

Next Generation Statistical Process Control

*Assessing and Predicting KPIs
and Pathogen Outcomes with Machine Learning*

Tim Buisker, November 2018



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SS|Science.Solutions

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Smart Data Science Solutions

→ We are **data scientists** and **statisticians**

→ We believe that **data is an underutilized resource** in poultry and other ag operations

- (Yes, still, in almost-2020...)

- Why?

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- o Geneticists breed hearty animals
- o Veterinarians raise healthy animals
- o Biologists perform lab tests and experiments

- o XYZ professionals do XYZ

- o Data scientists **analyze** and **interpret data**

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→ So how do we propose to make better use of it?

→ One million little ways:

- De-silo it
- Connect it
- Analyze it
- **Learn from it**

Smart Data Science Solutions

→ **So how do we propose to make better use of it?**

→ Three (connected) big ways:

- Short-term statistical process control
- Long-term statistical process control
- Predictive process control

→ (And others that aren't the focus of this talk)

Statistical Process Control (SPC)

- What is the goal of SPC systems?
 - o SPC systems assess upward or downward trends in a process outcome and **flag changes that represent true departures from a baseline as opposed to random variation around it**
- *We augment historical algorithms with machine learning*
 - o This gives us the ability to **assess** and **predict** KPIs and pathogens

Three-Part SPC Systems

- Short-term: identify short-term signals from the noise
 - What deserves *my* attention **this week?**
- Long-term: detect when long term averages have shifted
 - What deserves *my team's* attention **this quarter?**
- Predictive: identify problematic flocks *prior* to processing
 - What's going to hit my *plant* **two weeks from now?**

Innovation: Short- and Long-Term SPC

We combine historically successful SPC algorithms used in telecoms, manufacturing, and human disease monitoring with machine learning algorithms to optimize timing, detection, and sensitivity.

How?

1. Enhanced Feature Specification
2. Optimized Reset & Retuning
3. Continual Maintenance & Updates

Innovation: Predictive SPC

We utilize historical flock and location-based data, as well as plant-level outcomes, to dynamically model the live operations supply chain, predict outcomes, and assign outcome “Scores”.

How?

1. Domain Expertise
2. Historical Data + Outcomes of Interest
3. Machine Learning 😊

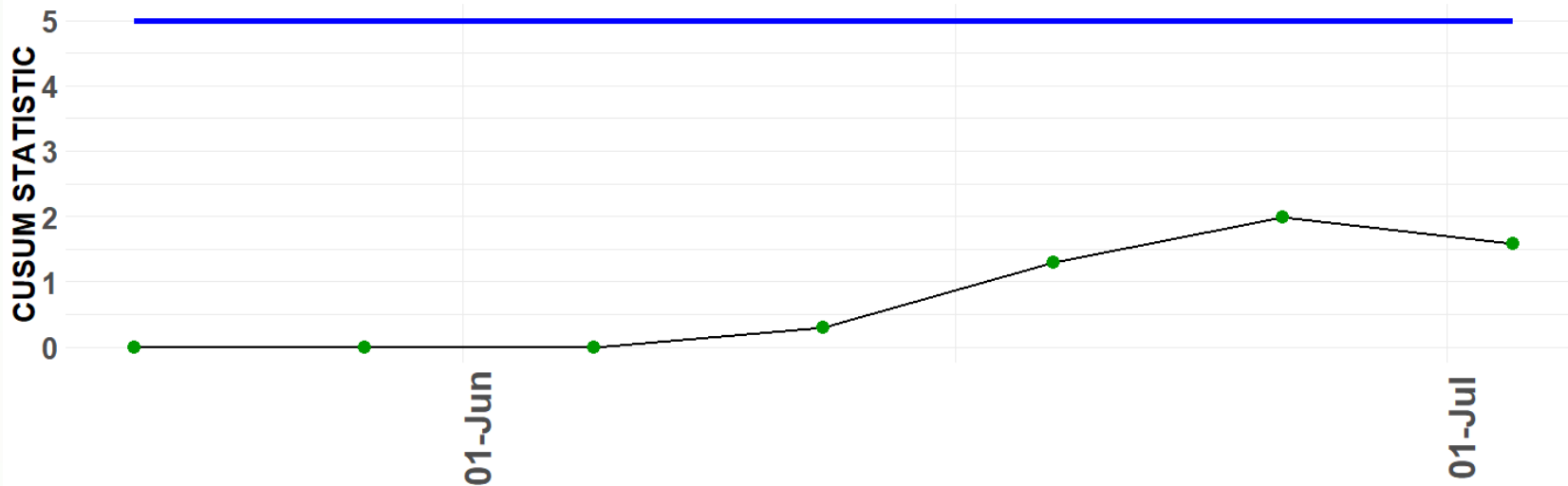
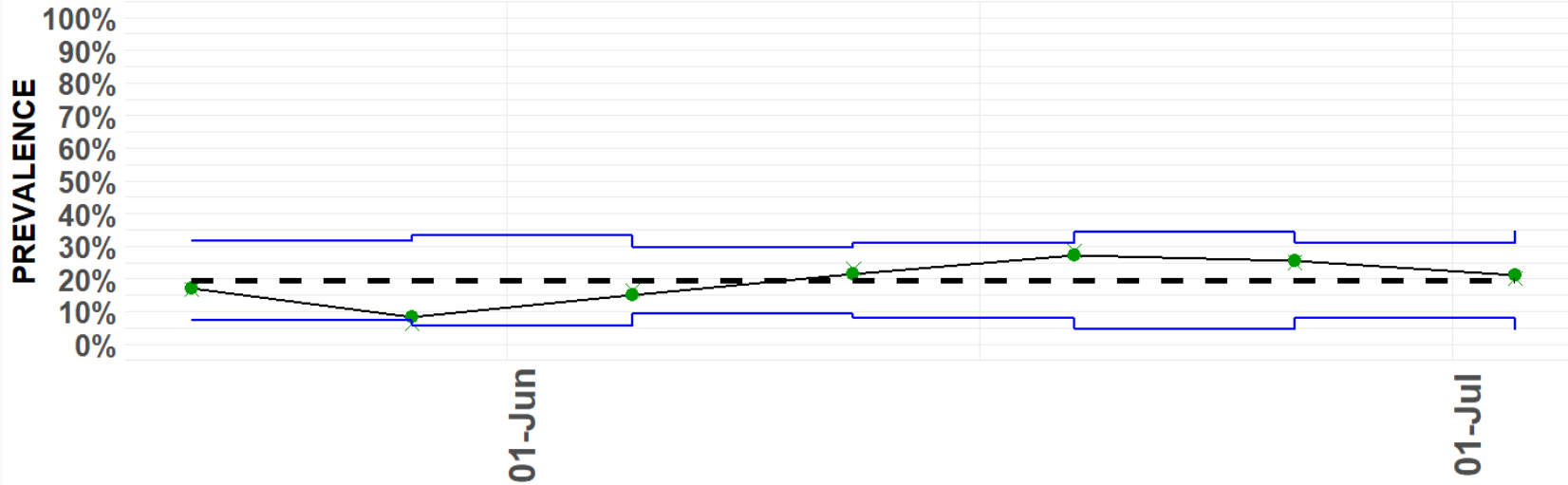
Short- and Long-Term SPC: Example

Let's watch this system work in real time.

This is real data, anonymized and with some noise added.

It measures the prevalence of a live operations outcome that we seek to *minimize*.

Short- and Long-Term SPC: Example

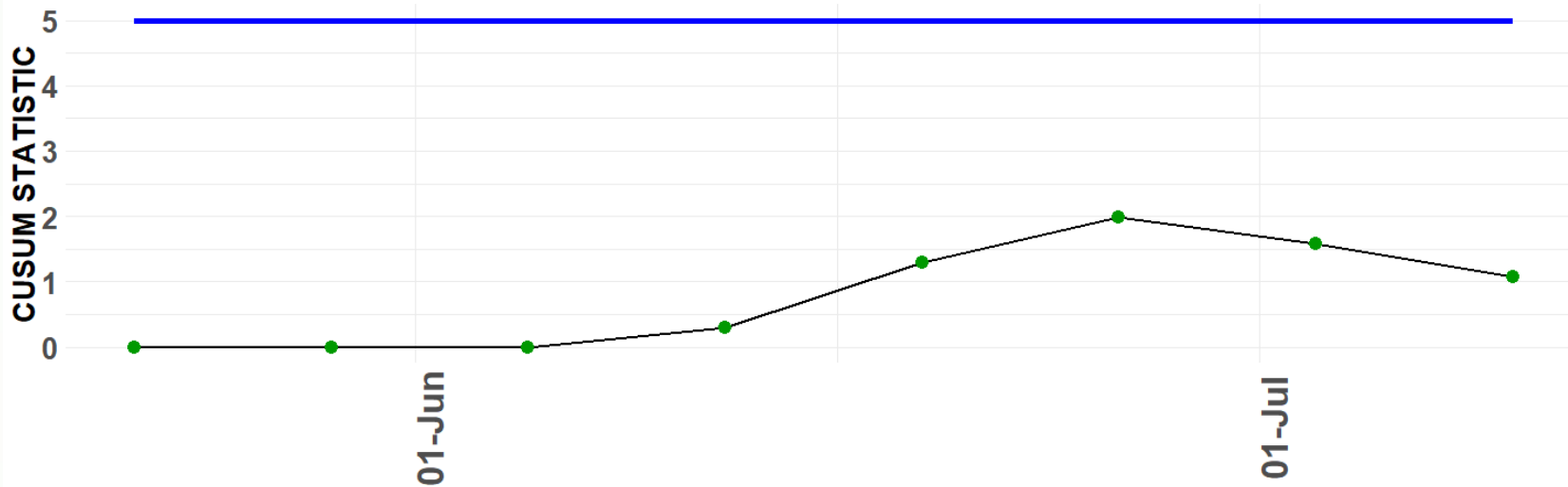
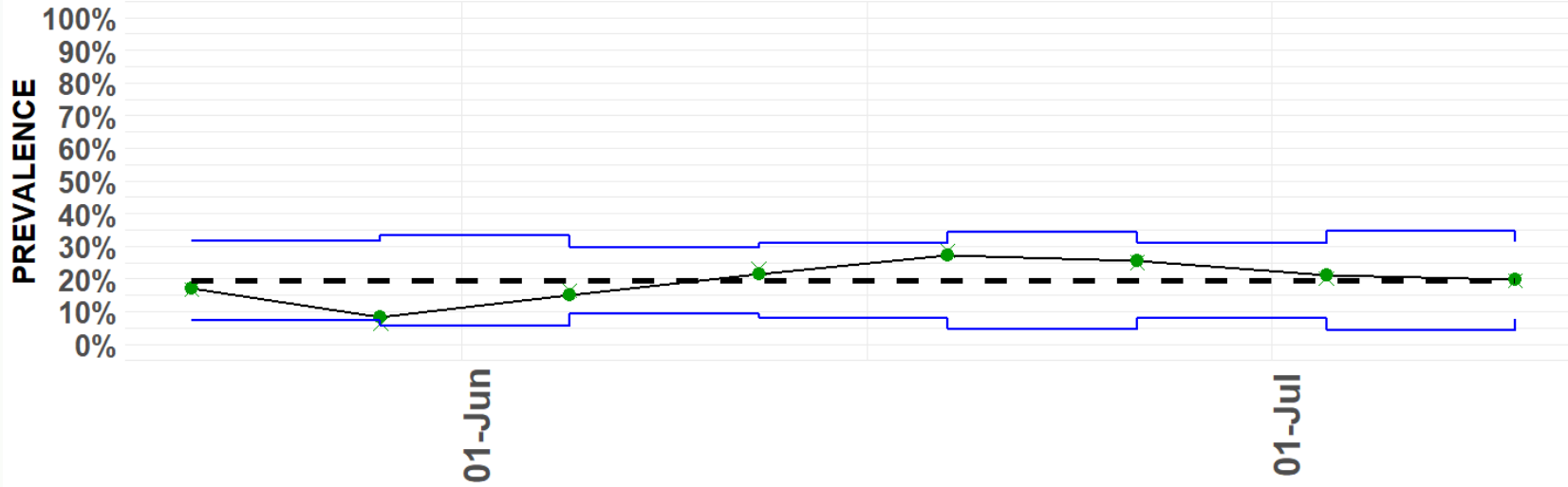


