

# CONSIDERATIONS AND RESOURCES FOR VEGETATION SELECTION ON LEVEES

*An Analysis based on USACE Sacramento Case Studies  
Lorena Guerrero USACE Sacramento District  
Presented at Vegetation Best Practices Workshop #2  
Strategy, Assessment And Management Approaches  
June 2023*

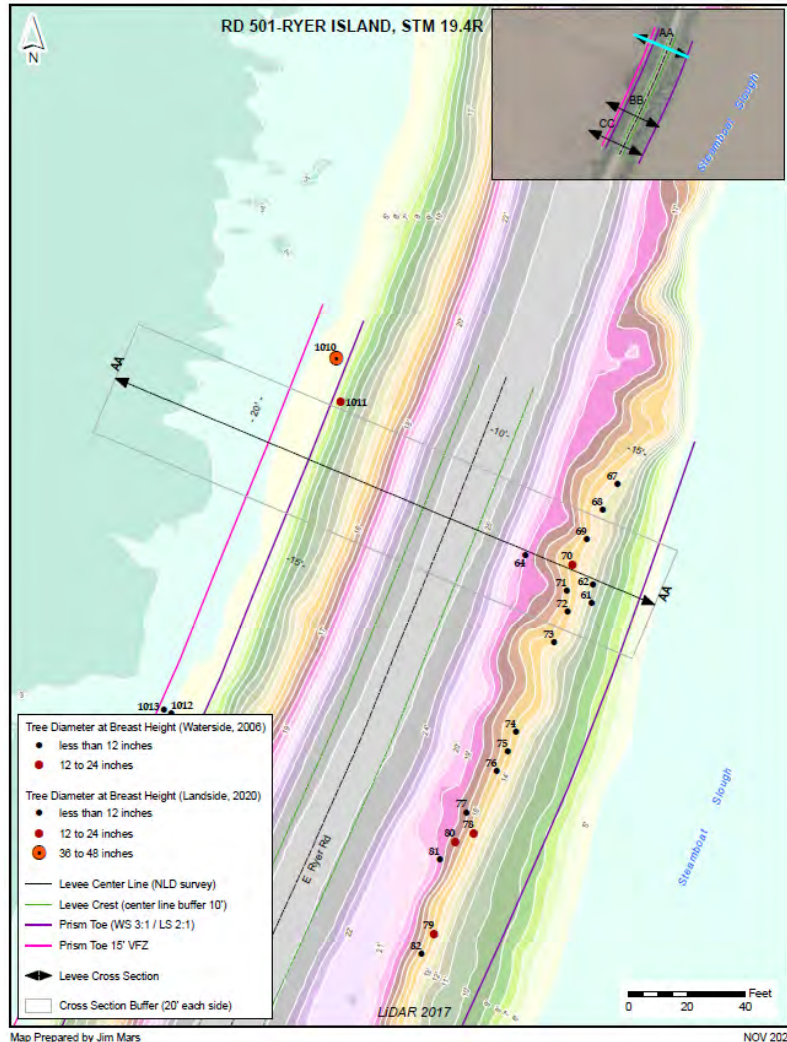


# PRESENTATION ROADMAP



- The Sacramento River Bank Protection Program SQRA's
- Considerations for Vegetation Selection or Assessment for Retention
  - Stressors
  - Management Objectives
  - Plant Properties
- Case Study on Vegetation on Levees in Sacramento
- Demo using CalFlora, CalScape, and FEIS
- Resources available for other areas

