Evaluation of sampling practices for assessing spatial variation in water quality in a eutrophic urbanized watershed

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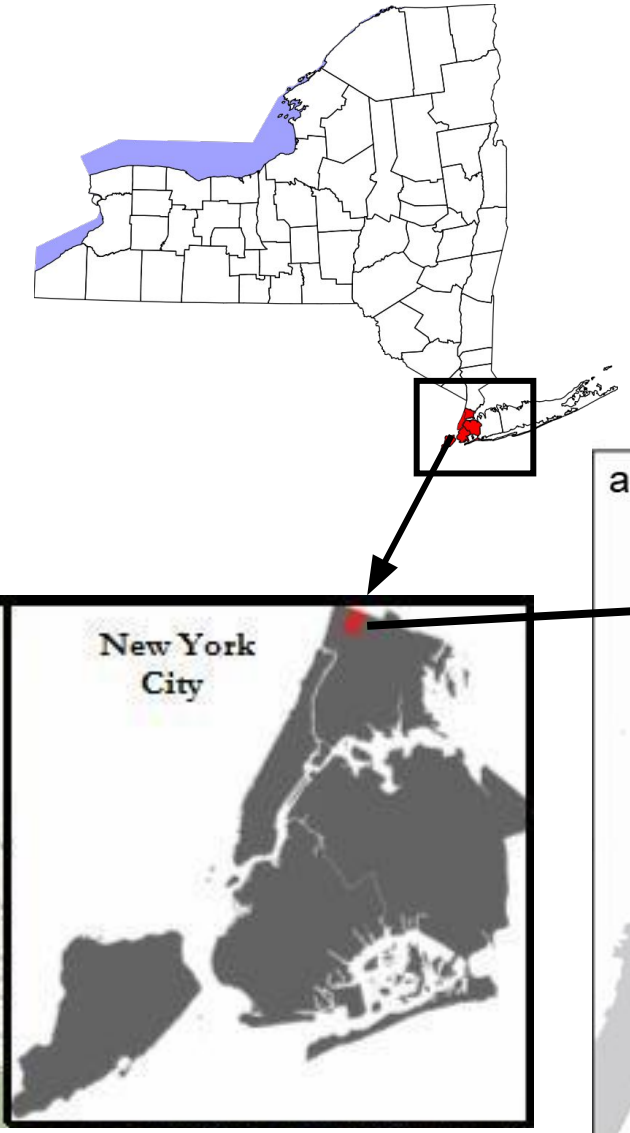
New York City
a)
N
Bronx
Harlem River Watershed
Manhattan
b)
N
Site 1
Site 2
Site 5
Site 3
Site 4
0 250 500 1,000 Meters
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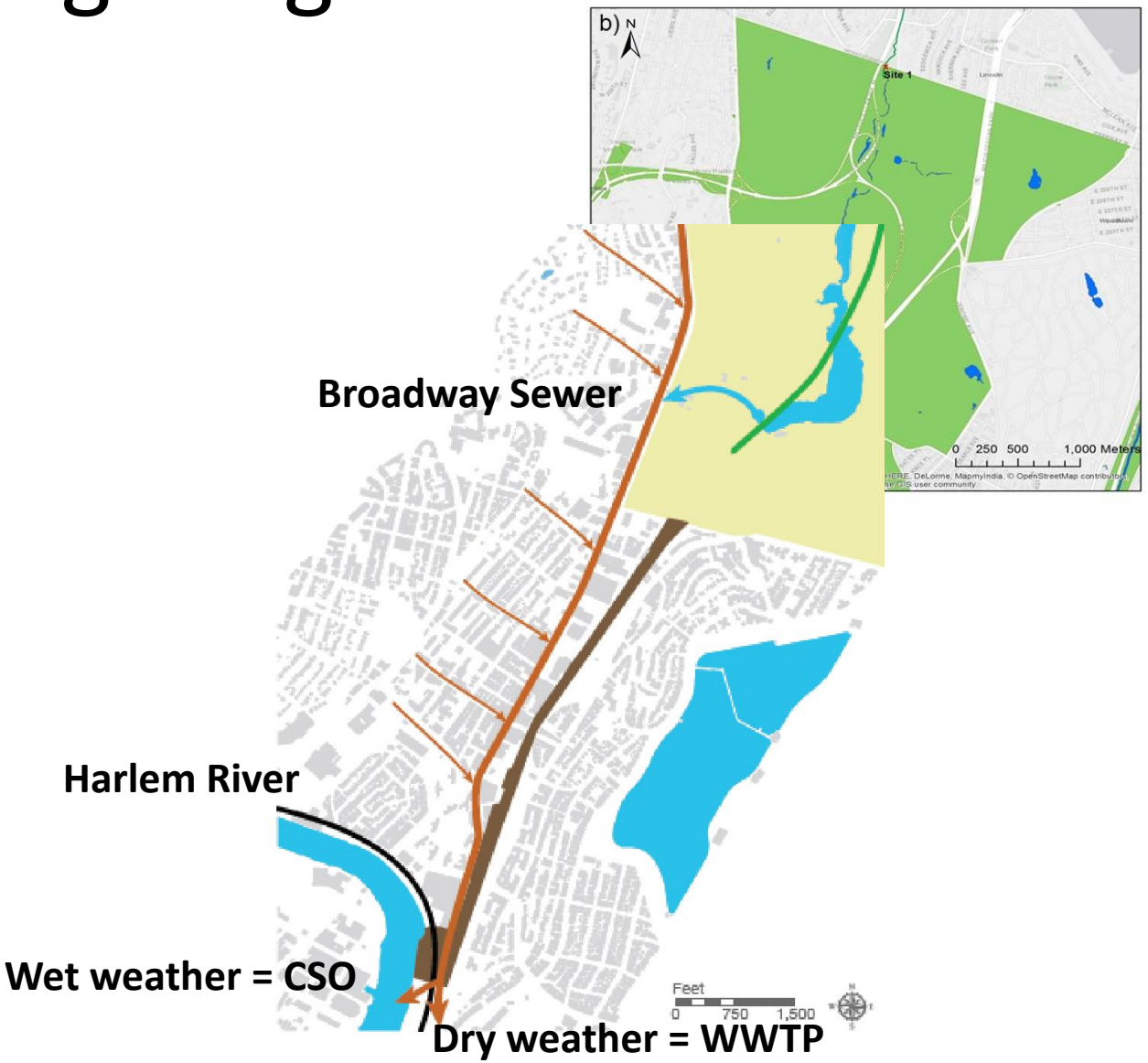
Tibbetts Brook (TB) and Van Cortlandt Lake (VCL)

- Class B waterbodies
  - Swimming and contact recreation
- Highly eutrophic
  - Total phosphorus > 0.20 mg/L
  - 20,000 cubic yards of sediment removed in 2001
    - No improvements in water quality