We'll start 8 weeks into a brand new process

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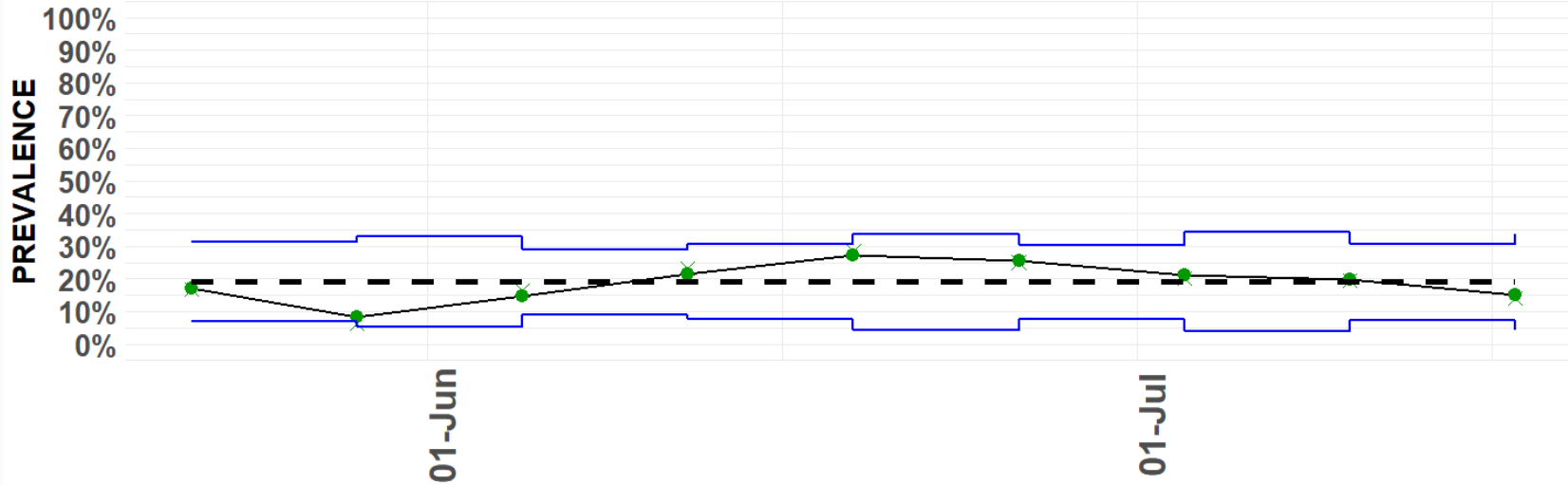


Short- and Long-Term SPC: Example

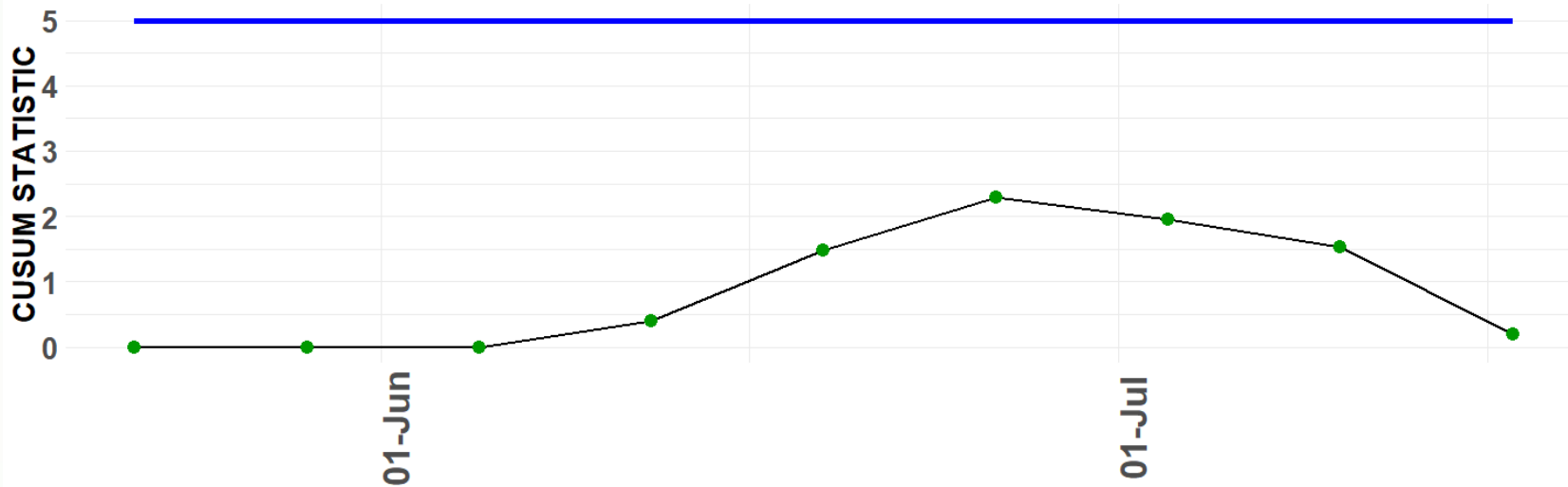


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Short- and Long-Term SPC: Example

