Climate change adaptation for biodiversity

Introduction

- Global biodiversity is in trouble[1].
- Whilst conservation activity has reduced this decline, substantial increases in the magnitude of conservation effort are required in the longer term[2].
- Climate change has contributed to some biodiversity declines (Box 1), and is likely to become increasingly important through time[3].
- Biodiversity conservation will increasingly need to take account of climate change.

Adaptation

- Adaptation is defined as initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects**.**
- Some have suggested adaptation will require a paradigm shift in conservation. Others, that it involves the application of existing conservation approaches in a changing climate[4].
- Helping biodiversity adapt is important for maintaining ecosystem services integral to livelihoods and to human climate change adaptation.
- There is an urgent need for practical guidance on what conservation adaptation should look like, and how it relates to the adaptation of other sectors.

Box 1. Climate change impacts on amphibians

One third of amphibian species are currently threatened with extinction. Climate change appears to be a significant causal factor for many species. This strawberry dart-frog is amongst the community of Costa-Rican amphibians which have declined in abundance by 75 %, a decline which has been at least partially attributed to climate change[5].

Kate Risely

Climate-smart conservation actions

- Adaptation action undertaken now should be based on existing conservation measures which are also likely to be useful in a changing climate (climate-smart actions).
- These are likely to be effective now and are best understood because they are based on current conservation practice.
- They can be identified by considering the most likely impacts of climate change on species and habitats, but also include some general actions that will always be beneficial (Box 2).
- Reducing the severity of existing threats to species will always be beneficial.

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[1] Butchart et al. 2011 Science 328: 1164-1168
[2] Rands et al. 2010 Science 329: 1298-1303
[3] IPCC 2007 Contribution of working group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
[4] Dawson et al. 2011 Science 332: 53-58, Doerr et al. 2011. *J Appl Ecol* **48**, 143–147, Hodgson et al. 2009 *J Appl Ecol* **46**, 964–969; 2011 *J Appl Ecol* **48**, 148-152, Heller & Zavaleta 2009 Biol Cons 142: 14-32
[5] Whitfield et al. 2007 PNAS 104: 8352-8356, Wake & Vredenberg 2008 PNAS 105: 11466-11473

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Box 2. Example climate-smart conservation actions

- Prioritise the establishment of protected areas in areas of high environmental heterogeneity (e.g. mountains, ecotones) to maximise resilience to a changing climate (Box 3).
- Create coherent networks of protected areas to enhance metapopulation resilience and accommodate range-change in response to climate change.
- Undertake hydrological management to manipulate water levels and flow to minimise detrimental consequences of likely future changes to precipitation patterns (Box 4).
- Soft engineering to control coastal and terrestrial erosion as a result of increased frequency of storm events and sea-level rise.
- Appropriate management of fire regimes and vegetation succession to maximise habitat quality and promote habitat heterogeneity.
- Management to control potential competitor, predator or parasitic species whose populations may increase as a result of climate change to the detriment of other species of conservation concern.
- Management to enhance prey populations and food resources negatively impacted by climate change to the detriment of populations of conservation concern (Box 4).

Box 3. Site protection in a changing climate

The Cape Floristic Region of South Africa is one of the most floristically diverse parts of the globe, but is threatened by climate change. Models project significant future changes in the distribution of many plant species which mean that many may be poorly protected by the current protected area network. These models can be used to identify priority areas for further protection. Boundary zones between different rock-types should also be targeted for conservation action as they are focal areas for ecological and evolutionary processes[5].

Odette Curtis, Renosterveld Project Co-ordinator / FFI

Box 4. Adaptation management in action

Golden plovers are characteristic of northern peatland habitats. Here, craneflies provide an important food source whose abundance is linked to breeding success. However, young cranefly larvae are killed by high summer temperatures which cause the peat to dry out. Management to raise water levels by blocking drainage ditches increases cranefly abundance and improves the resilience of the whole system to climate change. The control of increasing generalist predators may also compensate for climate change impacts on plovers[6].

Nigel Clark / BTO

[5] Hannah et al. 2005 Bioscience 55: 231-242, Pressey et al. 2007 TREE 22: 583-592

[6] Pearce-Higgins *et al.* 2010 Global Change Biology 16: 12-23, Pearce-Higgins 2011 *Ibis 153: 345-356, Carroll et al. 2011* Global Change Biology 17: 2991-3001

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Novel conservation actions

- With an increasing magnitude of climate change, then more novel conservation actions will need to be considered.
- These are less closely related to existing conservation action, and therefore less well understood, less certain in their feasibility and effectiveness and potentially more risky with greater potential for unintended consequences (Box 5).

Box 5. Example novel conservation actions

- Reduce long-term exposure to climate change through soft (e.g. tree planting) or hard (e.g. deepen waterways) engineering options to increase the range of microclimates.
- Implement emergency intervention to reduce exposure to severe climate change events, such as temporary shading or pumping cold water into warming aquatic habitats.
- Assisted colonisation of species outside of their existing range into areas which become climatically suitable (Box 6).
- Tolerate or translocate non- native species into new areas where they provide functional surrogates of other species vulnerable to climate change, to ensure ecosystem function.
- Promote hybridisation, selective breeding or genetic engineering to increase the resilience of populations to change.