Daylighting Tibbetts Brook

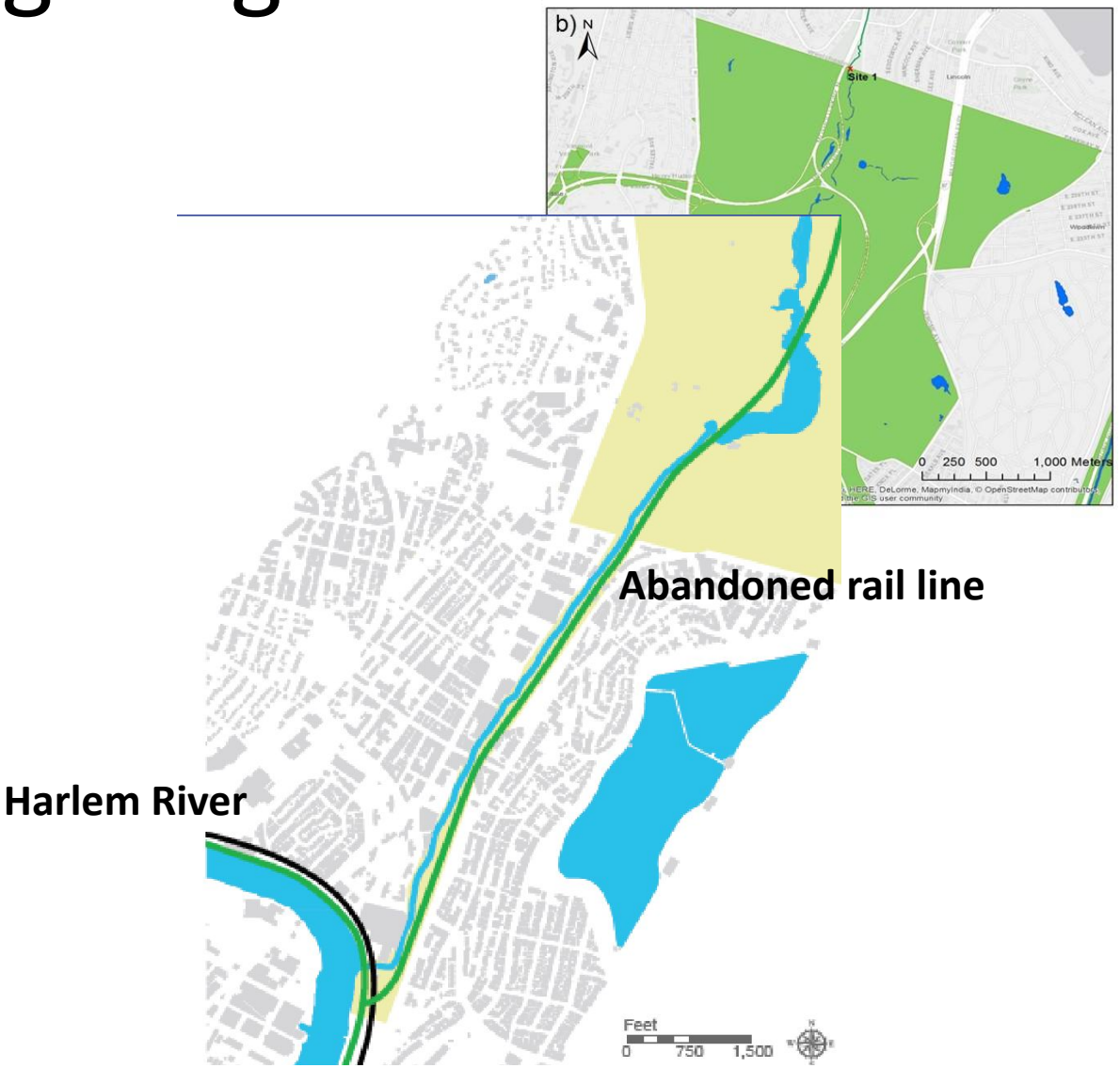


Dry weather: Lake effluent from (4-5 MGD) enters sewer system and is treated at a wastewater treatment plant (unnecessarily)

NYC is a combined sewer system

Wet weather: Lake effluent + street runoff + sewage bypasses the WWTP and flows directly into Harlem River

Daylighting Tibbetts Brook



CSO makes up more than half of the CSO water entering the Harlem River

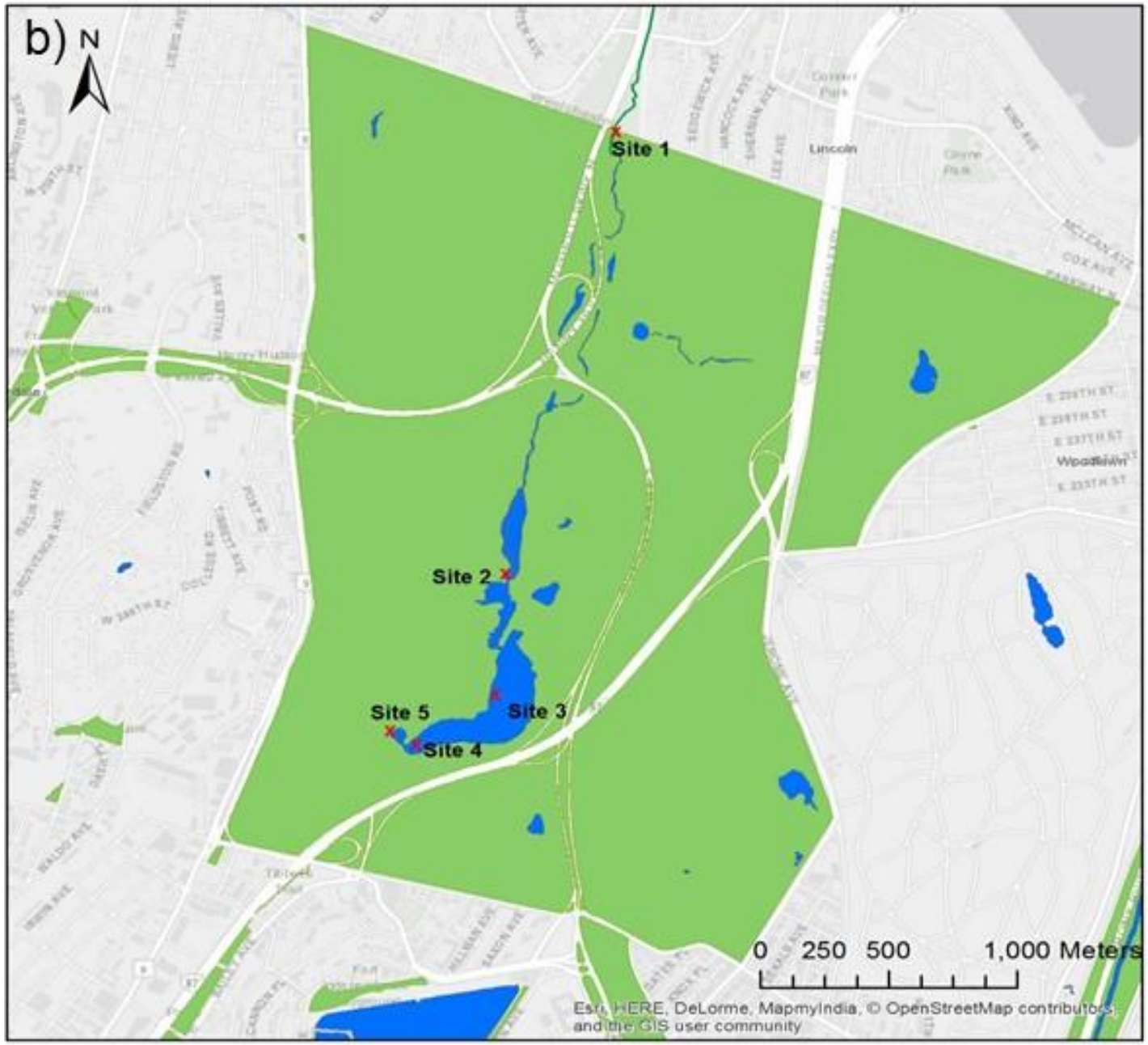
Daylighting TB will reduce CSO occurrences on the Harlem River

