Summary of 2019 Bay-Wide Tidal Water Quality Trends

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U.S. Geological Survey

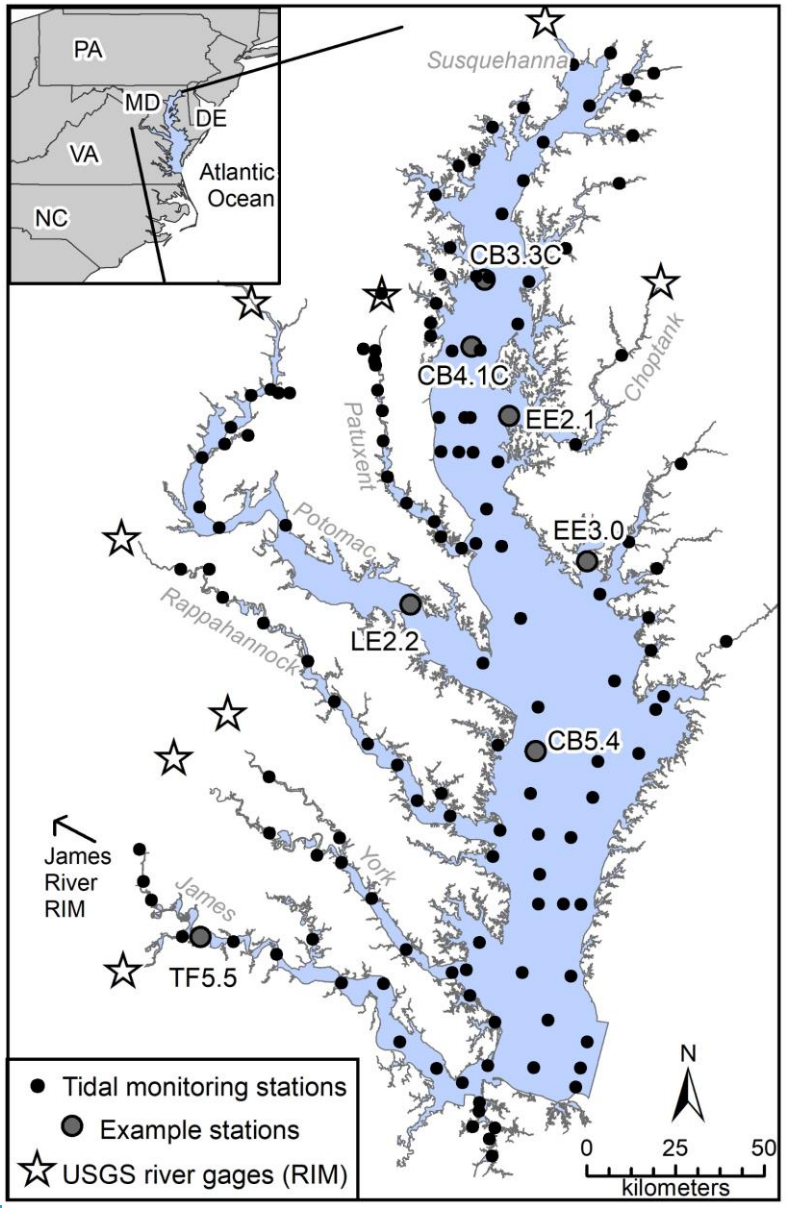
*Trends run by **Renee Karrh** (MDDNR) and **Mike Lane** (ODU)*

WQGIT meeting

Jan 25, 2019

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Chesapeake Bay Program
Science. Restoration. Partnership.



Extensive long-term coordinated tidal water quality monitoring

- MDDNR, VADEQ, DC and others have been sampling at 150+ stations since the 1980s 1-2 times/month
- Nutrients, chlorophyll-*a*, dissolved oxygen, Secchi depth, salinity, temperature, and others
- Long-standing coordinated effort to analyze trends in these data between the partners

Matt Rath/Chesapeake Bay Program

Outcome: Water Quality Standards Attainment and Monitoring

- Assessing tidal trends annually is part our Management Strategy and Logic & Action Plan
- Paired with assessing:
  - Nutrient and sediment changes in the watershed, and
  - Attainment of water quality.
- These tidal trends are necessary to understanding:
  - Links between the watershed and estuary response.
  - Incremental progress towards attainment of water quality standards.

Photo by Will Parson/Chesapeake Bay Program

Annual tidal trend results

- Multiple parameters at every station:
  - Nutrients: Total Nitrogen, Dissolved Inorganic Nitrogen, Total Phosphorus, Orthophosphate
  - Secchi Depth, Chlorophyll-*a*, Dissolved Oxygen, Total Suspended Solids
  - Temperature, Salinity
- Capture the spatial and temporal dynamics:
  - Surface & bottom
  - True conditions & flow-adjusted
- Post-process analysis possible for time periods and seasons:
  - Long-term (ideally 1985-present)
  - Short-term (last 10 years)
  - Spring & summer chlorophyll-*a*, summer bottom DO

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  - Short-term (last 10 years)
  - Spring & summer chlorophyll-*a*, summer bottom DO

Total monitored flow into tidal waters

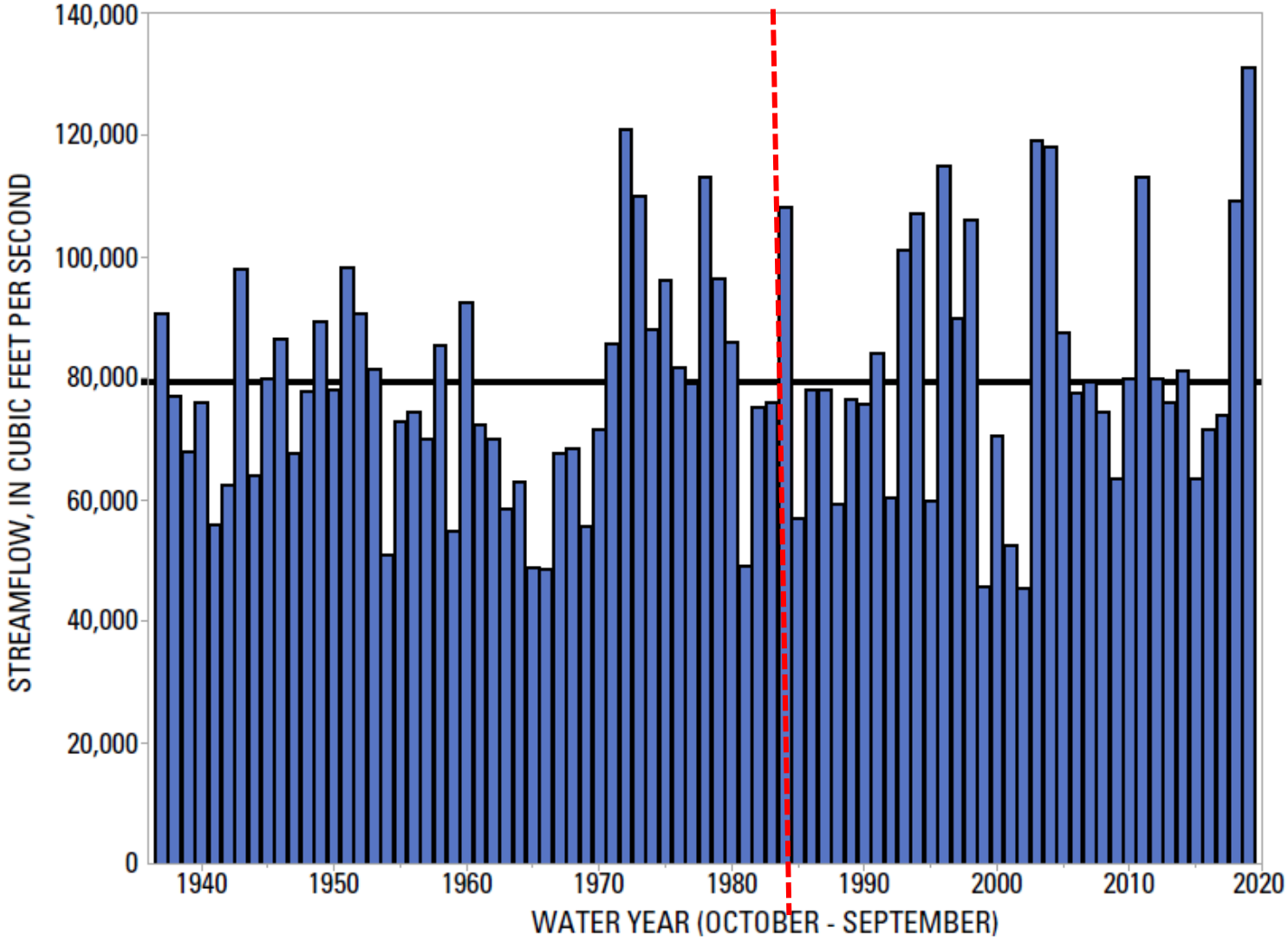


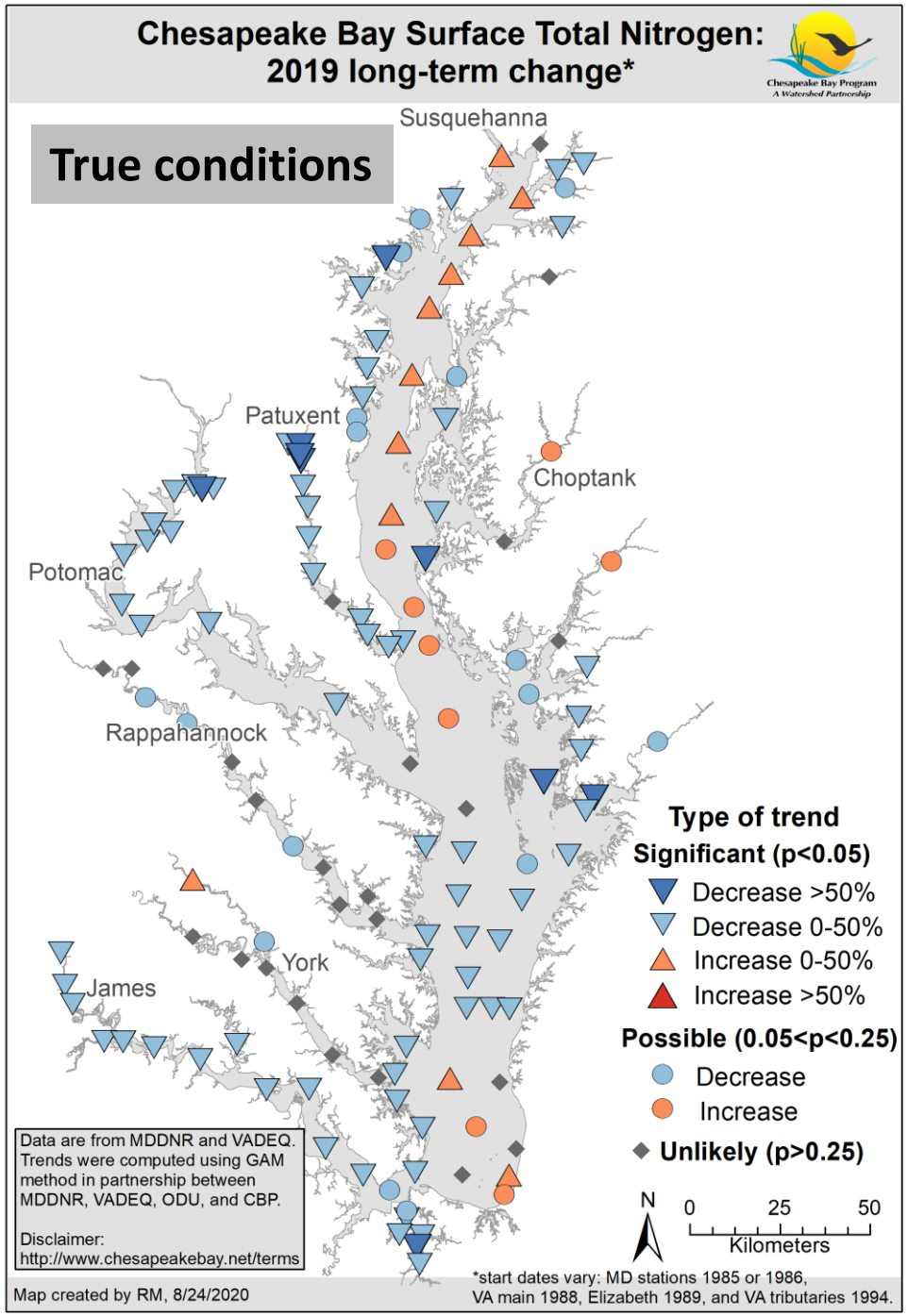
Figure 2. Estimated annual-mean streamflow entering Chesapeake Bay. Black line represents the average annual-mean streamflow of 79,423 cubic feet per second.

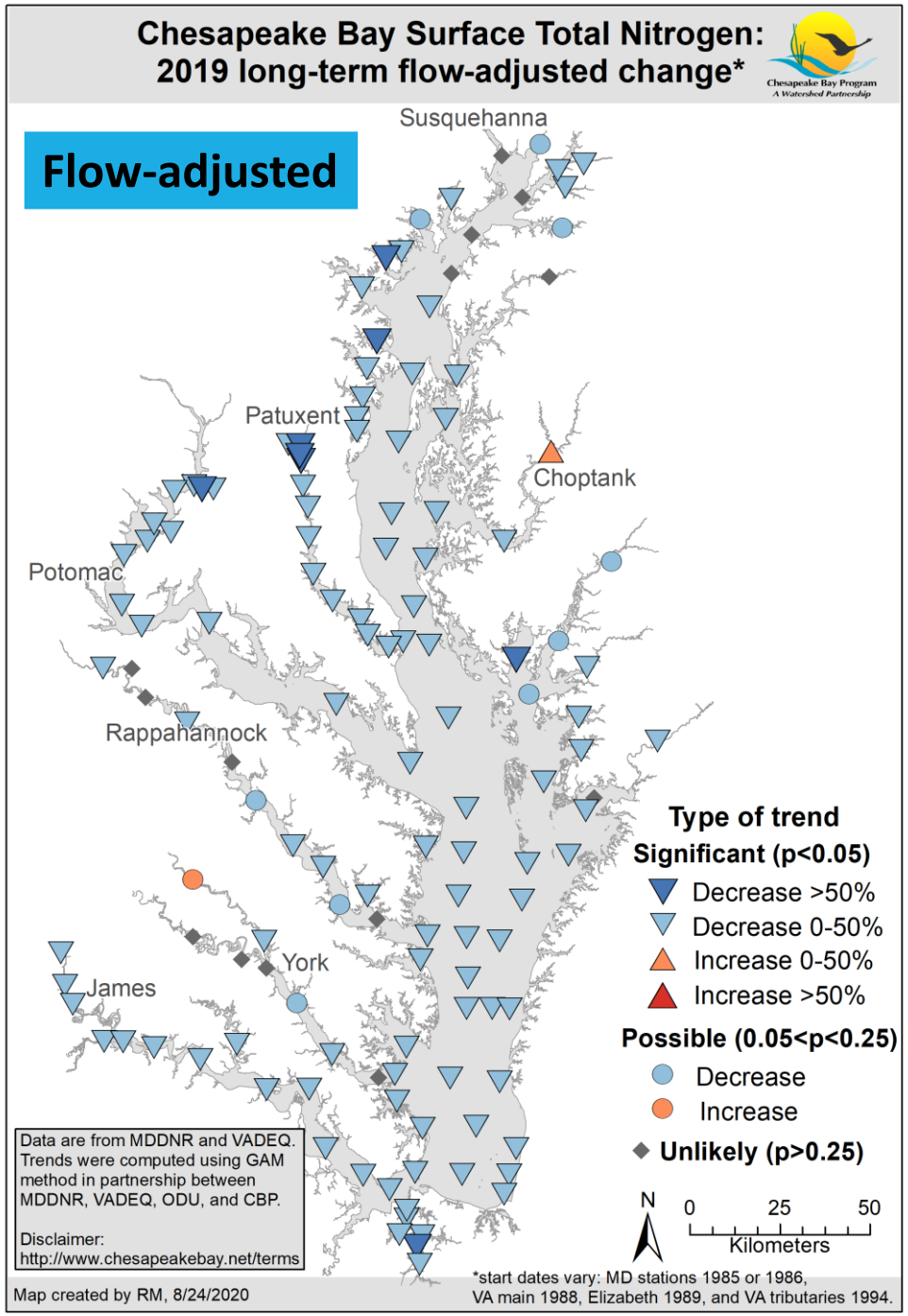
Note:
2019 highest in this record. 2018 very high too.

Moyer and Blomquist 2020. https://doi.org/10.5066/P9VG459V.

TN

long-term


Chesapeake Bay Surface Total Nitrogen:
2019 long-term change*
Chesapeake Bay Program
A Watershed Partnership
True conditions
Susquehanna
Patuxent
Choptank
Potomac
Rappahannock
York
James
Type of trend
Significant (p<0.05)
Decrease >50%
Decrease 0-50%
Increase 0-50%
Increase >50%
Possible (0.05<p<0.25)
Decrease
Increase
Unlikely (p>0.25)
N
0
25
50
Kilometers
Data are from MDDNR and VADEQ. Trends were computed using GAM method in partnership between MDDNR, VADEQ, ODU, and CBP.
Disclaimer:
http://www.chesapeakebay.net/terms
Map created by RM, 8/24/2020
*start dates vary: MD stations 1985 or 1986,
VA main 1988, Elizabeth 1989, and VA tributaries 1994.


