

Upright and Recumbent Bicycle Speed Comparison

Ten Configurations Measured at 200 Watts

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Laidback Bike Report

Ron Thompson

Generation Four Bicycle System Engineering, LLC

ronaldathompson7641@gmail.com

Bel Air, Maryland, USA

***Generation
Four
Bicycles***

www.g4bikes.com



Background

- I am a lifelong rider, commuter, engineer and shop guy - With a passion to reinvent the bike.
- Bikes can be so much better, particularly for people like me and Peggy.
 - Start with the fundamentals
 - Effectively integrate the rider - For responsiveness, control, efficiency, comfort and safety
 - Let the rider fully engage their body as when standing to pedal an upright
 - Ignore UCI constraints – Which made all bikes uprights and all riders racers
- Today, I am going to talk about speed and efficiency – An important part of, “the simple pleasure of a bike ride”.



Presentation Overview

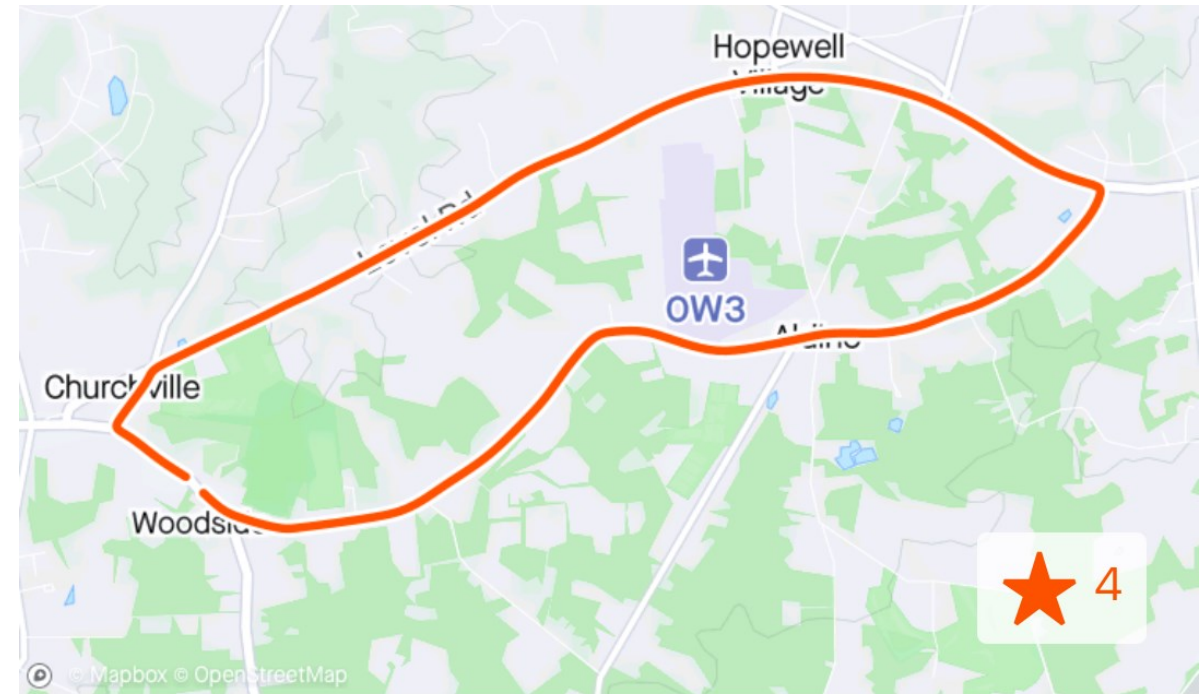
- Approach
- Scope
- Data Page for Each of the Ten Configurations Tested
 - Photo of Each Bike As Tested
 - Bike “Speed Specs.” - ~Frontal Area, Tires, Drivetrain, Weight
 - Weather
 - Summary Result
 - Detailed Data Logs
 - Comments
- Results
- Comparisons
- Conclusion

How fast are the different types of bicycle? Not the rider, just the Bike?

Approach

Bicycle Speed Comparison

- Averaged 200 Watts over each trial
 - Consistently varied power through each ride
 - More on climbs
 - Less on descents
 - Actual results are shown
- Paved course was an 8.56 miles “Strava Segment”.
- As shown by the inset, elevation is rolling.
- Climbing totaled about 325 feet.
- A closed loop was used to reduce wind and elevation effects.
- Stayed on the drops for upright bike aerodynamics.
- Data was collected using Garmin Bicycle Computer and Power Pedals, and Training Peaks & Strava software.



Segment

**Race Team Training Loop With
the Start /Finish at Arctic Cir...**



Distance

8.56 mi

Elevation

325 ft

Scope

- The bicycles tested were:

- | | |
|----------------------------|-----------------|
| A. Trek 930 | Mountain Bike |
| B. Surly Long Haul Trucker | Touring |
| C. Trek 5500 | Race |
| D. Bridgestone RB1 | Race |
| E. Rans Stratus 700 | LWB Recumbent |
| F. P38 Lightning | SWB Recumbent |
| G. G4 Gravel | Prototype 3 |
| H. G4 Sport | Prototype 4 |
| I. G4 Race | Prototype 6.5 |
| J. G4 Race | P6.5 w/Fairings |

- Detailed results provided are:

- Power
- Cadence
- Heart Rate
- Speed and Time
- Grade
- Weather
- Test Date

***The "G4 Race"
is a new
configuration,
optimized for hand
power input and
speed.***

A.



