Can harmful algal bloom mitigation make the problem worse?

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Outline

- Background
- PCMHAB
- Environmental Assessment
- Potential Impacts
- Requirements
- Perspective

Context

- Presentation from research/science perspective
- US environmental compliance can be extremely technical, involving an array of lawyers and specialists
- Assisting government, non-profits, and private companies navigate the various laws is a significant industry

HAB Mitigation in the US

- Use of control and mitigation techniques is relatively limited
- Primarily focused on early warning and forecasting
- Recent events highlight the significant need for PCM strategies

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Red tide off northwest Florida may hit economy

Jason Dearen, Associated Press 2:40 p.m. CDT September 18, 2014

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(Photo: Bruce Graner)

CLEARWATER –

It's like Florida's version of The Blob. Slow moving glops of toxic algae in the northeast Gulf of Mexico are killing sea turtles, sharks and fish, and threatening the waters and beaches that fuel the region's economy.

Known as "red tide," this particular strain called Karenia brevis is present almost every year off Florida, but large blooms can be particularly devastating. Right now, the algae is collecting in an area about 60 miles wide and 100 miles long, about 5 to 15 miles off St. Petersburg in the south and stretching north to Florida's Big Bend, where the peninsula ends and the Panhandle begins.

Fishermen who make a living off the state's northwest coast are reporting fish kills and reddish water.

"It boils up in the propeller wash like boiled red Georgia clay. It's spooky," said Clearwater fisherman Brad Gorst as he steered the charter fishing boat Gulfstream 2 in waters near Honeymoon Island, where dead fish recently washed ashore.

Red tide kills fish, manatees and other marine life by releasing a toxin that paralyzes their central nervous system.

The algae also foul beaches and can be harmful to people who inhale the algae's toxins when winds blow onshore or by crashing waves, particularly those with asthma and other respiratory ailments.

In 2005, a strong red tide killed reefs, made beaches stinky and caused millions in economic damage. A weaker red tide in 2013 killed 276 manatees, state records show, after infecting the grasses eaten by the endangered creatures.

"This red tide ... will likely cause considerable damage to our local fisheries and our

PCMHAB

- Prevention, Control, and Mitigation of Harmful Algal Blooms (PCMHAB) Research Program
- Established to foster the research on promising prevention, control, and mitigation (PCM) techniques
- Community developed, mandated by US Congress

S. 1254: Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014

Introduced: Jun 27, 2013 (113th Congress, 2013–2015)
Status: Enacted — Signed by the President on Jun 30, 2014
Law: This bill became the law numbered Pub.L. 113-124.

PCMHAB

- Conducted in 3 phases:
  - Development: advance and evaluate unproven but promising techniques
  - Demonstration: test, validate, and evaluate promising technologies
  - Technology Transfer: facilitate the transition to end-user application

PCMHAB

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- Selected 2 projects that included field demonstration
  - Clay flocculation of *Microcystis* in Chesapeake Bay

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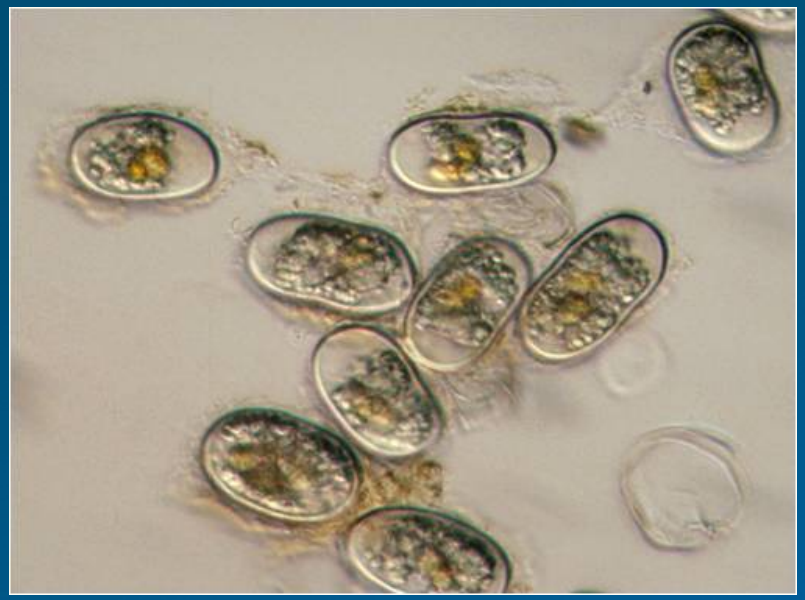

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  - Clay flocculation of *Microcystis* in Chesapeake Bay
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- Successful projects were submitted for internal review and approval
  - Routine process done for every grant recommended for funding
  - Approval has never been an issue
  - Until……

Environmental Impacts?