Chesapeake Bay Surface Total Nitrogen:
2019 long-term flow-adjusted change*
Chesapeake Bay Program
A Watershed Partnership
Flow-adjusted
Susquehanna
Patuxent
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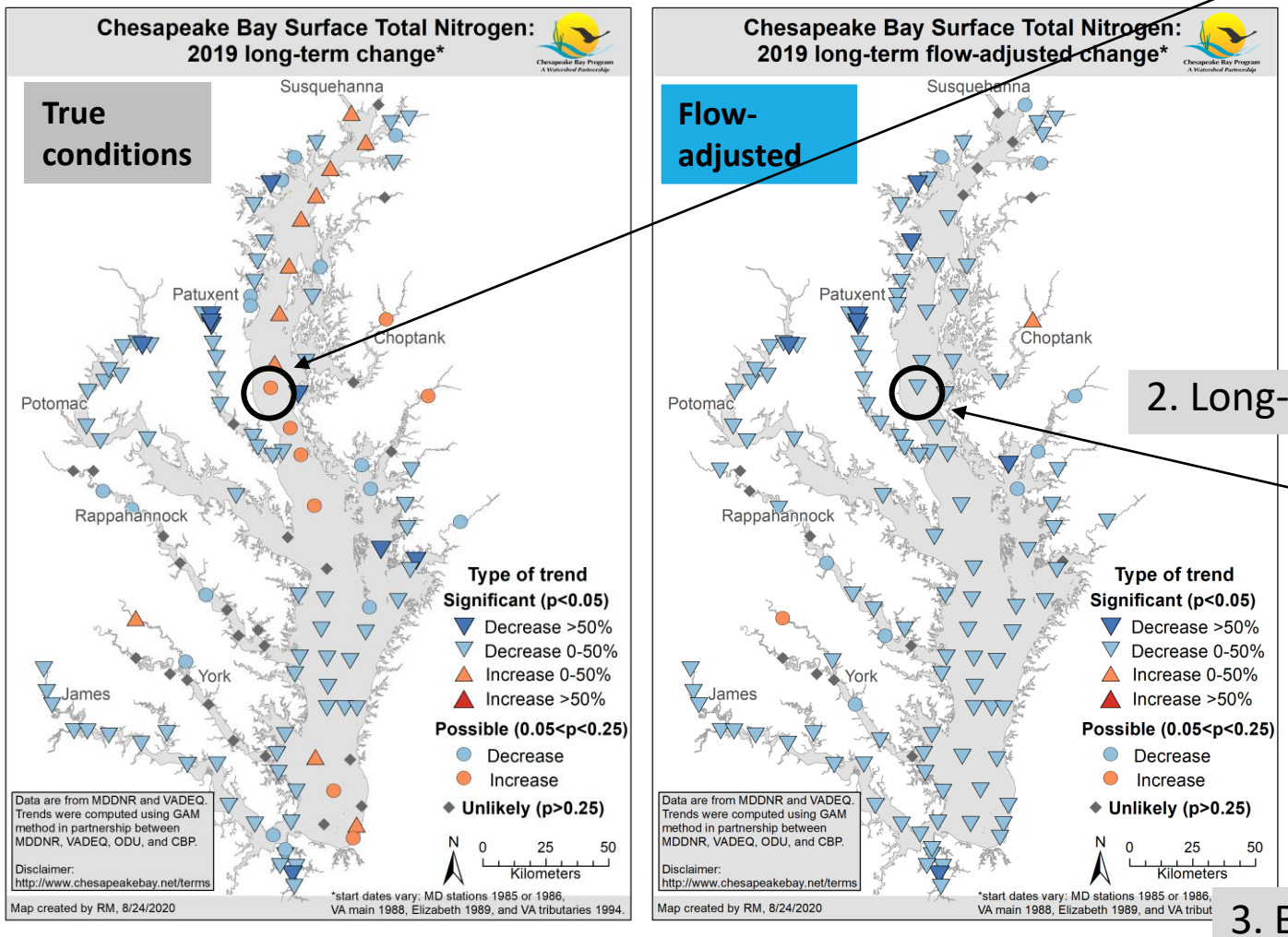
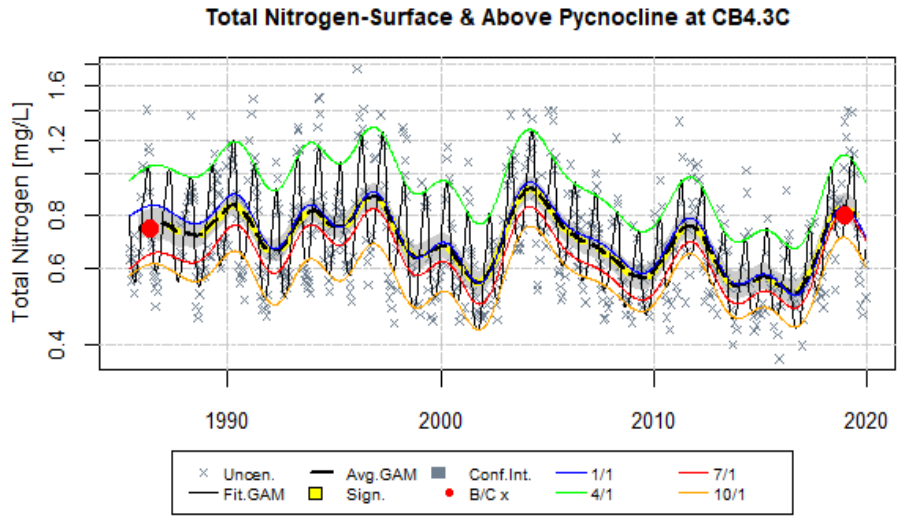
TN

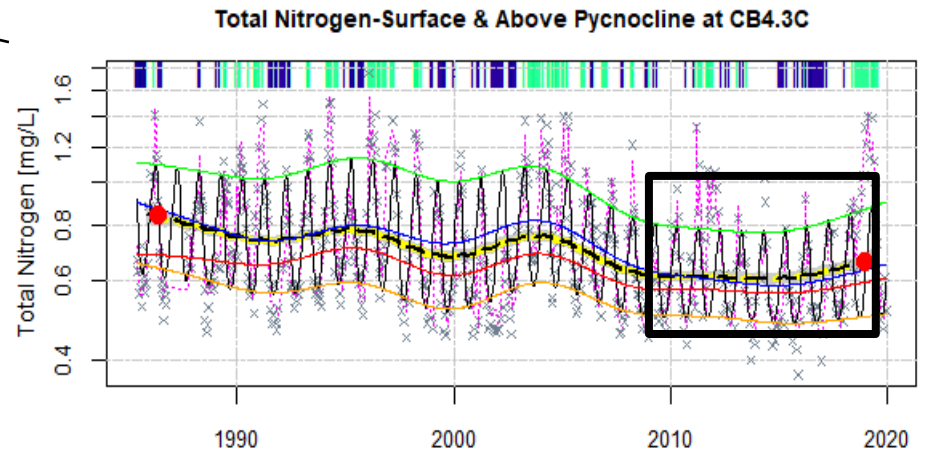
long-term

1. Entire upper half of mainstem shows increase before flow-adjustment. Example:





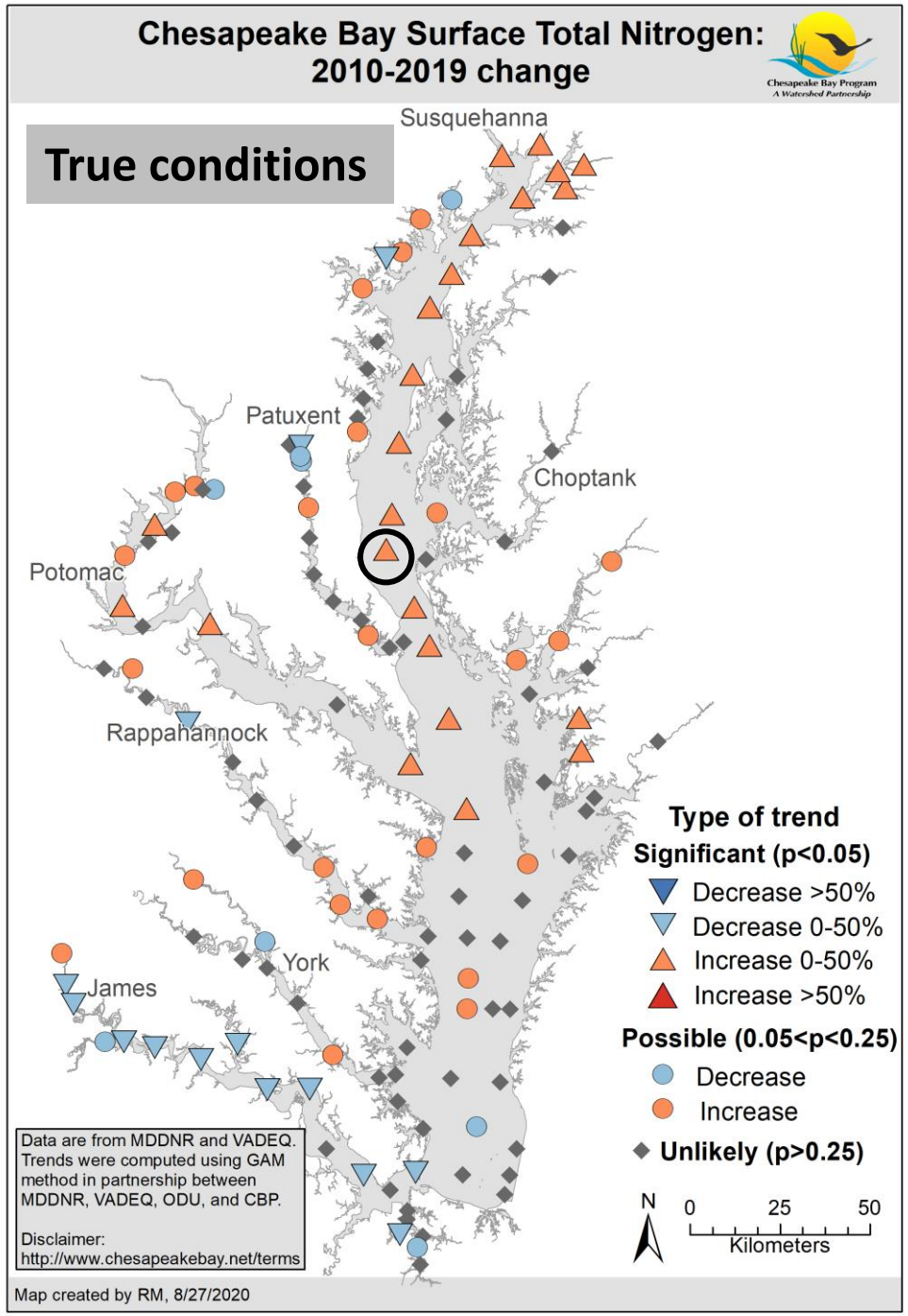
2. Long-term increase goes away after flow adjustment.

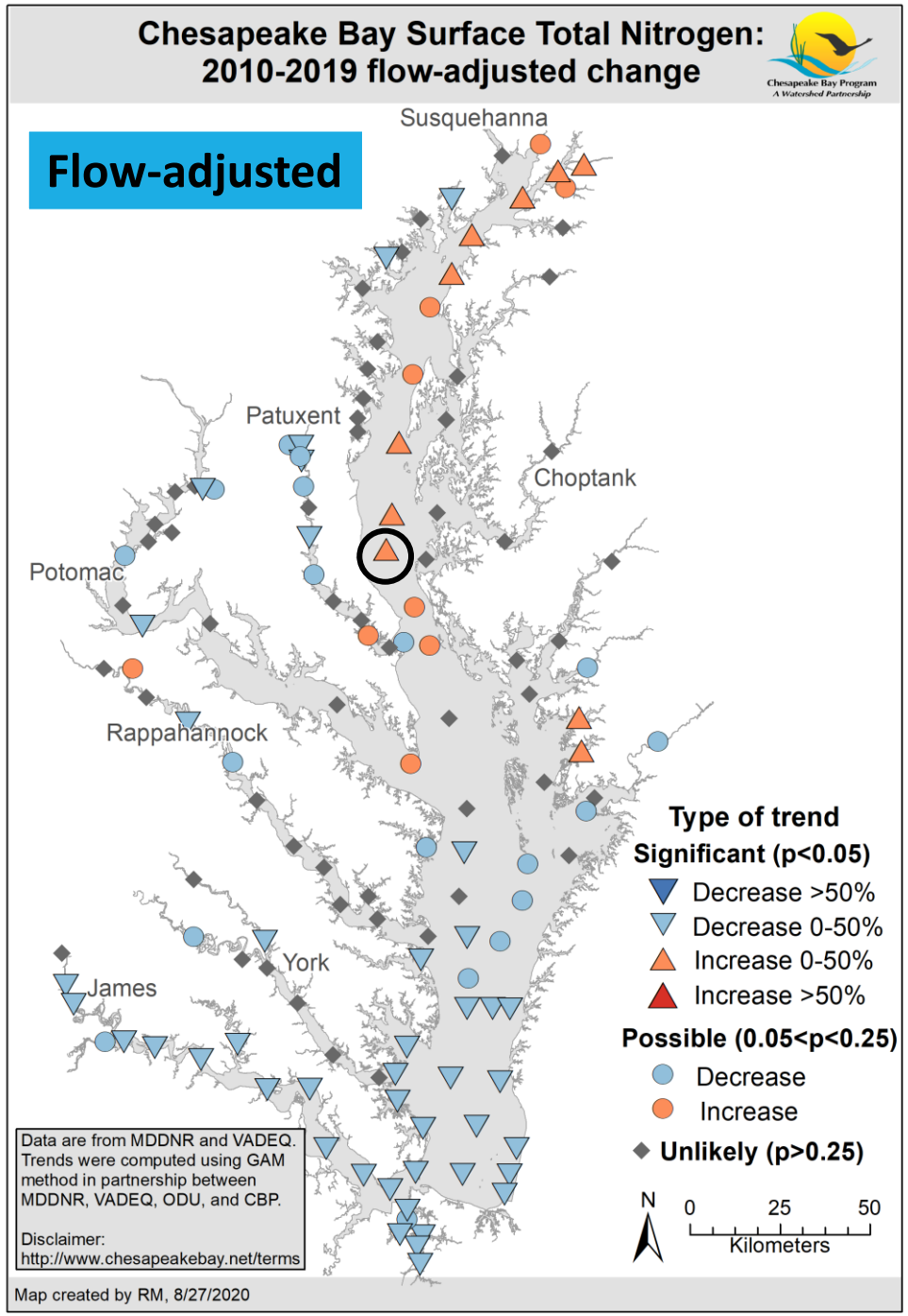


3. But over the last 10 year, the pattern swings up a bit.

TN

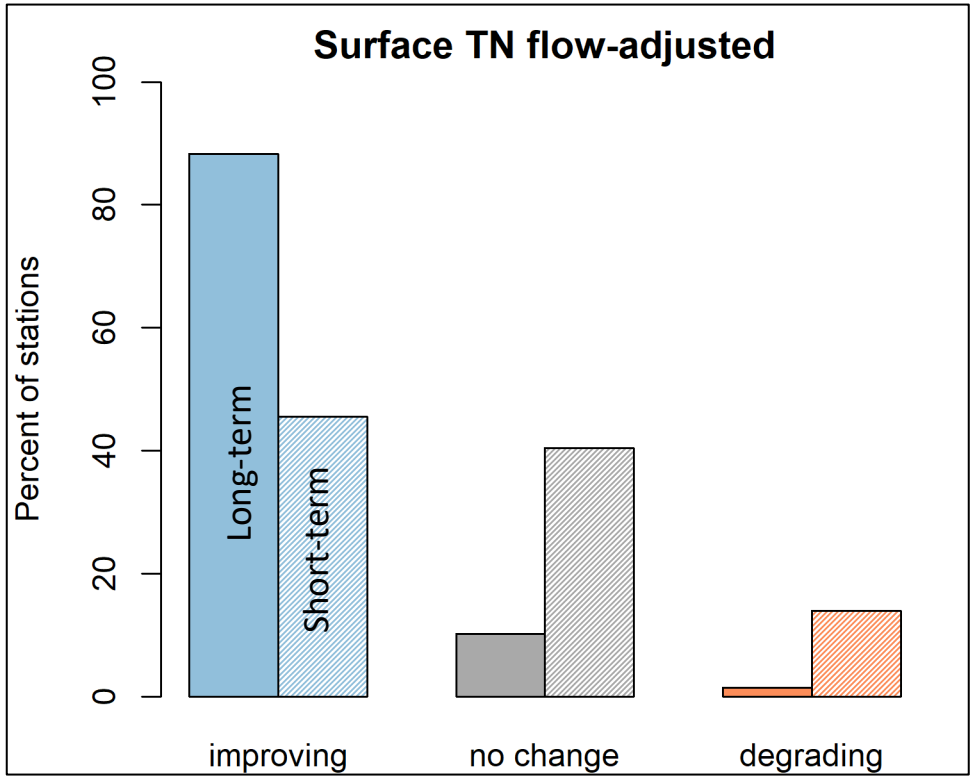
short-term





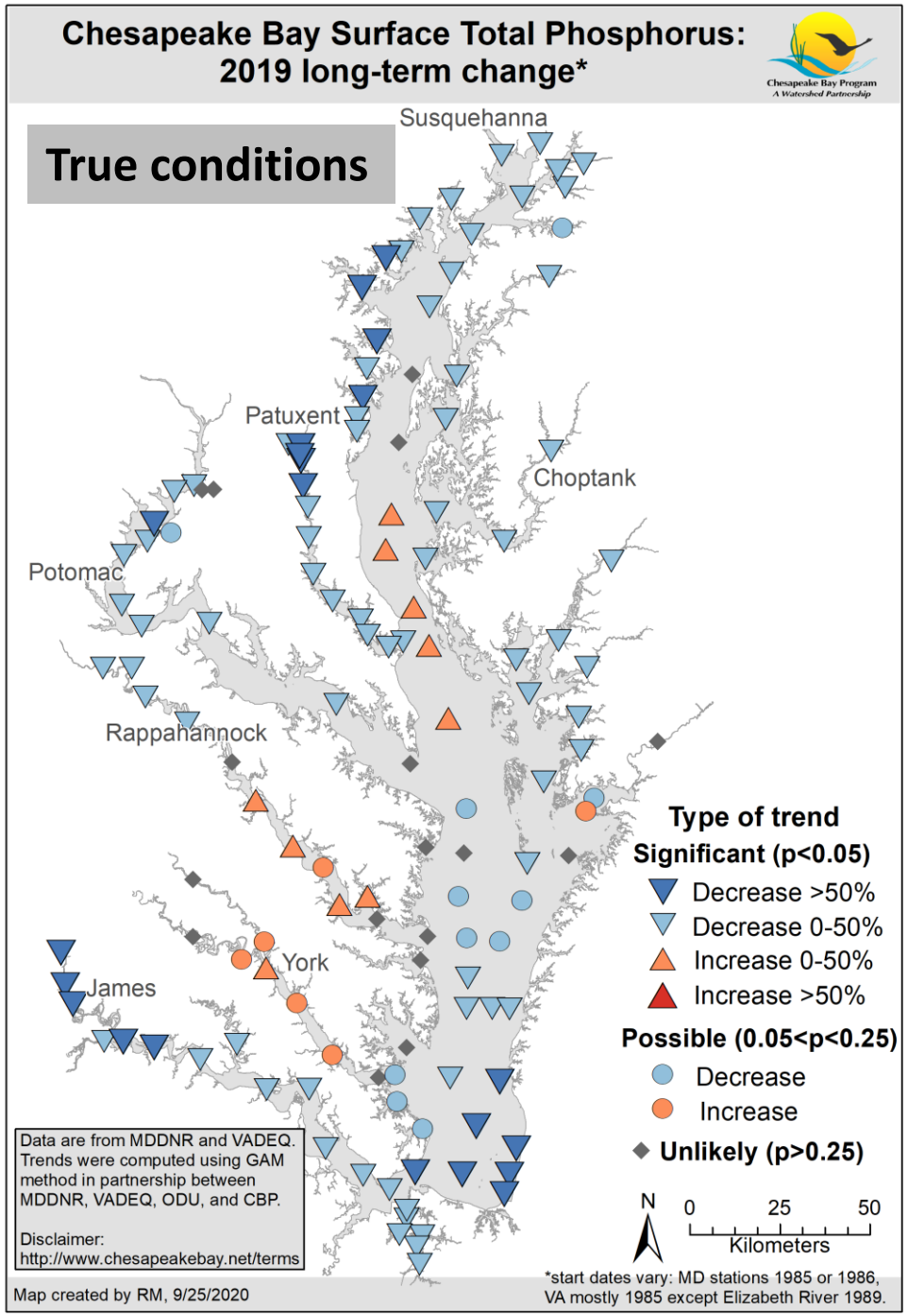
TN summary

- Long-term decreases at most stations (bottom is similar).
- Short-term changes are mixed, possibly some flow impacts that are not accounted for with adjustment.
- Only 2 long-term increases are not due to wet year.



