Oikos

OIK-02998

Tinoco, B. A., Graham, C. H., Aguilar, J. M. and Schleuning, M. 2016. Effects of hummingbird morphology on specialization in pollination networks vary with resource availability. – Oikos doi: 10.1111/oik.02998

Appendix 1

Table A1. Measures of morphological traits of male hummingbirds. Total bill length is the distance between bill base to tip.

Species	Weight		Bill length	
	N	Mean (SE) gr	N	Mean (SE) mm
Aglaeactis cupripennis	21	8.21 (±0.14)	25	21.5 (±0.32)
*Chaetocercus mulsant**	24	3.58 (±0.03)	24	19.5 (±0.15)
Colibri coruscans	25	8.21 (±0.07)	34	28 (± 0.54)
Coeligena iris	5	7.08 (±0.11)	7	31.81 (± 1.00)
*Ensifera ensifera**	4	9.68 (±0.27)	4	83.92 (± 1.33)
Eriocnemis luciani	10	6.12 (±0.13)	14	24.98 (± 0.40)
Heliangelus viola	12	5.63 (±0.11)	8	18.08 (± 0.78)
Lafresnaya lafresnayi	19	5.69 (±0.07)	18	29.69 (±0.26)
*Lesbia nuna**	7	3.66 (±0.05)	7	12.66 (± 0.21)
*Lesbia victoriae**	11	5.29 (±0.05)	11	17.58 (±0.17)
Metallura baroni	4	4.57 (±0.08)	3	17.77 (±0.62)
Metallura tyrianthina	35	3.79 (±0.04)	42	14.83 (±0.15)
Pterophanes cyanopterus	6	10.37 (±0.31)	6	36.45 (± 1.01)
*Ramphomicron microrhynchum**	15	3.67 (±0.06)	15	10.21 (±0.25)

* symbol denotes species for which morphology data was obtained from G. Stiles personal data base. Stiles contact information: Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia.

Table A2. Nectar characteristics of all plant species used by hummingbirds. Mean values of nectar volume include flowers with zero production of nectar. Sugar production was calculated as the product of nectar volume in ml multiplied by sugar concentration measured in sugar mg ml^{-1} following the table provided by Kearns and Inouye (1993).

Species (Family)	Nectar volume (µl per 24 h)		Sugar concentration (% w/w)		Sugar production (mg per 24 h per flower)
	n	Mean (±SE)	n	Mean (±SE)	Mean
Alloplectus peruvianus (Gesneriaceae)	11	0.04 (±0.02)	9	14.5 (±2.4)	0.01
Barnadesia arborea (Asteraceae)	15	9.22 (±1.5)	21	19.15 (±0.6)	1.91
Berberis lutea (Berberidaceae)	15	0.62 (±0.04)	16	25.69 (±1.7)	0.18
Bomarea sp. (Alstroemeriaceae)	7	2.33 (±0.89)	7	2.33 (±0.4)	0.05
Brachyotum confertum (Melastomataceae)	31	14.48 (±3.13)	30	14.62 (±0.7)	2.24
Bromelia sp.2 (Bromeliaceae)	9	1.5 (±0.22)	16	10.63 (±0.5)	0.17
Bromelia sp.3 (Bromeliaceae)	21	16.42 (±2.58)	21	14.52 (±1.2)	2.52
Brugmansia sanguinea (Solanaceae)	10	29.23 (±10.17)	9	20.89 (±1.8)	6.63
Cavendishia bracteata (Ericaceae)	18	0.14 (±0.04)	7	16.31 (±1.3)	0.02
Centropogon sp. (Campanulaceae)	10	6.14 (±1.89)	10	12.2 (±0.7)	0.78
Fuchsia cf. Vulcanica (Onagraceae)	44	6.39 (±1.74)	22	19.8 (±1.4)	1.37
Gaiadendron punctatum (Loranthaceae)	5	0.09 (±0.01)	3	31 (±1.4)	0.03
Gaultheria erecta (Ericaceae)	15	0.23 (±0.05)	8	13.9 (±1.8)	0.03
Macleania rupestris (Ericaceae)	46	10.81 (±1.59)	39	17.5 (±0.8)	2.02
Mutisia lehmanni (Asteraceae)	13	34.7 (±9.43)	21	19.5 (±0.9)	7.3
Oreocallis grandiflora (Proteaceae)	48	18.69 (±1.65)	42	14.8 (±0.4)	2.93
Palicourea sp. (Rubiaceae)	10	0.94 (±1.33)	10	14.4 (±0.6)	0.14
Passiflora cumbalensis (Passifloraceae)	5	142.51 (±29.45)	9	23 (±1.4)	35.88
Rubus floribundus (Rosaceae)	5	2.44 (±0.56)	1	50 (±NA)	1.5
Salvia corrugata (Lamiaceae)	46	2 (±0.33)	22	11.9 (±1.8)	0.25

