

Climate Change in the UK Overseas Territories

Guidance for Biodiversity Conservation and Management
in a Changing Climate in the UK Overseas Territories

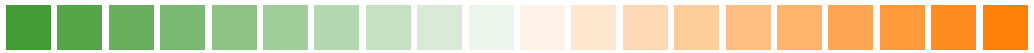


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Climate Change in the UK Overseas Territories



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Management in a Changing Climate in the
UK Overseas Territories

Leslie John Walling

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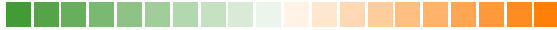
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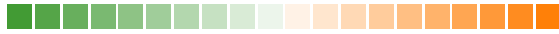
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Contents



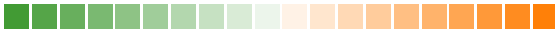
Abbreviations and Acronyms	5
Glossary	6
Introduction	8
About this guidance	8
Can one set of guiding principles fit all UKOTs?	8
Biodiversity and climate change in the UKOTs	9
The importance of adaptation in the UKOTs	14
Build on existing capacities and mechanisms for effective adaptation	15
Guiding principles	17
Guiding principles	
Principle 1: Conserve existing biodiversity	19
Principle 1a: Conserve Protected Areas and other high-quality wildlife habitats	19
Principle 1b: Conserve range and ecological variability of habitats and species	20
Principle 2: Reduce sources of harm not linked to climate	24
Principle 3: Develop ecologically resilient and varied landscapes	26
Principle 3a: Conserve and enhance local variation within sites and habitats	27
Principle 3b: Make space for the natural development of rivers and coasts	31
Principle 4: Establish ecological networks through habitat protection, restoration and creation	33
Principle 5: Make sound decisions based on analysis	34
Principle 5a: Thoroughly analyse causes of change	34
Principle 5b: Respond to changing conservation priorities	37
Principle 6: Integrate adaptation and mitigation measures into conservation management, planning and practice	45
The Way Ahead: Additional recommendations for the effective implementation of the guiding principles	51
Bibliography	55

Abbreviations and Acronyms



CBD	Caribbean Development Bank
DEFRA	Department of Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
ESI	Environmental State Indicator
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse gas
IPCC	The Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
OTEP	Overseas Territories Environmental Programme
SRI	Stress Reduction Indicator
UK	United Kingdom
UKOT	United Kingdom Overseas Territory
UKOTCF	United Kingdom Overseas Territories Conservation Forum
WG	Working Group of the Intergovernmental Panel on Climate Change

Glossary

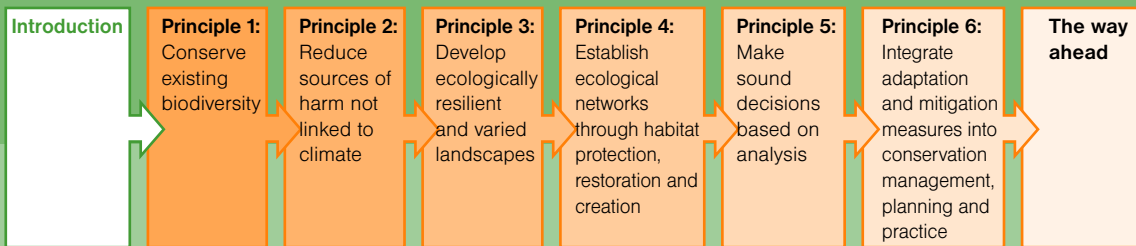


Adaptation	In the context of climate change, adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
Anthropogenic	Caused by humans or human activities; usually used in reference to environmental degradation.
Biome	A major portion of the living environment of a particular region, characterised by its distinctive vegetation and maintained largely by local climatic conditions.
Biodiversity	The variety of plant and animal life found in an ecosystem (see below) and the variation in their genetic makeup. Biodiversity is a measure of the health of an ecosystem, with healthy ecosystems having greater variety and variation in plant and animal life than unhealthy ones.
Climate	The average, or typical, weather conditions of a given area observed over a long period of time, usually 30 years or more. Climate zones are defined by parameters such as temperature, rainfall and even plant species.
Climate change	Any significant, long-term modification in the climate of a zone or region.
Critically endangered species	A plant or animal is critically endangered when it is considered to be facing an extremely high risk of extinction in the wild.
Ecosystem	Self-regulating communities of plants and animals interacting with each other and with their non-living environment.
Endangered species	A plant or animal is endangered when it is considered to be facing a very high risk of extinction in the wild
Endemic/endemism	Found only in a certain strictly limited geographical region, i.e. restricted to a specified region or locality. Can apply to a disease or to an animal or plant species.
Extinct (in the wild)	A plant or animal is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the range in which it previously occurred.
Greenhouse gases	The atmospheric gases that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. Water vapour (H ₂ O), carbon dioxide (CO ₂), nitrous oxide (N ₂ O), methane (CH ₄), and ozone (O ₃) are the primary greenhouse gases in the Earth's atmosphere.

Glossary cont'd

Habitat	A place or type of site where an organism or population naturally occurs.
Intergovernmental Panel on Climate Change	Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of information on climate change.
Invasive species	Plants and animals that are introduced to an area from another and successfully establish themselves and then overcome, otherwise intact, pre-existing native ecosystems.
Kyoto Protocol	An international agreement that is linked to the United Nations Framework Convention on Climate Change. Its major feature is that it sets binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions. These reductions amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.
Mitigation	In the context of climate change, interventions to reduce the sources or enhance the sinks of greenhouse gases.
Native species	All plants and animals that naturally occur, either presently or historically, in an ecosystem.
United Nations Framework Convention on Climate Change	The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the global challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, having been ratified by 192 countries.
Vulnerable species	A plant or animal is vulnerable when it is considered to be facing a high risk of extinction in the wild.
Weather	Short-term atmospheric conditions. Weather is measured by temperature, humidity, wind speed, atmospheric pressure, cloudiness and precipitation.

Sources: Convention on Biodiversity <http://www.cbd.int/cepa/toolkit/html/resources/FD/FDF8CE88-237B-46EE-BB5F-42304D735C23/Biodiversity%20Glossary.pdf>;
Green Facts Glossary <http://www.greenfacts.org>; IPCC Glossary of Climate change Terms <http://www.unfccc.int>; IUCN <http://www.iucn.org>; La Cité des Sciences et de l'industrie <http://www.cite-sciences.fr>.



Introduction

About this guidance

This guidance document has been developed primarily for those who plan and manage **biodiversity** in the United Kingdom Overseas Territories (UKOTs). It aims to provide a practical introduction to tools and methods for mainstreaming climate change risk reduction into conservation management planning, and by extension into the broader development processes within which conservation management takes place. It provides guiding principles for managing **ecosystem** goods and services in a changing **climate** and suggests approaches for adapting existing plans and projects. It focuses primarily on direct biodiversity management but also provides an overview of sectoral opportunities for managing ecosystem goods and services.

This guidance document is not intended to provide a comprehensive overview of global climate change and its implications for the UKOTs. These are addressed in a companion booklet *Climate Change in the UK Overseas Territories: An Overview of the Science, Policy and You* (Brown, 2008) available at <http://www.jncc.gov.uk/page-4362> or by request to Joint Nature Conservation Committee (JNCC) communications@jncc.gov.uk.

It also draws heavily on and is complemented by the Department of Environment, Food and Rural Affairs (DEFRA)

Definition *Climate is the average, or typical, weather conditions of a given area observed over a long period of time, usually 30 years or more. Climate zones are defined by parameters such as temperature, rainfall and even plant species.*

publication *Conserving biodiversity in a changing climate: guidance on building capacity to adapt* (Hopkins et al., 2007).

Can one set of guiding principles fit all UKOTs?

The UKOTs vary greatly in terms of their size, population, economic activities and Gross Domestic Product (GDP) (see Table 3). They range from the fragile, environmentally dependent subsistence economy of the Pitcairn Islands, based on fishing, horticulture, and the sale of handicrafts, to the more robust economies of Bermuda and Cayman Islands, based on tourism and off-shore financial services. Their climates range from arctic to temperate to tropical. Nevertheless, there is a logic to providing generic guidance for all UKOTs: with the exception of the British Antarctic Territories and Gibraltar, all the UKOTs are islands. And this means they share characteristics that make all small islands – whether UKOTs or not – particularly vulnerable to climate change (and other economic, social and environmental shocks) (Box 1).

Box 1. Small Island Vulnerability

Many small islands are highly vulnerable to the impacts of climate change and sea level rise. They comprise small land masses surrounded by ocean, and are frequently located in regions prone to natural disasters, often of a hydro-meteorological and/or geological nature. In tropical areas, they host relatively large populations for the area they occupy, with high growth rates and densities. Many small islands have poorly developed infrastructure and limited natural, human and economic resources, and often small island populations are dependent on marine resources to meet protein needs. Most of their economies are reliant on a limited resource base and are subject to external forces, such as changing terms of trade, economic liberalisation, and migration flows. Adaptive capacity to climate change is generally low, though traditionally there has been some resilience in the face of environmental change.

Source: IPCC Fourth Assessment Report, Working Group II, 2007

In addition to providing some overarching guiding principles, the focus of this document is on identifying strategies that can be applied in a small island context, where resources of all kinds are limited. While it draws heavily on the principles proposed by DEFRA (Hopkins *et al.*, 2007), where possible, case studies of UKOT or small island application of the principles and strategies are provided.

Biodiversity and climate change in the UKOTs

Conservation managers and policy makers in the UKOTs cannot afford to ignore the impacts of **climate change** on **biodiversity**. The United Nations Convention on Biological Diversity (UNCBD) has identified climate change as one of the five main threats to biodiversity, along with invasive alien species, nutrient loading and pollution, **habitat** change, and over-exploitation. Human and ecosystem well-being are inextricably linked, yet human activities have placed biodiversity and

ecosystem function under severe pressure at both the local and global scales.

The UKOTs' rich biodiversity is already under threat. Of the globally threatened species identified in the 2007 IUCN Red List, 61 **critically endangered species** are found in the UKOTs, compared to 5 in metropolitan UK. Fifty-eight **endangered species** occur in the territories (10 in metropolitan UK), along with 168 **vulnerable species** (23 in the metropolitan UK) (IUCN, 2007).

There are more than 200 **endemic** plant species, 20 known endemic bird species, and 500 endemic invertebrates in the UKOTs. There are also, however, 39 recorded extinctions in the UKOTs and two species are **extinct in the wild**. The latest extinction in the Overseas Territories, namely that of the St. Helena olive, *Nesiota elliptica*, occurred in 2003 when the last tree in cultivation died (JNCC, 2006).

In addition to the number of globally threatened species, the UKOTs also have concentrations of species that are important at the regional or global level. For example, Ascension Island supports the second largest green turtle rookery in the Atlantic; Gough Island (Tristan da Cunha) has been described as the world's most important

Definition *Climate change means any significant, long-term modification in the climate of a zone or region.*

Table 1. UKOT size, population and some economic statistics

UK Overseas Territory	Area (km ²)	Population	Major economic sectors	Major economic sectors	Per Capita GDP	Growth
Anguilla	90	13,600	Fishing, tourism, construction, Government Service, banks and insurance.	US\$158.2m (2006)	US\$9,711 (2006)	15.4% (2006)
Bermuda	53.3	64,000	Offshore financial services, insurance, re-insurance, tourism, light manufacturing	US\$5.4 billion (2006) • Tourism: 28% (2001) • Offshore Banking: 45% • Services: 89%	US\$83,935 (2006)	5.4% (2006)
British Antarctic Territory (BAT)	1,709,400	Small number of research staff	No economic activity. The UK's presence in BAT is through the British Antarctic Survey, which maintains two permanently-manned scientific stations and two summer-only stations.	N/A		
British Indian Ocean Territory	Land 60 Sea and land 54,400	4,000	There are no economic, industrial or agricultural activities on the islands. Construction projects and other services in support of the US defence facility in Diego Garcia are carried out by UK and US military personnel and civilian contract employees.	N/A		
British Sovereign Bases on Cyprus	254	6,000				
British Virgin Islands	153	27,000	Tourism, international financial services	• Tourism: 45% (1999) • Offshore financial services: • Services: 92%	\$41,700 (2006 estimate)	7.2% (2006 estimate)
Cayman Islands	260	53,252	Offshore financial services, tourism	US \$2442 million (2006) • Tourism:70% (1999)	US\$46,964 (2006)	6.5% (2005)
Falkland Islands	12,173	2,913	Fisheries, tourism, agriculture	£70 million (2001 estimate)	£24,030 (2001)	2% (estimated)