B.



C.



D.



E.



F.



G.



H.



I.



J.



Trek 930 Mountain Bike



10/06/2022 17.8 mph 28:49



Partly Cloudy, 72 °F. Feels like 72 °F. Humidity 56%. Wind 2.9 mi/h from W.

Weight: 33 lbs.
Bar Width: 22"
Seat Height: 43"
Crankset Height: 12"
Tires: 26 x 2.1, w/Ribbed Tread ("Rockster" brand)
Gearing: 26-38-46 x 12-30 (23-104 gear inches), 175mm cranks



Comments:

- The average power data number shown on all plots has been corrected using Garmin and Training Peaks data. This is a known problem with "Strava Segment Analysis".
- High tail wind trial was 16 seconds faster, ~consistent...
- Knobbed tires had a center ridge for street use.
- I found this much more comfortable than the drop bar bikes!

Surly Long Haul Trucker



10/12/2022 18.2 mph 28:13



Clear, 61 °F. Feels like 61 °F. Humidity 80%. Wind 6.4 mi/h from S.

Weight: 33 lbs.
Bar Width: 19"
Seat Height: 43"
Crankset Height: 11"
Tires: 700 x 44 RH Extra Light
Gearing: 26-36-48 x 11-36 (20-122 gear inches), 175mm cranks



Comments:

- Tires and weight here are most comparable to that of the G4 Touring/Gravel (P3).
- I have not ridden this bike in about a year, but I commuted to work my entire career on similar bikes.
- I was surprised at how uncomfortable I found it. Particularly on the drops. Neck, back, seat, hands and wrists.

Trek 5500



10/06/2022 18.5 mph 27:45



Clear, 64 °F. Feels like 64 °F. Humidity 70%. Wind 3.1 mi/h from NW.

Weight:	22 lbs.
Bar Width:	19"
Seat Height:	42"
Crankset Height:	11"
Tires:	700 x 25 Conti GP 5000
Gearing:	53-39 x 12-27 (39-119 gear inches), 180mm cranks



Comments:

- 22 pounds initially was noticeably lighter. Weight advantage vice the recumbents was more than offset by the aero drag.
- Head down, drop bar riding position really impaired my visibility.
- Bar end mirrors did not provide rear view I have come to expect.
- I was surprised by how much the reduced overall visibility detracted from perceived safety and ride pleasure!

