Raising the Arizona Eryngo

Report by Julia Fonseca, Pima County Office of Sustainability and Conservation for Jessie Byrd, Pima County Native Plant Nursery Manager.

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Abstract

The native Eryngo plant is a rare wetland plant that is currently being considered for listing under the Endangered Species Act. Twenty rare Eryngo plants from the Desert Botanic Garden were transplanted to Agua Caliente Park in 2017. Because no monitoring data had been previously collected, I conducted field visits in April and August 2018, interviewed staff, and reviewed photographs and plans to determine survivorship and examine factors that might influence successful transplants. Of the 20 original plants, only two plants survived to April 2018. By August 1, 2018, one of the remaining plants had died, and the other appeared to have reduced leaf mass. Damage to the young plants by javelina was an early cause of mortality, but placement of the plants in an inappropriate upland setting where they experienced water stress was the primary problem. In a separate propagation experiment, Pima County's Native Plant Nursery successfully grew around 130 additional plants from seed provided by Desert Botanic Garden. These new one-gallon plants could be placed either at Agua Caliente Park or Canoa Ranch. I recommend a second, small-scale trial at Agua Caliente in the area at the basin floor and perimeter of Pond 2's Native Planting Area. Assigning responsibilities for monitoring and reporting the condition of the transplants prior to the next transplant effort is also needed. A draft monitoring form is provided.

Purpose

The Arizona Eryngo, or *Eryngium sparganophyllum,* is a visually attractive, globally rare plant found on Pima County Conservation Land. The plant belongs to the Apiciaceae, or Parsley family, and produces striking white flowers rising above a perennial bush of strap-like leaves. The plant historically grew in wetlands associated with the Agua Caliente spring, but by the late 20th century the species had been extirpated from that site, leaving only two other known locations in the United States. One of those, near Tanque Verde Creek at La Cebadilla, occurs partially on land owned by Pima County Regional Flood Control District. The other known site is a spring-fed hillslope cienega in the San Pedro River valley.

In 2016, Pima County's Native Plant Nursery and the Pima County Regional Flood Control District (RFCD) began investigating the potential to re-establishment the species at Agua Caliente Regional Park as part of a larger effort to revegetate areas of disturbance around a pond. This report provides an update on that initial effort at Agua Caliente and suggests additional sites and tools for help ensure successful reintroductions in the future.

Eryngo Source Material

Seeds for the initial trial were obtained by Jessie Byrd (Pima County Native Plant Nursery Manager) from Desert Botanical Garden (DBG) on January 25, 2016. The seed (DBG Accession #2016-0009-10-0; one packet) was originally collected by DBG in June and September 2014 from the District's La Cebadilla property. DBG Accession #2016-0009-10-0 consisted of one packet of seed. Accession 2016-0010-10

consisted of 21 plants for research and display. Figures 1 and 2 show the healthy condition of these plants as received by the Nursery.

Figure 1 DBG Eryngium received by Pima County

Figure 2 Close-up of plant when received from DBG

Pima County Propagation Experiment

The Pima County Native Plant Nursery is located at 5800 N. Camino de la Tierra, mailing address 3500 W. River Road.

Seeds were cold stratified by holding in a refrigerator for six weeks. The seeds were soaked and then placed into five flats. About three full flats of plants germinated, or approximately 130 seedlings.

The seedlings were transferred into 2 ¼ inch rose pots on July 20, 2017. The soil used was a 50:50 mixture of perlite and mulch. No fertilizer was used in the soil, and the water source for the rose pots is potable, therefore nutrient content of the water is low. The rose pots were located in the shade house.

Rates of growth appeared to increase after the plants were bumped into one-gallon pots on May 3, 2018 with a richer soil mix of 60% mulch and 40% perlite with Osmocote. The first flower stalk was observed to emerge from one of the plantings on July 10, 2018. The one-gallon plants continue to grow in the

Figure 3 The Pima County Nursery serves public projects.

shade house, with the intention that some of these will be planted at Agua Caliente Park. Plants will be taken from the shade house outside to acclimate them to outdoor conditions prior to transplanting. Ten of these plants were transferred in August to Boyce Thompson Arboretum for their collection (Jessie Byrd communication to the author, August 17, 2018).

