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Annotated Bibliography for Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project

Project #3754-01

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Section 1. Introduction

The California sycamore (*Platanus racemosa*) is a riparian tree native to California and northern Baja California. California sycamore is the dominant species in sycamore alluvial woodland (SAW), a habitat type defined as open to moderately closed, winter-deciduous broad-leafed riparian woodland dominated by well-spaced *Platanus racemosa* (Holland 1986), and California sycamore also occurs in the "*Platanus racemosa* woodland alliance" with various associated species (Sawyer, Keeler-Wolf, and Evens 2009). The central California sycamore alluvial woodland (SAW) habitat type is cited in the Santa Clara Valley Habitat Plan (VHP) as a "very rare and threatened land cover type," and the VHP contains various goals to conserve and restore SAW habitat. The San Francisco Estuary Institute (SFEI) and H. T. Harvey & Associates (HTH), in conjunction with the Santa Clara Habitat Agency, have undertaken the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project to assess biotic and abiotic factors that influence California sycamore stand health and regeneration. The study is intended to gather and generate data that will be used by the Santa Clara Habitat Agency to guide acquisition and management of California sycamore habitat to meet its conservation goals.

One component of the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project is this annotated bibliography of existing scientific literature pertaining to California sycamore ecology. This annotated bibliography is a product of an extensive review into documents, mapping efforts, and personal communications, and presents sources that have been determined to be relevant to understanding the factors that influence California sycamore health and regeneration in central California. The annotated bibliography is divided into the following sections by topic: General Ecology; Historical and Present Distribution; Restoration Ecology and Management; Wildlife Ecology; Geomorphology; Hydrology and Soils; and Health and Regeneration. Each item is briefly summarized and its relevance to the project is described. References that fall under multiple categories are cross-referenced within the document. Similarly, key words are indicated or each reference to highlight various subtopics affecting California sycamore ecology.

Section 2. Annotated Bibliography

2.1 General Ecology

Holland, R. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Game, Natural Heritage Division. Sacramento.

The author describes vegetation communities throughout California including Sycamore Alluvial Woodland and other communities that contain California sycamore including Central Coast Cottonwood-Sycamore Riparian Forest and Southern Cottonwood-Willow Riparian Forest. These descriptions are highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because they provide key characteristics of California sycamore habitats.

Key words: document, California sycamore, *Platanus racemosa*

Gillies, E. L., 1998. Effects of Regulated Streamflow on the Sycamore Alluvial Woodland Riparian Community. Thesis. San Jose State University, California.

The author's thesis examined the effects of altered stream flows on sycamore alluvial woodland habitat. The author presents background on historical changes and ongoing threats to sycamore alluvial woodland habitat, including reservoirs, gravel mining, changes in sediment composition, channelization, recreation, grazing, and competition with riparian vegetation and nonnative species. The physical and biological structure of eight study sites were analyzed to compare sites influenced by regulated or altered flow with sites not influenced by regulated or altered flow (control). Parameters analyzed included surficial sediment composition, vegetation composition, understory cover and composition, and abundance of nonnative and upland species, and the relationship between California sycamore regeneration and geomorphic features. California sycamore regeneration and nonnative species cover was also compared across grazed and ungrazed sites. The author found that sycamore alluvial woodland habitat differed significantly in vegetation composition and surficial sediment composition between the sites with regulated or altered flow and the control sites. The presence of nonnative species and a reduction in open ground areas were two of the greatest observed changes in regulated or altered flow sites, and the author reported that riparian species other than California sycamore have established to a greater extent at these sites. The author observed regeneration exclusively by vegetative or clonal growth with no evidence of sexual reproductive regeneration, and found a relationship that regeneration was greatest in and adjacent to primary channels and lowest on the terraces. The author found no significant differences in California sycamore regeneration between grazed and ungrazed sites. The author provides management recommendations. This thesis is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it includes a study that closely examined sycamore alluvial woodland habitat ecology in Santa Clara and Alameda Counties and examined some of the most important variables in sycamore alluvial woodland habitat restoration. The study methods presented in this thesis can be replicated on additional sites.

Key words: document, *Platanus racemosa*, California sycamore, ecology, hydrology, grazing, study, sycamore alluvial woodland.

King, J. 2004. Sycamore Grove Park Dendrochronological Investigation. February. Lone Pine Research, Bozeman, Montana. Prepared for HortScience, Inc. Pleasanton, California.

The author, a researcher from Lone Pine Research, presents techniques, graphics, photographs, and findings of a dendrochronological study that examines the impacts of climate, hydrology, and sycamore anthracnose on California sycamore at Sycamore Grove Park in Livermore, California. This report is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it provides information that could be used to conduct a similar study in Santa Clara County.

Key words: 3754-01, document, Sycamore Alluvial Woodland, California sycamore, *Platanus racemosa*, dendrochronology, sycamore hydrology, sycamore anthracnose

Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A Manual of California Vegetation. Second edition. California Native Plant Society Press, Sacramento.

The authors, researchers from Humboldt State University, CDFW, and California Native Plant Society define and describe the *Platanus racemosa* Woodland Alliance (California sycamore woodlands), including extent, habitats, rarity ranking, life history traits of California sycamore, fire characteristics, regional status, management considerations, and associations. This section of *A Manual of California Vegetation* is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes the ecology of California sycamore woodlands.

Key words: book, California sycamore, *Platanus racemosa*

Stuart, J. D. and J. O. Sawyer. 2001. Trees and Shrubs of California. University of California Press, Berkeley.

