Preserving Hong Kong's Biodiversity

The Need for an Ecological Restoration Policy

by Joanna Clark

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CIVIC EXCHANGE

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Ecological Restoration Policy

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The views expressed in this report are those of the author and do not necessarily represent the opinions of Civic Exchange.

Abbreviations

AFCD	Agriculture, Fisheries and Conservation Department
CA	Conservation Areas
CBD	Convention on Biodiversity
CEDD	Civil Engineering and Development Department (formerly the TDD)
CPA	Coastal Protection Areas
EIA	Environmental Impact Assessment
EPD	Environmental Protection Department
GB	Green Belt
KFBG	Kadoorie Farm and Botanic Garden
LCSD	Leisure and Cultural Services Department
SAR Government	Government of the Hong Kong Special Administrative Region
SER	Society for Ecological Restoration
SSSI	Sites of Special Scientific Interest
TDD	Territory Development Department (now the CEDD)
WAPO	Wild Animals Protection Ordinance

Executive Summary

Hong Kong's biodiversity is important and worth protecting, both for its inherent value and to provide vital services for Hong Kong's population. The new nature conservation policy does not offer adequate means to protect and enhance this biodiversity. Further measures in the form of a separate restoration policy or a restoration element of the conservation policy are needed.

Key recommendations proposed in this report include:

1. Protection and management of existing biodiversity hotspots

- There is an urgent need to expand the Country Parks system to protect important lowland habitats such as remaining lowland forests and fung shui woods as these habitat types are not adequately represented in Hong Kong's protected area system.
- There is also a need to strengthen and enforce planning regulations to preserve important habitat areas outside of Country Parks. In particular, the list of land uses permitted in SSSI, CA, GB and CPA zones should be reviewed.

2. A conservation policy that is effective at different geographical scales

- Policies should protect biodiversity at multiple levels, both in specific areas of recognized conservation value and also at a broader regional level. For example, there is a need to create and maintain ecological corridors linking Hong Kong with the rest of China.

3. A restoration policy that is effective for a variety of habitat types

- Hong Kong's natural climax vegetation state is subtropical rainforest. However, we must be careful not to translate the need for restoration of our forests into mass reforestation efforts throughout Hong Kong. Other types of habitat are equally important for biodiversity, and must also be preserved as part of our landscape.

4. Effective policing and enforcement of fire prevention rules

- Funding must be made available for effective policing and enforcement of fire prevention rules and regulations. More stringent penalties should be put in place and more public education provided on the need to prevent hill fires.

5. Preferential use of native trees in tree planting programmes

- An interdepartmental policy for afforestation work is needed to ensure preferential use of native species in tree planting. Use of non-native species should ultimately be phased out.

6. Plans for the reintroduction of key species

- A comprehensive plan should be developed for the reintroduction of certain species; for example, bird species known to play a role in seed dispersal for Hong Kong's native plants.

7. A policy on exotic invasive species

- Decisions need to be made about which invasive exotic species are essential to control and which can be practically controlled. Public education to help with the control of these species is then needed.
- Stringent border checks to prevent future invasion of exotic species is also desirable.

Introduction

A review of Hong Kong's nature conservation policy was initiated in 2003.[1] The SAR Government sought views from NGOs, businesses, the general public and other interested parties on changes to current policy. The Government proposed a system to evaluate conservation areas and a public private partnership plan to develop, manage and conserve such areas. Consultation on this system provided the basis for the new nature conservation policy.[2]

The new nature conservation policy has obvious shortcomings. Indeed there has been a recent call from the Legislative Council for the Government to review it.[3] From the outset, the policy review was criticised for being too narrow in its focus.[4] Civic Exchange's own comment was that the proposals in the review were "limited in scope and will do little to meet the urgent need to protect threatened areas of high value that are under private ownership."[5]

One of the objectives of the new nature conservation policy, as outlined in the policy statement, is "to rehabilitate degraded ecosystems and promote the recovery of threatened species where practicable."[6] However, no further guidance is provided as to how this is to be achieved. The review and the new policy also make no mention of exotic and invasive species, specific protection for endemic species or protection of the marine environment and give no conservation guidance to SAR Government departments.[7] Were the policy to be broader, it would have to encompass these and other aspects of conservation and integrate the requirements of the Convention on Biological Diversity (CBD), to which China is a signatory.[8]

This report gives further consideration to how the objective of biodiversity protection and ecosystem rehabilitation can be achieved in Hong Kong. It looks at both theoretical and practical aspects of ecological restoration as a means of enhancing local biodiversity. The data for this report was gathered through literature review and interviews conducted with Hong Kong-based experts in the field.

Part 1 focuses on Hong Kong's biodiversity, the need to protect such diversity and the different restoration strategies that could be used to achieve this aim. **Part 2** looks at current protection for biodiversity in Hong Kong. **Part 3** outlines some of the key components of a restoration policy and **Part 4** makes recommendations specific to Hong Kong. The case studies in **Part 5** serve to

[1] Environment, Transportation, and Works Bureau, *Nature Conservation Policy Review - Consultation Document*, HKSAR Government, July 2003.
[2] See Appendix C. More information on the new nature conservation policy and the pilot scheme for public-private partnership for management of conservation areas is available at www.afcd.gov.hk/news/eWhatIsNew/NewNatureConservationPolicy/eng/index.html.
[3] On 15 June 2005, Hon. Cheung Hok-Ming moved a Member's Motion to urge the Government to review the nature conservation policy and this motion was carried. Legislative Council Minutes No 33, LC Paper No CB (3) 745/04-05.
[4] Canadian Chamber of Commerce, Hong Kong, "Sustainable Development and The Environment in Hong Kong: Moving From A Community-Defined Framework To A World City Agenda," Resource Paper III: Environmental Protection in Hong Kong – Natural Habitats, 31/07/05.
[5] Civic Exchange, "Response to ETWB Consultation Document: Nature Outlook, Review of Nature Conservation Policy," 17 Oct 2003, p1.
[6] ACE Paper 37/2004, "New Nature Conservation Policy," Environment Transport and Works Bureau, HKSAR Government, Nov 2004.
[7] Kilburn, M., "Conservation Policy Review, Unaffordable Luxury or Our Children's Legacy," Kadoorie Farm and Botanic Garden, 9 Sep 2003.
[8] - The Conservancy Association advocates that the policy review should consider other aspects of conservation. It also suggests an independent authority to oversee comprehensive conservation issues. Conservancy Association, 2003, *Hong Kong, Asia's World City, and the World's Eco-City*, Response to Review of Nature Conservation Policy, Oct 2003.
- WWF Hong Kong recommends a Biodiversity Action Plan (BAP) as part of the conservation policy with an authority responsible for conservation set up specifically to oversee the BAP. WWF Hong Kong, *Responses on Review of Nature Conservation Policy*, 17 Oct 2003.
- Kadoorie Farm and Botanic Garden recommend mandatory conservation commitments as part of a sustainability statement for every government department. Kilburn, M., "Conservation Policy Review, Unaffordable Luxury or Our Children's Legacy."

illustrate how ecological restoration strategies have benefited or could be of benefit in enhancing the richness of Hong Kong's countryside.

It is hoped that this report will provide a platform for discussion and debate on ecological restoration in Hong Kong. Ultimately some of the ideas presented here could help inform conservation policy development for Hong Kong.

Part 1: The Value of Biodiversity

Hong Kong's biodiversity

Hong Kong supports an amazing array of plant and animal life. Its unique climate and topography enable a wide range of flora and fauna to exist within a relatively limited geographic area of only 1,100 km^2. For some of these species, the population in Hong Kong makes up a significant proportion of the entire global population.[9]

Hong Kong's biodiversity is extraordinary and includes:

- 2,136 species of vascular plants, more than is found in many larger countries such as Great Britain;
- 488 species of birds, around one third the number of bird species recorded in mainland China;
- 67 non-marine reptile species;
- 23 species of amphibians;
- 234 species of butterfly, representing almost 20% of all butterfly species found in China; and
- 107 species of dragonfly, including seven species unique to Hong Kong.[10]

Despite this richness, Hong Kong's ecosystem is depleted – both with regard to historic conditions and in comparison to the current state of other regional systems.

Hong Kong was once a subtropical rainforest ecosystem that supported a huge diversity of animal and plant life such as gibbons, elephants, rhinoceroses, pheasants, tigers, oak trees, orchids and camellias. By the twentieth century, however, many of Hong Kong's more vulnerable native species had already become locally extinct.[11] Even in comparison to forested regions of neighbouring Guangdong Province today, Hong Kong's biodiversity is relatively impoverished.[12]

Depletion of local biodiversity reflects the continued and rapid encroachment of human development on Hong Kong's natural environment. Until relatively recently, Hong Kong was a compact city with dense housing and development concentrated in a few urban centres while rural areas remained sparsely populated. The development of new towns in previously rural locations such as Tung Chung and Tin Shui Wai and the spread of large infrastructure projects to the outlying islands,[13] however, has resulted in the redistribution of the urban population to the countryside and the urbanisation of previously remote locations. At the same time, improvements in the standard of living have led to a rise in the number of cars on the roads and increasing automobile and human traffic in the countryside.

The result is that Hong Kong's natural habitat areas are quickly disappearing. Those areas that do remain, including protected sites such as Country Parks, are threatened by pollution, and increased use of the countryside. It is this loss of quality habitat for native plant and animal species that poses the most immediate threat to Hong Kong's biodiversity.

[9] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*, Friends of the Country Parks, Joint Publishing (HK) Company Ltd., Hong Kong, 2004.
[10] Ibid.
[11] Ibid.
[12] Corlett, R.T., "Pollination in a degraded tropical landscape: a Hong Kong case study," *Journal of Tropical Ecology*, 17:1, pp155-161, 2001.
[13] These include the development of the airport at Chek Lap Kok and the Disneyland amusement park in Penny's Bay, both on Lantau Island.

Why protect habitat areas?

Encroachment by humans on the natural environment poses the most immediate threat to Hong Kong's biodiversity. Therefore, the most urgent priority in preserving biodiversity is adequate habitat protection for native plant and animal species.[14]

Protection and enhancement of habitat provides a myriad of ecological benefits as evidenced by the successful re-establishment of several species of birds and butterflies that were formally extinct in Hong Kong in Tai Po Kau.[15] On the other hand, loss of habitat has a significant impact on species populations and the biodiversity of the system as a whole. The more serious consequences of habitat loss or degradation include:

- Inability of species to establish a viable population due to geographic limitations;
- Absence of certain key species within the system; for example, large herbivores and top predators;
- An incomplete mix of species, meaning that there may be gaps in the food web;
- Decrease in the diversity of the habitat and thus in the species that depend on such diversity; and
- An increase in the size of the 'edge' region separating the habitat from the surrounding area, which decreases habitat quality.

Natural geophysical processes may also be affected by a decrease in habitat area and this, in turn, can have far-reaching consequences for both human and natural populations. For example, natural ecosystems such as forests are the source of important resources such as clean water and oxygen. They also serve as sinks for carbon dioxide and decrease rainwater runoff.[16]

Conservation of nature makes sense, whether viewed from an ecocentric perspective in terms of the value of nature for its own sake or from an anthropocentric perspective in terms of the goods and services like clean air and water that it provides for people. In a densely populated area such as Hong Kong, natural areas also serve as a vital 'green lung.'[17] As Swart, van der Windt and Keulartz note, "The starting point of nature conservation is that nature is valuable and worthy of protection, preservation, restoration and even development."[18]

The value of nature in the Hong Kong context was recognised in the 1993 White Paper, "Pollution in Hong Kong; A Time to Act," in which the "moral obligation to preserve natural habitats for scientific study and for the benefits of future generations" was noted.[19]

Biodiversity conservation is a fundamental principle of sustainable ecological management and serves to enhance the richness and viability of natural ecosystems.[20] Conservation and restoration strategies are needed to prevent further depletion of habitat areas in Hong Kong and, if successful, may even help to increase local biodiversity. Hong Kong once had and could again have a much

[14] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[15] The Tai Po Kau example demonstrates what can be achieved through ecological restoration of a severely deforested landscape. Tai Po Kau is now home to butterfly species such as *Neope muirheadii* and bird species such as the Grey-throated minivet (*Pericrocotus solaris*) and the Chestnut Bulbul (*Hemixos castanonotus*) that were previously extinct in Hong Kong. Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History," *Asian Journal of Environmental Management*, Vol 4 No 2, Nov 1996.
[16] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries," *Nature and Environment*, No 135, Council of Europe Publishing, 2003.
[17] As evidenced by the extensive use of Country Parks by the general population during the SARS outbreak in 2003.
[18] Swart, J.A.A., van der Windt, H.J. and J. Keulartz, J., "Valuation of Nature in Conservation and Restoration," *Restoration Ecology*, Vol 9 No 2, pp230-238.
[19] 1989 White Paper on "Pollution in Hong Kong: A Time to Act," published in 1993.
[20] The Convention on Biological Diversity (1993) acknowledges in its preamble the value and importance of biological diversity for maintaining the life sustaining systems of the biosphere.

richer ecosystem with greater biodiversity. In addition, as it is a significant contributor to biodiversity in greater China, Hong Kong is in a position to be able to help sustain biodiversity on a much larger regional level.[21]

Restoration strategies

Restoration aims to return ecosystems to a point where they can naturally, through plant succession, develop to their climax state – in Hong Kong's case, subtropical rainforest. Restoration strategies are an important part of biodiversity preservation in cases where the ecosystem has been damaged to the point that it cannot naturally make this recovery unaided.[22]

Often a distinction is made between conservation and restoration so that these are presented as alternative options. However, in an ideal situation, restoration activities should be one component of broader sustainable land use and conservation policies. Conservation of existing habitat is the primary goal of biodiversity preservation, but given the very limited number of 'pristine' ecosystems, particularly in highly developed areas such as Hong Kong, restoration is also key.[23] As such, restoration should be regarded as a proactive conservation strategy but not as a substitute for the preservation of existing areas of conservation importance.

It should also be acknowledged that while restoration of degraded landscapes may make sense in theory, in practice it is a developing science with no guarantee of success. In the case of Hong Kong, for example, Corlett and Dudgeon comment that "the restoration and recreation of ecologically valuable habitats is one of the best hopes for the future of biodiversity in Hong Kong, but this does not mean that it should be used as an excuse to destroy existing habitats."[24]

Reference ecosystems

At present, restoration work tends to be 'backward looking'[25] in the sense that it uses past conditions as a reference for what we want to achieve in the present. This can be problematic, not least because the composition and structure of the past ecosystem is often unknown or only partially known.

