernmental organizations should support and collaborate to engage business to an even greater extent in the biodiversity agenda. The scenario now, even in the middle of an economic crisis, is more favorable than ever: we have the attention of the business sector and it has the ability to take decisions and invest in and promote changes much more quickly than any group. Our motivation, and that of our partners, is to help in promoting the sustainability agenda and ever increasing the engagement of companies.

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REFERENCES

[1] CEBDS, *Riscos climáticos: como o setor empresarial está se adaptando?* (Rio de Janeiro, KPMG, 2015).

[2] Carbon Disclosure Project. CDP. Mudanças Climáticas Brasil 100. Conexão entre mudanças climáticas e modelos de negócios: uma agenda em evolução. [S.I.], 2014.

[3] Brazil, Ministry of the Environment, Brazilian Forest Service, *Brazilian Forests at a Glance: Data from 2007 to 2012* (Brasilia, 2013).

[4] Norman Myers, Russell A. Mittermeier, Cristina G. Mittermeier, Gustavo A. B. da Fonseca & Jennifer Kent. "Biodiversity hotspots for conservation priorities", Nature, vol. 403, (24 February 2000). pp. 853-858.

[5] Britaldo Soares-Filho, Raoni Rajão, Marcia Macedo, Arnaldo Carneiro, William Costa, Michael Coe, Hermann Rodrigues and Ane Alencar, "Cracking Brazil's Forest Code", Science, vol. 344, Issue 6182 (April 2014), pp. 363 364.

[6] Antônio Márcio Buainain; Eliseu Alves; José Maria da Silveira & Zander Navarro. O mundo rural no Brasil do século 21: a formação de um novo padrão agrário e agrícola. Embrapa. Brasília. 2014.

[7] Valor Econômico, "Código Florestas exigirá R$25 bi de pecuaristas" (Brasília, 6 August 2015).

[8] Coalizão Brasil, Clima, Florestas e Agricultura. Caminhos para a implementação da economia de baixo carbono. Rio de Janeiro, 2016.

[9] Instituto Escolhas, *How much does Brazil need to invest to recover 12 million hectares of forests*, (São Paulo, Coalizão Brazil, Clima, Florestas e Agricultura, May 2016).

[10] IBGE, *Contas Nacionais Trimestrais: indicadores de volumes e valores correntes* (Rio de Janeiro, Instituto Brasileiro de Geografia e Estatística, June 2016).

[11] Available from http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm (accessed 26 September 2016).

[12] Available from: http://www.mma.gov.br/images/arquivo/80049/Planaveg/PLANAVEG_20-11-14.pdf (accessed 26 September 2016).

[13] Available from http://redd.mma.gov.br/index.php/en/what-is-redd/frequently-asked-questions (accessed September 2016)

[14] Available from http://cidadespelaagua.com.br/en/lp-en/ (accessed 22 September 2016).

[15] Available from: https://www.sosma.org.br/projeto/centro-de-experimentos-florestais/ (accessed 23 September 2016).

[16] Available from http://fas-amazonas.org/parceiros/parceiros-institucionais/coca-cola/ (accessed 23 September 2016).

[17] Available from http://blogsyngenta.com.br/projeto-agua-viva-revitalizando-as-nascentes-2/ (accessed 23 September 2016).

[18] Available from: http://www.legadodasaguas.com.br/ accessed 23 September 2016)

[19] Available from: http://www.spvs.org.br/projetos/parceriaspela-biodiversidade/ (accessed 23 September 2016)

[20] Fabiana Trebilock, "TNC lança o primeiro Plano Estratégico de Restauração Florestal para o Alto Teles Pires, MT", Grupo Cultivar, Pelotas, 21 July 2016. Available from http://www.grupocultivar.com.br/noticias/tnc-lanca-o-primeiro-plano-estrategico-de-restauracao-florestal-para-o-alto-teles-pires-mt

[21] Available from: http://www.conservation.org/global/brasil/Pages/paisagens-agricolas-sustentaveis.aspx (accessed 23 September 2016)

[22] Available from http://www.fundacaogrupoboticario.org.br/pt/o-que-fazemos/oasis/pages/default.aspx (accessed 26 September 2016).

[23] Available from: http://www.natura.com.br/a-natura/sustentabilidade/programa-carbono-neutro (accessed 26 September 2016).

[24] Natural Capital Coalition. Natural Capital Protocol. CEBDS. Rio de Janeiro, 2016.

[25] See: http://www.itauassetmanagement.com.br/asset/a-asset/sustentabilidade/index.html (accessed 26 September 2016)

[26] Holly K. Gibbs; Jacob Munger; Jessica L. Roe; Paulo Barreto; Ritaumaria Pereira; Mathew Christie; Ticiana Amaral & Nathalie Walker, "Fazendeiros e Frigoríficos responderam aos Acordos de Desmatamento Zero na Amazônia Brasileira?" Conservation Letters (Madison, Winconsin, United States of America).

[27] CNI, *Retrato do uso sustentável da biodiversidade pela indústria brasileira* (São Paulo, 2016).

Ecosystem Restoration and Conservation in the Machu Picchu Cloud Forest through Ecotourism

Jose Koechlin, *Inkaterra*, Gabriel Meseth, *Inkaterra*, Dennis Osorio, *Inka Terra Asociación*
Adolfo Schmitt, *Inka Terra Asociación*

ABSTRACT. The purpose of the case-study is to review the initiatives to restore and conserve a five-hectare area in the Andean cloud forest at the foot of the Historic Sanctuary of Machu Picchu, where the Inkaterra Machu Picchu Pueblo Hotel is located. As a pioneer of ecotourism in Peru since 1975, Inkaterra works through a holistic approach to create added value in rural areas, producing scientific research as a basis for biodiversity conservation, education and the sustainable development of local communities. Inkaterra's model is replicable and has been employed with success in different natural regions, including the Amazonian rainforest of Madre de Dios (south-east Peru), the Sacred Valley of the Incas, the city of Cusco, and the Cabo Blanco tropical ocean, desert and dry forest. Inkaterra's ecosystem-restoration efforts in the Machu Picchu cloud forest are reviewed in depth, showing how pastureland has been restored to form one of the most biodiversity-rich environments to be found in a hotel within the boundaries of a city. Flora and fauna inventories set a benchmark against which to measure future impacts. Inkaterra currently conserves an area containing 214 recorded bird species, 111 butterfly species and 372 native orchid species (the largest *in situ* native orchid collection, according to the American Orchid Society.

Restauration et conservation de l´écosystème dans la forêt des nuages de Machu Picchu grâce à l´écotourisme

RÉSUMÉ. Le but de cette étude est de faire le point sur les initiatives visant à rétablir et à conserver une zone de cinq hectares dans la forêt de nuages andine, au pied du Sanctuaire historique de Machu Picchu, où se trouve l'hôtel Inkaterra Machu Picchu Pueblo. En tant que pionnier de l'écotourisme au Pérou depuis 1975, Inkaterra travaille par une approche holistique pour créer de la valeur ajoutée dans les zones rurales, utilisant la recherche scientifique comme base pour la conservation de la biodiversité, l'éducation et le développement durable des communautés locales. Le modèle d'Inkaterra est reproductible et a été utilisé avec succès dans différentes régions naturelles du Pérou, y compris la forêt tropicale amazonienne de Madre de Dios (sud-est du Pérou), la vallée sacrée des Incas, la ville de Cusco, et l'océan, le desert et la forêt sèche de Cabo Blanco. Les efforts déployés par Inkaterra en vue de restaurer l'écosystème de la forêt de nuages du Machu Picchu sont examinés en profondeur, en montrant comment les pâturages ont été restaurés pour former l'un des environnements les plus riches en biodiversité que l'on trouve aux alentours d'un hôtel dans les limites d'une ville. Les inventaires de la flore et de la faune constituent une référence pour mesurer les impacts futurs. Inkaterra conserve actuellement une zone contenant 214 espèces d'oiseaux enregistrées, 111 espèces de papillons et 372 espèces d'orchidées indigènes (la plus grande collection *in situ* d'orchidées indigènes, selon l' «American Orchid Society»).

Restauración y Conservación de Ecosistemas en el Bosque de Nubes de Machu Picchu a Través del Ecoturismo

RESUMEN. El propósito del siguiente estudio de caso es reflexionar sobre las iniciativas para restaurar y conservar un área de cinco hectáreas en el bosque de nubes andino al pie del Santuario Histórico de Machu Picchu, donde se encuentra Inkaterra Machu Picchu Pueblo Hotel. Pionera del ecoturismo en el Perú desde 1975, Inkaterra trabaja bajo un enfoque holístico para crear valor agregado en áreas rurales, produciendo investigación científica como base para la conservación de la biodiversidad, la educación y el desarrollo sostenible de comunidades locales. El modelo replicable se viene realizando con éxito en diversas áreas naturales, incluyendo el bosque amazónico de Madre de Dios (al sudeste del Perú), el Valle Sagrado de los Incas, la ciudad del Cusco, y el océano, desierto y bosque seco tropical de Cabo Blanco. Los esfuerzos de Inkaterra en pos de la restauración de ecosistemas en el bosque de nubes de Machu Picchu son estudiados a profundidad en el presente ensayo, revelando cómo una zona de pastoreo fue renovada para convertirse en uno de los ambientes de mayor riqueza natural en un hotel dentro de los límites de una ciudad. A través de inventarios de flora y fauna se cuenta con un punto de referencia frente al cual comparar el impacto futuro. Actualmente Inkaterra conserva un espacio donde 214 especies de aves, 111 especies de mariposas y 372 especies de orquídeas nativas (según el American Orchid Society, la colección de orquídeas nativas más grande del mundo dentro de su hábitat) han sido registradas.

I. INTRODUCTION

Tropical cloud forests play a key ecological role due to their high rate of endemism. The diversity of arboreal epiphytes such as ferns, mosses, orchids and bromeliads is due to moist climate with persistent low-level fog, caused by reduced sunlight and low evapotranspiration [1]. In montane and premontane ecosystems, endemic animals have a crucial function in forest dynamics as agents of pollination via seed dispersal.

The loss of cloud forests occurs due to factors such as population growth and land use for grazing, logging and agriculture, with alterations in forest structure as a consequence. Extending the length of large parts of mountain ranges within the tropics, many slopes are subjected to rapidly accelerating deforestation and spontaneous colonization [2]. Among the world's most fragile and threatened ecosystems, their rate of loss exceeds that of the lowland tropical rain forests, with serious consequences for lower watersheds and disastrous results in the form of floods combined with accelerated erosion, or marked reduction of river flow during dry seasons and high water problems during rainy periods [3]. Converting cloud forests to pasture may influence total water yield and seasonal distribution of flow negatively, because of the loss of moisture inputs via Horizontal Precipitation [4].

Declared a UNESCO World Heritage Site in 1983 and one of the New Seven Wonders of the World in 2007, the Historic Sanctuary of Machu Picchu in South Eastern Peru is defined by its archaeological beauty. However, its natural richness is yet to be appreciated in its real dimension, considering that many native and threatened species such as the spectacled bear (*Tremarctos ornatus,* see figure 10) and the Neotropical otter (*Lontra longicaudis*, see figure 11) are found here. From the 84 life zones found in Peru, according to the Holdridge Scale, nine are found in the Historic Sanctuary of Machu Picchu [5]

- Subtropical moist forest (S-mf)
- Subtropical Lower Montane moist forest (SLM-mf)
- Subtropical Lower Montane wet forest (SLM-wf)
- Subtropical Montane wet forest (SM-wf)
- Subtropical Montane rainforest (Ssa-wp)
- Subtropical Subalpine wet páramo (Ssa-rp)
- Subtropical Subalpine rainy páramo (Ssa-wp)
- Subtropical Alpine rainy tundra (SA-rt)
- Subtropical Nival (SN)

Of Machu Picchu's total surface area (37,302 ha), some 13,806 ha are covered by cloud forest (see figure 1) [6]. The Machu Picchu cloud forest has an altitude range of approximately 2,000–3,400 m above sea level with an average rainfall of 1,985 mm, an average temperature of 15.1°C, and an average evapotranspiration of 1,027 mm with 84,5% relative humidity. Natural vegetation is catalogued as evergreen forest with bushes, ferns, vines and orchids. Representative genera and species are *Inga* sp., *Erythrina* sp., *Podocarpus* sp., *Cecropia* sp., *Ocotea* sp., *Cedrela lilloi*, *Cedrela odorata*, *Cinchona officinalis*, *Eugenia*, *Rubus* sp., among others.

The paper shares Inkaterra's restoration goals and results via ecotourism and the sustainable use of natural resources in such an environment.

FIGURE 1 VIEW OF MACHU PICCHU CLOUD FOREST.

II. APPROACH ON SUSTAINABLE TOURISM

Since its establishment in 1975, Inkaterra has pioneered ecotourism and sustainable development in Peru. Aiming to underscore the value of biodiversity, the organization works under a holistic approach, performing scientific research as a basis for natural and cultural conservation, education and the economic growth of local communities.

Having lodged more than 200,000 travellers in 2015, Inkaterra hotels are defined by their eco-friendly design inspired by traditional architecture and for being built with native materials, in harmony with the environment. The Amazon rainforest of Madre de Dios (Inkaterra Reserva Amazónica, Inkaterra Hacienda Concepción, and Inkaterra Guides Field Station), the Machu Picchu cloud forest (Inkaterra Machu Picchu Pueblo Hotel (see map in figure 2) and El MaPi by Inkaterra), the Sacred Valley of the Incas (Inkaterra Hacienda Urubamba), the city of Cusco (Inkaterra La Casona) and the Cabo Blanco ocean, desert and tropical dry forest (in development), are the natural areas of influence where Inkaterra has replicated its sustainable tourism model.

FIGURE 2 LOCATION MAP OF INKATERRA MACHU PICCHU PUEBLO HOTEL.

III. INTERVENTION LOGIC FOR THE ANDEAN CLOUD FOREST

Three years after co-producing Werner Herzog's *Aguirre, the Wrath of God* (1972) to encourage tourism through cinema, José Koechlin conceived Inkaterra in natural locations featured in the film – the Machu Picchu cloud forest and the Amazon rainforest.

In 1976, Inkaterra founder and Chief Executive Officer, José Koechlin, started negotiations to acquire a ten-hectare area in Machu Picchu Pueblo facing Vilcanota River, in-between Alccamayo and Aguas Calientes Rivers. The land was originally used as sawmill, with pasture to raise cattle and a tea plantation (conserved for organic tea production with millenary techniques). The most damaged area included three hectares located at KM 110 on the Ollantaytambo-Machu Picchu railway, where cattle caused eroded and compacted soil, with a poor floristic composition based in rustic herbaceous species. The intensity of past land uses, ranging from selective logging and hunting to grazing to small-scale or industrial agriculture, affects many site-specific factors that influence the rate of recovery [7].

Inkaterra officially held rights to the property and started working on reforestation endeavors in 1980, aiming to repair damage to ecological function or ecosystem services [8], including the recovery of a proper habitat for the Andean cock-of-the-rock (*Rupicola peruviana*), considered Peru's national bird (figure 4). Low-impact construction started towards the late 1980's under an architectural conception new to the vicinity, which combines local design with modern structure, with waterfalls, stone pathways and gardens that maintain the area's natural floristic structure.

Inkaterra Machu Picchu Pueblo Hotel opened its doors in 1991. Since then, operations are focused on bird watching, the conformation of an orchid garden to conserve native species, and a rescue center for Andean bear specimens, the only bear species native to South America.

IV. RESTORATION AND CONSERVATION INITIATIVES

The following efforts by Inkaterra have contributed to ecosystem restoration in the Andean cloud forest of Machu Picchu.

A. Flora and Fauna Inventories

Biodiversity inventories are performed by Inkaterra since 1978, as to set a benchmark to compare its own impact over natural areas, while being the first step to determine goals for restoration and conservation of a natural environment. Hobbs and Harris describe biological potential inventory as probably the earliest form of ecosystem assessment, typified by the species list, which can take the form of a simple list of plant species, extending to complex descriptions of everything from bacteria to avian guild structures, including abundance measurements [8].

Within its areas of influence in the Machu Picchu cloud forest, to this date Inkaterra has registered 214 bird species, 111 butterfly species, 372 native orchid species and 98 fern species, whilst 19 orchids, two bromeliads and one butterfly have been described as new to science.

B. Restoration of Native Flora

Towards the late 1970s, Inkaterra started its reforestation project within property to recover botanical species of the tropical cloud forest, aiming to attract native birds in search of food as a means to promote bird watching in Machu Picchu. The task was accomplished through observation and surveying local communities to collect their knowledge on native flora. Hobbs and stress that past system composition or structure are unknown or partially known, and past data provide only snapshots of system parameters. An alternative is to use nearby existing systems as a model or reference; this certainly can be used to advantage in inferring the likely management interventions needed to restore degraded systems. Setting a clear and achievable goal is essential, and it should focus on the desired characteristics for the system in the future, rather than in relation to what these were in the past [8].

"Yanay argoz" (*Nectandra furcata*), "Pisonay" (*Erythrina falcata*), "Pacaemono" (*Inga adenophylla*), 'Bamboo palm' (*Chusquea spp.*), "Chalanque" (*Myrsine pseudocrenata*) or "Platanillo" (*Heliconia sp.*), as well as various species of Heliconia, ferns and bromeliads, are among local plant species sowed and nurtured to restore and conserve forest composition. The integral environmental management plan has allowed Inkaterra Machu Picchu Pueblo Hotel to host one of the most biodiversity-rich environments in a hotel within city limits (figure 3).

FIGURE 3 PHOTOGRAPHS FROM 1995 (TOP) AND 2005 (BOTTOM) SHOW RESULTS OF NATIVE FLORA RESTORATION AT INKATERRA MACHU PICCHU PUEBLO HOTEL.

Natural pollination is encouraged as a means to entice birds, butterflies and other pollinating agents (figure 9). For instance, a communal lek where male Andean cock-of-the-rock specimens challenge rivals and mate with females during breeding season, has been found within property. The cock-of-the-rock plays a crucial role in forest dynamics as their diet consists of fruit. However, these birds do not digest seeds, passing through their digestive tracts and getting scattered along the ground. Hence, the cock-of-the-rock is an extremely important seed disperser [9].

FIGURE 4 ANDEAN COCK-OF-THE-ROCK (*RUPICOLA PERUVIANA*), PERU'S ICONIC BIRD AND POLLINATING AGENT IN THE MACHU PICCHU CLOUD FOREST.

FIGURE 5 ANDEAN MOTMOT (*MOMOTUS AEQUATOREALIS*) SIGHTED IN HOTEL GROUNDS.

C. Bird Monitoring

Some 485 bird species from 59 families have been identified at the Historic Sanctuary of Machu Picchu [10], 214 of which have been registered in hotel grounds to this date (see appendix 1). This data represents a 20% growth in comparison to bird diversity inventoried in 2005. An indicator of the positive impact of ecotourism, confirming that birds and tourism activities coexist harmonically. The number of travelers at Inkaterra Machu Picchu Pueblo Hotel keeps rising without disturbing ecosystems, as proven by the constant increase in new species registered in hotel grounds and in the Historic Sanctuary of Machu Picchu.

The Crimson-bellied woodpecker (*Campephilus haematogaster*), the Sword-billed hummingbird (*Ensifera ensifera*), the Violet-throated starfrontlet (*Coeligena violifer*), the Undulated antpitta (*Grallaria squamigera*), and the Black and chestnut Eagle (*Spizaetus isidori*), once considered rare at Machu Picchu and thought to be extinct here, are recent sightings new to Inkaterra Machu Picchu Pueblo Hotel. The Rufus casiornis (*Casiornis rufus*), the Green-fronted lancebill (*Doryfera ludovicae*), the Scarlet Tanager (*Piranga olivacea*) and the Fork-tailed flycatcher (*Tyrannus savana*) are some of the sightings new to the Historic Sanctuary of Machu Picchu, many of which were accomplished by Inkaterra Explorer Guides.

The Inkaterra hotel grounds are habitat of endemic species such as the Green-and-white hummingbird (*Amazilia viridicauda*), the Masked fruiteater (*Pipreola pulchra*), the Inca wren (*Pheugopedius eisenmanni*), the Cuzco brush-finch (*Pheugopedius eisenmanni*), and the yellow-scarfed tanager (*Iridosornis reinhardti*). Representative species commonly sighted in birding excursions are the Andean cock-of-the-rock (*Rupicola peruviana*) (figure 4), the Andean motmot (*Momotus aequatorialis*) (figure 5), the versicoloured barbet (*Eubucco versicolor*), the Golden-headed quetzal (*Pharomachrus auriceps*), the Torrent duck (*Merganetta armata*), the white-capped dipper (*Cinclus leucocephalus*), the dusky-green oropendola (*Psarocolius atrovirens*), the Lyre-tailed nightjar (*Uropsalis lyra*), the Andean guan (*Penelope montagnii*) and the white-throated quail-dove (*Geotrygon frenata*), as well as 18 species of hummingbirds.

Aiming to promote Peru as a top destination for birding, Inkaterra conceived the World Birding Rally (figure 6). The international competition has been celebrated in two circuits – the Inkaterra Route, a six-day,

FIGURE 6 AUTHOR DENNIS OSORIO AT THE WORLD BIRDING RALLY 2013.

800km journey across Madre de Dios, Cusco, the Sacred Valley of the Incas and Machu Picchu; and the Nor-Amazon Route, spanning 1503 km in nine days through 12 life zones in the regions of Lambayeque, Cajamarca, Amazonas and San Martin.

The World Birding Rally was designed to validate bird inventories within Inkaterra properties stressing immediacy and low costs. Its purpose is to raise awareness of confirmed values of biological diversity in Peru, as well as to support nature conservation though fauna observation. It intends to prompt the establishment of more local reserves to preserve natural habitats for endemic bird species, thus improving the quality of life of rural communities while preserving their environment. Career opportunities related to ecotourism reduce emigration, helping to safeguard local cultures.

The event offers a chance to expand bird watching throughout diverse routes in Peru, promoting social inclusion, tourism diversification and the decentralization of economic development, providing income and working opportunities in remote areas with limited economic resources.

Inkaterra and Centro de Ornitología y Biodiversidad (CORBIDI) are currently working on an initiative to ensure proper conservation strategies for bird species to be shared with neighbouring countries (Safe Migratory Routes). Peru is situated in a privileged spot for bird observation, being a sort of crossroads for migratory birds, as well as a hotspot for endemics due to its geography, 84 life zones and favourable weather conditions [11].