We received significant concerns about environmental impacts

"Due to settled time periods of Cape Cod, historic and prehistoric, there may be a requirement for cultural and historical surveys"

"Nauset marsh waters used to have extensive eelgrass beds. Large scale turnorver of sediments will impact the current habitat. Assessment required"

"Just because water is already negatively impacted by a HAB, does not mean that the action would have no impact. This exactly how cumulative effects occur"

An analysis of environmental impacts was required

NEPA

- US environmental compliance mandated through the National Environmental Policy Act (NEPA)
- Provides a format for a comprehensive impact analysis of any government activity
  - Gov't projects
  - Anything requiring a permit or approval
  - Gov't funding of projects

NEPA

- Three possible ways to meet NEPA requirements
  - Categorical exclusion (CE).....significant impacts not likely
  - Environmental Assessment (EA)….significant impacts possible
  - Environmental Impact Statement (EIS)….significant impacts likely
- Amount of analyses, efforts, and public engagement increases GREATLY between CE and EIS
- Most research is funded through a categorical exclusion, but not sufficient for PCM demonstration

NEPA

To meet NEPA requirements an environmental assessment was initiated for the PCMHAB program field demonstration projects

The environmental assessment asks….

Will projects result in significant direct, indirect, or cumulative impacts to the environment?

Environmental Assessment

Core components include:

- Integrates a suite of US environmental laws focused on:
  - Water Quality
  - Protected Species (endangered, threatened, etc)
  - Invasive species
  - Essential habitat (e.g., SAV beds, coral reefs)
  - Historic preservation
  - Human health

Environmental Assessment

- Analysis of the impacts of PCM demonstration versus no action

- Goal was to evaluate PCM demonstration techniques for possible significant impacts on the environment

AND

- To advance PCM field demonstration prudently, but as rapidly as possible

Environmental Assessment

Physical control methods evaluated:

- Clay flocculation
- Sediment resuspension, burial, and removal
- Cell harvesting and removal
- Water column mixing

Chemical control methods evaluated

- Native macroalgae and extracts
- Barley Straw
- Biosurfactants
- Purified algidical compounds
- Copper
- Silica
- Hydrogen peroxide

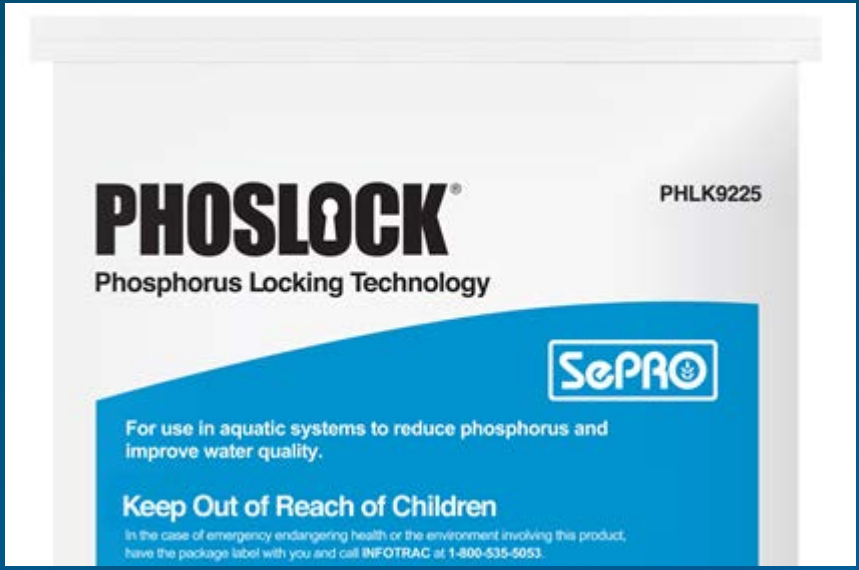
Most biological controls EXPLICTLY EXCLUDED

Environmental Assessment

How did we choose these techniques?

Criteria for inclusion

- Techniques that manipulate the environment
- Promising laboratory and/or mesocosm results
- Already in use (private ponds and lakes)
- Expected to be ready for demonstration in next 5 years



Environmental Assessment

How did we choose these techniques?

