

NOTES ON SIGNIFICANT COLLECTIONS AND ADDITIONS
TO THE FLORA OF GLEN CANYON NATIONAL RECREATION AREA,
UTAH AND ARIZONA, BETWEEN 1992 AND 2004

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ABSTRACT.—*Symphytotrichum expansum* (Puepp ex Spreng.) Nesom is reported new to Utah from the Escalante River drainage. A major range extension is reported for *Aralia racemosa* L. in the Escalante drainage, and additional populations are reported of the rare species *Imperata brevifolia* Vasey in Utah, including the 1st record for the Grand Staircase–Escalante National Monument. *Heterotheca grandiflora* Nutt. is reported new to north central Arizona. New locations and notes on an additional 22 rare species in Glen Canyon National Recreation Area are listed.

Key words: flora, Glen Canyon National Recreation Area, Utah, Arizona, relicts, dispersal.

Intensive fieldwork in Glen Canyon National Recreation Area (NRA) was conducted on riparian communities in side canyons around Lake Powell between 1991 and 2002 (cf. Spence 1996, 2005). This work has added numerous species to the NRA, as well as 1 species new to Utah. In this paper significant collections are reported, including species that are rare in the region or that represent new range extensions.

Glen Canyon NRA comprises 508,000 ha in south central Utah and north central Arizona, 13% (66,000 ha) of which is occupied by Lake Powell. Over 440,000 ha of arid and semiarid vegetation along the Colorado River drainage system occurs within the NRA, much of it rugged and inaccessible. Currently, ca. 800 species have been collected or are known (Spence and Zimmerman 1996), while an additional 100 species are known from adjacent Bureau of Land Management, Navajo Nation, and National Park Service lands. The flora is based primarily on inventories completed in the 1980s (Welsh 1984, Schulz et al. 1987).

As part of a riparian vegetation survey of selected side canyons around Lake Powell, plant collections were made of rare or otherwise interesting species (Spence 1996). Most work was conducted in canyons draining into the lake incised through the Triassic–Jurassic Glen Canyon group, comprising from youngest to oldest the Navajo, Kayenta, and Wingate Formations. Many species were associated with springs, common in these canyons, which

emerge at the Navajo–Kayenta interface. In addition to these records, new records for the Colorado River below Glen Canyon Dam in northern Arizona are also discussed.

Below, the collection locality, habitat, and significance for the new Utah State record are presented; then other records are listed with families and genera arranged alphabetically. Nomenclature follows Welsh et al. (2003) unless otherwise noted. In a few cases the current accepted name in the USDA Plants database (<http://plants.usda.gov>) is used instead of Welsh. Each species is represented by 1 or more collections, although specimens were not collected for some species at all newly reported localities. Specimens are deposited in the Glen Canyon NRA herbarium and Northern Arizona University (AST). Universal transmercator (UTM) coordinates are based on the NAD27 datum. Duplicates of *Perityle specuicola* from the San Juan River are located at BYU. The ecological setting of many of the species is reported elsewhere (Spence 1996), while the distribution and ecology of several rare species found in relict stands of *Pseudotsuga menziesii* are reported in Spence (1995). The status, distribution, and ecology of 3 additional rare species in Utah, *Cladium californicum* (Wats.) O'Neill, *Cycladenia jonesii* Eastwood, and *Platanthera zothecina* (Higgins & Welsh) Kartesz & Gandhi, will be reported elsewhere (Spence in preparation).

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NEW TO UTAH

ASTERACEAE

Symphotrichum expansum (Puepp ex Spreng.) Nesom. UTAH: Kane County. Cow Canyon, main fork, Escalante Arm of Lake Powell. Along stream in lower portion of canyon, on disturbed, moist sand. Associated with *Panicum virgatum*, *Thinopyrum ponticum*, and *Plantago lanceolata*. Elevation 1160 m. UTM: 12E505600N4140200. 31 July 1992. Spence 4966.

Symphotrichum expansum is now a common species along the Colorado River below Glen Canyon Dam in Arizona, although it may have been rare prior to the construction of the dam in 1963. It probably extended well into Utah along the Colorado River and its tributaries, in areas now drowned by Lake Powell. Since it tends to flower in late summer and fall, it could have been easily overlooked during the river studies conducted while Glen Canyon Dam was being constructed. A variety of other species, typical of riparian and spring vegetation in the lower Grand Canyon and Sonoran and Mojave Deserts, also follow this same pattern of extending along the Colorado River into Utah. Other species displaying this pattern include *Baccharis salicifolia*, *Chloracantha spinosa*, *Cercis occidentalis*, *Cladium californicum*, *Imperata brevifolia*, *Parthenocissus vitacea*, *Frangula betulifolia*, and *Tessaria sericea*.

