The role of agroecosystems in biodiversity conservation

Carlo Rondinini
Global Mammal Assessment programme
Dipartimento di Biologia e Biotecnologie
Università degli Studi di Roma La Sapienza
1. Increasing human pressure (conversion to agroecosystems included) causes global biodiversity decline.
1. Increasing human pressure (conversion to agroecosystems included) causes global biodiversity decline

2. Species concentrate in the remnant natural areas

3. This is where most conservation efforts are directed

BUT

4. Conserving biodiversity in intact natural areas is not enough

5. Future scenarios predict further loss of natural habitat

THEREFORE

6. Biodiversity must be conserved also in converted areas
1. The increasing human pressure on the natural environment, including the conversion into agroecosystems, is causing the ongoing global biodiversity decline
The IUCN Red List

The IUCN Red List of Threatened Species™ 2009.2

Mammals

Included in the IUCN Red List is the comprehensive assessment of the conservation status of the world's 5,488 species mammal species. Here you will find global summary statistics for the assessment, as well as individual species accounts including IUCN Red List threat category, range map, ecology information, and other data for every mammal species.

The current dataset on mammals is the product of one of several global initiatives led by IUCN and partners to rapidly expand the geographic and taxonomic coverage of the IUCN Red List.

Use the search tool at the top of the page to search for mammals in the IUCN Red List database by name, taxonomy, country, region, habitat type, threat type, or IUCN Red List status.

Globally threatened species

Global past trend of threat

Past, present and predicted global extinctions

Species extinction

E/MSY

Mammals, birds & amphibians

Birds

Plants

Plants & animals

Background extinction rate
Red list
Jetz
van Vuuren
Malcom
Thomas

CBD (2010)
Global threats to mammals

How we are dealing with threats globally

2. Species concentrate in the remnant natural areas that are still intact or have not been extensively converted
Sample: 5030 (ca. 95%) terrestrial mammals

<table>
<thead>
<tr>
<th>Order</th>
<th>Number of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afrosoricida</td>
<td>54</td>
</tr>
<tr>
<td>Carnivora</td>
<td>280</td>
</tr>
<tr>
<td>Cetartiodactyla</td>
<td>240</td>
</tr>
<tr>
<td>Chiroptera</td>
<td>1139</td>
</tr>
<tr>
<td>Cingulata</td>
<td>21</td>
</tr>
<tr>
<td>Dasyuromorphia</td>
<td>73</td>
</tr>
<tr>
<td>Dermoptera</td>
<td>2</td>
</tr>
<tr>
<td>Didelphimorphia</td>
<td>94</td>
</tr>
<tr>
<td>Diprotodontia</td>
<td>139</td>
</tr>
<tr>
<td>Eulipotyphla</td>
<td>442</td>
</tr>
<tr>
<td>Hyracoidea</td>
<td>5</td>
</tr>
<tr>
<td>Lagomorpha</td>
<td>92</td>
</tr>
<tr>
<td>Macroscelidea</td>
<td>16</td>
</tr>
<tr>
<td>Microbiotheria</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Order</th>
<th>Number of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monotremata</td>
<td>5</td>
</tr>
<tr>
<td>Notoryctemorphia</td>
<td>2</td>
</tr>
<tr>
<td>Paucituberculata</td>
<td>6</td>
</tr>
<tr>
<td>Peramelemorphia</td>
<td>19</td>
</tr>
<tr>
<td>Perissodactyla</td>
<td>16</td>
</tr>
<tr>
<td>Pholidota</td>
<td>8</td>
</tr>
<tr>
<td>Pilosa</td>
<td>10</td>
</tr>
<tr>
<td>Primates</td>
<td>411</td>
</tr>
<tr>
<td>Proboscidea</td>
<td>2</td>
</tr>
<tr>
<td>Rodentia</td>
<td>2215</td>
</tr>
<tr>
<td>Scandentia</td>
<td>19</td>
</tr>
<tr>
<td>Sirenia</td>
<td>3</td>
</tr>
<tr>
<td>Tubulidentata</td>
<td>1</td>
</tr>
</tbody>
</table>

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
An example from IUCN Red List website for *Lyncodon patagonicus*

**Habitat and Ecology**

*Lyncodon patagonicus* is found in herbaceous and shrub steppes and xerophytic woodlands (Osgood, 1943; Prevosti and Pardiñas, 2001). Its habits are little known; available data indicate that *L. patagonicus* is nocturnal-crepuscular and that it preys on fossorial rodents and birds (Cabrera and Yepes, 1940; Koslowsky, 1904; Redford and Eisenberg, 1992). May be associated with tuc-tuc (Ctenomys spp.) communities (Tell et al. 2001).

