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Earth Surface Dynamics
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*Supplement of*

# Coarse bedload routing and dispersion through tributary confluences

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### A: Study site topography and hydrology data

We measured cross sections at each seed reach corresponding to the placement of pressure transducers in the active channel. Cross sections were measured perpendicular to the flow direction from bankfull to bankfull at a point spacing of ~0.5-1 m. We placed cross sections as to capture the channel characteristics of the seed reaches where particle tracers were initially located. These cross sections were the basis of our calculations of I* and critical Shields number.

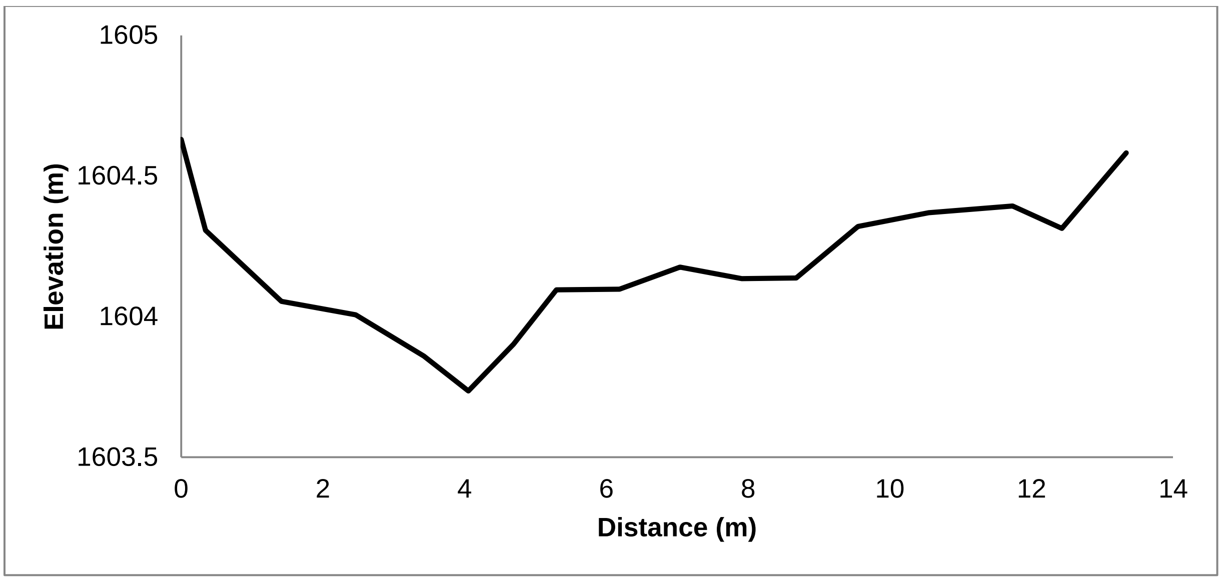


Figure S1: Moose Creek seed reach in the upper confluence.

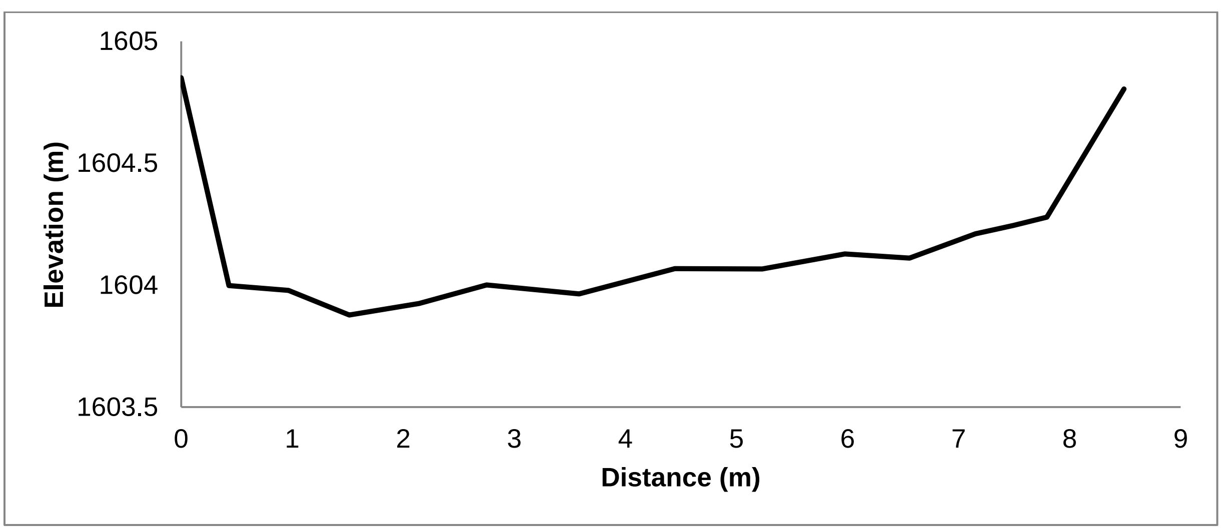

Figure S2: Martin Creek seed reach in the upper confluence.

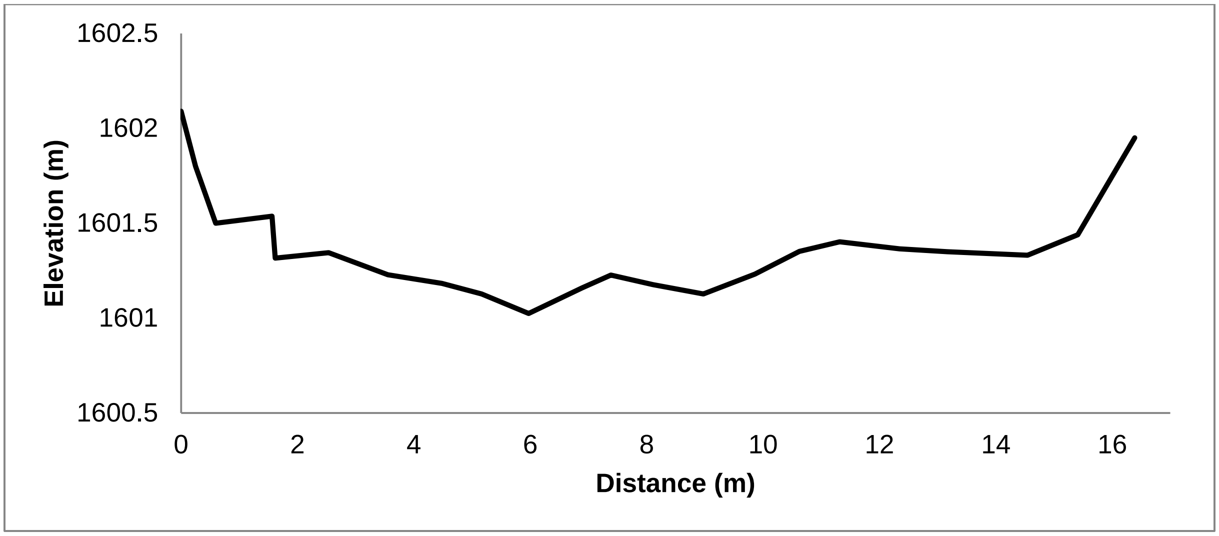


Figure S3: The control reach.

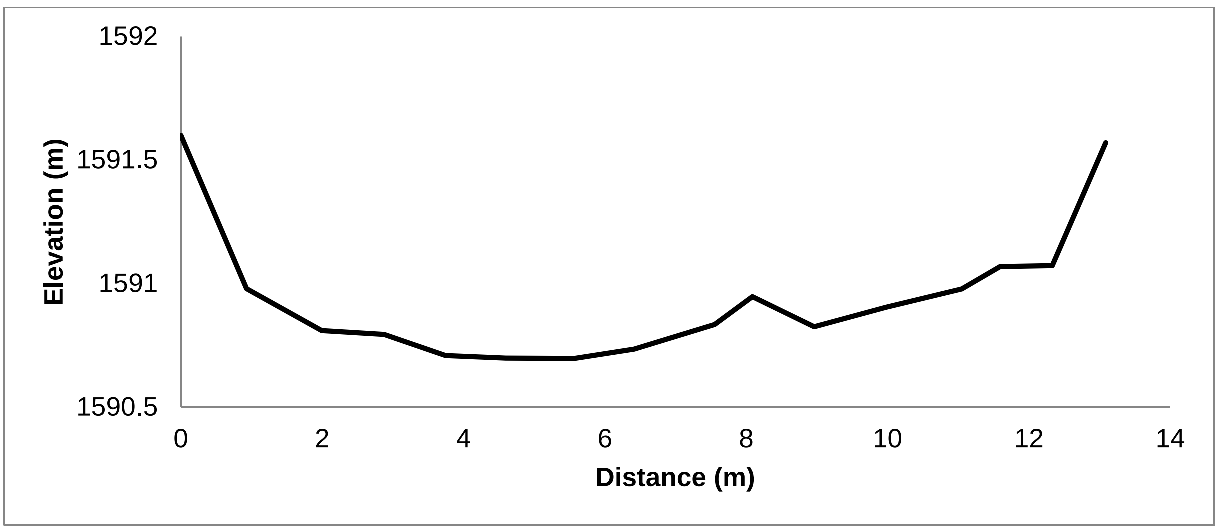


Figure S4: Martin Creek seed reach in the lower confluence.

