Guidance to Assist in the Assessment of, and Conservation Efforts for, Vernal Pool Systems on the Agate Desert, Jackson County, Oregon

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Introduction

The guidance provides information to assist biological consultants contracted to conduct activities within the Agate Desert vernal pool wetland systems near Medford, Jackson County, Oregon. Specifically this guidance addresses:

- Definitions and terms commonly used in the guidance,
- Appropriate methods to characterize the function and condition of vernal pool wetland complexes and develop biological or environmental assessments,
- Appropriate methods to conduct surveys for listed fairy shrimp and plant species,
- Guidance to conduct vernal pool habitat restoration activities (including the collection of soil inoculum to be used in restoration activities); and,
- Appropriate documentation of all assessment, survey and restoration work completed within vernal pool habitat.

The guidance supports

- The Corps' Regional General Permit regarding vernal pool habitat in the Agate Desert,
- The DSL's General Authorization regarding vernal pool habitat in the Agate Desert; and,
- The comprehensive wetland conservation planning underway by local entities, including the Rogue Valley Council of Governments; City of Medford; Jackson County; private stakeholders; and, state and federal agencies concerned with the Agate Desert Vernal Pool Ecosystem.

The guidance should also provide consistency regarding information necessary to guide management plans which promote recovery of the federally threatened vernal pool fairy shrimp *(Branchinecta lynchi*) (fairy shrimp), Cook's lomatium (*Lomatium cookii*) (lomatium) and large-flowered woolly meadowfoam (*Limnanthes floccosa ssp. grandiflora*) (meadowfoam) and other native species known to occur in the Agate Desert area (Table 1).

This guidance will be reviewed annually and updated as new information becomes available.

Definitions

Cysts: One of the life history phases of the vernal pool fairy shrimp. This refers to the life history stage present during the vernal pool "dry season".

Qualified wetland specialist: A person possessing training and experience (one year minimum) regarding vernal pool activities (such as botanical survey and identification, restoration, species reintroductions). Documentation of training and experience must be provided to, and approved by, the Service.

Section 10(a)(1)(A) permit: A section 10(a)(1)(A) permit, also referred to as a recovery, enhancement of survival, or scientific permit, allow for "take" of listed species (i.e. vernal pool fairy shrimp) that may or will occur while conducting research to further the recovery of a listed species.

Soil inoculum: soil taken from a vernal pool to introduce seed or cysts to another location.

Vernal Pool Complex: an area including both vernal pools and adjacent upland mounds.

Voucher Specimens: An individual or collection of individual adult, juvenile or cyst forms of fairy shrimp properly preserved and labeled for deposition at an approved fairy shrimp repository.

Table 1. Species of particular interest occurring in the Agate Desert vernal pools, listing status, associated habitats and recommended survey times.

Common Name	Scientific Name	Status	Habitat	Survey times
Vernal Pool Species				
Plants				
Henderson's bentgrass	*Agrostis hendersonii*	Federal species of concern, State threatened	Occurs in vernal pool edges	Early to mid-spring
Pacific foxtail	*Alopecurus saccatus*	None	Occurs in vernal pools	Early to mid-spring
annual hairgrass	*Deschampsia danthonioides*	None	Occurs in vernal pools	Mid spring
Cascade calicoflower	*Downingia yina*	None	Occurs in vernal pools	Early to mid spring
coyote thistle	*Eryngium petiolatum*	None	Occurs in vernal pools	May to June
quillwort	*Isoetes nuttallii*	None	Occurs in vernal pools	Early to mid-spring
toadrush	*Juncus bufonius*	None	Occurs in vernal pools and along edges	Spring
slimpod rush	*Juncus diffusissimus*	None	Occurs in vernal pools	Spring
soft rush	*Juncus effusus*	None	Occurs in vernal pools	Spring
Herman's dwarf rush	*Juncus hemiendytus*	None	Occurs in vernal pools	Spring
pointed rush	*Juncus oxymeris*	None	Occurs in vernal pools	Spring
iris-leaved rush	*Juncus xiphiodes*	None	Occurs in vernal pools	Spring
California goldfields	*Lasthenia californica*	None	Occurs on vernal pool edges and surrounding uplands	Early to mid spring
smooth goldfields	*Lasthenia glaberinna*	None	Occurs in vernal pools	Early to mid-spring
woolly meadowfoam	*Limnanthes floccosa* ssp. *floccosa*	None	Occurs in vernal pools	Early to mid-spring
large-flowered woolly meadowfoam	*Limnanthes floccosa ssp. grandiflora*	Federal endangered	Occurs in vernal pools	April to May
Cook's lomatium	*Lomatium cookii*	Federal endangered	Occurs on vernal pool edges and surrounding uplands	March to April
California sandwort	*Minuartia californica*	List 4, ORNHIC	Occurs on vernal pool edges	Early to mid spring
least mousetail	*Myosurus minimus*	None	Occurs in vernal pools	Early to mid-spring
Tehama navarretia	*Navarretia heterandra*	List 4, ORNHIC	Occurs on vernal pool edges	Mid spring
white-flowered navarretia	*Navarretia leucocephala* ssp. *leucocephala*	List 2, ORNHIC	Occurs in vernal pools	Early to mid-spring
slender phlox	*Phlox gracilis*	None	Occurs on vernal pool edges and surrounding uplands	Early to mid-spring

Common Name	Scientific Name	Status	Habitat	Survey times
American pillwort	*Pilularia americana*	List 2, ORNHIC	Occurs in vernal pools	Early to mid spring
bracted popcornflower	*Plagiobothrys bracteatus*	None	Occurs in vernal pools	Early to mid spring
rough-seeded popcornflower	Plagiobothrys glyptocarpus var. glyptocarpus	None	Occurs on vernal pool edges	Early to mid-spring
Green's popcornflower	*Plagiobothrys greenei*	List 2, ORNHIC	Occurs on vernal pool edges	Early to mid-spring
stipitate popcornflower	*Plagiobothrys stipitatus*	None	Occurs in vernal pools	Early to mid-spring
dwarf wollyheads	*Psilocarphus brevissimus*	None	Occurs in vernal pools	Early to mid spring
Oregon woolly-heads	*Psilocarphus oregonus*	None	Occurs in vernal pools	Early to mid-spring
white brodiaea	*Triteleia hyacinthina*	None	Occurs both in vernal pools and surrounding uplands	Spring
Upland Species				
Lemmon's needlegrass	*Achnatherum lemmonii*	None	Occurs in uplands surrounding vernal pools	Mid spring
blow-wives	*Achyrancheana mollis*	None	Occurs in uplands surrounding vernal pools	Early to mid spring
harvest brodeaia	*Brodeaia elegans*	None	Occurs in uplands surrounding vernal pools	Summer
wedge-leaf buckbrush	*Ceanothus cuneatus*	None	Occurs in uplands surrounding vernal pools	Spring
Fitch's tarweed	*Centromadia fitchii*	None	Occurs in uplands surrounding vernal pools	Mid to late spring
purple clarkia	*Clarkia purpurea*	None	Occurs in uplands surrounding vernal pools	Late spring to early summer
spinster's blue-eyed mary	*Collinsia sparsiflora*	None	Occurs in uplands surrounding vernal pools	Early to mid-spring
Roemer's fescue	*Festuca roemeri*	None	Occurs in uplands surrounding vernal pools	Summer
California hesperiochiron	*Hesperichiron californicus*	None	Occurs in moist meadows surrounding vernal pools	Early to mid spring
junegrass	*Koeleria macrantha*	None	Occurs in uplands surrounding vernal pools	Summer
slender hareleaf	*Lagophylla ramosissima*	None	Occurs in uplands surrounding vernal pools	Mid spring
dwarf woolly meadowfoam	*Limnanthes floccosa* ssp. *pumila*	Federal species of concern State threatened	Occurs in open oak woodlands and open prairie	Early to mid-spring
foothills desert parsley	*Lomatium utriculatum*	None	Occurs in uplands surrounding vernal pools	Early to late spring
bicolored lupine	*Lupinus bicolor*	None	Occurs in uplands surrounding vernal pools	Early to mid spring
coral seeded allocarya	*Plagiobothrys figuratus* ssp. *corallicarpus*	Federal species of concern, State candidate	Occurs in floodplains adjacent to vernal pools	Mid-spring to mid summer
fulvous popcornflower	*Plagiobothrys fulvus*	None	Occurs in uplands surrounding vernal pools	Early to mid-spring
rusty popcornflower	*Plagiobothrys*	None	Occurs in uplands	Early to mid-

Common Name	Scientific Name	Status	Habitat	Survey times
	nothofulvus		surrounding vernal pools	spring
bristly pogogyne	*Pogogyne zizyphoroides*	None	Occurs in uplands surrounding vernal pools	Mid spring
bluebunch wheatgrass	*Pseudoroegneria spicata*	None	Occurs in uplands surrounding vernal pools	Summer
Oregon white Oak	*Quercus garryana*	None	Occurs in uplands surrounding vernal pools	Anytime
southern Oregon buttercup	*Ranunculus austro-oreganus*	State Candidate	Occurs in oak woodlands surrounding vernal pools	Spring
poverty clover, cow's udder clover	*Trifolium depauperatum*	None	Occurs in uplands and on vernal pool edges	Early to mid-spring
tomcat clover	*Trifolium willdenovii*	None	Occurs in uplands surrounding vernal pools	Mid spring
mules ears	*Wyethia angustifolium*	None	Occurs in uplands surrounding vernal pools	Mid spring
Wildlife				
Botta's pocket gopher	*Thomomys bottae*	None	Occurs in uplands surrounding vernal pools	Mid-March through mid-July
burrowing owl	*Athene campestris*	None	Occurs in uplands surrounding vernal pools	Mid-March through mid-July
Lewis woodpecker	*Melanerpes lewis*	Species of concern	Occurs in oak woodlands surrounding vernal pools	Mid-March through mid-July
savanna sparrow	*Passerculus sandwichensis*	None	Occurs in uplands surrounding vernal pools	Mid-March through mid-July
vernal pool fairy shrimp	*Branchinecta lynchi*	Federal threatened	Occurs in vernal pools	Mid-December through mid-February
western pond turtle	*Clemmys marmorata*	Federal species of concern, State species of concern	Occurs in wetlands, ponds, lakes, slow moving streams and rivers	Mid-March through mid-July

Species Accounts

The section provides information regarding the three listed species and the designated vernal pool fairy shrimp critical habitat.

Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp is a member of the aquatic crustacean order Anostraca, in the Branchinectidae family (Figure 1). The species are endemic to vernal pools, an ephemeral freshwater habitat. The fairy shrimp are ecologically dependent on seasonal fluctuations in their habitat, such as absence or presence of water during specific times of the year, duration of inundation, and other environmental factors that include specific salinity, conductivity, dissolved solids, and pH levels. They are sporadic in their distribution, often inhabiting only one or a few pools in otherwise more widespread vernal pool complexes. Although the species has been collected from large vernal pools it tends to occur in smaller, frequently measuring less than 0.05 acre and shallower (mean of 2.5 inches) pools (Helm 1998). Genetic characteristics, as well as ecological conditions, indicate that populations are defined by pool complexes rather than by individual vernal pools.

Fairy shrimp inhabit vernal pools with clear to tea-colored water, most commonly in grass-or mud-bottomed swales, or basalt flow depression pools in unplowed grasslands. This species has a sporadic distribution within vernal pool complexes wherein the majority of pools in a given complex typically are not inhabited by the species. Fairy shrimp typically are found at low population densities. Eggs are speculated to be dispersed by "hitching a ride" on the legs or feet of wading birds or other animals passing through the pool, or by animals that ingest the eggs. They can mature quickly, with populations persisting in short-lived shallow pools, but they also can persist later into the spring where pools are longer lasting.

At the time they were listed, there were 32 known populations of the vernal pool fairy shrimp, all within California (USFWS 1994). They were subsequently discovered in vernal pools of the Agate Desert landform in southern Oregon.

Fairy shrimp have delicate elongate bodies, large-stalked compound eyes, no carapace, and eleven pairs of swimming legs. They swim or glide upside down by means of complex beating movements of the legs that pass in a wave-like anterior-to-posterior direction. While swimming on their backs, they feed on small particles of detritus, algal cells, and bacteria by scraping vegetation or other surfaces with their legs, or filtering the surrounding waters. The second pair of antennae in the adult females is cylindrical and elongate, but in the males these antennae are greatly enlarged and specialized for clasping the females during copulation. The females carry the eggs in an oval or elongate ventral brood sac. The fertilized eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks. The "resting" or "summer" eggs, also called diapause eggs, are not actually eggs, but cysts capable of withstanding heat, cold, and prolonged desiccation. After the eggs are fertilized, the embryo undergoes additional development to the nauplius or metanauplius stage before entering diapause.