Frequently, reference is made to existing nearby systems to infer the makeup, structure and function of the 'original' system and devise appropriate management techniques.[26] For example, Dinghu Shan[27] in Guangdong Province has been used as a reference in reconstructing Hong Kong's past ecosystem. Although historic conditions may be difficult to determine accurately and may not be possible to recreate, they are generally regarded as the ideal starting point for restoration design.[28]

An alternative approach is to "explicitly recognize the dynamic nature of ecosystems, and to accept that there is a range of potential short and long-term outcomes of restoration projects. This is a

[21] Kadoorie Farm and Botanic Garden, "Consensus Paper: Main Points for Hong Kong Conservation Policy based on common issues raised by green groups over last 20 years," undated.
[22] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*. www.ser.org & Tuscon: Society for Ecological Restoration International, Oct 2004.
[23] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium," *Restoration Ecology*, Vol 9 No 2, 1996, pp239-246.
[24] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[25] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[26] Yates et al, 1994, and Noss, 1996, as cited in Hobbs, R.J. and J.A. Harris, J.A., "Repairing the Earth's Ecosystems in the New Millennium."
[27] The Dinghu Shan landscape is similar to hilly areas of Hong Kong and its ecosystem includes a variety of vegetation types that are also found here. The Ding Hu Mountain Nature Reserve, which was established in 1956, covers an area of 1,200 hectares and includes some areas of relatively untouched forest.
[28] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.

future-oriented focus in which a decision is made as to the desired characteristics of the system in the future instead of what was present in the past."[29] This type of 'future-oriented' approach enables a wider variety of options in repairing degraded ecosystems. Rather than recreating a past ecosystem, an entirely new system may be introduced that is in fact better suited to current conditions, provided that it is consistent with the abiotic features of the area.

Taken in the broadest sense, the "restoration" of ecosystems encompasses a wide variety of different activities. Based on the goals of a particular policy or project, restoration work can be classified into one of three broad groupings: restoration, rehabilitation or reclamation.

Restoration

Restoration is defined by the Society for Ecological Restoration (SER) as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed….it is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability."[30] The ultimate aim of restoration projects is the creation of sustainable ecosystems.[31]

More recently, it has been proposed that the concept of ecological restoration be extended to include cultural landscapes such as farmland.[32] This is particularly relevant in areas such as Europe and China where cultural landscapes are predominant and may support high levels of biodiversity. More locally, Hong Kong's 'gei wais' are a major feature of the rich wetland ecosystem and contribute to local biodiversity.[33]

There are also different 'degrees' of restoration. Simple restoration involves "removing or modifying a specific disturbance, thereby allowing ecological processes to bring about an independent recovery." By contrast, complex restoration may involve "the deliberate reintroduction of native species that have been lost, and the elimination or control of harmful, invasive exotic species to the greatest practical extent."[34] In the local context, simple restoration measures might include a reduction in human-caused disturbances such as hill fires, while complex restoration measures might entail the reintroduction of various native flora and fauna.

Rehabilitation

Unlike restoration, which focuses on ecosystem sustainability and biodiversity, rehabilitation "is more productive or utilitarian oriented and refers to measures that make land useful again after

[29] Wheeler et al, 1995, as cited in Hobbs, R.J. and J.A. Harris, J.A., "Repairing the Earth's Ecosystems in the New Millennium."
[30] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration.*
[31] In the European context, for example, "restoration is required to ensure that environmental conditions are improved where these are sub-optimal to sustain a characteristic biodiversity and to expand the network of natural values where these have become degraded." STRA-REP (98) 6:21, p14, as quoted in Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."
[32] This reflects the observation that nearly all natural ecosystems have been culturally influenced in some way; there are few areas on Earth today that are 'pristine' in the sense of being true wilderness. It is now acknowledged that "ecological restoration may accept and even encourage new culturally appropriate and sustainable practices that take into account contemporary conditions and restraints." Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*, p2.
[33] 'Gei wais' are artificial shallow ponds created to capture shrimp and fish. A recent report by WWF Hong Kong highlights the value of these types of wetland ecosystems in protecting rare dragonfly species. Press Release: WWF survey reveals 40% of Hong Kong dragonfly species found at Mai Po (28/07/2005), www.wwf.org.hk/eng/pdf/references/pressreleases_hongkong/prhk20050728.html.
[34] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*, p1.

disturbance."[35] Like restoration, rehabilitation uses historical conditions or similar ecosystems as references. However the goals and strategies employed differ, as "rehabilitation emphasises the reparation of ecosystem processes, productivity and services, whereas the goals of restoration also include the re-establishment of the pre-existing biotic integrity in terms of species composition and community structure."[36] An example of a rehabilitation project would be afforestation to prevent erosion.

Reclamation

The objectives of reclamation are different from those of both restoration and rehabilitation. Essentially reclamation seeks "the stabilisation of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose."[37] Reclamation "results in a stable, self-sustaining ecosystem with or without some exotic species…that includes a similar but not identical structure and functioning as the original land."[38] The end goal is an area with some form of functioning ecosystem – but not necessarily that which was there originally - that is useful to society.

[35] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries. Nature and Environment," p15.
[36] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*, p12.
[37] Ibid.
[38] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."

Part 2: Current Framework for Biodiversity Protection in Hong Kong

Land preservation

The system of land preservation in Hong Kong has certain key advantages and disadvantages. Given Hong Kong's small geographic size, its land preservation system is impressive: 40% of the total land area (about 41,582 hectares (ha))[39] has some form of protected status. This includes 23 Country Parks and 15 Special Areas, 11 of which are located within Country Parks.[40] In addition, the planning process incorporates a number of zoning and land-use regulations that can be used to protect ecologically important sites that are not located within protected areas, as discussed below.

The major advantage of the current land preservation system is that it enables protection of large adjoining areas. This, in turn, enables preservation of whole ecosystems and their various processes, meaning that different elements of the food web, the water catchment and much of the biodiversity within a protected area remain intact. This is clearly of critical importance in terms of preserving biodiversity.

However, most of Hong Kong's protected areas were set aside primarily because they were too steep or inaccessible for development. Thus, a key disadvantage of the land preservation system is that the majority of protected area consists of upland habitat. Various important lowland habitats, lowland streams, wetlands and coastal areas are not given sufficient protection under the current land preservation system.[41]

Biodiversity conservation

Legal instruments relating directly to biodiversity conservation [42] include The Forests and Countryside Ordinance (1937), which prohibits the felling, cutting or burning of trees and other plants within forests and plantations on Government land.[43] One effect of this Ordinance is to give additional protection to valuable areas of countryside outside of the Country Parks system (provided these areas are on Government land) such as lowland forests and mangrove stands. However while the Ordinance gives general protection to all growing plants on Government land and special protection to some, many of the species it lists are common and more rare species are omitted altogether.[44]

Many animal species are protected under the Wild Animals Protection Ordinance (WAPO) (1976). This Ordinance provides protection for all wild bird and mammal species (except rats, mice and shrews), selected reptiles, three amphibian species, a birdwing butterfly species and common species of fish, shrimp and dragonfly. However, as with The Forests and Countryside Ordinance, many rare species are not protected, and a number of the freshwater fish species caught and sold as part of the aquarium trade are not listed in the Ordinance.[45] In addition, while the Ordinance

[39] Canadian Chamber of Commerce, Hong Kong, "Sustainable Development and The Environment in Hong Kong: Moving From A Community-Defined Framework To A World City Agenda."
[40] Country Parks are protected areas intended for a variety of uses, including nature conservation, outdoor recreation and outdoor education. By contrast, Special Areas are set aside primarily for the purpose of nature conservation. A complete listing of all Country Parks and Special Areas in Hong Kong is available at the Country and Marine Parks website at www.afcd.gov.hk/parks/parks_e.htm. Hong Kong also has four marine parks and one marine reserve.
[41] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[42] See also Appendix A.
[43] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[44] Ibid.
[45] Ibid.

protects the animals themselves from capture, it provides no protection against habitat destruction or pollution of habitats.[46]

There is some scope for protection of land under WAPO, which provides for the creation of Restricted Areas.[47] For example, this Ordinance was applied successfully in the creation of the Mai Po Nature Reserve, Yim Tso Ha Egretry and the Sham Wan Beach Restricted Area on Lamma Island. These cases suggest that the Ordinance "can be a useful tool for sites where nature conservation and recreational use are in conflict."[48]

The major drawback of the current legal framework for biodiversity protection in Hong Kong is that it is passive rather than active. With the important exception of the Marine Parks Ordinance (1995), which includes a proactive element,[49] in general the existing legislation requires the Government to do very little unless a protected site is actually under threat. This is not in line with legislation in other parts of the world, which generally requires a more proactive role by government.[50]

In 1992, China and the UK were among the 153 countries that signed the Convention on Biological Diversity (CBD).[51] The SAR Government, although not officially a contracting party, has pledged to adhere to the principles of the Convention, which "requires that a broad range of conservation-related policy goals are pursued, including identifying and monitoring biodiversity, establishing a protected area system, protecting biodiversity outside protected areas, requiring EIAs [Environmental Impact Assessments] for projects likely to damage biodiversity, rehabilitating and restoring degraded ecosystems and controlling exotic species."[52]

The Legislative Council Panel on Environmental Affairs held a meeting on 25 April 2005 to discuss the proposed legislation for implementation of the Cartegena Protocol on Biosafety, which was adopted by the CBD in 2000. Despite hopes that the implementation of the CBD in Hong Kong would lead to a more comprehensive conservation policy, the EPD and AFCD "have assessed the requirements under the Convention and concluded that no legislative amendments are required for the implementation of the Convention in Hong Kong." The SAR Government, having decided that its "Nature Conservation Policy and Measures are in line with the objectives and requirements of the Convention," is focusing purely on legislation to achieve the aims of the Protocol. The estimated date of implementation of both the CBD and the Protocol is fiscal year 2005/2006.[53]

Hong Kong is also a signatory to various other conferences and treaties on the protection of endangered species and key habitat areas.[54]

[46] An upgrade of the Ordinance to include a list of endangered species and a requirement that the welfare of these species be considered in all developments has been recommended.
[47] Members of the public are prevented from entering a designated Restricted Area for a specified period of time.
[48] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[49] This element requires the Government to restore and enhance the marine environment. Hong Kong has four marine parks and one marine reserve, representing a total area of 24.3 km^2.
[50] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[51] For more information on the Convention on Biological Diversity (CBD), see www.biodiv.org/default.shtml.
[52] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*. Article 6 of the CBD requires countries to develop or adopt plans for the conservation and sustainable use of biological diversity as part of policy making. See also Kadoorie Farm and Botanic Garden, "Consensus Paper: Main Points for Hong Kong Conservation Policy based on common issues raised by green groups over last 20 years."
[53] ETWB and AFCD, *Proposed Application of the Convention on Biological Diversity and the Cartagena Protocol on Biosafety – Consultation Paper*, HKSAR Government, Dec 2003, as quoted in Canadian Chamber of Commerce, Hong Kong, "Sustainable Development and The Environment in Hong Kong: Moving From A Community-Defined Framework To A World City Agenda."
[54] These include The Convention on Wetlands of International Importance, The Convention on International Trade in Endangered Species of Wild Fauna and Flora and The Convention on Migratory Species of Wild Animals.

Planning policy

The primary piece of legislation for planning policy in Hong Kong is the Town Planning Ordinance (1939), which outlines the land use zoning system. Four zone designations are relevant for conservation purposes:

- Sites of Special Scientific Interest (SSSI) – Areas recognised to have important conservation value. This value should be taken into account in any land use planning.
- Conservation Areas (CA) – Areas set aside with the goal of preserving certain ecological features and/or to shield SSSI.
- Green Belt (GB) – Areas of conservation value used for visual or noise screening.
- Coastal Protection Areas (CPA) - Coastline areas protected for their conservation or scenic value.

While zoning does offer some protection against development by specifying the permitted uses within an area, in many cases, zone designations serve an administrative rather than a legal purpose and thus do not provide any real legal protection (unlike Country Parks and Special Areas, which have legal status as protected areas).[55] The situation is further complicated by the fact that many lowland areas zoned for conservation purposes, including degraded areas in need of ecological restoration, are in private ownership. Moreover, there is a real need to review the land uses permitted in SSSI, CA, GB and CPA zones and to improve enforcement of existing regulations in these zones.[56] The current list of permitted uses in CA zones, for example, does not, ironically, reflect good conservation management.

The effectiveness of zoning in protecting important habitat areas is further limited by the fact that the planning system fails to incorporate an ecological assessment of sites at a sufficiently early stage in the process.[57] For example, it would be helpful to list potential CA zones in land use plans to enable planners to take these into account in project development.[58] Indeed, up until 1997, developers essentially had a carte blanche to proceed with infrastructure projects regardless of zone designation. The Environmental Impact Assessment Ordinance (EIAO) was introduced in 1997 in an attempt to provide some protection for sites of cultural and heritage value that are threatened by development. The Ordinance requires submission of an EIA to determine the likely impact on the existing landscape and ecosystem of an area before permission to begin development is granted.[59]

Although the EIAO has been useful in some cases in protecting areas with high conservation value from development, as in the case of Long Valley,[60] it does have flaws. The key limitation is that an EIA is only required for certain types of projects. An EIA is not required for small and medium-sized housing developments (defined by the Ordinance as those containing fewer than 2,000 flats) or for minor public works, even though these kinds of projects can destroy or degrade sites of high conservation value.[61] Moreover, the EIAO fails to address the cumulative effects of separate

[55] Wan, J. and A. Telesetsky, "Creating Opportunities: Saving Hong Kong's Natural Heritage," Civic Exchange, Jan 2002, available online at www.civic-exchange.org.
[56] There are numerous examples in which 'protected' zones have been degraded as a result of activities such as flytipping and infilling that are technically not permitted in these areas. The Pui O lowlands CPA on Lantau Island has been almost completely ruined through illegal flytipping.
[57] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[58] Kadoorie Farm and Botanic Garden, "Nature Outlook: Review of Conservation Policy," 17 Oct 2003.
[59] Uebergang, K. and C. Chu, "Saving Hong Kong's Cultural Heritage," Civic Exchange, May 2002, available online at www.civic-exchange.org.
[60] The KCRC wished to run its Sheung Shui to Lok Ma Chau Spur Line through Long Valley, an area of ecologically valuable wetland systems. The KCRC EIA, which largely focused on a mitigation proposal (development of 'new' wetlands as replacement for the area through which the rail line would run), was rejected by the EPD as there was insufficient evidence that the new wetlands could adequately compensate for the loss of the existing wetland areas. This rejection was upheld on appeal and the rail line has been built in an underground tunnel as a consequence.
[61] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

projects on similar habitats within the same locality and does not take into account the regional impacts of development projects in Hong Kong. Cumulative effects can lead to fragmentation of habitat, which has an adverse effect on biodiversity. This type of habitat fragmentation currently threatens a number of Hong Kong's lowland freshwater fish species.[62] In addition, there are serious problems in addressing the issues raised in a strategic environmental assessment and applying appropriate onsite mitigation measures.[63]

In general, reliance on zoning regulations for biodiversity protection is undesirable, as "zoning places a burden on property owners and is susceptible to changes in political will." Between 1994 and 2001, for example, 469 ha of CA land in Hong Kong was upzoned to a higher development zoning.[64] Zoning also depends on the availability of ecological data and does not provide for active environmental management.[65]

Management of protected areas

Preservation of adequate quality habitat is clearly a key first step in protecting Hong Kong's biodiversity. However, effective management of these protected areas is equally crucial.
It is telling that the Country Parks Ordinance (1976), the major legal instrument for managing protected areas, makes no mention of the need to manage for biodiversity or to enhance the existing landscape to increase biodiversity.

