Transient Explorer's Progress Report

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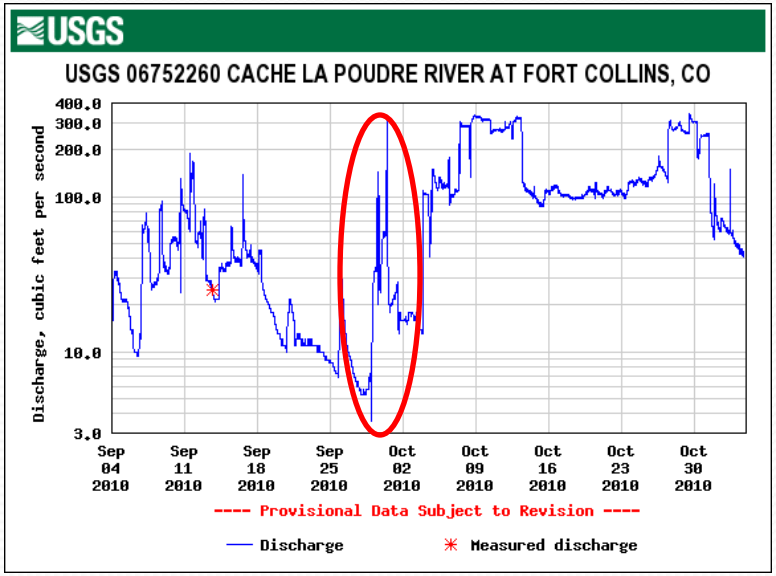
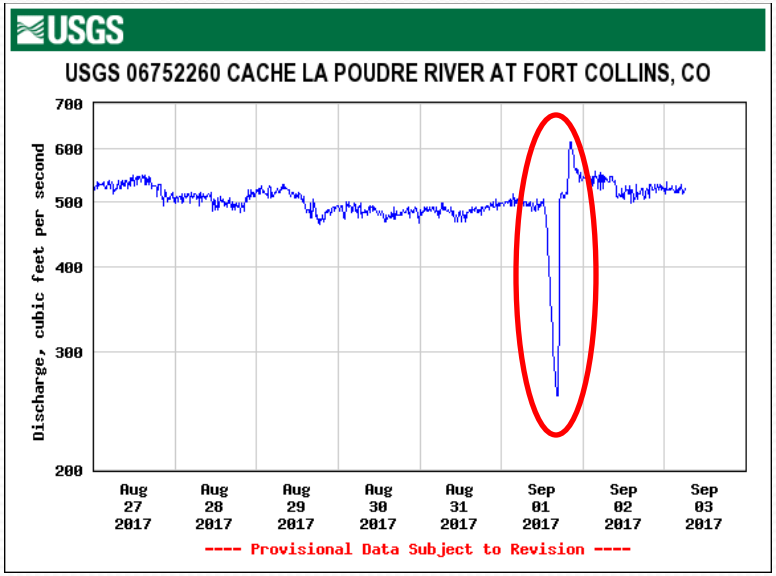
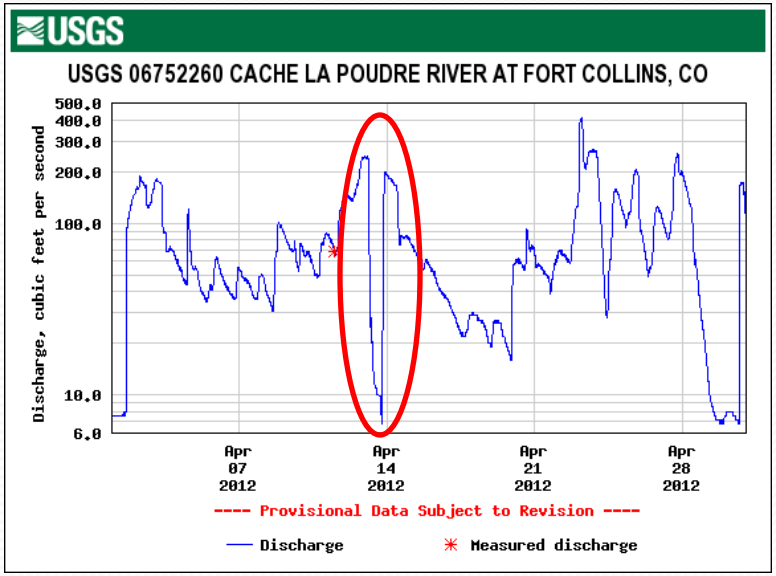
PRTI, January, 2017

Why?

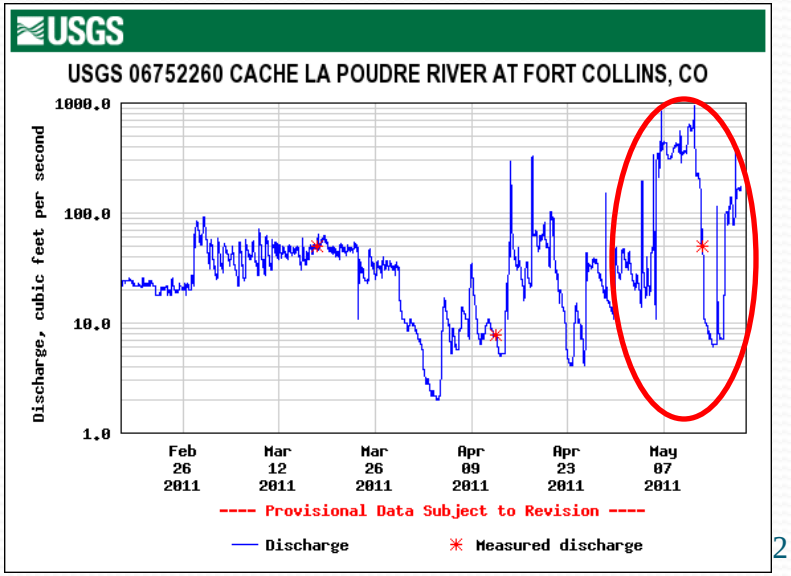
Documented Abrupt Flow Events







Note logarithmic scales



Initial Goals

- **Understand** the likely causes of flow fluctuations that are **Transient**:
  - Abrupt – begin and end rather suddenly
  - Short-lived
  - Represent a large percentage or absolute flow change
  - Occur in the Poudre, primarily through the Fort Collins reach
- **Understand** how transients may impact aquatic organisms, public safety, sediment management and/or water temperature (positively or negatively)

