Contact Recreation Assessments – Addressing Uncertainty

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Guidance Advisory Workgroup Meeting

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Background - Recreational use

- Criteria based on risk associated with gastrointestinal illness due to ingestion
- Criteria expressed as a geometric mean
- Recreational use assessment based on comparison of ambient data to geometric mean criteria

Current Methodology

- Seven-year period of record considered
- Minimum sample size = 10
- Geometric mean calculated
- Recreational use assessment based on comparison of geometric mean of ambient data to criteria (126 col\100ml)
- New impairment typically assigned to Category 5c

Advantages

- Simple to assess recreational uses
- Conservative determination of use support
- Maximizes use of data
  - Considers long term averages

Disadvantages

- Not appropriate to determine risk due to instantaneous exposure
- Does not account for data variability
  - Other standards have incorporated variability in criteria development

Data variability

- Indicator bacteria data from surface water can be highly variable
- Current assessment methods assume high level of confidence when determining attainment status
- Accounting for variability can increase our confidence when allocating resources for implementation

Goals

- Consider a method to assess recreational uses that addresses variability to ensure:
  - Identified impairments are real problems
  - Effective use of resources directed to address impairments

Addressing Variability

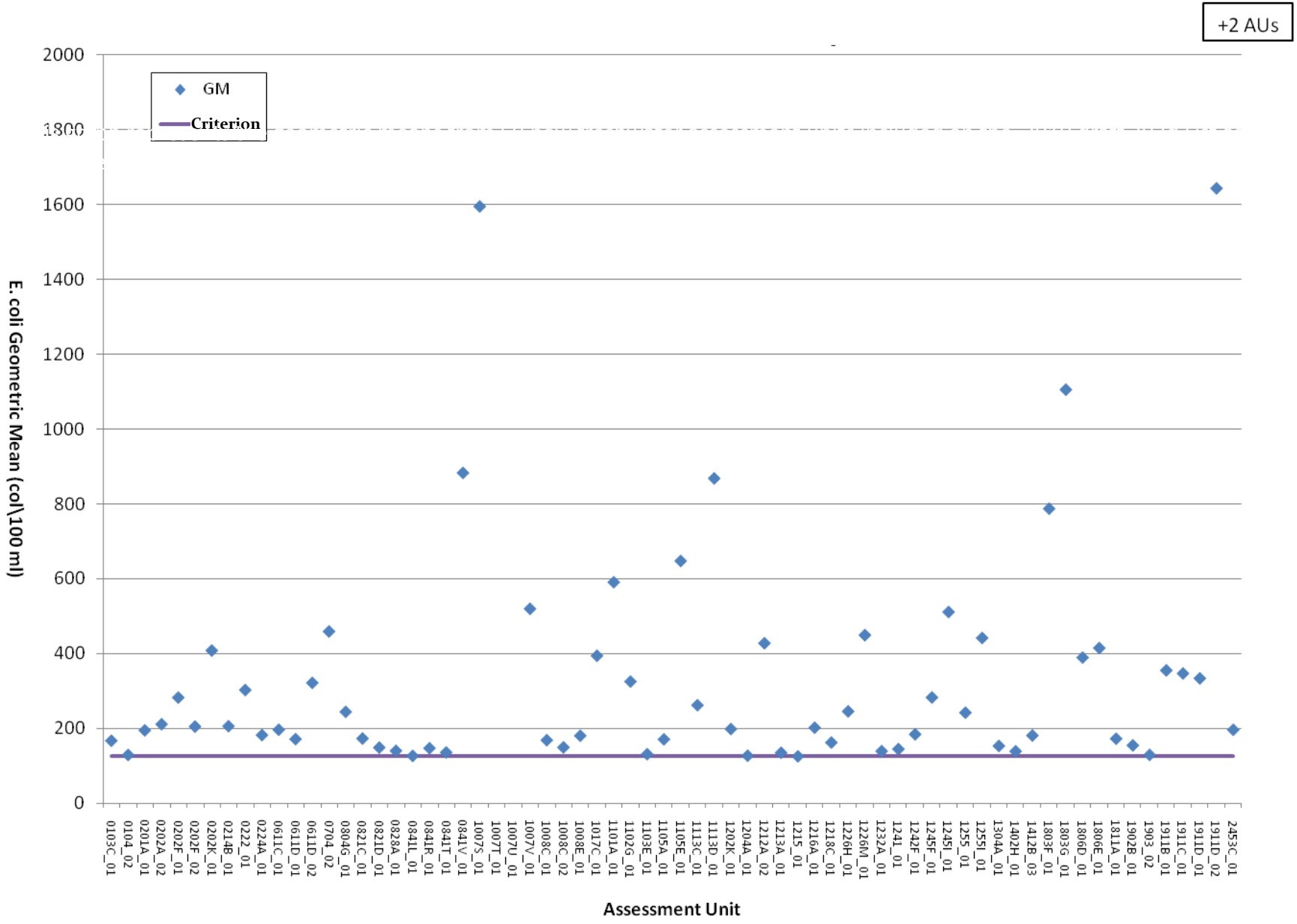
- Two approaches
  - Increase sample size
  - Consider confidence intervals

