Mechanical/Physical Ballast Treatments

Examples and Findings from the Great Lakes Ballast Technology Demonstration Project and Status of Other Research

Principal Mechanical/Physical Treatment Options Being Researched or Demonstrated

- Filtration (Strainer or Depth)*
- Filtration + UV*
- Cyclonic Separation + UV*
- Heat
- Ozone?
- Supersaturation or Deoxygenation

Strengths, In General

- Flexible
  - Treats BOB and NOBOB
  - Treats Coastal and Transoceanic Voyages
- Minimizes Environmental Trade-offs
  - Less Need for Environmental Permits
  - More Readily Accepted in Port States
- Maximizes Incentive to Treat Regularly (on all voyages)
- Several Already in Full-Scale Trials

Limitations, In General

- Installation and Operational Learning Curve
- Costs Concentrated Up-front
- May not be 100% Effective Against All Organisms

Great Lakes Ballast Technology Demonstration Project

Biological Research Team

- Allegra Cangelosi, NE-MW Institute
- Mary Balcer, University of Wisconsin
- Chip Blatchley, Purdue University
- Dave Wright and Rodger Dawson, University of Maryland
- Xenqing Gao, Kent Sate University
- Anwar Huq, Maryland Biotechnology Institute
- Ivor Knight, James Madison University
- Donald Reid, Consultant
- Nicole Mays and Jessica Taverna, NEMWI
- Rochelle Sturtevant, NOAA

Barge Platform Tests
Technologies

- **1998 -** 25 um vs. 50 um Screen Filtration
- **2000 -** 40 um Screen Filtration + Ultra Violet Radiation **vs.** Cyclonic Separation + Ultra Violet Radiation
- **2001 -** 100 um Depth Filtration + Stronger UV

Range of Biotic Groups, Assays

- Zooplankton (Ambient)
  - total density across taxa (1998, 2000)
  - live density across taxa (2000, 2001)
- Phytoplankton (Ambient)
  - total density of individual taxa (1998, 2001)
  - initial Chlorophyll a (1998, 2000, 2001)
  - incubated Chlorophyll a (2000 + 2001)
- Bacteria (Ambient) and Viruses (Spiked)
  - total culturable bacteria (1998, 2000, 2001)
  - spiked coliphage (2000, 2001)

Fig 10. Relative Efficiencies for the 25 µm (1998), 40 µm (2000) and 50 µm (1998) Screens at Reducing Total Zooplankton Density of Macrozooplankton, Microzooplankton and Total Zooplankton

