Perspectives on a resilient and healthy river

Jen Shanahan Environmental Planner

October 9th 2013

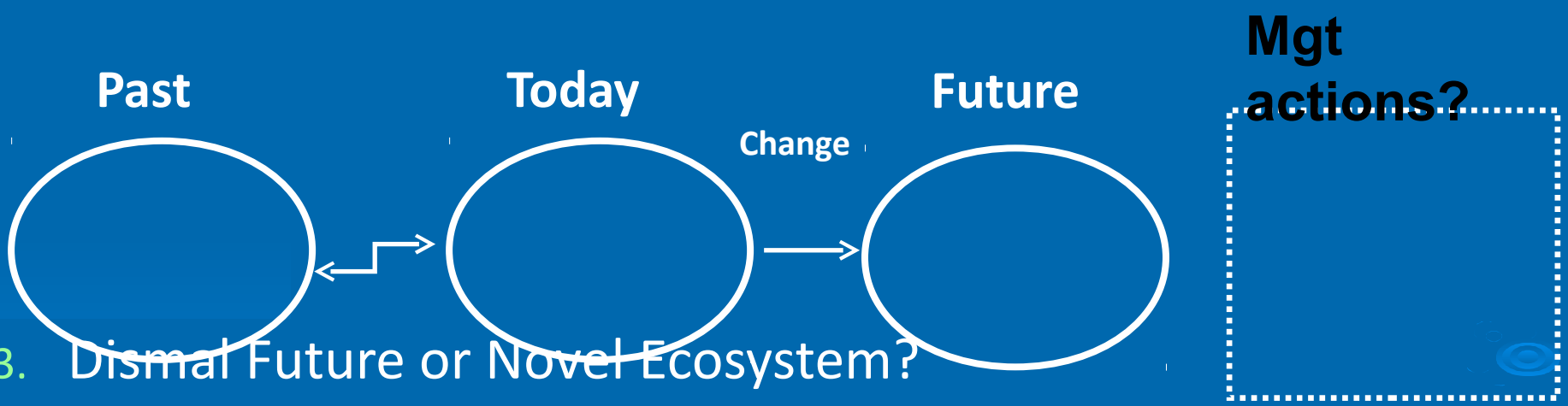
Sustaining Colorado's Watersheds

City of Fort Collins Natural Areas

City Plan 2011

The City will support a healthy and resilient Cache la Poudre ecosystem and protect, enhance, and restore the ecological values of the River

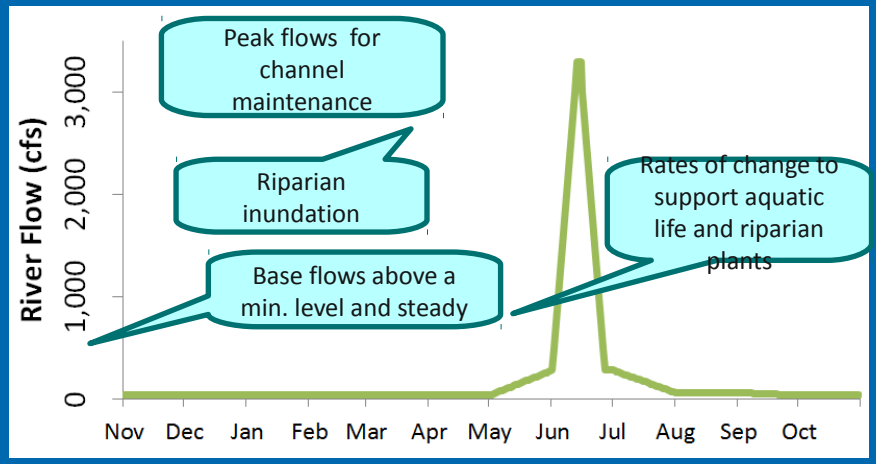
3 Key Themes

1. Use of Google Earth to demonstrate a lot of ideas and integrate multiple conversations in short time to broad audience.
2. 

3. Dismal Future or Novel Ecosystem?
   - Urban paradigm, new conversations, anthropocentric

1. *Flows*, and env. flows., functions of flows

2. *Physical form*



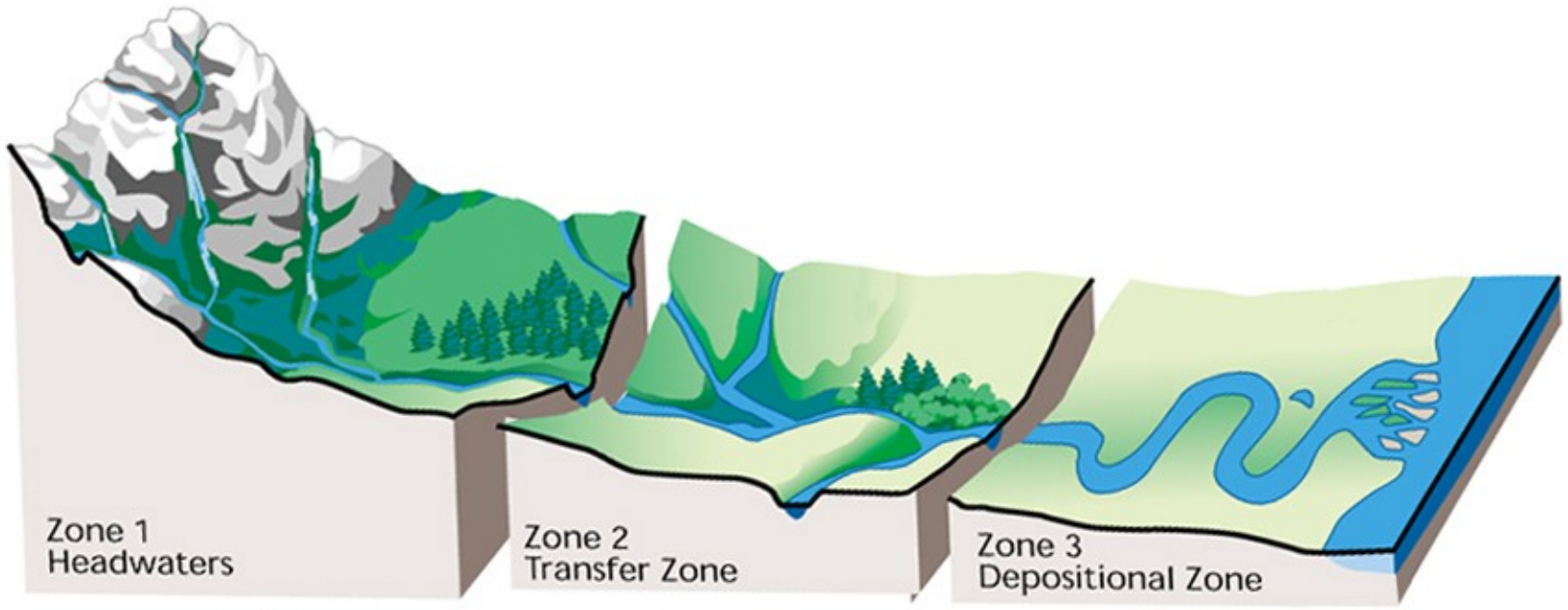
3. Ecol
   - Alg
   - Aq h
   - Rip

- We don’t have all the answers,…developing a better understanding of the **components** to consider

