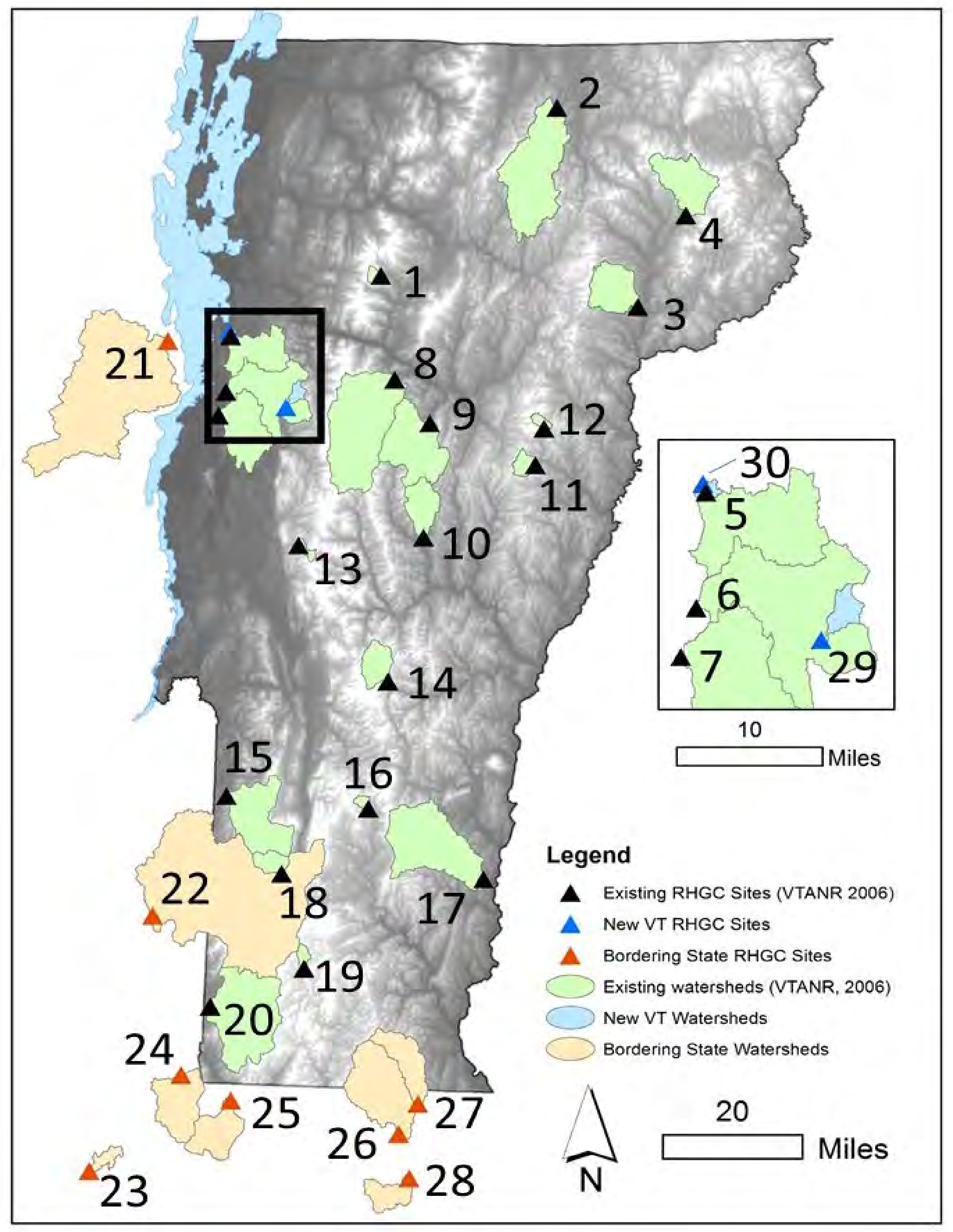
Leveraging High-Resolution LiDAR and Stream Geomorphic Assessment Datasets to Expand Regional Hydraulic Geometry Curves for Vermont

Kristen L. Underwood, Sienna Roberge, Donna M. Rizzo, Arne Bomblies
Department of Civil & Environmental Engineering, University of Vermont

Background & Project Need

In the decade since Regional Hydraulic Geometry Curves (RHGCs) were first developed for Vermont streams (Jaquith and Kline, 2006), new remote-sensing data have become available (including Light Detection and Ranging [lidar] data), and field-based stream geomorphic assessment (SGA) data have been collected for more than 1,500 miles of river. Our objective was to improve the RHGC's prediction of stream width, depth, and cross-sectional area using SGA data to expand the number of observations, and by exploring additional predictor variables to refine regression estimates and reduce uncertainty.