Table 1 (cont'd.). UKOT size, population and some economic statistics

UK Overseas Territory	Area (km ²)	Population	Major economic sectors	Major economic sectors	Per Capita GDP	Growth
Gibraltar	6.5	28,779	Financial services, shipping and tourism	£602 million (2005) <ul style="list-style-type: none"> • Government (25%) • Retail (15%) • Internet gaming (12%) • Construction (10%) • Business Services & Real estate (10%) • Financial services (8.5%) • Ministry of Defence (8%) 	£19,552 (2004/05)	6%
Montserrat	102	4,655	Mining and quarrying, construction, financial and professional services, tourism.	Current EC\$106.5m (2006) Constant EC \$58.9 (2006)	EC\$22,803 (2006)	-2.83% (2006)
Saint Helena	122	4000	Fishing licences, overseas remittances, fisheries (migratory, e.g. tuna), tourism	US\$10.1 million (2000/2001)	US\$2,291 (2000/2001)	
- Ascension Island	90	1,000	Revenue is raised from Personal Income Tax, Property Tax, Import Duties. A small amount of revenue is raised by philatelic sales. Communications companies and military presence also raise revenue.	Total revenue: £5.54m (2007/08)		
- Tristan da Cunha	98	275	Fishing (cray fish), overseas remittances.		Approx. US\$3000	
South Georgia and the Sandwich Islands	3,755	0	Fisheries and sale of fishing licenses, tourism, harbour administration charges, sale of stamps and commemorative coins	Government revenue: £4.4 million (2006)		
Turks and Caicos Islands	430	32,000	Tourism, fisheries (lobster and conch), international finance, property development, real estate.	US\$297 million (2003)	US\$13,506 (2003)	6.1% (2003)

Sources: Foreign and Commonwealth Office Website at <http://www.fco.gov.uk/en/about-the-fco/country-profiles>

Table 2. Projected change in temperature °C by region, relative to the 1961–1990 period (IPCC, 2007a)

Region	2010 - 2039	2040 - 2069	2070 - 2099
Mediterranean	0.60 to 2.19	0.81 to 3.85	1.20 to 7.07
Caribbean	0.48 to 1.06	0.79 to 2.45	0.94 to 4.18
Indian Ocean	0.51 to 0.98	0.84 to 2.10	1.05 to 3.77
Northern Pacific	0.49 to 1.13	0.81 to 2.48	1.00 to 4.17
Southern Pacific	0.45 to 0.82	0.80 to 1.79	0.99 to 3.11

seabird island; and the reefs of the Chagos Archipelago (British Indian Ocean Territory) are considered to be some of the most pristine and best protected in the Indian Ocean (and account for some 1.3 per cent of the world resource). The important role that the territories play in conservation is also evident in the designation as World Heritage Sites of Gough Island and Inaccessible Island (Tristan da Cunha) and Henderson Island (Pitcairn Islands) for their insular natural heritage interests (JNCC, 2006).

Climate change will exacerbate existing threats to biodiversity in the UKOTs, both directly and in combination with other impacts resulting from human activities. According to the Fourth Assessment Report of the **Intergovernmental Panel on Climate Change (IPCC)**, the evidence of global climate change is already discernable. The warming of the climate system is evident from increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea levels.

IPCC projections of temperature rise (see Table 2) are now considered by some to be conservative. Moreover, even if the concentration of all **greenhouse gases** and aerosols were kept constant at year 2000 levels, a further warming of about 0.1°C per decade is expected.

Definition **Greenhouse gases** are atmospheric gases that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. Water vapour (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), and ozone (O₃) are the primary greenhouse gases in the Earth's atmosphere.

As a consequence of the current and projected temperature increases, it is anticipated that sea-levels will rise and global sea water temperature will increase. **Weather** patterns will change, resulting in an increase in the frequency and intensity of extreme events, such as droughts, floods and possibly hurricanes. The projected impacts on small islands are outlined in Box 2.

Definition **Weather:** short-term atmospheric conditions. Weather is measured by temperature, humidity, wind speed, atmospheric pressure, cloudiness and precipitation.

These projected changes in climate are likely to affect the biodiversity of UKOTs in a number of ways:

- changes in the timing of seasonal events, which may mean that interdependent species no longer have synchronised life cycles;
- changes in species distribution, including arrival of non-native species, and potentially loss of species for which suitable climate conditions disappear;
- changes in community composition;
- changes in ecosystem function; and
- loss of physical space due to sea level rise and increased storminess.

Several of the ecosystems found in the territories, such as mangroves and coral

reefs in the Caribbean and Pacific, sea ice **biomes** in the Antarctic, and Mediterranean-type ecosystems are among those that the IPCC has identified as “most vulnerable” and “virtually certain to experi-

ence the most severe ecological impacts” of climate change.

Scientists' ability to accurately project future climatic conditions is still limited, which means that it is difficult for us to predict the

Box 2. Main Projected Climate Change Impacts for Small Islands – Indicative impacts for UKOT consideration (IPCC, 2007)

- Sea-level rise and increased sea-water temperature are projected to accelerate beach erosion, and cause degradation of natural coastal defences such as mangroves and coral reefs. It is likely that these changes would, in turn, negatively impact the attraction of small islands as premier tourism destinations.
- Port facilities at Suva, Fiji and Apia, Samoa, are likely to experience overtopping, damage to wharves and flooding of the hinterland following a 0.5 m rise in sea level combined with waves associated with a 1 in 50-year cyclone.
- International airports on small islands are mostly sited on or within a few kilometres of the coast, and the main (and often only) road network runs along the coast. Under sea-level rise scenarios, many of them are likely to be at serious risk from inundation, flooding and physical damage associated with coastal inundation and erosion.
- Coastal erosion on Arctic islands has additional climate sensitivity through the impact of warming on permafrost and massive ground ice, which can lead to accelerated erosion and volume loss, and the potential for higher wave energy.
- Reduction in average rainfall is very likely to reduce the size of the freshwater lens. In general, a reduction in physical size resulting from land loss accompanying sea-level rise could reduce the thickness of the freshwater lens on atolls by as much as 29%.
- Without adaptation, agricultural economic costs from climate change are likely to reach between 2-3% and 17-18% of 2002 GDP by 2050, on high terrain (e.g., Fiji) and low terrain (e.g., Kiribati) islands, respectively, under SRES A2 (1.3°C increase by 2050) and B2 (0.9°C increase by 2050).
- With climate change, increased numbers of introductions and enhanced colonisation by alien species are likely to occur on mid- and high-latitude islands. These changes are already evident on some islands. For example, in species-poor sub-Antarctic island ecosystems, alien microbes, fungi, plants and animals have been causing a substantial loss of local biodiversity and changes to ecosystem function.
- Outbreaks of climate-sensitive diseases such as malaria, dengue, filariasis and schistosomiasis can be costly in lives and economic impacts. Increasing temperatures and decreasing water availability due to climate change is likely to increase burdens of diarrhoeal and other infectious diseases in some small-island states.
- Climate change is expected to have significant impacts on tourism destination selection. Several small-island countries (e.g., Barbados, Maldives, Seychelles, Tuvalu) have begun to invest in the implementation of adaptation strategies, including desalination, to offset current and projected water shortages.
- Studies so far conducted on adaptation on islands suggest that adaptation options are likely to be limited and the costs high relative to GDP.

way in which biodiversity will be influenced by climate change. But this cannot be an excuse for the conservation practitioner to do nothing; it means instead that we must learn to manage by taking account of uncertainty.

The importance of adaptation in the UKOTs

As noted above, regardless of their political status, geographic location, or level of development, small islands share a range of characteristics that make them among the most economically, socially, and environmentally vulnerable areas of the world.

Among the reasons for this are their:

- small geographic size;
- remoteness;
- vulnerability to natural disasters;
- fragile ecosystems;
- constraints on transport and communications;
- isolation from markets;
- vulnerability to exogenous economic and financial shocks;
- limited internal markets;
- limited natural resources and capacities;
- limited fresh water supplies;
- dependence on imports and limited commodities;
- depletion of non-renewable resources;
- limited human resources (inherently and as a result of migration), particularly persons with relevant skills; and
- limited ability to reap the benefits of economies of scale.

Definition *Adaptation: in the context of climate change, adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.*

Definition *Mitigation: in the context of climate change, interventions to reduce the sources or enhance the sinks of greenhouse gases.*

Climate change introduces additional vulnerabilities and UKOTs ought to assume that future climate impacts will be more severe than anything experienced to date. Despite the **mitigation** measures that have been and will be taken under the **Kyoto Protocol** and subsequent international and national arrangements such as the “Bali road map”, the inertia that has developed in the global climate system will ensure that global average temperatures will continue to increase. As a result, climate change impacts will intensify over the course of the century. Consequently, the least likely future scenario for any of the UKOTs is that it will experience the same weather characteristics as in the past 50 years (Sear *et al.*, 2001). The reality that decision makers and practitioners in the UKOTs must face is that the additional vulnerabilities that will be created by climate change will make islands more vulnerable. Given the inevitability of the impacts of climate change and the highly vulnerable nature of small island territories, a much faster pace and level of commitment to adaptation solutions by decision makers and practitioners is now needed to avoid catastrophic dislocations in social, economic, and environmental systems.

Definition *Kyoto Protocol: an international agreement that is linked to the United Nations Framework Convention on Climate Change. Its major feature is that it sets binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions. These reductions amount to an average of five per cent against 1990 levels over the five-year period 2008-2012.*

As noted in *Climate Change in the UK Overseas Territories: An Overview of the Science, Policy and You* (Brown, 2008), although climate change and its impacts may seem daunting, there are things UKOTs can do about them in their local context. Addressing climate change is an opportunity for the territories to build resilience in the face of the inherent vulnerabilities associated with their size and natural features, in addition to adapting to changing climate conditions. It is also an opportunity for these countries to take measures to stem future impacts as part of a strategy of moving towards what former UN Secretary-General Kofi Annan has referred to as “safer, sounder models of development” (Annan, 2006). UKOTs have the potential to be models of climate change adaptation for the rest of the world.

In fact, adaptation can be a ‘win-win’ situation for UKOTs. Targeted actions designed to address current issues, such as the



Tropical habitat of Montserrat.

Credit: Royal Botanical Gardens Kew

need for effective biodiversity conservation and the reduction of vulnerability to climatic events (for example, droughts, storms, floods), are also the first steps in the climate change adaptation process. If a country or community is not fully able to manage its biodiversity under current climatic conditions, it cannot expect to effectively adapt to future changes in climate. In other words, it is not a choice between investment in current biodiversity needs or adaptation to future climate change – they are one and the same.

Build on existing capacities and mechanisms for effective adaptation

Effective adaptation to current conditions is the first step in the process of climate change adaptation. This is as true for biodiversity conservation as it is for any other sector. Therefore the effectiveness of current biodiversity conservation capacities and mechanisms must be developed and/or enhanced to address current biodiversity conservation needs.

It would be useful to have an overarching institutional mechanism to coordinate the implementation of biodiversity conservation for adaptation to climate change in the UKOTs. Its responsibilities could include coordination of a systematic identification of UKOT biodiversity conservation and adaptation needs; lobbying for and coordinating technical assistance; fund raising; and the coordination, monitoring, and evaluation of project and programme implementation.

The Caribbean Community Climate Change Centre (CCCCC) might be considered as a model for this type of mechanism. It operates as an articulated mechanism, coordinating, drawing on, and developing the existing expertise and capacities in the Caribbean to meet the challenges posed by climate change. This

approach enables it to work with a relatively small staff, reduces institutional overheads and allows funds that are raised to be directed to developing capacity, tools, and awareness specifically related to addressing the challenges of climate change.

One of the first tasks that the institution would need to undertake is a broad stakeholder identification and consultative process to validate the proposed approach and to identify what roles various stakeholders might play. This should include both the stakeholders within the UKOTs and those that support them from outside (see below).

Stakeholders within the UKOTs would obviously include relevant government departments, civil society organisations working in the field of climate change adaptation or biodiversity conservation, the private sector and communities situated in vulnerable areas. In very small or micro-islands, the entire population can therefore be considered stakeholders..

A number of external agencies are currently engaged in environmental and conservation activities in the UKOTs. The JNCC and the Overseas Territories Environment Programme (OTEP), a joint programme of the Foreign and Commonwealth Office and the Department for International Development (DFID), are the main statutory agencies. The vision of the JNCC in UKOTs is to promote measures that effectively protect and enhance biological and geological diversity in the UK Overseas Territories. The JNCC engages in programmes which have a strategic or a broad application to multiple territories or contribute to capacity building of UKOTs. The OTEP supports the implementation of the Environment Charters in the UKOTs, and generally promotes sound environmental management. DFID is also the sponsor of a project entitled



Montane habitat of West Point Island, the Falkland Islands. Credit: Falklands Conservation

“Mainstreaming adaptation to climate change in the Caribbean UKOTs”, which is managed by the CCCCC. The aim of the project is for all Caribbean UKOTs to develop and implement adaptation strategies.

