Spatial Patterns in Stream Condition Index from Statewide Stream Surveys in Virginia

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Happy 20th Anniversary Local Neighborhood Variance Estimator!!

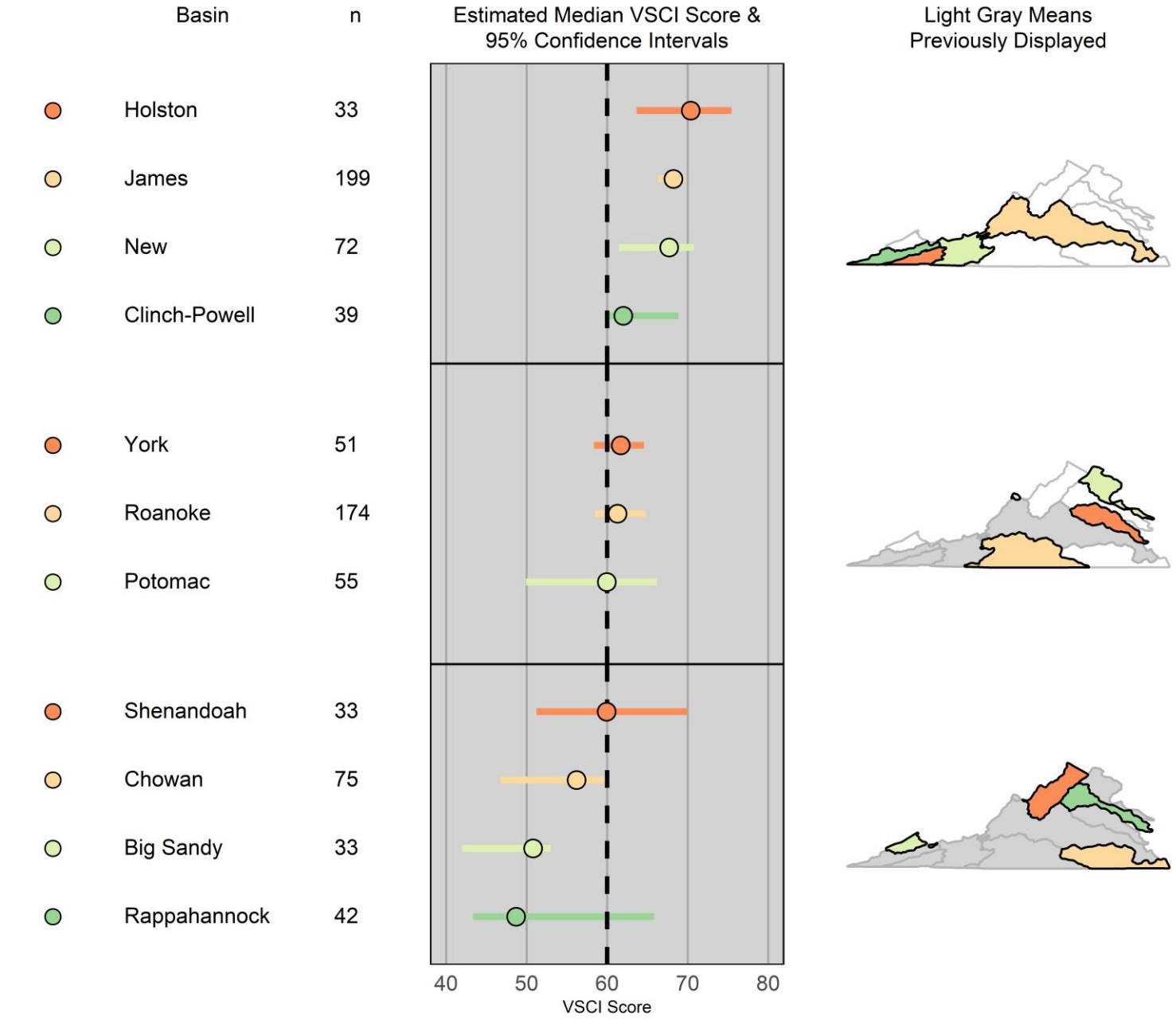
- Don L. Stevens, Jr. and Anthony Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14:593-610.

- Local neighborhood variance is used in the analysis of spatially balanced probabilistic surveys and takes an incremental look at space.

- Uses the Virginia Stream Condition Index (VSCI) of a site itself plus three nearest neighbors, calculates a variance, then moves to the next site and does the same thing, and so on. Ultimately, averaging all those variances to give the local neighborhood variance estimate for the basin.

