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Southwest Idaho Vernal Pool and Playa Distribution and Vegetation

Bach's calicoflower (*Downingia bacigalupii*), a rare vernal pool plant.

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2012

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ABSTRACT

The goal of this project was to collect baseline information on vernal pools and playas in southwestern Idaho. Objectives were to classify and describe vernal pool and playa ecosystems, plant associations, and flora, including rare plants. We sampled 40 vegetation plots at 30 sites during 2008 and 2009. Existing vernal pool and playa vegetation plot data from southwest Idaho, west-central Idaho, and Davis' peppergrass (*Lepidium davisii*) monitoring transects were also included in the complete dataset of 81 plots. Cluster analysis and ordination were used to determine classification at the plant association level. Fifteen vernal pool and playa plant associations were identified. Four plant associations had not been previously documented. At least 169 vascular plant taxa were documented from vernal pools and playas in southwest Idaho. Four new occurrences of rare plant species were recorded during this survey: profuseflower mesamint (*Pogogyne floribunda*), Bach's calicoflower (*Downingia bacigalupii*), California damsonium (*Damasonium californicum*), and thinleaf goldenhead (*Pyrrocoma linearis*). These surveys indicate widespread occupancy of vernal pools and playas in southwest Idaho by niche-specific flora and a broad diversity of plant associations, including rare types.

KEYWORDS

classification, ecological systems, plant associations, playa, southwest Idaho, rare plants, vegetation, vernal pool

ACKNOWLEDGMENTS

Fieldwork was conducted by Idaho Department of Game, Wildlife Bureau, staff members Lisa Harloe, Luana McCauley, Jennifer Miller, Chris Murphy, Suzin Romin, and Tim Weekley. Justine Murphy volunteered to assist with data collection. Kristen Pekas assisted with data entry. Maps were created by Jennifer Miller and Tim Weekley. The project was planned, managed, and administered by Chris Murphy, Tim Weekley, and Stephanie Mitchell, with assistance from Bill Bosworth. Davis' peppergrass monitoring data was contributed by Lynn Kinter (IDFG) and Michael Mancuso. Project funding was through a Challenge Cost Share Grant from the Idaho State Office of the Bureau of Land Management.

SUGGESTED CITATION

Murphy, C. 2012. Southwest Idaho vernal pool and playa distribution and vegetation. Habitat Section, Wildlife Bureau, Idaho Department of Fish and Game, Boise, ID. 23 pp. plus appendices.

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INTRODUCTION

Vernal pools are precipitation-filled, isolated ephemeral wetlands flooded during the early growing season (when supporting aquatic or amphibious plant growth). This period is followed by a saturated soil stage (supporting terrestrial plant growth) and then extreme and long-lasting soil desiccation (supporting drought tolerant species) (Zedler 1987, Keeley and Zedler 1998). Though not identical, Idaho's vernal pools roughly fit this definition of pools from Mediterranean-type climates and have analogous flora and fauna. Like vernal pools, playas also occur in closed topographic depressions. Playas, however, are more intermittently and less predictably flooded. They are more likely to have alkaline water and evaporative salt deposits (NatureServe 2011). Both vernal pools and playas are underlain by impermeable duripans created by clay lenses or bedrock layers that impede drainage. Larger pools and playas can be aquifer recharge wetland systems filled only by precipitation and surface runoff.

Ephemeral wetlands may be overlooked by resource managers because they are only seasonally productive and vegetation can be sparse. These wetlands occur at scattered locations in southern and west-central Idaho. However, no systematic classification of vernal pool and playa vegetation has occurred in this region. Vernal pool and playa vegetation is under-represented in the National Vegetation Classification (NVC) (NatureServe 2011). Vernal pool and playa habitats in semi-arid regions often support unique assemblages of plants and animals, as evidenced by the recent description of a new, large branchiopod crustacean from Elmore County (Rogers et al. 2006). At least 10 BLM special status plants have the potential to occur in Idaho vernal pools or playas. With the exception of Davis' peppergrass (*Lepidium davisii*), these plant species have not been thoroughly inventoried and their conservation status in Idaho is poorly understood.

The goal of this study is to collect baseline information on vernal pools and playas that will benefit resource managers by providing a preliminary characterization of these habitats in southwestern Idaho. Objectives are to:

- characterize vernal pool and playa distribution in the Owyhee Uplands;
- classify vernal pool and playa habitats in a way that integrates abiotic (hydrologic, geomorphic, climate, soil) and biotic elements, while explaining ecologic variation;
- classify vegetation within accepted hierarchical system (e.g., NVC; FGDC 2008);
- create a key to vernal pool and playa plant associations of southwest Idaho;
- describe plant associations, including the range, successional and disturbance dynamics, environmental setting, restoration, management, functions, and identification of each type;
- document distribution of special status plants.

This is a companion report to "Southwest Idaho vernal pool and playa faunal inventory and condition assessment" (Weekley and Murphy 2012). This vegetation inventory was part of a broader survey. The companion report summarizes results of amphibian, bird, and invertebrate surveys; assesses the ecological condition of vernal pools and playas at multiple spatial scales; and evaluates the conservation value of these habitats for special status animal species.

STUDY AREA

Geography: The study area is defined by Bailey's (1980) Owyhee Uplands Ecological Section, inclusive of 6 subsections (Figure 1) (Quigley et al. 1999). From north to south, the study area stretches from the foothills of Idaho Batholith and volcanic uplands of the Bennett Hills, across the Snake River Plains to the Snake River. The Snake River canyon and lowlands are the hottest and driest areas in Idaho and are characterized by saltbush-dominated benches, alkaline flats, and badlands on lacustrine deposits that extend from Weiser River Basin to the Owyhee Plateau. Further south, the study area is characterized by the Owyhee Mountains and sagebrush-covered uplands of the Owyhee Plateau and Owyhee River Canyonlands. Topography is a mosaic of ridges, mesas, plateaus, tablelands, and canyons. To the southeast, the sagebrush and grass-covered plateaus of the Snake River Plains and Bruneau Desert are dissected by deep canyons of the Bruneau River, Jarbidge River, and Salmon Falls Creek. The plateaus stretch south to a basin-and-range landscape that includes the Bull Run, Mahogany, and Jarbidge Mountains, and Elk Mountain/Salmon Falls Highlands.

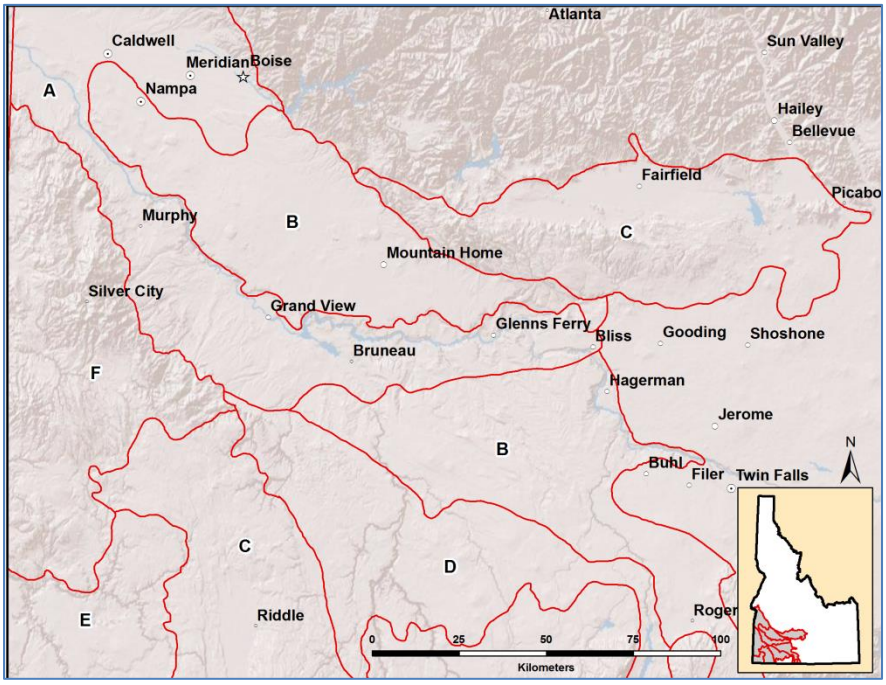

Figure 1. Owyhee Uplands Section in southwest Idaho. Subsection outlines in red: A) Boise–Payette–Snake River Valleys Lacustrine Deposits, B) Snake River Plains, C) Bennett Hills–Owyhee Plateau, D) Bruneau Desert, E) Owyhee River Canyonlands, F) Owyhee Mountains.

Geology: The Owyhee Uplands Section is geologically diverse and includes the loess-covered basaltic plateau of the western Snake River Plains and Bruneau Desert and the alluvium filled lower Boise, Payette, and Snake River valleys. It also includes the Snake River canyon and surrounding low-lying badlands and benches of lacustrine deposits. The fault-block Owyhee Mountains, with their granitic core and the volcanic escarpments of the Owyhee Plateau (to the south) and Bennett Hills (to the northeast), rise from the desert-like setting along the Snake River. The Owyhee Plateau and Bennett Hills are mainly rhyolite and welded tuff layers that are often capped by basalt flows. Erosion and fault blocking have formed high mesas, tablelands,

and plateaus interspersed by basins and cut by deep, narrow canyons carrying numerous perennial and intermittent streams. Many seeps and springs are present.

Climate: While total relief ranges from as low as 2,100 feet on the Snake River to as high as 8,400 feet in the Silver City Range of the Owyhee Mountains, the majority of the Owyhee Uplands Section occurs between 2,800 and 6,200 feet. Throughout the area at these lower elevations, precipitation generally averages 9 - 12 inches (Idaho State Climate Service 2008). Winters are generally moderately cold and moist, and summers hot and dry. Average winter low temperatures range from 16 - 23 degrees F while average summer high temperatures range from 85 - 93 degrees F (Idaho State Climate Service 2008). At elevations above 6,000 feet, in the juniper and mountain big sagebrush zones, precipitation is about 16 - 20 inches per year, the majority from snow accumulation. In contrast, the low elevation shadscale - greasewood zone along the Snake River, stretching from about Marsing to Hammett has mild winters (low temperatures averaging between 20 - 24 degrees F), very hot summers (average high temperatures 91 - 96 degrees F), and very low precipitation (only 7 - 8 inches per year). Precipitation in the Owyhee Uplands Section generally has a dual peak, one in January and another but lesser peak in May and June when thunderstorms tend to develop.

Though total precipitation is generally low, drainage on the shallow and eroded plateau soils can be impeded by sub-soil clay-pans or bedrock. As a result, numerous ephemerally moist drainages, vernally wet pools or lakes, and playas collect snowmelt and rainfall runoff. In order for water to pool, drainage-resistant geology, clay-rich soil, and topographic closed-depressions (often formed in collapsed craters and flow features or from other volcanic and tectonic activity) must all be present. Whether or not pooling is intermittent and less predictable (e.g., playa-like) or temporary but more predictable (e.g., vernal pool-like) depends on the timing, duration, and amount of precipitation, combined with the rate of evaporation, basin size, and presence of specific geologic and soil types (Zedler 1987, Keeley and Zedler 1998). Much of the study area is capable of supporting vernal pools or playas, with the exception of low elevation lacustrine deposit landforms. These are apparently too porous and sloped, precipitation events too few and small, and evaporation too rapid to support even playa ecosystems. Likewise, mountainous areas with granitic soils are too steep and well-drained, or too cold to support vernal pools. These areas have ample water and low evaporation potential, but perennial or semi-permanent (rather than intermittent) flooding is commonly expressed in wetland depressions.

METHODS

Vernal pool and playa sample selection: We used a stratified randomized approach to guide choices of our sampling locations. All BLM and state of Idaho-managed lands within the Owyhee Uplands Ecological Section comprised the sample frame. Township/ranges with greater than 20% of their area in BLM and state management were chosen as the sampling unit. This approach maximized both geographic and environmental variation in the study area while increasing the likelihood of public access. We stratified the sample frame by subsection, with the number of randomly selected township/range sites proportionate to the total available in each subsection (Table 1). We then scrutinized each randomly selected township/range for the existence of vernal pools and playas.

Table 1. Sample distribution by subsection.

Subsection	Potential Sample Sites Randomly Selected % of total	Plots Sampled 2008-2009 #	Supplemental Plots Used in Analysis* #	Plots Represented in Subsection % of total
Bennett Hills–Owyhee Plateau	20	33	8	51
Boise–Payette–Snake River Valleys Lacustrine Deposits	15	3	0	4
Bruneau Desert	15	2	8	12
Owyhee Mountains	18	0	1	1
Owyhee River Canyonlands	9	0	15	19
Snake River Plains	23	2	4	7

*5 supplemental plots were located outside the Owyhee Section

Vernal pools and playas to sample were identified by examining aerial photos (NAIP imagery), U.S. Geological Survey topographic maps, National Wetland Inventory maps, National Hydrographic Dataset (NHD) maps, geologic formations, soils, and known occurrences of vernal pool and playa-dependent rare plant species. Numerous vernal pool-like depressions have been created by hydrologic alterations of springs and ephemeral drainages. These include reservoirs for livestock, ditches and dikes, and roadbeds. We did not include human-created pools unless they were dug out within a naturally formed vernal pool or playa.

To maximize sampling efficiency, sites that occurred in clusters or were in close proximity to one another were favored over individual or isolated sites. Randomly selected sites in the Owyhee Mountains subsection lacked vernal pools. Vernal pools and playas were also rare in the Boise–Payette–Snake River Valleys Lacustrine Deposits. In contrast, vernal pools were abundant in the Bennett Hills–Owyhee Plateau subsection (Table 1). The Owyhee River Canyonlands was not sampled in 2008 or 2009 due to time and accessibility constraints, although existing vegetation plot data from this subsection supplemented the dataset.

Vegetation sampling: Sampling was timed to match the best phenology for identification of the maximum number of plant species (May at lower elevations and June to July at higher elevations). Vegetation was first qualitatively assessed by walking through the vernal pool or playa below the approximate average level of temporary inundation (usually indicated by the presence of wetland-obligate species, high cover of facultative wetland species, or algal growth). During this reconnaissance changes in species dominance, growth form, or vegetation height that would indicate the presence of different plant associations were noted (Barbour et al. 2007). At the same time, searches were made for rare plant species. Efforts were made to collect as many plant species vouchers as time allowed, as well as unknown species for later identification. Regional floras (e.g., Flora of the Pacific Northwest, Intermountain Flora, Jepson Manual) were used to identify species. Taxonomy followed PLANTS database (USDA 2011).

Quantitative fixed-area plots were used to sample vegetation. Most large vernal pools had 2 or more apparent plant associations that were distributed along the hydrologic gradient. Fixed-area plot methods similar to those described by Barbour et al. (2007) were used. Plot sizes

were typically 10 x 5 m, although 5 x 2 m plots were occasionally used for small stands and 20 x 5 m plots used for low diversity communities. Because boundaries between plant communities were sometimes "fuzzy," plots were subjectively located in a representative area near the center of the stand. The cover of all vascular plant species was estimated in each plot. Non-vascular species and algae were not identified. Dominant surface soil texture and cover of soil, rocks, litter, water, etc., as well as depth of water and other environmental information was recorded.

Forty vegetation plots were sampled during 2008-2009. Maps of sample plot locations are shown in Appendix 1. Existing vernal pool and playa plot data from southwest Idaho (Jankovsky-Jones et al. 2001), west-central Idaho (Murphy et al. 2011), and Davis' peppergrass monitoring transects (IDFG 2011) were used to supplement the dataset generated from 2008-2009 sampling (Appendix 1). Eighty-one plots were included in the dataset.

Ecological classification: We used existing classification schemes (ecological systems, NVC) to place vernal pool and playa habitats in an ecological context. Ecological systems represent recurring groups of biological communities found in similar physical environments and influenced by similar dynamic ecological processes, such as flooding (Comer et al. 2003). Ecological systems are conceptualized as groups of plant associations that co-occur within landscapes having similar ecological processes, substrates, and/or environmental gradients. A system typically occurs at intermediate geographic scales of 10's to 1,000's of hectares and persists for at least 50 years (Comer et al. 2003). This temporal scale allows typical successional dynamics to be integrated into the description of the system. This mid-scale classification is hierarchical in that it encompasses the NVC. The NVC macrogroup and group classification levels similarly integrate climate, geology, substrates, hydrology, and disturbance regimes while also encompassing floristic variation (FGDC 2008).

Map of potential vernal pool and playa distribution: We used existing GIS layers to create a map of the potential distribution of vernal pools (including silver sagebrush, typically occurring in vernal pools) and playas in the Owyhee Uplands and adjacent areas. Individually, no GIS layer came close to approximating the observed distribution of vernal pools, silver sagebrush, and playas. However, GIS layers could be stacked together to greatly improve a distribution map. We used GIS spatial analysis tools to create a raster-based map built from pertinent map units from existing layers (Table 2). The distribution map was enhanced by known vernal pool and playa locations (e.g., plots, observations, rare plant occurrences).

Table 2. Spatial layers used to build vernal pool and playas distribution map.

GIS Layer*	Ecological System/Map Unit
NW ReGAP Land Cover (2009)	Inter-Mountain Basins Playa
NW ReGAP Land Cover (2009)	Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub Steppe
NW ReGAP Land Cover (2009)	Columbia Plateau Vernal Pool
NW ReGAP Land Cover (2009)	Inter-Mountain Basins Alkaline Closed Depressions
Idaho Ecological Systems (2005)	Inter-Mountain Basins Playa
Idaho Ecological Systems (2005)	Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub Steppe
National Hydrographic Dataset (1999)	Playa

*Sources: NW Gap Analysis Project (2009); NatureServe (2005); NHD (1999)

Plant association classification: To reduce noise, the dataset was first segregated by ecological setting (60 vernal pool and silver sagebrush plots and 21 playa plots) and any species occurring in only one plot were dropped from the analysis. Potential plant associations in each dataset were derived by hierarchical, polythetic, agglomerative cluster analysis using Relative Sorenson (Bray-Curtis) distance measure and the flexible beta linkage method (flexible beta = -0.250, to minimize chaining) (PC-ORD v. 4.25, McCune and Mefford 1999, McCune and Grace 2002). Relationships between groups were examined by Bray-Curtis and Nonmetric Multidimensional Scaling (NMS) ordination (PC-ORD v. 4.25, McCune and Mefford 1999, McCune and Grace 2002). Bray-Curtis ordination used a Relative Sorenson distance measure and endpoints selected using variance-regression. NMS was run using a Sorenson distance measure with 40 runs of real data and 50 runs of randomized data for a Monte Carlo test of significance interpreted for 6 axes.

Results were checked against field observations before determining the final classification. Results were also compared to other described vernal pool and playa plant associations from the Columbia Basin, northeastern California, and northern Great Basin (Crowe et al. 1994, Moseley 1995, Sawyer and Keeler-Wolf 1995, Bjork 1997, Brown 1999, Jankovsky-Jones et al. 2001, Clausnitzer and Huddleston 2002, Crawford 2003, Barbour et al. 2007, Bjork and Dunwiddie 2004, Dlugolecki 2010) and the NVC (NatureServe 2011). A key to vernal pool and playa plant associations was developed.

RESULTS

Ecological classification: Sampled vernal pools and playas were classified into 4 ecological systems (Comer et al. 2003), 4 NVC macrogroups, and 4 NVC groups (Table 3). Vegetation and hydrology, specifically timing and duration of inundation, were the primary factors useful for distinguishing between ecological systems and macrogroups. Faunal composition was not a useable factor for classifying vernal pools and playas due to insufficient samples and no apparent trends in faunal distribution (Weekley and Murphy 2012). The ecological system classification best encompassed the characteristics of vernal pools and playas documented in the study area. NVC macrogroup and group levels did not accurately represent the ecology of Bolander's silver sagebrush (*Artemisia cana* ssp. *bolanderi*) and playa habitats surveyed in southwest Idaho. Vernal pools from the study area fit the description of the Western North American Vernal Pool macrogroup and North Pacific Vernal Pool group.

Columbia Plateau Vernal Pool Ecological System (Crowe et al.1994, Bjork 1997, Brown 1999, Crawford 2011, NatureServe 2011): This system occurs as shallow ephemeral water bodies ranging from very small (< 50 m^2) (Figure 2) to large and lake-like (> 10 ha) (Figure 3). These depressions frequently (but not always) fill with water during winter and spring. They are dry by early summer, though in exceptionally wet years they can remain inundated. The average hydroperiod is variable, lasting 10 - 100 days. Inundation is irregular, but more predictable than playas. Water is from rainfall and snowmelt in variably sized basins. Because these pools are either perched above the surrounding landscape on plateaus or otherwise isolated by basalt rock ridges, they are not subject to runoff from stream systems. Closed basins fed by springs or seeps are depressional wetlands but not considered vernal pools.

Table 3. Classification of vernal pool and playa habitats and vegetation.

Ecological System	NVC Macrogroup	NVC Group	Association Common Name	Association Scientific Name
Columbia Plateau Silver Sagebrush	Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland*	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland*	Bolander's Silver Sagebrush / Mat Muhly	*Artemisia cana* ssp. *bolanderi* / *Muhlenbergia richardsonis*
Columbia Plateau Silver Sagebrush	Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland*	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland*	Bolander's Silver Sagebrush / Common Spikerush	*Artemisia cana* ssp. *bolanderi* / *Eleocharis palustris*
Columbia Plateau Silver Sagebrush	Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland*	Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland*	Bolander's Silver Sagebrush / Nevada Bluegrass	*Artemisia cana* ssp. *bolanderi* / *Poa nevadensis*
Columbia Plateau Scabland Shrubland	Great Basin & Intermountain Dwarf Sage Shrubland & Steppe	Columbia Plateau Scabland Shrubland	Owyhee Sagebrush / Sandberg Bluegrass	*Artemisia papposa* / *Poa secunda*
Inter-Mountain Basins Playa	Cool Semi-Desert Alkali-Saline Wetland*	Intermountain Basins Alkaline-Saline Shrub Wetland*	Shadscale Playa	*Atriplex confertifolia* Playa
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Mat Muhly	*Muhlenbergia richardsonis*
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Annual Hairgrass	*Deschampsia danthonioides*
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Needle Spikerush Vernal Pool	*Eleocharis acicularis* Vernal Pool
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Common Spikerush Vernal Pool	*Eleocharis palustris* Vernal Pool
Inter-Mountain Basins Playa	Cool Semi-Desert Alkali-Saline Wetland*	Intermountain Basins Alkaline-Saline Herb Wet Flat*	Davis' Peppergrass - Ibapah Springparsley	*Lepidium davisii* - *Cymopterus ibapensis*
Inter-Mountain Basins Playa	Cool Semi-Desert Alkali-Saline Wetland*	Intermountain Basins Alkaline-Saline Herb Wet Flat*	Davis' Peppergrass	*Lepidium davisii*
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Milkwort Knotweed - Sleeping Popcornflower - Navarretia spp.	*Polygonum polygaloides* - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp.
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Sleeping Popcornflower - Mousetail spp.	*Plagiobothrys scouleri* var. *hispidulus* - *Myosurus* spp.
Columbia Plateau Vernal Pool	Western North American Vernal Pool	North Pacific Vernal Pool	Clasping Pepperweed	*Lepidium perfoliatum*
Inter-Mountain Basins Playa	Cool Semi-Desert Alkali-Saline Wetland*	Intermountain Basins Alkaline-Saline Herb Wet Flat*	Saltlover	*Halogeton glomeratus*

*We consider these macrogroups and groups provisional; they do not accurately represent the ecological context for the associations classified in southwest Idaho. For example, Bolander's silver sagebrush occurs in vernal pools rather than wet meadows, marshes, riparian zones, or seeps. Similarly, playas in southwest Idaho are not known to be alkaline-saline wetlands.

The Columbia Plateau Vernal Pool Ecological System typically has silty clay soils, sometimes with varying amounts of sand and rock present. Soils can resemble Vertisols and pools can be found within areas of mounded topography. Vegetation is predominately herbaceous, distinguishing this system from the Columbia Plateau Silver Sagebrush ecological system (which occurs in similar ecological settings). This system is similar to the Modoc Basalt Flow Vernal Pool Ecological System occurring in northeastern California and immediately surrounding areas of Nevada and Oregon (Sawyer and Keeler-Wolf 1995, Crawford 2011).

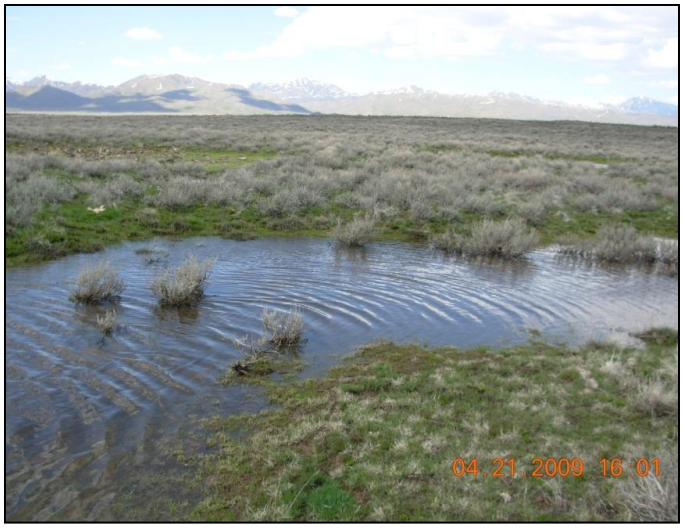

Figure 2. A fully inundated small vernal pool (< 50 m^2) on Macon Flat in the Bennett Hills, April 21, 2009.

Figure 3. A large vernal pool/lake (~ 8 ha) on the Owyhee Plateau at nearly full inundation, May 9, 2008.

Columbia Plateau Silver Sagebrush Ecological System (Jankovsky-Jones et al. 2001, Clausnitzer and Huddleston 2002, Dlugolecki 2010, NatureServe 2011): This system usually occurs in ephemerally moist depressions and non-alkaline vernal pools. The ecologic factors and environmental settings are very similar to the Columbia Plateau Vernal Pool system. Dominance by silver sagebrush (typically Bolander's [*Artemisia cana* ssp. *bolanderi*]) and a slightly shorter hydroperiod distinguishes this system from the herb-dominated Columbia Plateau Vernal Pool. Short inundation vernal pools can be wholly dominated by Bolander's silver sagebrush stands (Figure 4). Alternatively, the silver sagebrush system can form a ring around the herbaceous-dominated Columbia Plateau Vernal Pool system that occurs in pool centers with longer inundation (Figure 5). Stands occur slightly above to slightly below the average high water elevation in a topographic depression. Stands are typically shallowly inundated from mid-winter through mid-April, on average (Clausnitzer and Huddleston 2002). Soils tend to be deep (> 50 cm), somewhat poorly drained silt loams or clay loams (Jankovsky-Jones et al. 2001) derived from loess, weathered basalt, and volcanic ash (Clausnitzer and Huddleston 2002, Dlugolecki 2010). Soils in silver sagebrush vernal pools have redoximorphic features indicative of hydric soil conditions (Clausnitzer and Huddleston 2002).

Figure 4. Large vernal pool (~ 10 ha) on Owyhee Plateau completely dominated by Bolander's silver sagebrush (*Artemisia cana* ssp. *bolanderi*).

Figure 5. The Columbia Plateau Silver Sagebrush Ecological System forms a ring around the vernal pool system (green, herbaceous vegetation, left-center of photo) in this depression on the Owyhee Plateau.

Inter-Mountain Basins Playa Ecological System (Moseley 1995, Jankovsky-Jones et al. 2001, Rocchio 2006, NatureServe 2011): This system occurs in topographic closed depressions and is distinctively barren or sparsely vegetated (generally < 10% plant cover) (Figures 6 and 7). These systems are intermittently flooded with irregular inundation (Figure 7). Flooding does not occur every year and can be very short-duration. Precipitation and snowmelt runoff is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soils are clay-rich and often become very hard and hexagonally cracked upon drying. Rocks range from nearly absent to very abundant on the playa surface. Soil salinity varies greatly with soil moisture and greatly affects community composition. In the study area, playa soils are not usually highly saline or alkaline (Moseley 1995).

Figure 6. Playas in the Bruneau Desert.

Figure 7. Remnant rainwater on playa, Snake River Plains, June 5, 2008.

Columbia Plateau Scabland Shrubland (Hironaka et al. 1983, Jankovsky-Jones et al. 2001, NatureServe 2011): This system occasionally occurs on the periphry of the silver sagebrush, vernal pool, and playa ecological systems. It is characterized by low-height *Artemisia*-dominated shrublands (including Owyhee sagebrush [*Artemisia papposa*]). Soils are shallow, frequently clayey and rocky, occurring over fractured basalt. Because drainage is impeded by underlying basalt and claypans, soils are often saturated from winter through spring by precipitation and snowmelt. Sites are dry by mid-summer. Elevated water tables on the margins of vernal pools may also feed moisture into this system. Sites are not inundated. Vegetation cover is often sparse and specially adapted species, including annuals typical of vernal pools (on moist sites), are common.

Vernal pool and playa distribution: Maps of potential vernal pools and playas are shown in Appendix 1. In the study area, vernal pools and silver sagebrush stands most frequently occur on basalt flows in the Bennett Hills (mostly in the Camas Creek basin on Macon Flat east of Camas Prairie) and basalt tablelands on the Owyhee Plateau (primarily in the Riddle and Grasmere area, extending northwest toward the Owyhee Mountains. Elevations in the Bennett Hills are +/- 5,000 feet (1,525 m). On the Owyhee Plateau, vernal pools and silver sagebrush stands occur most abundantly between approximately 5,400 and 6,000 feet (1,645 - 1,830 m) elevation. These habitats are also relatively abundant on the basalt plateaus in the Owyhee River Canyonlands at elevations +/- 5,200 feet (1,585 m). Sites are also known from basalt plateaus on the Boise–Payette–Snake River Valleys Lacustrine Deposits subsection (near Bliss), scattered locations on the Snake River Plains, and occasional basalt flow locations in the Owyhee Mountains. In southwest Idaho, vernal pools also occur outside the study area in the Snake River Basalts, Northwestern Basin and Range, and Blue Mountains (e.g., Weiser River Basin) ecological sections.

Playas typically occur in 3 distinct regions, their distribution limited to elevations below 5,300 feet (1,615 m). Playas are most abundant on basalt plateaus in the Bruneau Desert west of the Bruneau River. Another cluster occurs on the plateaus surrounding the South Fork Owyhee River in the Owyhee River Canyonlands subsection. A third group is found on the Snake River Plains to the southwest of Mountain Home. A few playas also occur on the plateaus surrounding Salmon Falls Creek.