SIGNIFICANT COLLECTIONS
IN GLEN CANYON NATIONAL
RECREATION AREA

ACERACEAE

Acer grandidentatum Nutt. in T. & G. UTAH: Kane County. Cow Canyon, north fork, Escalante Arm of Lake Powell. Along stream in shaded, north-facing alcove at base of Navajo Sandstone cliff, growing with *Acer negundo*, *Quercus gambelii*, and *Frangula betulifolia*. Elevation 1200 m. UTM: 12E510400N4145350. 30 July 1992 (not collected). Fence Canyon, Escalante Arm of Lake Powell. Along stream in shallow, north-facing alcove on steep colluvial slope at base of Navajo Sandstone cliff, growing with *Acer negundo*, *Betula occidentalis*, *Quercus gambelii*, and *Frangula betulifolia*. Elevation 1260 m. UTM: 12E505450N4138900. 29 July 1993 (not collected). Millers Creek, off Halls Creek, Waterpocket Fold. Growing in dense shade under Douglas-fir in north-facing alcove, associated with *Ostrya knowltonii*, *Quercus gambelii*, *Mahonia repens*, *Platanthera zothecina*, and *Maianthemum stellatum*. Elevation 1770 m. UTM: 12E507160N4158040. 24 September 1992. Spence 5059.

Although *Acer grandidentatum* is a common species at higher elevations on the Col-

orado Plateau generally along streams and around springs, the new locations for this species are at unusually low elevations. The 2 populations in Cow and Fence Canyons occurred only 30–90 m above the high-water elevation of Lake Powell at 1130 m. These populations may be relicts from the late Wisconsin when the species was more common at lower elevations. Remarkably, macrofossils of this species have been found in late Wisconsin and early Holocene deposits in canyons on the west side of the Escalante Arm of Lake Powell within a few kilometers of these stands (Withers and Mead 1993).

ANACARDIACEAE

Rhus glabra L. UTAH: Kane County. Cow Canyon, north fork, Escalante Arm of Lake Powell. Around spring in southeast facing alcove at base of Navajo Sandstone cliff, growing in mixed deciduous woodland of *Quercus gambelii* and *Frangula betulifolia*. Elevation 1260 m. UTM: 12E507380N4143200. 30 July 1992. Spence 4972. West fork of Bowns Canyon, far end in easternmost alcove, associated with *Frangula betulifolia* and *Cirsium rydbergii*. Elevation 1280 m. UTM: 12E496300N4141250. 16 July 1997 (not collected). Coyote Gulch, at southeast-facing spring near Jacob Hamblin's Arch. Associated with *Adiantum capillsveneris*, *Frangula betulifolia*, *Rosa woodsii*, and *Toxicodendron rydbergii*. Elevation 1220 m. UTM: 12E496300N4141250. 10 May 2002 (not collected).

These represent the 2nd through 4th populations in Glen Canyon NRA. The only other population is from a hanging garden at Buoy 73 Mile on Lake Powell (Welsh 1989). In southern Utah this species is rare and is most common in the upper Virgin River drainage in Zion National Park. Woodbury (1959) reported smooth sumac as "occasional" in "hillside glens" along the Colorado River. All these populations were drowned by Lake Powell.

ARALIACEAE

Aralia racemosa L. UTAH: new to Kane County. Cow Canyon, north fork, Escalante Arm of Lake Powell. Along stream in shaded, north-facing alcove at base of Navajo Sandstone cliff, growing under mixed woodland of *Acer grandidentatum*, *A. negundo*, *Quercus gambelii*, and *Frangula betulifolia*. Elevation 1200 m. UTM: 12E510400N4145350. 30 July 1992. Spence 4976.

In Utah, *Aralia racemosa* was considered restricted to narrow, shaded canyons in Zion National Park and immediately adjacent areas (Welsh et al. 1993). The Cow Canyon locality is about 180 km northeast of Zion Canyon. About

50 plants were counted in 1992 and on a return visit in 1994. The species had flowered both years and had set fruit in 1994. The stream, along which the plants grow, issues from a permanent spring. The site receives no direct sunlight. The *Aralia* was associated with a mixed deciduous woodland that is widespread in side canyons around Lake Powell. These woodlands harbor several boreal-montane disjuncts as well as state rare species. At the spring where *Aralia* grew, other species present included *Acer grandidentatum*, *Amelanchier alnifolia*, *Carex rossii*, *Glyceria striata*, *Platanthera zothecina*, *Mahonia repens*, and *Ostrya knowltonii*. These probably represent remnants of late Wisconsin woodlands that may have occurred on stream bottoms and in side alcoves in these canyons during glacial climates.

