IRRIGATION EFFICIENCY: FRIEND or FOE of ENVIRONMENTAL FLOW?

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Freezeout Lake WMA, Mont. Photo by John Lambing

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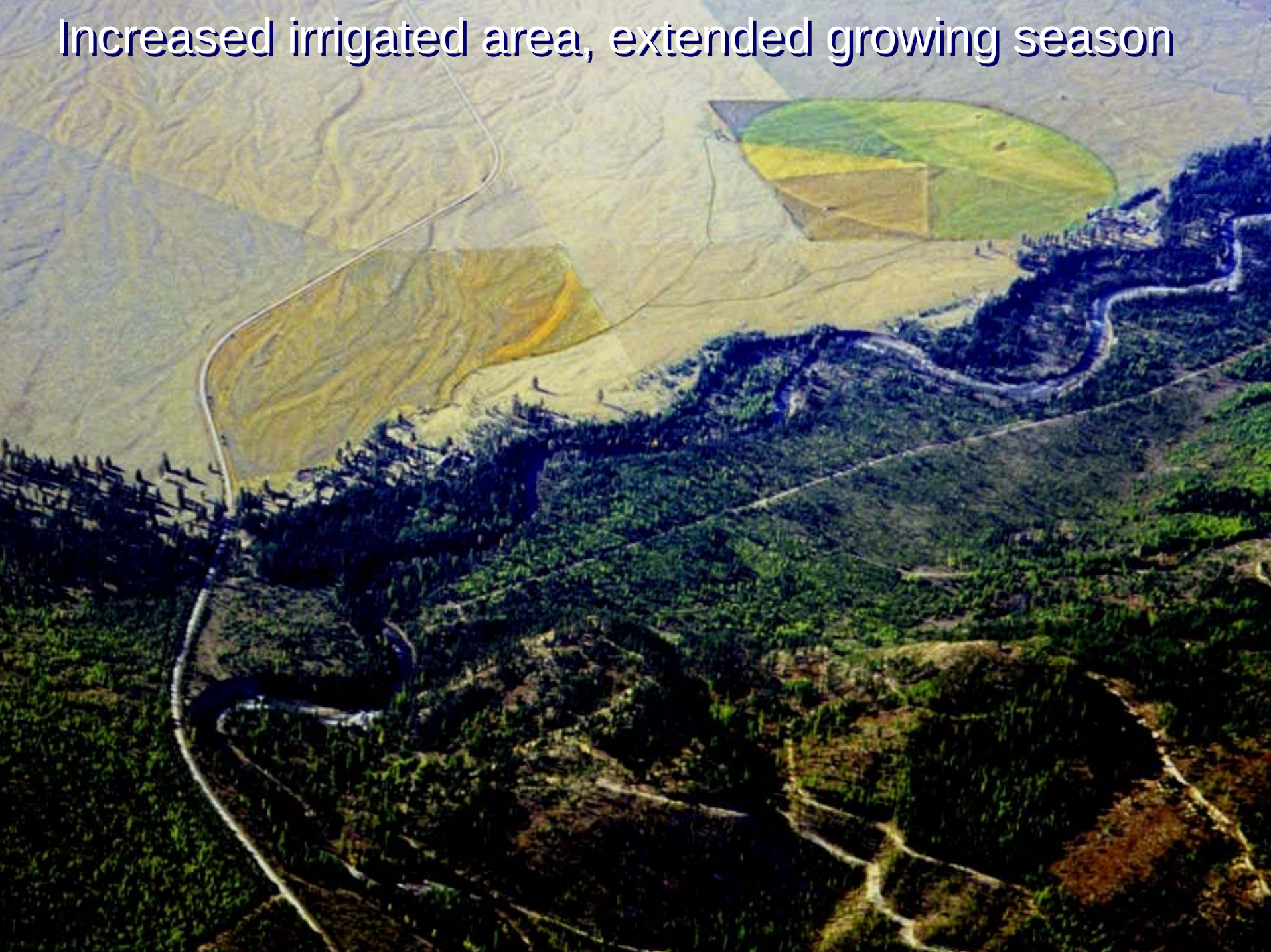
Irrigation Efficiency Improvements

Converting from flood (35%) to sprinkler (75%)