Plant associations: Fifteen vernal pool and playa plant associations were classified from plot data collected in southwest Idaho between 1997 and 2009 (Table 3). Cluster dendrograms and ordination results for the classification are in Appendix 2. Cluster analysis yielded several outlier groups or plots. The composition of these groups and plots were inspected and professional judgment used to place them in the classification. Two of the outlying groups represented degraded stands of the Bolander's silver sagebrush / Nevada bluegrass (*Artemisia cana* ssp. *bolanderi* / *Poa nevadensis*) and Davis' peppergrass (*Lepidium davisii*) plant associations that had high cover and constancy of non-native species. Ordination results supported groups identified by cluster analysis and professional judgment. Groups also aligned well with known environmental gradients, specifically inundation frequency and duration. A key to identifying plant associations and complete descriptions of each type are found in Appendix 3. Stand

tables for each association are in Appendix 4.

Three of the 15 plant associations classified have been included in the NVC (NatureServe 2011):

- Bolander's silver sagebrush / mat muhly (*A. cana* ssp. *bolanderi* / *Muhlenbergia richardsonis*)
- Bolander's silver sagebrush / common spikerush (*A. cana* ssp. *bolanderi* / *Eleocharis palustris*)
- Bolander's silver sagebrush / Nevada bluegrass (*A. cana* ssp. *bolanderi* / *Poa nevadensis*)

Five plant associations had been previously documented, but have not been included in the NVC. Of these associations, 3 were included within wider ranging types with broader composition, likely due to a lack of data from vernal pools:

- Owyhee sagebrush / Sandberg bluegrass (*Artemisia papposa* / *Poa secunda*) (Jankovsky-Jones et al. 2001, Murphy et al. 2011)
- needle spikerush vernal pool (*Eleocharis acicularis* vernal pool)
- common spikerush vernal pool (*Eleocharis palustris* vernal pool) (Jankovsky-Jones et al. 2001, Murphy et al. 2011)

Two other associations (annual hairgrass [*Deschampsia danthonioides*] and Davis' peppergrass [*Lepidium davisii*]) have been previously described but not yet included within the NVC (Jankovsky-Jones et al. 2001, Murphy et al. 2011). Four associations have been reported anecdotally, but plot data from these types had not previously been analyzed for the region:

- shadscale playa (*Atriplex confertifolia* playa) (reported from Nevada; Vegbank 2011)
- mat muhly (*Muhlenbergia richardsonis*) (Jankovsky-Jones et al. 2001)
- clasping pepperweed (*Lepidium perfoliatum*) (reported from Nevada; Vegbank 2011)
- saltlover (*Halogeton glomeratus*) (reported from Nevada; Vegbank 2011)

Three plant associations had not been previously documented in any vegetation classification:

- Davis' peppergrass - Ibapah springparsley (*Lepidium davisii* - *Cymopterus ibapensis*)
- milkwort Knotweed - sleeping popcornflower - navarretia spp. (*Polygonum polygaloides* - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp.)
- sleeping popcornflower - mousetail spp. (*Plagiobothrys scouleri* v. *hispidulus* - *Myosurus* spp.)

Flora: At least 169 vascular plant taxa were documented from vernal pools and playas in southwest Idaho (Appendix 5). Approximately 27% of the flora could be classified as species specially adapted or restricted to vernal pools, playas, or similar ephemerally wet habitats. Of the species occurring in at least 30% of sampled stands, all were native species and, all except common spikerush (*Eleocharis palustris*) were vernal pool specialists:

- common spikerush (*Eleocharis palustris*) (47% of stands)
- sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) (42%)

- milkwort knotweed (*Polygonum polygaloides*) (41%)
- silver sagebrush (*Artemisia cana*) (typically Bolander's silver sagebrush, ssp. *bolanderi*) (35%)
- smooth spike-primrose (*Epilobium pygmaeum*) (32%)
- short woollyheads (*Psilocarphus brevissimus* var. *brevissimus*) (30%)

The vegetative composition of southwest Idaho vernal pools is distinct from eastern Washington, central Oregon, and northeast California by the high frequency and abundance of fleshy porterella (*Porterella carnosula*) (Figure 8) in several plant associations. Mansfield (2010) reported fleshy porterella as common in similar habitats in the Owyhee River Basin of adjacent southeast Oregon. Fleshy porterella is rare or not present in vernal pools elsewhere.

Figure 8. Fleshy porterella (*Porterella carnosula*) with sleeping popcornflower.

Other plant species that are sometimes documented from vernal pool and silver sagebrush plant associations in the study area, but which have not been listed from similar habitats in eastern Washington, southeast Oregon, and northeast California include:

- filiform rockjasmine (*Androsace filiformis*) (Bennett Hills only)
- Owyhee sagebrush (*Artemisia papposa*)
- white mariposa lily (*Calochortus eurycarpus*)
- Colorado rush (*Juncus confusus*)
- clustered broomrape (*Orobanche fasciculata*)
- yellow owl's-clover (*Orthocarpus luteus*)
- Gardner's yampah (*Perideridia gairdneri*)
- plantain goldenweed (*Pyrrocoma uniflora* var. *uniflora*)

Southwest Idaho playas support endemic plant associations. Some species in these playas have only been reported from playas in southeast Oregon (Mansfield 2010) and immediately adjacent northern Nevada. These playas represent unique ecological communities of limited distribution. Unlike playas typically occurring in the Great Basin of southeast Oregon, Nevada, and Utah, these clay hardpan playas are not highly alkaline or saline. Species especially confined to southwest Idaho playas include:

- Davis' peppergrass (*Lepidium davisii*)
- Ibapah springparsley (*Cymopterus ibapensis*)
- Torrey's milkvetch (*Astragalus calycosus*)

Fourteen percent of the flora was non-native species (Table 4; Appendix 5). The most frequently documented non-native species in vernal pools was prostrate knotweed (*Polygonum aviculare*). Clasping pepperweed (*Lepidium perfoliatum*) and prickly Russian thistle (*Salsola tragus*) were the most frequently encountered non-native species in playas. Prostrate knotweed and saltlover (*Halogeton glomeratus*) were the next most frequently occurring non-native species in playas. The mean cover of any individual non-native species was always less than 5% in vernal pools and 2% in playas.

Table 4. Most frequently occurring non-native plant species by habitat (n = 81).

Common name	Scientific name	Vernal Pools		Playas	
		constancy %	mean cover %	constancy %	mean cover %
prostrate knotweed	*Polygonum aviculare*	30	0.9	24	0.6
Japanese brome	*Bromus japonicus*	15	2.4		
cheatgrass	*Bromus tectorum*	15	0.6	19	0.4
bulbous bluegrass	*Poa bulbosa*	13	4.9		
clasping pepperweed	*Lepidium perfoliatum*	13	2.2	29	0.5
prickly lettuce	*Lactuca serriola*	13	0.1		
bur buttercup	*Ceratocephala testiculata*	8	2.6	10	0.1
medusahead	*Taeniatherum caput-medusae*	5	2.3	5	0.1
tall tumblemustard	*Sisymbrium altissimum*	5	0.7	10	0.1
prickly Russian thistle	*Salsola tragus*	3	0.1	29	1.6
annual wheatgrass	*Eremopyrum triticeum*	3	0.1	5	0.1
saltlover	*Halogeton glomeratus*			24	1.8
burning bush	*Bassia scoparia*			19	0.7

Rare plants: At least 10 BLM special status plant species have the potential to occur in southwest Idaho vernal pools and playas:

- twinleaf onion (*Allium anceps*),
- fringed redmaids (*Calandrinia ciliata*),
- California damsonium (*Damasonium californicum*)
- Bach's calicoflower (*Downingia bacigalupii*) (Figure 9)
- harlequin calicoflower (*Downingia insignis*)
- bee thistle (*Eryngium articulatum*)
- Davis' peppergrass (*Lepidium davisii*) (Figure 10)
- short-flowered monkeyflower (*Mimulus evanescens*)
- wholeleaf goldenweed (*Pyrrocoma insecticruris*)
- thinleaf goldenhead (*Pyrrocoma linearis*)

Figure 9. Bach's calicoflower (*Downingia bacigalupii*)

Other plants at-risk in Idaho having the potential to occur in vernal pools include Modoc eryngo (*Eryngium alismifolium*), profuseflower mesamint (*Pogogyne floribunda*), and false chicken-sage (*Vesicarpa potentilloides*).

Four new occurrences of rare plant species were recorded during this survey: profuseflower mesamint (*Pogogyne floribunda*), Bach's calicoflower (*Downingia bacigalupii*), California damsonium (*Damasonium californicum*), and thinleaf goldenhead (*Pyrrocoma linearis*) (Figure 11). Profuseflower mesamint, a globally vulnerable species, is known from only 2 occurrences in Idaho.

Other rare plants observed during this study are occasionally encountered in vernal pools and playas. Bach's calicoflower is known from 4 other vernal pools / lakes and 19 additional non-vernal pool sites (e.g., livestock reservoirs, intermittent drainages, and roadside ditches) in Idaho. California damsonium is known from 5 other vernal pools / lakes and 15 non-vernal pool sites. Due to taxonomic questions and poor documentation, the conservation status of thinleaf goldenhead is questionable in Idaho. There are approximately 15 known sites, but the occurrence found during this study is the only known from a vernal pool. This species typically occurs in ephemeral drainages, swales, and meadows. It is likely more common than records indicate. There are over 160 playas supporting Davis' peppergrass in Idaho (see playa distribution in Appendix 1; Moseley 1995).

Other Idaho rare plants that potentially occur in vernal pools, including twinleaf onion (*Allium anceps*) (this species also occurs in playas), fringed redmaids (*Calandrinia ciliata*), harlequin calicoflower (*Downingia insignis*), Modoc eryngo (*Eryngium alismifolium*), short-flowered monkeyflower (*Mimulus evanescens),* wholeleaf goldenweed (*Pyrrocoma insecticruris*), and false chicken-sage (*Vesicarpa potentilloides*), were not observed. Of these, only twinleaf onion and harlequin calicoflower have been confirmed to occur in vernal pools (Figure 11). Other known sites for these species include ephemerally moist meadows, livestock reservoirs, intermittent drainages, and roadside ditches.

Figure 10. Davis' peppergrass (*Lepidium davisii*)

DISCUSSION

Ecological systems provided a convenient and meaningful classification scheme of habitats surveyed during this study. Existing NVC macrogroups and groups did not always accurately represent the ecological context for the associations classified in southwest Idaho. For example, Bolander's silver sagebrush (*Artemisia cana* ssp. *bolanderi*) occurs in vernal pools rather than wet meadows, marshes, riparian zones, or seeps as indicated by the macrogroup and groups including silver sagebrush (NatureServe 2011).

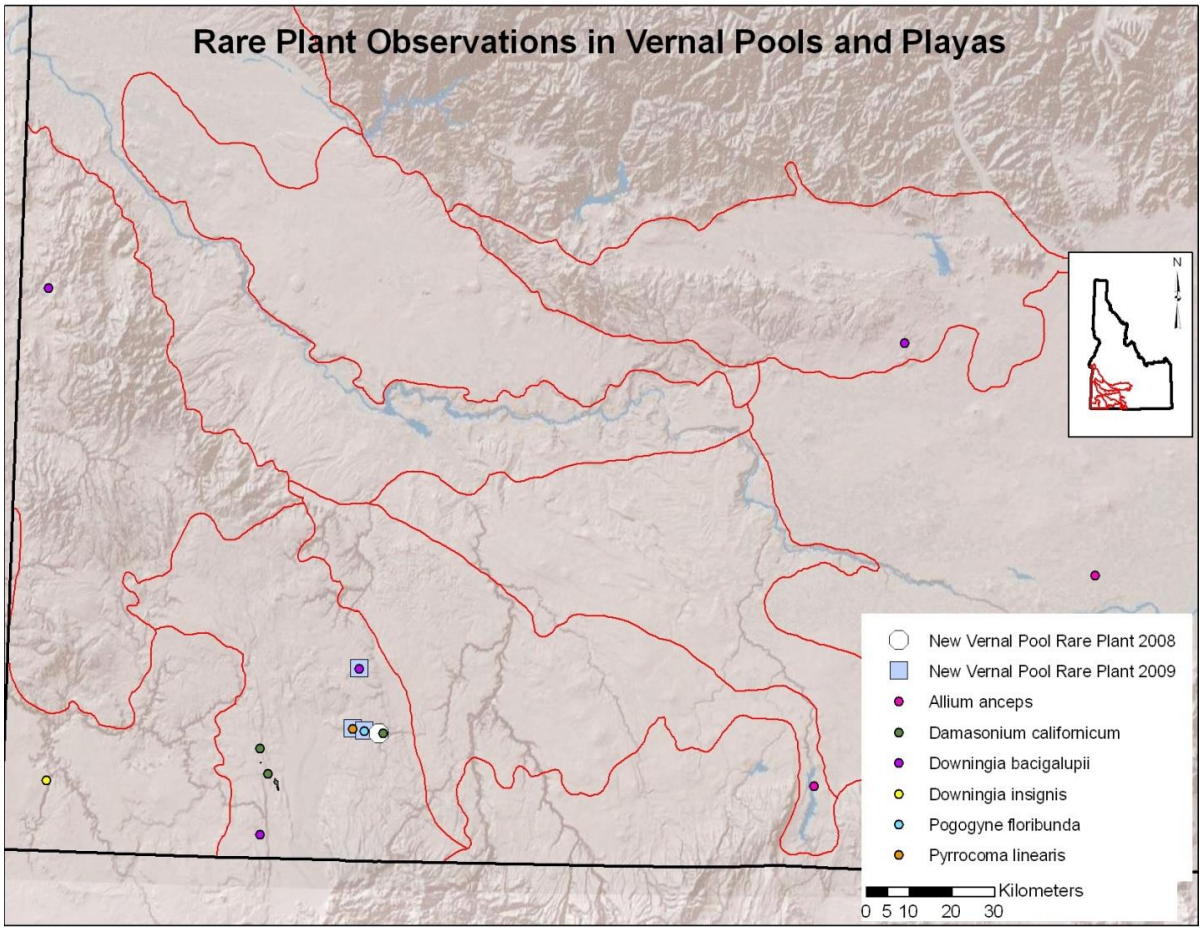

Figure 11. Distribution of vernal pools containing rare plants (other than Davis' peppergrass [*Lepidium davisii*])

Similarly, playas in southwest Idaho are not known to be alkaline-saline wetlands as indicated by the macrogroup and groups that include cool desert playas. There may be a need for the NVC to create macrogroups and groups that better capture these unique vegetation types.

Southwest Idaho vernal pools and playas supported several previously undescribed and regionally endemic plant associations of conservation interest. Playa associations, such as Davis' peppergrass (*Lepidium davisii*) and Davis' peppergrass - Ibapah springparsley (*Lepidium davisii - Cymopterus ibapensis*), are endemic to the study area and immediately adjacent Oregon and Nevada. They are threatened by various impacts, especially non-native species invasion and hydrologic alteration (Appendix 3; Weekley and Murphy 2012). Prior to this study, annual-dominated vernal pool vegetation had not been described from southwest Idaho. Two additional vernal pool plant associations (Carolina foxtail [*Alopecurus carolinianus*] and prostrate knotweed [*Polygonum aviculare*]) have been observed in the study area, but were not sampled during this survey. Additional sampling may be necessary to confirm new vegetation types.

Other southwest Idaho vernal pool plant associations share similarities with vegetation types documented from northeast California, eastern Oregon, and eastern Washington. Bolander's silver sagebrush plant associations are equivalent to those described from central and

southeast Oregon (Clausnitzer and Huddleston 2002, Taylor 2004, Dlugolecki 2010). Common spikerush (*Eleocharis palustris*) and annual hairgrass (*Deschampsia danthonioides*) plant associations are equivalent to those documented from the Modoc Plateau of northeastern California (Sawyer and Keeler-Wolf 1995, Barbour et al. 2007) and eastern Washington (Crowe et al. 1994, Bjork 1997, Brown 1999, Crawford 2003, Bjork and Dunwiddie 2004).

The floristic diversity of southwest Idaho vernal pools and playas is slightly higher than that of central Oregon (Dlugolecki 2010) and northeastern California (Barbour et al. 2007) (Table 5). Mansfield (2010) recorded 140 species from an unknown number of vernal wetlands and playas in the Owyhee River Basin of southeast Oregon. The floristic composition of southwest Idaho vernal pools and playas appears most closely aligned with northeast California and northwest Nevada floras (Table 5). Thirty-five percent of the flora documented in northeast California's Modoc Plateau and adjacent Nevada was shared with southwest Idaho vernal pool and playa flora (Barbour et al. 2007). Southwest Idaho flora appears less similar to the flora of central Oregon vernal pools and playas (only 23% of species shared with southwest Idaho), although survey effort was not as high there as in other areas (Dlugolecki 2010).

The floristic diversity of vernal pools and playas in southwest Idaho was significantly less than Columbia Basin vernal pools in eastern Washington (Bjork and Dunwiddie 2004). Only 26% of Columbia Basin vernal pool species were shared with southwest Idaho. Although survey thoroughness may account for a larger number of taxa recorded in eastern Washington, the total number of taxa is closer to that found in California (Keeler-Wolf et al. 1998). Approximately 34% of the flora of eastern Washington vernal pools was shared with northern California vernal pools (Bjork and Dunwiddie 2004). The percent of vernal pool flora that is comprised of non-native species was similar across all regions.

Table 5. Comparison of vernal pool and playa floras.

Vernal Pool and Playa Survey Area-- Ecological Sections	**# of plots or sample sites**	**# of vascular plant taxa**	**% of taxa that were non-native**	**% of taxa shared with Southwest Idaho**
Southwest Idaho-- Owyhee Uplands	81	169	14	-
Central Oregon-- Northwestern Basin and Range/High Lava Plains (Dlugolecki 2010)	70	159	11	23
Northeast California, adjacent Nevada-- Modoc Plateau/Northwestern Basin and Range (Barbour et al. 2007)	134	131	18	35
Eastern Washington-- Columbia Basin (Bjork and Dunwiddie 2004)	352	283	15	26
California--entire state (Keeler-Wolf et al. 1998)	n/a	367	15	12

Vernal pools were found to support several at-risk plant species. Profuseflower mesamint, a globally vulnerable species known from only 2 occurrences in Idaho, was the most significant discovery. Southwest Idaho is the northeastern extent of its global range. The majority of occurrences are in northeastern California, with scattered locations in southeastern Oregon (Meinke 2006, Mansfield 2011). Meinke (2006) found significant morphologic variation in 3 eastern Oregon populations. Specimens of profuseflower mesamint we collected on the Owyhee Plateau (near Riddle) are morphologically similar to the Foley Lake Research Natural Area (Lake County, Oregon) population examined by Meinke (2006).

Several other plants not tracked as rare or having special status in Idaho were collected during this study. They have limited known distribution and number of occurrences in Idaho. About 8 milkwort (*Polygonum polygaloides*) specimens collected from the Owyhee Plateau keyed to whitemargin (or Modoc) knotweed (*P. polygaloides* ssp. *esotericum*). This subspecies was not previously known from Idaho. Milkwort specimens north of the Snake River keyed to fruitleaf knotweed (*P. polygaloides* ssp. *confertiflorum*). Whitemargin knotweed was previously thought to be endemic to the northeastern California's Modoc Plateau and immediately adjacent south-central Oregon. However, recent collections in eastern Washington (Bjork and Dunwiddie 2004) and in the Owyhee River Basin of southeastern Oregon (Mansfield 2010) indicate this subspecies to have a broader range than previously thought. Stalked popcornflower (*Plagiobothrys stipitatus* var. *micranthus*) was collected from 4 vernal pools on the Owyhee Plateau. This taxon was not previously known from Idaho, but it has been collected in adjacent southeastern Oregon (Mansfield 2010). Although not encountered during this survey, doublehorn calicoflower (*Downingia bicornuta*) is only known in Idaho from several vernal pools or similar habitats in Owyhee County. It is likely rarer in Idaho than Bach's calicoflower, a recognized special status species occurring in vernal pool and ephemerally moist habitats.

The function of vernal pools and playas are threatened by specific land-uses observed in the study area (Weekley and Murphy 2012). The majority of survey sites are grazed by livestock. The long-term effects of livestock grazing on vernal pools and playas in Idaho are not known. Studies from California suggest that livestock grazing can benefit vernal pool ecosystems by lengthening the inundation period and increasing cover and richness of native plant species (Marty 2005). In our concurrent assessment of vernal pool and playa ecological condition (Weekley and Murphy 2012), we observed soils that were churned and exposed by the cattle hooves. These trampling effects, combined with utilization of forage, can lead to changes in vegetation composition and structure. Other documented land uses known to impact vernal pool and playa hydrology and vegetation include excavation of livestock water reservoirs and roads (Dlugolecki 2010, Weekley and Murphy 2012). In addition to site specific impacts, landscape-scale changes to southwest Idaho ecosystems have occurred which may have negative effects on vernal pools and playas. For example, several vernal pools observed on the basaltic plateau near Bliss were within habitat burnt by multiple wildfires. The surrounding landscape had been completely converted to non-native, annual-dominated vegetation. These vernal pools were wholly dominated by non-native prostrate knotweed (*Polygonum aviculare*) and bur buttercup (*Ceratocephala testiculata*).

Davis' peppergrass (*Lepidium davisii*) is a globally vulnerable plant species that is also diagnostic of a globally vulnerable plant association. It has been extirpated from several playas. Other occurrences have been degraded by OHV use, livestock water reservoirs, non-native species invasion, and livestock grazing, predominantly in the Bruneau Desert and Snake River Plains (Moseley 1995, Tuason 2005). Disturbances to playas can initiate invasion by non-native species (Moseley 1995, Tuason 2005). The litter of non-native plants can build up on playas and directly smother Davis' peppergrass. In addition, sediment from wind and water erosion on degraded rangelands can deposit on playas. This creates habitats for xeric perennial species and weeds to invade while decreasing the habitat for Davis' peppergrass. If livestock water reservoirs or salt blocks are located in or adjacent to the playa, then direct trampling of Davis' peppergrass and alteration of the hydrology and micro-environment (promoting plant competition) may occur (Moseley 1995, Tuason 2005). Damage occurs mostly when the soil is wet. Similar problems can result from OHV use on playas.

The information gained from classification of vernal pools and playas in southwest Idaho is useful for prioritizing conservation, management, and restoration efforts. It can be used by BLM managers to evaluate the conservation value of these habitats during Resource Management Plan revisions. Based on our surveys, the Bennett Hills - Owyhee Plateau subsection contains numerous high quality vernal pools that support a range of common and rare plants, animals, and plant associations (Weekley and Murphy 2012). Conservation and restoration of vernal pools in these areas is recommended. Information may be useful in land management considerations for OHV use, livestock grazing, water management, post-wildfire vegetation restoration, and noxious weed control. Long-term monitoring of vernal pools, in an adaptive management context, may be needed to document changes resulting from land use, management, and climate change.

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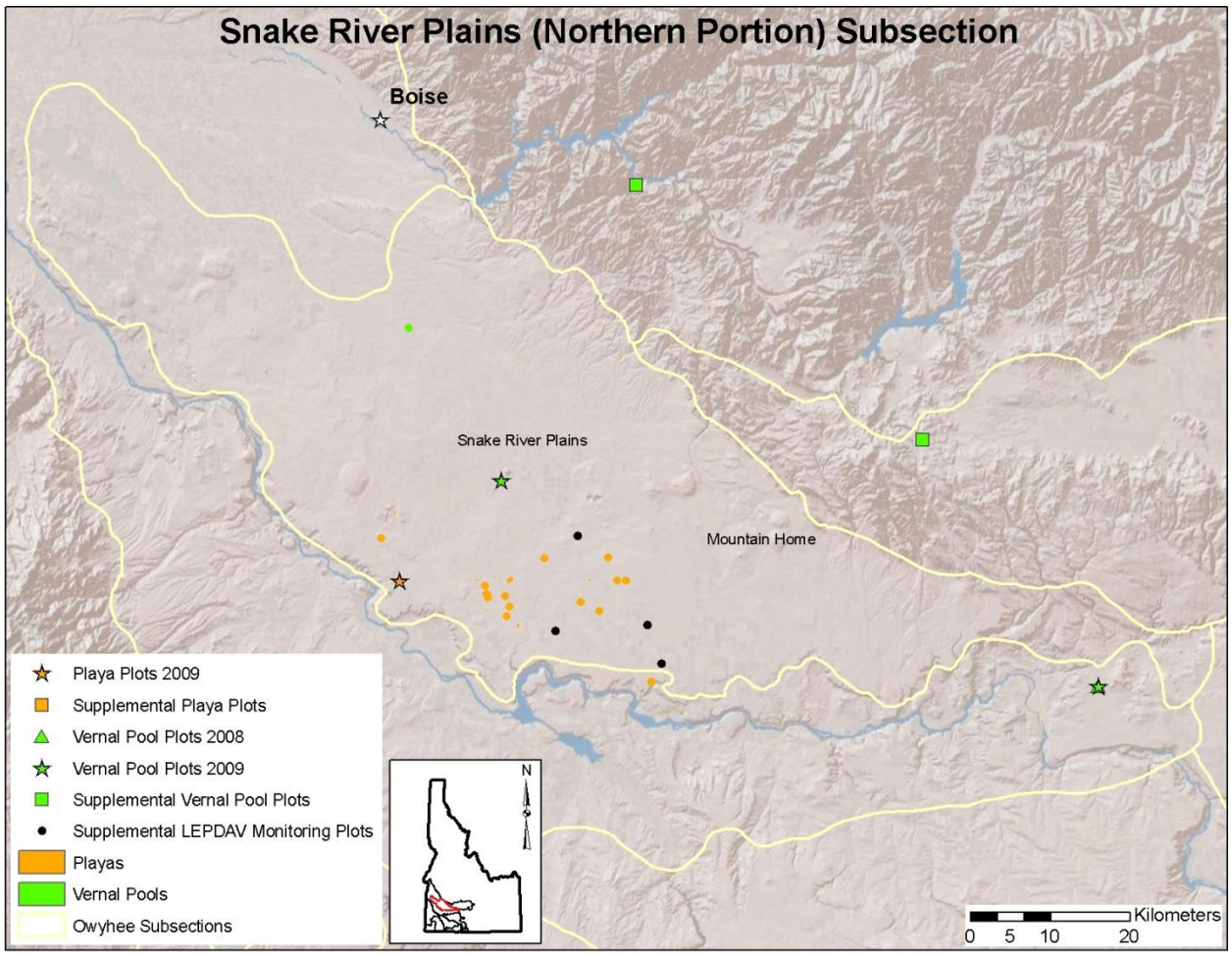
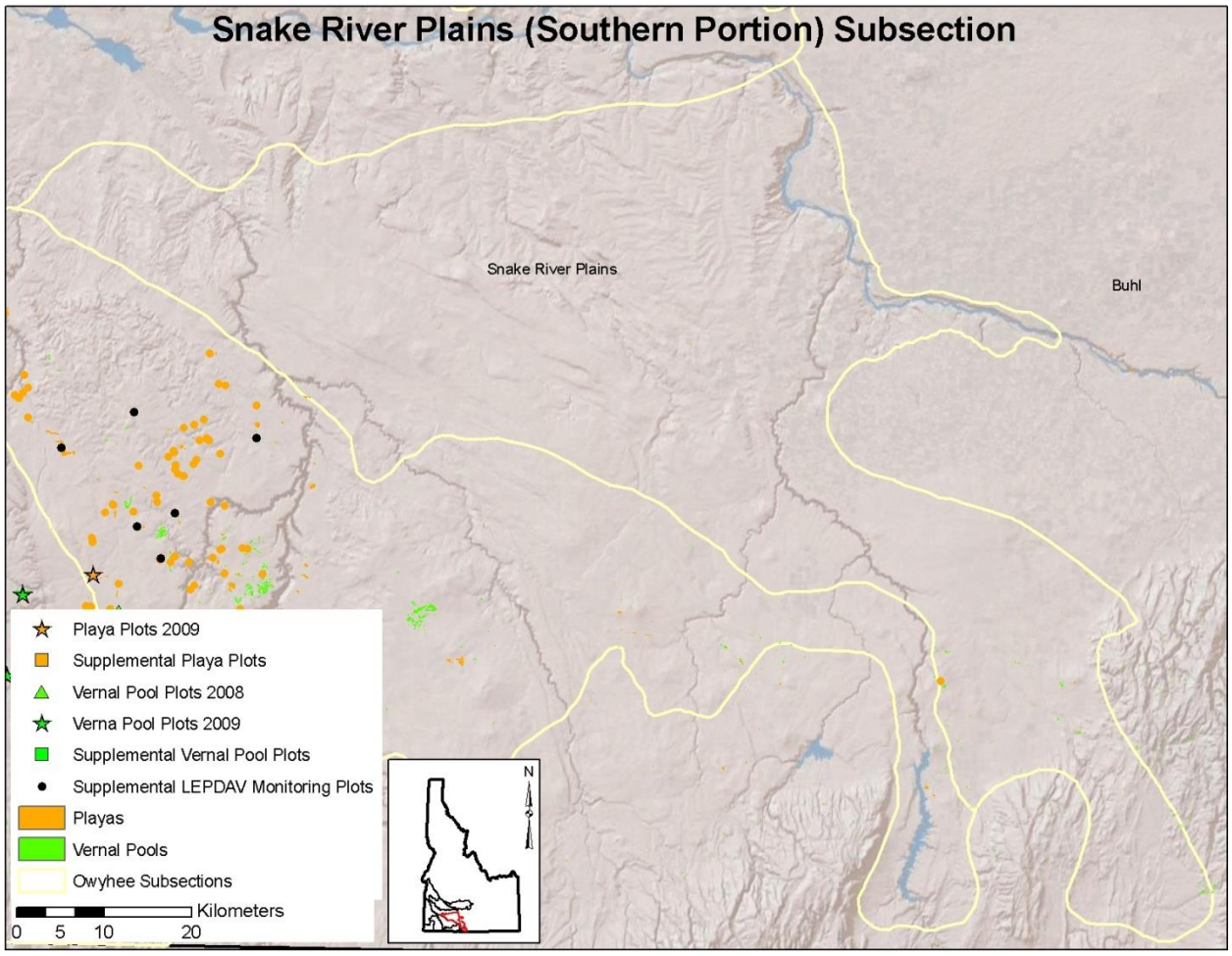
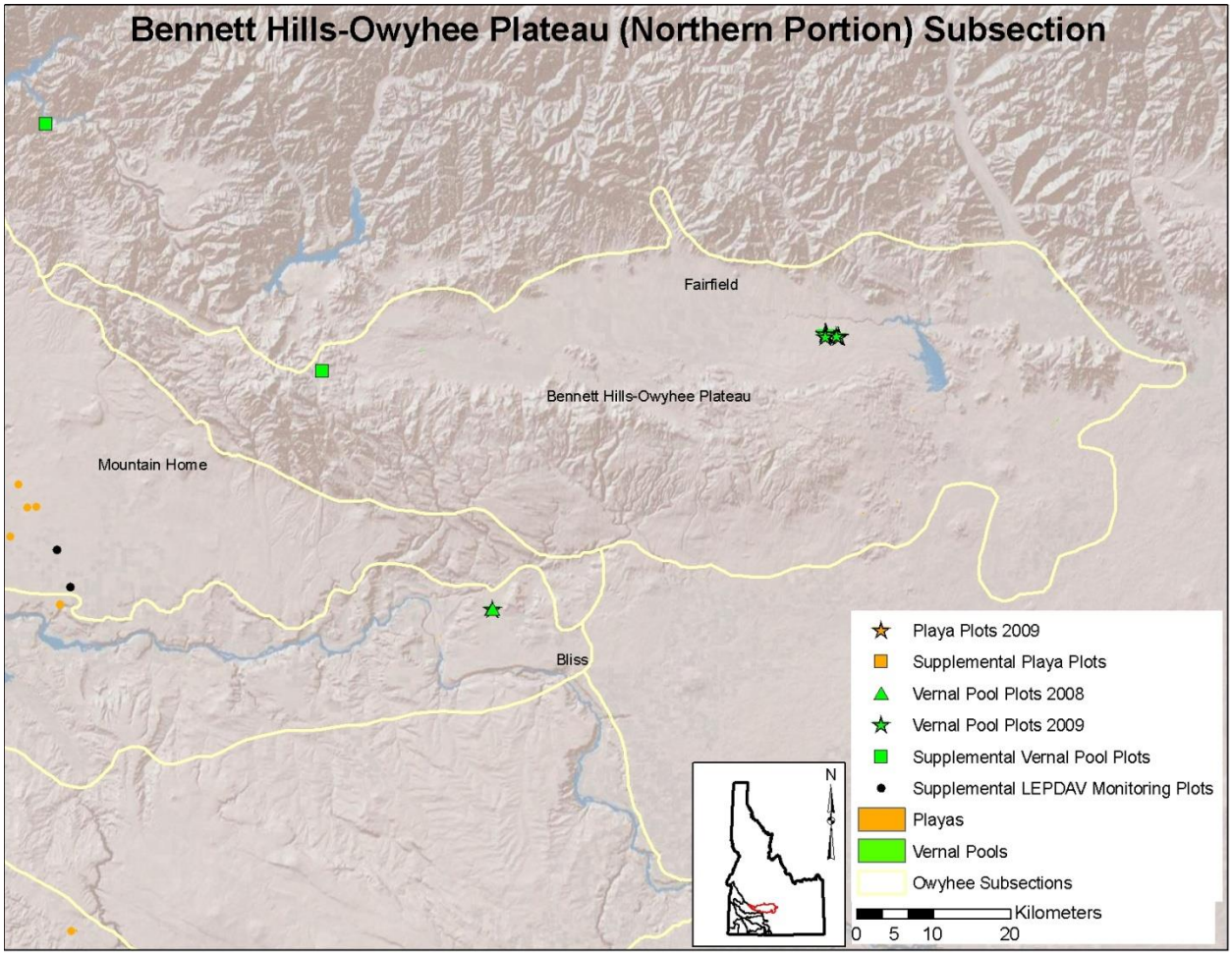
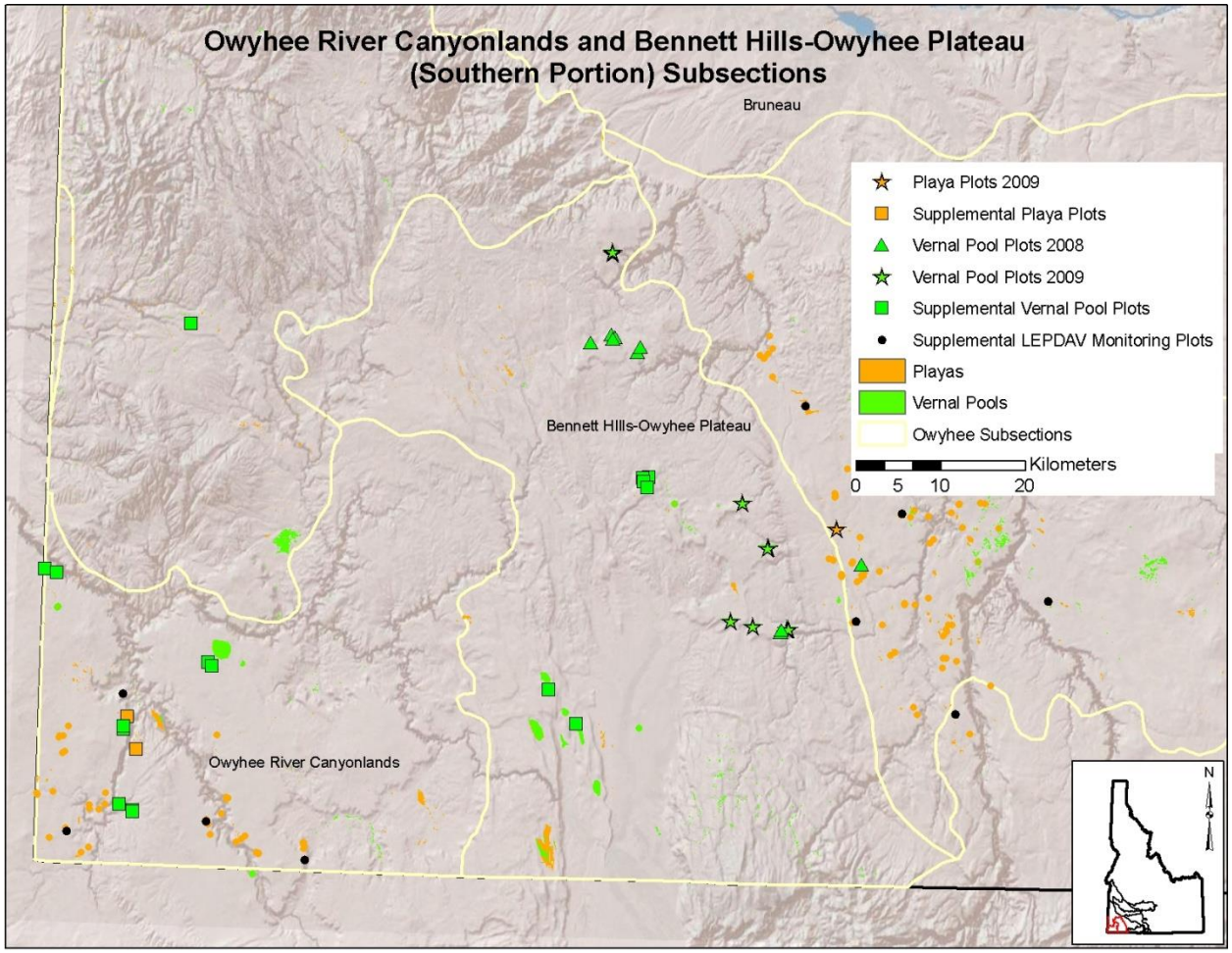
APPENDIX 1