Bridgestone RB1

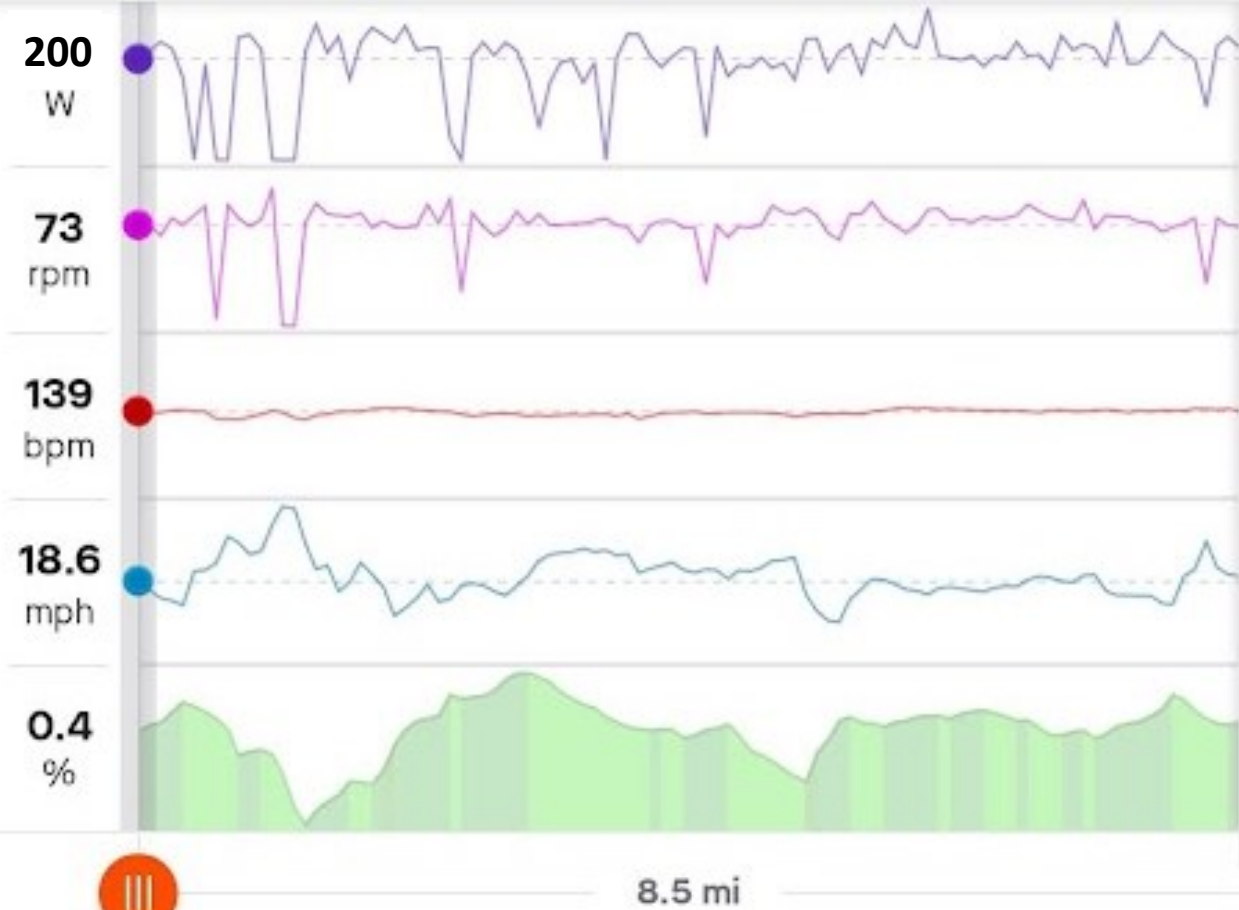


09/27/2022 18.6 mph 27:42



Clear, 64 °F. Feels like 64 °F. Humidity 54%. Wind 9.1 mi/h from W.

Weight:	26 lbs.
Bar Width:	18"
Seat Height:	42"
Crankset Height:	11"
Tires:	700 x 25 Conti GP 5000
Gearing:	53-39 x 12-25 (42-119 gear inches), 175mm cranks



Comments:

- By 3 seconds, this was the fastest upright.
- Uses narrower handlebars and aero wheels.
- This is the “baseline” selected for the comparisons I will show.

Rans Stratus 700



10/15/2022 18.5 mph 27:48



Clear, 61 °F. Feels like 61 °F. Humidity 72%. Wind 8.7 mi/h from S.

Weight: 37 lbs.
Bar Width: 21"
Seat Height: 24" @ 47degrees
Crankset Height: 14.5"
Tires: 35 x 406 Kojak, 700 x 32 Conti GP 5000
Gearing: 50 x 11-50 (27-123 gear inches), 175mm cranks

201
W

75
rpm

128
bpm

18.5
mph

0.5
%



8.5 mi

Comments:

- This was the slowest of the recumbents.
- Speed was still consistent with the upright race bikes.
- The high seat, limited recline used, and low pedals create higher frontal area than the other recumbents.
- Southerly wind may have slightly increased speed.

P38 Lightning

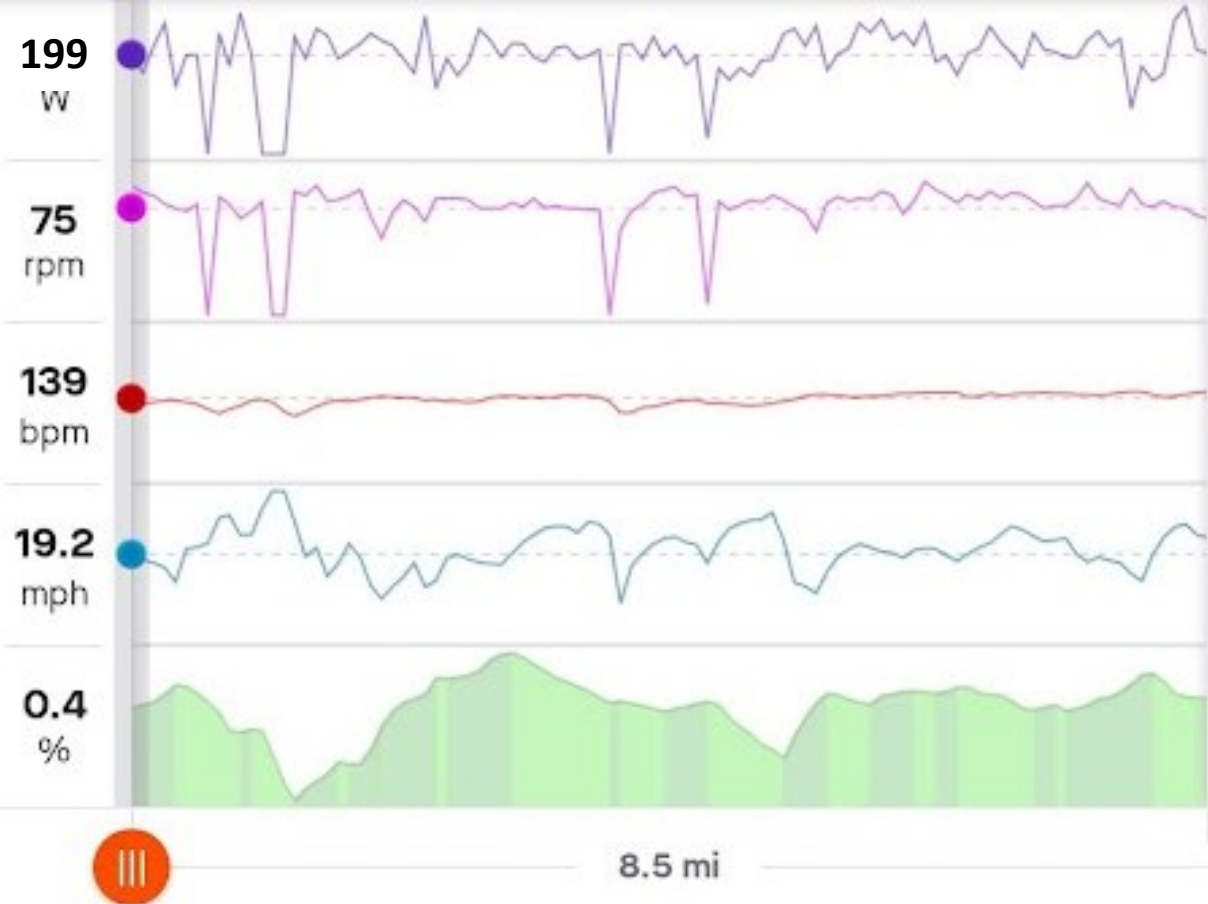


10/06/2022 19.2 mph 26:42



Clear, 67 °F. Feels like 67 °F. Humidity 66%. Wind 2.8 mi/h from NW.