Non-governmental organisations (NGOs) at work in the UKOTs include the UK Overseas Territories Conservation Forum (UKOTCF). The UKOTCF is supported by a number of international conservation and scientific organisations and aims to promote the conservation of species and habitats in the territories through the provision of expertise, information and liaison between NGOs and governments. The Royal Botanical Gardens, Kew has a UKOT science team to undertake conservation and help build capacity in the territories for the documentation, conservation, assessment and management of botanical resources. Other NGOs involved in programmes in various UKOTs include the Royal Society for the Protection of Birds and the Durrell Wildlife Conservation Trust.

There are also a number of universities, supporting research and capacity building in the UKOTs and/or hosting UKOT Masters students, including the University of Exeter and the University of Reading in the UK, and Vrije University in the Netherlands.

Guiding principles

In order to help biodiversity plans and projects take account more explicitly of the impacts of climate change, six guiding principles with actions that flow from them are outlined here. These cover a great deal of sound conservation practice which will

ensure the best possible outcome for wildlife conservation in the face of limited knowledge and uncertainty about the future effects of climate change. The principles provide a holistic framework for biodiversity conservation in the face of climate change (adapted from Hopkins *et al.*, 2007).

Box 3. Summary of the Guiding Principles

1 Conserve existing biodiversity

Effectively conserving existing biodiversity under uncertain future climatic conditions requires an integrated and overarching institutional mechanism that builds on existing capacities and mechanisms.

- **1a Conserve protected areas and other high quality habitats**

These areas will remain important because they have characteristics which will continue to favour high biodiversity. However, more flexible and adaptable conservation management approaches will be necessary to effectively conserve biodiversity under uncertain future climatic conditions.

- **1b Conserve range and ecological variability of habitats and species**

It is impossible to predict which localities will continue to have climatic conditions suitable for a given species or habitat; by conserving the current range and variability we will reduce the probability of all localities being lost, although some losses will be inevitable.

- Promote dispersal of species
- Increase available habitat

2 Reduce sources of harm not linked to climate

Climate change is one of many threats to biodiversity and by reducing other sources of harm we will help natural systems maintain their biodiversity in the face of climate change.

3 Develop ecologically resilient and varied landscapes

By ensuring landscapes remain varied, and allowing space for physical processes to take place, we will increase their ability to retain biodiversity.

- **3a Conserve and enhance local variation within sites and habitats.**

Maintaining diversity in the landscape in terms of features such as vegetation structure, slope, aspect and water regime will increase the chances that species whose current habitat becomes inhospitable will be able to spread locally into newly favourable habitat.

- **3b Make space for the natural development of rivers and coasts**

Changing rainfall patterns and rising sea levels will affect our rivers and coasts. By allowing natural processes of erosion and deposition to take place we will increase the potential for wildlife to naturally adapt to these changes.

Box 3 continued overleaf

4 Establish ecological networks through habitat protection, restoration and creation

Some species will need to move some distance from their current locality if they are to survive climate change; creating new habitat, restoring degraded habitat, or reducing the intensity of management of some areas between existing habitat, will encourage this. However, this may not always be feasible in very small or micro islands.

5 Make sound decisions based on analysis

Adopt an evidence-based approach which recognises that biodiversity is constantly changing.

- **5a Thoroughly analyse causes of change**

Not all change will be due to climate change and by thoroughly analysing the causes of change we will identify those situations where climate change adaptation is needed.

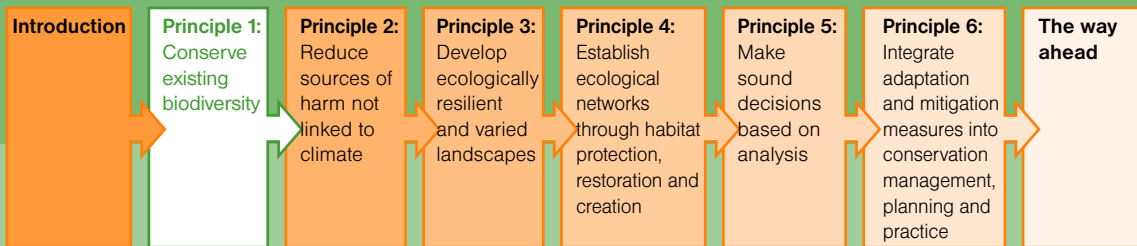
- **5b Respond to changing conservation priorities**

Regularly review conservation targets to ensure resources are directed towards genuine conservation priorities as some species increase, others decline and habitats change in character.

6 Integrate adaptation and mitigation measures into conservation management, planning and practice

When reviewing conservation management plans consider the impacts of climate change – for example more frequent summer fires and floods – and make changes as appropriate. Where they can be identified, reduce the release of greenhouse gases to the atmosphere.

Source: Adapted from Hopkins et al., 2007 and Mitchell et al., 2007.



Guiding principle 1

Conserve existing biodiversity

The importance of protecting existing biodiversity cannot be overemphasised. Future biodiversity will adapt and evolve from the richness of the biodiversity conserved in the 20th century and from the extent of semi-natural habitats that will be protected, restored and created in the 21st century.

But this is not to suggest biodiversity should be preserved in aspic. Climate change means that at sites currently considered to be of wildlife importance, some of the wildlife features, both species and habitats, may disappear, other species may arrive and habitats may change in their composition and structure.

Principle 1a: Conserve Protected Areas and other high-quality wildlife habitats

Conservation of protected areas is already an important strategy in most UKOTs (Procter and Fleming, 1999). Those that are managed specifically for biodiversity conservation are likely to be the ones in which direct measures for dealing with climate change can be developed and implemented most effectively. This is because they already have resources available, including site managers specialised in conservation management.

However, although preservation of protected sites will continue to be an important part of conservation strategies, in

some situations there will need to be changes in the way they are managed and designated.

The flexibility and adaptability of conservation management approaches will become increasingly important in the trade-off between the need to conserve biodiversity and the uncertainty surrounding projections of future climatic conditions. The question of what constitutes a 'favourable condition' will need to be re-evaluated in the context of projected climatic conditions in anticipation of the possible modification and/or loss of features for which sites are designated.

The most acute issues are likely to be faced in the coastal zone. Rising sea level and the consequent changes in patterns of erosion and deposition will cause some areas of high quality habitats to disappear. In many cases, the only feasible response will be to identify suitable sites in which new areas of valuable habitat can be established as part of a managed retreat. Conservation targets in existing coastal protected sites may also become inappropriate or inaccurate if not regularly reviewed and adapted. It will also be important to include new features of conservation importance (for example, colonisation by a new species) in citations and targets for a site. Away from the coast, the issues will usually be less severe and designated sites are likely to remain valuable

even if conditions alter under climate change. However, in small islands, most of the country can be considered coastal zone and a “ridge to reef” approach is needed.

Suggested actions to enhance the resilience of Protected Areas

In some cases, UKOTs may need to adopt a more flexible approach to designation and management of sites so that new ones can be designated and/or designations altered or removed from existing sites if they are no longer appropriate. In cases where the existing designation is appropriate, it may be necessary to improve enforcement of boundaries and conditions of use.

The relationship between protected sites and the wider area around them is important. The resilience of designated sites may be improved by increasing their size and heterogeneity. Where a site is currently surrounded by land of low conservation value, it may be valuable to create new habitat around the edge, which will gradually develop in biodiversity interest, whilst at the same time functioning as a buffer between semi-natural habitat and the surrounding land. However, in a small island context, with limited land space and competing pressures for usage, this may not always be possible.

Increasing connectivity with other areas of semi-natural habitat, and increasing the biodiversity value of the agriculture matrix in the area around the site, will also improve the resilience of the protected area.



Sea level rise in the BIOT.

Credit: Charles Sheppard

Principle 1b: Conserve range and ecological variability of habitats and species

The small size of most UKOTs, combined with the limited extent and/or number of specific habitats, means that it is likely that most habitats or species will be under threat from climate change. The risk of species becoming extinct or a habitat being lost will be reduced if a varied set of locations are conserved that encompass the full range of ecological situations in which they occur.

It is recommended that a landscape scale approach be adopted and two main strategies are proposed – promoting the dispersal of species and increasing the available habitat.

Promote dispersal of species

If species approaching their climatic limits cannot adapt to the new climate and cannot be maintained in their present locations by management, they will only survive if they move into new areas where the climate is suitable. Accommodating change requires ‘permeable’ landscapes, which allow dispersal of species between habitat patches. This is termed functional connectivity and does not necessarily require physical linkage (Catchpole, 2006



The Wild Bermuda pepper, *Peperomia septentrionalis*, is endemic to Bermuda.
Credit: Martin Thomas

in Mitchell *et al.*, 2007). Functional connectivity also increases resilience by allowing recolonisation following local one-off extinctions (for example, from fire or a pollution incident) and promotes outbreeding.

The concept of connectivity across landscapes is well accepted but the best means of determining and achieving it will depend on specific circumstances and the organisms of interest. Three main strategies have been proposed to increase connectivity:

- 'corridors';
- 'stepping stones'; and
- improving the quality of the matrix in which habitat patches are found.

Corridors are linear and directly link habitat patches; stepping stones are small patches of suitable habitat in a landscape of unsuitable habitat, which reduce the distance between larger areas of a habitat.

The matrix surrounding semi-natural habitat patches is important in promoting the dispersal of species between patches (Catchpole, 2006; Donald and Evans, 2006; quoted in Mitchell *et al.*, 2007).

In practice, in the UKOT and small island context, this approach is likely to entail a range of small-scale, local solutions that

maintain swaths and patches of managed or semi-managed habitat associated with cultivated areas (hedgerows, ditches, field margins), rivers (riparian swale) and gullies, settlements and urban areas (gardens, tree lines, parks), and abandoned land. These habitat features will serve as a matrix of connectivity between natural habitats. Targeted habitat creation can be employed to develop ecological networks. Planting of new woodlands may be most effective if targeted to fill in gaps between existing woodlands. The principle of connectivity also applies to marine systems where sea mounts, coastal wetlands, and shallow coastal habitats, connected by the sea and currents, may serve as islands or way points, in local or regional dispersal processes.

A risk that must be taken into account when considering an increase in landscape permeability is the increased risks to biodiversity from non-native invasive species (Varnham, 2006). The situation will need to be monitored, with control measures put in place if necessary. One of the best means of reducing risk from invasive plant species is the restoration of stable semi-natural communities, as these are less susceptible to invasion than more disturbed, early successional areas (Mitchell



A large reforestation scheme is underway in Millenium Forest, St. Helena.
Credit: St. Helena National Trust

et al., 2007). Control of non-native species may therefore be partially dependent on effective management response within semi-natural habitats (adapted from Mitchell *et al.*, 2007).

Suggested actions

- *Promote functional connectivity by developing and maintaining landscapes to allow the dispersal of species between habitat patches, through the creation of corridors or 'stepping stones'.*
- *Create targeted habitats, e.g., the planting of new woodlands to fill gaps between existing woodlands.*
- *Restore stable semi-natural terrestrial communities that are less susceptible to invasion by invasive plant species than more disturbed, early successional areas.*

Increase available habitat

Habitat creation or restoration helps to reduce fragmentation and promote permeability of the landscape. Increases in habitat area can be achieved by:

- expanding the area occupied by existing habitat patches; and
- increasing the number of discrete areas of habitat.

Both larger patches of habitat and more patches have advantages. Larger patches support larger populations which are more resilient to extinction during extreme climatic events such as droughts and floods (Mitchell *et al.*, 2007). Extending existing areas can create a buffer between agricultural land and protected areas and help to safeguard them from other pressures, for example spray drift and disturbance. It may also be a good strategy to promote



Degraded land in Montserrat.
Credit: Stephen Mendes

colonisation of plants and animals from the existing habitat. More patches may contribute to the possibility of species dispersal into new areas and may also allow recolonisation following local extinctions.

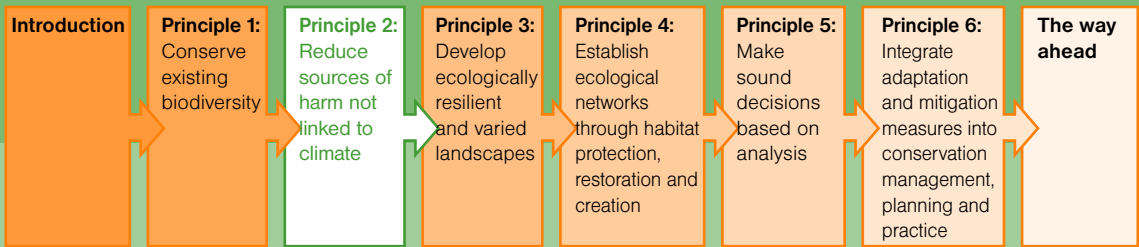
When expanding habitat area, it is also important to increase the range of soil types and topographical variations in the microclimate. This in turn improves the probability of species being able to persist in localised pockets of suitable conditions. In temperate situations, the extent of temperature variation on sunny days can be considerable between south-facing slopes and north-facing slopes. On a cold night, air temperatures at the bottom of a slope may fall several degrees compared to those at the top because of cold air drainage, creating a 'frost hollow'.

