Mycotoxins 2018:

Fit For Purpose σ Review

Presented at AAFCO 2018 Annual Meeting, PT Committee session, July 30th, Fort Lauderdale, Florida.

“Do we inform or do we instruct?”

The Role of ffp σ in Z Scores for the Mycotoxin PT Scheme

Z is a Normalized measure of where you stand relative to the assigned value for the analyte. The ffp σ is the normalizing factor.

$$Z = \frac{x_{LAB} - X_{AV}}{\sigma_{ffp}}$$

- Measured as the difference between your analysis (x_{LAB}) and our best estimate of the true analyte concentration (X_{AV}) described as the Assigned Value.
- And here's the issue: This difference is divided by the Modified Horwitz SD (σ_{ffp} is $\sigma_{Modified\ Horwitz}$).

AAFCO Proficiency Testing Program

AAFCO PTP Mycotoxins Scheme

How ffp σ Affects Z Scores in the Mycotoxin PT Scheme

We are currently using the Thompson (The Analyst, Vol 125, 385-386, accepted Jan., 2000) Modified Horwitz %RSD to estimate the fit-for-purpose SD in the Mycotoxin scheme.

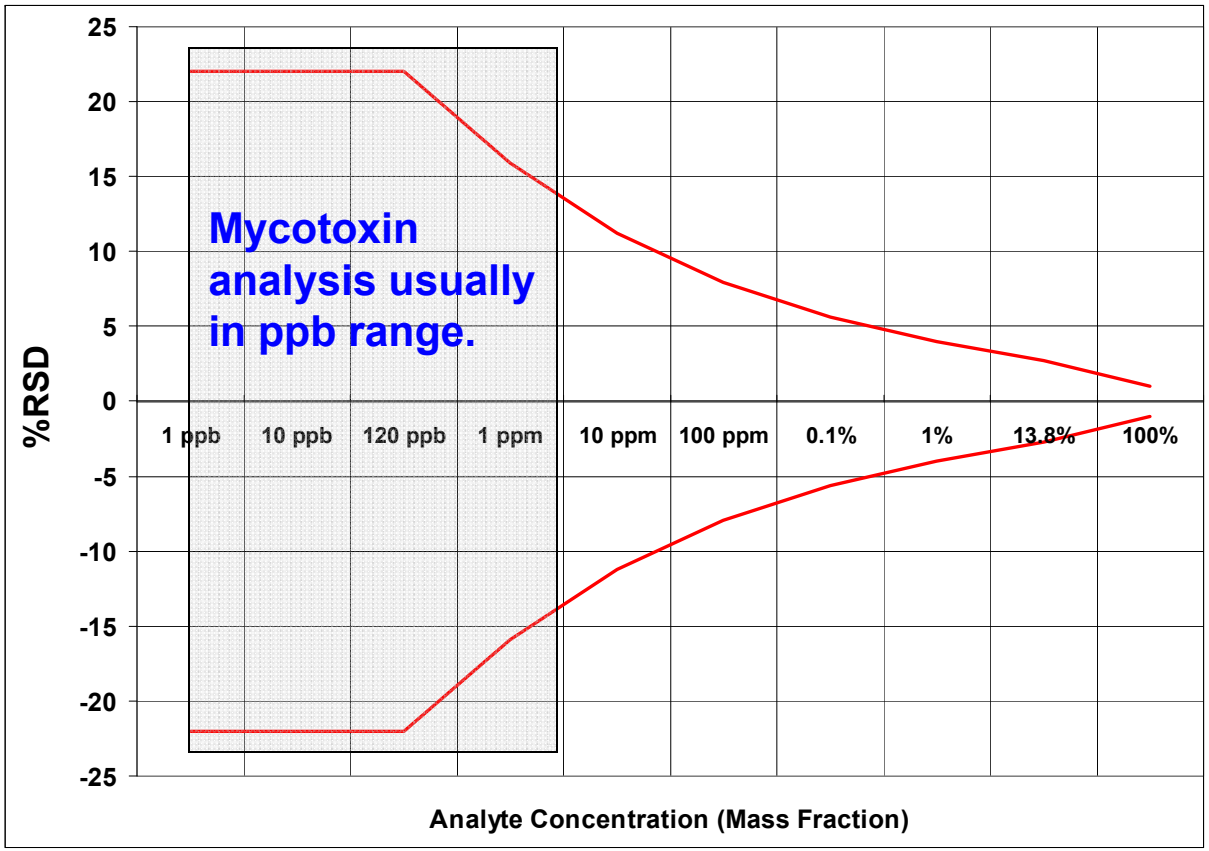
$$Z = \frac{x_{LAB} - X_{AV}}{\sigma_{\text{Modified Horwitz}}}$$