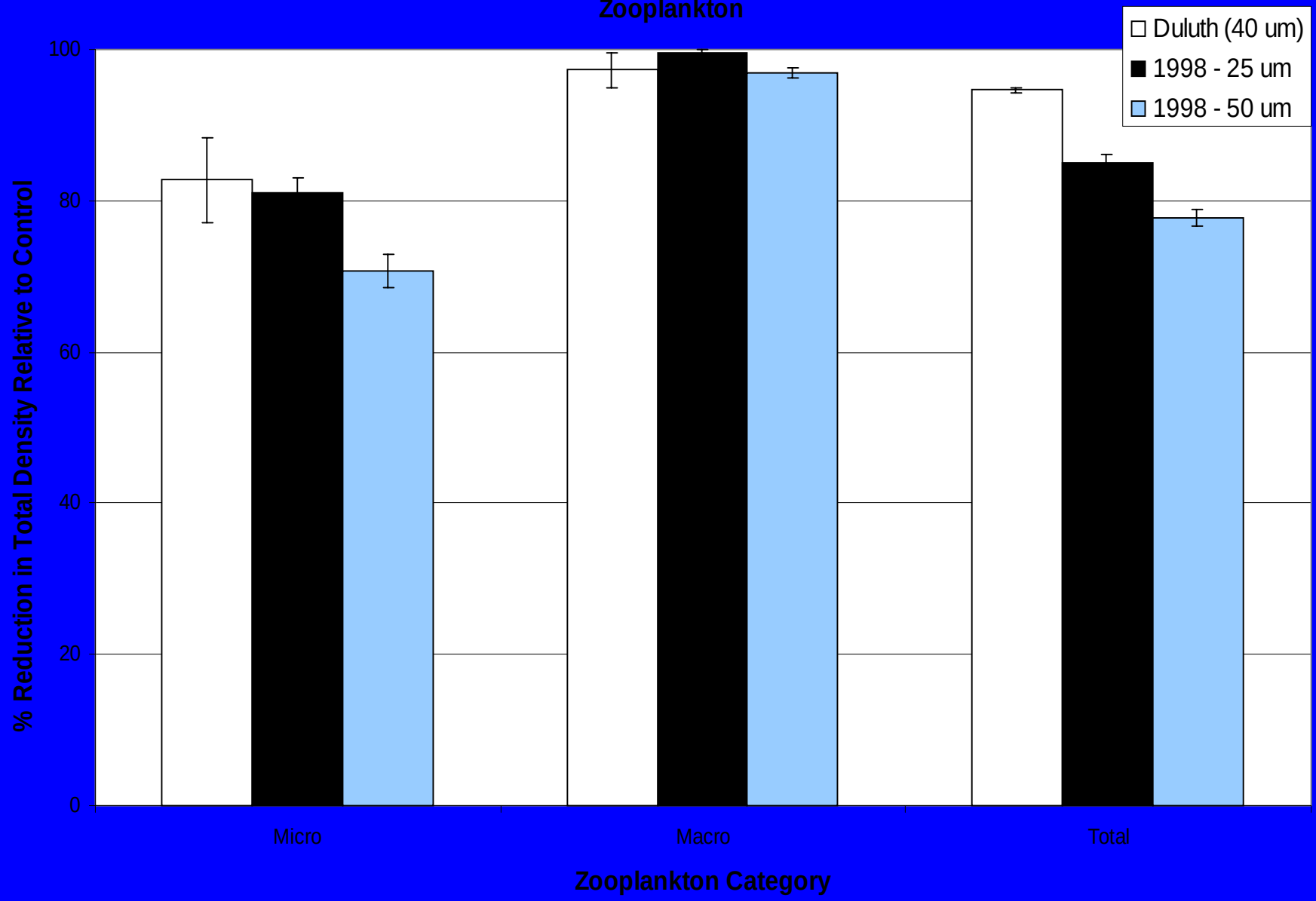
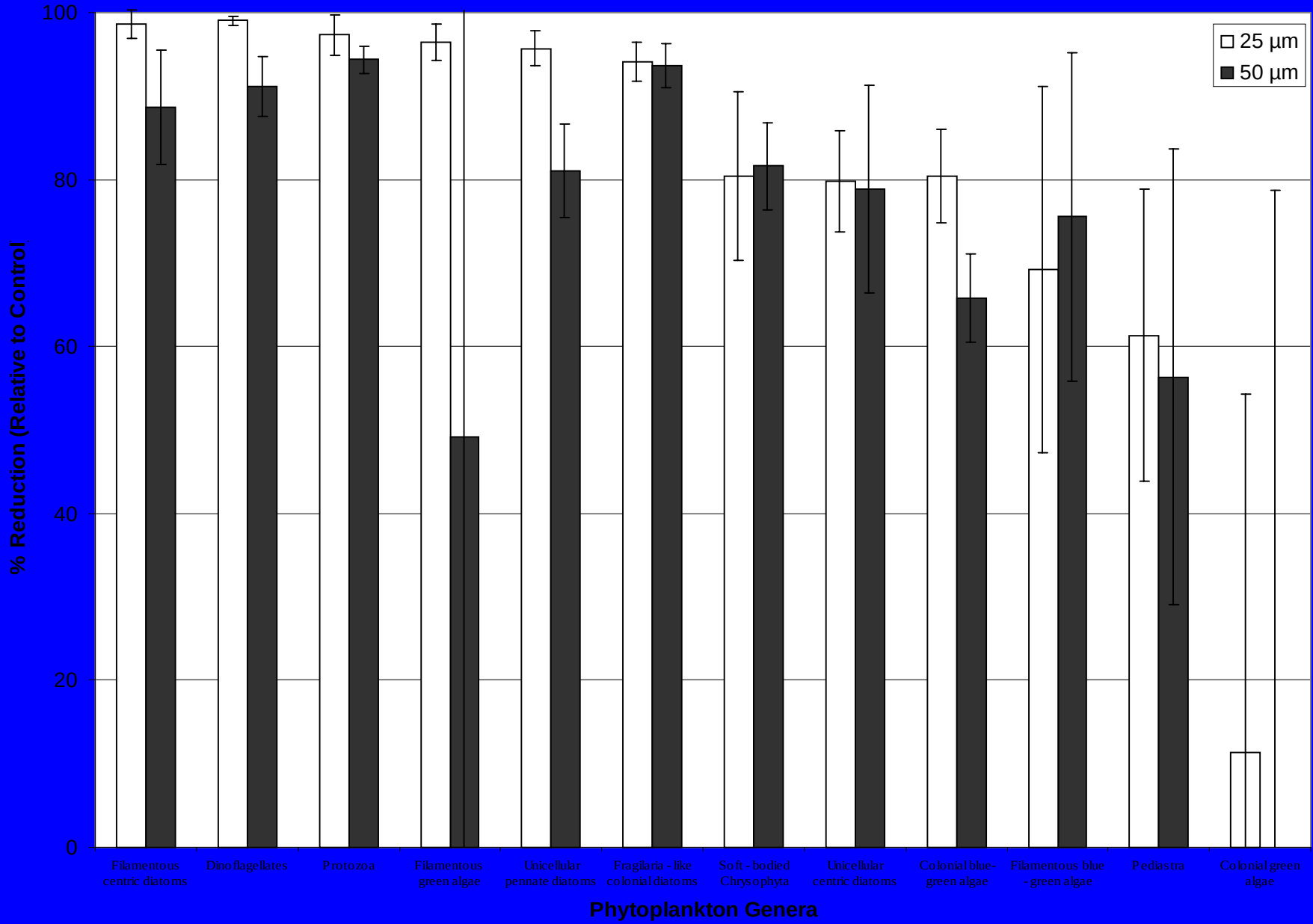