ASTERACEAE

Erigeron kachinensis Welsh. UTAH: Garfield County. Clearwater Canyon, off Cataract Canyon, just down from major fork, at top of talus on west-facing slope, base of Cedar Mesa Sandstone, in seepy area. Associated with *Carex curatorum* and *Hedeoma drummondii*. Elevation 1550 m. UTM: 12E574400N4208050. 13 August 1992. Spence 5014.

This is a new report for Glen Canyon NRA. This locality extends the range of *E. kachinensis* slightly west of its known distribution (Cronquist 1994). The central part of Clearwater Canyon is difficult to reach as it is protected by cliffs above and below. Because of this, it had apparently not been explored floristically before 1992. Within this protected part of the canyon, the following species (in addition to *E. kachinensis*) were collected: *Carex rossii*, *Ostrya knowltonii*, *Perityle speciosa*, and *Rubus neomexicanus*.

Erigeron zothecinus Welsh. UTAH: Kane County. Long Canyon, near upper end of canyon on damp, shaded soil in seep along stream. Associated with *Juncus ensifolius* and *Epilobium ciliatum*. Elevation 1400 m. UTM: 12E513000N4142800. 3 September 1992. Spence 5044. San Juan County. Seepy soil slopes near Lake Powell, Buoy Marker 66 Mile, and along drainage to east. Elevation 1140 m. UTM: 12E512450W4124990. 16 August 1995. T. Haberle s.n.

The status of *E. zothecinus* is not well understood. Although Welsh et al. (1993) considered it a good species, Cronquist (1994) placed it under *E. pumilus*. The species and its habitat appear distinctive, however, compared with typical *E. pumilus*, and its status needs to be investigated. Originally *E. zothecinus* was

known only from the type locality on Pollywog Bench, just upstream from the confluence of the Escalante Arm and main channel of Lake Powell. Surveys conducted on the west end of Pollywog Bench located ca. 100 individuals in May 1995. However, during an August 1995 trip, a large population, numbering in the hundreds, was located down-lake from the confluence on the east side of the canyon, between Buoy Markers 65 and 66 Mile. Typically, the plants grow on exposed, seepy slopes in the Kayenta Formation where soil has accumulated and carbonate deposits occur at the surface. The Long Canyon population showed some differences in morphology and habitat and may not be closely related to the other populations. The leaves of this population are wider and the heads somewhat larger than plants at Pollywog Bench. The habitat, on damp shaded soil at a spring, is also distinctive.

Heterotheca grandiflora Nutt. ARIZONA: Coconino County. Junction of Highway 89 and Lakeshore Drive, south entrance, along roadside in disturbed sandy soil, growing with *Baileya multiradiata* and *Machaeranthera canescens*. Elevation 1170 m. UTM: 12E455930N4087910. 24 October 2002. Spence 5533.

Telegraph weed is a weedy native species found in the southwestern deserts of North America. This is the 1st report for the region and a significant range extension from known populations in Washington County, Utah, and Yavapai County, Arizona. The location suggests that it may have been brought in as part of a seed mix, probably also including the exotic *Baileya multiradiata*, that was used to revegetate the roadside at the site. Although this project was completed in the late 1980s, telegraph weed is well known to produce dormant seeds from ray flowers (Flint and Palmblad 1978), and it is possible that fruits have been dormant in the seed bank since that time. Alternatively, the species may have been recently and inadvertently brought to the site through transport on tourist vehicles and boats, some of which originate from the Las Vegas–Lake Mead region.

Pectis angustifolia Torr. UTAH: Kane County. Long Canyon, ca. 1 km from upper end, on open, east-facing, sandy slopes. Associated with *Ipomopsis gunnisonii* and *Eriogonum palmerianum*. Elevation 1400 m. UTM: 12E513000N4142800. 3 September 1992. Spence 5050.

Pectis angustifolia is a rare species in Utah, previously known from a few sites in southern

Kane and San Juan Counties. It is fairly common in sandy sites in Coconino County in northern Arizona.

Perityle specuicola Welsh & Neese. UTAH: Garfield County. Clearwater Canyon, off Cataract Canyon, downstream ca. 200 m from major fork in canyon, in exposed cracks of Cedar Mesa Sandstone in dry stream channel. Associated with *Brickellia microphylla*. UTM: 12E574400 N4208050. 13 August 1992. Spence 5013. San Juan County. San Juan River, Point Lookout Canyon, on right (north side) at river mile 62.5 at Government Rapid. In hanging garden above 1st ledges. 13 September 1997. Atwood, Curtis and Melloy 23319 (BYU). San Juan County, Easter Pasture Canyon overlooking Cataract Canyon, on dry rock faces around hanging garden, 1st drop from top toward river. Elevation 1460 m. UTM: 12E578180N4208940. 5 August 1998 (not collected).