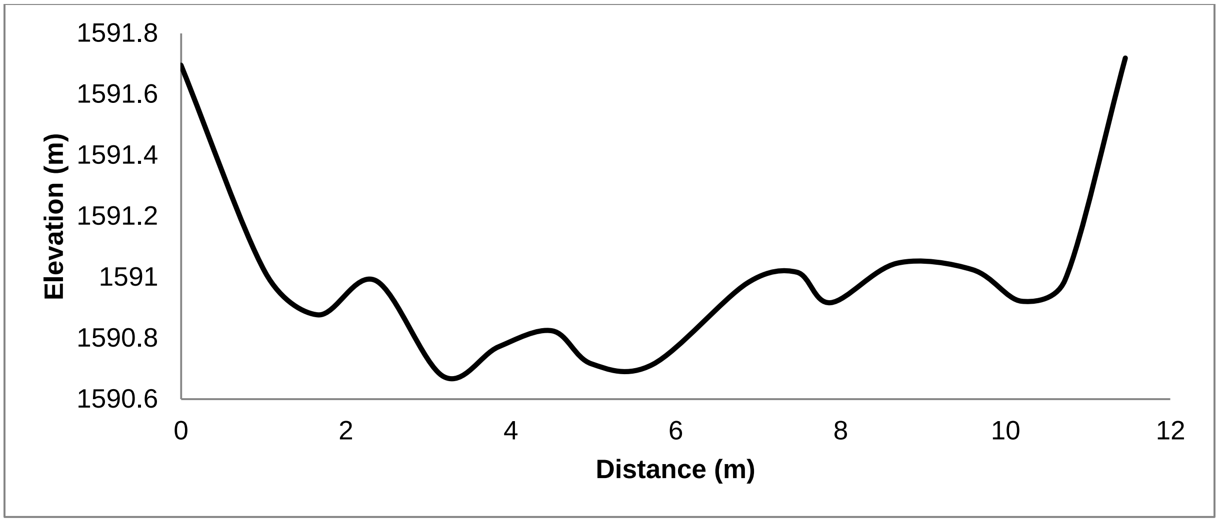


Figure S5: East Fork Bitterroot seed reach in the lower confluence.

We used transducer data at each study reach to produce flood hydrographs for each seed reach at the study site. Mueller et al. (2005) and Recking (2013) thresholds for incipient motion are indicated on each figure, as is the bankfull level.

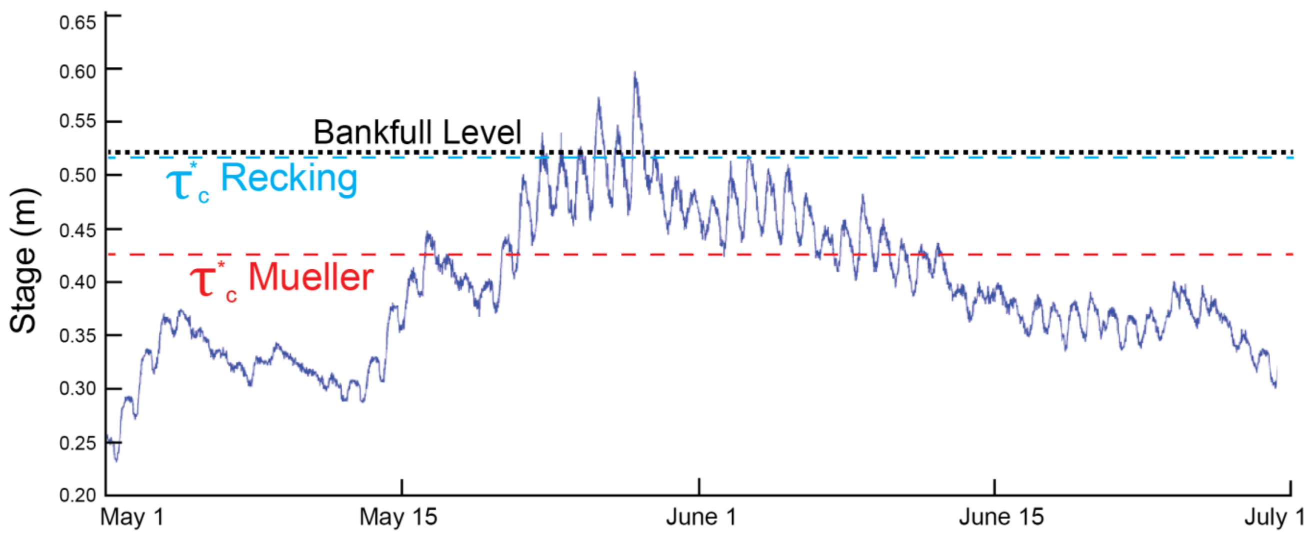


Figure S6: 2014 stage hydrograph at the Moose Creek (upper confluence) transducer.

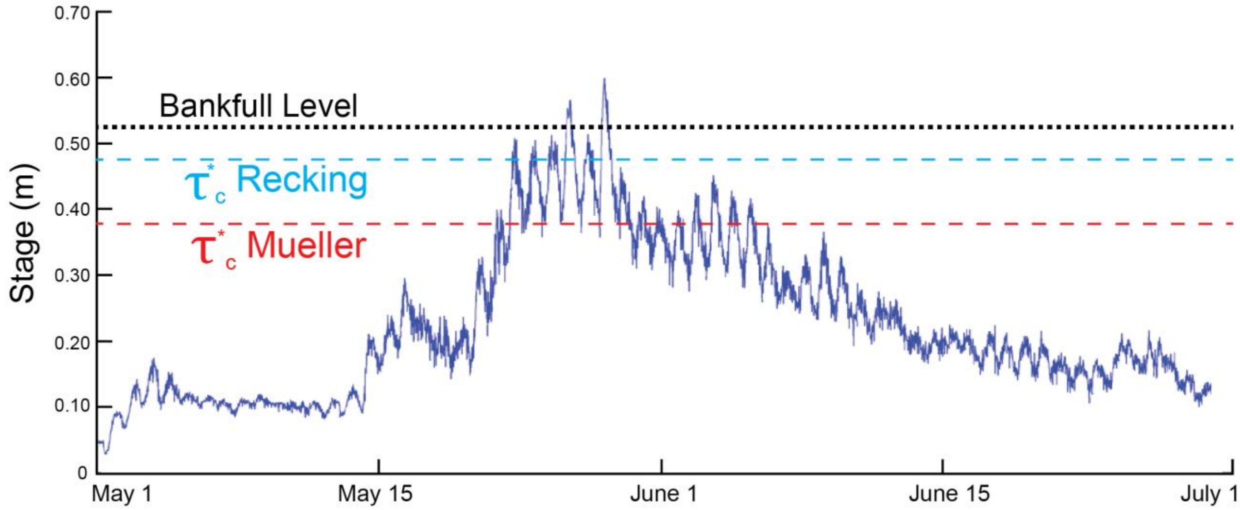


Figure S7: 2014 stage hydrograph at the Martin Creek (upper confluence) transducer.

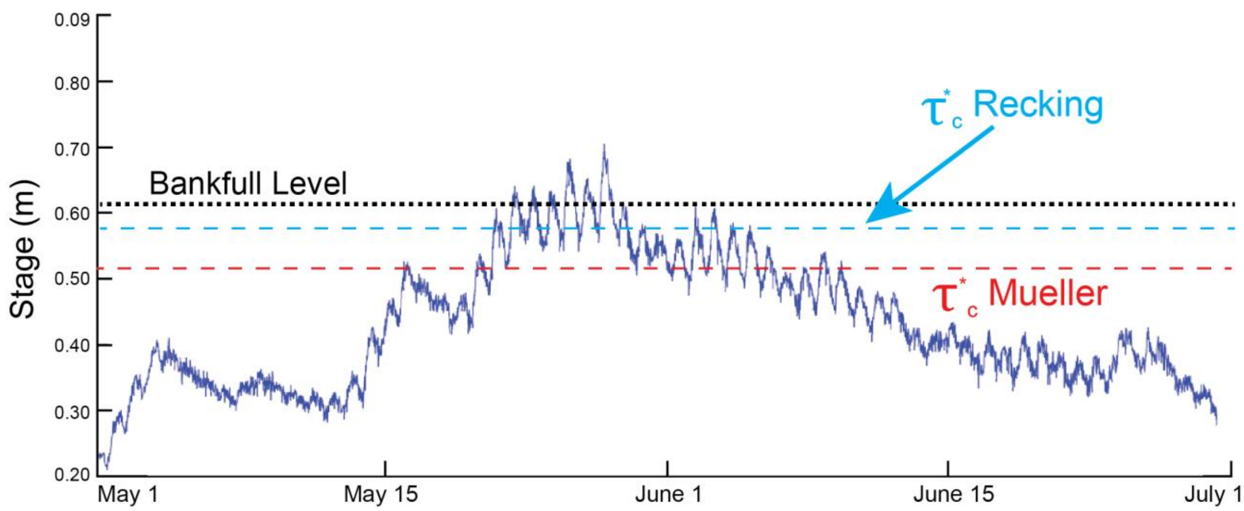


Figure S8: 2014 stage hydrograph at the control reach.

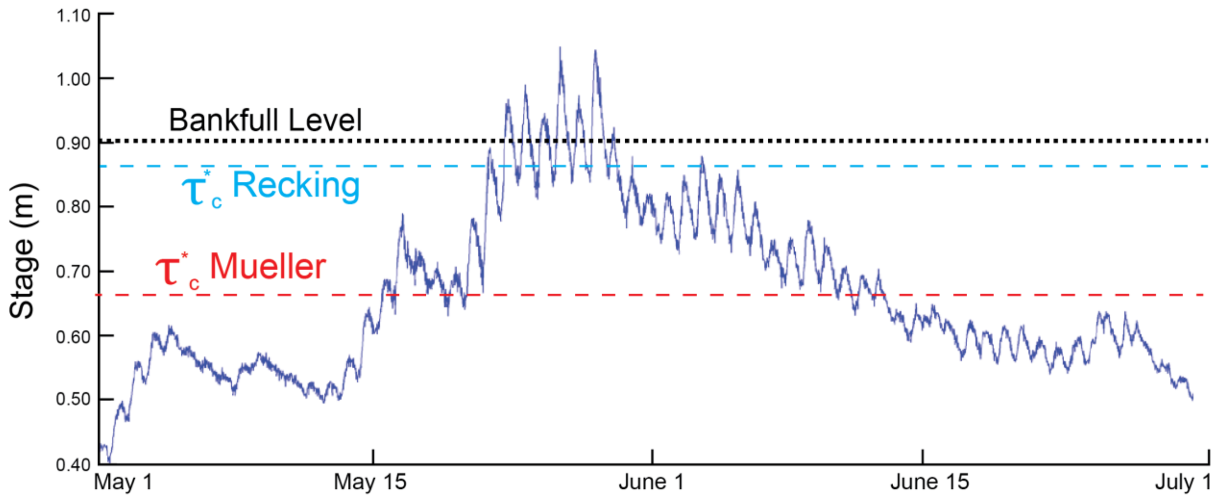


Figure S9: 2014 stage hydrograph at the Martin Creek (lower confluence) transducer.