TP

long-term


Chesapeake Bay Surface Total Phosphorus:
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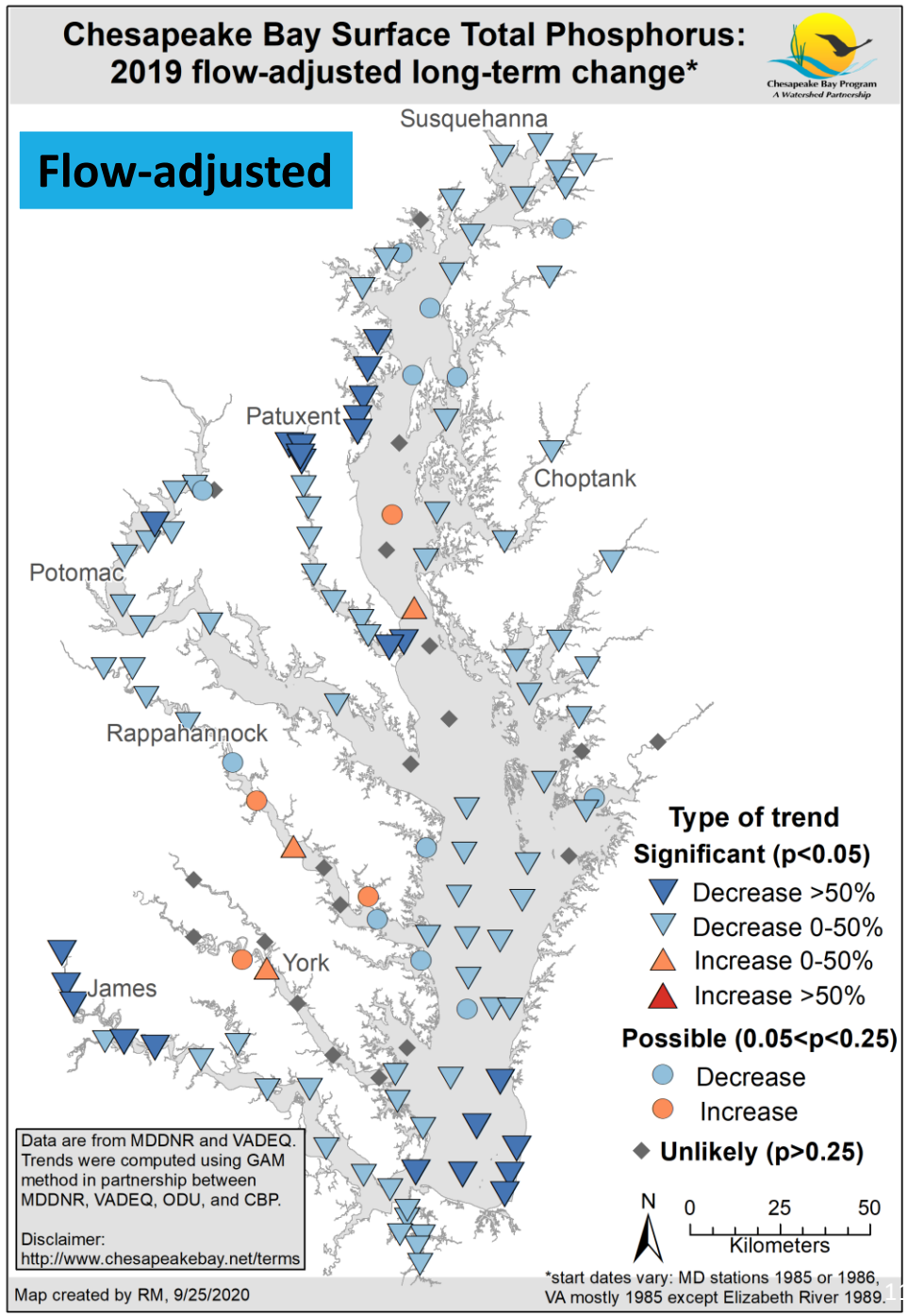
Chesapeake Bay Surface Total Phosphorus:
2019 flow-adjusted long-term change*
Chesapeake Bay Program
A Watershed Partnership
Flow-adjusted
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Patuxent
Choptank
Potomac
Rappahannock
York
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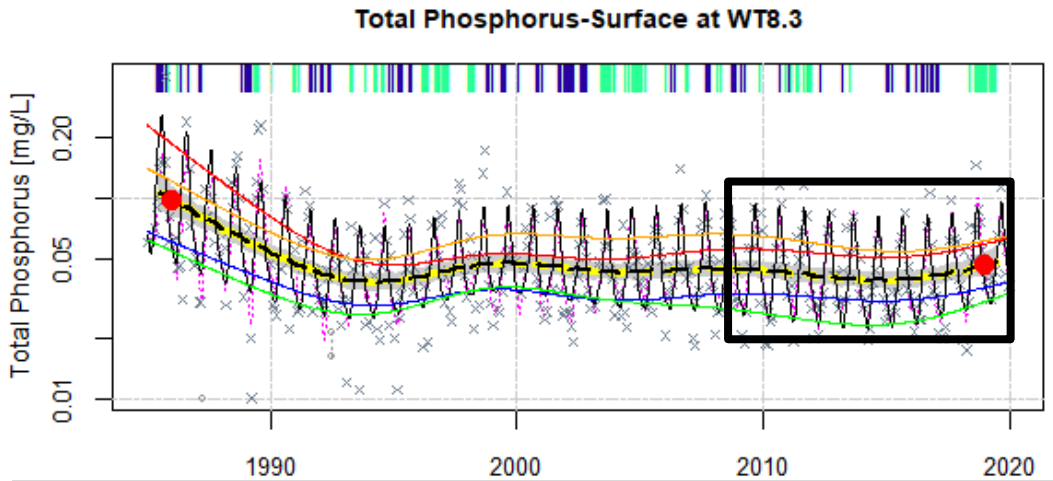
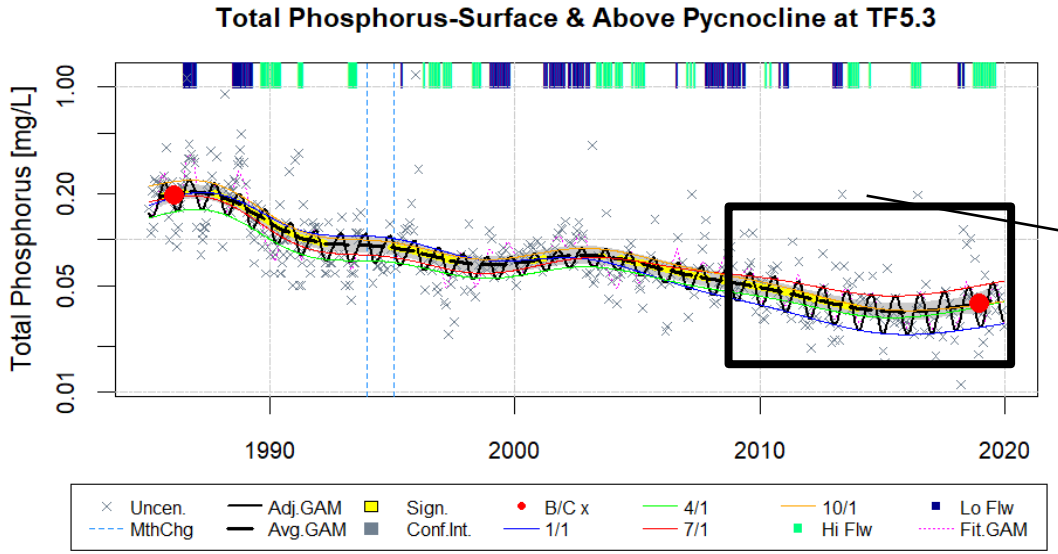
TP

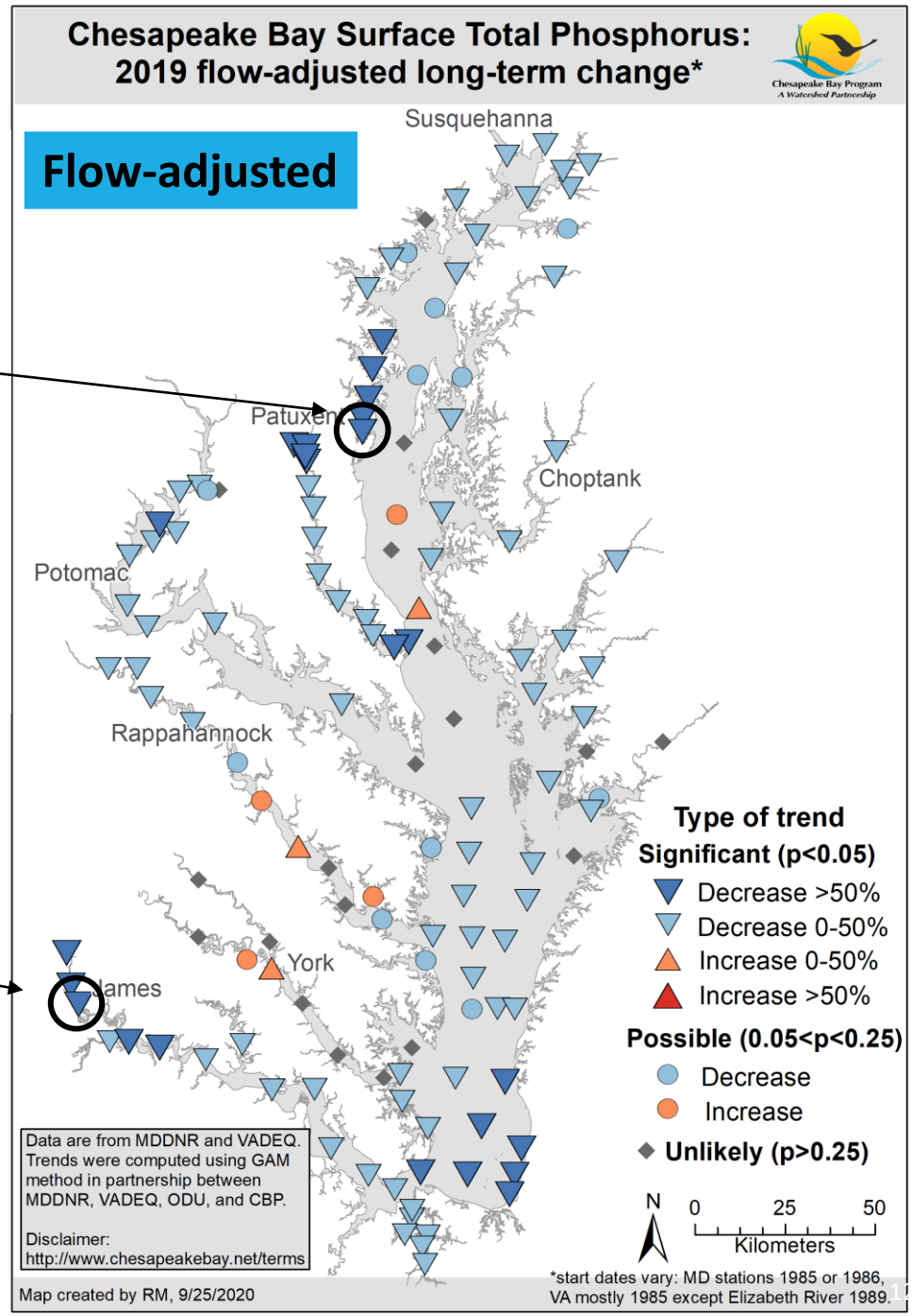
long-term

1. Many of the decreases are large changes in the first decade.



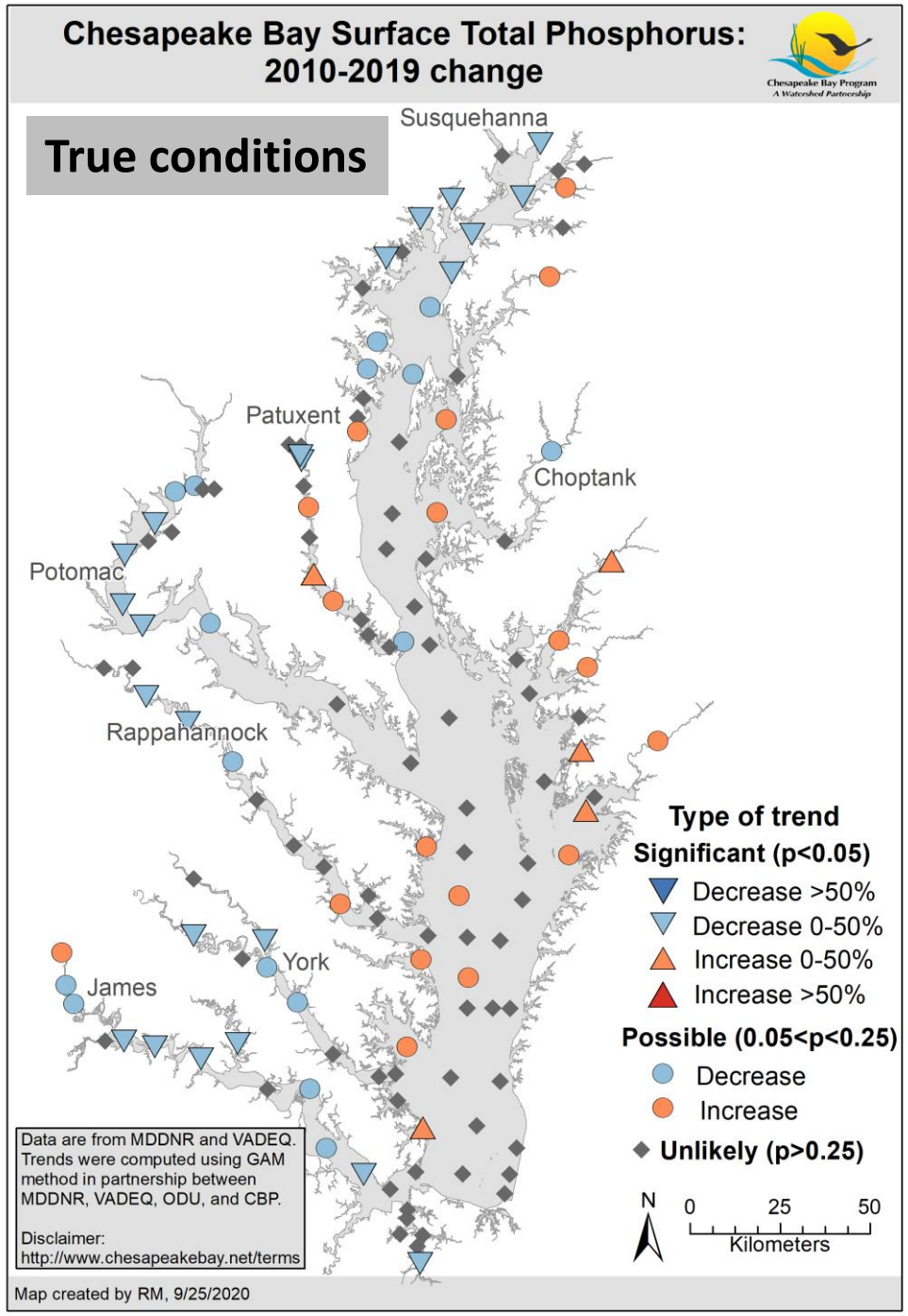
2. Some decreases continue through the entire record, with the James River a key example of this.