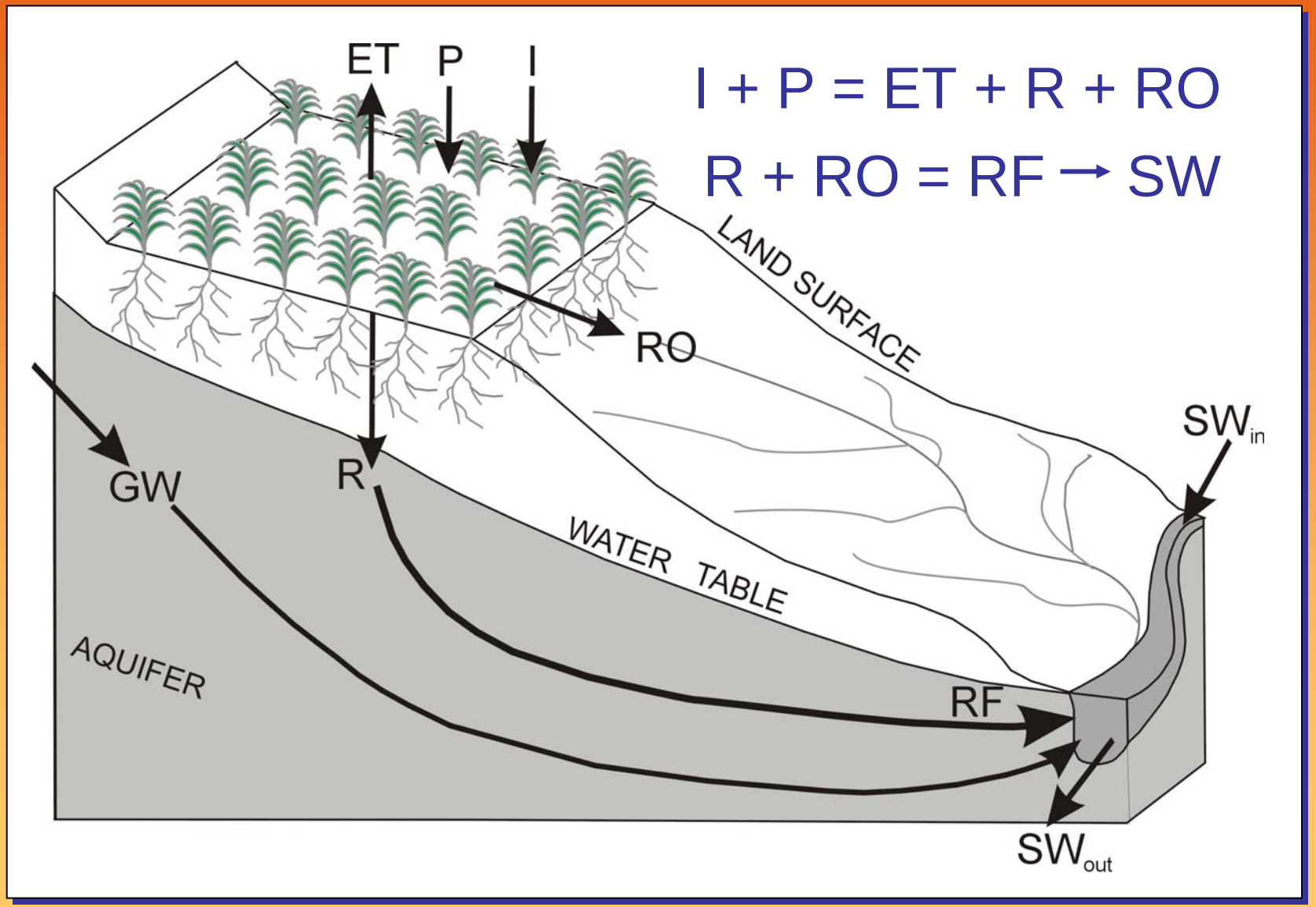
Lining irrigation canals

Photos: Mike Roberts, Montana DNRC WRB

Increased irrigated area, extended growing season



Water Balance of an Irrigated Basin



Irrigation efficiency improvements change streamflow *timing*, *quantity*, and *location*

