Monitoring and Forecasting Chimpanzee Habitat Health in Africa to Inform Conservation Actions, Strategies, and Measure Success

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Nasa (to grasp or catch in Swahili)
female chimpanzee from Kasekela community in Gombe, Tanzania

Source: National Geographic Society
Partners

Local communities and Governments of Tanzania, DRC, Uganda and Republic of Congo

Source: Jeff Kerby / the Jane Goodall Institute
Mission: to understand and protect chimpanzees, other apes and their habitats, and to work towards creating a critical mass of informed and compassionate citizens who will help to create a better world for people, other animals and our shared environment.
Great Ape Ranges in Africa (source IUCN 2016)

- Western Gorilla (Gorilla gorilla)
- Eastern Gorilla (Gorilla beringei)
- Bonobo (Pan paniscus)
- Chimpanzee (Pan troglodytes)

Countries
Threats to Great Apes in Africa

- Insecurity
- Bushmeat hunting
- Unregulated Mining
- Low protection capacity
- Habitat conversion to agriculture
- Logging

Source: Stuart Nixon & JGI
Habitat loss is one of the major threats to chimpanzee survival.
Processing > #30,000 Landsat satellite images to map great ape range in Africa at 30 meter resolution
DSS Objective & Geographic Scope

- Develop a practical DSS to be used by the Jane Goodall Institute and partners to annually monitor and forecast chimpanzee habitat conditions to support decision-making from local to species range scales in Africa.
- DSS covers geographic ranges of all four sub-species of chimpanzees.
- Will enable systematic monitoring of habitat change over time.
Table 1. List of predictor variables used as input to Random Forest regression models.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>Source</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat ETM+ band 3 (0.63–0.69 μM)</td>
<td>% reflectance</td>
<td>Hansen et al. 2013 [28]</td>
<td>B3</td>
</tr>
<tr>
<td>Landsat ETM+ band 4 (0.77–0.90 μM)</td>
<td>% reflectance</td>
<td>Hansen et al. 2013 [28]</td>
<td>B4</td>
</tr>
<tr>
<td>Landsat ETM+ band 5 (1.55–1.75 μM)</td>
<td>% reflectance</td>
<td>Hansen et al. 2013 [28]</td>
<td>B5 *</td>
</tr>
<tr>
<td>Landsat ETM+ band 7 (2.09–2.35 μM)</td>
<td>% reflectance</td>
<td>Hansen et al. 2013 [28]</td>
<td>B7</td>
</tr>
<tr>
<td>Canopy cover</td>
<td>Percent</td>
<td>Hansen et al. 2013 [28]</td>
<td>CC *</td>
</tr>
<tr>
<td>Canopy height</td>
<td>M</td>
<td>Hansen et al. 2013 [28]</td>
<td>HT *</td>
</tr>
<tr>
<td>Distance to forest</td>
<td>M</td>
<td>Hansen et al. 2013 [28]</td>
<td>DF</td>
</tr>
<tr>
<td>Distance to forest loss</td>
<td>M</td>
<td>Hansen et al. 2013 [28]</td>
<td>DL</td>
</tr>
<tr>
<td>Forest loss in 1 km buffer</td>
<td>Proportion</td>
<td>Hansen et al. 2013 [28]</td>
<td>L1K</td>
</tr>
<tr>
<td>Forest loss in 25 km buffer</td>
<td>Proportion</td>
<td>Hansen et al. 2013 [28]</td>
<td>L25K *</td>
</tr>
<tr>
<td>Distance to forest edge</td>
<td>M</td>
<td>Hansen et al. 2013 [28]</td>
<td>DE *</td>
</tr>
<tr>
<td>Forest edge in 1 km buffer</td>
<td>Proportion</td>
<td>Hansen et al. 2013 [28]</td>
<td>E1K</td>
</tr>
<tr>
<td>Forest edge in 25 km buffer</td>
<td>Proportion</td>
<td>Hansen et al. 2013 [28]</td>
<td>E25K *</td>
</tr>
<tr>
<td>Distance to rivers</td>
<td>M</td>
<td>SWBD [35]</td>
<td>DR *</td>
</tr>
<tr>
<td>Distance to steep slopes</td>
<td>M</td>
<td>SRTM [35]</td>
<td>DS *</td>
</tr>
<tr>
<td>Elevation</td>
<td>M</td>
<td>SRTM [35]</td>
<td>EL *</td>
</tr>
<tr>
<td>Slope</td>
<td>Degrees</td>
<td>SRTM [35]</td>
<td>SLP *</td>
</tr>
</tbody>
</table>

