BREATHE: Bay Revitalization Efforts Against the Hypoxic Environment

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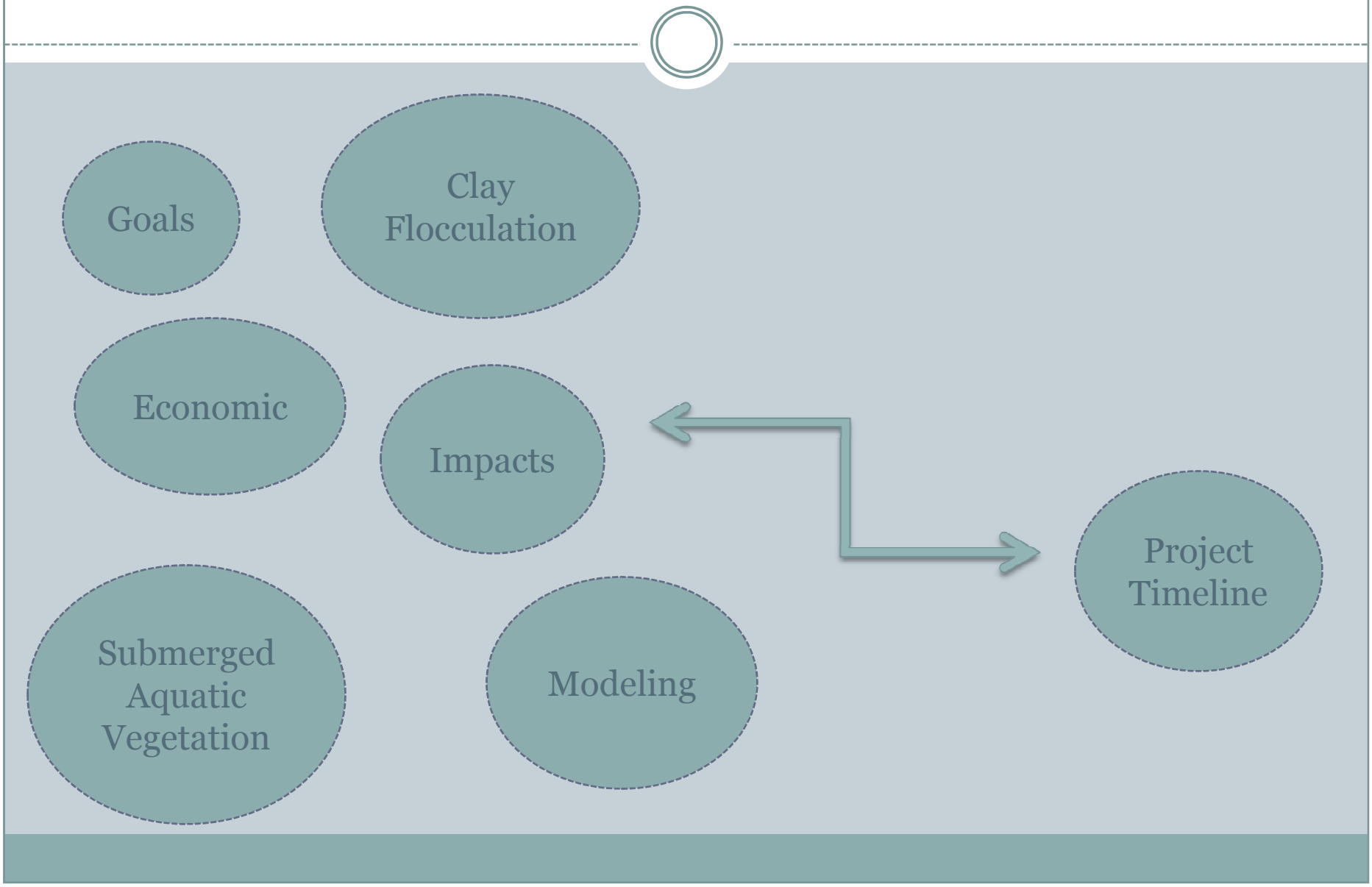
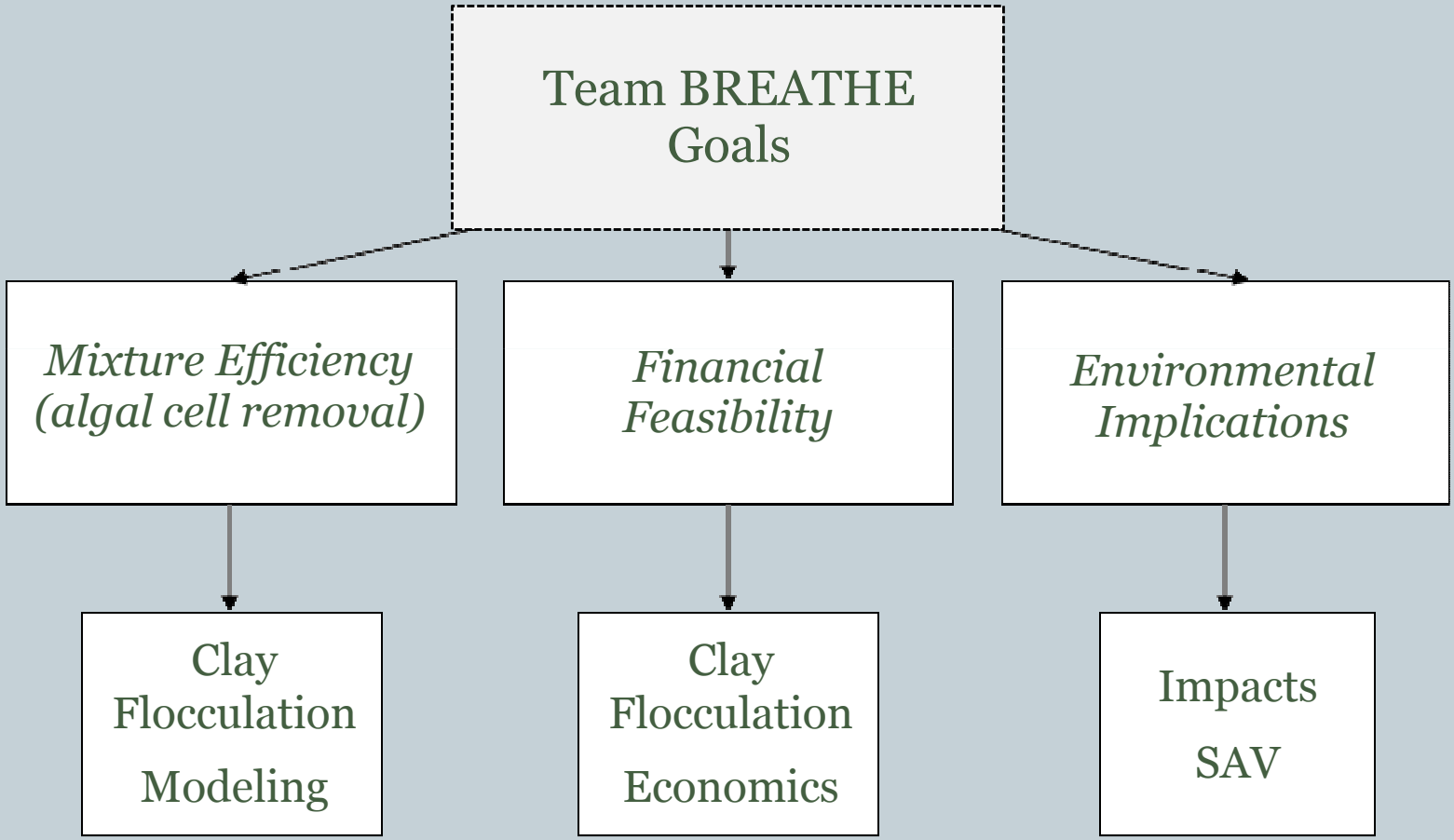
BREATHE


