Yellowstone River - Cumulative Effects Analysis

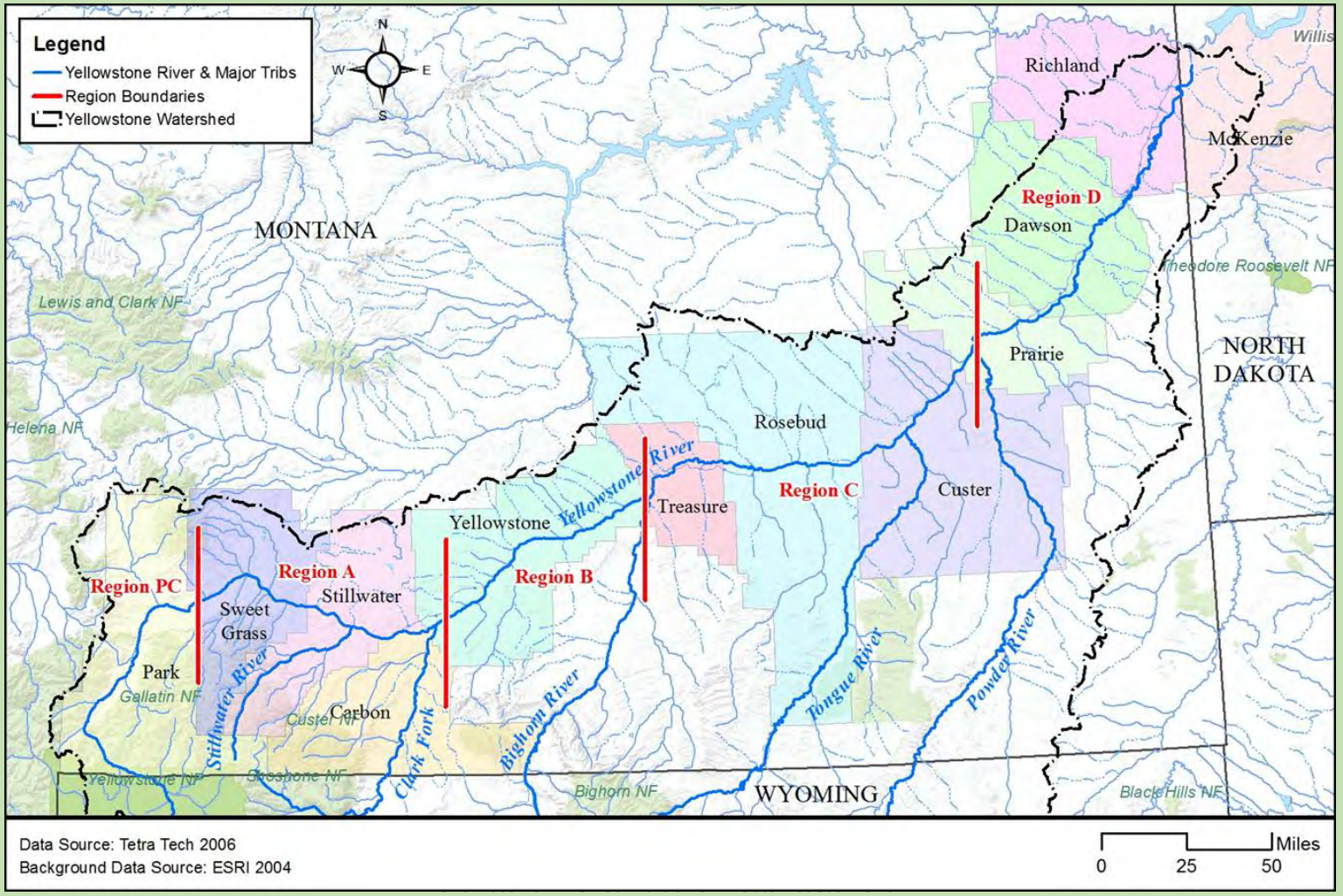
Project Objectives

1. Evaluate the cumulative hydraulic, biological, and socioeconomic impacts of human activity on the Yellowstone River.

2. Develop recommended management practices and position statements.

Project Extent

- Gardiner MT to the Missouri River confluence (565 River Miles)



Montana's Involvement

- Yellowstone River Conservation District Council (YRCDC)
  - Technical Advisory Committee (TAC)
  - Resource Advisory Committee (RAC)

- 2004 Cost-Share Agreement with Corps of Engineers
- YRCDC – Local Leadership and Participation

Primary Project Components

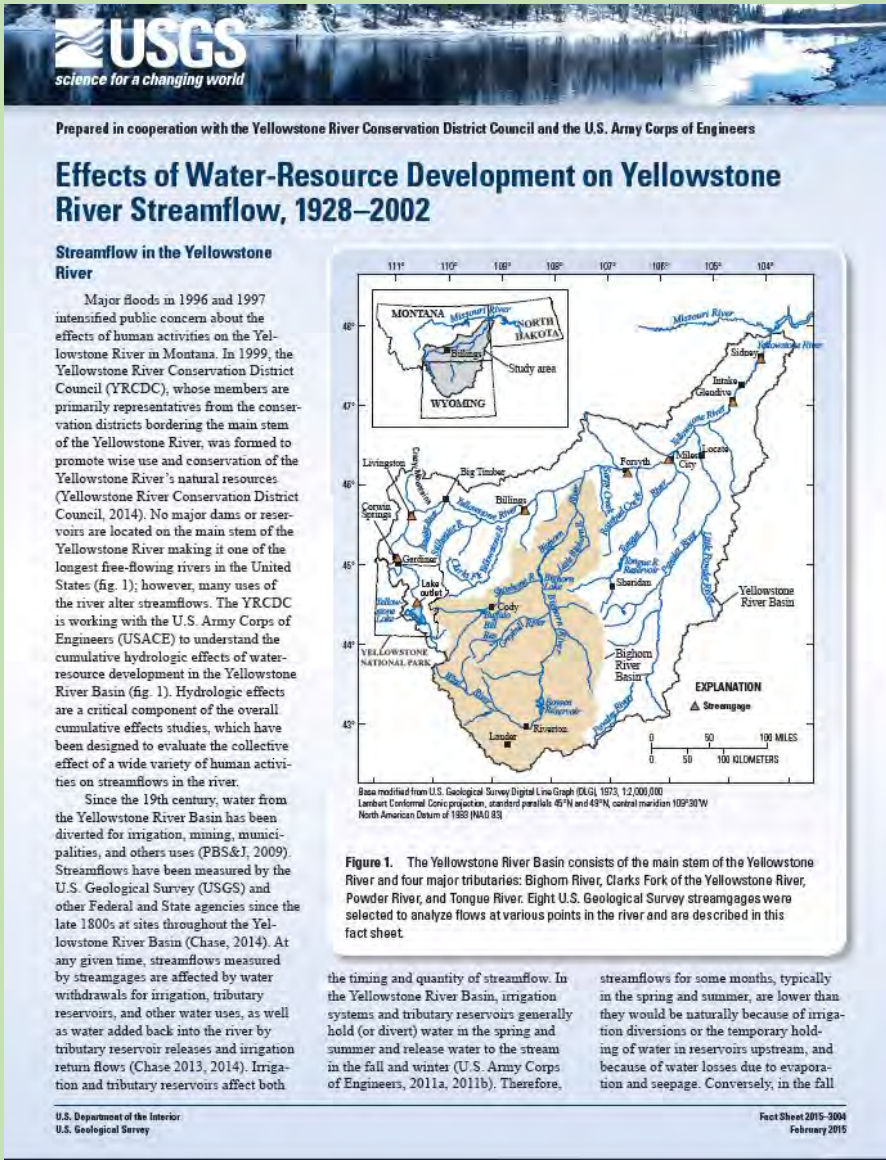
- Hydrology
- Hydraulics - Floodplain
- Channel Geomorphology
- Riparian
- Wetlands
- Water Quality
- Avian
- Fisheries
- Land Use Trends
- Socioeconomics
- Lidar Topographic Mapping
- Cumulative Effects Analysis