* indicates variable was included in final model. See Section 2.4.1 for details on variable selection.
Crowdsourcing chimpanzee presence data from community monitoring, ranger patrols, researchers, Distance surveys, and UAVs)
Modelling habitat suitability annually (2000-2018 and predicted to 2030)
Open Standards for the Practice of Biodiversity as a Management Framework

1. Conceptualize
   - Define planning purpose and project team
   - Define scope, vision, targets
   - Identify critical threats
   - Analyze the conservation situation

2. Plan Actions and Monitoring
   - Develop goals, strategies, assumptions, and objectives
   - Develop monitoring plan
   - Develop operational plan

3. Implement Actions and Monitoring
   - Develop work plan and timeline
   - Develop and refine budget
   - Implement plans

4. Analyze, Use, Adapt
   - Prepare data for analysis
   - Analyze results
   - Adapt strategic plan

5. Capture and Share Learning
   - Document learning
   - Share learning
   - Create learning environment

Chimpanzee Habitat Health DSS
## Chimpanzee Habitat Health Index using Open Standards

### Open Standards Viability Analysis: Markings to Interpret Chimpanzee Health

<table>
<thead>
<tr>
<th>Target</th>
<th>Category</th>
<th>KEA</th>
<th>Indicator</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chimpanzee Habitat in Zambezian Miombo Woodland</td>
<td>Size</td>
<td>Area with tree cover suitable for chimpanzees</td>
<td>% of 2000 baseline area loss</td>
<td>&gt; 5 % loss</td>
<td>2.5 - 5.0 % loss</td>
<td>1 - 2.5 % loss</td>
<td>&lt; 1 % loss</td>
</tr>
<tr>
<td></td>
<td>Condition</td>
<td>Area with evergreen forests suitable for chimpanzees</td>
<td>% of 2000 baseline area loss</td>
<td>&gt; 5% loss</td>
<td>2.5 – 5.0 % loss</td>
<td>1 – 2.5% loss</td>
<td>&lt; 1% loss</td>
</tr>
<tr>
<td></td>
<td>Landscape context</td>
<td>Distance to humans</td>
<td>Avg pixel dist to human feature</td>
<td>&lt; 2.5 km</td>
<td>2.5 – 5 km</td>
<td>5 – 10 km</td>
<td>&gt; 10 km</td>
</tr>
</tbody>
</table>
DSS converts satellite data into actionable habitat health information for conservation planning using Open Standards
Step-By-Step adaptive management process clearly outlining connections between different Project phases and processes

Common Approach & Standard Terminology

Project Design, Implementation and Learning Modules tailored to JGI's specific needs & existing processes.

Set of Tools and Templates developed to support any Project from Design to Learning

Digital Tool Kit and Workbook designed to fit JGI's culture and practices
OUR VISION

Stable, viable, and diverse populations of chimpanzees live in peaceful coexistence with human population
Our Africa Programs Ten-Year Strategy:

The Road Ahead

OUR GOAL

By 2044, ecological and cultural diversity of chimpanzees conserved in viable populations across the range

the Jane Goodall Institute
Chimpanzee habitat health / viability 2014 by chimpscapes
% habitat loss 2000 baseline (>15% tree cover)

- **1.0 - 2.5 / Very Good**
- **2.6 - 5.0 / Good**
- **5.1 - 10.0 / Fair**
- **> 10 / Poor**

Country boundaries (other)
Chimpanzee habitat health / viability 2017 by chimpscapes
% habitat loss 2000 baseline (>15% tree cover)

- **1.0 - 2.5 / Very Good**
- **2.6 - 5.0 / Good**
- **5.1 - 10.0 / Fair**
- **> 10 / Poor**

Country boundaries (other)
JGI's Conservation Decision Support System using Microsoft Azure & Esri ArcGIS Enterprise Platforms

Concepts of Operations
Migrating our village forest monitoring citizen science/crowdsourcing platform

From ODK & Google cloud → to Survey 123 and Esri’s ArcGIS

New Partnership with Esri East Africa
Most of the world’s biodiversity is under the care of indigenous people and local communities.

