Improving Assessment Tools for California's Episodic Streams

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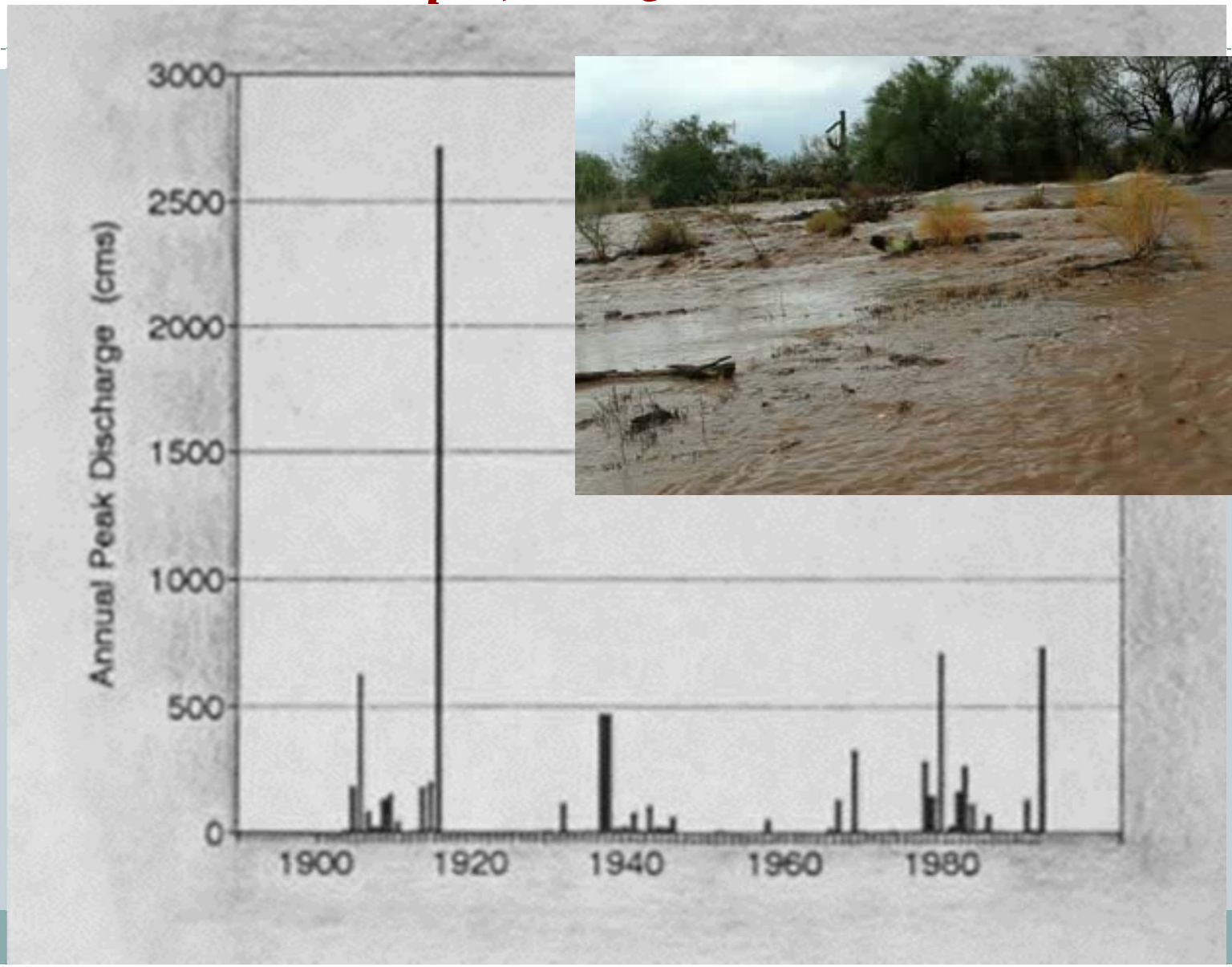
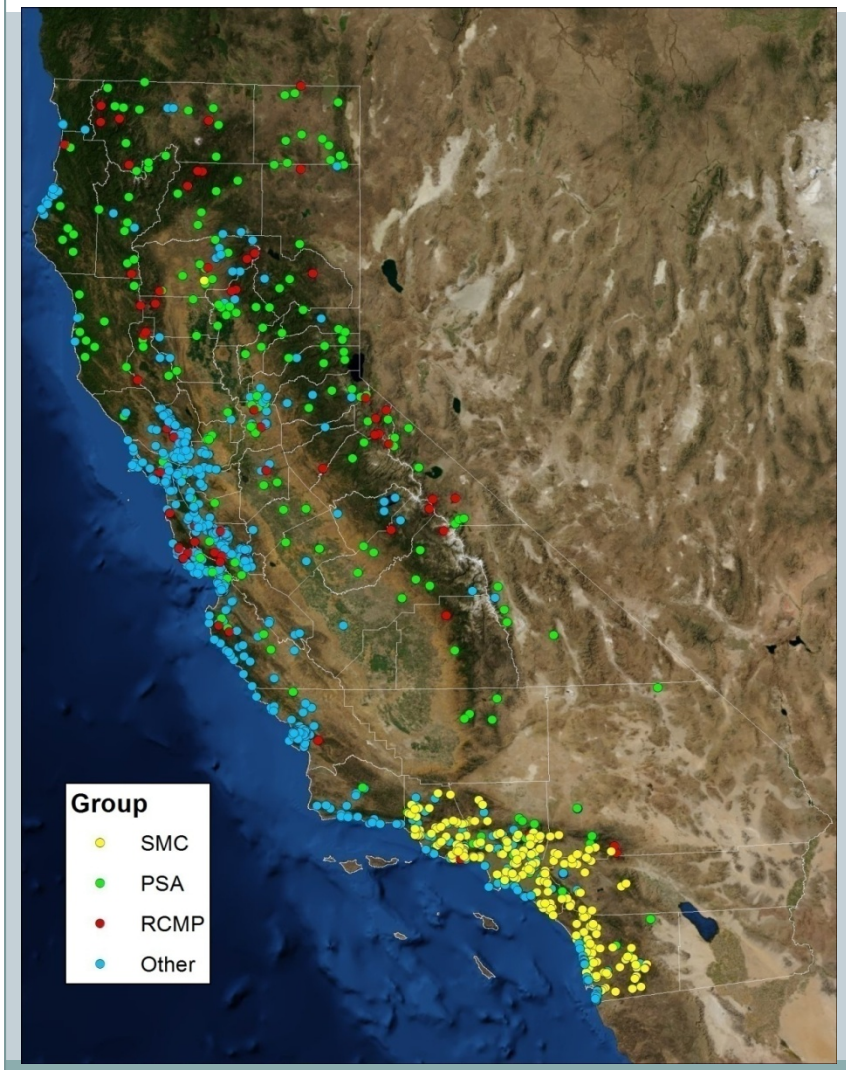
Long periods of boredom, brief moments of terror

