Southern California Alluvial Scrub Habitats

Climate Change Vulnerability Assessment Synthesis

An Important Note About this Document: *This document represents an initial evaluation of vulnerability for alluvial scrub habitats based on expert input and existing information. Specifically, the information presented below comprises habitat expert vulnerability assessment survey results and comments, peer-review comments and revisions, and relevant references from the literature. The aim of this document is to expand understanding of habitat vulnerability to changing climate conditions, and to provide a foundation for developing appropriate adaptation responses.*


Photo by Arlee Montalvo/RCRCD-USFS-PSW

Executive Summary

In southern California, alluvial scrub habitats are commonly located in outwash fans and riverine deposits at canyon mouths toward the base of mountain ranges, including the San Gabriel, San Bernardino, San Jacinto, and Santa Ana ranges (Hanes et al. 1989; Safford and Quinn 1998). Alluvial scrub habitats can also be found on wash deposits of rivers (Hanes et al. 1989), including the Santa Ana River and its tributaries. Alluvial scrub consists mainly of flood-adapted drought-deciduous subshrubs and evergreen woody shrubs (Hanes et al. 1989).

The relative vulnerability of alluvial scrub habitats in southern California was evaluated to be moderate-high[1] by habitat experts due to moderate-high sensitivity to climate and non-climate stressors, high exposure to projected future climate changes, and moderate adaptive capacity.

Sensitivity and Exposure	Climate sensitivities: Precipitation, snowpack depth, snowmelt timing, flow regimes (high and low flows), soil moisture, drought, air temperature, extreme low temperature events Disturbance regimes: Flooding & erosion, wildfire Non-climate sensitivities: Dams & water diversions, invasive & problematic species

Alluvial scrub habitats are critically sensitive to climate drivers and disturbance regimes that alter hydrologic, flooding, and scouring regimes and/or that alter moisture availability, as these factors affect habitat distribution, composition, and survival. Other factors (e.g., temperature, wildfire) are also likely to affect vegetation and associated wildlife communities. Alluvial scrub habitats are also very sensitive to non-climatic drivers that exacerbate climate-driven changes. For example, dams and water diversions compound hydrological shifts, and invasive species can directly compete with alluvial scrub vegetation for increasingly limited resources.

Adaptive Capacity	Habitat extent, integrity, and continuity: Low-moderate geographic extent, low integrity (i.e., degraded), low-moderate continuity Resistance and recovery: Moderate resistance, moderate-high recovery potential

---

[1] Confidence: High

Habitat diversity: Low-moderate overall diversity
Management potential: Moderate-high societal value and management potential

Large portions of alluvial scrub habitat have been lost as a result of human activity, resulting in isolated habitat patches along unaltered streams and alluvial outwashes. A variety of landscape barriers, in addition to the soil requirements of component vegetation, limit habitat connectivity and may reduce alluvial scrub dispersal opportunities in response to climatic stressors. However, alluvial scrub communities are disturbance-adapted and feature moderate diversity, which may enhance their resilience in the face of climate change. Alluvial scrub habitats provide a variety of ecosystem services (e.g., biodiversity, flood and erosion protection). Potential management options identified by habitat experts largely deal with maintaining hydrological regimes in existing habitats and minimizing non-climatic stressors (e.g., invasive species, development/alteration of existing habitat).

Sensitivity

The overall sensitivity of alluvial scrub habitats to climate and non-climate stressors was evaluated to be moderate-high by habitat experts.[2]

Sensitivity to climate and climate-driven changes

Habitat experts evaluated alluvial scrub habitats to have moderate-high sensitivity to climate and climate-driven changes,[3] including: precipitation, snowpack depth and snowmelt timing, flow regimes (high and low flows), soil moisture, drought, and air temperature (including low temperature events).[4]

Altered hydrology (soil moisture, precipitation, snowpack, drought,[5] flow regimes)

Soil texture and subsurface moisture influence alluvial scrub species composition and distribution (Hanes et al. 1989). For example, annual precipitation typically increases with elevation, and field studies have shown pioneer alluvial scrub species to be associated with lower elevations and less annual precipitation and intermediate and mature alluvial scrub plant communities to be associated with higher elevations and higher annual precipitation (Buck-Diaz et al. 2011). Increased moisture deficits associated with climate change may prevent succession to mature vegetation (Hanes et al. 1989) and/or cause conversion to more xeric plant communities (e.g., coastal sage scrub), particularly in areas farther from the stream channel that are inundated less frequently (Smith 1980). Shifts in precipitation and hydrological changes are also likely to impact the abundance, germination, and seed production of annual species present (Allen 1996; Harris 1987; Sclafani 2013). For example, low precipitation years may reduce abundance and establishment of native annuals such as the slender-horned spineflower (*Dodecahema leptoceras*), while high precipitation years may favor establishment and result in

---

[2] Confidence: High

[3] Confidence: Moderate

[4] Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found at the end of this document.

[5] Habitat experts identified drought as a climate stressor, but did not provide any additional comments, and no supporting information could be found in the literature.

population increases (Allen 1996; Sclafani 2013). Similarly, reduced annual precipitation may negatively affect cryptobiotic soil crust species, which flourish during wet periods (Jigour et al. 2001).