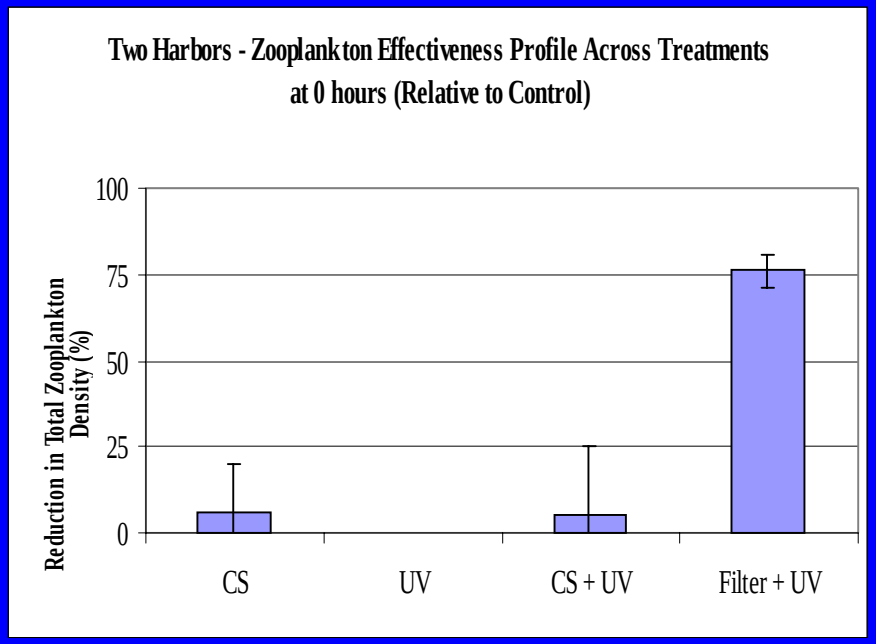
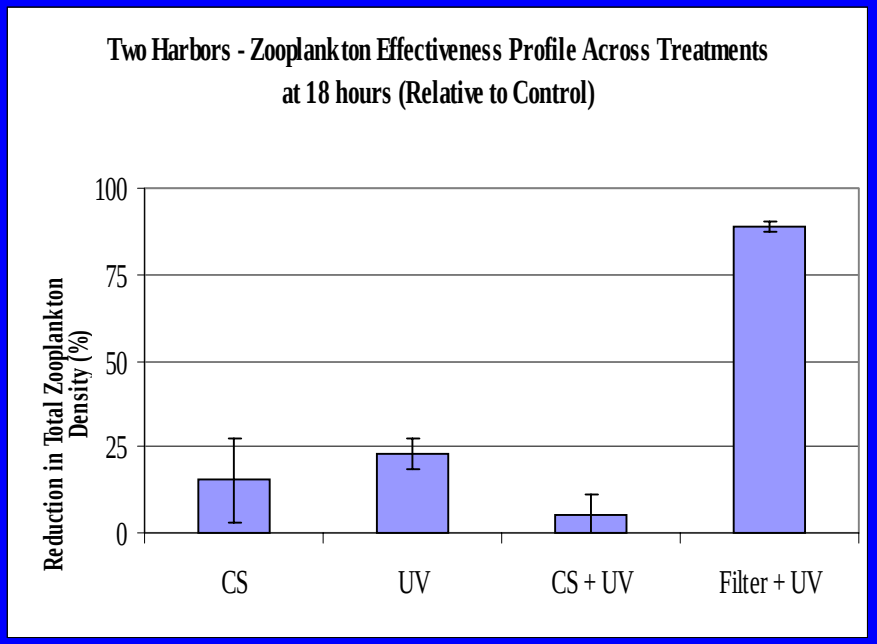