As noted above, when the Country Parks system was established in 1976, the goal was to set aside areas with low development potential for the recreational needs of the public rather than to conserve biodiversity. The system included areas that were unoccupied Crown Land at the time and for which no future use was envisaged. Many of the areas incorporated into Country Parks were water catchment areas for Hong Kong's reservoirs and thus were already protected under the Waterworks Ordinance (1938). In cases where a Country Park enclosed an existing village, park boundaries were drawn to ensure that village lands remained in the control of villagers.[66]

This model has significant drawbacks. The focus on unused and unusable land has meant that most of the land (73%) in Country Parks consists of upland.[67] Very few lowland areas in Hong Kong have been protected although these include many important habitat areas; for example 77% of Hong Kong's freshwater marshes are not in protected areas.[68] In addition, the exclusion of village areas from Country Parks has prevented protection of areas such as fung shui woods and lowland streams, which are often 'hot spots' of biodiversity.[69] It has been suggested that SSSI status be applied to these areas where relevant in order to provide immediate, short-term protection. Areas could then be upgraded to Country Park status at a later stage.

The Biodiversity Survey conducted by the University of Hong Kong in 2000 recommended that the Country Parks system be extended by approximately 6% to incorporate lowland habitats. This represents a small fraction of Hong Kong's total land area but would enable significant gains in

[62] Ibid.
[63] Kadoorie Farm and Botanic Garden, "Nature Outlook: Review of Conservation Policy."
[64] Kilburn, M, "Conservation Policy Review, Unaffordable Luxury or Our Children's Legacy."
[65] Wan, J. and A. Telesetsky, "Creating Opportunities: Saving Hong Kong's Natural Heritage."
[66] Ibid.
[67] Yip, Jackie Yin, "Conserving Biodiversity in Protected Areas: Recommendations for the Extension of Protected Areas in Hong Kong," University of Hong Kong, Department of Ecology and Biodiversity, June 2000, p5.
[68] Kilburn, M, "Conservation Policy Review, Unaffordable Luxury or Our Children's Legacy."
[69] According to the Hong Kong Herbarium, a number of plant species including the Pea-like Fruit Popowia (*Popowia pisocarpa*), Long-leaved Xylosma (*Xylosma longifolium*) and Medicinal Fat-head Tree (*Nauclea officinalis*) have only been found in fung shui woods and are not found in other forest areas of Hong Kong: "It may well be that the unique environment of fung shui woods is most suited to these species, or they are remnants of native vegetation which have been prevented from wide distribution due to isolation. Evidently, fung shui woods are unique habitats with great ecological significance." Hong Kong Herbarium website, "Plants of Fung shui woods," AFCD, www.hkherbarium.net/Herbarium/frame.html, July 2005.

biodiversity protection.[70] An earlier recommendation by the Agriculture, Fisheries and Conservation Department (AFCD) in 1997 proposed an extension of the Lantau North Country Park and the creation of two new marine parks on the Soko Islands and Southwest Lantau.

The fact that these proposals have yet to be implemented despite the important ecological benefits of doing so indicates some of the problems encountered in conservation protection in Hong Kong. The consultation process to extend Country Parks can be slow and the many stakeholders involved in the process have different views as to the value of conservation in relation to other priorities, such as economic and infrastructure development. Landowners, rural committees and fisherpeople often raise objections to the extension of protected areas.

Restoration of disturbed areas

SAR Government policy in rehabilitation of disturbed lands and restoration of the landscape has emphasized an ecological approach.[71] In areas that have been quarried, for example, there is a statutory requirement to restore the landscape.

Hill fires

If left alone, disturbed land will revert through natural succession from grassland to shrubland to forest. Often, the best policy for restoration of an area is to allow the land to recover naturally through this process. However, due to the large number of hill fires in Hong Kong, natural progression will not occur without investment in fire prevention and other land management strategies.[72]

In the dry season, hill fires are common in Hong Kong, causing widespread damage to the countryside and threatening biodiversity. It has been shown that successive hill fires have an impact on soil properties and thus the types of tree species that will grow there, thereby precluding natural succession.[73] In addition, hill fires accelerate erosion. Hill fires are widely regarded as a 'natural' phenomenon in Hong Kong because of the frequency of their occurrence. In fact virtually all fires in Hong Kong are started by people.

Tree planting

The SAR Government has dedicated significant resources to the afforestation of Hong Kong's hillsides. Afforestation efforts began under the Colonial administration in the 1870s and have continued unabated with the exception of the Japanese occupation during World War II, during which there was extensive felling of trees for fuel.[74] In addition to the importance of tree planting for

[70] Jackie Yip identified 75 sites with a total area of 42.5 km^2 that should be added to the protected area system to ensure that all species of conservation concern in Hong Kong are included. Part of this area (17.3 km^2) is already protected from development by planning mechanisms, so protection is required only for an additional 25.2 km^2. This is approximately 2% of the total land area of Hong Kong and represents an extension of the existing protected area by only 6%. Details of these sites were given to the Government in 2000. See Yip, Jackie Yin, "Conserving Biodiversity in Protected Areas: Recommendations for the Extension of Protected Areas in Hong Kong."

[71] Jim, C.Y. "Ecological and landscape Rehabilitation of a Quarry Site in Hong Kong," *Restoration Ecology*, Vol 9 No 1, March 2001.

[72] It has been noted that "dry season fire is the primary factor in inhibiting natural succession and regeneration." Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History", *Asian Journal of Environmental Management*, Vol 4 No 2, Nov 1996.

[73] Marafa, L.M. and K.C. Chau, "Effect of Hill Fire on Upland Soil in Hong Kong," *Forest Ecology and* Management, 120, 1999, pp97–104.

[74] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997," *Forest Ecology and Management*, 116, 1999, pp93-105.

natural succession, afforestation efforts also have significant uncosted benefits for the people of Hong Kong. These include watershed protection, landslip prevention and pollution absorption.[75]

However, as noted below, tree planting is expensive and the effectiveness of current afforestation schemes is unclear. Efforts are not necessarily concentrated in the most suitable areas and sometimes result in isolated plantations rather than extending existing forest cover. Ultimately, given the high cost of tree planting, "encouraging natural succession by fire prevention may often be more effective than the same amount of money spent on planting trees that may fail to survive."[76] This is especially true given that on more successful afforestation sites it is difficult to separate the results of tree planting from the effects of the long-term fire protection exercised in plantations.[77] There is also evidence that spontaneous secondary forest is more successful than afforestation efforts as shrubs may act as nurse species to enable natural succession.[78]

Native species

As the quality of a habitat affects the levels of biodiversity found in that area, the decision to use native or non-native species in tree planting efforts will affect the biodiversity of the afforested area. Native species provide food and shelter to a variety of local species whereas non-native species have not adapted to provide for the needs of native wildlife. It has been argued that the lack of food for birds and animals also means there is less chance of native forest regeneration in the long-term as there are no visiting birds to drop native seed. However, there is no concrete evidence of this.[79]

Past afforestation efforts in Hong Kong focused on preventing erosion and protecting watersheds and used both native tree species, such as Chinese Pine, and non-native species, such as acacia and eucalyptus. Multiple plantations have been established throughout Hong Kong, and approximately 5% of the forest cover today is plantation.[80] Plantations generally have lower plant diversity, a poorly developed understorey and a simpler structure than natural forests, all factors that reduce biodiversity.

In the last decade or so, the Government has made increasing use of mixed native species in its tree planting programmes. This is optimal as native species provide resources for native animal species, while mixed plantings result in a more complex forest structure than single species plantations. In addition mixed plantings protect against the devastation that can be caused by destructive alien species; in the 1980s the Pinewood Nematode destroyed most of the Chinese Red Pine (*Pinus massoniana*) plantations in Hong Kong, but luckily natural succession had already begun and native broadleaved species soon replaced the pines.[81]

There may also be lessons to be learned from the experience of other countries. The Forestry Minister for the UK announced a new forestry policy for the UK on 9 June 2005. The new policy will involve a major programme of tree felling and thinning in woodlands to remove millions of conifers and non-native species of trees over the next 20 years or so. These trees will be replaced with native species, such as oak, ash and beech, which will be allowed to naturally seed and regenerate.[82] While the UK's temperate forest systems are very different from Hong Kong's subtropical forests, it is interesting to note the introduction of a policy aimed specifically at restoration of ancient woodlands. If Hong Kong continues to use non-native species in its

[75] The watershed protection and pollution absorption services of Hong Kong's forests have been valued at a minimum of HK$940 million. See Hopkinson, L. and R. Stern, "Wild But Not Free: An Economic Evaluation of the Benefits of Nature Conservation in Hong Kong," Civic Exchange, March 2002, available online at www.civic-exchange.org.
[76] Ibid.
[77] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."
[78] Nurse species enable the growth of other species, facilitating natural succession. For example, nurse shrubs may provide cover for shade-tolerant species, prevent erosion or help fix nitrogen or other nutrients into the soil. Richard Corlett, University of Hong Kong, Personal Communication, 9 Dec 2004.
[79] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."
[80] Billy Hau, University of Hong Kong, Personal Communication, 15 Dec 2004.
[81] Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History."
[82] http://www.forestry.gov.uk/newsrele.nsf/WebPressReleases/AB250D9C968B51428025702D004D0805

reforestation efforts it may well face a large felling operation (requiring significant funds) to remove these trees at some point in the future. [83]

Native species afforestation programmes must also ensure that those species that are most suitable for a site are chosen and that the resulting forest is viable and varied. Corlett notes that "most current planting of native tree species seems to be based on the assumption that any species native to Hong Kong will grow anywhere, and that all combinations of species are equally compatible. The result is 'native plantations,' which gradually become mixed forests."[84]

An additional consideration is the source of seeds used in tree planting. Seeds should be collected from a wide variety of parent trees to ensure genetic diversity and resistance to stress, which will improve the long-term health of our forests.[85]

Current funding

As noted earlier, achieving consensus among affected stakeholders on the value of restoration and conservation initiatives remains a challenge in Hong Kong. Under these circumstances, biodiversity preservation is dependent on top-down initiatives by the relevant government departments. This in turn necessitates significant government expenditure. In Hong Kong, government departments must justify their expenses on a yearly basis. Political wrangling inevitably affects budgets, especially as these are allocated as part of a short funding cycle.[86]

The government departments that are involved in different aspects of ecological restoration such as conservation management, biodiversity protection and tree planting are the Agriculture, Fisheries and Conservation Department (AFCD), the Civil Engineering and Development Department (CEDD), the Housing Department, the Leisure and Cultural Services Department (LCSD), the Home Affairs Department, the Drainage Services Department, the Water Services Department, the Highways Department, and the Architectural Services Department.

The total AFCD annual budget for conservation-related activities in the period 2001-2003 was around HK$400 million. Dudgeon and Corlett point out that this sum must cover the management of 40% of Hong Kong's land area, amounting to about HK$100 per hectare per year if the entire amount were spent on land management. However this budget must also cover "controlling around 100 hill fires, planting a million trees, managing the Mai Po and Inner Deep Bay Ramsar site, dealing with around 150 ecological impact assessments, enforcing protected species legislation outside the protected area system and controlling the international trade in endangered species."[87] Considering the extensive responsibilities of the AFCD, its annual budget is incredibly small.

In the past few years the AFCD has planted on average about 800,000 tree seedlings per year in Country Parks. The average annual expenditure for tree planting is about $8 million,[88] which includes contract costs, direct labour costs and materials. The two main objectives of the AFCD tree planting initiatives are the control of soil erosion on barren hill slopes and rehabilitation of areas damaged by hill fires.[89] While the number of trees planted is impressive, quality planting should be the main emphasis, not quantity.

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[83] See Case Study A for a more detailed discussion of current Government policy on use of native tree species in afforestation efforts.
[84] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[85] Ibid.
[86] D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis," *Restoration Ecology*, Vol 10 No 4, Dec 2002, p703.
[87] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[88] This figure should be interpreted in the context of the significant uncosted benefits of conservation for Hong Kong. The point is not to cut budgets for conservation-related projects such as tree planting but rather to ensure that existing programmes are as effective as possible and undertaken with the goal of restoring Hong Kong's native forests and other ecosystems to a self-sustaining state.
[89] AFCD, Personal Communication, 15 June 2005.

The CEDD, which was formerly known as the Territory Development Department (TDD), carries out restoration planting of quarries, borrow areas (which provide fill for land reclamation), eroded slopes on the margins of new towns and visually degraded areas along the urban fringe. The CEDD also carries out erosion control planting at some sites after hill fires. The main goal of CEDD plantings is erosion control and visual reintegration of degraded sites. The CEDD also has responsibility for establishing species-rich native dominant forests for wildlife and is therefore involved in the control of exotic species.[90] CEDD's expenditure on greening works[91] has ranged from $235.9 million in 2004-2005 (due to large infrastructure projects such as the Penny's Bay development, Road T7 in Ma On Shan and planting for several drainage channels) to $68 million as the estimate for 2005-2006.

[90] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."

