Conservation of surface and ground water in a Western watershed experiencing rapid loss of irrigated agricultural land to development

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Outline

- Project objectives
- Accomplishments to date (and new results)
- Major conclusions
- Education/outreach plan (Amy and Veronica)

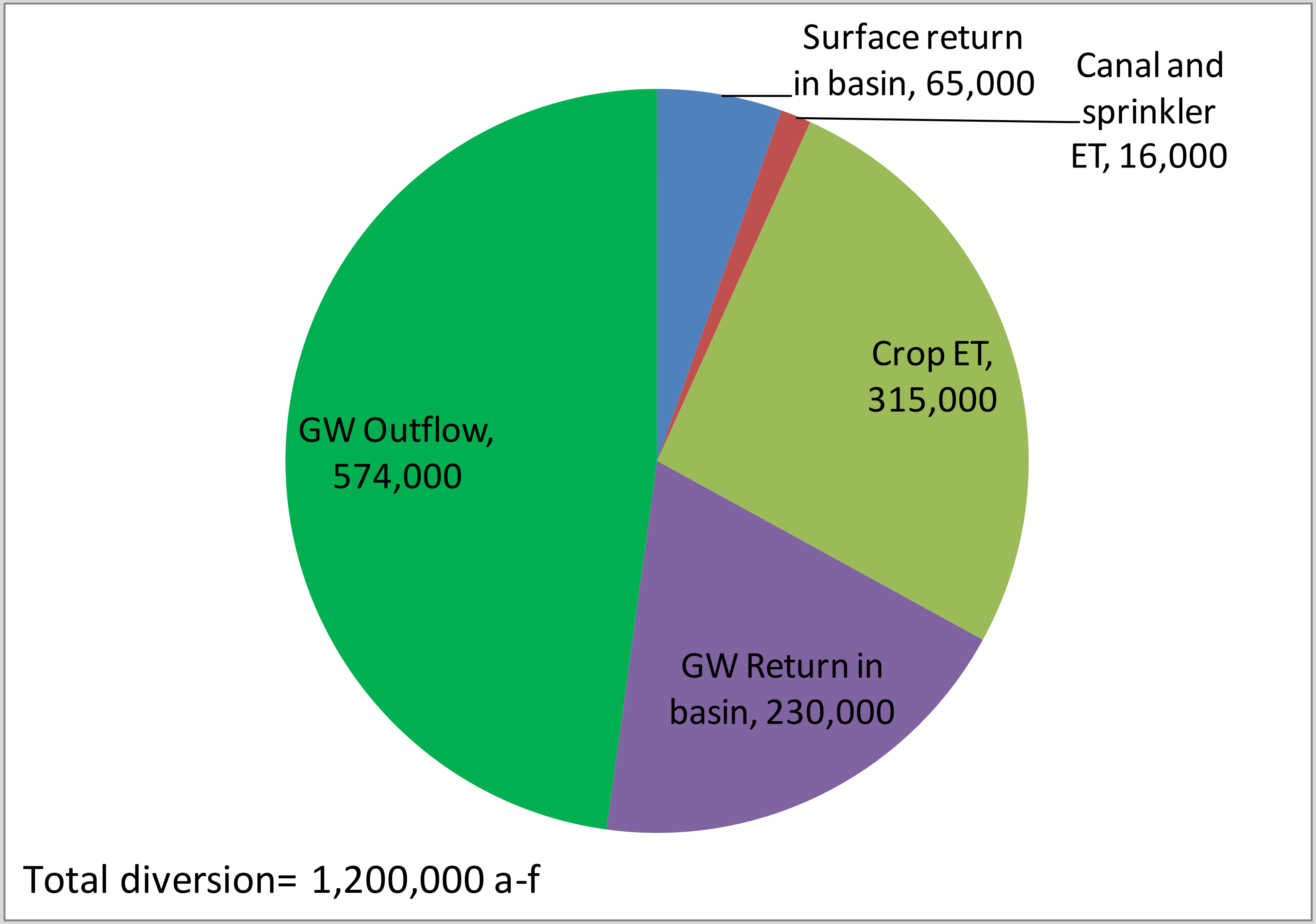
Project Objectives

1. Model ground and surface water flow under historic, current and future land and water use scenarios.
2. Identify socioeconomic factors that determine water use on formerly irrigated land that has been developed and on irrigated land in proximity to development.
3. Provide information on hydrology and water use to decision-makers and stakeholders.
4. Develop strategies to increase water availability for agriculture while enhancing ecological benefits in key stream reaches.
5. Train an interdisciplinary team of graduate students.

Accomplishments to date

1. Model ground and surface water flow (major results follow)
   - Lower watershed model currently being calibrated
   - Teton Valley scenarios nearly complete
2. Identify socioeconomic factors that determine water use
   - Analysis completed; one paper submitted for publication
   - Subdivision water use analysis completed (results to follow)
3. Provide information on hydrology and water use
   - Extensive information provided to USBR special study
   - Materials and plans being prepared (Amy and Veronica)
4. Develop strategies to increase water availability for agriculture while enhancing ecological benefits in key stream reaches
   - 1st draft completed (Amy and Veronica)
5. Train an interdisciplinary team of graduate students
   - Two M.S. thesis defenses completed, one thesis completed
   - All students (including Veronica) have presented results at a major water conference

Hydrologic Modeling Results: Surface diversion budget



- Less than 30% of diverted water is consumptively used
- 2/3 of diverted water recharges aquifers

