Supplementary Information for

Conservation prioritization can resolve the flagship species conundrum

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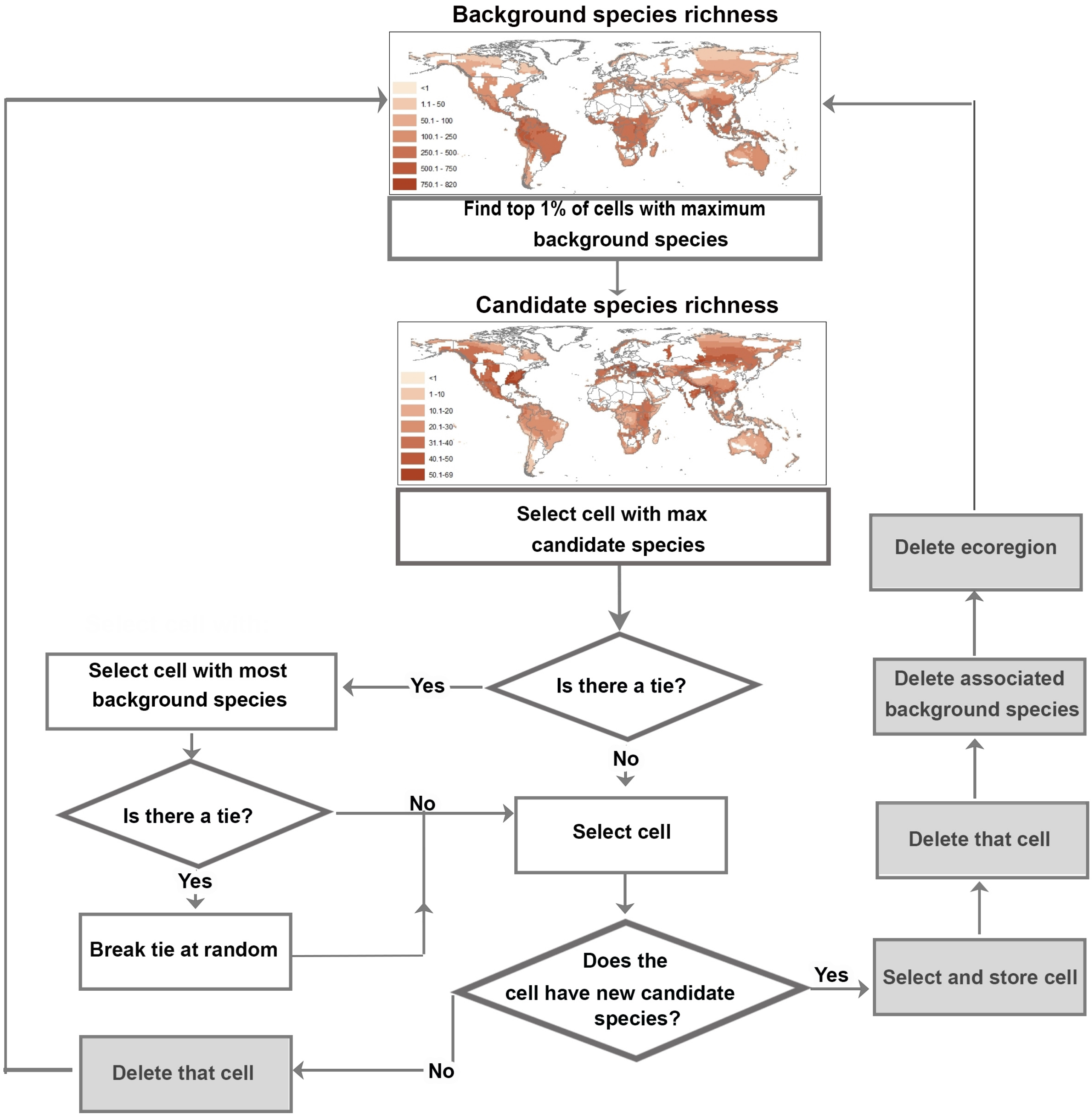
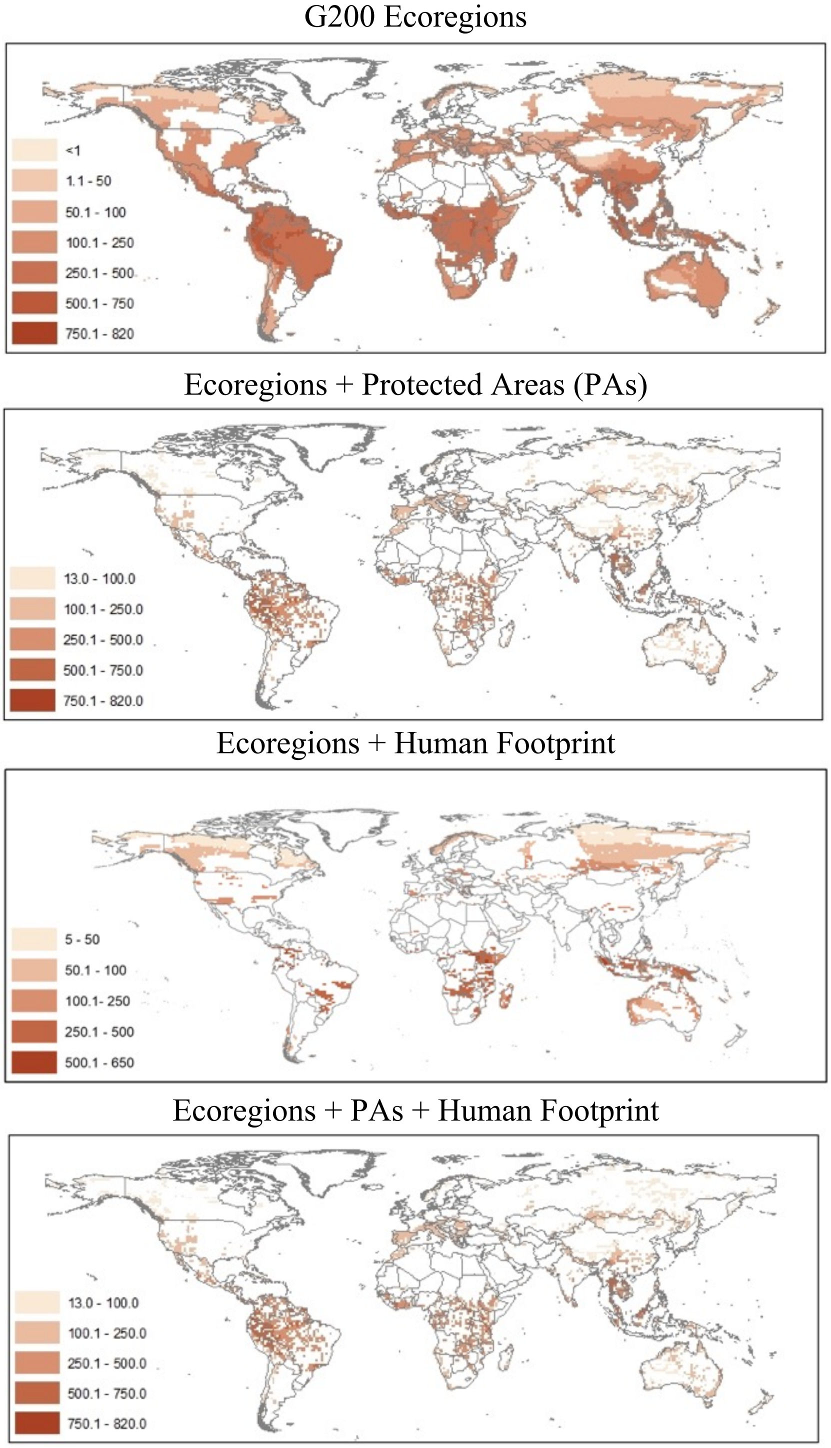


