PHOTOS BY SHARON EVERSMAN

Cladonia fimbriata, a very common species growing on old moist logs, and one of the major species recolonizing forest sites after the 1988 fires.

Lichens in Yellowstone National Park

Sharon Eversman

THE BRIGHT SPLASHES of yellow-green or orange color on rocks are due to the presence of lichens; the gray-green and black "beards" hanging from spruce branches are likewise lichens. Lichens are partnerships of algae and fungi, unique because when the two components are together, the resulting form is different from the algae and fungi separately. The algae, usually green, contribute carbon compounds (sugars) to the fungus. The fungus provides a framework, good at absorbing water from the atmosphere, in which the algae can live.

Lichens have different growth forms. The bushy or fruticose form (e.g., *Letharia, Usnea, Bryoria*), most common on conifer trees, is about 7% of the total number of species identified in Yellowstone National Park (YNP). Foliose, flat leafy forms (e.g., *Parmelia, Xanthoria, Xanthoparmelia, Umbilicaria*) grow on all substrates, and are 34% of the species. Crustose species (e.g., *Lecanora, Lecidea, Rhizocarpon*) form crusts tightly attached to substrates and are 44% of the total. The genus *Cladonia* has squamules with little fruiting bodies that look like trumpets or oboes pointing upward; *Cladonia* and another squamulose species (*Psora*) are 6% of the total. A rare form is called a "pin" lichen—it has a crustose part with a little fruiting body protruding up like a dressmaker's pin; they (2% of the species) are found on moist Douglas-fir bark and shady rock cliffs. "Reindeer lichen," species of *Cladonia*, are rare in the Yellowstone region, but stunted forms of *Cladonia mitis* (gray-white, abundantly branched) can be seen in three thermal basins—Biscuit Basin, Norris Geyser Basin, and Phantom Fumarole on the Pitchstone Plateau. Reindeer lichens are more common in moister areas north of YNP, so we assumed that there was adequate moisture in these basins for their growth.

The ecological roles of lichens vary with their substrate and growth form (Brodo et al., 2001). Lichens on rocks help break down the rock, a first step in soil formation. On soil, crusts that contain lichens help stabilize soil against erosion. Elk and deer have been observed eating the fruticose forms, especially *Bryoria*, on trees, and mountain goats eat foliose lichens (*Rhizoplaca, Umbilicaria*) on rocks. Birds and flying squirrels sometimes use lichens as a construction material for their nests. Reindeer lichen is a major survival food for caribou and reindeer in far northern countries. Some native peoples have used lichens as medicines and food, and in many places, lichens are boiled to make dyes. In all cases, since lichens have relatively slow growth rates compared to plants, their presence

indicates stable, undisturbed conditions.

We have identified about 367 species of lichens in the park, collected from 87 sites in six different vegetation communities since 1977 (Aho, unpublished data; Eversman et al. 1987, 2002; Eversman and Horton 2004). Lichens are most abundant and diverse in the moister Douglas-fir and Engelmann spruce/subalpine fir forests, with 206 and 256 species found there, respectively (Eversman et al. 2002). That compares to 152 species in lodgepole pine forests and 133 in lodgepole/whitebark pine stands. We collected 97 species in alpine regions and 146 in the grasslands, which included aspen stands and big sagebrush. Although scientific names are used more often than common names in literature and among lichenologists, Table 1 gives common names of the genera mentioned in this paper and their growth form (Brodo et al. 2001).

Moisture and available substrate contribute to lichen diversity. For example, 425 lichen species were reported from Glacier National Park (Debolt and McCune 1993), which is smaller than YNP but more diverse in forest type because it lies mostly west of the Continental Divide and generally lower in elevation. In comparing distribution of 305 lichen species east and west of the divide in Montana, Eversman (2004) reported that 32.3% of the species have been found only west of the divide, especially in forests influenced by Pacific air masses; 55.7% were on both sides of the divide, and just 12% were only east of the divide. Most of the sites from which lichens have been collected in YNP have been east of the divide, probably contributing to the lower count of species than in Glacier National Park. In extensive surveys in YNP through 1998 (Eversman et al. 1987, 2002), we found that about 41% of the lichen species grow on rock, 25% are on bark and wood, 18% live on soil, and 16% are on other lichens and mosses.

In considering forest sites in Yellowstone, pines grow in drier, more exposed sites than other conifer species and tend to self-prune their lower branches. Douglas-fir, Engelmann spruce, and subalpine fir are more likely to keep their lower branches, providing more substrate for epiphytic species (non-parasitic organisms that grow upon or attached to a living plant). We took advantage of a 1984 windstorm that blew down thousands of trees, mostly lodgepole pine, between Norris Geyser Basin and Canyon Village, to identify lichens that grew on tree trunks all the way to the top, out of view from normal eye level when the trees are standing (Eversman et al. 1987). Twelve species were identified on a total of 15 trees; all 12 species were on subalpine fir, nine were on whitebark pine, and four were on lodgepole pine. While subalpine fir supported lichen growth from ground level to tree top, lodgepole pine supported one species at ground level (*Parmeliopsis ambigua,* a common yellow-green foliose lichen) and the other three species (*Bryoria* sp., *Lecanora piniperda, Letharia vulpina*) at more than six meters above ground level where branches were present. Those lichens were close to the axils of branches and where

