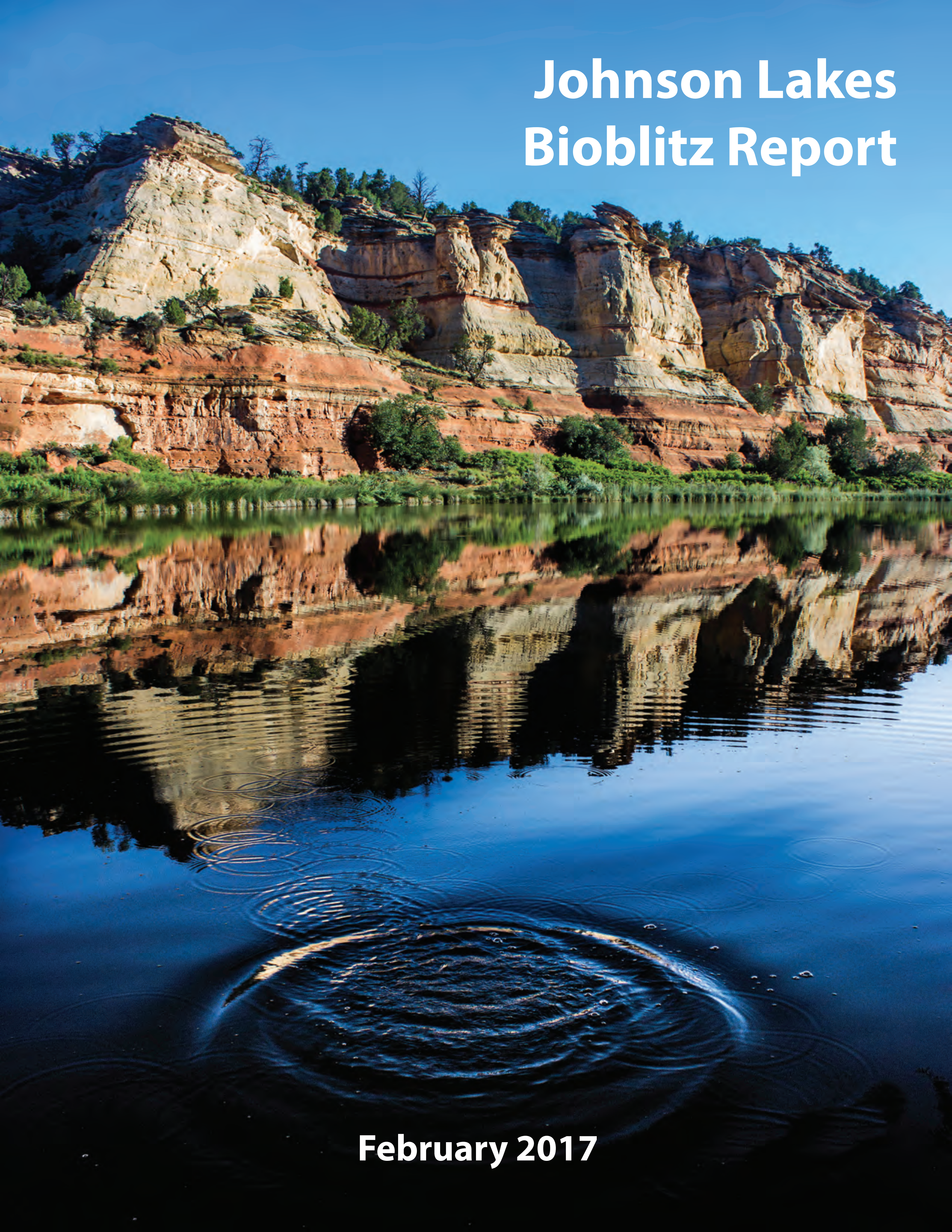
Johnson Lakes Bioblitz Report



February 2017

A Guide to Some of the Really Old Residents of Johnson Lakes Canyon

In 2014, Susan and Richard Knezevich partnered with the Grand Canyon Trust to establish Johnson Lakes Canyon, their 800-acre property and refuge, as a long-term restoration and reference area. Surrounded by Grand Staircase-Escalante National Monument (GSENM), Johnson Lakes Canyon also serves as a site for diverse restoration experiments and projects, as well as a landing spot for scientists and volunteers contributing to its wonder, diversity, astounding beauty, and recovery from decades of livestock grazing.

With 96.4 percent of the surrounding 1.8 million-acre GSENM actively grazed by cattle, Johnson Lakes Canyon serves as a lesson in the recovery and conditions that are possible when these desert public lands are not actively grazed by cattle. Cottonwoods and willows, not visible prior to the removal of cattle are thriving, biological soil crusts cover entire hillsides, sandstone bees dig nesting sites out of walls, peregrine falcons nest, water birds drop by during their travels, and dead and living sagebrush give interesting clues to the past and present.

Since 2014, Grand Canyon Trust volunteers have been joining the Knezeviches for a week each year to help with priority restoration tasks (esp. removal of invasive species) and to photograph and document species changes within the restoration areas.

In 2016, 18 scientists came to hike anywhere they wished in Johnson Lakes Canyon for a three-day bioblitz. Their delightful task: documenting the presence of plant and animal species that call the spring, lake, canyons, cliffs, and mesa tops of Johnson Lakes Canyon their home.

After the scientists left, they graciously compiled their lists and photos in order to provide the Knezeviches (and you and future scientific expeditions) with their observations, thoughts, and restoration suggestions. This report presents those lists and photos, with great formatting and design by botanist/photographer Jonathan Barth. This report is a fine base upon which to build future lists and observations. The report includes:

1. Birds

2. Plants (updating a 2005 plant list)

3. Bees

4. Insects

5. Historical Ecology

6. Flickr Instructions to access hundreds of great plant photos the two photographers posted from their 2016 visit

Johnson Lakes Canyon is dynamic, and so we'll learn more and more in the coming years. But welcome to this tour of some of what makes the canyon – and the Knezeviches – so special to southeastern Utah.

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JLC Bioblitz 2016

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PRELIMINARY SURVEY OF BREEDING BIRDS, 2016
JOHNSON LAKES CANYON, KANE COUNTY, UTAH

by Kathleen Munthe

INTRODUCTION

Shortly after purchase of the Johnson Lakes Canyon property by Richard and Susan Knezevich, Walt Fertig conducted a botanical and ecological survey of the property. Attached to his written report (2005) were lists of the property's potential vertebrate fauna, which included 112 bird species. The bird list was based on a checklist of birds for the adjacent Escalante-Grand Staircase National Monument and a variety of other sources.

During the Johnson Lakes Canyon BioBlitz of 26-29 May 2016, a systematic search for bird species was undertaken, both within the canyon walls and on the mesa tops, especially the west mesa. The east mesa and the open area north of the campground received only brief attention; Center Canyon was not visited.

The results of this survey can be found below. These include a list of bird species seen and/or heard, the general habitats in which they were found, and an assessment of breeding status on the property for each. Suggestions for future survey work and for habitat management benefiting birds (and other wildlife) are also presented.

RESULTS

Sixty bird species were found during the BioBlitz and are listed in Table 1. Of the potential 112 species listed by Fertig (2005), 47 were found; 13 species seen were not on Fertig's list. Considering habitat variety and the presence of permanent water, it is not surprising that the majority of bird species detected (45, 75% of total) occurred on or within the canyon walls. Of those, 13 (just under 22%) are wetland species. As would be expected, the dry, pinyon-juniper mesa tops produced only 15 species (25% of total). A handful (5) of "dryland" species were found both within the canyon and on the mesa tops.

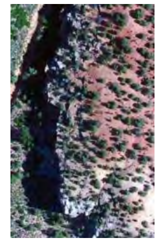
Table 1: Bird Species Detected on the Johnson Lakes Canyon BioBlitz of May 2016.

wetlands = lake/wetlands
canyons = canyon outside of wetlands, including cliff walls and top;
mesas = mesa tops
new = species not on Fertig's potential list

Species	 wetlands	 canyons	 mesas	new
Mallard	✓			
Green-winged Teal	✓			
Great Blue Heron	✓			
Northern Harrier	✓			
American Coot	✓			
Common Yellowthroat	✓			
Song Sparrow	✓			
Red-winged Blackbird	✓			
Willow Flycatcher	✓			✓
Black Phoebe	✓			✓
Virginia Rail	✓			✓
Spotted Sandpiper	✓			✓
Lincoln's Sparrow	✓			✓
Wild Turkey		✓		
Sharp-shinned Hawk		✓		
Red-tailed Hawk		✓		
Mourning Dove		✓		
Great Horned Owl		✓		
White-throated Swift		✓		
Northern Flicker		✓		
American Kestrel		✓		
Say's Phoebe		✓		
Ash-throated Flycatcher		✓		
Western Kingbird		✓		
Plumbeous Vireo		✓		
Warbling Vireo		✓		
Western Scrub Jay*		✓		
American Robin		✓		
Yellow Warbler		✓		
Spotted Towhee		✓		

*The western scrub jay was split into two species in 2016. The California scrub jay, and the Woodhouse's scrub jay which is what is found in Utah.

Table 1: continued.

Species	 wetlands	 canyons	 mesas	new
Virginia's Warbler *		✓		
Western Tanager		✓		
Black-headed Grosbeak		✓		
Lazuli Bunting		✓		
Lesser Goldfinch		✓		
House Finch		✓		
Violet-green Swallow		✓		
Common Raven		✓		
Cliff Swallow		✓		
Canyon Wren		✓		
Hairy Woodpecker		✓		✓
Black-billed Magpie		✓		✓
Western Bluebird		✓		✓
Peregrine Falcon		✓		✓
Dusky Flycatcher		✓		✓
Chipping Sparrow		✓	✓	
Black-chinned Hummingbird		✓	✓	
Bewick's Wren		✓	✓	
Rock Wren		✓	✓	
Blue-gray Gnatcatcher		✓	✓	
Pinyon Jay			✓	
Gray Flycatcher			✓	
Pine Siskin			✓	
Turkey Vulture			✓	
Mountain Chickadee			✓	
Juniper Titmouse			✓	
Common Poorwill			✓	
Black-throated Gray Warbler			✓	✓
Black-throated Sparrow			✓	✓
Gray Vireo			✓	✓

*When searching for Virginia's warbler at AllAboutBirds.org the bird did not come up. A little more looking elsewhere showed why: not much is known about the bird. An excerpt from here:

"This small, gray warbler of the south-western Rocky Mountain states has been described in numerous accounts as shy, retiring, and not easy to observe. This combination of traits, in addition to slow progress in describing the natural history of its steep-sloped, xeric, piñon-juniper, and oak woodland–dominated habitat, has no doubt helped make it one of the most overlooked warblers in North America."

All of the species listed here were considered summer or permanent residents by Fertig and thus potential breeders in the general area, with the exception of green-winged teal, which nests further north in Utah. One pair was seen on the lake; the female fell prey to Peregrine Falcons.

The birds listed from Table 1 are grouped into categories below. These categories reflect degrees of confidence in breeding status and are similar to those used in state Breeding Bird Atlas surveys and other studies. The behaviors/observations used to place birds within the Confirmed, Probable, Possible, or Non-Breeder Categories are noted for each species.

Confirmed Breeders (14 species)

Wild Turkey – fledged young with adult
Black-chinned Hummingbird – females on nests
Peregrine Falcon – occupied nest?
Black Phoebe – feeding nestlings
Pinyon Jay – fledged young with adults
Common Raven – occupied nest
Violet-green Swallow – nest building
Cliff Swallow – nest building
Rock Wren – used nests
Western Bluebird – nest with eggs
American Robin – feeding nestlings
Spotted Towhee – nest with eggs
Chipping Sparrow – feeding nestlings
Song Sparrow – feeding nestlings

Wild Turkey

Notes: Most of the behaviors exhibited by the Peregrine Falcons – a pair vigorously defending territory, visiting the nest site, engaged in courtship behavior (exchange of prey in the air) would place them in the "Probable" category. Peregrines in southern Utah usually start breeding in March/April, so these are late starters. It was not possible to determine, during the time span of the BioBlitz, whether eggs or young were present on the nest ledge, pictured on the last page of this report's bird section.

A single adult Common Raven was seen entering a nest hole in the cliff between frequent foraging trips; whether the other adult was sitting on eggs or fledglings is not known.

Probable Breeders (27 species)

Northern Harrier – pair in appropriate habitat
Red-tailed Hawk – territorial behavior
American Coot – pair in appropriate habitat
Mourning Dove – pair in appropriate habitat
White-throated Swift – pair in appropriate habitat
Hairy Woodpecker – pairs, multiple calling males
Northern Flicker – pairs, multiple calling males
Gray Flycatcher – multiple singing males
Ash-throated Flycatcher – pairs in appropriate habitat
Western Kingbird – pairs in appropriate habitat
Gray Vireo – multiple singing males
Plumbeous Vireo – multiple singing males
Western Scrub Jay – pairs in appropriate habitat
Black-billed Magpie – pairs in appropriate habitat
Juniper Titmouse – agitated behavior
Bewick's Wren – multiple singing males
Canyon Wren – multiple singing males
Blue-gray Gnatcatcher – pairs in appropriate habitat
Virginia's Warbler – multiple singing males
Common Yellowthroat – pairs, multiple singing males
Yellow Warbler – pairs, multiple singing males
Black-throated Sparrow – pair in appropriate habitat
Black-headed Grosbeak – multiple singing males
Red-winged Blackbird – pairs in appropriate habitat
House Finch – multiple singing males
Pine Siskin – pairs in appropriate habitat
Lesser Goldfinch – pairs in appropriate habitat

Red-tailed Hawk

Common Yellowthroat

Possible Breeders (13 species)

Turkey Vulture – single individual seen in appropriate habitat
Sharp-shinned Hawk – single individual seen in appropriate habitat
Virginia Rail – 2 individuals heard but not seen, both vocalized but one called vigorously
Spotted Sandpiper – group of 4 observed in appropriate habitat
Great-horned Owl – 1 calling at night (nest known in general area but not on property)
Common Poorwill – single individual seen in appropriate habitat
American Kestrel – single individual seen in appropriate habitat
Dusky Flycatcher – single individual seen in appropriate habitat
Say's Phoebe – one heard in appropriate habitat
Warbling Vireo – single individual seen in appropriate habitat

Mountain Chickadee – single individual seen in appropriate habitat
Black-throated Gray Warbler – single individual heard in appropriate habitat
Lazuli Bunting – single individual seen in appropriate habitat

Probable Non-breeders (6 species)

Mallard – single individual seen
Green-winged Teal – one pair seen on the lake, female taken by Peregrines; usually nests further north
Great Blue Heron – single individual, mate lost previously (R Knezevich, pers. comm.)
Willow Flycatcher – one individual, no appropriate willow thickets
Lincoln's Sparrow – one individual, no extensive wet thickets
Western Tanager – one individual, nests at higher altitudes

FUTURE SURVEY WORK

The BioBlitz provided a good start, but its duration did not allow for complete exploration of the property. More of the west mesa needs to be surveyed, as do the east mesa and Center Canyon.

An extended survey during the proper season would likely add a number of potential breeding birds to the list. These might include Cooper's Hawk and Prairie Falcon (Golden Eagle was seen along the high cliffs on the drive in, outside the property), Northern Pygmy and Western Screech Owls (a single, abbreviated series of "toots" heard the first night may have been a Pygmy Owl); Common Nighthawk; Loggerhead Shrike; Sora Rail; Bushtit; White-breasted Nuthatch; Green-tailed Towhee; and Brewer's Sparrow. An extended survey would also provide additional data on the breeding status of species in the Probable and Possible categories.

Several of the species noted as permanent or summer residents by Fertig are unlikely to breed on the property. These include Flammulated Owl, Broad-tailed Hummingbird, Cordilleran Flycatcher, Red-breasted Nuthatch, Hermit Thrush, and Dark-eyed Junco, all of which nest at higher altitudes, in Ponderosa Pine or Spruce-Fir forests. Horned Lark, which nests in large, open areas with sparse, low vegetation, is also an unlikely breeder on the property.

Observation at times of the year other than breeding season would doubtless add species to the general bird list for the property. Bald Eagle has already been noted during the winter (R.K., pers. comm.). Other winter additions might include Merlin, Mountain Bluebird, Townsend's Solitaire, White-crowned Sparrow, Dark-eyed Junco, and American Goldfinch.

Many of the species on Fertig's list which were not seen during the BioBlitz, especially waterfowl and shorebird species, are migrants. A group of migrant Black-necked Stilt was seen previously at the lake (R.K., pers. comm); other species may stop in future, but the number of species and individuals will probably vary greatly from year to year. Other migrants might include raptors, terns, and hummingbirds.

HABITAT MANAGEMENT FOR BIRDS

During the last decade, enormous strides have been made in the recovery of the Johnson Lakes Canyon property from the devastation of intense grazing. The resultant habitat improvements have been of great benefit to birds and other wildlife. Removal of cattle alone has greatly reduced pressure on bird species. e.g., vireos, warblers, gnatcatchers and sparrows, subject to parasitism by Brown-headed Cowbirds, which often accompany cattle.

Pinyon-Juniper and Pinyon-Juniper-Sagebrush communities cover about 75% of the property (Fertig, 2005). These woodlands are home to a number of obligate or semi-obligate bird species. With two exceptions, all of the Pinyon-Juniper Birds of Conservation Concern listed by Gillhan (2006) were found on the property. The exceptions were Ferruginous Hawk and Scott's Oriole, whose preferred sub-habitats do not exist in Johnson Lake's Canyon. Among other Pinyon-Juniper species, only Bushtit was not found during the BioBlitz, but are probably present. They are nomadic except when nesting, so encountering them is a hit or miss proposition.

