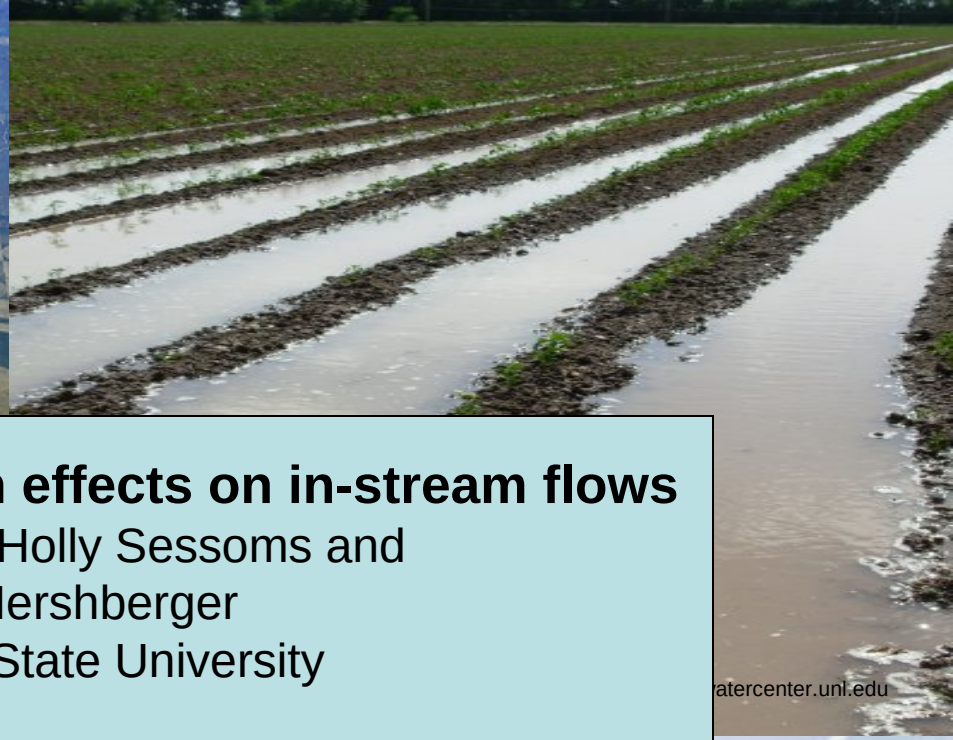


Ag water conservation effects on in-stream flows

Jim Bauder*, Holly Sessoms and
Kim Hershberger
Montana State University

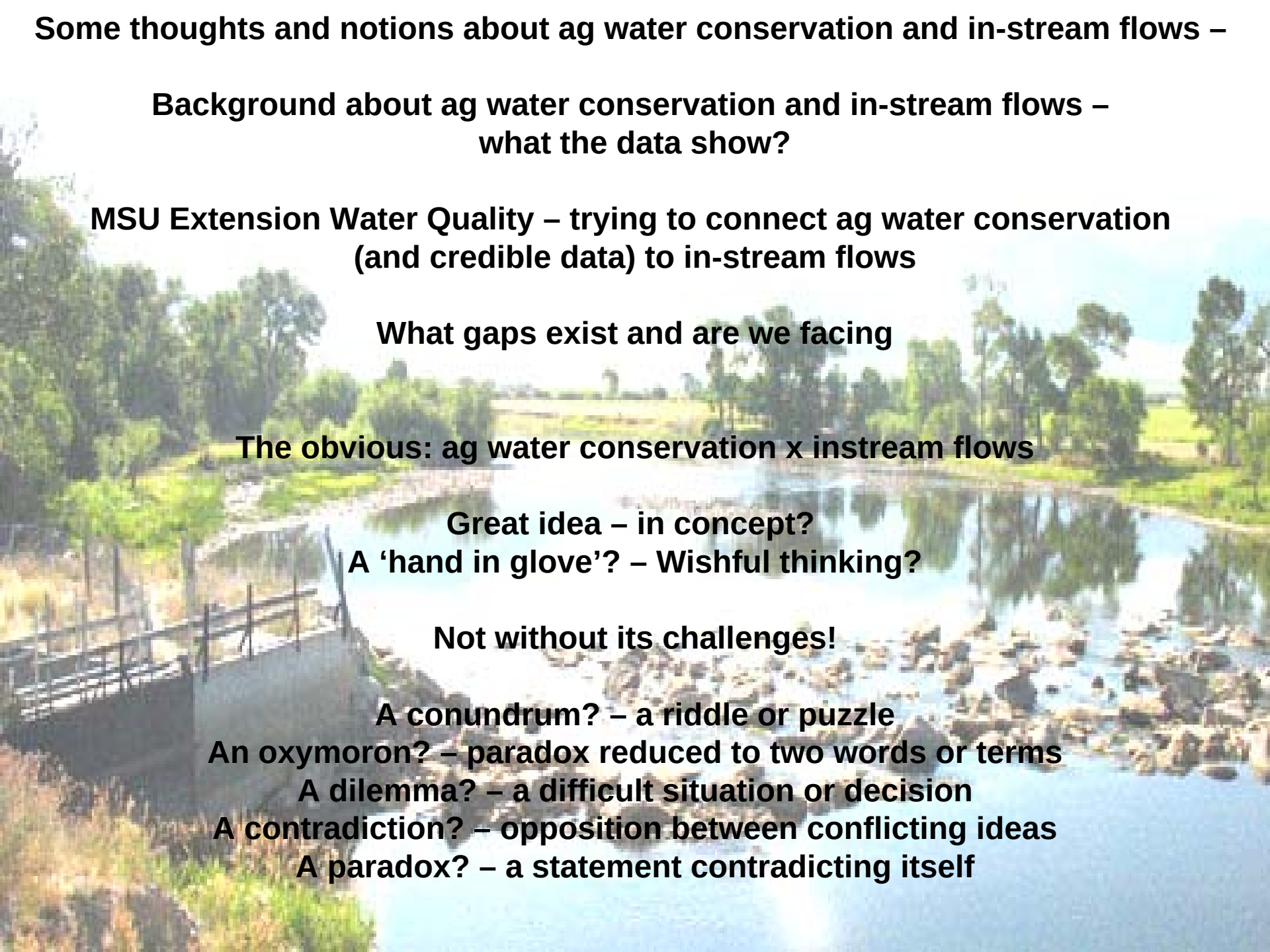
Northern Plains and Mountains Region
USDA-CSREES Regional Water Quality Team

How does agricultural water conservation relate to in-stream flows? Interesting question!

The premise
or assumption behind this question is that there is a documented corollary between agricultural water conservation and in-stream flows. It also assumes that there are functional mechanisms or (if necessary) motivators, regulations, policy implementations applied to agricultural water users (irrigator), and which will result in conservation of water.

Here's how it's gonna happen!

Just one more!



Some thoughts and notions about ag water conservation and in-stream flows –

Background about ag water conservation and in-stream flows – what the data show?

MSU Extension Water Quality – trying to connect ag water conservation (and credible data) to in-stream flows

What gaps exist and are we facing

The obvious: ag water conservation x instream flows

Great idea – in concept?
A 'hand in glove'? – Wishful thinking?

Not without its challenges!

A conundrum? – a riddle or puzzle
An oxymoron? – paradox reduced to two words or terms
A dilemma? – a difficult situation or decision
A contradiction? – opposition between conflicting ideas
A paradox? – a statement contradicting itself

Scheierling, Young, and Cardon, 2004. CSU. *Can farm irrigation technology subsidies effect real water conservation?*

"With **irrigated agriculture** being by far **the largest and often lowest-valued water use**, efforts are increasingly undertaken to **encourage agricultural water conservation** with the aim of transferring some water to higher-valued uses *(including in-stream flows)* and improving the economic efficiency of water resource allocation."

"Adopting **improved on-farm irrigation technologies** is often cited as one potential approach for farmers **to conserve water** while **maintaining yield levels with little or no loss of income**."

Question: Does 'conserving water' mean more in-stream flow?

How? …**by subsidizing irrigation technology transitions.**

(the obvious question: does technology make a difference?)

The authors make reference to the USDA-NRCS EQIP, focused on **financial assistance for installation of improved irrigation technologies** such as sprinklers (NRCS 2003).

(But, does conversion to sprinklers result in 'more' water in-stream?)

Most financial assistance is **directed toward irrigators** and is generally **focused on on-farm irrigation water conservation** and various creative mechanisms for financing such approaches.

Fact is: many of us knowledgeable about irrigation have tried numerous approaches to bring about additional on-farm agricultural water conservation.

(Agricultural practitioners are one of our audiences!)

(the obvious question: does technology make a difference?)
(if so, then what technologies? where? how?)
(the obvious question: will irrigators conserve water?)

