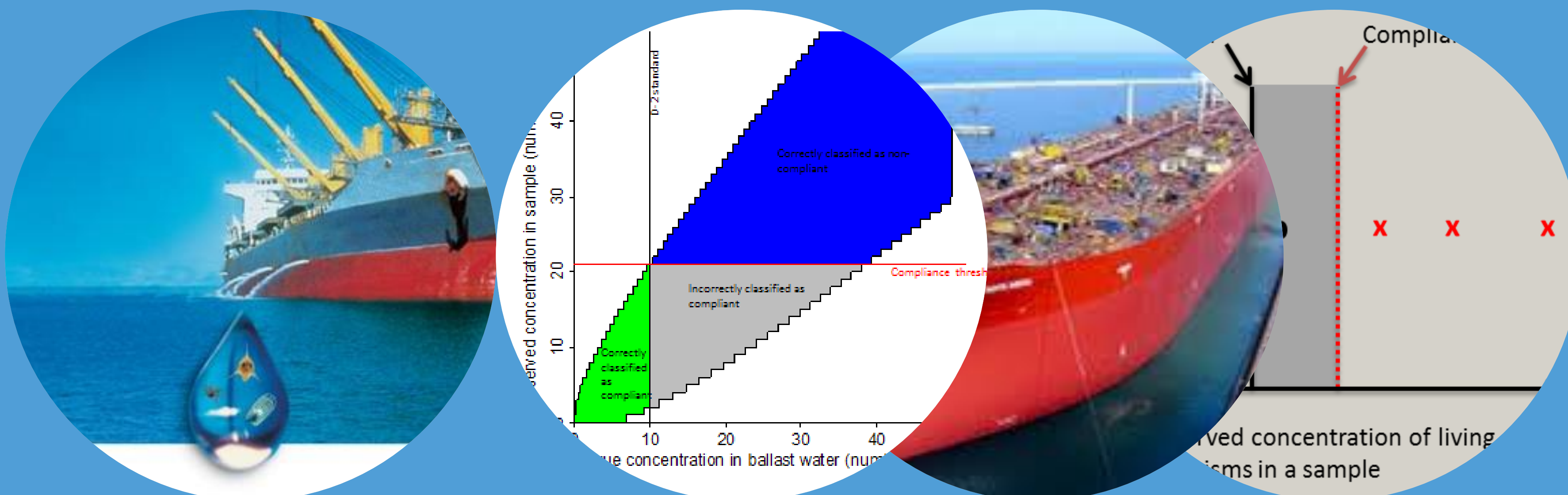
Development of a full standard methodology for testing ballast water discharges for gross non-compliance

7th March 2013, Andrea Sneekes



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Presentation outline

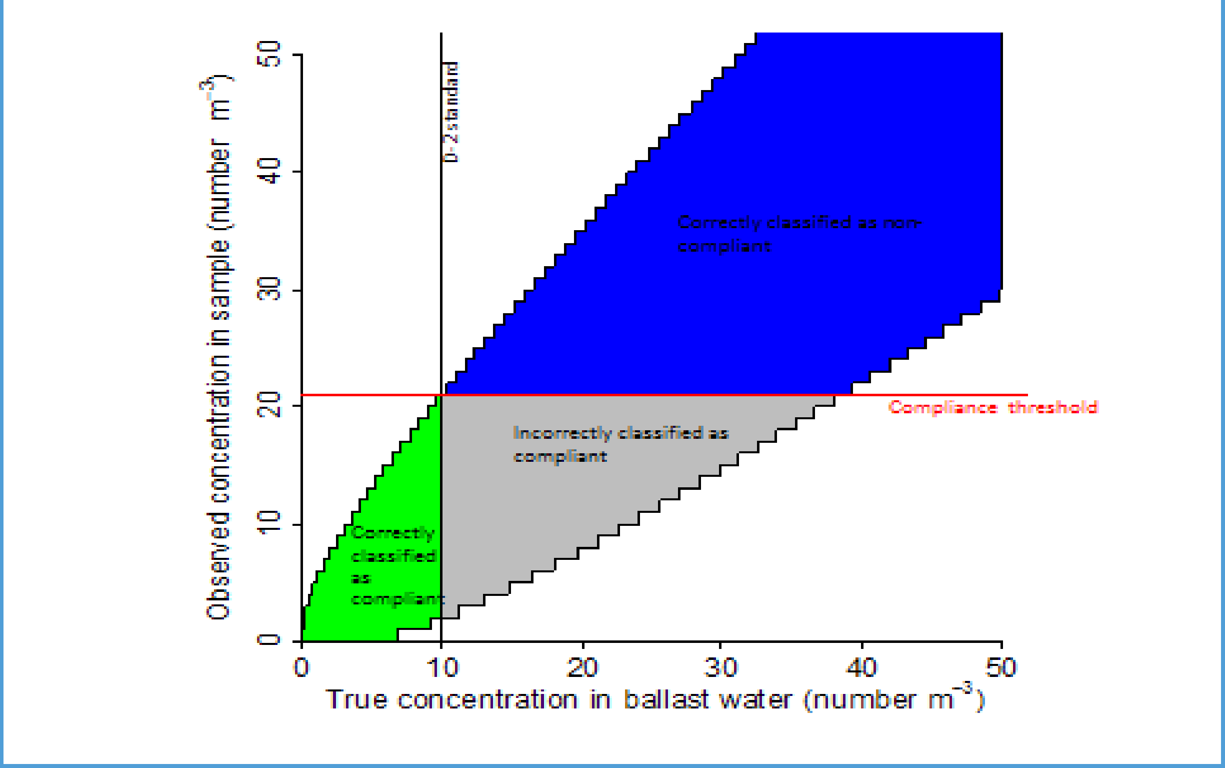
- Aim of the project
- Approach
- Poisson rate test
- Available data
- Negative binomial model
- Deriving GNC thresholds using NB model
- Assumptions

Aim of the project

- To develop a full standard methodology for testing for gross non-compliance (GNC), complete with sampling protocol, analysis methodology and confidence limits, based on the existing EMSA research, so that when used by Port State Control, an Administration can be 99.9% sure that a vessel is in non-compliance with the standards in the BWM convention.

