A

The Chesapeake Bay Water Quality Criteria Attainment Assessment Framework

Assessment Analysis of Monitoring Data[1]

CBP WQ Monitoring Network

Data collection, spatial interpolation, and ranking of attainment results

Time exceedance

Assessment curve (CFD curve)

Space exceedance
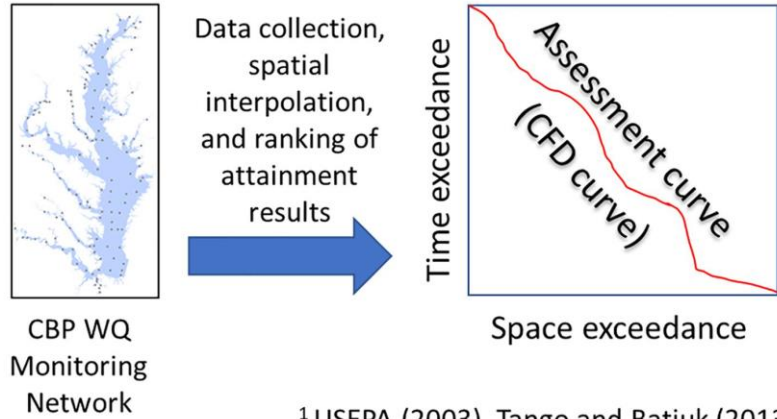
[1] USEPA (2003), Tango and Batiuk (2013)

Compliance Decision Framework[2]

Time exceedance

Water Quality Standard Non-compliance space

Space exceedance

Time exceedance

Non-compliance region

Reference curve*

Compliance region

Space exceedance
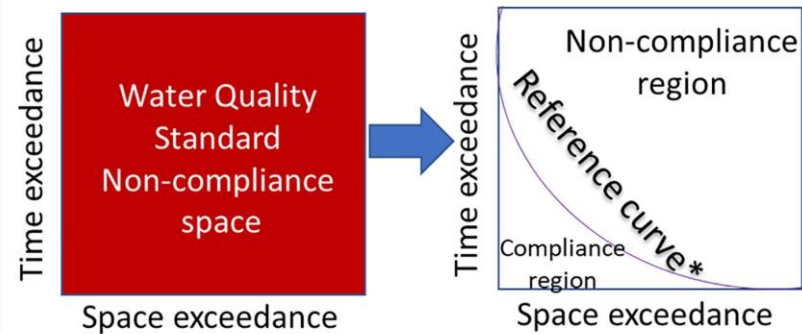
[2] USEPA (2003), Batiuk et al. (2009)

*Reference curve: Allowable non-compliance threshold

For each habitat, all space is equally important for the assessment accounting
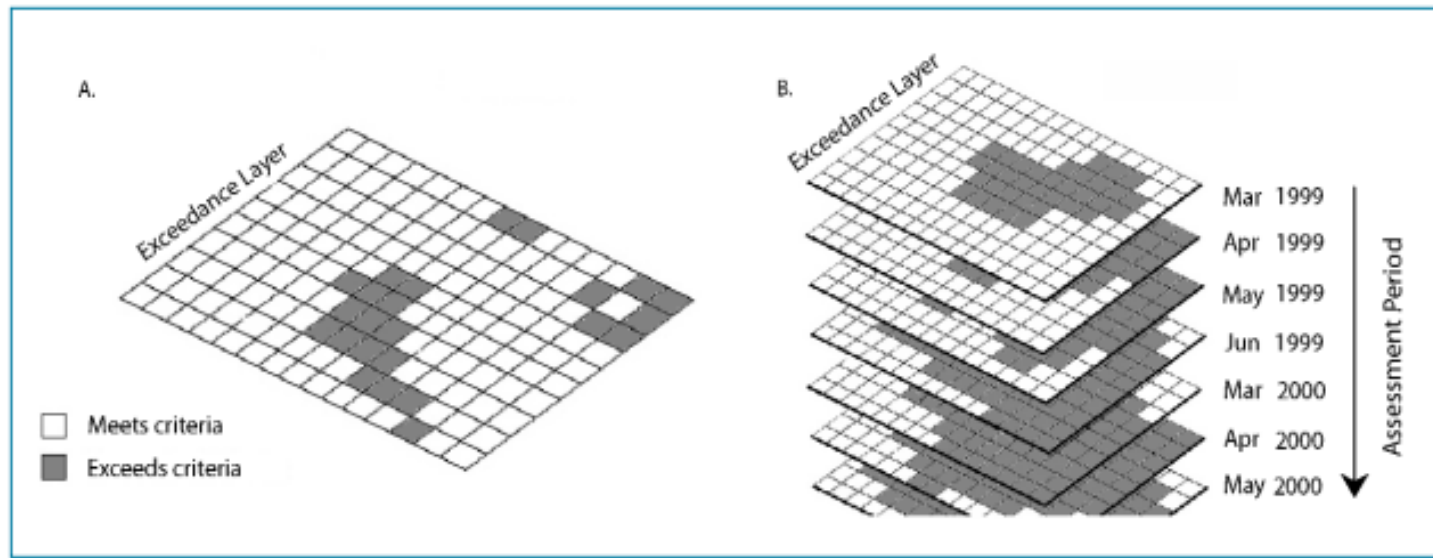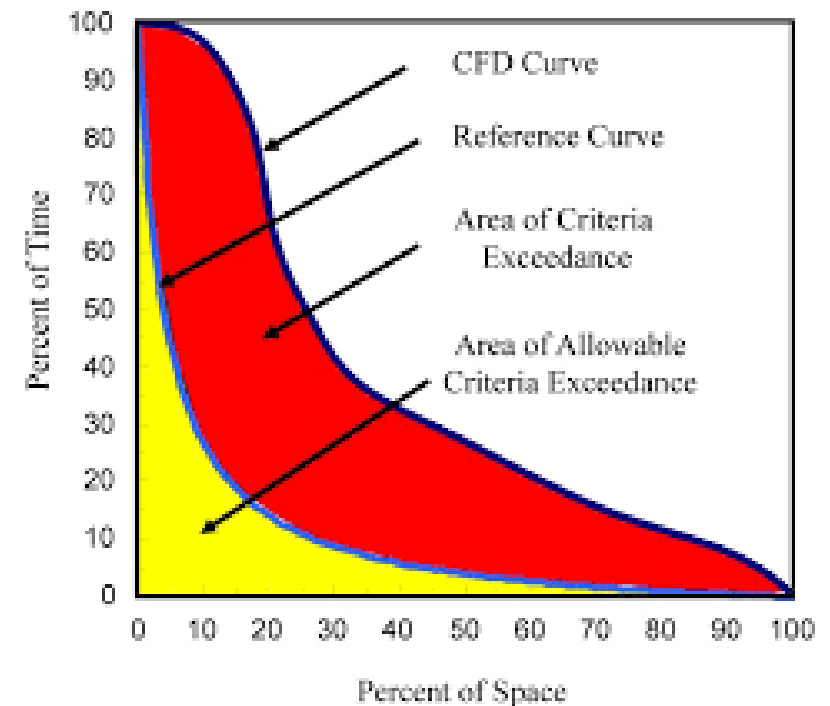