And Also…

- **Brainstorm** promising opportunities for further exploration that might:
  - Reduce the magnitude / frequency / length of river / or avoid certain times of the year of large transients
  - Opportunities could include:
    - Structural changes
    - Operational changes
  - All directed toward a healthier working river and <u>acceptable to all parties</u>

Abrupt Flow Plunges

- Can dewater channels (especially side channels) leading to fish stranding if long lasting

Abrupt Flow Spikes

- Can disrupt brown trout spawning in October

Biological 'Guidance'

- Scientific literature is scarce and incomplete:
  - Especially for warm water species
- Stranding is worse when:
  - Water is cold (< 40-44°F)
  - Substrate is coarse and gradients low
  - Ramping rate (rate of change) is greater than ~1/3 to 1/2 foot per hour in a low flow range
    - Example: At McMurry Bridge, a 100 cfs change = 0.36 feet when flows are low
- Abrupt fluctuations are associated with higher energetic costs, lower growth rates, reduced spawning and rearing success

Recreation and Safety

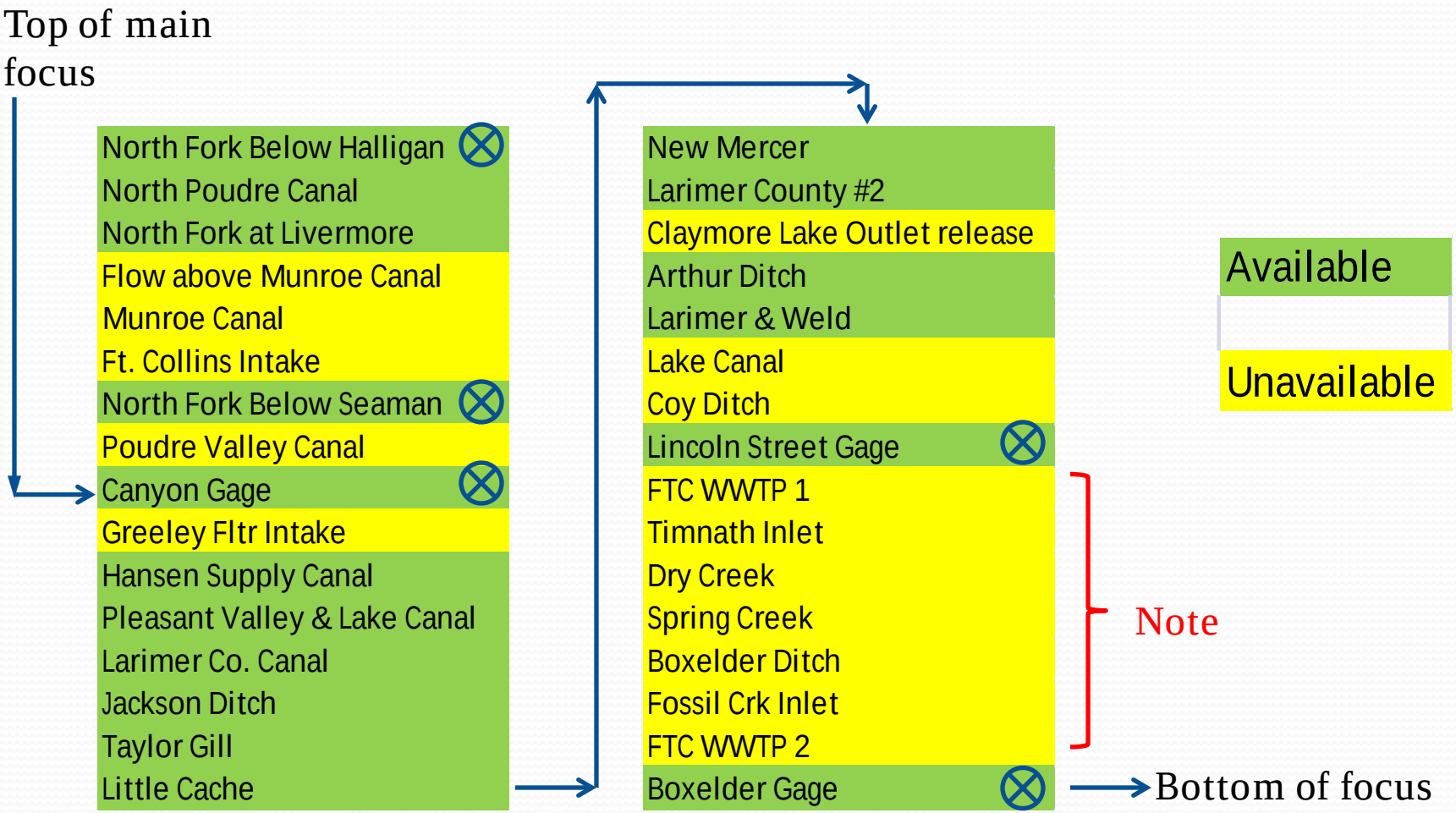
- Both abrupt flow increases and decreases can affect quality and safety of river-based recreation

- There is no way for public to anticipate sudden changes
  - Flows that are safe for a young child for tubing at 10 am could become unsafe by noon

