

APPENDIX A

A Brief Guide to Plant Species in the Yucca Mountain Region: A Compilation to Support Infiltration Studies

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rabbit thorn
California buckwheat bladder-sage
apricot mallow



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Plates 1-16 are photos of the plants on the landscape

Plates 17-24 are photos of plant specimens

Introduction

This botanical guide has been assembled to enable scientists with the Nuclear Regulatory Commission (NRC) and the Center For Nuclear Waste Regulatory Analyses (CNWRA) who are not trained in botany to recognize the most common and important plant species growing on Yucca Mountain. Yucca Mountain is the site of a proposed interment of high-level radioactive waste. A major concern for the safe operation of such a repository is the potential for infiltration of precipitation to become seepage into the proposed repository. In their role of extraction and transpiration of soil water, plants may greatly reduce the infiltration rate. The inclusion of transpiration, specified in terms of leaf cover, rooting patterns, and life cycle, is important for determining the present-day distribution of infiltration rates and for estimating future infiltration rates under different climate conditions. Thus, an understanding of plants and their distribution on Yucca Mountain is central to any determination about infiltration.

Sources of Information Contained in this Guide

This guide was assembled based upon field observations at Yucca Mountain over a period of 2 years, from photographs taken for illustration, and from descriptions and drawings contained in several books. Drawings contained in this guide were copied from these books and included in this guide with the understanding that this guide may be generally distributed as part of an NRC document, but can not be commercially distributed. The drawings associated with each plant description include a circled number corresponding to the source references listed below. In order of reliance and usage, the sources of data and drawings are as follows:

1. Hickman, J.C. (ed.), 1993. *The Jepson Manual: Higher Plants of California*. University of California Press. These illustrations are under copyright by the Regents of the University of California and are reproduced with the permission of the Jepson Herbarium, University of California, Berkeley.
2. Jaeger, E.C., 1969. *Desert Wildflowers*. Stanford University Press (no longer in print). Gratis permission to reproduce these illustrations has been granted by the Stanford University Press.
3. Munz, P.A., 1962. *California Desert Wildflowers*. University of California Press; these illustrations are under copyright by the Regents of the University of California and are reproduced with the permission of the University of California Press.
4. Hitchcock, A.S. 1955. *Vascular plants of the Pacific Northwest*. University of Washington Press.

How to Use

This guide contains only the most common plants that are likely to be encountered at Yucca Mountain. Because of their larger representation on the landscape, these species are also the most important from the hydrologic perspective. In some cases, for example desert larkspur and heliotrope phacelia, the plant may not be very common but is quite showy. Such plants have been included because they may be of interest to the lay scientist in the field.

A key to the plants contained in this guide is not included because of the potential complexity it would present to persons lacking botanical training, and probably more importantly, because of the highly variable phenology that occurs for plants in a desert environment where flowers, fruits or even leaves may be present or absent dependent upon the preceding weather. Instead, labeled color plates are included to provide visual cues to appearance. The plants can then be found within the guide listed alphabetically by common name, scientific name and life form in a species list that follows. Within each life form, the plants are presented alphabetically by scientific name. For cacti and Sandberg bluegrass, color plates are

lacking. Illustrations have been copied from the four sources listed and placed adjacent to the plant descriptions. The source for each illustration is cued by (1), (2), (3) or (4), in the order of the four sources listed above.

The plants in this guide are divided into the following life forms:

grasses - further divided into annual and perennial

forbs - non-grass herbaceous species, further divided into annual and perennial

shrubs - which may have woody branches that persist for more than one year

trees - at Yucca Mountain the sole plant fitting this life form is the Joshua tree

cacti- thorny and succulent, all members of the cactus family

Each species has been classified into one of these life form for discussion within the text.

Species List

(The list is alphabetic by common name; the names and authorities per Hickman, 1993. Bold numbers denote the order of presentation in the text.)

<u>Species and Authority</u>	<u>Common Name</u>	<u>Life Form</u>
<i>Lycium andersonii</i> Gray	37 Anderson desert thorn	shrub
<i>Sphaeralcea ambigua</i> Gray	16 Apricot mallow	perennial forb
<i>Opuntia basilaris</i> Engelm. & J.Bigelow	47 beavertail cactus	cactus
<i>Artemisia tridentata</i> Nutt.	48 big sagebrush	shrub
<i>Coleogyne ramosissima</i> Torr.	25 blackbrush	shrub
<i>Salazaria mexicana</i> Torr.	41 bladder-sage	shrub
<i>Ambrosia dumosa</i> (Gray) Payne	18 burrow-weed	shrub
<i>Eriogonum fasciculatum</i> Benth.	31 California buckwheat	shrub
<i>Bromus tectorum</i> L.	4 cheatgrass	annual grass
<i>Amsinckia tessellata</i> A. Gray	8 checker fiddleneck	annual forb
<i>Hymenoclea salsola</i> A. Gray	33 cheesebush	shrub
<i>Echinocactus polycephalus</i> Engelm. & J.Bigelow	44 clustered barrel cactus	cactus
<i>Ericameria cooperi</i> (Gray) Hall	29 Cooper goldenbush	shrub
<i>Tetradymia axillaris</i> A. Nels.	42 cottonthorn	shrub
<i>Larrea tridentata</i> (DC.) Cov.	36 creosote bush	shrub
<i>Cuscuta denticulata</i> Engelm.	11 desert dodder	annual forb (parasite)
<i>Mirabilis bigelovii</i> Gray	14 desert four-o'clock	perennial forb
<i>Castilleja angustifolia</i> (Nutt.) G. Don	9 desert Indian paintbrush	perennial forb
<i>Delphinium parishii</i> A. Gray	12 desert larkspur	forb
<i>Achnatherum speciosum</i> Trin. and Rupr. Barkworth	2 desert needlegrass	perenn. grass
<i>Cirsium neomexicanum</i> Gray	10 desert thistle	perennial forb
<i>Eriogonum inflatum</i> Torr. & Frem.	13 desert trumpet	perennial forb
<i>Stephanomeria pauciflora</i> (Torr.) A.Nels.	17 fewflower wirelettuce	perennial forb

Species List, Continued

<u>Species and Authority</u>	<u>Common Name</u>	<u>Life Form</u>
<i>Mammillaria tetrancistra</i> Engelm.	46 fish-hook cactus	cactus
<i>Atriplex canescens</i> (Pursh) Nutt.	20 four-wing saltbush	shrub
<i>Bromus rubens</i> L.	3 foxtail chess	annual grass
<i>Psoralea fremontii</i> (a.Gray) Barneby	40 Fremont indigo bush	shrub
<i>Pleuraphis jamesii</i> Torrey	6 galleta grass	perenn. grass
<i>Opuntia echinocarpa</i> Engelm & J.Bigelow	48 golden cholla	cactus
<i>Ephedra viridis</i> Colville	28 green ephedra	shrub
<i>Echinocereus engelmannii</i> (Engelm) Lemaire	45 hedgehog cactus	cactus
<i>Phacelia crenulata</i> Torr. Ex S. Wats.	15 heliotrope phacelia	annual forb
<i>Achnatherum hymenoides</i> (Roemer & Schultes)	1 Indian ricegrass	perenn. grass
<i>Yucca brevifolia</i> Engelm.	43 Joshua tree	tree
<i>Krameria erecta</i> Willd. Ex J.A. Schultes	34 littleleaf rhatany	shrub
<i>Ericameria linearifolia</i> Urb. & J.Wussow	30 narrowleaf goldenbush	shrub
<i>Chrysothamnus teretifolius</i> (Dur. & Hilg.) Hall	23 needleleaf rabbitbrush	shrub
<i>Ephedra nevadensis</i> S. Wats.	27 Nevada ephedra	shrub
<i>Lycium pallidum</i> Miers	38 rabbit thorn	shrub
<i>Chrysothamnus nauseosus</i> (Pallas) Britton	22 rubber rabbitbrush	shrub
<i>Poa secunda</i> J.S. Presl.	7 Sandberg bluegrass	perenn. grass
<i>Atriplex confertifolia</i> (Torr. & Frem.) S. Wats.	21 shadscale	shrub
<i>Grayia spinosa</i> (Hook.) Moq.	32 spiny hopsage	shrub
<i>Menodora spinescens</i> Gray	39 spiny menodora	shrub
<i>Elymus elymoides</i> (Raf.) Swezey	5 squirreltail	perenn. grass
<i>Chrysothamnus viscidiflorus</i> (Hook.) Nutt.	24 stickyleaf rabbitbrush	shrub
<i>Encelia virginensis</i> A. Nels.	26 Virgin River encelia	shrub
<i>Krascheninnikovia lanata</i> (Pursh)	35 winterfat	shrub

A.D.J. Meuse & Smit

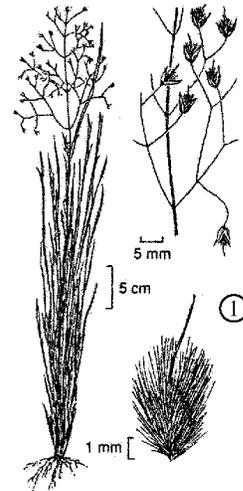
-----Grasses at Yucca Mountain-----

1. *Achnatherum hymenoides* (Roemer & Schultes)

Indian ricegrass. Grass family - Poaceae.

