Transport and Survival of Zebra Mussel Veligers in Recreational Boats

Minnesota Aquatic Invasive Species Research Center
University of Minnesota
Driven to Discover™

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Introduction and Background

Recreational watercraft being used on zebra mussel infested waters are at risk of transporting veligers in water trapped inside the boat after removing it from the water. This "residual" water can be found in bilge areas, live wells, ballast tanks, engines, and many other areas. Boaters are able to drain some, but not all of the water trapped in these areas – especially if the boat has inboard or inboard/outboard engines, or ballast tanks.

The goal of this project was to:

- determine how much residual water on average is present in each compartment
- determine how often, and how many veligers are found in residual water samples
- determine how long veligers survive in residual water at various temperatures in live wells, ballast tanks, and engines

Sampling and Experiments Overviewed

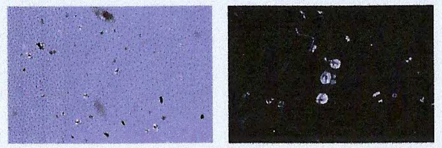
Sampling of residual water containing veligers from recreational boats

- From watercraft exiting two popular, high-use, zebra mussel infested water bodies in Minnesota (Lake Minnetonka, Hennepin County; Gull Lake, Crow Wing County).
- From inboard/outboard engines on boats that were used and stored on Lake Minnetonka.
- From a ballast tank mounted in a ski boat that was filled with water from various locations in Lake Minnetonka, then drained.

Experiments on veliger survival

- Were conducted on residual water heated to 70, 80, 90, and 100° F in experimental live wells.
- Were conducted on residual water heated to 70, 80, 90, and 100° F in a ballast tank.

Zebra Mussel Veligers under Cross Polarized Light



Zebra mussel veliger larvae can be viewed using a cross polarized light microscope, under which their shells "glow" and exhibit a characteristic cross pattern. Live veligers are scored by motility of whole larvae and cilia on swimming structures, and by organ movement when viewed under cross or plane polarized light.

Residual Water Sampling

Minnesota Department of Natural Resource watercraft inspectors collected residual water samples from boats leaving Lake Minnetonka and Gull Lake. Additional ballast water samples were collected from an aftermarket "Fatsac" ballast tank, and also residual engine water from inboard/outboard (I/O) boats with the help of Tonka Bay Marina.

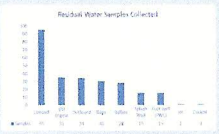


Figure 1: Residual water sample sizes from different compartments and sources

This study determined that I/O engines and ballast tanks contain the most residual water, on average, compared to any other compartment. Inboard engines, though not sampled, have similar design features and would be expected to hold as much water as I/O engines.

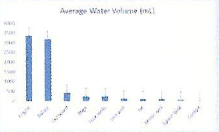


Figure 2: Mean volume per collected sample

Ballast tanks and engines also contained greater numbers of veligers when compared to other sources of residual water. This may be due to these systems pulling in water faster from greater lake depths than livewell intakes or surface water splash. Veligers may be more abundant at these depths rather than closer to the surface.

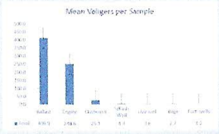
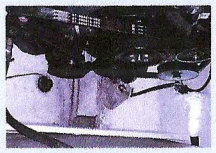


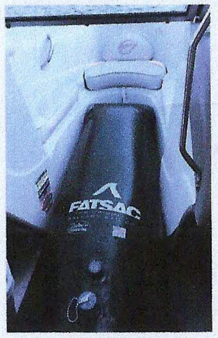
Figure 3: Mean number of veligers per sample



Residual water draining from an I/O engine.

No live veligers were ever observed in residual water from engines or ballast; samples collected from other compartments were preserved in ethanol, so survival was not determined in these field samples.

Mechanics aid researchers to help collect water



An aftermarket ballast tank designed to hold 370 lbs. of water.

Livewell Survivorship

Six experimental live wells were built by Brunswick Boat Group's New York Mills Operation; makers of Lund and Crestliner boats. Three live wells were placed in each of two separate housings constructed from marine plywood. Housing 1 was covered by marine carpet and housing 2 by vinyl—two commonly used materials used in fishing boats, which may influence temperatures within live wells.

To simulate real-world environmental conditions, 1 liter of water was heated from the control temperature (70° F) with infrared ceramic heaters to 80, 90, and 100° F. This was done to bracket temperatures that might be reached when a boat is trailered or parked after use.

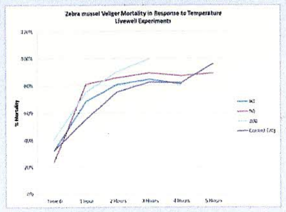


Figure 4: Veliger mortality in livewell experiments

Survival trials (Figure 4) showed an effect of exposure temperature, with all trials (including the control) reaching > 75% mortality after 2 hours. Water heated to 100° F showed 100% mortality after 3 hours.

Temperature probes were placed in each of the six experimental livewells. One liter of water was added to each, and they were placed outdoors to record the temperatures reached in each compartment. Livewell water temperatures consistently exceeded air temperatures (e.g. Figure 5) and reached % lethal levels (> 100° F) by mid to late afternoon . This suggests that even with moderate air temperature, livewell residual water can easily reach lethal levels for veligers. Additional probes were placed in ballast bags, engine compartments, ski lockers, and bilge areas. Data from these probes has not been analyzed yet.

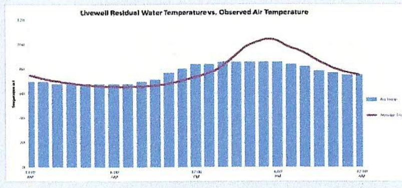


Figure 5: Outdoor temperature profile compared to livewell water exposed to outdoor conditions

Ballast Bag Survivorship

Ballast bag samples were collected from multiple locations in Lake Minnetonka. Lake depth at sampled points varied between 2 and 55 feet; pumping occurred approximately 3 feet below the surface. Samples were collected by filling an aftermarket ballast tank with 370 pounds of water through a high-flow pump capable of pumping 165 pounds of water per minute.

Once filled, the ballast bag was drained using the same pump, until no more water was expelled. The pump (Tsunami Pro X) used is commonly used by a variety of boat manufacturers. Volumes were measured in the field and concentrated into one liter sample bottles. Sample bottles were stored in coolers filled with water held at ambient lake water temperatures until laboratory analysis.

All samples contained live and dead veligers (Fig. 6, sample number on X-axis). Analysis of time after-pumping prior to scoring each sample (Fig. 7) shows no significant effect of time on mortality. While % survival at time of collection is unknown, a few ballast samples contained moderate numbers of live veligers.

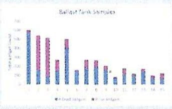


Figure 6: Veligers collected in ballast tank residual water.

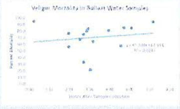


Figure 7: Veliger mortality in residual ballast water over time.

Management Implications

Data suggests that veliger counts in fishing boat compartments are low, while counts in engines and ballasts are higher. Engines carry large amounts of water between water bodies, but the risk of moving live veligers is low based on these data. Veliger survival in livewells declines rapidly with time, and is temperature dependent. This means that short trips are much more likely to result in transfer of live veligers to the next visited water body.

Boat manufacturers may also use information collected during this research when making design decisions to help improve drainage and/or filtration of water.

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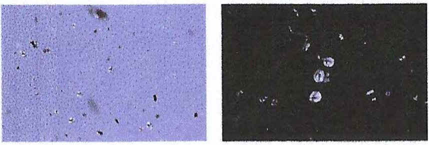

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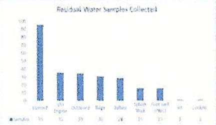

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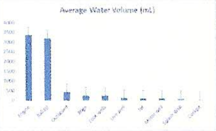

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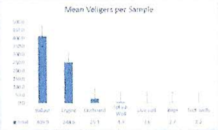

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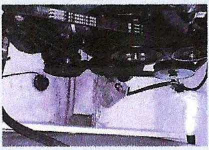

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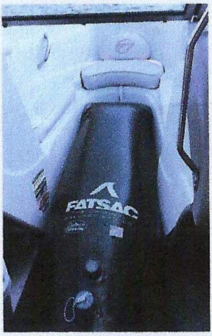

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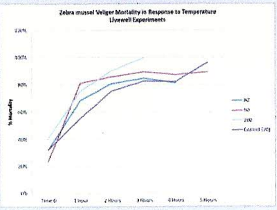

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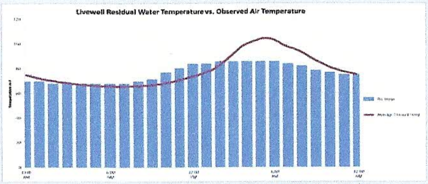

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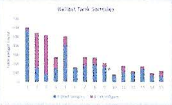

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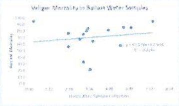

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