Figure VI-4. For a given sampling event, cells that exceed the criterion are determined by comparing the interpolator estimated water quality value in each cell (e.g., chlorophyll *a*) to the appropriate criterion value (a) as in Figure VI-3. The same process is repeated for each sampling event through the assessment period (b).
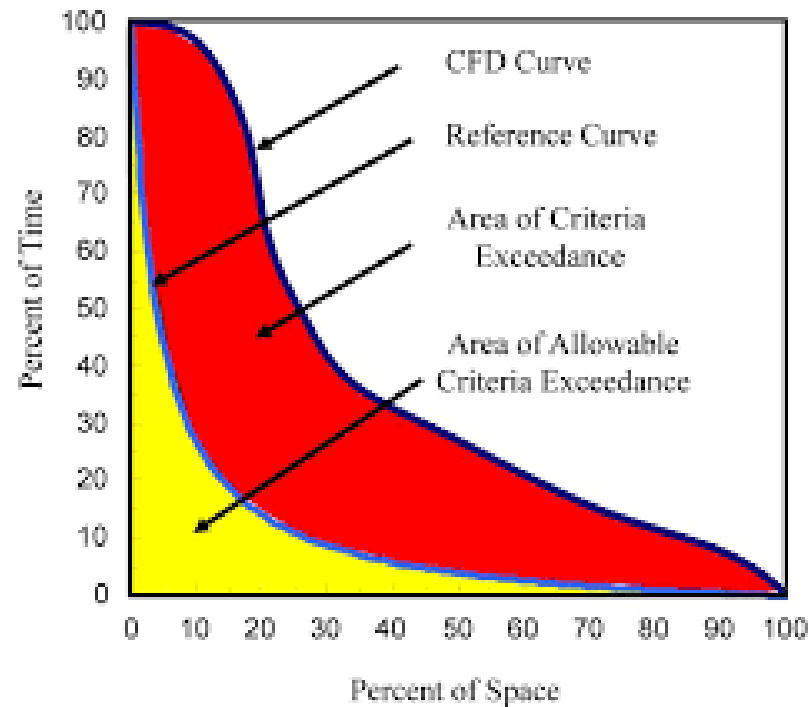
USEPA (2003): Criteria assessment accounting

USEPA (2003): The CFD Attainment Test

Criterion assessment

You passed!
You are in!

USEPA (2003): The CFD Attainment Test

You failed!
You are out!

Clean Water Act: More than pass/fail reporting.

Integrated Water Quality Assessment Reports, each assessed waterbody or waterbody segment is listed in one of the five following categories

- Category 1 – Attaining all designated uses
- Category 2 – Attaining some designated uses, and insufficient or no data information to determine if remaining uses are attained
- Category 3 – Insufficient or no data and information to determine if any use is attained
- Category 4- Impaired or threatened for one or more uses but not needing a TMDL because –
  a) TMDL has been completed
  b) Expected to meet standards
  c) Not impaired by a pollutant
- Category 5 – Impaired or threatened by pollutant(s) for one or more designated uses and requiring a TMDL. These are the waters entered onto a states' 303(d) list.

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"Passed"

"Uncertain"

"Failed"