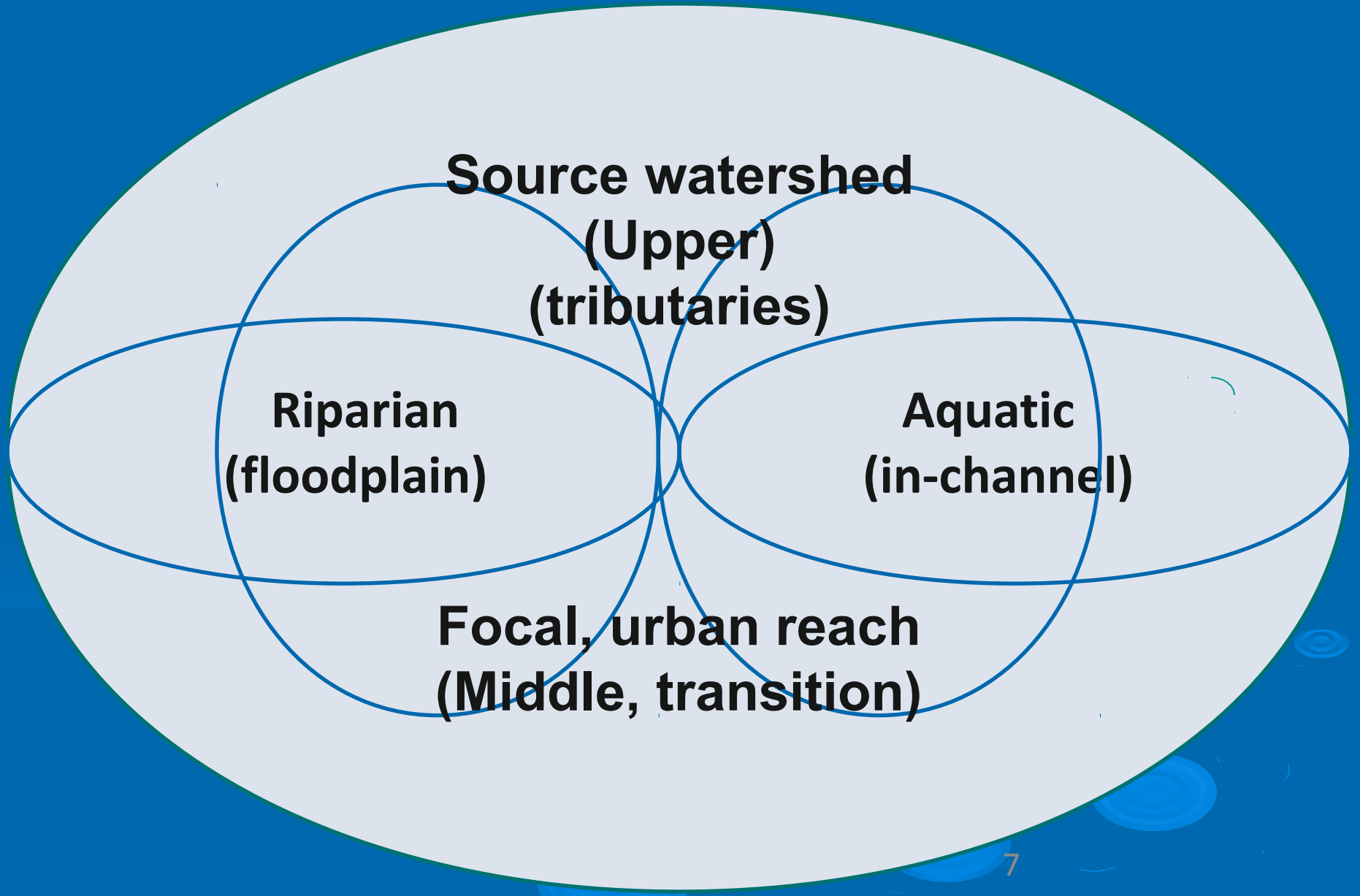
- What level and direction of change are acceptable?

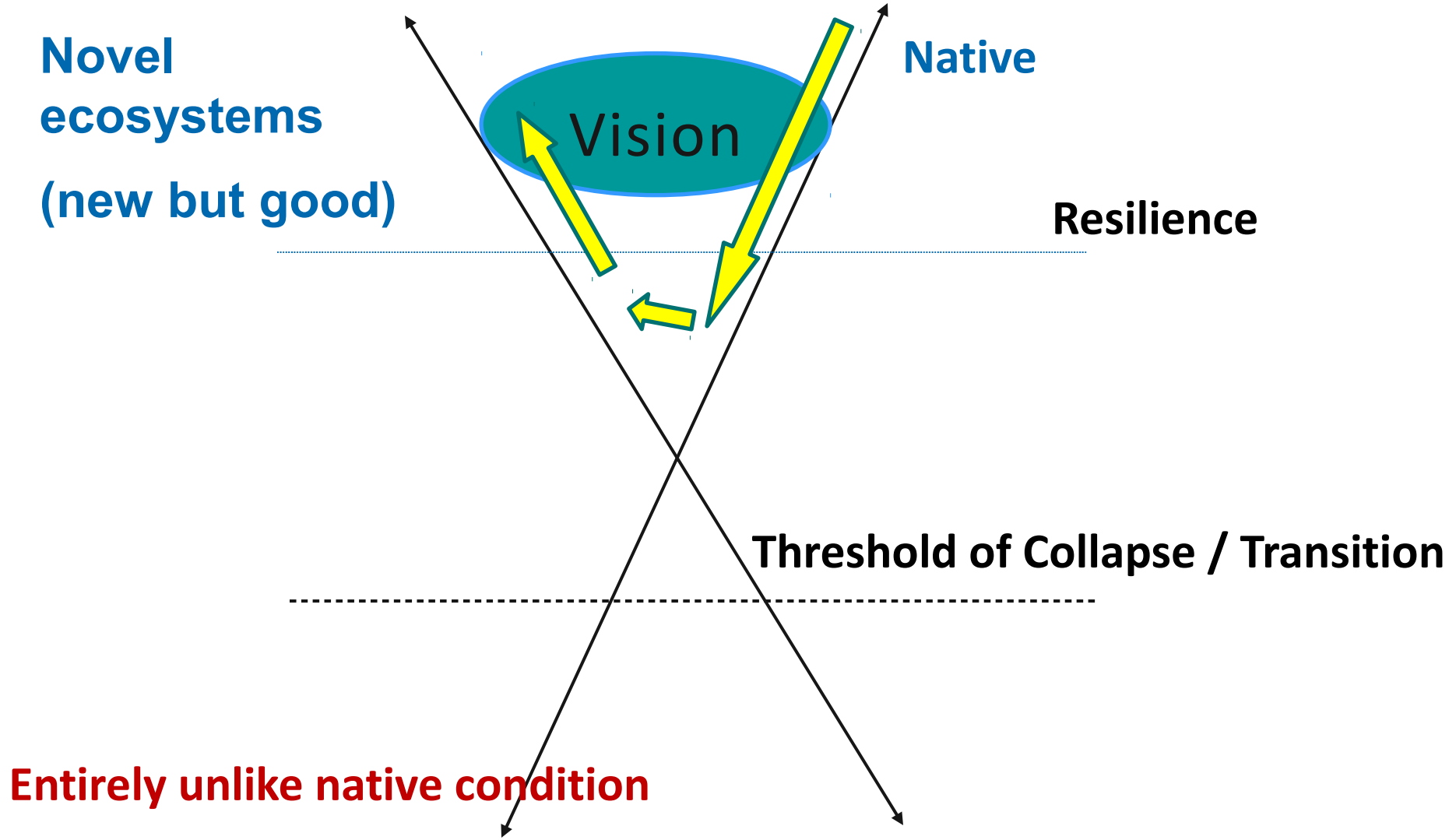
The Urban Reach

- 13 miles through Fort Collins
- A transition reach(middle Poudre)
- 66 miles upstream, 2000 miles downstream.