<u>Need to assess existing water quality</u> to ensure daylighting will not negatively impact Harlem River

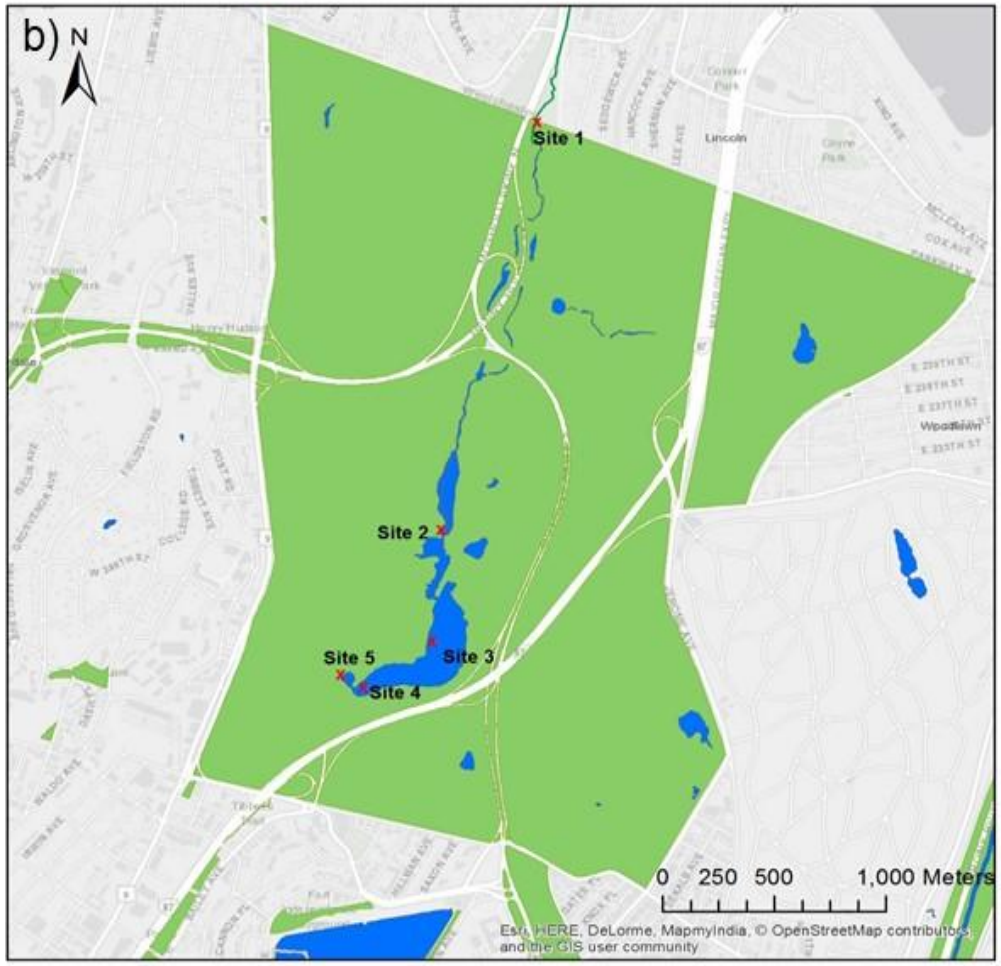
Project Objectives

- Evaluation of overall health of waterbody
  - pH, conductivity, dissolved oxygen, temperature
  - Nitrate, phosphorus, turbidity

- Develop appropriate sampling strategies
  - Sampling location/frequency
  - Water quality criteria attainment
  - Limited resources



Different sampling practices can lead to an overestimation or underestimation of eutrophication in a watershed and can alter decisions made regarding overall water quality



