Hail Estimation: How Good Are Your Spotters?

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The views expressed are those of the authors and do not necessarily represent those of the National Weather Service.

Motivation

- Gain perspective on the accuracy and behavior of our spotter hail reports.

Methodology: Year One

- 63 balls placed into a box ranging from 0.50 to 3.50 inches in diameter.
- Spotters drew one ball out and wrote an estimate to the nearest 1/8 inch.
- Spotters replaced the ball and redrew for a second estimate.
- Statistics calculated.
  - Known as the "number" dataset (NUM).

Methodology: Year Two

- 63 balls placed into a box ranging from 0.50 to 3.50 inches in diameter.
- Spotters drew one ball out and circled the closest estimate from a list of known objects.
  - Allowed for number entry.
- Spotters drew only one ball.
- Statistics calculated.
  - Known as the "known object" dataset (KO).

Methodology: Year Two

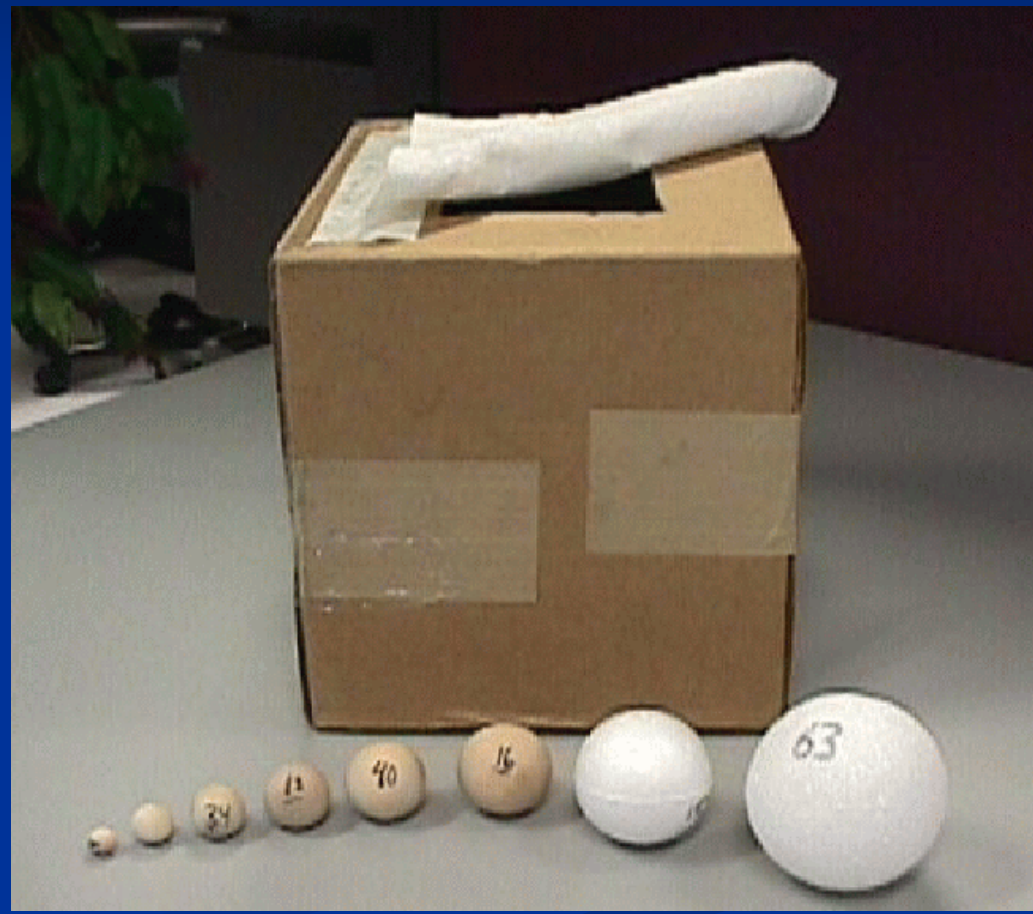
- The "known object" (KO) form.

Draw ONLY 1 ball. Circle the size of the ball below. Please do not discuss your answer with others until you enter your estimate. **Your Ball Number is: _____**	
Dime Quarter Pea Nickel Golfball Marble	Baseball Penny Half-Dollar Tennis Ball Softball Walnut
If the ball size is **not** represented above, fill in your estimate to the nearest 1/8" here_____.	

Pea	0.25"
Dime	0.75" (0.71" actual)
Penny	0.75"
Nickel	0.88"
Quarter	1.00"
Half-Dollar	1.25"
Walnut	1.50"
Golfball	1.75"
Tennis Ball	2.50"
Baseball	2.75"
Softball	4.50"

Methodology

- Very technological
  - Space-age cardboard
  - Highest-end industry glues
  - Bounty paper towel
  - Permanent marker
- Total Cost: $15.63
  - Grant not funded by NSF



