2023 Wildfire Season: Washington Forecast Performance

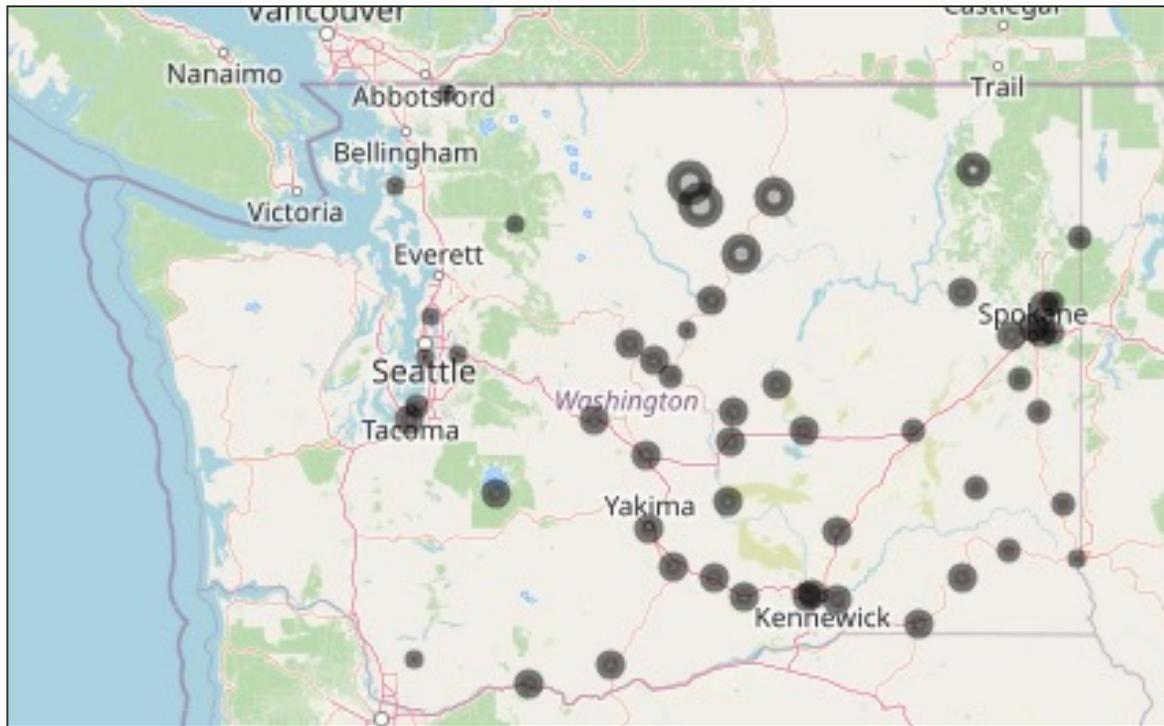NW-AIRQUEST Meeting

October 26, 2023

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Presented by: Farren Thorpe

Other ECY Contributors: Jill Schulte, Shuang Xia,Tes Berhane
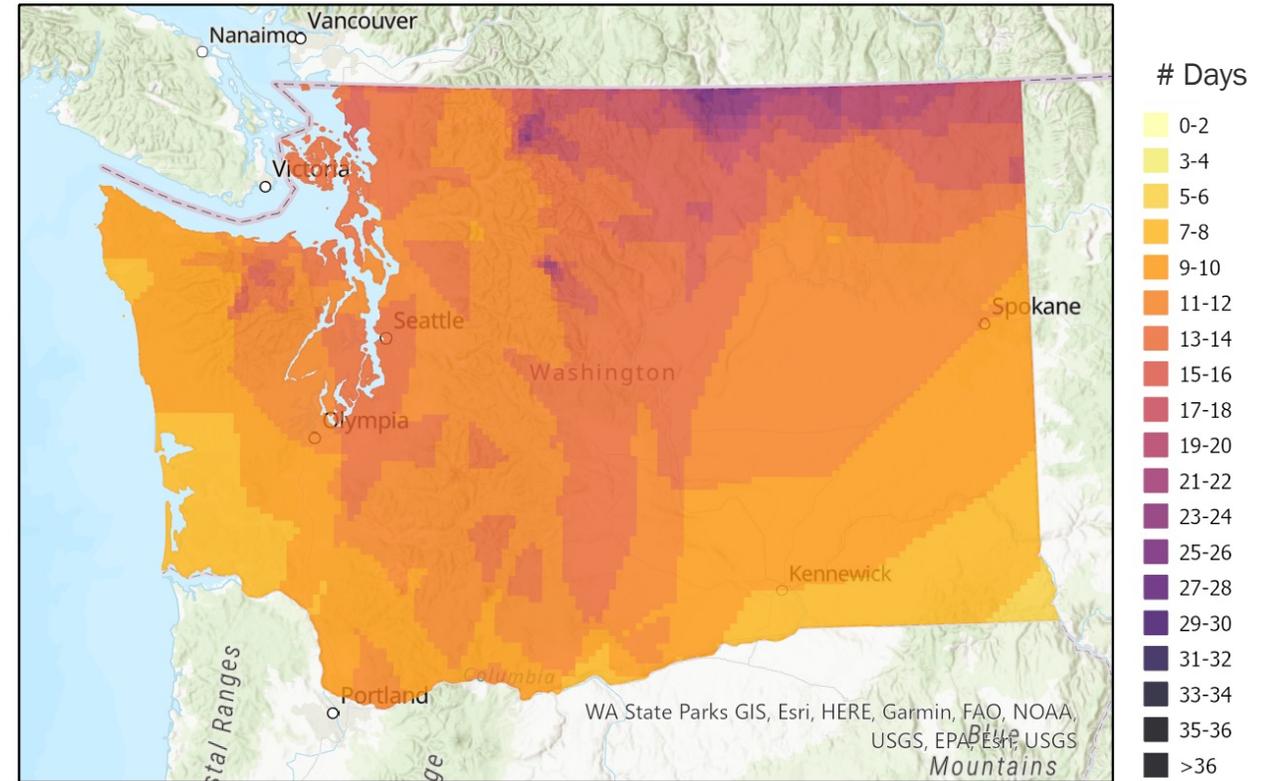
Where were the smoke impacts in 2023?

PM2.5 Monitors

HMS Smoke Polygons (Heavy)

Size of point is proportional to number of days of unhealthy or worse air quality at each monitor (May – Sept)
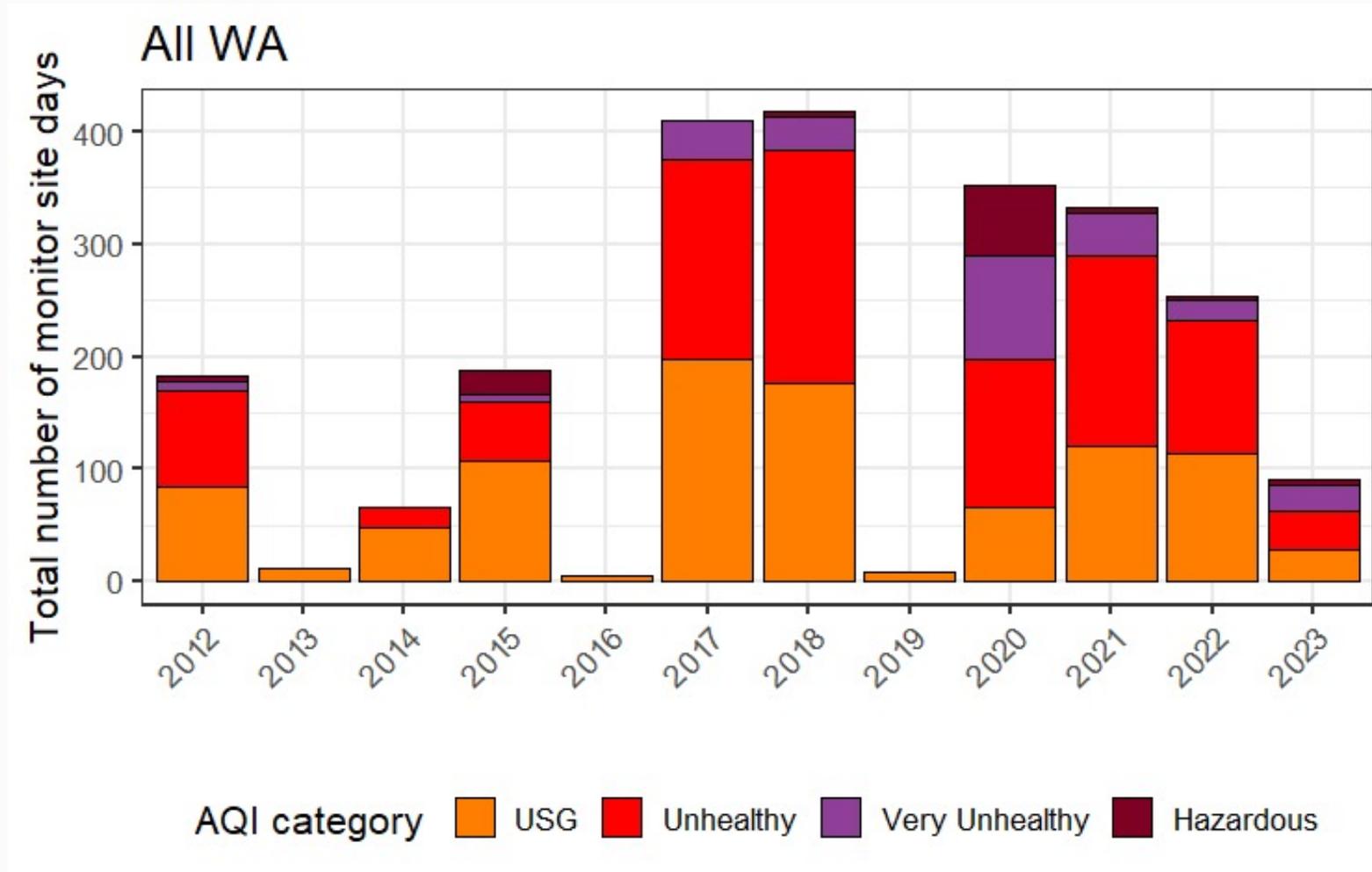
HMS "heavy" smoke polygons are based on visual classification of plumes using GOES-16 and GOES-17 ABI true-color imagery available during the sunlit part of the orbit.
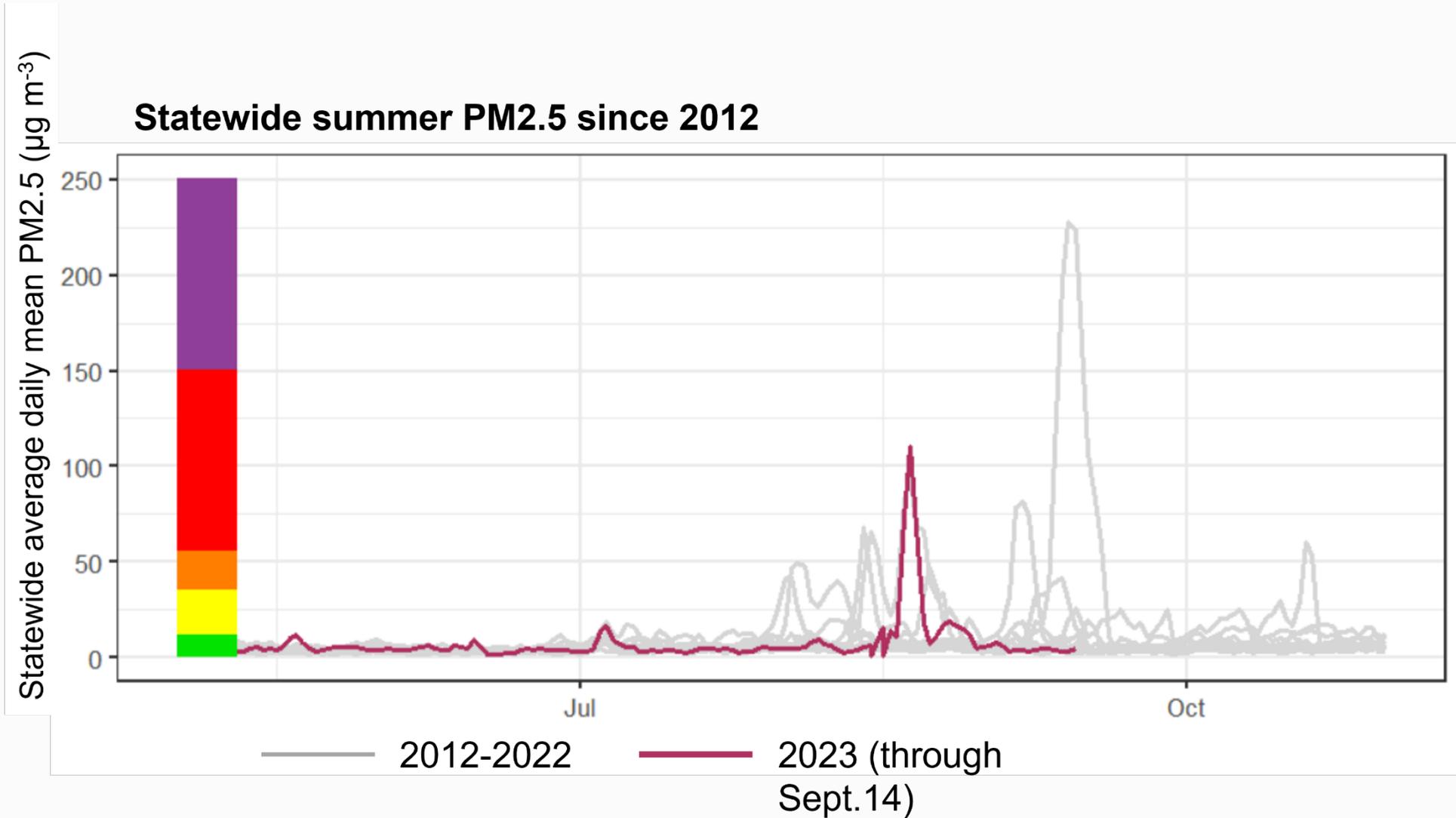
Where were the smoke impacts in 2023?
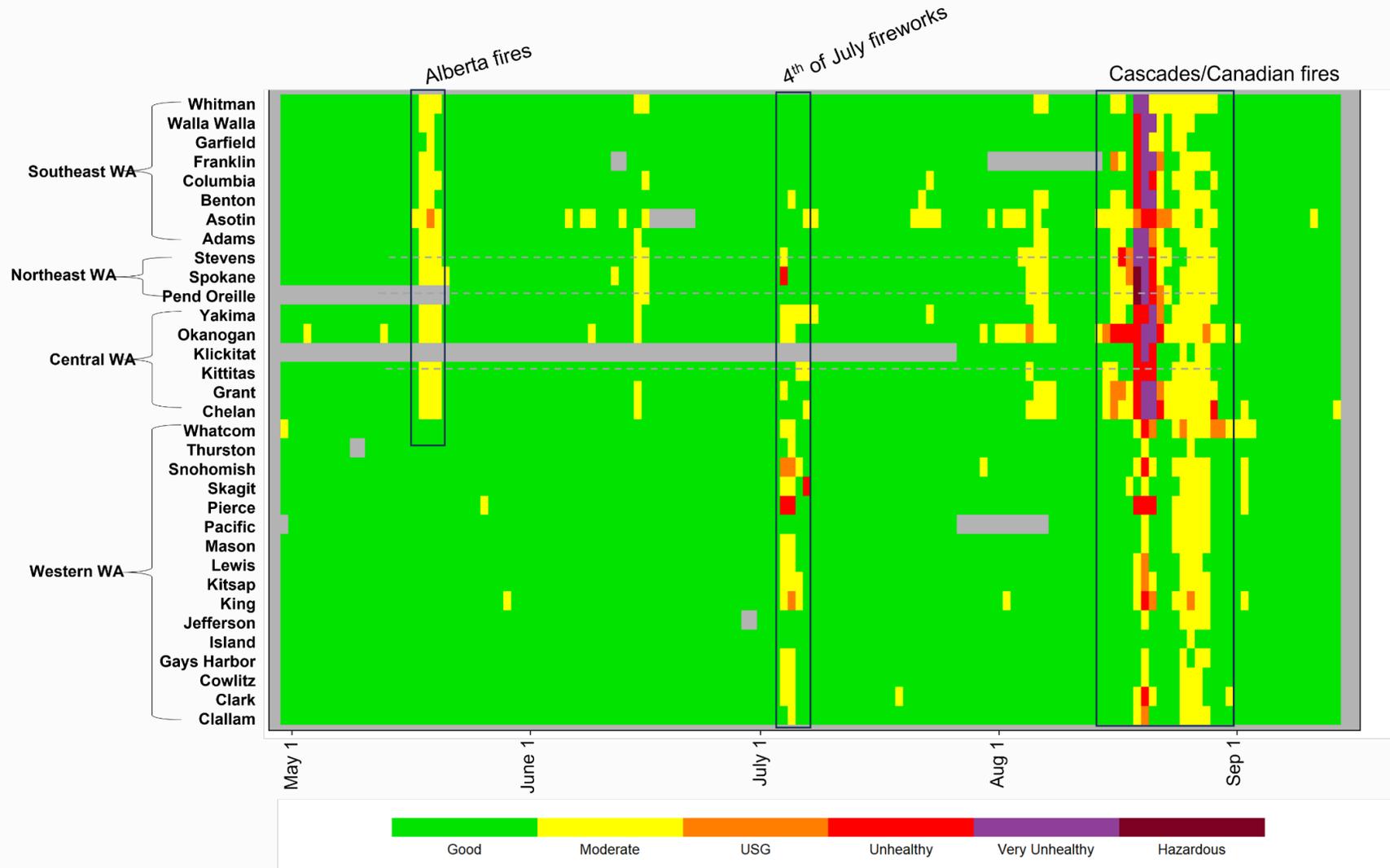
2023: AQI Monitor-Days