Case studies

Blackfoot River

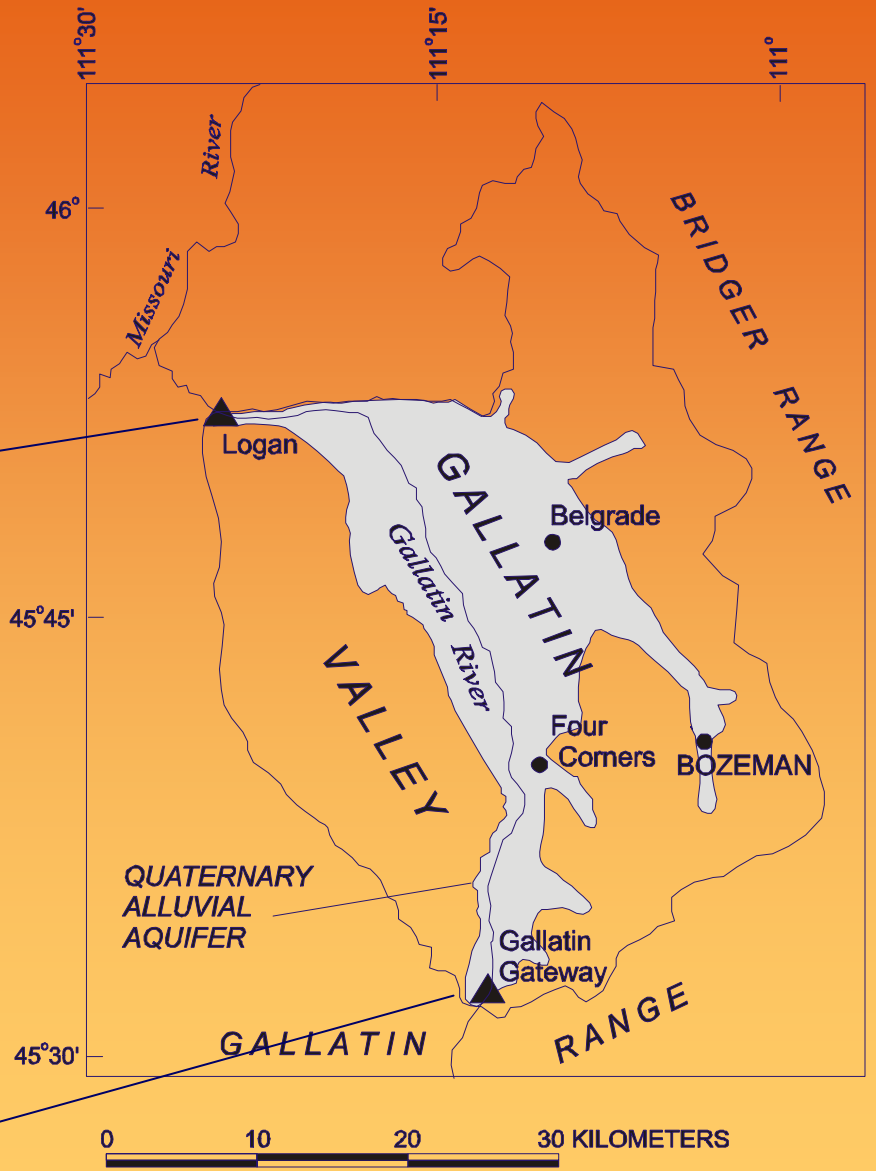
Gallatin River, Montana, USA

Photos: Bigskyfishing.com

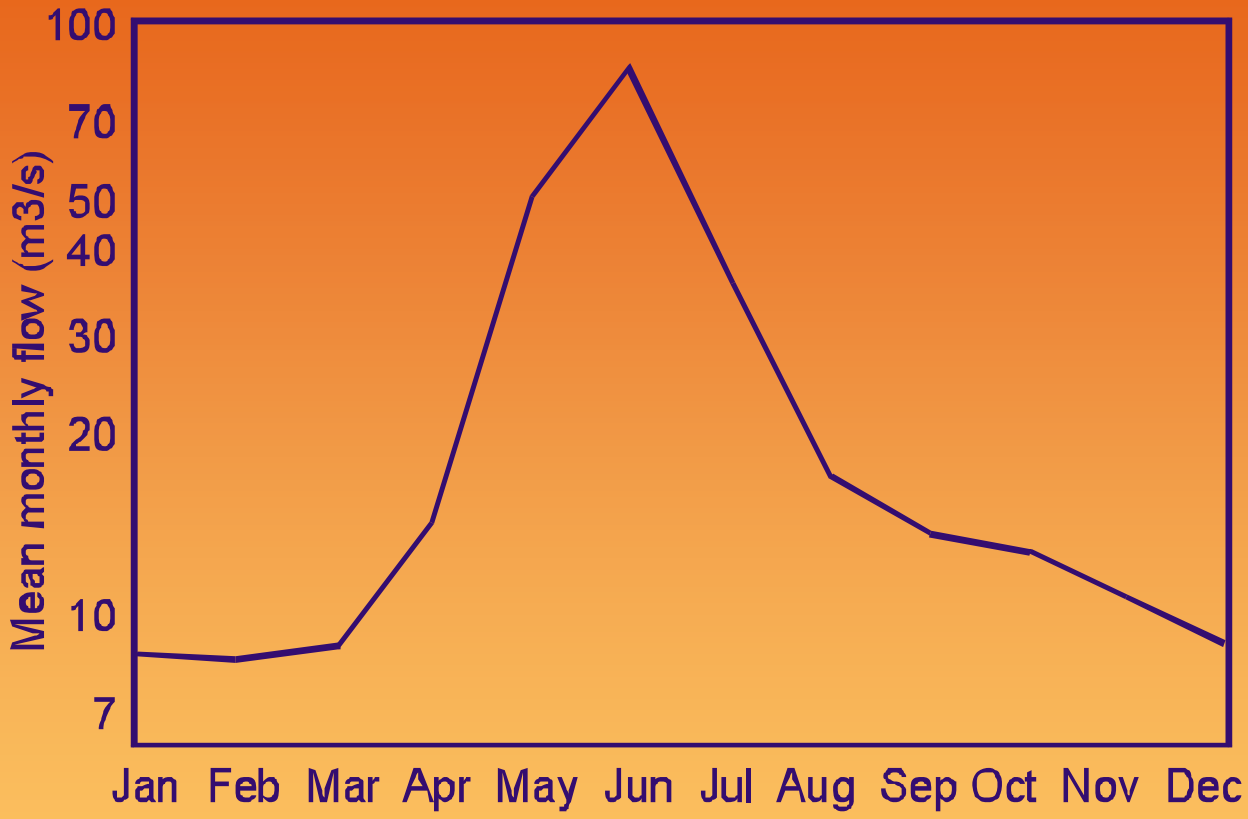
Case study: Effect on streamflow *timing*