River ecosystem



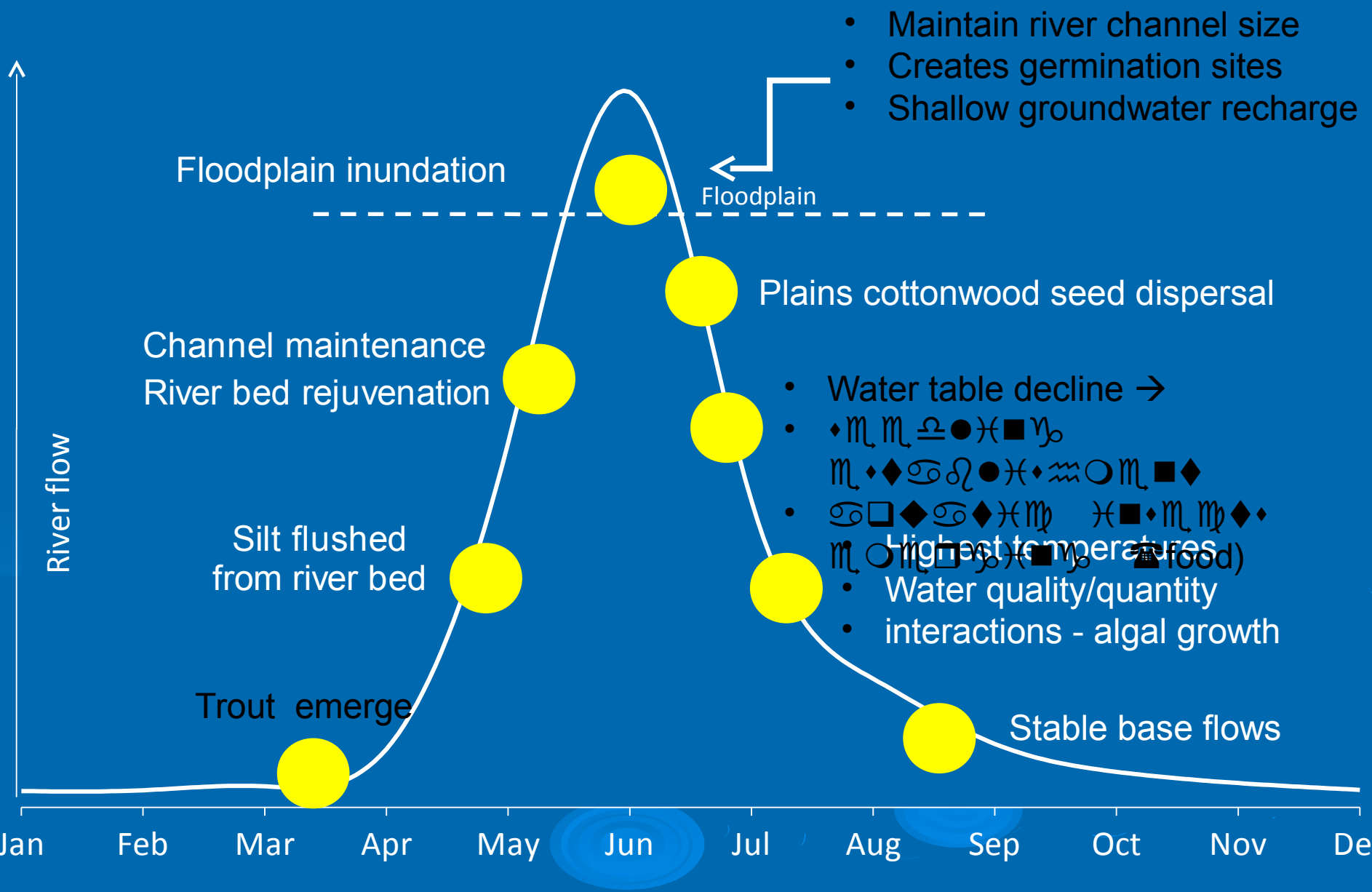

Novel ecosystems
(new but good)
Vision
Native
Resilience
Threshold of Collapse / Transition
Entirely unlike native condition

Using Google Earth to Set the Stage with the Public for this Conversation

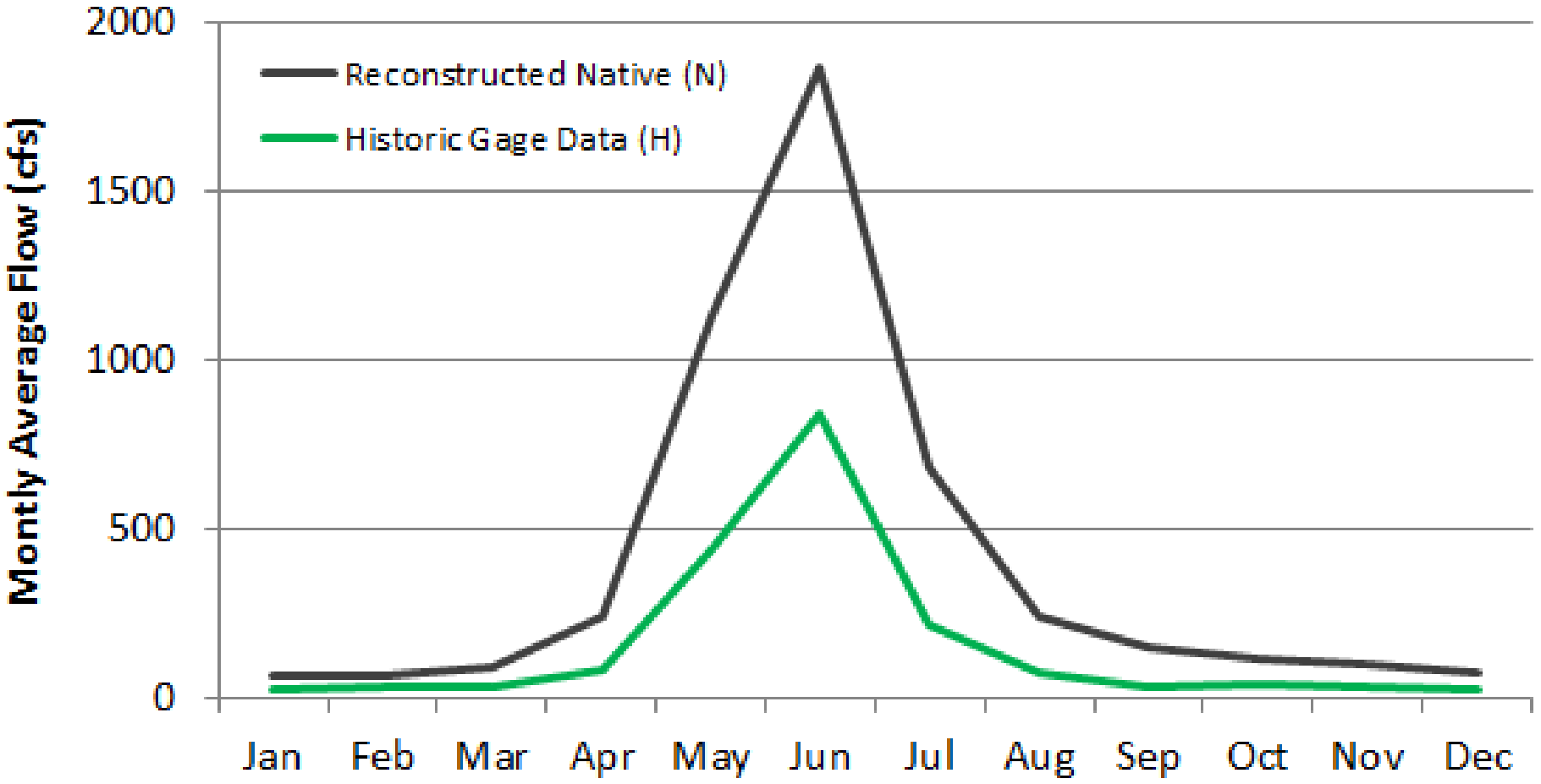
A Look into Poudre River Past and Present

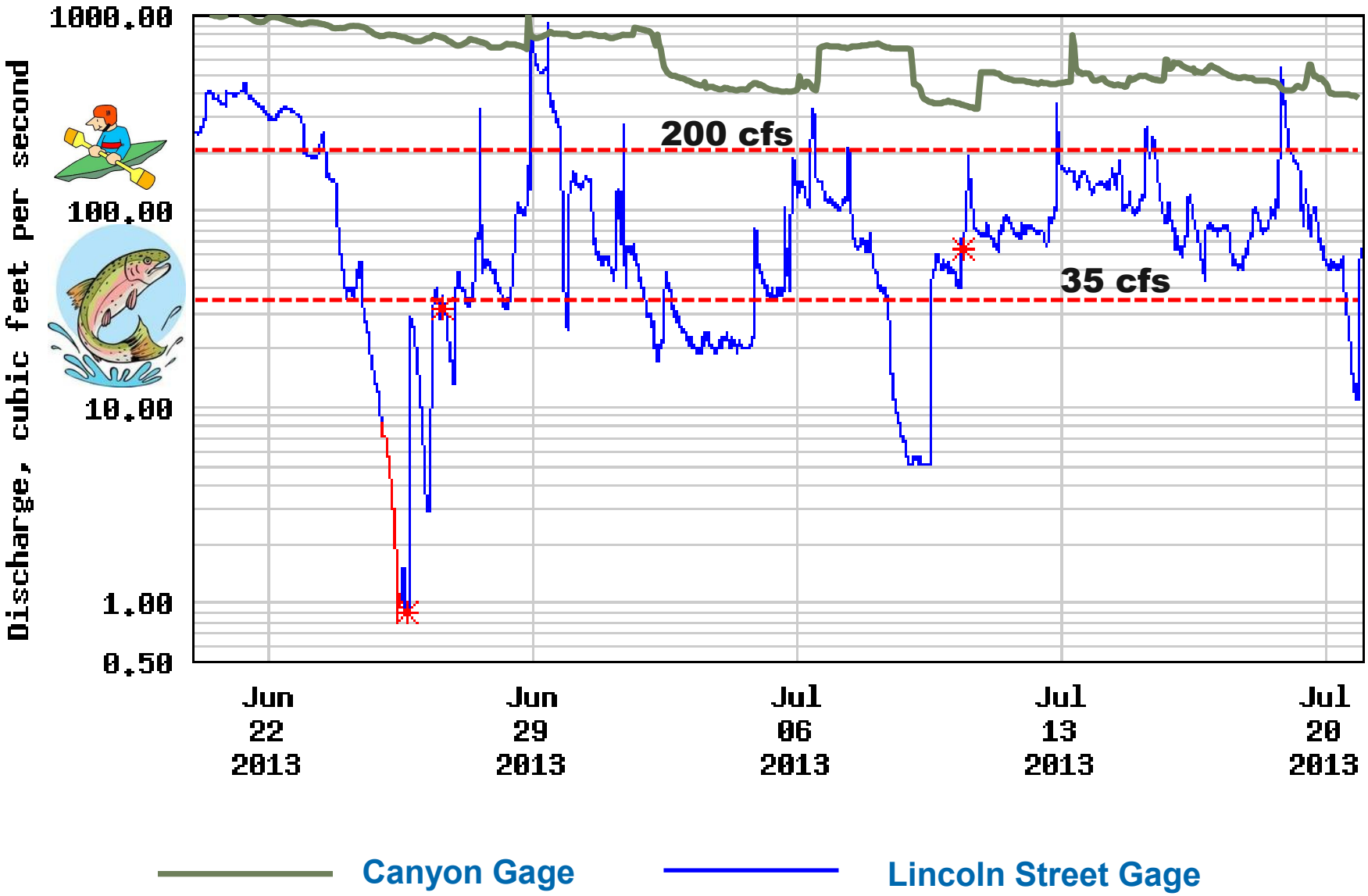
A little more on flows…

The Poudre River Hydrograph



Comparison between historical gage record and a synthesized native record over the last 50 years