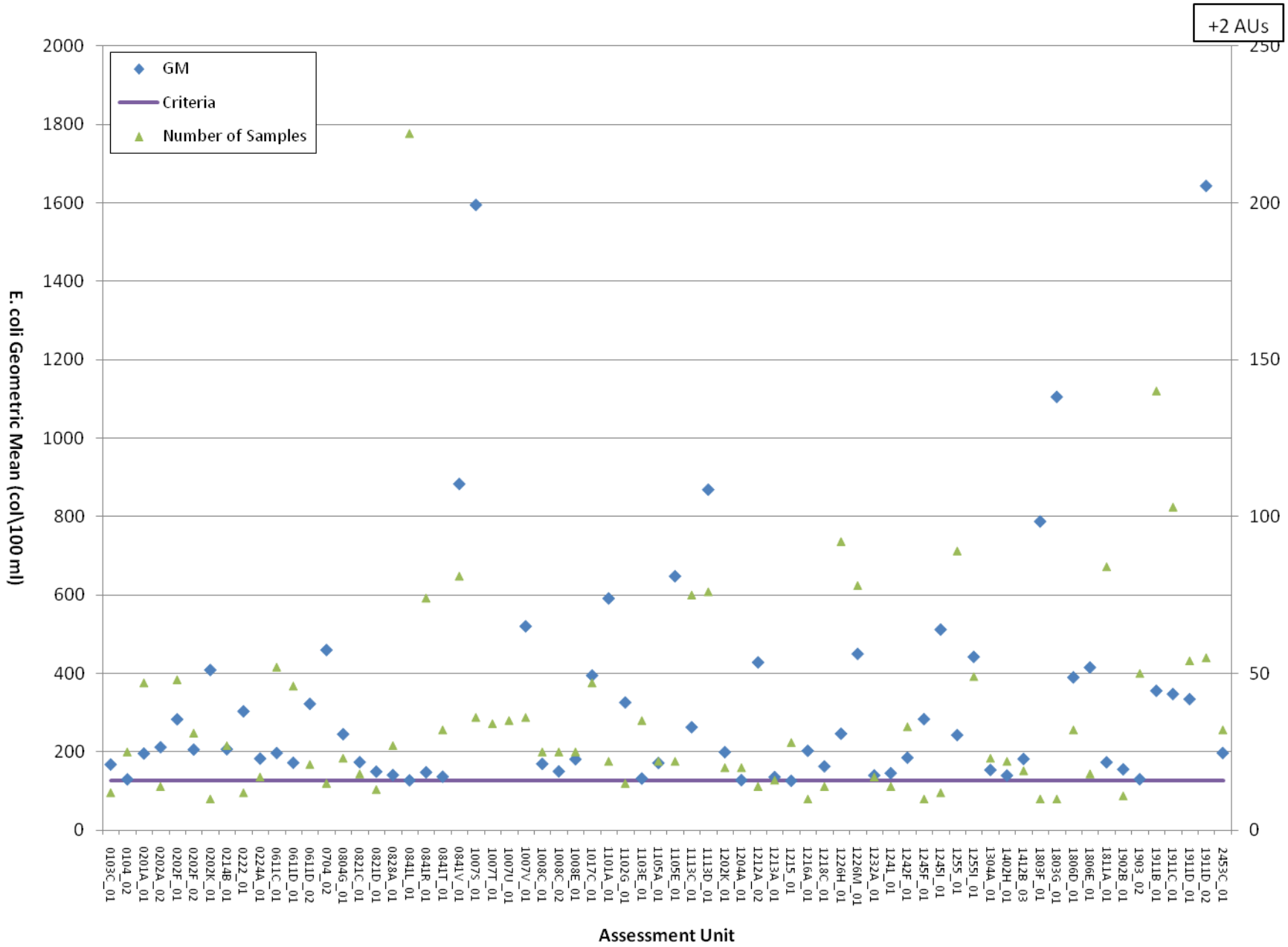
Case Study

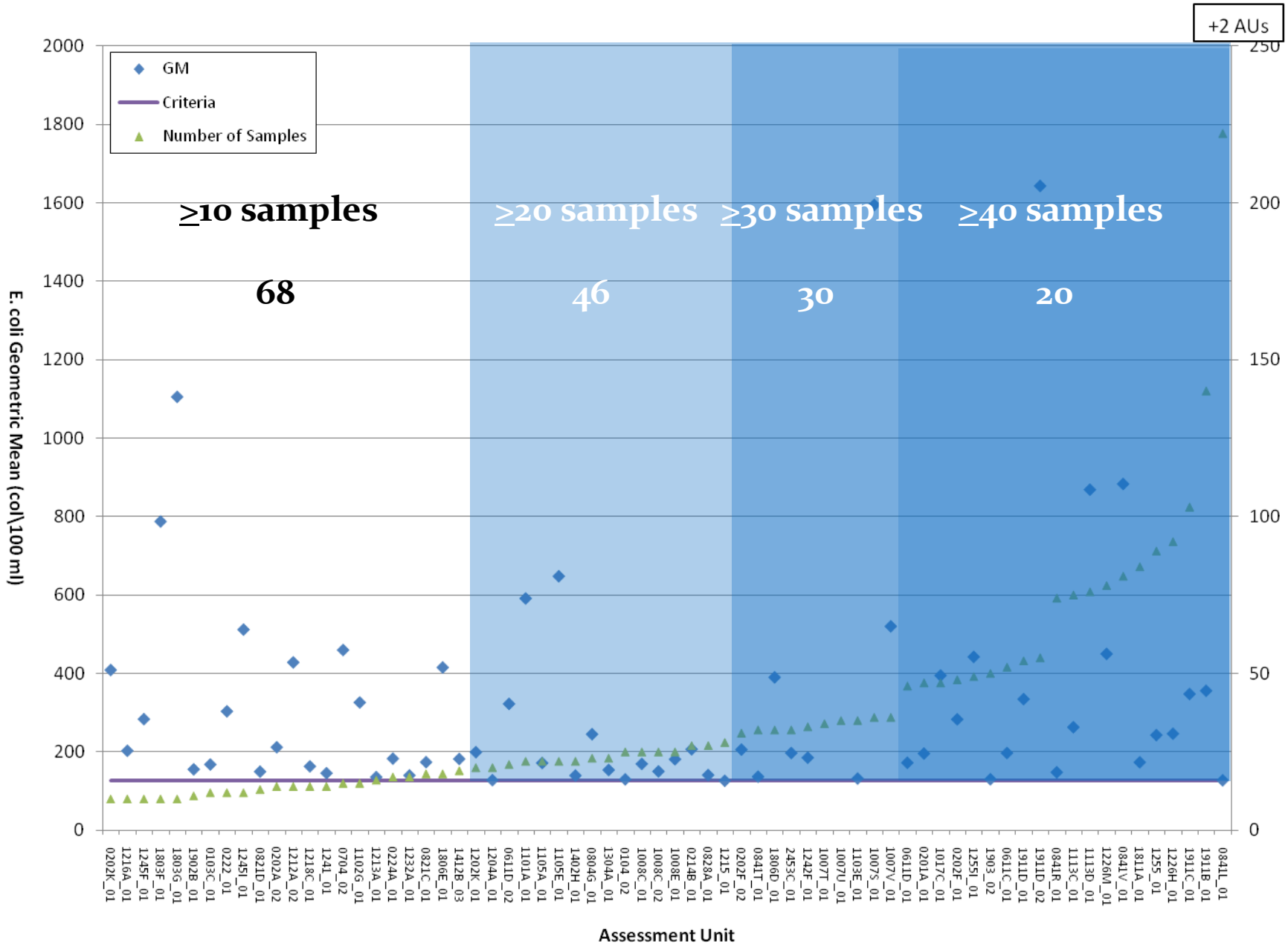
- 68 new freshwater recreational use impairments identified in 2010
  - *E. coli* data
  - Assessment units with datasets containing 10 or more samples
  - Exceeded geometric mean criteria
  - Identified as Category 5 on the 2010 Integrated Report

Sample Size

- Ten samples are currently needed to make attainment determinations for recreational use support
- Increasing sample sizes can decrease variability and uncertainty


+2 AUs
GM
Criterion
E. coli Geometric Mean (col\100 ml)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0103C_01
0104_02
0201A_01
0201A_02
0202F_01
0202F_02
0202K_01
0214B_01
0222_01
0224A_01
0611C_01
0611D_01
0611D_02
0704_02
0804G_01
0821C_01
0821D_01
0828A_01
0841L_01
0841R_01
0841T_01
0841V_01
1007S_01
1007T_01
1007U_01
1007V_01
1008C_01
1008C_02
1008E_01
1017C_01
1101A_01
1102G_01
1103E_01
1105A_01
1105E_01
1113C_01
1113D_01
1202K_01
1204A_01
1212A_02
1213A_01
1215_01
1216A_01
1218C_01
1226H_01
1226M_01
1232A_01
1241_01
1242F_01
1245F_01
1245I_01
1255_01
1255I_01
1304A_01
1402H_01
1412B_03
1803F_01
1803G_01
1806D_01
1806E_01
1811A_01
1902B_01
1903_02
1911B_01
1911C_01
1911D_01
1911D_02
2453C_01
Assessment Unit