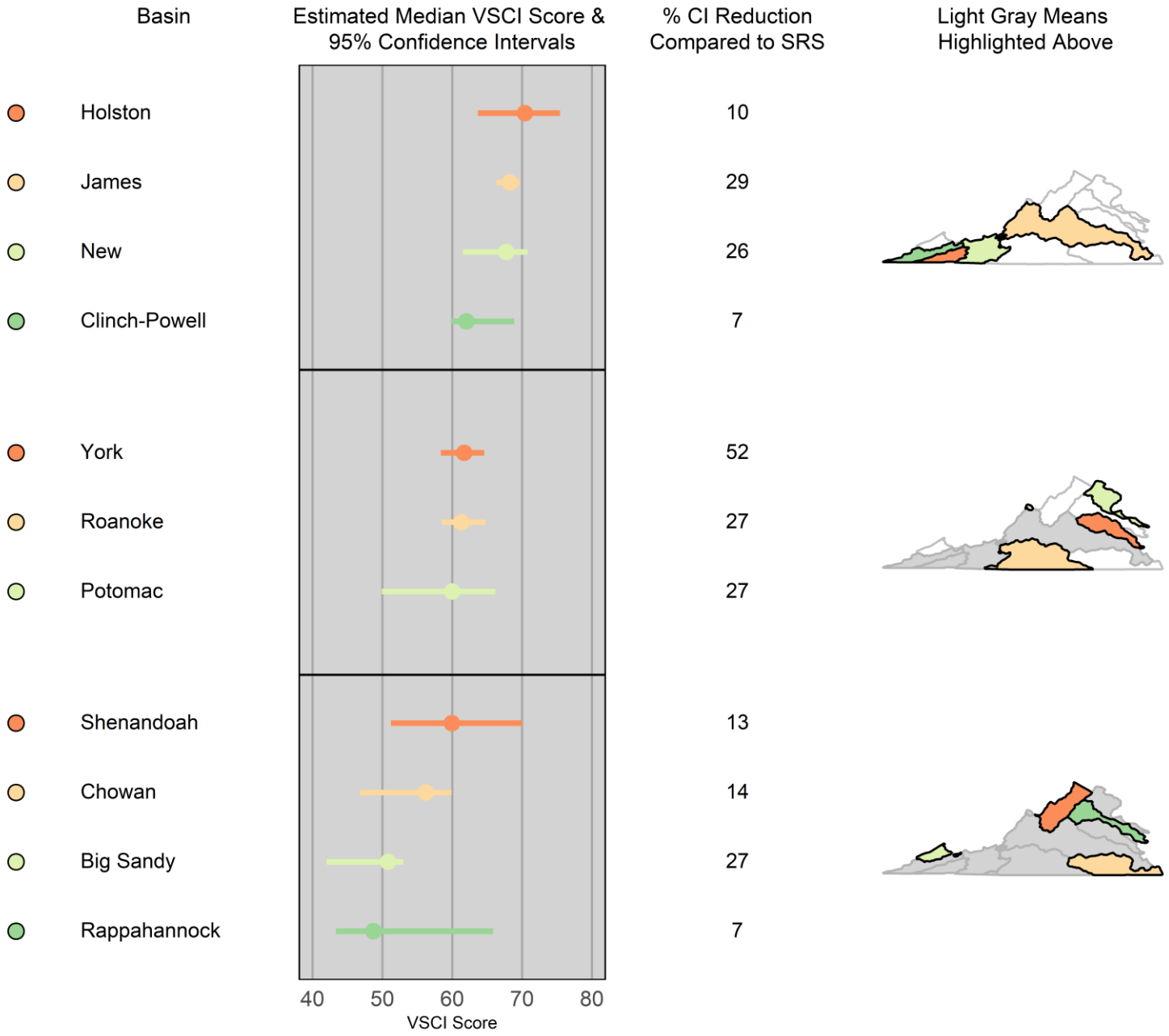
VSCI Linked Micromap

- Data collected from spatially balanced probabilistic stream surveys from 2001-2018
- Confidence intervals (CI) estimated using local neighborhood variance estimator
- If observed data have a **definite spatial pattern**, the local neighborhood variance estimator takes advantage of that pattern to give a smaller confidence interval than a simple random sample (SRS) estimator



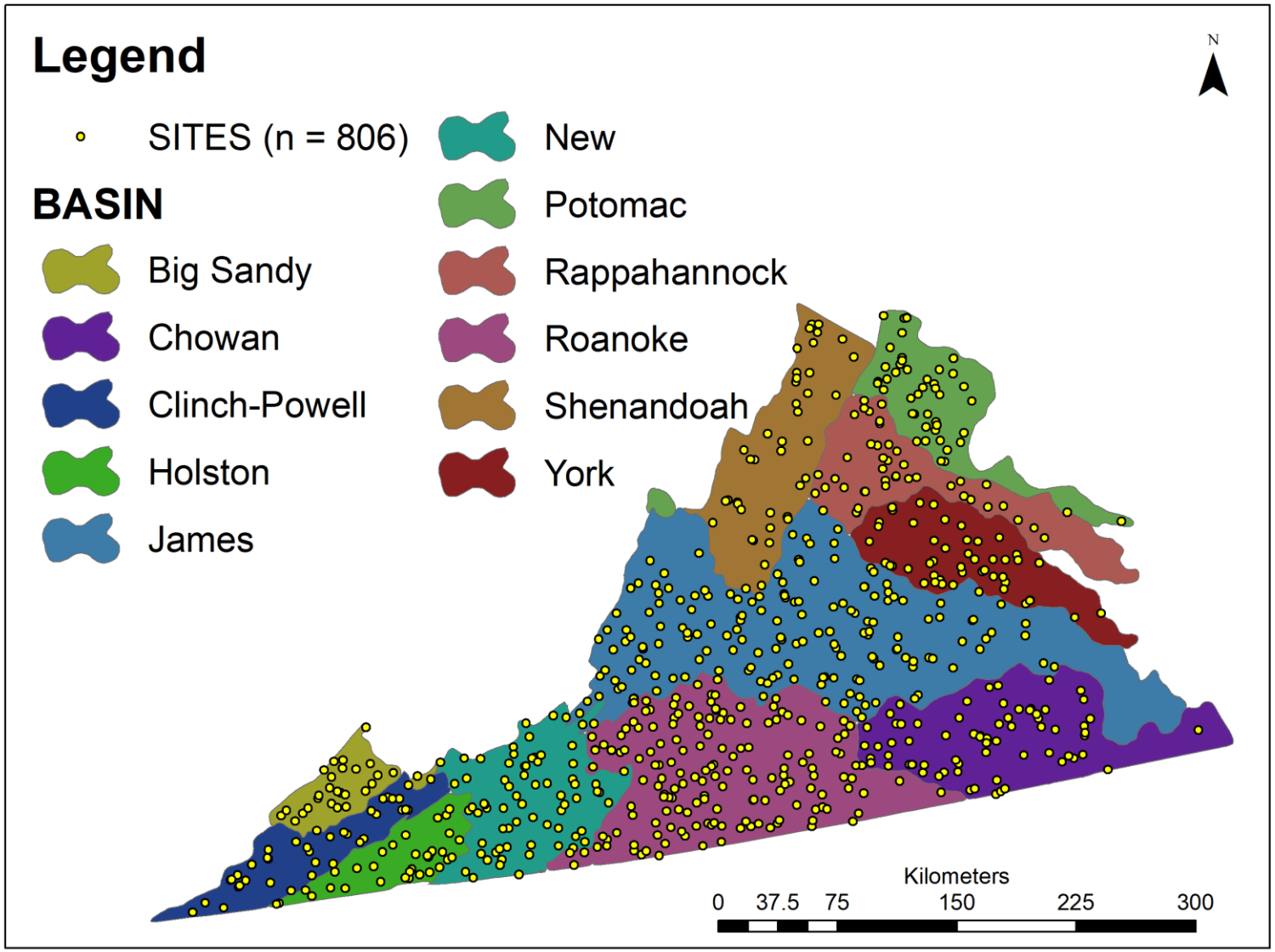
Smaller Confidence Intervals

- Some basins had large reductions in confidence intervals (CI) of 29-52%
- Some basins had moderate reductions in CI of 13-27%
- Some basins had slight reductions in CI of 7-10%
- What does the local neighborhood variance pattern in VSCI among basins tell us?



