

VEGETATION COMMUNITIES OF ZION NATIONAL PARK

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Objectives

The overall objectives of this study are to (1) provide a map of the current vegetation of Zion National Park (ZNP), (2) provide a listing of all vascular plants known for the Park, (3) list all rare, endangered and exotic plant species growing within the Park and describe the distribution and habitat preferences of each as fully as possible, (4) list representative locations for examples of undisturbed stands of each of the major vegetational types, and (5) present our basic field data to the Park on computer disks with software programs that will permit employees to access data files easily and systematically. These objectives are being satisfied through systematic sampling of the vegetation at 1.6 km intervals. Ideally, the samples should be taken at all section corners using cadastral survey maps, but some remote portions of the park have never been surveyed. As a consequence, we are using the Universal Transverse Mercator grid system for describing locations of all study plots.

At each grid intersection of the 1.6 km sampling grid which we have overlain on a map of the Park, a 0.01 ha sample plot is inventoried using a procedure developed by the Zurich-Montpellier School of Phytosociology. At each plot, a worker lists all species rooted on the plot and assigns a scaled value for foliage coverage (projected crown cover) and sociability (dispersion of individuals) for each species. Each plot is permanently marked with a steel reinforcing bar at its center (plots are circular in outline), photographed in color, and identified with its grid designation on an aluminum tag secured to the peg at the center of the plot. The stand location is simultaneously recorded on a low level, aerial photograph by running a straight pin through the map and circling and properly identifying the grid location of the pin prick on the back of the photograph. Photos and data forms

will ultimately be placed on file at ZNP.

Information concerning geologic substrate, topography, aspect, slope steepness, prior use, and vegetational condition and trend are recorded at each plot. Ultimately, computer files will be accessible using software developed by one of us (SCS). One will be able to readily obtain printouts showing all locations at which any given species occurs, grid locations of all plots supporting a particular vegetational type, or relative number of exotic versus native species.

1988 Results

Vegetational Sampling. Our efforts were concentrated in the southeastern third of the Park in the 1987 field season: over 100 survey plots were sampled in that year. In 1988, we have focused our efforts on that portion of the Park west of the main canyon and south of the Kolob Section. We have again sampled 100 survey plots during the field season and completed field sampling work on all portions of the Park south of the Kolob section. In 1988, we also sampled the botanical composition of 18 more rock crevice communities on Navajo Sandstone.

A total of 83 cadastral survey section corners remain unsampled in the Park; all are in the Kolob Section. Those points will be sampled in 1989 and a vegetational map will be drafted using remote sensing imagery and the Geographical Information System to provide maps that are fully rectified with real points on the surveyed portions of the Park. Major roads and developments will be shown on the completed map to increase the ease with which Park employees can locate themselves on the map and use the information inherent in the vegetational map.

In addition to the foregoing activities, one of us (JST) has surveyed seven designated or potential Research Natural Areas (RNAs) within the Park. Four of the areas now designated as portions of RNAs (Church Mesa, Great Heart Mesa, Timber Top Mesa, and West Checkerboard Mesa) are free of human related disturbances and are well vegetated. All of those areas merit detailed baseline work in which biotic composition and natural processes are carefully documented on permanently marked study plots. Such studies should be repeated at least every 5 years in order to document natural fluxes in composition and processes. The possible deleterious effects of nonpoint source pollution of the atmosphere (air contaminants per se and acid rain) are most likely to be detected first in natural areas free of the plethora of impacts associated with heavy human use. Impacts of regional pollution can only be detected, however, if the natural "noise" levels in ecosystems are documented and understood. Such an understanding of ecosystems will require careful and regular monitoring at specific locations.

Three other potential RNAs were surveyed at Hanging Canyon (west edge of Timber Top Mesa), Mesa 6665 (Mesa top elevation) in the Virgin Narrows, and Langston Mountain in the Kolob Section of the Park. The

first two locations are pristine and large enough to have well developed vegetative covers. Both merit recognition as RNAs. Langston Mountain has been much impacted by human activities during the past century and probably does not merit further consideration as an RNA.

