

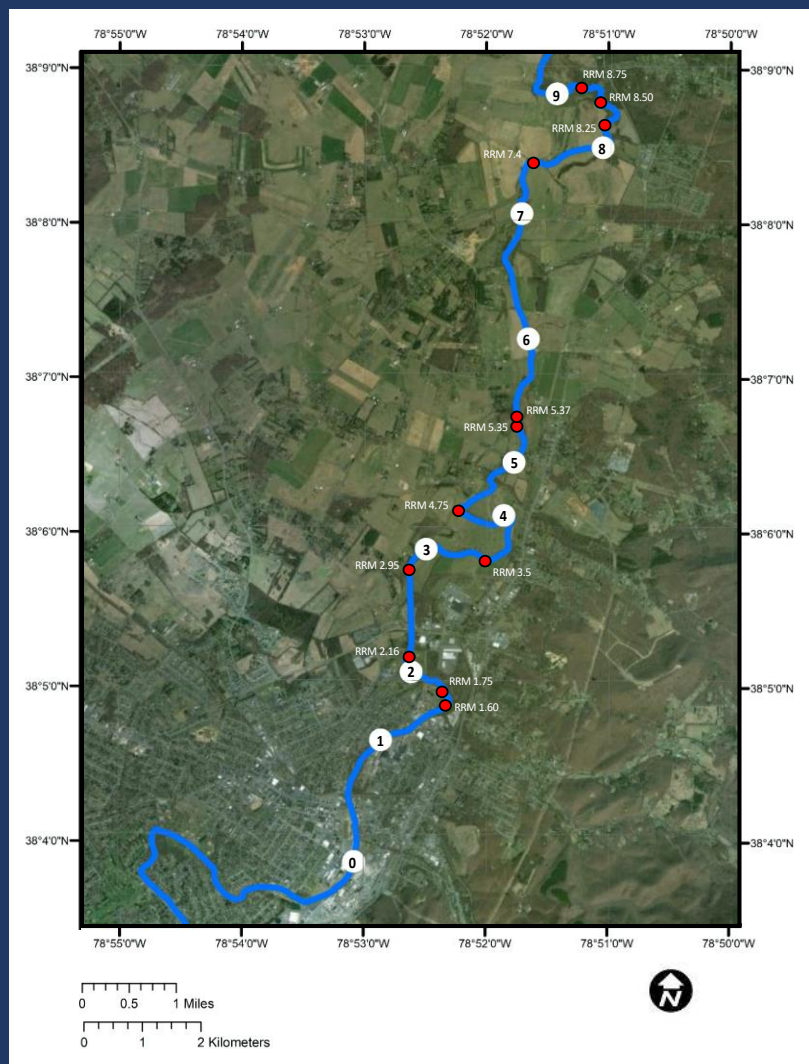
Bank Erosion Rates Determined From Terrestrial Laser Scanner Surveys (2006 to 2019)