How did 2023 compare to previous years?


Statewide summer PM2.5 since 2012

Brief smoke forecast overview

- In 2020 Ecology developed a zone forecast using WSU's 2-day ML forecasts.

- Became a 5 day forecast in 2021 using WSU ML (days 1 and 2) and HYSPLIT and global models (days 3-5)
  - Also rely on forecasts from LCAAs and manual forecasts from ECY modelers

- Updated in 2023—improved HYSPLIT ensemble and reduced oversight
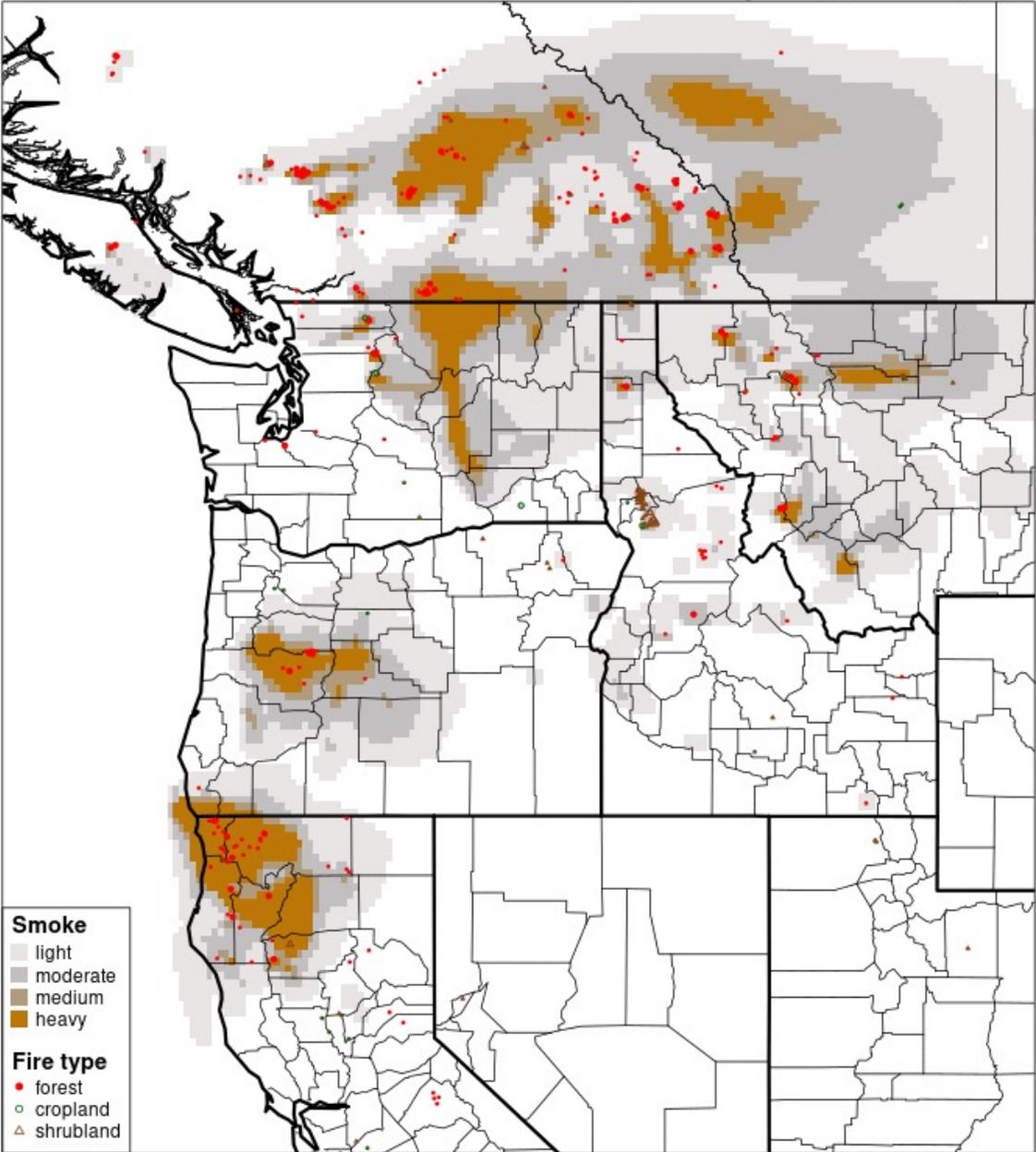
2023 Forecast updates

Change	Why
Use HYSPLIT output days 1 and 2 if machine learning is unavailable [in August updated days 1 and 2 to include HYSPLIT + ML]	A late or missing machine learning forecast resulted in no forecast (grey polygon) for days 1-2.
Updated polygons to fill in the zone gaps	Provide more spatial coverage (low-populated areas)
Removed global forecast models	Global forecast models were problematic
Used all HYSPLIT values within the polygons (instead of monitor location)	Expanded the range instead of a point forecast; maximum within the polygon is also possible.
Updated the emissions processing method for the 8 HYSPLIT ensemble members, and only use WRF vertical scheme	Use FRP-modification scenarios, instead of 2 vertical motion schemes and area-based emissions
Removed the HYSPLIT "bias correction"	The "bias correction" based on ML performance, so not appropriate for HYSPLIT
Updated ML to use the PM IDEQ forecast instead of WSU forecast	IDEQ ML has updated sites and ML training. Also, WSU ML changed throughout each morning, causing confusion.
Created a plume animation of the daily average HYSPLIT output with fire locations	Visualization of the forecasted smoke plume
Updated shiny apps (layout, added a forecast source, auto-evaluation plots)	Improved ability to manual forecast
Added static background concentration to HYSPLIT values	HYSPLIT has no carryover smoke and no anthropogenic emissions

Updated polygons to fill in the gaps + use all HYSPLIT values within the polygon

Existing polygons

New polygons

Monitoring sites
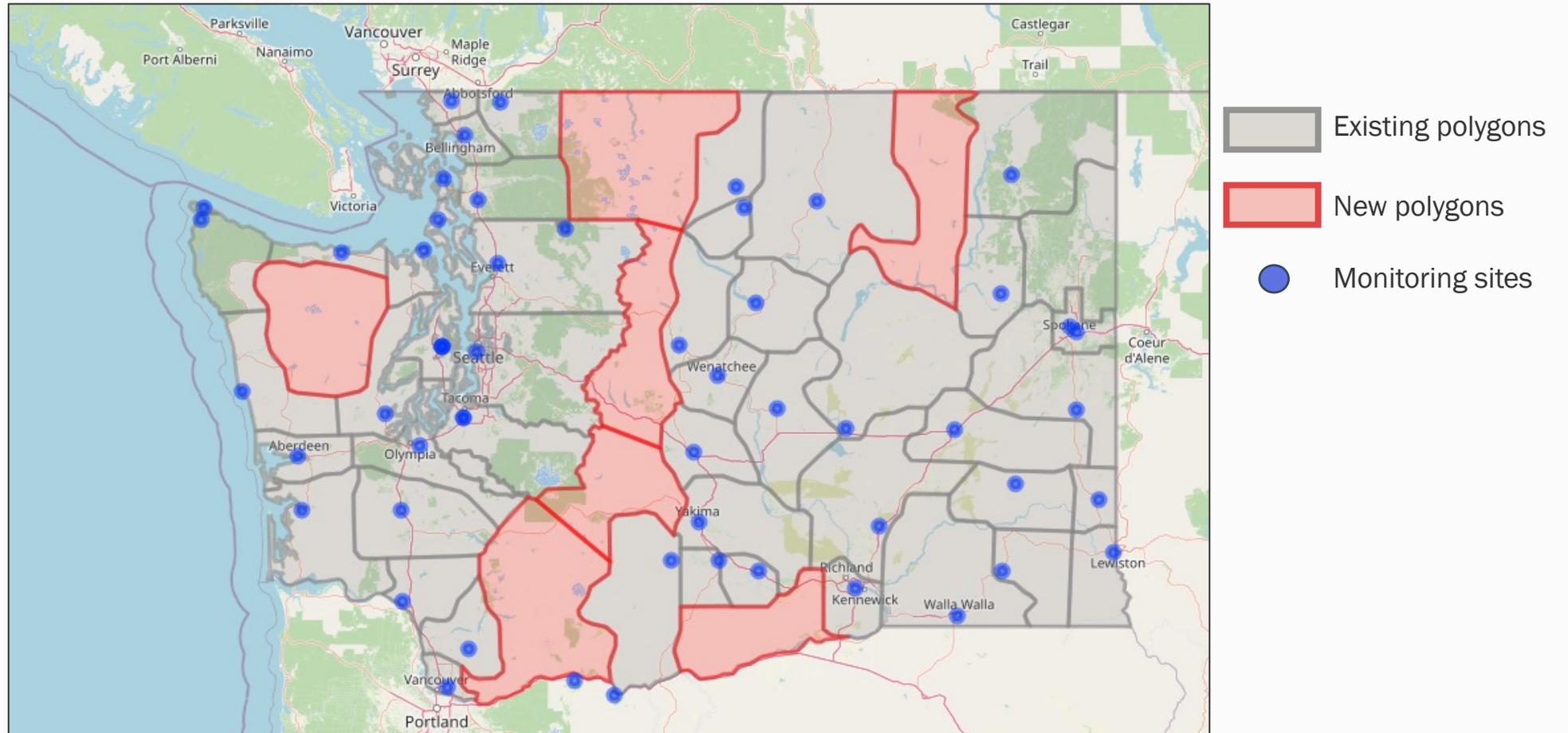
Daily plume image animation