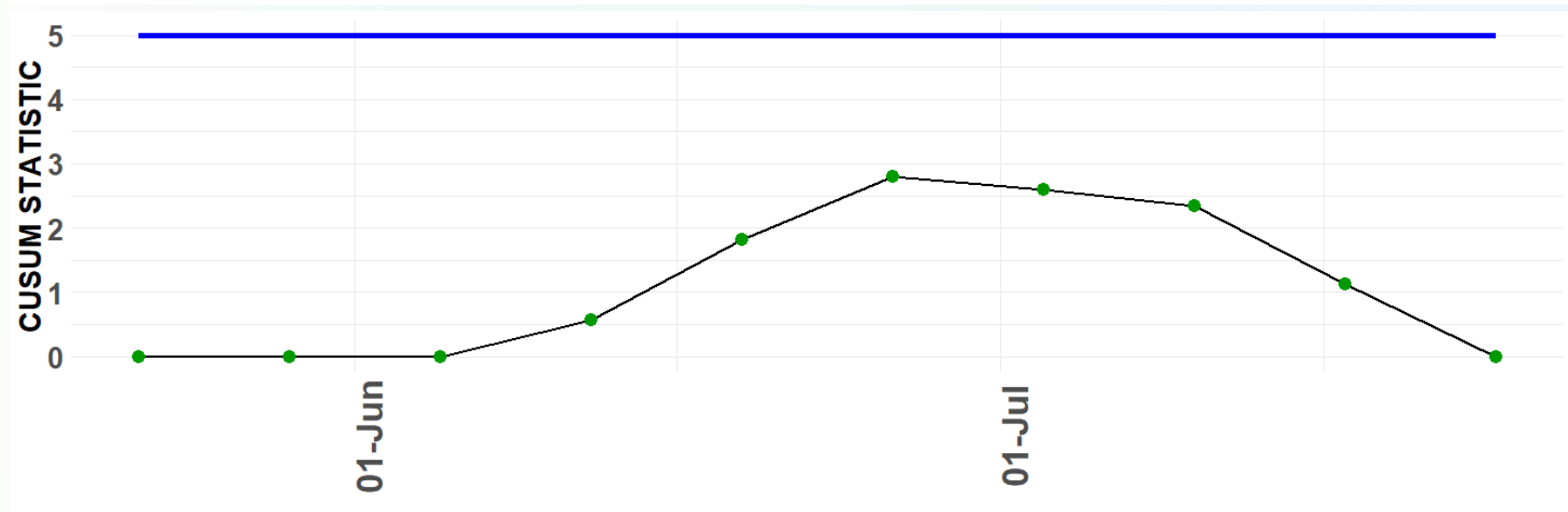
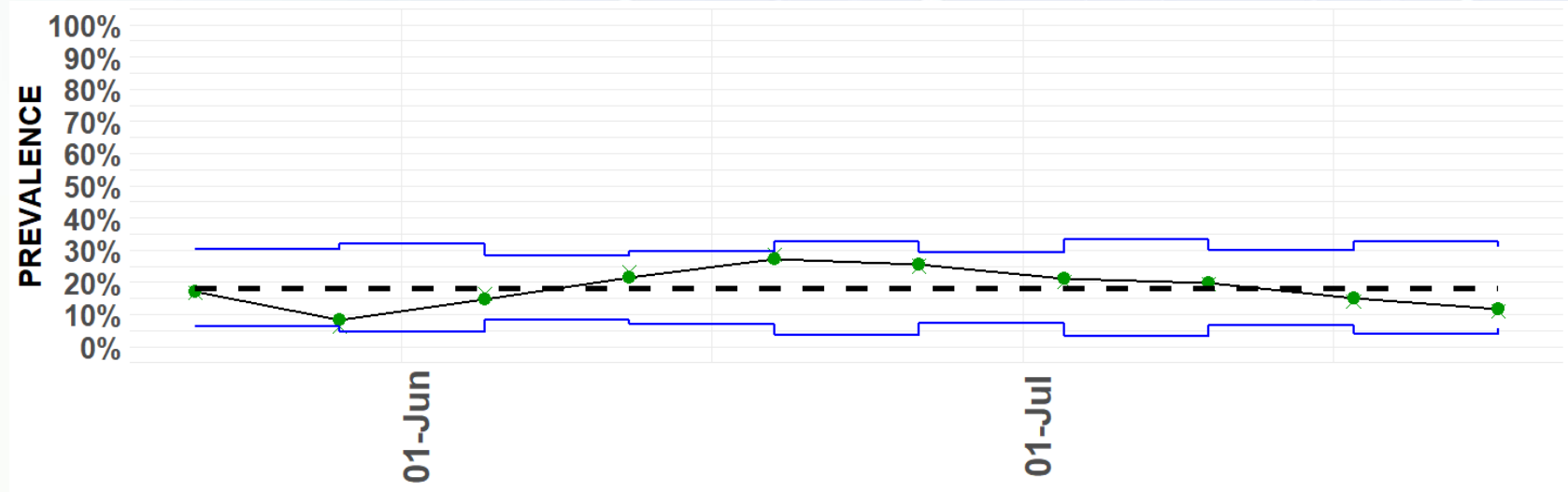


10 weeks

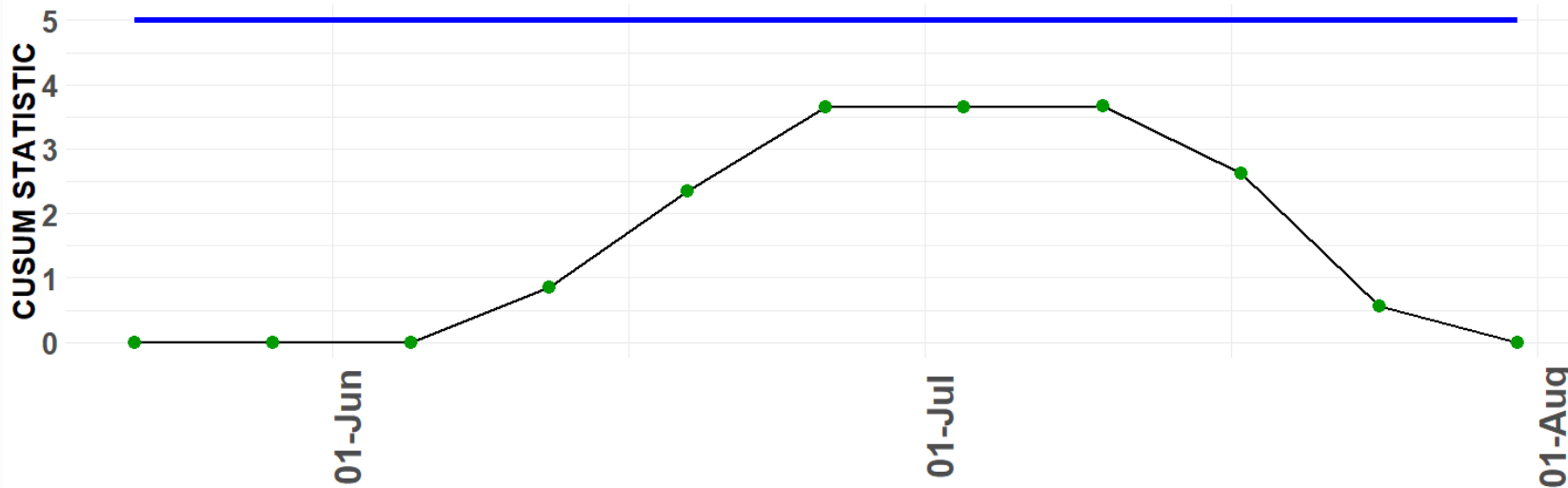
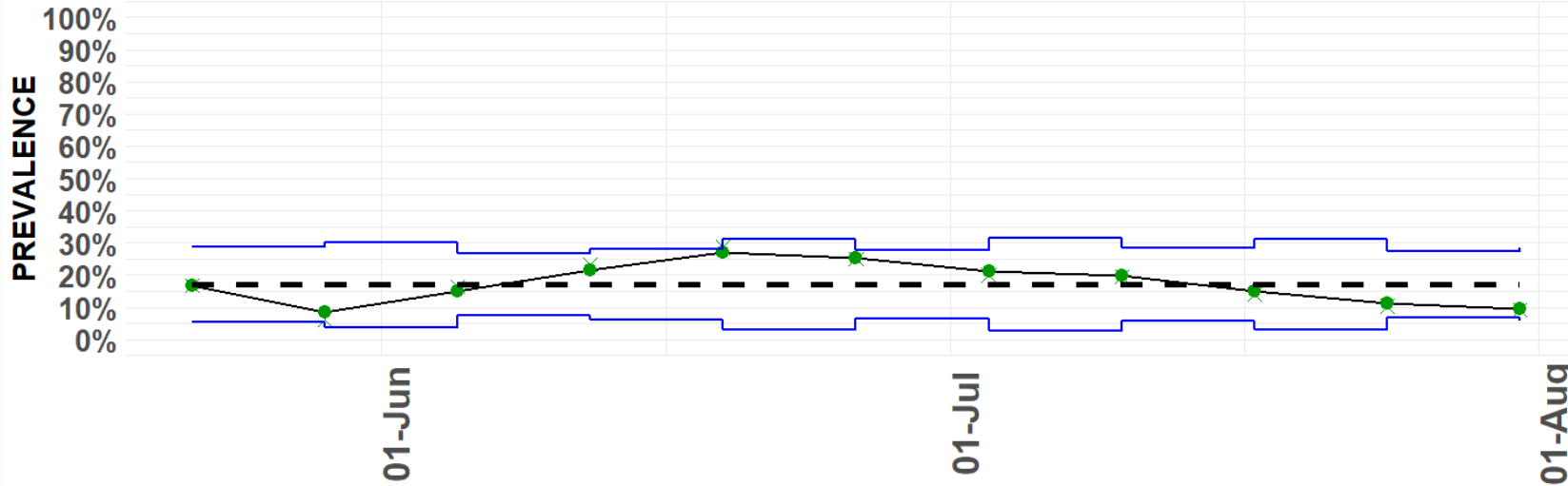


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Short- and Long-Term SPC: Example



