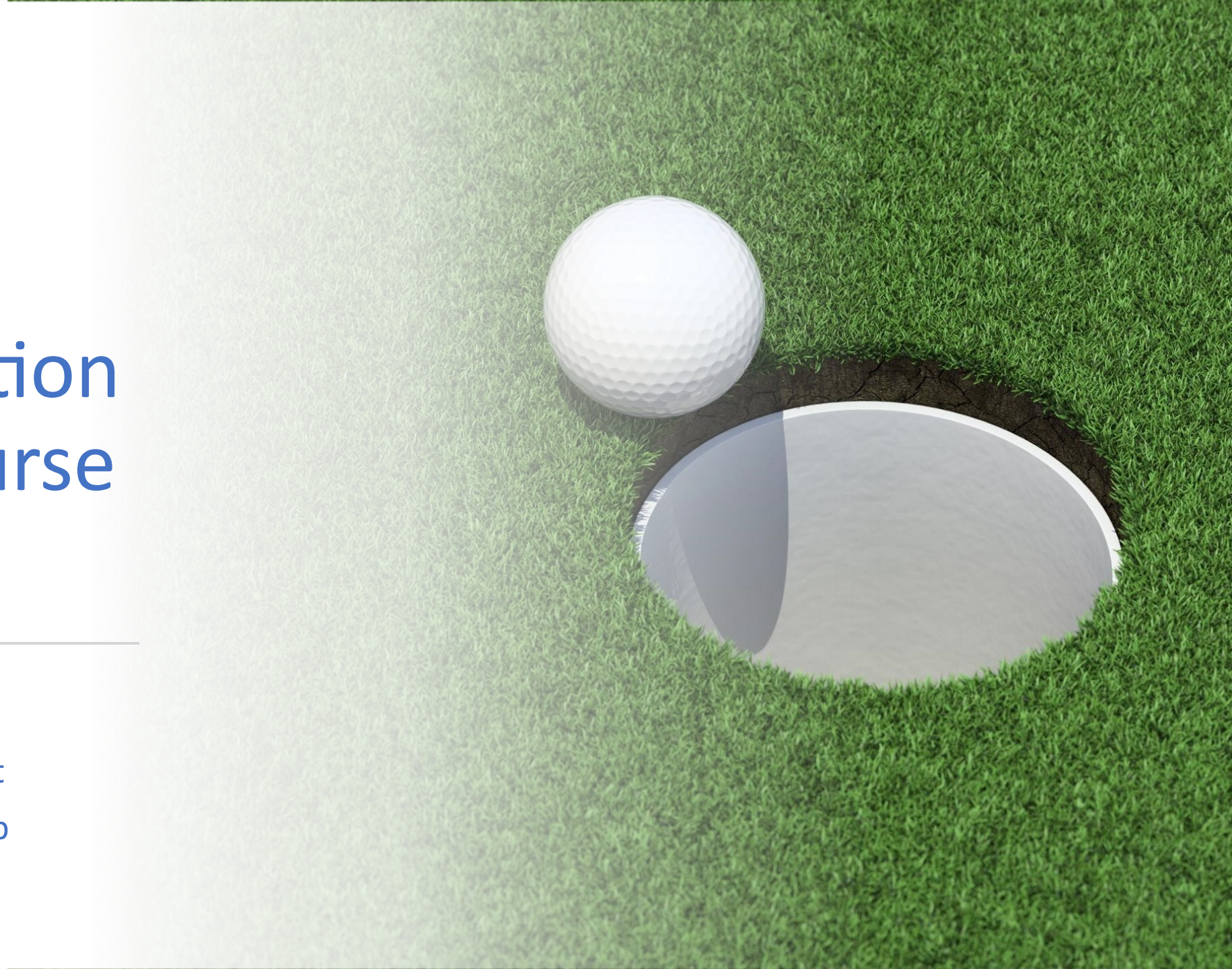
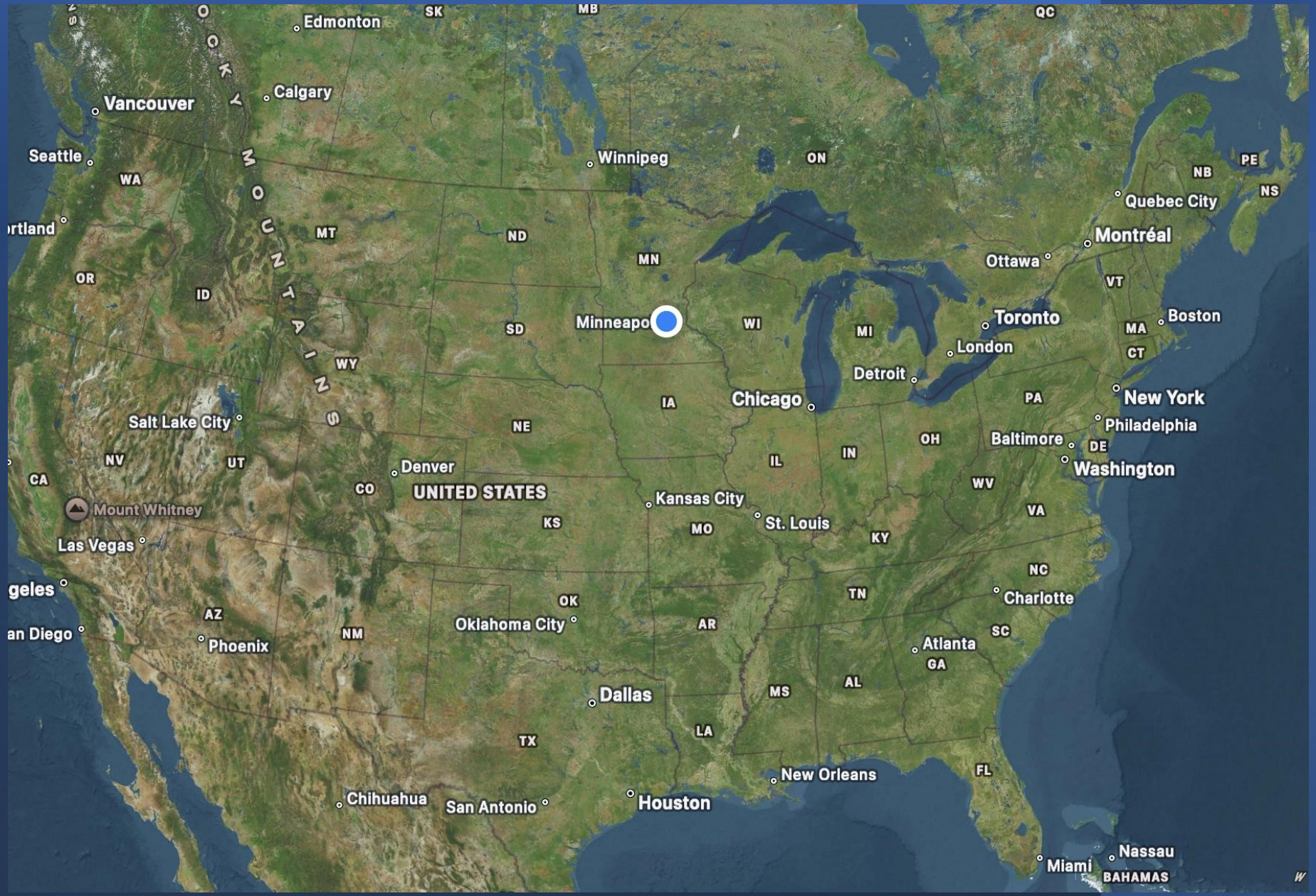
Data Collection for Golf Course Turf

Chris Tritabaugh

Golf Course Superintendent

Hazeltine National Golf Club

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Charlotte
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Oklahoma City
AR
SC
NM
Phoenix
Atlanta
GA
AL
Dallas
MS
LA
TX
FL
New Orleans
Chihuahua
San Antonio
Houston
Miami
Nassau
BAHAMAS

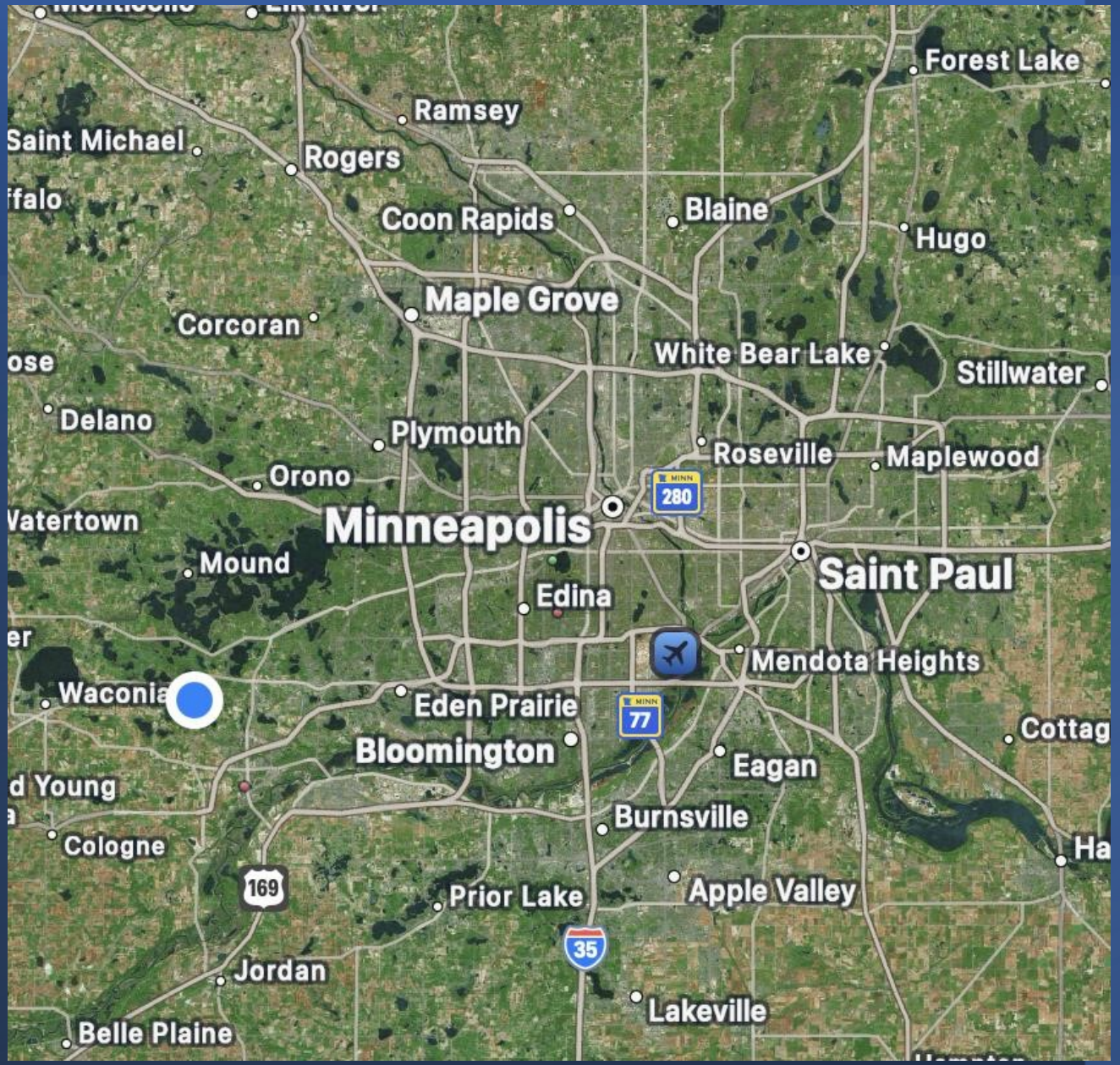
Comparison

Denmark

- 42,952 km^2
- Population 5.97 million
- Copenhagen metro 1.38 million

Minnesota

- 225,181 km^2
- Population 5.76 million
- Twin Cities metro 3.71 million


Forest Lake
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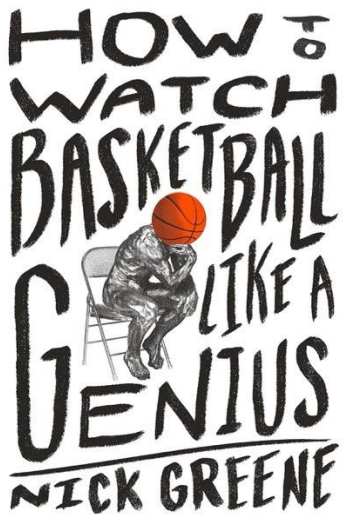
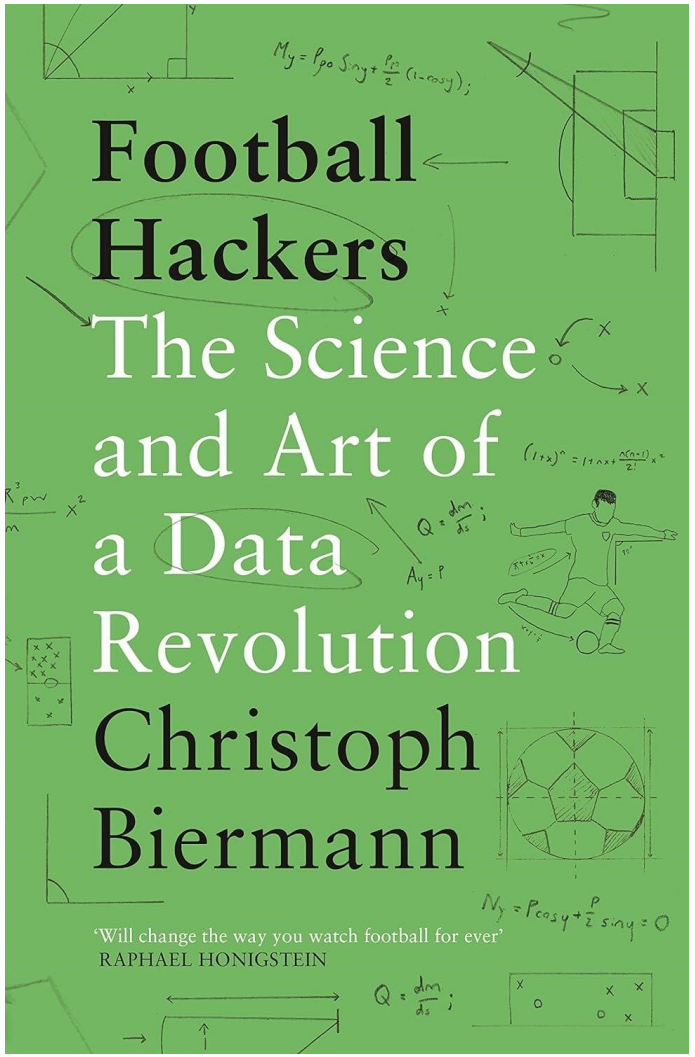
Saint Michael
Rogers
Coon Rapids
Blaine
Hugo
Maple Grove
Corcoran
White Bear Lake
Stillwater
Delano
Plymouth
Roseville
Maplewood
Orono
280
Minneapolis
Saint Paul
Mound
Edina
Mendota Heights
Waconia
Eden Prairie
77
Bloomington
Eagan
Burnsville
Cologne
169
Prior Lake
Apple Valley
35
Jordan
Lakeville
Belle Plaine

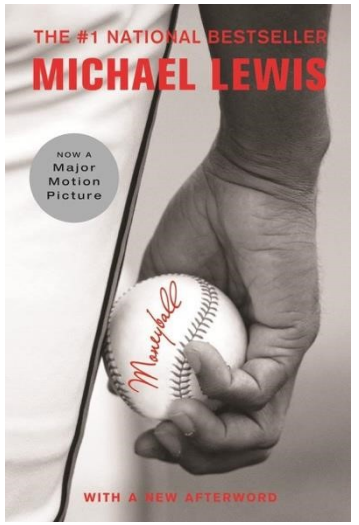

BIRDIE LANE CHASKA
Hazeltine National Golf Club
b Foods
pa Johns Pizza
gs Credit
n
ORIOLE LN
NIGHTINGALE CT
Chaska High School
AUTUMN WOODS

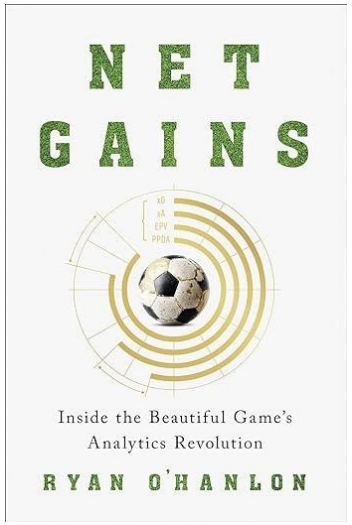
QR Codes

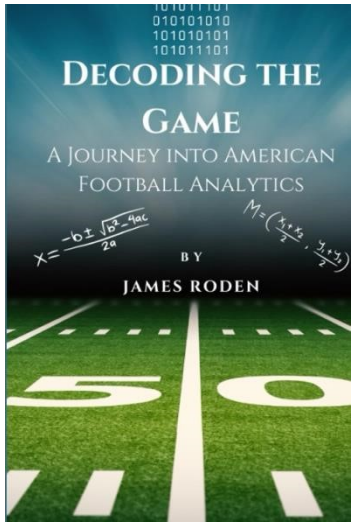
Throughout this presentation, you'll see QR codes that lead to websites offering more information and context on the subject.