2017 Agua Caliente Transplant Experiment

One-gallon flowering plants that were received from DBG were held several months at the Nursery before being transferred to Groundskeeper, a local contracting firm, for planting at the Park in September or October 2017. Groundskeeper substituted the Eryngos for eighteen monkeyflower and two pappus grass plants in the plans provided to them by Pima County Regional Flood Control District. This substitution was authorized by Sandy Bolduc, RFCD, landscape architect for the Pond 2 rehabilitation effort at Agua Caliente Park.

I determined that soil conditions at the planting sites are a sandy loam (some silt and not much clay) using a field test of site soils. Some soils also have gravel. There is an abundance of either calcium carbonate or sodium sulfate in the soil, contributing to a whitish gray soil color. All plantings were in full sun. No fertilizer was used.

According to Amy Loughner, Agua Caliente Park manager, the contractor hand-watered all perimeter plants around Pond 2 and the Native Planting Area until the plants were installed onto the drip irrigation system (Figure 4). The drip irrigation system was operated manually three times a week for approximately 30 minutes each event. Plants on the perimeter of Pond 2 but outside the drip system were hand-watered one to three times a week by manually filling the wells around the plants.

Many of the *Eryngium* plants were uprooted by javelina right after planting, but it was not clear that the animals were eating the plants (Jessie Byrd, personal communication). Some surviving plants were caged in response (Jessie Byrd, personal communication). The two remaining plants looked healthy in April 2018, but had not grown noticeably since their planting. One surviving plant was located at the northern edge of Pond 2A, under a mesquite and near a saltbush. Another was in full sun on the southern edge of Pond 2B near a boulder. None of the *Eryngium* plants along the "improved land bridge" survived (Figure 4). These were irrigated with the manually-operated drip system.

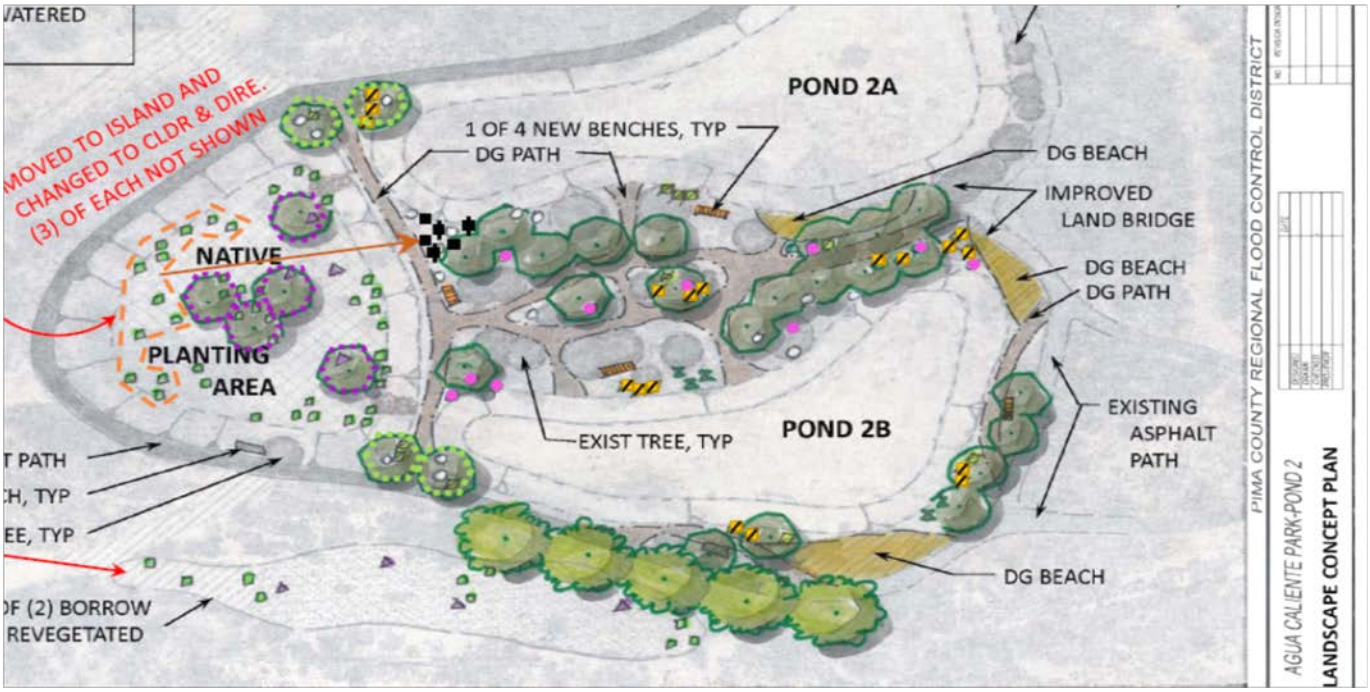

Figure 4 Partial view of as-built plan. Yellow circles and squares indicate Eryngium locations. Green squares indicate yerba mansa, which is another wetland plant. Many of the yerba mansa transplants successfully established as of August 2018.

