Point Blue Report

A How-to Guide and Metadata for the Riparian Restoration Design Database

Calibrated to Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties, CA

Updated by Jennifer Benson August 17th, 2016

7 April 2014

John J. Parodi, Leia Giambastiani, Nathaniel E. Seavy, Isaiah M. Thalmayer, Eliza Lasky, and Thomas Gardali

Conservation science for a healthy planet

3820 Cypress Drive, #11 Petaluma, CA 94954
T 707.781.2555 | F 707.765.1685
pointblue.org

A How-to Guide and Metadata for the Riparian Restoration Design Database

Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties, California

17 August 2016, version 2

Point Blue Conservation Science

Acknowledgements

This project was made possible by grants from the Marin Community Foundation and the Susie Tompkins Buell Fund at Marin Community Foundation.

The revision of this database was made possible by a grant from the California Landscape Conservation Cooperative.

Suggested Citation, and website link

Parodi, J.J., L. Giambastiani, N.E. Seavy, I.M. Thalmayer, E. Lasky, and T. Gardali. 2014. A how-to guide and metadata for the Riparian Restoration Design Database for Marin and Sonoma counties. Point Blue Conservation Science www.pointblue.org/restorationtools. www.pointblue.org/restorationtools.

Point Blue Conservation Science – Point Blue's 140 staff and seasonal scientists conserve birds, other wildlife and their ecosystems through scientific research and outreach. At the core of our work is ecosystem science, studying birds and other indicators of nature's health. Visit Point Blue on the web www.pointblue.org.

This document is a companion to the Riparian Restoration Design Database calibrated to Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties, available at www.pointblue.org/restorationtools. Its purpose is to provide general information on how to use the database to design riparian restoration planting projects in a manner that prepares them for the consequences of climate change. It also provides metadata on each plant characteristic assessed including why it was chosen, how it was defined, and how it was scored.

WHY

The revegetation of riparian areas is an important tool for protecting water quality and providing habitat for riparian-associated wildlife (Gardali et al. 2006, Lennox et al. 2009). Climate change puts an additional premium on riparian restoration (Seavy et al. 2009). To be successful, restoration practitioners need to consider the projected consequences of climate change. In addition to the practical need for projects to be successful in a range of future climate scenarios, planning for climate change is beginning to be required for grants, contracts, and permits.

WHO

The Riparian Restoration Design Database calibrated to Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties is designed to help restoration practitioners, the regulatory community, and land managers in the Central Coast ecoregion make sound climate-smart decisions when selecting plant species for riparian restoration projects.

WHERE

The Riparian Restoration Design Database is suited for riparian areas in Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties, California. For simplicity throughout this document, we will refer to these five counties as the Central Coast counties.

WHAT AND HOW

To help restoration practitioners' select riparian plants that are resilient to extreme weather events and to reduce the threats of phenological mismatches, we have developed a database of plant characteristics. This Design Database or "tool" has two components. The first describes the tolerances that each plant species has to a variety of conditions that might ensure survival in a future with increasingly frequent and extreme weather events. The second describes resources each plant species provides for wildlife and the months in which each species provides flowers and/or seeds. The Riparian Restoration Design Database can be modified by adding species to fit your project.

The Riparian Restoration Design Database helps restoration practitioners develop planting designs that (1) reduce the vulnerability of a project area to extreme weather events by increasing the capacity of the restoration to rebound from longer and/or more frequent periods of drought, floods, and fire and (2) reduce the vulnerability of wildlife to phenological mismatches by selecting species that provide resources (cover, food) throughout much or all of the year. It can be used to develop planting palettes to meet climate change project specific restoration goals (e.g., Does the project include any species that are drought tolerant? How many?) and/or to add ecological redundancy to a design (e.g., Does this project include multiple species that flower in January?). As noted above, the Riparian Restoration Design Database can be modified by adding plant species to fit your project's goals.