Data Used

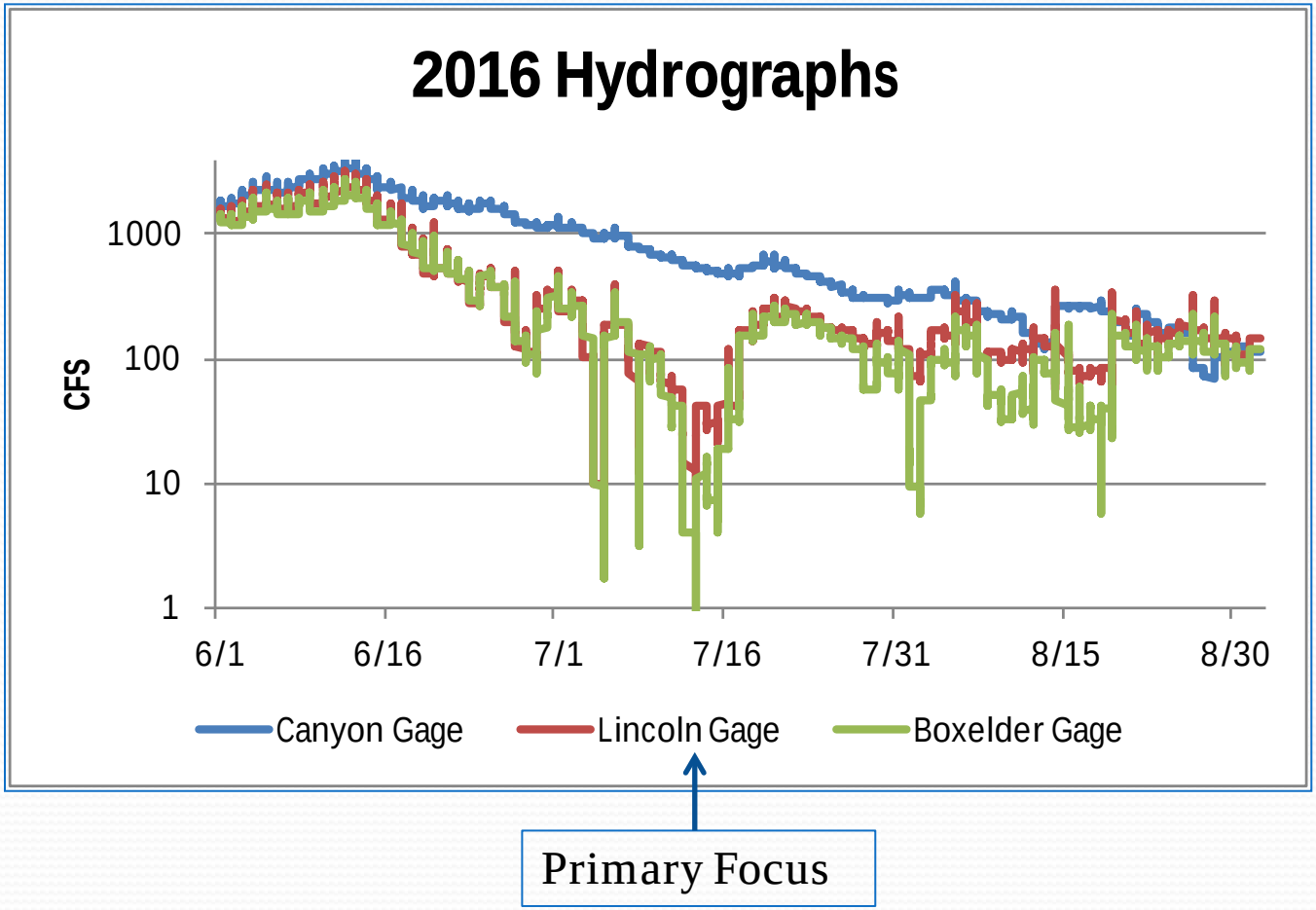
- November 2015 through October 2016, i.e., WY 2016
  - Telemetry was added to many diversion points for 2016
  - 15-minute data only
    - No QA/QC; obvious data gaps and bad values
  - Inflows (Mainstem, North Fork & Hansen Supply Canal)
  - Many, but not all, diversions

Data Used, cont.