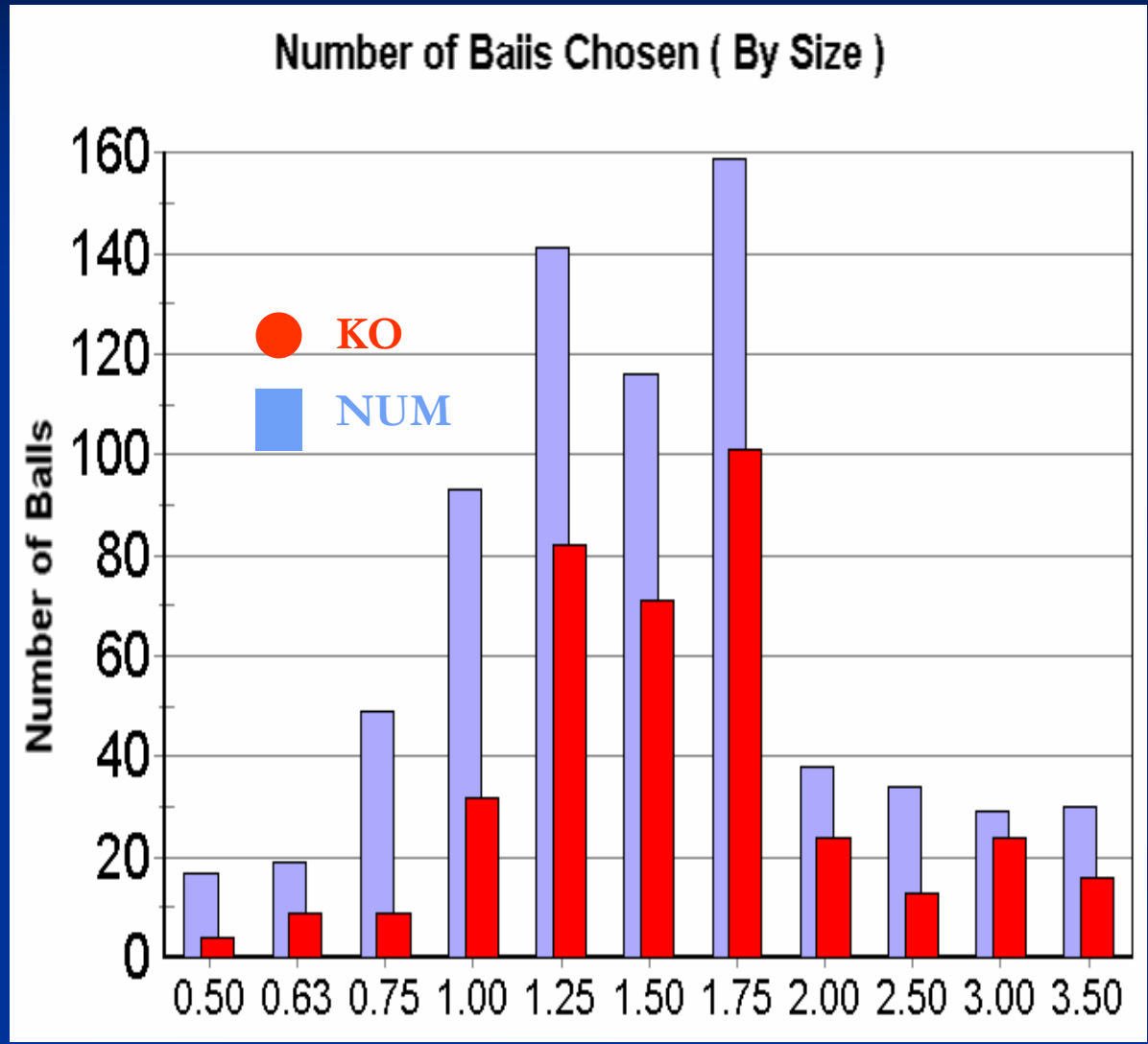
Methodology

- Data/Controls:
  - Balls were drawn separately - no comparing! (NUM)
  - Spotters were able to hold the "hail".
  - About 725 NUM "hail size" estimates were made.
  - About 388 KO "hail size" estimates were made.
    - Less because only one draw allowed.

Golden,CO

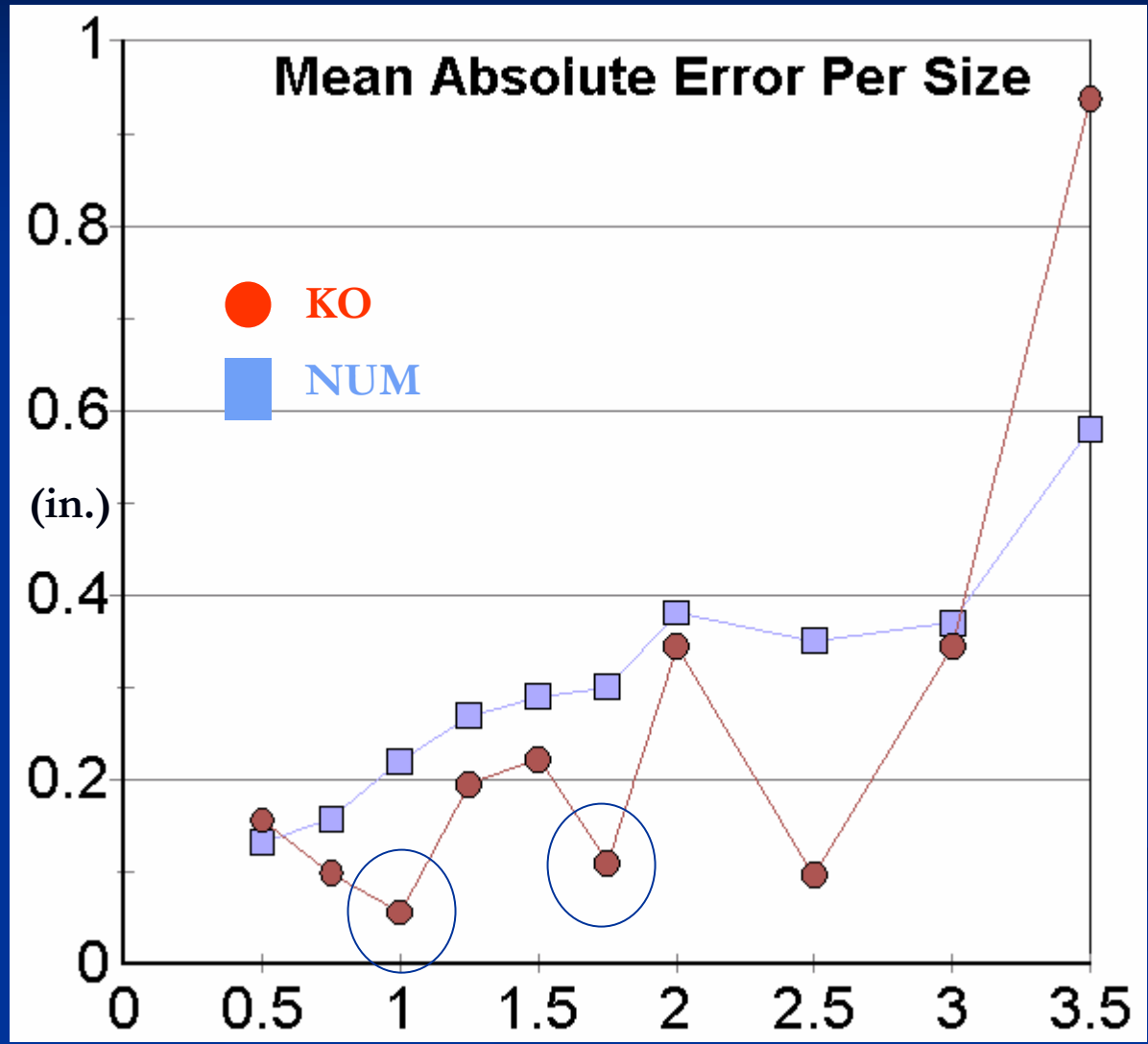
Data: Population

- KO: few attempts 0.75” and below.