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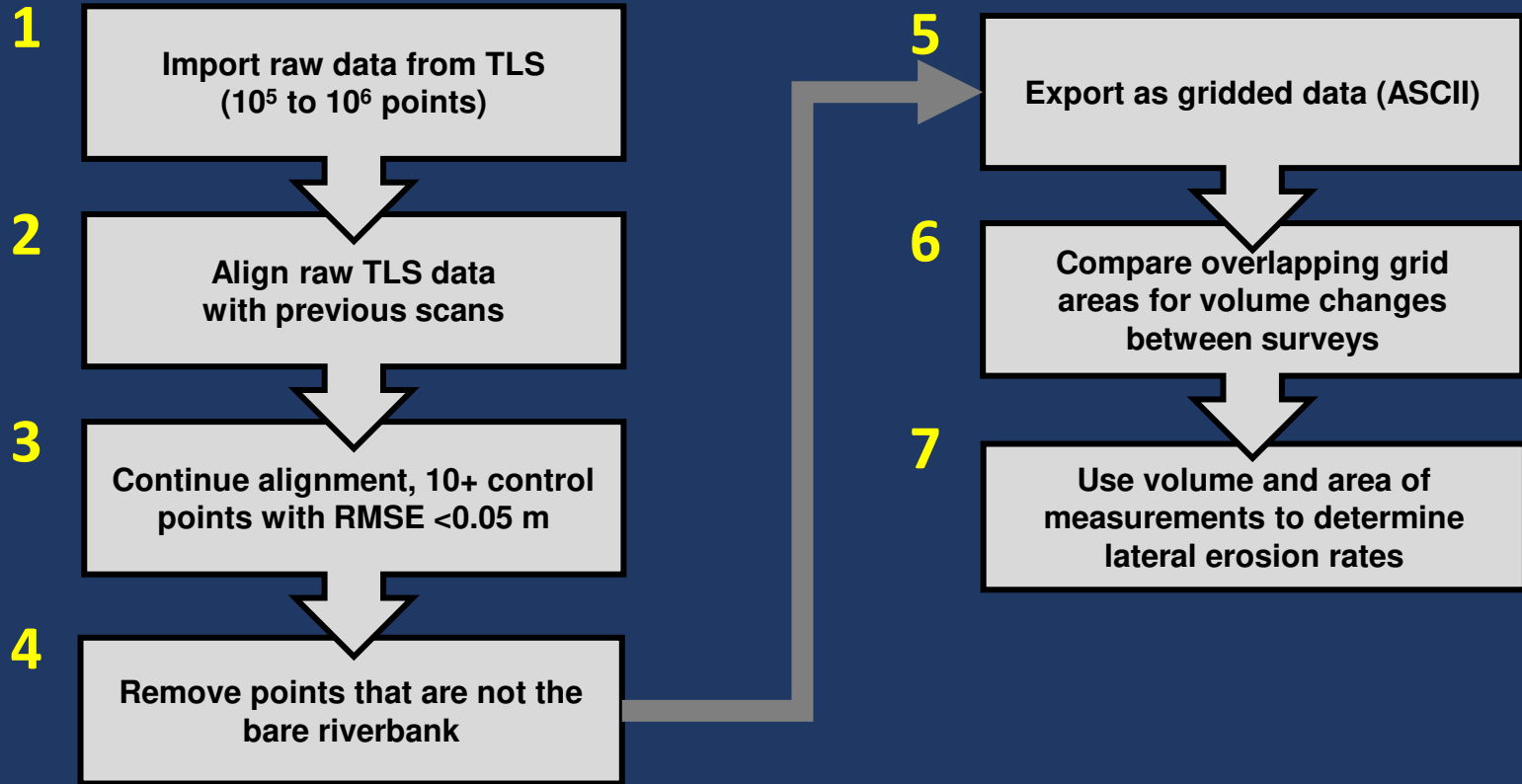
Resurvey all sites within the first 10 river miles that were scanned in 2006- 2007 and again in 2013-2014