## B: Tracer data

To transform total station-measured data of tracer displacement to streamwise transport distances, we employed open-source MATLAB code called "xy2sn." This code transforms spatial data from Cartesian coordinates to streamwise coordinates, with a downstream (s) and lateral (cross-channel, n) component. To determine the lateral component, we input a digitized stream centerline for each study reach, comprised of 15-20 points corroborated by field notes. This digitized centerline spanned the distance of tracer displacement in each study reach by ~10 m on both ends. We input the Cartesian coordinate data, entered in points of the centerline, and received transformed coordinate data for both pre and post-flood tracer locations at each reach. We then subtracted the streamwise distance of pre-flood tracers from their post-flood locations to compute transport distance downstream. In the rare cases that pre-flood streamwise distance exceeded post-flood distance (always occurring within the antenna measurement error), we considered the tracer stationary. Tables S1 and S2 show travel distances of recovered tracers for each study reach, with tag ID and b-axis included.

Table S1: Tracer data for the pre-flood survey (March 2014), in streamwise coordinates.

**Moose**

| Tag ID | Npos | Spos | Dist (m) | B (mm) |
|---|---|---|---|---|
| 91806 | 0.347871 | 0.142189 | 2.85 | 86 |
| 91821 | 2.613436 | 0.175178 | 3.55 | 80 |
| 91823 | -2.74345 | 0.152109 | 18.28 | 100 |
| 91827 | -1.10628 | 0.253458 | 3.41 | 101 |
| 91828 | -1.75281 | 0.11617 | 19.98 | 102 |
| 91834 | 2.029138 | 0.328281 | 1.76 | 85 |
| 91835 | 0.87074 | 0.182494 | 3.15 | 79 |
| 91836 | 0.485809 | 0.312603 | 5.7 | 64 |
| 91841 | -0.50899 | 0.144468 | 23.7 | 92 |
| 91843 | -2.54474 | 0.35372 | 12.31 | 85 |
| 91849 | -0.70138 | 0.369063 | 0 | 100 |
| 91859 | 0.63181 | 0.206109 | 9.8 | 98 |
| 91865 | 1.685904 | 0.097638 | 0.2 | 79 |
| 91868 | 1.115882 | 0.144123 | 3.74 | 56 |
| 91873 | 0.925781 | 0.377128 | 0.69 | 90 |
| 91874 | 2.579787 | 0.387635 | 0 | 86 |
| 91895 | -0.20559 | 0.070381 | 12.95 | 96 |
| 91903 | 0.043055 | 0.249637 | 2.74 | 104 |
| 91907 | -0.66348 | 0.284096 | 2.79 | 67 |
| 91908 | 1.259715 | 0.281014 | 0.71 | 108 |
| 91912 | -2.64999 | 0.217697 | 11.15 | 81 |
| 91914 | -1.25508 | 0.307678 | 6.67 | 127 |
| 91922 | -0.18497 | 0.175549 | 17.06 | 61 |
| 91928 | -2.36181 | 0.333267 | 11.46 | 83 |
| 91931 | 1.577886 | 0.202198 | 0 | 116 |
| 91932 | -1.08573 | 0.183216 | 24.5 | 72 |

| | | | | |
|---|---|---|---|---|
| 91933 | -1.0116 | 0.073397 | 0 | 126 |
| 91945 | 0.191063 | 0.280473 | 16.86 | 114 |
| 91947 | 2.225698 | 0.29073 | 4.01 | 63 |
| 91949 | -2.05637 | 0.187514 | 12.6 | 84 |
| 91950 | -2.15992 | 0.307369 | 17.01 | 92 |
| 91956 | -0.24266 | 0.310036 | 3.62 | 62 |
| 91965 | -0.34251 | 0.203649 | 7.83 | 119 |
| 91970 | -1.79743 | 0.154154 | 12.97 | 76 |
| 91972 | 2.848032 | 0.247538 | 0.44 | 96 |
| 91995 | -2.06504 | 0.279536 | 14.53 | 106 |
| 92007 | 2.038426 | 0.357057 | 9.95 | 92 |
| 92020 | 2.629909 | 0.205983 | 0 | 106 |
| 92023 | 1.998442 | 0.25204 | 6.21 | 69 |
| 92052 | -1.28277 | 0.334488 | 7.41 | 67 |
| 92053 | 0.07675 | 0.105907 | 7.38 | 67 |
| 92055 | -1.38497 | 0.145761 | 14.39 | 85 |
| 92063 | 3.712752 | 0.204877 | 0 | 87 |
| 92066 | 0.81126 | 0.064915 | 0.41 | 84 |
| 92092 | 1.240442 | 0.320425 | 3.53 | 88 |
| 92093 | 0.407138 | 0.340504 | 5.35 | 108 |
| 92095 | -0.46274 | 0.339865 | 12.77 | 70 |
| 92102 | -2.30538 | 0.256231 | 13.2 | 98 |
| 505514 | 1.119101 | 0.345753 | 5.78 | 76 |
| 505528 | 2.88587 | 0.29758 | 1.36 | 73 |
| 505539 | -1.58891 | 0.21266 | 3 | 73 |
| 505587 | -1.642 | 0.356303 | 11.96 | 94 |
| 505596 | 3.677135 | 0.175887 | 0 | 61 |



| **Mart_Up** | | | | |
|---|---|---|---|---|
| | | | **Dist** | |
| **Tag ID** | **Npos** | **Spos** | **(m)** | **B (mm)** |

| | | | | |
|---|---|---|---|---|
| 91805 | -1.18719 | 0.366912 | 6.23 | 109 |
| 91807 | -0.2186 | 0.15831 | 3.42 | 73 |
| 91824 | -0.10247 | 0.244096 | 0 | 86 |
| 91825 | -2.29226 | 0.240954 | 3.87 | 97 |
| 91837 | 0.384815 | 0.26385 | 1.49 | 82 |
| 91844 | 0.118965 | 0.222598 | 2.3 | 85 |
| 91846 | 1.817712 | 0.168724 | 2.82 | 80 |
| 91853 | -1.21065 | 0.22081 | 0.84 | 83 |
| 91864 | 1.534454 | 0.36401 | 0 | 94 |
| 91879 | 1.48499 | 0.223299 | 0 | 104 |
| 91891 | -0.99591 | 0.158764 | 0.62 | 96 |
| 91897 | 1.292956 | 0.075429 | 11 | 69 |
| 91900 | 1.620956 | 0.287724 | 3.83 | 100 |
| 91901 | -0.42546 | 0.227927 | 8.38 | 93 |
| 91906 | 0.502415 | 0.320518 | 1.18 | 112 |
| 91911 | 1.988038 | 0.249434 | 1.91 | 91 |
| 91915 | -0.24941 | 0.097927 | 4.52 | 80 |
| 91934 | -1.55962 | 0.295468 | 0.46 | 77 |
| 91943 | -1.01983 | 0.118911 | 6.83 | 63 |
| 91953 | -0.44861 | 0.192508 | 1.54 | 99 |
| 91957 | -1.98316 | 0.163515 | 0.38 | 85 |
| 91978 | 1.315128 | 0.153137 | 6.08 | 65 |
| 91999 | -1.41616 | 0.099571 | 2.13 | 96 |
| 92008 | 0.44748 | 0.157352 | 1.69 | 72 |
| 92010 | 0.45916 | 0.184033 | 5.44 | 72 |
| 92027 | -0.8391 | 0.066071 | 20.67 | 83 |
| 92043 | -1.89738 | 0.262797 | 5.48 | 71 |
| 92054 | 0.88396 | 0.263813 | 0 | 75 |
| 92078 | 1.905724 | 0.263589 | 5.83 | 83 |
| 92082 | 0.210165 | 0.392073 | 4.98 | 73 |
| 92096 | -1.18581 | 0.32383 | 0.26 | 70 |

| | | | | |
|---|---|---|---|---|
| 505500 | 1.858562 | 0.150735 | 6.39 | 51 |
| 505504 | 0.942786 | 0.393802 | 4.38 | 74 |
| 505508 | -1.14672 | 0.259422 | 0.62 | 48 |
| 505512 | 1.353207 | 0.314726 | 7.7 | 89 |
| 505513 | -0.47801 | 0.280437 | 0.55 | 83 |
| 505550 | -1.6467 | 0.200699 | 0 | 61 |
| 505553 | 0.648034 | 0.06137 | 3.92 | 84 |
| 505568 | -1.80318 | 0.117501 | 11.17 | 94 |
| 505573 | -2.10789 | 0.22256 | 10.01 | 69 |
| 505586 | -0.66964 | 0.395081 | 0 | 66 |
| 505598 | -2.24663 | 0.203937 | 0.79 | 75 |

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**Control**

| **Tag ID** | **Npos** | **Spos** | **Dist (m)** | **B (mm)** |
|---|---|---|---|---|
| 91812 | 6.242331 | 0.172297 | 0.74 | 112 |
| 91822 | 2.288752 | 0.175454 | 13.29 | 73 |
| 91838 | -5.21323 | 0.199262 | 0 | 73 |
| 91842 | 0.351121 | 0.043198 | 1.64 | 106 |
| 91845 | 6.056943 | 0.095899 | 0.7 | 77 |
| 91847 | -4.20195 | 0.129688 | 0.66 | 87 |
| 91848 | -1.15284 | 0.111054 | 8.48 | 90 |
| 91854 | 7.25586 | 0.113613 | 2.19 | 65 |
| 91862 | -0.89323 | 0.069074 | 4.71 | 63 |
| 91870 | -3.33846 | 0.143647 | 2.03 | 113 |
| 91878 | 5.428543 | 0.008826 | 0.28 | 104 |
| 91881 | 5.332243 | 0.157948 | 2.9 | 99 |
| 91885 | -1.6546 | 0.072082 | 8.19 | 80 |
| 91887 | 1.56427 | 0.170958 | 14.28 | 61 |
| 91888 | -2.17945 | 0.075708 | 16.69 | 84 |
| 91893 | 3.655599 | 0.117982 | 9.08 | 80 |