The first 2 collections extend the range of *Perityle specuicola* in Cataract Canyon several miles to the west of previously known locations in and around Dark Canyon (Cronquist 1994). The San Juan River population represents a considerable range extension south from the species main center of distribution in and around Natural Bridges National Monument.

BETULACEAE

Ostrya knowltonii Cov. UTAH: Garfield County. Clearwater Canyon, off Cataract Canyon, forming woodland on stream terrace ca. 200 m up west fork of canyon. Associated with *Penstemon rostriflorus*, *Rubus neomexicanus*, and *Symphoricarpos longiflorus*. Elevation 1450 m. UTM: 12E572900N4209100. 13 August 1992. Spence 5021. Northeast Fork of Cow Canyon, upper Escalante Arm of Lake Powell, in north-facing alcove with spring. Associated with *Amelanchier alnifolia*, *Aralia racemosa*, *Galium aparine*, *Mahonia repens*, *Platanthera zothecina*, *Parthenocissus vitacea*, and *Frangula betulifolia*. Elevation 1350 m. UTM: 12E510440 N4145400. 30 July 1992 (not collected). South fork of Ticaboo Canyon, in north-facing alcove with spring. Associated with *Cercis occidentalis*, *Quercus gambelii*, *Frangula betulifolia*, *Symphoricarpos longiflorus*, and *Toxicodendron rydbergii*. Elevation 1250 m. UTM: 12E539720N4172900. 14 August 1996 (not collected). Waterpocket Fold, in dense shade under Douglas-fir in north-facing alcove, associated with *Acer grandidentatum*, *Quercus gambelii*, *Mahonia repens*, *Platanthera zothecina*, and *Maianthemum stellatum*. Elevation 1770 m. UTM: 12E507160N4158040. 24 September 1992. Spence 5059.

Knowlton hophornbeam is a small tree found along the Colorado River in southern Utah from near the Colorado border to the Escalante River drainage. It reappears in the Grand Canyon region (Brian and Spamer 2000) and along the Mogollon Rim. A disjunct popu-

lation also occurs in the mountains of south central New Mexico and adjacent Texas. The species is rare throughout most of its range. In Glen Canyon NRA there are only 7 known populations, including the 4 reported here.

BRASSICACEAE

Rorippa islandica (Oeder) Borbas. ARIZONA: Coconino County. Glen Canyon, rooted in mud and sand along margins of return channel marsh along Colorado River, 6.5 miles upstream from Lees Ferry. Associated with *Melilotus officinalis* and *Juncus articulatus*. Elevation 950 m. UTM: 12E450500N4080900. 5 August 1992. Spence 4975.

The only other record for this species along the Colorado River below Glen Canyon Dam is at river mile 51.5 (miles downstream from Lees Ferry; 84.4 km) in Marble Canyon (Ayers et al. 1994).

CYPERACEAE

Carex rossii F. Boott. UTAH: Garfield County. Clearwater Canyon, off Cataract Canyon, on soil in shade of *Ostrya knowltonii* woodland on stream terrace ca. 200 m up west fork of canyon. Associated with *Penstemon rostriflorus*, *Rubus neomexicanus*, and *Symphoricarpos longiflorus*. Elevation 1450 m. UTM: 12E572900 N4209100. 13 August 1992. Spence 5018. Millers Creek, off Halls Creek, Waterpocket Fold. Growing in dense shade under Douglas-fir in north-facing alcove, associated with *Ostrya knowltonii*, *Quercus gambelii*, *Mahonia repens*, *Platanthera zothecina*, and *Smilacina stellata*. Elevation 1770 m. UTM: 12E507160 N4158040 (not collected). Wayne County. Millard Canyon, near Hans Flat. In alcove at upper end of canyon under Douglas-fir, at base of wet detritus slope associated with *Amelanchier alnifolia*, *Rosa woodsii*, and *Cornus sericea*. Elevation 1890 m. UTM: 12E574540 N4233100 (not collected).

These populations are associated with patches of mixed deciduous woodland and Douglas-fir stands at unusually low elevations for the species on the Colorado Plateau.

Cyperus squarrosus L. ARIZONA: Coconino County. Glen Canyon, rare in bare mud along margins of return channel marsh along Colorado River, 6.5 miles upstream from Lees Ferry. Elevation 950 m. UTM: 12E450500N4080900. 4 October 1994. Spence 5248.

