Data Submitted (UTC 11): 9/25/2015 12:00:00 AM
First name: Jim
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Organization:
Title:
Comments: Comments on Little Water Canyon for Cibola NF Forest Plan Revison Process

Dear Champe Green - Forest Planner for Cibola National Forest -

Please find attached my comments regarding the Little Water Canyon in
the Zuni Mountains, Mt. Taylor District.

I did not have time to thoroughly review the"Draft forest-wide
Ecological and Socioeconomic Desired Conditions" document.
I looked at about half of it and did not see any place where I could
make any significant additions or deletions.

Thanks for giving me the opportunity to comments on the revision of the
Forest Plan.

Jim McGrath
Field Botanist
Member, Native Plant Society of New Mexico

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All text from the submitted attachment was entered into this text box (below) by Forest Service personnel.
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TO: Mr Champe Green, Forest Planner
Cibola National Forest and Grasslands
2113 Osuna Rd. NE
Albuquerque, NM 87113

FROM: Jim McGrath, Field Botanist; member, Native Plant Society of New Mexico

DATE: September 24, 2015

RE: Management of Little Water Canyon (LWC) in the Zuni Mountains, Mt. Taylor District,
Cibola National Forest as it pertains to the Cibola National Forest Management Plan Revision
Process

I would like to request the Cibola National Forest Management Plan Revision Process consider some sort of special management for the Little Water Canyon. During the last Cibola National Forest Management Plan (1985: 79-80, cited in Dunmire and Toll 1987) this site was recommended for establishment as a Research Natural Area (RNA). A total of 910 acres was proposed for establishment as an RNA. The location of the proposed RNA is in the southern part of the Zuni Mountains and is described in detail by Dunmire and Toll (1987). Unfortunately, the U.S. Forest Service never followed up by establishing the RNA.

My intent with this letter is to point out 1) the intrinsic values present in the proposed Little Water Canyon (hereafter referred to as LWC in this letter) RNA (as described by Dunmire and Toll 1987) that make it worthy of some sort of protection; 2) the threats and potential threats to this area; 3) recommended boundaries of an area designated for special management that will ensure adequate protection of the integrity of this ecosystem for

future generations; and 4) suggested additional on-the-ground research of the LWC Area to firmly establish the extent of its biological resources and its unique and natural character.

I base my comments on two documents (Dunmire and Toll 1987 and Billings, jr. and McCallum 1984), two personal visits to LWC during the summer of 2015 and with conversations with people involved with the original proposal to establish LWC as an RNA and with folks currently involved in finding a way to protect LWC.

INTRINSIC VALUE OF THE LITTLE WATER CANYON

1. Type Locality for the Colorado Blue Spruce / Red Osier Dogwood Plant Association. The primary feature of the original proposed RNA is that it contains the type locality for the Picea pungens / Cornus stolonifera or Colorado blue spruce / red-osier dogwood plant association, "SAF 216, a major riparian blue spruce association of the southwestern United States" (Dunmire and Toll 1987). The fact that this association is the type locality for this plant association is enough reason in itself to establish this site as a Research Natural Area. However, the blue spruce forest occupies only 20 acres or about 2% of the original proposed RNA (Dunmire and Toll 1987).

2. Near Pristine Condition. The blue spruce -red-osier dogwood forest lies in a steep-sided, narrow and highly shaded canyon. Reggie Fletcher (personal communication, 2015),who prepared the plant species list reported by Dunmire and Toll (1987), suggests that the narrow canyon has not been accessible to livestock. Therefore, this vegetation community would be in a near pristine state. Overall, the blue spruce forest appeared to be intact in 2015 and is probably in about as pristine a state as possible. The pristine character is fragile and subject to deterioration given the enormous influences we humans have on natural ecosytems. Therefore, the Colorado Blue Spruce forest must be protected.

3. Permanent Stream from One of the Highest Flow Springs in the Zuni Mountains. The upper end of the blue spruce forest contains a spring in the narrow canyon that creates a permanent flow of water. Rebecca Frus (personal communication, 2015), a graduate student at the University of New Mexico, has been studying springs in the Zuni Mountains. She has found that 48.6% (18 of 37) of the springs in the Zuni Mountains are actually flowing. But she reported the spring in the upper part of the blue spruce forest is one of the highest flow springs in the Zuni Mountains. Because surface water resources in the Zuni Mountains have deteriorated over the years, protection of the spring in LWC becomes that much more important. The spring in LWC is not only important for the maintenance of the unique blue spruce forest, it is also extremely important for wildlife in the Zuni Mountains. It is important to keep this spring flowing at a high rate by protecting the surroundings of the spring.