The Good News – Bad News story might go something like this:

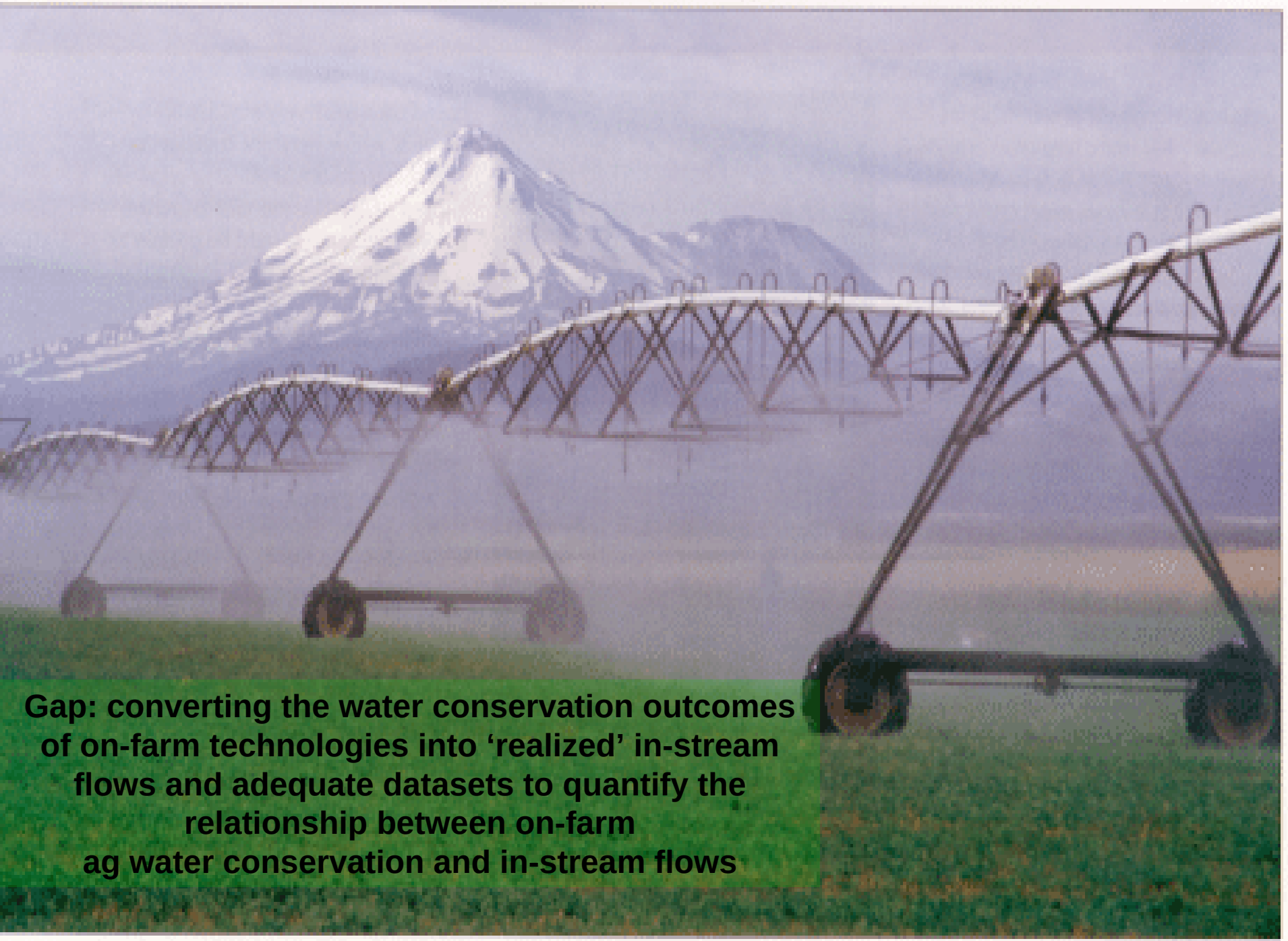
"A few analysts have questioned the conservation potential of improved irrigation technologies …. "

"Even if improved **on-farm irrigation efficiency** leads to reduced withdrawals and deliveries, consumptive use may not decrease — it may even increase, especially if the irrigated area can be expanded. In addition, at the river basin level the magnitude and/or timing of return flows may be changed, negatively impacting water users who depend on them."

Scheierling, Young, and Cardon, 2004. CSU. *Can farm irrigation technology Subsidies effect real water conservation?*

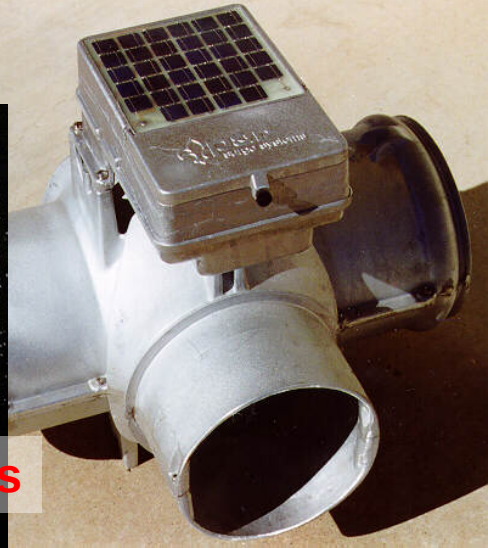
"… direct subsidies do not provide incentive to decrease the number of irrigations, shift to less water-consuming crops, or reduce the acreage irrigated; **subsidies appear unlikely to diminish consumptive use … In fact, consumptive use may rise — even without an accompanying expansion in irrigated area —,** when yield levels can be profitably increased by applying additional numbers of irrigations. Thus, in a basinwide context, the subsidy approach to on-farm technology is limited in its water conservation potential.

Unless…


Gap: converting the water conservation outcomes of on-farm technologies into ‘realized’ in-stream flows and adequate datasets to quantify the relationship between on-farm ag water conservation and in-stream flows

There are several venues besides equipment technology (subsidized or not) which afford opportunity to realize either improved irrigation management or ag water conservation.

Irrigator x water management technology – **AGRIMET** (**WA, ID, OR, MT**)
WASHINGTON IRRIGATION SCHEDULING EXPERT (**WISE)** SOFTWARE
Computer Software for Irrigation Scheduling (**CA**)
***Minnesota/Wisconsin* Engineering Notes** - Irrigation Scheduling Software
Irrigation Scheduling With Atmometers (**CO**)
Co-Agmet Irrigation Scheduling (**CO**)
Irrigation Scheduling Checkbook Method (**ND**)
Arizona Irrigation Scheduling System (**AZSCHED**)



Equipment-intense technology for irrigators

The obvious question: is connecting with the irrigator the most effective means?
And, will conservation at the irrigated field level lead to in-stream flow changes?

At the watershed, basin, irrigation district level
At the water resource manager level
At the permitting level