Goals
Clay Flocculation
Economic
Impacts
Project Timeline
Submerged Aquatic Vegetation
Modeling

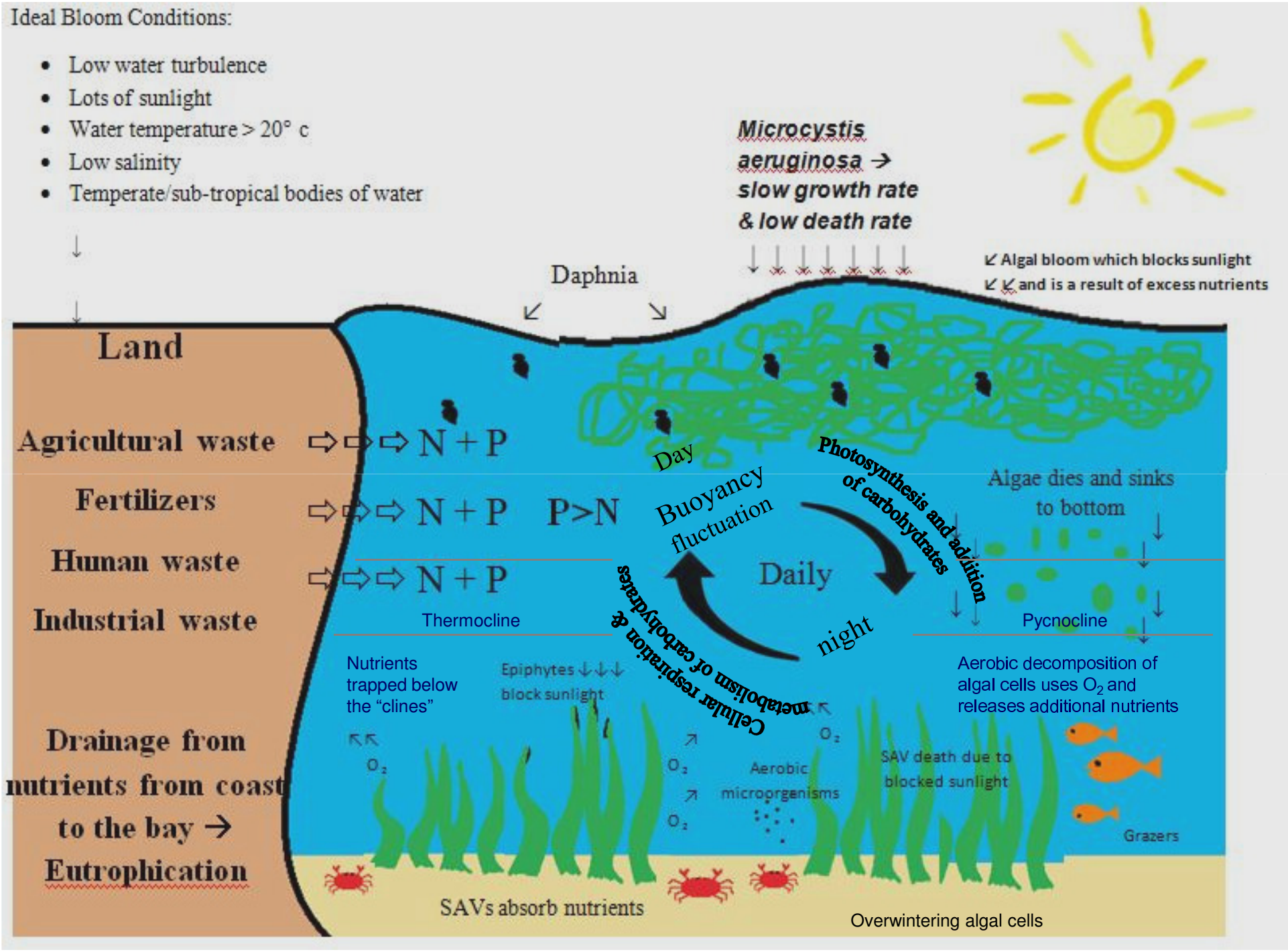
BREATHE


Team BREATHE Goals
Mixture Efficiency (algal cell removal)
Financial Feasibility
Environmental Implications
Clay Flocculation Modeling
Clay Flocculation Economics
Impacts SAV

