# DEATH VALLEY NATIONAL PARK TRAVERTINE SPRINGS COMPLEX VEGETATION

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## PROJECT OVERVIEW

The Travertine Springs complex (referred hereafter as Travertine Springs) in Death Valley National Park, California, includes water discharge from several springs and associated runoff drainages. Travertine Springs supports a relatively diverse plant community that has not been mapped prior to this report. This document presents the findings of US Geological Survey (USGS) studies of the Travertine Springs plant communities as requested by the Natural Resources Division of Death Valley National Park.

The objectives of this project are:

- To characterize the vegetation communities surrounding Travertine Springs and associated washes flowing from the springs, and
- To develop a digital map of the vegetation communities using National Vegetation Classification standards

The project products include this report with accompanying hardcopy map and CD-ROM. The 'Read me' file for the CD is included in the appendices (Appendix A) and includes recommended citations for the various digital products. In summary the digital data included are:

Vegetation Data
- Tree point map (athel and Palm) (shapefile and coverage) and metadata
- Vegetation map (shapefile and coverage) and metadata

Ancillary Data
- Death Valley National Park Boundary (shapefile and coverage)
- Road segments within the study area (shapefile and coverage)
- Study area for Travertine Springs Complex (shapefile and coverage) and metadata
- Digital ortho quarter quads (DOQQ's) for study area (GeoTiff) and metadata

Field Data
- Database of field observations (Access)

Printable map
- An image of the map (jpg and Powerpoint)

Project Report
- This report (.pdf)

Metadata is included for coverages and shapefiles developed by the project and for the DOQQ's.

## BACKGROUND

### The Travertine Springs

This project was conducted in Death Valley National Park in the eastern Mojave of California. The mapped areas included Travertine Springs and vegetation on the upland habitat immediately adjacent to wetland areas; with the wetland and phreatophytic vegetation the mapping target. The study area is contained within approximately 2 sq. miles about one and a quarter mile east of Furnace Creek Ranch and extending southeast to an area just south of State 190 as it parallels Furnace Creek Wash (Figure 1). The spring complex covers approximately 20% of the study area. The main springs are Texas and Travertine Springs. However, these springs discharge from multiple points and "identification of any single discharge point as being a Travertine, Texas, or an undeveloped spring is only a matter of which of two water-collecting systems the springs discharge into" (Pistrang and Kunkel 1958).

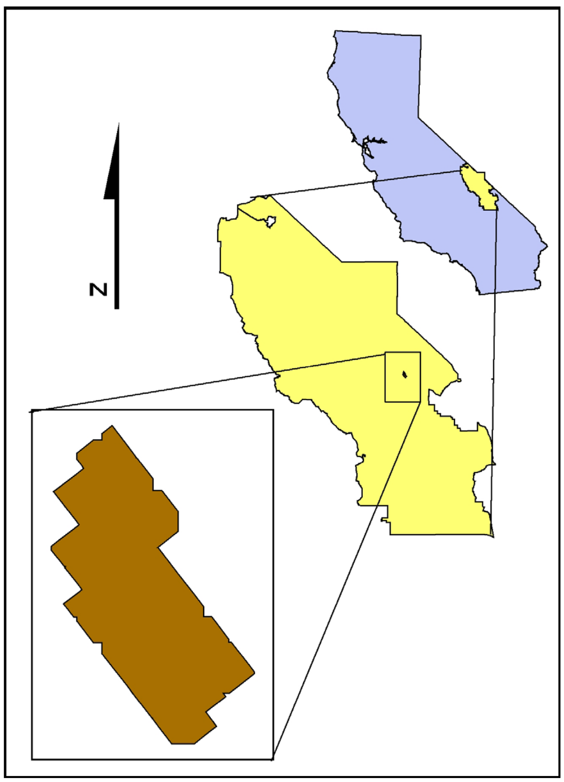


Figure 1. The location of Travertine Springs within Death Valley National Park and California.