The mesas were apparently subject to far less pressure from cattle than the canyon itself and are therefore least in need of habitat restoration. My only suggestions are these:

1. Retain older trees and dead snags, which provide nest sites for cavity-nesting birds (e.g. titmice, bluebirds, wrens, Ash-throated Flycatcher) and foraging perches for insect eaters (e.g. flycatchers, bluebirds).
2. Maintain the integrity of sagebrush/perennial grass areas within the Pinyon-Juniper woodland by removal of any young, encroaching trees. These areas are important for birds such as sparrows and towhees.

The challenges of restoring native vegetation within the canyon are well known to the property owners and anyone associated with the restoration project. At the risk of preaching to the choir, I would say that the following would greatly benefit bird populations:

1. Removal of as many Russian Olive as possible. Although some bird species seem to be making do with them, these trees are not preferred for nesting and feeding.
2. Establishment of more cottonwoods, which are used by Warbling Vireo, Bullock's oriole, Black-headed Grosbeak, Yellow Warblers and other species for both nesting and feeding.
3 Protection of existing Gambel's Oak, which currently support a healthy population of Virginia's Warblers and provide food for both insect eaters and acorn eaters.
4 Unless they threaten humans or their structures, preserve dead tree snags. These provide sites for cavity nesters and foraging perches for insect eaters.
5 Continue to improve the quality of the sagebrush areas, preferred nesting sites of Green-tailed Towhee, Brewer's Sparrow, and Black-throated Sparrow. Encourage deciduous shrub thickets, which provide cover and food for several species, both breeding and wintering.

6 Continue to encourage native grasses over invasives. They provide food for both breeding and wintering finches and sparrows.
7 Leave brush piles where possible, which afford cover for wrens and wintering sparrows and juncos.
8 Assess the quality/productivity of the lake. Due to its size, paucity of shore vegetation, and limited area of navigable wetlands at its north end, the lake will probably never host many nesting ducks, and they will be under constant pressure as long as the peregrines remain. Because it is the only open water in the area, though, the lake will be a draw for some migrant ducks and shorebirds. The question is whether there is enough for them to eat.

ACKNOWLEDGEMENTS

Countless thanks to Rick and Susie Knezevich for their enthusiasm, curiosity, years of hard work, and everything they did to make the BioBlitz a success, including providing fabulous food. The property could not have better caretakers. Many thanks to Mary O'Brien, Andrew Mount, and others of the Grand Canyon Trust for organizing the BioBlitz and for the care and feeding of us field folks. It was a rare treat to be able to do our thing without worrying about anything else. Finally, thanks to those BioBlitz participants, especially Lynn "Nest Finder Extraordinaire" Bohs, for their contributions to the bird list.

REFERENCES

Fertig, W. 2005. Botanical and Ecological Survey of the Johnson Lakes Canyon Property, Kane County, Utah. Moenave Botanical Consulting, Kanab UT.

Gillhan, S. W. 2006. Sharing the Land with Pinyon-Juniper Birds. Partners in Flight Western Working Group, Salt Lake City UT.

Sibley, D.A. 2014. The Sibley Guide to Birds, Second Edition. Alfred E. Knopf, New York City NY.

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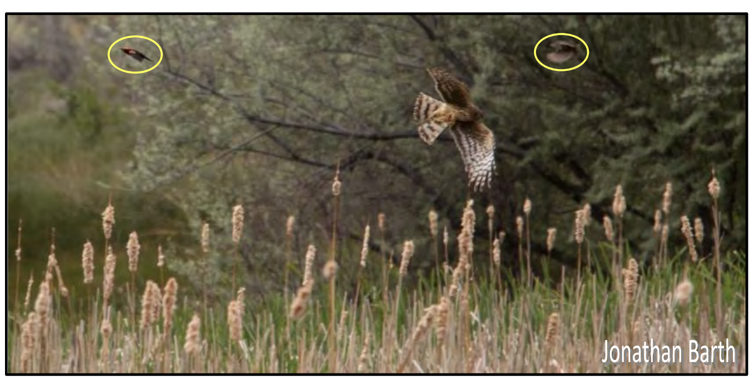
Red-winged Blackbirds (male left, and female right) attacking a Northern Harrier as it gets near their nest.



Peregrine falcon nesting ledge circled in red to the right.

Easting 381507
Northing 4107688

In the digital form of this report, you can click on the aerial photo below and it will take you to this location in Google Maps. The camera icon below represents the location from where the photo was taken. The bird icon is the approximate location of the nesting ledge.

Plants

INTRODUCTION by Jonathan Barth

Livestock grazing can cause some plant species to disappear, while others – native and non-native – can increase in numbers. Rick and Susie Knezevich, owners and stewards of Johnson Lakes Canyon, privately-owned land surrounded by the Grand Staircase Escalante National Monument, ceased to allow cattle grazing on the property in 2009, ending over 100 years of livestock grazing on the property.

The first season after the cows were gone, Rick and Susie witnessed plant species changes. One of the first things they noticed was the explosive growth and spread of bull thistle (*Cirsium vulgare*). These, along with Russian olive – their spiny branches protecting the bull thistles growing beneath them - were their first restoration targets. Initially, they dug up, bagged, and hauled out the thistles by themselves. This seemingly endless task was helped along when the Grand Canyon Trust supplied annual volunteers. By 2016, Rick and Susie realized they were winning the battle against this "vulgar" thistle.[1]

Post-livestock grazing at JLC hasn't brought only weeds. Native plants are returning, too. Fremont cottonwood, coyote willow, and Booth's willow have returned to JLC after grazing ended. None of these three species were recorded in Walt Fertig's extensive 2005 survey of JLC. By the end of 2016, a handful of returning cottonwoods were over 40 feet tall.

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[1] "Vulgar" is a playful reference to the thistle's Latin name, *C. vulgare*, which in Latin means common, but in English means, "crude, course, or unrefined."

Cottonwood grow fast and die young. Like many other short-lived trees, they produce a lot of young. Even though the adult trees are huge, and reproduce prolifically from root sprouts (and to a lesser extent viable seedlings), they are no match for annual browsing by cattle or other ungulates (e.g., elk, deer, sheep, goats). While trees are generally safe from cattle browsing once they are 6' tall, sprouts less than 6' tall are vulnerable.[2] If young trees can't grow into the overstory, a cottonwood gallery can be lost as the old trees die.

Willows, in particular coyote willow, are returning with vigor. This is great news. They are growing along areas where seasonal water flows have been eroding the sandy soil. Booth's and Coyote willows are listed as mid-secession plants, meaning they aren't the first to establish after a disturbance, and they probably won't be the last. It will be fascinating to see what late succession plants will replace these willows. New plants that need shade and moisture will flourish beneath the cottonwoods and willows. What might they be?

Willows and a Fremont cottonwood returning to Johnson Lakes Canyon.

PLANT COUNTS

In Walt Fertig's 2005 plant survey at Johnson Lakes Canyon, he found 178 plant species, and 9 more just beyond JLC boundaries (marked in the chart with an asterisk), for a total of 187 plant species. Since the end of grazing in 2009 much has changed at JLC. There were likely more plant species at JLC in 2016 than in 2005.[3] The 2016 bioblitz indeed added to Fertig's list; 69 more, bringing the total to 265 species. Though this is still much fewer than the 1,251 species listed in *Grand Staircase Escalante NM Master Checklist 5.3*,[4] that's to be expected. At 1.9 million acres, the monument is 2,262 times larger than 840-acre JLC. As diverse as the landscape at Johnson Lakes Canyon is, the much larger monument contains an even greater diversity of ecosystems and habitats. The monument's 4,000 foot altitude range (4,000' to 8,000') is more than nine times that of JLC's 430-foot altitude range (5,330' to 5,760').[5]

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[2] Asplund, Kenneth K.; Gooch, Michael T. 1988. Geomorphology and the distributional ecology of Fremont cottonwood (*Populus fremontii*) in a desert riparian canyon. Desert Plants. 9(1): 17-27. [563]

[3] The increase in species found at JLC in 2016 can't be completely attributed to the end of cattle grazing. The number of bioblitzers looking for species contributed to more species being located and identified.

[4] Walt Fertig's 2005 JLC report noted that the monument contained 983 taxa (i.e., species and subspecies). Originally created by Fertig, an updated monument plant list is maintained by Grand Staircase-Escalante National Monument Botanist, Amber Hughes in the Escalante Office

[5] Low and high elevation points of JLC extracted from https://viewer.nationalmap.gov/viewer/ .

The following chart lists all the species in an Excel spreadsheet. The original file contains much more information, including notes, as well as links to photos, and botanical websites. Contact the Trust (maryobrien10@gmail.com) for the Excel sheet, and soon it will be up on the Trust's website.-JB

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Abronia fragrans	Fragrant sand-verbena	perennial forb	Native		382108	4108299
Abronia nana	Dwarf sand verbena	perennial forb	Native	16	381075	4106803
Acer grandidentatum	Bigtooth maple	tree	Native	16	382177	4108166
Achnatherum hymenoides	Indian ricegrass	perennial graminoid	Native	16	381406	4107569
Agastache urticifolia	Nettleleaf giant hyssop	perennial forb	NO	16	382256	4108328
Microsteris gracilis	Little phlox, slender phlox	annual forb	Native			
Allium bisceptrum	Twincrest onion	perennial forb	Native	16		
Ambrosia acanthicarpa	Bur ragweed	annual forb	Native			
Amelanchier alnifolia	Saskatoon serviceberry	shrub	Native	16	382255	4108266
Amelanchier utahensis	Utah serviceberry	shrub	Native			
Arabis fendleri	Fendler's rockcress	perennial forb	Native	16	382005	4108023
Arabis holboellii var. retrofracta (Boechera retrofracta)	Second rockcress	biennial forb	Native	16		
Arabis perennans	Perennial rockcress	perennial forb	Native	16	382158	4108391
Arabis perennans var. perennans (Boechera perennans, B. gracilenta)	Common rockcress	perennial forb	Native	16		
Arctostaplrylos patula	Greenleaf marranita	shrub	Native			
Arenaria fendleri var. eastwoodiae (Eremogone eastwoodiae)	Eastwood's sandwort	perennial forb	Native			
Argemone munita ssp. rotundata	*Armed prickly-poppy	perennial forb	Native			
Aristida purpurea	Purple three awn	annual or perennial graminoid	Native	16	381456	4107599
Artemisia campestris var. scouleriana	Sand wormwood	perennial forb	Native			
Artemisia dracunculus	*Tarragon	perennial forb	Native			
Artemisia filifolia	Sand sagebrush	shrub	Native		380970	4106404
Artemisia frigida	Fringed sagebrush, prairie sagewort	shrub	Native		381931	4108024
Artemisia ludoviciana var. albula	Louisiana wormwood	perennial forb	Native			

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Artemisia ludoviciana var. mexicana	Louisiana wormwood, white sagebrush	perennial forb	Native		382230	4108236
Artemisia tridentata var. tridentafa	Basin big sagebrush	shrub	Native		382158	4108360
Asclepias asperula var. asperula	Spider milkweed	perennial forb	Native		382049	4107622
Asclepias subverticillara	*Whorled milkweed	perennial forb	Native			
Aster ascendens	Pacific aster	perennial forb	Native			
Astragalus ceramicus var. ceramicus	painted milkvetch	perennial forb	Native	16		
Astragalus mollissimus var. thompsoniae	Woolly locoweed, wooly milkvetch	perennial forb	Native		382158	4108391
Astragalus sesquiflorus	Sandstone milkvetch	perennial forb	Native		381355	4107446
Atriplex canescens var. canescens	Fourwing saltbush, spiny hopsage	shrub	Native		382158	4108360
Berula erecta var. incisa (B. incisa)	Cutleaf water-parsnip, lesser water parsnip	perennial forb	Native		382257	4108359
Bouteloua gracilis	Blue grama	perennial graminoid	Native	16	381455	4107569
Brickellia microphylla var. scabra	Rough brickellbush	shrub	Native			
Calochortus nuttallii	Sego lily	perennial forb	Native	16		
Camissonia parvula	Tiny camissonia	annual forb	Native			
Carex simulata	Analogue sedge	perennial graminoid	Native	16		
Castilleja chromosa	Northwestern Indian paintbrush	perennial forb	Native	16		
Castilleja linariifolia	Wyoming paintbrush	perennial forb	Native			
Centrostegia thurberi (Chorizanthe thurberI)	Thurber's spineflower	annual forb	Native		381380	4107508
Cercocarpus intricatus (C. ledifolius var. intricalas)	Dwarf mountain mahogany	shrub	Native			
Cercocarpus ledifolius	Curlleaf mountain mahogany	shrub	Native	16	382029	4108023
Chaenactis stevioides	Esteve's pincushion	annual forb	Native	16		
Chaetopappa ericoides	Rose heath	perennial forb	Native	16	381406	4107600
Chamaesyce glyptosperma (Euphorbia glyptosperma)	Ridge-seeded spurge	annual forb	Native			
Chenopodium album	Lambsquarters	annual forb	Native?	16		
Chenopodium berlandieri	Lamb's quarters, pitseed goosefoot	annual forb	Native	16	382233	4108483

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Chenopodium leptophyllum	Narrowleaf goosefoot	annual forb	Native			
Chorispora tenello	Musk-mustard	annual forb	NO			
Chrysopsis villosa var. minor (Heterotheca villosa var. minor)	Hispid goldenaster	perennial forb	Native			
Chrysopsis zionensis (Heterotheca zionensis)	Zion goldenaster	perennial forb	Native			
Chrysothamnus viscidiflorus var. stenophyllus	Slenderleaf rabbitbrush	shrub	Native			
Chrysothamnus viscidiflorus var. viscidiflorus	Viscid rabbitbrush	shrub	Native			
Cirsium arizonicum var. bipinnatum	Arizona thistle or Four-corners thistle	perennial forb	Native		382254	4108267
Cirsium calcareum	Cainville thistle	biennial or perennial forb	Native	16	382404	4108388
Cirsium neomexicanum	New Mexico thistle	biennial forb	Native	16		
Cirsium scariosum var. thorneae	Meadow thistle	biennial or perennial forb	Native		381654	4107720
Cirsium vulgare	Bull thistle	biennial forb	NO			
Clematis ligusticifolia	White virgin's bower, western white clematis	perennial forb	Native		381956	4108117
Cleome lutea	Yellow beeplant	annual forb	Native		382079	4108084
Cleome serrulata	Rocky Mountain beeplant	annual forb	Native		382208	4108514
Comandra umbellate var. pallida	Bastard toadflax	perennial forb	Native			
Conyza canadensis var. glabrata	Horseweed, Canadian horse weed	annual forb	Native		382208	4108514
Corydalis aurea	Golden corydalis	perennial forb	Native			
Crepis occidentalis	Largeflower hawksbeard	annual forb	Native	16		
Cryptantha barbigera	Bearded cryptanth	annual forb	Native	16	381174	4106926
Cryptantha cinerea var. pustulosa	James' cryptantha, sand cryptanth	perennial forb	Native			
Cryptantha circumcissa	Opening cryptanth	annual forb	Native			
Cryptantha confertiflora	Golden cryptanth	perennial forb	Native			
Cryptantha crassisepala var. elachantha	Thicksepal cryptanth	annual forb	Native			

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Cryptantha fendleri	Fendler's cryptanth	annual forb	Native			
Cryptantha flava	Yellow cryptanth	perennial forb	Native		382229	4108236
Cryptantha gracilis	Slender cryptanth	annual forb	Native			
Cryptantha nevadensis var. nevadensis	Nevada cryptanth	annual forb	Native	16		
Cryptantha pterocarya var. pterocarya	Wing-nut cryptanth	annual forb	Native			
Cryptontha cinerea var. cinerea	Ashy cryptanth	perennial forb	Native			
Cylindropuntia whipplei	Whipple cholla	cactus	Native	16		
Cymopterus purpurascens	*Wide-wing spring-parsley	perennial forb	Native			
Datura wrightii	sacred datura, Indian-apple	perennial forb	Native		382208	4108483
Delphinium andersonii var. scaposum (D. scaposum)	Anderson's larkspur, tall mountain larkspur	perennial forb	Native		382074	4107745
Descurainia incana subsp. incisa (Descurainia incisa)	Mountain tansymustard	biennial forb	Native	16		
Descurainia pinnata subsp. halictorum	Western tansymustard	biennial forb	Native	16		
Descurainia pinnata subsp. paysonii	Payson's tansymustard	biennial forb	Native	16		
Descurainia pinnata var. osmiarura	Pinnate tansymustard	annual forb	Native			
Descurainia sophia	Flixweed	annual forb	NO		381979	4108024
Distichlis spicata	Saltgrass	perennial graminoid	Native	16	381630	4107751
Dithyreo wislizenil (Dimorphocarpa wislizenii)	Spectacle pod	annual forb	Native			
Draba cuneifolia var. cuneifolia	Wedgeleaf draba	annual forb	Native			
Echinocereus coccineus	Scarlet hedgehog cactus	cactus	Native	16	381583	4107937
Echinocereus triglochidiatus var. melanacanthus	Claretcup cactus	cactus	Native		381380	4107539
Elaeagnus angustifolia	Russian olive	tree	NO			
Eleocharis palustris var. palustris	Common spikerush	perennial graminoid	Native	16		
Ephedra cutleri	Cutler's ephedra	shrub	Native	16	382074	4107745
Ephedra viridis var. viridis	Green ephedra	shrub	Native			
Epilobium ciliatum	Northern willowherb	perennial forb	Native			
Equisetum arvense	Field horsetail	perennial forb	Native	16	382255	4108328
Equisetum laevigatum	Smooth scouring-rush	perennial forb	Native	16	381730	4107812
Eriastrum diffusum	Miniature woolystar	annual forb	Native	16		