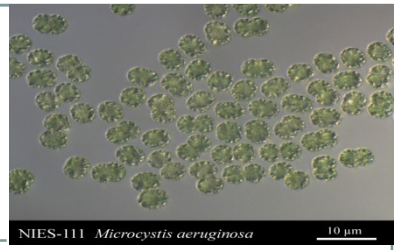
Economics

- "Congress finds… HABs have been responsible for an estimated $1,000,000,000 in economic losses during the past decade."
  - Losses in public health, commercial recreation/tourism.

- Chesapeake Bay "*Pfiesteria Hysteria" which cost seafood industry $46,000,000 in losses.*
- Hope to gain public opinion regarding HABs through administering surveys to UMD students as well as communities around the Chesapeake Bay area.

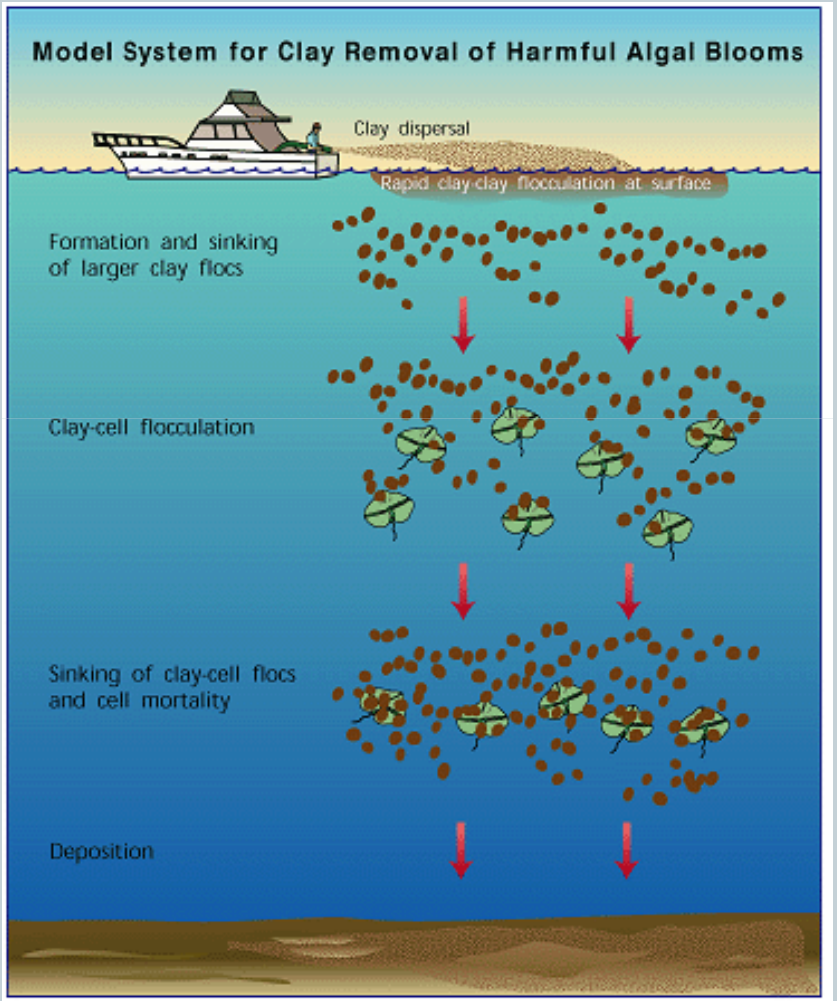

Ideal Bloom Conditions:
Low water turbulence
Lots of sunlight
Water temperature > 20° c
Low salinity
Temperate/sub-tropical bodies of water
Microcystis aeruginosa → slow growth rate & low death rate
Algal bloom which blocks sunlight and is a result of excess nutrients
Daphnia
Land
Agricultural waste
Fertilizers
Human waste
Industrial waste
N + P
P>N
Drainage from nutrients from coast to the bay → Eutrophication
Day
Buoyancy fluctuation
Photosynthesis and addition of carbohydrates
Daily
night
Cellular respiration & metabolism of carbohydrates
Algae dies and sinks to bottom
Thermocline
Pycnocline