Given uncertainties in our assessment, when results are reaaaaaaallllllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?
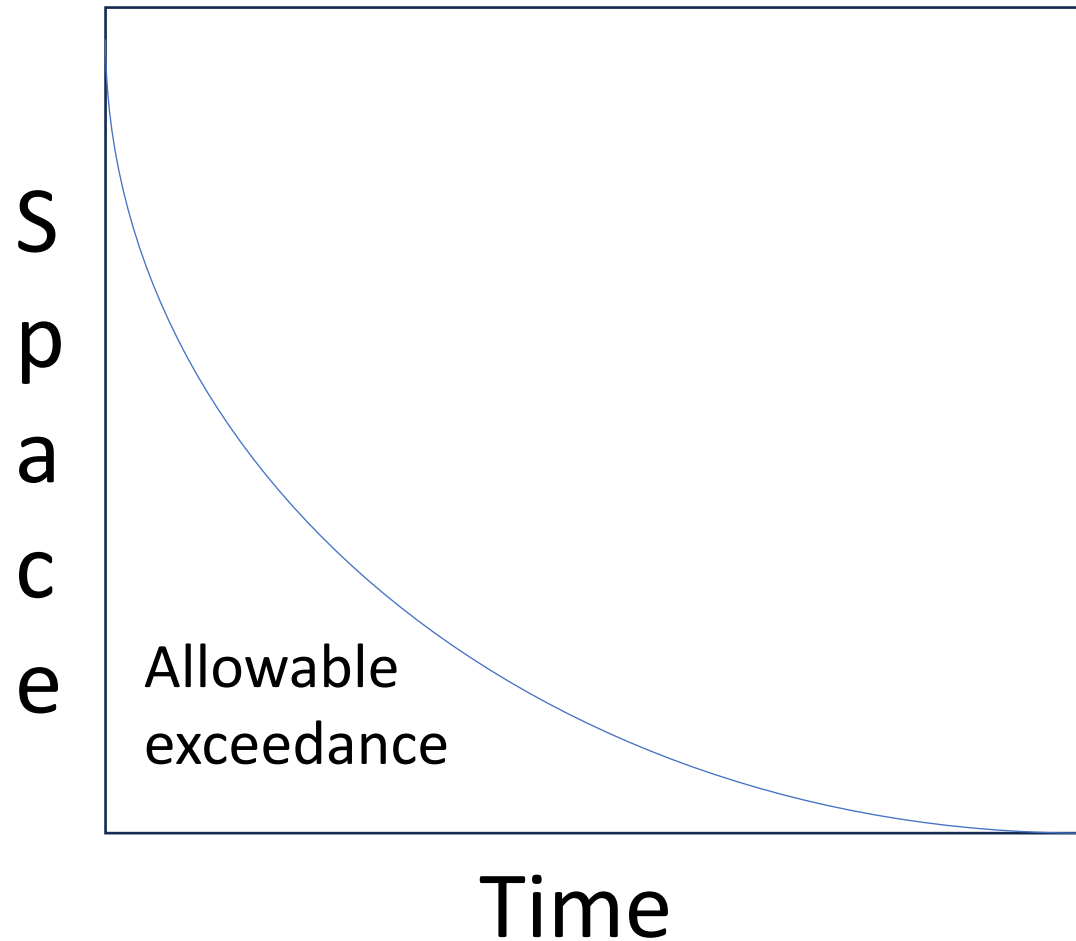
Given uncertainties in our assessment, when results are reaaaaaaallllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?
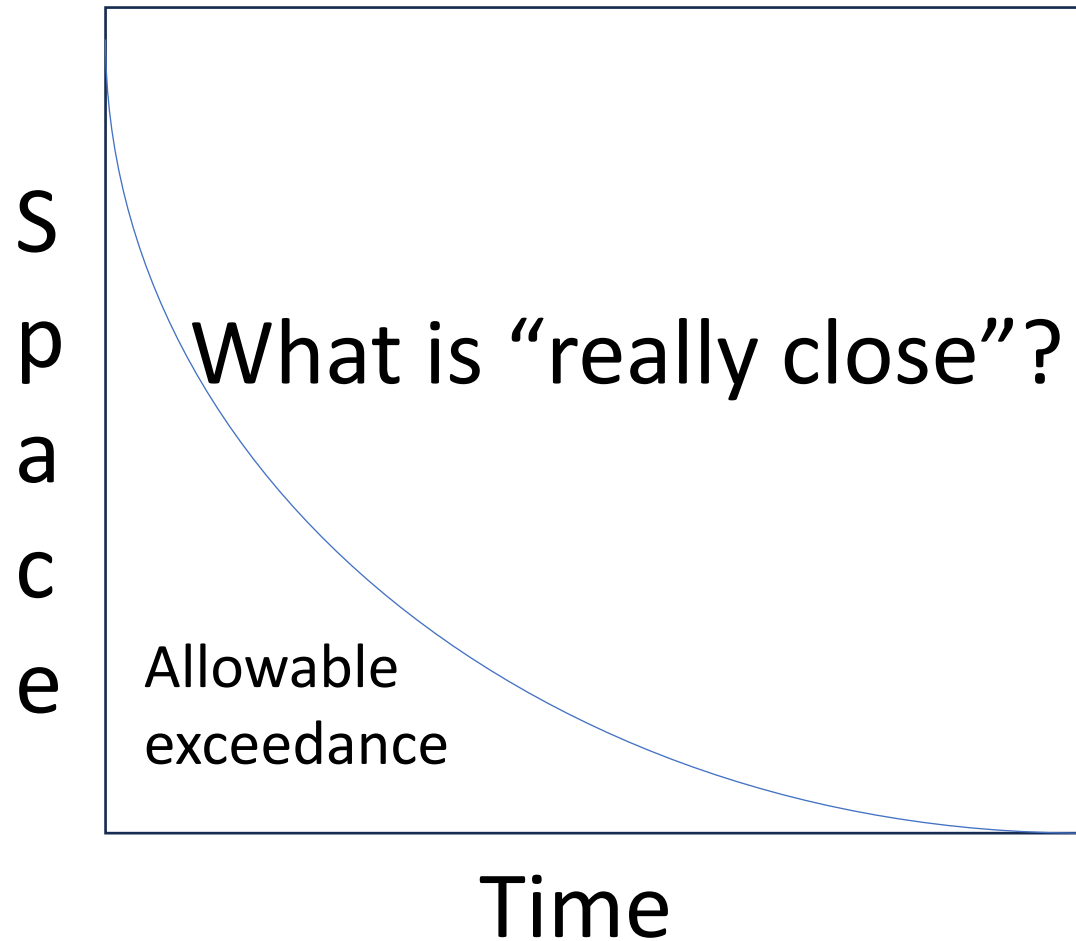
We can look at half of the picture with our attainment deficit results
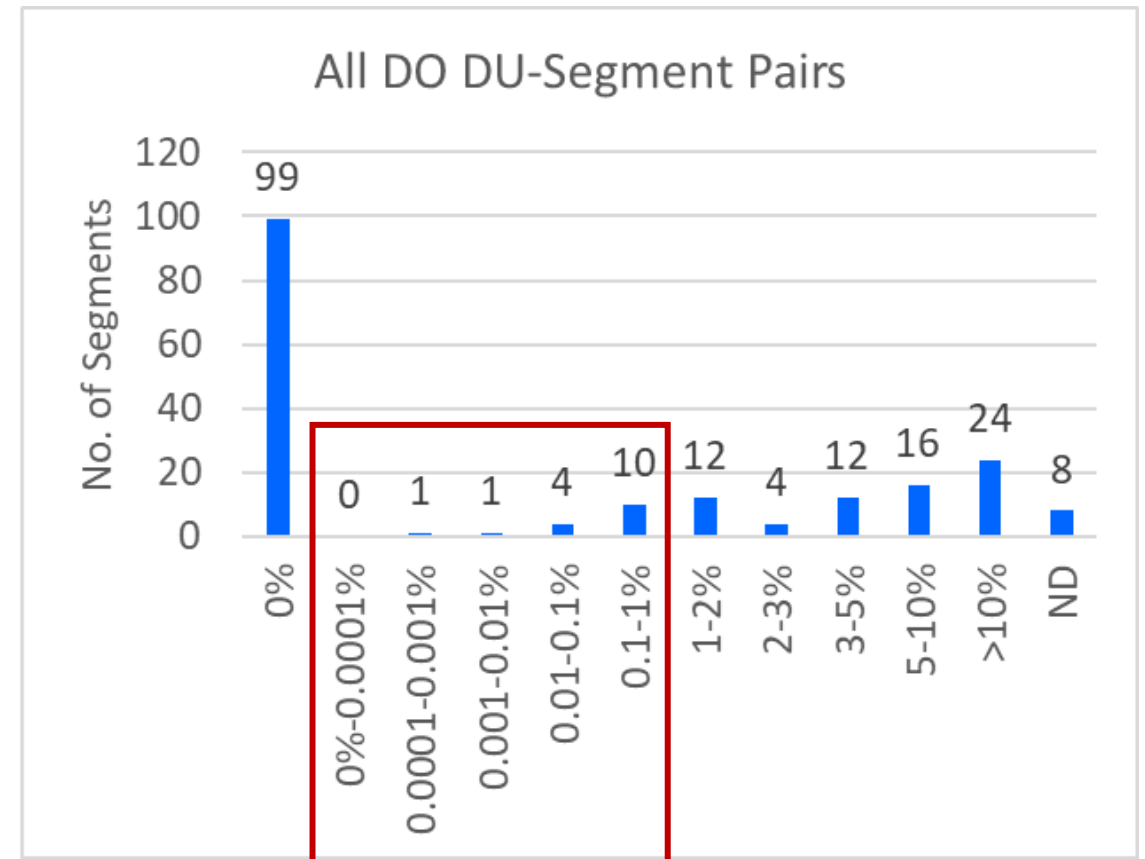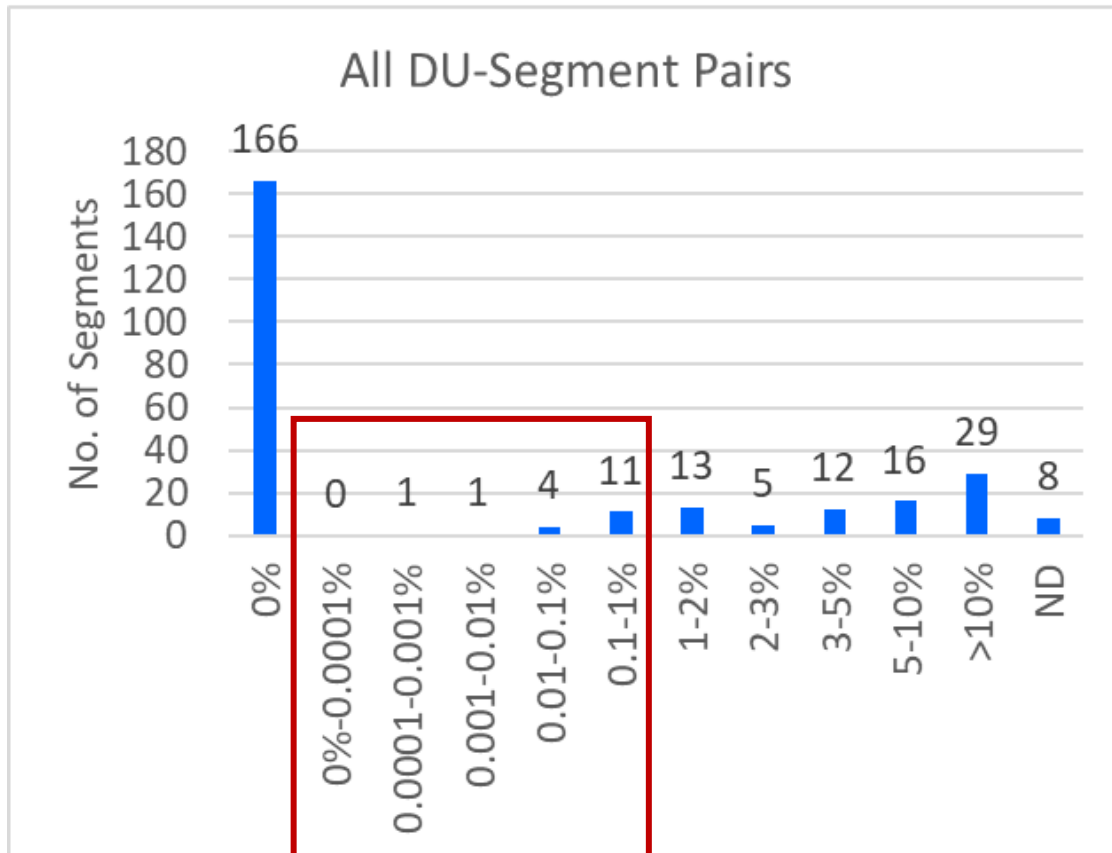## Breakdown of Attainment Status by Threshold 2019-2021

What is "really close"?

Deficit	Count
0%	?
0%-0.0001%	?
0.0001-0.001%	?
0.001-0.01%	?
0.01-0.1%	?
0.1-1%	?
1-2%	?
2-3%	?
3-5%	?
5-10%	?
>10%	?
ND	?