Hypothesis

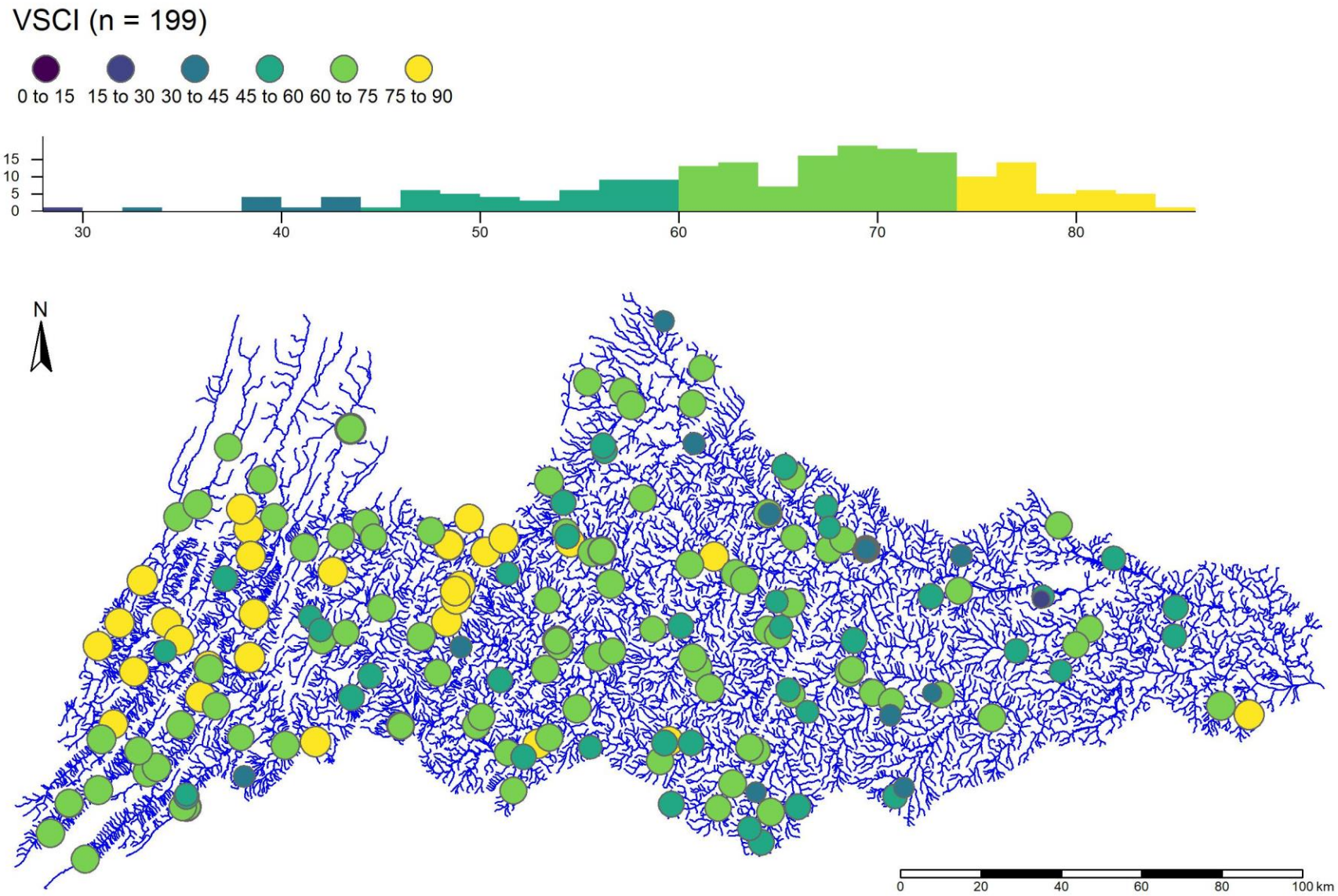
Basins with large CI reductions by using the local neighborhood estimator (York, James) will have stronger geostatistical patterns in VSCI than basins that had smaller CI reductions (Holston, Clinch-Powell, Rappahannock)



Methods for Geostatistical Pattern Detection

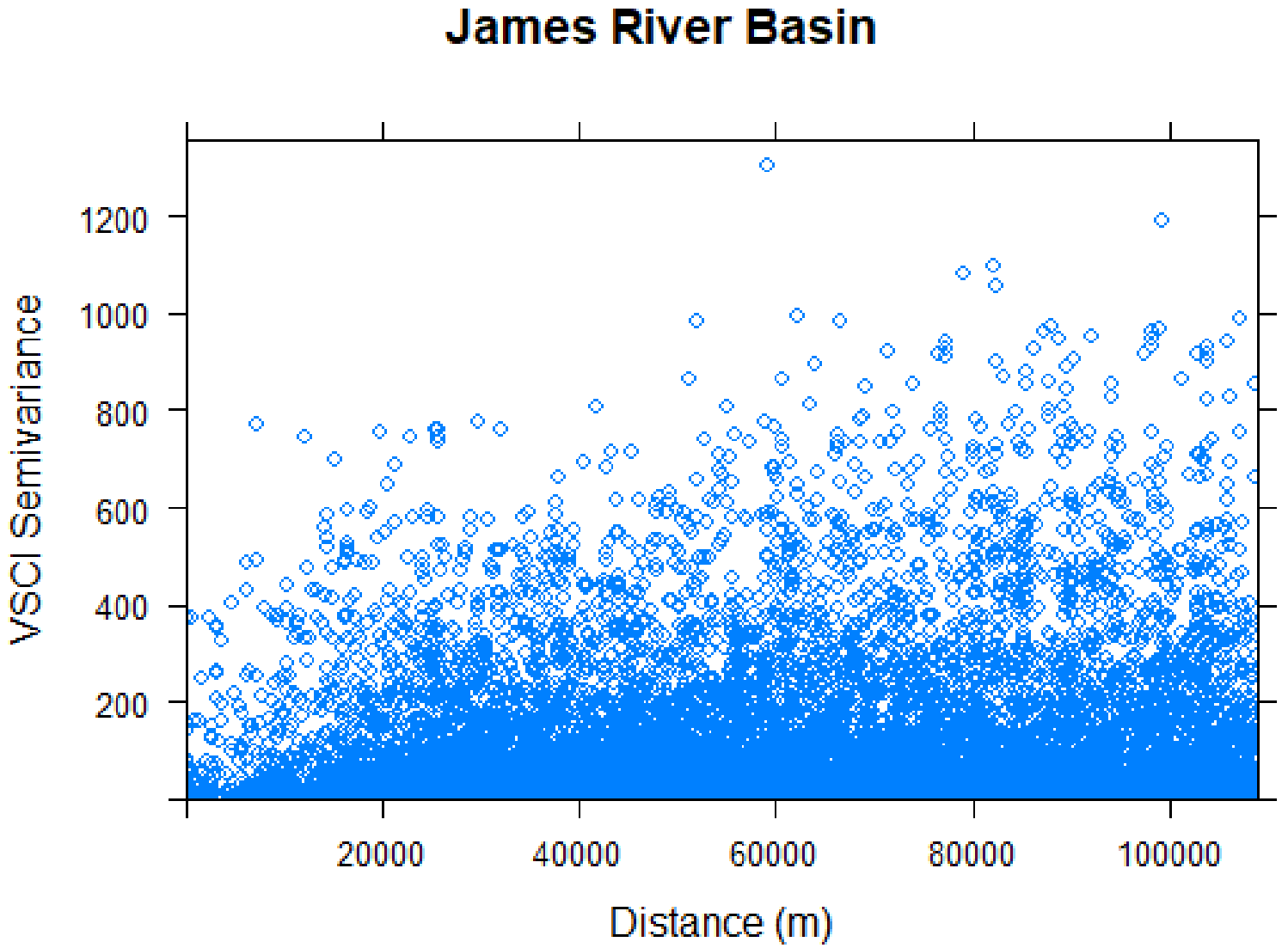
- Basin map and histogram of Virginia Stream Condition Index (VSCI)
- Make a semivarogram cloud
- Plot empirical semivariogram
- Compare empirical semivariogram to hypothesis of complete spatial randomness