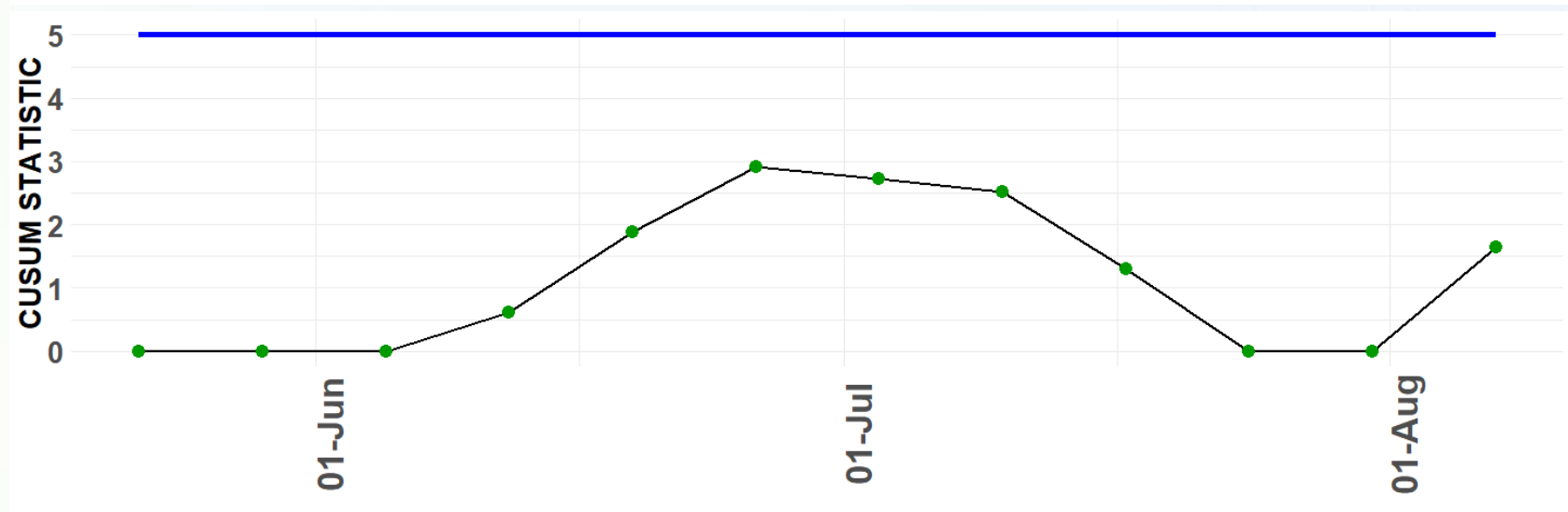
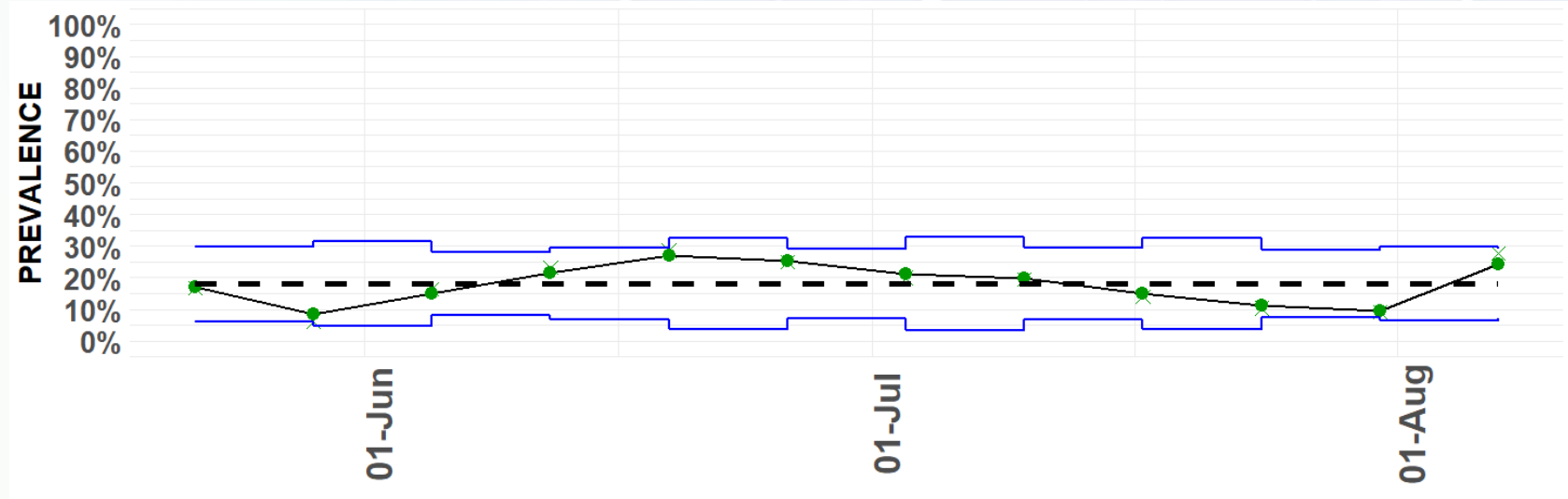
Short- and Long-Term SPC: Example



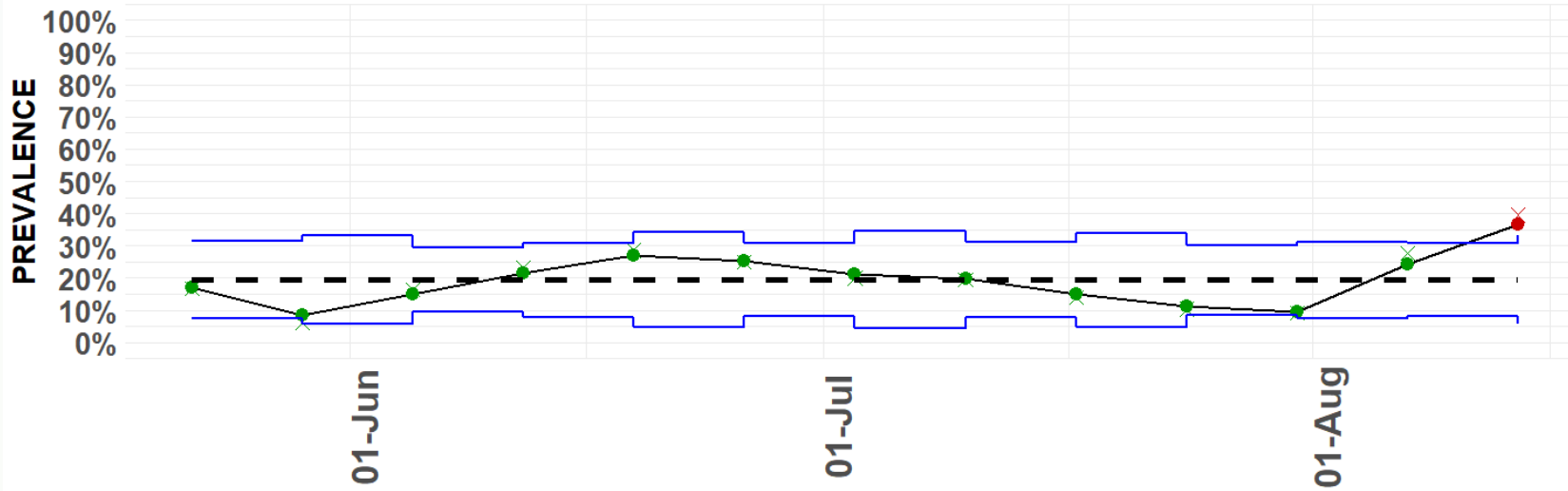
**12 weeks:
Still gathering
data**

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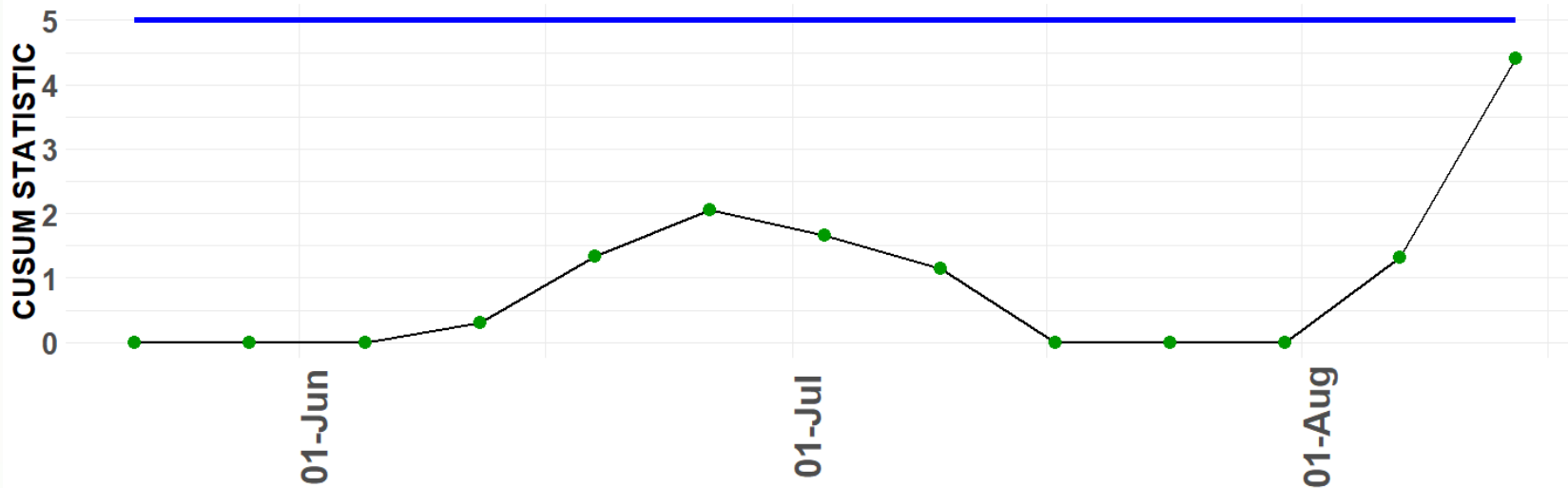
Short- and Long-Term SPC: Example