Alluvial scrub communities are adapted to periodic flooding (Hanes et al. 1989) due to seasonal snowmelt hydrograph peaks as well as short, high-volume precipitation events characteristic of southern California (Safford and Quinn 1998; Wood and Wells 1996). Changes in precipitation, snowpack, and snowmelt timing are likely to interact with human watershed management to affect soil moisture, flow volumes, and scouring and sedimentation regimes, which may affect the succession, composition, and persistence of alluvial scrub vegetation (Hanes et al. 1989; Harris 1987; Harvey 2002). For example, reduced flood frequency due to climate- or human-driven changes in hydrologic regimes may homogenize alluvial scrub stand age and structure by reducing the number of early seral communities (U.S. Fish and Wildlife Service 2009; Western Riverside County (WRC) 2003), degrading habitat value for wildlife (U.S. Fish and Wildlife Service 2009).

Temperature

Temperature influences alluvial scrub species composition (Buck-Diaz et al. 2011; Orr et al. 2011), establishment (Haner 1984), and survival (Sclafani 2013). For example, hot conditions can prevent alluvial scrub establishment (Haner 1984) and regeneration (Smith 1980). The diverse associations of alluvial scrub communities contribute to variable temperature sensitivity. For example, some alluvial scrub species (e.g., *Lepidospartum squamatum*) exhibit winter dormancy, which may allow them to survive freezing periods. By contrast, other alluvial scrub associates have winter growth periods (e.g., *Eriogonum fasciculatum* var. *foliolosum*, *E. f.* var. *polifolium*, *Artemisia californica*) or are common associates of coastal sage scrub (i.e. are more adapted to mild temperatures), which may make them more sensitive to cold events (Vulnerability Assessment Reviewers, pers. comm., 2015). Overall, shifts in minimum winter temperatures are likely to affect the distribution and species composition of alluvial scrub vegetation (Vulnerability Assessment Reviewers, pers. comm., 2015), and increasingly warm conditions may alter establishment and mortality patterns (Haner 1984; Smith 1980). Increasing annual temperatures may also impact alluvial scrub communities by driving shifts from snow to rain (Hayhoe et al. 2004; Sun et al. 2015), which will likely cause hydrological alterations in this habitat (Vicuna and Dracup 2007).

Sensitivity to disturbance regimes

Habitat experts evaluated alluvial scrub habitats to have low-moderate sensitivity to disturbance regimes[6], including: flooding and erosion and wildfire.[7] Disease and wind also shape this habitat, but to a lesser degree (Vulnerability Assessment Reviewers, pers. comm., 2015).

---

[6] Confidence: Moderate

[7] Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found at the end of this document.

Flooding and erosion

Alluvial scrub is adapted to infrequent but severe flooding, erosion, and sedimentation events (Hanes et al. 1989; Smith 1980), which deliver new nutrients and organic matter, redistribute sediments, and facilitate succession and spatial diversity within alluvial scrub habitat (Hanes et al. 1989; Jigour et al. 2001; Kirkpatrick and Hutchinson 1977; Safford and Quinn 1998; Wirka 1997 and citations therein). Several important alluvial scrub species are resilient to flood shear and can recolonize sediments from severed roots and rhizomes (e.g., *Eriodictyon* spp., *L. squamatum*), but many species colonize fresh sediments from seed (Sclafani 2013; for further discussion, see Resistance and Recovery section below). Different sets of species tend to colonize and persist in sediments of different ages and compositions which results in a diverse set of alluvial scrub plant communities (Hanes et al. 1989; Smith 1980).

The location and composition of substrates within floodplains depends on many factors (Haner 1984). Channel morphology, slope, age and type of parent materials, flood frequency, flood velocity, flood depth and presence of vegetation islands interact to influence how different particle sizes sort themselves out across the floodplain. Subsequent surface erosion, including wind erosion, provides the opportunity for deposition and incorporation of fine particles (including organics) downward into the initially porous, typically sandy/gravely substrates (Haner 1984; Hanes et al. 1989; Safford and Quinn 1998; Smith 1980; Wood and Wells 1996). Recognizable zones with different disturbance regimes and substrate qualities form across floodplains and have been examined for associations with their vegetation communities (e.g., see Barbour and Wirka 1997, Burk et al. 2007, Hanes et al. 1989, Smith 1980), and different combinations of plants tend to occupy the different zones. For example, flooding during 1938 and 1969 in southern California created distinct terraces along stream channels, which now feature various successional species assemblages (Hanes et al. 1989; Smith 1980).

Although alluvial scrub communities are adapted to flooding, prolonged inundation and accumulation of silt and clay particles as a result of landscape and hydrological alterations can lead to the colonization and dominance of different plant communities (e.g., more mesic species; Burk et al. 2007; Jigour et al. 2001). Alluvial scrub soils drain fairly quickly, but dikes, dams and other features slow runoff, constrain flows, and change the pattern of floods important to rejuvenation of alluvial scrub plant communities (Barbour and Wirka 1997; Burk et al. 2007; Hanes et al. 1989).

Wildfire

Fire resets alluvial scrub succession, alters species composition, and releases nitrogen, which facilitates fertilization (Safford and Quinn 1998), but finer details regarding the frequency and the role of fire in alluvial scrub maintenance and development are not well understood (WRC 2003). Many alluvial scrub species are fire-adapted; most of the common shrubs and subshrubs in alluvial scrub communities are facultative seeders, and some common annuals germinate readily after fire (Keeley et al. 2006; Sclafani 2013). Analysis of survey data from 2010-11 found that the highest fire frequency was associated with the Scalebroom (*L. squamatum*)-California buckwheat (*E. fasciculatum*) association relative to other alluvial vegetative groupings, and the longest time between fires was associated with the *L. squamatum-Eriodictyon trichocalyx-*

Hesperoyucca whipplei and *L. squamatum*/mixed ephemeral annuals associations (Buck-Diaz et al. 2011). Fire may be less likely in pioneer stands in the most recently flooded zones due to reduced fuel availability (WRC 2003). In general, increased human activity adjacent to alluvial scrub stands (e.g., development) can increase fire risk (Safford and Quinn 1998). Shifting fire regimes, as well as shifting flood regimes and other ground disturbance, may also negatively impact native ground-dwelling insects (Cane 1991; Williams et al. 2010), which alluvial scrub species utilize for pollination and seed dispersal (Atallah and Jones 2003; DeSimone and Zedler 1999; Dorsett et al. 2001; Hobbs 1985; Moldenke 1976; Moldenke and Neff 1974; Montalvo and Beyers 2010; Sclafani 2013).