Figure 1. Artist's depiction of adult male and female vernal pool fairy shrimp.

When the pools refill in the same or subsequent seasons some, but not all, of the cysts may hatch. Branchiopods respond to inherent variability in climatic conditions by producing eggs with different diapause characteristics in each clutch. Some hatch after drying and getting wet again;

while others may go through several wet/dry cycles before they hatch. The cyst bank in the soil may also be comprised of individuals from several years of breeding. The species typically produces only one clutch of eggs each year and then dies. Vernal pool fairy shrimp have been collected from early December to early May.

Fairy shrimp first hatch at the bottom of the vernal pool when water temperatures reach 50 degrees Fahrenheit. Under optimal conditions they undergo a series of molts before reaching maturity in about 2 1/2 weeks, when they are approximately 0.2 inches - 0.8 inches in length. They have been reported to live anywhere from 2-4 1/2 months, depending on many environmental factors (Eriksen and Belk 1999). These fairy shrimp often disappear early in the season long before the vernal pools dry up. Many species of insects, amphibians, waterfowl and crustaceans prey on fairy shrimp, making this species an important link in the food web, particularly as a supply of energy for migratory birds.

The Service listed the fairy shrimp as a threatened species primarily due to the present or threatened destruction, modification, or curtailment of their habitat or range (USFWS 1994). They determined that "the habitat of these animals is imperiled by a variety of human-caused activities, primarily urban development, water supply/flood control activities, and conversion of land to agricultural use. Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, and other activities, as well as modification of surrounding uplands that alters vernal pool watersheds." A final recovery plan for fairy shrimp was completed in 2005 (USFWS 2005).

Vernal Pool Species Critical Habitat

On August 8, 2003, the Service issued a final rule designating critical habitat for 15 vernal pool species, including fairy shrimp. A total of approximately 1,184,513 acres of land falls within the boundaries of designated critical habitat. Approximately 7,574 acres occur in Oregon and 1,186,969 acres occur in California (USFWS 2003).

Critical habitat is defined in Section 3 of the Act as:

> (i) The specific areas within the geographic area occupied by a species at the time it is listed in accordance with the Act, on which are found those physical or biological features
>
> (I) essential to the conservation of the species; and,
>
> (II) may require special management considerations or protection; and
>
> (ii) Specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.[1]

The physical or biological features include, but are not limited to, the following: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and (5) habitats that are

[1] ''Conservation,'' as defined by the Act, means the use of all methods and procedures that are necessary to bring an endangered or a threatened species to the point at which listing under the Act is no longer necessary.

protected from disturbance or are representative of the historic geographical and ecological distributions of a species. Our regulations at 50 CFR 424.12(b) further direct that when considering the designation of critical habitat, we are to focus on the principal biological or physical constituent elements (PCE) within the defined area that are essential to the conservation of the species, and we are to list known PCEs with the critical habitat description. Our regulations describe known PCEs in terms that are more specific than the description of physical and biological features. Specifically, PCEs may include, but are not limited to, the following: roost sites, nesting grounds, spawning sites, feeding sites, seasonal wetland or dryland, water quality or quantity, host species of plant pollinator, geological formation, vegetation type, tide, and specific soil types.

Because it is logistically difficult to determine how extensive the cyst or seed bank is at any particular site, and because hatched vernal pool crustaceans or above-ground vernal pool plants may or may not be present in all vernal pools within a site every year, we cannot quantify in any meaningful way what proportion of each critical habitat unit may actually be occupied by the vernal pool crustaceans or vernal pool plants. Therefore, areas of unoccupied habitat are probably interspersed with areas of occupied habitat in each unit. The inclusion of unoccupied habitat in our critical habitat units reflects the dynamic nature of the habitat and the life history characteristics of the vernal pool crustaceans and vernal pool plants. Unoccupied areas provide areas into which populations might expand, provide connectivity or linkage between groups of organisms within a unit, and support populations of pollinators and seed dispersal organisms. Both occupied and unoccupied areas that are designated as critical habitat are essential to the conservation of the species.

Based on our current knowledge of the life history and ecology of the 15 listed vernal pool species, the relationship of their essential life history functions to their habitat, and the ecological and hydrologic functions of vernal pool complexes, we determined that all of the 15 vernal pool species share the following two PCEs. These are:

> (1) Vernal pools, swales, and other ephemeral wetland features of appropriate sizes and depths that typically become inundated during winter rains and hold water for sufficient lengths of time necessary for the 15 species to complete their life cycle.
>
> (2) The geographic, topographic, and edaphic features that support aggregations or systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands when taken together form hydrologically and ecologically functional units called vernal pool complexes. These features contribute to the filling and drying of the vernal pool, maintain suitable periods of pool inundation, and maintain water quality and soil moisture to enable the 15 vernal pool species to carry out their lifecycles.

Vernal Pool Fairy Shrimp Critical Habitat

Fairy shrimp is the only species addressed in the Service's 2003 critical habitat designation regarding vernal pool species occurring in Oregon (Figure 2). Four critical habitat units in Oregon are designated as essential to the conservation of fairy shrimp, and there are 29 units in California. The Oregon units are comprised of 7,574 acres in Jackson County. These units occur approximately 125 miles north of the nearest unit designated for this species in California. The Service identified critical habitat areas essential to the conservation of fairy shrimp to reflect

the species geographic distribution and varying habitat types and species associations across its range. Maintaining fairy shrimp across their full geographic distribution would make the species less susceptible to environmental variation or negative impacts associated with human disturbances or natural catastrophic events across the species entire range at any one time (Helm 1998).

Variation in environmental conditions such as precipitation amount, precipitation timing, and temperature, influence vernal pool species including hatching and reproduction of fairy shrimp from year to year (Eriksen and Belk 1999, Helm 1998).

The following critical habitat unit descriptions are taken from the Service's final rule designating critical habitat for vernal pool species in California and southern Oregon (USFWS 2003):

Unit 1A, B, C, D, E, F, and G, North Agate Desert Unit, Jackson County (2,130 ac)
This unit consists of seven subunits, all located to the north of Little Butte Creek. This unit represents the northern limit of the species' distribution. It is of sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat, and is separated from the nearest other unit designated for Oregon, Unit 4, by over 2 miles. Three of the subunits are west of the Rogue River, and the remaining four are to the east. All but one of these subunits is located to the south of U.S. Route 234 (Sam's Valley Highway). The one remaining unit is located to the east of the Rogue River, about 1.5 miles north of the confluence with Reese Creek.

Unit 2A, B, C, D, and E, White City East Unit, Jackson County (2,251 ac)
This unit consists of five subunits, located east of U.S. Route 62 (Crater Lake Highway) and south and southeast of Dutton Road. This unit provides the easternmost extent of the species' range in Oregon. It represents a significant component of the species' original range in the State and is of a sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat. The largest and easternmost of the subunits occurs just to the east and north of Agate Lake. It is separated by more than 1 mile from Unit 3, White City West, and by approximately 3.5 miles from the North Agate Desert Unit.

Unit 3A, B, and C, White City West Unit, Jackson County (2,301 ac)
This unit consists of three subunits, located west of Agate Road, south of the Rogue River, and east of Bear Creek. This unit contains the least fragmented intact examples of the original Agate Desert mounded vernal pool grassland habitat. It is of sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat; it is separated from the White City East Unit by more than 1 mile and from the Table Rocks Unit by over 1.5 miles.

Taken together, the designated Agate Desert units (Units 1–3) comprise a functional vernal pool complex consisting of vernal pools, mounded grassland and associated uplands, where natural processes, including connectivity, function within or near the natural range of variability. Each of the three designated Agate Desert units is essential to the conservation of vernal pool fairy shrimp in the Agate Desert area.

Unit 4A and B, Table Rocks Unit, Jackson County (892 ac)
This unit consists of two subunits, located on two flat-topped mesas known as Upper and Lower Table Rocks, situated north and west of the Rogue River. These rimrock features are remnants of

ancient lava flows that filled portions of the Rogue River nearly 10 million years ago. Subsequent erosion of softer geologic layers has left these harder andesite (volcanic rock) formations rising some 800 feet above the present Rogue Valley. Vernal pools on the Table Rocks differ from those of the Agate Desert, in that they are formed over an impervious layer of bedrock. This unit represents a unique habitat for vernal pool fairy shrimp in Oregon. The Table Rocks Unit is disjunct from the North Agate Desert Unit by over 2 miles, and from the White City West Unit by approximately 1.5 miles.

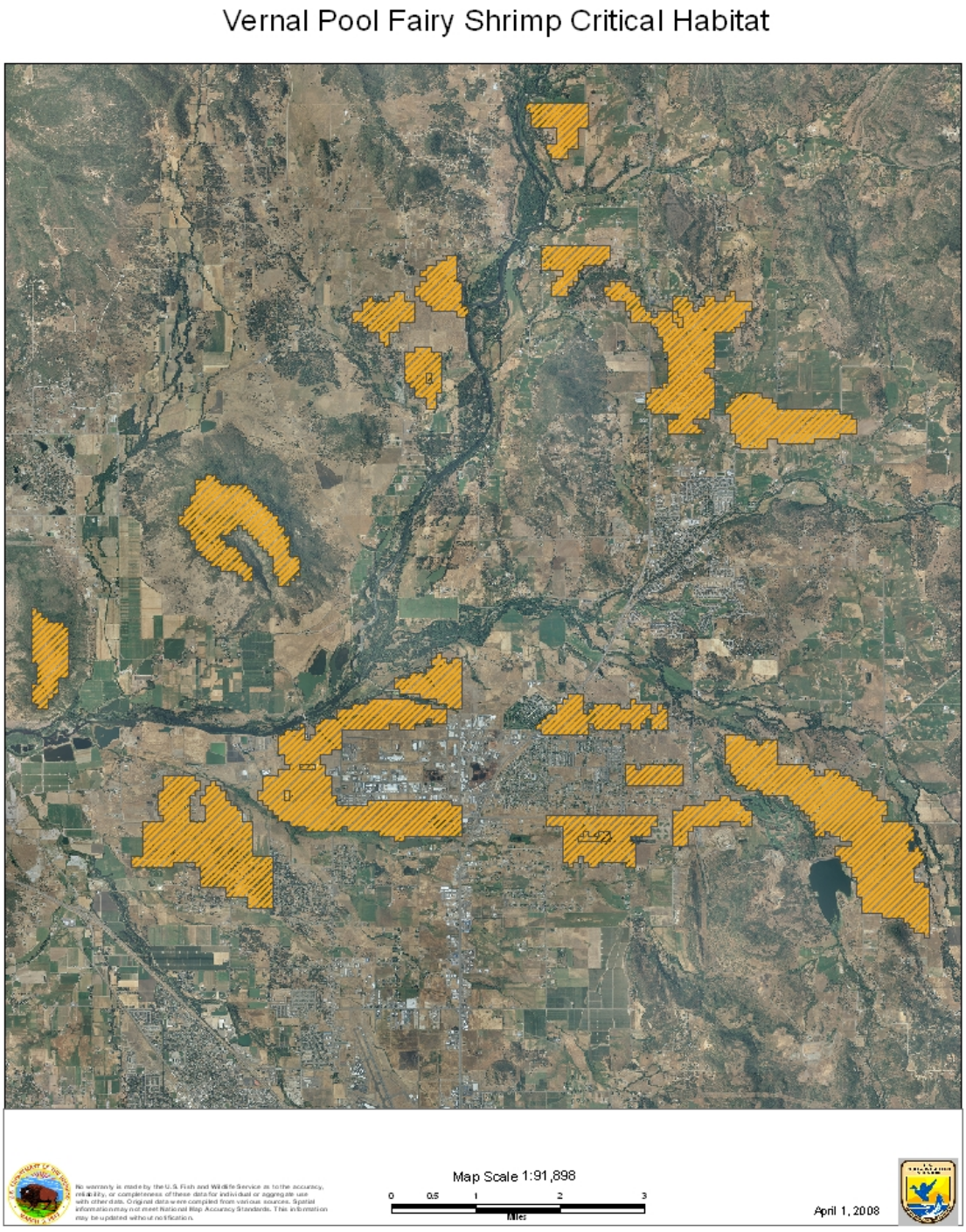

Figure 2. Map of Designated Vernal Pool Critical Habitat in the Agate Desert area.

