Applying the Principles of Shallow Lake Ecology to the Recovery of an Endangered Fish

-a brief history of the June Sucker Recovery Implementation Program

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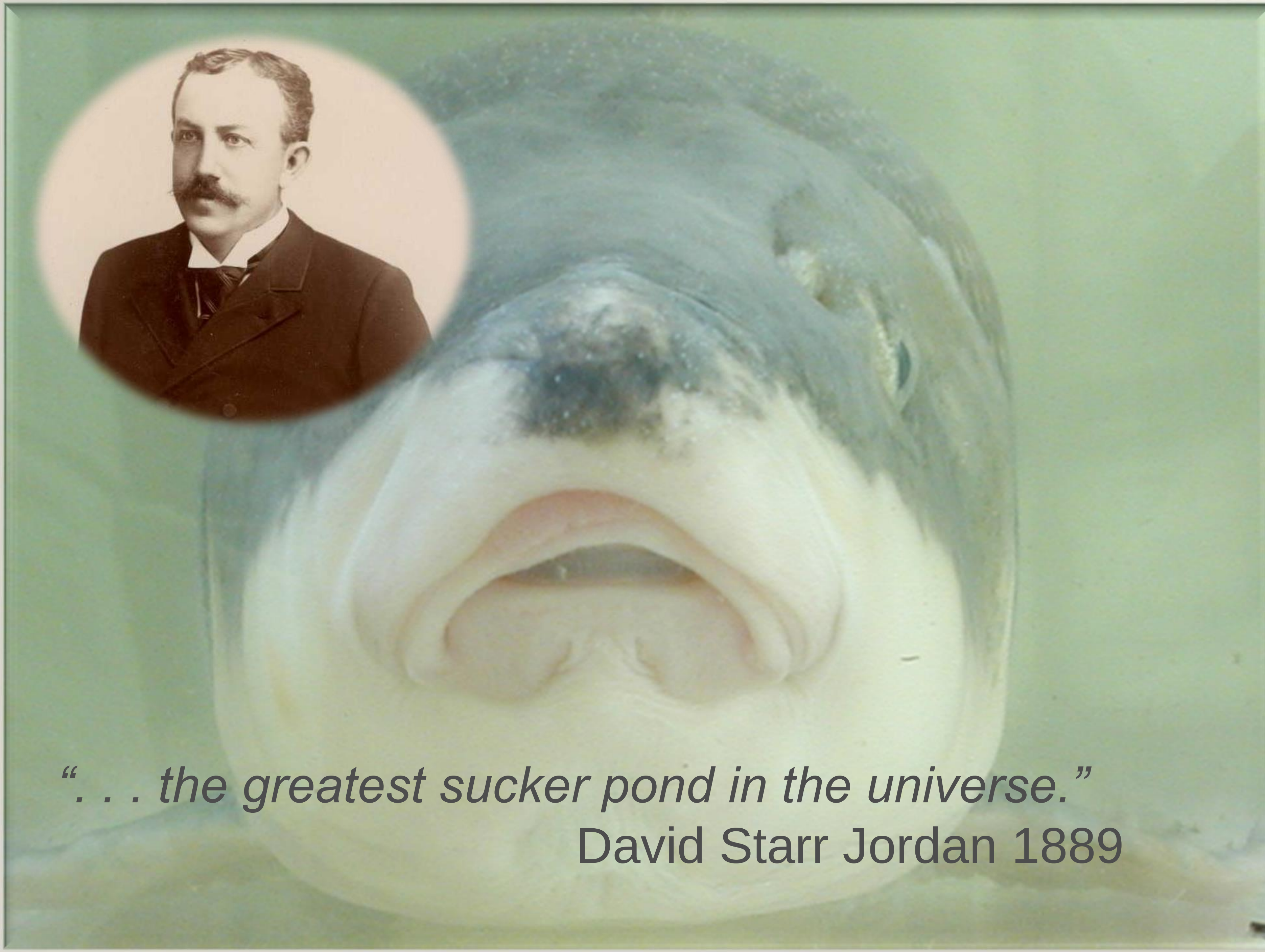
Presentation Overview

- June sucker life history, biology, and ecology
- Listing history and implications
- Conceptual modeling
- Preventing extinction
- Ecosystem based approach to recovery
- Lake level fluctuations study
- Common carp – status of control efforts
- Preliminary results from ecosystem monitoring


“. . . the greatest sucker pond in the universe.”
David Starr Jordan 1889

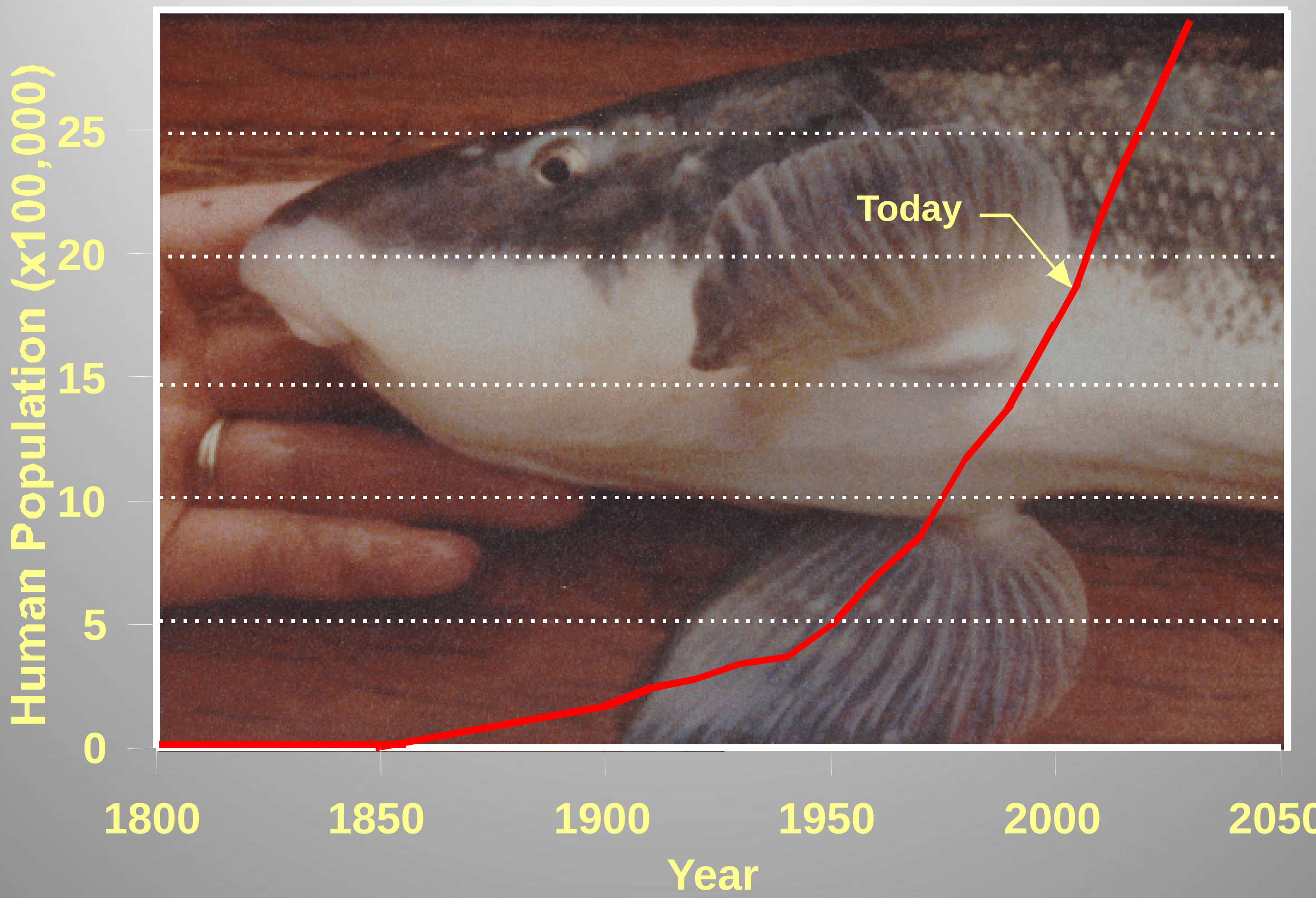
June Sucker Listing Package
Endangered with Critical Habitat – April 30, 1986

- Reasons for listing included habitat alteration (physical and hydrological), fisheries and nonnative introductions, and loss of recruitment.

- Critical Habitat was designated as the lower 7.8 km (4.9 miles) of the Provo River from Utah Lake upstream to the Tanner Race Diversion.

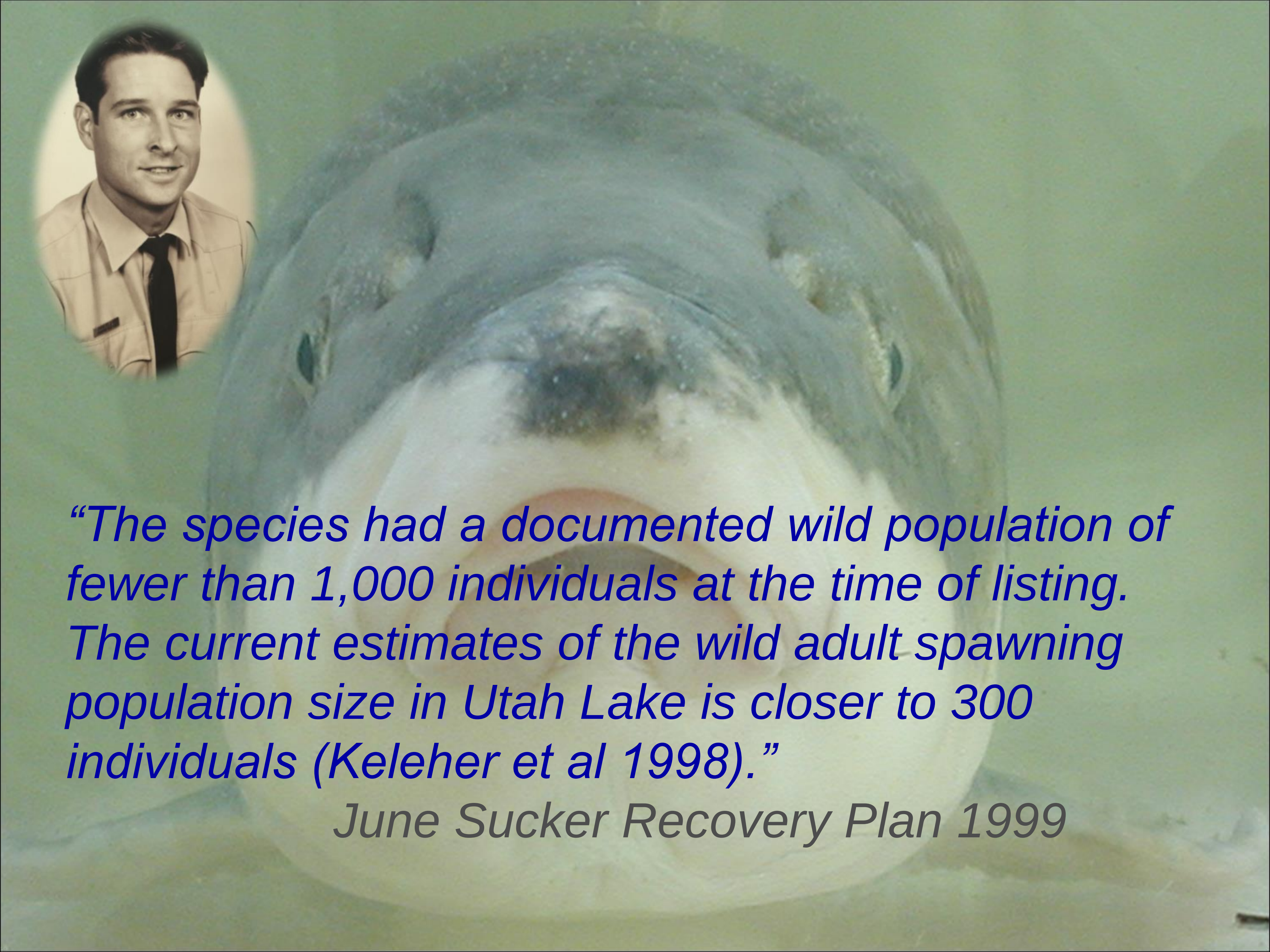
- FWS gave June sucker a recovery priority which applies to a species with a high threat of extinction, a low recovery potential and the presence of conflict.