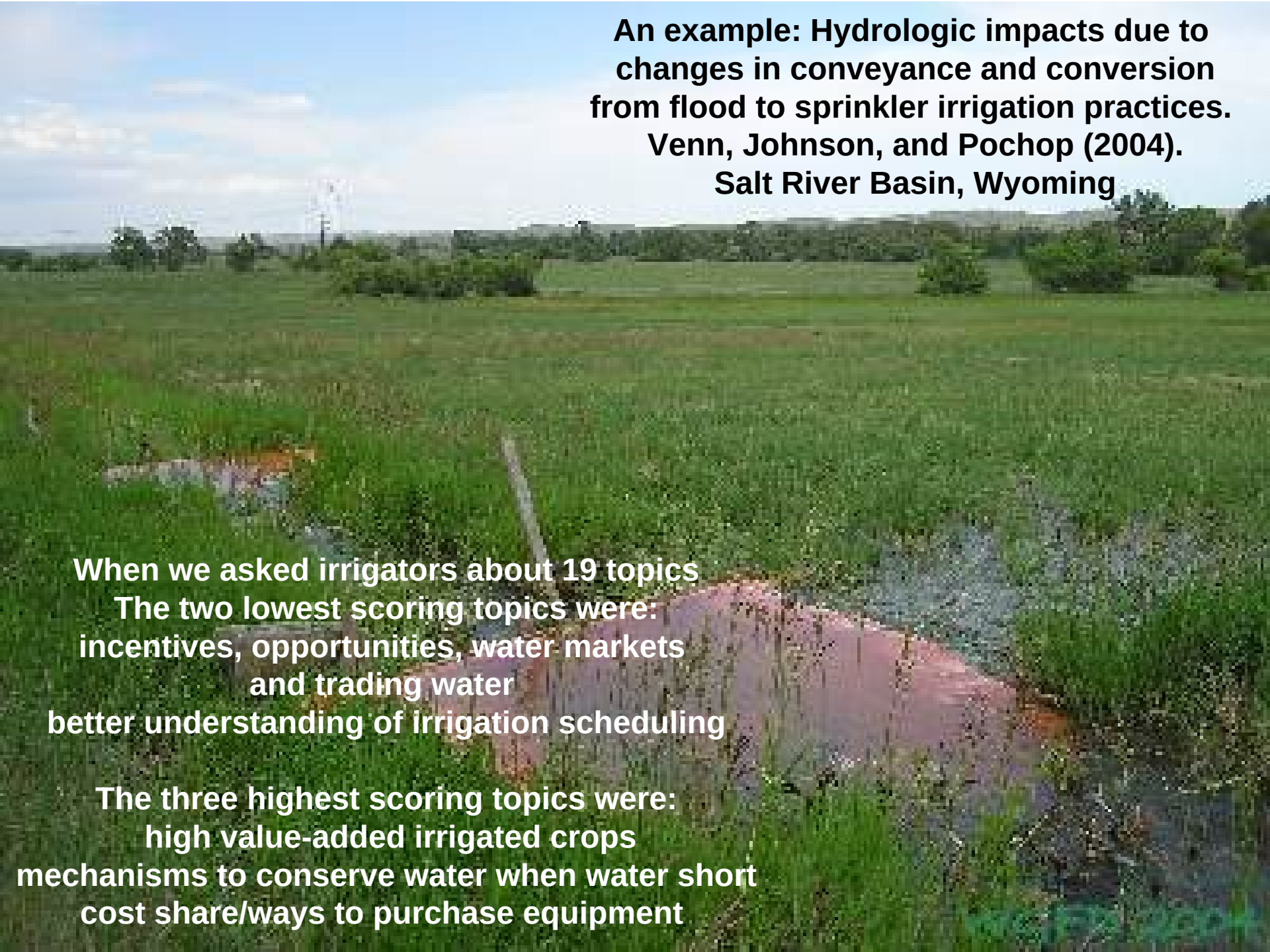
"….. **only if consumption is reduced**
will any basinwide *real* conservation be achieved."
Scheierling et al. (2004)

(Obvious question: So how does one orchestrate basin-wide conservation?)

Greek mythology says "… cut the head off of the snake."

Which translates into – control the deliveries – such as court-ordered or negotiated approaches.

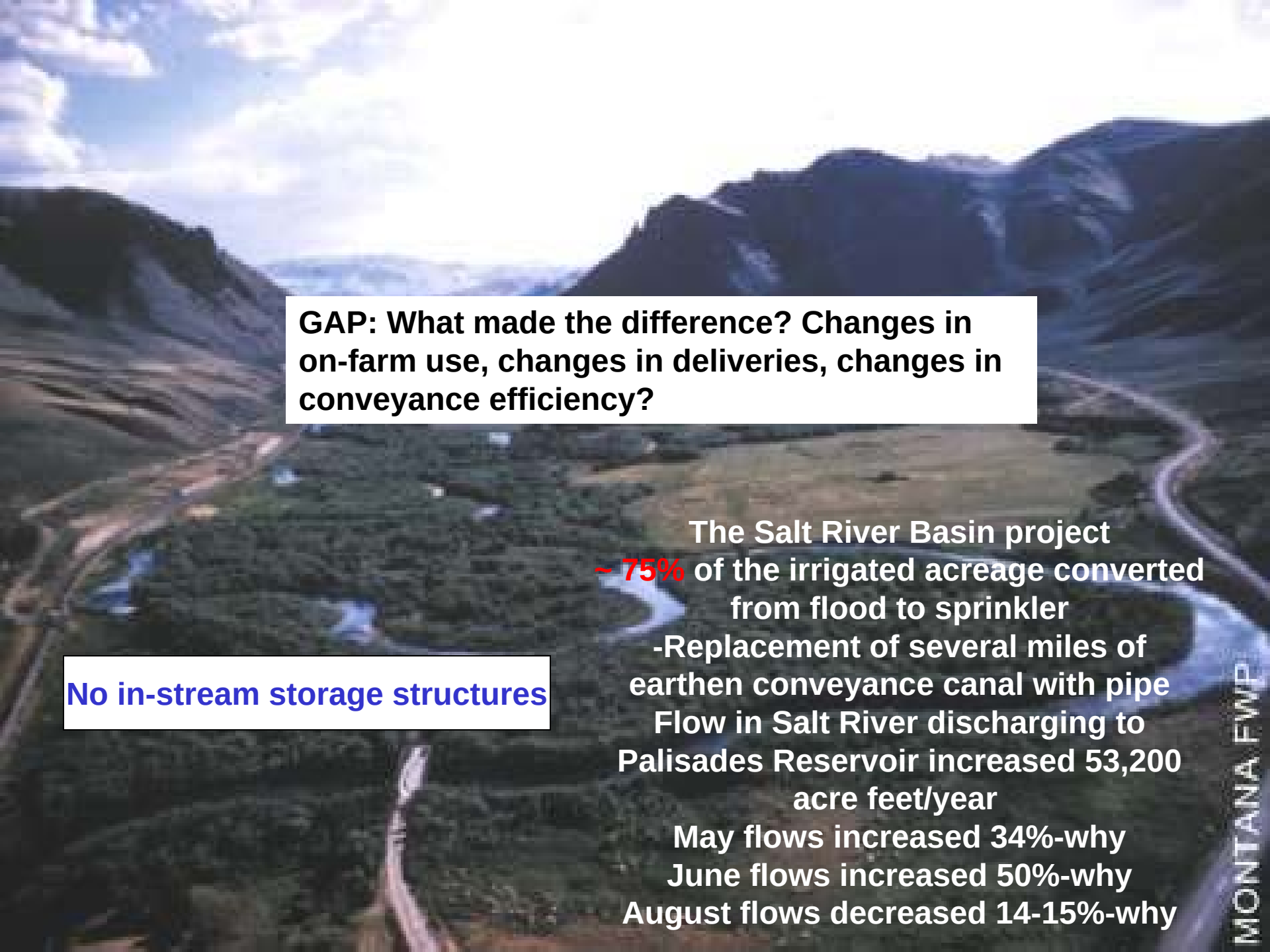
For example…initiate basin-wide conservation measures and actions!



An example: Hydrologic impacts due to changes in conveyance and conversion from flood to sprinkler irrigation practices. Venn, Johnson, and Pochop (2004). Salt River Basin, Wyoming

When we asked irrigators about 19 topics
The two lowest scoring topics were:
incentives, opportunities, water markets and trading water
better understanding of irrigation scheduling

The three highest scoring topics were:
high value-added irrigated crops
mechanisms to conserve water when water short
cost share/ways to purchase equipment

