Bankfull Channel Dimensions and Watershed Size Influences on Potential Riparian Community Type in Arizona.

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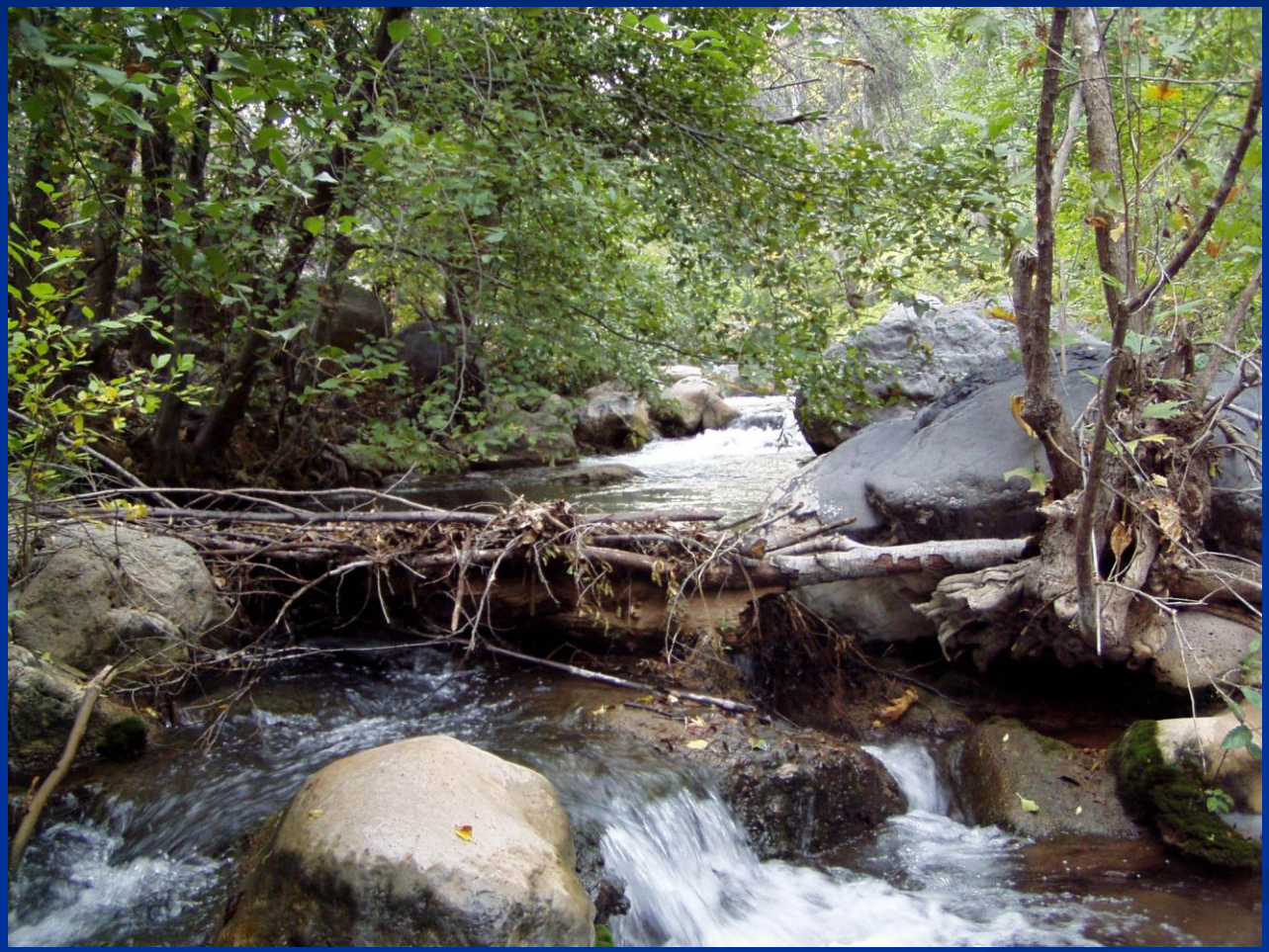
This presentation discusses the differences between large and small watersheds and their ability to support different vegetation communities in the arid southwest

Determining the potential vegetation community of a river is an important step, whether restoring or assessing its functionality.



Systems with higher gradients and larger substrates generally support woody riparian communities.

Whereas, herbaceous wetland vegetation is is found in broad, lacustrine valleys with very low gradients and very fine sediments.

The issue gets much more complicated in large river systems, especially those with very low summer base flows, compared to bankfull flows, such as the Big Sandy River in NW AZ.