Erich Maria Remarque, All Quiet on the Western Front



The Issue



- ~ 66% of CA's streams characterized as non-perennial (intermittent, ephemeral)
- Lots of stream-based monitoring, but most programs exclude non-perennial streams
- Lack of appropriate maps, assessment tools, and indicators
- Provides incomplete picture of overall watershed health

Why We Care

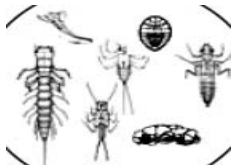
- Non-perennial streams collectively drain large areas of land
  - Important interface between land-use activities and downstream impacts
- Development in upstream non-perennial streams can have significant impacts in downstream perennial streams
  - Implications for water quality, sediment, nutrients
- Often support rich biotic communities in channel and surrounding riparian zone
- Jurisdictional waterbodies (WoState, WoUS)

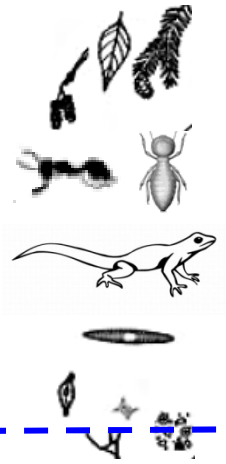
Long-term Goal

Perennial | short-term non-perennial | **Intermittent** | long-term non-perennial | **Ephemeral (episodic)**

~12 mos. | 10 mos. | 8 mos. | 6 mos. | 4 mos. | 2 mo. | < week

Typical flow duration





CRAM

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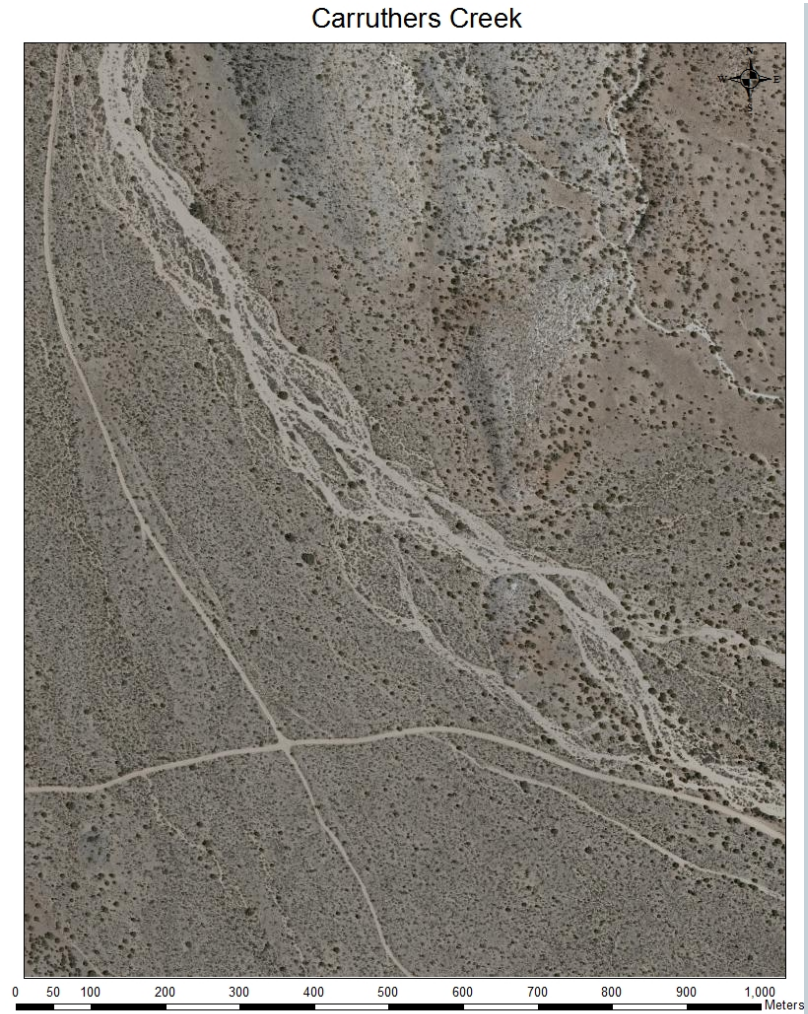
Current Project

- Develop framework for a rapid assessment method for dryland ephemeral (episodic) channels
  - Conceptual model of form and function
  - Classification system (are multiple tools needed?)
- Criteria for reference site identification
- Recommend appropriate intensive indicators to validate rapid assessment method

Challenges and Considerations

- Highly variable systems over space and time (episodic)
- Difficult to discern “impacts” from patterns of natural disturbance
- Subtle field indicators
- “Biological” assessment tools & indicators may not be appropriate



