Habitat Characterization and Selection of Potential Sites for Establishment of New Populations of *Amsinckia grandiflora*

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Abstract

The recovery plan for Amsinckia grandiflora[1] Kleeb. ex Gray calls for the establishment of four new Amsinckia populations within historic range in order to reduce the probability of extinction. The present study is part of an effort to create those new populations. Using existing data on the distribution and ecology of the species, we sought to 1) characterize and evaluate the most important biological factors affecting Amsinckia and 2) locate and rank potential sites for the new populations based on biological, land use and logistic criteria.

The criteria used for site selection were based on biological and land use factors thought to affect Amsinckia performance at Site 300 and logistic factors that could affect a reintroduction effort. Information on slope, aspect, soil, disturbance, community type, habitat size, potential for development and road access were obtained from map, aerial photograph and field data, as well as from members of the Amsinckia recovery team. Sites for reintroduction within historic range were located and evaluated using the following general characteristics: 1) mesic annual grassland community, 2) sandy, loamy or clay-loam soils of the Vaquero - Carbona or Altamont - Fontana complex, well-drained and deep, 3) at least 0.25 mile wide in a single dimension, 4) undeveloped with little potential for future development, 5) no apparent damage to slope, soil and existing vegetation, and 6) access by small roads with restricted entry.

The study area reflected the known and historical distribution of Amsinckia and extended from northern Contra Costa County at the San Joaquin River Delta, south to Corral Hollow and adjacent portions of the Connolly Ranch in San Joaquin County. A total of 55 candidate sites were delineated on 9 U.S.G.S. 7.5' map overlays that accompany this report (on file in offices of the Endangered Plant Project, Sacramento). A list of 35 nominee sites, obtained from scoring the candidate sites and from field survey, was then generated. Further scrutiny of the available map and field information produced a list of 12 finalist sites that were ranked and discussed with respect to the reintroduction effort. A recommendation was made to use the Stewartville 1 site within Black Diamond Mines Regional Preserve to support the first reintroduced population.

[1] Amsinckia grandiflora will be referred to by its generic epithet

Introduction

Amsinckia grandiflora[1] Kleeb. ex Gray is known from only two locations within Site 300 of Lawrence Livermore Laboratory, approximately 14 miles east of Livermore, California. In recent years the largest population (the "droptower" population) has fluctuated in size between 23 and 400 individuals, having once been comprised of "thousands" in the mid 1960's (Taylor 1987). The other population (the "gulley" population), less than two miles away, had fewer than 25 individuals when discovered in the spring of 1988. Consequently, Amsinckia is considered to be one of the most endangered plants in California. The recovery plan for this taxon, drafted by the U.S. Fish and Wildlife Service, has called for the establishment of four new Amsinckia populations within its historic range in order to reduce the probability of extinction. The present study is part of an effort to create those new populations. Using existing data on the distribution and ecology of the species, we sought to 1) characterize and evaluate the most important habitat factors of the Amsinckia populations at Site 300, and 2) locate and rank potential sites for the new populations based on the analysis of habitat factors as well as logistic factors that could effect the success of a reintroduction effort.

Background and Methods

Habitat Factors at the Extant Populations

The two extant populations of Amsinckia grandiflora at Site 300 share several habitat features. They are both found in grassland communities (containing both annual and perennial grasses) on the edge of oak (Quercus douglasii) or juniper (Juniperus californica) woodland at an elevation of about 1000 feet. These sites are

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somewhat more mesic than adjacent sites lower in elevation and farther to the east where only annual grassland predominates. Both populations occur on very steep, north- or west-facing slopes in canyons, such that prolonged exposure to the sun is somewhat diminished. These observations suggest that a combination of macro- and micro-environmental habitat factors create a relatively mesic grassland habitat for Amsinckia.