HOW TO WATCH BASKETBALL LIKE A GENIUS
NICK GREENE


Football Hackers
The Science and Art of a Data Revolution
Christoph Biermann
'Will change the way you watch football for ever'
RAPHAEL HONIGSTEIN


THE #1 NATIONAL BESTSELLER
MICHAEL LEWIS
NOW A Major Motion Picture
Moneyball
WITH A NEW AFTERWORD


NET GAINS
Inside the Beautiful Game's Analytics Revolution
RYAN O'HANLON


DECODING THE GAME
A JOURNEY INTO AMERICAN FOOTBALL ANALYTICS
BY
JAMES RODEN


THIS IS THE RYDER CUP
RYDER CUP
SATURDAY
FOURSOMES
EUR
USA
citi
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1999

When you collect and use data:

- Your use of resources will become more efficient, using what's necessary better and not using what's unnecessary.
- You'll punch above your weight.
- You'll be able to allocate more funds to personnel.
- Your golfers will be more satisfied.

- You’ll win more!

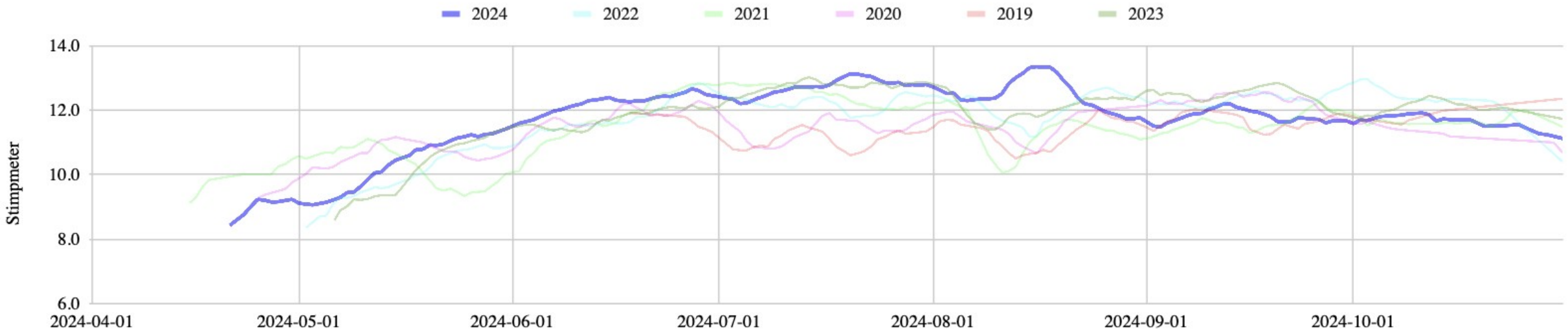

2017NBA
CHAMPIONS


ARIZONA STATE
UNIVERSITY

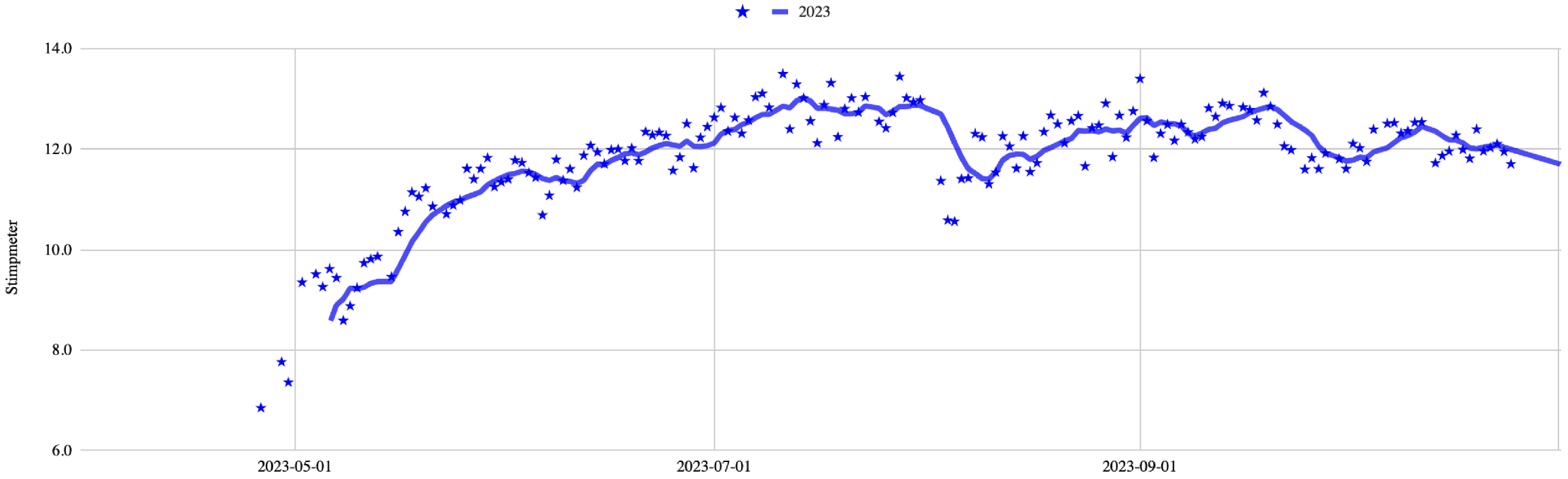

USGA


124TH U.S. AMATEUR
HAZELTINE

Seven-day Average Greenspeed



Greenspeed



disclaimers

- My data collection process has led us to do less work rather than more. Most of this presentation will focus on doing less. However, as you start collecting data, you may need more work.
- This presentation isn't about more or less work; it's about gathering the proper info so you can do the appropriate amount of work.

- I'm going to show a lot of data, charts, etc.
- I want you to understand how collecting this data can improve your job and course.

- Please ask questions, stop me when you don't understand, and be curious.
- Please don't get caught up in how this data relates to your course.
- Please ask questions.

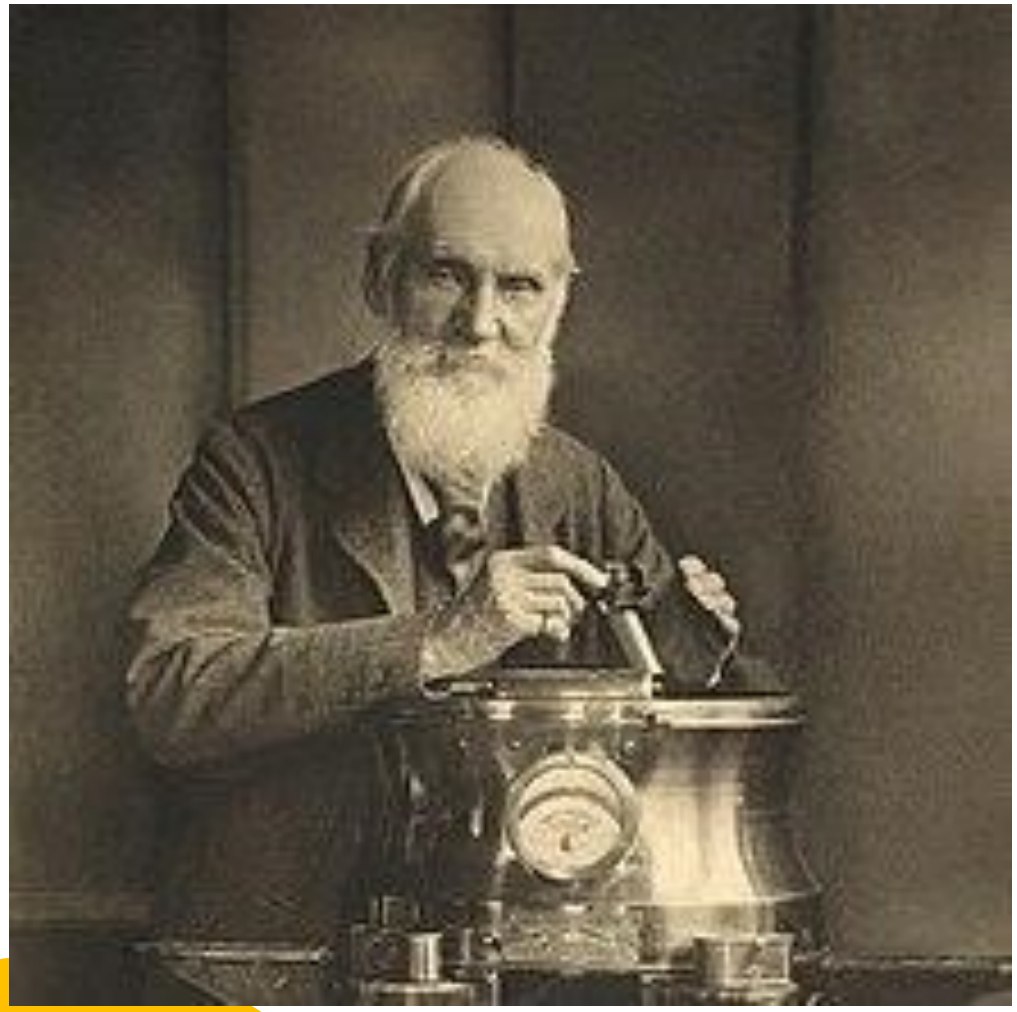
When you leave here, you'll have the tools to get started. Once you start, I assure

Why data?

you, you'll see the value and the benefits.

- "To measure is to know."
- "If you can't measure it, you can't improve it."
- "What gets measured gets done."
- Collecting and measuring can motivate employees.
- They'll know more about what they are doing and will be part of improving the course.
- It puts knowledge in their in their hands. For example, the green mowers know the usual number of clippings.
- Anyone finding their employees have interest in this?

Lord Kelvin



“I often say that when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter

Why data?

may be." (Thomson Citation1889).

- Membership confidence
- When you show them the data, they believe
- It will show you're in control of the situation
- It can confirm or deny inquiries about course conditions
- Confirmation of processes
- You'll know how much you need to do to the course. It's probably less than you do now, but it could be more; you will know when you collect

Why data?

the correct data.

- You can skip or eliminate processes that irritate golfers. When that happens, everyone wins.

- Proper allocation of inputs
- You will only provide the necessary inputs because you know what needs to be done to the course. Again, this will likely result in using/ spending less rather than more.
- When you save on inputs, it can provide

opportunities to spend more on staff/team members.

We lament that our golfers complain about the course, but maybe they're right about things like greenspeed or too much topdressing. If we had checked and known the speed or only added the sand necessary, we would have avoided their disappointment.

- 4.6 g/m^2

What has collection allowed us to data reduce?

- 46 kg/ha
- Only three aerifications in the past 4 years
- One tining event in the past 4 years
- No vertical mowing

Topdressing

- Typically apply 1/4 to 1/3 of the textbook recommendation

No Maintenance Mondays!

- Garbage in=garbage out; what you choose to measure matters

- The quantities we measure and track must have rational, reliable, and robust correlations with the intended outcomes.

What do I mean by rational, reliable, robust?

- Extreme example: Don't measure Greenspeed when there is dew on the grass!

- It must mean something to what you're trying to accomplish.

- It needs to be consistent.

- It should concentrate on what your golfers are going to care about– surface conditions!

What should you collect?

- Avoid surrogate markers:
- leaf tissue nutrient levels
- surface area removal/displacement from aerification
- base cation ratios in soil
- infiltration rate

- canopy temperature after syringing
- Asianturfgrass.com for Dr. Micah Woods' blog post on surrogate markers in turfgrass

Gathering the data

- Make it as simple/easy as possible because…
- You need to remain consistent!
- You will need to get team members involved.
- Get trusted assistants involved.
- Use software/spreadsheets to share with your team and let them contribute.
- Some of the data you may want to collect yourself.
- I like to…
- Stimp

- Measure VWC + Klegg

Clipping Volume

- Greensmowers empty baskets into a 20-litre graduated bucket, then record the amount on their phone. They message me the numbers at the end of their route—total time-10-15 minutes for the entire route.
- An assistant or I input the numbers into the spreadsheet. Total time less than 5 minutes

Stimpmeter & Bobble Test

- If I do it, I will walk or ride the course in order, stimping behind the set-up team.
- I rate each of the six rolls on the STRI smoothness scale.
- I measure the stimp in each direction.

- I record all scores on a scorecard I carry with me.
- The total time is less than 5 minutes per green; 5-18 greens are stimped daily. I would be on these greens anyway, so the time added is minimal.
- I record numbers in the spreadsheet when I return to the office—5-10 minutes.

VWC & Firmness

- I do this myself, checking six locations on each green. First, I check and record the firmness, then I check VWC. I used a Clegg hammer in ‘22 & ‘23 and switched to the GS3 in 2024.
- This year, I measured VWC and firmness using the GS3 in six locations on the same four greens daily.
- I enter the data into the spreadsheet, which takes about 10 minutes.
- **Daily**

results

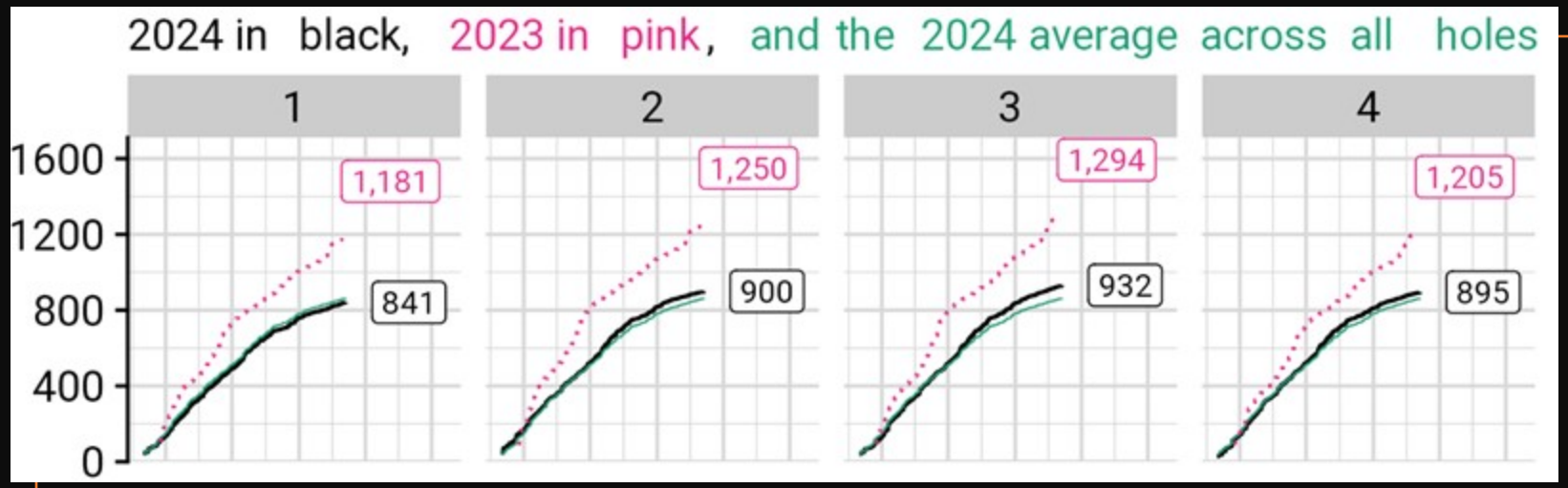
- **Clipping volume**
- **Growth potential (GP)**
- **Growth ratio (GR)**
- **Greenspeed**
- **Bobble test**

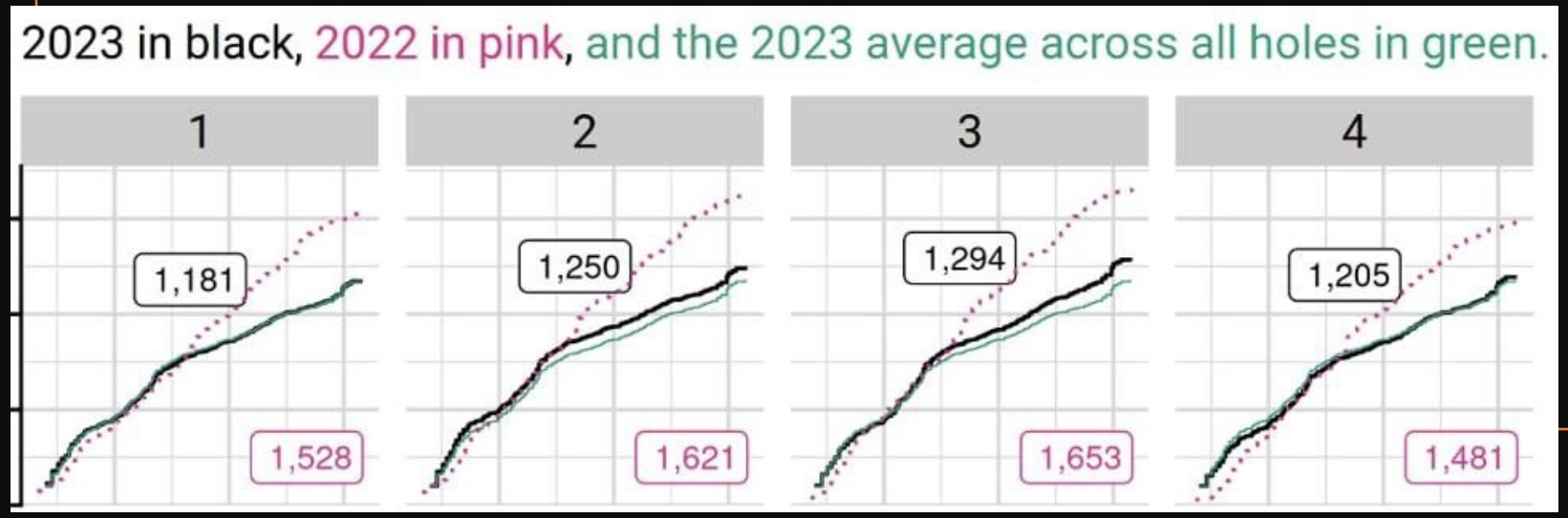
- Weekly/less than daily
- Firmness w/ VWC
- Amount of nitrogen applied

- Annual
- OM246
- Soil nutrient analysis
- Topdressing amounts by depth

Clipping Volume

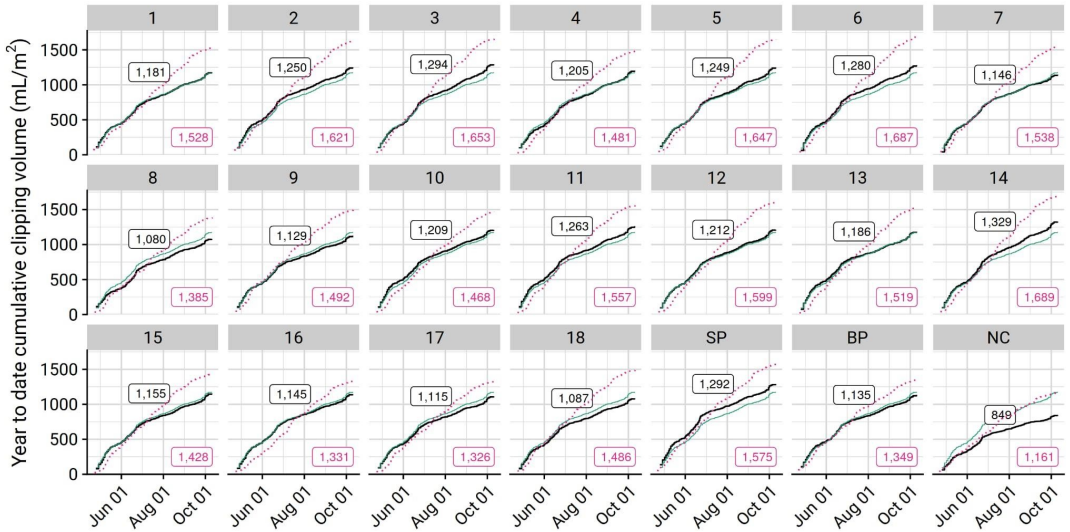
- How much is the grass growing
- Be careful not to get too attached to one day’s volume.
- day trailing average
- Don’t worry about the fine details: wet or dry, one of your employees measuring wrong, etc.
- This will provide tremendously accurate information.