4. Fish and Clams in the Stream. According to Reggie Fletcher (personal communication, 2015), there were both fish and clams in the stream created by the spring in LWC in the mid 1980's. It is not clear if the fish and clams have succumbed to the extensive drought in the first decade of the 21st century. If the fish and clams are still present in the stream, they need to be identified. They may possibly represent endemic or even listed threatened or endangered species. Also, the fish and clams would demonstrate that the blue spruce forest ecosystem in LWC is truly unique and rare and, therefore, worthy of special protection.

5. Near Record Size Blue Spruce Trees in the LWC blue spruce forest. One such tree measures 44.5 inches DBH (Dunmire and Toll 1987). I personally have seen one tree about this size and a few more that are over 3 feet in diameter. However, I have been in only a very small part of the forest to date. The diameter and height of the spruce trees reflect the maturity of the forest and the fact that the forest has been maintained in a more or less pristine state. The blue spruce forest with trees of this size is truly rare, especially in the Zuni Mountains of west central New Mexico.

6. The Blue Spruce Forest is a Relict of an Earlier Era when Colder and Moister Conditions Prevailed in New Mexico. The blue spruce forest lies in a very narrow, steep-sided, shaded canyon that creates microclimatic conditions that simulate colder and moister conditions found much further north and at much higher elevation than that found in the Zuni Mountains. Thus, the blue spruce forest may represent a relict from an earlier era

when conditions in central New Mexico were much colder and wetter - such as following the retreat of Pleistocene glaciers. For example, the prairie violet (Viola pedatifida) was collected by Fletcher in 1982 in the blue spruce forest at LWC. This specimen is one of only 8 such specimens reported from the states of New Mexico and Arizona on SEINET (2015), an on-line searchable database of plant specimens housed in more than 100 herbaria mostly in the southwestern United States. The collection from LWC and the two specimens collected in Arizona constitute the southernmost locations where the prairie violet has ever been collected. The distribution of the prairie violet extends through the central United States to as far north as Canada (USDA, NRCS 2015).

Water birch (Betula occidentalis) is a shrub that I have observed in the blue spruce forest at LWC. A collections search on SEINet (2015) and a review of the The PLANTS database (USDA, NRCS 2015) reveal that LWC would constitute by a substantial distance the furthest south location where water birch has ever been found in New Mexico. Similar to the prairie violet, the distribution of water birch
extends northward throughout the western United States well into Canada.

7. A Rare Orchid in the Vicinity of LWC. To date there are no known endangered, threatened or rare plant species known to occur in the LWC or the general area surrounding the LWC (Dunmire and Toll 1987; Cibola County Rare Plant List- NMRPTC 1999; SEINet 2015). However, Billings, jr. and McCallum (1984) report finding the orchid, Piperia unalascensis, "in the pine forest between Hausner and Ojo Bonito Canyons" in 1981. Unfortunately, no specimen of the orchid was deposited in an herbarium. Therefore, it is unclear if the specimen was correctly identified. However, there exists a single record of Piperia unalascensis collected from McKenzie Ridge in the Zuni Mountains - about 16 miles northwest of LWC (SEINet 2015). This is the only known location in New Mexico or Arizona where this species has been found (Coleman 2002). Tom Todsen, who collected the specimen at McKenzie Ridge in 1987, was a known authority on orchids in New Mexico (Todsen 2000). Ron Coleman would surely have verified Todsen's specimen prior to publishing "The Wild Orchids of Arizona and New Mexico" in 2002. The significance of this specimen is amplified by the fact that Piperia unalascensis is also unknown in the southern tier of counties of both Colorado and Utah (USDA, NRCS 2015). The presence of Piperia unalascensis at McKenzie Ridge strongly suggests that the orchid reported by Billings, jr. and McCallum between Hausner and Ojo Bonito Canyons really was Piperia unalascensis. It seems likely that intensive searches for the Piperia would reveal this species in the area near LWC. Its presence would add credence to the idea the LWC and environs be protected as a Research Natural Area or some other protected management area because the area is an outstanding example of biodiversity in the Zuni Mountains.