According to U.S. Soil Conservation Service (SCS) soil surveys, the soil types upon which the droptower and the gulley populations occur are Linne clay loam and Altamont clay, respectively. Consultation with two soil scientists was necessary to clarify inconsistencies between the Alameda and Contra Costa county soil surveys. Mike Mackelhaney of SCS Fresno, who is familiar with the droptower population, provided additional information on the area's upland soils. He stated that Linne clay loam and Altamont clay are now classified under the umbrella name of Vaquero-Carbona clays. These erodable soils are associated with saline seeps and are derived from old terraces and streambeds which have been elevated by tectonic activity. Don White of SCS Santa Rosa, who helped compile the Contra Costa County Soil Survey, concurred that Altamont clay and Linne clay loam both form on elevated sedimentary rock but felt that saline seeps were not a common feature of the Site 300 landscape. He expressed surprise that a rare plant like Amsinckia would favor both Altamont and Linne soils, since the former is a clayey vertisol with considerable shrink-swell character, while the latter is a loamy mollisol with relatively good drainage. We have seen the plant growing on a wide variety of soils (from potting soil to Yolo clay) and conclude that soil type per se may not be a particularly restrictive habitat factor with respect to the growth of Amsinckia populations (see results, below).

Site management policies, such as using controlled burns to diminish wildfire frequency and intensity, may also be important habitat factors that affect the Site 300 populations. Those burns, in addition to occasional wildfires, have probably contributed to the maintenance of the native flora on the site, including native

bunchgrasses (e.g. Poa scabrella). It is not clear, however, what effect the fires have had on Amsinckia. Although the droptower site has undoubtedly been negatively affected by construction and other site management activities, the extant population is found on undisturbed soils that have never been graded or plowed. We conclude, therefore, that this species does not respond well to human-caused disturbance.

Development of Site Selection Criteria

The criteria used for site selection were based on biological and land use factors thought to affect Amsinckia performance at Site 300 and logistic factors that could affect a reintroduction effort. The biological and land use factors were chosen and evaluated by members of the Amsinckia grandiflora Recovery Team (Susan Cochrane, Ann Howald, Jim Jokerst, Ron Kelley and Dean Taylor) during a visit to Site 300 on March 17, 1988. Each member was asked to rank the relative importance of slope, aspect, soil, disturbance and community type to the vigor of the populations. A scale of 1 to 5 was used, with 1 being most important and 5 the least. These values were averaged and ranked once again in order to test for consensus (uniformity of opinion on the factors) and to take advantage of the expertise and experiences of the evaluators. From the ranking of these factors, we derived an ecological characterization of Amsinckia and, simultaneously, the biological and land use criteria used for selection of the candidate sites. Additional biological (e.g. habitat size), land use (e.g. ownership) and logistic (e.g. road access) criteria were used to reduce the list of candidate sites to a short list of nominee sites prior to field inspection (see the following section).

Selection of Candidate and Nominee Sites for Reintroduction

In searching for reintroduction sites, geographic boundaries were established that reflected the known historic and ecological ranges of Amsinckia. The study area extended from northern Contra Costa County at the San Joaquin River Delta, south to

Corral Hollow and adjacent portions of the Connolly Ranch in San Joaquin County. The western boundary was formed by undeveloped portions of the easternmost coast ranges (Diablo, Tassajara and Altamont ranges), east to the edge of the San Joaquin Valley. Also included were Stewartville and Judsonville, where Amsinckia was collected by E.L. Green and Katherine Brandagee more than 100 years ago. Ecologically, the study area is a typical mosaic of grassland, oak woodland, chaparral and lowland conifer woodland.

In order to identify candidate sites for the reintroduction of Amsinckia, we began working from topographic, geologic and soil survey maps, eliminating areas that did not conform to the factors thought to be important at Site 300 and to the reintroduction effort as a whole (Tables 1 and 2). Specifically, we:

1) eliminated areas altered by development and other catastrophic disturbance

2) favored northwest, north and northeast slopes, tended to reject south, southwest, and southeast slopes and remained neutral on east and west slopes

3) eliminated serpentine,volcanic, and heavy clay soils and favored erodable, sandy, loamy or clay-loamy soils derived from sedimentary formations, especially those in the Linne and Altamont series (Vaquero-Carbona and Altamont-Fontana complexes)

4) favored the bottom third of steep canyons or wide ravines

5) eliminated slopes of less than 45% or more than 75%

6) eliminated areas covered by riparian, oak woodland, chaparral and coastal sage scrub communities

All sites were first delineated on U.S.G.S. 7.5 minute topographical maps using soil type and slope criteria. We were able to establish a reasonable synonomy between the Altamonts and Linnes of Alameda, Contra Costa and San Joaquin counties by consulting with Mike Mackelhaney of SCS Fresno, Don White of SCS Santa Rosa (formerly with SCS in Alameda County), and Ron Kelley of UC Davis. A total of 55 candidate sites were thus obtained (see the set of 9 map overlaps that were filed with the Endangered Plant Project in Sacramento and Table 3 of this report).