The vernal pool habitat within these four units was selected based on information provided by a wetland function and values assessment and habitat integrity analysis completed in 1999. Information describing the physical (i.e., parcel size, presence of intact hydrology) and biological (i.e., species diversity, presence and composition of native vegetation) condition of the vernal pool habitat, species inventory information detailing the presence fairy shrimp, lomatium and meadowfoam, and parameters describing the potential long term sustainability of habitat (defensibility of the parcel, ownership, and positioning of the parcel relative to nearby habitat parcels) was used to identify specific parcels for inclusion as critical habitat.

Cook's lomatium

Lomatium is a perennial forb in the carrot family (Apiaceae) which grows 15 to 50 centimeters (cm) (6 to 20 in) tall, from a slender, twisted taproot (Figure 3). Leaves are smooth, finely dissected, and strictly basal (growing directly above the taproot on the ground, not along the stems). One to four groups of clustered, pale yellow flowers produce boat-shaped fruits 8 to 13 mm (0.3 to 0.5 in.) long with thickened margins. The taproot can often branch at ground level to produce multiple stems. The branching taproot distinguishes Cook's lomatium from *Lomatium bradshawii* (indigenous to wet prairies from southern Willamette Valley, Oregon to southwest Washington) and *L. humile* (found in vernal pools in northern California) (Kagan 1986). *L. utriculatum*, found on mounds adjacent to pools in the Agate Desert, is distinguished from Cook's lomatium by its more intense yellow flowers, wider, overlapping involucel bracklets (leaf-like structures below the flowers), and thin-winged fruits (Kagan 1986). *L. tracyi*, occurring in California and the Illinois Valley, has a similar appearance to Cook's lomatium, but *L. tracyi* has slender-margined fruits and can grow on dry sites.

Recent genetic research has shown lomatium to be most closely related to *L. bradshawii*. *L. marginatum* and probably *L. tracyi* are likely the next closely related species (M. Gitzendanner, pers. comm. 2002). Cook's lomatium flowering and fruiting time occurs from approximately mid-March to mid-May (Kaye and Rohland 2007).

Lomatium occurs in both the Rogue River Valley in Jackson County, Oregon and the Illinois Valley in Josephine County, Oregon. Illinois Valley lomatium populations occur on seasonally wet soils mapped as Abegg, Brockman, Eightlar, Josephine, Pollard, Takilma, and Newberg soil series. Rogue Valley lomatium populations only occur on areas mapped as Agate-Winlo complex soils and Coker soil series.

Slight morphological differences exist between lomatium populations in the Rogue Valley and the Illinois Valley, but these differences are not considered significant enough to separate the species into subspecies. Recent genetic research found no evidence of significant genetic differences between the lomatium populations, thus not warranting the separation of the species into subspecies (M. Gitzendanner, pers. comm. 2002).

Researchers knew of only about 15 occurrences of lomatium in the Rogue Valley and 21 in the Rogue Valley at the time the species was listed as endangered (USFWS 2002). The continued existence of lomatium is imperiled primarily due to destruction of its habitat by urban development, including road and powerline construction and maintenance, mining, and forest succession due to fire exclusion. Agricultural conversion, certain grazing practices, off-road vehicle use, competition with nonnative plants, and unknown factors also contribute to

population declines. A rule listing lomatium as endangered was published in the Federal Register on November 2, 2002 (USFWS 2002). The rule became effective on December 9, 2002.

Figure 3. **Cook's lomatium, with yellow flowers**.

Large-flowered woolly meadowfoam

A delicate annual in the meadowfoam, or false mermaid, family (Limnanthaceae), the meadowfoam grows 2 to 6 inches tall; with 2 inch leaves divided into 5 to 9 segments (Figure 4). The stems and leaves are sparsely covered with short, fuzzy hairs. The flowers, and especially the sepals, are sparsely covered with woolly hairs. Each of the five yellowish to white petals has two rows of hairs near their base. Each meadowfoam flower usually produces 5 nutlets. In the Rogue Valley, meadowfoam flowering and fruiting time occurs in early spring, from March to mid-April (S. Friedman, pers. comm. 2008).

Mason (1952) described three varieties of woolly meadowfoam (*Limnanthes floccosa*), but did not recognize *ssp. grandiflora* as distinct. Based on her study of specimens grown under controlled conditions from field-collected seed, Arroyo (1973) elevated Mason's varieties to subspecies and described two additional subspecies, *californica* and *grandiflora*. Arroyo (1973) distinguished *grandiflora* from the other subspecies of *L. floccosa* by: a combination of: petal length 0.30 to 0.35 inch; sepal length 0.33 to 0.35 inch; sepal pubescence (dense on inner surface and sparse to absent on outer surface); sparsely hairy stems and leaves; two lines of hairs at the petal base; relative flowering time; and, occurrence relative to soil moisture (Arroyo 1973).

Over much of its range, *ssp*. *grandiflora* is sympatric or closely related with *L. floccosa ssp*. *floccosa*; however, *ssp*. *floccosa* grows on the slightly drier, outer fringes of the vernal pools, whereas *ssp. grandiflora* grows on the relatively wetter, inner fringe of the pools (Arroyo 1973).

Figure 4. Large flowered woolly meadowfoam, in clump of grass.

Meadowfoam is associated with vernal pools that occur on Agate-Winlo complex soils in the Agate Desert area of the Rogue Valley, in Jackson County Oregon. Typically the plant only occurs at the margins of the vernal pools. Meadowfoam has declined primarily by destruction of its habitat by urban development, including road and powerline construction and maintenance. Agricultural conversion, certain grazing practices, off-road vehicle use, and competition with nonnative plants also contribute to population declines.

A rule listing meadowfoam as endangered was published in the Federal Register on November 2, 2002 (USFWS 2002).

Vernal Pool Function and Condition Assessment Methodology

The following narrative describes a wetland function and value assessment methodology developed by Environmental Science Associates (ESA) as part of a contract with DSL. For more

information regarding the full methodology please see Agate Desert Vernal Pool Functional Assessment Methodology. (ESA 2007)

Methodology

The primary goal of the Agate Desert Vernal Pool Functional Assessment methodology, was to provide a "…scientifically based, rapid, and consistently applicable tool to comparatively assess functions and values of vernal pool wetlands in the Agate Desert area of White City, Jackson County, Oregon (ESA 2007a). In other words, this methodology (hereafter referred to as the "vernal pool assessment methodology"):

IS specific to the Agate Desert vernal pool ecosystem;
IS based on the best available science as of 2007, as well as the professional judgment of scientists working in vernal pool ecosystems;
IS designed to compare vernal pools in the Agate Desert region to each other, not to a pristine ideal;
IS designed to be easy for non-wetland experts to use;
IS designed so that it is time-efficient (hence, the commonly used phrase, "rapid assessment" method);
IS foremost a planning tool;
IS NOT free of assumptions – without a significant investment of time and research money, assumptions about some ecological relationships and societal values were necessary; and
IS *NOT* intended to evaluate site-specific impacts or proposed mitigation.

This vernal pool assessment methodology uses carefully-selected, and yet easily measurable or observable "indicators" as substitutes for actually measuring ecological processes and societal values. Why? Ecological processes are notoriously difficult to measure, especially those that happen across a wide area (e.g., wildlife migration) or span decades.

The following sections explain, in more detail, how ESA developed the ecological function and societal value scores used for the Agate Desert Project.

Determining Vernal Pool Complexes

Vernal Pool Complexes" (VPCs) are clusters of vernal pools hydrologically and ecologically connected. VPCs can be very large, or quite small. ESA include several important caveats for deciding upon the boundaries of VPCs. These caveats are as follows:

1. If other kinds of wetlands (e.g., riparian) adjoin a VPC, they should be assessed with a different wetland assessment method (e.g., Oregon Freshwater Wetland Assessment Method).
2. The rationale for determining the boundary of a VPC is based on both biological functioning (e.g., species dispersal) and relative degree of hydrologic separation.
3. VPCs are considered hydrologically separated if a paved road runs between them – even if the paved road has culverts underneath the road bed. The water regime of vernal pools is driven by rainwater as well as lateral movement over the hardpan. Culvert connections under paved roads are considered insufficient for maintaining an ecologically viable hydrologic connection.
4. VPCs with unimproved ("dirt") roads or trails running through are not considered separate VPCs.

5. VPCs on either side of natural or man-made drainage (stream or canal) are considered contiguous.
6. VPCs extending beyond boundary of the study area are considered in their entirety.

Indicators And Models

Indicators

There are 31 indicators used in the vernal pool assessment methodology. Some indicators must be collected or measured in the field; others can be determined in the office using aerial photographs, maps, and existing databases (e.g., National Wetlands Inventory). Three are "derived indicators," meaning that they are derived from a combination of other indicators. Table 2 includes a brief description of all 31 indicators in the second column. (Note: In ESAs' vernal pool assessment methodology document, indicators are sometimes referred to as "variables.")

Table 2. Ecological function and societal value models of which each indicator is a part.

Indicators		**Ecological Function and/or Societal Value Models of which each indicator is a part**		
Abbreviation	**Description**	**Ecological Function Models**		**Societal Value Models**
		Landscape Scale	**Pool-scale**	
Landscape-*level indicators*				
Access1	Public accessibility (ownership, physical barriers)			ER
Access2	Public access is developed (e.g. parking, trails)			ER
Access3	Access developed to accommodate mobility-impaired users			ER
Area	Area of VPC	WS, NW		RE, SU
Brach	Presence or absence of Vernal Pool Fairy Shrimp		NW	
Connect	Pool connectivity via linear swale features	WS, NW, NP		RE
Gofer	Presence or absence of gopher holes/activity	WP, NW, NP		
HydAlt2	Evidence of hydrologic alteration within/around VPC (water drained in or out of VPC)	WS, WP, NW, NP		RE, SU
HydD	Diversity of hydroperiod types within complex	NW, NP		RE
LcNat2	Naturalness of land cover surrounding complex	NW, NP		WS, WP, NW, RE, SU
LIFL	Presence and population size of *Limnanthes floccosa ssp. grandiflora*			NP
LOCO	Presence and population size of *Lomatium cookie*			NP
OpSpace	Sense of open space/degree of urban "viewshed" from site			ER
Patt	Pattern: VP distribution and abundance within VPC	WS, NW, NP		NW, SU
Peri	Ratio of VPC perimeter to VPC area (amount of edge to core)	WP, NP		
Psens	Presence and number of sensitive (non-federally			NP

Indicators		Ecological Function and/or Societal Value Models of which each indicator is a part		
Abbreviation	**Description**	**Ecological Function Models**		**Societal Value Models**
		Landscape Scale	**Pool-scale**	
	designated) plant species in complex			
School	Distance to nearest school facility			ER
SizeD	Diversity of individual pool sizes within VPC	NW		
SoilAlt2	Evidence of soil alteration (e.g. tilling) within VPC	WP, NW, NP		RE, SU
UpNIS	Degree of upland dominance by NIS plant species	NW, NP		SU
Wet%	% Watershed containing wetlands (vernal pool *and* other types)	NW		WS, WP, NW
Pool-level indicators				
Depth	Maximum depth of pools within complex		WS, NW	RE
HydAlt1	Evidence of hydrologic inputs/outputs at pool scale		WS, WP, NW, NP	RE, SU
HydRest	Potential restorability to natural hydrology at pool scale			RE
HyVeg	Relative degree of hydrophytic (water-loving) vernal pool plants		WP	
PnatPC	% Cover native plants in vernal pools		NW, NP	SU
SoilAlt1	Evidence of soil alteration at pool scale		WP, NW, NP	RE, SU
SoilRest	Potential restorability of soil conditions at pool scale			RE
Derived Indicators				
WS score	Water storage function score	WP		
NP score	Native Plants function score			ER
NW score	Native wildlife function score			ER

WS = water storage, WP = water purification, NW = native wildlife, NP = native plants,
ER = education and recreation, RE = restorability, and SU = sustainability.