2024 in black, 2023 in pink, and the 2024 average across all holes
1
2
3
4
1600
1200
800
400
0
1,181
841
1,250
900
1,294
932
1,205
895


2023 in black, 2022 in pink, and the 2023 average across all holes in green.
1
2
3
4
1,181
1,528
1,250
1,621
1,294
1,653
1,205
1,481

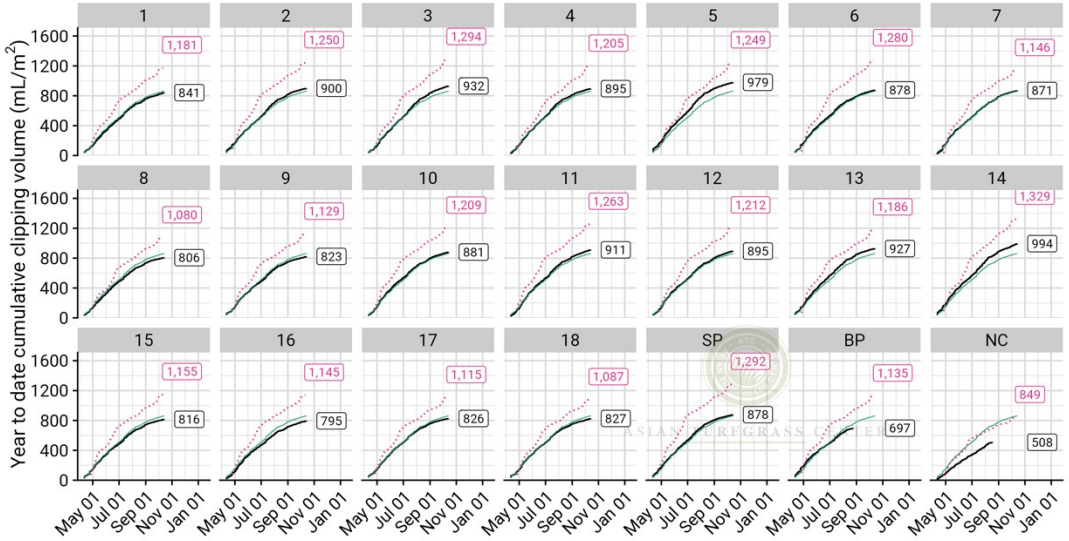
Cumulative clipping volume green by green

2023 in black, 2022 in pink, and the 2023 average across all holes in green.



Cumulative clipping volume green by green

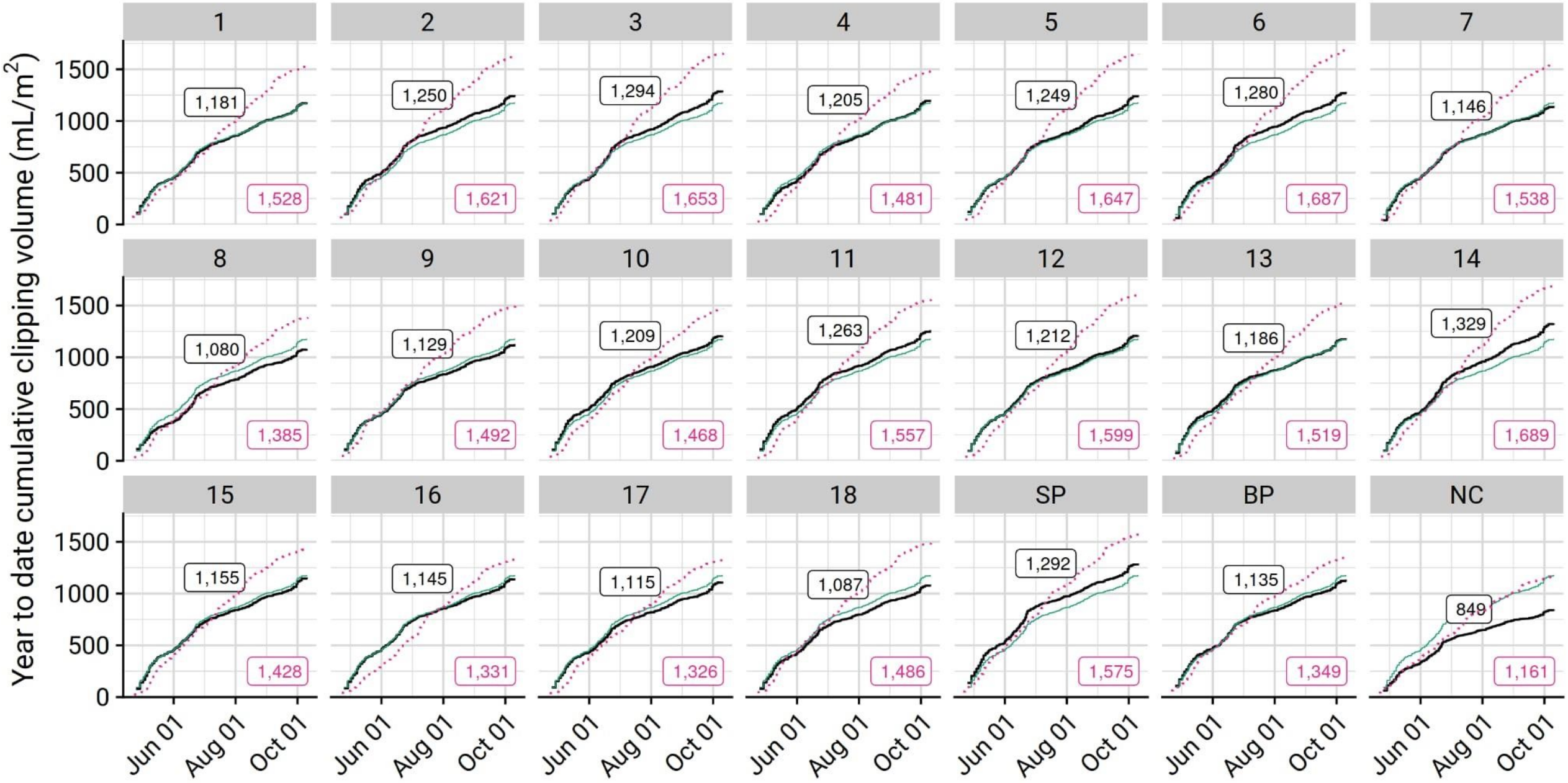
2024 in black, 2023 in pink, and the 2024 average across all holes in green.



Cumulative clipping volume green by green

2023 in black, 2022 in pink, and the 2023 average across all holes in green.

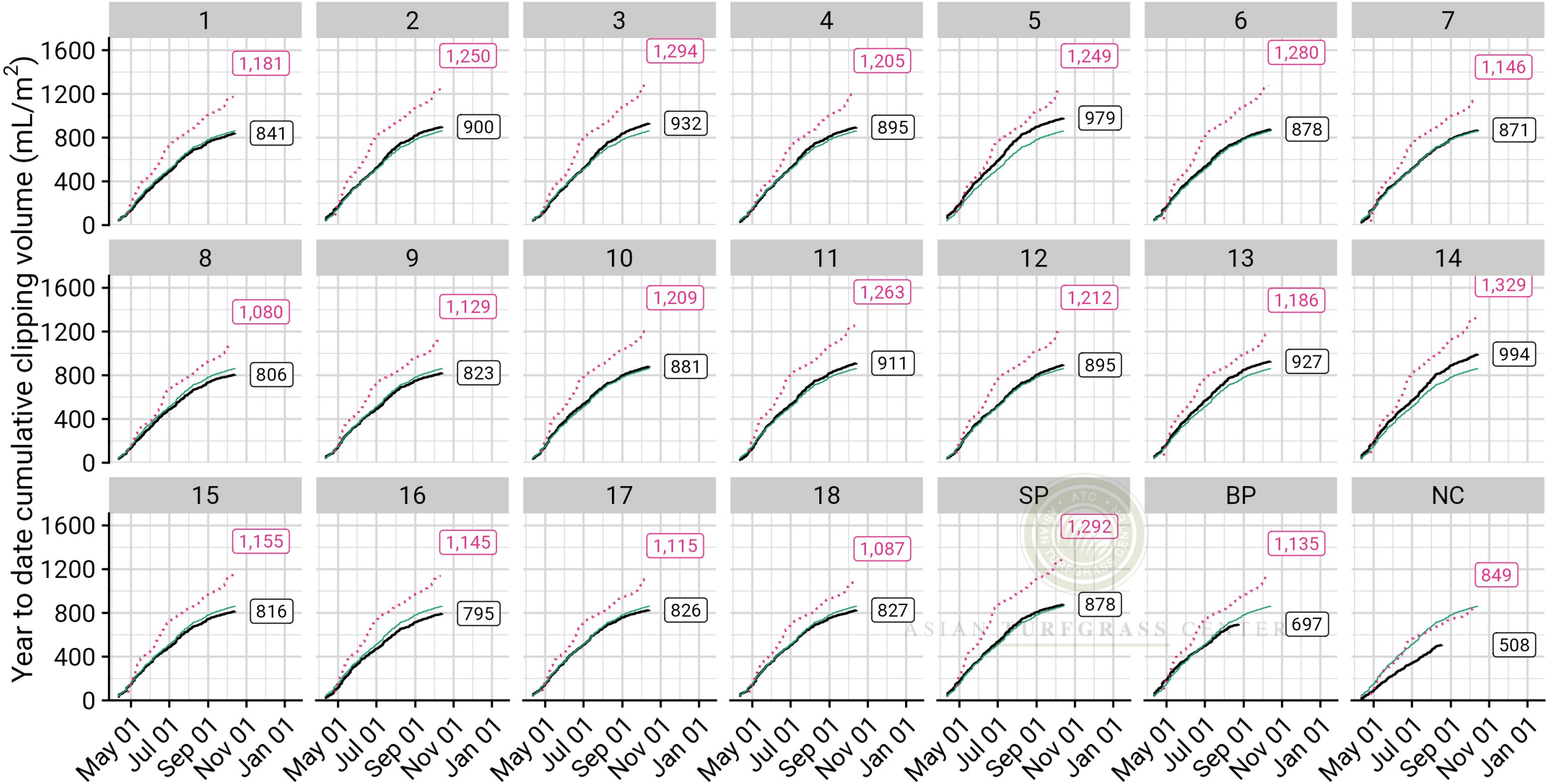
2023



Cumulative clipping volume green by green

2024 in black, 2023 in pink, and the 2024 average across all holes in green.