Project Constructs

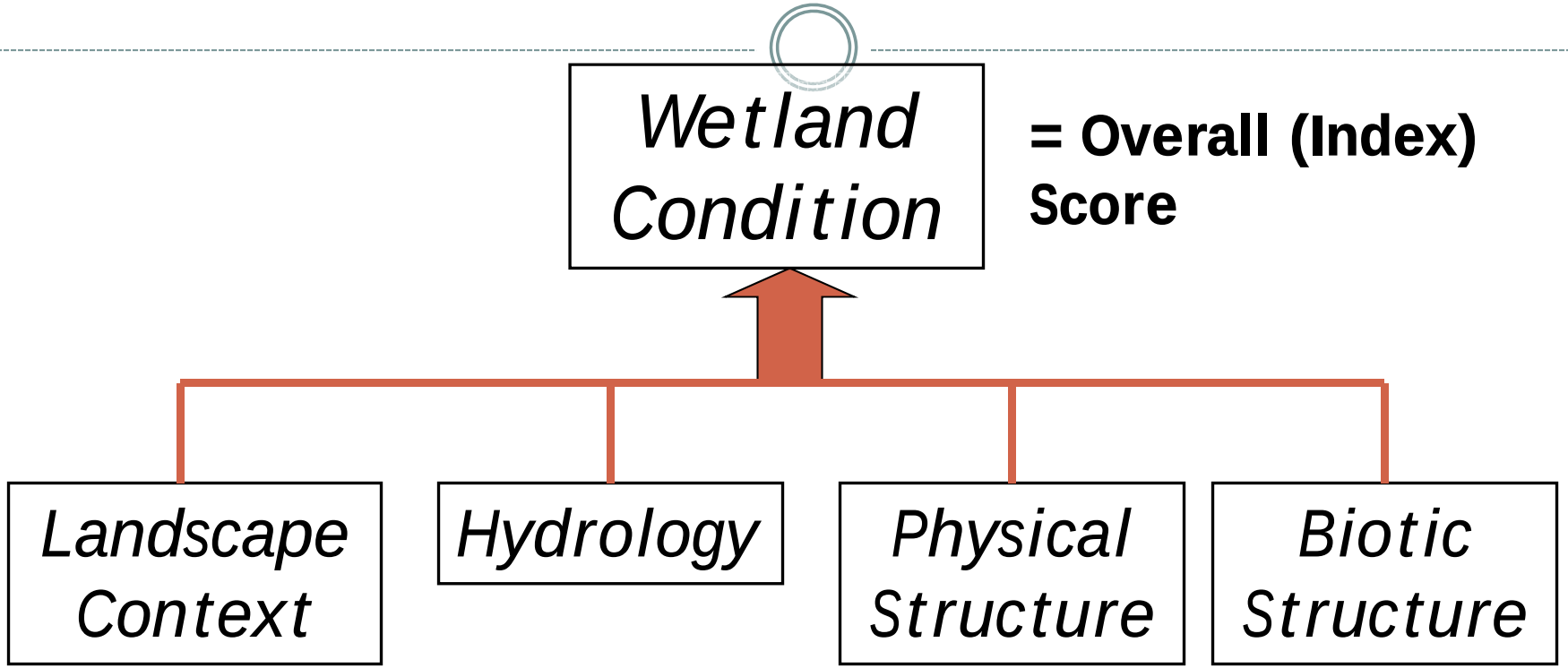
Strive for consistency with existing State program

- Use of CA Rapid Assessment Method (CRAM) as conceptual foundation for RAM
  - Universal attributes of condition
  - Many existing metrics also apply to episodic channels
- Use of SWAMP reference site criteria
- Adjust scale and indicators where necessary based on function of episodic channels

Reference Condition Criteria

- Same approach as for perennial streams
  - Urban/ag. land use
  - Road density
  - Percent canal pipes
  - Dams, diversions, etc.
- Sites identified as reference condition to become part of State reference network

CRAM Framework



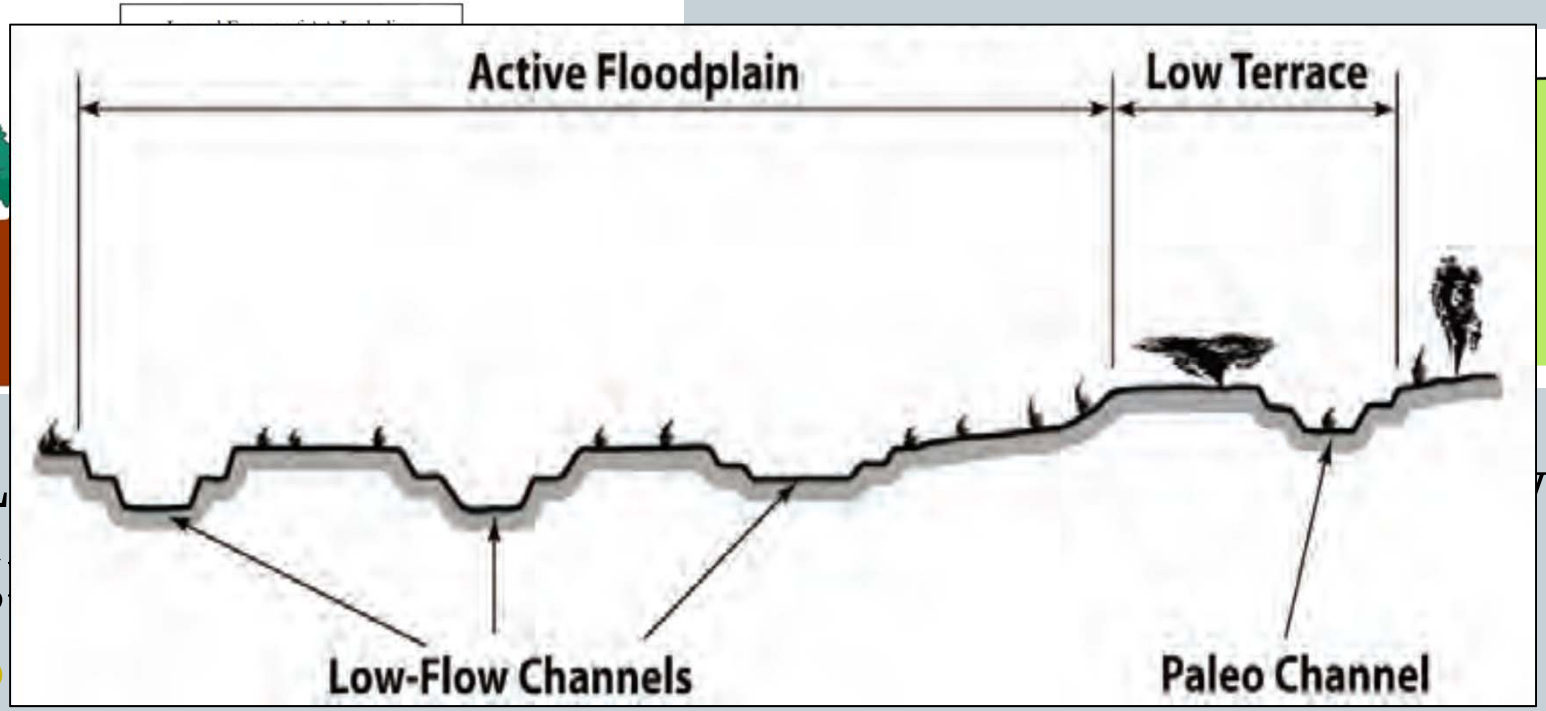
- CRAM is comprised of four attributes
- Each attribute is represented by 2-3 metrics, some of which have sub-metrics.