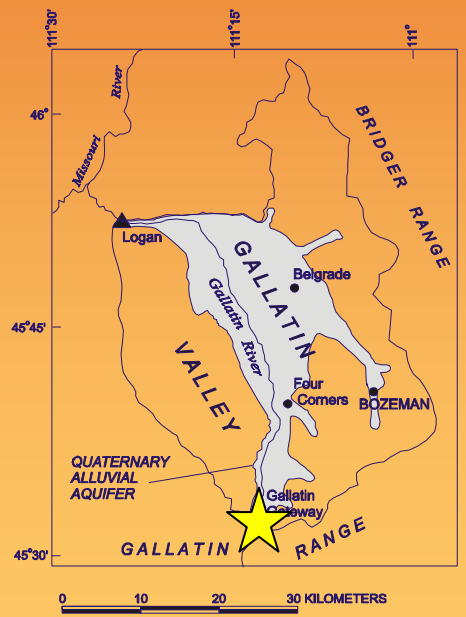
LOGAN

GALLATIN GATEWAY



Natural streamflow pattern

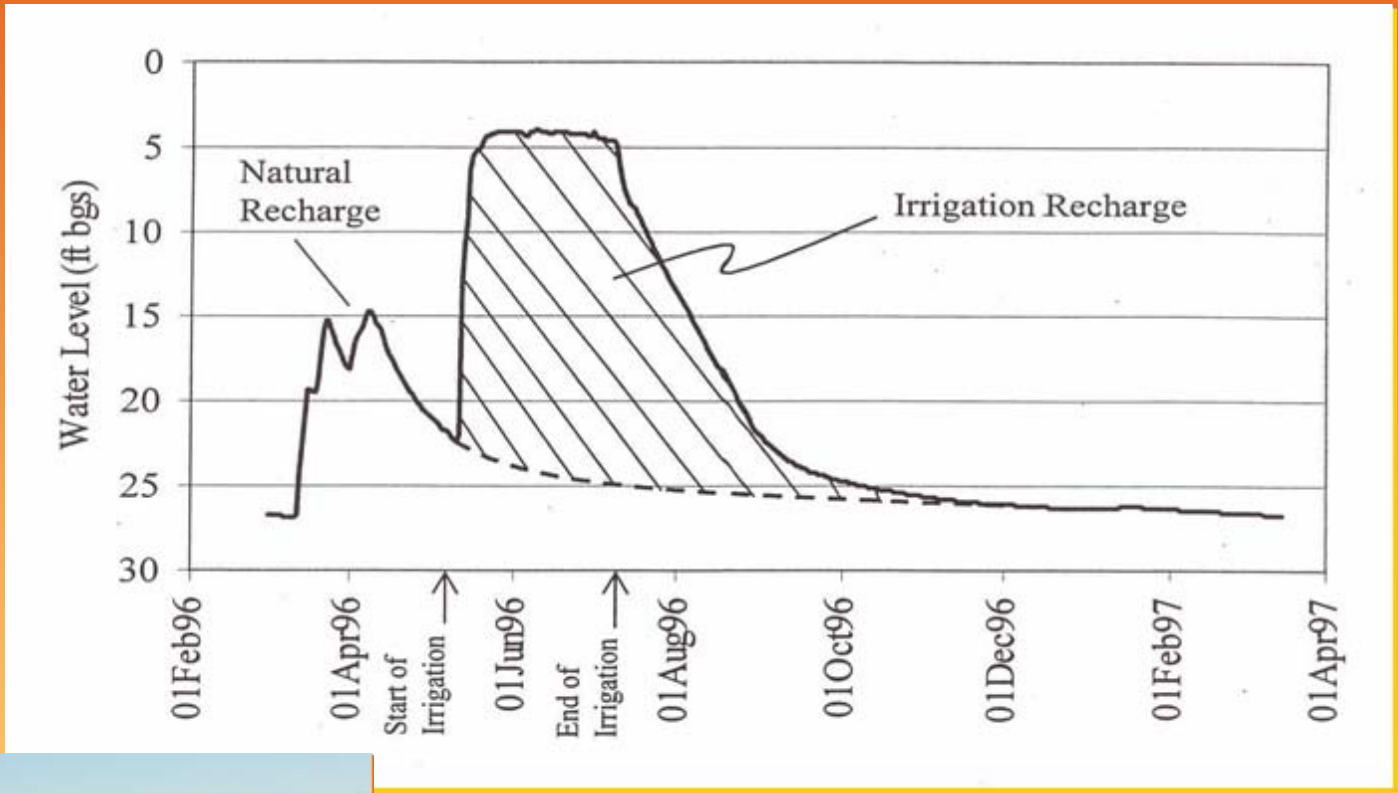




Average monthly flow of the Gallatin River at Gallatin Gateway

Kendy and Bredehoeft 2006

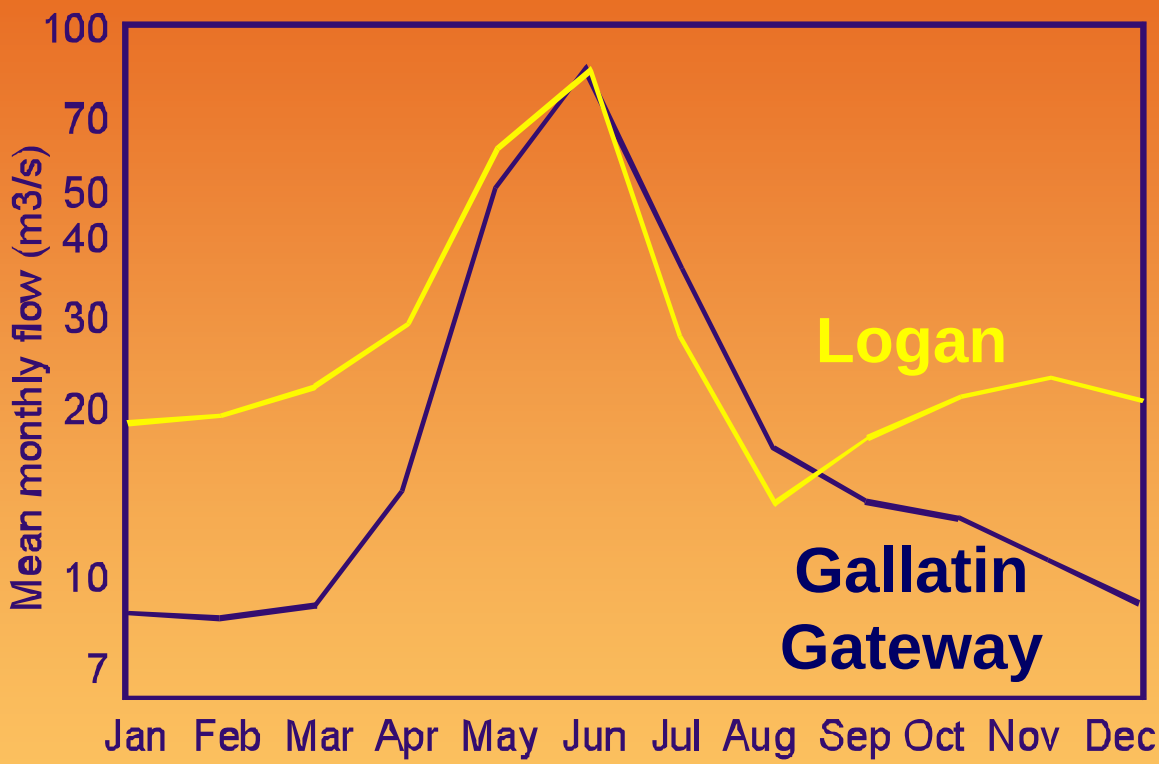
Excess irrigation water artificially recharges ground water