+2 AUs
GM
Criteria
Number of Samples
E. coli Geometric Mean (col\100 ml)
Assessment Unit
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
50
100
150
200
250
0103C_01
0104_02
0201A_01
0202A_02
0202F_01
0202F_02
0202K_01
0214B_01
0222_01
0224A_01
0611C_01
0611D_01
0611D_02
0704_02
0804G_01
0821C_01
0821D_01
0828A_01
0841L_01
0841R_01
0841T_01
0841V_01
1007S_01
1007T_01
1007U_01
1007V_01
1008C_01
1008C_02
1008E_01
1017C_01
1101A_01
1102G_01
1103E_01
1105A_01
1105E_01
1113C_01
1113D_01
1202K_01
1204A_01
1212A_02
1213A_01
1215_01
1216A_01
1218C_01
1226H_01
1226M_01
1232A_01
1241_01
1242F_01
1245F_01
1245I_01
1255_01
1255I_01
1304A_01
1402H_01
1412B_03
1803F_01
1803G_01
1806D_01
1806E_01
1811A_01
1902B_01
1903_02
1911B_01
1911C_01
1911D_01
1911D_02
2453C_01


+2 AUs
GM
Criteria
Number of Samples
≥10 samples
68
≥20 samples
46
≥30 samples
30
≥40 samples
20
E. coli Geometric Mean (col\100 ml)
Assessment Unit
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
50
100
150
200
250
0202K_01
1216A_01
1245F_01
1803F_01
1803G_01
1902B_01
0103C_01
0222_01
1245I_01
0821D_01
0202A_02
1212A_02
1218C_01
1241_01
0704_02
1102G_01
1213A_01
0224A_01
1232A_01
0821C_01
1806E_01
1412B_03
1202K_01
1204A_01
0611D_02
1101A_01
1105A_01
1105E_01
1402H_01
0804G_01
1304A_01
0104_02
1008C_01
1008C_02
1008E_01
0214B_01
0828A_01
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1007V_01
0611D_01
0201A_01
1017C_01
0202F_01
1255L_01
1903_02
0611C_01
1911D_01
1911D_02
0841R_01
1113C_01
1113D_01
1226M_01
0841V_01
1811A_01
1255_01
1226H_01
1911C_01
1911B_01
0841L_01