Classification of Episodic Channels

Valley Class	Relative Position	Substrate
Confined	Source	Bedrock
	Erosional	Bedrock with alluvium
Confined to Unconfined	Erosional	Incised alluvium (arroyo)
Unconfined	Depositional	Sand bed (desert wash)
		Piedmont headwater (alluvial fan)

Defining the Assessment Area (AA)

- Traditional concepts may not always apply
  - "Bankfull" channel
  - Limits of riparian vegetation providing allochthonous input



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Example: Defining the AA

Metric Development

ATTRIBUTES		METRICS
Buffer and Landscape Context		Stream Corridor Continuity
		Buffer:
		Percent of Assessment Area with Buffer
		Average Buffer Width
		Buffer Condition
Hydrology		Water Source
		Channel Stability
		Hydrologic Connectivity
Structure	Physical	Structural Patch Richness
		Topographic Complexity
	Plant Community	Number of Plant Layers Present
		Number of Co-dominant Plant Species
		Percent Co-dominant Plant Species that are Invasive
		Horizontal Interspersion
		Vertical Structure

Considerations for Physical Indicators

- Episodic channels tend to be in dynamic flux, with indicators of aggradation and degradation co-occurring
- Equilibrium indicators rarely achieved or differ from perennial streams
- Reference condition sites for low gradient, depositional areas naturally tend toward aggradation

