Who Are You Going to Call?
A Leverage and Run Expectancy-Dependent Evaluation of the Relief Pitcher

Our Bullpen

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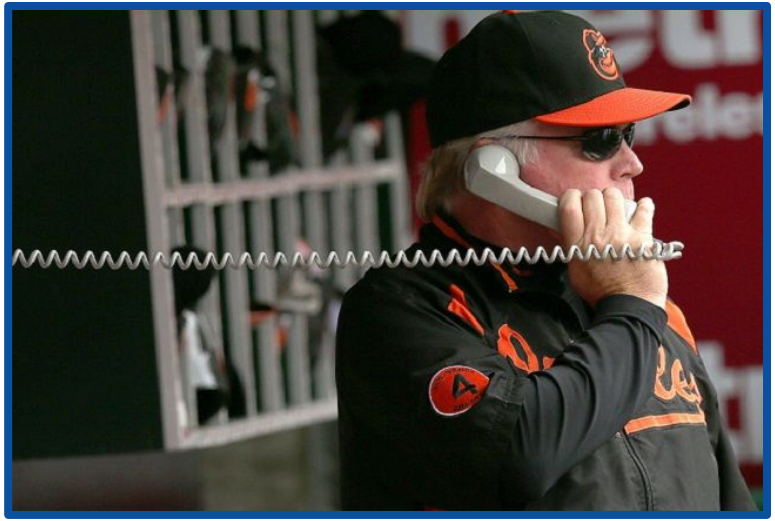

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Introduction

Defining Relievers

Using 2022-2024 MLB regular season data:

Reliever

- Pitcher who is not the first for their team in a game

Not a Reliever

- Pitcher who is the first for their team in a game
- Opener

Why?

- If a pitcher starts the game and throws the first pitch, they are not considered to be relieving anyone

The Case

- Most current reliever performance metrics are too basic. They don’t consider:
  - Run expectancy state
  - Leverage within game
  - Batter quality
  - Pitcher fatigue
  - Park factors
- Goal is to create metrics that:
  - Logically combine the contextual factors above with in-game performance
  - Represent different aspects of the responsibility of a reliever

Our Thesis

Reliever Performance Should Be Judged Primarily In Context

Save Shares Accumulated

Save Shares Accumulated (SSA)

$$SSA = \Delta WP(Hitter_{adj})(Park_{adj}) * 10$$

$$Hitter_{adj-} = \frac{250 - wRC+_{roll}}{100} \qquad Park_{adj-} = \frac{200 - PF_{event}}{100}$$

$$Hitter_{adj+} = \frac{wRC+_{roll}}{100} \qquad Park_{adj+} = \frac{PF_{event}}{100}$$

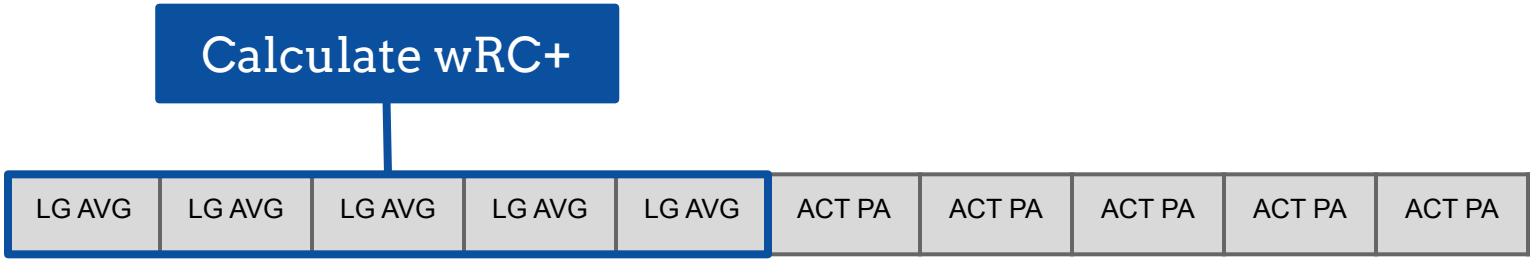
- Only for situations where reliever's team leads by 1+ run
- Calculated per batter faced
- Credits relievers for protecting leads throughout a game
- Provides greater bonus for doing so against better hitters and/or in worse parks, for that specific event type
  - Likewise punishes for poor performance against poor hitters