Weight: 29 lbs.
Bar Width: 22"
Seat Height: 20" @ 58 degrees
Crankset Height: 23"
Tires: 32 x 369 Moulton, 27 x 1-1/8" Isotech
Gearing: 52-42 x 12-28, 7 Speed, (40-117 gear inches)
170mm cranks



Comments:

- Elevated pedals reduced frontal area. But I found starts and stops were more difficult.
- Limited seat recline increased frontal area.
- Lighter than all but the two upright race bikes.
- Small wheel (and my limited experience?) caused a handling problem on a rough shoulder.

G4 Gravel - Prototype 3



10/15/2022 20.3 mph 25:16 ☀️ Clear, 50 °F. Feels like 50 °F. Humidity 91%. Wind 4.7 mi/h from SE.

Weight: 37 lbs.
Bar Width: 21"
Seat Height: 18" @ 36 degrees
Crankset Height: 14.5"
Tires: 700 x 38F & 44R RH Extra Light
Gearing: 40 x 9-50 & 20 x 20 (22-124 gear inches), 175mm cranks



Comments:

- Wide tires used for “Gravel” (dirt roads) did not seem to hurt speed.
- Mechanical loss due to double chain drive did not seem to hurt speed. Losses may be more apparent on long, steep low speed climbs.
- Southerly wind may have increased speed.

G4 Sport - Prototype 4

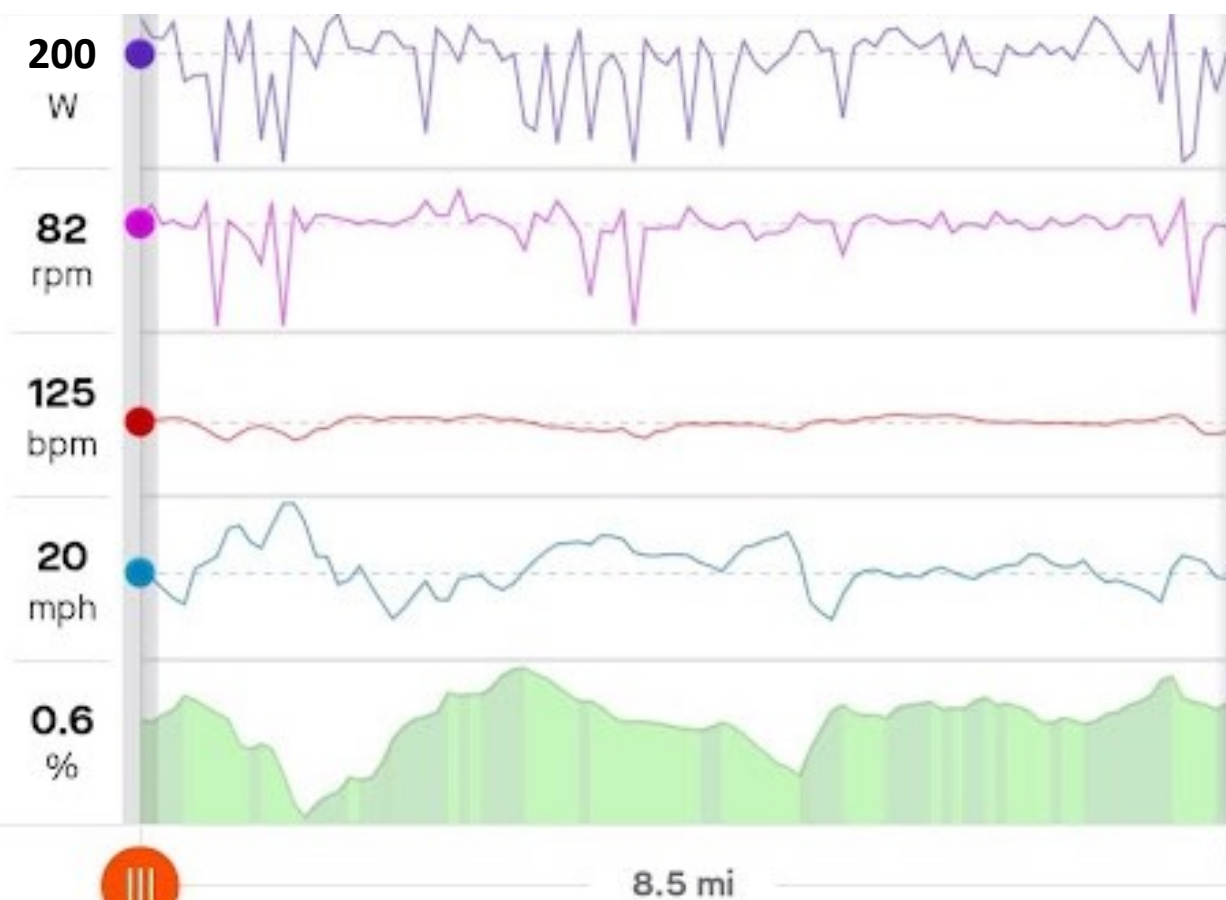


09/24/2022 20 mph 25:41



Partly Cloudy, 51 °F. Feels like 51 °F. Humidity 70%. Wind 4.9 mi/h from NW.