Map information was then used to further evaluate each of the 55 candidate sites with respect to use, road access, exposure, disturbance and size by assigning points (3 per criterion, 15 total for a perfect site). A high scoring candidate site would then be regarded as a nominee site and subjected to field inspection. Within each category a candidate site was assigned a rank value from 0 to 3, with 3 being the most desirable state from a standpoint of introducing and maintaining a population of Amsinckia grandiflora. The first category was land use history and ownership status; a score of 3 = public land, 2 = private ownership, and 1 = Lawrence Livermore Laboratory (LLL) property (because it would not be desirable to establish a new population near Site 300). Category two was road access, important for overseeing a reintroduced population; some mode of access is necessary but heavy public access is undesirable. (This factor also came into play in the field survey as we were not able to visit some of the nominee sites (see Table 5)). A score of 3 = dirt road access, 2 = access by minor paved road, 1 = access by major paved road, and 0 = no road at all. The third category was a measure of predominant exposure or aspect. A score of 3 = north-facing, 2 = east or west-facing, and 1 = south-facing. Slopes in steep, narrow canyons were regarded as sites with limited exposure to the sun and given an additional notation (c). The fourth category took into account disturbance and was measured in terms of proximity to development. A score of 3 = no nearby development, 2 = light or sparse development, and 1= heavy development nearby. The fifth category relates to the size of the delineated site as an indicator of stability or susceptibility to perturbation. A score of 3 was assigned to a large site having at least

one dimension greater than 1 mile; a score of 2 = medium size, or 1/4 to 1 mile across, and a score of 1 = a small site, less than 1/4 mile in all directions.

The total score (Σ) for a candidate site was the sum of its rank values in each of the five categories. The cutoff score of 12 assured us that a candidate site could not attain nominee status if it had scored 1 in any single category. For example, site A7 (Table 3) scored 2 in the categories of use and size, and 3 with regard to access and development. Its south-facing exposure, however, is undesirable with respect to Amsinckia as determined from Site 300. A7 scored a total of 11, one point short of being considered as a nominee site. On the other hand, site A15 (Table 2) scored a total of 14 points, falling just short of the maximum 15 points only because of its private ownership status. It should be emphasized that neither our ranking system nor the U.S.G.S aerial photographs could predict with complete accuracy the actual suitability of each site for Amsinckia reintroduction. For example, A15 was not included in the list of finalists (Table 5) because the field survey revealed significant impact due to recent windpower development and heavy grazing.

The 27 nominee sites were initially examined using recent aerial photographs from U.S.G.S. in Menlo Park, noting any obvious disturbance from overgrazing or development. Finally, we met with Barbara Leitner on May 17, 1988 to discuss land ownership issues and to obtain recommendations based on her 1986 and 1987 field surveys of the study area.

As sites were visited during our field survey (see below), they were compared to the two known population localities on Site 300. Our selection criteria were based on these adjacent sites and they reflected a narrow range of ecological variability. Field observations, however, suggested that modifications be made to account for climatic and topographic gradients along an east-west transect with respect to Site 300. For example, a canyon comparable to one of those inhabited by Amsinckia but further east would be drier and, therefore, less suitable as a reintroduction site. Likewise, a site

with similar topography at the same longitude but at lower elevation would be drier and less suitable.

Field Survey of the Nominee Sites

After an ecological and land use profile had been compiled for each of the 27 nominee sites, field inspections were conducted during the week of May 23, 1988. Fifteen of the 27 listed sites were visited and photographed. An additional eight were added to the nominee list based on field observations, 7 of which were visited and photographed. This led to a total of 35 nominee sites (Table 4) obtained from map ranking and field observations. A final field survey was performed on June 3, 1988 by revisiting both known populations on Site 300 and our most promising nominee sites with Ron Kelley (UC Davis). The purpose of this survey was to obtain his opinion on our selection process and nominee sites and to confirm our decisions and concensus in light of all available information. In addition, we collected bulk soil samples and tested them for pH, electrical conductivity, particle size distribution and color.

