Strong and weak environmental perturbations cause contrasting restructure of ant transportation networks
Supplementary Material S2
Supplementary Results

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Contents

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Overview

This supplementary document provides detailed results for Sandor Simulation MS. The sections present the results by network measures in the form of a) a figure showing the mean values of the network measures, and b) a table presenting the same means at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons) and 95% family-wise confidence intervals adjusted using the Bonferroni-Holm method [1] estimating the mean at the end of the simulation ($t = 84$). This interval was included to show the precision reached by running 10000 model simulations. See Supplementary Methods S1.1.4.8.1 Network measures for their detailed description.

S2.1 Number of nests

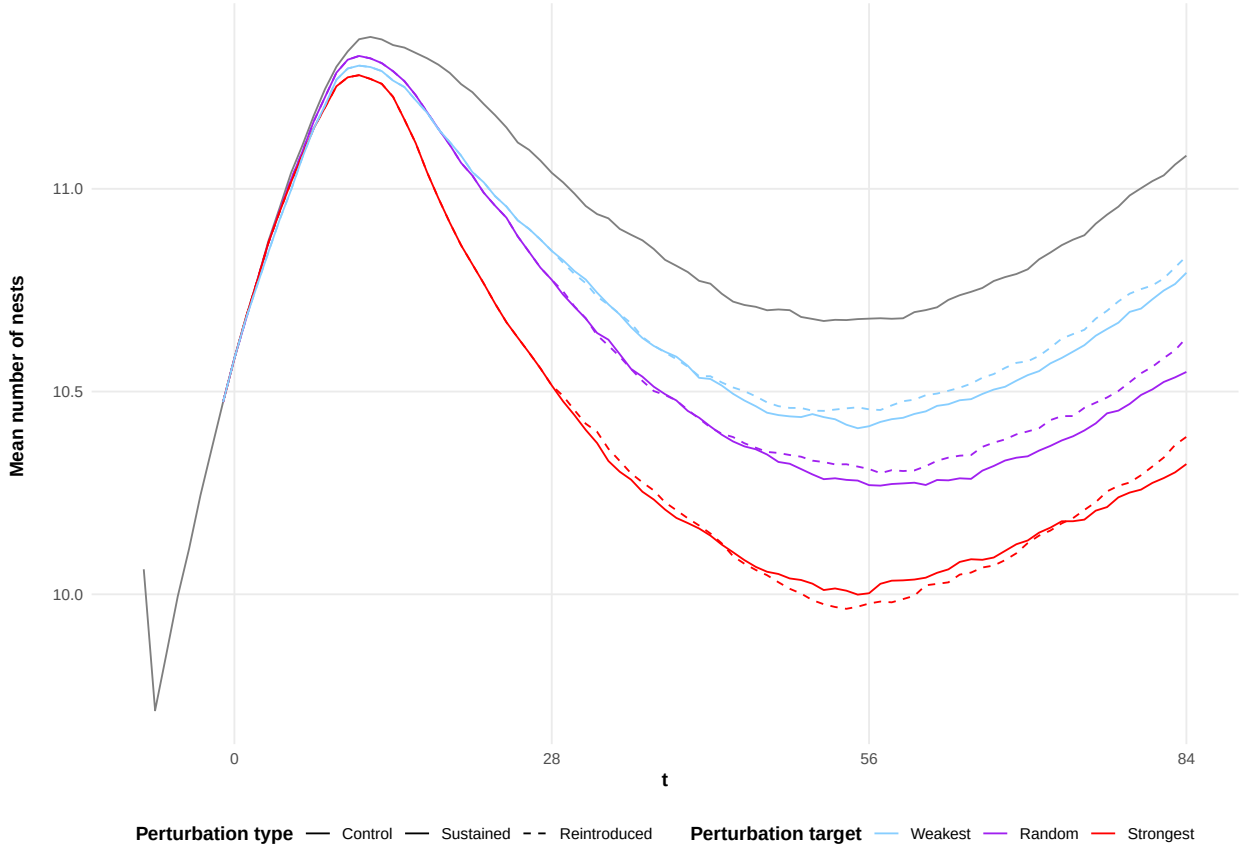

Figure S2.1: Mean number of nests over time by different treatments.

Table S2.1: Mean number of nests at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		10.582	11.040	10.680	11.082	10.933	11.230
Sustained	Weakest	10.582	10.847	10.415	10.793	10.644	10.941
Reintroduced	Weakest	10.582	10.847	10.456	10.834	10.685	10.982
Sustained	Random	10.582	10.776	10.269	10.548	10.400	10.697
Reintroduced	Random	10.582	10.776	10.309	10.633	10.484	10.781
Sustained	Strongest	10.582	10.515	10.003	10.321	10.173	10.470
Reintroduced	Strongest	10.582	10.515	9.977	10.388	10.240	10.537

S2.2 Number of used trees

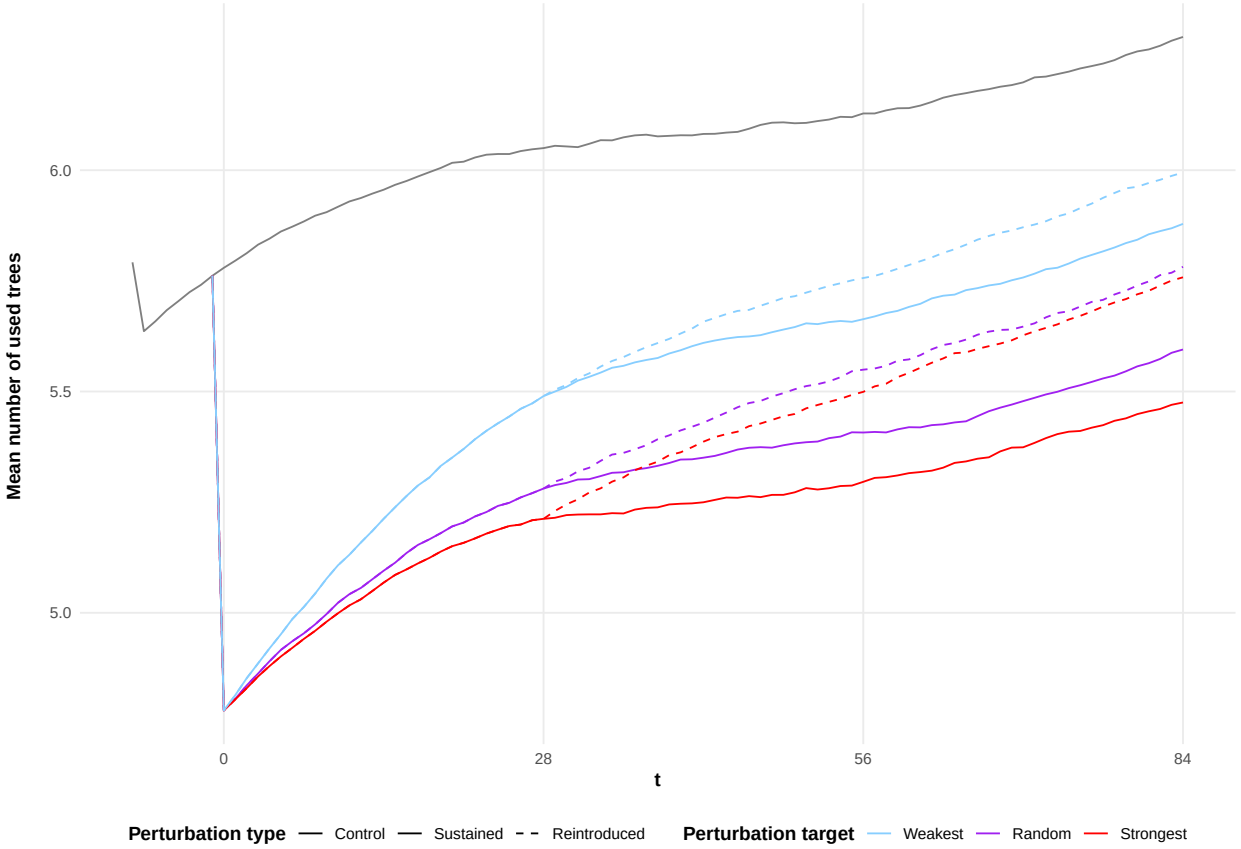

Figure S2.2: Mean number of used trees over time by different treatments.

