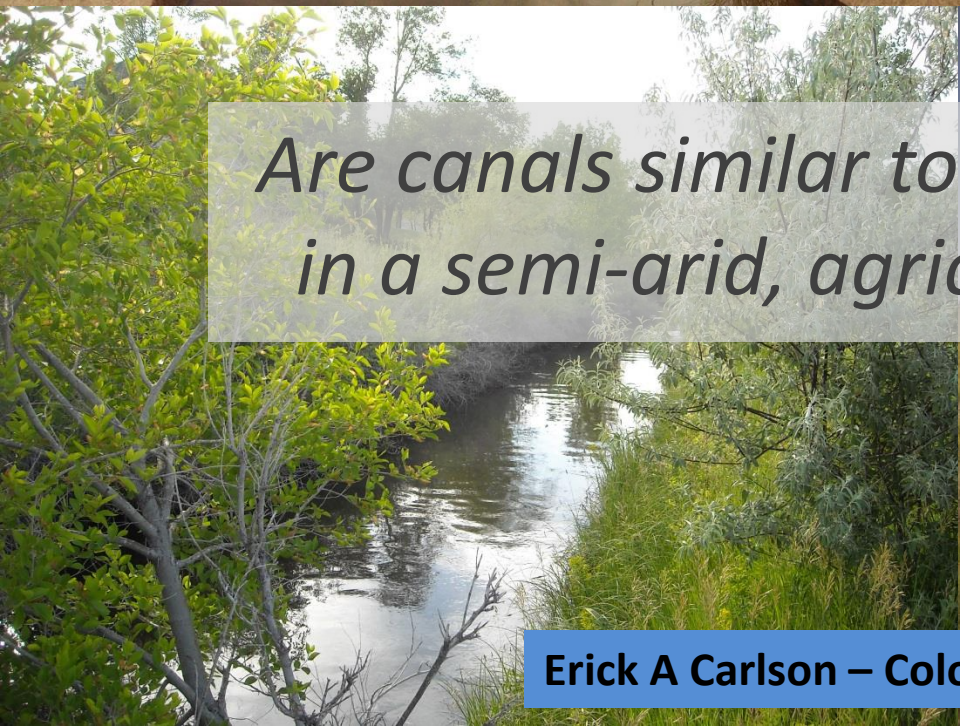




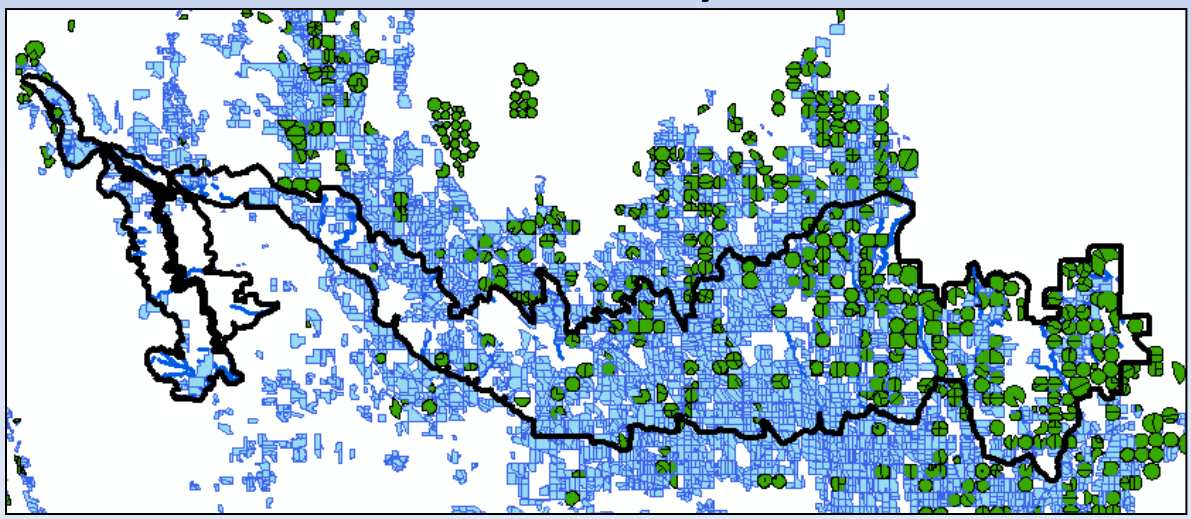
The New Rivers of the West

*Are canals similar to rivers and streams
in a semi-arid, agricultural landscape*



The Well Watered Landscape

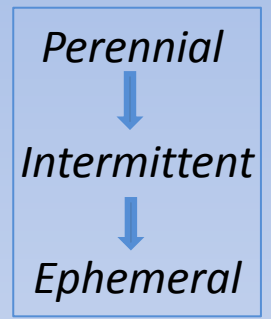
- Majority of water is no longer in rivers
 - 70% of Colorado River flow diverted
 - 85% of Cache la Poudre flow diverted
- Irrigated agriculture and municipalities
 - Necessitates conveyance canals and ditches



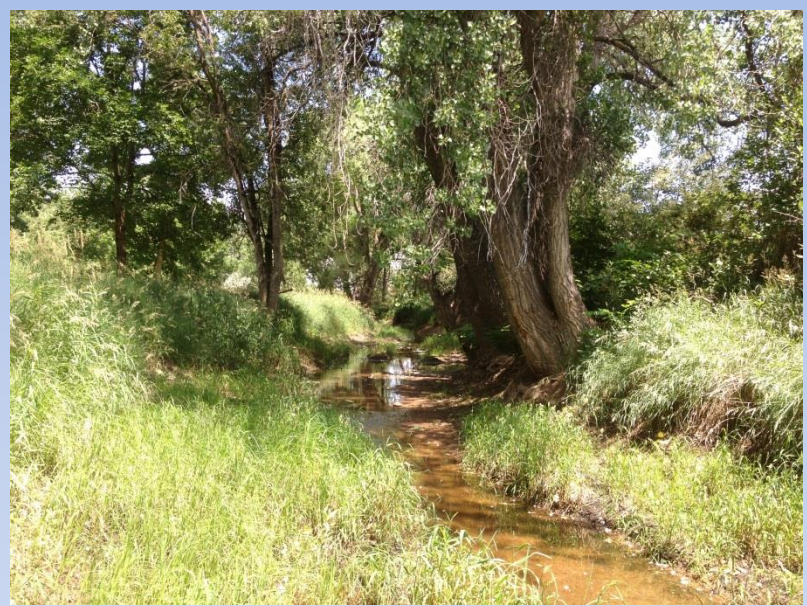
“Use it or lose it”

The Result: Degraded Natural Aquatic & Riparian Habitats

- No surprise in the effects of “dewatering”
 - Increased temperature, shift in flow regime
 - Changes in sediment supply and disturbance
 - Invasive species (plant, animal, insect)



The Result: Novel Aquatic & Riparian Habitats



The Result: Novel Aquatic & Riparian Habitats

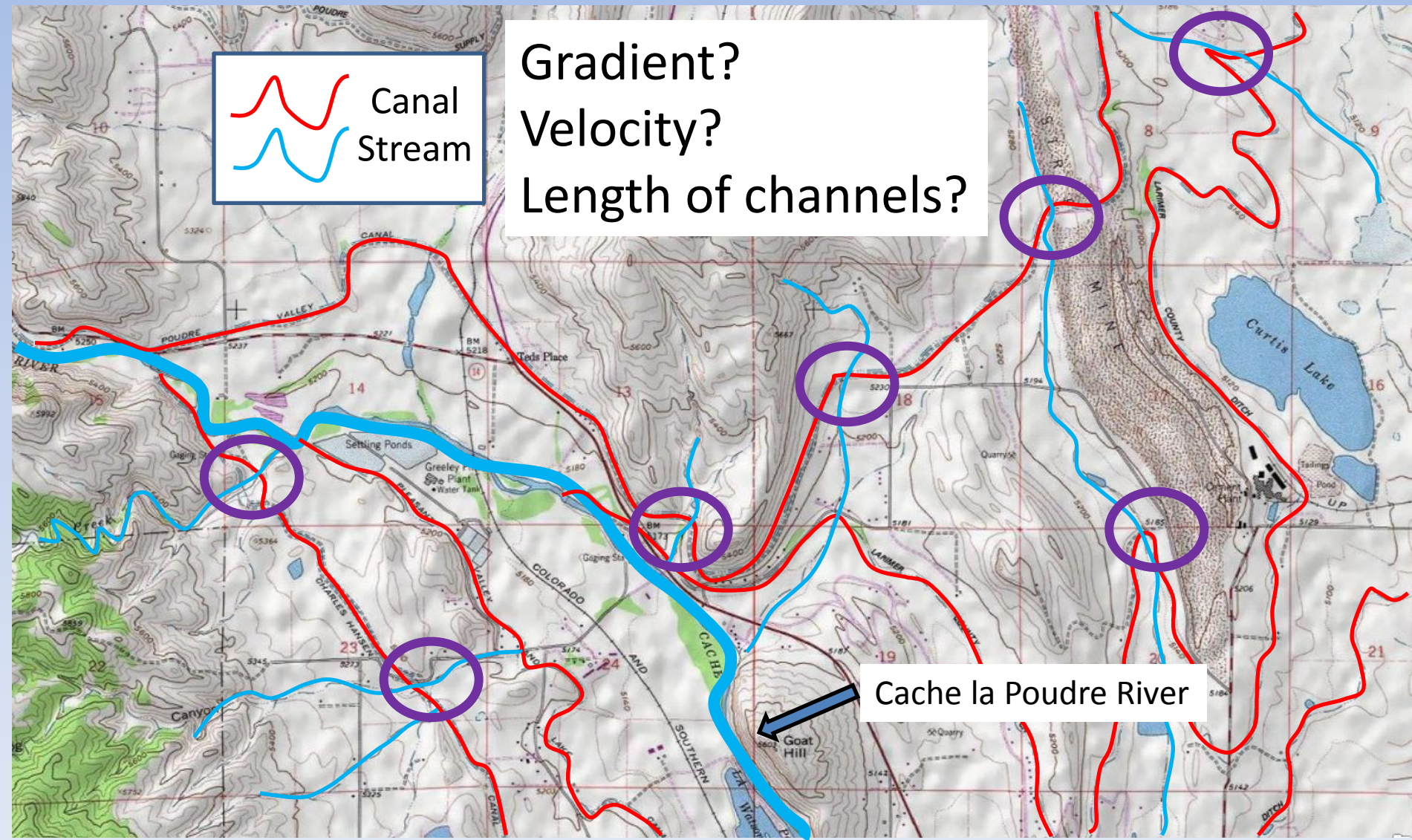
- Same components as rivers and riparian areas
 - Water, plants, sediment, disturbance, insects, birds
- But some key differences
 - Orientation, shape
 - Complete flow control
 - Disturbance type
 - Vegetation
 - Aquatic macro-invertebrates



Orientation



Gradient?
Velocity?
Length of channels?