D. Native Orchids

Orchids grow in cloud forests due to the interception of cloud water droplets from moving air, likely to be an important source of water for bryophytes of pendant and other diffuse life forms, especially in periods of low rainfall [12]. An evidence of orchid efflorescence in tropical cloud forests is found at Inkaterra Machu Picchu Pueblo Hotel, which hosts the world's largest orchid species collection set in a natural environment in a private facility according to the American Orchid Society. 372 native orchid species – some of which are yet to be identified –, including 19 species new to science, have been registered in its orchid trails (see appendix 2, and figures 7 and 8).

FIGURE 7 *KEFERSTEINIA KOECHLINORUM*, ONE OF THE 19 NATIVE ORCHID SPECIES, NEW TO SCIENCE REGISTERED AT INKATERRA MACHU PICCHU PUEBLO HOTEL.

FIGURE 8 INKATERRA ORCHID TRAILS.

The following is a brief list of the methodology developed by specialists in the process of identifying and describing new species [13]:

- The species (unknown) must be in flower; its morphology is examined and then compared with known species already described in orchid books, such as Icones Orquidacearum Peruviarum, Icones Tropicarom Plantarum (Orchids of Peru, Orchid of Ecuador, Orchids of Venezuela, Colombia Orchids, Orchids of Mexico, Icones Pleurothallidinarum, etc.).
- If the specimen in full bloom coincides with one of the species already described in the specialized bibliography, then the "unknown" status will be discarded.
- Consequently, if the species in flower is different from all species previously described, then we have encountered a new species to science.
- Botanical drawings of the plant, including its flower, are done in graph paper. The flower is dissected under a stereoscope; each of the segments (sepals, petals, lip, column, anther, pollinarium and others) are drawn.
- The floral segments are stored in a bottle with alcohol and glycerin (Luer Solution) with the lid sealed airtight.
- The preliminary drawing is transferred to ink-tracking paper, or similar, and a meticulous botanical drawing is completed.
- At the same time the total morphology of the specimen, colour and sizes of each part are described.
- For this process, it is required to have at least two additional specimens in bloom.
- Three samples are pressed to be deposited in a scientific institution, such as the Natural History Museum of the National University of San Marcos (UNSM), the Agriculture University of La Molina (MOL), the Herbarium Vargas (CUS), or another.
- The description of the morphological specifications that distinguishes this species from all others is made in Latin.
- The description of the plant is completed, along with other records, recognition, distribution, ecology, conservation status, etymology, author, illustrator, and editor.
- Finally, it is published in a scientific journal, or in any specialty book (Icones Orchidacearum). The herbarium and the publication of the description of the new species are a sort of "birth certificate" that attests to the existence of the species to the scientific community.

FIGURE 9 NATURAL POLLINATION

A germplasm bank was developed by Inkaterra to repopulate the cloud forest in the potential scenario of a natural disaster, as forest fires and floods are constant threats to Machu Picchu's ecology.

E. Andean Bear Conservation Center

The only bear species native to South America and the largest arboreal mammal in the Neotropics, the Andean bear (*Tremarctos ornatus*) are classified with a Vulnerable conservation status by the IUCN Red List

FIGURE 10 FEMALE ANDEAN BEAR (*TREMARCTOS ORNATUS*) AT THE SEMIFREEDOM AREA FACILITIE

due to loss of habitat [14]. Considered an umbrella species, its conservation influences other species in its ecosystem. A territorial species, the Andean bear is a pollinating agent with a key role in forest dynamics due to seed dispersion, as seeds stuck in its fur when feeding from fruit, orchid bulbs and bromeliads, are spread when wandering across a distribution range in the Western Andean region from Venezuela to Bolivia, including coastal deserts, premontane forests, cloud forests, evergreen forests, plains and highlands.

The Andean Bear Conservation Center at Inkaterra Machu Picchu Pueblo Hotel was established in 2001 to study and rehabilitate Andean bear specimens found in inadequate captivity conditions, with the purpose of performing scientific studies on the species behaviour in the cloud forest (see figure 10).

Managed by NGO Inkaterra Asociación, the project currently hosts four specimens, while a female bear was successfully reinserted into wildlife. Its facilities include a captivity area with trees, ramps and a fresh-water pool, as well as a 2980 m^2 semi-freedom area, where two bears (one male and one female) were transferred for reproduction and reinsertion-into-wildlife programs. Skin care and medical controls are constantly monitored in coordination with the Protected Natural Areas National Services (SERNANP) and the Forestry and Wildlife Technical Administration (ATFFS).

Inka Terra Asociación has collaborated with Wildlife Conservation Society (WCS) and SERNANP in the publication of the National Strategy for the Conservation of the Andean Bear in Machu Picchu (see appendix 3), a model for other wildlife management programmes.

V. CAPACITY-BUILDING IN MACHU PICCHU PUEBLO

In addition to research and conservation projects, Inkaterra also focuses on education to raise awareness among local communities on the value of biodiversity and the sustainable use of natural resources. Workshops are held every month for schoolchildren and their families, who learn about environmental care through games and experiments. Recycling campaigns to clean riverbeds and forests are organized with the participation of volunteers from Machu Picchu Pueblo. Conferences on hospitality and field guidance have contributed to develop ecotourism-related career

opportunities as a means to nature and culture conservation. In case of Inkaterra Machu Picchu Pueblo Hotel's lodge staff, 85% comes from local areas.

Birdcalls CDs, checklists, plates and interactive DVDs are some of the multimedia tools produced by Inkaterra for educational purposes, in an effort to promote eco-friendly activities such as wildlife observation in an interactive way and through scientific knowledge (see appendix 4).

VI. CONCLUSION

Wildlife native to the Machu Picchu cloud forest is conserved through Inkaterra's impact management based on ecotourism, and its educational efforts to raise awareness on environmental care. Bird diversity, including the presence of communal leks populated by Andean cock-of-the-rock specimens, as well as various Torrent ducks registered at the Vilcanota River, is one of the symptoms of a healthy ecosystem.

On the other hand, the rate of recurrence for wild Andean bear sightings – including cubs – has augmented in hotel surroundings, a hint of population growth. The Neotropical otter (*Lontra longicaudis*), a Near Threatened species according to IUCN [15], has also been found at the Vilcanota riverbed facing the hotel, an evidence of sustainable food chains with waters rich in fish and crustaceans (figure 11).

Biological inventories, the observation of nearby existing systems as a model or reference, and surveying local communities on native floristic composition, have proven to be successful measures in ecosystem restoration. Hence, the recovery of cloud forest dynamics in aspects such as hydrological flow (including horizontal precipitation) allows the flourishing of representative species of orchids, ferns, heliconia and bromeliads.

Inkaterra's sustainable approach was certified by the Control Union Green Choice Sustainable Tourism Standard (2012), becoming the world's first hotel enterprise to be acknowledged by Control Union due to its initiatives on biodiversity conservation and for raising awareness on the sustainable use of natural resources. On a yearly basis, an average of 160,302 travellers are catered at Inkaterra Machu Picchu Pueblo Hotel, suggesting that ecosystem restoration has a direct influence over the progress of ecotourism, creating added value in rural areas.

The United Nations General Assembly declared 2017 the International Year of Sustainable Tourism for Development [16], in an effort to endorse the above expressed ethos as a global trend.

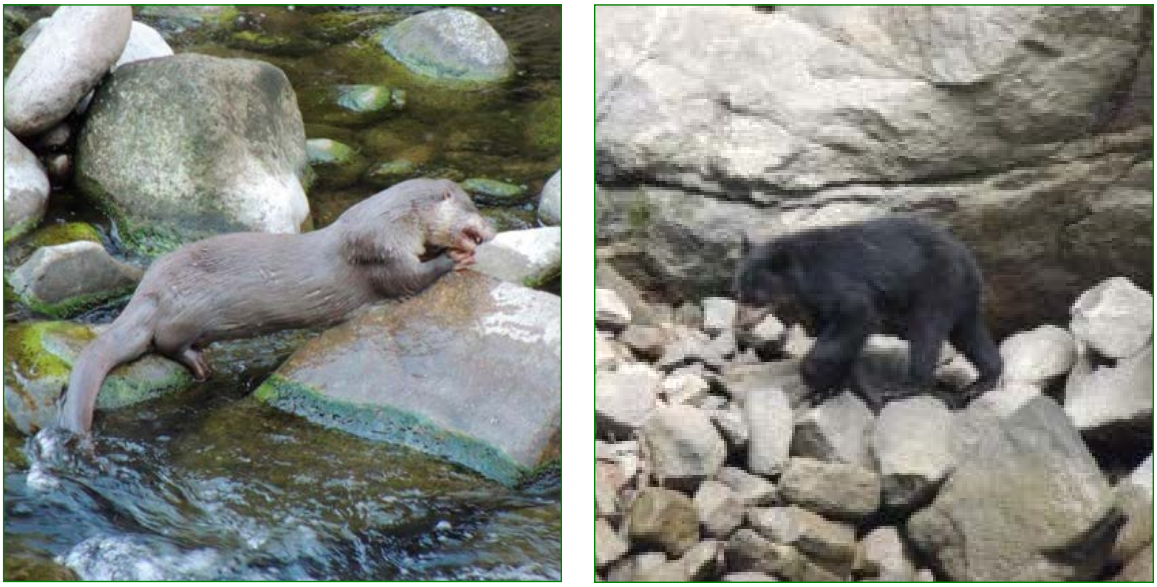

FIGURE 11 NEOTROPICAL OTTER (*LONTRA LONGICAUDIS*) AND ANDEAN BEAR CUB, THREATENED SPECIES FOUND IN HOTEL SURROUNDINGS.

APPENDICES

1. Inkaterra Machu Picchu Pueblo Hotel, *Bird Checklist* Available from: http://www.inkaterra.com/nature_conservations/check-list/#!inkaterra-machu-picchu-pueblo-hotel

2. Inkaterra Machu Picchu Pueblo Hotel, *Orchid Calendar*. Available from: http://www.inkaterra.com/wp-content/uploads/2015/11/CALENDARIO_ORQUIDEAS.pdf

3. SERNANP, Gobierno Regional del Cusco, WCS and Inkaterra, *Estrategia para la conservación del oso andino en el Santuario Histórico de Machu Picchu y el* Área *de Conservación Regional Choquequirao*, https://peru.wcs.org/es-es/especies/oso-andino.aspx

4. Inkaterra Machu Picchu Pueblo Hotel, *Bird Calls,* http://www.inkaterra.com/media/bird-calls/#!inkaterra-machu-picchu-pueblo-hotel

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REFERENCES

[1] A. Häger, Einfluss von Klima und Topographie auf Struktur, Zusammensetzung und Dynamik eines tropischen Wolkenwaldes in Monteverde, Costa Rica, Göttingen: Dissertation Georg August Universität Göttingen (2006).

[2] T. Stadtmüller, Cloud forests in the humid Tropics, Turrialba: CATIE (1987).

[3] L. Hamilton, J. Juvik and F. Scatena, "The Puerto Rico Tropical Cloud Forest Symposium: Introduction and Workshop Synthesis", Ecological Studies Vol. **110**, pp.1-23 (2011).

[4] L. Bruijnzeel and J. Proctor, J. "Hydrology and Biogeochemistry of Tropical Montane Cloud Forests: What Do We Really Know? "Ecological Studies Vol. **110**, pp.38-78, (2011).

[5] C. Soto, A. Marín and J. Purisaca, Avifauna en Hotel Inkaterra Machu Picchu Pueblo, Lima: Inka Terra Asociación (2005).

[6] SERNANP, "Plan Maestro 2015-2019 Santuario Histórico de Machu Picchu", Planes Maestros SERNANP, April 17, 2015, http://old.sernanp.gob.pe/sernanp/archivos/biblioteca/planes_maestros_2015/MACHUPICCHU/RP%20N%20070-2015-SERNANP.pdf

[7] K. Holl and T. Aide. "When and where to actively restore ecosystems?", Forest Ecology and Management 261, pp. 1558 - 1563 (2011).

[8] R. Hobbs and J. Harris, "Restoration Ecology: Repairing the Earth's ecosystems in the New Millennium", Restoration Ecology Vol. 9 N°2, pp.239-246 (2001).

[9] "Species Profile Cock-of-the-Rock (Rupicola Peruviana)", Rainforest Alliance, accessed 10 September 2016, http://www.rainforest-alliance.org/education/documents/cock_of_the_rock.pdf

[10] B. Walker, Birds of Machu Picchu and the Cusco Region, Peru, Barcelona: Lynx Edicions (2015).

[11] F. Vignati, D. Hawkins and B. Priedeaux, Sustainable Tourism: Driving Green Investment and Shared Prosperity in Developing Countries, North Charleston: CreateSpace Independent Publishing Platform (2016).

[12] Y. León-Vargas, S. Engwald, M. Proctor, "Microclimate, light adaptation and desiccation tolerance of epiphytic bryophytes in two Venezuelan cloud forests", Journal of Biogeography Vol. **33** Issue 5, pp.901-913 (2006).

[13] B. Collantes, C. Soto and J. Koechlin, Orchids at Inkaterra Machu Picchu Pueblo Hotel, Lima: Inkaterra (2007)

[14] I. Goldstein, X. Velez-Liendo, S. Paisley, D.L. Garshelis, "Tremarctos ornatus", IUCN Red List, June 30, 2008, accessed September 6, 2016, http://www.iucnredlist.org/details/22066/0

[15] M. Rheingantz and C. Trinca, "Lontra longicaudis", IUCN Red List, June 1, 2014, accessed September 7, 2016, http://www.iucnredlist.org/details/12304/0

[16] United Nations General Assembly 70/193 of 22 December 2015, "International Year of Sustainable Tourism for Development, 2017", available from: http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/193

Excellence in post-mining restoration within a global biodiversity hotspot in Western Australia

Vernon J. Newton, *Hanson Construction Materials*, and Deanna P. Rokich, *Western Australian Botanic Gardens and Parks Authority*

ABSTRACT. Perth – the capital city of Western Australia – sits at the centre of one of the world's 34 global biodiversity hotspots. For Hanson Construction Materials (Hanson), one of Australia's leading suppliers of heavy materials to the building industry, the extraction of sand in the south-west of Western Australia presents significant environmental and social challenges in demonstrating leading practice within public view.

This article outlines a 21-year research partnership forged between Hanson and the Western Australian Government's Botanic Gardens and Parks Authority to tackle the complex environmental and biodiversity issues associated with post-mining restoration of iconic *Banksia* woodland communities. Once a common and widespread feature of the Swan Coastal Plain on which the Perth metropolitan area has developed, today there remains less than 10% of the original *Banksia* woodlands, yet this ecosystem alone contains more plant species than all of the plant species found in the United Kingdom!

The research partnership tested ecological restoration theory based on melding the principles of adaptive management (decisions made on the basis of lessons learned) with integrated restoration science (linking core restoration disciplines—topsoil handling, mulch and seed enhancement treatments). The success of the research partnership has been a demonstration of innovation, leadership and environmental excellence with Hanson now having the highest levels of species and plant reinstatement per unit area of post-mined restoration in the Australian resources sector.

Excellence dans la restauration post-exploitation minière au sein d'un hotspot mondial de la biodiversité en Australie occidentale

RÉSUMÉ. Perth – la capitale de l'Australie occidentale - se trouve dans l'un des 34 points chauds de la biodiversité mondiale. Pour 'Hanson Construction Materials' (Hanson), l'un des principaux fournisseurs australiens de matériaux lourds pour l'industrie de la construction, l'extraction de sable dans le sud-ouest de l'Australie-Occidentale présente des défis environnementaux et sociaux significatifs pour démontrer des pratiques de pointe dans l'opinion public.

Cet article décrit un partenariat de recherche de 21 ans entre Hanson et l'Office des jardins botaniques et des parcs du gouvernement de l'Australie occidentale mis en place pour s'attaquer aux problèmes complexes environnementaux et de la biodiversité associés à la restauration post-exploitation minière des communautés forestières iconiques de *Banksia*. Jadis c'était une caractéristique commune et répandue de la plaine côtière de cygnes sur laquelle s'est développée la région métropolitaine de Perth ; aujourd'hui il reste moins de 10% des forêts originales de *Banksia*, pourtant ce seul écosystème contient plus d'espèces végétales que le Royaume-Uni.

Le partenariat de recherche a mis à l'épreuve la théorie de la restauration intégrée basée sur la fusion des principes de gestion adaptative (décisions prises sur la base des leçons apprises) avec la science de la restauration intégrée (reliant les disciplines de restauration de base - traitement des terres arables, paillis et traitements pour l'amélioration des semences). Le succès du partenariat de recherche a été une démonstration d'innovation, de leadership et d'excellence environnementale, Hanson ayant maintenant les niveaux les plus élevés de rétablissement d'espèces et de plantes par unité de surface de restauration post-exploration minière dans le secteur des ressources en Australie.

La excelencia en la restauración post-minería en un hotspot de biodiversidad en Australia Occidental

RESUMEN.[1] Perth - La capital de Australia Occidental - se encuentra dentro de uno de los 34 puntos calientes de biodiversidad [*hotspot*] del mundo. Para Hanson Construction Materials (Hanson), uno de los principales proveedores de materiales pesados en la industria de la construcción de Australia, la extracción de arena en el sur-oeste de Australia Occidental presenta desafíos ambientales y sociales significativos al buscar demostrar liderazgo en esta práctica ante la opinión pública.

En este artículo, se describe una asociación de investigación de 21 años forjada entre Hanson la Administración de Jardins Botánicos y Parqes del Gobierno de Australia Occidental para hacer frente a los complejos problemas ambientales y de biodiversidad asociados con la restauración post-minera de las icónicas comunidades boscosas de *Banksia.* Estas comunidades, una vez características y comunes en la Llanura Costera de *Swan*, en donde se ha desarrollado el área metropolitana de Perth, ocupan ahora menos del 10% de los bosques originales *Banksia*; sin embargo, este ecosistema por sí solo contiene más especies de plantas que todas las especies vegetales que se encuentran en el Reino Unido.

La asociación de investigación, ha probado la teoría de ecología y restauración sobre la base de fusionar los principios del manejo adaptativo (decisiones tomadas sobre la base de las lecciones aprendidas) con la ciencia integrada de restauración (que une las disciplinas básicas de restauración - manipulación vegetal y tratamientos de mejora de semillas). El éxito de la asociación de investigación ha sido una demostración de la innovación, el liderazgo y excelencia ambiental, haciendo que Hanson tenga actualmente los más altos niveles de especies y restablecimiento de plantas por unidad de área en la restauración post-minera en el sector de recursos de Australia.

1 Translated by Daniela Cajiao

I. BACKGROUND

Hanson Construction Materials (Hanson) is owned by Heidelberg Cement Group, a global manufacturer of cement, aggregates, ready-mixed concrete and asphalt. Hanson extracts, processes and distributes sands, aggregates and cement for pre-mixed concrete, concrete products for industrial uses, landscaping and other building and construction applications. It operates 80 quarry sites of hard rock and sand relatively close to all major Australian capital cities.

Perth, the capital city of Western Australia, is built over a large and ancient coastal plain and its continued growth and development is highly dependent on significant sand resources generally restricted to isolated pockets in specific geological units within its metropolitan region. One key Hanson resource—and the initial site for research work—is located 30 km north-east of Perth's central business district. Hanson's sand-extraction processes, which deliver essential materials for the building industry, necessarily impact on plant communities—notably in what is known as *Banksia* woodland—supported by deep siliceous dune sands (figure 1).

The process of sand extraction requires clearing *Banksia* woodland vegetation, stripping topsoil and removing the underlying white and yellow quartz sand horizons which constitute some 18–40 metres of the sand profile.

FIGURE 1 Banksia woodland plant communities are among the most biodiverse woodland types in Australia (top). The woodlands have developed on deeply weathered and leached sands that form the basis of major sand extraction for silica products and building sands (bottom).

II. UNIQUE RESEARCH COLLABORATION

In 1995, Hanson approached the Kings Park Science Directorate of the Western Australian Government's Botanic Gardens and Parks Authority with a unique proposal and a highly ambitious plan of returning mined sites to an ecosystem closely resembling the species composition of naturally-occurring *Banksia* woodland.

The aim was to develop international-leading practice for the integrated restoration of post-mined sites (combining topsoil management; seed broadcasting, seed-germination enhancement technology, mulch management and smoke technology), using principles of adaptive management (management applied on the basis of lessons learned). Such an approach had not been attempted previously for a biodiverse ecosystem in a biodiversity hotspot.

Prior to the commencement of the collaborative research programme (which has now spanned more than two decades), the diversity and sustainability of postmined *Banksia* woodland was limited in both species diversity and plant abundance values (figure 2).

FIGURE 2 Although some plant cover was established, the diversity of species was well below that of natural recruitment levels of undisturbed woodland at Hanson sites pre-1995 and prior to the formation of the Kings Park and Hanson research partnership.

Research at the first site for restoration (more than 70 hectares located to the north of the Perth central business district) focused on two key scientific areas of inquiry: seedling recruitment and plant survival; and plant growth and development responses to a reconstructed soil environment.

The research programme aimed to demonstrate innovation and environmental research excellence through:

- Compiling the largest database on soil and plant development data for reinstated *Banksia* woodland species, benchmarked with natural *Banksia* communities;
- Detailing a better understanding and optimization of the regenerative potential of the soil seed bank.
- Resolving methods for topsoil handling and storage;
- Researching and developing innovative seedgermination enhancement pretreatments (e.g., smoke);
- Enhancing greenstock-enabling treatments (e.g. tree-guards, anti-transpirants);
- Definitively testing site treatments (e.g., mulching, irrigation and soilripping practices and application of soil stabilizers);
- Researching the autecology and selective control of dominant weeds species impacting upon native plant survival in restored sites;
- Investigating eco-physiological parameters (nutrient and soil water relations);
- Considering and designing engineering solutions for the restoration challenges facing industry.

III. KEY ISSUES

A. Conservation Awareness

Banksia woodlands are such a familiar site on the Swan coastal plain (including in and around the Perth metropolitan area) that few people consider these plant communities to be of serious conservation concern. Yet only 10% remain within the metropolitan area. As a result, these woodlands had not been seriously researched. The challenge for the collaborative project has been to use research leadership and successes to increase the awareness of *Banksia* woodlands and to train the next generation of restoration practitioners. This has been supported by tours, lectures and undergraduate training onsite by Hanson, as well as community workshops by Kings Park.