Functions and Values

The indicators are used to assess four important "ecological functions" and seven "societal values" of VPCs. An ecological function is something that a wetland does, a process that a wetland performs naturally. The four ecological functions that ESA chose to use for the vernal pool assessment methodology include:

Water storage;
Water purification;
Maintaining native wildlife; and
Maintaining native plants.

"Societal values" are indices of a vernal pool's ability to provide functions (e.g. water storage) valued by humans, as well as societal values not directly associated with ecological functions (e.g. recreation). The seven societal values chosen by ESA to use for the methodology include:

Value (to society) of water storage;
Value of water purification;
Value of maintaining native wildlife;

Value of maintaining native plants;
Education and passive recreation;
Restorability; and
Sustainability.

Spatial Scales: Landscape vs. Pool
One of the reasons it is difficult to measure ecological function is that natural processes are taking place, simultaneously at different spatial scales. "Different spatial scales" means simply that a human would have to get down on his or her hands and knees to observe some things, and study aerial photos to observe others. For example, weed seeds germinate at the edge of a vernal pool, but might blow from one VPC to another three miles away. Similarly, Environmental Studies Associates explain that "administrative actions (e.g. issuing environmental permits) by resource agencies occur at different [spatial] scales. For example, actions to conserve vernal pools typically assess 'landscape-level' factors such as the extent and quality of corridors of habitat between vernal pool complexes, because this maximizes conservation efficiency. In contrast, decisions under Oregon's Removal-fill law and the federal Clean Water Act, such as issuing permits for a road-widening project, often involve only small portions of VPC's or even single pools." In order to be ecologically meaningful, the vernal pool assessment methodology includes indicators that are measured at landscape (i.e. over the entire VPC) and pool scales, as well as different mathematical models for ecological functions occurring at each spatial scale.

Indicator Data Types
Many of the 31 indicators are categorical. In other words, the data collected for an indicator are divided among different categories: high/medium/low, for example. The nearness of a VPC to a school is a categorical indicator. Rather than record exact mileage (and via which route?), school proximity was recorded as "near" (1.0), "some distance away, but close enough" (0.5), or "too far" (0.0). In order to ensure that the vernal pool assessment methodology was both easy and quick, broader categories were used rather than splitting results into more specific classes.

Some indicators are simply measured and the measurement recorded. These are called "continuous variables" or "continuous scores" because the data can be any number from 0 to infinity. For example, vernal pool depth is simply measured. However, in order to be useful within the mathematical modeling scheme, the depth measurements were scaled relative to each other so that all fell within the range of 0.0 – 1.0.

Models
Each of the 31 indicators is part of at least one mathematical model. These "scoring models" are used to estimate a VPC's ability to perform one of the four ecological functions or attain one of the seven societal values (Table 2).

For each function or value, ESA created a mathematical equation with the indicators that were measured in the field. Whether each indicator in the equation was multiplied together, or added or subtracted, depended upon whether the indicator has a particularly strong effect on the function or value (multiplied), or is positively (added) or negatively (subtracted) associated with the function or value. For example, the ability of a vernal pool to store water (the pool scale "Water Storage" function) was estimated by the following formula: WS = Depth + HydAlt1. Both pool depth and lack of hydrologic alteration of the pool were positively correlated with water storage. The mathematical models for the ecological functions and societal values are in Table 3.

Table 3. Mathematical models used as proxies for ecological functions and societal values chosen to assess vernal pool conservation value.

Water Storage

Pool-scale Function: *Depth + HydAlt1*

Landscape-scale Function: {*Area * [Average: Patt, (1.0 - Connect)]} + HydAlt2*

Value: *Average: Wet%, (1.0 - LcNat2)*

Water Purification

Pool-scale Function: *HyVeg + (Average: HydAlt1, SoilAlt1)*

Landscape-scale Function: *Wstor + [Average: (1.0 - Peri, Gofer)] + (Average: HydAlt2, SoilAlt2)*

Value: *Average: Wet%, (1.0 - LcNat2)*

Maintain Native Wildlife

Pool-scale Function: *Brach + (Average: Depth, PnatPC) + (Average: HydAlt1, SoilAlt1)*

Landscape-scale Function: *(Average: Wet%, Area) + (Average: LcNat2, Patt, Connect, HydD, SizeD, Gofer) + (Average: HydAlt2, SoilAlt2, UpNIS)*

Value: *(Average: 1.0 - LcNat2, 1-Patt, Wet%)*

Maintain Native Plants

Pool-scale Function: *PnatPC + (Average: (HydAlt1, SoilAlt1)*

Landscape-scale Function: *(Average: LcNat2, UpNIS, 1.0 - Peri, Gofer) + Patt + Connect + HydD + (Average: HydAlt2, SoilAlt2)*

Value: (*Maximum: LOCO, LIFL, Psens)*

Education and Passive Recreation

Value*: (Average: Access1, Access2, Access3) + School + OpSpace + (Maximum: Wildlife Score, Plant Score)*

Restoration Priority

Value*: (Area + LcNat2) * {[(Average: (1.0 - Depth), (1.0 - HydD), (1.0 – Connect)]} + {HydRest * [Average: (1.0 - HydAlt1), (1.0 - HydAlt2)]} + {SoilRest * [Average (1.0 - SoilAlt1), (1.0 -SoilAlt2)]}*

Sustainability

Value*: [Area * (Average: Patt, LcNat2, PnatPC)] + UpNIS + (Average: HydAlt1, HydAlt2, SoilAlt1, SoilAlt2)*

Cumulative Scores
Some wetland assessment methodologies stop at this point, keeping the results of each mathematical model separate. However, ESA and the Agate Desert Technical Advisory Committee decided to combine the ecological function scores and societal value scores in order to help "rank" VPCs from high conservation value to low. Certain caveats, however, must be met in order to keep the results useful and reduce the "muddying effect" of too many averages and mathematical averaging. These caveats are:

- Functions and values are always kept separate in cumulative soring; each VPC has one combined function score and one combined value score.
- In cumulative scores, all functions (or values) are weighted equally. No single function or value drives the [cumulative] model scoring more than any other.
- In cumulative scores, pool- and landscape-scale functions are averaged; the result being that pool- and landscape-scale indicators are weighted equally.
- Cumulative scores should be used with caution "and for the purposes of informing wetland planning decisions for the Agate Desert assessment area."

Model Verification
In order to test the validity of the mathematical models used to describe vernal pool ecological function and society value, as well as the cumulative function and value scores (above), the results for two preserves were compared with the rest of the data. For the four ecological functions, the two preserves managed by The Nature Conservancy (Agate Desert and Whetstone Savannah) were determined by Environmental Science Associates and the TAC to be among the highest-functioning VPCs in the White City study area. Their scores should be among the highest of all 59 VPCs. VPCs were ranked from highest score to lowest. The Nature Conservancy sites were ranked 5 and 13, respectively.

Vernal Pool Fairy shrimp (*Branchinecta lynchi*) Survey and Sampling Procedure

This section contains information regarding wet season and dry season survey methods for fairy shrimp. It should be noted *Eubranchipus oregonensis*, another fairy shrimp (not listed) also co-occurs in this area. This procedure is intended to be used by holders of current section 10(a)(1)(A) recovery permits specific to actions regarding the listed fairy shrimp.

Fairy Shrimp Survey Approval

Unless otherwise authorized by the Service in writing, this guidance will be utilized for all surveys conducted to determine presence of the listed fairy shrimp in the Agate Desert area. The Service must approve any deviations from the methods prescribed by this guidance before surveys are conducted. The entity conducting the surveys will provide the appropriate Service Office with all of the following information in writing for each project site at least 10 working days prior to the anticipated start date of survey work:

- The precise location of the project site, preferably transmitted as an electronic file in a GIS format (preferably reported in UTM Zone 10 NAD 83 (Meters) coordinates), or clearly delineated on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=24,000 ft.) with the quad name clearly indicated. Other information needed includes: (1) project name; (2) name of county in which the project site is located; (3) type of project (e.g., urban, agricultural, and or commercial development); (4) the

estimated total acreage of the project site, an estimate of the number and acreage of vernal pools/swales on the site and the ratio of pool to upland mounds.

- Names and qualifications of all vernal pool biologists and associated personnel conducting field work and their section 10(a)(1)(A) permit number(s); and,

- A written request to commence wet season and/or dry season sampling for each project area that will be surveyed for fairy shrimp.

Fairy Shrimp Sampling

A complete fairy shrimp survey consists of sampling for either:

1. Two full wet seasons within a 5-year period; or

2. One dry season survey; or,

3. A combination of a wet and a dry season survey.

NOTE: during periods of drought, an increase in sampling duration for wet season sampling or mandatory dry sampling may be required. For example, if during two wet season sampling periods pools were not inundated long enough to allow for the hatch and maturation of the fairy shrimp, then negative sampling results may be determined to be inconclusive and further surveys may be needed when conditions allow the fairy shrimp to complete their life cycles (e.g., amount and duration of inundation and/or hatching temperatures are sufficient to allow detection and identification of the species).

Once initiated, surveys conducted pursuant to these Guidelines may be suspended prior to completion if:

1. The presence of the listed fairy shrimp on the subject site is determined through identification at any point within the wet season survey cycle; or

2. It is agreed the listed fairy shrimp are present on the subject site.

Each vernal pool/swale in a vernal pool complex will be surveyed as per this Guidance. However, in cases involving large areas of vernal pools/swales (i.e., large is generally defined as many hundreds of pools/swales on a single site), a plan to subsample a representative portion of the site may be submitted by the surveyor. The Service will evaluate each case individually, and if acceptable, give written authorization to proceed with the sub-sampling plan.

Accurately tracking survey efforts is a critical part of the sampling protocol. As part of the Service's on going efforts to track vernal pool surveys, recovery implementation, and habitat loss using a GIS, we are asking surveyors to submit information about their survey areas in electronic format whenever possible, in addition to submitting forms to ONHIC to track species occurrence information through the ONHIC.

Notification Requirements

The surveyor will notify the Service of the first date that the vernal pools fill and the date that wet season sampling is begun. Notification should be by letter or fax to the appropriate Service Office (see Service Contacts section).

If the surveyor determines the listed fairy shrimp are present at a site, the surveyor will notify the Service within 10 working days by letter or fax. A copy of the completed survey form for the occurrence will be included.

The surveyor will notify the Service by letter or fax if sampling is cancelled. Notification should occur within 10 working days of the decision to cancel and should include the reason for cancellation. If sampling is stopped because the listed fairy shrimp are found, notification and a copy of the survey form should be mailed or faxed to the appropriate Service Office (see Service Contacts section).

Fairy Shrimp Wet Season Surveys

Wet season survey sampling will not be conducted at any project site unless the surveyor receives prior permission from the Service. Because early surveys are critical to the detection of fairy shrimp, Service permission to sample may not be granted for surveys initiated beyond the first 8-10 days after inundation. A pool/swale is considered inundated when it holds greater than 3 cm of standing water 24 hours after a rain event.

Fairy Shrimp Survey Initiation, Frequency, and Termination

1. Surveyors should visit sites immediately after initial storm events to determine if pools/swales have been inundated. Surveyors desiring to survey distant areas will need a local monitor onsite when the wet season approaches, and throughout the sampling season, to alert the surveyor when sampling needs to be initiated or re-initiated.

2. Fairy shrimp sampling will be conducted at the following frequency: a) one survey conducted 7 - 10 days after inundation; b) a second survey conducted seven days after the first; c) a third survey conducted seven days after the second; and d) follow-up surveys conducted every 14 days for the remainder of the survey period. Surveys will continue until the pools are no longer inundated, or until they have experienced 120 days of continuous inundation.

3. In cases where the pools/swales dry and then refill (i.e., hold 3 cm or more of standing water) in the same wet season or if the pools are in a dry down phase (even if not dry) and then increase significantly in size due to a rain event, even if the pool/swale has already experienced 120 days of continuous inundation, sampling will be re-initiated between six and eight days of re-inundation or additional fill and the sampling schedule described above will be followed until the pools have experienced 120 days of continuous inundation, or until they are no longer inundated. This return to the initial sampling schedule is necessary because refill of pools or significant increased water can trigger osmotic shock and may result in hatching or hydration of cysts in parts of the pool not previously hydrated.

4. Wet season surveys conducted pursuant to these Guidelines may be suspended prior to completion. Suspension of surveys during the wet season will occur immediately if fairy shrimp are determined to be present on the subject site, unless the Service determines that continued sampling for other listed vernal pool crustacean species that may be present on the site is warranted.