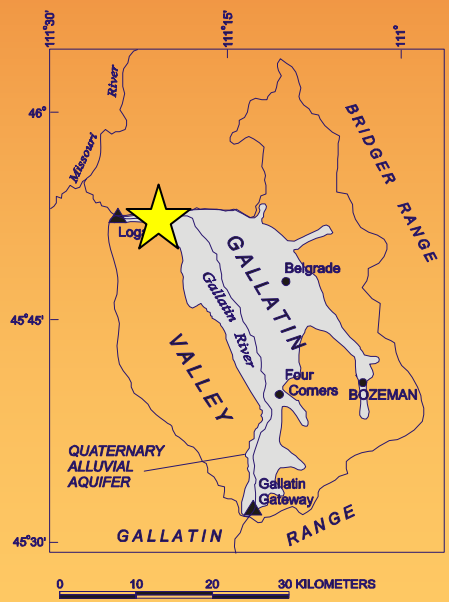


Seasonal water-table fluctuation, Upper Big Hole Basin

Marvin and Voeller, 2000, MBMG OFR 417. Photo: Mike Roberts

Streamflow under the influence of irrigation

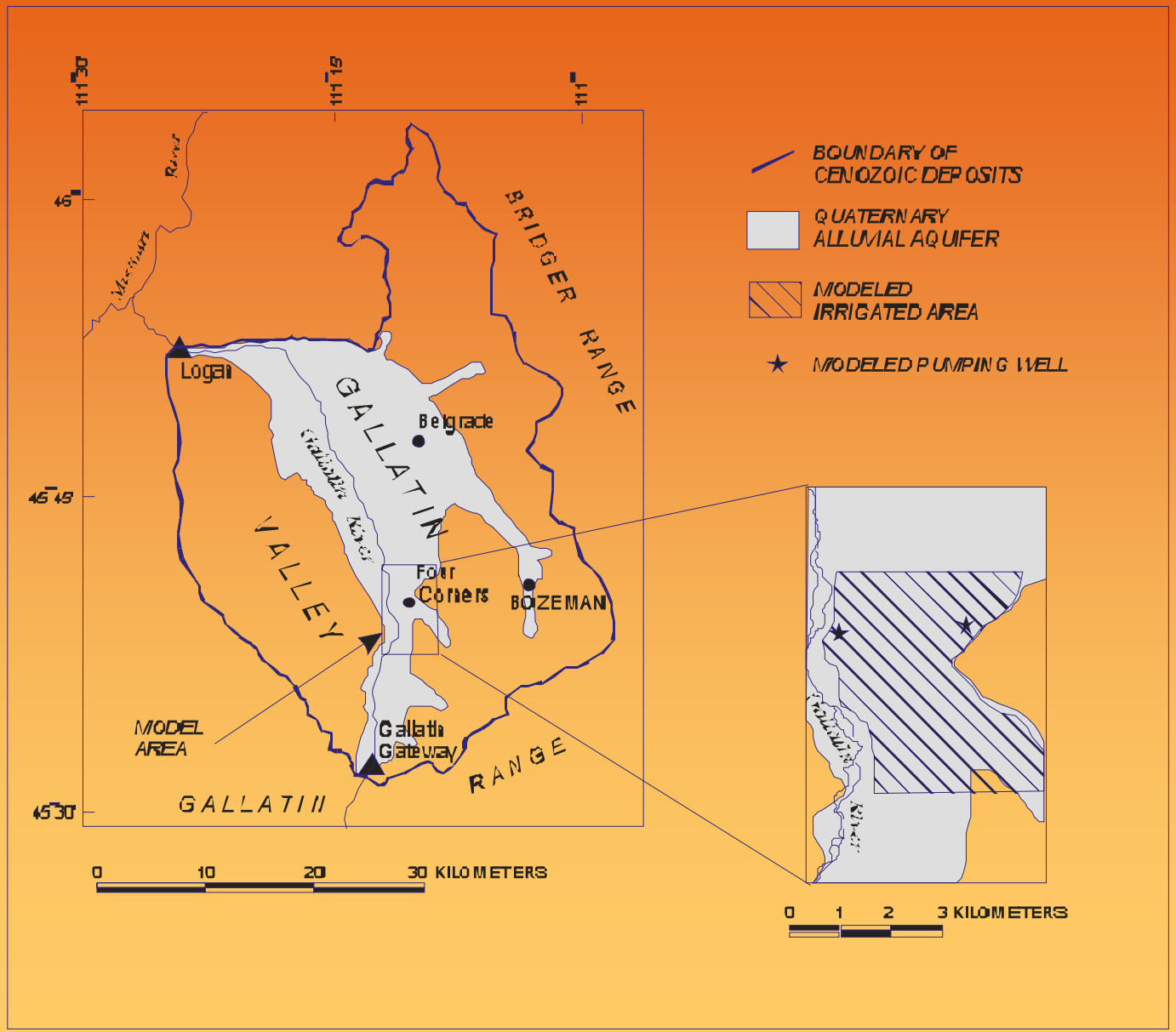