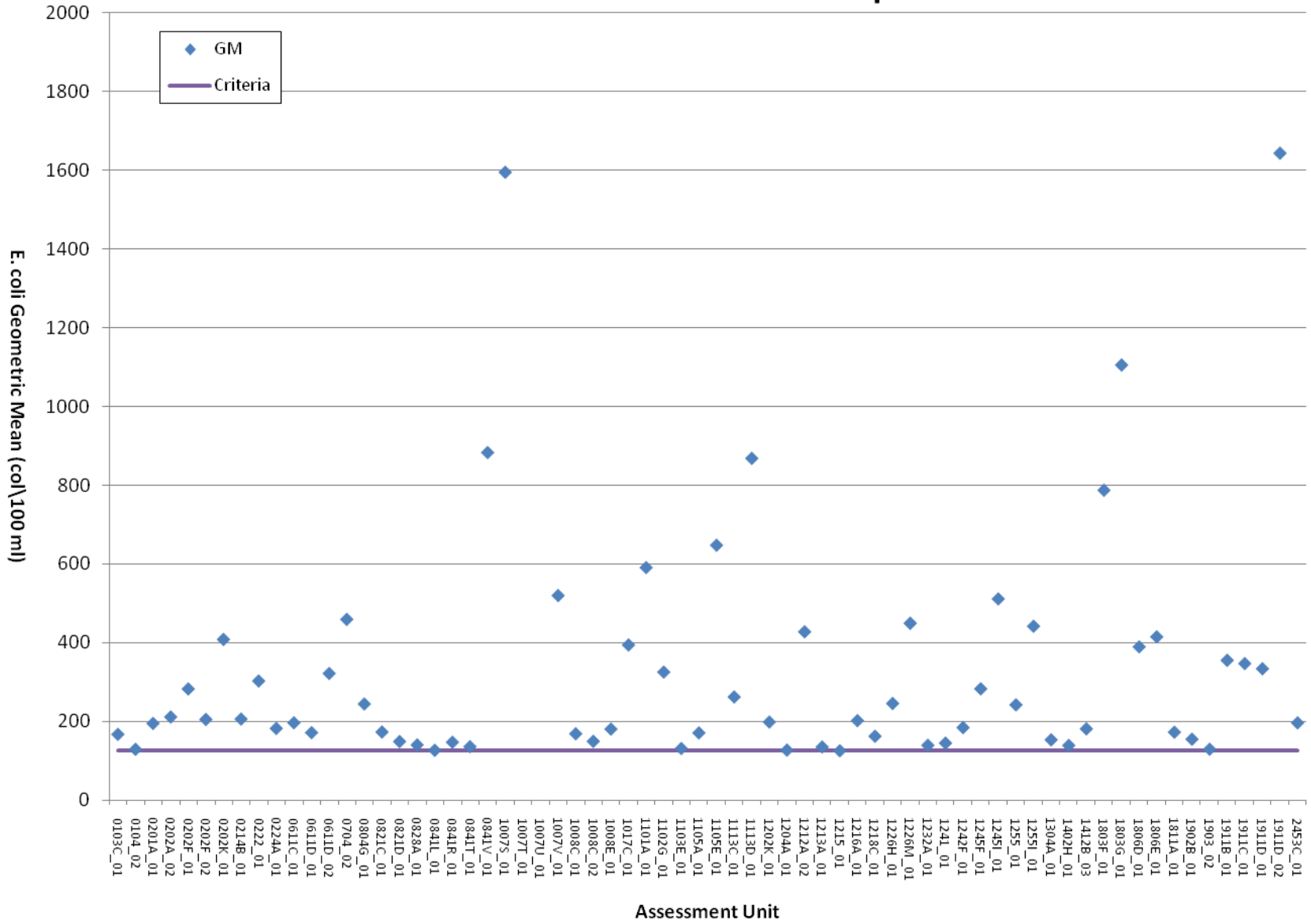
Confidence Intervals

- Statement of the probability or likelihood that the interval contains the true population value (reliability)
- Wider for data sets having greater variability
- Geometric mean confidence intervals can be computed

$$\exp(\bar{y} - t_{(\alpha/2,\, n-1)} * \sqrt{s^2 y / n}) \leq GM \leq \exp(\bar{y} + t_{(\alpha/2,\, n-1)} * \sqrt{s^2 y / n})$$

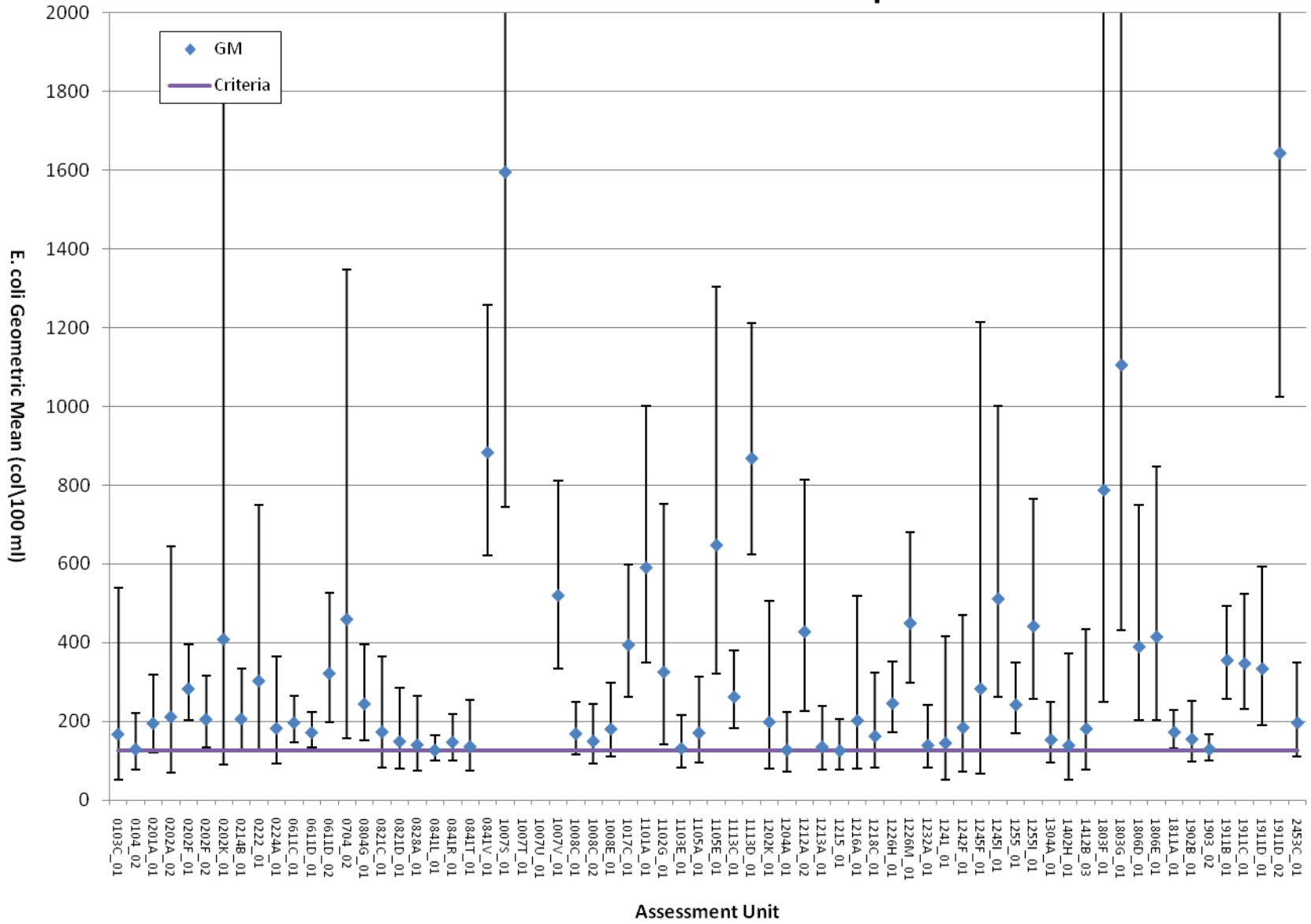
Geometric Means, 90th Confidence Intervals and Sample Numbers for New 2010 Freshwater Bacteria Impairments