**Systems:** Terrestrial

**List of Habitats:**
- 3. Shrubland
- 3.4. Shrubland - Temperate
- 4. Grassland
- 4.4. Grassland - Temperate

**Range of**

*Lyncodon patagonicus*

---

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Species-habitat relationships

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Environmental variables

Globcover (ESA, 2008)
300m resolution

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Environmental variables

SRTM elevation (NASA and USGS, 2007) at 90m resolution

Globcover and SRTM water

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals Phil Trans R Soc B in press
Habitat suitability models (HSM)

Habitat data

Combined environmental variables:
- Land cover
- Elevation
- Hydrology

Range of *Lycodon patagonicus*

Habitat suitability model of *Lycodon patagonicus*

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Results of HSM evaluation

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Global mammal richness (geographic ranges)

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
Global mammal richness (HSM)

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals Phil Trans R Soc B in press
Relative difference (ranges - HSM)
Global trend of threat

Human population density

WCMC (2004)
Mammal distribution by broad habitat type

Rondinini et al. (2011) Global habitat suitability models of terrestrial mammals *Phil Trans R Soc B* in press
3. Remnant natural areas are also those where most conservation efforts (including the creation of protected areas) are directed
Protection level of main biomes

Protection level of main biomes

<table>
<thead>
<tr>
<th>Habitat converted</th>
<th>Habitat protected</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperate Grasslands, Savannas &amp; Shrublands</td>
<td>4.6</td>
<td>10.1</td>
</tr>
<tr>
<td>Mediterranean Forests, Woodlands &amp; Scrub</td>
<td>5.0</td>
<td>8.2</td>
</tr>
<tr>
<td>Tropical/Subtropical Dry Broadleaf Forests</td>
<td>7.6</td>
<td>6.4</td>
</tr>
<tr>
<td>Temperate Broadleaf &amp; Mixed Forests</td>
<td>9.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Tropical/Subtropical Coniferous Forests</td>
<td>6.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Tropical/Subtropical Moist Broadleaf Forests</td>
<td>16.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Tropical/Subtropical Grasslands, Savannas &amp; Shrublands</td>
<td>11.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Flooded Grasslands &amp; Savannas</td>
<td>18.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Deserts &amp; Xeric Shrublands</td>
<td>9.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Montane Grasslands &amp; Shrublands</td>
<td>24.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Temperate Conifer Forests</td>
<td>26.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Boreal Forests/Taiga</td>
<td>8.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Tundra</td>
<td>16.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

4. Unfortunately it is demonstrated that protecting only intact natural areas is not enough to conserve biodiversity
Species represented in remaining habitat

Species Numbers and Habitat Area

Estimated Range of Species Loss

Ecoregional Goal of 30% of Historical Extent (e.g. circa 1850)

Habitat Remaining

IUCN YEAR 2000 GOAL 12% PROTECTED

McNeely et al. (2001)
Italian protected areas

Boitani et al. (2003)
Elevation of Italian protected areas

High elevation == low economic value

Boitani et al. (2003)
What else should be protected in Italy to conserve vertebrates

Boitani et al. (2003)
5. The scenarios of socio-economic development (including the most optimistic) predict an increase rather than a decrease of anthropogenic pressure in the next 40 years, with further habitat loss for species
Global models of socio-economic development

- **Scenarios**
  - Millennium Ecosystem Assessment (MEA 2005)

- **Amount of land converted**
  - IMAGE (Alkemade et al. 2009)

- **Spatial allocation**
  - Globio (Alkemade et al. 2009)

The four scenarios

Proactive Environmental policies

Globalized

Techno-Garden: Emphasis on green technology. 8.8 billion people*

Global Orchestration: Emphasis on economic growth and public goods. 8.1 billion people

Regionalized

Adapting mosaic: Emphasis on local governance and sustainability. 9.5 billion people

Order from Strength: Emphasis on national economic growth. 9.6 billion people

Reactive Environmental policies

*Global population in 2050

Projected increase in conversion of natural habitat

Projected global habitat loss for mammals to 2050 as compared to 2000

Projected global habitat loss for mammals to 2050 as compared to 2000

6. The planning and management tools that allow the coexistence between production and conservation now exist
Forest use in East Kalimantan, Borneo

# Contribution of different forest uses to mammal conservation in East Kalimantan

<table>
<thead>
<tr>
<th>Land use</th>
<th>Plantain squirrel (low sensitivity)</th>
<th>Lesser mouse-deer (medium sensitivity)</th>
<th>Bornean gibbon (high sensitivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Converted</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Production, &lt;30% forest cover</td>
<td>0.1 (0.25)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Improved production, &lt;30% forest cover</td>
<td>0.1 (0.25)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Production, between 30 and 90% forest cover</td>
<td>0.1 (0.5)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Improved production, between 30 and 90% forest cover</td>
<td>0.25 (0.5)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Production, &gt;90% forest cover</td>
<td>0.25 (1)</td>
<td>0.25 (1)</td>
<td>0.25 (1)</td>
</tr>
<tr>
<td>Improved production, &gt;90% forest cover</td>
<td>0.5 (1)</td>
<td>0.5 (1)</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Protected, &lt;30% forest cover</td>
<td>0.1 (0.25)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Improved protection, &lt;30% forest cover</td>
<td>0.25 (0.25)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Protected, between 30 and 90% forest cover</td>
<td>0.25 (0.5)</td>
<td>0.25 (0.5)</td>
<td>0</td>
</tr>
<tr>
<td>Improved protection, between 30 and 90% forest cover</td>
<td>0.5 (0.5)</td>
<td>0.5 (0.5)</td>
<td>0</td>
</tr>
<tr>
<td>Protected, &gt;90% forest cover</td>
<td>0.5 (1)</td>
<td>0.5 (1)</td>
<td>0.5 (1)</td>
</tr>
<tr>
<td>Improved protection, &gt;90% forest cover</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