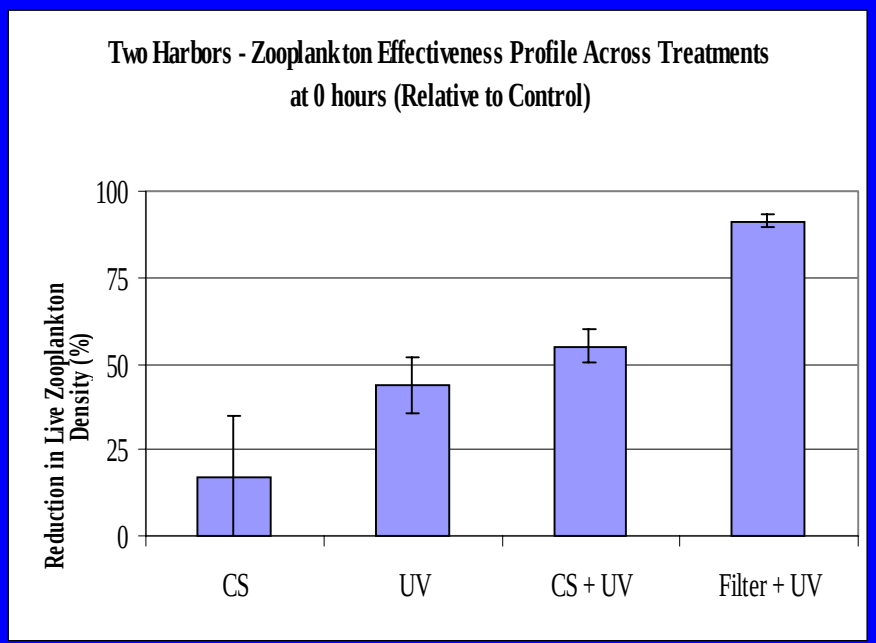
Fig 7. Relative Efficiencies for the 25 µm and 50 µm Screens at Reducing Phytoplankton Genera