DATA DEFINITIONS

Tolerates full or partial sun

Why: The future climate of Central Coast counties over the next century will be warmer and drier in the summer than it is currently (Maizlish et al. 2015, PRBO 2011). Because many species that can tolerate full sun are also relatively drought tolerant, selecting species with this attribute may increase survival. Alternatively, this is an important trait to consider in projects that are adjacent to already existing mature vegetation.

Definition: Species in this category can tolerate being in full sun or part sun/shade; not full shade. Plants that typically experience more than four hours of sun are included here. Coastal plants in full sun are frequently subjected to fog which can act similar to shade, but can also tolerate days with no fog and full sun. Therefore, they are considered plants that tolerate full sun.

Published information and expert opinion indicate that:

Y – Plant can tolerate full or partial sun (more than four hours of sunlight)
N – Plant cannot tolerate full or partial sun (more than four hours of sunlight)
? – Information unavailable, inconclusive, or of inadequate quality

Tolerates clay soil

Why: In Central Coast counties, soil can frequently have a substantial amount of clay as evidenced through the presence of a myriad of soil orders such as alfisols, mollisols, vertisols, and entisols (UC Davis, CA Soil Resource Lab). Although clay does retain moisture well, it can be challenging for plant establishment due to its expansive nature (cracking in summer months) and it can cause slow root growth. Hence, while not necessarily a specific climate change plant characteristic, we judged it important to include because of its importance in project design and plant survival.

Definition: Species in this category have evolved to thrive in heavy clay soils.

Published information and expert opinion indicate that:

Y – Plant occurs and thrives clay soil
N – Plant does not occur or thrive in clay soil
? – Information unavailable, inconclusive, or of inadequate quality

Tolerates wet conditions

Why: Although most climate models predict increased ambient air temperatures and overall drier soil conditions in the summer, many also predict more extreme, erratic precipitation events and some project wetter conditions in the winter (Micheli et al. 2010, PRBO 2011). Alternatively, other models such as Cal-Adapt suggest inconsistent precipitation trends through the next century. By incorporating species that tolerate or thrive in wet conditions into planting designs with species that tolerate dry conditions, practitioners can address the uncertainty in the future precipitation patterns.

Definition: Species in this category can persist in high moisture conditions throughout the calendar year.

Published information and expert opinion indicate that:

Y – Plant is known to occur and thrive wet conditions year round

N – Plant is not known to occur and survive in wet conditions year round
? – Information unavailable, inconclusive, or of inadequate quality

Tolerates dry conditions
Why: In the Central Coast area, overall temperatures are expected to increase through the end of this century (Maizlish et al. 2015). For example, Cal-Adapt models project that future precipitation will be variable and may show little change. Considering these projections, we need to plan for projects to experience extended warmer periods of slightly less soil moisture.

Definition: Species in this category have evolved to thrive in low moisture conditions throughout the calendar year.

Published information and expert opinion indicate that:
Y – Once established, plant is known to occur and thrive without water during the summer and fall
N – Once established, plant is not known to occur and survive without water during the summer and fall
? – Information unavailable, inconclusive, or of inadequate quality

Evergreen
Why: Climate change is impacting both animal migration and the timing of the availability of resources that animals rely on. Empirical observations, modeling, and vulnerability analyses suggest that migratory wildlife may be vulnerable to climate change if their migration schedules become mismatched with the timing of their food resources (e.g., Memmott et al. 2007, Gardali et al. 2012). Evergreen vegetation provides resources and especially cover from predators year round. For that reason, we include species that provide shelter throughout the calendar year, allowing for cover from predators regardless of timing variations resulting from a changing climate. They also provide year-round shade, which may benefit stream temperature as well.

Definition: Species in this category have leaves present throughout the calendar year, and are not deciduous.