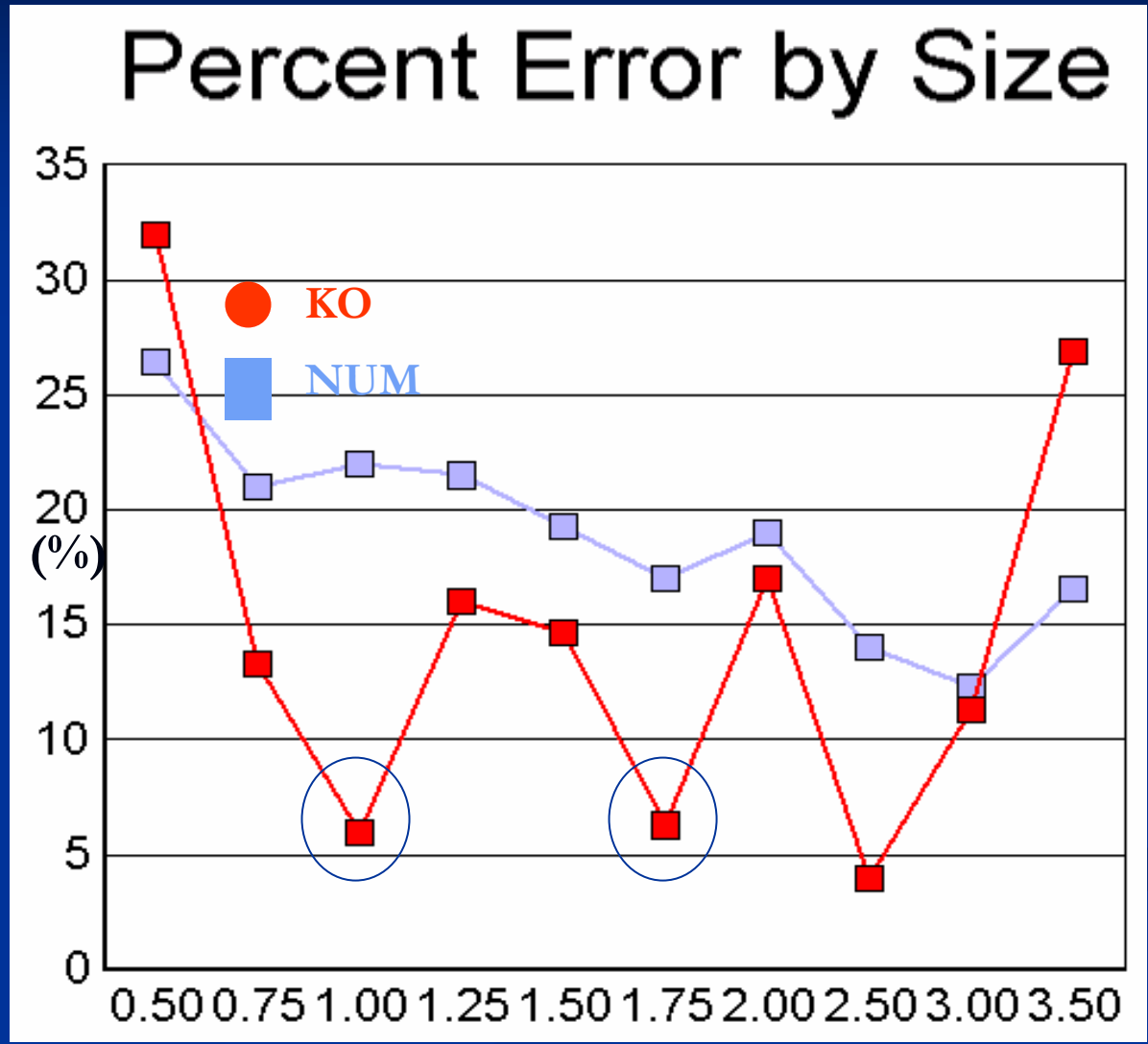
Data: Mean Absolute Error

- KO has less absolute error than NUM.
- KO error growth slightly less than NUM as size increases.



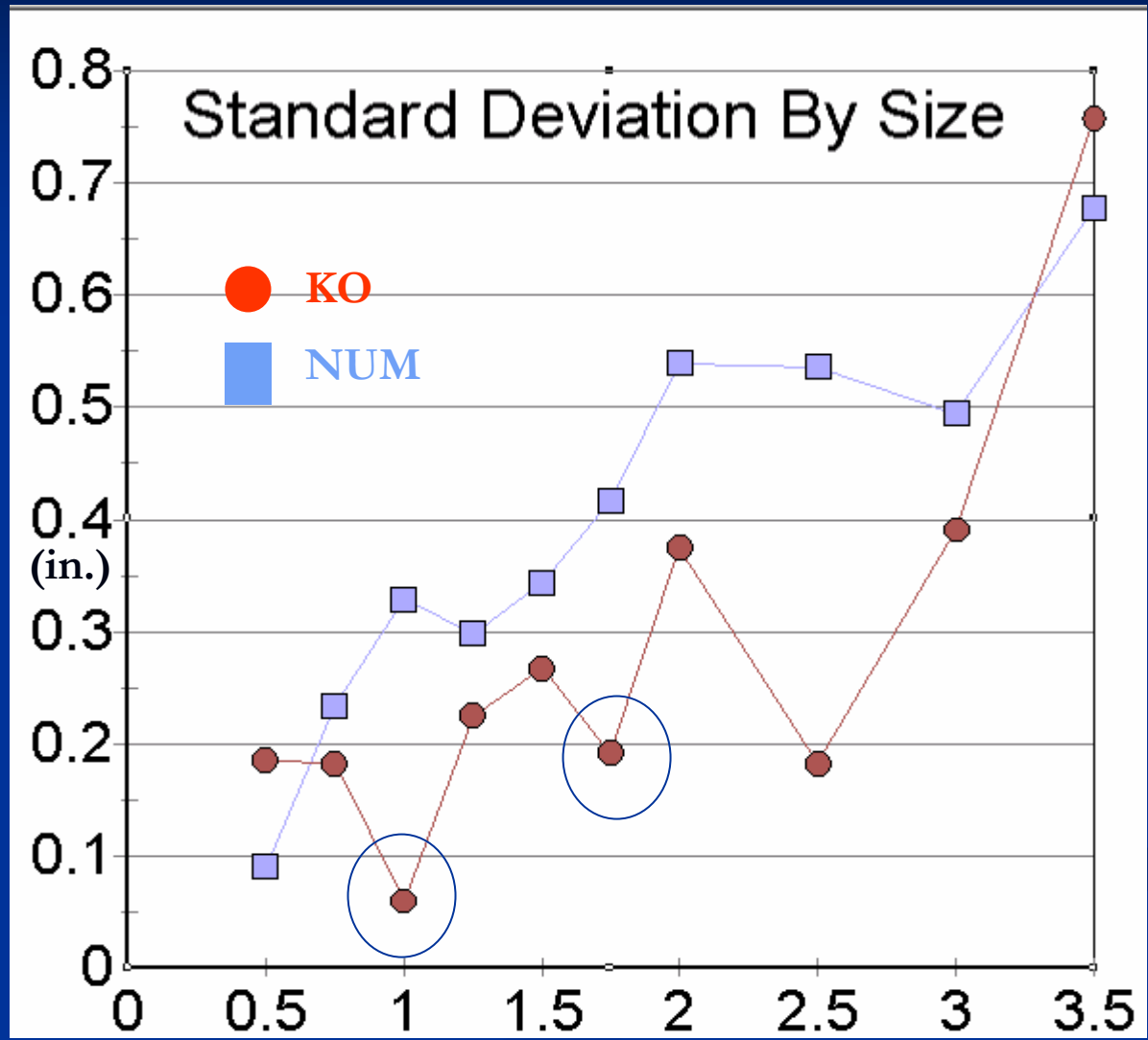
Data: Percent Error

- KO remains 5-15% and lower than NUM.
- NUM 21% errors around 0.75", decreasing with size.