Discharge, cubic feet per second
1000.00
100.00
10.00
1.00
0.50
200 cfs
35 cfs
Jun 22 2013
Jun 29 2013
Jul 06 2013
Jul 13 2013
Jul 20 2013
Canyon Gage
Lincoln Street Gage

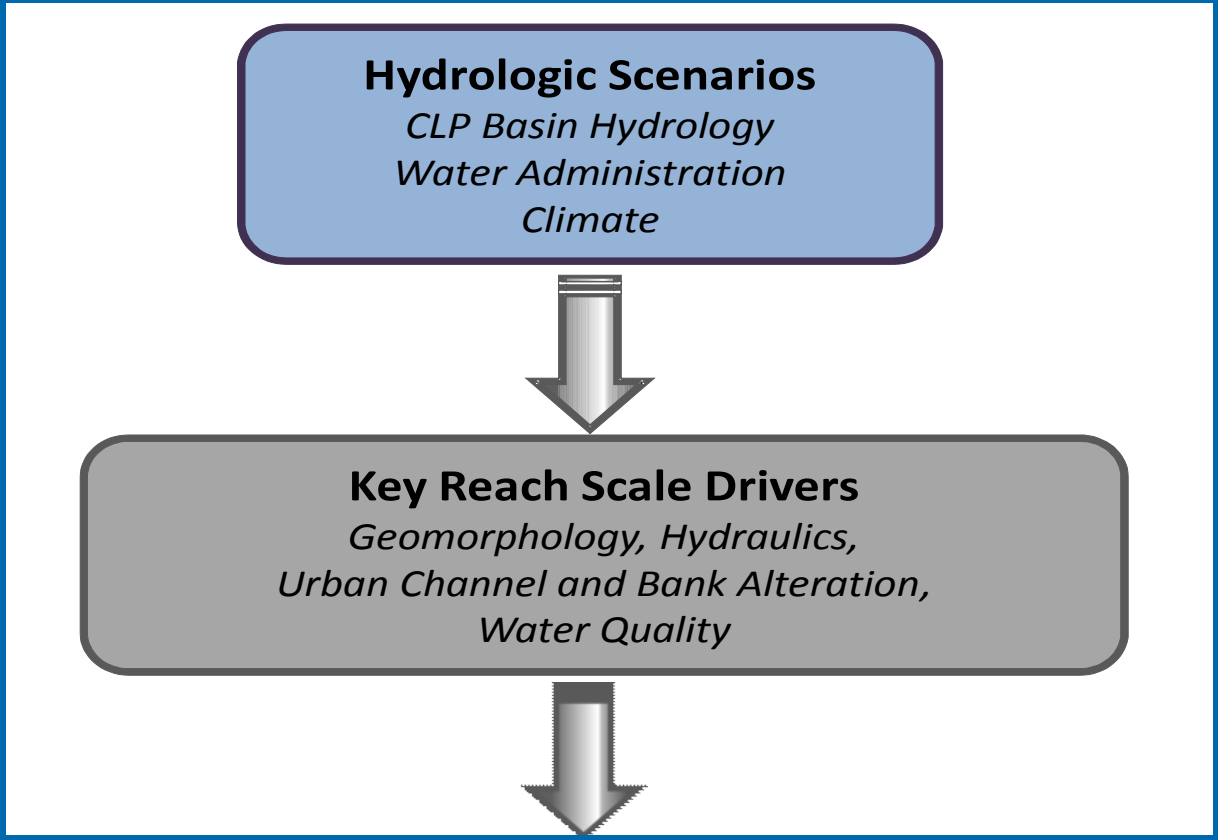
Ecological Response Model

1. Understand past present and likely future conditions
2. Understand parameters associated with a healthy resilient river
   (env. flows and other considerations)

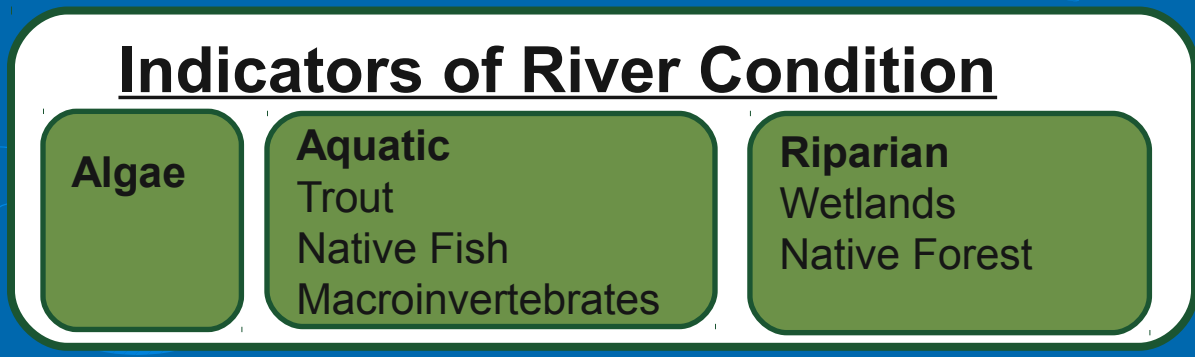
Decision support tool

Communication tool

1. *Flows*, and env. flows., <u>functions</u> of flows
2. *Physical form*
3. Ecological Indicators



Channel Structure



The process- We learned….

- Extremely complex to build an integrated model in altered environment
- Output as good as input data
- Still- best effort available for integrated perspective

- Biggest challenge- assuring results are interpreted within context!

About the river- We learned….

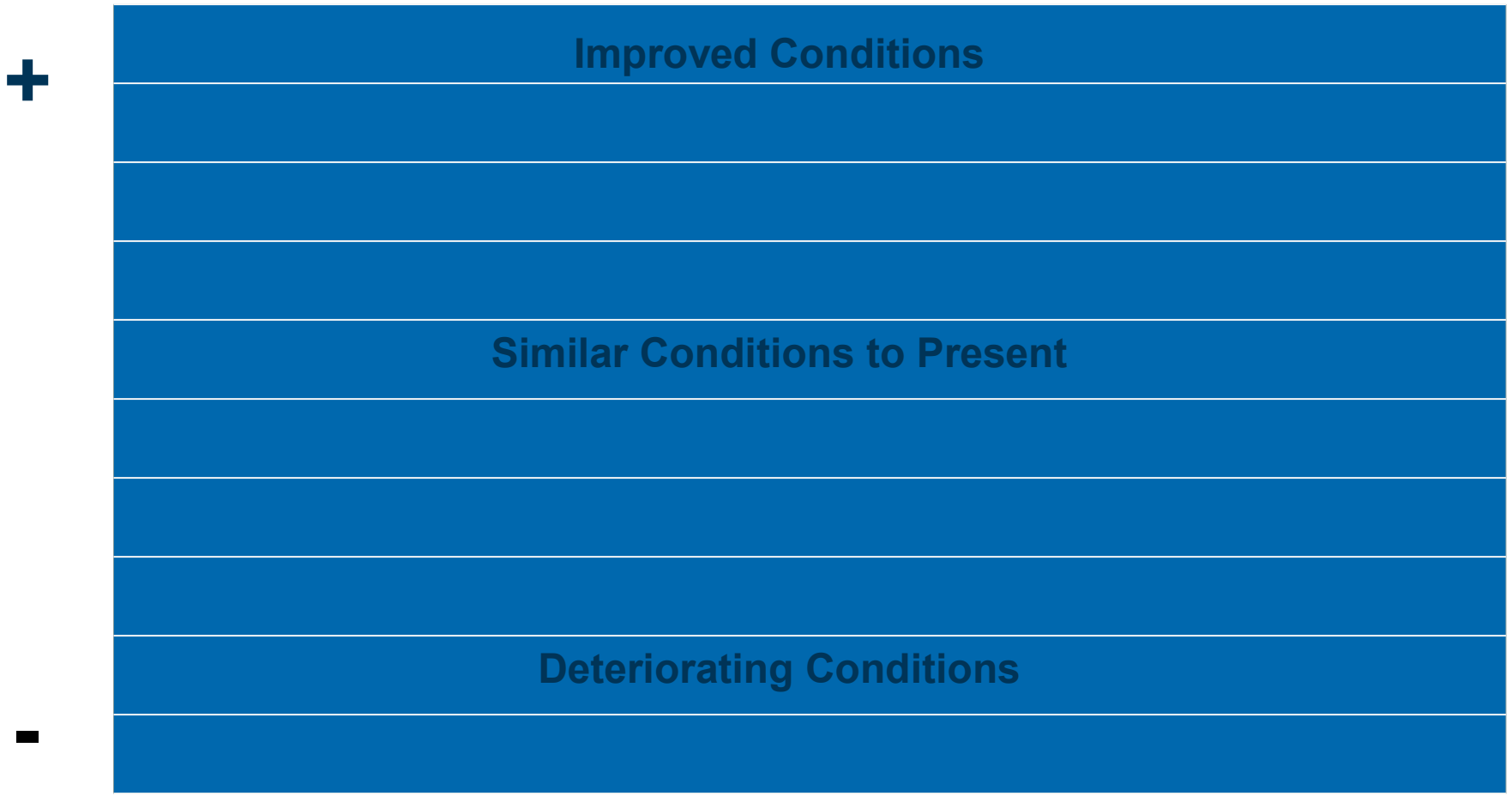
- The river has already been changing for some time.
- You could restore native flows and still not have the same river
  - rigid form
  - species extirpated