+2 AUs

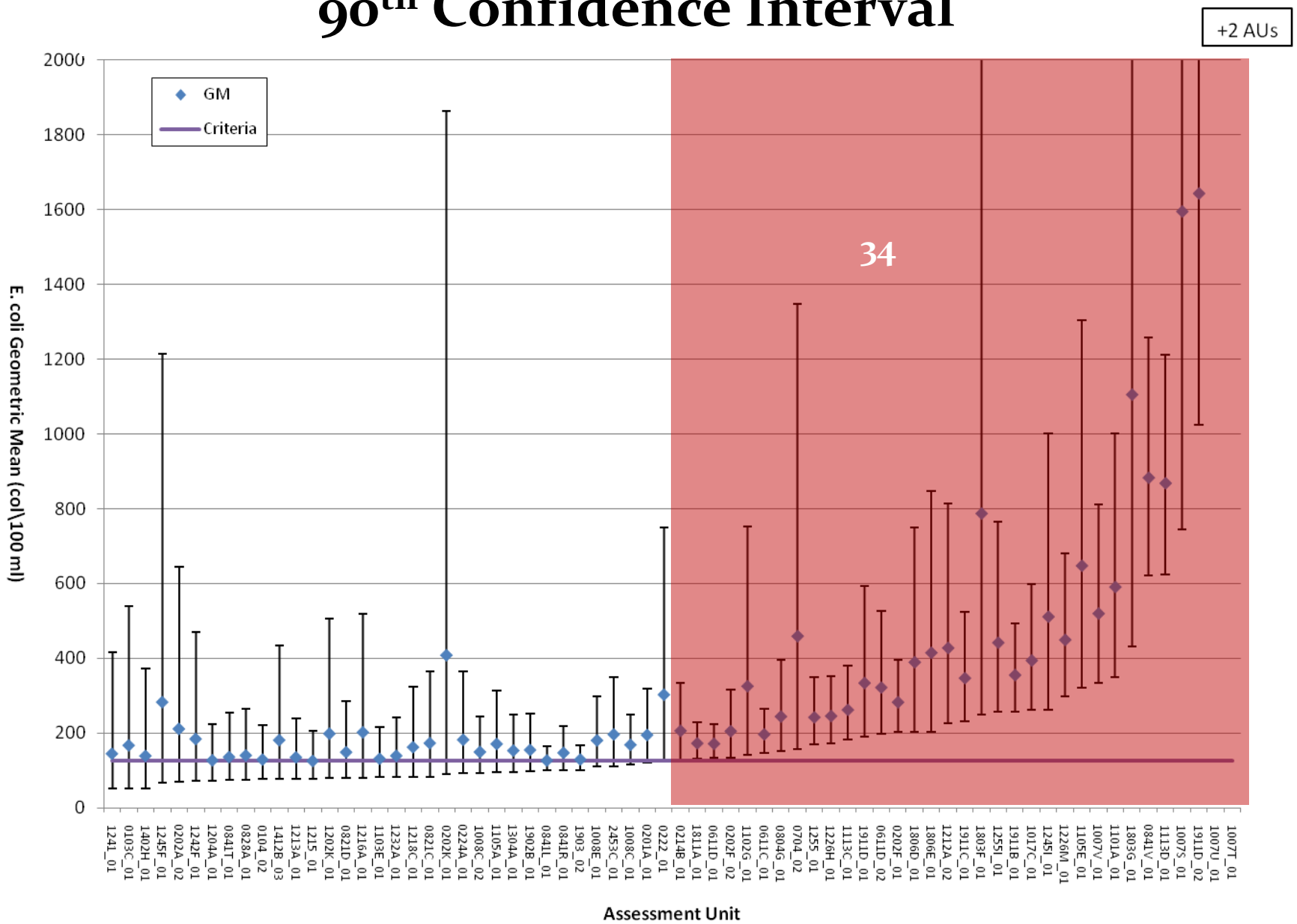


Geometric Means, 90th Confidence Intervals and Sample Numbers for New 2010 Freshwater Bacteria Impairments

