Assessing
Species’ Vulnerability to
Climate Change

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Thomas et al. 2004

“We predict, on the basis of mid-range climate-warming scenarios for 2050, that 15-37% of species in our sample of regions and taxa will be ‘committed to extinction’”
Leucospermum tomentosum:
range centres in 10 year time slices

<table>
<thead>
<tr>
<th></th>
<th>Distances moved (km)</th>
<th>Average altitude (m)</th>
<th>Average latitude (°S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>0</td>
<td>88.57</td>
<td>33.21</td>
</tr>
<tr>
<td>20%</td>
<td>25.3</td>
<td>113.83</td>
<td>33.43</td>
</tr>
<tr>
<td>40%</td>
<td>20.0</td>
<td>137.93</td>
<td>33.59</td>
</tr>
<tr>
<td>60%</td>
<td>17.2</td>
<td>194.85</td>
<td>33.72</td>
</tr>
<tr>
<td>80%</td>
<td>46.4</td>
<td>269.91</td>
<td>33.98</td>
</tr>
<tr>
<td>100%</td>
<td>17.4</td>
<td>296.06</td>
<td>34.09</td>
</tr>
</tbody>
</table>

Midgley et al 2002
Projected 2050 Range Centroid Shifts of Proteaceae in the Cape Floral Region

Midgley et al 2002
Leatherback Turtles and climate change

Turtle-y exposed to climate change
Arctic Foxes and climate change

Out-foxed by Arctic warming
Salmon and climate change

Fish in hot water
Koalas and climate change

Hungry for CO$_2$ cuts
Quiver Trees and climate change
Hoffmann and Kaleme have used repeat photography to track changes in *Aloe dichotoma* populations.

**Calvinia**

Increase of 108% over 98 years
Pofadder District

Decline of 52%

Decline of 80%
Aloe dichotoma’s range is being **squeezed** between.....

A rapidly **contracting** trailing range edge

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Slow or **limited dispersal** at the leading range edge
Cultivation of savanna trees (C$_3$ photosynthesis) at a range of CO$_2$ concentrations

- Plants exposed to a full range of CO$_2$ levels viz. 180, 280, 370, 550, 700 and 1000 ppm, in Open Top Chambers
- Plants - Acacia karroo, Acacia nilotica, Dichrostachys cinerea and Themeda triandra.
Cultivation of savanna trees (C₃ photosynthesis) at a range of CO₂ concentrations (100-700ppm)

Kgope et al. (2005)
Bush Encroachment

Increased CO$_2$ levels are causing shifts in savannah dynamics due to improved C$_3$ (tree) vs. C$_4$ (grass) competitive ability

Managed Nature Reserve

Communal grazing area outside reserve

Hluhluwe Game Reserve
1954

Hluhluwe Game Reserve
2001

South Africa

Bond et al (2005)
Thomas et al. 2004

“We predict, on the basis of mid-range climate-warming scenarios for 2050, that 15-37% of species in our sample of regions and taxa will be ‘committed to extinction’.”
Which species are most **susceptible** to climate change?
Assessing species’ vulnerability to climate change

**Sensitivity and Unadaptability Traits**

>90 detailed traits
SENSITIVITY to Climate Change

A. Specialised habitat

B. Narrow environmental tolerances or thresholds

C. Environmental triggers
   which are likely to be disrupted
   e.g. for migration or breeding times

D. Interspecific interactions
   which are likely to be disrupted
   e.g. changes in food sources, disease,
   competition & mutualisms

E. Rarity
POOR ADAPTABILITY to Climate Change

A. Poor dispersal ability
   Low maximum dispersal distances
   Barriers to dispersal

B. Poor evolvability
   Low genetic diversity
   Slow turnover of generations
   Low reproductive output
EXPOSURE to Climate Change

A. Sea level rise

B. Temperature change
   Heat waves, ice/snow melt

C. Precipitation change
   Droughts, floods, extreme storms, changing river flow

D. Ocean Acidification
7 Forms of Susceptibility and their Implications for Conservation

- **High latent risk (4)**
  - No current threat
  - Monitor environment

- **Potential adapters (5)**
  - May not be threatened
  - Monitor and support adaptive responses

- **Sensitive (1)**

- **Un-Adaptable (2)**

- **Exposed (3)**

- **Potential copers (6)**
  - May not be threatened
  - Monitor population trends

- **Highly Susceptible (7)**
  - Of greatest concern
  - Specific research needed. Interventions probably needed

*The IUCN Red List of Threatened Species™*
Assessing species’ vulnerability to climate change

Pilot Species Groups

- Birds (~9,856 spp.)
- Amphibians (~6,204 spp.)
- Warm-water reef-building corals (797 spp.)
- South African Proteaceae (389 spp.)