The study area ranges from sea level to 250 feet in elevation within an extremely hot, 115° F average high in July, and arid, 1.92" average yearly precipitation, environment (http://www.nps.gov/deva/FrameSet-weather.htm). Aside from vegetation associated with the springs and immediate uplands, the area is barren (Figure 2). The area is on a west-southwesterly sloping alluvium covered pediment derived from the Funeral Mountains on the east (Pristang and Kunkel 1958) with the springs and associated runoff often incised. Many of the springs are surrounded by tuffaceous silt and clay, derived from Pliocene or Pleistocene lake deposits. The name travertine derives from precipitated calcium carbonate around the spring discharge points and around former spring discharge points.

The springs have been a source of water for habitants of Death Valley in recent, Anglo settlement and pre-settlement times. Various Native American tribes have used the springs throughout history, with the Timbisha Shoshone being the most local. It is likely that the springs were known to early Anglo-American travelers to the eastern Mojave Desert such as the Bennett and Arcan party that camped at Travertine Springs near the mouth of Furnace Creek in January of 1850 (Lingenfelter 1986). Andrew Jackson

Laswell was the first settler in the general area; he started a hay ranch at the mouth of Furnace Creek around 1875 (Lingenfelter 1986), which he abandoned shortly after. But it was most likely this site that became the Greenland Ranch seven years later, in 1882. Greenland Ranch was established to supply alfalfa, vegetables, and fruit to workers of the Harmony Borax Works. The first diversion of Furnace Creek consisted of a mile long irrigation ditch to the ranch. The Harmony Borax Works shut down in 1888 and the Greenland Ranch was left to a single caretaker after 1890 (Lingenfelter 1986). Borax production and management in this area continued with the purchase of Harmony Borax Works property by Pacific Coast Borax, which later consolidated into Borax Consolidated. The USDA supported the planting of date palms at the Greenland Ranch in 1922 (Davenport, Death Valley NP library curator, pers. comm.). In 1926, the Furnace Creek Inn was built. The building of the hotel, which was sponsored by the borax industry and their railroad connections, marked the beginning of actively endorsed tourism in the area. The development at Furnace Creek Ranch and Inn, now owned by Xanterra Parks and Resorts®, the Timbisha Shoshone tribal lands near the Furnace Creek Ranch and Inn and the National Park Service are now all contenders for the use of the water that discharges from the spring complex. (Pristang and Kunkel 1958). Other authors have described the hydrology of the springs (Crippen 1963 and Belcher 2004) including, most recently, the Reconstruction of the Furnace Creek Water Collection System Final Environmental Impact Statement (Death Valley National Park 2006).

Figure 2. Overview of Travertine Springs Complex at Death Valley National Park showing barren habitat except for incised springs and drainage basins.

### The National Vegetation Classification System

Vegetation scientists usually describe assemblages of plants by a classification system, which assumes that there are characteristic and repeated groupings of species across the environment. While these plant groupings may not show consistency temporally, they may be considered a static geographic entity that can be mapped for a particular time period. The Federal Geographic Data Committee (FGDC) recognized the need for a consistent standard for vegetation classification and reporting of vegetation statistics (1997). To that end, they adopted the National Vegetation Classification (NVC, Grossman et al. 1998) for inventory, mapping and reporting on vegetation resources. The standard is based on earlier work on vegetation classification such as the UNESCO (1973) and Driscoll et al. (1984).

NVC is a hierarchical classification with the upper levels (system, class, subclass, group, subgroup and formation) describing physiognomic levels of the vegetation and the lower levels (alliance and association) based on floristic levels of the vegetation. The standards (FGDC 1997) describe the upper level categories, but do not yet describe alliances and associations.

An alliance is described as a 'physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species, which as a rule are found in the uppermost stratum of the vegetation' (Grossman et al. 1998). An association is 'characterized by diagnostic species that occur in all strata (overstory and understory) of the vegetation' (FGDC 1997).