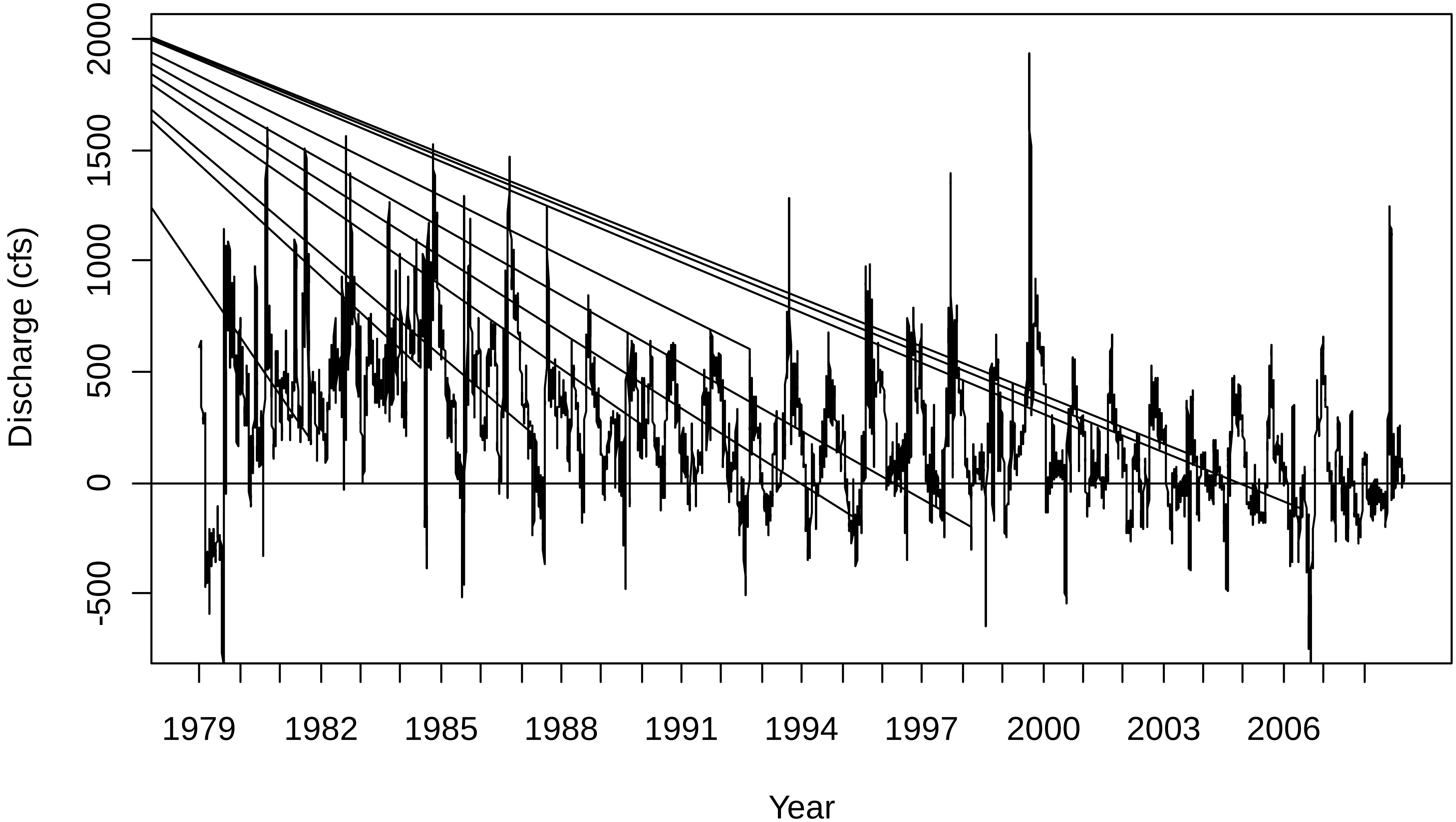
USDA CSREES

Major Hydrologic Modeling Results

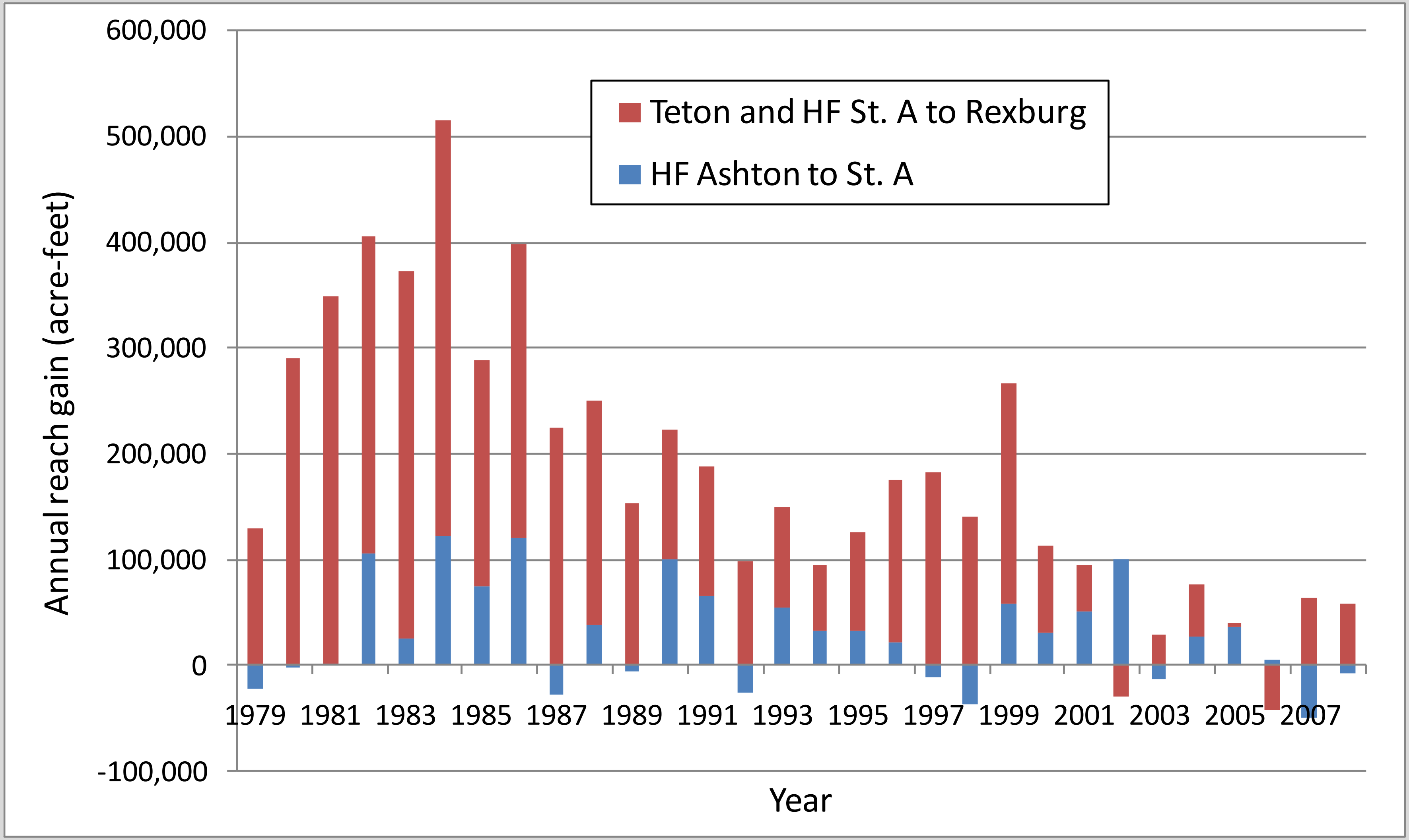
- Canal seepage accounts for majority of recharge
- Total diversion has decreased about 20% since 1978
- Recharge has decreased by about the same amount
- River reach gains have also decreased
- Recharge to regional aquifer has decreased
- Decreased diversion is due largely to increased application "efficiency" (sprinkler versus surface methods); less water is required to irrigate with sprinklers
- Only about 5% of irrigable land has been removed for development since 1970 (map in Amy's talk)