[91] The expenditure for greening is a combination of spending for the TDD and CEDD prior to 1 July 2004 when they merged and includes the cost for: site clearance and site preparation (i.e. ground modelling); provision of planters or planting pits; addition of topsoil; provision of planting materials; planting operations; establishment operations; provision of plant-related materials such as tree guards, tree grilles, grasscrete, etc.; provision of irrigation facilities; and transplanting.

Part 3: Developing a Restoration Policy

Before we begin to outline a potential restoration policy for Hong Kong, we must consider the ultimate goals and outcomes of such a policy and their value to society.

The initial questions to be addressed in developing any new policy or agenda should be "what are we trying to achieve?" and "what are our end goals or outcomes?" Coming up with answers to these questions will help us to determine whether we are attempting conservation, restoration, rehabilitation or reclamation and what the appropriate tools and strategies are in each case.

Outlined below are four different approaches to biodiversity conservation.

- **The Aesthetic Approach**
  According to the aesthetic approach, natural areas are appreciated for their inherent beauty rather than their utility. The aesthetic value of a restored ecosystem is rarely articulated in policy but arouses strong feelings in the general public because of deep-rooted cultural and historical associations to the area. On a basic level, these kinds of emotions reflect a community's historical and cultural identity. Valuation of the area is therefore based on a combination of ecology, ethics and aesthetics and incorporates both general and scientific considerations.

- **The Wilderness Approach**
  The wilderness approach involves the spatial separation of large natural areas from areas inhabited by humans, such as farmland. Valuation is based on the ability to preserve ecosystems, food webs and biological and physical processes. The underlying principle of this approach is self-regulation by nature with little or no human interference. Recreational and other human activities are permitted only on a small scale.

- **The Arcadian Approach**
  The Arcadian approach is often used in the context of semi-natural and extensively used cultural landscapes. In these situations, human involvement can be viewed as a positive influence as it may actually enhance biodiversity. This approach relies on humans as 'stewards' of nature; both natural processes and human intervention contribute to the maintenance of the ecosystem. The focus is on "improving the quality of natural (and cultural) elements in cultural landscapes and nature reserves."[92]

- **The Functional Approach**
  In the functional approach, "nature is adapted to the current utilisation of the landscape such as modern agriculture, hydro-engineering and urban functions."[93] Hence the land is used primarily to support human activities like forestry and water management. This approach is strongly anthropocentric (human-centred) as opposed to being ecocentric (environment-centred) and seeks to maintain a 'green' environment that is practical and productive for humans.

Among ecologists, the wilderness approach is the preferred model. However, in densely populated areas such as Hong Kong, biodiversity conservation may be feasible only if it coincides with other, more human-centred goals. Similarly, initiatives that rely on top-down or hierarchical implementation may be counterproductive in the long-run. The involvement of the public in creating policy and implementing projects is crucial. Restoration must be based on sound environmental knowledge but must also be economically possible and practically achievable.[94]

[92] Black, 1970, as quoted in Swart, J.A.A., van der Windt, H.J. and J. Keulartz, J., "Valuation of Nature in Conservation and Restoration."
[93] Ibid.
[94] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."

As biodiversity conservation is an ongoing, long-term commitment that affects land and resource usage, stakeholder involvement is essential. There can be no substitute for local participation in decision-making on conservation and restoration projects. Protecting biodiversity, while of definite ecological benefit, must also be seen as valuable to the general public for it to be politically acceptable.[95] The process of negotiating the best possible outcome with the funds available and taking on board the diverse views of stakeholders is of as much importance as the restoration work itself.[96] As SER points out, "Collective decisions are more likely to be honoured and implemented than those that are made unilaterally."[97]

Best practice in restoration

Restoration requires both a conceptual framework for understanding how ecosystems work and the factors involved in restoration and a practical framework for implementing specific projects.[98] Hobbs and Harris suggest that "restoration efforts need to focus first on removing the degrading factor and repairing the physical and or chemical environment" and then look at biotic manipulation.[99]

SER identifies the following elements as necessary components of effective restoration initiatives:

1. A clear rationale as to why restoration is needed;
2. An ecological description of the site designated for restoration;
3. A statement of the goals and objectives of the restoration project;
4. A designation and description of the reference;
5. An explanation of how the proposed restoration will integrate with the landscape and its flows of organisms and materials;
6. Explicit plans, schedules and budgets for site preparation, installation and post-installation activities, including a strategy for making prompt mid-course corrections;
7. Well-developed and explicitly stated performance standards with monitoring protocols by which the project can be evaluated;
8. Strategies for long-term protection and maintenance of the restored ecosystem; and
9. Where feasible, inclusion of at least one untreated control plot at the project site for purposes of comparison with the restored ecosystem.[100]

The case studies at the end of this report provide an insight into two restoration projects in Hong Kong and the lessons to be learned in each case.

What options are available?

Determining which ecological restoration options are available for a particular site depends on a variety of factors. These include the current state of the particular ecosystem, the underlying factors leading to this state and the restoration threshold of the ecosystem. Ecosystems may exist in many different states and without appropriate management will reach thresholds that prevent them from returning naturally to their original state. Restoration thresholds can exist on a variety of levels, affecting a particular locality or a wider landscape.[101]

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[95] An elaborate long term conservation policy has been drafted by the New Zealand Department of Conservation. This policy contains specific goals, objectives and targets that are implemented in part by Conservation Boards that have responsibility for different Conservation Areas. There is no reason why the SAR Government could not do something similar in cooperation with interested stakeholders such as non-governmental organisations (NGOs), civic groups and government agencies. Hong Kong still lacks a detailed conservation blueprint.

[96] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."

[97] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.

[98] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."

[99] Ibid.

[100] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*. See Appendix B for an alternative set of principles for ecological restoration.

[101] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."

The first group of thresholds are due to biotic factors. Biotic thresholds occur as landscapes become increasingly fragmented and modified and there is an accompanying loss of biotic connectivity, i.e. species populations become disconnected and the gene pool is reduced. If a biotic threshold has been crossed then restoration should be aimed at enlargement of habitat or creation of connective wildlife corridors, perhaps for a particular target species.[102]

The second group of thresholds are abiotic. Abiotic thresholds refer to broad-scale changes in physical processes such as hydrology. The primary goal of restoration in such a situation may be to restore water flows for a river or wetland system. Restoring physical systems to overcome abiotic thresholds may also have the effect of overcoming biotic thresholds; for example, restoring river flow can enhance biotic connectivity.[103]

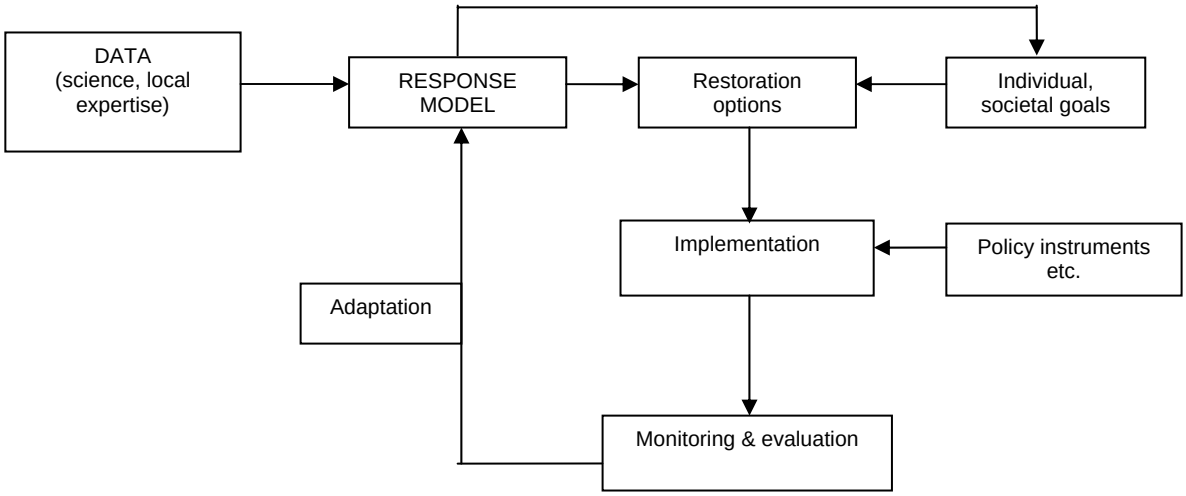

Diagram A: Ecological Response Model from Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium," *Restoration Ecology*, Vol 9 No 2, pp. 239-246.

Assessing current conservation status

Assessment of the current conservation status of potential restoration sites makes use of practical tools such as a 'baseline ecological' inventory. Such an inventory lists the key attributes of the abiotic environment and also identifies important aspects of biodiversity such as species composition and community structure.[104] The conservation assessment should also consider food-web complexity and symbiotic relationships to determine their status within the system.

Setting objectives and goals

As part of the planning process, we must determine the objectives of the project, as these will determine how restoration work proceeds. Restoration projects can be classified according to the following objectives:

1. Improvement of habitat quality
2. Enlargement of existing habitat
3. Development of missing habitats in the ecological network
4. Creation of new habitats or corridors
5. Establishment of local populations to reconstruct a former population network[105]

[102] Ibid.
[103] Ibid.
[104] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.
[105] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."

Planning for individual projects should specify the following:

1. Number of habitats or species involved
2. Number of purposes to be fulfilled
3. Scale and extent of the project
4. Systemic landscape changes induced by the project[106]

More specific, measurable goals must also be established that move the project towards success and relate directly to its broader objectives. Ecosystems are dynamic, and restoration goals therefore cannot be based on static attributes. It is necessary to set clear and achievable goals that focus not on the past but rather on the desired characteristics of the system in the future.[107]

As reference ecosystems are generally used to set the goals for a project, care should be used in selecting the reference system. SER recommends that a composite reference be assembled using multiple sites.[108] One of the difficulties in using reference sites, as mentioned earlier, is that the reference sites are generally at a different ecological stage from the restoration site. Therefore, it is necessary to interpolate the reference back to an earlier ecological stage in order to plan and evaluate the project properly. In addition, as the reference sites themselves are unlikely to be pristine wilderness, the reference should be interpreted to minimize human impacts and ensure that the restoration site will resemble its original natural state as closely as possible.[109]

Goals must be realistic; for example, the cost of different options should be taken into account. They must be specific to the type of project being undertaken and to the factors that led to the initial degradation. As Hobbs and Harris point out, "If we have goals relating to composition, structure, function and the like, what measures do we use to quantify the success or otherwise of the restoration process?" By contrast, if we work towards a concrete goal, for example, "to re-establish vegetation with a woodland structure of 20 trees per hectare, comprising local provenance native species which attain a height of at least 2 m within 5 years, and an understory of native shrubs, forbs and herbs achieving a site density of 25+/-6 species" then we can actively monitor and measure the progress of the restoration project."[110]

We also need to determine what level of structural/compositional replication we want to achieve and how fast we want systems to develop. Do we know how long this process would take without human intervention?[111]

Problems in restoration

Restoration projects are often used to justify human encroachment on areas of conservation value. Restoration is an imprecise science, still in the experimental stages, and experts have pointed out that we must be careful not to allow restoration to be used as an excuse for destruction of biodiversity or the increased fragmentation of habitats.[112] This is particularly relevant in the light of Hong Kong's new conservation policy (see Appendix C), which allows for development in areas of conservation importance provided that a portion of the area is managed for conservation.[113] This policy seems to run counter to Article 8 of the CBD which, when read in conjunction with the

[106] Ibid.
[107] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[108] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.
[109] Ibid.
[110] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[111] Ibid.
[112] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."
[113] More information on the new nature conservation policy and the pilot scheme for public-private partnership in management of conservation areas is available at www.afcd.gov.hk/news/eWhatIsNew/NewNatureConservationPolicy/eng/index.html.

preamble, requires in-situ conservation as the primary method for conservation.[114] Indeed the new conservation policy does not address the implications of applying the CBD to Hong Kong.

There is also disagreement between ecologists as to the state to which a disturbed area should be restored; for example, whether an area should be restored to pristine wilderness, what this would mean in ecological terms and whether such a restoration is even possible. In Hong Kong, for example, is the climax vegetation state (subtropical rainforest) the optimum habitat for Hong Kong's current wildlife or would creation of another habitat type in fact be more beneficial?[115]

Disagreement over the state to which an area can and should be restored is further complicated by the fact that natural environments are constantly evolving and changing. Why restore areas to the conditions existing thousands of years ago when global warming may make that landscape entirely unsuitable in a few hundred years time? Is it possible to restore the land to previous conditions given massive soil erosion and the fact that it takes centuries for soil to develop? As Swart, van der Windt and Keulartz note, ecosystems are in a state of continuous flux, so that "restoring ecosystems is like shooting at a moving target."[116]

Length of time required for restoration

Different restoration projects take different lengths of time to implement and establish. Eckhart and de Blust point out that there is a vast difference between establishing mudflats in a river and introducing woodland on former farmland. Mudflats are capable of supporting wildlife communities within two years of being established – as evident locally in the restoration of the Tung Chung Stream (see Case Study B) - whereas a forest requires decades or even centuries before 'complete' communities are established.[117]

In light of the length of time it can take for restoration work to be 'completed' it is absolutely essential that appropriate mechanisms are put in place to ensure sufficient stakeholder involvement. Otherwise restoration projects may be abandoned when political change occurs and spending priorities change. Political opportunism could be the downfall of lengthy restoration projects unless the community values the result and appropriate checks are put in place.[118]

Funding options for restoration projects

Restoration projects incur considerable costs and all start with one key issue; how is society going to pay for restoration? The SAR Government has thus far limited its options under the new conservation policy to public-private partnership agreements [119] and, possibly, conservation trusts.[120]

[114] Kadoorie Farm and Botanic Garden, "Consensus Paper: Main Points for Hong Kong Conservation Policy based on common issues raised by green groups over last 20 years."
[115] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."
[116] MacMahon, 1997, as cited in Swart, J.A.A., van der Windt, H.J. and J. Keulartz, "Valuation of Nature in Conservation and Restoration."
[117] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."
[118] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[119] Under this arrangement certain parcels of ecologically sensitive land are developed as a trade off for conservation, management and restoration of other ecologically sensitive and connected areas.
[120] The possibility of using conservation trusts is an option currently being explored by the SAR Government. Another option would be a matching funds system for ecosystem preservation and management similar to that established in the US state of Minnesota. Under this system, a critical habitat matching programme provides a pool of government and private funds to acquire wildlife management areas, restore wetlands and protect spawning sites. This option, one which was not considered in the recent review of conservation policy in Hong Kong, could provide significant funds for restoration projects. For further discussion of this programme and other options for funding conservation initiatives see Wan, J. and A. Telesetsky, "Creating Opportunities: Saving Hong Kong's Natural Heritage."