The authors, researchers from Humboldt State University, describe the morphology, habitat, and range of California sycamore. They describe California sycamore as a fast-growing and tall shade tree that helps cool streams and riparian zones and provide nesting and roosting habitat for wildlife. They state that the fungus anthracnose may occasionally completely defoliate trees; however, trees rarely die from the disease because a second set of leaves is often produced. This book is applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes physical characteristics and ecological functions.

Key words: book, California sycamore, *Platanus racemosa*, anthracnose, ecosystem functions

[USDA, NRCS] U.S. Department of Agriculture, Natural Resources Conservation Service. 2015. The PLANTS Database. Results of search for Conservation Plant Characteristics of *Platanus racemosa*, 11 August 2015. <http://plants.usda.gov>. National Plant Data Team, Greensboro, NC 27401-4901.

The authors and researchers present plant characteristics of California sycamore, including: morphology/physiology, growth requirements, reproduction, and suitability/use. This information is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it can be used to help restore and manage California sycamore.

Key words: document, California sycamore, *Platanus racemosa*, restoration

2.2 Historical and Present Distribution

Casagrande, J. M. 2010. Distribution, Abundance, Growth, and Habitat Use of Steelhead in Uvas Creek, California. Thesis. San Jose State University, California.
See section 2.6: Wildlife Ecology for full description.

Grossinger, R. M., C. J. Striplen, R. A. Askevold, E. Brewster, and E. E. Beller. 2007. Historical landscape ecology of an urbanized California valley: wetlands and woodlands in the Santa Clara Valley. Landscape Ecology 22: 103–120.
This paper briefly discusses the historical ecology of various habitat types in the Santa Clara Valley, including sycamore alluvial woodlands. The authors also discuss sycamore alluvial woodlands in the context of their merits for conservation. The authors suggest that restoring this habitat type may be a beneficial goal given projections of droughts and water quantity issues in the future, as sycamore trees appear to perform well with intermittent flows and minimal competition from dense riparian forest trees. In other words, the authors suggest restoration for this habitat type might be a prudent, cost-effective option.

Key words: journal article, historical ecology, restoration, hydrology.

Grossinger, R.M., R.A. Askevold, C.J. Striplen, E. Brewster, S. Pearce, K.N. Larned, L.J. McKee, and J.N. Collins, 2006. Coyote Creek Watershed Historical Ecology Study: Historical Condition, Landscape Change, and Restoration Potential in the Eastern Santa Clara Valley, California. Prepared for the Santa Clara Valley Water District. A Report of SFEI's Historical Ecology, Watersheds, and Wetlands Science Programs, SFEI Publication 426, San Francisco Estuary Institute, Oakland, CA.
This report synthesizes historical evidence into a picture of how Coyote Creek looked and functioned before intensive landscape modification. This new view shows how the contemporary landscape was shaped and provides an array of tools for the restoration of watershed functions, natural flood protection, and integrated water management. This report provides a better understanding of historical conditions as a basis for developing locally appropriate habitat goals and guidelines for restoration design. Understanding how habitat patterns and their controlling physical processes have been altered helps determine the relative potential for recovery, and suggests appropriate measures to implement. Historical evidence indicates that Coyote Creek's dominant riparian habitat was sycamore alluvial woodland. Now mostly eliminated along the creek (and throughout the state), this habitat of episodic, gravel-dominated Central Coast streams had a relatively open tree canopy with widely-spaced sycamores — in contrast to the densely wooded contemporary conditions.

Key words: document, historical ecology, restoration, *Platanus racemosa*, sycamore alluvial woodland

Holstein, G. 1981. California riparian forests: deciduous islands in an evergreen sea. Pages 8–10 *in* R. Warner and K. M. Hendrix, editors. California Riparian Systems. University of California Press. Berkley, California.
The author provides a taxonomic description and brief history of the *Platanus* genus in western North America and a general overview of the ecology of California sycamore. The species range and typical habitat characteristics in which they occur are described. A discussion as to why the California sycamore does not occur in the North Coast Ranges is presented, and the region's typically cool, wet spring is presented as a possible limiting factor because such conditions can promote anthracnose and stress California sycamore populations. This paper is applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes California sycamore ecology and presents cool, wet springs and

anthracnose as factors which stress California sycamore at the northwestern edge of its range in Alameda, Contra Costa, and Santa Clara Counties.

Key words: 3754-01, document, Platanus racemosa, Platanus wrightii, California sycamore, anthracnose, ecology.

H. T. Harvey & Associates. 2014. Upper Llagas Creek Flood Protection Project Mitigation Monitoring Plan California Sycamore Woodland Habitat Map Shapefile. (Geographic Information System files). Los Gatos, California.

In 2014, H. T. Harvey & Associates mapped sycamore woodland habitat on approximately 10–12 miles of Upper Llagas Creek from East Main Avenue in Morgan Hill south to approximately 1000 feet south of Buena Vista Avenue. The shapefile data provide additional mapping of sycamore stands for use in the supplemental mapping task in the California Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project. (Geographic Information System files).

Key words: GIS, Upper Llagas Creek

Keeler-Wolf, T., K. Lewis, and C. Roye. 1996. The definition and location of Sycamore Alluvial Woodland in California. State of California, Resources Agency, California Department of Fish and Game, Sacramento.

The authors, researchers at CDFG, quantitatively defined and mapped all stands of SAW in California. A total of 17 occurrences on 2032 acres were mapped. All major stands occurred on terraces along intermittent streams. This report is highly applicable to the SAW Habitat Mapping and Regeneration Studies Project because it provides a good overview of the life history requirements of SAW and descriptions of stand size, distribution and surrounding environment; adjacent vegetation and topography; estimated density and numbers of sycamore stems, age of stems, reproduction, variation in cover and association type; and impacts to and the condition of each stand. The authors list factors needed for persistence and spread of this community. They argue that the likelihood of establishing long-term, self-perpetuating SAW where stands are small or absent is remote.