Increased Observation Sites Expand Coverage of RHGCs



With the addition of 10 new sites (Fig. 1), RHGCs have been expanded to cover drainage areas up to 396 (from 194) square miles (Fig. 2).

Figure 1 (left). Ten new observation sites include 2 (blue triangles) located in Vermont; and 8 (red triangles) located in bordering regions of Massachusetts and New York state. These complement 20 existing stations used in the original Vermont RHGCs (black triangles).

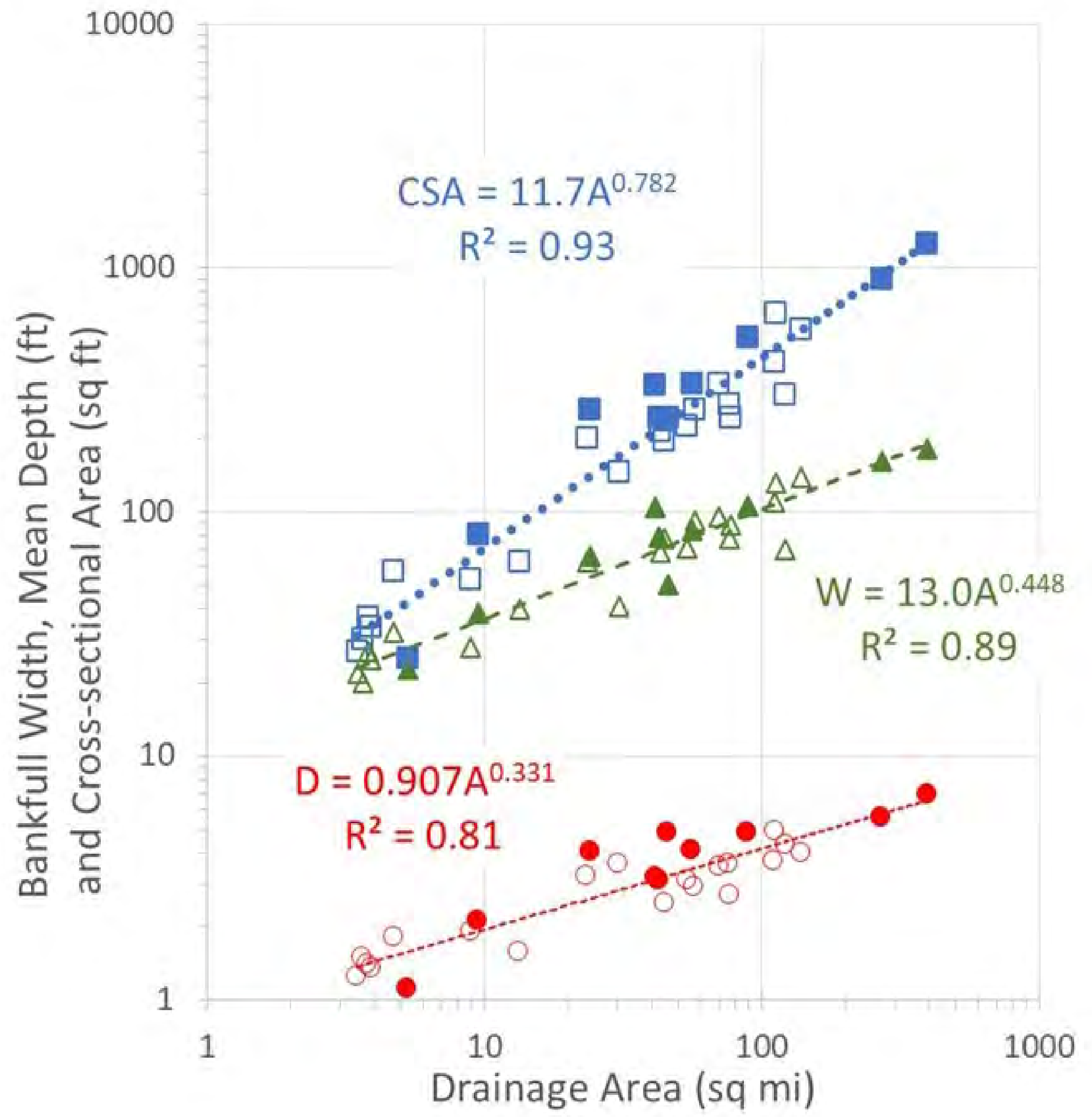


Figure 2 (right). 2021 RHGCs for Vermont streams, including bankfull cross-sectional area (CSA), bankfull width (W) and bankfull mean depth (D). Open symbols signify original sites; solid symbols reflect new data points. Trend lines are fit through all data (n=30).