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Source. Q. Zhang

Breakdown of Attainment Status by Threshold 2019-2021
Is fractional attainment "really close"?
Some results are less than 1% out of attainment

All DU-Segment Pairs

All DO DU-Segment Pairs

Source. Q. Zhang

Breakdown of Attainment Status by Threshold 2019-2021
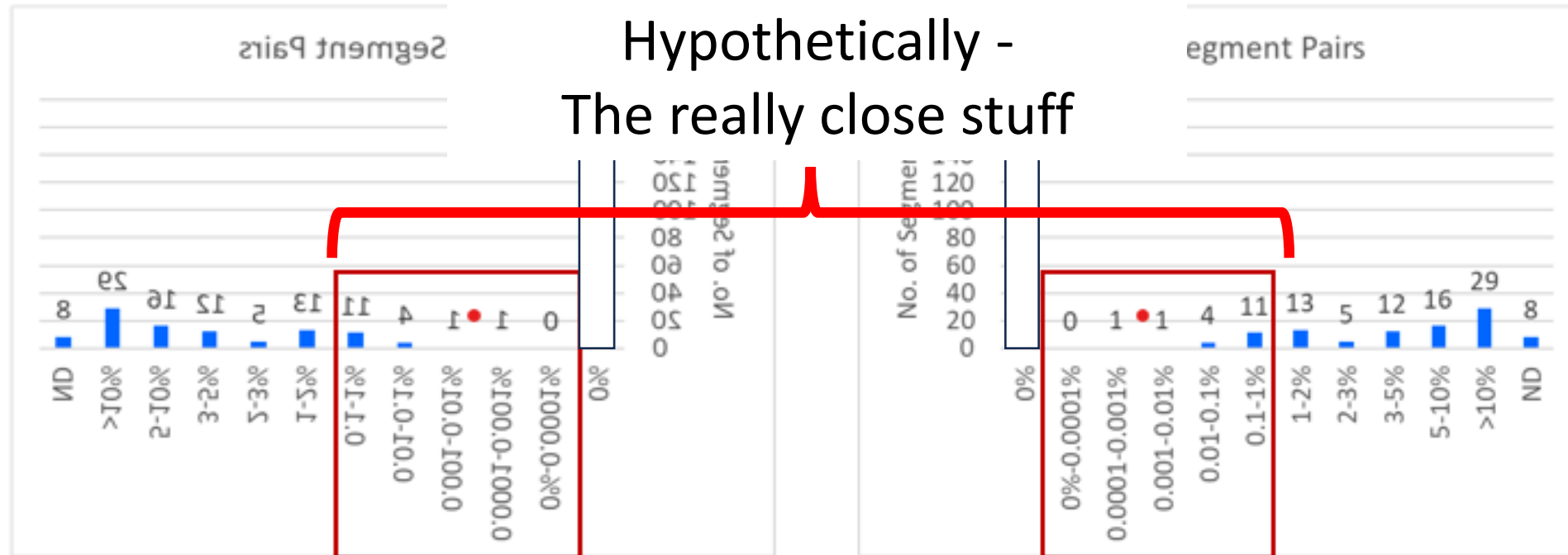## Is fractional attainment "really close"?
Some results are less than 1% out of attainment
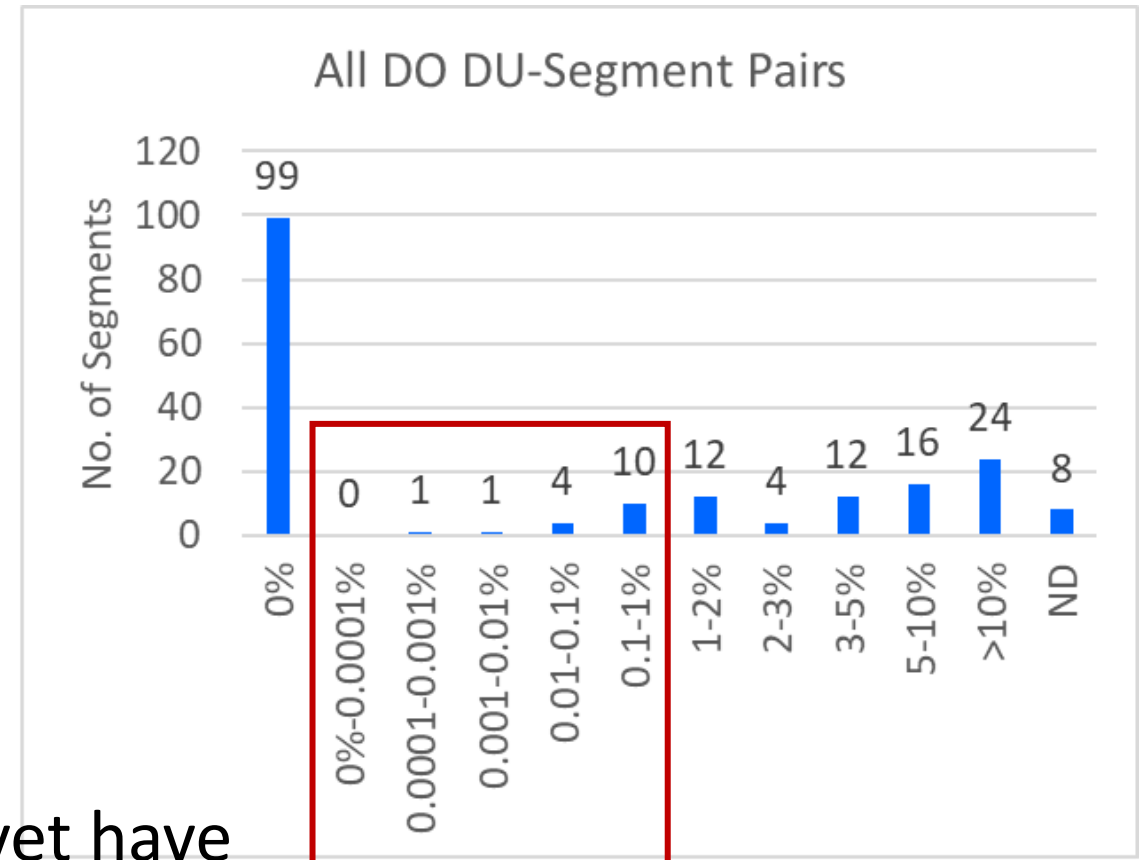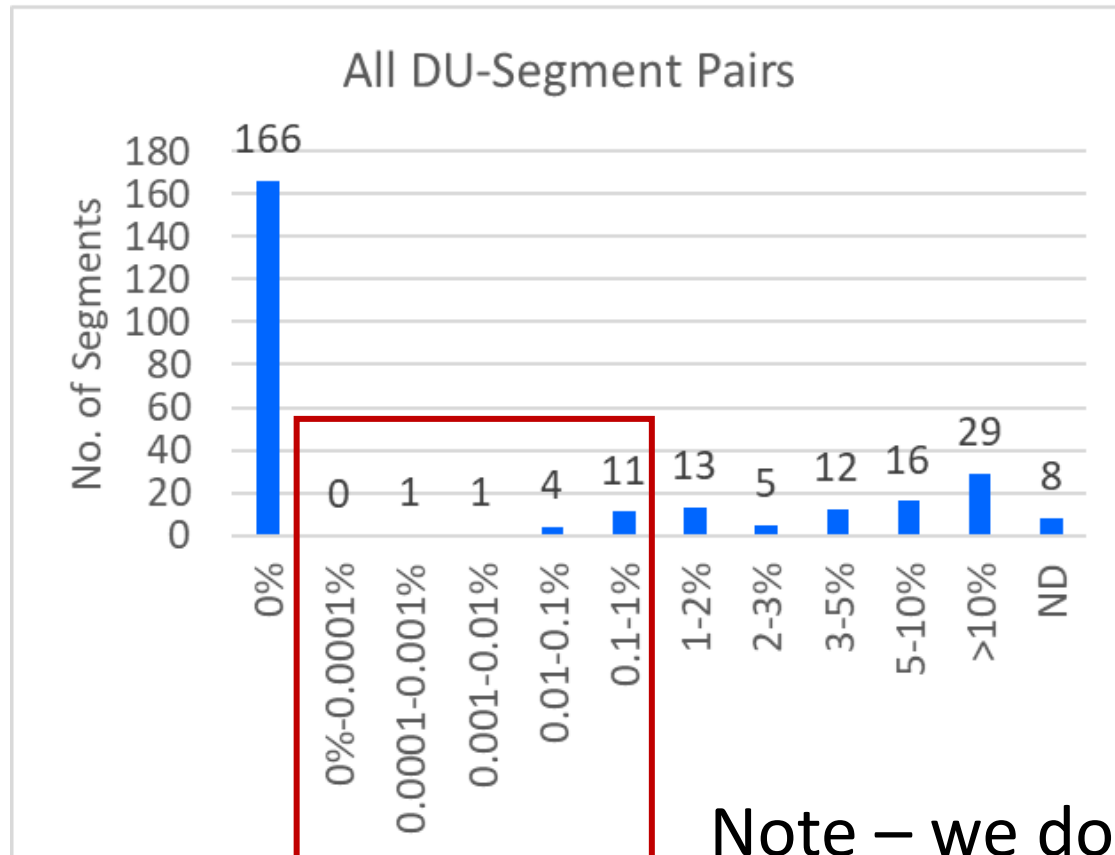
Note – we do not yet have "attainment buffer" distributions