Our vegetational data base is now large enough to begin a search for major relationships in the data sets. We recently queried the file for the names of all species encountered in the 203 reconnaissance plots and the number of plots in which each has been found. It is of interest that of the 832 vascular plant species recorded for Zion National Park by Dr. Stanley L. Welsh and associates, only 458 species appear in the reconnaissance and rock crevice study plots. Furthermore, 136 of those 458 species appear in only one reconnaissance plot, and only 246 species appear in two or more plots. The inescapable conclusion of such results is that the majority of the vascular plant species in the Park are uncommon and rarely encountered even by professional biologists. Additionally, it is clear that the vegetational tapestry that covers the Park is relatively simple. Only 64 species occur in 10% or more of the reconnaissance plots (Table 1).

Species that appear in 10% or more of the reconnaissance plots are listed in Table 2. The most frequently encountered species are two grasses: Poa fendleriana in 63% of the plots and the introduced species Bromus tectorum in 53% of the plots. Juniperus osteosperma occurred in over one-third of the plots: Amelanchier utahensis in 48%. Quercus gambelii in 37%, and Arctosaphylos patula in 34% of the plots. The most common cactus in the Park is Opuntia macrorhiza (47% frequency).

The most common forbs (broad leaved herbs) in our file are Gilia inconspicua (41%), Arabis perennans (36%), Senecio multilobatus (31%), Heterotheca villosa (26%), Erysimum asperum (21%), and Phlox austromontana in 20% of the reconnaissance plots.

One might predict that the families that are represented by the most species in Zion National Park would produce more than their share of the widespread and common taxa listed in Table 2. That prediction might logically arise from the assumption that unusually successful taxa would arise proportionally more often in families in which an unusual amount of genetic experimentation is occurring. If we assume that the amount of genetic experimentation (or ease with which new stable genetic recombinations arise) in a family is directly proportional to the number of species from that family in the local flora, we can then identify families that differ strongly in respect to the degree to which active evolution (genetic experimentation) has proceeded. One can objectively test the hypothesis that large families have generated unusually successful species proportionally faster than plant families that have only a few local species.

In Table 3 are listed all families that contribute over 10 species to the flora of the Park. As one might expect, the large families contribute most of the common (occurring in over 10% of all reconnai-

Table 1. Summary of species occurrences in Zion National Park flora and vegetation. Data are summarized by life form and abundance class. A total of 203 0.01 hectare (1/40 acre) inventory plots are considered.

Life Form Class	Species in Park Flora	No. of Species Occurring in a Given Percentage of 203 Vegetation Inventory Plots		
		>1%	>5%	>10%
Trees	32	9	5	4
Shrubs	139	53	31	18
Graminoids	138	17	13	11
Forbs	523	167	57	31
Total Species	832	246	106	64

Table 2. Species encountered in over 10% (20 or more) of the Zion National Park vegetational survey plots (203 inventoried).