Sample Location

Site 1 vs. Site 2

Site 3 vs. Site 4 vs. Site 5

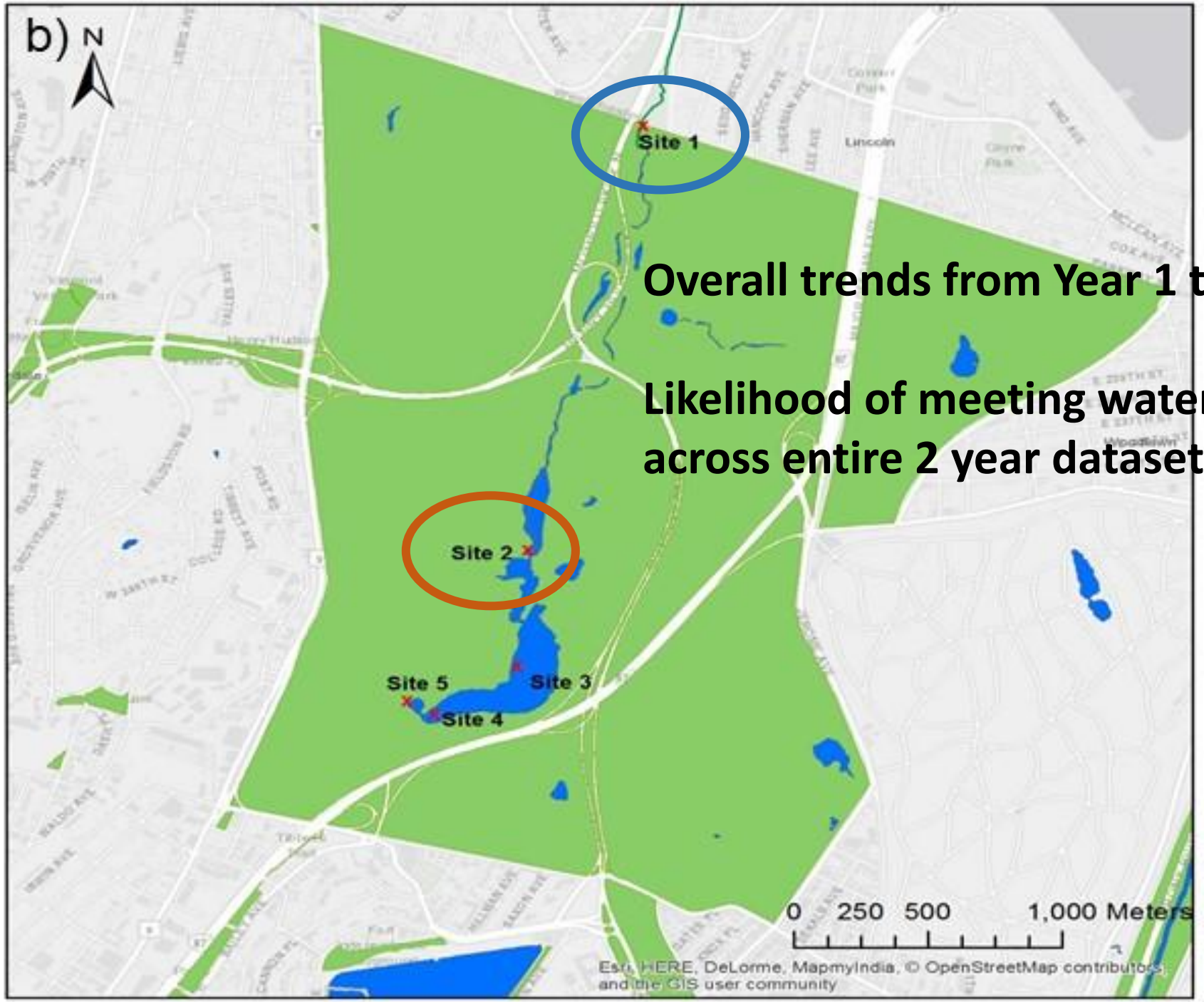
Sampling Frequency

Higher frequency: Weekly

Lower frequency: Monthly

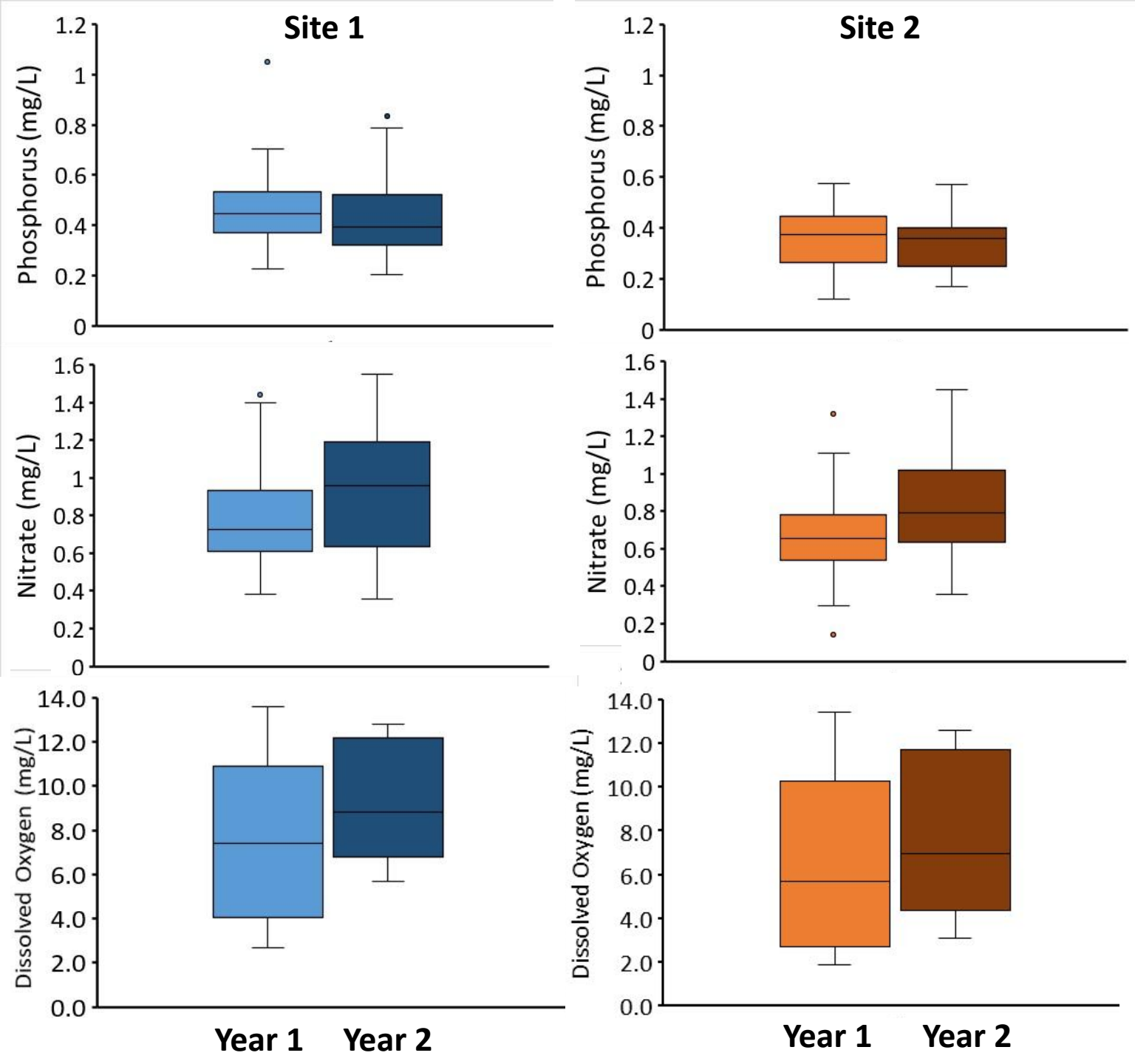
Does sample location affect the likelihood of meeting or exceeding certain criteria for nutrients and dissolved oxygen?

Parameter	Proposed Threshold (mg/L)	Reference
Nitrate	0.356 mg/L	(Smith et al. 2013)
Phosphorus	0.017 mg/L	(Smith et al. 2013)
Parameter	**Standard (mg/L)**	**Reference**
Dissolved Oxygen (DO)	4 mg/L	(NYSDEC 2017)