Criteria for exclusion

- Likelihood of significant environmental harm
  - Sodium hypochlorite (bleach)
- Introduction of live organisms (biological control)
  - Algicidal bacteria/viruses
  - Non-native macroalgae
- Categorical exclusion sufficient
  - Selective shellfish breeding for aquaculture

Overall PCM Effects

Potential effects identified for all PCM techniques:

- Water quality impairments associated with dead or lysed cells
  - Increased biological oxygen demand
  - Low dissolved oxygen and hypoxic
- Initiate or enhance release of toxins
- Temporary elimination of recreation areas
- Overall effects not anticipated to be significant or add to environmental impacts already being experienced

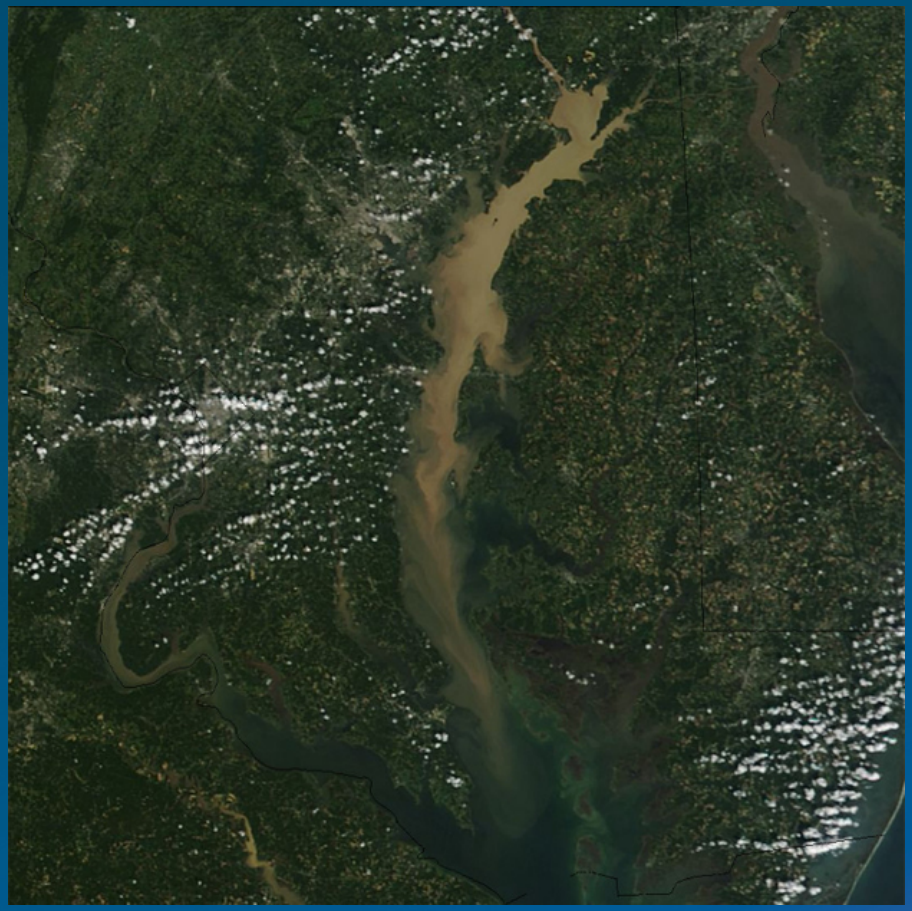
Sediment-based Controls

- Includes clay flocculation and sediment resuspension and/or burial

Possible effects include:

- Water quality:
  - Increased turbidity
  - Altered nutrient levels
  - Hypoxic or anoxic conditions
  - Could violated discharge allowances under the Clean Water Act

- Size of system and flushing rate is a critical factor



Sediment-based Controls

Possible effects include:

- Living resources
  - ‘Coughing’ in fish
  - Reduced clearance rates in bivalves
  - Sedimentation of key habitats (e.g., coral reefs, oysters)
  - Reduced SAV photosynthesis and hydrogen sulfide toxicity
- Human health risks limited to possible resuspension of contaminants

Mixing and Cell Harvesting

- Includes water column mixing and physical removal of HAB cells

Possible effects include:

- Water quality:
  - Possible increases in turbidity
  - Temporary movement of low DO waters to surface