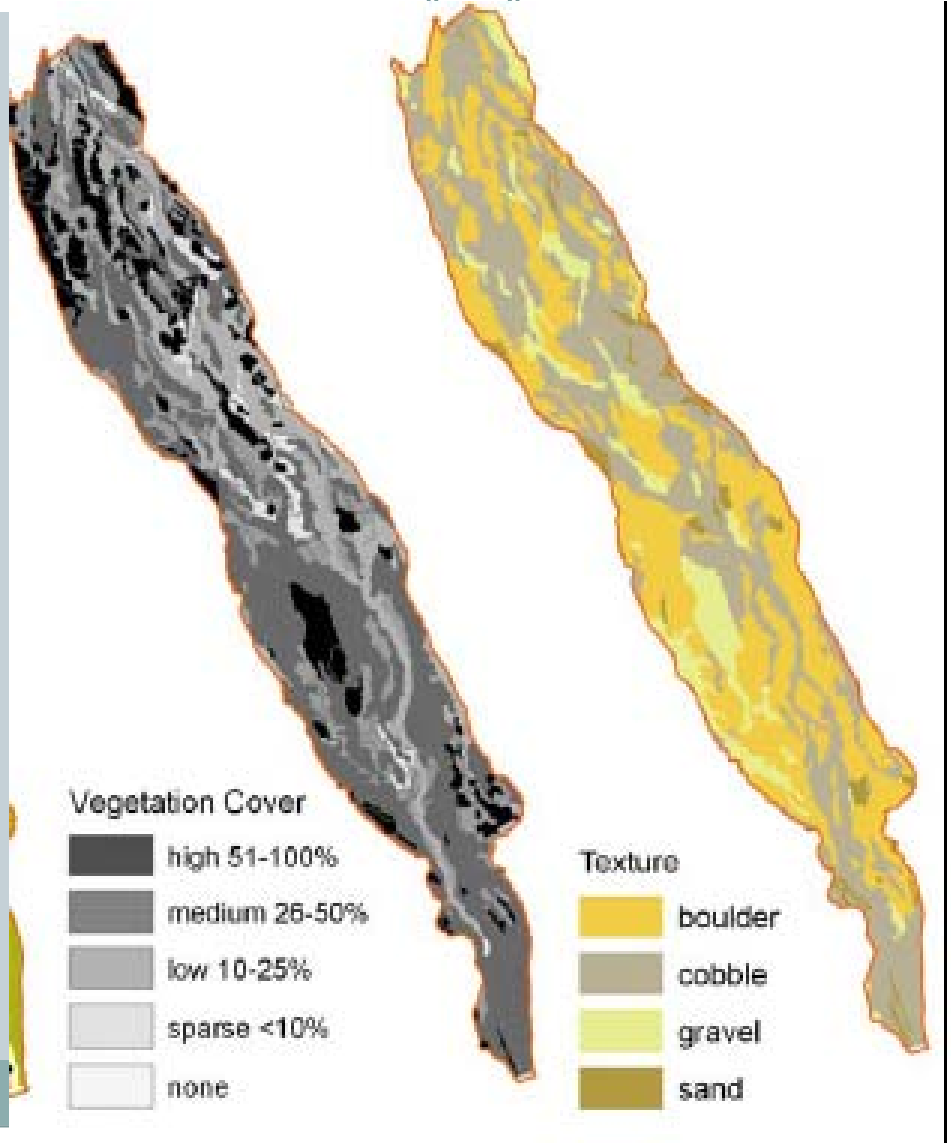
Physical Patch Types

Substrate Composition

Bed material indicates flow zones

Characteristic lack of vegetation

Interspersion and Complexity



Deviation from Reference

Degraded transitions/connections between channel and floodplain

Considerations for Biological Indicators

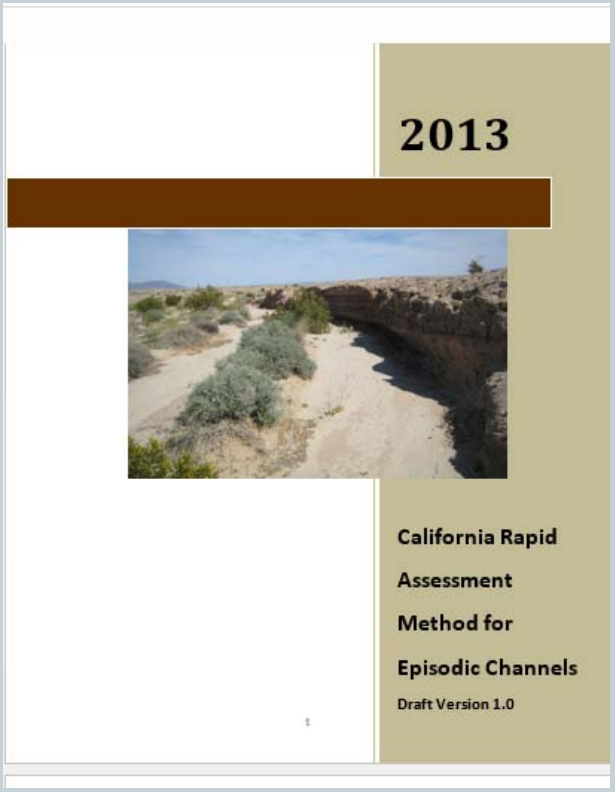
- Important to consider vegetation composition and density across entire floodplain, including upper terraces.
- Vegetation often comprised of upland species with few riparian components (xeroriparian)
- Stand age distribution is a function of time since last episodic event

Plant Indicators

- Plant densities and distribution/position across the floodplain
- Structural complexity of floodplain plant communities
- Diversity of non-invasive plants

Characteristic Plant Communities

What Happens Next



- Conceptual component complete
- Field testing currently ongoing through early spring 2014
- Indicators refined based on data
- Data analysis will be used to define metric scaling
- Draft module available by late 2014
- Peer review via field testing by users

Potential Intensive Indicators

- Surrogate measures of faunal use
  - Reptile/mammal/arthropod burrow counts
- Intensive measures of vegetation
- Terrestrial arthropod community
  - Ground-dwelling beetles, ants
- Soil microbial community

THANK YOU

Folks whose content I pilfered
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Matt Kondolf – UC Berkely

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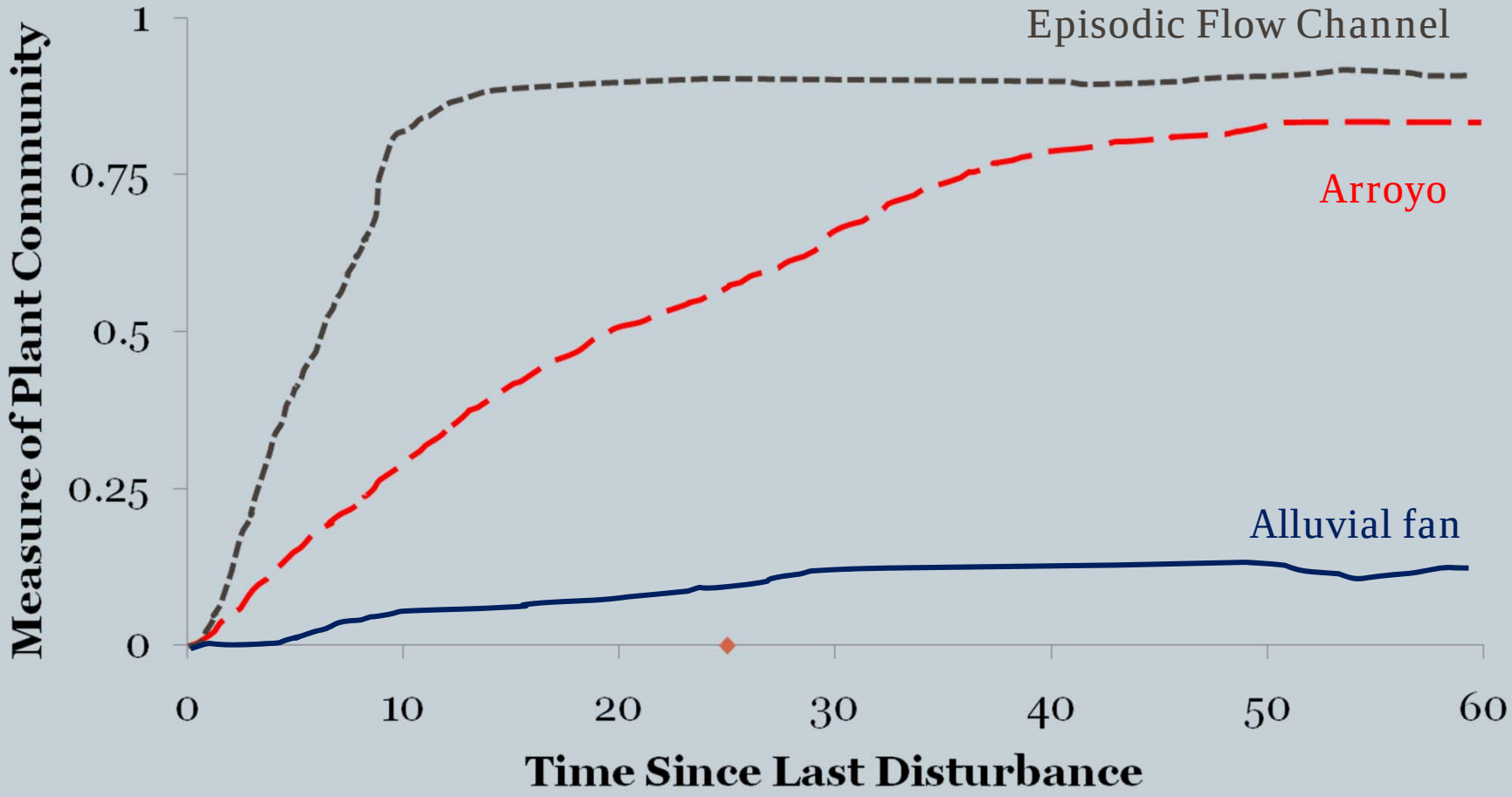
Expectations Vary as a Function of Time