Starting Point – Gage Data

- Logarithmic scale use to highlight differences
- Only part of year shown here

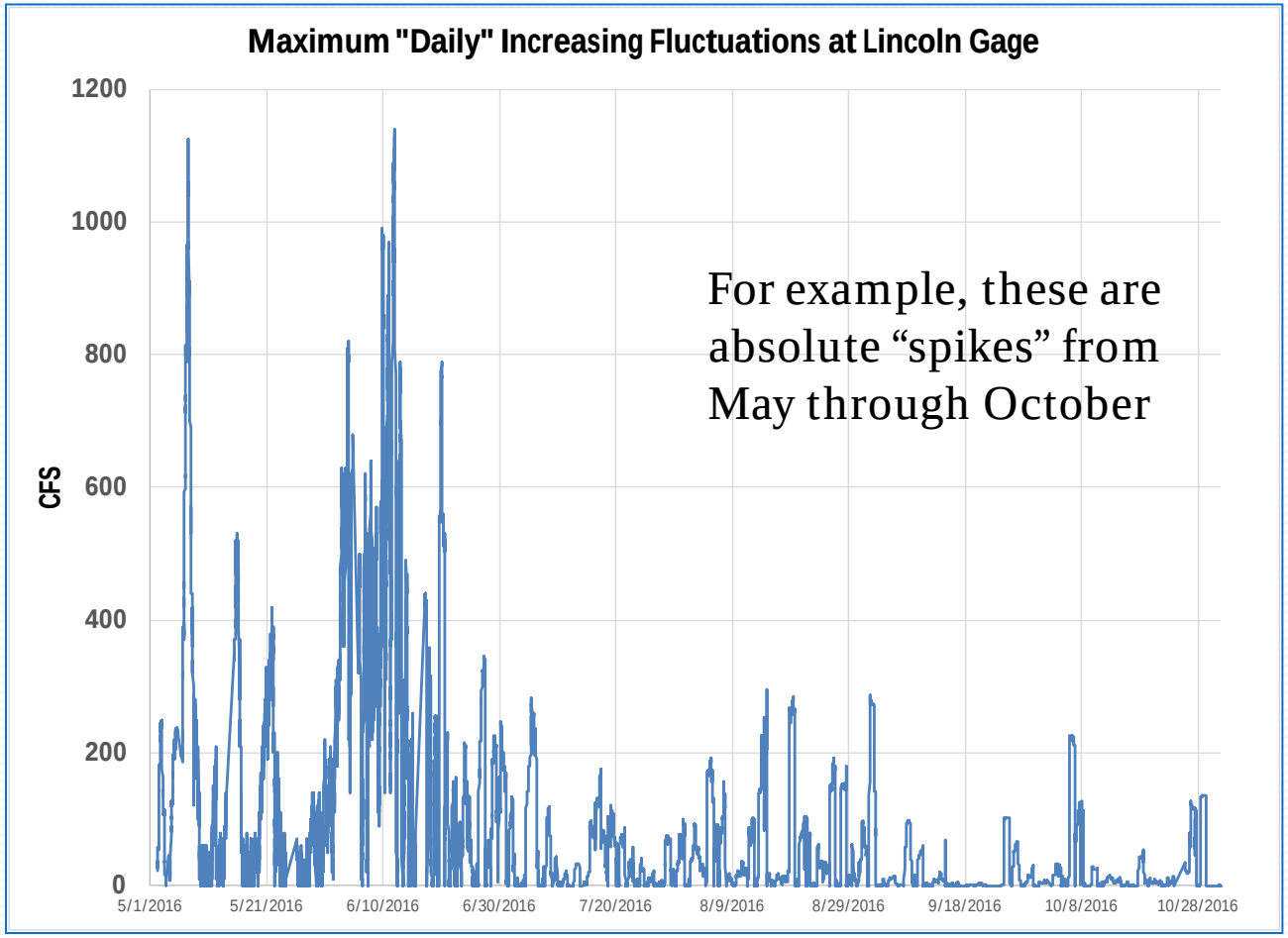


Approach

- Calculated the maximum positive or negative flow changes within 24-hours following each 15-minute data point
  - **Absolute**, i.e., maximum – minimum cfs, & vice-versa
  - **Percentage** (Relative) change in cfs
  - Each may have utility in exploring impacts
- Sampled largest transient events to identify major contributing factors

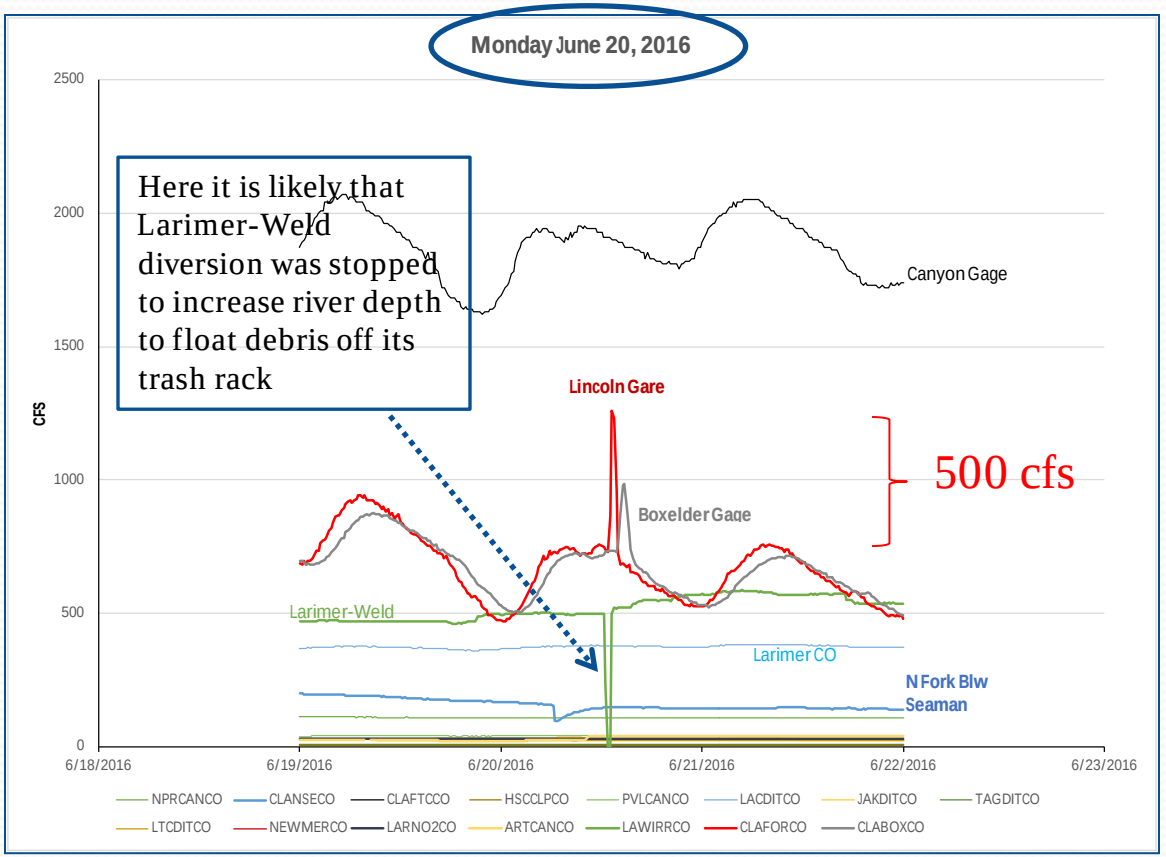
Selected Findings – 1

- Large transients, both absolute and percentage, occur year-round
- But <u>mostly</u> occur during the irrigation season, June through October