This is a new record for the Colorado River between Glen Canyon Dam and Lake Mead (Phillips et al. 1987, Ayers et al. 1994). The plants were growing in an area that had been thoroughly surveyed several times between 1992 and 1994. The plants had not been seen before this collection nor have they been seen since then. Hence, this record apparently represents a recent dispersal to the area, possibly

by waterfowl, which are abundant along this stretch of the river in winter (NPS unpublished data, Spence and Bobowski 2003).

DRYOPTERIDACEAE

Cystopteris utahensis Windham & Haufler. UTAH: Kane County. Cow Canyon, south fork, Escalante Arm of Lake Powell. In rock crevices near spring in permanently shaded, north-facing alcove at base of Navajo Sandstone cliff. Elevation 1285 m. UTM: 12E509400 N4143050. 31 July 1992. Spence 4977. Millers Creek, off Halls Creek, Waterpocket Fold. On boulders along stream in dense shade under Douglas-fir in north-facing alcove. Associated with *Acer grandidentatum*, *Ostrya knowltonii*, *Quercus gambelii*, *Mahonia repens*, *Platanthera zothecina*, and *Maianthemum stellatum*. Elevation 1770 m. UTM: 12E507160N4158040 (not collected). Coyote Gulch, in north-facing alcove with spring. Associated with *Galium aparine*, *Platanthera zothecina*, *Frangula betulifolia*, *Maianthemum stellatum*, and *Toxicodendron rydbergii*. Elevation 1220 m. UTM: 12E499280N4140740. 9 May 2002 (not collected).

Cystopteris utahensis is generally found in moist, shaded sites in the mountains on the Colorado Plateau, including the Abajo, La Sal, Henry, Boulder, and Navajo Mountains. The collections from the Escalante River drainage in Cow Canyon and Coyote Gulch are at an unusually low elevation for the species on the Colorado Plateau. The plants in Millers Creek are associated with the relict stand of Douglas-fir.

EUPHORBACEAE

Euphorbia aaron-rossii A. Holmgren and N. Holmgren. ARIZONA: Coconino County. On steep limestone slope at mouth of Cathedral Wash, above the Colorado River, 4.4 km downstream from Lees Ferry. Associated with *Atriplex confertifolia* and *Ephedra torreyana*. Elevation 975 m. UTM: 12E444860N4077850. 10 May 1994. J. Spence & J. Crawford s.n.

Euphorbia aaron-rossii was described from collections along the Colorado River in Marble Canyon (Holmgren and Holmgren 1988). This is the 1st record for Glen Canyon NRA and extends the species distribution to above Navajo Bridge at the mouth of Cathedral Wash, about 4.4 km downstream from Lees Ferry.

LAMIACEAE

Lycopus americanus Muhl. ex Barton. ARIZONA: Coconino County. Glen Canyon, rooted in mud and sand along margins of return channel marsh along Colorado River, 6.5 miles upstream from Lees Ferry. Associated with *Mentha arvensis*, *Juncus articulatus*, and *Euthamia occidentalis*. Elevation 950 m. UTM: 12E450500 N4080900. 5 August 1992. Spence 4975. In marsh 8.8 miles upstream from Lees Ferry, Horseshoe Bend,

rooted in mud. Associated with *Typha domingensis*, *Phragmites australis*, and *Leersia oryzoides*. Elevation 950 m. UTM: 12E (not collected).

Lycopus americanus is a common marshland and riparian species in northern and eastern Utah and Colorado. It has been reported from a few localities at high elevations on the Navajo Reservation and White Mountains. These new locations are over 200 km west of these localities. The Horseshoe Bend population was found associated with other wetland species, including *Leersia oryzoides*, in a small natural marsh, the lower edges of which are trimmed by high flows of the Colorado River. The other locality was an artificial return-channel marsh resulting from fluctuating flows from Glen Canyon Dam (cf. Stevens et al. 1995).