Selection of the Finalist Sites

Finalist sites were chosen based on observations made in the field and comparisons of the nominee sites with the ecological characteristics of Site 300. Finalist sites were ranked to reflect; 1) potential as Amsinckia habitat, 2) current patterns of land use and ownership, and 3) logistic considerations (access, size, etc). Nominee sites which were ranked highly from map information but could not be assigned finalist status because of a lack of information (field observations, etc.) were set aside for later consideration.

Results and Discussion

Development of Site Selection Criteria

The results of the habitat factor survey are shown in Table 1. There was considerable agreement among members of the recovery team on the importance of soil and community, especially in terms of how they would affect moisture availability and interspecific competition. Likewise, slope, aspect, and disturbance were viewed as most relevant within the context of the same two factors.

Table 1. Ranking of habitat factors thought to be important (1 = very, 5= not very important) to the vigor of Amsinckia grandiflora populations at Site 300. Means represent the collective opinion of five members of the recovery team.

	slope	aspect	soil	disturbance	community
mean	2.8	2.5	2.6	4.2	2.3
rank	4	2	3	5	1

The implication, based on subjective observations rather than tested hypotheses, is that Amsinckia may perform best when amply supplied with deep soil moisture and not overtopped by annual grasses. This condition could be affected in three obvious ways, each with several possible translations into criteria for the selection of reintroduction sites:

1) limited exposure to late morning and afternoon sun
   a. steep north, northwest or northeast facing slopes
   b. deep canyons or ravines on any slope with afternoon shade

2) high soil moisture for a grassland site
   a. deep sandy or loamy soil, readily infiltrated by precipitation that subsequently percolates into lower soil layers. Such deep moisture would be more accessible to tap-rooted dicots (e.g. Amsinckia) and perennial grasses.
   b. perennial, rather than annual grass cover (e.g. Poa scabrella rather than Bromus diandrus)
   c. low plant cover in general compared to surrounding grassland (eroded soil with surface disturbance)
   d. sites at higher elevations and farther to the north and west of Site 300

3) less intense competition for soil moisture
   a. sandy, eroded soil slightly less favorable for establishment/growth of annual grasses with fibrous roots
   b. community dominated by perennial grasses rather than annual grasses and forbs
   c. low plant cover compared to surrounding grassland

In comparing soil samples between the droptower and gulley populations at Site 300 and the finalist sites, we found no outstanding correlation or deviation among the measured characteristics. In general, all of the soils from sites with and without Amsinckia tended to have neutral or slightly basic pH, low conductivity, high organic matter, and loamy or clayey structure, all qualities typically associated with grasslands. Perhaps other, more subtle soil attributes explain the current distribution of Amsinckia. It should be noted, however, that large numbers of seed-producing plants have been grown on soil types ranging from potting mix to Yolo clay-loam. For these reasons we

have required only that the soils at potential reintroduction sites possess the general characteristics of the Altamont-Fontana and Vaquero-Carbona complexes.

The site selection criteria used to delineate and compare candidate, nominee and finalist sites for new populations of Amsinckia grandiflora were developed from these considerations and are shown in Table 2.

Candidate, Nominee and Finalist Sites

The 55 candidate sites, developed from the criteria presented in Table 2, are shown in the set of 9 U.S.G.S. 7.5' map overlays that accompany this report (on file in offices of the Endangered Plant Project, Sacramento) and are summarized in Table 3. The list of 35 nominee sites, obtained from scoring the candidate sites and field survey, are summarized in Table 4. Further scrutiny of the available map and field information produced a list of 12 finalist sites that are ranked in Table 5 and discussed below.

Our field observations clearly indicate that Site 300 possesses a unique set of characteristics not duplicated by any of the candidate, nominee or finalist sites. Those characteristics were climatic, topographic and geologic and related to a multitude of land-use factors. Most importantly, we believe that Site 300 is ecologically distinct because of its 1) relatively high elevation, 2) steep, eroded, bedrock-lined canyons, 3) towering Neroly Blue sandstone exposures, 4) complex vegetation mosaic, and 5) management with fire and without livestock grazing. Whether Amsinckia is somehow dependent on these characteristics or has simply persisted there because of them remains unknown. Reintroduction experiments conducted at new sites will hopefully distinguish between the essential and non-essential habitat characteristics.