Reach gains in lower Teton and HF

Reach gain = Q at bottom – Q at top + diversions – surface return

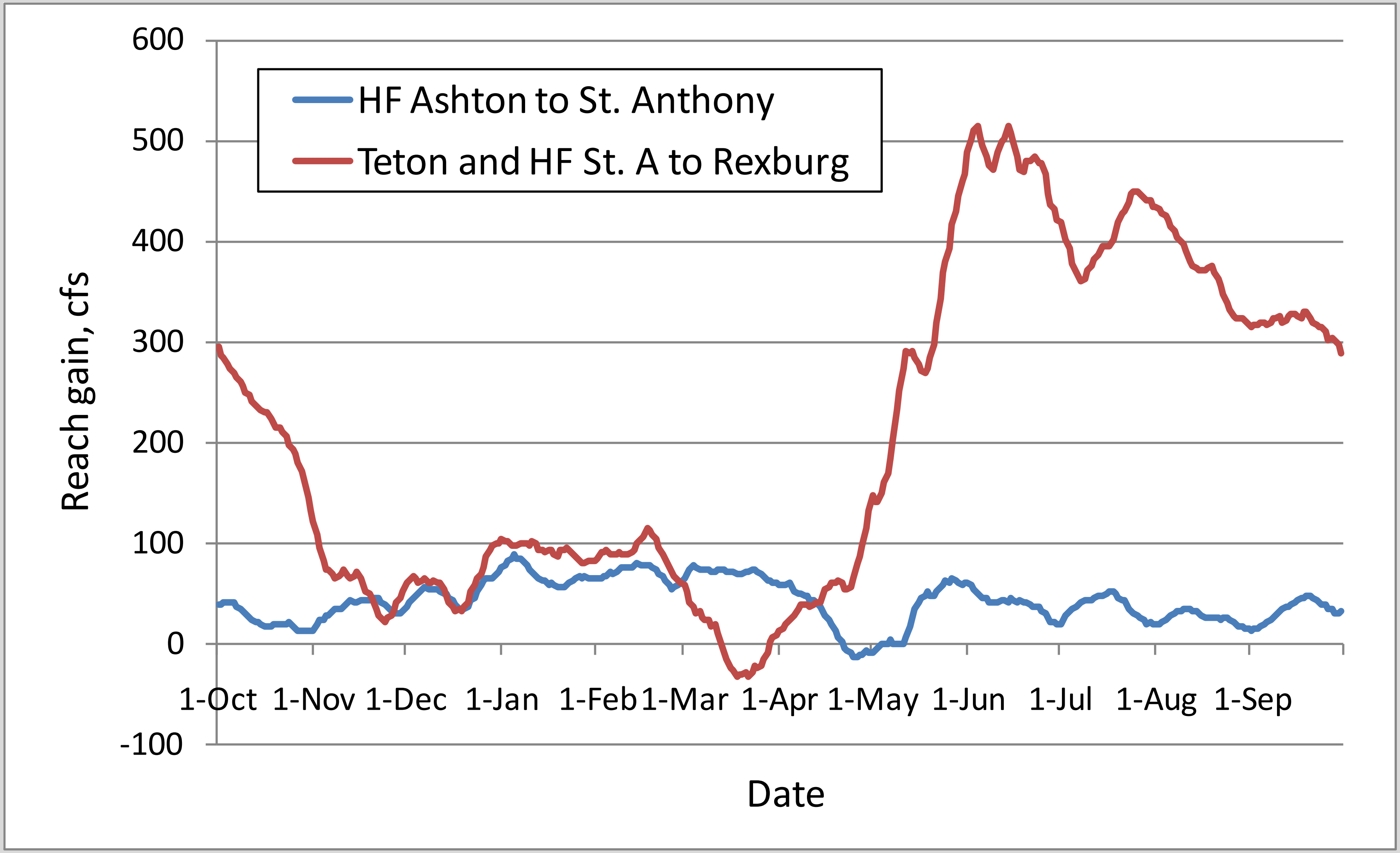


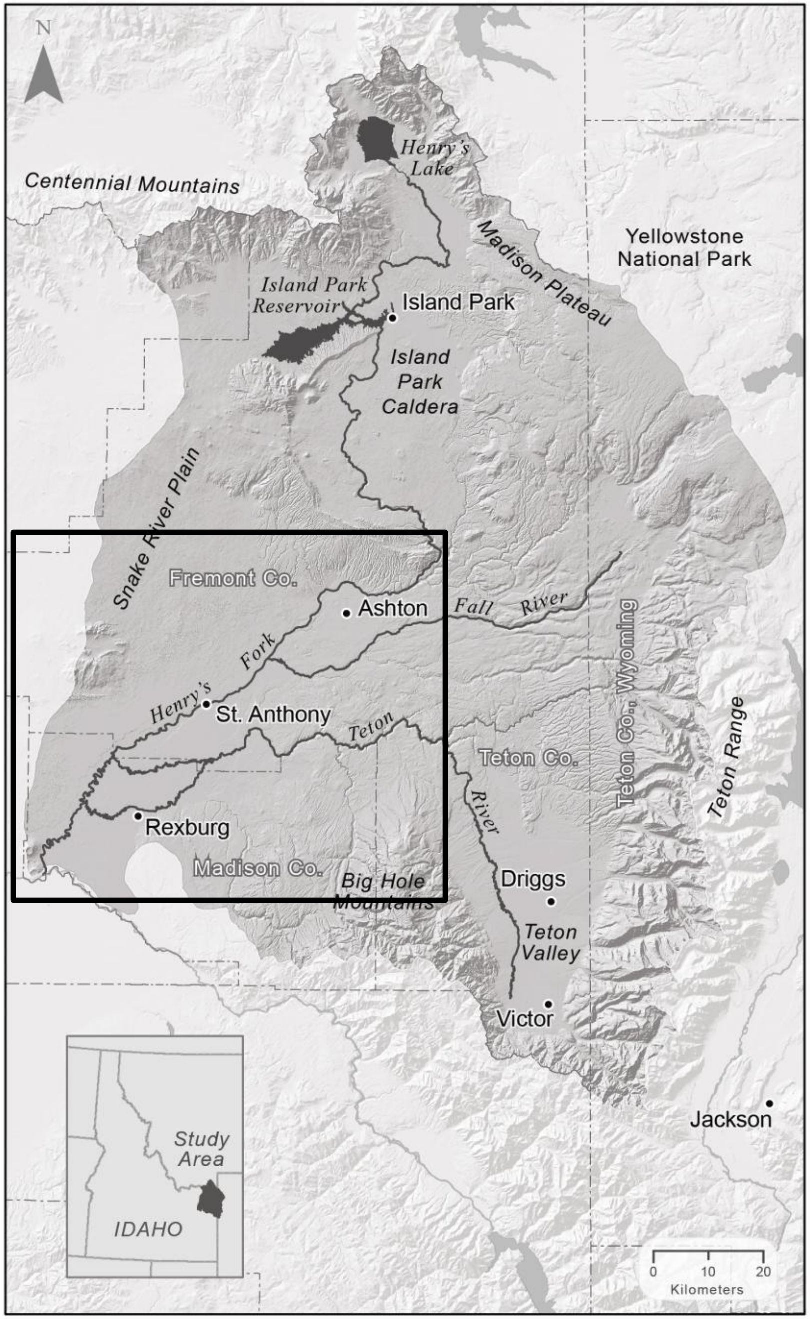
Reach gains in lower Teton and HF



Annual means: Ashton to St. A.: 30,096 a-f; to Rexburg: 147,717 a-f