Conflict

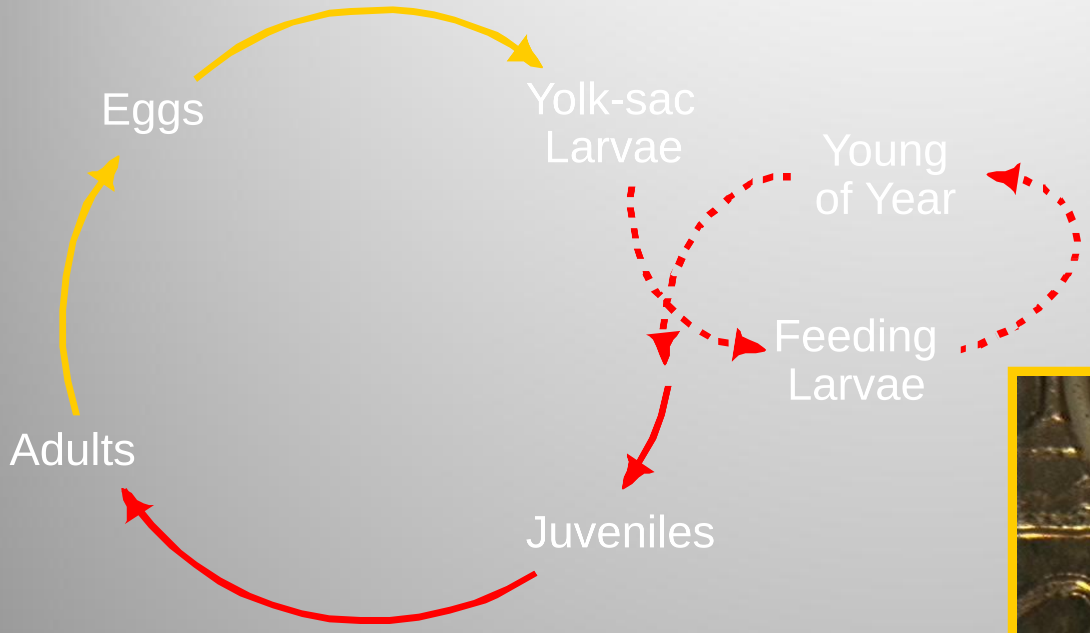

Human Population (x100,000)
25
20
15
10
5
0
Today
1800
1850
1900
1950
2000
2050
Year

"June suckers are precariously near to extinction. They remain only as a rapidly shrinking and aging remnant population, without recent successful reproduction. This demographic observation, combined with the overwhelming dominance of non-native fishes in Utah Lake and current water management practices, may preclude their survival in nature."

Scoppettone and Vinyard 1991

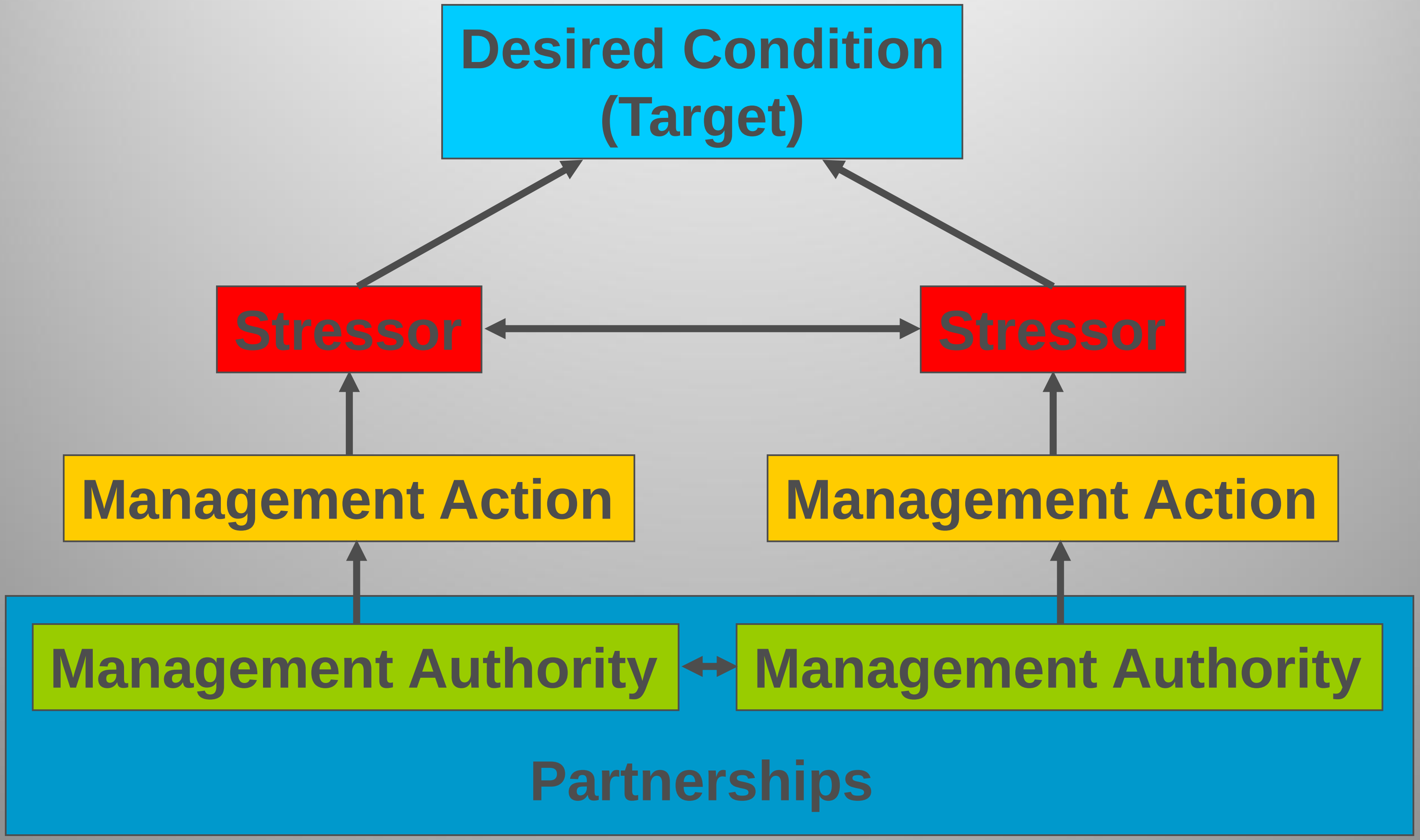

“The species had a documented wild population of fewer than 1,000 individuals at the time of listing. The current estimates of the wild adult spawning population size in Utah Lake is closer to 300 individuals (Keleher et al 1998).”
June Sucker Recovery Plan 1999