NatureServe, a non-profit conservation organization, has maintained a repository of occurrence descriptions of alliances and associations that is used as the review standard for description of NVC vegetation types for the USGS-NPS Vegetation Mapping Program. This repository, the Biological Conservation Datasystem database, is part of NatureServe's International Classification of Ecological Communities (ICEC) which is based upon the NVC framework. ICEC is currently the only source for review and national documentation of NVC alliances and associations. NatureServe's maintains a web site in which information on documented associations and alliances are available; see http://www.natureserve.org/explorer/

## METHODS

### Imagery and Imagery Interpretation

The Park had acquired true color digital aerial photography at 1:2400 scale (0.3 foot pixel resolution) in 1993. The photography had been later orthorectified to UTM Zone 11 WGS 1984 datum. Fifty-nine photos of the study area were provided to the USGS in late 2000 for vegetation mapping; however, not all of these photos contained springs or wash outflow areas.

A USGS image analyst used the Earth Resources Research Institute© (ESRI) ArcInfo Image Analysis extension to view the aerial imagery and to interpret and delineate initial vegetation polygons. The image analyst identified polygons around drainage channels and spring sites. Each delineated polygon was assigned an alphanumeric number that related the polygon to an image and to the polygon number within the image but was not assigned a vegetation type at this step. In addition, occurrences of single athel (*Tamarix aphylla*) and palm (*Phoenix dactylifera* or *Washingtonia filifera)* trees were indicated by either a polygon or a point.

Based on input from field observations (see below), the image analyst adjusted the polygon boundaries. Polygons identifying plant communities characteristic of xeric upland habitat were maintained where the dry upland community was interspersed with the target mesic plant community.

**Field Observations**

We conducted a field floristic assessment of the springs and associated drainage channels in January and March 2001. We used field maps of the initial vegetation polygons overlain on an imagery backdrop to locate nearly half of the delineated polygons. We compared the initial vegetation polygon configuration determined from the aerial imagery with what was observed in the field and corrections to polygon line delineation were made on the field maps. Also, some polygons were subdivided based on field observations. Within each polygon all perennial species present were noted and their cover within the polygon were visually assigned a cover class using a categorical scale that relates the cover class to a percent cover range (Table 1).

Table 1. Cover class and cover percentage values used to attribute vegetation polygons for the Travertine Springs.

| Percent Cover | <1% | 1-9% | 10-24% | 25-49% | 50-75% | >75% |
|---|---|---|---|---|---|---|
| Cover Class | 1 | 2 | 3 | 4 | 5 | 6 |

**Data Management and Analysis**

Species composition and cover data for each polygon assessed in the field was recorded in a database using the USDA PLANTS codes for species names and then exported into a species composition and cover matrix (species matrix) for assessment of species frequency, richness and dominance. The database was subset into datasets that represented the dominant lifeform of the polygon: tree/large shrub, shrub, grass.

Cluster analysis, a group of multivariate techniques that can be used to define groups of observations based on their similarity, was then applied to each of the lifeform datasets using PC-Ord software program version 4.36 (McCune and Mefford 1999). We used an agglomerative method of cluster analysis, group averaging, with the distance measure defined as by Sorensen's coefficient (also known as the Czekanowski or Jaccard coefficient).

We examined descriptions of alliances and associations as occurs in the ICEC database to identify vegetation types that describe the species groups determined in the classification analysis. Each polygon was assigned a vegetation type label by iteratively examining the vegetation descriptions in the ICEC, the species composition and cover matrix, and the group averaging clusters.

### Map Production

The corrected and updated polygons from each image were mosaiced within a geographic information system (GIS) environment. Each polygon was assigned a map class label based on the alliance or association that characterized the plant species assemblages found at the polygon's location. Individual tree species were maintained as point features or as polygons in some cases. As 44% of the polygons had been field verified, no additional accuracy assessment was conducted.

## RESULTS and DISCUSSION

Two-hundred twenty four vegetation polygons were mapped representing 12 vegetation types: 3 alliances, 7 associations, and a single tree species (Table 2). Ninety-nine of these polygons were visited in the field. The vegetation polygons ranged in size from 31 meters squared to 16,330 meters squared, with a mean of 963 meters.