Published information and expert opinion indicate that:
Y – Plant has evergreen leaves
N – Plant does not have leaves all year
? – Information unavailable, inconclusive, or of inadequate quality

Fire Adapted
Why: Warming average temperatures, increased heatwaves, and steep slopes in coast mountain ranges may lead to more intense fires in Monterey, San Benito, San Luis Obispo, Santa Clara, and Santa Cruz counties (Maizlish et al. 2015). Cal-Adapt wildfire risk map model suggests between a 0.8 to 1.2 increase in potential area burned (through 2085, High Emissions Scenario). Because many of our California native plants have evolved in concert with natural wildfire regimes, including these species in restoration designs can increase the ability of vegetation to persist after fire. Potential fire adaptations include the ability to resprout from the roots, tubers or rhizomes, tolerance of the seed to fire including serotinous seeds, bark thickness, tall crowns, and bud protection.

Definition: Species in this category are tolerant of occasional exposure to fire, and may require fire during some component of its life cycle.

Published information and expert opinion indicate that:

Y – Plant is adapted to fire
N – Plant is maladapted to fire
? – Information unavailable, inconclusive, or of inadequate quality

Max Salinity Tolerance

Why: High concentrations of salts in the soil may inhibit a plant's ability to absorb water and nutrients due to interference with osmotic pressure and exchange capacity of nutrient ions, respectively (USDA, NRCS). Many factors can influence the amount and movement of water-soluble salts in soils. In the Upper Pajaro River floodplain, for example, historical seasonally wet alkali meadows were converted to pastureland as they provided lush greens for livestock in late summer months (Restoration Vision 2008). Further, the soils in this floodplain are nutrient-rich and have a high water-holding capacity which makes them well suited for crop production. Climate change may also impact the movement of water-soluble salts in several ways, resulting in the salinization of soils. Extended droughts can lead to relying more and more on groundwater sources, especially when irrigating new plants and crop lands. Natural weathering of soil and human activity may result in the mobilization of stored salts within the soil profile or groundwater (Valipour 2014). Similarly, increased temperatures and decreased precipitation may result in increased crop transpiration, further taxing regional groundwater availability (Schoups et al. 2010). Lastly, seawater intrusion through increased ground-water pumping and sea-level rise threatens aquifer contamination in the coastal communities of Central California (Loáiciga et al. 2012).

Definition: Species in this category are tolerant of a specified soil max salinity value assigned to a location as quantified by Calflora. Site salinity can be determined by looking up the soil salinity value on Calflora's website; instructions are listed on 'Plant Selection' tab on the database. Based on this value, the number of selected plant species that tolerate this salinity value are counted and graphed on the "Climate-Smart Performance" tab.

Published information found on www.Calflora.org indicates that most California plant species have a known maximum soil salinity value as measured by the concentration of water-soluble salts in soils (mmhos/cm). This value then informs which salinity class the plant belongs to:

Table 1. CalFlora electrical conductivity table, adapted from USDA NRCS NSSH Part 618.20, represents a visualization of how salinity values translate to relative soil salinity as utilized in the database. Electrical Conductivity. Electrical conductivity measures the concentration of water-soluble salts in soils thus indicating soil salinity.

	Class	**Conductivity** in mmhos / cm
	Non-saline	0 to <2
	Very slightly saline	2 to <4
	Slightly saline	4 to <8
	Moderately saline	8 to <16

	Strongly saline	≥16

Further, Calflora assigns salinity values to almost all locations in the state of California. Therefore, a salinity value for both the plant and the planting location can be identified and therefore determine if compatible. When possible, taking actual measurements in the field from multiple samples across a restoration site is a more accurate and site specific way to determine soil salinity.

Wildlife Fruit, Nectar and Seed Source

Why: If a goal of your restoration project is to provide food resources for both resident and migratory wildlife, planting species known to provide abundant resources under various climatic conditions may be important. In addition, climate change has the potential to create new "novel" assemblages of wildlife that might use a project in ways that have not been observed (Ko 2014). A component of climate-smart restoration could be to ensure that project designs include multiple sources of forage that fill as many niches as possible. Note that a critical component of this characteristic is timing of fruiting, flowering, seeding – see below.

Definition: Species in this category provide a food resource (nectar, berries, and/or seeds) available or known to be used by wildlife at some point during their lifecycle.