June Sucker Life Cycle and Recruitment Bottleneck

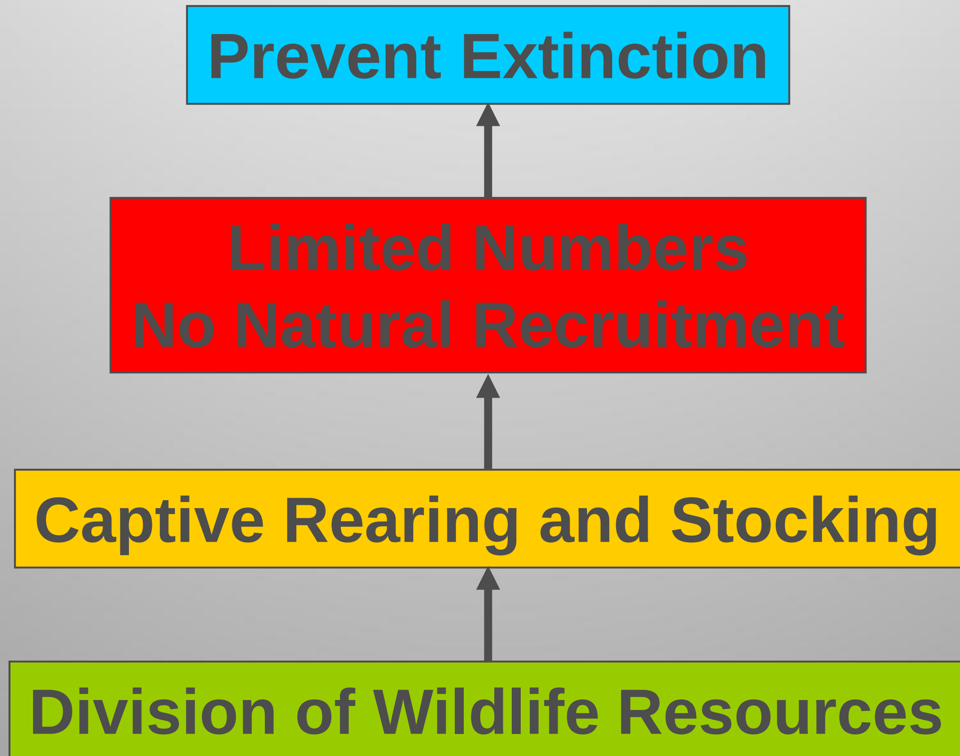


Immediate threat (mid-late 1990’s) – Extinction

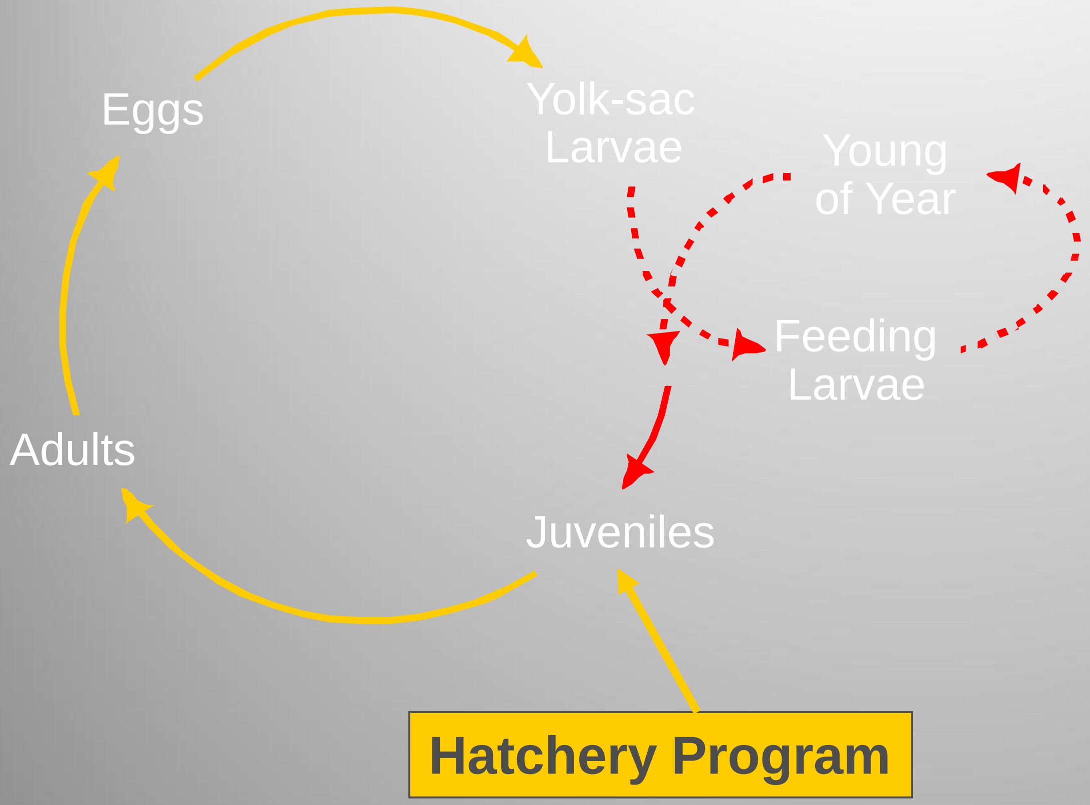
Conceptual Models



Original June Sucker Conceptual Model

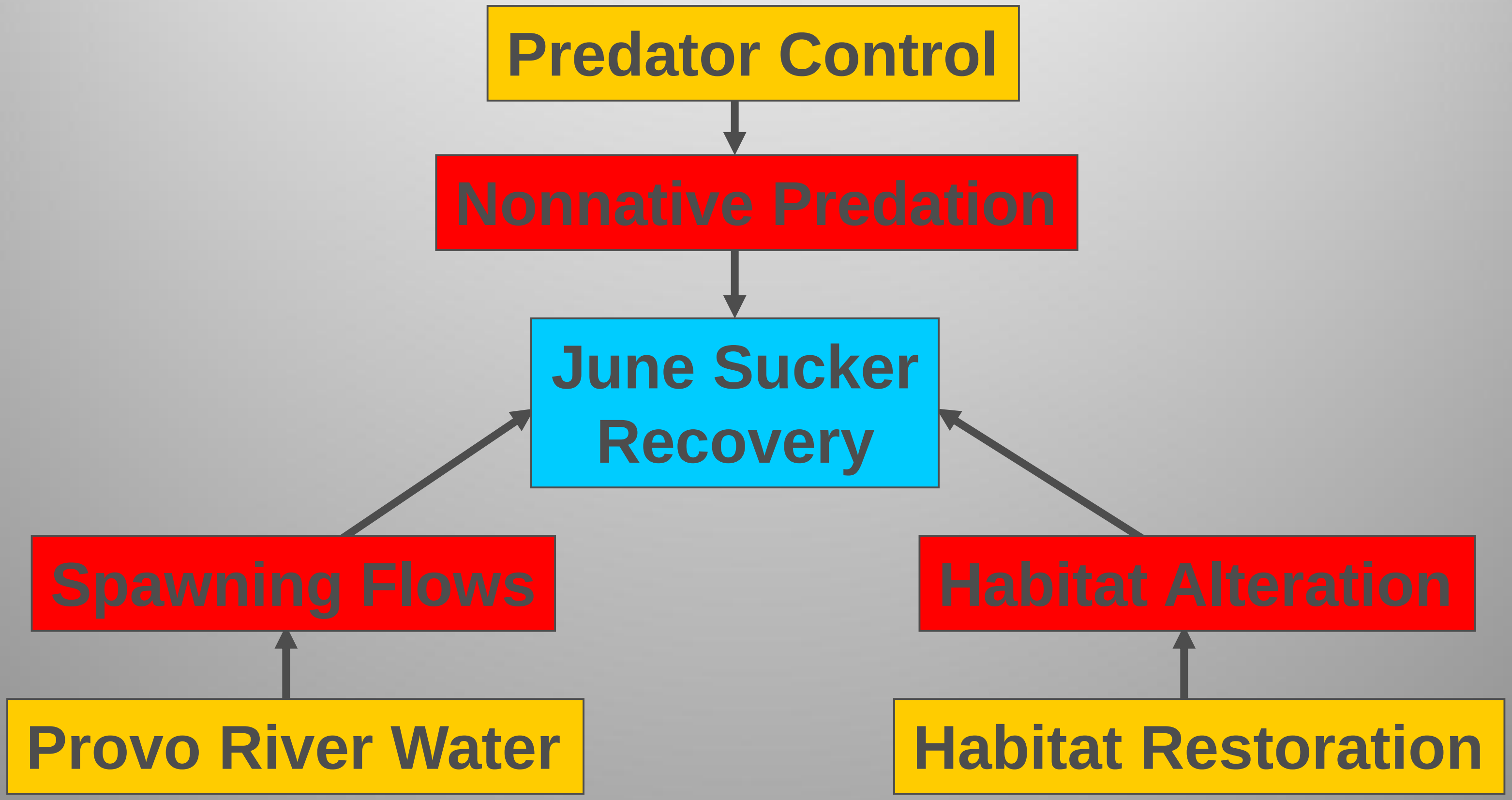


June Sucker Life Cycle and Recruitment Bottleneck



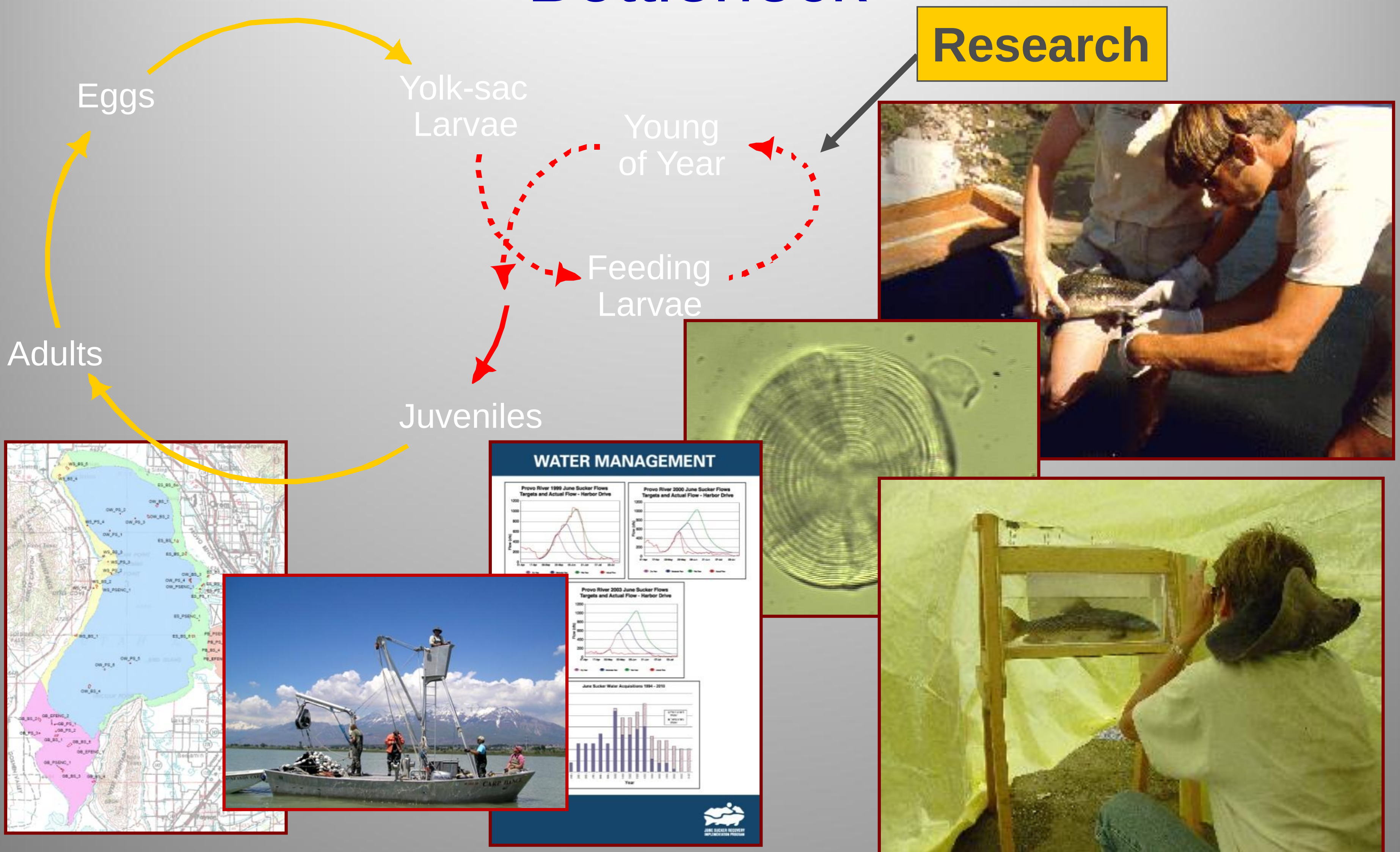
Stressors **Nonnative Fish, Habitat Alteration, Water Management**