Thursday August 17, 2023

Smoke
- light
- moderate
- medium
- heavy

**Fire type**
- forest
- cropland
- shrubland

2023 Forecast: June 1 – Sept 30
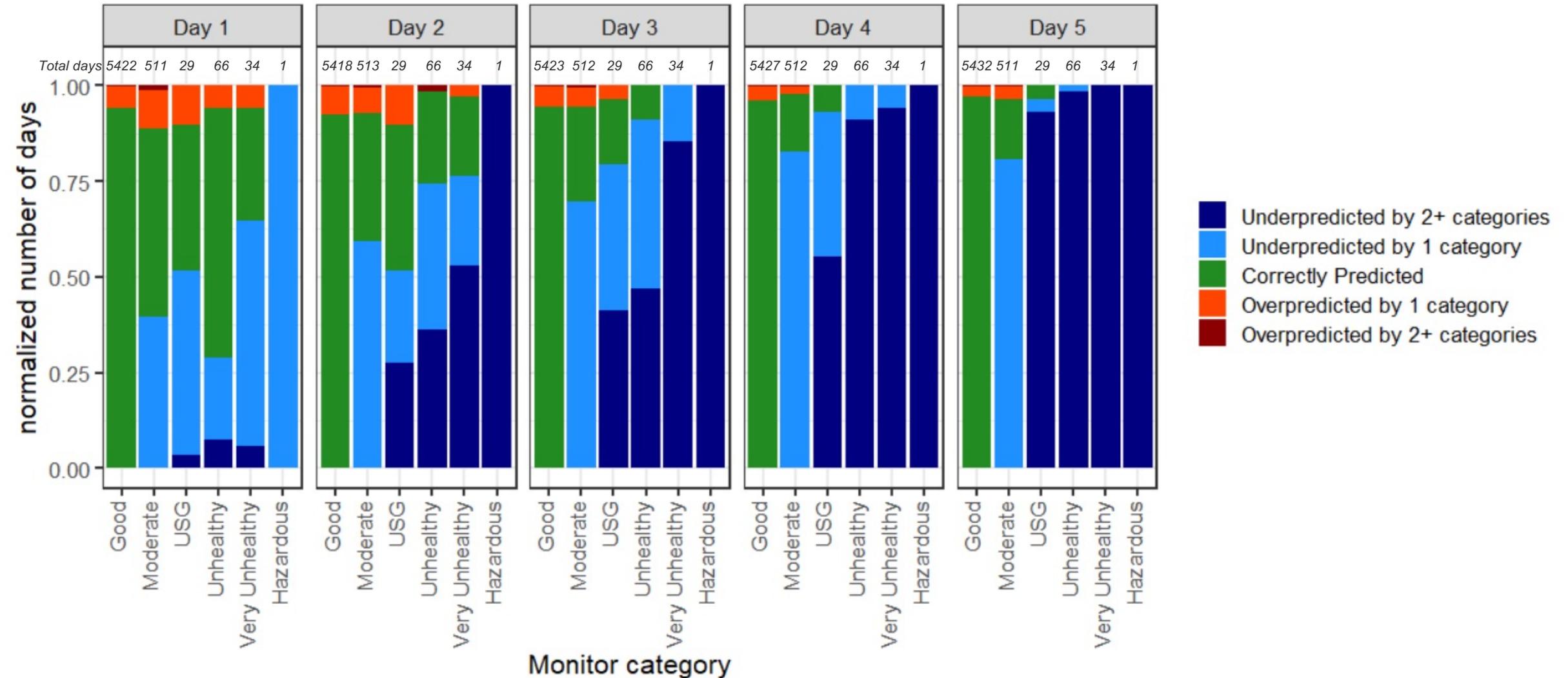
The issued forecast is based on:

1. LCAA's manual forecast submitted to AirNow
2. ECY modelers manually set polygon forecast
3. Automated forecast
   - Days 1-2: Machine Learning*
   - Days 3-5: HYSPLIT Ensemble Average + background
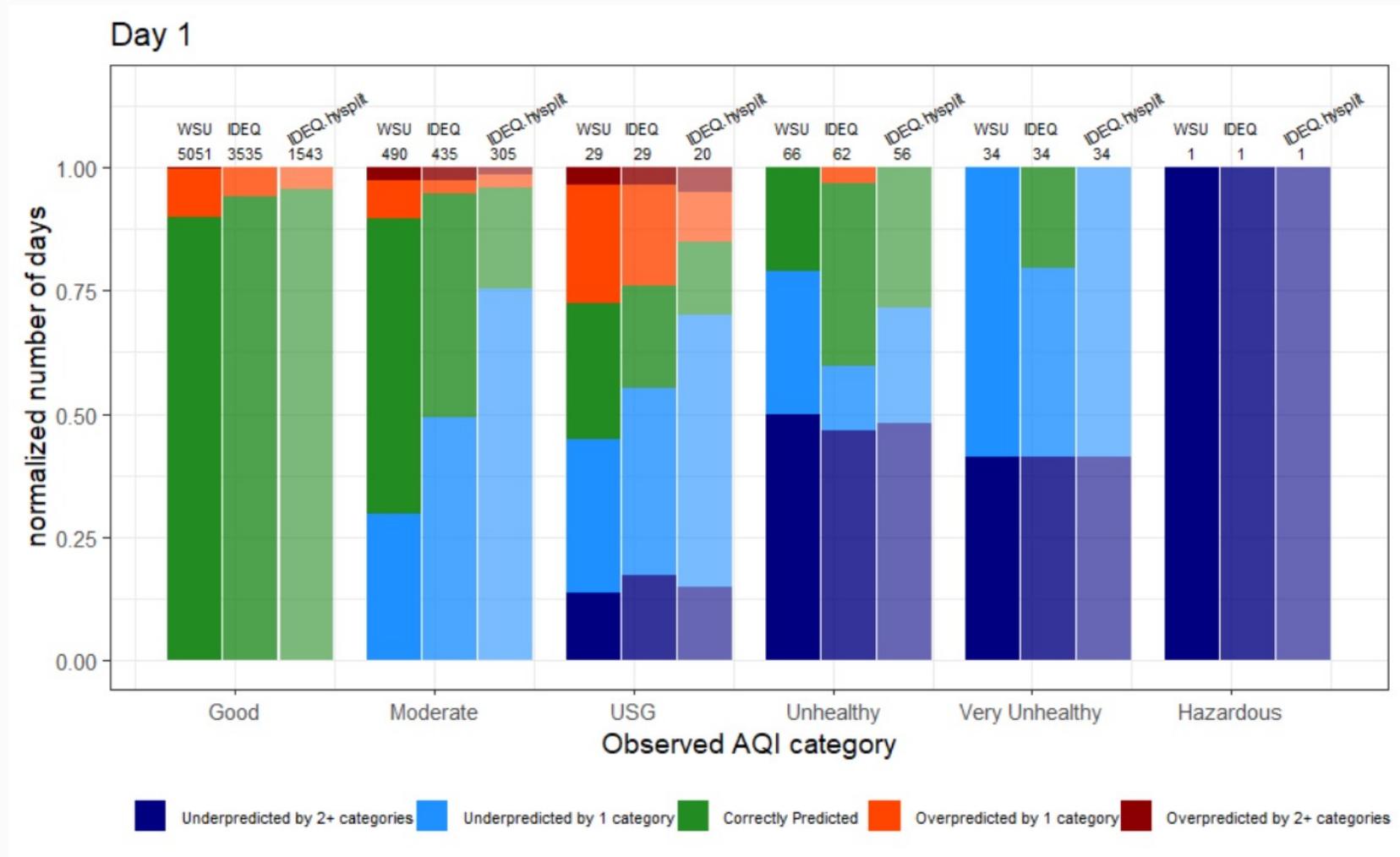
July 12 switched to IDEQ ML (pm forecast only)
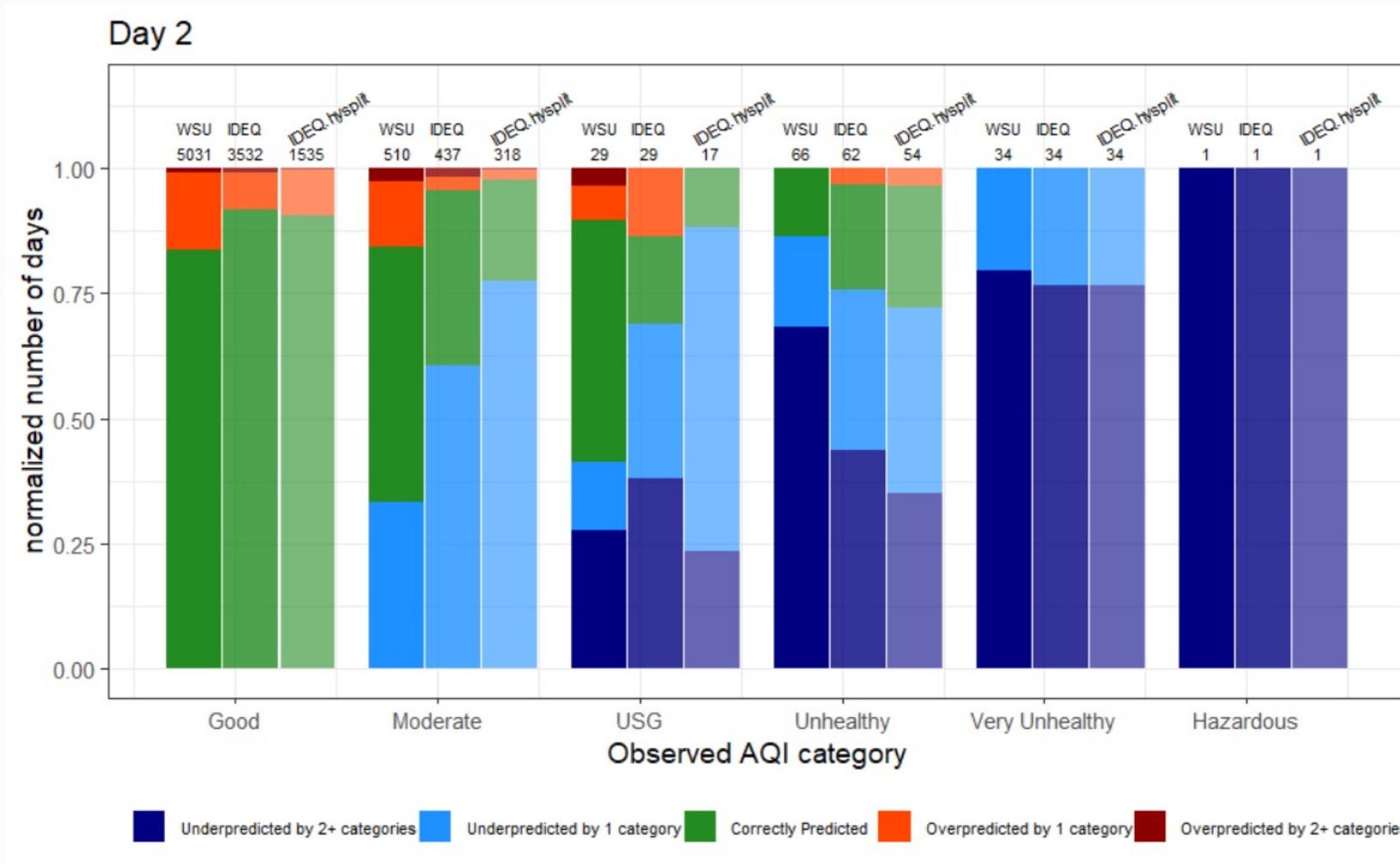*August 18 added in HYSPLIT to days 1 and 2*
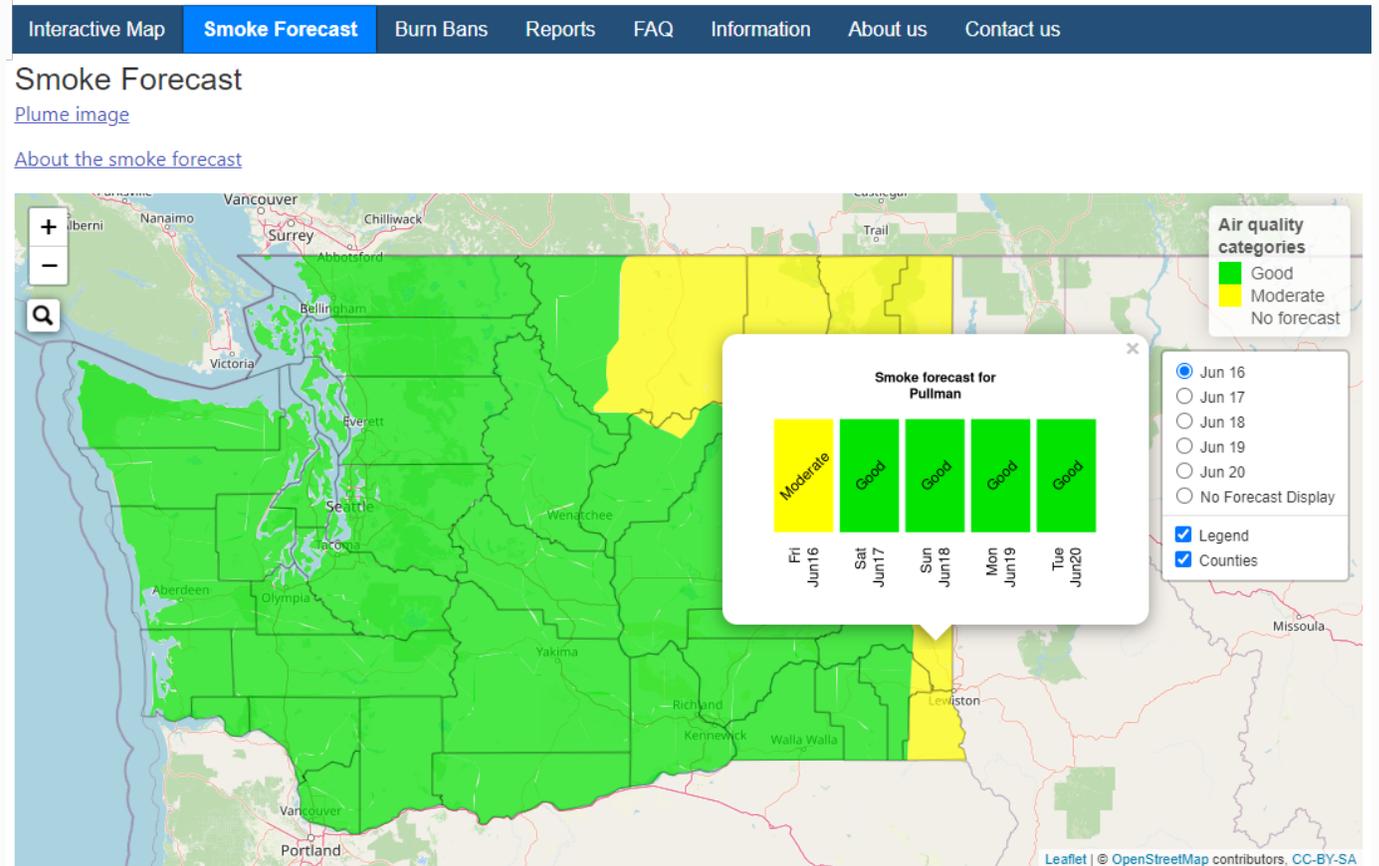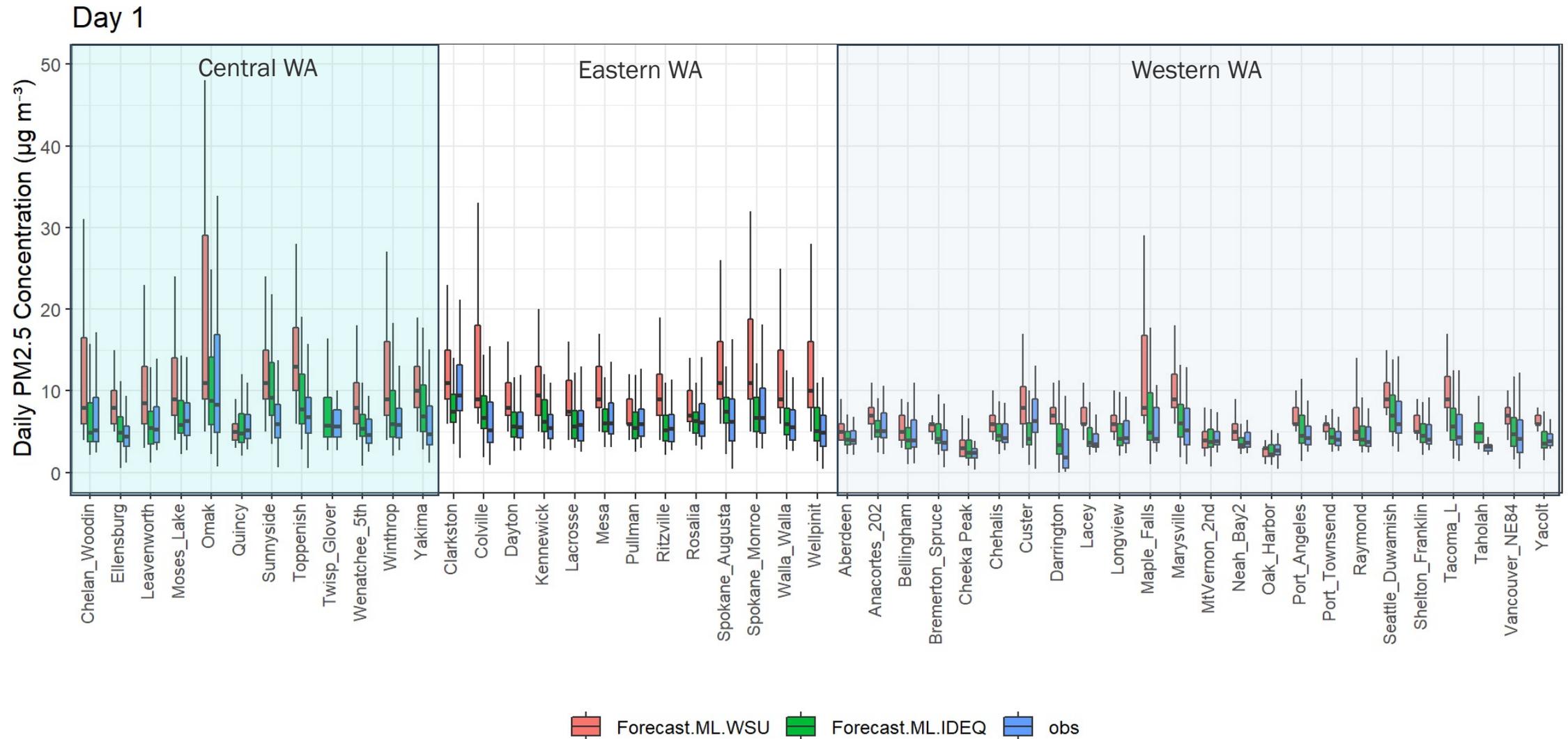
Forecast: how did we do in 2023?