Hitter Quality

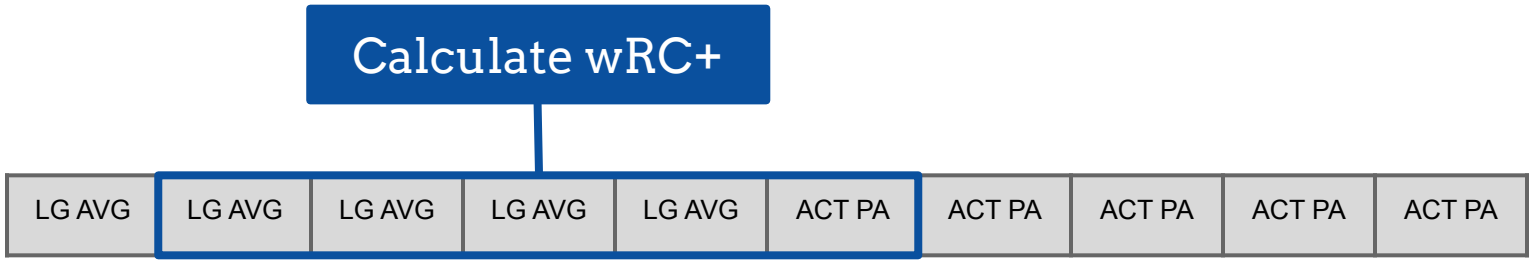
$$wRC+ = \frac{\frac{wRAA}{PA} + \frac{LR}{PA} + (\frac{LR}{PA} - PF * \frac{LR}{PA})}{\frac{LwRC}{PA}} * 100$$

- wRC+ enables comparison across seasons and reflects talent
- Used wRC+ over last 250 PA vs. RHP and last 125 PA vs. LHP
- Rolling wRC+ looks across seasons if needed (beginning in 2022)
  - Takes average of league factors if across season
  - Looks at average park factor across all PAs
  - Imputes league average PAs for missing information