In 1998 livestock were removed from the Big Sandy River during the spring-summer growing season. It was assumed due to the presence of a wide channel and a shallow water table that cottonwood and willow would re-establish and we'd be counting willow flycatchers soon.

After a few years of growing season rest, an emergent wetland established with cattail and bulrush, instead of cottonwood and willow.

Conditions changed after the big floods of 2005

What are the natural vegetative communities in these large river systems - herbaceous emergent wetlands?

Or woody riparian communities?

What do we want to assess or predict: the potential vegetation on the floodplain or in the active channel, or both?

Very few studies or monitoring reports describe or discuss how the actual floodplain or bankfull channel was determined. One persons' bankfull channel can be other's low flow channel.

Bankfull Discharge

For an extreme example, the USGS gage on the Santa Maria River measures 0 cfs for 75% of the record. Bankfull discharge, that occurs every 1.5 years (1.5 year return interval), is 3,300 cfs.

This channel, upstream of the USGS Gage on the Santa Maria River would not carry 3,300 cfs. This is not the bankfull channel.

When we discuss vegetative potential of a river reach, we must speak in specific terms. What is the current vegetation community in the active channel? What is the floodplain vegetation?

This is the floodplain behind the previous shown group of willow

Rivers with large watersheds have large bankfull discharges

	Watershed Size (mi^2)	Bankfull Discharge
Big Sandy River	2,743	2,260 cfs
Santa Maria River	1,129	3,300 cfs
Verde River @Clarkdale	3,500	2,400 cfs
San Pedro River @ Palominas	741	1,800 cfs
Virgin River @ Littlelfield	5,100	3,500 cfs

There are large differences between bankfull and mean summer flows in these arid land rivers.

	Bankfull Discharge	May	June	July
Big Sandy River	2,260 cfs	9.02	4.99	4.99
Santa Maria River	3,300 cfs	6.64	1.58	2.61
Verde River	2,400 cfs	86.2	75.9	99.3
San Pedro River	1,800 cfs	1.1	4.48	82.7
Virgin River	3,500 cfs	408	138	106

Big Sandy River in July at less than 2 cfs. Wetland herbaceous vegetation is very limited in having suitable habitat. In this case they are established only at the edge of active flow. The bankfull channel is mostly dry.

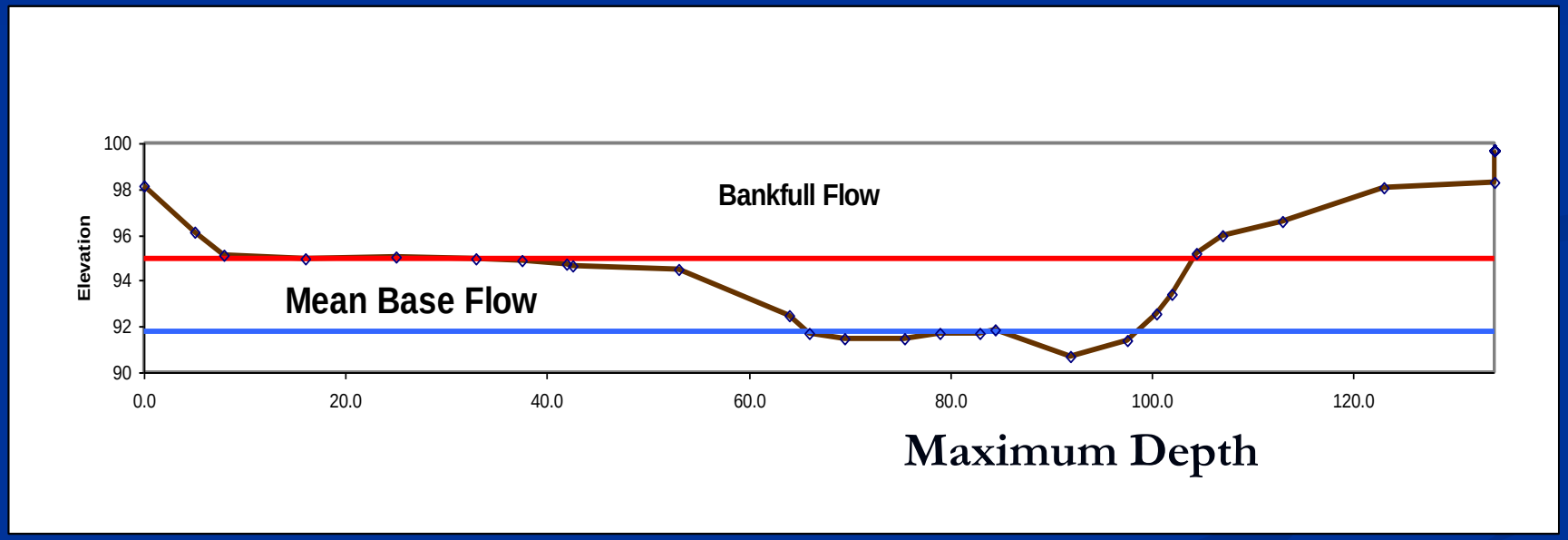
Large bankfull discharges need a large channel to flow through. These are bankfull channel cross-sectional areas for large AZ rivers.