Evaluation

Eryngium sparganophyllum was known to live in spring-fed wetland at what is today Agua Caliente Park (SWCA 2002). The plant is known from a specimen collected in 1908 by J. J. Thornber and Forrest Shreve. Forrest Shreve's specimen reported "marshy ground". My review of the specimen records collected concurrently with *Eryngium* are consistent with an herbaceous cienega: *Juncus bufonius, Saliciaceae, Scirpus americanus, Almutaster pauciflorus.*

Evaluation of the 2017 transplant experiment at Agua Caliente was hampered by lack of any formal documentation of the plants during or after construction. I interviewed Jessie Byrd and Amy Loughner and reviewed emails and photographs and plans. I visited the site and discussed the issues with staff on April 11, 2018. I had additional communications with staff after the field visit, and visited again on August 1, 2018.

The key problem with the 2017 plantings appears to have been their location: the transplants were placed in upland locations on the uppermost perimeter of Pond 2, where they were unable to receive any natural runoff. The water table at Ponds 1, 2 and 3 is never near the root zone, so the available sites will depend on natural runoff or deliberate irrigation of some kind. *Eryngium* typically grow where the soil experiences seasonal saturation. Wetland plants were observed in the bottom of Pond 2A and the Native Planting Area during our site visit, but none of the *Eryngium* had been placed either in the bottom of the basin or along the lower basin slopes where the soils might be periodically saturated.

The placement of the Eryngos in upland settings where they depend on irrigation likely contributed to lack of survival. I visited all of the planting sites in August. Very few of the landscaping species that were placed in the uplands survived. Most of the sites were empty or had pappus grass (*Pappaphorum vaginatum*) or wheeler saltbush (*Atriplex wheeleri)*. Pappus grass is the most drought tolerant species that was in the planting palette. No monkeyflower, virgin's bower, or *Dicliptera* survived, and very few of the other species survived. In some areas, the emitters were no longer visible. Because the surviving plants are those species that require little water, I believe water stress was a contributing factor to the demise of the container plants.

Figure 5 Typical upland planting sites near Pond 2A, August 1, 2018, with no Eryngium remaining.

Competition with other plants was not an issue that led to the early demise of the DBG specimens, as each plant was initially placed alone in a planting hole surrounded by a small "well" of dirt intended to contain water to the well. As time passed, however, competition from adjacent upland plants increased for the two survivors at Pond 2. A wetland plant species such as Eryngo may not thrive in competition for water in an upland setting.

Figure 6 At top left, the sole surviving Eryngo at Agua Caliente Park, outside Pond 2A, August 1, 2018. Arrow indicates plant location. Same plant below left, on April 11, 2018. Note flower and offsets. By August, leaf mass had been reduced and shrub and grass encroachment advanced. At top right, dead Eryngo leaves remain August 1, 2018. Below right, close-up view of the same plant on April 11, 2018. Note change in condition of well. Some burial may have occurred.

High soil salinities are present on the planting site, but are not thought to be limiting since the Arizona occurrences of the species I have seen are in settings where there is visual or chemical evidence of elevated salinity in the soil or spring water. For instance, I see visible accumulations of salts at the Flood Control District's La Cebadilla site where Eryngos have established on soils that were graded for development in the late 1970s (Figure 7). According to Wolkis and Stromberg (2016), the soils at La Cebadilla has the highest electrical conductivities of the six cienegas they examined. Agua Caliente spring water and soils have elevated levels of sodium and sulfate (Julia Fonseca, unpublished data), and alkali is present at Lewis Springs (Julia Fonseca, personal observation).

Figure 7 Eryngium at La Cebadilla, with alkali accumulation on moist soil, August 1, 2018.

Low levels of organic soil matter and sandy soil texture at Pond 2 may be suboptimal for *Eryngium*. Perhaps this could

contribute to water stress because sand and low organic content have low water-holding capability. At La Cebadilla, soils have approximately 20% organic matter, and 50% silt and clay (Wolkis and Stromberg 2016), and so water-holding capacity is higher.