- Living resources
  - Altered plankton community composition
  - “Bycatch” of non-target species
  - Food web disruption through removal of primary production

Algicidal Isolates

- Includes isolates from bacteria, viruses, and macro-algae

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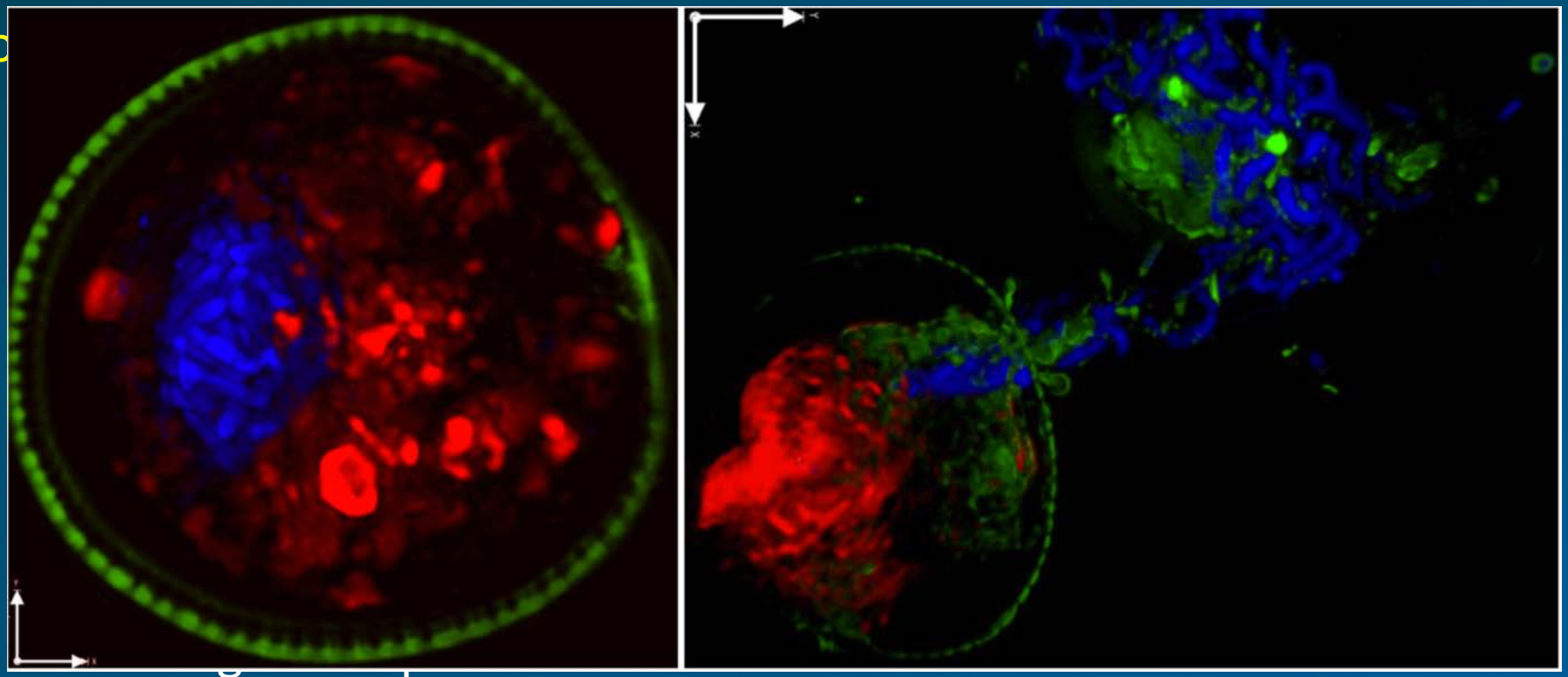


Copper and H_2O_2

- Includes copper sulfate, chelated compounds, and hydrogen peroxide
- Copper-based algicides are widely used in freshwater

Possible effects include:

- Water quality:
  - Contamination of sediments
  - Water soluble
  - Potential to violate Clean Water Act

- Living resources
  - Can be toxic to non-target organisms
  - Has the potential to bioaccumulate
  - Sub-lethal effects on hormone function, growth rate, and respiratory distress

Other PCM Techniques

- Includes biosurfactants, silica, barley bales, and whole macro-algae

Possible effects include:

- Water quality:
  - Localized turbidity from dissolved organic matter (barley)
  - Foaming in high energy environments (biosurfactants)
  - Altered nutrient dynamics