- San Pedro River at Palominas 310 ft^2
- Verde River at Clarkdale 380 ft^2
- Big Sandy River at Wikieup 385 ft^2
- Santa Maria River 531 ft^2
- Virgin River at Littlefield 484 ft^2

Rivers seek to maintain stability.

- River channels are naturally going to narrow as they regain stability in order to move what sediments are delivered from the watershed.
- A channels' efficiency to move sediment increases as it's mean depth increases.

Maximum depth of the bankfull channel is going to have an important influence on the water table level and what plant species can live outside of the active channel.



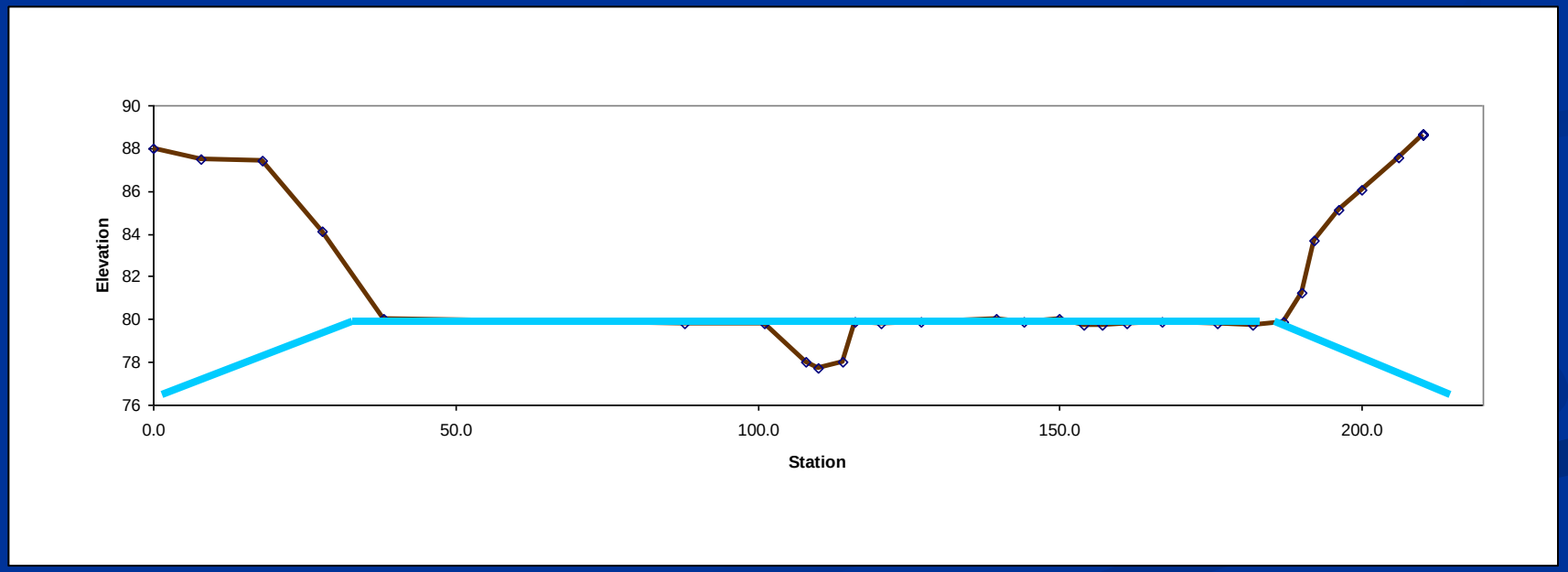
Water Table Depth Thresholds

- Adult Salix (San Pedro River) 3.2 m (10.5 ft) (Stromberg et al. 1996).
- Sapling Salix (San Pedro River) 2 m (6.5 ft) (Stromberg et al 1996).
- Carex-Juncus sp. (Nevada) 0 to 100 cm (~40”)(Manning and Padgett 1995). (Wide range in species thresholds)