B. Site-Specific Restoration

The *Banksia* woodlands represent a floristically rich and taxonomically diverse plant community, strongly affected by small edaphic differences. As a result, understorey assemblages have a complex spatial arrangement as a result of small changes in the topography, degree of leaching, kaolin content, and iron-mineral content. The challenge in restoration endeavours has involved habitat-matching to ensure that local-provenance seed of the correct floristic type is taken to post-sand-extraction sites.

A key finding that transformed restoration operational practice was that unlike many ecosystems elsewhere (e.g., in North America and Europe), plant ecological succession patterns do not occur in *Banksia* woodland—that is, what is restored in the first year remains the fingerprint for species composition into the long term.

Given the great age and geological stability of the landscape, *Banksia* woodland soils are typically well-formed, deep, well-drained, and low in moisture and nutrients. The age of the landscape has also led to a high level of speciation and evolutionary development. As a result, there is little chance for restoration activities (after the sand extraction process) to rely on site residuals and/or natural migration of seeds and gene flow across long distances. The research found that restoration principles for *Banksia* woodlands are sitespecific. Unlike other mining ecosystems, a key priority in developing restoration principles is to achieve the highest possible seedling recruitment levels in the first year of restoration, given poor recruitment after the second winter stemming from soil compaction issues associated with disturbance of *Banksia* woodland soils (figure 3). Furthermore, a high degree of human intervention is necessary; otherwise naturally migrating weeds out-compete the native species.

FIGURE 3 Reference sites sourced in Banksia woodland (top), are used as models to set benchmarks for seedling recruitment in restoration sites (bottom).

C. A Delicate Natural Balance

The *Banksia* woodland does not represent a resilient plant community; it is a delicately-balanced environment, far less able to withstand the impact of long-term urbanization than any other plant community adjacent to an Australian city. Human-use can lead to irreversible degradation. Indeed, the *Banksia* woodland appears to be more susceptible to weed invasion than any other plant community in the south-west of Western Australia. Woodland sites adjacent to Hanson's post-sand extracted sites are impacted by *Pinus radiata* and invaded by a pernicious weed, *Ehrharta calycina*.

Kings Park and Hanson endeavoured to keep the weeds at a distance from restoration areas through careful topsoil management (to minimize *Ehrharta calycina* invasion) and by ongoing woody weed removal (to eliminate *Pinus radiata* from restoration sites).

D. Soil Compaction and Impedance

The research uncovered a new concept – cryptic soil compaction (penetrometric changes occurring without evidence at the macro scale). Previously unknown in podzolic silica sands, cryptic soil compaction results in significant and lasting negative impacts upon restoration capability. By realizing that first principles in restoration ecology for *Banksia* woodland are site-specific and cannot be cross-applied from other ecosystems, approaches to minimize the impacts of cryptic compaction have been implemented. For example, the common practice of replacing the overburden profile is associated with greater soil compaction within *Banksia* woodland sands. Further, given the poor recruitment of plants after the second winter with the onset of soil compaction, a key priority is to strive for optimal seedling recruitment in the first year of restoration. These two principles alone have resulted in a five to eight-fold increase in seedling abundance in restoration outputs when compared with restoration success at the start of the research programme (figure 4).

FIGURE 4 Experimental plots implemented to test deep ripping of the soil profile (top) and broad-acre deep ripping based on ground-breaking research that demonstrated the impact of soil ripping and organic material on root architecture and plant survival (bottom).

For the successful restoration of a wide suite of species, efforts need to be directed to the management of the soil environment. The research programme found that a key factor for describing soil conditions was soil impedance related to the development of deep, penetrating root systems that may have direct impact on seedling survival within restoration areas. Researchers found that the commonly reconstructed soil profile in the resources sector of topsoil over overburden reflected the highest impedance values, highest moisture levels, least favorable root development and architecture and consequently the highest seedling mortality than any other reconstructed soil profile. With results indicating that reconstructed soils have higher soil impedance and more fluctuations in impedance through the year than in natural sites, penetrability becomes an important criterion for estimating rehabilitation success and as a benchmark for defining the restorability of *Banksia* woodlands.

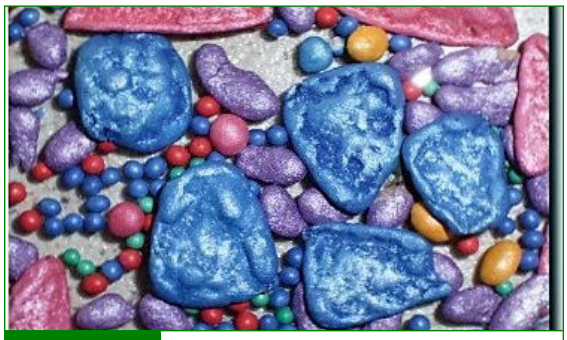


FIGURE 5

Testing new techniques. Aerosol smoke application to post-sand extracted sites leads to a threefold increase in plant numbers to restoration sites (top), while innovative seed coating developed for Banksia woodland species has trebled seedling performance in restoration efforts (middle and bottom).

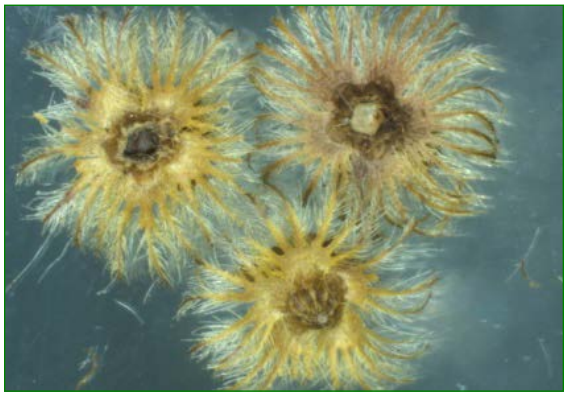
E. Topsoil Preservation

Given the sequence of operations, fresh topsoil is not always available for use in new restoration sites, resulting in the lack of a plant source. The challenge involved investigated ways to conserve topsoil. Innovative research on seed burial effects and topsoil stripping and replacement depths found that topsoil can be stripped at a greater depth (but less than 10 cm) and spread at a shallower depth (less than 5 cm). As a result, Hanson developed innovative precision stripping technology and embarked on operator training to ensure that topsoil stripping and replacement was optimized for plant recruitment. Outstanding seedling recruitment results have been achieved from topsoil replacement (e.g. more than 100 plants/5 m^2 in year 1). The development of unique smoke application techniques have enabled a threefold increase in seedling recruitment from topsoil. Furthermore, the collaborative partners have determined that coating and raking seeds, and sowing prior to winter rains, leads to a tenfold increase in seedling recruitment (figure 5).

F. Seed Biology and Displacement

There was a lack of general understanding of seed biology for restoration, including what constituted genetic provenance in seed, as well as almost a total lack of knowledge of seed dormancy, viability and germinability characteristics (figure 6).

The availability of *Banksia* seeds is generally declining on the Swan coastal plain as climate change, water extraction and loss of habitat result in a poor seed set and a loss of seed catchment. Through innovative research into seeding phenology and applying principles of seed quality and viability as well as seeduse optimization, there has been a four- to tenfold improvement in use of seed resources collected from the wild (species-dependent). This has resulted in improved collection knowledge for commercial seed-collecting companies meaning less wastage of seed and better environmental outcomes through more efficient use of wild-sourced seed.



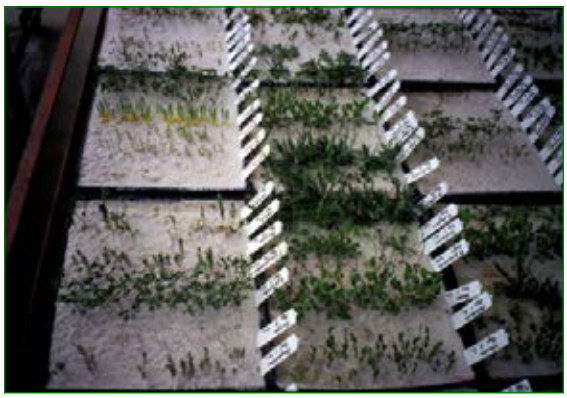


FIGURE 6 Testing seed viability via a cut test (top), and seed germinability via a seedlingemergence test (bottom).

Given the high wind activity and soil erosion experienced on site, displacement of seeds broadcast to site is high (greater than 50% of seeds are displaced). Research found that traditional topsoil stabilizers, such as paper mulches, impede seed germination, with restoration deficits related to the thickness of the stabilizers. As a result, innovative research using wind-tunnel experiments in the Faculty of Engineering at the University of Western Australia is developing new concepts in wind-abating fencing based on understanding height and spacing criteria.

G. Planning, Management and Engineering

Careful planning is vital, vigilant management is important, up-to-date engineering approaches are necessary, and well-executed timing is critical in delivering successful restoration. Any restoration schedule needs to incorporate these factors, with timing associated with soil-profile reconstruction and topsoil handling viewed as the most important aspect. Restoration has now begun to drive the operational programme. This is particularly relevant to topsoil where poorly handled topsoil or ineffective direct seeding causes restoration to rely on the more expensive use of planted seedlings. These new engineering approaches have a direct and significant impact on restoration success. For example, the project saw the first introduction of new land-plane techniques that have now been widely adopted, with more than 20 land planes operating in the southwest of Western Australia. Similarly, new approaches to counter weeds have been employed widely following the finding that when earthmoving machinery was used to shape the land (e.g., in the formation of batters), the disturbance could stimulate germination of weed seeds. Weed liability near the soil surface is now removed (to at least 100 mm) prior to commencing operations and is either taken offsite or is deeply buried within earthworks and then capped with more than one metre of weed-free soil to reduce the risk of weed seedlings emerging.

H. Increased Native Species

The excellence of the research has increased the number of native species returning following sandextraction activities to levels significantly greater when compared to natural recruitment cycles in undisturbed *Banksia* woodland. Indeed, in the second and third years, the number of native species per $5m^2$ is almost double the best achieved in undisturbed ecosystems.

FIGURE 7 Experimental restoration sites are demonstrating pre-sand extracted species composition.

Today, as a result of the collaborative research partnership, and with more than 100 plants per 5 m^2, Hanson boasts the highest levels of species and plant reinstatement per unit of area of post-mining restoration in the resources sector (figure 7).

IV. ONGOING OUTREACH

The continuing commitment by Kings Park and Hanson to the restoration of biodiverse *Banksia* woodland plant communities has been marked by:

- Continuous support by Hanson of graduate and postgraduate research programmes since 1995;
- Co-sponsorship of six PhD and 10 honours-level student research programmes since 1995.
- Hanson's sponsorship of the first ever restoration eco-physiologist dedicated to understanding the ecophysiology of *Banksia* woodland species;
- Development of an innovative research programme that will apply and further refine restoration principles from the Hanson/Kings Park programme for restoration of plantation pine forest sites within the Perth metropolitan area;
- Extension of the restoration message to a broader national and international audience through sponsorship of conferences related to plant ecology and restoration, including the 2001 International Orchid Congress, the 2007 Mediterranean Ecosystems (MEDECOS) Conference, the 2007 Seed Ecology Conference, and the 2009, 2013, 2014, 2015 and 2016 Society of Ecological Restoration Australasian and International Conferences.
- Using restoration excellence at sites to promote leading practice in the resources sector through sponsorship of ongoing educational tours (by universities in particular) to allow participants to learn first-hand about the importance of *Banksia* woodland and its ecology, conservation and restoration.

V. CONCLUSION

For more than two decades, the unique partnership of government research through Kings Park and an industry partnership with Hanson, has enabled the restoration and management needs of the biodiverse *Banksia* woodland ecosystem to be seriously addressed. By examining restoration research and monitoring within both intact urban bushlands and post-sand extracted sites, the collaborative partners have gained a holistic understanding of *Banksia* woodlands.

The research has established for the first time, a set of integrated principles for the restoration biology and ecology of plant communities for sand extraction industries mining in these biodiverse ecosystems. The research partnership has delivered world-class improvements in biodiversity replacement and created a new industry benchmark for post-mining restoration.

The significance of this work does not only provide key information for the ecologically sound restoration and management of the plant communities in *Banksia* woodlands within Hanson's postsandextraction sites; it also is of great value to conservation and restoration of *Banksia* woodlands right across Western Australia's Swan coastal plain. The partnership has shown that restoration of biodiverse ecosystems within a biodiversity hotspot is possible through dedicated, long-term environmental research excellence and leadership,

ACKNOWLEDGEMENTS

Professor Kingsley Dixon, Director, Australian Research Council (ARC) Centre for Mine Restoration, Department of Environment and Agriculture, Curtin University; Visiting Professor, Kings Park and Botanic Garden; Visiting Professor, School of Plant Biology, the University of Western Australia; Research Associate, Missouri Botanic Garden, Missouri, USA.

FURTHER READING

J.C. Stevens, D.P. Rokich, V.J. Newton, R.L. Barrett and K.W. Dixon, *Banksia woodlands - A restoration guide for the Swan Coastal Plain, University of Western Australia Press (UWAP), 2016.*

LIFE Certification—Experience of a Hydroelectric Power Plant in Restoring Ecosystems in the South of Brazil

N. L. Kaminski, C. Henn, E. S. Suemitsu, C. Teixeira, M. C. S. Carvalho, R. Borsato, M. A. Alexandre
Itaipu Binacional, Inc./Life Institute

ABSTRACT. The article presents a case-study of how the efforts of a hydroelectrical power company are contributing to restore life in Paraná, in southern Brazil. The company, Itaipu, is a world leader in clean and renewable energy having produced more than 2.3 billion MWh since it started operating, in 1984. With 20 generating units and 14,000 MW of installed capacity, Itaipu provides around 15 per cent of the energy consumed in Brazil and 75 per cent of the energy consumed in Paraguay. The company is located on a basaltic line spanning the border between Argentina and Brazil. The surrounding subtropical rainforest has over 2,000 species of vascular plants and was originally home to the typical wildlife of the region: tapirs, giant anteaters, howler monkeys, ocelots, jaguars and caymans. In addition to the impacts of the installation and operation of Itaipu, prior decades of economic development in the region, mainly agricultural activities, have resulted in the loss of natural areas. To maintain and restore life in the region, the company has been contributing through a wide variety of projects such as: biodiversity corridors, reserves and sanctuaries, reforestation, seedling production, forest restoration and wildlife management, including repopulation programmes and fish farming. In recognition of all this proactive work and the resulting improved maintenance of ecosystem services, the company has been awarded the LIFE Certification.

Certification LIFE - Expérience d'une centrale hydroélectrique dans la restauration des écosystèmes du Sud du Brésil

RÉSUMÉ. L'article présente une étude de cas sur la façon dont les efforts d'une compagnie d'énergie hydroélectrique contribuent à rétablir la vie au Paraná, dans le sud du Brésil. Itaipu est un leader mondial de l'énergie propre et renouvelable qui a produit plus de 2,3 milliards de MWh depuis sa mise en service en 1984. Avec 20 unités de production et 14 000 MW de puissance installée, Itaipu fournit environ 15% de l'énergie consommée en Brésil et 75% de l'énergie consommée au Paraguay. L'entreprise est située sur une ligne basaltique traversant la frontière entre l'Argentine et le Brésil. La forêt subtropicale environnante a plus de 2000 espèces de plantes vasculaires et abritait à l'origine la faune typique de la région: tapirs, fourmiliers géants, singes hurleurs, ocelots, jaguars et caïmans. Outre l'impact de l'installation

et du fonctionnement d'Ipaitu, les dernières décennies de développement économique dans la région, principalement les activités agricoles, ont vu la perte de zones naturelles. Pour assurer la pérennité et le rétablissement de la vie dans la région, la société a participé à divers projets tels que: couloirs de biodiversité, réserves et sanctuaires, reboisement, production de semis, restauration de forêts et gestion de la faune, y compris les programmes de repeuplement et la pisciculture. En reconnaissance de toutes ces actions proactives et de leurs résultats pour le maintien des services écosystémiques, la société a reçu la certification LIFE.

Certificación LIFE - La experiencia de una central hidroeléctrica en la restauración de ecosistemas en el sur de Brasil

RESUMEN. El artículo presenta un estudio de caso de cómo los esfuerzos de una empresa hidroeléctrica están contribuyendo para restaurar la vida en el sur de Brasil, Paraná. La empresa, Itaipú, es un líder mundial en energía limpia y renovable habiendo producido más de 2,3 mil millones de MWh desde que comenzó a funcionar, en 1984. Con 20 unidades generadoras y 14.000 MW de potencia instalada, Itaipú proporciona aproximadamente el 15% de la energía consumida en Brasil y el 75% de la energía consumida en Paraguay. La empresa está ubicada sobre una formación basáltica en una región fronteriza entre Brasil, Paraguay y Argentina. El bosque subtropical que rodea las instalaciones de la empresa tiene más de 2.000 especies de plantas vasculares y ha sido originalmente el hogar de la fauna típica de la región: tapires, osos hormigueros gigantes, monos aulladores, de ocelotes, jaguares y caimanes. Además de los impactos de la instalación y del funcionamiento de la empresa, las últimas décadas de desarrollo económico también han provocado pérdidas de áreas naturales en la región, especialmente debido a las actividades agrícolas. Para mantener y restaurar la vida en la región, Itaipú está involucrada en varios proyectos: la creación de corredores ecológicos, reservas y santuarios, reforestación, producción de plántulas, la restauración forestal y manejo de la fauna, incluyendo programas de cría en cautividad y piscicultura. Dado el conjunto de acciones proactivas y sus resultados para el mantenimiento de los servicios ecosistémicos, Itaipu obtuvo el reconocimiento de la certificación LIFE.

I. INTRODUCTION

In recent decades, economic development in west Paraná, Brazil, has resulted in serious losses of natural areas.

To maintain and restore life in the region, Itaipu has been contributing with a large number of projects projects involving, for example: biodiversity corridors, reserves and sanctuaries, reforestation, seedling production, forest restoration and wildlife management, including captive breeding programmes. In recognition of all these proactive actions and their positive results for the maintenance of biodiversity and ecosystem services, the company received the LIFE (Lasting Initiative for Earth) Certification in 2015.

II. ITAIPU

The company Itaipu is a world leader in clean and renewable energy having produced more than 2.3 billion MWh since it started operating in 1984. With 20 generating units and 14,000 MW of installed power, Itaipu provides around 15% of the energy consumed in Brazil and 75% of the energy consumed in Paraguay. The company is located on a basaltic line spanning the border between Argentina and Brazil. The surrounding subtropical rainforest has over 2,000 species of vascular plants and was originally home to the typical wildlife of the region: tapirs, giant anteaters, howler monkeys, ocelots, jaguars and caymans.

III. ITAIPU CONSERVATION ACTIONS

Many of the environmental results expected from the establishment of the company were foreseen in the early phases of its planning and installation. They were consolidated in some documents as the Basic Plan for Environmental Conservation (1975) and the Master Plan for the Reservoir Area (1982). These references jointed all the information available from previous research carried out in the project area, as the ichthyofaunistic (19771981), floristic (1976) and faunistic (1979) inventories that allowed compensatory and mitigatory measures to be proposed, even though there were no legal obligations concerning environmental responsibilities at the time.

Itaipu maintains a technical team of biologists, foresters, veterinarians, zoo technicians, agronomists, educators and other specialists, a total of 38 people dedicated to actions focused in flora, fauna and ichthyofauna. The infrastructure includes a forest nursery, which can produce 350,000 seedlings from 75 species a year; an ichthyofauna laboratory; a zoo that maintains a gene bank (living and cryopreserved) of 360 animals from 61 species; a veterinary hospital; and a 10.3 km long fish transposition system.

The restoration of natural areas covering 1,007 km^2 along the river includes reserves and sanctuaries that were devastated for agriculture and livestock farming before the company was set up. Since 1979, more than 23 million forestspecies seedlings have been planted on the Brazilian side of the company, called "the left bank". It was considered the most extensive reforestation in the world carried out by a hydroelectric power company. On the Brazilian side alone, the protected area along the river is 1,395 km long and 210 m wide. The protection strip along the reservoir was the greatest effort regarding to reforestation; it accounts for 86% of the total land ecosystem under company's protection in Brazilian territory (figure 1).

Since 2002 Itaipu, together with some partners, has been operating the Santa Maria Ecological Corridor, linking the Iguaçu National Park to the company´s reserves and other significant forest remaining, as

FIGURE 1 RIPARIAN FOREST ALONG RESERVOIR MARGINS.

Ilha Grande National Park. This work used the seed of 128,000 seedlings over 73.3 ha and conserved 902 ha of forest remnants and natural areas along the river. Itaipu participation comes within a Management Network, established to develop the mapping and boundaries of the Paraná River Biodiversity Corridor. This process took in account the identification of the priority areas and their social and economic relationships.

Itaipu is also responsible for the conservation of two sanctuaries: the 1,920-hectare Bela Vista Sanctuary and the 1,482-hectare Santa Helena Sanctuary. There is also the 1,356hectare Maracaju Sanctuary, which is located in the border between Brazil and Paraguay and is comanaged by the two sides of the company.

For the maintenance of these preserved areas, Itaipu keeps and manages staff for security, environmental protection and fire control.

Beyond the direct results of maintaining the composition, structure and function of the natural ecosystems, the natural areas preserved by Itaipu contribute to biodiversity conservation through wildlife research and environmental education.

In addition to providing seedlings for all forest restoration carried out by Itaipu in its own territory, the nativeforest seedling production facility in the Itaipu nursery (figure 2) also donates seedlings to the initiatives of partners, such as municipalities, non-governmental organizations and others located in the river basin. More than 4.5 million seedlings have been distributed in the last 13 years. Some of the most wellknown species produced are the pink trumpet tree (*Tabebuia avellaneda*), the cedro (*Cedrela fissilis*), and the pau marfim (*Balfourodendron riedelianum*), intended for the restoration of the riparian forests of the Paraná basin, the Protection Strip and the Maracaju Sanctuary. According to 2016 IUCN Red List, four endangered species are grown in the forest nursery (table 1).