Key words: document, Sycamore Alluvial Woodland, sycamore, *Platanus racemose*

Stanford, B., R. M. Grossinger, J. Beagle, R. A. Askevold, R. A. Leidy, E. E. Beller, M. Salomon, C. Striplen, A. A. Whipple. 2013. Alameda Creek watershed historical ecology study. SFEI Publication #679, San Francisco Estuary Institute, Richmond, California.

The authors, researchers from San Francisco Estuary Institute, synthesized historical data sources to understand the historical landscape of the Alameda Creek watershed and explore management implications. They described and mapped the stream network and habitat patterns in the early 1800s and how these networks and habitats changed through time. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes the historical ecology of Sycamore Alluvial Woodland in Alameda Creek watershed, which is just north of the study area. The authors give brief management and research recommendations/considerations related to sycamore regeneration.

Key words: document, Sycamore Alluvial Woodland, California sycamore, *Platanus racemosa*, historical ecology

2.3 Hybridization

Baldwin, B. G., D. H. Goldman, D. J. Keil, R. Patterson, T. J. Rosatti, and D. H. Wilken, editors. 2012. The Jepson Manual: Vascular Plants of California. Second edition. University of California Press, Berkeley.

The editors present a taxonomic key and description for the plane-tree or sycamore family (Platanaceae). This book is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it could potentially be used to distinguish California sycamore and London plane tree species in the field; however, based on genetics work conducted by Johnson et al. (in preparation), California sycamore and California sycamore-London plane tree hybrids cannot reliably be distinguished morphologically.

Key words: book, California sycamore, *Platanus racemosa*, London plane tree, *Platanus* x *hispanica*, hybridization

Holland, R. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Game, Natural Heritage Division. Sacramento.

See full description in 2.1: General Ecology

Key words: document, California sycamore, *Platanus racemosa*

H. T. Harvey & Associates. 2014. Upper Llagas Creek Flood Protection Project—California Sycamore Mitigation Assessment [technical memorandum]. January 29. Los Gatos, California. Prepared for Melissa Moore, Sunshine Julian, and Linda Spahr of the Santa Clara Valley Water District. San Jose, California.

This technical memorandum provides an overview of impacts on sycamore woodland habitat from the Upper Llagas Creek Flood Protection Project based on design plans available (approximately 90%) when the memo was written. It includes a section on California sycamore habitat restoration challenges, including issues related to hydrologic modifications of creeks, hybridization with London plane tree, sycamore anthracnose, and difficulties with propagation of California sycamore. It also describes potential California sycamore propagation research opportunities that could be employed to help advance the science of restoring sycamore-dominated habitats. This technical memorandum is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it summarizes the key issues facing California sycamore and the challenges associated with restoring sycamore-dominated habitat types.

Key words: document, sycamore, anthracnose, hybridization, restoration, hydrologic

Johnson, M. G., K. Lang, P. Manos, G. H. Golet, and K. A. Schierenbeck. 2016. Evidence for genetic erosion of a California native tree, *Platanus racemosa*, via recent, ongoing introgressive hybridization with an introduced ornamental species. Conservation Genetics 17:593–602.

The authors and researchers at Chicago Botanic Garden, California State University at Chico, Duke University, and The Nature Conservancy expanded the work of Whitlock (2003) to investigate populations of *Platanus* in northern California to determine the age structure of the invasion of London plane tree and the nature and persistence of hybridization and subsequent introgression of alleles between California sycamore and London plane tree. Their results indicate that even relatively large trees (e.g, ≥48 inch diameter at breast height) can be California sycamore-London plane tree hybrids. They found a high incidence of hybrids among intermediate age classes (29.5–48.8-inch diameter at breast height [dbh]). Thus, propagules used for restoration should be collected from large trees (e.g., ≥50 inch dbh), though they may have less viable tissue

for propagation. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it provides evidence that cuttings from California sycamore trees that are 50 inches or greater dbh are likely sources of "pure" propagules (cuttings, not seeds) that should be used for restoration.

Key words: journal article, California sycamore, *Platanus racemosa*, London plane tree, *Platanus* x *hispanica*, hybridization, restoration

Lang, K. R. 2010. Microsatellite Development of *Platanus* for Documenting Gene Flow among Species. Thesis. California State University, Chico.

The author, a researcher from California State University at Chico, developed microsatellite markers to quantify gene flow within the genus *Platanus* between the native and ornamental taxa. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because these markers can be used to predict the long-term consequences of gene movement at the regional and landscape level and to identify pure stands of California sycamore that could be propagule (cutting, not seed) sources for restoration.

Key words: document, California sycamore, *Platanus racemosa*, London plane tree, *Platanus* x *hispanica*, hybridization, genetics, restoration

Whitlock, D. L. 2003. The Hybridization of California Sycamore (*Platanus racemosa*) and the London Plane Tree (*Platanus* x *acerifolia*) in California's Riparian Woodland. Thesis. California State University, Chico.

The author, formerly a graduate student at the California State University, Chico, used molecular markers to determine whether *Platanus* seedlings grown for riparian forest restoration along the Sacramento River, California, may have been the product of hybridization between California sycamore and London plane tree. Whitlock provided an historical and evolutionary account of the genus and described extant Platanaceae species. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because the results of the study indicate that California sycamore hybridizes with London plane tree and that genetically contaminated trees were mistakenly planted as part of a large-scale native riparian restoration effort along the Sacramento River. Whitlock expressed concern that *Platanus* hybrids may be less susceptible to diseases that cause deadwood and cavities within trunks that provide important habitats for the wood duck and ringtail.