June Sucker Recovery Early Conceptual Model

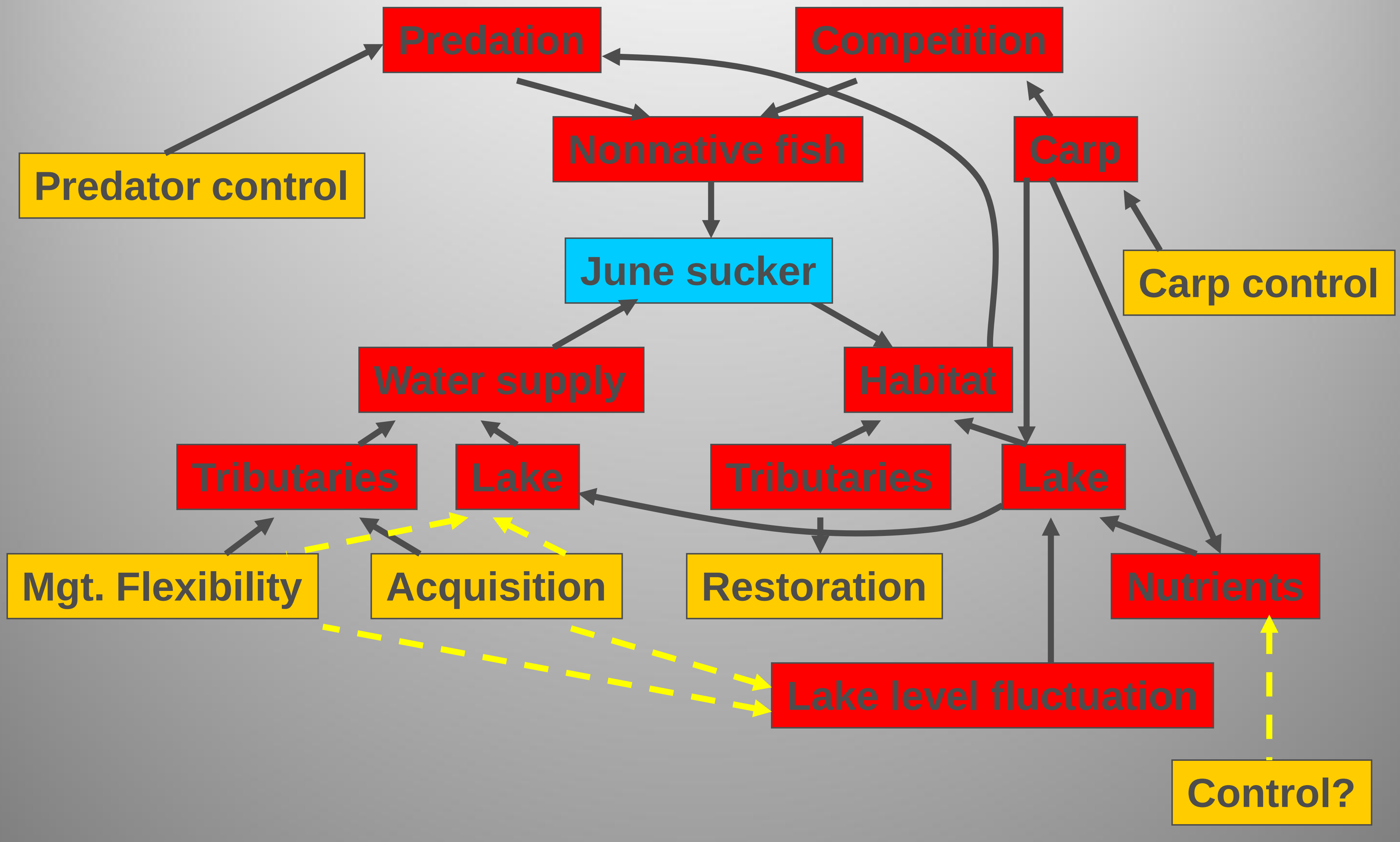


Interpretation of System Function

June Sucker Life Cycle and Recruitment Bottleneck

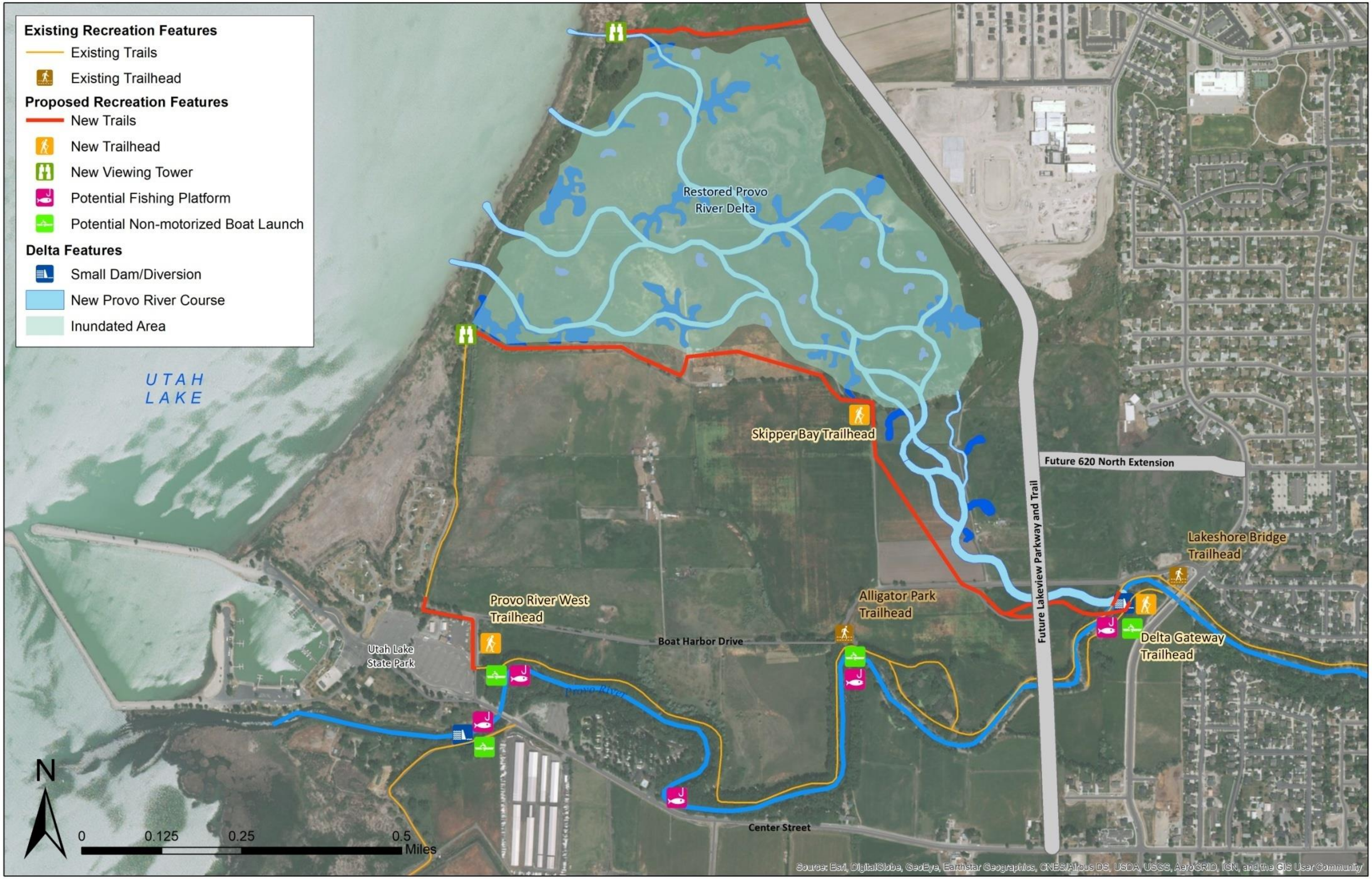


June Sucker Focused Conceptual Model



Hobble Creek Delta Restoration

Provo River Delta Restoration Project



Provo River Delta Restoration Project

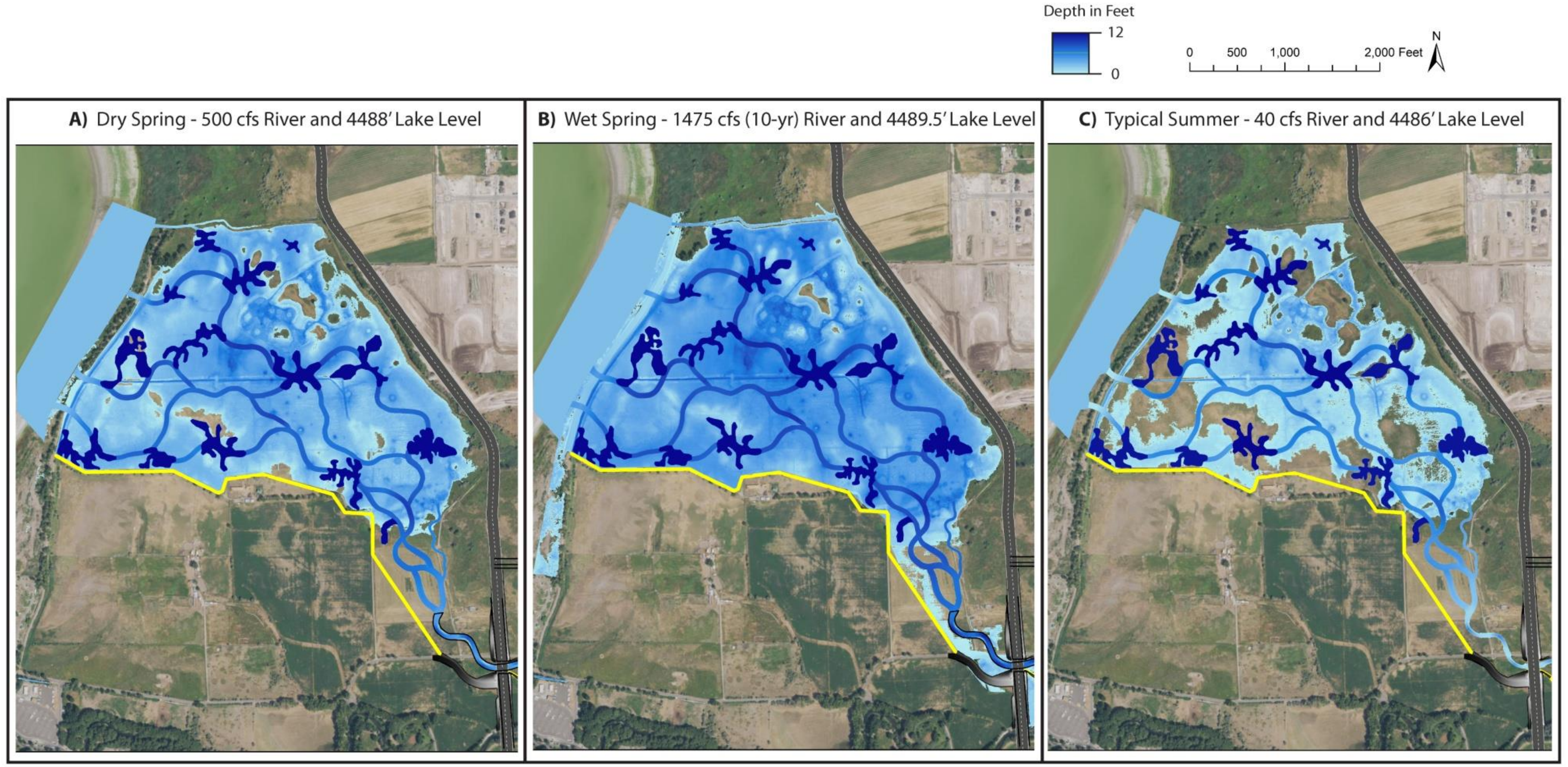


Figure 38. Maps showing modeled inundation area and water depth for three scenarios; A) Dry Spring with Provo River flowing at 500 cfs and Utah Lake level at 4488 feet asl, B) Wet Spring with Provo River flowing at 1475 cfs (10-yr peak) and Utah Lake level at 4489.5 feet asl, and C) Typical Summer with Provo River flowing at 40 cfs and Utah Lake level at 4486 feet asl.

Endangered Species Act

Purpose – to promote the recovery of T&E species and . . .

