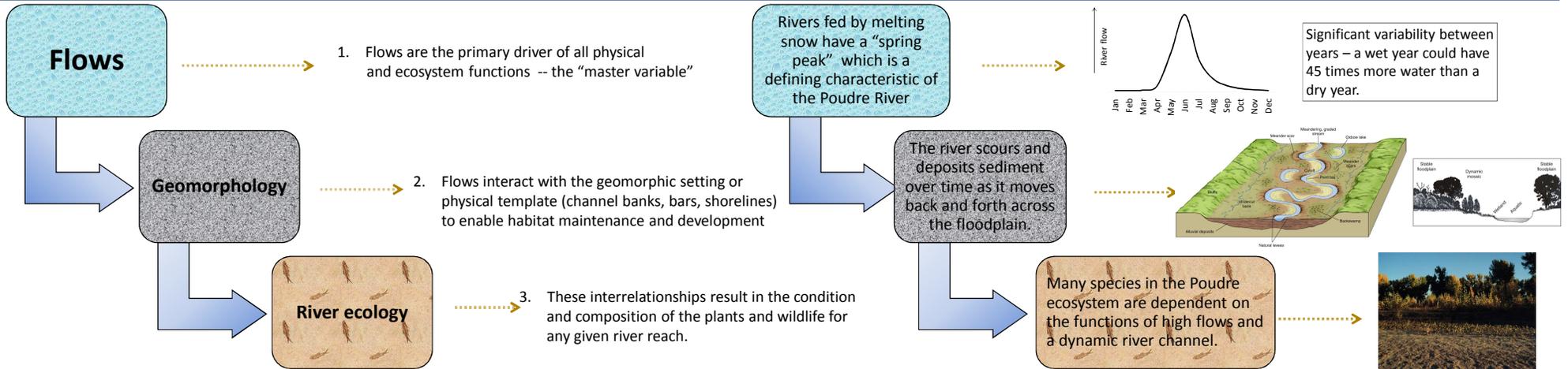
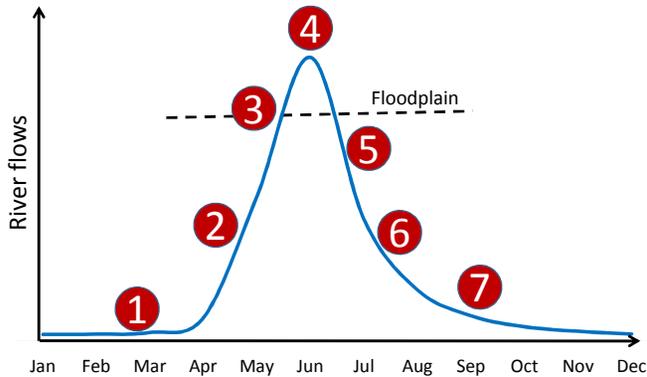


Poudre River *Past*: The Native Ecology

Building blocks of a Front Range river ecosystem



How does flow (the "master variable") govern biotic and physical processes in the riverine ecosystem?

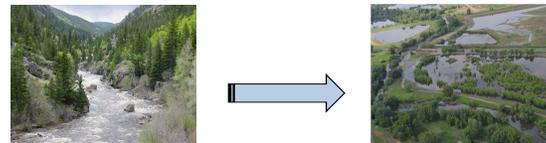
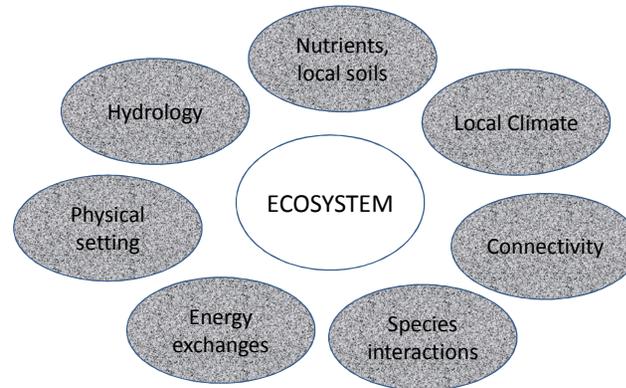


- 1 Trout emerge
- 2 Silt flushed from river bed
- 3 Channel maintenance
- 4 Riparian inundation
- 5 Cottonwood seed dispersal
- 6 Seedling establishment
- 7 Stable base flows (maintain aquatic and riparian organisms)

Elements of Flows

1. Magnitude
2. Frequency
3. Duration
4. Timing
5. Rate of Change

What else contributes to the composition, condition, characteristics and functions of the ecosystem?