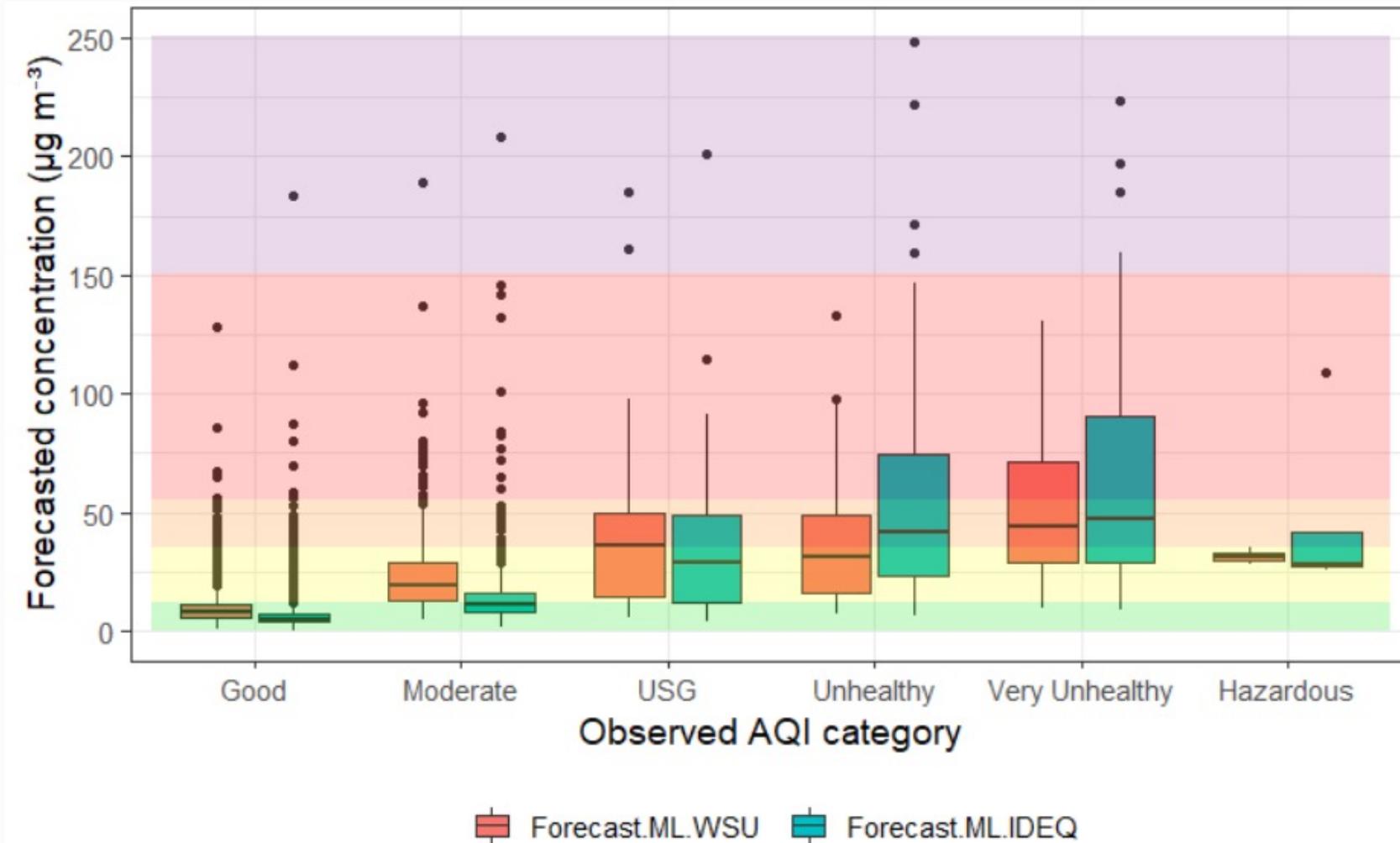# Days 1 and 2: WSU vs. IDEQ ML vs. IDEQ.ML+Hysplit

