The Development and Application of Hydroseres in Riparian & Wetland Restoration

A Means of Increasing Resolution in the Design Phase
and
Enhancing Success in the Construction Phase

John Giordanengo, CERP

AloTerra
Restoration Services

Riparian areas comprise less than 1% of the land area of western states (Cooperrider, Boyd, and Stuart, 1986). Up to 80% of wildlife species in the west are dependent upon riparian areas for part of their life cycles (Wayland, 1997).

Wetland Zone A, Scour Zone, Littoral Zone, Construction Zone, AND …….

ASU
NISSAN
GEICO
Ford
Ford
SUN DEVIL HONOR ROW
Sun Devils
43
42

Hydrogeomorphic Classification

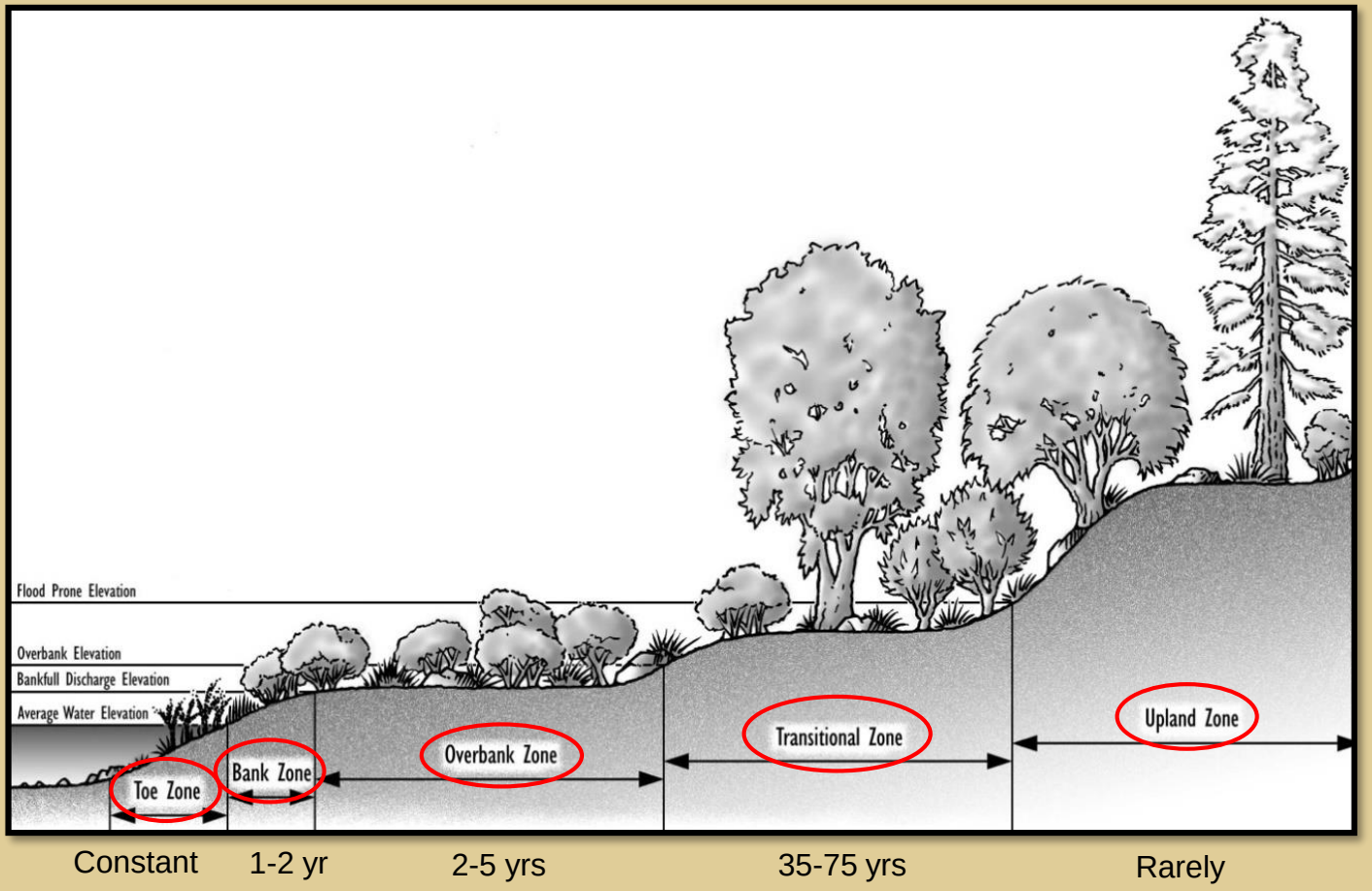
Hydroriparian, Mesoriparian, Xeroriparian Communities

During the First North American Riparian Conference in 1985 (Tucson, AZ), Johnson, R.R. and C.H. Lowe discussed the influence of moisture gradients on riparian plant communities (*On the Development of Riparian Ecology. pp 112-116)*.

Transriparian Continuum: *A decreasing soil moisture gradient from channel to uplands*.