Hydrology

A Comparison of Pre-Development and Modern Stream Flows

Main Results:

- Natural streamflows have been affected by human development.
- Primary influences are flow alterations on the Bighorn River and irrigation withdrawals.
- The Yellowstone River has responded to these flow alterations.



USGS science for a changing world

Prepared in cooperation with the Yellowstone River Conservation District Council and the U.S. Army Corps of Engineers

Effects of Water-Resource Development on Yellowstone River Streamflow, 1928–2002

Streamflow in the Yellowstone River

Major floods in 1996 and 1997 intensified public concern about the effects of human activities on the Yellowstone River in Montana. In 1999, the Yellowstone River Conservation District Council (YRCDC), whose members are primarily representatives from the conservation districts bordering the main stem of the Yellowstone River, was formed to promote wise use and conservation of the Yellowstone River's natural resources (Yellowstone River Conservation District Council, 2014). No major dams or reservoirs are located on the main stem of the Yellowstone River making it one of the longest free-flowing rivers in the United States (fig. 1); however, many uses of the river alter streamflows. The YRCDC is working with the U.S. Army Corps of Engineers (USACE) to understand the cumulative hydrologic effects of water-resource development in the Yellowstone River Basin (fig. 1). Hydrologic effects are a critical component of the overall cumulative effects studies, which have been designed to evaluate the collective effect of a wide variety of human activities on streamflows in the river.

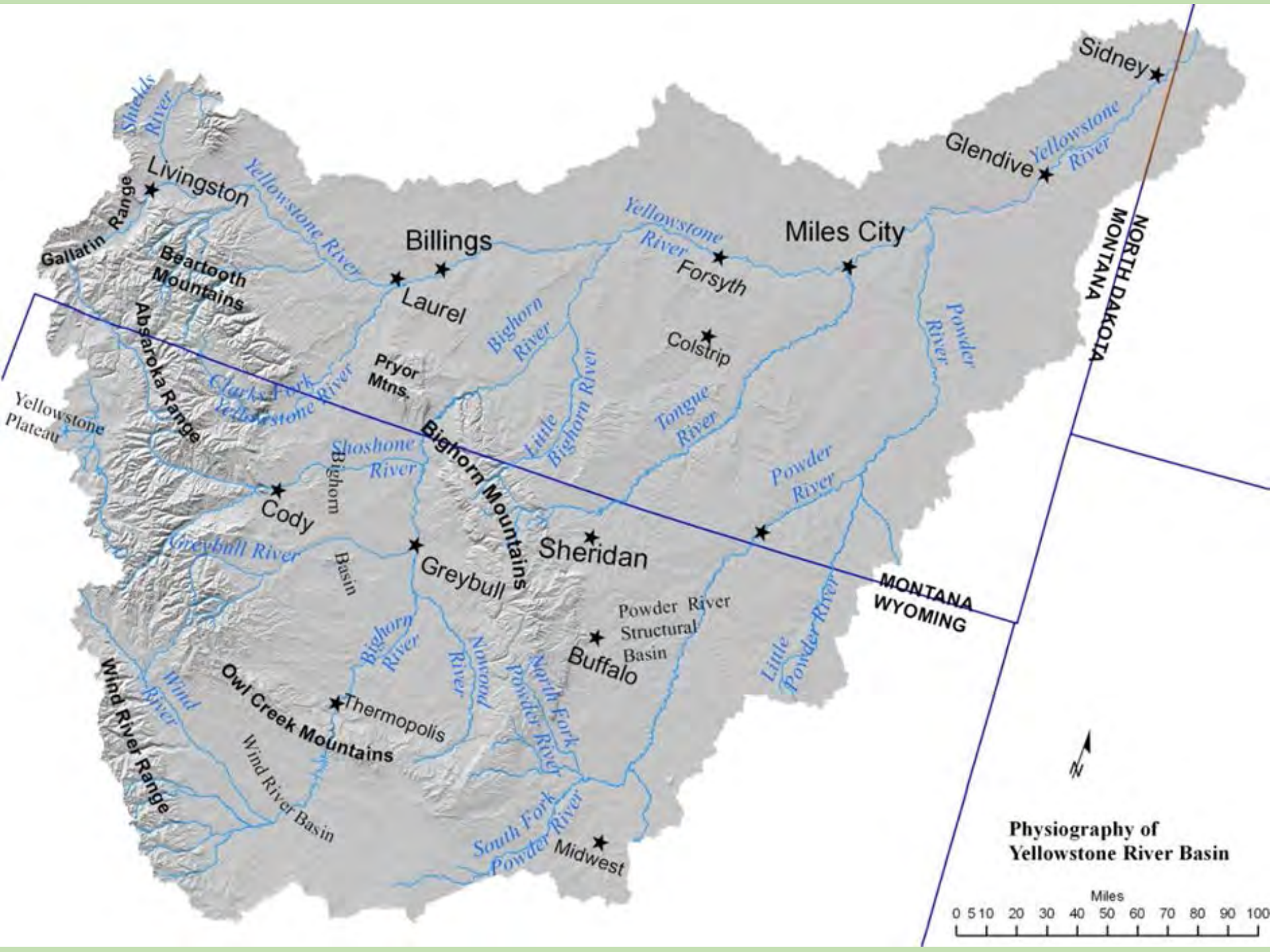
Since the 19th century, water from the Yellowstone River Basin has been diverted for irrigation, mining, municipalities, and others uses (PBS&J, 2009). Streamflows have been measured by the U.S. Geological Survey (USGS) and other Federal and State agencies since the late 1800s at sites throughout the Yellowstone River Basin (Chase, 2014). At any given time, streamflows measured by streamgages are affected by water withdrawals for irrigation, tributary reservoirs, and other water uses, as well as water added back into the river by tributary reservoir releases and irrigation return flows (Chase 2013, 2014). Irrigation and tributary reservoirs affect both the timing and quantity of streamflow. In the Yellowstone River Basin, irrigation systems and tributary reservoirs generally hold (or divert) water in the spring and summer and release water to the stream in the fall and winter (U.S. Army Corps of Engineers, 2011a, 2011b). Therefore, streamflows for some months, typically in the spring and summer, are lower than they would be naturally because of irrigation diversions or the temporary holding of water in reservoirs upstream, and because of water losses due to evaporation and seepage. Conversely, in the fall