Key words: document, sycamore, *Platanus racemosa*, London plane tree, *Platanus* x *hispanica*, hybridization

Schierenbeck, Kristina. Professor. California State University, Chico. August 2015. Charles McClain of H. T. Harvey & Associates communicated with Kristina Schierenbeck via email regarding hybridization of *Platanus racemosa* with *P.* x *hispanica* (formerly known as *P.* x *acerifolia*). Telephone: 530.898.6099; email: kschierenbeck@csuchico.edu. (Personal communication).

This communication is part of a thorough search of scientific literature pertaining to Sycamore Alluvial Woodland ecology. Kristina provided a Word copy of Evidence for Genetic Pollution of a California Native Tree, *Platanus racemosa*, via Recent, Ongoing Introgressive Hybridization with an Introduced Ornamental Species (Johnson et al. 2015). The authors recently submitted this document to Conservation Genetics for publication. The document has not yet been accepted by the journal. *P. racemosa* is difficult to propagate because seed is typically contaminated with *P.* x *hispanica*. This document is applicable to the Sycamore

Alluvial Woodland Habitat Mapping and Regeneration Studies Project because genetic contamination poses a problem for restoration of Sycamore Alluvial Woodland.

Key words: personal communication, hybridization

2.4 Restoration Ecology and Management

Allen, J. A., B. D. Keeland, J. A. Stanturf, A. F. Clewell, and H. E. Kennedy Jr. 2001. A guide to bottomland hardwood restoration: U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS. U.S. Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-40, 132.

This technical report, produced by the U.S. Forest Service and the U.S. Geological Survey, describes methods to restore bottomland hardwoods (forested floodplains) in the Midwest and southeastern United States. General restoration planning considerations are discussed as well as more specific elements of floodplain restoration such as species selection, site preparation, direct seeding, planting of seedlings, and alternative options for revegetation such as cuttings, transplants, and natural revegetation. Postplanting and monitoring considerations are also addressed. Although written for restoration in the eastern U.S., the guide can be useful for the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project as a model for concise instructions concerning the handling and planting of seedlings and cuttings, including proper planting techniques and types of tool to use, are given.

Key words: document, restoration, forested wetlands

Griggs, F. T. 2009. California Riparian Habitat Restoration Handbook. River Partners. Chico, California.

This handbook, a collaborative effort between River Partners, California Partners in Flight, and the California Riparian Habitat Joint Venture, provides guidelines for planning and implementing riparian restoration projects on the ground. The goal of the handbook is to provide practitioners, regulators, land managers, planners, and funders with basic strategies and criteria to consider when planning and implementing riparian restoration projects. Case studies of statewide riparian restoration projects are included and illustrate implementation of the principles presented in the handbook. The material was developed primarily from experience with rivers in California's Central Valley, and is therefore most applicable to habitat restoration in the Central Valley and on the floodplains of coastal rivers. However, many of the concepts are applicable to other areas of the state and the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project. An overview of the major restoration objectives as they apply to other bioregions throughout California is provided in Appendix 1. Case studies of riparian restoration projects outside of the Central Valley can be found in Appendix 2.

Key words: document, restoration, hydrology

Grossinger, R. M., C. J. Striplen, R. A. Askevold, E. Brewster, and E. E. Beller. 2007. Historical landscape ecology of an urbanized California valley: wetlands and woodlands in the Santa Clara Valley. Landscape Ecology 22: 103–120.

See full description in Section 2.2: Historical and Present Distribution.

H. T. Harvey & Associates. 2014. Upper Llagas Creek Flood Protection Project—California Sycamore Mitigation Assessment [technical memorandum]. January 29. Los Gatos, California. Prepared for Melissa Moore, Sunshine Julian, and Linda Spahr of the Santa Clara Valley Water District. San Jose, California.

See full description in 2.3: Hybridization.

Hughes, F. M., A. Colston, and J. O. Mountford. 2005. Restoring Riparian Ecosystems: The Challenge of Accommodating Variability and Designing Restoration Trajectories. Ecology and Society, 10(1), 12.

This journal article discusses both variability and unpredictability in the ecological outcomes of river restoration projects. Reference systems can give a false sense of the predictability of ecological outcomes and need to be used with caution. The article also outlines possible restoration trajectories for floodplain forests. Floodplain forests have distinctive ecological characteristics that are strongly related to the variable flow regimes and sediment loads of their adjacent rivers. The most applicable part of this article for the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project is a discussion on the conditions required for the regeneration of floodplain forest trees including flows, regeneration sites, water table conditions, and propagation materials.

Key words: journal article, river restoration, restoration trajectories, reference systems, floodplain forests

ICF International 2012. Santa Clara Valley Habitat Conservation Plan. Prepared for County of Santa Clara, City of San Jose, City of Morgan Hill, City of Gilroy, Santa Clara Valley Water District, and Santa Clara Valley Transportation Authority.

The Santa Clara Valley Habitat Plan (Plan) provides a framework for the protection and recovery of endangered species, while streamlining the permitting process for planned development and maintenance activities. The Plan allows the County of Santa Clara, the Santa Clara Valley Water District, the Santa Clara Valley Transportation Authority, and the cities of Gilroy, Morgan Hill, and San Jose to receive endangered-species permits for projects they conduct and those under their jurisdictions. The Permittees are also asking CDFG to issue to them a 50-year permit that authorizes take of all covered species under the Natural Community Conservation Planning Act (NCCP Act). The NCCP Act calls for the protection of natural communities on a landscape or ecosystem level. The California Department of Fish and Wildlife considers central California sycamore alluvial woodland a sensitive biotic community. Especially relevant for the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project, the Plan reports the results of the mapping of this land cover type conducted for the HCP/NCCP.

