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).
NEW TO UTAH

ASTERACEAE


*Symphyotrichum 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*, *Cloracantha spinosa*, *Cercis occidentalis*, *Cladium californicum*, *Imperata brevifolia*, *Parthenocissus vitacea*, *Frangula betulifolia*, and *Tessaria sericea*.

SIGNIFICANT COLLECTIONS IN GLEN CANYON NATIONAL RECREATION AREA

ACERACEAE


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


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**


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 specicola*, and *Rubus neomexicanus*.


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.


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: 12E513000N4142900. 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.


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**


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).

**Lycopus americanus** Muhl. ex Barton. **AZ**: 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 *Menhia arenaria*, *Juncus articulatus*, and *Euthamia neomexicanus*. Elevation 950 m. UTM: 12E512480 N4124850. 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 show signs of trampling by humans.

*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).

**POLEMONIACEAE**

*Gilia flavocincta* A. Nels. **Utah**: new to Garfield County, Two Mile Canyon, ca. 4 km up-canyon from Lake Powell, in dry sand along stream. 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 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.


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, Pseudotsuga menziesii, and Eriogonum corybosum 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 Canyon 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*, *Maianthemum stellatum*, *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*, *Symphyotrichum 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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