The starting point of restoration work must be to quantify ecosystems and their services to demonstrate their value.[121] A Civic Exchange report estimates that the value of Hong Kong's natural resources is equal to at least HK$1.8 billion to 6.5 billion annually.[122]

Holl and Howarth identify six approaches to allocating funding for restoration projects:

- **Replacement Cost**, an estimation of the cost to restore the ecosystem;
- **Replacement Cost Multiplier**, to allow for uncertainties within the project;
- **Valuing Ecosystem Goods and Services**, to identify whether restoration costs generate sufficient environmental services;[123]
- **Contingent Valuation,** used to "quantify all of the values people place on ecosystems, including existence values" in an effort to identify willingness to pay for restoration;
- **Travel Cost,** identification of the amount spent both getting to and travelling within protected areas gives an indication of people's willingness to pay for the restoration of recreational areas; and
- **Hedonic Price Methods** take into account the effect the restoration will have on nearby property prices in ascertaining the value of a restored area.[124]

It is also critical to identify who will bear the restoration costs. Where development work will clearly affect the ecological value of an area, as in mining or housing development, it is possible to designate financial accountability before works begin using the "polluter pays" principle.[125] Funds for restoration can be secured through environmental assurance bonds but these must be of a sufficiently high value to cover all facets of restoration.[126] Restoration Insurance can be acquired to cover any additional unforeseen costs.

However, it is often difficult to identify the party responsible for damage to ecosystems, especially where damage occurred long ago or involved invasive species. In these cases the burden of funding often falls on the taxpayer. Holl and Howarth suggest an "intergenerational environmental security tax" to ensure a certain level of environmental quality for the next generation.[127] It is important that the use of taxpayer money is clear and transparent and to that end information about funding allocation for restoration efforts by various Government departments should be readily available to the public.

On the subject of funding, it is important to note that the goal of ecological restoration is returning damaged or disturbed ecosystems to their original state – or at least to a self-sustaining state. According to SER, an ecosystem has recovered – and is restored – when it contains sufficient biotic and abiotic resources to continue development without further assistance or subsidy.

Evaluating restoration initiatives

Restoration projects must be monitored on an ongoing basis to determine the degree of success and provide data as to how restoration efforts can be improved. Project planning should create protocols for this kind of monitoring and assessment.[128] Evaluation of projects must incorporate a

[121] See Hopkinson, L. and R. Stern, "Wild But Not Free: An Economic Valuation of Benefits of Nature Conservation in Hong Kong."
[122] Ibid.
[123] New York City invested US$1-1.5 billion to restore a watershed in the Catskill Mountains in 1996, thus avoiding the need to build a water filtration plant that would have cost US$6-8 billion. Chichilnisky and Heal, 1998, as quoted in Holl, K.D. and R.B. Howarth, "Paying for Restoration," *Restoration Ecology*, Vol 8 No 3, pp260-267.
[124] Holl, K.D. and R.B. Howarth, "Paying for Restoration."
[125] Constanza and Cornwall, 1992, as cited in Holl, K.D. and R.B. Howarth, "Paying for Restoration."
[126] Holl, K.D. and R.B. Howarth, "Paying for Restoration."
[127] Ibid.
[128] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.

number of different viewpoints, including ecological, economic, historical, cultural, social, moral and aesthetic factors.[129] These varied concerns are all important to policy makers.

We can use a number of different strategies for evaluation – such as direct comparison, attribute analysis and trajectory analysis.[130] The criteria for determining the success of a project must always be related to the specific restoration goals of that project, which are in turn based on the essential attributes of the particular ecosystem.[131]

Even after an ecosystem has been 'restored,'[132] there is still a need for management to counteract invasive species, human impacts and other factors that may degrade the ecosystem. On completion of any restoration work we must be able "to guarantee the continued well-being of the restored ecosystem thereafter."[133]

Corlett notes that while "ecological restoration is difficult, expensive and rarely completely successful," it is also of vital importance.[134] As habitat types both locally and globally become increasingly degraded, restoration work will be a key aspect of maintaining biodiversity.[135]

[129] Higgs, 1997, as cited in Swart, J.A.A., van der Windt, H.J. and J. Keulartz, "Valuation of Nature in Conservation and Restoration."
[130] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.
[131] Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[132] See the Attributes of Restored Ecosystems as compiled by SER in Appendix A.
[133] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.
[134] Corlett, R., "Ecological Restoration and Habitat Creation," *Conservation Biology*, p9.
[135] See Appendix D for a list of the attributes of restored ecosystems.

Part 4: Recommendations for Hong Kong

To achieve effective biodiversity conservation in Hong Kong, we need to ensure that policies function on different geographic scales and address both macro and micro level issues. Policies to protect and restore local biodiversity must address macro level issues such as species migration, regulation and enforcement of protection measures and land use in different planning zones, in addition to more specific issues like hydrology flows, removal of woodland and the filling in of ditches.[136]

Effective policies should encompass the following five principals:

1. Maintenance of ecosystem connectivity through riparian buffers or other means, as these buffers protect the hydrological integrity of habitat systems,
2. Maintenance of landscape heterogeneity,
3. Maintenance of tree stand structural complexity,
4. Maintenance of aquatic system integrity, and
5. Adoption of a 'risk-spreading' approach whereby a range of management options is deployed to limit negative consequences if any one strategy proves to be ineffective or hostile.

Management for biodiversity

Conservation legislation should protect key habitat areas in Hong Kong on a variety of geographic levels, from individual Sites of Special Scientific Interest (SSSIs) to Country Parks to entire regions, and provide for effective management of these areas that is consistent with conservation aims. In addition, there is a need to consider land use and management in non-protected areas, as this is also important for biodiversity preservation.

Managed ecosystems are made up of three primary components:

1. Core Areas such as Country Parks where nature conservation is the primary land use.
2. Wildlife Corridors, which connect different Core Areas. These must provide connectivity on multiple geographic scales (e.g. locally, regionally and nationally) and serve the needs of multiple species.
3. Buffer Zones, which serve to protect Core Areas and Corridors from negative external impacts. Buffer Zones have multiple purposes and objectives, including nature conservation.[137]

Within Hong Kong's Core Areas, we need to ensure:

- Protection of specialised habitats, biodiversity hotspots and sensitive areas;
- Establishment of systems of retained habitat, such as wildlife corridors and riparian stream buffers; and
- Careful design, construction and maintenance of road networks to take account of conservation aims.[138]

Wildlife corridors

Wildlife corridors are intended to join ecosystems and thereby avoid the impacts of infrastructure barriers – such as the current urban barrier along the Hong Kong/Shenzhen border – to natural

[136] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."
[137] Ibid.
[138] Lindenmayer D.B. and J.F. Franklin, *Conserving Forest Biodiversity*, Island Press, 2002.

ecosystems to the greatest extent possible. Ideally there should be linkage between Hong Kong's Country Parks and older forests in China in order to facilitate the natural recolonisation of our forests by species that once existed here and to give larger species more habitat area. Currently, "natural recolonisation…is impossible for all but the most vagile species, because of the impenetrable barrier formed by urban Shenzhen and the agricultural lowlands to the north."[139]

It has been noted that there is a real risk of total terrestrial fragmentation of Hong Kong from the rest of China if the Frontier Closed Area is opened for uncontrolled development.[140] Kadoorie Farm and Botanic Garden have recommended that Lin Ma Hang/Wutong Shan area be designated as the first wildlife corridor between Hong Kong and Shenzhen.[141]

At the same time, establishing local and cross-border wildlife corridors will be fraught with difficulties. Such corridors must simultaneously sustain viable populations of multiple species and also allow the free exchange of organisms. Establishing effective corridors requires time. Moreover, migration through corridors may create new problems, such as species drain from the original habitat or loss of species diversity through interbreeding.[142] It is also important to recognise the intrinsic ecological value of the land through which corridors are placed. For example, artificially maintained grassland is an important habitat for many species of butterfly.[143] An additional problem is the potential for invasion by exotic species that are non-native to Hong Kong and may have a detrimental impact on native species, as discussed further below.

Matrix areas (including buffer zones)

Areas outside the protected system are referred to as the 'matrix.' Lindenmayer and Franklin contend that "comprehensive strategies for the conservation of forest biodiversity must include both reserves and matrix-based strategies."[144] Management of the matrix area affects population sizes and biodiversity inside protected areas, movement between protected areas and the level of buffer protection provided for protected areas. Matrices are important buffers for all protected environments, influencing water flow, nutrient cycling, seed dispersal and plant pollination within these areas. It has been recommended that buffer zones be established around Hong Kong's Country Parks and biological hotspots with limited land use in these areas.[145]

How we manage our matrix areas will affect the functioning of protected ecosystems and the levels of biodiversity within them. However, integrated management of matrix and Country Park areas will be challenging as it requires interaction among and compromise by diverse stakeholders such as landowners, politicians, scientists, conservationists and Government.

The few 'natural' areas that remain in Hong Kong are subject to ever-increasing external pressures, resulting in increased edge effects and decreasing habitat quality. Ultimately, the enlargement of habitat areas to prevent further degradation of good quality habitat is more important than the establishment of wildlife corridors.[146] This is particularly true given that ecological hotspots containing important species often occur outside of the protected area system.[147] In Hong Kong, for example, fung shui woods tend to be located outside of Country Parks and therefore have no

[139] Corlett, R.T., "Reintroduction of "Missing" Vertebrates to Hong Kong: Benefits, Problems and Prospects," *Challenges of Nature Conservation in the face of Development Pressure. Proceedings of the 2001 IUCN World Commission on Protected Areas, East Asia Conference*, AFCD, Hong Kong, pp175-180.
[140] Kadoorie Farm and Botanic Garden, "Nature Outlook: Review of Conservation Policy," 17 Oct 2003
[141] Kadoorie Farm and Botanic Garden 2004, "A Pilot Biodiversity Study of the eastern Frontier Closed Area and North East New Territories," Hong Kong, June-Dec 2003.
[142] Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries."
[143] Ibid.
[144] Lindenmayer D.B. and J.F. Franklin, *Conserving Forest Biodiversity.*
[145] Kadoorie Farm and Botanic Garden, "Nature Outlook: Review of Conservation Policy."
[146] Ibid.
[147] Lindenmayer D.B. and J.F. Franklin, *Conserving Forest Biodiversity*

protection despite the fact that these woods contain a range of native trees that are invaluable for their genetic stock and ability to provide seed for future forests.

Fire control

As noted earlier, the frequency of hill fires in Hong Kong prevents natural succession of an area and also reduces biodiversity and the potential for further restoration – for example, due to the depletion of soil. Corlett and Dudgeon note that "despite considerable efforts in public education, fire prevention and fire-fighting, fire is still a major threat to both the biodiversity and the beauty of [Hong Kong's] Country Parks." [148] Although hill fires are generally regarded as a 'natural' phenomenon in Hong Kong, virtually all hill fires are started by people.[149]

Suggestions for alleviating this problem include:

- Allocation of additional resources for construction of firebreaks, law enforcement and fire control;
- A large increase in the penalties for starting fires in the countryside, which would serve an educational function even though enforcement would be extremely difficult due to the size of protected areas and the limited staff available to patrol them;[150]
- Public education to reduce the incidence of careless fire-lighting; and
- Provision of water supplies and fire beaters at all cemeteries.[151]

As noted by Lamb and Tomlinson, fire is only likely to be solved "when local residents see it as being in their self interest to help prevent it."[152]

Tree planting

In the last ten years forest cover in Hong Kong has neither increased nor decreased.[153] If we want to move Hong Kong towards its ecologically rich, climax vegetation type, a restoration policy for Hong Kong is clearly needed.

As noted earlier, afforestation schemes require considerable resource expenditure. Therefore, tree planting efforts should be concentrated only where needed and in the most suitable sites to ensure the greatest degree of success in establishing quality forest with mixed native species. Similarly, efforts should aim to extend existing forest rather than establish isolated pockets of trees. Dudgeon and Corlett point out that "except where rapid establishment of tree cover is needed to prevent erosion in catchment areas, or to shade recreational facilities, forest *quality* should carry at least as much weight as *quantity* when planting decisions are made."[154]

In addition, given the significant advantages associated with establishing mixed native plantations, there is a need for increased coordination between Government departments to ensure that this becomes standard policy.

It is vitally important that restoration not be confused with afforestation or reforestation. Although these activities aim to increase tree cover, they often do not emphasise the ecological value of forests. As mentioned above, many afforestation efforts utilise non-native tree species and lead to

[148] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[149] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."
[150] Effective enforcement is particularly important on public holidays and grave sweeping days, when a large number of fires are lit.
[151] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[152] Lamb, D. and M. Tomlinson, "Forest Rehabilitation in the Asia-Pacific region: past lessons and present uncertainties," *Journal of Tropical Forest Science*, 7(1), 1994, pp157-170.
[153] Billy Hau, University of Hong Kong, Personal Communication, 15 Dec 2004.
[154] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

the establishment of ecologically-simplified plantations that bear little resemblance to natural forests.[155]

Control of invasive species

The growth of global transport links has enabled many species to colonise areas to which they are not native, particularly areas in close proximity to urban settlements. Man-made dispersal has facilitated this process on a scale not possible through natural dispersal alone; hence the only limit to species dispersal is the climatic range that the transplanted plant or animal species can tolerate.

Exotic, or non-indigenous, species present a dilemma in terms of ecological restoration in Hong Kong. First, how can we be sure which species are invasive and which are native when our records of past ecological conditions are limited? As Dudgeon and Corlett point out, "Many non-forest species that we and others treat as 'native' probably spread into Hong Kong only after deforestation and thus are, in the strict sense, 'alien.' Conversely, a number of forest species that have become established in Hong Kong over the last century probably occurred here in the past prior to deforestation, and thus might reasonably be considered 're-established natives.'"[156] The distinction between native and non-native is not as clear-cut as might be imagined.

Second, are invasive species really detrimental or do they in fact fill a vital 'ecological niche' that has been vacated due to the local extinction of another species? Are they providing a critical service or role that was formerly played by a now-absent native species? In other words are they neutral, beneficial or detrimental to native species?