“the ecosystems upon which they depend”

T&E species are an indication of ecosystem “health”

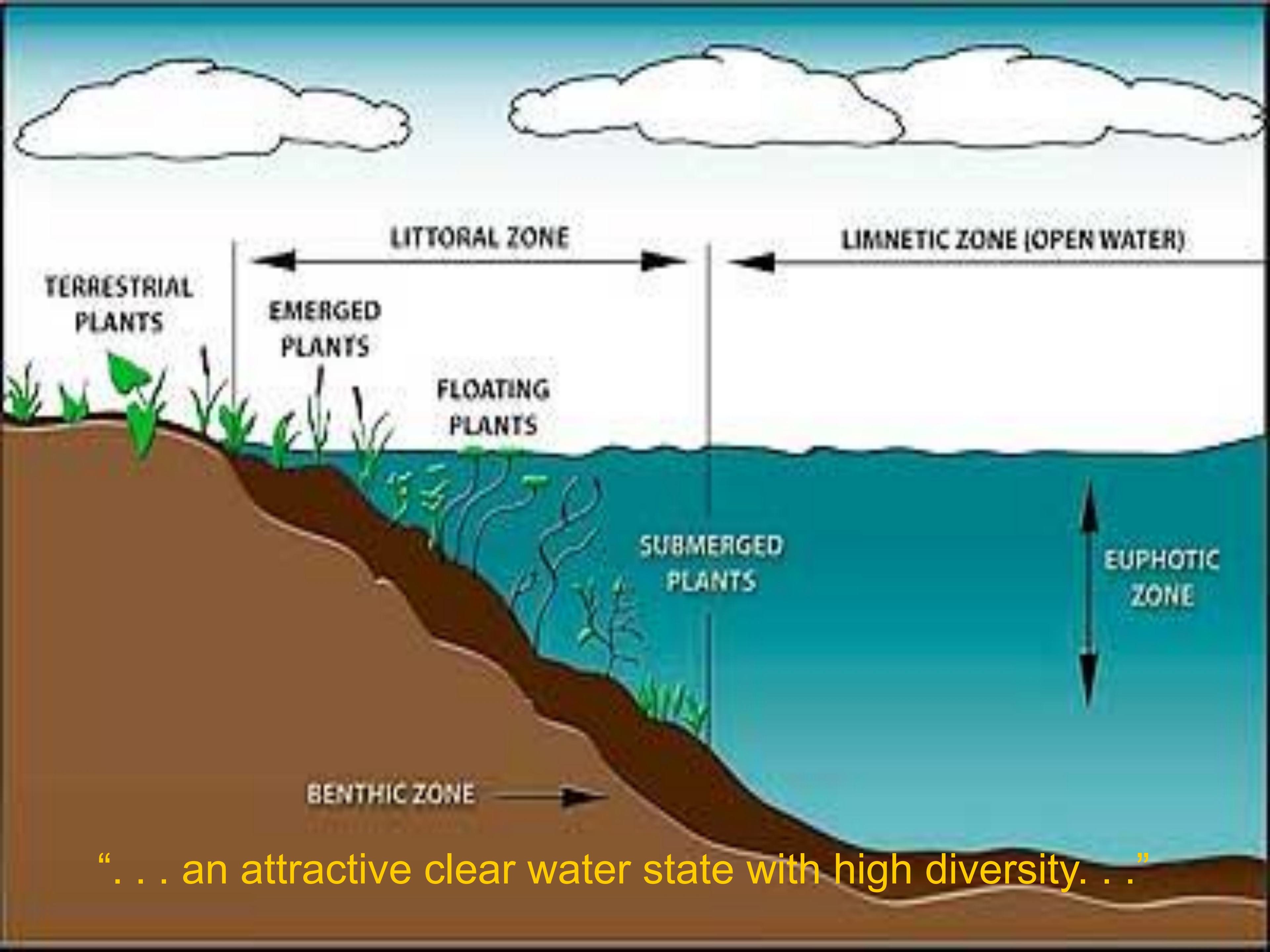
June sucker ~ Utah Lake ecosystem

Utah Lake is a Shallow Lake

"Many shallow lakes have degraded badly as a result of human activities from an attractive clear water state with a high diversity to a monotonous murky pool."

Scheffer 1998

“ . . . a monotonous murky pool.”



". . . an attractive clear water state with high diversity. . ."

Ecological Importance of Aquatic Vegetation

Aquatic vegetation plays an important role in a lake ecosystem in that it:

- provides habitat for invertebrates and small fish
- provides cover from predators
- anchors bottom sediments from wave disturbance
- cascading effects

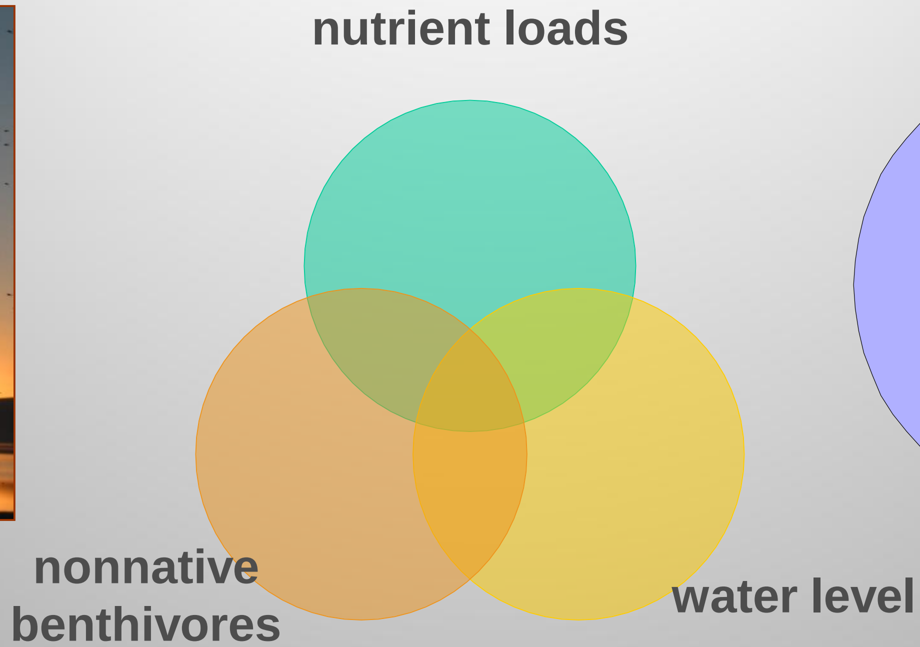
Ecosystem Drivers

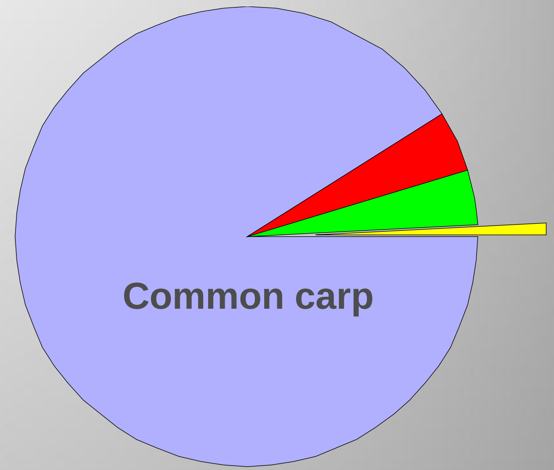
". . . in ecosystems several independent mechanisms do often contribute to an observed phenomenon that could also in theory be explained from each mechanisms alone. One of the mechanisms will often dominate but dominance will differ from case to case and may even shift in time."

Scheffer 1998

Shallow lakes – nutrients, bottom-feeding fish, and lake level fluctuation.

Habitat Simplification





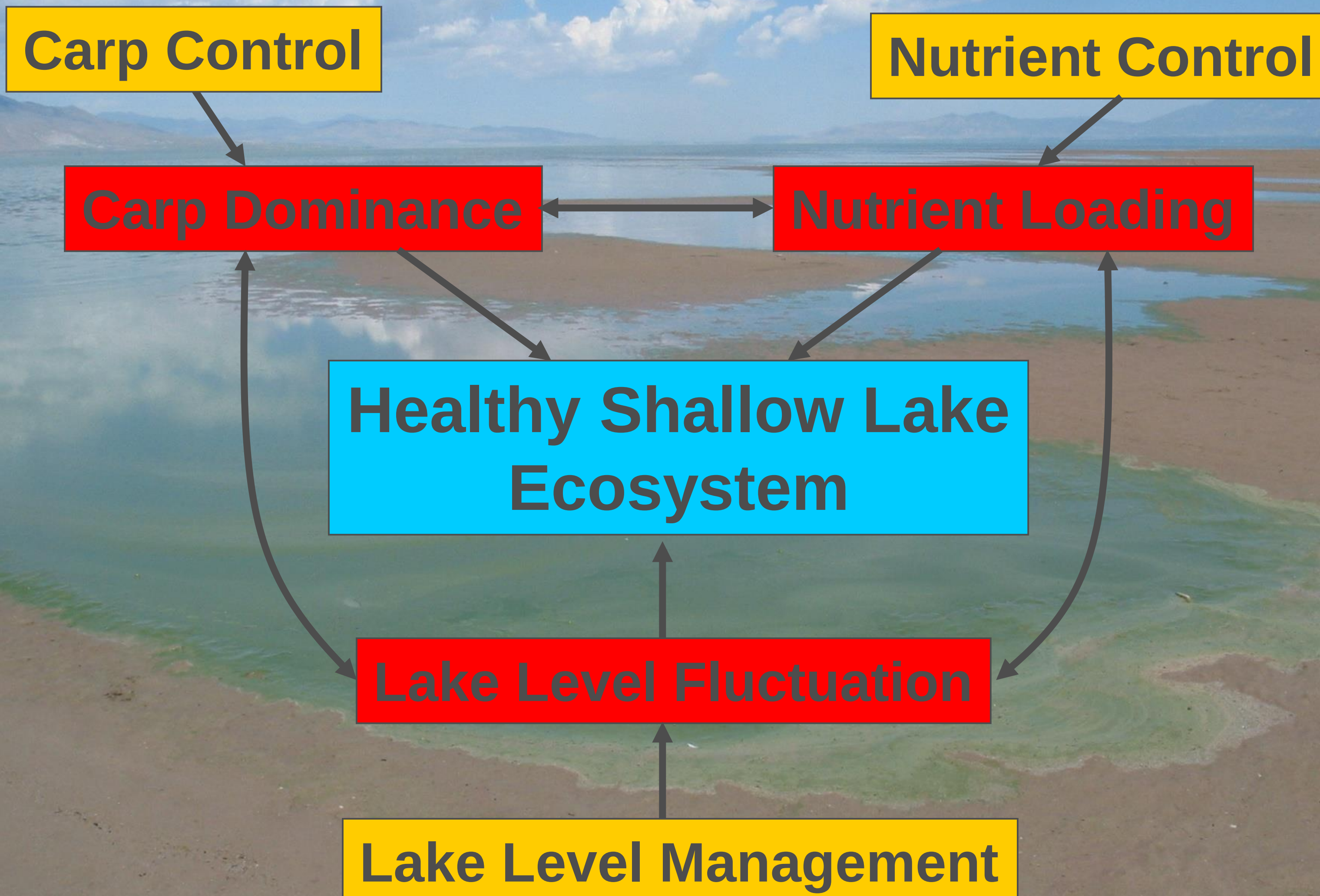
- contribute to lack of aquatic macrophytes which provide complexity needed to balance predator-prey relationships
- increase in predator efficiency and reduction in June sucker recruitment