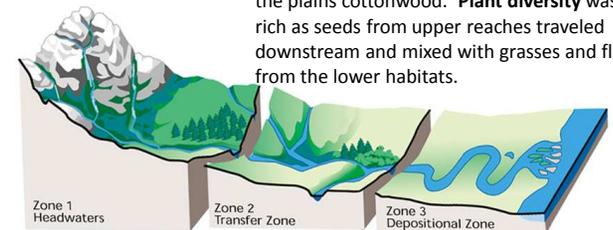


What makes the reach of the Poudre through Fort Collins globally unique?

From the canyon mouth to beyond I-25 the Poudre River is located in a unique **ecological transition zone** (or ecotone) between the mountain and plains environments and supported a unique blend of wildlife and plants from both the plains and montane environments.

Historically this reach was a "hot spot" of fish diversity in the region, including a mixture of species typical of plains streams, and those like greenback cutthroat trout typical of coldwater reaches upstream. Many of these fishes that inhabited the transition zone require coarse gravel substrate, cool water, and habitat structure (e.g., woody debris) in the channel.

The dominant tree transitioned in this reach from narrowleaf **cottonwood** (found in the canyon) to the plains cottonwood. **Plant diversity** was also rich as seeds from upper reaches traveled downstream and mixed with grasses and flowers from the lower habitats.



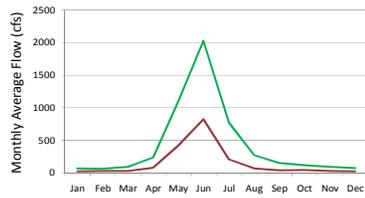
So what made a healthy and resilient native Poudre river system?

A resilient system is one that can respond to disturbance and extremes and be fundamentally the same system afterwards. In other words, after an extremely large spring flood or several years of drought, the plants, animals and basic network of relationships between the physical and biological elements of the system were still intact.

Poudre River Recent Past: Human Influences

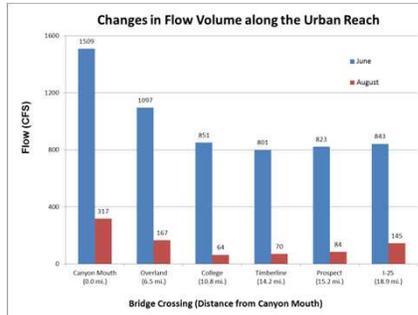
How have flows changed since human settlement in the late 1800s?

Flows are reduced
 Total flows today are less than 25% of the native flows. The diversion of flows for agriculture and municipal uses has affected the flows year round. The loss of high flows has diminished geomorphic functions while low flows have increased in magnitude, but greatly increase volatility.



Comparison of the monthly median flows between the historical gage record and a synthesized native record over the last 50 years

The flows of the Poudre are like a plumbing system

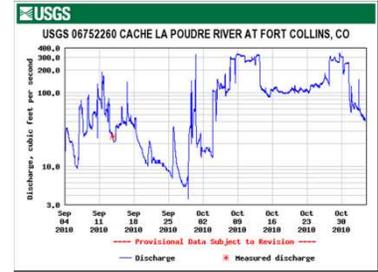


The data for this chart (left) comes from maps developed by AMEC Environment and Infrastructure. Average flows were calculated for the months of January and June for water year 2008 based on inflows and outflows throughout the reach. These bar charts are a simplification of the AMEC analysis and do not show all changes along this reach.

Location	Date	Time	Flow (CFS)
Canyon Mouth	6/25/2013	15:45	780
Lincoln Bridge	6/25/2013	16:15	1.2



Low flow variability



Flow variability is the daily and hourly fluctuation of flow volume because of legal water delivery requirements. There can be a significant detrimental impact on water quality and invertebrates which can then impact fish as well.