	No. Plots	Forbs	No. Plots
<u>Trees</u>			
<i>Juniperus osteosperma</i>	92	<i>Arabis perennans</i>	74
<i>Pinus edulis</i>	39	<i>Arenaria macradenia</i>	27
<i>P. monophylla</i>	44	<i>Artemisia ludoviciana</i>	39
<i>P. ponderosa</i>	42	<i>Calochortus nuttallii</i>	21
		<i>Castilleja scabrida</i>	32
		<i>Chaenactis douglasii</i>	35
		<i>Comandra umbellata</i>	24
		<i>Cryptantha confertiflora</i>	29
		<i>Descurainia pinnata</i>	25
		<i>Draba asprella</i>	25
		<i>Draba verna</i>	40
		<i>Erigeron utahensis</i>	37
		<i>Eriogonum davidsonii</i>	32
		<i>Eriogonum racemosum</i>	36
		<i>Erysimum asperum</i>	42
		<i>Euphorbia albomarginata</i>	22
		<i>Gilia inconspicua</i>	84
		<i>Heterotheca villosa</i>	52
		<i>Machaeranthera canescens</i>	33
		<i>Microsteris gracilis</i>	21
		<i>Penstemon laevis</i>	23
		<i>Phacelia heterophylla</i>	28
		<i>Phlox austromontana</i>	41
		<i>Polygonum douglasii</i>	25
		<i>Senecio multilobatus</i>	63
		<i>Stephanomeria tenuifolia</i>	33
		<i>Streptanthus cordatus</i>	25
		<i>Tradescantia occidentalis</i>	20
<u>Shrubs and Succulents</u>			
<i>Amelanchier utahensis</i>	97		
<i>Arctostaphylos patula</i>	69		
<i>Artemisia tridentata</i>	36		
<i>Cercocarpus intricatus</i>	31		
<i>C. montanus</i>	20		
<i>Chrysothamnus nauseosus</i>	29		
<i>Echinocereus triglochidiatus</i>	22		
<i>Fraxinus anomala</i>	32		
<i>Gutierrezia microcephala</i>	21		
<i>G. sarothrae</i>	63		
<i>Haplopappus scopulorum</i>	32		
<i>Opuntia macrorhiza</i>	95		
<i>Pachystima myrsinites</i>	32		
<i>Purshia tridentata</i>	25		
<i>Quercus gambelii</i>	75		
<i>Q. turbinella</i>	42		
<i>Symphoricarpos oreophilus</i>	28		
<i>Yucca angustissima</i>	29		
<u>Graminoids</u>			
<i>Aristida purpurea</i>	26		
<i>Bromus rubens</i>	42		
<i>B. tectorum</i>	108		
<i>Carex rossii</i>	43		
<i>Hilaria jamesii</i>	38		
<i>Oryzopsis hymenoides</i>	54		
<i>Poa fendleriana</i>	128		
<i>Sitanion hystrix</i>	43		
<i>Sporobolus cryptandrus</i>	41		
<i>Stipa comata</i>	35		
<i>Vulpia octoflora</i>	72		

Table 3. Species richness of selected vascular plant families represented in Zion National Park. In this table, common species are interpreted as those occurring in 10% or more of the 203 reconnaissance plots.

Family	No. Common Species	No. Species Occurring in ZNP
Dicots		
Apiaceae	0	14
Asteraceae	12	157
Boraginaceae	2	25
Brassicaceae	6	49
Cactaceae	2	12
Caryophyllaceae	1	12
Euphorbiaceae	1	10
Fabaceae	1	62
Hydrophyllaceae	1	14
Lamiaceae	0	14
Onagraceae	0	18
Polemoniaceae	3	21
Polygonaceae	3	25
Ranunculaceae	0	22
Rosaceae	4	20
Salicaceae	0	14
Saxifragaceae	0	12
Scrophulariaceae	3	38
Solanaceae	0	11
Monocots		
Cyperaceae	1	19
Liliaceae	1	16
Poaceae	<u>10</u>	<u>81</u>
Species Subtotals	51	666
Other families (69)	<u>13</u>	<u>166</u>
Totals	64	832

ssance plots) species. In the form given in Table 3, it is not possible to readily see whether larger families are producing proportionally more common species than smaller families. In Table 4, the data are reorganized for a statistical test of the hypothesis that larger families (over 25 species in the Park) produce more than their fair share of the common species in the Park. The results do not support the hypothesis. Thus species from large plant families are no more likely to become regionally common (or dominant) than species from small families.

In other work completed in 1988, our crews have added five species to the list of plants known from the Park. Those species are: Bromus japonicus, Circaea alpina, Epilobium angustifolium, Epilobium cf. oregonense, and Phalaris arundinacea. The Bromus and Phalaris species are introduced to the United States.

Finally, a paper detailing our work with Sphaeromeria ruthiae (a composite subshrub confined to crevices in Navajo Sandstone, usually on vertical faces) has been accepted for publication in the Southwestern Naturalist. The manuscript gives the location of many previously unknown populations for this rare, local, endemic and gives the first chromosome count known for the species.

Table 4. Chi-square analysis of the hypothesis that species-rich families (over 25 species in ZNP) generate proportionally more common taxa (defined as occurring in over 10% of 203 reconnaissance plots) than species-poor families (less than 25 species in ZNP). The results do not support the hypothesis. Expected value are shown in parentheses.

		No. Species in Family		
		<25	>25	Total
		No. Species in Category		
%Frequency of Species	<10	27 (30.4)	37 (33.6)	64
	<10	368 (364.6)	400 (403.4)	768
	Total	395	437	832

Summation Chi-square = 0.785 (Not statistically significant)