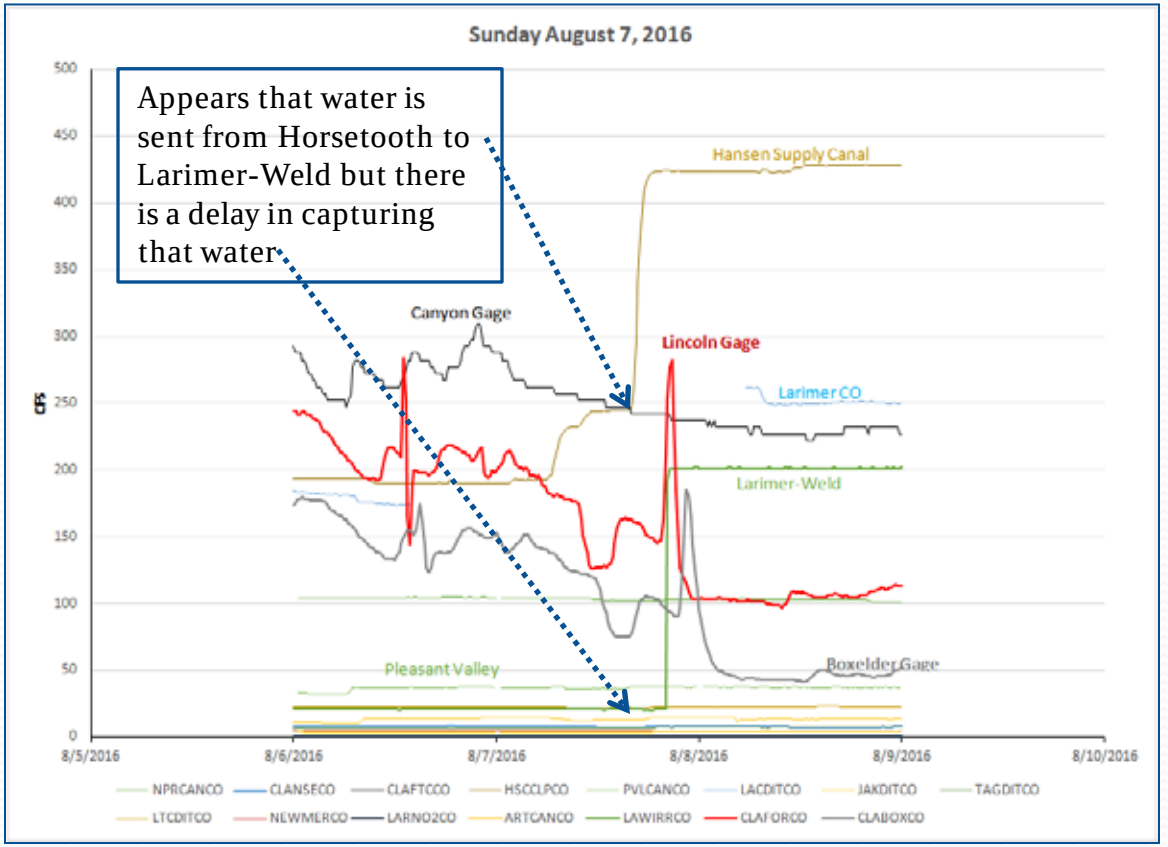
Selected Findings – 2

- Some events are straightforward resulting from day-to-day operations
- For example a canal headgate must be cleared or tended