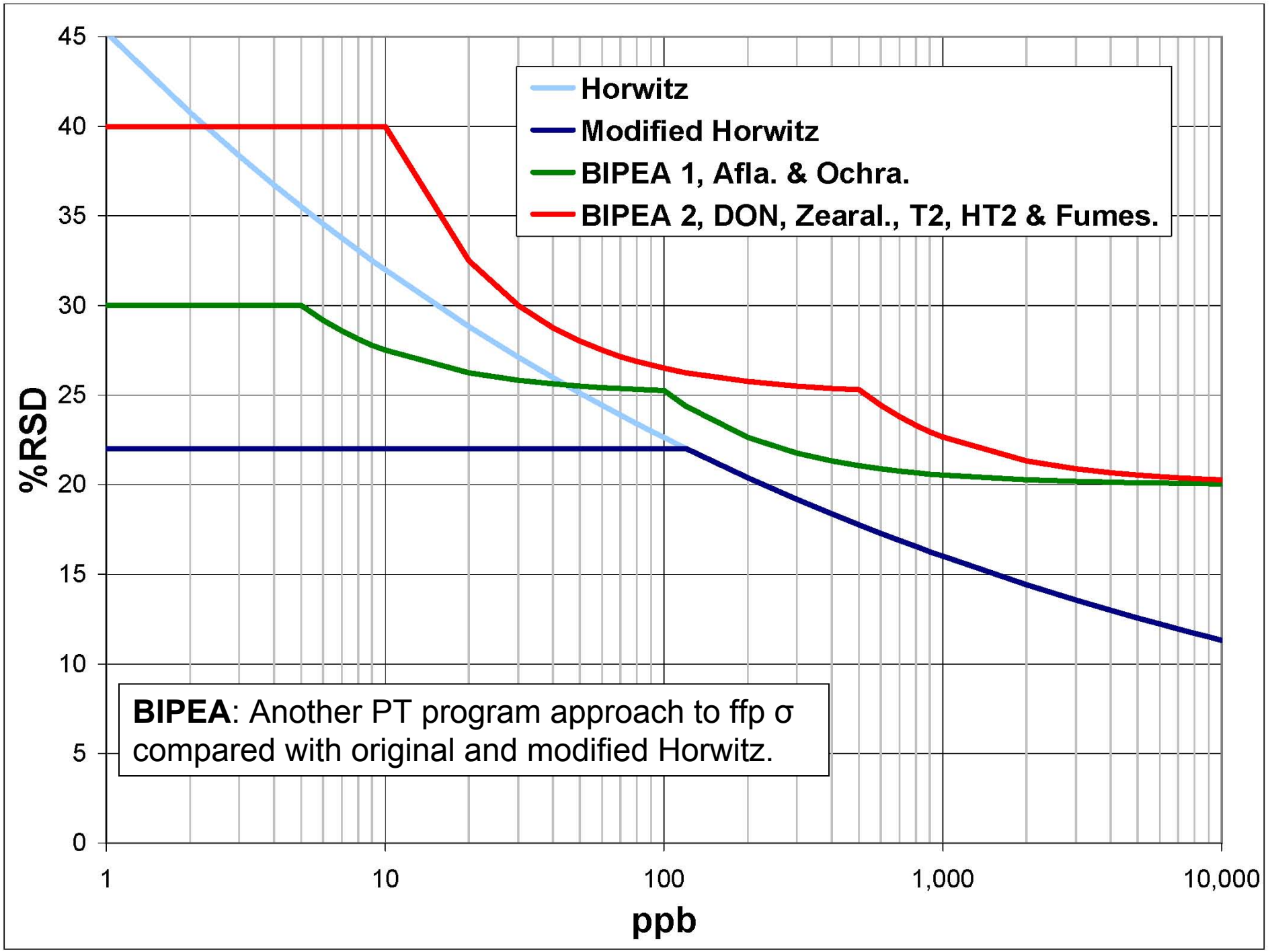
$\sigma_{\textbf{Modified Horwitz}}$ controls your Z score.
If it is too low, you will get a higher (failing) Z.
If it is too high, a lower Z and an artificial PASS.