Supplementary Figure 1. The algorithmic decision tree developed for the integrated approach. The process begins by identifying the top 1% of sites which hold the maximum benefit (e.g. the highest numbers of background species). From that initial selection, the algorithm then picks the site which also has the most candidate flagship species. Given a tie, we preference sites with the most background species. Once a site is selected, both the ecoregion and background species associated with the site and ecoregion are deleted to ensure complementarity is achieved (cells in grey) and the algorithm cycles through the selection again until all background species have been captured. Species richness maps are from Scenario a (see Table 2 in main document).



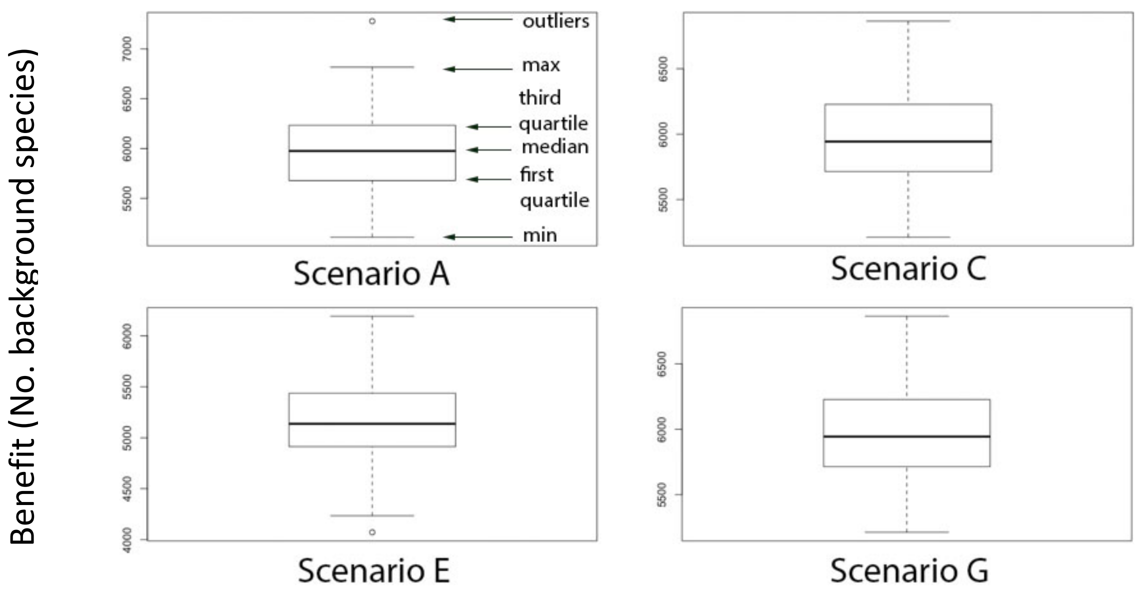
Supplementary Figure 2. Distribution maps of the number of background species as determined by the different place-based constraints. Note: these maps reflect the initial benefit to which we apply the algorithm from Supplementary Figure 1 and show the spatial extent of candidate places described in Table 2.

Supplementary Methods

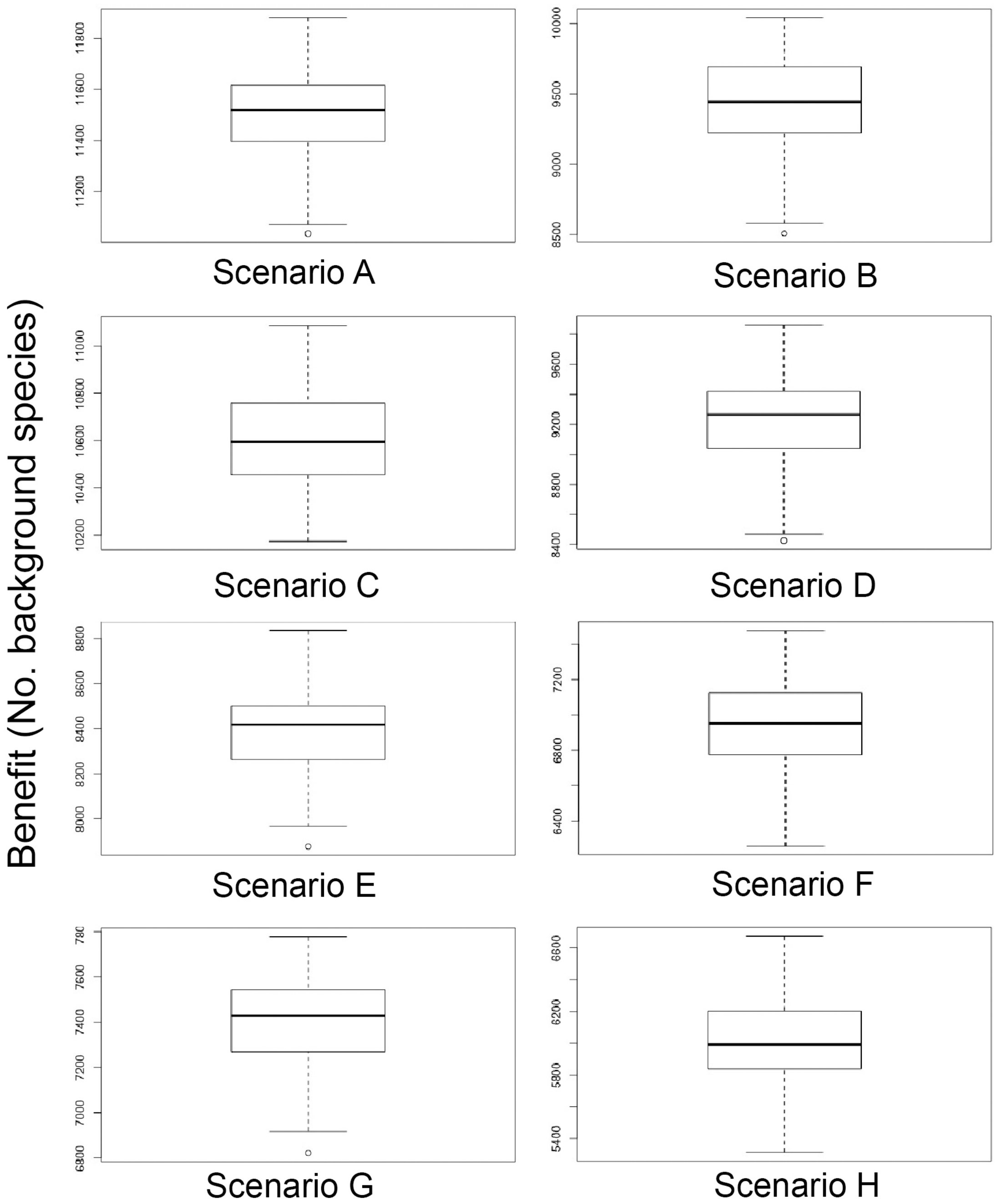
We generated two randomizations of the problem. The first was a place-based randomization which was executed on Scenarios a, c, e, and g (Main document Table 2). For this analysis, we ignored the influence of flagship species, focusing solely on the accumulation of background species in the random selection for comparisons.

Additionally, we opted to conduct a second randomized test. For this, we selected a random flagship species from the candidate species list, followed by the location in its range that provided the maximum benefit. No ecoregional constraints were considered in either of the random tests and we ran 100 randomizations for each relevant scenario.

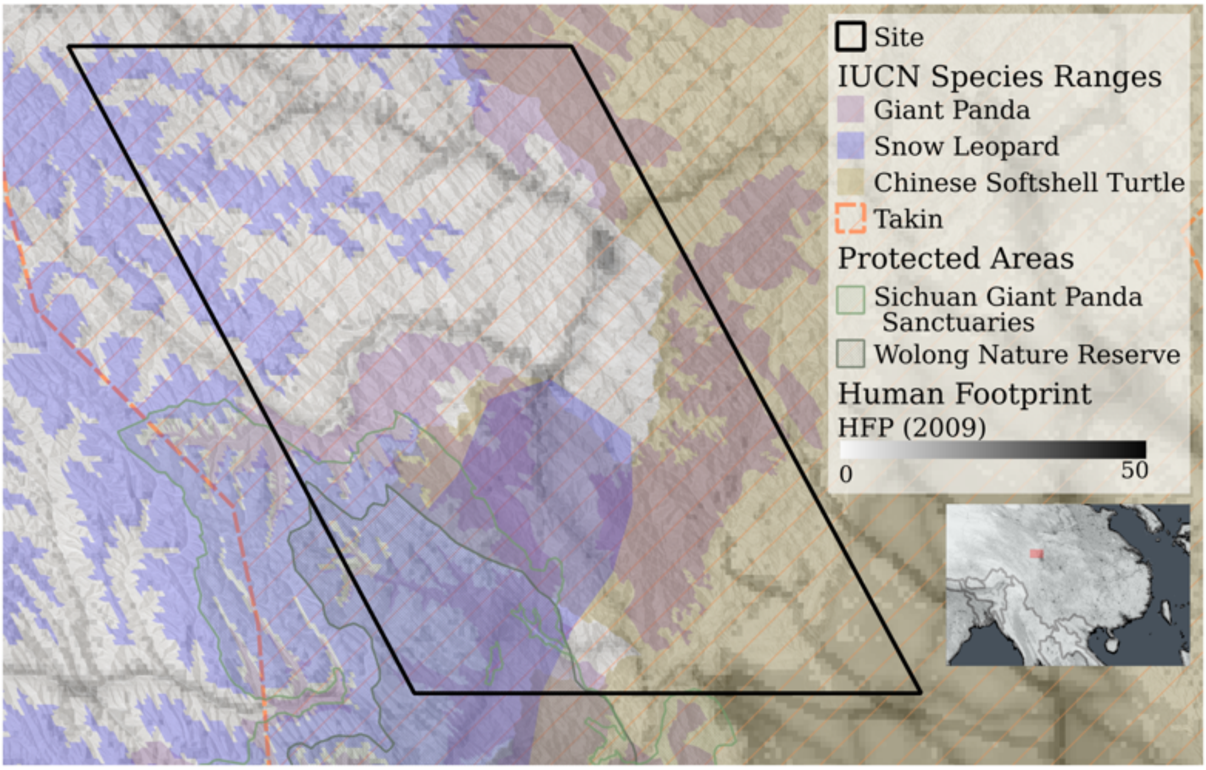
Our integrated approach outperformed both randomized tests. For the random selection of places, the mean benefit ranged from 39-55% across the suite of sites as presented in the main document (Table 1; Supplementary Figure 3). When we tested the performance of selecting a random flagship species first, followed by identifying the site in its range which delivers the maximum benefit, we found similar performance to our integrated approach (87-90% efficiency). However, these randomized analyses were not subjected to the ecoregional complementarity constraint placed on the selection of sites that our integrated approach upholds (Supplementary Figure 1). Interestingly, when we look at the top 10 most efficient sites for this species-based randomization, the average performance efficiency is 15% lower compared to our integrated approach (range 68-74%) (Supplementary Table 2, Supplementary Figure 4).



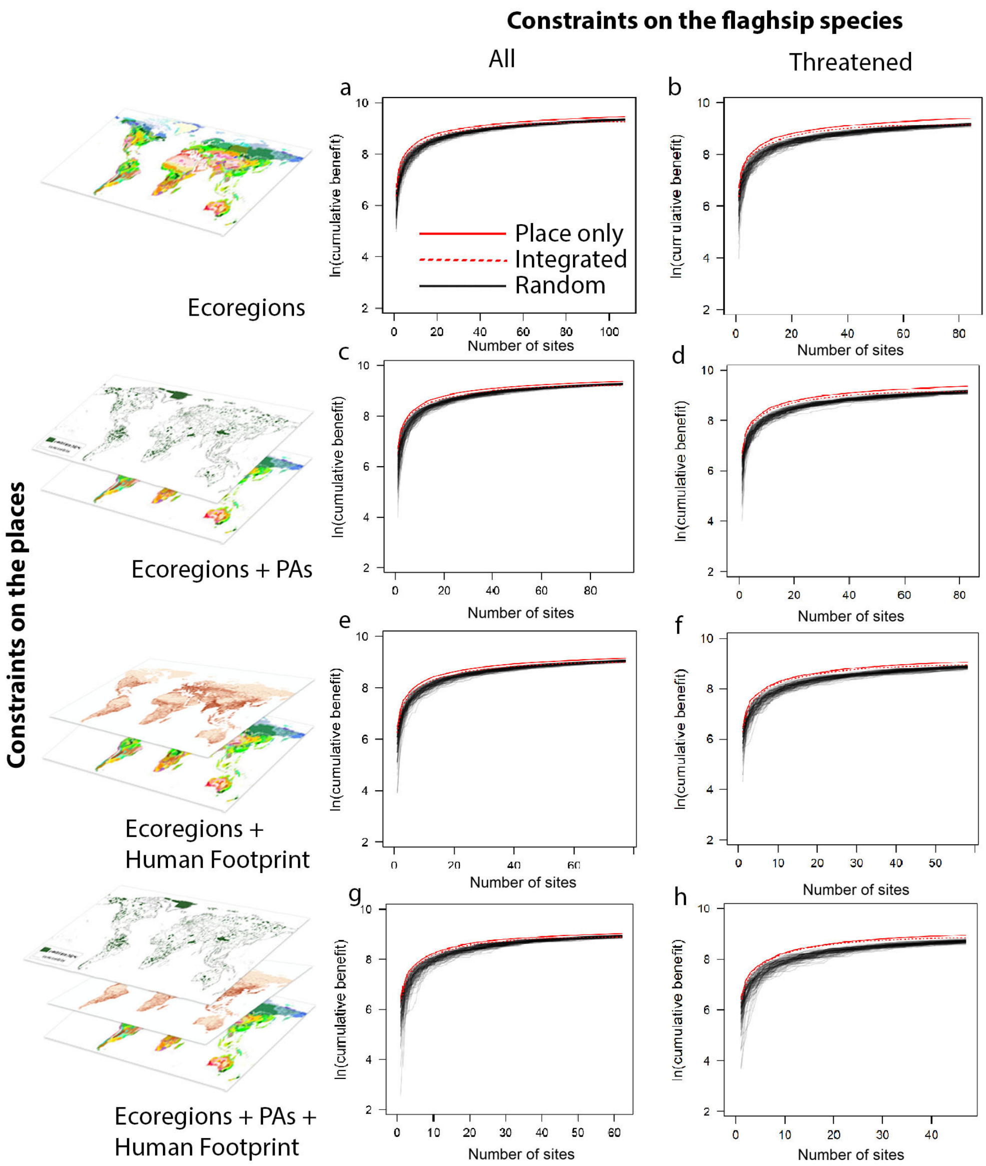
Supplementary Figure 3. The benefit delivered from the place-based randomization test. Boxplots show results from 100 random selections of sites for Scenario A (mean = 5,973 species); Scenario C (mean =5,968 species); Scenario E (mean = 5, 136 species); and Scenario G (mean = 5,968 species). See Source Data for raw values.



Supplementary Figure 4. The benefit delivered from the species-based randomization test. Boxplots show the benefit delivered from 100 random selections of species for Scenarios a-h. See Supplementary Table 2 for more details. See Source Data for values.



Supplementary Figure 5. **Example of the distribution of potential flagship species, protected areas, and human footprint within site I** (Figure 2 main document).



Supplementary Figure 6. Performance comparisons across scenarios for the species-based randomized test. The scenario performance of the place only, integrated, and random flagship species approaches (a-h) in achieving the conservation benefit (defined as the number of background species protected). Random selections were performed 100 times for each scenario. Threatened Status refers to the candidate flagship group driven by IUCN classification of Near Threatened and higher.

Supplementary Table 1. A summary of the IUCN threat status classifications for the 534 candidate flagship species.

IUCN status	Candidate Birds	Candidate Mammals	Candidate Reptiles	Total
Critically Endangered	12	62	4	78
Endangered	12	98		110
Vulnerable	16	90	7	113
Near Threatened	27	7	1	35
Least Concern	160	4	27	191
Lower Risk/conservation dependent			1	1
Lower Risk/least concern			5	5
Lower Risk/near threatened			1	1
Grand Total	227	261	46	534

Supplementary Table 2. Results from the place-only, integrated, and random species approaches. Values describe the maximum benefit available for each scenario (Scenarios a-h) as described in Table 2 and Supplementary Figure 6. We report on the mean benefit of 100 prioritizations for the randomized tests.