Genera	Common name
Acarospora	Cobblestone, cracked lichens (crustose on rock)
Aspicilia	Sunken disk lichens (crustose on rock)
Bryoria	Horsehair, tree-hair lichens, bear hair (fruticose on bark)
Candelariella	Goldspeck, yolk lichens (crustose on rock, wood)
Cetraria	Iceland, Icelandmoss, heath lichens (foliose on bark, alpine soil)
Cladonia	Reindeer lichens, pixie cup, trumpet lichen (squamulose on soil, decaying logs, moss)
Collema	Jelly lichen, tarpaper lichens (foliose on rock, soil)
Evernia	Oakmoss lichen (fruticose on alpine gravelly soil)
Flavocetraria	Snow lichen (foliose on alpine soil)
Hypogymnia	Tube lichens (foliose on bark)
Lecanora	Rim lichens (crustose on rock, bark)
Lecidea	Disk, tile lichens (crustose on rock, bark, wood)
Lepraria	Dust lichens (crustose on rock, moss, soil, wood)
Leptogium	Jellyskin, vinyl lichens (foliose on rock, bark)
Letharia	Wolf lichen (fruticose on wood, bark)
Melanelia	Camouflage, brown lichens (foliose on rock, bark)
Parmelia	Shield lichens (foliose on bark, rock)
Parmeliopsis	Starburst lichens (foliose on bark, wood)
Peltigera	Pelt lichens, dog-lichens (foliose on soil, moss)
Physcia	Rosette lichens (foliose on bark, rock)
Psora	Scale lichens (squamulose on soil, rock)
Rhizocarpon	Map lichen (crustose on rock)
Rhizoplaca	Rock-posy lichens, rockbright (foliose on rock)
Umbilicaria	Rock tripe (foliose on rock)
Usnea	Beard lichen, old man's beard (fruticose on bark, wood)
Vulpicida	Sunshine lichens, yellow ruffle lichens (foliose on bark, alpine soil)
Xanthoparmelia	Rock shield, tumbleweed shield (foliose on soil, rock, bark)
Xanthoria	Sunburst, orange lichens (foliose on bark, rock)

Table 1. Common names of genera mentioned in this paper (Brodo, et al. 2001) with growth form and most common substrates.

Typical lichen communities on conifer branches. On the upper branch (left to right) are the chartreuse *Letharia vulpina* (wolf lichen); black stringy *Bryoria fuscescens*; and gray-green *Usnea substerilis*. In addition to tufts of *Usnea* on the lower branch is the gray foliose *Hypogymnia imshaugii*.

the bark was still relatively young and smooth, not as scaly as older bark. We determined the pH of distilled water solutions in which one-gram samples of outer bark were soaked in 30 ml for one hour. The pH of the solutions in which subalpine fir had been soaked averaged 4.94, significantly higher than those of lodgepole pine (pH 3.78) and whitebark pine (pH 4.03). Absorption of water by dry bark, and drying times of saturated pieces of bark after one and four hours, were not significantly different among the species, indicating that probably the pH and texture of the bark are more important in allowing colonization and retention of lichens on these three conifer species. Subalpine fir bark is smoother, less scaly than that of lodgepole or whitebark pine.

Foliose *Xanthoparmelia chlorochroa* among rocks on soil near Gardiner. This is a species characteristic of grasslands, and usually associated with the presence of pronghorns.

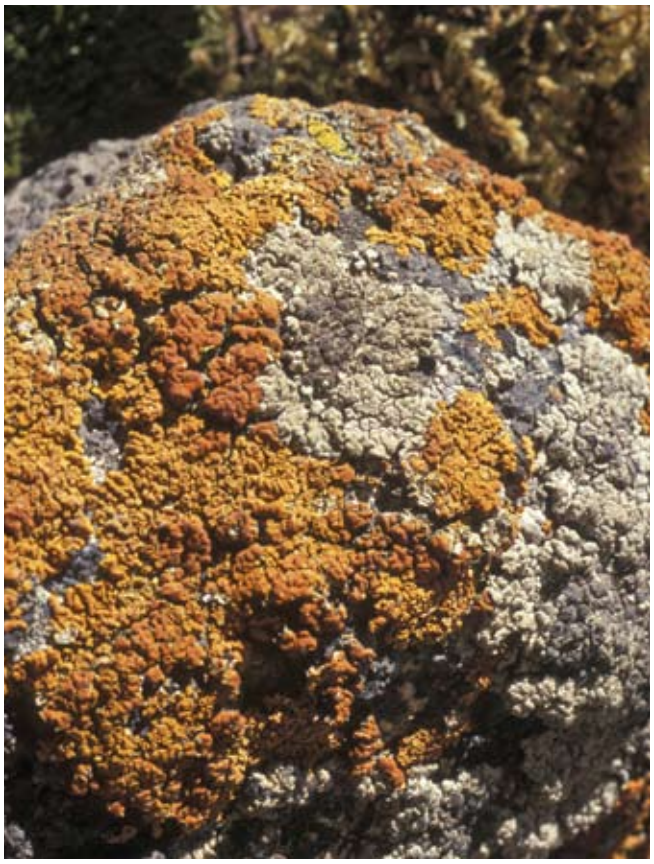
Yellow-green foliose *Xanthoparmelia plittii* on rock. Growth of the thallus occurs on the margins, and the older inner part dies leaving substrate for other lichens to grow. The grayish grainy appearance is due to many isidia, little packages of alga and fungus for asexual dispersal.