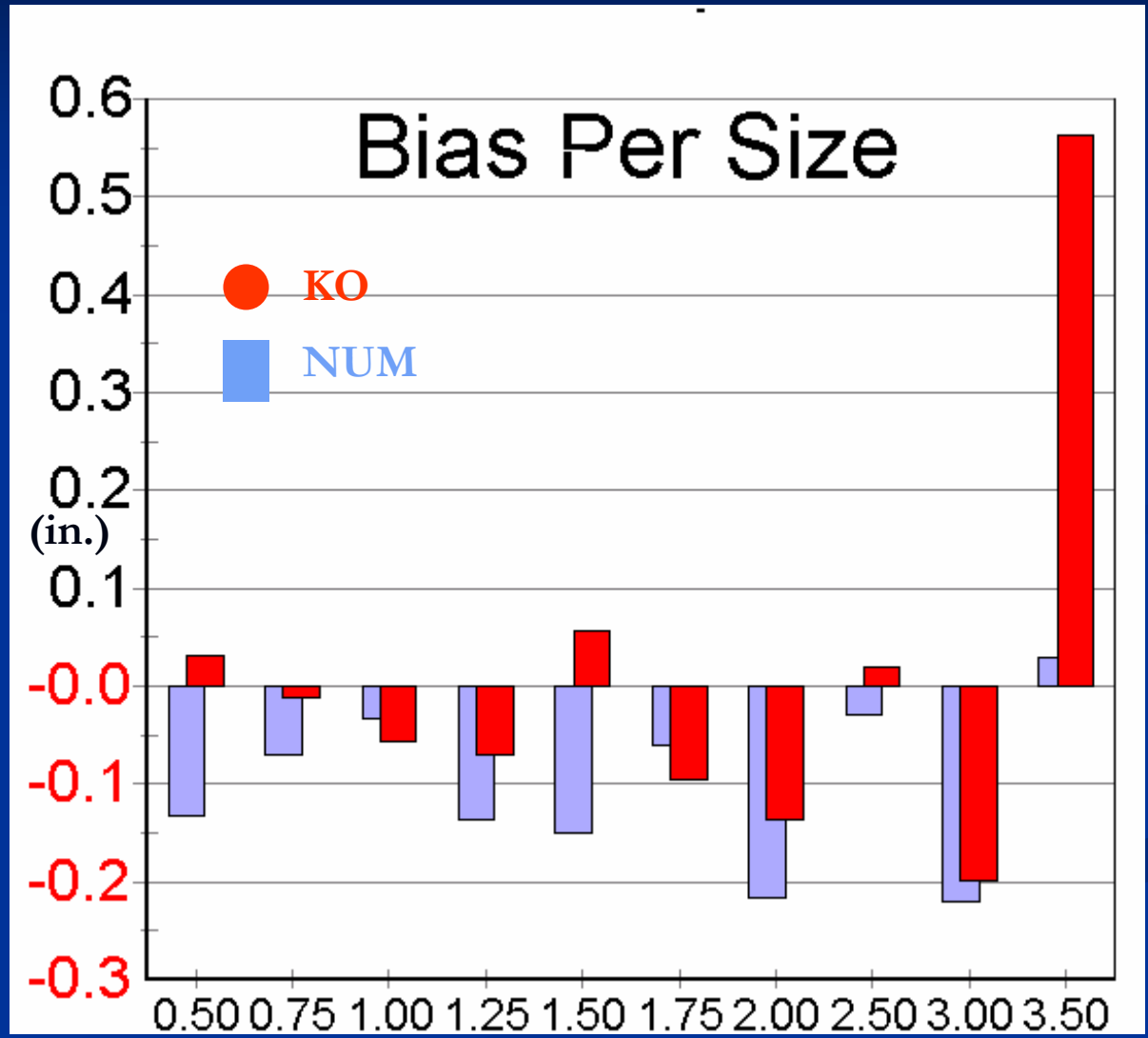
Data: Standard Deviation

- KO STD lower overall, especially above 1.50”.
- Near 0.75”, NUM STD nearly 0.25”.



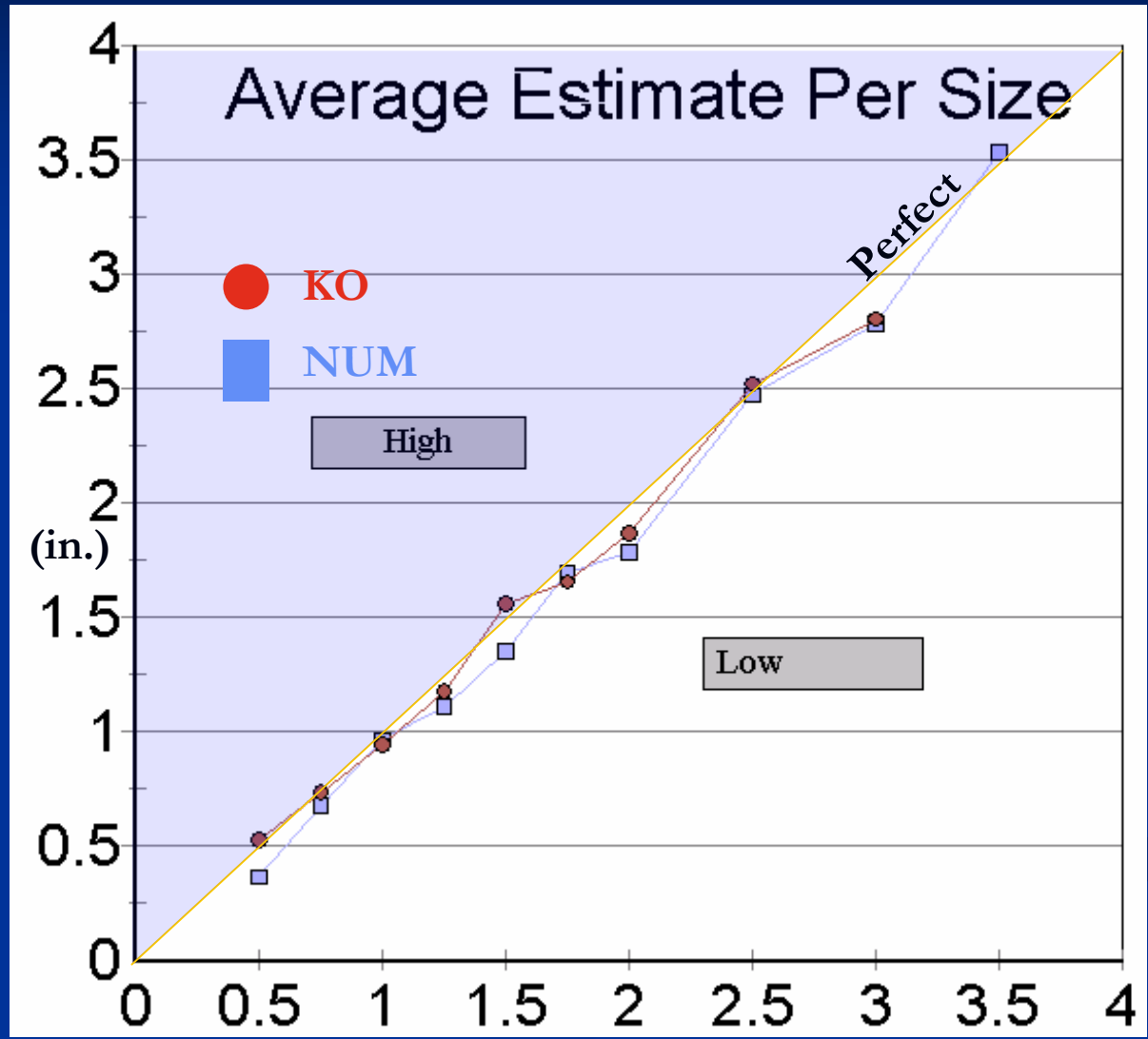
Data: Bias

- NUM underestimates all below 3.5”.
- KO bias less and also negative except 1.50”.
  - Special 0.50” KO case