Approach to GNC testing

- Our proposed approach to testing for gross non-compliance is to assume that a vessel is in compliance until it can be demonstrated, on the basis of data from samples of the ballast water, that the vessel is in non-compliance with a high level of certainty.



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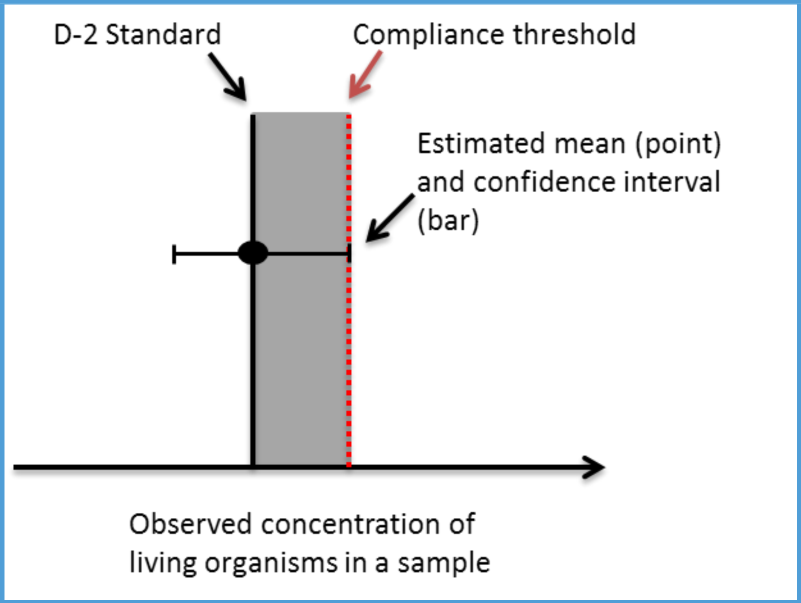
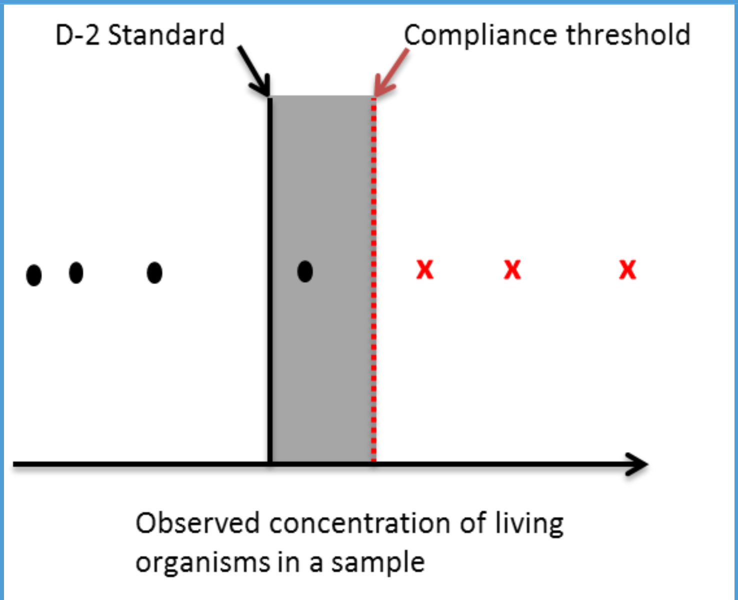
Approach to GNC testing

- Our proposed approach to testing for gross non-compliance is to assume that a vessel is in compliance until it can be demonstrated, on the basis of data from samples of the ballast water, that the vessel is in non-compliance with a high level of certainty.

- A good sampling methodology would specify the procedure and minimum requirements that, if adhered to, would lead to a predictable level of reliability of the estimate of the mean concentration of living organisms in the ballast water.

Gross non-compliance testing





- The compliance threshold is set at the value below which $1-\alpha$ % of possible test statistics are expected to fall given that the true (unobserved) concentration is equal to the D-2 standard.
- GNC would be evidenced if a point estimate, based on counts in a sample, is higher than a concentration which can be expected to occur by chance like processes if the true concentration is equal to the D-2 standard

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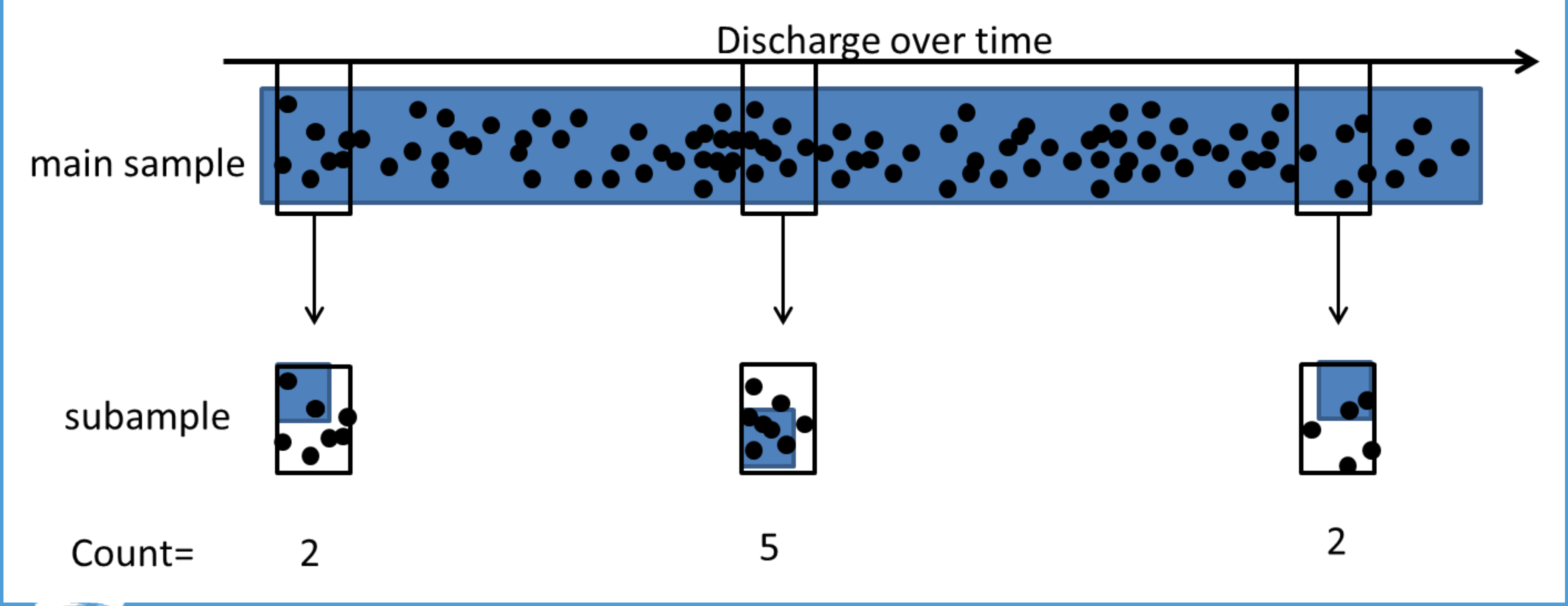
The starting point: Poisson rate test