Cache la Poudre River

Disturbance - Canals



Scraping



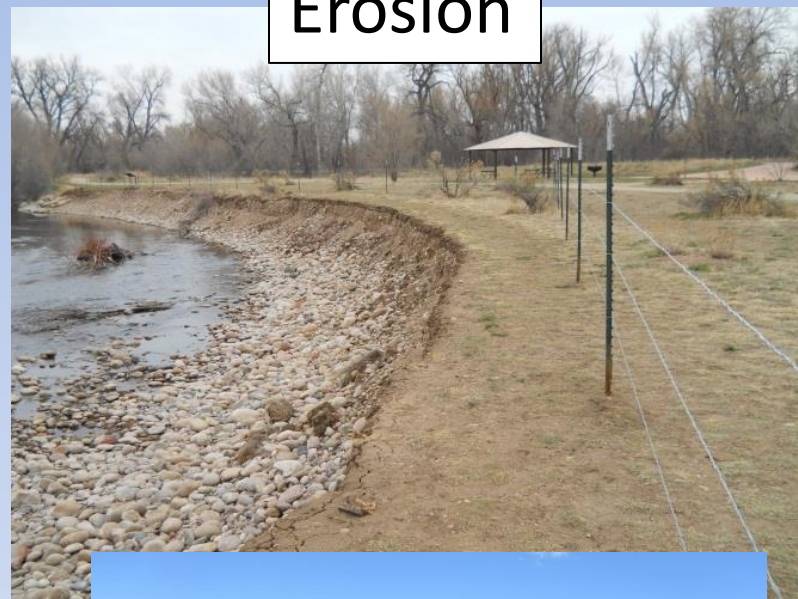
Burning



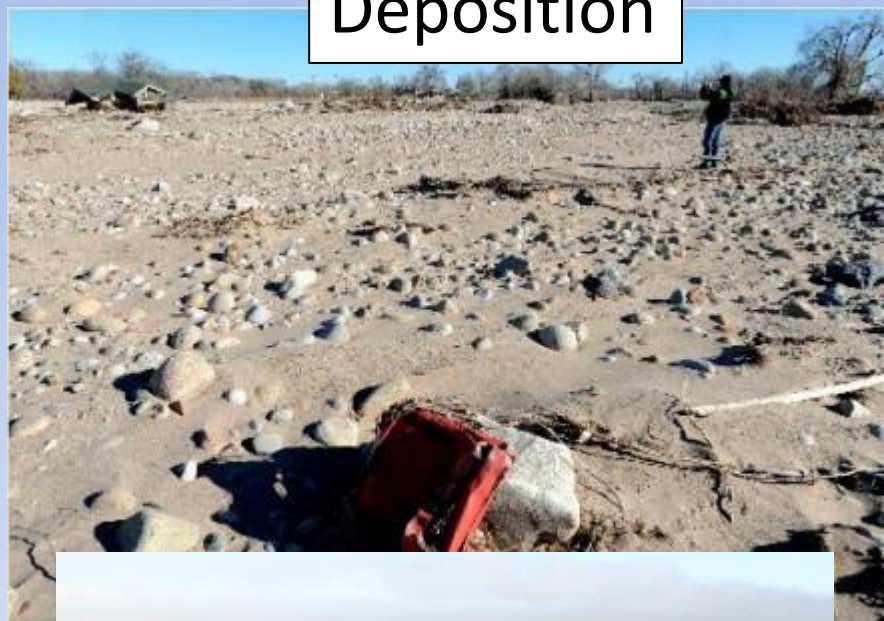
Spraying

Disturbance - Rivers

Erosion



Deposition



INTRODUCTION

Environmental Learning Center : Cache la Poudre River, SE Fort Collins

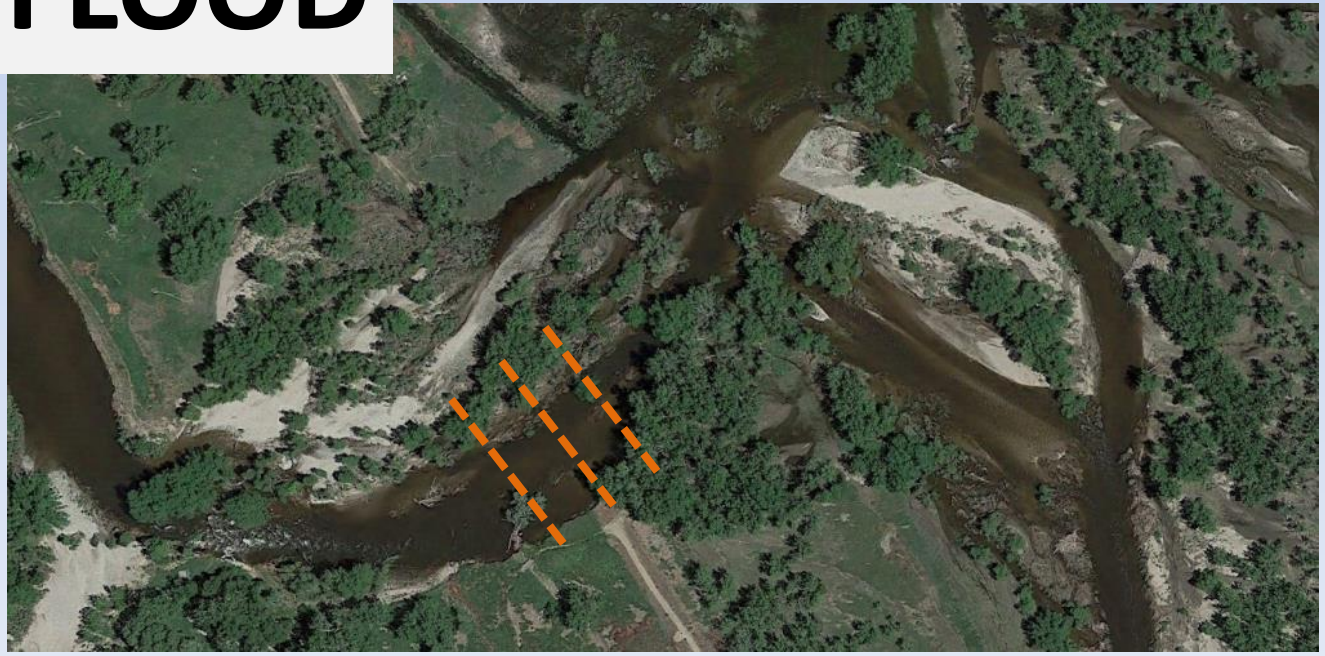
August 2012



Sept 2013 =

FLOOD

June 2014



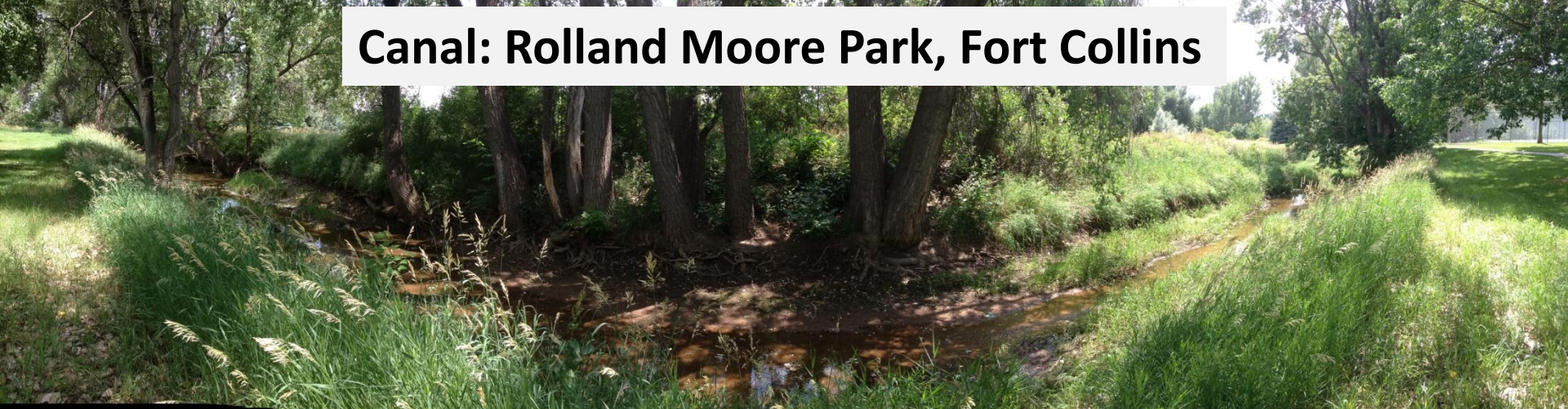
Lets play a game

Canal? or Stream?

Canal or Stream?



Canal: Rolland Moore Park, Fort Collins



Stream: Lone Tree Creek, Greeley



Canal: Teds Place, Bellvue



Willow Creek, Weld County



New Mercer Canal, Fort Collins



Larimer #2 Canal, Fort Collins



Law Slough (canal), Severance





Canals



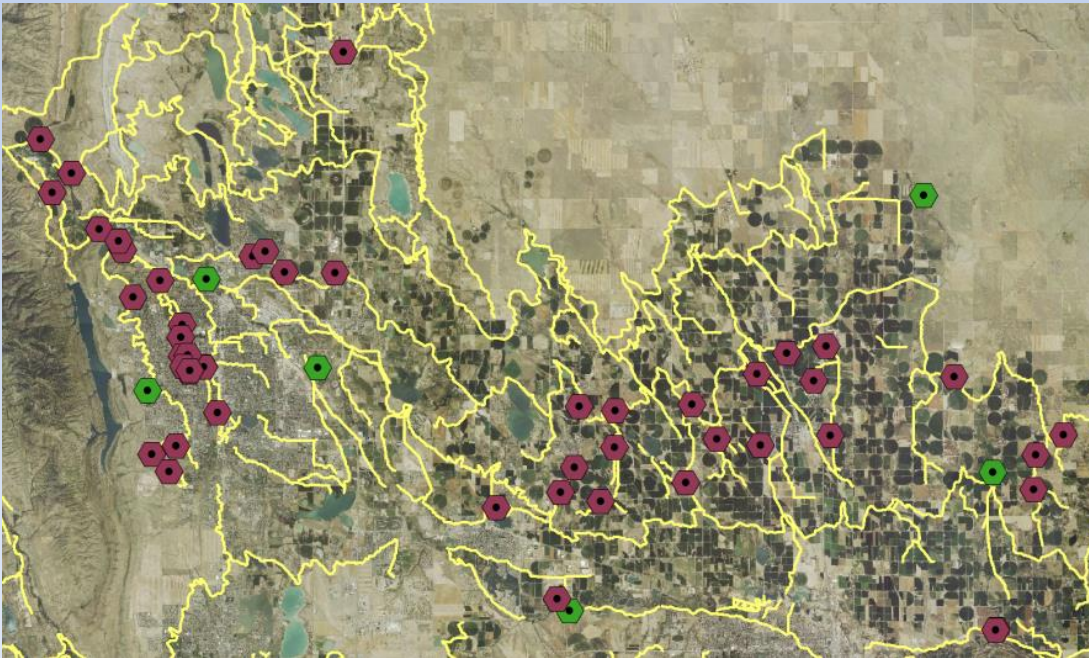
Take away

- Streams, rivers, canals and ditches *can* look SIMILAR or DIFFERENT
- Do two channels that look a certain way have biological communities to match?