Weight: 42 lbs.
Bar Width: 21"
Seat Height: 17" @ 36 degrees
Crankset Height: 14"
Tires: 700 x 32 Conti GP 5000
Gearing: 38 x 9-50 & 23 x 20 (24-131 gear inches),
175mm cranks



Comments:

- A second trial was 7 seconds faster, so good repeatability.
- I was surprised this bike was not faster than P3. The pack? Or the wind effects?
- Front wheel drive allows routine use of front disk wheel.
- Heart rate variation throughout the testing is due, I believe, primarily due to my level of fatigue.

G4 Race - Prototype 6.5



09/20/2022 22.8 mph 22:31



Clear, 80 °F. Feels like 80 °F. Humidity 50%. Wind 9.1 mi/h from NW.

Weight: 44 lbs.
Bar Width: 26"
Seat Height: 21" @ 20 degrees
Crankset Height: 26"
Tires: 700 x 32 Conti GP 5000
Gearing: 54 x 11-50 (29-133 gear inches), 145mm cranks

197

W

84

rpm

149

bpm

22.8

mph

0.4

%



8.5 mi

Comments:

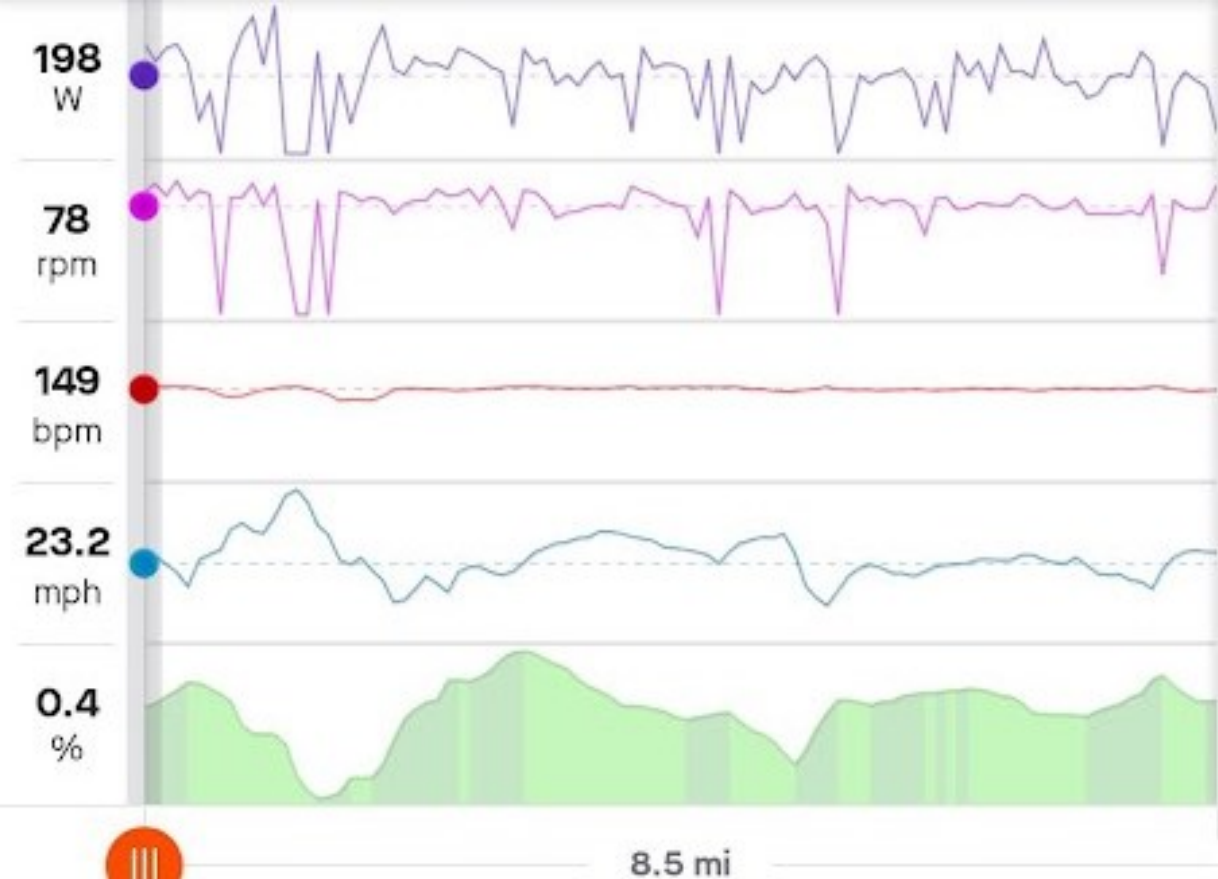
- Speed due to low frontal area and some streamlining by the aero tail box and disk wheels. The bike allows routine use of a front disk wheel.
- The high pedals and ~horizontal seating make it harder to start and stop. Not yet able to U-turn on standard roads. This is after several months and ~2000 miles of riding.
- Very comfortable when underway.