**Notes:** The values in parentheses indicate the maximum possible zone contribution given the allowable zone transitions, which was used to calculate the contributing area of occupancy for each species. The plantain squirrel (*Callosciurus notatus*) has low sensitivity to forest degradation; the lesser mouse-deer, also known as the lesser Indo-Malayan chevrotain (*Tragulus kanchil*), has medium sensitivity; and the Bornean gibbon (*Hylobates muelleri*) has high sensitivity.

Cost of different conservation strategies in East Kalimantan

<table>
<thead>
<tr>
<th>Cost component</th>
<th>Establishment of new protected areas</th>
<th>Improved management of production forest</th>
<th>Improved management of protected areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start up costs</td>
<td>50</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Management costs</td>
<td>163</td>
<td>60</td>
<td>163</td>
</tr>
<tr>
<td>Opportunity costs</td>
<td>2634</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2847</td>
<td>60</td>
<td>163</td>
</tr>
</tbody>
</table>

Cost minimisation analysis

- Mammal distribution from HSM
- Species-specific persistence target
- Cost minimisation through software MarZone (UQ)
  - Simulated annealing

Recommended management changes in East Kalimantan to optimise mammal conservation

<table>
<thead>
<tr>
<th>Land use zones</th>
<th>Current area of each land use (ha)</th>
<th>Recommended area under the full zoning analysis (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared</td>
<td>5 714 366</td>
<td>5 714 366</td>
</tr>
<tr>
<td>Converted</td>
<td>2 105 111</td>
<td>2 105 111</td>
</tr>
<tr>
<td>Production, with less than 30% forest cover remaining</td>
<td>4 469 618</td>
<td>4 429 808</td>
</tr>
<tr>
<td>Improved production, with less than 30% forest cover remaining</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Production, with between 30 and 90% forest cover remaining</td>
<td>918 610</td>
<td>33 620</td>
</tr>
<tr>
<td>Improved production, with between 30 and 90% forest cover remaining</td>
<td>0</td>
<td>872 641</td>
</tr>
<tr>
<td>Production, with greater than 90% forest cover</td>
<td>2 278 120</td>
<td>137</td>
</tr>
<tr>
<td>Improved production, with greater than 90% forest cover</td>
<td>0</td>
<td>2 186 951</td>
</tr>
<tr>
<td>Protected, with less than 30% forest cover remaining</td>
<td>835 808</td>
<td>182 190</td>
</tr>
<tr>
<td>Improved protection, with less than 30% forest cover remaining</td>
<td>0</td>
<td>693 429</td>
</tr>
<tr>
<td>Protected, with between 30 and 90% forest cover remaining</td>
<td>710 865</td>
<td>15 025</td>
</tr>
<tr>
<td>Improved protection, with between 30 and 90% forest cover remaining</td>
<td>0</td>
<td>708 188</td>
</tr>
<tr>
<td>Protected, with greater than 90% forest cover</td>
<td>2 513 334</td>
<td>0</td>
</tr>
<tr>
<td>Improved protection, with greater than 90% forest cover</td>
<td>0</td>
<td>2 604 365</td>
</tr>
<tr>
<td>Total area</td>
<td>19 545 832</td>
<td>19 545 832</td>
</tr>
</tbody>
</table>

Scenario comparison for East Kalimantan

Wilson, ... , Rondinini et al. (2010) Conserving biodiversity in production landscapes. Ecol Appl 20:1721
Conclusion

To slow down or reverse decline, biodiversity must be conserved also in (partly) converted areas, including agroecosystems, by applying planning and management techniques that allow the coexistence between production and conservation.

This is doable.
Special thanks to friends and collaborators at:

The Global Mammal Assessment lab at Sapienza: Luigi Boitani, Giovanni Amori, Daniele Baisero, Alessia Battistoni, Federica Chiozza, Moreno Di Marco, Piero Visconti

The IUCN SSC: Mike Hoffmann, Jan Schipper, Simon Stuart and the other approx. 5000 individuals involved in the mammal Red List

The University of Queensland and James Cook University: Kerrie Wilson, Hugh Possingham, Bob Pressey and many others