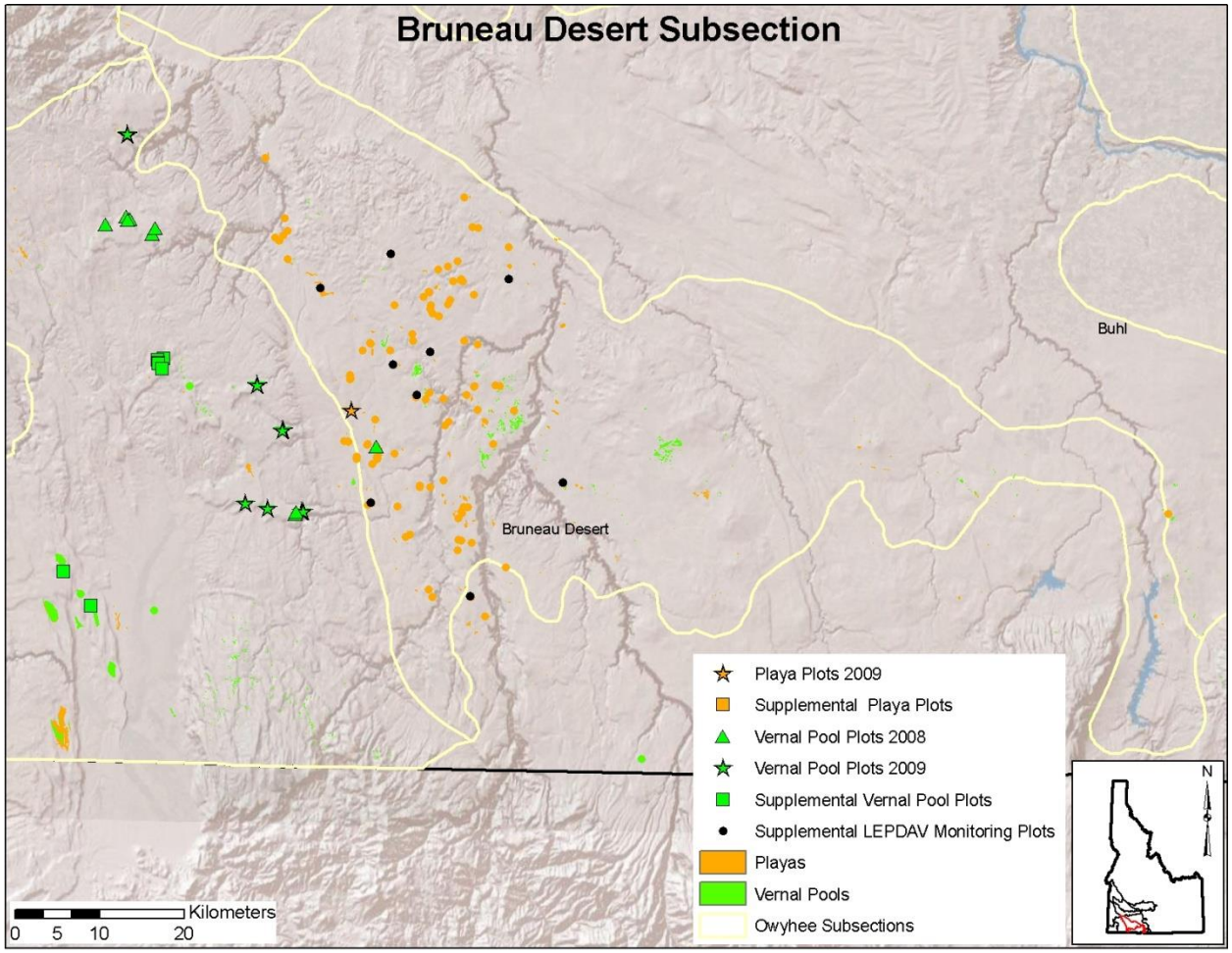
Maps of potential vernal pool (inclusive of silver sagebrush) and playa distribution, and locations of sample plots and supplemental plots used in classification

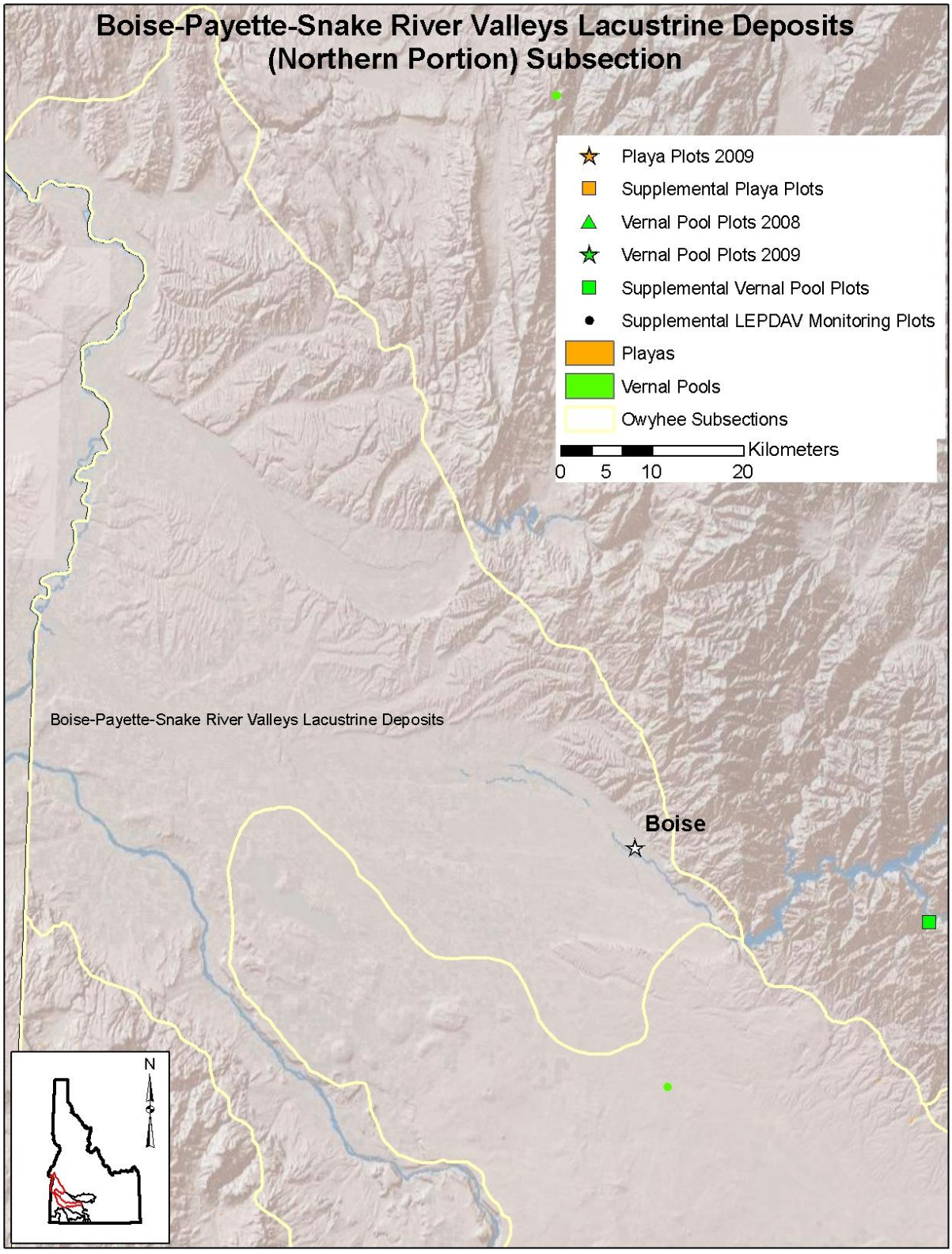

Snake River Plains (Northern Portion) Subsection
Boise
Snake River Plains
Mountain Home
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
N
Kilometers
0 5 10 20

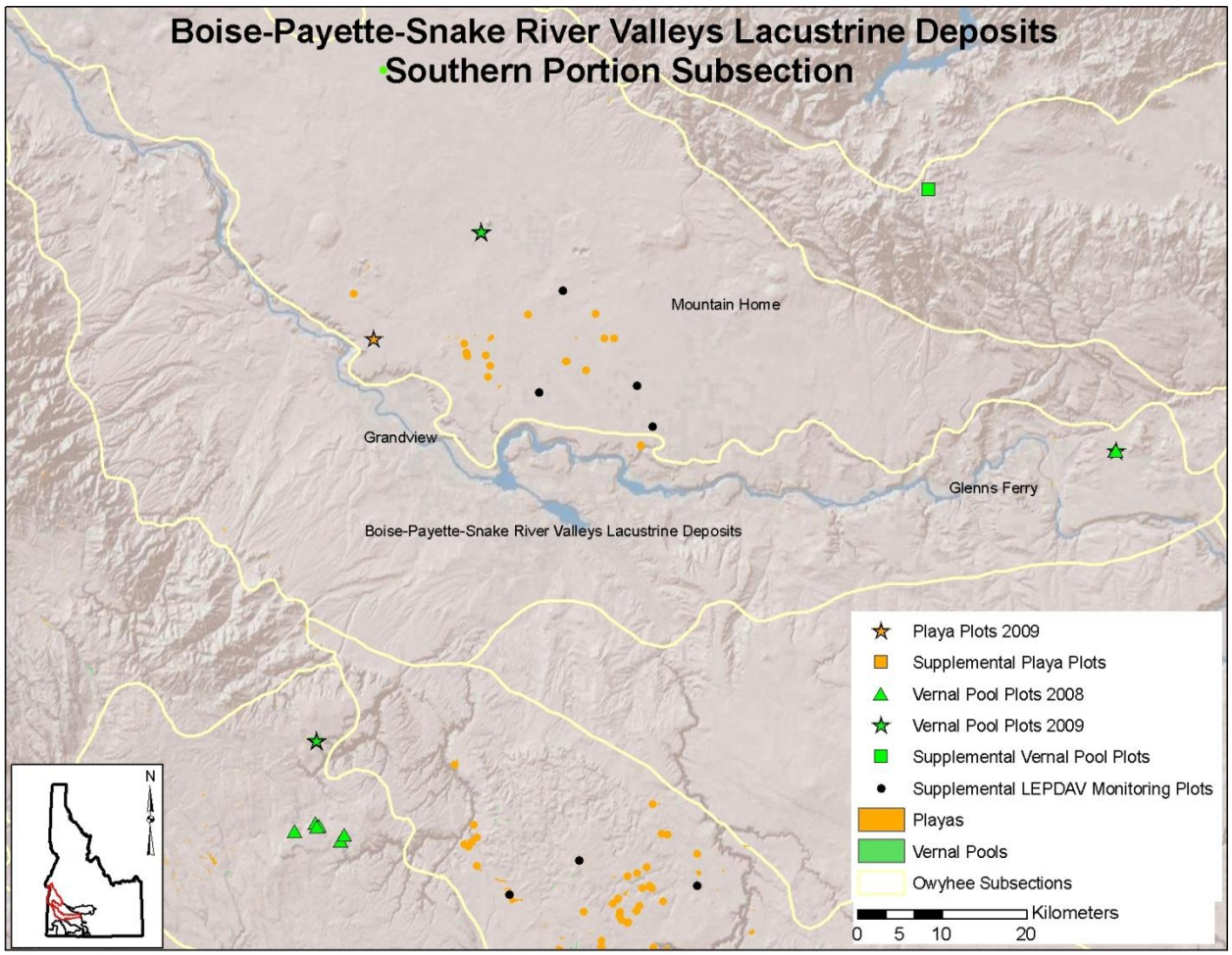

Snake River Plains (Southern Portion) Subsection
Snake River Plains
Buhl
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Verna Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20
N

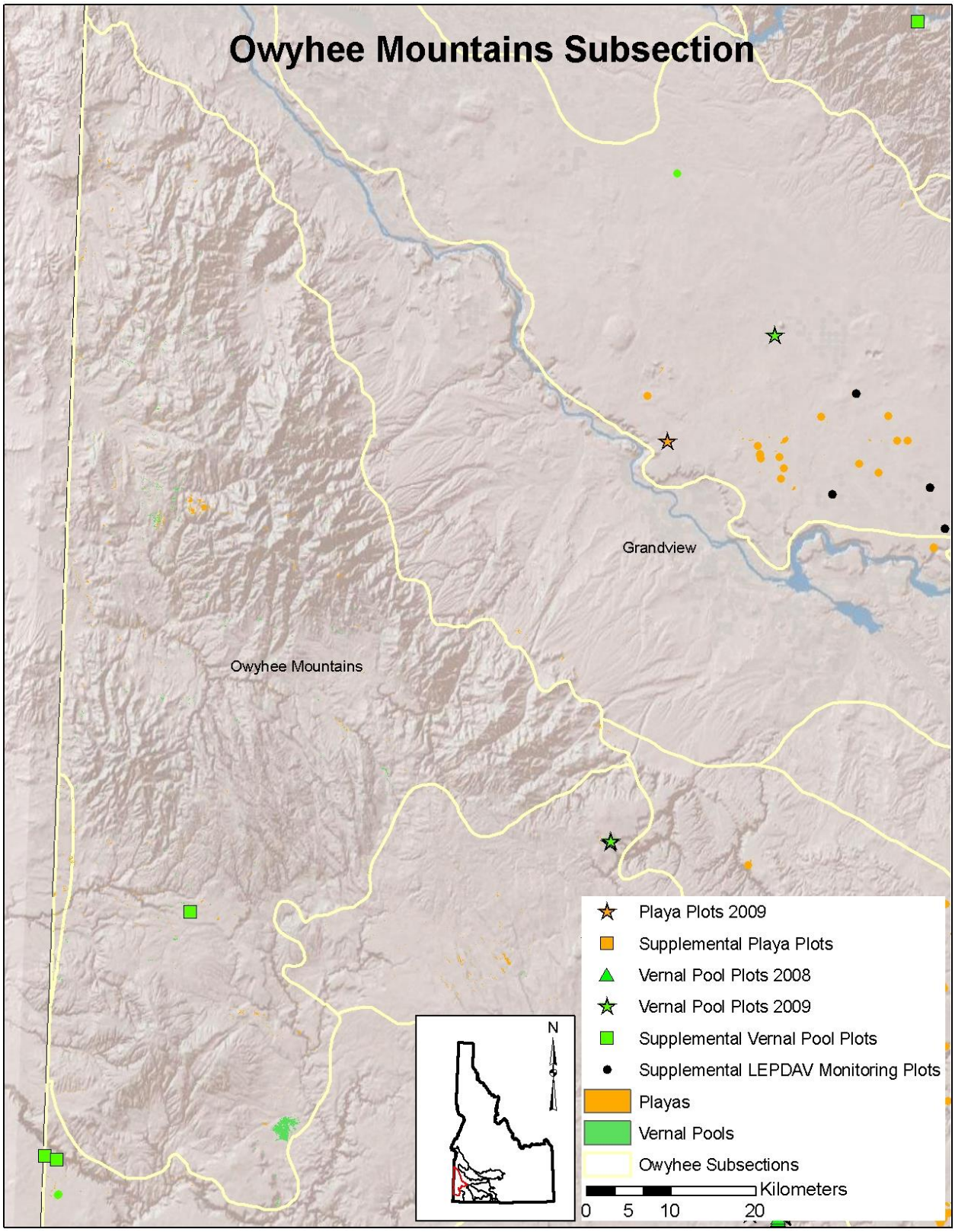

Bennett Hills-Owyhee Plateau (Northern Portion) Subsection
Fairfield
Bennett Hills-Owyhee Plateau
Mountain Home
Bliss
N
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20


Owyhee River Canyonlands and Bennett Hills-Owyhee Plateau
(Southern Portion) Subsections
Bruneau
Bennett HIlls-Owyhee Plateau
Owyhee River Canyonlands
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20
N


Bruneau Desert Subsection
Buhl
Bruneau Desert
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
N
Kilometers
0 5 10 20

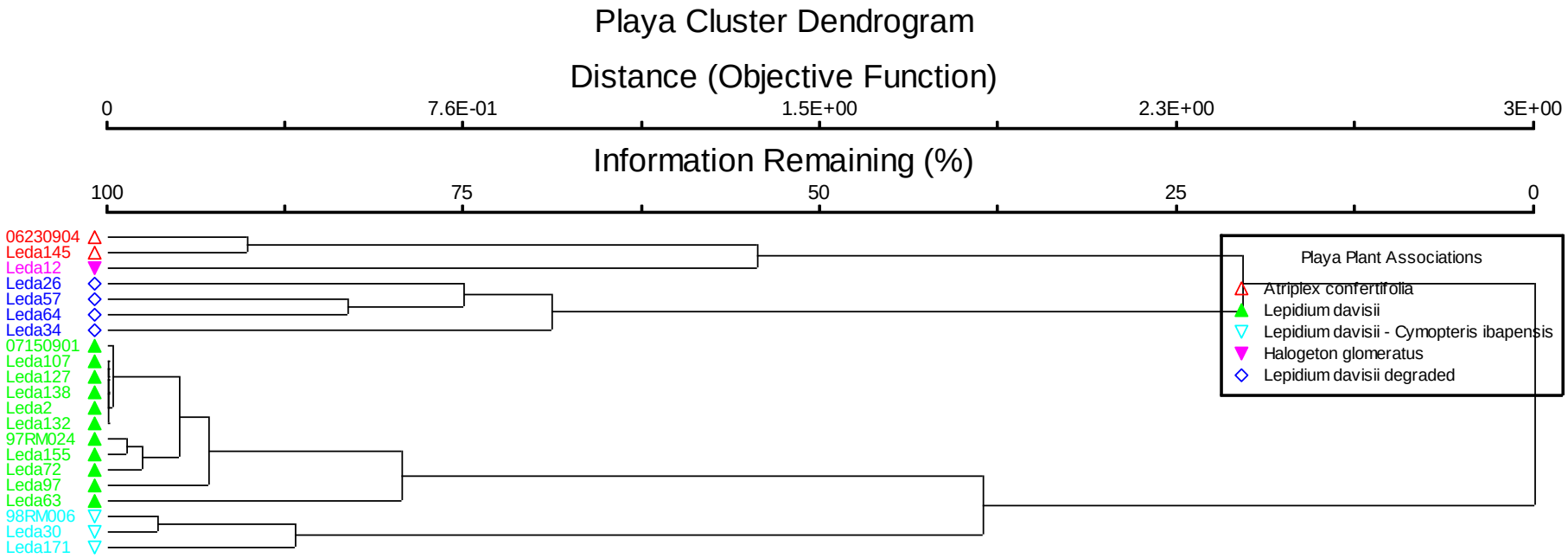

Boise-Payette-Snake River Valleys Lacustrine Deposits
(Northern Portion) Subsection
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20
Boise-Payette-Snake River Valleys Lacustrine Deposits
Boise
N

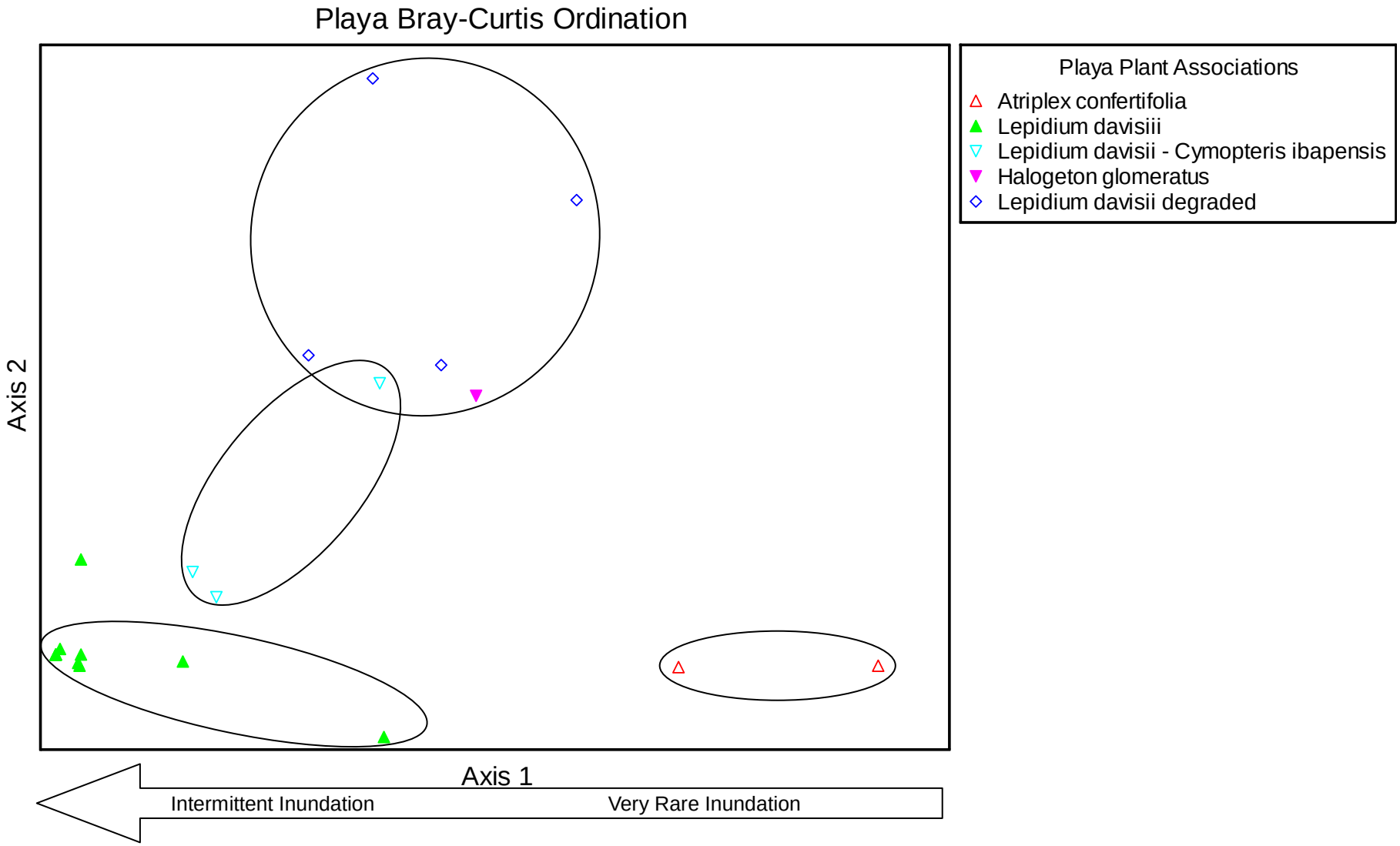

Boise-Payette-Snake River Valleys Lacustrine Deposits
Southern Portion Subsection
Mountain Home
Grandview
Glenns Ferry
Boise-Payette-Snake River Valleys Lacustrine Deposits
N
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20

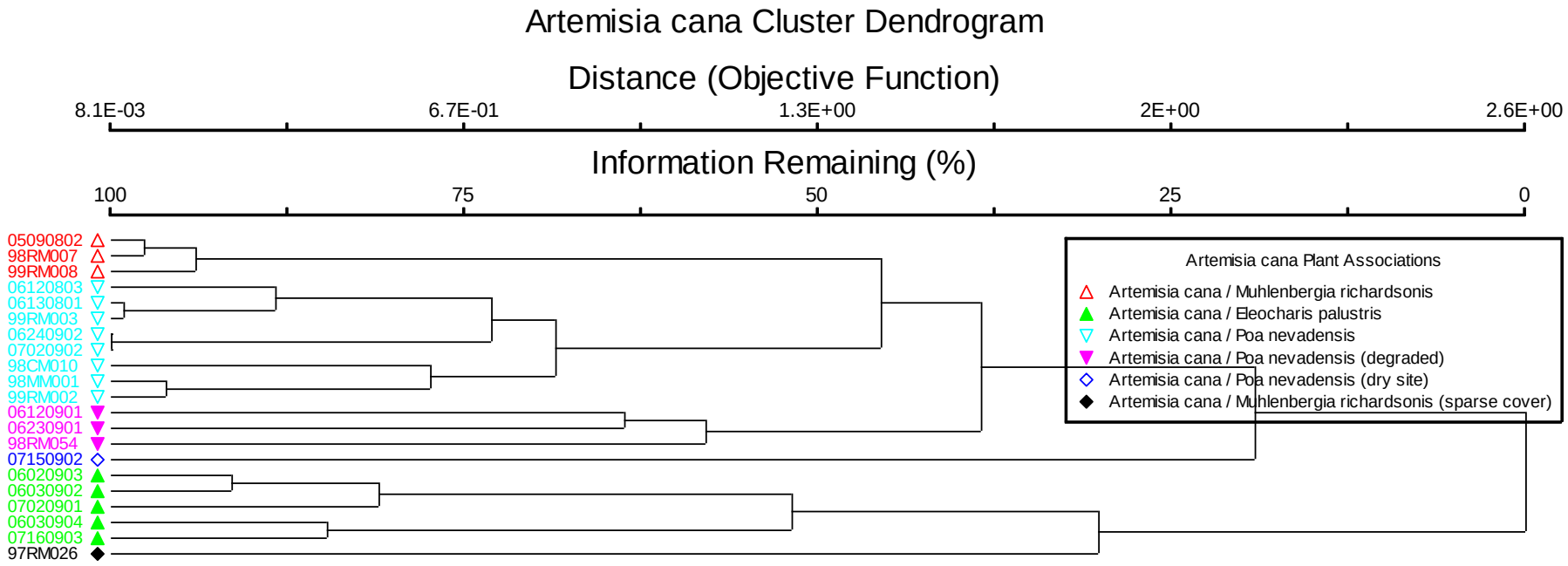

Owyhee Mountains Subsection
Grandview
Owyhee Mountains
N
Playa Plots 2009
Supplemental Playa Plots
Vernal Pool Plots 2008
Vernal Pool Plots 2009
Supplemental Vernal Pool Plots
Supplemental LEPDAV Monitoring Plots
Playas
Vernal Pools
Owyhee Subsections
Kilometers
0 5 10 20