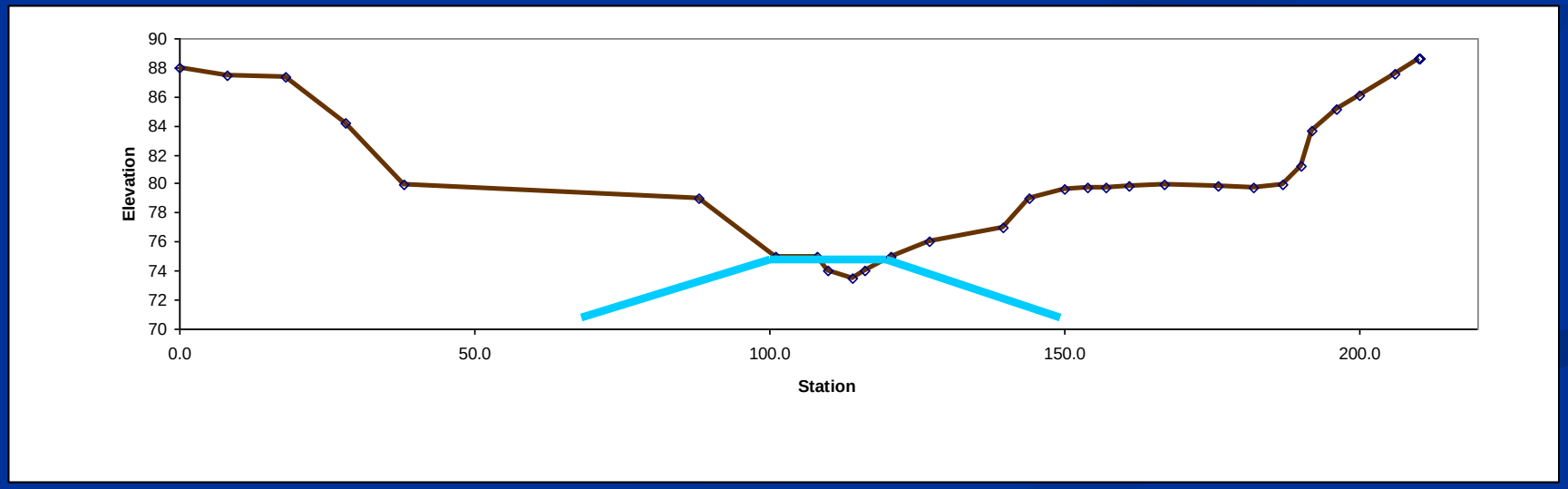
As a river channel stabilizes, it will narrow, increasing this maximum depth to water between the flood plain and the river low flow channel.

The low flow channel may narrow to a point where conditions are no longer suitable for herbaceous vegetation across the entire active channel.

The channel is over wide with a very high width depth ratio. There may be a small low flow channel is these reaches. The water table is high enough across the whole channel to support herbaceous vegetation.



The channel has narrowed as the river stabilizes. The high water table is now limited to the active channel. A flood plain has established where herbaceous vegetation once spread across the channel. Water table depths are now too deep for herbaceous vegetation.



This is not a case of the woody riparian species forcing herbaceous vegetation out; conditions improve for woody species as the channel narrows and groundwater depths across the active channel increase.

Herbaceous wetlands are limited to low gradient streams with small watersheds which produce smaller bankfull event which flow in smaller bankfull channels.