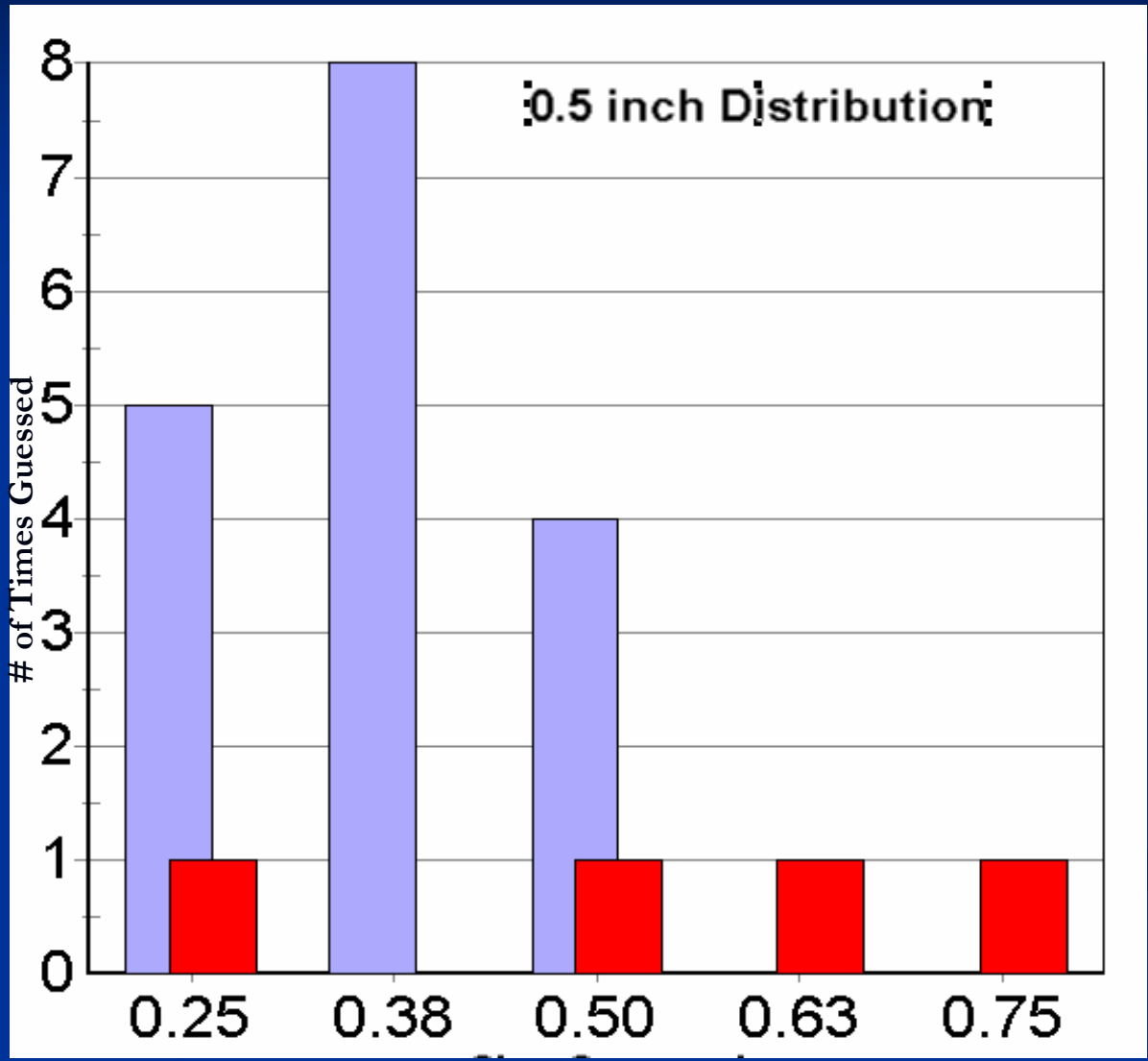
Data: Average Estimate

- KO better average estimates overall.



Data: 0.5” Distribution

- Few draws.
- NUM underestimates.

