Systems Modeling to Improve the Hydro-Ecological Performance of Diked Wetlands

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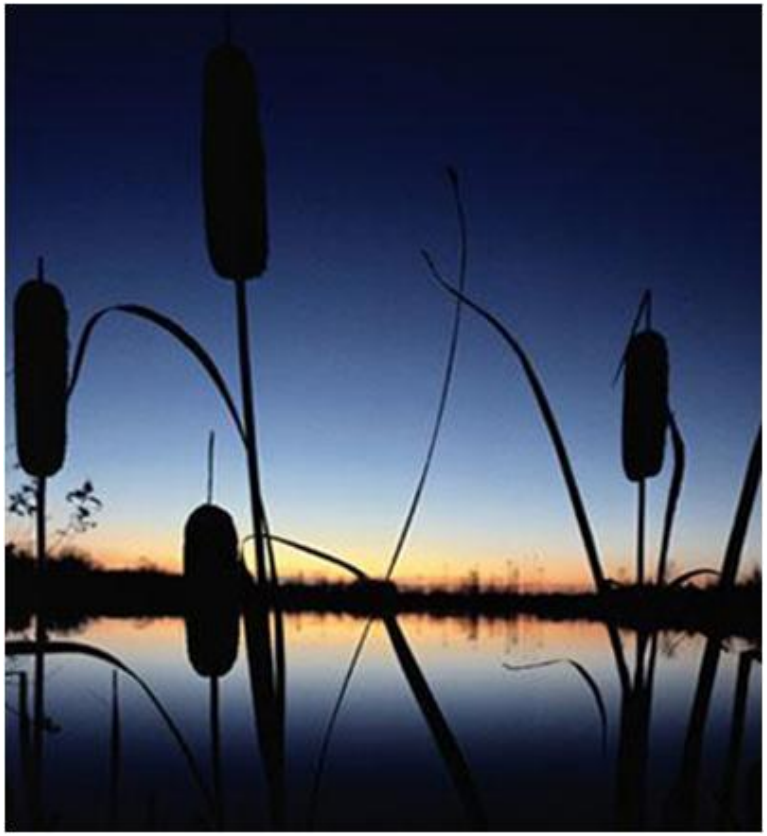
Spring Runoff Conference
9 April, 2013