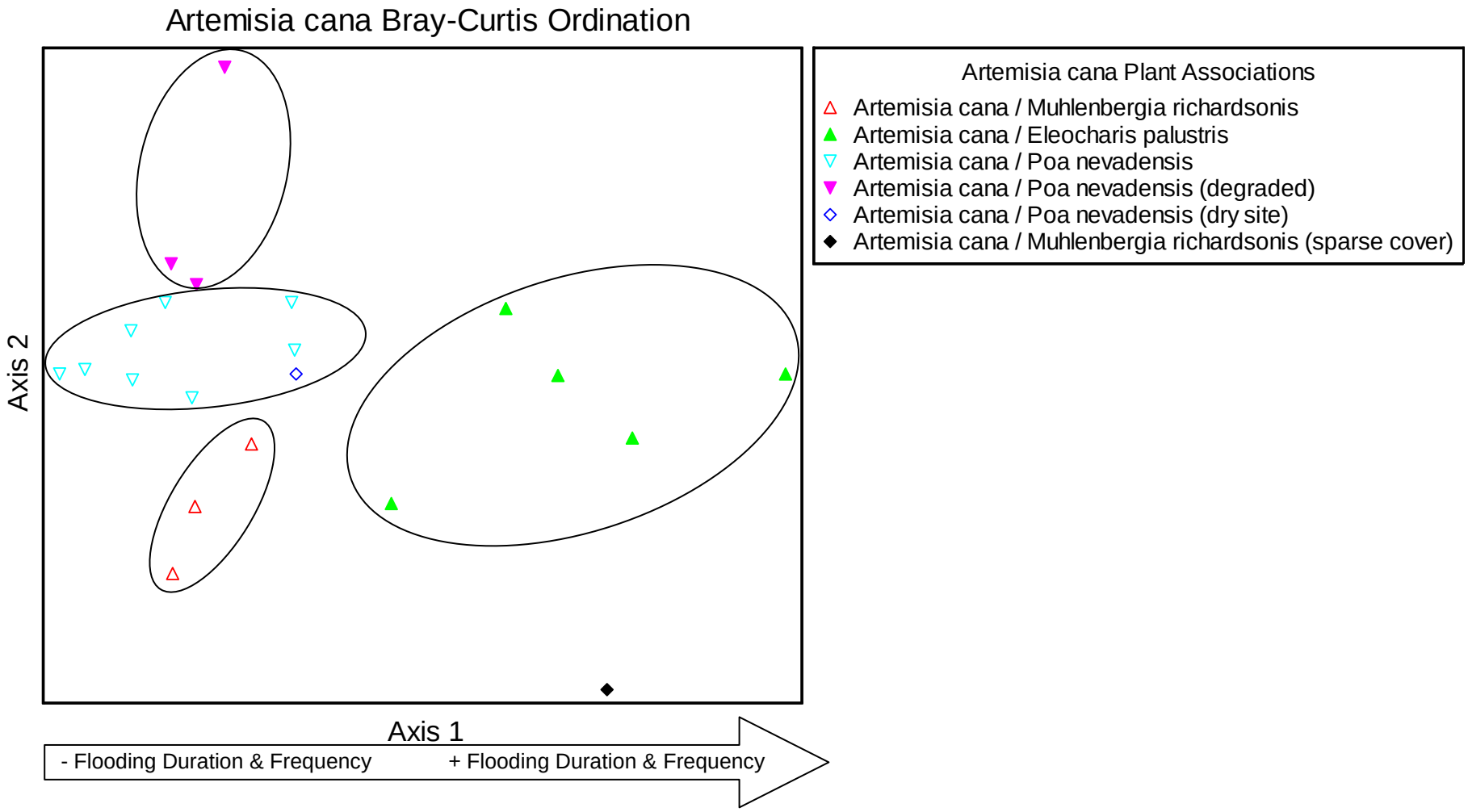
APPENDIX 2

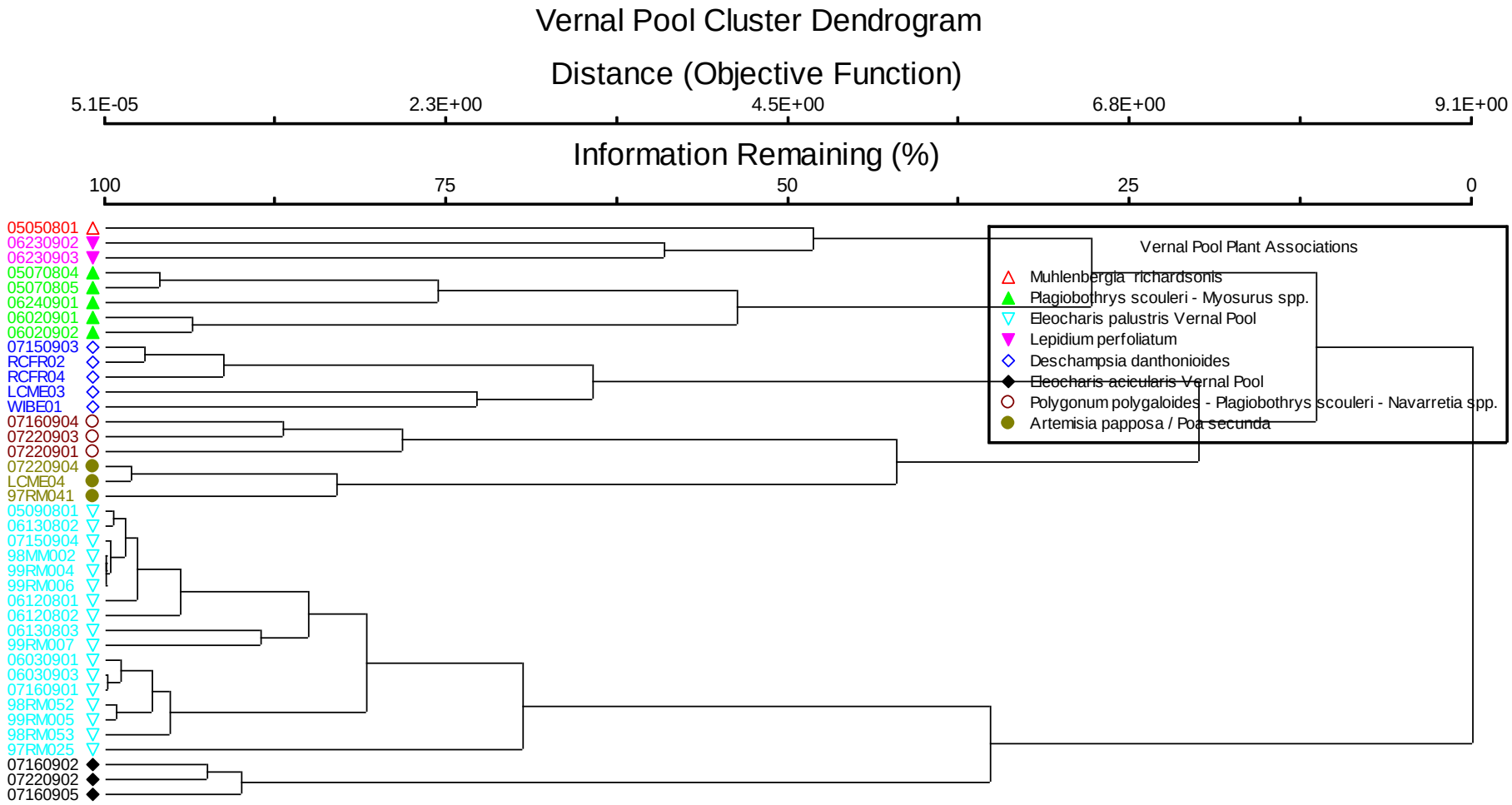
Cluster dendrograms and ordination results


Playa Cluster Dendrogram
Distance (Objective Function)
0
7.6E-01
1.5E+00
2.3E+00
3E+00
Information Remaining (%)
100
75
50
25
0
06230904
Leda145
Leda12
Leda26
Leda57
Leda64
Leda34
07150901
Leda107
Leda127
Leda138
Leda2
Leda132
97RM024
Leda155
Leda72
Leda97
Leda63
98RM006
Leda30
Leda171
Playa Plant Associations
Atriplex confertifolia
Lepidium davisii
Lepidium davisii - Cymopteris ibapensis
Halogeton glomeratus
Lepidium davisii degraded

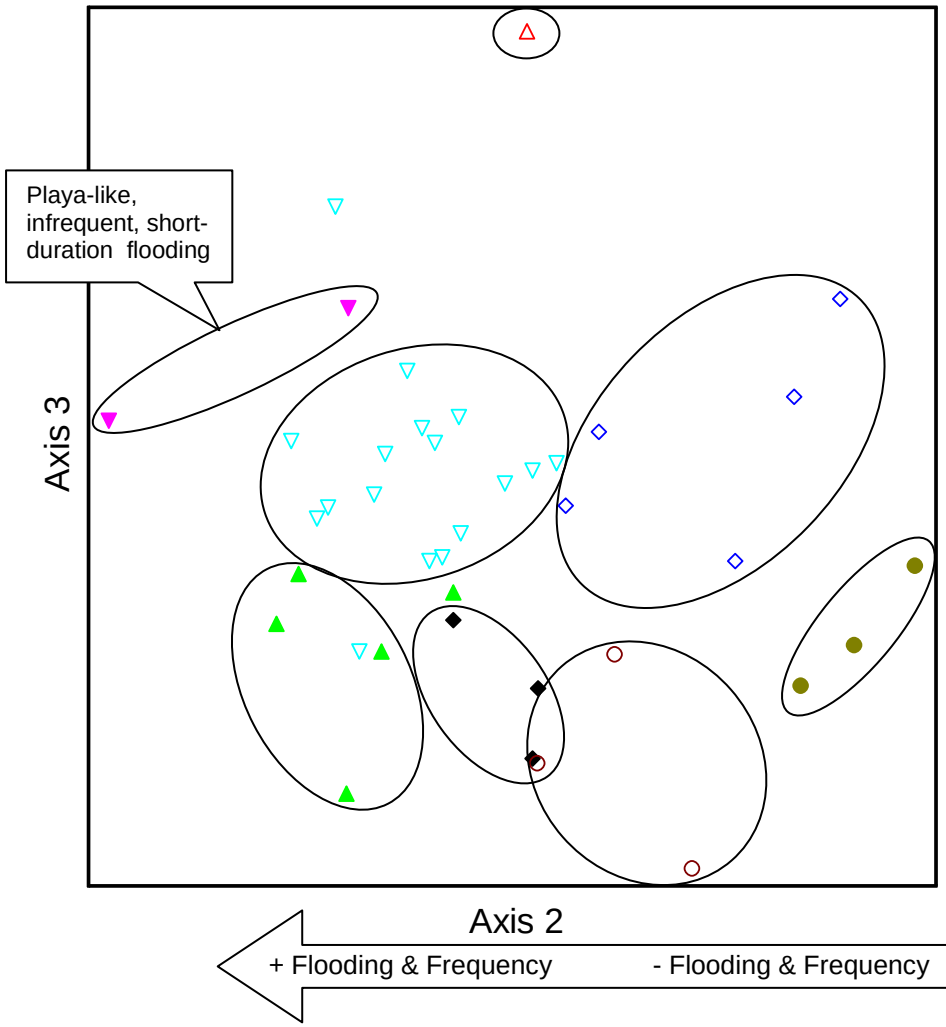

Playa Bray-Curtis Ordination
Playa Plant Associations
Atriplex confertifolia
Lepidium davisiii
Lepidium davisii - Cymopteris ibapensis
Halogeton glomeratus
Lepidium davisii degraded
Axis 2
Axis 1
Intermittent Inundation
Very Rare Inundation


Artemisia cana Cluster Dendrogram
Distance (Objective Function)
8.1E-03
6.7E-01
1.3E+00
2E+00
2.6E+00
Information Remaining (%)
100
75
50
25
0
05090802
98RM007
99RM008
06120803
06130801
99RM003
06240902
07020902
98CM010
98MM001
99RM002
06120901
06230901
98RM054
07150902
06020903
06030902
07020901
06030904
07160903
97RM026
Artemisia cana Plant Associations
Artemisia cana / Muhlenbergia richardsonis
Artemisia cana / Eleocharis palustris
Artemisia cana / Poa nevadensis
Artemisia cana / Poa nevadensis (degraded)
Artemisia cana / Poa nevadensis (dry site)
Artemisia cana / Muhlenbergia richardsonis (sparse cover)


Artemisia cana Bray-Curtis Ordination
Artemisia cana Plant Associations
Artemisia cana / Muhlenbergia richardsonis
Artemisia cana / Eleocharis palustris
Artemisia cana / Poa nevadensis
Artemisia cana / Poa nevadensis (degraded)
Artemisia cana / Poa nevadensis (dry site)
Artemisia cana / Muhlenbergia richardsonis (sparse cover)
Axis 2
Axis 1
- Flooding Duration & Frequency
+ Flooding Duration & Frequency


Vernal Pool Cluster Dendrogram
Distance (Objective Function)
5.1E-05
2.3E+00
4.5E+00
6.8E+00
9.1E+00
Information Remaining (%)
100
75
50
25
0
05050801
06230902
06230903
05070804
05070805
06240901
06020901
06020902
07150903
RCFR02
RCFR04
LCME03
WIBE01
07160904
07220903
07220901
07220904
LCME04
97RM041
05090801
06130802
07150904
98MM002
99RM004
99RM006
06120801
06120802
06130803
99RM007
06030901
06030903
07160901
98RM052
99RM005
98RM053
97RM025
07160902
07220902
07160905
Vernal Pool Plant Associations
Muhlenbergia richardsonis
Plagiobothrys scouleri - Myosurus spp.
Eleocharis palustris Vernal Pool
Lepidium perfoliatum
Deschampsia danthonioides
Eleocharis acicularis Vernal Pool
Polygonum polygaloides - Plagiobothrys scouleri - Navarretia spp.
Artemisia papposa / Poa secunda

Vernal Pool NMS Ordination



Vernal Pool Plant Associations

- Muhlenbergia richardsonis
- Plagiobothrys scouleri - Myosurus spp.
- Eleocharis palustris Vernal Pool
- Lepidium perfoliatum
- Deschampsia danthonioides
- Eleocharis acicularis Vernal Pool
- Polygonum polygaloides - Plagiobothrys scouleri - Navarretia spp.
- Artemisia papposa / Poa secunda

APPENDIX 3

Key to vernal pool and playa plant associations and descriptions of plant associations

Instructions for identifying vernal pool and playa plant associations

Walk through the vernal pool or playa site of interest. Note the distribution of lifeform groups present (e.g., shrubland or dwarf shrubland; aquatic, graminoid, or forb herbaceous). Within each lifeform group, identify distinct stands of vegetation that appear relatively homogenous or that are dominated by one or a few species (each visible shrub or herbaceous layer present may have one or two dominant species). Each shrub or herbaceous stand should ideally be a minimum of about 15 m long and 5 to 8 m wide, however smaller stands do occur. Also locate areas of differing hydrology and soils. This may aid in identifying stands. Vernal pools often have a mosaic and/or rings of distinctive stands of vegetation separated by boundaries, or ecotones, that range from sharp to transitional (or "fuzzy").

After identifying stands, place a 50 m^2 (10 x 5 m) rectangular plot in the middle of shrubland or herbaceous vegetation stands that you want to sample. Some herbaceous stands forming rings on outer pool margins can be less than 5 m wide. In that case, place 20 x 2.5 m plot. Avoid placing plots across transitional ecotones or stand boundaries. Sampling highly disturbed stands is possible but can result in heterogeneous vegetation that may be difficult to classify to plant association. On the data form provided, estimate canopy cover of every vascular plant species in the plot that has at least 1% cover. Record the physical environmental setting, geology, soil, ground cover, and apparent hydrology at the plot. Based on plant species canopy cover recorded in the plot, use the key to identify the plant association. Confirm the plant association identified with the key by comparing the environmental and vegetation data from the sampled plot to the written description and tables for that association.

Key to Lifeform Groups

1a. Shrub canopy cover typically $\geq$ 10%; shrubs clearly dominant, not restricted to stand margins; cover of any individual herbaceous species approximately $\leq$ than shrubs; if shrub cover < 10% then total herbaceous cover also sparse and $\leq$ approximately 10%..... 2
1b. Shrub canopy cover < 10% 3

2a. Medium-height shrubs (typically $\geq$ 0.4 m tall, including silver sagebrush [*Artemisia cana*]) dominate stand with canopy cover > than dwarf shrubs ..... **Shrubland Vegetation Key**
2b. Dwarf shrubs (typically < 0.4 m tall, including shadscale [*Atriplex confertifolia*] and Owyhee Sagebrush [*Artemisia papposa*]) dominate stand with canopy cover > than medium-height shrubs ..... **Dwarf Shrubland Vegetation Key**

3a. Graminoid cover $\geq$ forb (including ferns [e.g., *Marsilea vestita*]) cover and/or graminoids and forbs co-dominant and average graminoid height > average forb height .... **Graminoid Herbaceous Vegetation Key**
3b. Forb (including ferns [e.g., *Marsilea vestita*]) cover > graminoid cover and/or forbs and graminoids co-dominant and average forb height > average forb height .... **Forb Herbaceous Vegetation Key**

Key to Shrubland Associations

1a. Silver Sagebrush (typically Bolander's, *Artemisia cana* ssp. *bolanderi*) cover typically ≥ 10%; if Silver Sagebrush cover < 10% then herbaceous cover also minimal (≤ approximately 10%); Mat Muhly (*Muhlenbergia richardsonis*) always present with ≥ 5% cover and the dominant herbaceous species; annual herbaceous species typical of vernal pools often present but seldom abundant; sites are closed depressions, usually vernal pools / lakes; Silver Sagebrush can dominate depression or form stands on margins of vernal pools dominated by herbaceous species.....
Bolander's Silver Sagebrush / Mat Muhly (*Artemisia cana* ssp. *bolanderi* / *Muhlenbergia richardsonis*)

1b. Not as above..... 2

2a. Silver Sagebrush (typically Bolander's, *Artemisia cana* ssp. *bolanderi*) cover ≥ 10% (typically much higher); Common Spikerush (*Eleocharis palustris*) always present with 5 - 20% cover and at least a co-dominant herbaceous species; Common Spikerush cover never > than Silver Sagebrush; Nevada Bluegrass (*Poa nevadensis* [syn. *Poa secunda* '*nevadensis*']) rarely co-dominant; Annual Hairgrass (*Deschampsia danthonioides*) and Milkwort knotweed (*Polygonum polygaloides*) typically present and locally abundant; other annual herbaceous species typical of vernal pools sometimes abundant; sites are closed depression vernal pools / lakes; Silver Sagebrush can dominate depression or form stands on margins of vernal pools dominated by herbaceous species .....
Bolander's Silver Sagebrush / Common Spikerush (*Artemisia cana* ssp. *bolanderi* / *Eleocharis palustris*)

2b. Not as above..... 3

3a. Silver Sagebrush (typically Bolander's, *Artemisia cana* ssp. *bolanderi*) cover ≥ 10% (typically much higher); Nevada Bluegrass (*Poa nevadensis* [syn. *Poa secunda* '*nevadensis*']) nearly always present with cover ≥ 1% (typically ≥ 3%) and often a co-dominant herbaceous species (although it may be absent in degraded stands); Squirreltail (*Elymus elymoides*) can co-dominate drier sites; Common Spikerush (*Eleocharis palustris*) can co-dominate wetter sites; Mat Muhly (*Muhlenbergia richardsonis*) uncommon, always with < 5% cover; sites are often, but not always closed depressions, with stands occurring on bottoms of ephemerally moist depressions, on margins of vernal pools / lakes, on inter-mound flats in "mound-and-swale" topography, and in low-gradient intermittent streambeds .....
Bolander's Silver Sagebrush / Nevada Bluegrass (*Artemisia cana* ssp. *bolanderi* / *Poa nevadensis*)

3b. Not as above.....
anomalous stand, vernal pool / playa association not known from southwest Idaho, undescribed association, or other association known from southwest Idaho but not sampled in this study:

Silver Sagebrush / Idaho Fescue (*Artemisia cana* / *Festuca idahoensis*)
(Jankovsky-Jones et al. 2001)

Scabland Sagebrush (*Artemisia rigida*) associations (Franklin and Dyrness 1988,

Johnson and Simon 1987)
Big Sagebrush (*Artemisia tridentata*) associations (Jankovsky-Jones et al. 2001)
Greasewood (*Sarcobatus vermiculatus*) associations (Franklin and Dyrness 1988, Crawford 2003)

Key to Dwarf Shrubland Associations

1a. Owyhee Sagebrush (*Artemisia papposa*) cover typically ≥ 10%; Sandberg Bluegrass (*Poa secunda*) always present, typically with cover > 10%, and at least a co-dominant herbaceous species; Milkwort (*Polygonum polygaloides*) and Wasatch Desertparsley (*Lomatium bicolor* var. *leptocarpum*) typically present and locally common; sites are ephemerally moist, occurring on margins of vernal pools, on inter-mound flats in "mound-and-swale" topography, and in low-gradient intermittent streambeds .... **Owyhee Sagebrush / Sandberg Bluegrass (*Artemisia papposa* / *Poa secunda*)**
1b. Not as above 2

2a. Shadscale (*Atriplex confertifolia*) cover ≥ 3% and dominant species; Shadscale cover > than any other species; sites are playa margins and areas of mounded soil within playas .... **Shadscale (*Atriplex confertifolia*) Playa**
2b. Not as above .....
anomalous stand, vernal pool / playa association not known from southwest Idaho, undescribed association, or other association known from southwest Idaho but not sampled in this study:

Little Sagebrush (*Artemisia arbuscula* ssp. *arbuscula*) associations (Hironaka et al. 1983, Jankovsky-Jones et al. 2001, Taylor 2004)
Alkali Sagebrush / Sandberg Bluegrass (*Artemisia arbuscula* ssp. *longiloba* / *Poa secunda*) (Hironaka et al. 1983, Jankovsky-Jones et al. 2001)

Key to Graminoid Herbaceous Vegetation Associations

1a. Mat Muhly (*Muhlenbergia richardsonis*) cover ≥ 10% cover (typically higher) and a co-dominant species; annual herbaceous species typical of vernal pools seldom common; sites are ephemerally moist (but infrequently inundated) closed depressions and ephemeral / intermittent drainages with relatively well-drained, coarse-textured soil (compared to other vernal pools) ..... **Mat Muhly (*Muhlenbergia richardsonis*)**
1b. Not as above 2

2a. Annual Hairgrass (*Deschampsia danthonioides*) cover typically ≥ 10% (occasionally less in degraded stands) and usually a co-dominant species; Small Camas (*Camassia quamash*), Bluegrass (*Poa* spp.), Spikerush spp. (*Eleocharis* spp.), and/or Onespike Danthonia (*Danthonia unispicata*) can be co-dominant; annual forb species typical of ephemeral drainages and vernal pools (e.g., Needleleaf Navarretia [*Navarretia intertexta*]) often present

and locally abundant; sites are vernal pool / lake margins (or less commonly bottoms), ephemeral / intermittent drainages, and drawdown zones of seasonally flooded livestock reservoirs ..... **Annual Hairgrass (*Deschampsia danthonioides*)**

2b. Not as above.....3

3a. Needle Spikerush (*Eleocharis acicularis*) cover typically ≥ 20% and always > than cover of Common Spikerush (*Eleocharis palustris*); Common Spikerush cover usually < 10%; annual forb species typical of vernal pools (e.g., Smooth Spike-primrose [*Epilobium pygmaeum*], Sleeping Popcornflower [*Plagiobothrys scouleri*], Short Woollyheads [*Psilocarphus brevissimus*], Fleshy Porterella [*Porterella carnosula*], Least Navarretia [*Navarretia leucocephala*]) typically abundant; sites are bottoms of moderately long-inundated vernal pools and temporarily flooded livestock reservoirs .... **Needle Spikerush (*Eleocharis acicularis*) Vernal Pool**

3b. Not as above.....4

4a. Common Spikerush (*Eleocharis palustris*) cover typically ≥ 10% (typically much higher) and the dominant species; Common Spikerush cover always > than cover of Needle Spikerush (*Eleocharis acicularis*); Silver Sagebrush (*Artemisia cana*) occasionally present with up to 10% cover (or rarely higher), but cover always < than Common Spikerush; annual herbaceous species typical of vernal pools typically common; aquatic species (e.g., California damsonium [*Damasonium californicum*], Pondweed spp. [*Potamogeton* spp.]) occasionally abundant; sites are bottoms of long-inundated vernal pools / lakes and seasonally flooded livestock reservoirs..... **Common Spikerush (*Eleocharis palustris*) Vernal Pool**

4b. Not as above..... **anomalous stand, vernal pool / playa association not known from southwest Idaho, undescribed association, or other association known from southwest Idaho but not sampled in this study:**

Carolina foxtail (*Alopecurus carolinianus*) (Jankovsky-Jones et al. 2001)

Douglas' Sedge (*Carex douglasii*) (Jankovsky-Jones et al. 2001)

Onespike Danthonia - Sandberg Bluegrass (*Danthonia unispicata - Poa secunda*) (Johnson and Simon 1987)

Saltgrass (*Distichlis spicata*) (Franklin and Dyrness 1988, Crawford 2003, Taylor 2004)

Squirreltail (*Elymus elymoides*) (Jankovsky-Jones et al. 2001, Taylor 2004, Dlugolecki 2010)

Baltic Rush (*Juncus balticus*) (Taylor 2004, Dlugolecki 2010)

Basin Wildrye (*Leymus cinereus*) (Franklin and Dyrness 1988, Crowe et al. 1994, Crawford 2003)

Beardless Wildrye (*Leymus triticoides*) (Jankovsky-Jones et al. 2001, Taylor 2004, Dlugolecki 2010)

Western Wheatgrass (*Pascopyrum smithii*) (Jankovsky-Jones 1998)

Nevada Bluegrass (*Poa nevadensis* [syn. *Poa secunda* '*nevadensis*']) (Jankovsky-Jones et al. 2001, Dlugolecki 2010)

Key to Forb Herbaceous Vegetation Associations

1a. Stand dominated or co-dominated by non-native annual forb species (e.g., Clasping Pepperweed [*Lepidium perfoliatum*], Saltlover [*Halogeton glomeratus*]) and/or Knotweed species of disturbed habitats (e.g., Prostrate Knotweed [*Polygonum aviculare*], Bushy Knotweed [*P. ramosissimum*]); if present, Davis' Pepperweed (*Lepidium davisii*) cover < 1%; annual herbaceous species typical of vernal pools are rare..... 6

1b. Not as above..... 2

2a. Davis' Pepperweed (*Lepidium davisii*) cover typically ≥ 1% and co-dominant; Ibapah Springparsley (*Cymopterus ibapensis*) always present and co-dominant with cover ≥ 1%; all other species have cover ≤ 1%; sites are sparsely vegetated playas ..... **Davis' Pepperweed - Ibapah Springparsley (*Lepidium davisii* - *Cymopterus ibapensis*)**

2b. Not as above..... 3

3a. Davis' Pepperweed (*Lepidium davisii*) cover typically ≥ 1% and usually the dominant species; if cover < 1%, then no other species has cover > Davis' Pepperweed; all other species have cover < 2%; sites are sparsely vegetated playas (unless degraded, see couplet 8) ..... **Davis' Pepperweed (*Lepidium davisii*)**

3b. Not as above..... 4

4a. Milkwort Knotweed (typically Fruitleaf, *Polygonum polygaloides* ssp. *confertiflorum*) cover ≥ 3% (usually ≥ 10%) and a co-dominant species; Sleeping Popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) and Navarretia spp. (Near Navarretia [*Navarretia intertexta* ssp. *propinqua*] and/or Least Navarretia [*Navarretia leucocephala* ssp. *minima*]) always present and often co-dominant, individual cover of these always ≤ Milkwort Knotweed; other annual herbaceous species typical of vernal pools are uncommon; sites are bottoms of short-inundation, small-area vernal pools and temporarily flooded livestock reservoirs ..... **Milkwort Knotweed - Sleeping Popcornflower - Navarretia spp. (*Polygonum polygaloides* - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp.)**

4b. Not as above.....5

5a. Sleeping Popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) cover ≥ 3% (often higher) and a co-dominant species; Mousetail spp. (e.g., Bristly Mousetail [*Myosurus apetalus*] and/or Tiny Mousetail [*Myosurus minimus*]) always present and often co-dominant; Near Navarretia (*Navarretia intertexta* ssp. *propinqua*), finebranched popcornflower (*Plagiobothrys leptocladus*), or Fleshy Porterella (*Porterella carnosula*) are sometimes also co-dominant; Milkwort Knotweed (*Polygonum polygaloides*) cover always ≤ 1%; sites are bottoms of moderately-long inundated vernal pools / lakes and seasonally flooded livestock reservoirs ..... **Sleeping Popcornflower - Mousetail spp. (*Plagiobothrys scouleri* var. *hispidulus* - *Myosurus* spp.)**

5b. Not as above.....6

6a. Clasping Pepperweed (*Lepidium perfoliatum*) and/or Bushy Knotweed (*Polygonum ramosissimum*) dominate stand with combined cover ≥ 5%; no other species has cover ≥ 5%; annual herbaceous species typical of vernal pools are uncommon; sites include short-inundation vernal pools, playas, and ephemerally moist closed depressions..... .....**Clasping Pepperweed (*Lepidium perfoliatum*)**

6b. Not as above..... 7

7a. Saltlover (*Halogeton glomeratus*) cover ≥ 5%; no other species has cover ≥ 5%; Davis' Pepperweed (*Lepidium davisii*) cover ≤ 1% or absent; sites are playas, alkaline flats, and ephemerally moist closed depressions.....**Saltlover (*Halogeton glomeratus*)**

7b. Not as above.....