Disease

Root infections (e.g., *Phytophthora*) thrive under moist conditions (Swain 2002) and may be more common in alluvial scrub habitats (e.g., on fans and upper alluvial terraces) during summer storm flood periods (Vulnerability Assessment Reviewers, pers. comm., 2015).

Sensitivity and current exposure to non-climate stressors

Habitat experts evaluated alluvial scrub habitats to have high sensitivity to non-climate stressors,[8] with an overall high exposure to these stressors within the study region.[9] Key non-climate stressors identified by habitat experts for alluvial scrub habitats include dams and water diversions and invasive and other problematic species.[10] Habitat experts also identified land-use conversion, recreation, transportation corridors, and energy production and mining as non-climate stressors for alluvial scrub habitats.[11] The scientific literature additionally suggests that fire suppression may also affect this habitat. Habitat experts evaluated alluvial scrub exposure to most non-climate stressors to be fairly consistent across the study region, with the exception of recreation and invasive species; experts indicated recreation impacts occur in more localized areas, and invasive species, though present throughout the study area, exhibit patchy invasion of alluvial scrub habitats (Vulnerability Assessment Reviewers, pers. comm. 2015).

Dams, water diversions, and flood control structures

Water demands (including surface and groundwater withdrawals) and flood-control projects alter alluvial scrub community composition and threaten the integrity and persistence of this habitat type by altering flooding and scouring regimes, water supply (Burk et al. 2007; Hanes et al. 1989; Rundel 2007; Safford and Quinn 1998; Sclafani 2013), and connectivity to river and stream systems. For example, debris basins interrupt sediment delivery to downstream habitats (BonTerra Consulting 2010), which can alter scour patterns in alluvial scrub communities and reduce nutrient delivery via new sediment (Hanes et al. 1989; Jigour et al. 2001). In addition, alluvial vegetation that establishes in these debris basins may be removed during routine basin maintenance (BonTerra Consulting 2010). Similarly, stream channelization associated with

---

[8] Confidence: High

[9] Confidence: High

[10] Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found at the end of this document.

[11] Not all habitat experts agreed on these non-climate stressors.

water projects can cause a variety of alterations to natural stream function and processes (Paul and Meyer 2001; Walsh et al. 2005), impacting adjacent alluvial scrub habitats.

Current and planned water infiltration areas (e.g., infiltration ponds), which are designed to collect water for aquifer infiltration, can significantly alter and/or displace alluvial scrub vegetation (Safford and Quinn 1998). Percolation ponds and related infrastructure can increase and prolong inundation in alluvial scrub communities, potentially resulting in a shift toward more mesophytic vegetation, whilst simultaneously decreasing soil moisture elsewhere in the alluvial fan, affecting alluvial scrub species composition (Safford and Quinn 1998). Pond construction can also physically remove alluvial scrub vegetation and result in altered vegetation communities (e.g., as has occurred below the Seven Oaks Dam on the upper main stem of the Santa Ana River; A. Montalvo, pers. comm., 2015). Infiltration areas and other water control structures can interact with climate-driven shifts in disturbance regimes to significantly affect soil moisture and alluvial scrub community composition (Safford and Quinn 1998). Further, climate change may increase demand for these structures (Tanaka et al. 2006).

Invasive and other problematic species

Exotic grasses and other invasive species may increase competition, reduce fitness, and/or depress abundance of native alluvial scrub vegetation, particularly annuals (Allen 1996; Safford and Quinn 1998). Invasive species have been introduced via agriculture, development, and transportation corridors, and continue to threaten this habitat (Safford and Quinn 1998; Sclafani 2013), particularly under shifting climatic conditions (e.g., shifting summer precipitation patterns). Invasions are patchy in distribution (Vulnerability Assessment Reviewers, pers. comm., 2015).

Transportation corridors, recreation

Transportation corridors and recreation, including off-highway vehicle (OHV) use, can contribute to habitat fragmentation, degradation, and disturbance (Safford and Quinn 1998; Sclafani 2013). For example, transportation corridors and associated levees often constrict or fill flood channels, altering natural flooding, scouring, and hydrological regimes (Vulnerability Assessment Reviewers, pers. comm., 2015). Transportation corridors and illegal recreation activities can also facilitate invasive species establishment and dominance (Vulnerability Assessment Reviewers, pers. comm., 2015). Illegal OHV use can undermine native vegetation recovery/colonization in a drier climate by compacting soil (Vulnerability Assessment Reviewers, pers. comm., 2015). However, some alluvial scrub species may be able to colonize tire tracks and old roadbeds (Allen 1996; Safford and Quinn 1998).