25 detailed traits
Assessing Species’ Susceptibility to Climate Change
<table>
<thead>
<tr>
<th>Trait Group</th>
<th>Biological Trait</th>
<th>No. of species qualifying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Birds</td>
</tr>
<tr>
<td><strong>A. Specialised habitat and/or microhabitat requirements</strong></td>
<td>Altitudinal range narrow and at high elevation</td>
<td>224</td>
</tr>
<tr>
<td></td>
<td>Restricted to habitats susceptible to climate change</td>
<td>820</td>
</tr>
<tr>
<td></td>
<td>High degree of habitat specialisation</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td>Dependence on a particular microhabitat</td>
<td>438</td>
</tr>
<tr>
<td></td>
<td><strong>Contribution of trait group</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>46%</td>
</tr>
<tr>
<td><strong>B. Narrow environmental tolerances or thresholds that are likely to be exceeded due to climate change at any stage in the life cycle</strong></td>
<td>Global temperature tolerances likely to be exceeded</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Larvae particularly susceptible to heat stress</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>Sensitive to increased sedimentation</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>Vulnerable to physical damage from storms and cyclones</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td><strong>Contribution of trait group</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td><strong>C. Dependence on specific environmental triggers or cues that are likely to be disrupted by climate change</strong></td>
<td>Environmental trigger/cue disruption observed or likely</td>
<td>316</td>
</tr>
<tr>
<td></td>
<td><strong>Contribution of trait group</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td><strong>D. Dependence on interspecific interactions which are likely to be disrupted by climate change</strong></td>
<td>Dependent on very few prey or host species</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Dependent on an interspecific interaction that is likely to be impacted by climate change</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Susceptible to chytridiomycosis and/or enigmatic decline</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Susceptible to breakdown of coral-zooxanthellae interaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Contribution of trait group</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td><strong>E. Poor ability or limited opportunity to disperse to or colonise a new or more suitable range</strong></td>
<td>Low maximum dispersal distances</td>
<td>1,500</td>
</tr>
<tr>
<td></td>
<td>Geographic barriers limit dispersal opportunity</td>
<td>709</td>
</tr>
<tr>
<td></td>
<td>Limited opportunity to establish at new locations</td>
<td>769</td>
</tr>
<tr>
<td></td>
<td>Low genetic diversity or known genetic bottleneck</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td><strong>Contribution of trait group</strong></td>
<td></td>
</tr>
</tbody>
</table>
Assessing Vulnerability of Albertine Rift Species to Climate Change

January 2010 – December 2011
Threatened amphibians

Total numbers

Proportion of total species

The IUCN Red List of Threatened Species™
Threatened birds

Total numbers

Proportion of total species

The IUCN Red List of Threatened Species™
Assessing climate change susceptibility of human utilised species in the Albertine Rift

Using the susceptibility framework approach to assess:

397 mammals
175 reptiles
260 plants

~1000 fishes
(120 amphibians)

(1060 birds)

Species Experts Technical Meeting – Entebbe (August 2010)
We’re gathering information on the use and livelihoods values of Albertine Rift species.

→ Projections of future declines (and resilience) of important resource species.
Assessing climate change vulnerability of Albertine Rift species

→ ‘Holistic’ assessments of species’ vulnerability
→ Contribution to assessment of human’s vulnerability
→ Key information for adaptation strategies for both biodiversity and humans (e.g. lists of susceptible species per PA, inputs into regional and local monitoring strategies, human development plans, species management plans, regional and taxonomic conservation prioritisation, etc.)
“Thank God! A panel of experts!”
Reintroductions and Invasives SG’s are drafting IUCN Guidelines on Assisted Migration
The European Butterfly Climate Change Indicator

Changes in Community Temperature Index (CTI)

Species Temperature Index (STI) – long-term average temperature experienced by a species over its range

Community Temperature Index (CTI) – the average STI in an assemblage

Increased CTI = butterfly communities increasingly composed of species associated with warmer temperatures

Overall shift (1990-2007) corresponds to:
- 206 ±148km in the UK;
- 125 ± 62km in France

Birds shown to move 86km over this period

Van Swaay et al. 2009 - unpublished
Found a significant positive relationship between observed population changes and bioclimatically modelled change in potential range (based on population trends in 108 Species from 20 European countries (1980-2005))

Used this to derive a Climate Impact Indicator – ratio of population index for those gaining vs. those losing range (applied to 122 species in 26 European countries)
An Indicator of the Impacts of Climate Change on European Bird Populations

Climate Positive vs. Climate Negative Species

Gregory et al. 2009 – PLoS ONE

Tracking climate change impacts on species over time

Increasing climatic impact on bird populations

Decreasing climatic impact on bird populations