TABLE 1. ENDANGERED FOREST SPECIES (IUCN) USED IN SEEDLING PRODUCTION

COMMON NAME	SCIENTIFIC NAME
Peroba rosa	*Aspidosperma polyneuron*
Pau marfim	*Balfourodendron riedelianum*
Cedro	*Cedrela fissilis*
Guabiju	*Myrcianthes pungens*

Itaipu is also responsible for captivebreeding research for some threatened species in Brazil, developing new protocols and serving as a model in the country for several researches institutions. Located in the Bela Vista Sanctuary, the wildlife captivity facility has the capacity for more than 300 animals. Since it was set up, more than 1,000 births have been recorded from a total of 48 species, mainly the Brazilian dwarf brocket/pygmy brocket (*Mazama nana*), the margay (*Leopardus wiedii*) and the lowland tapir/*anta* (*Tapirus terrestris*) (figure 3) with a success rate above 70%. One of the highlights of these endeavours was the successful breeding of the endangered species known as the royalhawk or harpy eagle (*Harpia harpyja)*, with 25 individuals being hatched in Bela Vista

FIGURE 2 SEEDLING PRODUCTION OF NATIVE SPECIES.

FIGURE 3 *TAPIRUS TERRESTRIS* IN CAPTIVITY.

Sanctuary since 2007 (figure 4). The wildlife breeding centre counts five species on the IUCN Red List, many of them breeding (table 2).

TABLE 2. ENDANGERED NATIVE FAUNA SPECIES IN THE WILDLIFE BREEDING CENTRE

COMMON NAME	SCIENTIFIC NAME	BIRTHS UP TO 2012
Northern tiger cat	*Leopardus tigrinus*	30
Lowland tapir	*Tapirus terrestres*	8
Marsh deer	*Blastocerus dichotomus*	15
White-lipped peccary	*Tayassu pecari*	64
Giant anteater	*Myrmecophaga tridactyla*	0
Vinaceous-breasted amazon	*Amazona vinacea*	0
Black-fronted pipingguan	*Pipile jacutinga*	0

Given the important relationship between the company and the river, Itaipu is developing a specific line of action to maintain the composition of the aquatic ecosystem: the Piracema channel that promotes population connectivity among migratory fishes of the region. The channel, which is 10.3 km long, promotes the flow of genes and mitigates fragmentation effects. It has been in operation since 2002 and is composed of natural segments of the Bela Vista River, concrete stretches and artificial lakes [1].

The evaluation of fishpassage structures are often limited by small sample sizes and the lack of detailed information on the movements of individual fish. Water and environmental conditions affecting the efficiency of passage can vary widely within a given experiment, which hinders the meaningful interpretation of data. Several techniques have been employed to address this problem, but prohibitive costs in terms of both time and money have limited the scope of the experiments [2].

In recent years, a technology has developed to allow the collection of detailed information on small and largescale movements of large numbers of individual fish. The passive integrated transponder (PIT) is a small, relatively inexpensive tag that can be programmed with an almost infinite number of individual codes and, with no battery, has an unlimited life expectancy. Individual PIT-tagging studies conducted in the Columbia River Basin have successfully monitored the movements of tens of thousands of juvenile

FIGURE 4 THE ROYAL-HAWK, *HARPIA HARPYJA*, IN ITAIPU, SUCCESSFULLY BRED IN CAPTIVITY

salmonids through and around the hydroelectric facilities. Comparisons with markrecapture techniques of similar sample size have demonstrated the superior level of data acquisition offered by the PIT tag [3].

In 1997, Itaipu started its own studies to determine migratory fish routes, based on the tagging and recapture protocol. Since 2009, PIT tag has also been used to determine detailed behavioural patterns of migratory species into the transposition system (figure 5). The tagging is used on migratory species as the pacu (*Piaractus mesopotamicus*), the jaw characin (dorado) (*Salminus brasiliensis*) and the grumatá (curimba) (*Prochilodus lineatus*) [4]. The information generated helps in adjusting transposition projects for neotropical fish [5].

FIGURE 5 PIT TAG INSERTION PROCEDURE. TAGS ARE IMPLANTED INTO THE ABDOMINAL CAVITY OF NATIVE CAPTURED FISH.

Since 2001, the nursery areas for fish species have been mapped systematically, in association with universities, in the main tributaries of Itaipu reservoir and Ilha Grande National Park, the largest undammed stretch of Paraná River.

Itaipu also undertakes environmental-education activities, raising the awareness of the public and social groups, thus contributing to the building of a sustainable society.

During the major water crisis in Brazil in 2015, the Itaipu "Cultivating Good Water" (CGW) programme received the United Nations Best Water Management Practices award [6]. The main activities of the CGW programme include: restoration of watersheds, with an emphasis on springs and riparian forests, soil conservation, rural road improvement, installation of community water points and water tanks for water recycling, as well as the promotion of more sustainable production and consumption systems.

All these experiences have been transformed into social technology to help local governments affected by water crisis. This programme is already being replicated in other Latin American countries and has inspired many other countries.

IV. LIFE CERTIFICATION

As the problems of environmental change become more evident, we increasingly realize how much we depend upon wildlife for a wide range of so-called ecosystem services. We all depend for our survival upon processes such as biological productivity, nutrient cycling, and water cycling which provide clean air and water, maintain the fertility of the soil, and help to regulate the climate. In recent years, economists have made important progress in defining the kinds of benefits that biological diversity provides, and in developing methods for assessing their value. The sustainable use of any natural resource implies that nothing should be done in the short term that reduces the ability of the resource to provide services in the future [7]. But, because most ecosystem services are public goods, markets are not available to provide clear units of account [8].

Certification programmes—organized and coordinated by non-State actors—exemplify efforts to encourage and control information flows to resolve environmental and social challenges within and beyond State boundaries. Such initiatives have been developed in numerous sectors to address the problems of labour exploitation, environmental degradation, and social injustice. The hope is that certification can be a tool for nongovernmental organizations, investors, governments, and consumers to identify and support high performers [9].

The need to conserve biodiversity by strengthening the engagement of the private sector has set the scene for the creation of the LIFE Methodology and Certification, a technical approach related to an international non-State market-driven instrument that can be applied in any country or sector [10]. The LIFE Methodology is applied to those businesses concerned with the increasing risks of global environmental thresholds and that, in response, aim to implement robust and measurable biodiversity action plans to compensate for the organization's impacts.

Besides the application of the LIFE Methodology, companies may have a third-party evaluation of its biodiversity performance taking into account its impact and size. The third-party evaluation can result in the granting of the Certification for the company.

Taking into account the LIFE Methodology, an organization´s biodiversity impact index (BII) is quantified by measuring its annual waste generation, greenhousegas emissions, energy consumption, ecoregional location, and water usage. These data are ranked in terms of their severity through information on the destination and degree of hazard of wastes, gaswarming potential, impacts of the energy source, ecoregional remnants and fragility and water availability in the region. Once the BII is obtained, a minimum biodiversity-conservation performance standard is calculated [11].

Finally, the organization is obliged to demonstrate quantitatively its voluntary biodiversity conservation results each year. The scoring quantification of performance is done by evaluating the company's biodiversity action plan (BAP), the score being higher when the BAP is well aligned and focused on concrete actions and results. The biodiversityactions scoring takes into account the company's technical methodology and efficiency and efficacy for the maintenance of the composition, structure and function of local biodiversity [12]. In this sense, the LIFE initiative promotes a change of mindset to mainstream natural

capital conservation in all business practices, taking into account a technical and scientific approach for the company's biodiversity action plan.

The LIFE Methodology makes it possible to assess the effectiveness of an environmental management system (EMS), highlighting potential areas of improvements for management, including the minimization of expenses and optimization of investments and reforms. This is very important, especially when the EMS also values the efficiency of processes, which does not always lead to the truly effective management of resources [13].

LIFE is considered an innovative and robust tool and it is a unique quantitative and universal calculation methodology that is able to measure; evaluate; monitor and compare numerically the environmental impact of different organizations and sectors. It is also innovative in that its methodology establishes a minimum biodiversity conservation performance that shall be calculated in proportion to the impact of each organization. Finally, the organization shall quantitatively prove its voluntary biodiversity conservation results each year. In this sense, the LIFE initiative promotes a change in mindset to mainstream natural capital conservation in all business practices.

V. LIFE CERTIFICATION OF ITAIPU

Itaipu Binacional organized a ceremony in Foz do Iguaçu on 7 April 2015 for the company to officially receive LIFE Certification. The ceremony took place in the Itaipu Auditorium during the event "Sustainable Dialogues" in the presence of Jorge Samek, Brazilian General Director of Itaipu, Nelton Friedrich, Director of Coordination and Environment, and Clovis Borges, VicePresident of the LIFE Institute Board of Directors.

For Itaipu, LIFE Certification provides a means to guide the wide range of environmental measures taken by the company, according to a robust technical protocol that provides scientific information to determine the real effectiveness of the chosen course of action.

In addition to the environmental aspects of the methodology, a huge improvement was noticed when Itaipu performed complete year-by-year monitoring of its impact. This meant an improvement in the documentation and record-keeping at all stages of the project. Statistical information has supported all the decisions taken for company´s future planning.

From now on, the main challenge is to maintain this structured system, in an attempt to achieve the best sustainability practices in its sector, a goal to be reached by 2020.

REFERENCES

[1] A. S. Fiorini, D. R. Fernandez, H. M. Fontes Jr., "Itaipu Dam Piracema migration channel", in *Proc. Vingt Deuxième Congrès Des Grands Barrages,* Barcelona, 2006, pp. 325-348

[2] T. Castro-Santos, A. H. Stephen Walk, "A passive integrated transponder (PIT) tag system for monitoring fishways", *Fisheries Research* vol. 28 (1996), pp. 253-261.

[3] E. F. Prentice, T. A. Flagg, and S. McCutcheon, "Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids", in *Fish Marking Techniques*, N.C. Parker, A.E. Giorgi. R.C. Heidinger, D.B. Jester, Jr., E.D. Prince and G.A. Winans, eds, *American Fisheries Society Symposium*, vol. 7 (1990), pp 317-322.

[4] J. M. C. Makrakis, L. E. Miranda, S. Makrakis, H. M. Fontes Jr., W. G. Morlis, J. H. P. Dias, J. O. Garcia , "Diversity in migratory patterns among neotropical fishes in a highly regulated river basin," *Journal of Fish Biology*, vol. 81, pp. 866-881, 2012.

[5] H. M. Fontes Jr., T. Castro-Santos, S. Makrakis, L. C. Gomes, J. D. Latini, "A barrier to upstream migration in the fish passage of Itaipu Dam (Canal da Piracema), Paraná River Basin," *Neotropical Ichthyology*, vol. 10, pp. 697-704, 2012.

[6] Itaipu Binacional, "Relatório de Sustentabilidade 2015," 2015, accessed September 22, 2016, https://www.itaipu.gov.br/sites/default/files/RS2015_180816_comseloGRI.pdf

[7] P. J. Edwards, C. Abivardi, "Where ecology and economy blend", *Biological Conservation*, vol. 83, No. 3 (1998), pp. 239-246.

[8] J. Boyd, S. Banzhaf, "What are ecosystem services? The need for standardized environmental accounting units", *Ecological Economics*, vol. 63 (2007), pp. 616 – 626.

[9] G. Auld, L. Gulbrandsen, "Transparency in Nonstate Certification: Consequences for Accountability and Legitimacy", *Global Environmental Politics* 10:3, August 2010.

[10] R. Borsato, J.T., Mendes Filho, M.S. Milano, A. Salzmann, M.A. Alexandre, B. Brasil, M. Nunes, C. Borges, M. Posonski. "Biodiversity accountability in Brazil: the role of LIFE (R) Certification", in Michael Jones (Org.), *Accounting for Biodiversity*, 1st ed., (Abingdon and New York, Routledge, 2014), pp. 172-188.

[11] LIFE, "Cálculo do Índice de Impacto à Biodiversidade e definição de desempenho mínimo em Ações de Conservação", LIFE Technical Guide LIFE-TG01 Available from: http://institutolife.org/wp-content/uploads/2016/08/LIFE-BR-TG01-3.1-Portugues.pdf . 2016.

[12] LIFE, "Avaliação do Desempenho em Ações de Conservação da Biodiversidade", LIFE Technical Guide LIFE-TG02. Available from: http://institutolife.org/wp-content/uploads/2016/06/LIFE-BR-TG02-3-1-Portugues.pdf. 2016a.

[13] R. Reale, L. C. Ribas, R. Borsato, T. C. Magro, M. Voigtlander. "The LIFE certification methodology as a diagnostic tool of the environmental management system of the automotive industry", *Environmental Science and Policy*, vol. 57 (March 2016), pp. 101-111.

Gains in Nature Conservation based on Compensatory Reforestation in the Atlantic Forest, Brazil

Marcelo B. Pinto, *Society for Wildlife Research and Environmental Education (SPVS)*; Daniela B. G. Bussmann, *Grupo Arteris*; Alessandra X. de Oliveira, *Society for Wildlife Research and Environmental Education (SPVS)*; Ricardo G. Luiz, *Society for Wildlife Research and Environmental Education (SPVS)**

ABSTRACT. The Atlantic Forest biome is considered a world biodiversity hotspot that originally covered 15% of the territory of Brazil, or 1,306,421 km^2. Spread out along the Atlantic coast of Brazil, it includes a wide range of ecosystems, such as mangroves, *restinga* vegetation, lowland and upland forests, Araucaria forest and *campos de altitude* (Brazilian highaltitude grasslands). Currently, the Atlantic Forest has been reduced to a mere 7.84% of its original size and now covers some 102,000 km^2. Studies indicate deforestation amounting 18,433 hectares (184 km^2) of the remaining forest in the period 2014-2015. Due to the high fragmentation of forests, restoration projects are important and may incorporate actions that benefit the conservation of the biome. Infrastructure projects, such as the construction or expansion of highways, can bring significant impacts to biodiversity, such as through the removal of native vegetation. To make up for such impacts, Brazilian environmental agencies follow the rule of demanding offset measures. Such measures result, for the most part, in the planting of trees in an amount arrived at by multiplying the number of organisms lost. When companies are involved in activities that benefit biodiversity conservation, its offset measures required by environmental agencies could be targeted at more consistent outcomes in favour of the natural heritage, such as environmental restoration and synergies with the management of protected areas. Against this background, a partnership was established between a company in the infrastructure sector and an institution working for nature conservation. The aim was to direct offset measures for restoration of endangered ecosystems in protected areas of the Atlantic Forest. In addition to the environmental outcomes, this initiative is a model for future activities involving environmental offset measures in Brazil.

DES GAINS POUR LA CONSERVATION DE LA NATURE BASÉS SUR DES PLANTATIONS COMPENSATOIRES DANS LA FORÊT ATLANTIQUE, BRÉSIL

RÉSUMÉ. Le biome 'Forêt Atlantique' est considéré comme un *hospot* mondial de la biodiversité qui couvrait à l'origine 15% du territoire brésilien, soit 1.306.421 km^2. Étendu le long de la côte atlantique du Brésil, il comprend un large éventail d'écosystèmes, tels que les mangroves, la végétation de *restinga* (végétation côtière), les forêts de plaine et de montagne (versants de la « Serra do Mar »), la forêt d'Araucaria et les champs d'altitude (prairies brésiliennes de haute altitude). Actuellement, la forêt atlantique a été réduite à seulement 7,84% de sa taille originale et couvre maintenant quelque 102 000 km^2. Des études indiquent un déboisement de 18 433 hectares (184 km^2) de la forêt

restante pour la période de 2014 à 2015. En raison de la forte fragmentation des forêts, les projets de restauration sont importants et peuvent intégrer des actions qui favorisent la conservation du biome. Les projets d'infrastructure comme la construction ou l'élargissement des autoroutes peuvent avoir des répercussions importantes sur la biodiversité, par exemple en supprimant la végétation indigène. Pour compenser ces impacts, les agences environnementales brésiliennes appliquent la règle des mesures de compensation. Ces mesures se traduisent, dans la plupart des cas, dans la plantation d'un nombre d'arbres calculé sur base du nombre d'arbres perdus. Lorsque les entreprises participent à des activités qui favorisent la conservation de la biodiversité, les mesures d'atténuation requises par les institutions environnementales pourraient viser des résultats plus concrets en faveur du patrimoine naturel, comme la restauration écologique et les synergies avec la gestion des aires protégées. Dans ce contexte, un partenariat est établi entre une entreprise du secteur des infrastructures et une institution travaillant pour la conservation de la nature, son objectif étant d'orienter les mesures de compensation pour la restauration des écosystèmes menacés situés dans les zones protégées de la forêt atlantique. En plus des résultats environnementaux qu'elle réalise, cette démarche représente un modèle à suivre pour d'autres actions futures de compensation écologique au Brésil.

BENEFICIOS EN LA CONSERVACIÓN DE LA NATURALEZA BASADOS EN REFORESTACIONES COMPENSATORIAS EN EL BOSQUE ATLÁNTICO, BRASIL

RESUMEN. El Bosque Atlántico es considerado un hotspot global que originalmente cubrió el 15% del territorio brasileño, equivalente a 1.306.421 Km^2. Distribuidos a lo largo de la costa atlántica está formado por un conjunto de ecosistemas: manglares, marismas, bosques de tierras bajas y cuestas de la Sierra del Mar, Bosque de Araucaria y los *campos de altitude*. El área original del Bosque Atlántico ha sido reducida a 7,84%, con cerca de 102.000 Km^2. Los estudios indican claramente la deforestación de 18.433 hectáreas, o 184 Km^2 de bosques remanecientes en el periodo comprendido entre 2014 y 2015. Debido a la fragmentación de los bosques, los proyectos de restauración son importantes y pueden integrar acciones para la conservación del bioma. Proyectos de infraestructura, como la construcción o ampliación de carreteras, pueden traer impactos significativos para la biodiversidad - tales como la eliminación de la vegetación nativa. Para compensar este impacto es la regla en Brasil que agencias ambientales soliciten medidas compensatorias. Estas medidas se reflejan, en su mayor parte, en un número de árboles plantados a partir de un recuento de multiplicación del número de individuos suprimidos. Al involucrar las empresas en acciones que vengan a favorecer la conservación de la biodiversidad, las medidas de compensación requeridas por las agencias ambientales pueden ser dirigidas a generar resultados más consistentes en favor del patrimonio natural, como la restauración ecológica y las sinergias con trabajos de gestión de las áreas protegidas. Con base en este contexto, se estableció una cooperación técnica entre una empresa del sector de la infraestructura y una institución que trabaja para la conservación de la naturaleza. La cooperación tuvo por finalidad direccionar una solicitud de compensación ambiental para la restauración de áreas protegidas del Bosque Atlántico, en ecosistemas en peligro de extinción. Además de los resultados ambientales, esta iniciativa es un modelo para las futuras acciones de compensación ambiental en Brasil.

*M. B. Pinto is Project Coordinator, Society for Wildlife Research and Environmental Education (SPVS) (e-mail: marcelob@spvs.org.br).

A. X. de Oliveira is Project Assistant, Society for Wildlife Research and Environmental Education (SPVS) (e-mail: alessandra.xavier@spvs.org.br).

D. B. G. Bussmann is Environment Coordinator, Autopista Litoral Sul, Grupo Arteris (e-mail: daniela.bussmann@arteris.com.br).

R. G. Luiz is Corporate Relationship Coordinator, Society for Wildlife Research and Environmental Education (SPVS) (e-mail: ricardo@spvs.org.br).

I. INTRODUCTION

This article outlines the conception and results of an ecological restoration process, based on an arrangement that stipulates: (i) environmental compensation mechanisms established by the Brazilian environmental law; (ii) conservation of biodiversity in threatened ecosystems; (iii) improvements needed in the management of public and private protected areas.

Under these headings, the central argument is based on experience gained in the use of environmental compensatory measures following the loss of vegetation in the course of highway construction, one of the sectors falling under economic infrastructure. This case is presented as a model, with the recommendation that it can be replicated to other projects.

The scenario also discusses an increased number of economic-infrastructure projects in Brazil, which are of relevance to a developing country, as well as the environmental compensation mechanisms in place when certain impacts are inevitable.

The article refers to reviewed literature on the characteristics and current situation of the Atlantic Forest biome, including the particular situation of associated ecosystems, such as the Araucaria Forest in the highlands of southern Brazil and the *restinga* formation in coastal areas. These areas are the subject of this article on restoration. The scenario presented introduces the real dimension of the responsibilities of, and opportunities for, companies in addressing the demands of environmental compensatory measures that have the ability to contribute to the maintenance of natural heritage.

II. THE ATLANTIC FOREST BIOME

The Atlantic Forest is considered one of the most biodiversity-rich biomes of the planet and is amongst the 25 most important biodiversity hotspots worldwide [1].

Spread along the Brazilian Atlantic coast, the Forest originally covered 15% of Brazil––an area of 1,306,421 km^2 that comprises a wide range of ecosystems, such as mangroves, *restinga* vegetation, lowland and upland forests, Araucaria forest and *campos de altitude* (high altitude grasslands) [2] [3].

Despite the degradation indicated in studies, the Atlantic Forest biome harbours in its ecosystems around 20,000 plant species and 849 bird species, 370 amphibian species, 200 reptile species, 270 mammal species and 350 fish species. More than 530 of these species are officially endangered, some are nationally endangered, and the endemic species are globally endangered [4] [5]. Yet, 70% of the Brazilian population lives within area of the biome, which includes the such major Brazilian cities as São Paulo, Rio de Janeiro, Belo Horizonte, Salvador and Curitiba [6].

Given this wide-reaching human presense, there is a constant threat of habitat destruction to the various plant formations and associated ecosystems. Currently, the Atlantic Forest is reduced to a mere 7.84% of its original size and now covers only about 102,000 km^2. Studies indicate that 18,433 hectares (184 km^2) of the forest remnants were lost between 2014 and 2015 [7] [5].

In southern Brazil, the Araucaria Forest (figure 1) stands out among the ecosystems associated with the Atlantic Forest biome. The Araucaria Forest originally covered approximately 200,000 km^2 [8], extending mainly throughout southern Brazil, specifically the territories of the states of Paraná (40%), Santa Catarina (31%) and Rio Grande do Sul (25%) [9]. However, since

FIGURE 1 ARAUCARIA FOREST.

the 1990s, it has been reduced to only 20,000 km^2 [10]. In 2004, mapping demonstrated that in the State of Paraná, less than 0.8% of its original cover remained in an advanced stage of succession [11].