James River Basin



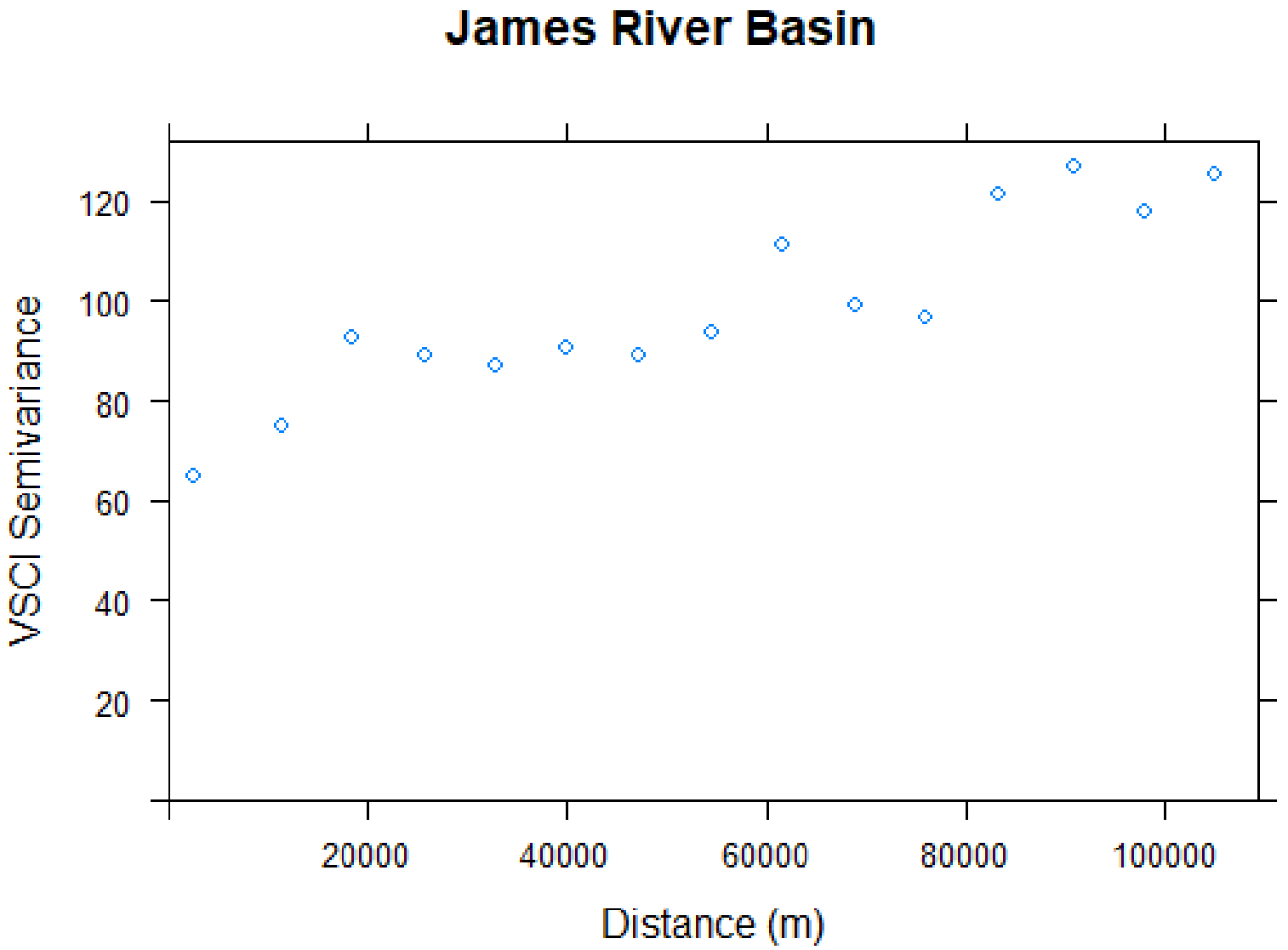
Distance & VSCI

	Distance (m)	VSCI
Min	3	28.7
Q1	50,946	59.1
Median	83,330	67.6
Mean	92,526	65.3
Q3	125,832	73.1
Max	299,788	85.0