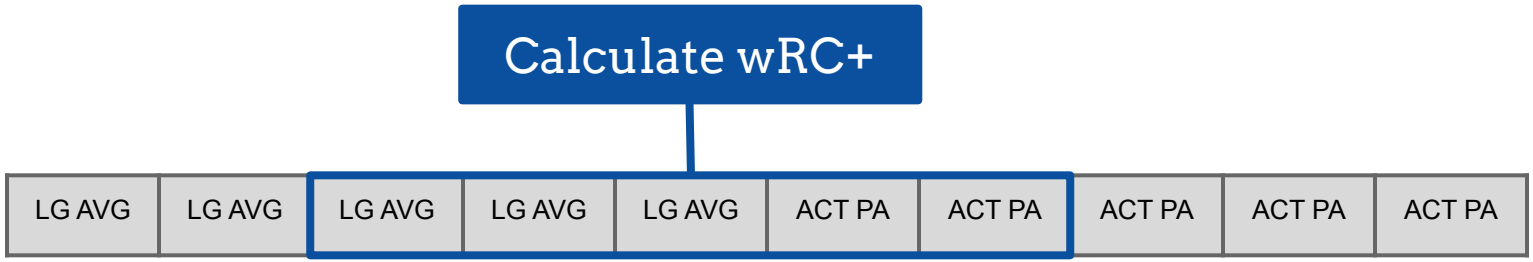
The Rolling Average



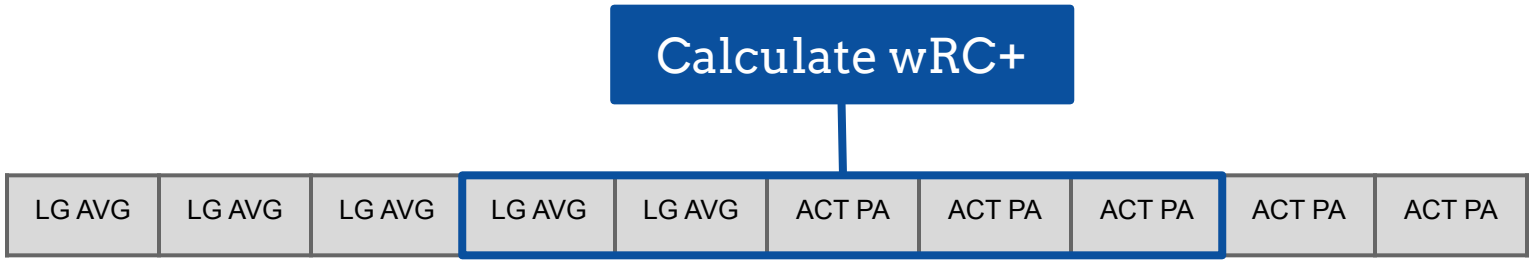
The Rolling Average



The Rolling Average



The Rolling Average



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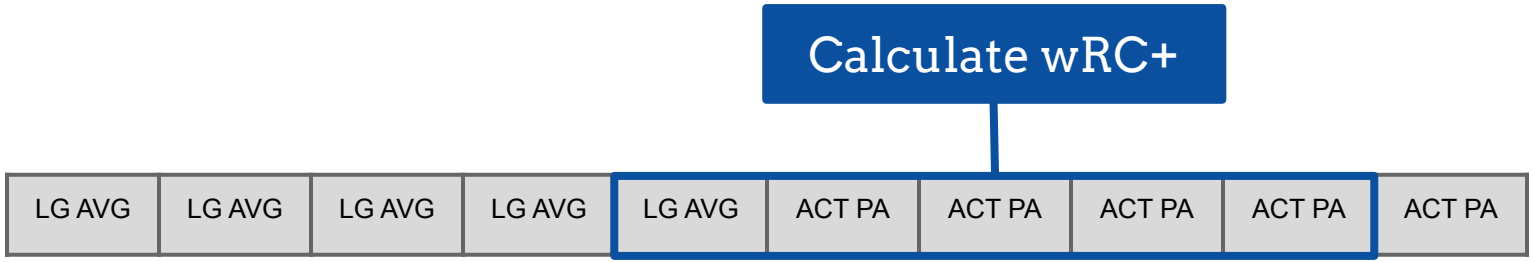

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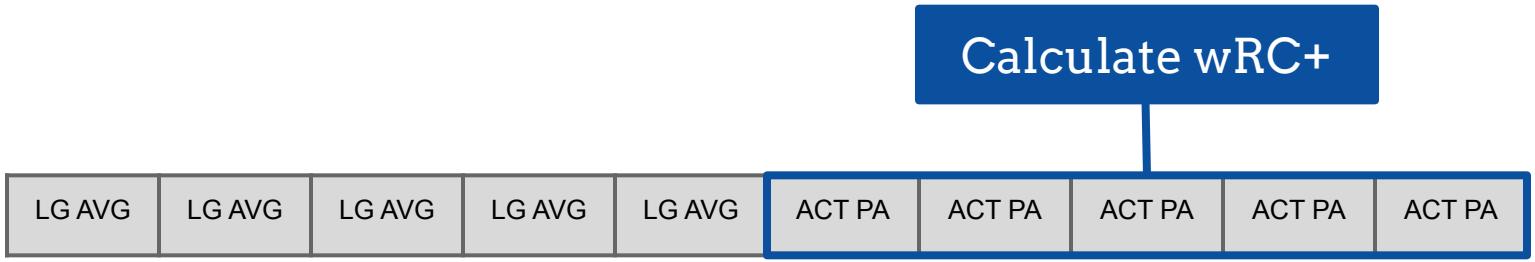


2023 SSA Leaderboard

#1 

Erik Swanson: 24.95
Toronto Blue Jays, 66.2 relief innings

#2 

Tanner Scott: 24.80
Miami Marlins, 78.0 relief innings

#3 

Héctor Neris: 24.26
Houston Astros, 68.1 relief innings

#4 

Alexis Diaz: 20.44
Cincinnati Reds, 67.1 relief innings

#5 

Adbert Alzolay: 18.05
Chicago Cubs, 64.0 relief innings

#326 

Emmanuel Clase: -51.62
Cleveland Guardians, 72.2 relief innings

#325 

Jake Bird: -44.17
Colorado Rockies, 89.1 relief innings

#324 

Ryan Helsley: -32.03
St. Louis Cardinals, 36.2 relief innings

#323 

Gregory Santos: -31.38
Chicago White Sox, 66.1 relief innings

#322 

Andrew Chafin: -30.53
2 teams (D-backs/Brewers), 51.1 relief innings

Minimum 20 innings pitched in relief

2023 mean SSA: -5.57
2023 median SSA:-3.31

2024 SSA Leaderboard

#1 
Kirby Yates: 37.17
Texas Rangers, 61.2 relief innings

#2 
Emmanuel Clase: 34.88
Cleveland Guardians, 74.1 relief innings

#3 
Tanner Scott: 29.28
2 teams (Marlins/Padres), 72.0 relief innings

#4 
Ryan Helsley: 28.38
St. Louis Cardinals, 66.1 relief innings

#5 
Luke Weaver: 27.79
New York Yankees, 84.0 relief innings

#315 
Clay Holmes: -57.07
New York Yankees, 63.0 relief innings

#314 
Craig Kimbrel: -41.78
Baltimore Orioles, 52.1 relief innings

#313 
David Bednar: -39.2
Pittsburgh Pirates, 57.2 relief innings

#312 
Justin Lawrence: -34.32
Colorado Rockies, 59.2 relief innings

#311 
Edwin Diaz: -33.16
New York Mets, 53.2 relief innings

Minimum 20 innings pitched in relief

2024 mean SSA: -4.47
2024 median SSA: -2.64

Relief Pitcher Metrics

Adjusted Reliever WPA

Adjusted Reliever WPA (ARWPA)

- Very similar formula to our Save Shares Accumulated
- In all reliever situations ~~only for situations where pitcher's team leads by 1+ run~~
- Calculated per batter faced
- Credits relievers for ~~protecting leads throughout a game~~ all of their performance
- Provides greater bonus for doing so against better hitters and/or in worse parks
    - Likewise punishes for poor performance against poor hitters