Overall trends from Year 1 to Year 2

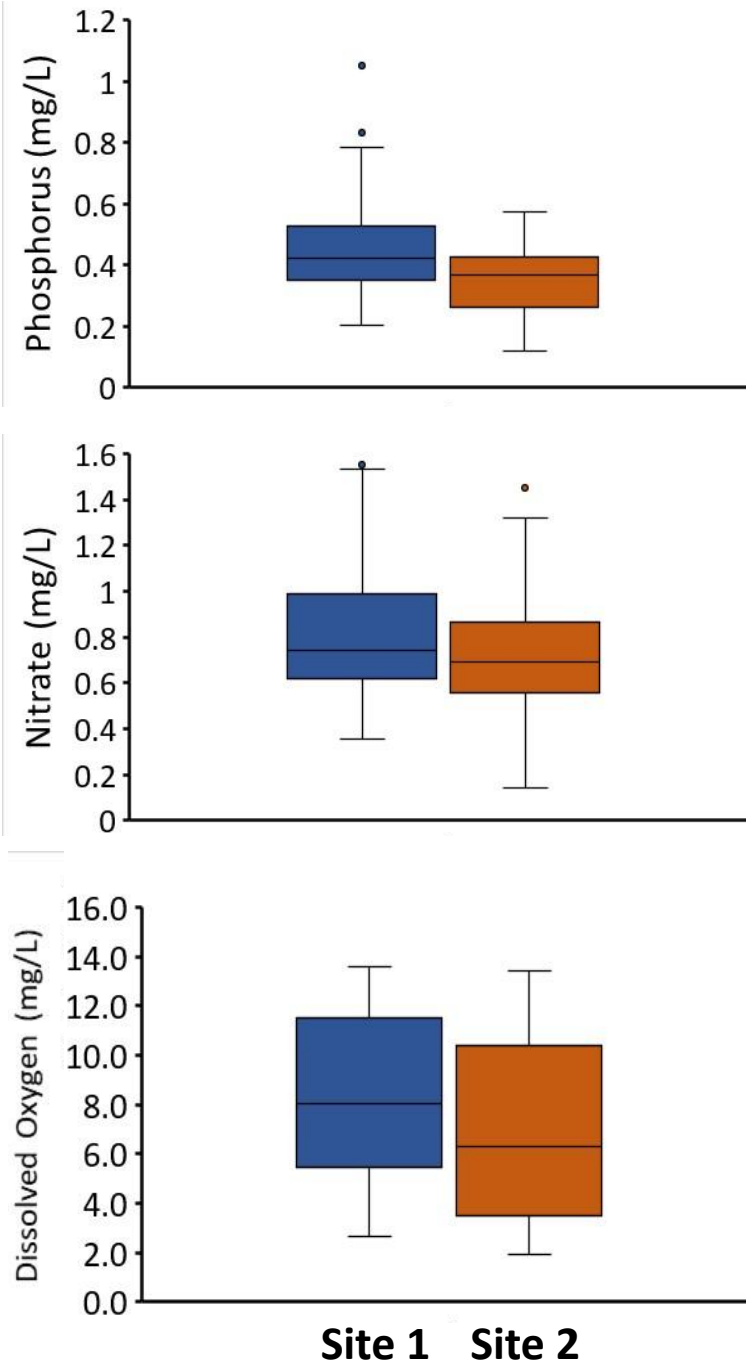
Likelihood of meeting water quality criteria across entire 2 year dataset



No statistically significant difference in TP between Years 1 and 2 at either Site

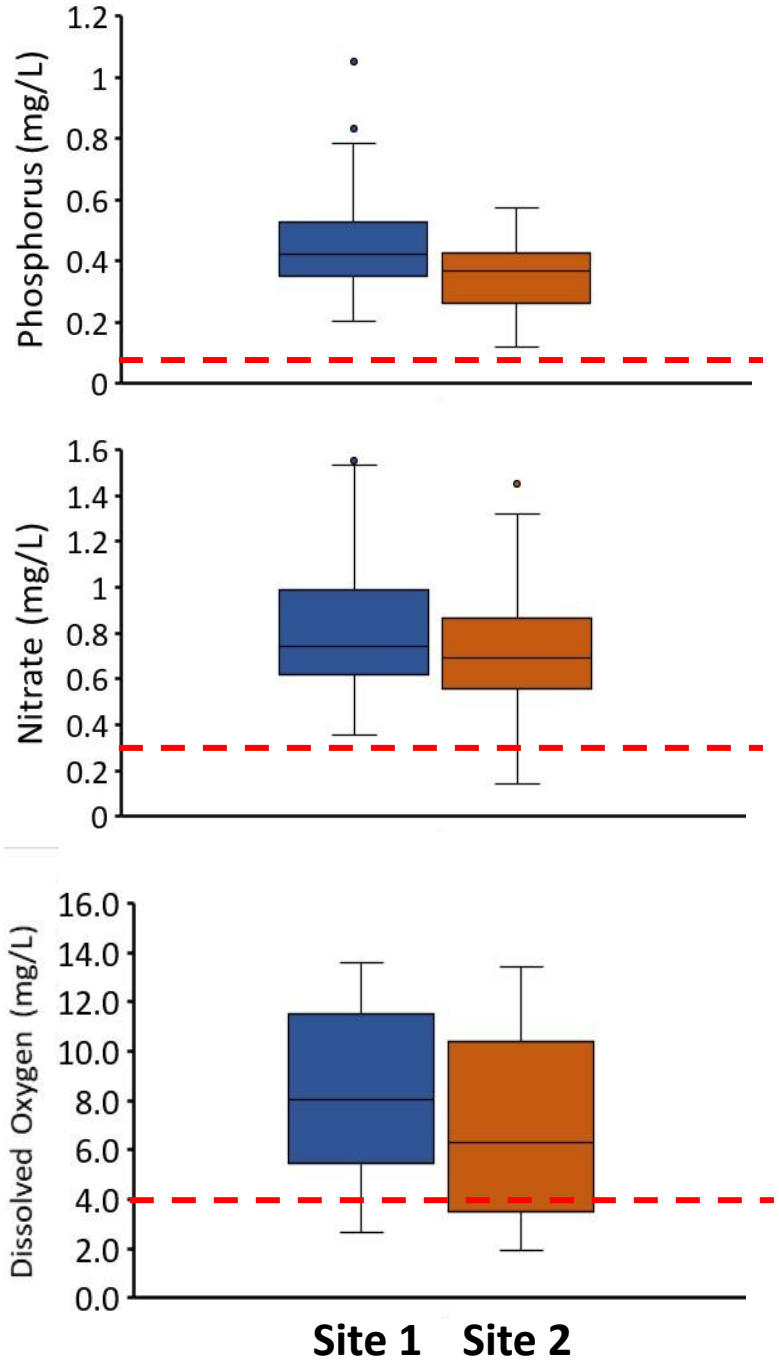
Nitrate statistically significantly higher in Year 2 than Year 1 at both Site 1 and Site 2
($p = 0.030$ and $p < 0.001$, respectively)

DO statistically significantly higher in Year 2 than Year 1 at Site 1 ($p = 0.033$)