Deforestation and economic timber cycles were two of the main drivers of fragmentation and decrease of Araucaria Forest coverage, threatening the continuity of existing plant populations and in some cases meaning a risk of extinction [12].

The *restinga* vegetation as well as the Araucaria Forest has undergone severe degradation due to urban expansion and economic exploitation of the Atlantic Forest. The *restinga* formation comprises a set of coastal ecosystems with rich diversity communities, which colonize sandy soil in different environmental settings. It forms complex edaphic vegetation occupying beaches, dunes and associated depressions, sand bars, terraces and plains, which extend along the Brazilian coast [13] [14].

III. CONSTRUCTION INFRASTRUCTURE AND COMPENSATION FOR ENVIRONMENTAL IMPACTS

Brazil is among the largest countries in the world, and therefore is faced with many demands for improving the economic infrastructure throughout its territory, which covers 8.5 million km^2, including 27 states with over 205 million inhabitants and an economy with a nominal GDP of US$ 1,775 trillion in 2015 [15]. Thus, it is crucial to invest in infrastructure such as highways, railways, communication and power, among others [16] [17].

As with other sectors, Brazilian regulations for the granting of start-up and operating licences require the preparation of environmental impact studies and reports. This procedure generates documents to be analysed and reviewed by the environmental authorities with a view to approving and issuing the licences [18] [19].

Even so, in the case of projects completed in line with regulatory requirements, they often inevitably lead to negative impacts on the environment, which cause biodiversity loss. The work of regulatory bodies, civil society and the media also contributes to a monitoring system to pinpoint instances of enterprises that pose risks to the environment and the natural heritage [20].

In order to mitigate this, Brazilian law stipulates that projects with significant environmental impacts must set up or maintain officially protected public areas representing 0.5% of the project value [21].

Additionally, Brazilian regulatory agencies at the municipal, state or federal level have the legal means to require specific environmental compensation, particularly in cases of impact on permanent preservation areas [22], keeping in mind that removal of vegetation in these areas should be treated as an exception. Permanent preservation areas are defined in the Brazilian Forest Code, which laid down the obligation to maintain vegetation around waterways or hilltops [23].

Reforestation is an example of an environmental compensatory measure requested by environmental agencies. The number of trees to be planted is based on multiplying the number of individuals eliminated, with each species weighted accordingly. Furthermore, there is a set time of year and region for planting. A three-year monitoring plan is also requested. However, licensing conditions may vary case-by-case and agency-by-agency.

Based on the above-mentioned compensatory measures, there is a low potential for satisfactory results when considering the context of Brazilian biodiversity: first, because it is clear that a short monitoring period does not ensure the longevity of the results [24]; secondly, because planting a single species does not ensure the ideal species composition aimed at successional stages of vegetation in a natural environment and its ecological processes [25]; and, thirdly, the need for compensatory reforestation is debatable, given of the priorities in terms of maintaining the natural heritage, such as fighting deforestation of the last remnants in threatened ecosystems.

Southern Brazil has only 55.5% of its natural vegetation remaining due in large part to the high flux of infrastructure projects in this region (13 % in Paraná, 29.6% in Santa Catarina, and 12.9% in Rio Grande do Sul) [26]. Much of it is broken up into fragments, which are under pressure from competing activities, such as agriculture, livestock and urban development [27].

IV. INVESTMENTS OF COMPANIES IN BIODIVERSITY CONSERVATION INITIATIVES

Companies can play an important role in biodiversity conservation, with a social responsibility to protect and maintain existing natural areas, or incorporate restoration measures as part of their corporate strategy.

Moreover, natural areas are essential to maintain living conditions of society as a whole, providing ecosystem services, such as the provision of water, climate regulation and the production of food and medicine [28] [29]. The ecosystem services also allow companies to recognize the dependency its operations have on the existence of natural areas [30] [31].

Other mechanisms also encourage companies to consider the importance of biodiversity for their activities. Amongst these mechanisms, the Global Reporting Initiative developed guidelines for reporting sustainability performance indicators, including specific aspects related to biodiversity, such as habitats protected or restored and the number of endangered species affected by the operations [32]. Another mechanism is the establishment of LIFE Certification that recognizes organizations efforts towards net positive biodiversity operational strategies [33].

In order to achieve the greatest environmental gain, the main goal of the partnership between Arteris Group, a Brazilian roadconcession operator, and the Society for Wildlife Research and Environmental Education (SPVS), a non-governmental organization, was to go beyond the compensatory measures required by the environmental agencies.

These agen/cies may require environmental impact measures and authorize the continuation of a project through the legal instrument called a Vegetation Removal Authorization (ASV). Among the cases were two involving Brazilian road concession operators who were required by the environmental agencies to carry out compensatory reforestation as a measure of environmental compensation and as a condition for continuing the ASV.

In one case, based on the authorization to remove vegetation in sections where the construction consisted of forks and shoulders in the road, the environmental offset was to plant 70,373 seedlings of the species *Araucaria angustifolia* in an area of 76.57 hectares. In the other case, the ASV was for the construction of a new stretch of a highway, which gave rise to an offset measure of restoring an area of 83.26 hectares.

The partnership established, as shown in the next section, was to propose to the environmental agencies a solution focused on generating greater results in favour of biodiversity. The compensatory reforestation was required to be carried out in protected areas recognized under the Brazilian National System of Conservation Units (SNUC).

For the company, this meant meeting the requested compensatory measures for the licensing process, offsetting the environmental impact caused by its activities at a reduced cost, enhancing the results. For SPVS as a non-profit organization working for nature conservation, it meant an effective mechanism to expand results in nature conservation, which in turn relates directly to the goals established by the Convention on Biological Diversity for land restoration and ecosystem maintenance.

V. RESTORATION IN PROTECTED AREAS

Human disturbance negatively affects Brazilian biodiversity, especially in the Atlantic Forest biome that contains 70% of the population. Protected areas play a key role in preventing the disturbance of natural heritage and ensure the continuity of Brazilian biodiversity. The SNUC establishes these areas [34], proposes guidelines and defines territorial space, legally instituted by the government, aiming at protecting ecosystems [35].

Despite the pressure on ecosystems of the Atlantic Forest biome, which has been exacerbated by urban expansion and industrial farming, there are mechanisms and initiatives that promote the restoration of priority areas. The restoration in protected areas through compensatory reforestation, integrates efforts and innovative initiatives for biodiversity conservation. This integration was possible due to the partnership between SPVS and the Arteris Group through two initiatives.

The first initiative, aimed not only at meeting the offset measures requested by the Brazilian Institute of Environment and Renewable Natural Resources

(Ibama), but also to contribute to the protection of a private nature reserve (RPPN).

The compensatory measure was based on the authorization to suppress vegetation in sections where road forks and shoulders of Highway BR-116 went under construction, in the metropolitan region of Curitiba, capital of the State of Paraná. Even though the location of the project is within the Araucaria Forest domain, previous urban settlements suppressed all significant remnants. Nonetheless, to obtain a vegetation removal authorization, an environmental compensatory measure was still requested.

Based on extensive conservation needs, it is important to go above and beyond the minimum requirements designated by the governing agencies. As such, enhanced terms have been requested and agreed upon to benefit biodiversity. So to meet the request for compensatory reforestation, two measures were defined: the restoration itself and the effective protection of a remnant of this threatened ecosystem. Ecological restoration was made in 32 hectares of old pasture and another 45 hectares of forest (initial stage of regeneration). Instead of a single species, 39 species of the Araucaria Forest were selected, including rare and endangered species, thereby increasing the biological diversity.

A project worked on by SPVS since 2003 was taken into account when choosing the restoration location project. The project seeks private areas with good conservation standards and develops mechanisms to ensure their maintenance, with the eventual aim of transforming the areas into private nature reserves. Despite the pressures of deforestation, the restoration activities were developed on a property in a region that is home to significant natural remnants. Therefore, compensatory reforestation meant both the ecological restoration of a degraded land and ensured the conservation of an important natural remnant. The 77 restored hectares combined with the existing remnants come to 100 hectares in good conservation condition, totalling 513 hectares in one property.

The second initiative on compensatory measures arose from the construction of a new stretch of highway approximately 50 km long in the metropolitan region of Florianópolis, capital of the State of Santa Catarina in southern Brazil. Authorization was requested to remove vegetation for the construction of lanes, overpasses and tunnels. The compensatory measure requested by Ibama was the restoration of approximately 85 hectares. With the intention of enhancing the gains of this measure for biodiversity, an agreement with the environmental agency of the State of Santa Catarina was established. The aim was to direct the compensatory measure towards a protected area, in this case the Serra do Tabuleiro State Park, also in the metropolitan region of Florianópolis. The search for a public protected area took into account the possibility of the compensatory measure signifying empowerment in the state park management. This protected area, as well as many others in Brazil, faces challenges in restoring degraded areas, strengthening its surveillance systems and improving the environmental quality of its ecosystems (by, for example, removing alien species,).

Taking into account this scenario, the compensatory reforestation covered an area of 83.26 hectares, and incorporated management actions for invasive species on 350 hectares of protected land in the *restinga* formation (figure 2). Besides meeting the compensatory measures required by Ibama, the project generated a gain in scale of biodiversity conservation. SPVS surpassed the standards of conventional planting, which only requires a single species, and succeeded in carrying out restoration with a higher species diversity, improving and accelerating the recovery process and contributing to the management of the state park.

VI. CONCLUSION

The rich and biological diverse Brazilian ecosystems face unparalleled deforestation pressure, which should be taken into account in offset measures requested by environmental agencies. The main goal must be to obtain better results in the restoration of natural areas, their continuity and their connectivity.

The expertise of SPVS and Arteris Group show that it is possible to exceed the minimum request compensatory measures, surpassing the requirements coupled with big picture strategies and significant efforts for biodiversity. This arrangement also present to companies the opportunity for strategic positioning and proactivity facing the loss of Brazil's natural heritage, intrinsically related to the change in land use for agriculture and infrastructure, in addition to the inefficient management of public protected areas.

FIGURE 1 *RESTINGA* RESTORATION.

The ability of companies to support the maintenance of private nature reserves and public protected areas established by the Brazilian National System of Conservation Units (SNUC) and managed by the Government is extremely innovative and ensures the perpetuity and connectivity of ecosystems under pressure, such as in the case of the Atlantic Forest, which is threatened with extinction.

Ultimately, an investment in medium and long-term monitoring activities is crucial to ecological restoration processes associated with the creation of private nature reserves and contribution to the management of public protected areas. This is a key aspect to effectively measure the true results of environmental impact and that should be the compensation guidelines required of companies wishing to pursue the Vegetation Removal Authorization.

REFERENCES

[1] B. G. Miner *et al.*, "Ecological consequences of phenotypic plasticity", *Trends in Ecology and Evolution*, Maryland Heights, vol. 20, No. 12, pp. 685–692, 2005.

[2] SOS Mata Atlântica, Instituto NacionaL de Pesquisas Espaciais - INPE. *Atlas dos Remanescentes Florestais da Mata Atlântica 2013/2014*. São Paulo, 2015, 60p.

[3] M. Campanili; W. B. Schaffer, Mata Atlântica: patrimônio nacional dos brasileiros. Ministério do Meio Ambiente, Brasília, 2010.

[4] M. Tabarelli *et al.*, Desafios e oportunidades para a conservação da biodiversidade na Mata Atlântica brasileira. Megadiversidade 1(1): 132-138. 2005.

[5] R. C. Forzza et al., *Lista de Espécies da Flora do Brasil*. Jardim Botânico do Rio de Janeiro, 2013.

[6] Brasil, Ministério do Meio Ambiente - MA, *Diretrizes para a Política de Conservação e Desenvolvimento Sustentável da Mata Atlântica*, Brasília-DF, 1998. 26p.

[7] M. Tabarelli *et al.*, "Desafios e oportunidades para a conservação da biodiversidade na Mata Atlântica brasileira",. *Megadiversidade* 1(1): 132-138. 2005.

[8] R. Maack, Geografia física do estado do Paraná. 4. ed. Ponta Grossa: UEPG. 2012, 526 p.

[9] R. M. Klein, O aspecto dinâmico do pinheiro brasileiro. Sellowia, 12 (12): 17-44, 1960.

[10] P. F. Leite ; R. M. KLEIN, Vegetação**.** In**:** Geografia do Brasil: Região Sul. v 2. Rio de Janeiro: IBGE, 1990.

[11] P. R. Castella; R. M. Britez. A Floresta com Araucária no Paraná: conservação e diagnóstico dos remanescentes florestais. Brasília: Ministério do Meio Ambiente – PROBIO, 2004, 233p.

[12] J. D. Medeiros *et al.*, Seleção de áreas para criação de unidade de conservação na Floresta Ombrófila Mista. Biotemas, Florianópolis, v. 18, n. 3, p. 33-50, 2005.

[13] D. B. Falkenberg, Aspectos da flora e da vegetação secundária da restinga de Santa Catarina, Sul do Brasil. Insula 28: 1-30. 1999.

[14] L. A. Pires *et al.*, Produção, acúmulo e decomposição da serapilheira em uma restinga da Ilha do Mel, Paranaguá, PR, Brasil. Acta Botanica Brasilica, v. 20, n. 1, p. 173-184, 2006.

[15] World Bank (2016), "Brazil – Data". Available from: http://data.worldbank.org/country/brazil (accessed 14 September 2016).

[16] R. Bielschowsky, *Estratégias de desenvolvimento e as três frentes de expansão no Brasil: um desenho conceitual*, (Rio de Janeiro: IE-UFRJ, 2012).

[17] P., Bolivar; C. A. S. Campos Neto, "Infraestrutura econômica no Brasil: diagnósticos e perspectivas para 2025', *IPEA. Brasília*. 2010.

[18] A. A. Farias *et al.*, "Principais Considerações Sobre o Estudo de Impacto Ambiental." *Revista Enciclopédia Biosfera, Centro Científico Conhecer-Goiânia* 7 (12), 2011.

[19] J. C. Barbieri, "Avaliação de impacto ambiental na legislação brasileira." *Revista de Administração de Empresas* 35:78-85, 1995.

[20] A. Vulcanis, "Os problemas do licenciamento ambiental e a reforma do instrumento", *Congresso Internacional de Direito Ambiental* (14.: 2010). Conferencistas e Teses Profissionais São Paulo: Imprensa Oficial do Estado de São Paulo, 2010.

[21] L. Geluda, C. E. F. Young. "Financiando o Éden: Potencial econômico e limitações da compensação ambiental prevista na Lei do Sistema Nacional de Unidades de Conservação da Natureza", IV Congresso Brasileiro de Unidades de Conservação, 2004.

[22] Brasil. Resolução CONAMA nº 369 de 28 de março de 2006. edited by Conselho Nacional do Meio Ambiente. Brasília, DF. 2006.

[23] Brasil. Lei nº 12.651 de 25 de maio de 2012. edited by Subchefia para assuntos jurídicos Casa Civil. Brasília - DF: Diário Oficial da República Federativa do Brasil. 2012.

[24] R. R. Rodrigues *et al.*, Conceitos, tendências e ações para a recuperação de florestas ciliares. (Ed.) Matas ciliares: conservação e recuperação. 3 ed., São Paulo: EDUSP, p.235-247, 2004.

[25] Pacto pela restauração da Mata Atlântica : referencial dos conceitos e ações de restauração florestal [organização edição de texto: Ricardo Ribeiro Rodrigues, Pedro Henrique Santin Brancalion, Ingo Isernhagen]. – São Paulo : LERF/ESALQ : Instituto BioAtlântica, 2009.

[26] SOS Mata Atlântica, Instituto NacionaL de Pesquisas Espaciais - INPE. Atlas dos Remanescentes Florestais da Mata Atlântica, Dados mais recentes 2014/2015. accessed 14 sep. 2016. https://www.sosma.org.br/projeto/atlas-da-mata-atlantica/dados-mais-recentes

[27] M. Tabarelli *et al.*, "A conversão da floresta atlântica em paisagens antrópicas: lições para a conservação da diversidade biológica das florestas tropicais." *Interciencia* 37 (2):88-92. 2012.

[28] TEEB, *The Economics of Ecosystems and Biodiversity in Business and Enterprise*, edited by Joshua Bishop (London,Earthscan, 2010).

[29] P. Hawken et al., Capitalismo Natural: criando a próxima revolução industrial. Translated by Luiz A. de Araújo and Maria Luiza Felizardo. São Paulo: Editora Cultrix, 2012.

[30] Earthwatch Institute, International Union for Conservation of Nature, World Business Council for Sustainable Development, and World Resources Institute, *Business and Ecosystems: Ecosystems Challenges and Business Implications,* 2006.

[31] C. Hanson, et al., "The Corporate Ecosystem Services Review: Guidelines for Identifying Business Risks and Opportunities Arising from Ecosystem Change" (Washington, DC, World Resources Institute, 2012).

[32] Global Reporting Initiative. G4 Guidelines–Reporting principles and standard disclosures, 2015.

[33] Instituto LIFE, Padrões de Certificação LIFE - LIFE-BR-CS-3.1. Curitiba, 2016.

[34] L. Geluda, C. E. F. Young. "Financiando o Éden: Potencial econômico e limitações da compensação ambiental prevista na Lei do Sistema Nacional de Unidades de Conservação da Natureza", IV Congresso Brasileiro de Unidades de Conservação, 2004.

[35] Brasil. Lei n. 9.985, de 18 de julho de 2000. Lei do Sistema Nacional de Unidades de Conservação da Natureza (SNUC), 2000.

Verifying Voluntary Ecosystem Restoration–Case-Studies from Mozambique and Sweden

Francis Vorhies, *Earthmind*, and Sebastian Winkler, *Global Footprint Network*

ABSTRACT. Under the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, adopted by the Conference of the Parties to the Convention on Biological Diversity, Governments have committed themselves to restoring 15 per cent of degraded ecosystems by 2020. It is not enough to rely solely on legally protected areas to conserve and restore areas. Conservation efforts must be expanded across all parts of the planet, especially to the places where people live and work. The Verified Conservation Area (VCA) approach aims to scale up conservation efforts by encouraging new stakeholders to conserve and restore areas and by providing support to their efforts. This includes recognizing ecosystem restoration and enhancing the assurance that funding provided to these efforts delivers biodiversity-positive outcomes. The VCA approach is backed by an international multistakeholder coalition including the Secretariat of the Convention on Biological Diversity and the IUCN Commission on Ecosystem Management.

By adopting a standards-based approach to recognizing area-based conservation and restoration, the VCA approach aims to establish a new, investable asset class of natural capital. VCAs may be used as an assurance mechanism for biodiversity loss mitigation and ecosystem restoration. They may also be used as a way to verify the natural-capital enhancement derived from ecosystem restoration for various landuse options, such as agriculture, fisheries, forestry, mining, ranching, recreation, or tourism. They may also be used to increase the market valuation of the land itself. In all these cases, as the VCA approach scales up, there is likely to be an increasing interest in valuing and investing in VCAs as natural capital assets.

This paper looks specifically at two VCAs that aim to restore degraded ecosystems: Cinco Grandes in Mozambique and Tullstorp Stream in Sweden. Cinco Grandes aims to restore a wilderness area by a major restocking of wildlife and establishing a sustainable wildlife-management system that engages both private investors and local communities. Tullstorp Stream has established a partnership of local farmers to restore a freshwater ecosystem, including through the establishment of ingetlands (“no-man’s lands” or “no-go areas”) for wildlife habitat, and to reduce polluted runoffs into the Baltic Sea. Both cases demonstrate the potential for recognizing the voluntary restoration of degraded ecosystems beyond protected areas, in places where people live and work.

Vérification de la restauration volontaire des écosystèmes - Études de cas du Mozambique et de la Suède

RÉSUMÉ. Dans le cadre du Plan stratégique pour la diversité biologique 2011-2020 et des objectifs d’Aichi pour la biodiversité adoptés par la Conférence des Parties à la Convention sur la diversité biologique, les gouvernements se sont engagés à restaurer 15 pour cent des écosystèmes dégradés d’ici à 2020. Il ne suffit pas de compter uniquement sur les zones légalement protégées par la loi pour conserver et restaurer les écosystèmes. Les efforts de conservation doivent être étendus à toutes les parties de la planète, en particulier aux endroits où les gens vivent et travaillent. L’approche des zones de conservation vérifiée (ZCV) vise à intensifier les efforts de conservation en encourageant les nouvelles parties prenantes à conserver et à restaurer les écosystèmes et en soutenant leurs efforts. Cela comprend la reconnaissance de la restauration des écosystèmes et l’assurance que le financement accordé à ces efforts offre des résultats positifs pour la biodiversité. L’approche ZCV est soutenue par une coalition internationale multipartite comprenant le Secrétariat de la Convention sur la diversité biologique et la Commission sur la gestion des écosystèmes de l’UICN.

En adoptant une approche basée sur des normes pour reconnaître la conservation et la restauration par zones, l'approche ZCV vise à établir une nouvelle classe d'actifs investissables en capital naturel. Les ZCV peuvent servir de mécanisme d'assurance pour l'atténuation des pertes de biodiversité et la restauration des écosystèmes. Elles peuvent également servir à vérifier l'amélioration du capital naturel résultant de la restauration des écosystèmes pour diverses options d'utilisation des terres comme l'agriculture, la pêche, la foresterie, l'exploitation minière, l'élevage en ranch, les loisirs ou le tourisme. Elles peuvent également être utilisées pour augmenter la valeur marchande du terrain lui-même. Dans tous ces cas, à mesure que l'utilisation de l'approche ZCV augmente, il est vraisemblable que l'intérêt pour la valorisation et l'investissement dans les ZCV en tant qu'actifs du capital naturel augmentera.

Cet article examine spécifiquement deux ZCV qui visent à restaurer des écosystèmes dégradés: Cinco Grandes au Mozambique et Tullstorp Stream en Suède. Cinco Grandes vise à restaurer une zone sauvage par un réapprovisionnement important de la faune et en mettant en place un système durable de gestion de la faune qui engage à la fois les investisseurs privés et les communautés locales. Tullstorp Stream a établi un partenariat de fermiers locaux pour rétablir un écosystème d'eau douce, notamment en créant des «*ingetlands*» (zones où les visites, l'utilisation et les impacts humains sont strictement contrôlés et limités) pour l'habitat faunique et pour réduire les ruissellements pollués dans la mer Baltique. Les deux cas démontrent la possibilité de reconnaître la restauration volontaire des écosystèmes dégradés au-delà des zones protégées, là où les gens vivent et travaillent.