Stratification by Slope Improves Performance

(A)

Linear Regression Model
Coefficient of Determination, R^2

Model	n	W	D	CSA
2001 RHGCs	14	0.78	0.59	0.85
2006 RHGCs	20	0.91	0.87	0.95
2021 RHGCs	30	0.89	0.81	0.93
2021 Slope Stratified RHGCs				
Slopes > 0.1%	23	0.95	0.81	0.92
Slopes ≤0.1%	7	0.89	0.72	0.96

(B)

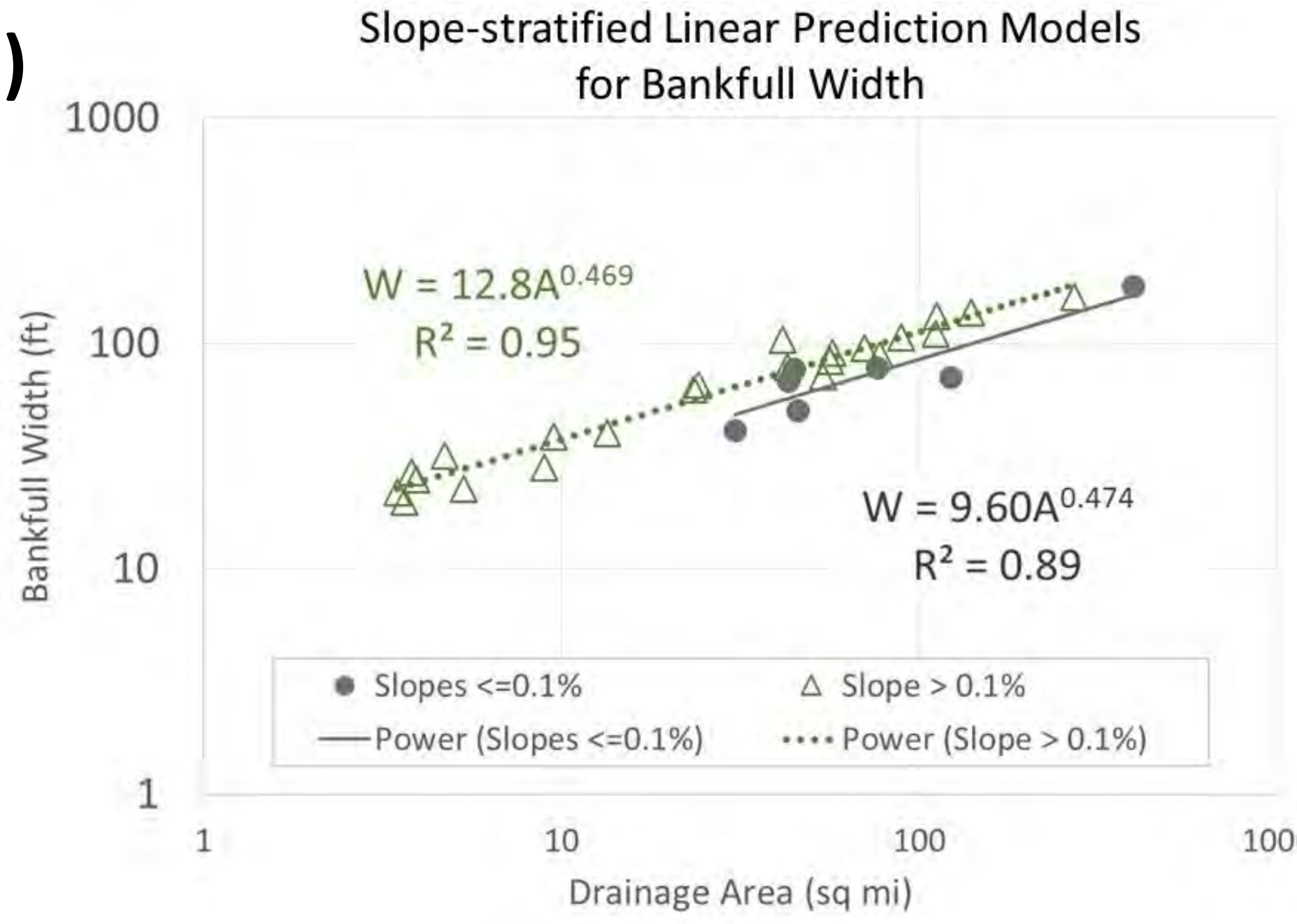


Figure 3. (A) An increasing proportion of the variation in bankfull width explained by drainage area is achieved when (B) stratifying the curves by channel slopes at a threshold of 0.1%.

Broader Impacts

Updated curves will be used to predict width, depth, and cross sectional area of the bankfull discharge (R.I. of Q1.5) to support flood-resilient sizing of stream crossing structures as well as embankment design for roads and rails that share narrow valleys with rivers. Geomorphically-compatible structures will have greater resilience to extreme flood events and will support aquatic organism passage objectives.

Acknowledgments

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