- Living resources
  - Enhanced growth of existing diatoms (silica)
  - Can attract wildlife (barley, macro-algae)
  - Mortality of non-target phytoplankton (barley)

Conclusions

Explicit definition of “demonstration” for PCMHAB program:

- The minimum amount of a control method anticipated to decrease, but not eliminate, a HAB
- Limited to waters already experiencing a HAB
- Less then an acre in size with limited number of applications
- Explicitly not full implementation of a technique

Conclusions

- Environmental impacts resulting from PCM techniques likely
- Determined that *demonstration* will likely not result in "significant" impacts (good or bad)
- Recommends the funding of field demonstration projects since the majority of impacts would be:
  - Temporary
  - Limited in scope and scale
  - Subject to strict guidelines and monitoring requirements
- Overall, quantification of habitat and living resource effects is limited

Mitigation Measures

Extensive technique specific guidelines required to reduce impacts to:

- Protected Species
  - Avoid use of copper in waters with low pH and Ca-CO_3
  - Maximize use of biodegradable chemicals
- Water Quality
  - Use of turbidity curtains
  - Clay flocculation only on ebb tides
- Human Health
  - Contaminated soils or toxin collection disposal plan
  - Restricted access
- Benthic Environment
  - Shallow slope wall angle for sediment removal
  - Sediment grain size and contaminants

Mitigation Measures

- Projects are excluded from testing PCM techniques must avoid and maintain a 100 meter buffer around:
  - Coral reefs
  - Turtle nesting areas (while turtles are present)
  - Bird nesting areas
  - Wetland
  - Submerged aquatic vegetation beds
  - Cultural or historical resources

- Winds, waves, and tides should be considered while maintaining a 100 meter buffer

Monitoring Requirements

- All projects must:
  - Analyze zoo- and phytoplankton abundance and density pre- and post-treatment
  - Record water quality and hydrology parameters pre- and post-treatment
  - Determine the abundance and density of benthic fauna pre- and post-treatment
- All PCM techniques using chemicals must test for desired concentrations post-treatment
- Sediment-based PCM techniques conduct an initial screening for legacy industrial compounds, metals, and pesticides
- Additional project-specific monitoring will likely be necessary

Additional Perspectives

- Core tenant of the NEPA process is to demonstrate analysis of possible environmental impacts and compare alternatives
- Implementation will likely need a “toolbox” of techniques
- Balance between treatment, no treatment, and side-effects
  - Nuisance bloom….versus….
  - Drinking water ban impacting 100,000’s of people

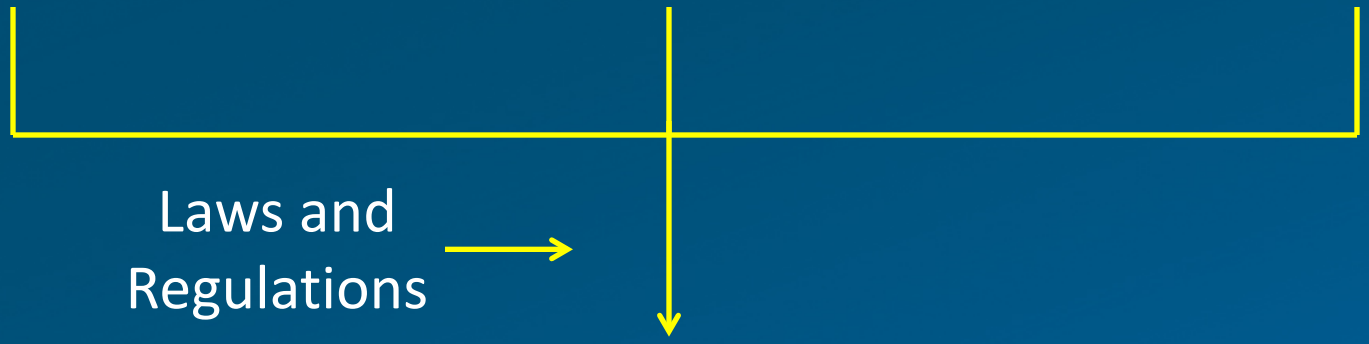
Additional Perspectives

Critical factors in "tool selection"

Effectiveness
- Species
- Toxin
- Env.