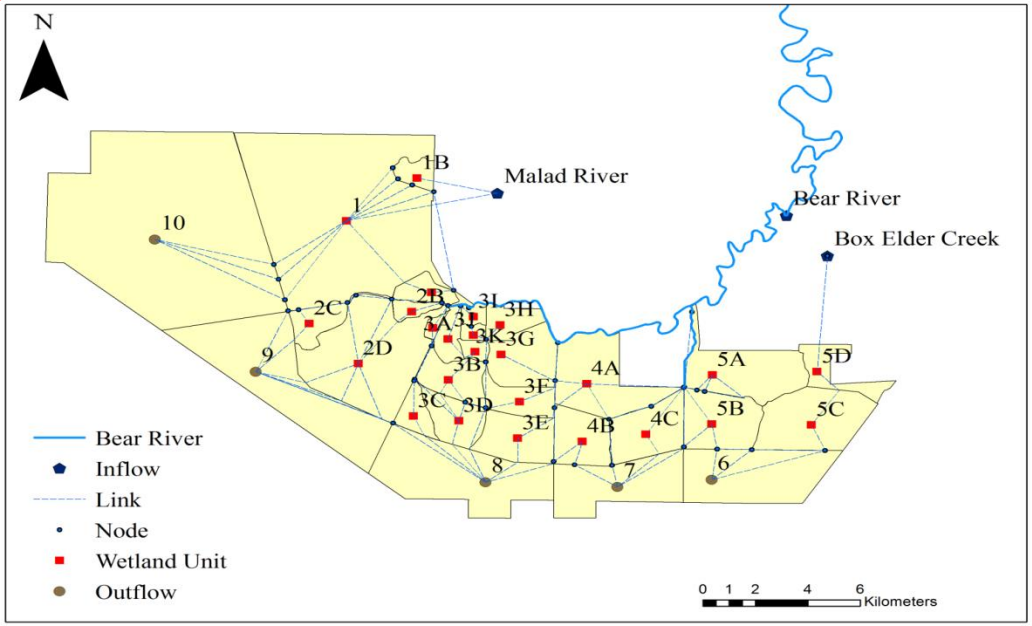
Outline

- Area of Study
- Problems
- Research Objective
- Model Formulation
- Results
- Conclusions

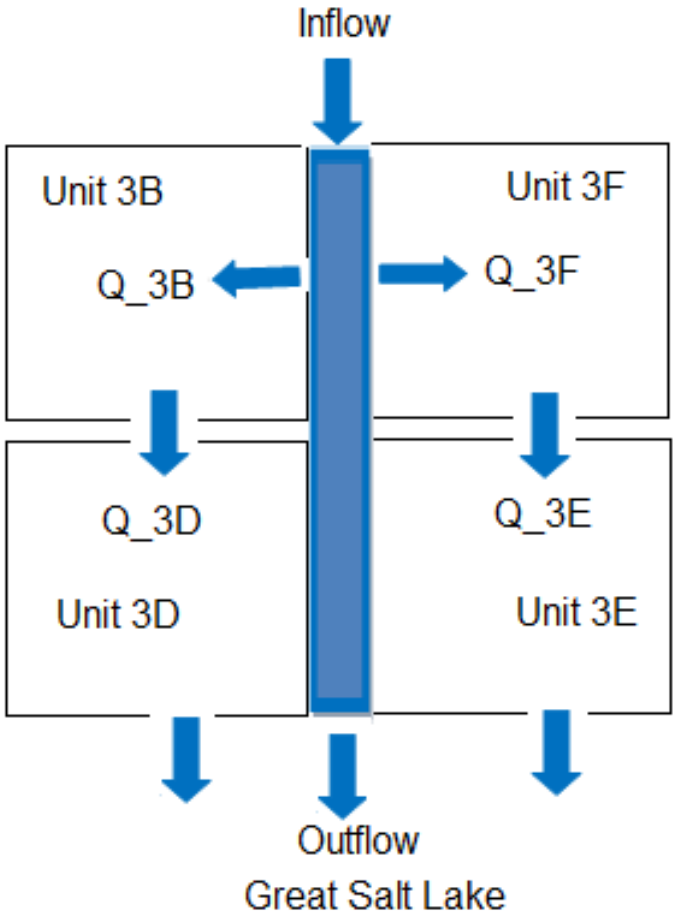


Area of Study

- ✓Bear River Migratory Bird Refuge, Utah (The Refuge)
- ✓Covers 300 Km^2
- ✓Important for migratory birds on the Pacific Flyway.



Water Allocation Problems at the Refuge



Invasive Species Problems at the Refuge

Research Objective

Develop a systems optimization model to recommend water allocations and vegetation control actions among wetland units to improve hydro-ecological performance of diked wetlands.