Dudgeon and Corlett suggest that alien species should be viewed as a "symptom, rather than a cause, of environmental degradation."[157] Hobbs and Humphries go a step further and argue that "projects that aim at system restoration through the removal or control of invasive weed species frequently miss the point that the weed invasion is merely a symptom of more fundamental system change."[158]

Benefits of exotic species

Exotic species may have important ecological benefits that should be considered as part of any efforts to control or eradicate non-native species. In Hong Kong, the grazing activities of feral cattle[159] serve to 'prune' grasslands and this may reduce fuel loads and thus hill fires, ultimately facilitating natural succession. In addition, feral cattle trample though areas of shrubland and the forest understorey, maintaining forest openings and possibly playing a role similar to that played in the past by native herbivores such as the Javan Rhinoceros (*Rhinoceros sondaicus*) and the Sambar Deer (*Cervus unicolor*), both now locally extinct.[160]

Another example of an alien invasive species that has ecological benefit is the water hyacinth, whose trailing roots enhance the aquatic habitat and may increase aquatic biodiversity. Even *Mikania micratha* ('mile-a-minute vine'), which smothers everything in its path, and lantana, which instantly colonises open areas, have beneficial elements – both are good sources of nectar for butterflies and lantana berries are a good food source for native birds. Moreover, both species tend to dominate disturbed areas rather than untouched forest.[161]

[155] Featherstone, A.W., as cited on www.treesforlife.org.
[156] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[157] Ibid.
[158] Hobbs and Humphries, 1995, as cited in Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium."
[159] Domestic stock that has been abandoned and is now wild.
[160] However, this activity may also contribute to the dispersal of non-native species into new areas. Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[161] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

It has also been noted that since alien species have in some cases replaced functions formerly carried out by native species, control or eradication of the alien species could be detrimental to other species that now rely on the alien species for habitat or food. [162]

Negative impacts

The benefits provided by alien species must be weighed against their negative impacts, however. In Hong Kong, there is some evidence that feral dogs hunt native species such as barking deer, porcupines and civets. There is also circumstantial evidence that the presence of alien species in human-modified habitats causes a decline in native species through competition or predation. In some cases, as with the Pinewood Nematode, which devastated the native pine tree population in Hong Kong, the devastation caused by alien invaders is all too evident.[163]

It has been suggested that restoration work should begin with an assessment of the potential positive and negative impacts of invaders and then consider the potential for control in order to ascertain whether it is a problem worth tackling and if it is one that is even feasible to control.[164] SER advises that it is "essential for a policy to be developed for each exotic species present, based upon biological, economic and logistical realities."[165]

Use of exotic species in restoration work

In some situations, exotic species are used to restore particular functions within an ecosystem when natives cannot be used to fill this role. For example, in reclamation projects where the area is badly degraded, exotic species may be used if native species are not available, would not survive or cannot deliver the desired function. This may include the use of exotic species as nurse crops (particularly for shade-tolerant species that cannot be established in the open), to prevent erosion or to fix nitrogen or other nutrients into the soil.[166] It is important to ensure that these species are either short-lived or are species that will be replaced naturally in the course of succession. If not, then plans for removal of these species should be included in the restoration plans.[167]

Reforestation of disturbed areas in Hong Kong frequently uses non-native *Acacia confusa* or *Leucaena leucocephala*, as these pioneer species perform well with fast growth rates and high tolerance of hostile conditions.[168] There is evidence that the harsh environmental conditions on barren sites can be ameliorated by the planting of non-indigenous trees and that this will eventually facilitate the establishment of native tree species.[169] Indeed, extensive trials have shown that natives only do well in less degraded areas. Out of a large number of native species tested for use as pioneer species in Hong Kong, only a small number were successful. The trials, many of which took place some time ago, are poorly documented but were performed under realistic conditions so the results are likely to be reliable.[170]

Corlett argues that the results of these trials suggest that "current optimism about our ability to restore species-rich native forests to degraded tropical and subtropical hillsides by direct planting

[162] Chen, 2001, as cited in D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis."
[163] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[164] D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis."
[165] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration.*
[166] D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis."
[167] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.
[168] Jim, C.Y. "Ecological and landscape Rehabilitation of a Quarry Site in Hong Kong," 1990.
[169] D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis."
[170] Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997."

may be misplaced, at least in Hong Kong,"[171] although this does not preclude indirect planting (colonisation in tandem with nurse crop species). However, other local experts feel that the growth potential of native species has not been fully explored or researched and contend that there are native species that would be effective as pioneer species.[172] In fact, the AFCD, Kadoorie Farm and Botanic Gardens (KFBG) and the University of Hong Kong are currently conducting afforestation trials at Middle Gap Road utilising native tree species.[173]

Continued control of alien species

While efforts to control exotic species generally focus on the eradication of existing alien species, we must also remain vigilant regarding the potential for future invasions that could harm biodiversity. A single species could change our countryside forever, as in the case of the Pinewood Nematode. Hong Kong has a unique level of biodiversity that is worth preserving and protecting from dilution.

This is an additional issue to bear in mind with regard to establishing regional wildlife corridors. Linking protected areas in Hong Kong to areas on the mainland raises the possibility of exotic species migration along these corridors, which could create significant problems. In particular, we need to guard against invasive plant species that are especially mobile and invasive animal species that displace or consume native species.[174]

Reintroduction of species

At present, Hong Kong's natural areas are predominantly occupied by habitat generalists[175] along with some species that have established themselves as a result of accidental or deliberate release.[176] Historically, Hong Kong had a tropical rainforest system and local biodiversity would have included a much wider range of species than exists today. By the nineteenth century, a number of native species including monkeys, gibbons, elephants, rhinoceroses, squirrels, flying squirrels, bamboo rats, pheasants and woodpeckers had already become locally extinct.[177] However, some animals such as tigers only became extinct in the twentieth century. Two key questions for any restoration policy are whether to introduce species that formed part of our original flora and fauna and if so, which species to reintroduce.

Increased local biodiversity is one reason for species reintroduction, but an additional argument is the interconnectedness of the various species in an ecosystem. Many of our native plants, for example, depend on the seed-dispersal services of certain native animal species. Where these seed-dispersing species have become locally extinct, the ability of trees and plants to reproduce is compromised and their long-term survival is threatened. Reintroductions can be beneficial in this sense. The example of the fagaceae species that is believed to have formed part of Hong Kong's original forest cover illustrates the importance of native fauna for seed dispersal. It is likely that the original seed dispersal agent for this tree species is extinct. Without the reintroduction of wildlife to disperse its seeds, the fagaceae species is unlikely to recolonise Hong Kong's forests.

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[171] Ibid.

[172] Paul Melsom, Personal Communication. From a Hong Kong perspective, the use of certain native broadleaved species such as ivy and tallow trees that play a pioneer role in local communities should be further investigated. Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History." See also Ewel et al., 1999, as cited in D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis."

[173] The native tree nursery at KFBG has a turnover of around 30,000 trees and a maximum capacity of 100,000 trees, and is a good source of stock for native reforestation efforts. Lawrence Chau, Kadoorie Farm and Botanic Garden, Personal Communication, 14 Dec 2004.

[174] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.

[175] Habitat generalists are adaptable species that can survive in a variety of habitats.

[176] Corlett, R.T., "Reintroduction of "Missing" Vertebrates to Hong Kong: Benefits, Problems and Prospects."

[177] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

Several species of bird have been re-established in Hong Kong since 1945 without evidence of adverse impacts. One species in particular, the Greater Necklaced Laughingthrush, is now in many places the largest-gaped avian frugivore and provides essential seed dispersal services for several large-fruited plants that rely on birds with a wide gape.[178]

There is also the opportunity to enhance regional biodiversity for endangered species by reintroducing them to Hong Kong. In this way we can ensure greater genetic diversity and maintain a larger population, both of which will help ensure long-term species survival.[179]

Another reason for the planned reintroduction of native species is to inhibit the colonisation of vacant biological niches by animals that may or may not be native to Hong Kong. These species may be introduced inadvertently by man through uncontrolled releases; for example, pet owners setting unwanted pets free, as in the case of the Yuen Long crocodile.[180]

A small number of animals manage to cross the urban area of Shenzhen to recolonise parts of Hong Kong's countryside. Cross-border animal migration should be monitored to prevent alien invasion, as noted above, but even in the case of species that are native to Hong Kong, these animals are unlikely to migrate or reproduce in sufficient numbers to maintain genetic diversity and establish a local population. This type of "reintroduction by lottery" is unlikely to be of long-term benefit and may in fact create new problems in the form of alien species.[181]
Planned reintroductions, on the other hand, offer the best chance of successful re-establishment of native species.

Reintroductions can also be used to boost existing numbers of a rare species to increase its range within Hong Kong, as has been done successfully in the case of Romer's tree frog. Alternately, reintroduction of an existing species may use animals or plants from outside Hong Kong in order to improve the genetic stock of a rare or threatened species.

Problems of reintroduction

If we reintroduce species into an environment, what level of care and monitoring is appropriate?[182]
One only has to look at the problems created by the expanding macaque population in the Kowloon Hills to appreciate the complexities associated with species reintroduction. Feeding by ill-informed members of the public has led to aggressive and threatening behaviour by these animals, not to mention the odd police chase of stowaway monkeys on cross-harbour ferries!

Reintroduced species may compete directly with existing native species (or, in some cases, human populations) for food and space, resulting in complex ecological management issues.
Certainly a basic level of research is required for successful species reintroduction. The following list outlines a number of key issues that must be addressed in any reintroduction programme:

1. Background research on historical-ecological conditions in Hong Kong to ensure that Hong Kong is in fact within the natural range of the species and whether it is likely to have existed here in the past. While this may not be possible to determine for certain, "data from modern and historical distributions is an adequate substitute."[183]

[178] Ibid.
[179] Corlett, R.T., "Reintroduction of "Missing" Vertebrates to Hong Kong: Benefits, Problems and Prospects."
[180] In general, it is advisable to "ban the release of captive animals whatever their origin, except after rigorous studies of their ecological and biogeographical appropriateness and their likely impact on other species." Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[181] Ibid.
[182] Callicott, 1989, 1997; Oksanen, 1997; and O'Neil, 1997, as cited in Swart, J.A.A., van der Windt, H.J. and J. Keulartz, "Valuation of Nature in Conservation and Restoration."
[183] There is some confusion as to the areas of Hong Kong where specific native species existed in the past, as afforestation efforts over the last century have altered the landscape, but there is a reasonable amount of data that can be used to determine whether or not a species was present. Corlett, R.T., "Reintroduction of "Missing" Vertebrates to Hong Kong: Benefits, Problems and Prospects."

2. We need to carry out research on the target species for reintroduction, looking in particular at whether the species can survive and breed in Hong Kong. Are the climate and conditions right? In addition we need to consider the likely consequences of its reintroduction. Will there be a harmful impact on other native species through predation, competition or disease? What are the potential benefits, such as re-establishment of formerly native species in their ecological niches, restoration of biological processes or increased public interest and support for conservation?[184] Where it is difficult to reintroduce a particular species, it may be possible to substitute its ecological role through careful human intervention.

3. A thorough field investigation should be carried out. Food sources and nesting spaces for the species need to be identified. Clearly larger animals such as rhinoceroses and tigers cannot be reintroduced to Hong Kong as there is insufficient habitat left for them to thrive and there would be constant competition with human populations for habitat space.

4. The source of the animals or plants needs to be ascertained and should be appropriate. Are the species of suitable genetic stock? Do they come from an area in reasonably close proximity to Hong Kong?

5. Other non-scientific issues also need to be thought through. For example, what is the public perception of the species? Does it enhance the value of conservation in their eyes? Does the reintroduction provide an educational benefit?

6. After reintroduction, permanent monitoring and follow-up is required. We need to ascertain the effects of the reintroduction on the target species and the ecosystem as a whole.

Ecological restoration in China

According to the *Main Conclusions and Policy Recommendations* from the 2004 International Workshop on Financing and Investment in China's Forestry Sector, China now leads the world in public investment in ecological restoration.[185] Most of China's current restoration programmes are relatively new initiatives operating on a short-term basis and the report recommends a move to make such programmes long-term. It also recommends the implementation of legal mechanisms to support such programmes and improvements in the effectiveness and efficiency of implementation.

The report identifies investment in forests as the best way to maintain and preserve these areas. It concludes that "the government can do much more by establishing the legal and regulatory framework for private actors to invest and trade in ecosystem services – as is happening in many other parts of the world. New private markets for carbon sequestration, watershed protection and biodiversity conservation are providing new, private investment into forestry – compensating natural forest owners for the many public benefits of their private forests."[186]

While Hong Kong does not have forests or land areas comparable to those in mainland China, its forested areas do contribute significantly to watershed protection and, if planted with native species, biodiversity conservation. The value of these areas should be recognised by the SAR Government

[184] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

[185] The workshop report defines the term 'ecological restoration' broadly to include the planting of shelterbelts, trees and grass on sloping lands and anti-desertification campaigns. *Main Conclusions and Policy Recommendations from the 2004 International Workshop on Financing and Investment in China's Forestry Sector, September 22-23, 2004*, Coorganized by the Forest Economics and Development Research Center (FEDRC), Forest Trends, and the Center for International Forestry Research (CIFOR), Co-sponsored by the UK Department for International Development, the World Bank and the International Tropical Timber Organization, Summarized and delivered by Ms. Zhang Lei, Director General Forest Economics and Development Research Center State Forest Administration (English Translation of Chinese Original).

[186] *Main Conclusions and Policy Recommendations from the 2004 International Workshop on Financing and Investment in China's Forestry Sector.*

and incentives for investing in resource protection established. A number of the recommendations made in the 2004 report are applicable to Hong Kong, including:

- The need for experiments and pilot projects in ecosystem services and more active involvement by the Government, community and the private sector in such experiments;
- More research on the effectiveness of existing restoration projects; and
- The establishment of methods of direct compensation for the social ecological benefits provided by such areas. Various sectors and agencies benefit from ecological restoration; for example, water authorities in terms of a cleaner water catchment and the leisure and tourism industry in terms of increased opportunities for recreation and ecotourism. Charges could be applied to these sectors to fund management of restored areas.

Article 11 of the Convention on Biodiversity (CBD) provides for the adoption of these types of incentives to promote biodiversity preservation. It has been recommended that the SAR Government "adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of the components of biological diversity."[187]

Establishment of a conservation trust for Hong Kong and a national nature reserve affiliated with the Chinese protected area system is required for long-term planning and sustainable community financing to supplement funding from Government. This would provide a vision for the future in which all can share.[188]

[187] Kadoorie Farm and Botanic Garden, "Consensus Paper: Main Points for Hong Kong Conservation Policy based on common issues raised by green groups over last 20 years."
[188] Ibid.