- Results….Dismal future or Novel Ecosystem?

Preface to the results:

All models are wrong,
some are useful

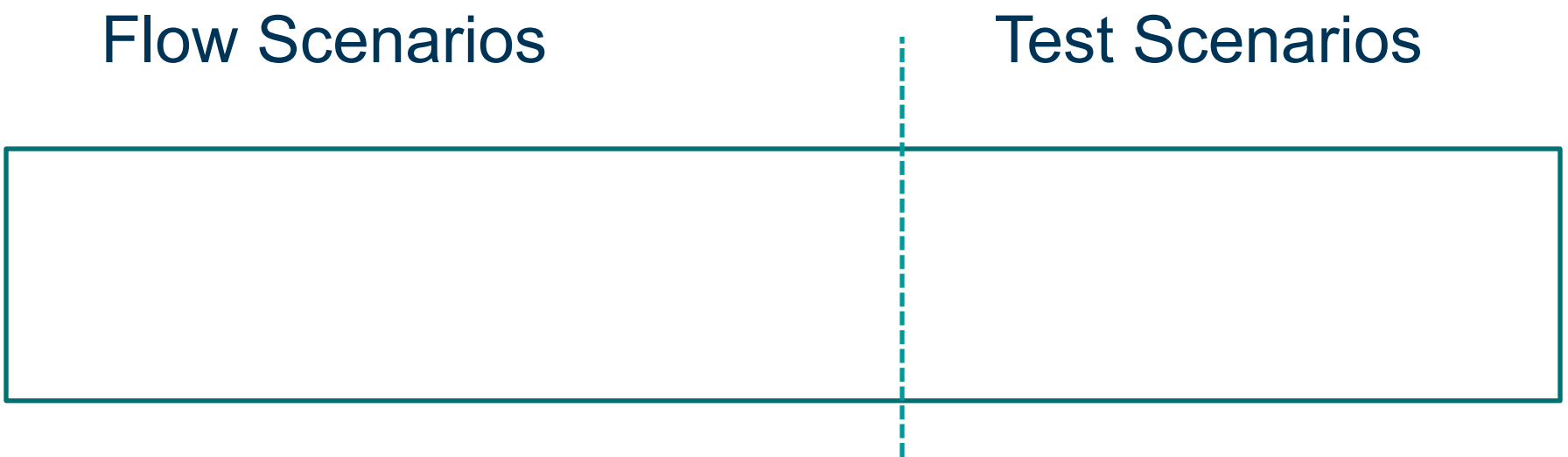
George E.P. Box

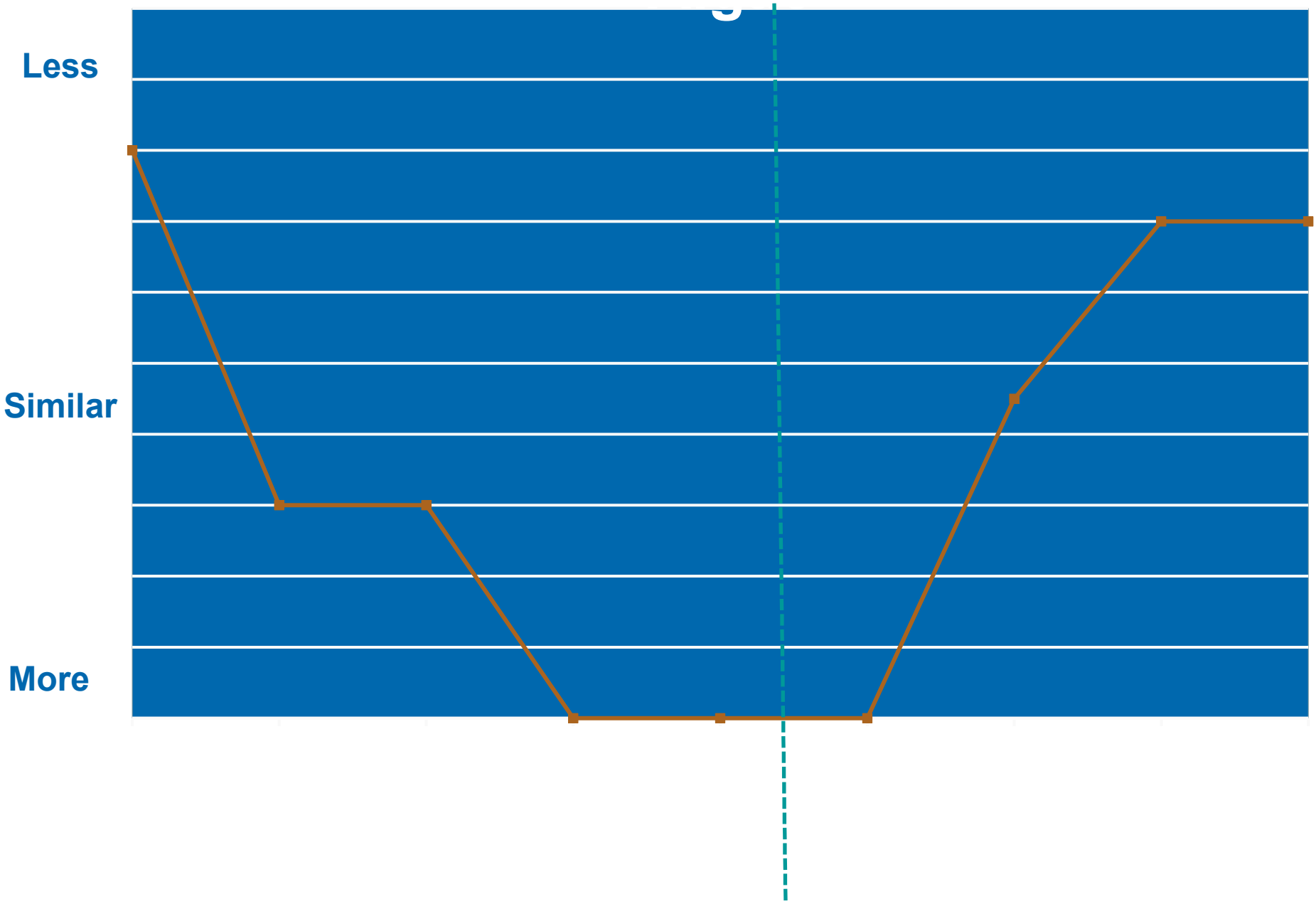


Flow Scenarios

Test Scenarios

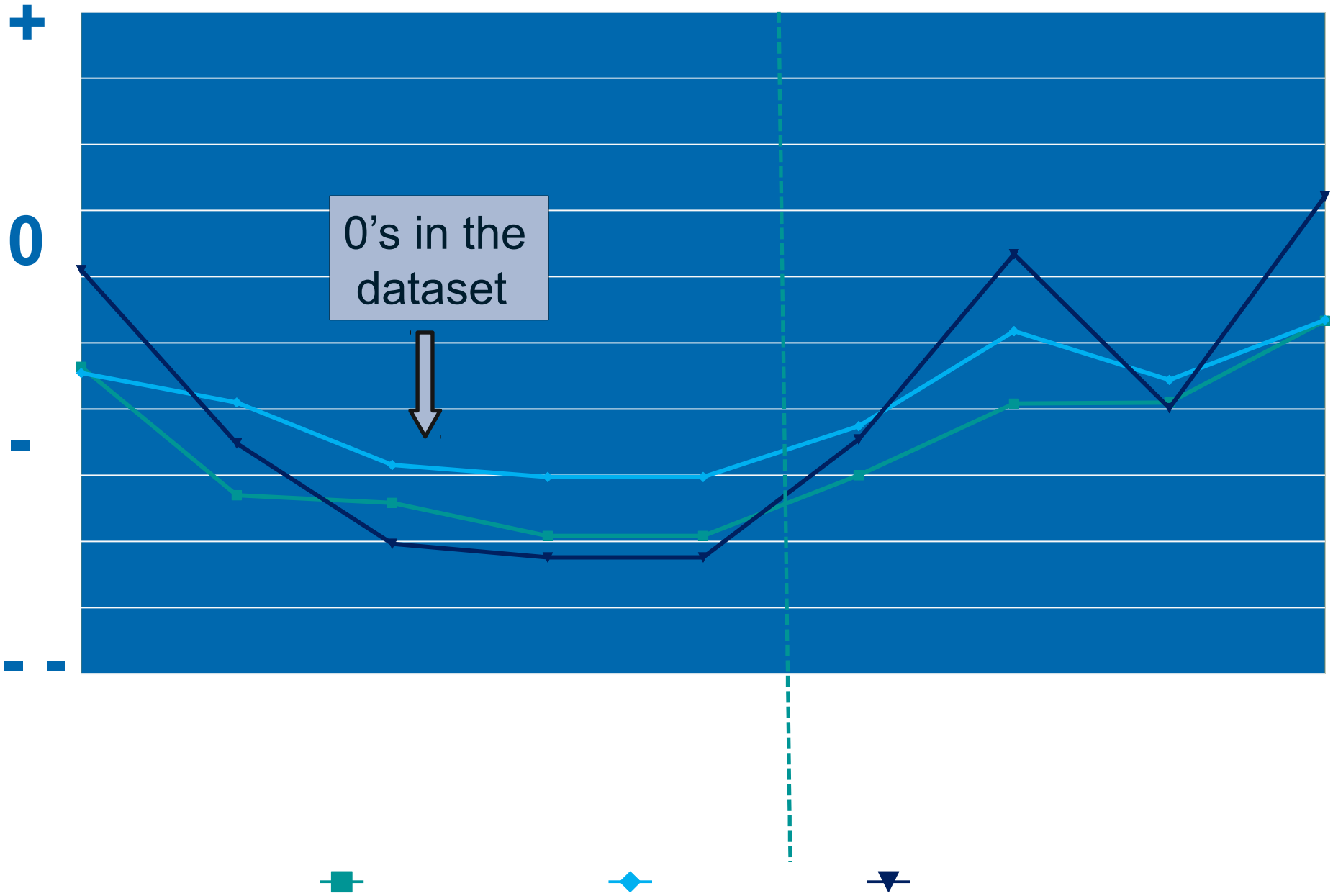
Shields to College




Less
Similar
More

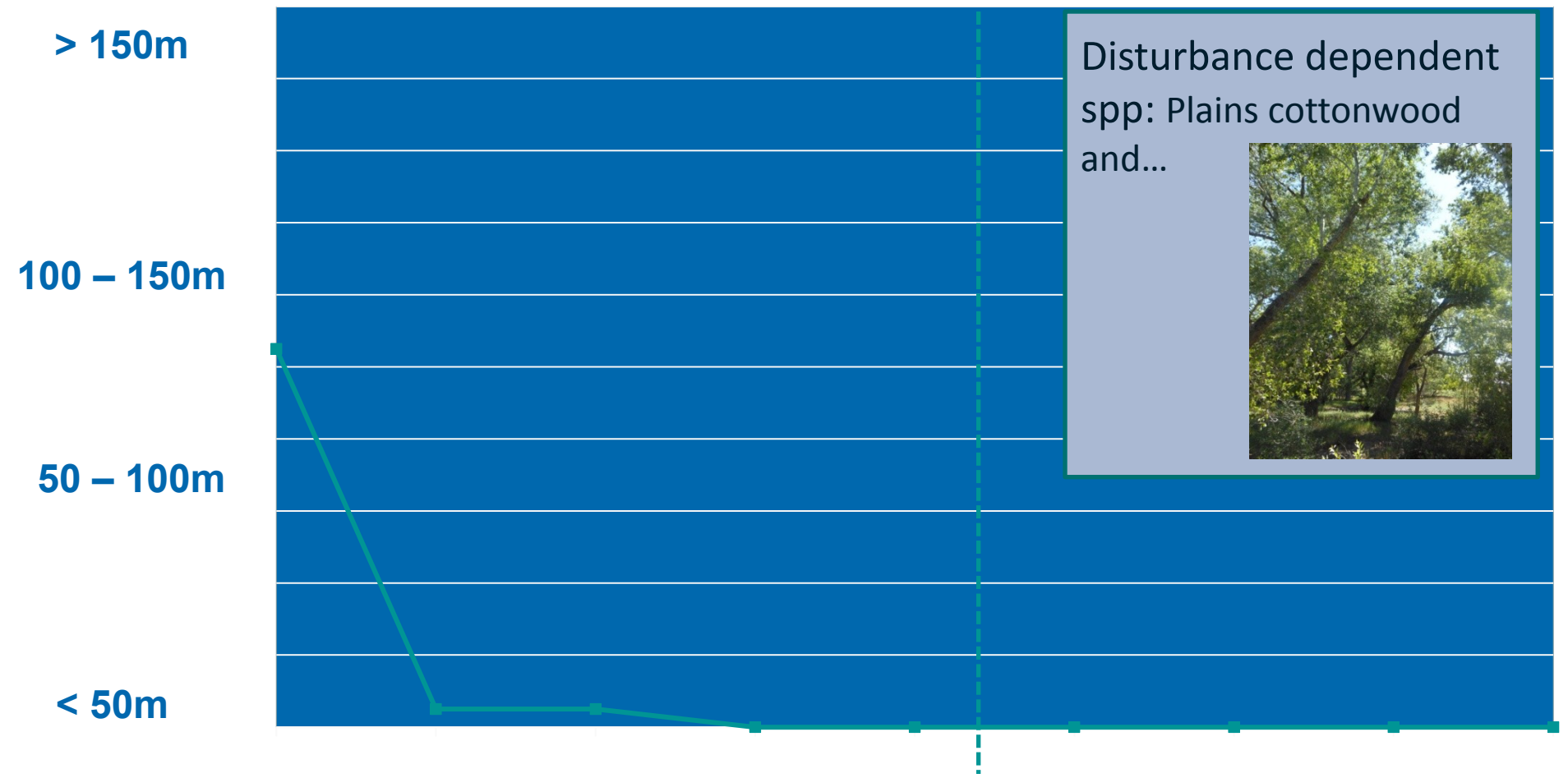
Algae-Summary

- Dilution
- Integration, cross jurisdictional management (ag to ex-urban to urban)
- Algae: Whose job is it anyways? How can we be proactive?
  - CDPHE, Regulations , Chlorophyll
- When there is an issue like algae that people care about who takes the lead? Foresight …


+
0
-
- -
0's in the dataset

Aquatic

- Native communities are highly altered already.
- All aquatic organisms reliant on both high and low flows
- Improvements to base flows important for all aquatics organisms (critical thresholds-temps, habitat)
- Hard to quantify impact of low flow variability but it can "break the camels back"


> 150m
100 – 150m
50 – 100m
< 50m
Disturbance dependent spp: Plains cottonwood and…

It can't be that bad….?