simple habitat → simple communities

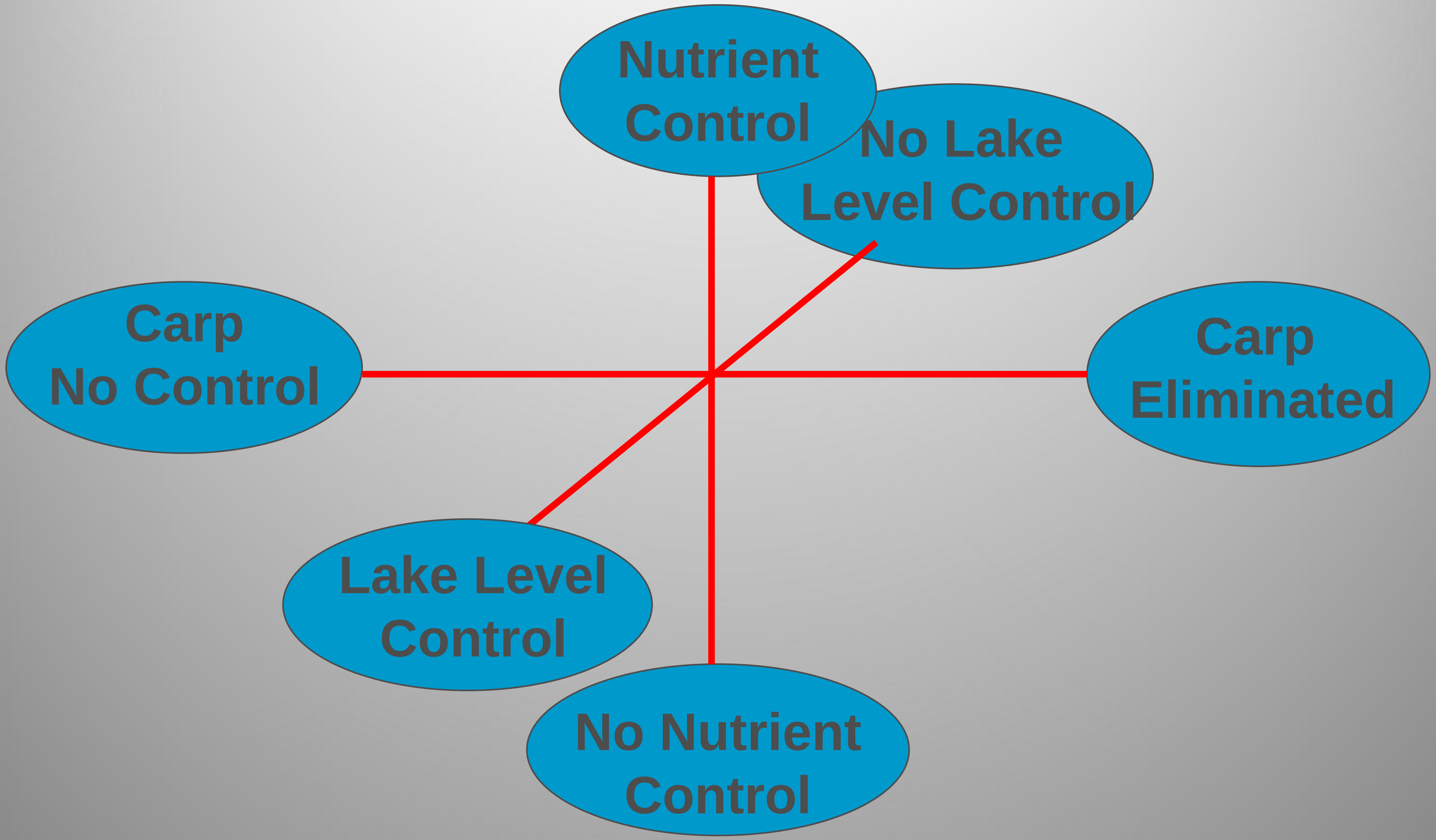
Stressors to Healthy Utah Lake

- Nutrient loading
  - Long-term external phosphorus load 297.6 tons/year, 83.5 tons/year outflow
  - WWTP account for 76.5 percent of inputs
  - Internal loading (wind resuspension of sediments, bottom-feeding fish)
  - Control is expensive and results may be uncertain
- Lake level fluctuation
  - Average annual inflow ~ 726,000 AF – highly variable
  - Average evaporative loss ~ 380,000 AF
  - Complex water rights issues
- Nonnative benthivorous fish (carp)
  - Carp population estimated at ~ 7.5 million (age 2+)
  - Mechanical control is feasible

Murky Pool Conceptual Model



Management Scenario Planning



Scenario Planning

Management Actions to Achieve Target Condition		
Carp	Nutrient Loads	Lake Fluctuation
No	No	No
Yes	No	No
No	No	Yes
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

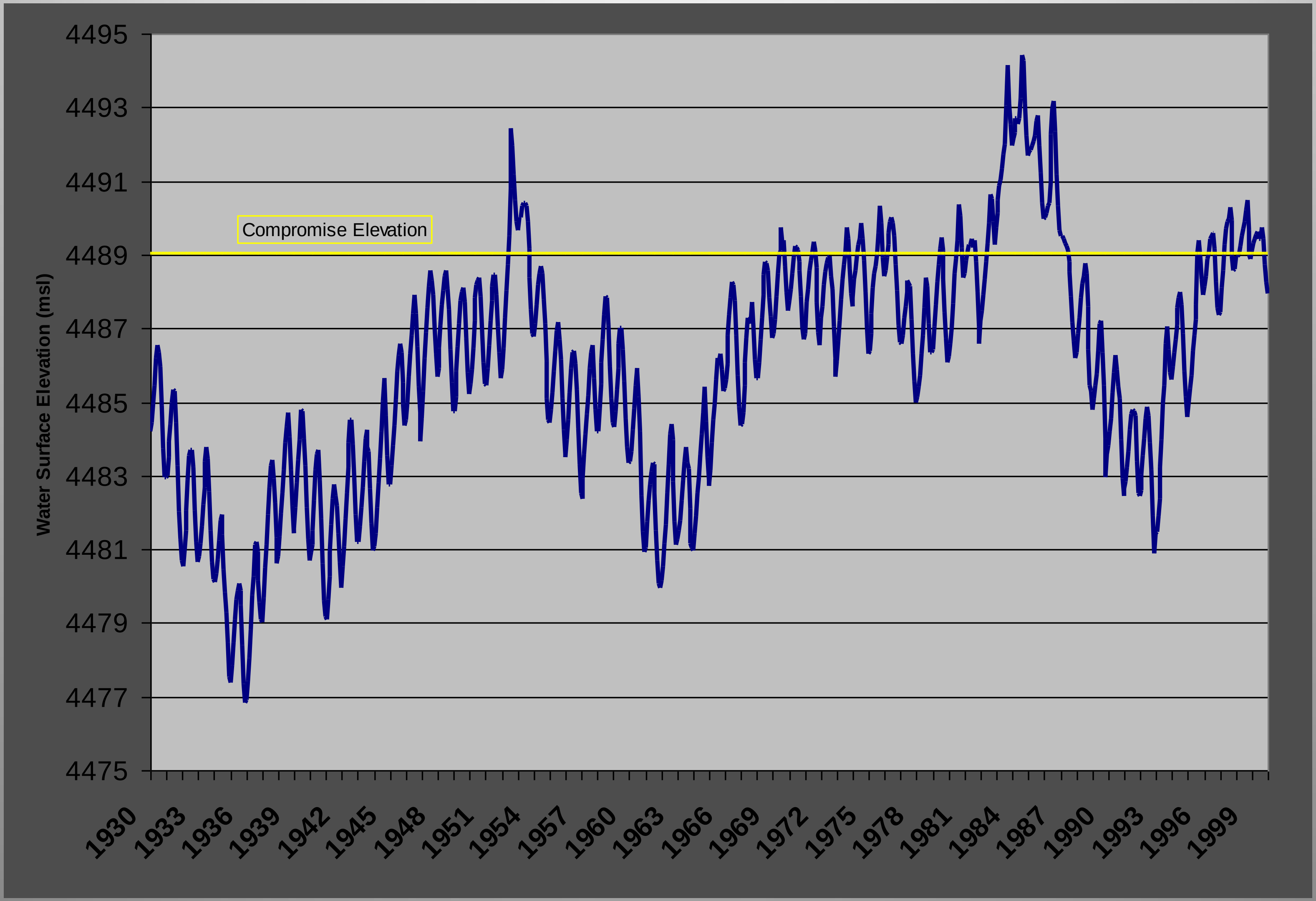
Ideal Management Scenario

Management Actions to Achieve Target Condition		
Carp	Nutrient Loads	Lake Fluctuation
No	No	No
Yes	No	No
No	No	Yes
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

Scenario Planning

Management Actions to Achieve Target Condition		
Carp	Nutrient Loads	Lake Fluctuation
No	No	No
Yes	No	No
No	No	Yes
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

Past Utah Lake Level Variation



Lake Level Management

Desired Conditions

- Continue as currently directed by State Engineer’s Interim Distribution Plan
- Stabilize (proposed in the past)
- Mimic natural conditions (JSRIP study)
- Others . . .

Utah Lake Water Level Fluctuation Study
(JSRIP, Thurin 2007)

Purpose

- To quantify the effects of development on lake level fluctuations
- To investigate the feasibility of managing Utah Lake water elevation to mimic more natural conditions to contribute to enhancing rooted aquatic vegetation for June sucker recovery purposes

Utah Lake Water Level Fluctuation Study
(JSRIP, Thurin 2007)

Results

- Utah Lake naturally fluctuated about 2.1 feet annually
- Over the recent past (1950-2000), Utah Lake fluctuated about 3.5 feet annually
- Under current and planned conditions Utah Lake fluctuates about 2.5 feet annually

My perspective: lake level fluctuation is probably the lesser of the stressors to a healthy Utah Lake.

Scenario Planning

Management Options to Achieve Target Condition		
Carp	Nutrient Loads	Lake Fluctuation
No	No	No
Yes	No	No
No	No	Yes
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

Existing Management Scenario

Management Options to Achieve Target Condition		
Carp	Nutrient Loads	Lake Fluctuation
No	No	No
Yes	No	No
No	No	Yes
Yes	No	Yes
No	Yes	No
No	Yes	Yes
Yes	Yes	No
Yes	Yes	Yes

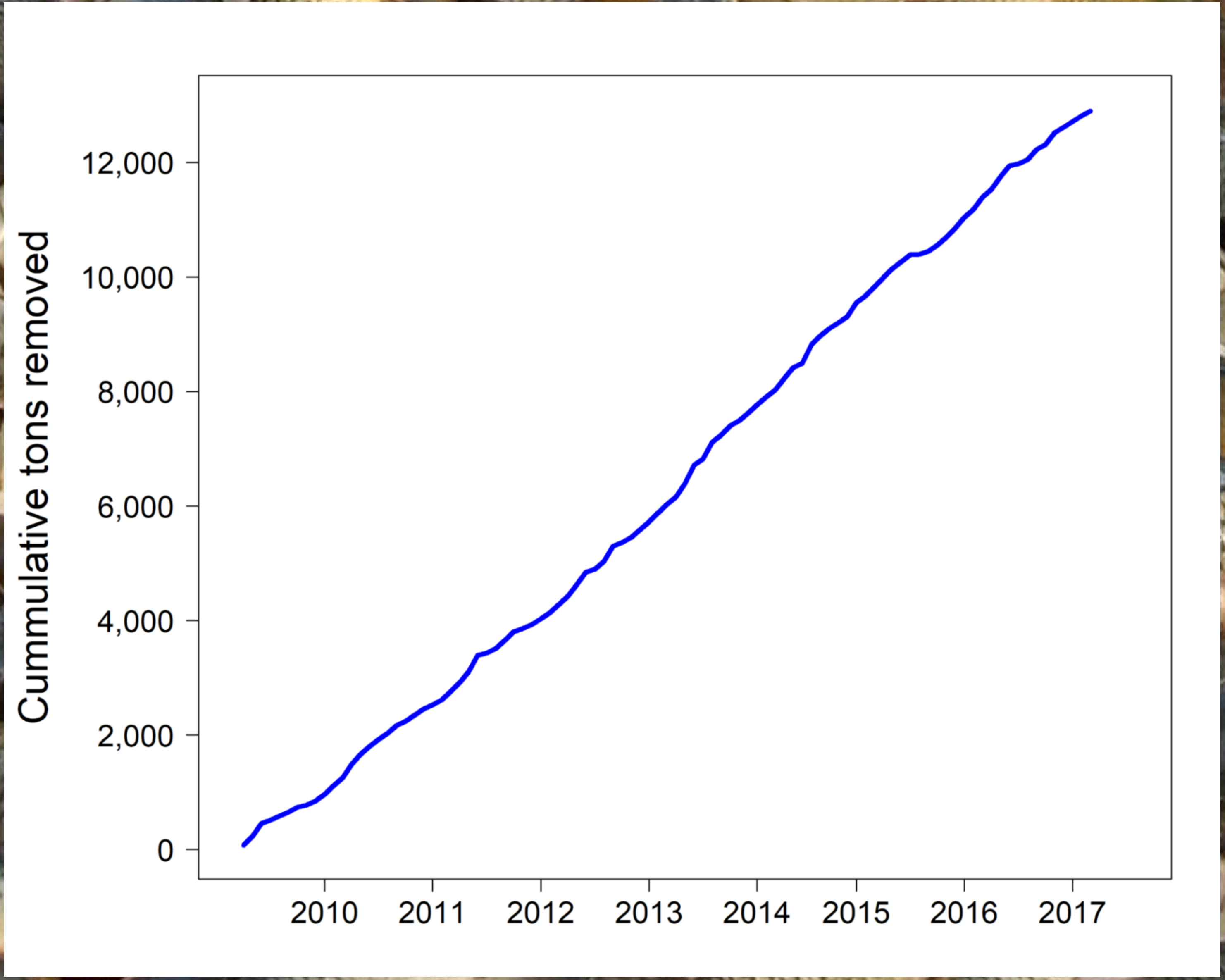
"We found the lake trout had done poorly, because Of the low and consequently muddy water; and then the carp, which have thriven immensely, have Eaten off the mosses and similar growth along the bottom of the lake, so that the trout have not Had enough to eat. Carp are a good deal like the English sparrow – once they get into a place they are there to stay."