# SRBPP VEGETATION EVALUATION PROCESS

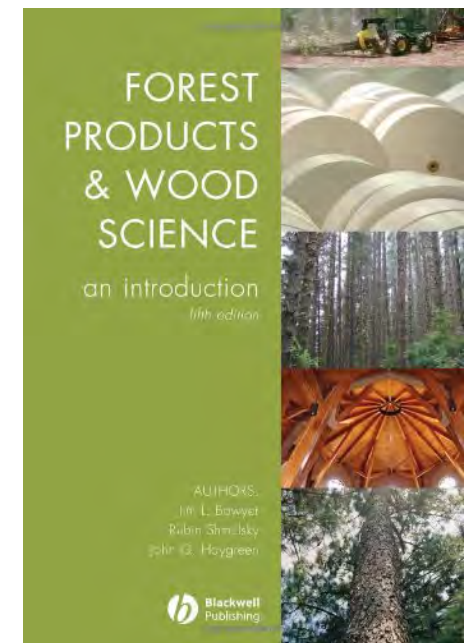
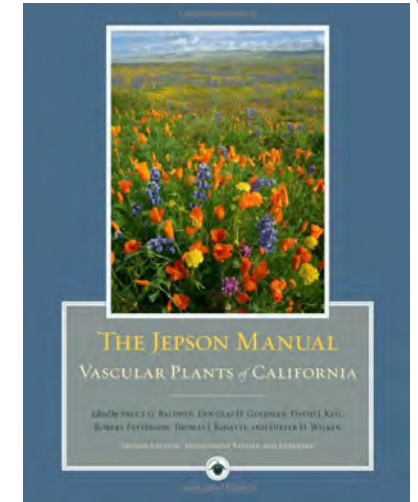
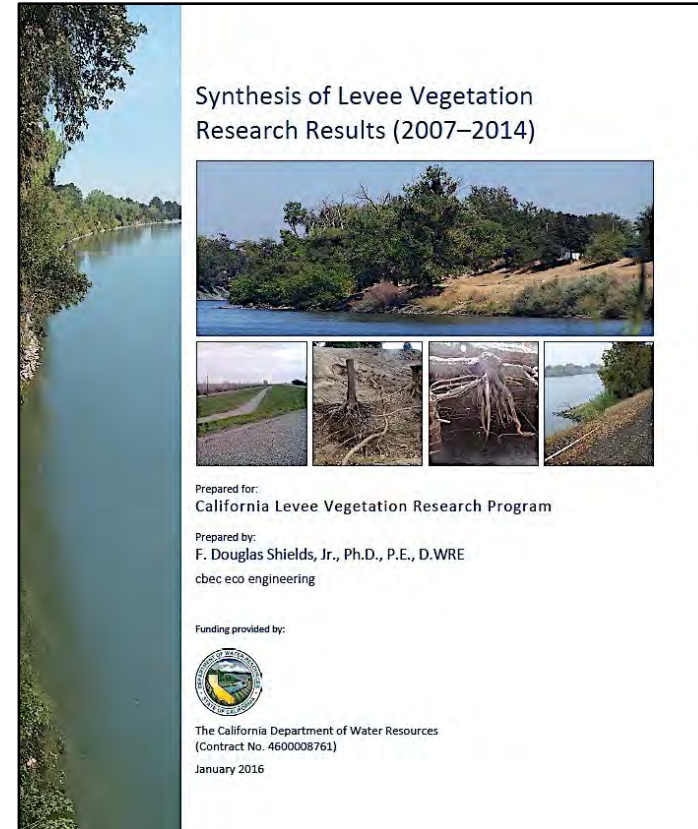


1. Surveyed existing vegetation (current size, health, location, context)
2. Gathered information about existing species- maximum size, tolerances, traits, ecological data, root architecture etc.
3. Input survey data into geographic information system (ArcGIS) to visualize how the vegetation existed with respect to the levee (location along the vertical profile, location along the levee horizontally, density of vegetation, species distribution)
4. Used this data to inform risk analysis assessments



# DATA SOURCES USED FOR SRBPP (VEGETATION ONLY)

- Scientific Journal Articles
- Online databases hosted by universities, non-profits, and agencies
- Government papers (ERDC reports, reports from other government agencies)
- Monitoring and performance data
- Modeling & calculations







# CONSIDER STRESSORS



## Common to all Plants on the Levee

- Hurricane
- Fire
- Drought
- Human Impacts
- Soil Compaction

## Specific to Sections of the Levee

- Mowing
- Burning
- Water velocities
- Prolonged inundation
- Placement of riprap on/or near the rootbase
- Wind forces