Land use conversion

Agricultural and urban development has destroyed a large portion of alluvial scrub habitat (Allen 1996; Hanes et al. 1989; Rundell 2007; Safford and Quinn 1998; Wood and Wells 1996) outside of national forest lands in southern California. Land use conversion can also act as a physical barrier to vegetation dispersal (Vulnerability Assessment Reviewers, pers. comm., 2015). Urban development changes runoff and percolation patterns, affecting flood regimes and the formation of fans and axial washes (Safford and Quinn 1998; Scott 1973), effects that will likely be exacerbated under changing climate conditions (altered flooding regimes; Vulnerability Assessment Reviewers, pers. comm., 2015). Pollution from residential and urban runoff can degrade or destroy alluvial scrub habitat (WRC 2003), and increased human activity can increase fire risk (Safford and Quinn 1998). In general, human disturbance can reset alluvial scrub succession, interrupt habitat continuity, and/or threaten community persistence (Vulnerability Assessment Reviewers, pers. comm., 2015).

Energy production and mining

Rock and sand mining in floodplain alluvium can destroy alluvial scrub habitat, remove key sediment (Hanes et al. 1989), kill component vegetation (Allen 1996), and contribute to establishment of non-native species (Sclafani 2013). Southern California has a long history of aggregate and sand mining, including activity in Tujunga Wash (Scott 1973), Temescal Wash, tributaries to the Santa Ana River and mainstem, the upper Santa Ana River below Seven Oaks Dam, and below national forest land in Lytle Creek (e.g., see City of Rialto 2012, San Bernardino Valley Water Conservation District 2008). Desert alluvial scrub habitats are also vulnerable to shifting flooding regimes as a result of energy farms (Vulnerability Assessment Reviewers, pers. comm., 2015). Fracking may also affect this habitat by removing water from stream and river systems (Bryce et al. 2012). Fracking is occurring in the Los Padres National Forest and expanding in Los Angeles County (Vulnerability Assessment Reviewers, pers. comm., 2015).

Fire suppression

Fire suppression has increased over the last century in order to protect developments. However, suppression has contributed to altered fuel profiles in both alluvial scrub and adjacent vegetation communities (chaparral, sage scrub; Safford and Quinn 1998), perpetuating the risk of altered fire regimes under climate change. In addition, fire suppression can contribute to invasive species establishment (Vulnerability Assessment Reviewers, pers. comm., 2015).

Future Climate Exposure

Habitat experts evaluated alluvial scrub habitats to have high exposure to projected future climate and climate-driven changes,[12] and key climate variables to consider include: increased air temperature and drought, precipitation changes, increased wildfire, decreased soil moisture, and altered streamflows (Table 1).[13] For a detailed overview of how these factors are projected to change in the future, please see the Southern California Climate Overview (http://ecoadapt.org/programs/adaptation-consultations/socal). In general, refugia from changing climate conditions are less likely to exist for alluvial scrub in comparison to other vegetation types because terrain exerts a strong influence on the location and formation of alluvial deposits (i.e., higher elevations are steeper and rockier and support less alluvial deposits; Vulnerability Assessment Reviewers, pers. comm., 2015).

---

[12] Confidence: High

[13] Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found at the end of this document.

Table 1. Anticipated alluvial scrub responses to climate and climate-driven changes.

Climate and climate-driven changes	**Anticipated alluvial scrub response**
Hydrology *Variable annual precipitation volume and timing; increased climatic water deficit; longer and more severe droughts with drought years twice as likely to occur; shifting flow regimes (increased winter flow, decreased summer flow)*	• Altered species composition and recruitment; dry years may inhibit annual plant establishment • Altered succession patterns; dry conditions may prevent succession to mature communities • Potential conversion to more xeric soils and species if moisture declines
Air temperature *+2.5 to +9°C by 2100*	• Altered distribution • Altered species composition; freeze-sensitive vegetation may have more growth opportunities, but hot conditions may alter annual plant establishment and survival • Altered species composition and succession patterns due to related shifts in hydrology
Flooding regimes *Increased winter flood volume and frequency; reduced spring flood volume*	• Shifts in habitat location • Altered seasons for colonization • Altered succession patterns and seral structure; increased flooding will likely promote habitat heterogeneity • Altered species composition • Altered pollination and dispersal due to flooding impacts on native ground-dwelling insects
Wildfire *Increased fire size, frequency, and severity*	• Effects largely unknown • More frequent fire may alter species composition and impede vegetation recovery • Altered pollination and dispersal due to fire impacts on native ground-dwelling insects

Hydrology

Shifts in precipitation (including shifts from snow to rain) that alter flood regimes and alluvial fan processes will likely affect alluvial scrub vegetation composition and distribution (Harvey et al. 2002; Safford and Quinn 1998). For example, climatically induced flow regime shifts may cause heightened channel incision and reduced sedimentation, contributing to alluvial fan base level changes and affecting fan evolution and component vegetation (Harvey et al. 2002). Shifting flow regimes may also change patterns of scour and deposition on axial wash deposits, affecting vegetation (Harvey et al. 2002). Shifts in precipitation timing, particularly summer rains, may also alter invasive species composition, establishment, and dominance in alluvial scrub habitats (Vulnerability Assessment Reviewers, pers. comm., 2015). Reduced snowpack and earlier snowmelt timing may affect the seasonal duration and depth of intermittent streamflows and groundwater recharge, resulting in altered hydrology in different alluvial areas and affecting the distribution and persistence of alluvial scrub vegetation communities (A. Montalvo, pers. comm., 2015).