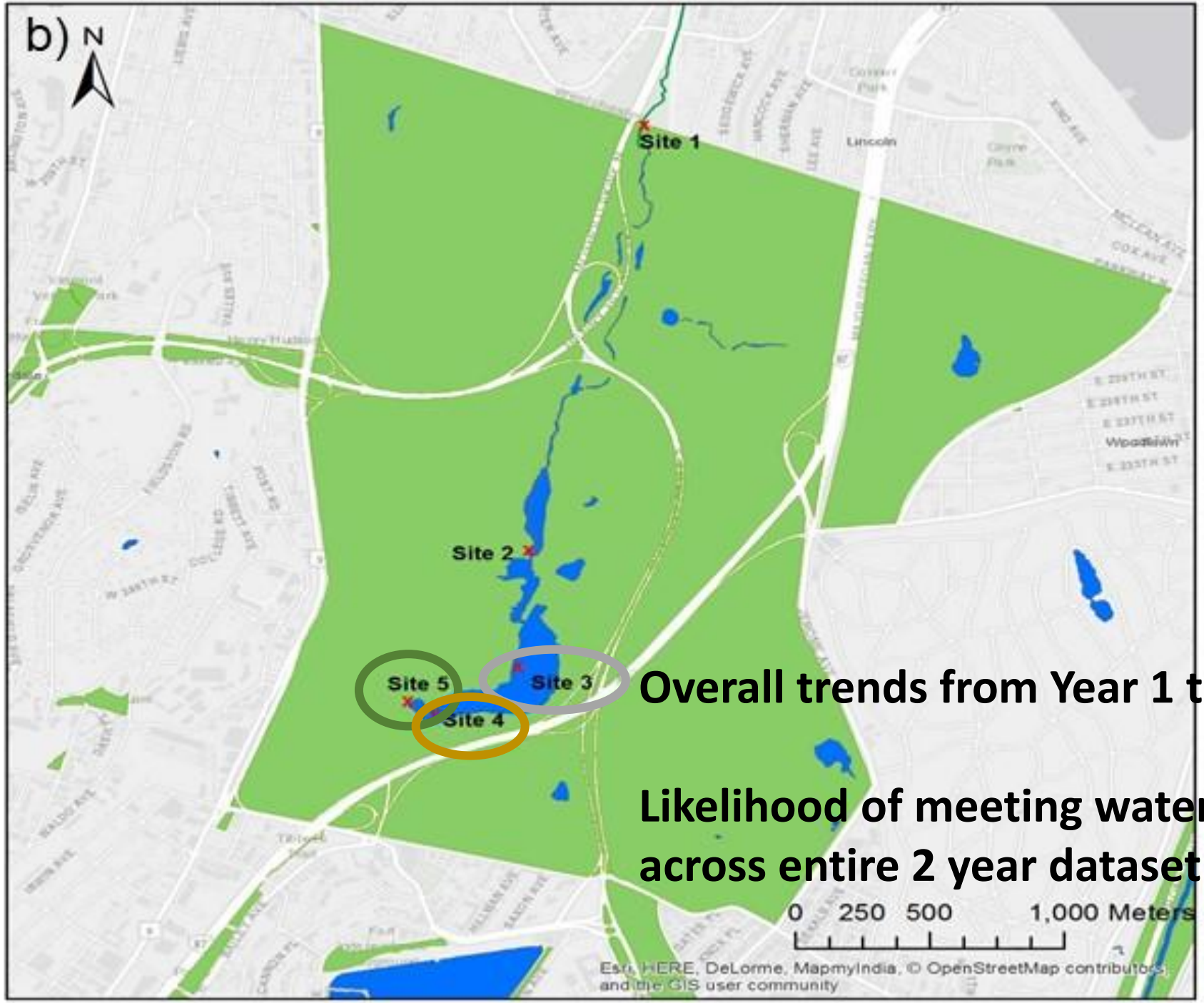


Over entire 2 year dataset, TP, nitrate, and DO statistically significantly higher at Site 1 than Site 2
($p < 0.001$, $p = 0.044$, and $p = 0.033$, respectively)

Sample location is an important factor when assessing Tibbetts Brook for nutrients and dissolved oxygen as selection of one site over another may lead to an underestimation or overestimation of nutrient enrichment

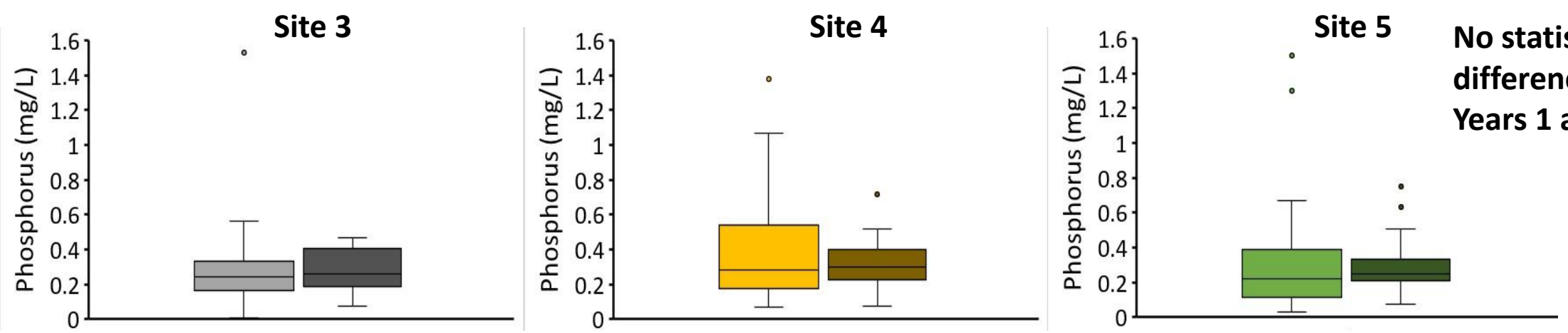


	Observation not meet criteria/standard (%)	
Parameter (criteria/standard)	**Site 1**	**Site 2**
Phosphorus (0.017 mg/L)	100	100
Nitrate (0.356 mg/L)	98	96
Dissolved Oxygen (4 mg/L)	24	15