LILIACEAE

Zigadenus vaginatus (Rydb.) Macbr. UTAH: Kane County. At head of south fork of main north fork of Cow Canyon, Escalante Arm of Lake Powell, in large alcove, on wet backwall of hanging garden. Associated with *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Carex curatorum*, *Cirsium rydbergii*, and *Mimulus eastwoodiae*. Elevation 1372 m. UTM: 12E510800 N4145780. 30 July 1992 (not collected). At head of main south fork of Cow Canyon, Escalante Arm of Lake Powell, in large alcove on wet backwall of hanging garden. Associated with *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Carex curatorum*, *Cirsium rydbergii*, and *Mimulus eastwoodiae*. Elevation 1292 m. UTM: 12E509840N4143350. 31 July 1992 (not collected). At head of Fence Canyon, Escalante Arm of Lake Powell, in large alcove on wet backwall of hanging garden. Associated with *Adiantum capillus-veneris*, *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Cirsium rydbergii*, and *Lobelia cardinalis*. Elevation 1280 m. UTM: 12E507050N4139780. 29 July 1992 (not collected). At head of unnamed canyon on Escalante Arm, 1st canyon north of Cow Canyon on east side of lake, in large alcove on wet backwall of hanging garden. Associated with *Adiantum capillus-veneris*, *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Carex curatorum*, *Cirsium rydbergii*, and *Mimulus eastwoodiae*. Elevation 1210 m. UTM: 12E504183N4141230. 15 August 1995 (not collected). San Juan County. In small hanging garden near entrance to Ribbon Canyon, Lake Powell, on detritus slopes and backwall. Associated with *Rubus neomexicanus*. Elevation 1130 m. UTM: 12E514300 N4123480. 9 June 1992 (not collected).

Sheathed deathcamas is a rare species distributed in hanging gardens along the Colorado River drainage in southeastern and south central Utah. Within Glen Canyon NRA the species was known from 3 locations (Welsh 1989). These additional locations bring the number of populations of the species in the

NRA to 8. In Glen Canyon the species is typically found in alcoves in large, shaded hanging gardens on wet backwalls. Most populations are inaccessible, as they are usually growing on seeping cliffs >100 m aboveground.

POACEAE

Imperata brevifolia Vasey. UTAH: new to Kane County. Coyote Gulch, in sand along stream in lower portion, associated with *Baccharis emoryi*, *Juncus balticus*, *Equisetum hyemale*, and *Scirpus pungens*. Elevation 1190 m. UTM: 12E499380N4141175. 9 May 2002 (not collected). In sand along stream in lower portion, associated with *Juncus balticus* and *Salix exigua*. Elevation 1195 m. UTM: 12E499374N4141172. 9 May 2002 (not collected). In sand on terrace in upper Coyote Gulch above confluence with Hurricane Wash, growing with *Juncus balticus*, *Equisetum hyemale*, *Salix exigua*, and *Scirpus pungens*. Elevation 1250 m. UTM: 12E494200N4141920. 10 May 2002 (not collected).

Satintail grass is a distinctive species that was known previously from 3 locations in Utah, in Wilson Creek on the lower San Juan Arm of Lake Powell, at the mouth of Forbidding Canyon, and from the vicinity of Rainbow Bridge (Woodbury 1958). The latter 2 locations are presumably under Lake Powell as the species has not been relocated at these sites. These 3 new populations in Coyote Gulch increase the number of extant populations in the state to 4. The 2 lower Coyote Gulch populations are in Glen Canyon NRA, while the upper population is in the Grand Staircase–Escalante National Monument near the boundary with the NRA. Even with these new locations, the status of this species in Utah remains precarious. All 3 new populations are small and are located in the flood zone of Coyote Gulch. The upper Coyote Gulch population is within 50 m of a livestock fence, and the area had been grazed until the fence was built in 1992. Coyote Gulch receives heavy recreational use, and all 3 populations show signs of trampling by humans.

Leersia oryzoides (L.) Swartz. ARIZONA: new to Coconino County. Colorado River, Horseshoe Bend, river mile 8.8, left bank, rooted in mud along marshy edges of stream. Associated with *Typha domingensis* and *Scirpus acutus*. Elevation 950 m. UTM: 12E454100N4081145. 23 September 1993. Spence 5223a.

Rice cutgrass is known from western Colorado and the Great Salt Lake and Utah Lake areas of northern Utah. It has also been found in southern Arizona, where it is possibly introduced (Kearney and Peebles 1960). The population was found in a natural, spring-fed marsh

on the banks of the Colorado River downstream of Glen Canyon Dam. This collection fills in a significant gap in the distribution of rice cutgrass on the central Colorado Plateau. The species may have been introduced to the site by waterfowl that overwinter on the river below the dam (NPS unpublished data).

Sporobolus asper (Michx.) Kunth. UTAH: new to Kane County. Long Canyon, ca. 3 km from upper end, on dry soil along stream. Elevation 1380 m. UTM: 12E513300N4141600. 3 September 1992. Spence 5052.

Tall dropseed is known from a few localities in eastern Utah. The population in Long Canyon represents a significant range extension westward from populations in Grand County.

POLEMONIACEAE

Gilia flavocincta A. Nels. UTAH: new to Garfield County. Two Mile Canyon, ca. 4 km up-canyon from Lake Powell, above major drop in canyon, in dry sand along dry wash. Associated with *Physaria acutifolia*. Elevation 1250 m. UTM: 12E542000N4181900. 22 April 1992. Spence 4936.