Nutrient loading

- Urban development and agricultural practices lead to increased nutrients (e.g. nitrogen (N) and phosphorus (P)).
- The condition of nutrient levels, algae, and low flow conditions are intertwined.
- Thick mats of filamentous algae occur in warmer months as a direct response to higher nutrient levels
- These algal mats overwhelm macroinvertebrates and are viewed by many as unaesthetic



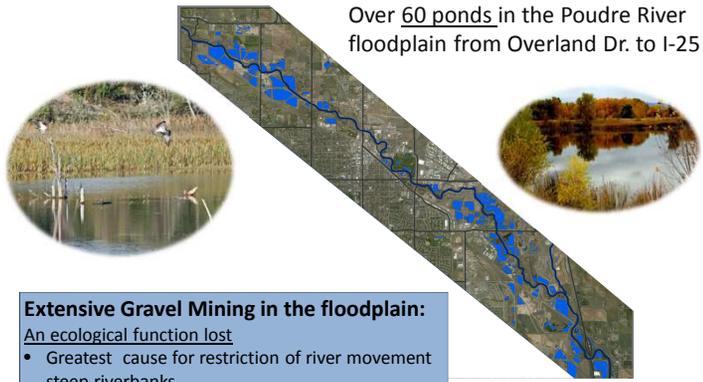
The river can no longer move around across the floodplain. The physical template is rigid.

Bridges, development in the floodplain, and underground infrastructure are common causes for **armoring the riverbanks** in an urbanized river. This has reduced or eliminated all ecosystem functions dependent on this process known as "lateral migration" (from erosion and deposition).

This image (below) shows the former river paths near Shields St. We can still see mature cottonwood stands today along this former meander.



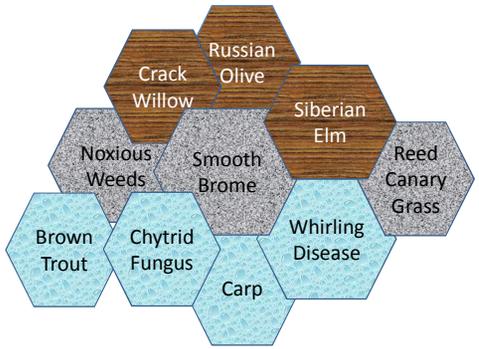
These "gallery forests" are relics of an earlier time and are not being recreated today because of the limited ability of the river to move around as seen with the armoring of the river from Shields to Mulberry (see river armoring- right).



- Extensive Gravel Mining in the floodplain:**
- An ecological function lost
- Greatest cause for restriction of river movement steep riverbanks
 - Limits width of riparian forest and plains cottonwoods rejuvenation along the river
- An ecological asset gain
- Wetlands and shallow water habitats
 - Amphibians, fish, water fowl
 - If restored pond edges are great habitat for regeneration of plains cottonwoods
 - Ecological diversity
- New Recreational Asset
- Fishing, boating, wildlife viewing
 - Family exploration, exercise and urban escape



Non-native species

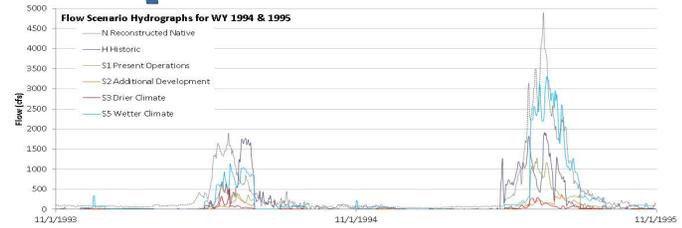
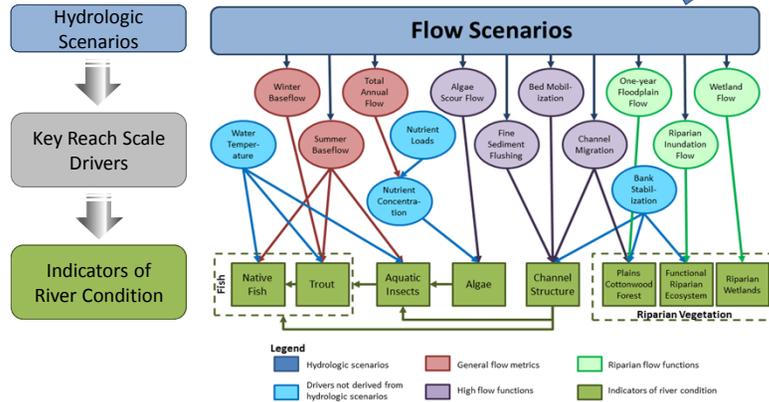


Poudre River *Present/Future*: Ecological Response Model

Using an Ecological Response Model (ERM) to Understand the Modern River

What are the goals of the ERM?