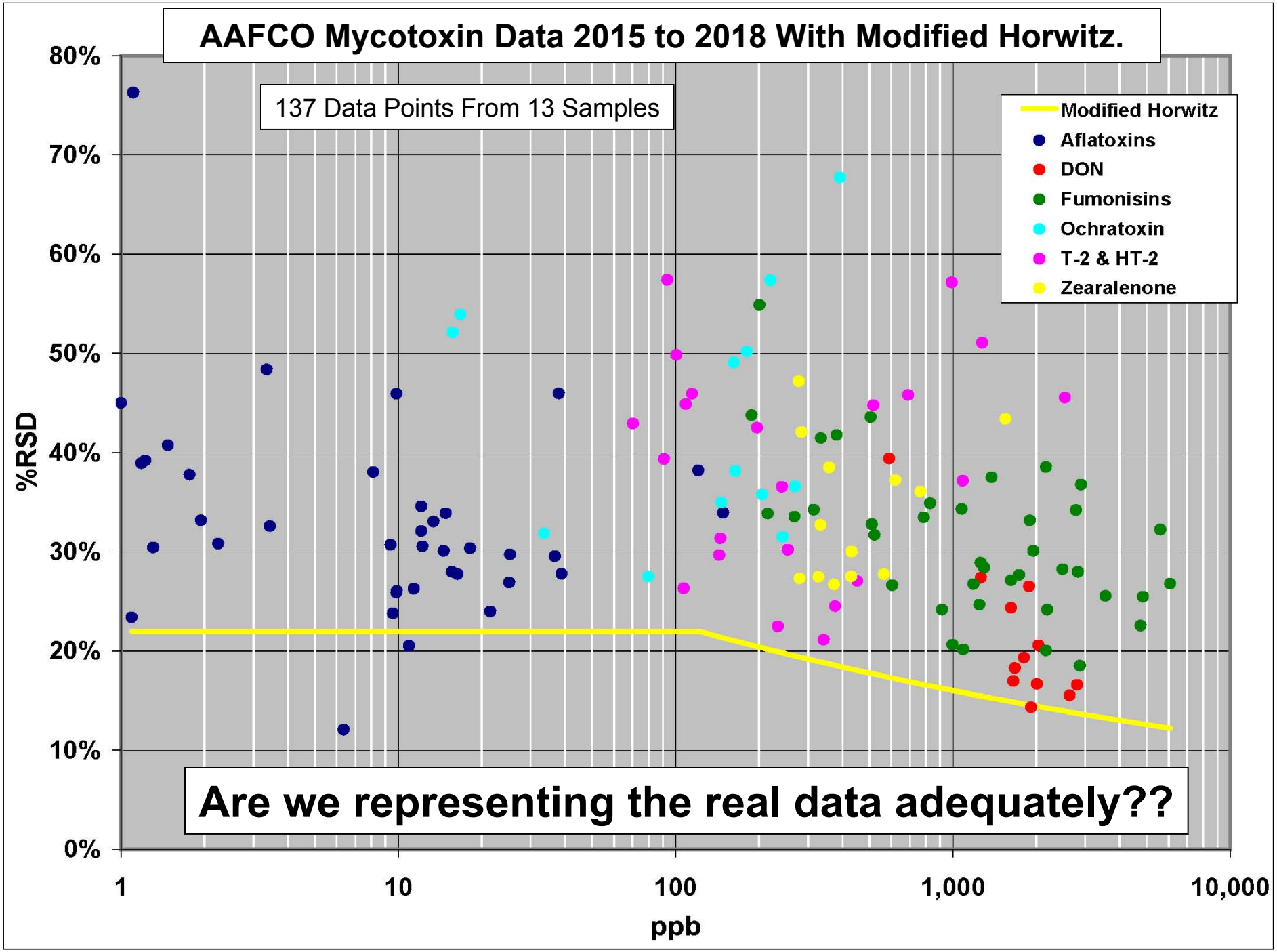
Horwitz Trumpet

