Species Richness and Complementarity: Sizing Up Utah's National Parks, Monuments, Recreation Areas, and Historic Sites

By Walter Fertig

In order to stave off the threat of widespread species loss, conservation biologists hope to eventually create a network of protected areas across North America that will preserve a representative sample of the continent's full native plant and animal diversity. National park units are an important component of this network, as they are among the most highly protected of all lands and are managed with an emphasis on preserving native species. Utah has one of the highest concentrations of national parks and monuments in the United States, as well as one of the richest biotas.

But how effective is the existing system of Utah parklands in meeting the goal of full representation of biological diversity? To find out, I compiled vascular plant species checklists for 14 national parks, monuments, recreation areas, and historic sites in the state managed by the National Park Service and the Bureau of Land Management into a master species database derived from the 4th edition of *A Utah Flora* (Welsh et al. 2008). I wanted to see how many species were present in these parklands, what sort of species were absent, and how important each park was to the overall network. I hoped that patterns might emerge that would help guide future protection efforts for geographic areas, habitats, and species that remain inadequately protected.

Species Richness: Not surprisingly, I found that larger parklands, on average, had the greatest number of species (also called species richness or alpha diversity). Based on data current through 2008, Grand Staircase-Escalante National Monument (GSENM) had the highest species richness of any of the parklands I examined, with 999 taxa. At over 761,000 ha, GSENM is also the largest protected area in Utah. Overall, the six largest parks all had the largest floras (see table above). Likewise, the six smallest units had the lowest species richness. These patterns generally hold if park area is normalized by taking the natural log of the area, though Zion National Park then emerges as having the richest flora with 90.1 species/ln(area), followed by Capitol Reef National Park and Grand Staircase*.

Rank of Park Units in Plant Species Richness
(based on data through 2008)

Park	# Vascular Plant Taxa	Size (ha)
1. GSENM	999	761,070
2. ZION	991	59,900
3. GCNRA	889 (863 in UT)	505,868
4. CARE	888	97,895
5. DINO	757 (485 in UT)	85,096
6. CANY	600	136,610
7. BRCA	587	14,502
8. ARCH	523	30,966
9. NABR	428	3,099
10. CEBR	354	2,491
11. HOVE	340 (240 in UT)	318
12. TICA	235	101
13. RABR	224	65
14. GOSP	149	1,107

Protection Status: The 14 parklands studied here contain at least 2007 of the state's 3659 native and naturalized vascular plant species (54.8% of the flora of Utah). Rare or endemic species (those with ranges limited to a small geographic area) are more than twice as likely as common or widespread species to be missing from the protected area network. Protection also tends to be biased towards species found in habitats of low economic value. In the Colorado Plateau area, 70% of the unprotected plant taxa occur in just 12 hotspots of endemism (the La Sal, Abajo, Henry, Tushar, Boulder, and Pine Valley mountains, Book Cliffs, Tavaputs and Fish Lake plateaus, Sevier Valley, Uinta Basin, and San Rafael Swell). Many other unprotected species are found on low elevation private lands.

Comparing Floras—the Importance of Complementarity: While small parks tend to have fewer species, their contribution to the overall protected area network may greatly exceed their diminuitive size due to the concept of complementarity. Also called beta diversity, complementarity measures the degree of dissimilarity between the floras of different parks. The fewer species that two parks have in common, the greater the degree of complementarity and the more important the contribution of the park with the most unique flora. Parks with high beta diversity tend to have relatively high numbers of endemic or rare species that might not otherwise be represented in the protected area network.

The table on page 7 documents the degree of similarity (or dissimilarity) between each of the 14 parklands I analyzed. The data in the upper right hand columns show the number of species shared among parks. This number can be deceiving because of the disparity in size between many parks. Jaccard's Coefficient of Similarity (JCS) is a useful way to compare the size of floras by taking into account disparities in overall species richness. Based on JCS, two of the smallest parks (Golden Spike NHS and Cedar Breaks NM) are the least similar to other parks, and thus make significant contributions of unprotected species to the network.

*New discoveries in Zion NP in 2009 have increased the park's flora by nearly a dozen species and have enabled the park to pass GSENM in total plant species richness. The complete list of new species will be published in a future issue of the *Sego Lily* at the conclusion of the field season.

Number of Species in Common

Park	ARCH	BRCA	CANY	CARE	CEBR	DINO-UT	GLCA-UT	GOSP	GSENM	HOVE-UT	NABR	RABR	TICA	ZION
ARCH		215	402	414	73	260	425	75	418	182	293	160	80	324
BRCA	0.24		250	390	227	229	288	81	423	126	224	85	111	365
CANY	0.557	0.267		455	83	261	495	80	482	198	342	179	83	367
CARE	0.415	0.359	0.44		168	321	547	90	648	204	353	178	129	499
CEBR	0.091	0.318	0.095	0.156		92	103	29	172	37	89	32	75	202
DINO-UT	0.347	0.272	0.317	0.305	0.123		293	90	329	137	220	95	110	281
GLCA-UT	0.442	0.248	0.511	0.454	0.092	0.278		87	630	201	360	208	96	469
GOSP	0.125	0.124	0.12	0.095	0.061	0.165	0.094		108	63	66	27	62	97
GSENM	0.378	0.364	0.432	0.523	0.146	0.285	0.511	0.104		214	357	195	140	613
HOVE-UT	0.313	0.18	0.308	0.221	0.066	0.233	0.223	0.193	0.209		162	88	42	180
NABR	0.445	0.283	0.499	0.367	0.128	0.317	0.387	0.129	0.334	0.32		137	79	299
RABR	0.272	0.117	0.278	0.191	0.059	0.155	0.237	0.078	0.19	0.234	0.266		22	157
TICA	0.118	0.156	0.11	0.13	0.146	0.18	0.096	0.193	0.128	0.097	0.135	0.05		156
ZION	0.272	0.301	0.3	0.362	0.177	0.235	0.339	0.093	0.445	0.171	0.267	0.148	0.146	
	ARCH	BRCA	CANY	CARE	CEBR	DINO-UT	GLCA-UT	GOSP	GSENM	HOVE-UT	NABR	RABR	TICA	ZION

Jaccard's Coefficient of Similarity

Annotated checklists for 16 parks, monuments, and historic sites managed by the National Park Service in the Northern Colorado Plateau Network (NCPN) are now available as downloadable pdfs from the NCPN website (http://science.nature. nps.gov/im/units/ ncpn/). These checklists were developed from 2004-2008 and include information on species confirmed for each park with an herbarium voucher, plants reported in literature (without a voucher), species that are falsely reported or questionable, and species that may potentially occur in the park based on records from the vicinity. Each list is annotated with information on synonyms, common name, growth form, geographic distribution, nativity, abundance, flowering period, habitat preferences, and other data of interest.

Left: Map of Utah showing the distribution of parklands examined in this study and their standard abbreviations: ARCH (Arches National Park), BRCA (Bryce Canyon National Park), CANY (Canyonlands National Park), CARE (Capitol Reef National Park), CEBR (Cedar Breaks National Monument), DINO (Dinosaur National Monument), GLCA (Glen Canyon National Recreation Area), GOSP (Golden Spike National Historic Site), GSENM (Grand Staircase-Escalante National Monument), HOVE (Hovenweep National Monument), NABR (Natural Bridges National Monument, RABR (Rainbow Bridge National Monument), TICA (Timpanogos Cave National Monument), ZION (Zion National Park).