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

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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

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Turbine Operating in Muskeget Channel

Traditional Plankton Collection Methods

Deploy plankton net at turbine hub depth
(30 cm diameter, 50μm)

Record current velocities for volume estimates

Perform serial dilutions to ensure proper zooplankton densities

Analyze within 2 hours

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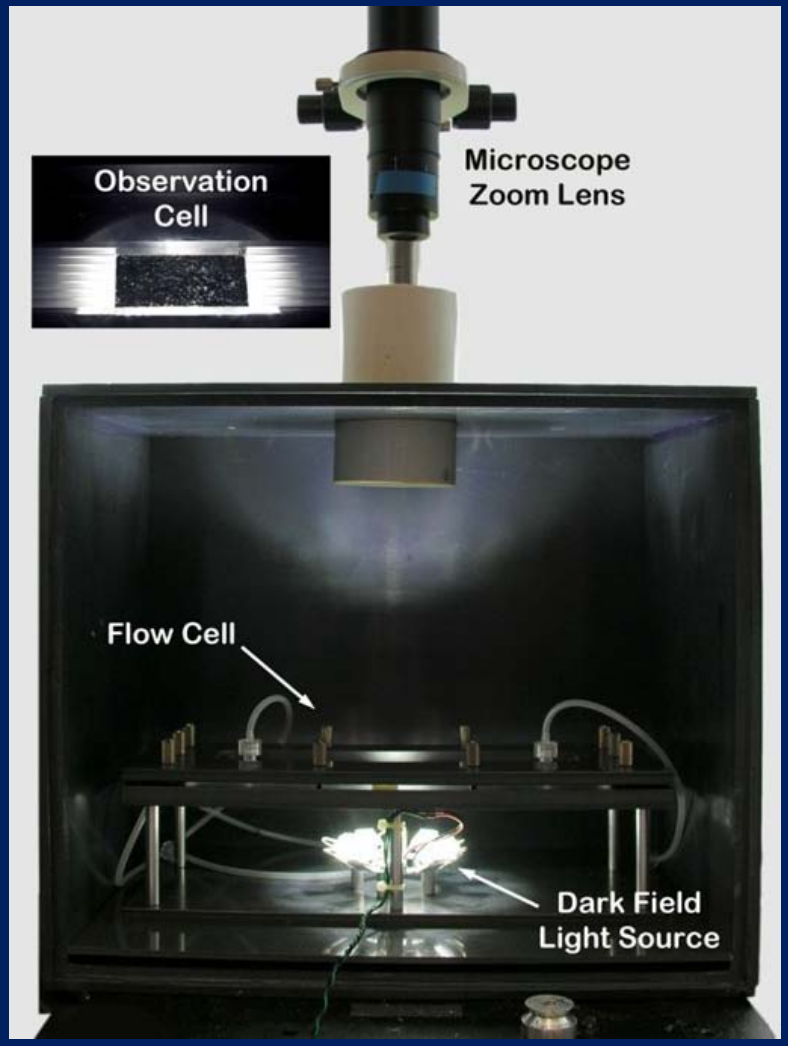
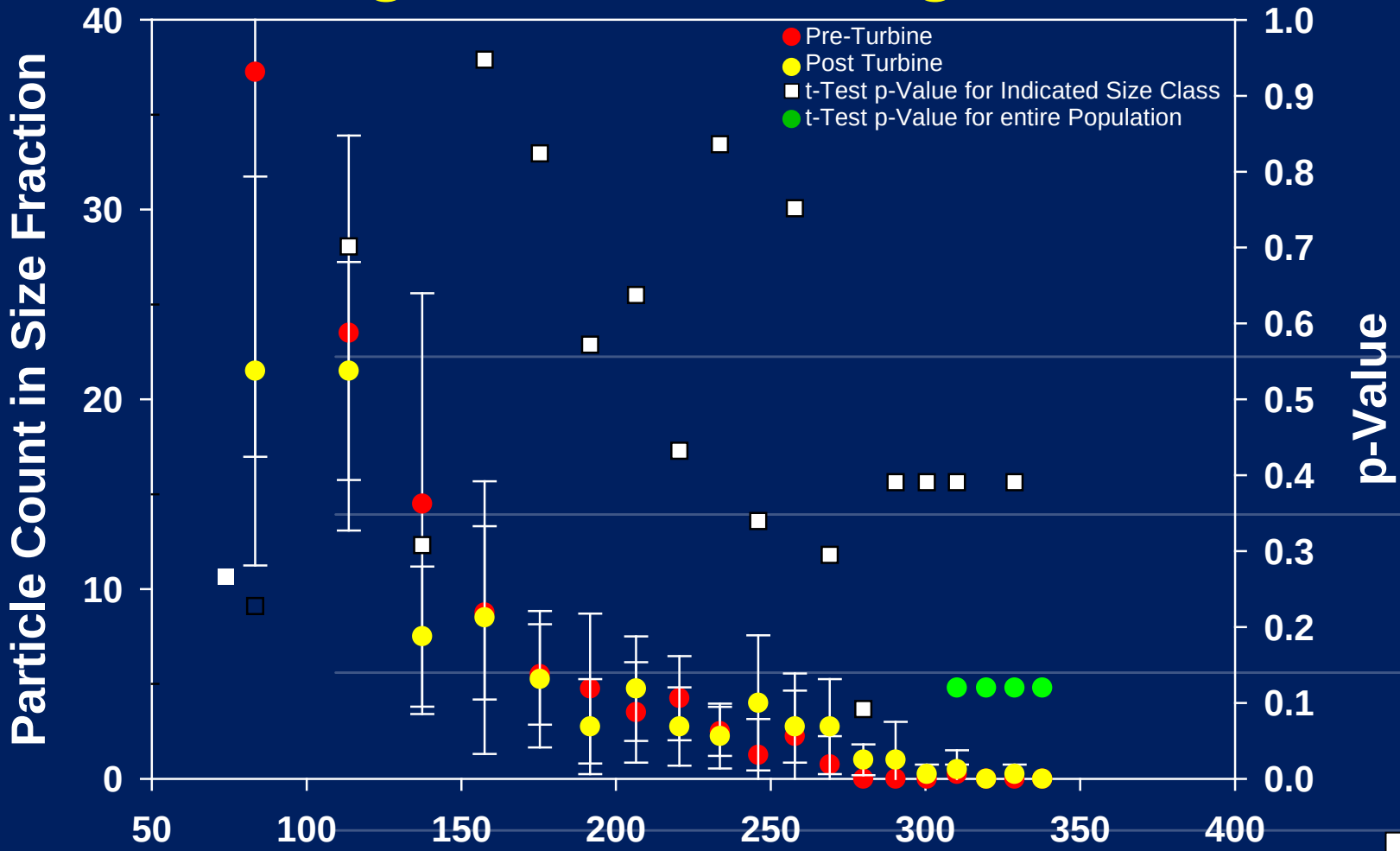
Determining Viability of Zooplankton

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



Effect of Turbine Blades on Zooplankton
Free Flow Demonstration
Muskeget Channel, August 2011



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Conclusions Regarding Risk

- Tidal turbines do not affect the viability of small zooplankton (75-350μm)
  - risk to zooplankton is therefore expected to be very low, and
  - food webs in the region of tidal turbines should not be affected
- Effects on organisms in the size range of millimeters to a few centimeters have not yet been investigated
  - Risk of negative interactions with turbines is expected to be higher than that for smaller organisms, but still low.
  - Organisms in this larger size class are comparatively rare and difficult to image.

Monitoring Effects on Plankton

- Technology is just now approaching the point where *in situ* video monitoring and assessment may be carried out.
- Initial estimates for collecting images sufficient to determine species identity in a 1 knot current are approximately 240 frames per second.
- Robust image analysis software will be required
  - to identify potential organisms, and
  - to discard frames without organisms in order to limit storage and computing requirements.

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