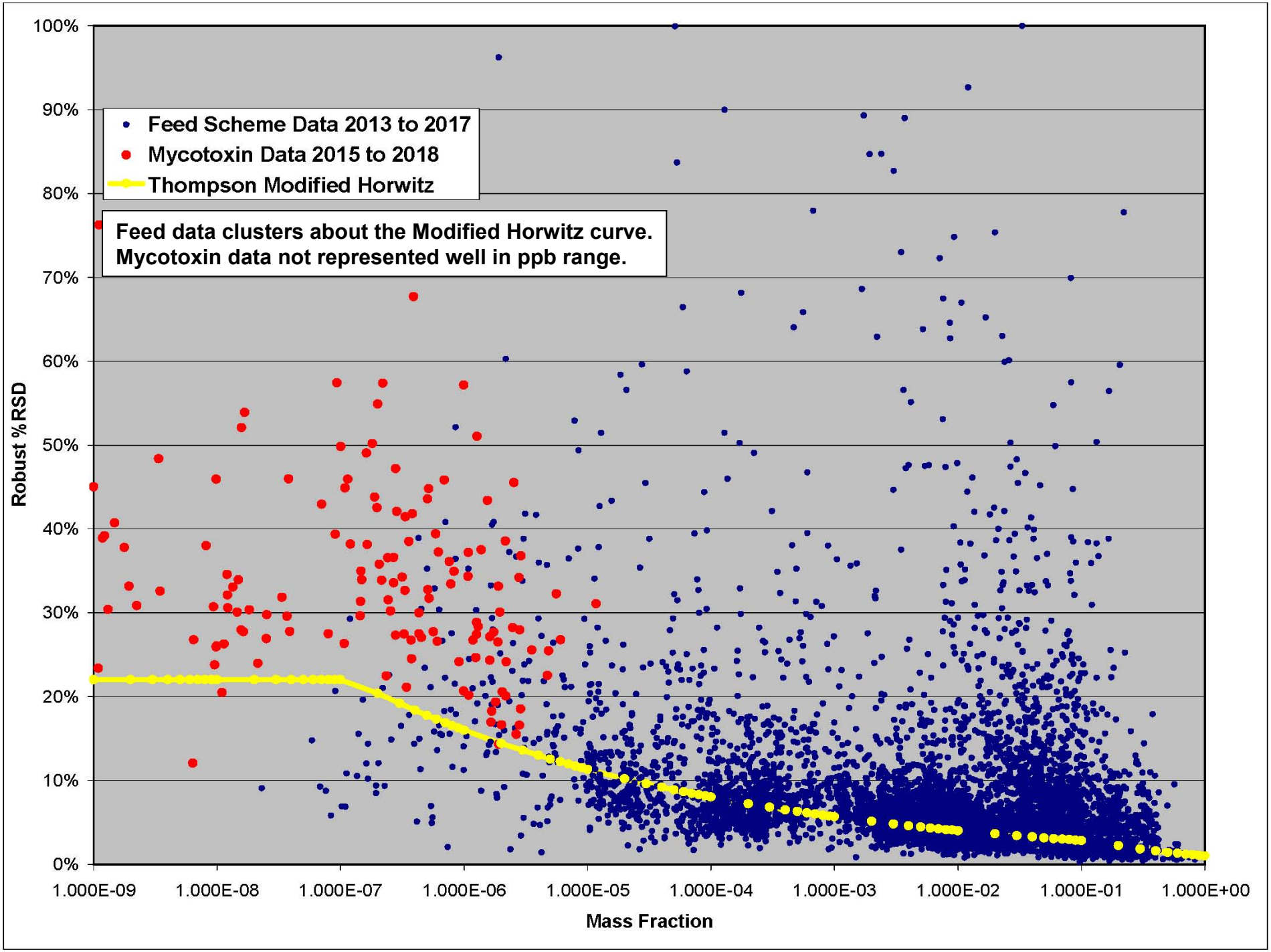
Thompson Modification (January, 2000)