How to Choose

- Step 1: Map canal networks based on dominant cover
- Step 2: ArcGIS to create random points along the network



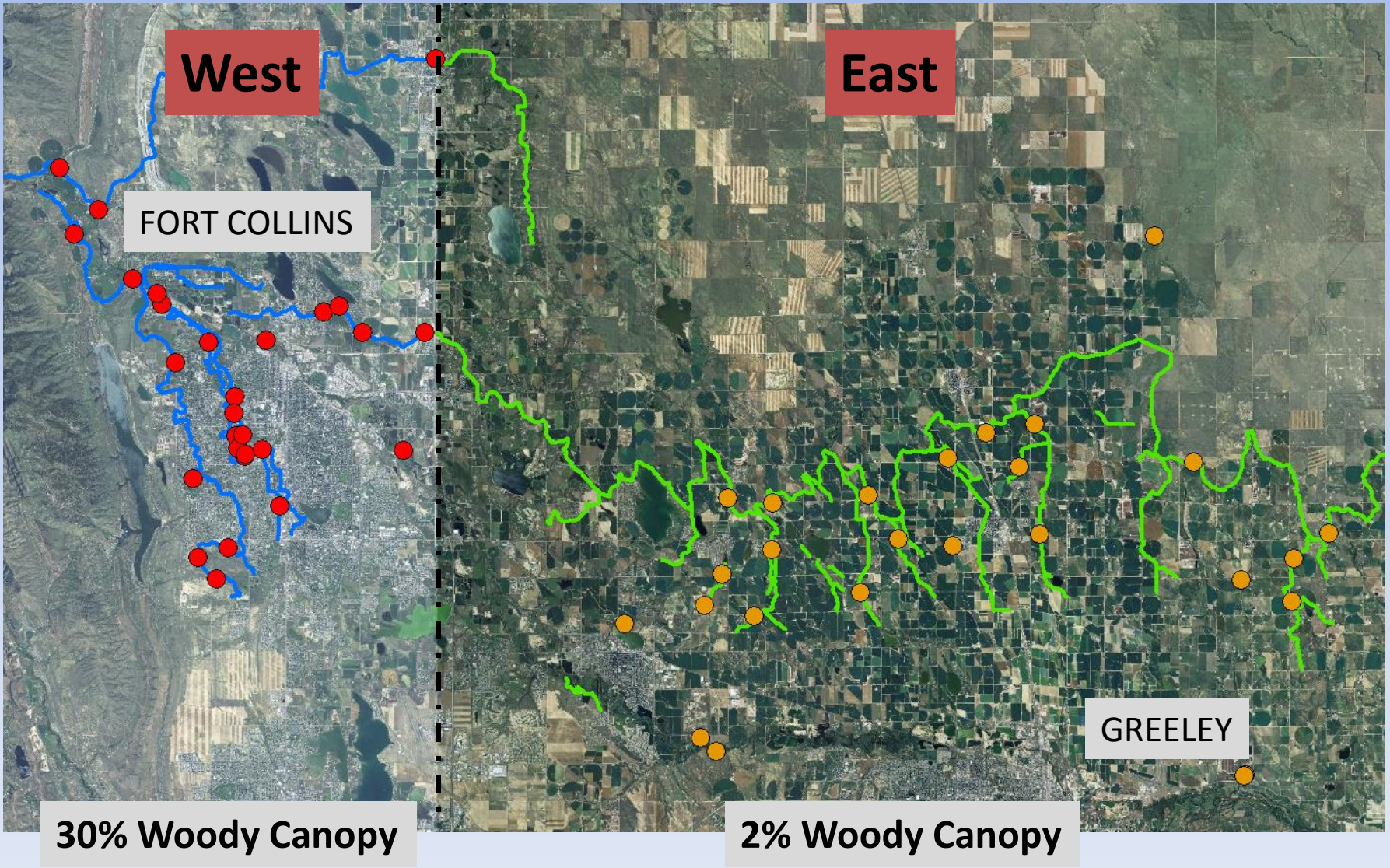
Reference Site Selection...ha

- Cache la Poudre River: many floodplain constrictions, gravel pits

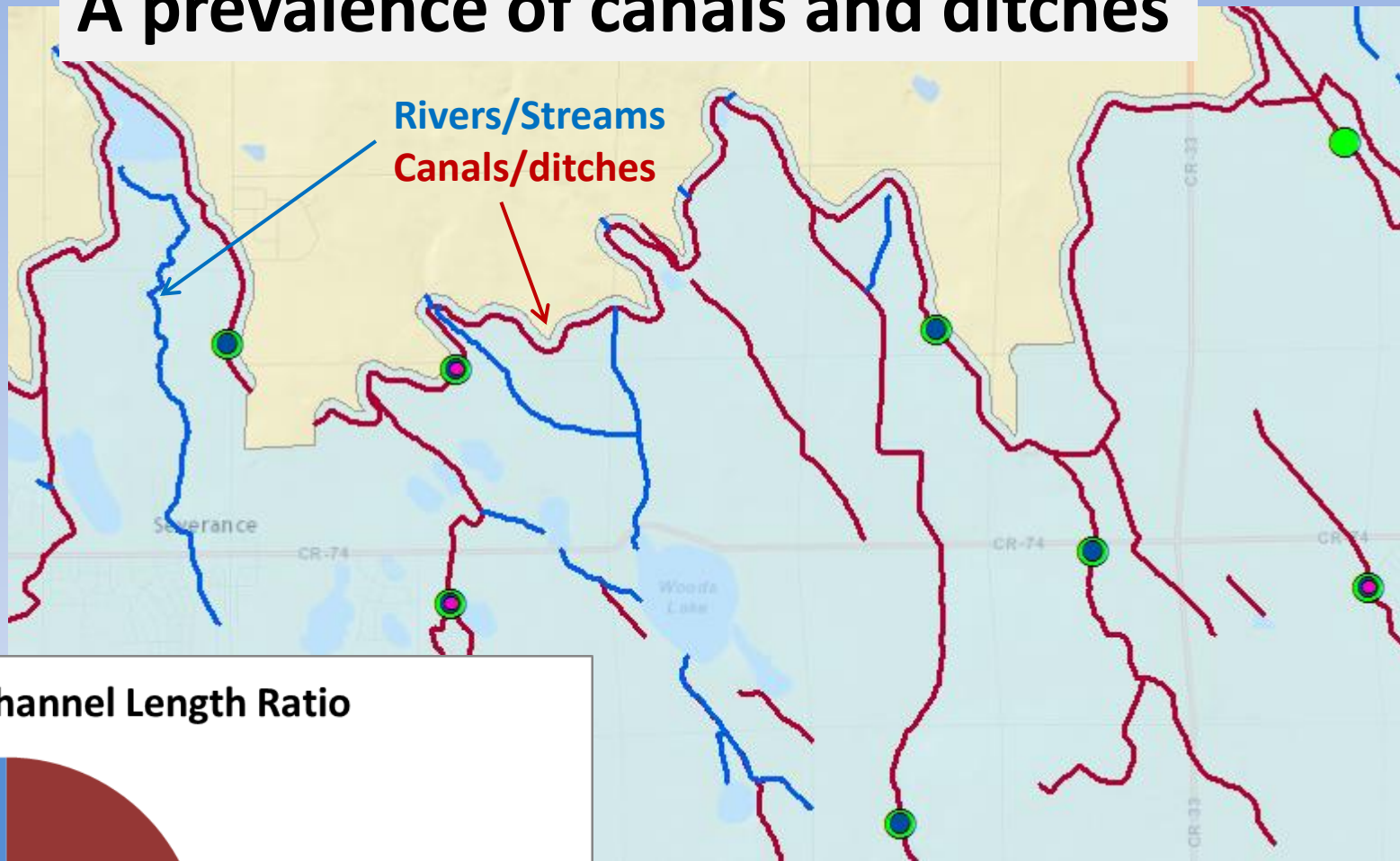


- Willow Creek, Owl Creek, Lone Tree Creek): are highly impacted, straightened, drained or augmented