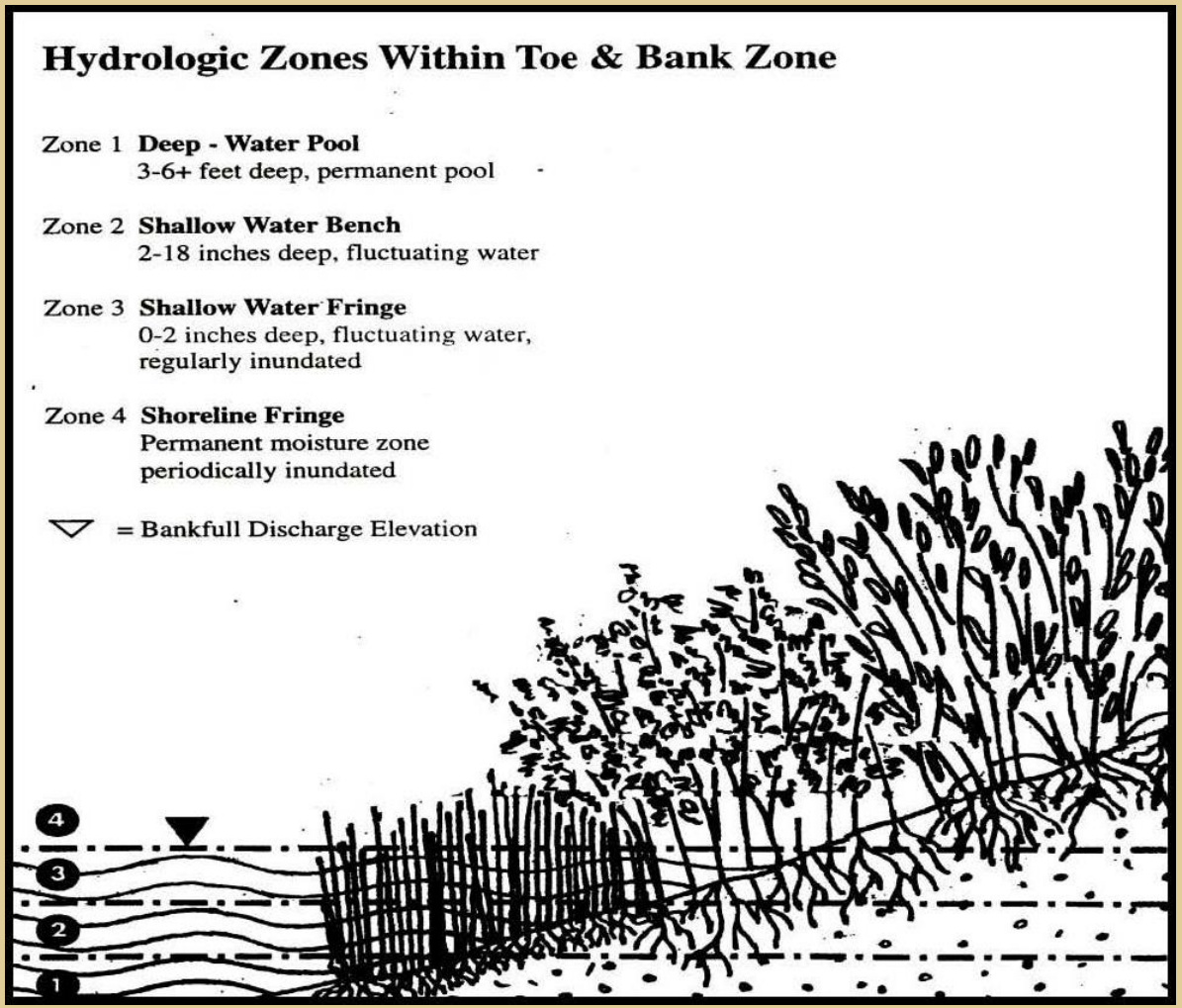
Johnson, R.R, S.W. Carothers, and J.M. Simpson. 1984. *A riparian Classification System*, in: Warner, R.E., K.M. Hendrix (eds), California Riparian Systems: Ecology, Conservation, and Productive Management. Berkley. University of California Press, c1984.