# CONSIDER MANAGEMENT OBJECTIVES



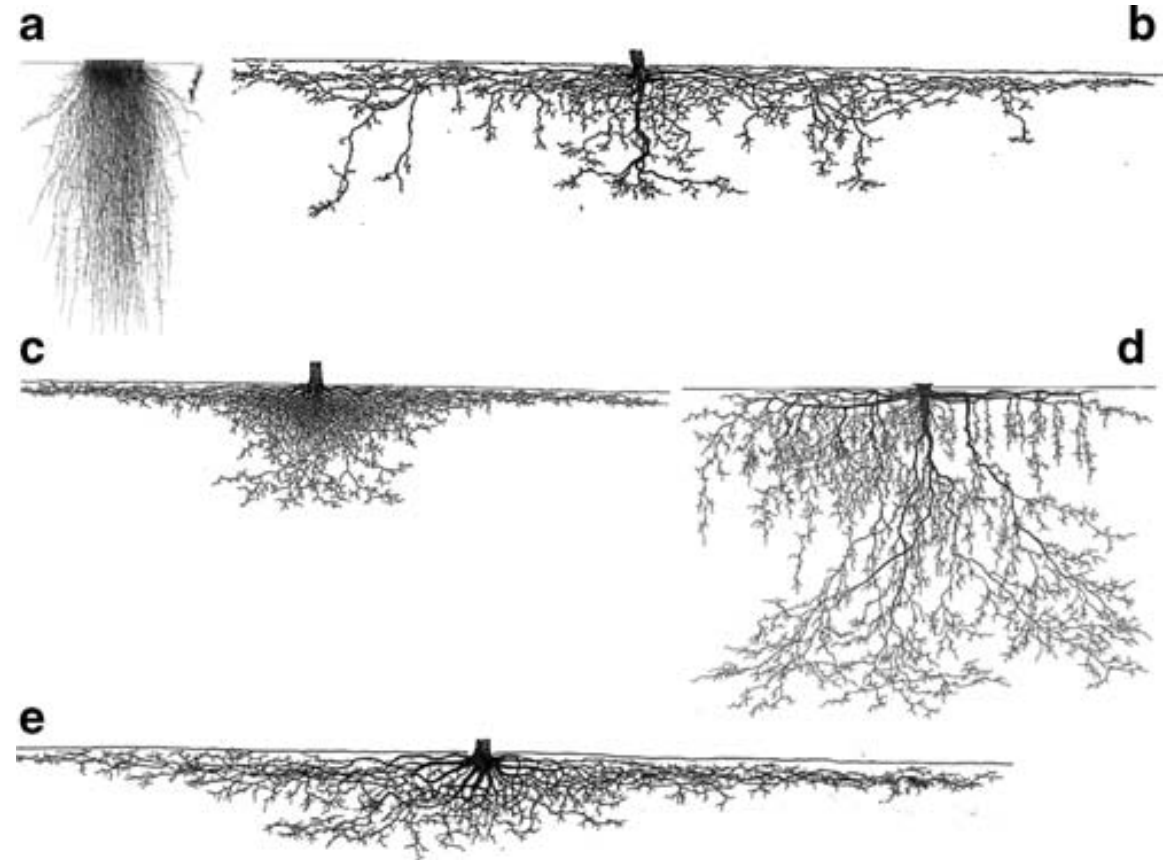
- What kind of maintenance can the maintainer afford?
- What is the desired maintenance regime?
- Are there specific habitat objectives?
- What access is needed for floodfighting and where?
- What access is needed for inspection and where?
- Are there other drivers that would favor one type of vegetation over another?



# CONSIDER PLANT PROPERTIES



- What is the rooting depth of this species?
- What is the rooting pattern of this species?
- What type of seed does it have?
- Does it sucker or sprout?
- Is it windfirm?
- Does it resprout after fire?
- Is it shade tolerant?
- Is it flood tolerant?
- What soil types does it prefer?
- What are the characteristics of the wood?



Rooting Patterns of Various Types of Vegetation (Reprinted from "The Influence of Plant Root Systems on Subsurface Flow: Implications for Slope Stability," by Ghestem, M., Sidle, R.C., and Stokes, A., 2011, BioScience, Vol. 6 No.11, page 875)





# THE WATERSIDE TOE



## Desirable properties

- Dense grasslike or deeply anchoring roots
- Tolerance for prolonged inundation
- Ability to sucker or sprout
- Weak branches
- Soft, limber wood
- Rapid decay
- Windfirm



LAT 38.156936°

THURSDAY 08.15.2019

LONG -121.684094°

LOCAL TIME 09:47:57

16645 CA-160, Isleton, CA 95641, USA, California, Isleton, United States, 95641





# CASE STUDY

## OREGON ASH- FOUND ON SAC 26.9L



- Number of individuals: 5
- Max height: 40 feet
- Average observed height: 16 feet
- Max dbh: 12 inches
- Average observed dbh: 4 inches
- Lifespan: 250 years
- Typical location on levee profile: midslope to water's edge





