Optimization at Wisconsin: CS and WID

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http://wid.wisc.edu/research/optimization

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Biomass Research and Development Initiative (BRDI)

- Whole farm (complex interacting) mathematical model
- Long term sustainable (environment and financial)
- Economic/Logistic Optimization, taking into account phosphorus runoff, other environmental restrictions
- Incorporates data analytics (e.g. SNAP+)
- New insights to operate system efficiently, how to enforce much stricter environmental constraints using blend of rotations, NMP and separations
- Large (mixed integer) optimization

Ferris (Univ. Wisconsin)

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**Total Yearly Cost of Running Farm**

- **No sep**
- **1st sep**
- **2nd sep**

**Cost of Nutrient Management ($ millions)**

- 0.7
- 0.8
- 0.9
- 1.0
- 1.1
- 1.2
- 1.3
- 1.4
- 1.5
- 1.6

**Number of Cows**

- 3000
- 3500
- 4000
- 4500
- 5000
- 5500
- 6000
- 6500
- 7000
Fishwerks: A decision support tool

- Great lakes basin scale data visualization
- 250,000+ interdependent barriers on a river network
- Crowd sourcing data updates
- Complex optimization for budget constraints, specific fish guilds, invasives
- Adopted for use by Fish and Wildlife Service www.greatlakesconnectivity.org
Water rights pricing (Britz/F./Kuhn)
The model IO + trade (mechanism design)

\[
\begin{align*}
\max_{q_i, x_i, w_{oi}, w_{ri}^b, w_{ri}^s \geq 0} & \left( q_i \cdot p - \sum_{f} x_{i,f} \cdot w_f - w_{ri}^b \cdot (w_{wr} + \tau) + w_{ri}^s \cdot w_{wr} \right) \\
\text{s.t.} & \quad q_i \leq \prod_f (x_{i,f} + e_{i,f})^{\epsilon_{i,f}} \\
& \quad x_{i,\text{land}} \leq e_{i,\text{land}} \\
& \quad w_{oi-1} = x_{i,\text{wat}} + w_{oi} \\
& \quad w_{ri} + w_{ri}^b \geq x_{i,\text{wat}} + w_{ri}^s \\
\end{align*}
\]

\[
\begin{align*}
0 & \leq p \perp \sum_i q_i - d(p) \geq 0 \\
0 & \leq w_{lab} \perp \sum_i e_{i,lab} - \sum_i x_{i,lab} \geq 0 \\
0 & \leq w_{wr} \perp \sum_i w_{ri}^s - \sum_i w_{ri}^b \geq 0 \\
\end{align*}
\]
Different Management Strategies

![Bar Chart]

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<th>Equitable rights</th>
<th>Water charges 10</th>
<th>Water charges 14</th>
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<th>Water charges 30</th>
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<th>Water right trade</th>
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<td>1000</td>
<td>1400</td>
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<td>2200</td>
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<td>1969</td>
<td>3398</td>
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