Relation of Flood Frequency to Geomorphic Position



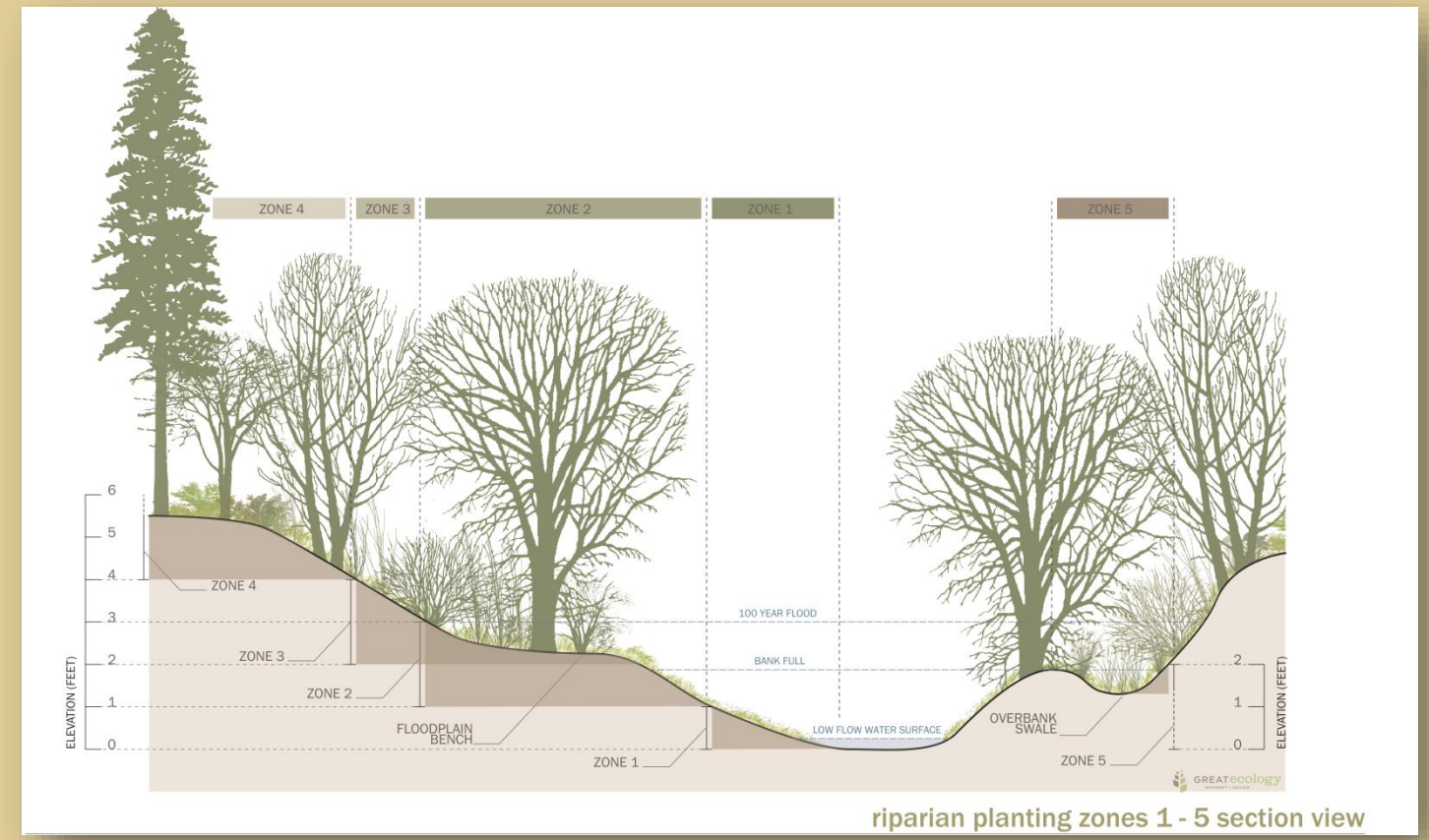
Hoag and Fripp, 2005. The *bank zone* experiences frequent stress, resulting in colonization by **early *seral*** (i.e., pioneer) vegetation. The *transition zone* experience infrequent stress, and expresses **late seral** vegetation.

Hydrogeomorphic Classification



(Hoag et. al., 2001)

Hydrogeomorphic Classification



Zone 1-5: 2013 CO Flood Recovery EWP Program

Variety of Terminology

Riparian Guild & Flow-response Guilds

(Merritt et al., 2009 & 2010)

A group of species with a common life history strategy based on species' morphological and/or functional traits, and which respond predominantly to hydrologic and hydrogeomorphic variability. A guild occupies a unique niche within a riparian environment.

Riparian guilds on upper Missouri (Hough-Snee et al., 2015)

(1) Rapidly growing, multi-stemmed, rhizomatous and thicket-forming, shrubs;
(2) Short-statured, shade-tolerant, flood-intolerant understory shrubs.

Knowledge of a particular guild

informs

development of a specific hydrosere

Hydrosere Classification

Basis of Classification System or Term	Emergent	Mesic Meadow	Hydrodriparian	Mesoriparian	Xeroriparian	Upland
Soil Moisture Gradient & Flood Frequency:						
Flood Frequency & Geomoprhic Position:	Inner Berm	Immer Berm	Bank	Overbank	Terrace	Hillslope
Flood Frequency & Innundation (Hoag et. al. 2001):	Zone 1 or 2	Zone 3	Zone 4			
Flood Frequency & Geomoprhic Position (EWP program)		Zone 1	Zone 1 or 2	Zone 2	Zone 3	Zone 4
Flood Frequency & Geomoprhic Position (by Ogle and Hoag (2000)	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
Hydrogeomorphic and Biological Variables (Merritt et al., 2010)	n/a	n/a	Site Based Descriptions	Site Based Descriptions	Site Based Descriptions	n/a
General Terms Based on Hydrology and Vegetation:	Lower Riparian	Lower Riparian	Lower Riparian	Upper Riparian	Upper Riparian	Upland
General Terms Based on Hydrology and Vegetation:	Riparian	Riparian	Riparian	Riparian	Riparian	Riparian
General Terms Based on Hydrology and Vegetation:	Wetland Zone A-F	Wetland Zone A-F	Wetland Zone A-F	Wetland Zone A-F	Wetland Zone A-F	upland
General Terms Based on Hydrology and Vegetation:	n/a	n/a	n/a	greenline	greenline	n/a
General Terms Based on Hydrology and Vegetation:	Bottomlands	Bottomlands	Bottomlands	Bottomlands	Bottomlands	Upland
Geomorphic Position:	lower 1/3 of bank & inner berm	lower 1/3 of bank & inner berm	very near bankfull	just above bankfull	Q25 to greater benches and terraces	above Q25 benches and terraces

high ← *moisture gradient* → low

frequent ← *flood frequency* → infrequent

What Makes for Good Terminology

Desiderata for Controlled Medical Vocabularies in the 21st Century, Cimino, J. J. (1998)