# CASE STUDY

## OREGON ASH

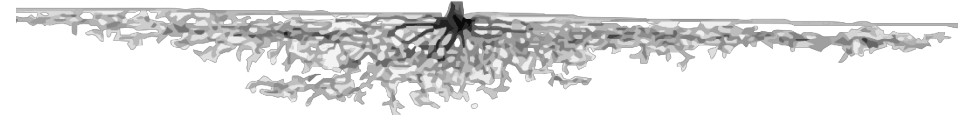


### Pros

- Tolerates heavy soils and poor drainage too wet for other species, including cottonwood
- Creates dense shade
- Host plant for many butterflies
- Withstands strong wind
- Prone to shrublike growth
- Resprouts from suckers

### Cons

- Provide food and habitat for beaver and nutria, which also significantly damage the trees



Maximum rooting depth: 12 feet

### Likely Fracture Points & Why:

Likely a trunk fracture, due to small diameter, however, little data available

Wood is of moderate flexibility and strength

Tree is rhizomatous, many are suckers attached to a network of other trees



# CALFLORA DATABASE

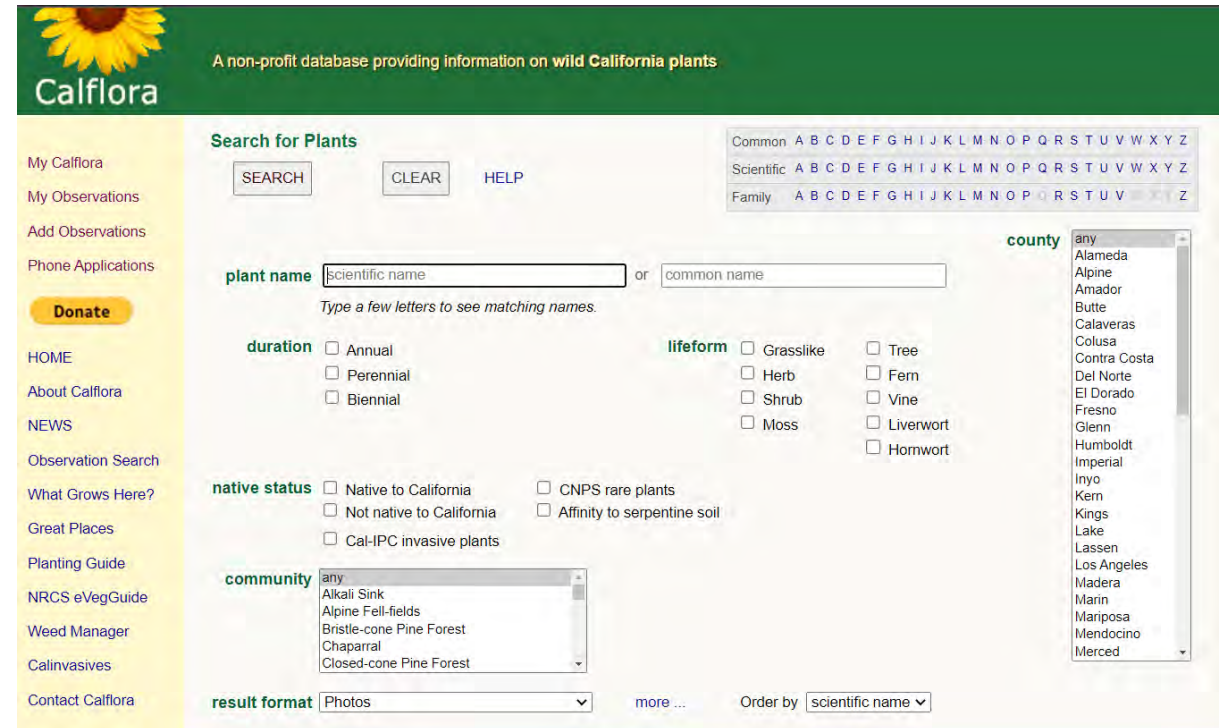


**Purpose:** Provide information on native and non-native plants in California including distribution and traits such as preferred habitat, bloom periods, and basic botanical data.

**Uses:** Helpful in identifying types of plants that are native to habitat types in California.

**Creator:** Non-profit organization

**Cost:** Free to use



The screenshot shows the Calflora website search interface. At the top, there is a green header with a sunflower icon and the text "Calflora A non-profit database providing information on wild California plants". Below the header is a navigation menu with links: "My Calflora", "My Observations", "Add Observations", "Phone Applications", "Donate", "HOME", "About Calflora", "NEWS", "Observation Search", "What Grows Here?", "Great Places", "Planting Guide", "NRCS eVegGuide", "Weed Manager", "Calinvasives", and "Contact Calflora".