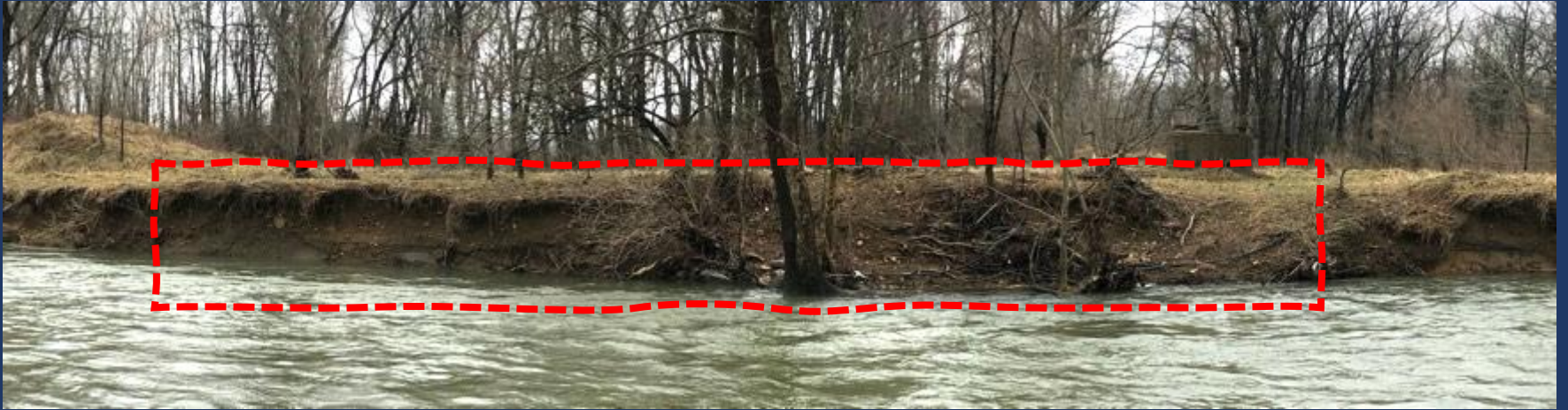


	Survey A 2006-7		Survey B 20013-14		Survey C 2019	
<i>River Mile</i>	<i>Scan Date</i>	<i>Points Measured</i>	<i>Scan Date</i>	<i>Points Measured</i>	<i>Scan Date</i>	<i>Points Measured</i>
1.6	2/16/07	1,836,487	12/19/13	252,992	3/2/19	161,496
1.75	2/16/07	454,581	12/19/13	796,219	3/2/19	576,146
2.16	11/21/06	427,922	4/23/14	168,557	4/27/19	533,425
2.95	3/27/07	1,496,250	4/23/14	714,377	4/28/19	530,560
3.5	4/26/07	997,469	4/23/14	716,744	4/28/19	288,955
4.75	6/5/07	1,254,327	N/A	N/A	4/28/19	323,523
5.35	4/27/07	431,927	12/20/13	63,930	4/28/19	272,647
5.37	9/20/06	1,404,934	12/20/13	598,723	4/28/19	232,713
7.4	3/28/07	351,476	4/24/14	378,724	4/29/19	391,232
8.25	3/28/07	1,540,959	4/24/14	338,811	10/7/19	328,293
8.5	3/28/07	1,427,894	4/24/14	284,457	10/7/19	759,388
8.75	3/29/07	877,105	4/24/14	284,780	10/7/19	488,086