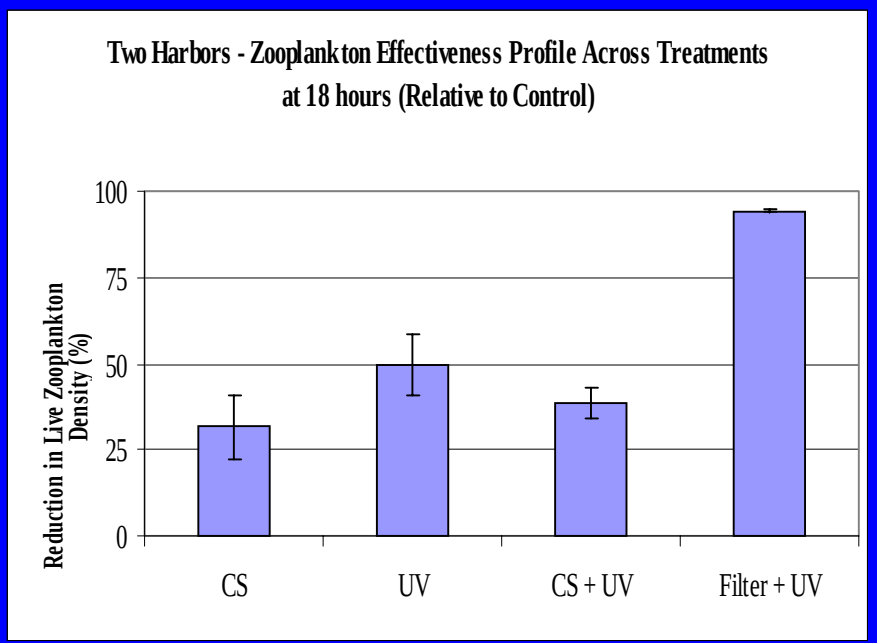



GREAT LAKES
BALLAST TECHNOLOGY DEMONSTRATION PROJECT
BIOLOGICAL SAMPLING TANKS
ULTRAVIOLET
FILTER
HYDROCYCLONE
DIESEL PUMP
CO-CHAIRS
RICK HARKINS – LAKE CARRIERS' ASSOCIATION
ALLEGRA CANGELOSI – NORTHEAST MIDWEST INSTITUTE


Two Harbors - Zooplankton Effectiveness Profile Across Treatments
at 0 hours (Relative to Control)
Reduction in Total Zooplankton Density (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV


Two Harbors - Zooplankton Effectiveness Profile Across Treatments
at 18 hours (Relative to Control)
Reduction in Total Zooplankton Density (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV


Two Harbors - Zooplankton Effectiveness Profile Across Treatments
at 0 hours (Relative to Control)
Reduction in Live Zooplankton Density (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV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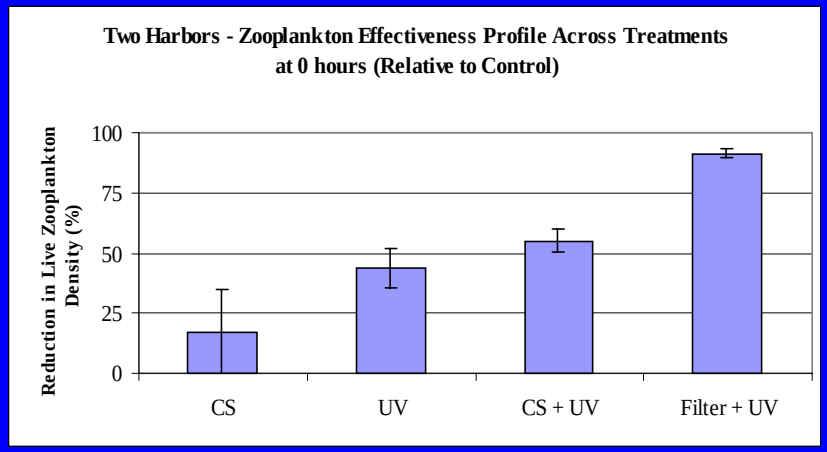
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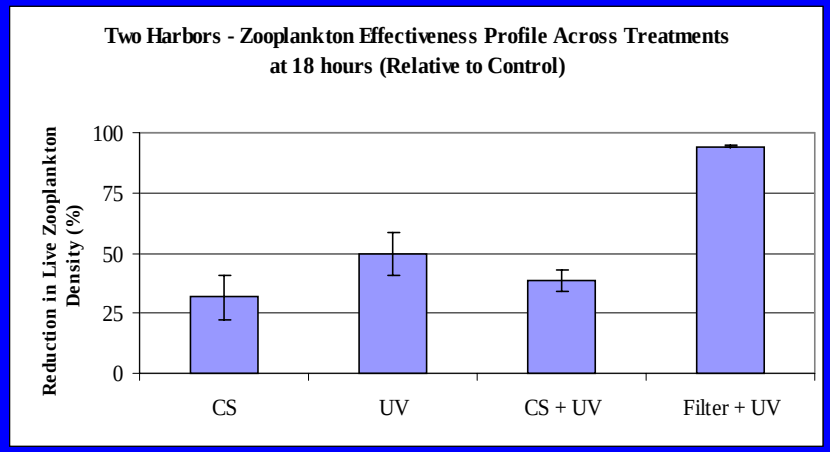
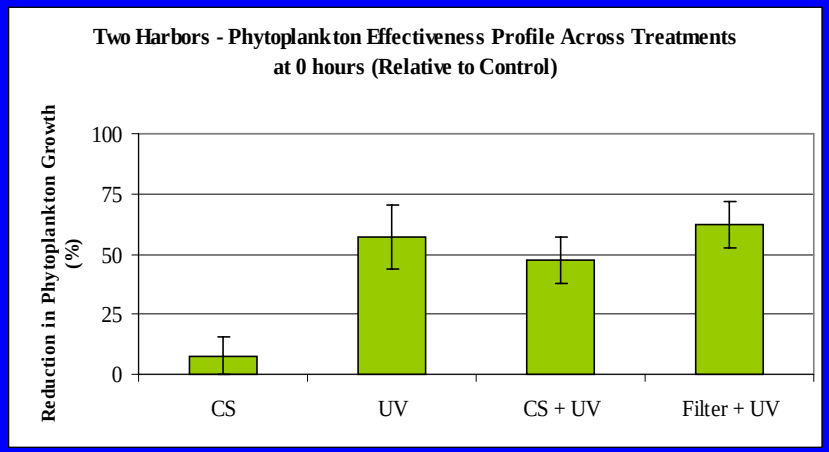
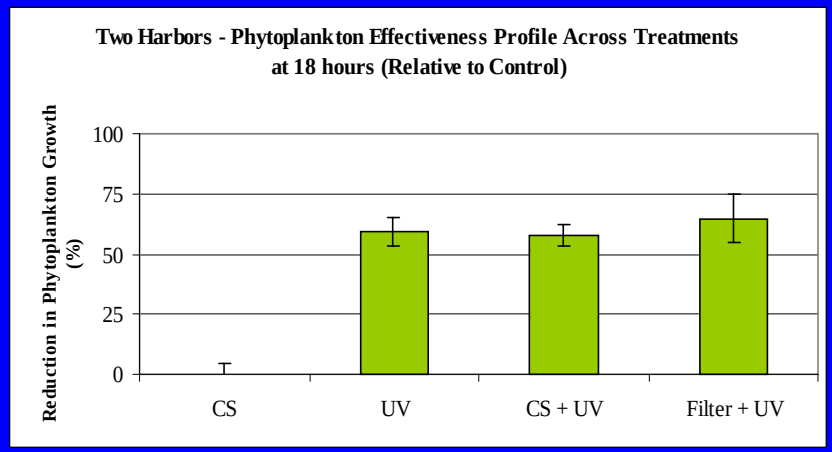
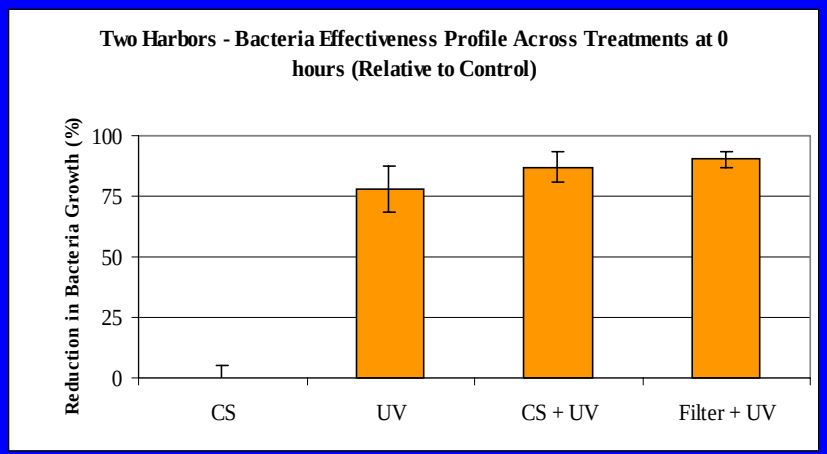
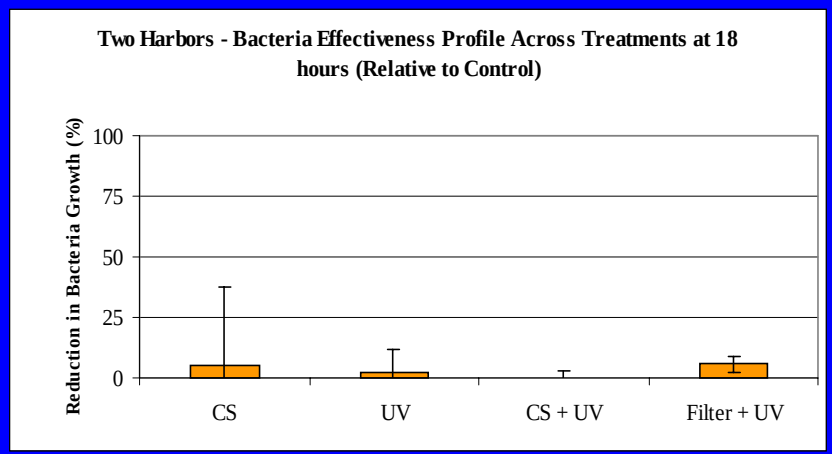