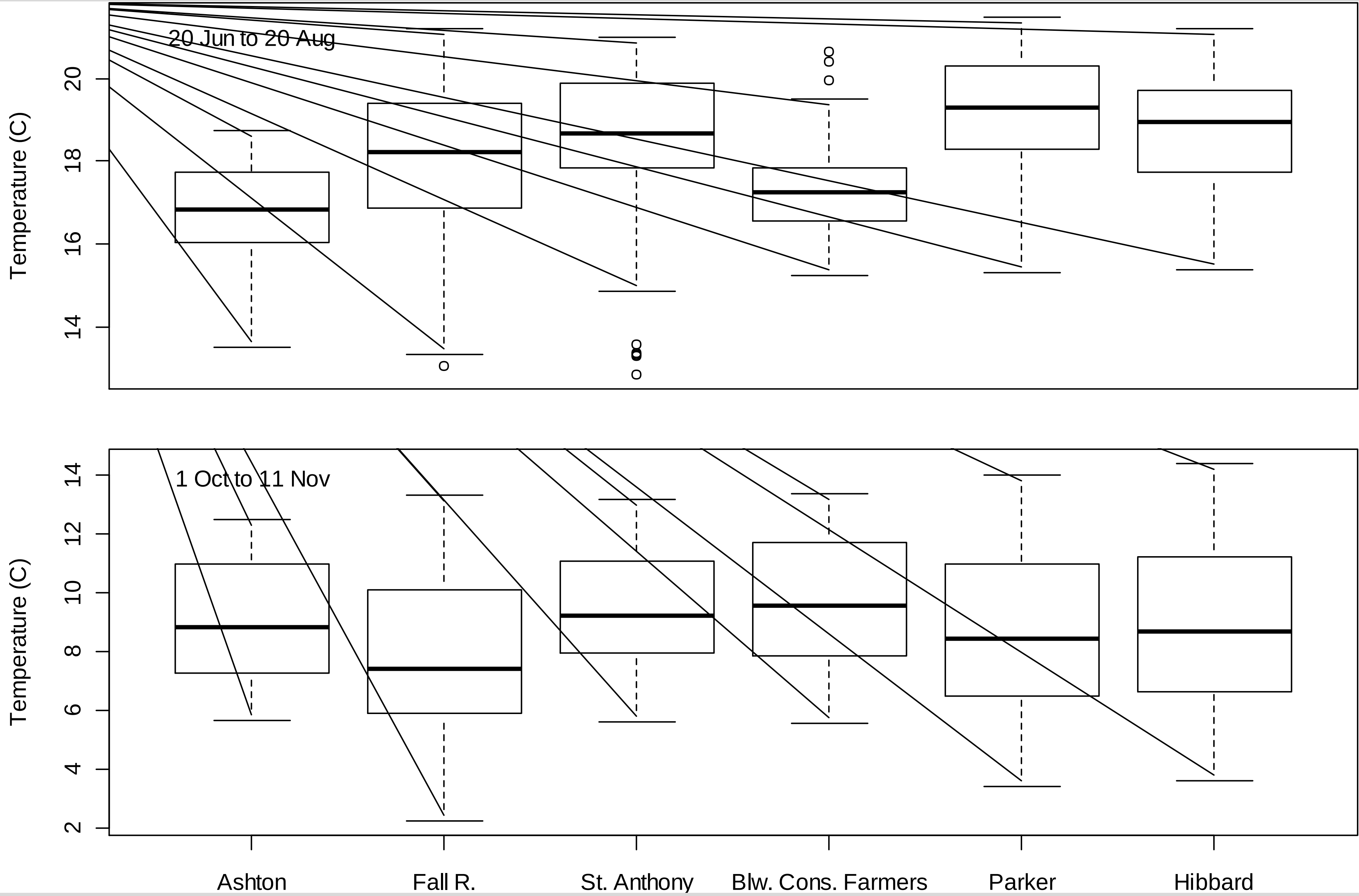
Reach Gain Hydrographs

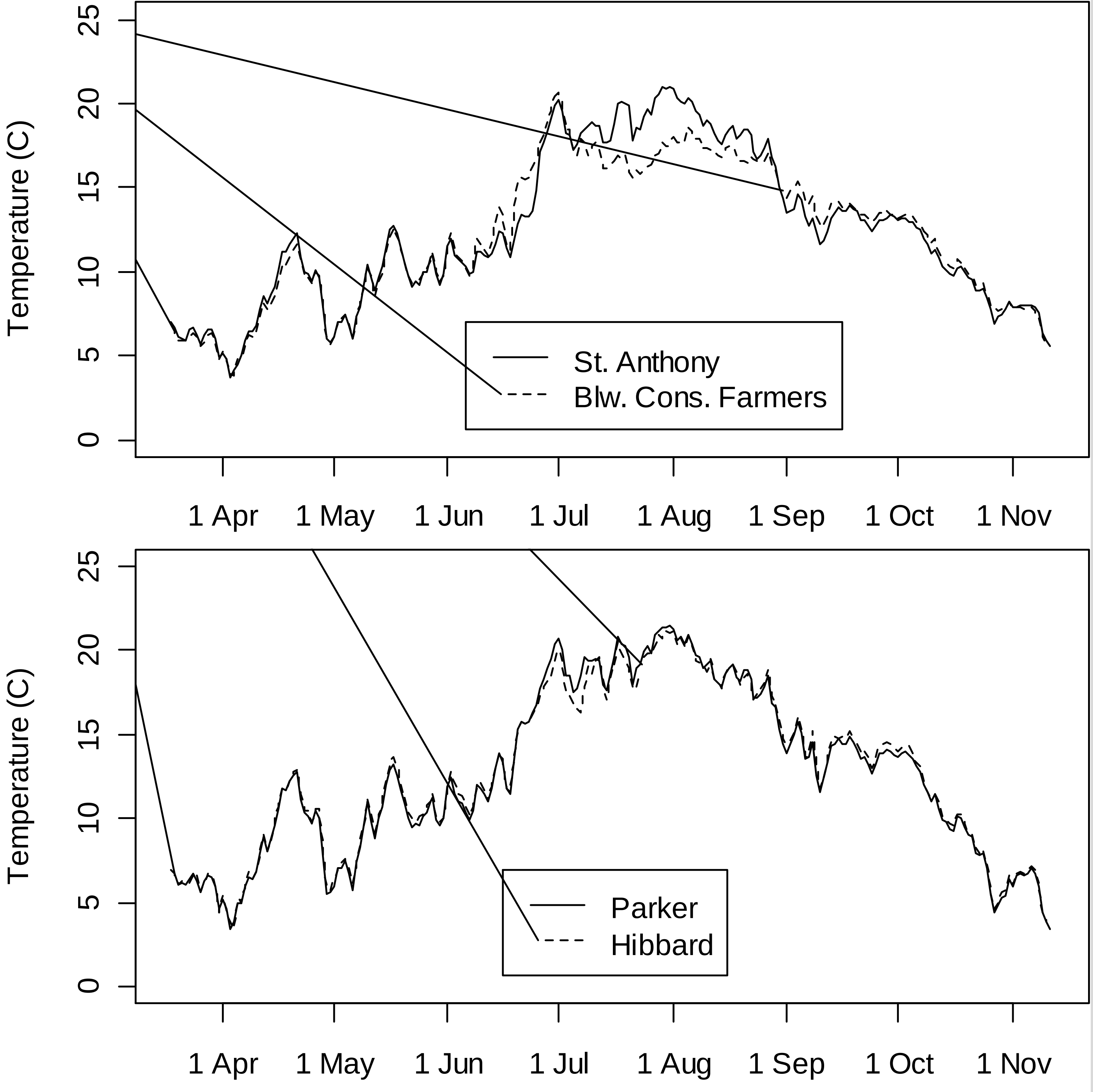




Analysis of water temperature data to identify important reaches of groundwater contribution in lower Henry's Fork

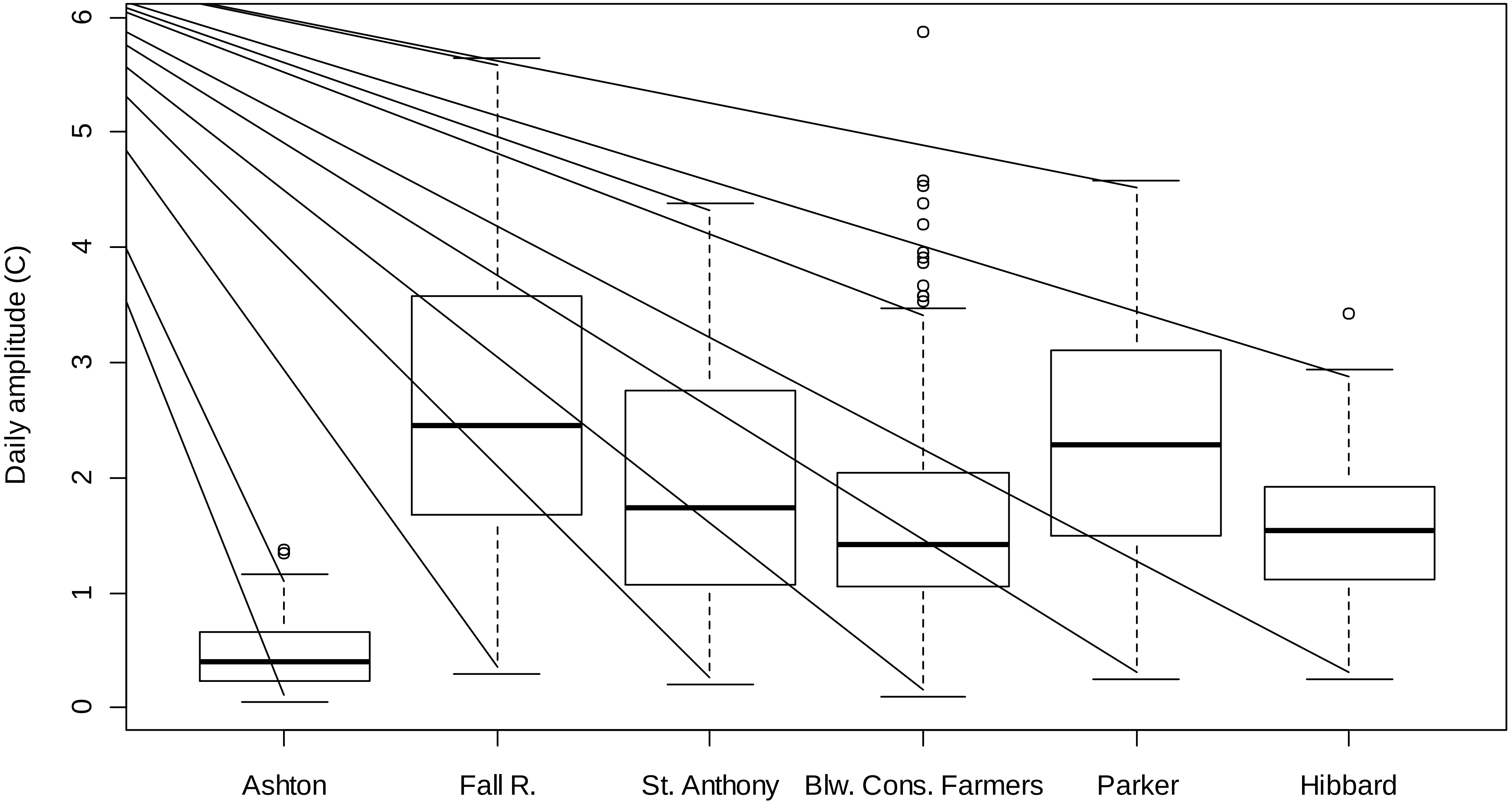
▲ Locations of water temperature recorders during 2010