Nutrients trapped below the "clines"
Epiphytes block sunlight
Aerobic decomposition of algal cells uses O_2 and releases additional nutrients
O_2
Aerobic microorganisms
SAV death due to blocked sunlight
Grazers
SAVs absorb nutrients
Overwintering algal cells

Clay Flocculation



Research Questions:

- Which clay/flocculant mixture will be the most effective in submerging the *M. aeruginosa* bloom?
- How will flocculation be affected by:
  -->treating single cells VS colonies?
  --> the time of day?



Impacts

Background

- Certain strains of *Microcystis aeruginosa* release toxins upon lysing called microcystin-LR, which affixes to liver cells
- We want to prevent any negative side effects of toxin release that may occur with the removal of a bloom

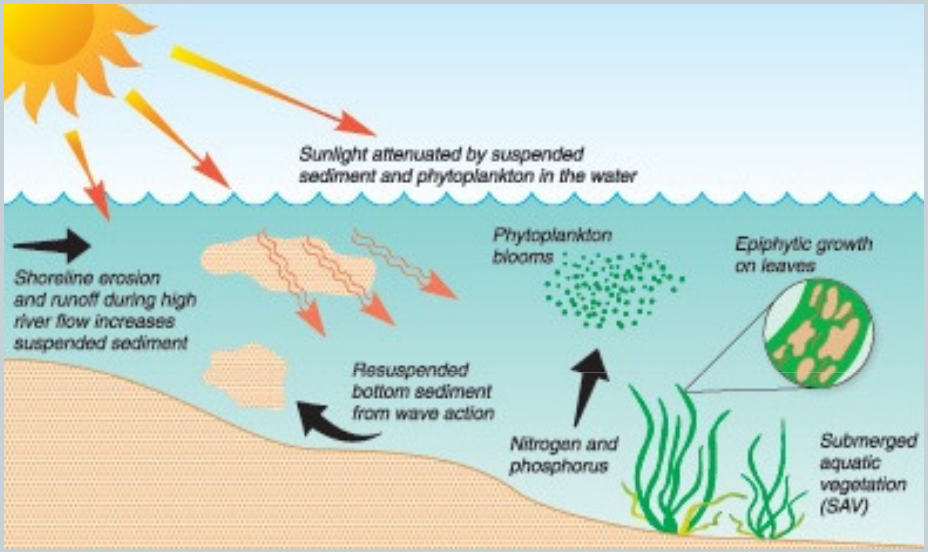
Methodology

- Test flocculant mixture on algal blooms in laboratory setting with a sentinel species and observe for any negative side effects
- Add liver to mixture and test water before and after using ELISA and HPLC/TMS for toxin concentrations
  - Other potential assays include spectrophotometry and pH

SAV Restoration

Research Questions:

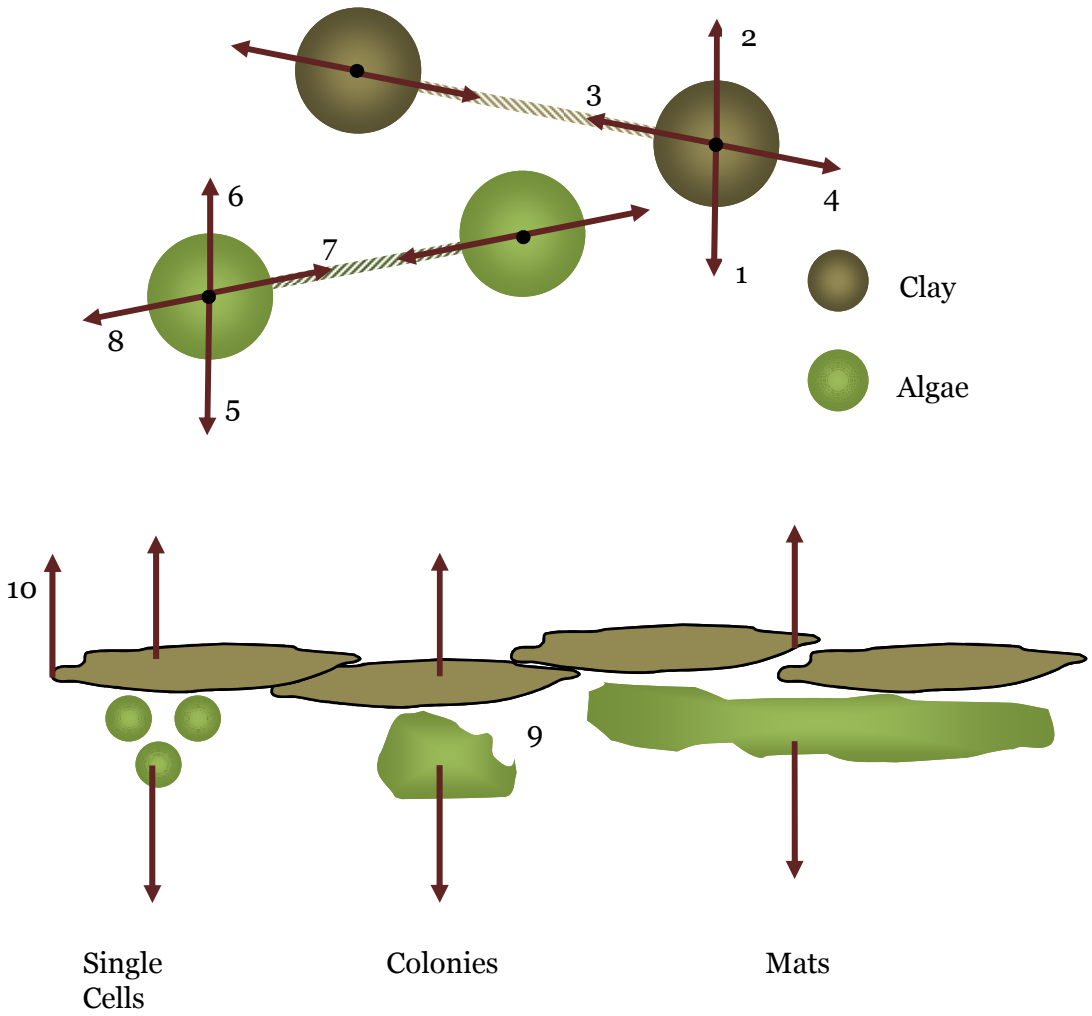
- Which species?
- Interaction with dying algae and flocculant?
- SAVs improve water quality?



Hypotheses:

- Mixture of species will be best.
- Excess nutrients from decaying algae will be taken up by SAVs.
- SAV growth will prevent bloom reoccurrence.