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|---|---|---|---|---|
| 91898 | 4.006979 | 0.095106 | 4.94 | 70 |
| 91904 | -4.49714 | 0.088934 | 0.37 | 84 |
| 91913 | 4.195602 | 0.019427 | 0.56 | 72 |
| 91916 | -5.082 | 0.179459 | 1.34 | 63 |
| 91921 | 1.082968 | 0.188328 | 0.68 | 86 |
| 91924 | -4.2694 | 0.112633 | 1.1 | 83 |
| 91926 | 3.494922 | 0.157823 | 5.75 | 76 |
| 91930 | -2.59657 | 0.143647 | 2.53 | 74 |
| 91946 | -2.77146 | 0.172007 | 0 | 75 |
| 91959 | -3.74222 | 0.085332 | 0.85 | 85 |
| 91960 | 0.257218 | 0.192349 | 0.58 | 125 |
| 91964 | -0.9496 | 0.088858 | 4.56 | 108 |
| 91977 | 5.746844 | 0.035957 | 9.41 | 90 |
| 91979 | 1.293594 | 0.034377 | 11.04 | 95 |
| 91980 | 3.057424 | 0.20039 | 7.22 | 88 |
| 91991 | 7.018058 | 0.083119 | 0.64 | 93 |
| 91993 | 0.005751 | 0.081093 | 22.39 | 101 |
| 92003 | 2.468248 | 0.037926 | 3.8 | 112 |
| 92004 | 3.011124 | 0.014172 | 2.71 | 88 |
| 92009 | -0.31305 | 0.187927 | 18.51 | 62 |
| 92011 | 2.425993 | 0.213048 | 3.02 | 93 |
| 92012 | 2.541386 | 0.099443 | 2.9 | 90 |
| 92014 | -0.83511 | 0.131634 | 0 | 83 |
| 92026 | 5.339401 | 0 | 0 | 106 |
| 92030 | 1.162246 | 0.206704 | 1.02 | 90 |
| 92032 | -1.90012 | 0.097388 | 4.17 | 110 |
| 92036 | 5.05439 | 0.205028 | 0.44 | 80 |
| 92042 | -0.03752 | 0.20693 | 8.3 | 78 |
| 92046 | -4.29668 | 0.14639 | 0 | 96 |
| 92048 | 4.461366 | 0.156192 | 9.78 | 80 |
| 92050 | -1.73908 | 0.169109 | 2.95 | 84 |

| | | | | |
|---|---|---|---|---|
| 92051 | 2.089909 | 0.187298 | 0.27 | 108 |
| 92057 | -4.32479 | 0.189194 | 0.71 | 97 |
| 92076 | 3.18917 | 0.095734 | 11.17 | 79 |
| 92086 | 4.001639 | 0.203783 | 1.03 | 82 |
| 505403 | 1.753948 | 0.101087 | 1.14 | 119 |
| 505415 | 0.701398 | 0.049349 | 0.41 | 118 |
| 505426 | 2.274472 | 0.026101 | 0.68 | 116 |
| 505430 | -1.76789 | 0.122863 | 4.72 | 111 |
| 505432 | 0.534506 | 0.172163 | 6.5 | 107 |
| 505444 | -0.20259 | 0.110436 | 0.85 | 110 |
| 505450 | -4.65177 | 0.069074 | 0 | 136 |
| 505453 | 3.668802 | 0.071886 | 2.99 | 106 |
| 505462 | -1.1411 | 0.183668 | 7.65 | 116 |
| 505464 | -3.23588 | 0.126553 | 0.64 | 114 |
| 505476 | -3.05394 | 0.202321 | 0.78 | 109 |
| 505477 | -0.74928 | 0.208205 | 0 | 122 |
| 505480 | 1.688456 | 0.049156 | 8.22 | 105 |
| 505486 | -2.31134 | 0.0554 | 3.08 | 127 |
| 505487 | 4.270355 | 0.228424 | 1.09 | 112 |
| 505501 | -3.18945 | 0.184213 | 3.93 | 53 |
| 505507 | 4.109607 | 0.003644 | 0 | 83 |
| 505530 | -2.06484 | 0.207409 | 10.43 | 80 |
| 505535 | 1.520339 | 0.119924 | 13.68 | 71 |
| 505536 | 3.315041 | 0.030921 | 1.17 | 87 |
| 505546 | -2.04358 | 0.181668 | 0.38 | 86 |
| 505554 | 2.530991 | 0.11633 | 13.86 | 55 |
| 505555 | -1.76694 | 0.141589 | 5.15 | 96 |
| 505562 | 4.726006 | 0.114483 | 0 | 90 |
| 505564 | -4.68609 | 0.169067 | 0 | 63 |
| 505575 | 4.59321 | 0.055968 | 0 | 90 |
| 505577 | -1.41627 | 0.050951 | 1.4 | 101 |

| | | | | |
|---|---|---|---|---|
| 505578 | 1.472548 | 0.078042 | 2.7 | 88 |
| 505579 | -3.66187 | 0.172695 | 0 | 95 |
| 505582 | 0.731063 | 0.105147 | 22.71 | 76 |
| 505592 | 5.024893 | 0.081746 | 3.09 | 71 |
| 505599 | 7.11762 | 0.170051 | 0.69 | 75 |

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**Mart_Lo**

| **Tag ID** | **Npos** | **Spos** | **Dist (m)** | **B (mm)** |
|---|---|---|---|---|
| 91975 | -0.87994 | 0.090752 | 0.91 | 118 |
| 91976 | 0.21253 | 0.103514 | 0 | 92 |
| 91981 | -0.38033 | 0.110382 | 0 | 118 |
| 91994 | 0.283111 | 0.128573 | 1.89 | 87 |
| 91997 | 1.264003 | 0.092874 | 4.74 | 91 |
| 92000 | 2.635628 | 0.091249 | 0.34 | 90 |
| 92001 | 0.121602 | 0.124659 | 10.79 | 98 |
| 92017 | 0.501803 | 0.096951 | 0.53 | 73 |
| 92031 | 0.896232 | 0.113737 | 14.52 | 70 |
| 92037 | -1.23992 | 0.050148 | 0 | 85 |
| 92058 | -1.02252 | 0.076035 | 10.13 | 75 |
| 92059 | -1.73387 | 0.088785 | 13.99 | 110 |
| 92060 | 1.334197 | 0.054954 | 0 | 134 |
| 92077 | -1.38088 | 0.118536 | 1.14 | 77 |
| 92081 | -0.17425 | 0.039033 | 10.02 | 80 |
| 92084 | 2.636988 | 0.042531 | 7.67 | 101 |
| 92100 | -0.81014 | 0.08144 | 1.04 | 110 |
| 92104 | 2.357163 | 0.081854 | 29.42 | 106 |
| 505400 | 0.513401 | 0.116196 | 1.27 | 93 |
| 505401 | 0.060495 | 0.109875 | 1.7 | 88 |
| 505402 | 0.171348 | 0.081243 | 62.06 | 96 |
| 505404 | -0.0373 | 0.049765 | 54.58 | 76 |

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|---|---|---|---|---|
| 505405 | 2.646222 | 0.095809 | 0.88 | 116 |
| 505410 | -2.13631 | 0.055247 | 0.38 | 91 |
| 505411 | -0.59393 | 0.097357 | 11.27 | 78 |
| 505412 | 1.304788 | 0.104573 | 37.73 | 80 |
| 505413 | 0.917549 | 0.113944 | 21.2 | 106 |
| 505414 | 0.147906 | 0.044099 | 4.03 | 75 |
| 505416 | 1.673985 | 0.115217 | 1.52 | 72 |
| 505417 | -2.44185 | 0.067381 | 0 | 106 |
| 505419 | 1.252622 | 0.111352 | 0.43 | 113 |
| 505422 | 0.091691 | 0.122246 | 39.52 | 96 |
| 505423 | -0.99302 | 0.117713 | 1.87 | 95 |
| 505424 | 1.2683 | 0.038744 | 5.98 | 100 |
| 505425 | 0.229578 | 0.0909 | 0 | 69 |
| 505427 | 1.001765 | 0.124321 | 30.24 | 81 |
| 505433 | 1.222487 | 0.126757 | 1.6 | 71 |
| 505435 | -1.47017 | 0.043198 | 26.08 | 89 |
| 505436 | 1.327014 | 0.086078 | 44.39 | 74 |
| 505439 | -0.8813 | 0.0241 | 132.93 | 80 |
| 505446 | -1.21765 | 0.073083 | 38.46 | 97 |
| 505447 | -2.30864 | 0.110101 | 0.59 | 89 |
| 505448 | 1.835198 | 0.124727 | 0 | 128 |
| 505449 | 2.599856 | 0.112762 | 1.67 | 76 |
| 505451 | 1.393119 | 0.120818 | 0.36 | 87 |
| 505454 | -1.75918 | 0.077262 | 1.05 | 95 |
| 505455 | -0.66184 | 0.028199 | 3.16 | 131 |
| 505457 | 1.556394 | 0.016958 | 1.7 | 89 |
| 505458 | -0.62793 | 0.123016 | 0.33 | 90 |
| 505459 | 0.264943 | 0.0547 | 59.75 | 99 |
| 505460 | 0.434964 | 0.113737 | 50.68 | 88 |
| 505461 | -0.18191 | 0.113503 | 36.94 | 102 |
| 505463 | -2.0408 | 0.112889 | 0.3 | 88 |

| | | | | |
|---|---|---|---|---|
| 505465 | -0.83736 | 0.114945 | 38.12 | 80 |
| 505468 | 2.69943 | 0.017658 | 1.18 | 66 |
| 505471 | -0.28525 | 0.12453 | 0.89 | 123 |
| 505472 | 1.017805 | 0.049709 | 0 | 83 |
| 505473 | 2.912792 | 0.055989 | 2.9 | 89 |
| 505474 | -1.2313 | 0.122447 | 4.68 | 84 |
| 505475 | 2.503539 | 0.085633 | 25.51 | 63 |
| 505478 | -0.05648 | 0.072525 | 1.92 | 97 |
| 505479 | -0.67547 | 0.126423 | 11.93 | 92 |
| 505483 | -1.67541 | 0.021492 | 1.83 | 125 |
| 505485 | -1.23299 | 0.128342 | 0.58 | 87 |
| 505491 | -2.22115 | 0.074029 | 1.13 | 120 |
| 505493 | 0.643943 | 0.01531 | 70.05 | 80 |
| 505495 | -1.84103 | 0.101191 | 0.25 | 117 |
| 505496 | -1.17711 | 0.098487 | 20.67 | 87 |
| 505497 | -0.54518 | 0.01607 | 33.15 | 77 |
| 505499 | 1.937815 | 0.11377 | 2.7 | 94 |
| 505543 | 0.843408 | 0.121555 | 34.14 | 58 |

