

# Assessment of Zooplankton Injury and Mortality Resulting from the Deployment of Underwater Turbines for Tidal Energy Production

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# Turbine Effects on Megafauna



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# Turbine Effects on Zooplankton

Traditional Hydroelectric Plants have existed for decades, and turbines rotate at similar speeds (e.g. Hoover Dam turbines 90 rpm).



- Very difficult to make quantitative measurements
- Not always possible to separate trauma factors:
  - Blade strikes
  - Shear Stress
  - Cavitations
  - Barotraumas

- Environmental changes caused by dams alter zooplankton communities both up and down stream of the dam.

**Best Hydroelectric Plant data suggests mortality range of 5-15%.**

**No data exists for Tidal Turbines**

# Study Area: Muskeget Channel



Cape Cod

Nantucket Sound, Massachusetts

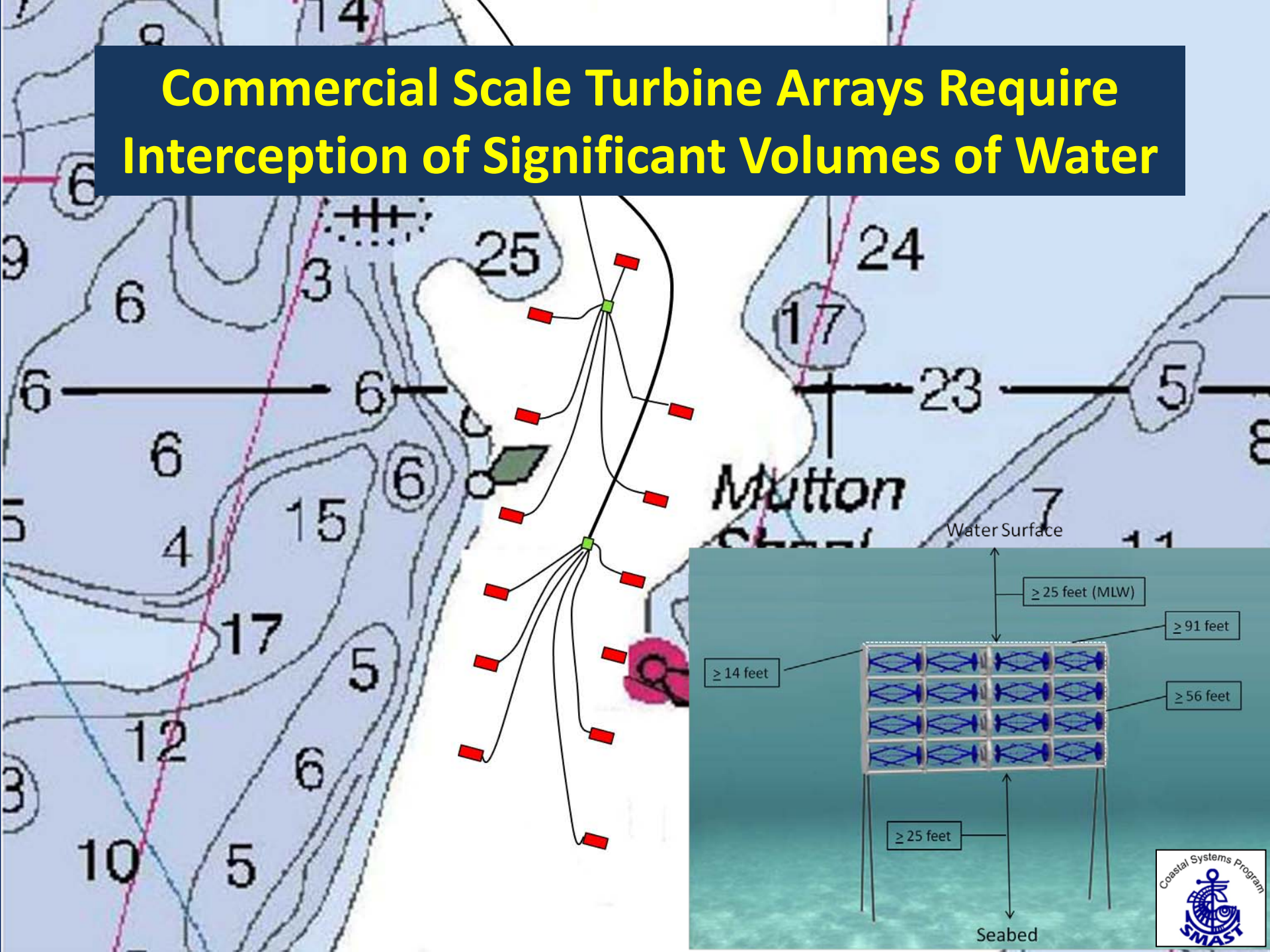
Martha's  
Vineyard

Muskeget  
Channel

Nantucket

Channel Depth: ~50 m  
Channel Width: 0.5-2.0 km  
Max current velocity: 2.5 m/s

# Commercial Scale Turbine Arrays Require Interception of Significant Volumes of Water



# Launch of Barge for 2011 Technology Demonstration



Small scale pilot projects often provide the only source for information required to permit commercial projects.

# Turbine Operating in Muskeget Channel



# Traditional Plankton Collection Methods

Deploy plankton net at turbine hub depth  
(30 cm diameter, 50 $\mu$ m)