Average monthly flow of the Gallatin River at Logan

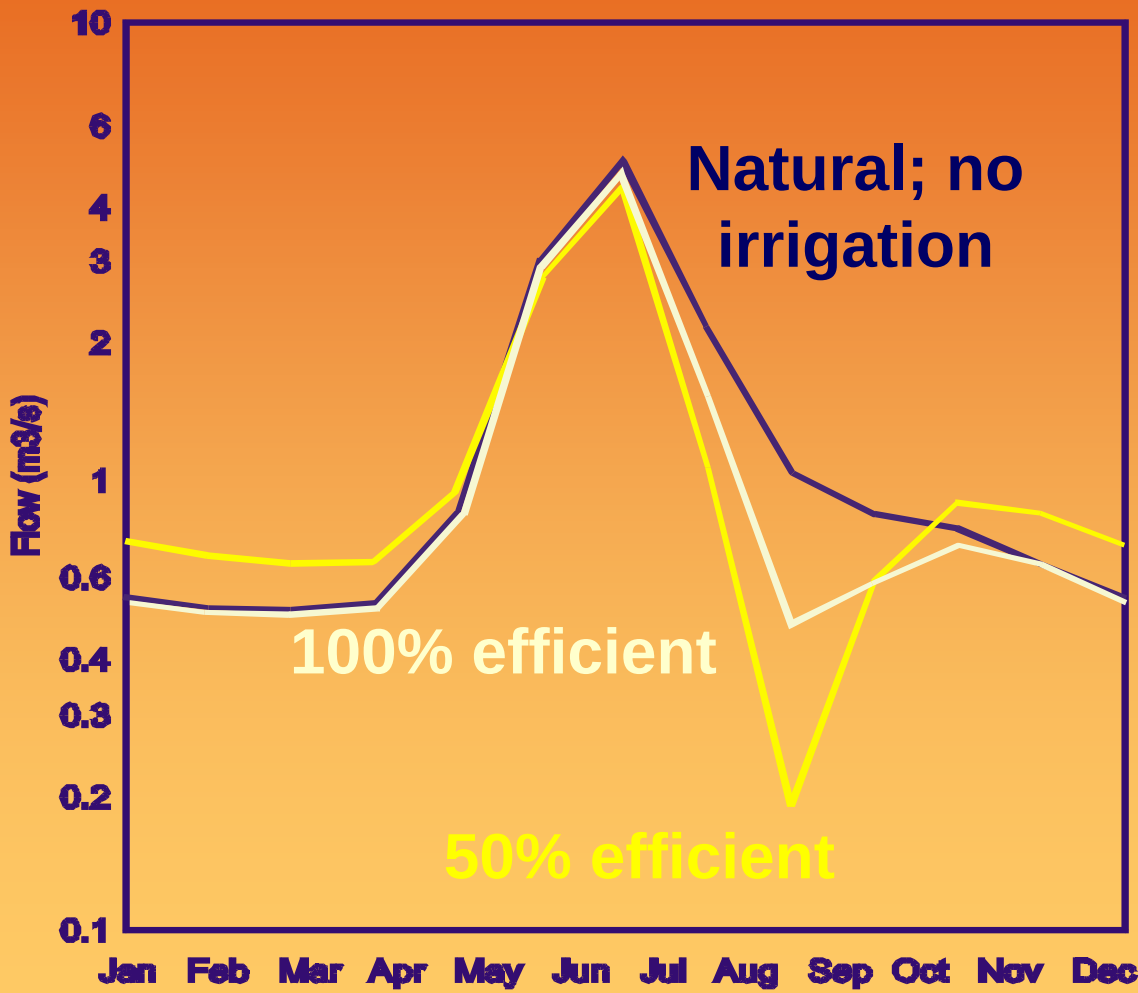
Kendy and Bredehoeft 2006

Ground-Water Model



Kendy and Bredehoeft 2006

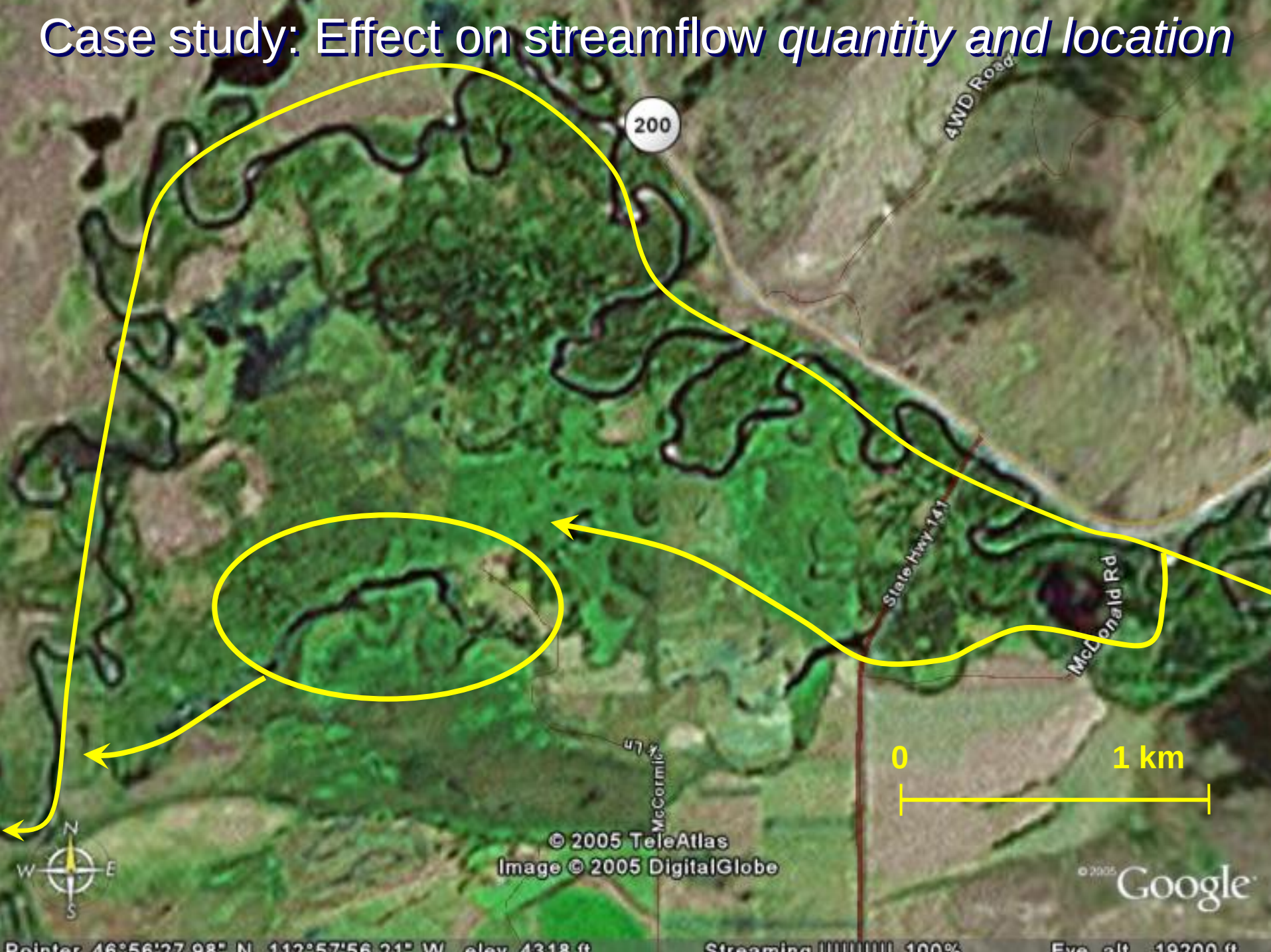
Impacts of Irrigation Efficiency on Streamflow