2023 ARWPA Leaderboard

#1 

Tanner Scott: 3.27
Miami Marlins, 78.0 relief innings

#2 

Félix Bautista: 3.15
Baltimore Orioles, 61.0 relief innings

#3 

Erik Swanson: 3.15
Toronto Blue Jays, 66.2 relief innings

#4 

Chris Martin: 2.70
Boston Red Sox, 51.1 relief innings

#5 

Héctor Neris: 2.64
Houston Astros, 68.1 relief innings

#326 

Emmanuel Clase: -7.02
Cleveland Guardians, 72.2 relief innings

#325 

Jake Bird: -5.94
Colorado Rockies, 84.1 relief innings

#324 

Carlos Hernández: -5.47
Kansas City Royals, 63.0 relief innings

#323 

Pierce Johnson: -4.55
2 teams (Rockies/Braves), 62.2 relief innings

#322 

Justin Lawrence: -4.49
Colorado Rockies, 75.0 relief innings

Minimum 20 innings pitched in relief

2023 mean ARWPA: -1.16
2023 median ARWPA: -0.71

2024 ARWPA Leaderboard

#1 

Emmanuel Clase: 4.82

Cleveland Guardians, 74.1 relief innings

#2 

Kirby Yates: 4.03

Texas Rangers, 61.2 relief innings

#3 

Tanner Scott: 3.55

2 teams (Marlins/Padres), 72.0 relief innings

#4 

Raisel Iglesias: 3.24

Atlanta Braves, 69.1 relief innings

#5 

Tyler Holton: 2.92

Detroit Tigers, 77.1 relief innings

#316 

Justin Lawrence: -7.13

Colorado Rockies, 59.2 relief innings

#315 

Jalen Beeks: -5.68

2 teams (Rockies/Pirates), 70.0 relief innings

#314 

David Bednar: -5.41

Pittsburgh Pirates, 57.2 relief innings

#313 

Craig Kimbrel: -5.37

Baltimore Orioles, 52.1 relief innings

#312 

Clay Holmes: -5.16

New York Yankees, 63.0 relief innings

Minimum 20 innings pitched in relief

2024 mean ARWPA: -0.95
2024 median ARWPA: -0.60

Adjusted Run Averages

Adjusted Run Average by Entrance State (ARAE)

adjustment for RE with 0 outs, Bases Loaded

$$\left(\sum \frac{\textit{pitcher's runs allowed in inning} - \textit{RE upon entering inning} + 2.31}{1 + \textit{outs recorded in inning}} - 0.45\right) \cdot \left(\frac{9}{\textit{innings pitched in season}}\right)$$

corrects clean slate inning to 0.00 ARAE

- Number of runs a reliever would allow himself per nine innings, above expected, adjusted by entrance state
- Credits relievers for entering/escaping jams
- Considers run expectancy but independent of game context