- Unique Identifiers: The same identifier (i.e. term) should never represent two different concepts in the terminology. *Zone = location of plants on the bank; Zone = location of a wetland within a floodplain. Zone = Construction Area.*

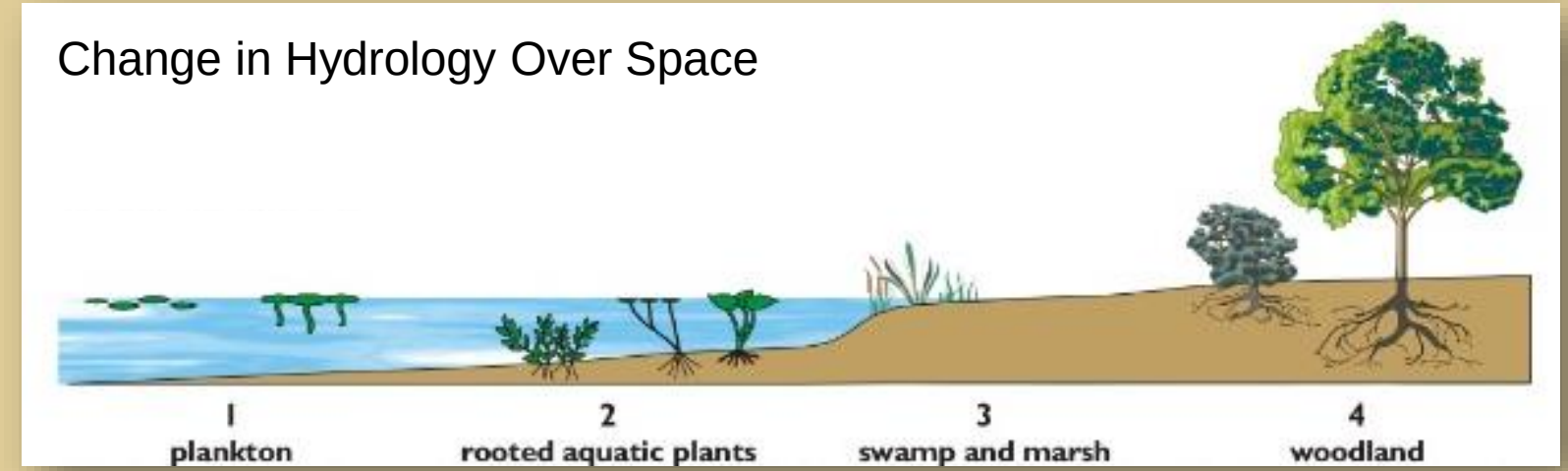
- Concept Orientation: Terms must correspond to no more than one meaning ("unambiguous"). *Is Zone 1 always located in the same position?*

- Consistent Term Structure: The terms themselves should have a consistent structure (*i.e., hydro-riparian, meso-riparian, xero-riparian*).

Hydrosere

Pool (1914: p 189, in *Plant Succession: An Analysis of the Development of Vegetation*, Clements, Frederic. E., 1916)

Change in Hydrology Over Time: Pool defined hydroseres of the sand-hills of Nebraska as occurring over time in the same space. Succession begins with an aquatic pond-weed association and progresses (as sediment fills the pond) over time to a hay meadow association.