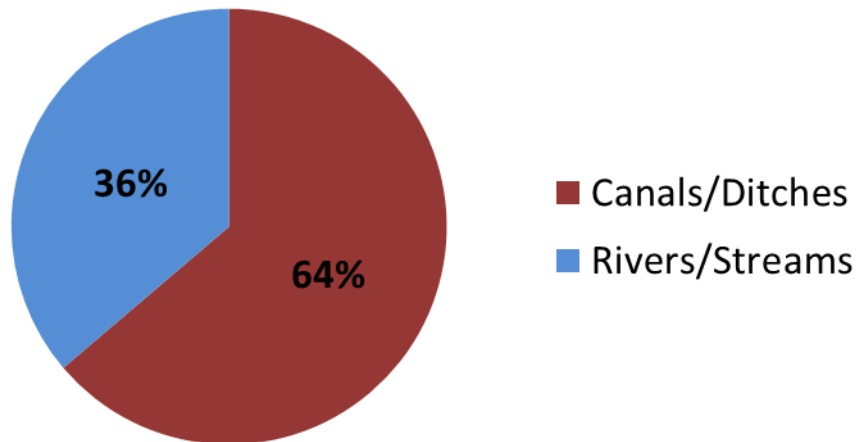
Study Site Locations



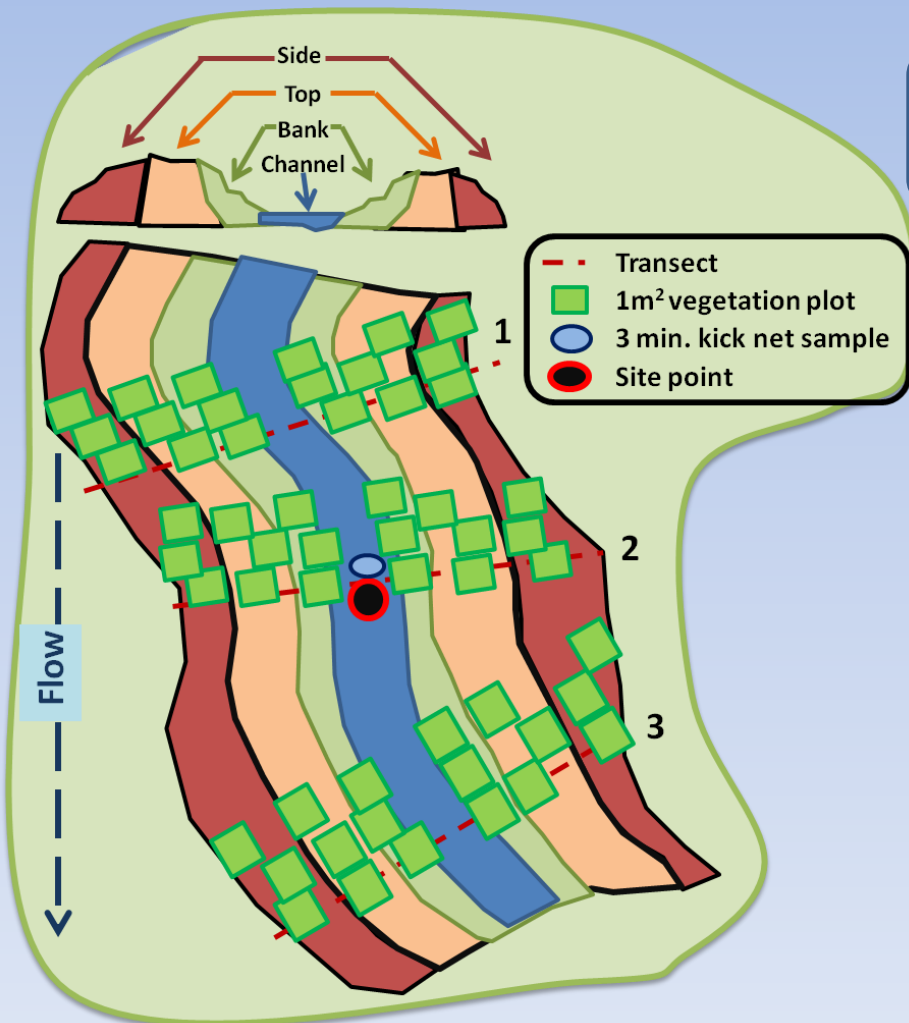
A prevalence of canals and ditches



Channel Length Ratio



Field Site Design



plots/surface/side/transect
 $5 * 3 * 2 * 3 = 90$

sites/plots
 $54 * 90 = 4,860 \text{ 1m}^2 \text{ plots}$

Actually surveyed 4,477



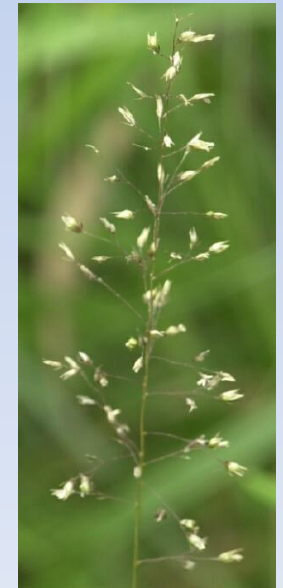
Data Collection- **Benthos**

- Kick Net Sampling
 - Use feet to disturb substrate upstream of net
 - Sweep net under vegetation hanging into water



Data Collection- Vegetation

- 1 meter x 1 meter PVC square
- Identify all species present, vertical strata, total % cover



Copyright 2002, University of Illinois

What do these places look like?

What type of data are we working
with?

East Canal Example

Site Name: Arch

Region: East

Canal Name: Larimer and Weld

Width: 14 meters

Depth: 1.1 meters

Distance: 51.6 km

Substrate: Mud

Cover: Herbaceous

Landuse: Row crops (2)

Shannon-Weiner Effective # of Species: Plants 8.2 , Benthos 4.1

Plant List:

Anisantha tectorum

Asclepias speciosa

Bassia sieversiana

Bouteloua curtipedula

Bromus inermis

Buchloe dactyloides

Carex emoryi

Convolvulus arvensis

Dactylus glomerata

Descuriana sophia

Echinichloa crus-galli

Eupatorium dentata

Hippochate laevigata

Lactuca tartarica

Lycopus asper

Oenothera villosa

Panicum capillare

Phalaris aurundinacae

Polypogon

monospeliensis

Portlaca olearacea

Potentilla sp.

Rumex crispus

Solanum physalifolium

Sonchus asper

Sporobolus cryptandrus

Thinopyrum intermedium

Native

Non-native

Benthos List (2013):

Chyptochironomus sp.

Endochironomus sp. (MIDGES)

Procladius sp.

Orctonectes sp. (CRAYFISH)

Physa sp. (SNAIL)



West Canal Example

Site Name: Bryan

Region: West

Canal Name: New Mercer

Width: 6 meters

Depth: 1 meter

Distance: 8.7 km

Substrate: Mud

Dominant: Light Canopy

Landuse: Dense residential (2)

Shannon-Weiner Effective # of Species: Plants 9.0, Benthos 7.0

Species: Plants 8.2, Benthos 4.1

Plant List:

Ambrosia trifida

Arctium minus

Aspergo procumbens

Breea arvensis

Bromus inermis

Carex emoryi

Chenopodium album

Convolvulus arvensis

Echinocytis lobata

Fraxinus americana

Lactuca serriola

Malus sylvestris

Malva neglecta

Medicago sativa

Oligosporus dracunulinus

Padus virginiana

Pascopyrum smithii

Persicaria maculata

Phalaris canariensis

Populus deltoides

Poa pratensis

Prunus americana

Rumex altissimus

Taraxicum officinale

Thinopyrum intermedium

Tithymalus uralensis

Benthos List (2013):

Agabus sp. (BEETLE)

Ephemerella dorthea-infrequens (MAYFLY)

Sigara sp. (BACKSWIMMER)

Cryptochironomus sp.

Dicrotendipes sp.

(MIDGES)

Microtendipes sp.

Procladius

Oligochaeta (WORM)

Orctonectes (CRAYFISH)

Lumbicullidae (WORM)

Lirceus sp. (ISOPOD)

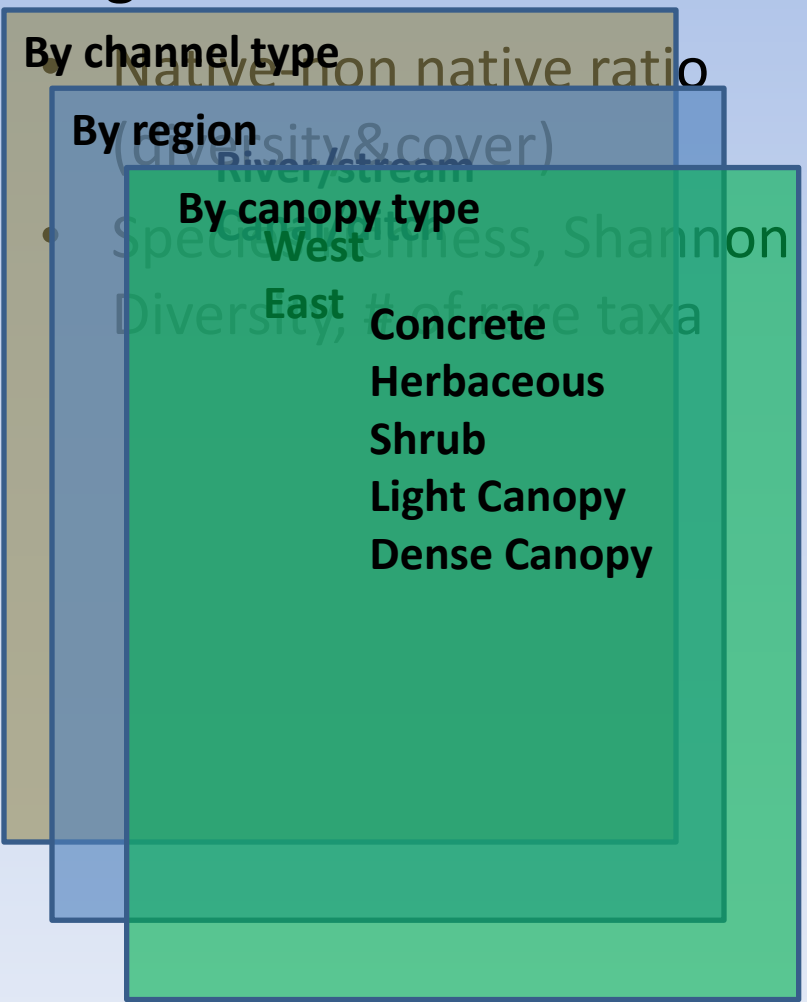


Selected Results

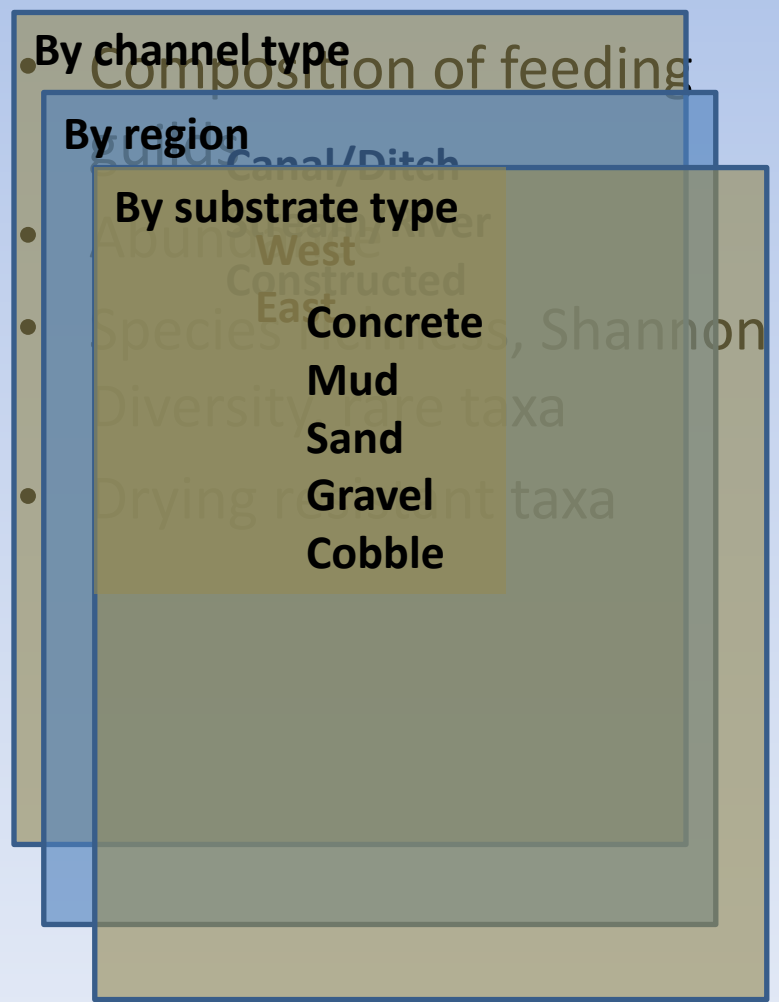
- Many potential comparisons between groups, nesting
- Highlight regional comparisons, canal – river/stream comparisons,

Biological comparisons

Vegetation



Benthic Macro-invertebrates

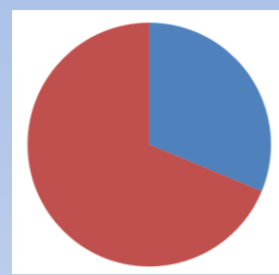
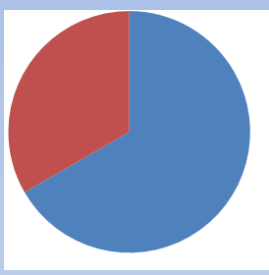


Ephemeroptera, Plecoptera, Trichoptera

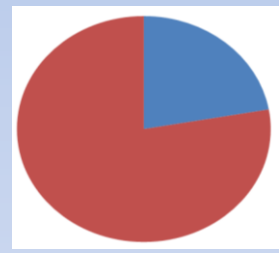
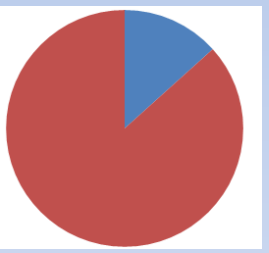
WEST