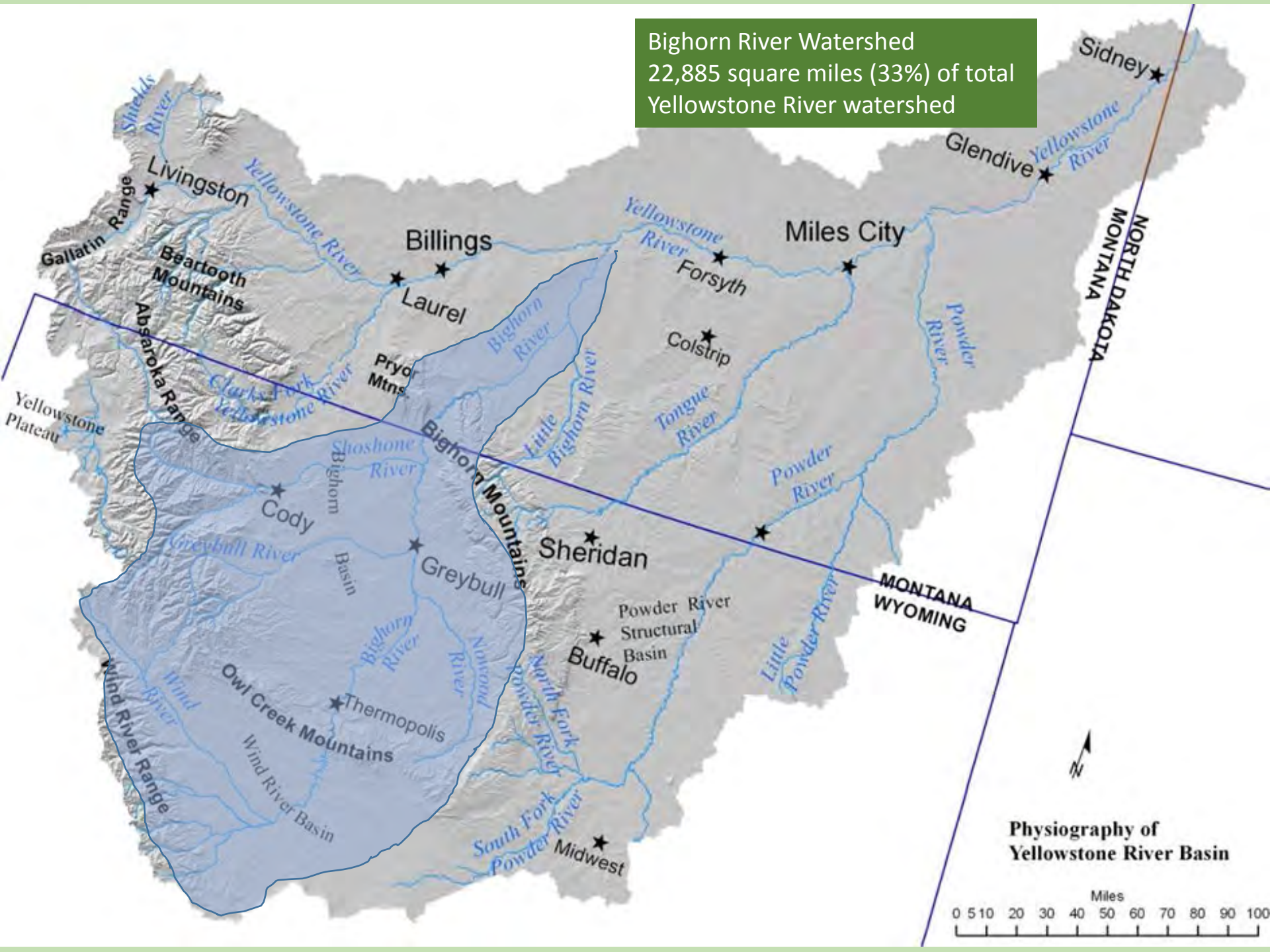
Base modified from U.S. Geological Survey Digital Line Graph (DLG), 1973, 1:2,000,000
Lambert Conformal Conic projection, standard parallels 45°N and 49°N, central meridian 109°30'W
North American Datum of 1983 (NAD 83)

Figure 1. The Yellowstone River Basin consists of the main stem of the Yellowstone River and four major tributaries: Bighorn River, Clarks Fork of the Yellowstone River, Powder River, and Tongue River. Eight U.S. Geological Survey streamgages were selected to analyze flows at various points in the river and are described in this fact sheet.

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2015–3004
February 2015


Sidney
Glendive
Yellowstone River
Shields River
Livingston
Gallatin Range
Beartooth Mountains
Absaroka Range
Billings
Laurel
Yellowstone River
Miles City
Forsyth
Colstrip
Bighorn River
Powder River
NORTH DAKOTA
MONTANA
Pryor Mtns.
Clarks Fork Yellowstone River
Yellowstone Plateau
Bighorn Mountains
Little Bighorn River
Tongue River
Shoshone River
Bighorn Basin
Cody
Greybull River
Greybull
Sheridan
Powder River
MONTANA
WYOMING
Powder River Structural Basin
Buffalo
Little Powder River
Bighorn River
Nowood River
North Fork Powder River
Wind River
Wind River Range
Owl Creek Mountains
Thermopolis
Wind River Basin
South Fork Powder River
Midwest
Physiography of
Yellowstone River Basin
Miles
0 5 10 20 30 40 50 60 70 80 90 100