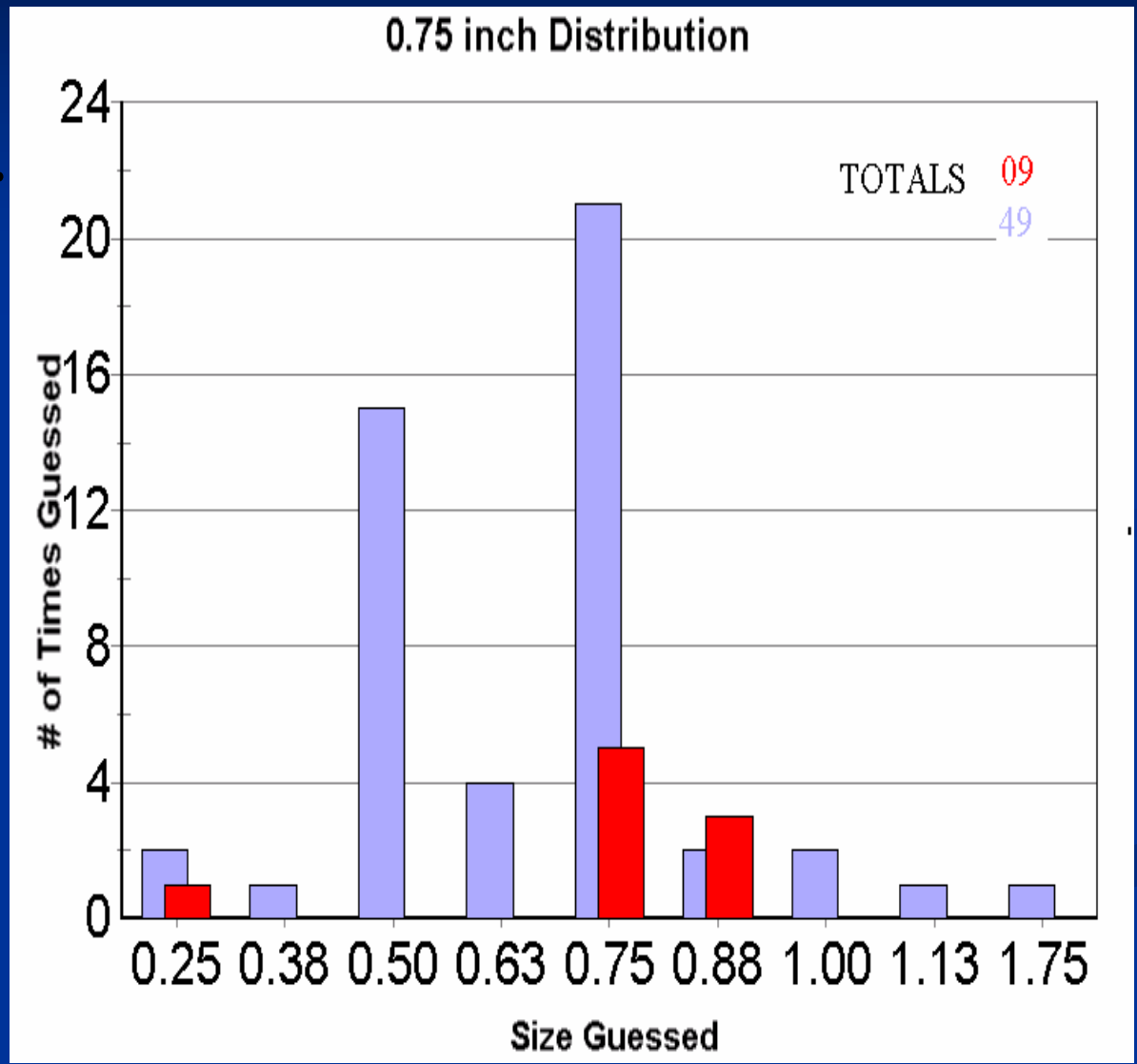


KO 4

NUM 17

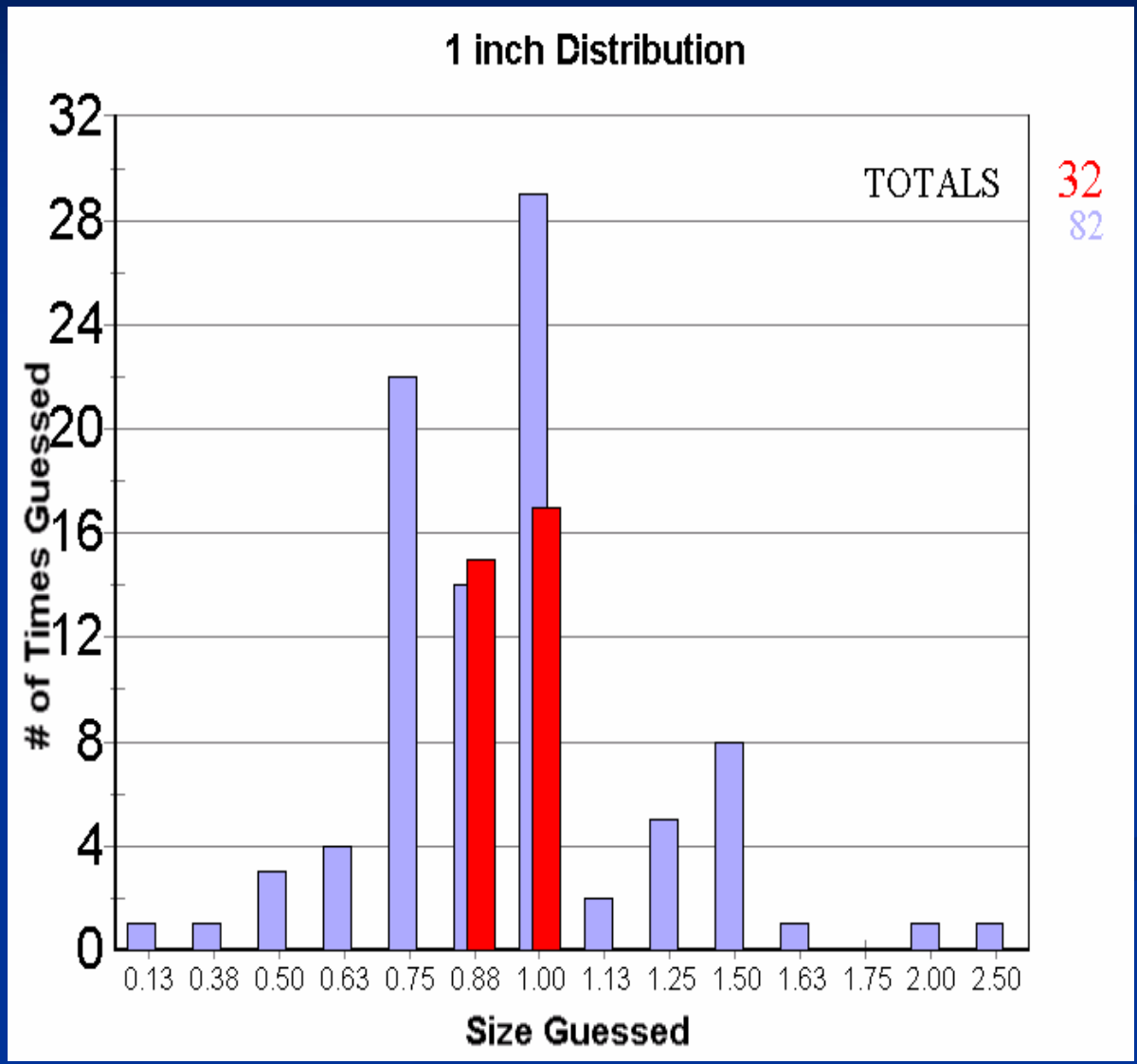
Data: 0.75” Distribution

- Few KO draws.
- NUM: 50% underestimates.
- KO signs of more accurate.



Data: 1.00” Distribution

- NUM: 50% underestimates.
- KO more accurate.

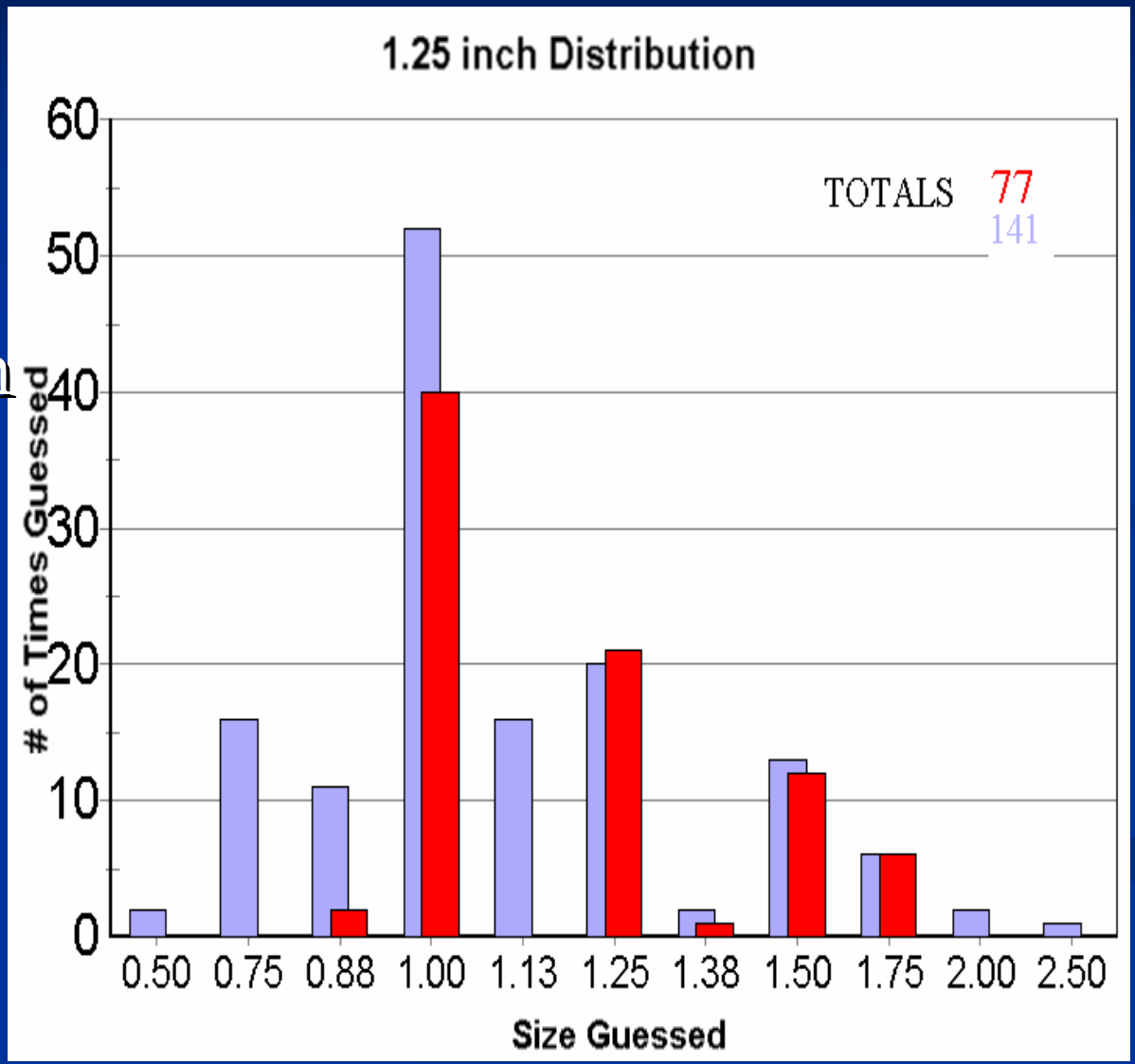


KO

NUM

Data: 1.25” Distribution

- NUM and KO show underestimation toward 1.00”.
- 1/8” size estimates not preferred.