Reducing artificial recharge increases summer flows, decreases fall and winter flows compared to present (unnatural) conditions.

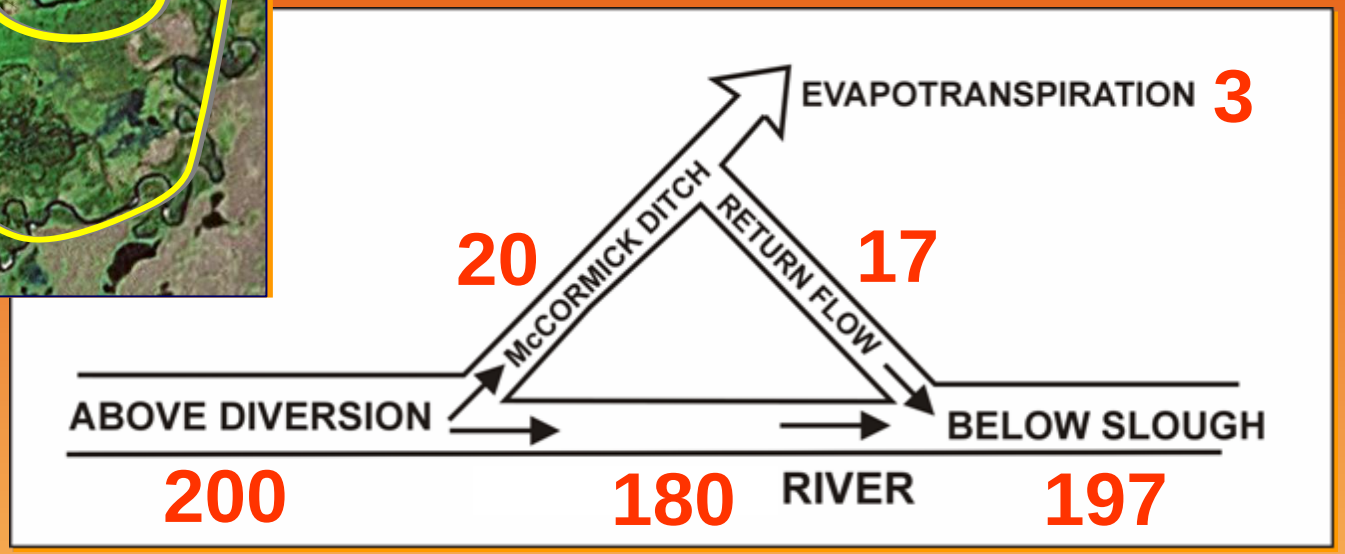
Photo: Gallatin River at Cameron Bridge, running low due to irrigation. Bigskyfishing.com