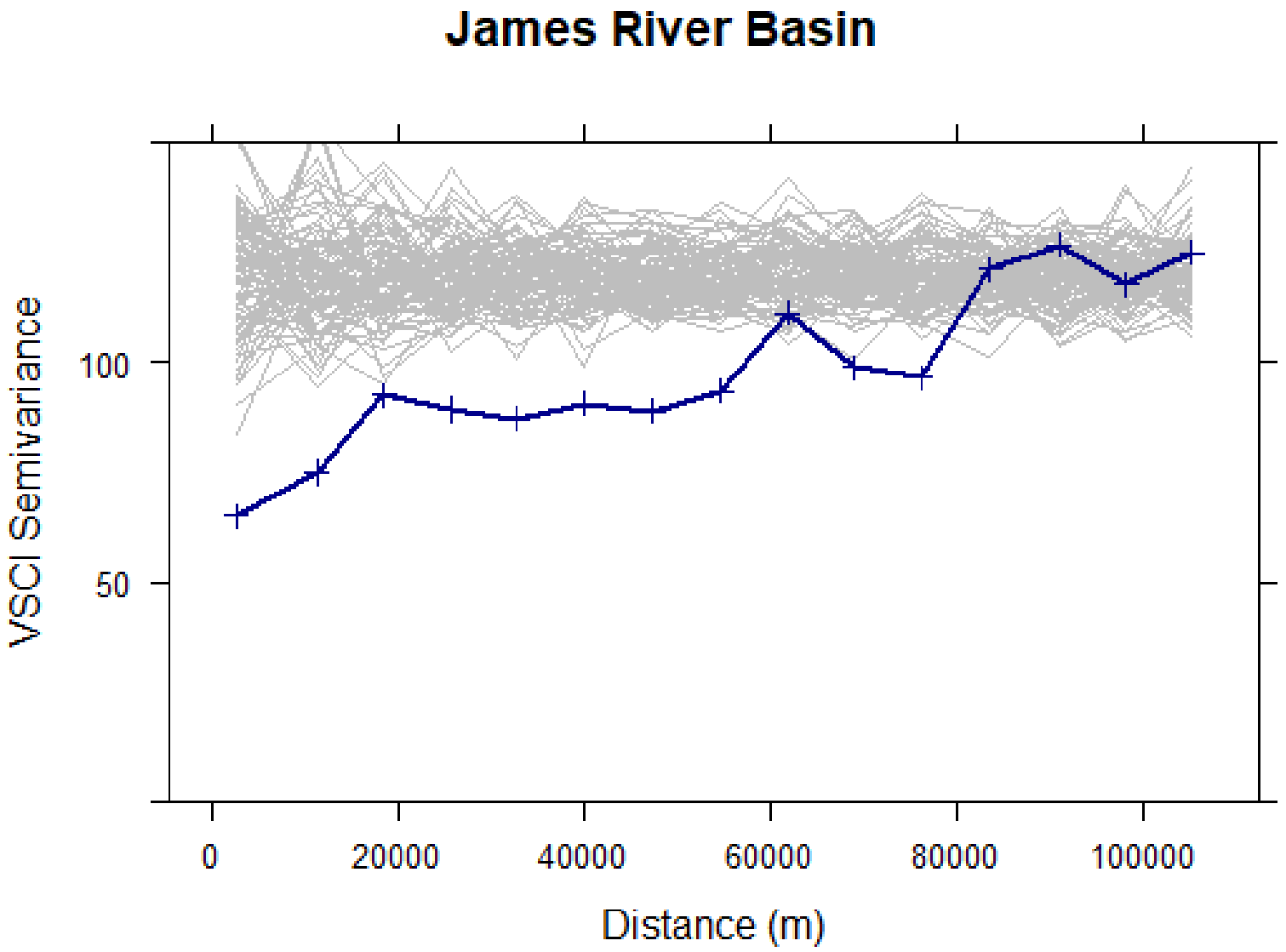
Empirical Semivariogram

Number of Pairs	Distance (m)	Gamma
196	2,576	65.1
335	11,231	75.0
520	18,409	92.7
847	25,672	89.3
938	32,744	87.2
954	39,801	90.7



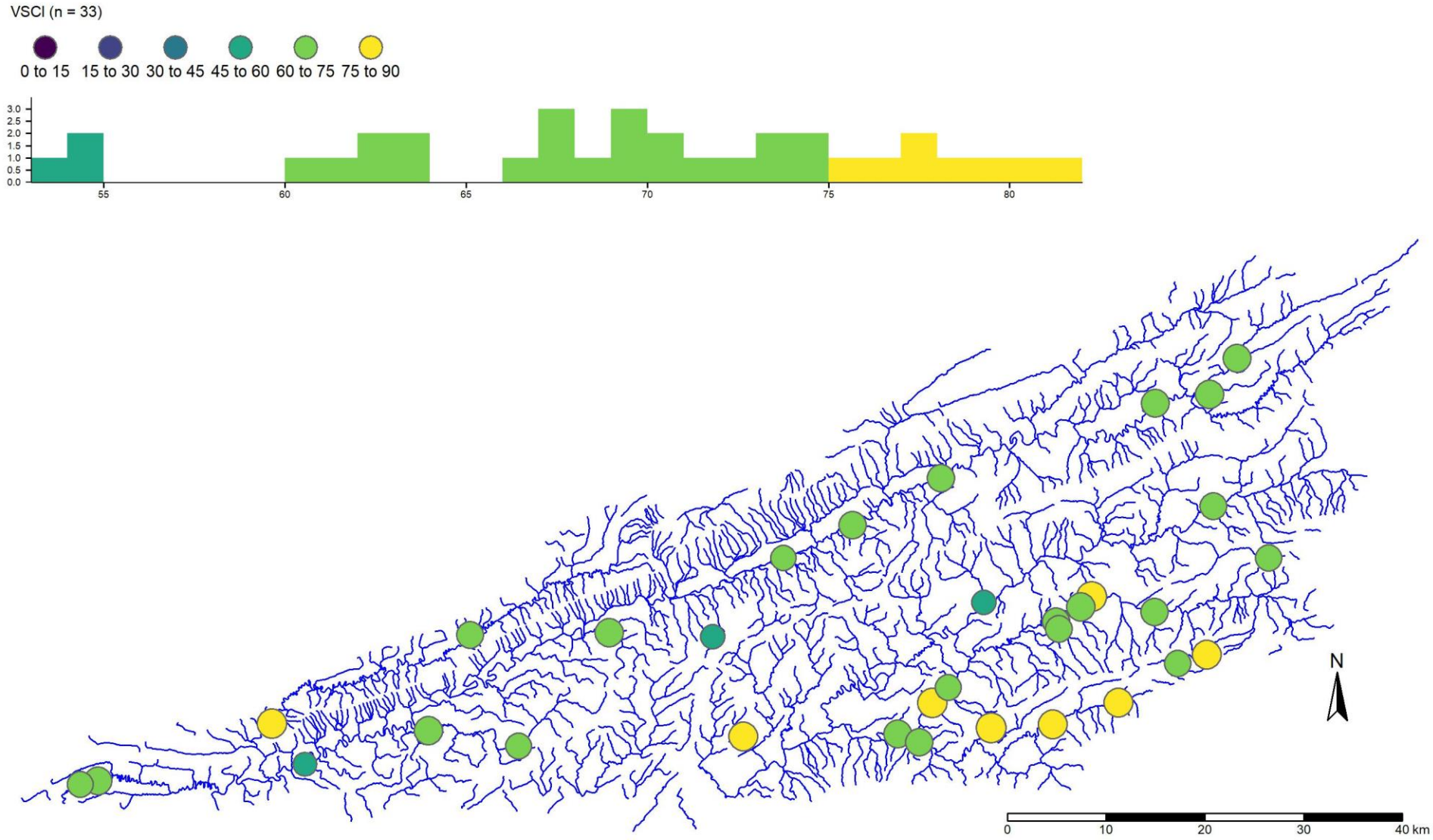
Complete Spatial Randomness

- Randomly select VSCI scores and assign to sites
- Calculate a semivariogram, plot as a gray line
- Repeat 99 times
- Compare empirical semivariogram to randomized semivariograms