In tropical settings, the orientation of slopes can have a similar effect on soil moisture and humidity. Water content and availability can also vary dramatically between different soils and topographies with, for example, spring lines and flushes remaining wet through the summer where surrounding areas dry out.

Increasing available habitat may be achieved by restoring degraded habitats or creating new areas of habitat. Explicit consideration of climate change should be incorporated into the planning stage for any specific scheme, taking into account the long term viability of the habitat in that location and its contribution to wider landscape adaptation (adapted from Mitchell *et al.*, 2007).

Suggested actions

- *Expand the area occupied by existing habitat patches.*
- *Increase the number of discrete areas of habitat.*
- *Restore degraded or affected habitats.*



Guiding principle 2

Reduce sources of harm not linked to climate



Shot upland geese (*Chloephaga picta*).
Credit: Falklands Conservation

At any given moment, the state of the environment in each UKOT is defined by a range of climatic, physical and biological factors. These factors change over time scales ranging from days and years to centuries and millennia. Over the last two hundred years, the influence of human activity on the environment has become a major factor. Globally, human activities have had a wide range of negative impacts on the environment, including increased levels and types of pollution released into the environment, the destruction of natural habitats, and species exploited beyond sustainable levels. These impacts have, in turn, directly and indirectly affected biodiversity.

Where action can be taken to remove or reduce existing stresses, action to combat climate change is likely to be more effective since it will allow wildlife to resist and adapt more successfully. In order to take action, conservation practitioners must be able to identify the existing threats, be aware of

their impacts, and take action if that is a viable strategy.

Some examples of the more common threats are:

- the introduction and spread of non-native species, resulting in changes in habitat structure, increased predation on native species, changes in the genetic make-up of native species through interbreeding, and the spread of wildlife diseases;
- habitat destruction and fragmentation, which can reduce the numbers of species or size of populations to levels that are not viable in the long term;
- nutrient enrichment of rivers and coastal waters through:
 - the inappropriate use of fertilisers;
 - the inappropriate disposal of sewage, agricultural and commercial waste; and
 - the loss of top-soil to erosion as a result of inappropriate land management and farming practices.
- inappropriate watershed management practices, resulting in low river and stream flows, flash flooding, siltation, and the alteration of water regimes in wetlands;
- over-abstraction of water, resulting in low river or stream flows and alteration of water regimes in wetlands; and
- over-fishing of coastal reefs, resulting in changes in the composition of reef communities and their productivity

(Adapted from Hopkins *et al.*, 2007)

Suggested actions

Make Environmental Impact Assessments a mandatory condition for the approval of all commercial development activities (see Principle 5).

Promote traditional land management practices that conserve biodiversity and protect ecosystem functions and processes.

Practice aggressive management of invasive non-native species.

Employ land use planning and integrated watershed and integrated coastal zone management processes to regulate land use practices in order to incorporate biodiversity conservation considerations into the decision-making processes for development planning.

Develop systems of legislation and regulations that provide deterrents and penalties for pollution so that the real costs of environmental damage, remediation, mitigation, and restoration are borne by the polluter (polluter pays principle).



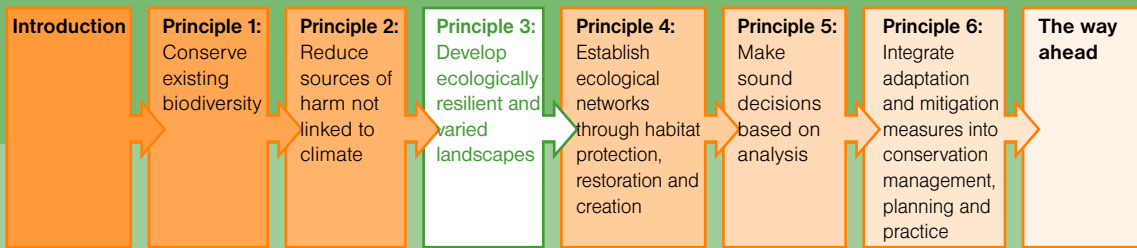
Debris cleared from the beach, Anguilla.

Credit: Anguilla National Trust



Wastepipe flowing into Stanley Harbour,

Falkland Islands. *Credit: Falklands Conservation*



Guiding principle 3

Develop ecologically resilient and varied landscapes

Landscapes comprise a variety of habitats and an associated range of land uses (for example, conservation, tourism, agriculture and human settlement). It is likely that landscapes will change in complex ways, in response to both the direct impacts of climate change upon habitats, and indirectly due to the way in which land use patterns evolve in general, or sectoral practices adapt and change with changing climate, for example, in farming, forestry and water management.

Natural and semi-natural habitat may be sacrificed if new coastal protection structures (sea walls and groins) are constructed, or tourism and public sector infrastructure is relocated from newly-vulnerable coastal locations.

Within the landscape this may well result in some habitats increasing, decreasing or changing in structure, and others appearing for the first time or disappearing.

Taking a combination of actions that promote habitat connectivity and permeability will provide the best possible chance of conserving the greatest amount of biodiversity.

Reducing the intensity of land use in intervening parts of the landscape can greatly increase the chance for species to disperse between existing, restored and newly created high-quality wildlife habitats (adapted from Hopkins *et al.*, 2007).

Box 4. Resilient landscapes through habitat connectivity

Resilience is the ability of a landscape to maintain its functions and characteristics after being disturbed or damaged. The maintenance of species diversity within the landscape is essential for it to be considered resilient and as a consequence it is vital that species are able to disperse to more suitable locations should their existing localities become unsuitable under a changing climate. Habitat connectivity and landscape permeability have been recognised as key to helping species dispersal and enhancing resilience. Habitat connectivity describes the spatial links between core areas of suitable habitat. Landscape permeability is the capacity for dispersal of biodiversity across the wider landscape. Improving the capacity for species to disperse across unsuitable habitats enhances landscape permeability. It has been shown experimentally that physically connecting fragmented habitats or making the intervening habitat less hostile improves dispersal for some species.

Source: Hopkins et al., 2007

Suggested actions

Promote habitat connectivity and permeability through actions such as:

- *maintaining a diversity of semi-natural habitats;*
- *increasing the area of semi-natural habitats (e.g., the creation or restoration of mangroves, seagrass meadows or woodlands habitats); and*
- *mitigating the adverse impacts of unsympathetic uses of the land and coastal area.*

Allow natural processes to shape the ecology and structure of whole landscapes.

Where possible, reduce the intensity of land use in intervening parts of the landscape, which can greatly increase the chance for species to disperse between existing, restored and newly created high-quality wildlife habitats.

Collectively these actions will enhance the capacity of UKOT landscapes to maintain their ecological functions and characteristics after being disturbed or damaged.

(Adapted from Hopkins et al., 2007)

Principle 3a: Conserve and enhance local variation within sites and habitats

The habitat requirements of different species will vary considerably with respect to habitat size, climatic and micro-climatic preferences, and diurnal and seasonal cycles.

The maintenance of a wide variety of healthy habitat patches will increase the likelihood that species will be able to respond to climate change by relocating between core habitats within a landscape that they already occupy.

Maintaining a wide variety of natural and semi-natural habitat options within a short distance of core habitat areas will reduce the distance over which populations would have to relocate in the event of climate change. This would increase the probability that populations will be maintained if dispersal is required to reach a suitable location.

Maintaining a diverse range of healthy habitats will ensure that suitable habitat options exist for the widest possible range of species.

Those landscapes which are richest in terms of their current biodiversity are also likely to be more varied in terms of their habitat mosaic and thereby most likely to allow some species to adapt to a changing climate by dispersing to nearby habitat patches in the future. The following characteristics are worth maintaining and enhancing:

- Diverse and structurally varied vegetation.* Different types of vegetation have different microclimates and some species may be able to adjust to climate change by expanding the range of vegetation types they occupy, or by moving from one type of vegetation to another.
- Semi-natural habitat on a range of slope and aspect.* Microclimate varies considerably with slope and aspect. At sites with varied topography, species adversely affected by higher temperature and summer drought on south-facing slopes may be able to move to cooler, more humid north-facing slopes. Quite small differences in topography, for example, on different sides of a hillock, may provide the topographical variation required if the magnitude of change is not too great.



Unusually high levels of rainfall cause invasive species to flourish in Fisher's Valley, St. Helena.

Credit: Vince Thompson, St. Helena National Trust

- c. *Uninterrupted semi-natural vegetation over a range of altitude.* In UKOTs with significant differences in elevation, for some species the response to climate change will be to move to higher areas, where climate is generally cooler and wetter. Hence, uninterrupted habitat within mountains and hills will allow the dispersal of species but montane species on the highest peaks are likely to be left with nowhere to go. This and the following point demonstrate the principle of connectivity.
- d. *Uninterrupted semi-natural habitat across coastal zones.* Coastal areas have complex microclimates compared to inland areas and there is large climate variation over distances of less than one kilometre at the coast meaning species may find suitable nearby habitat patches as climate changes.
- e. *Diverse water regimes.* Climate change is likely to have a complex effect upon water regimes. In some locations summers or dry seasons may become drier while winters or rainy seasons may become wetter. Rainfall may become less evenly distributed, with increased

rainfall-intensity leading to flooding. The most complex range of habitats, and therefore the most aquatic and wetland species, are likely to survive in landscapes where there is variation from open water to dry land. A diversity of wetland conditions is most likely to persist where the open waters and wetlands are fed by a combination of surface drainage, ground water and aquifers.

(Recommendations adapted from Hopkins *et al.*, 2007)

Management of competing and invasive species

Invasive non-native species can reduce local variation within sites by reducing the number of species in an area through competition for space and resources, preying on species for food, or infecting native species.

Particularly in an island setting, native species may not have been exposed to particular types of predation, competition or disease, and therefore may lack the capacity to cope with an introduced species. The island environment may lack the predators, competitors, or diseases to keep the invasive non-native species in



The invasive Patagonian fox (*Lycalopex culpaeus*) in the Falkland Islands has been known to affect ground nesting bird population. Credit: Falklands Conservation

check, allowing the population of the non-native species to grow to overwhelming levels.

Where conditions might not be suitable for an invasive non-native species to gain a

foothold in a UKOT, disturbance caused by human activity may create localised conditions in which competition and or predation is sufficiently reduced to allow the invasive non-native species to gain a foothold and become established.

Box 5. Case Study: Increasing the percentage of endemic and native plant species in Bermuda provides increased resilience to hurricanes

The island of Bermuda has experienced a greatly increased frequency of major impacts by hurricanes in recent years, with seven storms of hurricane-force or greater winds during the last 20 years, compared to only one for the previous 25 years.

During the increased hurricane activity of recent years, introduced invasive species suffered considerable damage, with from 50% to 75% of mature trees being uprooted or snapped off. Surviving introduced vegetation also suffered complete defoliation and considerable dieback from wind and salt spray blown over the island during the hurricanes. This is significant as introduced tree and plant species in woodland and landscaped areas are estimated to account for 95% to 98% of the island's vegetative biomass.

By contrast, tree and plant species endemic or native to Bermuda are mainly found as isolated specimens or small stands on coastal cliffs, rocky areas or offshore islands. The most noteworthy of these plant species are the Bermuda cedar (*Juniperus bermudiana*), Bermuda olivewood (*Cassine laneanum*), Bermuda palmetto palm (*Sabal bermudana*) and yellow-wood (*Zanthoxylum flavum*).

A number of Nature Reserve and Park areas have had invasive vegetation removed and endemic vegetation planted as part of a native reforestation program. The most noteworthy of these are the Nonsuch Island Nature Reserve and Walsingham Trust reserve, where reforestation efforts have been underway for over forty years. In both areas, an immature closed-canopy forest has developed, with a high diversity of understory plant species. These restored endemic/native woodland areas have shown significant resistance to both hurricane-force winds and salt damage.

The increased resistance stems from adaptations common to most of Bermuda's endemic and native tree species, including a shorter, dense growth form; salt-resistant foliage; and robust root systems which can penetrate deep into cracks in the limestone rock which underlies Bermuda's generally thin soils.

These adaptations have given the endemic tree species an advantage over the introduced tree species in extreme hurricane conditions, and have led to the increased propagation and use of endemic species in replanting and landscaping uses on Bermuda. Much of the seed and seedlings used for this purpose are now obtained as surplus from the regenerating native forest on Nonsuch Island.

*Source: Jeremy Madeiros, Conservation Officer (Terrestrial),
Department of Conservation Services, Bermuda*



Darrell's fleabane, *Erigeron darrellianus*, endemic to Bermuda.