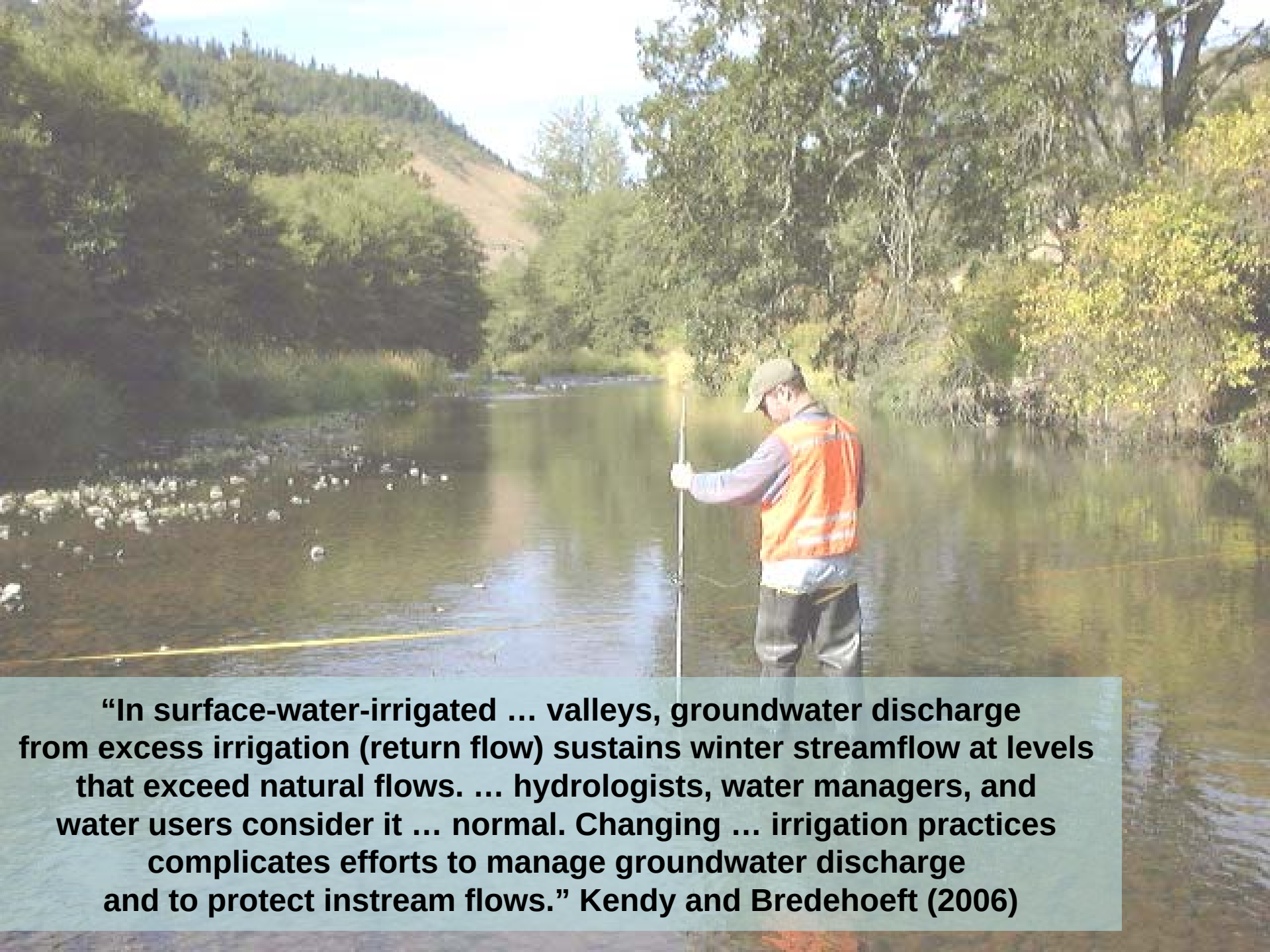


GAP: What made the difference? Changes in on-farm use, changes in deliveries, changes in conveyance efficiency?

No in-stream storage structures

The Salt River Basin project
~ 75% of the irrigated acreage converted from flood to sprinkler
-Replacement of several miles of earthen conveyance canal with pipe
Flow in Salt River discharging to Palisades Reservoir increased 53,200 acre feet/year
May flows increased 34%-why
June flows increased 50%-why
August flows decreased 14-15%-why

MONTANA FWP



“In surface-water-irrigated … valleys, groundwater discharge from excess irrigation (return flow) sustains winter streamflow at levels that exceed natural flows. … hydrologists, water managers, and water users consider it … normal. Changing … irrigation practices complicates efforts to manage groundwater discharge and to protect instream flows.” Kendy and Bredehoeft (2006)

"… increasing irrigation efficiency has implications beyond simply reducing diversions. Improving irrigation efficiency reduces fall and winter flows… However, existing water users and aquatic ecosystems may rely upon return flows from inefficient irrigation systems." Kendy and Bredehoeft (2006).

At the water resource manager level
At the contracting or permitting level
At the responsible party level

Clark Canyon Contract **Renewal.** The **Bureau** of **Reclamation** … renew or convert the water service contracts with the East Bench Irrigation District and the **Clark Canyon** Water Supply Company in accordance with the Act of July 2, 1956, entitled "Administration of Contracts Under Section 9, **Reclamation** Project Act of 1939." The contracts will provide a continued water supply from the East Bench Unit of the Pick-Sloan Missouri Basin Program.

HELENA, Mont. -- The **Bureau** of **Reclamation** has scheduled public scoping sessions … pertaining to proposed **renewal** of long-term water contracts with Helena Valley Irrigation District, **Toston** Irrigation District, and City of Helena .


The GAP! Having the right data to know what basin or district-level irrigation water management decision or action makes a difference with respect to in-stream flows.
GAP: Having credible, convincing data that can be used as a basis for negotiations, mitigations.
Ian Parker 06

Working at the district manager and water contract level


Muddy Creek/Sun River

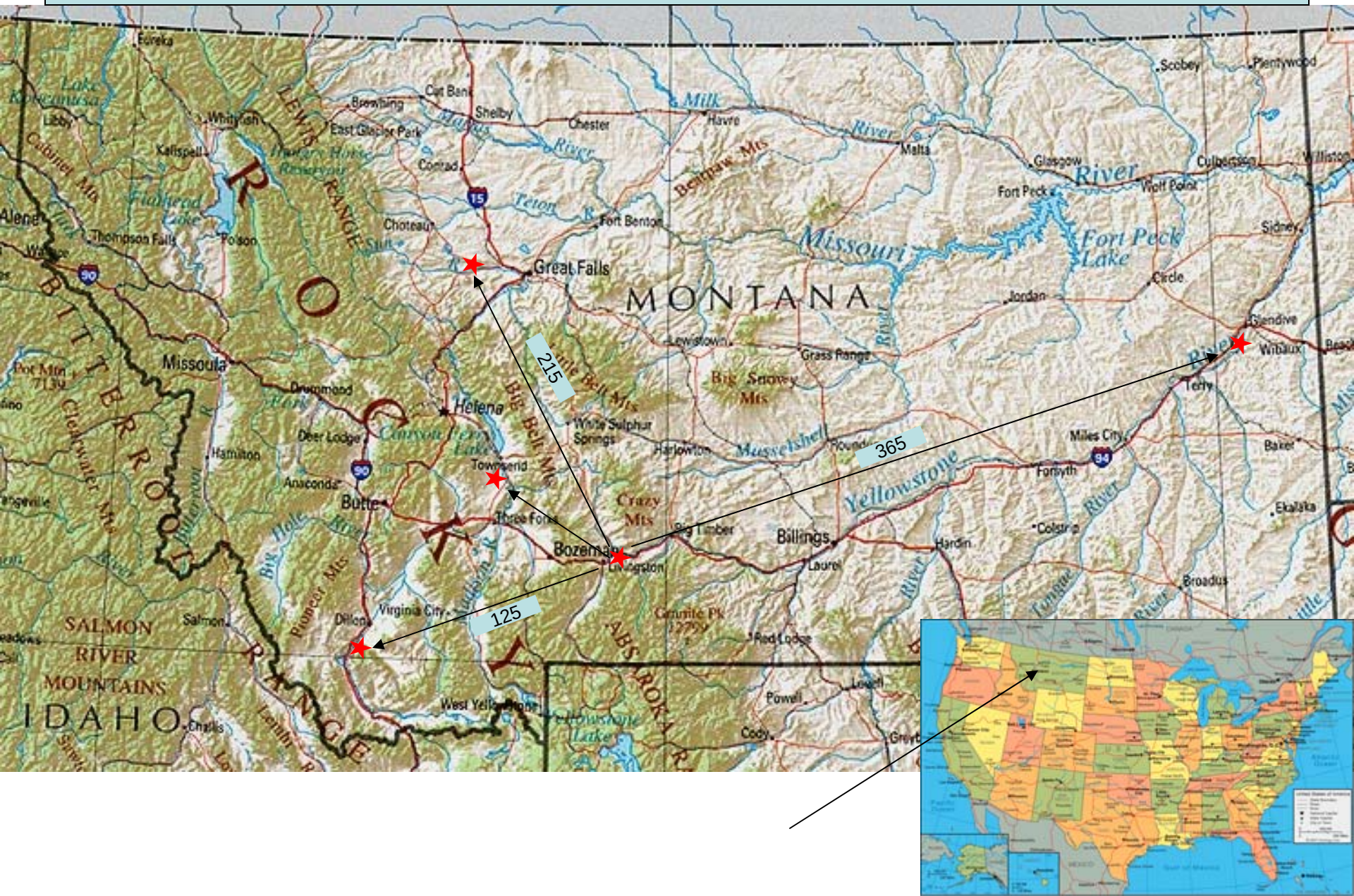

Upper Missour River

Our partners – USDI Bureau of Reclamation, Upper Missouri
USDA- NRCS Water Quality Specialist/program
Sun River Watershed Group
Buffalo Rapids Irrigation District – 22,719 acres
Toston/Crow Creek Irrigation District – 18,000
Greenfields Irrigation District/Muddy Creek – 81,000
Clark Canyon and East Bench Irrigation Districts – 28,000, 21,800 acres