8. The Original Proposed RNA is an outstanding Example of Biodiversity in the Zuni Mountains. The Zuni Mountains have a long history of livestock overuse and a checkerboard pattern of land ownership. Areas with significant biodiversity and which are relatively unaffected by livestock grazing are rare in the Zuni Mountains. The original proposed LWC RNA does indeed exhibit high biodiversity that is largely undisturbed by landscape altering disturbances such as livestock grazing. Dunmire and Toll (1987) report 7 vegetation plant associations within the original proposed RNA. Reggie Fletcher documented 168 plant species during just two 1-day visits in the early 1980's. Collections searches on SEINet (2015) revealed that at least some of the species recorded by Fletcher represent species for which there are no specimens collected from the Zuni Mountains in herbaria connected to SEINet. Examples are Pedicularis procera (SY=P. grayi), Maianthemum racemosum (SY= Smilacina racemosa) and Penstemon whippleanus. Dana Price and I documented an additional 11 species when we visited LWC in the afternoon of July 25, 2015. Dana checked off plants species on Fletcher's species list as we hiked through the original proposed RNA. The vegetation did not appear to be significantly different from the vegetation as described by Dunmire and Toll (1987) or as characterized by Fletcher's species list developed in the early 1980's. Presumably, there are many plant and animal species that have not as yet been documented within the biotic communities of the original proposed RNA.

8. Relative Absence of human-caused Disturbance. When Dana Price and I visited the proposed LWC RNA on July 25, 2015, we saw no evidence of livestock grazing as we walked from north to south through the proposed

Research Natural Area. There also did not appear to be any other major disturbance in the area. Since the majority of the Zuni Mountains has a long history of livestock grazing, the relative absence of this and other major types of human-caused disturbance make preservation of the LWC and nearby areas an exceptionally good idea.

9. Absence of Non-native Plant Species. Fletcher's species list (Dunmire and Toll (1987) report only a few non-native plant species. Dana Price and I observed no non-native plant species during our brief hike in July 2015. Nor did I notice any non-native plant species during my August 2015 visit to LWC.
The relative absence of non-native plant species reflects the observed minimal effect of livestock grazing and other human-based intrusions in the LWC area.

THREATS TO THE LITTLE WATER CANYON PROPOSED RESEARCH NATURAL AREA
Five Major Threats to the Ecological Integrity of Biotic Communities of Forests. These threats are 1) logging, 2) mining, 3) human extraction of water as indicated by the presence of a pipeline, livestock watering troughs, and water storage tanks, 4) human recreational activities, and 5) livestock grazing. These are discussed below.
Logging and Mining. Based on only two visits to LWC, there appears to be no evidence of recent logging activity and no evidence at all of mining. The ponderosa pine forest is spread out enough that there probably wont be a need for thinning. Dunmire and Toll (1987) report that "no mineral resources are known within the boundaries of the RNA." However, they also say that mineral rights for 960 acres "are reserved for all minerals by private interests" and about 115 acres "are reserved for fissionable minerals only (uranium and thorium) by the State of New Mexico".
Recommendation.
1) Both logging and mining must be prohibited from the entire area proposed for special management as described in the discussion of proposed boundaries below.
2) The Forest Service should acquire and then retire all applicable mineral rights beneath the entire area recommended for special management. (see boundaries discussion below).

Water Extraction. Based on two visits to LWC, there is no evidence of water pipelines or various structures such as cattle watering troughs and water storage tanks around the spring or along the stream in the blue spruce forest. Evidence of such structures was also absent within viewing distance of other areas visited during the two 2015 visits.
Recommendation.
No structures of any kind should be constructed to facilitate movement or storage of water for human or livestock usage at the spring and stream associated with the blue spruce forest. Nor should any of these structures be constructed anywhere within the entire area proposed for designation as special management (see boundaries discussion below).

Recreational Activities. The area surrounding LWC does not appear to be significantly used by recreationists. The area is very remote from major population centers such as Albuquerque, Santa Fe, Grants and Gallup. Hunting for big game may be the single recreation activity that currently has the potential to impact LWC. Reggie Fletcher (personal communication, 2015) reported seeing ATVs used by hunters when he took his son elk hunting in the LWC area around 2000. However, there does not appear to be serious impacts by vehicles in the proposed RNA as observed by Dana Price and I during our visit in July 2015. Old 2-tracks exist within the original proposed RNA. These 2-tracks do not detract from the natural character of the area and may serve as suitable walking trails.