Side-effects
- Habitat
- Species
- Human

Society
- Severity
- Cost
- Disturbance



Additional Perspectives

Case Study: Poplar Island (Microcystis)

Effectiveness

- Barley bales
- ~~Clay~~
- ~~Phoslock~~
- ~~Copper~~

Side Effects

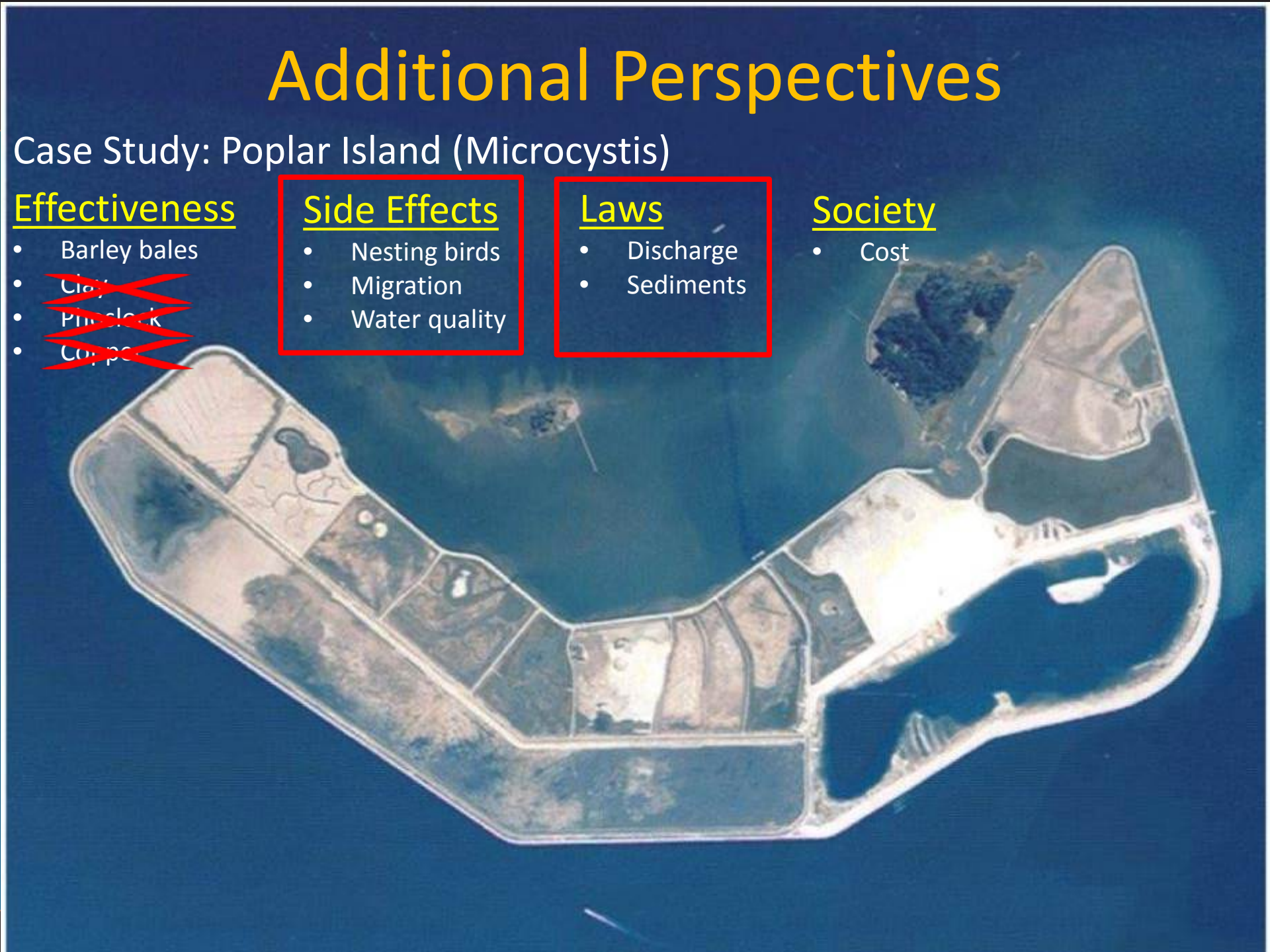
- Nesting birds
- Migration
- Water quality

Laws

- Discharge
- Sediments

Society

- Cost



Concluding Thoughts

- Environmental laws should be not be a barrier
- Some key questions to consider
  - Is a technique practical?
  - Could there be unintended consequences?
  - Is there another, less harmful option?
  - And, finally….

Could mitigation make the problem worse?

The End

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