Chimpanzee technological landscapes:

Exploring the complexities of the technology, environment, and behaviour triad through agent-based modelling

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How are landscape-scale patterns of stone tool use influenced by the broader foraging and ecological contexts?

Background

Archaeological assemblages are the product of a dynamic relationship between tool-using primates and their natural environment. Nevertheless, while research has extensively explored the role of the materials and resources targeted during tool use, comparatively little has been achieved regarding the broader behavioural and environmental contexts.

Previous findings from chimpanzee nut-cracking in Bossou, Guinea[1]:

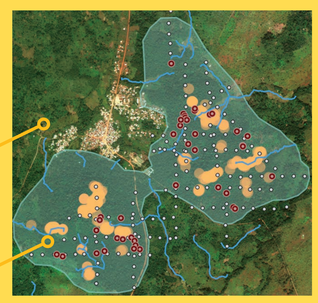
- **SITE SELECTION influenced by:**
  - Availability of **raw materials for tools**
  - Availability of **food-providing trees**
  - Proximity to **nesting sites**
- **SITE USE and INACTIVITY influenced by:**
  - Availability of **nuts**
  - Avaliability of **stone tools**

But what happens when conditions change?

- We explore how 3 key resources — FOOD, WATER, SHELTER — may shape landscape-scale patterns of chimpanzee stone tool use
- We combine REAL-WORLD DATA and ARTIFICIALLY-GENERATED LANDSCAPES to create an experiment using COMPUTER SIMULATION

1 Collect Empirical Data

SEASONALITY OF FOOD
SPATIAL DISTRIBUTION OF RESOURCES



Site-specific ecological data

Species-wide physiological data

ENERGETIC COST OF TRAVEL
ENERGETIC GAIN FROM FOOD
TRAVEL SPEED
FORAGING SPEED

2 Build Agent-Based Model

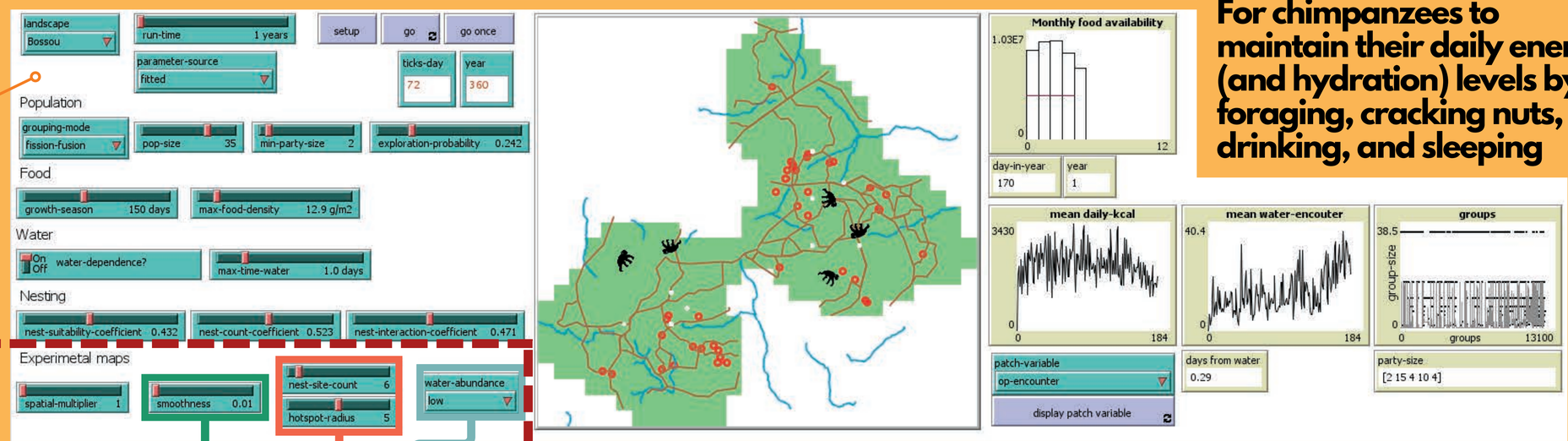
NetLogo

With support from Bossou field guides: Henry Didier Camara, Gounou Zogbila, Ce Vincent Mamy, Jules Doré, Boniface Zogbila; Institut de Recherche Environmentale de Bossou; Kyoto University Primate Research Institute

MODEL OBJECTIVE

For chimpanzees to maintain their daily energy (and hydration) levels by foraging, cracking nuts, drinking, and sleeping