Verificación de Restauración Voluntaria del Ecosistema - Estudios de caso de Mozambique y Suecia

RESUMEN[1]: En el marco del Plan Estratégico para la Diversidad Biológica 2011-2020 aprobado por la Conferencia de las Partes en el Convenio sobre la Diversidad Biológica, los gobiernos se han comprometido a restaurar el 15% de los ecosistemas degradados para 2020. No es suficiente con confiar exclusivamente en áreas legalmente protegidas para conservar y restaurar áreas. Los esfuerzos de conservación deben expandirse a través de todas las partes del planeta, especialmente a los lugares donde las personas viven y trabajan. El enfoque del Área de Conservación Verificada (VCA, por sus siglas en inglés) apunta a incrementar los esfuerzos de conservación alentando a los nuevos actores a conservar y restaurar áreas y apoyar esfuerzos. Esto incluye reconocer la restauración de los ecosistemas y mejorar la seguridad de que la financiación correspondiente a estos esfuerzos proporciona resultados positivos para la diversidad biológica. El enfoque de VCA está respaldado por una coalición internacional de múltiples partes interesadas, incluida la Secretaría del Convenio sobre la Diversidad Biológica y la Comisión de Gestión de Ecosistemas de la UICN.

Al adoptar un enfoque basado en estándares para reconocer la conservación y la restauración establecidas en el área, el enfoque VCA tiene como objetivo establecer una nueva clase de activos de inversión de capital natural. Las VCA pueden utilizarse como mecanismo de garantía para la mitigación y restauración de la biodiversidad. También pueden utilizarse como una forma de verificar la mejora del capital natural derivada de la restauración de ecosistemas para diversas opciones de uso de la tierra, tales como agricultura, pesca, silvicultura, minería, ganadería, recreación o turismo. Además pueden utilizarse para aumentar la valoración en el mercado de la misma tierra. En todos estos casos, a medida que el enfoque de VCA aumenta, es probable que haya un creciente interés en valorar e invertir en VCAs como activos de capital natural.

Este artículo examina específicamente dos VCA que tienen como objetivo restaurar ecosistemas degradados: Cinco Grandes en Mozambique y Tullstorp Stream en Suecia. "Cinco Grandes" tiene como objetivo restaurar un área silvestre mediante una importante repoblación de la vida silvestre y el establecimiento de un sistema sostenible de manejo de vida silvestre que involucre tanto a inversionistas privados como a comunidades locales. Tullstorp Stream ha establecido una asociación de agricultores locales para restaurar un ecosistema de agua dulce, incluyendo el establecimiento de *ingetlands* («tierra de nadie» o «áreas de no-acceso») para el hábitat de la vida silvestre, y para reducir los ríos contaminados en el Mar Báltico. Ambos casos demuestran el gran potencial de la restauración voluntaria de ecosistemas degradados fuera de las áreas protegidas, en lugares donde la gente vive y trabaja.

1 Translated by Sofia Calvo

I. INTRODUCTION

Everywhere, life on Earth is under threat. Scientists think that the continuing loss of biodiversity is as serious as climate change. Ecosystems are being degraded, natural habitats and open spaces are disappearing, and many wild species are becoming more endangered.

Nature, however, can be conserved and used sustainably. Ecosystems can be restored, habitats and open spaces can be protected, species can be saved, and natural resources can be harvested sustainably. Everyone—individuals, local communities, private companies, non-profit organizations and public agencies—we can help to conserve nature. Hectare by hectare, we can conserve our planet.

Under the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, adopted by the Conference of the Parties to the Convention on Biological Diversity, Governments have made a commitment to conserving17% of terrestrial areas and 10% of marine areas, and to restore 15% of degraded ecosystems by 2020. There is broad agreement, however, that current conservation efforts are not enough to mitigate the everincreasing ecological footprint of humanity. And even these targets are unlikely to halt the loss of biodiversity.

Reliance on legally protected areas is necessary, but insufficient. With the growing human population and its increasing levels of prosperity, the pressures on biodiversity are great. There is a need to expand our conservation efforts across the planet. In this context, the VCA approach, by encouraging effective, area based conservation by communities, companies and individuals, is opening up a new voluntary, inclusive platform for nature conservation. It is enabling innovative and entrepreneurial opportunities for all of us to become directly involved in caring for our planet, hectare by hectare.

II. OVERVIEW OF THE VCA APPROACH

The Verified Conservation Area (VCA) approach aims to scale up conservation efforts by encouraging new stakeholders to conserve and restore areas and by providing support to their efforts. This includes recognizing ecosystem restoration and enhancing assurance that funding provided to these efforts delivers biodiversity positive outcomes. The approach is backed by an international multi-stakeholder coalition that includes the Secretariat of the Convention on Biological Diversity and the IUCN Commission on Ecosystem Management.

A. Core elements of the VCA approach

1. A **Verified Conservation Area** (**VCA**) is a geographically-defined area listed on the VCA Registry and managed to conserve nature and use living natural resources sustainably, taking into account human needs for the services nature provides.

2. The **VCA Registry** at ConserveAreas.org/Registry is a voluntary, public listing of area-based conservation management. It is a place where VCA managers can communicate their projects to the public and to supporters.

3. The VCA approach is inclusive. VCAs can be managed by public, private or community organisations. And they may be managed for profit or not-for-profit.

4. VCA registration requires submission of an audited conservation management plan. Alternatively, an area can be listed with a proposal and a commitment to submit an audited plan within two years.

5. To stay registered, VCAs must submit audited performance reports annually.

6. Audits of plans and reports are undertaken by Board-approved **VCA auditors**.

7. VCA management plans, reports and audits are published on the VCA Registry providing visibility, accountability and assurance.

8. The requirements for management plans, performance reports and audits are set out in the **VCA Standard** [1]. These are aligned with Performance Standard 6 of the International Finance Corporation (IFC), on biodiversity conservation and sustainable management of living natural resources [2].

9. The **VCA Toolkit** recommends best available practical guidance for conservation management planning and reporting.

10. The **VCA Team** at Earthmind at the IUCN Conservation Centre manages the VCA approach and offers conservation planning and fundraising services to VCAs and their supporters.

B. Benefits of the VCA Approach

1. The VCA approach recognizes and encourages the efforts by committed individuals, communities, local governments, NGOs, and companies to conserve and restore our natural capital.

2. It provides a mechanism for innovative conservation initiatives beyond legally protected areas to be recognised, celebrated and supported.

3. VCAs enable companies, public agencies, NGOs, foundations, and individuals to invest directly in verified conservation by providing standardised, transparent, monitored, and effective conservation management.

4. The VCA approach enables conservation to be visible and gives assurance that money invested in conservation is well spent.

5. It provides transparency and public accountability in recognising management plans, which address the biodiversity mitigation hierarchy – avoid, minimize, restore and offset.

6. The VCA approach establishes a new, international platform for verified sustainable land management which connects to the demands of stakeholders including local communities and public authorities.

7. It encourages voluntary action and creates new and exciting opportunities to connect conservation area owners and managers with impact investors.

8. VCAs enable governments to reach their marine and terrestrial conservation targets in the support of the Sustainable Development Goals 14 and 15.

III. VERIFIED CONSERVATION AREAS

By adopting a standards-based approach to recognizing area-based conservation and restoration, the VCA approach aims to establish a new, investable asset class of natural capital. VCAs may be used as an assurance mechanism for biodiversity mitigation and restoration. They may also be used as a way to verify the natural capital enhancement of restoring ecosystems for various landuse options, e.g., agriculture, fisheries, forestry, mining, ranching, recreation, or tourism. And they may be used to enhance the market valuation of the land itself. In all of these cases, as the VCA approach scales up, there is likely to be an increasing interest in valuing and investing in VCAs as natural capital assets.

A. Area-based conservation

A VCA can be registered by any community, company, organization, government authority, or individual who is able to implement a conservation management plan for a geographically-defined area. This requires the right to manage the area, but it does not necessarily require actual ownership of the area.

An indigenous community, for example, could register a VCA for which they have recognised traditional rights, but for which they may not have a registered title deed. A company could register an area for which they have a concession, and an NGO could register an area for which they have a management agreement with its owners.

Local authorities, for example, may wish to attract residents and businesses to their towns by registering VCAs to make clear their commitment to conservation and sustainable development. Legally protected areas may want to register as VCAs to enhance their ability to secure additional financial support.

Intergovernmental organizations, such as the United Nations Development Programme (UNDP), may partner localcommunity organizations to develop VCAcompliant management plans for specific areas that have clear conservation and development outcomes. International conservation NGOs may want to partner with local stakeholders to register VCAs for key biodiversity areas. Companies may wish to register VCAs to provide ongoing assurance of their biodiversity mitigation actions.

B. Conservation and Sustainable Development

The objective for a VCA is sustained area-based conservation. This objective is premised on the original definition of conservation set out in the World Conservation Strategy, which was launched in 1980 by IUCN in partnership with the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and WWF. Conservation is defined as follows:

> "Conservation is… the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment."

This definition sees sustainable use as an integral component of conservation management. In this respect, VCAs are aligned directly with the core objectives of the Convention on Biological Diversity, namely, "the conservation of biological diversity" and "the sustainable use of its components". Importantly, VCAs address the recognition, reflected in the preamble to the Convention, that the "fundamental requirement for the conservation of biological diversity is the *in situ* conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings".

The VCA approach has been designed to support central tenets of the Convention's Strategic Plan for Biodiversity 2011-2020. It supports several of its targets, most importantly its Aichi biodiversity targets 11 and 15 on the conservation of 17% of terrestrial and inland water areas and 10% of coastal ad marine areas and on the restoration of at least 15% of degraded ecosystems, respectively.

Regarding Target 4, on sustainable production, the VCA Standard provides a CBD-compliant standard for biodiversity-responsible management of productive areas. This includes areas under agriculture, aquaculture and forestry, as well as the ecosystems that provide essential services, targets 7 and 14 respectively. It also supports target 20 as a platform for the mobilizing financing for biodiversity conservation.

Likewise, the VCA approach is also aligned with the focus of the United Nations Convention to Combat Desertification (UNCCD) on "long-term integrated strategies that focus simultaneously… on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the community level" and with the United Nations Framework Convention on Climate Change (UNFCCC) on "stabilization of greenhouse gas concentrations in the atmosphere… within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Thus the VCA approach is aligned with both the ecosystem approach under the Convention on Biological Diversity and the approaches to sustainable land management and zero land degradation under the Convention to Combat Desertification.

In terms of the Sustainable Development Goals, VCAs directly support goal 14 to "conserve and sustainably use the oceans, seas and marine resources for sustainable development" and goal 15 to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." Further, VCAs are a means for implementation of sustainable finance and trade as set out in goal 17.

C. Verifying Conservation Performance

VCA registration, as set out in VCA Standard, aims to enable transparent and accountable verification of the conservation management of an area. It does so through: (1) best practice guidance; (2) transparency; and (3) independent audits.

1. BEST PRACTICE GUIDANCE

The core guidance for establishing and reporting on a conservation area management plan is based on best practice for biodiversity-responsible financing as set out in the IFC Performance Standards on Environmental and Social Sustainability, notably Performance Standard 1, on assessment and management of environmental and social risks and impacts [3], and Performance Standard 6 [2], on biodiversity

conservation and sustainable management of living natural resources. The IFC Performance Standards have been adopted by major investment banks worldwide, notably by the export credit agencies of OECD member countries and also by the Equator Principles financial institutions, which are responsible for more than 70% of the international project finance in developing countries.

IFC Performance Standard 1 sets out the overall framework for the assessment and management of environmental and social risks and impacts as follows:

- To identify and evaluate environmental and social risks and impacts;
- To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities and the environment; and
- To promote improved environmental and social performance through the effective use of management systems.

IFC Performance Standard 6 sets out the specific objectives for biodiversity conservation and the sustainable management of living natural resources, as follows:

- To protect and conserve biodiversity;
- To maintain the benefits from ecosystem services; and
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

The VCA Standard includes a toolkit of recommended tools for effective conservation area management.

2. TRANSPARENCY

Second, VCA registration promotes transparency by requiring that an area's conservation management plan is posted on the VCA website. For an area to remain on the VCA Registry, it must also post annual conservation performance reports. These requirements effectively facilitate visibility, public accountability and assurance of the area's conservation outcomes.

3. INDEPENDENT AUDITS

Third, VCA management plans and annual performance reports must be audited by an independent auditor who has been approved by the VCA Board. The audit reports must also be published on the VCA website (ConserveAreas.org). This requirement provides further verification that the area is being managed to achieve positive conservation outcomes. By verifying area-based conservation, the VCA approach is establishing a platform for biodiversity management assurance and facilitating new opportunities for conservation impact investment.

IV. CASE-STUDIES

A. Cinco Grandes (Mozambique)

Coordinates: 20°54'06.2"S; 34°17'23.0"E

Status: Registered

Ecoregion: Tropical and subtropical grasslands, savannas and shrublands

Size: 250,000 hectares

VCA Registry page: ConserveAreas.org/areas/mz/cincograndes

Cinco Grandes aims to restore a wilderness area by a major restocking of wildlife and establishing a sustainable wildlife management system that engages both private investors and local communities. It is part of the Coutada 5 hunting concession.

Located in eastern Mozambique, Coutada 5 is the largest and most diverse of Mozambique's hunting concessions (fig. 1). The 687,000 ha Coutada is home to around 50,000 people, mostly inhabiting the coastal towns. This leaves 85% of the Coutada sparsely populated and ready for conservation activities including establishing Cinco Grandes, a 250,000 restored wilderness conservancy.

Although many of the flora within the ecosystems within the Coutada are in excellent condition, and some species such as the hippotamus and crocodile have stable populations, the debilitating civil war

FIGURE 1 A SHRUBLAND IN EASTERN MOZAMBIQUE

that took place in the 1980s and 1990s has deprived the area of much of its famous megafauna. Lost species include elephant, buffalo, Sable antelope, Lichtenstein's hartebeest, eland, plains zebra, blue wildebeest, reedbuck and waterbuck.

The overarching goal is to plan, develop and utilize the Cinco Grandes wilderness conservancy in a manner such that the seriously depleted biodiversity resources are rehabilitated over time. This ambitious plan will take place with a zoning policy so that large-scale wildlife reintroductions can occur in harmony with continued economic development in this remote area, including agriculture and mixed livestock/wildlife ranching.

FIGURE 2 ACTIVITIES FOR THE RESTORATION OF THE TULLSTORP STREAM

B. Tullstorp Stream (Sweden)

Coordinates: 55°24'56.7"N; 13°24'46.9"E

Status: Proposed

Ecoregion: Temperate broadleaf and mixed forests

Size: 6,300 hectares

VCA Registry page: ConserveAreas.org/areas/se/tullstorp

Tullstorp Stream has established a partnership of local farmers to restore a freshwater ecosystem, including establishing *ingetlands* ("no-man's lands" or "no-go areas") for wildlife habitat and reduce polluted run-offs into the Baltic Sea. It demonstrates the potential for recognizing voluntary restoration of degraded ecosystems beyond protected areas, in places where people live and work.

The Tullstorp Stream restoration project in southern Sweden (fig. 2 and fig.3) is a promising initiative to improve the living conditions for fauna and flora in intensively cultivated farmland at the same time as reducing the eutrophication of the Baltic Sea.

Already after the first 4-5 years, positive impacts have been registered for birds associated wetlands while the living conditions of fish and bottom fauna are more or less unchanged. The nutrient leakage to sea has significantly improved for phosphorus, but for nitrogen the improvement is evident only during the summer period due to the uptake in the 35 newly created wetlands.

With the promising results already achieved, the project has been awarded regionally, nationally and been nominated internationally, and it is interesting example of a landowner conservation initiative, which hopefully will multiply to other areas in the future, both nationally and internationally. This includes serving as a model conservation/restoration area for other agricultural lands neighbouring the Baltic Sea.

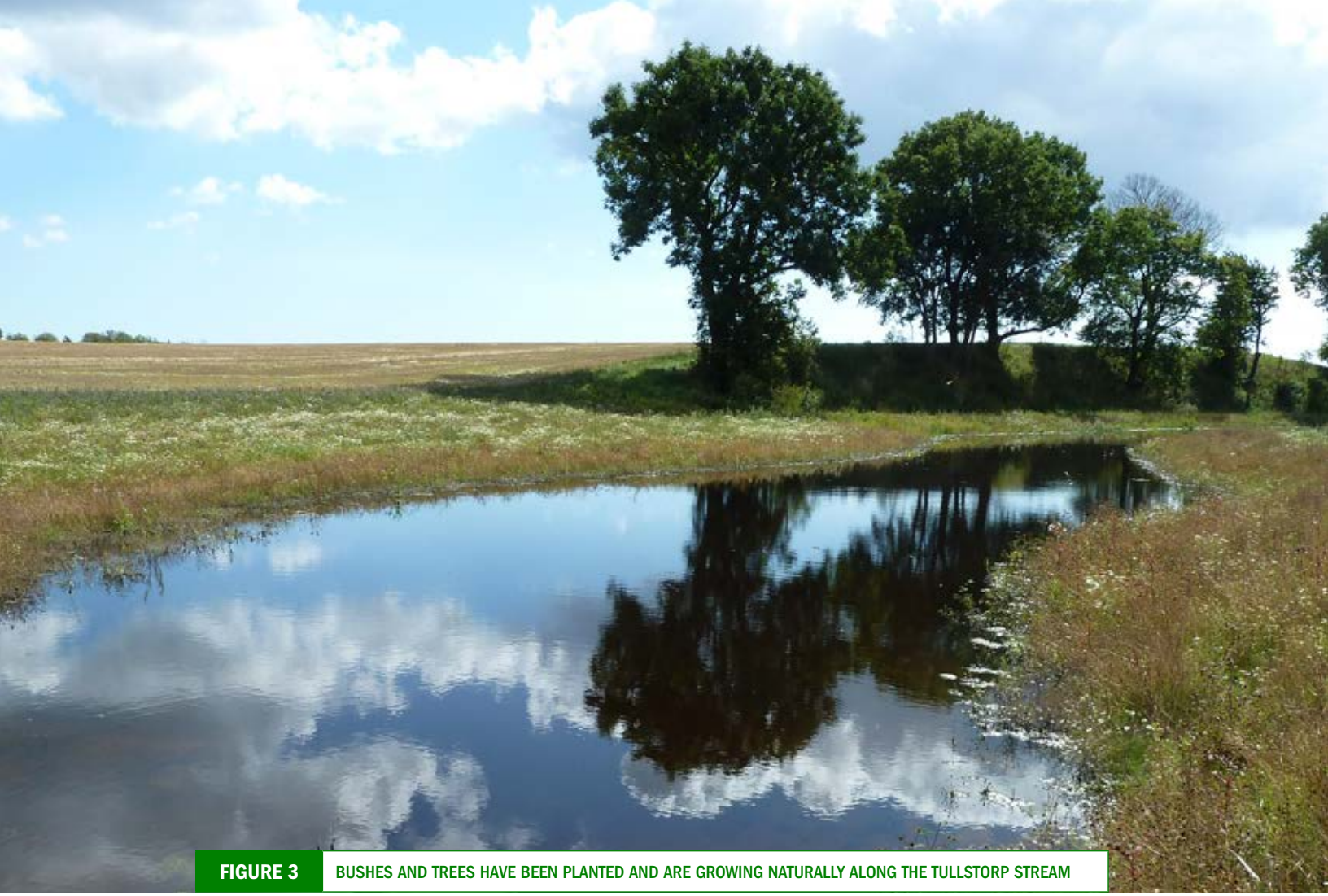


FIGURE 3 BUSHES AND TREES HAVE BEEN PLANTED AND ARE GROWING NATURALLY ALONG THE TULLSTORP STREAM

V. A VOLUNTARY ALLIANCE FOR RESTORING AND CONSERVING AREAS

The VCA approach is building an inclusive, voluntary alliance of stakeholders who are caring for our planet by restoring and conserving areas where they live and work. Co-hosted by Earthmind and the Global Footprint Network, the VCA approach includes core Partners, supporting organizations, conservation auditors, a technical advisory committee, a governing board, a management team, and a growing network of friends of voluntary, verified conservation areas.

The VCA alliance includes small non-governmental organizations seeking funds for their local conservation efforts, local and indigenous communities seeking recognition of their conservation actions, companies mitigating their biodiversity impacts, impact investors seeking growth in natural capital, and governments striving to reverse the loss of biodiversity.

REFERENCES

[1] The VCA Standard, May 2014. Available from: http://earthmind.org/files/redlac10/5G-VCA-Standard.pdf

[2] International Finance Corporation (IFC), *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources,* 1 January 2012. Available from: http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES

[3] International Finance Corporation (IFC), *Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts* 1 January 2012. Available from: https://www.ifc.org/wps/wcm/connect/3be1a68049a78dc8b7e4f7a8c6a8312a/PS1_English_2012.pdf?MOD=AJPERES

Nature's Benefits: Latin America's Blue Biotrade Delivered to Society by Valuable and Healthy Ecosystem Services

Tundi Agardy*, Federico Vignati** and René Gómez-García

ABSTRACT. Marine and coastal ecosystems provide valuable biotrade resources and investment opportunities throughout Latin America. Mangrove forests, coastal wetlands, estuaries, coral reefs, sea grass beds, macro-algae assemblages and upwelling areas all support social cohesion, leisure, and economic activities in the region. Sustainable fisheries and aquaculture, and marine eco-tourism, are two sectors that are entirely supported by coastal ecosystems, their degradation is an issue of global concern and its restoration a challenge that need to be addressed through different scopes, including blue biotrade investments. In addition, through coastal and marine habitats restoration, healthy ecosystem services contribute to culture and identity enhancement, support agriculture, mitigate the effects of climate change, provide educational opportunities, and safeguard sacred sites. These ecosystem services are currently undervalued, yet their contribution to a healthy planet, income generation, national economies, and a positive climate change agenda is significant – and cannot by substituted.