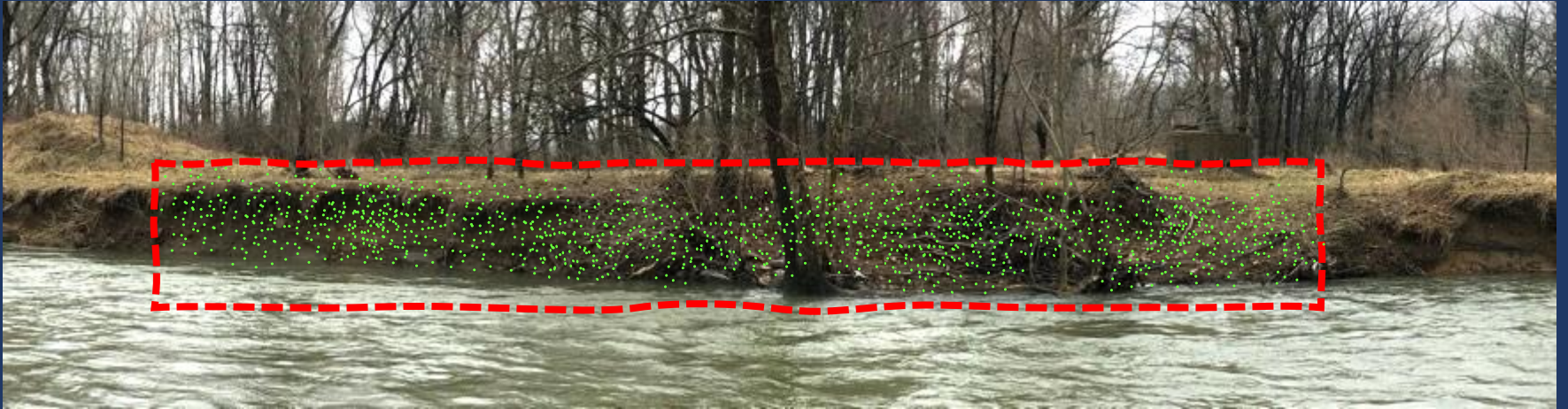
Example Difference Models

RRM 1.75



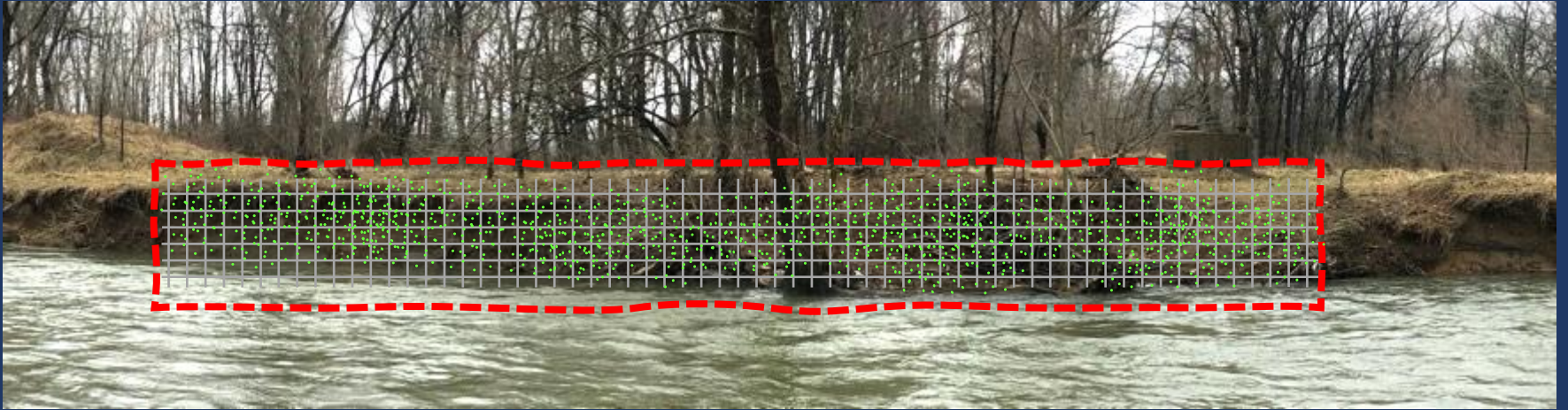
Example Difference Models

RRM 1.75



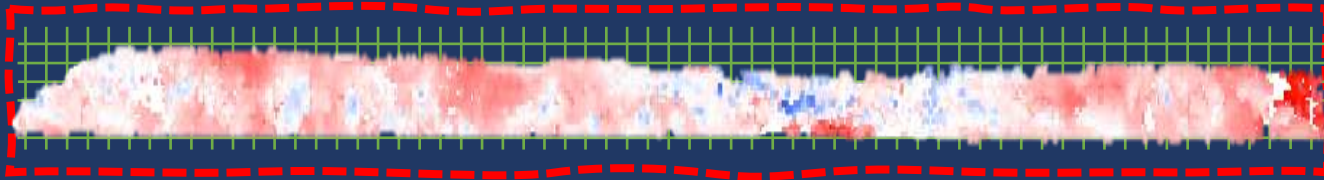