- Random distribution of living organisms in both discharge and samples
- Only sample error is taken into account

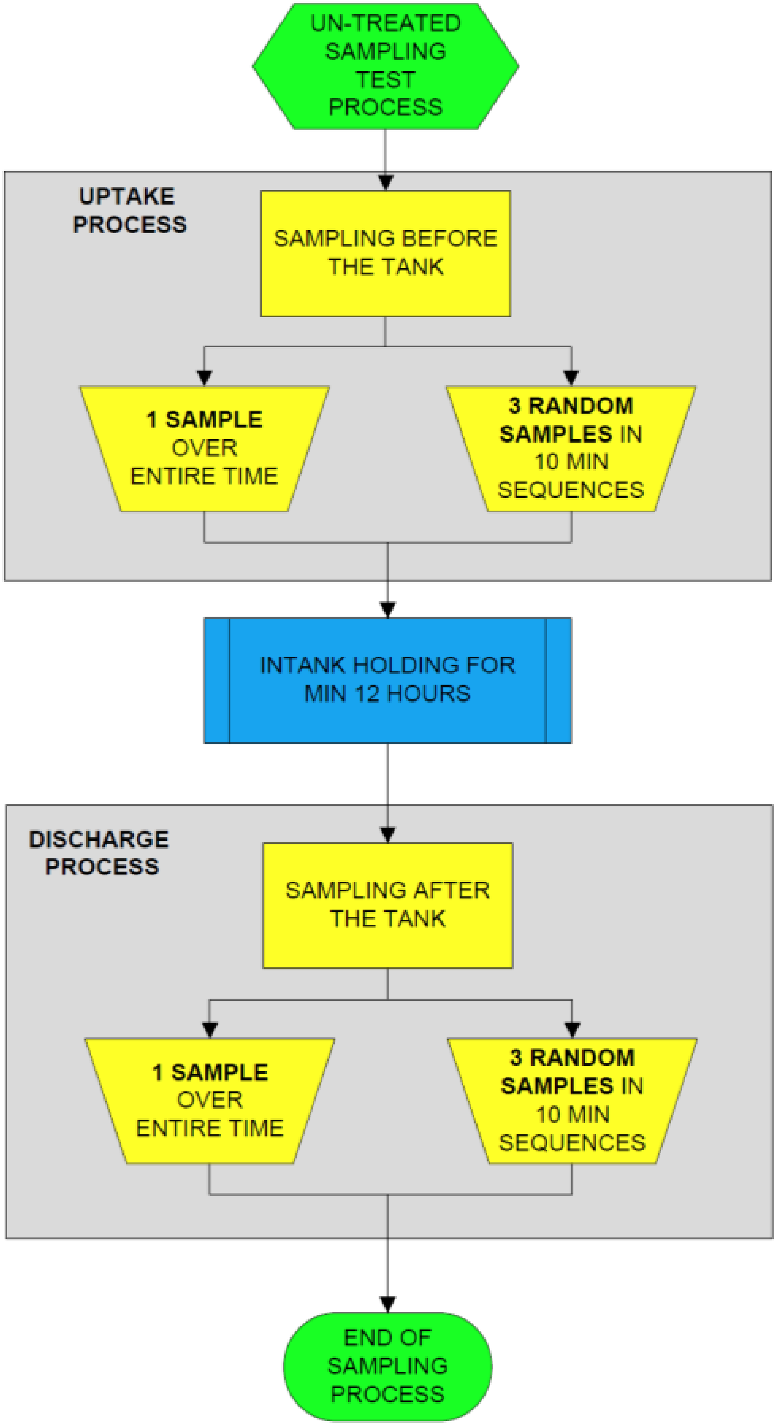


Available data

- 4 runs from 2 ships
- Untreated ballast water
- Uptake (UPT) & Discharge (DIS)
  - 1 continuous sample (OET)
  - 3 discrete samples (beginning, middle, end)

From: Gollasch and David 2010

(EMSA/NEG/09/2010)