Table 2. Criteria used to identify potential reintroduction sites for Amsinckia grandiflora.

Biological

1. within known historic range (Antioch to Corral Hollow, Livermore to San Joaquin valleys)

2. mesic annual grassland

   - borders on oak/juniper woodland and chaparral
   - elevation exceeding 800'
   - steep north, east or west-facing slopes with low exposure to sun
   - remnant populations of native perennial grasses

3. loamy soils with deep drainage

   - Altamont-Fontana complex
   - Vaquaro-Carbona complex
   - pH 6.5 - 8, low EC, grey-brown to pale brown (Munsell)

4. size of potential habitat at least 0.25 mile along one axis

Land Use

1. undeveloped and with low potential for future development

2. no apparent damage to slope, soil and existing vegetation

   - moderate or no grazing at present
   - no gullying or other signs of soil eroision
   - cover by grasses rather than non-palatable broadleaf species

Logistic

1. access by small roads with restricted use

Table 3. 55 candidate sites for the reintroduction of Amsinckia grandiflora. See end of table forexplanation of categories and rank values. Site numbers refer to the map overlays filed with this report (Endangered Plant Project, Sacramento, CA.)

SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
A1	Mendenhall Springs '78	2	3	2	3	2	12	near rec. area
A1.5	Altamont '81	2	3	2c	3	2	12c	
A2	"	2	1	1	1	1	6	
A3	"	2	1	1	1	2	7	
A3.5	"	2	3	2	2	1	10	
A4	"	2	3	3c	2	3	13c	
A5	"	2	1	2	1	2	8	RR, freeway
A6	"	2	1	2	1	1	7	depression
A7	"	2	3	1	3	2	11	LLL?
A8	"	2	3	1	3	1	1	
A9	"	2	2	3	3	2	12	
A10	"	2	2	2	3	2	11	
A11	Midway '80	2	2	2	3	2	11	
A12	"	2	2	1	3	2	10	
A13	"	2	2	2	3	2	11	w/ oaks?

Table 3. Candidate sites (cont.)

SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
A14	Midway	2	3	2	3	2	12	flanked by oak
A15	"	2	3	3	3	3	14	windpowered out
A16	"	2	3	2	2	2	11	
A17	"	1-2	3	3	3	3	13.5	partly LLL land
A18	"	1-2	3	2	3	3	12.5	"
A19	"	1	3	2	3	2	11	LLL
A20	"	1	3	2	3	2	11	
A21	"	1	3	2	3	1	10	
A21.5	"	2	1	2	3	1	9	
A22	Tassahara '74	2	3	1	3	1	10	rd. in photo
A23	Byron Hot Springs '68	2	3	1	2	2	10	nr gravel pit
A24	"	2	3	2	3	2	12	
A25	"	2	3	2c	3	2	12c	"
A26	"	2	3	2c	3	2	12c	road between A26 and A27
A27	"	2	3	2c	3	2	12c	
A28	Clifton Ct. Forebay '78	2	3	2	3	2	12	
A29	"	2	3	2c	2	2	11c	nr aquaduct

Table 3. Candidate sites (cont.)

SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
L1	Altamont '81	2	3	2	2	1	10	
L2	"	2	3	2c	3	2	12c	
L3	"	2	3	2	3	2	12	
L4	Midway	2	3	3	3	1	12	too small
L5	"	2	2	3c	3	2	12c	
L6	"	2	2	3	3	3	13	
A'1	Tassahara/ Byron H.S.	2	3	1	3	3	12	some oak
A'2	Byron H.S.	2	2	2	3	3	12	
A'3	"	2	2	3c	3	2	12c	
A'4	"	2	2	3	3	2	12c	
A'5	"	2	2	3	3	2	12	
A'6	"	2	3	3	3	3	14	
A'7	Clayton '80	2	3	1	2	2	10	naval reserve
A'8	"	2	2	2	2	3	11	1/3 "
A'9	"	2	2	2	2	3	11	
A'10	"	2	3	2	2	2	11	

Table 3. Candidate sites (cont.)

SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
A'11	Clayton	2	1	2	3	2	10	
A'12	"	2	3	3c	3	2	13c	
A'13	"	2	1	3	2	3	11	
A'14	Clayton/ Antioch S.'80	2	2	3c	3	3	13c	E.B.R.P.
A'15	Antioch S.	2	2	2	3	2	11	"
A'16	"	2	2	3	3	3	13	"
A'17	"	2	2	1	3	3	11	"

c = canyon or creek canyon

Scoring values (high to low desirability) for categories in Table 2:

Ownership

3: public 2: private 1: Lawrence Livermore Lab

Road access

3: dirt 2: small paved 1: large paved 0: none

Exposure (predominant)

3: North facing 2: East or West 1: South

Disturbance/development

3: undisturbed 2: light or sparse disturbance 1: heavy

Size of site

3: large, >1 mile across 2: medium, 1/4-1 mi. 1: small,<1/4 mi

Table 4. 35 nominee sites for the reintroduction of Amsinckia grandiflora. √ = visited during field survey, • = not visited.

	SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
•	A1	Mendenhall Springs '78	2	3	2	3	2	12	near rec. area
•	A1.5	Altamont '81	2	3	2c	3	2	12c	U.S. Wind-power gate7
√	A4	"	2	3	3c	2	3	13c	
•	A7.5	"	added to list while in field						creek canyon looks plausible
√	A9	"	2	2	3	3	2	12	oak, too grazed and exposed
√	A14	Midway '80	2	3	2	3	2	12	flanked by oak
√	A15	"	2	3	3	3	3	14	windpowered out
•	A17	"	1-2	3	3	3	3	13.5	partly LLL land
•	A18	"	1-2	3	2	3	3	12.5	"
•	A24	Byron Hot Springs '68	2	3	2	3	2	12	U.S. Windpower
•	A25	"	2	3	2c	3	2	12c	"
•	A26	"	2	3	2c	3	2	12c	road between A26 and A27
•	A27	"	2	3	2c	3	2	12c	
•	A28	Clifton Ct. Forebay '78	2	3	2	3	2	12	

Table 4. Nominee sites (cont.). • = not visited, √ = visited.

	SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
•	L2	Altamont	2	3	2c	3	2	12c	blue oak, avena erodium
√	L3	"	2	3	2	3	2	12	soil sample
√	L4	Midway	2	3	3	3	1	12	too small
√	L5	"	2	2	3c	3	2	12c	
√	L6	"	2	2	3	3	3	13	U.S. Windpower gate 9 plausible canyon
√	A'1	Tassahara/ Byron H.S.	2	3	1	3	3	12	some oak viewed A'2,3,4
√	A'2	Byron H.S.	2	2	2	3	3	12	
√	A'3	"	2	2	3c	3	2	12c	
√	A'4	"	2	2	3	3	2	12c	
√	A'5	"	2	2	3	3	2	12	heavily grazed
•	A'6	"	2	3	3	3	3	14	
•	A'12	Clayton '80	2	3	3c	3	2	13c	
√	A'14	Clayton/ Antioch S.'80	2	2	3c	3	3	13c	E.B.R.P.
√	A'16	Antioch S.	2	2	3	3	3	13	E.B.R.P. soil sample

Table 4. Nominee sites (cont.). • = not visited, √ = visited.

SITE#	MAP QUAD/DATE	OWN	ROAD	EXP	DIST	SIZE	Σ	NOTES
√ Connolly 1	Lone Tree Creek '71	two West facing ravines w/ rock outcrop and Junipers.						Too dry and exposed.
√ Connolly 2	"	East facing slope, v. steep; ashen soil, v. dry, sample taken. Amsinckia, Avena, Bromus diandrus, Brassica nigra.						
√ Connolly 3	"	steep North facing slope w/ sandstone outcrops; saline seep; soil sample taken. On lower slopes: Distichlis spicata, Frankenia, Juncus, Amsinckia, Avena, Bromus diandrus, Poa scabrella, also Lupinus, Juniperus upslope.						
√ Judsonville	Clayton	small canyon, soil sample taken						
√ Fish & Game	Tracy	North-northeast facing, mollasol, composite soil, sample taken, Ca. Sage, no oak, no juniper, annual grasses, Gutierizia, Poa S.						Too arid?
√ Stewartville 1	Antioch S.	East facing steep slope, soil sample taken.						
√ Stewartville 2	"	East facing steep slope, many rock outcrops, ashen soil, sample taken.						