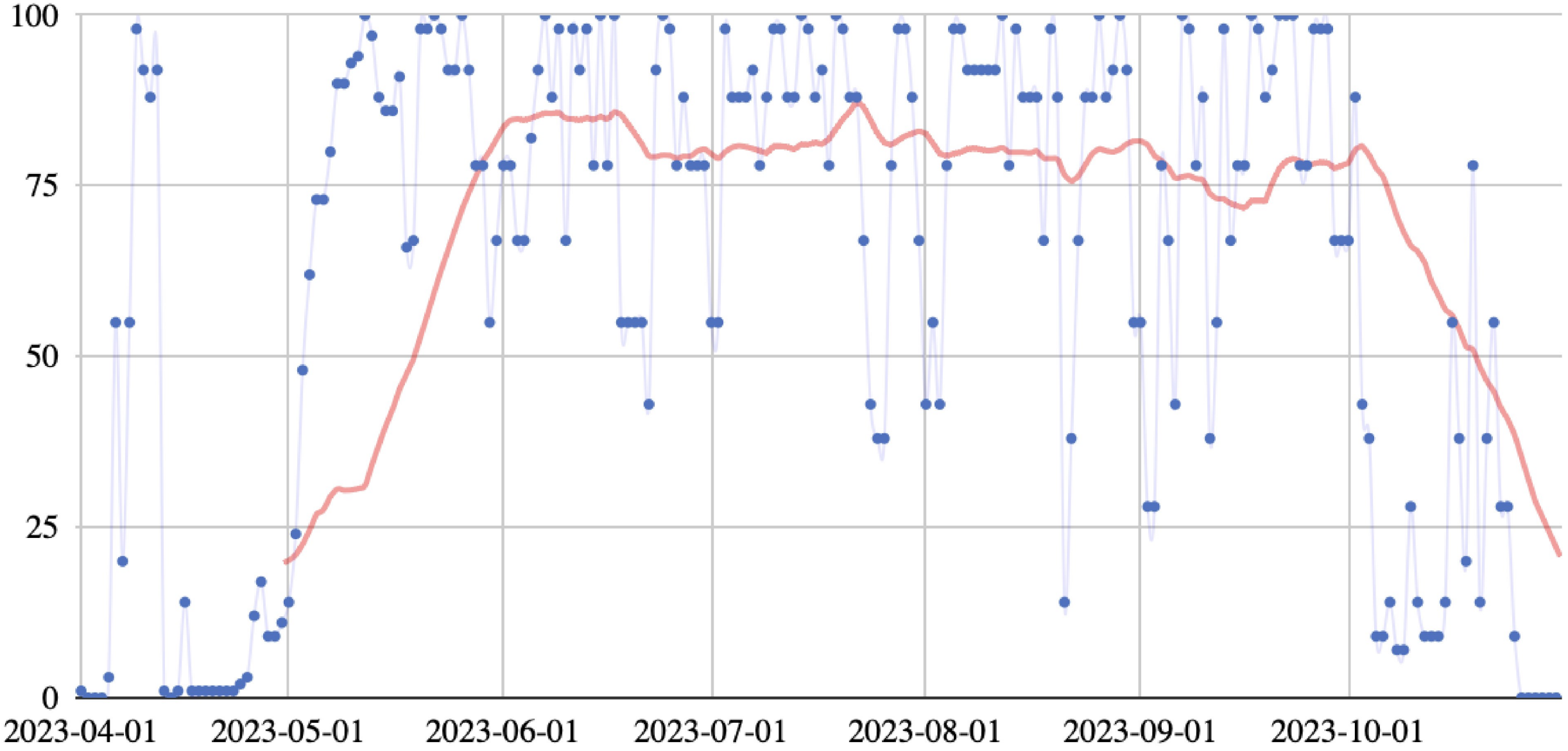
2024

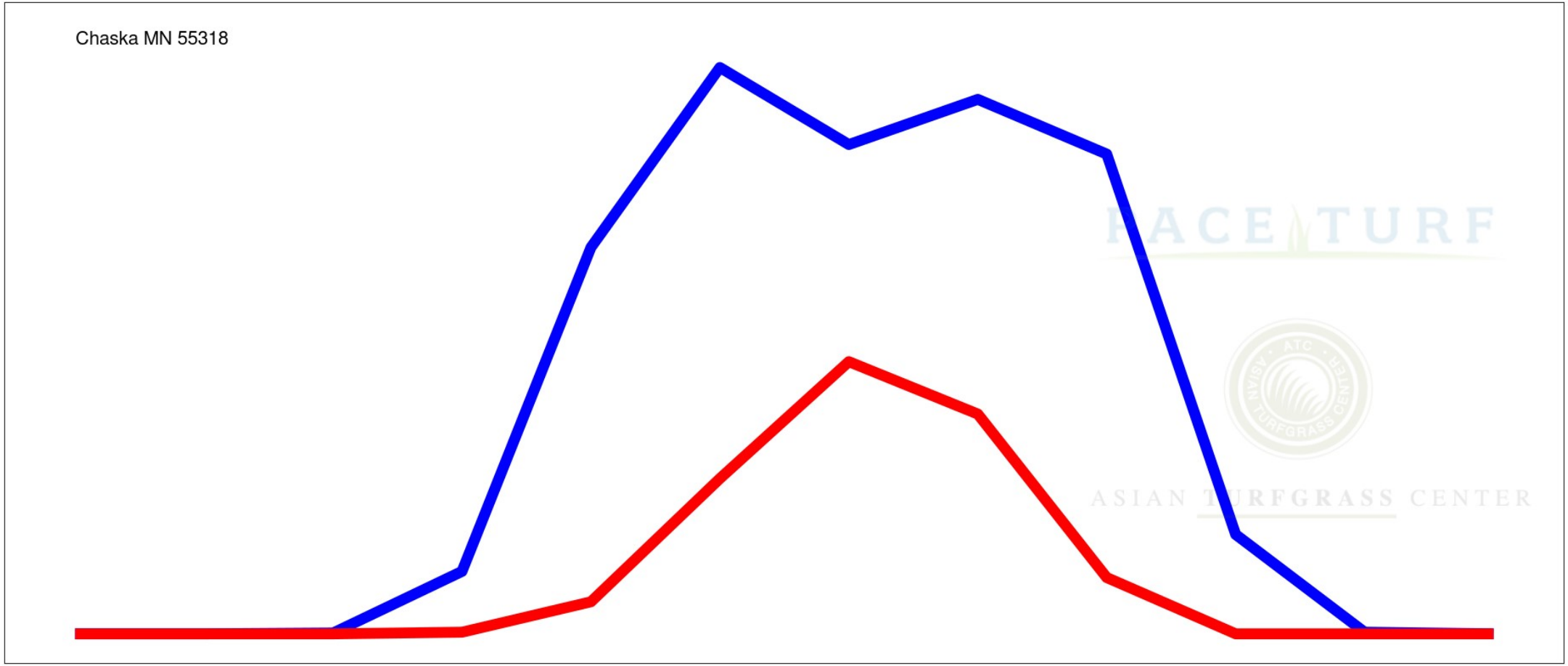


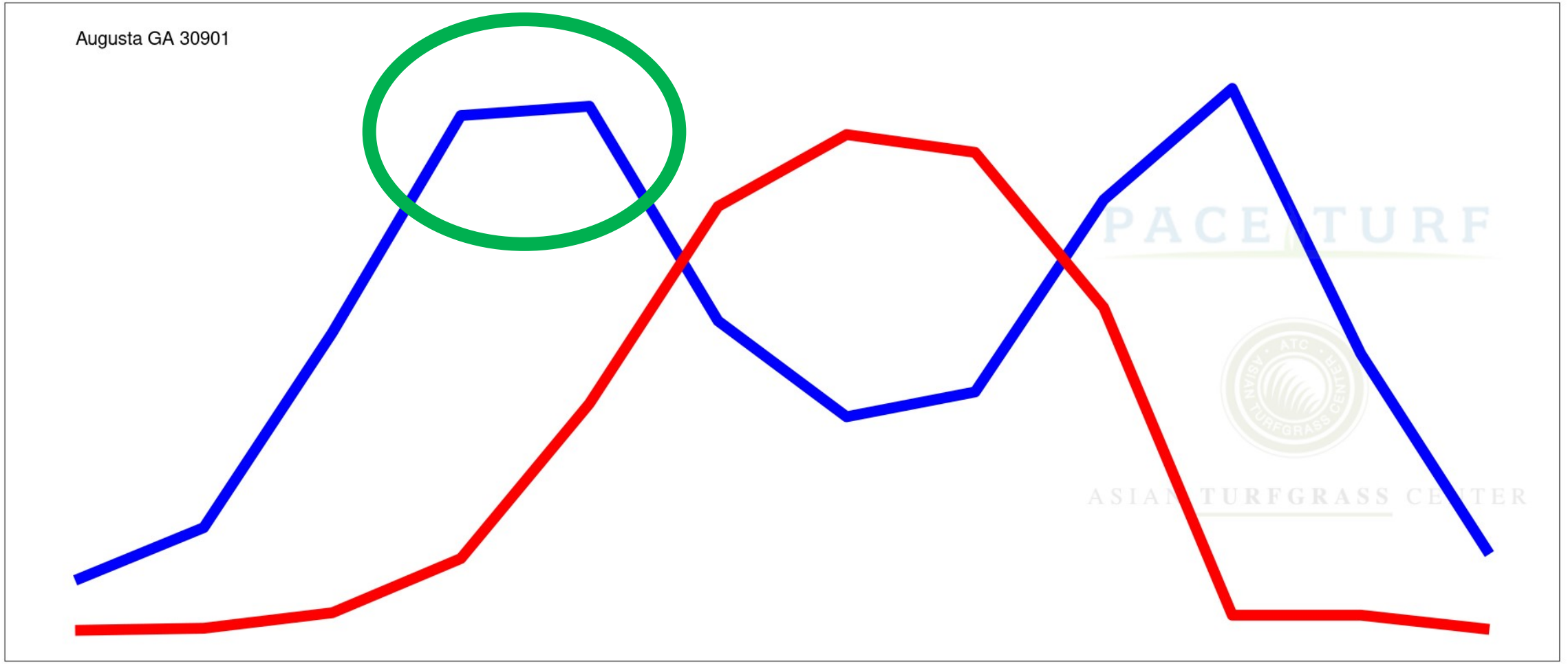
Growth potential (GP)

- How much is the grass capable of growing based on the weather conditions.
- Exp: grass in Antarctica will not grow at all. Grass in Hawaii will growth a lot.
- A number from 0-100.
- Recorded every day
- Acquired from my subscription to PACE Turf

Growth Potential

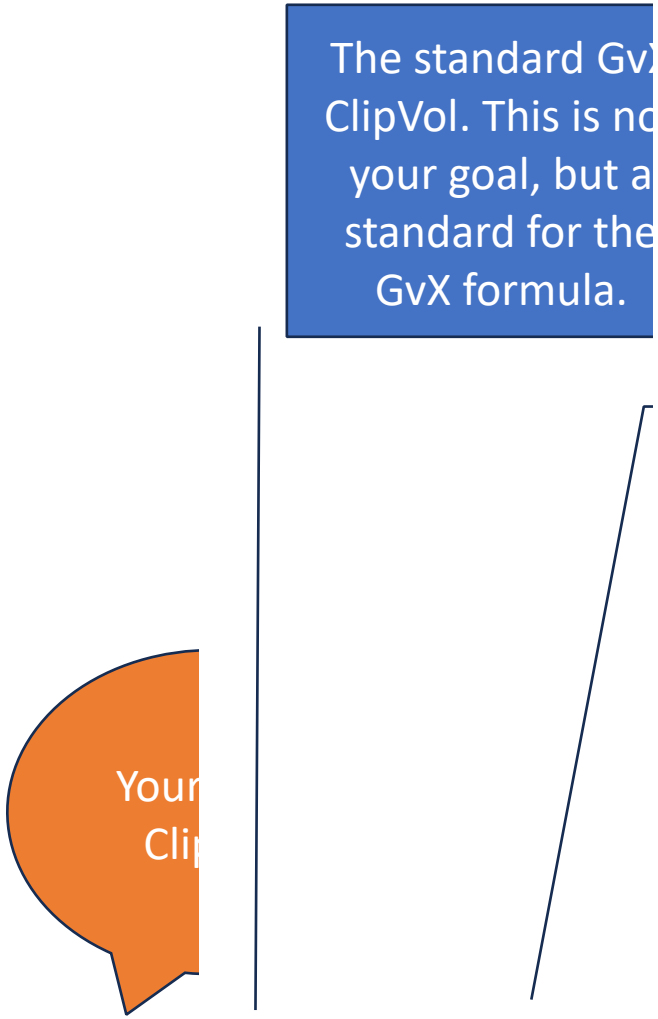



Chaska MN 55318


Augusta GA 30901

GvX (Growth v Expected)

- Developed by Jason Haines of Cabot Links (Formerly the Turf Speedo)
- It is subtly different than clipping volume alone
- Given the current weather, how much is the grass GROWING, compared to how much is it EXPECTED to grow?
- It is calculated using a formula that measures clipping volume and growth potential.
- ClipVol/20(GP/10000)=GvX
- Look at a 7, 14, or 30-day trailing average GvX.

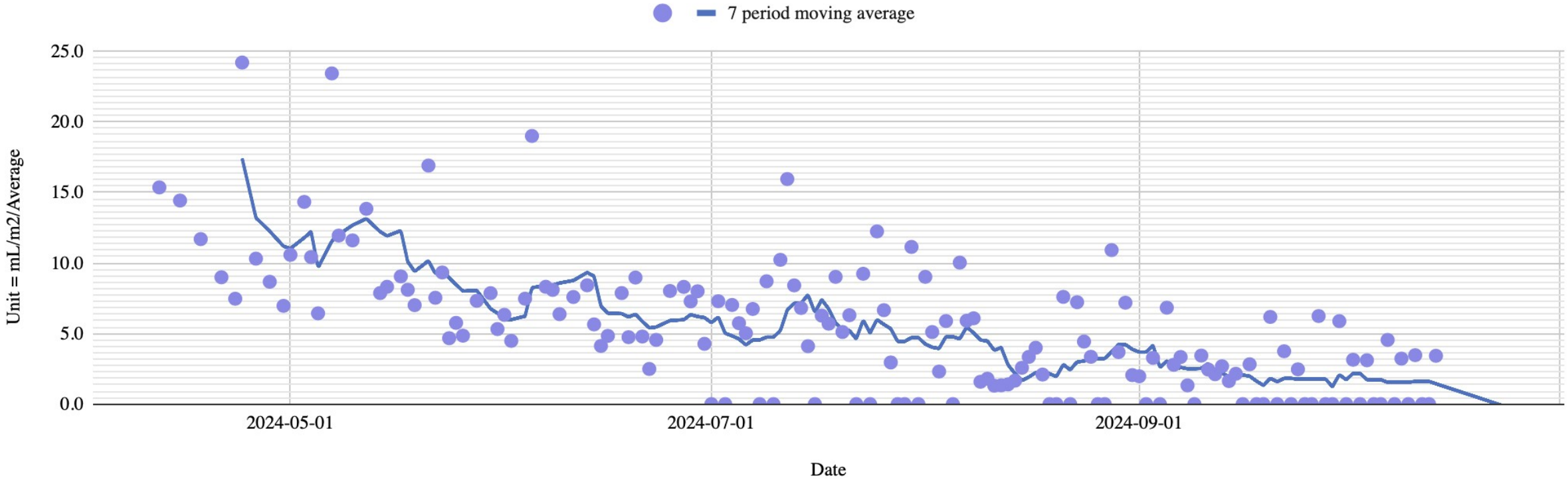


Divide by 10000 to make GvX an integer.

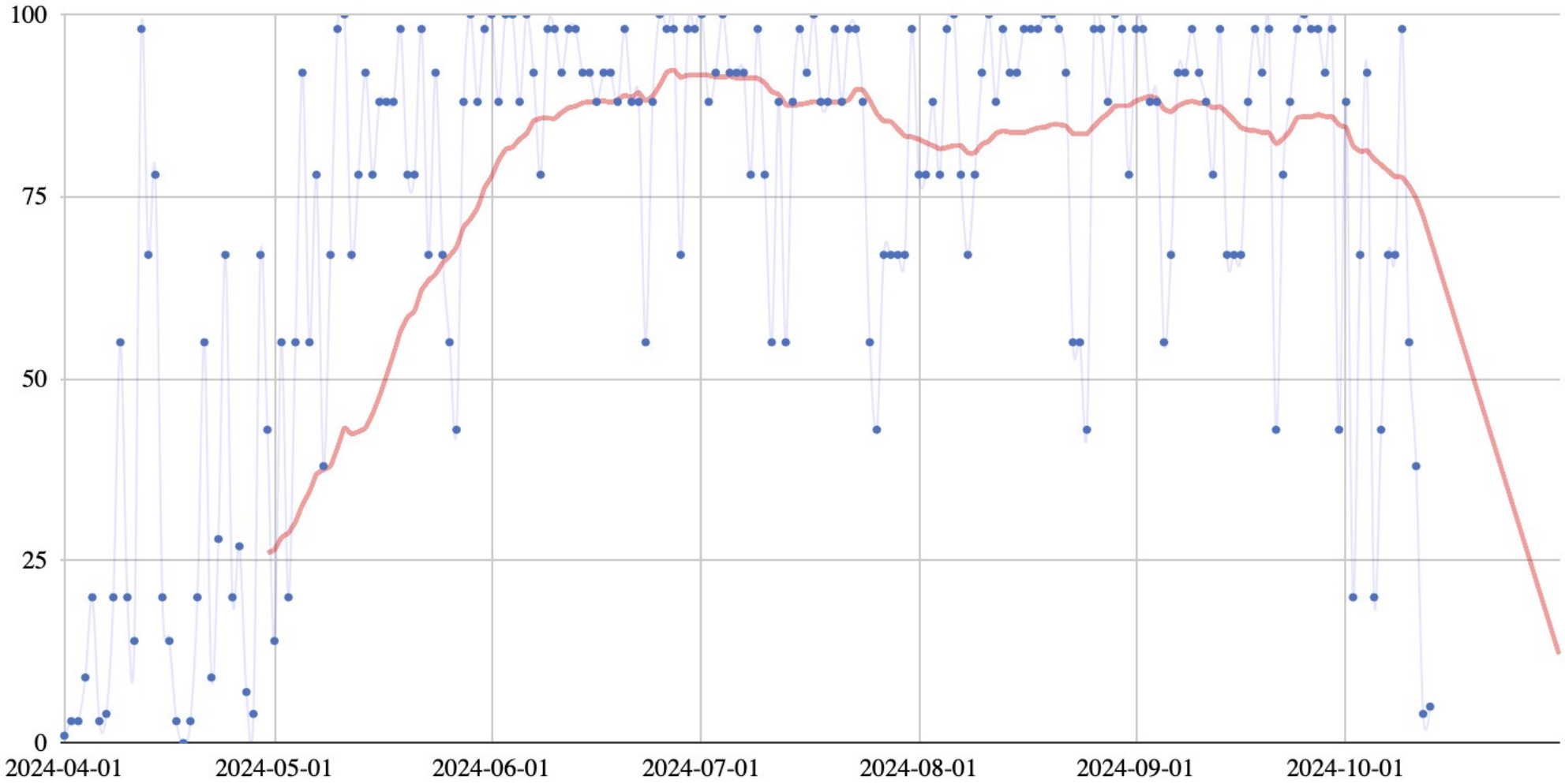
ClipVol/20(GP/10000)=GvX

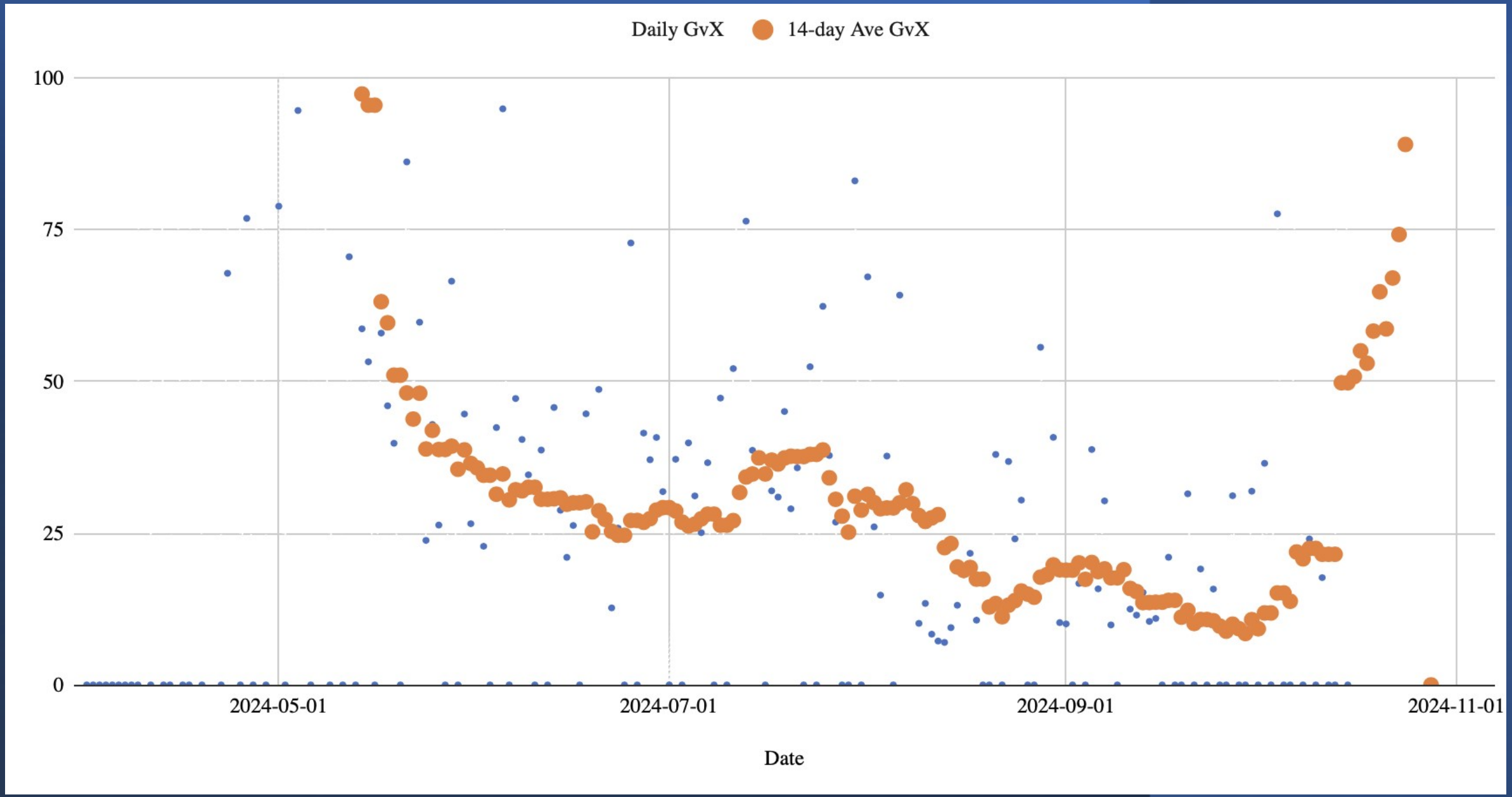
GvX explained in charts!