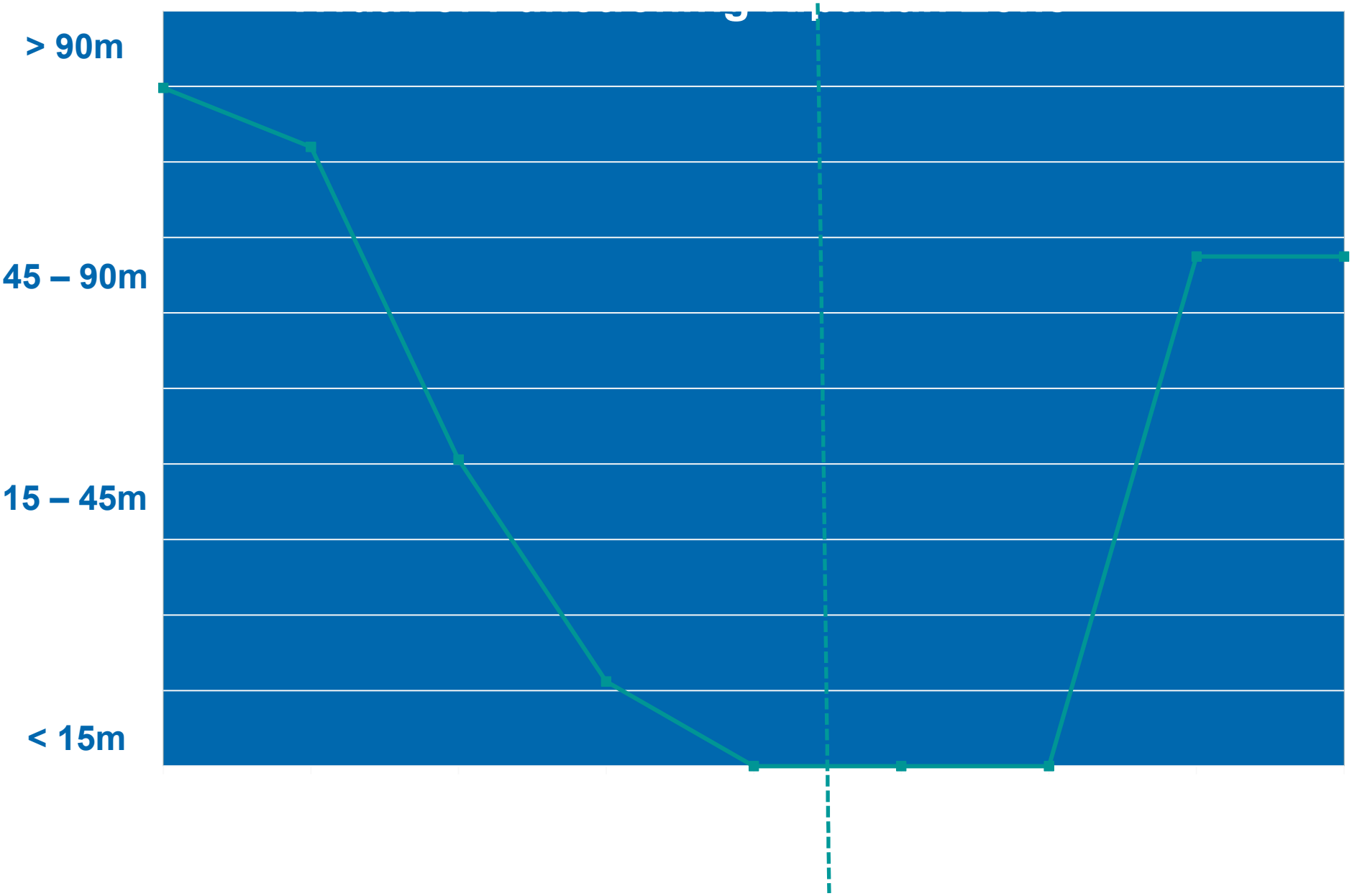
Developed a *new* riparian endpoint

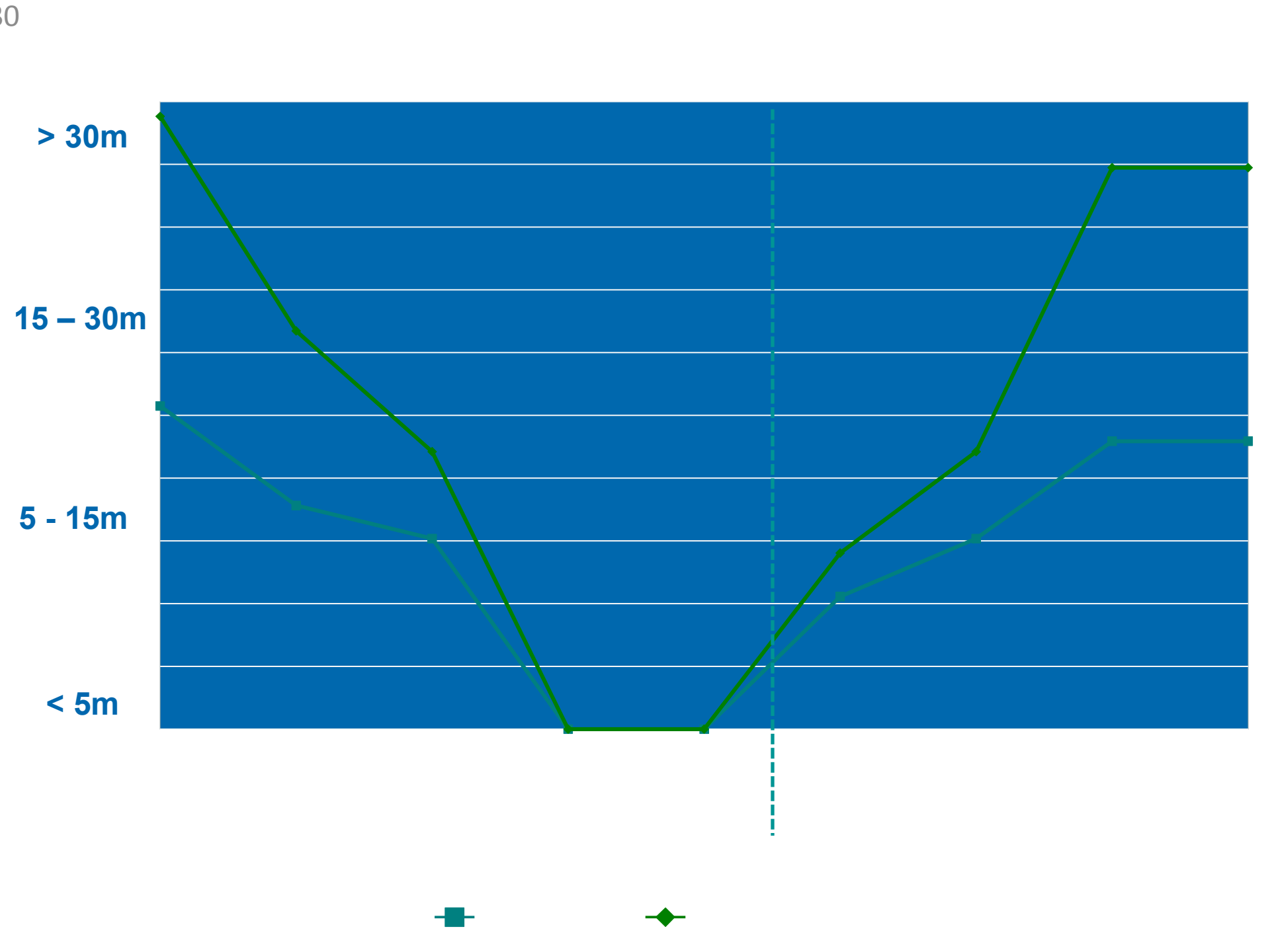
What else can happen in the riparian zone?

Functioning Riparian zone…?

- Productive, prolific woody vegetation
  - Habitat, cover in urban environment,
  - Green shady corridor valued by community
- Nutrient cycling
- Nutrient (pollutant) filtration
- Slows down floodwaters

- Unpredictable species makeup ⇛ resilience


> 90m
45 – 90m
15 – 45m
< 15m


> 30m
15 – 30m
5 - 15m
< 5m

Channel structure
(Geomorphic or physical setting)

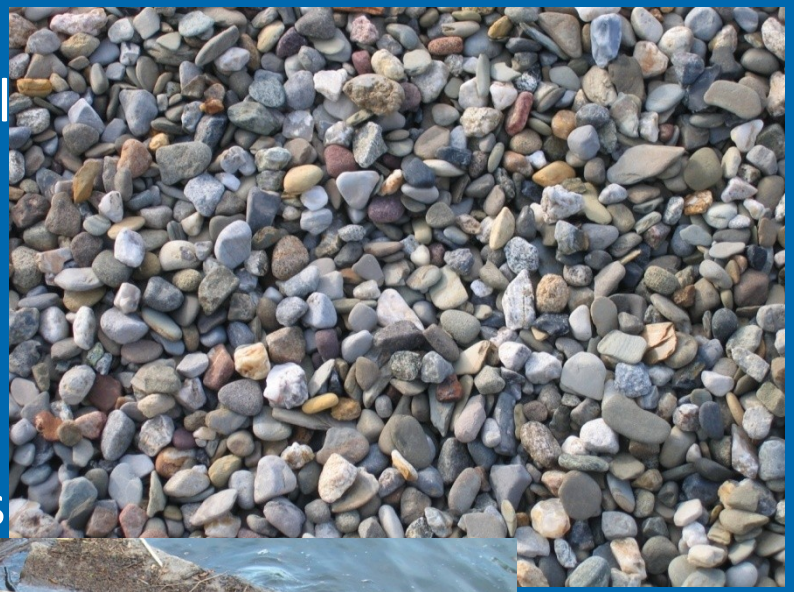
1. Channel width under drier scenarios
2. Flows required to turnover bed?
3. Steep stabilized banks vs restoration

- Reach specifics matter
- Lots of details
- Ignite conversations…

- Channel width
  - Is it overwidened? impacts to fish
  - Is it shrinking? Impacts to flood levels

ke?