Wildfire

Shifts in wildfire frequency would likely affect alluvial scrub species composition and long-term population structure (Safford and Quinn 1998) and frequent fires are likely to be detrimental to habitat recovery (Vulnerability Assessment Reviewers, pers. comm., 2015). Alluvial scrub vegetation associations that feature common sage scrub or chaparral associates will likely exhibit similar responses to those habitat types (Keeley et al. 2005; see sage scrub and chaparral habitat syntheses).

Adaptive Capacity

The overall adaptive capacity of alluvial scrub habitats was evaluated to be moderate by habitat experts.[14]

Habitat extent, integrity, continuity and permeability

Habitat experts evaluated alluvial scrub habitats to have a low-moderate geographic extent (i.e., habitat is quite limited within the study region),[15] low integrity (i.e., habitat is degraded),[16] and feature low-moderate continuity (i.e., only some habitat patches are connected).[17] Habitat experts identified dams and water diversions, transportation corridors, energy production and mining, and geologic features as barriers to habitat continuity and dispersal for this ecosystem type.[18]

In southern California, alluvial scrub habitats are most commonly found in floodplains at canyon mouths on the western side of the San Gabriel, San Bernardino, and San Jacinto ranges (Hanes et al. 1989; Safford and Quinn 1998), and on all sides of the Santa Ana Mountains (A. Montalvo, pers. comm., 2015). Alluvial scrub also grows in other riverine, floodplain, and wash habitats throughout southern California (Hanes et al. 1989). Historically, alluvial scrub habitat was widely distributed and extensive in southern California, but a variety of human activities (e.g., agriculture, development, mining, dams and water diversions) have eliminated a majority (90-95%) of historical habitat (Hanes et al. 1989; Orr et al. 2011 and citations therein; Safford and Quinn 1998; Wirka 1997). Current alluvial scrub habitats are fairly isolated, restricted only to unaltered streams and alluvial fan outwashes (Hanes et al. 1989; Safford and Quinn 1998; WRC 2003), and connectivity varies. For example, alluvial scrub habitat is patchy but connected along a given stream or river course, but connectivity between different alluvial fans is low (Vulnerability Assessment Reviewers, pers. comm., 2015). In addition to barriers noted by habitat experts, alluvial scrub habitat continuity and dispersal may also be affected by the soil requirements and various dispersal capabilities of different species (Allen 1996; Hanes et al. 1989; Safford and Quinn 1998; Sclafani 2013).

Resistance and recovery

Habitat experts evaluated alluvial scrub habitats to have moderate resistance to climate stressors and maladaptive human responses,[19] and moderate-high recovery potential.[20] As a

---

[14] Confidence: High

[15] Confidence: High

[16] Confidence: Moderate

[17] Confidence: Moderate

[18] Barriers presented are those ranked most critical by habitat experts. A full list of evaluated barriers can be found at the end of this document.

[19] Confidence: Moderate

disturbance-adapted community, alluvial scrub may be fairly resilient and able to recover if given time and space (Safford and Quinn 1998). Further, component alluvial scrub species have diverse reproductive capacities, which may enhance overall habitat resilience (A. Montalvo, pers. comm., 2015).[21] For example, after scouring floods, several important shrubs reestablish readily from extensive root and rhizome systems, including *L. squamatum, Eriodictyon crassifolium,* and *E. trichocalyx*. *Malosma laurina* also resprouts after floods, but can colonize readily from seed. Most of the common shrubs and subshrubs in alluvial scrub are facultative seeders and some of the common annuals germinate readily after fire (Keeley et al. 2006). For example, the *Eriodictyon* species has tiny, highly dormant seeds that germinate post-fire (Keeley et al. 2006). Unlike *Eriodictyon*, *L. squamatum* seeds are short-lived and are not adapted to fire, but the seeds disperse by wind in the late fall and germinate readily in open, moist sandy alluvium. *E. fasciculatum* also establishes primarily from seed, but partially buried plants can sometimes resprout. Several rare plants of alluvial scrub establish only from seeds, including *Eriastrum densifolium* ssp. *sanctorum*, *Dodecahema leptoceras*, *Chorizanthe parryi* var. *parryi,* and *C. leptotheca*.

Habitat diversity

Habitat experts evaluated alluvial scrub habitats to have low-moderate physical and topographical diversity,[22] moderate component species diversity,[23] and low-moderate functional group diversity.[24] Alluvial scrub is adapted to porous substrates with low nutrient levels, including Riverwash Association soils (most commonly found along river channels and composed of sand, gravel, cobbles, and stones) and Soboba Association soils (found along outwash terraces and alluvial fans and composed of alluvium; Hanes et al. 1989; National Cooperative Soil Survey 2015).

Alluvial scrub habitats are structurally complex (Kirkpatrick and Hutchinson 1977). Local site conditions and variable flood intervals, magnitudes, and intensities result in different successional stages of alluvial shrub vegetation (Hanes et al. 1989; Safford and Quinn 1998; Smith 1980; Wirka 1997). Successional stages have been described as pioneer, intermediate, and mature (Smith 1980), but later studies recognize these categories as too simplistic (Barbour and Wirka 1997; Buck-Diaz et al. 2011; Burk et al. 2007; Wirka 1997). Generally, there is a progression in vegetation composition observed on different terraces, progressing outward and upward from the more frequently flooded wash channel (Burk et al. 2007; Hanes et al. 1989). Pioneer species are typically sparsely located in the younger and more actively flooded locations, and include scalebroom and California buckwheat (Barbour and Wirka 1997; Burk et al. 2007). Intermediate communities include a variety of dense subshrubs and drought-deciduous shrubs (Hanes et al. 1989). More mature communities associated with an accumulation of fine soil particles include fully developed subshrubs and larger, long-lived evergreen woody shrubs (Burk et al 2007; Hanes et al. 1989). However, succession is highly

---

[20] Confidence: Moderate

[21] All information after this citation also comes from A. Montalvo, pers. comm., 2015, except where noted.