-US Fish Commissioner Tulian 1901

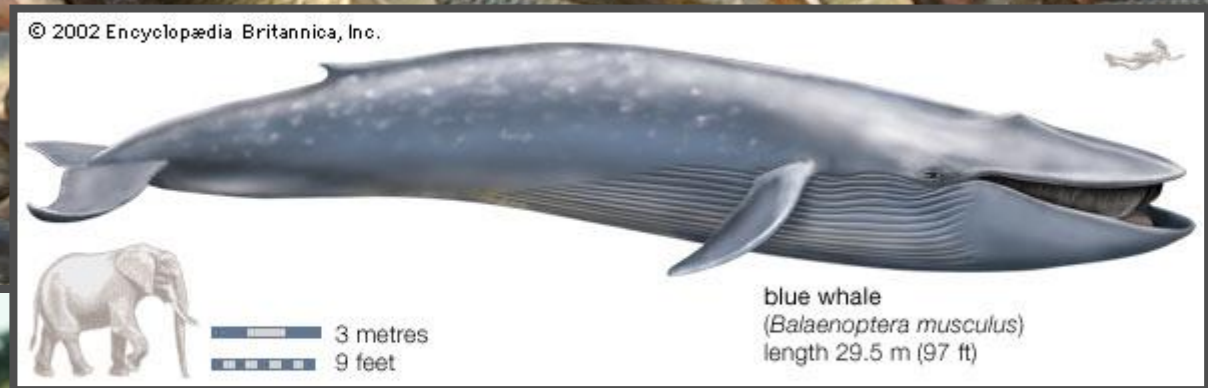

Removal Program Started September 2009

- **Over 27.2 Million pounds (13.5 tons) removed through March 2018**

Carp Removal



Large Scale Carp Removal Effort



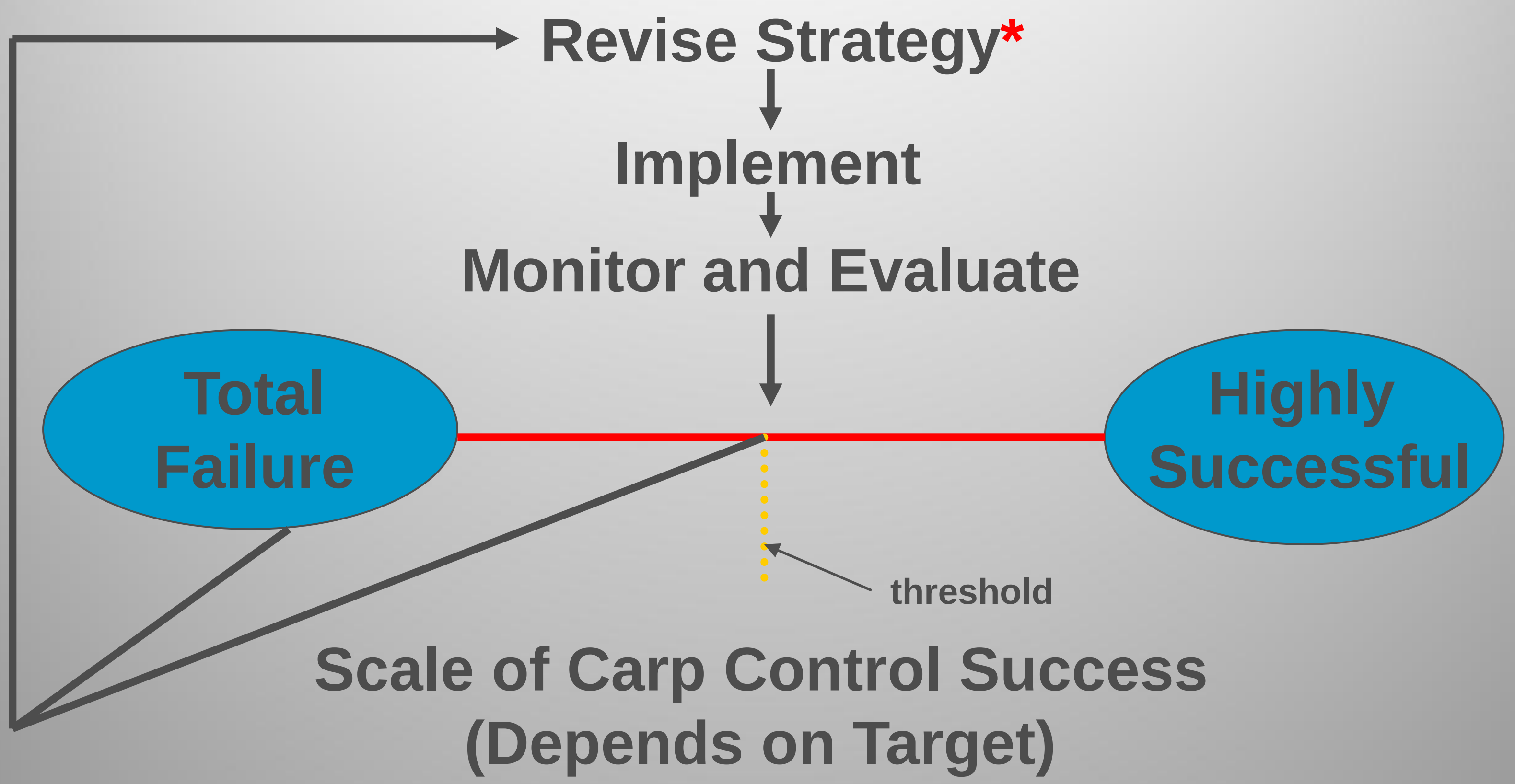
~ 110 Blue whales = 13,000 tons

~ 2,710 African elephants = 13,000 tons

Carp Monitoring: 84% Reduction

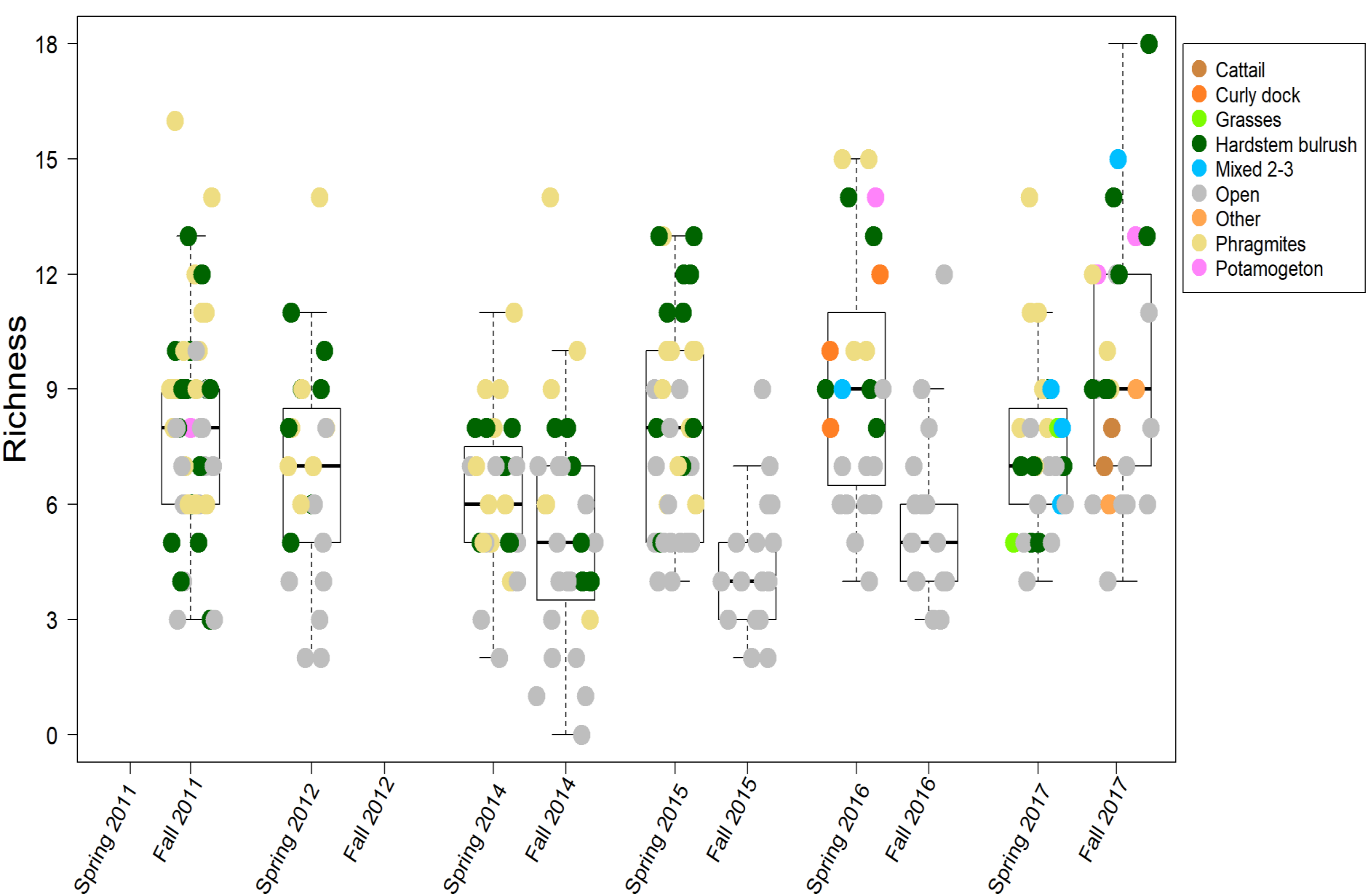
Year	Density (kg/acre)
2004 – 2005	160 – 193 (SWCA Reports)
2012	64.2
2013	39.8
2014	35.5
2015	36.0
2016	35.7
2017	10.9