Credit: Lisa Greene



Casuarina, *Casuarina equisetifolia*, was introduced to Bermuda and is now aggressively invasive in coastal situations. The plant weakens the rock which is then much more prone to significant erosion in storms. Credit: Denise Grubesch-Speakman

Given the impact that invasive non-native species can have on local biodiversity, preventative management and aggressive mitigation are essential to maintaining and enhancing local biological diversity.

Specific interventions or changes in management may reduce adverse impacts of climate change on certain aspects of biodiversity. These can be site-based operations for localised effects, or they can be applied across wider areas.

For example, most plant species can survive at warmer sites than those in which they typically occur naturally. In natural conditions they are excluded by competition with species that grow faster and larger at higher temperatures (Morecroft and Paterson, 2006 in Mitchell *et al.*, 2007). So in some cases, reducing competition may allow threatened species to persist, for example, by changing grazing regimes, preventing spread of competitor species or even direct removal of competitors in the vicinity of particularly threatened individuals (see case study in Box 5).

Manipulating microclimate by modifying vegetation height or canopy structure is

another option, perhaps more suitable for invertebrates and other small animal species.

Soil and surface temperatures decrease with increasing vegetation height and this offers opportunities for management intervention. For example, allowing grassland swards to grow taller will create cooler conditions at the soil surface. Planting shade trees may also provide cooler microclimates for some species. In some habitats, water supply can be manipulated through changing drainage or water level which may offer potential to offset some of the effects of drier summers.

Approaches like these will usually need to be considered and implemented at a local level, with an element of trial and error, at least for the immediate future. There will also need to be an assessment of the feasibility for each, in the light of available resources and a cost-benefit analysis. For example, the direct removal of individual competitors is only likely to be viable for very threatened species at a small number of sites (adapted from Mitchell *et al.*, 2007).

Suggested actions

- Reduce competition by:
 - preventing spread of competitor species;
 - direct removal of competitors in the vicinity of particularly threatened individuals;
 - managing invasive species.
- Manipulate microclimate by modifying vegetation height or canopy structure.
- Allow grassland swards to grow taller.
- Plant shade trees.

Principle 3b: Make space for the natural development of rivers and coasts

The rivers, estuaries and shallow coastal areas of UKOT islands serve a number of functions. They connect habitats, transport plants, propagules, eggs, larvae, sediments organic matter and nutrients, and provide pathways along which animals travel.

The process of erosion and downstream and longshore transport shape geographic features such as estuaries and coastlines and create conditions for the development of a range of habitats such as coastal wetlands and mangroves.

A range of coastal habitats, such as mangroves, seagrass beds and coral reefs, may be functionally interlinked by the fact that they provide support to different developmental stages of a particular species. Nutrients and food material from one habitat may provide sustenance to species in a downstream habitat.

The historical tendency for commercial activity (ports, business districts, factories,



Beachfront development can exacerbate coastal erosion.

Credit: Dept of Env. Cayman Islands Government

tourism) and human settlements to be concentrated in coastal areas has led to the destruction of coastal habitats. The interruption by development activities of the natural functions and processes supported by rivers and coastal waters is probably more important but more difficult to observe. To provide biodiversity with the best chance of coping with climate change, the connectivity between coastal habitats provided by river flows and near-shore coastal transport processes will have to be maintained.

Climate change will cause sea level rise globally and increased storm intensity and coastal inundation from storm surges in



A healthy reef in BVI.

Credit: BVI National Trust

some regions. The more extensive intrusion of sea water along river courses and into coastal wetlands and coastal aquifers will result in changes in habitat location and distribution.

Efforts will have to be made to maintain the diversity of coastal habitats by making space for habitats and species to re-locate. Similar consideration should be given to actions that conserve the processes and

functions performed by river and coastal waters that promote and sustain coastal and riparian habitats. Examples include using set-backs to ensure that coastal transport processes are not obstructed by construction on the beach berm and maintaining a river's riparian vegetation and flood plains to conserve stream flow, natural flood control processes and to minimise erosion.

Suggested actions

Develop national land use plans that promote development away from the coast.

Manipulate water supply to managed habitats by changing drainage or water level.

Ensure that a diversity of water regimes are maintained despite seasonal variations in precipitation, by carefully regulating extraction and water flows where possible, and increasing water storage within and between sites (Hopkins et al., 2007).

Maintain water levels in wetlands through watershed and water resources management.

Remove or re-engineer sea-defences and infrastructure in coastal areas.

Restore connectivity between streams and rivers and their estuaries.

Reduce barriers across channels or engineer the bypass of these barriers.

Restore wetlands and riparian borders.

Restore watersheds.

Facilitate the strategic planting and/or maintenance of mixed species woodland stands, ensuring that the selected species mix can cope with anticipated range of plausible future climatic conditions e.g. drought resilient or wet woodland species.

Promote the use of native species.

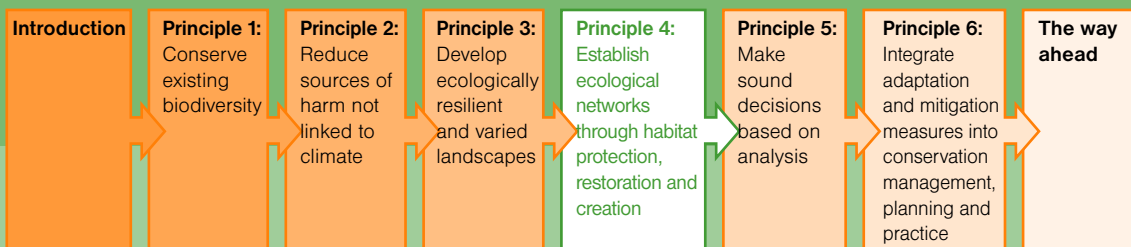
Promote continuous-cover forestry.

Promote the managed realignment of coast lines.

Institute a mechanism for the development and implementation of "shoreline management plans" and "coastal zone management plans".

Implement measures that ensure natural development of coasts and rivers by including them within coastal zone management plans, protected areas management plans, and other local management frameworks.

Retain or restore natural river profiles and flood plains and the associated semi-natural habitat.



Guiding principle 4

Establish ecological networks through habitat protection, restoration and creation

Creating ecological networks that improve connectivity between habitat patches and allow species to disperse across the territory or in its coastal waters will enhance the resilience of the landscape and further increase the probability of species surviving (Hopkins *et al.*, 2007).

The tendency for development activities to be concentrated in coastal areas, when combined with the preference for level or mildly sloping land for agricultural activities, may limit intact semi-natural and natural habitats to rugged elevated coastal areas and upland elevations, where topography and relief are sufficient to make land marginal for development and agricultural uses.

Habitat fragmentation is a challenge to the conservation of biodiversity and, in the setting of a small UKOT where habitats and ecosystems may be limited, fragmentation may become synonymous with habitat loss. In some cases, protection may be the only practical conservation measure. However, providing habitat options for species to move in response to climate change will assist dispersal through the wider countryside.

The creation of ecological networks between core habitats will be strengthened by initiatives that promote habitat maintenance, restoration and creation at a range of scales. Protected areas may serve as one of a range of options if space considerations permit. However, where

development and agricultural activities account for continuous swaths of land use, more modest options, such as wooded recreational parks, woodlands, hedgerows, river courses and their associated riparian vegetation, and wetlands, might together form a matrix of stepping stones, oases, and corridors that support the dispersal of species.

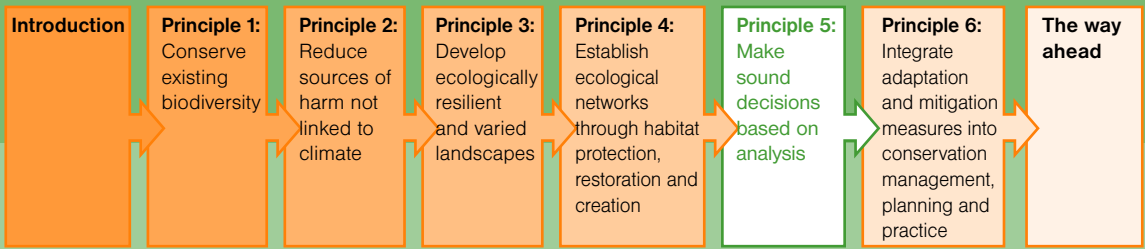
Restoration and creation will be a strategically valuable adaptation tool where specific habitat and ecosystems are not plentiful and those that do exist must be maintained in order to conserve the associated species and functions.

It is important for conservation practitioners to bear in mind that ecological networks will reduce not prevent biodiversity loss due to climate change. The networks will increase the available habitat for existing species and enhance dispersal of some species if the need arises.

Suggested actions

Assess those species that will benefit from the creation of ecological networks and those that will not be able to take advantage of the network for dispersal. Consider alternative adaptation measures for species that cannot disperse across an ecological network.

See Principles 1a, 1b, 3a, 3b.



Guiding principle 5

Make sound decisions based on analysis

Most UKOTs should be able to access a range of basic climatological and biodiversity data collected by research institutions, the armed forces, meteorological offices, agriculture, environment and fisheries departments, non-governmental organisations and protected area management agencies.

Predictive modelling at the appropriate (that is, territory) scale is essential to make the correct policy and planning decisions to prepare communities in UKOTs for global climate change. However, most UKOTs do not have sufficient technical and scientific resources to undertake this type of modelling. Moreover, the availability of and access to data will to some extent be determined by the form in which data is stored. Data which were collected before digitisation and computer technology became commonplace will probably be stored in written or printed formats that are not easily or cheaply converted to the digital formats used for modelling purposes.



British Virgin Islands.
Credit: BVI National Trust

It would seem that the best approach to the development of UKOT climate projection models would be through collaborative arrangements between the Governments of UKOTs (individually or collectively), UK government departments and agencies, including the Foreign and Commonwealth Office, the Hadley Centre and the UK Meteorological Office, as well as international organisations involved in climate modelling and monitoring (Falkland Islands Government, 2007).

Principle 5a: Thoroughly analyse causes of change

One of the greatest challenges for nature conservation will be both identifying and responding to declines of species caused by climate change. It is important that all biodiversity change is not seen as an inevitable and unavoidable consequence of climate change. In many cases cessation of management, nutrient enrichment and other factors, often working in combination, will be the most important causes of habitat degradation and species decline. For some species, climate change may be only a small component of the problem but for others it may be the main cause.

Detailed criteria for identifying and responding to declines and extinctions induced by climate change do not currently exist but below we suggest actions which will focus conservation appropriately. (Hopkins *et al.*, 2007)

Suggested actions

- *Ensure that all other factors which might explain the decline in a species have been thoroughly considered and action taken (see Principle 2).*
- *Accept local decreases if there is clear evidence that the species is increasing elsewhere within its range, as this forms part of an inevitable change in distribution related to climate.*
- *Identify any long-term monitoring schemes already underway for relevant habitats or species and assess their implications. It will be important to maintain and continue existing monitoring, and to initiate additional schemes or research where the cause of declines may be the result of a changing climate.*
- *Undertake interventions to address decline where this is strategically the right thing to do. For example, breeding populations in captivity and releasing them into the wild is only appropriate where changes to habitat management to allow long-term survival have been achieved.*
- *Translocation is an option for species unable to disperse quickly enough to keep pace with climate change, though it will be limited on the grounds of cost, technical difficulty and risk of unintended ecological damage by translocated species. Any translocation exercise should follow procedures and guidance laid out by the UK JNCC.*

(Recommendations adapted from Hopkins et al., 2007).

Box 6. Case study of translocation of Bermuda petrel as a response to climate change.

The Bermuda petrel, or cahow (*Pterodroma cahow*) is a gadfly petrel that once nested abundantly on the Islands of Bermuda before the island was discovered by Portuguese and Spanish explorers in the early 1500s. The species was so decimated by introduced mammal predators such as pigs, rats, cats and dogs, and by hunting by English settlers who had colonised the islands by 1612, that the cahow seemingly disappeared and was thought to be extinct by the 1620s. A small number of nesting pairs were rediscovered on several small rocky low islands off the eastern end of Bermuda in 1951, and a long-term intensive management and recovery program has succeeded in increasing the number of nesting pairs from 18 pairs in 1962 to 85 in 2008.

The Bermuda petrel is listed as critically endangered and is Bermuda's national bird. It still faces a number of threats, including predation of chicks by rats that can swim out to the nesting islands and nest site competition by the more aggressive white-tailed tropicbird (*Phaethon lepturus*). The most serious threat is that of severe erosion and inundation of the low-lying nesting islands by high surf and tides during hurricanes. These islands have maximum elevations ranging from only 4.5 m to 10 m and have a combined area of less than 1 ha. During the first 30 years of the recovery programme for the species, there was almost no major flooding or over-washing of the nesting islands recorded. By contrast, during the next 20 years (1989 to 2008) there have been at least

Box 6 continued overleaf

Box 6 Cont'd.

seven major hurricane events which have caused major flooding and erosion of the islands. The most serious of these has been hurricane Fabian in 2003, which caused severe erosion and the partial collapse of two of the nesting islands. The ongoing damage from the increased frequency and intensity of hurricanes affecting Bermuda, and the threat of anticipated sea-level rise due to climate change, has necessitated a programme to establish a new nesting colony of cahows on the nearby Nonsuch Island Nature Reserve. This island is much larger in area at 6.8 ha, compared to less than 1 ha for all four of the present nesting islands combined. It is also higher in elevation at 22 m and has abundant soil deposits for the petrels to dig their own burrows in. Now that it has been replanted in native forest, it closely resembles the original nesting habitat of the petrel as described by the early settlers.