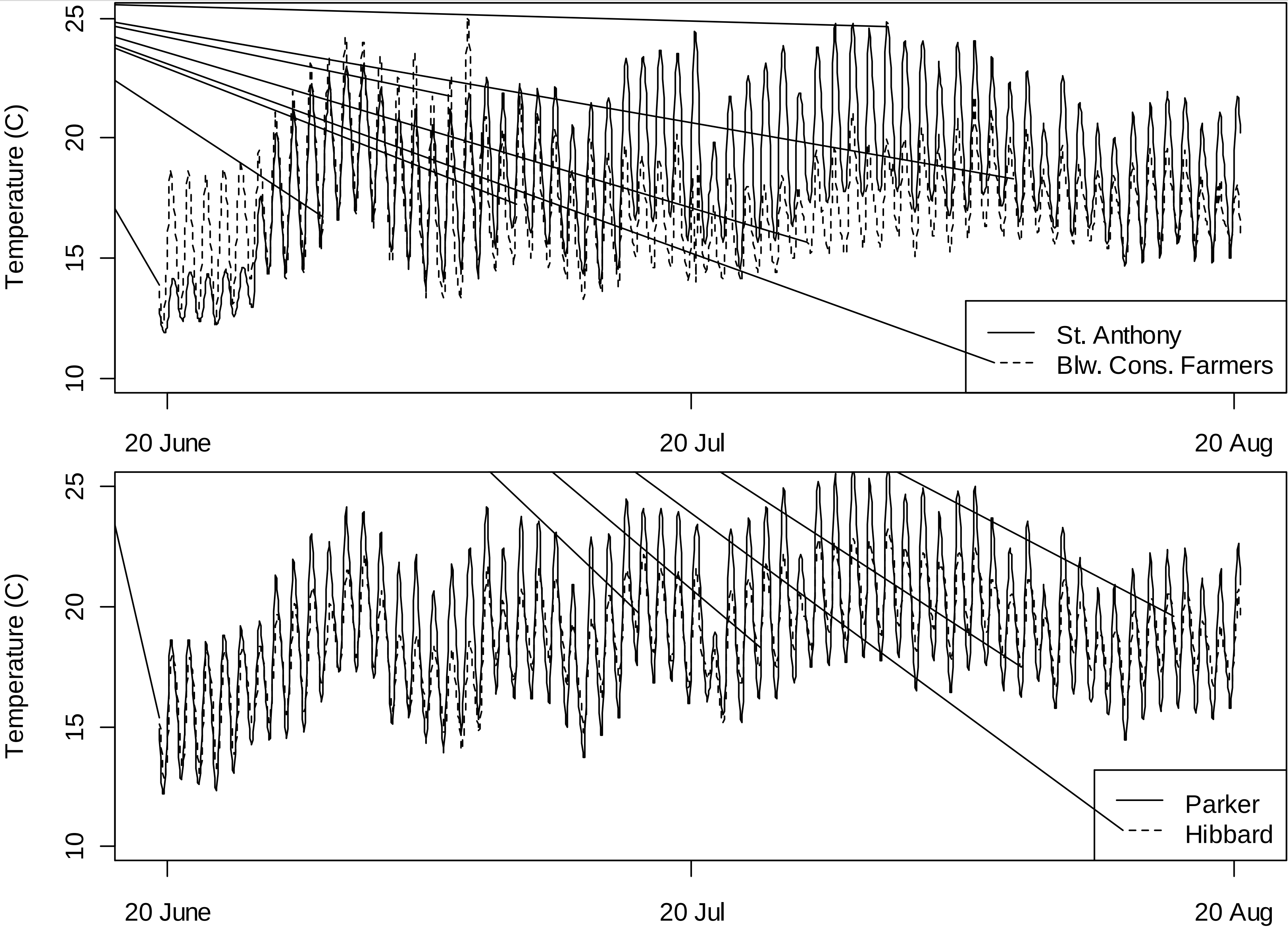

20 Jun to 20 Aug
1 Oct to 11 Nov
Temperature (C)
Temperature (C)
14
16
18
20
2
4
6
8
10
12
14
Ashton
Fall R.
St. Anthony
Blw. Cons. Farmers
Parker
Hibbard



Temperature (C)
0
5
10
15
20
25
1 Apr
1 May
1 Jun
1 Jul
1 Aug
1 Sep
1 Oct
1 Nov
St. Anthony
Blw. Cons. Farmers
Temperature (C)
0
5
10
15
20
25
1 Apr
1 May
1 Jun
1 Jul
1 Aug
1 Sep
1 Oct
1 Nov
Parker
Hibbard

Daily amplitude in temperature



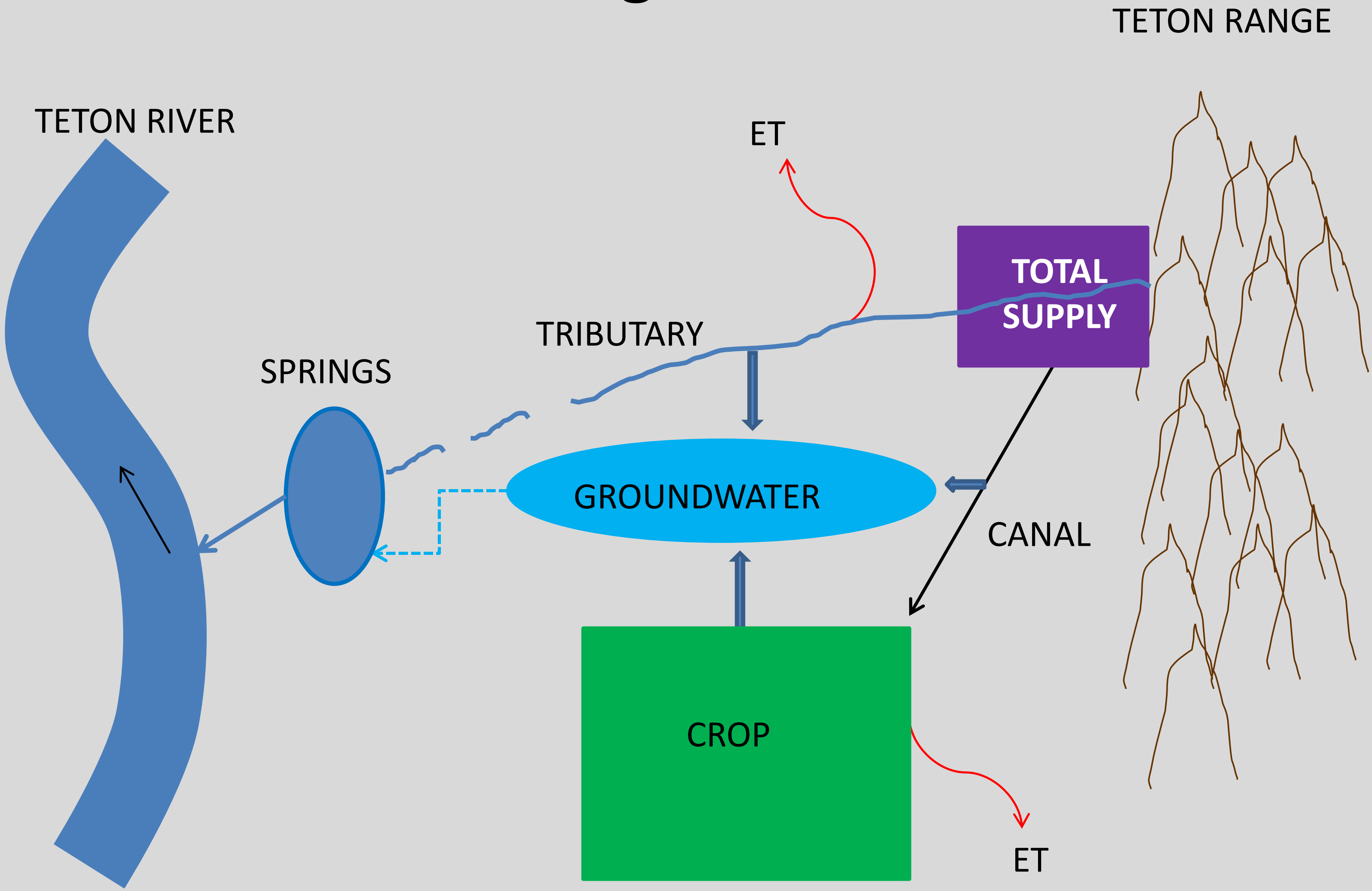


Temperature (C)
10
15
20
25
20 June
20 Jul
20 Aug
St. Anthony
Blw. Cons. Farmers
Temperature (C)
10
15
20
25
20 June
20 Jul
20 Aug
Parker
Hibbard