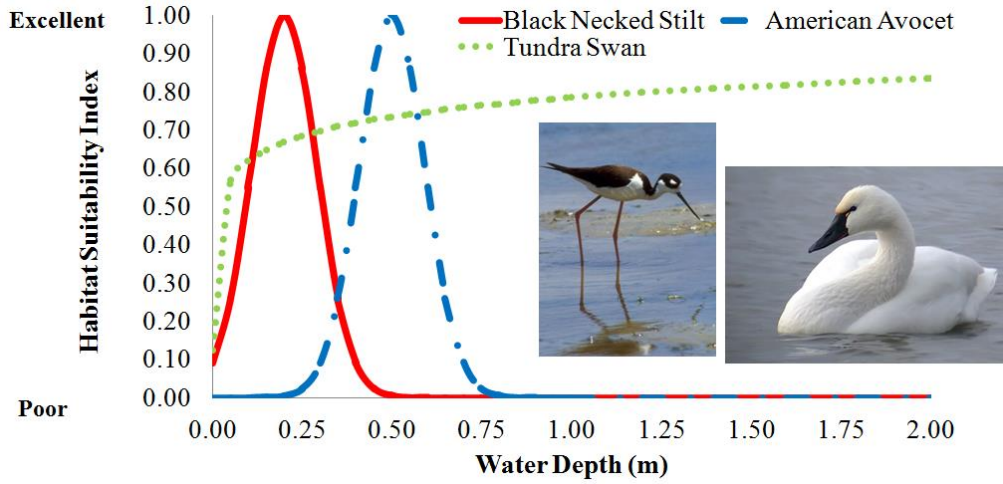
Model Development

1. Identify Wetland Management Purposes
2. Identify Performance Indicators
3. Identify Decision Variables
4. Determine Relationship between Decision Variables and Performance Indicators
5. Identify Constraints
6. Formulate Optimization Model