(Plate 21)

This perennial bunchgrass was formerly known as *Oryzopsis hymenoides*. It is generally 2.5-7 cm. tall with narrow (<1mm wide) rolled leaves. The inflorescence is an open panicle (loose feathery collection of branches and spikelets) with the stalks widely spreading and spikelets borne at the tips. It inhabits dry, well-drained soils generally sandy. Native Americans used this species for food.

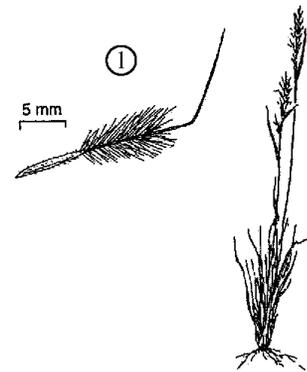


2. *Achnatherum speciosum* Trin. and Rupr. Barkworth

desert needlegrass. Grass family - Poaceae.

(Plates 6 and 23)

A perennial grass formerly known as *Stipa speciosa*, desert needlegrass forms bunches that are 3-6 dm tall. The inflorescence is a spike 10-15 cm long, often partly enclosed by the uppermost leaf sheath. A distinguishing characteristic is the presence of long awns (bristles that extend from the coat around seeds), 35-40 mm, that are once-bent. Desert needlegrass generally inhabits rocky slopes.

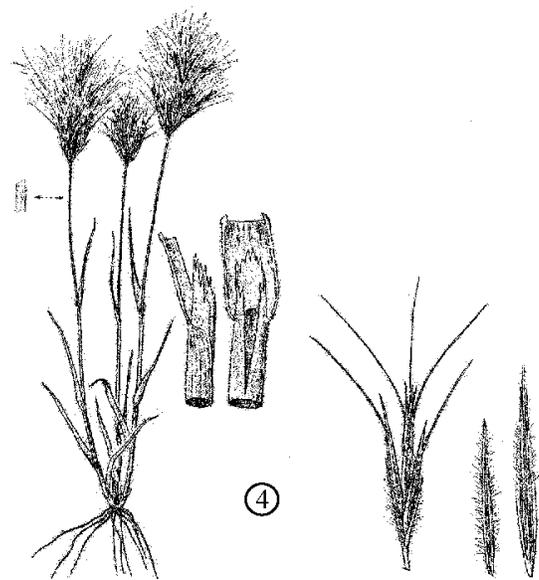


3. *Bromus madritensis* L. foxtail chess.

Grass family - Poaceae.

(Plates 1 and 2)

This annual grass, formerly known as *B. rubens*, is 1-5 dm in stature with short soft-hairy leaf blades and a 3-11 cm cylindrical to slightly compressed inflorescence. This species was introduced from Eurasia and probably reached the region of Yucca Mountain during the 1930's. It has become the dominant annual species on Yucca Mountain and is apparently replacing native shrub species by out-competing their seedlings. Foxtail chess germinates during the fall, grows slowly as a basal rosette during the winter and reaches full growth rate during the spring period at about the time that the seedlings of most native species are just becoming established. The upper elevational limit of this species is partly determined by competition with another weedy brome, cheatgrass. On Yucca Mountain, the upper limit of foxtail dominance may occur between 5,000 and 6,000 feet. Foxtail chess will grow in all habitats on Yucca Mountain but has become established more aggressively in locations where the soil is relatively deep and where slopes are aligned to the south-east through south-west.

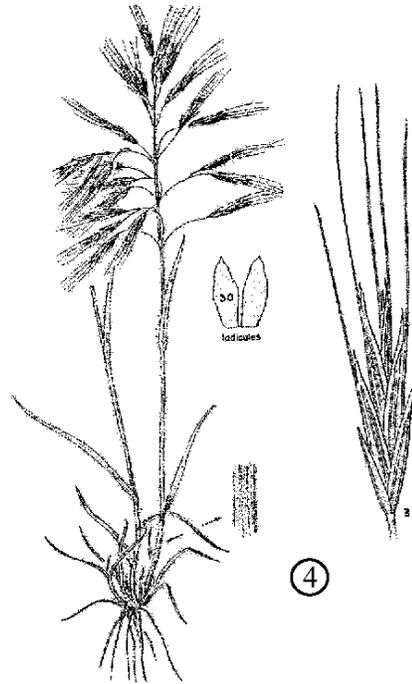


4. *Bromus tectorum* L. **cheatgrass.**

Grass family - Poaceae.

(Plates 1 and 2)

This weedy annual grass was also introduced from Eurasia. It grows between 1-5 dm tall and has a more open inflorescence than foxtail chess that is 6-22 cm long, cylindric to slightly compressed. Leaves are hairless to densely soft hairy and 1-5 mm broad. This species and foxtail chess contrast markedly from native vegetation in the spring and early summer by assuming red-brown color that later in summer turns to a straw color. Like foxtail chess, cheatgrass often germinates during the fall and becomes established over winter, a habit which permits it to out-compete the seedlings of native shrub species and thereby eventually establish near pure stands. This habit and the potential that this species has for carrying wildfire hasten replacement of native shrub species. Presently on Yucca Mountain, the distribution of cheatgrass is spotty. However, in the event of return to cooler and wetter climatic conditions, this species is expected to dominate over foxtail chess since it is dominant at higher elevations and latitudes.

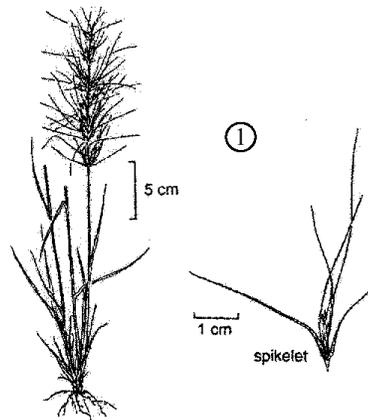


5. *Elymus elymoides* (Raf.) Swezey **squirreltail.**

Grass family - Poaceae.

(Plate 17)

This bunchgrass was formerly known by the name *Sitanion hystrix*. It is 1-6.5 dm tall and can be distinguished easily from other grass species by the appearance of its 2.5-15 cm inflorescence which has long (90 cm) awns that form the appearance of a squirrel's tail. Leaves are generally less than 1 mm broad. This species prefers dry open areas and rocky slopes on Yucca Mountain.

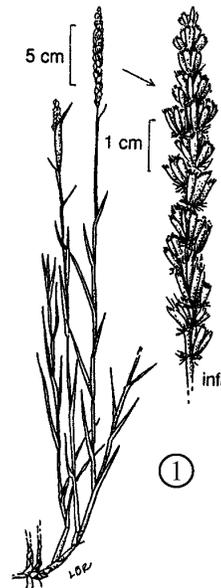


6. *Pleuraphis jamesii* Torrey **galleta grass.**

Grass family - Poaceae.

(Plates 7 and 19)

Formerly known as *Hilaria jamesii*, this small bunchgrass grows 1.5 to 4 dm tall. The leaves are generally basal and the inflorescence is 3-7 cm long with spikelets borne in distinct clusters of 6-9 mm (a distinguishing characteristic for this species). On Yucca Mountain, this species generally inhabits the zone near ridges, most commonly in association with big sagebrush.

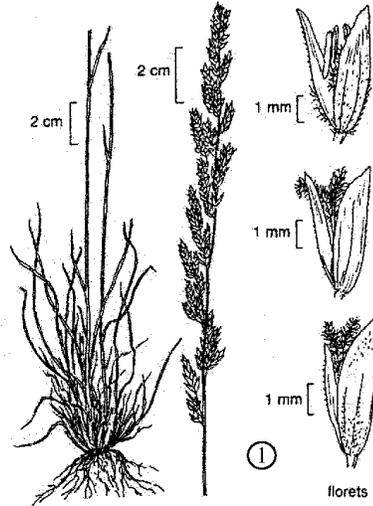


7. *Poa secunda* J.S. Presl. **Sandberg bluegrass.**

Grass family - Poaceae.

(No Plate)

This perennial grass grows in short dense bunches that, on Yucca Mountain tend to be between 1 and 4 dm tall. The inflorescence is 2-10 cm long in an appressed, often one-sided panicle. On Yucca Mountain, this species is generally restricted to north-facing slopes of rocky hillsides.



-----**Forbs at Yucca Mountain**-----

8. *Amsinckia tessellata* Gray **checker fiddleneck.**

Borage family - Boraginaceae.

(Plates 2, 4 and 23)

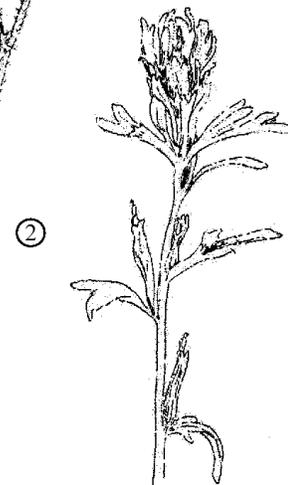
Checker fiddleneck is the most common of the native annual species that inhabit Yucca Mountain. It has yellow or orange flowers that are borne in a scorpioid cyme (curving like a scorpion's tail, with flowers borne along the outside). This species has dense hooked prickles that, to the human skin, are highly irritating. It inhabits sandy soil, often very densely, and is persistent in a dried state for up to a year after growth.



9. *Castilleja angustifolia* (Nutt.) G. Don **Desert Indian paintbrush.** Snapdragon family - Scrophulariaceae.

(Plates 7, 9 and 17)

This perennial species grows 1.5-4.5 dm tall, is few-branched with gray-green foliage. The inflorescence consists of a calyx (sepals, collectively) 15-25 mm, a corolla tube of yellowish green and bracts that are bright red to yellowish orange. On Yucca Mountain it is found on the crest or associated commonly with sagebrush on north-facing hillsides.

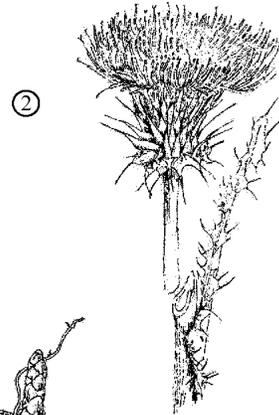


10. *Cirsium neomexicanum* Gray desert thistle.

Aster family - Asteraceae

(Plate 11)

Because this perennial is tall, 4 to 29 dm, with large white to lavender inflorescences, it is easily identified. It inhabits Yucca Mountain along the crest where the erosion-resistant caprock has created deep, relatively well-watered soils between boulders.



11. *Cuscuta denticulata* Engelm. desert dodder.

Dodder family - Cuscutaceae.

(Plate 13)

This annual species is parasitic on shrubs in the creosote scrub vegetation. It can be recognized by its yellow-orange color of its elongated hairlike stems that twine and clasp the branches and leaves of various shrubs and grasses. Within the creosote bush dominated vegetation, this species may form large patches of up to several square miles and, if the infestation is severe, may cause the mortality of shrubs they parasitize.



12. *Delphinium parishii* A. Gray desert larkspur.

Buttercup family - Ranunculaceae.

(Plate 14)

Desert larkspur can be easily identified by its sky-blue, irregular flowers that have a spur extending aft of the point of attachment. Leaves are mostly basal with a few attached to the stem and deeply cleft into several to many lobes. On Yucca Mountain desert larkspur is most commonly found in soils derived from resistant caprock where the remnant rock pans permit extra water to accumulate.

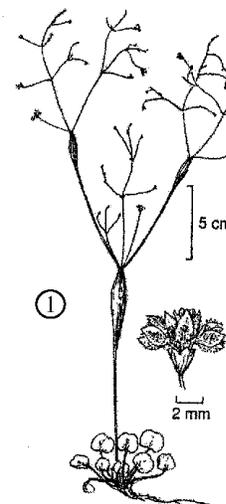


13. *Eriogonum inflatum* Torr. & Frem. desert trumpet.

Buckwheat family - Polygonaceae.

(Plate 19)

The leaves on this annual to perennial species are basal and the upright stems are inflated. The flowers are borne in loose and spreading umbels with the tops at up to 10 dm tall. It is easily identified by its persistent inflated stems.

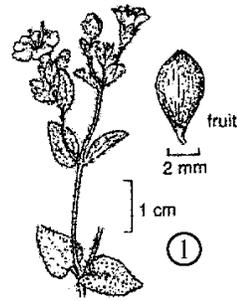


14. *Mirabilis bigelovii* Gray desert four-o'clock.

Four-o'clock family - Nyctaginaceae.

(Plate 16)

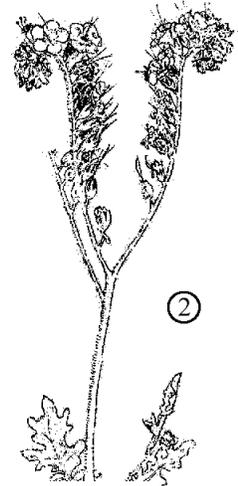
This perennial white-flowered species is less than 8 dm tall with a growth habit of spreading along the ground. The stem and leaves are glandular hairy and bright green. The flower is a five petaled, 12-15 mm long, funnel shaped and slightly hairy. On Yucca Mountain, it is found in protected areas along the sides of the caprock.



15. *Phacelia crenulata* Torr. Ex S. Wats. heliotrope phacelia. Waterleaf family - Hydrophyllaceae.

(Plate 15)

This annual forb is erect (1 to 6 dm tall), with no to few branches from the base. Leaves may have margins that vary from rounded projections to deeply lobed, are 20 to 80 mm long and elliptic. Flowers are bell shaped, blue to purple and borne in a scorpioid cyme. This species is generally found in rocky areas, frequently near the caprock where large rocks provide greater water catchment and protection. Another favored habitat is sandy or gravelly washes where runoff may concentrate additional water.

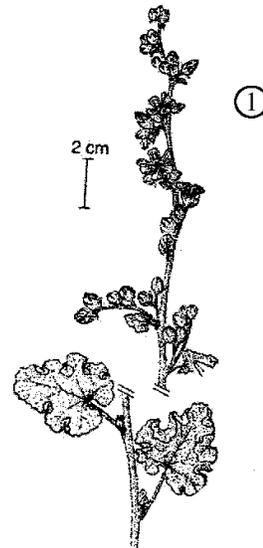


16. *Sphaeralcea ambigua* Gray apricot mallow.

Mallow family - Malvaceae.

(Cover and Plates 6 and 11)

A perennial forb between 5 and 10 dm tall, apricot mallow is covered with hairs (canescent) and has leaves that are 15 to 50 mm, more or less triangular, weakly three lobed with three veins and rounded margins. The flowers are large, regular and five petaled, 20-30 mm across and of red orange to apricot color. This species inhabits all of the micro-environments on Yucca Mountain and is often found in disturbed ground along roadways.

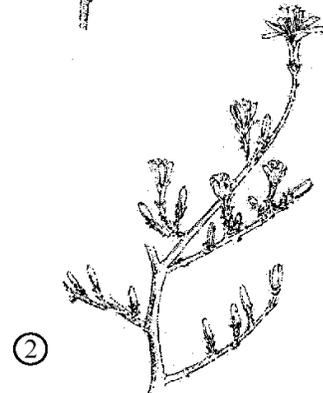


17. *Stephanomeria pauciflora* (Torr.) A.Nels.

fewflower wirelettuce. Aster family - Asteraceae.

(Plate 4)

This perennial forb forms a subshrub (herbaceous with a woody base) that is 3-6 dm in height. The stems are bright green, with no hairs to hairs that are dense and short. The leaves are generally reduced to scales. Flowers are pink with only a few on each plant. On Yucca Mountain this species generally inhabits washes and lower side-slopes.



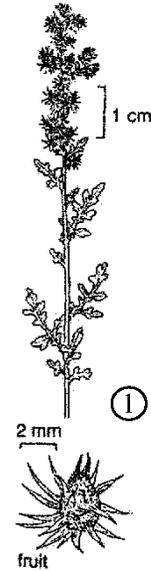
-----**Shrubs at Yucca Mountain**-----

18. *Ambrosia dumosa* (Gray) Payne burrow-weed.

Aster family - Asteraceae

(Plates 8, 12, 14 and 18)

A short 2-9 dm shrub, much branched with soft white pubescence covering leaves and growing stems. Leaves are generally clustered at nodes with the blades 0.5-4 mm long, ovate, and 1-3 pinnate. Flowers are borne in separate staminate and pistillate heads, the latter which are two-flowered. Fruit is a bur. Burrow-weed is commonly found in association with creosote bush. On Yucca Mountain, however, burrow-weed also grows on the steep slopes and ridges where creosote bush is largely absent.

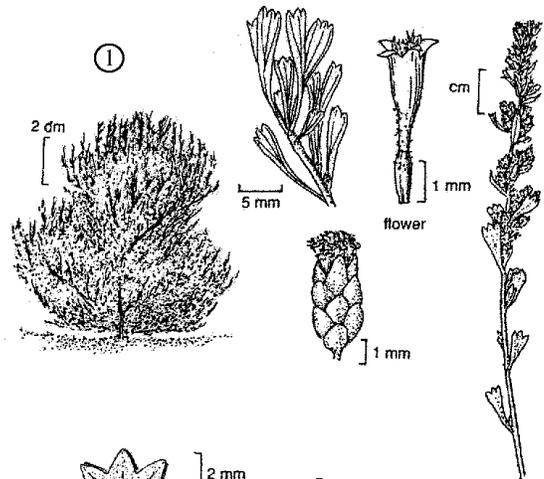


19. *Artemisia tridentata* Nutt. big sagebrush.

Aster family - Asteraceae.

(Plates 8 and 19)

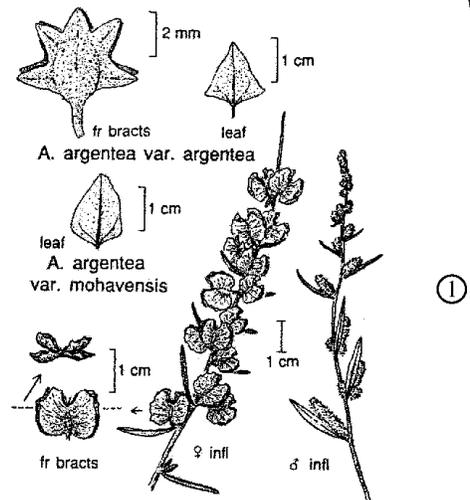
This species of shrub is easily identified with its three-toothed grey-green densely hairy aromatic leaves. It is tall, 5 to 20 dm at Yucca Mountain, and here is found on north facing slopes near the crest. The small flowers (2-2.5 mm diam.) are borne in open cymes in the fall.



20. *Atriplex canescens* (Pursh) Nutt. four-wing saltbush. Goosefoot family - Chenopodiaceae.

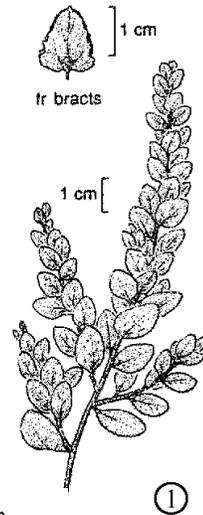
(Plates 10 and 20)

The fruit of the four-wing saltbush is the most easily distinguished characteristic of this 5-20 dm tall shrub that has erect ascending and spreading branches. The leaves are linear to oblanceolate 8-50 mm and covered with dense white scaly hairs. Blooming in the summer, the fruit is four-winged bract that covers the 1.5-2.5 mm seed. These plants are mostly dioecious. On Yucca Mountain fourwing saltbush is found in varied habitats.



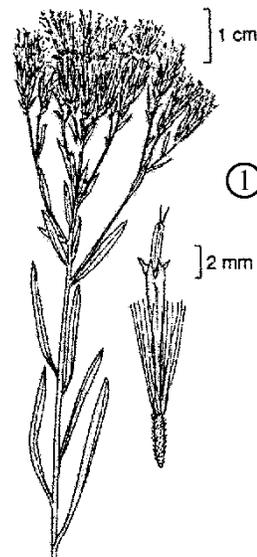
21. *Atriplex confertifolia* (Torr. & Frem.) S. Wats.
shadscale. Goosefoot family - Chenopodiaceae.
 (Plates 6, 12 and 22)

Shadscale is a dioecious shrub that is less than 10 dm tall and having many spreading stiff, often prickly branches. The leaves are short-petioled, elliptic to ovate, 8-24 mm and covered with densely gray scaly. The pistillate inflorescence develops terminal bracts that enclose the seed that may have a fold and that are elliptic to round. This species inhabits all micro-environments on Yucca Mountain.



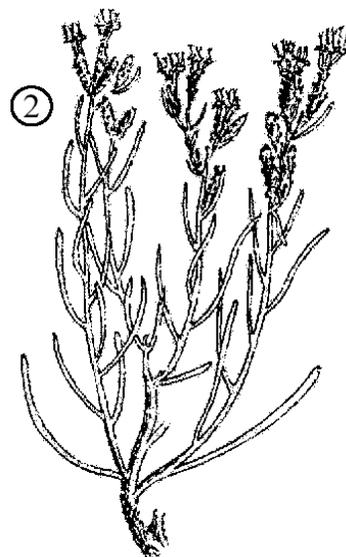
22. *Chrysothamnus nauseosus* (Pallas) Britton
rubber rabbitbrush Aster family - Asteraceae.
 (Plates 7 and 19)

Rubber rabbitbrush is an erect tomentose shrub that may reach 20 dm tall on Yucca Mountain. The leaves are linear and threadlike and tend to be shed during drought leaving the upper stems intact as a photosynthesizing and transpiring surface of restricted area. It blooms in the fall with a profusion of yellow flowers that are borne in umbels that tend to dominate the upper crown. On Yucca Mountain it is restricted to the north-facing slopes near the crest.



23. *Chrysothamnus teretifolius* (Dur. & Hilg.) Hall
needleleaf rabbitbrush . Aster family - Asteraceae.
 (Plates 6, 10, 11 and 20)

Needle-leaved rabbitbrush is a bright green shrub that can achieve 15 dm at Yucca Mountain. It is much branched with brittle gland dotted gland-dotted leaves 1-7.5 cm long that are threadlike, subcylindric, dark green and resinous. It flowers in the fall with yellow flowers borne in cymes. On Yucca Mountain, this species has been found to be strongly associated with rock fissures through which it must receive a more stable supply of water not subject to competition: when more shallow-rooted species have gone dormant and lost all leaves, needleleaf rabbitbrush is green and productive.



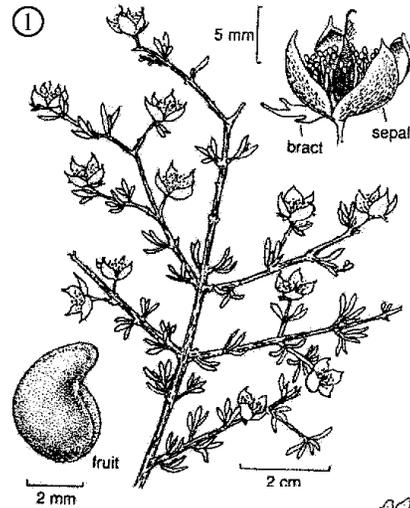
24. *Chrysothamnus viscidiflorus* (Hook.) Nutt.
stickyleaf rabbitbrush Aster family - Asteraceae.
 (Plates 3, 10, 16 and 18)

This rabbitbrush can be distinguished easily from the previous two species by its more yellow appearance and more delicate branches and foliage. On Yucca Mountain it generally grows to no more than 8 dm. Leaves are 1-7.5 cm, 1-10 mm broad and threadlike and very sticky. The inflorescence is a dense, flat-topped cyme, blooming in the fall. On Yucca Mountain, this species is generally found on the crest and on slopes. It is often the first perennial species to colonize a disturbed area.



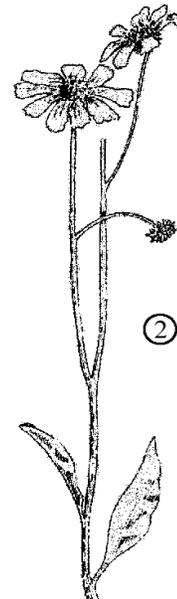
25. *Coleogyne ramosissima* Torrey **blackbrush**
 Rose family - Rosaceae.
 (Plates 5 and 17)

This much branched, often thorny shrub has a dark gray appearance in comparison to other shrubs. The leaves are borne in opposite clusters are 5-15 mm and linear-oblongate. The inflorescence is single, terminal yellow flowers with reddish sepals with the base (an hypanthium) leathery. On Yucca Mountain this species is found in deeper soils at the base of slopes and soils on the crest, It is intolerant of fire: large stands of pure blackbrush indicate sites that have not burned for many centuries.



26. *Encelia virginensis* Nelson **Virgin River encelia.**
 Aster family - Asteraceae.
 (Plates 3 and 23)

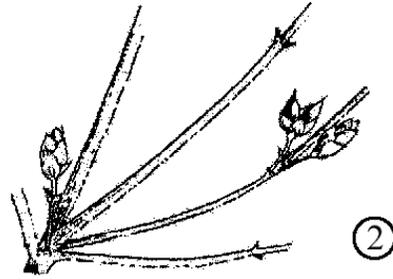
This shrub may be up to 8 dm tall on Yucca Mountain with many slender branches arising only from the base. Young stems and leaves are hairy. Leaves tend to be scattered along the stems with long petioles (2-7 mm) with the leaves 1.2-2.5 cm, ovate to deltate and acute to obtuse tips and gray-green. Ray flowers and disk flowers are present in the inflorescence. This species is found on many types of locations on Yucca Mountain.



27. *Ephedra nevadensis* S. Watson. **Nevada ephedra.**
Ephedra family - Ephedraceae.

(Plates 9 and 24)

This shrub may grow to 8 dm on Yucca Mountain. Its grayish green stems are pale green when young with leaves reduced to scales at the nodes. It is distinguishable from green ephedra by its color. More so than green ephedra, this species spreads clonally and may form large but sparse patches of several meters in diameter. On Yucca Mountain, this species can be found in all habitats.

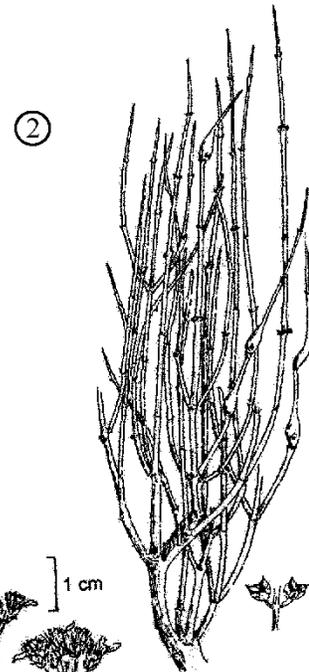


28. *Ephedra viridis* Colville **green ephedra.**

Ephedra family - Ephedraceae.

(Plate 6, 9 and 24)

On Yucca Mountain green ephedra grows much more robust than Nevada ephedra and may reach 15 dm tall. Like the needle-leaved rabbitbrush, the bright green foliage of green ephedra stands out against the more drab background of the other arid plant species. Like the Nevada ephedra, the leaves are reduced and only located nodes. On Yucca Mountain, green ephedra is often found growing around talus slopes that are penetrated by its long root systems. Under these conditions, the talus slope acts as a significant moisture store and green ephedra grows especially robust.

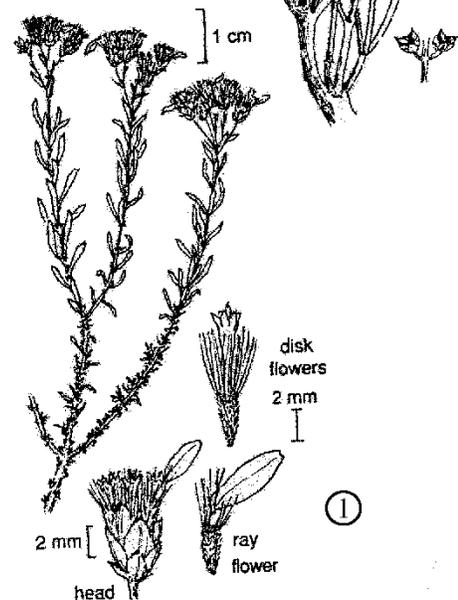


29. *Ericameria cooperi* (Gray) Hall

Cooper goldenbush. Aster family - Asteraceae.

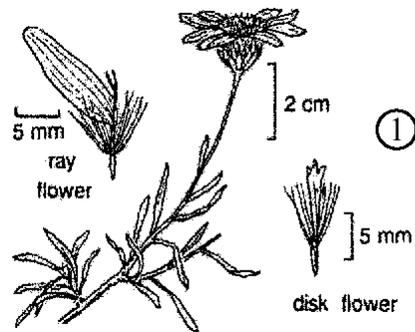
(Plates 4, 8, 10, 16 and 18)

A short, 3-6 dm tall, rounded, dark green shrub. Leaves are 3-15 mm linear, acute, mostly lacking hairs and dotted with glands. The inflorescence is borne in radiate open cymes with the flower heads having ray flowers 0-2 with ligules 4-9 mm and disk flowers 4-12. This shrub may be found in any habitat on Yucca Mountain but generally not on exposed south-facing slopes.



30. *Ericameria linearifolia* Urb. & J. Wussow
narrowleaf goldenbush Aster family - Asteraceae.
 (Plates 3, 9, 10 and 18)

This goldenbush is less rounded than Cooper goldenbush and much less dense. The leaves are dark green and may or may not have fine hairs, are 10-55 mm long, and linear to acute with bases narrowed. The yellow flower heads are relatively large and showy with ray flowers 13-18 and 9-20 mm long. Disk flowers are many. This species tends to be found only on the caprock at Yucca Mountain. Both narrowleaf goldenbush and Cooper goldenbush bloom in the spring.



31. *Eriogonum fasciculatum* (Benth.) Torrey & Gray
California buckwheat. Buckwheat family -
 Polygonaceae.

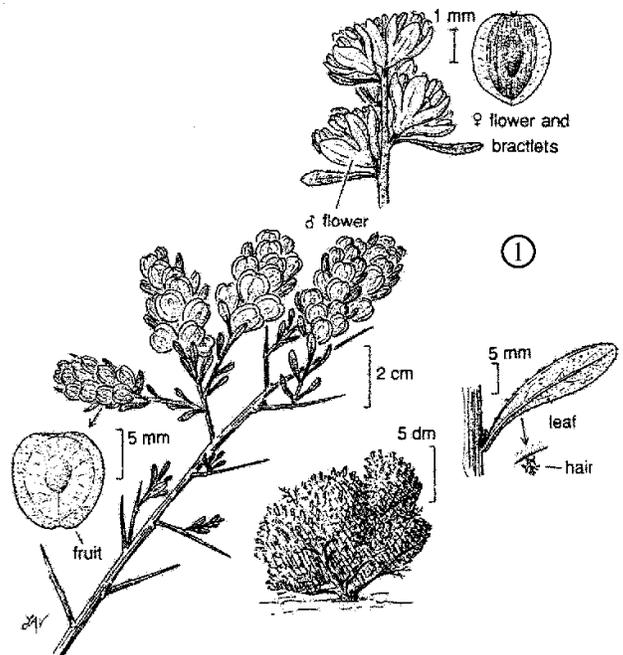
(Cover and Plates 7 and 9)

On Yucca Mountain this shrub grows to 8 dm tall with erect brittle branches. Leaves arise from stems and are clustered at the nodes with blades 6-18 mm, linear to oblanceolate, leathery and rolled under with dense short white hairs on under surfaces. Flowers are cream colored to pinkish and are borne in umbels of heads. On Yucca Mountain, this species may inhabit any habitat but is most numerous on north facing slopes near the crest.



32. *Grayia spinosa* (Hook.) Moq. spiny hopsage
 Goosefoot family - Chenopodiaceae.
 (Plates 4, 6, and 22)

This generally <10 dm shrub has many stiff branches that often have linear striations. Leaves are oblanceolate to elliptic, flat, smooth, bright green and relatively succulent. The bracts of the fruit may have a bright red to purple tinge when nearing maturity in mid- to late-summer. This species may be found in all habitats on Yucca Mountain.

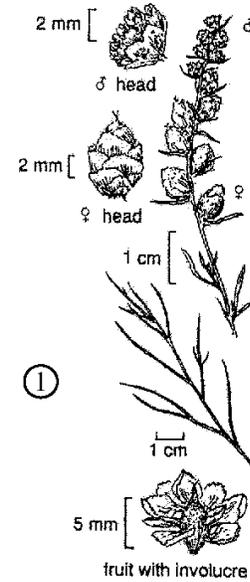


33. *Hymenoclea salsola* A. Gray cheesebush.

Aster family - Asteraceae

(Plates 8 and 18)

This wispy bright green subshrub grows <15 cm at Yucca Mountain. Woody stems are straw colored and the finer new growth is highly branched. The fruit is winged, straw colored and papery with 5-19 wings that are 2-7 mm and 1.5-8 mm wide and often kidney shaped.

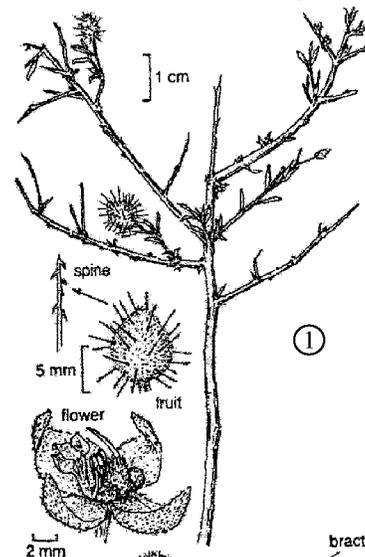


34. *Krameria erecta* Schultes littleleaf rhatany.

Rhatany family - Krameriaceae.

(Plate 21)

The roots of this small shrub (<5 dm) are parasitic on other plants. The stems are relatively delicate and the leaves are linear, about 5 mm long, a dark olive green color and covered with hairs. Flowers are pink with glandular petals and the fruit is covered with spines. In the Yucca Mountain region, this species tends to occupy alluvial terraces and washes but is largely absent from rocky slopes.



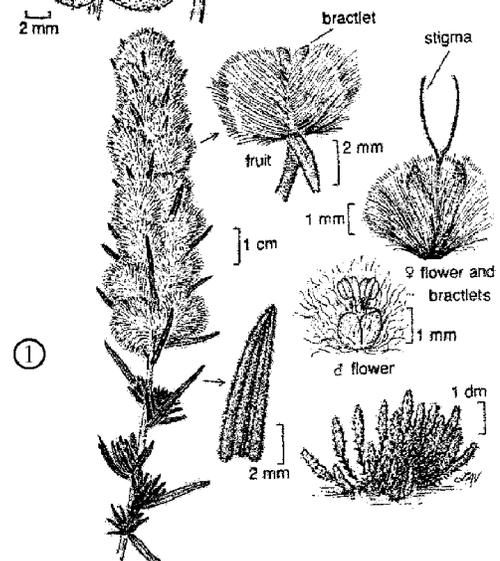
35. *Krascheninnikovia lanata* (Pursh)

A.D.J. Meeuse & Smit **winterfat.**

Goosefoot family - Chenopodiaceae.

(Plate 21)

Winterfat is a common shrub that can be readily distinguished by its whitish appearance due to woolly pubescence covering leaves and stems. It is generally less than 10 dm tall. The fruit has cotton-like hairs and the leaves have inrolled margins and are 6-30 m; 1.5-5 mm wide. On Yucca Mountain winterfat is found in any of the habitats.

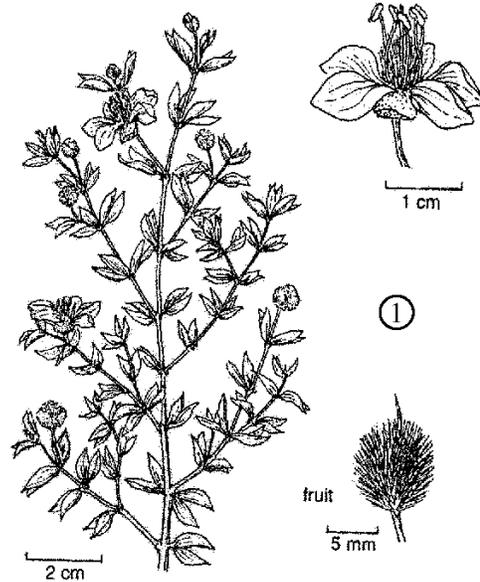


36. *Larrea tridentata* (DC.) Cov. creosote bush.

Caltrop family - Zygophyllaceae

(Plates 8, 13 and 21)

A tall (15-30 dm) widely spreading shrub easily identified by its shiny dark green leaves that are <18 mm long and <8.5 mm wide. Stems are light gray and have pronounced transverse scars from leaf attachment. Flowers are yellow (<2.5 mm wide), petals 5 and clawlike, and in wet years may be quite showy. At Yucca Mountain creosote bush is an indicator of extensive patches of soil that are at least 0.5 m deep. Creosote bush is generally absent from highly rocky slopes.

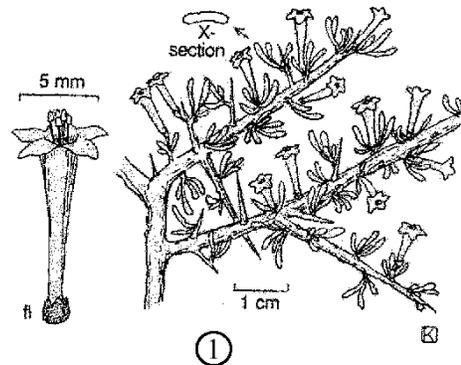


37. *Lycium andersonii* Gray Anderson desert thorn.

Nightshade family - Solanaceae.

(Plates 4 and 21)

This shrub generally lacks hairs on leaves and stems, has erect, stiffly spreading branches and is less than 12 dm tall near Yucca Mountain. Leaves are 3-15 mm, linear and elliptic in cross section. The flowers are funnel-shaped whitish, often with a violet tinge with the tube 5-10 mm long. The fruit is 3-8 mm, red or orange and juicy. On Yucca Mountain, this species is most common in the lower washes and is generally absent on north-facing slopes.

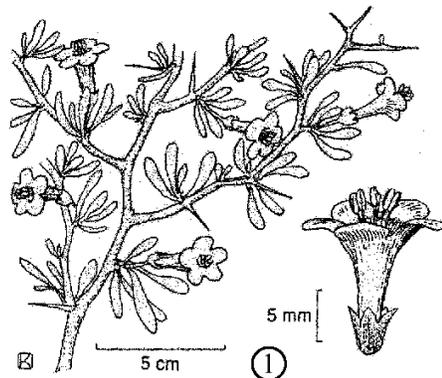


38. *Lycium pallidum* Miers rabbit thorn.

Nightshade family - Solanaceae.

(Cover and Plate 8)

Rabbit thorn is less common than Anderson desert thorn and tends to be more robust. Branches are many, spreading and ascending. All foliage and stems lack hairs. Leaves are oblong to narrowly oblong-ovate with a waxy bloom, 10-50 mm long. Flower tube is 8-12 mm long, bell shaped and greenish white with purple veins. The fruit is fleshy, firm and greenish purple. Near Yucca Mountain, this species is generally restricted to the lower washes.



39. *Menodora spinescens* Gray spiny menodora.
Olive family - Oleaceae.

(Plates 4 and 18)

This short, compact and very green shrub has short intricate branching that gives rise to a profusion of spines. Leaves are alternate or clustered 3-11 mm, oblong to oval and fleshy. Flowers are borne in axils with the white corolla tube 4-9 mm. On Yucca Mountain this species is generally absent from steep rocky slopes, apparently preferring deeper soils.



**40. *Psorothamnus fremontii* (A. Gray) Barneby
Fremont indigo bush.** Pea family - Fabaceae.

(Plate 12)

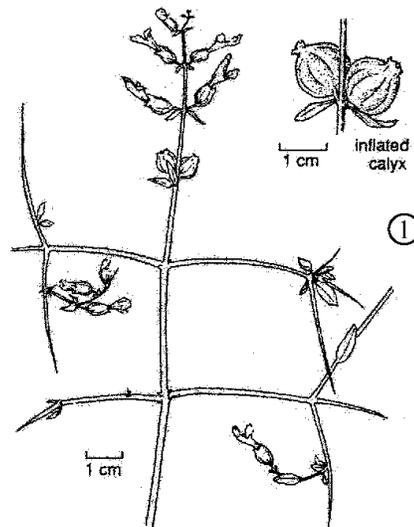
A widely spreading shrub, <10 dm in the Yucca Mountain region. Generally with stiff appressed silvery hairs. Leaves in pinnately compound leaflets, each 3-25 mm. The inflorescence is an open raceme of purple flowers. In the region of Yucca Mountain indigo bush occupies the lowermost washes and alluvial fans. A diagnostic clue is an astringent, pine-like, odor to the leaves and stems when crushed.



41. *Salazaria mexicana* Torrey bladder-sage.
Mint family - Lamiaceae.

(Cover and Plates 9 and 24)

Bladder sage, 8-15 dm tall, can be readily distinguished by bladder-like 1-2 cm fruits in the late summer through early winter period and earlier by its irregular mint-family flowers that are purplish and 15-25 mm long. Its widely divergent branching pattern and sparse foliage are diagnostic. On Yucca Mountain it is found almost exclusively in lower washes.

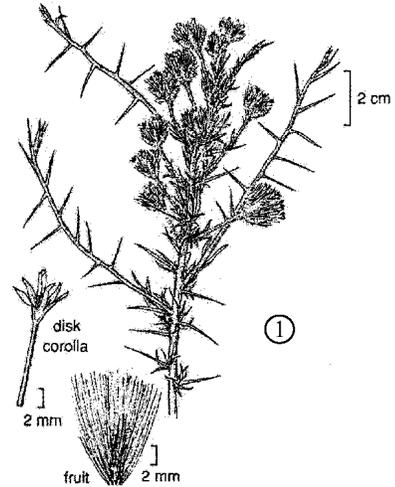


42. *Tetradymia axillaris* A. Nels. cotton-thorn.

Aster family - Asteraceae.

(Plate 15)

This spiny shrub can be readily distinguished by its white densely hair covered stems and lower leaves. It is tall (15 dm) with 1-5 cm leaves that become glabrous and forming straight spines. Flowers, borne 1-3 heads per axil, are yellow, discoid, and about 8 mm long. On Yucca Mountain cotton-thorn is uncommon and found on the rim of the caprock.



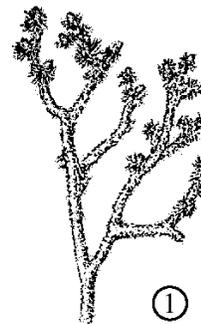
-----Trees at Yucca Mountain-----

43. *Yucca brevifolia* Engelm. Joshua tree.

Lily family - Liliaceae.

(Plate 3)

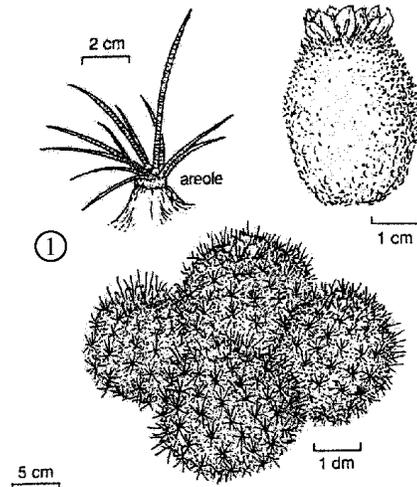
Tree-like open-branched yucca with 20-35 cm thorn-tipped leaves borne in rosettes at branch ends. Flowers are white, and borne at the tips of branches with perianth 4-7 cm long. On Yucca Mountain, Joshua trees are restricted to several clumps on the crest.



-----Cacti at Yucca Mountain-----

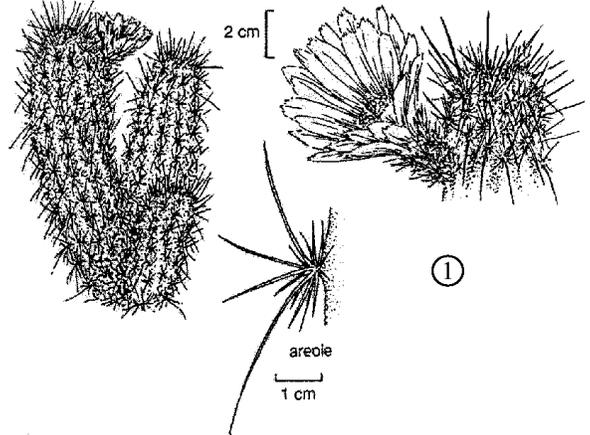
44. *Echinocactus polycephalus* Engelm. & J. Bigelow clustered barrel cactus. Cactus family - Cactaceae
(No Plate)

A less than 10 dm tall cactus with multiple heads (1-30) that are 10-20 cm diameter with 13-21 ribs. Central spines 4, 6-7.5 cm are red or yellow with fine white hairs at the base. Radial spines, 6-8, 3-4.5 cm are spreading, slightly curved and red or yellow. Flower is 4-5 cm diameter with petals yellow tinged with pink. This cactus generally inhabits very rocky locations on Yucca Mountain.



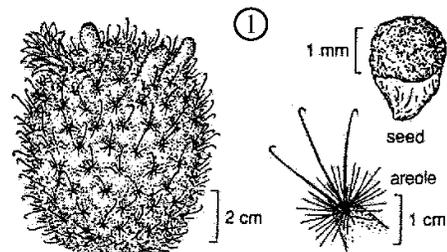
45. *Echinocereus engelmannii* (Engelm) Lemaire hedgehog cactus. Cactus family - Cactaceae.
(No Plate)

This cactus is branched, forming clumps or mounds (<1 m diameter) with numerous branches (<60) that are green, 4-9 cm in diameter, and with 10-13 ribs. Central spines 2-7 and <8 cm and spreading. Radial spines 6-14 are 2-20 cm long. Flower is 5-7.5 cm in diameter and purplish, magenta or lavender in color. This cactus generally inhabits very rocky locations on Yucca Mountain.



46. *Mammillaria tetrancistra* Engelm. fish-hook cactus. Cactus family - Cactaceae.
(No Plate)

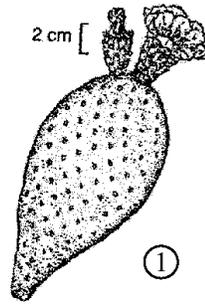
Generally with only one stem, this cactus is 3.5-7.5 cm diameter and 7-25 cm long. Central spines 3-4 are diagnostically hooked. Radial spines number 30-60. Flowers are 2.5-4 cm in diameter and deep pink to lavender. On Yucca Mountain, this cactus is generally found on moderately rocky south-facing slopes.



47. *Opuntia basilaris* Engelm. & J. Bigelow
beavertail cactus. Cactus family - Cactaceae.

(No Plate)

Stems are erect and ascending 7-40 cm with multiple flat segments that bare no spines but many soft highly irritating bristles. The flower is 5-8 cm in diameter and pink-magenta. On Yucca Mountain beavertail cactus may all inhabits except shady north-facing slopes and the crest.



48. *Opuntia echinocarpa* Engelm & J. Bigelow
golden cholla. Cactus family - Cactaceae.

(No Plate)

This cactus has a tree-like form often reaching 15 dm in the Yucca Mountain region. The segments are cylindric 2-3 cm diameter with spines <4 cm in length and of a silver to golden translucent appearance that gives this species its common name. The flower is green yellow and <2.5 cm diameter. At Yucca Mountain this species inhabits alluvial fans and lower washes.

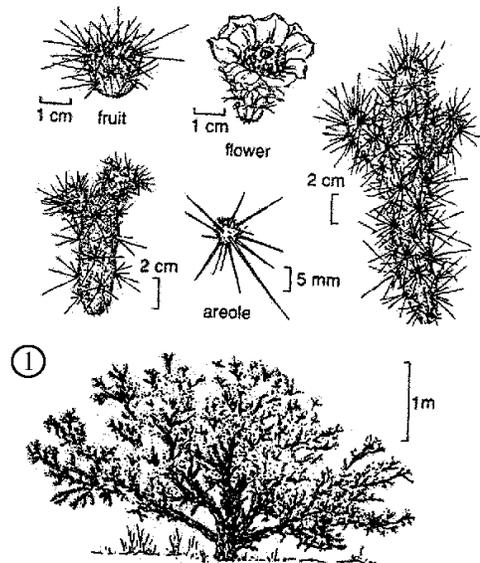


Plate 1



foxtail chess

cheatgrass

Plate 2

cheatgrass

checker fiddleneck

foxtail chess





Joshua tree

Plate 3

foxtail chess

narrow-leaved goldenbush

sticky-leaved rabbitbrush

Virgin River encelia

Cooper goldenbush

foxtail chess

Plate 4

spiny menodora

Anderson desert thorn

fewflower wirelettuce



Plate 5

Cooper goldenbush

checker fiddleneck



blackbrush

winterfat

foxtail chess

Plate 6

desert needlegrass

winterfat

shadscale (male)

needle-leaved rabbitbrush

spiny hobsage

green ephedra

foxtail chess



Plate 7

big sagebrush

desert Indian paintbrush

rubber rabbitbrush



galleta grass

California buckwheat

Plate 8

rabbit thorn

burro-weed

cheese weed

creosote bush



Plate 9

narrow-leaved goldenbush blackbrush bladder-sage green ephedra



desert Indian paintbrush

Nevada ephedra

California buckwheat

Plate 10

narrow-leaved goldenbush four-winged saltbush
Cooper goldenbush sticky-leaved rabbitbrush California buckwheat

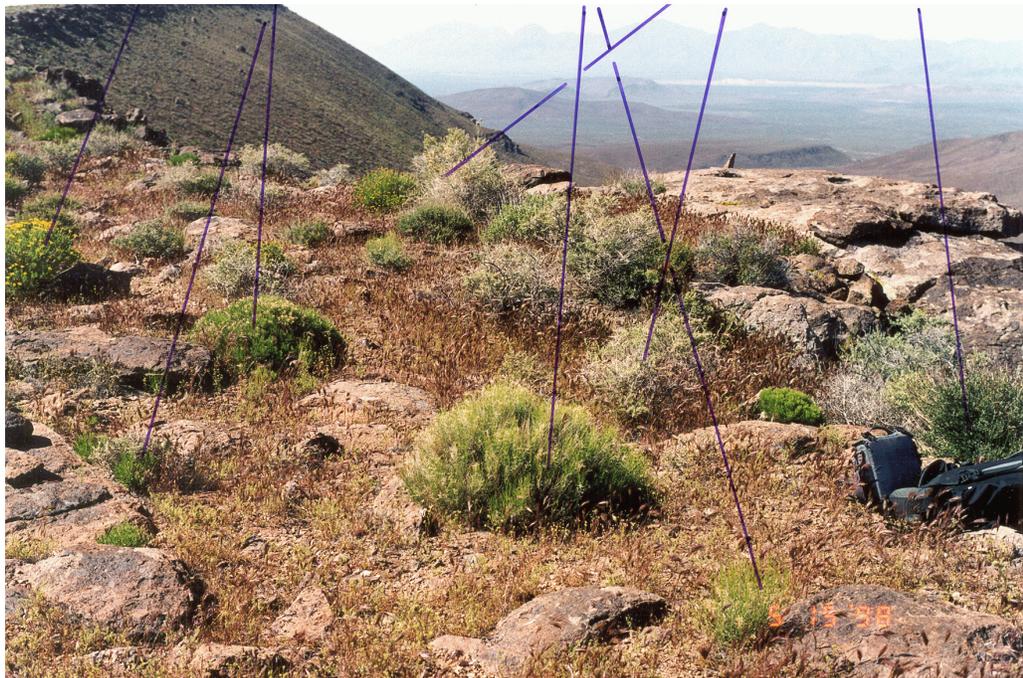


Plate 11

needle-leaved rabbitbrush

spiny hopsage

desert thistle



foxtail chess

winterfat

apricot mallow

Plate 12

shadscale (female)

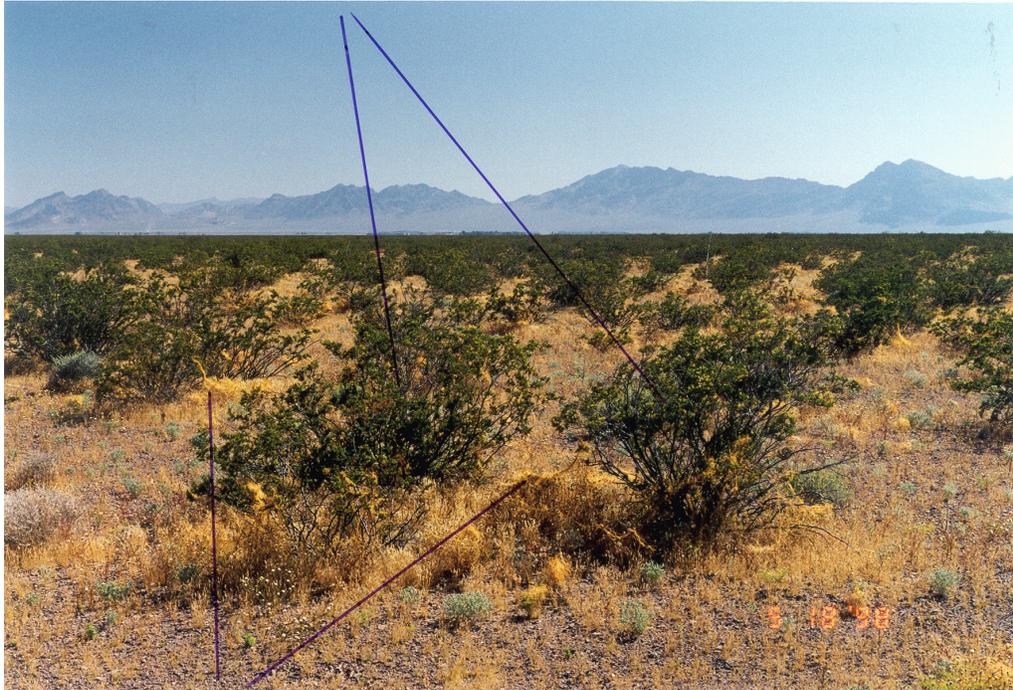
burro-weed

Fremont indigo bush



Plate 13

creosote bush



desert dodder

Plate 14

burro-weed foxtail chess desert larkspur winterfat





cottonthorn

Plate 15

heliotrope phacelia

checker fiddleneck

Plate 16

Cooper goldenbush desert four-o'clock



Plate 17

squirreltail
blackbrush narrow-leaved goldenbush
desert Indian paintbrush



Plate 18

Cooper goldenbush spiny menodora
cheesebush burro-weed



Plate 19

galleta grass
desert trumpet

big sagebrush
rubber rabbitbrush



Plate 20

four-wing saltbush (male)
sticky rabbitbrush

four-wing saltbush (female)
needle-leaved rabbitbrush



Plate 21

burro-weed little leaf rhatany
 Indian rice grass
Anderson desert thorn creosote bush



Plate 22

spiny hopsage (with fruit) shadscale (male)
spiny hopsage (without fruit) winterfat



Plate 23

desert needlegrass
checker fiddleneck Virgin River encelia



Plate 24

green ephedra bladder-sage
Nevada ephedra California buckwheat