The main search area is titled "Search for Plants" and includes a search bar with "SEARCH", "CLEAR", and "HELP" buttons. Below the search bar are three dropdown menus for "Common", "Scientific", and "Family" names, each with an alphabetical index (A-Z). The search criteria section includes:

- plant name:** A text input field with "scientific name" or "common name" options and a prompt "Type a few letters to see matching names."
- duration:** Radio buttons for Annual, Perennial, and Biennial.
- lifeform:** Radio buttons for Grasslike, Tree, Herb, Fern, Shrub, Vine, Moss, Liverwort, and Hornwort.
- native status:** Radio buttons for Native to California, Not native to California, Cal-IPC invasive plants, CNPS rare plants, and Affinity to serpentine soil.
- community:** A dropdown menu with options: any, Alkali Sink, Alpine Fell-fields, Bristle-cone Pine Forest, Chaparral, and Closed-cone Pine Forest.
- county:** A dropdown menu listing California counties: any, Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, and Merced.
- result format:** A dropdown menu set to "Photos" and a "more ..." link.
- Order by:** A dropdown menu set to "scientific name".





# FIRE EFFECTS DATABASE



**Purpose:** Synthesis of fire ecology data

**Creator:** US Forest Service

**Uses:** Provides botanical and ecological data- covers many trees and shrubs

**Cost:** Free to use



## Fire Effects Information System (FEIS)

*Syntheses about fire ecology and fire regimes in the United States*



[Home](#) [General](#) [How to Use FEIS](#) [Glossary](#) [Other Resources](#) [Contact Us](#)

### Helpful Links

- [Recent publications](#)
- [How to cite FEIS](#)
- [Tree distribution maps](#)
- [Vegetation crosswalks](#)

### Select New Publications

Syntheses for the SW

- [Desert willow](#)
- [Arizona sycamore](#)
- [Arizona walnut](#)
- [Saguaro](#)

Invasive Species

- [Sahara mustard](#)
- [Ventenata](#)
- [Buffelgrass](#)
- [Spotted knapweed](#)
- [Yellow starthistle](#)
- [Diffuse knapweed](#)
- [Himalayan blackberry](#)
- [Cutleaf blackberry](#)

### Home

Find fire effects and fire regime information by species common or scientific name:

Or use the advanced search to find [Species Reviews](#), [Fire Regimes](#), or [Fire Studies](#) by species' name, location, plant community, and/or other criteria

**Species Reviews** include information about plant and animal species' biology, habitats, regeneration or reproductive processes, relationships with fire, and management considerations.

**Fire Regime** publications include information about how often and how severely fires burned in specific ecosystems.

**Fire Studies** are summaries of one or more fire research publications.



# CALSCAPE DATABASE



**Purpose:** Provide data to the general public about California native plants including suitability for various planting areas and pollinator benefits.

**Uses:** Helpful in rounding out habitat benefits including finding herbaceous species that would increase benefits.

**Creator:** Non-profit organization

**Cost:** Free to use



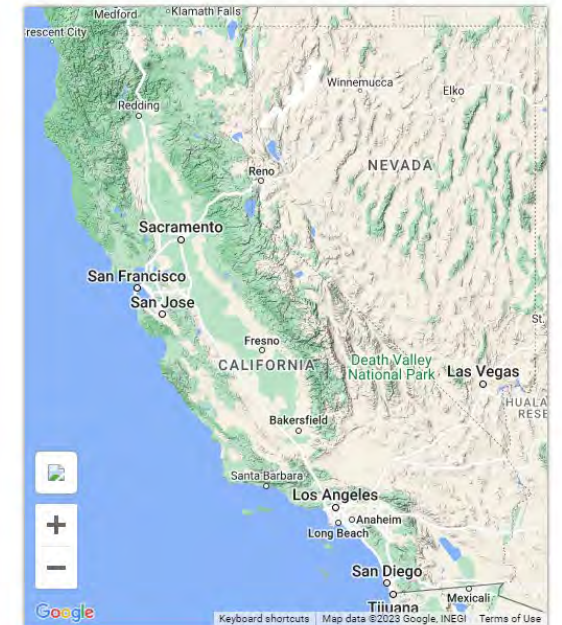
Search for California native plants by name

Enter a California address or click the map to see plants native to that location