Salvia hirta (Lamiaceae)	17	6.36 (±1.78)	18	18.1 (±1.2)	1.23
Saracaha quitensis (Solanaceae)	14	13.29 (±2.54)	19	12.5 (±0.9)	1.74
Tillandsia complanata (Bromeliaceae)	9	1.49 (±0.22)	9	10.6 (±0.7)	0.17
Tristerix longebracteatus (Loranthaceae)	30	4.56 (±0.8)	18	18.9 (±0.6)	0.93
Verbesina latisquama (Asteraceae)	15	0.69 (±0.05)	18	22.1 (±0.5)	0.17
Viola arguta (Violaceae)	16	4.08 (±0.73)	14	12.5 (±1.1)	0.54

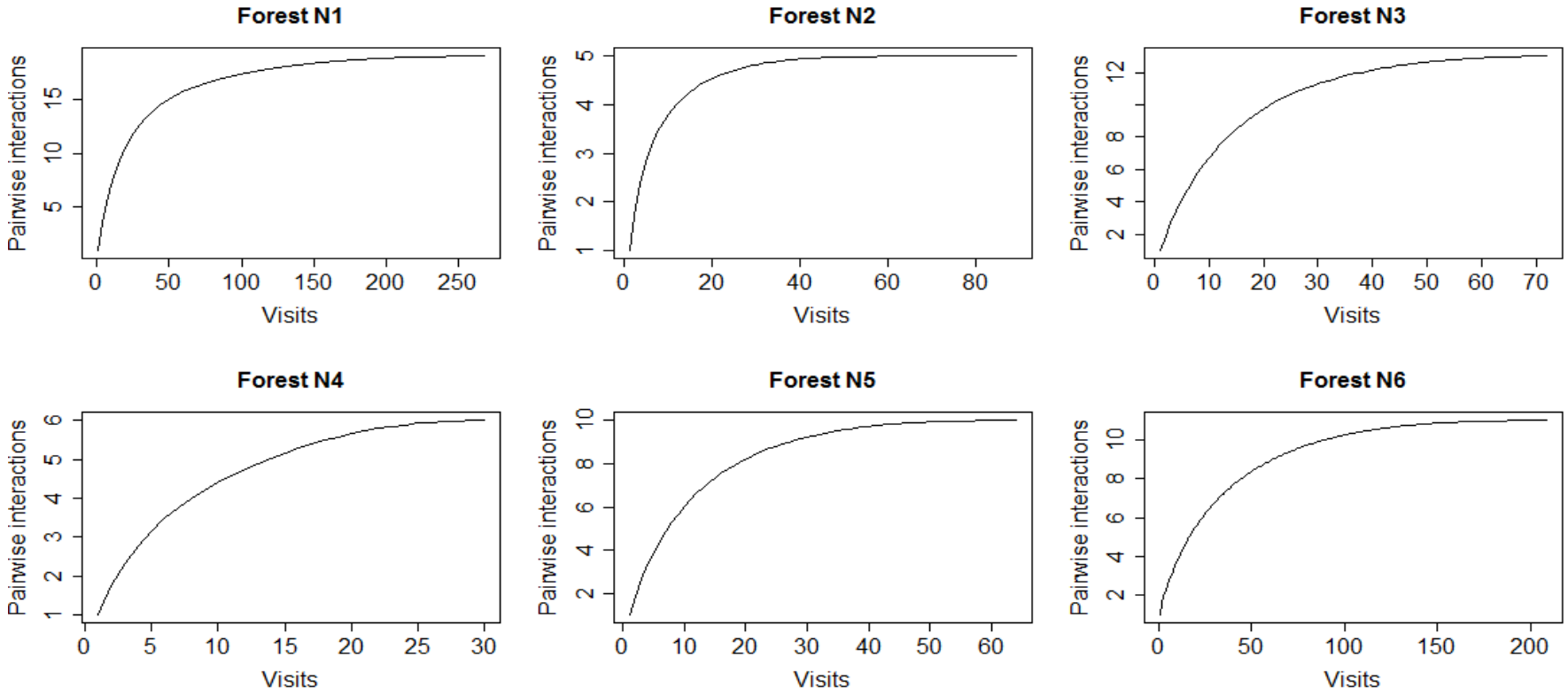
References

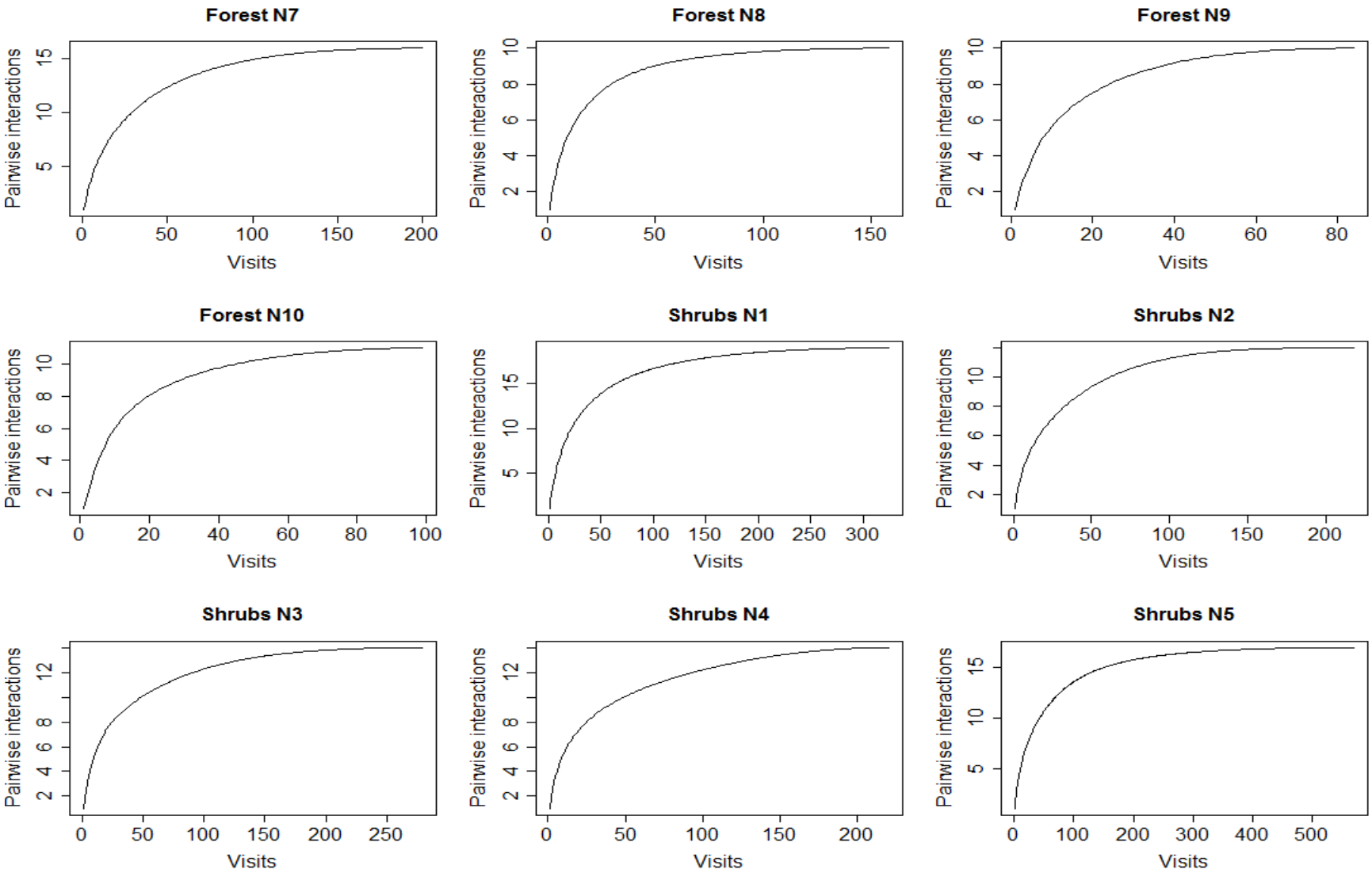
Kearns, C. A. and Inouye, D. W. 1993. Techniques for pollination biologists. – Univ. Press Colorado.

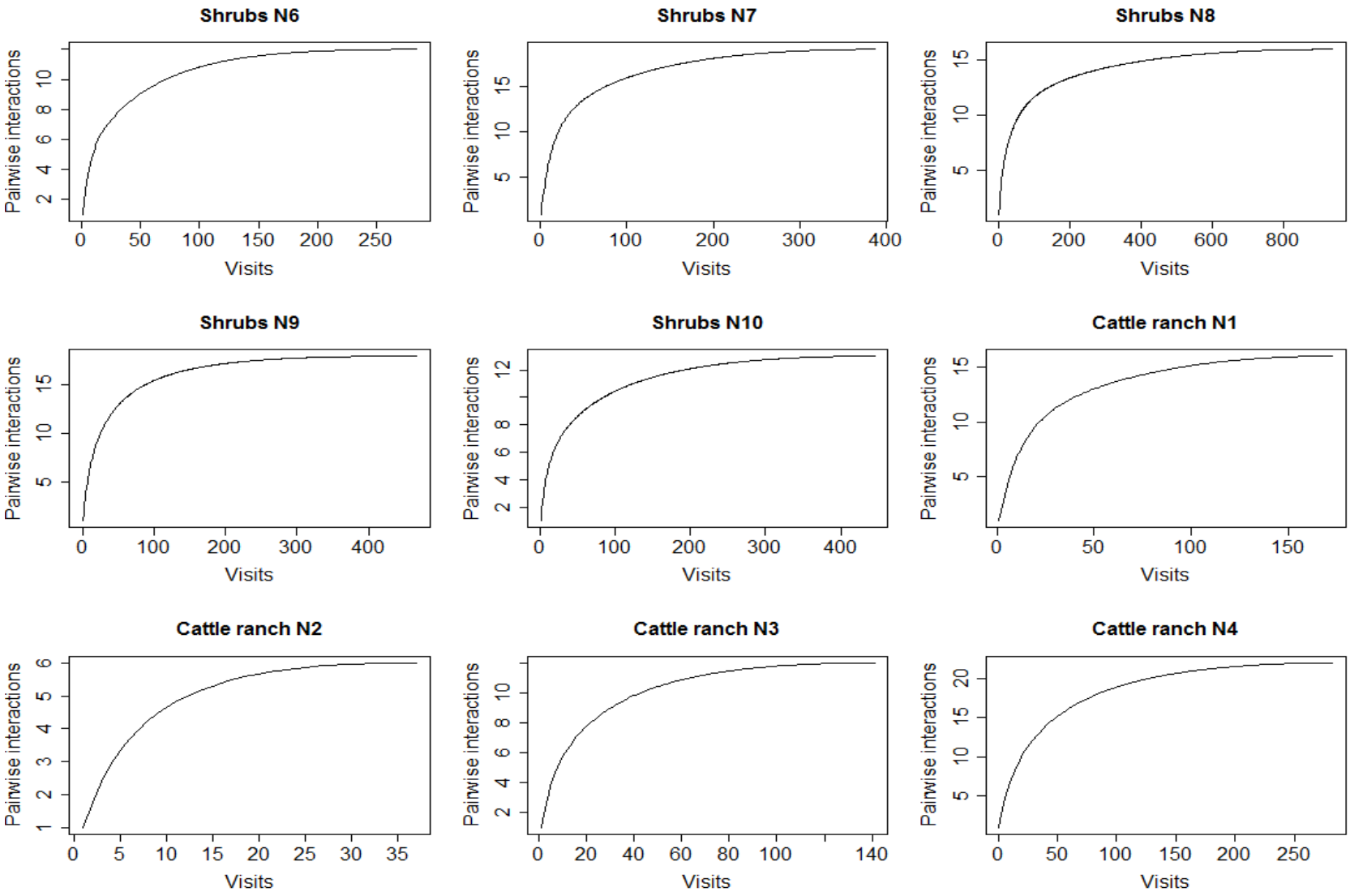
Table A3. Top supported models (ΔAICc values < 2) of the effects of morphological traits of hummingbirds and resource availability on (A) specialization d', (B) generality, and (C) pollinator service index (PSI) of hummingbirds in pollination networks in south central Andes of Ecuador. Given are sample-size adjusted AIC (AICc), Akaike differences (ΔAICc) and Akaike weights (AICc weight).

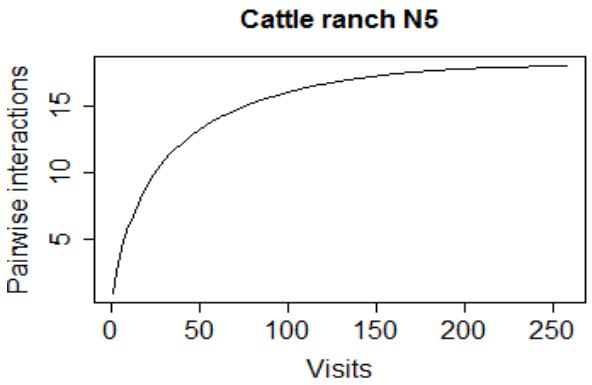
Model description	AICc	Δ AICc	AICc weight
(A) Specialization d'			
Sugar production × Bill length	–30.24	0.00	0.26
Sugar production × Body mass + Bill length	–30.17	0.07	0.25
Sugar production × Bill length + Body mass	–29.40	0.84	0.17
Sugar production × Bill length + Sugar production × Body mass	–28.52	1.72	0.11
Richness of flowering plants + Bill length + Sugar production × Body mass	–28.45	1.79	0.11
Richness of flowering plants + Sugar production × Bill length	–28.40	1.84	0.10
(B) Generality			
Sugar production + Body mass	162.09	0.00	0.24
Sugar production × Body mass	162.43	0.34	0.21
Sugar production	162.81	0.72	0.17
Sugar production × Bill length	162.86	0.77	0.17
Sugar production + Bill length	163.62	1.53	0.11
Sugar production × Bill length + Sugar production × Body mass	163.83	1.74	0.10
(C) PSI			
Sugar production + Body mass	25.09	0.00	0.20
Sugar production	25.17	0.08	0.19
Sugar production × Bill length	25.23	0.14	0.18
Sugar producion + Bill length	25.59	0.50	0.15
Sugar production × Body mass	26.42	1.33	0.10
Sugar production × Bill length + Body mass	26.61	1.52	0.09
Sugar production + Bill length + Body mass	26.78	1.69	0.08

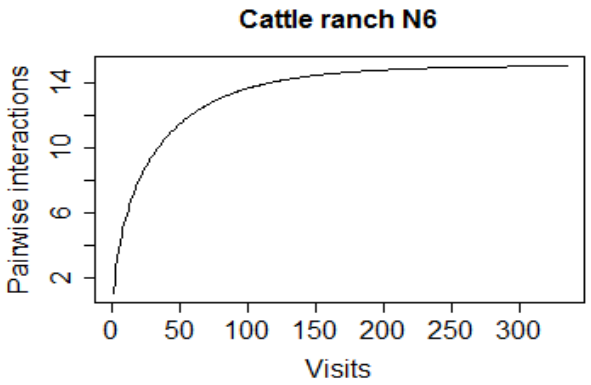
Figure A1. Rarefaction curves of plant–hummingbird pairwise interactions in relation to the number of visits recorded in the southern Andes of Ecuador. 30 rarefaction curves are presented, which correspond to 10 temporal networks in three habitat types: Forest, Shrubs, Cattle ranch sampled. The curve reaches an asymptote in most cases.

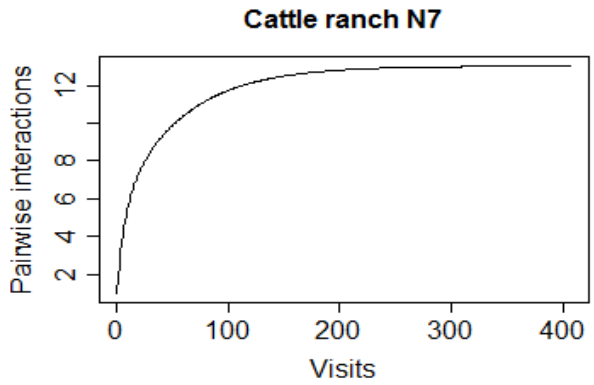


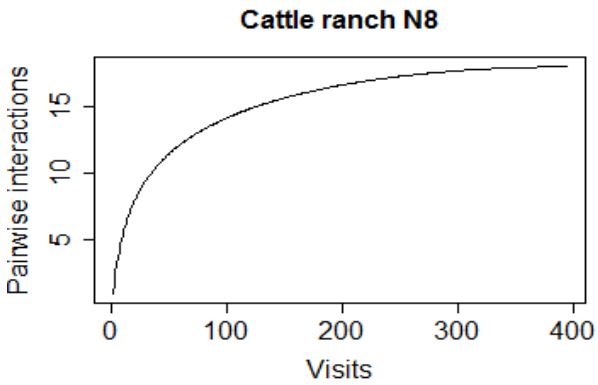

Forest N7
Pairwise interactions
Visits
Forest N8
Pairwise interactions
Visits
Forest N9
Pairwise interactions
Visits
Forest N10
Pairwise interactions
Visits
Shrubs N1
Pairwise interactions
Visits
Shrubs N2
Pairwise interactions
Visits
Shrubs N3
Pairwise interactions
Visits
Shrubs N4
Pairwise interactions
Visits
Shrubs N5
Pairwise interactions
Visits

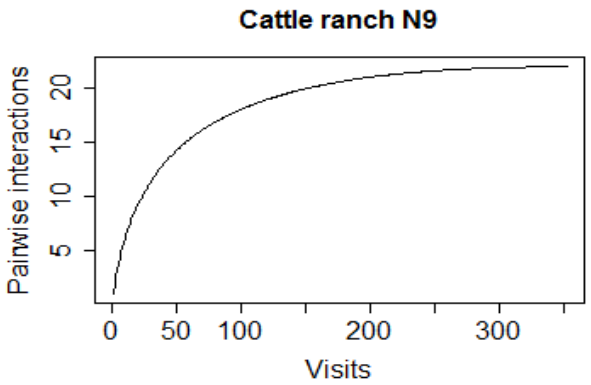

Shrubs N6
Pairwise interactions
Visits
Shrubs N7
Pairwise interactions
Visits
Shrubs N8
Pairwise interactions
Visits
Shrubs N9
Pairwise interactions
Visits
Shrubs N10
Pairwise interactions
Visits
Cattle ranch N1
Pairwise interactions
Visits
Cattle ranch N2
Pairwise interactions
Visits
Cattle ranch N3
Pairwise interactions
Visits
Cattle ranch N4
Pairwise interactions
Visits


Cattle ranch N5
Pairwise interactions
5
10
15
0
50
100
150
200
250
Visits


Cattle ranch N6
Pairwise interactions
2
6
10
14
0
50
100
150
200
250
300
Visits


Cattle ranch N7
Pairwise interactions
2
4
6
8
12
0
100
200
300
400
Visits


Cattle ranch N8
Pairwise interactions
5
10
15
0
100
200
300
400
Visits


Cattle ranch N9
Pairwise interactions
5
10
15
20
0
50
100
200
300
Visits

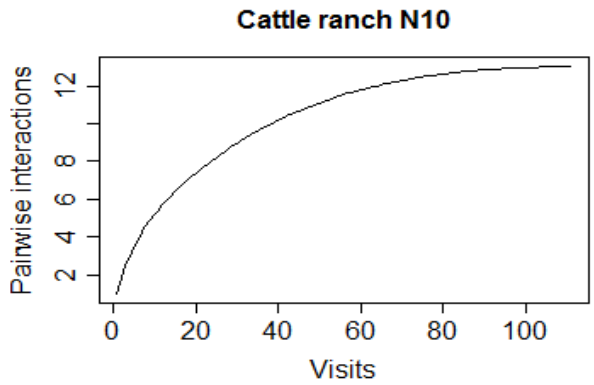

Cattle ranch N10
Pairwise interactions
2
4
6
8
12
0
20
40
60
80
100
Visits

Figure A2. Bipartite pollination networks of hummingbirds (top) and plants (bottom) in the south central Andes of Ecuador. The figure depicts networks of three habitats: (a) forest, (b) shrubs and (c) cattle ranch. For the figures, data where pooled from 10 observation periods from February 2011 to December 2012. The width of the top and bottom boxes represent the frequencies of interactions of each species within the network.