In alpine areas, the 97 identified lichen species were primarily on rock and soil, as would be expected. The species on rock are frequent at nearly all elevations in this region. Five common species on soil in alpine meadows on the Beartooth Plateau (Eversman 1995)—*Cetraria ericetorum, C. islandica, Flavocetraria nivalis*, *Evernia divaricata* and *Vulpicida tilesii*—were not found at any alpine sites in YNP. No obvious explanation is apparent.

In grasslands, the species that grow on soil are generally inconspicuous. The lichens are part of soil crusts, or microbiotic crusts, that also include mosses, algae, diatoms, and cyanobacteria. One common black crust species, *Collema tenax,* has cyanobacteria that fix nitrogen and contribute to the nitrogen content of the soil. A yellow-green foliose species, *Xanthoparmelia chlorochroa*, can be common in sagebrush-grasslands, but becomes very rare where there is significant trampling or grazing by ungulates. Two exclosures near Gardiner, Montana, illustrate the difference between areas where animals are excluded and where grazing animals are present; the exclosures have carpets of the lichen. According to *Lichen Use By Wildlife in North America* by Stephen Sharnoff and Roger Rosentreter (Bureau of Land Management, Idaho) at the website www.lichen.com, pronghorn in some areas are known to eat *X. chlorochroa*.

Aspen and cottonwood bark support similar lichen growth patterns—generally the foliose species of the genera *Melanelia* (brown), *Xanthoria* (orange), and *Physcia* (gray-white). Evidently, there is enough nitrogen present in the runoff through leaves down the bark to support the nitrophilic *Xanthoria* species.

A species of crustose *Porpidia* growing on rock near Bechler Falls.



Orange foliose *Xanthoria elegans* and crustose *Lecanora argopholis* on rock. The presence of Xanthoria indicates that this rock is a favorite perch of birds or small mammals.

On rock, the bright orange genus *Xanthoria* (sens. lat.) indicates the presence of birds and other animals—their urine or droppings leave high concentrations of soluble nitrogen, which supports the growth of *Xanthoria*. At Sheepeater Cliffs, the white uric acid crystals from yellow-bellied marmots are at the top of rock columns, and the orange *Xanthoria* grows lower on the columns; they are indicators of the marmots' presence. In high elevation sites, pika caves can be located in talus slopes by observing the orange color. On boulders in the Lamar Valley, the orange *Xanthoria* advertises the presence of perching birds.

About 80% of all lichens are a symbiotic partnership between a unicellular green alga and a fungus; the alga is 5–10% of the lichen, and the fungus 90–95%. The remaining species have cyanobacteria as the only photosynthesizing partner or as a second photosynthetic partner; cyanobacteria fix nitrogen. Lichens with cyanobacteria tend to be gray or black in color and live in relatively moist habitats, especially on soil with moss or where rock is close to seeps. The most common nitrogen-fixing genera are *Peltigera* on soil (15 species in Yellowstone), *Collema* on soil or rock (5 species) and *Leptogium,* mostly on rock (6 species).

Since most lichen species grow very slowly, 1–2 mm in diameter per year in the case of many crustose species on rock, they are good indicators of stable environmental conditions. The black and yellow-green growth of lichens (*Lecanora, Lecidea, Rhizocarpon, Xanthoparmelia, Candelariella*) on the granite boulders in the Lamar Valley and talus slopes elsewhere, for example, indicate that the rock has not moved for hundreds, if not thousands of years. The presence of many species in old Douglas-fir and Engelmann spruce/subalpine fir forests indicates that fire has not burned there for at least 300 years. Many studies have shown that the number of lichen species increases with time after fire.

In 2001, we undertook a study to identify the lichen species that had recolonized burned substrates after the 1988 fires (Eversman and Horton 2004). Our hypothesis was that drier lodgepole pine sites would have fewer recolonizing lichen species than the more moist Douglas-fir and Engelmann spruce. We soon realized that we were seeing more moss growth than lichen growth; the ubiquitous moss species were *Bryum caespiticium* and *Ceratodon purpureus*, and there was significantly more moss growth in the Engelmann spruce sites than in the other forest sites (Douglas-fir, lodgepole pine, whitebark pine). The original hypothesis was partially supported—burned Douglas-fir sites had a total of 15 recolonizing lichen species (in the genera *Bryoria, Candelariella, Cladonia, Lepraria, Letharia, Melanelia, Parmelia, Parmeliopsis, Physcia, Usnea, Xanthoparmelia* and *Xanthoria*), lodgepole pine and Engelmann spruce sites each had 11 lichen species, and whitebark pine sites had 5 species (genera *Cladonia, Lepraria, Melanelia, Parmeliopsis,* and *Xanthoria*). *Peltigera rufescens* and *P. didactyla* were on burned soil. These recolonizing lichen species are among the most common species in the park according to our previous collections, and nearly all of them have asexual reproductive structures called soredia—powdery or granular "starter packages" of both the alga and fungus that are efficiently dispersed by wind. When soredia land in a suitable habitat, they can immediately start growing. Lichens without soredia must recolonize after the appropriate algae and fungi find each other and form their symbiosis.