Nevertheless, there is the potential that increasing population pressure and future unforeseen development may occur in areas near the proposed area for special management (see boundaries discussion below). These developments could lead to increased human recreation activities that may impact LWC. These recreation activities may involve mechanized methods of travel such as sight-seeing by auto, off-road vehicle (ORV) usage by ATVs, trucks and cars, bicycling, and mountain biking.

Additional new roads must be prohibited from establishment within the area proposed for special management. Increasing access for more and more humans to an area will result in increased impact to the area. But the roads also have a drastic impact on the natural biotic communities of an area. Road surfaces drastically alter the way water is delivered to the soil and, therefore, to plants. A good example of the impact of a road on the ecology of an area was demonstrated on my second visit to LWC on August 28, 2015. Our group, which included several U.S. Forest Service personnel, hiked up an old road from the south in order to reach LWC. The old road was characterized by substantial erosion, gullying and a vegetation community substantially different from the adjacent forested vegetation. Fortunately, that road is not within the LWC or even Cibola National Forest.

Some folks may say that mountain biking would have little impact on existing trails. However, I have seen wider trails and an abundance of non-native plant species adjacent to trails available for use by bicycles in the Sandia Mountains. Therefore, I do not recommend mountain biking in the area proposed for special management.

Horseback riding is generally allowed in a wilderness area, but horses also introduce non-native plant species to an area. Pack animals may be used for certain purposes (transporting scientific instruments and equipment, for example) occasionally. Impacts from horse hooves can be severe if horses visit the same area too often. But there is not enough horse usage in this area at this time to result in such severe impacts.

Recommendations:
1) No new roads or trails should be constructed within the proposed area for special management. Once roads are established, the people will come and the biotic communities we are trying to protect will be gradually impacted and ultimately destroyed.
2) No mechanized vehicles (trucks, cars, ATVs, bicycles, mountain bikes are examples) of any kind should be allowed in the area of special management. However, an exception may be made for ATVs used during hunting season or by scientists studying the LWC, but, if so, ATVs should not be allowed within 500 feet of the blue spruce forest, spring and stream. The ATVs must be restricted to existing trails as much as possible. ATV usage must be monitored and perhaps controlled by a permit system.
3) No horses or pack animals should be allowed within 500 feet of the blue spruce forest, spring and stream.

Livestock Grazing. My two personal brief visits to LWC revealed little or no evidence of livestock grazing in the Colorado blue spruce forest as well as much of the original proposed RNA by Dunmire and Toll (1987). This observation was most surprising because the Zuni Mountains exhibits a tremendous amount of livestock grazing. Areas with long histories of livestock grazing are characterized by pronounced erosion, gullying, lowered water table, and downcutting of streams and arroyos. Livestock grazing reduces the diversity of plant species in the process of changing the composition of plant communities. Grazing also results in an abnormal number of non-native plant species, some of which are often highly invasive weeds. The fact that livestock grazing impact is relatively minimal in the LWC area is absolutely precious. Such areas are extremely rare in New Mexico and by itself is enough reason to permanently protect this area. It is fortunate that the current owners of grazing allotments in this area are not grazing livestock at high stocking levels.
Recommendation.
Livestock grazing must be totally prevented in the entire area to come under special management, but especially the blue spruce forest and the entire Little Water Canyon watershed. Grazing allotments in the area proposed for special management should be retired or some arrangement made with allotment lessees to eliminate grazing. Fencing may be necessary to completely eliminate grazing from the area.

BOUNDARIES OF THE LWC AND ADJACENT AREA DESIGNATED FOR SPECIAL MANAGEMENT
Purpose of Management Designation
In these comments I am uncertain what management status is best for the blue spruce forest and the adjacent surrounding area. I have heard the terms Research Natural Area and Special Management Area. I do not know which of these designations or some other designation is most appropriate. I do know that the blue spruce forest

has scientific significance (type locality of the Colorado blue spruce/red osier dogwood plant association; fish and clams in a very rare stream). Therefore, any designation should facilitate scientific research and monitoring. The second aspect of the management designation would facilitate the strategies described above for protection against possible threats to the blue spruce forest and the associated spring and stream.