[22] Confidence: High

[23] Confidence: High

[24] Confidence: High

variable at the site level, and long-established communities can include variable densities of species from all three successional stages (Barbour and Wirka 1997; Wirka 1997).

Alluvial scrub habitats are floristically diverse (Kirkpatrick and Hutchinson 1977; Wirka 1997) and support a diversity of rare animal species. Alluvial scrub vegetation tends to include more mesic species than other scrub habitat such as coastal sage scrub. Scalebroom is the main indicator species of most alluvial scrub communities in southern California (Buck-Diaz et al. 2011), and is found in all successional stages (Hanes et al. 1989), but some older alluvial scrub plant communities on finer substrates lack scalebroom (Barbour and Wirka 1997; Buck-Diaz et al. 2011). In San Diego County, scalebroom tends to be replaced by broom baccharis (*Baccharis sarothroides*) as an indicator species (Smith 1996). Other common alluvial scrub species include: California buckwheat, California sagebrush (*A. californica*), white sage (*Salvia apiana*), deerweed (*Acmispon glaber*), prickly pear (*Opuntia* spp.), yerba santa (*Eridictyon trichocalyx* and *E. crassifolium*), and chaparral yucca (*Hesperoyucca whipplei*) (Barbour and Wirka 1997). Alluvial scrub communities also feature diverse cryptobiotic soil crusts that include lichens, mosses, liverworts, and cyanobacteria that thrive during wet periods (Allen 1996; Jigour et al. 2001). Alluvial scrub habitats can also include annual spring wildflowers, chaparral and desert species, and some small riparian woodland species, though the latter groups are typically found only in intermediate or mature vegetation communities and are often stunted (Barbour and Wirka 1997; Hanes et al. 1989; Jigour et al. 2001; Safford and Quinn 1998). Analysis of surveys of alluvial scrub communities from the Santa Ana River Watershed detailed over 438 vascular plant species and classified vegetation into 10 different alliances[25] and 12 different associations (Buck-Diaz et al. 2011), demonstrating the diversity and species richness of this habitat type.

Some species within alluvial scrub habitats may be more vulnerable to climate change impacts. For example, annual species and short-lived perennials are likely more vulnerable to annual climatic fluctuations due to short life spans (Vulnerability Assessment Reviewers, pers. comm., 2015). Other species may also experience enhanced vulnerability due to current threatened or endangered status. For example, two alluvial scrub species, the Santa Ana River woolly-star (*Eriastrum densifolium* spp. *sanctorum*) and slender-horned spineflower, are classified as endangered species and are endemic to only a few watersheds of southern California (Allen 1996; Atallah and Jones 2003; Barbour and Wirka 1997; Brunell and Rieseberg 1993; Hanes et al. 1989; Sclafani 2013; Wood and Wells 1996). Limited distribution and population sizes make these species vulnerable to changes in flood regimes and deposition patterns in their current habitat area. In addition, some populations of these species are located in areas prioritized for human use (e.g., mining, percolation pond construction; Vulnerability Assessment Reviewers, pers. comm., 2015). Additionally, the alluvial scrub alliance *L. squamatum* is ranked as G3:S3 by the California Department of Fish and Wildlife (California Department of Fish and Wildlife [CDFW] 2010), indicating that this association is rare and threatened throughout its range, and highly imperiled within the state (CDFW 2015).

---

[25] An alliance is defined as “a generic unit that is usually represented by dominant and/or characteristic plant species in the upper layer of vegetation” (Buck-Diaz et al. 2011).

Management potential

Habitat experts evaluated alluvial scrub habitats to be of moderate-high societal value.[26] Alluvial scrub habitats are valued for their aesthetics, recreational opportunities (e.g., hiking), rare species, and as tribal cultural and archaeological sites (Vulnerability Assessment Reviewers, pers. comm., 2015). Alluvial scrub habitats provide a variety of ecosystem services, including: biodiversity, water supply/quality/sediment transport, recreation, carbon sequestration, and flood and erosion protection (Vulnerability Assessment Reviewers, pers. comm., 2015).

Habitat experts ranked the potential for managing or alleviating climate impacts on alluvial scrub habitats as moderate-high.[27] Habitat experts identified the following actions as potential management options for alluvial scrub habitats, but commented that actions taken will depend largely on direction and rate of climate changes: maintenance of water flow through habitat; removal of structures (dams/levees) that constrict flows or affect sediment transport; structural additions to slow flow velocity; habitat restoration and revegetation; invasive species monitoring and removal; and protection of alluvial scrub through archaeological/cultural site protection. Safford and Quinn (1998) also outlined potential management strategies for alluvial scrub habitats, including: maintaining connectivity of outwash fans; maintaining intact alluvial scrub habitat with minimal or no human disturbance; maintaining fire and flooding regimes; limiting development in alluvial fans; and preserving/maintaining as many distinct alluvial scrub stands as possible.

Recommended Citation

Reynier, W.A., L.E. Hillberg, and J.M. Kershner. 2016. Southern California Alluvial Scrub Habitats: Climate Change Vulnerability Assessment Synthesis. Version 1.0. EcoAdapt, Bainbridge Island, WA.

This document is available online at the EcoAdapt website (http://ecoadapt.org/programs/adaptation-consultations/socal).