Conclusions from reach gain analysis

- Large groundwater inputs immediately downstream of St. Anthony
- Large groundwater inputs in lower NF Teton and HF below Parker
- GW inputs moderate water temperature (cooler in summer, warmer in winter, lower diurnal fluctuations)
- GW inputs greatest in mid- to late-summer
- GW inputs derive primarily from irrigation return flow
- Aquatic system in lower HF and lower Teton driven by irrigation-influenced hydrology
- GW returns have declined substantially since 1970s

Hydrologic Modeling: Teton Valley, 6 major Teton Range tributaries



Teton Valley Model Scenarios

Natural: pre-irrigation conditions

Flood: simulated flood irrigation

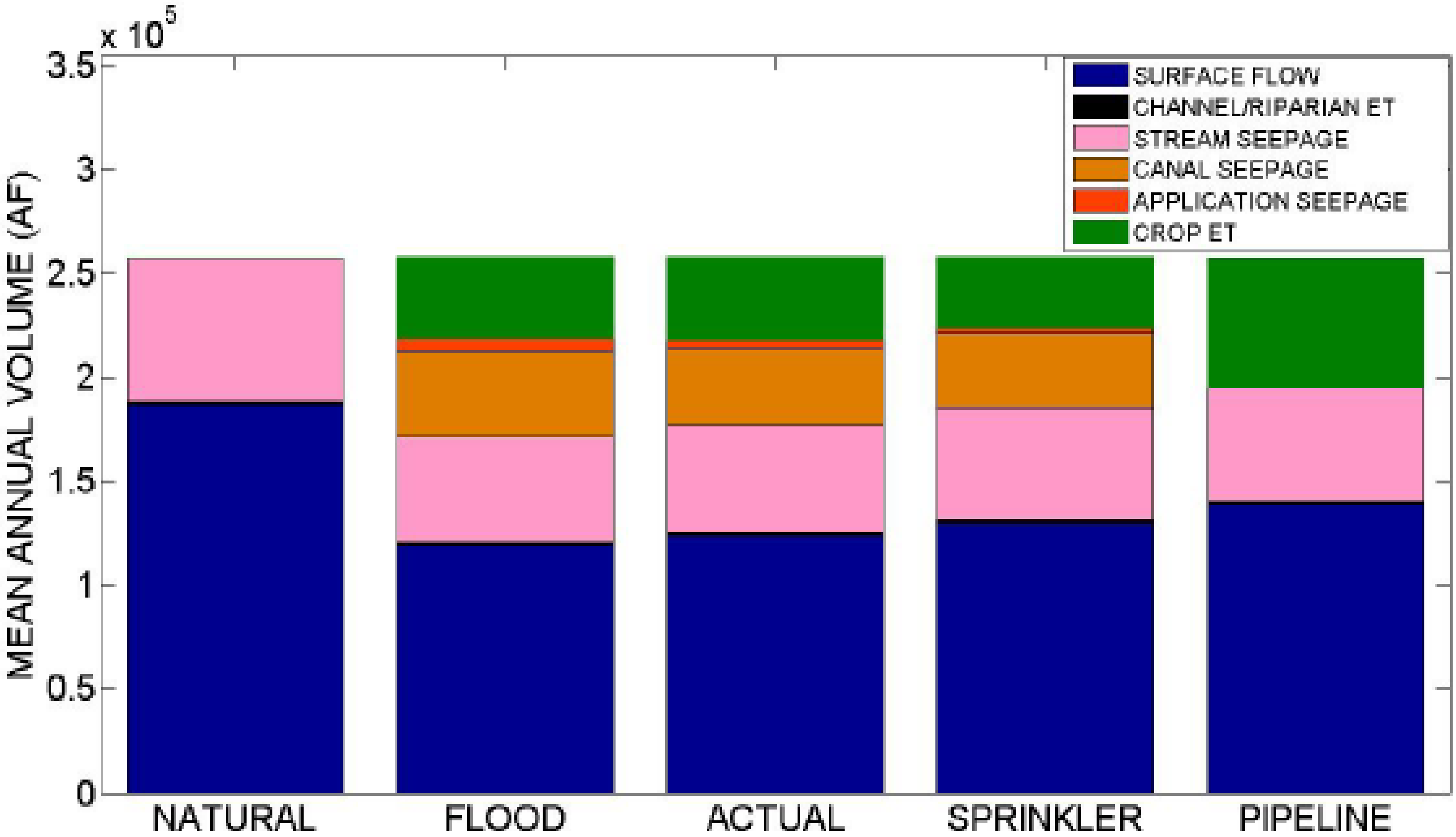
Actual: actual conditions experienced 1979-2008

Sprinkler: current condition (90% sprinkler application)

Pipeline:

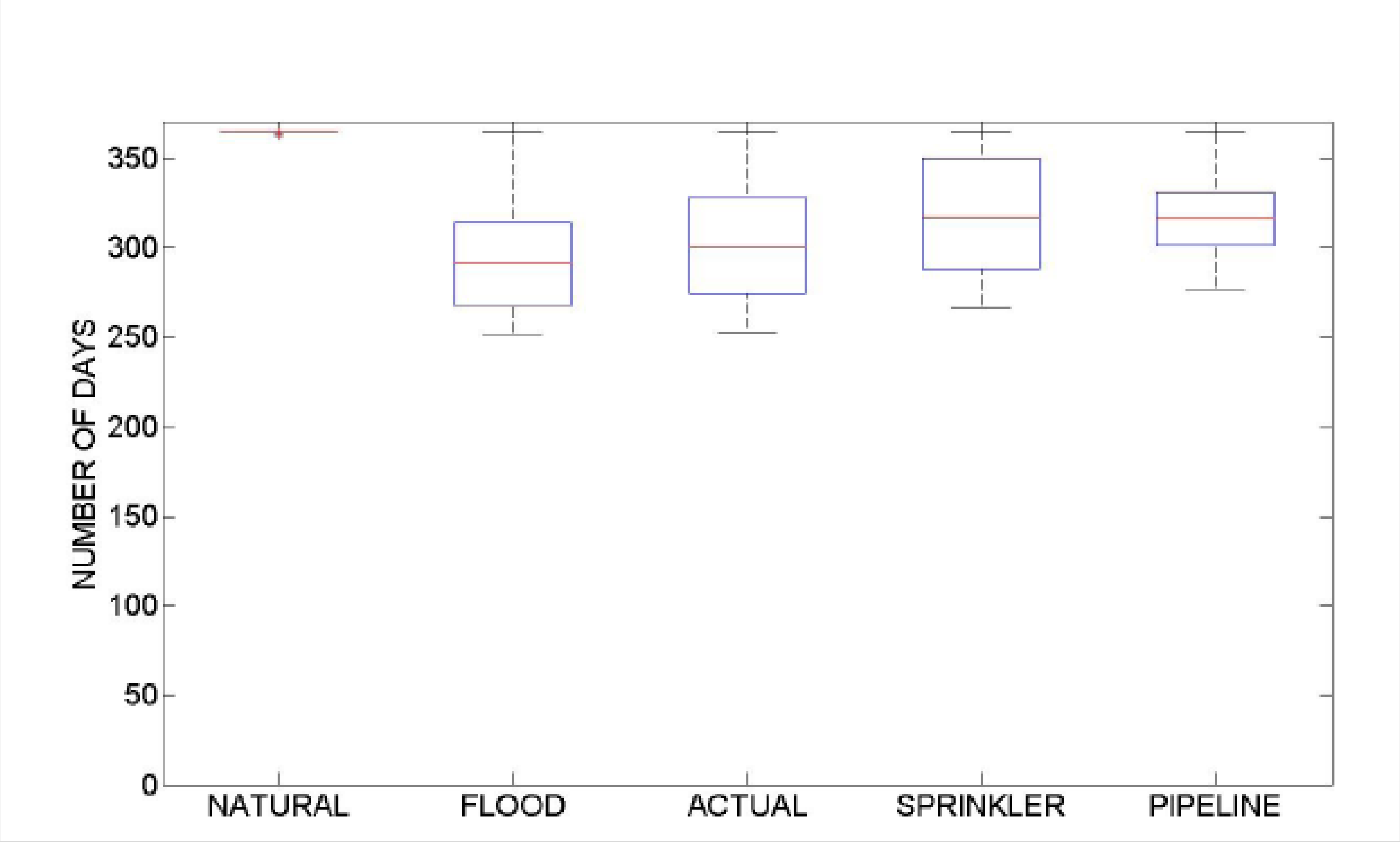
- divert only what crops can use
- up to maximum system capacity and supply
- deliver and apply with 100% efficiency