Channel "stability" metric worksheet

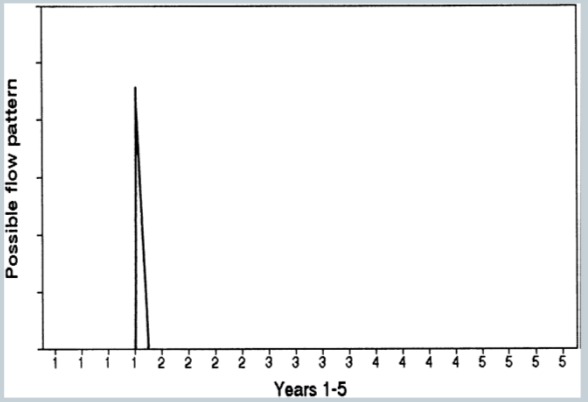
Worksheet for Assessing Channel Stability for Riverine Wetlands.

Condition	Field Indicators (check all existing conditions)
Indicators of Channel Equilibrium	☐ The channel (or multiple channels in braided systems) has a well-defined bankfull contour that clearly demarcates an obvious active floodplain in the cross-sectional profile of the channel throughout most of the AA. ☐ Perennial riparian vegetation is abundant and well established along the bankfull contour, but not below it. ☐ There is leaf litter, thatch, or wrack in most pools. ☐ The channel contains embedded woody debris of the size and amount consistent with what is naturally available in the riparian area. ☐ There is little or no active undercutting or burial of riparian vegetation. ☐ There are no densely vegetated mid-channel bars and/or point bars that support perennial vegetation. ☐ Channel bars consist of well-sorted bed material. ☐ There are channel pools, the spacing between pools tends to be regular and the bed is not planar through out the AA ☐ The larger bed material supports abundant mosses or periphyton.
Indicators of Active Degradation	☐ The channel is characterized by deeply undercut banks with exposed living roots of trees or shrubs. ☐ There are abundant bank slides or slumps. ☐ The lower banks are uniformly scoured and not vegetated. ☐ Riparian vegetation is declining in stature or vigor, or many riparian trees and shrubs along the banks are leaning or falling into the channel. ☐ An obvious historical floodplain has recently been abandoned, as indicated by the age structure of its riparian vegetation. ☐ The channel bed appears scoured to bedrock or dense clay. ☐ Recently active flow pathways appear to have coalesced into one channel (i.e. a previously braided system is no longer braided). ☐ The channel has one or more knickpoints indicating headward erosion of the bed.
Indicators of Active Aggradation	☐ There is an active floodplain with fresh splays of coarse sediment (sand and larger that is not vegetated) deposited in the current or previous year. ☐ There are partially buried living tree trunks or shrubs along the banks. ☐ The bed is planar overall; it lacks well-defined channel pools, or they are uncommon and irregularly spaced. ☐ There are partially buried, or sediment-choked, culverts. ☐ Perennial terrestrial or riparian vegetation is encroaching into the channel or onto channel bars below the bankfull contour. ☐ There are avulsion channels on the floodplain or adjacent valley floor.
Overall	**☐ Equilibrium ☐ Degradation ☐ Aggradation**

Condition	Field Indicators (check all existing conditions)
Evidence of Aggradation	☐ Lobate bar ☐ Coarse materials in riffles embedded ☐ Siltation in pools ☐ Medial bars ☐ Accretion on point bars ☐ Poor longitudinal sorting of bed materials ☐ Deposition in the overbank zone
Evidence of Degradation	☐ Exposed bridge footings ☐ Exposed sanitary/storm sewer/pipeline/etc. ☐ Elevated storm sewer outfall ☐ Undermined gabion baskets/concrete aprons/etc. ☐ Scour pools downstream of culverts/stormsewer outlets ☐ Cut face on bar forms ☐ Head cutting due to knick point migration ☐ Terrace cut through older bar material ☐ Suspended armor layer visible in bank ☐ Channel worn into undisturbed overburden/bedrock
Evidence of Widening	☐ Occurrence of large organic debris ☐ Fallen/leaning trees/fence posts/etc. ☐ Exposed tree roots ☐ Basal scour on inside meander bends. ☐ Basal scour on both sides of channel through riffle ☐ Gabion baskets/concrete walls/armor stone/etc. out flanked ☐ Exposed length of previously buried pipe/cable/etc. ☐ Fracture lines along top of bank ☐ Exposed building foundation
Evidence of Planimetric Form Adjustment	☐ Formation of cute(s) ☐ Evolution of single thread channel to multiple channel ☐ Evolution of pool-riffle form to low-bed relief form ☐ Cutoff channel(s) ☐ Formation of islands ☐ Thalweg alignment out of phase with meander geometry ☐ Bar forms poorly formed/reworked/removed

Challenges for Episodic Channel Assessment

- Short-duration, highly localized and extremely variable flow
  - Only flow in response to significant rainfall
  - No flow for long periods
- Catastrophic flood magnitudes/movement of sediment
  - Much larger than temperate climate streams (as multiple of avg. flow)
  - System is periodically "reset"
- Systems in dynamic flux
  - Transient channel forms and indicators
  - Equilibrium/climax community may never be obtained



General Project Concepts II

- Biological communities of these systems reflect that surface water occurs at low frequency, typically does not persist, and substrates are often dry (i.e. not saturated)

