**Supplementary Materials**

from

“Comparing transmission potential networks based on social network surveys, close contacts, and environmental overlap in rural Madagascar.”

by

Kayla Kauffman1,4, Courtney S. Werner1, Georgia Titcomb4, Michelle Pender5, Rabezara Jean Yves6, James P. Herrera7, Julie Teresa Shapiro8, Alma Solis1,5,Soarimalala Voahangy9,Pablo Tortosa10, Randall Kramer3,5, James Moody2, Peter J. Mucha11, Charles Nunn1,5

1Department of Evolutionary Anthropology,

2Department of Sociology, and

3Nicholas School of the Environment, Duke University, Durham, NC 27708, USA

4Marine Science Institute, University of California, Santa Barbara, Santa Barbara, CA 93106, USA

5Duke Global Health Institute, Durham, NC 27516 USA

6Science de la Nature et Valorisation des Ressources Naturelles, Centre Universitaire Régional de la SAVA, Antalaha, Madagascar

7Duke Lemur Center SAVA Conservation, Durham NC, USA

8Department of Life Sciences, Ben-Gurion University of the Negev, Be'er Sheva, Israel

9Association Vahatra, Antananarivo, Madagascar

10UMR Processus Infectieux en Milieu Insulaire Tropical (PIMIT), Université de La Réunion, Ile de La Réunion, France.

11Department of Mathematics, Dartmouth College, Hanover, NH 03755, USA

**Contents**

Table S1. Exponential Random Graph Model selection table.

Table S2. Summary of land use classification results

Table S3. All network characteristic comparisons.

Figure S1. The four main networks examined in the study

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **model ID** | **parametersᶧ** | | | | | | | | | | | | | **AICᵃ** | **accuracyᵇ** | **specificityᵇ** | **sensitivityᵇ** |
| edges | VI 95 day¹ | VI 95 night¹ | VI 95¹ | VI 50¹ | naming network² | reciprocal naming³ | house distance⁴ | live close⁵ | gender⁶ | age⁷ | GWESP⁸ | GWNSP⁹ |
| m14 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4762 | 0.78 | 0.89 | 0.54 |
| m21 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4778 | 0.78 | 0.89 | 0.53 |
| m22 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4781 | 0.78 | 0.89 | 0.54 |
| m13 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4782 | 0.78 | 0.89 | 0.54 |
| m15 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4849 | 0.78 | 0.89 | 0.54 |
| m12.1 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4866 | 0.78 | 0.89 | 0.54 |
| m19 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4882 | 0.78 | 0.89 | 0.54 |
| m20 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4883 | 0.78 | 0.89 | 0.53 |
| m16 |  |  |  |  |  |  |  |  |  |  |  | α=1 |  | 4906 | 0.77 | 0.88 | 0.52 |
| m12.05 |  |  |  |  |  |  |  |  |  |  |  | α=0.5 |  | 4921 | 0.78 | 0.89 | 0.54 |
| m12.0 |  |  |  |  |  |  |  |  |  |  |  | α=0 |  | 4949 | 0.78 | 0.89 | 0.54 |
| m9 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4951 | 0.78 | 0.89 | 0.54 |
| m8 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4952 | 0.78 | 0.89 | 0.54 |
| m11 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4954 | 0.79 | 0.89 | 0.54 |
| m10 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4954 | 0.78 | 0.89 | 0.54 |
| m4 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4954 | 0.78 | 0.89 | 0.54 |
| m5 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4954 | 0.78 | 0.89 | 0.54 |
| m3 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4955 | 0.78 | 0.89 | 0.54 |
| m7 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4956 | 0.78 | 0.89 | 0.54 |
| m6 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4956 | 0.78 | 0.89 | 0.54 |
| m18 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4958 | 0.78 | 0.89 | 0.54 |
| m17 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4958 | 0.78 | 0.89 | 0.54 |
| m1 |  |  |  |  |  |  |  |  |  |  |  |  |  | 5067 | 0.78 | 0.89 | 0.53 |
| m2 |  |  |  |  |  |  |  |  |  |  |  |  |  | 7454 | 0.69 | 0.81 | 0.38 |
| m0 |  |  |  |  |  |  |  |  |  |  |  |  |  | 8582 | 0.63 | 0.76 | 0.25 |
| ᶧparameters included in each model are shaded in grey; ¹Volume intersection (VI) of the home range (VI 95), core-use area (VI 50), and VI of the home range calculated separately for night time (VI 95 night) and daytime (VI 95 day); ²weighted full, undirected naming network (weights range 1-10); ³if both individuals named each other; ⁴distance between individuals’ houses; ⁵if the individuals lived less than 25 m apart, only applied as an interaction term with house distance; ⁶gender match; ⁷age difference; ⁸geometrically weighted edgewise shared partner with the fixed α value noted; ⁹geometrically weighted non-edgewise shared partner; ᵃAkaike information criterion; ᵇcalculated using the Held-Out Predictive Evaluation method for cross-validation | | | | | | | | | | | | | | | | | |