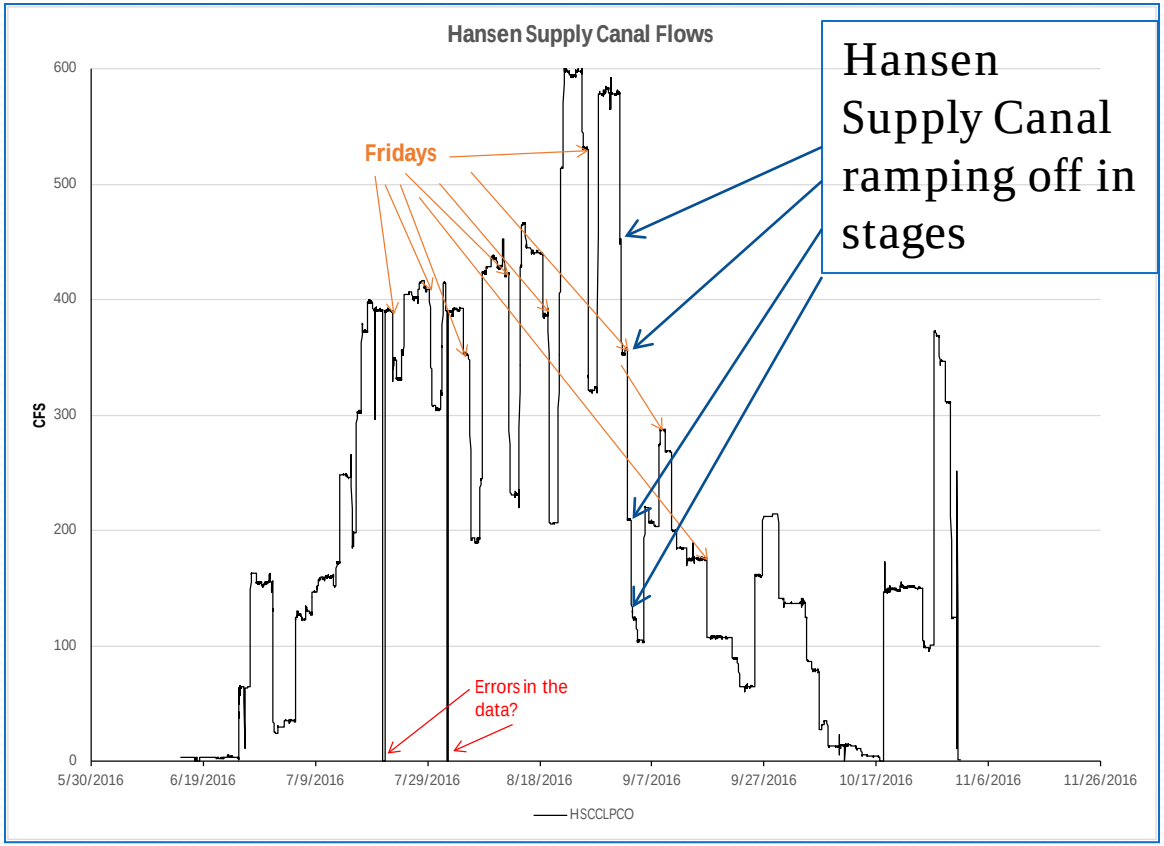
Selected Findings – 3

- Some events are more complex timing or coordination issues
- Commissioner prefers to see “bumps” rather than “holes”



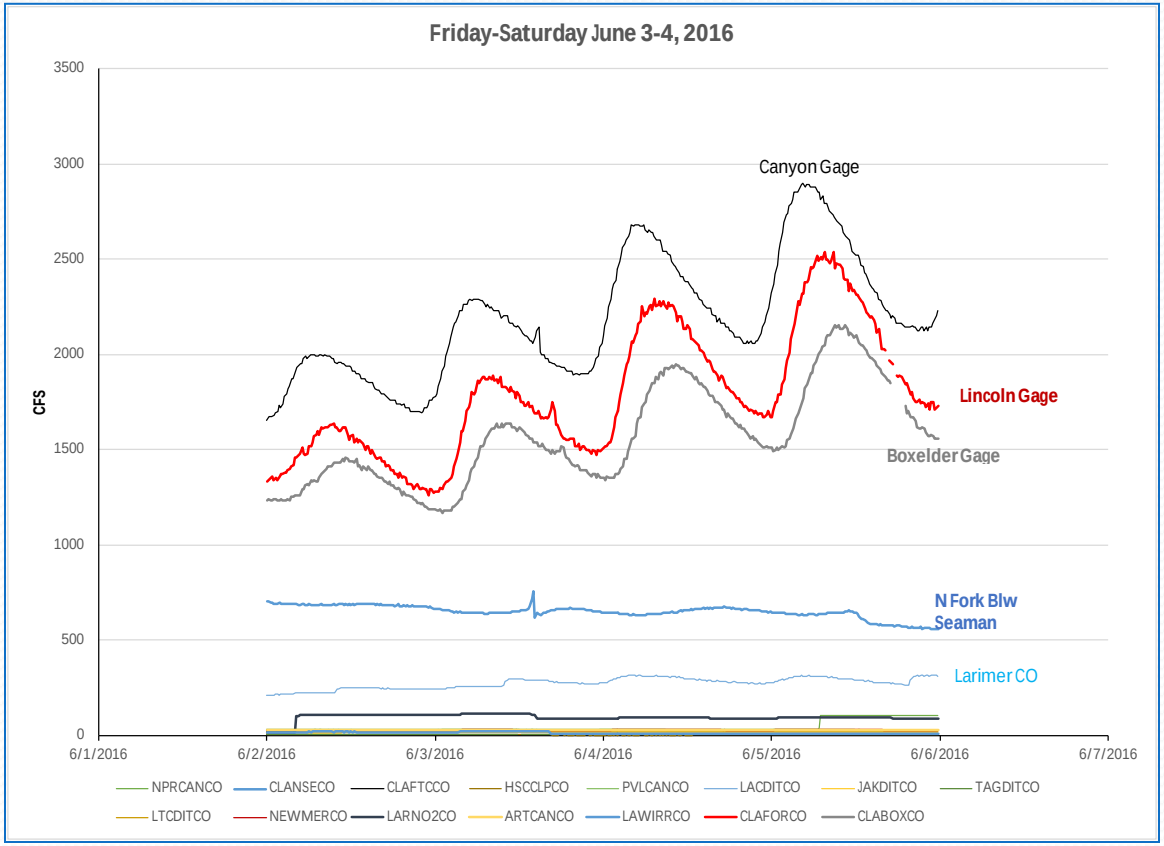
Selected Findings – 4

- Transients often observed Thursday to Monday
- Shown is a common 'shut-down' pattern – small Thursday drops followed by larger Friday drops