Part 5: Case Studies

Case Study A: Hong Kong Forests

Introduction

Before the arrival of humans, Hong Kong's forest cover was subtropical rainforest, rich in plant life and supporting a wide range of animal species. The forest cover today is secondary forest, an impoverished version of original conditions. The fact that many of our seedlings and saplings cannot tolerate shade is indicative of the fact that they are pioneer species adapted to colonising open spaces rather than indigenous species.[189] The last remaining remnants of Hong Kong's primary forest may exist in steep ravines on Hong Kong's highest peaks, such as Tai Mo Shan and Lantau Peak. Corlett and Dudgeon suggest that the restoration of forest cover should be the first step in restoring Hong Kong's upland landscape.[190]

Reasons for restoration of our forests

Until recently, most afforestation work in Hong Kong was undertaken to protect water catchments, prevent erosion and for aesthetic reasons. As more and more of our natural areas are lost to development, there is an increasing need to ensure that those areas that still remain support the greatest possible levels of native flora and fauna. Restoration is needed to enable maximum preservation of our biodiversity. Forests stabilise slopes, prevent erosion, absorb carbon dioxide and pollution, reduce flash floods and provide habitat for many of Hong Kong's native species.

Hong Kong will soon have an additional legal commitment to preserving local biodiversity under the terms of the Convention on Biodiversity (CBD), to which China is already a signatory.[191] On implementation of the CBD, the SAR Government will be required to implement more comprehensive measures to protect Hong Kong's biodiversity.[192] This is particularly important as Hong Kong's unique zoographical position means that it is home to a high proportion of China's biodiversity relative to its small geographic size.

Hong Kong does have areas of forest that have been successfully restored from a state of complete degradation to a reasonably high level of biodiversity such as Tai Po Kau.[193] However, this case study focuses on a more recent example that illustrates the need for a specific government policy and action plan for forest restoration.

Slope reforestation work on Northeast Lantau

On 24 November 2004 a large hill fire devastated an area of shrubland and small patches of forest on Northeast Lantau Island. Subsequent to this fire, in late 2004 the CEDD, which "has an ongoing slope afforestation programme to prevent soil erosion, mitigate the visual impact and re-establish sustainable woodland on unleased land," identified the area affected by the hill fire as an area susceptible to erosion and therefore requiring tree planting work. The area concerned is an area of about 190 ha located east of Lai Pik Shan, near Penny's Bay and the new Disneyland theme park .

In January 2005 a public notice of the CEDD plan to plant 2 million trees from non-native species on this site between March and September was posted. On 26 February 2005 a meeting was held between professionals from the CEDD, tree experts and conservation groups at the request of The Honourable Albert Chan Wai-Yip to discuss the exclusive use of non-native species in this

[189] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.
[190] Ibid.
[191] The Convention on Biological Diversity was set up as an international framework for biodiversity preservation at the Earth Summit in Rio in 1992. China became a signatory to the framework document in June 1992.
[192] Dr. Alan Leung, Senior Conservation Officer, WWF Hong Kong, Personal Communication, 19 May 2005.
[193] Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History."

afforestation exercise. As a result of the meeting, the CEDD revised the planting proposal to include approximately 238,400 trees from native species (around 11% of the total number of trees to be planted).

Photo A.1: Part of the area between Penny's Bay and Discovery Bay that was burnt in the 24 November 2004 fire. 2 million trees that are predominantly non-native were scheduled to be planted plantation style in an area of 190 ha by the CEDD on this site during the 2005 season. © Paul Melsom

Key issues

Hill fires

The destructive impact of hill fires in Hong Kong is discussed in the context of this report. Simply put, hill fires prevent plant succession. They artificially maintain areas that would otherwise revert to forest as grassland or shrubland. The effect of fire on many of our hillsides is evident: grassland on recently burnt slopes, shrubland in areas that have been fire-free for about a decade and forest in areas that have not been burnt for over 20 years.[194]

As most hill fires in Hong Kong are started by people, investment in fire prevention measures is a critical first step in restoring our woodland. Some of the recommendations for reducing the incidence of hill fires also mentioned in this report include:

- Increasing funding for fire prevention.
- Creating firebreaks with the use of fire-resistant trees and clear cut areas.
- An increase in fire-monitoring patrols, possibly with volunteers, particularly on days which traditionally see large numbers of fires, such as Ching Ming and Cheung Yeung.
- Thorough follow-up investigations of fires.
- Increasing penalties for starting hill fires.
- Effective public education to decrease tolerance for hill fires.

[194] Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*.

Tree planting

It has been noted that the best policy for restoration of disturbed areas is to allow the site to regenerate naturally. Where tree planting is necessary, there are benefits to using native tree species. It has been common practice in Hong Kong to use exotic pioneer species in tree planting schemes, particularly in barren sites, although there are native pioneer species in Hong Kong that could be put to the same use.

While the use of non-native pioneer species has been past Government policy, in recent years more and more native species have been used in afforestation efforts. Indeed the AFCD annual report for 2002-2003 notes the use of 69% native trees in its tree planting efforts.

Photo A.2: A plantation of non-native Brisbane box (*Tristania conferta*) estimated age 15-20 years near Nam Shan, Lantau Island, that shows a monoculture of trees with very little undergrowth of native species of plants. © Paul Melsom

Government guidance notes on the subject appear to support the use of native species. GEO Technical Guidance Note No 20 (TGN20) states that "although these exotic species are generally more effective than the native species in providing an initial vegetation cover, their ecological value and sustainability are of great concern because they cannot reproduce naturally and their dense canopies inhibit the growth of native species and hence natural succession of the slope vegetation covers….the extensive use of these exotic species should be adopted with care." In addition the Note acknowledges that "for ecological enhancement, more self-regulating species, in particular the native species of strong pioneer character, should be introduced into the vegetation mixes."[195] Given these recommendations, it is interesting that the afforestation plans for northeast Lantau initially contained no native species until the CEDD was encouraged by members of the public to

[195] GEO Technical Guidance Note No 20 (TGN20) Updating of GEO Publication No.1/2000 – Technical Guidance on Landscape Treatment and Bio-engineering for Man-made Slopes and Retaining Walls. 5.4 Suitable vegetation for use on slopes: www.cedd.gov.hk/eng/publications/guidance_notes/doc/tgn20.pdf.

reconsider its plans. Compare this with government practise in other countries that are now emphasising the use of native species alone for tree planting efforts.[196] A planting mix with only 11% natives is still clearly far from ideal according to the department's own guidelines.

In contrast to TGN 20, a paper prepared for the TDD (now the CEDD) identifies the best option for establishing diverse forests as the "planting of mixed pioneers with or without the inclusion of native species in the planting mix provided that proper woodland management techniques were to be applied to encourage the natural regeneration of vegetation on site."[197] An information note issued in May 2002 on Ecological Enhancement in Slope Works also comments that where exotic pioneers are used there is a need for long-term maintenance in order to facilitate succession of native species. Indeed it recommends that "the fast-growing exotic, pioneer tree species in woodland areas are removed entirely as a one-off operation after some five to eight years in order to avoid them becoming dominant. This will promote the subsequent establishment of native plants."[198] Ongoing pruning of non-natives and eventual felling all add to the cost of reforesting the area and may not be the most cost effective way to achieve restoration.

Setting specific restoration goals for reforestation projects

The afforestation work in Northeast Lantau proceeded on a very short timescale. The months between the fire and the reforestation efforts did not even allow existing vegetation to recover from the fire sufficiently to enable an inventory of surviving species.[199] In addition there is no evidence of an ongoing management and evaluation programme for the site. This is needed both for research work and to permit an evaluation of the expense incurred in reforestation. It is understood that responsibility for the site will pass to a different Government department two to three years after the planting efforts so continuity in management may be affected.[200]

Photo A.3: The regeneration of native vegetation in March 2005 on the planting site. This is long before the start of the wet season and much of the burnt area would be well covered with native plants by the end of the season. © Paul Melsom

[196] www.forestry.gov.uk/newsrele.nsf/WebPressReleases/AB250D9C968B51428025702D004D0805.
[197] Chong S.L., "Healing the Wounds – Restoring Hong Kong's Borrow Areas – A TDD Challenge," Territory Development Department, Hong Kong.
[198] www.cedd.gov.hk/eng/publications/information_notes/info_0205.htm.
[199] Paul Melsom, Personal Communication, 31 July 2005.
[200] Ibid.

The hasty nature of afforestation projects such as that on Northeastern Lantau illustrates the need for a policy that encompasses the SER Guidelines for Restoration Projects, which are as follows:

A clear rationale as to why restoration is needed;
An ecological description of the site designated for restoration;
A statement of the goals and objectives of the restoration project;
A designation and description of the reference;
An explanation of how the proposed restoration will integrate with the landscape and its flows of organisms and materials;
Explicit plans, schedules and budgets for site preparation, installation and post-installation activities, including a strategy for making prompt mid-course corrections;
Well-developed and explicitly stated performance standards with monitoring protocols by which the project can be evaluated;
Strategies for long-term protection and maintenance of the restored ecosystem; and
Where feasible, inclusion of at least one untreated control plot at the project site for purposes of comparison with the restored ecosystem.[201]

Photo A.4: Much more use could be made of native flowering trees like this Hong Kong Hawthorn (*Rhaphiolepis indica*), which provides beautiful flowers that are a source of nectar for butterflies and berries for birds to eat, thus regenerating the native forests. © Paul Melsom

[201] Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*.

Case Study B: Hong Kong Rivers and Streams

Hong Kong's rivers/streams are home to a wide range of organisms, including insects, crustaceans, gastropods, bivalves, amphibians, reptiles, fish and aquatic and riparian plants. As these habitats are highly integrated with the surrounding terrestrial environment, they cannot be considered in isolation from their drainage basins. Hong Kong's rivers/streams are under constant threat and pressure from terrestrial development, as pollutants can affect the chemistry and nutrient concentrations in the water as well as the geology of the river or stream bed itself.

Rivers/streams play a significant role in ensuring that our natural world exists in equilibrium. However, the World Wildlife Fund (WWF) notes that "half of the freshwater biodiversity has been destroyed worldwide in the last 30 years. Freshwater habitats are considered as the most critically threatened ecosystems." [202] Rivers/streams need to be considered in all aspects of conservation and ecological restoration as they are an integral part of a much larger ecosystem.

Threats to rivers/streams can occur in a number of ways; either through the quality of the water or due to changes in the geology of the river/stream itself or the river or stream basin. In Hong Kong, the Drainage Services Department has incorporated concrete channelisation of lowland streams as part of its flood prevention measures with devastating consequences to stream biodiversity.[203] However, recently there has been a focus on ecologically friendly stream design and various environmental NGOs are participating in development of these designs.[204]

Although Hong Kong has many river/stream habitats that have been threatened by various disturbances, this case study focuses on the example of the Tung Chung Stream. This is a very recent example of how development can result in the critical deterioration of a freshwater habitat. However, the Tung Chung Stream is also a positive example of how a habitat can be returned to its original state with the involvement of a number of concerned parties as part of a successful ecological restoration project.

Current framework for protecting rivers/streams

Under the current framework, the following government bureaux and departments are responsible for rivers/streams in Hong Kong:

Environment, Transport and Works Bureau (ETWB)
Drainage Services Department (DSD)
Water Supplies Department (WSD)
Lands Department (LD)
Environmental Protection Department (EPD)
Housing, Planning and Land Bureau (HPLB)

At present, Hong Kong does not have an ordinance specifically designed for the protection of natural rivers. However, most rivers/streams in Hong Kong are on Government land and are subject to the Control of the Land (Miscellaneous Provisions) Ordinance (Cap. 28), the Public Cleansing and Prevention of Nuisances Regulation (Cap. 132), Fisheries Protection Ordinance (Cap. 171) and Waste Disposal Ordinance (Cap. 354).

According to this legislation, anyone who carries out excavation work without a valid excavation permit; extracts or removes earth, turf or stone from the land without a valid removal permit; or erects a structure on the land without authorisation commits an offence.

[202] www.wwf.org.
[203] News Archive, www.wwf.org.hk/eng/conservatoin/intro/old_tungchungriver_230204.html
[204] Dr. Alan Lau, Senior Conservation Officer, WWF Hong Kong, Personal Comment, 19 May 2005.

In addition, some natural rivers (on both Government and private land) fall within protected areas such as Country Parks, Conservation Areas and Sites of Special Scientific Interest (SSSI). Under these circumstances, the river is protected by the Country Parks Ordinance (Cap. 208), the Town Planning Ordinance (Cap. 131) and the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499).

The most recent technical circular issued by the SAR Government with regards to rivers/streams in HK is entitled "Protection of natural streams/rivers from adverse impacts arising from construction works." The circular was produced in March 2005 in response to the Tung Chung scenario. It provides a more comprehensive administrative framework for protecting natural rivers/streams from the impacts of development projects initiated by the Government and by private developers. The circular formalises existing measures for the protection of natural rivers/streams, and provides guidance to the relevant departments to minimise and, if possible, avoid any impacts to natural rivers/streams during the planning, design and construction stages for a given works project. Monitoring is now required throughout the construction process, as is the implementation of any necessary mitigation measures.

The Tung Chung Stream

This case study is a classic example of how development severely affected one of Hong Kong's most unspoiled streams. In 1994, the Tung Chung Stream on North Lantau was described by David Dudgeon and Richard Corlett as being "important as a habitat for rare fishes…one of the few relatively large streams in the Territory to have escaped the worst effects of pollution."

In other words, at the time of writing, the stream was essentially undisturbed and home to a rich and healthy bio-diverse ecosystem. Perhaps the best indicator of this fact was the presence of 20 species of freshwater fish, seven of which were native to Hong Kong. These native species included *Acrossocheilus wenchowenensis* and *Oryzias curvinotus*, both of which are considered to be of very high conservation value on both a local and an international level.

What went wrong?

In June 2003, a report was made to the Civil Engineering Department (CED) that the Rural Committee of Tung Chung had employed a contractor ('Contractor 1') to carry out "flood protection" works for the stream. Approval for carrying out these works had not been sought from the Government. Contractor 1 removed pebbles and boulders and was found to be stockpiling these on a nearby plot of land.

The work caused significant damage to the lower part of the stream between Shek Lau Po and Shek Mun Kap. As part of the project, an access road 5-15 metres wide and 330 metres long had been built alongside the stream, resulting in serious damage to the stream bank. Rocks and boulders from the streambed had been removed. In addition, several temporary dams had been built along the stream. These activities significantly damaged the stream bed and severely impacted the water quality. It was later discovered that all the materials from the streambed were in fact being used as construction material for the artificial lake at Penny's Bay, the site of the Hong Kong Disneyland development.