EAST

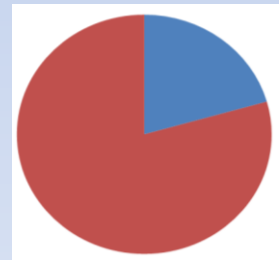
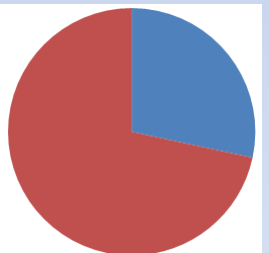
Rivers



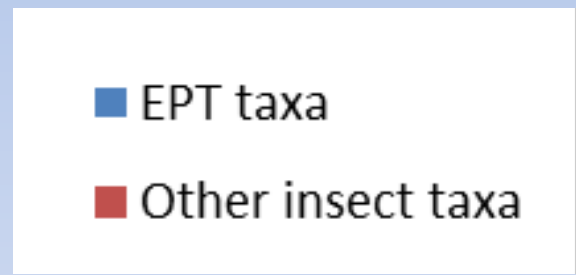
Streams



Canals



Species Richness



E



P



T

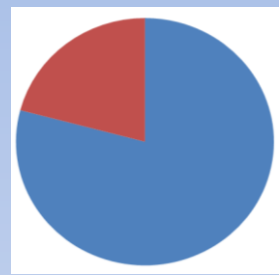
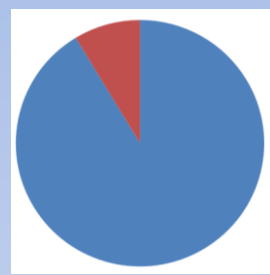


Ephemeroptera, Plecoptera, Trichoptera

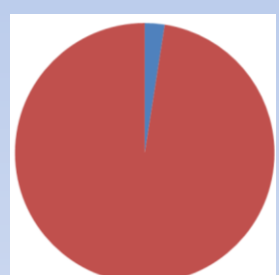
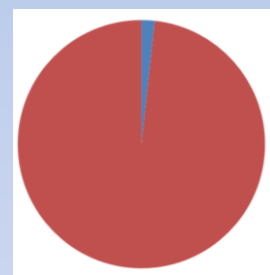
WEST

EAST

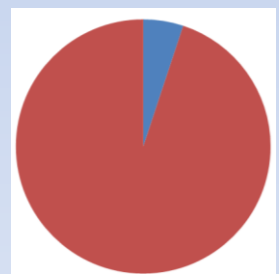
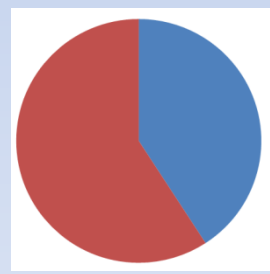
Rivers