G4 Race – P6.5 w/Fairings



08/09/2022 23.2 mph 22:07  Clear, 86 °F. Feels like 100 °F. Humidity 79%.
Wind 6.4 mi/h from WSW.

Weight: 47 lbs.
Bar Width: 19"
Seat Height: 21" @ 20 degrees
Crankset Height: 26"
Tires: 700 x 32 Conti GP 5000
Gearing: 58 x 11-50 (31-142 gear inches), 145mm cranks



Comments:

- Temporary fairings were of duct tape and foam
 - Under seat
 - Head “splitter panel”
 - Frame front
- Used a short straight handlebar and large chainring.
- This data was collected from a prior ride. More accurate Training Peaks power data not available.

Ranked Speed Results and Power

	Speed (MPH)	Time (Min:Sec)	Power (Watts)
1. G4 Race Faired	23.2	22:07	198
2. G4 Race	22.8	22:31	197
3. G4 Gravel	20.3	25:16	200
4. G4 Sport	20.0	25:41	200
5. P38	19.2	26:42	199
6. RB1	18.6	27:42	200
7. Trek 5500	18.5	27:45	201
8. Rans	18.5	27:48	201
9. Surly	18.2	28:13	200
10. Trek 930	17.8	28:49	200

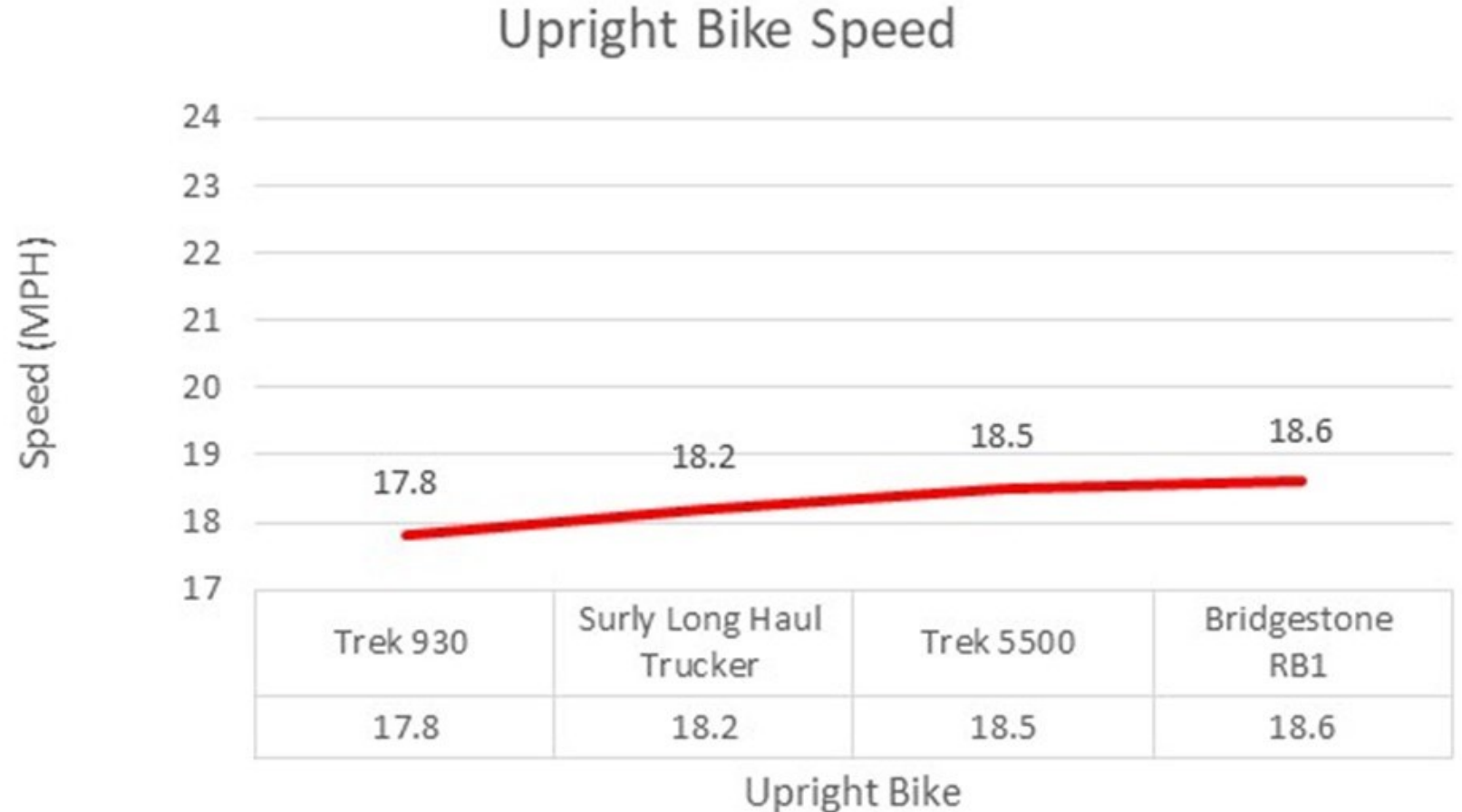
Speed Percentage Differences

	Speed (MPH)	Percent Difference (Time)
G4 Race Faired	23.2	20 %
G4 Race	22.8	19 %
G4 Gravel	20.3	9 %
G4 Sport	20.0	7 %
P38	19.2	4 %
<i>RB1</i>	<i>18.6</i>	<i>Baseline</i>
Trek 5500	18.5	~
Rans	18.5	~
Surly	18.2	- 2 %
Trek 930	17.8	- 4 %