Source. Q. Zhang

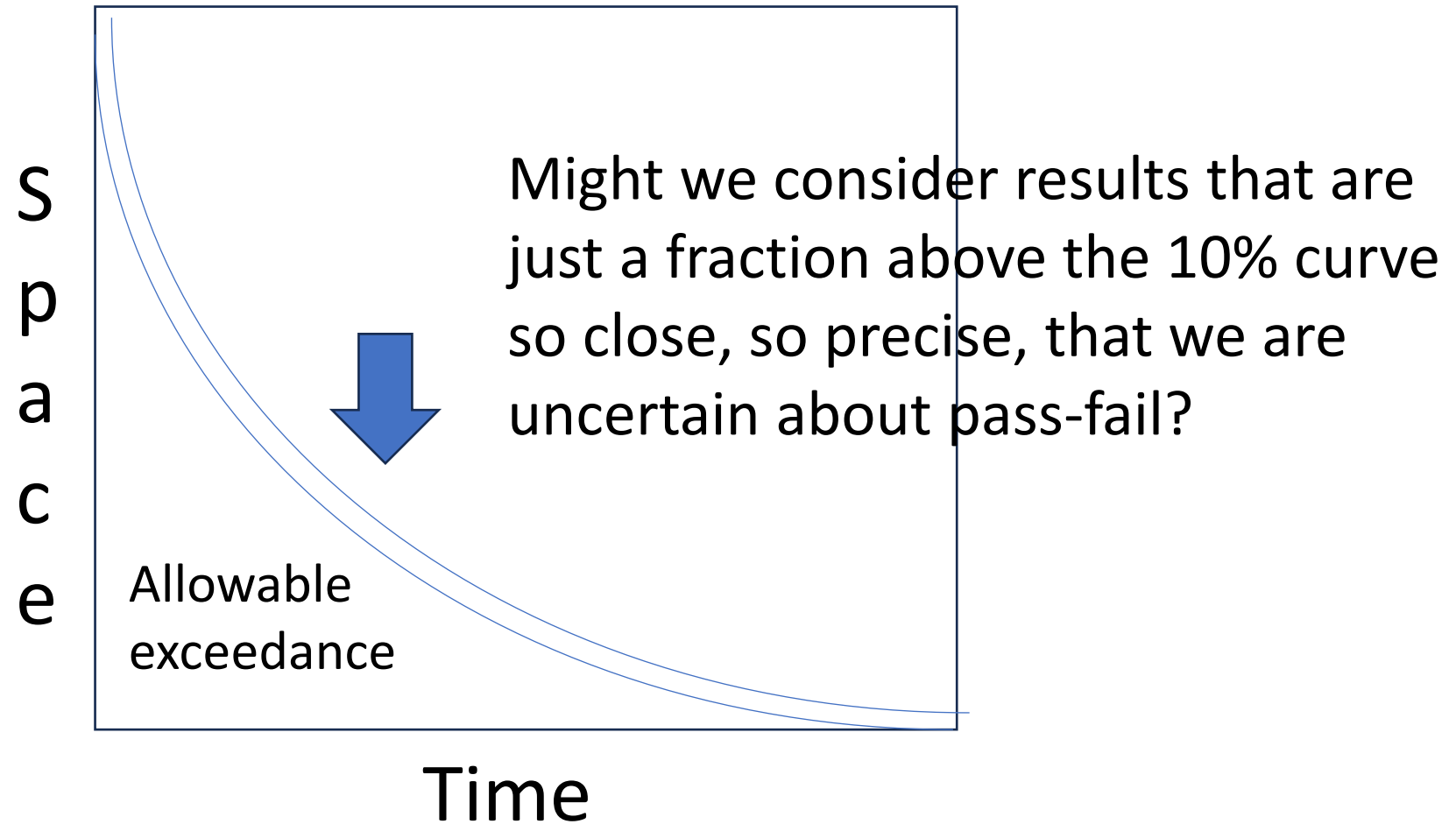# Note: we don't yet have an "attainment buffer", i.e., how far "in" is in?
Maybe the distribution is mirrored on the buffer side as a first cut hypothesis

Hypothetically -
The really close stuff

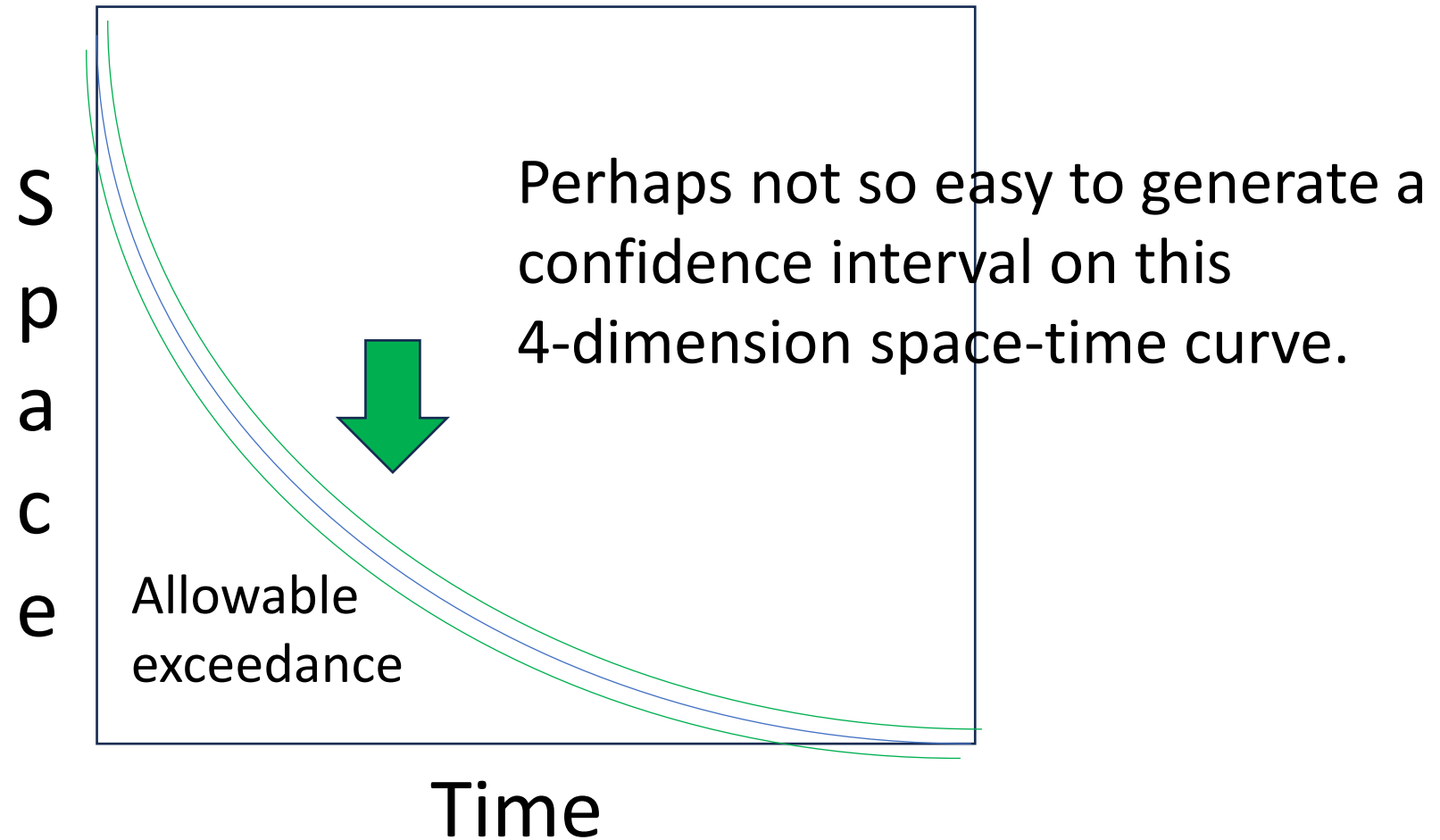Hypothetical attainment buffer scores

Attainment deficit scores

Given uncertainties in our assessment, when results are reaaaaaaalllllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?