- To create an integrated holistic science-based understanding of Poudre River ecology
- To reveal patterns of long-term trends associated with seven biological indicators
- To provide decision makers and the community with a decision support tool intended to help inform management efforts to achieve the community's aspirations for a healthy and resilient Poudre River



Hydrographs of Water Years 1994 and 1995 across all six ERM flow scenarios.

This model is unique

- Integrated, probabilistic evaluation of cause and effect across complex ecosystem
- Includes different sources/types of data and information (e.g., output from other sub-models, empirical data and expert judgment)

What have we learned so far?

The Riparian Forest- A Legacy of the Past?

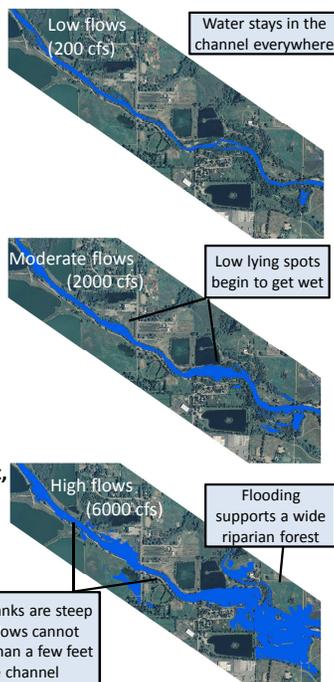
Not necessarily, but we should expect major shifts in the type of trees and an **overall narrowing** of the riparian corridor because of armored physical setting

Many non-native plants already dominate the understory

Nevertheless, when the **riverbanks are low-lying** moderately high flows can still flood the riparian zone, supporting many important functions of a riparian forest

This corridor of lowland woody habitat **filters pollutants, provides diverse habitat, and attenuate floods**

Plains cottonwood is **thriving** along the banks of adjacent ponds



Nutrients, Algae, and Aquatic Insects

The ERM indicates

- nutrient levels are likely to exceed regulatory standards with increasing frequency
- algae blooms are likely to increase
- aquatic insects are already dominated by resilient species so little change is expected

Compared to the terrestrial habitats, the aquatic ecosystem is less adaptable to change. To maintain the same recreational benefits (swimmable, fishable, odorless, clean water) specific conditions must be met:

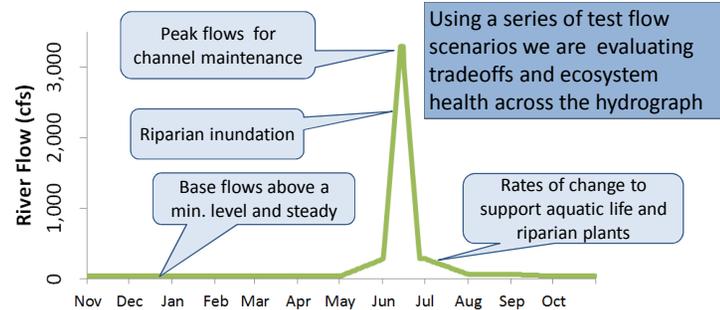
- River bed needs to be "reset" (turned over, unclogged, algae scoured periodically)
- Minimal water quality and temperatures maintained

Trout and Native Fish

- Cool water above warmer temps below College Ave. limit extent of trout vs. native plains fishes.
- Sensitive to water quality- **baseflow is critical!**
- Fisheries health influenced by the physical habitat template (e.g. **clean riverbed maintained by higher flows**) and number and types of pools, riffles, and backwaters (controlled by flows and local conditions)



Test Flow Scenarios – Evaluating Tradeoffs



What might a resilient future Poudre look like?

The ERM clearly indicates the river is on a trajectory of narrowing and performing fewer functions than historically and has been for some time. However it is also sparking a more informed, invigorated conversation about the future of the Poudre River as an **ecosystem of the 21st century** – likely one with a different character from its pre-settlement past, but still supporting numerous ecologic and social amenities.

Even with this **paradigm shift** the Poudre River will always be a natural system that continues to be characterized by episodic change, patchiness, variability, and multiple stable states. Like any ecosystem the Poudre River will change state abruptly in response to incremental impacts.

The task ahead is to **identify critical thresholds and system requirements** required to keep the Poudre healthy and resilient.

What is a healthy Poudre River to you?