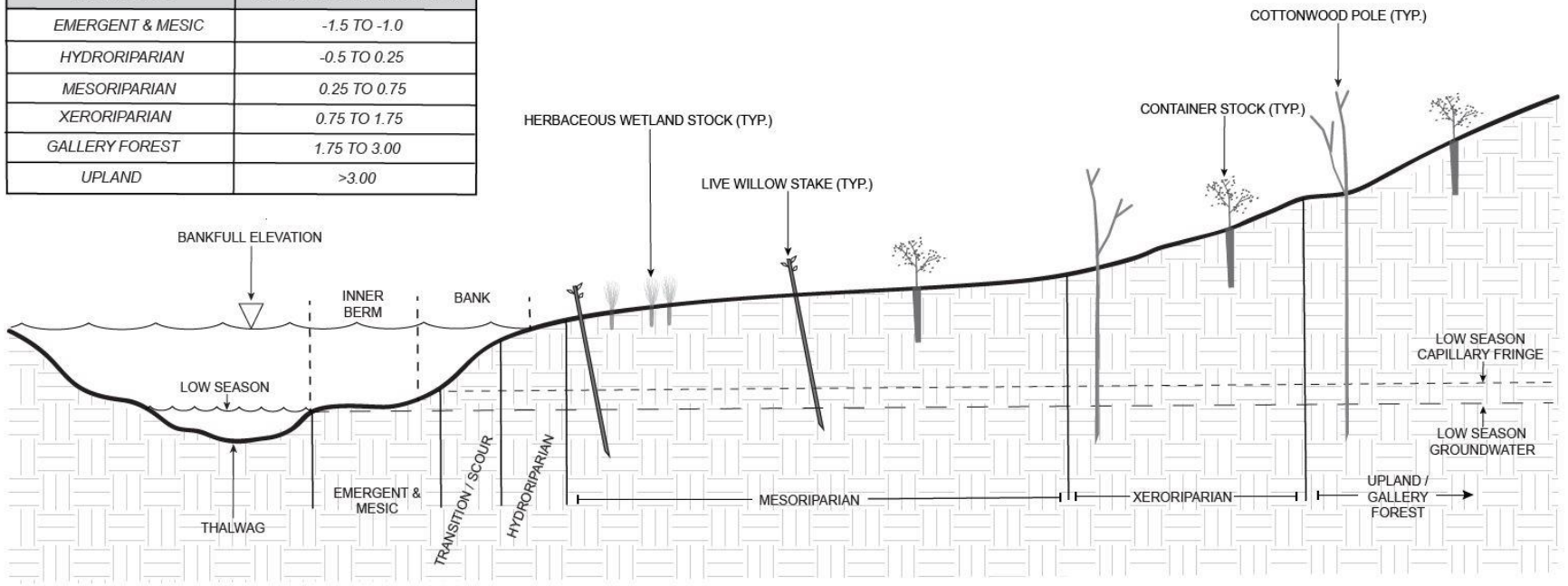
Source: Modified from Pinterest.com (https://www.pinterest.com/pin/531635930983874777/)

Seral stage: successional stage in which a suite of species is most prevalent in a community.