The lichen thalli seen in 2001, 13 years after the fires, were generally small. The longest tuft of the fruticose *Bryoria fuscescens* was 32 mm in an Engelmann spruce site, followed by *Letharia vulpina* in a lodgepole pine site, and 16 mm for *Usnea substerilis* in a Douglas-fir site. The little foliose thalli of *Melanelia exasperatula, Parmelia sulcata, Parmeliopsis ambigua, Physcia* spp., *Xanthoparmelia* sp., and *Xanthoria fulva* were rarely more than 1–2 cm in diameter on logs or snags. The genus *Cladonia*, however, grows relatively fast on shaded horizontal logs, especially close to the ground; *Cladonia* squamules and associated moss species (*Bryum caespiticium, Ceratodon purpureus*) accounted for most of the recolonization on logs and bases of snags. It was not always possible to tell if rocks with lichen growth had been burned and recolonized, or if capricious fires left unburned rocks or parts of rocks. On rocks that had obviously been burned, granitic boulders between Mammoth Hot Springs and Tower Junction had nine lichen species and burned rhyolite near Madison Junction had six species. Again, the recolonizing lichens (*Candelariella aurella, Lecanora novomexicana, Lecanora polytropa, Lecidea atrobrunnea, Aspicilia* spp., *Rhizocarpon geographicum, Physcia dubia, Umbilicaria hyperborea* and *Xanthoria elegans*) are among the most common species in the park. A widely available book, *Lichens of North America,* (Brodo et al. 2001), has excellent illustrations of and information about these species, as does the website www.lichen.com. Another website, http://www.ies.wisc.edu/nplichen, lists all lichens from all the national parks, as well as reference papers and element analysis results.

Lichens, especially fruticose species with their large surface area, are sensitive to certain gaseous air pollutants and particulate matter. In cities, lichens disappear due to the presence of sulfur dioxide and ozone. The lodgepole pines that surround thermal areas have little to no lichen growth on their trunks and branches, probably because of particulate matter deposited by the geothermal activity. It is curious that a bright yellow-green species, probably *Rhizocarpon geographicum*, grows at the mouth of many fumaroles; it is evidently not sensitive to the hydrogen sulfide and other gases emanating from the fumarole.

Element	YNP[1] (n=18)	GTNP[2] (n=6)	Anaconda–Pintler[3] (n=3)	Gates of the Mountains[3]
Potassium	3,183	3,400	4,860	5,697
Phosphorus	1,390	900	2,341	1,989
Calcium	1,188	1,188	1,603	1,228
Sulfur	1,004	1,100	810	1,220
Magnesium	441	574	251	209
Iron	168	358	449	482
Aluminum	144	405	259	253
Manganese	52	76	359	46
Sodium	36	104	55	16
Zinc	24	25	25	25
Boron	21	17	21	13
Titanium	12	15	11	14
Lead	3	1	5	5
Copper	2	2	6	6
Nickel	1	0	2	1
Arsenic	1	na	0.1	0.1
Chromium	0.6	0.6	1.03	0.9
Vanadium	0.3	1	0.2	0
Cadmium	0.2	0.2	8	0
Cobalt	0.1	0	0.5	0.2
Mercury	0.1	na	na	na
Molybdenum	0.1	0	0.1	0.03

[1] Bennett and Wetmore 1999
[2] Schanz 1996. Unpublished data, Montana State University
[3] Schubloom 1995

Table 2. Comparative tissue analysis for *Bryoria fremontii* from Yellowstone National Park (YNP) and Grand Teton National Park (GTNP). The Anaconda–Pintler and Gates of the Mountains Wilderness Areas in Montana are included for comparison, although the number of samples is very small. Values are means in parts per million (ppm), in descending order based on values from Yellowstone National Park, and na = not available.

Lichens can accumulate heavy metals and other elements from the atmosphere without apparent detrimental effects, so their tissues can be analyzed to indicate atmospheric chemistry. Three separate studies in the Yellowstone region have compared *Letharia vulpina* and *Bryoria fremontii* with collections from other locations in Montana and Grand Teton National Park (Tables 2, 3). The YNP collection sites, chosen to avoid proximity to geothermal areas, were at Divide Lake, the Pebble Creek trail, Dunraven Picnic Area, Lake Butte, Snake River by the South Entrance, and the west side of Yellowstone Lake.

We expected higher levels of sulfur in YNP compared to the Montana and Grand Teton National Park locations because of geothermal activity. The sulfur contents in the lichens from YNP were more similar to those from the Gates of the Mountains Wilderness area, downwind of a former lead smelting operation near Helena. (Tables 2 and 3). The sulfur content in *Bryoria* from Grand Teton National Park was

Element	YNP[1] (n=15)	Anaconda–Pintler[2] (n=18)	Gates of the Mountains[2] (n=9)
Calcium	3727	1707	3729
Potassium	2861	3994	4288
Sulfur	862	610	830
Phosphorus	756	2154	1954
Magnesium	693	284	192
Aluminum	267	325	349
Iron	232	538	390
Manganese	93	132	83
Sodium	31	66	73
Zinc	27	22	24
Titanium	17	55	51
Boron	5	6	6
Lead	3	6	7
Copper	2	3	4
Nickel	1	3	2
Arsenic	0.7	0.2	0.13
Chromium	0.6	1.3	1.3
Vanadium	0.4	0.3	0.04
Cadmium	0.4	2.2	0
Copper	0.2	0.5	0.6
Mercury	0.1	na	na
Molybdenum	0.1	0.1	0.1