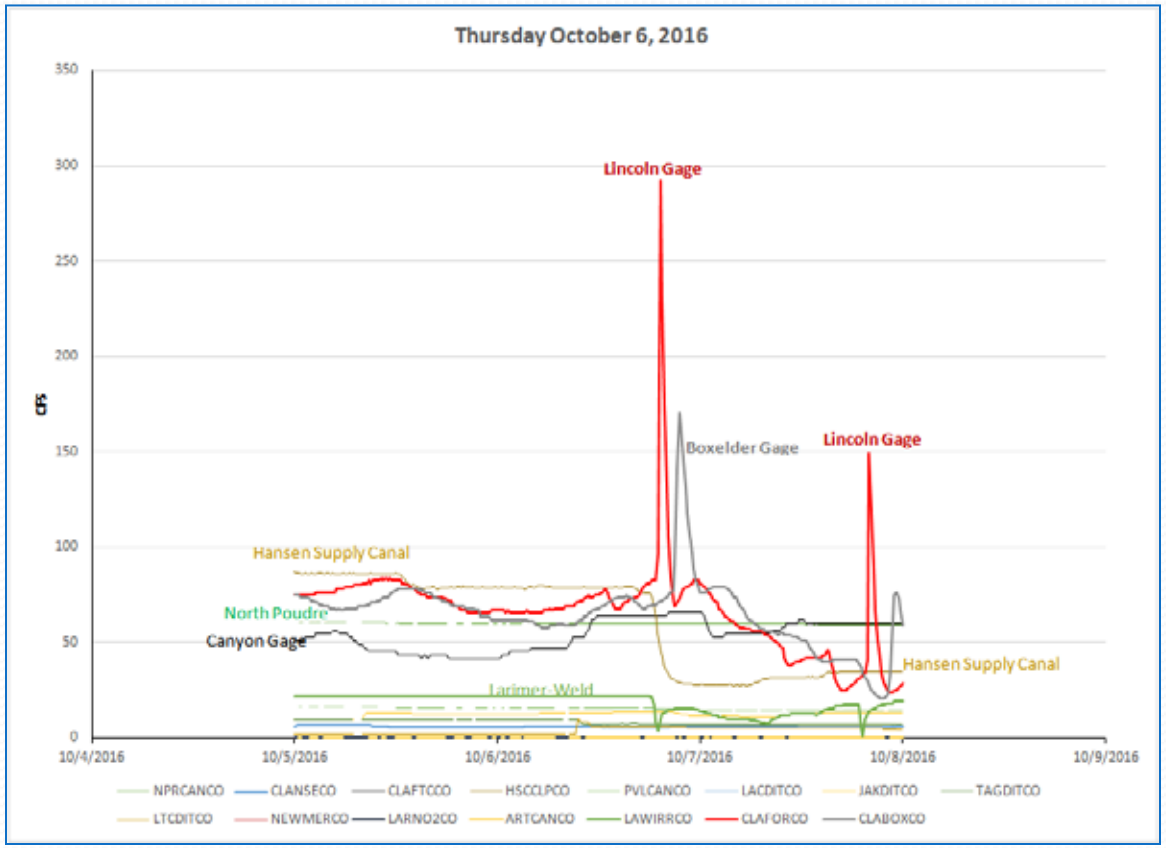
Selected Findings – 5

- Diurnal fluctuations during peak snowmelt can be large but are rarely abrupt
- Here we see ±400 cfs variation from a high daily mean flow



Selected Findings – 6

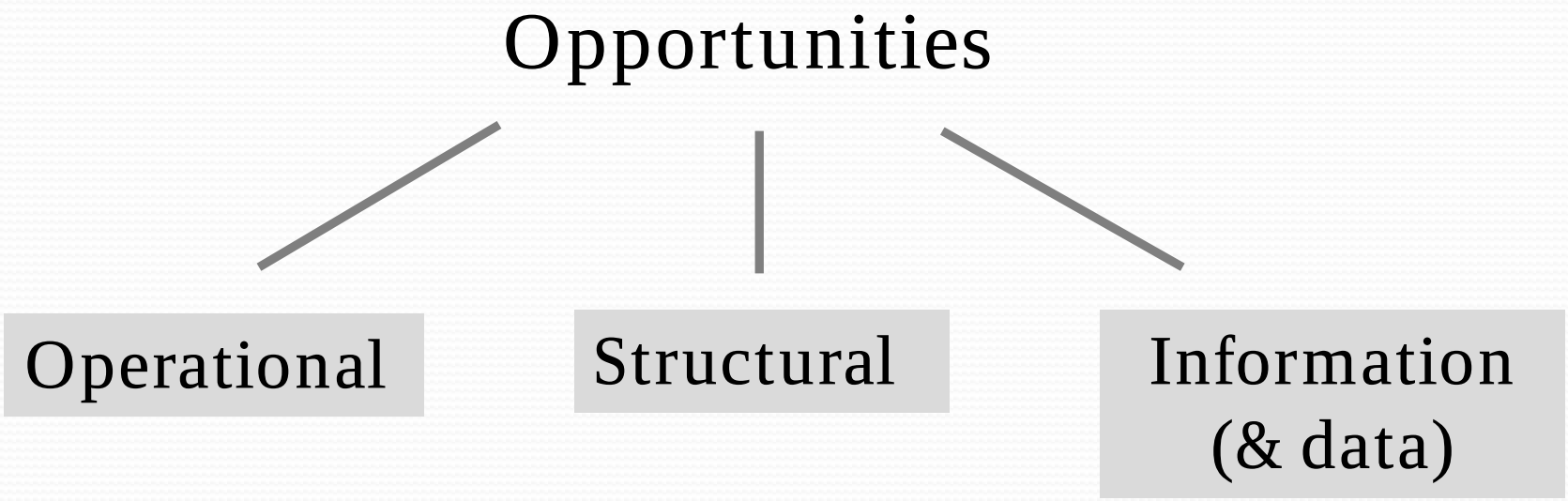
- Often no obvious explanation for magnitude of transients
- Could be rainfall, ice, bad or misleading gage data, …



Looking Ahead

- There may be fewer large transients in the future
  - C-BT deliveries to the Poudre will likely decline as downstream agricultural deliveries convert to upstream municipal withdrawals
- But if less water is in the river, there may be more large percentage flow changes from river operations
  - Less “buffering” capacity
- Time will tell

Brainstorming



Operational Opportunities - 1

- Meet with large diverters to better understand their operations, explore possibilities, and brainstorm incentives for all parties

- Potential operational examples:
  - Tweak the 'normal' Hansen ramping rate guidelines
  - Use more but smaller step changes when large flow changes are scheduled and automated receipt of water is, or becomes, possible