Table 2. Mapped vegetation at Travertine Springs Death Valley.

| **Vegetation type** | **#Polygons** | **Area (m sq)** |
|---|---|---|
| *Andropogon glomeratus* Temporarily Flooded Herbaceous Alliance | 1 | 36 |
| Athel | 6 | 1490 |
| *Atriplex hymenelytra* Shrubland | 2 | 2927 |
| *Baccharis sergiloides* Shrubland | 5 | 3000 |
| *Distichlis spicata* Herbaceous Vegetation | 9 | 6003 |
| Mixed Herbaceous | 1 | 310 |
| *Pluchea sericea* Seasonally Flooded Shrubland | 44 | 62595 |
| *Prosopis glandulosa* Shrubland | 136 | 120844 |
| *Prosopis pubescens* Shrubland Alliance | 4 | 9367 |
| *Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation | 10 | 7157 |
| *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance | 5 | 1487 |
| *Typha domingensis* Western Herbaceous Vegetation (Provisional) | 1 | 600 |
| *Total* | 224 | 215,816 |

The most abundant vegetation type is *Prosopis glandulosa* Shrubland followed by *Pluchea sericea* Seasonally Flooded Shrubland. One polygon was a mixture of herbaceous species that could not be classified due to lack of dominance of any one grass or forb. The athel tree polygons do not represent all occurrences of athel in the study area. The larger trees were mapped as polygons and numerous smaller trees are indicated as point occurrences on a separate GIS coverage with 15 point locations for athel. On the same coverage, the point location of 155 palm trees are indicated. Both the athel and the palms are not native to the Travertine Springs, and were being removed from some locations in the spring complex at the time of the field observations.

Forty-three plant species are listed for the Travertine Springs area (Appendix B). These include 32 plant species recorded on the 99 polygons visited in the field during the USGS survey conducted in 2001. Additional species noted in the Travertine Springs complex by former park botanist D. York (pers. comm. 2006) and from biological surveys conducted by Schramm (1982) and by McDougall (1945) are also listed in Appendix B. An additional species, *Iva acerosa* (cooper weed), was last seen at Texas Springs in 1937 and is possibly extirpated that area as it has not been relocated in subsequent searches, including ours (D. York, pers. comm. 2006).

Seven of the 43 plants listed for the Travertine Springs complex are annual or biennial. Of these only one was found during the USGS field measurements, *Polypogon monspeliensis* (annual rabbitsfoot grass). Four non-native species were found during the field survey: the annual rabbitsfoot grass, *Phoenix dactylifera* (the data palm), *Tamarix aphylla* (athel) and *Tamarix ramosissima* (saltcedar). Schramm (1982) also listed the introduced forb *Bassia hyssopifolia* (fivehorn smotherweed). While the annual rabbitsfoot grass was detected in only six of the 99 field plots visited, this may be an under representation of its presence since the most intense field sampling occurred in January when this annual grass would not be evident. Additional non-native annual grasses, such as *Cynodon dactylon* (Bermuda grass), may have been present but not apparent. The two tamarix species and the data palm were abundant, occurring within mapped polygons, and as scattered trees. One other palm, *Washingtonia filifera* (California fan palm), is native to the state, but is considered introduced to the Travertine Springs complex. The California Invasive Plant Council, CAL-IPC, (http://www.cal-ipc.org/ip/inventory/) rating of each species is provided in Appendix B. Only saltcedar is rated with high potential for ecological impact. However, a rating of limited is applied where the species is invasive but there is not sufficient statewide impact or not enough information is available for the species to justify a high impact score. Annual rabbitsfoot grass is a facultative wetland species so its distribution is limited. Its potential local ecological impacts should not be ignored. The biological and ecological considerations for CAL-IPC assessments are available for each species on the Cal-IPC web site or on the Southwest Exotic Plant Information Clearinghouse (http://www.usgs.nau.edu/SWEPIC/).

The five most common species among the polygons visited were *Pluchea sericea* (arrowweed, 75% of the polygons), *Prosopis glandulosa* (honey-mesquite, 71%), *Distichlis spicata* (saltgrass, 64%), *Baccharis sergiloides* (desert baccharis, 45%), and *Atriplex hymenelytra* (desert holly, 36%). With the exception of *Atriplex hymenelytra*, these four other species also had the most cover among all plots. *Sporobolus airoides* had more overall cover than *Atriplex hymenelytra*. Twelve species occurred in only one polygon each. Notable among the species with restricted distribution are the interesting *Vitis girdiana* (desert wild grape), the culturally important *Anemopsis californica* (yerba mansa), the rare *Fimbrystylis thermalis* (hot-springs fimbristylis), the near endemic *Sisyrinchium funereum* (Funeral Mountain blue-eyed grass) and the uncommon *Schoenus nigricans* (black sedge). Species richness on each visited polygon varied from 1 to 12 species, with an average of 5.