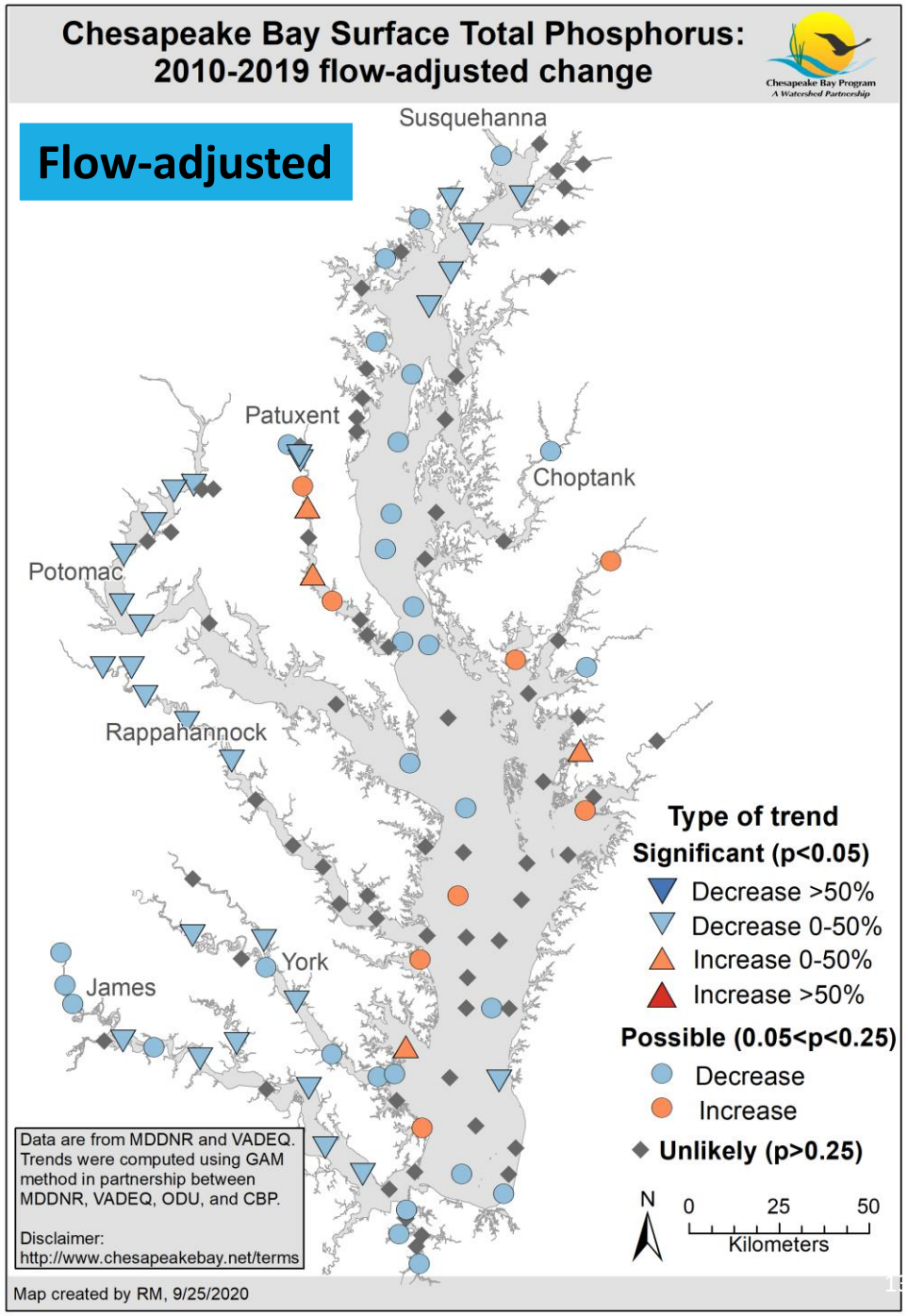




TP

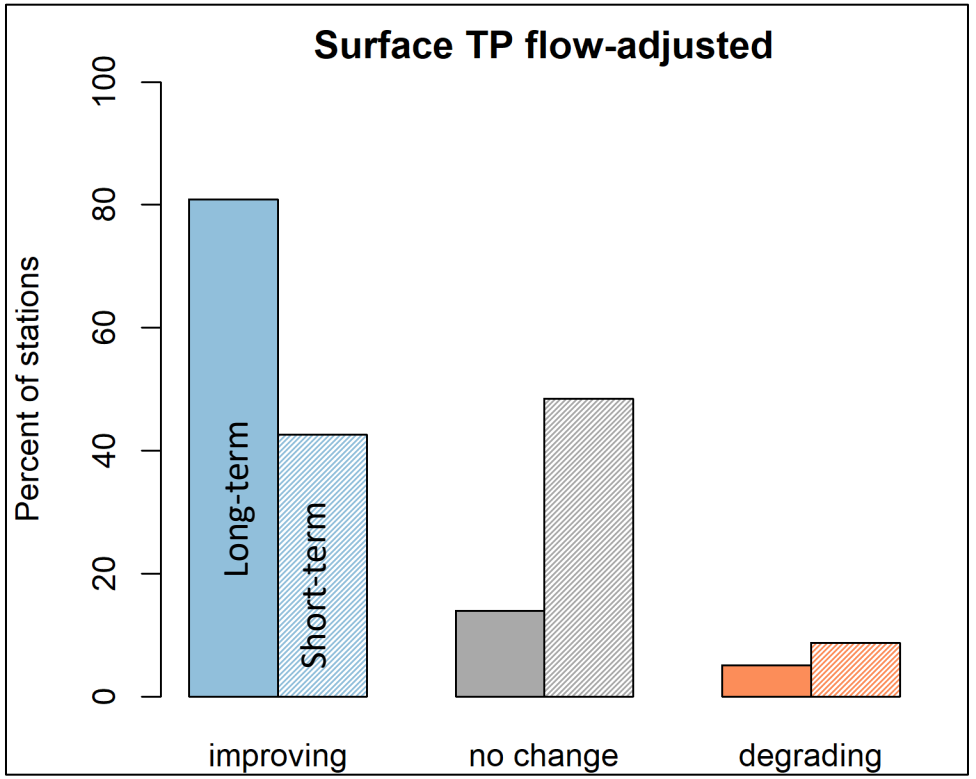
short-term





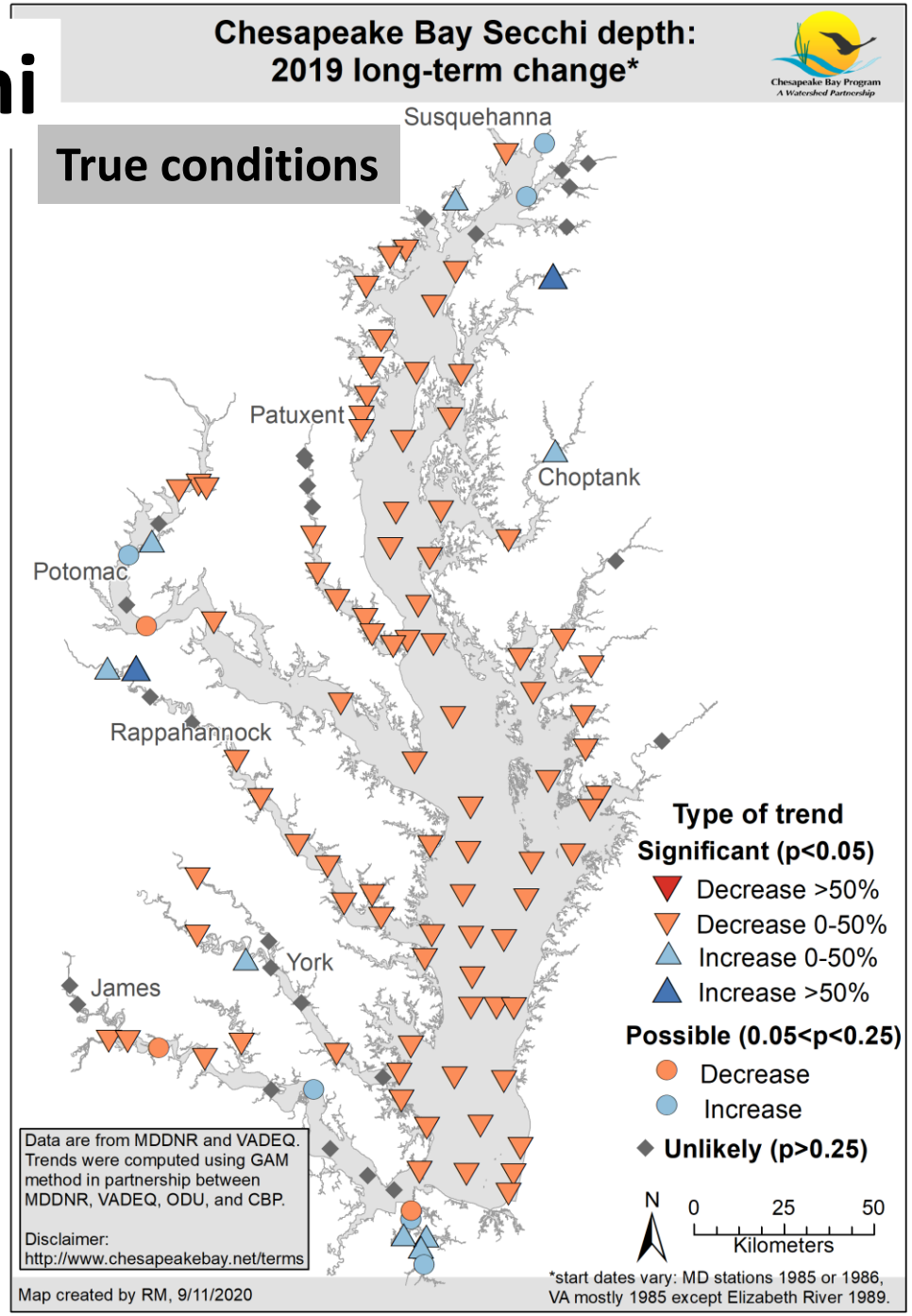
TP summary

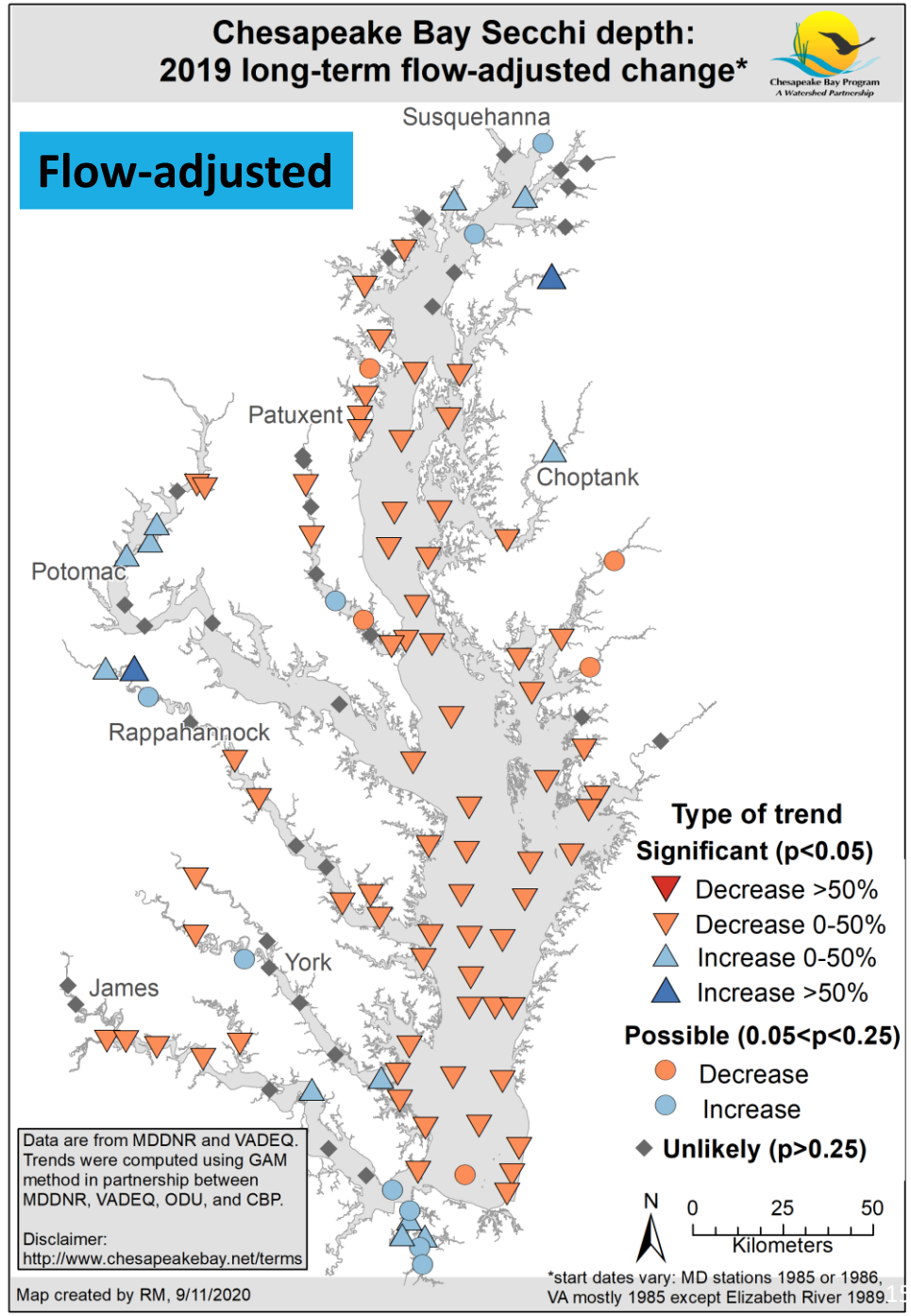
- Long-term TP is decreasing at most of the stations, but short-term changes are more mixed.
- Long-term, the 1980s decrease in TP drives the downward changes in many places.



Secchi

long-term

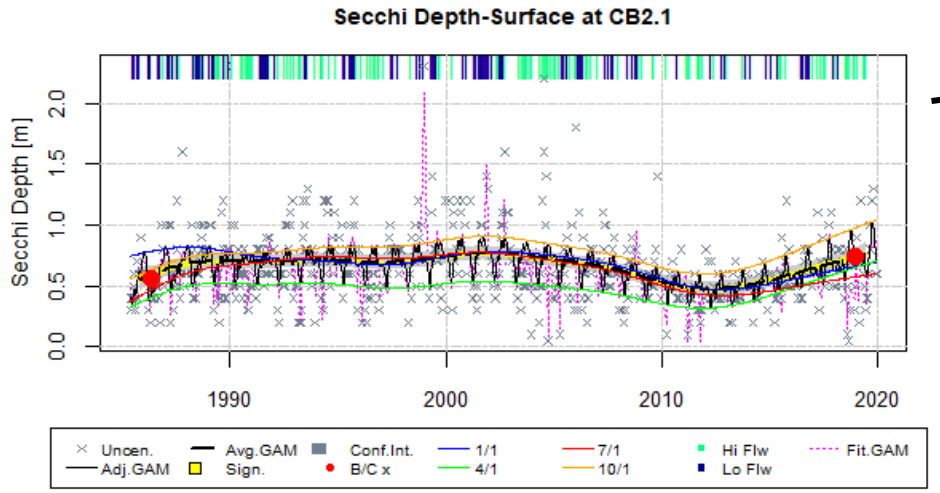




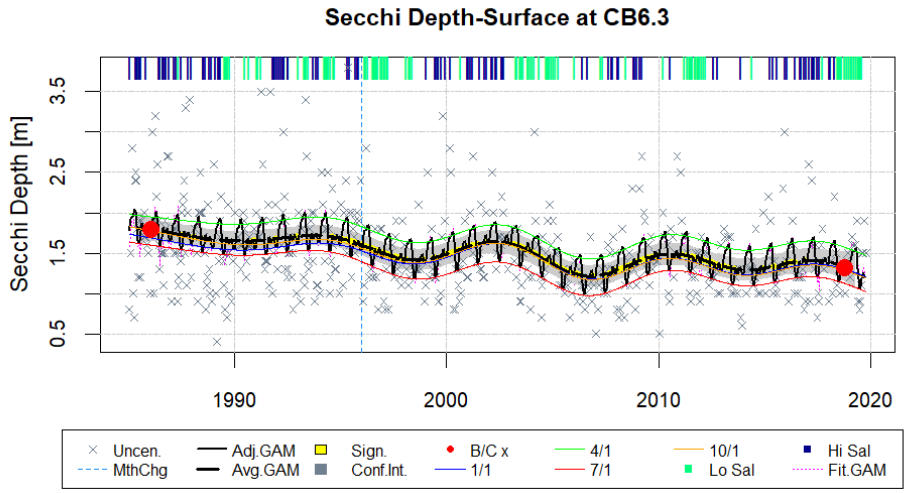
Secchi

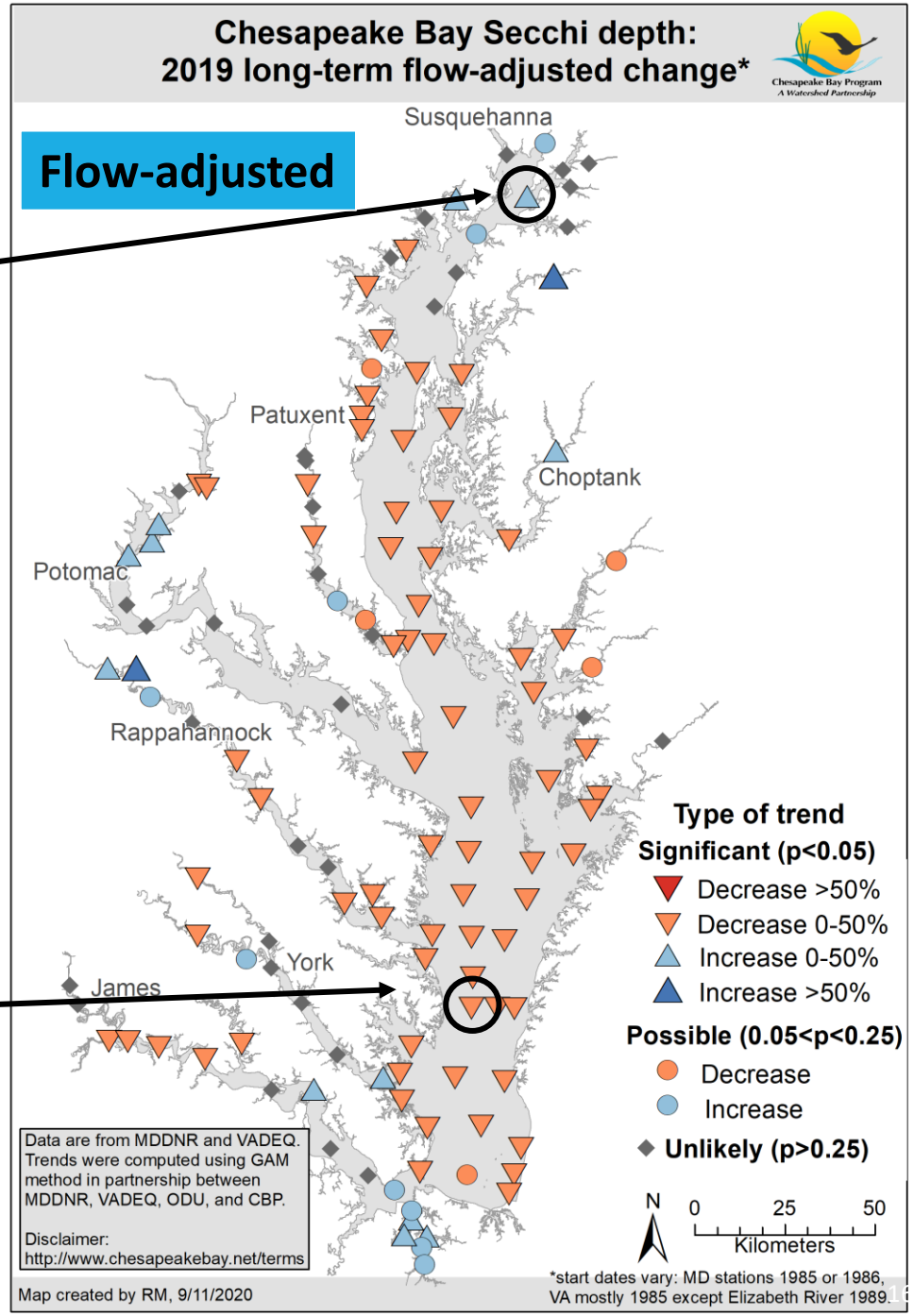
long-term

1. Upper bay Secchi is flat over long-term, with slight increase recently.



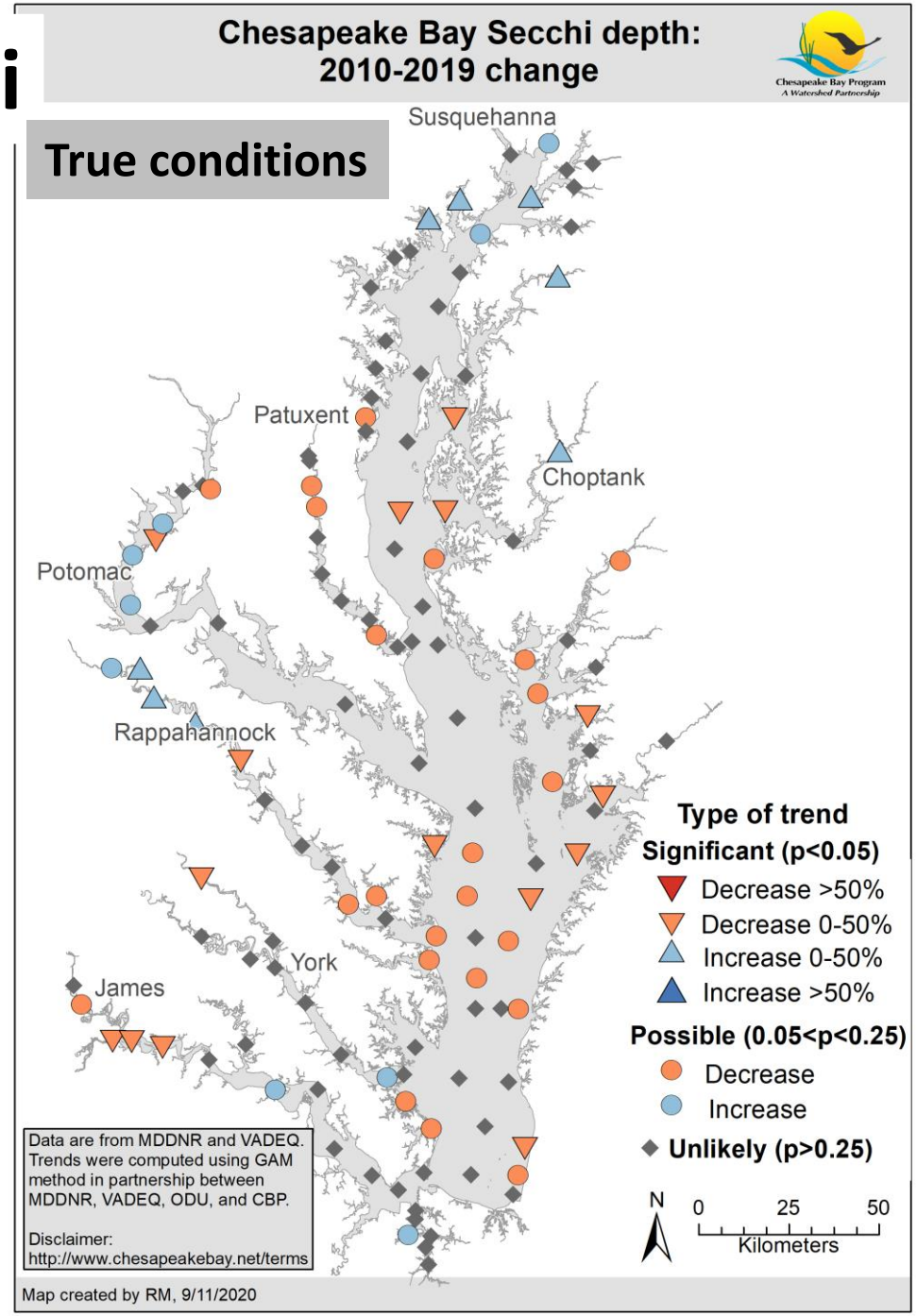
2. Mid- and lower-mainstem stations all decrease over long-term, but are mostly flat over short-term.