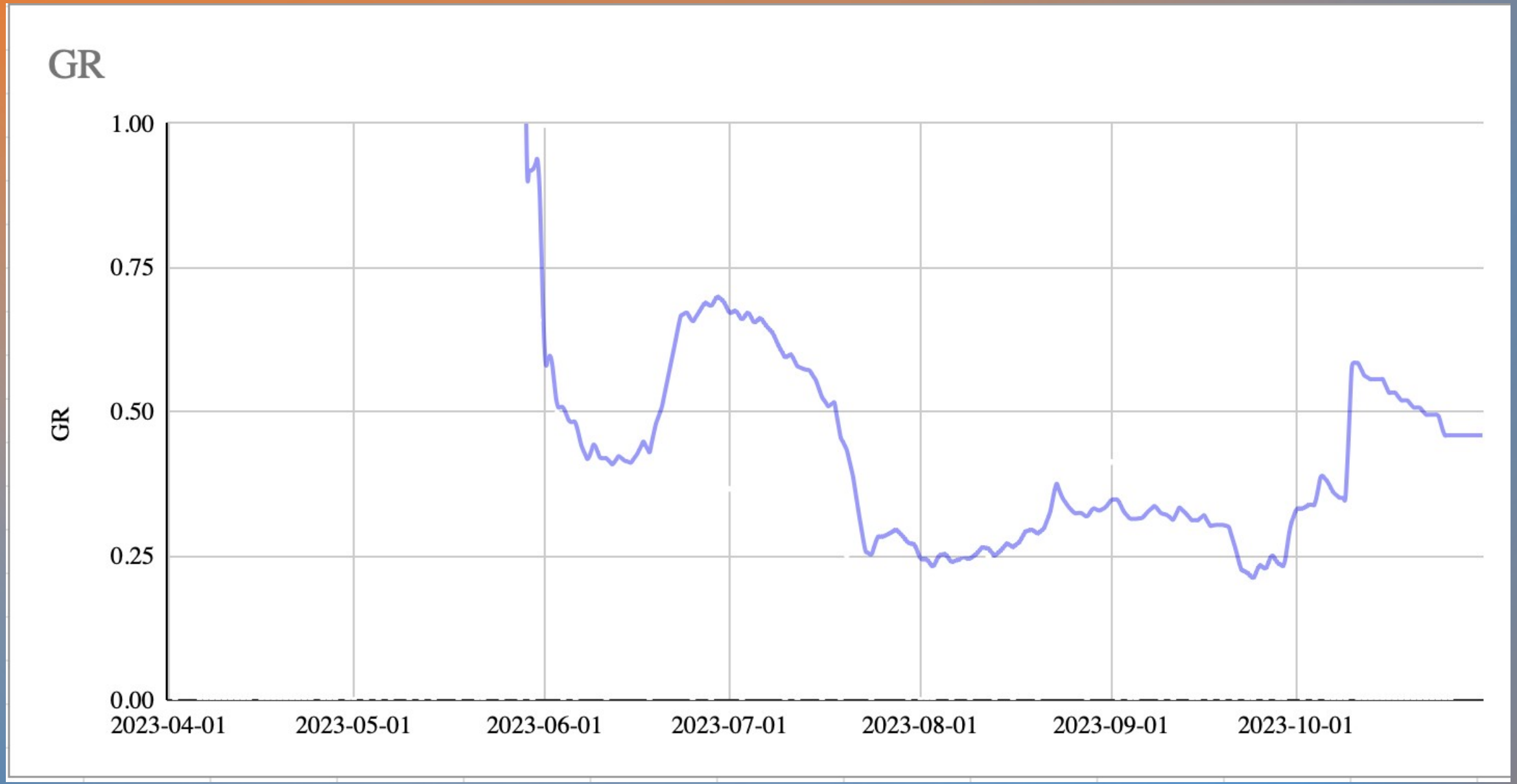
2024 Seven day average clipping volume

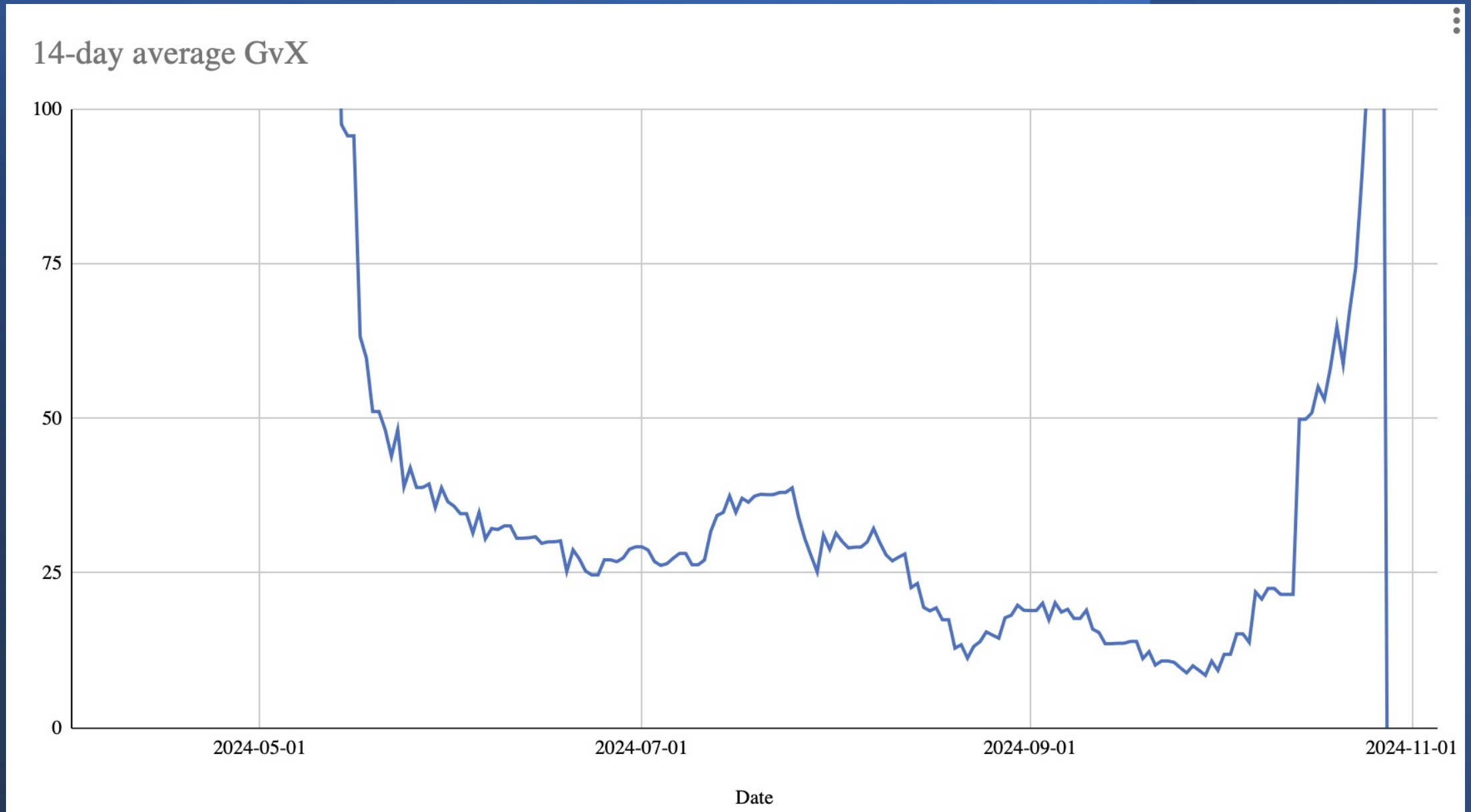


Growth Potential

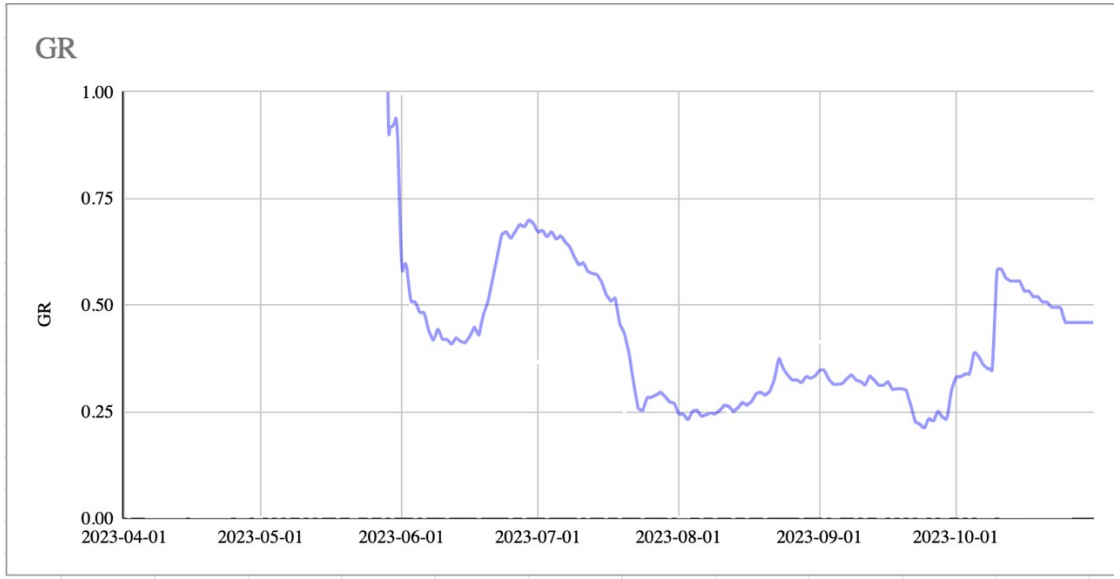



Daily GvX
14-day Ave GvX
100
75
50
25
0
2024-05-01
2024-07-01
2024-09-01
2024-11-01
Date

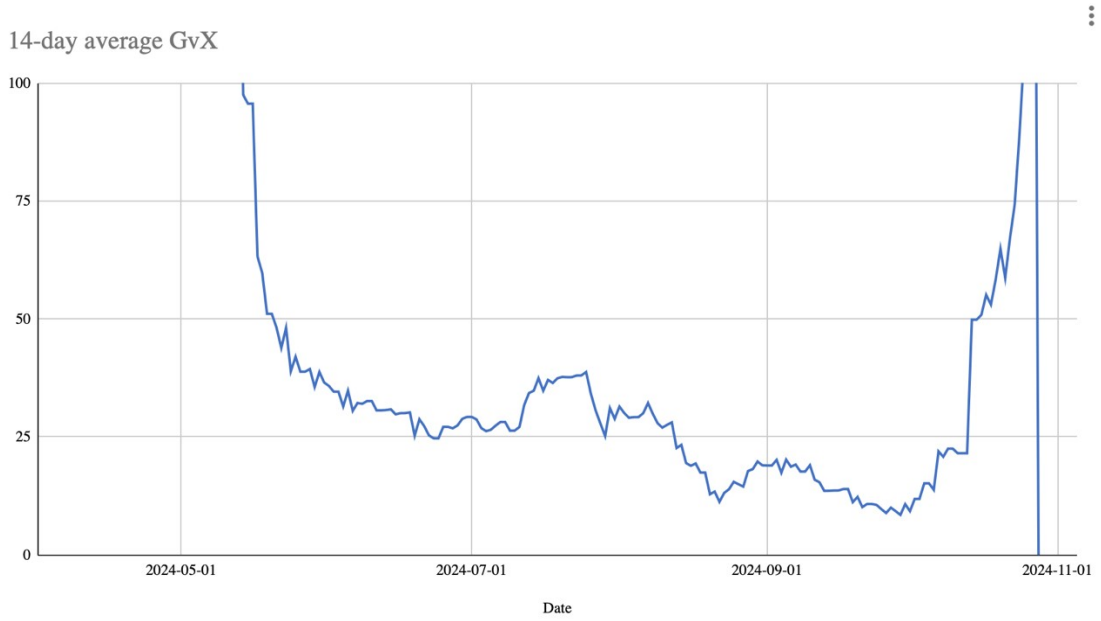

GR
GR
1.00
0.75
0.50
0.25
0.00
2023-04-01
2023-05-01
2023-06-01
2023-07-01
2023-08-01
2023-09-01
2023-10-01


14-day average GvX
100
75
50
25
0
2024-05-01
2024-07-01
2024-09-01
2024-11-01
Date

2023


GR
1.00
0.75
0.50
0.25
0.00
GR
2023-04-01
2023-05-01
2023-06-01
2023-07-01
2023-08-01
2023-09-01
2023-10-01

2024


14-day average GvX
100
75
50
25
0
2024-05-01
2024-07-01
2024-09-01
2024-11-01
Date

Your ideal GR will come from your situation

- How much grass do you want to grow?
- *Poa* is more, about 100
- Bent is less, about 20-40
- Fescue is less than bent, maybe 25
- GR corrects your growth rate for how much the grass should be growing and how much you are adding, or subtracting to that growth.
- By adjusting PGRs, or nitrogen, it is possible to create crazy consistent growth rates.

Let’s get nuts!!!

From Clipvol to Nitrogen Rates

What you need:

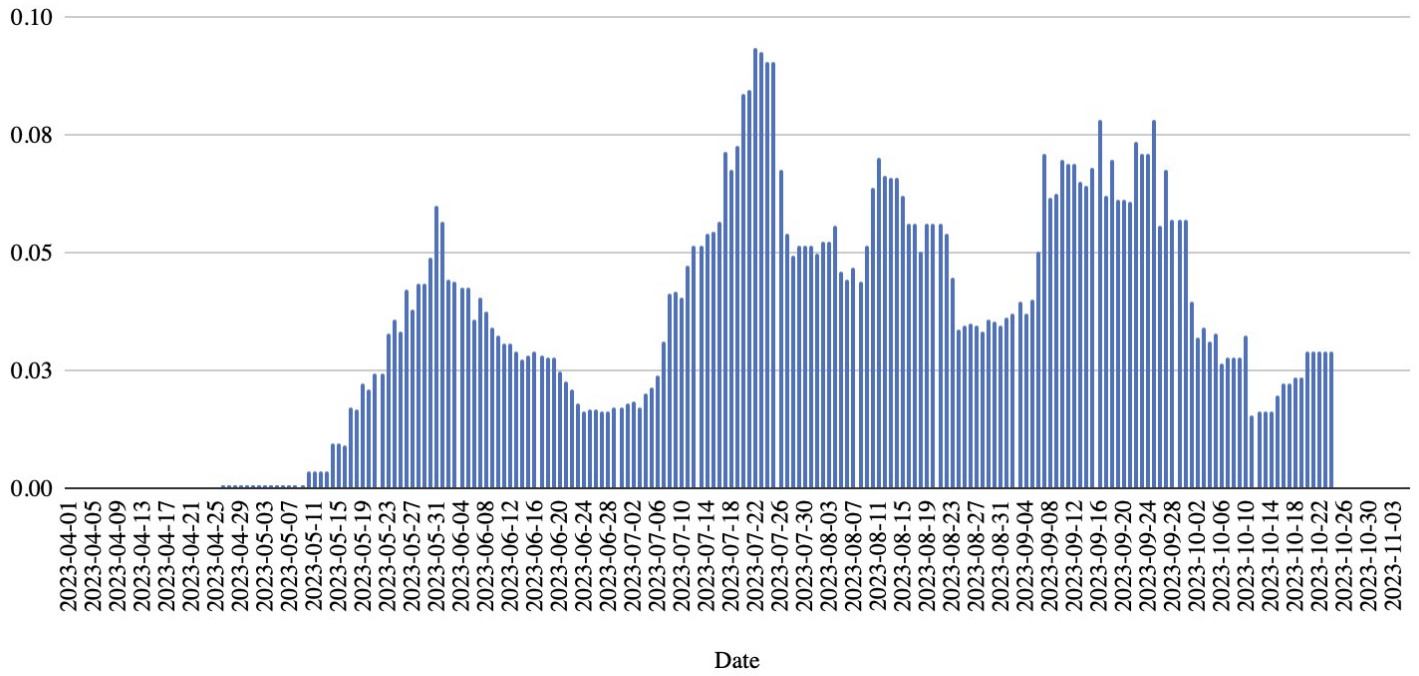
- The desired rate of nitrogen applied at each app: 2.5 kg/ha (0.05 lbs/N/ 1000 ft^2)
- In theory, this number could be anything, but the closer it is to what is usually applied, the easier it is to achieve the desired GR.