An estimated 65% of the world’s land is under indigenous or local community customary ownership and use (75 % in Tanzania and Uganda) (Rights and Resources Initiative, 2015).
Focusing resources on capacity Building needs to use DSS
Kigoma, March 2019
Decision Support System User Needs Workshop in Kigoma, March 2019
**Chimpanzee Habitat Status:** The plan assessed the status of chimpanzee habitat by assessing the viability of indicators for each of the key ecological attributes (Table 2.2).

**Table 2.2. Key Attributes and Indicators for Chimpanzee Habitat**

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat 1. Woodland cover</td>
<td>Size</td>
<td>&gt;5%</td>
<td>2-5-5%</td>
<td>1-2.5%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>✓ Percent of forest loss (year 2000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat 2. Evergreen forest</td>
<td>Condition</td>
<td>&gt;5%</td>
<td>2-5-5%</td>
<td>1-2.5%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>✓ Percent of forest loss (Year 2000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat 3. Distance to humans</td>
<td>Landscape</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Average pixel (30m) distance to human feature</td>
<td></td>
<td>&lt;250m</td>
<td>250-499m</td>
<td>500-1000m</td>
<td>&gt;1000m</td>
</tr>
</tbody>
</table>
Chimpanzee habitat viability in protected areas management units (village & gov forest reserves and NP)
House data source: DigitalGlobe

Imagery: 2017-10-05
WorldView2 / DigitalGlobe

Map developed by:
Lilian Pintea,
the Jane Goodall Institute

JGI Office
Distance from roads, footpaths & villages

Distance from houses

DigitalGlobe satellite images

Chimp habitat health

Proximity to people (km)

- > 10 / Very Good
- 5 - 10 / Good
- 1 - 5 / Fair
- < 1 / Poor

Map developed: February 14, 2017

Map developed: May 13, 2019
Management Unit:
Forest patches
Management Unit: Parishes
Management Unit: Forest patches by Parishes
Management Unit:
Forest patches by Parishes
Focusing on the right data summarized by relevant management units.
Focusing on the right data summarized by relevant management units.
Focusing on the right data summarized by relevant management units.
Next Steps

- Expand suitability models to cover all great apes in Africa
- Finalize the GeoPlanner tool
- Use the DSS to support more conservation action plans and great ape conservation efforts (Liberia, Angola, Burundi etc)
- Integrating Population Habitat Viability Analysis into the OS process in order to correlate a threat reduction to a measured response in the chimpanzee habitat health index
- Explore other digital sensors to monitor chimpanzee habitat health
JGI & Microsoft’s Gombe Project Premonition

Using mosquitoes as surveying tools:

Developing a novel, scalable, entomological monitoring platform that harnesses advances in arthropod collection and next generation “deep” sequencing (NGS) methods to convert biologic samples into big digital genomic data.

Robotic trap in Gombe

Metagenonomic pipeline

- Ag1000G Phase 1 dataset (n=765 genomes; ~182M reads)
- Quality Control
- Cloud-scale matching with SNAP alignment tool
- Resolves ambiguities
- Bayesian Mixture Model
- Identifies novel species
- De novo assembly
- Summarizes results
- Annotation and classification
- Data visualization & output
- Premonition Studio Analysis Tool

Includes all known genomic data in “Tree of Life” - (Genbank[2] & RefSeq[3])

1.3T nucleotides ~60K species
Robotic mosquito traps that identify and capture interesting mosquitoes in milliseconds
THANK YOU!

Local communities and Governments of Tanzania, DRC, Uganda and Republic of Congo

-thankyou-