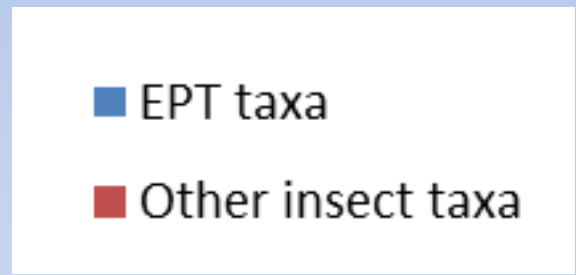
Streams



Canals



Abundance



E



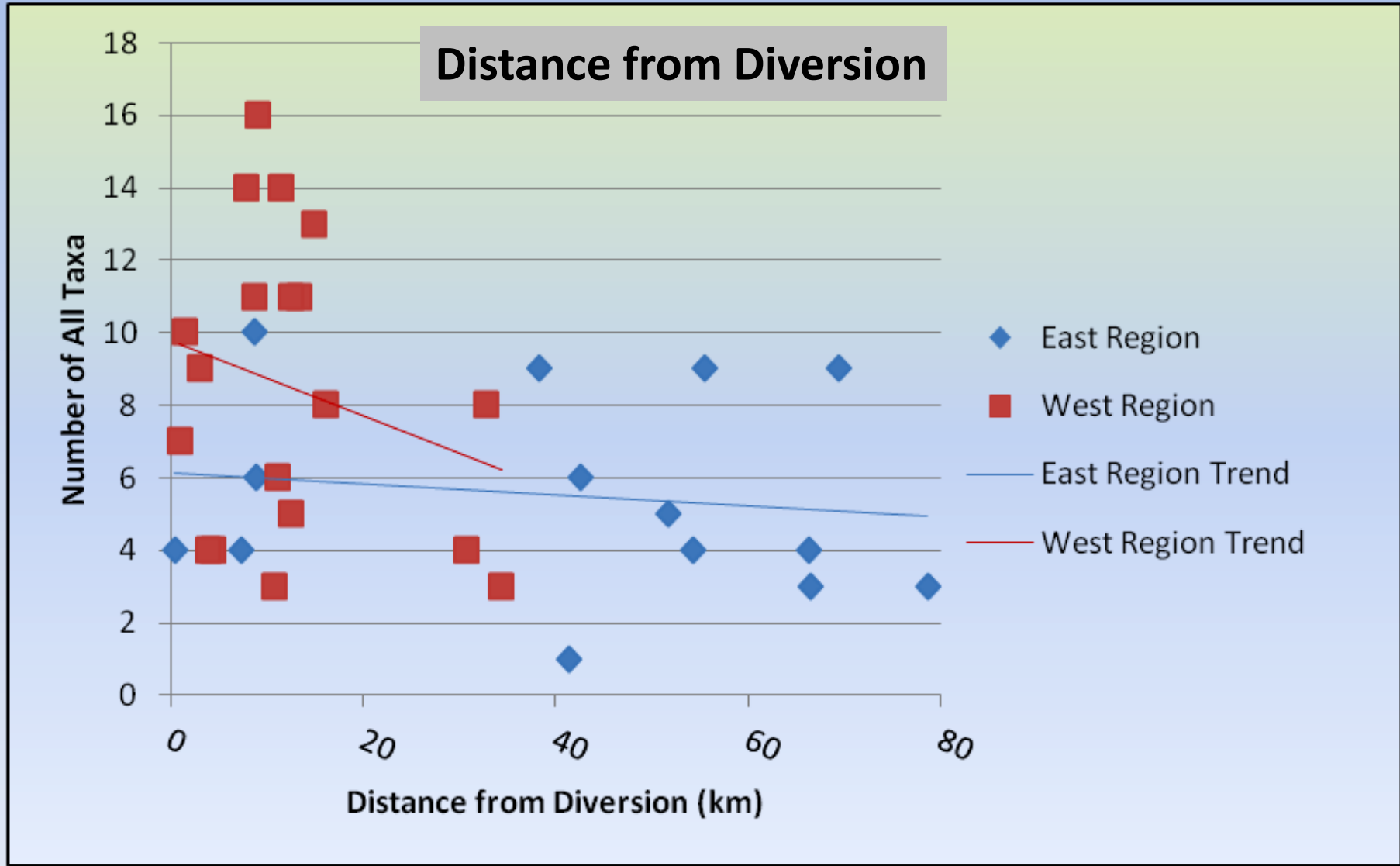
P



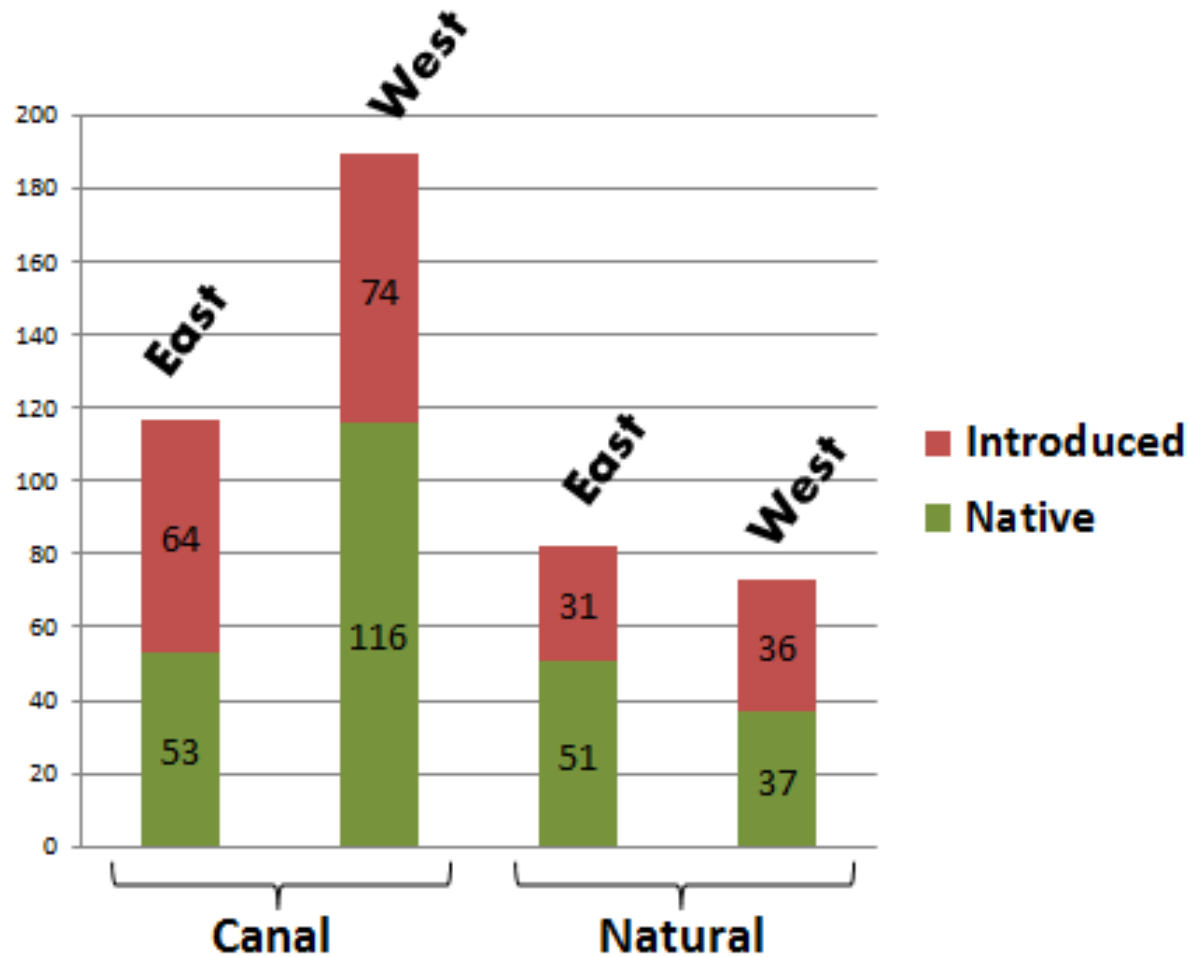
T



BENTHOS – All taxa



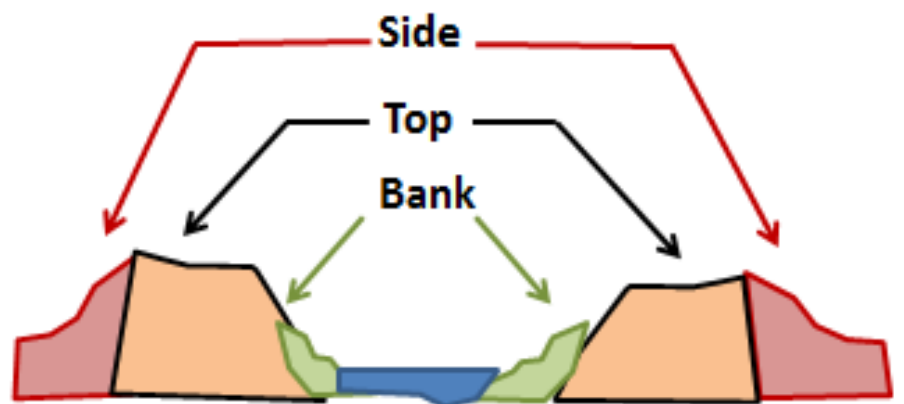
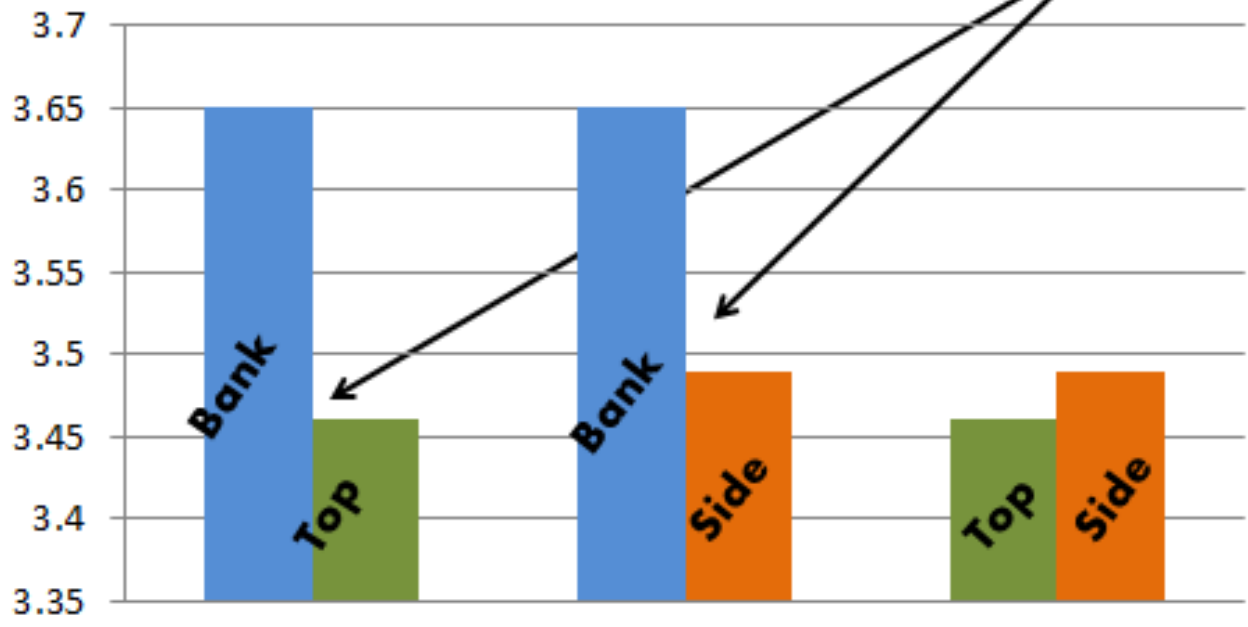
Vegetation – Species Richness



Vegetation

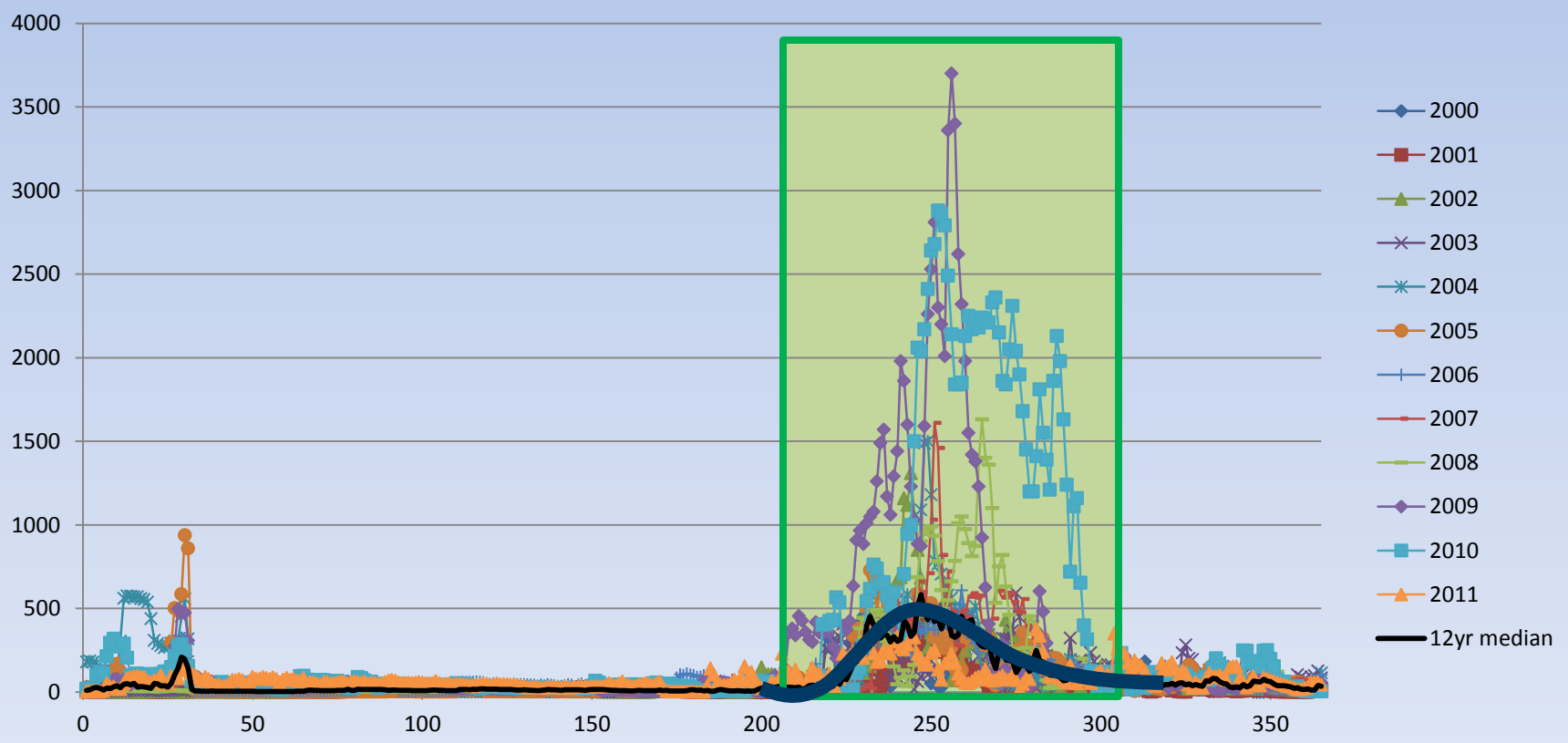
Surface Richness Comparison

P-value < 0.05



Timing of Peak(s)

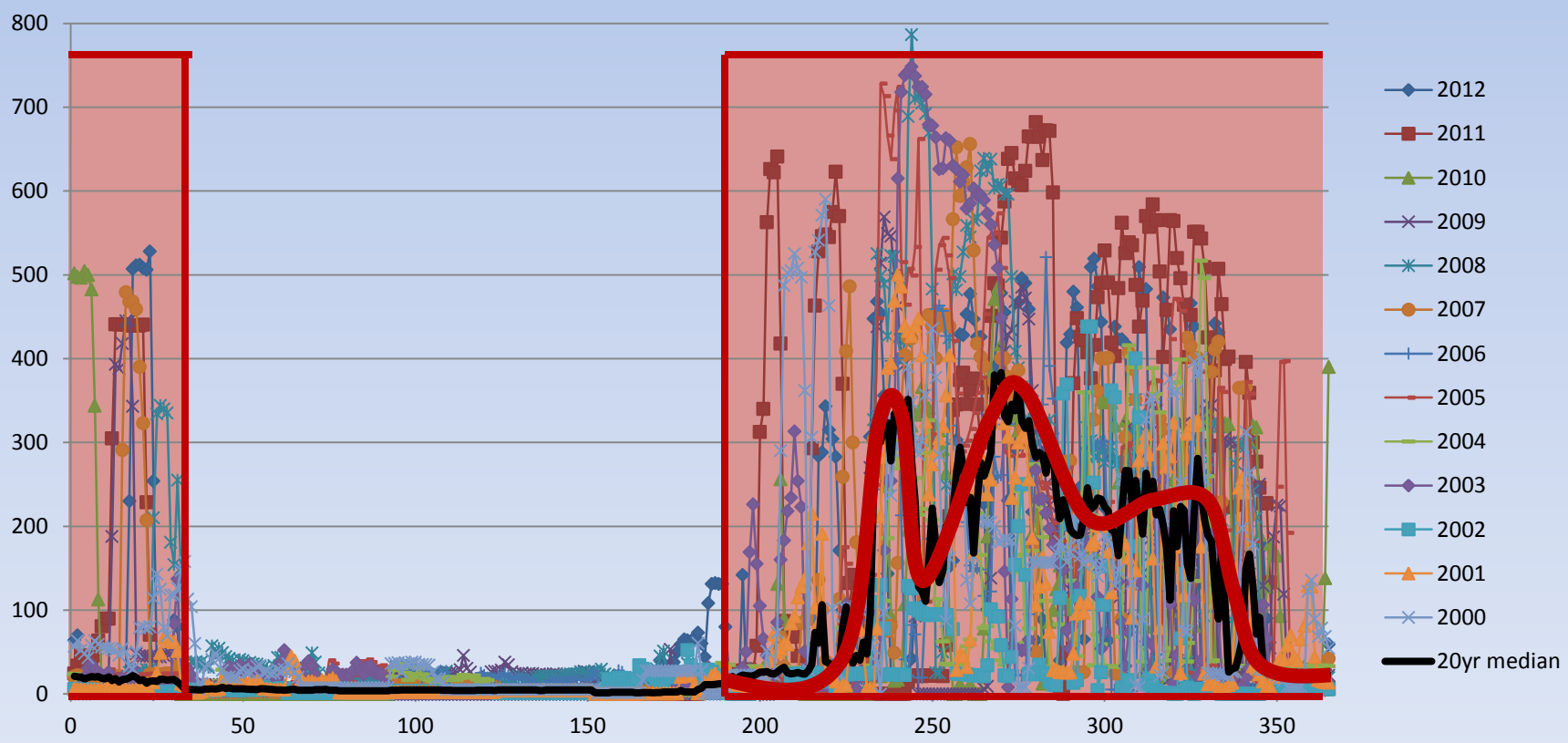
Cache la Poudre River – Fort Collins



October 1st

Timing of Peak(s)