   NOTE: Surveyors should make every attempt to minimize walking and wading in inundated pools. Surveyors should be deliberate whenever entering an inundated pool, (i.e., plan activities and scout out a path before entering pool, minimize splashing, use a "shuffling" technique when walking or wading through inundated pools, etc.,).

Fairy Shrimp Sampling

At each wet season visit, representative portions of the pool/swale bottom, edges and vertical water column will be adequately sampled using a seine, dip net or aquarium net appropriate for the size of the pool or swale. Net mesh size will not be larger than 3 mm (i.e., 1/8 inch). Seines will be examined and emptied of material at least once every five linear meters of habitat that is sampled.

It is recommended that surveyors also net with a smaller mesh size net than required above to detect larvae and small juveniles. Although these immature forms are unlikely to be identified to species, knowledge of the presence of these individuals and their stage of development will assist surveyors in determining the appropriate time to return to a particular pool/swale or site to collect adult specimens. All immature forms captured should be immediately returned to the pool from which they were captured.

Sampling results should be reported to the Service using the Vernal Pool Data Sheets for wet season sampling or dry season sampling.

Sanitizing Protocol

Hands, footwear and field equipment can transport cysts, pathogens and parasites from one study site to another. It is vitally important for those involved in wetland studies, including those studying amphibians, fish, invertebrates and plants, to take steps to minimize the spread of disease and parasites between study sites, and to prevent artificial dispersal of propagules between sites. The following protocol is necessary to ensure the integrity of the surveys, and to reduce the likelihood of the unnatural transfer of populations and the spread of disease.

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires and all other surfaces. Rinse cleaned items with water before leaving each study site.

2. Boots, nets, traps, etc., must be scrubbed with 70 percent ethanol or 3 to 6 percent sodium hypochlorite and thoroughly rinsed with clean tap water between study sites. Do not clean equipment in the immediate vicinity of a pond, stream, or wetland.

3. In remote locations, clean all equipment as described above upon return to the lab, office, or "base camp". Elsewhere, when washing machine facilities are available,

remove nets from poles and wash with bleach on a "delicates" cycle, contained in a protective mesh laundry bag.

4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately at the end of each field day.

5. When fairy shrimp are collected, ensure the separation of individuals from different sites and take great care to avoid indirect contact between them (e.g. via handling, reuse of containers) or with other captive animals. Isolation from unsterilized plants or soils, which have been taken from other sites, is also essential. Always use disinfected/disposable husbandry equipment.

6. Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

Fairy Shrimp Voucher Specimens

1. Voucher specimens of fairy shrimp will be collected only once from each individual vernal pool/swale each year that wet sampling is conducted. If pools and swales are highly interconnected, fewer vouchers are needed.

2. If voucher specimens are warranted, no more than 20 fairy shrimp from each pool/swale, or less than 10 percent of the subpopulation present in the pool/swale, whichever is the lesser amount, may be retained and preserved as voucher specimens. Museums, universities, and/or researchers may want voucher specimens of unlisted species. Surveyors are encouraged to check with such entities to see if specimens of unlisted species are needed and accommodate them if possible.

3. All other specimens will be immediately returned in good condition to the vernal pool/swale where they were collected as quickly as possible.

4. Only sexually mature, adult fairy shrimp will be used for purposes of voucher specimens for species identification. The Service will not accept species identifications made using immature specimens. Voucher specimens collected from each pool/swale or interconnected group of pools/swales will include at least three sexually mature males.

5. Voucher specimens will be accessioned to a museum accepted as a repository by the Service (e.g., California Academy of Sciences, Natural History Museum of Los Angeles County, or Southern Oregon University). (See approved institutions)

Fairy Shrimp Dry Season Surveys

Dry season soil sampling will not be conducted at any project site unless the surveyor receives prior written permission from the Service. The following soil collection protocol is specifically

for dry season cysts sampling. This soil collection protocol should not be used for collection of soil inoculum samples for restoration activities (see soil inoculum collection protocol)

Dry Season Soil Collection

Soil will be collected when it is dry to avoid damaging or destroying fairy shrimp cysts, which are more fragile when wet. A hand trowel or similar instrument will be used to collect 10 approximately 100 ml subsamples of substrate from each pool/swale; total volume of material collected will be approximately 1 liter (Figure 5). Soil will be collected from the top 1-3 cm of pool sediment. Whenever possible, each subsample of soil will be collected as a single intact sample. A trowel or other appropriate tool will be used to pry up intact pieces of sediment, rather than raking or scraping the surface, which can damage cysts.

In the case of a very large vernal pool the Service may require a sample greater than 1.0 liter of soil. Check with the appropriate Service office (see Service Contacts section) if the proposed sampling site has large pools.

If a pool has a diameter of less than three meters, the total soil sample taken should not exceed 0.5 liter in volume per pool, and the 10 subsamples should be approximately 50 ml each in volume.

There are federally listed plant species (*e.g.*, *Lomatium cookii,* and *Limnanthes flocossa grandiflora*) that often co-occur with the fairy shrimp. Removal of soil could damage populations of these listed plants by inadvertently removing seed. Dry sampling should be minimized or avoided within those vernal pools/swales that are known to, or may, contain these species. The surveyor will contact the appropriate Service office (see Service Contacts section) regarding the distribution of these listed plants species prior to conducting dry sampling.

Dry Season Soil Sample Locations

A total of 10 soil subsamples, of which each subsample will be approximately 100 ml in volume, will be collected from the following locations within each pool/swale sampled (Figure 5):

1. Establish a transect along the length (i.e., longest part) of the pool/swale. Collect a subsample from each end of the transect at the margin of the pool and one subsample midway along the transect for a total of three subsamples.

2. Establish a transect along the width (i.e., widest part) of the pool/swale. Collect a subsample from each end of the transect at the margin of the pool and one subsample midway along the transect for a total of three subsamples. If the midline of the transect intersects the midline of first transect then you will only have 2 additional subsamples for this step.

3. Collect one additional subsample from each of the above described transects approximately one meter from the point of the midway sample for a total of two additional subsamples.

4. Collect the remaining two to three subsamples from the deepest parts of the pool/swale. This should yield a total of 10 subsamples.

5. As described above, additional samples may be required in very large pools or very long swales.

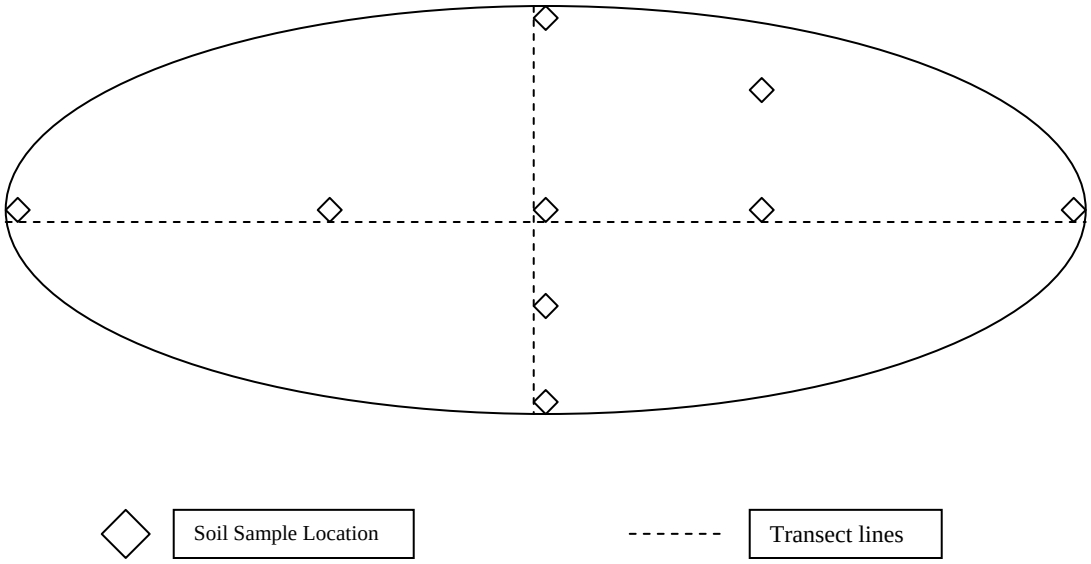

Figure 5. Location of possible soil sub-samples for dry season cyst survey

Dry Season Soil Storage

Each soil sample from the 10 soil subsample locations will be labeled, stored, and analyzed individually.

1. The soil samples from each soil sample location will be stored in separate paper bags or boxes, labeled with the specific location within the pool/swale from where each soil sample was taken. A sketch of the pool/swale showing the specific location of each soil sample will be included in the 90-day report.

2. Soil samples containing any residual moisture initially will be adequately ventilated and allowed to air dry thoroughly before they are subject to long-term storage (i.e., 2 or more days). The paper bags or boxes containing the soil samples will not be left out in direct sunlight or stored under conditions of excessive heat (e.g., in a non-moving vehicle for extended periods of time).

3. All soil samples will be retained and stored as directed above until identified as described below.

Dry Season Soil Examination and Processing

Surveyors may or may not be qualified to isolate cysts from the soil samples. Surveyors must check the conditions of their permit before proceeding to sieve soil samples for cysts. If

qualified and permitted to perform this procedure, surveyors should have received a copy of the procedure with their permit. Copies of this procedure can be obtained from a Service Office (see Service Contacts section). This procedure may be updated from time to time. Surveyors will be notified by the Service of any changes in the procedure.

Cyst Identification

Surveyors may or may not be qualified to perform the various procedures required to identify cysts to the species level. Surveyor must check the conditions of their permit before proceeding. If you are qualified and permitted to perform any of the cyst identification procedures you should have received a copy of the procedure(s) for which you are qualified with your permit. Copies of these procedures can be obtained from a Service Office (see Service Contacts section). These procedures may be updated from time to time. The Service will notify Permittees of any changes in the procedures.

At this time very few of the listed vernal pool crustaceans can be identified or differentiated to species based solely on cyst morphology. While molecular markers have been developed for some species and identification based on DNA is likely to be available in the future, most of the listed species do not have known molecular markers that would allow for species-level identification. Therefore, this level of identification is usually accomplished through hatching and rearing of the cysts. Very few surveyors have the laboratory facilities and necessary equipment, and are qualified to perform these procedures. Surveyors are encouraged to seek training in the collection and identification of cysts. The Service will notify surveyors of any instructional sessions offered, or sponsored, by the Service.

Fairy Shrimp Cyst Density

Cyst density information for each soil sample location will be calculated by dividing the total number of cysts recovered by the total amount of soil from the individual aliquots from that soil sample location. Total cyst density information for each soil sample location will be reported for each species in terms of: none; 1-10 cysts/100 ml soil; 11-20 cysts/100 ml soil; 21-30 cysts/100 ml soil; 31-40 cysts/100 ml soil; or more than 40 cysts/100 ml soil (Dry Season Survey).

Fairy Shrimp Cyst Voucher Specimens

A representative sample of each cyst type from each pool/swale will be accessioned to an institution accepted as a repository by the Service. (See approved institutions) At least one, and preferably several, cysts of each type should be packaged as directed by the collections manager at the institution where the specimens will be housed.

Accessioning Voucher Specimens

All fairy shrimp voucher specimens (i.e., adults or cysts) collected will be accessioned to a museum or other institution approved by the Service. All specimens will be preserved according to the accession standards of the repository, which will accession and maintain the specimens. Standards for the institutions listed below are available from Service Offices (see Service Contacts section). While 10(a)(1)(A) permits only require listed fairy shrimp to be accessioned, many of the institutions listed in this section would like donations of non-listed species. Please contact the institutions to determine which species they need and will accept. If the list of

institutions below does not include the institution to which you would like to accession the voucher specimens, contact the Service. Individuals conducting research may also need specimens. Written authorization from the Service must be obtained prior to release of any voucher specimens of listed vernal pool crustacean to any individual or institution not listed below.

All fairy shrimp voucher specimens (i.e., adults or cysts), along with a copy of the Vernal Pool Data Sheet, will be permanently deposited within a Service-approved institution within 90 calendar days of the completion of the field survey and the Service will be supplied with the exact location and catalog numbers given to the specimens.