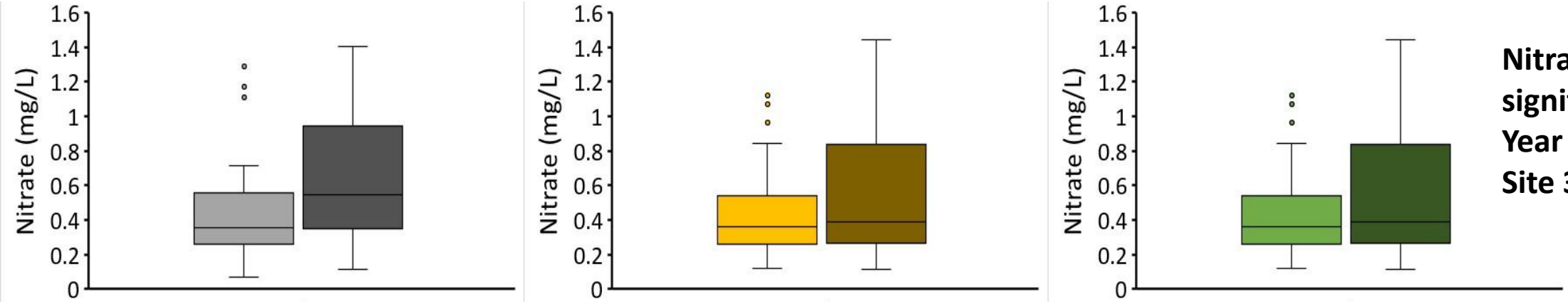


Overall trends from Year 1 to Year 2

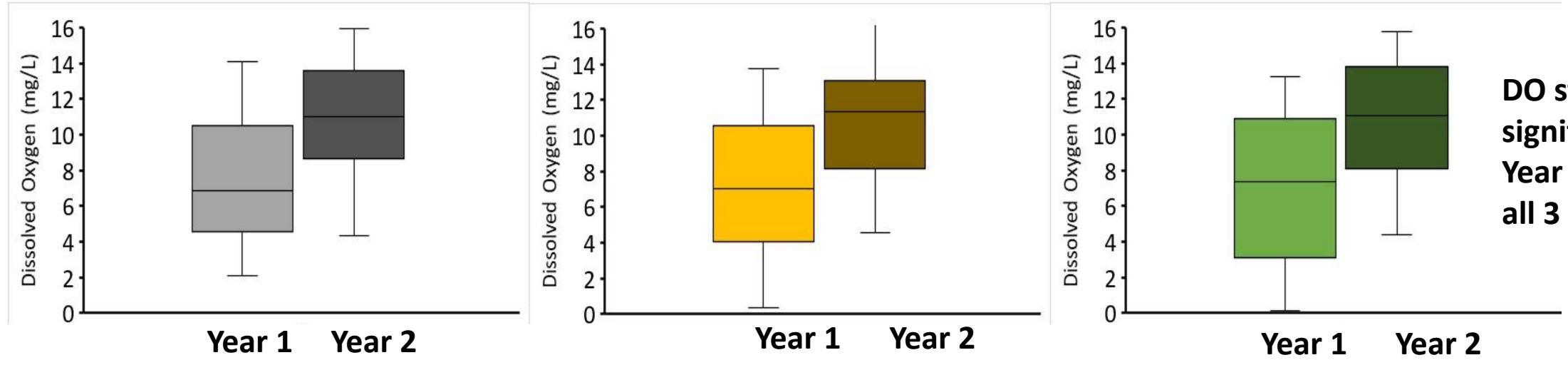
Likelihood of meeting water quality criteria across entire 2 year dataset



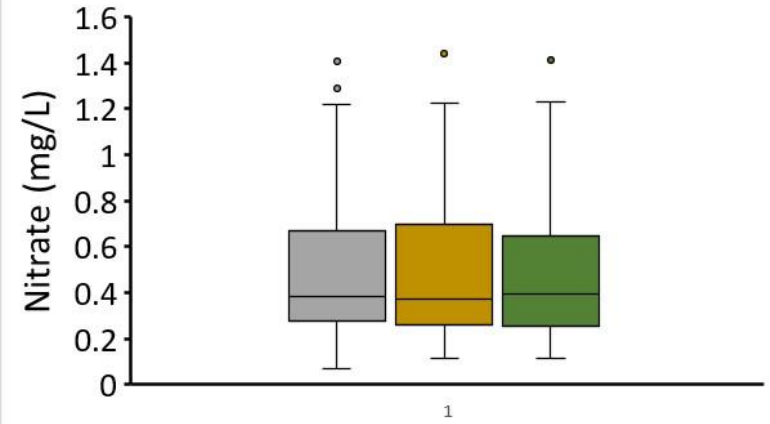
No statistically significant difference in TP between Years 1 and 2 for all Sites

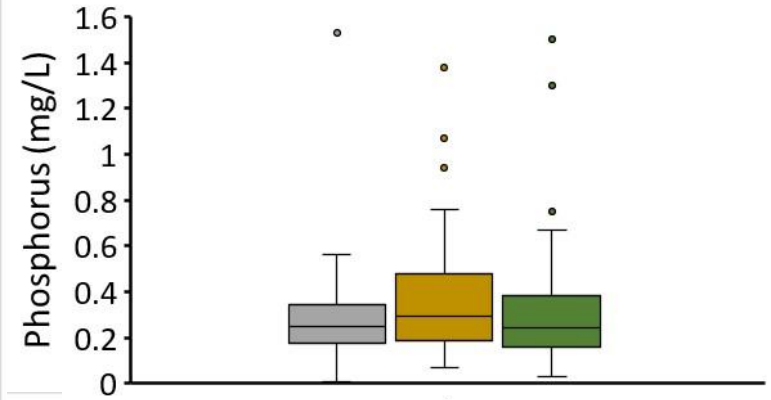


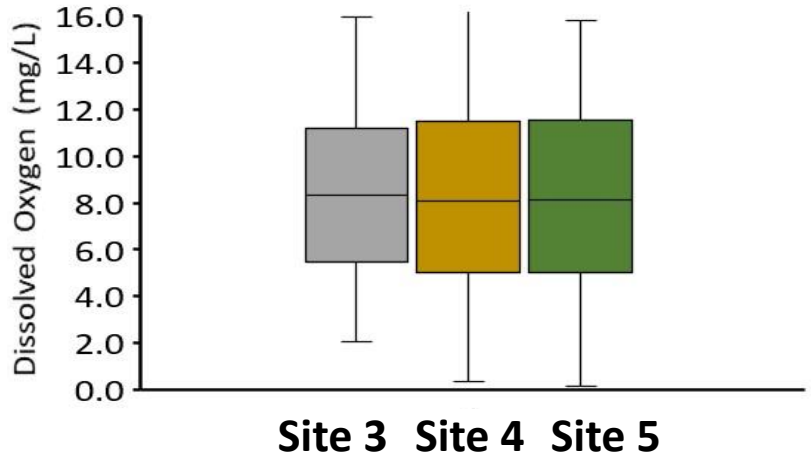
Nitrate statistically significantly higher Year 2 than Year 1 for Site 3 ($p = 0.016$)