Promote diverse habitat types

HSI =Habitat Suitability Index

HSI = Capacity of a given attribute to



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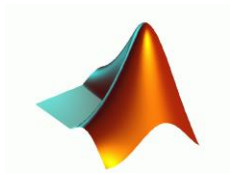
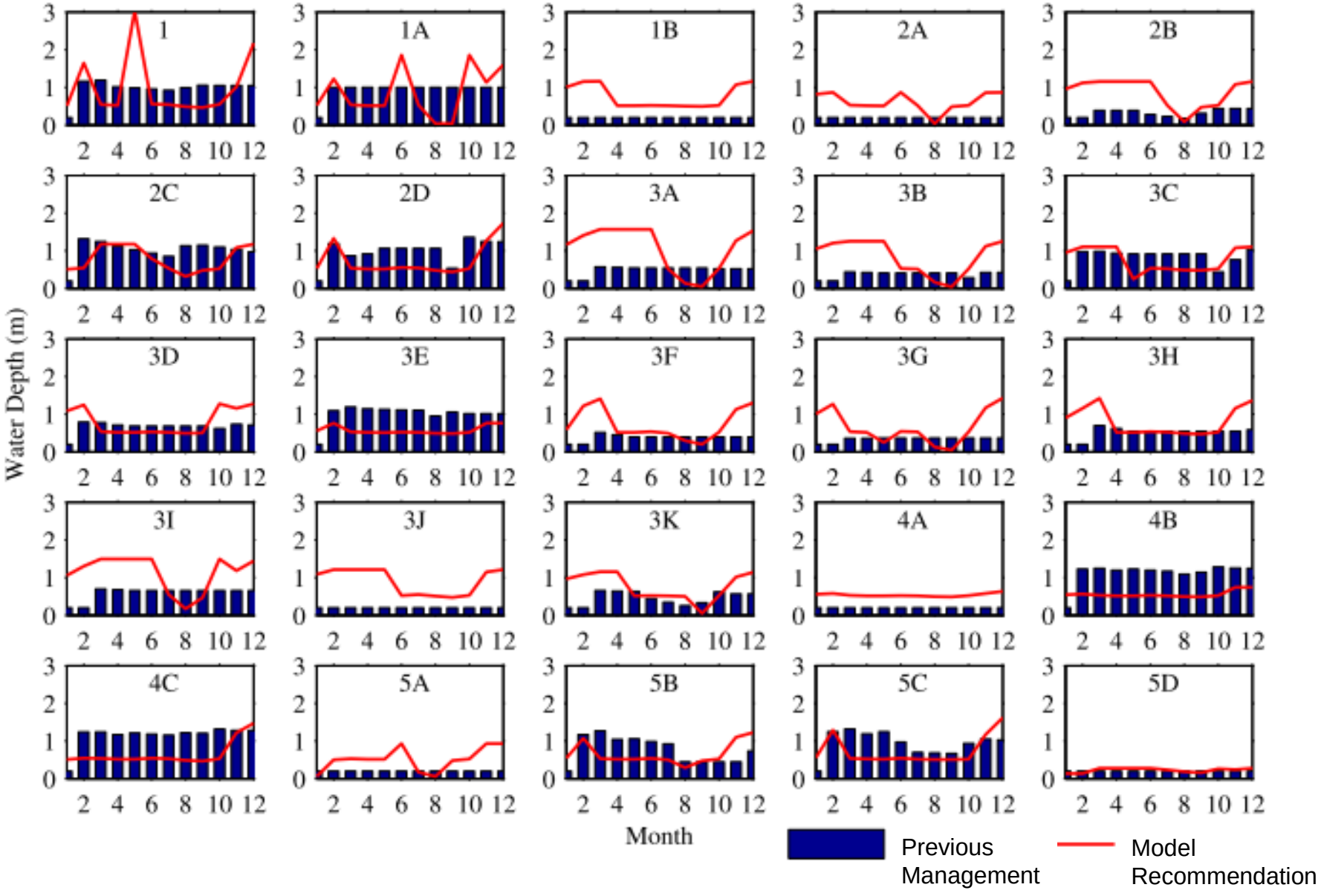
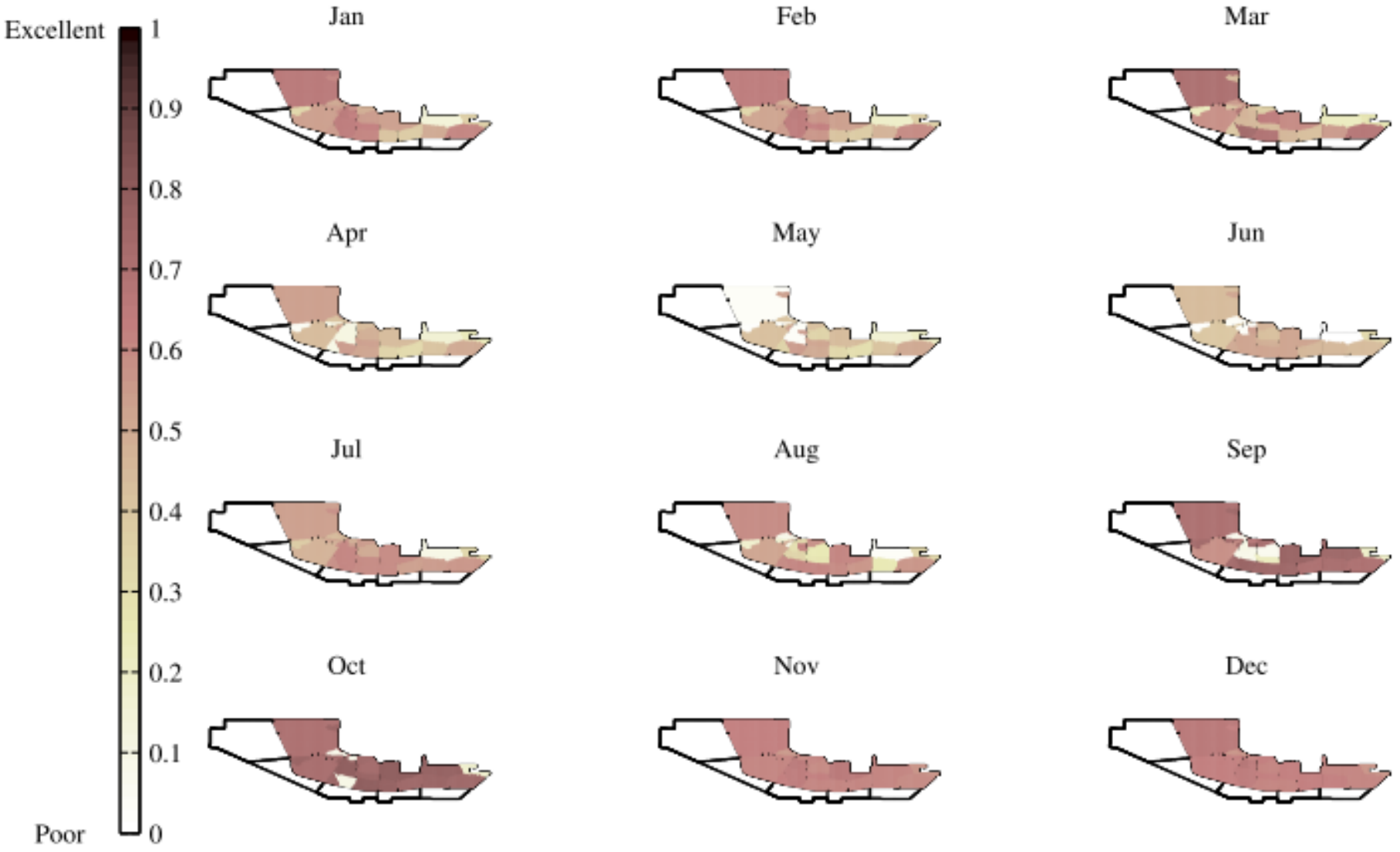
Model Organization