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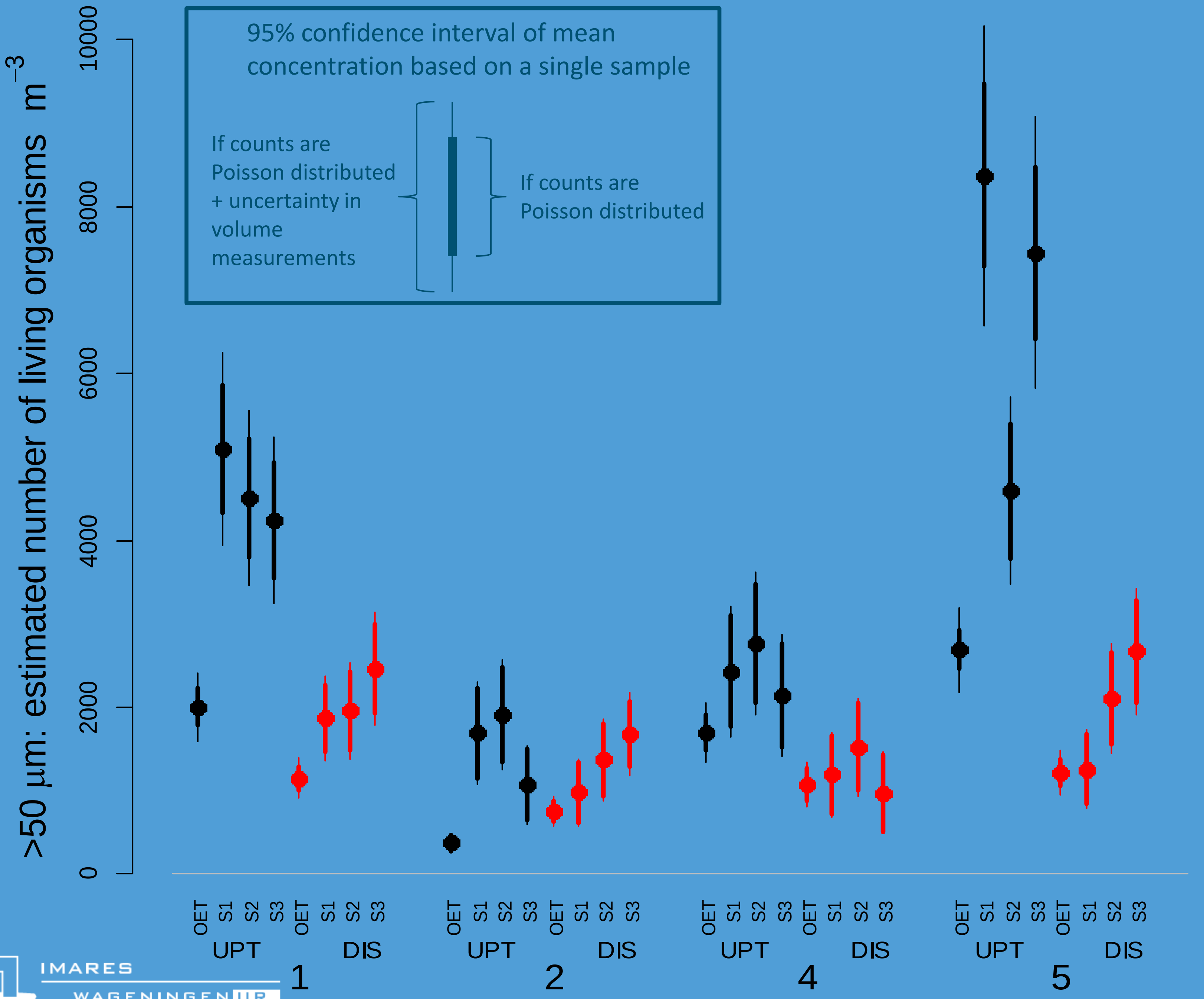