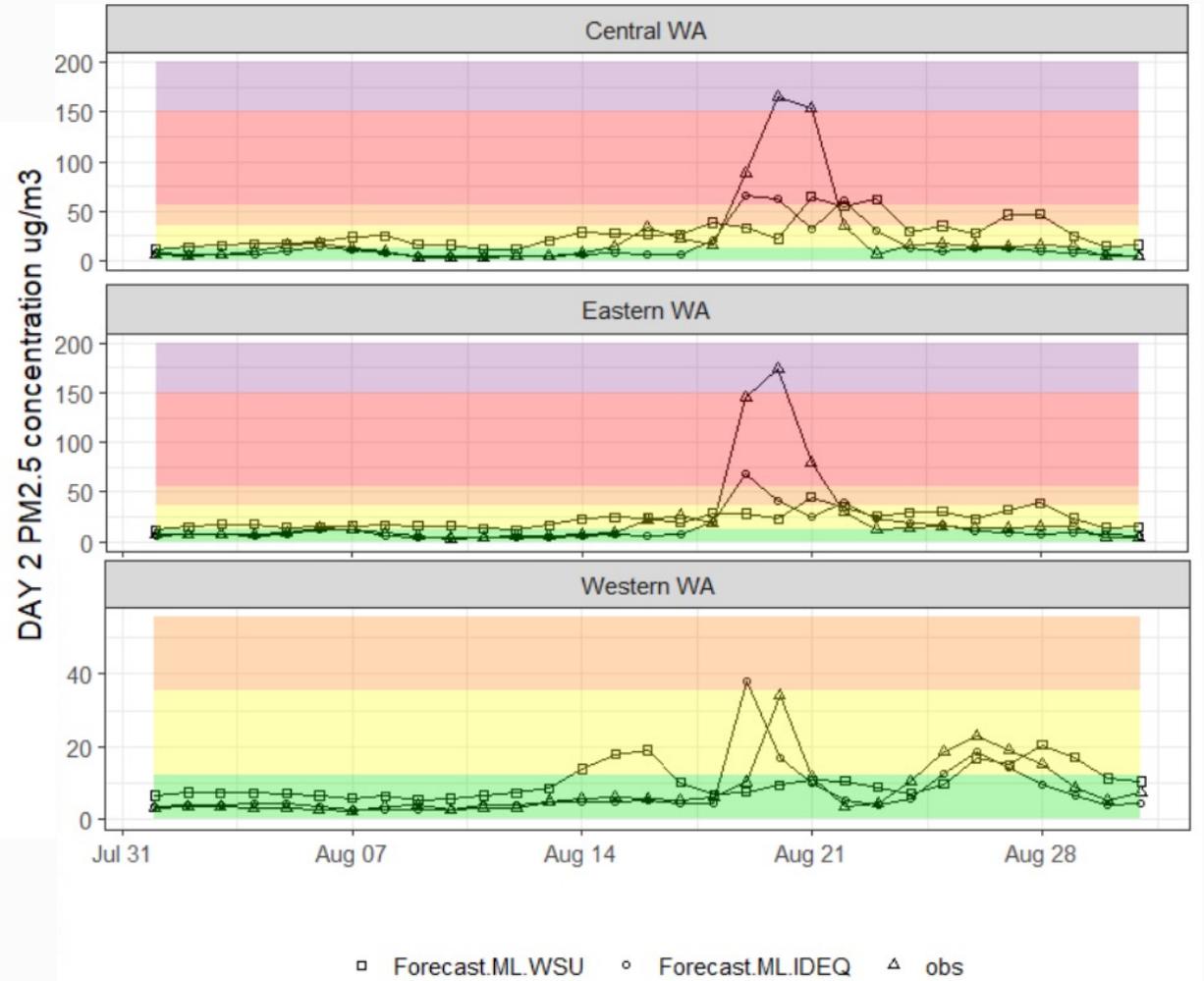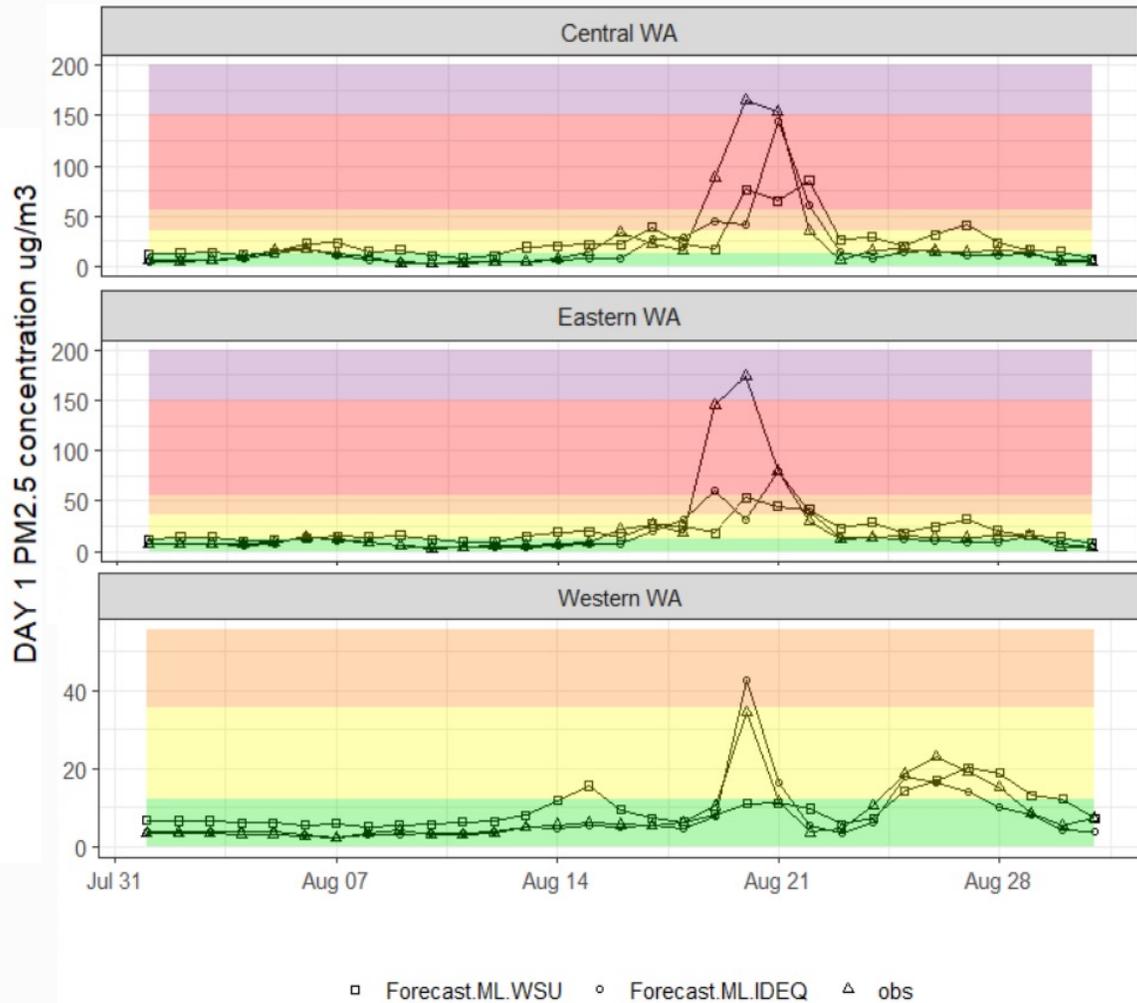# Days 1 and 2: WSU vs. IDEQ ML vs. IDEQ.ML+Hysplit

WSU ML generally predicts higher concentrations than IDEQ ML across all monitoring sites

But WSU ML is not always greater than IDEQ across all concentrations (caveat that good+moderate days outnumber the higher AQI categories)
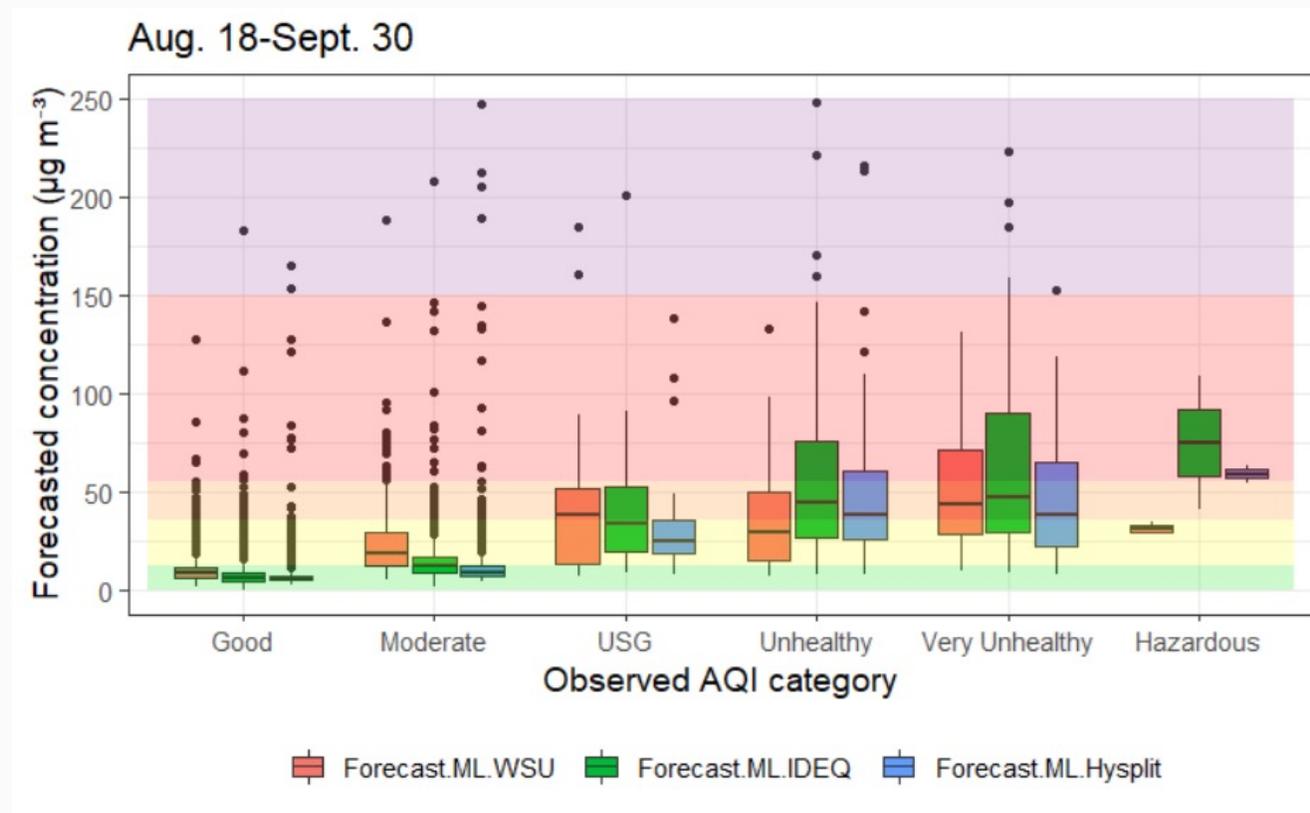
Is WSU > IDEQ at all locations?

How did adding in HYSPLIT to days 1 and 2 impact the forecast?