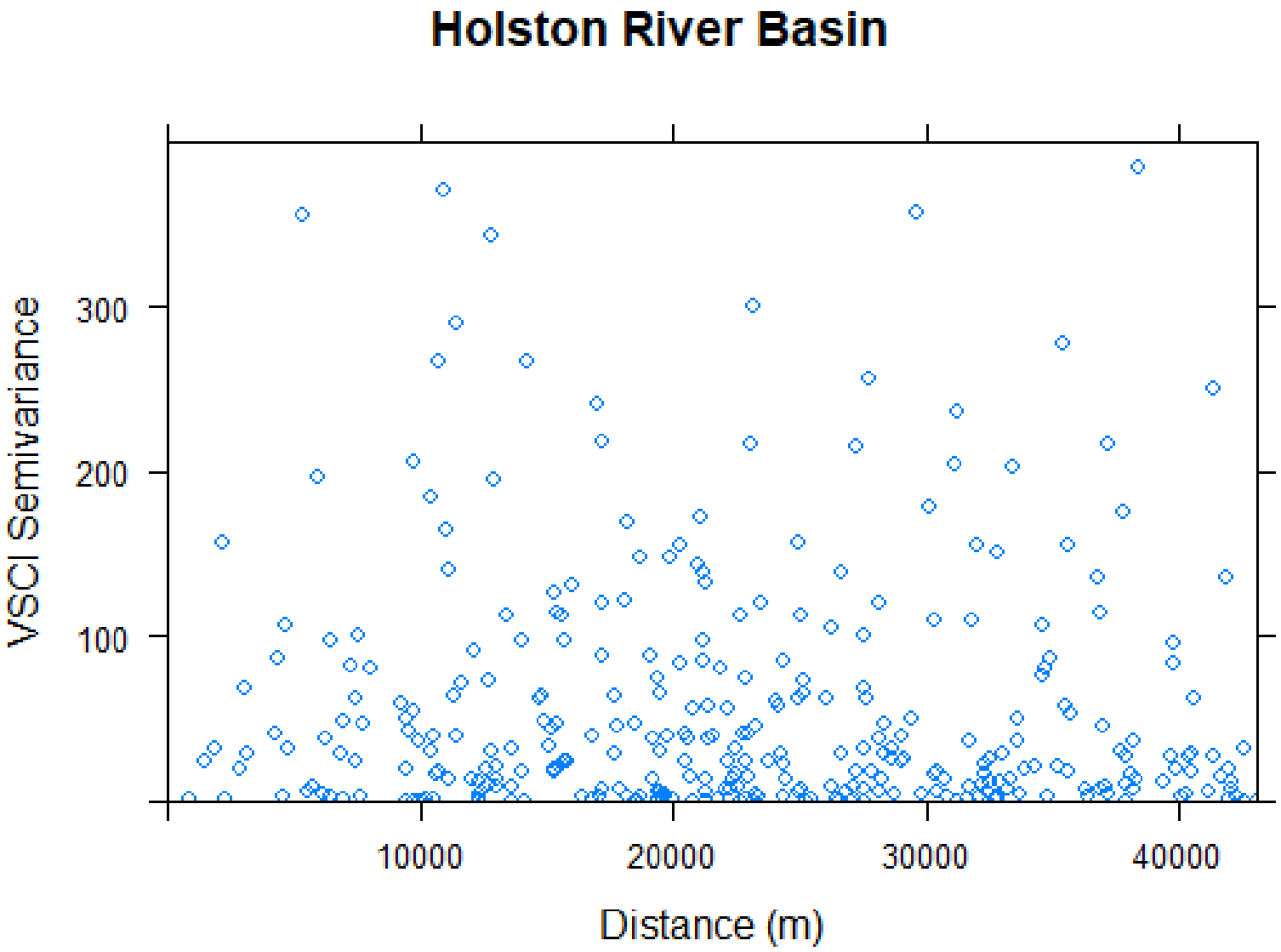
Strong Geostatistical Pattern

Holston River Basin



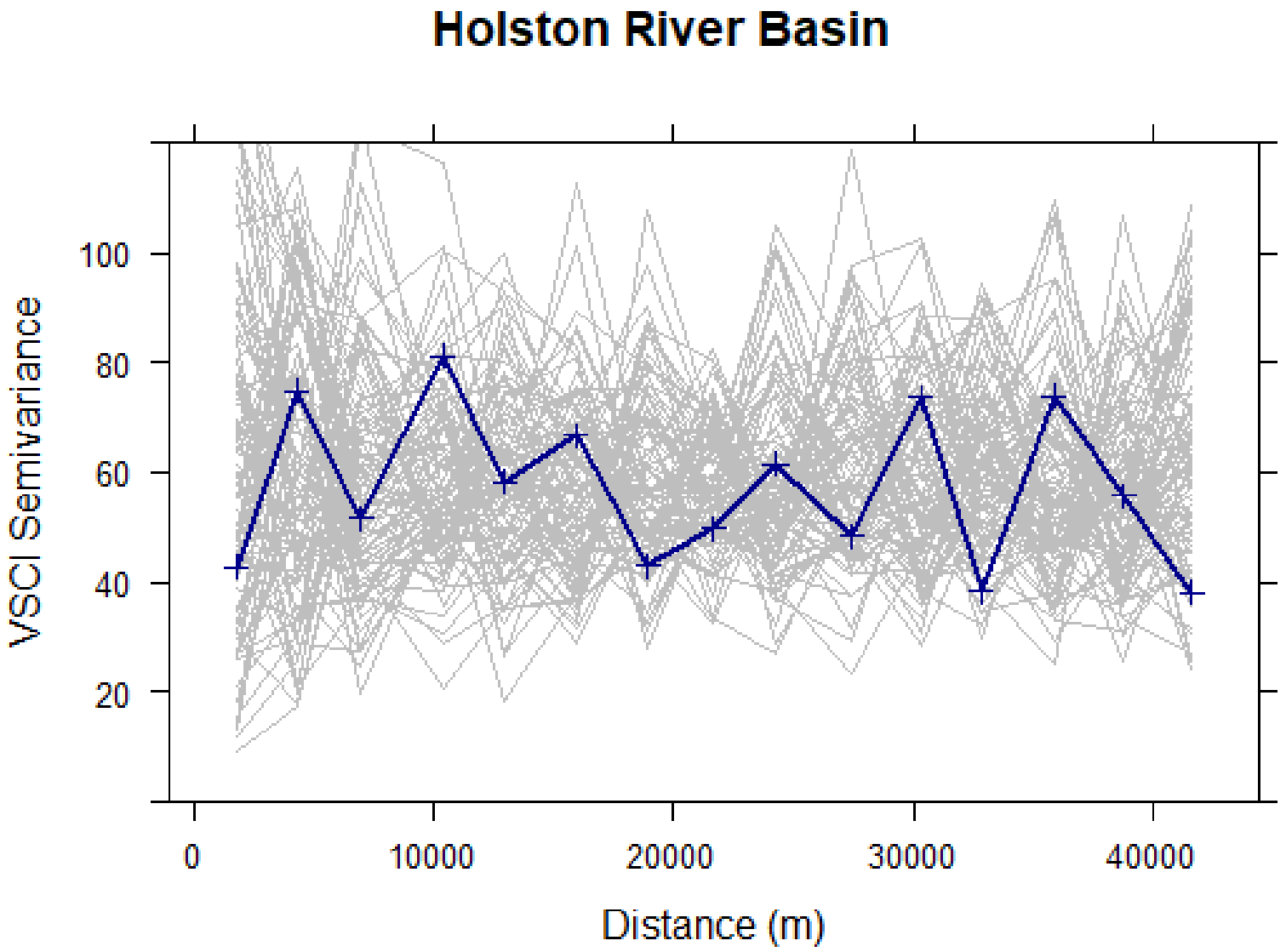
Distance & VSCI

	Distance (m)	SCI
Min	861	53.3
Q1	19,789	63.7
Median	33,497	69.8
Mean	42,059	69.4
Q3	60,217	75.0
Max	124,165	81.9