3 Experiment



Artificially generated landscapes

Abundance and distribution

LOW
MEDIUM
HIGH

FOOD · NEST SITES · WATER

10-year simulation
100 runs

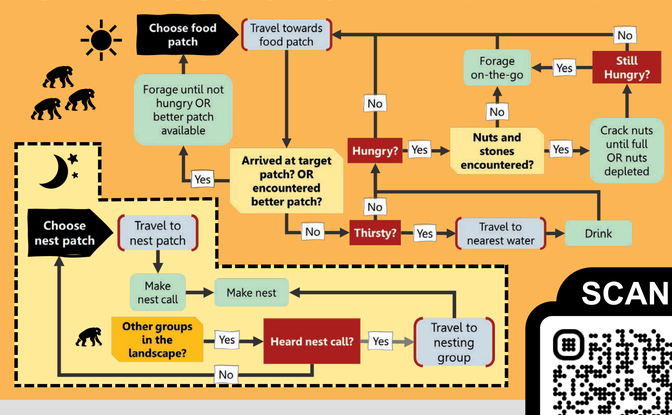
MODEL ASSUMPTIONS

KNOWLEDGE
Dynamic, imperfect, shareable

FORAGING DECISIONS
Optimal Foraging Strategy with nuts as secondary foods[2,3]

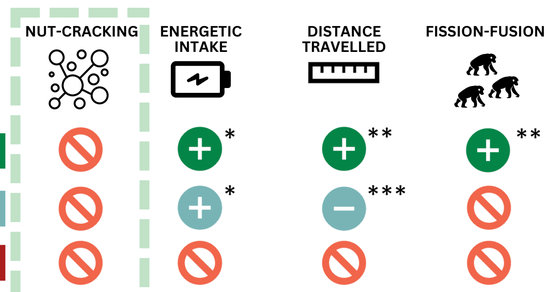
FISSION-FUSION
Dictated by food availability and night time[4,5]

MODEL PROCEDURES: A DAY IN THE LIFE...



SCAN ME
For full model description and results

4 Results

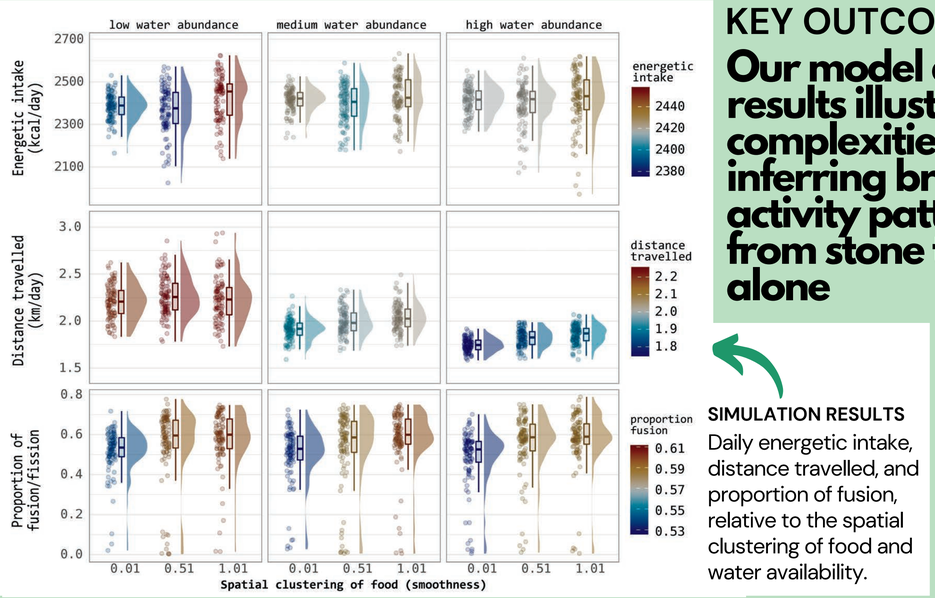


Spatial distribution of nut-cracking activities (Global Moran's I)

- Non-random ***
- BUT did not differ between conditions (range: 0.428-0.469)

*p < 0.05 **p < 0.01 ***p < 0.001

However, different environmental conditions produced different patterns of overall behaviour



SIMULATION RESULTS
Daily energetic intake, distance travelled, and proportion of fusion, relative to the spatial clustering of food and water availability.

KEY OUTCOMES

Our model and results illustrate the complexities of inferring broader activity patterns from stone tool sites alone

Implications for the interpretation of early hominin lithic assemblages?

FUTURE MODEL ENHANCEMENTS

LEAST-COST PATHS
Integrate elevation and enable emergent paths

ARTIFICIAL LANDSCAPES
Experiment with modified distributions of raw materials and nut trees

FORAGING PREFERENCES
Enable flexibility in the depencence on nuts

References

[1]Almeida-Warren, K., et al. (2021) *International Journal of Primatology*, 43(5), 885-912; [2]Trapanese, C., et al. (2019) *Biological Reviews*, 94(2), 483-502; [3]Hockings, K. J., et al. (2009). *American Journal of Primatology*, 71(8), 636-646; [4]Furuichi, T. (2009). Primates, 50(3), 197-209; [5]Ogawa, H. et al. (2007). International Journal of Primatology, 28(6), 1397-1412.