**Coupling Water Quality Numerical Simulation and Hedonic Models to Evaluate Impacts of Changes in Nutrient Loading**

Hedonic team (KB-lead, WW), GLM team (CC-co-lead, KF, PH), KC & others

Target journal: *Journal of* *Environmental Management* (other suggestions welcome)

Introduction

1. Environmental issue: water quality in many lakes is decreasing globally due to increasing nutrient loads. Nutrient pollution (eutrophication) has severe negative impacts on lake ecology, water quality, and consequently services enjoyed by people
2. Coupling of limnology-hedonic models facilitates policy-relevant scenarios to enhance decision making
   1. Literature is focused on hedonic models based on observed limnological conditions
   2. Knowledge gap is linking hedonic models to models of limnological processes in catchments to understand how potential changes in the landscape can alter water quality and, in turn, lakeshore property values
3. What is novelty of this paper
   1. No papers of which we are aware have explicitly coupled a water quality numerical simulation model to a Hedonic model
   2. We focus Lake Mendota in Wisconsin, USA here as an example of how lake and hedonic models can be coupled to provide projections of economic impacts that are linked to limnological processes
4. Motivation of the scenarios
   1. Proof-of-concept of coupling, so chose twin scenarios showing increases and decreases in nutrient loading
   2. Illustrates the connection between ecological-economic systems within a catchment
   3. Sets the foundation for exploration realistic scenarios to inform by policy actions

Mendota description

1. Why Mendota
   1. One of the most well-studied lakes, providing excellent long-term water quality data for model calibration
   2. Water quality in lake is strongly linked to nutrient loads from catchment
   3. Long-term water quality degradation in Lake Mendota motivates the need to study the effects of changing services for humans
2. Description of the long-term datasets that inform study

GLM description

1. Model description
2. Model calibration, parameters (supplementary table)
3. Baseline observed WQ and simulation (Figure 1. Chla etc. - time series)

Hedonic model description

1. Model description
2. Data – explain estimated with observed data (Figure 2. Spatial distribution of property sales, Table 1. Summary Statistics)
3. Estimation results (Table 2. Estimation Results)

Coupling simulation

1. Scenarios – static based on changes in current conditions
2. GLM WQ results from assumed changes in nutrient loadings (Figure 3. GLM outcomes - not all but focal graphs)
3. Hedonic projections of changes in water front property values (Table 3. Property and aggregate impacts by scenario)
4. Lessons learned

Next steps

1. Dealing with climate variability: we are simulating a decadal time period that encompasses a large range of temperature and precipitation conditions
2. Allowing for changes in realized outcomes through time
3. Opportunities for enhanced coupling
   1. Addressing identification in hedonic model estimation
   2. Structurally coupling lake and hedonic models
   3. More realistic scenarios for Mendota (and connections to the policy drivers that may result in those scenarios)
   4. Application to other catchments and scaling

Notes from Spring 2017 CNH workshop

* Use Lake Mendota 2000 to 2014 conditions as baseline conditions, “do nothing”
* Run scenarios to investigate “what if” actions were taken to enhance or degrade water quality
* Scenarios developed based on strategies to accomplish limnological goals, e.g., 25, 50, 75 and 100% decreases and increases in nutrient loading
* Holds climate constant to observed conditions and changes nutrient loadings
* Demonstrates bilateral model coupling to inform lake management decision making and policy development

Rough timeline

* + Skeleton of 1st draft completed by Kevin and Cayelan by mid-March