S
p
a
c
e

Allowable exceedance

Time

Might we consider results that are just a fraction above the 10% curve so close, so precise, that we are uncertain about pass-fail?

Given uncertainties in our assessment, when results are reaaaaaaalllllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?

Perhaps not so easy to generate a confidence interval on this 4-dimension space-time curve.
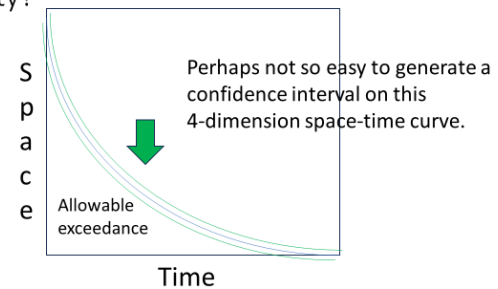
Space

Allowable exceedance

Time

What to do?

Given uncertainties in our assessment, when results are reaaaaaallllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?

Perhaps not so easy to generate a confidence interval on this 4-dimension space-time curve.

Space

Allowable exceedance

Time

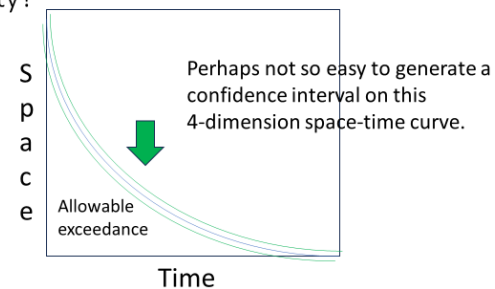# If it was easy we probably would have done it long ago ☺

Given uncertainties in our assessment, when results are reaaaaaaalllllly close, should we really be calling them in, or out, or do we have a zone of uncertainty?

Perhaps not so easy to generate a confidence interval on this 4-dimension space-time curve.

Any precedents for decision-making similar to this in our Chesapeake Bay work?

- Yes!
- See USEPA (2017)

United States Environmental Protection Agency | Region III Chesapeake Bay Program Office | Region III Water Protection Division | EPA 903-R-17-002 CBP/TRS 320-17 November 2017

In coordination with the Office of Water/Office of Science and Technology, Washington, D.C., and the states of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia and the District of Columbia
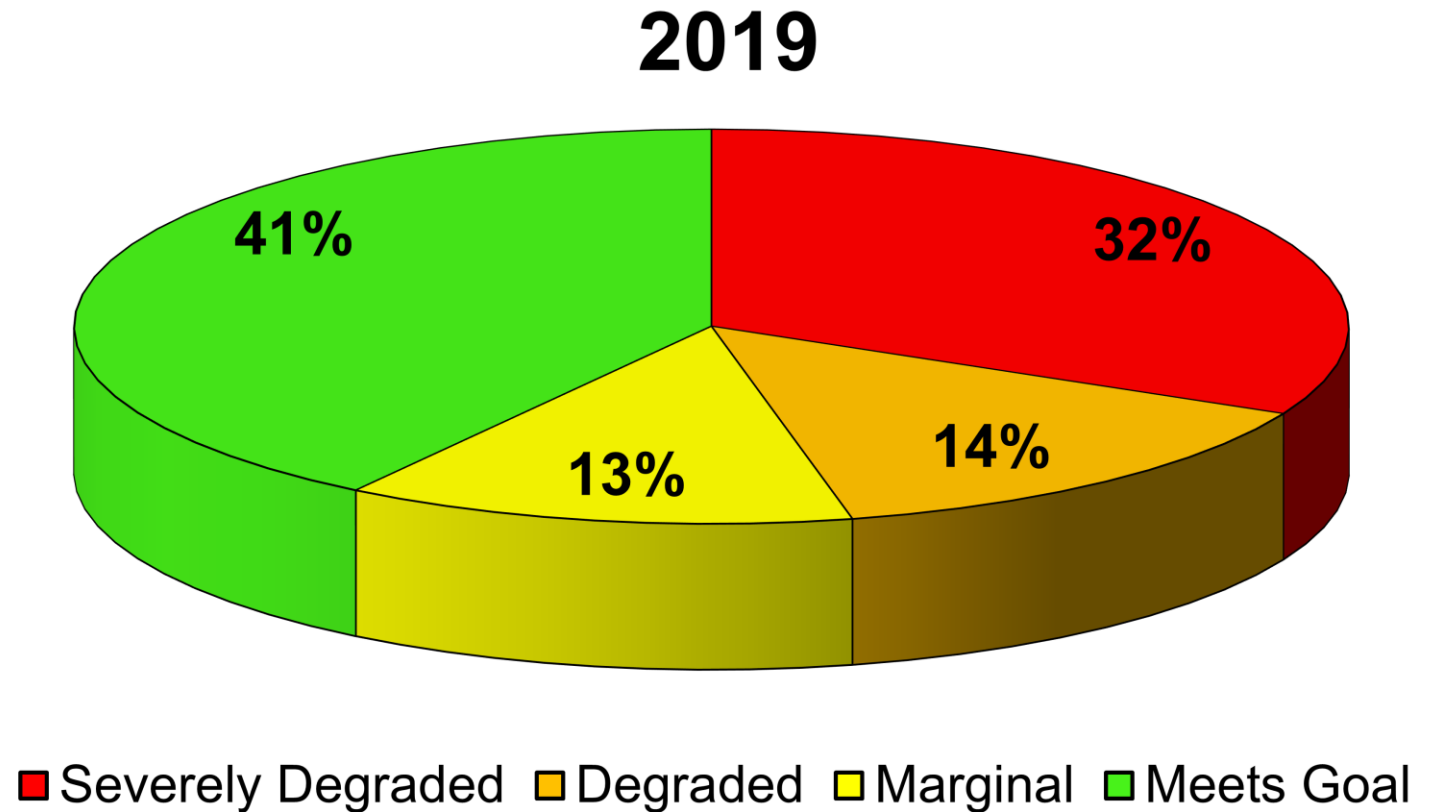
Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll *a* for the Chesapeake Bay and Its Tidal Tributaries

2017 Technical Addendum

November 2017

Aquatic Life Use assessment – the Bay BIBI

2019

Legend: Severely Degraded, Degraded, Marginal, Meets Goal

- Severely Degraded: 32%
- Degraded: 14%
- Marginal: 13%
- Meets Goal: 41%

There are shades of failure expressed in the results

Source: Versar Inc. Results (versar.com)

Application of Benthic IBI assessment to decisions affected by data variability – wide confidence intervals on segment scoring.

- For segments where the CWA Section 303(d) listing classification results are "Impaired = No", Maryland and Virginia would identify those segments that also have a breadth of confidence limits ((Upper confidence Limit) – (Lower confidence Limit)) ≥ 0.5) of 0.5 or greater.

- Of that subset of segments with confidence limits > 0.5, those that also have a Mean B-IBI >2.7 would classified as Category 3 (insufficient information) until more conclusive information is available.