Bighorn River Watershed
22,885 square miles (33%) of total
Yellowstone River watershed
Sidney
Glendive
Yellowstone River
Livingston
Billings
Laurel
Miles City
Forsyth
Colstrip
Gallatin Range
Beartooth Mountains
Absaroka Range
Pryor Mtns
Bighorn River
Powder River
Tongue River
Little Bighorn River
Clarks Fork Yellowstone River
Yellowstone Plateau
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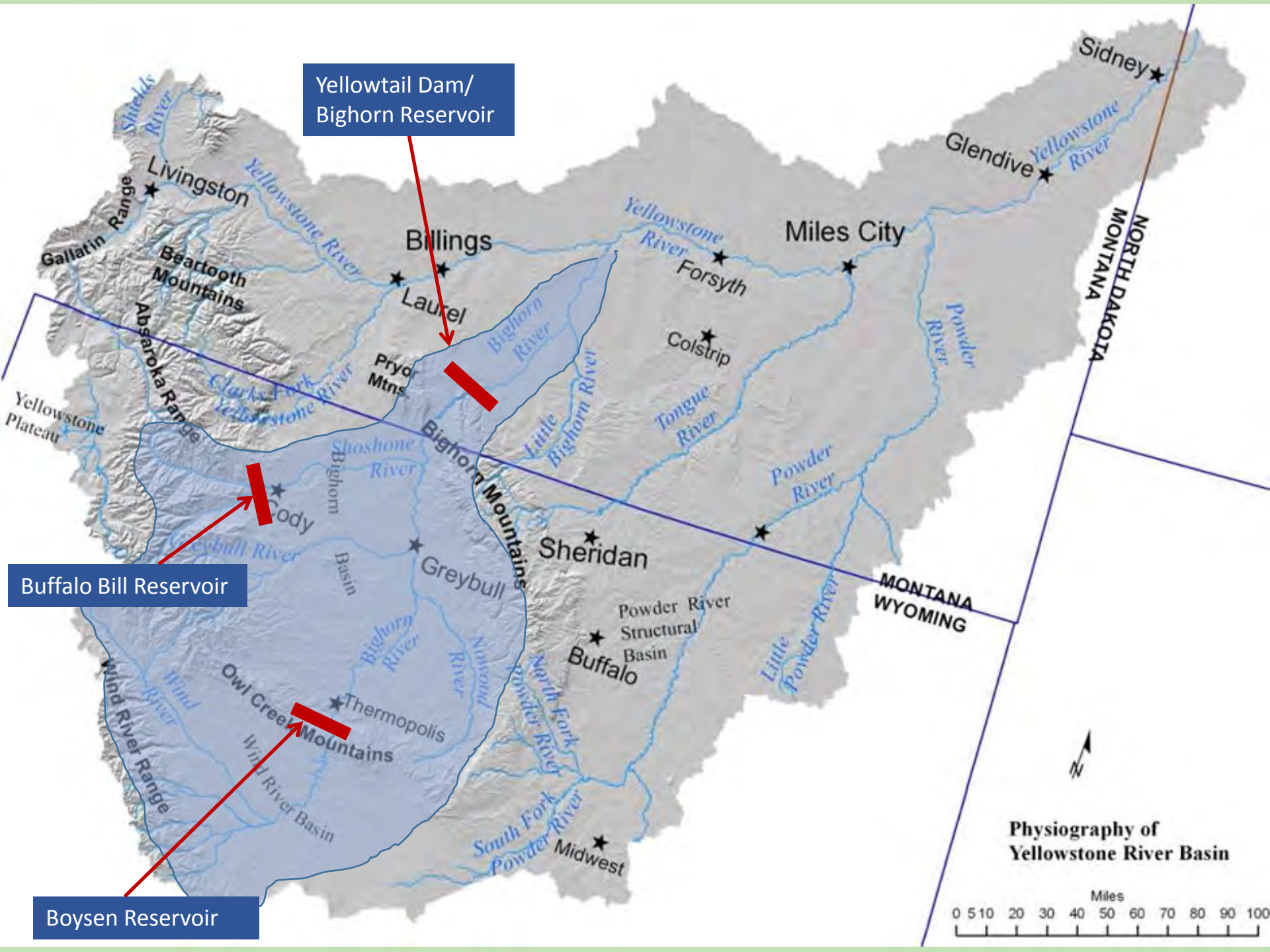
Yellowtail Dam/
Bighorn Reservoir
Buffalo Bill Reservoir
Boysen Reservoir
Sidney
Glendive
Yellowstone River
Livingston
Billings
Laurel
Miles City
Forsyth
Colstrip
Gallatin Range
Beartooth Mountains
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Physiography of
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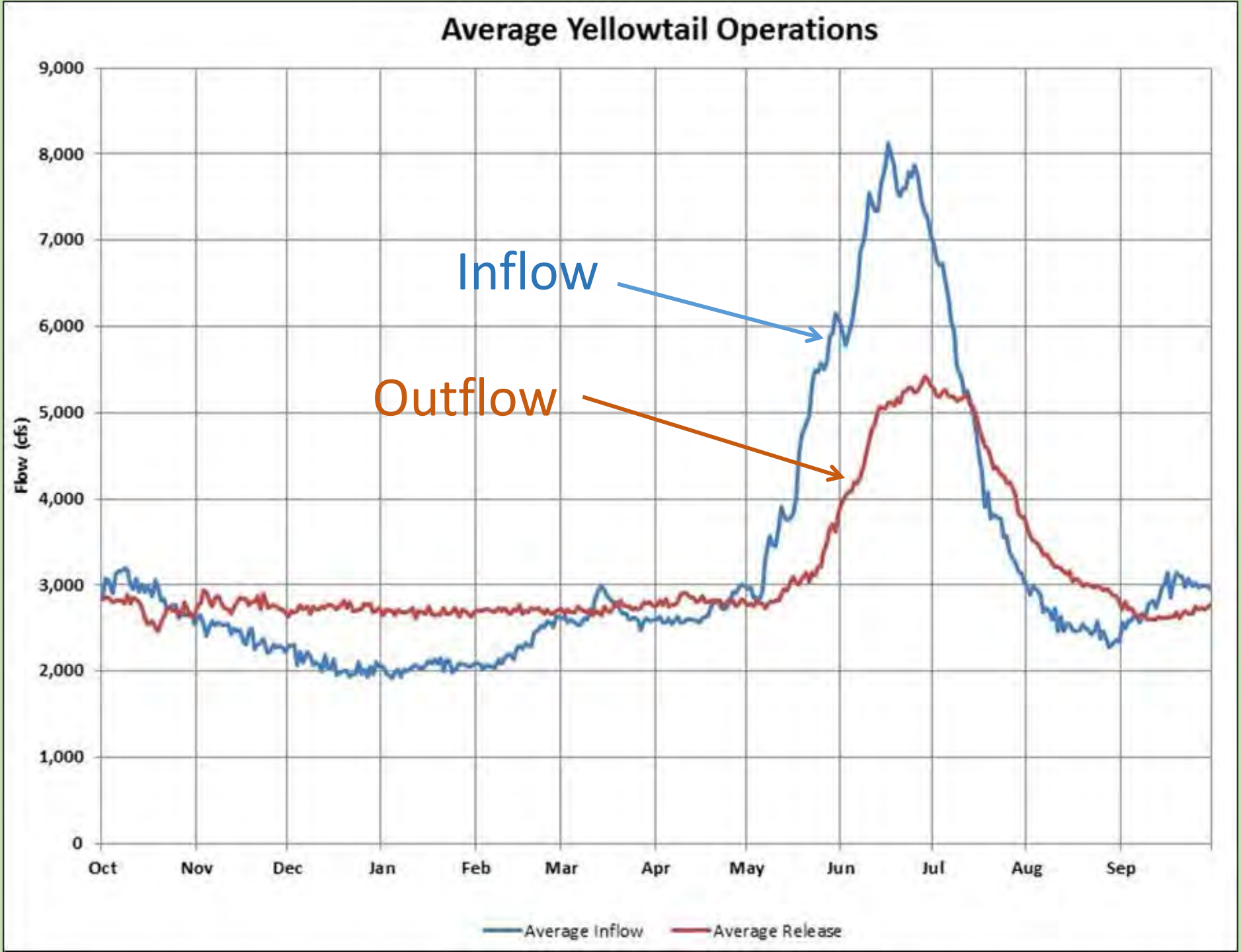
0 5 10 20 30 40 50 60 70 80 90 100