Key words: *Platanus racemosa*, sycamore alluvial woodland

Shanfield, A. 1984. Alder, cottonwood, and sycamore distribution and regeneration along the Nacimiento River, California. Pages 196–201 *in* R. Warner and K. M. Hendrix, editors. California Riparian Systems. University of California Press. Berkley, California.

Allan Shanfield, formerly with the CDFG, assessed the distribution and regenerative status of alder, cottonwood, and sycamore along the Nacimiento River upstream from the Nacimiento Dam in northern San Luis Obispo County, CA. Five representative segments of two miles in length that extended from the late-spring waterline to the furthest extent of mesic riparian species were studied in spring 1979. Sycamore regeneration was largely clonal (i.e., trunk sprouting); however, seedlings were also present. Regeneration was typically limited to the water's edge along wide, braided floodplain, likely because of poor lateral water flows.

Sites with active regeneration had characteristics similar to those for good cottonwood regeneration. Cattle grazing may benefit sycamore regeneration by removing strong competitors such as cottonwood, which is much more palatable to livestock than sycamore. Large-scale regeneration could occur from periodic, massive flooding and depositional events coupled with cessation of limiting factors (e.g., anthracnose and competition with cottonwood). This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes factors that govern the distribution and regeneration of sycamore along a California central coast river.

Key words: book, sycamore, *Platanus racemosa*, regeneration, grazing, anthracnose, competition

Sycamore Associates. 2004. Sycamore Grove recovery program: phase 1 technical report, preliminary findings, Sycamore Grove Park, Livermore, Alameda County, California, final. Walnut Creek, California. Prepared for the Livermore Area Recreation and Park District, Livermore, CA. and Zone 7 Water Agency, Pleasanton, California.

This technical report presents the findings from Phase 1 studies of the Sycamore Grove Recovery Program. The goal of the study is to determine the cause of the severe growth decline of sycamores during the late 1980s to early 1990s. The cause of the dieback was suspected to be the modified flows on Arroyo del Valle as a result of the Del Valle Reservoir construction and subsequent managed water releases. Prior to the completion of the reservoir, flows on Arroyo del Valle followed a seasonal pattern that increased during the wet winter, decreased throughout spring and early summer, and generally ran dry by late summer/early fall. Post reservoir construction, storm water during the winter was stored and released year round to downstream users, altering the hydrologic cycle to which the trees are adapted. The study consists of hydrology analysis, increment boring analysis, root excavation analysis, and above ground evaluation of sycamore trees. This report is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project as the alteration of the grove's natural hydrologic processes by an upstream reservoir is similar to that encountered on Pacheco Creek and elsewhere in central California.

Key words: document, *Platanus racemosa*, restoration, hydrology

2.5 Grazing/Browsing

Gillies, E. L., 1998. Effects of Regulated Streamflow on the Sycamore Alluvial Woodland Riparian Community. Thesis. San Jose State University, California.

See full description under Section 2.1: General Ecology.

Sarr, D. A. 2002. Riparian livestock exclosure research in the western United States: a critique and some recommendations. Environmental Management 30:516–526.

This journal article surveys the existing research literature on the effects of livestock exclusion on many characteristics of riparian ecosystems, including vegetation, aquatic and terrestrial animals, and geomorphology. The author states that a shift in focus from simply documenting livestock effects to quantifying recovery dynamics would allow a more rigorous scientific foundation to develop from exclosure research, which will ultimately improve both biodiversity conservation and livestock management. Perhaps the greatest use of this article for the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies

Project is the exhaustive list of references at the end on all aspects of the ecological costs of livestock grazing on riparian ecosystems.

Key words: riparian ecosystems, livestock grazing, restoration

Smith, J. 2016. Effect of cattle removal upon the riparian vegetation of North Fork Pacheco Creek in Henry Coe State Park. San Jose State University, California.

This document discusses the impacts of removal of cattle grazing on one of the sites (Pacheco) in question. This paper is relevant for its discussion of the impact of disturbance regimes, specifically cattle grazing, on the impact of sycamore regeneration. The author discusses how cattle were removed from portions of the site, and tracked the subsequent patterns in regeneration. The author concludes that that sycamores are likely significantly affected under heavy cattle browsing.

Key words: document, grazing, ecology

Shanfield, A. 1984. Alder, cottonwood, and sycamore distribution and regeneration along the Nacimiento River, California. Pages 196–201 *in* R. Warner and K. M. Hendrix, editors. California Riparian Systems. University of California Press. Berkley, California.

See full description under 2.4: Restoration Ecology and Management.

Stromberg, J. C. 2002. Flood flows and population dynamics of Arizona sycamore (*Platanus wrightii*). Western North American Naturalist, 62, 170–197.

See full description under Section 2.4: Restoration Ecology and Management.

2.6 Wildlife Ecology

Belli, J. P. 2015. Movements, Habitat Use, and Demography of Western Pond Turtles in an Intermittent Central California Stream. Thesis. San Jose State University, California.

This thesis discusses the habitat use of the western pond turtle on Coyote Creek. This paper is relevant as it demonstrates some degree of western pond turtle habitat use within sycamore alluvial woodland. Turtles generally preferred deeper scour pools and complex channel habitat associated with braided channels and backwaters. Overall, this paper implies that habitat structure associated with sycamore alluvial woodlands may benefit the western pond turtle, and efforts aimed at restoring this habitat might also benefit the turtles.