2023 ARAE Leaderboard

#1 

Josh Hader: 0.49
San Diego Padres, 56.1 relief innings

#2 

Chris Martin: 0.53
Boston Red Sox, 51.1 relief innings

#3 

Félix Bautista: 0.68
Baltimore Orioles, 61.0 relief innings

#4 

Craig Kimbrel: 0.70
Philadelphia Phillies, 69.0 relief innings

#5 

Pedro Avila: 0.73
San Diego Padres, 24.2 relief innings

#326 

Kyle Nelson: 6.63
Arizona Diamondbacks, 54.2 relief innings

#325 

Alex Young: 6.41
Cincinnati Reds, 53.2 relief innings

#324 

Matt Barnes: 6.25
Miami Marlins, 20.1 relief innings

#323 

Ryan Borucki: 5.75
Pittsburgh Pirates, 36.2 relief innings

#322 

Keegan Akin: 5.34
Baltimore Orioles, 22.2 relief innings

Minimum 20 innings pitched in relief

2023 mean ARAE: 2.79
2023 median ARAE: 2.73

2024 ARAE Leaderboard

#1 

Emmanuel Clase: 0.15

Cleveland Guardians, 74.1 relief innings

#2 

Devin Williams: 0.38

Milwaukee Brewers, 21.2 relief innings

#3 

Ryan Helsley: 0.47

St. Louis Cardinals, 66.1 relief innings

#4 

Carlos Estévez: 0.67

2 teams (Angels/Phillies), 55.0 relief innings

#5 

Mason Miller: 0.71

Oakland Athletics, 65.0 relief innings

#316 

Brennan Bernardino: 6.63

Boston Red Sox, 47.2 relief innings

#315 

Josh Fleming: 6.26

Pittsburgh Pirates, 24.0 relief innings

#314 

Angel Zerpa: 6.23

Kansas City Royals, 53.2 relief innings

#313 

Grant Anderson: 6.20

Texas Rangers, 26.2 relief innings

#312 

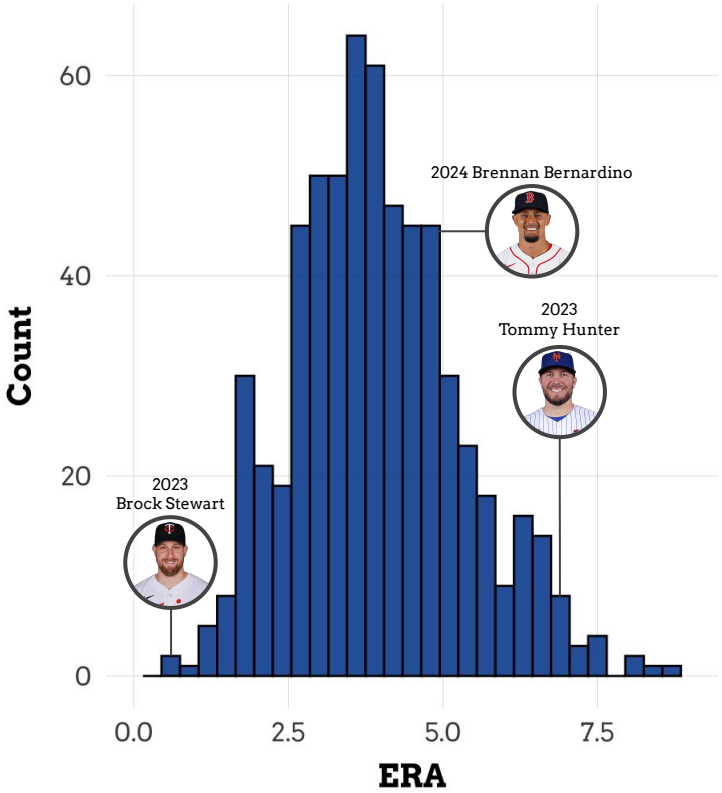
Giovanny Gallegos: 6.11

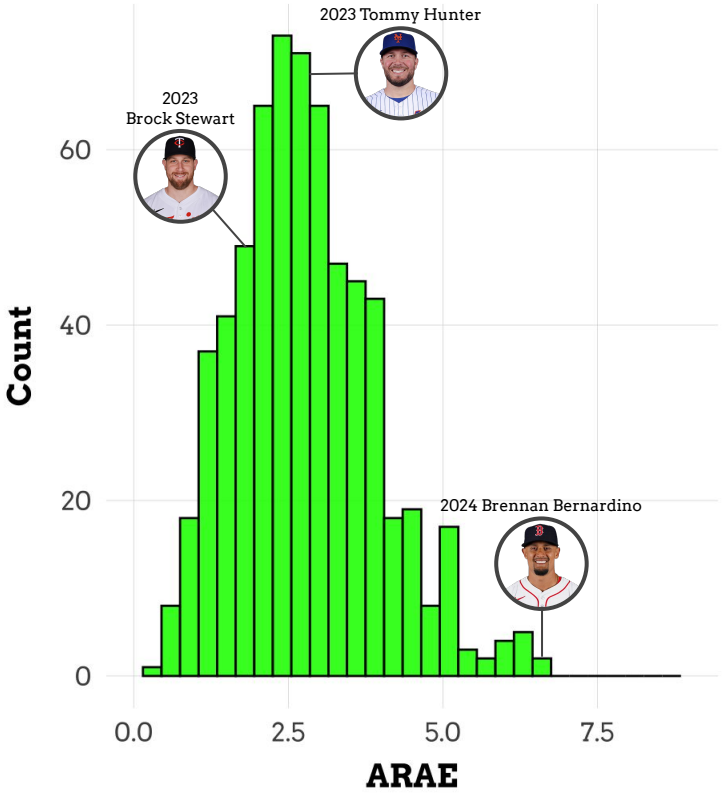
St. Louis Cardinals, 20.2 relief innings

Minimum 20 innings pitched in relief

2024 mean ARAE: 2.77
2024 median ARAE: 2.65

ERA vs. ARAE Distributions





Adjusted Run Average by Departing State (ARAD)

$$\left(\sum \frac{pitcher's\ runs\ allowed\ in\ inning\ +\ RE\ in\ departing\ state}{1\ +\ outs\ recorded\ in\ inning}\right) \cdot \left(\frac{9}{innings\ pitched\ in\ season}\right)$$

- Number of runs a reliever would allow himself per nine innings, above expected, adjusted by departing state
- Credits relievers for pitching clean innings and leaving with nobody on base