California

7984 plants native to California

 All Plants 7984	 Trees 216	 Shrubs 1449	 Perennials 3702
 Annuals 2215	 Grasses 644	 Succulents 188	 Vines 92
 Ferns 113	 Sun 2845	 Shade 580	 Part Shade 2284
 Groundcovers 827	 Butterfly Hosts 7981	 Hedges 322	 Bank Stabilization 307
 Low Water 1625	 Very Low Water 504	 Damp Soils 741	 Very Easy 402





# RESOURCES FOR OTHER AREAS



## **Texas**

<http://www.txsmartscape.com/plant-search/>  
<https://npsot.org/resources/native-plants/native-plants-database/>

## **Washington State**

<https://www.wnps.org/native-plant-directory>  
<http://nativeplantspnw.com/design-shopping-guides/>

## **New Jersey**

<https://npsnj.org/>  
<https://wildrootsnj.com/blog/plant-this-not-that-eco-friendly-alternatives-to-invasive-plants>  
<https://soildistrict.org/nj-native-plants/>

## **Missouri**

<https://grownative.org/>  
<https://monativeplants.org/>

## **Florida**

<https://www.fnps.org/plants>  
<https://gardeningsolutions.ifas.ufl.edu/plants/ornamentals/native-plants.html>  
<https://www.south-florida-plant-guide.com/native-plants-of-florida.html>  
<https://florida.plantatlas.usf.edu/>





# CONSIDER BENEFITS BEYOND GRASSES



- Trees can shade out invasive species
- Tree shade can facilitate other native grasses and wildflowers
- Trees can intercept high intensity rainfall, reducing rill erosion
- Trees can reduce the density of burrowing animals
- Shrubs can increase hydraulic roughness
- Wildflowers can increase habitat for pollinators and form the base of foodwebs
- Native wildflowers do not require irrigation
- Native wildflowers may require less or no mowing
- Native grasses may require less or no mowing
- Native grasses may require less or no irrigation
- Roots can reduce erosion
- Heterogenous landscapes provide an aesthetic benefit
- Heterogenous landscapes provide a habitat benefit
- Healthy soils store carbon
- Benefits can “spillover” to the adjacent landscape



# RECAP



- Engage a multidisciplinary team
- Consider Stressors on the Vegetation
- Consider your Management Objectives
- Consider the Properties of Existing or Proposed Vegetation
- Consider the Potential Benefits of Vegetation
- There are MANY existing resources!
- Reach out for help

## Think Beyond the Grass



**QUESTIONS?**





# BACKUP SLIDES



# THE WATERSIDE SLOPE



## Desirable properties

- No need for irrigation
- Soil stabilizing properties (common on hillsides)
- Windfirm or deciduous
- Repels other plants?
- Shades out non-natives
- Allows inspection
- Prone to heart or root rot





# CASE STUDY

## COTTONWOOD- FOUND ON SAC 26.9L



- Number of individuals: 149
- Max height: 100 feet
- Average observed height: 60 feet
- Max dbh: 60 inches
- Average observed dbh: 36 inches
- Lifespan: 100-125 years
- Typical location on levee profile:  
Riparian bench to mid slope