Bienfaits de la nature: le biocommerce bleu de l'Amérique latine livré à la société par des services écosystémiques précieux et sains

RÉSUMÉ. Les écosystèmes marins et côtiers fournissent de précieuses ressources pour le biocommerce et des opportunités d'investissement dans toute l'Amérique latine. Les forêts de mangroves, les zones humides côtières, les estuaires, les récifs coralliens, les herbiers marins, les assemblages de macro-algues et les zones d'upwelling (remontée d'eau) soutiennent tous la cohésion sociale, les loisirs et les activités économiques dans la région. La pêche et l'aquaculture durables et l'écotourisme marin sont deux secteurs qui sont entièrement soutenus par les écosystèmes côtiers. Leur dégradation est une question de préoccupation mondiale et leur restauration un défi qui doit être abordé à travers différents moyens, notamment les investissements dans le commerce des ressources biologiques d'origine marine (biocommerce bleu). De plus, grâce à la restauration des habitats côtiers et marins, des services écosystémiques sains contribuent à la promotion de la culture et de l'identité, soutiennent l'agriculture, atténuent les effets des changements climatiques, offrent des possibilités d'éducation et protègent les sites sacrés. Ces services écosystémiques sont actuellement sous-évalués, mais leur contribution à une planète saine, à la génération de revenus, aux économies nationales et à un programme positif pour les changements climatiques est importante - et ne peut pas être substituée.

Los beneficios de la naturaleza: el biocomercio azul de Latinoamérica entregado a la sociedad para servicios ecosistemicos valiosos y saludables

RESUMEN. Ecosistemas marino-costeros proporcionan servicios ambientales valiosos y que cada vez más ganan importancia en el ámbito de la inversión pública y privada en América Latina. Los manglares, humedales costeros, estuarios, arrecifes de coral, los lechos de algas marinas, ensamblajes macro algas y todas las zonas de afloramiento tienen un papel fundamental en la cohesión social y desarrollo de actividades económicas asociadas al turismo y a la pesca que tienen contribución directa en el desarrollo económico e inclusión social. La pesca sostenible el turismo ecológico, son dos sectores altamente dependientes de la calidad de los servicios eco sistémicos marino-costeros. Los servicios de los ecosistemas actualmente están infra-valorados, sin embargo, su contribución a la salud del planeta, la generación de ingresos, las economías nacionales, es cada vez más reconocida. En este estudio, se presenta una perspectiva general sobre la importancia de la pesca y el turismo como elementos catalizadores de esta puesta en valor.

*Tundi Agardy, Marine Ecosystem Services programme, Forest Trends

**Federico Vignati and René Gómez-García, Department of Environment and Climate Change, Development Bank of Latin America (CAF)

I. INTRODUCTION

Latin America and the Caribbean (LAC) is an ocean-dominated region. The vast majority of its countries and the bulk of their populations are coastal, with economies inextricably tied to the health and productivity of marine ecosystems. The region's seas and coasts are filled with valuable assets that generate substantial revenues for economic development, support livelihoods, improve the wellbeing of local communities and visitors, and have a key role in climatechange mitigation. The values of some of these assets are recognized, while other opportunities for sustainable use have been left untapped, and in many cases there is a need of direct intervention for restoration.

Healthy marine and coastal ecosystems are vital for maintaining the marine fisheries and aquaculture sectors in the LAC region. They are likely to be increasingly important as populations grow, land becomes scarce, the climate changes, and new markets for seafood and marine products emerge. While Latin Americans have already capitalized on the existence of the marine resources that these ecosystems have provided, there are many challenges regarding the restoration of these ecosystems and new opportunities for investment in the green and blue economies.

In the LAC region, as in the rest of the world, fisheries are an engine of economic growth. Fish is one of the most highly traded commodities worldwide. In the record-setting year of 2013, global exports reached US$136 billion [1]. While the Latin American and Caribbean fish harvest between 1970 and 1996 fluctuated widely, it still contributed from 9 to 24 per cent of the world fisheries catch [2]. Although a regional assessment of fisheries has not yet been completed, the most recently compiled annual FAO data show that in Latin America export values for fisheries products (including wild capture and aquaculture) amounted to approximately US$14.5 billion in 2011. Notably, LAC regional exports accounted for nearly a quarter of all fish traded from developing countries worldwide. Fisheries are a significant contributor to the economies of LAC nations (Table 1 shows Latin American and Caribbean GDP at purchasing power parity and fisheries export figures for 2011). The seafood value chain is long and lucrative; with additional earnings generated by value-added industries that process both domestic and imported seafood products.

II. CONTENT OF THE PAPER

A. Oceans, Livelihoods, and Blue Biotrade in Latin American

The economy of the LAC region is uneven, with five countries (Brazil, Mexico, Argentina, Colombia and Venezuela) accounting for more than two thirds of the region's economic output. The contribution of fisheries exports to the overall GDP also varies significantly. Chile and Peru are the top fisheries exporters in the region, accounting for more than half of the fisheries exports in LAC. While fish exports from LAC represent less than 1 per cent of the regional GDP, their contribution in terms of food security, jobs and livelihoods are far more important for the region as a large share of the harvest and processed products are kept in local and regional markets.

There are interesting subregional patterns as well. While the total fisheries export values of Caribbean island States represent just one per cent of regional exports, they have vibrant, ocean-based societies with great cultural diversity. Both fisheries and aquaculture are expanding rapidly in the Caribbean region, and even in its most developed countries fish consumption is increasing both per capita and in absolute terms, with implications for food security, trade and social stability.

Fisheries play a key role in ensuring food security, which may be even more important than their export value or direct economic output to GDP. Seafood, whether procured through capture fisheries or via aquaculture, is a major component of food security in Latin America as local populations are highly dependent on these resources. Per capita fish consumption is significantly higher in the Caribbean than the global average. In addition, food for subsistence and much-needed cash provide social benefits in areas where coastal communities are marginalized or in rural locations [2]. In the less developed countries of the LAC region, and particularly in remote coastal areas, fish is not only the major source of animal protein, it is also a critical source of micronutrients essential to people with otherwise deficient nutrition [3]. For these reasons, it will be increasingly important to bring together governments, companies and local communities to engage in sustainable and innovative fisheries exploration practices, where ecosystems restoration and sustainable fisheries harvesting go hand in hand.

TABLE 1. INDICATIVE RELATIONSHIP BETWEEN 2011 GDP AND FISHERIES EXPORTS FOR TRADING NATIONS IN THE LAC REGION (USD THOUSANDS)

COUNTRY	GDP (PPP)	FISHERIES EXPORTS	FISHERIES:GDP %
Brazil	2,615,234,935	242,543	<1
Mexico	1,169362,160	1,122,897	<1
Argentina	557,890,204	1,471,838	<1
Colombia	335,415,157	188,791	<1
Venezuela	316,482,191	23,566	<1
Peru	170,564,249	3,164,417	1.9
Chile	250,832,363	4,630,913	1.8
Ecuador	79,276,664	2,496,615	3.1
Dominican Republic	58,361,929	14,783	<1
Guatemala	47,654,787	106,199	<1
Panama	33,270,500	126,122	<1
Costa Rica	41,237,294	132,369	<1
Uruguay	47,962,439	234,559	<1
El Salvador	23,139,000	79,151	<1
Trinidad and Tobago	24,409,842	14,786	<1
Honduras	17,710,315	144,222	1
Nicaragua	9,755,620	132,992	1.4
Jamaica	14,396,817	11,991	<1
Haiti	7,516,834	10,116	<1
Suriname	4,422,277	71,548	1.6
The Bahamas	7,889,750	75,293	1.0
Guyana	2,576,598	53,619	2.1
Barbados	4,358,000	536	<1
Belize	1,487,005	25,408	1.7
Antigua and Barbuda	1,129,918	899	<1
Grenada	778,649	5767	<1
Saint Kitts and Nevis	728,051	719	<1
Saint Vincent	676,129	270	<1
Dominica	501,481	12	<1
Latin America / Caribbean	**$ 5,845,021,158**	**$14,582,955**	**2.5%**

World Bank database /FAO Statistical Summary

Seafood and fishing are also culturally important to the region, with millions of people engaged in artisanal fishing as part of traditional and recreational uses that appeal to urbanites as well as those living in rural areas. From a cultural perspective, seafood has played a central role in the development of traditional gastronomy, which has become a fundamental part of cultural pride and identity. Regional seafood dishes range from "*muqueca*" in Brazil, "*ceviche*" in Mexico, Ecuador and Peru, conch chowder and fritters in the Caribbean, to other local specialties. This supports not only cultural identity, but also the growing marine and cultural tourism trade. In this sense the restoration of ecosystems and blue biotrade investment relevance go beyond direct trade output, it promotes relevant social capital that spins other economic and social activities.

The fisheries and aquaculture sectors provide employment as well as a source of livelihoods in coastal and

island nations across the LAC region. As a mainstay of many coastal communities, small-scale fisheries and aquaculture play an important role in the social fabric of society [4]. In other parts of the region, especially in the Humboldt Current area (Pacific), large-scale commercial fisheries are targets for business investment and major contributors to GDP. Stock assessments and subsequent quota determinations to maintain catch at a maximum sustainable yield is accomplished by national fisheries ministries and regional fishery organizations and arrangements in LAC, including the Western Central Atlantic Fishery Commission, the Regional Fisheries Advisory Commission for the Southwest Atlantic, the Organization of Eastern Caribbean States, the Caribbean Community and Common Market, the Latin American Organization for Fisheries Development and the Permanent Commission for the South Pacific. However, most of these organizations deal only with migratory species such as tuna.

In some places competition over access to resources between large-scale commercial fisheries and small-scale artisanal or subsistence fisheries has created conflict. This trend may accelerate throughout the region if stocks become more overexploited, and if perverse subsidies that drive overcapitalization resulting in even more overexploitation are not reined in. Insufficient investment in monitoring and surveillance, along with effective enforcement, threaten to diminish the likelihood that the blue economy will be harnessed in a sustainable way. Assuring natural and human lead species restoration through holistic ecosystem-based efforts and law enforcement is a key challenge that should be addressed collectively.

These issues can also signal opportunities, however. Latin American and Caribbean nations are taking steps to mitigate these conflicts through formal regional environmental agreements such as the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region , as well as informal regional discussions on combatting illegal, unreported and unregulated (IUU) fishing [5]. Several countries, including Mexico, Ecuador, Peru and Chile, are also making efforts to address IUU by revising their regulatory and administrative measures. While these measures are positive, much remains to be done, especially when it comes to the fisheries industry's adoption of benchmarks and best practices from other industries that have emerged from the intensive overexploitation of natural capital. Feasibility studies and opportunity assessments can point to investments that will not only diminish conflicts and degradation, but also yield large returns.

With the adoption of more ethical and sustainable fisheries practices, there are good possibilities that the conflict between local communities and mainstream fisheries will be minimized, restoration of stocks is key. Direct fisheries management (controlling catch) goes hand in hand with the protection and restoration of habitats that maintain this resource. Fisheries management organizations are utilizing tools such as marine protected areas, green financing mechanisms (for instance, payments for ecosystem services) and certification schemes to ensure that management is more committed to eco-efficiency and a holistic ecosystem-based approach [6]. Good business practices increase benefitsharing along the value chain and revenue flows to operators, investors and governments.

Aquaculture operations are also improving, due in part to the 2009 establishment of the Aquaculture Stewardship Council (ASC) and its standards for the 12 most commonly farmed fish and shellfish species. Many Latin American aquaculture operations have already moved to get ASC or Best Aquaculture Practices (BAP) certification. For instance, in January 2015, Makro Supermayorista SA – a major Latin American wholesaler with operations in Argentina, Brazil, Colombia, Peru and Venezuela – moved to get BAP certification for its farmed seafood as part of a company-wide sustainability initiative. Schemes such as these provide measurable standards and third-party verification in order to ensure that their aquaculture operations adhere to best practices and are attractive to the industry due to the marketing opportunities that certification can provide. Several Latin American countries, such as Ecuador, have already developed strategies for sustainable seafood and aquaculture [7]. Nonetheless, there is scope for improvement, both to increase efficiency and net benefits to society, and to ensure that economic development in the fisheries sector does not constrain other maritime industries and benefits in the long run.

Countries adjacent to rich upwelling systems like the Humboldt Current (e.g. Peru and Chile) take advantage of the naturally high production in most years; other Latin American and Caribbean countries have developed high value commodities that contribute significantly to GDP (e.g. Bahamas with its export of conch and lobster). However, the contribution that

trade in fisheries products makes to GDP masks the fact that certain LAC countries have a high dependence on fisheries.

B. Specific Fisheries of Value to Latin American and Caribbean Countries

Fish products provide essential proteins for human consumption globally, with regional variations (figure 1). While the proportion of food protein provided by fish is significantly smaller than that provided by meat and dairy products (figure 2), its share will increase rapidly around the world as global populations grow from 7.4 billion to 9 billion by 2050.

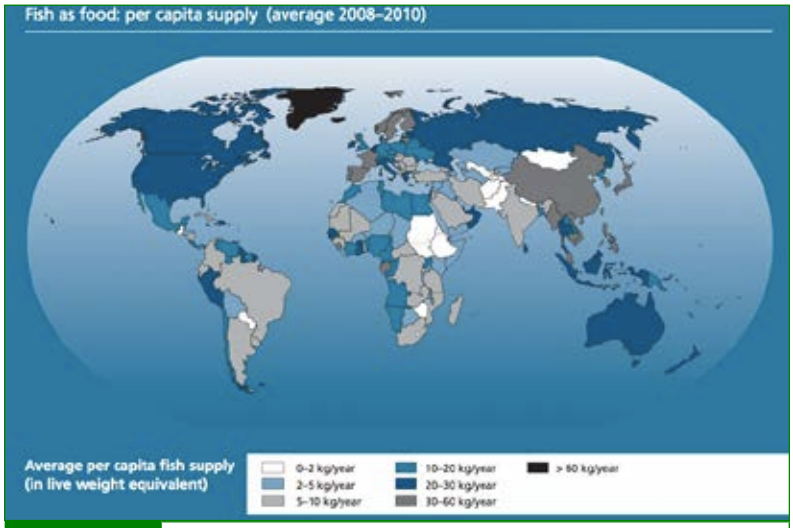


FIGURE 1 AVERAGE PER CAPITA FISH SUPPLY [4].

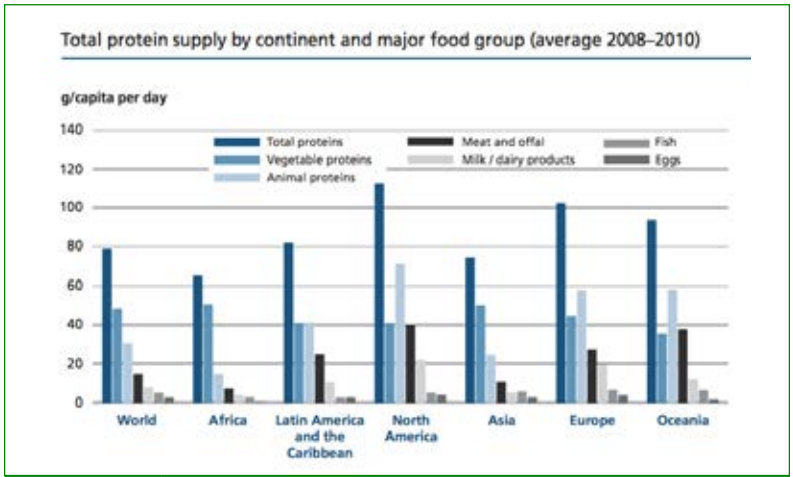


FIGURE 2 DERIVATIONS OF GLOBAL PROTEIN SUPPLY, AVERAGE DATA 2008-2010 [4]

The importance of some fisheries products for food security is larger than it appears. For instance, the Peruvian anchovy fishery is a crucial component of both animal feed and crop fertilizers. As technologies for sustainable agriculture improve in both scale and effectiveness, industries should reduce the use of fish for feedstock (indirect human consumption) and the production of fertilizers, substituting them by more effective and less strategic natural resources. Through development and industrialization, LAC countries may shift progressively from exports of fish commodities to emerging and more attractive fisheries-related markets.

Fisheries, and by extension, aquaculture, are thus major economic drivers in Latin America and the Caribbean, however based on minimal industrial value added, low investment in applied research, and insufficient attention given to restoration and protection of habitats that support fisheries as well as sustainability issues, fisheries contribution to regional wealth is below its capacity.

Historically, much of this sector's economic value lies in international trade. The total export value of marine fisheries and aquaculture products across the Latin America and Caribbean region (excluding Cuba, for which data are unavailable) was over $14 billion in 2011 (Table 1).

The main seafood products driving this trade are the high value commodities: farmed salmon and shrimp, wild caught shrimp, snapper, lobster, and conch, and high volume small pelagics such as anchoveta, sardines, and larger pelagics like mackerel, and tuna. Approximately two thirds of the region's landings are small pelagics, and the volume coming from the region is about three quarters of the global catch in small pelagics,

this context brings important inputs to better understand fisheries economics in LAC and its potential as a driver for new and more innovative applications for fisheries output.

Latin American trade in fisheries products is not only robust, but increasing, with a surplus that has been rising over recent years (figure 3; [4]).

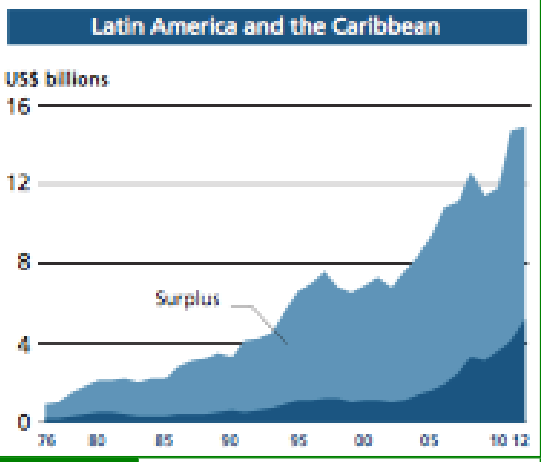


FIGURE 3 IMPORT/ EXPORT OF FISHERIES PRODUCTS FROM LATIN AMERICA [4].

As marine ecosystems are pushed to extreme conditions by climate change, acidification of oceans and exponential loss of marine biodiversity, promoting a holistic, ecosystem-based approach for restoration and management will become a necessity.

The speed with which the adoption of more ecosystem- and social resilience-based approaches in the fisheries value chain, will depend primarily in the capacity of local governments to understand marine ecosystem services strategic role for long-term performance. The trade-off is not whether LAC countries should use fisheries as a driver for more consistent growth or remain exploring fisheries in the same way they have been doing for decades. The trade-off is whether LAC countries shift from a quantitative performance output for fisheries to a qualitative, or potentially face the loss of comparative advantage. In this scenario, ecosystems restoration and ethical blue biotrade investments play a key role.

The huge variation in export figures among Latin American and Caribbean countries belies several complexities inherent in assessing marine fisheries value. Countries for which fisheries (and aquaculture) produce a significant proportion of GDP are economically reliant on consistent catches and market demand. Paradoxically, many of the most lucrative fisheries are also the most dynamic, exhibiting boom and bust cycles tied to oceanographic features such as the El Niño Southern Oscillation (ENSO) events [8].

Those LAC countries such as Peru and Chile that tap the highly productive upwelling systems like the Humboldt Current, or those like Ecuador and Chile that practice large scale aquaculture of shrimp or salmon, or those such as the Bahamas or Mexico that export high value commodities like conch and lobster, recognize the value of oceans in providing resources to support these operations.

But smaller countries such as the Caribbean Island States, while hardly visible in terms of international trade statistics, are nonetheless reliant on fisheries. Taking Dominica as an example, Boyd (2010) [9] shows that local reef fisheries provide employment to fully 11% of the working population – a significant engine of economic well-being for which substitution will hardly be available. In nations such as Trinidad and Tobago, fisheries support a high per capita GDP, suggesting that even in countries where fisheries revenues are limited, low population density can lead to a very high per capita contribution to GDP for fisheries.

Fisheries have been increasing in importance in LAC. From 1973, fisheries contributions to GDP increased steadily, in part to expanding effort in small pelagic fisheries (especially Peru and Chile), but also due to expansion of the sector into other products: demersal fishes, crustaceans, mollusks (primarily squid), and large pelagics, as well as aquaculture (see below). Fisheries contracted slightly between 1984 and 1990, but have been increasing in both value and contribution to employment in recent years [4].

Since 1991, the value of regional exports has grown faster than world value [2] [4].

In recent decades, aquaculture has expanded in response to new market demand and a new spate of investors. Chile, Ecuador, Mexico, Brazil, Colombia, and Cuba account for the vast bulk of production. Shrimp and salmon aquaculture targeting markets in the US, Japan, and Europe account for over 80% of regional aquaculture production [2] [4]. In Ecuador, shrimp production has topped 300,000 metric

tonnes, with exports generating some $2.6 billion in 2014 [10]. Strong and increasing demand for shrimp in the United States, combined with a drop in Asian shrimp production due to early mortality syndrome, underlies this growth. In addition to Ecuador, other major shrimp producers in the region include Mexico, Colombia, Honduras, and Panama. In contrast, Chile is the sole large-scale developer of salmon farming, accounting for over 10% of the world salmon supply. As in other parts of the world where industrial aquaculture exists, the farming operations are vulnerable to disease outbreaks. Farming operations have been the source of large-scale habitat destruction (especially the destruction of mangrove forests for shrimp ponds, see [[11], as well as degradation tied to release of fishery waste products, antibodies and other medicines, and nutrients into local waters. This situation has, however, been steadily improving through the application of international certification, emerging regulation and a rising interest of governments for protecting and managing coastal and marine ecosystem services in more environmentally sound ways [12].

On the opposite end of the commodity spectrum, fisheries targeting small pelagics for fishmeal represent high volume, low-value fisheries. These fisheries represent close to three quarters of the region's output in the sector. While these fisheries cause less concern about environmental effects than do shrimp and salmon farming operations, the large-scale harvest of small pelagics does have destabilizing effects on marine food webs, especially in periods of El Nino. In addition, by-catch (catch of non-targeted fish, shellfish, marine turtles, marine mammals, and seabirds) in these and other wild capture fisheries can have profound effects on marine biodiversity, though this pressure is abating as LAC countries take measures to reduce by-catch and increase efficiency.

Although intraregional trade is still quite limited, the setting up of the MERCOSUR common market opened up the Brazilian market for duty-free fishery products from Uruguay and Argentina and the regional trade of canned pilchard from Peru to other South American countries [2].