	Max benefit (No. of background species)	No. sites in solution:	Number of species delivered with:			Percent of efficiency retained for full suite of sites:		Percent of efficiency retained for top 10 sites:	
Scenario		integrated approach	place-only approach	integrated approach	Species-based random test	integrated	Species-based null (mean 100 runs)	integrated	Species-based random test
a	19,616	107	12,878	10,545	11,493	82%	89%	87%	72%
b	19,616	84	11,961	9,487	9,448	79%	79%	90%	68%
c	16,542	93	11,835	9,965	10,596	84%	90%	92%	74%
d	16,542	83	11,443	9,387	9,220	82%	81%	92%	69%
e	12,053	77	9,362	7,972	8,391	85%	90%	89%	74%
f	12,053	58	8,557	7,621	6,935	89%	81%	96%	71%
g	9,833	62	8,363	7,269	7,400	87%	88%	93%	74%
h	9,833	47	7,702	6,849	6,017	89%	78%	97%	71%

Supplementary Table 3. The locations of the 47 sites associated with Fig 2 and Supplementary Data Table 2.

Site_ID	Ecoregion	Country
1	Sumatran Islands Lowland and Montane Forests	Indonesia
2	East African Acacia Savannas	Kenya
3	Rio Negro-Jurua Moist Forests	Peru
4	Guinean Moist Forests	Cote d'Ivoire/Liberia
5	Northern Andean Montane Forests	Ecuador
6	Naga-Manapuri-Chin Hills Moist Forests	India/Bhutan
7	Madagascar Forests and Shrublands	Madagascar
8	Mesoamerican Pine-Oak Forests	Guatemala
9	New Guinea Montane Forests	Papua New Guinea
10	Choco-Darien Moist Forests	Colombia
11	East African Coastal Forests	United Republic of Tanzania
12	Cerrado Woodlands and Savannas	Brazil
13	Congolian Coastal Forests	Gabon/Equatorial Guinea
14	Appalachian and Mixed Mesophytic Forests	United States
15	Chihuahuan-Tehuacan Deserts	Mexico/United States
16	Hengduan Shan Conifer Forests	China
17	Philippines Moist Forests	Philippines
18	Madagascar Spiny Thicket	Madagascar
20	Borneo Lowland and Montane Forests	Indonesia/Malaysia
25	Drakensberg Montane Woodlands and Grasslands	South Africa
26	Sulawesi Moist Forests	Indonesia
28	European-Mediterranean Montane Forests	Greece/Bulgaria
34	Amazon River and Flooded Forests	Brazil
35	Albertine Rift Montane Forests	Uganda/Democratic Republic of the Congo
43	Central and Eastern Miombo Woodlands	Angola/Zambia
52	Horn of Africa Acacia Savannas	Ethiopia
63	Mediterranean Forests, Woodlands and Scrub	Algeria
82	Valdivian Temperate Rain Forests / Juan Fern□«□□nde	Chile
95	Atlantic Dry Forests	Brazil
101	Guianan Highlands Moist Forests	Venezuela
102	Altai-Sayan Montane Forests	Kazakhstan
106	Madagascar Dry Forests	Madagascar
112	Lower Mississippi River	United States
124	Eastern Arc Montane Forests	United Republic of Tanzania
129	Russian Far East Broadleaf and Mixed Forests	China/Russia
130	Sonoran-Baja Deserts	Mexico

131	Southwestern Amazonian Moist Forests	Bolivia
137	Colorado River	United States
145	Moluccas Moist Forests	Indonesia
146	Namib-Karoo-Kaokoveld Deserts and Shrublands	Namibia
152	New Zealand Temperate Forests	New Zealand
157	Chihuahuan Freshwater	Mexico
159	Patagonian Steppe	Argentina
161	New Guinea Rivers & Streams	Indonesia
403	Northern Prairies	Canada
527	Volga River Delta	Russia
589	Greater Sundas Mangroves	Indonesia