***RB1 chosen as the
Comparison Baseline
Because it was the
Fastest Upright***

Upright Speeds

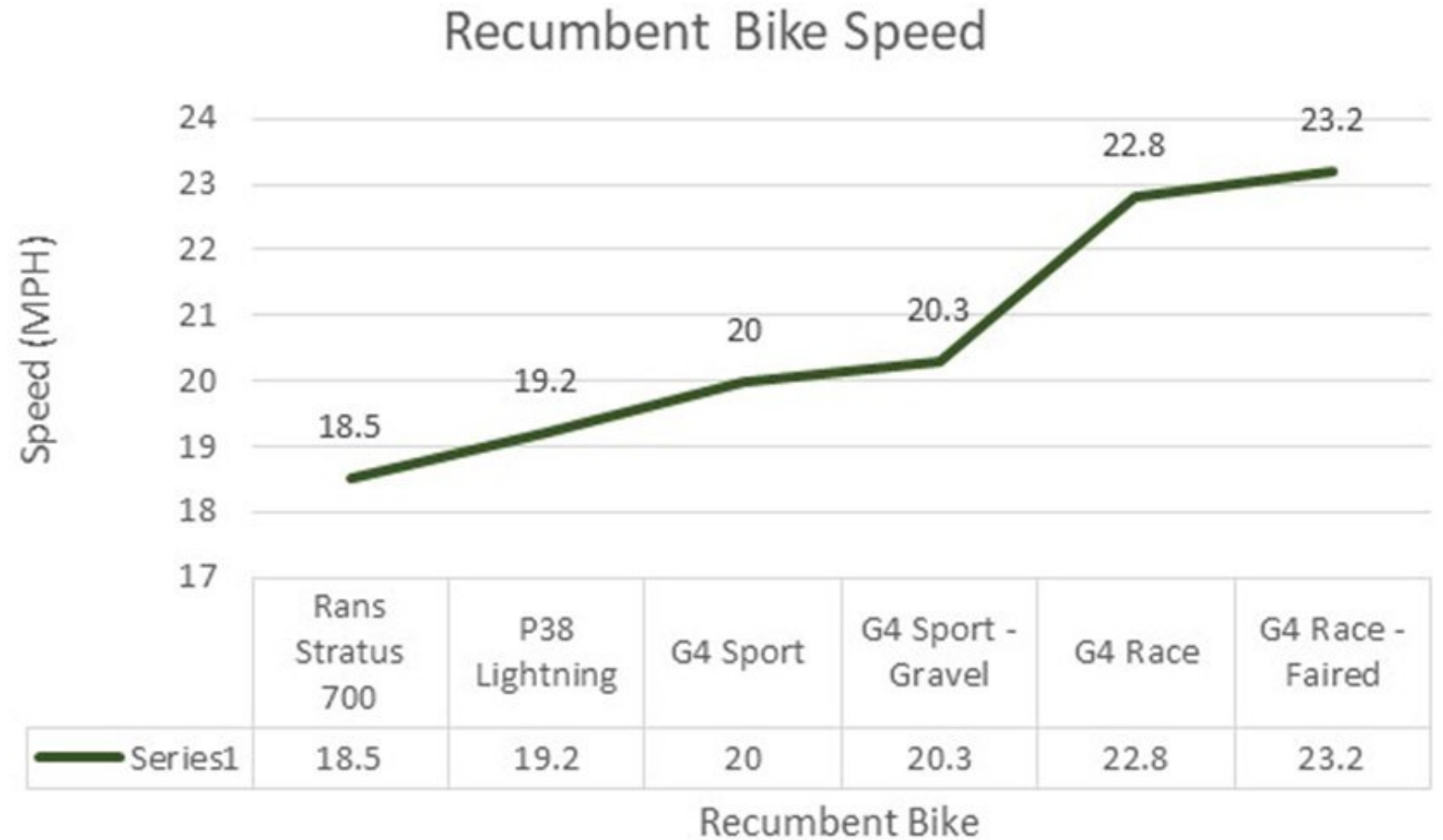
- This is a broad range of upright bicycle configurations.
- My race bikes always seemed much faster to me than my touring bikes.
- My touring bikes always seemed much faster to me than my mountain bike.
- That difference on this course is about .4 mph each, a total of .8 mph.
- Speed delta of .8 mph may be big on a long ride.



Comment: Speed is not the only important part of a bike ride... I was surprised how uncomfortable I found my drop bar bikes after some time of not having ridden them! Neck, back, seat, hands. Plus, my inability to watch where I was going from the drops. Plus, none of the mirrors allowed me to comfortably watch what was behind me. All seriously detracted from the ride.