2023 ARAD Leaderboard

#1 

Chris Martin: 0.31

Boston Red Sox, 51.1 relief innings

#2 

Josh Hader: 0.45

San Diego Padres, 56.1 relief innings

#3 

Félix Bautista: 0.49

Baltimore Orioles, 61.0 relief innings

#4 

Shelby Miller: 0.51

Los Angeles Dodgers, 41.2 relief innings

#5 

Bowden Francis: 0.53

Toronto Blue Jays, 36.1 relief innings

#326 

Matt Barnes: 5.19

Miami Marlins, 20.1 relief innings

#325 

Tim Hill: 4.33

San Diego Padres, 44.1 relief innings

#324 

Aaron Bummer: 4.21

Chicago White Sox, 58.1 relief innings

#323 

Matt Carasiti: 4.15

Colorado Rockies, 24.1 relief innings

#322 

Keegan Akin: 4.13

Baltimore Orioles, 22.2 relief innings

Minimum 20 innings pitched in relief

2023 mean ARAD: 2.06
2023 median ARAD: 2.01

2024 ARAD Leaderboard

#1 

Emmanuel Clase: 0.27

Cleveland Guardians, 74.1 relief innings

#2 

Devin Williams: 0.48

Milwaukee Brewers, 21.2 relief innings

#3 

Kirby Yates: 0.53

Texas Rangers, 61.2 relief innings

#4 

Ryan Helsley: 0.61

St. Louis Cardinals, 66.1 relief innings

#5 

Ryan Walker: 0.63

San Francisco Giants, 79.1 relief innings

#316 

Josh Fleming: 5.23

Pittsburgh Pirates, 24.0 relief innings

#315 

Yerry Rodríguez: 4.98

2 teams (Rangers/Blue Jays), 21.2 relief innings

#314 

Grant Anderson: 4.98

Texas Rangers, 26.2 relief innings

#313 

Giovanny Gallegos: 4.97

St. Louis Cardinals, 20.2 relief innings

#312 

Wandy Peralta: 4.70

San Diego Padres, 38.1 relief innings

Minimum 20 innings pitched in relief

2024 mean ARAD: 2.03
2024 median ARAD: 1.89

Reliever Game Score

Reliever Game Score (RGS)

$$RGS = (Fatigue_{adj})pLI(\sum_{e \in events}(-RV_e(Count_e))$$

- Holistic approach to quantifying the quality of an outing for a relief pitcher by accounting for leverage within the game, run value of various events and fatigue
- No reliever interdependency, besides game leverage
- pLI is a pitcher's average leverage index for the whole outing
- The events we consider are K, Field Out, H, BB, HBP, ER

RGS Fatigue Adjustment

$$Fatigue_{adj} = 1 + (.117 * Appearances_{last3Days}) + (.165 * Appearances_{PrevDay})$$

- Wanted to account for workload a reliever has been under
- Created a buffer for both good and bad performance
  - Positive RGS is amplified, multiplied by fatigue adjustment
  - Negative RGS is mitigated, divided by fatigue adjustment
- Lasso Regression to find optimal weights and factors that contributed to a lower RGS

Best RGS Outing

Inn	Score	Out	RoB	Pit(ct)	R/O	@Bat	Batter	Pitcher	wWPA	wWE	Play Description
Top of the 10th, Diamondbacks Batting, Tied 8-8, Athletics' Austin Pruitt facing 1-2-3											
									Austin Pruitt replaces Richard Lovelady pitching *Dominic Fletcher running at second base to start the extra inning*		
t10	8-8	0	-2-	4,(1-2)	O	ARI	Ketel Marte	Austin Pruitt	11%	61%	Strikeout Looking
									Pavin Smith pinch hits for Alek Thomas (DH) batting 2nd		
t10	8-8	1	-2-	3,(1-1)	O	ARI	Pavin Smith	Austin Pruitt	8%	68%	Flyball: CF (Deep CF); D. Fletcher to 3B
t10	8-8	2	--3	2,(0-1)	O	ARI	Lourdes Gurriel Jr.	Austin Pruitt	12%	81%	Lineout: LF (Deep LF)
May 16, 2023									***0 runs, 0 hits, 0 errors, 1 LOB. Diamondbacks 8, Athletics 8.***		

- Runner on 2nd to start each half inning
- 7.47 RGS: 0 H, 0 BB/HBP, 8 Field Outs, 1 K, 0 ER, 1.06 FF, 3.46 pLI* *96th pctl

Austin Pruitt

Worst RGS Outing

Inn	Score	Out	RoB	Pit(ct)	R/O	@Bat	Batter	Pitcher	wWPA	wWE	Play Description
Top of the 9th, Braves Batting, Behind 4-5, Diamondbacks' Miguel Castro facing 9-1-2											
									Miguel Castro replaces Scott McGough pitching *Gabriel Moreno moves from PH to C*		
t9	4-5	0	---	5,(3-1)		ATL	Michael Harris II	Miguel Castro	12%	28%	Walk
t9	4-5	0	1--	2,(1-0)		ATL	Ronald Acuna Jr.	Miguel Castro	27%	55%	Single to RF (Line Drive to Short RF Line); M. Harris to 3B
t9	4-5	0	1-3	2,(1-0)		ATL	Matt Olson	Miguel Castro	6%	61%	R. Acuña Steals 2B
t9	4-5	0	-23	7,(3-2)	O	ATL	Matt Olson	Miguel Castro	-16%	45%	Strikeout Looking
t9	4-5	1	-23	,(3-0)		ATL	Austin Riley	Miguel Castro	1%	46%	Intentional Walk
t9	4-5	1	123	3,(0-2)	O	ATL	Travis d'Arnaud	Miguel Castro	-22%	23%	Lineout: SS
t9	4-5	2	123	2,(1-0)	RRRR	ATL	Eddie Rosario	Miguel Castro	72%	96%	Home Run (Fly Ball to Deep RF); M. Harris Scores; R. Acuña Scores; A. Riley Scores
									Austin Adams replaces Miguel Castro pitching		
June 4, 2023									***4 runs, 3 hits, 0 errors, 1 LOB. Braves 8, Diamondbacks 5.***		