8a. Davis' Pepperweed (*Lepidium davisii*) present with cover typically ≤ 1%; Saltlover (*Halogeton glomeratus*), Russian Thistle (*Salsola tragus*), Burningbush (*Bassia scoparia*), Clasping Pepperweed (*Lepidium perfoliatum*), Prostrate Knotweed (*Polygonum aviculare*), Crested Wheatgrass (*Agropyron cristatum*), and/or Forage Kochia (*Bassia prostrata*) alone, or in combination, dominate the site with Davis' Pepperweed; sites are playas .... **Degraded Stands of Davis' Pepperweed (*Lepidium davisii*)**

8b. Not as above.....

anomalous stand, vernal pool / playa association not known from southwest Idaho, undescribed association, or other association known from southwest Idaho but not sampled in this study:

Forage Kochia (*Bassia prostrata*) (Tuason 2005)
Tansyleaf Evening-primrose (*Camissonia tanacetifolia*) (Taylor 2004)
Povertyweed (Iva axillaris) (Dlugolecki 2010)
Gray's Biscuitroot (*Lomatium grayi*) (Crowe et al. 1994, Crawford 2003)
Prostrate Knotweed (*Polygonum aviculare*) (Brown 1999)

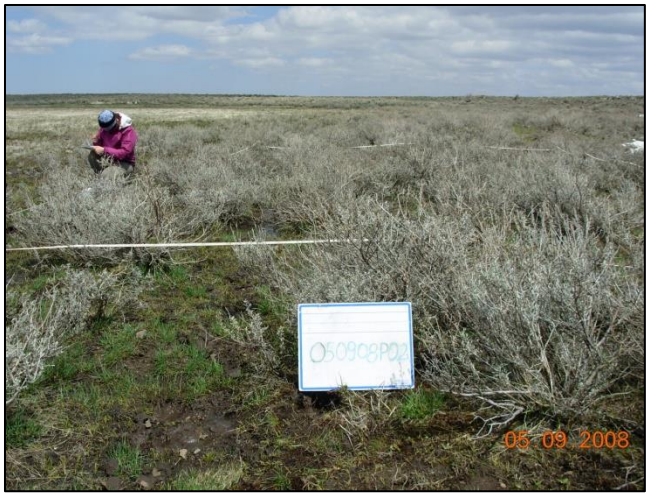
Descriptions of Plant Associations

Shrubland Associations

Bolander's Silver Sagebrush / Mat Muhly
Artemisia cana* ssp. *bolanderi* / *Muhlenbergia richardsonis
n = 4 NVC Code: CEGL001743

Range

In Idaho, this association primarily occurs on basaltic tablelands of the Owyhee Plateau and plains above the Owyhee River Canyonlands (Jankovsky-Jones et al. 2001). It has also been documented from the Snake River Plains northeast of Bliss (Hironaka et al. 1983). In Oregon, it is known from the south-central portion of the state, near the east base of the Cascades (Dealy 1971, Franklin and Dyrness 1988), as well as in the northern Great Basin portions of central (Dlugolecki 2010) and southeastern Oregon. Stands are also known from northwestern Nevada (Manning and Padgett 1995), northeastern California, and Wyoming (NatureServe 2011).



Vegetation

Bolander's silver sagebrush (*Artemisia cana* ssp. *bolanderi*) dominates the 0.4 to 0.5-m tall shrub layer, typically with cover ≥ 10%. Low stature mat muhly (*Muhlenbergia richardsonis*) is always present in the understory with ≥ 5% cover and is the dominant herbaceous species. Common spikerush (*Eleocharis palustris*) may be present, but never with cover greater than mat muhly. Annual herbaceous species typical of vernal pools, including milkwort knotweed (*Polygonum polygaloides*) are often present, but seldom abundant. Povertyweed (*Iva axillaris*) is commonly present in sparse amounts, possibly indicating past disturbance. Bare exposed soil often exceeds 50% of the ground surface.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs				
Artemisia cana	100	3.0	50.0	28.3
Graminoids				
Muhlenbergia richardsonis	100	5.0	30.0	15.0
Eleocharis palustris	50	1.0	1.0	1.0
Forbs				
Iva axillaris	75	0.1	1.0	0.7
Polygonum polygaloides	50	1.0	3.0	2.0

Successional and Disturbance Dynamics
Silver sagebrush can resprout after disturbances, such as after fire or prolonged flooding top-kills shrubs (Howard 2002). It can also root from stems that make contact with soil. Dealy (1971) suggests that area covered by this association can expand or contract as the average high water line of a vernal pool moves back and forth in response to climatic fluctuation. Silver sagebrush and early seral species, such as povertyweed (*Iva axillaris*), may increase in cover with continuous high levels of livestock grazing (Dlugolecki 2010).

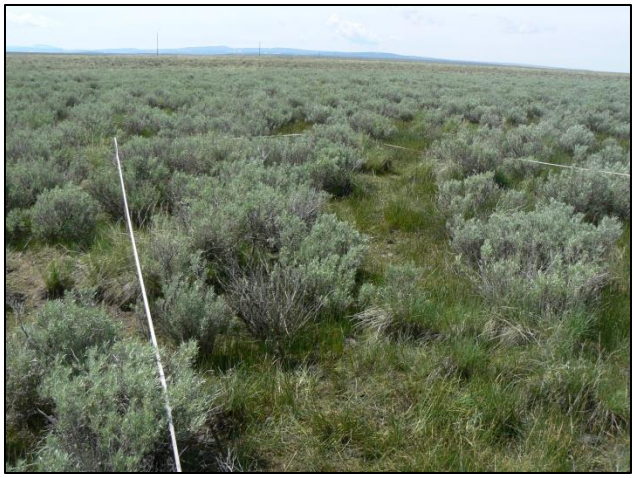
Hydrogeomorphic Environment
This association occurs in closed, internally drained depressions that accumulate fine-textured alluvium. Sites occur on volcanic plains or plateaus in the sagebrush-steppe and lower montane forest / woodland zones. These depressions are usually vernal pools / lakes that are shallowly flooded in the spring of most years, but where surface soils are thoroughly dry by mid-summer. This association can dominate the depression bottom or form stands on margins of vernal pools dominated by herbaceous species. Soils tend to be deep (> 50 cm), somewhat poorly drained silt loams or clay loams (Jankovsky-Jones et al. 2001). Soils are derived from loess, weathered basalt, and volcanic ash (Clausnitzer and Huddleston 2002, Dlugolecki 2010). Soils in silver sagebrush vernal pools have redoximorphic features indicative of hydric soil conditions (Clausnitzer and Huddleston 2002). Soils have relatively high water-holding capacity.

Restoration and Management
Mat muhly and povertyweed can increase with livestock grazing (Aleksoff 1999). Mat muhly tolerates moderate levels of disturbance, as evidenced by its persistence in areas frequented by cattle and vehicles. However, excessive grazing results in decreased mat muhly cover (Dlugolecki 2010).

Functions
Livestock and native ungulates compete for the minimal forbs that occur in stands of this association (Dealy 1971). Pronghorn (*Antilocapra americana*) frequently use silver sagebrush vernal pools / lakes for forage and cover (Good 1977, Howard 2002, Taylor 2004). Povertyweed is sometimes utilized by pronghorn (Good 1977). Songbirds, especially horned lark (*Eremophila alpestris*) and Brewer's sparrow (*Spizella breweri*), and 12 bat species utilized silver sagebrush habitats in central Oregon (Dlugolecki 2010).

Identification and Classification
This type was originally defined by two brief descriptions (Dealy 1971, Hironaka et al. 1983). There was no quantitative analysis of composition and structure data. Stand data was presented in Jankovsky-Jones et al. (2001). Hironaka et al. (1983) note that Baltic rush (*Juncus balticus*) was a sparse associate of mat muhly. Dealy (1971) states that "*M. richardsonis*, *Juncus* sp., and *Eleocharis* sp. form a fairly heavy stand" under a silver sagebrush canopy. Jankovsky-Jones et al. (2001) included several stands better classified as the Bolander's silver sagebrush / common spikerush association within its broad description of the Bolander's silver sagebrush / mat muhly association. Stands very similar to this association were described by Dlugolecki (2010) from Lakebed ecological sites in central Oregon.

Bolander's Silver Sagebrush / Common Spikerush
Artemisia cana* ssp. *bolanderi* / *Eleocharis palustris
n = 5 NVC Code: CEGL002987



Range

In Idaho, this association is known from locations on the basalt tablelands of the Owyhee Plateau (Jankovsky-Jones et al. 2001) and also at Macon Flat on the Camas Prairie at the base of the Bennett Hills. It has also been reported from several locations in central and eastern Oregon (Dlugolecki 2010) and is suspected to occur in northern Nevada (NatureServe 2011).

Vegetation

Bolander's silver sagebrush (*Artemisia cana* ssp. *bolanderi*) forms an open to dense shrub layer (typically 20 - 40% cover) averaging about 0.45 m in height. Common spikerush (*Eleocharis palustris*) is always present (with 5 - 20% cover) and usually dominates the 10 to 25 cm-tall graminoid layer. Annual hairgrass (*Deschampsia danthonioides*) is present and abundant with common spikerush in favorable years. Annual forb species typical of vernal pools are sometimes abundant, especially milkwort knotweed (*Polygonum polygaloides*), sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*), tiny mousetail (*Myosurus minimus*), and least navarretia (*Navarretia leucocephala* ssp. *minima*). Stands often have 10 - 50% of the soil surface covered with gravel and rocks. Much of the remaining ground surface is litter.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs				
Artemisia cana	100	20.0	40.0	26.0
Graminoids				
Eleocharis palustris	100	7.0	20.0	13.2
Deschampsia danthonioides	100	2.0	30.0	11.8
Forbs				
Polygonum polygaloides	100	10.0	30.0	17.0
Plagiobothrys scouleri var. *hispidulus*	80	0.1	8.0	3.0
Epilobium brachycarpum	80	0.1	3.0	0.8
Myosurus minimus	60	0.1	20.0	6.7
Navarretia leucocephala ssp. *minima*	60	2.0	30.0	12.3
Psilocarphus brevissimus var. *brevissimus*	60	0.1	3.0	2.0

Successional and Disturbance Dynamics

This association occurs in the wettest sites capable of supporting silver sagebrush. Bolander's silver sagebrush can tolerate over one month of shallow inundation (Howard 2002). Silver sagebrush, especially in wetter habitats, is susceptible to sometimes-lethal fungal infections (Dlugolecki 2010). Stands of this association may form when silver sagebrush expands into a common spikerush stand during drought periods when pools flood for only short durations.

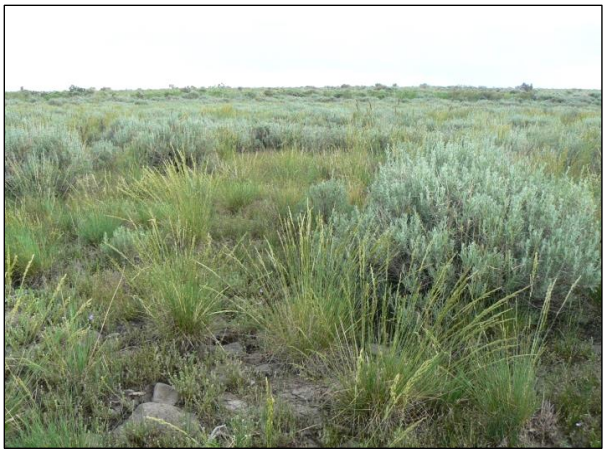
Hydrogeomorphic Environment
This association typically occurs on higher elevation basaltic tableland plateaus; less commonly in broad basin valleys. Sites are closed depression vernal pools / lakes. This association can dominate the depression bottom or form stands on margins of vernal pools dominated by herbaceous species. Stands are typically shallowly inundated from mid-winter through mid-April, on average (Clausnitzer and Huddleston 2002). The extent of the algal mat is an indicator of maximum inundation area. Sites have thick, clay-rich sandy or silty soils that crack upon drying (Dlugolecki 2010). Soil redoximorphic features are few to common (Clausnitzer and Huddleston 2002). Bolander's silver sagebrush can tolerate alkaline soils (Howard 2002).

Restoration and Management
Livestock trampling and OHV traffic on vernal pool sites with fine-textured soils leads to compaction, surface erosion, and increased bare soil (Hansen et al. 1995). The heterogeneous mix of understory herbaceous species (primarily native species in this association) can reflect invasion of bare soil disturbed by livestock grazing (Jankovsky-Jones et al. 2001). Excessive grazing results in decreased cover of common spikerush (Dlugolecki 2010).

Functions
Greater sage-grouse (*Centrocercus urophasianus*) adults and chicks require forbs late in the growing season, including those that grow in vernal pools after upland communities have desiccated (Dlugolecki 2010). Juveniles also depend on invertebrates (e.g., grasshoppers, ants, and beetles) that are supported by high quality forb communities found in vernal pools. A survey in eastern Oregon documented 62 aquatic macroinvertebrates in silver sagebrush vernal pools (Dlugolecki 2010). Sage-grouse also forage on silver sagebrush (Howard 2002). This association is habitat for the rare Bach's calicoflower (*Downingia bacigalupii*).

Identification and Classification
Similar in many ways to the silver sagebrush / mesic graminoid association described from meadows in Nevada by Manning and Padgett (1995), the understory of stands in vernal pools of eastern Oregon and southwest Idaho is more clearly dominated by either common spikerush or mat muhly (Jankovsky-Jones et al. 2001). Stands with high cover of mat muhly have been classified as silver sagebrush / mat muhly (Jankovsky-Jones et al. 2001). Stands with minimal mat muhly are classified as the silver sagebrush / common spikerush. Stands similar to this association were noted by Dlugolecki (2010) from Lakebed ecological sites in central Oregon.

Bolander's Silver Sagebrush / Nevada Bluegrass
Artemisia cana* ssp. *bolanderi* / *Poa nevadensis
n = 12 NVC Code: CEGL001548



Range
In Idaho, this association primarily occurs on basaltic tablelands of the Owyhee Plateau and plains above the Owyhee River Canyonlands (Jankovsky-Jones et al. 2001). It ranges to east-central Oregon (Taylor 2004,

Dlugolecki 2010, NatureServe 2011). Similar stands also likely occur in northern and central Nevada (Manning and Padgett 1995) and possibly on the Modoc Plateau of northeast California.

Vegetation

Silver sagebrush (typically Bolander's, *Artemisia cana* ssp. *bolanderi*) forms a 0.3 to 0.4 m-tall canopy typically with 20 - 40% cover. Nevada bluegrass (*Poa nevadensis* [syn. *Poa secunda* '*nevadensis*']) is nearly always present (typically with cover ≥ 3%) and often co-dominant in the 15 to 20 cm-tall graminoid layer. It may be absent in degraded stands. Squirreltail (*Elymus elymoides*) can co-dominate drier sites while common spikerush (*Eleocharis palustris*) can co-dominate wetter sites. Annual forbs, especially smooth spike-primrose (*Epilobium pygmaeum*), tall annual willowherb (*Epilobium brachycarpum*), milkwort knotweed (*Polygonum polygaloides*), and sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) are common. Stands degraded by livestock grazing often have noticeable cover of non-native annual species including cheatgrass (*Bromus tectorum*), prostrate knotweed (*Polygonum aviculare*), bur buttercup (*Ceratocephala testiculata*), and clasping pepperweed (*Lepidium perfoliatum*). Bare exposed soil often exceeds 50% of the ground surface in stands of any condition.

Species	Minimally Disturbed Stands				Degraded Stands			
	Constancy %	Min % Cover	Max % Cover	Mean % Cover	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs								
Artemisia cana	100	20.0	50.0	36.7	100	10.0	40.0	21.7
Graminoids								
Poa nevadensis	78	1.0	15.0	5.6	33	1.0	1.0	1.0
Eleocharis palustris	78	0.1	30.0	5.9				
Elymus elymoides	44	0.1	15.0	8.8	67	0.1	0.1	0.1
*Bromus tectorum**					67	0.1	3.0	1.6
Forbs								
Epilobium pygmaeum	67	0.1	1.0	0.4	33	30.0	30.0	30.0
Epilobium brachycarpum	56	1.0	10.0	3.4	67	0.1	0.1	0.1
Polygonum polygaloides	67	0.1	3.0	1.9	33	0.1	0.1	0.1
Plagiobothrys scouleri var. *hispidulus*	67	0.1	1.0	0.7				
Polygonum aviculare	33	0.1	1.0	0.4	67	0.1	1.0	0.6
Ceratocephala testiculata					67	1.0	8.0	4.5
Lepidium perfoliatum					67	0.1	5.0	2.6

*Species in yellow are non-native

Successional and Disturbance Dynamics

Excessive livestock grazing can shift undergrowth toward early seral species, and high silver sagebrush cover (Jankovsky-Jones et al. 2001, Dlugolecki 2010). Productive sites attract livestock; their grazing can reduce vigor and cover of palatable species such as Nevada bluegrass. Competitive, often non-native forbs typically invade disturbed stands (photo at right; Manning and Padgett 1995).

Hydrogeomorphic Environment

Species characterizing this association are tolerant of imperfect drainage, high water tables, and periodic flooding. Sites supporting this association are often, but not always closed depressions; stands occur on bottoms of ephemerally moist depressions, on margins of vernal pools / lakes, on inter-hummock flats in "mound-and-swale" topography, in broad meadows with perennial streams, or on low terraces along intermittent drainageways. Soils have thick mollic epipedons or other indicators of advanced soil development and include Haploxerolls, Cryoborolls, and Argixerolls. Soil particle sizes vary and include silty, clayey, clayey-skeletal, coarse-loamy, and loamy-skeletal textures (Manning and Padgett 1995). Redoximorphic concentrations (mottles) are sometimes common and indicate a fluctuating water table (Clausnitzer and Huddleston 2002). Soil pH ranges from slightly acidic to moderately alkaline (pH 6.0 to 8.0) (Jankovsky-Jones et al. 2001). Available water is moderate (Youngblood et al. 1985, Hansen et al. 1995).

Restoration and Management

Dominant species in this association have moderate to high soil stabilizing function. Native graminoid associates in this type are desirable forage for both livestock and wildlife, and management should favor these species. Excessive soil and hydrologic disturbance from livestock watering dugouts, livestock trampling, and vehicles may result in higher cover of silver sagebrush, xeric species, and non-native species (Dlugolecki 2010). Prescribed fire can promote silver sagebrush re-sprouting and result in denser stands over the long-term (Manning and Padgett 1995). Herbicides can effectively control silver sagebrush if they are applied when the shrub is phenologically active (Youngblood et al. 1985). Silver sagebrush is used in seed mixtures for big game range restoration, highway stabilization and beautification, and mine reclamation work. Profuseflower mesamint (*Pogogyne floribunda*), a globally rare plant occurring in this habitat, can be threatened by hydrologic alteration resulting from livestock water reservoirs (Meinke 2006). Trampling by livestock is a concern at some vernal pools, but many populations appear to tolerate moderate grazing.

Functions

Because of its productivity and proximity to wetter associations, this type is an important source of forage and cover for mammals, songbirds, and game birds. Due in part to the high protein content found in silver sagebrush, pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) may browse this association, especially in winter when snow covers lower growing vegetation (Good 1977, Howard 2002, Taylor 2004). Greater sage-

grouse (*Centrocercus urophasianus*) use silver sagebrush for food and nesting cover (Hansen et al. 1995, Dlugolecki 2010). This association supports the globally vulnerable rare plant profuseflower mesamint (*Pogogyne floribunda*), of which only 2 occurrences are known from Idaho. It is also habitat for Bach's calicoflower (*Downingia bacigalupii*), a rare plant in Idaho.

Identification and Classification

Prior to this study, stands classified as this association were included within the silver sagebrush / dry graminoids association in Nevada (Manning and Padgett 1995) and southwest Idaho (Jankovsky-Jones et al. 2001). The silver sagebrush / dry graminoids association differs by having a diverse mix of more xeric understory graminoids when compared to the association described here. The silver sagebrush / Nevada bluegrass association differs from the silver sagebrush / Idaho fescue association by supporting hydrophytic vegetation and its occurrence in more frequently inundated settings. Stands similar to the association described here were noted by Dlugolecki (2010) from Ponded Clay ecological sites in central Oregon.

Dwarf Shrubland Associations

Owyhee Sagebrush / Sandberg Bluegrass
Artemisia papposa* / *Poa secunda
n = 3
proposed

Range

This association has been documented from two disjunct locations in Idaho. One area is in the Bennett Hills at the northern edge of the Snake River Plains in Blaine, Camas, Gooding, Lincoln, and Elmore counties. The other area is on the Owyhee Plateau south of the Snake River Plains. Owyhee sagebrush (*Artemisia papposa*) also occurs in adjacent Humboldt and Elko Counties, Nevada, and Malheur County, Oregon.

Vegetation

Owyhee sagebrush (*Artemisia papposa*) forms an open dwarf shrub (10 - 15 cm tall) canopy with 10 - 30% cover. Low stature Sandberg bluegrass (*Poa secunda*) is always present and at least co-dominant in the herbaceous layer, typically with cover > 10%. Squirreltail (*Elymus elymoides*) and/or onespike danthonia (*Danthonia unispicata*) are sometimes co-dominant graminoids. Perennial forbs, primarily Wasatch desertparsley (*Lomatium bicolor* var. *leptocarpum*) and rush pussytoes (*Antennaria luzuloides*), are typically present and locally common. Milkwort (*Polygonum polygaloides*) is the most abundant annual forb species. Bare exposed soil typically exceeds 50% of the ground surface, often with high cover of gravel and rock also present.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs				
Artemisia papposa	100	10.0	30.0	20.0
Graminoids				
Poa secunda	100	3.0	25.0	14.3
Elymus elymoides	100	1.0	3.0	1.7
Danthonia unispicata	67	0.1	10.0	5.1
Forbs				
Polygonum polygaloides	100	0.1	10.0	4.8
Lomatium bicolor var. *leptocarpum*	100	2.0	10.0	4.7
Allium	100	0.1	1.0	0.7
Navarretia intertexta ssp. *propinqua*	100	0.1	1.0	0.7
Antennaria luzuloides	67	2.0	3.0	2.5

Successional and Disturbance Dynamics

Owyhee sagebrush appears to form climax communities on seasonally moist, clay-rich, shallow and stony basaltic soils (Meyer 2009). Owyhee sagebrush is not fire adapted and likely killed if burned. Due to lack of fuel, wildfires are infrequent in this association (Meyer 2009).

Hydrogeomorphic Environment

This association occurs on gently rolling volcanic plateaus, toeslopes, and low hills. One stand sampled occurred on the margin of a vernal pool that was rarely shallowly inundated. Other stands occur on low lying terraces of low-gradient, intermittently flooded drainages that carry water in the spring, or possibly during intense thunderstorms, but which are dry during summer. It can also occur in areas of patterned ground. Stands form on shallow soils in poorly drained flats or swales between deep-soil mounds where water perches over bedrock (Jankovsky-Jones et al. 2001). Soils are clayey or stony-clays derived from volcanic parent material, typically basalt. Some authors claim Owyhee sagebrush is tolerant of alkaline conditions (Meyer 2009).

Restoration and Management

Clayey soils disturbed by livestock grazing or other human-related activities may be prone to invasion by non-native species, especially bulbous bluegrass (*Poa bulbosa*) and Japanese brome (*Bromus japonicus*).

Functions

Feral horses browse Owyhee sagebrush in the spring and both deer and sheep readily consume the flower stalks in summer (Meyer 2009). This association provides minimal cover for larger mammals and birds due to its short stature (< 30 cm tall). It may, however, provide escape cover for smaller birds, mammals, reptiles. Because it is deciduous, Owyhee sagebrush provides little thermal cover during the winter (Meyer 2009).

Identification and Classification

Composition and structure of Owyhee sagebrush stands have only recently been sampled (Jankovsky-Jones et al. 2001). Stands classified as this association were included within the broader Owyhee sagebrush association described by Jankovsky-Jones et al. (2001). Similar

stands from slightly drier habitats in Oregon and Idaho have been classified as the Owyhee sagebrush / California Oatgrass - Idaho fescue (*Artemisia papposa* / *Danthonia californica* - *Festuca idahoensis*) association (NatureServe 2011).

Shadscale Playa
***Atriplex confertifolia* Playa**
n = 2
proposed

Range
Stands were sampled on the Snake River Plains south of Boise and on the plateau above the Little Owyhee River in the Owyhee River Canyonlands near where the borders of Idaho, Oregon, and Nevada intersect. Several stands likely classified as this association have been sampled in northeast, central, and east-central Nevada (Vegbank 2011). This association is expected to occur on margins of playas throughout the range of shadscale (*Atriplex confertifolia*).

Vegetation
In the two playa stands sampled, shadscale (*Atriplex confertifolia*) (+/- 0.4 m tall) dominated stands with cover averaging only 5%. Shadscale had patchy distribution. No other species had cover greater than shadscale. Only non-native annual species, such as cheatgrass (*Bromus tectorum*), saltlover (*Halogeton glomeratus*), and Russian thistle (*Salsola tragus*) were scattered in the understory. Total understory cover was < 10%. Bare ground comprised 50% of the ground surface, with either rock and gravel or litter being next most abundant.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs				
Atriplex confertifolia	100	2.6	8.0	5.3
Graminoids				
Bromus tectorum	50	1.0	1.0	1.0
Forbs				
Halogeton glomeratus	100	0.2	1.0	0.6
Salsola tragus	50	5.0	5.0	5.0
Lepidium davisii	50	0.6	0.6	0.6

Successional and Disturbance Dynamics
Shadscale does not tolerate prolonged flooding, excessive precipitation, or fire (Simonin 2001). Its presence on playas may indicate invasion during drought periods. Alternatively, it may inhabit playa habitats with highly infrequent and short-lived inundation. Sediment from wind and water erosion on degraded rangelands can deposit on playas. This creates micro-habitats for xeric species, such as shadscale, and non-native species to colonize (Taylor-Grant and DeBolt

1995, Tuason 2005). Once established on a playa, xeric species may further trap sediment and organic debris necessary to build soil, further reducing playa habitat and altering hydrology.

Hydrogeomorphic Environment
This association is known from playa margins and areas of mounded soil within playas. Inundation is likely rare and brief. Soils are silty, clayey, and sometimes rocky. Soils are likely alkaline and probably mapped as Playas-Duric Natrargids association (similar to Davis' peppergrass playas) (Jankovsky-Jones et al. 2001).

Restoration and Management
Shadscale is a facultative halophyte and often an indicator of soil salinity (Simonin 2001). Its dominance on a playa site may represent the potential for that playa based on current edaphic conditions formed under altered ecological processes (e.g., fire regimes, hydrology, and nutrient cycling) (Tuason 2005).

Functions
Shadscale provides important cover and food for songbirds and small to mid-sized mammals, especially black-tailed jackrabbits (*Lepus californicus*) (Simonin 2001).

Identification and Classification
This association has not been formally described by other researchers. It was noted by Tuason (2005) during monitoring of Davis' peppergrass playas. Shadscale is diagnostic in another playa association, greasewood / shadscale - (bud sagebrush, shrubby Seepweed) (*Sarcobatus vermiculatus / Atriplex confertifolia* - [*Picrothamnus desertorum, Suaeda moquinii*]), known from southeast Oregon, northern Nevada, and Utah (NatureServe 2011).

Graminoid Herbaceous Vegetation Associations

Mat Muhly
Muhlenbergia richardsonis
n = 1
proposed

Range
In Idaho, this association is known from a few locations in the Bruneau Desert (at least 3 ephemerally moist closed depressions in the Grasmere area) and Snake River Plains. It is also known from playas and alkaline closed depressions in Nevada (Weixelman et al. 1996). It may occur in south-central Oregon at Hart Mountain National Wildlife Refuge (NWR) (Good 1977).

Vegetation

Mat muhly (*Muhlenbergia richardsonis*) (< 10 cm tall) clearly dominated the stand sampled. It had 30% cover in the sampled stand and 15 - 20% cover in other observed stands. Squirreltail (*Elymus elymoides*) formed a poorly defined border around mat muhly on drier margins of the depression. Sandberg bluegrass (*Poa secunda*) and western wheatgrass (*Pascopyrum smithii*) have also been observed in this association. Tansyleaf evening primrose (*Camissonia tanacetifolia*) was the only vernal pool species present in the sampled stand. Other annual herbaceous species typical of vernal pools are seldom common in other stands. Weedy, non-native mustard species (e.g., tall tumblemustard [*Sisymbrium altissimum*], clasping pepperweed [*Lepidium perfoliatum*], hare's ear mustard [*Conringia orientalis*]), bur buttercup (*Ceratocephala testiculata*), and povertyweed (*Iva axillaris*) are commonly documented in degraded stands.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Muhlenbergia richardsonis	100	30.0	30.0	30.0
Elymus elymoides	100	0.1	0.1	0.1
Forbs				
Camissonia tanacetifolia	100	0.1	0.1	0.1
Conringia orientalis	100	0.1	0.1	0.1
Cusickiella douglasii	100	0.1	0.1	0.1

Successional and Disturbance Dynamics

Mat muhly increases (relative to other grasses) under moderate grazing (Aleksoff 1999). Non-native species, such as bur buttercup (*Ceratocephala testiculata*), can be common in highly disturbed stands. Mat muhly tolerates moderate levels of disturbance, as evidenced by its presence in ephemerally moist drainages traversed by cattle and OHVs. However, excessive grazing results in decreased mat muhly cover (Dlugolecki 2010).

Hydrogeomorphic Environment

Mat muhly dominates the lowest areas of the depressions and drainages where soils are ephemerally wet (or occasionally flooded) from snow melt and rainfall runoff. Sites are closed depressions or intermittent drainages that appear infrequently inundated. Soils are relatively well-drained and coarse-textured (compared to other vernal pools) and appear derived from volcanic ashes. Sites not saline, but may be slightly alkaline (pH 8.2) (Good 1977). The soil in the stand sampled was sandy clay that formed wide cracks when dry. Other observed stands occurred in rocky drainages on the surface of basaltic plateaus. Soils include thin, coarse-gravelly sand deposited in rock interspaces.