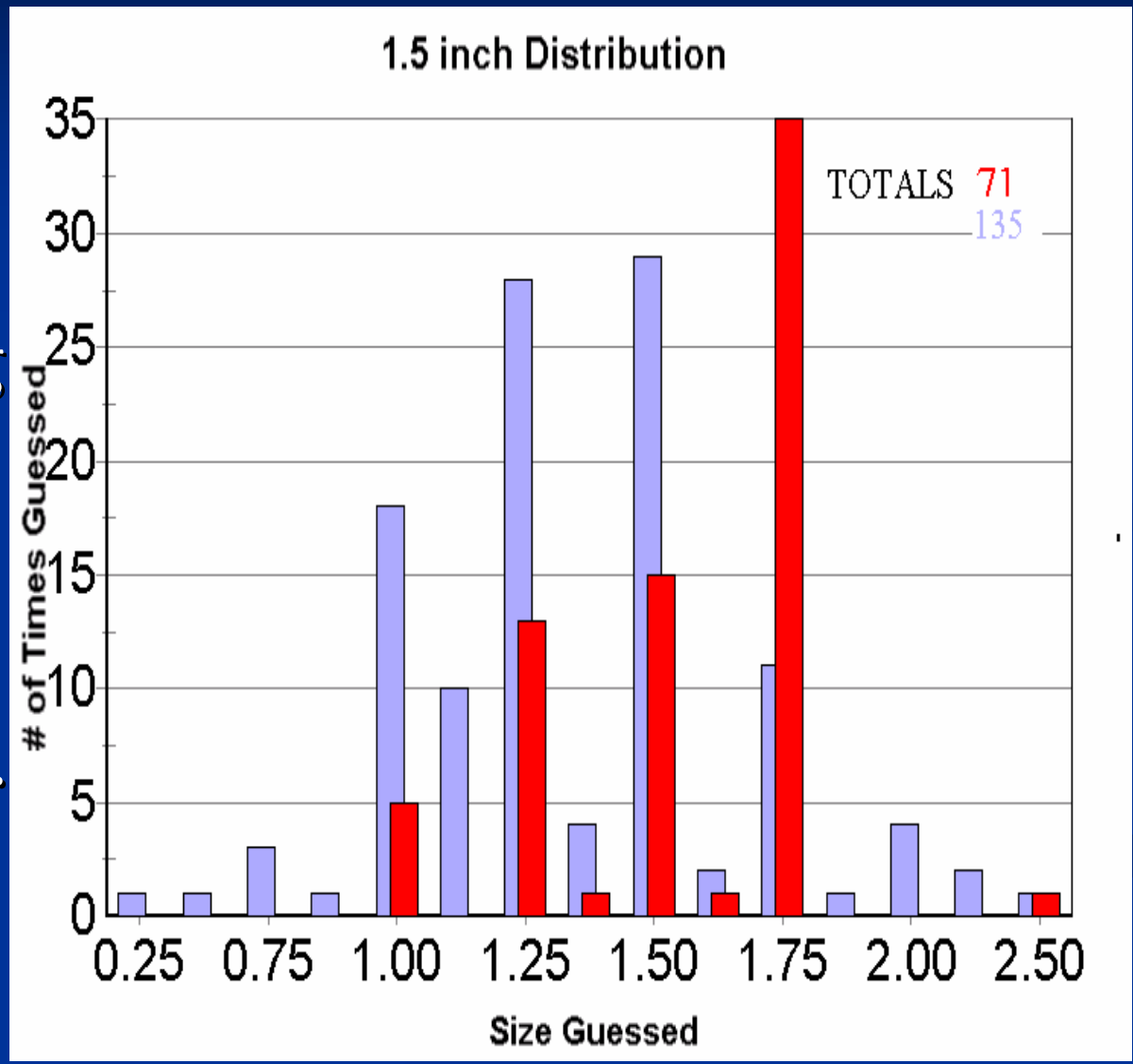


KO

NUM

Data: 1.50” Distribution

- NUM 50% underestimates.
- KO shows strong bias toward golfball (1.75”).
- Only KO size with positive bias.

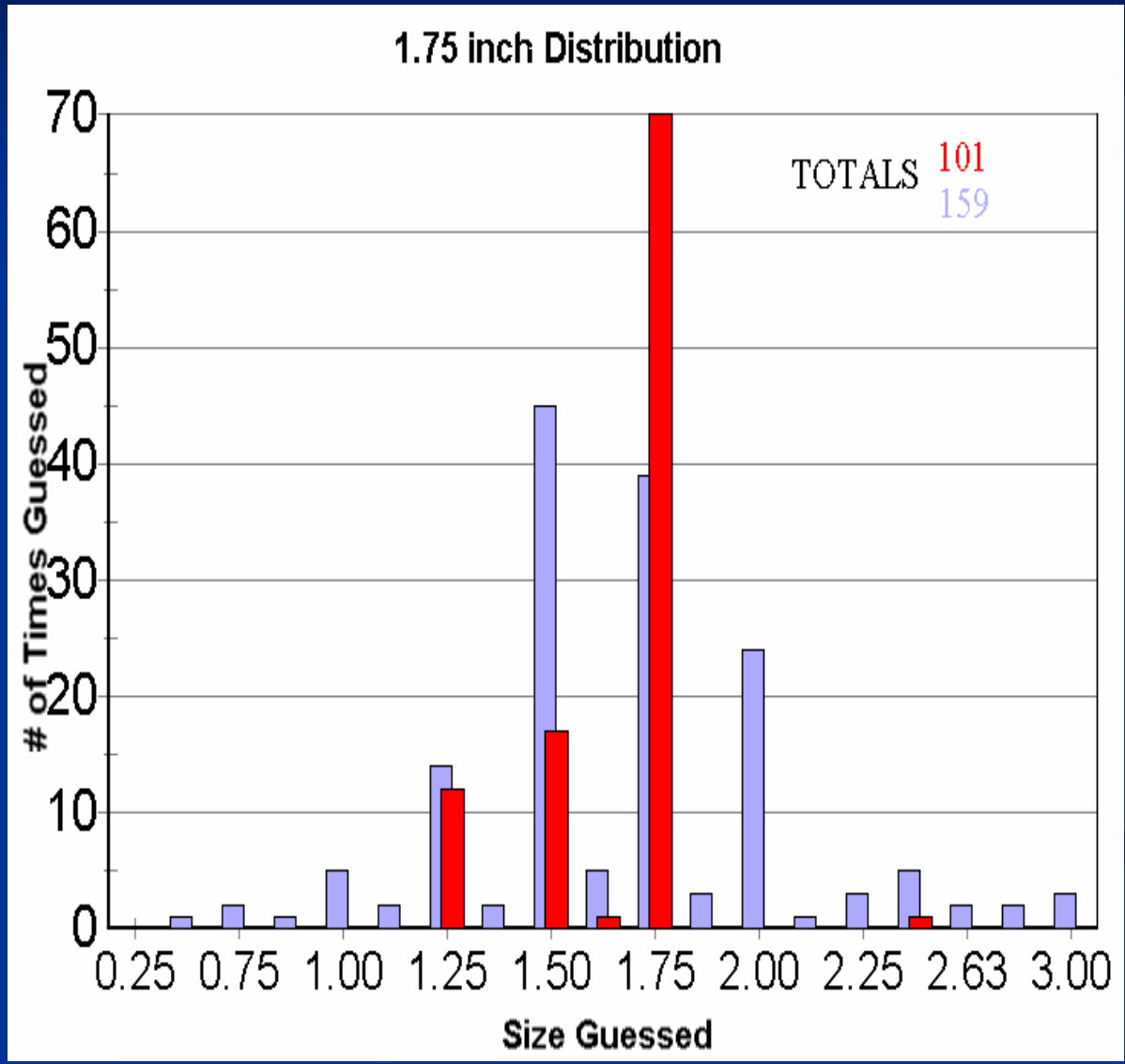


KO

NUM

Data: 1.75” Distribution

- NUM 45% underestimates.
- KO hits many! Low error and STD!