# CASE STUDY

## COTTONWOOD

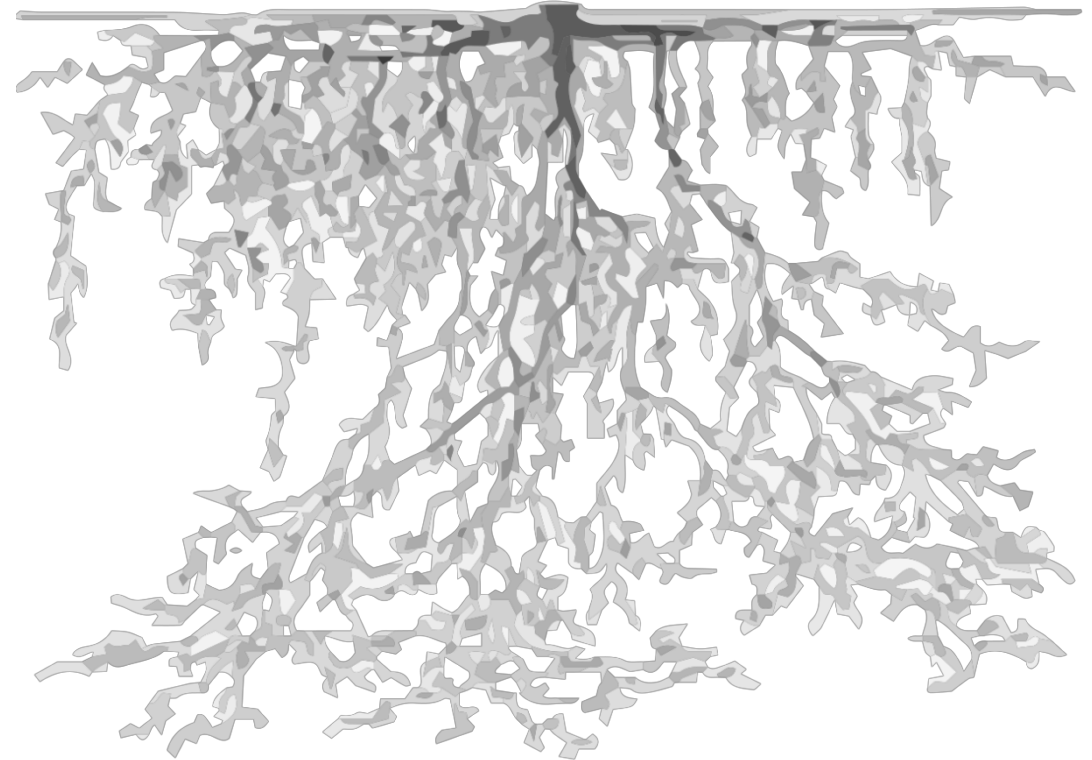


### Pros:

- Does not provide a food source to ground squirrels, seeds are tiny and cottony;
- Soft-wooded, unlikely to uproot due to impacts with foreign objects;
- Provides habitat for species of concern and migratory birds;
- Heart rot and root rot make it more likely the tree will fail at the trunk rather than uproot;
- Provides deep shade allowing the creation of a microclimate which is conducive to sod formation and retention;
- Complex root system reduces the chance of uprooting;

### Cons:

- Relatively short lived, lives around 100-125 years



Maximum rooting depth: 16 feet

### Likely Fracture Points & Why:

Trunk fracture due to very soft wood, propensity for heart rot, and strong potential to be hollow at maturity





# CASE STUDY

## WINDTHROWN COTTONWOODS



### Consistent with literature review-

observed tree fall on SAC 26.9L

- Large cottonwoods (deep rooted species);
- Likely wind toppled at crown of levee;
- broke at trunk;
- did not uproot;
- revealed to be rotted and hollow inside;
- new vegetation observed colonizing dead rootzone, thereby not allowing persistence of voids in the soil.



# OTHER CONSIDERATIONS FOR VEGETATION



## The Crown of the Levee

- Limited options due to use as a road
- Low growing pollinator species?
- Low growing grass species with dense roots
- Will need to intercept rain to some degree to reduce rill erosion
- Aggressive natives will help protect the rest of the system from non-native invasion

## The Landside Slope and Toe

- Primary location for floodfighting
- Generally dry and often exposed
- Subject to influence by adjacent land uses
- Depending on the context, may have less habitat value than waterside