Keywords: document, wildlife ecology, hydrology

Bock, C. E. and J. H. Bock. 1981. Importance of sycamores to riparian birds in southwestern Arizona. Journal of Field Ornithology 55:97–103.

The authors, researchers from University of Colorado, Boulder, describe the avifauna of riparian ecosystems in southwestern Arizona and assess the importance of Arizona sycamores (*Platanus wrightii*) to birds associated with them. Twelve summer species and seven winter species were dependent upon sycamores. Total numbers of summer birds were higher in riparian habitat with sycamores than without. Sycamores in Arizona canyons

often grow among live oaks. The authors suggest that sycamores are of value to birds because of their large size and substantial dead wood. Arizona sycamores provide food (seed and insects) and nesting/roosting cavities. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it provides evidence for the importance of a closely related native sycamore to riparian birds. Arizona sycamores provide a more open canopy, are taller, and have more cavities than California sycamore. Thus, *Platanus wrightii* may be more valuable to riparian birds than *Platanus racemosa* would be in the context of Santa Clara County.

Key words: journal article, sycamore ecology, *Platanus wrightii*, riparian habitat, ecosystem function

Casagrande, J. M. 2010. Distribution, Abundance, Growth, and Habitat Use of Steelhead in Uvas Creek, California. Thesis, San Jose State University, California

This paper describes a historical transition from a sycamore alluvial floodplain characterized by "intermittent stream flow, braided channel morphology and a sparsely vegetated riparian zone dominated by mature California sycamores" to denser riparian forest and canopy closure, and attributes these changes to reservoir regulated stream flow within Uvas Creek, Santa Clara County, CA. The thesis goes into detail regarding how steelhead ecology tracked with ecosystem changes. Overall, the effects on steelhead are somewhat mixed and locally variable, but many management strategies appear compatible with both maximizing steelhead and restoring Sycamore Alluvial Woodland habitat. In terms of changes, reservoir management has reduced flood flows – both in frequency and intensity - downstream of the reservoir, limiting large scouring events. Instead, water has been released between storms to reduce peak flow, which reduces channel scouring. As a result, young woody species have improved survivorship, leading to many physical and competitive dynamic changes in the ecosystem. Fewer and less intense disturbance events have led to higher canopy closure, denser riparian cover and species composition changes. In the channel, sediments in pools have changed from sand to finer sediments (silt and organic matter). These effects cumulatively have reduced stream primary productivity, invertebrate/insect production, and fish growth and abundance in these reaches. For instance, steelhead were found to be substantially smaller in these reaches. Steelhead, however, were found to be most abundant in these reaches. Increased flows reduce habitat quality in the upper reaches but extended flow to previously intermittent areas, thus extending rearing habitat. Overall, the paper offers management recommendations to improve habitat quality for steelhead by reducing riparian canopy cover to improve primary productivity and food for fish. Other recommendations include increasing the frequency and intensity of flows, by, for instance, better managing stream flow releases and maintaining continuous flow from summer to fall in certain areas; and strategic placement of feeding structures (strategic boulder placement, anchored root wads or other structures).

Key words: document, wildlife ecology, hydrology, historical ecology.

2.7 Geomorphology, Hydrology and Soils

Beagle, J. S. Baumgarten, R. M. Grossinger, R. A. Askevold, B. Stanford. 2014. Landscape scale management strategies for Arroyo Mocho and Arroyo Las Positas: process-based approaches for dynamic, multi-benefit urban channels. SFEI Publication #714, San Francisco Estuary Institute, Richmond, California.

The authors, researchers from San Francisco Estuary Institute, present management strategies for Arroyo Mocho and Arroyo Las Positas channel reaches in the Livermore-Amador Valley. They describe a historical

shift of plant community types from xeric Sycamore Alluvial Woodland to a more mesic Mixed Riparian Forest because of a hydrologic regime change from intermittent flows with periodic floods to managed perennial flows. The authors suggest that tree-ring data may be used to reconstruct disturbance regimes associated with sycamore regeneration. This paper is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes changes in the extent of Sycamore Alluvial Woodland along two channel reaches and presents management strategies for sycamore restoration and conservation.

Key words: document, California sycamore, *Platanus racemosa*, management, hydrologic regimes

Belli, J. P. 2015. Movements, Habitat Use, and Demography of Western Pond Turtles in an Intermittent Central California Stream. Master's Thesis. San Jose State University, California.
See Section 2.6: Wildlife Ecology for full description.

Casagrande, J. M. 2010. Distribution, abundance, growth, and habitat use of steelhead in Uvas Creek, CA. Thesis. San Jose State University, California.
See Section 2.6: Wildlife Ecology for full description.

Gillies, E. L. 1998. Effects of Regulated Streamflow on the Sycamore Alluvial Woodland Riparian Community. Thesis. San Jose State University, California.
See full description in Section 2.1: General Ecology.

Griggs, F. T. 2009. California Riparian Habitat Restoration Handbook. River Partners. Chico, California
See full description in 2.4: Restoration Ecology and Management.

H. T. Harvey & Associates. 2014. Upper Llagas Creek Flood Protection Project—California Sycamore Mitigation Assessment [technical memorandum]. January 29. Los Gatos, California. Prepared for Melissa Moore, Sunshine Julian, and Linda Spahr of the Santa Clara Valley Water District. San Jose, California.
See full description in 2.3: Hybridization.