B-IBI Level	Score
Severely Degraded	1.0 - 2.0
Degraded	2.1 - 2.6
Marginal	2.7 - 2.9
Meets Restoration Goals	3.0 - 5.0

Measuring Benthic Health (versar.com)

- • Virginia refines this rule classification further such that a segment will be classified as Category 3B
  - when the analysis suggests non-impairment but the difference between the upper and lower 95% confidence limits equals or exceeds 0.5 and
  - the average B-IBI score is less than 2.7, or,
  - when the number of sites sampled during the six-year data window is less than 10, (i.e., where some data exist but are insufficient to determine support of the designated uses).

B-IBI Level	Score
Severely Degraded	1.0 - 2.0
Degraded	2.1 - 2.6
Marginal	2.7 - 2.9
Meets Restoration Goals	3.0 - 5.0

Measuring Benthic Health (versar.com)

USEPA 2017 Expanded subcategories for uncertainty under Cat 3

Table VI-2. Updated application of U.S. EPA 5-category system for classifying Chesapeake Bay aquatic life use water quality status as the basis for reporting water quality for Clean Water Act section 303(d) listing assessments [1].

Classification Category for Water Quality Status	Description
Category 1	All designated uses are supported; no use is threatened.
Category 2	Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	All jurisdictions: There is insufficient available data and/or information to make a use support determination.
Category 3a	VA: no data are available within the data window of the current assessment to determine if any designated use is attained and the water was not previously listed as impaired.
Category 3b	VA: some data exist but are insufficient to determine support of designated uses. Such waters will be prioritized for follow up monitoring, as needed.
Category 3c	VA: data collected by a citizen monitoring or another organization indicating water quality problems may exist but the methodology and/or data quality has not been approved for a determination of support of designated use(s). These waters are considered as having insufficient data with observed effects. Such waters will be prioritized by Department of Environmental Quality for follow up monitoring.
Category 3d	VA: data collected by a citizen monitoring or other organization indicating designated use(s) are being attained but the methodology and/or data quality has not been approved for such a determination.
Category 4	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
Category 4a	A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
Category 4b	Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period of time.
Category 4c	The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
Category 5	Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

1. Agreed to by the Chesapeake Bay Program's Criteria Assessment Protocol Workgroup and approved by the Chesapeake Bay Program's Water Quality Goal Implementation Team in 2013.
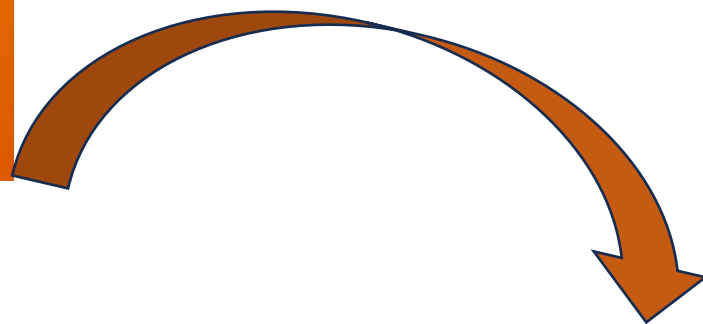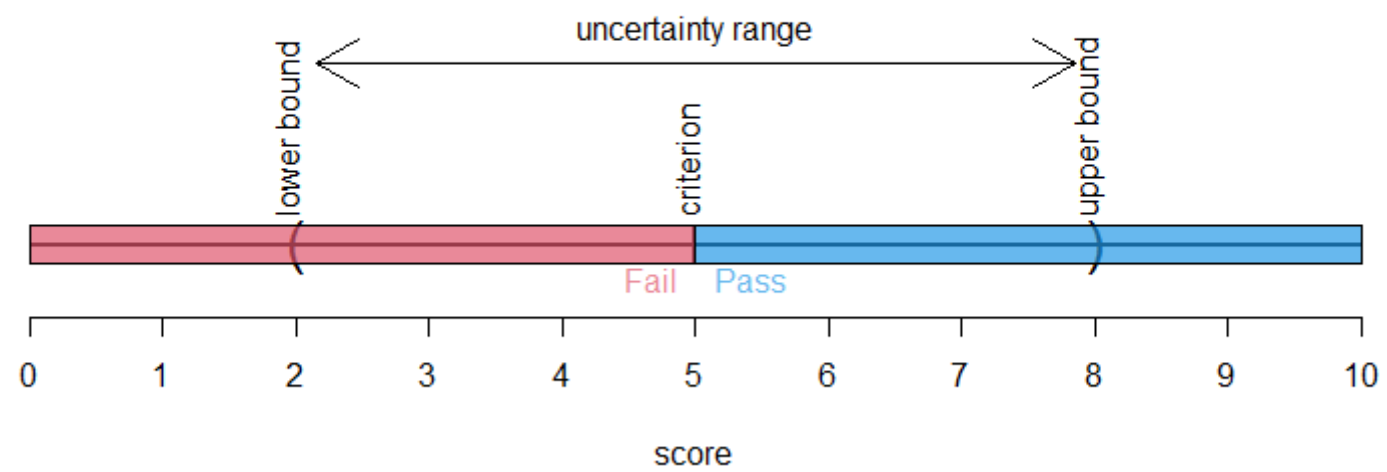
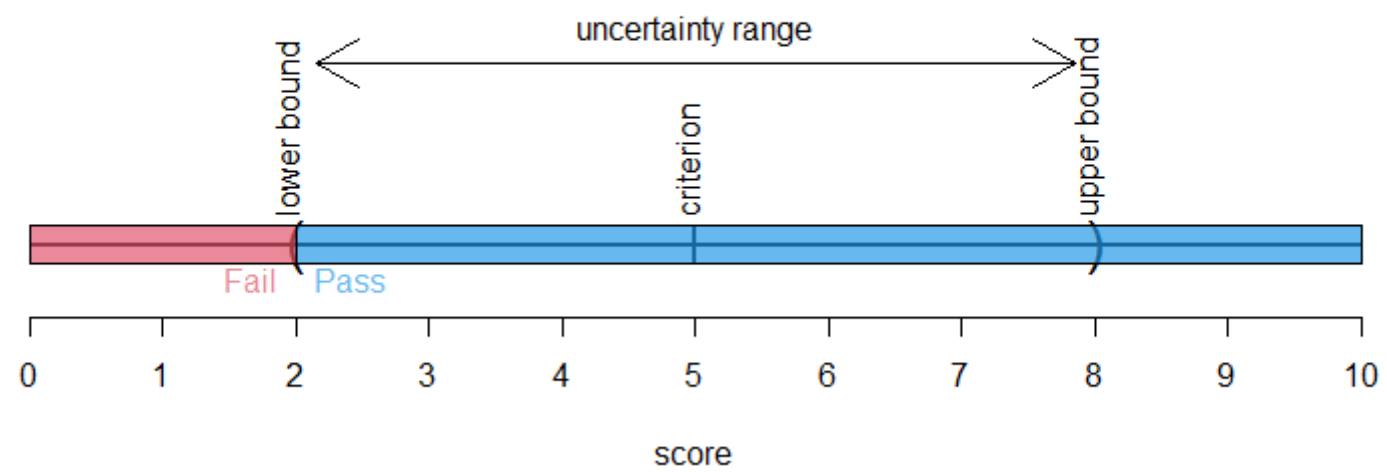**Thoughts on the role of uncertainty in Criteria Assessment.**
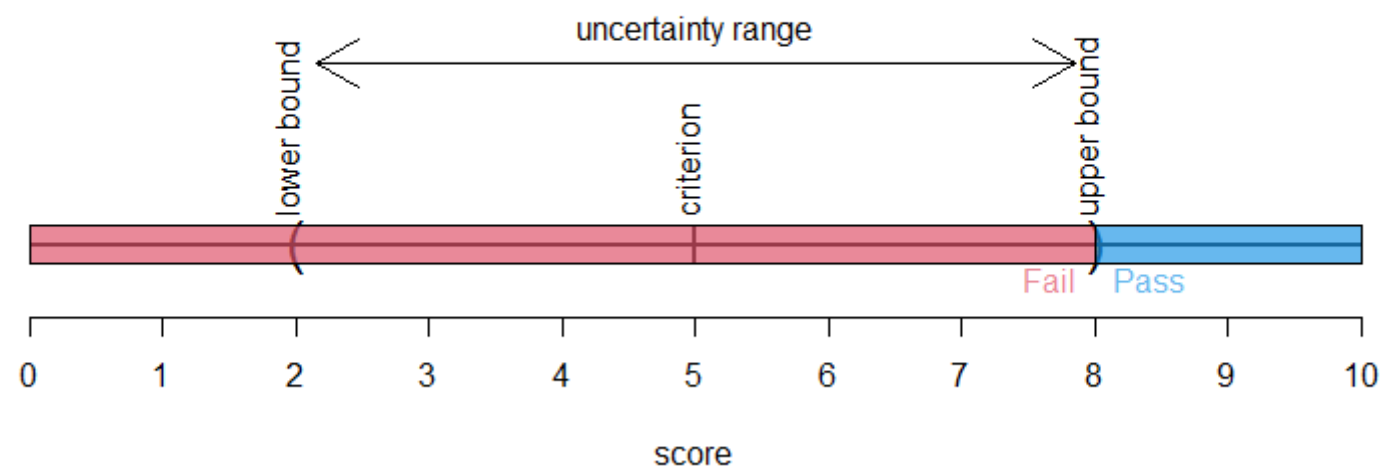Mon Jul 31 10:14:41 2023
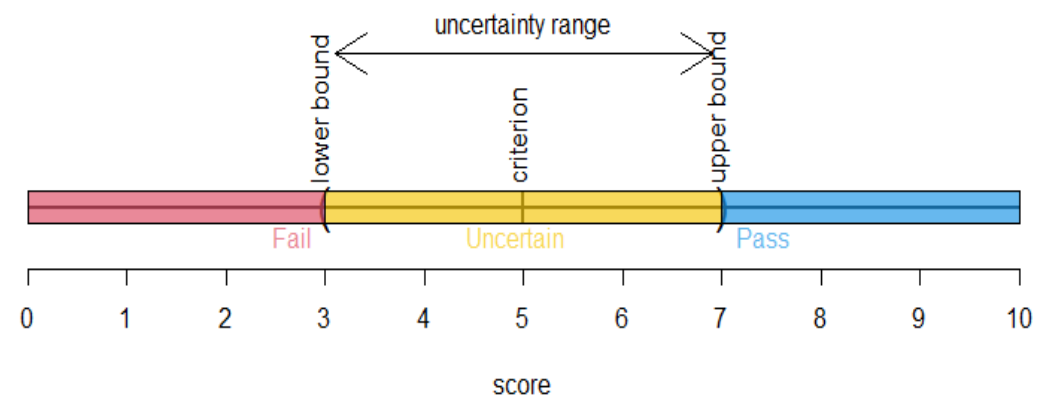
Elgin S. Perry, Ph. D.
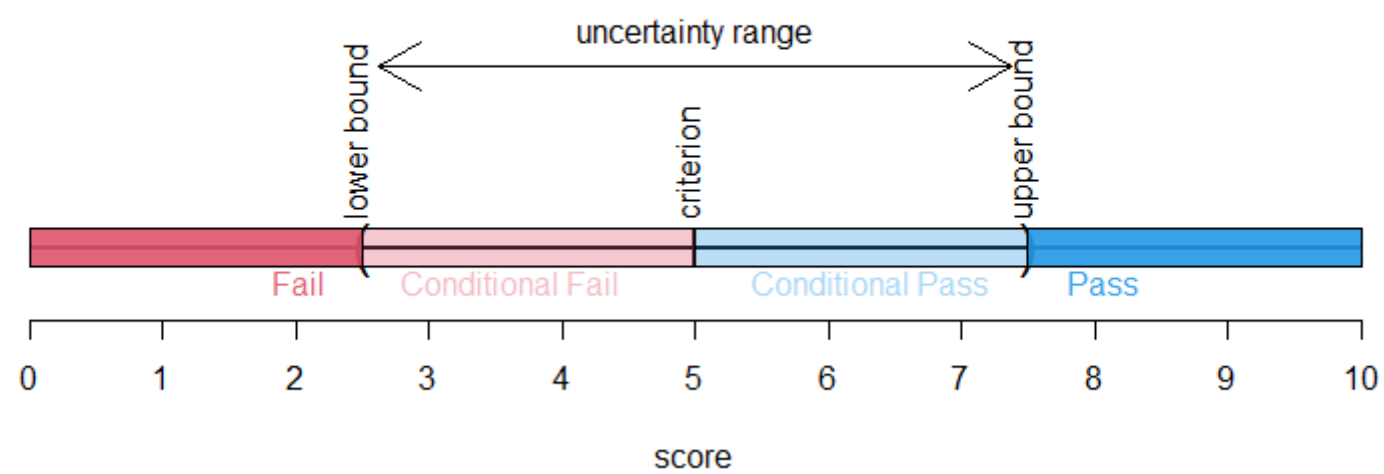
Even Handed Approach