c = canyon or creek canyon

Discussion of Finalist Sites

Two sites, **Connolly 2** and **3**, are situated east of Site 300 at lower elevations (mostly under 600'), and are probably too arid for Amsinckia. They are also not part of the same geologic formation as they lack the characteristic blue sandstone of the Neroly formation. It is worth noting, however, that **Connolly 3** is on a north/ northeast-facing slope with a perched saline seep and is covered in part by salt marsh species such as Distichlis spicata, Frankenia and Juncus. A different species of Amsinckia does occur here along with Poa scabrella, Bromus diandrus, Avena, Lupinus albifrons and Juniperus californica.

The **Fish and Game** property in Corral Hollow supports a relatively xeric grassland community, composed principally of introduced grasses, Poa scabrella, Gutierrezia and Artemisia californica, and lacking the oak and juniper components of the other sites. Its low elevation and eastern position relative to the droptower population indicate it would be too dry for Amsinckia grandiflora. Geologically, this site is also inappropriate.

West and north of Site 300 but at a lower elevation, is the **Judsonville** site. We found no sign of this town of a century ago or its mining operations; even the topography has changed due to the construction and subsequent disassembly of the railroad. Despite the fact that it is a historical locality for Amsinckia, we could not find suitable slopes and exposures.

Sites **A 24** on Brushy Peak, **A 7.5**, and the Los Vaqueros property sites **A'2, A'3** and **A'4** were viewed from a distance but not visited during the field survey. The sites were on private property and permission could not be obtained for entry at this time. They appear to fit the habitat characteristics for Amsinckia and warrant a closer examination as potential reintroduction sites. Unfortunately, the Los Vaqueros sites may be less suitable if the proposed reservoir is built.

Table 5. Ranking of 12 finalist sites, including criteria for comparing characteristics of candidate sites to the "gulley" and "droptower" sites at Site 300. ok = soil sample taken, analyzed and sucessfully compared to site 300 soils. ns = no sample taken.

SITE	EAST/WEST	ELEV.	ASPECT	SOIL	COMMUNITY	OWNERSHIP	LAND USE	RANK
Stew. 1	W	800	E	ok	annual grassland	public	recreation/ preserve	1
Stew. 2	W	800	E	ok	annual grassland	public	rec./ pres.	12
A'16 B.D. ridge	W	1100	N	ok	annual/ oak woodland	public/ private	rec./ pres./ grazing	4
Judsonville	W	450	S	ok	annual grassland	private	grazing	8
A' 2, 3, 4 Los Vaqueros	W	800-1200	N	ns	annual/ oak woodland	private	grazing	5
A24 Brushy Peak	W	900	E	ns	annual/ oak/ chaparral	private	grazing/ windpower	6
L 6, A 17, A 18 Mulqueeny/LLL	W	900	E or W	ns	annual grassland	private	grazing	2
A 7.5	W	1400	N	ns	annual/ oak woodland	private	grazing	7
L2,3 Santos	W	1400	N	ok	annual/ oak woodland	private	grazing	3
Fish & Game	E	600	E	ok	annual grassland	private	preserve	9
Connolly 2	E	800	E	ok	annual grassland	private	grazing	11
Connolly 3	E	800	N	ok	annual grassland	private	grazing	10

Site **A'16** on the northeastern boundary of Black Diamond Mines Regional Preserve was initially very encouraging. It is on a north-facing slope along an east-west trending ridge that supports a mixed grassland and oak woodland community. An Amsinckia species was found, probably A. intermedia, but no native grasses were identified in the immediate vicinity. Further east, along the same ridge, we found Eriogonum and Stipa pulchra among the blue oaks. Unfortunately, site **A'16** spans the property line between East Bay Regional Park land and the Garraventa holdings, which have been proposed as a solid waste disposal site. Development plans are not final at present, however, any further consideration of this site for the reintroduction of Amsinckia would necessitate a thorough assessment of the potential for future development.