Upon further investigation it was found that a contractor employed by the CED ('Contractor 2') had approached the first contractor in order to source suitable materials for the Penny's Bay construction. The materials were purchased from Contractor 1 by Contractor 2, and when the legality of the source was questioned, a letter from the Rural Committee of Tung Chung was produced to support the removal of the stones from the stream bed. After further investigation by the CED, it became apparent that the materials were being removed illegally from the Tung Chung Stream. All activities were stopped immediately.

In due course, the Lands Department reported Contractor 1 to the Hong Kong Police and this case became part of an investigation by the Independent Commission Against Corruption (ICAC). The Environmental Protection Department (EPD) also examined the site and reported that the activities that had taken place along the streambed were not in accordance with the EIAO.

Photo B.1: The damaged streambed. © Photogallery – news.gov.hk

Ecological restoration of the stream

An interdepartmental task force chaired by the Environment, Transport and Works Bureau (ETWB) and made up of representatives from the Agriculture, Fisheries and Conservation Department (AFCD), Drainage Services Department (DSD), Home Affairs Department, EPD and the Lands Department was set up to examine the restoration plans for the stream and oversee the subsequent implementation of the restoration work.

A Specialist Group, comprising members from the Advisory Council on the Environment and several civic or green groups including the World Wide Fund for Nature Hong Kong, Conservancy Association, Friends of the Earth, Green Power, Green Lantau Association and Kadoorie Farm and Botanic Garden, was also formed to advise the task force on how the work should be conducted from an ecological perspective.

Objectives of the restoration work

The objective of the stream restoration was to restore the natural setting of the damaged section of the stream, including the topography, substrates and riparian habitats. The restoration work, if successfully implemented, would then facilitate recovery of the aquatic communities.

The projects involved the following tasks:

- Removal of the access road,
- Reinstatement of the longitudinal and cross-sectional profiles of the stream course,
- Re-laying of boulders and pebbles on the stream course,
- Creation of meanders, riffles and pools along the stream course to provide a variety of habitats for aquatic fauna, and
- Replanting of vegetation along the stream bank to restore the riparian habitats.

Outcome

Due to the effort and assistance of a large number of different government departments, NGOs and other parties, the ecological restoration of the Tung Chung Stream has been a great success. Reportedly, within two months the stream was again teeming with wildlife. In July 2004, the Land, Transport and Works Bureau (LTWB) reported that: "So far, more than 20 different kinds of fresh water fish and macro-invertebrates have been seen in the repaired stream section. They include the rare Beijiang thick-lipped barb, predaceous barb, Chinese barb, mosquito fish, swordtail, mayflies, dragonflies, caddisflies and damselflies."

Photo B.2: The stream following restoration. © Photogallery – news.gov.hk

Recommendations

The example of the Tung Chung Stream highlights the importance of the following elements for any successful restoration project:

- A clear rationale as to why restoration is needed;
- An ecological description of the site designated for restoration;
- A statement of the goals and object of the restoration project;
- Designation and description of the references;
- An explanation of how the proposed restoration will integrate with the landscape and its flows of organisms and materials;
- Explicit plans, schedules and budgets for site preparation, installation and post-installation and post installation activities, including a strategy for making prompt mid-course corrections; and
- Well-developed and explicitly stated performance standards, with monitoring protocols by which the project can be evaluated.[205]

[205] SER International, 2004.

Conclusion

There is a clear need for a comprehensive conservation policy for Hong Kong. While the new conservation policy introduced in 2004 addresses some key conservation issues, a more comprehensive policy is needed. If Hong Kong is to fulfil its obligations under the CBD, further measures to enhance and preserve our biodiversity are required.

Ecological restoration is gaining recognition worldwide as a valid technique for the enhancement of biodiversity. While total restoration of Hong Kong's natural areas may not be compatible with the needs of its urban population, it is possible to ensure that our protected areas are restored (or perhaps rehabilitated) and managed for maximum biodiversity. Proposals for the restoration and active management of areas of conservation value in Hong Kong should be incorporated into a more comprehensive policy for Hong Kong. It is hoped that some of the ideas and recommendations outlined in this report could form a basis for such a policy.

References

Advisory Council on the Environment (ACE), *ACE Paper 37/2003 - Unauthorized works at Tung Chung Stream*, HKSAR Government, 2003.

---, *ACE Paper 37/2004 - New Nature Conservation Policy*, HKSAR Government, Nov 2004.

Agriculture, Fisheries and Conservation Department (AFCD) website, HKSAR Government, www.afcd.gov.hk/parks/parks_e.htm

Canadian Chamber of Commerce, Hong Kong, "Sustainable Development and The Environment in Hong Kong: Moving From A Community-Defined Framework To A World City Agenda," Resource Paper III: Environmental Protection in Hong Kong – Natural Habitats, 31/07/05.

Chong, S.L., "Healing the Wounds – Restoring Hong Kong's Borrow Areas – A TDD Challenge" Territory Development Department, Hong Kong.

Civic Exchange, "Response to ETWB Consultation Document: Nature Outlook. Review of Nature Conservation Policy," 17 Oct 2003.

Civil Engineering Department, Pebbles and Boulders from Tung Chung Stream
Information Leaflet, 29 April 2004.

Civil Engineering and Development Department (CEDD) website, HKSAR Government, www.cedd.gov.hk/eng/publications/information_notes/info_0205.htm

Conservancy Association, 2003, *Hong Kong, Asia's World City, and the World's Eco-City*, Response to Review of Nature Conservation Policy, Oct 2003.

Convention on Biological Diversity (CBD) website, www.biodiv.org/default.shtml.

Corlett, R.T., "Pollination in a degraded tropical landscape: a Hong Kong case study," *Journal of Tropical Ecology*, 17:1, pp155-161, 2001.

Corlett, R.T., "Reintroduction of "Missing" Vertebrates to Hong Kong: Benefits, Problems and Prospects."

Corlett, R.T, "Environmental Forestry in Hong Kong 1871–1997," *Forest Ecology and Management*, 116, 1999, pp93-105.

D'Antonio, C. and L.A. Meyerson, "Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis," *Restoration Ecology*, Vol 10 No 4, Dec 2002, p703.

Dudgeon, D. and R. Corlett, *The Ecology and Biodiversity of Hong Kong*, Friends of the Country Parks, Joint Publishing (HK) Company Ltd., Hong Kong, 2004.

Eckhart, K. and G. de Blust, "The Restoration of Sites and Ecological Corridors in the Framework of Building up the Pan-European Ecological Network with Examples of Best Practice from European Countries," *Nature and Environment*, No 135, Council of Europe Publishing.

Environment, Transportation, and Works Bureau, *Nature Conservation Policy Review - Consultation Document*, HKSAR Government, July 2003.

Environmental news website, www3.news.gov.hk/ISD/ebulletin/en/category/environment/040707/features/html/040707en04002.htm

Featherstone, A.W., as cited on www.treesforlife.org

Forestry Department website, UK Government,
http://www.forestry.gov.uk/newsrele.nsf/WebPressReleases/AB250D9C968B51428025702D004D0805

Hobbs, R.J. and J.A. Harris, "Restoration Ecology: Repairing the Earth's Ecosystems in the New Millennium," *Restoration Ecology*, Vol 9 No 2, 1996, pp239-246.

Hopkinson, L. and R. Stern, "Wild But Not Free: An Economic Valuation of the Benefits of Nature Conservation in Hong Kong," Civic Exchange, June 2002, available online at www.civic-exchange.org.

Jim, C.Y., "Ecological and Landscape Rehabilitation of a Quarry Site in Hong Kong," *Restoration Ecology*, Vol 9 No 1, March 2001.

Kadoorie Farm and Botanic Garden, "Consensus Paper: Main Points for Hong Kong Conservation Policy based on common issues raised by green groups over last 20 years," undated.

Kilburn, M, "Conservation Policy Review, Unaffordable Luxury or Our Children's Legacy," Kadoorie Farm and Botanic Garden, 9 Sep 2003.

Lamb, D. and M. Tomlinson, "Forest Rehabilitation in the Asia-Pacific region: past lessons and present uncertainties," *Journal of Tropical Forest Science*, 7(1), pp157-170, 1994.

Lands Department website, HKSAR Government,
www.info.gov.hk/landsd/legco/2004_01_14/20040114_lcq20_e.htm

Legislative Council Panel on Environmental Affairs, "Progress Report on the Restoration of the Tung Chung Stream," CB(1) 1133/04-05(05), Environment, Transport and Works Department, 24 March 2005.

Legislative Council Panel on Planning, Lands and Works and Panel on Environmental Affairs, "Impact of Construction Works on Rivers in Hong Kong," 23 March 2004,
www.epd.gov.hk/epd/english/environmentinhk/conservation/policy/files/tungchung180304.pdf

Lindenmayer, D.B. and J.F. Franklin, *Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach*, 2002.

Main Conclusions and Policy Recommendations from the 2004 International Workshop on Financing and Investment in China's Forestry Sector, September 22-23, 2004, Co-Organized by the Forest Economics and Development Research Center (FEDRC), Forest Trends, and the Center for International Forestry Research (CIFOR), Co-Sponsored by the UK Department for International Development, the World Bank and the International Tropical Timber Organization,
Summarized and Delivered by Ms. Zhang Lei Director General Forest Economics and Development Research Center State Forest Administration (English Translation of Chinese Original)

Marafa, L.M. and K.C. Chau, "Effect of Hill Fire on Upland Soil in Hong Kong," *Forest Ecology and Management*, 120, 1999, pp97–104.

Nicholson, B., "Tai Po Kau Nature Reserve, New Territories, Hong Kong: A Reafforestation History," *Asian Journal of Environmental Management*, Vol 4 No 2, Nov 1996.

Palmer, M.A., Ambrose, R.F. and N. LeRoy Poff, "Ecological Theory and Community Restoration Ecology," *Restoration Ecology*, Vol 5 No 4, Dec 1997, pp291-300.

Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*, *www.ser.org* & Tuscon: Society for Ecological Restoration International, Oct 2004.

Swart, J.A.A., van der Windt, H.J. and J. Keulartz, "Valuation of Nature in Conservation and Restoration," *Restoration Ecology*, Vol 9 No 2, pp230-238.

Uebergang, K. and C. Chu, "Saving Hong Kong's Cultural Heritage," Civic Exchange, May 2002, available online at www.civic-exchange.org.

Van Diggelen, R., Grootjans, Ab P. and J.A. Harris, "Ecological Restoration: State of the Art of State of the Science?" *Restoration Ecology*, Vol 9 No 2, June 2001, pp115-118.

World Wildlife Foundation (WWF) website, www.wwf.org

WWF Hong Kong, *Responses on Review of Nature Conservation Policy*, 17 Oct 2003, www.wwf.org.hk/eng/pdf/references/pressreleases_hongkong/prhk20050728.html

1989 White Paper on "Pollution in Hong Kong – A Time to Act," 1993.

Wan, J. and A. Telesetsky, "Creating Opportunities: Saving Hong Kong's Natural Heritage," Civic Exchange, Jan 2002, available online at www.civic-exchange.org.

Yip, Jackie Yin, "Conserving Biodiversity in Protected Areas: Recommendations for the Extension of Protected Areas in Hong Kong," University of Hong Kong, Department of Ecology and Biodiversity, June 2000.

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Appendices

Appendix A

Hong Kong Legislation with Relevance to Biodiversity

ORDINANCE	CAP	YEAR OF ENACTMENT
Forests and Countryside Ordinance	96	1937
Wild Animals Protection Ordinance	170	1976
Fisheries Protection Ordinance	171	1962
Animals and Plants (Protection of Endangered Species) Ordinance	187	1976
Plant (Importation and Pest Control) Ordinance	207	
Country Parks Ordinance	208	1976
Protected Places (Safety)Ordinance	260	
Marine Fish Culture Ordinance	353	1980
Environment and Conservation Fund Ordinance	450	1994
Marine Parks Ordinance	476	1995
Plant Varieties Protection Ordinance	490	1996
Environmental Impact Assessment Ordinance	499	1997

Appendix B

Trees for Life Principles of Ecological Restoration

1. Mimic nature wherever possible.
2. Work outwards from areas of strength, where the ecosystem is closest to its natural condition.
3. Pay particular attention to 'keystone' species.
4. Utilise pioneer species and natural succession to facilitate the restoration process.
5. Re-create ecological niches where they have been lost.
6. Re-establish ecological linkages.
7. Control and/or remove introduced species.
8. Remove or mitigate the limiting factors that prevent restoration from taking place naturally.
9. Let nature do most of the work.
10. Love has a beneficial effect on all life.

Trees for Life, www.treesforlife.org.uk/tfl.eco.html#5

Appendix C

Hong Kong's New Nature Conservation Policy

The objectives of Hong Kong's new nature conservation policy as outlined in the Policy Statement are:

"To identify and monitor the important components of biological diversity;
To identify, designate and manage a representative system of protected areas for the conservation of biological diversity;
To promote the protection of ecosystems and important habitats, and the maintenance of viable populations of species in natural surroundings;
To identify, monitor and assess activities that may have adverse impacts on biological diversity and to mitigate such impacts;
To rehabilitate degraded ecosystems and promote the recovery of threatened species where practicable;
To promote the protection and sustainable use of natural resources that are important for the conservation of biological diversity;
To provide opportunities for people to appreciate the natural environment;
To promote public awareness of nature conservation;
To collaborate with the private sector, including the business community, non-governmental organisations and academia, to promote nature conservation, and to conduct research and surveys as well as to manage ecologically important sites for such purpose; and
To cooperate with and participate in regional and international efforts in nature conservation."

More information about the new nature conservation policy is available online at www.afcd.gov.hk/news/eWhatIsNew/NewNatureConservationPolicy/index.html.

Appendix D

Attributes of Restored Ecosystems

An ecosystem has recovered – and is restored – when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy. More specifically:

1. The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
2. The restored ecosystem consists of indigenous species to the greatest practicable extent.
3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.
4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.
6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges
7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem. P3
9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions.
10. Any other goals of the project e.g. goods/services/habitat for endangered species/diverse gene pool, aesthetic amenities, social goals.

Society for Ecological Restoration International Science and Policy Working Group 2004, *The SER International Primer on Ecological Restoration*, www.ser.org & Tuscon: Society for Ecological Restoration International, Oct 2004.