[1] Bennett and Wetmore 1999
[2] Schubloom 1995

Table 3. Tissue analysis for *Letharia vulpina* collected from Yellowstone National Park (YNP) and two wilderness areas in Montana. Values are means in parts per million.

slightly higher than in YNP, and is perhaps related to drift from YNP. The sulfur content of the lichens in the Anaconda-Pintler Wilderness sites, upwind of mining and smelting activities in the Butte-Anaconda area, was lower than any other locations (Tables 2 and 3). Bennett and Wetmore (1999) correlated the sulfur level with that of mercury, rarely measured in other studies. Based on their other studies, they concluded that the levels of mercury and sulfur were elevated throughout YNP, probably related to the geothermal activity. The level of arsenic, although low, is also higher in YNP than that found in other studies.

Lichens are interesting in themselves because of their various colors and shapes, and their symbiotic system, but their presence advertises the environmental conditions in which they live. Where they are abundant, they indicate appropriate habitat, clean air, and stable environmental conditions. Where they are absent, one looks for signs of disturbance or pollution.

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Acknowledgments

I am grateful for assistance with collections and identifications through the years from I. M. Brodo, Don Despain, Kathryn Glew, Dan Gustafson, Carol Johnson, Dan Macrae, Thomas H. Nash, III, William A. Weber and Cliff Wetmore. John Varley, Hank Harlow, and Jim Bennett have helped secure funding. Funding for projects has come from Yellowstone National Park (CX-1200-2-B040, PX No. 1570-3-2107), the University of Wyoming/National Park Service, USGS (R-9801448), and Montana State University.

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What Draws People to Yellowstone's Backcountry?

Tim Oosterhous, Mike Legg, and Ray Darville

NPS/JIM PEACO

NPS/J. SCHMIDT

Hikers on Observation Peak trail (above), and backcountry camp (left). Solitude and scenery both rated as important elements of a quality backcountry experience for many survey respondents.

EACH YEAR, Yellowstone National Park receives around three million visitors, making it one of the busiest national parks. Most of these visitors drive the more than 300 miles of park roads known as the Grand Loop, while seeing the traditional sites of Old Faithful, Yellowstone Lake, Mammoth Hot Springs, and the Canyon area. The roads are certainly one path for unparalleled outdoor recreation. But for many others, the roads with their busy traffic are not the transportation method of choice. Rather, they choose to hike in Yellowstone's incomparable backcountry. For thousands annually (in 2005, 5,089 permits were issued representing 39,344 person use nights), it is the backcountry that captivates their interest and motivates them to take the road less traveled. These are individuals who choose a different experience, a different approach to outdoor recreation. Who are they? What do they seek? What kind of park management preferences do they have?

This study, conducted as part of a master's thesis project by Tim Oosterhous, was consistent with the objectives of the National Park Service (NPS) Social Science Program: "to conduct and promote state-of-the-art social science related to the mission of the National Park Service and deliver usable knowledge to NPS managers and to the public." This project originated with a personal and academic interest that Tim developed as he hiked hundreds of miles of trails during the three summers and one winter season he spent working as a backcountry ranger in Yellowstone.

Methods

The purpose of this study was to investigate salient features of the backcountry experience for unguided backcountry users. We focused on visitors who appeared at one of the designated offices to obtain a backcountry permit, excluding outfitters and guides who go through a separate permit process. These visitors are required to obtain a permit for overnight camping in the backcountry (permits are not required for day use). Backcountry permits are free of charge (advance reservations, offered since 1996, can be made for a $20 fee) and are available at 10 ranger stations and visitor centers throughout the park. After obtaining the backcountry permit, visitors are required to watch a 15-minute video about regulations and possible dangers in Yellowstone's backcountry. They also complete a form that provides demographic information used for

park statistics and in case of an emergency. With the help of the permit issuer, visitors select one or more campsites from more than 300 possibilities throughout the park. Camping is allowed only in designated campsites and within size limits that range from 4 to 25 individuals per party, depending on the location. Access to backcountry campsites may be permissible by foot, stock, motorized boat, and/or non-motorized boat.

A questionnaire developed after consultation with backcountry managers was pre-tested with potential backcountry users and modified based on their feedback. Data collection began in June 1999, and lasted two months. Staff and volunteers at each of the 10 ranger stations and visitor centers that regularly issue backcountry permits helped in the data collection. After backcountry visitors completed the permit process, one person from the party who was at least age 18 was asked to participate in a study regarding the backcountry experience. Willing participants provided their name and mailing address on a sign-up sheet. The sheets were collected weekly, and each participant was mailed a questionnaire following standard mail protocol, along with a cover letter explaining the purpose of the study. A postage-paid, return envelope was provided. The initial response rate was about 50% and after a second mailing was sent to non-respondents, the response rate increased 11%, yielding a final response rate of 61%. A total of 646 usable questionnaires were analyzed.