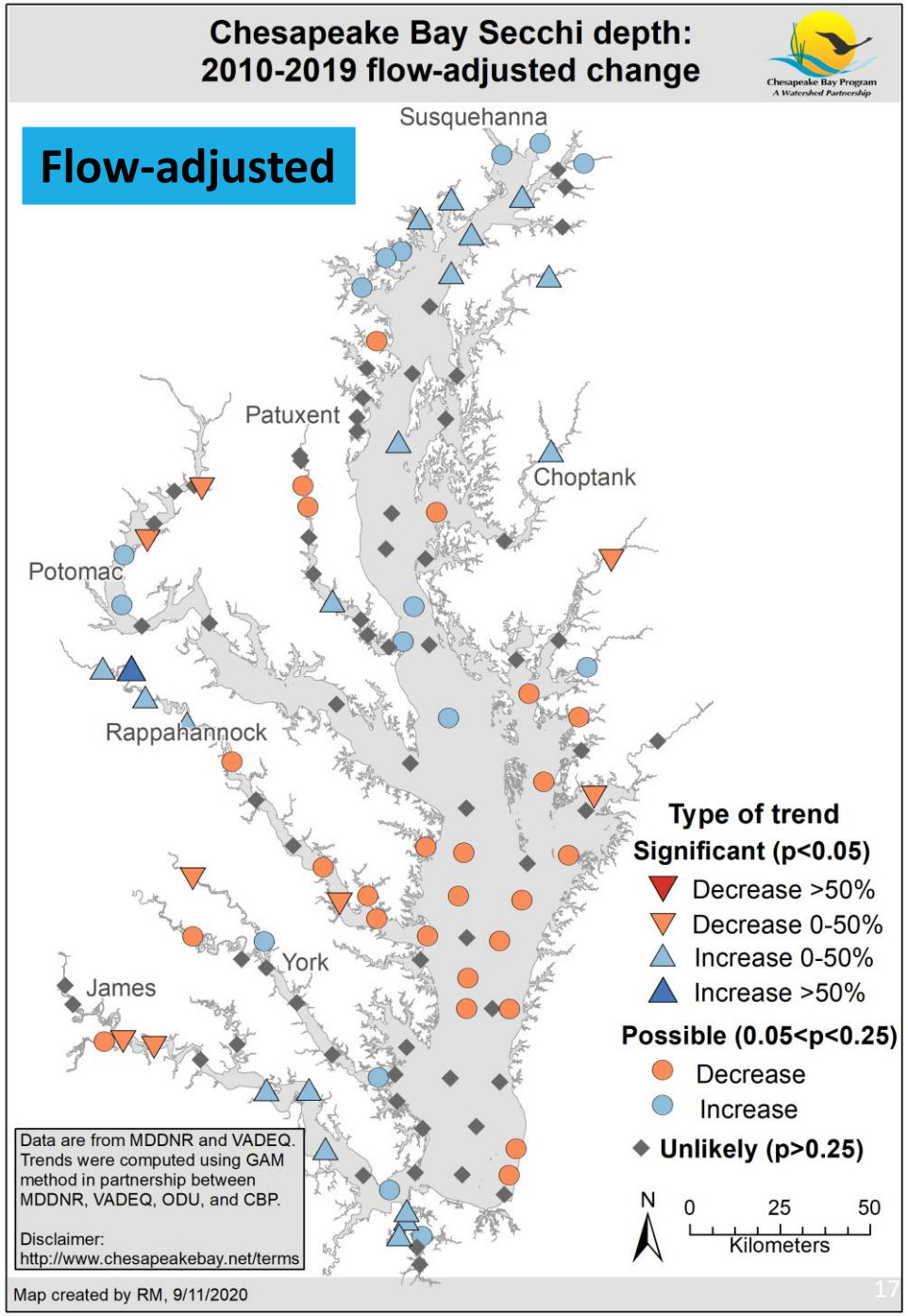




Secchi

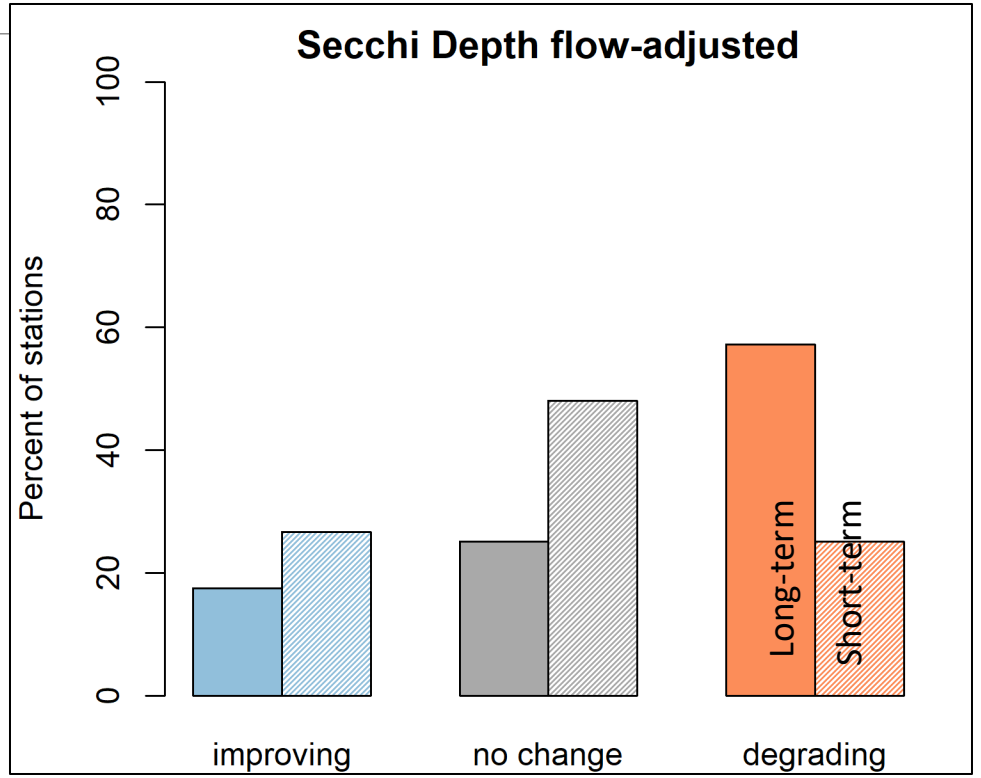
short-term





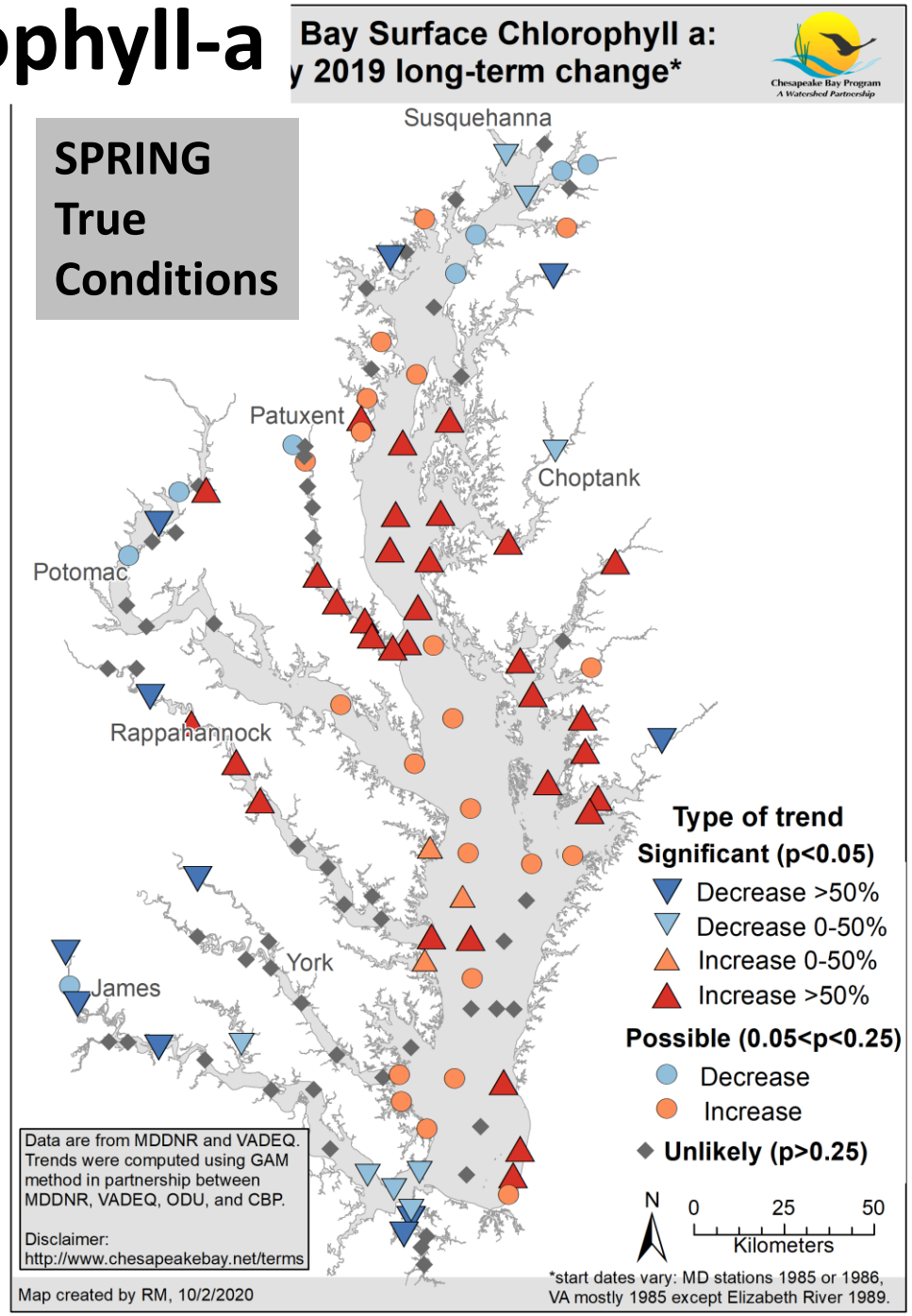
Secchi summary

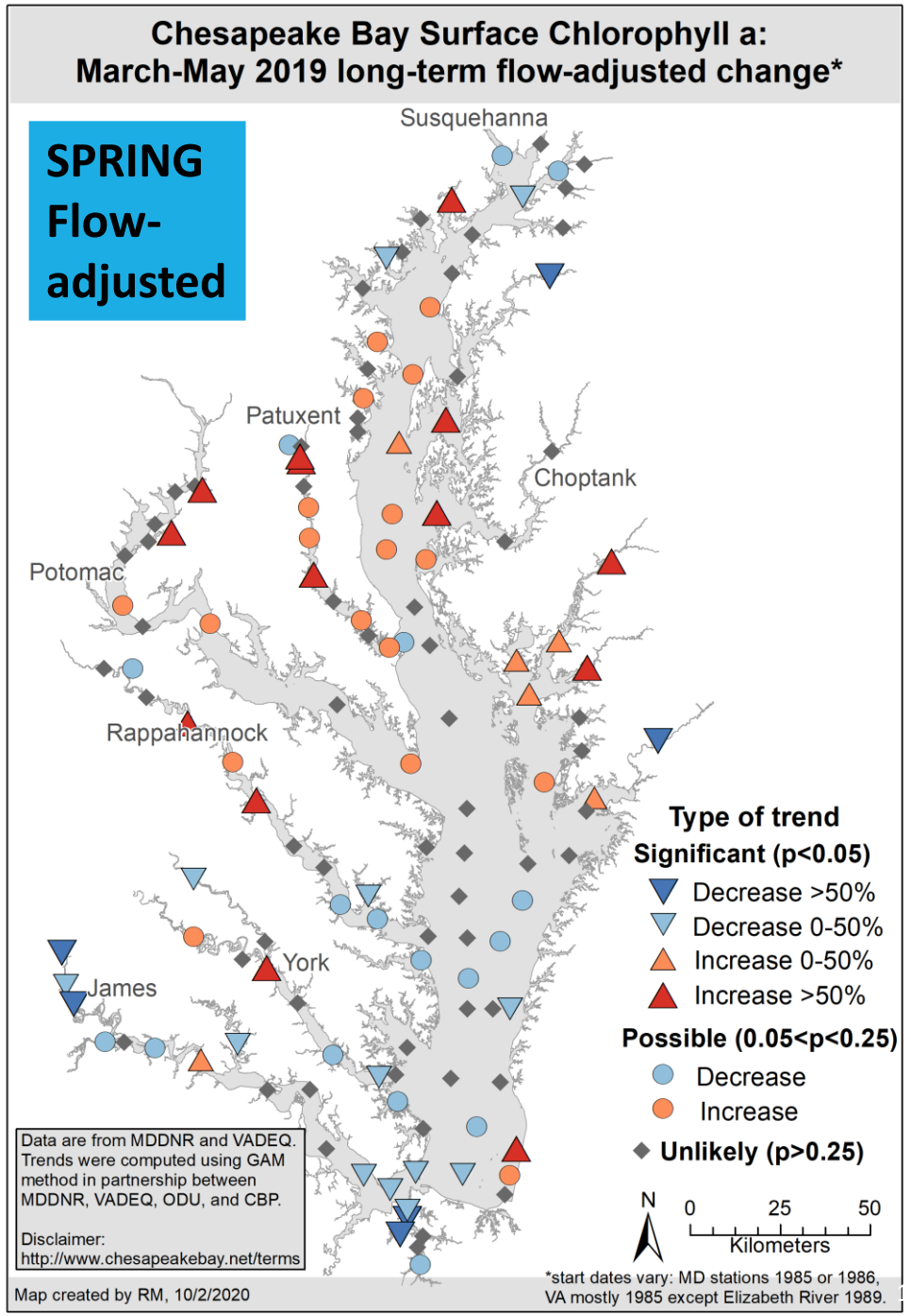
- Long-term degradation of Secchi at many stations is most obvious take-away.
- Shorter-term, the number of degradations is much lower, and there are even slightly more improvements than degradations (flow-adjusted).
- The diverse set of data patterns over time suggests that many different factors influence water clarity depending on location.



Chlorophyll-a

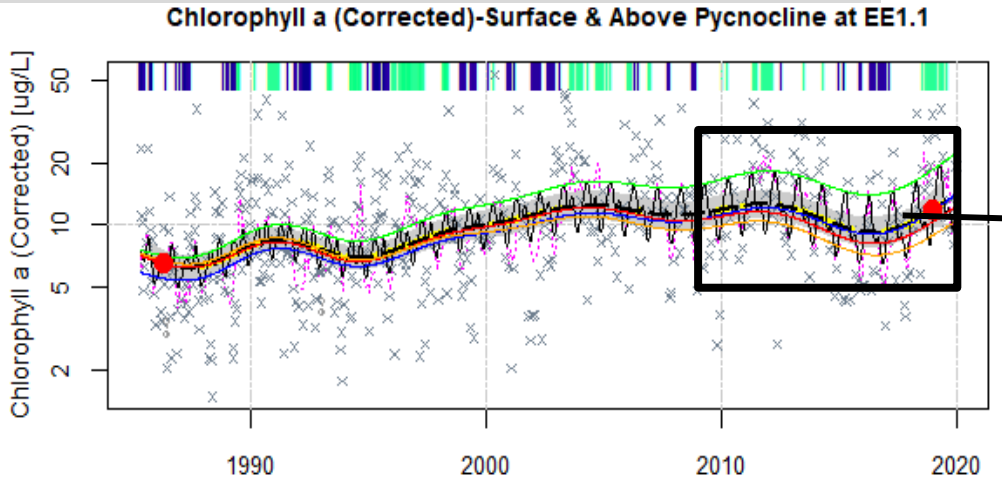
long-term



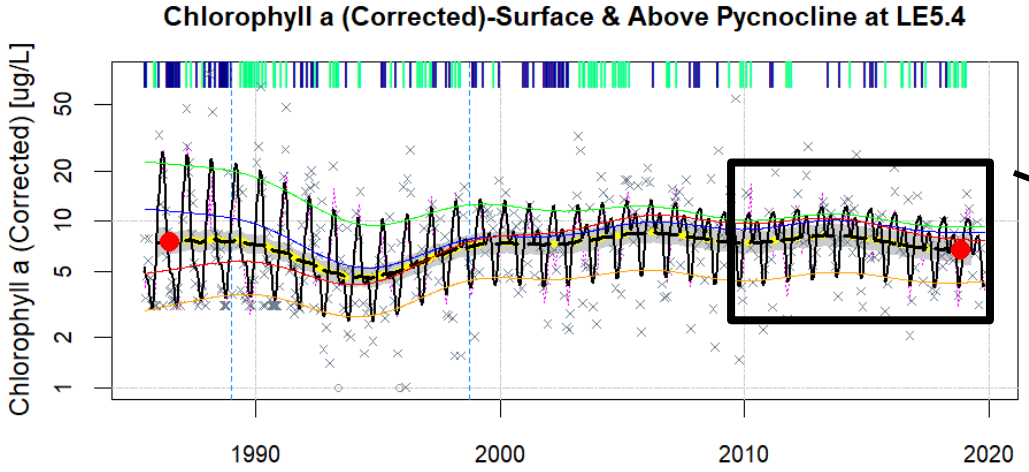


Chla: Diverse set of patterns Bay-wide

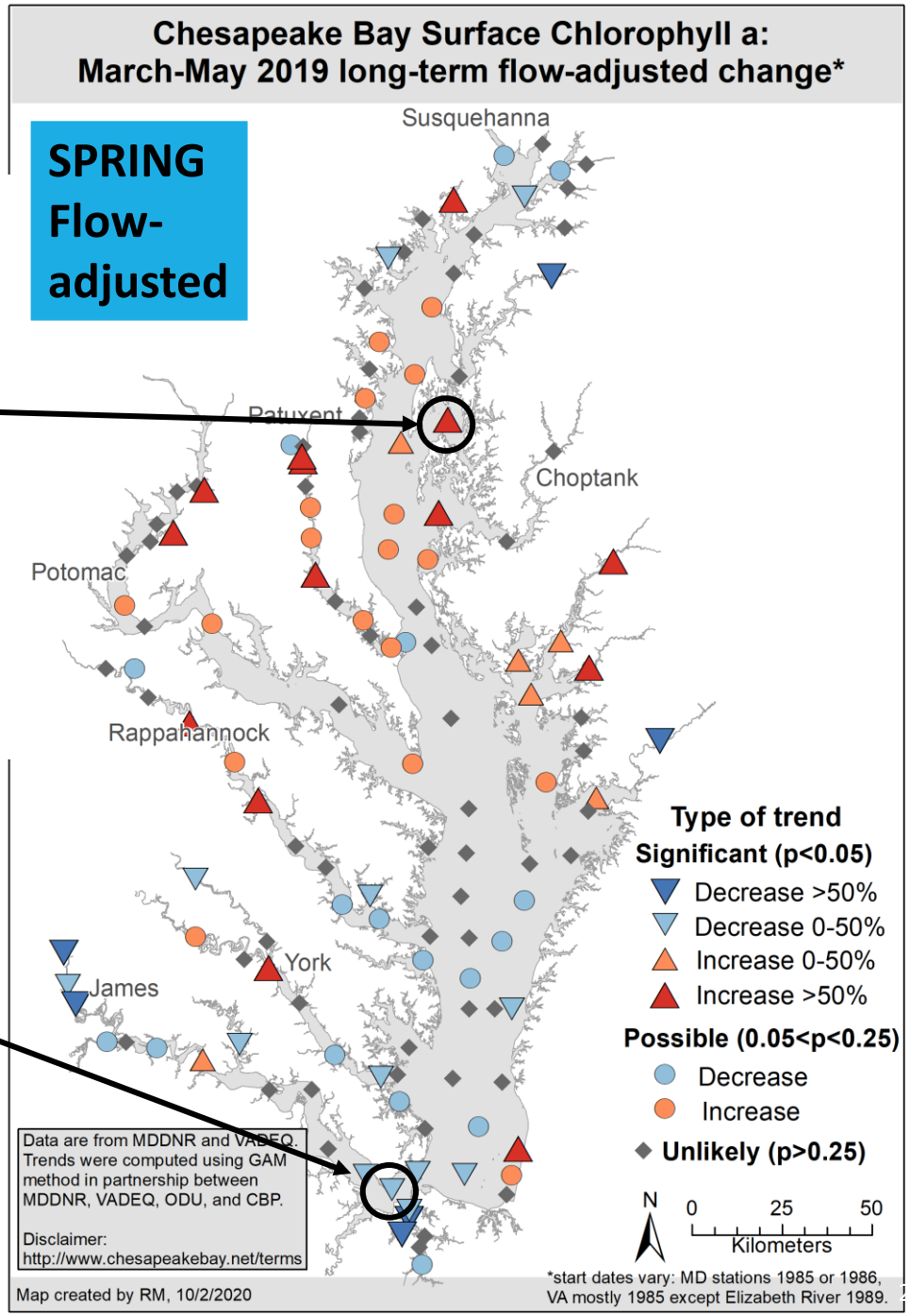
1. Some long-term increases.