$\sigma_R = 0.22 \times C$	%RSD = 22	if $C < 1.2 \times 10^{-7}$
$\sigma_R = 0.02 \times C^{0.8495}$	$\%RSD = 2 \times C^{-0.1505}$	if $1.2 \times 10^{-7} \leq C \leq 0.138$
$\sigma_R = 0.01 \times C^{0.5}$	$\%RSD = C^{-0.5}$	if $C > 0.138$




Horwitz
Modified Horwitz
BIPEA 1, Afla. & Ochra.
BIPEA 2, DON, Zearal., T2, HT2 & Fumes.
%RSD
45
40
35
30
25
20
15
10
5
0
1
10
100
1,000
10,000
ppb
BIPEA: Another PT program approach to ffp σ compared with original and modified Horwitz.


AAFCO Mycotoxin Data 2015 to 2018 With Modified Horwitz.
137 Data Points From 13 Samples
Modified Horwitz
Aflatoxins
DON
Fumonisins
Ochratoxin
T-2 & HT-2
Zearalenone
80%
70%
60%
50%
40%
30%
20%
10%
0%
%RSD
1
10
100
1,000
10,000
ppb
Are we representing the real data adequately??


Feed Scheme Data 2013 to 2017
Mycotoxin Data 2015 to 2018
Thompson Modified Horwitz
Feed data clusters about the Modified Horwitz curve.
Mycotoxin data not represented well in ppb range.
Robust %RSD
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1.000E-09
1.000E-08
1.000E-07
1.000E-06
1.000E-05
1.000E-04
1.000E-03
1.000E-02
1.000E-01
1.000E+00
Mass Fraction

Reevaluation of AAFCO Mycotoxin ffp σ: Back to the Original Horwitz Approach J. AOAC, 1980

Relationship between σ (Reproducibility SD) and concentration C (mass fraction).

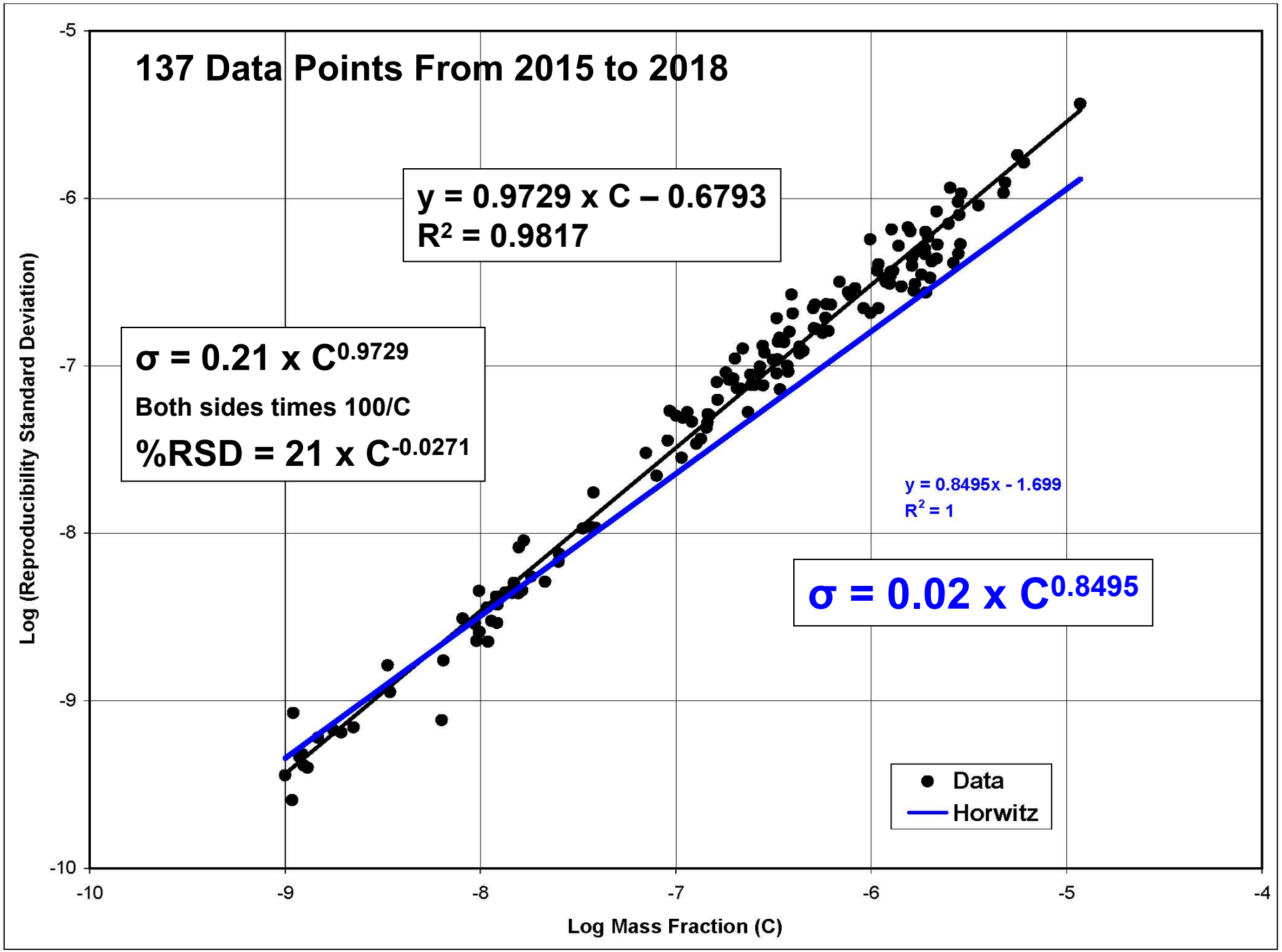
$$\sigma = AC^{B}$$ Where A and B are constants