Literature Cited

Atallah, Y. C., and Jones, C. E. (2003). Assessing the reproductive biology of Eriastrum densifolium subsp.sanctorum (Santa Ana River Woolly Star, Polemoniaceae). *Madroño, 50*(2), 101-109.

Allen, E. B., Ferguson, N., Kee, S., & Vasquez, L. (1996). *Characterizing the habitat of slender-horned spineflower (Dodecahema leptoceras): Ecological analysis. Final report to the California Department of Fish and Game.* Riverside, CA: University of California, Riverside. Retrieved from https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3123

Barbour, M. G., & Wirka, J. (1997). *Classification of alluvial scrub in Los Angeles, Riverside and San Bernardino Counties*. Retrieved from https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3125

BonTerra Consulting. (2010). *Initial study/mitigated negative declaration: Section 1605 long-term streambed alteration agreement for the debris basin maintenance program. Report prepared for the County of Los Angeles, Department of Public Works on behalf of Los Angeles County Flood Control District*. Pasadena, CA: BonTerra Consulting. Retrieved from https://dpw.lacounty.gov/LACFCD/files/mnd.pdf

---

[26] Confidence: Moderate

[27] Confidence: Moderate

Brunell, M. S., & Rieseberg, L. H. (1993). Genetic variation in the endangered Santa Ana River woolly-star, Eriastrum densifolium ssp. sanctorum (Polemoniaceae). *Plant Species Biology*, *8*(1), 1–6.

Bryce, S. A., Strittholt, J. R., Ward, B. C., & Bachelet, D. M. (2012). *Colorado Plateau rapid ecoregional assessment report. Prepared for the U.S. Department of the Interior, Bureau of Land Management*. Denver, CO: Bureau of Land Management. Retrieved from http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/coloplateau.html#memo

Buck-Diaz, J., Evens, J., & Montalvo, A. (2011). *Alluvial scrub vegetation of southern California, a focus on the Santa Ana River watershed In Orange, Riverside, and San Bernardino Counties, California*. Retrieved from http://www.cnps.org/cnps/vegetation/pdf/alluvial_scrub-diaz_evans2011.pdf

Burk, J. H., Jones, C. E., Ryan, W. A., & Wheeler, J. A. (2007). Floodplain vegetation and soils along the upper Santa Ana River, San Bernardino County, California. *Madroño, 54*(2), 126-137.

California Department of Fish and Wildlife (CDFW). (2015). Natural communities – background information. Accessed November 2015. https://www.dfg.ca.gov/biogeodata/vegcamp/natural_comm_background.asp

California Department of Fish and Wildlife (CDFW). (2010). List of vegetation alliances and associations. Vegetation Classification and Mapping Program, California Department of Fish and Game. Sacramento, CA. Accessed September 2010. http://dfg.ca.gov/biogeodata/vegcamp/natural_comm_list.asp

Cane, J. H. (1991). Soils of ground-nesting bees (Hymenoptera: Apoidea): Texture, moisture, cell depth and climate. *Journal of the Kansas Entomological Society, 64*(4), 406-413.

City of Rialto. (2012). *Lytle Creek Ranch Specific Plan*. Rialto, CA: City of Rialto. Retrieved from http://www.yourrialto.com/wp-content/uploads/2016/09/Lytle%20Creek%20Ranch%20Specific%20Plan.pdf

DeSimone, S. A., & Zedler, P. H. (1999). Shrub seedling recruitment in unburned Californian coastal sage scrub and adjacent grassland. *Ecology, 80*(6), 2018-2032.

Dorsett, D. K., Jones, C. E., & Burk, J. H. (2001). The pollination biology of Eriastrum densifolium ssp. sanctorum (Polemoniaceae), an endangered plant. *Madroño, 48*(4), 265-271.

Haner, B. E. (1984). Santa Ana River: An example of a sandy braided floodplain system showing sediment source area imprintation and selective sediment modification. *Sedimentary Geology, 38*(1), 247-261.

Hanes, T. L., Friesen, R. D., & Keane, K. (1989). Alluvial scrub vegetation in coastal southern California. In D. L. Abell (Ed.), *Proceedings of the California riparian systems conference: Protection, management, and restoration for the 1990s: September 22-24, 1988; Davis, CA* (pp. 187–193). (Gen. Tech. Rep. PSW-GTR-110). Berkeley, CA: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. Retrieved from http://www.treesearch.fs.fed.us/pubs/27966

Harris, R. R. (1987). Occurrence of vegetation on geomorphic surfaces in the active floodplain of a California alluvial stream. *The American Midland Naturalist*, *118*(2), 393–405.

Harvey, A. (2002). The role of base-level change in the dissection of alluvial fans: Case studies from southeast Spain and Nevada. *Geomorphology, 45*(1), 67-87.

Hayhoe, K., Cayan, D., Field, C. B., Frumhoff, P. C., Maurer, E. P., Miller, N. L., … Verville, J. H. (2004). Emissions pathways, climate change, and impacts on California. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(34), 12422–12427.

Hobbs, R. J. (1985). Harvester ant foraging and plant species distribution in annual grassland. *Oecologia, 67*(4), 519-523.

Jigour, V., Cooper, D., & Stoecker, M. (2001). *Appendix F: Habitat restoration in the Arroyo Seco Watershed*. Santa Clara, CA: Verna Jigour Associates - Conservation Ecology Services. Retrieved from http://www.arroyoseco.org/FinalReport/HabitatRestoration.pdf

Keeley, J. E., Fotheringham, C., & Baer-Keeley, M. (2006). Demographic patterns of postfire regeneration in Mediterranean-climate shrublands of California. *Ecological Monographs, 76*(2), 235-255.