Bighorn River Flow Alterations

Yellowtail Dam: Built mid-1960s

- 1,331,725 acre-feet of storage in Bighorn Reservoir
- Flood control targets including preventing flows at the confluence of the Yellowstone River from exceeding 25,000 cfs

Billingsgazette.com


Average Yellowtail Operations
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (cfs)
Inflow
Outflow
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Average Inflow
Average Release

Hydrology

Changes in Flow from Undeveloped to Developed Conditions

1. High Flows: Decreased for all flood events, beginning at the Clark Fork River and increasing downstream.

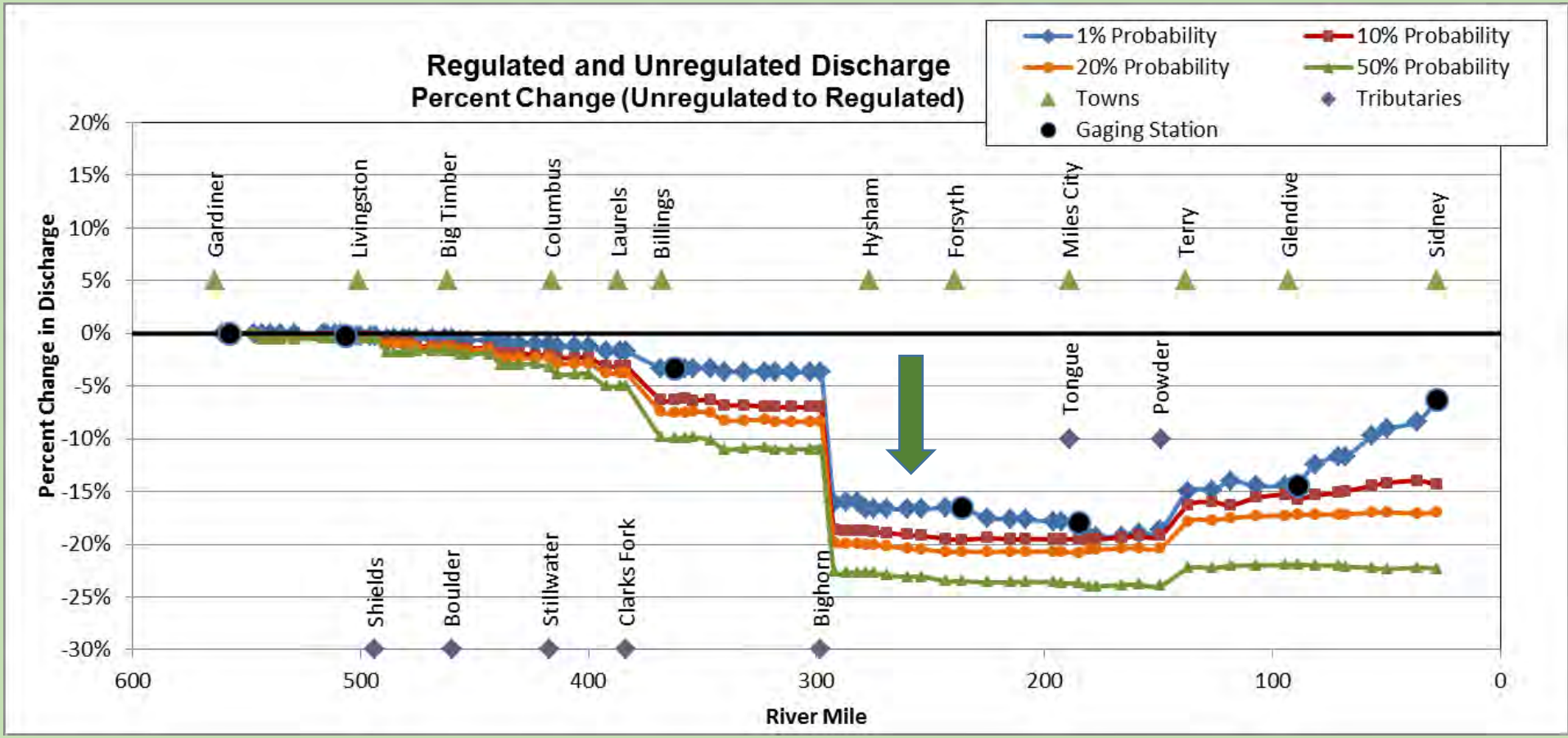
2. Summer Flows: Decreased

3. Winter Flows: Increased below mouth of Bighorn River

Comparison of "Unregulated" (Undeveloped) and "Regulated" (Developed) Flows --- USGS and USACE