Defining Hydroseres for Riparian Restoration

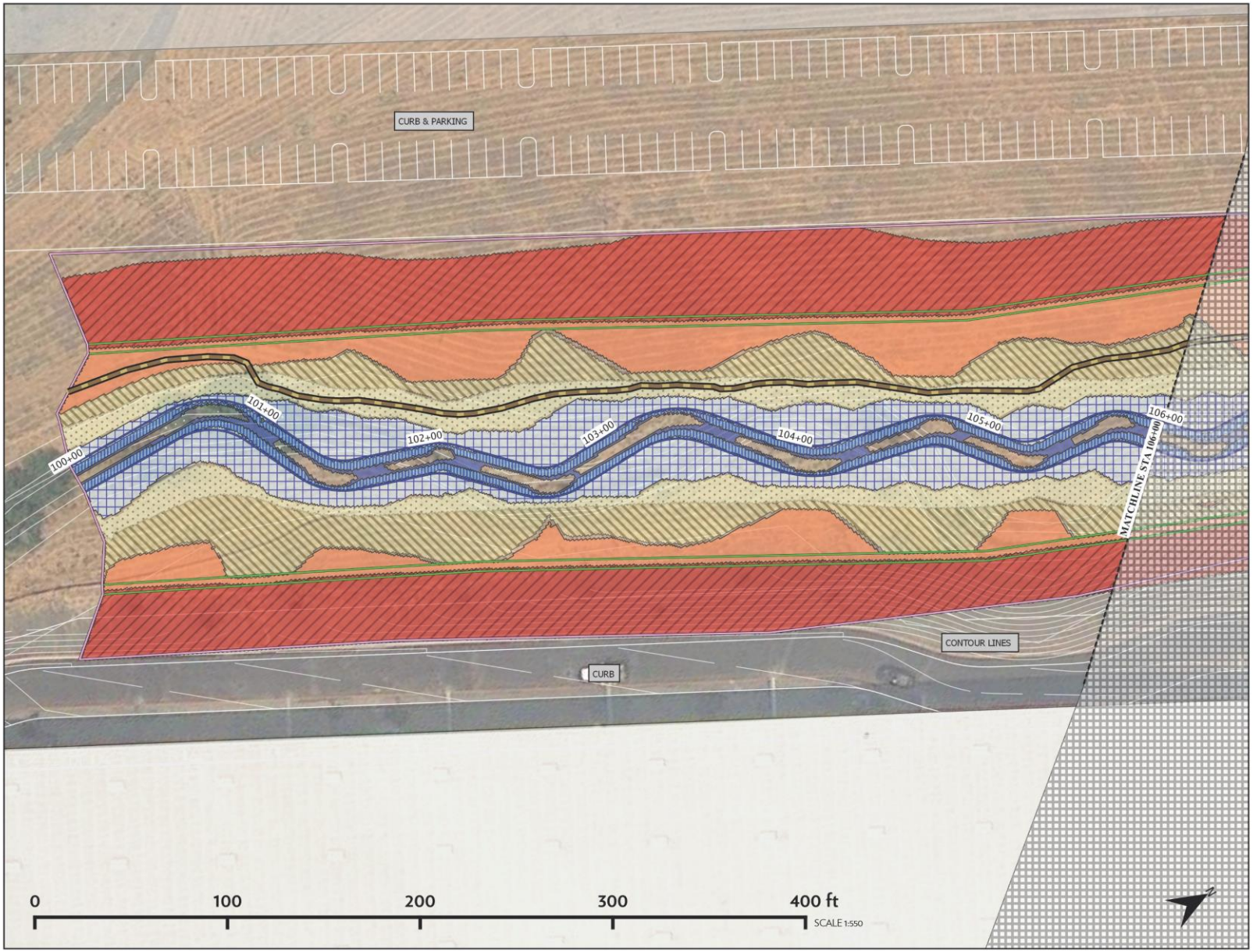
Change in Hydrology Over Space

HYDROSERE ELEVATIONS	
HYDROSERE	RELATIVE TO BANKFULL (FT)
EMERGENT & MESIC	*-1.5 TO -1.0*
HYDRORIPARIAN	*-0.5 TO 0.25*
MESORIPARIAN	*0.25 TO 0.75*
XERORIPARIAN	*0.75 TO 1.75*
GALLERY FOREST	*1.75 TO 3.00*
UPLAND	*>3.00*



Riparian Hydrosere

A riparian plant community whose composition and structure is influenced primarily by hydrology, landform, and frequency of disturbance.



IPC Arroyo Stream Restoration

30% Design -
Not for Construction

LEGEND:

- Trail
- Bridge
- Conceptual Culvert
- Design Bankfull
- Design Floodplain (approx. 100yr)
- Limits of Disturbance
- Matchline Stations
- Delta Mendota Canal
- Buildings
- Channel Bed
- Inner Berm Bench
- Bank
- Overbank
- Transition
- Gallery Forest
- Upland

PREPARED FOR:

PROLOGIS®

International Park of Commerce
City of Tracy, California

PREPARED BY:

AloTerra Restoration Services

Tailwater Limited

LAYER PROJECTION:	NAD 83/ California Zone 3
SOURCE OF MAP:	Google Satellite Imagery
DATE ISSUED:	04/16/2018
DRAWING NO:	REC 2
SHEET NO:	__ of __

Example Plant Allocation by Hydrosere

Woody Containers (D-60)		Reach 1								
		Emergent		Mesic Wetland		Mesoriparian		Xeroriparian		Qty (all seres)
		Area (s.f.):	0	Area (s.f.):	1522	Area (s.f.):	899	Area (s.f.):	834	
		Density (qty/s.f.):	0.00	Density (qty/s.f.):	0.00	Density (qty/s.f.):	0.20	Density (qty/s.f.):	0.14	
Species Name	**Common Name**	% in palette	Qty	% in palette	Qty	% in palette	Qty	% in palette	Qty	
Acer glabrum	Rocky mountain maple		0		0	5	9	5	6	15
Alnus incana subsp. Tenuifolia **	thinleaf alder **		0		0	15	27		0	27
Betula occidentalis *	western riverbirch *		0		0	20	36		0	36
Cornus sericea	red osier dogwood		0		0	10	18		0	18
Crataegus erythropoda *	river or cerro hawthorn *		0		0	10	18	10	12	30
Juniperus scopulorum **	Rocky mountain Juniper **		0		0	5	9	5	6	15
Prunus virginiana *	chokecherry *		0		0	10	18	10	12	30
Physocarpus monogynus	ninebark		0		0		0	10	12	12
Picea pungens *	blue spruce *		0		0	5	9	5	6	15
Populus tremuloides *	quaking aspen *		0		0	10	18	5	6	24
Ribes cereum	wax currant		0		0		0	5	6	6
Ribes lacustre or *Ribes inerme*	gooseberry/currant		0		0		0	5	6	6
Rosa woodsii	Wood's rose		0		0		0	10	12	12
Rubus deliciosus	boulder raspberry		0		0		0	5	6	6
Rubus idaeus subsp. strigosus	wild raspberry		0		0		0	5	6	6
Symphoricarpos rotundifolius	snowberry		0		0	10	18	20	24	42
	Subtotal:	0	0	0	0	100	180	100	119	299

Design Processes Takeaways

Define hydroseres relative to a known hydrologic position

- Bankfull, Normal Pond, Ordinary High Water Mark, etc.
- Avoid purely geomorphic terminology (i.e., overbank) when designing hydroseres, as this limits the revegetation extents of that hydrosere across the floodplain.

Work with engineer (and rest of team) early in process to integrate design elevations using a compatible approach