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Eriastrum sparsiflorum	Fewflower eriastrum	annual forb	Native			
Ericameria nauseosa	Rubber rabbitbrush	shrub	Native	16	381679	4107751
Ericameria nauseosa var. arenaria (Chrysothamnus turuseosus var. arenarias)	Sand rabbitbrush	shrub	Native			
Ericameria nauseosa var. juncea	Rush rabbitbrush	shrub	Native	16	381380	4107539
Ericameria nauseosa var. oreophila (Chrysothamnus nauseosus var. consimilis)	Greenish rabbitbrush	shrub	Native			
Ericameria parryi var. attenuata	Parry's rabbitbrush	shrub	Native	16	382157	4108391
Erigeron bellidiasrum	Pretty daisy	annual forb	Native			
Erigeron formosissimus	Beautiful daisy	shrub	Native	16	381023	4106681
Erigeron lonchophyllus	Longleaf daisy	perennial forb	Native			
Erigeron religiosus	Clear Creek fleabane	annual forb	Native	16		
Erigeron utahensis var. utahensis	Utah daisy	perennial forb	Native			
Eriogomtm palmerianum	Palmer's buckwheat	annual forb	Native			
Eriogonum alatum	Winged buckwheat	perennial forb	Native			
Eriogonum fasciculatum var. polifolium	Eastern Mojave buckwheat	shrub	Native	16		
Eriogonum microthecum var. simpsonii	Slender buckwheat	shrub	Native	16	382554	4108540
Eriogonum racemosum var. zionis	Zion buckwheat	perennial forb	Native			
Eriogonum subreniforme	Kidneyshape buckwheat	annual forb	Native	16		
Eriogonum umbellatum var. subaridum	Arid buckwheat, sulphur-flower buckwheat	perennial forb	Native	16	381380	4107508
Eriogonum wetherillii	Wetherill's buckwheat	annual forb	Native	16		
Eriogorum cernuum var. cernuum	Nodding buckwheat	annual forb	Native			
Erodium cicutarium	Storksbill, redstem filaree, redstem stork's bill	annual forb	NO		382107	4108330
Erysimum capitatum var. capitatum	Sanddune wallflower	biennial forb	Native	16		
Fallugia paradoxa	Apache plume	shrub	Native	16		
Festuca sororia	Ravine fescue	perennial graminoid	Native	16		
Fraxinus anomala	Singleleaf ash	shrub	Native	16	381406	4107600

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Gaillardia pinnatifida	Red dome blanketflower, hopi blanketflower	annual forb	Native	16	382081	4108238
Gilia inconspicua (G. tweedyi, G. sinuata)	Floccose gilia	annual forb	Native			
Gilia leptomeria var. leptomeria (Aliciella leptomeria)	Common gilia	annual forb	Native			
Gilia leptomeria var. micromeria	Common gilia	annual forb	Native	16	381149	4106895
Glaux maritimum	Sea milkwort	perennial forb	Native			
Glycyrrhiza lepidota	Licorice, wild licorice	perennial forb	Native		381505	4107630
Grimmia anodon	Grimmia dry rock moss	nonvascular	Native	16	382157	4108391
Gutieruezia sarothrae	Broom snakeweed	shrub	Native	16	381330	4107478
Helianthus annuus	*Common sunflower	annual forb	Native			
Hesperostipa comata	Needle-and-thread grass	perennial graminoid	Native	16	382157	4108391
Heterotheca villosa	Hairy false goldenaster	perennial forb	Native	16	382157	4108391
Heuchera rubescens	Red alumroot	perennial forb	Native	16	382004	4107993
Heuchera rubescens var. versicolor	Pink alumroot	perennial forb	Native	16		
Holodiscus dumosus	Mountain spray	shrub	Native	16	382176	4108167
Hordeum jubatum	Foxtail barley	perennial graminoid	Native	16	382233	4108483
Hytnenopappus filifolius var. cinereus	Hyaline herb	perennial forb	Native			
Ipomopsis arizonica	Arizona ipomopsis	biennial forb	Native	16		
Ipomopsis congesta var. frutescens (Gilia congesta var.frutescens)	Shrubby gilia	perennial forb	Native			
Juncus arcticus subsp. littoralis	Mountain rush	perennial graminoid	Native	16	381629	4107659
Juncus tenuis	Poverty rush	perennial graminoid	Native	16		
Juniperus osteosperma	Utah juniper	tree	Native	16		
Juniperus scopulorum	Rocky Mountain juniper	tree	Native			
Lactuca serriola	Prickly lettuce	annual forb	NO	16	382255	4108328
Lappula occidentalis var. cupulata (L. redowskii)	Western stickseed	annual forb	Native			
Lappula occidentalis var. occidentalis (L. redowskii var. redowskii)	Flatspine stickseed	annual forb	Native	16		
Lathyrus brachycalyx var. zionis	Zion sweetpea, bush pea	perennial forb	Native	16	382427	4109131

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Layia glandulosa	Tidytips	annual forb	Native			
Lemna minor	Duckweed	perennial forb	Native	16		
Lepidium densiflorum var. ramosum	Densecress	annual forb	Native			
Lepidium montanum	Western peppergrass	biennial or perennial forb	Native	16	382132	4108361
Linum aristatum	Broom-flax, bristle flax	annual forb	Native		381149	4106895
Lomatium minimum	Little desert parsley	perennial forb	Native	16	381805	4107903
Lycium pallidum	Pale wolfberry	shrub	Native		382157	4108391
Machaeranthera canescens var. aristata	Aristate aster	perennial forb	Native			
Mahonia fremontii (Berberis fremontii)	Fremont's mahonia	shrub	Native			
Mahonia repens (Berberis repens)	Creeping Oregon grape, creeping mahonia	shrub	Native		382254	4108267
Marrubium vulgare	Horehound	perennial forb	NO		381956	4108117
Medicago lupulina	Black medic	annual forb	NO		382255	4108328
Melilotus officinalis	Yellow sweet-clover	perennial forb	NO		382254	4108267
Mentha arvensis (M. arvensis var. glabrata)	Field mint	perennial forb	Native			
Mentzelia albicaulis	Whitestem blazingstar	annual forb	Native	16		
Mimulus guttatus	Yellow monkeyflower	perennial forb	Native		381377	4107323
Mimulus rubellus	Little redstem monkeyflower	annual forb	Native	16		
Nasturtium officinale (Rorippa nasturtium-aquaticum)	Water-cress, watercress	perennial forb	NO		382256	4108359
Oenothera cespitosa var. marginata	Tufted evening primrose, longtube evening-primrose	perennial forb	Native		382404	4108388
Oenothera pallida var. pallida	Pale evening-primrose	perennial forb	Native		382082	4108300
Onopordum acanthium	Scotch thistle, Scotch cottonthistle	biennial forb	NO	16	382208	4108483
Opuntia erinacea var. aurea (O. aurea)	Pipe Spring cactus	cactus	Native		381330	4107478
Opuntia phaeacantha var. major	Large pricklypear	cactus	Native			
Opuntia polyacantha	Plains pricklypear	cactus	Native			

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Orobanche fasciculata	Cluster cancerroot, cluster broomrape	annual forb	Native	16	381674	4107452
Orobanche ludoviciana	Louisiana broomrape	annual forb	Native	16	381872	4107409
Packera multilobata (Senecio multilobatus)	Uinta groundsel	perennial forb	Native		382157	4108361
Pediocactus sileri	Siler's pincushion cactus	cactus	Native	16	382276	4108051
Penstemon ambiguus var. laevissimus	Bush penstemon	perennial forb	Native		382433	4108696
Penstemon eatonii var. undosus	Firecracker penstemon	perennial forb	Native		381355	4107478
Penstemon laevis	Smooth penstemon	perennial forb	Native			
Penstemon linarioides var. sileri	Siler's penstemon	perennial forb	Native	16		
Penstemon palmeri	Palmer's penstemon	perennial forb	Native	16		
Penstemon rostriflorus (P. bridgesii)	Beaked penstemon, bridge penstemon	perennial forb	Native		381354	4107447
Penstemon utahensis	Utah penstemon	perennial forb	Native	16	381447	4107014
Perityle tenella	Springdale rockdaisy	shrub	Native	16		
Phaeelia ivesiana	Ives' phacelia	annual forb	Native			
Phalaris arundinacea	Reed canary grass	perennial graminoid	Native?	16		
Phlox austromontana	Desert phlox	perennial forb	Native	16	382229	4108236
Phlox austromontana var. austromontana	Desert phlox	perennial forb	Native		381330	4107478
Phlox longifolia	Longleaf phlox	perennial forb	Native	16	382229	4108236
Phoradendron juniperinum	Juniper mistletoe	shrub	Native	16	382096	4109060
Physalis hederifolia var. palmeri	Palmer's ground-cherry	perennial forb	Native			
Pinus edulis	Two-needle pinyon	tree	Native			
Pinus flexilis	Limber pine	tree	Native	16	381447	4107014
Plantago eriopoda	Woolly-foot plantain	perennial forb	Native		381679	4107720
Plantogo patagonica	Pursh's plantain	annual forb	Native			
Poa pratensis	Kentucky bluegrass	perennial graminoid	NO?	16	381930	4107994
Polygonum amphibium (Persicaria amphibia)	Water knotweed, water smartweed, swamp smartweed,	perennial forb	Native			
Polygonum douglasii	Douglas' knotweed	annual forb	Native	16		
Populus fremontii	Fremont cottonwood	tree	Native	16	382096	4109060

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Portulaca oleracea	Purslane	annual forb	NO?			
Prunus virginiana var. melanocarpa	Black chokecherry	tree	Native	16	382176	4108167
Psilostrophe sparsiflora	Greenstem paperflower	perennial forb	Native	16		
Psoralidium lanceolatum var. lanceolatum	*Dune scurfpea	perennial forb	Native		381375	4107169
Purshia stansburiana (P. mexicana var. stansburyana, Cowania mexicana)	Stansbury cliffrose, cliff-rose	shrub	Native		381406	4107600
Purshia tridentata	Bitterbrush	shrub	Native			
Quercus gambelii var. gambelii	Gambel's oak	shrub	Native		381979	4107993
Ranunculus cymbalaria	Marsh buttercup	perennial forb	Native		381629	4107659
Ranunculus sceleratus var. multifidus	Blister buttercup, cursed buttercup	annual forb	Native		381352	4107324
Rhus trilobata (R. aromatica var. trilobata)	Skunkbush sumac, squawbush	shrub	Native		382157	4108361
Ribes aureum	Golden currant	shrub	Native			
Ribes cereum var. pedicellare	Whisky currant	shrub	Native	16		
Ribes velutinum	Desert gooseberry	shrub	Native		382254	4108267
Rosa woodsii	Woods' rose	shrub	Native		382004	4108054
Rumex crispus	Curled or curly dock	perennial forb	NO		382256	4108359
Rumex salicifolius var. mexicanus	Mexican dock	perennial forb	Native	16		
Salix boothii	Booth's willow	shrub	Native	16		
Salix exigua	Coyote willow, narrowleaf willow	shrub	Native	16		
Salsola paulsenii	Barbwire Russian thistle	annual forb	NO	16		
Salsola tragus (S. iberica, S. pestifer, S. kali)	Russian thistle or tumbleweed	annual forb	NO		382282	4108482
Salvia dorrii	Dorr's sage, purple sage	shrub	Native	16	381583	4107937
Schoenoplectus pungens var. longispicatus	Common threesquare	perennial graminoid	Native	16	381604	4107628
Senecio spartioides var. spartioides	Broom groundsel	perennial forb	Native			
Sisymbrium altissimura	Tumbling mustard, tall tumblemustard	annual forb	NO		382029	4108054
Sisyrinchium demissum	Blue-eyed grass	perennial forb	Native		381048	4106712
Sonchus asper	Spiny sow-thistle, spiny sowthistle	annual forb	NO		382256	4108359

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Sophora stenophylla	Silvery sophora	perennial forb	Native	16		
Sphaeralcea parvifolia	Nelson's globe mallow	perennial forb	Native			
Sporobolus cryptandrus	Sand dropseed	perennial graminoid	Native	16	382079	4108084
Stanleya pinnata	*Prince's plume	perennial forb	Native			
Stenotus acaulis	Stemless mock goldenweed	perennial forb	Native	16		
Stenotus armerioides var. armerioides	Thrifty goldenweed	perennial forb	Native	16	381406	4107600
Stephanomeria exigua	Annual wire-lettuce	annual forb	Native			
Stephanomeria tenuifolia var. tenuifolia	Slender wire-lettuce	perennial forb	Native			
Streptanthella longirostris	Little twistflower	annual forb	Native			
Streptanthus cordatus	Heartleaf twistflower	biennial forb	Native	16		
Symphoricarpos longiflorus	Desert snowberry	shrub	Native	16		
Symphoricarpos oreophilus	Mountain snowberry	shrub	Native	16	381800	4107890
Symphoricarpos oreophilus var. utahensis	Utah snowberry	shrub	Native	16		
Tortula caninervis (Syntrichia caninervis)	Tortula Moss	nonvascular	Native	16	382157	4108361
Tamarix ramosissima	Tamarix, Saltcedar	shrub	NO	16		
Tarmacum officinale	Common dandelion	perennial forb	NO			
Tetradymia canescens	Gray horsebrush	shrub	Native			
Thalictrum fendleri	Fendler's meadow-rue	perennial forb	Native	16	382003	4107962
Tortula ruralis (Syntrichia ruralis)	Tortula moss	nonvascular	Native	16		
Townsendia incana	Silvery townsendia	perennial forb	Native		381521	4107013
Tradescandia occidentalis	Spiderwort	perennial forb	Native			
Tradescantia occidentalis var. scopulorum	Prairie spiderwort	perennial forb	Native	16	382446	4108708
Tragopogon dubius	Yellow salsify	perennial forb	NO			
Typha domingensis	Cattail	perennial forb	Native	16	381730	4107842
Verbascum thapsus	*Woolly mullein	perennial forb	NO	16		
Veronica americana	American speedwell	annual forb	Native	16	381352	4107293
Veronica anagallis-aquatica	Water speedwell	annual or perennial forb	NO	16	382255	4108328
Veronica peregrina ssp. xalapensis	Purslane speedwell	annual forb	Native	16	381679	4107751

BOTANICAL NAME (synonyms in parentheses)	COMMON NAMES	FORM	NATIVE?	New In	GPS NAD83 UTM Zone 12	
					Easting	Northing
Vicia americana var. americana	American vetch	perennial forb	Native			
Viola nephrophylla (V. sororia var. affinis)	Bog violet, northern bog violet	perennial forb	Native		381956	4108117
Vulpia octoflora	Sixweeks fescue	perennial graminoid	Native	16	381380	4107508
Xanthium strumarium var. canadense	Cocklebur	annual forb	Native		382157	4108391
Yucca angustissima var. angustissima	Narrow leaved yucca	shrub	Native			
Yucca baccata	Banana yucca	shrub	Native			
Yucca kanabensis (Y. angustissima var. kanabensis)	Kanab yucca	shrub	Native		381598	4107197

EDITED FROM PERSONAL CORESPONDENCE FROM MICHAEL ORR, SENT TO O'BRIEN & KNEZEVICH

Edited by Jonathan Barth

Observations Regarding Bees at JLC by Michael Orr, August 2, 2016

On August 2, 2016, early in the fall bloom period, Michael Orr briefly visited Johnson Lakes Canyon (JLC) to observe bees. During his visit, most bees were seen on beeplant, or cleome (*Cleome serrulate,* or *Cleome lutea*).

Orr expects there would be many more species present during peak fall bloom, when additional plants are flowering. The presence of numerous permanent water sources should make JLC a very good site for bees, especially in light of restoration efforts. Observed genera and species:

- *Agapostemon* sp. (metallic sweat bees)
- *Anthidium* sp. (mason bees)
- *Bombus* sp. (bumblebees)
- *Bombus nevadensis* (Nevada bumblebee)
- *Dianthidium* sp.
- *Lasioglossum (Dialictus)* sp. (sweat bees)
- *Perdita* sp.
- 2 *Megachile* spp. (leafcutter bees)
- Another smaller *Megachile* sp. reusing nests in the sandstone.
- MANY *Xylocopa californica* (California carpenter bee)
- *Apis mellifera* of course (European Honey Bee)

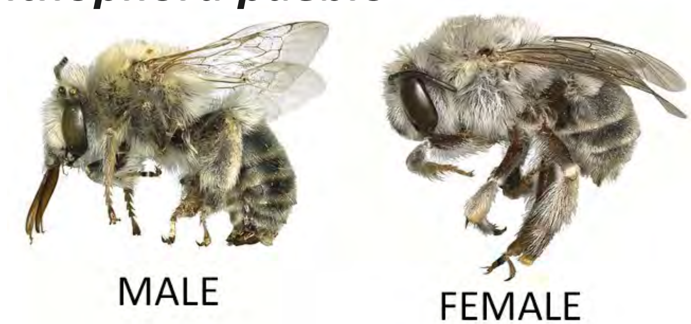
Sandstone Nesting Bees
of JLC

Two species of sandstone nesting bees likely inhabit Johnson Lakes Canyon, *Anthopora pueblo* and *Anthophora peritomae*. When the sandstone nests are present, both species are likely present. The combination of sandstone faces and sources of water makes Johnson Lakes Canyon perfect habitat for these bees. [1] The nests are almost always on east or south facing vertical banks because the morning sun helps warm up the bees.[2] These bees also use sandstone protected from rain because water could drain into nests. Proximity to water allows the bees to weaken the sandstone while they use their mandibles to excavate their holes.