INPUTS	MODEL	OUTPUTS
Hydrological • Water availability • Network conveyance • Initial, maximum and minimum wetland storage • Evaporation loss • Storage, area, and water depth relationships for wetland unit • Channel capacities **Ecological** • Initial vegetation coverage • Habitat species requirements • Species weights **Management** • Unit cost of removing invasive vegetation • Total financial budget to manage vegetation • Number of wetland units at which manager can operate gates.	**Hydro Platform** Manages inputs and displays network. **GAMS** Optimization engine (General Algebraic Modeling System) **MATLAB** Graphic Interface.  	**Wetland Performance** • Available surface area that provides suitable conditions for priority bird species **Recommend** • Water allocations to wetland units • Reduction of invasive vegetation • Allocation of financial budget to reduce invasive vegetation **Simulate** • Water allocations based on wetland management requirements **Shadow Values and Sensitivity Analyses** • How changes in water availability, vegetation response, financial budgets affect wetland management performance.

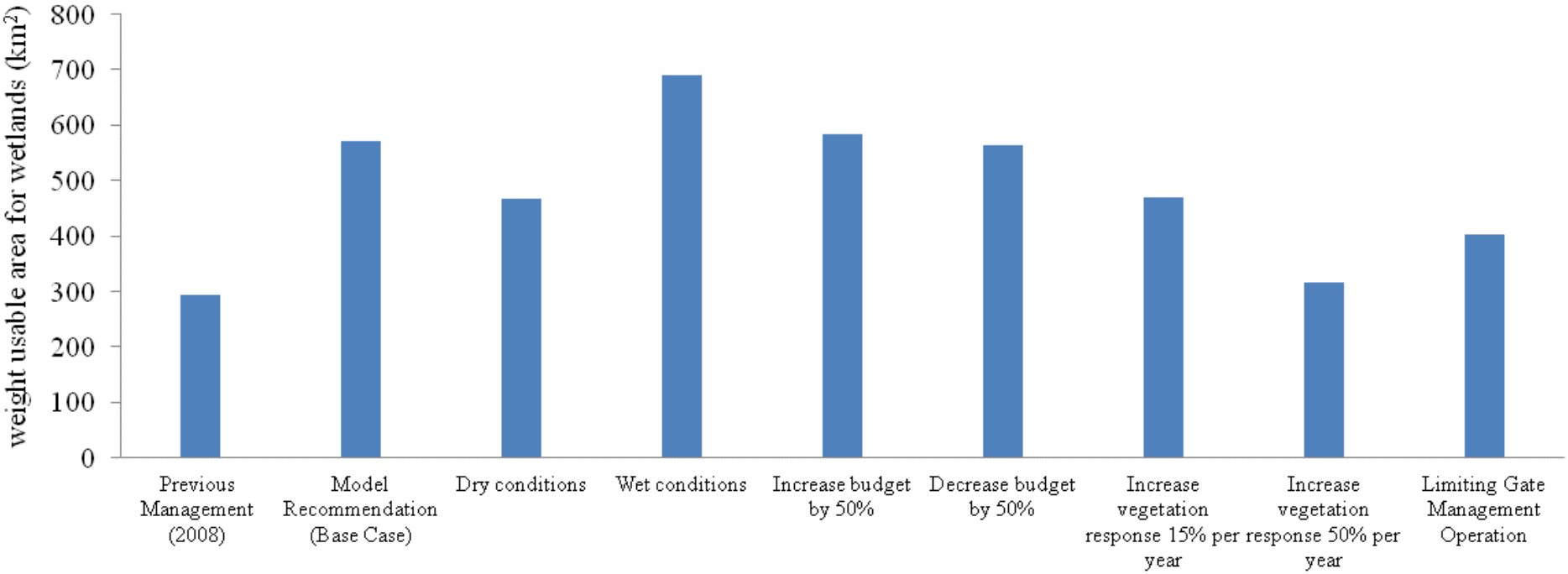
Results: Previous Management vs. Model Recommendation