Published information and expert opinion indicate that:

Y – Plant produces nectar, berries and/or seeds known to be used by insects and wildlife
N – Plant does not produce nectar, berries and/or seeds known to be used by insects and wildlife
? – Information unavailable, inconclusive, or of inadequate quality

Insectary Plant

Why: Insects provide many services to ecological systems; they are critical for pollination of both native and agricultural landscapes, and provide food for other organisms. For example, they provide a critical source of protein during nesting season for birds. By including species that provide resources for insects under a range of climate conditions, projects can promote a large and diverse population of insects that will enhance the ecological benefits.

Definition: Plant species is used by insects, known to play a role in an insect's lifecycle, and/or be beneficial to insects through food or shelter.

Published information and expert opinion indicate that:

Y – Plant is known to be used or beneficial to insects
N – Plant is not known to be used or beneficial to insects
? – Information unavailable, inconclusive, or of inadequate quality

Seed and Flower Phenology

Why: Climate change will modify existing ecological systems, assemblages, and processes in unpredictable ways. Empirical observations, modeling, and vulnerability analyses suggest that migratory wildlife may be vulnerable to climate change if their migration schedules become mismatched with the timing of their food resources (e.g., Memmott et al. 2007, Gardali et al. 2012). Considering that ecological patterns such as migration and plant phenology are subject to unpredictable changes, long-term project success may be enhanced by providing food resources for wildlife regardless of future scenarios. One way to maximize the potential for success is to ensure that the plants provide resources over the entire calendar year (or nearly so). Doing so will ensure that there are resources available that may buffer species from phenological mismatches in riparian systems.

Definition: Plant species included in the Riparian Restoration Design Database currently provide resources during the months outlined in the accompanying table.

Published information and expert opinion indicate that:

F – Plant is known to flower during the indicated month(s)
S – Plant is known to seed during the indicated month(s)
F/S – Plant is known to seed and flower during the indicated month(s)

LITERATURE CITED

Gardali, T., A.L. Holmes, S.L. Small, N. Nur, G.R. Geupel, and G.H. Golet. 2006. Abundance patterns of songbirds in restored and remnant riparian forests on the Sacramento River, California, USA. Restoration Ecology 14:391-403.

Gardali, T., R. DiGaudio, N.E. Seavy, and L. Comrack. 2012. A climate change vulnerability assessment of California's at-risk birds. PLoS ONE 7: e29507.

Ko, C.-Y., O.J. Schmitz, M. Barbet-Massin, and W. Jetz. 2014. Dietary guild composition and disaggregation of avian assemblages under climate change. Global Change Biology 20: 790–802.

Loáiciga, Hugo A., Thomas J. Pingel, and Elizabeth S. Garcia. 2012. Sea Water Intrusion by Sea-Level Rise: Scenarios for the 21st Century. Ground Water 50(1): 37-47.

Lennox, M.S., D.J. Lewis, R.D. Jackson, J. Harper, S. Larson, and K. W. Tate. 2009. Development of vegetation and aquatic habitat in restored riparian sites of California's North Coast rangelands. Restoration Ecology 19:225-233.

Maizlish N, Dervin K, English P, English D, Chan J. Climate and Health Profile Report: San Benito County. Sacramento, CA: Office of Health Equity, California Department of Public Health; 2015.

Memmott, J., P.G. Craze, N.M. Waser, M.V. Price. 2007. Global warming and the disruption of plant-pollinator interactions. Ecology Letters 10:710-717.

Micheli, L., L. Flint, A. Flint, M. Kennedy, S. Weiss, and R. Branciforte. 2010. Adapting to Climate Change: State of the Science for North Bay Watershed. North Bay Watershed Association and Pepperwood Preserve: http://tbc3.org/wp-content/uploads/NBWA_Climate_SOS_Guide_Dec_2010.pdf (Accessed 13 March 2014).