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**EFB**

| Tag ID | Npos | Spos | Dist (m) | B (mm) |
|---|---|---|---|---|
| 91810 | -5.37404 | 0.125135 | 80.88 | 96 |
| 91819 | -2.41495 | 0.020828 | 203.19 | 83 |
| 91830 | -2.57535 | 0.082293 | 27.43 | 75 |
| 91832 | -5.45584 | 0.010076 | 43.7 | 83 |
| 91851 | -5.72994 | 0.025039 | 29.27 | 64 |
| 91855 | -5.71705 | 0.013163 | 35.58 | 108 |
| 91856 | -7.4354 | 0.125855 | 0.33 | 59 |
| 91860 | -4.86109 | 0.129452 | 0.51 | 64 |
| 91867 | -5.79578 | 0.028458 | 1.95 | 59 |

| | | | | |
|---|---|---|---|---|
| 91875 | -3.26957 | 0.015949 | 103.33 | 79 |
| 91876 | -4.07995 | 0.017883 | 149.42 | 79 |
| 91884 | -2.79892 | 0.048128 | 64.59 | 112 |
| 91899 | -4.57462 | 0.013471 | 26.46 | 70 |
| 91902 | -6.97099 | 0.127865 | 0.21 | 112 |
| 91917 | -3.18908 | 0.044871 | 42.13 | 100 |
| 91920 | -3.72522 | 0.012115 | 25.39 | 63 |
| 91925 | -2.23893 | 0.080617 | 9.87 | 93 |
| 91938 | -3.80956 | 0.057261 | 0.76 | 83 |
| 91940 | 0.205836 | 0.065327 | 68.33 | 125 |
| 91942 | -2.09064 | 0.062175 | 5.79 | 99 |
| 91952 | -1.79769 | 0.080974 | 4.96 | 123 |
| 91955 | -5.10694 | 0.023277 | 28.96 | 103 |
| 91961 | -4.16952 | 0.021717 | 62.1 | 79 |
| 91963 | -1.54119 | 0.056915 | 3.45 | 87 |
| 91973 | -1.55581 | 0.062036 | 49.86 | 108 |
| 91985 | -2.30219 | 0.079488 | 19.16 | 113 |
| 91986 | -2.56758 | 0.04362 | 35.27 | 90 |
| 91987 | -3.92773 | 0.034078 | 44.33 | 98 |
| 91988 | -3.52269 | 0.123892 | 0.3 | 108 |
| 91990 | -0.98828 | 0.07359 | 159.55 | 73 |
| 91992 | -4.62649 | 0.050233 | 1.98 | 115 |
| 91998 | -5.14162 | 0.122912 | 0.51 | 136 |
| 92002 | -2.63338 | 0.027324 | 89.39 | 76 |
| 92015 | -3.97261 | 0.041192 | 6.05 | 83 |
| 92018 | -6.11673 | 0.03256 | 24.67 | 77 |
| 92019 | -2.62124 | 0.014367 | 98.72 | 99 |
| 92021 | -2.79728 | 0.08551 | 11.9 | 76 |
| 92033 | -5.44875 | 0.036166 | 30.53 | 89 |
| 92038 | -6.60564 | 0.124733 | 0 | 82 |
| 92040 | -3.47967 | 0.026907 | 211.59 | 77 |

| | | | | |
|---|---|---|---|---|
| 92041 | -4.08833 | 0.050426 | 11.02 | 87 |
| 92061 | -6.34401 | 0.130096 | 0.91 | 74 |
| 92065 | -3.24281 | 0.032976 | 193.53 | 86 |
| 92071 | -2.93431 | 0.024066 | 40.72 | 102 |
| 92072 | -2.25946 | 0.065895 | 39.52 | 77 |
| 92074 | -1.5197 | 0.066037 | 83.07 | 124 |
| 92075 | -4.06068 | 0.028849 | 52.05 | 84 |
| 92088 | -2.42627 | 0.051637 | 82.09 | 84 |
| 92094 | -1.04078 | 0.07908 | 46.07 | 81 |
| 92097 | -2.55963 | 0.039482 | 51.22 | 86 |
| 505420 | -2.99527 | 0.082181 | 18.32 | 89 |
| 505428 | -7.63753 | 0.127793 | 0 | 116 |
| 505442 | -6.16648 | 0.127283 | 0.5 | 134 |
| 505466 | -4.31428 | 0.128329 | 0.32 | 129 |
| 505467 | -0.59862 | 0.067226 | 52.3 | 112 |
| 505482 | -4.16201 | 0.046772 | 27.24 | 108 |
| 505484 | -5.99752 | 0.123009 | 0.38 | 137 |
| 505489 | -3.38073 | 0.078725 | 11.76 | 144 |
| 505498 | -2.19238 | 0.08551 | 6.69 | 100 |
| 505506 | -2.02049 | 0.024707 | 25.81 | 77 |
| 505517 | -2.97914 | 0.065642 | 0.97 | 90 |
| 505520 | -2.5015 | 0.011577 | 141.3 | 69 |
| 505523 | -4.5121 | 0.035196 | 76.66 | 79 |
| 505525 | -3.45287 | 0.050425 | 37.2 | 80 |
| 505534 | -3.73212 | 0.025282 | 102.31 | 77 |
| 505540 | -5.00516 | 0.129467 | 1.03 | 63 |
| 505544 | -2.51625 | 0.057258 | 183.36 | 74 |
| 505551 | -5.495 | 0.129653 | 0 | 88 |
| 505557 | -2.77056 | 0.052623 | 1.63 | 82 |
| 505559 | -0.1564 | 0.071687 | 2.86 | 92 |
| 505560 | -4.55234 | 0.021629 | 172.64 | 82 |

| | | | | |
|---|---|---|---|---|
| 505576 | -5.98893 | 0.012974 | 29.24 | 92 |
| 505594 | -6.44037 | 0.009993 | 30.88 | 74 |
| 505597 | -1.8104 | 0.073756 | 182.98 | 88 |

Table S2: Tracer data for the post-flood survey (August 2014), in streamwise coordinates.

| **Moose** | | | | |
|---|---|---|---|---|
| **Tag ID** | **Npos** | **Spos** | **Dist (m)** | **B (mm)** |
| 91806 | 0.601974 | 0.227178 | 2.85 | 86 |
| 91821 | 2.871856 | 0.281269 | 3.55 | 80 |
| 91823 | 2.306223 | 0.697678 | 18.28 | 100 |
| 91827 | -0.84551 | 0.35514 | 3.41 | 101 |
| 91828 | -0.02425 | 0.71253 | 19.98 | 102 |
| 91834 | 0.583336 | 0.380882 | 1.76 | 85 |
| 91835 | 1.66831 | 0.276569 | 3.15 | 79 |
| 91836 | 1.615959 | 0.482609 | 5.7 | 64 |
| 91841 | 0.992296 | 0.851753 | 23.7 | 92 |
| 91843 | 1.989558 | 0.721135 | 12.31 | 85 |
| 91849 | -1.31499 | 0.238825 | 0 | 100 |
| 91859 | 0.636081 | 0.498689 | 9.8 | 98 |
| 91865 | 1.744002 | 0.103685 | 0.2 | 79 |
| 91868 | 1.778011 | 0.25578 | 3.74 | 56 |
| 91873 | 1.072474 | 0.397853 | 0.69 | 90 |
| 91874 | 1.027192 | 0.247978 | 0 | 86 |
| 91895 | 2.454466 | 0.456972 | 12.95 | 96 |
| 91903 | -3.41045 | 0.331428 | 2.74 | 104 |
| 91907 | -0.16547 | 0.36726 | 2.79 | 67 |
| 91908 | 0.197288 | 0.302249 | 0.71 | 108 |
| 91912 | -2.68747 | 0.550476 | 11.15 | 81 |
| 91914 | -0.75721 | 0.506689 | 6.67 | 127 |

| | | | | |
|---|---|---|---|---|
| 91922 | 1.808993 | 0.68465 | 17.06 | 61 |
| 91928 | -1.5435 | 0.675257 | 11.46 | 83 |
| 91931 | 1.667911 | 0.198675 | 0 | 116 |
| 91932 | -0.1053 | 0.914411 | 24.5 | 72 |
| 91933 | -0.97898 | 0.079295 | 0 | 126 |
| 91945 | 1.604199 | 0.783587 | 16.86 | 114 |
| 91947 | 1.688601 | 0.410456 | 4.01 | 63 |
| 91949 | -1.96172 | 0.563625 | 12.6 | 84 |
| 91950 | 0.187565 | 0.815098 | 17.01 | 92 |
| 91956 | -2.07867 | 0.418176 | 3.62 | 62 |
| 91965 | 0.712043 | 0.437291 | 7.83 | 119 |
| 91970 | -0.4697 | 0.541317 | 12.97 | 76 |
| 91972 | 2.752764 | 0.260577 | 0.44 | 96 |
| 91995 | 0.6185 | 0.713173 | 14.53 | 106 |
| 92007 | 2.351152 | 0.654115 | 9.95 | 92 |
| 92020 | 2.845123 | 0.204469 | 0 | 106 |
| 92023 | 1.482014 | 0.437419 | 6.21 | 69 |
| 92052 | -2.01123 | 0.555496 | 7.41 | 67 |
| 92053 | 0.677942 | 0.326055 | 7.38 | 67 |
| 92055 | -0.00062 | 0.575345 | 14.39 | 85 |
| 92063 | 3.598813 | 0.205976 | 0 | 87 |
| 92066 | 0.859233 | 0.077075 | 0.41 | 84 |
| 92092 | -1.32936 | 0.42577 | 3.53 | 88 |
| 92093 | 1.319496 | 0.500287 | 5.35 | 108 |
| 92095 | 1.876765 | 0.720987 | 12.77 | 70 |
| 92102 | -0.48961 | 0.650137 | 13.2 | 98 |
| 505514 | 1.199647 | 0.518172 | 5.78 | 76 |
| 505528 | 1.628247 | 0.338038 | 1.36 | 73 |
| 505539 | -1.69695 | 0.302284 | 3 | 73 |
| 505587 | 0.533919 | 0.713251 | 11.96 | 94 |
| 505596 | 3.779705 | 0.172641 | 0 | 61 |