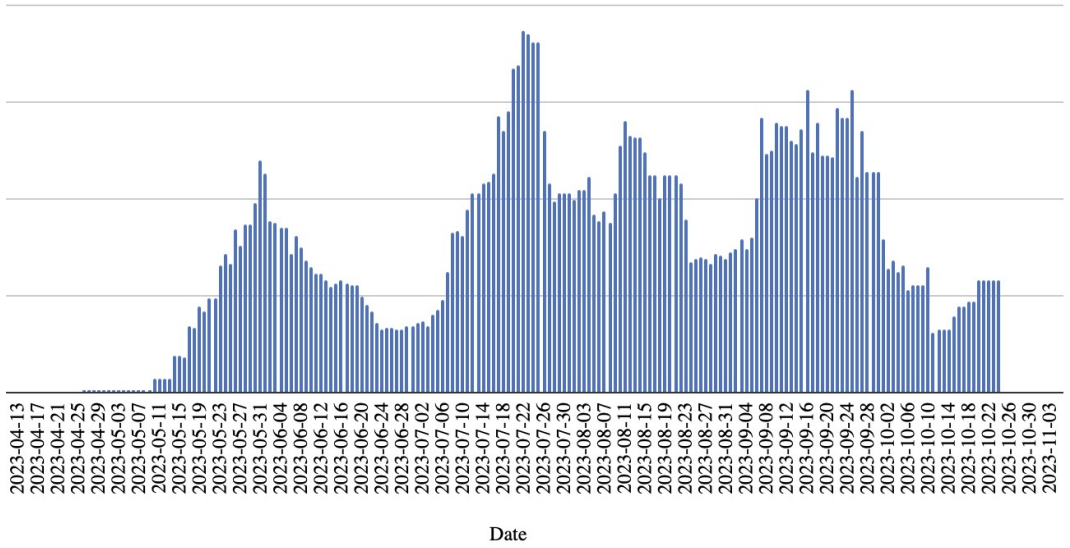
- Our desired GvX is 30 for bentgrass
- Jason Haines believes 100 was correct for *Poa*, while 25 is ideal for fine fescue.
- If you want more or less growth, you change this number.

- Trailing 14-day average GvX

The equation is…

0.05*(30(Past 14 days GvX Average))=your nitrogen rate for the next app




2023-04-13
2023-04-17
2023-04-21
2023-04-25
2023-04-29
2023-05-03
2023-05-07
2023-05-11
2023-05-15
2023-05-19
2023-05-23
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2023-06-24
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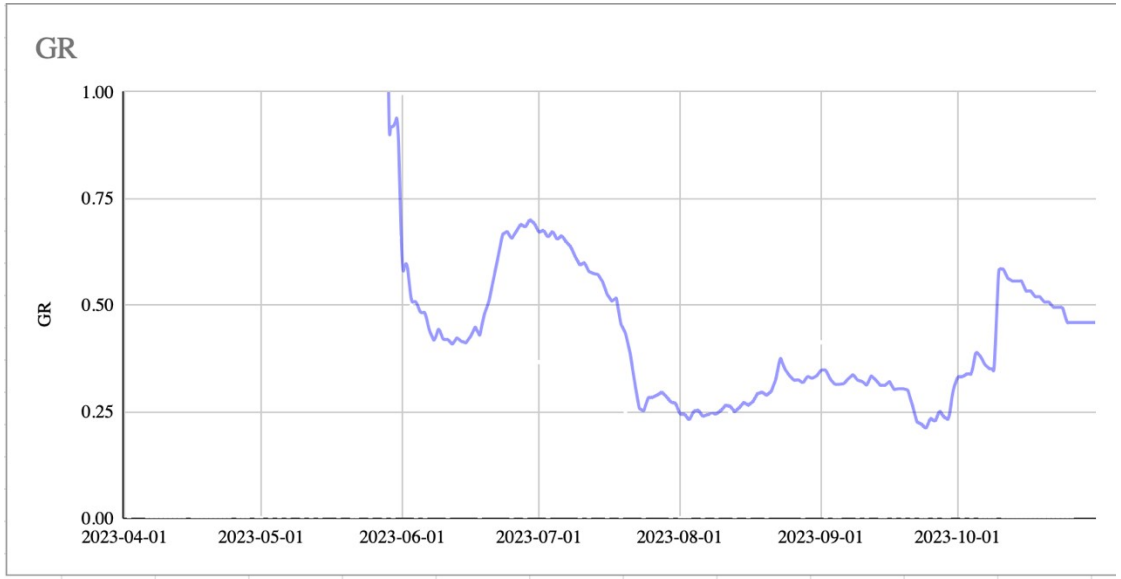
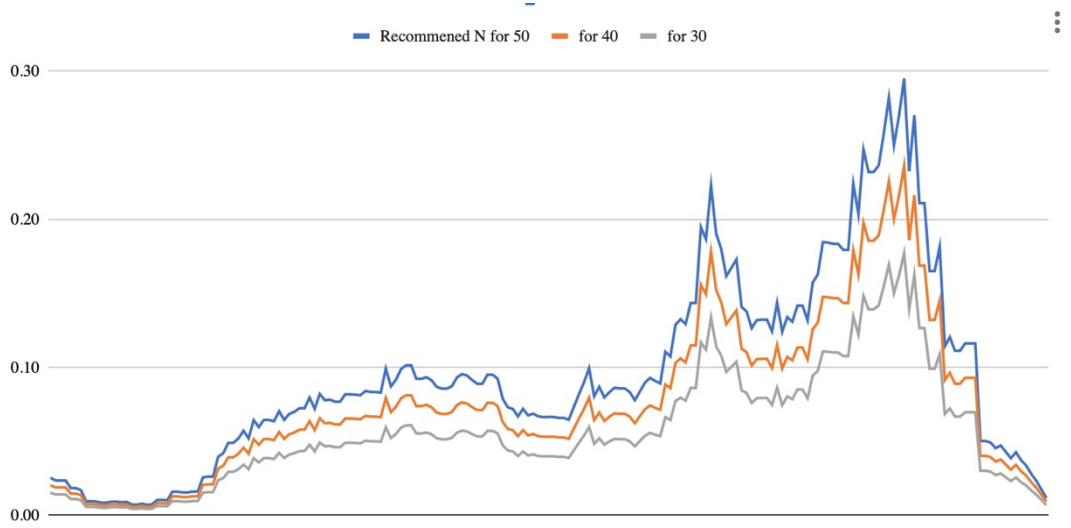
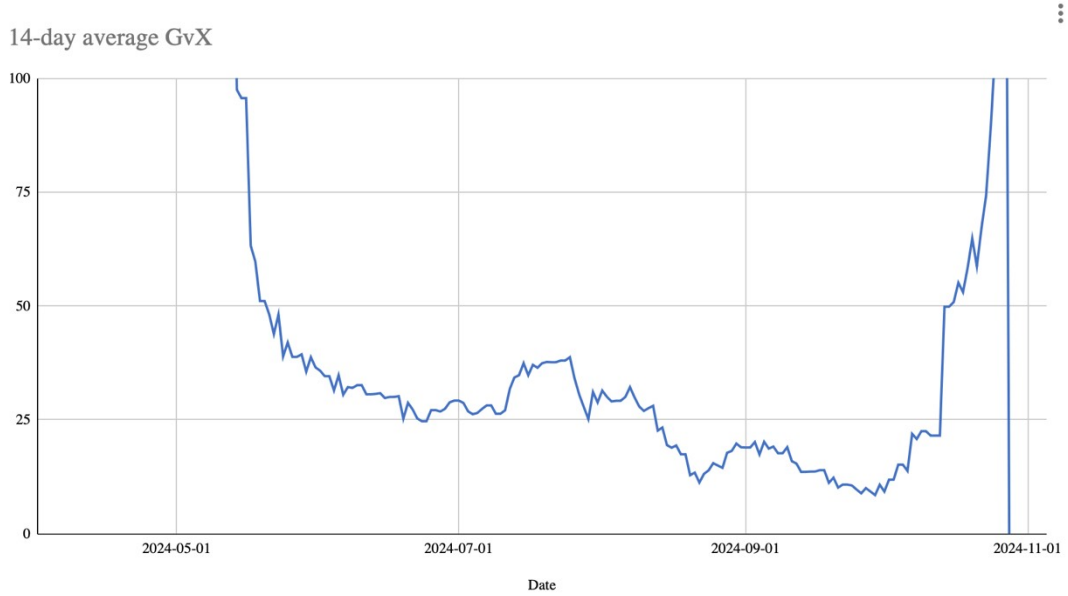
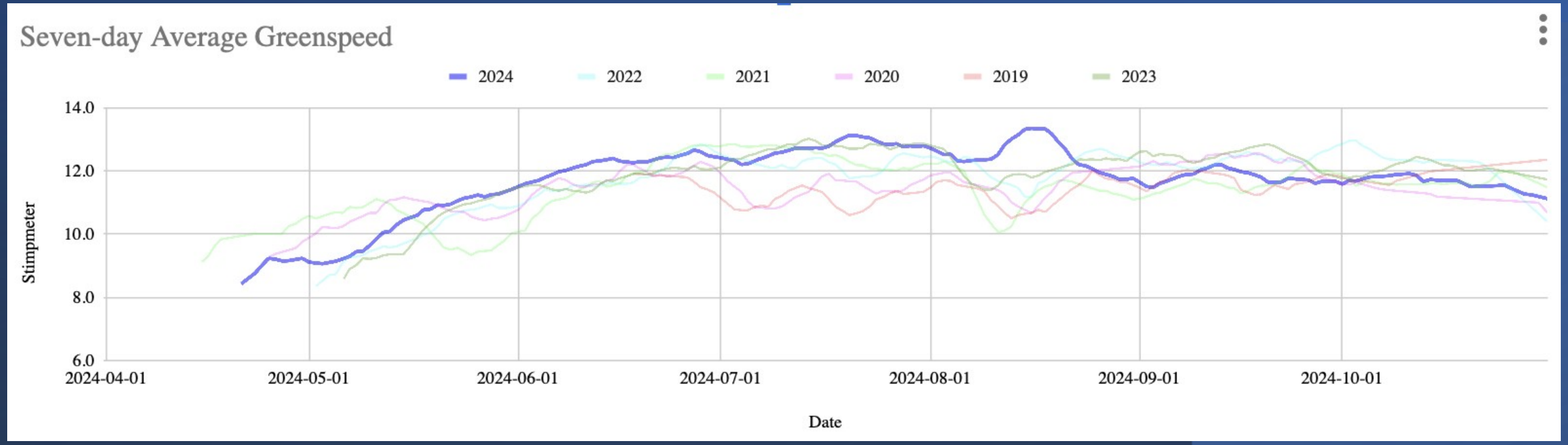
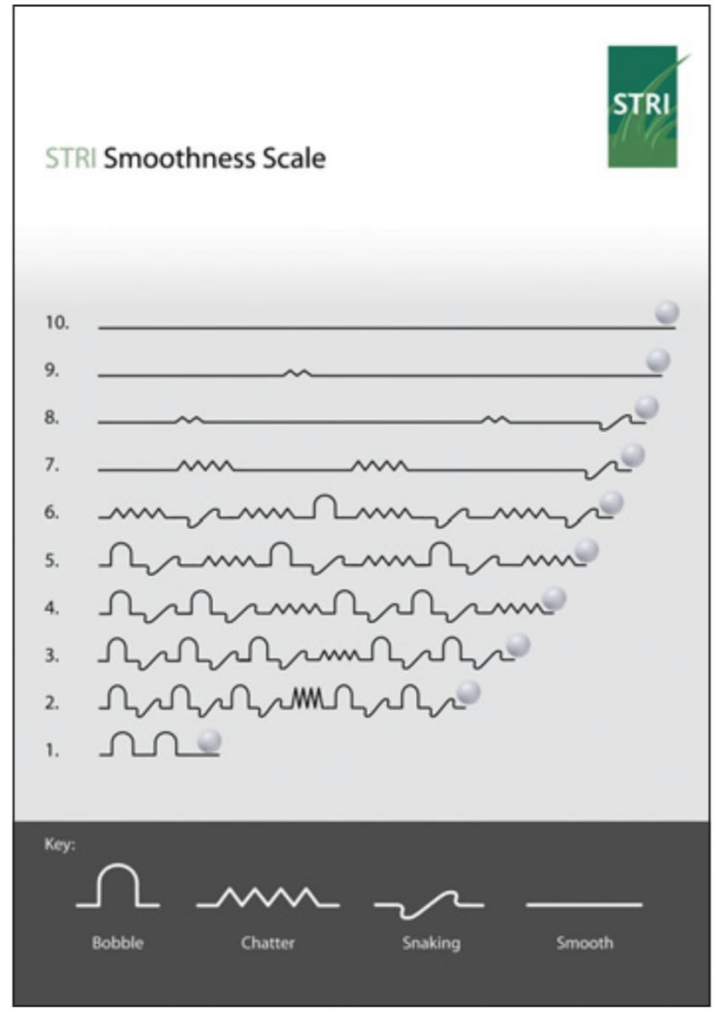
2023-10-10
2023-10-14
2023-10-18
2023-10-22
2023-10-26
2023-10-30
2023-11-03
Date

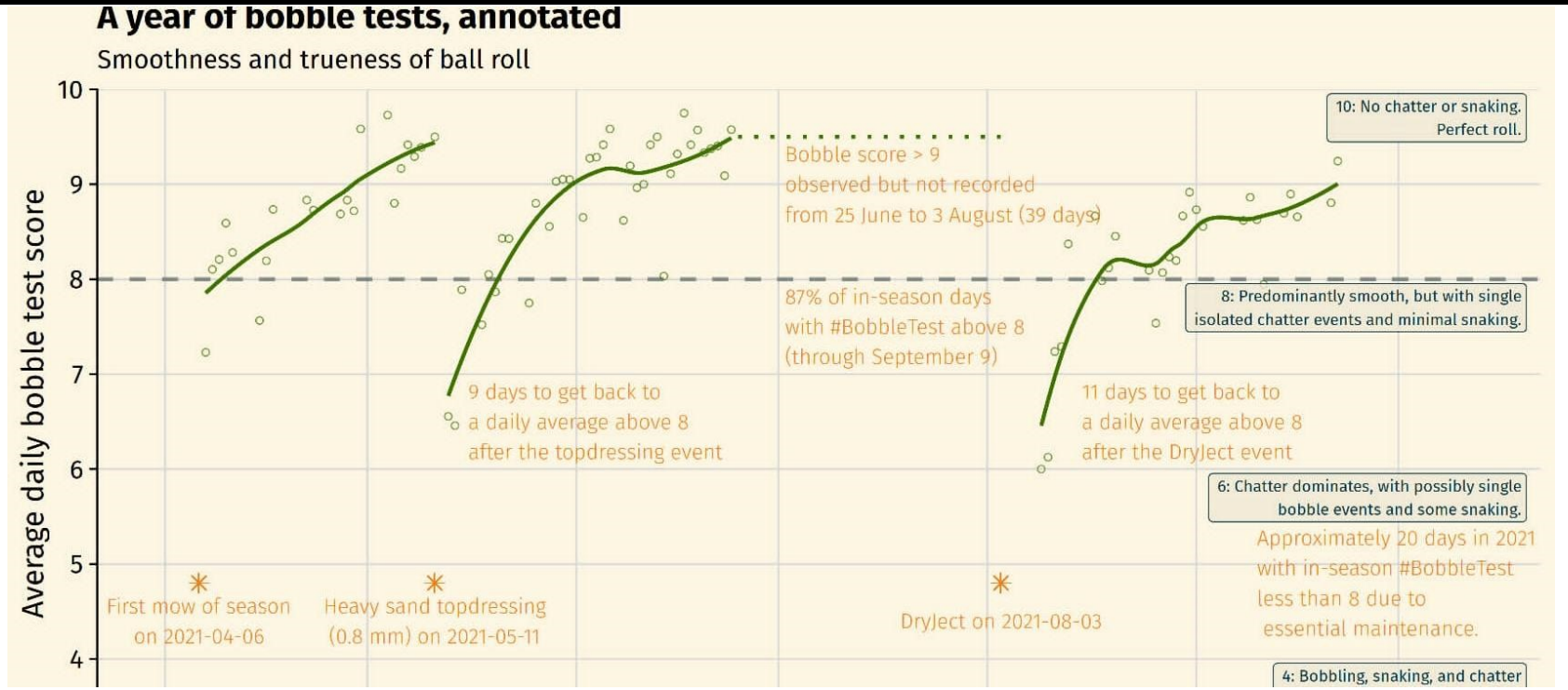

GR
1.00
0.75
0.50
0.25
0.00
GR
2023-04-01
2023-05-01
2023-06-01
2023-07-01
2023-08-01
2023-09-01
2023-10-01


Recommened N for 50
for 40
for 30
0.30
0.20
0.10
0.00


14-day average GvX
100
75
50
25
0
2024-05-01
2024-07-01
2024-09-01
2024-11-01
Date


Seven-day Average Greenspeed
2024
2022
2021
2020
2019
2023
14.0
12.0
10.0
8.0
6.0
Stimpmeter
2024-04-01
2024-05-01
2024-06-01
2024-07-01
2024-08-01
2024-09-01
2024-10-01
Date