Changes in Flood Flows

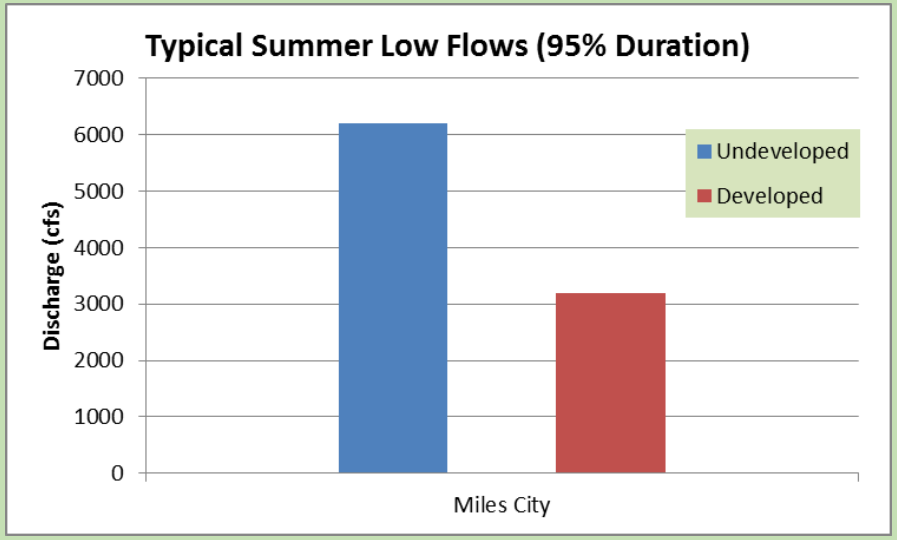
Biggest reductions are downstream of the mouth of the Bighorn River (15-25 percent)



Typical Summer Low Flows

Decreased ~ 48% at Miles City

- Undeveloped Summer Low Flow was ~ 6,200 cfs
- Developed Summer Low Flow is ~ 3,200cfs.



Irrigation Water Use (2000)

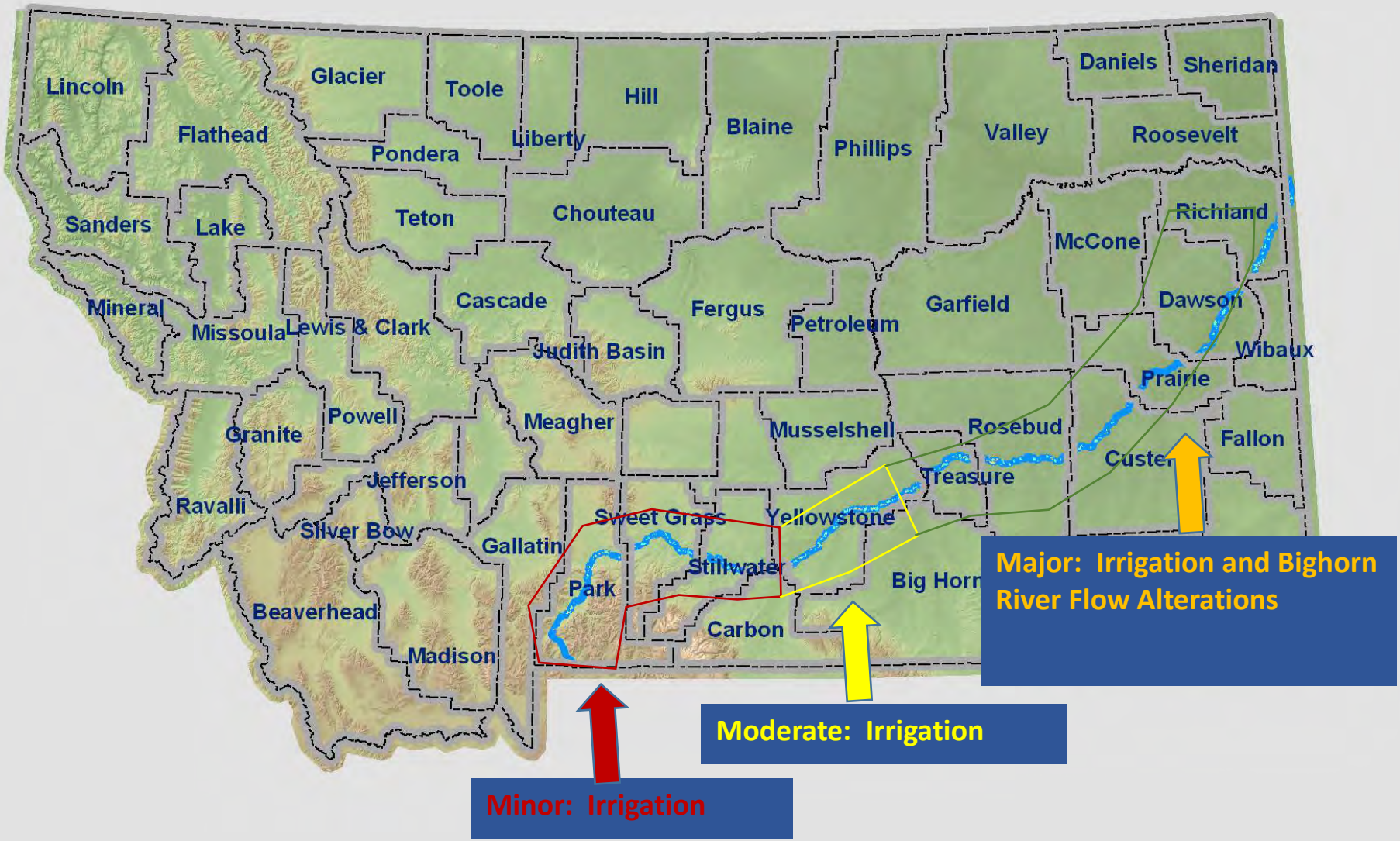
- All uses: 3.5 million acre feet per year withdrawn
- Irrigation
  - 94% of total (3.3 million acre feet per year) withdrawn for irrigation
  - 660,340 acre feet per year consumed by irrigation

How do influences of irrigation compare to changes on Bighorn River?