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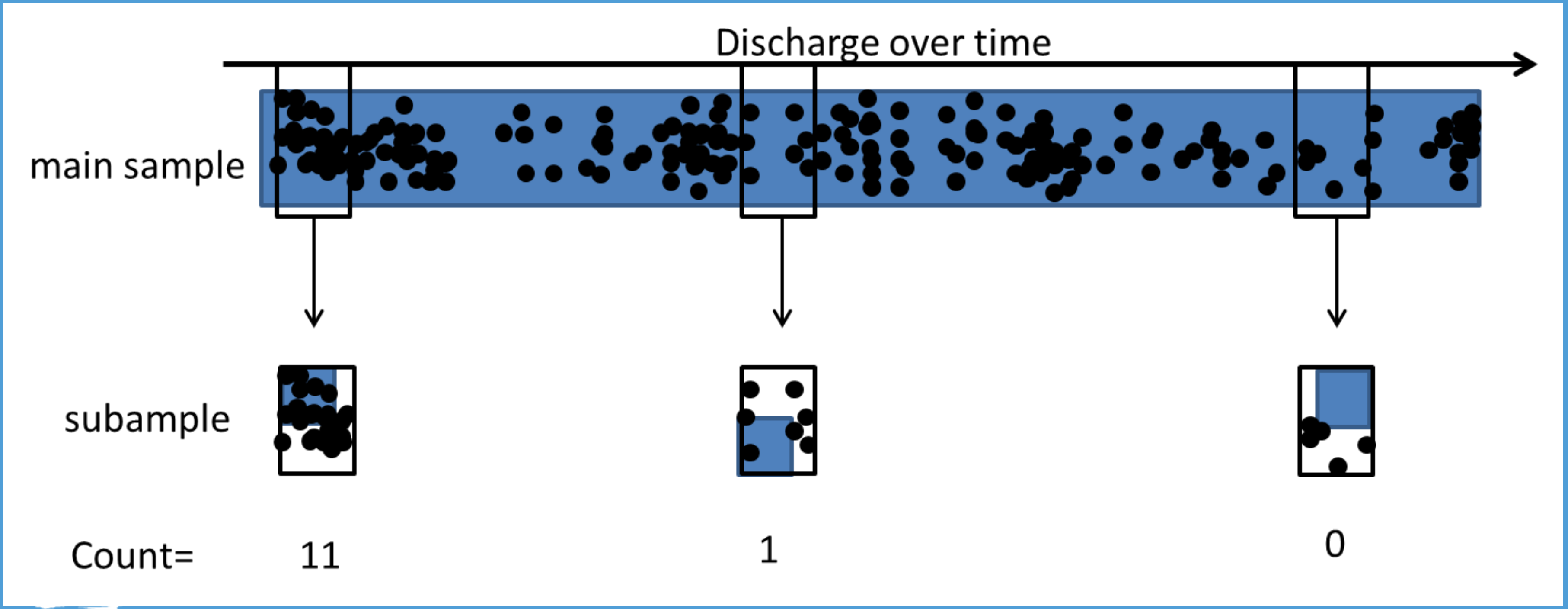
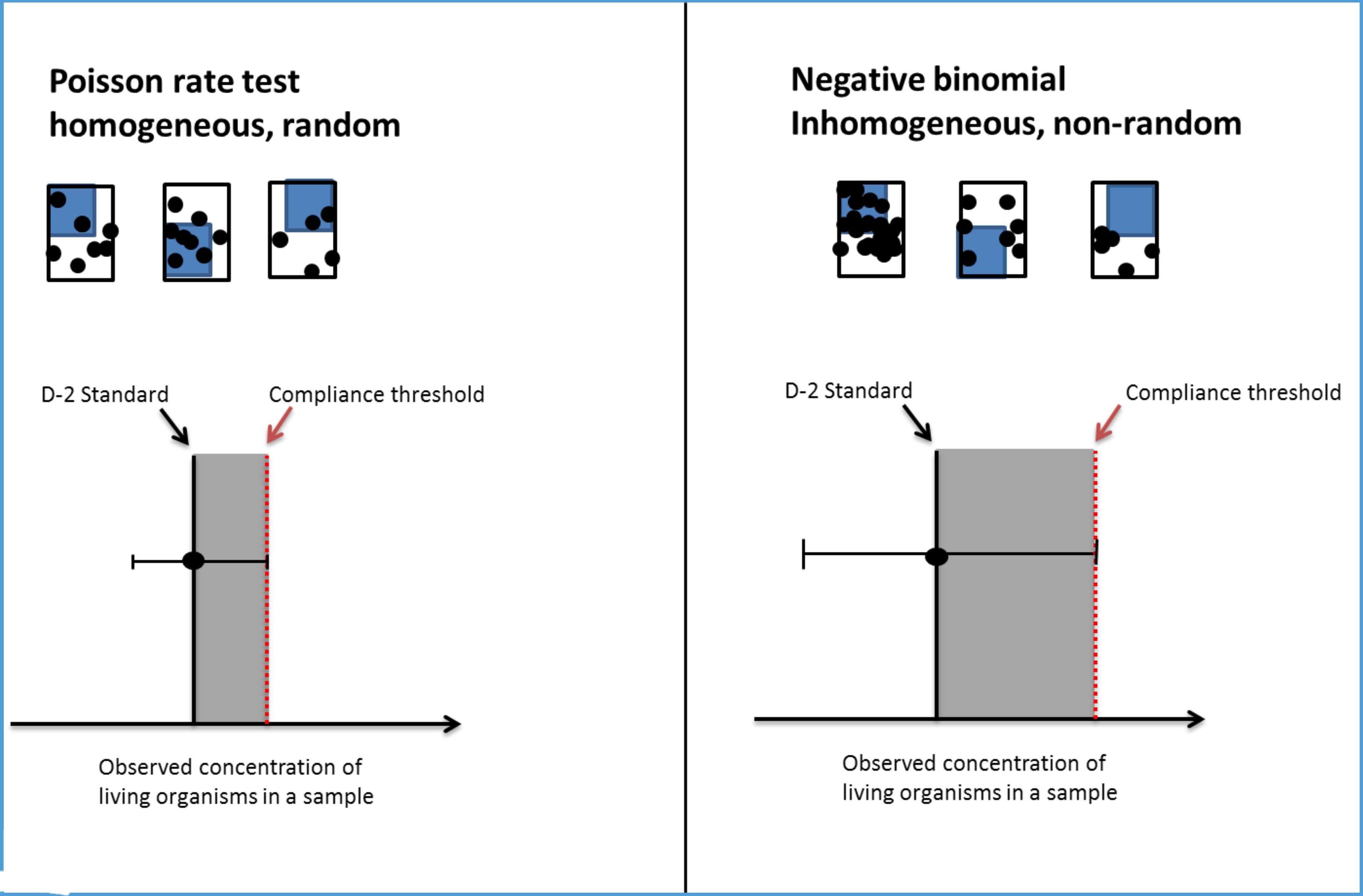
Generalisation of Poisson rate: Negative binomial

- Clumping of organisms
- Trend in concentration during discharge
- Error in measurements of sample volumes
- Differential death rates between samples (e.g. due to differential holding times)
- ....



Negative binomial: counts are more variable

- Negative binomial leads to a more conservative threshold



Derive GNC threshold using Negative binomial distribution model

- A conservative estimate of the variance of the estimated concentration in a sample:

  ≥50 µm: the variance is 3.17 times the expected count

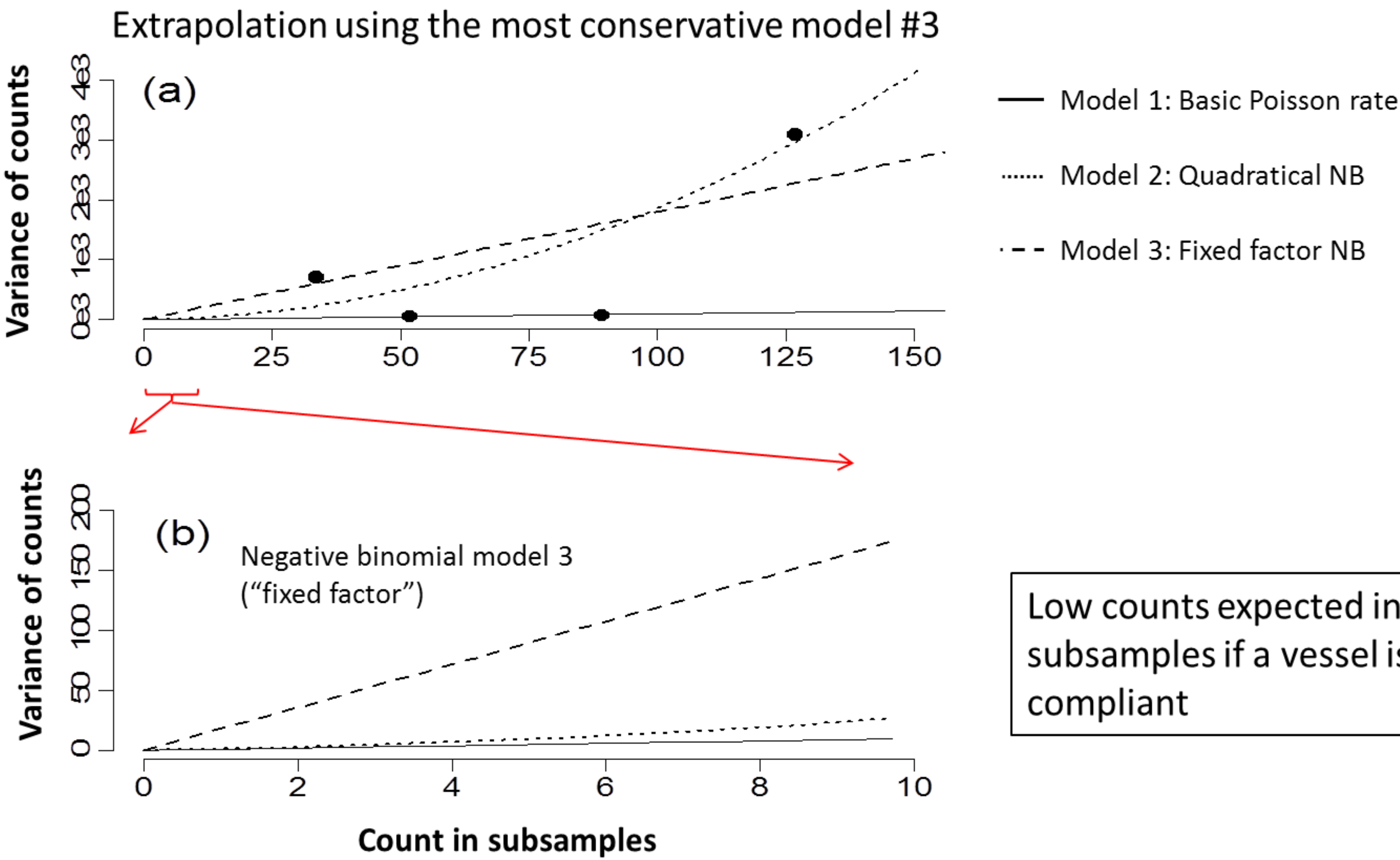
  ≥10–<50 µm: the variance is 17.9 times the expected count

Note that for the Poisson rate test, the variance is equal to the mean

Thus; the Negative Binomial model will be much more conservative

≥10 - <50 µm

Estimating the variance of the counts at the D-2 standard

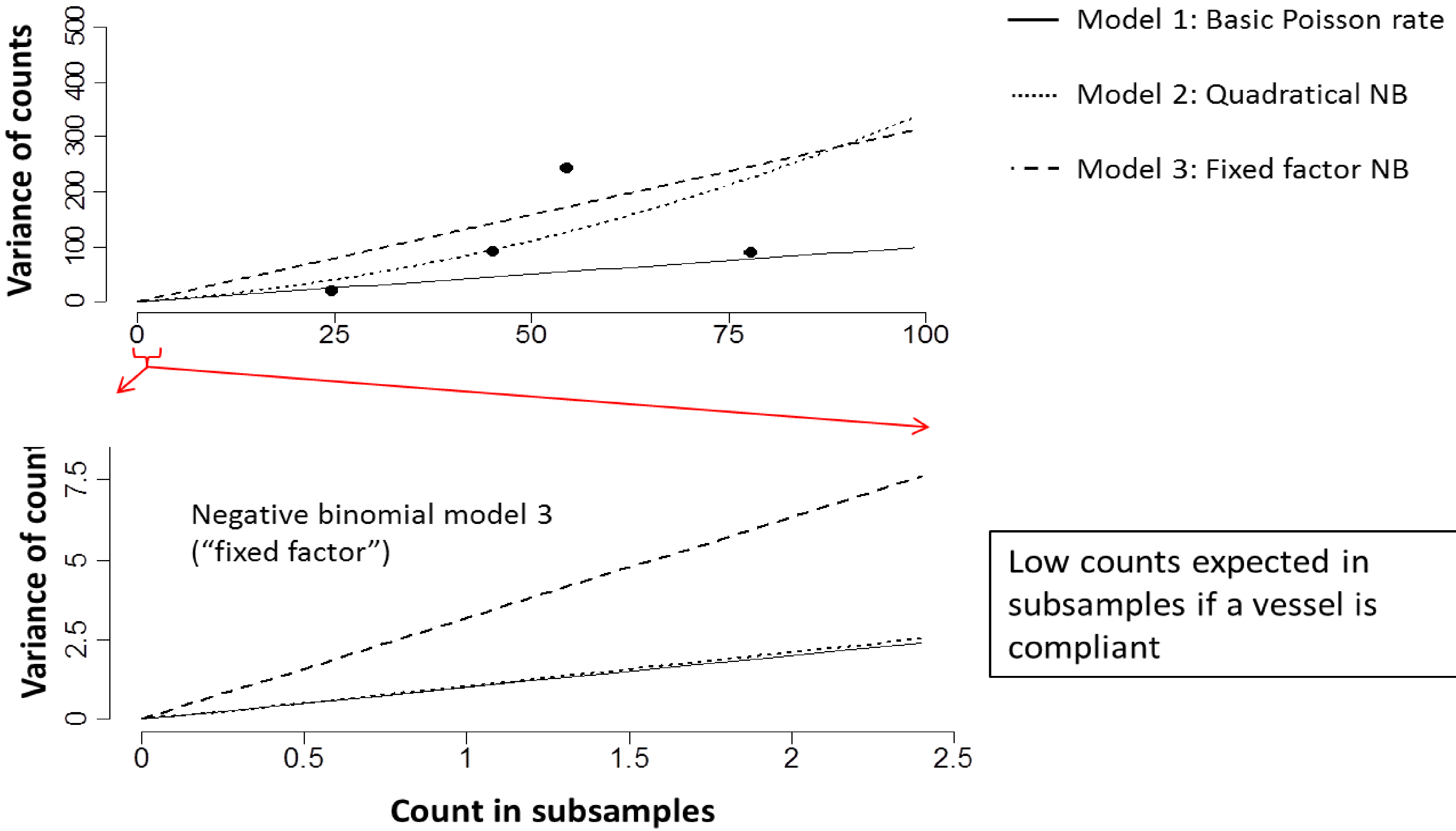


Low counts expected in subsamples if a vessel is compliant

≥50 μm

Estimating the variance of the counts at the D-2 standard

Extrapolation using the most conservative model #3



Low counts expected in subsamples if a vessel is compliant

Example of derived threshold

≥10 - <50 µm

- Sampled volume:
  0.81 ml
- Poisson:
  23.5 org/ml
- Negative binomial:
  116.0 org/ml