The surveyor will supply the institution with a photocopy of their section 10(a)(1)(A) permit to validate that the specimens supplied to them were taken pursuant to a permit. The Service will likely consider refusal by an institution to accession any listed vernal pool crustacean specimens due to improper preservation/storage to be a violation by the surveyor of their section 10(a)(1)(A) permit.

Approved Institutions:

California Academy of Sciences (CAS)
Department of Invertebrate Zoology and Geology, Golden Gate Park,
San Francisco, CA 94118; telephone (415) 750-7082

Natural History Museum of Los Angeles County (LACM)
Crustacea Section, Invertebrate Zoology, 900 Exposition Boulevard,
Los Angeles, CA 90007; telephone (213) 744-3450

Southern Oregon University
1250 Siskiyou Boulevard
Ashland, OR 97520
Attn: Biology Department; telephone (541) 552-6341

Reporting of Fairy Shrimp Survey and Sampling Activities

The surveyor will provide the appropriate Service Office (see Service Contacts section) with a 90-day report and a summary annual report. The surveyor will submit data sheets to the ONHIC for each site sampled where state or federally listed species or other sensitive species were collected or observed.

90-Day Reports

Surveyors must submit a report no more than 90 calendar days after completing the last field visit of the season at each project site. The 90-day report should be typewritten and will contain a qualitative description of the project site and habitats present, the vernal pool/swale animal and plant communities, and features or required activities undertaken by the surveyors that may negatively affect listed species. The Service is interested in procedures or techniques adopted by surveyors to minimize disturbance to vernal pool/swale sites when using the required survey protocols. The following information will also be included. Surveyors may use the Vernal Pool

Data sheet(s), which is/are attached and available electronically on the Service's internet sites, to report the information or similar form which includes all the same information.

1. The location of the project site, preferably reported in UTMs and contained within a GIS data file, (see the GPS/GIS Vernal Pool Survey Location Report in the Vernal Pool Data Sheet Section for instructions on reporting survey locations), or clearly delineated on an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=2000 ft.). The location of the fairy shrimp is to be included on the 7.5-minute maps in as precise a manner as possible.

2. Five color photographic 35mm slides and/or 3" x 5" or larger photographs or digital images of each project site taken during sampling in the wet season; this is to include two photographs taken from a standing position that portray the general landscape of the site [i.e., taken from an opposing axis of the site (e.g., north and south compass headings)]; and three images of representative vernal pools, swales, and other areas within the site sampled for fairy shrimp. The following information will be legibly written on each slide/photograph with permanent ink or labeled on each digital image: precise location of the project site, direction from which photograph was taken, date of photograph, initials of photographer, and initials of the scientific names of the fairy shrimp found at the depicted site. Slides, photographs, and/or digital images only need to be submitted once per project site.

3. The estimated number of fairy shrimp individuals observed in each pool/swale will be reported in terms of an order of magnitude (e.g., 10's, 100's, 1000's). (Refer to the Vernal Pool Data Sheet)

4. The number of fairy shrimp individuals or cysts collected from each pool/swale and the name of the institution in which they are accessioned. (Refer to the Vernal Pool Data Sheet)

5. A qualitative description of the vernal pool/swale community. A general list of amphibian species and non-listed vernal pool crustacean species (by common and/or scientific name) encountered at the project site is desirable. For purposes of this permit a full survey for these species is not required. However, if more detailed information is collected, it will be included in the Vernal Pool Data Sheet. (Refer to the Vernal Pool Data Sheet)

6. Data collected during each field visit, including: date, air temperature, water temperature, weather conditions (e.g., sunny, overcast), maximum depth of each pool/swale, and size (area in square meters) of each pool/swale. (Refer to the Vernal Pool Data Sheet).

7. (Optional) water chemistry data collected during each field visit, including: alkalinity (total: ppm or mg/l), conductivity (uMHO), dissolved oxygen (ppm or mg/l), dissolved NH_4 (ppm or mg/l), pH, salinity (ppt), total dissolved solids (TDS, ppm), and turbidity. (Refer to the Vernal Pool Data Sheet)

Activities in Oregon

1. Surveyors conducting activities in Oregon should consult with the Oregon Department of Fish and Wildlife (503-826-4474), or the Oregon Department of Agriculture (541-737-4135, Rebecca Currin) to determine their responsibilities under the Oregon Endangered Species Act.

2. The surveyor will supply the Oregon Natural Heritage Information Center database, (1807 13th Street, Suite 202, Portland, Oregon 97233; telephone 503-731-3070) with completed Field Survey Forms, no more than 90 calendar days after completing the last field visit of the season at each project site.

Service Contacts:

Roseburg Field Office: telephone number 541 957-3470, fax number 541 957-3475

Oregon Fish and Wildlife Office: telephone number 503 231-6179, fax number: 503 231-6195

Listed Plant survey methodology

Unless otherwise authorized by the Service in writing, this guidance will be utilized for all surveys conducted to determine presence of Cook's lomatium and large-flowered woolly meadowfoam in the Agate Desert area (Figure X and B). The Service must approve any deviations from the methods prescribed by this guidance before surveys are conducted. The entity conducting the surveys will provide the appropriate Service office (see Service Contacts section) with all of the following information in writing for each project site at least 10 working days prior to the anticipated start date of survey work:

- The precise location of the project site, preferably transmitted as an electronic file in a GIS format (preferably reported in UTM Zone 10 NAD 83 (Meters) coordinates), or clearly delineated on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=24,000 ft.) with the quad name clearly indicated. Other information needed includes: (1) project name; (2) name of county in which the project site is located; (3) type of project (e.g., urban development, agricultural development; (4) the estimated acreage of the project site and an estimate of the number and acreage of vernal pools/swales on the site.

- Names of all vernal pool biologists and associated personnel conducting field work.

- A Cook's lomatium and/or large-flowered woolly meadowfoam survey report

- Condition of vernal pool complex habitat at time of survey

To perform listed plant surveys, a qualified botanist, scientist, or consultant familiar with the local flora should take part in survey efforts. Surveyors should contact Service staff if uncertain about identification of potentially listed plants (see Service Contact Information). Adverse conditions may prevent surveyors from determining presence of target species. Surveyors should ensure listed plants are left undisturbed when monitoring. To avoid harm to plants, walk slowly out to vernal pool while checking ground and keeping on dry ground as much as possible. If surveyor cannot distinguish individual plants without crushing plants on ground, surveyor may utilize best professional judgment to estimate plant numbers using sample reference plots or grids. A survey report that documents results of the plant survey will be provided to the Service within 90 days following survey.

A Cook's desert-parsley (Cook's lomatium) and large-flowered woolly meadowfoam survey procedure will include:

1. A field survey performed between April 1 and May 15.
2. A visit to a reference site to determine if lomatium or meadowfoam is flowering.
3. A complete flowering plant census for lomatium and a total plant census for meadowfoam. A qualitative assessment can be used to determine plant count if count is in excess of 2,000 plants.
4. Mapping location of the lomatium and/or meadowfoam patches, preferably using GPS equipment (preferably in UTM Zone 10 NAD 83 (Meters) coordinates), or clearly marking on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=24,000 ft.).

A survey report will include:

1. Notes on evidence of plant disease or herbivory.
2. Methods used to survey for target plant species.
3. Survey dates.
4. Name and location of reference plant population, if used.
5. If target species are found report should include:
   a. The estimated plant population size of lomatium (flowering plant census) and/or meadowfoam (total plant census).
   b. Mapped location of the lomatium and/or meadowfoam patches, preferably preferably transmitted as an electronic file in a GIS format (UTM Zone 10 NAD 83 (Meters) coordinates), or clearly marking on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=24,000 ft.).
6. A complete plant list of plants encountered during plant survey.
7. Estimation of non-native invasive plant abundance at survey site.

NOTE: during periods of drought, a delay in surveys may be required. For example, if vernal pool habitat did not receive adequate rainfall, long enough to allow for plant emergence, then negative sampling results may be determined to be inconclusive and further surveys may be needed when conditions allow plants to germinate or re-sprout. An additional botanical survey in a subsequent year may be required if adverse survey

conditions occur in potential habitat. It is best to plan plant surveys when target plants at a reference site are in bloom.

Precautions

Clean foot-wear prior to entering vernal pool habitat to avoid transporting or distributing noxious weed plant parts to vernal pool areas (See Sanitizing Protocol).

Vernal Pool Restoration Guidelines

The following guidelines are provided to assist in the design and planning of appropriate restoration actions within the Agate Desert vernal pool habitat area. These guidelines should be used to design restoration activities for compensatory mitigation projects, actions taken by landowners to restore vernal pools, or actions taken to conserve existing vernal pool habitat. Restoration actions, while supported by the Service, must be approved by the Service prior to implementation.

Project Planning and Pre-work Coordination

A site sediment and erosion control plan should be prepared as part of the construction documents. Implementation of this erosion plan will prevent loss of soil during and after construction by storm runoff and/or wind erosion. The plan should also address stockpiled soils on- or off-site. Implementation of the plan will prevent any sediment from entering adjacent vernal pools. A copy of the site sediment and erosion control plan should be provided to the Fish and Wildlife Service (see Service Contact section) as part of the proposed wetland mitigation plan.

A pre-construction meeting should be held on-site with the construction inspectors, the construction contractor, a wetland biologist, and a soil scientist familiar with the complexities associated with vernal pool habitat.

During the pre-construction meeting, existing vernal pools and those to be restored will be identified, and site conditions and the mitigation plan would be reviewed. This would allow all parties to understand the intent of the plan and to ensure that all specified materials and conditions would be met.

The soil scientist and/or a qualified wetland biologist should stake the layout of the general plan form of the mound and swale complex for the contractor. This staff person will be on-site during any work-associated activity in the immediate vicinity of the mounded swale complexes to ensure compliance with all restoration actions. Any necessary or required deviations will be immediately reported to the Service and the Corps. All deviations from the general plan should be reported in writing to the Service and Corps within 24 hours of its occurrence.

Prior to construction and impacts, soil inoculum should be taken from all pre-existing pools and depressions that have to potential to support populations of vernal pool fairy shrimp. These samples would then be introduced into pools throughout the restoration area to transfer potential cysts into the restored habitat. Soil samples would be collected and dispersed by the wetland consultant following the methods outlined by the Service.

Earth work should only occur during the dry summer months (i.e., from July 1 to September 30) to minimize the potential for both direct (e.g., surface destruction) or indirect (e.g., siltation or sedimentation) impacts to the site.

The construction contract specifications should require that tracked vehicles used for excavation of fill material will not enter any vernal pools on- or off-site; only rubber-tired vehicles may enter identified vernal pools and only during the dry season. If needed, heavy equipment (i.e., trucks, backhoes) should only have access to upland sites to prevent damage to sensitive habitat. A wetland biologist or soil scientist with local knowledge and experience working with vernal pool restoration on the Agate-Winlo soil complex should be on-site during periods of any construction activities in the restoration area or in the immediate vicinity of the mounded swale complexes to ensure compliance with all guidelines. This individual need not be present during construction only taking place on the development site.

If the contractor removes waste fill material from a swale or pool the excess fill material shall be hauled away to a designated upland disposal site. Extreme care should be taken during construction to ensure that native topsoils and any associated biological layers or cryptobiotic crusts are not destroyed or buried, and the underlying duripan is not disturbed during any grading activities.

Native Plant and Weed Management

All equipment should be washed before entering the restoration area. Upon leaving the restoration area equipment should be washed.

The vernal pools should be treated for noxious and invasive weeds through hand pulling, or other approved, hand-operated, mechanical means.

Consistent with the mitigation plan, hand-collected native seed, obtained from local sources should be broadcast in the vernal pools, if necessary. The seeding and any hand raking deemed necessary would only occur during the fall after excavation, just prior to the rainy season (for best germination and survival). (See Table 4, for proposed seeding mix information)

The upland mounds associated with the vernal pools should be treated for noxious and invasive weeds through hand pulling and/or, mowing.

a. The upland mounds (except for sensitive and endangered species areas) will be hand raked only where appropriate to facilitate new seeds to germinate in early autumn (after minor rainfall).
b. The upland mounds should be seeded with bunch grass and native forbs (Lemon's needlegrass, lupine, etc) (See Table 4). It may be necessary to repeat this approach to minimize the non-native species that grow on the mounds.

Within six months of the start of construction, a noxious weed management plan should be developed for the entire restoration area pursuant to the details outlined in the mitigation plan.

a. Before the noxious weed management plan is developed, a list of primary target species should be identified (Table 5).

b. Before implementation, the final noxious weed management plan should be reviewed and approved by the Service.