Recumbent Speeds

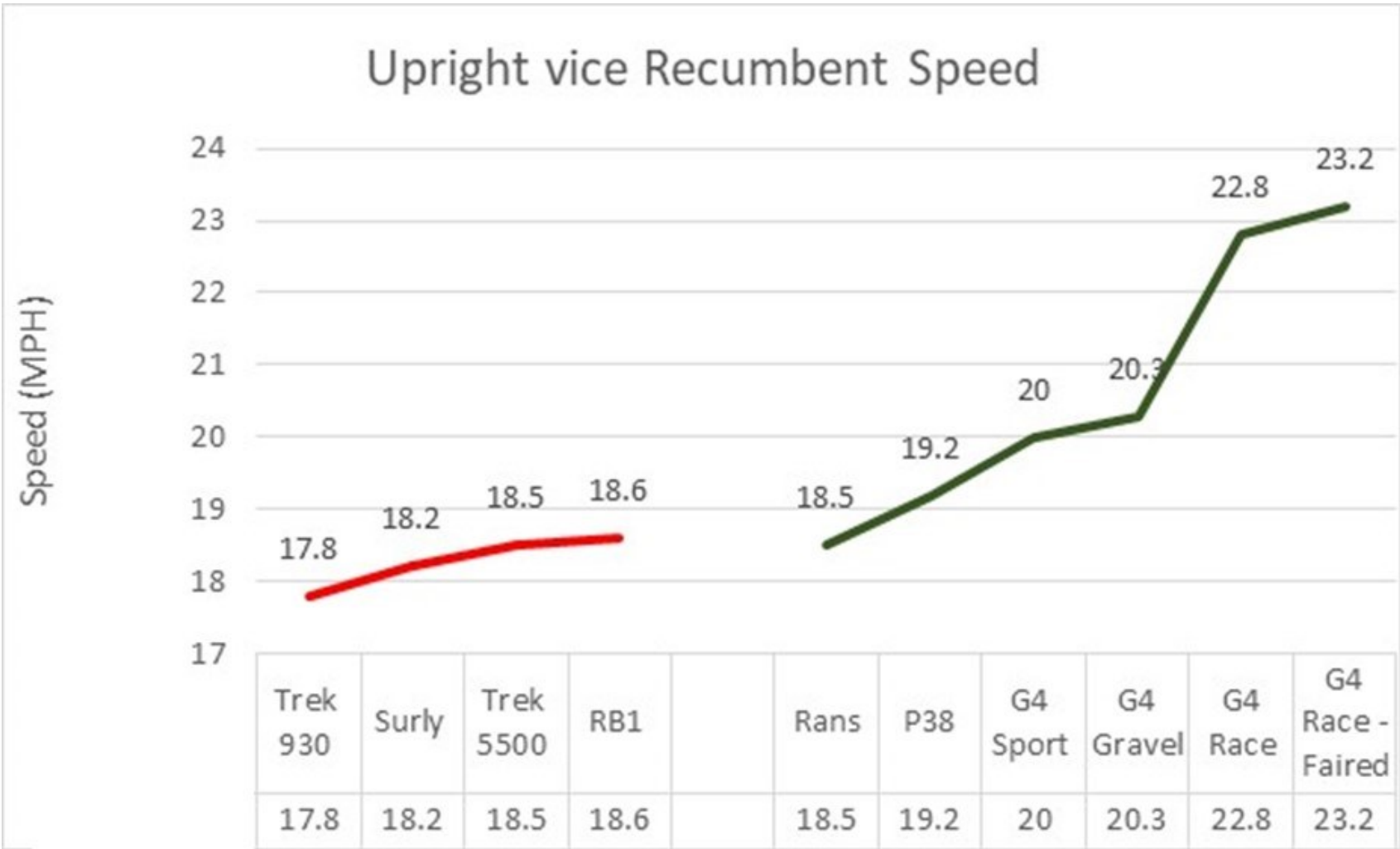
- Recumbent bicycle configurations are even more varied than uprights.
- The four different basic configurations each have different speeds.
- Compared with the uprights, these speed differences are dramatic.
- All these speeds are also high.
- The slowest recumbent is still about the same speed as the fastest uprights.



Comment: Again, speed is not the only thing that is important. Here, I found the differences in handling, and responsiveness in acceleration and climbing to be dramatically different. For recumbents and the uprights. Here “Getting used to a bike” probably also matters. I am not sure how to fairly quantify these differences, but it is beyond the scope of this effort.

Upright vice Recumbent Speeds

- Over this course, at this power, the recumbents are a lot faster than the uprights.
- The difference in speed between recumbents is much greater than the differences between the uprights.
- For these bikes, I think the speed differences were due primarily to aerodynamic frontal area differences.
- The upright race bikes may have been faster if my “race tuck position” was better.



Comment: It would be interesting to extend this testing to include one or more trikes, velomobiles and a RWD high racer.

Conclusion

- A wide range of upright and recumbent bikes were tested.
- Upright speeds varied over a narrow range (0.8 mph)
- Recumbent speeds varied much more (4.7 mph)
- The fastest upright was about as fast as the slowest recumbent
- I think frontal area drives speed
 - Rider more so than bike
 - Seat back angle, pedal height and handlebar bar width are important
- Results seem reasonable
 - Not based on multiple repetitions
 - I don't know the potential errors
 - Multiple repetitions would be a lot more work...
- If I get any significant new information, I will put it out on www.g4bikes.com

Additional Charts
Detailed Data
Compilation