- Episodic events = substantial changes in planform, morphology, and biotic communities
  - brief periods of substantial instability/change followed by long periods of quiescence
  - scale of change proportional to size of stream and its position in the watershed

- Following an episode, systems undergo recovery periods where physical and biotic features re-stabilize until next event

Considerations for Metric/Indicator Development

- Conducting baseline evaluations on ranges of values for key indicators of interest (field)
  - Consider overall planform structure vs. floodplain/in-channel features
- Identify the semi-stable field indicators or macro-structures
  - Less variable over time
- Identify indicators of repeating patterns of flow or sediment movement
  - Prevalence of indicators across active floodplain
- Focus on features that provide requisite faunal habitat
  - Diversity of substrate types and physical features

General Approach

1. Define subclasses of episodic streams
   - Classification system

2. Define criteria for reference site identification

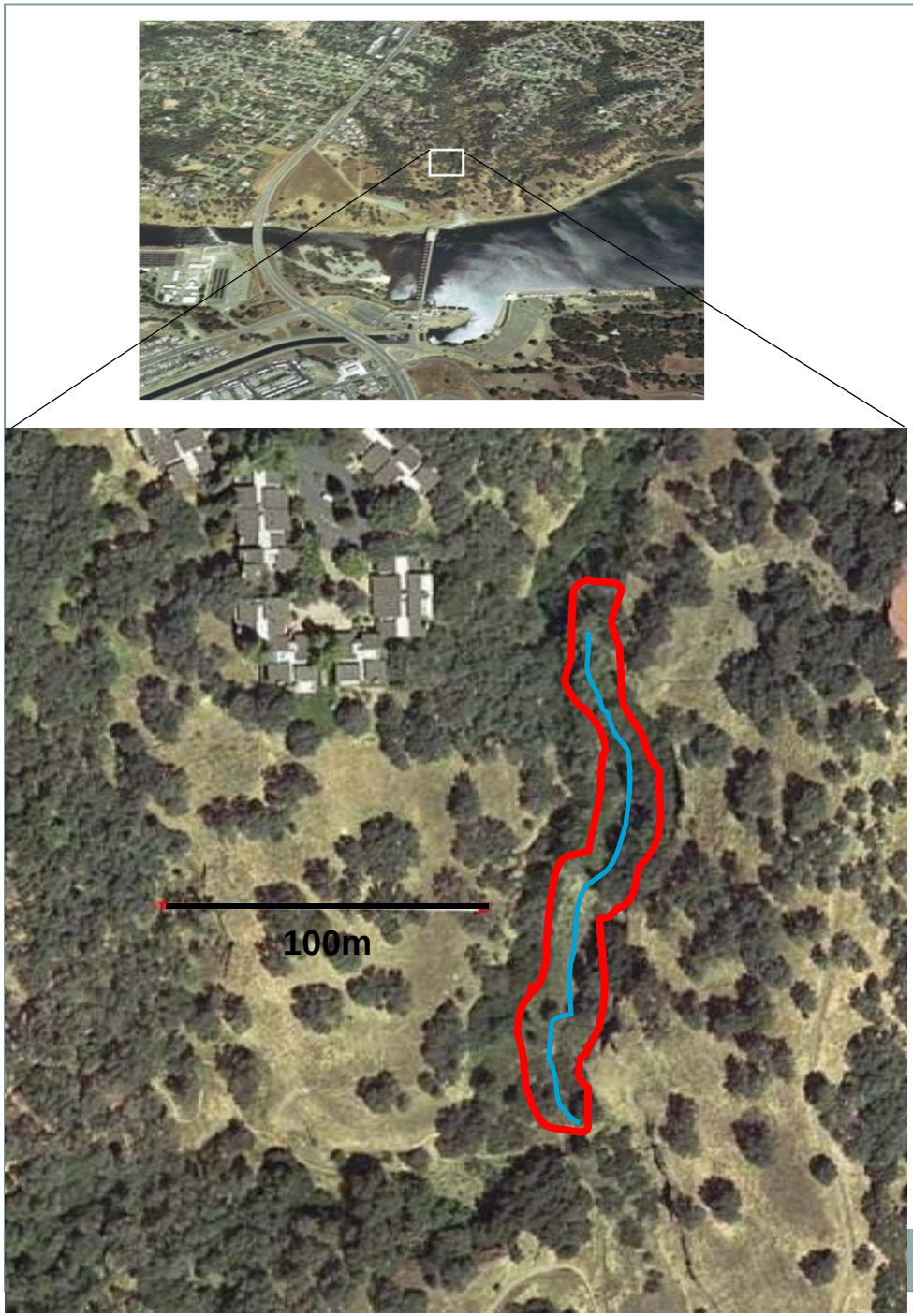
3. Define Assessment Area (AA)