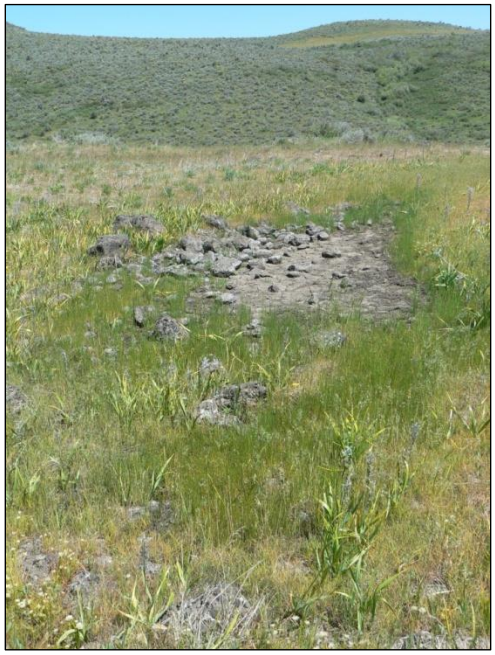
Restoration and Management

Weedy forbs typical of drier soils (including povertyweed [*Iva axillaris*], hare's ear mustard [*Conringia orientalis*], herb sophia [*Descurainia sophia*], clasping pepperweed [*Lepidium perfoliatum*], tall tumblemustard [*Sisymbrium altissimum*], and field pennycress [*Thlaspi arvense*]) invade bare soil of ephemerally moist mat muhly sites disturbed by excessive cattle grazing and trampling.

Functions
Mat muhly functions as a soil binder preventing erosion (Aleksoff 1999). It provides minimal, but fair to good quality forage for wildlife.

Identification and Classification
The mat muhly plant association is inadequately described due to lack of plot data. It has been noted from southwestern Idaho (Jankovsky-Jones et al. 2001), eastern Idaho (Jankovsky-Jones 1997, 1998), Oregon (Good 1977), and Nevada (Weixelman et al. 1996). In high elevation basins of east-central and southeast Idaho, mat muhly dominates shallow, sandy or silty alkaline soil of alluvial benches and meadows (Jankovsky-Jones 1997, 1999). Mat muhly is diagnostic of vernal pools sampled in northeastern California and adjacent northwest Nevada (Barbour et al. 2007). Its dominance of large areas, however, appears infrequent across its range.

Annual Hairgrass
Deschampsia danthonioides
n = 5
proposed



Range
In Idaho, this association is known from basaltic plateaus in the Weiser River Basin (Blue Mountains section), foothills of the Boise Mountains, Bennett Hills (e.g., Camas Prairie), Snake River Plains, and Owyhee Plateau (Murphy et al. 2011). Elsewhere, it has been described from similar vernal pool habitats in eastern Washington (Crowe et al. 1994, Brown 1999, Crawford 2003). It is expected to occur in eastern Oregon and California. In California, annual hairgrass is considered the most common vernal pool grass, often forming a ring on the upper margins of pools (Zedler 1987).

Vegetation
This association is diverse and composition varies across its range. It is characterized by sparse to dense annual hairgrass (*Deschampsia danthonioides*). Annual hairgrass is often co-dominant with bluegrass species (Sandberg [*Poa secunda*], or bulbous bluegrass [*Poa bulbosa*] in degraded stands), oatgrass species (e.g., onespike oatgrass [*Danthonia unispicata*] or California oatgrass [*Danthonia californica*]), spikerush species (common spikerush [*Eleocharis palustris*] or Bolander's spikerush [*Eleocharis bolanderi*]), and/or small camas (*Camassia quamash*). A suite of annual forbs typical of vernally moist, clay-rich soils is always associated, primarily needleleaf navarretia (*Navarretia intertexta* ssp. *propinqua*), milkwort knotweed (*Polygonum polygaloides*), sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*), smooth spike-primrose (*Epilobium pygmaeum*), yellow owl's-clover (*Orthocarpus luteus*), and short woollyheads (*Psilocarphus brevissimus* var. *brevissimus*). Exposed bare soil and litter comprise the majority of ground cover.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Deschampsia danthonioides	100	3.0	60.0	33.6
Poa bulbosa	80	0.1	30.0	8.5
Poa secunda	80	0.1	10.0	3.3
Bromus japonicus	80	0.1	5.0	2.3
Danthonia unispicata	60	0.1	15.0	5.4
Danthonia californica	60	0.1	5.0	2.0
Eleocharis palustris	40	10.0	20.0	15.0
Eleocharis bolanderi	40	1.0	20.0	10.5
Forbs				
Navarretia intertexta ssp. *propinqua*	100	0.1	20.0	6.6
Epilobium brachycarpum	100	0.1	1.0	0.3
Camassia quamash	80	0.1	15.0	9.0
Polygonum polygaloides	80	0.1	10.0	3.3
Plagiobothrys scouleri var. *hispidulus*	80	0.1	7.0	2.1
Allium	60	1.0	10.0	4.0
Epilobium pygmaeum	60	1.0	5.0	3.3
Orthocarpus luteus	60	0.1	4.0	2.0
Psilocarphus brevissimus var. *brevissimus*	40	4.0	5.0	4.5

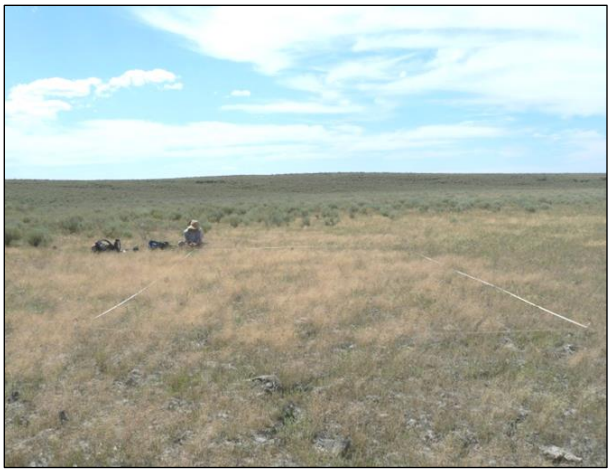
Successional and Disturbance Dynamics

Annual hairgrass readily colonizes depressions and drainages that are flooded briefly during the late winter or spring and then dry out by early or mid-summer. It germinates on saturated, clay-rich soil just before or after standing water has evaporated. Adjacent sites that hold water longer into the summer tend to be dominated by common spikerush or annual forb species. As a result, this association often forms a narrow band like a “bathtub ring” around ephemerally wet depressions, only occupying soils with the proper moisture regime. Stands may be sparse during years without ideal moisture conditions.

Hydrogeomorphic Environment

This distinctive association ranges from basaltic plateaus to foothills and lower montane zones. It is found in ephemerally wet drainages, on vernal pool / lake margins, and in drawdown zones of seasonally flooded livestock watering reservoirs. Sites are flooded during most years. Soils are characteristically clay-rich and sometimes gravelly or cobbly. This association often forms a band immediately below the full pool water line in vernal pools and stock ponds where it is adjacent to annual forb or common spikerush (*Eleocharis palustris*) associations occupying deeper portions of the pool. Rarely does annual hairgrass dominate the central bottom of a vernal pool. Silver sagebrush occurs at the full pool elevation, while upland sagebrush-steppe occurs above the inundation level.

Restoration and Management
Annual hairgrass is useful in wetland restoration because it rapidly covers bare, ephemerally moist soil (Darris and Bartow 2008). It is not highly competitive and requires disturbance (including hydrologic fluctuations found in vernal pools) to maintain dominance.



Functions
Waterfowl and other birds eat annual hairgrass seeds (Darris and Bartow 2008). Annual hairgrass functions to reduce soil on margins of vernal pools and disturbed wetland habitats (Darris and Bartow 2008).

Identification and Classification
This association is similar to the small camas association and variants of the common spikerush association, both of which can be adjacent (Murphy et al. 2011). The small camas association is distinguished by always having > 15% cover of small camas and $\leq$ 3% cover of annual hairgrass. The common spikerush association usually has having $\geq$ 20% cover of common spikerush. Annual hairgrass is diagnostic of analogous (but otherwise dissimilar) vernal pool associations described from northeastern California's Modoc Plateau (Barbour et al. 2007).

Needle Spikerush Vernal Pool
***Eleocharis acicularis* Vernal Pool**
n = 3
proposed

Range
This association is described from 3 vernal pools sampled in Macon Flat, in the Camas Prairie east of Fairfield, Idaho. Similar stands dominated by needle spikerush (*Eleocharis acicularis*) are known from depressional wetland settings over a broad geographic area, ranging from California, Oregon (Crowe et al. 2004), and Nevada to Colorado and Wyoming (NatureServe 2011). This vernal pool association has not been described from areas outside Idaho, but could be expected in California, Oregon, or Washington.

Vegetation
Needle spikerush (*Eleocharis acicularis*) (< 10 cm tall) dominates this productive association with cover typically exceeding 20%. Common spikerush (*Eleocharis palustris*) is typically present, but its cover is usually < 10% and never more than needle spikerush. Annual forb species typical of vernal pools (e.g., smooth spike-primrose [*Epilobium pygmaeum*], sleeping

popcornflower [*Plagiobothrys scouleri var. hispidiulus*], short woollyheads [*Psilocarphus brevissimus var. brevissimus*], fleshy porterella [*Porterella carnosula*], and least navarretia [*Navarretia leucocephala ssp. minima*]) are always present and typically abundant, but no species ever has cover greater than needle spikerush. Exposed bare soil and litter comprise the majority of ground cover.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Eleocharis acicularis	100	20.0	60.0	40.0
Eleocharis palustris	100	4.0	30.0	13.7
Forbs				
Epilobium pygmaeum	100	0.1	20.0	10.0
Plagiobothrys scouleri var. *hispidulus*	100	0.1	10.0	4.4
Psilocarphus brevissimus var. *brevissimus*	100	0.1	10.0	4.0
Porterella carnosula	100	2.0	5.0	3.3
Navarretia leucocephala ssp. *minima*	67	10.0	30.0	20.0
Polygonum polygaloides ssp. *confertiflorum*	67	0.1	10.0	5.1

Successional and Disturbance Dynamics

In ideal environmental settings, needle spikerush is a vigorous, spreading species that apparently tolerates moderate disturbance (e.g., trampling, grazing) by livestock. Extended livestock grazing will result in lower cover of needle spikerush (Brown 1999).

Hydrogeomorphic Environment

This association occurs on bottoms of moderately long-inundation vernal pools / lakes and temporarily flooded livestock reservoirs. Sites appear inundated for slightly less time and depth than areas dominated by common spikerush (*Eleocharis palustris*). Soils are fine textured, predominantly clayey. Needle spikerush does not prefer alkaline soils (USDA 2011).

Left photo: Vernal pool with remnant puddle, June 10, 2008. Right photo: Same vernal pool, July 22, 2009

Restoration and Management

Needle spikerush has lower cover in vernal pools grazed by livestock (Brown 1999). Because it propagates by division of rhizomes and can form floating masses if uprooted, populations may rapidly recover after disturbances (including livestock grazing and trampling).

Functions

Needle spikerush provides food for waterfowl. Due to its small stature, needle spikerush does not provide significant cover and forage for other wildlife. However, the rich forb community present in this type could support a diverse insect population. A short-horned lizard (*Phrynosoma douglassii*) was observed in this association.

Identification and Classification

The needle spikerush association is not well described from anywhere within its suspected range. Needle spikerush is a characteristic member of several vernal pool associations described from central California (Barbour et al. 2007). These associations are not synonymous with the type described here. Needle spikerush can dominate seasonally flooded depressional wetlands in many other environmental settings (ranging from foothills to upper montane zones), but species composition would differ from composition described here for vernal pools.

Common Spikerush Vernal Pool
***Eleocharis palustris* Vernal Pool**
n = 17
proposed

Range

In Idaho, the common spikerush (*Eleocharis palustris*) vernal pool association has been documented on the Snake River Plains (including east-central Idaho at Big Lost Sinks), margins of the Bennett Hills (e.g., Camas Prairie), Owyhee Plateau, and Weiser River basin. Similar vernal pools dominated by common spikerush occur in northeastern California, eastern Oregon (Good 1977), and Washington, and probably northern Nevada. In studies of eastern Washington vernal pools, a zone dominated by common spikerush was identified (Crowe et al. 1994, Brown 1999) that shares some associated species with Idaho stands. Those stands are likely equivalent to the association described here. Similar stands have also been documented from central Oregon (Taylor 2004). Vernal pools supporting this association appear analogous to the “Northern basalt flow vernal pool” type described from the Modoc Plateau of northeastern California by Sawyer and Keeler-Wolf (1995).

Vegetation

Common spikerush (*Eleocharis palustris*) dominates this association with cover averaging 50%. Common spikerush cover is always greater than cover of needle spikerush (*Eleocharis acicularis*), an occasional associate. Bolander’s silver sagebrush (*Artemisia cana ssp. bolanderi*)

is occasionally present on stand margins with up to 10% cover (or rarely higher), but it always has less cover than common spikerush. Annual herbaceous species typical of vernal pools are common, but seldom abundant. The most important annual forbs are navarretia species (*Navarretia* spp.), fleshy porterella (*Porterella carnosula*), and smooth spike-primrose (*Epilobium pygmaeum*). Aquatic species (e.g., California damsonium [*Damasonium californicum*], pondweed species [*Potamogeton* spp.]) are occasionally abundant.

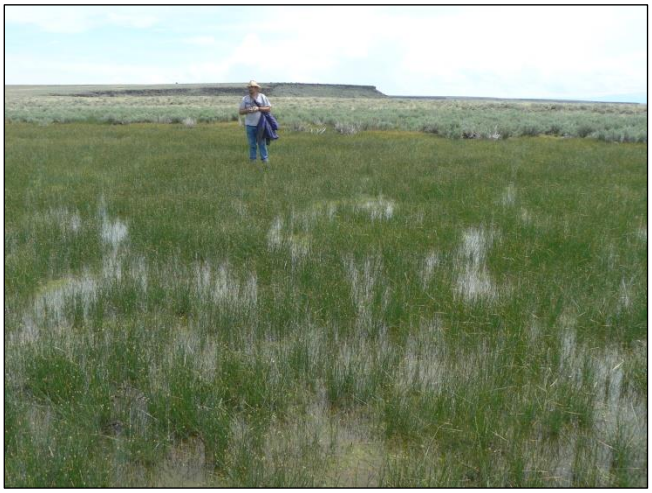
Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Shrubs				
Artemisia cana	18	10.0	40.0	20.0
Graminoids				
Eleocharis palustris	100	3.0	98.0	50.9
Eleocharis acicularis	35	20.0	30.0	26.7
Alopecurus carolinianus	18	0.1	2.0	1.0
Forbs				
Navarretia spp.	35	0.1	3.0	1.0
Porterella carnosula	29	1.0	10.0	4.2
Epilobium pygmaeum	29	0.1	7.0	2.4
Plagiobothrys scouleri var. *hispidulus*	29	0.1	5.0	1.8
Damasonium californicum	12	5.0	50.0	27.5
Ferns and Fern Allies				
Marsilea vestita	18	0.1	5.0	2.0

Successional and Disturbance Dynamics

The area occupied by this plant association may be related to precipitation trends. During drought periods the area occupied by the common spikerush may decline and during wet cycles it may increase (Jankovsky-Jones et al. 2001). The area of vernal pools occupied by different associations is a function of flooding depth and duration. Padgett at al. (1989) and others (Hauser 2006) suggest that common spikerush can be early seral in ponds where water is at or above the ground surface. Due to regularly saturated conditions and dense growth of common spikerush, stands are difficult to displace. However, Hansen et al. (1995) observed that disturbance can drastically shift the vegetative composition of this type.

Hydrogeomorphic Environment

This association occurs on bottoms of long-inundated vernal pools / lakes and seasonally flooded livestock reservoirs. Stands dominate portions of depressions that stay wet later in the growing season. Although shallowly flooded by rain and snowmelt in the winter through spring, by early or mid-summer habitats are dry (Jankovsky-Jones et al. 2001). Soils are fine-textured, derived from alluvium. Soil textures are generally silty clays, clay-loams, or silt-loams, often included in the Babbington-Piline association of southwest



Idaho (Jankovsky-Jones et al. 2001). Because stands are located vernal pool centers, soils supporting this type have the finest textures (i.e., highest clay content) in the pool (Crowe et al. 1994). Soil pH is usually slightly alkaline (typically pH 7.0 - 8.4) (Good 1977, Crowe et al. 1994).

Restoration and Management

Common spikerush is a competitive species in vernal pools, but cover is reduced by livestock grazing (Brown 1999, Dlugolecki 2010). This allows annual forbs and non-native species to increase in cover. Overall, common spikerush has relatively low palatability for livestock, but it is utilized during drought periods (Hauser 2006).

Functions

These vernal pool habitats are important spring stopover points for migratory waterfowl and shorebirds. Willets (*Tringa semipalmata*) were commonly observed nesting and foraging in vernal pools dominated by the common spikerush association in the study area. Common spikerush is an important food source for waterfowl (Hauser 2006). This association provides important cover for various birds and amphibians. Freshwater crustaceans occurring in these vernal pools were a potentially important food source for early inhabitants of southwest Idaho (Henrickson et al. 1998). This association is habitat for the rare aquatic plant California damsonium (*Damasonium californicum*). Forb-rich stands of this type are highly valuable foraging habitats for pronghorn (*Antilocapra americana*) at Hart Mountain NWR (Good 1977).

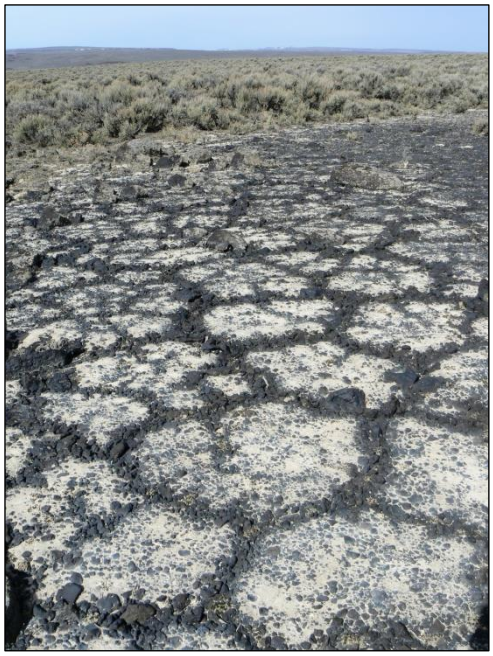
Identification and Classification

The presence of obligate vernal pool species and environmental setting distinguish this association from other common spikerush associations. Common spikerush is widespread and occurs in a variety of moisture and hydrology gradients. These habitats range from perennially wet stream courses to pond and lake margins to vernal pools. In recognition of this diversity, several common spikerush dominated plant associations are recognized in Idaho (Murphy et al. 2011). Other associations include stands occurring along streams, rivers, and lakeshores. Analogous vernal pool associations described from northeastern California's Modoc Plateau (Sawyer and Keeler-Wolf 1995, Barbour et al. 2007) list common spikerush as an important species, but many associated species are different from those documented in this study. In the Great Plains, common spikerush is diagnostic in some playa associations (NatureServe 2011). The association described here is distinct, sharing few species with Great Plains stands.

Common spikerush belongs to a complex of spikerush taxa with similar botanical and ecological characteristics. It is possible that some stands of this association are dominated by closely related, difficult to distinguish species including pale spikerush (*Eleocharis macrostachya*) or bald spikerush (*Eleocharis erythropoda*). Plant material collected from southwest Idaho vernal pools in this study keyed to common spikerush.

Forb Herbaceous Vegetation Associations

Davis' Peppergrass - Ibapah Springparsley
Lepidium davisii - Cymopterus ibapensis
n = 3
tentative



Range
This association is described from only 3 playas on plateaus above the South Fork Owyhee River in the Owyhee River Canyonlands near where the borders of Idaho, Oregon, and Nevada intersect. It could be expected in immediately adjacent playas in Oregon and Nevada.

Vegetation
Davis' peppergrass (*Lepidium davisii*) and Ibapah springparsley (*Cymopterus ibapensis*) are always present and co-dominate this sparse playa association with ≥ 1% cover each. All other species typically have ≤ 1% cover. Sandberg bluegrass (*Poa secunda*) and stemless mock goldenweed (*Stenotus acaulis*) occur in the majority of stands. Rock, gravel, and barren clay soil, in varying combinations, account for over 90% of the soil surface.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Poa secunda	67	0.1	0.3	0.2
Forbs				
Cymopterus ibapensis	100	0.6	3.0	1.7
Lepidium davisii	100	0.5	3.0	1.4
Stenotus acaulis var. *acaulis*	67	0.8	1.0	0.9

Successional and Disturbance Dynamics
Stands of this association likely represent the climax vegetation type on clay-bottomed, minimally alkaline playas. Davis' peppergrass and Ibapah springparsley are well adapted to temporarily flooded, heavy clay soils of playas. However, neither appears to tolerate regular or prolonged inundation. Stands of Davis' peppergrass have been degraded or extirpated by OHV use, livestock watering dugouts, non-native species invasion, and livestock grazing (Moseley 1995, Tuason 2005).

Hydrogeomorphic Environment
This association occurs on sparsely vegetated playas on basaltic plains. Rain and snowmelt shallowly floods (< 10 cm deep) playas from winter to early spring during high-precipitation years. Playas occasionally re-fill after intense summer thunderstorms. During dry years the playa surface is merely saturated or only partially inundated. By late spring, the playas dry to a rock-hard, whitish or grey-colored, clay bottom. The clay shrinks and swells through the year, forming polygonal cracks upon drying (Moseley 1995). Davis' peppergrass often reproduces in the soil cracks. The clay soils do not have alkali deposits; they have neutral to slightly alkaline pH (Moseley 1995).

Restoration and Management
Restoration of Davis' peppergrass playas has not yet been undertaken. Removal of organic debris from playas (e.g., by prescribed burning during wet winter periods) and re-grading of playa surfaces by filling livestock watering dugouts are recommended.

Functions
Davis' peppergrass, a vulnerable globally rare species, is only found in these playa habitats. Playas are sometimes used by greater sage-grouse (*Centrocercus urophasianus*) as leks. Pronghorn (*Antilocapra americana*) have also been observed on playas (Tuason 2005). Although playas are infrequently inundated for short periods, these habitats do support unique invertebrate communities. These invertebrates provide food for migrating shorebirds.

Identification and Classification
Stands of this association were included within the broader Davis' peppergrass association described by Jankovsky-Jones et al. (2001). This newly described association is distinguished from the Davis' peppergrass association by the presence of $\geq$ 1% cover of Ibapah springparsley.

Davis' Peppergrass
Lepidium davisii
n = 15
proposed

Range
This association is known from about 300 playas scattered from south-central Idaho across southwest Idaho into southeast Oregon, and barely extending into north-central Nevada (Jankovsky-Jones et al. 2001). There are six clusters in this range: 1) Mountain Home Desert (Snake River Plains); 2) Bruneau Desert; 3) Salmon Falls Creek (Snake River Plains); 4) South Fork Owyhee River Canyonlands; 5) Alvord Desert (Malheur County, Oregon); 6) Barren Valley (Malheur County) (Moseley 1995). Surveys indicate the association is found on about 50 to 60% of suitable playas in its range.

Vegetation

Davis' peppergrass (*Lepidium davisii*) is typically the dominant species in playas. Its cover is usually ≥ 1%, but seldom more than 5%. Davis' peppergrass density is typically < 10 plants per m^2 (Moseley 1995). If Davis' peppergrass cover is < 1%, then no other species has cover greater than Davis' Peppergrass. Very few plant species can tolerate the environmental conditions in playas supporting Davis' peppergrass. In minimally disturbed playas no other species has > 2% cover. Clasping pepperweed (*Lepidium perfoliatum*), prickly Russian thistle (*Salsola tragus*), burningbush (*Bassia scoparia*), prostrate knotweed (*Polygonum aviculare*), and/or other non-native species are locally common in playas degraded by livestock or surrounded by rangelands in poor condition. Rock, gravel, and barren clay soil, in varying combinations, account for over 90% of the soil surface.

Species	Minimally Disturbed Stands				Degraded Stands			
	Constancy %	Min % Cover	Max % Cover	Mean % Cover	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids								
Elymus elymoides	36	0.1	0.2	0.1				
Forbs								
Lepidium davisii	100	0.1	6.0	2.5	100	0.7	1.4	0.9
Lepidium perfoliatum	18	0.1	0.1	0.1	75	0.1	1.7	0.8
Salsola tragus					100	0.2	3.3	1.1
Bassia scoparia					100	0.2	1.3	0.7
Polygonum aviculare	18	0.1	0.1	0.1	50	0.5	1.9	1.2

Successional and Disturbance Dynamics

The year to year cover, density, and reproduction of Davis' peppergrass is variable due to fluctuating precipitation (Moseley 1995). Extreme wetness inhibits growth on certain portions of playas. Drought slows reproduction. The Davis' peppergrass association is long-lived and maintained by the physical stability of the playa habitat (Moseley 1995). However, disturbances to playas can initiate successional changes. For example, crested wheatgrass (*Agropyron cristatum*), forage kochia (*Bassia prostrata*), burningbush (*Bassia scoparia*), whitetop (*Cardaria draba*), saltlover (*Halogeton glomeratus*), clasping pepperweed (*Lepidium perfoliatum*), prostrate knotweed (*Polygonum aviculare*), and/or prickly Russian thistle (*Salsola tragus*) frequently invade degraded sites and directly compete with Davis' peppergrass (Moseley 1995, Tuason 2005). The litter of these plants (especially tumbleweeds of prickly Russian thistle) can build up on playas and directly smother Davis' peppergrass (Taylor-Grant and DeBolt 1995, Tuason 2005). In addition, sediment from wind and water erosion on degraded rangelands can deposit on playas. This creates habitats for xeric perennial species and non-native species to invade while decreasing the habitat for Davis' peppergrass (Taylor-Grant and DeBolt 1995, Tuason 2005). Davis' peppergrass has been extirpated from several playas.

Hydrogeomorphic Environment

This association occurs in sparsely vegetated playas on basaltic plains within the Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) zone. It occurs in internally drained depressions that shallowly pool rain and snowmelt (< 10 cm deep) during winter and early spring of years with high precipitation. Playas occasionally re-fill after intense, localized spring or summer thunderstorms. During drier years the playa surface is merely saturated or only partially inundated. By late spring, the playas dry to a rock-hard, whitish or grey-colored, clay bottom. The clay shrinks and swells through the year, forming polygonal cracks upon drying. This process differentially sorts volcanic gravels, cobbles, and stones on its surface into a "stone net" (Moseley 1995). Davis' peppergrass often reproduces in the soil cracks. The clay soils do not have alkali deposits; they have neutral to slightly alkaline pH (Moseley 1995). Soils are mapped as the Playas-Duric Natrargids association in southwest Idaho (Jankovsky-Jones et al. 2001).

Restoration and Management

The persistence of Davis' peppergrass depends on the maintenance of playa hydrology and soil characteristics. Davis' peppergrass is apparently not preferred forage for livestock. However, if livestock water reservoirs are dug in playas or salt is located in the playa or adjacent, then direct trampling of Davis' peppergrass and habitat alteration (promoting plant invasion) may occur (Taylor-Grant and DeBolt 1995, Moseley 1995, Tuason 2005). Damage occurs mostly when soil is wet. Similar problems result from OHV use on playas. Digging of livestock reservoirs within playas physically destroys Davis' peppergrass habitat and alters playa hydrology (Moseley 1995). Though fuels and conditions are rarely sufficient on playas to carry fire on Davis' peppergrass playas, fires in surrounding rangelands may lead to soil erosion and deposition on playas (Taylor-Grant and DeBolt 1995, Moseley 1995, Tuason 2005). Several stands of Davis' peppergrass have been extirpated or severely degraded by poorly planned range restoration. This has resulted in herbicide spraying of Davis' peppergrass and conversion of to forage kochia or crested wheatgrass communities (Tuason 2005). Restoration of Davis' peppergrass playas could include removal of organic debris from playas (e.g., by prescribed burning during wet winter periods), control of non-native species, and re-grading of playa surfaces by filling livestock watering dugouts. Filling of livestock reservoirs has restored hydrology of vernal pools in central Oregon (Dlugolecki 2010).

Functions

Davis' peppergrass only occurs in these playa habitats. Playas are sometimes used by greater sage-grouse (*Centrocercus urophasianus*) and pronghorn (*Antilocapra americana*). When wetted, playas support aquatic invertebrate species that provide food for migrating birds such as American avocet (*Recurvirostra americana*). Playas in the western Snake River Plains are the only known habitat for a recently described giant predatory fairy shrimp (*Branchinecta raptor*).

Identification and Classification
This association is characterized by obvious dominance of Davis' peppergrass with few associated plant species (Jankovsky-Jones et al. 2001). Though minimal plots have been sampled for classification purposes, vegetation composition and structure data from 13 Davis' peppergrass monitoring transects were used in the classification of this type. This association is distinct and easily recognized in the field. Playas lacking Davis' peppergrass or any other plant species (a less frequent situation) are classified as "Barren Playa" habitats.

Milkwort Knotweed - Sleeping Popcornflower - Navarretia spp.
***Polygonum polygaloides* - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp.**
n = 3
proposed

Range
This association is described from 3 vernal pools sampled in the Macon Flat area, in the Camas Prairie east of Fairfield, Idaho. A similar vernal pool was observed in the Weiser River Basin, north of Boise, in the Blue Mountains section. The association is expected to occur in eastern Oregon, eastern Washington, and possibly northeastern California.

Vegetation
Milkwort knotweed (typically Fruitleaf, *Polygonum polygaloides* ssp. *confertiflorum*) dominates this association with ≥ 3% cover (usually ≥ 10% cover). Other annual forbs typical of vernal pools, such as sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) and navarretia species (near navarretia [*Navarretia intertexta* ssp. *propinqua*] and/or least navarretia [*Navarretia leucocephala* ssp. *minima*]) are always present and often co-dominant. The individual cover of these is always less than milkwort knotweed. Other annual vernal pool forbs (e.g., hairy purslane speedwell [*Veronica peregrina* ssp. *xalapensis*]) are uncommon. Wasatch desertparsley (*Lomatium bicolor* var. *leptocarpum*) occurs on pool margins. The presence of prostrate knotweed (*Polygonum aviculare*) may indicate past livestock disturbance. A combination of exposed bare soil and rock comprise over 80% of the ground surface.

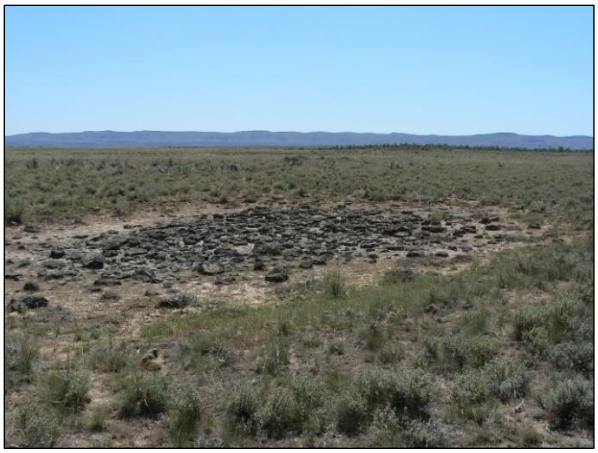
Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Danthonia unispicata	100	0.1	1.0	0.4
Elymus elymoides	67	1.0	1.0	1.0
Forbs				
Polygonum polygaloides ssp. *confertiflorum*	100	4.0	20.0	11.3
Plagiobothrys scouleri var. *hispidulus*	100	0.1	10.0	3.7
Navarretia intertexta ssp. *propinqua*	100	0.1	4.0	1.7
Polygonum aviculare	100	0.1	2.0	1.0
Lomatium bicolor var. *leptocarpum*	100	0.1	2.0	0.7
Veronica peregrina ssp. *xalapensis*	100	0.1	2.0	0.7
Navarretia leucocephala ssp. *minima*	67	3.0	3.0	3.0

Successional and Disturbance Dynamics

Annual species typical of vernal pools can have substantial year-to-year variability in plant abundance in response to varying precipitation (Brown 1999). In eastern Washington vernal pools prostrate knotweed (*Polygonum aviculare*) was not preferred by livestock and may expand under regular grazing (Brown 1999).