Kamman Hydrology. 2009. Phase 2 Technical Report Sycamore Grove Recovery Program. Sycamore Grove Park, Livermore, California. Prepared for Livermore Area Recreation and Park District and Zone 7 Water Agency.
This technical report presents the results of Phase 2 research of the Sycamore Grove Recovery Program. This research builds on information gained in Phase 1 (Sycamore Associates) studies completed in 2004. An important goal of the recovery program is to understand how best to manage Sycamore Grove Park and to identify environmental management strategies, including water releases into Arroyo del Valle, to sustain the grove. The key findings demonstrate that the hydrologic regime of Arroyo del Valle has been modified post-dam installation. Creek flows are now year-round and the normal summer-dry pattern to which the sycamores

were established has been eliminated. The reduction of peak flows to control flooding eliminated large magnitude flood events necessary to carry away anthracnose-infected leaf litter and create gravel beds favorable for seed germination. The arroyo has changed from an active braided channel network to a more defined central channel system. This affects water distribution through the grove. These hydrologic changes may affect sycamore growth, distribution, and regeneration. This technical report is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it summarizes the key issues associated with restoring sycamore-dominated habitat types and the hydrology that supports them.

Key words: document, *Platanus racemosa*, anthracnose, restoration, hydrology

King, J. 2004. Sycamore Grove Park dendrochronological investigation. Lone Pine Research, Bozeman, Montana.

See full description under Section 2.1: General Ecology.

Lytle, D. A., and D. M. Merritt. 2004. Hydrologic regimes and riparian forests: a structured population model for cottonwood. Ecology 85:2493–2503.

Cottonwood populations, like those of sycamore, are threatened by flow alteration and channel degradation caused by dams, water diversions, and groundwater pumping. The authors of this journal article seek to determine through modeling whether complex forest stand dynamics can be predicted from basic cottonwood vital rates (stage-specific births and deaths) and river hydrology. They anticipate that their model will aid in planning prescribed floods by projecting how altered flow regimes might affect populations. Their model describes how annual variation in the hydrograph affects cottonwood mortality (via floods and droughts) and recruitment (via scouring of new habitat and seedling establishment). The model analysis also suggests that flow regimes with high flood frequencies result in stable (albeit small) population sizes, while stable flows result in highly variable population sizes prone to local extinction. This article is highly relevant to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project as the hydrology needs (flooding, scouring) of both cottonwood and sycamore for regeneration are similar.

Key words: journal article, riparian ecosystems, hydrology, disturbance, drought, flooding, recruitment

Scott, M. L., J. M. Friedman, and G. T. Auble. 1996. Fluvial process and the establishment of bottomland trees. Geomorphology 14:327–339.

This journal article looks at the effects of river regulation on floodplain tree communities in western North America. The relationship between streamflow and the establishment of floodplain trees is governed by the dominant fluvial process or processes acting along a stream. The association between flow and tree establishment varies from site to site. Along one stream, cottonwoods may establish following high flows, whereas along another they establish during low flows. This variation results from differences in the fluvial-geomorphic processes that form surfaces suitable for establishment. Channel narrowing, channel meandering, and flood deposition promote different spatial and temporal patterns of establishment. This research is helpful to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project as it relates

the establishment of floodplain trees, such as sycamore, to the various fluvial-geomorphic processes found in central California streams.

Key words: journal article, riparian ecosystems, hydrology, disturbance, drought, flooding, recruitment

Stromberg, J. C. 2001. Influence of Stream Flow Regime and Temperature on Growth Rate of the Riparian Tree, *Platanus wrightii*, in Arizona. Freshwater Biology 46:227–239.

The author examines the influence of flood flows associated with summer thunderstorms and winter rain storms on the population dynamics of the Arizona sycamore. Floods are described as both allowing for establishment of the trees and as providing a water source during the growing season. Arizona sycamore is a dominant pioneer species of the warm-temperate riparian deciduous forests of the US Southwest and northern Mexico, where rivers have large temporal variability in surface flow rate and flood frequency. The author hypothesized that the growth of Arizona sycamore in non-perennial reaches would be related to surface flow rate and winter flood frequency and that growth of trees in perennial reaches would be related to summer flood frequency. The four sites had varying stream flow regimes: summer dry, intermittent, and perennial. Increment cores were collected from trees at each site and compared with flow rate and temperature data from stream flow gauges and weather stations near the study sites. The author found that growth of Arizona sycamore in non-perennial reaches was frequently limited by water availability and that growth was not as limited by water availability in perennial reaches. The author also discussed the influence of winter flooding on summer water availability. Management recommendations are provided. This paper is somewhat applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it discusses the relationship of a related tree species with intermittent and perennial water sources and the influence of winter flow rates on summer water availability, which can be studied as a proxy for altered flow regimes along reaches in Santa Clara County.

Key words: document, *Platanus wrightii*, Arizona sycamore, ecology, hydrology.

Stromberg, J. C., 2002. Flood flows and population dynamics of Arizona sycamore (*Platanus wrightii*). Western North American Naturalist 62:170–197.

The author describes how flood disturbance influences the population dynamics of many riparian tree species. Large floods can intermittently create conditions that allow for establishment of pioneer species by altering geomorphology, clearing competing vegetation, and providing a water source on floodplains. The author examines the establishment patterns of the Arizona sycamore, a dominant species of the warm-temperate riparian deciduous forests of the US Southwest and northern Mexico. It is suggested that the Arizona sycamore is adapted to disturbance and reproduces vegetatively as well as by seed. The author studied 9 sites in Arizona, some with intermittent and some with perennial flows, and examined tree age and population age structure compared with flow rate and temperature data from stream flow gauges and weather stations near the study sites. The author observed that Arizona sycamore seedlings established episodically, and predominantly during years with winter floods and high spring flows. All years with observed establishment occurred within three years of large winter floods. Arizona sycamore did not establish in response to summer floods. Clonal colonies were observed more frequently than seedlings. Grazing is

described as possibly influencing establishment and recommended for further study. Anthracnose was observed during the study. This paper is somewhat applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it examines the establishment patterns of a related species and also discusses triggers for vegetative reproduction that may be similar to the triggers in the California sycamore. The study methods presented in this paper may inform future studies on the California sycamore.