Entomologist Michael Orr believes sandstone bees still live at JLC, "given the sheer number of holes, but it's best to be 100% sure." He encourages others to keep an eye out for activity. If you think you've observed or photographed either of the sandstone nesting bees, let Michael Orr know at:

michael.christopher.orr@gmail.com

Anthophora pueblo



A. pueblo photos by Michael

- Length range is from 10-14mm, usually 12mm.
- Active in the spring. Approximately April and May.
- Generalist feeders, but they especially like mints and legumes.

Anthophora peritomae

FEMALE LATERAL VIEW

FEMALE DORSAL VIEW

A. peritomae photos courtesy of © SEM-UBC

- Just under 1 CM long.
- Active in the fall. Approximately from mid September to late October.
- The only described species like this that goes to sandstone this time of year.[3]
- Feeds on rabbitbrush, purple asters, and any leftover cleome.

[1] *Anthophora* consistently nest at sites proximate to water. The staining found inside the tunnel nest may be caused by nectar/water mixtures they carry in. They bring the water with them in their crops, one of the first parts of their digestive tract that is often used as a holding area by other groups (for things like nectar to be used in nest provisioning, pollen for some bees like *Ceratina*, and water for honey bees and some others).

[2] The following characteristics together are helpful in identifying *Anthophora* nest tunnels: entrance perfectly round or nearly so, deep enough that the end cannot be seen (if still or recently active), entrance under 1 cm in diameter (unless they are old and worn), almost always in weaker sandstone, not stone with a patina, being located on a vertical or overhang and never horizontal, usually being densely clustered if they've been there long enough, and sometimes there may be remnants of pollen (yellow) or *Anthophora* cell linings (waxy, opaque white) still present.

[3] An undescribed species may also be using sandstone, although it isn't yet confirmed.

Argia vivida (vivid dancer damselfly)

A SURVEY OF INSECTS AT JOHNSON LAKES CANYON, KANE COUNTY, UTAH 2016

INTRODUCTION by Jonathan Barth

Entomologists have it hard. When searching Johnson Lakes Canyon, birders will see, at most, around 112 species. Plant people have about 1,176[1] possible species listed for Kane County. Entomologists have a gazillion[2] species to consider at JLC. To make matters worse, well meaning people come to them with a spider and ask, “What is this?” Spiders are arachnids; entomologists study insects, an entirely different order of animals. Though spiders crawl around like insects, they aren’t insects.

Because of the number of possibilities when identifying the over **2,650** arthropods (insects or arachnids) that were collected, it was infeasible to identify each one down to the species level. Still, this report gives a valuable snapshot into the diversity of arthropods supported by various plants in different environs at JLC.

THE EXPERTS

Irene Terry, PhD. Research Professor, Department of Biology, University of Utah
Nancy Matteson, MS. Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture,

THE “HELPERS”

Robert Roemer, PhD. Professor, Department of Mechanical Engineering, University of Utah
Thomas Kursar, PhD. Professor, Department of Biology, University of Utah

[1] The number of species listed when Kane County, Utah is searched at the plants.usda.gov web site.
[2] A very large number. -JB

COLLECTION METHODS

Pitfalls

Drinking cups with water at the bottom trapped and held arthropods that fell in. A barrier was placed between two cups to guide walking insects towards their doom. Most pitfall traps were collected after being place one night.

Sweeps

A cloth net swept across plants. Arthropods were then bagged for later sorting and identification.

Shakes

Selected plant tops, roots, and dead trunks, shaken above a container to collect the arthropods that fell.

NOTE: Due to limited space, when classification down to the Order was not possible, the Class, or Subclass is listed in the Order column and marked with an asterisk.*

T13 North

Order	Family	Common name	Pitfall
Acaridae*	-	Mites	5
Coleoptera	Bruchidae	Seed Beetles	1
Coleoptera	Histeridae	Hister Beetles	1
Collembola	-	Springtails	5
Diptera	-	Flies	6
Diptera	Phoridae	Flit flies	10
Heteroptera	Aphididae	Aphids	4
Heteroptera	Cicadellidae	Leaf Hoppers	5
Hymenoptera	Apoidea	Bees	1
Hymenoptera	Formicidae	Ants	400+
Lepidoptera	-	Butterflies/moths	1
Microcoryphia	-	Bristletails	1
Orthoptera	Caelifera	Grasshopper	1
Orthoptera	Gryllidae	Mole Cricket	1
Thysanoptera	-	Thrips	5

T13 South

Order	Family	Common name	Pitfall
Diptera	Mycetophilidae	Fugus Gnats	1
Heteroptera	Cicadellidae	Leaf Hopper	13
Heteroptera	Lygaeidae	Nysius sp.	1
Hymenoptera	Apoidea	Bees	3
Orthoptera	Grylloidea	Crickets	2
Phoridae *	-	-	3

T13 Area

Order	Family	Common name	Grass sp. Sweep	*Artemisia* sp. (sage brush) Sweep	*Artemisia* sp. (sage brush) Sweep	*Artemisia* sp. (sage brush) Sweep	*Hymenopappus filifolius* (threadleaf sunflower) Sweep	*Chrysothamnus* or *Ericameria* sp. (rabbitbrush) Sweep	*Artemisia* sp. (sage brush) Aspirator
Acaridae*	-	Mites	-	1	3	2	-	-	-
Arachnidae*	-	Spiders	-	-	-	-	11	-	-
Coleoptera	Chrysomelidae	Leaf Beetles	-	-	1	1	-	-	-
Coleoptera	Curculionidae	Weevils	-	-	-	12	-	6	-
Coleoptera	Leiodidae	Round Fungus	-	-	-	-	1	-	-
Coleoptera	Coccinellidae	Lady Beetle	-	-	-	-	1	-	-
Collembola	-	Springtails	-	-	-	3	-	-	-
Diptera	Mycetophilidae	Fungus Gnats	-	-	1	-	1	-	-
Heteroptera	Cicadellidae	Leafhoppers	5	2	34	8	22	-	4
Heteroptera	Lygaeidae	*Nysius* sp.	-	-	1	-	2	-	1
Heteroptera	Aphididae	Aphids	-	1	2	10	1	-	4
Heteroptera	Pseudococcidae	Mealybugs	-	-	-	5	-	-	-
Heteroptera	Psyllidae	Psyllids	-	-	-	2	1	-	1
Heteroptera	Miridae	Mirids	-	-	21	-	4	-	8
Heteroptera	Nabidae	Damsel Bugs	-	-	-	-	1	-	-
Heteroptera	Anthocoridae	*Orius* sp.	-	-	2	-	-	-	-
Heteroptera	-	*Harmostes* sp.	-	1	-	-	-	-	-
Heteroptera	Tingidae	Lacebugs	-	-	-	-	-	-	-
Hymenoptera	Chalcidoidea	Parasitic Wasps	-	2	1	1	-	-	-
Hymenoptera	Formicidae	Ants	-	21	-	3	-	-	-
Lepidoptera		-	-	-	1	-	-	-	-
Orthoptera	Grylloidea	Crickets	-	-	-	3	-	-	-
Orthoptera	-	Grasshoppers	1	-	-	-	-	-	-
Psocoptera	-	Tree lice	-	-	3	-	-	-	4
Thysanoptera	-	Thrips	-	17	2	-	1	-	-

T13: thrips on sagebrush leaves

Method: Shook the leaves of *Artemisia* sp. (sagebrush) into collection pans.

Results from sagebrush: Two sub-orders of thrips, Terebrantia, and Tubulifera.

Identified species: *Trichromothrips cyperaceae*, *Arpediothrips mojave* (perhaps), *Frankliniella occidentalis*, *Aeolothripidae melaleucas*

T13: thrips on rabbit brush leaves

Method: Shook the leaves of *Chrysothamnus* or *Ericameria* sp. (rabbitbrush) into collection pans.

Results from rabbitbrush: 3 thrips all from the same sub-order Terebrantia.

Thrip 1: *Frankliniella occidentalis*

Thrip 2: *Aeolothripidae melaleucas*

Thrip 3: probably also *Aeolothripidae melaleucas*

T14 North

Order	Family	Common name	Pitfall
Acaridae*	-	Mites	12
Heteroptera	Cicadellidae	Leafhoppers	4
Heteroptera	Fulgaroidea	Planthoppers	1
Heteroptera	Pseudococcidae	Mealybugs	2
Hymenoptera	Apoidea	Bees	2
Hymenoptera	Formicidae	Ants	20
Microcoryphia	-	Bristletails	1
Orthoptera	Gryllotalpidae	Mole Crickets	1
Thysanoptera	-	Thrips	3

T14 South

				Purshia sp. (bitterbrush)
Order	**Family**	**Common name**	**Pitfall**	**Sweep**
Acaridae*	-	Mites	11	-
Arachnidae*	-	Spiders	1	1
Coleoptera	Buprestidae	Wood borers	1	-
Coleoptera	Curculionidae	Weevils	1	-
Collembola	-	Springtails	4	-
Diptera	Phoridae	Phorid flies	3	-
Diptera	-	Flies	20	2
Heteroptera	Aphididae	Aphids	3	3
Heteroptera	Cicadellidae	Leafhoppers	3	20
Heteroptera	Fulgaroidea	Planthoppers	3	-
Heteroptera	Miridae	-	-	5
Heteroptera	Psyllidae	Psyllids	-	-
Hymenoptera	Apoidea	Bees	4	-
Hymenoptera	Chalcidoidea	Parasitic Wasps	1	1
Hymenoptera	Formicidae	Ants	20	-
Lepidoptera	-	Larvae	-	1
Microcoryphia	-	Bristletails	1	-
Orthoptera	Gryllotalpidae	Jerusalem Crickets	1	-
Orthoptera	Gryllotalpidae	Mole Crickets	2	-
Psocoptera	-	Tree lice	-	1
Raphidioptera	-	Snakeflies	-	1
Thysanoptera	-	Thrips	3	3

A mite, which is the subclass of arachnids called Acari, crawling on sand specked moss.

A beetle in the Buprestidae family, possibly *Acmaeodera bowditchi*, on a globemallow flower.

East Rim 1

Order	Family	Common name	*Senecio multilobata* (lobeleaf groundsel) Sweep	*Artemisia* sp. (sage brush) Sweep
Arachnidae*	-	Spider	2	-
Coleoptera	Curculionidae	Weevil	28	-
Coleoptera	Nitidulidae	Notoxus*	1	-
Diptera	-	Fungus Gnats	2	-
Heteroptera	Miridae	Plant Bugs	13	-
Heteroptera	Lygaeidae	*Nysius**	9	-
Heteroptera	Cicadellidae	Leafhopper	15	10
Heteroptera	Aphididae	Aphids	2	2
Heteroptera	Pseudococcidae	Mealy bugs	1	-
Heteroptera	Psyllidae	Psyllid	-	1
Heteroptera	Miridae	Mirids	-	8

East Rim

Method: Sweep of sagebrush leaves, and roots pulled up and shaken.
Result: Two sub-orders of thrips, Terebrantia and Tubulifera for a total of 3 or 4 species.

- *Frankliniella schultzei* (or similar)
- *Frankliniella* (*occidentalis* or *schultzei*)
- *Aeolothrips vitipennis*
- *Leptothrips* sp. (probably *mali*)

near East Rim 1

Method: Pulled and shook the flowers of *Yucca angustifolia* (narrow-leaf yucca).

Result: Lots of thrips which all keyed out to *Frankliniella occidentalis*. Some light yellow forms, others dark form, males and females.

East Rim 2

Method: Shook the ends of *Pinus edulis* (two-needle pinyon pine) boughs with needles, and pollen cones - not quite dehiscing yet – into a collection pan.

Result: Five species of thrips, of 3 genera.

- *Trichromothrips cyperaceae*
- *Frankliniella occidentalis*
- *Frankliniella gossypiana* (aka. *F. williamsi*)
- *Frankliniella schultzei*
- *Compsothrips jacksoni*

Pipe Springs North

Order	Family	Common	Pitfall
Acaridae*	-	Mites	5
Arachnidae*	Araneidae*	Orb Weavers	6
Coleoptera	Chrysomelidae	*Pachybrachis* sp.	1
Coleoptera	Staphylinidae	Rove beetle	1
Coleoptera	Tenebrionidae	-	1
Collembola	-	Springtails	15
Diptera	Phoridae	-	1
Diptera	Tachinidae	-	1
Heteroptera	Cicadellidae	Leafhoppers	2
Isopoda	Armadillidiida	Pill bugs	1
Orthoptera	Gryllidae	Crickets	4
Thysanoptera	-	Thrips	6
Thysanura	-	Silverfish	1

Pipe Springs South

Order	Family	Common	Pitfall
Arachnidae*	-	Spiders	4
Acaridae*	-	Mites	55
Coleoptera	Carabidae	Carabid	1
Coleoptera	Scarabaeidae	Scarab	1
Coleoptera	Staphylinidae	Rove Beetle	1
Diptera	-	Flies	4
Diptera	Mycetophilidae	Flies	5
Diptera	Simuliidae	Blackfly	1
Heteroptera	-	Bessbugs?	2
Heteroptera	Cicadellidae	Leafhopper	13
Heteroptera	Fulgaroidea	-	2
Heteroptera	Miridae	Plantbugs	7
Hymenopter	Apoidea	Bees	2
Hymenopter	Formicidae	Ants	9
Orthoptera	Caelifera	Grasshopper	1
Orthoptera	Gryllidae	Crickets	1
Unknown	Immature	-	1

¤

Pipe Springs

Order	Family	Common	*Rhus* sp. (sumac) **Sweep**	Cyperaceae I **Sweep**	Cyperaceae II **Sweep**
Arachnidae*	Araneidae	Orb Weavers	2	8	6
Coleoptera	-	Little Brown Beetle	-	1	-
Coleoptera	Anthribidae	Weevilish	-	-	6
Coleoptera	Carabidae	Carabids	-	1	-
Coleoptera	Chrysomelidae	Leaf Beetle Family	2	32	3
Coleoptera	Coccinellidae	Lady Beetles	-	-	1
Diptera	-	Large Flies	3	26	22
Diptera	Simuliidae	Blackflies	-	-	32
Heteroptera	Anthocoridae	*Orius* sp.	-	1	3
Heteroptera	Aphididae	Aphids	-	5	3
Heteroptera	Cicadellidae	Leafhoppers	3	8	15
Heteroptera	Fulgaroidea	Planthoppers	1	2	3
Heteroptera	Lygaeidae	Cymus/Nysius	7	13	1
Heteroptera	Miridae	Mirids	1	4	2
Heteroptera	Pentatomidae	Shield Bugs	-	1	-
Heteroptera	Psyllidae	Psyllids	-	-	1
Hymenoptera	Apoidea	Bees/Wasps	-	-	2
Hymenoptera	Chalcidoidea	Parasitic Wasps	1	5	11
Lepidoptera	Sphingidae	Sphynx moths	-	1	-
Neuroptera	-	Lace wings	-	-	1
Thysanoptera	-	Thrips	-	5	10

Aphids completely enveloping the stem of horseweed.

T2 North

Order	Family	Common	Grasses I Sweep	Grasses II Sweep
Acaridae*	-	Spiders	-	2
Coleoptera	Curculionidae	Weevils	1	4
Collembola	-	Springtails	-	7
Diptera	-	Crane Flies	-	1
Diptera	-	Larger Flies	2	10
Heteroptera	-	Unknown nymphs	-	5
Heteroptera	Cicadellidae	Leafhoppers	4	40
Heteroptera	Fulgaroidea	Planthoppers	-	6
Heteroptera		*Geocoridae* sp.	-	2
Heteroptera	Lygaeidae	*Emblethis* sp.	-	2
Heteroptera	Lygaeidae	*Nysius* sp.	-	2
Heteroptera	Miridae	An Ant Mimic	-	3
Heteroptera	Miridae	Lygus/Small	-	11
Heteroptera	Rhopalidae	-	-	3
Heteroptera	Rhopalidae	*Harmostes* sp.	-	1
Heteroptera	Scutelleridae	Shield Bug	-	1
Heteroptera	Tingidae	Lace Bug	1	-
Hymenoptera	Chalcidoidea	Parasitic Wasps	2	17
Hymenoptera	Formicidae	Ants	-	2
Orthoptera	-	Grasshopper	-	1
Thysanoptera	-	Thrips	-	6

Winged (alate) aphids, and non-winged (apterous) aphids, being tended to by ants on sagebrush.