**Table S1.** Exponential Random Graph Model selection table.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **SVM Classification Category** | | | | | |  |
| **Ground-truthed Polygon ID** | **Bare** | **Other (brushy)** | **Rice** | **Secondary** | **Village** | **Water** | **Polygon Area (m2)** |
| **Hillside Rice (mean)** |  | **0.186** |  | **0.814** |  |  | **17161** |
| hillside rice 1 |  | 0.022 |  | 0.978 |  |  | 7832 |
| hillside rice 2 |  | 0.484 |  | 0.516 |  |  | 5465 |
| hillside rice 3 |  | 0.238 |  | 0.761 |  |  | 2159 |
| hillside rice 4 |  |  |  | 1 |  |  | 1705 |
| **Rice (mean)** | **0.005** | **0.034** | **0.89** | **0.018** | **0.037** | **0.015** | **49546** |
| rice 1 |  |  | 1 |  |  |  | 4803 |
| rice 2 |  |  | 1 |  |  |  | 1125 |
| rice 3 |  | 0.013 | 0.602 |  | 0.384 |  | 5346 |
| rice 4 |  |  | 1 |  |  |  | 2102 |
| rice 5 |  | 0.029 | 0.971 |  |  |  | 3464 |
| rice 6 |  |  | 0.981 |  | 0.018 |  | 5033 |
| rice 7 |  |  | 0.953 |  | 0.046 |  | 4332 |
| rice 8 |  |  | 0.941 |  |  | 0.059 | 5612 |
| rice 9 |  | 0.022 | 0.863 | 0.115 |  |  | 3535 |
| rice 10 |  |  | 0.809 | 0.069 |  | 0.122 | 3734 |
| rice 11 |  | 0.25 | 0.727 | 0.022 |  |  | 4104 |
| rice 12 | 0.063 | 0.087 | 0.836 | 0.014 |  |  | 6356 |
| **Brushy Regrowth (mean)** |  | **0.321** | **0.123** | **0.546** |  | **0.009** | **11519** |
| brushy 1 |  |  |  | 1 |  |  | 1430 |
| brushy 2 |  | 0.759 |  | 0.24 |  |  | 1505 |
| brushy 3 |  |  |  | 1 |  |  | 2599 |
| brushy 4 |  | 0.063 |  | 0.937 |  |  | 2757 |
| brushy 5 |  | 0.898 |  | 0.102 |  |  | 1964 |
| brushy 6 |  | 0.205 | 0.74 |  |  | 0.055 | 1263 |
| **Secondary (mean)** |  | **0.066** |  | **0.934** |  |  | **33343** |
| secondary 1 |  | 0.071 |  | 0.928 |  |  | 2433 |
| secondary 2 |  |  |  | 1 |  |  | 1754 |
| secondary 3 |  |  |  | 1 |  |  | 1509 |
| secondary 4 |  |  |  | 1 |  |  | 3136 |
| secondary 5 |  |  |  | 1 |  |  | 3065 |
| secondary 6 |  | 0.117 |  | 0.883 |  |  | 4261 |
| secondary 7 |  | 0.042 |  | 0.957 |  |  | 4721 |
| secondary 8 |  | 0.145 |  | 0.855 |  |  | 4511 |
| secondary 9 |  |  |  | 1 |  |  | 3770 |
| secondary 10 |  | 0.28 |  | 0.719 |  |  | 4182 |