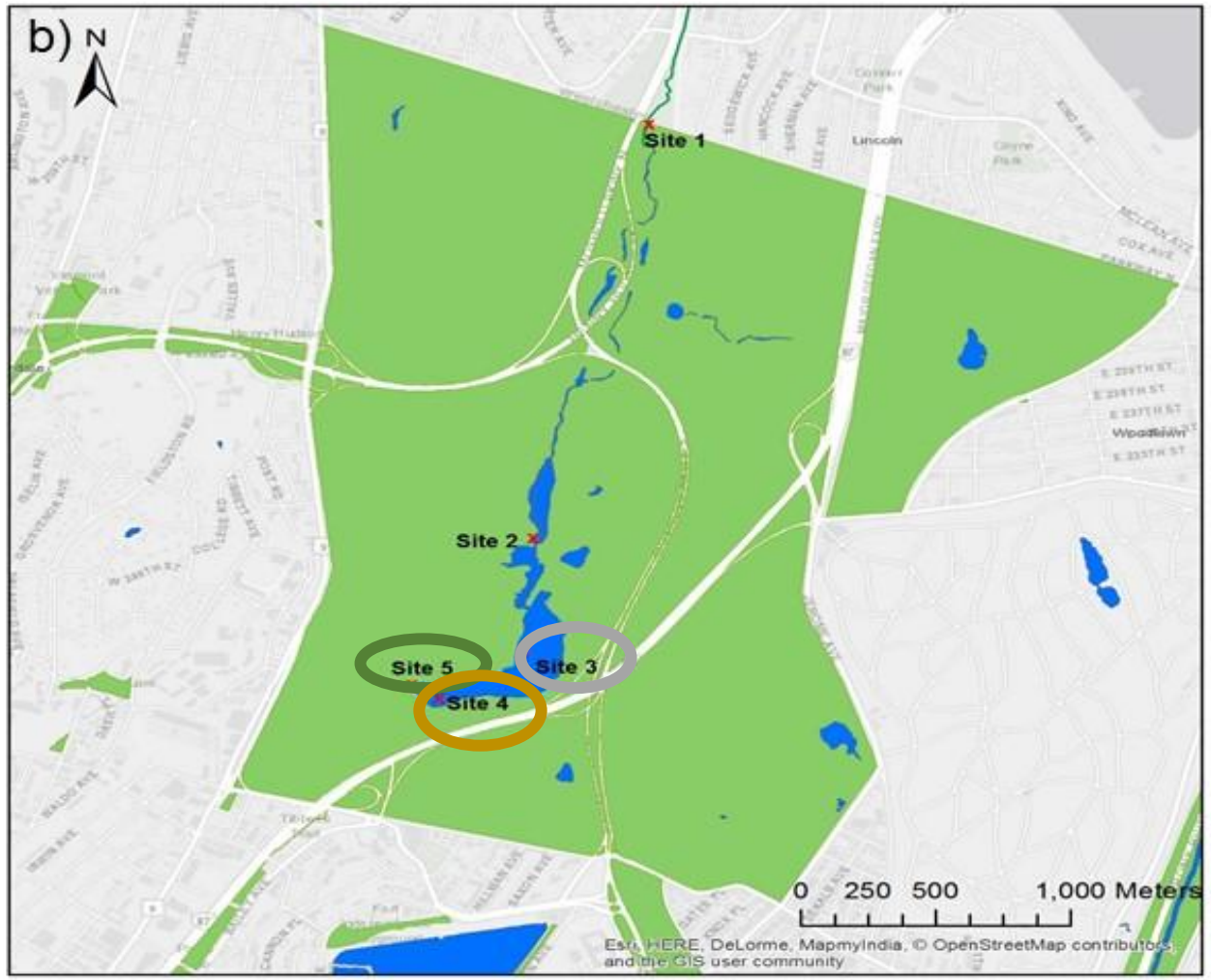
DO statistically significantly higher Year 2 than Year 1 for all 3 Sites ($p < 0.001$)



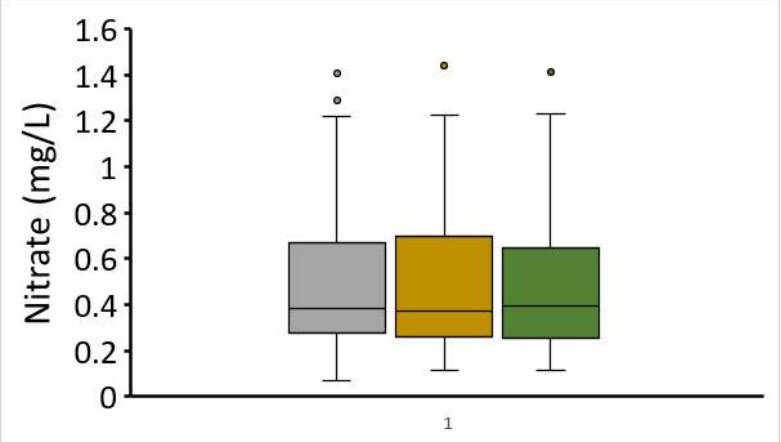


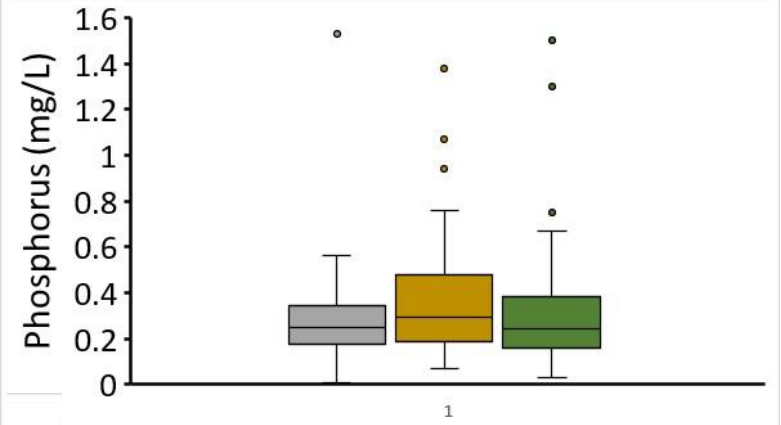


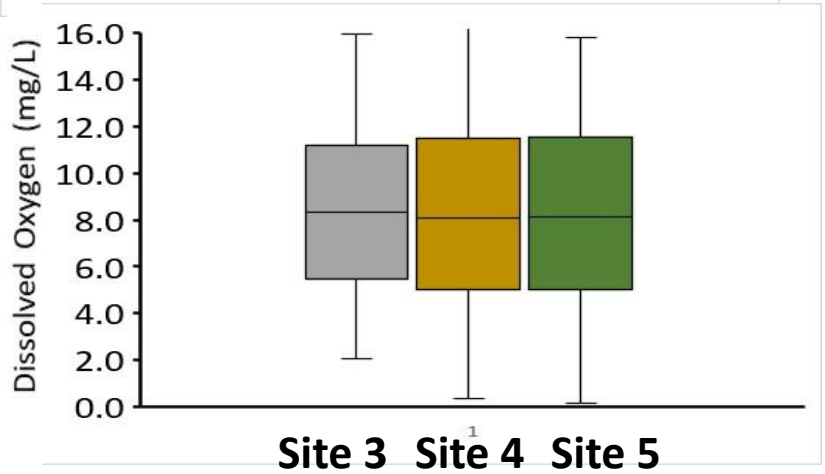
Over entire 2 year dataset, no statistically significant difference in TP, nitrate, or DO between the 3 sites



Sample location may not be as important in assessing water quality in Van Cortlandt Lake as it is in Tibbetts Brook







	Observation not meet criteria/standard (%)		
Parameter (criteria/standard)	**Site 3**	**Site 4**	**Site 5**
Phosphorus (0.017 mg/L)	99	99	100
Nitrate (0.356 mg/L)	57	57	56
Dissolved Oxygen (4 mg/L)	13	17	20

Overall water quality and implications for daylighting

Median Concentration (mg/L)	TB	VCL
Phosphorus	0.39	0.26
Nitrate	0.72	0.38
Dissolved Oxygen	7.33	8.16

- Water quality in Harlem River (USGS study, 2005-2012)
  - Median TP = 0.15 mg/L
  - Median nitrate = 0.35 mg/L
  - Median DO = 5.10 mg/L

EPA poor ecological condition criterion for orthophosphate = 0.05 mg/L
EPA poor ecological condition criterion for dissolved inorganic nitrogen (nitrate + nitrite) = 0.5 mg/L

Implications for design of water quality monitoring program

- Likelihood of meeting criteria differs throughout the watershed
  - Not sufficient to limit sampling to solely TB or VCL
- Likelihood of meeting criteria differs between sites
  - No noticeable differences in lake sites for nitrate and phosphorus
- Phosphorus sampling less sensitive to site location than nitrate
  - Potentially change sampling protocol given staff/budget limitation

Acknowledgements

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For more info: http://vancortlandt.org/tibbetts/