Hydrogeomorphic Environment

This association occupies the bottoms of short-inundation, small-area (40 - 80 m^2) vernal pools and temporarily flooded livestock reservoirs. Every year there is a moderately deep snowpack in the Macon Flat area where these vernal pools occur. The snowpack melts by April, filling the pools into June during a typical year. Substrates are often rockier than other vernal pools in the study area.



Left photo: Vernal pool on Macon Flat, April 20, 2008. Right photo: Similar vernal pool on Macon Flat, July 22, 2009.

Restoration and Management

The flora of eastern Washington vernal pools grazed by livestock had a higher percentage of non-native species than that of ungrazed pools (Bjork 1997, Brown 1999). Response of annual vernal pool plants to grazing varies according to grazing timing and intensity (Marty 2005).

Functions

Despite the ephemeral existence of water, small-sized vernal pools such as those supporting this association, provide habitat for unique assemblages of plant and animal species, including various fairy and tadpole shrimp (Branchiopoda) (Weekley and Murphy 2012).

Identification and Classification

Clear dominance by milkwort knotweed distinguishes this newly described association. Vernal pools dominated by other annual species of popcornflower (*Plagiobothrys* spp.) are known from Washington and Oregon (NatureServe 2011), and California, where Navarretia (*Navarretia* spp.) can also be prominent (Barbour et al. 2007). Milkwort knotweed (*Polygonum polygaloides*) is diagnostic of vernal pools on the Modoc Plateau of northeastern California (Barbour et al. 2007). None of these other types are equivalent to the association described here.

Sleeping Popcornflower - Mousetail spp.
***Plagiobothrys scouleri* var. *hispidulus* - *Myosurus* spp.**
n = 5
proposed

Range

Vernal pools supporting this association were sampled on the Snake River Plains near Bliss and on basalt tablelands of the Owyhee Plateau. Additional stands have been observed in the Weiser River Basin, north of Boise, within the Blue Mountains section. The association is expected to occur in eastern Oregon, eastern Washington, and possibly northeastern California.

Vegetation

Sleeping popcornflower (*Plagiobothrys scouleri* var. *hispidulus*) is dominant, having ≥ 3% cover (averaging 10% cover). Mousetail species (e.g., bristly mousetail [*Myosurus apetalus*] and/or tiny mousetail [*Myosurus minimus*]) are always present and often co-dominant. Other vernal pool annual forbs are sometimes prominent or even co-dominant, especially near navarretia (*Navarretia intertexta* ssp. *propinqua*), finebranched popcornflower (*Plagiobothrys leptocladus*), and fleshy porterella (*Porterella carnosula*). Milkwort knotweed (*Polygonum polygaloides*) is frequently present, but its cover is ≤ 1%. Common spikerush (*Eleocharis palustris*) is locally common in some stands, but it has patchy or marginal distribution. The presence of cheatgrass (*Bromus tectorum*) and prostrate knotweed (*Polygonum aviculare*) may indicate livestock induced soil disturbance. Bare exposed soil accounts for 60 - 90% of the ground surface; rocks are usually minimal.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Graminoids				
Bromus tectorum	60	0.1	1.0	0.7
Eleocharis palustris	40	8.0	15.0	11.5
Forbs				
Plagiobothrys scouleri var. *hispidulus*	100	4.0	20.0	9.8
Polygonum aviculare	100	0.1	3.0	1.0
Polygonum polygaloides	100	0.1	0.1	0.1
Myosurus minimus	80	0.1	5.0	1.8
Myosurus apetalus	60	0.1	20.0	10.0
Plagiobothrys leptocladus	60	0.1	10.0	5.7
Psilocarphus brevissimus var. *brevissimus*	60	0.1	2.0	1.0
Porterella carnosula	40	0.1	8.0	4.1
Navarretia intertexta ssp. *propinqua*	40	0.1	5.0	2.6

Successional and Disturbance Dynamics

The flora of eastern Washington vernal pools grazed by livestock had a higher percentage of non-native species than ungrazed pools (Bjork 1997, Brown 1999). In eastern Washington vernal pools prostrate knotweed (*Polygonum aviculare*) was not preferred by livestock and had higher cover in grazed pools (Brown 1999).

Hydrogeomorphic Environment

This association occurs on the bottoms of moderately-long inundated vernal pools / lakes and seasonally flooded livestock reservoirs. Pools are shallowly flooded by snowmelt and/or rain runoff during winter and spring of most years. Exact timing of pool flooding varies depending on elevation and snowpack (or lack thereof; photos below show annual variation). Soils are fine-textured (silty and clayey) with minimal rocks intermixed. The presence of tiny mousetail (*Myosurus minimus*) and finebranched popcornflower (*Plagiobothrys leptocladus*) may indicate slightly more alkaline soils (Barbour et al. 2007) than other vernal pools surveyed, however no soil chemistry data were collected.

Left: Vernal pool supporting this association, Weiser River Basin, May 21, 2004. Right: Same pool, May 27, 2009.

Restoration and Management

In central California, moderate livestock grazing increased diversity of annual vernal pool species (including rare species). Livestock grazing lessens competition from perennial species and reduces overwhelming biomass of non-native annual grasses (Marty 2005). The effect of livestock grazing on annual-dominated vernal pools is difficult to predict. Effects vary because of individual plant species biology, annual precipitation patterns, pool size, soil types, and timing and intensity of grazing (Brown 1999, Marty 2005, Meinke 2006, Dlugolecki 2010).

Functions

Vernal pools supporting this association provide habitat for unique assemblages of plant and animal species, including various fairy and tadpole shrimp (Branchiopoda) that occur in few other habitats on the landscape.

Identification and Classification
Clear dominance by sleeping popcornflower distinguishes this newly described association from other vernal pool types. Vernal pools dominated by other annual species of popcornflower (*Plagiobothrys* spp.) are known from Washington, Oregon (NatureServe 2011), and central California (Barbour et al. 2007). Tiny mousetail (*Myosurus minimus*) is diagnostic of alkaline vernal pool associations in central California (Barbour et al. 2007). None of these types are equivalent to the association described here.

Non-native Forb Herbaceous Vegetation Associations

Clasping Pepperweed
Lepidium perfoliatum
n = 2
tentative

Range
This association was documented from 2 plots in one vernal pool sampled in the Snake River Plains between Boise and Mountain Home. It is expected to occur elsewhere in southwestern Idaho. A stand likely classified as this association was sampled on an alkaline playa in northeast Nevada (Vegbank 2011).

Vegetation
Clasping pepperweed (*Lepidium perfoliatum*) and/or bushy knotweed (*Polygonum ramosissimum*) dominated the stands sampled with a combined cover of ≥ 5%. No other species had ≥ 5% cover. Annual forb species typical of vernal pools (e.g., finebranched popcornflower [*Plagiobothrys leptocladus*]) were uncommon. The substrate was noticeably barren silty clay soil.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Bromus tectorum	50	0.1	0.1	0.1
Lepidium perfoliatum	100	0.1	10.0	5.1
Polygonum ramosissimum	100	0.1	9.0	4.6
Plagiobothrys leptocladus	50	1.0	1.0	1.0
Epilobium brachycarpum	50	0.1	0.1	0.1
Ceratocephala testiculata	50	0.1	0.1	0.1

Successional and Disturbance Dynamics
Clasping pepperweed, cheatgrass (*Bromus tectorum*), and bur buttercup (*Ceratocephala testiculata*) can invade disturbed vernal pools and playas. Although a native species, bushy knotweed (*Polygonum ramosissimum*) has similar ecological traits as non-native prostrate knotweed (*Polygonum aviculare*). The clasping pepperweed association likely displaces the

sleeping popcornflower - mousetail spp. or milkwort knotweed - sleeping popcornflower - navarretia spp. associations. The litter of non-native plants can build up in vernal pools, smothering habitat, and altering soil properties (e.g., increase organic matter), furthering establishment of non-native species, and resulting in a decrease in native, vernal pool dependent species.

Hydrogeomorphic Environment

This association occurs in short-inundation vernal pools, playas, and ephemerally moist closed depressions. The stands sampled were in a rain-fed, infrequently flooded vernal pool approximately 250 m^2 in area. The pool had a silty-clay bottom that was dried hard in mid-summer. The substrate was not rocky.

Restoration and Management

Restoration of vernal pools invaded by non-native species, including clasping pepperweed, is difficult. Targeted weed and litter control may be necessary.

Identification and Classification

Clasping pepperweed (*Lepidium perfoliatum*) was documented from vernal pools in northwest Nevada, but it was not a diagnostic species (Barbour et al. 2007). Other annual pepperweed species (*Lepidium* spp.) are sometimes diagnostic of alkaline vernal pools and playas from central California (Barbour et al. 2007).

Saltlover
Halogeton glomeratus
n = 1
tentative

Range

One stand was sampled on a playa east of Grasmere in the Bruneau Desert. Two other stands were observed in the Bruneau Desert northwest of Grasmere, but plot data were not collected. Stands likely classifiable as this association have been sampled on playas and playa margins in alkaline basins of northwest and central Nevada (Vegbank 2011).

Vegetation

Saltlover (*Halogeton glomeratus*) clearly dominates playas with > 5% cover. No other species has $\geq$ 5% cover. Non-native annual grasses and forbs are noticeable, but have trace cover. Cheatgrass (*Bromus tectorum*) is most common. Squirreltail (*Elymus elymoides*) and Sandberg bluegrass (*Poa secunda*) may also be present. Davis' Pepperweed (*Lepidium davisii*) had 1% cover in the stand sampled, but this species is not expected to occur in all saltlover dominated areas. Rock, gravel, and barren clay soil accounted for 90% of the soil surface.

Species	Constancy %	Min % Cover	Max % Cover	Mean % Cover
Bromus tectorum	100	0.3	0.3	0.3
Vulpia octoflora	100	0.1	0.1	0.1
Halogeton glomeratus	100	7.0	7.0	7.0
Lepidium davisii	100	1.0	1.0	1.0
Salsola tragus	100	0.1	0.1	0.1
Sisymbrium altissimum	100	0.1	0.1	0.1

Successional and Disturbance Dynamics

Saltlover, non-native annual grasses, prickly Russian thistle (*Salsola tragus*), and various non-native forbs can invade disturbed playas and directly compete with Davis' peppergrass (Moseley 1995, Tuason 2005). The litter of these plants can build up on playas and alter soil properties (e.g., increase organic matter, increase alkalinity). This can promote further establishment of non-native species and result in a decrease in native, playa-obligate species (Taylor-Grant and DeBolt 1995, Tuason 2005).

Hydrogeomorphic Environment

This association is known from playas, alkaline flats, and ephemerally moist closed depressions. Inundation is likely infrequent and brief. Soils are silty, clayey, and rocky. Soils are likely alkaline and probably mapped as Playas-Duric Natrargids association in southwest Idaho (similar to Davis' peppergrass playas) (Jankovsky-Jones et al. 2001).

Restoration and Management

Saltlover is an aggressive, invasive species and indicator of degraded playa habitats (Tuason 2005). Control of populations may be necessary for restoring native playa communities.

Identification and Classification

The stand sampled occurred on a degraded playa that had the potential to support the Davis' peppergrass association. Central Nevada stands would lack Davis' pepperweed.

APPENDIX 4

Stand tables for plant associations

	A. cana ssp. *bolanderi* / *Muhlenbergia richardsonis* Shrub Vegetation (n = 4)				*A. cana* ssp. *bolanderi* / *Eleocharis palustris* Shrub Vegetation (n = 5)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Artemisia cana	100	3.0	50.0	28.3	100	20.0	40.0	26.0
Muhlenbergia richardsonis	100	5.0	30.0	15.0	40	0.1	3.0	1.6
Iva axillaris	75	0.1	1.0	0.7				
Polygonum polygaloides	50	1.0	3.0	2.0	80	10.0	30.0	16.3
Eleocharis palustris	50	1.0	1.0	1.0	100	7.0	20.0	13.2
Plagiobothrys scouleri var. *hispidulus*	50	0.1	1.0	0.6	80	0.1	8.0	3.0
Agoseris heterophylla	50	0.1	1.0	0.6	20	0.1	0.1	0.1
Unknown	50	0.1	1.0	0.6	20	0.1	0.1	0.1
Danthonia californica	25	10.0	10.0	10.0				
Elymus elymoides	25	10.0	10.0	10.0				
Artemisia arbuscula ssp. *arbuscula*	25	5.0	5.0	5.0				
Deschampsia danthonioides	25	3.0	3.0	3.0	100	2.0	30.0	11.8
Navarretia intertexta ssp. *propinqua*	25	3.0	3.0	3.0	20	2.0	2.0	2.0
Psilocarphus oregonus	25	3.0	3.0	3.0				
Epilobium pygmaeum	25	1.0	1.0	1.0	80	0.1	2.0	1.0
Alopecurus carolinianus	25	1.0	1.0	1.0	80	0.1	1.0	0.6
Veronica peregrina ssp. *xalapensis*	25	1.0	1.0	1.0	80	0.1	0.1	0.1
Myosurus minimus	25	1.0	1.0	1.0	60	0.1	20.0	6.7
Poa nevadensis	25	1.0	1.0	1.0	40	10.0	20.0	15.0
Collinsia parviflora	25	1.0	1.0	1.0	40	0.1	0.1	0.1
Camissonia tanacetifolia	25	1.0	1.0	1.0				
Crepis acuminata	25	1.0	1.0	1.0				
Juncus bufonius	25	1.0	1.0	1.0				
Lupinus brevicaulis	25	1.0	1.0	1.0				
Mentzelia albicaulis	25	1.0	1.0	1.0				
Nemophila pedunculata	25	1.0	1.0	1.0				
Orobanche fasciculata	25	1.0	1.0	1.0				
Microsteris gracilis	25	0.1	0.1	0.1	20	0.1	0.1	0.1

	A. cana / *M. richardsonis* (n = 4)				*A. cana* / *E. palustris* (n = 5)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Polygonum aviculare	25	0.1	0.1	0.1	20	0.1	0.1	0.1
Achillea millefolium	25	0.1	0.1	0.1				
Antennaria	25	0.1	0.1	0.1				
Bromus japonicus	25	0.1	0.1	0.1				
Erigeron latus	25	0.1	0.1	0.1				
Lepidium perfoliatum	25	0.1	0.1	0.1				
Lithophragma	25	0.1	0.1	0.1				
Mimulus guttatus	25	0.1	0.1	0.1				
Penstemon	25	0.1	0.1	0.1				
Epilobium brachycarpum					80	0.1	3.0	0.8
Navarretia leucocephala ssp. *minima*					60	2.0	30.0	12.3
Psilocarphus brevissimus var. *brevissimus*					60	0.1	3.0	2.0
Juncus nevadensis var. *nevadensis*					40	5.0	10.0	7.5
Plagiobothrys stipitatus var. *micranthus*					40	0.1	9.0	4.6
Plagiobothrys leptocladus					40	0.1	3.0	1.6
Poa secunda					40	0.1	2.0	1.1
Porterella carnosula					40	0.1	2.0	1.1
Eleocharis acicularis					40	0.1	1.0	0.6
Gnaphalium palustre					40	0.1	1.0	0.6
Myosurus apetalus					40	0.1	1.0	0.6
Lomatium bicolor var. *leptocarpum*					40	0.1	0.1	0.1
Polygonum polygaloides ssp. *confertiflorum*					20	20.0	20.0	20.0
Artemisia papposa					20	2.0	2.0	2.0
Camassia quamash					20	1.0	1.0	1.0
Downingia bacigalupii					20	1.0	1.0	1.0
Hordeum brachyantherum					20	1.0	1.0	1.0
Koeleria macrantha					20	1.0	1.0	1.0
Pyrrocoma linearis					20	1.0	1.0	1.0
Allium lemmonii					20	0.1	0.1	0.1
Bromus tectorum					20	0.1	0.1	0.1
Chenopodium					20	0.1	0.1	0.1
Eleocharis bolanderi					20	0.1	0.1	0.1
Madia glomerata					20	0.1	0.1	0.1
Marsilea vestita					20	0.1	0.1	0.1
Microseris nutans					20	0.1	0.1	0.1
Panicum capillare					20	0.1	0.1	0.1
Symphyotrichum					20	0.1	0.1	0.1

	Artemisia cana ssp. *bolanderi* / *Poa nevadensis* Shrub Herbaceous Vegetation (n = 9)				*Artemisia cana* ssp. *bolanderi* / *Poa nevadensis* Shrub Herbaceous Vegetation (degraded) (n = 3)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Artemisia cana	100	20.0	50.0	36.7	100	10.0	40.0	21.7
Eleocharis palustris	78	0.1	30.0	5.9				
Poa nevadensis	78	1.0	15.0	5.6	33	1.0	1.0	1.0
Plagiobothrys scouleri var. *hispidulus*	67	0.1	1.0	0.7				
Epilobium pygmaeum	67	0.1	1.0	0.4	33	30.0	30.0	30.0
Epilobium brachycarpum	56	1.0	10.0	3.4	67	0.1	0.1	0.1
Polygonum polygaloides	56	1.0	3.0	2.2	33	0.1	0.1	0.1
Elymus elymoides	44	0.1	15.0	8.8	67	0.1	0.1	0.1
Muhlenbergia richardsonis	44	0.1	3.0	1.3				
Veronica peregrina ssp. *xalapensis*	44	1.0	1.0	1.0				
Psilocarphus brevissimus var. *brevissimus*	44	0.1	1.0	0.6	33	10.0	10.0	10.0
Microsteris gracilis	33	0.1	2.0	0.7				
Navarretia intertexta ssp. *propinqua*	33	0.1	1.0	0.7				
Polygonum aviculare	33	0.1	1.0	0.4	67	0.1	1.0	0.6
Collinsia parviflora	33	0.1	0.1	0.1				
Alopecurus carolinianus	22	0.1	20.0	10.1				
Lomatium bicolor var. *leptocarpum*	22	5.0	7.0	6.0				
Poa secunda	22	0.1	3.0	1.6	33	0.1	0.1	0.1
Antennaria dimorpha	22	0.1	1.0	0.6				
Agoseris heterophylla	22	0.1	0.1	0.1	33	0.1	0.1	0.1
Deschampsia danthonioides	22	0.1	0.1	0.1				
Bromus japonicus	11	10.0	10.0	10.0				
Atriplex patula	11	3.0	3.0	3.0				
Lupinus brevicaulis	11	3.0	3.0	3.0				
Artemisia arbuscula ssp. *arbuscula*	11	2.0	2.0	2.0				
Artemisia tridentata ssp. *wyomingensis*	11	1.0	1.0	1.0				
Asteraceae	11	1.0	1.0	1.0				
Crepis acuminata	11	1.0	1.0	1.0				

	A. cana ssp.*bolanderi* / *Poa nevadensis* (n = 9)				*A. cana* ssp.*bolanderi* / *Poa nevadensis* (degraded) (n = 3)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Erigeron chrysopsidis	11	1.0	1.0	1.0				
Festuca idahoensis	11	1.0	1.0	1.0				
Gilia	11	1.0	1.0	1.0				
Gilia leptomeria	11	1.0	1.0	1.0				
Linanthus septentrionalis	11	1.0	1.0	1.0				
Lomatium	11	1.0	1.0	1.0				
Mentzelia albicaulis	11	1.0	1.0	1.0				
Microseris nutans	11	1.0	1.0	1.0				
Myosurus minimus	11	1.0	1.0	1.0				
Orobanche fasciculata	11	1.0	1.0	1.0				
Phlox longifolia	11	1.0	1.0	1.0				
Psilocarphus oregonus	11	1.0	1.0	1.0				
Tragopogon dubius	11	1.0	1.0	1.0				
Lactuca serriola	11	0.1	0.1	0.1	33	0.1	0.1	0.1
Arabis	11	0.1	0.1	0.1				
Camissonia andina	11	0.1	0.1	0.1				
Chrysothamnus humilis	11	0.1	0.1	0.1				
Downingia bacigalupii	11	0.1	0.1	0.1				
Hordeum brachyantherum	11	0.1	0.1	0.1				
Nothocalais troximoides	11	0.1	0.1	0.1				
Polyctenium fremontii var. *fremontii*	11	0.1	0.1	0.1				
Polygonum polygaloides ssp. *confertiflorum*	11	0.1	0.1	0.1				
Unknown	11	0.1	0.1	0.1				
Ceratocephala testiculata					67	1.0	8.0	4.5
Lepidium perfoliatum					67	0.1	5.0	2.6
Bromus tectorum					67	0.1	3.0	1.6
Taeniatherum caput-medusae					33	5.0	5.0	5.0
Poa bulbosa					33	3.0	3.0	3.0
Ericameria nauseosa ssp. *naus.* var. *naus.*					33	1.0	1.0	1.0
Plagiobothrys leptocladus					33	1.0	1.0	1.0
Descurainia sophia					33	0.1	0.1	0.1
Myosurus apetalus					33	0.1	0.1	0.1
Sisymbrium altissimum					33	0.1	0.1	0.1

	Deschampsia danthonioides Herbaceous Vegetation (n = 5)				*Artemisia papposa* / *Poa secunda* Shrubland (n = 3)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Deschampsia danthonioides	100	3.0	60.0	33.6	67	0.1	2.0	1.1
Navarretia intertexta ssp. *propinqua*	100	0.1	20.0	6.6	100	0.1	1.0	0.7
Epilobium brachycarpum	100	0.1	1.0	0.3	67	0.1	1.0	0.6
Camassia quamash	80	0.1	15.0	9.0				
Poa bulbosa	80	0.1	30.0	8.5	33	0.1	0.1	0.1
Poa secunda	80	0.1	10.0	3.3	100	3.0	25.0	14.3
Bromus japonicus	80	0.1	5.0	2.3	33	1.0	1.0	1.0
Plagiobothrys scouleri var. *hispidulus*	80	0.1	7.0	2.1	67	0.1	0.1	0.1
Danthonia unispicata	60	0.1	15.0	5.4	67	0.1	10.0	5.1
Epilobium pygmaeum	60	1.0	5.0	3.3	33	0.1	0.1	0.1
Danthonia californica	60	0.1	5.0	2.0	67	0.1	1.0	0.6
Orthocarpus luteus	60	0.1	4.0	2.0				
Lactuca serriola	60	0.1	0.1	0.1	33	0.1	0.1	0.1
Eleocharis palustris	40	10.0	20.0	15.0				
Eleocharis bolanderi	40	1.0	20.0	10.5				
Allium	40	1.0	10.0	5.5	33	0.1	0.1	0.1
Psilocarphus brevissimus var. *brevissimus*	40	4.0	5.0	4.5	67	0.1	0.1	0.1
Polygonum polygaloides	40	0.1	2.0	1.1	33	1.0	1.0	1.0
Veronica peregrina ssp. *xalapensis*	40	1.0	1.0	1.0	33	0.1	0.1	0.1
Festuca idahoensis	40	0.1	1.0	0.6	33	1.0	1.0	1.0
Juncus confusus	40	0.1	1.0	0.6	33	0.1	0.1	0.1
Myosurus minimus	40	0.1	1.0	0.6				
Polygonum douglasii	40	0.1	1.0	0.6				
Calochortus eurycarpus	40	0.1	0.1	0.1	33	5.0	5.0	5.0
Perideridia gairdneri	40	0.1	0.1	0.1	33	1.0	1.0	1.0
Microsteris gracilis	40	0.1	0.1	0.1	33	0.1	0.1	0.1
Agoseris heterophylla	40	0.1	0.1	0.1				

	Deschampsia danthonioides (n = 5)				*Artemisia papposa / Poa secunda* (n = 3)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Collomia linearis	40	0.1	0.1	0.1				
Lomatium nudicaule	20	15.0	15.0	15.0				
Polygonum polygaloides ssp. *kelloggii*	20	10.0	10.0	10.0	33	8.0	8.0	8.0
Juncus bufonius	20	2.0	2.0	2.0	33	0.1	0.1	0.1
Alopecurus carolinianus	20	2.0	2.0	2.0				
Artemisia papposa	20	1.0	1.0	1.0	100	10.0	30.0	20.0
Polygonum polygaloides ssp. *confertiflorum*	20	1.0	1.0	1.0	67	0.1	10.0	5.1
Allium brandegeei	20	1.0	1.0	1.0	33	1.0	1.0	1.0
Wyethia helianthoides	20	1.0	1.0	1.0	33	1.0	1.0	1.0
Epilobium densiflorum	20	1.0	1.0	1.0	33	0.1	0.1	0.1
Juncus hemiendytus var. *hemiendytus*	20	1.0	1.0	1.0	33	0.1	0.1	0.1
Lewisia pygmaea	20	1.0	1.0	1.0	33	0.1	0.1	0.1
Antennaria	20	1.0	1.0	1.0				
Blepharipappus scaber	20	1.0	1.0	1.0				
Phleum pratense	20	1.0	1.0	1.0				
Lomatium bicolor var. *leptocarpum*	20	0.1	0.1	0.1	100	2.0	10.0	4.7
Antennaria luzuloides	20	0.1	0.1	0.1	67	2.0	3.0	2.5
Microseris nutans	20	0.1	0.1	0.1	33	1.0	1.0	1.0
Achillea millefolium	20	0.1	0.1	0.1	33	1.0	1.0	1.0
Polygonum aviculare	20	0.1	0.1	0.1	33	0.1	0.1	0.1
Artemisia cana	20	0.1	0.1	0.1	33	0.1	0.1	0.1
Bromus tectorum	20	0.1	0.1	0.1				
Gnaphalium palustre	20	0.1	0.1	0.1				
Chenopodium album	20	0.1	0.1	0.1				
Tragopogon dubius	20	0.1	0.1	0.1				
Apera interrupta	20	0.1	0.1	0.1				
Castilleja tenuis	20	0.1	0.1	0.1				

	Deschampsia danthonioides (n = 5)				*Artemisia papposa / Poa secunda* (n = 3)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Dodecatheon	20	0.1	0.1	0.1				
Eleocharis	20	0.1	0.1	0.1				
Idahoa scapigera	20	0.1	0.1	0.1				
Isoetes bolanderi	20	0.1	0.1	0.1				
Lotus unifoliolatus var. *unifoliolatus*	20	0.1	0.1	0.1				
Madia gracilis	20	0.1	0.1	0.1				
Montia	20	0.1	0.1	0.1				
Polygonum	20	0.1	0.1	0.1				
Sedum stenopetalum	20	0.1	0.1	0.1				
Thinopyrum intermedium	20	0.1	0.1	0.1				
Elymus elymoides					100	1.0	3.0	1.7
Pyrrocoma uniflora var. *uniflora*					67	0.1	0.1	0.1
Collinsia parviflora					67	0.1	0.1	0.1
Sisyrinchium					33	3.0	3.0	3.0
Castilleja pallescens					33	2.0	2.0	2.0
Artemisia arbuscula ssp. *longiloba*					33	1.0	1.0	1.0
Navarretia breweri					33	1.0	1.0	1.0
Orobanche fasciculata					33	1.0	1.0	1.0
Phlox longifolia					33	1.0	1.0	1.0
Allium acuminatum					33	1.0	1.0	1.0
Erigeron					33	1.0	1.0	1.0
Eriogonum umbellatum					33	1.0	1.0	1.0
Microseris					33	1.0	1.0	1.0
Phlox aculeata					33	1.0	1.0	1.0
Stenotus stenophyllus					33	1.0	1.0	1.0
Madia glomerata					33	0.1	0.1	0.1
Camissonia andina					33	0.1	0.1	0.1
Koeleria macrantha					33	0.1	0.1	0.1
Gayophytum					33	0.1	0.1	0.1
Rumex acetosa					33	0.1	0.1	0.1

	Eleocharis acicularis Vernal Pool Herbaceous Vegetation (n = 3)				*Eleocharis palustris* Vernal Pool Herbaceous Vegetation (n = 17)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Eleocharis acicularis	100	20.0	60.0	40.0	35	20.0	30.0	26.7
Eleocharis palustris	100	4.0	30.0	13.7	100	3.0	98.0	50.9
Epilobium pygmaeum	100	0.1	20.0	10.0	29	0.1	7.0	2.4
Plagiobothrys scouleri var. *hispidulus*	100	0.1	10.0	4.4	29	0.1	5.0	1.8
Psilocarphus brevissimus var. *brevissimus*	100	0.1	10.0	4.0	18	0.1	0.1	0.1
Porterella carnosula	100	2.0	5.0	3.3	29	1.0	10.0	4.2
Navarretia leucocephala ssp. *minima*	67	10.0	30.0	20.0	18	0.1	1.0	0.4
Polygonum polygaloides ssp. *confertiflorum*	67	0.1	10.0	5.1				
Myosurus minimus	67	0.1	1.0	0.6	12	1.0	6.0	3.5
Marsilea vestita	33	7.0	7.0	7.0	18	0.1	5.0	2.0
Pyrrocoma uniflora var. *uniflora*	33	1.0	1.0	1.0				
Plagiobothrys leptocladus	33	0.1	0.1	0.1	12	0.1	0.1	0.1
Lomatium bicolor var. *leptocarpum*	33	0.1	0.1	0.1				
Artemisia cana					18	10.0	40.0	20.0
Navarretia intertexta ssp. *propinqua*					18	1.0	3.0	1.7
Alopecurus carolinianus					18	0.1	2.0	1.0
Gnaphalium palustre					18	0.1	1.0	0.4
Damasonium californicum					12	5.0	50.0	27.5
Plagiobothrys stipitatus var. *micranthus*					12	0.1	5.0	2.6
Alopecurus aequalis					12	0.1	5.0	2.6
Muhlenbergia richardsonis					12	1.0	3.0	2.0
Unknown					12	0.1	2.0	1.1
Juncus nevadensis var. *nevadensis*					6	20.0	20.0	20.0
Rumex salicifolius					6	15.0	15.0	15.0
Deschampsia danthonioides					6	10.0	10.0	10.0
Potamogeton natans					6	10.0	10.0	10.0
Polygonum aviculare					6	5.0	5.0	5.0
Iva axillaris					6	3.0	3.0	3.0