Summer: Overall Decrease in flows: ~ 50% Bighorn, ~ 50% Irrigation

Mean Monthly Flows

Relative Changes in Natural River Flows



Geomorphic Response to Flow Alterations

Smaller Channel below Bighorn Confluence

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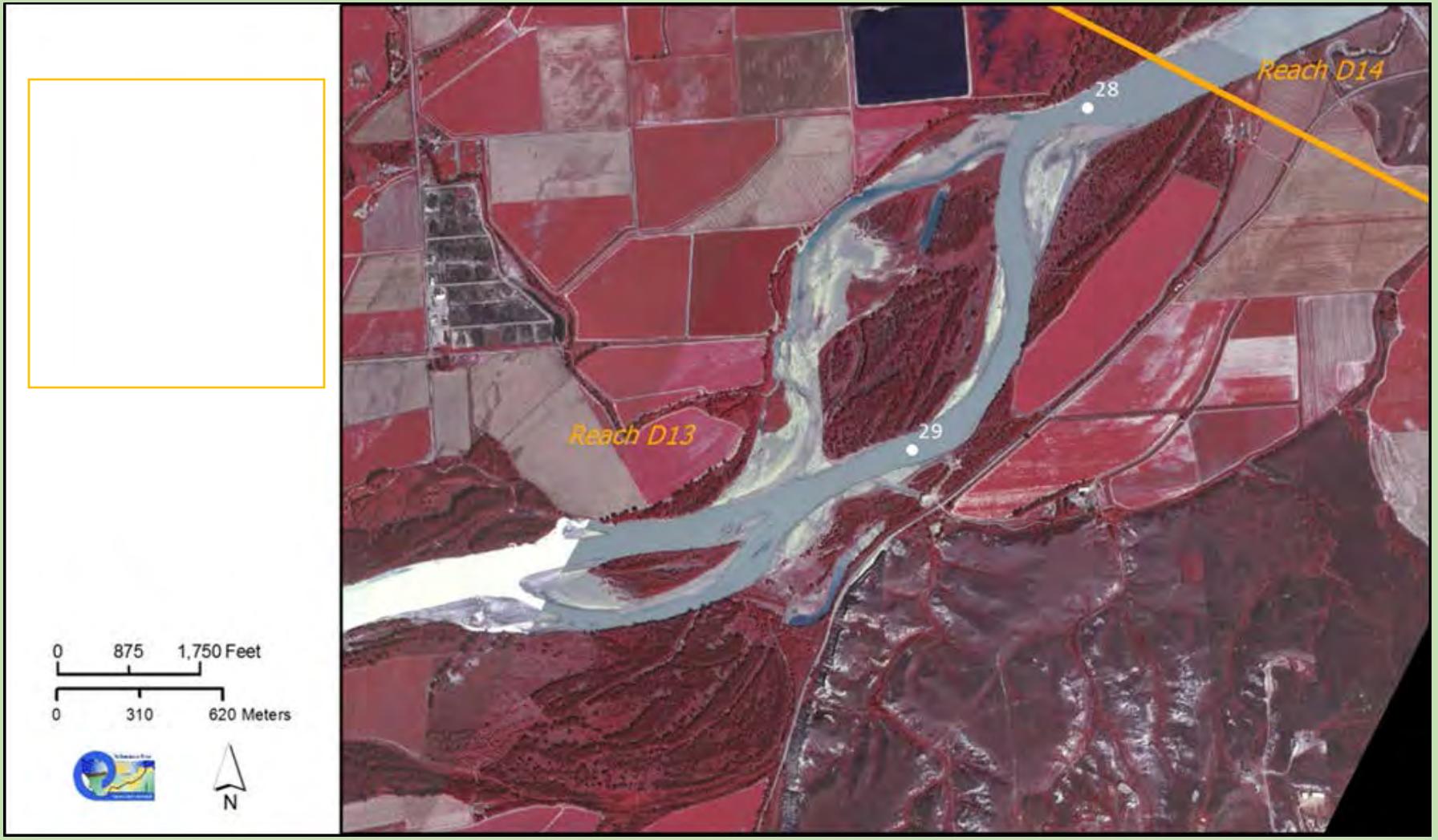
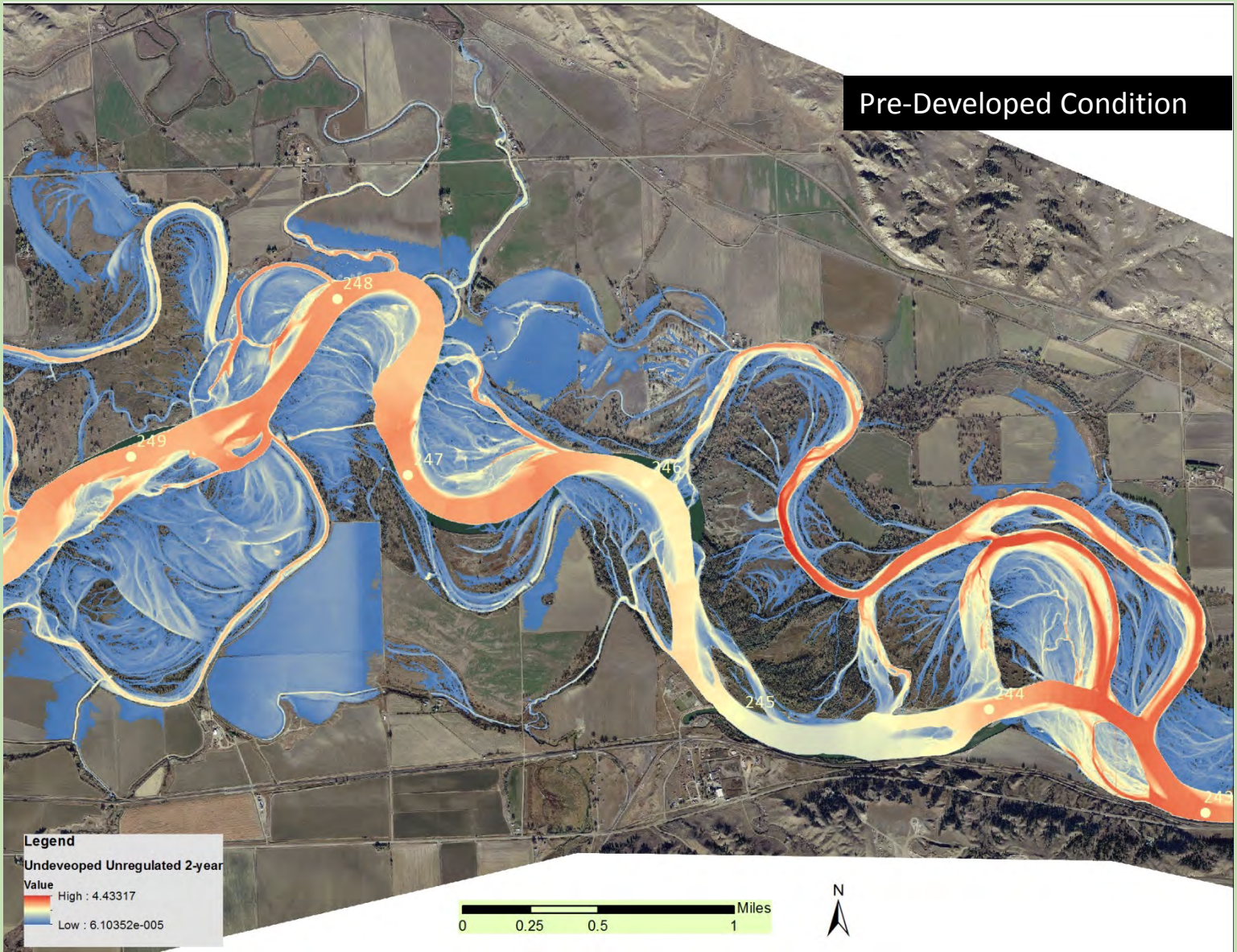