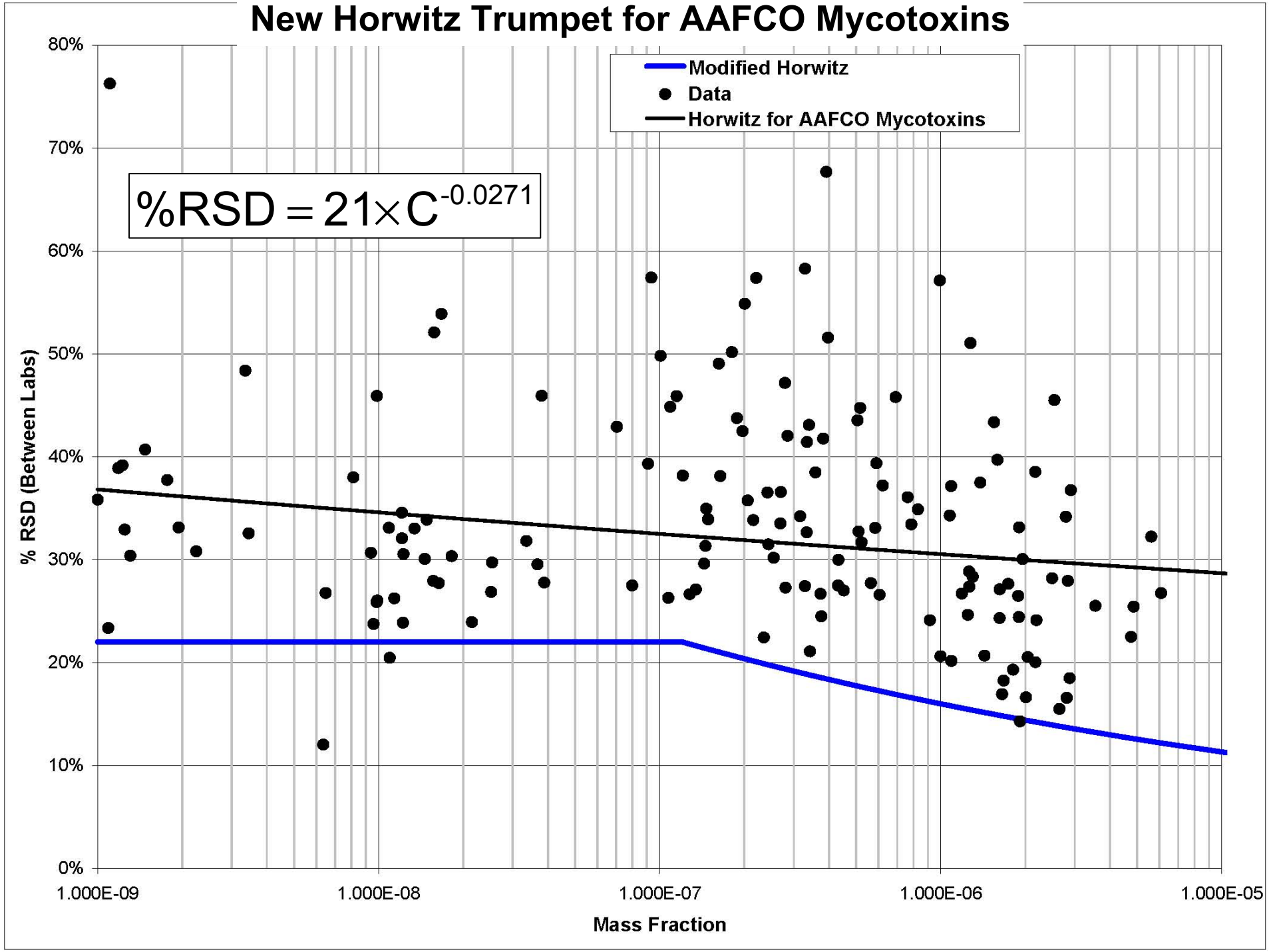
$$\mathrm{Log}(\sigma) = \mathrm{Log}(A) + B \times \mathrm{Log}(C)$$