2. Some long-term decreases (this one focused on the spring).

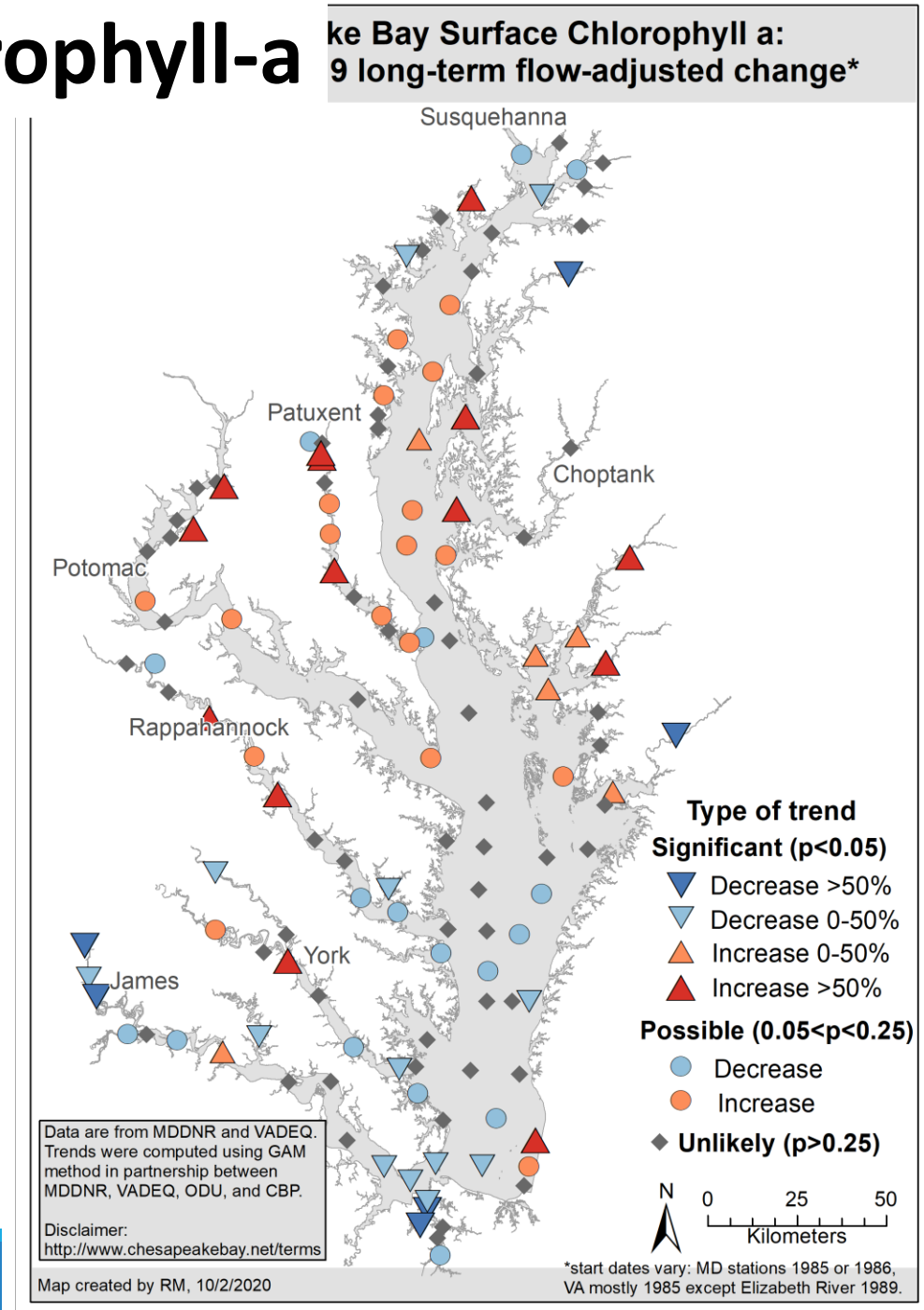


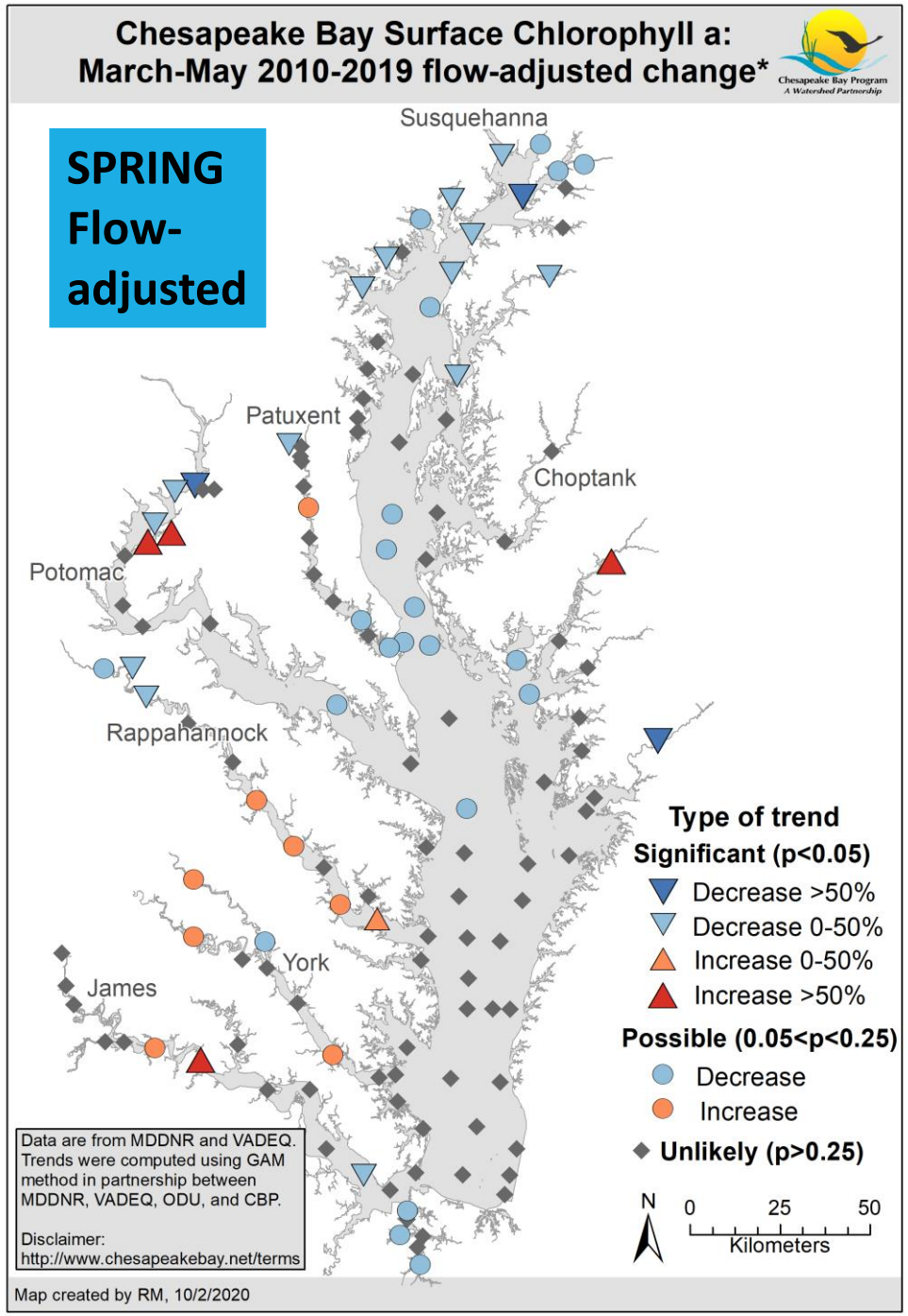
3. Over the short-term, many more constant patterns.



Chlorophyll-a

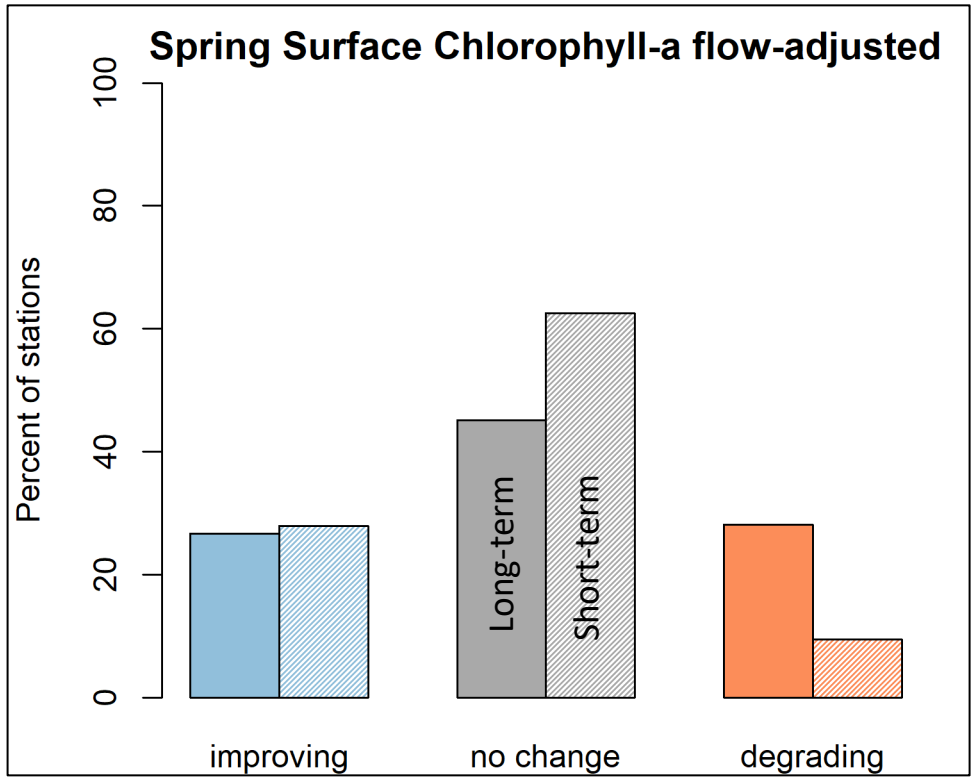
short-term





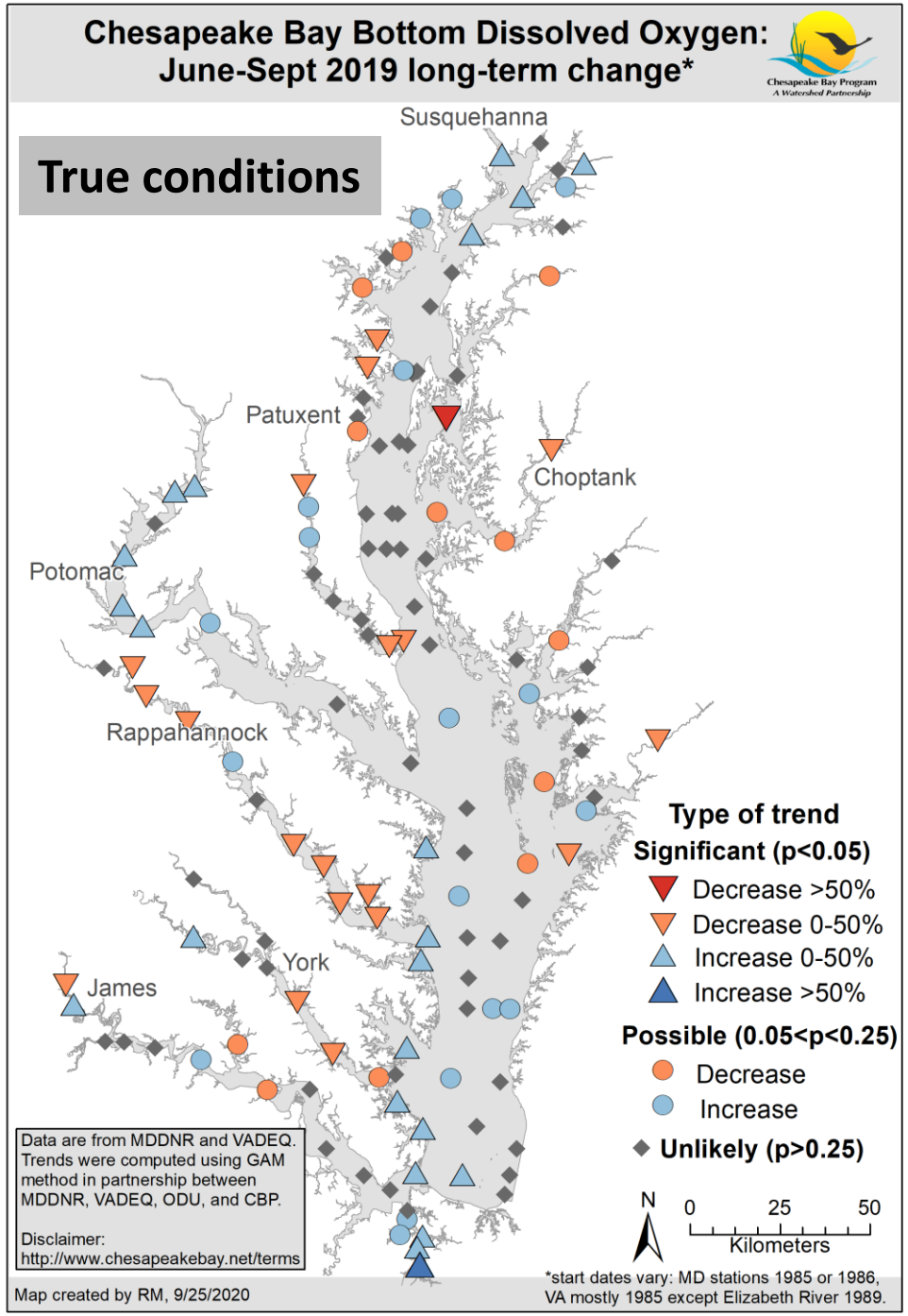
Chlorophyll-a summary

- Like Secchi, patterns differ greatly by region.
- Short-term chlorophyll-a has leveled out at many stations, turning degrading long-term changes into no change in the short-term.



Summer Bottom DO

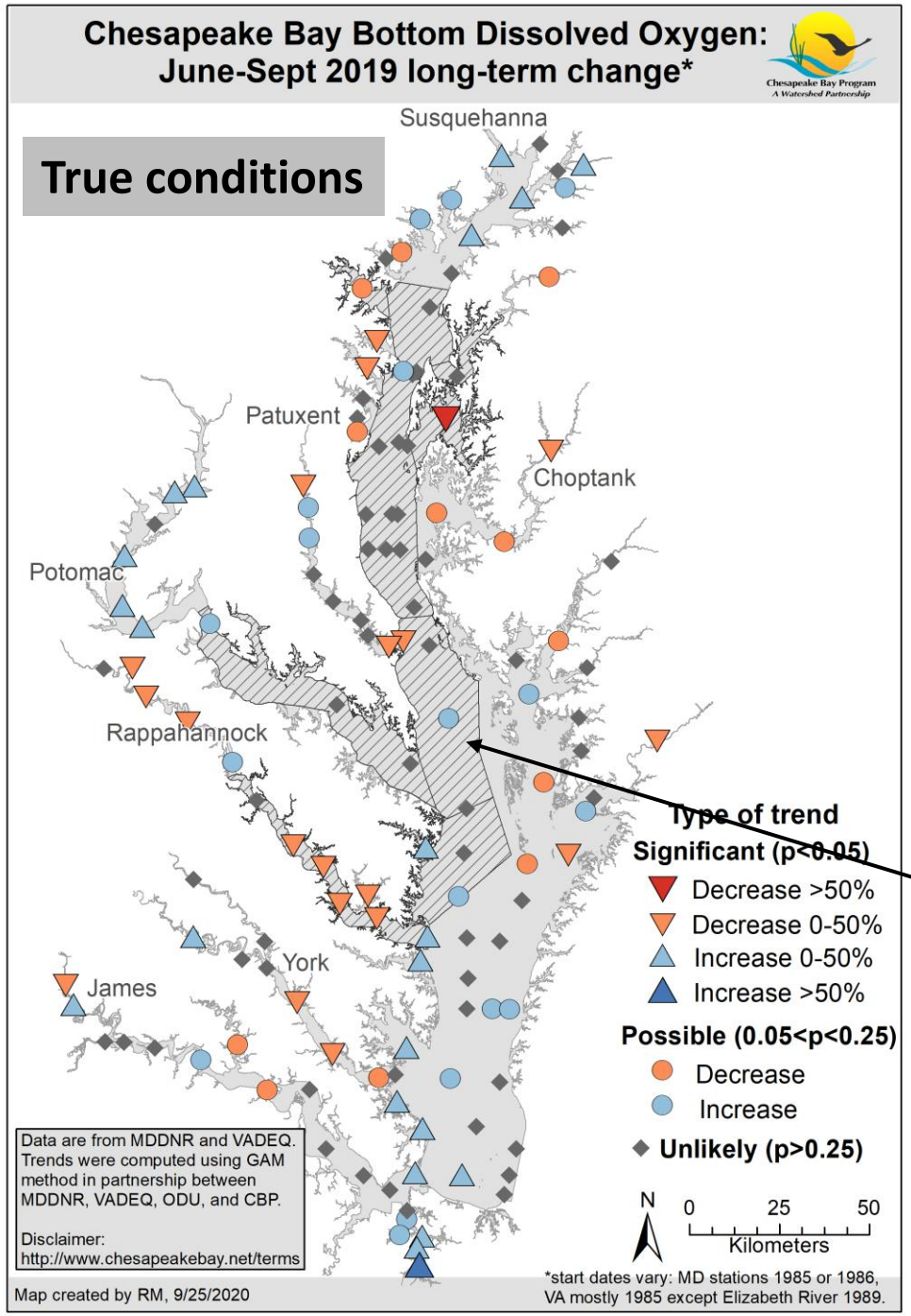
long-term



- Depths vary greatly across the tidal waters.
- Very different forces are influential depending on mixing and depth.