The cahow (*Pterodroma cahow*).
Credit: Jeremy Madeiros

The establishment of the new nesting colony is being carried out by a combination of two techniques, the first being translocation, in which petrel chicks are monitored through their development and are physically moved about 20 days before fledging to a new complex of artificial nest burrows built at the chosen new colony site. Once the chicks have been moved, they are then fed on fresh squid and anchovy every other day and their growth recorded until they are mature. The chicks then spend a period of three to eight nights when they emerge from their underground burrows to exercise their flight muscles and explore and imprint upon their surroundings before fledging out to sea, not returning for several years until they are sexually mature.

The second technique is sound attraction, where a digital recording of cahow courtship calls is played back over a solar-powered weatherproof sound system at the new colony site. This is to encourage young cahows returning for the first time to their original point of departure to land and prospect for nest sites, with the sound system providing the social simulation of the noise and activity of an established breeding colony. This counteracts the possibility of young birds returning to their departure points, only to be attracted back out to the present suboptimal nesting islands by the nesting activity of the nesting pairs there.

A total of 105 cahow chicks were translocated to Nonsuch Island between 2004 and 2008, of which 102 fledged successfully. In early 2008, the first translocated birds returned to Nonsuch Island, with four birds recaptured prospecting nest burrows at the new colony site. These were all identified from their ring (band) numbers as having been translocated as chicks to Nonsuch Island during the 2005 season, with two birds returning to the same nests to which they had originally been translocated. Up to eight birds were seen in flight and carrying out courtship activity over the Nonsuch site at night, and a total of seven nest burrows received prospecting visits by the end of the nesting season in May.

Prospects for further activity and eventual nesting activity at the new colony site look very promising for the 2009 nesting season and developments here will be closely monitored.

Principle 5b: Respond to changing conservation priorities

Conservation management is based on assumptions about species: their value (intrinsic or commercial); location; habitat preferences; the location and extent of suitable habitat; the nature of threats and associated levels of risk; and the positive conservation outcomes that management actions can achieve. Climate change will invalidate a number of these assumptions, depending on the species or habitat being considered and the UKOT. For example, current climatic conditions, topography, and ecosystem process combine to create gradients in physical factors such as temperature, salinity, and humidity, and zonation in habitat distributions. Climate change will affect these gradients and zones and the distribution and viability of the associated species.

Conservation practitioners will need to be able to review the validity of management assumptions and develop new conservation strategies and priorities to ensure effective management of biodiversity under changing climatic conditions.

It will be essential for conservation practitioners to develop species- and habitat-specific indicators of management effectiveness as well as indicators that provide information on the climatic and habitat characteristics that constitute the optimal minimal conditions of habitat suitability (boundary conditions).

Respond to Changes in Conservation Pressures.

Maintaining the diversity of coastal habitats by making space for habitats and species to re-locate under changing climatic and environmental conditions poses a number of management challenges. There is no guarantee that the necessary space for habitat retreat will be available in the vicinity of the current habitats. Roads,

commercial facilities, farmland, and residential developments may border mangroves, coastal wetlands, coastal forest and scrub lands, river courses or woodlands. The costs of changing these land uses to accommodate habitat retreat or habitat creation as a climate change adaptation strategy for biodiversity conservation will be high. The probability of achieving such a change in land use will be extremely low unless new threats associated with climate change mean these land use practices are no longer viable. This scenario is not far-fetched. Successive hurricanes have made waterfront residential lots physically and financially (insurance) unviable.

Manage Sea Level Rise

The purpose of adaptation is to reduce the net cost of climate change and sea level rise, whether social, economic, or environmental (IPCC, 2001).

For islands and territories with high coastline-to-area ratios, sea level rise and its associated impacts will be one of the major consequences of climate change. Managing sea level rise will involve a mix of adaptation approaches designed to adjust natural and human systems to respond to the direct and indirect effects of the anticipated changes in climate. The aim of these adaptive responses will be to moderate or eliminate the negative impacts of climate change. The adaptation options include anticipatory (proactive), reactive and autonomous adaptation approaches.

Given the levels of uncertainty associated with future climatic conditions, managed biodiversity will have the best chance of survival if an anticipatory or proactive approach to adaptation is adopted. The anticipatory approach provides the best opportunity to avoid or reduce damage to habitats, enhance resilience of habitats

and ecosystems, improve capacities to cope at the institutional level by:

- mainstreaming climate change and biodiversity into the long-term decision making process;
- increasing awareness of the relationship between climate change, biodiversity and development issues;
- learning by doing;
- developing technical and institutional capacity;
- providing legally enforceable negotiated responses that maximize the adaptation options left open for species, habitats and ecosystems; and
- reducing non-climate threats to biodiversity.

Box 7. Different types of adaptation

Anticipatory Adaptation—Adaptation that takes place before impacts of climate change are observed. This is also referred to as proactive adaptation.

Autonomous Adaptation—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. This is also referred to as spontaneous adaptation.

Planned Adaptation—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Reactive Adaptation—Adaptation that takes place after impacts of climate change have been observed.

Source: IPCC, 2001



Anguilla Harbour is vulnerable to sea level rise due to its low lying location.

Credit: Anguilla National Trust

The anticipatory approach addresses the fact that some adaptation measures require a considerable investment in time for planning, research, negotiations, preparation and implementation. Other adaptation approaches represent simple extensions of accepted conservation and management practices. Their implementation will provide immediate conservation benefits that are desirable with or without climate change (win-win).

The anticipatory approach allows conservation practitioners and planners to identify those ecosystems, habitats, or species that are highly unlikely to remain viable under the anticipated climatic conditions. Early identification can allow decisions to be made on the cost-benefit of investing resources in ongoing conservation. In the case of the Port Royal mangroves in Jamaica, for example, the benefit that they provide in the form of support to fisheries, coastal stabilisation, and the protection of strategically important infrastructure of national importance are considerable. This justifies their ongoing conservation even if their complete collapse is predicted because they demonstrate no capacity or opportunity to retreat or accrete in response to increasing sea level (Alleng, 1999).

Reactive adaptation is the least attractive adaptation approach to managing sea

level rise because it implies responding to an imminent or existing threat from sea level rise. If no anticipatory measures have been put in place, the ability for habitats and ecosystems to adapt will be hampered by urbanisation and infrastructural barriers to migration and retreat. The costs of this approach to adaptation will be high for species and ecosystems, and may also be high for the communities that benefit from the ecosystem goods and services.

In some cases, ecosystems will be able to cope with sea level rise. Wetlands that are able to keep-up with sea level rise as a result of sediment deposition from coastal or terrestrial sources or accretion will adapt independently to sea level rise without the assistance of management interventions (autonomous adaptation).

Suggested actions

Anticipatory (proactive) Adaptation

- Reserve land to the landward of coastal ecosystems to accommodate habitat retreat, expansion or relocation.
- Mainstream biodiversity conservation into national and local planning processes.
- Adopt integrated coastal area management as a framework for decision making on land use tradeoffs.
- Conduct a preliminary scoping exercise to determine which ecosystems, habitats, or species demonstrate the best chances for successful adaptation to climate change and sea-level rise.
- Reduce non-climate stresses on ecosystems, habitats, and species capable of autonomous adaptation.

Planned Adaptation:

- Mainstream climate change into conservation management and national planning and development processes.



Wirebird (*Chardrius sanctae helenae*),
St. Helena's last endemic bird.

Credit: St. Helena National Trust

Develop an indicators framework

In order for adaptive conservation management to be effective, an indicators framework is needed to assess the effectiveness of management relative to the biodiversity being managed.

Adaptive management indicators are used to provide information on the state and condition of environmental resources, the magnitude or the intensity of the stressors or threats to the health or condition of natural resources. Also of critical importance are indicators relating to governance processes and actions (management, enforcement, monitoring and evaluation, stakeholder participation and awareness) taken to relieve the stresses or threats.

The Standing Committee of the UK Biodiversity Partnership has developed a framework of headline indicators for reporting on the Convention on Biodiversity (CBD) 2010 biodiversity targets. Arising from discussions at the annual Biodiversity Partnership Conference held in June 2005, a provisional set of 18 indicators was agreed in October 2005 (Maddock and Rose, 2006).

The indicators cover six 'focal' areas:

- Status and trends in biodiversity;
- Sustainable use;
- Threats to biodiversity;
- Ecosystem integrity/ecosystem goods and services;
- Funding; and
- Public opinion

Given the significance of the contribution made by UKOTs to the biodiversity of the UK, it may be desirable in the longer term to regularly assess and report on the status of UKOT biodiversity in terms that are consistent with the stated goals and objectives of the UK government, as well as those developed at national and local level.

Box 8. Where Do I Go for Local Climate Projections (Tompkins, 2005)

For most small islands, local or even regional assessments of the impacts of climate change may not yet exist. Developing these scenarios is useful to ensure that the most detailed information about potential risks is available. There are freely available models that can be accessed to develop regional models of climate change, such as the Providing Regional Climates for Impact Studies (PRECIS) model developed by the UK Met Office Hadley Centre.

PRECIS is a regional climate modelling system available to anyone who wishes to generate regional climate information with useful local detail including realistic extreme events. It is designed to run on a PC and can be applied easily to any region of the globe to generate detailed climate-change predictions. These give an updated description of PRECIS, examples of its use and cover aspects such as availability, support and requirements.

Scenario generator models are also freely available, such as Model for the Assessment of Greenhouse-gas Induced Climate Change (MAGICC) and the Regional Climate SCENario GENerator (SCENGEN). MAGICC and SCENGEN are user-friendly interactive software suites that allow users to investigate future climate change and its uncertainties at both the global and regional levels. In running MAGICC/SCENGEN, the user can intervene in the design of the global or regional climate change scenarios.

These 'off-the-shelf' models are very useful, and the examples recommended above are the best that are currently available. These models should be viewed as an interim measure only. More refined scenarios can be generated by drawing on local weather data. Local meteorological data can be used to reveal local trends in rainfall and average annual temperature as well as seasonal changes that are occurring.

In many cases local weather data will not exist. In fact in many small islands there may not have been much investment to date in meteorology at all. Even if local data are not currently available it is useful to begin collecting local weather data to provide information to decision makers over time on how key indicators have changed.

Apply appropriate management tools and processes

A number of existing management tools and processes are particularly valuable in situations where there is competition for the use of land space. Some common tools, such as the Environmental Impact Assessment (EIA), may need to be modified in the face of climate change.

a) Environmental Impact Assessments

Traditionally EIAs have served to provide developers, planners, regulators, policy makers, the public and conservation practitioners with information on the wide variety of impacts that a development may have on a range of sectors and environments. By describing and quantifying the potential impacts of a development, the multi-disciplinary EIA process can help to identify mitigation options and analyse the trade-offs between the benefits and the costs, (for example, loss of nursery areas for fishable resources or of the landscape beauty which drives tourism).

Climate change will make it necessary to ensure that natural hazard risk considerations are also addressed, so that the impacts of the environment on proposed development projects are evaluated and considered. The EIA process provides an opportunity for conservation practitioners and decision makers to ensure that adaptive approaches to biodiversity management and the associated precautionary principles are brought to bear in the EIA process. The EIA process can help planners and developers to identify and conserve those environmental services that reduce a development's vulnerability and risk. Conservation practitioners can use the EIA process to ensure that the market and non-market values of goods and services provided by ecosystem, habitats, and species are considered in the trade-off and cost benefit assessments that form part of the development decision-making process

(Box 10). An example of the way this has been in a small island context (Antigua and Barbuda) is outlined in Box 9 below.

Box 9. Integrating Natural Hazard Mitigation and Climate Change Adaptation Considerations into the EIA Process in Antigua and Barbuda

It is recommended that the following measures be implemented to support the integration of natural hazard mitigation and climate change adaptation considerations into the EIA process in Antigua and Barbuda:

(a) Revision of Definition of EIA

It is recommended that the definition of EIA under the Physical Planning Act be revised to also address the impacts of the environment (that is, natural hazards and climate change) on the project.

(b) Establishment of Formal EIA Procedures

It is recommended that legislation (Physical Planning Act and EIA Regulations) be enacted to provide certainty and clarity to the EIA process, and to provide a framework for regulating, administering and managing EIAs. Such legislation should allow for the clear identification of the obligations and duties of the proponent and the Development Control Authority as the government agency responsible for administering the EIA process.