Key words: journal article, *Platanus wrightii*, Arizona sycamore, ecology, hydrology, restoration, anthracnose.

Sycamore Associates. 2004. Sycamore Grove recovery program: phase 1 technical report, preliminary findings, Sycamore Grove Park, Livermore, Alameda County, California, final. Prepared for the Livermore Area Recreation and Park District, Livermore, CA. and Zone 7 Water Agency, Pleasanton, California, prepared by Sycamore Associates, Walnut Creek, CA.

See full description in 2.4: Restoration Ecology and Management.

[USDA, SCS] U.S. Department of Agriculture, Soil Conservation Service in cooperation with University of California, Agricultural Experiment Station. 1974. Soil Survey of the Eastern Santa Clara Area, California. In cooperation with University of California, Agricultural Experiment Station. U.S. Government Printing Office, Washington, D.C.

The authors and researchers present maps and descriptions of the soils of the eastern Santa Clara area, encompassing areas of California sycamore habitat and the potential study sites. Information about California sycamore distribution can be overlain onto the soil maps to determine associations between soil types and characteristics and California sycamore habitat. This information is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it can be used to better understand abiotic factors of California sycamore ecology in the region.

Key words: document, soils, study sites, ecology.

2.8 Health and Regeneration

Bock, J. H. and C. E. Bock. 1989. Factors limiting sexual reproduction in *Platanus wrightii* in southeastern Arizona. Aliso 12:295–301.

A permanent water table close to the surface is essential to seedling survival. The authors noted that neither domestic animals nor lack of germinable seeds accounted for the failure of sycamore to reproduce.

Key words: journal article, sycamore ecology, *Platanus wrightii*.

Crump, A. 2009. Anthracnose. University of California Division of Agriculture and Natural Resources. Pest Notes Publication 7420, Oakland, CA.

This short publication from the University of California Integrated Pest Management Program provides an overview of the group of fungal diseases known as anthracnose. A brief ecology and guide to identification are given, along with management practices including fungicide applications. The author states that in

California, anthracnose rarely causes permanent damage to plants. Highly susceptible species include American sycamore (*Platanus occidentalis*) and the London plane tree (*P. acerifolia* or *P. hybrida*). Anthracnose does infect California sycamore (*P. racemosa*) in the northern part of the state, but not in the southern half. The conciseness of this article and its applicability to California are useful for the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project.

Key words: document, *anthracnose*

Department of Water Resources. 1994. Los Banos Grandes Facilities Sycamore Pilot Program Report Number 3. Sacramento, California.
and
Department of Water Resources. 1995. Los Banos Grandes Facilities Sycamore Pilot Program Report Number 4. Sacramento, California.

These two reports document studies by the California Department of Water Resources (DWR) to understand the growth and reproductive requirements of the California sycamore. The studies looked at the feasibility of mitigating for the loss of a significant sycamore alluvial woodland site that would have been flooded by the construction of the Los Banos Grandes Reservoir. The project tested sycamore regeneration techniques in both natural and nursery settings using cuttings and collected seed. Sycamore trees were successfully germinated from seed. The study found levels of irrigation to be an important consideration at sycamore mitigation sites. A system that produces a high ground water table was preferable since it encouraged root growth. Over-browsing and a low ground water table inhibited clonal reproduction. These reports are very applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project as they document a comprehensive experiment to establish sycamores on a large scale with varying sites and conditions.

Key words: document, *Platanus racemosa*, sycamore alluvial woodland, regeneration

Finn, M. S. 1991. Ecological characteristics of California sycamore *Platanus racemosa*. Thesis. California State University, Los Angeles.

The graduate student from California State University quantitatively characterized sycamore and sycamore woodland habitats from a coastal southern California drainage with emphasis on population structure and regeneration patterns. Adventitious sprouting was a significant means of regeneration; however, sexual reproduction was found at all eight study sites. Regeneration was assessed relative to distance from mature trees, landforms, and competition. Channelization, stabilization, and altered hydrology limit sycamore regeneration. This thesis is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it identifies characteristics of asexual and sexual regeneration and provides information that can be used in making habitat management and restoration decisions.

Key words: document, *Platanus racemosa*, California sycamore, regeneration, management

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See full description in 2.2: Historical and Present Distribution.

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See full description in 2.3: Hybridization.

King, J. 2004. Sycamore Grove Park dendrochronological investigation. Lone Pine Research, Bozeman, Montana.

See full description in 2.1: General Ecology.

Sinclair, W. A., H. H. Lyon, and W. T. Johnson. 1987. Diseases of Trees and Shrubs. Comstock Publishing Associates, a division of Cornell University Press. Ithaca, New York.

The authors, researchers at Cornell University, present a pictorial survey of diseases of forest and shade trees and woody ornamental plants in the United States and Canada. They separate diseases caused by biotic agents from those caused by environmental stimuli. The diseases are further grouped according to the plant part affected and to taxonomic relationships among pathogens. This book is highly applicable to the Sycamore Alluvial Woodland Habitat Mapping and Regeneration Studies Project because it describes sycamore anthracnose in detail, characterizing the pathogen by blight of leaves and shoots, cankers and dieback of twigs, and deformation of branches causing loss of vigor, dieback of large branches, and increased susceptibility to borers.

Key words: document, sycamore, *Platanus racemosa*, anthracnose

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See full description in 2.5: Grazing.

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See full description under Section 2.1: General Ecology.

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