T2 South

Order	Family	Common	Pitfall
Acaridae*	-	Mites	20
Acaridae*	-	Spiders	9
Coleoptera	Buprestidae	Wood Borers	1
Coleoptera	Carabidae	Carabid	1
Coleoptera	Curculionidae	Weevils	1
Coleoptera	Tenebrionidae	Tiny	1
Diptera	Mycetophilidae	Fungus Gnats	4
Heteroptera	Aphididae	Aphids	1
Heteroptera	Cicadellidae	Leafhoppers	11
Heteroptera	Fulgaroidea	Planthoppers	1
Heteroptera	Lygaeidae	*Emblethis* sp.	1
Heteroptera	Lygaeidae	*Nysius* sp.	1
Heteroptera	Miridae	An Ant Mimic	1
Heteroptera	Pseudococcidae	Mealy Bugs	1
Heteroptera	Tingidae	Lace Bugs	2
Hymenoptera	Apoidea	Bees	3
Hymenoptera	Formicidae	Ants	5
Lepidoptera	-	Larvae	2
Microcoryphia*	-	Bristletails	1
Orthoptera	Gryllidae	Crickets	4

A pair of mating *Eleodes obscures*, a beetle in the Tenebrionidae family like others collected.

https://en.wikipedia.org/wiki/Eleodes_obscurus

T2 Trees

Order	Family	Common	*Quercus gambeli* (Gabmel oak) Sweep
Diptera	Mycetophilidae	Fungus Gnats	3
Heteroptera	Miridae	Lygus/Small	3
Hymenoptera	Chalcidoidea	Parasitic Wasps	3
Hymenoptera	Formicidae	Ants	2
Lepidoptera	-	Larvae	7

T1 North

Order	Family	Common	lower *Salix* sp. (willow) Sweep	upper *Salix* sp. (willow) Sweep	lower *Artemisia* sp. (sagebrush) Sweep	upper *Artemisia* sp. (sagbrush) Sweep
Acaridae	-	Spiders	1	1	-	2
Coleoptera	-	Collops	1	-	-	-
Coleoptera	Chrysomelidae	Flea Beetles	1	1	-	6
Coleoptera	Corylophidae	-	1	-	-	-
Coleoptera	Curculionidae	Weevils	1	-	1	1
Coleoptera	Mordellidae	Flower Beetles	1	-	-	-
Diptera	-	Flies	50	12	3	8
Heteroptera	Tingidae	Lace Bugs	1	-	-	-
Heteroptera	Anthocoridae	*Orius* sp.	2	1	-	-
Heteroptera	Aphididae	Aphids	-	1	4	-
Heteroptera	Cicadellidae	Leafhoppers	12	50	20	32
Heteroptera	Leutiola sp.	An Ant Mimic	2	-	-	-
Heteroptera	Lygaeidae	*Emblethis* sp.	-	-	-	1
Heteroptera	Lygaeidae	*Nysius* sp.	5	1	10	10
Heteroptera	Miridae	Black	2	-	-	2
Heteroptera	Miridae	Black/Yellow	35	-	-	-
Heteroptera	Miridae	Common Green	300	3	150	400
Heteroptera	Miridae	Plant Bugs	20	7	4	8
Heteroptera	Psyllidae	Psyllid	2	2	-	-
Heteroptera	Rhopalidae	*Harmostes* sp.	-	-	-	1
Hymenoptera	Chalcidoidea	Parasitic Wasps	5	8	1	5
Hymenoptera	Formicidae	Ants	-	34	-	6
Lepidoptera	Unkn. Larvae	-	2	1	-	-
Neuroptera	-	Lacewings	-	-	-	1
Thysanoptera	-	Thrips	3	10	20	10

Sisymbrium altissimum
(tall tumblemustard) a non-native plant.

T1 Mustard

Method: Shook a yellow mustard plant in bloom [above].

Result: Two species of thrips both in the sub order Terebrantia.

- *Frankliniella occidentalis*
- *Aeolothrips fasciatus*

T1 South

Order	Family	Common	Pitfall
Acaridae	-	Spiders	8
Coleoptera	Carabidae	Carabid	4
Coleoptera	Curculionidae	Weevils	1
Coleoptera	Tenebrionidae	Tenebs	1
Diptera	-	Flies	9
Heteroptera	Cicadellidae	Leafhopper	20
Heteroptera	Geocoridae	Big Eyed Bug	2
Hymenoptera	Apoidea	Bees	3
Hymenoptera	Formicidae	Ants	2
Microcoryphia	-	Bristletail	1
Orthoptera	Gryllidae?	Camel cricket	1
Orthoptera	Gryllidae?	Mole cricket	1

T1 South East

Order	Family	Common	Pitfall
-	-	Field (cricket)	1
Acaridae	-	Spiders	3
Coleoptera	Carabidae	Carabids	1
Coleoptera	Histeridae	Hister Beetle	1
Coleoptera	Staphylinidae	Rove Beetle	1
Diptera	-	Flies	8
Heteroptera	Cicadellidae	Leaf Hopper	3
Heteroptera	Delphacidae	Planthopper	2
Heteroptera	Geocoridae	Big Eyed Bug	2
Heteroptera	Lygaeidae	Red Bug Nymph	1
Heteroptera	Miridae	-	2
Heteroptera	Miridae	Ant Mimic Plant Bug	2
Heteroptera	Pentatomidae	Stinkbugs	2
Hymenoptera	Apoidea	Bees	3
Hymenoptera	Chalcidoidea	Parasitic Wasp	5
Hymenoptera	Formicidae	Ants	100
Orthoptera	Caelifera	Grasshoppers	1
Orthoptera	Gryllotalpidae	Jerusalem Cricket	1

A yucca moth, *Tegeticula* sp. Probably *baccatella*. A mutualism exists where the moth pollinates the yucca flower and later, its larvae feed on some of the yucca's seeds.
https://en.wikipedia.org/wiki/Tegeticula_baccatella

***NOT* at JLC:**

After leaving JLC, Tim Graham found this *Utabaenetes tanneri*, (common name Tanner's black camel cricket, or San Rafael sand-treader cricket) about 70 miles NE of JLC as the crow flies. The species is listed as vulnerable on the IUCN Red List of Threatened Species. It lives in dunes and is endemic to Emery, Grand, Kane, and Wayne counties of Utah.

http://www.biodiversitylibrary.org/page/8116510#page/274/mode/1up

HISTORICAL ECOLOGY OF JOHNSON LAKES CANYON, KANE COUNTY, UTAH:

A SUPPLEMENT TO THE MAY 2016 BIOBLITZ

Submitted by Dennis M. Bramble (January, 2017)

Introduction

This contribution to the Johnson Lakes Canyon (JLC) Bioblitz report differs from the others. Rather than documenting current biodiversity, it is an attempt to help place those findings in historical context. Historical ecology can be an important adjunct to ecological restoration projects by offering insight into how the condition of a particular landscape developed and what factors most strongly influenced its trajectory. Historical ecological data can likewise assist in the formulation of restoration strategies and goals by helping to identify what the landscape once was, how it has been transformed and over what length of time (**Ref. 1**).

My observations focused chiefly on a limited sample of the pinyon-juniper woodland (including the sagebrush/P-J vegetation type of Fertig, **Ref. 2**) for two reasons. First, it is the dominant vegetation type on the JLC property (~ 75% by area). Second, and more importantly, it has the greatest potential to serve as a useful reference to inform management decisions on nearby public lands. Increasingly, P-J woodlands are at the center of controversy on the Colorado Plateau because of the fire hazard they can present and their tendency to “invade” or otherwise displace more desirable vegetation types (e.g., sagebrush/ grassland). There is also the widespread perception that P-J woodland is simply inferior to other forest types with respect to economic potential, soil and hydrologic function, and intrinsic biodiversity (**Ref. 3**). The fact is that P-J woodland is the third-most widespread forest type in the United States, but also the least understood. Very few intact, healthy stands of old-growth P-J remain to be studied. Those that have been investigated, for example at Mesa Verde National Park, suggest that many of the prevailing perceptions of this forest type are either wrong or greatly exaggerated (**Ref. 4**).

Some of my opinions and interpretations are informed by my experiences on our own restoration effort on roughly 200 acres of private and USFS land located in South Hollow, in the Upper Valley, Garfield County, UT. Our South Hollow project, now entering its 25th year, includes P-J woodland as well as other upland and riparian habitats. It is a “passive” restoration project, the only intervention being to substantially reduce grazing pressure over what the land had experienced for the previous 100+ years. In those years that the land has been grazed, it has been confined to the fall, thus giving both cool and warm season grasses ample opportunity to grow and reproduce (**Ref. 5**).

Objectives

My intention was to seek preliminary evidence related to three distinct questions about the P-J woodland at JLC.

1. Is there evidence of its fire history? Unlike some other Southwestern forest types (e.g., ponderosa pine), pinyon-juniper is not fire adapted. Its ignition amid drought and high wind often leads to high-intensity, stand replacing fires. Low-intensity ground fires are not considered to have been, historically, a frequent or significant factor in maintaining P-J woodland health. However, there is growing evidence that historical fire return intervals (= average time between major fires) for P-J woodland were surprisingly long (i.e., 200-500 years) (**Ref. 6**).

2. What evidence is there for human-driven change in the ecological condition of P-J woodland at JLC? Potential human-related impacts include post-settlement wood harvesting, intentional burning, and livestock grazing.

3. Does the current P-J woodland contain pre-settlement trees (i.e., established prior to 1880) and, if so, how old are they and are they suitable for paleo-climatic reconstructions of the JLC area?

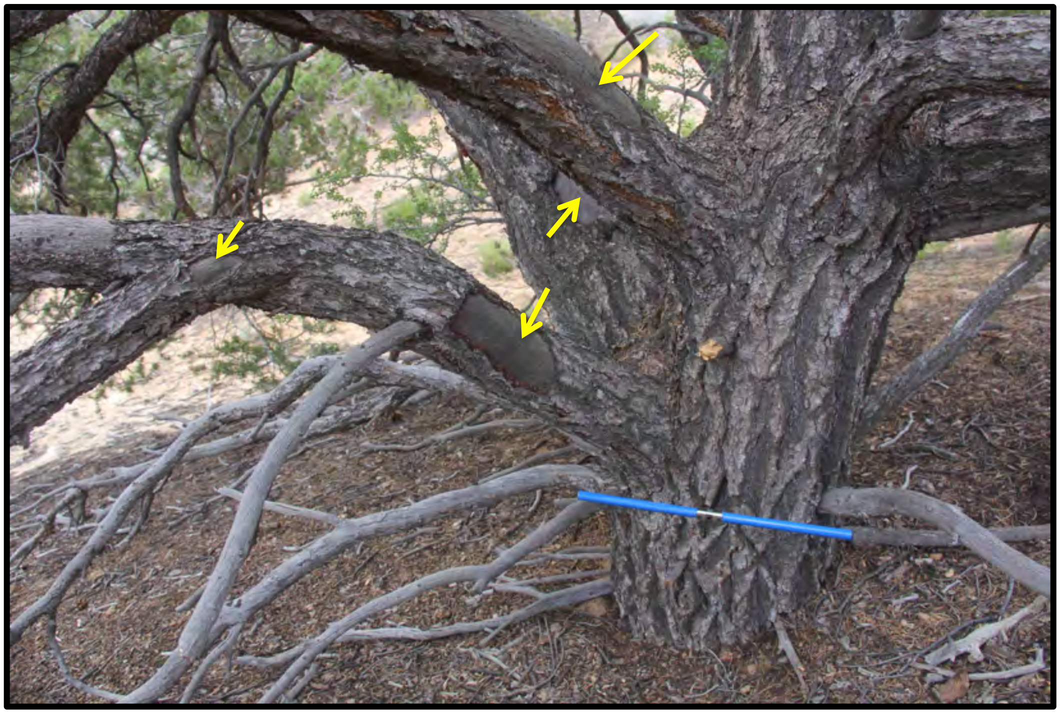
Methods: I surveyed a small section of P-J woodland on the west mesa of the JLC property (Appendix I, Map). Notes and photographs were made to document local ecological conditions within the survey area and to record points of interest (e.g., historical "post trees" used for wood harvesting; evidence of historic fires). A small number of sagebrush and pinyon pines were sampled in order to examine the growth history of the plants and to establish their ages. In the case of sagebrush, cross sections were obtained from primary stems as close to the ground as possible. Cores were taken from mature pinyon pines (Fig. 1A) with a standard increment borer well down on the trunk (Fig. 1B). For each dendrochronology sample, the ecological setting was noted, and the shrub or tree was photographed and geo-located prior to collection. The specimens were prepared for analysis using standard dendrochonological techniques (**Ref. 7**).

Figure 1A. Mature pinyon pine on slope above the west rim of JLC. (E 382005.97; N 4108259.11)

Fire History:

P-J Woodland: There has been no fire of consequence within this portion of the P-J woodland since well before settlement. Some of the dated pinyons retain dead, dry branches at nearly ground level (Fig. 1B). These trees provide positive evidence that the area in which they are growing has not experienced even a low-intensity ground fire in centuries.

A relatively small number of burned juniper stumps and other relict evidence of burned junipers were encountered in the study area. These specimens record pre-settlement wildfires, and likely more than one. It is not possible at the moment to establish the dates of the fire(s). However, in some cases mature junipers, probably at least 200+ years old, have since grown up in close proximity to the burned stumps, thereby providing a rough estimate of minimum time since the last fire. It is very unlikely that the burned junipers can be successfully cross-dated using their annual ring chronologies. But radiocarbon dating of the charcoal associated with the burned stumps could provide reasonably accurate dating of the fire that produced it. For now, the state of preservation of the stumps is the primary basis for suggesting that two or more historic fires are represented in this portion of the JLC woodland. The most recent fire produced stumps that extend well above ground level (Fig. 2). Likely remains of trees burned in still older fires are distinguished by their "bowl-like" structure, which projects only slightly above the soil surface (Fig. 3). The center of these trees has been burned out and resulting charcoal layer has subsequently been subjected to considerable weathering over a prolonged period of time. The fact that such trees have literally been burned to the ground suggests that they were already standing dead



when the latest fire occurred and may have already been partly reduced to a charred stump by a previous fire(s). However, it cannot be entirely ruled out that such a tree was initially a standing dead snag that was ignited by lightning under conditions that allowed the resulting fire to consumed most of the tree. While such events occur nowadays, they are quite uncommon.

Figure 1B. Same tree as in Fig. 1A showing the increment borer in place. The tree has retained branches close to the ground, a common occurrence in pinyon pine. The branches show that this portion of the JLC property has been free of fire for at least the life of the tree (~ 240 years). Arrows point to the characteristic feeding scars left by porcupines on many older pinyon pine.

The only certain post-settlement fire within the study area is a recent (i.e., within the last decade) event that affected a single large juniper (Fig. 4). The fire appears to have started at the base of the tree and then ascended the trunk to spread into the crown. Most of the east side of the tree was killed. Unless it represents an accidental human ignition, this fire is best interpreted as a ground-strike lightning ignition that began near the base of the tree. My cursory inspection of the tree did not suggest a direct lightning hit.

Figure 2. Burned juniper stump representing the remains of a pre-settlement fire. (E 381700.27; N 4108617.99).

Canyon bottom: There is likewise no evidence of meaningful wildfire in the oak groves in the canyon bottom. These trees are concentrated along the base of the cliff walls where they are relatively protected from strong winds and also, to some extent, from fire. Gambel oak is a fire-adapted tree that burns readily but also quickly re-sprouts from root crowns following the fire. Recovery from a fire in this type

of oak typically leads to a stand structure in which most stems (trunks) are of the same age and diameter (**Ref. 8**). My initial observations indicate that the stems within the oak groves at JLC are of mixed diameter and age. There was also no indication of burned remnant stumps within the groves although weathered cut stumps document earlier wood harvesting activities. A single medium-sized stem (8 cm diameter) of Gambel oak was cut close to the ground and the growth rings indicate an age of 41 years.

Figure 3. A large, burned-out and severely weathered juniper stump. Its condition suggests that it has experienced more than one pre-settlement fire. (E 381934.17; N 4108299.22)

Figure 4. Left. Isolated Utah juniper that has been damaged by a recent fire. Right. Charred base of the same tree. It was probably burned by a very localized, lightning-ignited ground fire. (E 381895.26; N 4108517.20)

A single mature juniper near the base of the east cliff, just NE of the camping area, records historical fire damage (Fig. 5, left). The downslope side of the tree bears a fire scar in which the associated char is recessed well into the base of the trunk (Fig. 5, right). The recessed char points to considerable post fire growth of the tree, suggesting that the damage was likely caused by a pre-settlement event. As with the isolated juniper on the west mesa, the fire seems to have started at the ground level and then climbed the trunk to enter the crown of the tree. This fire too may have been the result of a very localized sky-to-ground lightning strike that delivered a low intensity fire to the base of the tree. It could also have been an accidental ignition by indigenous people occupying the canyon bottom.

Figure 5. Left. An isolated juniper in the canyon bottom that displays evidence of fire damage, likely pre-settlement. Right. Base of the tree revealing deeply recessed fire char where the tree has attempted to grow over the damage. The fire scars extend up the trunk and into the lower canopy on the downslope side of the tree. (E 382344.20; N 4108443.12)

Human Impacts: Substantial grazing impacts, beginning in the 1880s, and only recently ended have almost certainly shaped much of the present structure of the P-J woodland, just as it has throughout the Intermountain West. The most important grazing impacts are considerable soil loss and degradation and the disappearance of most of the original P-J understory. Both the loss of the understory and the extensive die-off of native shrubs during recent drought periods are likely the consequences of a combination of soil loss and qualitative changes in soil properties (see below), all driven by prolonged and poorly managed livestock grazing.

There is evidence of historic wood harvesting but it is surprisingly sparse, at least within the area examined. Historical "post trees" were encountered, both living and dead, but overall there are relatively few (Fig. 6). These trees, based on the state of weathering as well as the fact that they are axe-cut, suggest that they were harvested early in the history of the JLC property. That large basal branches were targeted indicates that harvesting was aimed at procuring fence posts. There are no large pinyon pine currently in the study area except near the canyon rim. I saw no obvious sign of wood harvesting from these trees. However, pinyon wood degrades rapidly when in contact with the soil. It is possible, therefore, that some pinyon pine may have been harvested for firewood early in the post-settlement period and that traces of these trees have since disappeared.

