CENTRE FOR Tropical Biodiversity & Climate Change

JAMES COOK UNIVERSITY AUSTRALIA

Reef & Rainforest RESEARCH CENTRE

PROJECT FACT SHEET

CLIMATE CHANGE AND HABITAT REFUGIA

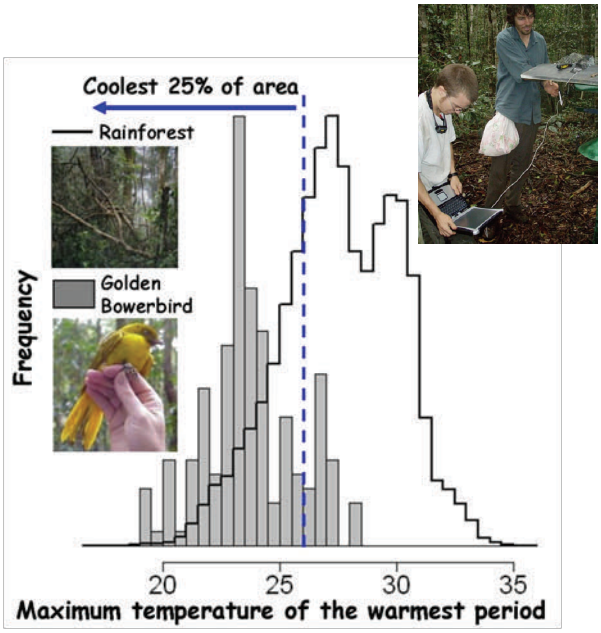
Importance of Cool Refugia

Climate change is set to compound existing threats to biodiversity such as habitat fragmentation and degradation in rainforests. Tropical species are already shifting their distributions in response to increasing modern temperatures. Thus, forests that are important to biodiversity now will not necessarily be so in the future. In many places, existing networks of protected areas will be inadequate to maintain representation of biodiversity under climate change.

There are large costs associated with delaying planning decisions that incorporate an adaptation-management response to climate change. Hence systematic investment in conservation needs to be immediately informed by climate change science.

The question is, how and where should we act to maximise return from conservation investment? One tangible action we can take to stem loss of biodiversity is to minimise exposure to climate change. This can be achieved by safeguarding places where species are most likely to survive as the climate warms. These places, termed refugia, are areas in the landscape that are naturally buffered from extreme weather by features such as dense canopy, elevation, coastal influences and shading. These elements combine to generate unusually cool microclimates. In many cases, species may survive only in these scattered, fragmented thermal refugia. Therefore, identification, protection and management of refugia will be critical in minimizing species extinctions.

The Beautiful Nursery Frog (*Cophixalus concinnus*) is a highly restricted rainforest species associated with cool mountaintop environments (© Stephen Williams).



Project Aims and Approach

Researchers from the Centre for Tropical Biodiversity and Climate Change at James Cook University (funded by the Marine and Tropical Sciences Research Facility), are working to identify climate refugia that could promote adaptation to climate change in rainforest species of Australia's Wet Tropics. Major priorities are to identify existing refugia not currently included in the protected area network, along with sites where land degradation could potentially be reversed to strengthen refugia. Around 45 per cent of the region's endemic rainforest species are found in just 25 per cent of the coolest rainforest and these limited areas of cool habitat could become increasingly important if species shift upslope in response to increasing temperatures.

Researchers monitor air temperature across a network of weather stations to determine the location of the coolest patches of rainforest in the region (inset). A disproportionately high number of endemic rainforest species in the region, such as the Golden Bowerbird (*Prionodura newtoniana*), are primarily found in just 25 per cent of the coolest rainforest (main graph).

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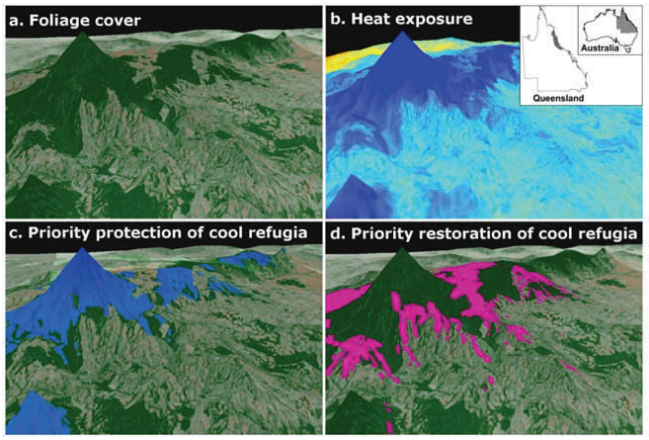
Making Decisions in Complex Landscapes

Deforestation has mostly impacted moderate to warm parts of the region. Further, the greater portion of remaining cool habitat (85%) is already contained within an established protected area network, the Wet Tropics World Heritage Area. Nevertheless, considerable work remains to be done to reduce extinction risk and maximize population sizes of rainforest dependant wildlife under climate change. Two major initiatives include encouraging private landholders to protect high conservation value forests and providing resources to augment degraded rainforest within key refugia. Nature Refuge Agreements are voluntary agreements between landholders and government and provide a mechanism to protect existing habitat on freehold land. Supplementary tree planting, weed control and provision of key microhabitat features such as fallen logs or tree hollows can increase the value of degraded forest for specialist rainforest species.

Restoration of rainforest has the potential to increase the local extent of cool habitat and consolidate existing areas of prime habitat in fragmented landscapes. Climate models provide clear guidance as to where restoration activities should be targeted. Models reveal that ninety-seven percent of degraded land within cool refugia of the Wet Tropics falls solely within the Evelyn-Atherton tablelands (above). This information is now being used to initiate projects to increase the size of refugia starting with linking fragmented patches of rainforest within the World Heritage protected area network.



Cool rainforest refugia within a modified landscape. Patterns of foliage cover (green, a) have a strong influence on buffering heat exposure (i.e. maximum temperature of the warmest period, blue to red, b). Two major adaptation strategies for habitat management include the protection of existing areas of cool habitat (blue, c), and restoration of foliage cover within deforested areas that formerly supported cool habitat (purple , d). Evelyn-Atherton tablelands are shown in the foreground.

This study shows how to target rainforest protection and restoration to maximize the persistence of biodiversity under climate change. The approach has been highly instructive in the Wet Tropics and has broader application in identifying important refugia across all rainforests and indeed other ecosystems in Australia. However, there remains a range of management actions that can be deployed to achieve this goal. For example, restoration can take the form of high diversity ecological plantings, less intensive plantings favored by mixed-species cabinet timber production and carbon sequestration models, or management of natural (autogenic) regrowth. Each of these options differ in their financial cost and time lag between implementation and realising biodiversity benefits. Optimizing tradeoffs between competing management strategies will be addressed in the next phase of this research program.

Ideas in this information sheet are based on:

Shoo LP, et al. (in press) Targeted protection and restoration to conserve tropical biodiversity in a warming world. *Global Change Biology*.

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The Centre brings together researchers with expertise in:

ecology, climate change, conservation biology, ecosystem processes, physiology, biogeography, genetics, terrestrial-freshwater systems, and spatial analysis.

We are located in
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