(c) Provision of Clear Criteria for Screening and Scoping Environmental Impacts

It is recommended that an EIA Manual be developed to provide clear criteria and checklists for screening and scoping to ensure identification of the significant natural hazard impacts on the proposed project or activity. The development of such checklists can assist with the review and evaluation of the EIA report.

Box 9 continued overleaf

Box 9 Cont'd.

(d) Provision of Clear EIA Guidelines for the Preparation of EIA Reports

It is recommended that an EIA Guide be prepared to assist developers and EIA practitioners in undertaking the EIA process. Such a Guide should ensure that the EIA process addresses natural hazard impacts. The provision of Model Terms of Reference for addressing natural hazard mitigation and climate change adaptation considerations would also assist applicants undertaking an EIA, and ensure consistency in approach.

(e) Provision of Clear Criteria Governing EIA Experts

It is recommended that criteria be established governing the qualification, skills, knowledge and experience that persons conducting EIAs must possess. This approach may be used to ensure that persons conducting EIAs and assessing natural hazard impacts possess the requisite qualification, skills, knowledge and experience on natural hazards, hazard mitigation, climate change and climate change adaptation policies and measures. The same standard will have to be applied to government experts who review and assess EIAs.

Source: Caribbean Development Bank, 2004

b) Economic valuation

Since conservation benefits are generally not considered to have a market value, biodiversity conservation will be outbid and out-competed by other land use options unless the benefits of biodiversity conservation as a land use option can be marketed and promoted in terms that policy makers, planners, politicians and the public can understand.

The economic valuation of environmental goods and services provides the means of



Aloe, Anguilla.

Credit: Anguilla National Trust

assessing the costs and benefits of biodiversity conservation in monetary terms and a common language for comparing alternative investment opportunities or enterprises. This approach allows a wide range of stakeholders to be sensitised to the relative benefits of the competing land use options.

c) Conflict management

The competition for scarce land resources will generally lead to conflict and this is likely to become more acute under future climate change scenarios. Conflict management approaches will allow conservation practitioners to anticipate, identify, and strategise to effectively manage conflict situations.

Conflict management and negotiations are best pursued through recognised and credible negotiating mechanisms. The establishment of these mechanisms can be facilitated by the process that mainstreams climate change into the development process.

Negotiations should be supported by reliable and credible biological and climatic data and information. Conservation practitioners must be frank about the strengths and limitations of the available data and the projections that are developed on future climate scenarios. Stakeholders must be prepared for involvement in informed decision-making through effective public awareness and education campaigns on climate change and the need for effective adaptation.

Box 10. Case Study: Economic Valuation of Natural Resource in Montserrat

The Centre Hills Economic Valuation Project is being funded through a grant from OTEP and is being implemented through an agreement between six national and international partners: the Ministry of Agriculture, Lands, Housing and Environment, the Montserrat National Trust, the Montserrat Tourist Board, the Royal Society for the Protection of Birds (RSPB), the Durrell Wildlife Conservation Trust, and the Royal Botanic Gardens - Kew.

The project's focus is primarily on the Centre Hills as the last remaining significant forest resource on the island, but must address the larger institutional and natural resource management context, needs, and priorities for the entire island.

The project was developed out of the recognition that economic valuation of natural resources in Montserrat is a critical component in efforts to plan for the sustainable use and management of the natural environment in general, and the Centre Hills in particular. The project's goal is to inform policy makers about the value of these resources, along with the costs and benefits of various management and use scenarios in order to support sustainable human activity and livelihoods.

The approach to the economic valuation was to determine the Total Economic Value (TEV) to show the relative importance of the ecosystem services from the Centre Hills. The tentative estimate of the TEV is around US\$1 million per year, with a minimum and maximum value of US\$0.6 million and US\$1.6 million per year, respectively. Because the Centre Hills are the only source of drinking water on Montserrat, more than 40% of the TEV of the Centre Hills is determined by water services. Species abundance (18%) and forest products for domestic consumption (15%) are also highly valued ecosystem services in Montserrat. The results were obtained from secondary data sources as well as a survey of a representative sample of residents of Montserrat in a choice experiment.

The preliminary results of the cost benefit analysis for control of invasive feral pigs suggested that it is not an economically effective activity, although numerous issues were raised on data gaps and assumptions, including the fact that the full benefits of control were not included. It was also felt that other control methods could be used (for example, hunting as a control method) and these may make the activity more cost effective.

The Montserrat Environment Charter 2001 sets out a series of commitments for the Governments of Montserrat and the United Kingdom. This includes a commitment by the Government of Montserrat to "ensure that environmental considerations are integrated within social and economic planning processes, promote sustainable patterns of production and consumption within the Territory". Economic valuation will clearly be a vital tool in meeting this commitment.

The Centre Hills Economic Valuation Project Research Plan proposes to contribute to addressing this need through estimating the total economic value of goods and services provided by the Centre Hills in its current state. This will give a quantitative measure of how important the Centre Hills are to Montserrat in monetary terms, and provide a reference point with which to compare possible alternative future ecological states and land uses.

Source: Leotaud, 2008.

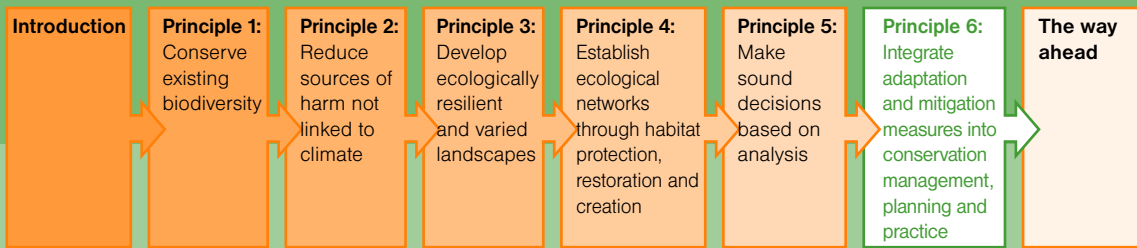
Suggested actions

Review the validity of management assumptions and approaches to ensure effective management of biodiversity under changing climatic conditions.

Adopt an indicators framework that is based on internationally-agreed principles and that has been mainstreamed into the national policy, planning and decision-making process, for example, the CBD reporting framework. This facilitates communication of UKOT-specific issues in terms that have already been defined and accepted at both the global and national level.

Develop local climate change scenario models as a basis for considering how conservation priorities may change.

Use management tools such as economic valuation, stakeholder identification, and conflict management to develop alternative scenarios and negotiate trade-offs.



Guiding principle 6

Integrate adaptation and mitigation measures into conservation management, planning and practice

In order for climate change adaptation initiatives to be effective and sustainable, climate change risk must be integrated into national and sectoral plans as well as those specifically aimed at biodiversity conservation. National governments, planning and development Ministries or agencies charged with management tasks in agriculture, water, forests, environment, physical planning, coastal development, health and

others, should begin to consider how climate change risks will affect their policies, plans, projects and programmes. This process, referred to as “mainstreaming” climate change, creates the broad enabling environment in which thematic or sectoral adaptation programmes and initiatives, such as biodiversity management and conservation, can be implemented on a sustained and coordinated basis.

Box 11. Case Study: Mainstreaming climate change: the Caribbean experience (Source: Walling and Creary, 2005)

Between 1998 and 2001, 12 members of the Caribbean Community (CARICOM) participated in the **Caribbean Planning for Adaptation to Climate Change (CPACC)** Project, designed to support Caribbean countries in preparing to cope with the adverse effects of climate change, particularly sea level rise.

One element of the programme was designed to help the countries to formulate a national climate change adaptation policy and an implementation plan. In the longer term, it was anticipated that national adaptation policies would inform and initiate a series of five-year national climate change vulnerability reduction programmes and strategies.

A seven-stage process was developed:

1. Inception meetings to identify the necessary actions and resources;
2. The development of a paper on climate change issues of national importance;
3. National consultative review of issues paper;
4. National workshop to solicit wider stakeholder input and build consensus on the appropriate climate change adaptation strategies and management mechanisms;
5. Drafting of national climate change policy;
6. Development of a five-year action plan/strategy for implementing Climate Change Adaptation Policy;
7. Submission of final policy to Cabinet for approval.

Box 11 continued overleaf

Box 11 Cont'd.

Lessons learned

The wider stakeholder involvement secured active participation and buy-in from all sectors and the issues paper served to document all stakeholder contributions. The process allowed stakeholders with different, and sometimes competing, development interests to recognise that climate change poses a common threat to all interests which necessitates a coordinated, collaborative approach to adaptation planning and implementation.

The CPACC process paved the way for subsequent vulnerability assessment initiatives in sectors critical to economic development in small islands of the Caribbean (tourism, water, agriculture, biodiversity) and for the more comprehensive adaptation programme, the Mainstreaming Adaptation to Climate Change (MACC), and projects under the Special Program on Adaptation to Climate Change (SPACC), which are now underway.

Mainstreaming climate change into conservation management

Given the uncertainties associated with projecting future climatic conditions, it is unlikely that in the immediate future practitioners will develop climate change adaptation strategies for conserving biodiversity that will adequately address all future climate change risks. Constant review and adjustment will be needed as new conservation research and information on climate projections becomes available. Flexible and iterative adaptive management will therefore become even

more essential to effective conservation management.

Table 3 provides guidance on the issues and actions that must be evaluated if conservation initiatives are to remain viable under climate change. Conservation strategies will range in scope from single species to habitats, ecosystems, and landscapes.

At the level of the individual UKOT, one of the existing conservation institutions should be allocated clear responsibility for co-ordinating and promoting the mainstreaming of climate change into conservation management plans and strategies.

Table 3. Evaluating management effectiveness in the context of climate change adaptation (based on IUCN, 2006)

Elements of management cycle	Design		Appropriateness/Adequacy		Delivery	
	Context	Planning	Inputs	Process	Outputs	Outcomes
Traditional focus of evaluation	Assessment of importance, threats and policy environment	Assessment of conservation management design and planning	Assessment of resources needed to carry out management	Assessment of the way in which management is conducted	Assessment of the implementation of management programmes and actions; delivery of products and services	Assessment of the outcomes and the extent to which they achieved objectives

Table 3 (cont'd.). Evaluating management effectiveness in the context of climate change adaptation (based on IUCN, 2006)

Elements of management cycle	Design		Appropriateness/Adequacy		Delivery	
	Context	Planning	Inputs	Process	Outputs	Outcomes
Additional focus of evaluation for climate change adaptation	Assessment of climate change threats (scenarios, models) and the adequacy of the enabling environment for climate change adaptation (mainstreaming)	Review of vision, goals, objectives, and strategies to assess their validity and feasibility in a changing climate	Assessment of resources required to review, revise and implement adaptive conservation management plans and strategies; assessment of new information and data needs. (e.g. local climate projections, scenarios, ecosystem models) for evidence based management	Assessment of new approaches to management that will be required to reduce the risk of climate change to managed species, populations, ecosystems, and habitats.	Assessment of the implementation of adaptation programmes and actions; the maintenance of ecosystem functions; delivery of ecosystem products and services.	Assessment of long-term adaptation outcomes and the extent to which they have effectively reduced climate risk, promoted resilience, and reduced vulnerability.
Traditional criteria that are assessed	Significance/values Threats Vulnerability Stakeholders National context	Protected area legislation and policy Protected area system design Protected area design Management planning	Resources available to the agency Resources available to the protected area	Suitability of management processes and the extent to which established or accepted management processes are being implemented	Results of management actions Services and products	Impacts: effects of management in relation to objectives
Additional criteria that are assessed for climate change adaptation	Significance/values, threats, risks, vulnerability, stakeholders, national context assessed in the context of climate change risk. The significance of climate threats, vulnerabilities.	Adaptation policy and strategies (climate change mainstreaming)	Resources available to the practitioners, agencies, protected areas in terms of: - downscaled climate projections. - decision support and modeling software. - training - expertise - funding	Suitability of management processes for sustaining ongoing adaptive approaches to conservation management. New management processes required for adapting to climate change	Results of management actions (see Recommended Actions for Principles 1 to 6)	Impacts: effects of management in relation to conservation and climate change adaptation objectives

Suggested actions

Review of the conservation vision, goals, objectives, strategies and values, along with the assumptions that underpin them. The basic question that will have to be answered is “Will this conservation initiative be viable under the plausible future climate conditions that we are considering?”

Evaluate both the “outputs” (work programme targets) and “outcomes” (long term objectives). Effective adaptation will be achieved through the incremental accumulation of management successes. A management approach that allows conservation practitioners to meet conservation output targets (species surveys completed, habitat restoration initiatives, public awareness events, interpretive signage erected) while managed populations, ecosystems or habitats continue to degrade, places the managed resources at risk. Managed recovery would be challenging under consistent climatic conditions. If climate change and the associated uncertainties are added to the mix, the challenge becomes daunting. The best adaptation approach is therefore to ensure that the health and resilience of biodiversity resources are being maintained or enhanced.