Example Difference Models

RRM 1.75

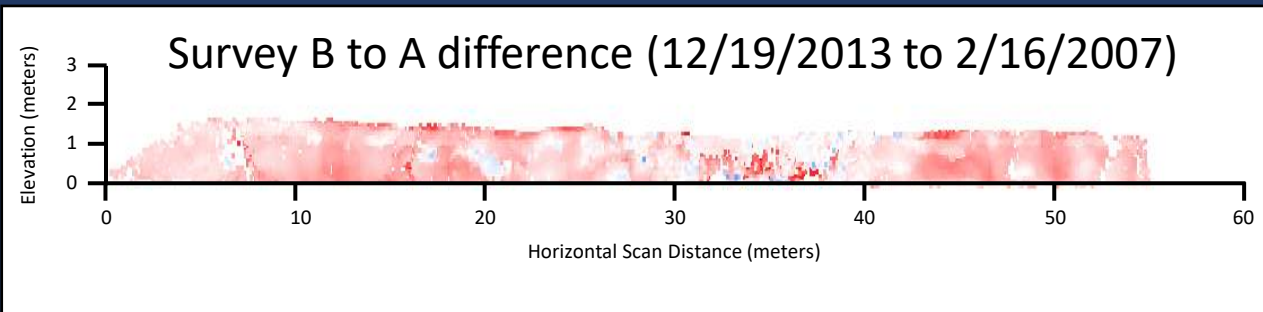
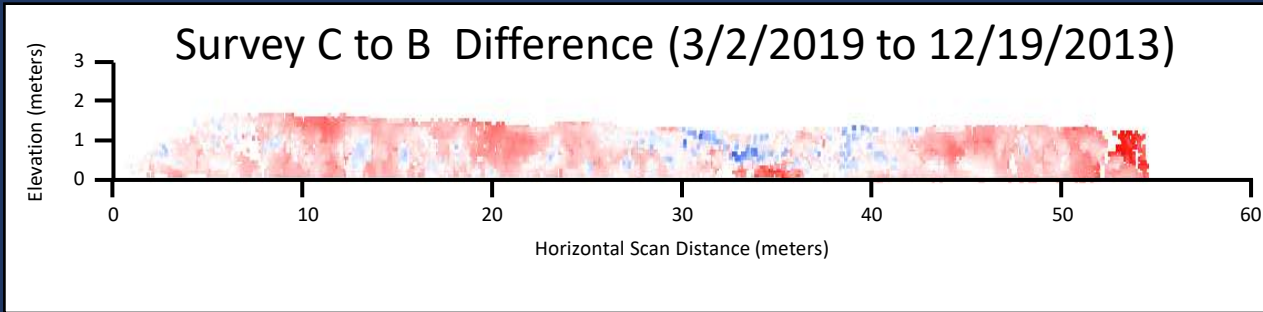
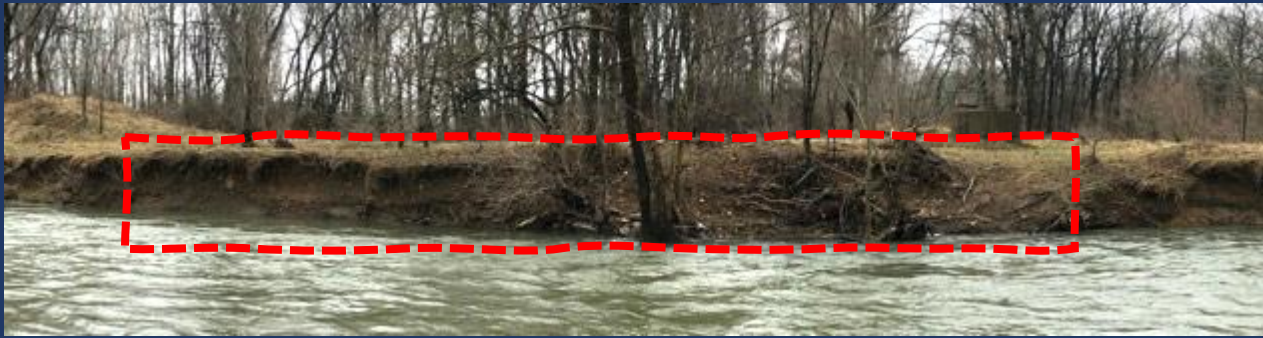