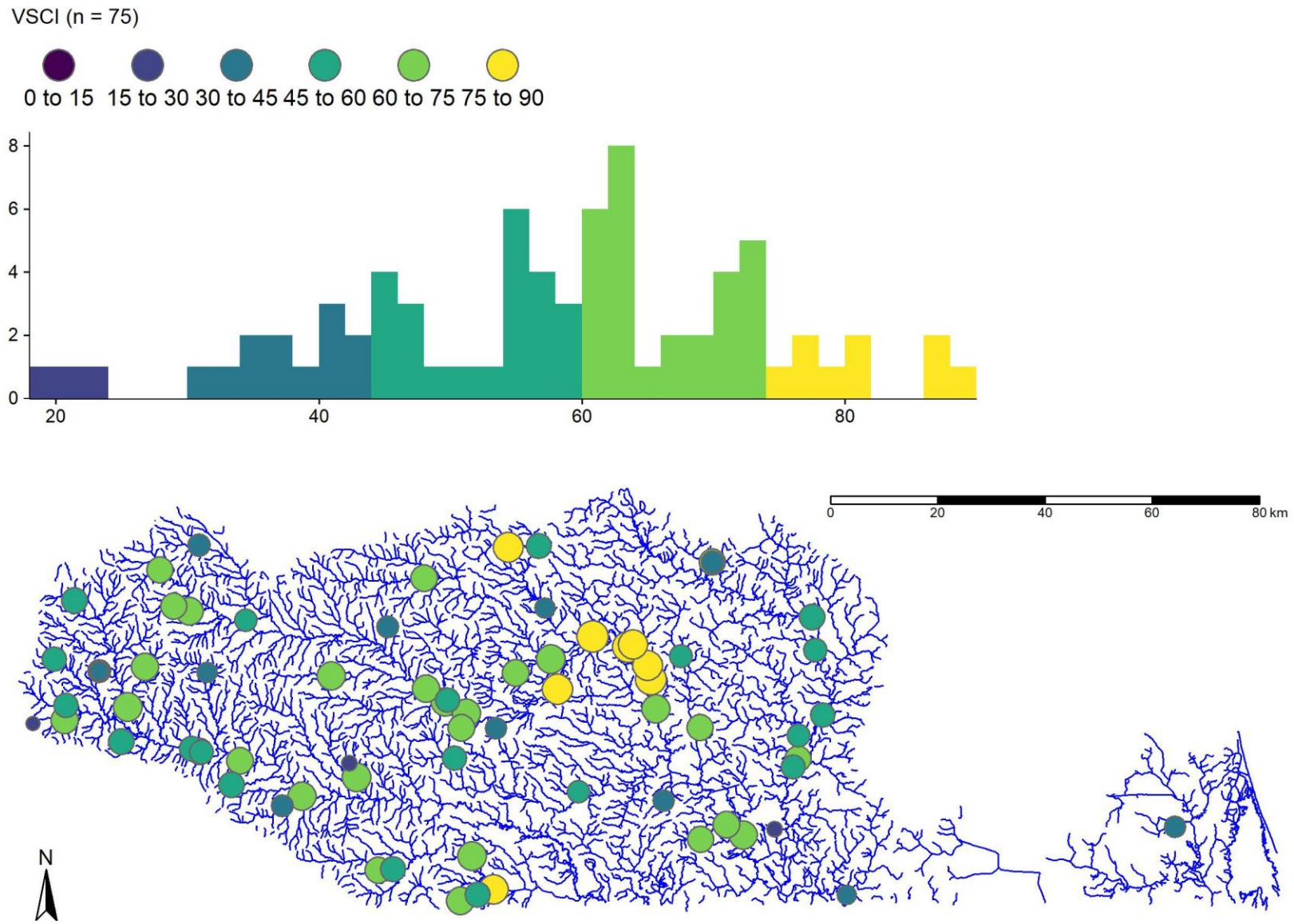
Empirical & Randomized Semivariograms

Number of Pairs	Distance (m)	Gamma
5	1,745	42.7
10	4,266	74.7
16	6,930	51.5
26	10,337	81.2
25	12,949	58.2
26	15,925	66.7