Short- and Long-Term SPC: Example

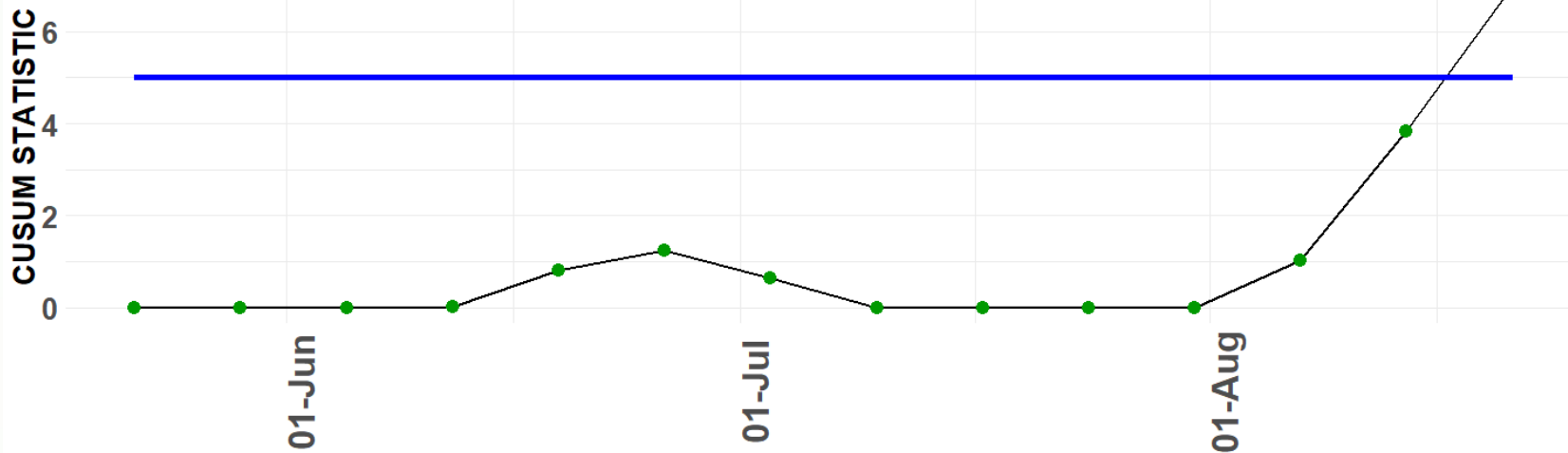
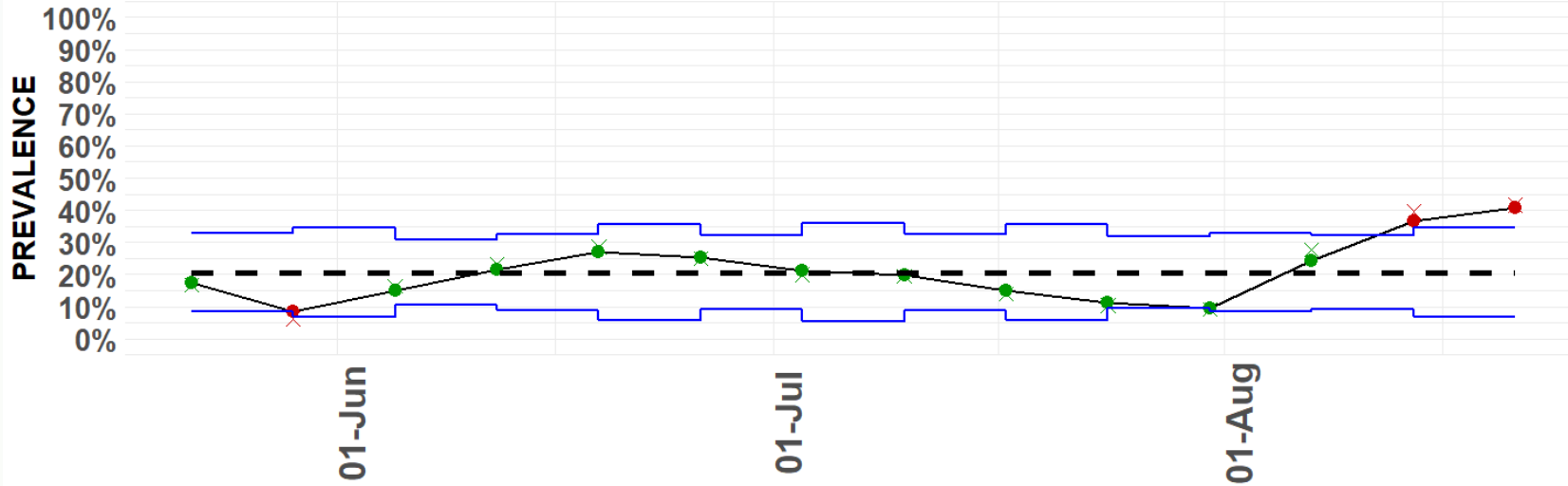


14 weeks:
An acute
event occurs



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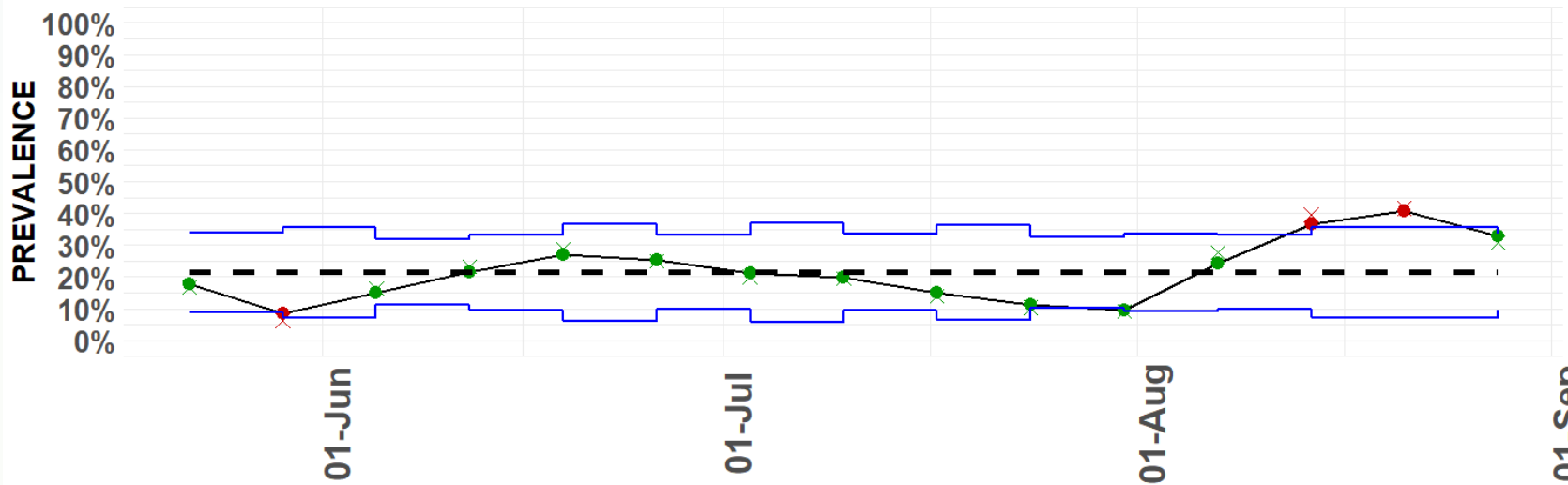
Short- and Long-Term SPC: Example



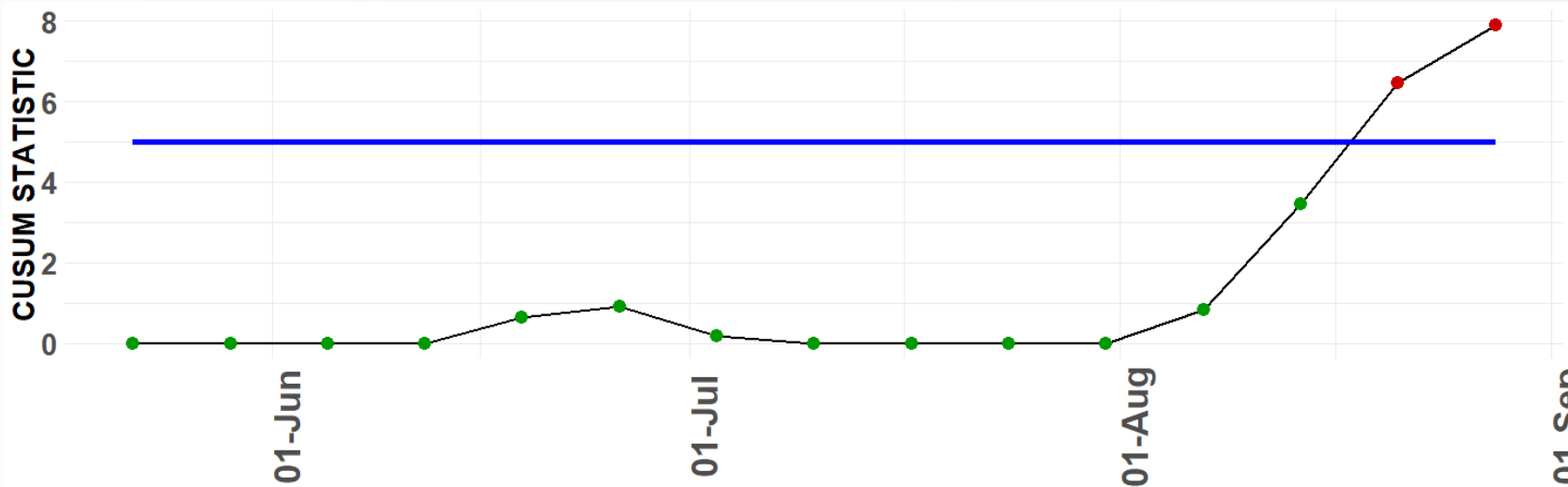
**15 weeks:
Event pulls
long-term
statistic over
threshold**

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Short- and Long-Term SPC: Example