Adaptive Management

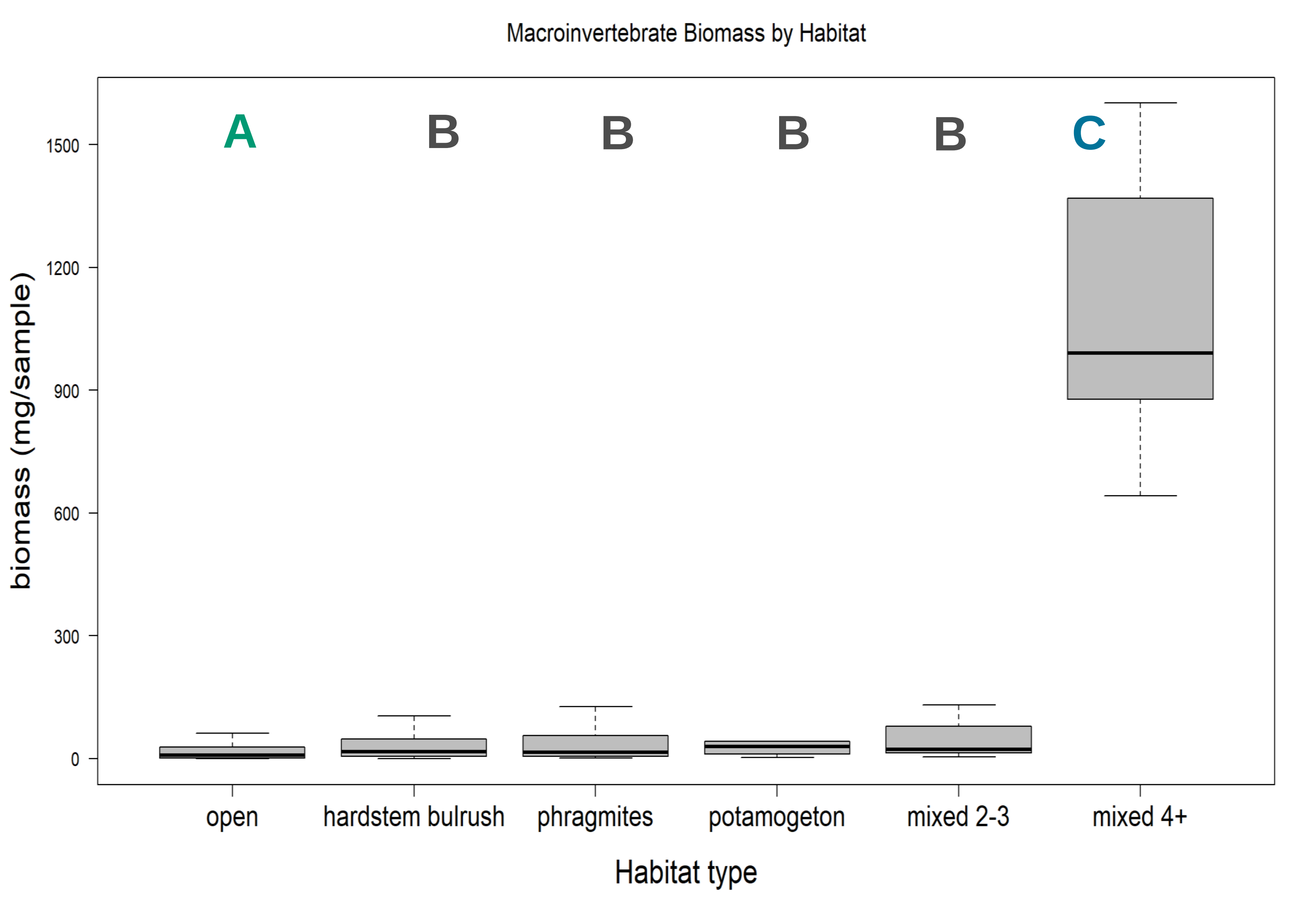


*Strategy Revision – Nutrient loading, Lake level management

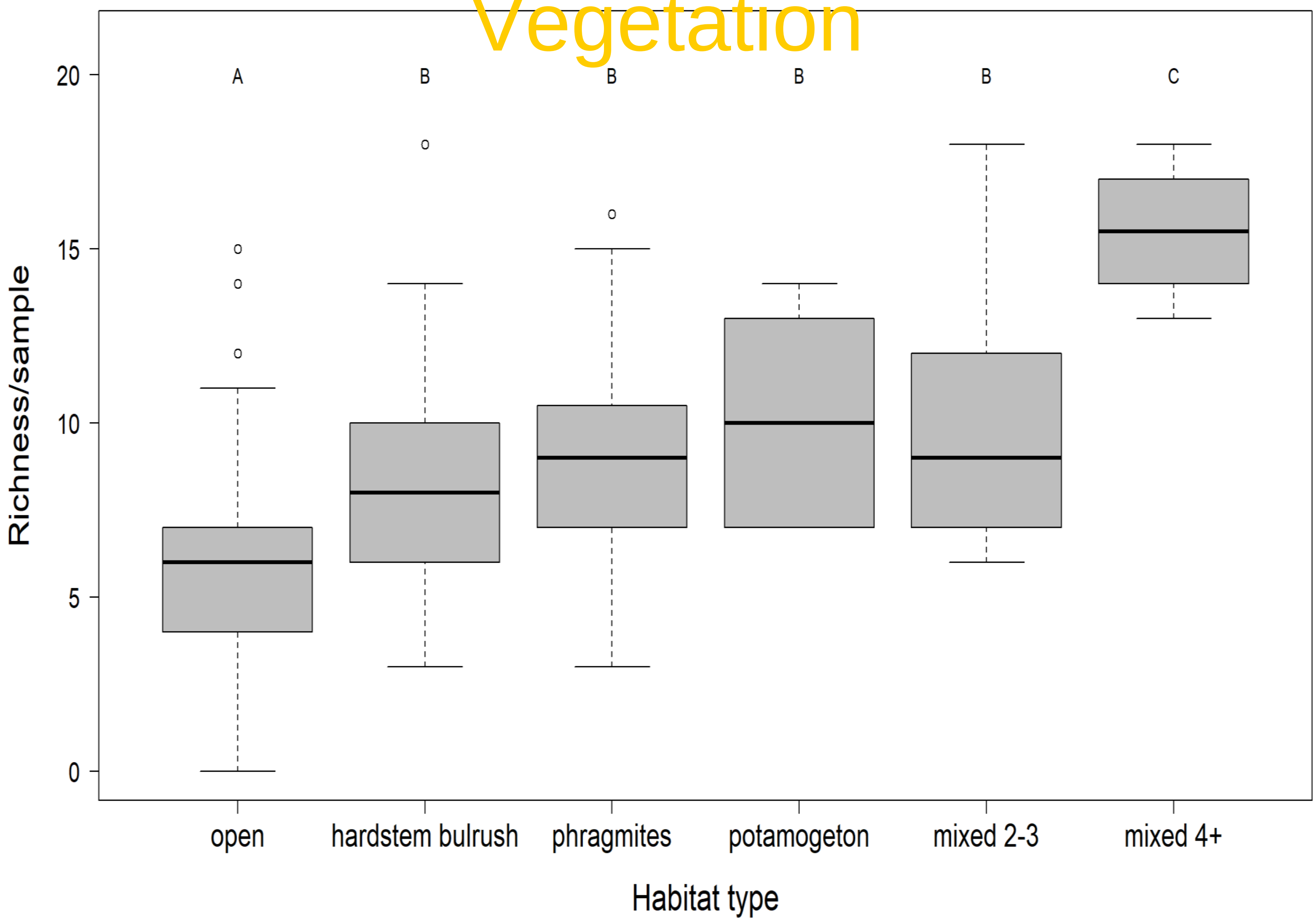
Invert Richness and Vegetation



Biomass and Vegetation

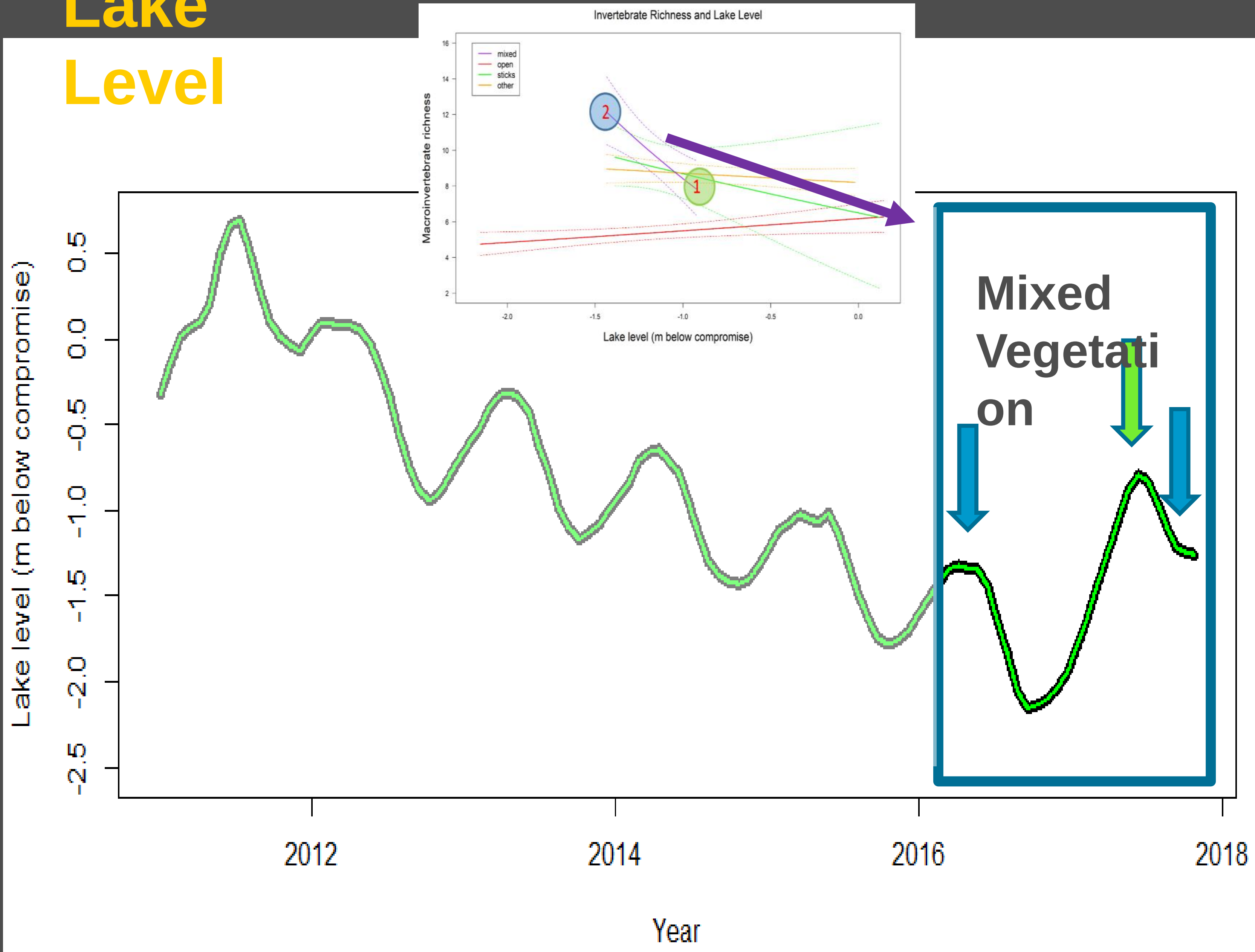


Macroinvertebrate Richness and Vegetation



* Vegetation with different letters are significantly different

Lake Level



Invertebrate Richness and Lake Level
mixed
open
sticks
other
Macroinvertebrate richness
Lake level (m below compromise)
2
1
Mixed Vegetati on
Lake level (m below compromise)
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
2012
2014
2016
2018
Year


fin