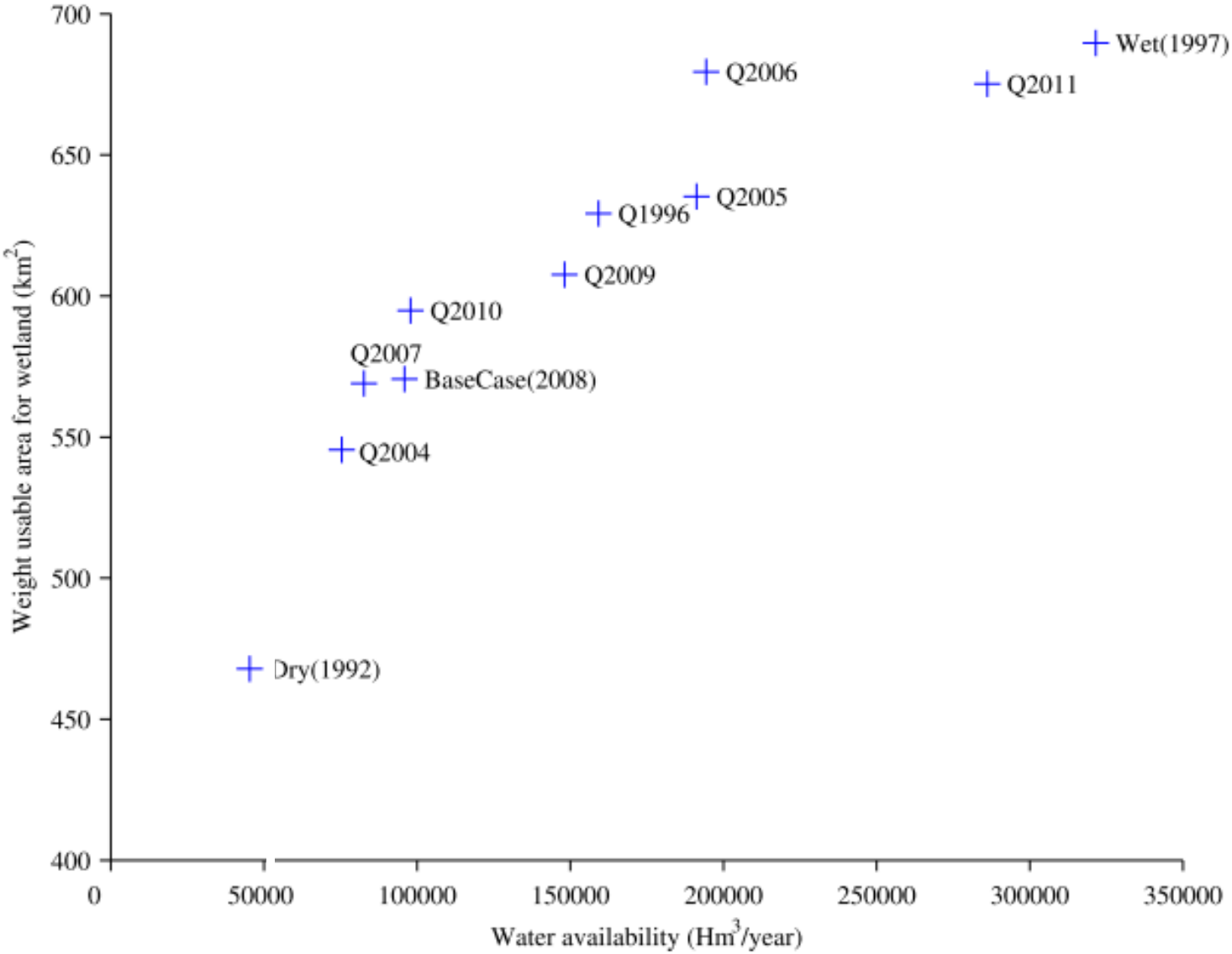
Results: Composite Habitat Suitability Index