Case study: Effect on streamflow *quantity and location*

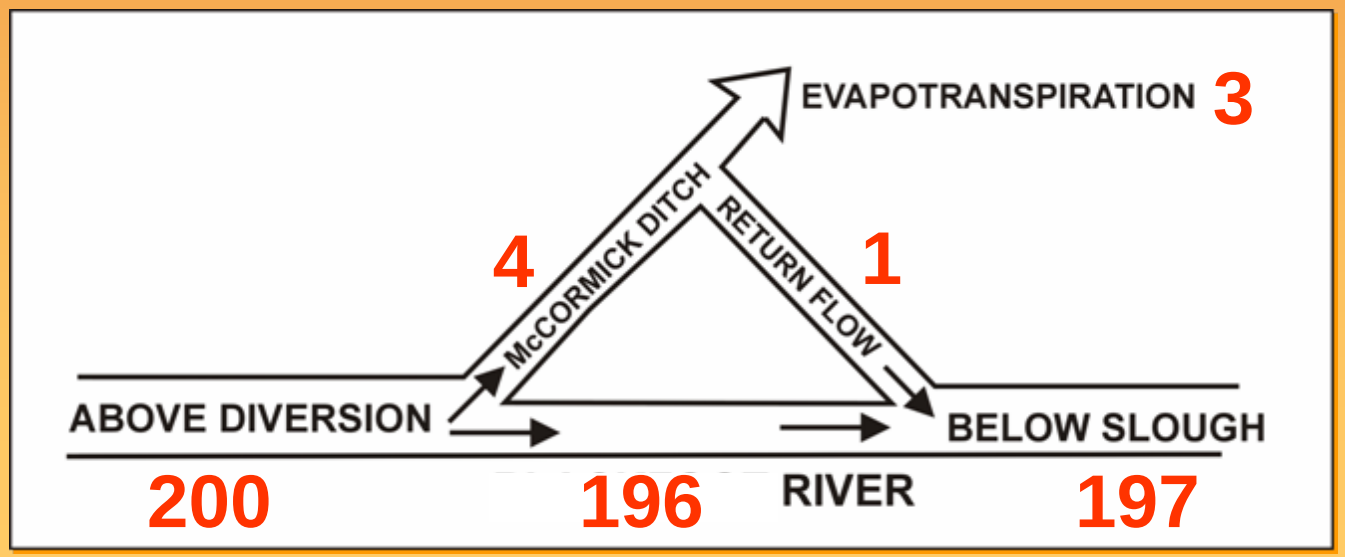


Water-Balance Analysis

Current



Future?



Kendy 2005

KEY POINTS

- Irrigation return flow sustains springs, seeps, and streams downstream from cropland.
- Irrigation efficiency improvement changes streamflow *timing*, *quantity*, and *location*.

- Assess project-specific and cumulative basin-wide effects of system operation.
- Understand basin hydrology and management objectives.

Photo by John Lambing

For more information…

Kendy, Eloise, and Bredehoeft, John D., 2006, Transient effects of ground-water pumping and surface-water irrigation returns on streamflow. *Water Resources Research* 42, W08415, doi:10.1029/2005WR004792.

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Photo by John Lambing

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Irrigation Efficiency: Friend or Foe of Environmental Flow?

Abstract

Improving irrigation efficiency by lining ditches and canals, switching from flood to sprinkler or drip application, and optimizing irrigation timing can greatly reduce diversions from freshwater ecosystems. Worldwide, water managers embrace irrigation efficiency as a means to conserve water, leaving more water instream for environmental flows. Farmers embrace irrigation efficiency as a means to increase crop production. Could this win-win situation be for real? Not necessarily. More crop production means more water consumption, which actually leaves less water available for streamflow. Even if water consumption is kept constant (for example by reducing the irrigated area), irrigation efficiency improvements can unintentionally harm aquatic ecosystems. Irrigation efficiency improvements rarely save water, but rather redistribute it over time and space. Irrigation return flow is the portion of irrigation water that is not consumed by crops, but instead returns to its original source or another source of water. In many cases, irrigation return flow feeds crucial springs, seeps, and streams downstream from irrigated areas. Thus, inefficient irrigation practices have become critical to maintaining some freshwater ecosystems, including wetlands and fisheries that otherwise would not exist. In these cases, irrigation efficiency improvements may be ill-advised. On the other hand, strategically implemented irrigation efficiency improvements can help reconnect a severely dewatered stream reach or return an altered hydrologic system to a more natural flow regime. Two case studies from Montana, USA – one at the stream segment scale and another at the basin scale – illustrate these concepts. In the first case, a simple water-budget analysis reveals that a proposed conversion from flood to sprinkler irrigation could harm a downstream wetland more than it would benefit the targeted reach of the Blackfoot River. In the second case, ground-water flow modeling suggests that the flood-to-sprinkler conversion throughout an irrigated valley would increase summer flows and decrease winter flows in the Gallatin River, approaching a more natural seasonal flow pattern than under current conditions. As a general rule, irrigation efficiency improvements provide more benefits to farmers than to environmental flows. Whether a particular proposal is an exception to this rule depends on how it will impact the entire water budget, including the amount and timing of return flow. Each case needs to be evaluated separately, considering the goals and scale of the specific project.