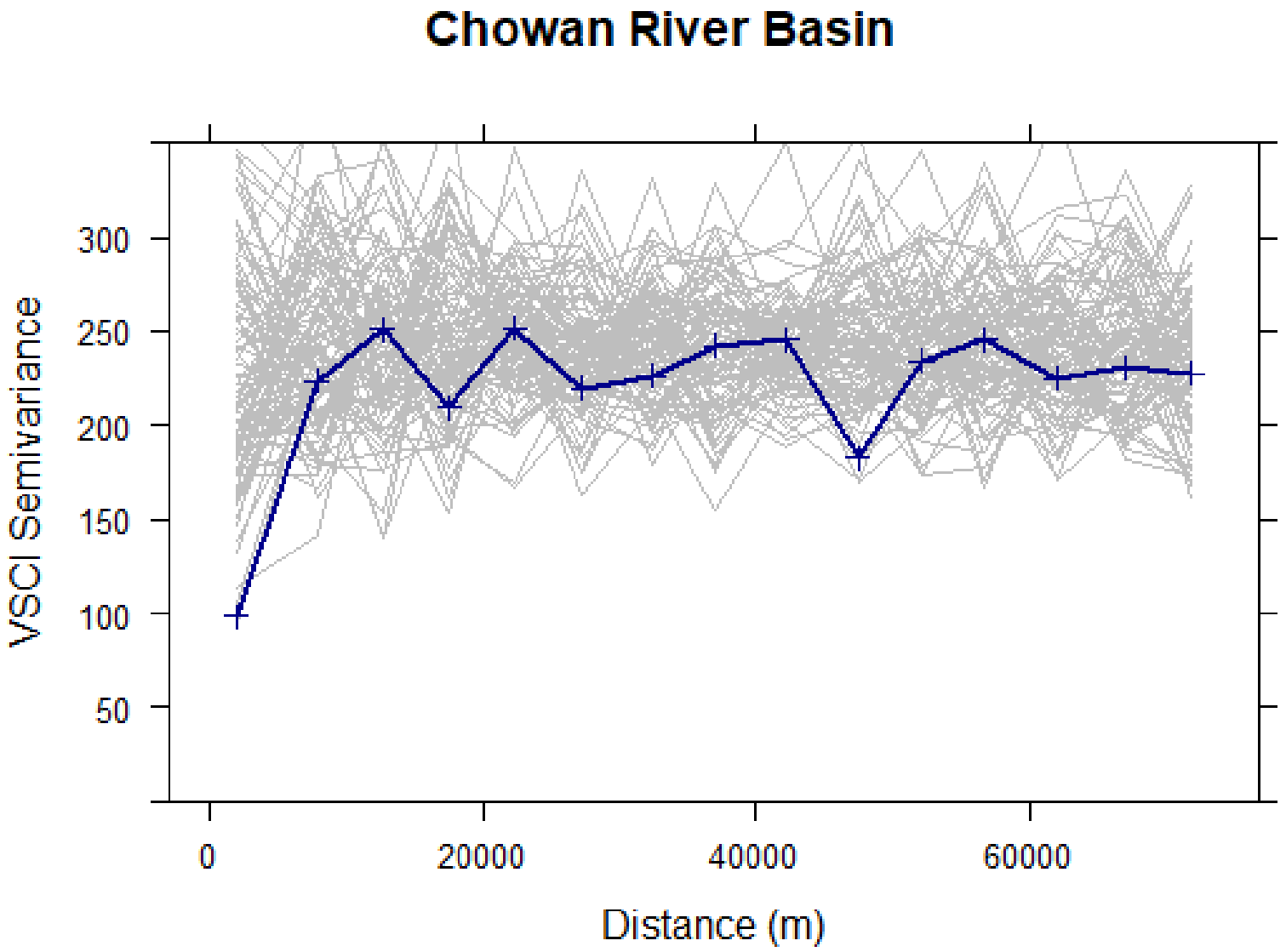
No Geostatistical Pattern

Chowan River Basin



Empirical & Randomized Semivariograms

Number of Pairs	Distance (m)	Gamma
36	1,945	98.5
72	7,827	223.3
83	12,654	251.2
96	17,539	209.6
149	22,315	251.6
155	27,245	219.4



Slight Geostatistical Pattern

Results: Hypothesis not Supported

Percent Reduction	Basin Name (n)	Geostatistical Pattern
52	York (51)	No
29	James (199)	Strong
27	Big Sandy (33)	No
27	Potomac (55)	Strong
27	Roanoke (174)	Strong
26	New (72)	Slight
14	Chowan (75)	Slight
13	Shenandoah (33)	No
10	Holston (33)	No
7	Clinch –Powell (39)	No
7	Rappahannock (42)	Slight

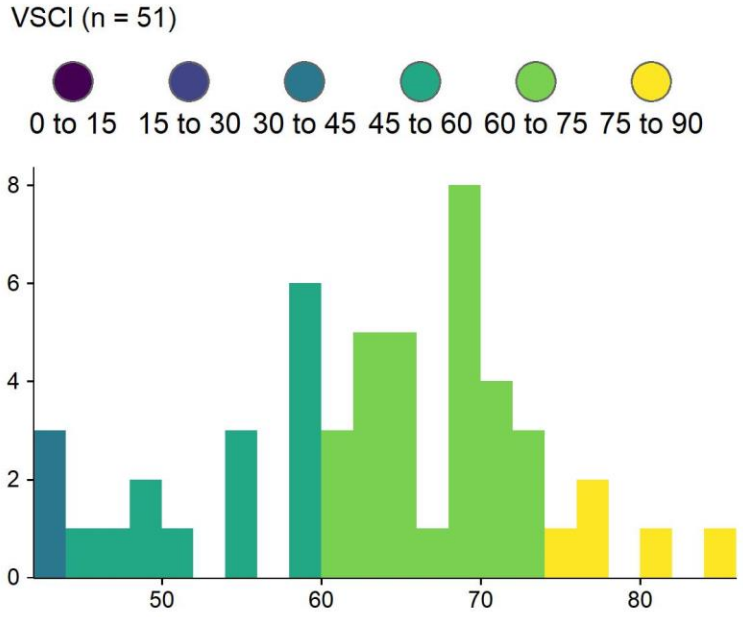
Different Constructions of Space

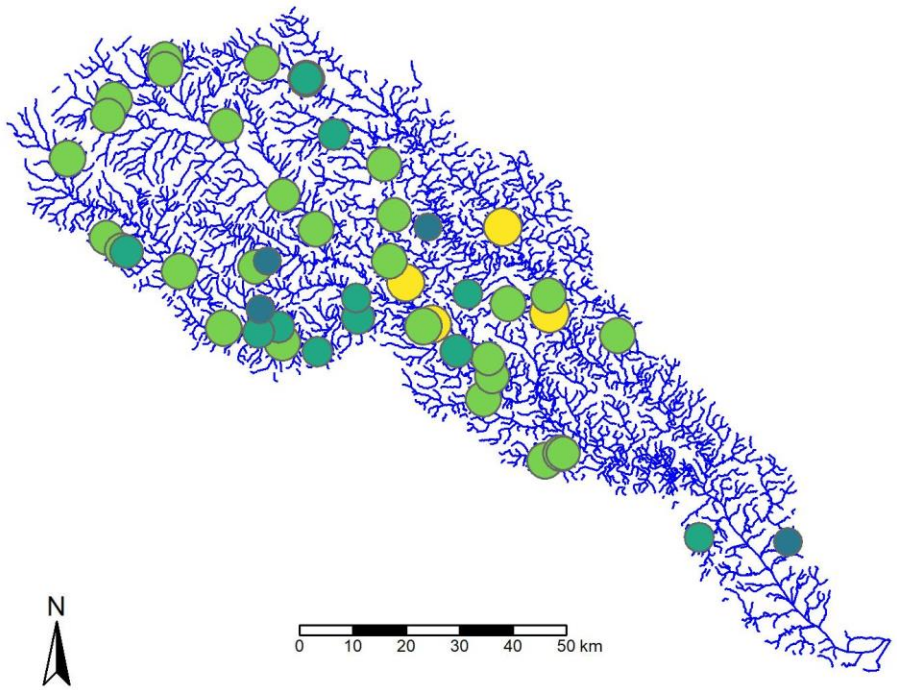
- Local neighborhood variance takes an incremental look at space as it using its three nearest neighbors, because of high density it does not have far to travel to get neighbors.

- Semivariogram works over Euclidean space at a larger spatial extent calculating all pairwise semivariances that then get binned and averaged for a particular lag distance and plotted.

- Should not expect concordance between the two approaches.

York River Basin: No Geostatistical Pattern





Cautions about Modeling Spatial Survey Data

- Model ignoring space
- Model incorporating space through Euclidean distances
- Model incorporating space through stream network distances

Conclusion

- 20 years ago Don Stevens and Tony Olsen provided the means whereby strong spatial patterns in survey data can be incorporated into survey estimates.

- However, as aquatic ecologists we need to understand why such patterns occur.

Acknowledgements

- Jason Hill and Emma Jones and field crews at Virginia Department of Environmental Quality