Results: Model Performance

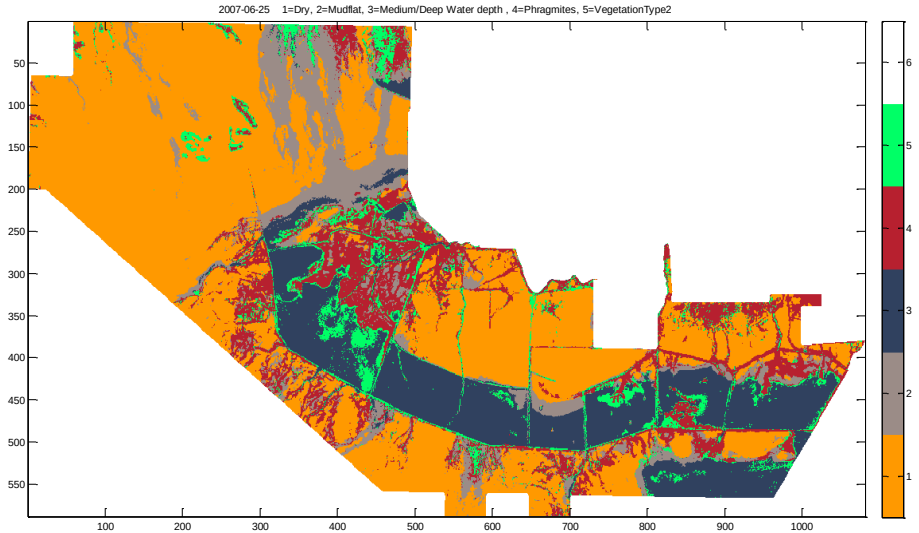


Results: Relationship between Weight Usable Area for Wetlands indicator and water availability



Further Work

- Identify hydrological-plant response relationships at the Refuge.
- Embed this relationship into the existing model.



Conclusions

- We develop a system optimization modeling to wetlands management.
- We use indicators to measure hydro-ecological performance in wetlands
- We can quantify impacts of changes in water availability and invasive vegetation on wetlands.
- We apply the model at the largest wetland complex on the Great Salt Lake, Utah.
- Participatory modeling effort – stakeholders were involved in problem identification through interpretation of results.

Acknowledgments

- Utah Water Research Laboratory
  - Utah Mineral Lease funds
- Bear River Migratory Bird Refuge

Thanks..

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