Another factor contributing to the low success rate of transplanted individuals could have been poor placement of the young plants into the soil. It is possible that the landscaping contractor may have placed the crown of the plant too deeply. Evidence for this is my later observation of one plant which seems to have been placed too deeply for optimal growth. It could have been buried by the movement of soil after plant. I noted that many of the landscaping plants were placed on slopes where soils are moving downhill into the planting "well" but bioturbation by burrowing animals could also be a factor.

In conclusion, while javelina rooting is likely to have been the earliest observed cause of mortality, water stress due to placement of the plants in an upland setting is probably the primary cause of death. If this is true, successful establishment of the plant in wetland setting offered at Agua Caliente Park may still be possible if planting sites are chosen more carefully.

Prospects for Future Transplants at Agua Caliente Park

Pond 1

At present, Pima County and RFCD are considering establishing the species at Ponds 1 and 2 at Agua Caliente Park. I evaluated potential planting sites during my field visit of August 1, 2018. Suitable sites are those that will not experience trampling by visitors and which have fairly stable soils. This may prove difficult because there is substantial soil erosion and trampling around the west side of Pond 1. The steep eastern face of Pond 1 might be suitable if there were less competition from palm trees and more seepage from the pond. However, current plans for lining of Pond 1 will eliminate potential seepage on the eastern face. Thus, if the Arizona Eryngo is to have a place in the renovated Pond 1, it would need to be planned as part of the revegetation effort there.

Figure 8 shows an important vantage point for a view across the pond to the Rincons. Cattails and bulrush have been a constant maintenance issue here on the southern end of Pond 1. Maintaining viewpoints with shoreline vegetation that does not obscure views is an important objective for the design of Pond 1. Eryngos are an attractive bushy plants with tall flowers that bring in butterflies and other pollinators. They do not obscure views. Combined with other species such as yerba mansa, spikerushes and other species, it could complement the view, if the viewing area could be redesigned to minimize trampling of the shoreline.

Figure 8 Pond 1 Viewpoint, August 1, 2018.

Figure 9 Eleocharis on shore of Pond 1

Figure 9 is located near the Rose Cottage, where a wetland plant called *Eleocharis* grows along the shoreline. This plant indicates appropriate soil moisture conditions exist. If trampling is not too great, will the placement of the liner allow for this seepage to continue to create potential habitat? However, young and mature palm trees are located nearby. Shading and competition by palms may render the shoreline habitat unsuitable. Without control of the palms, will there be any shoreline sites around Pond 1 in the future?

Pond 2

Ponds 2A and 2B are lined with a high-density polyethylene membrane up to around two feet of the top. It is possible that Eryngos could be planted along the shoreline either above or below the liner, but if too low, the plants would be exposed to prolonged inundation and too high might induce water stress. Finding the right shoreline elevation could be difficult. The plants need periodic soil saturation, and their leaves need to remain above water most of the time. Pond 2 will eventually be used to hold the water from Pond 1 when the liner is installed later in 2019, so it would be important to know what water level might be maintained during that period. A long-term consideration is competition with other plants, but at this point, there is little shoreline vegetation of any kind.

Native Planting Area

In contrast to Pond 1, encroachment by palms is not evident in the Native Planting Area located west of Pond 2, and there is no trampling here. The Native Planting Area is an unlined basin that receives rainfall. A gate can be operated to allow inflows of water from Pond 2. Transplants of arrowweed (*Pluchea tessaria*) Goodding willow (*Salix gooddingii*) and yerba mansa (*Anemopsis californica*) have successfully established in the bottom of the Native Planting Area with far less expenditure of staff effort than the Eryngo plantings around Pond 2 required (refer to Figure 4 for details). Although the area was dry during April 2018, parts of the basin floor had some standing water in August 2018. The presence of the wetland indicator plants such as the yerba mansa, cattail and bulrush indicates that periodic saturation of the soil has occurred during past seasons. The location of yerba mansa is primarily along the western margin. This area should be tested with a small (10 plants?) trial of one-gallon potted *Eryngium* placed during the monsoon growing season, preferably in a year projected to have El Niño conditions (i.e., high winter precipitation). Additional sites exist elsewhere in the basin floor near the cattail-bulrush, and near the inlet on the northeastern margin of the basin.