Herbicide Use

The applicant should consult with the Corps and the Service if the use of herbicides is anticipated to be necessary.

Scheduled Maintenance or Repairs

If needed, any scheduled maintenance or repairs to the restoration area should be completed before the onset of the following rainy season. If the hydrology and/or topography of the area become altered by a severe flood event, vandalism, or other cause, then the corrective measures may necessitate re-grading and re-vegetation to achieve performance goals. In such circumstances, the wetland consultant should specify the nature of the required corrective actions, such as barren ground seeding or prescription of replacement plantings.

Any replacement plantings should be installed during the following dormant season. The applicant should address any other unforeseen acts of nature, or other disruptive events, in a timely manner.

Table 4. Seed mixtures and plantings to be utilized for vernal pool restoration areas.

Vernal Pool Mitigation Plantings		
Common / Scientific Name	Planting	Anticipated Quantity
Vernal Pools		
Western mannagrass (*Glyceria occidentalis*, OBL)	Seed	1.0 lbs. /acre
Saccate foxtail (*Alopecurus saccatus*, OBL)	Seed	1.0 lbs. /acre
Annual hairgrass (*Deschampsia danthoniodes*, OBL)	Seed	1.0 lbs. /acre
Cascade downingia (*Downingia yina*, OBL)	Seed	0.25 lbs. /acre
Water foxtail (*Alopecurus geniculatus*, OBL)	Seed	0.5 lbs. /acre
Coyote thistle (*Eryngium petiolatum*, OBL)	Seed	0.5 lbs. /acre
Stipitate popcornflower (*Plagiobothrys stipitatus*, OBL)	Seed	0.5 lbs. /acre
White brodiaea (*Triteleia hyacinchina*, FAC)	Seed/bulb	0.5 lbs. /acre
California goldfields (*Lasthenia californica*, FACU)	Seed	2.0 lbs. /acre
UPLAND MOUND / MITIGATION BUFFER		
Buckbrush (*Ceanothus cuneatus*, NL)	Bareroot	
California brome (*Bromus carinatus*, NL)	Seed	4.0 lbs. /acre
California oatgrass (*Danthonia californica*, NL)	Seed	2.0 lbs. /acre
Roemer's fescue (*Festuca roemeri*, NL)	Seed	4.0 lbs. /acre
Two-colored lupine (*Lupinus bicolor*, NL)	Seed	1.5 lbs. /acre
Fitch's tarweed (*Hemizonia fitchii*, NL)	Seed	2.0 lbs. /acre
California goldfields (*Lasthenia californica*, FACU)	Seed	2.0 lbs. /acre
Lemmon's needlegrass (*Achnatherum lemmonii*, NL)	Seed	2.0 lbs. /acre
Purple clarkia (Clarkia purpuria, NL)	Seed	0.5 lbs/acre
Rusty popcornflower (*Plagobothrys nothofulvus*, NL)	Seed	0.5 lbs/acre

Any amendments to the mitigation plan should be documented and submitted to the regulatory agencies for review and approval.

Vegetation Sampling

The suggested vegetation monitoring is based on a presumption that reference sites can be used to help develop vegetation plans and performance standards. The Service recommends using relatively undisturbed reference sites that closely match the hydrogeomorphic and soil conditions of the habitat to be sampled. Consistent sampling protocols and vegetation performance standards are recommended to provide a means to evaluate the abilities of various implementation strategies (e.g. invasive plant removal, ditch filling, native vegetation planting, etc.) to meet the targeted design vegetation performance standards and to compare targeted vegetation outcomes against the actual outcomes (USFWS 2007).

Table 5. **Non-native, invasive plant species common to the Agate Desert vernal pool area.**

Species	Method of Control
1. Yellow star thistle (*Centaurea solstitialis*)	Multiple hand removal, mowing or burning efforts (between June 1 and August 1); managed grazing; herbicide use[2]; and/or native plant re-seeding.
2. Medusahead (*Taeniantherum caput-medusae*)	Mowing or burning in spring (In May); managed grazing; and/or native plant re-seeding.
3. Curley dock (*Rumex crispus*)	Hand removal, mowing or burning (between May 15 and July 15); managed grazing; herbicide use[2]; and/or native plant re-seeding.
4. Seaside barley (*Hordeum marinum* ssp. *gussonianum*)	Frequent hand removal, mowing or burning (between May 15 and June 15); herbicide use[2]; managed grazing; and/or native plant re-seeding.
5. Stork's bill, fillary (*Erodium cicutarium/Erodium botrys*)	Frequent hand removal, mowing or burning (between May 1 and June 15); managed grazing; herbicide use[2]; and/or native plant re-seeding.
6. Italian rye grass (*Lolium multiflorum*)	Frequent mowing or burning (between June 1 and August 1); managed grazing; herbicide use[2]; and/or native plant re-seeding. Do not till.
7. Russian thistle, tumbleweed (*Salsola kali*)	Hand removal, mowing or burning (between June 1 and September 1); managed grazing; herbicide use[2]; and/or native plant re-seeding.
8. Milk thistle (*Silybum marianum*)	Hand removal, mowing or burning (between May 1 and June 15); managed grazing; herbicide use[2]; and/or native plant re-seeding.

2. Herbicide use may be used after discussion and approval from US Fish and Wildlife Service

Vegetation should be sampled to acquire the following data at sample plots or points:

1. Relative (see definitions) percent cover of vegetation,
2. Percent cover of exposed substrate (indicate soil, rock),
3. Relative (see definitions) percent cover of native, non-native, or non-native invasive plant species,
4. Relative percent cover of dead plant material (indicate leaves, thatch, woody debris), and
5. Relative percent cover of vegetation types (indicate grass, herb, moss, algae, etc.).

Vegetation results acquired from any third-party random sampling should corroborate with vegetation data results at the subject habitat.

The mitigation/conservation bank site should be sampled annually for five years after the completion of the initial restoration phase of the project. Monitoring site visits should be completed as necessary to evaluate the success of the project and identify corrective measures necessary to meet performance criteria to be attained by the end of the post-construction five-year maintenance and monitoring period.

Seeding success should be measured by visually estimating percent vegetative cover for each plant species observed within a five-foot radius for herbaceous ground cover. Tree and shrub success should be evaluated using stem counts.

A vegetation sampling report will be compiled each year and provided to the Service within 90 days of the conclusion of sampling. The report should include:

1. A description of methods used to sample vegetation,
2. Native vegetation establishment goals and status (as compared to the plant and weed composition of a reference site),
3. Non-native invasive plant goals and status,
4. A complete list of plant species encountered during the vegetation monitoring,
5. Photographs and description of photo locations (permanent photo locations to document onsite conditions for progress and comparative purposes),
6. A tabulation of the sum total of vegetation percent cover at each habitat type, indicating
    a. Relative percent cover of vegetation.
    b. Percent cover of exposed substrate.
    c. Relative percent cover of native, non-native, or non-native invasive plant species.
    d. Relative percent cover of dead plant material.
7. A tabulation of target functions and values to demonstrate if goals are being met.

Fairy shrimp sampling

Sampling for the presence of fairy shrimp should be conducted after the restoration phase as part of a monitoring program. This sampling should be conducted to recognized standards by a qualified individual and reported to the Service. (See Fairy Shrimp Sampling)

Reporting

A set of restoration activity notes should be provided to the Service (See Service Contacts information).

A post-construction review of the completed work should be conducted to verify that the plan was properly implemented. Any deficiencies to the original plan should be noted; and recommendations provided as to how these deficiencies might be addressed. Any deficiencies that can be practically and immediately addressed should be corrected.

A report based on the post-construction review of the completed restoration work should be provided to the Service, including any recommendations for future work.

A final report should be submitted to the Service and Corps that includes as-built drawings and other relevant information documenting that authorized impacts were not exceeded.

Vernal Pool Restoration Inoculum Collection Method

Collection of soil from vernal pools will not be conducted at any project site unless the surveyor receives prior written permission from the Service. Prior permission to collect soil inoculum may be based on the scheduling of proposed habitat restoration projects covering the next 12-month period. Collection and storage of soil inoculum is not adequate grounds to justify allowing a project to proceed (i.e., soil inoculum storage is not a defacto mitigation/conservation bank).

The following inoculum collection protocol is specifically for vernal pool restoration activities. This soil collection protocol should not be used for collection of dry season cysts samples (see Fairy shrimp dry season collection protocol)

Fairy shrimp pond soil (inoculum), used for restoration activities, will be collected using the following guidelines. Inoculum may only be (re-)introduced to an approved Agate Desert vernal pool site upon approval of the Service.

i Inoculum will be collected when it is dry to avoid damaging or destroying fairy shrimp cysts. A hand trowel or similar instrument will be used to collect the soil. Whenever possible soil will be collected in chunks. The trowel will be used to pry up intact chunks of soil rather than loosening soil by raking or shoveling. Criteria for the appropriate quantity of inoculum to be collected will be specified through coordination with the Service. Soil will not be collected from any ponds until approved by the Service.

ii The soil from each pond will be stored individually in labeled bags or boxes that are adequately ventilated and archived out of direct sunlight to avoid the occurrence of fungus or excessively heating the soil.

The inoculum collection technique assumes shrimp cysts are present in a pool, a fact that may or may not be true. The advantage of this dry sampling technique is that a particular pool does not have to be sampled within the narrow time frame when animals are large enough to be noted, and mature enough to be identified to species. The disadvantage is that material must be collected from each pool using established protocols.

Unless otherwise authorized by the Service in writing, these soil inoculum guidelines should be utilized for activities focused on vernal pool habitat restoration. Any deviation from the methods prescribed by these guidelines must be justified by the applicant and approved by the Service before surveys are conducted.

On the Agate Desert there are two plant species (*Limnanthes floccosa ssp. grandiflora* and *Lomatium cookii*) listed as endangered under the Act that can co-occur with the fairy shrimp. Removal of soil could damage populations of these plants by inadvertently removing seed. Dry sampling should be coordinated with the Service (see Service Contacts section) within those vernal pools that are known to or may contain these species.

Soil sample quantity:

A minimum of 24 soil samples of approximately one square foot by approximately one inch in depth (144 cubic inches, or 2,360 cubic centimeters) each should be taken from each pool (see Figure 6), for a total sample volume of approximately 2 cubic feet (0.06 cubic meters) per pool. In the case of a large vernal pool (>0.05 acres), the Service may authorize the removal of more than 2 cubic feet of soil. If a pool has a diameter of less than 3 meters (~10 feet), the total soil sample taken should not exceed one cubic foot per pool.

Samples should be collected from the following locations (See Figure 6):

- At least 8 soil samples should be taken from equidistant points along the longest transect of the pool, including a minimum of 1 sample from the edge of the pool.

- At least 6 soil samples should be taken from equidistant points along the widest transect of the pool, including a minimum of 1 sample from the edge of the pool.

- If neither the longest nor widest transect encompasses the deepest part (or parts) of the pool, then at least 2 soil samples should be taken from the deepest part (or parts) of the pool.

- The remaining soil samples should be taken from pool edges; additional locations in the deepest part of the pool, and/or along the aforementioned transect lines.

Reporting

The soil samples should be stored individually in paper bags or boxes labeled with the specific location within the pool from where each sample was taken. The paper bags or boxes containing the soil samples should be adequately ventilated and kept out of direct sunlight in order to prevent the occurrence of fungus or excessively heating the sample. A sketch of the pool showing the specific location of each sample should be included as documentation.

The sampler should provide the Service with all of the following information in writing for each sample site at least ten (10) working days prior to the anticipated start date of the collection work:

1. The precise location of the project site clearly delineated on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=2,000 feet). The map should contain the project name, estimated area (acreage) of the project site and an estimated number or area (acreage) of pools/swales on the site, quad name, and county name.

2. The names of all vernal pool biologists and associated personnel associated with the active collection of the samples.