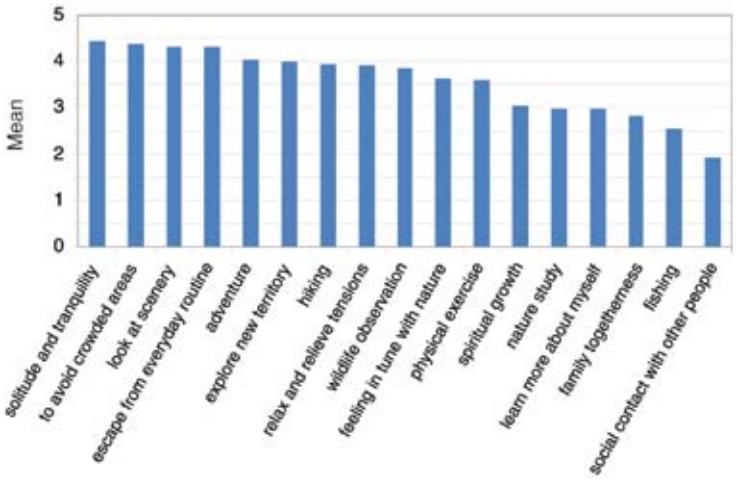

Figure 1. Importance of backcountry experience factors.

Results

Demographics

While we cannot claim that our respondents are entirely typical of Yellowstone backcountry users, we know that this information provides important, new insights into who backcountry users are and what their perceptions are. Based on Tim's personal experience and professional knowledge, the sample demographics appear to reasonably reflect the population of backcountry campers.

Demographically, 71% of our respondents were male, 94% were Caucasian, 46% were married, 55% were age 35 or younger, 73% had completed college, 49% had an annual family income of greater than $60,000, and 20% came from metropolitan areas with a population of more than one million people.

Backcountry Trip

For purposes of the study, the park was divided into 13 sections divided by major drainages. We asked participants to indicate in which sections they had camped at least one night. The top five were: Canyon (15.8%), Yellowstone River/Hellroaring (14.0%), Shoshone Lake (12.9%), Yellowstone Lake (12.2%), and Old Faithful (10.8%); almost two-thirds of respondents camped in these locations. Five areas (Bechler, Pelican Valley, Lamar, Heart Lake, and Thorofare) received relatively few backcountry users; combined, they represented only 19.6% of the respondents. About 83% of the respondents traveled by foot, while others traveled by horse, llama, motor boat, and non-motorized boat. About 10% traveled alone, while 82% traveled in parties of four or fewer. Party size ranged from 1 to 25; mean party size was 3.3. Parties averaged a little over two nights per trip itinerary under study, and 91% indicated that they spent four or fewer nights in the backcountry. Just over 50% of backcountry users had not spent a night in the Yellowstone backcountry before this trip, while one in six backcountry users had experienced 10 or more overnight trips in the Yellowstone backcountry. Overall, respondents were experienced backcountry hikers; 60% had experienced 10 or more overnight backcountry or wilderness trips outside of Yellowstone prior to this trip.

More than two-thirds of respondents indicated they saw five or fewer groups during their trip; about 11% saw more than 10 groups. To get a better indication of their experience, we also asked about their reaction to the number of groups they saw. More than three-quarters said the number of groups was "about right," while 20% indicated they saw too many other groups. It is interesting to note that of those individuals who saw 11 or more groups, 52% said the number of groups was "too many" and of those who saw 6 to 10 groups, 37% indicated that the number of groups was "too many."

Importance of Backcountry Experiences

We asked respondents to rate the importance (on a scale of 1 to 5, with 1 being very unimportant and 5 being extremely important) for 17 factors related to the backcountry experience (Table 1). Six factors (solitude and tranquility, to avoid crowded areas, look at scenery, escape from everyday routine, adventure, and explore new territory) averaged above four on the scale. The data suggest that there is a great deal of uniformity

Backcountry Experience Factor	Gender	Age	Marital Status	Family Income	Education	Previous YNP Trips	Employee or Visitor
Wildlife observation	females	36–75			<college degree	1	visitor
Escape from everyday routine							employee
Solitude and tranquility						1	
Explore new territory	females	18–35	single	<$60K		0	
Relax and relieve tensions	females						employee
Learn more about myself	females	18–35	single	<$60K			employee
Feeling in tune with nature	females	18–35	single				employee
Look at scenery	females					0	
Social contact with other people			single		<college degree	1	employee
Family togetherness		36–75	married	≥$60K	≥college degree		visitor
Fishing	males	36–75	married	≥$60K		1	visitor
Hiking	females	18–35	single	<$60K		0	
Nature study	females			≥$60K			
Physical exercise	females			≥$60K			
Adventure	females	18–35	single	$60K			
Spiritual growth	females	18–35	single	≥$60K	<college degree		
To avoid crowded areas				$60K		1	

Table 1. Analysis of backcountry experience factors by socio-demographics.

on these issues. In fact, 88% of the respondents marked solitude and tranquility as extremely important. In contrast, nature study, learning about oneself, family togetherness, fishing, and social contact with others were thought to be relatively unimportant.