Record current velocities for  
volume estimates



Perform serial dilutions to  
ensure proper zooplankton  
densities

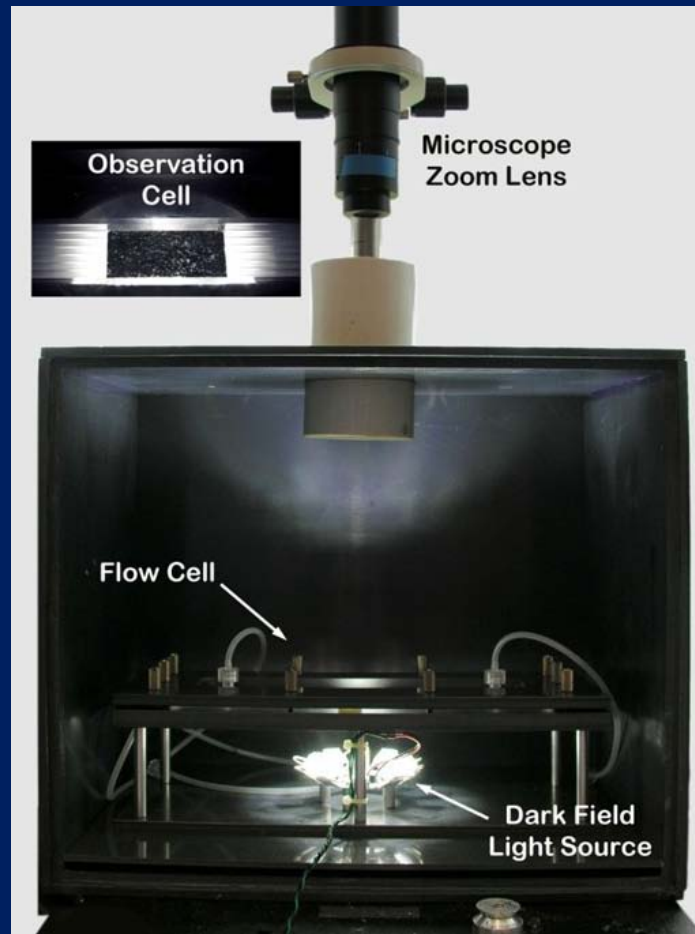


Analyze within 2 hours

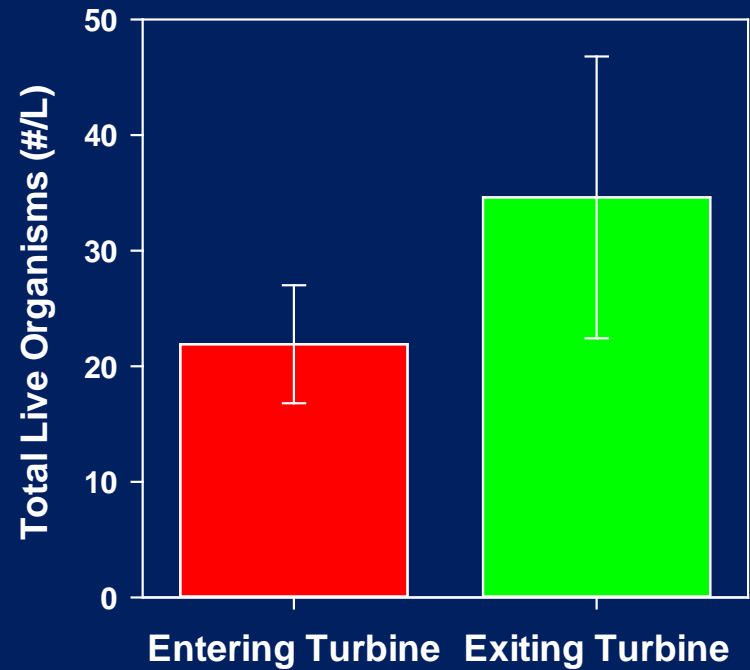
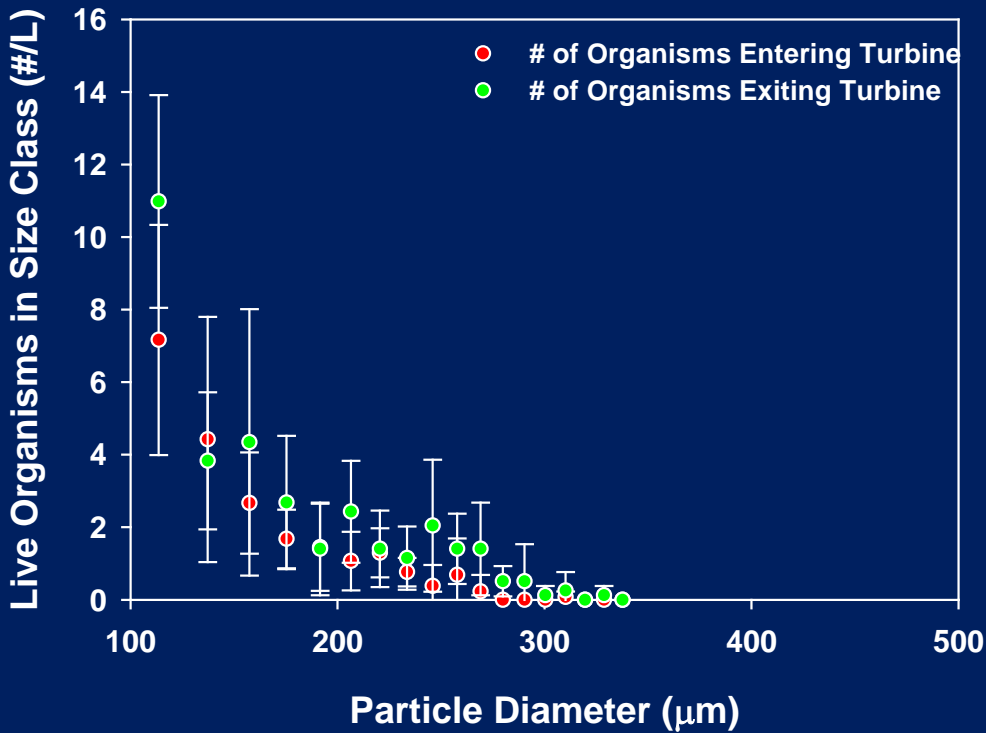