Yellowstone River


Beaverhead River

Upper Missouri River watershed above confluence with Yellowstone River



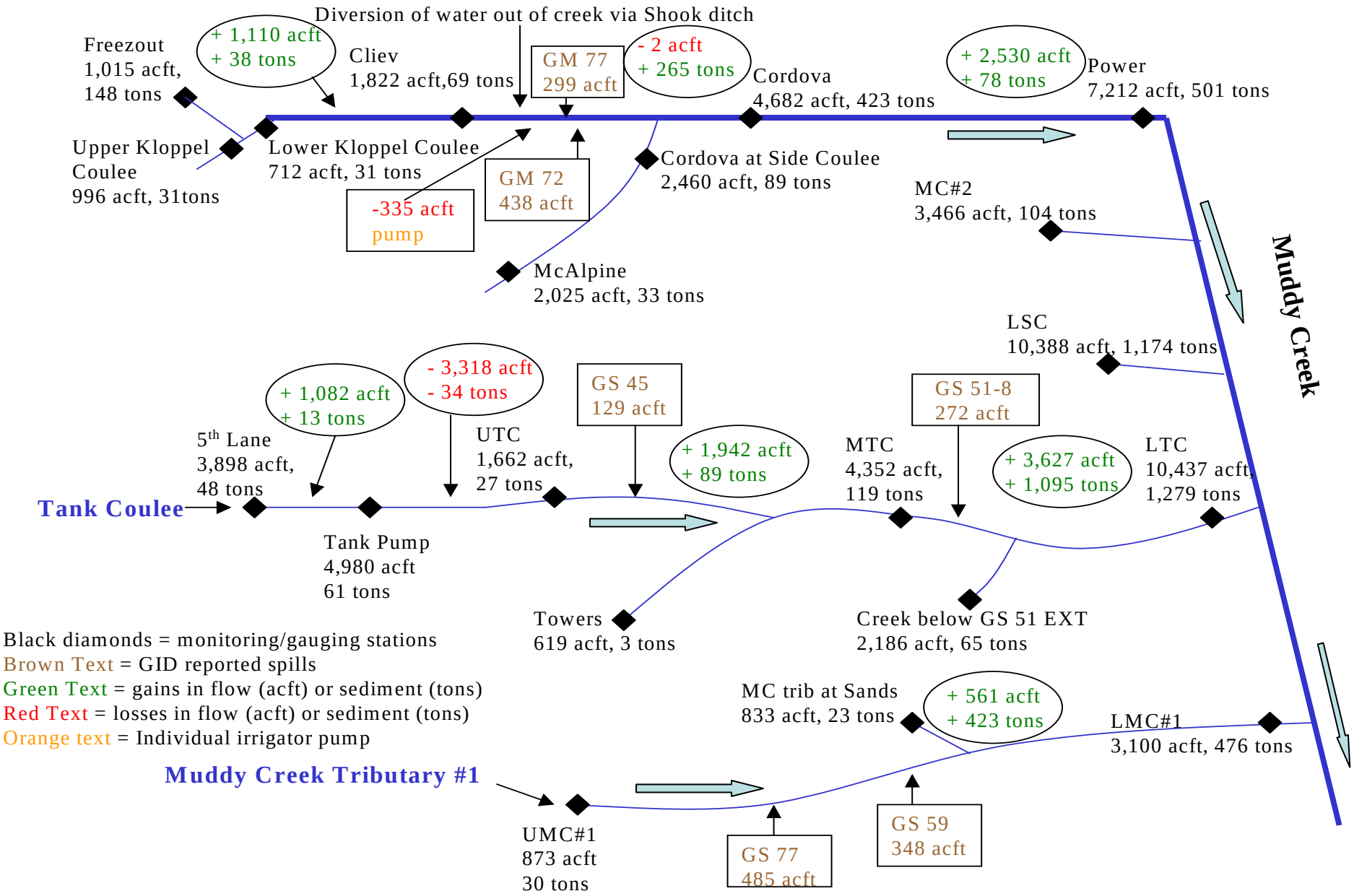
Muddy Creek Project – conflict between recreationists, fisheries, irrigation districts, DEQ

- Muddy Creek is a tributary of the Sun River, located in north-central Montana (Missouri River headwaters).
- The Sun River often has impaired flows during the summer, while Muddy Creek has excessive flows…often daily flows in Muddy Creek are greater than daily flows in the Sun River during summer irrigation months.
- In the past, 80% of Sun River sediment load came from Muddy Creek, though it only makes up 17% of watershed.
- In the 60's sediment transport exceeded 600,000 tons a year.
- Through data-driven water management and changes in operations, sediment has been reduced to 30,000 tons a year.

Where MSU comes in…..
Developing a ‘decisioning-tool’ database

- Identify and quantify flow contributions to Muddy Creek from irrigation project operational spillage and farm field sources, which include irrigation return flow and seepage.
- Quantify amounts of flow and sediment contributed by each irrigation-fed tributary to Muddy Creek.
- Determine and define relationships between Muddy Creek and tributary discharges and sediment – in terms of concentration and total sediment load within Muddy Creek.

Muddy Creek sediment x water quantity budget



Outcomes/Impacts/Needs

- **MSU continues to provide critical water conservation management decisioning information for water distribution regulators and water delivery contractors.**
- **Sun River Watershed coordinator: "… as a result of the studies the watershed group knows where their problems are. They are no longer spending time working on areas they can't control."**
- **Greenfield's Irrigation District manager: "… it has made us more conscious of day to day water delivery activities and has prompted us to investigate and implement projects that will help reduce flows in Muddy Creek". Projects include J- lake, pump-backs, ditch lining, and updated gate automation electronics.**
- **Efforts are still needed on-farm…need to concentrate on farming practices and education to reduce return flows.**

Beaverhead River

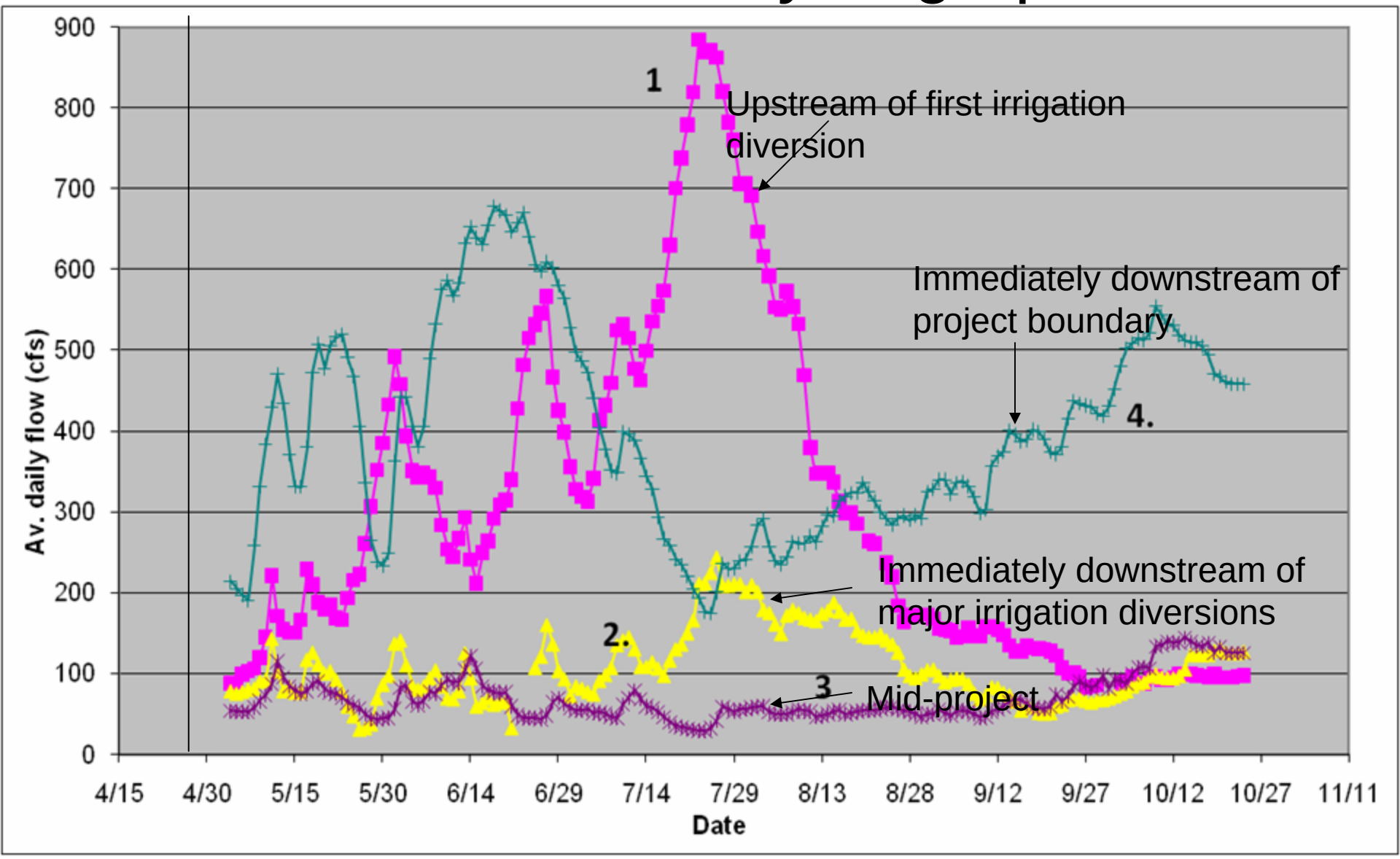
- Conflict between irrigators and recreationists (fisher-persons)
- “Blue Ribbon” trout stream
- Chronically dewatered (MT FWP, 2005)
- Clark Canyon Water Supply Co. – 4 ac-ft/acre for 26,000 acres
- East Bench Irrigation District – 3.1 ac-ft/acre for 22,689 acres
- Bureau of Reclamation Contract renewal in 2006
- Drought

