**Introduction Outline:**

**Identifying the Problem:**

Non-native species are capable of having large ecosystem effects:

Zebra mussels improving water clarity, reducing algal biomass (Leach 1993) Chapter 23

Common carp impairing water clarity, reducing macrophyte biomass, bioturbation of nutrients (Jackson et al. 2010, Badiou Goldsborough 2015, Huser et al. 2016, Bajer 2014)

Native species are also capable of affecting the aquatic system in a deleterious way

Native filter feeders, such as the Bigmouth Buffalo, can reduce large zooplankton grazers that could increase the phytoplankton biomass (Lazzaro 1987)

Ecosystem resilience is reduced or weakened by the presence of non-native species (carp) (Parkos et al. 2003)

**Biomanipulation and Stable States:**

Most lakes are found in a stable state. The two most common being clear water with high macrophyte abundance, and the opposite, turbid water with low macrophyte abundance (Scheffer et al. 1993)

The movement into one state results in more energy needed to move it back to the previous state (ball and cup idea)

Presence of carp help push the ball into the turbid stable state but also help keep it there.

The ability for the ecosystem to withstand a perturbation but remain in its stable state could be preventing biomanipulation actions from working (Gunderson 2000, Holling 1973, Mittelbach et al. 1995)

Biomanipulation could be used effectively to improve water quality (Shapiro et al. 1975)

In China the addition of silver carp to reduce algal blooms (Xie 2001)

In Europe and North America the removal of benthic fish (carp) to improve water quality (Meijer et al. 1989)

Iowa DNR has/is attempting to improve many of its lakes through biomanipulation.

Removal of Common Carp and Big Mouth Buffalo through mechanical harvesting

**Goal/Objectives of Study**

Goal: Quantify changes in water quality parameters in response to biomanipulation of carp and buffalo through commercial harvest.

Objectives

Are we seeing a short-term change in water quality after these fish removals?

How are the response variables in harvested lakes similar to or different from lakes that are not being harvested?

**Hypothesis**

I hypothesize that we will see slight perturbations in the ecosystems of each Lake, this would be seen in a decrease in nutrient loading, or increase in secchi depth, etc. However, due to the idea of stable states and ecosystem resilience the current process of biomanipulation is not enough to push the lakes back into the clear water and macrophyte dominated stable state.