In order to look at market segmentation with regard to the backcountry experience, we ran a series of analyses on the 17 backcountry factors by 8 socio-demographic variables: gender, age, marital status, race, family income, education, number of previous Yellowstone backcountry trips, and employment status (visitor or employee). All of the variables except race produced significant group differences. Gender yielded the most differences. Though fishing was ranked relatively low overall, males placed considerably greater importance on fishing than women. Women placed greater importance on wildlife observation, exploring new territory, relaxing, learning about themselves, feeling in tune with nature, looking at scenery, hiking, studying nature, physical exercise, adventure, and spiritual growth. Family income, age, marital status, number of previous Yellowstone backcountry trips, and employee status each produced at least nine significant group differences. Looking at the backcountry experience factors themselves reveals interesting patterns. For 6 of the 17 factors (escape from everyday routine, solitude and tranquility, look at scenery, nature study,

physical exercise, and avoid crowded areas), the socio-demographic variables made little difference (only one or two significant differences); this suggests a sense of universality—that many different types of individuals from different backgrounds and lifestyles are seeking the same experiences. On the other hand, 7 of the 17 factors were associated with at least five significant differences among groups (wildlife observation, explore new territory, learn more about myself, family togetherness, fishing, hiking, and spiritual growth). This pattern indicates that some experiences are more specialized; that is, there is a more specialized population of backcountry users. Of special note is fishing, which produced the most significant differences. Placing high importance on fishing are somewhat older, relatively affluent, married male visitors who are experienced in the Yellowstone backcountry.

To further analyze patterns in responses, we performed a principal components analysis with Varimax rotation on these 17 factors. This procedure identified five components that empirically stood out in explaining variance in the data. They cumulatively explained more than 57% of the data variance: 1) winding down (which includes escape from everyday routine, solitude and tranquility, relax and relieve tensions, and avoid crowded areas); 2) activity (physical exercise, hiking, adventure, and explore new territory); 3) personal growth (learn more about oneself, spiritual growth, and feeling in tune with nature); 4) wildlife observation; and 5) fishing and family togetherness. Of the 17 original factors, only three did not appear in one of the five components (nature study, look at scenery, and social contact with other people).

Conclusions and Recommendations

So who are backcountry users and what are they seeking? Demographically, the typical user is a relatively young, unmarried, white male, but there appears to be a great deal of diversity among these users in many ways. While solitude is the top experience desired, they also place high importance on avoiding crowded areas, looking at scenery, escaping from everyday routine, adventure, and exploring new territory. These are outdoor recreationists, desiring to be off of the roads and short hikes that lead past the famous geysers and thermal features and away from the large crowds. Instead, they desire a quiet, perhaps private experience. Therefore, one of the obvious management implications arising from this study pertains to the location of designated campsites. Campsites that are well-screened and adequately spaced from other sites would accommodate the strong desire for solitude. Moreover, because respondents placed high importance on the quality of campsites (data not shown here; respondents were asked to rate the importance of facilities and other aspects of the backcountry experience), we suggest that photos of campsites or camping units be available at permit stations to facilitate making appropriate choices for the parties based on their needs and preferences. We also recommend that pit toilets be more carefully and regularly maintained to ensure sanitary conditions (some commercial enterprises post the last date or time that a restroom has been cleaned). And finally, regarding campsite locations, we recommend that GPS information for trails and campsite locations be given to backcountry hikers if they have GPS equipment and access. This information could help hikers and park staff in a number of ways.

A minority of respondents indicated that they placed great importance on fishing and family togetherness; they combine relative solitude with a specialized recreational pursuit and family togetherness. Parents were there teaching children about Yellowstone scenery and ecosystems, implanting in children a respect and sensitivity to the natural world of Yellowstone. Furthermore, it is clear that Yellowstone has power of place—a capability to bring families together through a common recreational pursuit. As this is the first study of its kind, we recommend that researchers conduct the survey again in 2009 to learn about changes in backcountry hikers and campers as well as the backcountry experience. We do not know what changes would be observed, but that would be another interesting adventure.

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COURTESY OF AUTHOR

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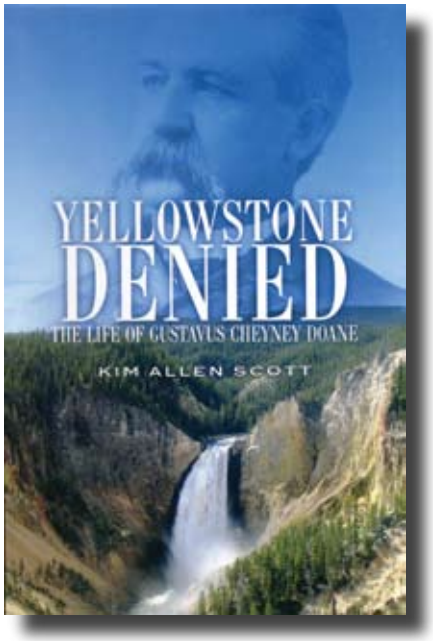

Book Review

Yellowstone Denied
The Life of Gustavus Cheyney Doane
by Kim Allen Scott

Leslie J. Quinn

Norman, OK: University of Oklahoma Press, 2007.
320 pages, 17 b&w illustrations, 3 maps. $32.95 cloth.

One of the pleasures of learning about Yellowstone's history is coming to know the grand pageant of eccentrics whose actions created the park we know and love today. While the big histories tell us the whole story, the biographies that have been written along the way let us delve into the motivations, deeds, and misdeeds of some of those pivotal to Yellowstone's evolution. Thanks to Kim Allen Scott's *Yellowstone Denied*, we may finally come to know the life of another important person in the park's past, Gustavus Cheyney Doane.

For many of us, Doane is a minor figure, the leader of the military escort for the 1870 Washburn Expedition, the second of the three expeditions that resulted in the park's establishment. Somewhat a tragic figure, he spent the latter part of his life trying futilely to gain the park superintendency and public recognition as the "discoverer" of Yellowstone. The indigenous people of America had discovered Yellowstone thousands of years before, and other white explorers set foot on and wrote about the future national park before Doane. But Doane's report to Congress, which was reprinted and gained attention, proved to be a key document in the establishment of the world's first national park, and six decades after his death, Doane is finally getting his due.