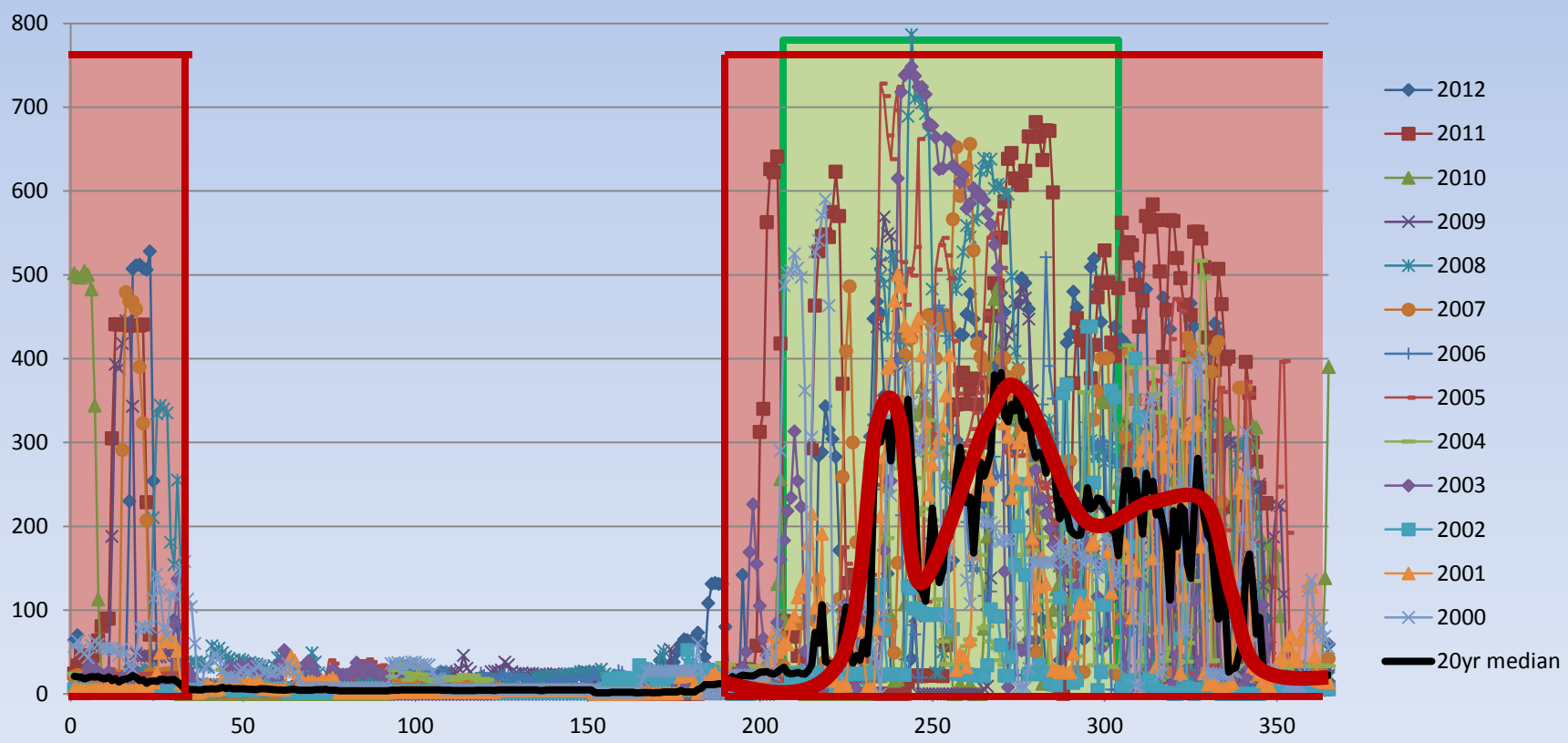
Larimer and Weld Canal



October 1st

Timing of Peak(s)