A rare species known from a single previous collection in Utah, in Kane County (Welsh et al. 1993), this newly discovered population extends the range to southern Garfield County.

POTAMOGETONACEAE

Potamogeton natans L. UTAH: new to Kane County. Bowns Canyon, southern end of Waterpocket Fold. In still water of pools in lower canyon and in beaver ponds just up from fork. Associated with *Typha domingensis*. Elevation 1320 m. UTM: 12E511900N4134950. 19 August 1992. Spence 5031.

Potamogeton natans is a rare species distributed in ponds, lakes, and slow-moving streams in northern Utah, in Duchesne, Rich, Uinta, and Utah Counties (Albee et al. 1988, Welsh et al. 1993). The present location represents a major range extension southward in the state and is at a lower elevation and in a lower vegetation zone than is typical for the species. It is common in beaver ponds in Bowns Canyon.

ROSACEAE

Amelanchier alnifolia Nutt. UTAH: Kane County. Cow Canyon, Escalante Arm. At spring in shaded, north-facing alcove at base of Navajo Sandstone cliff, growing in mixed woodland of *Acer grandidentatum*, *A. negundo*, *Quercus gambelii*, and *Frangula betulifolia*. Elevation 1200 m. UTM: 12E510400N4145350. 13 June 1994. Spence and J.A.C. Zimmerman 5231; Wayne County.

Millard Canyon, near Hans Flat, in alcove at upper end of canyon under Douglas-fir, at base of wet detritus slope associated with *Cornus sericea*, *Rosa woodsii*, and *Carex rossii*. Elevation 1890 m. UTM: 12E574540N4233100. 3 August 1994 (not collected).

In both cases the species was represented by a single individual. This species generally occurs at much higher elevations on the Colorado Plateau, generally in montane scrub and forests.

Rubus neomexicanus Gray. UTAH: new to Garfield County. Clearwater Canyon, left fork ca. 200 m above major fork in canyon, on shaded terrace along stream under *Ostrya knowltonii*. Elevation 1450 m. UTM: 12E572900 N4209100. 13 August 1992. Spence 5017.

Previously known from populations in Knowles, Ribbon, and Cataract Canyons, the Clearwater Canyon location represents only the 4th record for Glen Canyon NRA and Utah.

RUTACEAE

Ptelea trifoliata L. ARIZONA: Coconino County. Glen Canyon, on sandy benches along Colorado River 7.0 miles upstream from Lees Ferry, at base of Navajo Sandstone cliff. Associated with *Celtis reticulata*, *Forestiera pubescens*, *Galium trifolium*, and *Quercus turbinella*. Elevation 965 m. UTM: 12E451350N4080930 (not collected).

Hoptree is a small tree found in the southwestern deserts and mountains of North America. Although common in the Grand Canyon, the species is not found along the Colorado River in riparian vegetation. This new record is the 1st for Glen Canyon NRA and is associated with remnant, pre-dam, old, high-water-zone riparian vegetation.

SCROPHULARIACEAE

Mimulus eastwoodiae Rydb. UTAH: Kane County. Millers Creek, off Halls Creek, south end of Waterpocket Fold. Seep in east-facing alcove, near Douglas-fir stand, associated with *Calamagrostis scopulorum*, *Mahonia repens*, *Psuedotsuga menziesii*, and *Eriogonum corymbosum* var. *orbiculatum*. Elevation 1790 m. UTM: 12E507100N4158200. 24 September 1992 (not collected).

The population occurred at an elevation 415 m higher than previously reported for the species in Utah (Welsh et al. 1993). The plants were growing in an east-facing hanging garden near the isolated stand of Douglas-fir in upper Millers Creek, Waterpocket Fold.

DISCUSSION

Glen Canyon was not thoroughly surveyed floristically before the completion of Glen Can-

yon Dam in 1963 and the subsequent filling of Lake Powell. Sporadic fieldwork occurred between the 1930s and 1950s, summarized in Woodbury (1958). Clover and Jotter (1944) sampled sites along the river corridor in 1938, including 2 in Glen Canyon, the mouth of Forbidding Canyon, and the vicinity of Rainbow Bridge in Bridge Canyon. Gaines (1960) reported some additional species from the Glen Canyon region. In the summers of 1957 and 1958, two expeditions were launched to survey the vegetation and collect the flora and fauna of Glen Canyon, between Hite and Lees Ferry. Most of this work concentrated on the main river corridor, with occasional side canyon visits including Aztec, Lake, Little Eden, North Wash, Red, and Trachyte Canyons (Woodbury 1959). After the filling of Lake Powell, a major floristic study was conducted in Glen Canyon NRA (Welsh 1984), which added numerous species to the known flora of the side canyons.