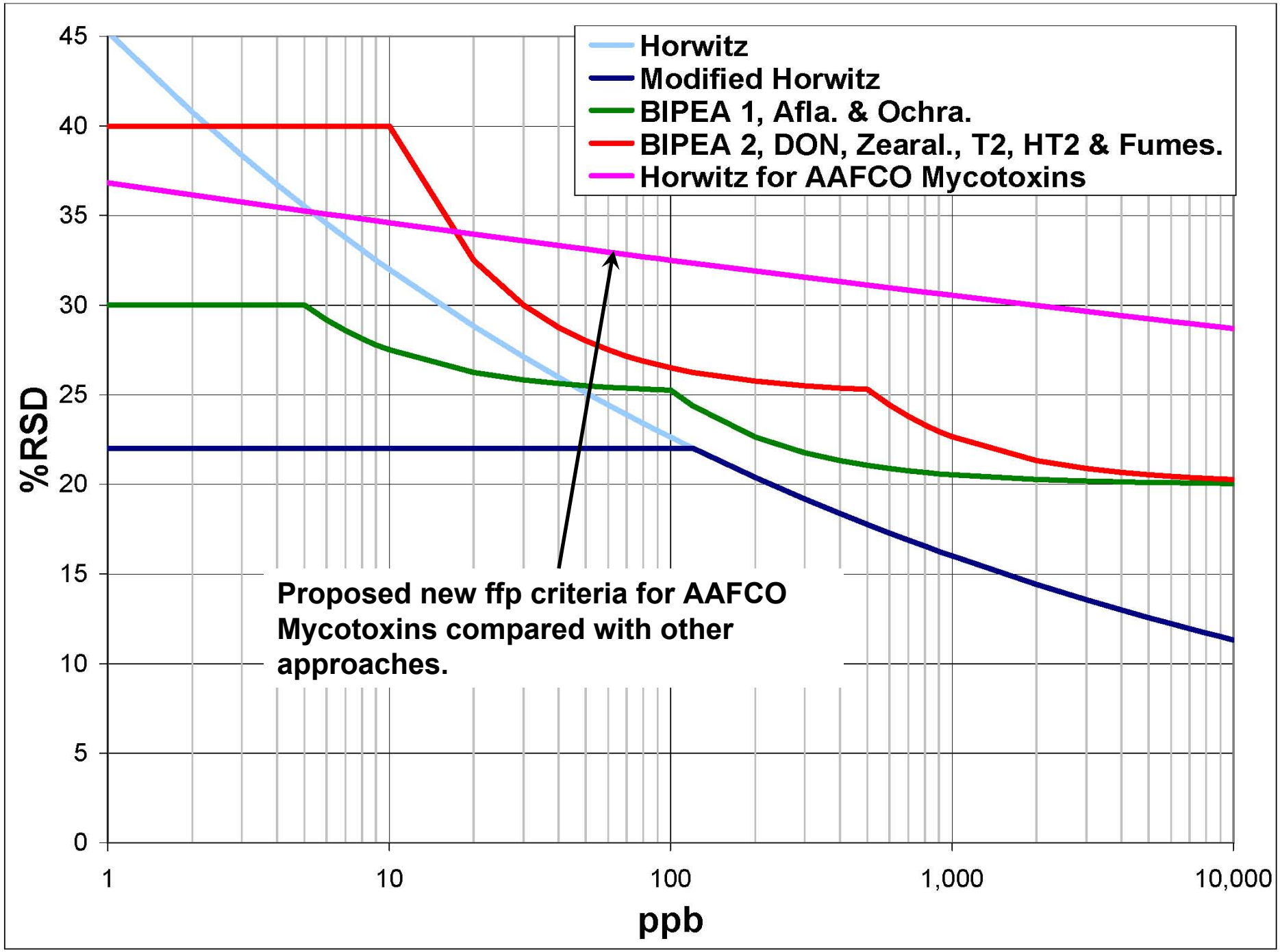
Straight line plot of Log (reproducibility SD) vs Log (concentration)
With Slope B and Intercept Log(A).