Modeling



Single Clay Particle Forces
1. Gravitational Force
2. Buoyant Force

Clay-clay Forces
3. Tensile Force – Flocculant
4. Electrostatic Repulsion

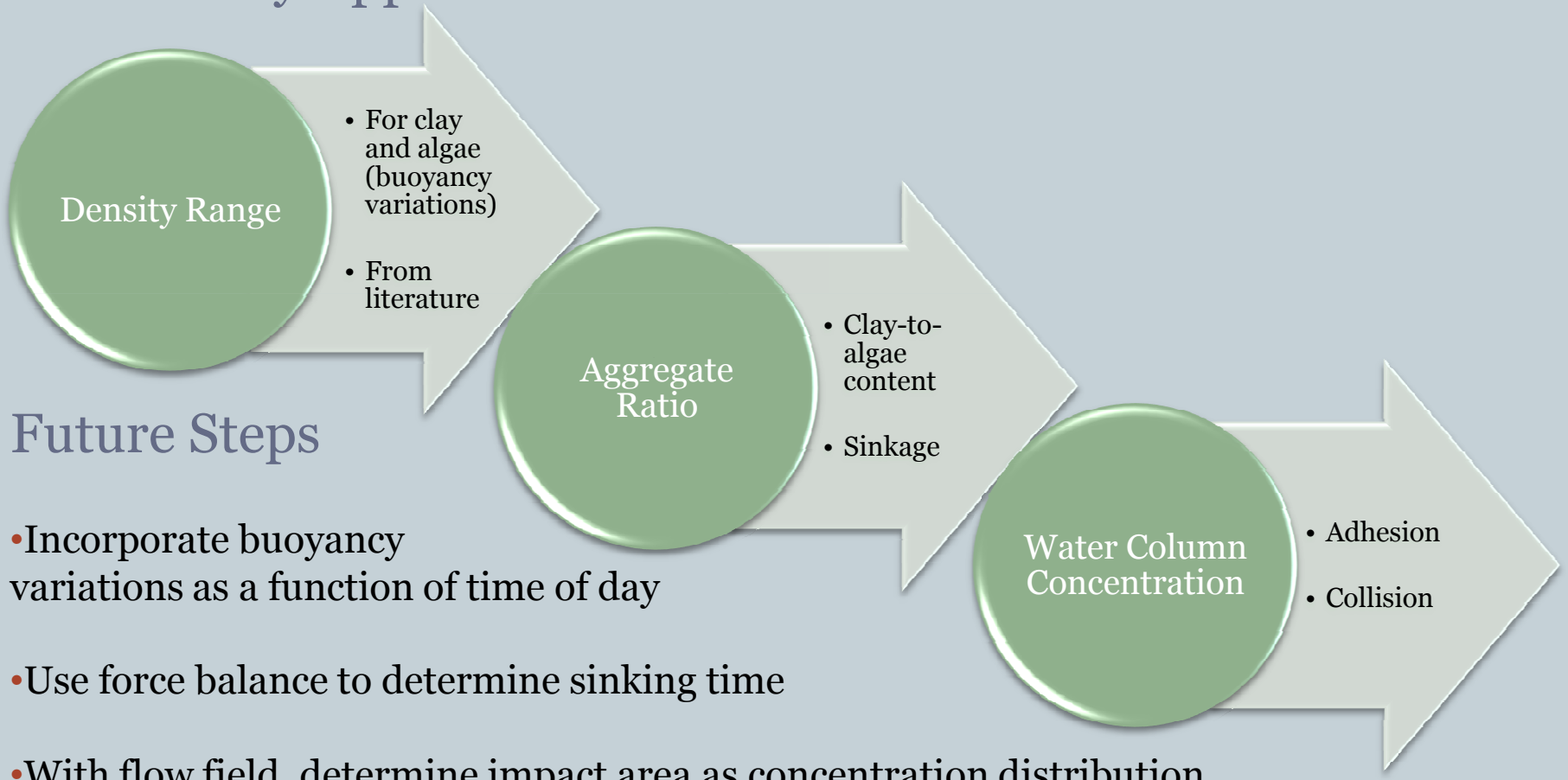
Single Algal Cell Forces
5. Gravitational Force
6. Buoyant Force

Algae-algae Forces
7. Tensile Force – Glycocalyx
8. Electrostatic Repulsion

Macroscopic Forces
9. Net Normal Force
10. Viscous Forces

Our Approach

Preliminary Approach



Future Steps

- Incorporate buoyancy variations as a function of time of day
- Use force balance to determine sinking time
- With flow field, determine impact area as concentration distribution

Project Timeline

Spring 2009
Begin laboratory work, complete survey questionnaires, develop preliminary model.

Fall 2009
Continue laboratory work, gain IRB approval/administer surveys, extend mathematical model.

Spring 2010
Complete laboratory work (finalize clay mixture), execute field experiments, conduct data analysis.

Fall 2011
Begin writing thesis.

Spring 2011
Present results at thesis conference


The Beatles
Yellow Submarine