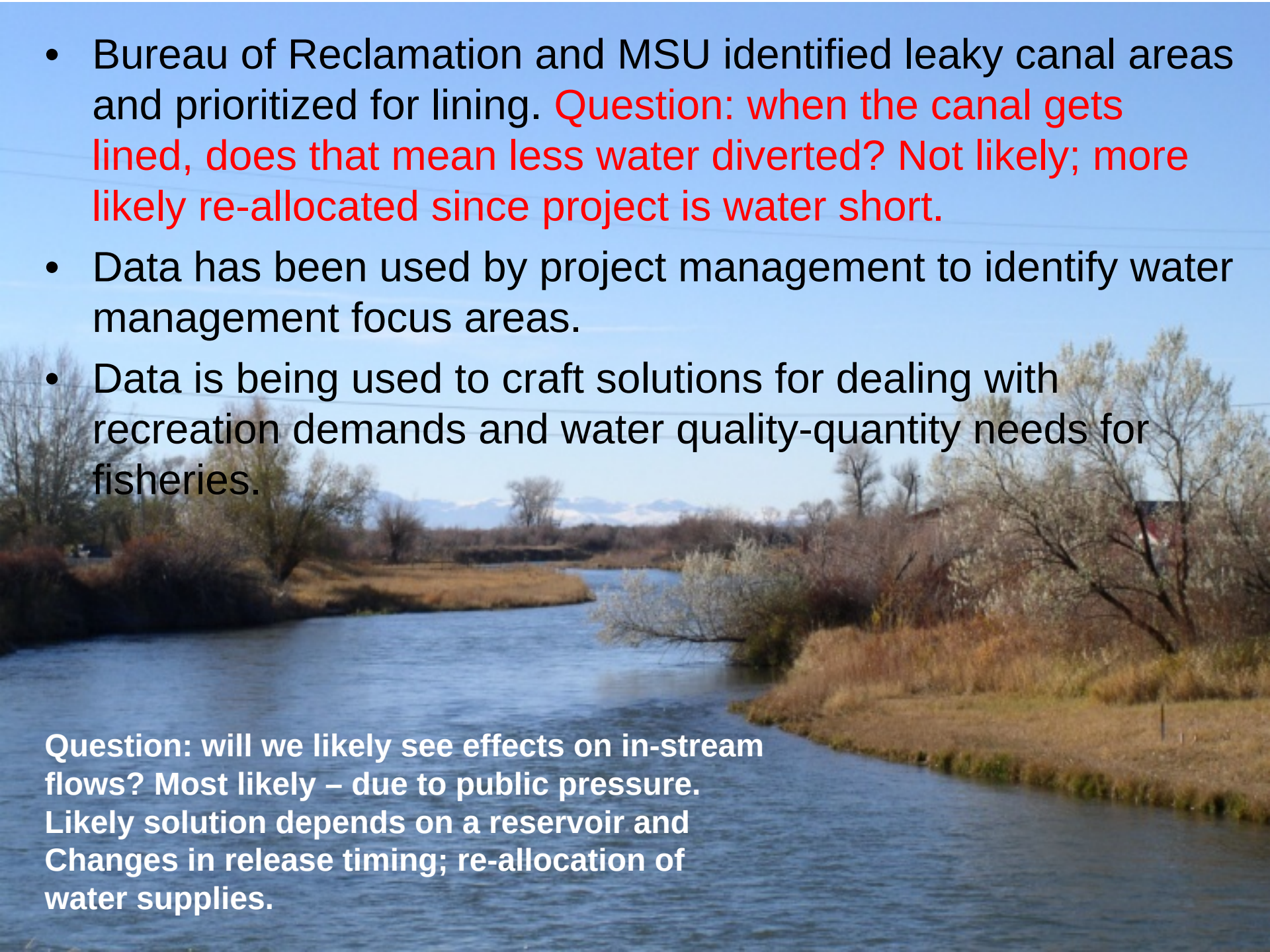
MSU role – defining appropriate data collection protocols, providing objective, credible decision-making data sets to water managers, transferring water quantity analyses and measurement technology to irrigators, district.

Water quantity data sets (district-wide water budgets)

- As many as 34 diversions, return flows and major tributaries monitored for flow, May through October

Beaverhead hydrographs





- Bureau of Reclamation and MSU identified leaky canal areas and prioritized for lining. Question: when the canal gets lined, does that mean less water diverted? Not likely; more likely re-allocated since project is water short.
- Data has been used by project management to identify water management focus areas.
- Data is being used to craft solutions for dealing with recreation demands and water quality-quantity needs for fisheries.

Question: will we likely see effects on in-stream flows? Most likely – due to public pressure. Likely solution depends on a reservoir and Changes in release timing; re-allocation of water supplies.

“While improvements in irrigation efficiency are well documented when changing from flood to sprinkler irrigation, impacts to the watershed are not well known …”

What we learned – more questions formulated than questions answered. We do have credible data detailing irrigation project water budgets and allocations. But….

Gaps – in data, knowledge, tools

- **Data:** Comprehensive, consistent, comparable pre- and post- implementation basin-wide and/or district-wide irrigation project water resources datasets, i.e., who much, when, where, what circumstances. (We're playing catch-up!)
- **Data:** Which technologies are the most effective with respect to ag water conservation and which will translate into in-stream flow benefits? Quantified and prioritized.
- **Data:** Convincing, credible, adequate user-friendly datasets to quantify the relationship between on-farm ag water conservation and in-stream flows. How will added technology to conserve water affect in-stream hydrology?
- **Tools:** Models for assessing and predicting the in-stream flow consequences of ag water conservation practices and technologies.
- **Tools:** Methods for converting the water conservation outcomes of on-farm technologies into 'realized' in-stream flows
- **Tools:** Models, policies, strategies, and approaches to orchestrate basin-wide ag water conservation.

Gap: Which Extension/research/education audience can, does, and will have the most influence on ag water conservation – and which will translate into desirable/favorable impacts on in-stream water flow?

Gap: As water quality specialists, how do we best serve those audiences – in extension, education, and research?