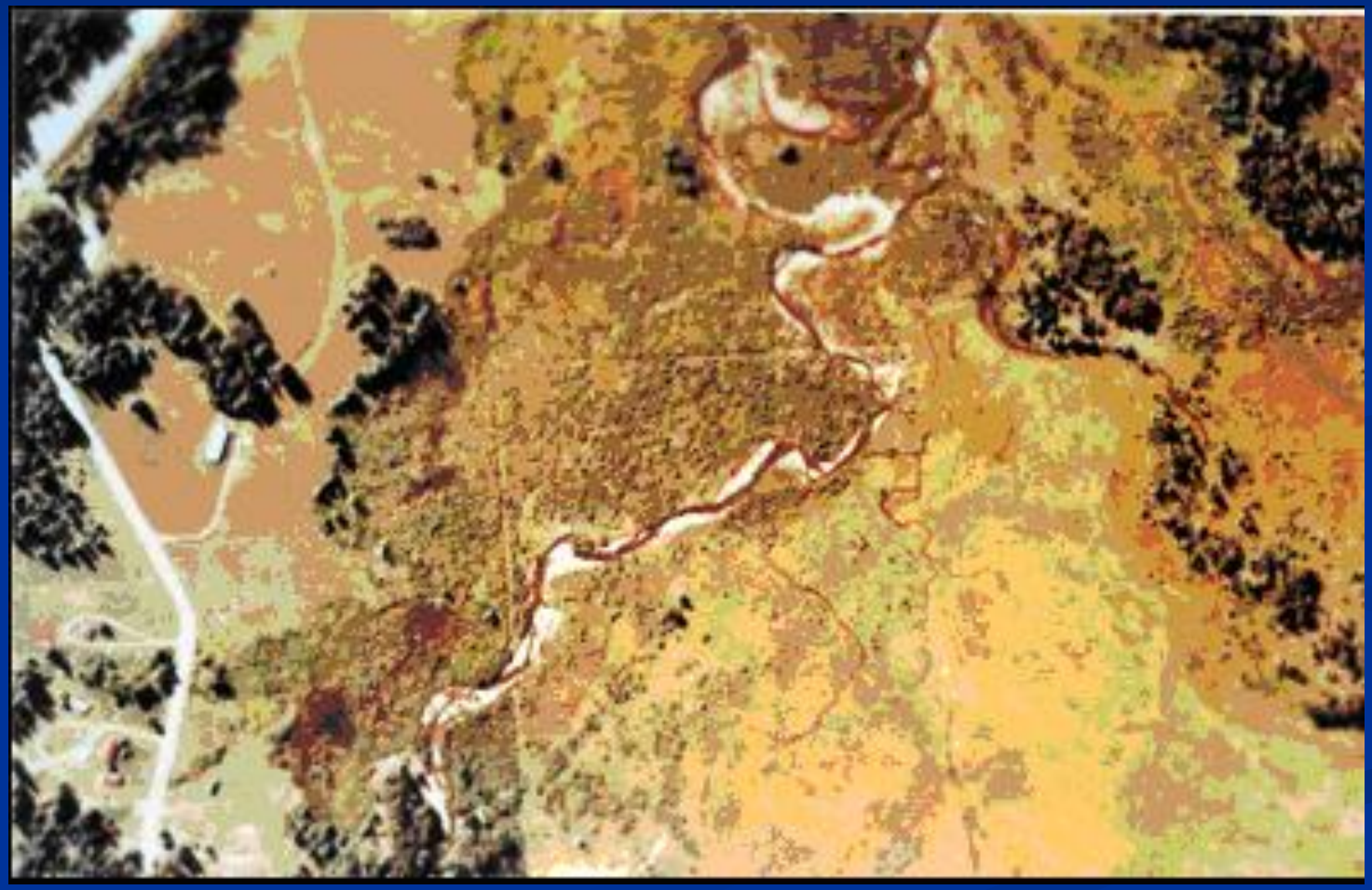
Herbaceous wetland soils - fine textured with a very high water holding capability.

Wood vs Grass (Herbaceous)