- Started on Aug 18 in the middle of a smoke event
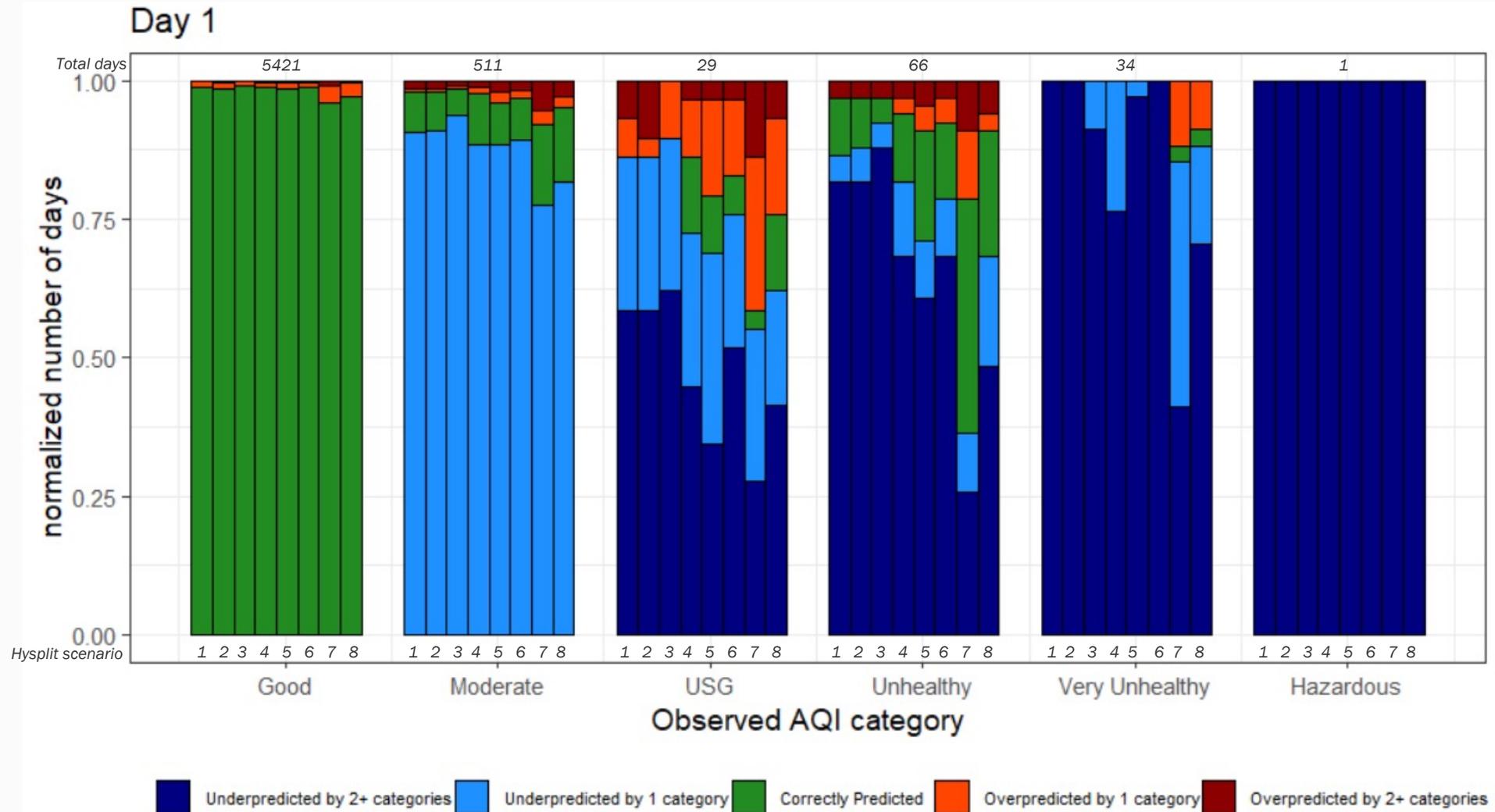- Need to evaluate further
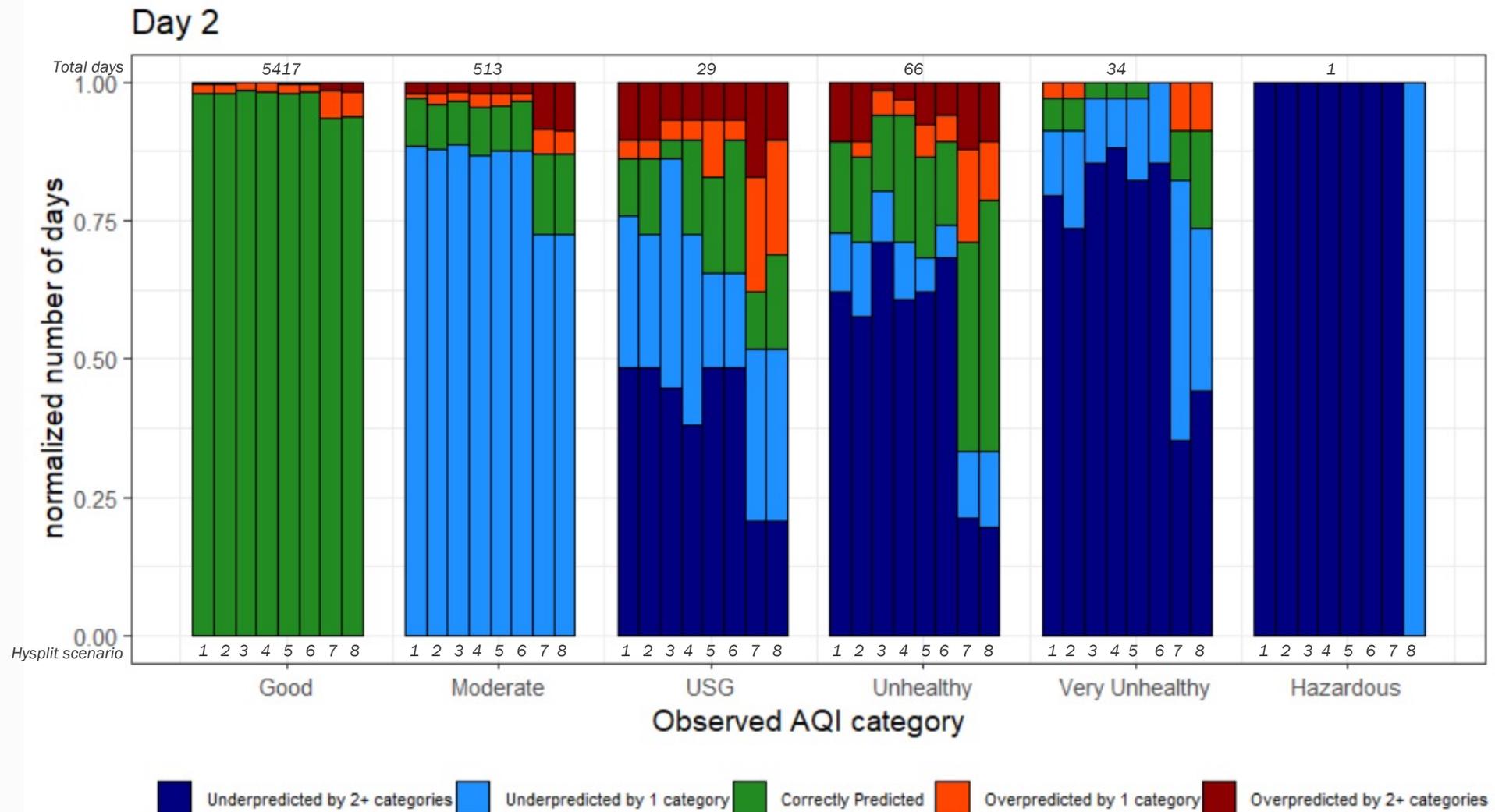
8 HYSPLIT Emissions Scenarios

HYSPLIT Emissions Scenarios

|	S1	S2	S3	S4	S5	S6	S7	S8
First Hour Kept from HMS	Noon (-1 Day)	Noon (-1 Day)	2 a.m. (-1 Day)	2 a.m. (-1 Day)	Noon (-1 Day)	Noon (-1 Day)	Midnight (-3 Days)	Midnight (-3 Days)
Duplicate Dist.	10m	10m	10m	10m	10m	10m	50m	50m
FRP Modification Formula	FRP max = 100 min = 0.3	1.25 FRP max = 100 min = 0.3	2 sqrt FRP max = N/A min = 0.3	2 sqrt FRP max = N/A min = 0.3	4 sqrt FRP max = N/A min = 0.3	4 sqrt FRP max = N/A min = 0.3	FRP max = 100 min = 0.3	3 sqrt FRP max = N/A min = 0.3
Area per Detect	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)
Merge Aggregation	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum
Merge Distance	1000m	1000m	1000m	1000m	1000m	1000m	1000m	1000m
USA Fire Potential Factors	None	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50
CAN Fire Danger Rating Factors	None	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25
Vegetation Factors	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20
Diurnal Profile	Legacy	Legacy	Legacy	WRF-CHEM	BlueSky	WRF-CHEM	BlueSky	Legacy

Hysplit scenarios: Day 1
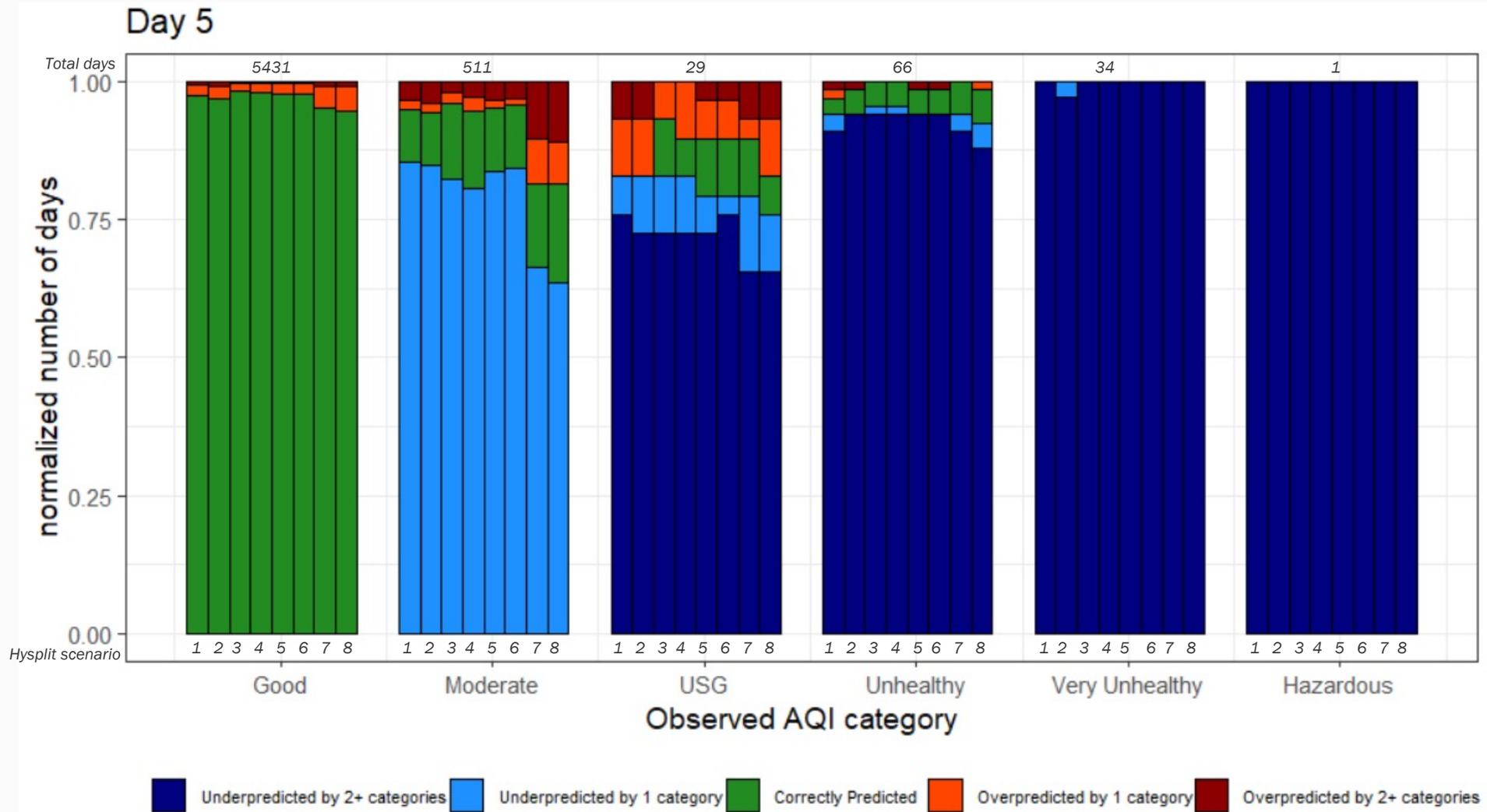
Hysplit scenarios: Day 2

Hysplit scenarios: Day 3
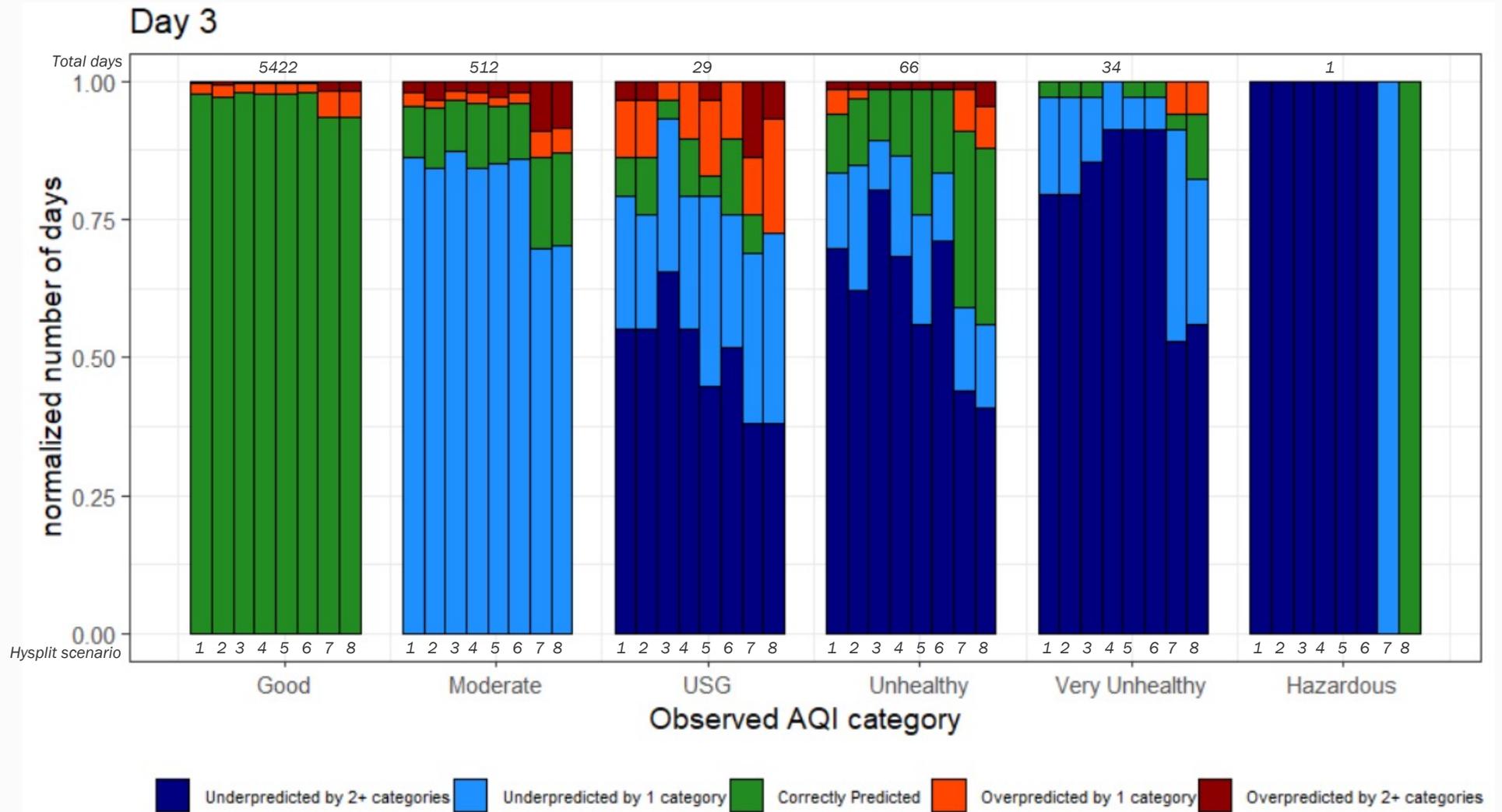
Hysplit scenarios: Day 4
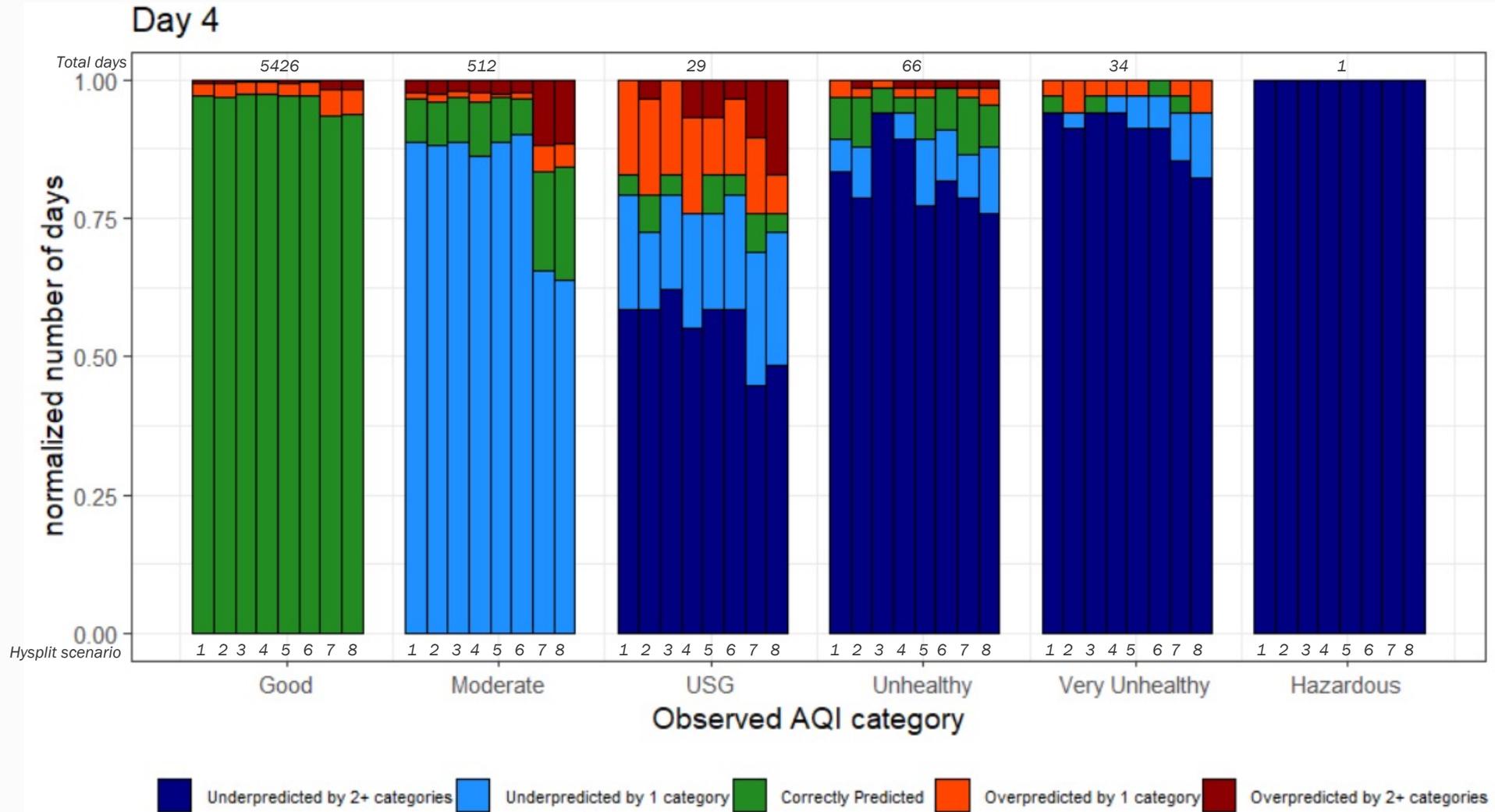
Hysplit scenarios: Day 5