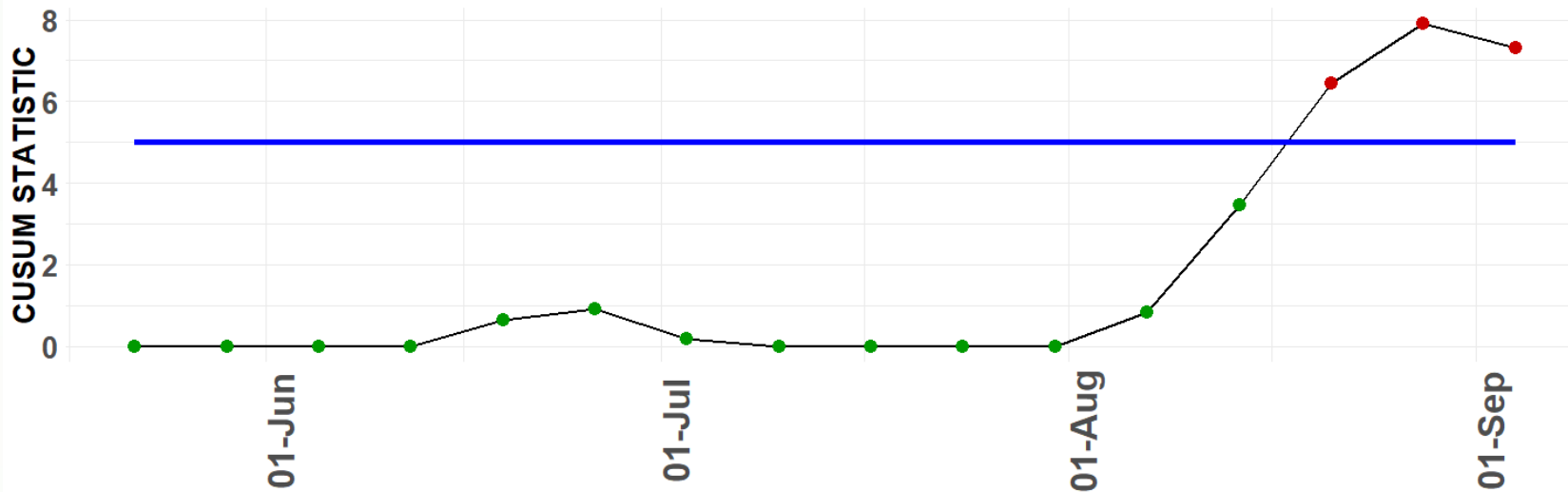
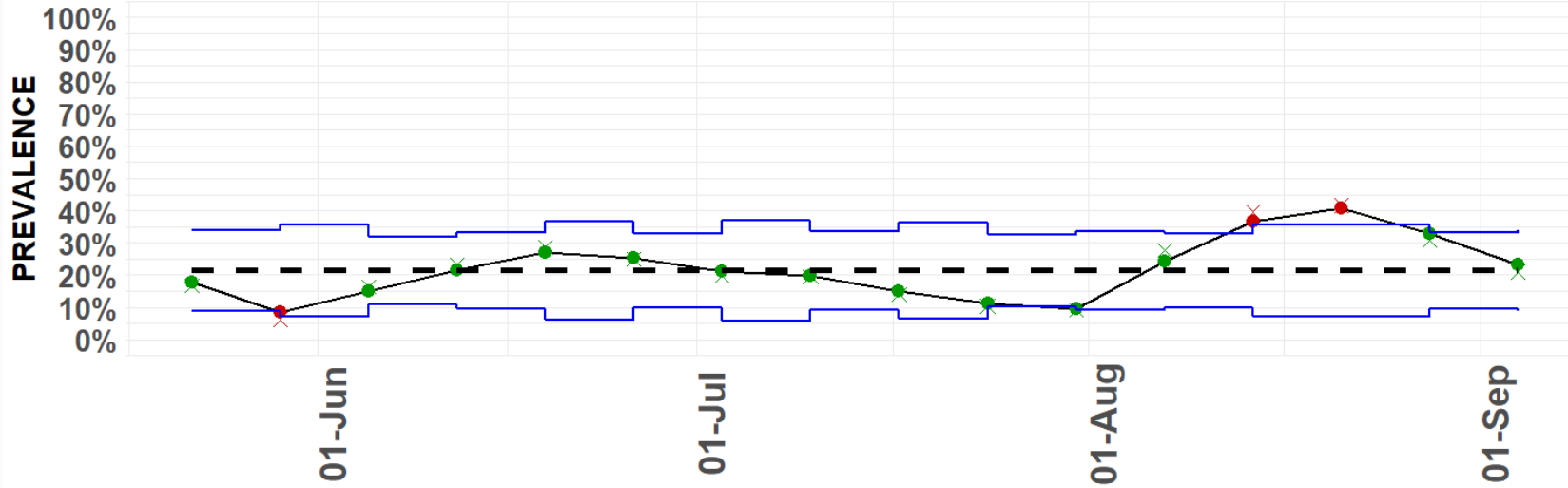


**16 weeks:
Event is over**



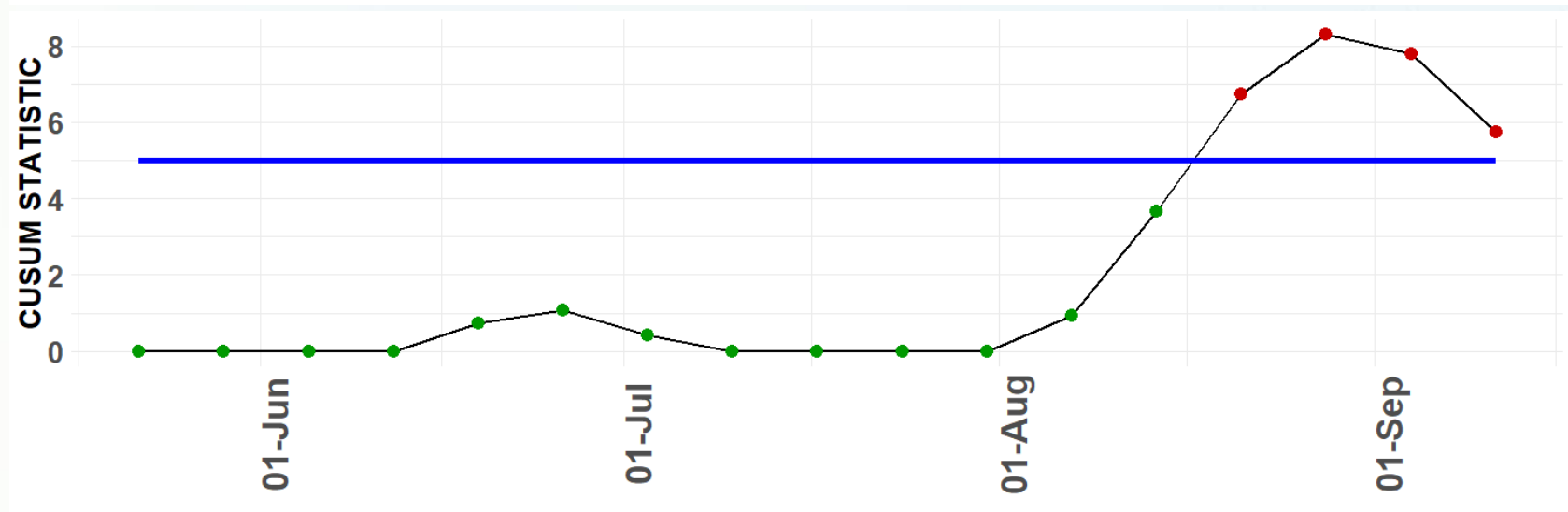
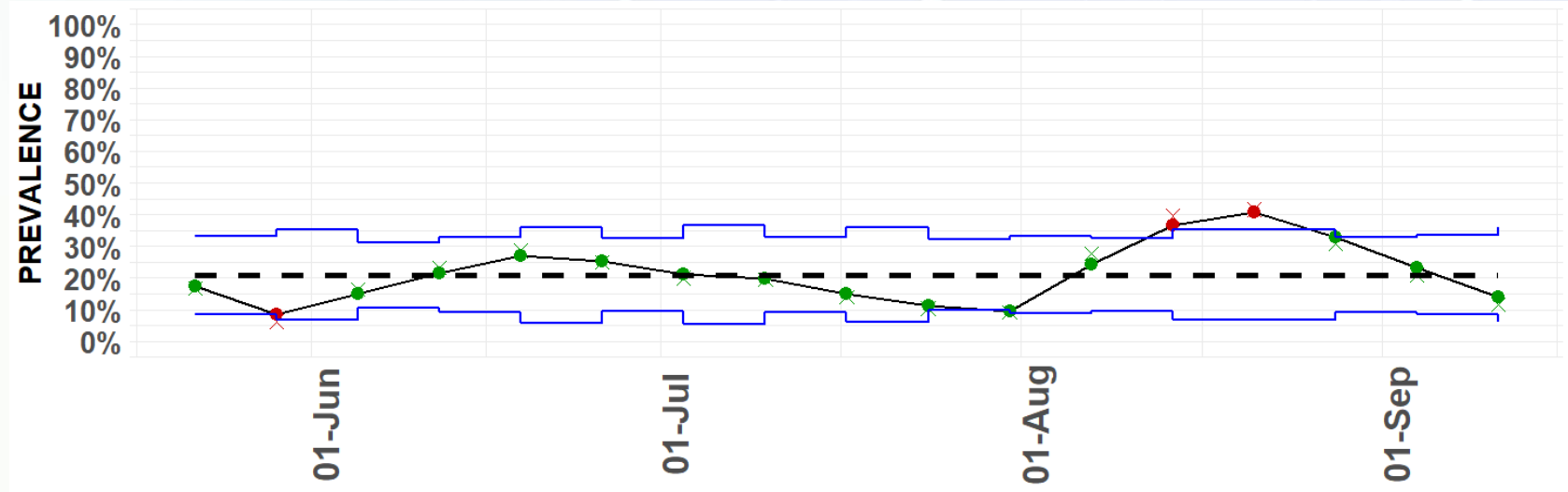
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Short- and Long-Term SPC: Example