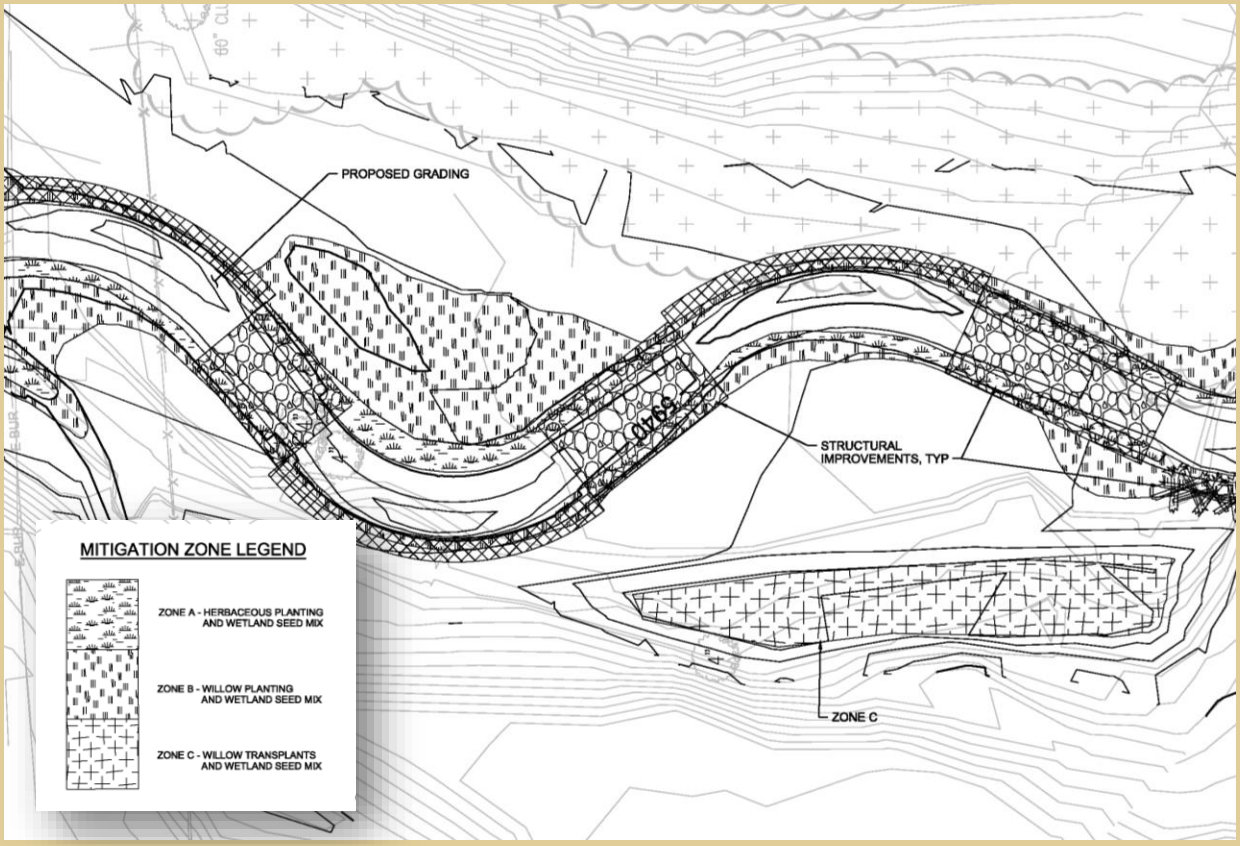
- File sharing, shared terminology, etc.
- This can and often should influence grading extents.

Utilize Design Products (i.e., takeoffs) to summarize plant/restoration materials needs

- Acres of wetland seed.
- Qty of xeroriparian shrubs.
- Qty of willow cuttings or cottonwood poles. Etc.
- This can be done readily in GIS or CAD.

Communicate (well) with Engineer During Design Phase

Define hydroseres well, and with a system that allows for easy integration with engineering design process (i.e., grading plans).



Design Hydrosere Extents not Simply with Consideration for Hydrogeomorphic position,

but also based on restoration niches of the plants within each hydrosere.

Expected (i.e., fundamental) Niche

A plant's expected location on the landscape based on natural means of recruitment (i.e., seed rain, fecal matter, episodic establishment associated with specific ppt/flood regimes, etc.)