Magna Carter Approach

IRS Approach

uncertainty range

lower bound

criterion

upper bound

Fail   Pass

score

Uncertainty Approach
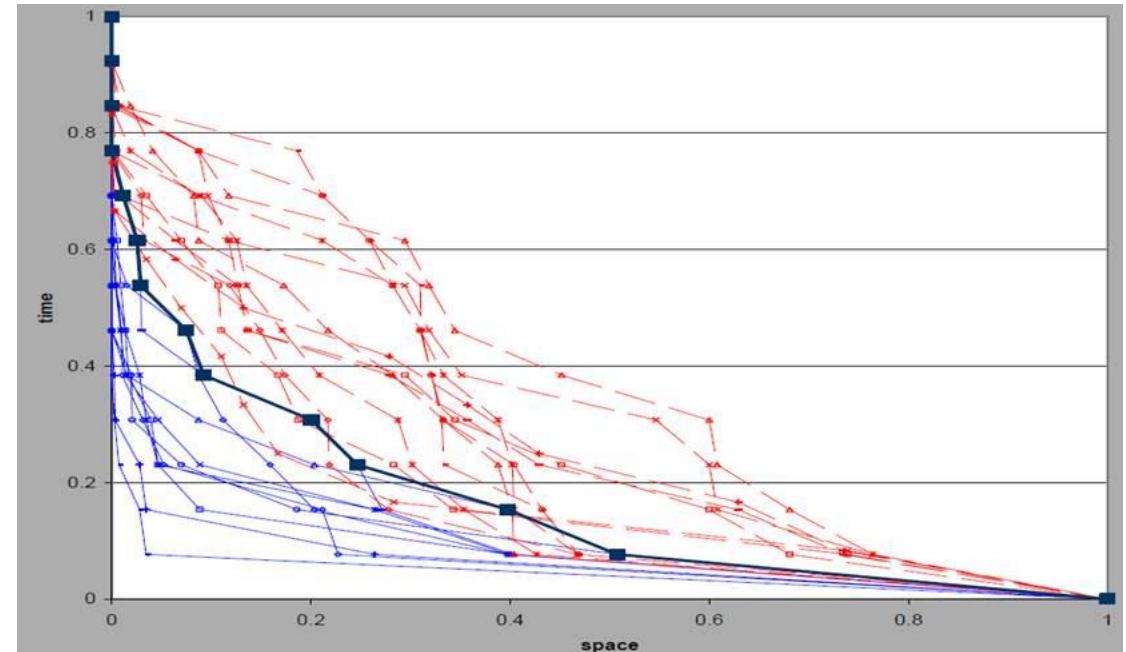
Conditional Approach

Other approaches?

Gary Shenk

- Is it possible to assign a probability to a particular assessment curve as being belonging to the pass-family of curves versus the fail-family of curves?

Deep water bioreference curve development based on BIBI score results (J. Kiesman work, 2009)

Red assessment curves are from DUs and 3-year periods with average BIBIs of 1 or 2. Blue curves have BIBI of 3, 4, or 5. The bioreference curve was drawn so that all of the blue ones pass and all of the red ones fail.

Does it work with the TMDL?

- Considerations for moving forward on work to create an uncertainty category in our assessments.

Thank you.
☺