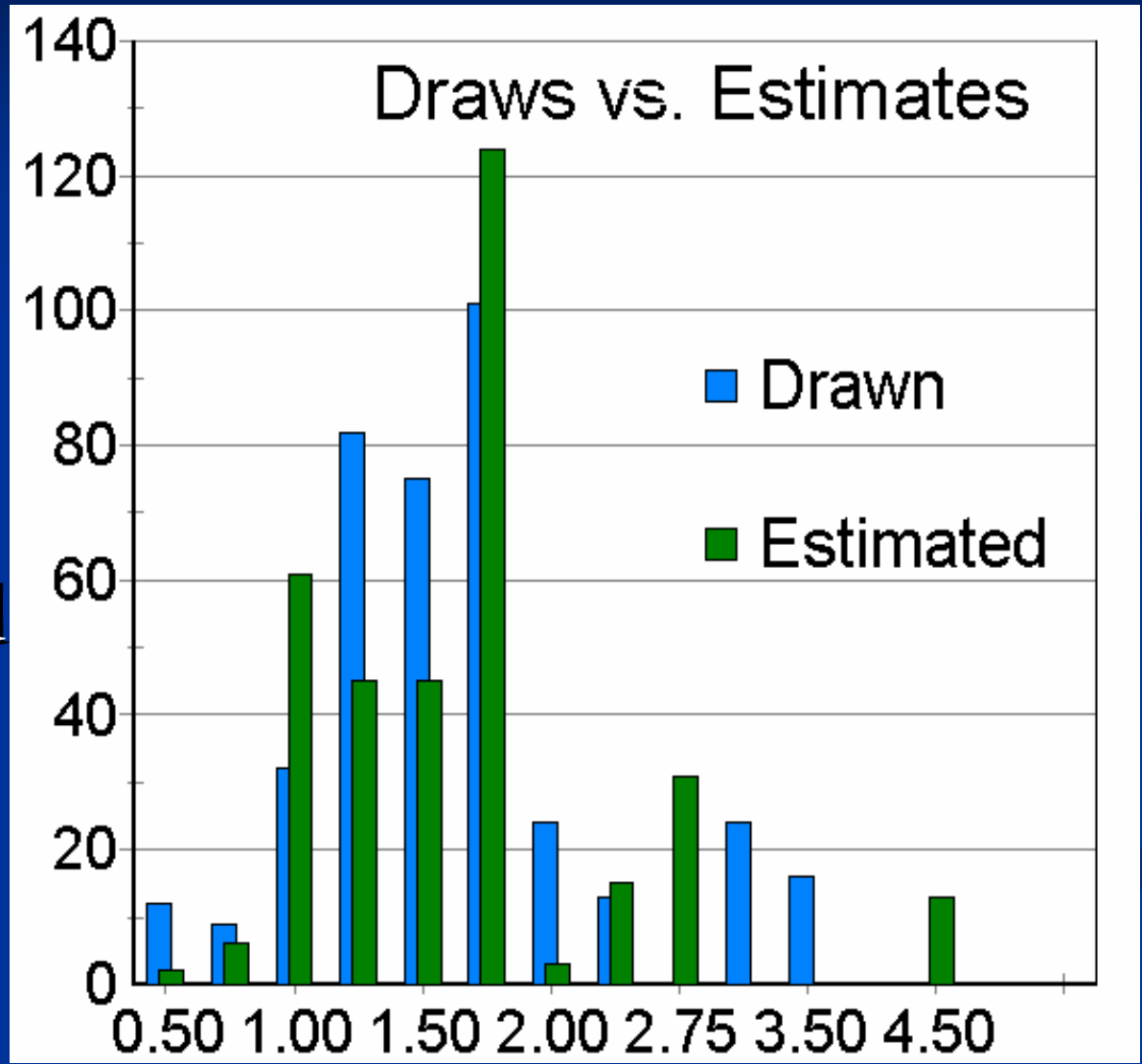


KO

NUM

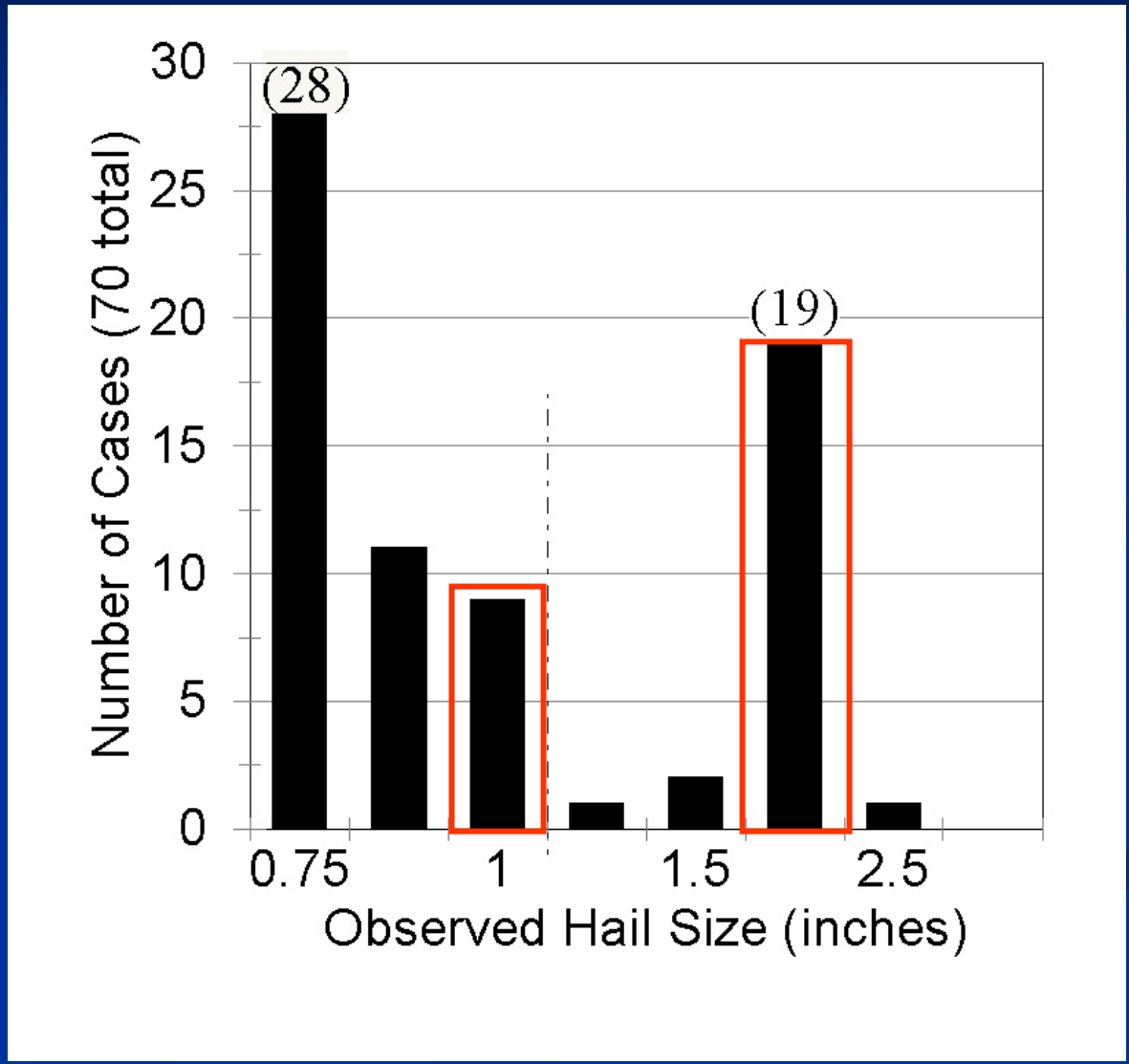
Data: KO Draw vs. Estimated

- People drawn toward the Quarter and Golfball sizes.
- Half-Dollar and Walnut poor KO's?



Data: KO Draw vs. Estimated

- Fewer reports for 1.25” and 1.50” also in Baumgardt and King (Fig. 1, 1998).



Ball Size (inches)

Baumgardt, D. A., and C. King, 1998: Verification of the WSR-88D Build 9.0 Hail Algorithm Over the Upper Midwest. Preprints, *19th Conf. on Severe Local Storms, Minneapolis, MN*, Amer. Meteor. Soc., pp. 52-55.

Summary: Limitations

- NUM dataset has double draw. Does that lead the witness on guess #2?
- Larger diameter balls drawn more. KO family <0.75" not large in number.
- Unfamiliar with Walnut size (vs. Ping-pong)?
- Large amount of data discarded – people cant follow directions.

Summary

- Be aware that spotters tend to underestimate hail overall.
- Having spotters associate hail size to known object is more accurate than numeric estimates.
  - Encourage spotters to ***measure*** hail size directly.
- Using numeric estimates produces a large number of underestimates: 40-50%. If they report above 0.50" to 0.75"…it is likely severe! (bias ~ -0.15")
- As "hail" sizes grow, more deviation from the truth occurs.
- For 1.00-1.75" diameter sizes, people tend to go toward Quarter and Golfball sizes.

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