*Much larger date range for high flows

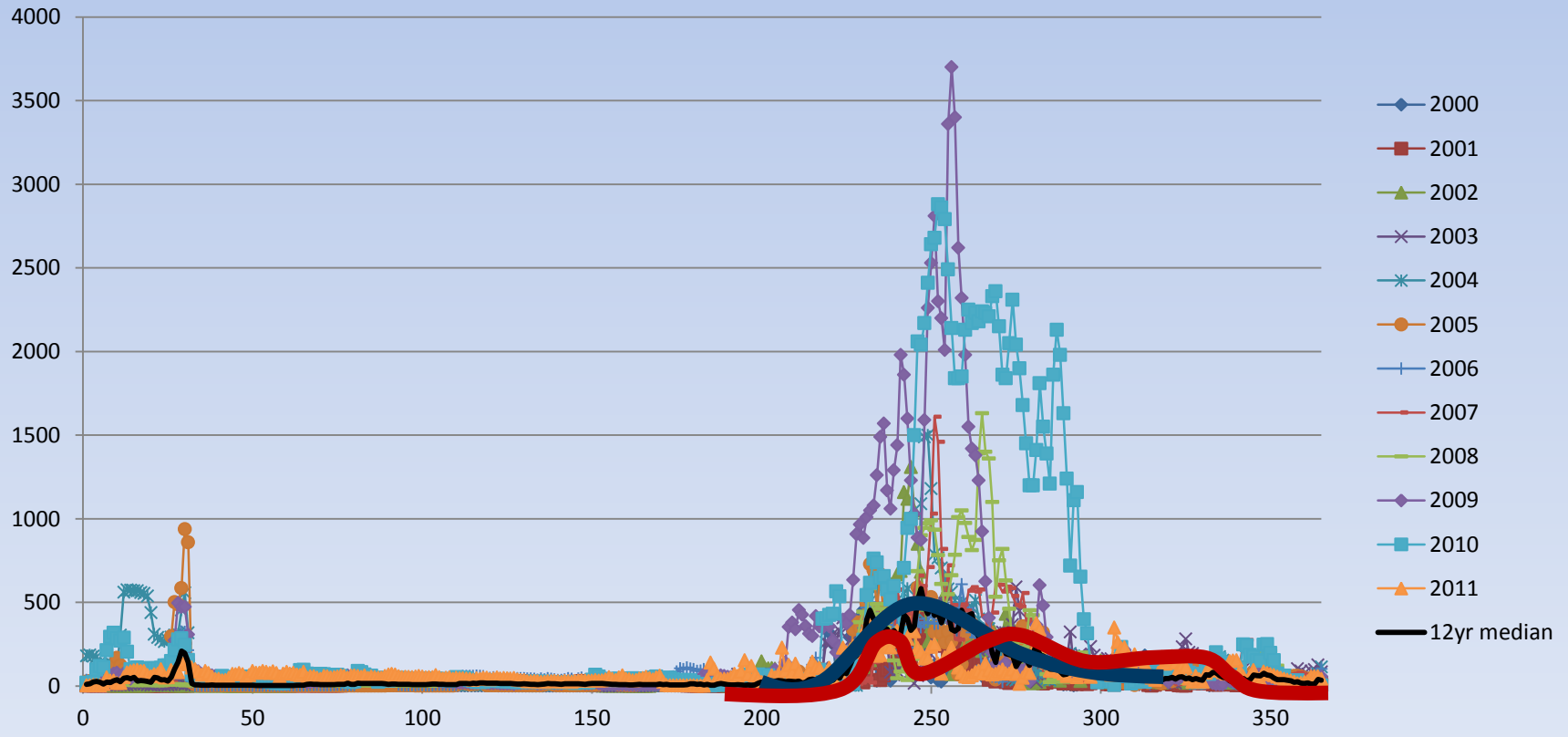


October 1st

Cache la Poudre River – Fort Collins

*Timing is off

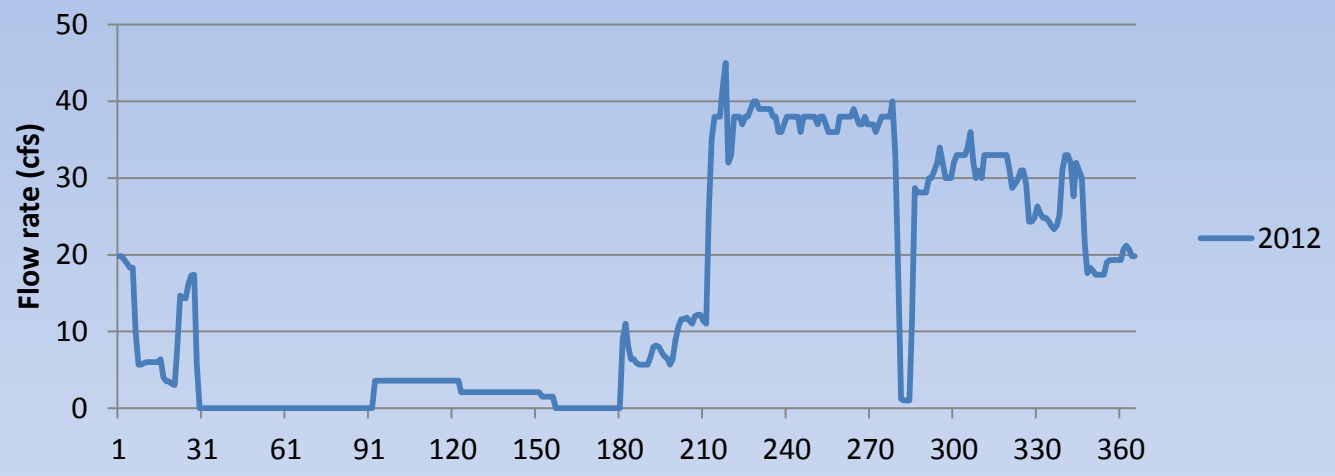
*Late season flows are higher



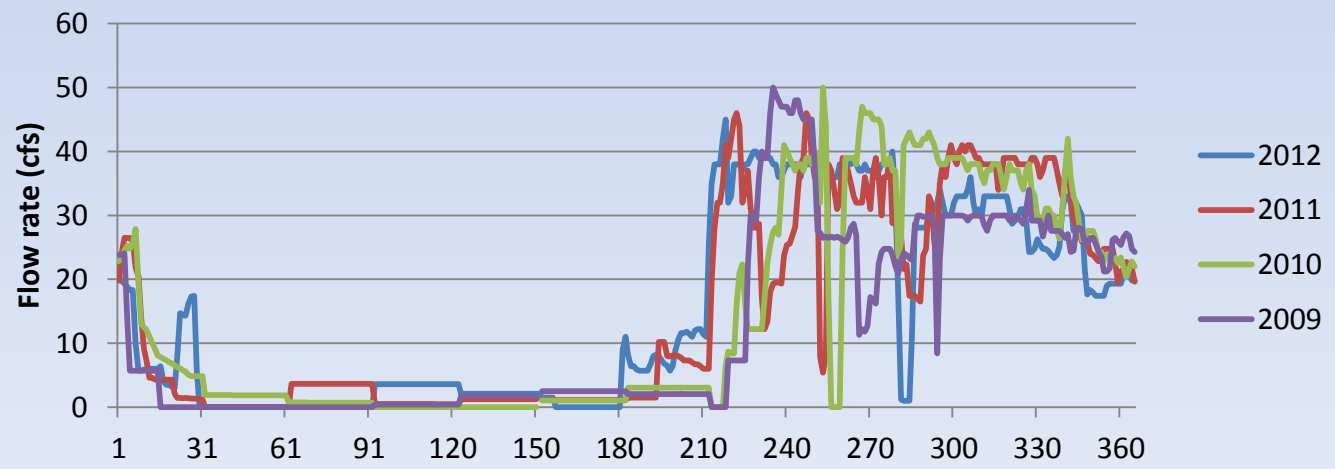
October 1st

Flow Variability

Annual

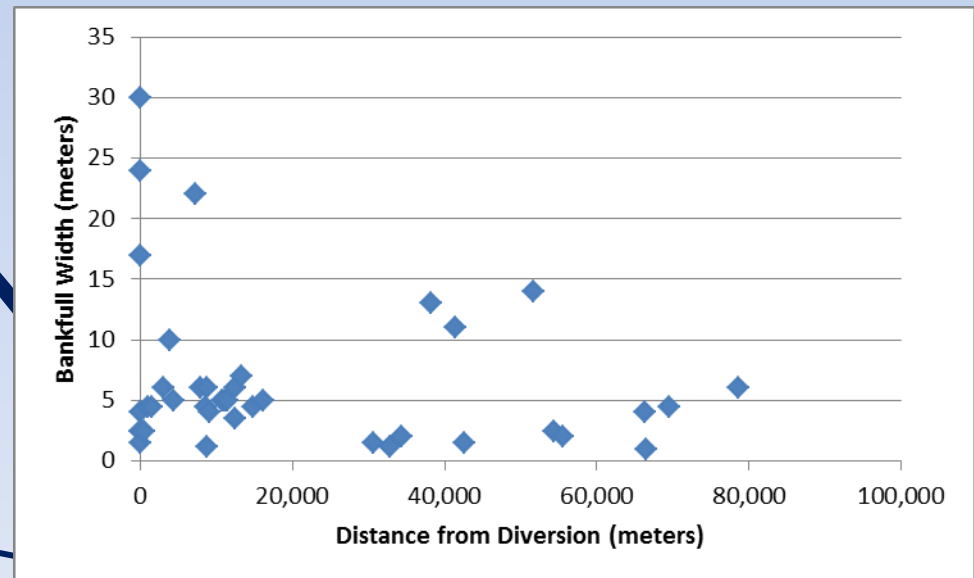
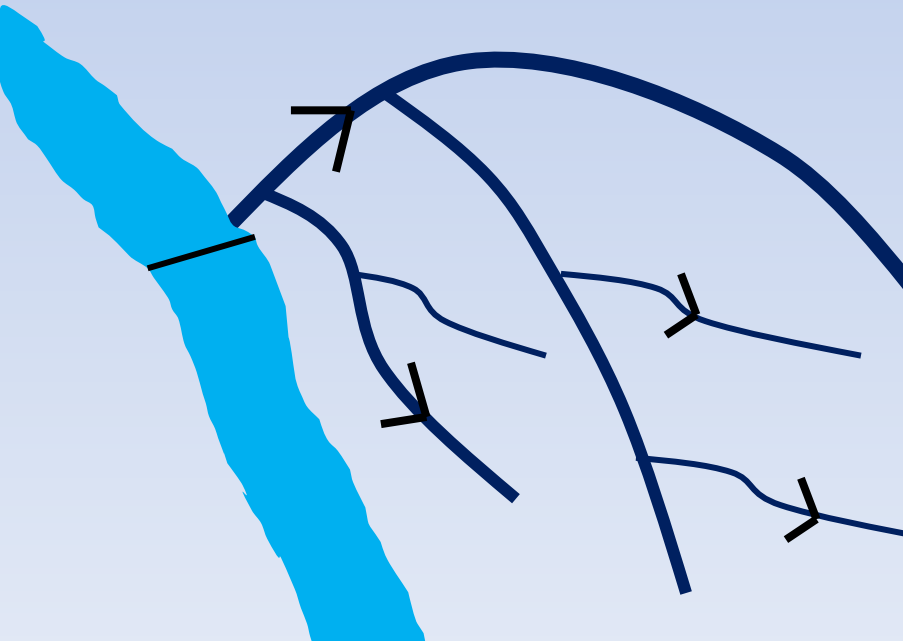


Inter-Annual



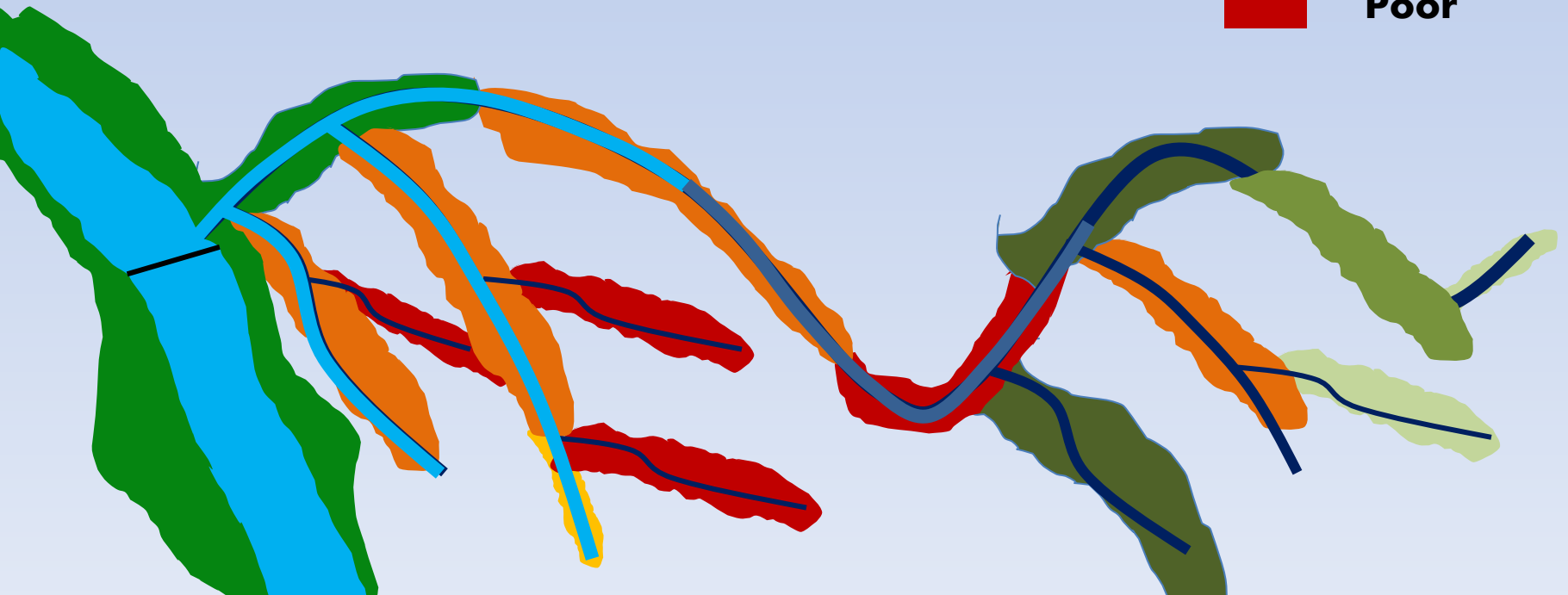
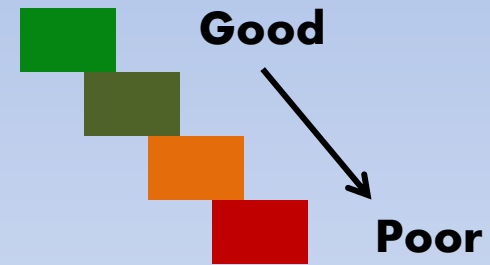
Future Work

- Examine network structure
 - Reverse dendritic
 - More like an alluvial fan



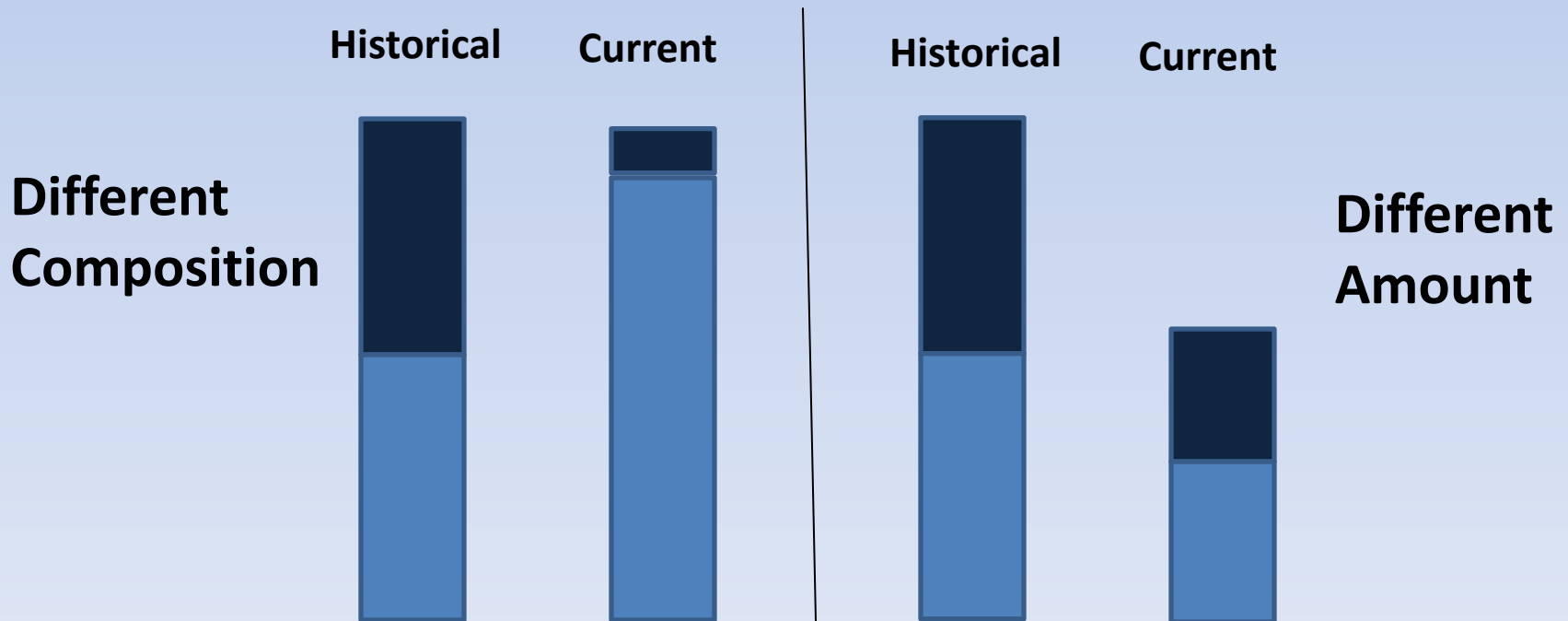
Future Work

- Categorize Habitat Value
 - Use a range of physical variables, profiles from sampled sites, aerial imagery



Functional Replacements?

- Are canal habitats similar to river/stream
 - Which types?
 - What functions are we missing



Future Interests

- Are these patterns similar to other regions?





I will take all easy questions

**Thanks to my committee: Cooper, Kondratieff, Waskom & Merritt
NSF and IWATER**

**Irrigation Companies: New Mercer, Larimer #2, Pleasant Valley and
Lake Larimer and Weld**