Summer Bottom DO

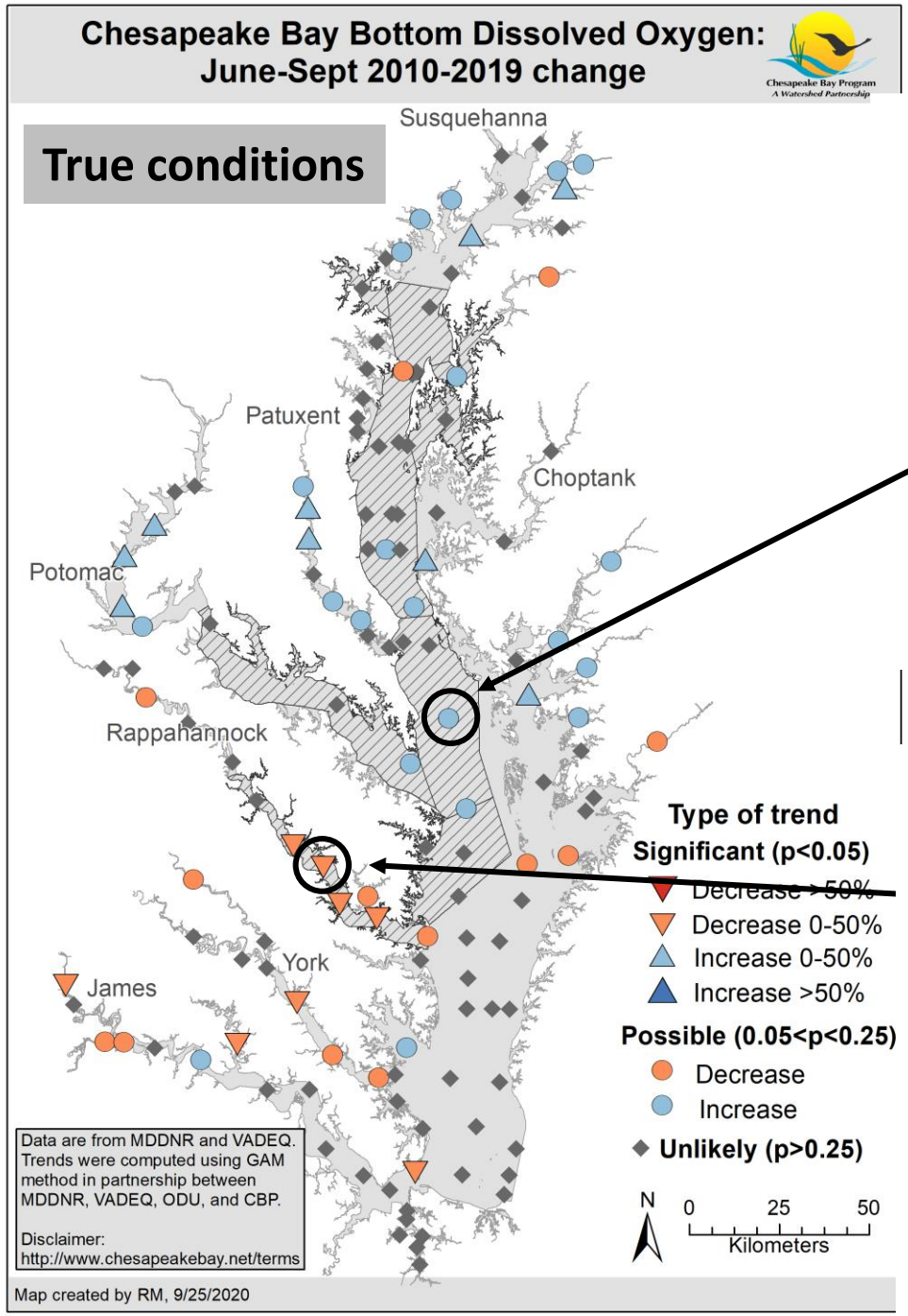
long-term



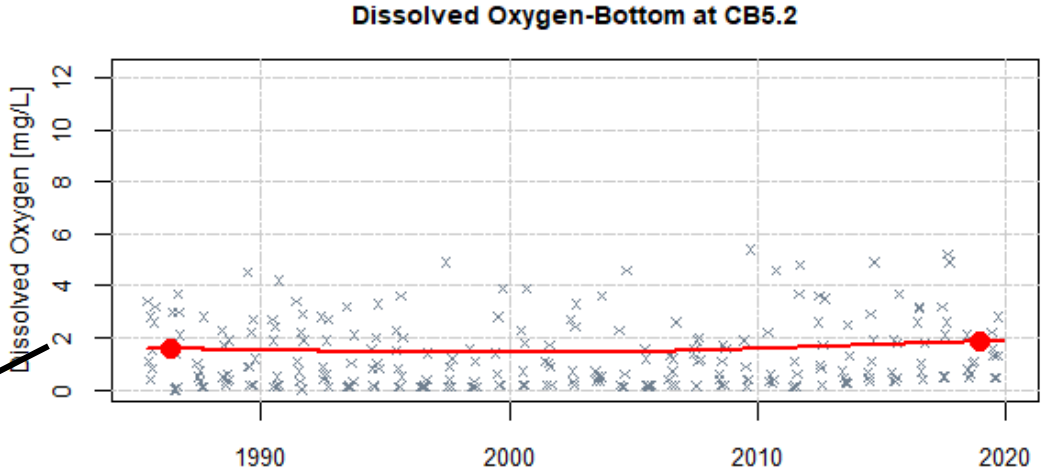
- Depths vary greatly across the tidal waters.
- Very different forces are influential depending on mixing and depth.
- Deep channel segments with the summer criteria 1 mg/L are indicated with hatching.

Summer Bottom DO

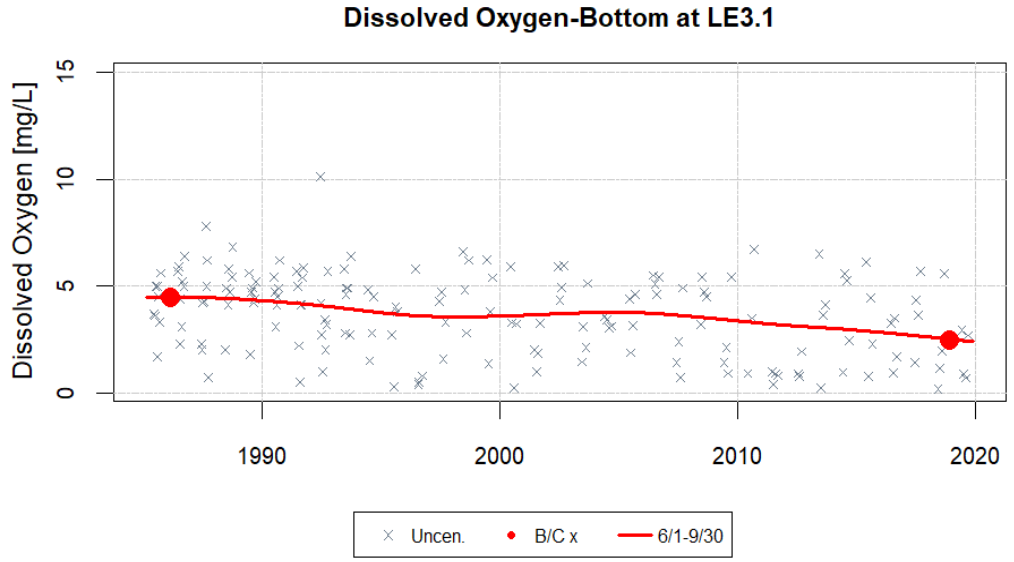
short-term



1. Small, but meaningful DO increase in deep mainstem in last 10 years.

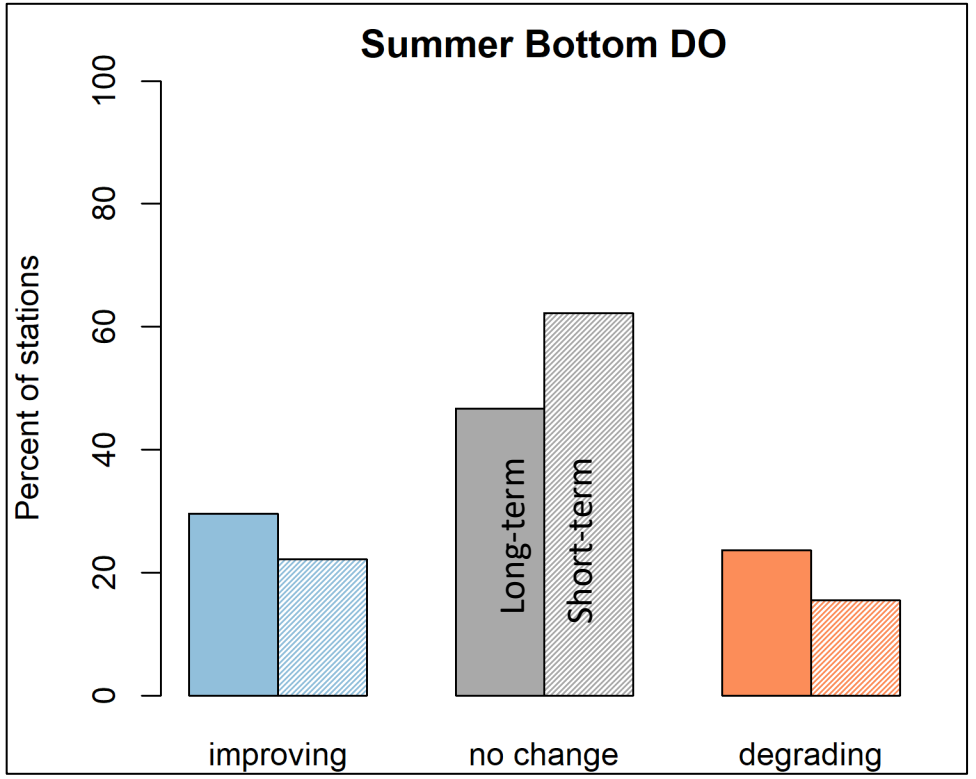


2. Only deep channel segment with degradation is in Rappahannock. Can see it clearly in plots.



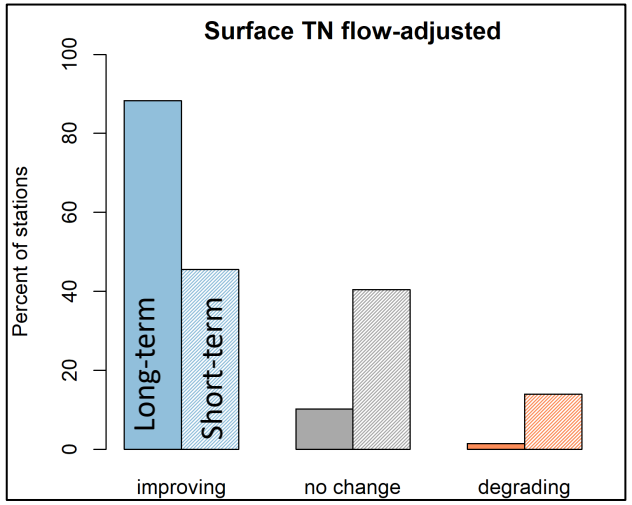
DO initial reactions

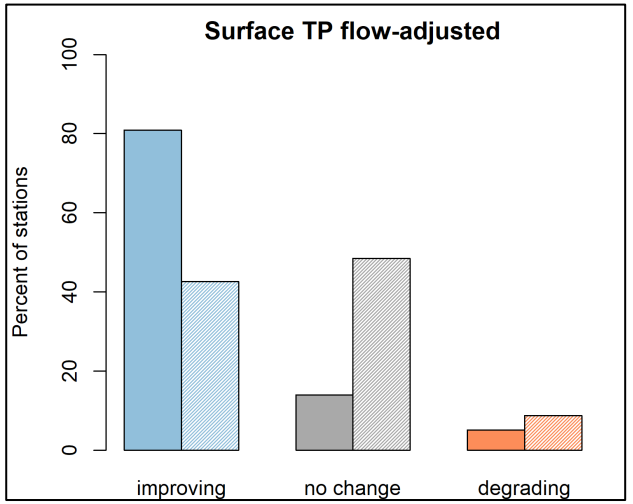
- A wide-variety of DO trends are likely due to different bottom conditions throughout the tidal waters.
- Most stations show no significant change over time.
- Notably, mainstem deep channel stations are slightly improving due to near-zero values not occurring as much anymore.

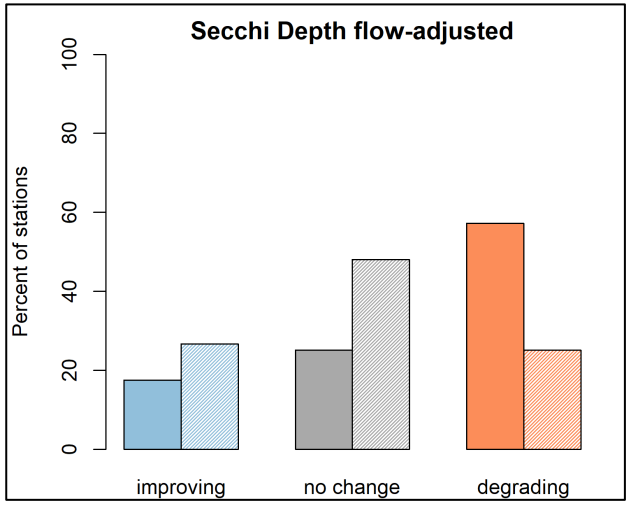


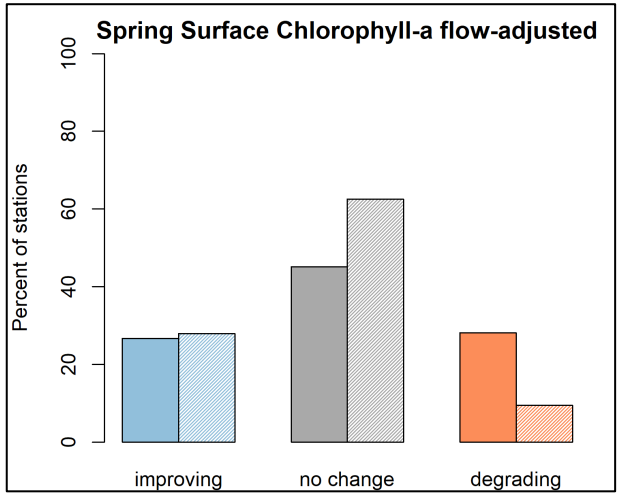
2019 Summary

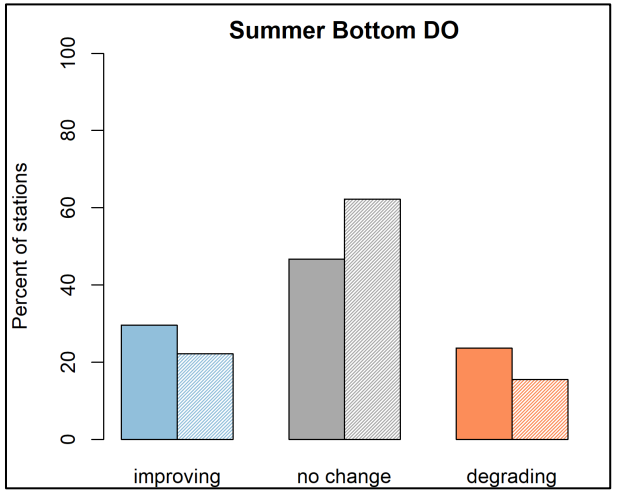
- Two very wet years influenced true conditions.
- Nutrient concentrations improved at the vast majority of stations over the long-term, with less improvement lately.
- Secchi, chlorophyll-*a* and DO improved at fewer stations than nutrients, but the numbers of degradations have decreased in recent years.





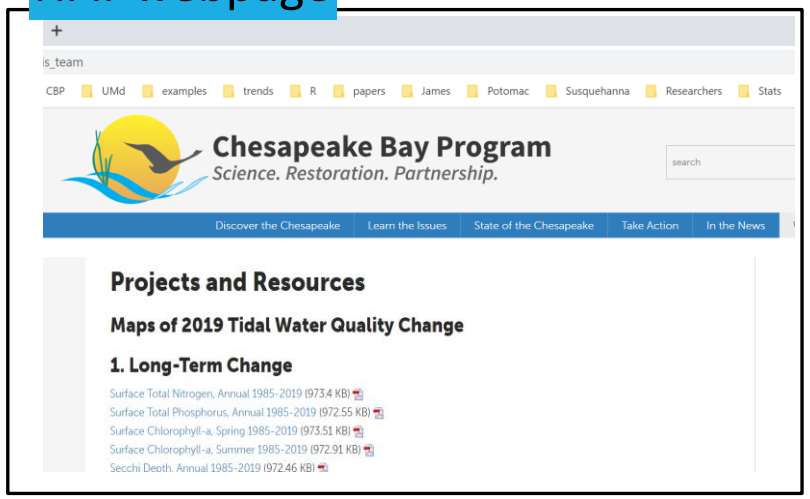






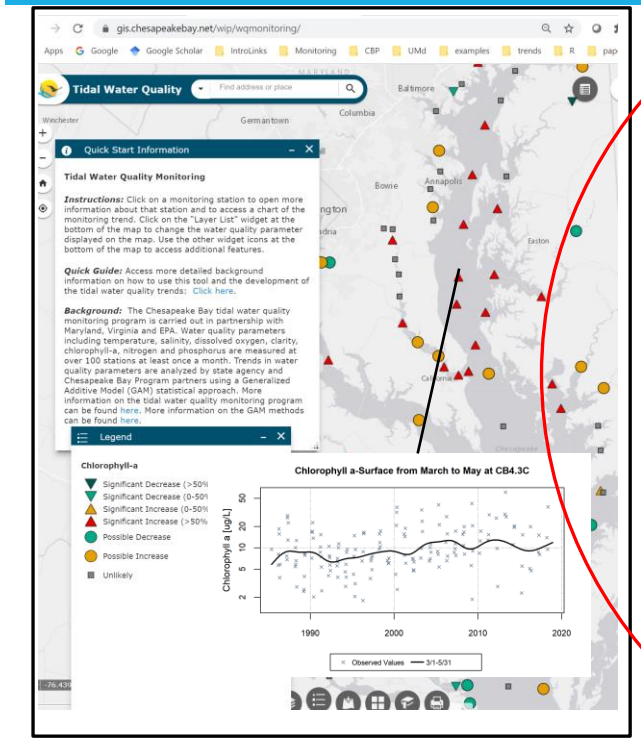
Results available

ITAT webpage



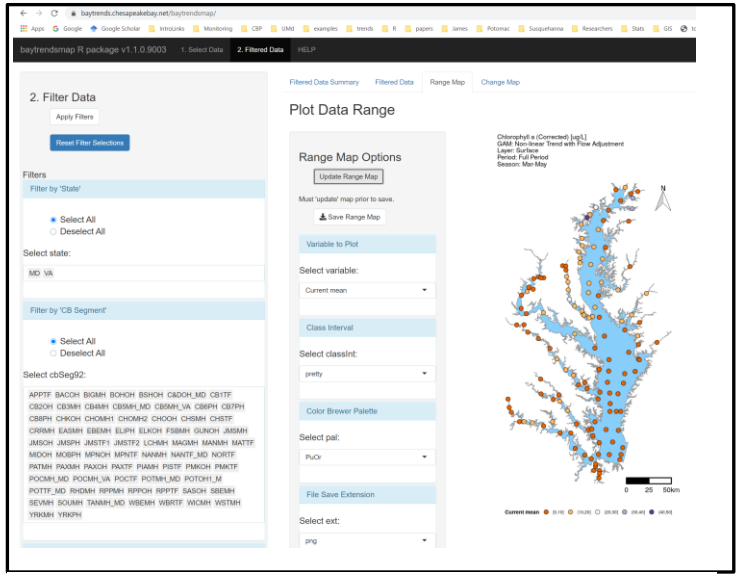
https://www.chesapeakebay.net/who/group/integrated_trends_analysis_team