PRBO Conservation Science. 2011. Projected Effects of Climate Change in California: Ecoregional Summaries Emphasizing Consequences for Wildlife. Version 1.0. http://data.prbo.org/apps/bssc/climatechange (Accessed 13 March 2014).

A Restoration Vision for the Pajaro River and Soap Lake, prepared for The Nature Conservancy. March 2008. Prepared by Philip Williams & Associates with The San Francisco Estuary Institute and H.T. Harvey & Associates. (Accessed with consent of The Nature Conservancy, 201 Mission St #4, San Francisco, Ca 94105).

Schoups, G., E.P. Maurer, and J.W. Hopmans, 2010, Climate change impacts on water demand and salinity in California's irrigated agriculture, *Climatic Change*.

Seavy, N.E., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, T.R. Kelsey, S. Small, J.H. Viers, and J F. Weigand. 2009. Why climate changes makes riparian restoration more important than ever: recommendations for practice and research. Ecological Restoration 27:330-338.

Valipour, M. 2014. Drainage, waterlogging, and salinity. Archives of Agronomy and Soil Science 60.12: 1625-1640.

INFORMATION USED TO SCORE THE SPECIES

The species list and their respective characteristics were compiled and categorized using several resources including expert knowledge, plant lists, publications, and websites. Here are the sources:

Publications

Beidleman, L., and E. Kozloff. 2003. Plants of the San Francisco Bay Region: Mendocino to Monterey, University of California Press.

Best, C., J.T. Howell, I. Knight, W. Knight, and M. Wells. 1996. A Flora of Sonoma County, California Native Plant Society Press.

Callahan, F. 2008. Hinds Walnut (*Juglans hindsii*) in Oregon. Kalmiopsis 15: 42-52. Accessed March 2014 http://www.npsoregon.org/kalmiopsis/kalmiopsis15/callahan.pdf

Callier, J. 2011. Monkey flowers. Napa Valley Register. Accessed March 2014 http://napavalleyregister.com/lifestyles/home-and-garden/columnists/master-gardener/monkey-flowers/article_5a4a528c-93cf-11e0-b46d-001cc4c03286.html.

DiTomaso, J.M., and G.B. Kyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California. 544 pp.

Forrestel, A.B., M.A. Moritz, and S.L. Stephens. 2011. Landscape-scale vegetation change following fire in Point Reyes, California, USA. Fire Ecology 7(2): 114-128. doi: 10.4996/ fireecology.0702114. Accessed March 2014 http://fireecology.org/docs/Journal/pdf/Volume07/Issue02/114.pdf.

Howell, J.T., F. Almeda, W. Follette, and C. Best, C. 2007. Marin Flora - An Illustrated Manual of the Flowering Plants, Ferns, and Conifers of Marin, California Academy of Sciences and California Native Plant Society, Marin Chapter.

Leck, M. A. 1989. Ecology of Soil Seed Banks. San Diego: Academic Press Inc. Google ebook.

LSA Associates, Inc. 2009. “Inner Coast Range natural community account. A report to the Solano County Water Agency. Accessed March 2014 http://www.scwa2.com/documents/hcp/Final%20Admin%20Draft/Appendix%20B/Inner%20Coast%20Range/ICR%20Natural%20Community%20Account.pdf

O’Dohery, E. A. Year unknown. Gardeners Guide to California Native Plants. Native Revival Nursery. Accessed April 2014 http://www.nativerevival.com/

Young, B. 2012. Nursery manual: the science and art of growing plants for habitat restoration. Golden Gate National Parks Conservancy. Accessed April 2014 https://www.dropbox.com/s/n7p496enf0y67j6/The%20Nursery%20Manual-The%20Science%20and%20Art%20of%20Growing%20Plants%20for%20Habitat%20Restoration%20%282nd%20Ed.%29%20-%20120108.pdf

Websites

Marin Chapter of the California Native Plant Society, Plant Lists. Accessed April 2014 http://www.marin.edu/cnps/MarinCNPS_Plant_Lists.html

Cal-Adapt. Exploring California's Climate Change Research. Accessed August 2016. www.cal-adapt.org

Calflora. Information on Wild California Plants for Conservation, Education, and Appreciation. Accessed March 2014 and August 2016 www.calflora.org .