| Mart_Up | | | | |
|---|---|---|---|---|
| Tag ID | Npos | Spos | Dist (m) | B (mm) |
| 91805 | -2.67012 | 0.532026 | 6.23 | 109 |
| 91807 | -1.5454 | 0.248957 | 3.42 | 73 |
| 91824 | 1.176049 | 0.151363 | 0 | 86 |
| 91825 | -1.86494 | 0.34342 | 3.87 | 97 |
| 91837 | -0.46368 | 0.303225 | 1.49 | 82 |
| 91844 | -0.79895 | 0.283413 | 2.3 | 85 |
| 91846 | 1.899192 | 0.24342 | 2.82 | 80 |
| 91853 | 0.646989 | 0.243162 | 0.84 | 83 |
| 91864 | 1.542234 | 0.364074 | 0 | 94 |
| 91879 | 1.652831 | 0.218939 | 0 | 104 |
| 91891 | -0.42149 | 0.175164 | 0.62 | 96 |
| 91897 | -1.17287 | 0.366912 | 11 | 69 |
| 91900 | 1.539867 | 0.389085 | 3.83 | 100 |
| 91901 | 16.46413 | 0.450024 | 8.38 | 93 |
| 91906 | -0.05385 | 0.351832 | 1.18 | 112 |
| 91911 | 1.348577 | 0.3001 | 1.91 | 91 |
| 91915 | 0.904341 | 0.21773 | 4.52 | 80 |
| 91934 | -1.50947 | 0.307715 | 0.46 | 77 |
| 91943 | -1.28823 | 0.299783 | 6.83 | 63 |
| 91953 | 0.658155 | 0.233209 | 1.54 | 99 |
| 91957 | -1.90535 | 0.173499 | 0.38 | 85 |
| 91978 | 0.372552 | 0.314246 | 6.08 | 65 |
| 91999 | -1.06494 | 0.156122 | 2.13 | 96 |
| 92008 | 0.560232 | 0.202021 | 1.69 | 72 |
| 92010 | -0.10349 | 0.32826 | 5.44 | 72 |
| 92027 | -3.42442 | 0.613511 | 20.67 | 83 |
| 92043 | -1.36836 | 0.408041 | 5.48 | 71 |

| | | | | |
|---|---|---|---|---|
| 92054 | -1.787 | 0.116812 | 0 | 75 |
| 92078 | -0.95759 | 0.417997 | 5.83 | 83 |
| 92082 | 0.387406 | 0.523928 | 4.98 | 73 |
| 92096 | -1.03355 | 0.330753 | 0.26 | 70 |
| 505500 | -0.40615 | 0.319965 | 6.39 | 51 |
| 505504 | 0.197872 | 0.509779 | 4.38 | 74 |
| 505508 | -1.34828 | 0.275742 | 0.62 | 48 |
| 505512 | 0.244488 | 0.518699 | 7.7 | 89 |
| 505513 | -0.72301 | 0.295129 | 0.55 | 83 |
| 505550 | -1.71907 | 0.205525 | 0 | 61 |
| 505553 | 0.244521 | 0.165274 | 3.92 | 84 |
| 505568 | -0.24867 | 0.413465 | 11.17 | 94 |
| 505573 | -1.87059 | 0.487855 | 10.01 | 69 |
| 505586 | -1.56466 | 0.264839 | 0 | 66 |
| 505598 | 0.124781 | 0.224827 | 0.79 | 75 |



**Control**

| Tag ID | Npos | Spos | Dist (m) | B (mm) |
|---|---|---|---|---|
| 91812 | 6.152899 | 0.191931 | 0.74 | 112 |
| 91822 | 2.462612 | 0.527276 | 13.29 | 73 |
| 91838 | -4.98584 | 0.201279 | 0 | 73 |
| 91842 | 1.041201 | 0.0867 | 1.64 | 106 |
| 91845 | 6.407009 | 0.114396 | 0.7 | 77 |
| 91847 | -3.85995 | 0.147158 | 0.66 | 87 |
| 91848 | -0.94239 | 0.335632 | 8.48 | 90 |
| 91854 | -0.1903 | 0.171553 | 2.19 | 65 |
| 91862 | 0.098779 | 0.193794 | 4.71 | 63 |
| 91870 | -3.23268 | 0.19744 | 2.03 | 113 |
| 91878 | 5.739473 | 0.016256 | 0.28 | 104 |
| 91881 | 5.017924 | 0.234806 | 2.9 | 99 |

| | | | | |
|---|---|---|---|---|
| 91885 | -3.00859 | 0.288811 | 8.19 | 80 |
| 91887 | 1.223251 | 0.548877 | 14.28 | 61 |
| 91888 | 0.350843 | 0.517616 | 16.69 | 84 |
| 91893 | 3.285862 | 0.358256 | 9.08 | 80 |
| 91898 | 4.530047 | 0.225793 | 4.94 | 70 |
| 91904 | -4.45277 | 0.098717 | 0.37 | 84 |
| 91913 | 4.494201 | 0.034238 | 0.56 | 72 |
| 91916 | -5.1585 | 0.214825 | 1.34 | 63 |
| 91921 | 0.515595 | 0.206296 | 0.68 | 86 |
| 91924 | -3.5959 | 0.141774 | 1.1 | 83 |
| 91926 | 1.986783 | 0.310052 | 5.75 | 76 |
| 91930 | -0.95288 | 0.210645 | 2.53 | 74 |
| 91946 | -2.57959 | 0.172406 | 0 | 75 |
| 91959 | -4.14603 | 0.107757 | 0.85 | 85 |
| 91960 | -0.63046 | 0.207641 | 0.58 | 125 |
| 91964 | -2.29162 | 0.209562 | 4.56 | 108 |
| 91977 | 3.456026 | 0.285124 | 9.41 | 90 |
| 91979 | -1.29798 | 0.326581 | 11.04 | 95 |
| 91980 | 3.169387 | 0.391484 | 7.22 | 88 |
| 91991 | -1.886 | 0.099962 | 0.64 | 93 |
| 91993 | -0.11976 | 0.673878 | 22.39 | 101 |
| 92003 | 4.289914 | 0.138552 | 3.8 | 112 |
| 92004 | 3.128322 | 0.085974 | 2.71 | 88 |
| 92009 | -2.79681 | 0.677817 | 18.51 | 62 |
| 92011 | 2.495787 | 0.292981 | 3.02 | 93 |
| 92012 | 2.223939 | 0.176324 | 2.9 | 90 |
| 92014 | -0.75351 | 0.133866 | 0 | 83 |
| 92026 | 5.330655 | 0 | 0 | 106 |
| 92030 | 1.882828 | 0.23373 | 1.02 | 90 |
| 92032 | -1.8694 | 0.207823 | 4.17 | 110 |
| 92036 | 5.150484 | 0.21656 | 0.44 | 80 |

| | | | | |
|---|---|---|---|---|
| 92042 | 1.183814 | 0.426605 | 8.3 | 78 |
| 92046 | -4.24076 | 0.149634 | 0 | 96 |
| 92048 | 3.560181 | 0.414974 | 9.78 | 80 |
| 92050 | -1.88099 | 0.247147 | 2.95 | 84 |
| 92051 | 2.509387 | 0.194419 | 0.27 | 108 |
| 92057 | -4.45354 | 0.207867 | 0.71 | 97 |
| 92076 | 1.078964 | 0.391424 | 11.17 | 79 |
| 92086 | 3.981884 | 0.231177 | 1.03 | 82 |
| 505403 | 2.146523 | 0.131299 | 1.14 | 119 |
| 505415 | 0.835739 | 0.060238 | 0.41 | 118 |
| 505426 | 3.333036 | 0.044088 | 0.68 | 116 |
| 505430 | -0.85467 | 0.247707 | 4.72 | 111 |
| 505432 | 0.551824 | 0.344213 | 6.5 | 107 |
| 505444 | 0.825266 | 0.132987 | 0.85 | 110 |
| 505450 | -4.42469 | 0.070335 | 0 | 136 |
| 505453 | 4.136018 | 0.150971 | 2.99 | 106 |
| 505462 | -0.48355 | 0.386194 | 7.65 | 116 |
| 505464 | -2.90396 | 0.143372 | 0.64 | 114 |
| 505476 | -3.11514 | 0.222954 | 0.78 | 109 |
| 505477 | -0.72183 | 0.211116 | 0 | 122 |
| 505480 | 1.720492 | 0.266637 | 8.22 | 105 |
| 505486 | -1.63311 | 0.136953 | 3.08 | 127 |
| 505487 | 4.637177 | 0.257394 | 1.09 | 112 |
| 505501 | -5.00945 | 0.28817 | 3.93 | 53 |
| 505507 | 4.26789 | 0.007312 | 0 | 83 |
| 505530 | -3.56148 | 0.483445 | 10.43 | 80 |
| 505535 | 1.544195 | 0.482043 | 13.68 | 71 |
| 505536 | 2.102324 | 0.061891 | 1.17 | 87 |
| 505546 | -2.19055 | 0.191615 | 0.38 | 86 |
| 505554 | 1.132209 | 0.48316 | 13.86 | 55 |
| 505555 | -1.0187 | 0.277808 | 5.15 | 96 |

| | | | | |
|---|---|---|---|---|
| 505562 | 4.763306 | 0.116832 | 0 | 90 |
| 505564 | -4.85072 | 0.173506 | 0 | 63 |
| 505575 | 4.617116 | 0.058687 | 0 | 90 |
| 505577 | -1.39283 | 0.08813 | 1.4 | 101 |
| 505578 | 2.966527 | 0.149385 | 2.7 | 88 |
| 505579 | -3.40654 | 0.169933 | 0 | 95 |
| 505582 | 0.460377 | 0.706337 | 22.71 | 76 |
| 505592 | 5.683859 | 0.163536 | 3.09 | 71 |
| 505599 | 7.124538 | 0.188325 | 0.69 | 75 |