-29.08 RGS: 2 H, 1 HR, 1 BB, 0 HBP, 1 Field Out, 1 K, 4 ER, 1.12 FF, 5.28 pLI* *99th pctl

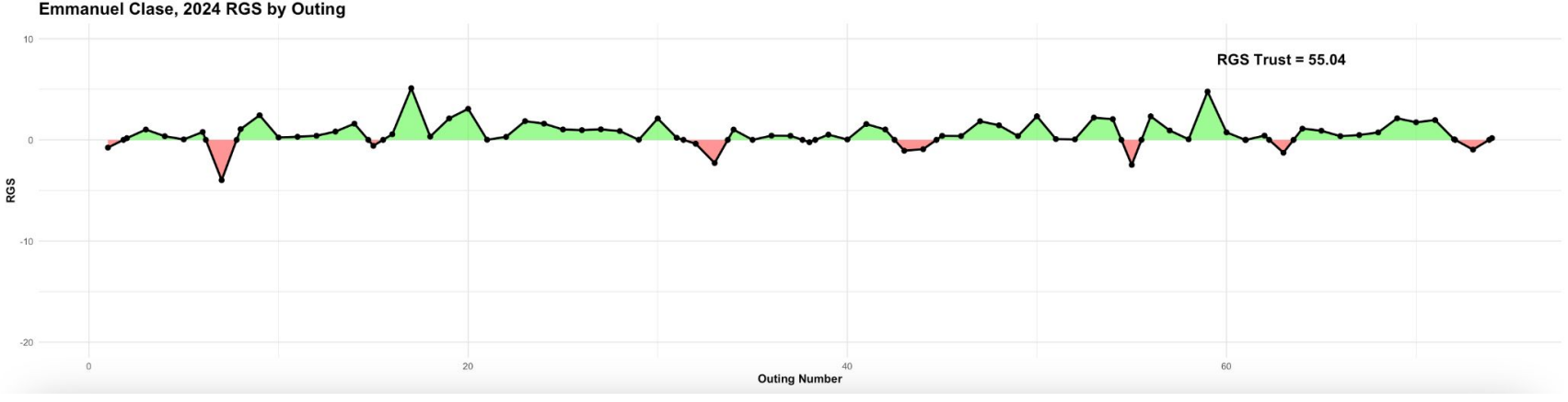
Miguel Castro

RGS Trust

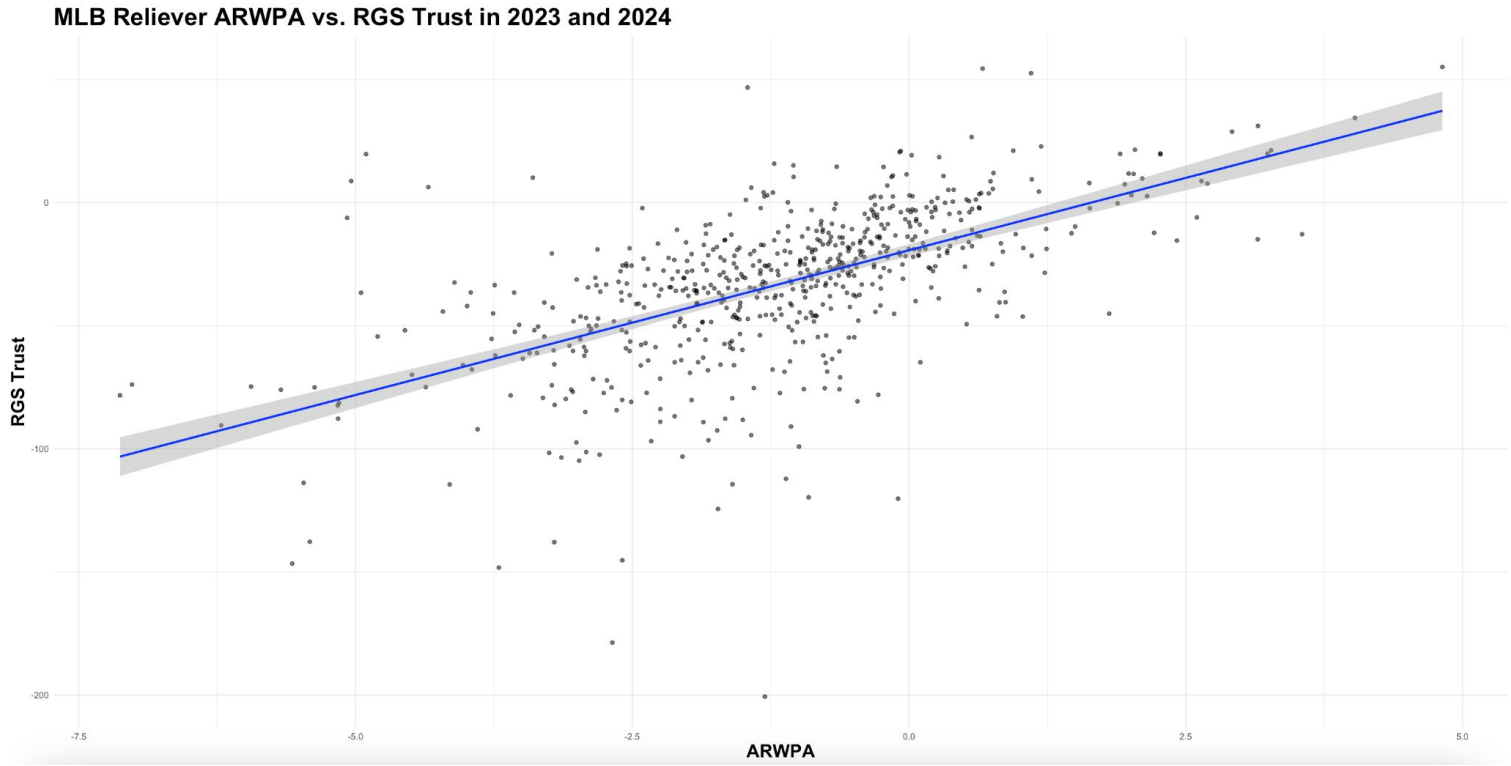
RGS Trust

- Used trapezoidal integration to calculate the RGS Trust for each reliever season
- $$\int_a^b f(x)\,dx \approx (b-a)\cdot\frac{1}{2}(f(a)+f(b))$$
- Compared to RGS, RGS Trust better…
  - Measures consistency across the full season
  - Penalizes for extreme outings that significantly affect their team

RGS Trust Example: Emmanuel Clase



Linear Regression: ARWPA vs. RGS Trust



- Very significant relationship
- RGS Trust increases by ~11.75 units for every increase in ARWPA

Underrated Relievers

2023 Underrated Relievers

Erik Swanson

4 saves

24.95 SSA, 3.15 ARWPA

99th percentile *99th percentile*

Gregory Soto

4.62 ERA, 3 saves

13.92 SSA, 1.11 ARWPA

99th percentile *98th percentile*

Greg Weissert

4.05 ERA, 1.45 WHIP

1.83 RGS Trust, 1.65 ARAD

91st percentile *67th percentile*

2024 Underrated Relievers

Xzavion Curry

4.79 ERA

1.58 ARAE, 15.78 RGS Trust

85th percentile *96th percentile*

Cionel Perez

2 saves

18.50 SSA

99th percentile

Tyler Kinley

6.19 ERA, Coors Field effect

1.63 ARWPA

97th percentile

Overrated Relievers

2023 Overrated Relievers

Ryan Pressly