Example Difference Models

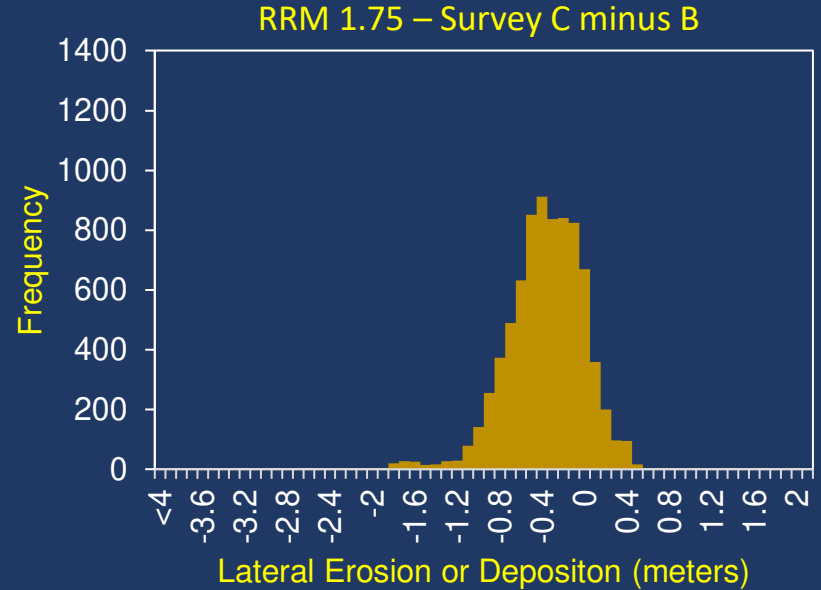
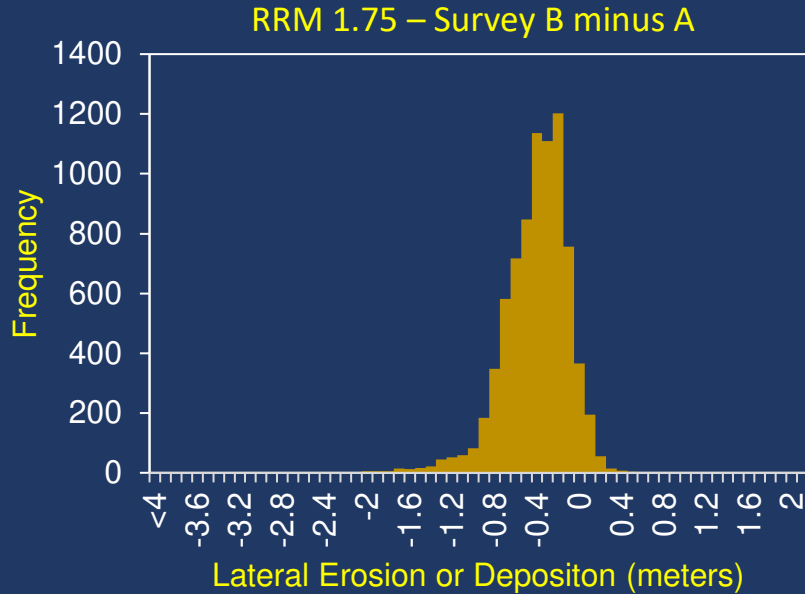
RRM 1.75