Operational Opportunities - 2

- If a weekly water users coordination conference should come to pass to discuss multiple objectives, keep transient issues in mind

- If new water development projects are built, explore possibilities to further minimize detrimental transients without injecting any new ones

Structural Opportunities

- Continue to look for funds to automate diversion headgates and maximize working-river coordination
- Continue to support Flows Initiative and fish passage retrofit since base flows help buffer large percentage flow changes and likely mitigate stranding
- Support redesign of large capacity headgates to minimize needs to abruptly “flush” debris from diversion pools

Information Needs - 1

- Continue to explore adding more real-time measurements to diversions
  - Though many have been added recently, many remain
  - Priorities are largest diversions and municipal intakes & outfalls
  - Data will benefit multiple objectives such as the Flow Augmentation Initiative
- Support local scientific studies that may shed light on the biological implications of abrupt flow fluctuations, e.g., fish movement

Information Needs - 2

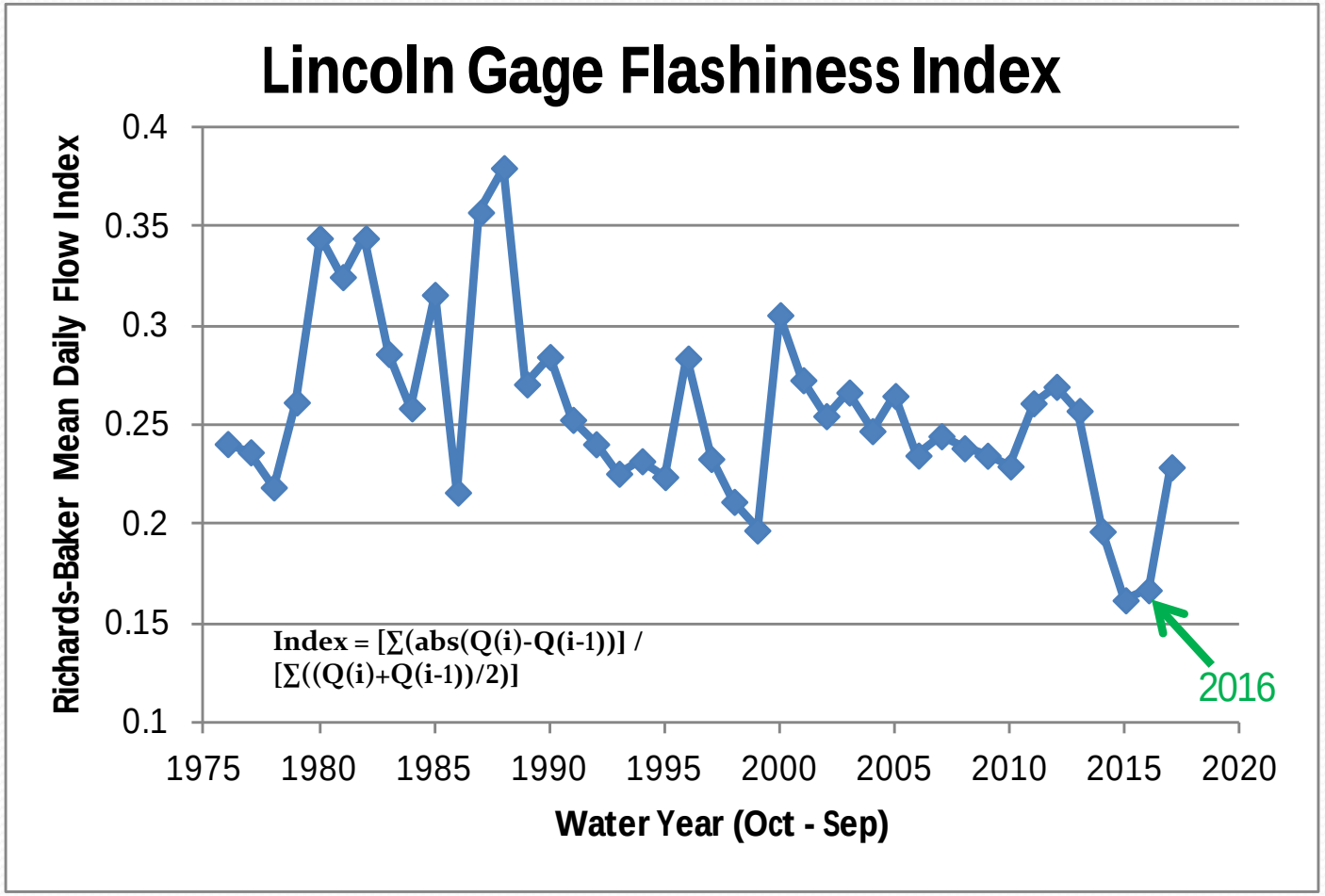
- For "educational" purposes only, consider Smartphone app to display real-time flow data with warnings on likely flow changes along the river
  - OWF oversee development with grant from Fort Collins
  - App could present other geo-referenced data
  - Must consider any liability issues

Caveats

- Existing operations system has been established over almost 150 years
  - Few incentives to change operations or infrastructure
  - Some reasons not to change:
    - Transit loss, expense, extra responsibilities, possible benefits of flow spikes

Data Limitation?

- Additional years of more complete data may reveal other issues and opportunities



Bob Milhous, personal communication, 2017

Progress Report Summary

- Identified at least some mechanisms causing large transient flow events
- Identified several potential opportunities
  - Operational
  - Structural
  - Information needs
  - Ranging from easy and inexpensive to harder, long-term and expensive
- More work to do!

Many Thanks To Many Advisors and Helpers:

Scott Hummer, Ken Kehmeier, Bob Milhous, Steve Malers, Andy Pineda, Jen Shanahan, Luke Shawcross, Mark Simpson, Kristin Swaim, Reagan Waskom, and Brad Wind