California Coastal Commission. 1995. Natural History of Fire and Flood Cycles. Accessed March 2014 http://www.coastal.ca.gov/fire/ucsbfire.html.

Catalina Island Conservancy. Catalina's Native Fire-Followers. Accessed March 2014 https://www.catalinaconservancy.org/index.php?s=wildlife&p=catalinas_native_fire_followers.

Chester, T. 2013. Plants of Southern California: Fire-Followers. Accessed March 2014 http://tchester.org/plants/analysis/fire/followers.html.

Garden Guides. Plant Taxonomy – Common & Scientific Names. Accessed March 2014 http://www.gardenguides.com/taxonomy/.

Gary Oak Ecosystems Recovery Team. Clarkia purpurea ssp. quadrivulnera. Accessed March 2014 http://www.goert.ca/documents/SAR_manual/Clarkia_purpurea.pdf.

McLean, C., and McLean, G. 2010. The Amazing Story of Fire Recovery. Presentation: Station Fire Symposium. Accessed March 2014 http://watershedhealth.org/Files/document/586_McLeanStation%20Fire%20Symposium%20-%20McLeans.pdf

Moosa Creek Nursery. Salix laevigata. California's Native Plants. Accessed March 2014 http://www.moosacreeknursery.com/Native_Plants/121/Salix-laevigata.

Native Grow Nursery. Accessed March 2014 http://www.nativegrow.com.

Natural History of Orange County. Phacelia tanacetifolia. Accessed March 2014 http://nathistoc.bio.uci.edu/Plants%20of%20Upper%20Newport%20Bay%20(Robert%20De%20Ruff)/Hydrophyllaceae/Phacelia%20tanacetifolia.htm

Odion, D., and T. Claudia. 2003. Presentation: Fire and maritime chaparral in Santa Barbara and San Luis Obispo Counties. Elkhorn Slough Coastal Training Program Workshop. Accessed March 2014 http://www.elkhornsloughctp.org/uploads/files/1112656798Odion%20Presentation.pdf

Raiche, R. 2010. Western Azalea: Beauty and Fragrance. Pacific Horticulture. Accessed March 2014. http://www.pacifichorticulture.org/articles/western-azalea-beauty-and-fragrance/

Sonoma State University. California's Coastal Prairies: Fire Ecology. Accessed March 2014 http://www.sonoma.edu/preserves/prairie/ecology/fire.shtml

USDA. *Plants Database*. Accessed March 2014 http://plants.usda.gov.

USDA. Natura Resources Conservation Service Soils. NSSH Part 618 (Subpart A). Accessed August 2016 http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054223

UC Davis. California Soil Resource Lab. Accessed August 2016. http://casoilresource.lawr.ucdavis.edu/

US Forest Service. Fire Effects Information Service. Accessed March 2014 and August 2016 http://www.fs.fed.us/database/feis/.

The University of Texas at Austin. "Native Plant Database." *Lady Bird Johnson Wildflower Center*. Accessed March 2014. <http://www.wildflower.org/plants/>.

Western Riverside County. Multiple Species Habitat Conservation Plan. Accessed March 2014 http://www.rctlma.org/mshcp/volume2/plants.html#TOC1_11 .

The Xerces Society. Accessed April 2014 www.xerces.org.

Experts consulted

Phil Van Soelen, owner of California Flora Nursery, Adjunct Professor at Santa Rosa Junior College

Hain Ranch Organics Riparian Restoration Project.

Harold Appleton, Registered Forester and Erosion Control Specialist. Prunuske Chatham Inc.

Nancy Bauer, author of The California Wildlife Habitat Garden: How to Attract Bees, Butterflies, Birds, and Other Animals and The Habitat Garden Book: Wildlife Landscaping for the San Francisco Bay Region