Gravel



Cobble

Fines

Flows that move….

	Confined	Moderate	Broad
Flush Fines ($\tau^*c=0.021$)	1750	1400	900
Mobilize Bed ($\tau^*c=0.030$)	2700	2500	1550
Reset Channel ($\tau^*c=0.050$)	5500	5600	7600

-Sediment size varies per reach
-Channel geometry varies per reach
*If armored, requires higher flows

Channel form-stabilization

- Large cobble sizes and loss of diversity in cobble sizes a symptom of channelization
- Lowering banks :↓sheer stress, ↓ bed turnover, could introduce add'l sediment source/sink (river connected to floodplain)
- Halting erosion (stabilizing):
  - straightening river ↑ flow velocity ↑increase flushing of fines, ↑ cobble size, ↑armored
- ↑homogenization of aquatic habitats
- Spectrum of stabilization options

	Degree of stabilization	Pro	Con
0	Native river movement	most resilient, river has its own floodplain for geomorph processes.	Unrealistic/undesirable in city
1	“Make room” approx. 40 m	Sustainable, lowest long term cost, river in charge	Requires longer reach, Culture shift,
2	Armor is setback within. 10 m	bank erosion is slowed Urban core	can develop unnatural “bubbles”, unpredictable
3	Armor buried at bank “Line in the sand”	Aesthetically pleasing, has habitat value Urban core	local deposition and erosion will still occur so mgt plan is needed for long term cycles and change (ie, aggradation, islands, local scour)
4	Hardened visible Structural and safety goals dominate	Appropriate at a bridge, downtown- diversion point	no cover/habitat values. #3
5	Rubble, trashy, old style stabilization	Historic artifact	not functional, not pretty.

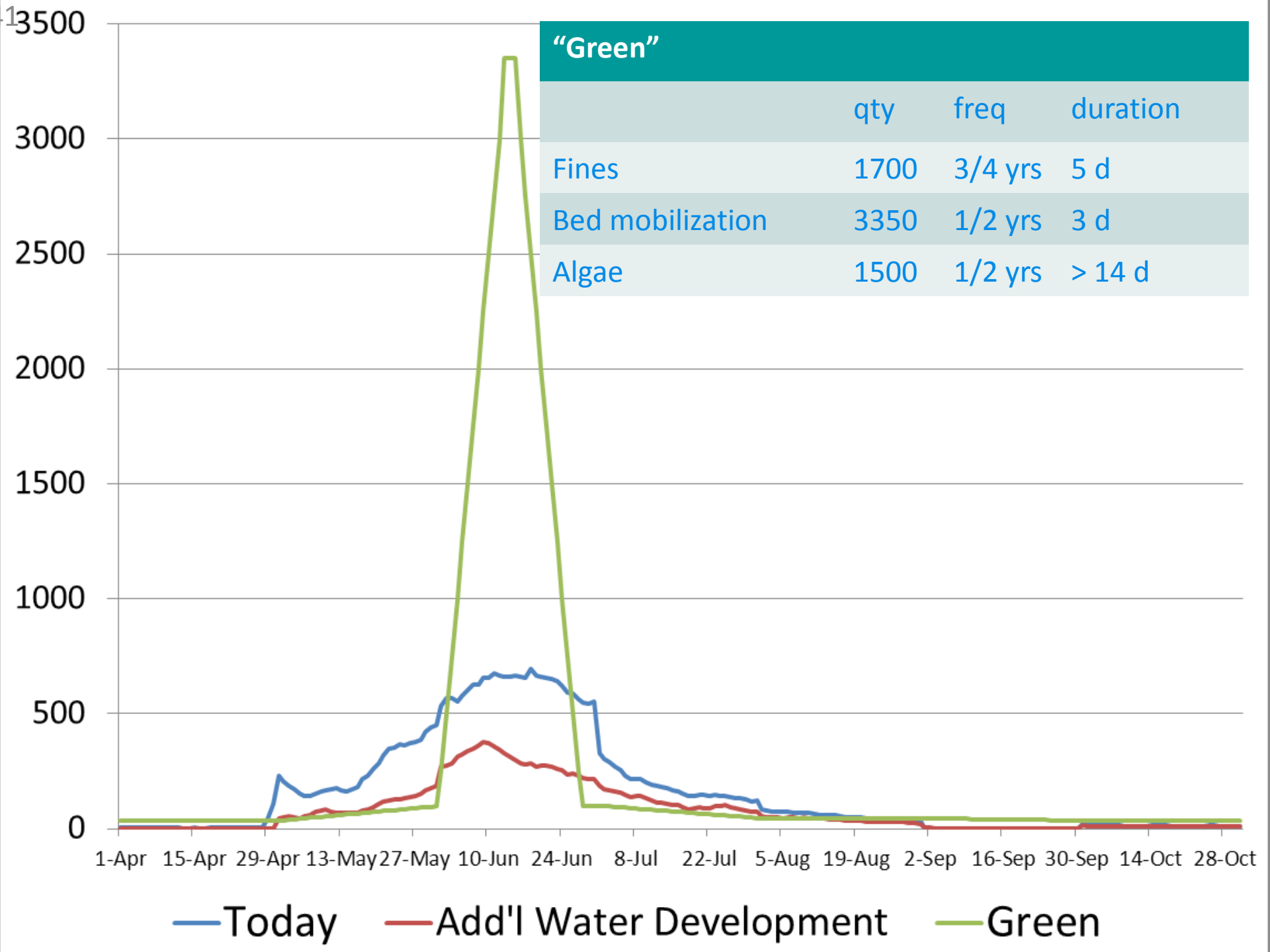
Consider reach scale impacts of restoration projects

- Uncertainty of each project engineering
- Collective impact, moving a problem downstream
- Site specific- no single answer

- Smart planning vs regulatory processes vs “the way its done”

How much water does it take?

Annual Volumetric Discharge			
Historic	Today	Add'l Water Dev't	Green
118,685	71,996	35,533	106,339



"Green"	qty	freq	duration
Fines	1700	3/4 yrs	5 d
Bed mobilization	3350	1/2 yrs	3 d
Algae	1500	1/2 yrs	> 14 d

- If we want to meet env. flow targets it will be very costly up front but more predictable path towards resilience
  - System takes care of itself

Good news: Same amount of water (as over past 50 years) delivered differently could greatly improve conditions

- If we don't meet flow targets, it will be very costly to provide the kind of river the community wants
  - Treating the symptoms

We must develop a vision of multiple resilient futures

- Env. flows only one trajectory. Not easy to achieve even with excellent regional collaboration

Possible Actions

- Low hanging fruit→
  - Restoring (optimizing) the floodplain, banks
  - Improving aquatic connectivity
  - Regular WQ work (stormwater pollution prevention, monitor source watershed)
- More complex→
  - Smooth out low flows (water sharing, instream flows, investigate operational changes and cultural willingness)
  - Restore source watershed health
- Most complex→
  - Restore functioning high flows
  - Maintain healthy baseflows
  - Reclaim floodplain from development and infrastructure

What is the 21st Century Poudre River?

1. *Flows*, and <u>functions</u> of flows
   - Drier overall, goal is to meet functions
   - Extremes still coming

1. *Flows*, and <u>functions</u> of flows
   - Drier overall, goal is to meet functions
   - Extremes still coming

2. *Physical form*
   - Urban spectrum of stabilization
   - Consider and discuss uncertainties
   - Reach scale impact of projects
   - OK for river to shrink? Manual sizing the river

1. *Flows*, and functions of flows
   - Drier overall, much to improve on
   - Extremes still coming
2. *Physical form*
   - Urban spectrum of stabilization
   - Consider and discuss uncertainties
   - Reach scale impact of projects
   - OK for river to shrink? Manual sizing the river
3. Ecological Indicators
   - A new kind of forest, unknown impact to wildlife
   - Wetlands and forest likely to narrow
   - Clean water (algae free) challenging, proactive
   - Must improve low and high flows for aquatic spp

A Future Vision

- Challenging, but not impossible to envision a resilient future when it is different from native.
- Novel Ecosystems of the 21st collective challenge

- Rivers are dynamic!
- Integrated management

Tour of current projects GE