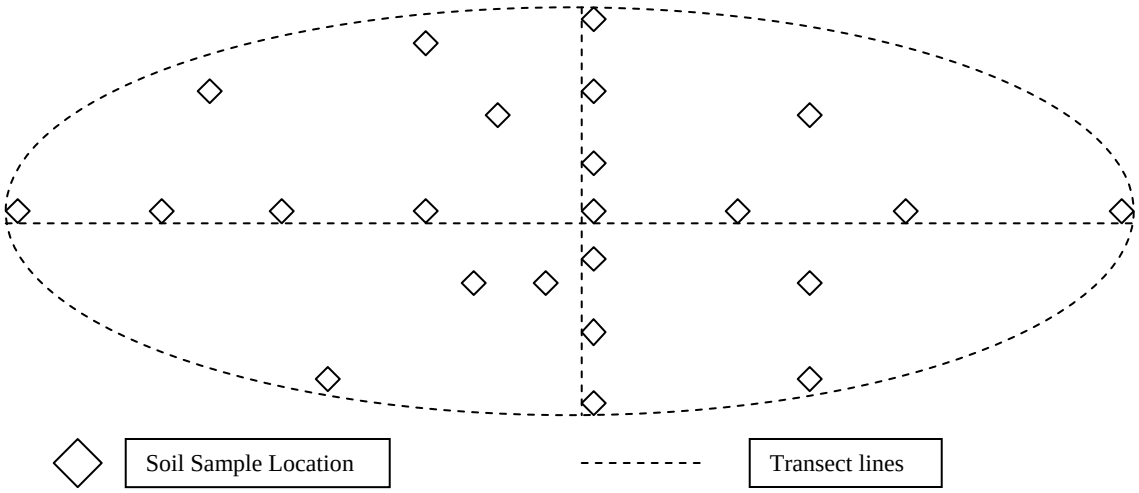

Figure 6. Location of possible soil samples for restoration activities (see sample location information).

The sampler should provide the Service the following information in writing no more than sixty (60) calendar days after completing the dry collection sampling:

1. The location of the project site clearly delineated on an original or high quality copy of a U.S. Geological Survey topographic map (1.5 minute, 1"=2,000 ft.).

2. Two representative photographs illustrating the general landscape of each vernal pool site at the time of sampling. The following information should be legibly written on each slide with permanent ink: precise location on the project site, direction from which the photograph was taken, date of photograph, and initials of photographer.

3. Careful labeling and record keeping are an important part of the collecting. Data collected during the collection visit, including: date, air temperature, weather conditions, average and maximum depth of each pool/swale, size (area in square meters) of each pool. A photograph of each pool for a visual record of the habitat type should also be included. Photographs should include a pool number, date, and brief description on the back of the photo.

4. Samples should be stored in a safe, cool, dry place, preferably in the dark.

5. Samples shall be stored a maximum of one season (year).

Specific circumstances may justify or necessitate revision of these survey guidelines. At the discretion of the Service, such a variance may be allowable under these guidelines if (1) the permittee explains in writing why a variance to the guidelines is needed, and (2) the Service concurs, in writing, with the variance request.

The Service reserves the right to reject surveys conducted under these protocols as inadequate if: (1) specific methods are not implemented as determined by the Service; (2) survey methods used are inconsistent with these guidelines; or (3) other information indicates that the survey is inadequate as determined by the Service.

We remind you that the above soil inoculum collection procedures are only appropriate for the dry season collection of samples for restoration activities. Other specific protocols have been designed for dry season fairy shrimp cyst sampling, and are not addressed in this methodology.

Listed Plant seed collection and restoration methodology

Unless otherwise authorized by the Service in writing, this guidance will be utilized for seed collection of Cook's lomatium and large-flowered woolly meadowfoam in the Agate Desert area for purposes of seed storage at an approved facility or for restoration efforts. Augmenting existing listed plant populations and establishing listed plants into new areas through seed is a more effective and preferable method than plant salvage and relocation. Relocation of the two listed plants has never been successfully achieved and is problematic due to difficulties in keeping plant tap roots intact and maintaining annual plants in restored habitat. Planting of seeds is also a more cost-efficient method than transplanting greenhouse grown plants.

Prior to all seed-collection efforts, the Service must receive and approve a seed collection plan. The entity conducting seed collection will provide the appropriate Service office (see Service Contacts section) with all of the following information in the seed-collection plan in writing for each project site at least 10 working days prior to the anticipated start date of seed collection efforts. A 10(a)(1)(A) permit is required only for seed collected on federally administered properties. A seed collection plan should include:

1. Names of plant species to be collected;
2. Purpose of seed collection;
3. Timing of collections;
4. Collection methods;
5. Desired amount of seed;
6. Precise location of source populations and restoration site, preferably transmitted as an electronic file in a GIS format (preferably reported in UTM Zone 10 NAD 83 (Meters) coordinates), or clearly delineated on either an original or high quality copy of a U.S. Geological Survey topographic map (exact scale, 7.5 minute, 1"=24,000 ft.) with the quad name clearly indicated. Other information needed includes: (1) project name; (2) name of county in which the project site is located; (3) type of project (e.g., urban development, agricultural development, seed collection for long-term storage); (4) the estimated acreage of the project site and an estimate of the number and acreage of vernal pools/swales on the site;
7. Names of all vernal pool biologists and associated personnel conducting field work and their section 10(a)(1)(A) permit number(s); and
8. Desired goal of restoration effort.

The amount of seed that can be collected in the field during one collection in one year is rarely sufficient to establish a new population without depleting a population's seed source. To achieve sufficient seed for population establishment, it is recommended to collect small amounts of seed

over multiple collections in multiple years or to propagate seed in a greenhouse. For plant populations that are less than plants, even moderate seed collection can be detrimental to the population.

Seed Collection Guidelines

1. Collect from plant populations with a minimum of 300 flowering lomatium plants or from 300 meadowfoam plants,
2. Collect from population nearest to restoration site,
3. Collect few seed from many plants rather all see from a few plants to maximize the genetic complement of the original population,
4. Collect several times within the year,
5. Collect in multiple years, and
6. Bulk seed in greenhouse or approved seed-bulking site if necessary to obtain enough seed for population establishment.

Before seed collection efforts begin, collectors must pre-determine amount of seed needed for plant cultivation or reintroduction objectives.

Collectors will gather loose seed from Cook's lomatium and seed (nutlet) clusters of meadowfoam. Collectors should collect seed by hand. Loose seed from plants or from ground may be gathered by hand or assisted by hand-held harvesting tools such as flails and hoppers (seed containers). Often plastic or paper bags may be tied around stems with developing seed so seed can be contained during maturation and subsequent seed release. All seed will be bagged immediately, kept dry, and stored in coolers immediately.

An annual status report on the success of plant establishment, growth, and monitoring will be required for 10 years. A status report will be provided to the Service within 90 days of a seed collection effort or the completion of restoration monitoring efforts that includes:

1. The seed collection methods and strategies (equipment used, number of collections, targeted size of population)
2. Locations of plant populations from where seed was collected,
3. The amount of seed collected,
4. Restoration description (if initiated)
5. Status of restoration efforts (if initiated). This should include success of establishment and loss.

The Service will determine whether seed collection and restoration efforts should be maintained, discontinued, or the design modified to achieve better success rates.

Literature Cited

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U.S. Fish and Wildlife Service Vernal Pool Data Sheet Wet Season Survey

Note: Please fill out the required information completely for each site visit.

This form is being submitted to serve as part of the 90-day report: ____ no ____ yes

Required color slides and/or photographs for the project site are included: ____ no ____ yes

Date: ____/____/____ Time: _____ County: _____ Quad: _____

Collector(s): _____ Permit #: _____

Site/Project Name: _____ Pool #: _____

Township: _____ Range: _____ Section: _____ _____lat._____long.

Temperature: Water: _____ ^{o}C Air: _____ ^{o}C

Pool Depth:
at time of sampling: _____cm
estimated maximum: _____cm

Surface Area:
at time of sampling: _____m x _____m
estimated maximum: _____m x _____m

Habitat Condition: (circle where appropriate)

- undisturbed disturbed: tire tracks garbage discing/plowing
- ungrazed grazed: cattle horses sheep other_____
  light moderate heavy
- land use of habitat:

(Optional) Water Chemistry Data

Alkalinity (total):_____ppm or mg/l Conductivity:_____uMHO

Dissolved NH_4:_____ppt or ppm Dissolved Oxygen:_____ppm or mg/l

pH:_____ Turbidity: (secchi disc depth)_____cm or: clear to bottom _____

Salinity :_____ppt or ppm Total Dissolved Solids (TDS):_____ppm

Notes:

U.S. Fish and Wildlife Service Vernal Pool Data Sheet
Wet Season Survey

Note: Please fill out the required information completely for each site visit.

Species Observations: state none or estimate # of individuals present in terms of an order of magnitude (e.g., 10's, 100's, 1000's)

Anostracans:
(note reproductive status)

Notostracans:
(note reproductive status)

Species Observations (Optional):

Cladocerans:	yes	no	Insects: (adult or larvae)		
Conchostracans:	yes	no	Anisoptera:	yes	no
Copepods:	yes	no	Zygoptera:	yes	no
Ostracods	yes	no	Hydrophilidae:	yes	no
Fish	yes	no	Dytiscidae:	yes	no
Frogs	yes	no	Corixidae:	yes	no
Salamanders	yes	no	Notonectidae:	yes	no
Waterfowl	yes	no	Belostomatidae:	yes	no
Other (specify) _____			Other (specify) _____		

Voucher Specimens

Specimens shall be preserved according to the standards of the institution in which they will be accessioned.

Species	# Individuals	Accession/Catalog #	Pool #

U.S. Fish and Wildlife Service Vernal Pool Data Sheet Dry Season Survey

Note: Please fill out the required information completely for each site visit.

This form is being submitted to serve as part of the 90-day report: _____ no _____ yes

Required color slides and/or photographs for the project site are included: _____ no _____ yes

Date: ____/____/____ Time: _____ County: _____ Quad: _____

Collector(s): _____ Permit #: _____

Site/Project Name: _____ Pool #: _____

Township: _____ Range: _____ Section: _____ _____lat. _____ long.

Habitat Condition: (circle where appropriate)

- undisturbed disturbed: tire tracks garbage discing/plowing

- ungrazed grazed: cattle horses sheep other_____
  light moderate heavy

- predominant land use (e.g., pasture, crop):

Pool Bottom Surface: (circle where appropriate)
hardpan claypan cobbly/rocky lava flow other_____

Pool Depth: _____cm (estimated maximum) Surface Area: _____m^2 (estimated maximum)

Sketch of pool and transects showing:
- scale
- indication of North
- sampling locations

U.S Fish and Wildlife Service Vernal Pool Data Sheet
Dry Season Survey Soil Analysis

Note: Please fill out the required information completely for each site visit.

Sample ID	Sample Volume(ml)	Genus (/species)	# Cysts (or None)	Cyst Density (#/100ml)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Voucher Specimens
Cysts shall be stored dry and shall be preserved according to the standards of the institution in which they will be accessioned.

Genus (/species)	# Cysts	Catalog/Accession #	Pool #

U.S. Fish and Wildlife Service Vernal Pool Data Sheet
Listed Plant Monitoring Form

Note: Please fill out the required information completely for each site visit.

This form is being submitted to serve as part of the 90-day report: _____ no _____ yes

Photo of listed plants included: _____ no _____ yes

Date: ____/____/____ Time: _____ County: _____

Township: _____ Range: _____ Section: _____ lat._____ long._____

Surveyors (s): _____

Site/Project Name: _____ Location (Pool #, etc): _____

Habitat Condition: (circle where appropriate)

- **undisturbed** **disturbed**: tire tracks garbage discing/plowing

- **ungrazed** **grazed**: cattle horses sheep other_____
light moderate heavy

- predominant land use (e.g., pasture, crop):

Sketch of parcel and transects showing:
- scale
- map of listed plant populations

Species Observations: (estimate # of individuals present, if any)

Limnanthes floccosa ssp. *grandiflora* _____ *Lomatium cookii* _____

Vegetation Field Sampling Form

Date_____ Site Name_____ Township, Range, Section _____
Surveyor(s):_____

Location: **Acreage:** **Reference Site:** **Ownership:**
Lat. _____ Long. _____

Existing Habitat Type: _____ Targeted Habitat Type: _____

Soil Series: _____

Transect:
Number _____ Bearing: _____ Length _____

Sample plot number	Plot size	Species	% cover	Guild code	N NN I	Habitat	VP position

Guild code: A: annual, P: perennial, T: tree, G: graminoid N: Native, NN: Non-native, I Non-native invasive Habitat: C: Chaparral, OW, Oak woodland, VPMP: Vernal pool mounded prairie
VP Position: P: Pool, F: flank or margin of pool, M: Mound