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**Mart_Lo**

| **Tag ID** | **Npos** | **Spos** | **Dist (m)** | **B (mm)** |
|---|---|---|---|---|
| 91975 | -1.01262 | 0.094624 | 0.91 | 118 |
| 91976 | 0.202589 | 0.103828 | 0 | 92 |
| 91981 | -0.28598 | 0.110862 | 0 | 118 |
| 91994 | 0.613938 | 0.136633 | 1.89 | 87 |
| 91997 | 0.241441 | 0.11314 | 4.74 | 91 |
| 92000 | 2.354542 | 0.092687 | 0.34 | 90 |
| 92001 | -1.38505 | 0.170755 | 10.79 | 98 |
| 92017 | 0.822566 | 0.099194 | 0.53 | 73 |
| 92031 | -0.57984 | 0.175746 | 14.52 | 70 |
| 92037 | -1.38726 | 0.050862 | 0 | 85 |
| 92058 | -0.1129 | 0.119293 | 10.13 | 75 |
| 92059 | 4.158253 | 0.148555 | 13.99 | 110 |
| 92060 | 1.241121 | 0.055706 | 0 | 134 |
| 92077 | -0.86602 | 0.123422 | 1.14 | 77 |
| 92081 | 4.440621 | 0.081838 | 10.02 | 80 |
| 92084 | 1.694078 | 0.075307 | 7.67 | 101 |
| 92100 | -0.8112 | 0.085883 | 1.04 | 110 |
| 92104 | -3.35313 | 0.207493 | 29.42 | 106 |

| | | | | |
|---|---|---|---|---|
| 505400 | 0.84564 | 0.121604 | 1.27 | 93 |
| 505401 | -0.10687 | 0.117132 | 1.7 | 88 |
| 505402 | -7.45387 | 0.346303 | 62.06 | 96 |
| 505404 | -1.32896 | 0.28288 | 54.58 | 76 |
| 505405 | 2.556268 | 0.099554 | 0.88 | 116 |
| 505410 | -2.61043 | 0.056871 | 0.38 | 91 |
| 505411 | -1.86356 | 0.145503 | 11.27 | 78 |
| 505412 | -3.67008 | 0.265719 | 37.73 | 80 |
| 505413 | -2.71133 | 0.204488 | 21.2 | 106 |
| 505414 | -2.38102 | 0.061304 | 4.03 | 75 |
| 505416 | 2.147443 | 0.121707 | 1.52 | 72 |
| 505417 | -2.48134 | 0.068074 | 0 | 106 |
| 505419 | 1.068447 | 0.113188 | 0.43 | 113 |
| 505422 | -2.77596 | 0.291015 | 39.52 | 96 |
| 505423 | -0.59204 | 0.125709 | 1.87 | 95 |
| 505424 | 1.889603 | 0.06428 | 5.98 | 100 |
| 505425 | 0.497729 | 0.091431 | 0 | 69 |
| 505427 | -1.94377 | 0.253473 | 30.24 | 81 |
| 505433 | 1.370718 | 0.13359 | 1.6 | 71 |
| 505435 | -1.07167 | 0.154575 | 26.08 | 89 |
| 505436 | -2.0197 | 0.27566 | 44.39 | 74 |
| 505439 | 0.458875 | 0.591862 | 132.93 | 80 |
| 505446 | -2.73568 | 0.23734 | 38.46 | 97 |
| 505447 | -2.04768 | 0.112627 | 0.59 | 89 |
| 505448 | 1.679667 | 0.125228 | 0 | 128 |
| 505449 | 3.405387 | 0.119896 | 1.67 | 76 |
| 505451 | 1.639874 | 0.122349 | 0.36 | 87 |
| 505454 | -2.06168 | 0.081745 | 1.05 | 95 |
| 505455 | -1.20968 | 0.041684 | 3.16 | 131 |
| 505457 | 1.428994 | 0.024218 | 1.7 | 89 |
| 505458 | -0.6027 | 0.124435 | 0.33 | 90 |

| | | | | |
|---|---|---|---|---|
| 505459 | -3.76969 | 0.309898 | 59.75 | 99 |
| 505460 | -0.37397 | 0.330188 | 50.68 | 88 |
| 505461 | -2.48106 | 0.271265 | 36.94 | 102 |
| 505463 | -2.06808 | 0.11419 | 0.3 | 88 |
| 505465 | -3.08014 | 0.277741 | 38.12 | 80 |
| 505468 | 2.667812 | 0.022692 | 1.18 | 66 |
| 505471 | 0.092626 | 0.128336 | 0.89 | 123 |
| 505472 | 0.857588 | 0.049852 | 0 | 83 |
| 505473 | 1.10249 | 0.068379 | 2.9 | 89 |
| 505474 | 2.804395 | 0.142419 | 4.68 | 84 |
| 505475 | -1.62913 | 0.194576 | 25.51 | 63 |
| 505478 | 0.04441 | 0.080737 | 1.92 | 97 |
| 505479 | -0.84756 | 0.17737 | 11.93 | 92 |
| 505483 | -1.58454 | 0.029287 | 1.83 | 125 |
| 505485 | -1.35212 | 0.130816 | 0.58 | 87 |
| 505491 | -3.67886 | 0.078868 | 1.13 | 120 |
| 505493 | -0.83598 | 0.314472 | 70.05 | 80 |
| 505495 | -1.87662 | 0.102246 | 0.25 | 117 |
| 505496 | -2.07076 | 0.186764 | 20.67 | 87 |
| 505497 | -0.06699 | 0.157672 | 33.15 | 77 |
| 505499 | 2.662159 | 0.125297 | 2.7 | 94 |
| 505543 | -3.2148 | 0.267381 | 34.14 | 58 |



**EFB**

| Tag ID | Npos | Spos | Dist (m) | B (mm) |
|---|---|---|---|---|
| 91810 | -3.78155 | 0.48003 | 80.88 | 96 |
| 91819 | -1.26452 | 0.912408 | 203.19 | 83 |
| 91830 | -2.29594 | 0.202653 | 27.43 | 75 |
| 91832 | -1.73855 | 0.201826 | 43.7 | 83 |
| 91851 | 0.132576 | 0.153474 | 29.27 | 64 |

| | | | | |
|---|---|---|---|---|
| 91855 | 1.752536 | 0.169287 | 35.58 | 108 |
| 91856 | -7.38944 | 0.127283 | 0.33 | 59 |
| 91860 | -4.72881 | 0.131701 | 0.51 | 64 |
| 91867 | -5.29001 | 0.037011 | 1.95 | 59 |
| 91875 | -4.11973 | 0.469361 | 103.33 | 79 |
| 91876 | -3.3138 | 0.67352 | 149.42 | 79 |
| 91884 | 0.112326 | 0.331554 | 64.59 | 112 |
| 91899 | -33.3535 | 0.129576 | 26.46 | 70 |
| 91902 | -6.90573 | 0.128788 | 0.21 | 112 |
| 91917 | 3.01387 | 0.229729 | 42.13 | 100 |
| 91920 | -3.1314 | 0.123538 | 25.39 | 63 |
| 91925 | -3.18007 | 0.12391 | 9.87 | 93 |
| 91938 | -3.67849 | 0.060597 | 0.76 | 83 |
| 91940 | -1.26584 | 0.365171 | 68.33 | 125 |
| 91942 | -4.34989 | 0.087564 | 5.79 | 99 |
| 91952 | -1.0323 | 0.102758 | 4.96 | 123 |
| 91955 | -0.11431 | 0.150349 | 28.96 | 103 |
| 91961 | 2.230704 | 0.294212 | 62.1 | 79 |
| 91963 | -1.7347 | 0.07204 | 3.45 | 87 |
| 91973 | 3.540759 | 0.280802 | 49.86 | 108 |
| 91985 | 4.478215 | 0.163577 | 19.16 | 113 |
| 91986 | 3.304107 | 0.19836 | 35.27 | 90 |
| 91987 | 0.784935 | 0.228608 | 44.33 | 98 |
| 91988 | -3.26375 | 0.125186 | 0.3 | 108 |
| 91990 | -5.09791 | 0.773685 | 159.55 | 73 |
| 91992 | -5.97715 | 0.058932 | 1.98 | 115 |
| 91998 | -4.87104 | 0.125135 | 0.51 | 136 |
| 92002 | -3.41899 | 0.41957 | 89.39 | 76 |
| 92015 | -5.15528 | 0.067737 | 6.05 | 83 |
| 92018 | -0.52678 | 0.140814 | 24.67 | 77 |
| 92019 | -1.96648 | 0.447528 | 98.72 | 99 |

| | | | | |
|---|---|---|---|---|
| 92021 | -2.10225 | 0.137718 | 11.9 | 76 |
| 92033 | 5.750483 | 0.170119 | 30.53 | 89 |
| 92038 | -6.78632 | 0.124906 | 0 | 82 |
| 92040 | 2.97 | 0.955327 | 211.59 | 77 |
| 92041 | -5.31266 | 0.098797 | 11.02 | 87 |
| 92061 | -5.52654 | 0.134067 | 0.91 | 74 |
| 92065 | -0.8655 | 0.882168 | 193.53 | 86 |
| 92071 | 2.218072 | 0.202745 | 40.72 | 102 |
| 92072 | 2.764937 | 0.239286 | 39.52 | 77 |
| 92074 | -1.36613 | 0.430524 | 83.07 | 124 |
| 92075 | 2.683712 | 0.25722 | 52.05 | 84 |
| 92088 | 2.547975 | 0.411852 | 82.09 | 84 |
| 92094 | 3.224059 | 0.281218 | 46.07 | 81 |
| 92097 | 4.396074 | 0.26423 | 51.22 | 86 |
| 505420 | 0.942499 | 0.162574 | 18.32 | 89 |
| 505428 | -7.5838 | 0.128126 | 0 | 116 |
| 505442 | -5.6779 | 0.129467 | 0.5 | 134 |
| 505466 | -3.68567 | 0.129719 | 0.32 | 129 |
| 505467 | 4.652453 | 0.296701 | 52.3 | 112 |
| 505482 | -1.18707 | 0.166284 | 27.24 | 108 |
| 505484 | -6.25292 | 0.124689 | 0.38 | 137 |
| 505489 | 5.215686 | 0.130333 | 11.76 | 144 |
| 505498 | -2.88317 | 0.114874 | 6.69 | 100 |
| 505506 | -2.7609 | 0.137961 | 25.81 | 77 |
| 505517 | -3.78983 | 0.069896 | 0.97 | 90 |
| 505520 | -0.04376 | 0.631583 | 141.3 | 69 |
| 505523 | -1.94896 | 0.371565 | 76.66 | 79 |
| 505525 | 4.118827 | 0.213642 | 37.2 | 80 |
| 505534 | -0.91969 | 0.474202 | 102.31 | 77 |
| 505540 | -5.03026 | 0.13399 | 1.03 | 63 |
| 505544 | -1.74971 | 0.861805 | 183.36 | 74 |