Trade in fisheries and aquaculture products originating in Latin America flows across the globe. According to 2014 FAO statistics [4], approximately 6% of South American marine fisheries products are exported to Africa, 13% to North America, 11% to Asia, 8% to Europe, and 4% to Australia. Intraregional trade in South America accounts for 61% of exports (figures 4 and 5).

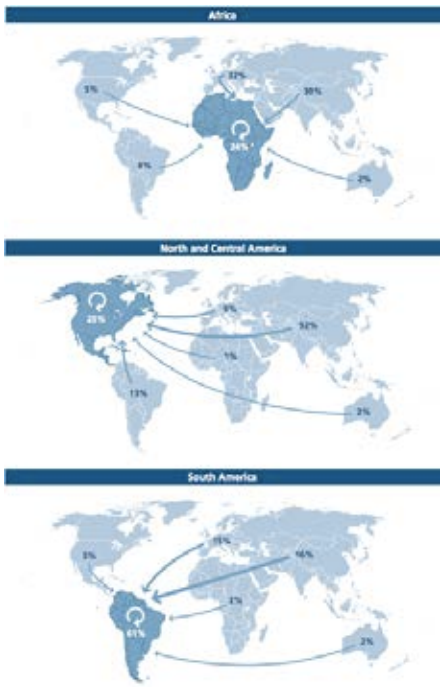


FIGURE 4 IMPORT/ EXPORT OF FISHERIES PRODUCTS FROM LATIN AMERICA [4].

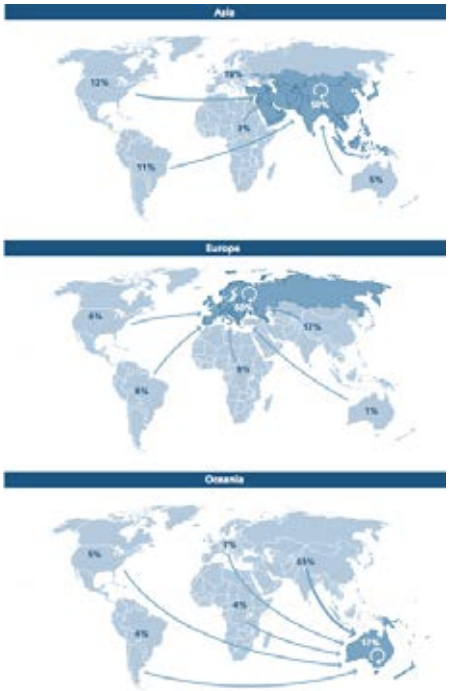


FIGURE 5 EXPORT OF FISHERIES FROM SOUTH AMERICA TO ASIA, EUROPE, AND AUSTRALIA [4].

Yet even these trade figures do not tell the whole story. Export values––the most easily obtained metric for fisheries valuation––do not indicate true contribution to GDP, since neither the sum of private and government consumption, capital formation, employee compensation, insurance, nor subsidies are calculated [13]. Import/export figures also shed no light on domestic commercial markets, small and informal markets, or subsistence reliance on marine resources (including fisheries products not only used directly for food, but also for bait as well as fertilizer for household crops and feed for fish ponds). According to the FAO, fisheries contribute nearly 10% of the food supply in Latin America [4]. In addition to this direct value, there are spin-off effects on the value chain. In Peru, for instance, fisheries contribute to 232,000 jobs, 35% of which are in restaurants [14].

In addition, fisheries can also boost the revenues of other industries in Latin America and the Caribbean. Across many localities, tourism drives demand for local fisheries products, and when such seafood is made available it is not only sold at a premium, benefitting the fisheries businesses, but can also allow for more high-end, profitable tourism. In some places fishers engage with tourism, taking visitors in their boats on tours when not fishing – this provides additional employment and diversifies their livelihoods, reducing risk. In this context fisheries spin-off impact on jobs at the base of the pyramid are probably as significant if not more as the direct impact of mainstream fisheries.

Marked differences exist between and within countries in terms of quantity and variety of fisheries products consumed per capita, depending on availability, cost, alternatives, income, and cultural factors such as food traditions and tastes [4]. Nonetheless, fisheries and aquaculture combine to form an undeniable mainstay in Latin American culture, trade, and economy.

Nature's role in providing these resources is obvious – without healthy, productive oceans, marine and coastal fisheries resources would not be available for harvesting. But nature does more than provide living resources for today– coastal and marine habitats also maintain the potential for food, livelihoods, and contributions to GDP in the future. Critical habitats for fisheries – the places without which there would be no fisheries production, and thus no fishing industry – include not only marine areas where fishing takes place, but also nursery areas in mangrove, seagrass, and estuaries, spawning grounds, and migration corridors, blue biotrade investment and restorations of this habitats is key [11]. Coastal habitats provide space to support fisheries infrastructure, habitats that stabilize shorelines and ports and safeguard fisheries capital investments from storms, and maintain the ports and shipping routes that allow transport of fisheries products to markets. Coastal habitats also provide waste management for fish processing and both space and waste management for fish and invertebrate aquaculture operations. Finally, coastal and marine habitats support other growth industries in Latin America, such as tourism, which in turn act to create more demand for fisheries product and potentially more profitability.

III. THE CHALLENGE

Among the major challenges facing the Latin American fisheries industry are: (i) lack of an adequate assessment of the current situation of marine fisheries and aquaculture; (ii) the inability to form an accurate picture of the condition of fish stocks; (iii) how the sector benefits society, and (iv) what additional potential exists for investment in the sector. The last regional appraisal of the sector was conducted using data now a half a decade old [15]. One of the main messages of that assessment was that information on fisheries, and smaller scale fisheries in particular, was sorely lacking for the LAC region.

As in other regions of the world, significant challenges remain for the management of marine fisheries even in areas where a scientific stock assessment has been performed and a framework exists for joint management through regional fisheries management organizations (RFMOs). Many stocks are overexploited, and IUU fishing remains a challenge even in countries with strong fisheries regulations [3]. Developing countries have even greater challenges than developed nations in building capacity for monitoring and enforcing regulations, especially in offshore areas.

Some of the fisheries of greatest commercial value in the region are also those facing significant ecological pressures, particularly with regard to straddling and migratory stocks in the high seas, including the tuna fishery in the eastern Pacific, the Peruvian/Chilean anchovy fishery in the Humboldt Current, and the southern ocean tooth-fish and squid fisheries [16]. The high degree of unpredictability concerning population sizes challenges fisheries managers and governments

alike. Add to this the fact that many stocks are trans boundary in nature, and shared threats need to be addressed collectively makes the situation even more challenging [[17]. In the Caribbean subregion, fisheries are characteristically shared between localized small-scale operators [18].

As fisheries expand in the region, emerging potential economic related conflicts may increase. These potential conflicts include competition between operators, displacement of fisheries due to conservation-related protections or allocations made for other interests (tourism, energy development, etc.). With the expansion of large-scale commercial fisheries, conflicts between industrial and artisanal fishers can only increase [19]. For marginalized coastal communities, these conflicts can exacerbate poverty and further disenfranchise societies. All evidence points to the fact that the adoption of ethical and science-based best practices is fundamental to the fisheries industry.

Conflicts may also occur between actors in fisheries value chains, post-harvest and sometimes away from the sea and coasts. Asymmetry in the capacity to develop or expand businesses by different actors in fisheries value chains leads to further inequities. Well-financed businesses, whether domestic or foreign, can more easily gain access to capital and the knowledge investments needed for efficient processing facilities. They can also invest in marketing/advertising, as well as establish the most efficient modes of delivery to markets. In contrast, many developing countries lack the capacity to comply with environmental, safety and trade regulations and standards, which limits their ability to access markets.

There are opportunities embedded in these challenges. For instance, the Marine Stewardship Council (MSC) and other sustainable marine certifications can help in keeping to standards for sustainability and equity. Many NGOs offer assistance in getting community-based fisheries products certified. Yet, even in cases where training and technical assistance increase this capacity, well-financed investors can "corner the market". In the worst case, the economic and social benefits flowing from commons property such as marine fisheries stocks may end up in the hands of only a few [20].

A final challenge is the uneven treatment of opportunities for improving and investing in the sector. Growth in fish and seafood products certified as sustainable has occurred throughout the world, and there is great potential to amend operations to conform to best practices, as well as expand and diversify industries as new markets emerge. One important way in which Latin American countries (and the investors they hope to woo) can increase production and profitability is to invest in the marine and coastal ecosystems themselves, thus ensuring continued production of wild stock and food for aquaculture operations, as well as the myriad ecosystem services that nature provides.

IV. THE OPPORTUNITIES

Latin America has a great chance to take full advantage of nature's potential, delivering marine and coastal ecosystem benefits and promoting more equitable benefit sharing. These opportunities occur on both the supply and the demand side. Throughout the region, there are possibilities to maintain or enhance production, improve quality and increase profitability in five related ways: (i) improving management in order to increase efficiency and profitability in the use of blue-biotrade-related product and services; (ii) enhancement of production through protection or restoration critical marine ecosystems in specific blue sites and the spawning and nursery habitats to restore fish stocks; (iii) development of fisheries businesses that generate profits through certification; utilization of by-catch and value-added processing of specialty products, (iv) expansion of export and domestic markets, and (v) implementation of land and marine use policies that maximize blue biotrade values alongside other benefits provided by nature, including the carbon sequestration needed for climate mitigation (blue carbon), flood control and disaster risk mitigation, tourism and recreation as well as support to regional and global biodiversity.

Donor interest in the region is strong. Conservation funding has been available for marine ecosystem services enhancement, especially in the Caribbean subregion [18]. Multilateral support for fisheries reform and projects in the form of loans and grants has been provided by development banks and the OECD, as well as bilateral funding from USAID, DIFD (UK overseas development agency), GIZ (German development agency) and others. These grants have supported assessments of local and sub-regional fisheries issues and studies related to the livelihoods of fishers, including their contributions to households and general wellbeing. Other project funding has allowed

the identification of ecologically and biologically significant areas under the Convention on Biological Diversity, as well as priority areas for marine protected areas (MPAs) and other spatial management measures specifically aimed at maintaining or enhancing sustainable development activities such as tourism, applied research and fisheries. These grants have helped communities to better manage their marine ecosystem services related businesses and the attendant impacts on the environment, including through MSC certification. Private sector and foundation funding has also supported the development of rights-based fishing in the region, including the use of territorial use right fisheries (TURFs) in Chile and Mexico, and individual transferable quota systems (ITQs) throughout the region. The Development Bank of Latin America (CAF) is currently evaluating opportunities for innovation to support sustainability, promoting both conservation and sustainable use of marine ecosystems and fisheries.

Despite this historical aid, many more opportunities to enhance marine ecosystem services, mainly related to fisheries and tourism and benefit sharing in the LAC region seem to have been overlooked. Outcome-oriented investments could facilitate access to capital, training and technology transfers focused on gear new ethical and biotrade related practices to improve and boost new sustainable business models, inclusive value chains and participatory governance platforms that could lead to a more holistic approach for coastal and marine ecosystem services planning and management, and through this approach, stimulate new productive models committed to long term sustainable development.

Trade and sustainable tourism policies should also be evaluated and possibly revamped. For fisheries policies, special attention on the emphasis on measures that reduce IUU fishing, decrease reliance on fisheries subsidies, and address tariffs that disadvantage small-scale or local fishers are key (for global recommendations and greater detail. In the case of sustainable tourism, policies should have in consideration the need to support tourism development zoning and investment in well-documented technical evaluations of marine and coastal ecosystem services evaluation. Tourism policy should also stimulate coastal and biodiversity remediation and restoration as a way forward to maintain tourism destinations long term competitiveness and to landscape deterioration that may undermine tourism development capacity in the long term.

Many Latin American countries are already investing in improving the management and efficiency of increased fishing and aquaculture [13] [21]. More effective management can generate revenues for individuals and businesses, as well as increase the economic standing of coastal communities and their ability to contribute to GDP. In addition, improved management can enhance the sustainability of revenue generation by allowing foreign fleets to fish within the Exclusive Economic Zones of coastal nations. Finally, improved management can increase regional fisheries' productivity through strengthened regional management organizations as well as bilateral or multilateral agreements that pool resources for fisheries research and harmonize fisheries legislation.

A shift from low value-added commodity fisheries used for animal feedstock and fertilizers to other applications better able to capture more of the economic output to the benefit of producer countries presents an opportunity to improve food security and climate change mitigation provided that adaptation funds are available. This leap from quantitative to qualitative output in the fisheries value chain could have a significant impact on restoring ecosystems capacity to perform in the long term.

One management tool that has gained traction in recent years is the establishment of marine reserves––a form of marine protected area where extractive uses are prohibited. Fisheries managers have utilized marine reserves to protect spawning stock, increase recruitment and catalyse spillover in which fisheries productivity outside the reserve is enhanced by production that "spills" over the border. The FAO has helped countries develop marine reserves and networks by providing guidance in the form of publications and training workshops (see, e.g., [22] and [23]). The most effective protected area measures are those embedded in wider-scale marine spatial planning and ocean zoning [11] [17]. These measures are particularly effective if they are placed within multilateral agreements that protect shared marine regions [17].

Other management measures that can enhance productivity and maintain the sustainability of fisheries include rotating harvest schemes and seasonal closures, regulations requiring by-catch reduction and efficiency enhancement gear, size or slot limits that

protect spawning stock, and property rights schemes such as territorial use right fisheries, and individual transferable quotas. Interestingly, Latin America lags behind many other regions of the world in adopting measures for improved fisheries management and increased efficiency.

Efficiencies can also be improved post-harvest as exemplified by new initiatives aimed at utilizing currently wasted fisheries by-products. For instance, the Iceland Ocean Cluster has launched a programme that trains fishing businesses to utilize 100 per cent of their catch––not only producing high-quality fish for human consumption, but also turning fatty tissue byproducts into fish oil for medicinal use, and scales and organs into fishmeal. Other fisheries utilize unwanted by-catch (low-value fish species, invertebrates, jellyfish, seaweeds) in addition to targeted fisheries stocks. In 2015, the FAO and the Global Environment Facility (GEF) launched a five-year project to promote the sustainable management of by-catch in LAC trawl fisheries involving Brazil, Colombia, Costa Rica, Mexico, Suriname and Trinidad & Tobago (GEF allocation US$ 5.8 million; total budget of nearly US$ 23 million). This project will support the implementation of the 2015 International Guidelines on By-catch Management and Reduction of Discards as well as the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication. Together, they provide another international instrument of high relevance to the trawl fisheries in the LAC region [25].

There are even greater opportunities if one considers the international context and the many policies and initiatives that are catalyzing improvements in fisheries [26]. For instance, Goal 14 of the recently adopted Sustainable Development Goals (SDGs) commits United Nations Member States to: "conserve and sustainably use the oceans, seas and marine resources for sustainable development" [1]. Under the Convention on Biological Diversity (CBD), ecologically or biologically important areas (EBSAs) have been identified for the region. These will receive special attention aimed at ensuring that the fisheries within EBSAs are sustainable. Parties to the Convention, in their decision X/2, have also committed themselves to a Strategic Plan for Biodiversity 2011–2020 including the 20 Aichi Biodiversity Targets. Target 11 calls specifically for the establishment of marine protected areas and other effective area-based conservation measures that will enhance fisheries productivity once Target 11 is implemented.

The Latin America and the Caribbean region has a great opportunity to unlock its vast potential for blue growth and maximize the profitability of their fisheries while at the same time safeguarding biodiversity and the marine environment that supplies all this potential wealth. Targeted investment in the ecosystems that support fisheries and trade policies that bolster sustainability in both fisheries and tourism will help achieve this. Conservation can be made to pay for itself through directed investments that divert a portion of beneficiaries' funds flows back to the ecosystem [27]. Subsequent returns on these investments, including through increased trade in properly valued product and through enhancement of supporting ecosystems will accrue not only to investors but, most importantly, to the Latin American and Caribbean communities as a whole.

Those who benefit from coastal and marine ecosystems and the services that they provide can profit even more from investing in their protection. This assures benefits will continue to flow, and can even lead to enhanced benefits and increased profitability from sustainable fisheries, blue tourism, and other forms of marine biotrade. Through innovative financing schemes like marine payments for ecosystem services (MPES), biodiversity offsets, public private partnerships, marine conservation agreements, trust funds and other endowments, and impact investing, the costs of effective marine management can be shared by the public sector and the private sector (both businesses and communities). Innovative financing and private sector investment in coastal ecosystems that provide goods and services is springing up around the world, especially where the capacity exists to assess marine ecosystem services, determine their value, and ascertain what factors affect ecosystem services delivery. New rapid assessment techniques for quantifying and valuing marine ecosystem services, from blue carbon to shoreline stabilization, have now come on line. The location of concentrations of ecosystem service-delivering habitats can be mapped, as can benefits flows across broader landscapes. This can set the stage for innovative financing mechanisms like payments for ecosystem services, and get not only the investments rolling but also the returns on those investments.

REFERENCES

[1] UNCTAD and the Commonwealth Secretariat. 2015. Sustainable fisheries: International trade, trade policy and regulatory issues. Background Note 25 September 2015

[2] FAO 1996. Fisheries and aquaculture in Latin America and the Caribbean: Situation and Outlook in 1996. FAO Fisheries Circular No 921 FIPP/C921

[3] Pauly, D. and D. Zeller. 2016. Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. Nature Communications 7:10244 (doi:10.1038/ncomms10244)

[4] FAO. 2014. The State of the World Fisheries and Aquaculture.: Opportunities and Challenges. Food and Agricultural Organization of the United Nations. Rome. 243 pp.

[5] FAO. 2015. Combatting IUU fisheries in the Caribbean through policy and legislation. FAO Subregional Office for the Caribbean Issue Brief 15. November 2015. 8 pp.

[6] Potts, J.,A. Wilkings, M. Lynch, and S. McFatridge. 2016. The State of Sustainability Initiatives: Standards and the Blue Economy. IISD/IIED/FAST, 2016

[7] UNCTAD/DITC/TED. 2015. Politica nacional de exportacion de productos verdes del Ecuador: Cacao-Chocolate y pesca sostenible. UN Geneva. 74pp.

[8] Cashin, P, K Mohaddes, and M. Raissi. 2015 Fair weather or foul: The macroeconomic effects of El Nino. IMF Working Paper 15/89

[9] Boyd, C. 2010. Fisheries sector. In A Bovarnick, F Alpizar, and C Schell (eds.) Latin America and the Caribbean: A biodiversity Superpower: Importance of biodiversity and ecosystems in economic growth and equity in Latin America and the Caribbean: An economic valuation of ecosystems. United Nations Development Programme. NY

[10] The Fish Site. 2015. Ecuador's shrimp production to increase in 2015. Available at http://www.thefishsite.com/fishnews/26294/ecuadors-shrimp-production-to-increase-in-2015/

[11] UNEP. 2014. The Importance of Mangroves to People: A Call to Action. Edited by J-W van Bochove, E Sullivan and T Nakamura. UNEP WCMC, Cambridge UK 188pp.

[12] Gunther, M. 2012. Shrimp farms' tainted legacy is target of certification drive. Environment 360: August 6 2012. Yale University, New Haven

[13] World Bank. 2005. Latin America and the Caribbean: Improving the Domestic Market for Seafood Products. Module 13: Activity Profile 4. World Bank, Wash Dc Available at http://siteresources.worldbank.org/INTGENAGRLIVSOUBOOK/Resources/Module13Innovation4.pdf

[14] Christensen, V, S de la Puente, C Sueiro, J Steenbeek, and P Majluf. 2014. Valuing seafood: The Peruvian fisheries sector. Marine Policy 44:302-311

[15] Salas, S.; Chuenpagdee, R.; Charles, A.; Seijo, J.C. (eds). Coastal fisheries of Latin America and the Caribbean. FAO Fisheries and Aquaculture Technical Paper. No. 544. Rome, FAO. 430p.

[16] World Bank and FAO. 2009. The Sunken Billions: The Economic Justification for Fisheries Reform". The International Bank for Reconstruction and Development, Agriculture and Rural Development - Sustainable Development Network. Wash DC

[17] UNCTAD. 2014. The Oceans Economy: Opportunities and Challenges for Small Island Developing States. UNCTAD - Division on International Trade in Goods and Services, and Commodities, Geneva. 32pp.

[18] Hoffmann, T.C. 2010. Identifying opportunities to address issues of marine fisheries and biodiversity conservation. MacArthur Foundation Conservation White Paper 2010. 86pp.

[19] Jarroud, M. 2015. Industrial fisheries crowd out artisanal fisherpersons in South America. Inter Press News Agency Available from http://www.ipsnews.net/2015/06/industrial-fisheries-crowd-out-artisanal-fisherpersons-in-south-america/

[20] Pinkerton, E. and R. Davis. 2015. Neoliberalism and the politics of enclosure in North American small-scale fisheries. Marine Policy 61:303-312.

[21] Wiefels, R 2003. Study of international trade in fishery products on food security in Latin America- A Regional approach. pp 155-160 International trade in fishery products in Latin America- A regional approach. FAO Fisheries Report 708, FAO Rome

[22] FAO. 2011. Fisheries management. 4. Marine protected areas and fisheries. FAO Technical Guidelines for Responsible Fisheries No. 4, Suppl. 4. Rome. 199 pp.

[23] Sanders, J.S., D. Greboval, and A. Hjort. 2011. Marine protected areas : Country case studies on policy, governance and institutional issues. FAO Fisheries and Aquaculture Technical Paper 556/1. FAO Rome

[24] Agardy, T., P. Christie, and E. Nixon, *Marine Spatial Planning in the Context of the Convention on Biological Diversity: a study carried out in response to decision X/29 of the Conference of the Parties to the Convention on Biological Diversity*, (CBD Technical Series No. 68, 2012)

[25] GEF 2015. Sustainable management of by-catch in Latin America. http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/International%20Waters/Regional%20-%20(5304)%20-%20Sustainable%20Management%20of%20Bycatch%20in%20Latin%20America/2-25-15_-_ProDoc1.pdf

[26] Deere, C. 2000. Net gain: Linking fisheries management, international trade, and sustainable development. IUCN Washington DC

[27] Credit Suisse AG and McKinsey Center for Business and Environment. 2016. Conservation Finance From Niche to Mainstream: The Building of an Institutional Asset Class.