Figure 6. Examples of relict "post trees". The one on the left is dead and badly weathered, while the one on the right is alive and healthy. Both are axe-cut. Locations: Left (E 381874.16; N 4108552.59); Right (E 381971.42; N 4108283.85)

Dendrochonology: A total of 7 specimens of basin big sagebrush (*Artemesia t. tridentata*) and 6 Colorado pinyon pine (*Pinus edulis*) were sampled. Cross sections of the sagebrush and a single core from each tree were used to establish ages and growth histories. One of the pinyon pine cores was unusable owing to rot within the interior of the tree.   The Tables in Appendix II summarize the information obtained for all the specimens used in the analysis.

Two of the sagebrush were still living, although barely. The others were dead and exhibited varying degrees of decay depending on how long they had been dead. The more recently deceased plants were standing with branches generally intact. Those that had died earlier were more weathered and tended to fall over in a splayed pattern (Fig. 7). My findings suggest that most or all of these shrubs had been recruited (i.e., successfully established) during a fairly narrow window of time in the 1920s and 30s. All the dead sagebrush had succumbed to well-documented periods of drought on the Colorado Plateau, specifically the intervals of 1977, 1990-91 and 2000-03. Most of the sagebrush exhibited considerable "sensitivity", meaning that their growth patterns over the years were quite responsive to climatic variation, especially precipitation and available soil moisture.

Figure 7. Photo illustrating the condition of the P-J woodland in much of the study area. There has been a nearly complete die-off of basin big sagebrush and little or no herbaceous understory remains. The live shrubs are chiefly snakeweed and Mormon tea. The varying states of decomposition of the sagebrush show that the shrubs did not all succumb at once.
(E 381738.92; N 4108545.56)

Three of the sampled pinyon pines were growing on the west rim of the canyon in locations having a combination of little soil and steep slope, conditions that limit growth and water availability. Two were growing directly on a weathered sandstone outcrop with no appreciable soil development (Fig. 8). This was the most extreme environment associated with the trees that were sampled. A single tree growing at the base of the east wall of the canyon was also cored. Because this tree has access to run-on water flowing down the adjacent canyon wall and occupies a relatively shaded location, its growing conditions would be less stressful than those of trees growing on the opposite canyon rim. Finally, one cored pine was growing inland next to an access road. All trees, except the last, turned out to be sensitive.

Figure 8. The oldest trees in the sample of pinyon pine. Both are on slick-rock substrates on the west rim of JLC. There is little or no soil on these sites. Under such conditions trees tend to grow very slowly but often live much longer than those on more favorable sites. The specimen on the left became established in the 1610s and the tree on the right in the 1680s. Old pinyons such as these tend to shed their lower branches. This, together with wide spacing and a scarcity of understory vegetation affords these trees considerable protection against fire. Locations: Left (E 381999.00; N 4108352.00); Right (E 381979.74; N 4108242.59)

All three specimens growing on the canyon rim are pre-settlement. The cores contained growth series ranging from 213 to 373 years. When account is taken of the likely number of missing rings in each core (because it missed the pith = center of the tree) and the time required to grow to the height where the core was taken, an estimate of the decade in which the tree was established was made. These values indicate that for this small series of trees the times of establishment range from the 1770s back to the early 17th century (i.e., 1610s). The tree at the base of the east canyon wall produced a core with 262 annual rings and an estimated recruitment date in the 1720s. The only pine representing post-settlement recruitment, established in the 1920s, was that growing next to the access road.

Interpretations and Other Thoughts:

First, a disclaimer. My samples are extremely limited and therefore cannot be used to make definitive statements regarding the history of vegetation change at the JLC site. They do justify limited speculation and the formulation of preliminary ideas whose validity could be the focus of future study.

Vegetation shifts in P-J woodland since settlement.

There seems ample evidence that at least some portions of the P-J woodland at JLC have experienced at least one important state change (i.e., ecological shift) since settlement (**Ref. 9**). Substantial areas within this woodland are now virtually devoid of understory, both woody shrubs and herbaceous plant types. It is clear that this has not always been the case. Direct evidence for this comes from the abundant population of dead basin big sagebrush located within the interspaces between living juniper trees (Fig. 7). While the varying states of decay of these shrubs show that they succumbed over a period of time, the actual growth records (Tables, Appendix II) reveal two important points: (1) Most of the shrubs died of water stress during known periods of drought; (2) most appear to have been established in the 1920’s and 30’s. The death of these shrubs indicates that although conditions were favorable for their establishment earlier in the 20th century, they deteriorated in the latter part of the century with the result that mature sagebrush became increasingly vulnerable to physiological stress. Advancing age alone cannot account for the death of the plants. Under favorable circumstances, the lifespan of basin big sagebrush extends well over 100 years (Bramble, pers. observations).

Two factors may have contributed to sagebrush decline in the JLC P-J woodland. The first is climate change, especially the increasing physiological stress associated with a combination of rising annual temperatures and substantial periods of drought. The limited sample of sagebrush from JLC indicates that the intervals 1990-91 and 2000-2002 were sufficiently stressful to kill plants that had survived in the area for decades. Meteorological data show that mean annual temperatures in the Southwest began to climb noticeably after the mid 1970s. It is possible that rising temperature was a major factor in pushing sagebrush beyond their ability to cope with drought conditions. Even those shrubs that survived these droughts clearly display suppressed growth during those the same periods. The extremely lobate growth pattern of most of the sagebrush sampled in this study indicates that water stress has been a frequent challenge throughout their lives (Fig. 9). Basin big sagebrush is intermediate, compared to Wyoming big sagebrush (highest) and mountain big sagebrush (lowest) in its resistance to the failure (= cavitation) of its water conducting system when the plant is under severe water deficit (**Ref. 10**). The lobate growth pattern appears to develop as a secondary consequence of the death of portions of the vascular cambium (just under the bark) arising from the cavitation of its vessels (Bramble, unpubl. data).

Figure 9. Cross-sections of sagebrush specimens from JLC study site. Both exhibit the intensely lobate growth pattern that reflects water stress over the lifetime of the shrub. The specimen on the left (JLC 5-28-16#1) records a chronology of 47 years (1943-1990). That on the right (JLC 5-27-16#2) preserves a chronology of 67 years (1949-2016). The shrub on the left died in 1990, but that on the right was still alive at the time of collection. The most recent growth rings (2016) are yellow and at the tips of the lobes.

A good illustration of the sensitivity of this shrub to local hydrologic conditions, especially the access to reliable soil moisture during drought episodes, is seen in the comparison of two shrubs growing only 88 meters (~300 ft.) apart on the Kursar-Coley property in Johnson Canyon (Fig. 10). The larger shrub was collected from a small area that supports the only pinyon pine on this property, the rest being J-P woodland occupied by only Utah juniper. The smaller (and more lobate) specimen was a nearly dead plant in a setting very similar to that of the JLC P-J in places having experienced the wholesale die-off of sagebrush. The two specimens have lived under essentially identical annual precipitation and temperature regimes for decades, but their very different growth histories point to important site-specific contrasts in hydrologic function. This level of environmental sensitivity is considerably greater than that exhibited by pinyon pine and thus offers the opportunity to document historical patterns of hydrologic function and change at a much finer scale.

Figure 10. Basin big sagebrush specimens collected on the Kursar-Coley property in Johnson Canyon on 5-29-16. The differences in size and shape reflect contrasts in the hydrologic histories of the two sites on which they were growing (see text). The top specimen had access to reliable soil moisture over its 52 year history (1964-2016), while the specimen at the bottom suffered growth limiting and tissue damaging water stress during most of the 74 years (1942-2016) recorded in this section and was barely alive (two lobes on extreme left) when collected. The deep incision across the upper specimen was caused by the emergence of a lateral branch and not water stress.

A second factor that may have contributed to sagebrush decline involves degradation of the soil and its impact on the ability of sagebrush to utilize an important survival mechanism during periods of severe water stress. Sagebrush possesses two distinct root systems, one vertical and deep and the other horizontal and shallow. When subjected to drought these shrubs draw up water with their deep roots during the night and shunt it into the shallow root system (and adjacent soil) where it is temporarily stored until utilized by the plant during the hot, dry daylight hours (**Ref. 11**). This process, called hydraulic lift, continues daily as long as drought conditions demand and there remains sufficient deep water to tap. However, it is possible that damage to the upper layers of the soil from long-term grazing (e.g., compaction, erosion, chemical and nutrient alterations) could compromise the health of the shallow root system. If so, the ability of the shrubs to defend themselves during periods of drought could be impaired with the result that they would be more likely to die. Recent studies suggest that there could also be a second negative consequence of damage to the shallow root system in big sagebrush. The water that leaks into the soil encasing the shallow roots during the night appears to be important to maintaining the community of symbiotic fungi associated with the root hairs. The fungi, in turn, are important in supplying nutrients to the shrub (**Ref. 12**).

The suggestion that water stress is the proximate cause of sagebrush decline within the JLC pinyon-juniper woodland is supported by another observation. A series of sites within the study area were observed that had either mature, healthy sagebrush or were places in which virtually all sagebrush had previously died but vigorous young shrubs had recently become established (Fig 11). The latter situation represents a reversal of shrub decline and possibly the early stages of localized ecological recovery. Significantly, all these sites describe a linear pattern along the bottom of a shallow swale that receives extra water (and probably sediment) from the adjacent slopes during monsoon events (see Map, Appendix I). The age of the newly established sagebrush was not determined, but their sizes suggested that they were probably recruited during the past decade and some possibly since grazing ended on the JLC property.

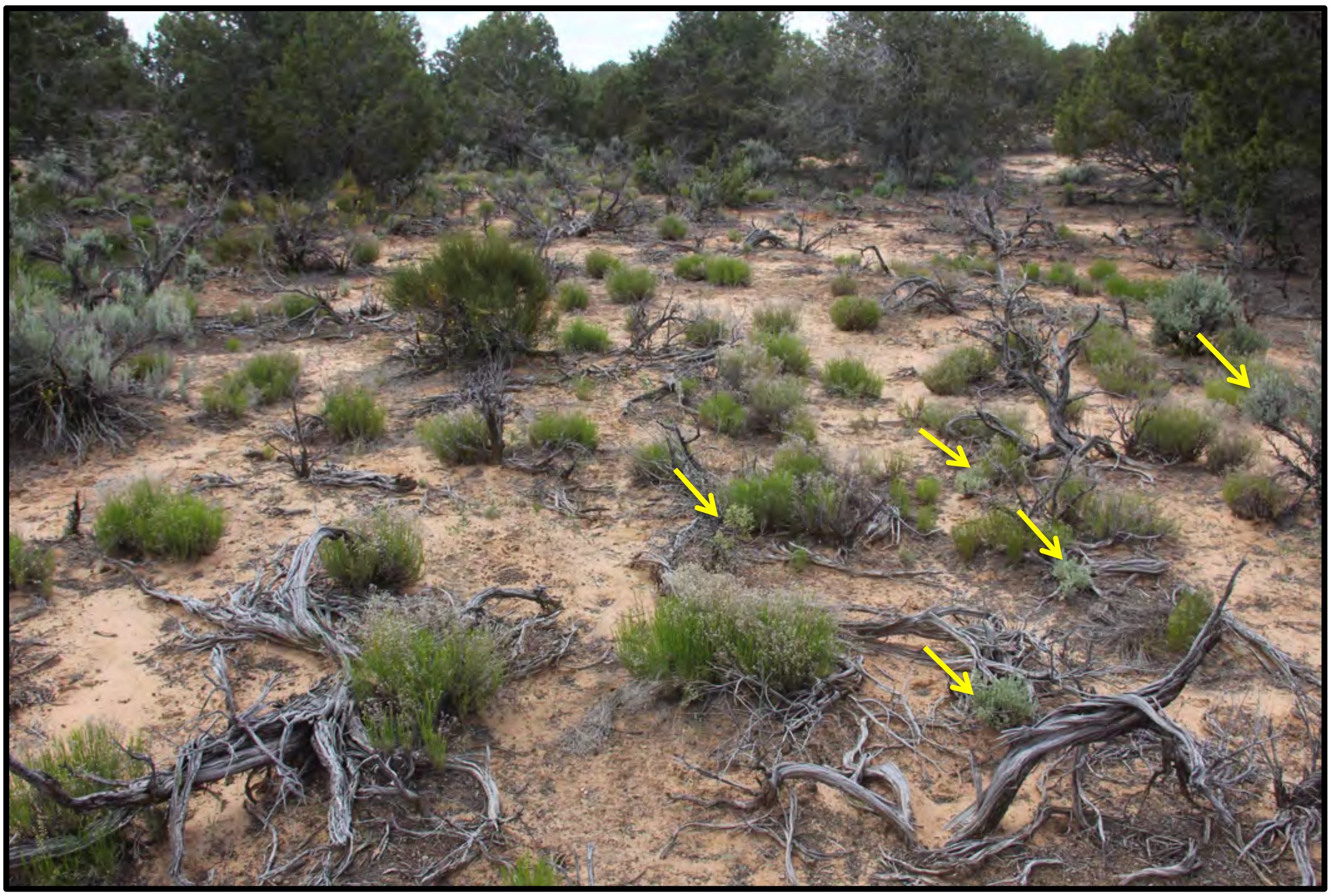


Figure 11. An area in a local swale in which there has been recent recruitment of sagebrush (arrows) following an earlier period in which most mature sagebrush died and were replaced by snakeweed. The swale receives extra water and sediment from the adjacent slopes. (E 381922.00; N 4108445.00)

Research Opportunities

The Knezeviches have indicated that they would be pleased to see their property used for scientific studies (both basic and applied) that might further our understanding of natural ecosystems on the Colorado Plateau and how they might be restored or managed for health and sustainability. The list of possible research topics below reflects my bias toward land history but is also stimulated by my personal observations during the bioblitz. Any one of the other participants could no doubt generate her/ his wish list of questions they would like to see explored.

1. Reconstructing Climate History. A reasonably robust paleo-climatic history might be achievable at JLC using the annual growth records of pinyon pine, which appear to be sufficiently sensitive for such a study. The initial sample shows that living trees provide a record extending back to at least the early 1600s. Wider sampling could easily produce trees that extend this record by a century or more. Making use of dead trees that are well preserved might well push this chronology back even farther. Specimens of this type are found in places where dead trees are either standing or are not exposed to soil once they have fallen. Sites that are hot and dry yield the best preserved "relict wood', frequently suppressing decomposition of cellular structure for many decades to centuries after the tree has died. Trees that occupy slick-rock on south facing slopes are ideal for such long-term preservation. Several examples of pinyon pine fitting this description were observed during this study. Climatic histories, if developed, would offer additional perspective on how the vegetation of the JLC property has been shaped by natural forces as well as indications as to how it might be expected to respond under various climate change scenarios.

2. Porcupine Disappearance. All the older pinyon pines that were cored on the west rim of the canyon displayed the distinctive feeding scars caused by porcupines (Fig. 1B). (Porcupines do not utilize juniper as a food source.) The scars are generated when these large rodents strip the inner bark (cambium layer) during the winter and early spring. Pinyon pine, unlike other pine species in the Southwest (e.g., ponderosa pine), does not repair such damage in subsequent years. Therefore, the damage to the trunk and limbs created by porcupines persists throughout the life of the tree. Moreover, careful examination of a scar will reveal the year in which it was formed (**Ref. 13**).

The widespread disappearance of porcupines in many parts of the Intermountain West is a significant and largely unnoticed change in the mammalian fauna of the forests and woodlands of the region. The causes of porcupine disappearance are unknown. Very preliminary attempts to date some of these scars on our South Hollow property suggest that the decline of this large rodent was rapid and occurred primarily in the 1960s. Study of the porcupine scars at JLC could provide useful information on this event. Because the South Hollow and JLC sites represent (respectively) higher, mesic and lower, drier P-J habitats and are located on opposite ends of the GSENM, comparison of the dates of the most recent porcupine activity at the two locations could be informative. For example, more or less synchronous termination of porcupine feeding at the two sites would suggest a sudden and widespread agent affecting porcupine populations on this portion of the Colorado Plateau, perhaps implicating a natural pathogen. Significant lags in the disappearance of these large rodents at the two locations might suggest a slower, more ecologically rooted cause for their decline.

3. Regional Drought Response. Significantly, the JLC P-J woodlands show no sign of the widespread and near catastrophic decline in P-J woodland that has afflicted other places on the Colorado Plateau in recent history (i.e., the mid 1950s; 2002-03 interval). In northern New Mexico and Arizona hundreds of thousands of mature trees, most often pinyon pine, have succumbed either in direct response to drought or secondarily from insect attack after having first been weakened by drought stress (**Ref. 14**) The same absence of die-off exists within the wider Escalante River watershed, including on our South Hollow property. Comparative tree-ring studies at both South Hollow and JCL may provide some insight into why our portion of the Colorado Plateau escaped the devastating effects of what has been termed "global-change-type-drought" (**Ref. 15**). In turn, this could help refine models that attempt to predict major changes in plant communities in response to climate change. One variable that would be especially important to examine is the impact of summer precipitation on the growth response of pinyon pine. Exactly how future shifts in monsoon rainfall will affect vegetation structure on the Colorado Plateau has been among the most difficult to address in climate change scenarios. Recent studies have reported progress, however, in teasing the "monsoon signal" out of the annual growth rings of Southwest conifers (**Ref. 16**). Under certain conditions, the annual growth rings of basin big sagebrush also contain an unambiguous monsoon signal (Bramble, unpublished data). Further study of signals of this type, from both trees and shrubs, might help explain why regional responses to drought vary so widely in P-J woodlands on the Colorado Plateau.