Figure 10 Yerba mansa along the basin floor of the Native Planting Area has been successful. These root-perennial plants were barely visible in April, but runners were spreading rapidly by August 2018.

Other Locations

Suitable habitat may exist at a number of other Pima County facilities, such as the new pond at Canoa Ranch, Kino Ecosystem Restoration Project wetlands, Mesquite Circle Pond, or the Roger Road ponds. Occasional drying of ponds or other wetlands should not pose a threat to established plants.

A true cienega setting at a natural spring site would be ideal, such as at Peck Spring or Mescal Spring. Office of Sustainability will evaluate rural locations where the suitable conditions may exist for this species.

Additional Eryngo Transplanting Recommendations

1. Consider soil amendments such as addition of organic matter, especially if native soil at the transplant site is sandy or drains too quickly. If soil amendments are feasible, it is recommended to experiment— prior to transplanting new specimens—with additions and site soils in the greenhouse to determine optimal mixes.

2. Place transplants in a setting where periodic inundation by water is possible, rather than relying solely on drip or manual irrigation. However, avoid placing the plants where the entire plant would be submerged for days. Even wetland plants such as these need to have access to air and sunlight.

3. Identify who will be responsible for ensuring plants are properly placed into the restoration site, and ensure they pre-water the planting holes. While it is unclear that caging is necessary, it might be appropriate to cage a few plants to gauge the effects of herbivory.

4. Place transplants where soil movement is not likely to bury the basal rosette of leaves. The soil level in the container should be placed at the same depth as the surrounding soil, no higher or lower.

5. Record the actual placement of plants, similar to the as-built landscape plan for the 2017 Pond 2 effort, and provide this information to Julia Fonseca, Office of Sustainability and Conservation.

6. Avoid placing young Eryngos right next to bulrush, cattail or trees or shrubs. Avoid heavy shade, or areas that will be quickly shaded by young trees or palms.

7. Monitor each transplant experiment. Identify who will report the condition of the transplants and establish a reporting schedule. A draft monitoring form is attached (Table 1). Monitoring should include reporting on survivorship, sources of stress, and some index of growth. Repeated photographs can supplement the record. Results of monitoring should be sent to Jessie Byrd, Pima County Native Plant Nursery and Julia Fonseca, Office of Sustainability and Conservation.

Legal Status

Eryngium sparganophyllum is considered globally imperiled and has been petitioned for listing under the Endangered Species Act by the Center for Biological Diversity (2018). The species is not covered by the Section 10 permit held by Pima County and the Regional Flood Control District, nor is its salvage or harvest regulated by the Arizona Native Plant Law.

The petition sets in motion a process requiring U. S. Fish and Wildlife Service to issue an initial finding indicating whether listing may be warranted within 90 days after receiving the petition. We anticipate that USFWS will issue a call for available information after publishing the initial finding. Information about the ability of the plant to be propagated and transplanted to new or historic locations will likely be of conservation value to USFWS and others at that time.

Even if the species were eventually listed under the Endangered Species Act, plants would not be protected against take. If the plant is eventually listed, the Act would prohibit the removal and reduction to possession of an endangered plant from areas under Federal jurisdiction, or any activity that would damage or destroy such species on any other area in knowing violation of any state regulation, or in the course of any violation of state criminal trespass law.

References

Center for Biological Diversity 2018. Petition to the U. S. Fish and Wildlife Service to Protect the Arizona Eryngo (*Eryngium sparganophyllum*) Under the Endangered Species Act. Submitted April 2, 2018.

SWCA 2002. Wetland Plant Evaluations for Agua Caliente Park. Prepared for Pima County Sonoran Desert Conservation Plan by Priscilla Titus. http://www.pima.gov/cmo/sdcp/reports/d8/023WET.PDF accessed July 16, 2018.

Wolkis, D. and J. Stromberg, 2016. Plant Ecology of Sharp Springs Cienega and other Cienegas of the Santa Cruz Watershed. Arizona State Parks Interpretive Education Project. Arizona State University School of Life Sciences.

Table 1 Draft Monitoring Form

Property ID:							
Date:							
Observer(s):							
Survey Notetaker:							
Plant ID	**Photo #**	**Condition (live or apparent dead)**	**Flowers or buds**	**Crown ht (in)**	**Soil wet or dry at surface?**	**Soil wet or dry at 3 inch below?**	**Notes on leaf appearance, etc.**