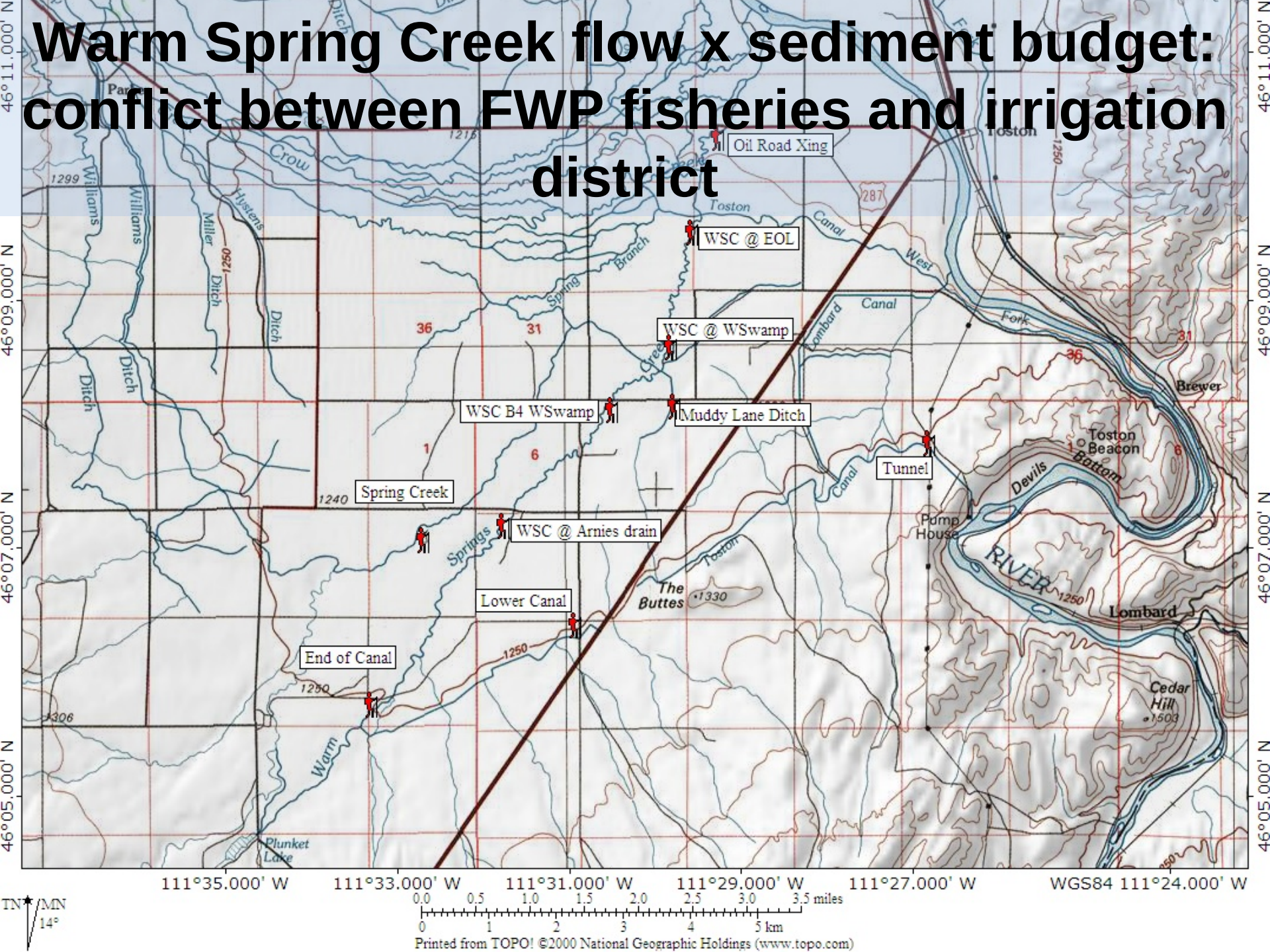
Gap: The appropriate mechanisms to convince or leverage ag water users to conserve – and which can be translated into desirable/ favorable impacts on in-stream water flow.

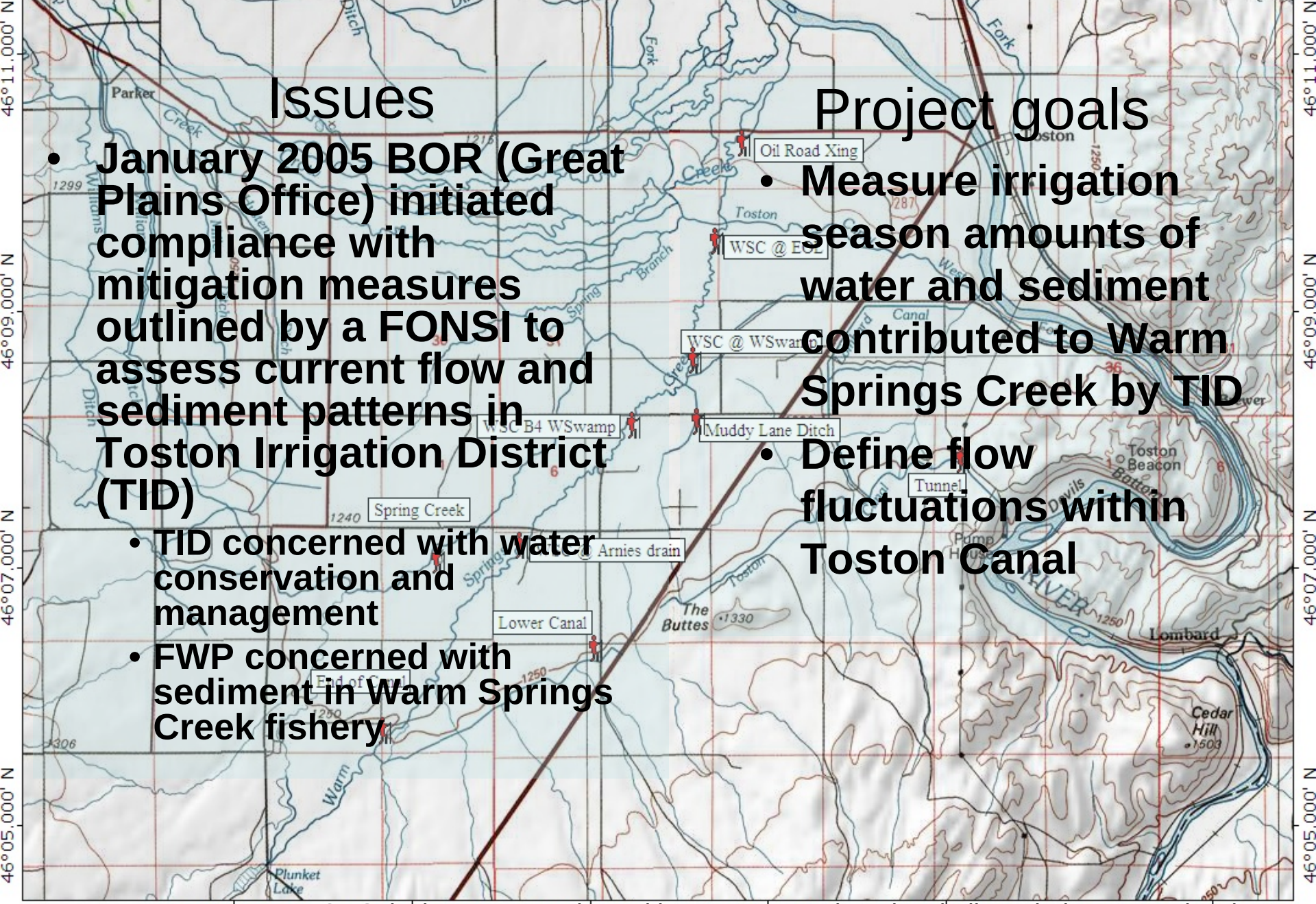
October 29, 2007

You may have been hearing about the drought in the Southeast, which has intensified the long-standing battle over water rights between Georgia, Alabama and Florida. Georgia's governor ordered **utilities and public water systems to reduce consumption by 10 percent** amid the state's worst drought in almost a century.

California is facing similar strains on its water resources, from an eight-year drought on the Colorado River to a judge's order that will reduce water deliveries to southern California in December to protect threatened fish in the Sacramento Delta.

Warm Spring Creek flow x sediment budget: conflict between FWP fisheries and irrigation district





A FONSI is the statement issued by an agency when they believe their proposed action will have no significant effect on the existing environment. This finding allows for a level of environmental analysis less rigorous than an EIS (ie EA).

What we found…

- Majority of water diverted from Missouri River into Toston Canal is diverted from the canal along the upper reaches of the district – where it is used.
- TID is not a major source of sediment, but it is a contributor of flows in WSC via operational spills.
- Greater seasonal flow and large fluctuations at EOL are due to off-project contributions to WSC, TID return flow and precipitation events respectively.
- A trend of increasing sediment after WSC leaves TID is seen regardless of irrigation.
- Increasing sediment loads downstream are likely a result of changing soil types, wildlife activity and livestock access, not irrigation practices.
- During irrigation, the diversion dam at Willow Swamp Canal acts as a sediment sink, trapping a majority of sediment.

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Outcomes…

On-the-ground solutions:

- Modifications to pumping plant to refine water delivery.
- TID constructed detention pond to reduce flow fluctuations in WSC and reserve diverted water for on-project use.

Suggested BMP's:

- establish vegetative buffer strips
- reclaim riparian areas
- limit livestock stream access

Post-project survey results:

- 100% would be willing to participate in a follow-up project with MSU in 3-5 years to assess any change in condition of WSC as a result of the project.
- 75% saw a difference in flow or sediment loads in WSC.
- 80% interested in attending seminars or information sessions about current irrigation management topics and learning what other districts are doing.