In his engaging and rewarding report, Scott breathes life and dimension into this energetic yet flawed character. Growing up in California, Doane enlisted in the military as part of the "California Hundred" who joined the Union cause in the Civil War. It was the beginning of a nearly lifelong military career for Doane. And as the author shows again and again, if marksmanship is a valuable commodity for a soldier, few in the history of the Army have had a greater propensity for shooting themselves in the foot than Gustavus Cheyney Doane. Through misadventures in the Civil War and in the Reconstruction, to more distinguished service in Montana and Arizona in the Indian Wars, and expeditions to explore the Yellowstone, the Snake River, and the Arctic (the first was his only success), we learn how, while a gifted scholar and writer, Doane would time and time again allow his ambition to cloud his judgement, often with disastrous results for his career and reputation.

Formerly, if one wished to know more about Doane, the one volume to turn to was Orrin and Lorraine Bonney's *Battle Drums and Geysers*. While valuable in that it reprints Doane's report of the 1870 expedition, it lacked much about the history of the man himself. Scott's book demonstrates superbly the kind of man Doane was, following his story throughout his life. The only part of the man one might wish we had gotten to know better is Doane the writer. While telling us of the high esteem Doane's prose held among his peers (especially his superior officers when reports needed writing), Scott would have done well to treat us to more of it. Doane's writings, especially of Yellowstone, were often elegant and bordered on prophetic at times (see below).

The other great tale told in *Yellowstone Denied* relates to the Bonneys, who in certain respects were doomed to an incomplete tale from the start of their research. For while a treasure trove of information existed that could (and finally has!) help a good writer illuminate this man, it was kept from everyone by historian Merrill G. Burlingame, who was planning to write Doane's biography himself. He had acquired most of the source material from Doane's widow with the express promise to create a biography. While failing to bring a work on Doane to fruition, he stonewalled anyone else from doing so. This tale of the darker side of a respected historian is almost as much fun as learning about Doane himself, and Scott reveals this aside with equal color and depth to that of his main topic. In addition, this tale

expands the roster of those who will be happy they picked the book up: those with either a casual or serious affinity for Yellowstone's history will find it a rewarding exercise, but those who enjoy biography and the study of history will also be pleased to dive into it.

At this late date, I will argue that Doane should be acknowledged as the discoverer of Yellowstone for Euro-America, fulfilling his great hope of recognition. Today, we know that the essence of Yellowstone National Park is its great caldera, the surface manifestation of the immense volcano that underlies the area, and Doane was the first to document its presence. On August 29, 1870, in describing the view from the summit of Mount Washburn, Doane wrote:

> Turning southward a new and strange scene bursts upon the view. Filling the whole field of vision, and with its boundaries in the verge of the horizon, lies *the great volcanic basin of the Yellowstone*; nearly circular in form, from fifty to seventy-five miles in diameter, and with a general depression of about two thousand feet below the summits of the great ranges which forms its outer rim. Mount Washburn lies in the point of the circumference northeast from the center of the basin. Far away in the southwest the three great Tetons, on Snake River, fill another space in the circle, and connecting these two highest are crescent ranges, one westward and south past the Gardiners river and Gallatin, bounding the lower Madison, and thence to the Jefferson, and by the Snake river range to the Tetons. Another eastward and south, a continuous range by the head of the Rosebud, inclosing the source of the Snake and joining the Tetons beyond.
>
> Between the south and west points this vast circle is broken through in many places for the passage of the rivers; but a single glance at the interior slopes of the ranges, shows that a former complete connection existed, and that *the great basin has been formerly one vast crater of a now extinct volcano*.
>
> The nature of the rocks, the steepness and outline of the interior walls together with other peculiarities to be mentioned hereafter render this conclusion a certainty. (Italics added.)
>
> —Lieutenant Gustavus C. Doane, "Official Report of the Washburn-Langford-Doane Expedition into the Upper Yellowstone in 1870."

PHOTO BY WILLIAM HENRY JACKSON, YELL #7569

Officers of the 2nd Cavalry at Fort Ellis, Montana Territory, 1871. Gustavus C. Doane is fourth from the left.

As the discoverer of the caldera, Doane *is* the discoverer of Yellowstone, and a man worth getting to know. Thanks to Kim Allen Scott, we can all now get to know this great and mysterious man. *Yellowstone Denied* is an enjoyable read and a great contribution to the historical writings of the Yellowstone.

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Leslie J. Quinn has been a Yellowstone National Park tour guide for 27 years, and a fifth cousin of Gustavus Cheyney Doane for a bit longer than that.

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The printing of *Yellowstone Science* is made possible through a generous annual grant from the nonprofit Yellowstone Association, which supports education and research in the park. Learn more about science in Yellowstone through courses offered by the Yellowstone Association Institute and books available by visiting www.YellowstoneAssociation.org.

The production of *Yellowstone Science* is made possible, in part, by a generous grant to the Yellowstone Park Foundation from Canon U.S.A., Inc., through *Eyes on Yellowstone* is made possible by Canon. This program represents the largest corporate donation for wildlife conservation in the park.

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Hikers on the Rescue Creek trail.

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