4. Develop candidate metrics and indicators

5. Test metric/indicator performance along a gradient of condition

6. Produce draft RAM

7. Recommend intensive (L3) indicators for RAM validation



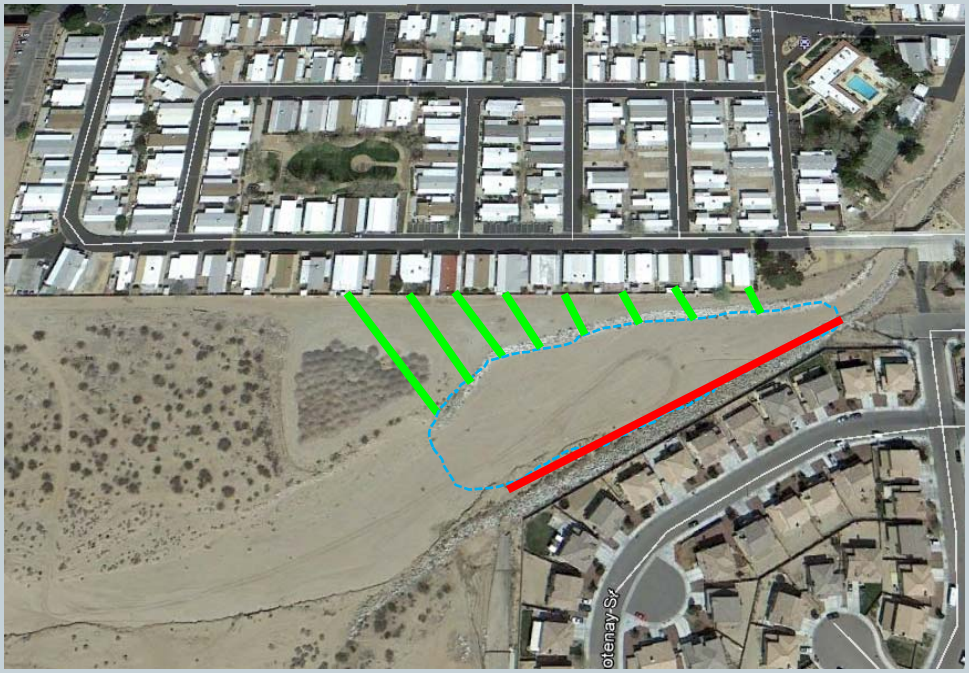
Sketch the AA

Subject to field verification

- Length = 10x mean BF Width within limits of 100m and 200m
- Width includes portion of riparian area that directly provides allochthanous matter
- AA is the channel, its floodplain, and essential riparian area

Buffer Metric Example

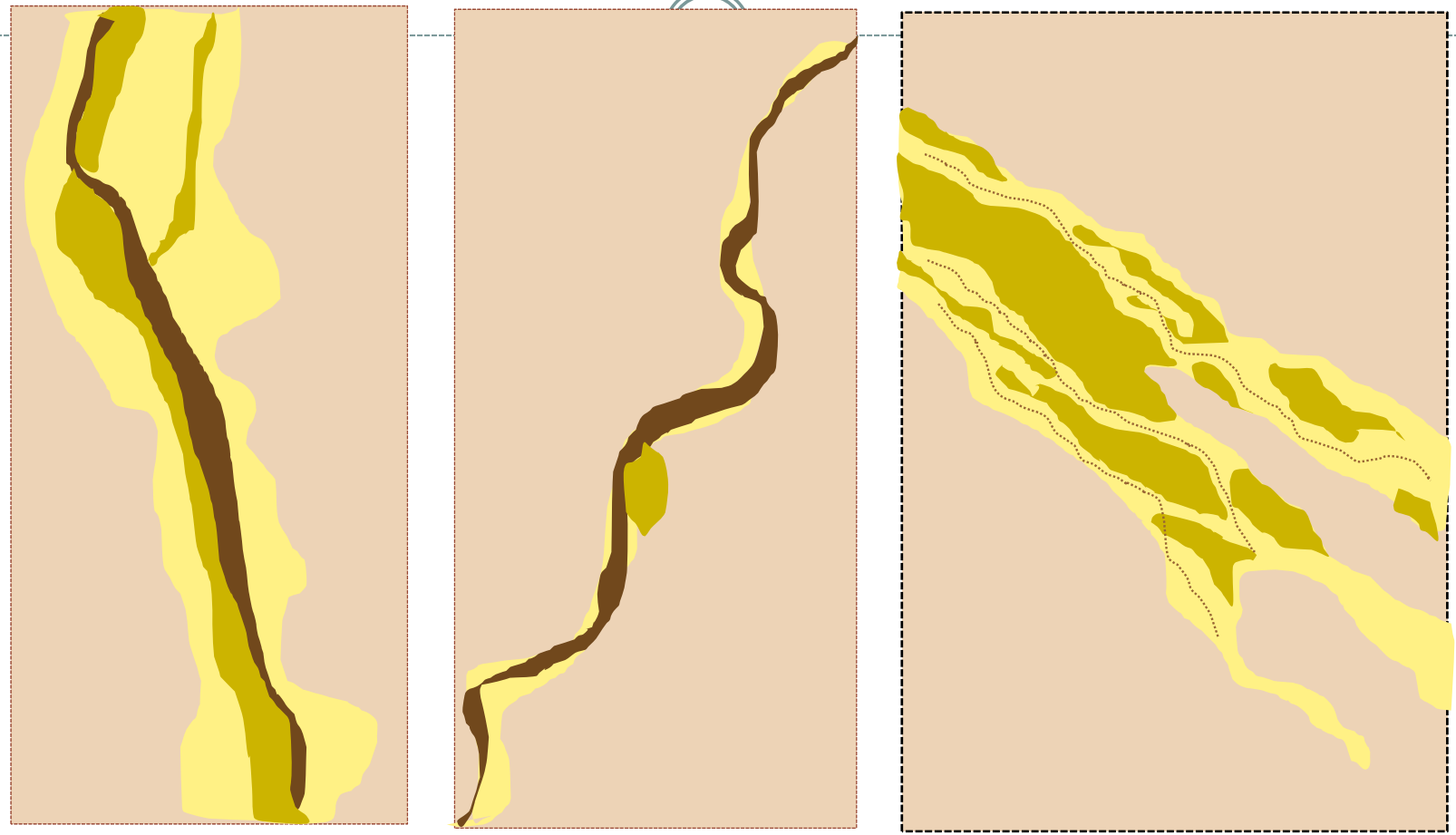
Function of buffer and way it is measured in CRAM does not differ conceptually differ between perennial and episodic channel types



Scoring Example

METRICS	Deep Canyon	Coyote Creek
Stream Corridor Continuity	A	A
Buffer:		
Percent of Assessment Area with Buffer	A	A
Average Buffer Width	A	A
Buffer Condition	A	A
Water Source	A	A
Channel Stability	C	C
Hydrologic Connectivity	B	C
Structural Patch Richness	B	C
Topographic Complexity	B	B
Number of Plant Layers Present	B	B
Number of Co-dominant Plant Species	D	C
Percent Co-dominant Plant Species that are Invasive	A	A
Horizontal Interspersion	C	C
Vertical Structure	D	D

Form Affects Function →Tools



Single-thread Discontinuous Compound (braided)