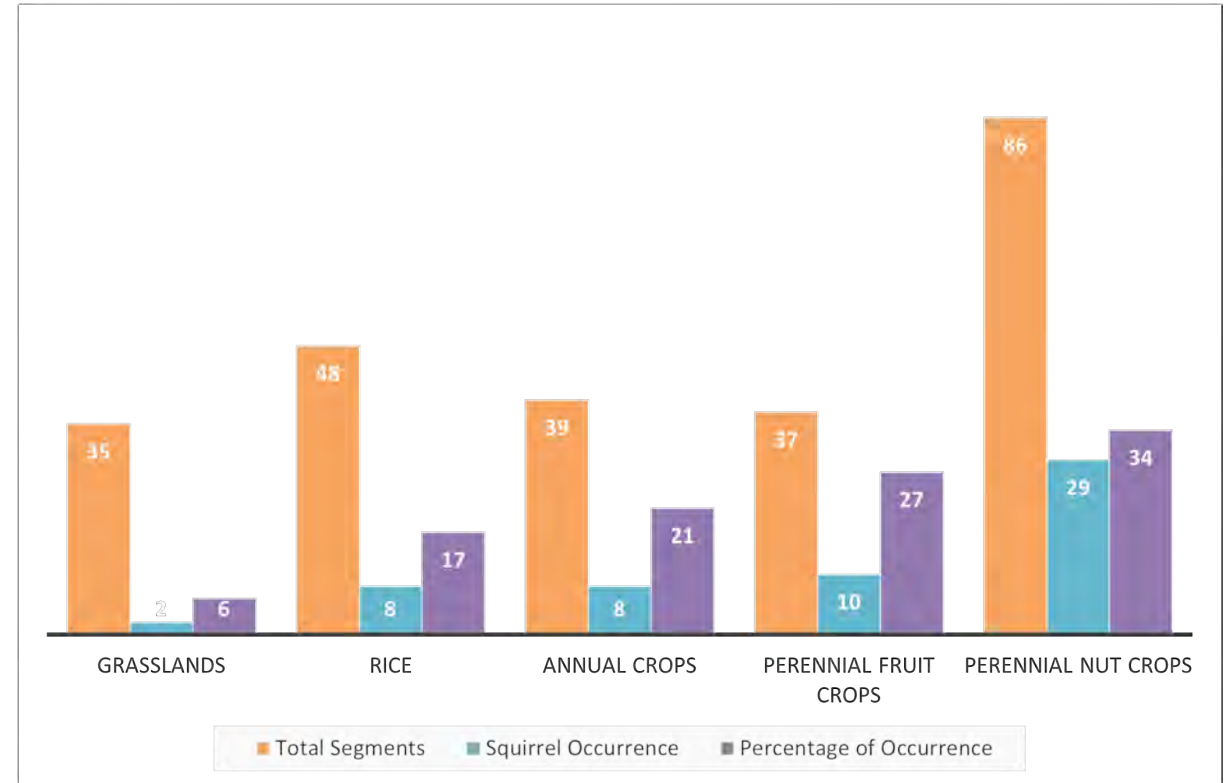


# LANDSCAPE CONTEXT



## ANIMAL BURROWS- Ground Squirrels

- The preferred habitat of ground squirrels is open grasslands, oak savannah, oak woodland, nearshore rocky outcrops, and on agricultural land (McGrann, Van Vuren & Ordeñana, 2013).
- Ground squirrels are generalists with regard to diet (Smith, et al., 2016).
- Vacant burrows are often rapidly reoccupied by neighboring squirrels (Van Vuren, et al., 2014).
- Grouting generally only fills 76-82 percent of the burrow (Cobos-Roa, D., M. Shriro, N. Sitar, and J. Bray., 2012)



Occurrence of California Ground Squirrel burrows on levee segments in the Sacramento Valley according to adjacent land-use types. "Among the 245 segments with 1 predominant land use, percent occurrence of ground squirrel burrows was highest adjacent to perennial fruit crops and lowest adjacent to grasslands. The odds of ground squirrels occurring adjacent to perennial nut crops and perennial fruit crops was 8.40 times greater and 6.11 times greater, respectively, than the odds of ground squirrels occurring adjacent to grasslands (McGrann, Van Vuren & Ordeñana, 2013)." Graph generated from data originally published in McGrann, M. C., Van Vuren, D. H., & Ordeñana, M. A. (2014). Influence of adjacent crop type on occurrence of California ground squirrels on levees in the Sacramento Valley, California. *Wildlife Society Bulletin*, 38(1), 111-115





# THAT SAID, IT MAY BE BEST TO AVOID



- Bramble forming (some species of berries-blackberry)
- Thicket forming (coyotebrush)
- Firm wooded, firm rooted (live oak)
- Agricultural species (fig)
- Non-natives (Black locust)
- Significant food sources (California walnut)
- Mat forming (creeping manzanita)







# SRBPP VEGETATION ON LEVEES FINDINGS



## **Well maintained trees can be beneficial**

- Trees may not reach their full size due to soil limitations, beaver activities etc.
- Shade allows for the establishment of grass (sod) in arid climates
- Large scale vegetation failures have not been observed, most plantings were self sustaining
- Monitoring has not observed erosion near planting areas
- Generally experienced positive outcomes with willows as mitigation and bank protection

## **The presence of quarry stone and soil filled quarry stone significantly reduced the risks associated with existing vegetation**

- Additional weight on the rootbases reduces the chance for an uprooting event to occur
- Presence of quarry stone reduces the chances for lone tree induced scour to occur
- Trees that have minimal quarry stone protection on upper slopes will be exposed to much lower flow velocities

## **Large prisms and excess berm areas reduced seepage concerns**

- Length of the seepage path made seepage unlikely