≥50 µm

- Sampled volume:
  0.06*500 litre
- Poisson:
  133.3 org/m^3
- Negative binomial:
  366.7 org/m^3

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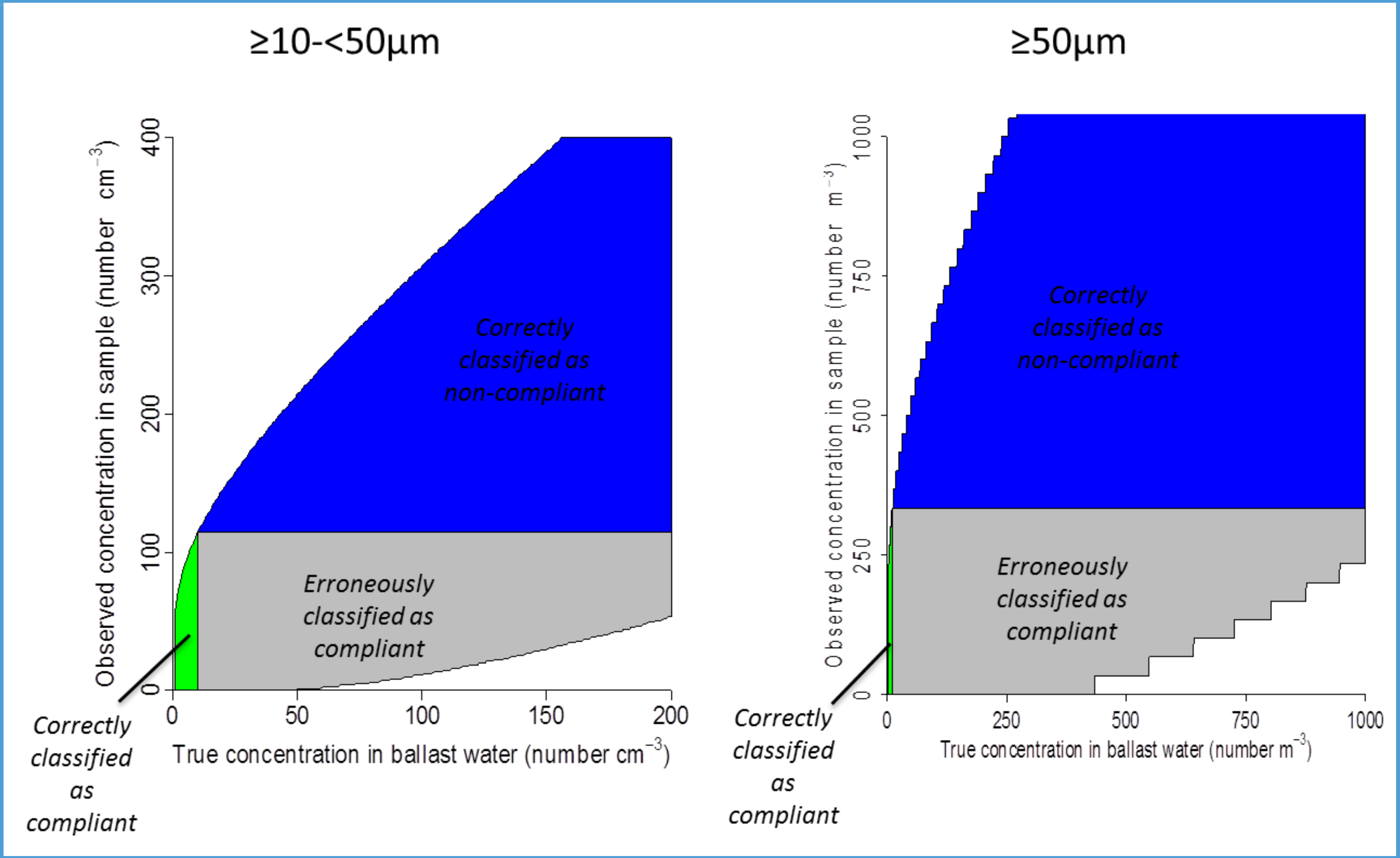
Example of derived threshold