**Table S2.** Summary of land use classification results within each of the ground-truth polygons created by walking a GPS around discrete land areas of a given type. Values represent the proportion of 10x10m grid cells that were assigned a given classification category by the support vector machine model in ArcGIS Pro (version 2.5.0). Cells are shaded (light to dark) by the proportion of grid cells in each polygon assigned to the respective land use category.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Network** | **Connected¹** | **Diameter** | **Average distance** | **Density** | **Transitivity** | **Modularity²** | **Reciprocity** |
| d  i  r  e  c  t  e  d | u  n  i  p  a  r  t  i  t  e | full | no | 22 | 5.205 | 0.021 | 0.163 | - | 0.429 |
| free time | no | 15 | 6.293 | 0.011 | 0.142 | - | 0.380 |
| help you farm | no | 7 | 2.145 | 0.006 | 0.229 | - | 0.227 |
| you help farm | no | 6 | 2.008 | 0.007 | 0.352 | - | 0.317 |
| help you food | no | 6 | 2.005 | 0.006 | 0.105 | - | 0.176 |
| you help food | no | 6 | 2.008 | 0.007 | 0.352 | - | 0.317 |
| farm | no | 12 | 3.544 | 0.009 | 0.254 | - | 0.355 |
| food | no | 14 | 3.580 | 0.009 | 0.080 | - | 0.211 |
| u  n  d  i  r  e  c  t  e  d | full | no | 20 | 3.875 | 0.032 | 0.163 | 0.707 | - |
| free time | no | 18 | 5.736 | 0.017 | 0.142 | 0.774 | - |
| help you farm | no | 13 | 4.575 | 0.010 | 0.229 | 0.820 | - |
| you help farm | no | 8 | 2.553 | 0.011 | 0.352 | 0.866 | - |
| help you food | no | 23 | 8.651 | 0.011 | 0.105 | 0.832 | - |
| you help food | no | 20 | 6.460 | 0.011 | 0.034 | 0.861 | - |
| farm | no | 21 | 5.385 | 0.015 | 0.254 | 0.811 | - |
| food | no | 21 | 6.284 | 0.017 | 0.080 | 0.792 | - |
| close contact³ | yes (n=66) | 0.114 ± 0.057 | 1.758 ± 0.023 | 0.275 ± 0.006 | 0.473 ± 0.008 | 0.630 ± 0.003 | - |
| no (n=934) |
| environmental, full | yes | 0.000 | 1.033 | 0.967 | 0.984 | 0.538 | - |
| environmental, rice | yes | 0.000 | 1.412 | 0.589 | 0.762 | 0.551 | - |
| b  i  p  a  r  t  i  t  e | environmental, full | yes | 0.150 | 3.737 | 0.001 | 0.000 | 0.548 | - |
| environmental, rice | yes | 0.045 | 3.548 | 0.006 | 0.000 | 0.753 | - |
| ¹ strong connectivity, ² modularity calculated using the Louvain method for the unipartite networks and the bipartite method for the bipartite networks ³ the mean ± standard deviation for each of the 1000 simulated close contact networks | | | | | | | | | |

**Table S3.** All network characteristic comparisons.

****

**Figure S1. The four main networks examined in the study**: (a) the full naming network, with edges weighted by the number of times one individual named the other, (b) the close-contact network, with edges weighted by the predicted proportion of close contacts, (c) the full environmental overlap network, with edges weighted by the sum-product of each dyad’s utilization distribution overlap in all shared spaces regardless of land-use type, and (d) the rice-field overlap network, with edges weighted by the sum product of each dyad’s utilization distribution overlap in flooded rice fields. Network vertices are consistent across all panels (based on the Fruchterman Reingold layout of the full, directed naming network (a)). Edges are colored according to naming network responses: green lines connect individuals who did not name each other for any question, orange lines connect pairs in which only one individual named the other, and purple lines connect reciprocally named individuals.

Low edge weights were omitted to improve network visualization: (b) fewer than 20 contacts per week, (c) less than 1% of both individuals’ utilization distributions (UDs), and (d) less than 0.1% of both individuals’ UDs.