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|---|---|---|---|---|
| 505551 | -5.48459 | 0.129841 | 0 | 88 |
| 505557 | -2.58061 | 0.059796 | 1.63 | 82 |
| 505559 | -0.42922 | 0.084255 | 2.86 | 92 |
| 505560 | -1.55062 | 0.779156 | 172.64 | 82 |
| 505576 | -2.14563 | 0.141256 | 29.24 | 92 |
| 505594 | -1.15703 | 0.145494 | 30.88 | 74 |
| 505597 | -2.12039 | 0.876665 | 182.98 | 88 |

## C: Summary of previous RFID tracer studies in gravel-bed rivers

Table S3: Previous experiments using RFID tracking technology in gravel-bed rivers.

| Reference | Study Site | n | S (%) | $D_{50b}$ (m) | $D_{50t}$ (m) | # Events | Model Fitting |
|---|---|---|---|---|---|---|---|
| Nichols (2004) | Walnut Gulch | 124 | 2.9-3.6 | n/a | 0.058 | 4 | No |
| Lamarre et al. (2005) | Moras Creek | 204 | 2.30 | 0.070 | 0.04-0.25 | 2 | No |
| Carre et al. (2007) | Nicolet River | 110 | n/a | 0.090 | 0.64-0.25 | 3 | No |
| Lamarre and Roy (2008) | Spruce Creek | 196 | 14.0 | ~0.090 | 0.086 | 5 | No |
| Carmenen et al. (2010) | Arc River | 300 | 0.2-1.0 | n/a | n/a | 3 | No |
| Schneider et al. (2010) | Erlenbach Stream | 495 | 17.0 | n/a | n/a | 8 | No |
| MacVicar and Roy (2011) | Moras Creek | 299 | 1.20 | 0.060 | 0.04-0.36 | 5 | No |
| Biron et al. (2012) | Nicolet River | 169 | 0.150 | 0.039 | 0.05-0.15 | n/a | No |
| Bradley and Tucker (2012) | Halfmoon Creek | 893 | 1.0 | 0.060 | 0.060 | 4 | Yes, Gamma-Exponential |
| Houbrechts et al. (2012) | Aisne River | 1500 | 0.47 | 0.092 | 0.080 | 7 | No |
| Liébault et al., 2012 | Bouinec Torrent | 451 | 1.60 | 0.020 | 0.053 | 3 | Yes, Power-law |
| Phillips et al. (2013) | Mameyes River | 300 | 0.78 | 0.120 | 0.125 | 6 | Yes, Exponential |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Milan (2013) | River Rede | 98 | 0.60 | 0.081 | 0.078 | 8 | No |
| Chapuis et al. (2015) | Durance River | 232 | 0.23 | 0.040 | 0.049 | 1 | No |
| Imhoff (2015) | E. Fork Bitterroot | 428 | 1.5-2.9 | ~0.070 | 0.079 | 1 | Yes |

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Houbrechts, G., Van Campenhout, J., Levecq, Y., Hallot, E., Peeters, A. and Petit, F.: Comparison of methods for quantifying active layer dynamics and bedload discharge in armoured gravel-bed rivers, Earth Surf. Process. Landforms, 37, 1501–1517, doi:10.1002/esp.3258, 2012.

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Schneider, J., Hegglin, R., Meier, S., Turowski, J.M., Nitsche, M., and Rickenmann, D.: Studying sediment transport in mountain rivers by mobile and stationary RFID antennas, in International Conference on Fluvial Hydraulics, 1723–1730, 2010.

## D: Analyses

D.1: Estimates of critical Shields number

Below are the calculations used for the lower (Mueller) and upper (Recking) estimates of critical Shields number at each study reach – four confluence seed reaches (tributary and mainstem for each) and the control reach. We chose these two methods as they provide a bracket of the highest and lowest estimates of critical Shields number we could obtain from published literature in steep, gravel-bed systems similar to the study site. We assumed the true value to fall between these two estimates.

*i). Mueller estimate*

$$\tau_c^* \sim \tau_r^* = 2.18S + 0.021 \qquad \text{(D1)}$$

*Notation:*

$\tau_c^*$ = Critical Shields number

$\tau_r^*$ = Reference dimensionless shear stress

S = Channel gradient

Mueller et al. (2005) define the reference dimensionless shear stress as the point where there is a very small, non-zero transport rate, a value that others (e.g., Bradley and Tucker, 2012) assume to be approximate of the true critical Shields number for coarse gravel and cobble particles. For each seed reach we measured the channel gradient of the thalweg during the initial bed topography survey. This gradient was input to the equation to produce Mueller estimates of critical Shields number:

i.1). Moose Creek (Upper confluence tributary)

$$\tau_c^* = 2.18(0.0185) + 0.021 = \mathbf{0.061}$$

i.2). Martin Creek (Upper confluence mainstem)

$\tau_c^* = 2.18(0.029) + 0.021 = \mathbf{0.084}$

i.3). Martin Creek (Control reach)

$\tau_c^* = 2.18(0.0164) + 0.021 = \mathbf{0.057}$

i.4). Martin Creek (Upper confluence tributary)

$\tau_c^* = 2.18(0.0168) + 0.021 = \mathbf{0.057}$

i.5). East Fork Bitterroot River (Upper confluence mainstem)

$\tau_c^* = 2.18(0.0163) + 0.021 = \mathbf{0.056}$

*ii). Recking estimate*

$$\tau_c^* \sim \tau_m^* = (5S + 0.06)\left(\frac{D_{84}}{D_{50}}\right)^{4.4\sqrt{S}-1.5} \qquad \text{(D2)}$$

*Notation:*

$\tau_c^*$ = Critical Shields number

$\tau_m^*$ = Mobility shear stress

S = Channel gradient

$D_{84}$ = Particle b-axis size for which 84% of reach particles are smaller (m)

$D_{50}$ = Median grain b-axis size (m)

Recking (2013) merged two asymptotic branches of a nonlinear relationship between grain size and critical Shields number to create a single continuous function that matches particle entrainment and sediment transport measurements. This work used a series of steep, mountainous streams to develop the relation, including Halfmoon Creek from Mueller et al. (2005). The relation only uses $D_{50}$, $D_{84}$, and S as inputs to estimate the reach-average threshold of gravel entrainment using (Equation 12, Recking 2013), and we apply this equation to estimate the threshold of motion for the tracer particles:

i.1). Moose Creek (Upper confluence tributary)

$$\tau_c^* = (5(0.0185)) + 0.06)\left(\frac{0.10}{0.052}\right)^{4.4\sqrt{0.0185}-1.5} = \mathbf{0.084}$$

i.2). Martin Creek (Upper confluence mainstem)

$$\tau_c^* = (5(0.029)) + 0.06)\left(\frac{0.147}{0.064}\right)^{4.4\sqrt{0.029}-1.5} = \mathbf{0.109}$$

i.3). Martin Creek (Control reach)

$$\tau_c^* = (5(0.0164)) + 0.06)\left(\frac{0.125}{0.057}\right)^{4.4\sqrt{0.0164}-1.5} = \mathbf{0.068}$$

i.4). Martin Creek (Upper confluence tributary)

$$\tau_c^* = (5(0.0168)) + 0.06)\left(\frac{0.117}{0.068}\right)^{4.4\sqrt{0.0168}-1.5} = \mathbf{0.086}$$

i.5). East Fork Bitterroot River (Upper confluence mainstem)

$$\tau_c^* = (5(0.0163)) + 0.06)\left(\frac{0.137}{0.069}\right)^{4.4\sqrt{0.0163}-1.5} = \mathbf{0.074}$$

D.3: Dimensionless impulse (I*)

Our incipient motion estimates were paired with seed reach cross-sections and flow data through the calculation of the dimensionless impulse, I*. Given the two estimates of critical Shields number for reach seed reach, we converted that value to an actual shear stress and identified the water surface elevations at each pressure transducer that correspond with the critical hydraulic radius ($R_c$) experiencing that shear stress. $R_c$ was transformed to hydraulic radius using cross-sectional data, and used to calculate critical shear velocity values corresponding with incipient motion estimates.

At each seed reach the implanted pressure transducer measured water surface elevations at 30-minute (1800 second) intervals ("cells"). Integration of all cells where the shear velocity exceeded the critical shear velocity is the basis of the impulse calculation:

$$I^* = \int_{ti}^{tf} \frac{(U^* - U_c^*)dt}{D_{50}}, U^* > U_c^* \qquad \text{(D3)}$$

*Notation:*

$I^*$ = Critical Shields number

$t_i$ = initial time above threshold

$t_f$ = final time above threshold

$U^*$= shear velocity (m/s)

$U_c^*$ = critical shear velocity (m/s)

$D_{50}$ = Median grain b-axis size (m)

Once integration occurs, dt becomes t and the impulse becomes dimensionless. We avoided pure forward or backward numerical integration, at the recommendation of Phillips et al. (2013), and instead took the average of $(U^*-U^*_c)/D_{50}$ from two adjacent time cells and multiplying that by the time difference between them (1800 seconds). This is analogous to the trapezoidal rule.