Cottonwood Forest Regeneration

Fewer Channel Gravel Bars

Geomorphic Response to Flow Alterations

Less Side Channel Length During Spring Runoff



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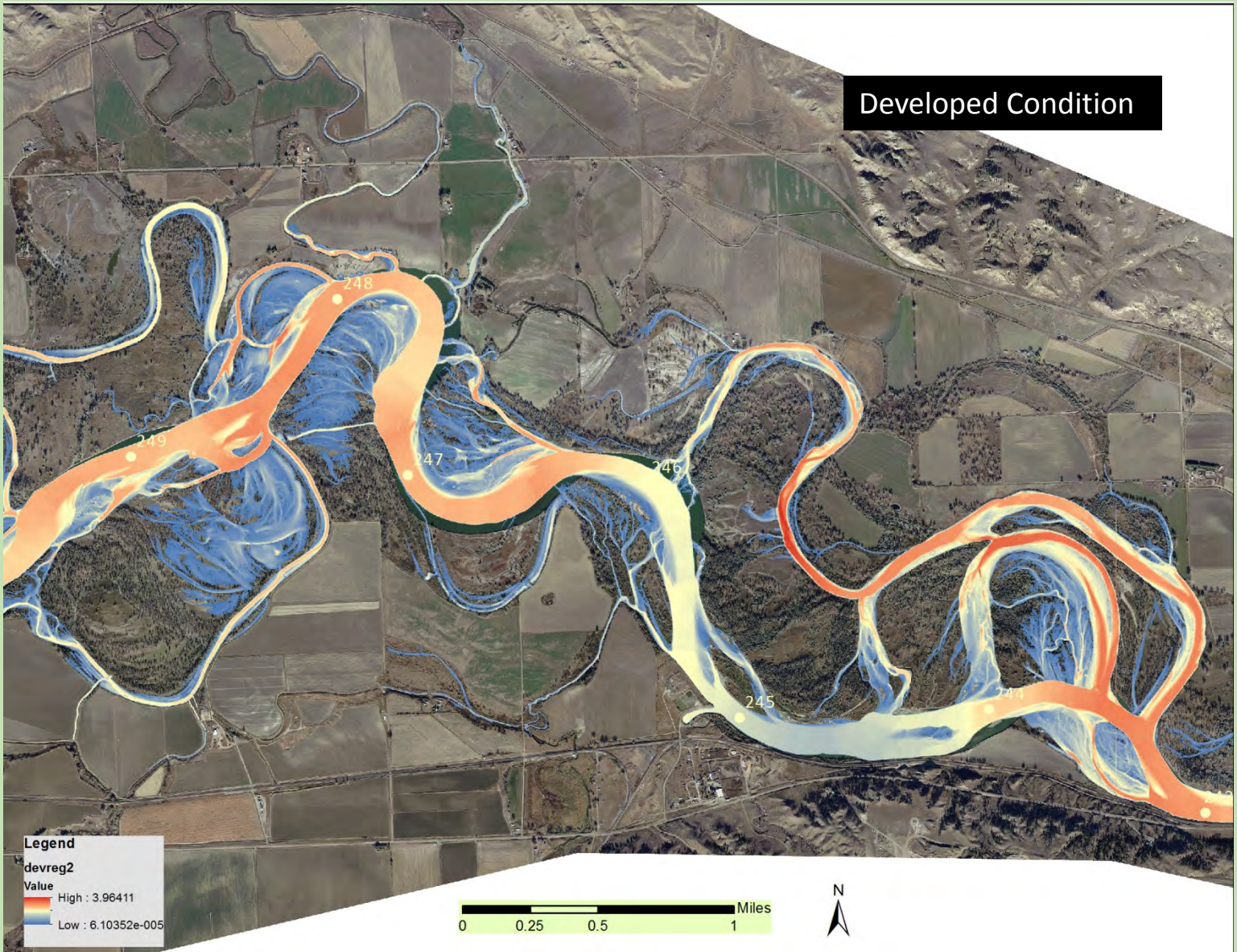
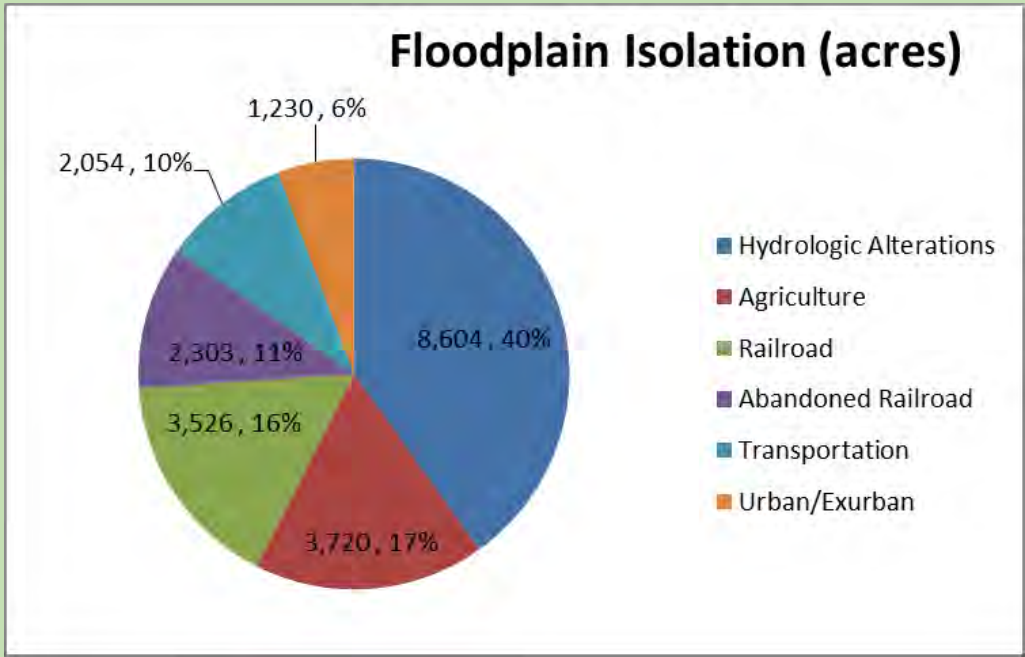


Floodplain Isolation Due To Flow Alterations and Floodplain Dikes

Between Springdale and the mouth (477 miles), over 21,000 acres of floodplain are no longer inundated at a 100-year flood

- The largest cause is the reduction in flows - 8,600 acres isolated at a 100-year event
- Agricultural dikes and levees and the railroad each isolate about 3,500 acres.
- The abandoned railroad isolates about 2,300 acres



Sediment Reduction
Leaking Irrigation Ditches

Yellowstone River Recommended Practices

& Position Statements: