

Ballast water statistics and sampling strategy

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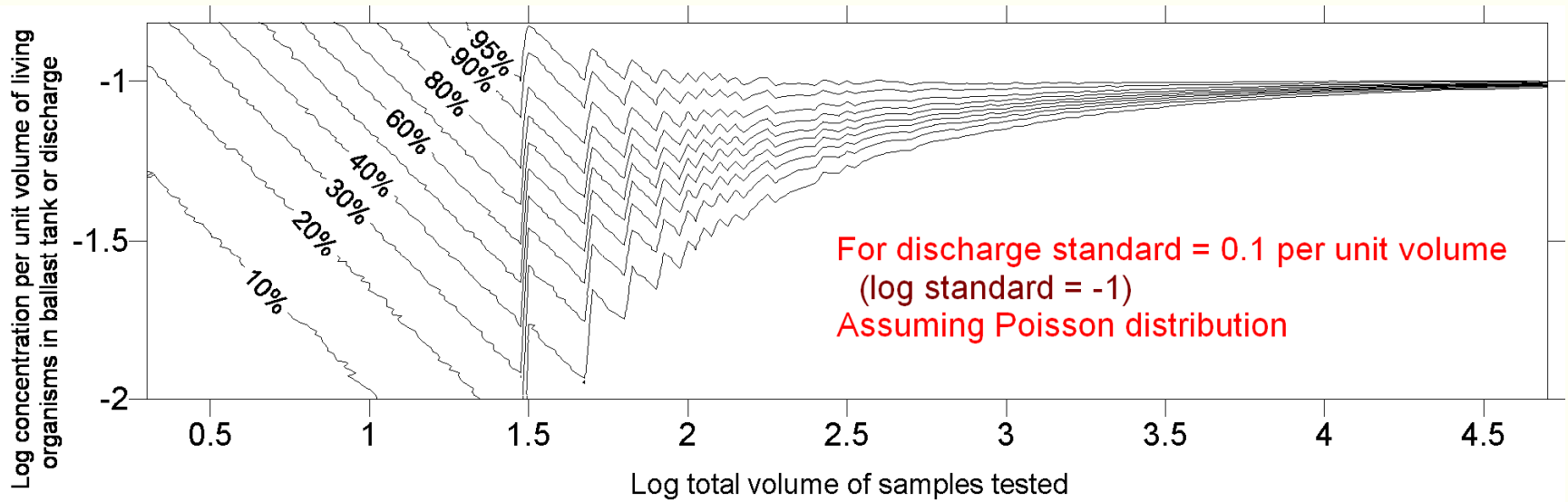
Buffalo, NY

Great Lakes Ballast Water Collaborative

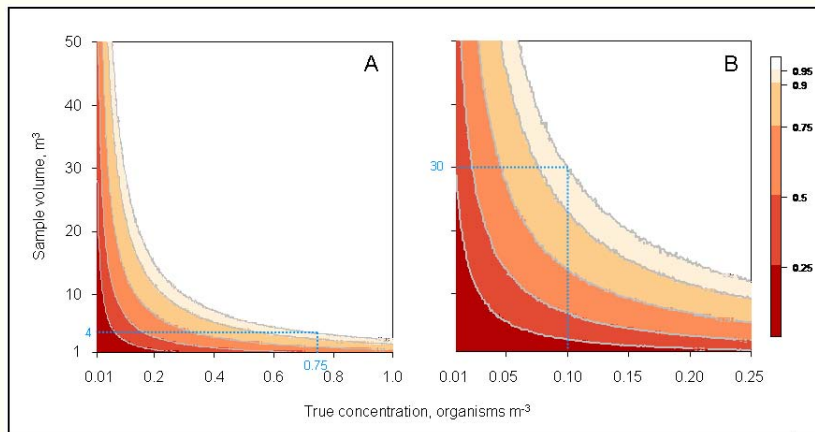
Toronto, January 19, 2011

Statistical overview

Confidence level as function of *sample volume* and *organism concentration*



Vaughan, FORTRAN Poisson simulation



Lee et al., 2010
(assuming Poisson distribution)

Organisms in ballast tanks may be aggregated - generally *can't* assume Poisson distribution in real tanks

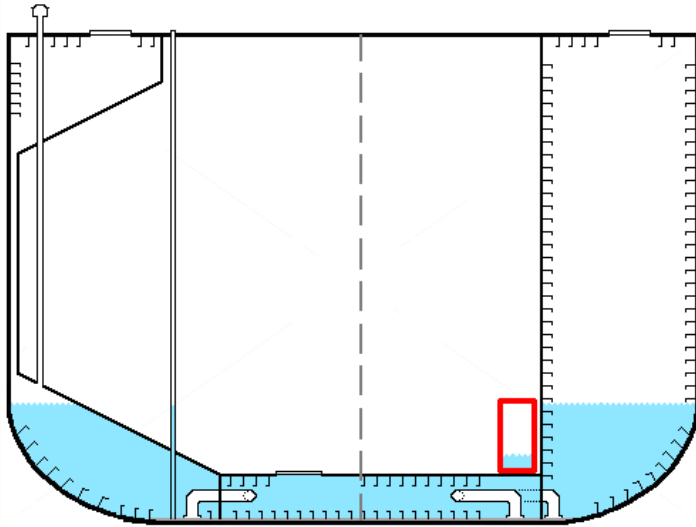
- **Statistical confidence will be lower (relative to Poisson distribution) when sampling from aggregated tanks, assuming the same volume is tested**
- **Would need larger volume to achieve same statistical confidence (relative to Poisson distribution) when sampling from aggregated tanks**

Alternatively: *Avoid the aggregation issue by continually collecting a representative quantity of ballast water in a sample tank*

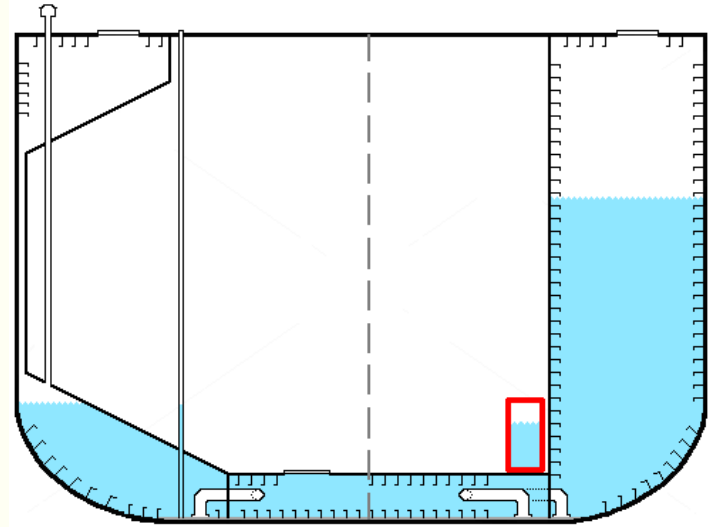
- **The sample tank should be configured as a separate ballast tank; its volume should be either *the volume needed to demonstrate compliance for a Poisson distribution*, or some fraction thereof**
- **The sample tank should be “partnered” with one of the main ballast tanks, and should be routinely filled or discharged whenever the main ballast tank is filled or discharged (so that both tanks remain *the same percent full*)**

- On uptake, part of the treated flow into the “partnered” main tank should be diverted isokinetically into the sample tank; *keep both tanks the same % full*
- Discharge BW from the sample tank into the “partnered” tank whenever the “partnered” tank is being discharged; *keep both tanks the same % full, and avoid backflow*
- **To collect sample: Discharge *entire contents* of sample tank through ballast water treatment system into clean container; test as usual**
- As needed, collect multiple samples over time

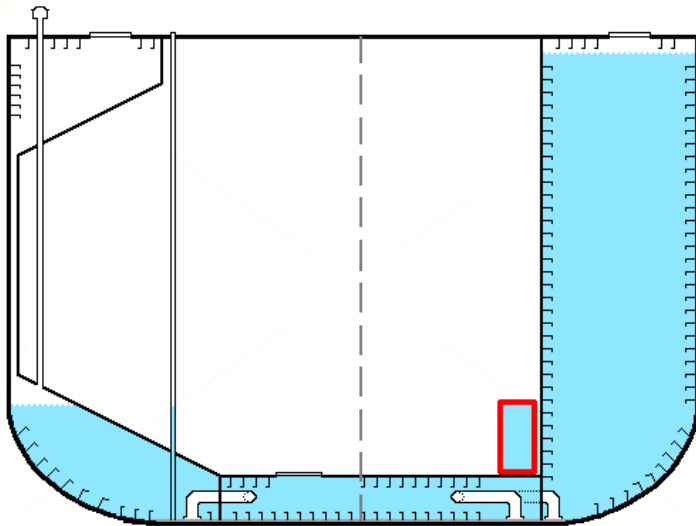
Sample tank & BW tank partly full



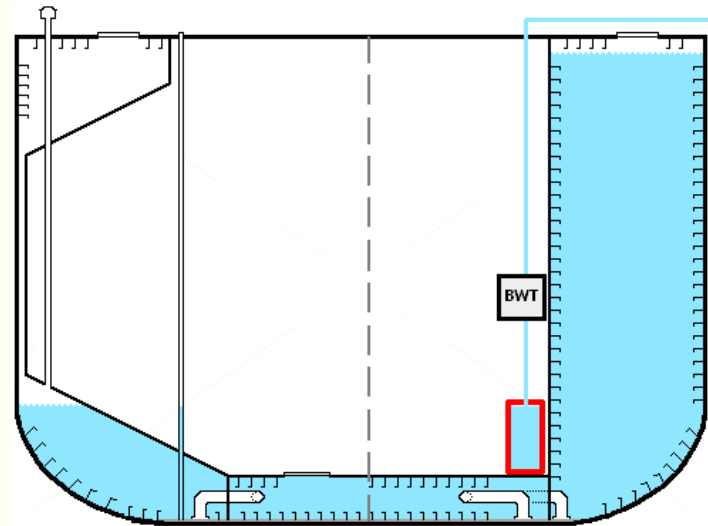
Sample tank & BW tank mostly full



Sample tank & BW tank full



Sample tank pumped out through BWT



Sample tanks of this type can be used for land-based testing, shipboard testing, or compliance monitoring

- **Aggregation effects are eliminated; the necessary total test volume is the volume needed for Poisson distribution**
- **Need to discuss/resolve NOBOB sampling (should test be conducted on residual ballast alone, or on residual ballast mixed with lake water?)**
- **Conduct occasional compliance monitoring in Montreal? Or at Detroit/Windsor or lakehead ports on Lake Superior?**

Conclusions

- **Aggregation of organisms in tanks will affect the statistics of sampling when samples are taken from a larger tank**
- **But this is an unnecessary complication – it can be avoided by collecting a *representative sample* in a sample tank and testing 100% of that sample**
- **Test method is roughly analogous to *composite samplers* that are widely used for land-based applications (e.g., Isco wastewater samplers) that are programmed to collect samples at specified time or flow intervals or at event-defined intervals (e.g., storm events)**