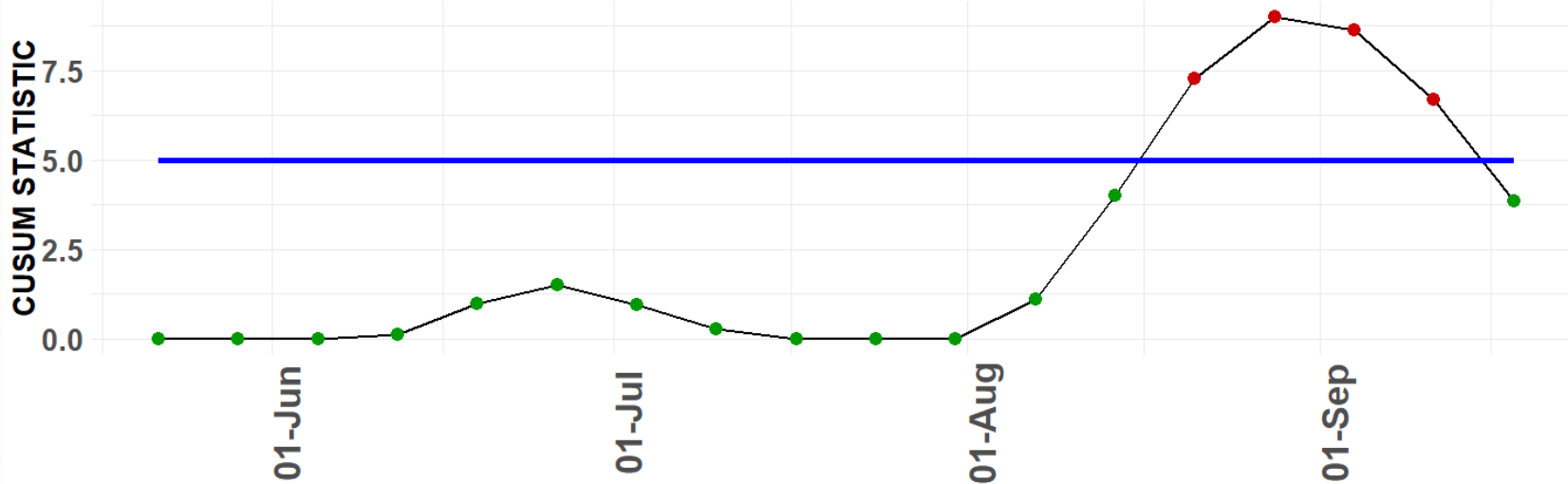
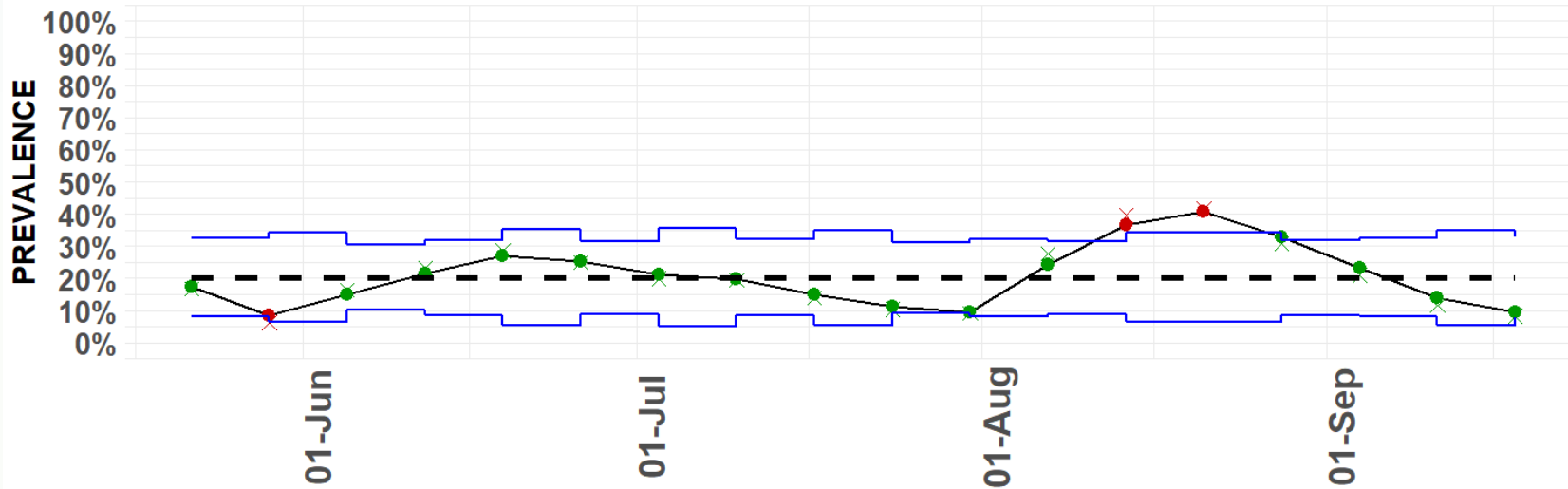


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Short- and Long-Term SPC: Example



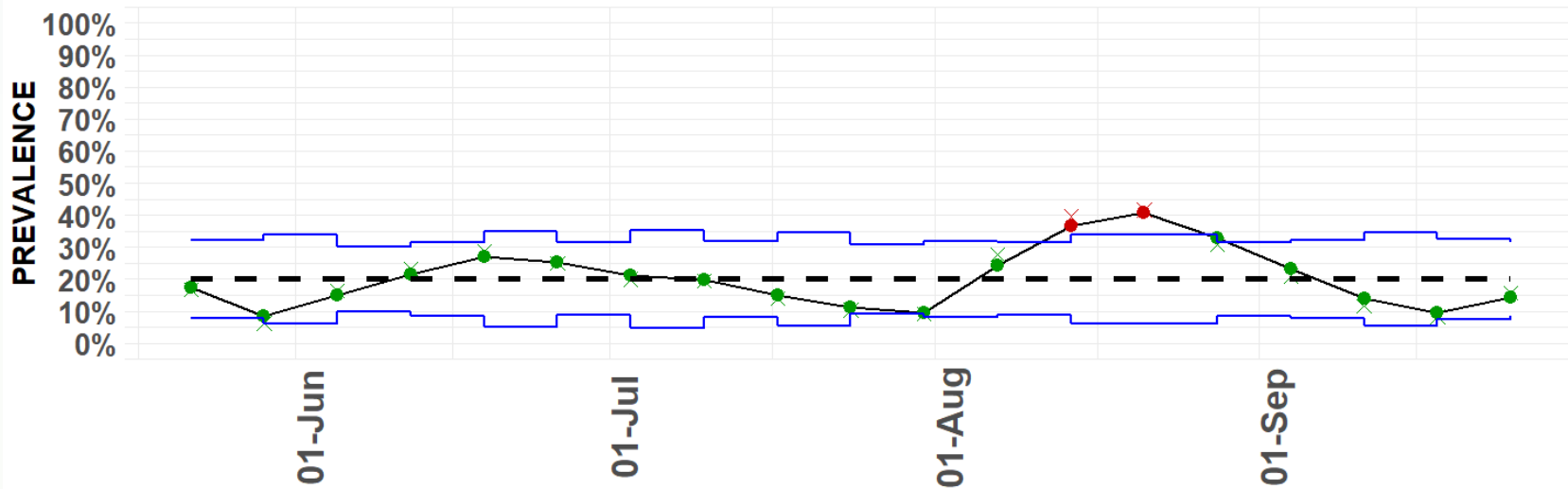
Short- and Long-Term SPC: Example



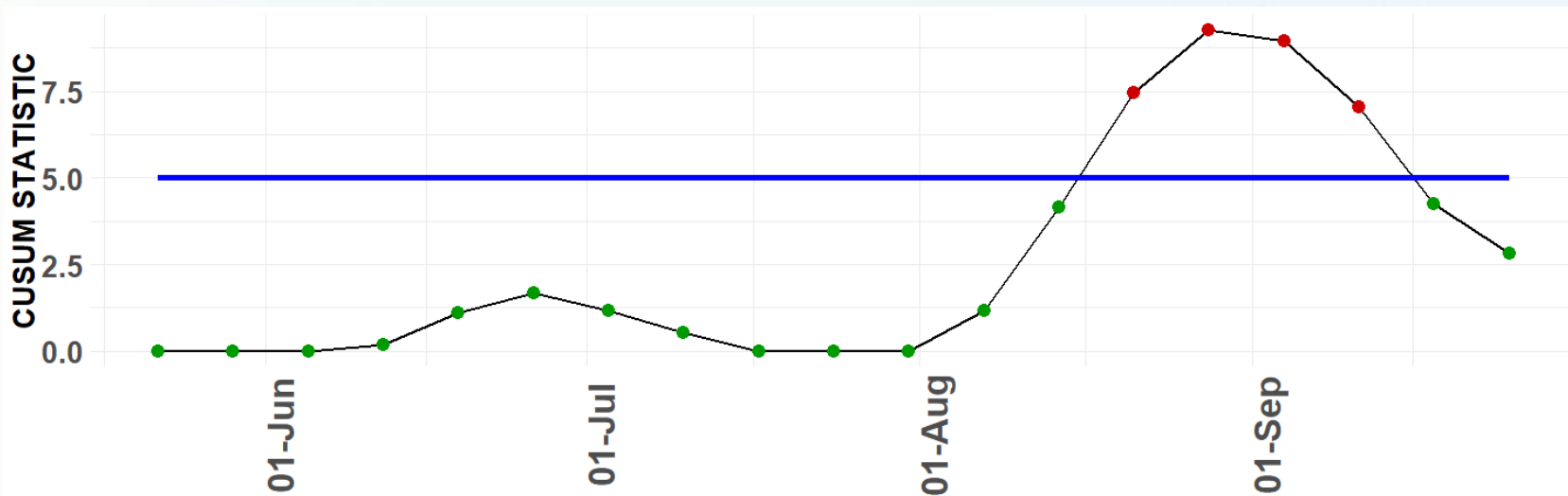
**19 weeks:
Short and
long-term
statistics back
below alert
threshold**

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Short- and Long-Term SPC: Example