Teton Valley Model Results: Water Budget



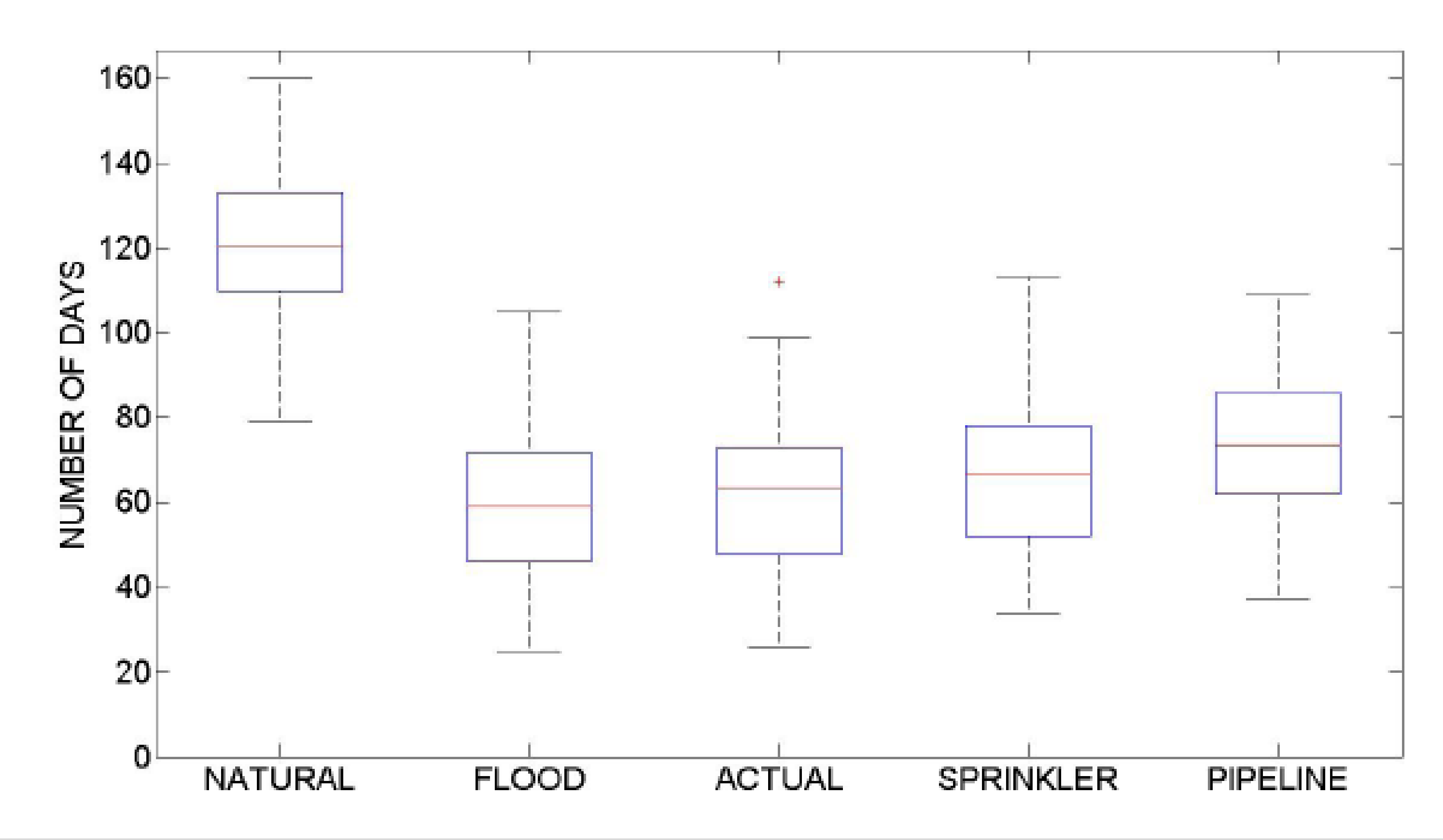
Teton Valley Model Results: streamflow

- Trail Creek: mean number of days surface flow is continuous across losing reach