# Determining Viability of Zooplankton

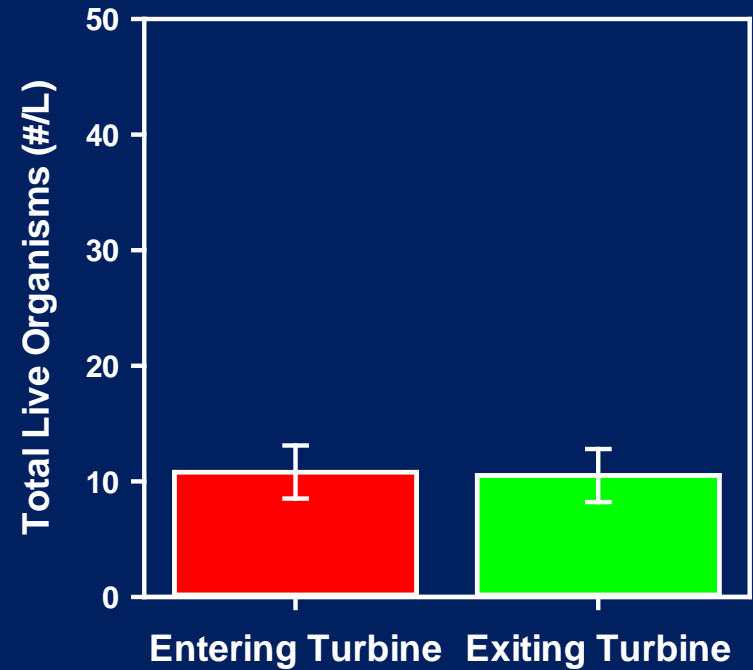
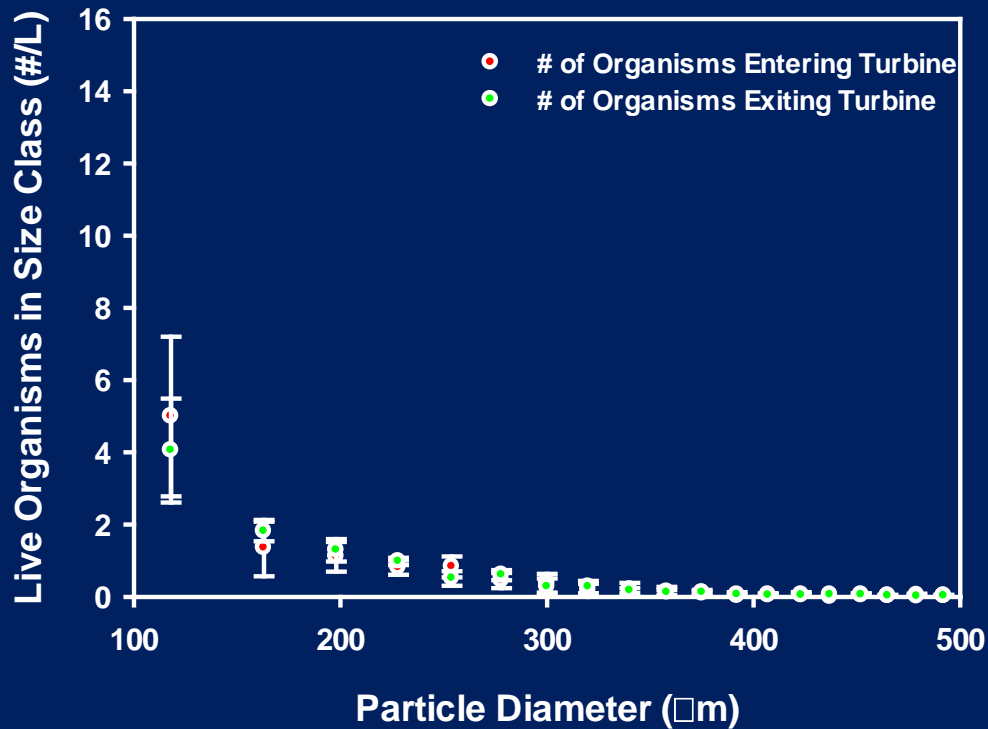
- ❖ Developed for USCG to assess ballast water treatment standards
- ❖ Techniques adapted from NIH protocols including Image J opensource software



# 2011 Free Flow Demonstration



# 2012 Flo Design Demonstration



# Future Work

- Enhance sample throughput and statistical significance through automation
- Obtain data from other turbine types
  - Gorlov Turbine
  - Ductless turbine
- Applications to Traditional Hydroelectric Powerplants
- Potential impacts on macroscopic zooplankton (Fish larvae, Jelly fish, siphonophores, etc)

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