STRI
STRI Smoothness Scale
10.
9.
8.
7.
6.
5.
4.
3.
2.
1.
Key:
Bobble
Chatter
Snaking
Smooth



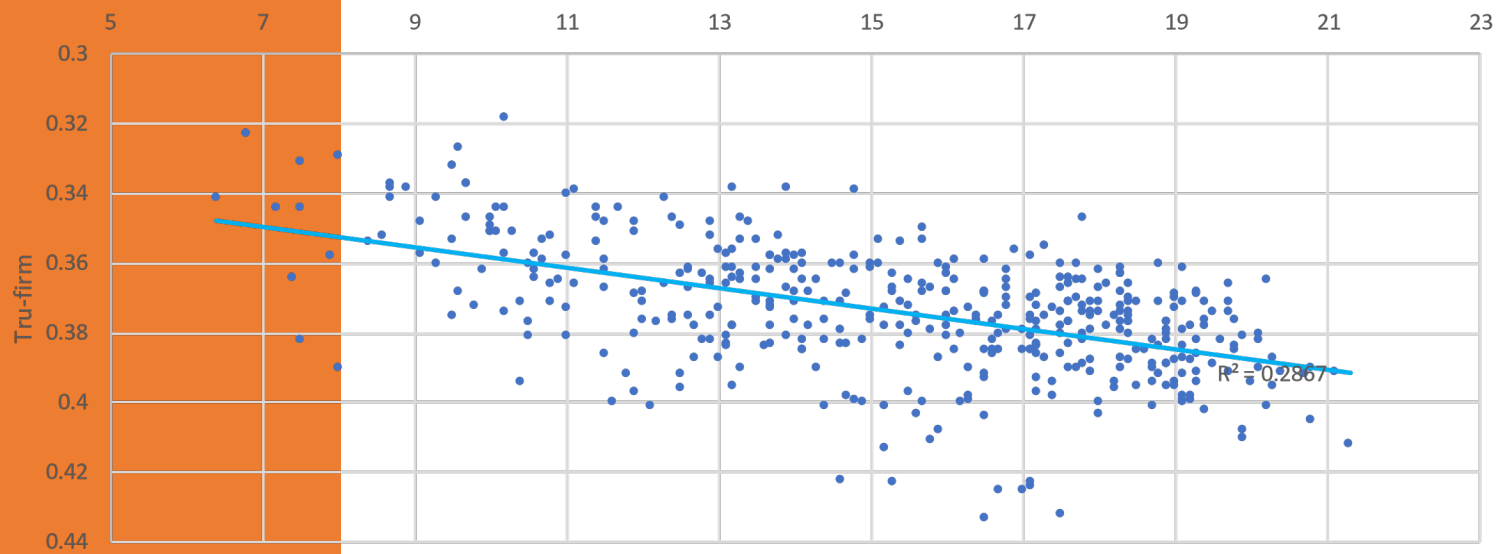
Daily

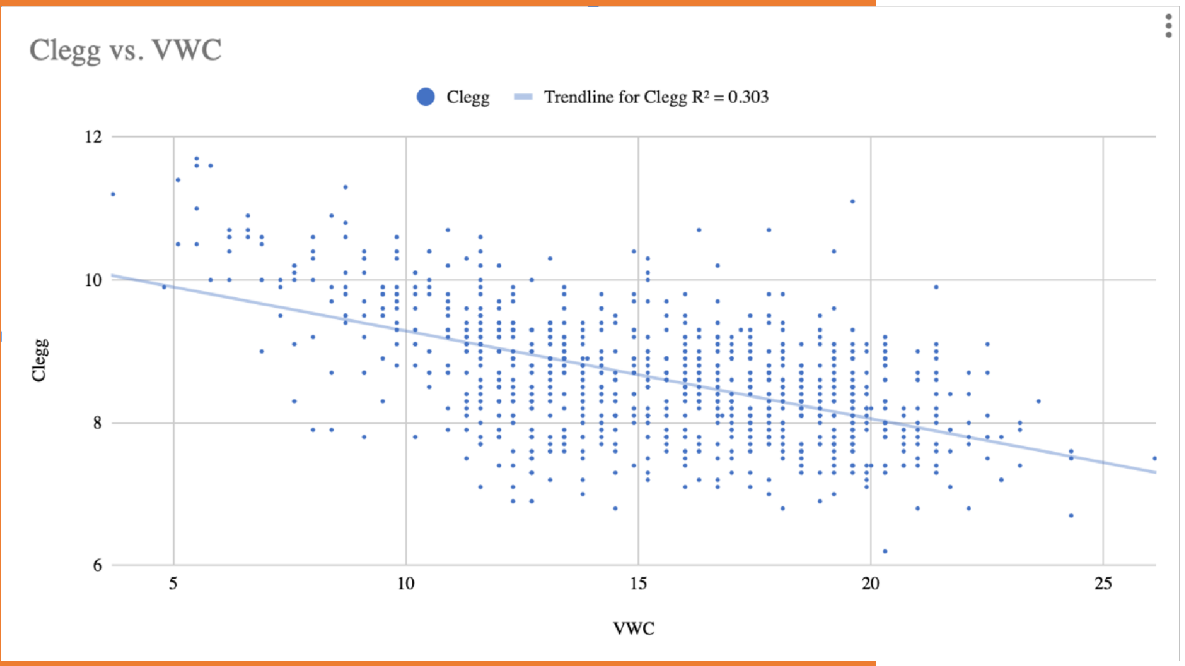
Clipping volume

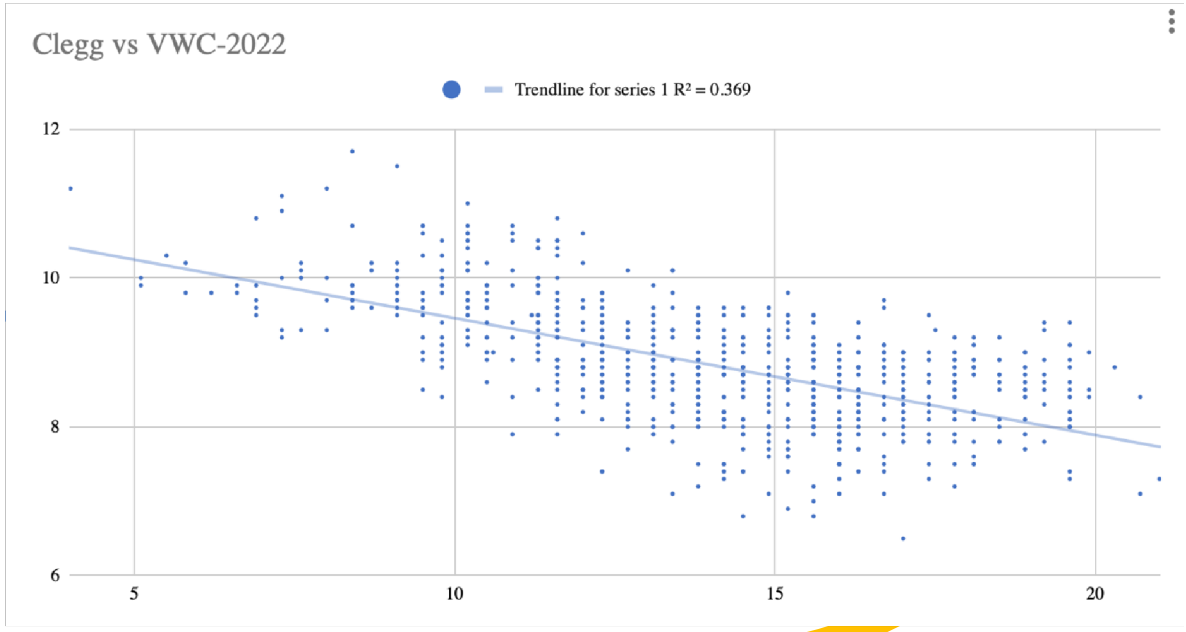
Growth potential (GP)

Growth ratio (GR)

Greenspeed


5
7
9
11
13
15
17
19
21
23
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
Tru-firm
R² = 0.2867


Clegg vs. VWC
Clegg
Trendline for Clegg R² = 0.303
12
10
8
6
5
10
15
20
25
Clegg
VWC


Clegg vs VWC-2022
Trendline for series 1 R² = 0.369
12
10
8
6
5
10
15
20

Bobble test

Weekly/less than daily

Firmness w/ VWC

Amount of nitrogen applied

Annual

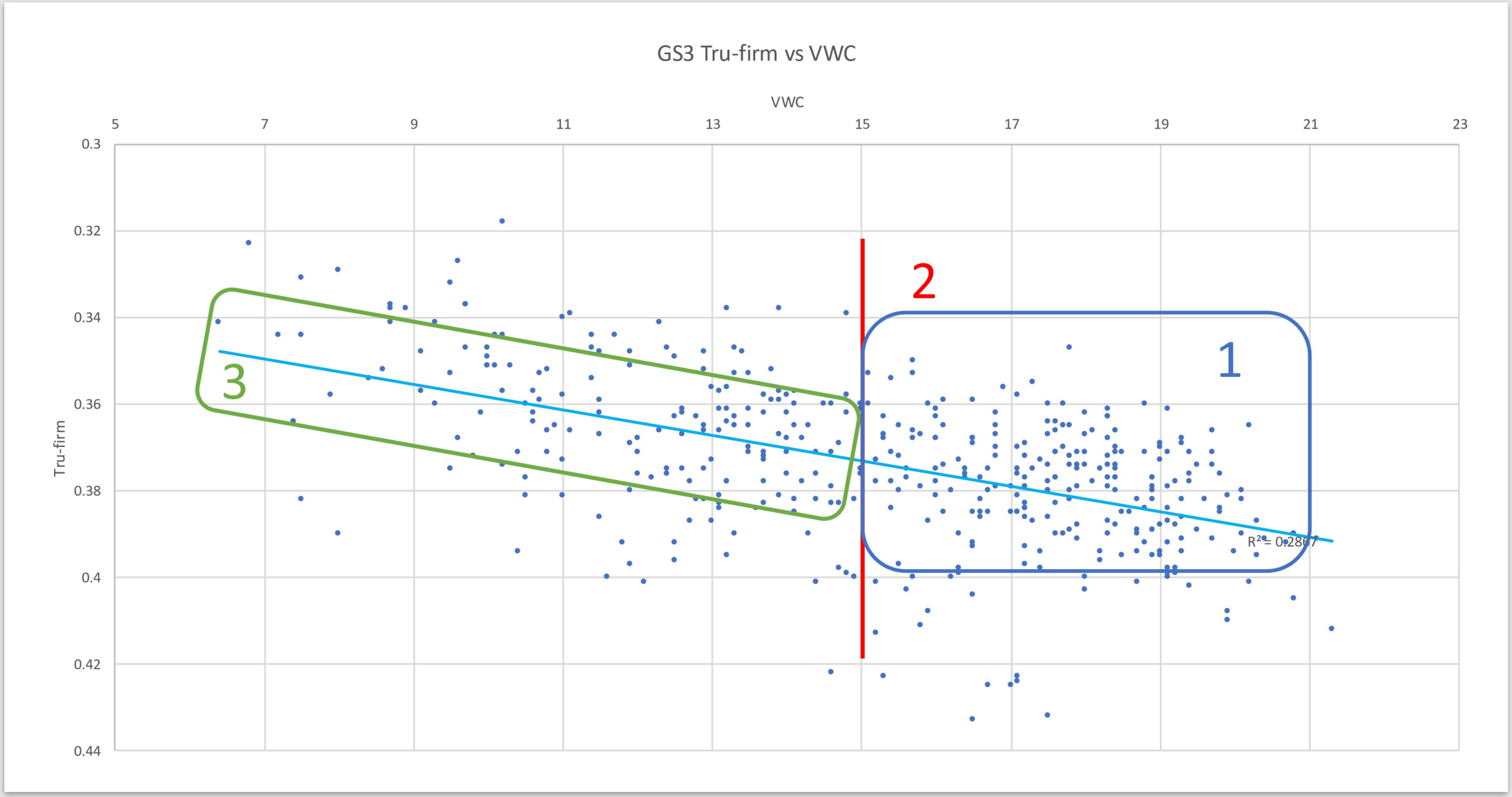
OM246

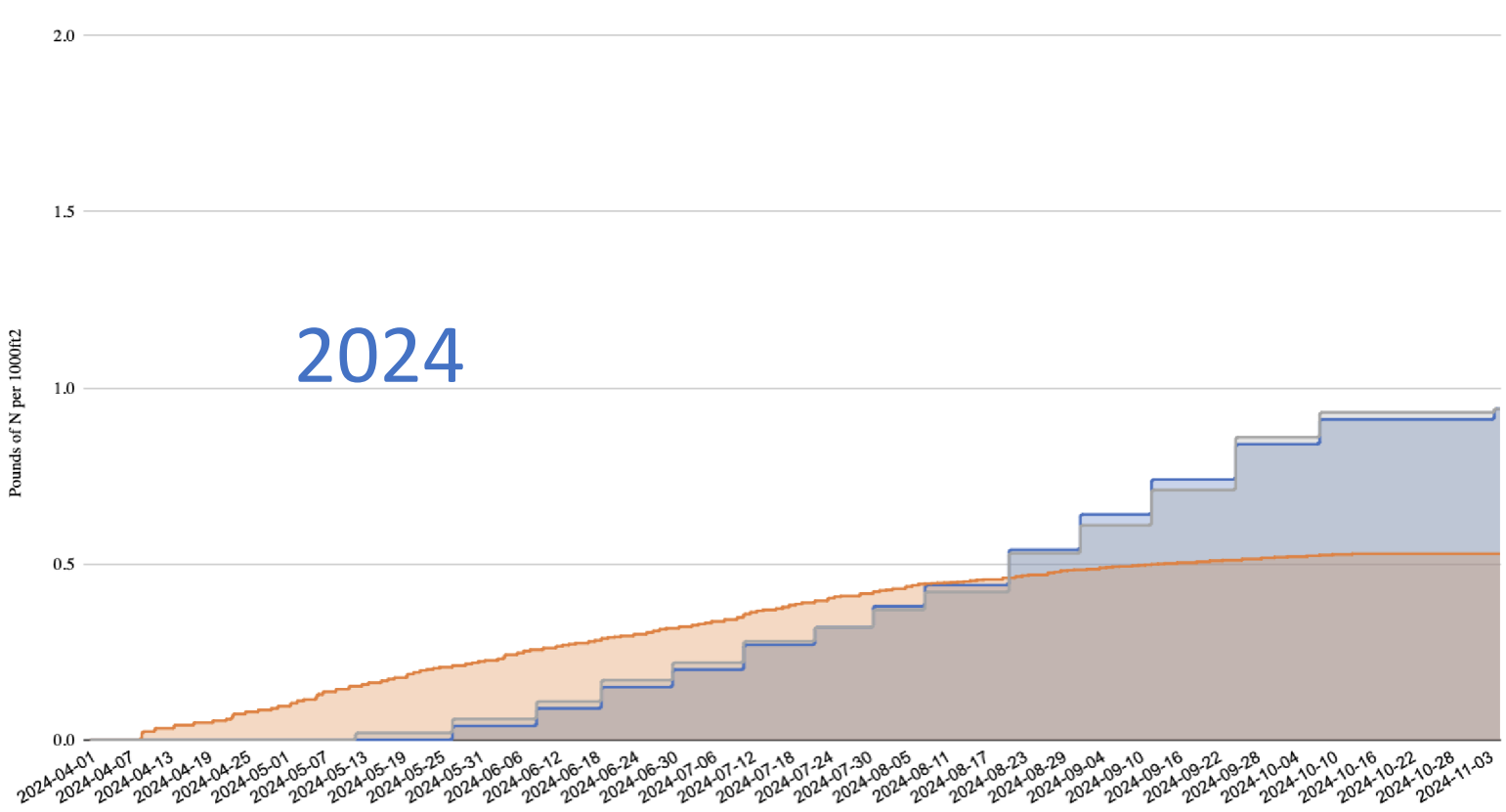
Soil nutrient analysis

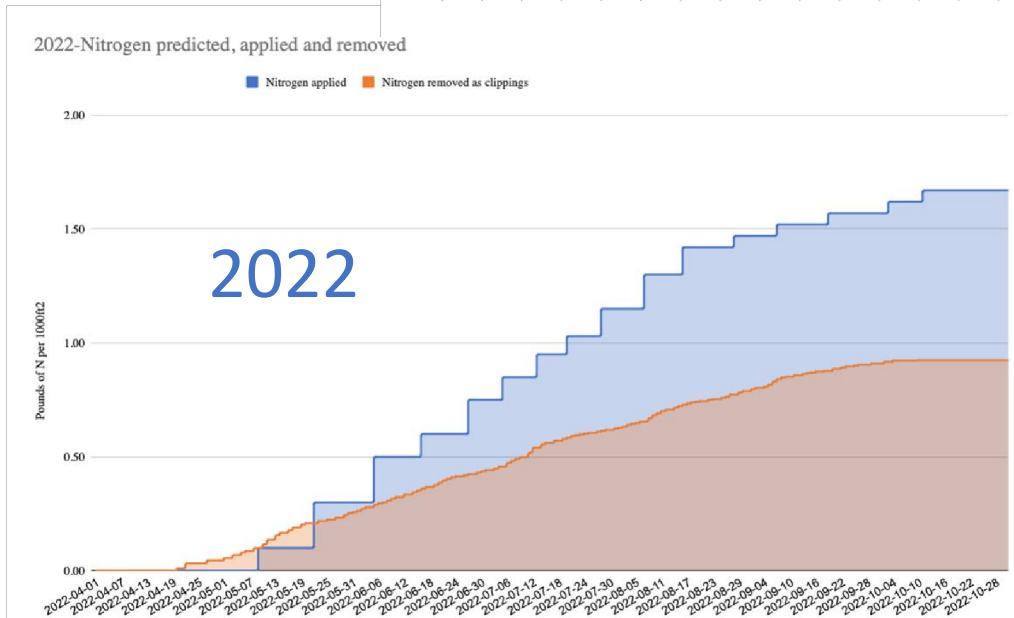
Topdressing amounts by depth

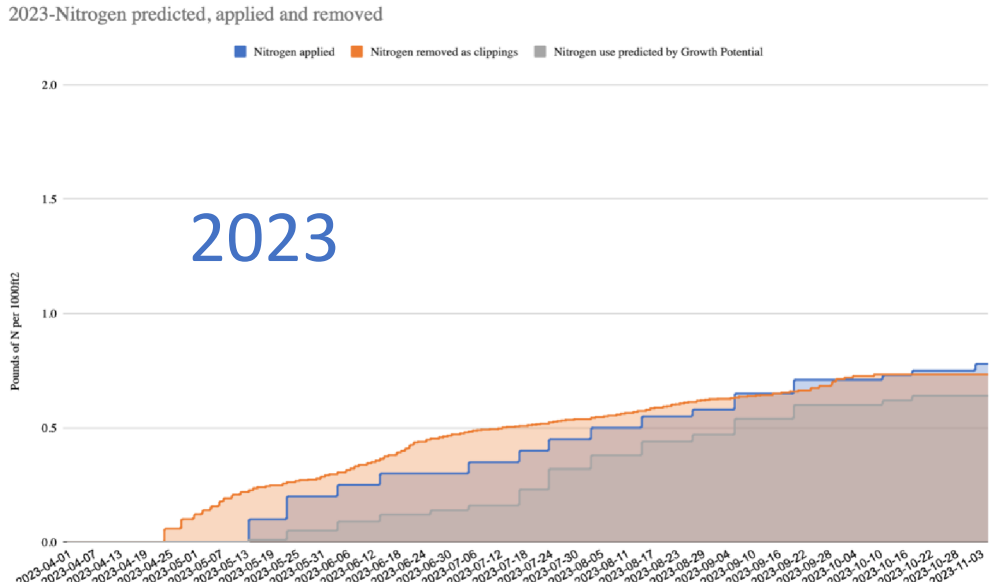
GS3 Tru-firm vs VWC

VWC


GS3 Tru-firm vs VWC
VWC
5
7
9
11
13
15
17
19
21
23
Tru-firm
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
1
2
3
R² = 0.2807