4. Microtopographic Features In P-J Habitat. Much of the current surface relief within the P-J woodland is related to shrub distribution. Specifically, living and some recently deceased shrubs are growing on slightly elevated patches of soil, to which the term "coppices" has been applied (Fig. 12). These structures are characteristic of semi-arid landscapes in various parts of the world. The coppices are typically separated by interspaces that support little vegetation. There is uncertainty about the meaning of the coppices and how they develop. Some workers have suggested that they represent relict soil surfaces that remain in shrub-protected locations after the majority of the soil in the surrounding area (i.e., the interspaces) has been removed through erosion. Others have argued that the coppices represent Aeolian deposits (i.e., wind transported) that coalesce under shrubs. Finally, there is experimental evidence that differential deposition of fine grained sediment, carried by rain-splash during summer thunderstorms, can contribute to these raised patches of soil (**Ref. 17**).

At JLC, at least some of the coppices are associated with apparently old, lichen-encrusted shrubs (e.g., antelope bitterbrush; Mormon tea; basin big sagebrush) that may even be pre-settlement vestiges. If so, the related coppice may well contain a relict soil surface that pre-dates grazing. Detailed study of the structure (e.g., soil composition with depth) of the JPL coppices might help resolve the uncertainty over what such structures represent. It may also provide an opportunity to gain additional information on the pre-settlement nature of the soil within the P-J woodland, assuming that at least some of the coppices with the P-J woodland are confirmed to contain relict soil horizons. Examination of a growth series from sagebrush growing on the coppices would provide a minimum age for the soil contributing to these mounds. In addition to representing accumulated (or protected) soil, the coppices are frequently "islands" of concentrated nutrients that favor the establishment and growth of plants (**Ref. 18**). They also tend to absorb and store more water than the soils found in the adjacent interspaces. For these reasons the coppices could be important contributors to P-J restoration by serving as focal points from which the poorly vegetated interspaces are naturally seeded with locally adapted genotypes.

Figure 12. A well-developed and likely old coppice, to judge from the dead sagebrush and mature biocrust. Selective seeding of some coppices with native (locally sourced) grasses and forbs might be a worthwhile experiment in active restoration. If established, the plants could serve as seed sources for re-vegetating the surrounding area. (E 381950.03; N 4108417.41)

5. Ecological State Changes in P-J Woodland: More Than One? It is quite possible that the P-J woodland may actually have experienced not one but two major ecological state changes during its post-settlement history. The most recent eliminated most of the woody shrubs, especially sagebrush. But the shrubs themselves may be the product of the first state change. Overgrazing of grasslands is a worldwide phenomenon and in most cases is linked to invasion by woody shrubs, thereby converting grassland to "shrubland". This pattern is most often observed on arid or semi-arid grasslands (**Ref. 19**). Both the elimination of competitive grasses (and forbs) and the altering of the normal fire regime are thought to be key factors in the transformation (state change) of grassland to shrubland. Hence, the first major shift in the JLC P-J woodland could have been a dramatic increase in woody shrubs coincident with the decline of native grasses, especially cool season bunchgrasses. The second state change was the death of these same shrubs together with most of the remaining herbaceous understory (grasses and forbs) in a more recent shift toward increased desertification. This transformation occurred in the early 1990s and early 2000s. If additional sampling of dead (and living) sagebrush were to show that most were recruited in the 1920s and 30s, it would lend support to the idea that shrub proliferation was the initial ecological shift in response to grazing pressure.

Adding Value to the JLC Restoration Experiment and Research Opportunities

The Knezevich property has significant potential for serving as a rare model for why ecological restoration is important on the Colorado Plateau. Its proximity to the GSENM makes it an especially obvious resource for land managers looking for better ways to improve conditions on the public lands. It is likewise a potentially valuable resource for scientific studies aimed at better understanding the processes by which damaged landscapes can recover their ecological integrity with varying levels of assistance (e.g., active restoration in the canyon bottom; passive or minimal active restoration on the P-J mesas). But whether serving as a restoration model or as a research opportunity, several additional actions would substantially increase the future value of the JLC property.

1. <u>Weather Station</u>: Weather patterns are highly variable in southern Utah. The responses (establishment, growth, reproduction) of plants in this region are closely coupled to yearly variation in precipitation. Moreover, rainfall on the Colorado Plateau is strongly influenced by orographic features, meaning that rainfall, especially in the summer months, is quite localized. For this reason, proxy meterological records (e.g., a weather station in Kanab) are too often unreliable sources for reconstructing the weather conditions that are actually determining the trajectory of a restoration project. Good quality weather stations are now relatively inexpensive and would be well worth the investment. They are low maintenance and will automatically store the data for long periods of time (6 months to a year) until downloaded by the user. At minimum any weather station at JLC should record the basics: air temperature, humidity, and rainfall. The stations can be set up to monitor numerous other parameters if desired (e.g., wind, soil temperature and water content).

2. <u>Soil Samples</u>: One ecological indicator that is generally missing in the records of long-term restoration efforts concerns soil properties. The official soil surveys (**Ref. 2**) contain valuable information on the physical structure and geological context of surface soils, which often help dictate the plant communities that grow on them, but offer little or no insight into their chemical and biological properties. There is increasing recognition that these "invisible" properties of soil can greatly influence the composition and health of the associated plant communities and, because of this, also the prospects for restoring vegetation to soils that have been degraded. For example, as already suggested, it may be that pre-settlement soils harbored microbial associations that were critical components of the pre-settlement native plant community (e.g., sagebrush) but have since been disrupted or lost altogether. Or it may be that soil chemistry and nutrient levels have been altered owing to post-settlement activities. By extension, the successful reestablishment of native vegetation may be dependent upon the return of appropriate soil conditions. But without comparative information on pre- and post restoration soil conditions, a potentially key aspect of the restoration process will go undocumented.

I had originally thought that simply collecting soil from key locations and storing them under cool, dry conditions might adequately preserve samples for later evaluation. Unfortunately, this appears not to be the case. Even under such conditions soil samples continue to metabolize and change their chemical composition (**Refs. 20, 21**). If data on current soil conditions are acquired for future reference, they would have to be gathered by qualified persons and analyzed as soon as practical.

3. <u>Stand Structure Within The J-P Woodland</u>. It would likewise be very helpful to have some explicit information on the structure of the P-J woodland before too much additional time passes. Several representative areas of a few hectares each could be identified for surveys that would gather data on the basics (e.g., spatial distribution of trees, species composition, sizes, basal area, canopy cover, etc.) needed to describe the current condition of the woodland. This information would then serve as a "pre-

restoration" model to compare with conditions down the road. This sort of survey is labor intensive but not technically difficult. It would lend itself to volunteer projects.

Restoration Implications For P-J Woodland

A history of severe disturbance coupled with infestation by exotic plants makes active restoration strategies the only game in town when it comes to the riparian areas at JLC. However, invasive species do not appear to be a serious threat in the J-P woodland I examined. For this reason I would recommend passive restoration first. This means eliminating the primary stressor(s) that have produced the degraded state of the woodland and letting nature drive the recovery (**Ref. 22**). In this case the primary stressor is grazing and it has been already been eliminated. As already noted, there are some places in which ecological recovery may already have started (Fig. 12). Still, passive restoration is generally a slow process, especially in semi-arid regions (**Refs. 23, 24**). For example, our upland habitats in South Hollow are still in an accelerating phase of recovery (e.g., increasing plant cover; arrival of new plant species) some 25 years after passive restoration began. Because of this, it might be worthwhile to set aside several small experimental areas where attempts to speed up the process can be tried (e.g., seeding of native grasses and forbs, derived from local sources). Targeting some of the older coppices might make sense in this regard (Fig. 12). However, it would be best to give the land some additional time to rest before attempting this.

Apart from shrub and understory loss, one unambiguous post-settlement shift in the west mesa P-J woodland is tree infilling, chiefly by Utah juniper. This refers to the post-settlement recruitment of young trees into the open interspaces of widely spaced pre-settlement trees (**Ref. 25**). While most of the increase in tree density may be attributable to management history (grazing), some of it might also be a natural response to 20th century climatic patterns. At the present time juniper infilling does not appear to be a serious obstacle to ecological recovery. Nonetheless, the number and distribution of burned pre-settlement juniper in the area I examined would imply that, historically, this portion of the JLC property was once far more open than even the current distribution of old junipers would suggest. On that basis a case could be made for thinning some of the younger junipers sooner rather than later. Open woodland creates more room for shrubs, grasses and forbs in the understory. Habitat heterogeneity of this type will likewise enhance biodiversity, as for example in the avifauna (see JLC report by K. Munthe). If young trees were thinned, I recommend a "lopp and scatter" approach. With this technique lopped tree branches and stems are spread over the surface of the ground and left to decompose. The method is known to help stabilize surface soil, reduce wind and water erosion, and promote greater infiltration of surface water. All of these actions will favor the establishment of new plants. The best place to apply this technique would be in the poorly vegetated interspaces between existing vegetation mounds (coppices). If there is reluctance to remove living trees, then you might consider pruning the broken and dead branches from mature trees that have suffered storm damage and scatter them instead.

Acknowledgements. I'm very grateful to have been able to participate in the Johnson Lakes Canyon Bioblitz. It was such a pleasure to be able to spend a few days with Rick and Susie Knezevich, the gracious owners of this beautiful and biologically fascinating property, as well as all the other varied and enthusiastic participants. Many thanks as well to the Grand Canyon Trust and its staff for helping to make this bioblitz such an enjoyable and successful event.

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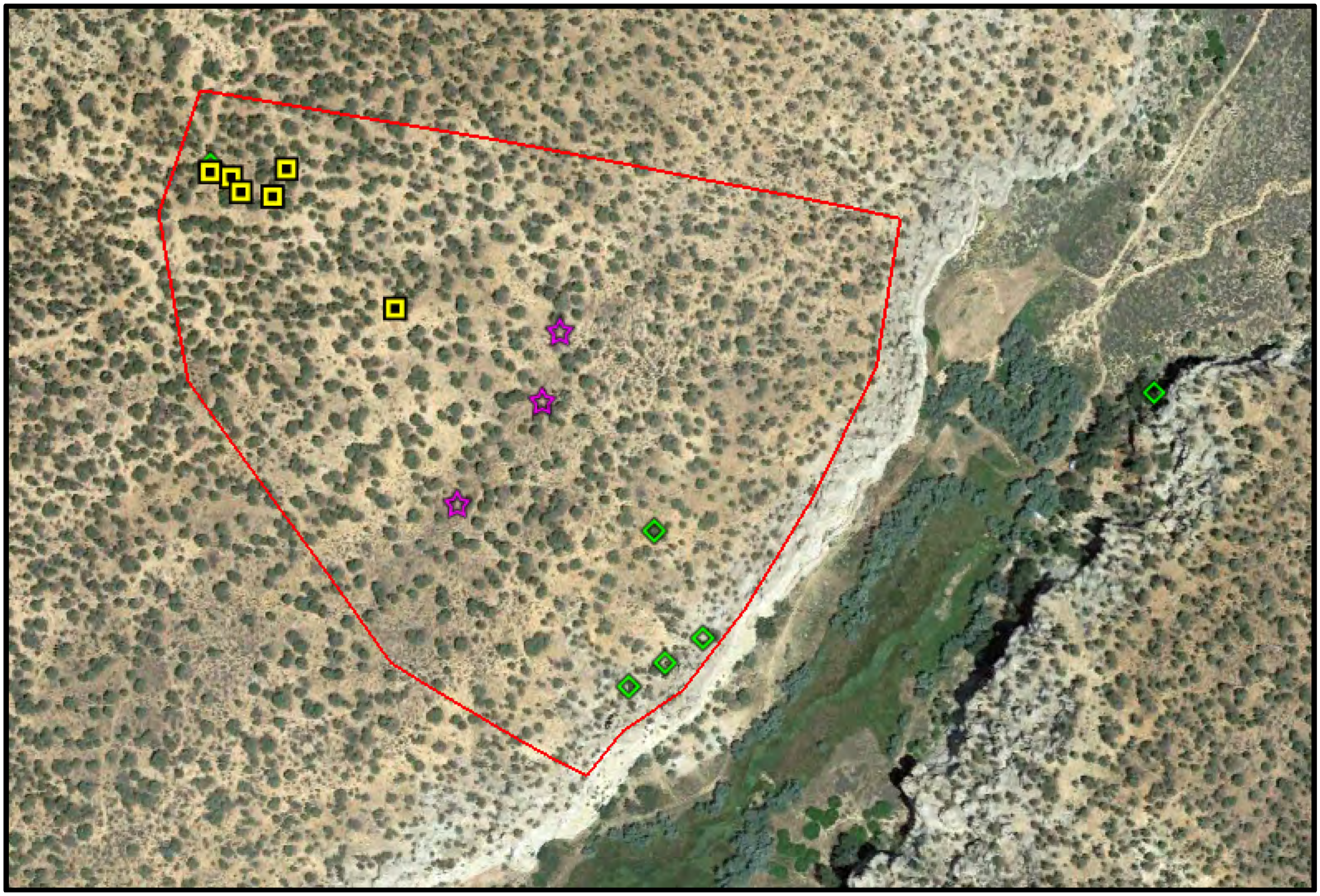
APPENDIX I: MAP OF JLC PINYON-JUNIPER STUDY AREA

The map shows the locations where sagebrush (yellow squares) and pinyon pine (green diamonds) were sampled for dendrochronological analysis. The sample just north of the three on the canyon rim was not used because the tree had heart rot. Line of purple stars mark sites within a local swale that show evidence of natural ecological recovery from previous mortality of sagebrush and understory vegetation. The approximate area surveyed in this study is enclosed by the red line.



APPENDIX II: SUMMARY TABLES OF JLC DENDROCHONOLOGICAL DATA

Sagebrush Specimen	Description	Pith Present	Inner Ring	Outer Ring	Decade Established*	Sensitivity	Location
5-27-16#2	Living	No	1949	2016	1930s	High	E 381695.49 N 4108605.81
5-28-16#1	Standing dead	Yes	1943	1990	1930s	High	E 381713.00 N 4108605.00
5-28-16#2	Listing dead	No	1951	2001	1930s?	Moderate	E 381738.68 N 4108588.26
5-28-16#3	Standing dead	No	1936	2001	1920s	High	E 381716.00 N 4108591.00
5-28-16#4	Splayed dead	Yes	1937	1990	1920s?	High	E 381748.64 N 4108607.19
5-28-16#5	Splayed dead	No	1934	1977	1920s	High	E 381786.00 N 4108569.00
5-28-16#6	Living	No	1955	2016	1930s	High	E 381713.00 N 4108605.00

Pinyon Pine Specimen	Description	Pith - Present	Rings Present	Outer Ring	Decade Established*	Sensitivity	Location
5-17-16#1	Inland next to road	No	72	2016	1920s	Moderate	E 381695.05 N 4108609.91
5-28-16#8	West rim on sandstone	No	373	2016	1610s	High	E 381999.00 N 4108352.00
5-28-16#9	West canyon rim on soil	No	213	2016	1770s	High	E 382005.97 N 4108259.11
5-28-16#10	West rim on sandstone	No	288	2016	1680s	High	E 381979.74 N 4108242.59
5-29-16#1	Base of E. canyon wall	No	262	2016	1720s	High	E 382364.59 N 4108448.62

*Estimate based on the number of rings recorded in the core (or cross-section) plus the calculated number of missing rings between the innermost ring of the core (or cross-section) and the center of the pith in addition to the projected number of years to grow to the height at which the tree (or shrub) was cored (sectioned).