31 saves

-24 SSA

4th percentile

Emmanuel Clase

44 saves, 2.91 FIP

–51.62 SSA, -7.02 ARWPA, -73.91 RGS Trust

1st percentile *1st percentile* *12th percentile*

Seranthony Dominguez

3.78 ERA

-24.43 RGS Trust

25th percentile

2024 Overrated Relievers

Jhoan Duran

23 saves

-33.88 RGS Trust

39th percentile

Clay Holmes

30 saves, 3.14 ERA

-57.07 SSA, -5.16 ARWPA, -82.45 RGS Trust

1st percentile *2nd percentile* *6th percentile*

Nick Sandlin

3.75 ERA

5.16 ARAE

5th percentile

Limitations

Limitations and Next Steps

- A reliever is assigned the totality of what happens during their outing
  - For example: stolen bases, passed balls, fielding errors
- Reliever's potential downside exceeds potential upside
- Create expected versions of the performance metrics
- Use metrics to evaluate potentially undervalued minor league relievers

Who Should You Call?

Conclusions

- Contextual factors help describe reliever performance
  - Best way to evaluate performance is finding a balance between explaining context and true results
- Small sample sizes make reliever performance metrics volatile
  - Expected stats are an important tool to overcome this
- Different reliever stats are useful for different decision-making processes
  - RGS Trust can be very useful for managers

Thank You