The Economic and Ecological Tradeoffs of Agricultural Water Use Demand Management in the Upper Green River Basin of Wyoming

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1) Colorado River Basin Drought

2) Primary Water Users with Senior Water Rights

3) SCPP participation
Systems Conservation Pilot Program (SCPP) 2015-2018

Initiated: Following the CRB’s worst consecutive dry years in modern recordkeeping, 2012/13

Purpose: To explore demand management through voluntary, temporary, and compensated reduction in consumptive use (CU)

How: Open-ended call for CU savings projects
• 28,000af WY CU Savings
• 27 projects
• 52 participants
• 24,519 acres
• Agricultural water users growing grass or alfalfa
• Split season deficit irrigation
• $4 million to WY
SCPP Participants

Why Participate?

- Increase family income
- Multi-generational sustainability
- Trout Unlimited recruitment
- Support increased streamflow
- Minimum hay yield impacts
SCPP Non-participants

**Why Not Participate?**

- Use it or Lose it
- Cultural threat of buy and dry
- Uncertain long-term yield impacts
- Threat to wetlands
- Threat to aquifer recharge
- Threat to late season return flows
1) If an SCPP-like program were to expand, where would split season deficit irrigation be implemented between three study sites in the UGRB to maximize economic and ecological benefits?

a) What physical characteristics have the strongest influence on participation between the three study sites?

b) What are the wetland and return flow impacts between the three study sites?

c) Can CU savings payments be cheaper?
Study Sites

1) Boulder Creek
2) Fontenelle Creek
3) Henry’s Fork River
The Model

Max ROVC = \sum_{i=1}^{6} \sum_{j=1}^{3} \left( P_{ij} Y_{ij} + AP_{ij} AY_{ij} - C_{ij} + b_{ij} z_{ij} \right) x_{ij}

where

\begin{align*}
  &i = \text{landuse} \\
  &j = \text{study site} \\
  &x_{ij} = \text{acres} \hspace{1em} (\text{response variable}) \\
  &P_{ij} = \text{cut hay price} \\
  &Y_{ij} = \text{cut hay yield} \\
  &AP_{ij} = \text{aftermath hay price} \\
  &AY_{ij} = \text{aftermath hay yield} \\
  &C_{ij} = \text{variable cost} \\
  &b_{ij} = \text{CU savings compensation} \\
  &z_{ij} = \text{CU savings}
\end{align*}
Study Site

Available Irrigated Benchland

Available Irrigated Bottomland

Flood Grass

Pivot Alfalfa

Flood Grass

\( \times 3 \)
Model Design

Inputs (per acre)
Yield
Yield Price
Aftermath Yield
Aftermath Price
Irrigation Variable Cost
Harvest Variable Cost
Loan Repayment Cost
CU Savings Payment
Water Applied
Consumptive Use
Percent Return Flow
Proportion Historic Wetlands

Constraints
Maximum Irrigated acreage
Minimum Wetlands
Minimum return flow
Minimum CU savings
## Policy Scenarios

<table>
<thead>
<tr>
<th>Scenario 1: Baseline</th>
<th>Scenario 2: Fixed CU Savings Payment</th>
<th>Scenario 3: Variable CU Savings Payment</th>
<th>Scenario 4: Variable CU savings minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximize profits subject to physical constraints as normal under no SCPP-like program</td>
<td>Baseline with a fixed payment per acrefoot of CU savings</td>
<td>Baseline with a variable payment per acrefoot of CU savings by location and landuse based on maximization of ecological benefits per site</td>
<td>New regulatory constraint on total CU savings in Scenarios 1-3</td>
</tr>
<tr>
<td>No constraint on wetlands nor return flows</td>
<td>Constrain total wetlands and return flows</td>
<td>Variable constraints on wetlands and return flows by study site</td>
<td></td>
</tr>
</tbody>
</table>

*CU* stands for *Computerized Urban*.
## Outputs (per acre)
- Return Over Variable Cost
- Compensation
- Consumptive Use Savings
- Change in Return Flow
- Change in Wetlands
GIS Data Collection

Fontenelle Creek

Boulder Creek
The National Wetlands Inventory Data Layer is used to quantify acres of wetlands and type of wetlands at each study site.
Wyoming State Engineer Office Irrigated Acreage remote sensing data is used to quantify the irrigated acreage in bottom (maroon outlined polygons) versus bench lands (yellow outlined polygons).
NRCS Soil Survey data is used to characterize historic wetlands (not irrigation dependent) and return flow behavior.

Fontenelle Creek

Boulder Creek
### Preliminary Results

<table>
<thead>
<tr>
<th>Scenario 1: Baseline</th>
<th>Scenario 2: Fixed CU Savings Payment (No Constraints)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All available irrigated acres are put into production and producers would not voluntarily choose to apply less water</td>
<td>All baseline irrigated acres participate in CU savings practices due to no constraints</td>
</tr>
<tr>
<td>Baseline CU, return flows and wetlands are calculated</td>
<td>$150/af CU savings</td>
</tr>
<tr>
<td></td>
<td>Change in CU, return flows and wetlands are calculated</td>
</tr>
</tbody>
</table>
Scenario 1 and 2 Preliminary Results (no constraints)

Percent Increase in Total ROVC

Study Sites:
- Total
- Boulder
- Fontenelle
- Henry's Fork

ROVC Percent Change:
- Total: 180%
- Boulder: 200%
- Fontenelle: 80%
- Henry's Fork: 80%
Scenario 1 and 2 Preliminary Results (no constraints)

Henry's Fork River ROVC

<table>
<thead>
<tr>
<th>Land Uses</th>
<th>ROVC ($/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FloodBtm</td>
<td>$250</td>
</tr>
<tr>
<td>FloodBtmSCPP</td>
<td>$350</td>
</tr>
<tr>
<td>FloodBench</td>
<td>$150</td>
</tr>
<tr>
<td>FloodBenchSCPP</td>
<td>$400</td>
</tr>
<tr>
<td>Pivot</td>
<td>$100</td>
</tr>
<tr>
<td>PivotSCPP</td>
<td>$200</td>
</tr>
</tbody>
</table>

Baseline_ROVC | SCPP_ROVC
Scenario 1 and 2 Preliminary Results (no constraints)

Consumptive Use

Study Sites

- Boulder
- Fontenelle
- Henry's Fork

Consumptive Use (acrefeet)

- Baseline_CU
- SCPP_CU
Scenario 1 and 2 Preliminary Results (no constraints)

Return Flow

Return Flow (acrefeet)

Study Sites

Boulder
Fontenelle
Henry's Fork

Baseline_Reflow
SCPP_Reflow
Scenario 1 and 2 Preliminary Results (no constraints)

**Wetlands**

<table>
<thead>
<tr>
<th>Study Sites</th>
<th>Wetland Acreage (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>4500 (Baseline_Wetlands)</td>
</tr>
<tr>
<td>Fontenelle</td>
<td>1500 (Baseline_Wetlands)</td>
</tr>
<tr>
<td>Henry's Fork</td>
<td>5500 (Baseline_Wetlands)</td>
</tr>
</tbody>
</table>
THANK YOU FOR LISTENING!

QUESTIONS?