Table S2.2: Mean number of used trees at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		5.779	6.050	6.128	6.301	6.229	6.373
Sustained	Weakest	4.779	5.490	5.663	5.879	5.807	5.950
Reintroduced	Weakest	4.779	5.490	5.756	5.995	5.923	6.066
Sustained	Random	4.779	5.281	5.407	5.595	5.523	5.667
Reintroduced	Random	4.779	5.281	5.549	5.782	5.710	5.853
Sustained	Strongest	4.779	5.212	5.296	5.475	5.404	5.547
Reintroduced	Strongest	4.779	5.212	5.499	5.758	5.686	5.830

S2.3 Number of internest trails

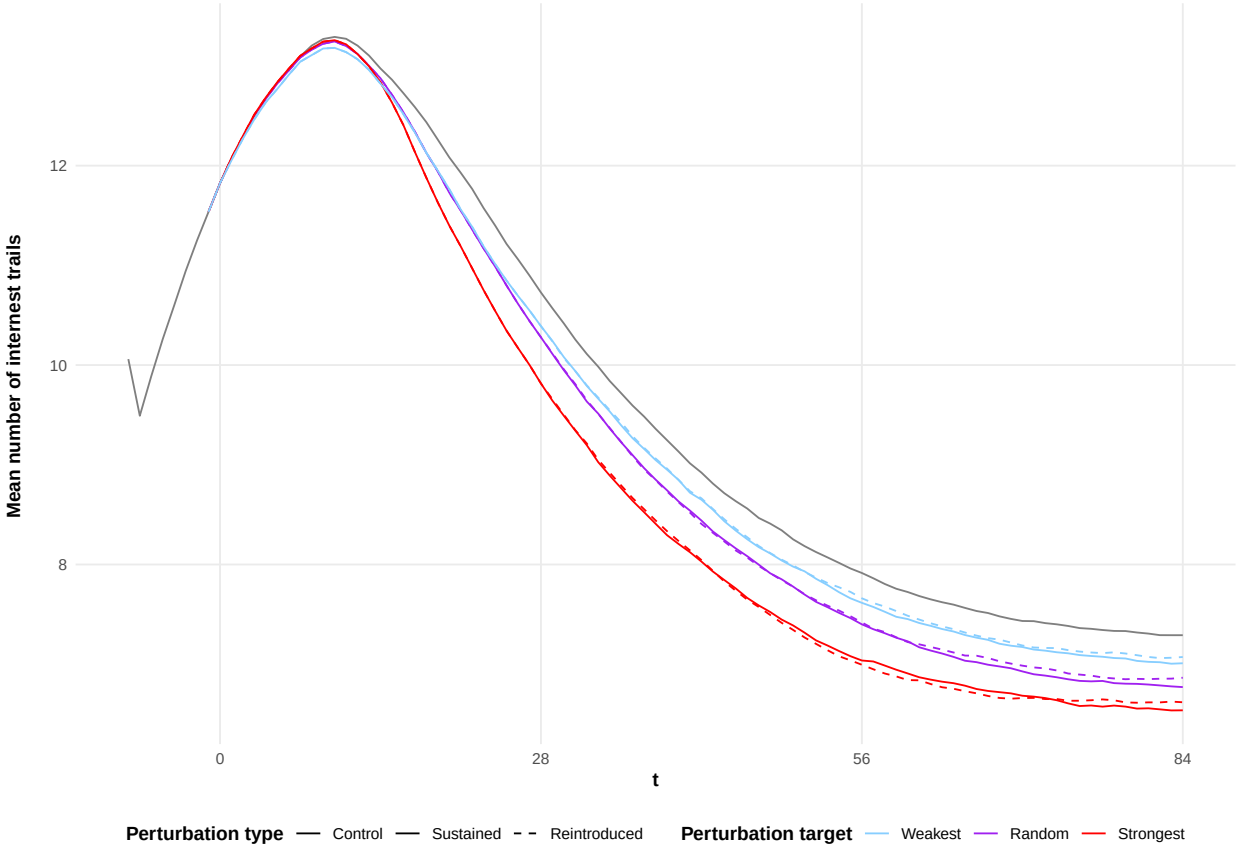

Figure S2.3: Mean number of internest trails over time by different treatments.

Table S2.3: Mean number of internest trails at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		11.824	10.728	7.915	7.291	7.162	7.420
Sustained	Weakest	11.824	10.390	7.615	7.010	6.881	7.138
Reintroduced	Weakest	11.824	10.390	7.661	7.072	6.943	7.201
Sustained	Random	11.824	10.278	7.400	6.770	6.642	6.899
Reintroduced	Random	11.824	10.278	7.418	6.864	6.736	6.993
Sustained	Strongest	11.824	9.815	7.037	6.537	6.409	6.666
Reintroduced	Strongest	11.824	9.815	6.995	6.618	6.490	6.747

S2.4 Number of foraging trails

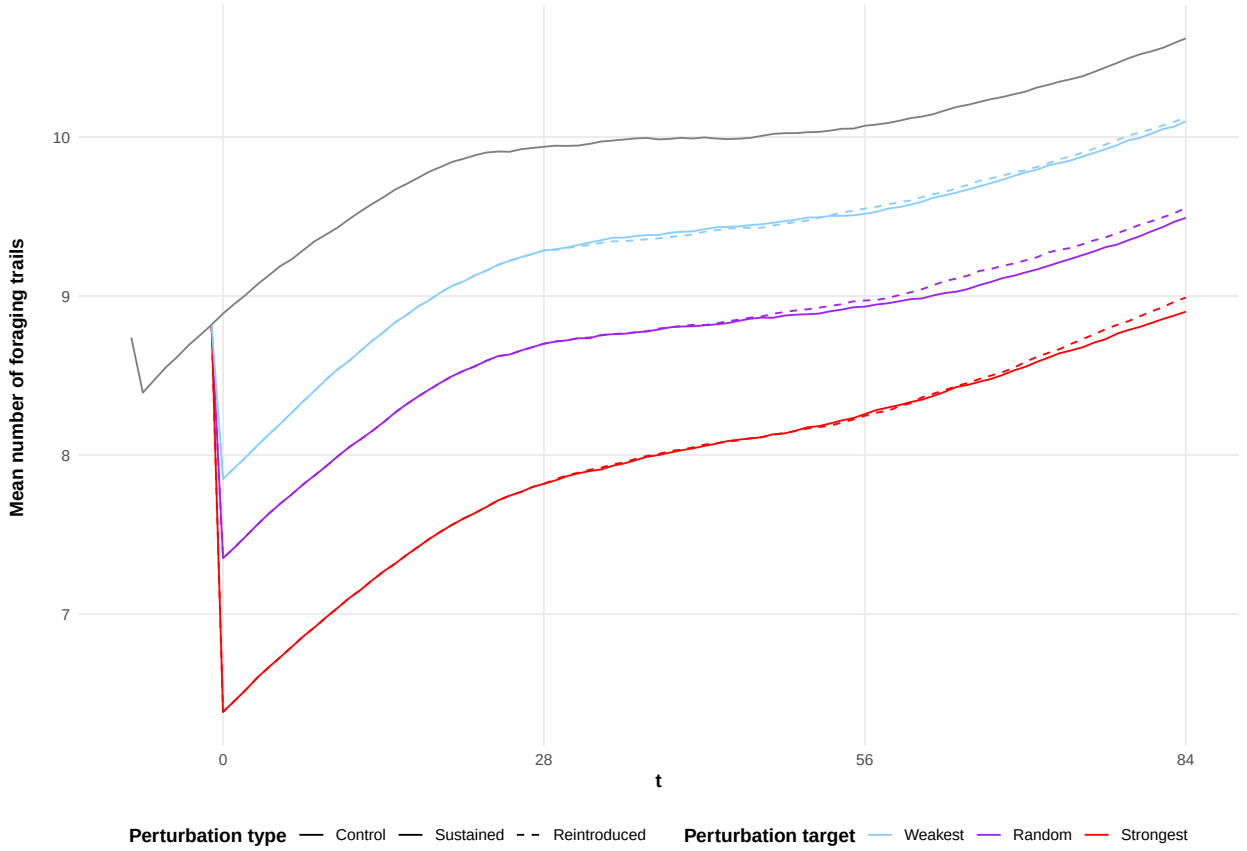

Figure S2.4: Mean number of foraging trails over time by different treatments.

Table S2.4: Mean number of foraging trails at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		8.890	9.939	10.071	10.620	10.479	10.762
Sustained	Weakest	7.850	9.287	9.517	10.099	9.957	10.241
Reintroduced	Weakest	7.850	9.287	9.550	10.123	9.981	10.265
Sustained	Random	7.352	8.700	8.933	9.492	9.350	9.633
Reintroduced	Random	7.352	8.700	8.972	9.554	9.412	9.696
Sustained	Strongest	6.385	7.819	8.258	8.902	8.760	9.043
Reintroduced	Strongest	6.385	7.819	8.247	8.991	8.849	9.133

S2.5 Trees to nests ratio

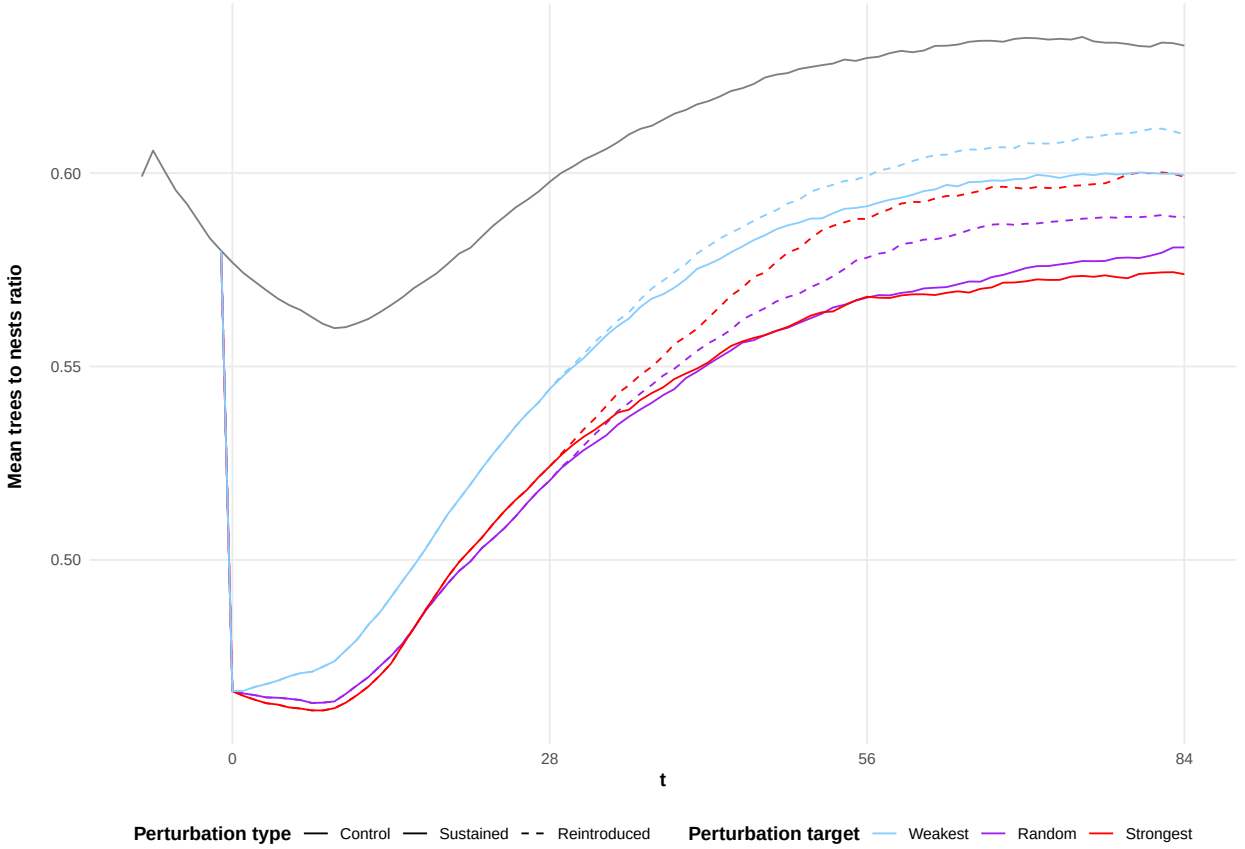

Figure S2.5: Mean ratio of the number of trees to the number of nests over time by different treatments.

Table S2.5: Mean ratio of the number of trees to the number of nests at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.577	0.598	0.630	0.633	0.626	0.640
Sustained	Weakest	0.466	0.544	0.591	0.600	0.592	0.607
Reintroduced	Weakest	0.466	0.544	0.599	0.610	0.603	0.617
Sustained	Random	0.466	0.521	0.568	0.581	0.574	0.588
Reintroduced	Random	0.466	0.521	0.578	0.589	0.581	0.596
Sustained	Strongest	0.466	0.524	0.568	0.574	0.567	0.581
Reintroduced	Strongest	0.466	0.524	0.588	0.599	0.592	0.606

S2.6 Internest trails to nests ratio

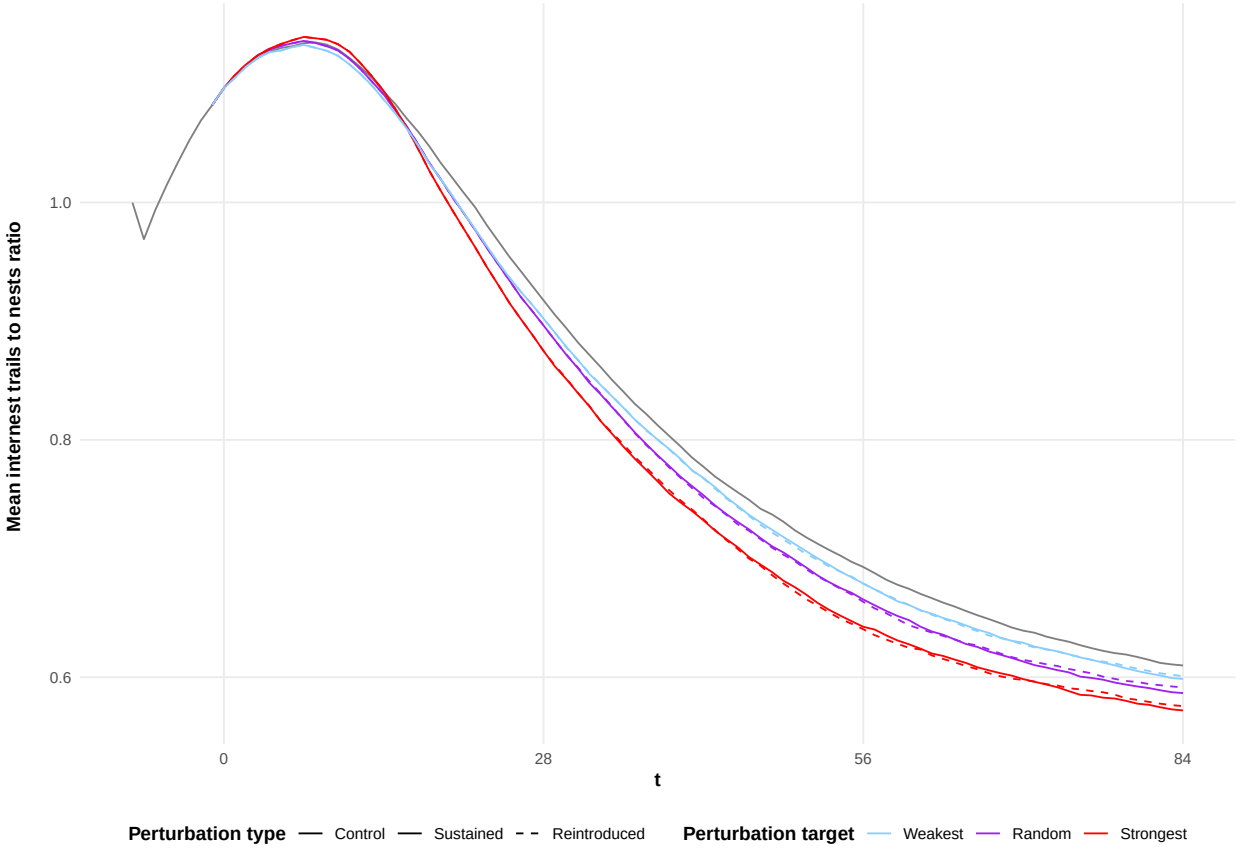

Figure S2.6: Mean ratio of the number of internest trails to the number of nests over time by different treatments.

Table S2.6: Mean ratio of the number of internest trails to the number of nests at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		1.096	0.918	0.693	0.610	0.604	0.616
Sustained	Weakest	1.096	0.902	0.679	0.599	0.593	0.604
Reintroduced	Weakest	1.096	0.902	0.679	0.601	0.595	0.607
Sustained	Random	1.096	0.896	0.666	0.587	0.581	0.593
Reintroduced	Random	1.096	0.896	0.664	0.591	0.586	0.597
Sustained	Strongest	1.096	0.875	0.642	0.572	0.566	0.578
Reintroduced	Strongest	1.096	0.875	0.640	0.576	0.570	0.582

S2.7 Foraging trails to nests ratio

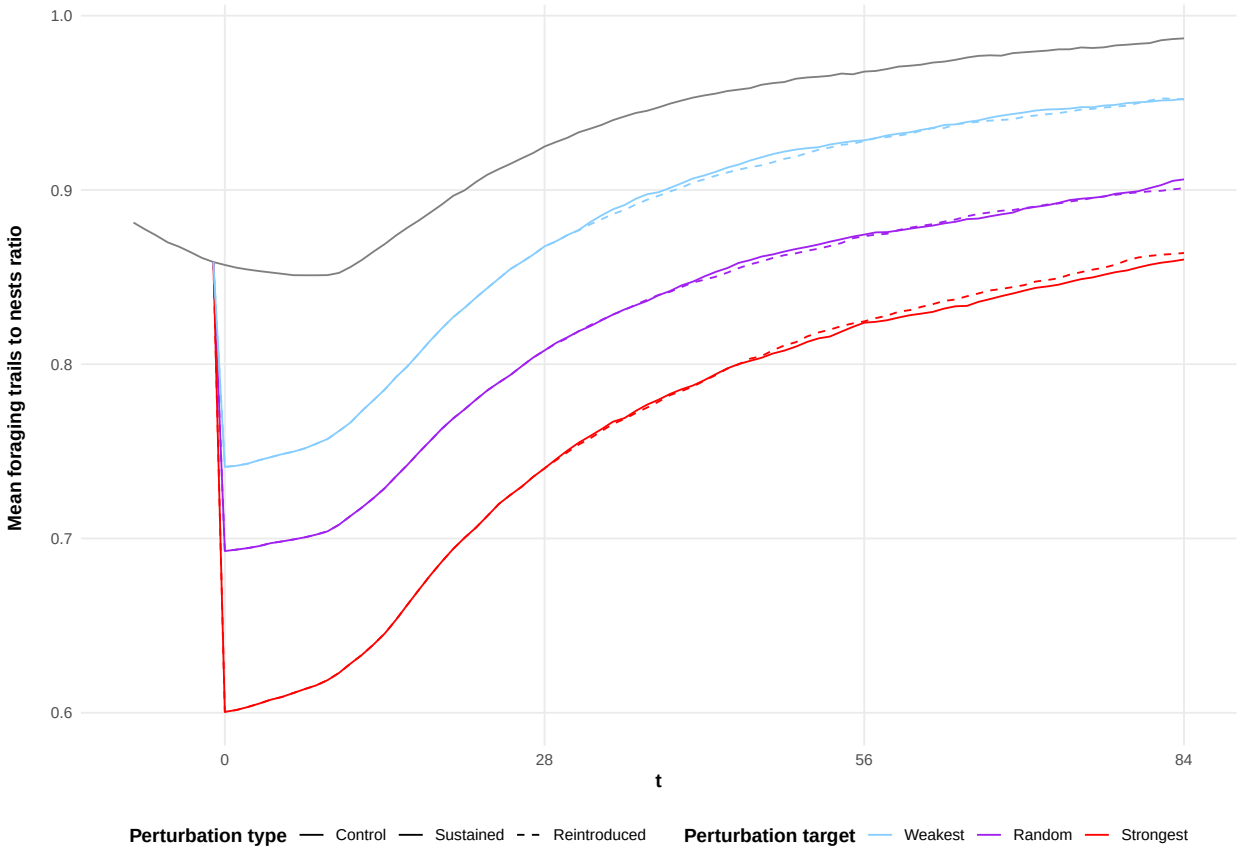

Figure S2.7: Mean ratio of the number of foraging trails to the number of nests over time by different treatments.

Table S2.7: Mean ratio of the number of foraging trails to the number of nests at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.857	0.925	0.968	0.987	0.979	0.995
Sustained	Weakest	0.741	0.868	0.928	0.952	0.944	0.960
Reintroduced	Weakest	0.741	0.868	0.928	0.952	0.944	0.960
Sustained	Random	0.693	0.808	0.874	0.906	0.898	0.914
Reintroduced	Random	0.693	0.808	0.873	0.901	0.893	0.909
Sustained	Strongest	0.601	0.740	0.824	0.860	0.852	0.868
Reintroduced	Strongest	0.601	0.740	0.825	0.864	0.856	0.872

S2.8 Number of network components

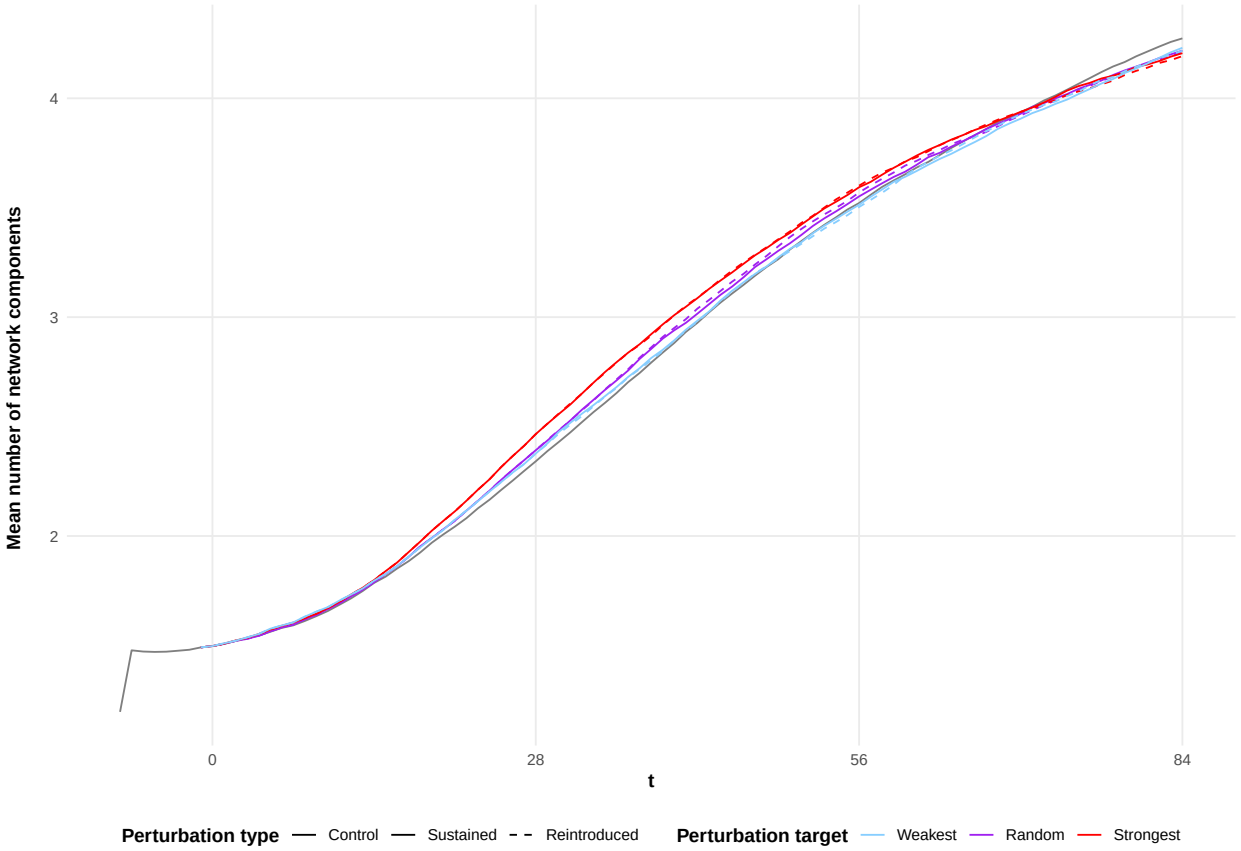

Figure S2.8: Mean number of network components over time by different treatments.

Table S2.8: Mean number of network components at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		1.497	2.341	3.521	4.274	4.218	4.329
Sustained	Weakest	1.497	2.377	3.514	4.231	4.175	4.286
Reintroduced	Weakest	1.497	2.377	3.503	4.217	4.162	4.273
Sustained	Random	1.497	2.392	3.552	4.218	4.163	4.274
Reintroduced	Random	1.497	2.392	3.570	4.213	4.157	4.268
Sustained	Strongest	1.497	2.466	3.594	4.206	4.151	4.262
Reintroduced	Strongest	1.497	2.466	3.601	4.193	4.137	4.248

S2.9 Network efficiency

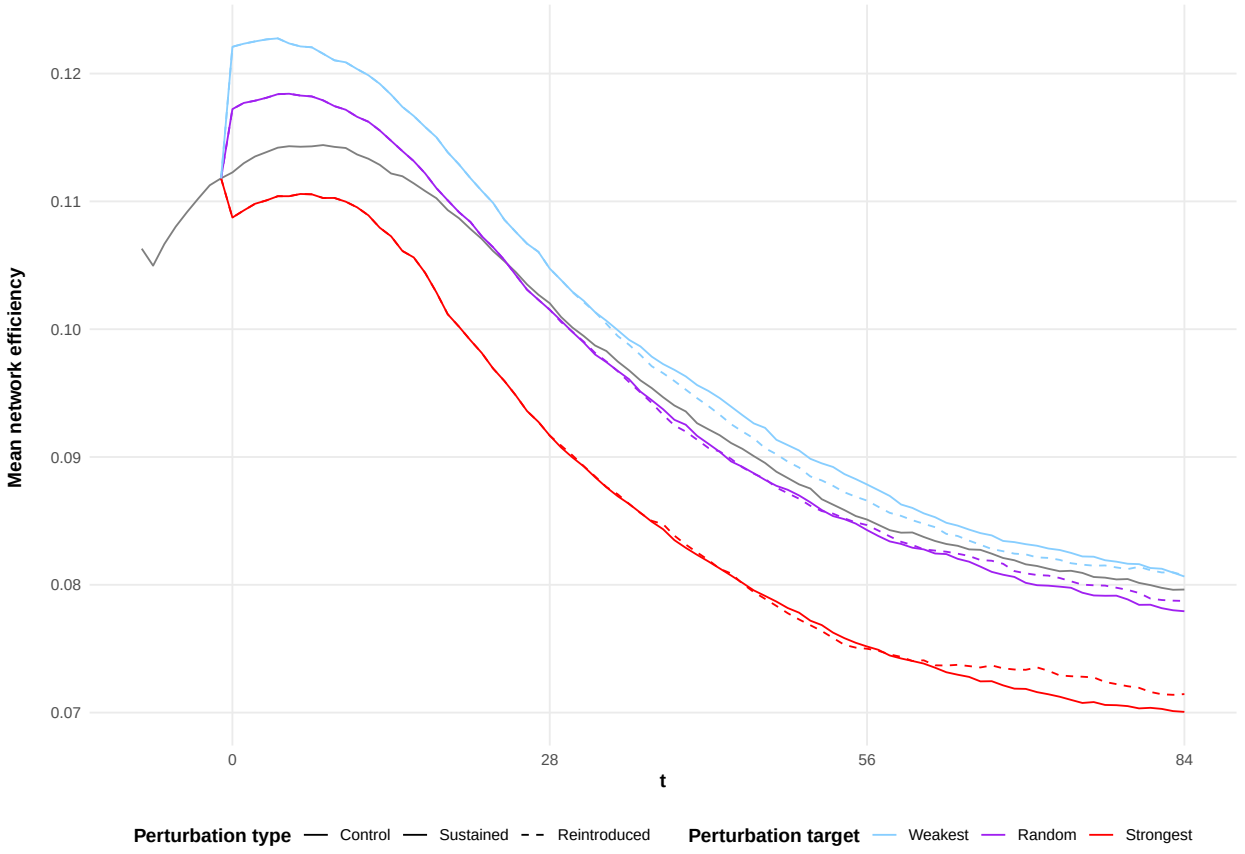

Figure S2.9: Mean network efficiency over time by different treatments.

Table S2.9: Mean network efficiency at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.112	0.102	0.085	0.080	0.078	0.081
Sustained	Weakest	0.122	0.105	0.088	0.081	0.079	0.082
Reintroduced	Weakest	0.122	0.105	0.087	0.081	0.079	0.082
Sustained	Random	0.117	0.102	0.084	0.078	0.076	0.079
Reintroduced	Random	0.117	0.102	0.085	0.079	0.077	0.080
Sustained	Strongest	0.109	0.092	0.075	0.070	0.069	0.072
Reintroduced	Strongest	0.109	0.092	0.075	0.071	0.070	0.073

S2.10 Network efficiency - nests only

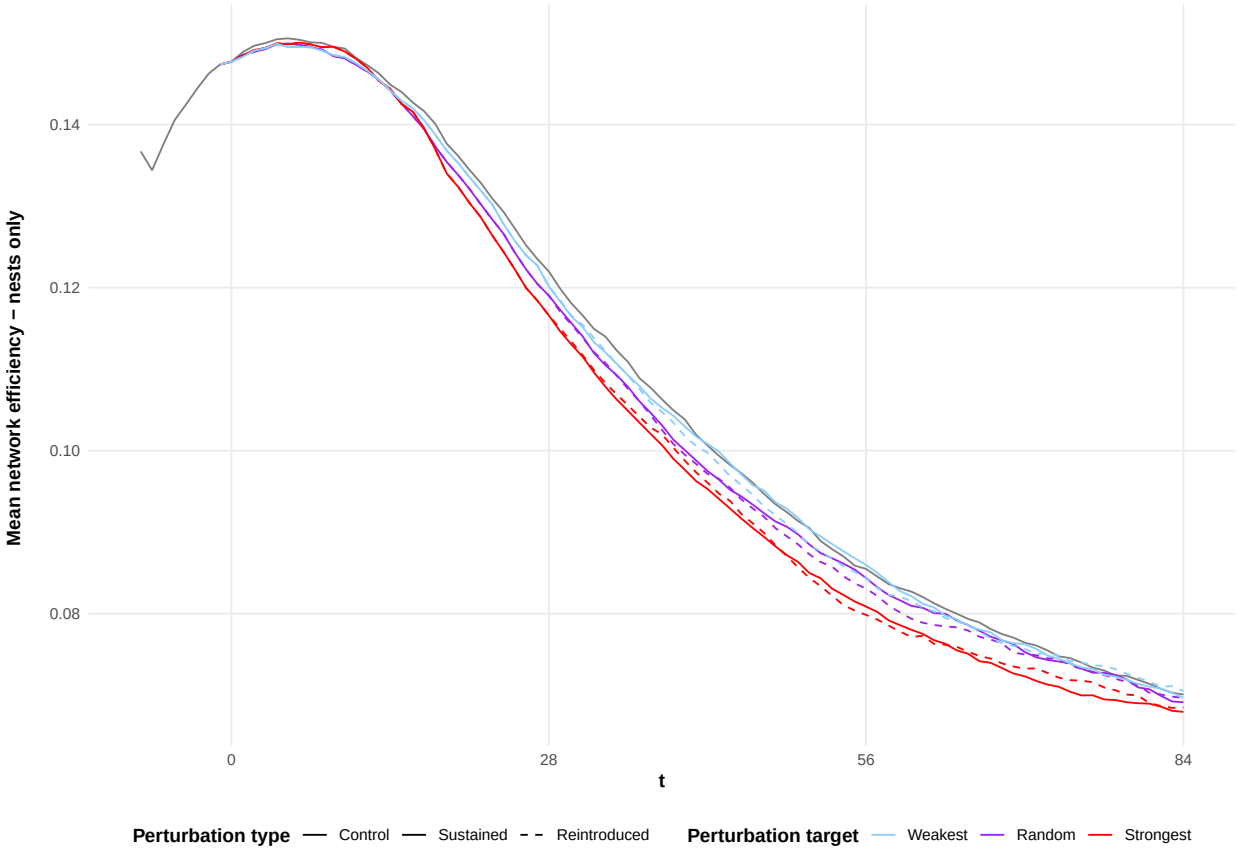

Figure S2.10: Mean efficiency of networks with only nests and internest trails over time by different treatments.

Table S2.10: Mean efficiency of networks with only nests and internest trails at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.148	0.122	0.085	0.070	0.068	0.072
Sustained	Weakest	0.148	0.120	0.086	0.070	0.068	0.071
Reintroduced	Weakest	0.148	0.120	0.084	0.071	0.069	0.072
Sustained	Random	0.148	0.119	0.084	0.069	0.067	0.071
Reintroduced	Random	0.148	0.119	0.083	0.070	0.068	0.071
Sustained	Strongest	0.148	0.117	0.081	0.068	0.066	0.070
Reintroduced	Strongest	0.148	0.117	0.080	0.069	0.067	0.070

S2.11 Network robustness

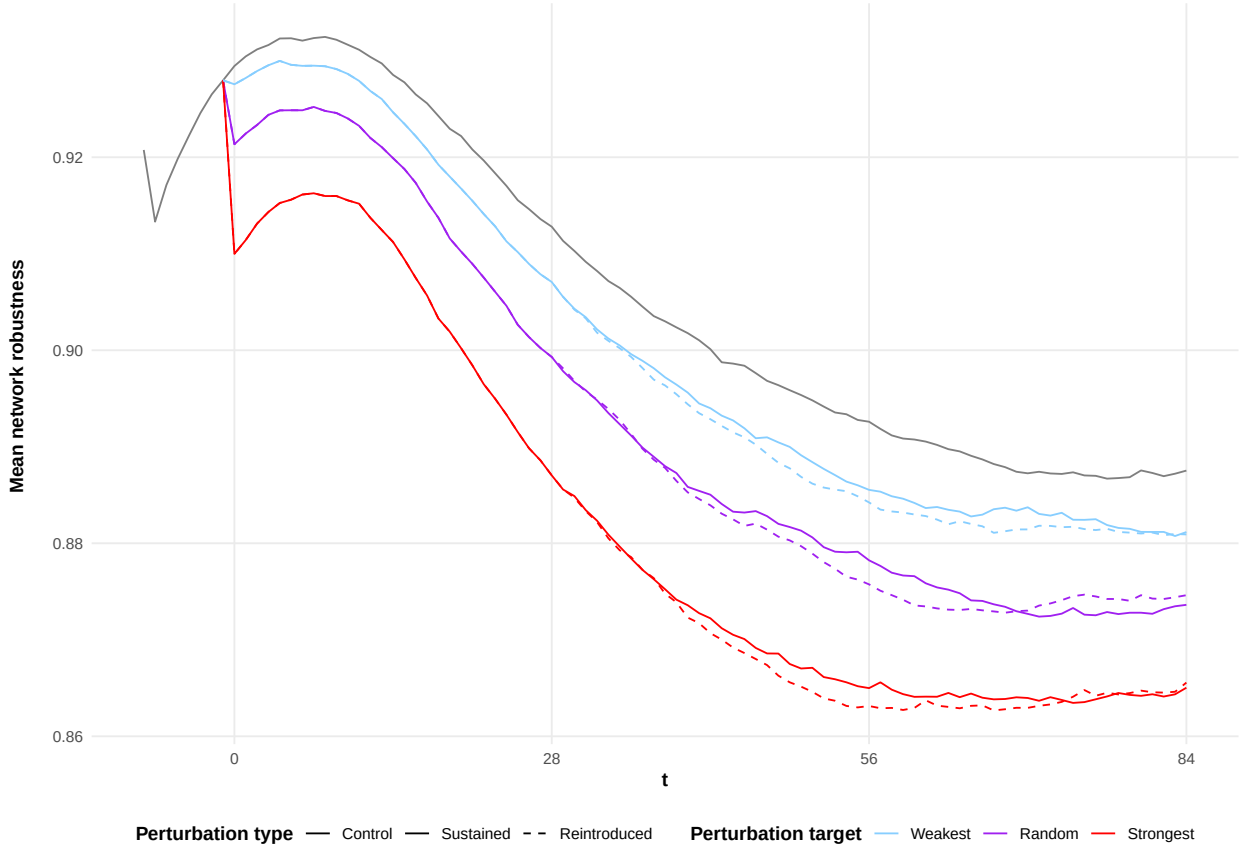

Figure S2.11: Mean network robustness over time by different treatments.

Table S2.11: Mean network robustness at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.929	0.913	0.893	0.888	0.884	0.891
Sustained	Weakest	0.928	0.907	0.886	0.881	0.878	0.884
Reintroduced	Weakest	0.928	0.907	0.884	0.881	0.878	0.884
Sustained	Random	0.921	0.899	0.878	0.874	0.870	0.877
Reintroduced	Random	0.921	0.899	0.876	0.875	0.871	0.878
Sustained	Strongest	0.910	0.887	0.865	0.865	0.862	0.868
Reintroduced	Strongest	0.910	0.887	0.863	0.866	0.862	0.869

S2.12 Network robustness - nests only

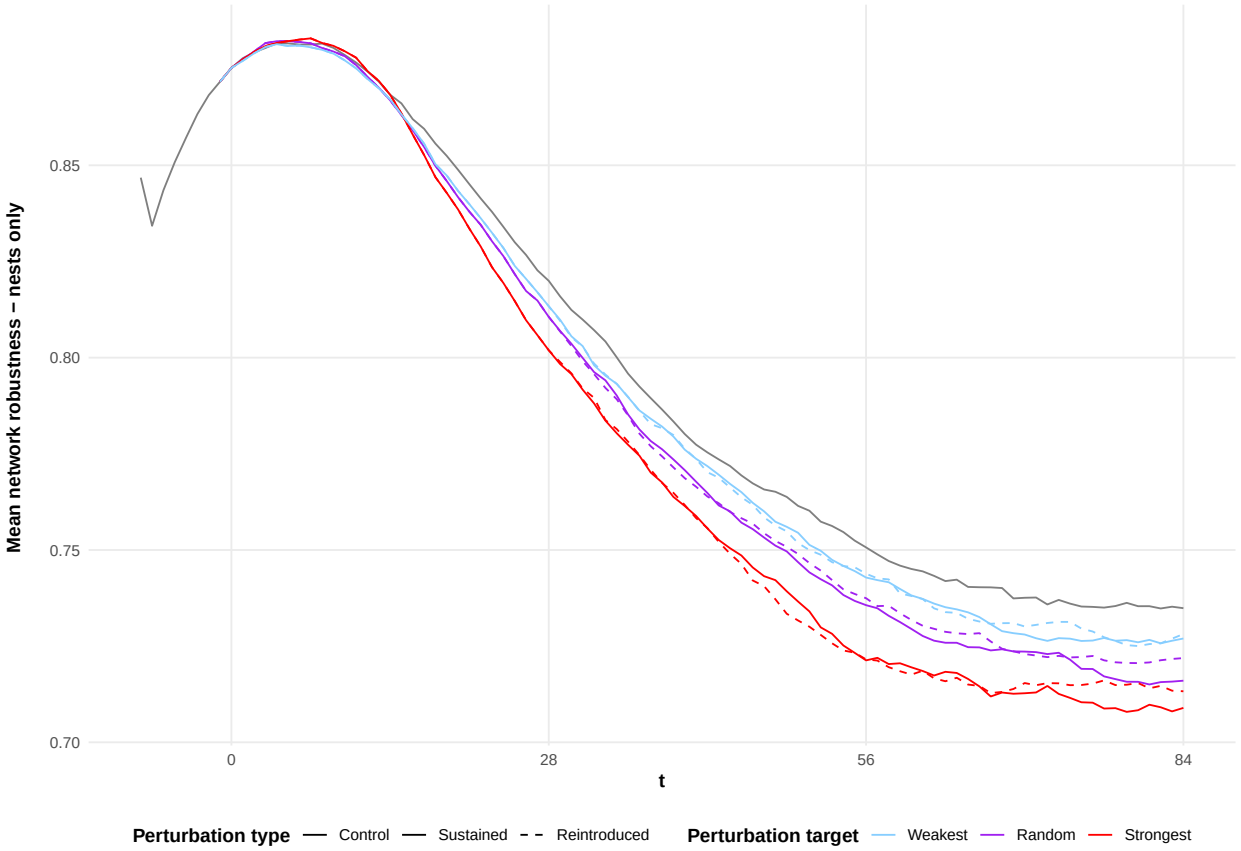

Figure S2.12: Mean robustness of networks with only nests and internest trails over time by different treatments.

Table S2.12: Mean robustness of networks with only nests and internest trails at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		0.875	0.820	0.751	0.735	0.729	0.741
Sustained	Weakest	0.875	0.813	0.743	0.727	0.721	0.733
Reintroduced	Weakest	0.875	0.813	0.744	0.728	0.722	0.734
Sustained	Random	0.875	0.811	0.736	0.716	0.710	0.722
Reintroduced	Random	0.875	0.811	0.737	0.722	0.716	0.728
Sustained	Strongest	0.875	0.802	0.721	0.709	0.703	0.715
Reintroduced	Strongest	0.875	0.802	0.722	0.713	0.707	0.719