Example Difference Models @ RRM 1.75

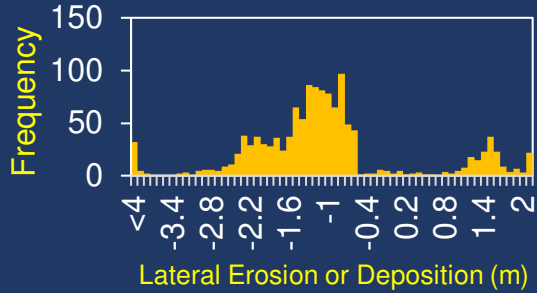


Frequency Histograms

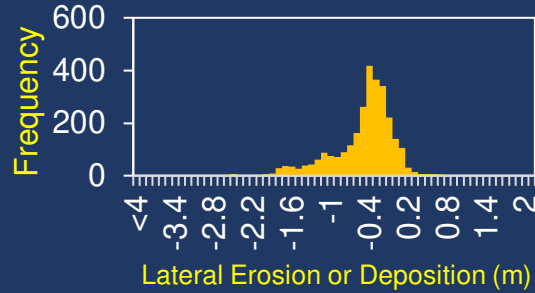


Frequency Histograms

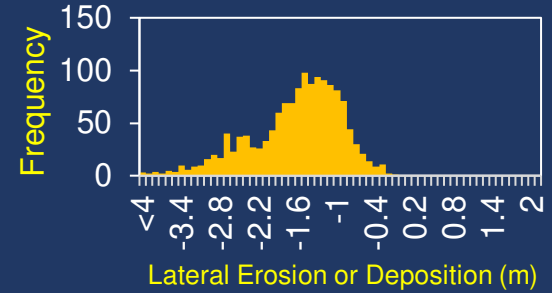
RRM 1.60 B minus A



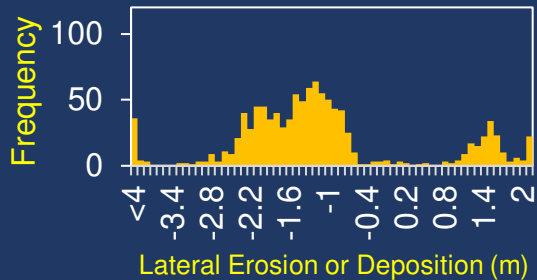
RRM 7.40 B minus A



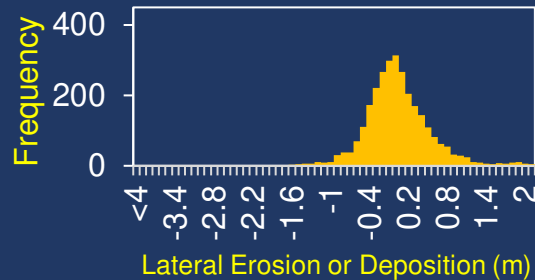
RRM 8.75 B minus A



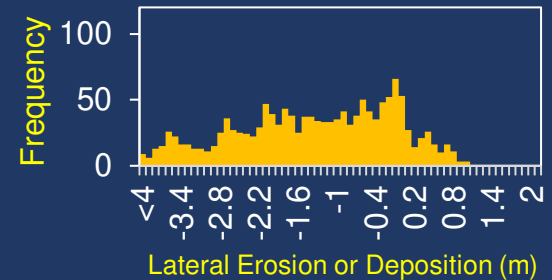
RRM 1.60 C minus B



RRM 7.40 C minus B



RRM 8.75 C minus B



2013-4 to 2006-7 Data Comparisons

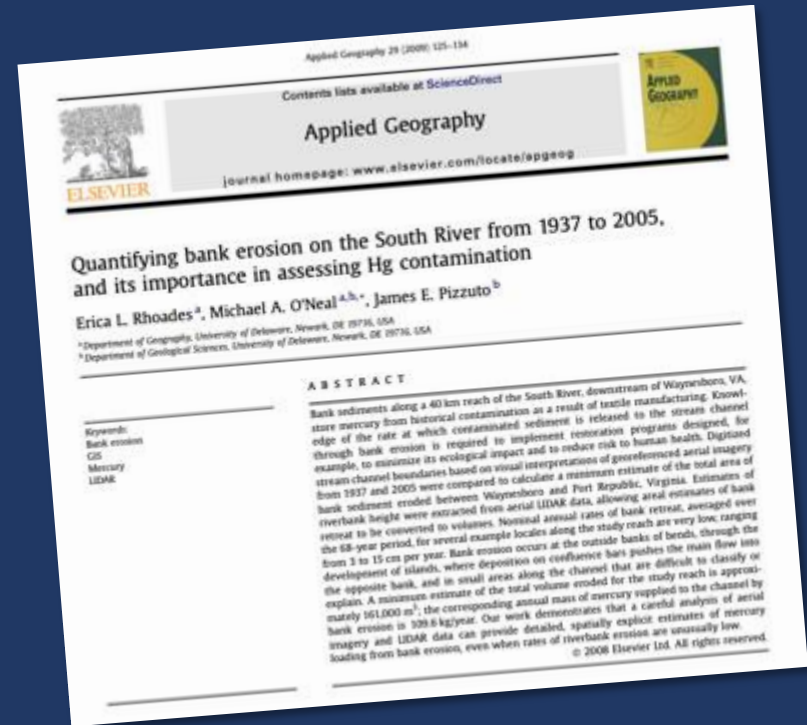
<i>River Mile</i>	<i>Scan Area (m²)</i>	<i>Volume Change (m³)</i>	<i>Added Volume</i>	<i>Removed Volume</i>
1.6	12.8	13.91	2.75	16.66
1.75	78.83	35.82	0.26	36.07
2.16	32.4	1.8	4.7	6.6
2.95	56.83	22.51	0.7	23.22
3.5	43.47	26.95	6.23	33.18
4.75	N/A	N/A	N/A	N/A
5.35	36	32.6	0.1	32.6
5.37	25.19	8.68	1.05	9.73
7.4	28.58	16.07	0.277	16.34
8.25	14.24	10.49	0.03	10.52
8.5	50.54	39.27	0.01	39.28
8.75	13.99	23.57	0	23.57

2019 to 2013-4 Data Comparisons

<i>River Mile</i>	<i>Scan Area (m²)</i>	<i>Volume Change (m³)</i>	<i>Added Volume</i>	<i>Removed Volume</i>