# What's next for the forecast

- Update polygons/add in SensWA sites?

- Increase time resolution [for HYSPLIT output]?

- Add in Hysplit to days 1 and 2 (not just ML). We did this at the end of August, need to evaluate further.

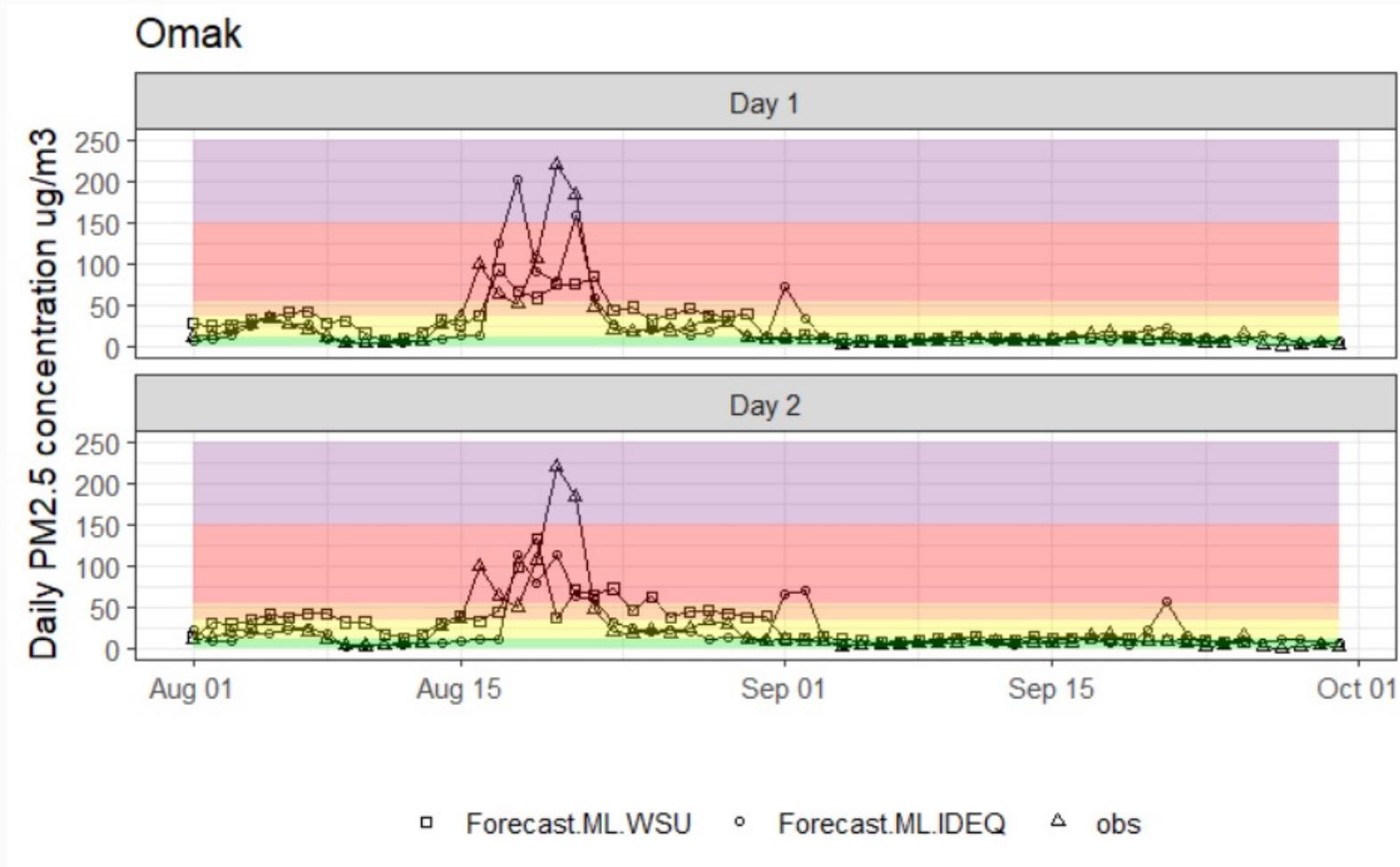- Build shiny-app for emissions analysis, to help further refine the scenario options.

Thank you!

Overall forecast visible to the public; omitting good days that were correctly predicted
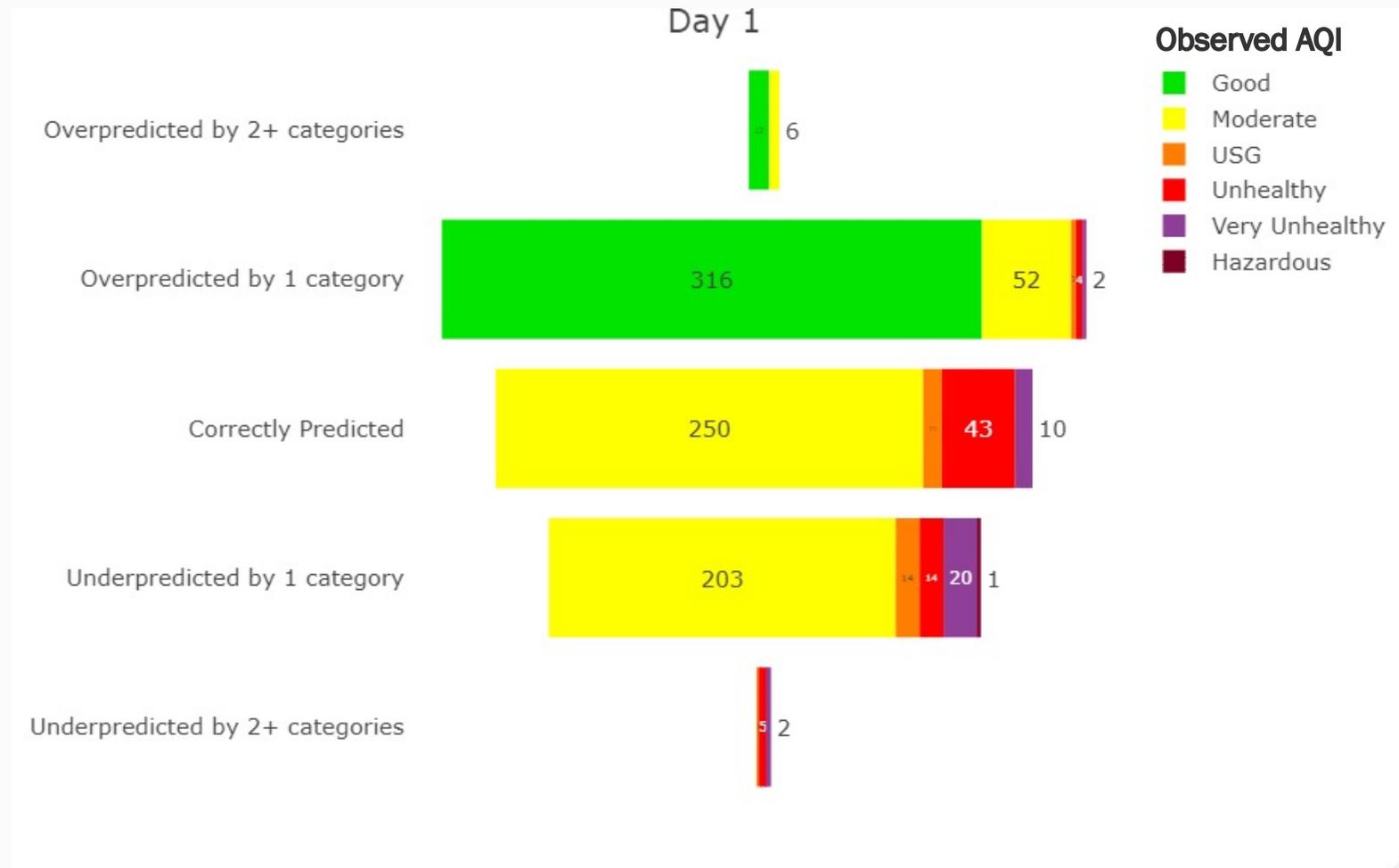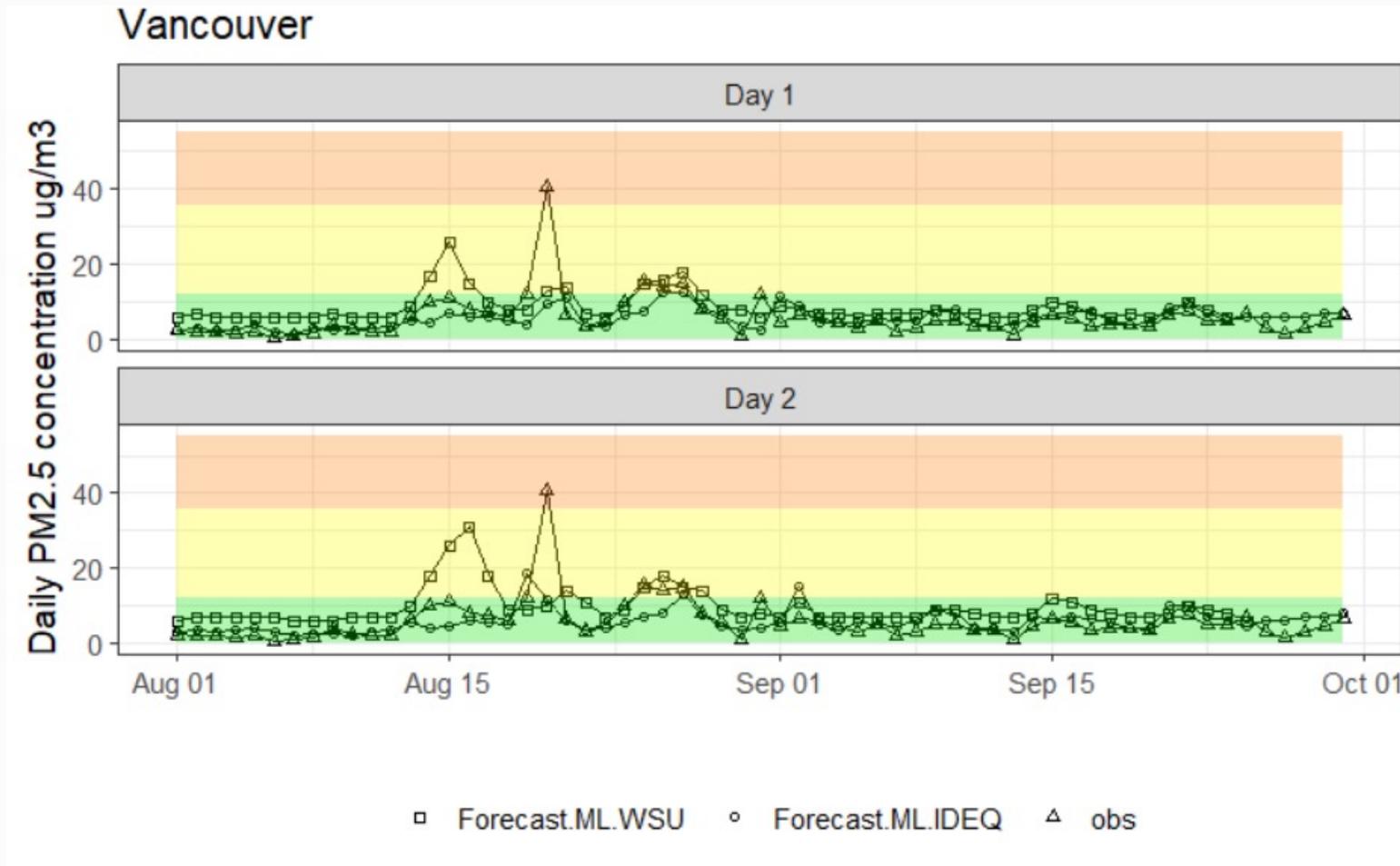
WSU vs. IDEQ ML at impacted sites