Towards an adaptation strategy

- Conservationists will need to progress along a spectrum of actions from those based on existing conservation actions to novel actions as climate change increases (Box 7).
- In the short-term, adaptation actions should build upon existing conservation action to minimise risk and maximise effectiveness. This will also make the most of limited conservation resources, focusing on those options which deliver outcomes now that are also likely to be climate-smart. Many of these will build resilience to change.
- In the longer-term, with increasing severity of climate change, more radical and novel actions may be required to accommodate and manage for change. Because of the uncertainties and risks associated with these, they should form the focus of research effort now[7]. Some measures may require lengthy lead-in time (e.g. woodland creation).
- A shift in conservation approach may be required with increasing severity of climate change, from actions to build resilience, which may buy time for vulnerable species and habitats, to those accommodating responses to change, such as promoting range shifts. Understanding how to manage and time this shift will require detailed ecological knowledge and biodiversity monitoring, and the trial of novel techniques.
- Through time, the past distribution and abundance of species will become less relevant for setting future conservation objectives, which should increasingly be based on the biodiversity potential in new climates and changing conservation need.

Box 6. Assisted colonisation

If options to increase the resilience of populations to climate change fail, and it is not possible to reduce the exposure of vulnerable populations to climate change, then measures to enable that species to colonise areas of favourable climatic conditions may be required. For species with limited dispersal ability, this could include assisted colonisation, where individuals are artificially translocated to new areas of increasingly favourable climate. Given the many conservation problems caused by introductions of invasive non-native species, this approach is controversial, and should become the focus of research to reduce the risks and maximise the associated potential benefits[8].

[7] Pearce-Higgins *et al.* 2011 *Ibis* 153: 207-211

[8] McDonald-Madden et al. 2011 *Nature Climate Change* 1: 261-265, Loss et al. 2011 *Biological Conservation* 144: 92-100

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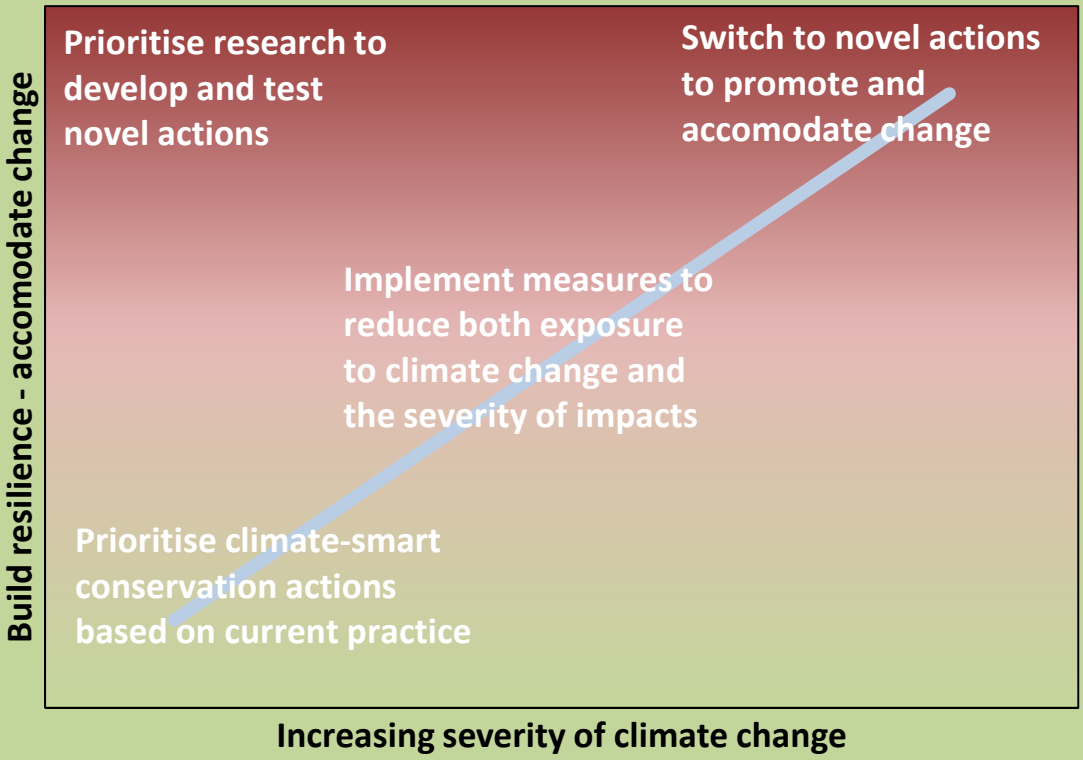
Conclusions

Box 7. Shifting from existing conservation to novel actions
With increasing severity of climate change the required shift from climate-smart conservation to build resilience, to novel actions to accommodate change, is indicated by the line. The current uncertainty / risk associated with actions in indicated by the shift from green (certain / low risk) to red (uncertain / high risk). Priority actions are given in white.



Conservation organisations should:

- Focus conservation effort on existing actions which are climate-smart, to build resilience.
- Develop robust monitoring and research of climate change impacts on populations, species, habitats and ecosystems.
- Reduce exposure and increase resistance of vulnerable species to negative climate change impacts.
- Undertake research and testing of novel options to increase their feasibility and reduce their risk when required in the future.
- When climate change exceeds the capacity to provide resilience, shift to measures which accommodate and manage for change.

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