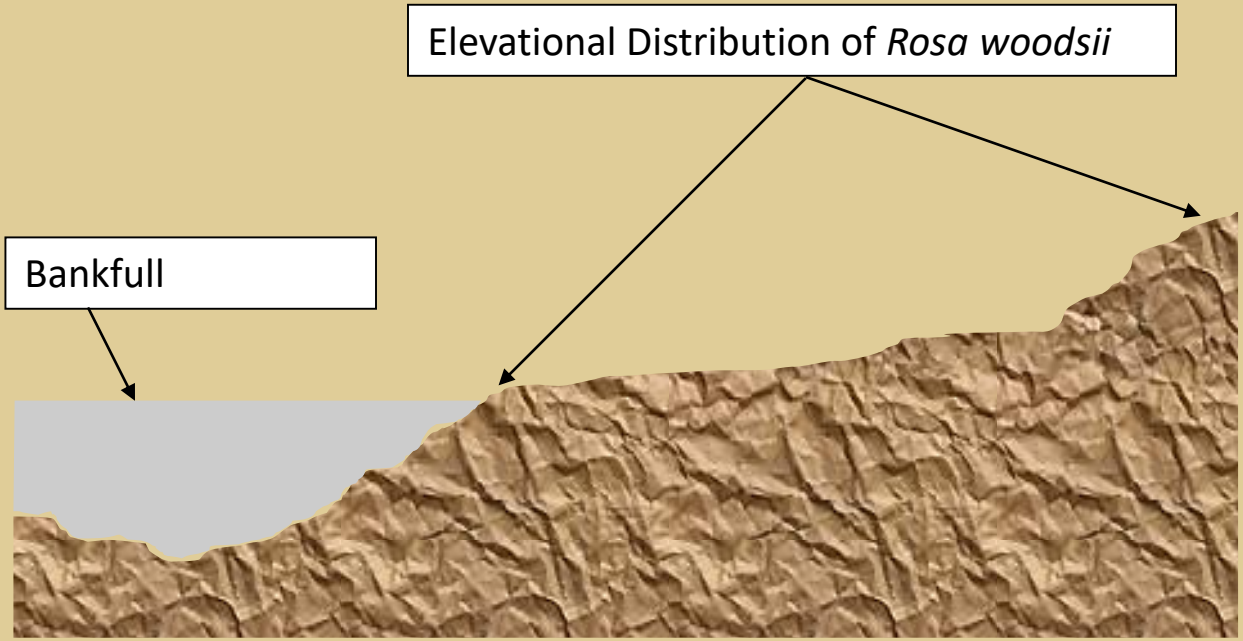
Restoration Niche

Where a plant can be located based on propagule type (i.e., seed, container, cutting).

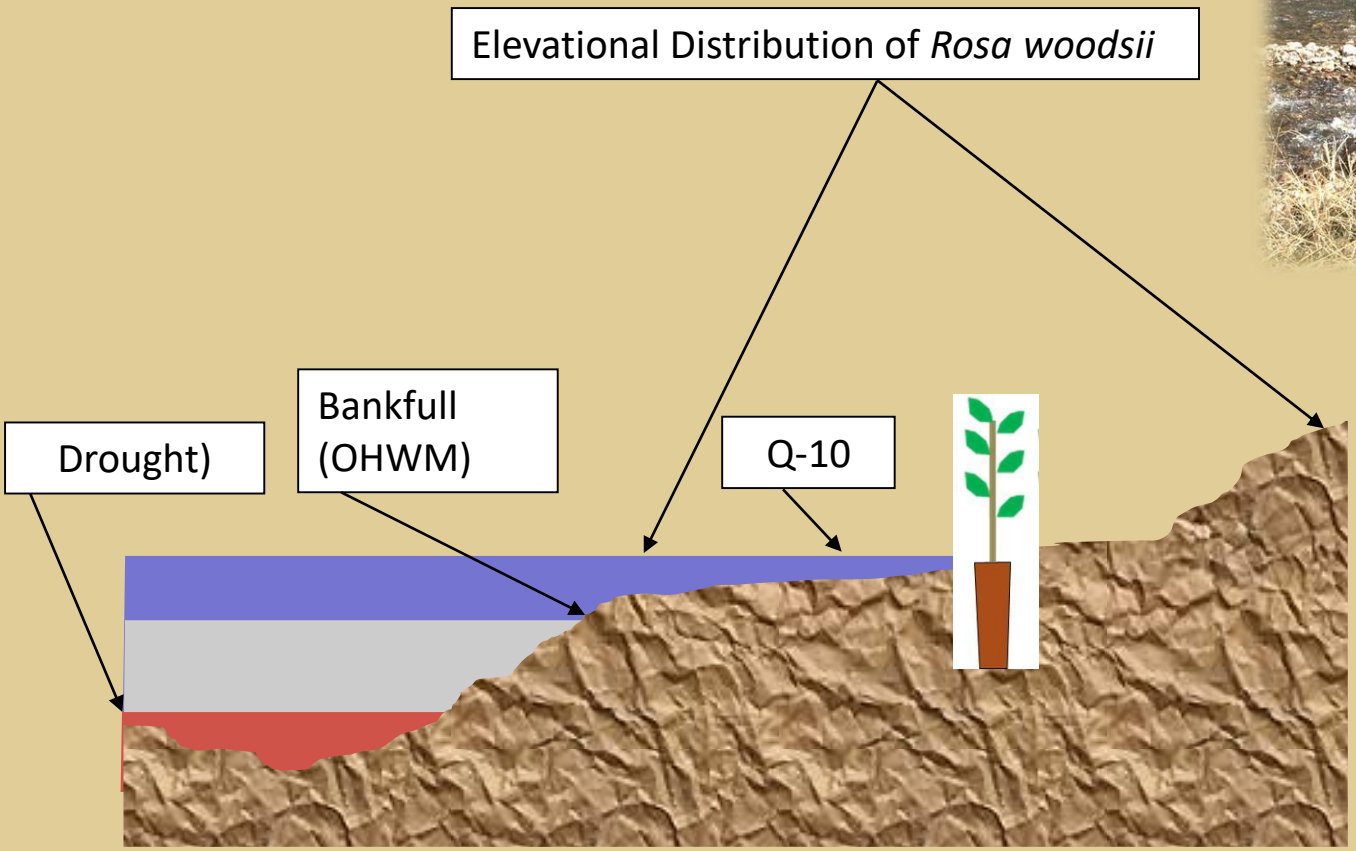
Influenced by risk of drought or scour.

Restoration Niche is often narrower than fundamental niche.

Ecological Niche vs. Restoration Niche



Expected Niche vs. Restoration Niche



Questions?

john@aloterraservices.com