S2.13 Network cost

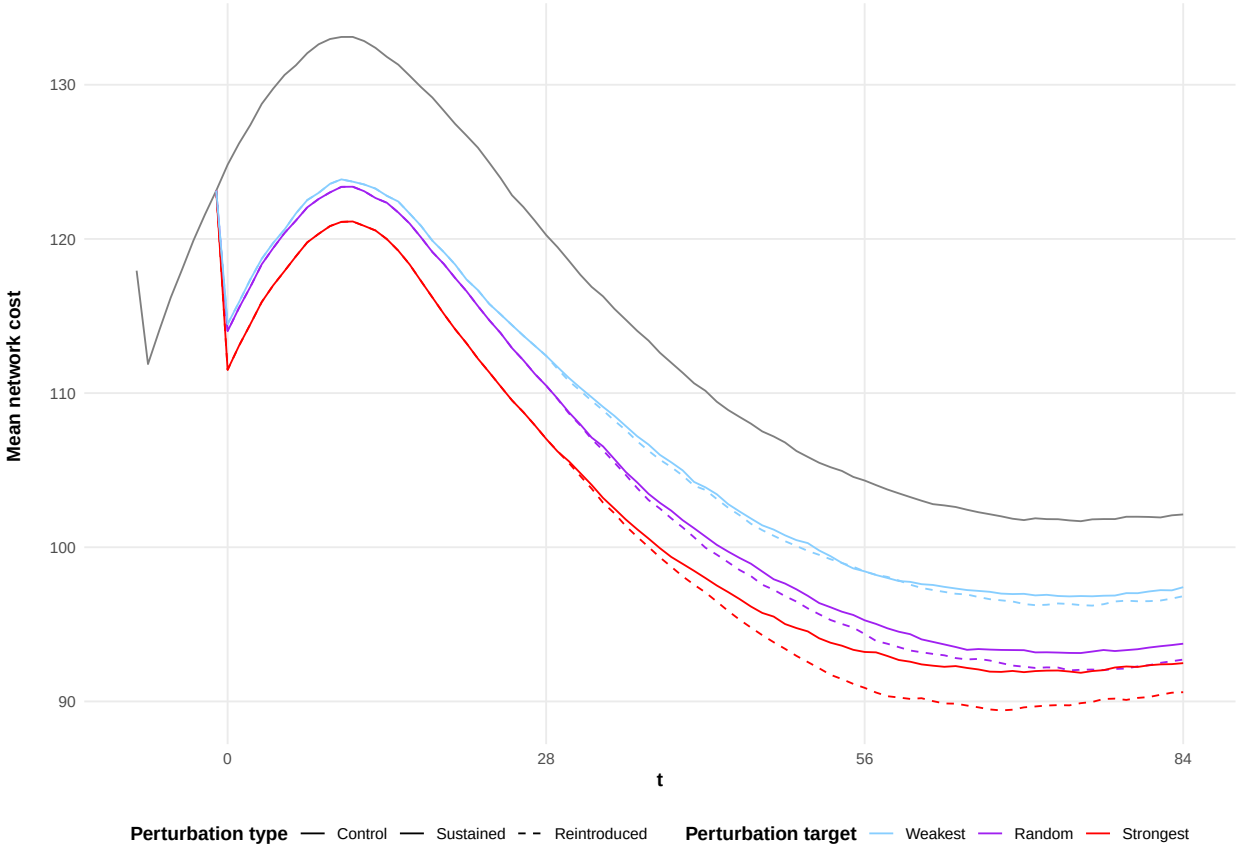

Figure S2.13: Mean network cost over time by different treatments.

Table S2.13: Mean network cost at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		124.813	120.256	104.328	102.129	100.580	103.677
Sustained	Weakest	114.474	112.420	98.435	97.410	95.861	98.958
Reintroduced	Weakest	114.474	112.420	98.432	96.826	95.278	98.375
Sustained	Random	114.016	110.487	95.263	93.743	92.195	95.292
Reintroduced	Random	114.016	110.487	94.373	92.715	91.167	94.264
Sustained	Strongest	111.510	107.033	93.208	92.483	90.935	94.032
Reintroduced	Strongest	111.510	107.033	90.880	90.598	89.050	92.146

S2.14 Network cost - nests only

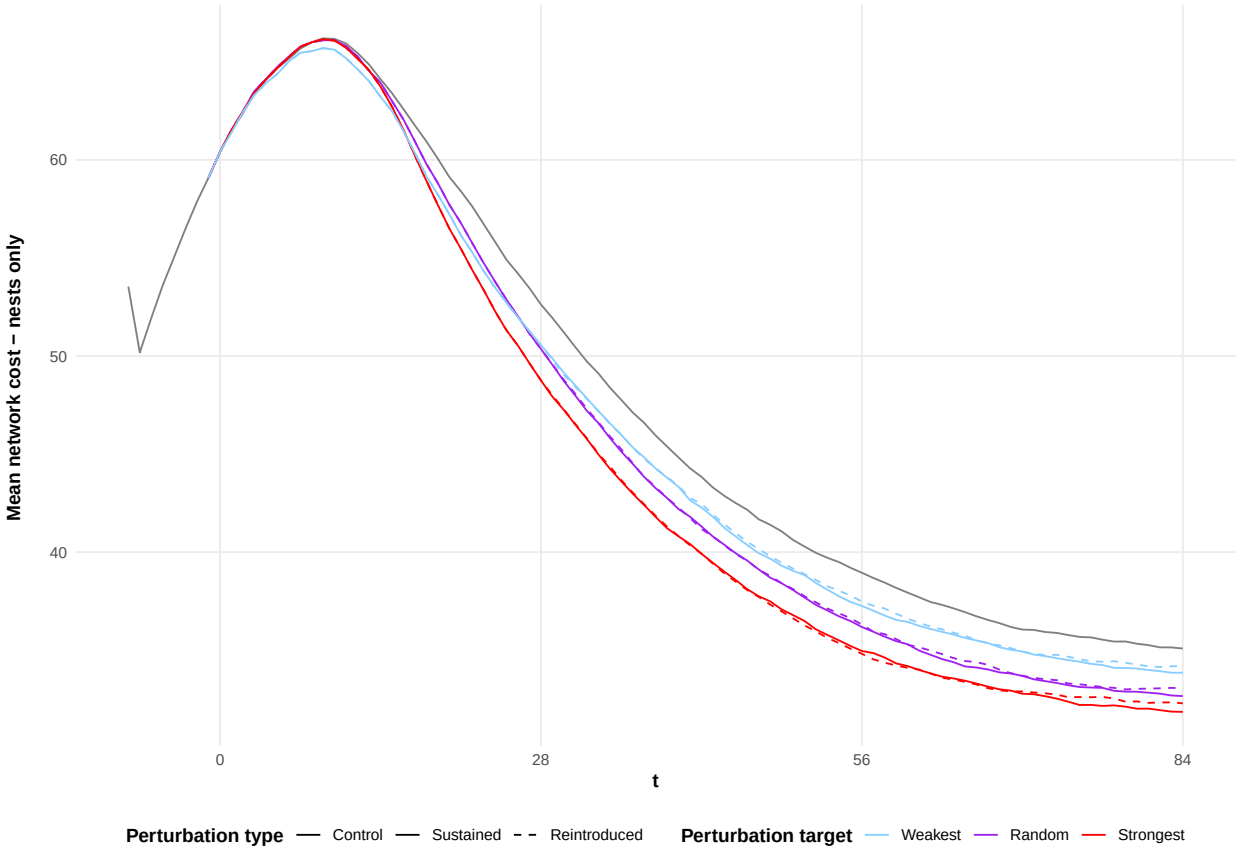

Figure S2.14: Mean cost of networks with only nests and internest trails over time by different treatments.

Table S2.14: Mean cost of networks with only nests and internest trails at highlighted timesteps ($t = -8$, the beginning of the burn-in phase; $t = 0$, the time of perturbations; $t = 28$ the time of tree reintroduction; and $t = 56, 84$, end of the rest of the seasons). 95% family-wise confidence interval for the mean at the last timestep (t=84).

Perturbation type	Perturbation target	t=0	t=28	t=56	t=84	t=84 95% CI LB	t=84 95% CI UB
Control		60.404	52.624	38.950	35.086	34.417	35.754
Sustained	Weakest	60.404	50.554	37.256	33.849	33.181	34.517
Reintroduced	Weakest	60.404	50.554	37.481	34.206	33.538	34.874
Sustained	Random	60.404	50.358	36.184	32.662	31.993	33.330
Reintroduced	Random	60.404	50.358	36.311	33.063	32.395	33.732
Sustained	Strongest	60.404	48.755	34.961	31.857	31.189	32.525
Reintroduced	Strongest	60.404	48.755	34.817	32.292	31.624	32.961

References

1. Holm S. 1979 A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics* **6**, 65–70.