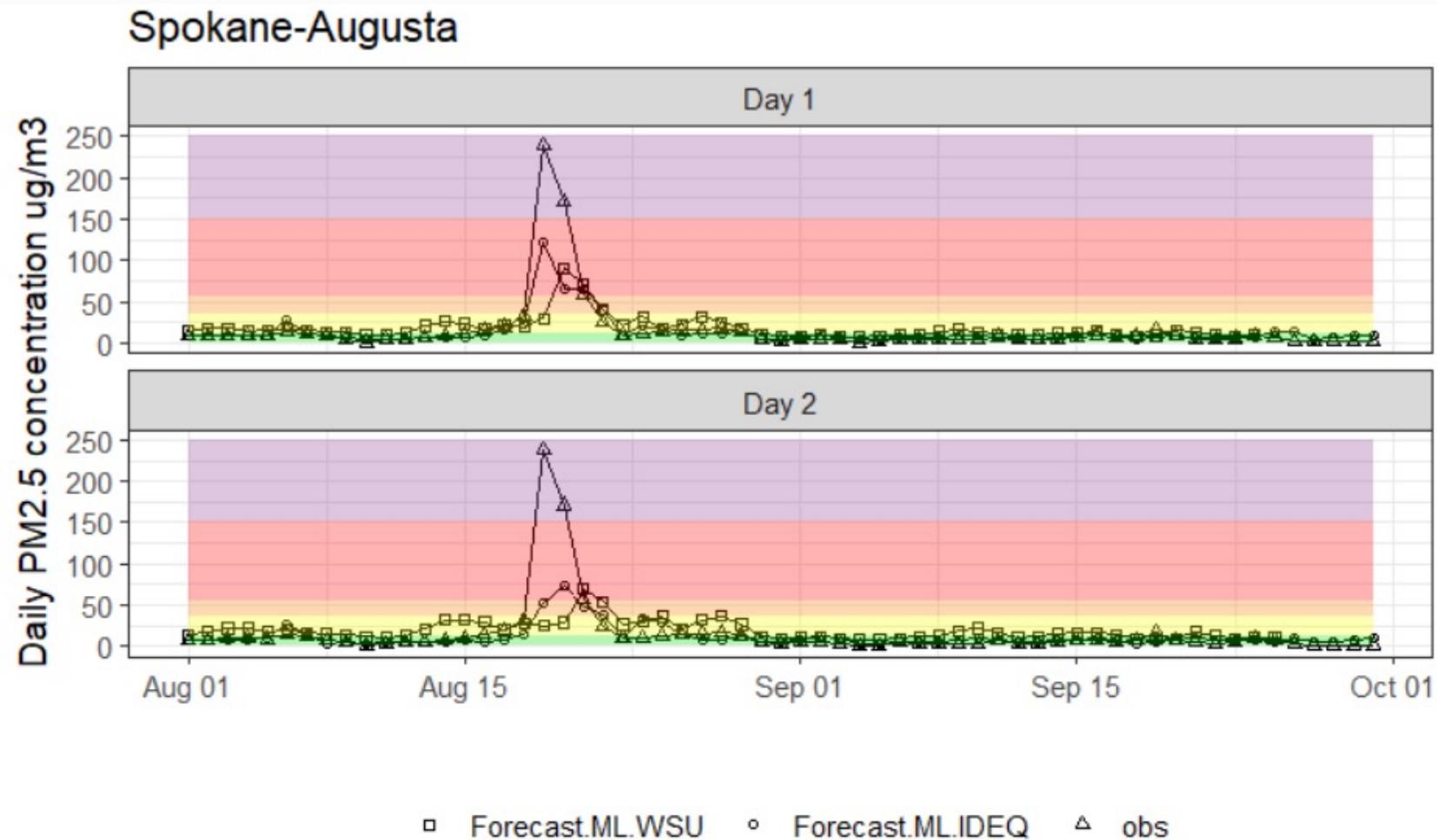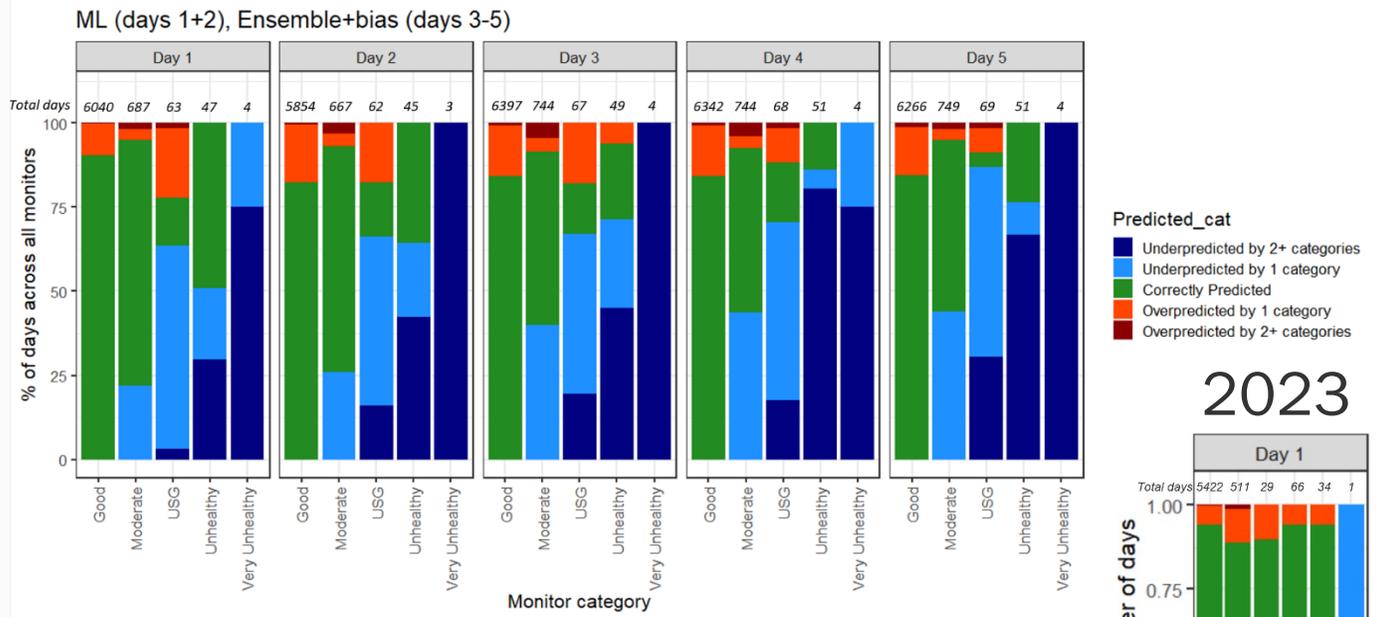# WSU vs. IDEQ ML at impacted sites
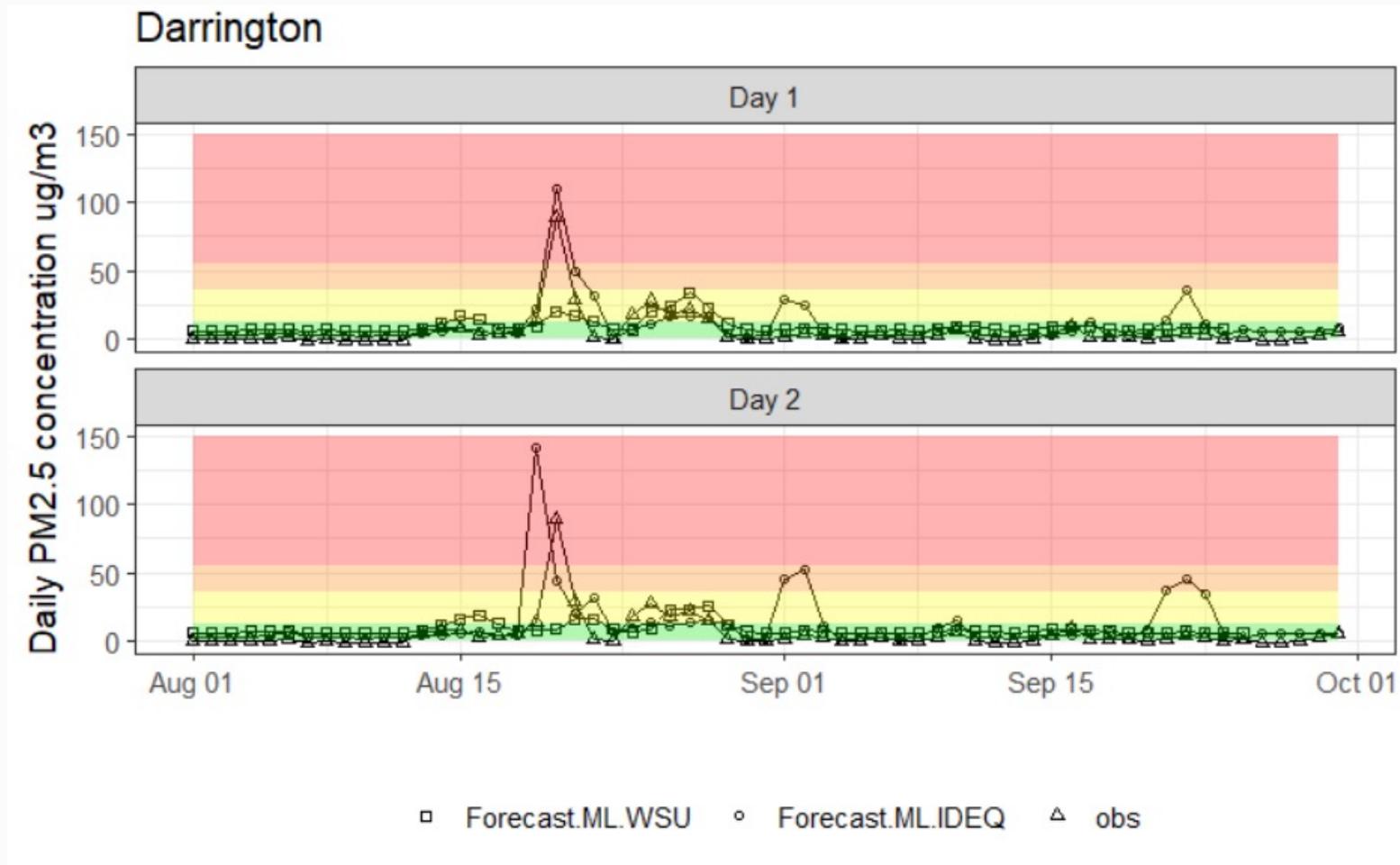
WSU vs. IDEQ ML at impacted sites

WSU vs. IDEQ ML at impacted sites

Comparison to 2022

2022

2023