	Eleocharis acicularis Vernal Pool Herbaceous Vegetation (n = 3)				*Eleocharis palustris* Vernal Pool Herbaceous Vegetation (n = 17)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Potamogeton gramineus					6	3.0	3.0	3.0
Poa nevadensis					6	1.0	1.0	1.0
Polygonum ramosissimum					6	1.0	1.0	1.0
Chenopodium album					6	1.0	1.0	1.0
Psilocarphus oregonus					6	1.0	1.0	1.0
Hordeum brachyantherum					6	1.0	1.0	1.0
Camissonia tanacetifolia					6	1.0	1.0	1.0
Downingia bicornuta					6	1.0	1.0	1.0
Potamogeton pusillus					6	1.0	1.0	1.0
Veronica peregrina ssp. *xalapensis*					6	0.1	0.1	0.1
Myosurus apetalus					6	0.1	0.1	0.1
Agoseris heterophylla					6	0.1	0.1	0.1
Polygonum polygaloides					6	0.1	0.1	0.1
Bromus tectorum					6	0.1	0.1	0.1
Callitriche palustris					6	0.1	0.1	0.1
Lilaea scilloides					6	0.1	0.1	0.1
Ranunculus aquatilis					6	0.1	0.1	0.1

	Lepidium perfoliatum Semi-natural Herbaceous Vegetation (n = 2)				*Muhlenbergia richardsonis* Herbaceous Vegetation (n = 1)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Lepidium perfoliatum	100	0.1	10.0	5.1				
Polygonum ramosissimum	100	0.1	9.0	4.6				
Plagiobothrys leptocladus	50	1.0	1.0	1.0				
Epilobium brachycarpum	50	0.1	0.1	0.1				
Bromus tectorum	50	0.1	0.1	0.1				
Ceratocephala testiculata	50	0.1	0.1	0.1				
Muhlenbergia richardsonis					100	30.0	30.0	30.0
Elymus elymoides					100	0.1	0.1	0.1
Camissonia tanacetifolia					100	0.1	0.1	0.1
Conringia orientalis					100	0.1	0.1	0.1
Cusickiella douglasii					100	0.1	0.1	0.1

	Polygonum polygaloides - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp. Herbaceous Vegetation (n = 3)				*Plagiobothrys scouleri* var. *hispidulus* - *Myosurus* spp. Herbaceous Vegetation (n = 5)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Polygonum polygaloides ssp. *confertiflorum*	100	4.0	20.0	11.3	20	0.1	0.1	0.1
Plagiobothrys scouleri var. *hispidulus*	100	0.1	10.0	3.7	100	4.0	20.0	9.8
Navarretia intertexta ssp. *propinqua*	100	0.1	4.0	1.7	40	0.1	5.0	2.6
Polygonum aviculare	100	0.1	2.0	1.0	100	0.1	3.0	1.0
Lomatium bicolor var. *leptocarpum*	100	0.1	2.0	0.7	20	0.1	0.1	0.1
Veronica peregrina ssp. *xalapensis*	100	0.1	2.0	0.7				
Madia glomerata	100	0.1	1.0	0.4				
Androsace filiformis	100	0.1	1.0	0.4				
Psilocarphus brevissimus var. *brevissimus*	100	0.1	1.0	0.4	60	0.1	2.0	1.0
Danthonia unispicata	100	0.1	1.0	0.4				
Navarretia leucocephala ssp. *minima*	67	3.0	3.0	3.0				
Elymus elymoides	67	1.0	1.0	1.0	40	0.1	0.1	0.1
Bromus japonicus	67	0.1	1.0	0.6				
Poa secunda	67	0.1	0.1	0.1	40	0.1	0.1	0.1
Allium	67	0.1	0.1	0.1				
Artemisia papposa	67	0.1	0.1	0.1				
Pyrrocoma uniflora var. *uniflora*	33	10.0	10.0	10.0				
Myosurus apetalus	33	0.1	0.1	0.1	60	0.1	20.0	10.0
Lepidium perfoliatum	33	0.1	0.1	0.1	40	1.0	1.0	1.0
Epilobium brachycarpum	33	0.1	0.1	0.1	40	0.1	0.1	0.1
Artemisia cana	33	0.1	0.1	0.1	20	1.0	1.0	1.0
Epilobium pygmaeum	33	0.1	0.1	0.1	20	0.1	0.1	0.1
Agoseris heterophylla	33	0.1	0.1	0.1				
Microseris nutans	33	0.1	0.1	0.1				
Collinsia parviflora	33	0.1	0.1	0.1				
Artemisia arbuscula ssp. *longiloba*	33	0.1	0.1	0.1				

	Polygonum polygaloides - *Plagiobothrys scouleri* var. *hispidulus* - *Navarretia* spp. Herbaceous Vegetation (n = 3)				*Plagiobothrys scouleri* var. *hispidulus* - *Myosurus* spp. Herbaceous Vegetation (n = 5)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Navarretia breweri	33	0.1	0.1	0.1				
Camissonia andina	33	0.1	0.1	0.1				
Polyctenium fremontii var. *fremontii*	33	0.1	0.1	0.1				
Chorizanthe watsonii	33	0.1	0.1	0.1				
Erigeron pumilus	33	0.1	0.1	0.1				
Lepidium	33	0.1	0.1	0.1				
Myosurus minimus					80	0.1	5.0	1.8
Polygonum polygaloides					80	0.1	0.1	0.1
Plagiobothrys leptocladus					60	0.1	10.0	5.7
Bromus tectorum					60	0.1	1.0	0.7
Eleocharis palustris					40	8.0	15.0	11.5
Porterella carnosula					40	0.1	8.0	4.1
Ceratocephala testiculata					40	2.0	2.0	2.0
Alopecurus carolinianus					40	0.1	2.0	1.1
Poa bulbosa					40	1.0	1.0	1.0
Taeniatherum caput-medusae					40	1.0	1.0	1.0
Sisymbrium altissimum					40	1.0	1.0	1.0
Lactuca serriola					40	0.1	0.1	0.1
Eremopyrum triticeum					40	0.1	0.1	0.1
Salsola tragus					40	0.1	0.1	0.1
Poa nevadensis					20	0.1	0.1	0.1
Chenopodium					20	0.1	0.1	0.1

	Atriplex confertifolia Playa Shrubland (n = 2)				*Halogeton glomeratus* Semi-natural Herbaceous Vegetation (n = 1)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of Cover**	**Mean Cover %**
Atriplex confertifolia	100	2.6	8.0	5.3				
Halogeton glomeratus	100	0.2	1.0	0.6	100	7.0	7.0	7.0
Salsola tragus	50	5.0	5.0	5.0	100	0.1	0.1	0.1
Bromus tectorum	50	1.0	1.0	1.0	100	0.3	0.3	0.3
Lepidium davisii	50	0.6	0.6	0.6	100	1.0	1.0	1.0
Amsinckia tessellata	50	0.1	0.1	0.1				
Descurainia incana	50	0.1	0.1	0.1				
Descurainia sophia	50	0.1	0.1	0.1				
Elymus elymoides	50	0.1	0.1	0.1				
Eremopyrum triticeum	50	0.1	0.1	0.1				
Mentzelia albicaulis	50	0.1	0.1	0.1				
Sisymbrium altissimum					100	0.1	0.1	0.1
Vulpia octoflora					100	0.1	0.1	0.1

	Lepidium davisii Herbaceous Vegetation (n = 11)				*Lepidium davisii - Cymopterus ibapensis* Herbaceous Vegetation (n = 3)				*Lepidium davisii* Herbaceous Vegetation (degraded) (n = 4)			
Species	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**	**Constancy %**	**Min of % Cover**	**Max of % Cover**	**Mean Cover %**
Lepidium davisii	100	0.1	6.0	2.5	100	0.5	3.0	1.4	100	0.7	1.4	0.9
Elymus elymoides	36	0.1	0.2	0.1	33	0.1	0.1	0.1				
Atriplex confertifolia	18	0.1	1.8	0.9								
Astragalus calycosus	18	0.1	0.6	0.4	33	0.2	0.2	0.2				
Poa secunda	18	0.1	0.1	0.1	67	0.1	0.3	0.2	25	0.1	0.1	0.1
Polygonum aviculare	18	0.1	0.1	0.1	33	0.2	0.2	0.2	50	0.5	1.9	1.2
Lepidium perfoliatum	18	0.1	0.1	0.1	33	0.1	0.1	0.1	75	0.1	1.7	0.8
Lupinus lepidus	9	1.8	1.8	1.8								
Cymopterus ibapensis	9	1.0	1.0	1.0	100	0.6	3.0	1.7				
Halogeton glomeratus	9	0.5	0.5	0.5	33	0.1	0.1	0.1				
Erigeron chrysopsidis	9	0.1	0.1	0.1	33	0.1	0.1	0.1				
Phlox hoodii	9	0.1	0.1	0.1	33	0.1	0.1	0.1				
Bromus tectorum	9	0.1	0.1	0.1					25	0.1	0.1	0.1
Agropyron cristatum	9	0.1	0.1	0.1								
Artemisia tridentata ssp. *wyomingensis*	9	0.1	0.1	0.1								
Chaenactis douglasii	9	0.1	0.1	0.1								
Chrysothamnus viscidiflorus	9	0.1	0.1	0.1								
Iva axillaris	9	0.1	0.1	0.1								
Taraxacum officinale	9	0.1	0.1	0.1								
Vulpia octoflora	9	0.1	0.1	0.1								
Unknown	9	0.1	0.1	0.1	33	0.1	0.1	0.1				
Stenotus acaulis var. *acaulis*					67	0.8	1.0	0.9				
Ceratocephala testiculata					33	0.1	0.1	0.1	25	0.1	0.1	0.1
Crepis					33	0.1	0.1	0.1				
Taeniatherum caput-medusae					33	0.1	0.1	0.1				
Salsola tragus									100	0.2	3.3	1.1
Bassia scoparia									100	0.2	1.3	0.7
Polygonum ramosissimum									25	0.5	0.5	0.5
Sisymbrium altissimum									25	0.1	0.1	0.1

APPENDIX 5

Vascular plant species documented from vernal pool and playas in southwest Idaho

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Shrubs									
Artemisia arbuscula ssp. *arbuscula*	little sagebrush	Asteraceae	Perennial			3	3.5	Native to U.S.	
Artemisia arbuscula ssp. *longiloba*	early low sagebrush	Asteraceae	Perennial			3	0.6	Native to U.S.	
Artemisia cana (typically ssp. *bolanderi*)	silver sagebrush (Bolander's)	Asteraceae	Perennial			47	25.0	Native to U.S.	FACU, FAC, FACW
Artemisia papposa	Owyhee sage	Asteraceae	Perennial			12	9.0	Native to U.S.	FAC+?
Artemisia tridentata ssp. *wyomingensis*	Wyoming big sagebrush	Asteraceae	Perennial	5	0.1	2	1.0	Native to U.S.	
Atriplex confertifolia	shadscale saltbush	Chenopodiaceae	Perennial	19	3.1			Native to U.S.	
Chrysothamnus humilis	Truckee rabbitbrush	Asteraceae	Perennial			2	0.1	Native to U.S.	
Chrysothamnus viscidiflorus	yellow rabbitbrush	Asteraceae	Perennial	5	0.1			Native to U.S.	
Ericameria nauseosa ssp. *nauseosa* var. *nauseosa*	rubber rabbitbrush	Asteraceae	Perennial			2	1.0	Native to U.S.	
Graminoids									
Agropyron cristatum	crested wheatgrass	Poaceae	Perennial	5	0.1			Introduced to U.S.	
Alopecurus aequalis	shortawn foxtail	Poaceae	Perennial			3	2.6	Native to U.S.	OBL
Alopecurus carolinianus	Carolina foxtail	Poaceae	Annual			22	2.3	Native to U.S.	FAC+, FACW
Apera interrupta	dense silkybent	Poaceae	Annual			2	0.1	Introduced to U.S.	
Bromus japonicus	Japanese brome	Poaceae	Annual			15	2.4	Introduced to U.S.	UPL, FACU
Bromus tectorum	cheatgrass	Poaceae	Annual	19	0.4	15	0.6	Introduced to U.S.	
Danthonia californica	California oatgrass	Poaceae	Perennial			10	2.9	Native to U.S.	FACU-, FACW
Danthonia unispicata	onespike danthonia	Poaceae	Perennial			13	3.4	Native to U.S.	
Deschampsia danthonioides	annual hairgrass	Poaceae	Annual			27	15.1	Native to U.S.	FAC, FACW-
Eleocharis	spikerush	Cyperaceae	Annual, Perennial			2	0.1	Native to U.S.	
Eleocharis acicularis	needle spikerush	Cyperaceae	Annual, Perennial			18	25.6	Native to U.S.	OBL
Eleocharis bolanderi	Bolander's spikerush	Cyperaceae	Perennial			5	7.0	Native to U.S.	FACW
Eleocharis palustris	common spikerush	Cyperaceae	Perennial			63	28.1	Native to U.S.	OBL
Elymus elymoides	squirreltail	Poaceae	Perennial	29	0.1	25	3.5	Native to U.S.	
Eremopyrum triticeum	annual wheatgrass	Poaceae	Annual	5	0.1	3	0.1	Introduced to U.S.	
Festuca idahoensis	Idaho fescue	Poaceae	Perennial			7	0.8	Native to U.S.	
Hordeum brachyantherum	meadow barley	Poaceae	Perennial			5	0.7	Native to U.S.	FAC, FACW
Juncus bufonius	toad rush	Juncaceae	Annual			5	1.0	Native to U.S.	FACW, OBL
Juncus confusus	Colorado rush	Juncaceae	Perennial			5	0.4	Native to U.S.	FAC, FACW
Juncus hemiendytus var. *hemiendytus*	Herman's dwarf rush	Juncaceae	Annual			3	0.6	Native to U.S.	

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Juncus nevadensis var. *nevadensis*	Sierra rush	Juncaceae	Perennial			5	11.7	Native to U.S.	
Koeleria macrantha	prairie Junegrass	Poaceae	Perennial			3	0.6	Native to U.S.	
Muhlenbergia richardsonis	mat muhly	Poaceae	Perennial			22	7.9	Native to U.S.	FACU, FACW
Panicum capillare	witchgrass	Poaceae	Annual			2	0.1	Native to U.S.	FACU, FAC
Phleum pratense	timothy	Poaceae	Perennial			2	1.0	Introduced to U.S.	FACU
Poa bulbosa	bulbous bluegrass	Poaceae	Perennial			13	4.9	Introduced to U.S.	
Poa nevadensis	Nevada bluegrass	Poaceae	Perennial			22	5.5	Native to U.S.	
Poa secunda	Sandberg bluegrass	Poaceae	Perennial	24	0.1	27	3.9	Native to U.S.	
Taeniatherum caput-medusae	medusahead	Poaceae	Annual	5	0.1	5	2.3	Introduced to U.S.	
Thinopyrum intermedium	intermediate wheatgrass	Poaceae	Perennial			2	0.1	Introduced to U.S.	
Vulpia octoflora	sixweeks fescue	Poaceae	Annual	10	0.1			Native to U.S.	UPL, FACU+
Forbs									
Achillea millefolium	common yarrow	Asteraceae	Perennial			5	0.4	Native to U.S.	UPL, FACU
Agoseris heterophylla	annual agoseris	Asteraceae	Annual			17	0.2	Native to U.S.	
Allium	onion	Liliaceae	Perennial			8	2.3	Native to U.S.	
Allium acuminatum	tapertip onion	Liliaceae	Perennial			2	1.0	Native to U.S.	
*Allium anceps**	twinleaf onion	Liliaceae	Perennial					Native to U.S.	
Allium brandegeei	Brandegee's onion	Liliaceae	Perennial			3	1.0	Native to U.S.	
Allium lemmonii	Lemmon's onion	Liliaceae	Perennial			2	0.1	Native to U.S.	
Amsinckia tessellata	bristly fiddleneck	Boraginaceae	Annual	5	0.1			Native to U.S.	
Androsace filiformis	filiform rockjasmine	Primulaceae	Annual			5	0.4	Native to U.S.	UPL, FACW, OBL
Antennaria	pussytoes	Asteraceae	Perennial			3	0.6	Native to U.S.	
Antennaria dimorpha	low pussytoes	Asteraceae	Perennial			3	0.6	Native to U.S.	
Antennaria luzuloides	rush pussytoes	Asteraceae	Perennial			5	1.7	Native to U.S.	
Arabis	rockcress	Brassicaceae	Perennial			2	0.1	Native to U.S.	
Asteraceae	composite family	Asteraceae	Annual, Perennial			2	1.0	Native and Introduced to U.S.	
Astragalus calycosus	Torrey's milkvetch	Fabaceae	Perennial	14	0.3			Native to U.S.	
Atriplex patula	spear saltbush	Chenopodiaceae	Annual			2	3.0	Introduced to U.S.	FAC, FACW
Bassia scoparia	burningbush	Chenopodiaceae	Annual	19	0.7			Introduced to U.S.	
Blepharipappus scaber	rough eyelashweed	Asteraceae	Annual			2	1.0	Native to U.S.	
Callitriche palustris	vernal water-starwort	Callitrichaceae	Perennial			2	0.1	Native to U.S.	
Calochortus eurycarpus	white mariposa lily	Liliaceae	Perennial			5	1.7	Native to U.S.	
Camassia quamash	small camas	Liliaceae	Perennial			8	7.4	Native to U.S.	FACW
Camissonia andina	Blackfoot River evening-primrose	Onagraceae	Annual			5	0.1	Native to U.S.	
Camissonia tanacetifolia	tansyleaf evening-primrose	Onagraceae	Perennial			5	0.7	Native to U.S.	

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Castilleja pallescens	pale Indian paintbrush	Scrophulariaceae	Perennial			2	2.0	Native to U.S.	
Castilleja tenuis	hairy Indian paintbrush	Scrophulariaceae	Annual			2	0.1	Native to U.S.	
Ceratocephala testiculata	bur buttercup	Ranunculaceae	Annual	10	0.1	8	2.6	Introduced to U.S.	
Chaenactis douglasii	Douglas' dustymaiden	Asteraceae	Biennial, Perennial	5	0.1			Native to U.S.	
Chenopodium	goosefoot	Chenopodiaceae	Annual			3	0.1	Native and Introduced to U.S.	
Chenopodium album	lambsquarters	Chenopodiaceae	Annual			3	0.6	Introduced to ID, Native to L48	FACU, FAC
Chorizanthe watsonii	fivetooth spineflower	Polygonaceae	Annual			2	0.1	Native to U.S.	
Collinsia parviflora	maiden blue eyed Mary	Scrophulariaceae	Annual			15	0.2	Native to U.S.	
Collomia linearis	tiny trumpet	Polemoniaceae	Annual			3	0.1	Native to U.S.	UPL, FACU
Conringia orientalis	hare's ear mustard	Brassicaceae	Annual			2	0.1	Introduced to U.S.	
Crepis	hawksbeard	Asteraceae	Perennial	5	0.1			Native to U.S.	
Crepis acuminata	tapertip hawksbeard	Asteraceae	Perennial			3	1.0	Native to U.S.	
Cusickiella douglasii	alkali cusickiella	Brassicaceae	Perennial			2	0.1	Native to U.S.	
Cymopterus ibapensis	Ibapah springparsley	Apiaceae	Perennial	19	1.6			Native to U.S.	
Damasonium californicum	California damsonium	Alismataceae	Perennial			3	27.5	Native to U.S.	
Descurainia incana	mountain tansymustard	Brassicaceae	Annual, Biennial	5	0.1			Native to U.S.	
Descurainia sophia	herb sophia	Brassicaceae	Annual, Biennial	5	0.1	2	0.1	Introduced to U.S.	
Dodecatheon	shootingstar	Primulaceae	Perennial			2	0.1	Native to U.S.	
Downingia bacigalupii	Bach's calicoflower	Campanulaceae	Annual			3	0.6	Native to U.S.	
Downingia bicornuta	doublehorn calicoflower	Campanulaceae	Annual			2	1.0	Native to U.S.	OBL
*Downingia insignis**	harlequin calicoflower	Campanulaceae	Annual					Native to L48	OBL
Epilobium brachycarpum	tall annual willowherb	Onagraceae	Annual			37	1.1	Native to U.S.	UPL, NI
Epilobium densiflorum	denseflower willowherb	Onagraceae	Annual			3	0.6	Native to U.S.	
Epilobium pygmaeum	smooth spike-primrose	Onagraceae	Annual			43	3.5	Native to U.S.	
Erigeron	fleabane	Asteraceae	Perennial			2	1.0	Native to U.S.	
Erigeron chrysopsidis	dwarf yellow fleabane	Asteraceae	Perennial	10	0.1	2	1.0	Native to U.S.	
Erigeron latus	broad fleabane	Asteraceae	Perennial			2	0.1	Native to U.S.	
Erigeron pumilus	shaggy fleabane	Asteraceae	Perennial			2	0.1	Native to U.S.	
Eriogonum umbellatum	sulphur-flower buckwheat	Polygonaceae	Perennial			2	1.0	Native to U.S.	
Gayophytum	groundsmoke	Onagraceae	Annual			2	0.1	Native to U.S.	
Gilia	gilia	Polemoniaceae	Annual			2	1.0	Native to U.S.	
Gilia leptomeria	sand gilia	Polemoniaceae	Annual			2	1.0	Native to U.S.	
Gnaphalium palustre	western marsh cudweed	Asteraceae	Annual			10	0.4	Native to U.S.	FAC+, OBL
Halogeton glomeratus	saltlover	Chenopodiaceae	Annual	24	1.8			Introduced to U.S.	
Idahoa scapigera	oldstem idahoa	Brassicaceae	Annual			2	0.1	Native to U.S.	
Isoetes bolanderi	Bolander's quillwort	Isoetaceae	Perennial			2	0.1	Native to U.S.	OBL

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Iva axillaris	povertyweed	Asteraceae	Perennial	5	0.1	7	1.3	Native to U.S.	FACU, FAC, FACW
Lactuca serriola	prickly lettuce	Asteraceae	Annual, Biennial			13	0.1	Introduced to U.S.	FACU, FAC
Lepidium	pepperweed	Brassicaceae	Annual, Biennial			2	0.1	Native and Introduced to U.S.	
Lepidium davisii	Davis' pepperweed	Brassicaceae	Perennial	95	1.9			Native to U.S.	OBL?
Lepidium perfoliatum	clasping pepperweed	Brassicaceae	Annual, Biennial	29	0.5	13	2.2	Introduced to U.S.	UPL, FACU+, FAC
Lewisia pygmaea	alpine lewisia	Portulacaceae	Perennial			3	0.6	Native to U.S.	FACU, FACW+
Lilaea scilloides	awl-leaf lilaea	Juncaginaceae	Annual			2	0.1	Native to U.S.	OBL
Linanthus septentrionalis	northern linanthus	Polemoniaceae	Annual			2	1.0	Native to U.S.	
Lithophragma	woodland-star	Saxifragaceae	Perennial			2	0.1	Native to U.S.	
Lomatium	desertparsley	Apiaceae	Perennial			2	1.0	Native to U.S.	
Lomatium bicolor var. *leptocarpum*	Wasatch desertparsley	Apiaceae	Perennial			22	2.2	Native to U.S.	
Lomatium nudicaule	barestem biscuitroot	Apiaceae	Perennial			2	15.0	Native to U.S.	
Lotus unifoliolatus var. *unifoliolatus*	American bird's-foot trefoil	Fabaceae	Annual			2	0.1	Native to U.S.	
Lupinus brevicaulis	shortstem lupine	Fabaceae	Annual			3	2.0	Native to U.S.	
Lupinus lepidus	Pacific lupine	Fabaceae	Perennial	5	1.8			Native to U.S.	
Madia glomerata	mountain tarweed	Asteraceae	Annual			8	0.3	Native to U.S.	UPL, FACU-
Madia gracilis	grassy tarweed	Asteraceae	Annual			2	0.1	Native to U.S.	
Mentzelia albicaulis	whitestem blazingstar	Loasaceae	Annual	5	0.1	3	1.0	Native to U.S.	
Microseris	silverpuffs	Asteraceae	Perennial			2	1.0	Native to U.S.	
Microseris nutans	nodding microceris	Asteraceae	Perennial			8	0.5	Native to U.S.	
Microsteris gracilis	slender phlox	Polemoniaceae	Annual			13	0.3	Native to U.S.	FACU, FAC-
Mimulus guttatus	seep monkeyflower	Scrophulariaceae	Annual, Perennial			2	0.1	Native to U.S.	OBL
Montia	minerslettuce	Portulacaceae	Annual, Perennial			2	0.1	Native to U.S.	
Myosurus apetalus	bristly mousetail	Ranunculaceae	Annual			13	3.9	Native to U.S.	
Myosurus minimus	tiny mousetail	Ranunculaceae	Annual			25	2.6	Native to U.S.	FACW-, OBL
Navarretia breweri	Brewer's navarretia	Polemoniaceae	Annual			3	0.6	Native to U.S.	
Navarretia intertexta ssp. *propinqua*	near navarretia	Polemoniaceae	Annual			35	2.7	Native to U.S.	
Navarretia leucocephala ssp. *minima*	least navarretia	Polemoniaceae	Annual			17	8.4	Native to U.S.	
Nemophila pedunculata	littlefoot nemophila	Hydrophyllaceae	Annual			2	1.0	Native to U.S.	FAC, FAC+
Nothocalais troximoides	weevil prairie-dandelion	Asteraceae	Perennial			2	0.1	Native to U.S.	
Orobanche fasciculata	clustered broomrape	Orobanchaceae	Annual			5	1.0	Native to U.S.	

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Orthocarpus luteus	yellow owl's-clover	Scrophulariaceae	Annual			5	2.0	Native to U.S.	FACU-, FACU
Penstemon	beardtongue	Scrophulariaceae	Perennial			2	0.1	Native to U.S.	
Perideridia gairdneri	Gardner's yampah	Apiaceae	Perennial			5	0.4	Native to U.S.	FACU, FACW
Phlox aculeata	sagebrush phlox	Polemoniaceae	Perennial			2	1.0	Native to U.S.	
Phlox hoodii	spiny phlox	Polemoniaceae	Perennial	10	0.1			Native to U.S.	
Phlox longifolia	longleaf phlox	Polemoniaceae	Perennial			3	1.0	Native to U.S.	
Plagiobothrys leptocladus	finebranched popcornflower	Boraginaceae	Annual			17	2.3	Native to U.S.	FACW, OBL
Plagiobothrys scouleri var. *hispidulus*	sleeping popcornflower	Boraginaceae	Annual			57	3.2	Native to U.S.	
Plagiobothrys stipitatus var. *micranthus*	stalked popcornflower	Boraginaceae	Annual			7	3.6	Native to U.S.	
*Pogogyne floribunda**	profuseflower mesamint	Lamiaceae	Annual					Native to U.S.	
Polyctenium fremontii var. *fremontii*	Fremont's combleaf	Brassicaceae	Perennial			3	0.1	Native to U.S.	
Polygonum	knotweed	Polygonaceae	Annual			2	0.1	Native and Introduced to U.S.	
Polygonum aviculare	prostrate knotweed	Polygonaceae	Annual, Perennial	24	0.6	30	0.9	Introduced to U.S.	UPL, FACW-
Polygonum douglasii	Douglas' knotweed	Polygonaceae	Annual			3	0.6	Native to U.S.	UPL, FACU, FAC
Polygonum polygaloides	milkwort knotweed	Polygonaceae	Annual			33	4.2	Native to U.S.	FACW-, FACW
Polygonum polygaloides ssp. *confertiflorum*	fruitleaf knotweed	Polygonaceae	Annual			18	6.9	Native to U.S.	
Polygonum polygaloides ssp. *kelloggii*	Kellogg's knotweed	Polygonaceae	Annual			3	9.0	Native to U.S.	
Polygonum ramosissimum	bushy knotweed	Polygonaceae	Annual	5	0.5	5	3.4	Native to U.S.	FACU-, FAC-, FACW
Porterella carnosula	fleshy porterella	Campanulaceae	Annual			20	3.4	Native to U.S.	OBL
Potamogeton gramineus	variableleaf pondweed	Potamogetonaceae	Perennial			2	3.0	Native to U.S.	OBL
Potamogeton natans	floating pondweed	Potamogetonaceae	Perennial			2	10.0	Native to U.S.	OBL
Potamogeton pusillus	small pondweed	Potamogetonaceae	Perennial			2	1.0	Native to U.S.	OBL
Psilocarphus brevissimus var. *brevissimus*	short woollyheads	Asteraceae	Annual			40	1.8	Native to U.S.	
Psilocarphus oregonus	Oregon woollyheads	Asteraceae	Annual			5	1.7	Native to U.S.	FACW, OBL
Pyrrocoma linearis	thinleaf goldenhead	Asteraceae	Perennial			2	1.0	Native to U.S.	
Pyrrocoma uniflora var. *uniflora*	plantain goldenweed	Asteraceae	Perennial			7	2.8	Native to U.S.	
Ranunculus aquatilis	whitewater crowfoot	Ranunculaceae	Perennial			2	0.1	Native to U.S.	OBL
Rumex acetosa	garden sorrel	Polygonaceae	Perennial			2	0.1	Introduced to U.S.	

Species scientific name	Common name	Family	Ecology	Playas		Vernal Pools		Nativity	Wetland indicator status (National, Region 9)
				Constancy %	mean cover %	Constancy %	mean cover %		
Rumex salicifolius	willow dock	Polygonaceae	Perennial			2	15.0	Native to U.S.	FAC, FACW, OBL
Salsola tragus	prickly Russian thistle	Chenopodiaceae	Annual	29	1.6	3	0.1	Introduced to U.S.	
Sedum stenopetalum	wormleaf stonecrop	Crassulaceae	Perennial			2	0.1	Native to U.S.	
Sisymbrium altissimum	tall tumblemustard	Brassicaceae	Annual, Biennial	10	0.1	5	0.7	Introduced to U.S.	UPL, FACU-, FAC
Sisyrinchium	blue-eyed grass	Iridaceae	Perennial			2	3.0	Native to U.S.	
Stenotus acaulis var. *acaulis*	stemless mock goldenweed	Asteraceae	Perennial	10	0.9			Native to U.S.	
Stenotus stenophyllus	narrowleaf mock goldenweed	Asteraceae	Perennial			2	1.0	Native to U.S.	
Symphyotrichum	aster	Asteraceae	Perennial			2	0.1	Native to U.S.	
Taraxacum officinale	common dandelion	Asteraceae	Perennial	5	0.1			Introduced to U.S.	UPL, FACU, FACW
Tragopogon dubius	yellow salsify	Asteraceae	Annual, Biennial			3	0.6	Introduced to U.S.	
Unknown playa				10	0.1				
Unknown vernal pool						10	0.6		
Veronica peregrina ssp. *xalapensis*	hairy purslane speedwell	Scrophulariaceae	Annual			27	0.6	Native to U.S.	
Wyethia helianthoides	sunflower mule-ears	Asteraceae	Perennial			3	1.0	Native to U.S.	FACU, FACW
Ferns and Fern Allies									
Marsilea vestita	hairy waterclover	Marsileaceae	Perennial			8	2.6	Native to U.S.	OBL
*rare plants known from vernal pools in southwest Idaho but not recorded in sampled stands									