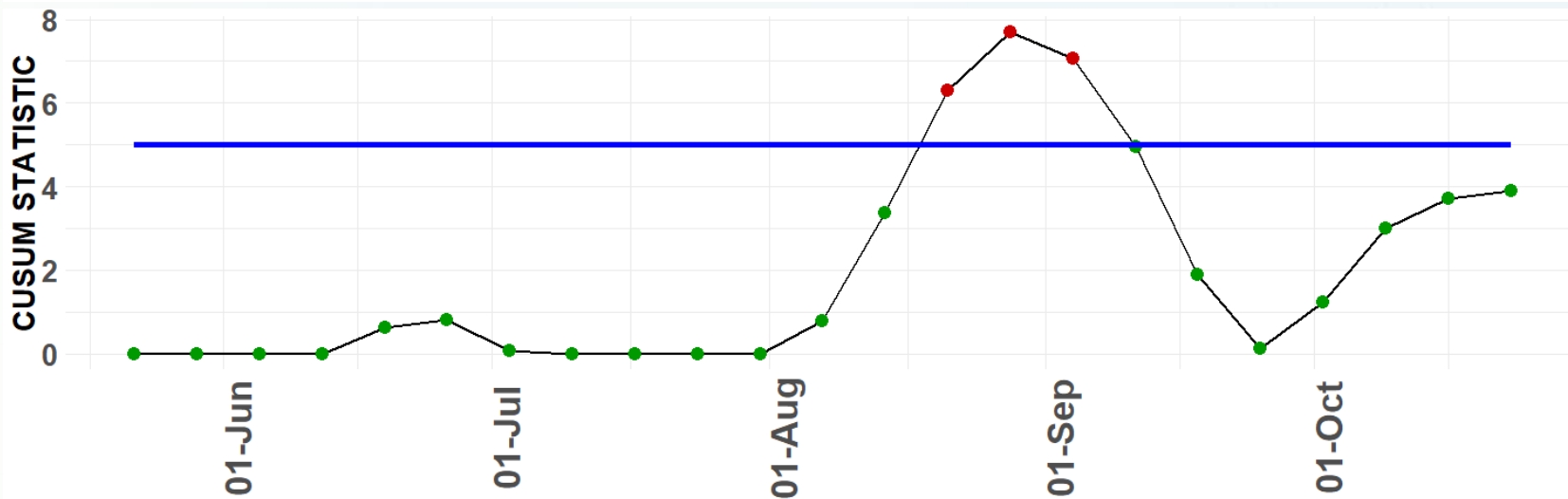
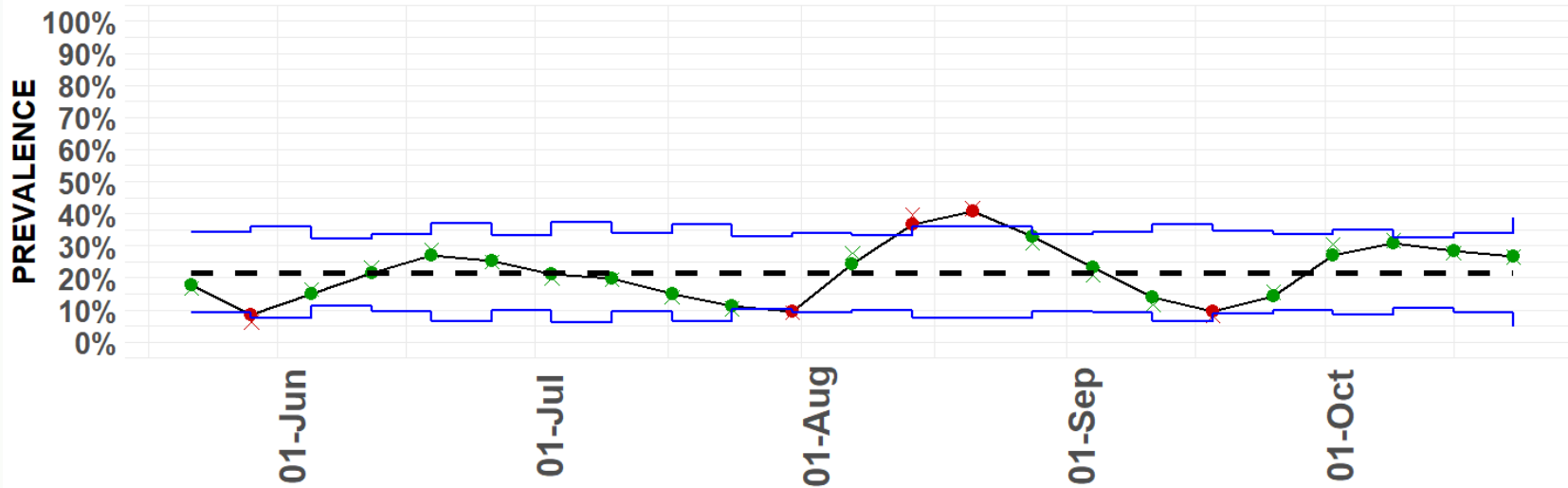


20 weeks



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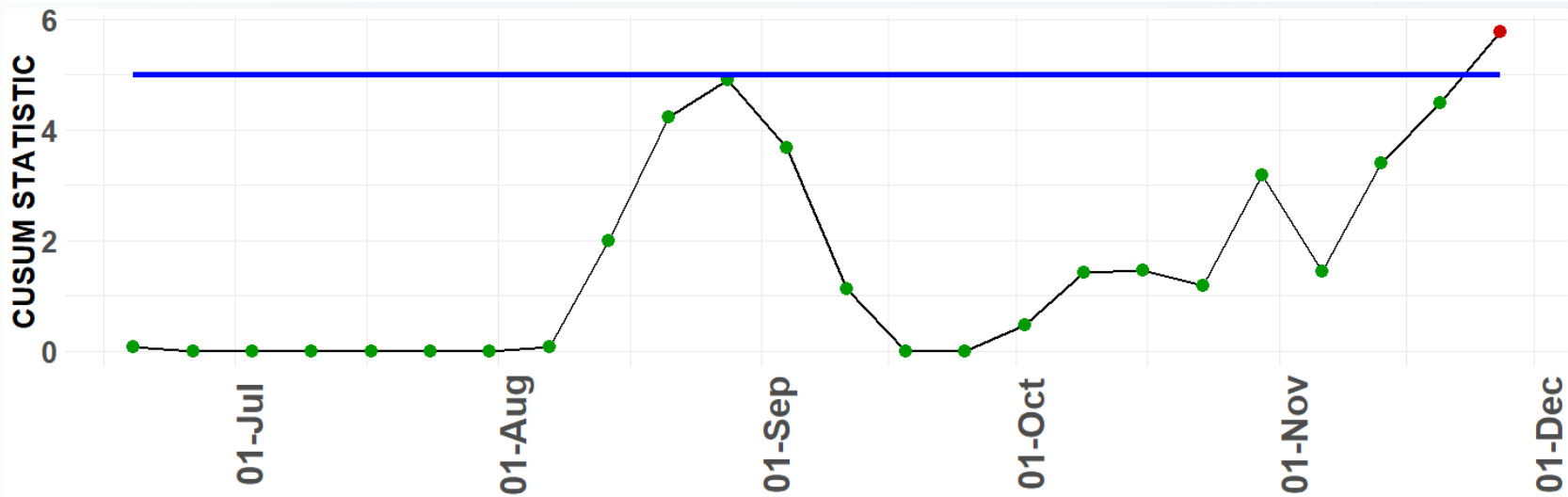
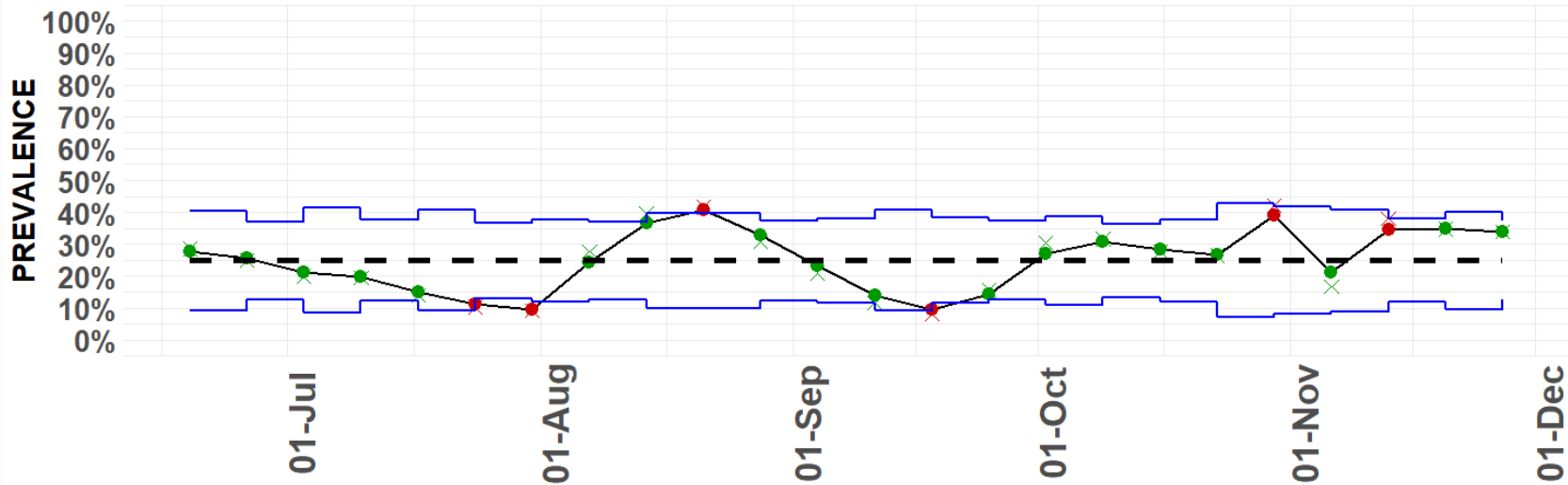
Short- and Long-Term SPC: Example



**24 weeks:
One full month
above average
(chronic event)
has pulled the
long-term
statistic up**

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Short- and Long-Term SPC: Example



**28 weeks:
7/8 weeks
above average
have brought
the long-term
statistic over the
threshold**

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Short- and Long-Term SPC: Example

This was an example of a process exceeding control thresholds in two different ways.

Acute: short-term spikes trigger short-term alerts and can bring up the long-term statistic quickly

Chronic: long-term changes in baseline may not be visibly on a week-to-week basis but will trigger the long-term alert

Predictive SPC: Example

What if we could tell 2+ weeks prior to processing what a flock's likely processing outcomes would be?

- Act to avert undesired outcomes
 - Changes to diet, supplements, medications
- Adjust processing parameters
 - Interventions, scheduling
- Divert product
 - Institutional, Cooked, RTE

Predictive SPC: Example

Using ML, we devise outcome Score assignments

- Risk Score
 - Rank incoming flocks and enable risk reduction
- Yield Score
 - Optimize processing outcomes
- P/L Score
 - Increase profits, cut losses
- XYZ Score

Predictive SPC: Example

This is less exciting to watch in real time

(Also we are probably pretty close to running out of time)

Predictive SPC: Example

This is less exciting to watch in real time

(Also we are probably pretty close to running out of time)

The results:

Flock ID	Risk Score
Smith 1	97.6
Jones 4	97.1
Brown 1	96.4
...	
Miller 2	21.2
Lee 3	18.7
White 1	14.1

Flock ID	Yield Score
Jones 2	93.1
Taylor 2	89.9
Garcia 3	86.3
...	
Smith 2	74.8
Chang 1	74.5
Wilson 5	73.9

Relationships take work...

Improve the relationship
with *your* data.



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