1.6	10.55	12.32	2.66	14.98
1.75	78.83	32.67	1.21	33.88
2.16	24.8	2.9	0.8	3.7
2.95	56.83	14.22	1.71	15.93
3.5	43.47	15.5	1.53	17.03
4.75	N/A	N/A	N/A	N/A
5.35	18.72	7.58	0.06	7.65
5.37	25.19	8.23	0.47	8.7
7.4	28.58	0.34	4.99	5.33
8.25	14.24	3.61	1.48	5.1
8.5	50.54	5.93	6.5	12.43
8.75	13.99	19.5	0.5	20

Lateral Erosion Rates Over Time

River Mile	C to B ($m^2 yr^{-1}$)	B to A ($m^2 yr^{-1}$)	1937-2005 ($m^2 yr^{-1}$)
1.6	0.22	0.16	0.25
1.75	0.08	0.07	0.29
2.16	0.02	0.01	0.05
2.95	0.05	0.06	0
3.5	0.07	0.09	0.07
4.75	* No B, C to A = 0.77		0.28
5.35	0.08	0.13	0
5.37	0.06	0.05	0
7.4	0.03	0.08	0.10
8.25	0.05	0.11	0.09
8.5	0.02	0.11	0.05
8.75	0.26	0.24	0.25



Key Points

1. Fidelity was more problematic than expected
2. Anthropogenic changes more dominant than natural ones
3. A few sites with large volumetric changes are the result of a change in bend geometry (RRM 1.6 & 4.5)
4. Generally, year-to-decadal erosion is 'noisy', but only on the 1 cm to 10 cm range
5. TLS determined erosion on the decadal scale starts to approximate values from photogrammetry using multidecadal datasets