Two Harbors - Zooplankton Effectiveness Profile Across Treatments at 18 hours (Relative to Control)
Reduction in Live Zooplankton Density (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV

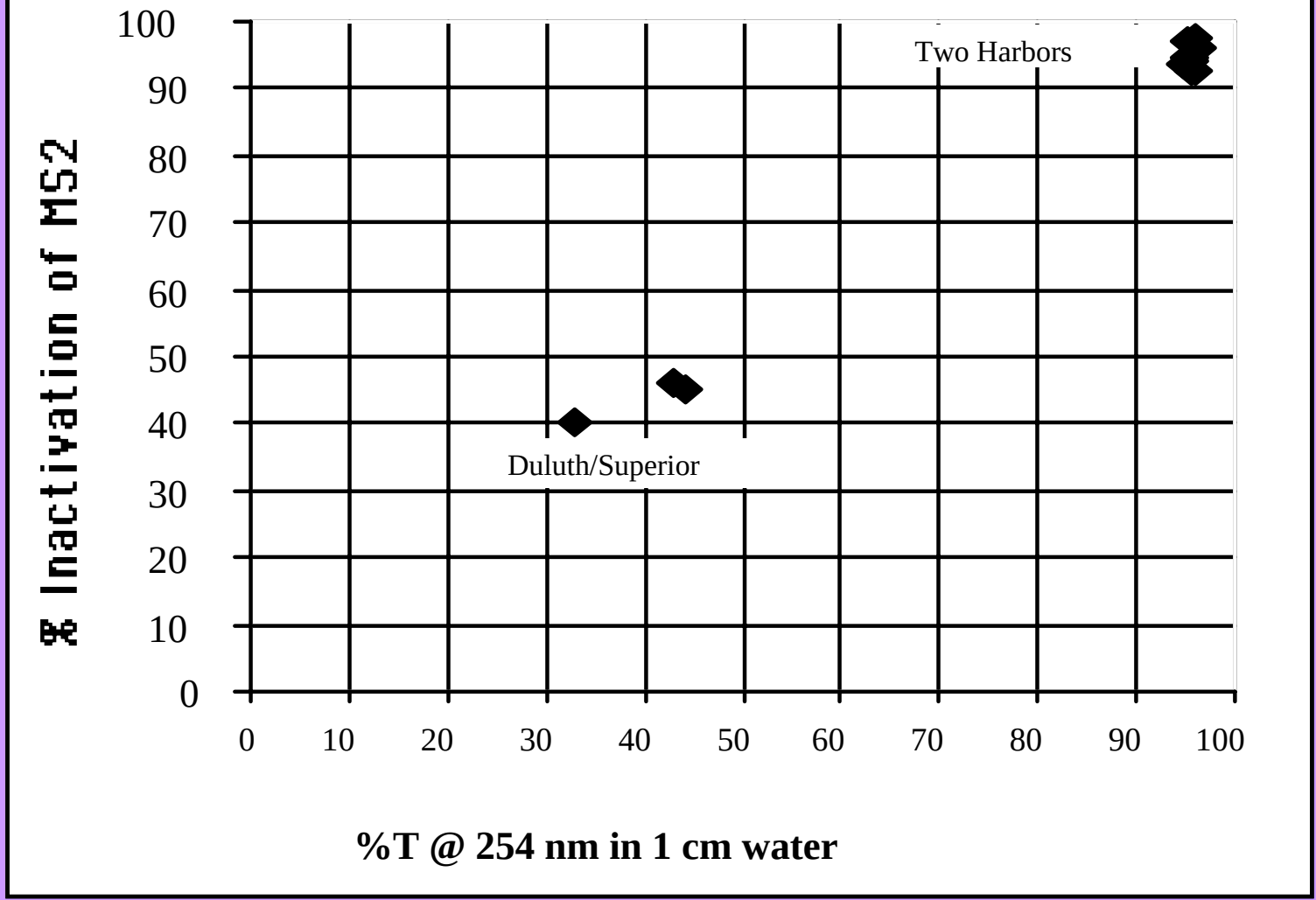

Two Harbors - Phytoplankton Effectiveness Profile Across Treatments at 0 hours (Relative to Control)
Reduction in Phytoplankton Growth (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV


Two Harbors - Phytoplankton Effectiveness Profile Across Treatments at 18 hours (Relative to Control)
Reduction in Phytoplankton Growth (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV


Two Harbors - Bacteria Effectiveness Profile Across Treatments at 0 hours (Relative to Control)
Reduction in Bacteria Growth (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV

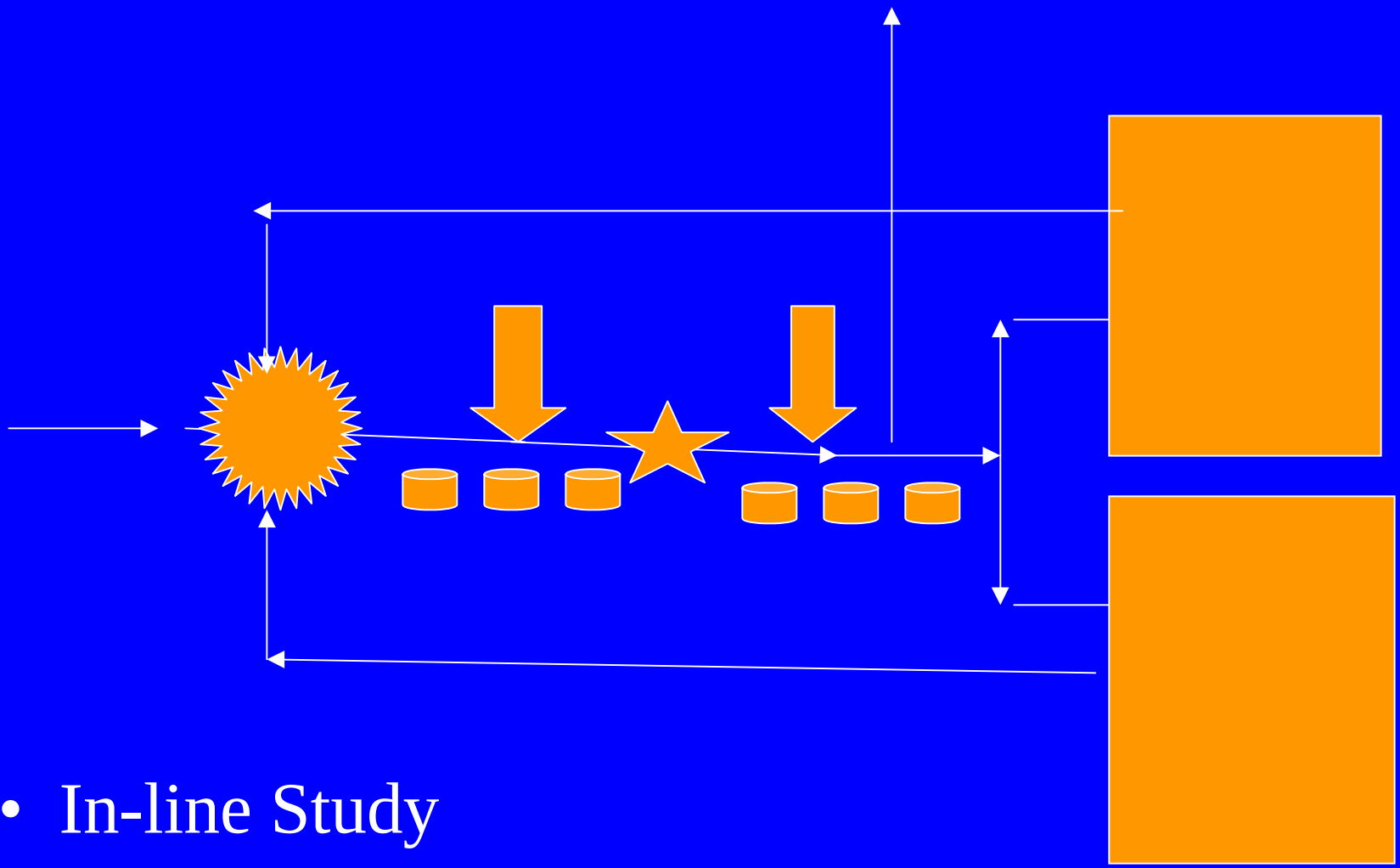

Two Harbors - Bacteria Effectiveness Profile Across Treatments at 18 hours (Relative to Control)
Reduction in Bacteria Growth (%)
100
75
50
25
0
CS
UV
CS + UV
Filter + UV

Relationship between UV transmittance of treated (UV only) water and effectiveness of inactivation of MS2. Duluth/Superior Harbor N=3; Two Harbors N=9.




MV Regal Princess - 2000
(880 GPM)

RP Tests



- In-line Study
- Time 0 Ballast Tank Study
- Time 18 Ballast Tank Study

Regal Princess--Effects of CS/UV Treatment and Retention in Ballast Tank on Culturable Bacteria

Selected Conclusions - ABSF:

- Powerful and highly consistent tool for removing zooplankton;
- Effective at removing some phytoplankton taxa and attached bacteria;
- Practical at 40 um for some ship applications;

Selected Conclusions - CS

- Did not reduce zooplankton concentrations; may have caused some delayed zooplankton mortality (30 percent) though not statistically significant;
- No effect on bacteria or phytoplankton growth or abundance;
- Did not enhance the effectiveness of UV on bacteria and viruses in our tests;
- Practical for larger flow rates.

Selected Conclusions - UV

- Reduced live zooplankton significantly at single pass, and more at two passes;
- Significantly reduced phytoplankton and microbial growth, but did not prevent regrowth of microbes;
- Effect highly influenced by %T (especially Dissolved Organic Material);

Selected Conclusions: Filtration and UV

- Strong prevention combination
- Filtration rating and UV strength can be adjusted against each other
- Will not yield 100 percent kill of phytoplankton and bacteria, and regrowth possible; UV treatment on discharge advisable
- Potentially reliable and easily monitorable

Other Ship Board Demonstrations

- Ozone - BP Oil Tanker
  - Likely High Effectiveneess
  - Residuals? Corrosive? Cost?
- CS/UV - *Sun Princess* Cruise Ship, *RJ Pfieffer* Container Ship
  - Reliable
  - Effectiveness of CS? Adequate UV Dose?
- Heat - *Iron Whyalla* Bulk Cargo Carrier
  - Effective Against Most Organisms (e.g. cysts)
  - Long Voyages Only? Cost for Short Voyages?

Full-Scale Design Studies

- Teams of Treatment Vendors, Ship Owners, and Marine Engineers
- Retrofit/for Actual Ships
  - RJ Pfeiffer
  - Polar Endeavor
  - FedNav Ve
  - ssel
- Findings by Fall 2001

International Ballast Technology Investment Fair

September 20-21, 2001

Chicago Navy Pier, Chicago, IL

NORTHEAST MIDWEST INSTITUTE

http://www.nemw.org/fair_about.htm

Lake Carriers' Association

Great Lakes Protection Fund