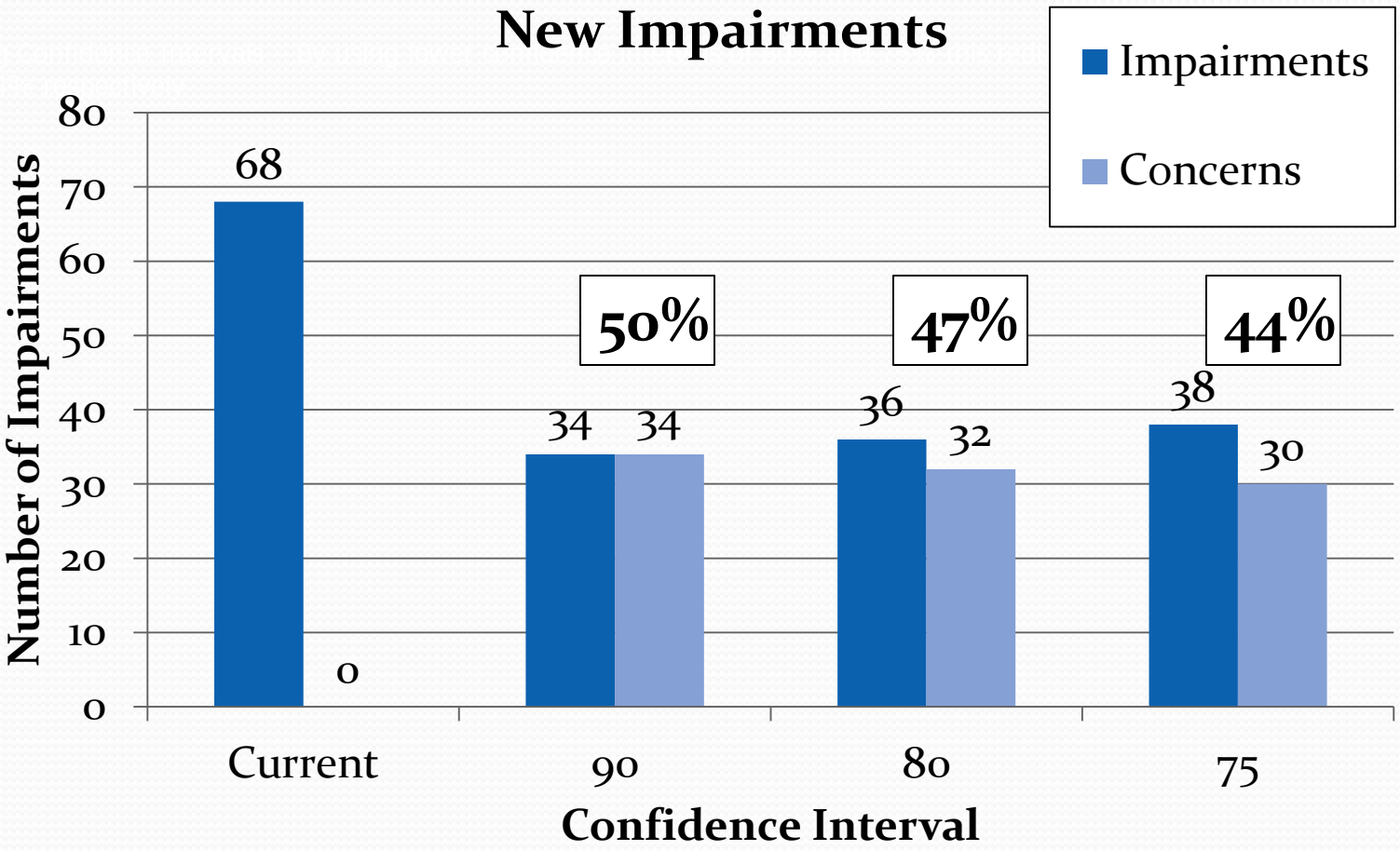
+2 AUs



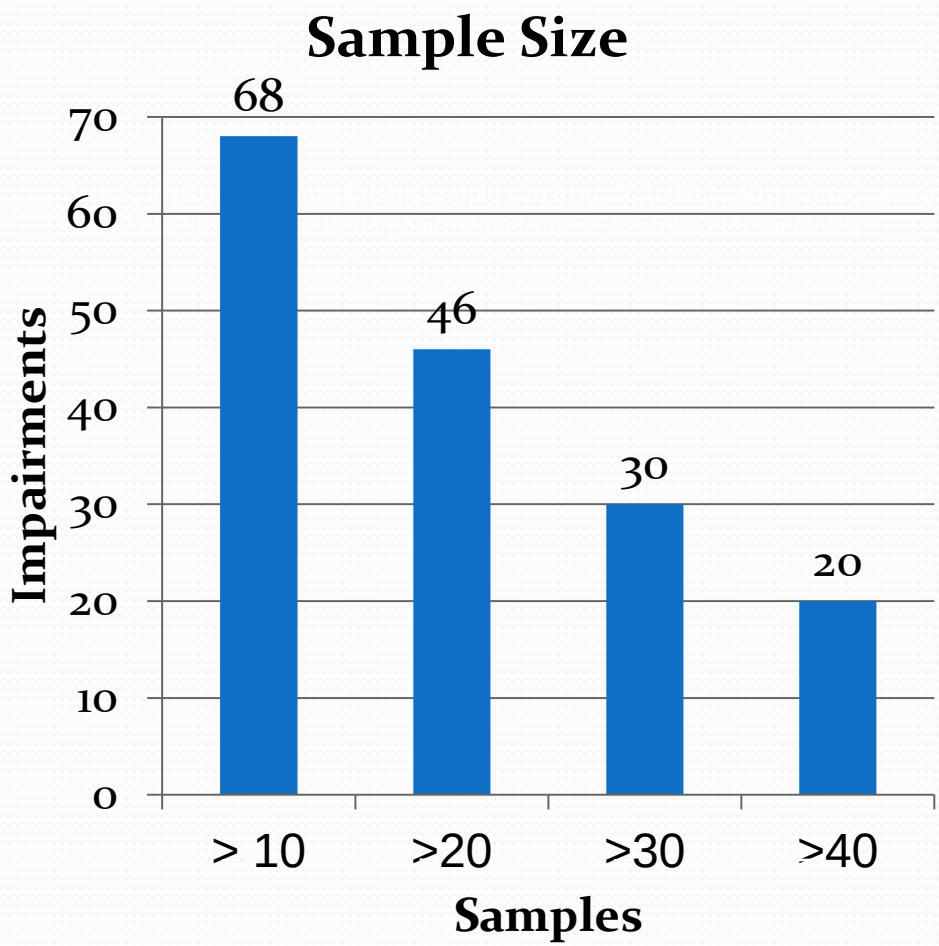
90th Confidence Interval

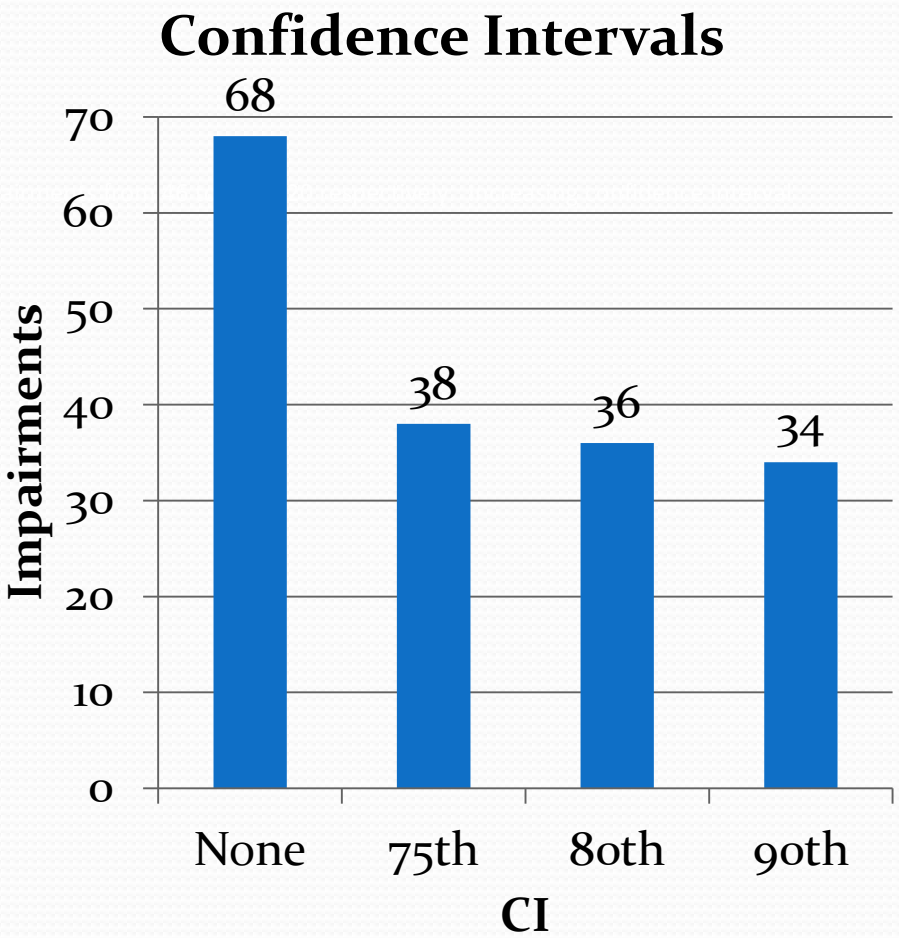


Setting Confidence Intervals



Case Study Comparison





Advantages

- Sample Size
  - Simple method for reducing uncertainty to identify impairments
- Confidence Intervals
  - Statistical basis for establishing probabilities and reducing uncertainty when identifying impairments
  - Maintains the ability to utilize small samples to make decisions

Disadvantages

- Sample Size
  - Larger proportion of waterbodies are not assessed
- Confidence Intervals
  - Some unimpaired waters will have geometric means that exceed criteria
  - Computations can be difficult to explain to the general public

Additional Considerations

- Should these methods be used to evaluate recreational use attainment in saline waters – *Enterococcus?*
- Will not apply to recreational beach assessments
- Should methods be used to remove existing impairments?

Conclusion

- Bacteria impairment represent the largest percentage of impairments in Category 5 of the Integrated Report
- Limited resources need to target those waterbodies that are truly impaired
- Decreasing uncertainty when identifying impairments can be accomplished through
  - Increasing sample size
  - Considering confidence intervals

Conclusion (cont.)

- Adjusting sample sizes represents a simple way to decrease uncertainty but results in many "unassessed waters"
- Considering confidence intervals allows application of statistics and the use of small datasets but may prevent an apparent exceedance of the criteria from being listed