Johnson Lakes Canyon photos on Flickr

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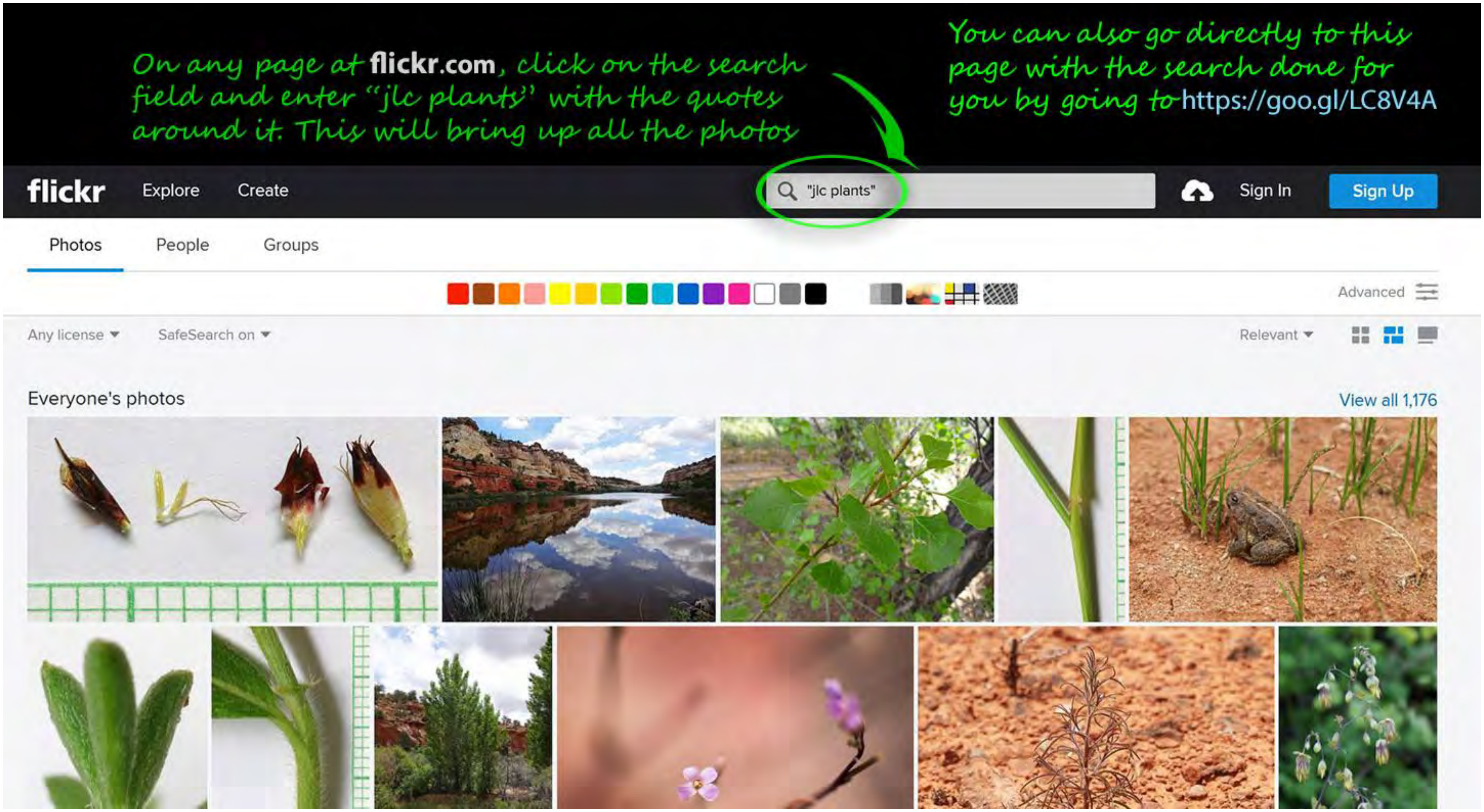

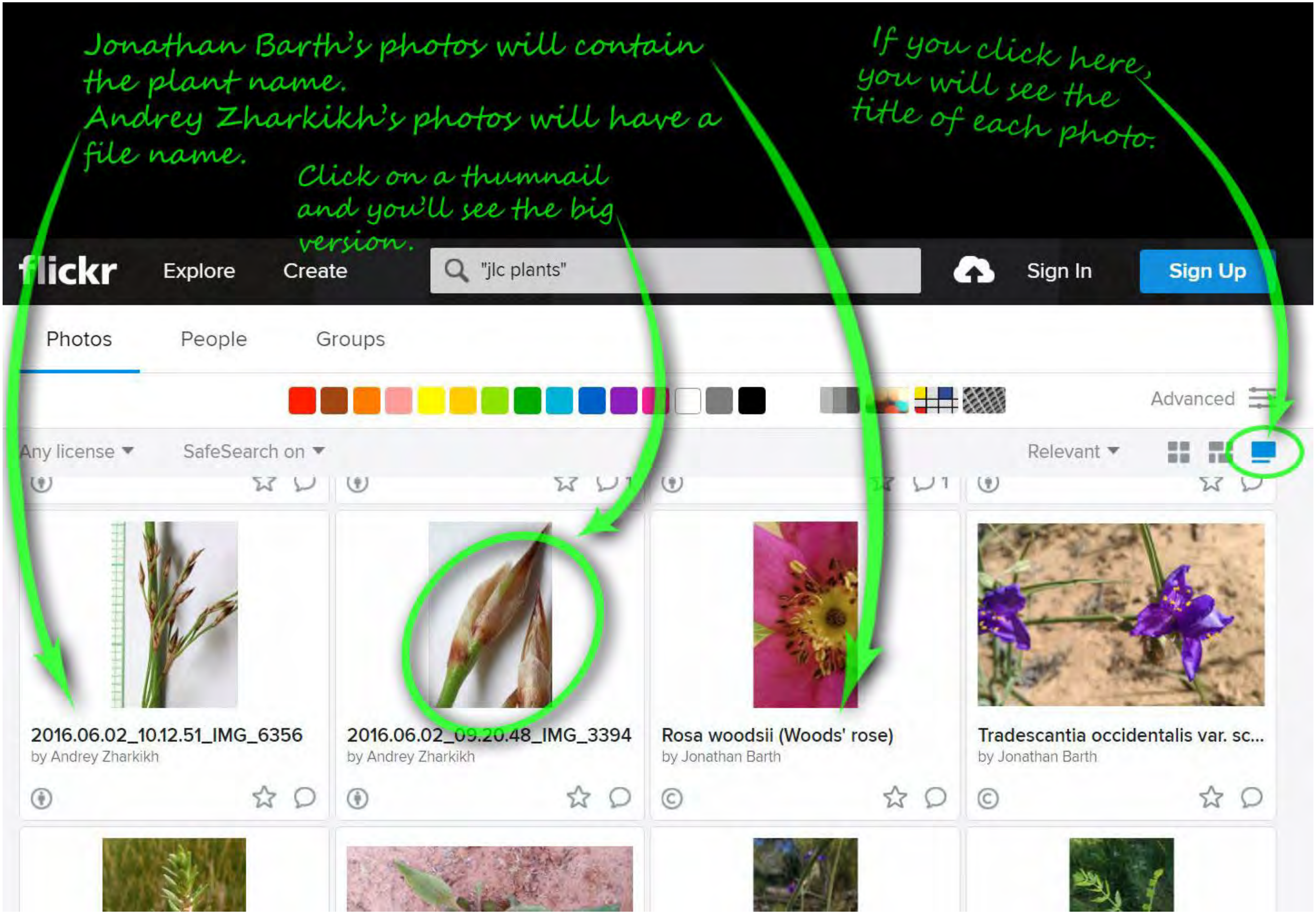
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2016.06.02_09.20.48_IMG_3394
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by Jonathan Barth
Tradescantia occidentalis var. sc...
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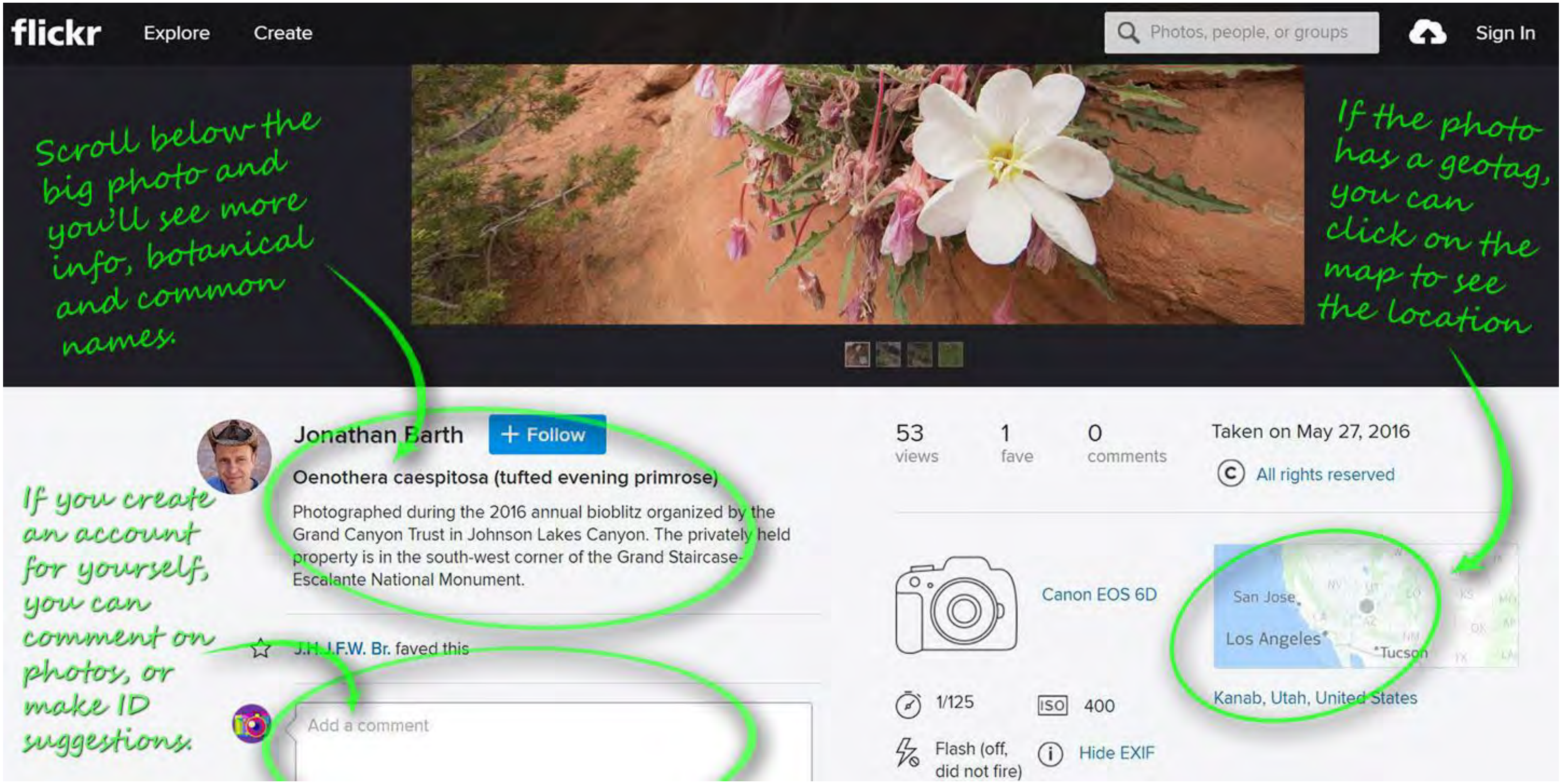
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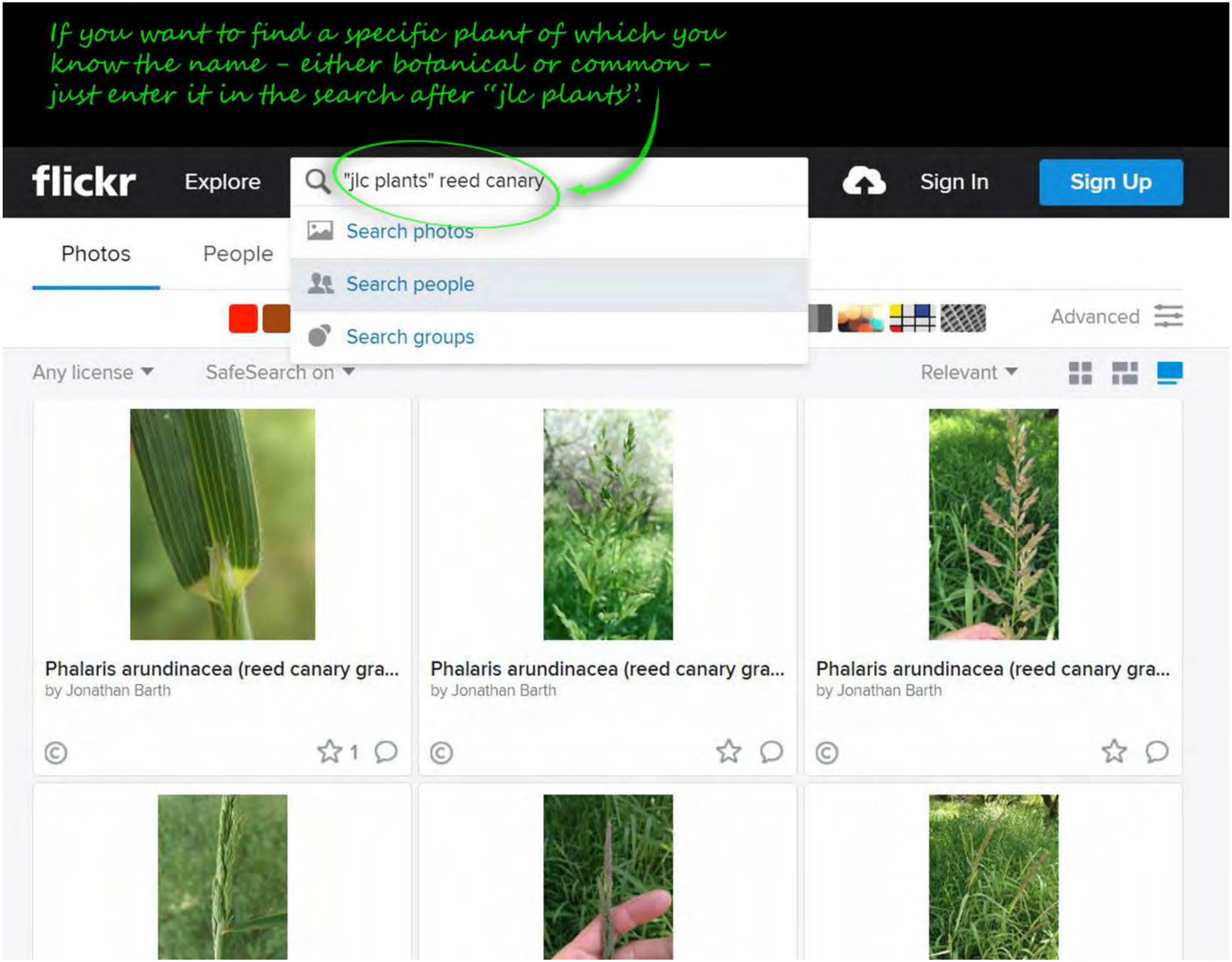
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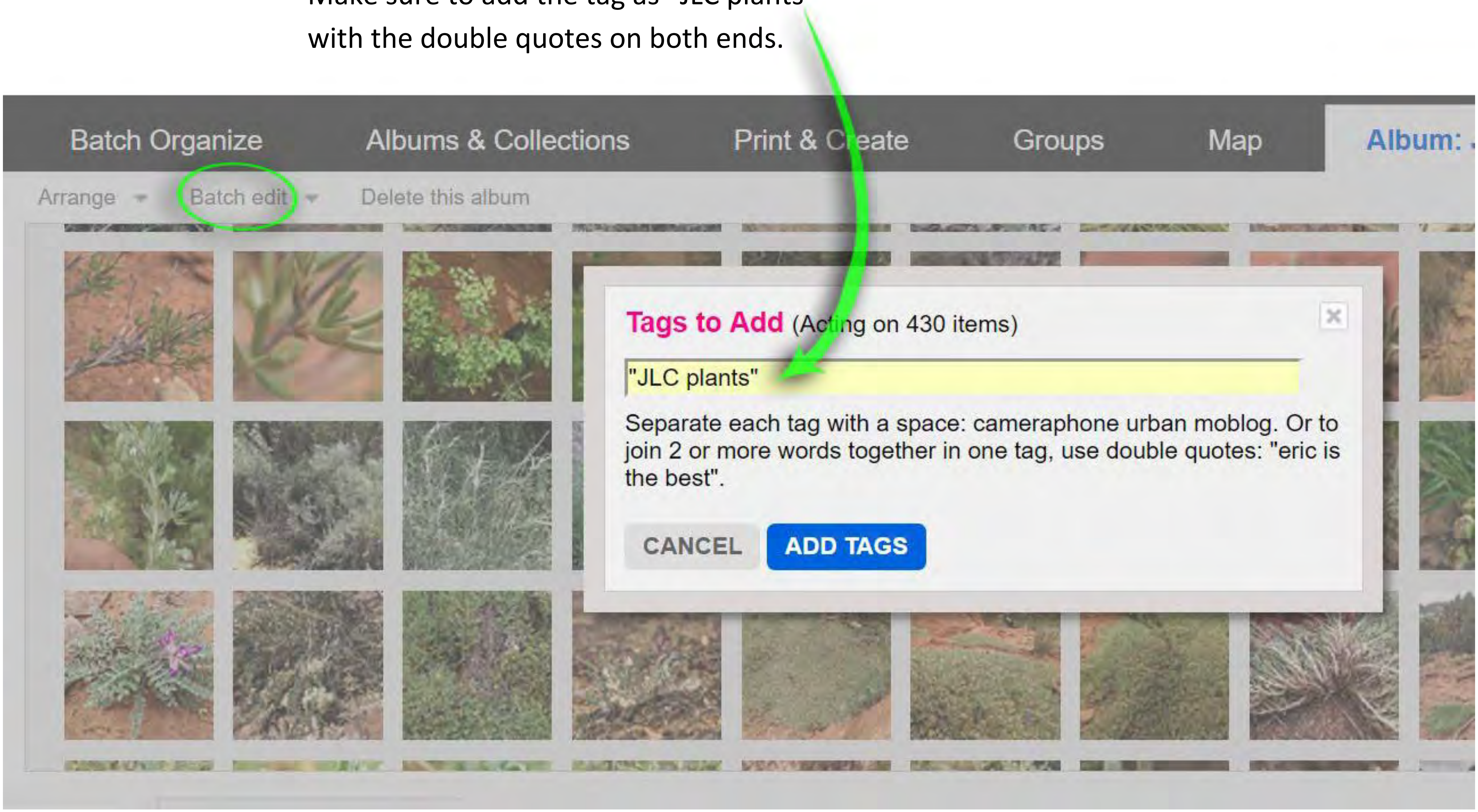

If you need help, let me know and I’ll help you figure it out. barth.ncy@gmail.com