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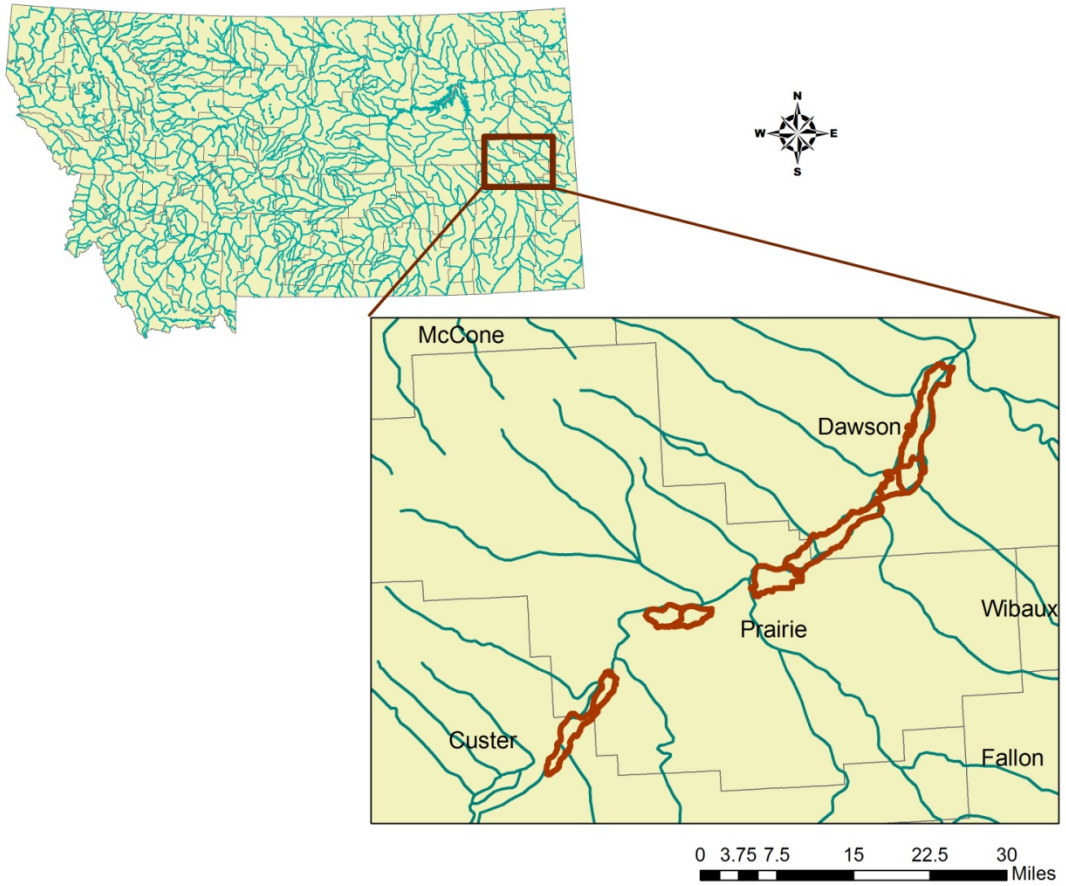
Buffalo Rapids Irrigation Project

- Floodplain, terraces, alluvial fans of Yellowstone River valley
- 22,719 irrigated acres
- 12”-15” precip. per year
- 62 miles canal, 96 miles of laterals, primarily earthen
- 115 miles of drains



Issues

- **Impaired water quality in Yellowstone River and shallow groundwater**
  - **~ 70% of project soils have high leaching potential**
  - **Lower Yellowstone on 1998 303d list (aquatic life support, drinking water supply, recreation, swimming, warm water fishery)**
- **Less than optimum irrigation water management**
  - **10-20% crop reduction from limited water supplies**
- **Excessive irrigation induced erosion on irrigated cropland**
  - **Furrow erosion well in excess of soil loss tolerance**
- (Buffalo Rapids PL 83-566 Watershed Plan, Custer, Prairie, Dawson CCDs and NRCS, July 2000)

2001 – EQIP Priority status

- Purposes:
  - reduce sediment, salt, and nitrate loading to surface and ground water
  - Reduce soil erosion

•345,300 feet of gated pipe
•157,000 feet on-farm pipeline
•1,900 acres center pivots
•1,900 acres land leveling

•386,300 feet lateral pipeline
•12 feedlot improvements
•8,000 acres PAM application

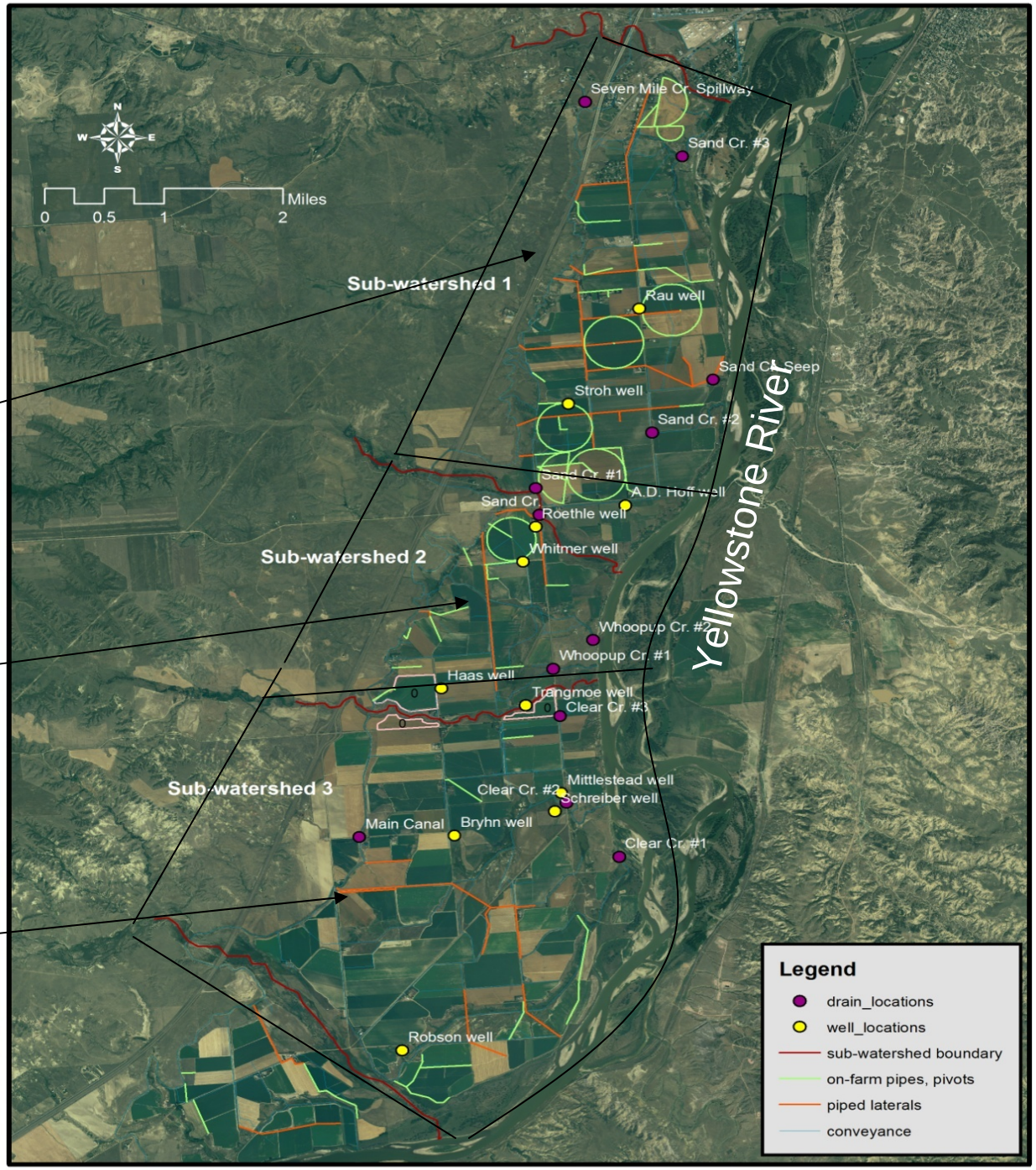
Replaces 168 miles of unlined, earthen conveyance lines
- Much in part by subsidy. Will it make a difference in in-stream flows?

Monitoring locations and BMPs

Sub-watershed 1: most subsidized and modernized

Sub-watershed 2: mid-level subsidization and modernization

Sub-watershed 3: least developed



Benefits of BMPs so far:

- Reduced power costs for pumping by 25% in 2003, reduced pumping from 3.5 months to 1.5 months for 1 pump
- Save ~ $105,000 annually in operation and maintenance costs
- Pipeline vs. ditch = quicker travel and response time, less spillage, less diverted
- Pipeline reduces weeds, no longer burning ditches
- No water rationing in 2004, 2005, and 2006 because of pipelines
- Reduced farm labor and improved quality of life
- Reduction in field erosion from PAM and conversion to gated pipe

Data gaps:

- Have practices reduced nutrient, salt, and sediment loading to Yellowstone River? To ground water? **A long-term data set is needed to answer this question.**
- Have practices resulted in reduced pumping and greater flows in Yellowstone, long-term? **A long-term data set is needed to answer this question.**
- Can the Buffalo Rapids approach be effectively applied to other irrigation projects? Can we build a model to aid in BMP planning? Does implementation of ag water conservation lead to enhanced in-stream flow? Only time will tell.