Most of the new records for the Glen Canyon region are associated with springs rather than riparian or upland vegetation. The side canyons of Glen Canyon where many of these springs occur may have been inaccessible from the river due to pour-offs and mass-wasting events in the narrow and deep lower portions of the canyons. Also, springs on the sides of the canyon walls along the river may have been difficult to reach from river level. Hence some of the species reported here may have been in sites difficult to access during pre-dam surveys. With the creation of Lake Powell, the lower portions of these canyons were drowned while many springs and upper portions of the side canyons became readily accessible by boat. Full pool elevation of the reservoir is 1130 m, which is about 150–170 m above the original river. Of the 650 springs identified on the Glen Canyon NRA GIS theme, 240 (37%) were drowned by the reservoir, including all the glens and springs described by J.W. Powell on his 1869 descent through Glen Canyon. It is likely that many unusual and interesting plant communities and species existed at these springs and alcoves that were not sampled during the 1957–1958 expeditions and were subsequently destroyed when Glen Canyon Dam was built. At least 3 species reported from the river corridor are no longer extant in Glen Canyon NRA, *Mamillaria tetrancistra*, *Montia perfoliata*, and *Prunus virginiana*. Two

other species that were listed by Clover and Jotter (1944) and Woodbury (1958) as occurring in Glen Canyon, *Adiantum pedatum* and *Aquilegia chrysantha*, may have been misidentified, as specimens do not exist and the species are not known from the region. Other species may have been locally extirpated from Glen Canyon as well.

The surviving natural springs in Glen Canyon support highly diverse plant communities with many unusual species. These shaded, cool, wet sites may have functioned as refugia for species favoring microclimates that are typically found at much higher elevations on the Colorado Plateau (Spence 2005). Numerous boreal-temperate and montane species have been found associated with springs in the upper ends of drowned side canyons, including *Acer grandidentatum*, *Amelanchier alnifolia*, *Aralia racemosa*, *Betula occidentalis*, *Calamagrostis scopulorum*, *Carex rossii*, *Cornus sericea*, *Cystopteris utahensis*, *Galium aparine*, *Glyceria striata*, *Mahonia repens*, *Prunus virginiana*, *Rhus glabra*, *Rosa woodsii*, and *Maianthemum stellatum*. A few of these were reported during the 1957–1958 trips in side canyons and river level vegetation. These species are currently disjunct and isolated from higher-elevation mountain populations; they may represent remnants of Wisconsin-age glacial riparian woodlands that were widespread during glacial climates. Some species associated with these woodlands, such as *Abies concolor* and *Picea pungens*, disappeared with the warming of the Holocene, while others could have persisted in cool, shaded alcoves where springs existed. Douglas-fir (*Pseudotsuga menziesii*), another montane species, is a common macrofossil component in portions of the Escalante River drainage (Withers and Mead 1993) and still exists as small, isolated stands in the region (Spence 1995). Betancourt (1990) argued for a similar origin for the many rare and disjunct boreal-temperate species found in Zion Canyon, which he suggested functioned as a “mega-refugium” during the Holocene. Canyons off the lower Escalante Arm of Lake Powell, in particular Cow and Fence Canyons, harbor many of the disjunct populations of boreal-temperate species in the Glen Canyon region and on a smaller scale create microclimates similar to those of Zion Canyon.

Although the existence of boreal-temperate species can be explained by persistence in

favorable microsites since the Wisconsin period, other species are likely to have dispersed more recently into the Glen Canyon region. An interesting group of species common in the lower Grand Canyon, and distributed primarily in the Sonoran and Mojave Deserts at springs and in riparian vegetation, occurs in Glen Canyon: *Cladium californicum*, *Symphyophytum expansum*, and *Imperata brevifolia*. These species may have expanded into the region during the Holocene thermal maximum. They may also have been more widespread prior to the creation of Lake Powell and could have been missed during early surveys that concentrated primarily at river level. Other species, such as *Cyperus squarrosus*, *Leersia oryzoides*, *Lycopus americanus*, and *Rorippa islandica*, are currently found in marshes and other new high-water-zone vegetation that has developed downstream since the completion of Glen Canyon Dam. The remaining 25 km of Glen Canyon below the dam supports abundant wintering waterfowl populations that did not exist prior to the completion of the dam (Spence and Bobowski 2003). The rare and sporadic occurrence of wetland plant species in this stretch of the river may thus be a result of long-distance dispersal by waterfowl that migrate south from areas where these plants are common, such as northern Utah. The *Cyperus*, *Lycopus*, and *Rorippa* were found in a return-channel marsh that did not exist prior to 1963 (Stevens et al. 1995).

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