Boundaries
Criteria.
1) LWC Watershed.The minimum area that must be protected is the entire watershed of Little Water Canyon. Anything that happens in the watershed has the potential to ultimately affect the stream, spring and blue spruce forest in Little Water Canyon. However, for the purpose of this forest management plan revision, the area of protection is limited to that area that is contained within Cibola National Forest boundaries.

2) Expanded Area beyond the LWC Watershed. Since the LWC is such a unique and special area within the Zuni Mountains, I believe that the area of protection should be expanded beyond the original proposed RNA as described by Dunmire and Toll (1987). The Cottonwood Gulch Foundation (Billings, jr. and McCallum 1984) in their comments on the last Cibola National Forest management plan makes an excellent case for expanding the proposed RNA to Hausner Canyon on the east and to Big Water Canyon (Water Canyon on my topographic maps) on the west. I quote directly from the Billings, jr and McCallum (1984) document:

"Little Water Canyon requires protection, but in fact it is
the crown jewel of a much larger area of unusual biotic diversity.
Stretching from Hausner Canyon on the east to Big Water Canyon on
the west (and perhaps beyond, we have not explored Muerto Canyon),
this area combines mesic canyon habitats with the open pine forest
and oak woodland more typical of the region. As a result of this
juxtaposition of habitats, and the range termini alluded to above,
one may hear the congeneric Hammond's Dusky, and Western Flycatchers
singing within a stone's throw of one another. Both
whip-poor-wills (here at the northern edge of their ranges) and
the more widespread Poor Will summer in this area, while the
boreal Olive-sided Flycatcher and the Southern Acorn Woodpecker,
both of which like tall snags, occur in the same canyons. The
Flammulated Owl, Band-tailed Pigeon, Goshawk, Wild Turkey, and
Black Bears are all common in this area, and elk sign has been
reliably identified."

Billings, Jr and McCallum (1984) state further:
"One finds more rare plants as one expands the view from
Little Water Canyon to the Big Water Canyon - Hausner Canyon axis.
Big Water Canyon is the only place in the Zunis on Forest Service
land where thin-leafed alder Alnus tenifloia grows, and the only
specimen of the showy butterflyweed Asclepias tuberosa from the
Zunis was collected in this canyon. Kinnikinnik Arctostaphylos
uva-ursi, a plant found in cold areas throughout the northern
hemisphere, is in one of its southernmost outposts on the rim of
Big Water Canyon, where it grows near stunted plants of its
southwestern relative, point-leaved manzanita (A. pungens). Fine
stands of Blue Spruce occur in Hausner and Ojo Bonito Canyons, making
this transect the center of abundance for that species in the
Zuni Mountains. One last plant is the most noteworthy. In the
pine forest between Hausner and Ojo Bonito Canyons, we innocently

collected a small orchid in 1981. Examination of material in the University of New Mexico Herbarium leads to identification of the specimen as Piperia unalaskensis."

Although I personally have not yet explored these areas, the general area described by Billings, jr and McCallum (1984) probably has not changed much since 1984.

3) The Oso Ridge provides a natural barrier that protects the LWC and the entire area south and west of the ridge. The slopes of the ridge may contain unusual plants and animals. Dana Price and I personally found two orchid species on the northeastern slope of Oso Ridge. The two orchid species are the rat-tail Malaxis (Malaxis soulei) and Western rattlesnake plantain orchid (Goodyera oblongifolia). Oso Ridge should be included in its entirety within the area designated for special management.

4) Areas occupied or utilized by local ranchers and residents should be avoided. Such areas would include the area around the Serna Homestead, Rock Spring and Serna Spring. Several roads present around Muerto Spring suggest that Muerto Spring is affected by livestock usage, which makes it undesirable for protection. At the same time these springs may be important water sources for local ranchers and other residents.

Proposed Boundaries for the Area Designated for Special Management.
1) The entire Little Water Canyon watershed as contained within Cibola National Forest Boundaries must be included in the area.
2) The area should extend east and north to include the Oso Ridge in its entirety, including the upper reaches of Hausner Canyon and Big Notch. The north and east edges of the ridge would form the northern and eastern boundary of the area.
3) The southern boundary of the area would be the Cibola National Forest boundary - the southern boundaries of sections 16,17, 18 of T10N R13W. The southern boundary would be extended eastward to include the southern boundaries of sections 15, 14 and the west half of section 13 (to include Oso Ridge) of T10N R13W.
4) The west boundary should be the Cibola National Forest Boundary or the western boundaries of sections 6,7 and 18 of T10N, R13W.
5) Nearly all of the southern half of T11N, R14W should be included in the designated area for special management. Exceptions would include the area around Muerto Spring (probably most of section 32) and the northern boundary would exclude the road adjacent to Bluewater Creek (i.e., this road would define the northern boundary of the area in T11N R14W). The southern and western boundaries of the area would be the Cibola National Forest boundary formed by the southern boundaries of sections 31-36 of T11N R14W and the western boundary would be the western boundaries of sections 19, 30 and 31 of T11N R14W.
6) The new management area should be certain to include that portion of the original proposed RNA found on the flats on the northeast side of Oso Ridge. According to Dunmire and Toll (1987), "Huge Gambel oaks are found on open meadows and flats co-dominated by ponderosa pine. These stands may well be the best example of Gambel oak in large tree growth form on forest lands in New Mexico."

EXPANDING OUR KNOWLEDGE OF THE LITTLE WATER CANYON AREA
Our knowledge of LWC is very limited. I have reviewed only a few documents describing the area and my personal experience has been limited to two brief visits to LWC. Much more exploration is needed to assess the extent of biotic features within the blue spruce forest, the stream and spring in LWC. Additional exploration is also needed in the entire area designated for special management as described in this document. In addition to biotic features of the area, we need to know the extent of livestock grazing effects within the entire area. Here are some suggestions for further on-the-ground investigation:
1) Determine the number and size of blue spruce trees withing the blue spruce forest.
2) Make a concerted effort to determine what fish and other aquatic organisms make their home in the stream in LWC.
3) A search should be conducted to determine the presence or absence of reptiles and amphibians

in the entire area proposed for special management and especially in the blue spruce forest and adjacent stream.
4) Make a thorough investigation of the blue spruce forest and the entire area for rare plants. A thorough botanical inventory should be conducted within the entire area designated for special management.
5) Explore the flats on the northeast side of Oso Ridge to determine the number and size of Gambel oak trees. These oaks may be representative of near record size oaks and the vegetation community may be rare in New Mexico.
6) Determine the extent of serious livestock grazing impacts throughout the entire area.
7) The size and movement habits of the elk herd should be determined. The number of hunters and their impact on the area should be assessed.
8) A Bioblitz should be conducted throughout the entire area, but especially the blue spruce forest. It would be nice to know if the plants and animals described by Billings, jr and McCallum (1984) really still exist within the area: Piperia unalascensis, both whip-poor-will and poor-will, dusky, Hammond's, western and olive-sided flycatcher, flammulated owl and goshawk.

LITERATURE CITED

Billings, jr., T.M. and D.A. McCallum. 1984. Comments on Cibola National Forest Proposed Plan by the Cottonwood Gulch Foundation. Letter addressed to C. Phil Smith, Forest Supervisor, Cibola National Forest, 10308 Candelaria NE, Albuquerque, NM 87112 from the Cottonwood Gulch Foundation, P.O. Box 969, Thoreau, NM 87323. Letter dated December 4, 1984 and signed by Thomas M. Billings, jr., Director of the Cottonwood Gulch Foundation, and D. Archibald McCallum, Naturalist for the Cottonwood Gulch Foundation.

Coleman, R.A. 2002. The Wild Orchids of Arizona and New Mexico. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, NY.

Dunmire, W.W. and M.S. Toll. 1987. Establishment Record for Little Water Canyon Research Natural Area within Cibola National Forest, Cibola County, New Mexico. Unpublished document prepared for the U.S. Forest Service and dated November 12, 1987.

Fletcher, R. (retired Regional Botanist for the Southwestern Region of the USDA Forest Service). 2015. Personal communication.

NMRPTC (New Mexico Rare Plant Technical Council). 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page: http://nmrareplants.unm.edu (Latest update: 20 April 2015). Cibola County Rare Plant List.

SEINet (SOUTHWEST ENVIRONMENTAL INFORMATION NETWORK), SEINet. 2015. http//:swbiodiversity.org/seinet/index.php. Accessed in September 2015.

Todsen, T. 2000. Artificial Key to the Orchids of New Mexico. The New Mexico Botanist 14: 1-2.

USDA, NRCS. 2015. The PLANTS Database. (http://plants.usda.gov, September 2015). National Plant Data Team, Greensboro, NC 27401-4901 USA.