Kirkpatrick, J. B., & Hutchinson, C. F. (1977). The community composition of Californian coastal sage scrub. *Vegetatio, 35*(1), 21-33.

Moldenke, A. R. (1976). California pollination ecology and vegetation types. *Phytologia, 34*, 305-361.

Moldenke, A. R., & Neff, J. L. (1974). *Studies on pollination ecology and species diversity of natural California plant communities*.

Montalvo, A. M., & Beyers, J. L. (2010). *Plant profile for Eriogonum fasciculatum. Native plant recommendations for southern California ecoregions*. Riverside, CA: Riverside-Corona Resource Conservation District and U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. Retrieved from http://www.fs.fed.us/psw/publications/beyers/psw_2010_beyers013%28montalvo%29eriogonumfasciculatum.pdf

National Cooperative Soil Survey. (2015). Soboba Series. Retrieved May 8, 2015, from https://soilseries.sc.egov.usda.gov/OSD_Docs/S/SOBOBA.html

Orr, B. K., Diggory, Z. E., Coffman, G. C., Sears, W. A., Dudley, T. L., & Merrill, A. G. (2011). *Riparian vegetation classification and mapping: Important tools for large-scale river corridor restoration in a semi-arid landscape* (pp. 212–232). Presented at the CNPS Conservation Conference, 17-19 January 2009, Sacramento, CA: California Native Plant Society. Retrieved from http://www.stillwatersci.com/resources/2011orretal.pdf

Paul, M. J., & Meyer, J. L. (2001). Streams in the urban landscape. *Annual Review of Ecology and Systematics*, 32, 333-365.

Rundel, P. W. (2007). Sage scrub. In M. G. Barbour, T. Keeler-Wolf, & A. A. Schoenner (Eds.), *Terrestrial vegetation of California* (pp. 208-228). Berkeley, CA: University of California Press.

Safford, J. M., & Quinn, R. (1998). *Conservation plan for the Etiwanda-Day Canyon drainage system supporting the rare natural community of alluvial fan sage scrub. Prepared for the California Department of Fish and Game*. Pomona, CA: California State Polytechnic University, Pomona. Retrieved from https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3127

San Bernardino Valley Water Conservation District. (2008). *Upper Santa Ana River wash land management and habitat conservation plan document*. San Bernardino Valley Water Conservation District. Retrieved from http://www.sbcounty.gov/lafco/items/2009july/item_ 8fc.pdf

Sclafani, C. J. (2013). Dodecahema leptoceras. *Fire effects information system, [online].* Retrieved May 2015, from http://www.fs.fed.us/database/feis/plants/forb/dodlep/all.html

Scott, K. M. (1973). Scour and fill in Tujunga Wash -- a fanhead valley in urban southern California -- 1969. *Geological Survey Professional Paper 732-B*.

Smith, D.S. (1996). *Composition and diversity of Diegan alluvial scrub*. (Master of Science). San Diego State University.

Smith, R. (1980). Alluvial scrub vegetation of the San Gabriel River floodplain, California. *Madroño 27*(3), 126-138.

Sun, F., Hall, A., Schwartz, M., Walton, D., & Berg, N. (2015). 21st-century snowfall and snowpack changes over the southern California mountains. *Journal of Climate*, *e-View*, 1–56.

Swain, S. (2002). Deconstructing sudden oak death. *Fremontia, 30*(1), 3-11.

Tanaka, S. K., Zhu, T., Lund, J. R., Howitt, R. E., Jenkins, M. W., Pulido, M. A., … Ferreira, I. C. (2006). Climate warming and water management adaptation for California. *Climatic Change*, *76*(3–4), 361–387.

U.S. Fish and Wildlife Service. (2009). *San Bernardino kangaroo rat (Dipodomys merriami parvus). 5-Year review: Summary and evaluation.* Carlsbad, CA: U.S. Fish & Wildlife Service. Retrieved from https://www.fws.gov/carlsbad/SpeciesStatusList/5YR/20090814_5YR_SBKR.pdf

Vicuna, S., and Dracup, J.A. (2007). The evolution of climate change impact studies on hydrology and water resources in California. *Climatic Change, 82*(3-4): 327-350.

Walsh, C. J., Roy, A. H., Feminella, J. W., Cottingham, P. D., Groffman, P. M., & Morgan, R. P. (2005). The urban stream syndrome: Current knowledge and the search for a cure. *Journal of the North American Benthological Society, 24*(3), 706-723.

Western Riverside County (WRC). (2003). *Western Riverside County multiple species habitat conservation plan*. Riverside, CA: Western Riverside County. Retrieved from http://wrc-rca.org/about-rca/multiple-species-habitat-conservation-plan/

Williams, N. M., Crone, E. E., Roulston, T. H., Minckley, R. L., Packer, L., & Potts, S. G. (2010). Ecological and life-history traits predict bee species responses to environmental disturbances. *Biological Conservation, 143*(10), 2280-2291.

Wirka, J. L. (1997). *Alluvial scrub vegetation in southern California: A case study using the vegetation classification of the California Native Plant Society*. (Master of Science). University of California, Davis.

Wood, Y., & Wells, S. (1996). *Final report: Characterizing the habitat of slender-horned spineflower (Dodecahema leptoceras): Geomorphic analysis. Prepared for the California Department of Fish and Game.* Retrieved from https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=3160