2024
Pounds of N per 1000ft2
2.0
1.5
1.0
0.5
0.0


2022-Nitrogen predicted, applied and removed
Nitrogen applied
Nitrogen removed as clippings
2022
Pounds of N per 1000ft2
2.00
1.50
1.00
0.50
0.00


2023-Nitrogen predicted, applied and removed
Nitrogen applied
Nitrogen removed as clippings
Nitrogen use predicted by Growth Potential
2023
Pounds of N per 1000ft2
2.0
1.5
1.0
0.5
0.0

1. With our greens as is (management, species, OM, sand), the firmness has a floor below which it will never drop.
2. On our greens, this minimum firmness comes at about 15% VWC.
3. From wilting to 15%, the firmness increases slightly for every incremental decrease in VWC.
4. It is reasonable to expect that this model would be accurate for any golf course surface worldwide, but with different floors (1), cutoffs (2), and slopes of the lines (3).

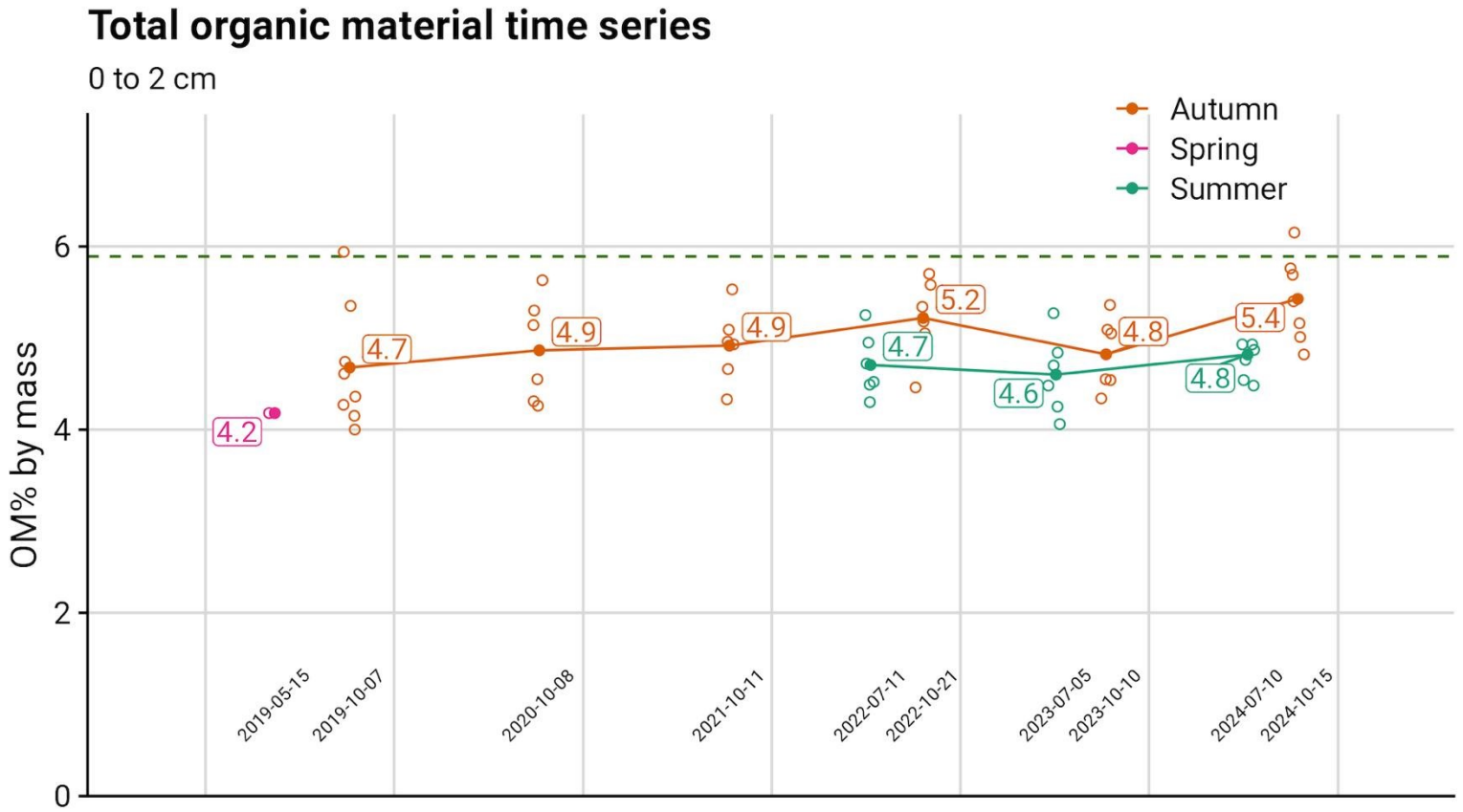

CABOT

results

- Daily
- Clipping volume
- Growth potential (GP)
- Growth ration (GR)
- Greenspeed
- Bobble test
- Weekly/less than daily
- Firmness w/ VWC
- Amount of nitrogen applied
- **Annual**
- **OM246**
- **Soil nutrient analysis**
- **Topdressing amounts by depth**

OM246

amount, but we don't desire to go higher.



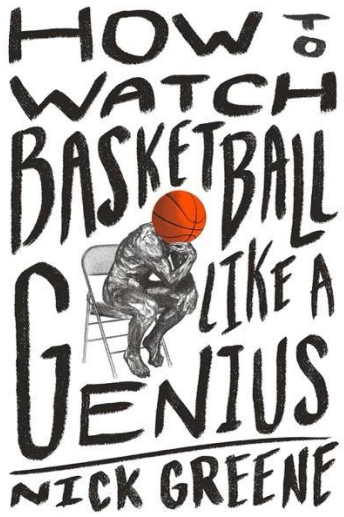
- We don't have a target. If we can meet performance metrics, then we have the right
- How are our practices impacting organic matter in the root zone?

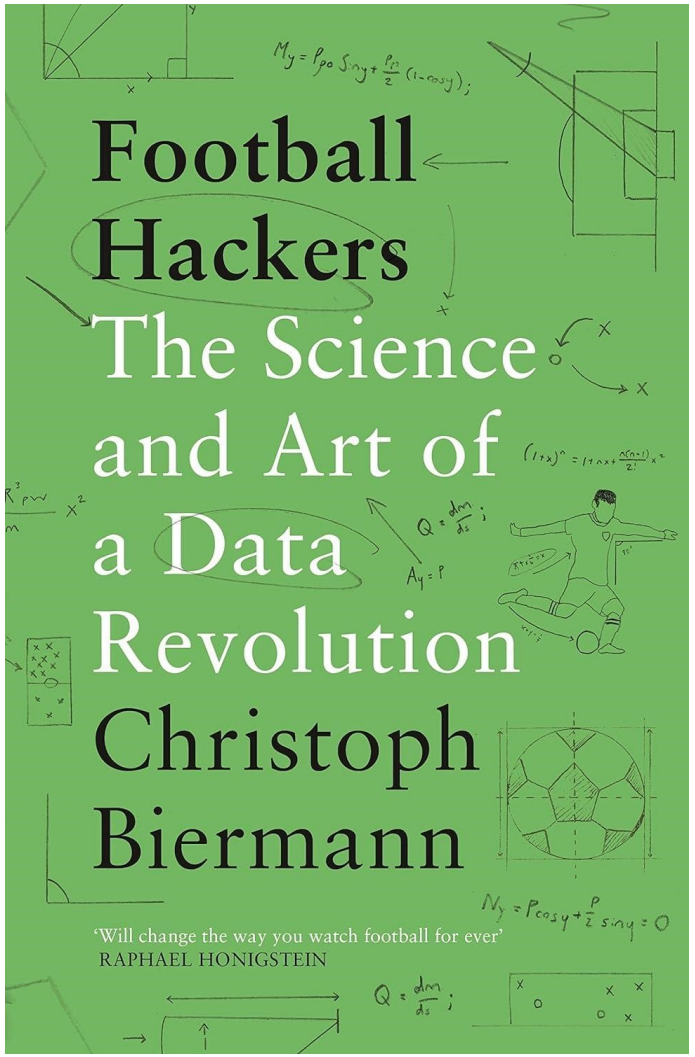
- What and how much do we need to do to keep it there?
- 2022 and 2023, no aerification
- tOM is lower in the summer.
- The overall change is minimal over 5 years.

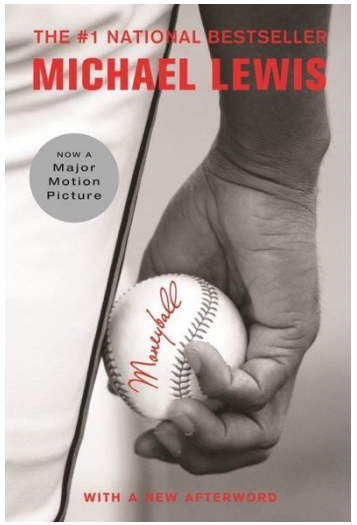
Soil Nutrient Analysis

From mass to depth…

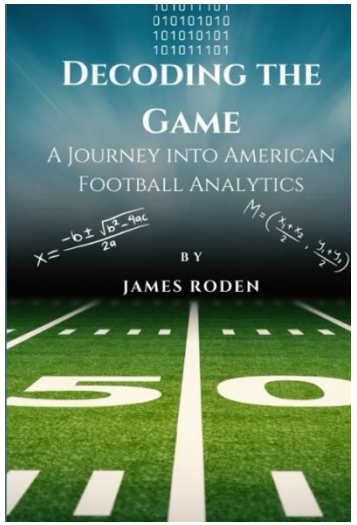
- 320 grams of sand in the catch pan
- The catch pan is 0.2 m^2
- We want to get to kg/m^2
- $(0.32kg/0.2m^2)=1.6\ kg/m^2$
- Now, we want to get to L/m^2 because it also equals mm.
- $1.6\ kg/m^2/1.63$ (bulk density of sand)=0.982mm
- It is very easy to set up a spreadsheet with the calculation.


HOW TO
WATCH
BASKETBALL
LIKE A
GENIUS
NICK GREENE


Football
Hackers
The Science
and Art of
a Data
Revolution
Christoph
Biermann
'Will change the way you watch football for ever'
RAPHAEL HONIGSTEIN


THE #1 NATIONAL BESTSELLER
MICHAEL LEWIS
NOW A
Major
Motion
Picture
Moneyball
WITH A NEW AFTERWORD


FC MIDTJYLLAND
1999


DECODING THE
GAME
A JOURNEY INTO AMERICAN
FOOTBALL ANALYTICS
BY
JAMES RODEN

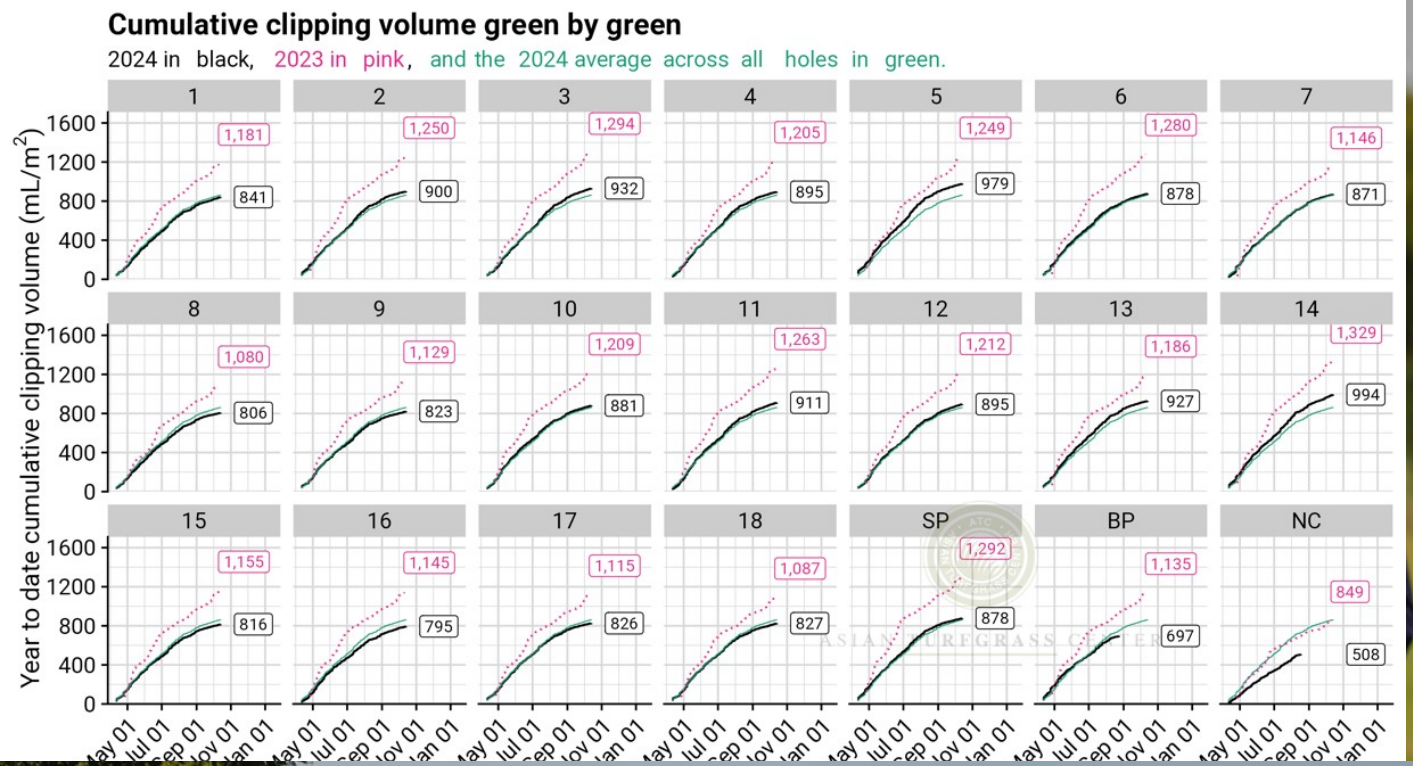

USGA

When you collect and use data:

- Your use of resources will become more efficient, using what's necessary better and not using what's unnecessary.
- You'll punch above your weight.
- You'll be able to allocate more funds to personnel.
- Your golfers will be more satisfied.

- You’ll win more!


2017NBA
CHAMPIONS


Cumulative clipping volume green by green
2024 in black, 2023 in pink, and the 2024 average across all holes in green.
Year to date cumulative clipping volume (mL/m²)
1
1,181
841
2
1,250
900
3
1,294
932
4
1,205
895
5
1,249
979
6
1,280
878
7
1,146
871
8
1,080
806
9
1,129
823
10
1,209
881
11
1,263
911
12
1,212
895
13
1,186
927
14
1,329
994
15
1,155
816
16
1,145
795
17
1,115
826
18
1,087
827
SP
1,292
878
BP
1,135
697
NC
849
508
0
400
800
1200
1600
May 01
Jul 01
Sep 01
Nov 01
Jan 01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