CB Watershed Data Dashboard



https://gis.chesapeakebay.net/wip/dashboard/

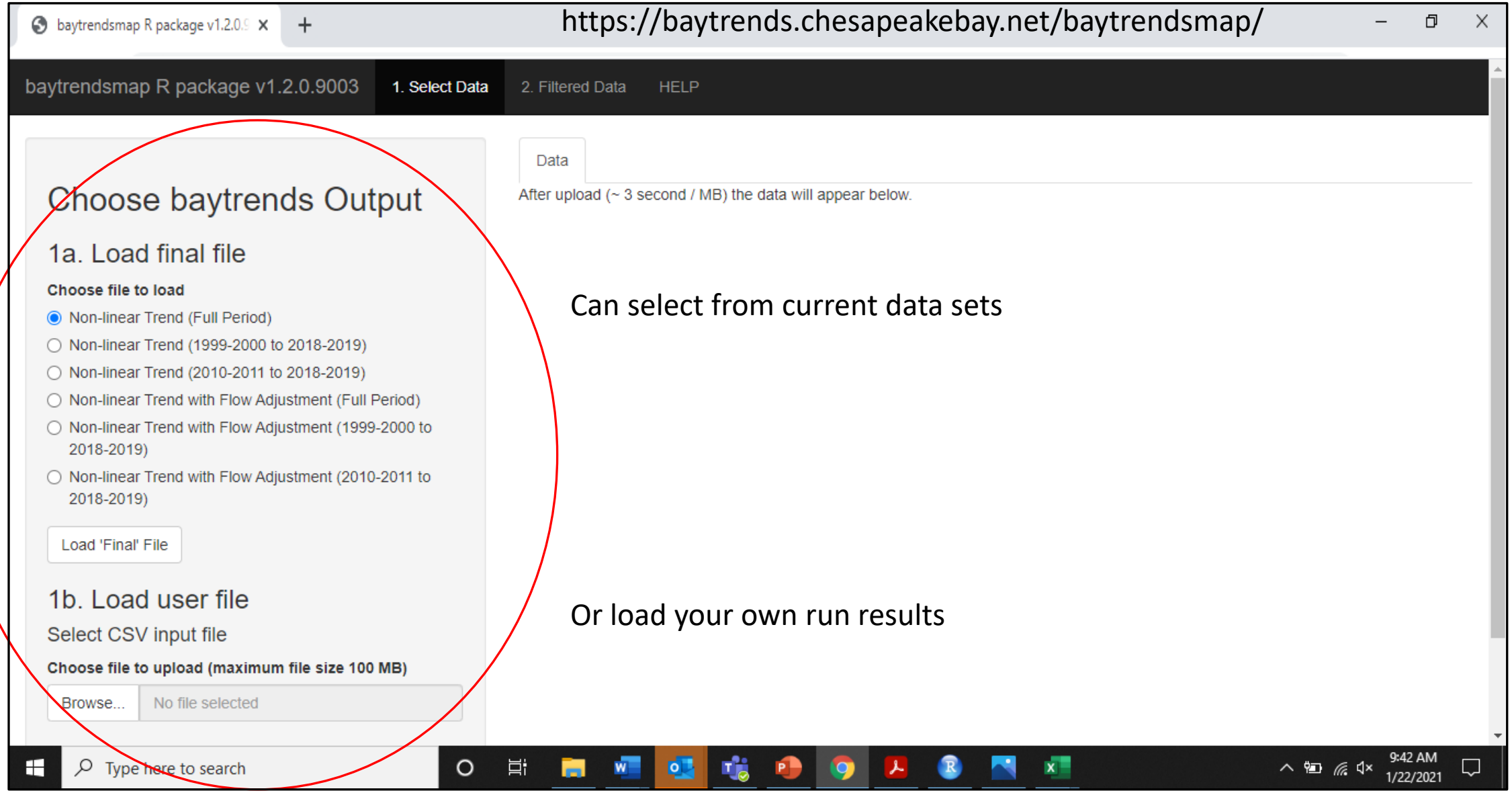
baytrendsmap app



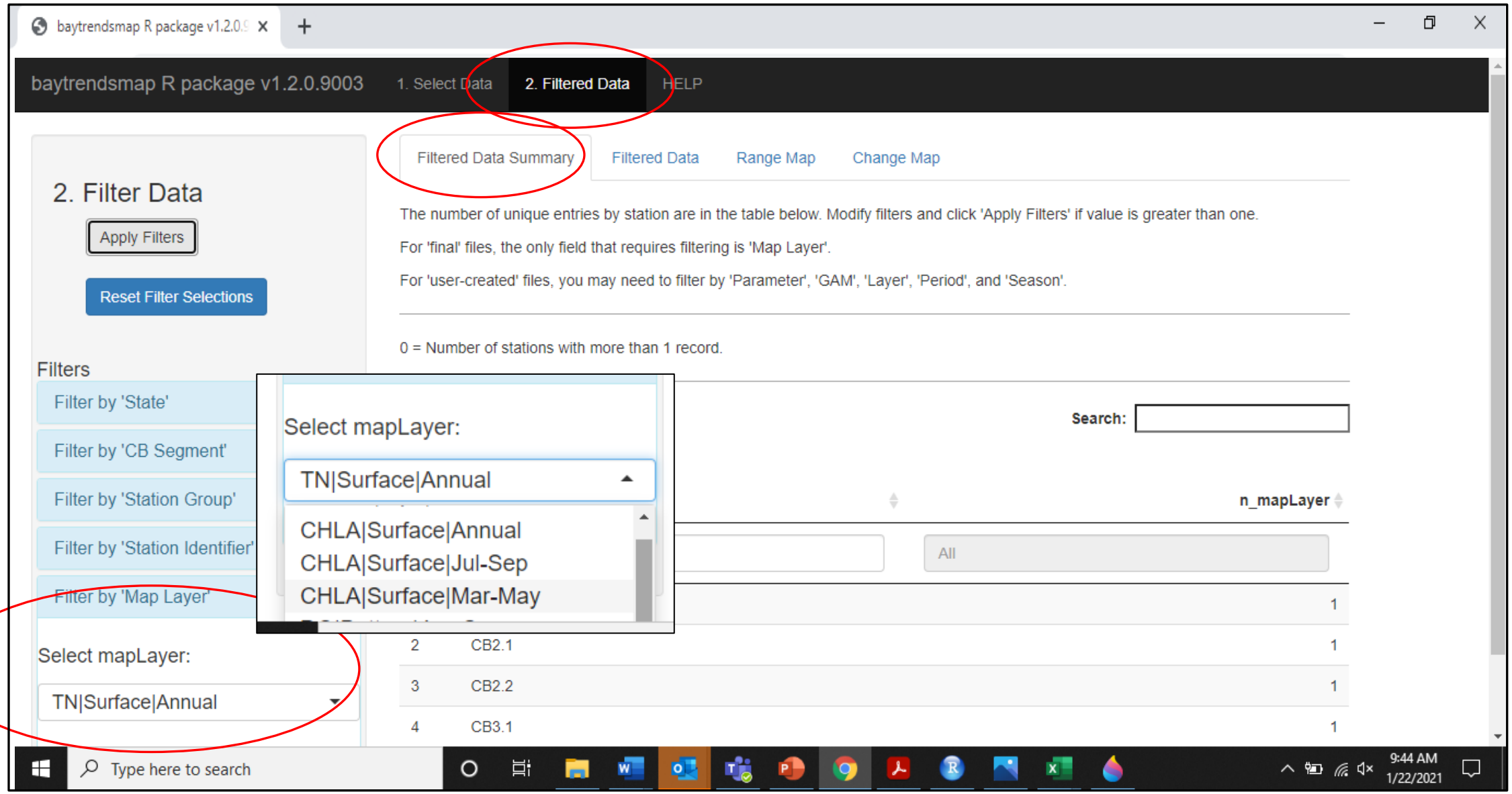
https://baytrends.chesapeakebay.net/baytrendsmap/

baytrendsmap

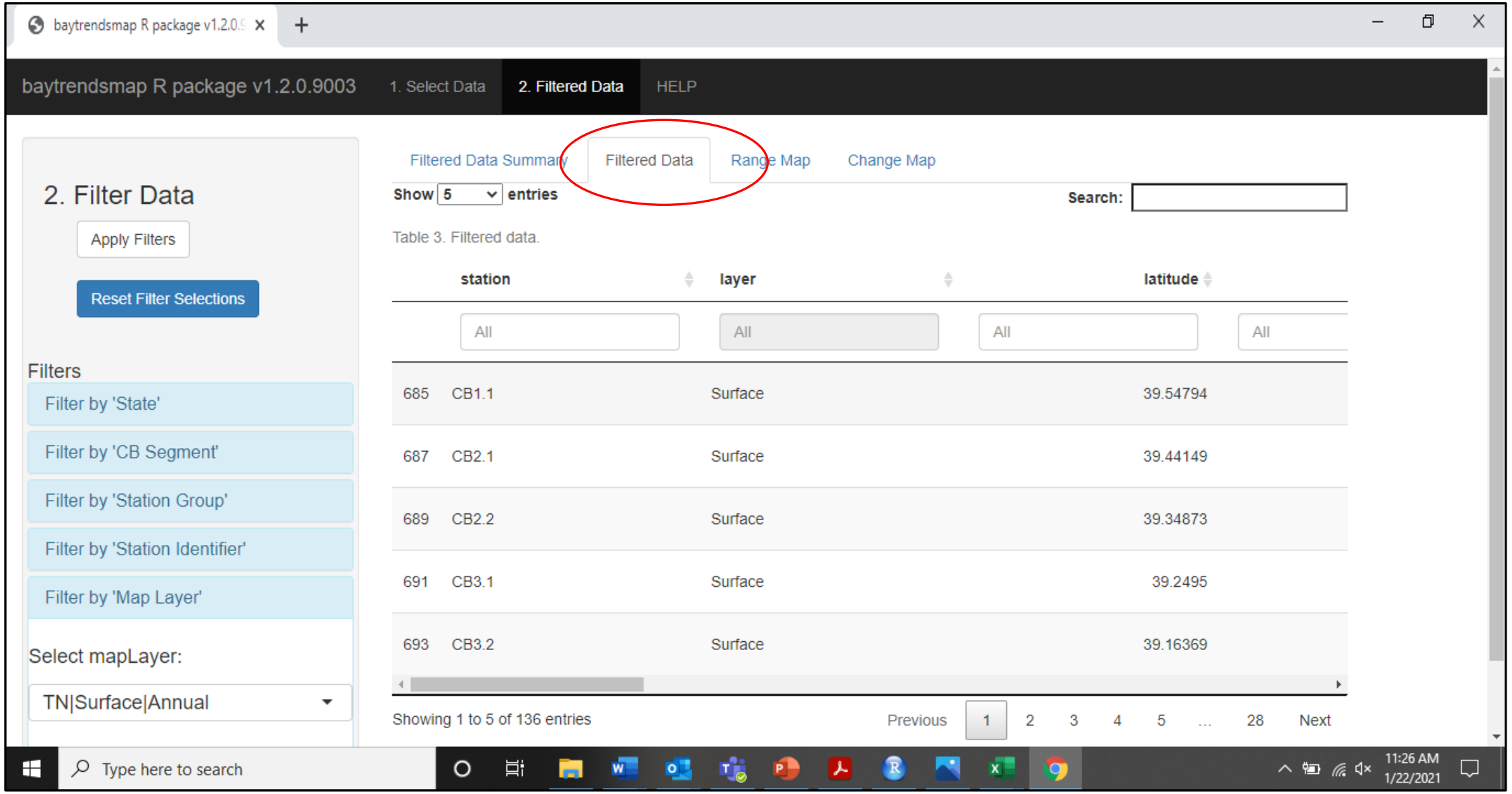
Tetra Tech Team: Jon Harcum and Erik Leppo



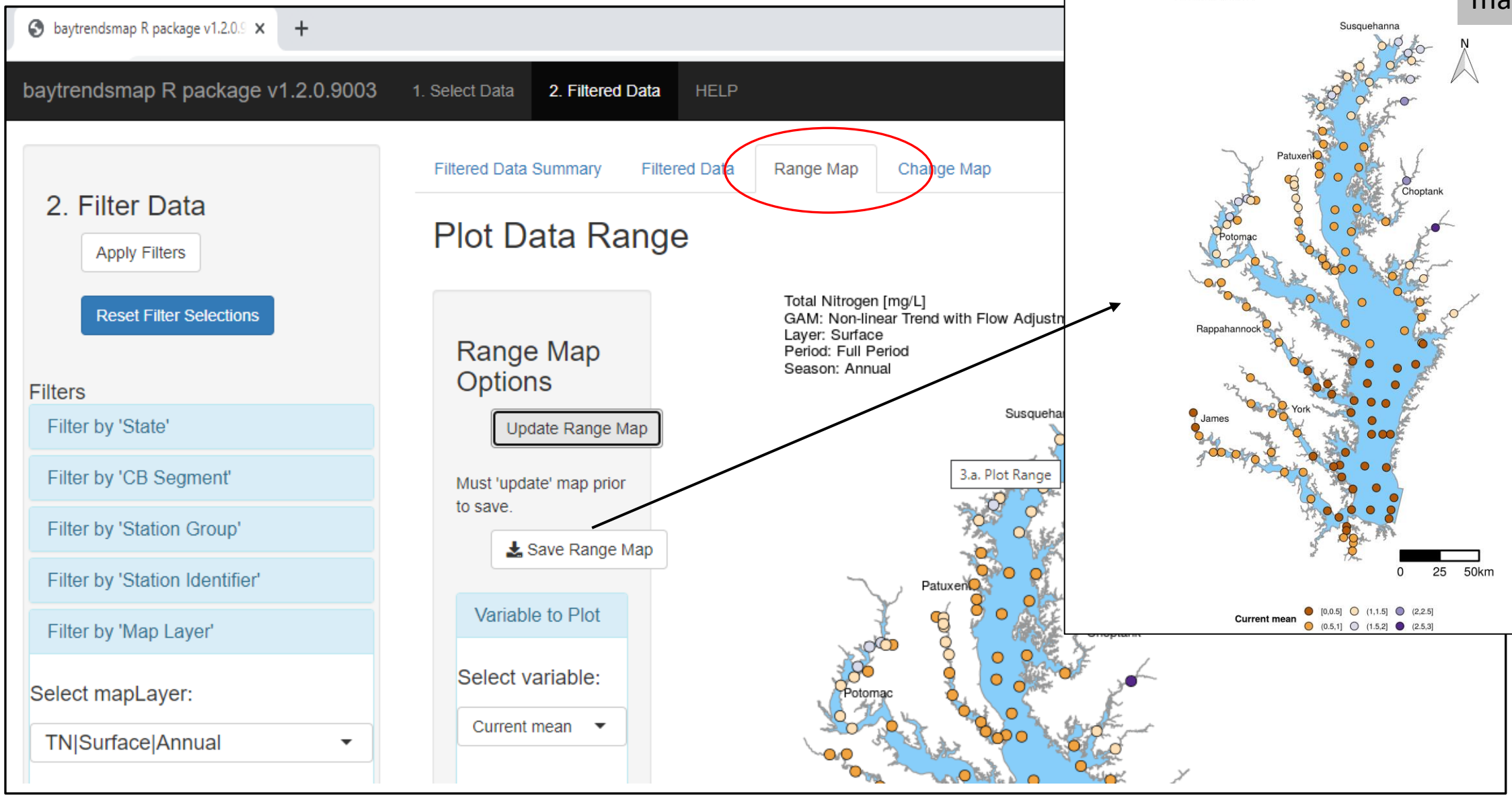
Options for filtering parameter/layer/season



Can view the filtered data set in the browser

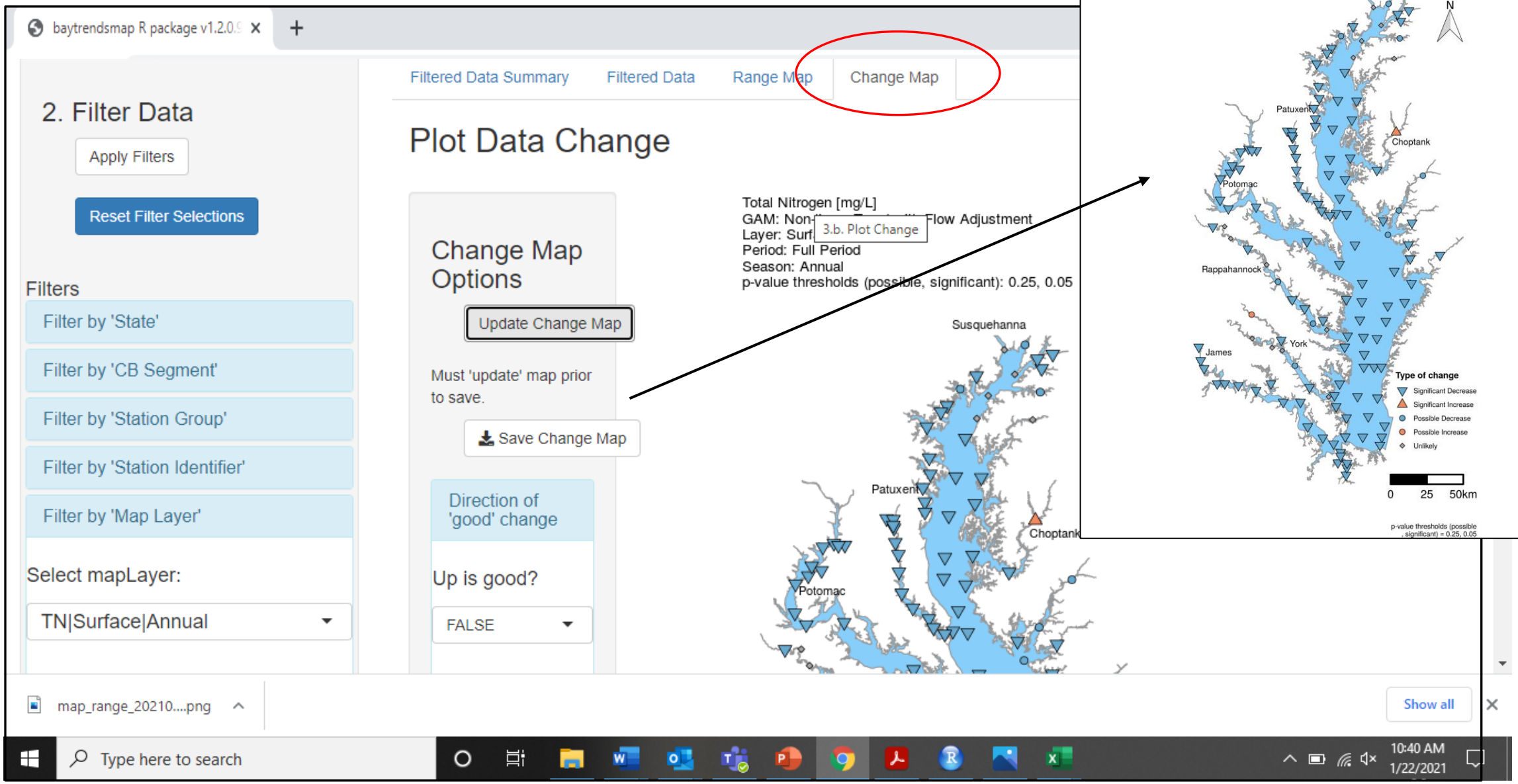


Range map: Can map various features of the data set (current mean, change over time, etc)



Exported map

Change map: Map the changes over time, choose colors, save image, etc



Exported map

Thank you

GAM team:

- Jeni Keisman (USGS)
- Elgin Perry
- Jon Harcum and Erik Leppo (Tetra Tech)
- Renee Karrh (MDDNR)
- Mike Lane (ODU)
- Cindy Johnson (VADEQ)

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