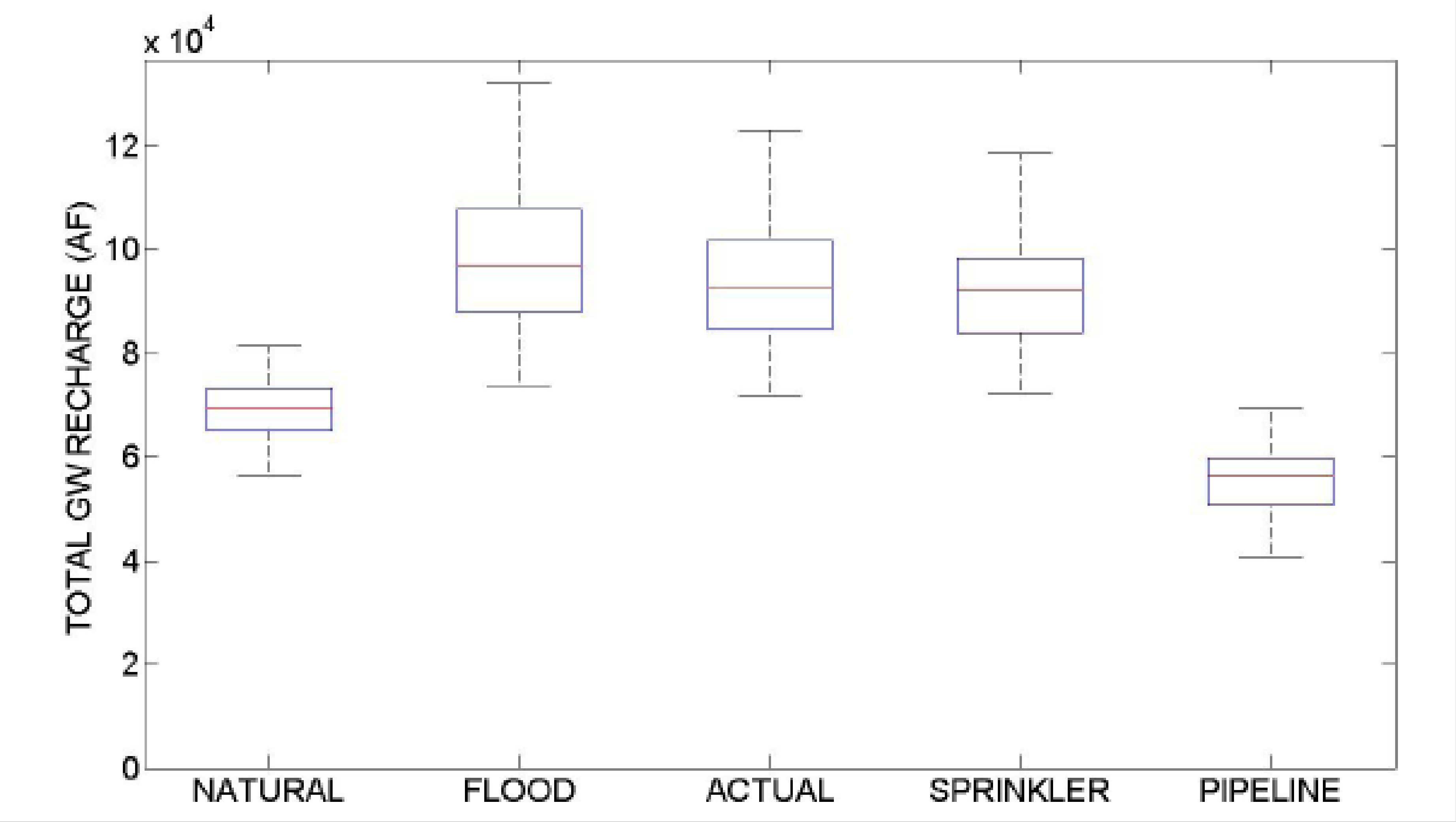


Teton Valley Model Results: streamflow

- Teton Creek: mean number of days surface flow is continuous across losing reach



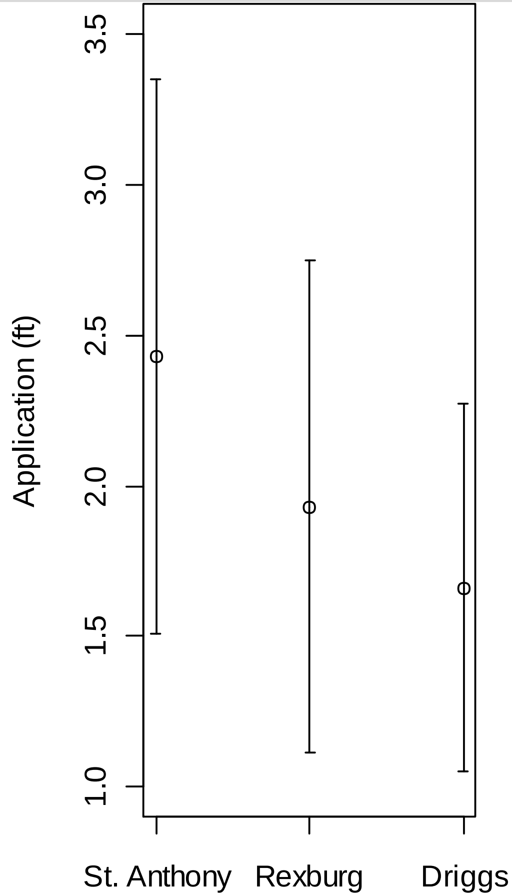
Teton Valley Model Results: GW recharge



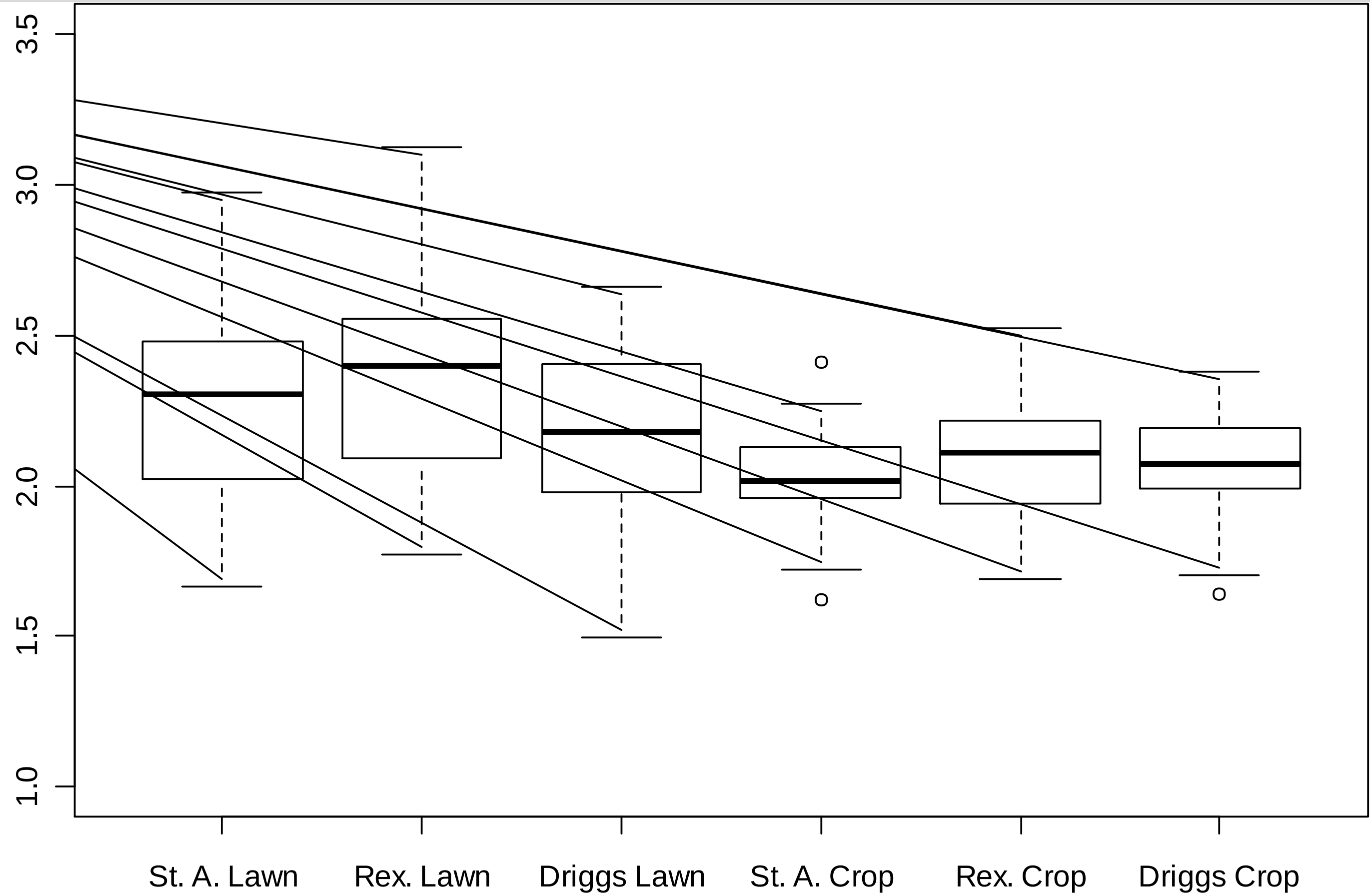
Conclusions from Teton Valley model

- Irrigation practices have lead to a large increase in groundwater recharge
- Placing canals in pipes could
  - Leave slightly more water in the tributaries
  - substantially increase water available for crops/landscaping
  - Decrease groundwater recharge to below pre-irrigation levels
- Whether these changes are desirable or not depends on the resources being considered
  - Native aquatic species
  - Wetlands and wetland-dependent species
  - Nonnative fish
  - Downstream irrigators

Subdivision summer water use analysis



Subdivision seasonal use: mean ± 95% CI



Growing season net ET, 1979-2008

Conclusion: application rates in new subdivisions no different than on agricultural land and no different than ET demand

Major Conclusions

•Canal seepage is primary source of GW recharge in valley locations of HF watershed.
•Application in excess of crop ET is second largest source.
•Conversion to more "efficient" irrigation application has decreased recharge, primarily through decreased diversion into canal system.
•Decreased recharge has decreased GW inflow to rivers
•Decreased GW inflow affects habitat/fish and downstream users.
•Development has removed very little land from crop production.
•Water use rates (depth/season) in new subdivisions are no different than on agricultural lands (and no different than demand).
•But, development can challenge ability of canal companies to continue to maintain and operate canals.
•MAJOR POINT: Changes in amount of water delivered through canals will affect local and regional hydrology and dependent resources. MAKE INFORMED, DELIBERATE DECISIONS!