The NatureServe Explorer web site provides the descriptions for each of the alliances and associations mapped. Following is a short description of each alliance and association with the conservation status of the vegetation as rated by NatureServe.

*Andropogon glomeratus* Temporarily Flooded Herbaceous Alliance: While the dominant grass species *Andropogon glomeratus* (Figure 3), bushy bluestem, has been described in California, this alliance has only been documented for the gulf coast and southern Atlantic states where it occurs in disturbed wetlands, low lying areas and/or ditches in old fields. No conservation status rating has been assigned to this alliance. The vegetation is most likely not an indication of a rare vegetation type; however, the rare hot-springs fimbristylis, *Fimbrystylis thermalis*, is expected to occur with this vegetation type (D. York, pers. comm. 2006).

*Atriplex hymenelytra* Shrubland: This upland shrubland is dominated by a Chenopod shrub commonly known as desert holly. The shrubland has been documented in California and Nevada and has a conservation rating of G5, secure.

*Baccharis sergiloides* Shrubland: This shrubland (Figure 4) typically occurs in intermittently flooded habitat. It has been documented in California but has not yet been assigned a conservation rating.

*Distichlis spicata* Herbaceous Vegetation: This grassland (Figure 5), dominated by saltgrass, occurs in intermittently flooded, often saline, areas in the semi-arid and arid west. The rare black sedge, *Schoenus nigricans*, is expected to occur with this vegetation type (D. York, pers. comm. 2006). The alliance is rated G5, secure.

*Pluchea sericea* Seasonally Flooded Shrubland: This shrubland (Figure 6) is dominated by the evergreen arrowweed. It has been documented in California and Utah in wetlands and floodplains. It is rated G3, vulnerable.

*Prosopis glandulosa* Shrubland: This shrubland (Figure 4) is dominated by honey mesquite and is indicative of wetlands. It has described by NatureServe in the arid west; however, not yet in California. It is rated G3, vulnerable.

*Prosopis pubescens* Shrubland Alliance: This shrubland is dominated by American screwbean and is also indicative of wetlands. Currently is described for New Mexico but not California. No conservation status has been assigned.

Figure 3. *Andropogon glomeratus*, a grass that dominates one vegetation polygon.

Figure 4. *Baccharis sergiloides* Shrubland at the Travertine Springs Death Valley.

Figure 5. *Distichlis spicata* Herbaceous Vegetation at the center right and *Prosopis glandulosa* Shrubland to the left overlooking Texas Springs in the Travertine Springs Complex, Death Valley. Honey mesquite was dormant when the photo was taken and had no leaves.

*Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation: This grassland is dominated by a mixture of two grasses, the alkali sacaton and saltgrass and is indicative of wetland conditions. It has been documented in the arid west, but not yet in California. It is rated G4, apparently secure.

*Sporobolus airoides* Intermittently Flooded Herbaceous Alliance: This grassland (Figure 7) is dominated by alkali sacaton and is typical of saline and alkali habitats. It has not yet been documented in California, but has been documented in the arid west. Alkali sacaton has been reported to be less tolerant of saline conditions than salt-grass. It has not been assigned a conservation status. The rare Death Valley blue-eyed-grass, *Sisyrinchium funereum*, is expected to occur with this vegetation type (D. York, pers. comm. 2006).

*Typha domingensis* Western Herbaceous Vegetation (provisional): This alliance (Figure 8) has not been previously described. Currently NatureServe documents *Typha* (*angustifolia/latifolia*) Western Herbaceous Vegetation as an accepted alliance but not one dominated by *T. domingensis*. However, *Typha latifolia* has never been documented in Death Valley and the presence of *T. angustifolia*, as it is currently described, has not been documented by park botanists (D. York, pers. comm. 2006) as occurring in Death Valley. The rare hot-springs fimbristylis, *Fimbrystylis thermalis*, is expected to occur with this vegetation type (D. York, pers. comm. 2006).

Figure 6.  *Pluchea sericea* shrubland at the Travertine Springs Death Valley with *Phoenix dactylifera* (date palm) at far edge of the shrubland association.

Figure 7.  *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance on a slope at the Travertine Springs, Death Valley. This vegetation is occurring along a seep on the slope and has a less saline habitat.

Figure 8. *Typha domingensis* Western Herbaceous Vegetation (Provisional) at Travertine Springs, Death Valley.

## CONCLUSIONS

The vegetation of Travertine Springs consists mainly of associations and alliances typical of saline and intermittently flooded habitats. Not all vegetation types have been documented in California by NatureServe. NatureServe requires substantial plot information to document the occurrence of a vegetation alliance or association in a state. This report has been sent to NatureServe to substantiate probable occurrence of *Prosopis glandulosa* Shrubland, *Sporobolus airoides – Distichlis* spicata Herbaceous Vegetation, and *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance in eastern California and the provisional identification of a *Typha domingensis* Western Herbaceous Vegetation.

The NatureServe conservation status codes provide a guide for management of mapped vegetation types. *Pluchea sericea* Seasonally Flooded Shrubland and *Prosopis glandulosa* Shrubland have been rated as vulnerable and should be treated as such. Several other vegetation types have not yet been assigned a conservation status but may also be vulnerable: *Baccharis sergiloides* Shrubland, *Prosopis pubescens* Shrubland Alliance, and *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance.

The various vegetation habitats and the species present at the Travertine Springs complex reflect the amount and seasonal persistence of water at a given location. Nineteen of the species are obligate or facultative wetland species; they occur always or almost always in wetland habitats. While soil salinity was not characterized as part of this study, observations of the soil and the types of vegetation and plants present indicate that gradients in salinity also affect the type of vegetation present. For example, the presence of *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance as well as *Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation *and Distichlis spicata* Herbaceous Vegetation is illustrative of the gradients of salinity present in the soil where the alkali sacaton drops out where salinity is too high and saltgrass dominates. It is expected that occasional floods and water diversions will change the moisture and salinity conditions supporting different habitats and plants will respond accordingly. No historical studies exist for the vegetation of Travertine Springs; however, the field work conducted in 2001 indicated that vegetation changes had occurred since the acquisition of the photos in 1993. The vegetation map represents conditions in 2001, as near as possible. Storms, such as occurred in August 2004, cause flooding that has immediate short term and long term influence on vegetation distribution and the 2004 storm is expected to have changed plant distributions as shown in the south portion of the vegetation map along Furnace Creek Wash.

This project describes the composition and distribution of the vegetation of and surrounding the wetland habitats of the Travertine Springs Complex as it existed in the spring of 2001. This vegetation is subject to human activities and natural events that can alter vegetation composition and extent on a variety of time scales. The need for management of invasive non-native plants has already been identified by the Park. Construction associated with the planned reconstruction of the Furnace Creek water collection system is eminent. Extreme weather events, such as the flooding of 2004, and long-term climatic events, such as gradual increases in temperature, will influence plant occurrence and duration. While it is beyond the scope of this project to identify all of these disturbances and to discuss their potential impacts, Death Valley NP management can use the information provided on the distribution and composition of the vegetation to guide responses to disturbance as they arise.

## ACKNOWLEDGMENTS

The author thanks Death Valley National Park for the funding to conduct this research and to the staff for providing logistical support for the field studies. The USGS team included field botanists Keith Pohs and Christian Singer, image analyst Shawn Tousley, GIS specialists Terry Arundel and Leslie O'Hare and reviewer Patty Guertin. Doug Threloff of the U.S. Fish and Wildlife Service and Dana York of the U.S. Forest Service provided insightful comments on the manuscript. This report was reviewed but not published before the issuance of the Reconstruction of the Furnace Creek Water Collection System Environmental Impact Statement (2006). Additional comment on vegetation conditions can be found in that report.

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# APPENDICES

## Appendix A.  CD-ROM 'README' File

March 2006

This CD-Rom contains all coverages and GIS data developed for the Death Valley Travertine Springs Complex Vegetation study: the vegetation and tree maps, the field observation database, associated metadata, display map files and ancillary data used to create map displays. All GIS products were developed using ESRI software. We also include the appropriate citation for each newly created coverage.

**The files are arranged on the CD-Rom as follows:**

README.doc – This file

1. VegetationData: This folder contains two subfolders, the individual tree locations and the vegetation polygons. The subfolders contain the following:
    a. TreePt_Locations: Trees (Athel and Palm) observed within the study area. **Citation:** Thomas, K.A. 2006. Death Valley National Park Travertine Springs Tree Locations. ArcGIS Shapefile/ ArcInfo Coverage. U.S. Geological Survey Southwest Biological Science Center, Arizona.
    b. Vegetation_Poly: Vegetation polygons delineated within the study area. **Citation:** Thomas, K.A. 2006. Death Valley National Park Travertine Springs Vegetation Map. ArcGIS Shapefile/ ArcInfo Coverage. U.S. Geological Survey Southwest Biological Science Center, Arizona.

2. ProjectData: This folder contains the field observations made at the Travertine Springs complex in 2001 in Access (.mdb).

3. ProjectReport: The folder contains the entire report (Deva_TS_Final_Report.pdf) in an Adobe Acrobat .pdf format.

4. DisplayMaps: This folder contains two different versions of the hardcopy map that is included in the report. Each can be used to create new versions of the image.
    a. JPEG_Image: A project file (.jpg) to be opened in Adobe Illustrator or other appropriate image software (24" x 30"),
    b. Powerpoint_Image: A powerpoint graphic (.ppt) to be opened in Powerpoint (30" x 36").

5. AncillaryData: This folder contains 4 subfolders which contain coverages or images that can be used to create a new map display.
    a. deva_bndry: Death Valley National Park Boundary (provided by Death Valley National Park).
    b. deva_ts_roads: Road segments within the study area.

c. stdy_bndry: Study area for vegetation map for Death Valley National Park Travertine Springs Vegetation Mapping.
d. DOQQ (Digital OrthoQuarter Quads): This subfolder contains the uncompressed Georeferenced Tagged Image File Format (GeoTIFF) of the seamless DOQQs and associated metadata for the study area. The TIF files can be viewed as images in ArcMap. These DOQQs are not to be confused with the aerial photographs used to delineate the vegetation at the Travertine Springs.

**Appendix B. List of plant species found at Travertine Springs, Death Valley [1]**

| Species | Common Name | USDA Symbol [2] | Source | Life Form [3] | Duration [4] | Origin [5] | Wetland Indicator [6] | CAL-IPC Rating [7] |
|---|---|---|---|---|---|---|---|---|
| *Anemopsis californica* | yerba mansa | ANCA10 | A | F | P | N | OW | |
| *Andropgon glomeratus* | bushy bluestem | ANGL2 | A | G | P | N | FW | |
| *Atriplex hymenelytra* | desertholly | ATHY | A | S | P | N | | |
| *Baccharis sergiloides* | desert baccharis | BASE | A | S | P | N | FW | |
| *Bassia hyssopifolia* | fivehorn smotherweed | BAHY | D | F | A | I | F | Limited |
| *Centaurium exaltatum* | desert centaury | CEEX | B | F | A | N | FW | |
| *Centaurium namophilum* | springloving centaury | CENA | C | F | A | N | | |
| *Cirsium mohavense* | Mojave thistle | CIMO | C | F | A/B/P | N | | |
| *Cladium californicum* | California sawgrass | CLCA2 | B | G | P | N | OW | |
| *Distichlis spicata* | saltgrass | DISP | A | G | P | N | FW | |
| *Eleocharis rostellata* | beaked spikerush | ELRO2 | A | G | P | N | OW | |
| *Ericamerica paniculata* | Pallas' wallflower | ERPA10 | A | F | B/P | N | | |
| *Fimbristylis thermalis* | hot springs fimbry | FITH | A | G | P | N | OW | |
| *Heliotropium curassavicum* | salt heliotrope | HECU3 | C | SS/F | A/P | N | OW | |
| *Imperata brevifolia* | California satintail | IMBR2 | A | G | P | N | | |
| *Juncus arcticus* ssp. *littoralis* | Baltic rush | JUARL | D | G | P | N | Prob. OW (ssp. Unclassified) | |
| *Juncus cooperi* | Colorado rush | JUCO2 | A | G | P | N | FW | |
| *Juncus mexicanus* | Mexican rush | JUME4 | A | G | P | N | FW | |
| *Larrea tridentata* | creosote bush | LATR2 | A | S | P | N | | |

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| *Lepidium lasiocarpum* var. *lasiocarpum* | shaggyfruit pepperweed | LELAL | D | F | A/B | N | | |
| *Lycium californicum* | California desert-thorn | LYCA | A | S | P | N | | |
| *Lythrum californicum* | California loosestrife | LYCA4 | C | SS/F | P | N | OW | |
| *Phoenix dactylifera* | date palm | PHDA4 | A | T/S | P | I | | Not assessed |
| *Pluchea sericea* | arrowweed | PLSE | A | S | P | N | FW | |
| *Polypogon monspeliensis* | annual rabbitsfoot grass | POMO5 | A | G | A | I | FW | Limited |
| *Prosopis glandulosa* | honey mesquite | PRGL2 | A | T/S | P | N | | |
| *Prosopis pubescens* | screwbean mesquite | PRPU | A | T/S | P | N | F | |
| *Pyrrocoma racemosa* var. *paniculata* | clustered goldenweed | PYRAP2 | A | F | P | N | | |
| *Rumex* sp. | dock | RUMEX | A | | | U | | |
| *Schoenoplectus americanus* | chairmaker's bulrush | SCAM6 | A | G | P | N | OW | |
| *Schoenus nigricans* | black bogrush | SCNI | A | G | P | N | OW | |
| *Sisyrinchium funereum* | Funeral Mountain blue-eyed grass | SIFU | A | F | P | N | | |
| *Sisyrinchium bellum* | western blue-eyed grass | SIBE | C | F | P | N | F | |
| *Sibara rosulata* | California winged rock grass | SIBO | D | F | P | N | | |
| *Solidago spectabilis* var. *confinis* | Nevada goldenrod | SOSPC | A | F | P | N | Either F or FW (variety not rated) | |
| *Sporobolus airoides* | alkali sacaton | SPAI | A | G | P | N | F | |
| *Stephanomeria pauciflora* (cf) | brownplume wirelettuce | STPA4 | A | SS/F | P | N | | |
| *Tamarix aphylla* | Athel tamarisk | TAAP | A | T/S | P | I | | Limited |
| *Tamarix ramosissima* | saltcedar | TARA | A | T/S | P | I | | High |

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| *Tidestromia oblongifolia* | Arizona honeysweet | TIOB | A | SS/S/F | P | N | |
| *Typha domingensis* | southern cattail | TYDO | A | F | P | N | OW |
| *Vitis girdiana* | desert wild grape | VIGI2 | A | V | P | N | |
| *Washingtonia filifera* | California fan palm | WAFI | A | T | P | N | |

[1] The USDA PLANTS database (http://plants.usda.gov/) provided information for the current taxonomy of the species, common name, USDA symbol, life form, duration, origin, and wetland indicator status.

[2] Data sources: A = USGS Field Survey 2001, B = Additional species noted by D. York, pers. comm. 2006, C = Schramm (1982), D = McDougall (1945)

[3] T=tree; V = vine, S = shrub, SS = subshrub, G = graminoid, F = Forb

[4] P = perennial, B = biennial, A = annual

[5] N = native, I = introduced, B = biennial

[6] Wetland indicator status is for the California region. OW = Obligate wetland: Occurs almost always (estimated probability 99%) under natural conditions in wetlands; FW = Facultative wetland: Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands; F = Facultative: Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%). USDA PLANTS database (http://plants.usda.gov/). Plants with no entry are upland plants.

[7] Limited = "These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic"; High = "These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically." The Cal-IPPC inventory (http://portal.cal-ipc.org/weedlist) rates plants for their potential ecological impacts in wildland habitats.