Sites **L2** and **L3** on the Santos property are steep, moderately grazed creek canyons of mixed grassland and oak woodland on Linne clay loam soil. The lower, north-facing slopes, unlike those in the canyons at Site 300, are fairly densely covered with blue oak; Avena and Erodium dominate the south-facing slopes. An east or west-facing slope at the eastern end of the canyon might be suitable for Amsinckia, as it would be less exposed than the grassy south-facing slopes and with less competition from the oak and brush of the north-facing slopes.

Sites **L6**, **A17** and **A18** are just north and west of Site 300, sharing many of the same climatic and geological features. As a result, these were ranked as finalists even though they did not have a field inspection. Like the Los Vaqueros sites, these were viewed from a distance due to our lack of permission for access. They are on privately held lands (Mulqueeny) and should eventually be surveyed for canyons like those at Site 300. Mr. Connolly suggested that the landowners could be approached regarding a reintroduction program for their land.

The two remaining finalist sites, **Stewartville1** and **Stewartville 2** lie within Black Diamond Mines Regional Preserve. Although geographically adjacent, they

differ considerably in ecological characteristics. Both are east-facing slopes, but the soil at **Stewartville 2** is calcarious, has a high pH and is excessively rocky. **Stewartville 1**, however, is found on more typical Altamont-Fontana soil (neutral or slightly basic, gravelly sandy-loam, low salinity, deep profile), within an acceptable elevation range (750-1000'), bordering oak woodland, and to the west of Site 300. These characteristics indicate that **Stewartville 1** possesses a soil type and regional climate that are compatable with the habitat characteristics of Amsinckia. In addition, the site is in a broad, steep canyon, easily accessible to park personnel but not particularly attractive to park visitors. As such it could be easily monitored and protected. Furthermore, Amsinckia was collected in this vicinity during the early years of this century, and so reintroduction seems especially appropriate. We recommend that **Stewartville 1** be the initial site for the creation and reintroduction of a new population of Amsinckia grandiflora.

Recommendations

1) **Stewartville 1** should be used as the first site for the reintroduction of Amsinckia grandiflora.

2) A successful reintroduction, confirmed by several years of monitoring the new population, would justify similar efforts at the highest ranked (e.g. #'s 2-7) finalist (Table 5). Contact of the landowners should not, however, precede the development of the new population at **Stewartville 1**, allowing sufficient time to 1) finalize the methods for reintroduction (are prescribed burns, grazing exclosures, intensive monitoring really necessary?), 2) generate large quantities of nutlets for use as innocula (Pavlik 1988), and 3) provide a final product for the landowners to evaluate themselves (i.e. "maybe a small patch of big-flowered

fiddleneck ('cattle poison') isn't all that bad").

3) Additional sites, if needed, could be obtained from the highest-scoring nominee sites that were not included in our initial assessment of finalists. These are presented in Table 6. All are on private land and access for evaluation would have to be negotiated in advance.

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Table 6. Best of the nominee sites that were not considered as finalists.

SITE#	MAP QUAD/DATE	USE	ROAD	EXP.	DIST.	SIZE	Σ	NOTES
A1	Mendenhall Springs '78	2	3	2	3	2	12	near rec. area
A1.5	Altamont '81	2	3	2c	3	2	12c	U.S. Wind-power gate7
A17	"	1-2	3	3	3	3	13.5	partly LLL land
A18	"	1-2	3	2	3	3	12.5	"
A24	Byron Hot Springs '68	2	3	2	3	2	12	U.S.Wind-power
A25	"	2	3	2c	3	2	12c	"
A26	"	2	3	2c	3	2	12c	road between A26 and A27
A27	"	2	3	2c	3	2	12c	
A28	Clifton Ct. Forebay '78	2	3	2	3	2	12	
L2	Altamont	2	3	2c	3	2	12c	blue oak, avena, erodium
A'6	"	2	3	3	3	3	14	
A'12	Clayton '80	2	3	3c	3	2	13c	

These may be very good reintroduction sites, but data were lacking (e.g. field survey). Accessing these sites will probably necessitate communication in advance with land owners and/or property managers.