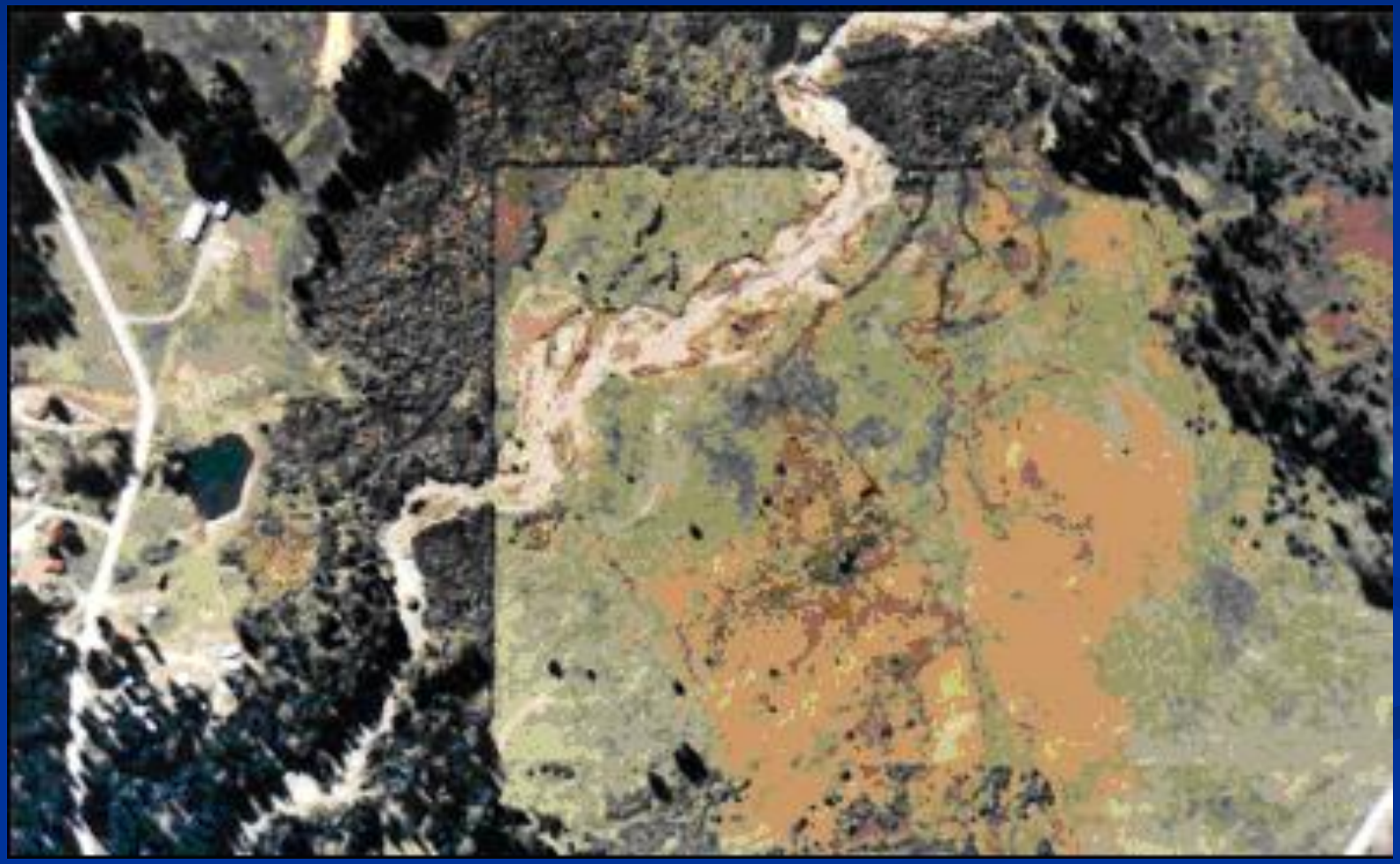
Channel Morphology

- Woody vegetation provides better bank protection due to deeper root systems (Wynn et al. 2004).
- Woody vegetation stabilizes streambanks better than herbaceous vegetation.
- Herbaceous roots are too shallow to protect deep bankfull channels.

Woody riparian vegetation protects stream banks from lateral erosion.



Willows were sprayed to increase forage on riparian pasture. A C-channel has degraded into a broad D-channel. The private landowner has lost quite a bit of property as a result of this "improvement" project.



Other benefits of woody vegetation

- Traps large amounts of sediment.
- Dissipates flood flow energy.
- Causes variable channel widths which provides variation in stream velocity, depths, and substrate size all of which lead to more heterogeneous habitats for many aquatic organisms.

Woody riparian vegetation is a major source of energy in streams.

Coarse woody debris and leaf packs derived from terrestrial sources (i.e. woody riparian plants)=

Lots of organic matter and healthy invertebrate populations for the stream food web.

Conclusion

When determining the potential vegetation of a riparian system

- Watershed size and bankfull discharge must be taken into account.

Large Bankfull Channels

- Maximum depths that will not support wetland herbaceous vegetation across much of the width of the active channel and flood plain.

- Herbaceous species need a high water table.

Herbaceous Wetlands

- Small Watersheds
- Small Bankfull Discharges
- Low Gradients
- Fine Sediments

Floodplain Location

- Difficult to determine where summer mean flows and bankfull flows differ greatly.
- False floodplains or depositional features form from vegetation establishing in the active channel.

Floodplain Location

- Must be substantiated when describing potential vegetation,
- Confirmed with regional curves,
- USGS gage data,
- And field indicators seen on the river.

Woody Riparian Vegetation

- Provides streambank stability.
- Traps large amounts of sediment.
- Provides variable habitats to support numerous riparian and aquatic species.

If we allow rivers to stabilize or remain stable, the potential vegetation for those conditions will establish without our help.