Employ a range of approaches to assess climate change risk in terms of the best available knowledge on projected climate trends at the managed area; knowledge of the boundary conditions required to sustain healthy target species, populations, habitats, or ecosystems; and an assessment of the value(s) of the targets of conservation.

Consider no-cost and low-cost adaptation approaches that will not preclude future management and adaptation options. For example, the following were identified in the context of managing mangroves for resilience to climate change (McLeod and Salm, 2006):

- applying risk-spreading strategies to address the uncertainties of climate change;*
- identifying and protecting critical areas that are naturally positioned to survive climate change;*
- managing human stresses on managed species, populations, habitats, ecosystems, or landscapes;*
- establishing green belts and buffer zones to allow migration in response to climate change, and to reduce impacts from adjacent land-use practices;*
- restoring degraded areas that have demonstrated resistance or resilience to climate change;*
- understanding and preserving connectivity between ecosystems, habitats, or biomes and sources of freshwater and sediment, and their associated habitats;*
- establishing baseline data and monitoring the response of targets of conservation to climate change;*
- implementing adaptive strategies to compensate for changes in species ranges and environmental conditions;*
- developing alternative livelihoods for ecosystem and habitat dependent communities as a means to reduce ecosystem and habitat destruction;*
- building partnerships with a variety of stakeholders to generate the necessary finances and support to respond to the impacts of climate change.*

Mainstreaming climate change into national development plans

Mainstreaming climate change into national development plans can also support effective biodiversity.

The mainstreaming or climate proofing of national development plans should be viewed as an additional component of

existing development processes and not a completely new process. In the case of the framework for economic development planning in the Turks and Caicos Islands, participation by the climate change focal point in the planning committee process facilitated the high level mainstreaming of climate change that would support and provide guidance to the consultative process.

Box 12. “Climate Proofing” National Development Plans (Source: Tompkins, 2005)

Infrastructural developments and the physical environment in general will be better able to withstand the projected impacts of climate change if weather and climate information (current climate variability and climate change projects), potential hazards and the associated risks are integrated into national and local physical planning processes. This type of activity is often referred to as “mainstreaming climate change” into or ‘climate proofing’ national development plans.

To successfully climate proof national development, a formal link must be established between the practitioners that understand climate change and its likely impacts (meteorologists, physicists, climate change professionals) and the planning arms of government. The priority is to establish a knowledgeable climate change focal point institution or mechanism (for example, the Meteorological Office or Service) that can interpret the climate science in the local context.

The first step in the climate proofing processes is to formally incorporate the focal point into development planning process. This could be through inclusion on a planning committee or by ensuring that, prior to planning approval being given, the focal point ‘climate checks’ the plans to ensure they are able to cope with and accommodate potential climate impacts. This arrangement increases the probability that decision makers will take climate change science into account. But inclusion of the focal point does not guarantee that climate science will be accepted as evidence to inform the development decision-making process. The focal point may be only a token presence until the impacts of climate change start to be experienced. The level of consideration given to climate science will depend on political commitment, the balance of interests among constituencies and vested interests; trade offs made in the context of scarce resources and development opportunities. For small islands, climate change is just one of many serious challenges with which they are confronted. Pressing priorities concerning socio-economic issues such as housing, education, and health care all compete for the resources available.

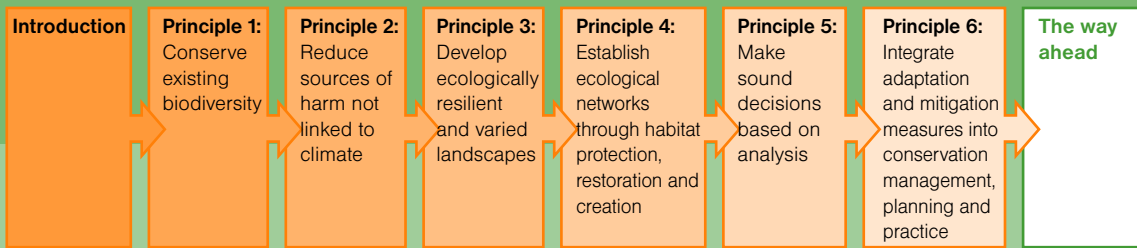
Climate change adaptation can find early acceptance where adaptation measures can deliver immediate and tangible benefits in addition to reducing risks of future climate change impacts. Adaptation measures that secure potable water supplies, reduce

Box 11 continued overleaf

Box 12 Cont'd.

vulnerability of human settlements to current climate extremes, create jobs and livelihoods, enhance investments, or increase food security, are more likely to be accepted by decision makers and their constituents. These types of adaptation options offer the opportunity for the integration of appropriate risk reduction strategies with other sectoral policy initiatives in areas such as:

- Sustainable development planning;
- Physical planning and development control (including infrastructure and transport planning);
- Natural disaster prevention, response and management;
- Fresh water resource management and development;
- Strategic environmental and public health management and planning;
- Integrated coastal management (coastal and marine resource management and development);
- Agriculture development;
- Economic initiatives and incentives;
- Fisheries management and development;
- Public education and awareness; and
- Sustainable tourism development.



The Way Ahead

Additional recommendations for the effective implementation of the guiding principles

In a small island territory setting, a number of factors may act jointly or individually as barriers to the enactment of policies and actions that will mitigate the adverse impacts of anthropogenic climate change in ways that may not pertain in continental settings.

Need for clear operational objectives

If strategies to mitigate the adverse impacts of anthropogenic climate change on natural resources and biodiversity cannot be monitored, they become difficult to implement. An adaptive management strategy, informed by clear operational objectives, and complemented by an indicators' mechanism developed around the Environmental State Indicators-Stress Reduction Indicators – Process (governance response) Indicators (ESI-SRI-PI), would provide both the clear focus and the process to keep operational management on target. An assessment of the environmental monitoring practices and capacities of 13 island states in the Caribbean under the GEF-funded Integrated Watersheds and Coastal Areas Management (IWCAM) project confirmed that a number of factors, including small staff complements, scarce funding, limited institutional size and capacity, and weak enabling environments, have contributed



Boobies on Letter Box Mast, Ascension.

Credit: Adrian Bowers

to the near absence of long-term, effective, environmental monitoring in all but a few cases. This situation is a common feature of small islands (Heileman and Walling, 2008).

Need for sufficient direct investment in environmental management

Local resources may be insufficient to cover the full range of investments needed to support an adaptive approach to environmental management. The establishment of baselines against which to assess changes in environmental state (ESI) and the effectiveness of management approaches (PI) to mitigate the impacts of

climate change through vulnerability reduction and resilience building (SRI) is an essential step in effective adaptation planning for biodiversity and ecosystem conservation. This requires the establishment of long term-monitoring of species and habitats, together with the factors that control the impacts of climate changes to detect changes and responses to adaptation strategies (Mitchell *et al.*, 2007). Support is also required for the cross-sectoral, multi-disciplinary research, experimentation, and modeling required for evidence based adaptive management (Mitchell *et al.*, 2007).

Integration of climate change issues and risks into sector policies

Climate change is a complex phenomenon. Its direct impacts on ecosystem goods and services will in turn affect economic activities across sectors, livelihoods, human health, and wellbeing. The cross-cutting influence of the impacts will require decision makers to adopt integrated multi-disciplinary approaches to adaptation planning. This will mean forgoing the traditional approaches to economic sector development and environmental management, characterised by compartmentalisation and limited coordination, if any. In order to effectively address the challenges posed by anthropogenic climate change, the strategies of sectors dependent on environmental resources and ecosystem goods and services must incorporate climate change risk into their sectoral strategies.

Institutional and human resource capacities

Many small island territories are characterised by small populations and small budgets. Technical expertise may exist within the population, but fall short in numbers and hence the range of specialisations. Small human resource pools and

budgets can lead to inadequate institutional capacity, misalignment of goals and poor governance. In most territories, environmental management units lack the breadth of technical expertise, technical tools and equipment needed to conduct effective cross-sectoral, adaptive natural resource management strategies in coordination with sectoral units. This challenge is being addressed in some island settings by establishing collaborative strategies that pool resources, skills, and expertise of the government, civil society and private sector.

Sufficient Investment in science and technology

Science and technology are critical if effective natural resource and conservation management is to be achieved under the impacts of anthropogenic climate change. In the context of adaptation to climate change in small islands, effective natural resource and conservation management is transformed from an environmental to a key developmental issue. Although the central role of environment in development has been a message that has been strongly promoted since the 1992 Rio Conference, climate change is fast depriving decision makers of the option to disagree with this reality. Effective adaptive natural resource and conservation management requires information and decision support tools to handle the complexity of the information that must be marshalled and coordinate the myriad of stakeholder influences and interests that must be considered. Adaptive natural resources management requires improved understanding and monitoring of the state of the environment (ESI) and the development of improved means to mitigate environmental degradation (SRI and PI).

Creative fund raising approaches will have to be combined with greater, coordinated support from the UK government to

address these issues. However, the needs and the types of support must be articulated by stakeholders in the UKOTs to ensure that the support is consistent with the circumstances and needs of each UKOT, and that a more programmatic approach to adaptive conservation is developed out of the disparate sources of funding that may emerge. In the Caribbean, the Caribbean Community Climate Change Centre (CCCCC) has coordinated the needs assessment and the development of partnerships among Caribbean national and regional research institutions, the Hadley Centre and DFID to provide down-scaled climate models for national and sub regional adaptation planning.

Knowledge transfer and communication

The effective implementation of adaption measures depends on effective communication and knowledge transfer. Traditionally, decision-making and planning have been based on historical data and documented experience but climate change requires greater focus on predicted scenarios. A new and evolving body of knowledge must be brought to bear on the various decision- and policy-making processes, and new, more holistic and integrated, evidence-based, decision-making processes will have to be developed and learned. The evidence and need for these changes, and the new approaches to process must be communicated effectively, capacities developed, and knowledge tested and exchanged. Researchers will need to have an understanding of the development and conservation questions for which policy makers and managers will require answers, while policy makers and managers will need to have an understanding of the new climate realities within which they will be required to manage. It is essential to communicate consistent messages in a recognised,



World Wetland Day Activities, Anguilla.
Credit: Anguilla National Trust

accessible, and straightforward way that reaches a wide audience (Mitchell *et al.*, 2007).

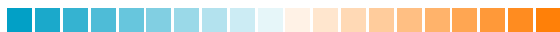
Broad public awareness of climate change and adaptation issues

Effective adaptive management is dependent on a functional response process. In this context process indicators (PIs) reflect the completion of institutional processes at the territorial level that will result in joint action on needed policy, legal, and institutional reforms and investments (Duda, 2002) that aim to mitigate the impacts of anthropogenic climate change and enhance the effectiveness of natural resources and conservation management. Process indicators can be considered to be “governance response” indicators, governance being processes through which diverse elements in society wield power and authority, influence and enact policies and decisions concerning public life and development (Ehler, 2003).

This process involves all stakeholders: government, private sector, and civil society. It follows that limited public awareness will constrain the effectiveness of the governance processes. Public awareness of the consequences of human-induced changes to the environment can serve to build a broad-based constituency for effective adaptation planning but is insufficient unless accompanied by action.

The chapters in this book are intended to provide UKOTs with guidance on practical steps they can take in planning for and adapting to climate change. By establishing strategies and implementing policies to adapt to and mitigate against climate change, the UKOTs will be providing a firm foundation for their own future well-being.

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This book is designed to provide guidance to practitioners who plan and manage biodiversity in the United Kingdom Overseas Territories (UKOTs). It aims to provide a practical introduction to tools and methods for mainstreaming climate change risk reduction into conservation management planning and, by extension, into the broader development processes within which conservation management takes place. It provides guiding principles for managing ecosystem goods and services in a changing climate and suggests approaches for adapting existing plans and projects. It focuses primarily on direct biodiversity management but also provides an overview of sectoral opportunities for managing ecosystem goods and services.

This book forms part of series on climate change in the UK Overseas Territories, prepared by the Caribbean Natural Resources Institute for the Joint Nature Conservation Committee. It has been funded by the Overseas Territories Environment Programme with assistance from the Commonwealth Foundation. The series comprises:

Climate Change in the UK Overseas Territories : An Overview of the Science, Policy and You - A look at climate science and policy and how global warming affects UK Overseas Territories.

Climate Change in the UK Overseas Territories : A Brief Overview of the Science, Policy and You - Executive summary of the document above.

Climate Change: An Overview for Politicians and Senior Decision Makers - Key issues for policy and decision makers to take into account in climate-proofing national policies and programmes.

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Guidance for Biodiversity Conservation and Management in a Changing Climate in the UK Overseas Territories – Practical guidance for the practitioners who must plan and manage biodiversity in the face of climate change.



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