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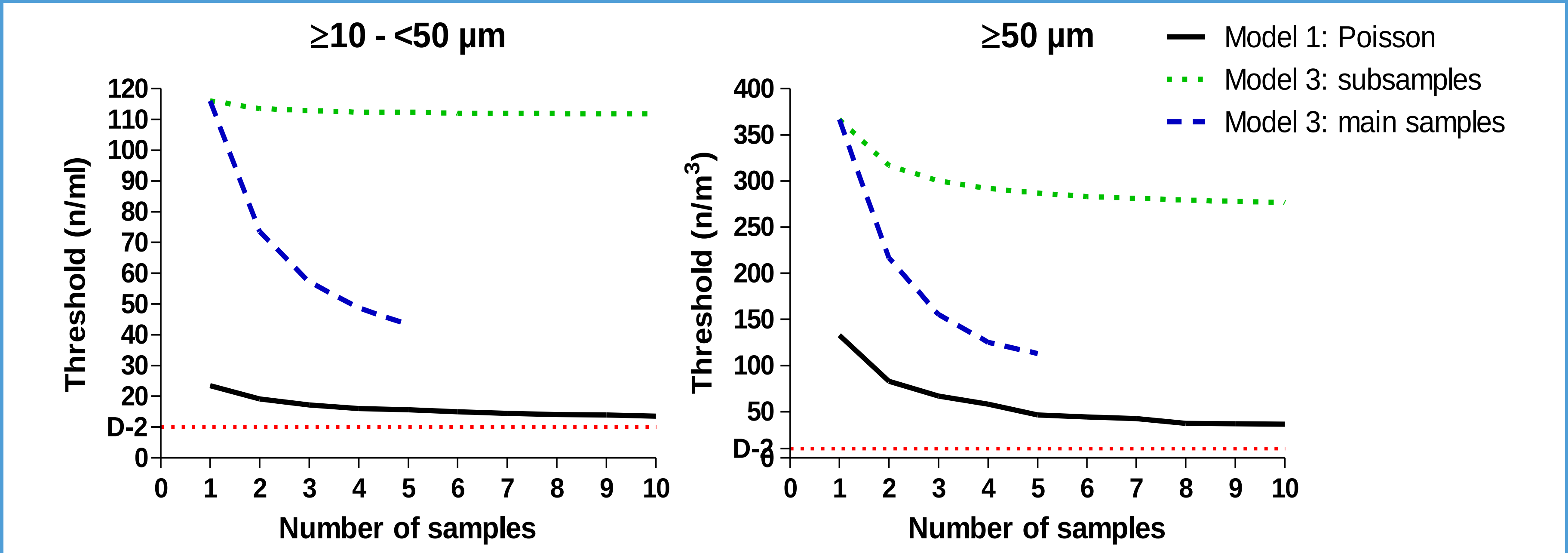
Derive GNC threshold using Negative binomial distribution model

The threshold is a function of:

- The sampled volumes: (knowingly) increasing the sampled volume will lower the GNC threshold
- The sampling strategy: increasing the number of main samples will lower the GNC threshold more than increasing the number of subsamples from the same main sample



Assumptions

The derived GNC thresholds are only valid if the following assumptions are met:

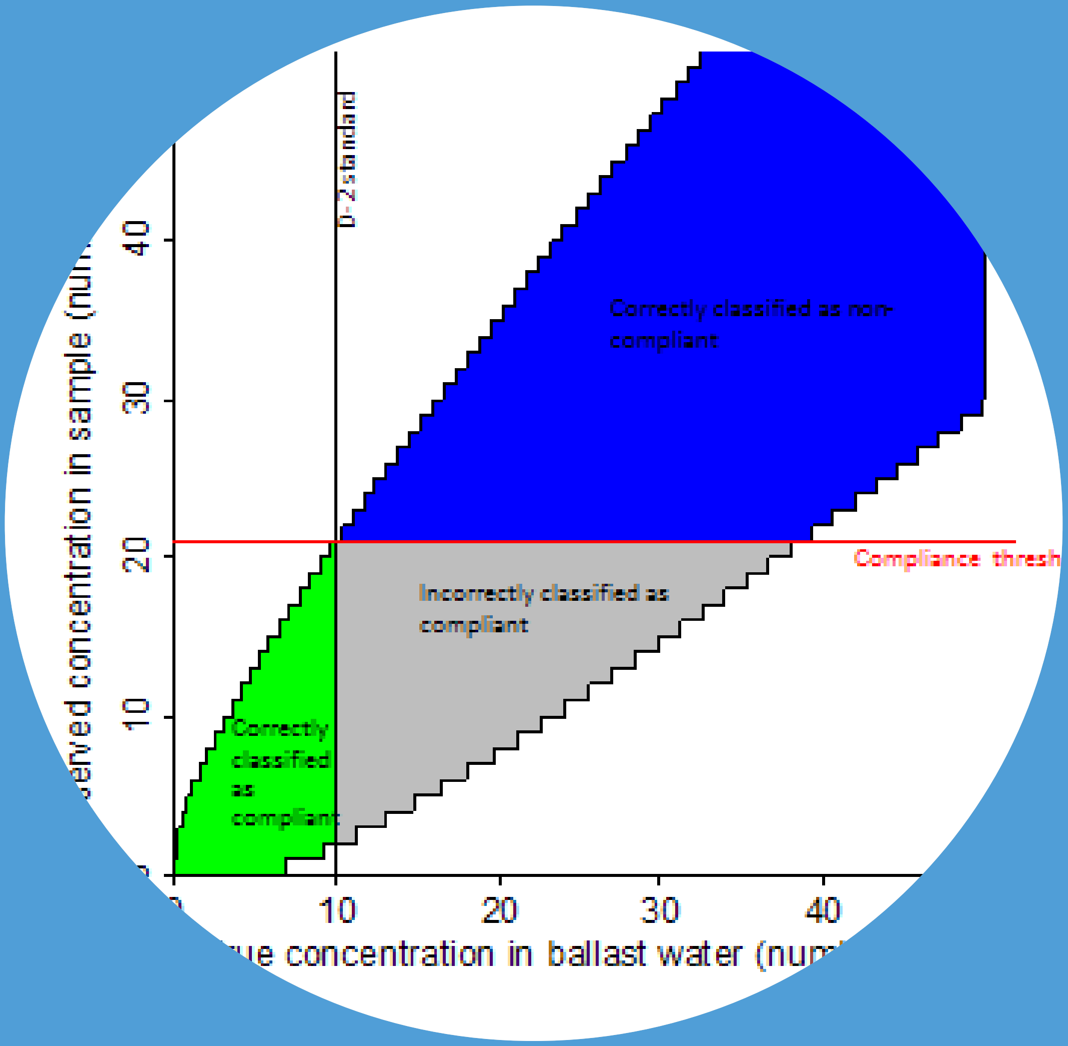
- Data used are representative
  - Fleet
  - Procedures
  - Methods
  - Treated vs non-treated

Remember:

GNC ≠ certification testing!

- For GNC it is important that systematic bias is avoided or at least conservative
  - Live-dead classification
  - Size classification
  - Volumes
  - ……

Thank you for your attention!



Questions?

Researchers involved:

- Pepijn de Vries
- Klaas Kaag
- Stijn Bierman

Website full report:

http://www.emsa.europa.eu/main/ballast-water/ballast-water-sampling.html

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