Original Horwitz Equation: $\sigma = 0.02 \times C^{0.8495}$

$$\%RSD = 2 \times C^{-0.1505}$$


137 Data Points From 2015 to 2018
y = 0.9729 x C – 0.6793
R2 = 0.9817
σ = 0.21 x C0.9729
Both sides times 100/C
%RSD = 21 x C-0.0271
y = 0.8495x - 1.699
R2 = 1
σ = 0.02 x C0.8495
Data
Horwitz
Log (Reproducibility Standard Deviation)
Log Mass Fraction (C)
-5
-6
-7
-8
-9
-10
-4


New Horwitz Trumpet for AAFCO Mycotoxins
Modified Horwitz
Data
Horwitz for AAFCO Mycotoxins
%RSD = 21×C^-0.0271
% RSD (Between Labs)
80%
70%
60%
50%
40%
30%
20%
10%
0%
1.000E-09
1.000E-08
1.000E-07
1.000E-06
1.000E-05
Mass Fraction


Horwitz
Modified Horwitz
BIPEA 1, Afla. & Ochra.
BIPEA 2, DON, Zearal., T2, HT2 & Fumes.
Horwitz for AAFCO Mycotoxins
Proposed new ffp criteria for AAFCO Mycotoxins compared with other approaches.
%RSD
ppb
45
40
35
30
25
20
15
10
5
0
1
10
100
1,000
10,000

Effect of New Horwitz Proposal on Z Scores

Based on 2,400 Z Scores over 3 Years

Z Option	Modified Horwitz		New Proposal	
Action	302	14.4%	127	6.0%
Warning	277	13.1%	95	4.5%
Compliant	1,529	72.5%	1,886	89.5%

14.4% Actionable!

More like Feed and Petfood Schemes

In Summary:

- Horwitz not necessarily “one-size-fits-all” approach.
- Our 137 Mycotoxin data points indicate a strong linear log-log relationship different to Horwitz.
- I suggest we implement the “New Proposal” as a “Fitness-For-Purpose” function for AAFCO Mycotoxins.
  - **%RSD = 21 x $C^{-0.0271}$**.
- I recommend “tune ups” every couple of years to refine the relationship, until we reach a point of diminishing returns.


Should we proceed?
The question is, “do we inform or do we instruct?”