

GEOMORPHIC ASSESSMENT OF THE BATTEN KILL, VT: CHANNEL ADJUSTMENTS TO PAST RIVER MANAGEMENT ACTIVITIES

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Abstract

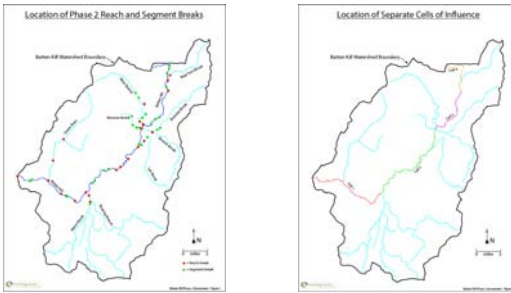
A Phase 2 geomorphic assessment of the Batten Kill mainstem and the lower reaches of 9 major tributaries was completed in Summer 2004. The results of the Phase 2 assessment document the morphological impacts of human land use on the river system (e.g., berming and channelization) identified during the previously completed Phase 1 assessment. Extensive straightening of the Batten Kill mainstem over 80 years ago, and periodically maintained in places through the 1970's, has created wide, shallow, slightly incised channels with a plane bed morphology. While largely a stable configuration, the straightened channels are regaining sinuosity where debris blocks the channel and flow "breaks out" onto the floodplain with sufficient force to scour a new meander bend into the floodplain surface. Habitat conditions are improved in these areas of flow and energy attenuation as evidenced by better particle size segregation, multiple velocity patterns, and deeper pools.

Nearly continuous berming is present along both banks on 4 of the 6 tributaries draining from the Green Mountains on the eastern side of the watershed: Mad Tom Brook, Bourn Brook, Lye Brook, and Roaring Branch. This berming was in response to watershed wide flooding in June 1973 but evidence exists for an earlier berming episode, perhaps following the 1936 flood. The berms still confine flows at nearly twice the bankfull depth or more, so the tributary channels have been unable to adjust to smaller "bankfull" flows. Consequently, habitat remains degraded and the channel unable to return to an equilibrium condition. Tributaries draining the Tectonic Mountains generally have a stable equilibrium morphology with very little human alteration. This results from bedrock controls and valley confinement by glacial deposits – conditions not as widely present on the more disturbed Green Mountain tributaries.

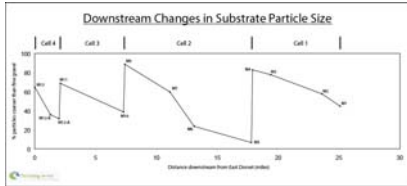
The original process of berming along the tributaries in the early 1970's most likely had a direct, perhaps significant, watershed wide impact on instream habitat. Flow confinement by berms on the Green Mountain tributaries prevents flow from crossing the alluvial fan surfaces at the lower ends of the Green Mountain tributaries, as occurred prior to human settlement of the region. Although removing berms in many localities would put property at greater risk, opportunities should be sought, far from any developments, where berm removal would allow flow to escape onto the alluvial fan surface. Restoration such as this could improve habitat while simultaneously reducing the risk of a berm failure in a more populated area. Straightened channel segments on the mainstem are prone to flow escaping the channel and creating new meanders across the floodplain. Mimicking this process as part of restoration efforts in the watershed will speed up the natural recovery of channel sinuosity, improve physical habitat conditions, and reduce the likelihood of an unplanned "break out" across the floodplain that could adversely impact landowners along the river. By identifying how stream channels are adjusting to human impacts in the Batten Kill watershed, the Phase 2 assessment results can be used to select restoration opportunities that will not only improve habitat, but do so in a way that will bring the channel closer to a sustainable equilibrium condition. In addition, where landowners and municipalities take advantage of river corridor planning, protection and management opportunities to avoid future conflicts and accommodate equilibrium condition for the Battenkill, a reduction in the type of catastrophic flood damages and habitat losses experienced in the 1970s may be realized.

Subdividing the river into cells, reaches and segments

The Batten Kill and its tributaries were subdivided into distinct reaches and segments based on gradient, valley width, location of tributary confluences, and human alterations. The Batten Kill in Vermont is more like 4 rivers in one with coarse sediment inputs from tributaries altering the river's character and creating separate cells of influence:



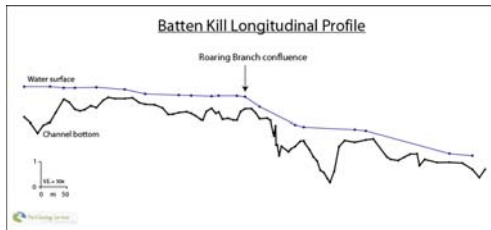
The size of sediment on the Batten Kill's channel bottom increases dramatically at the confluence of large tributaries with the channel becoming steeper and swifter downstream:



This is exemplified at the confluence with Roaring Branch:



Note flat water to the right of photograph upstream of confluence and formation of rapids on the left of photograph downstream of confluence.

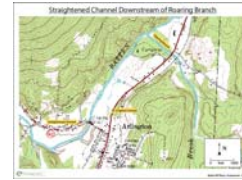
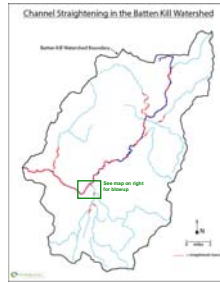


Note increase in gradient downstream of Roaring Branch confluence

Human Alterations to the Batten Kill

Mainstem

Over 40 percent of the Batten Kill mainstem was straightened by humans prior to 1900 with considerable straightening occurring on the tributaries as well. Nearly the entire river downstream of Roaring Branch was straightened. This straightening was probably done for a variety of reasons including railroad construction, agriculture, log drives, and flood control:



Note: Photos below show view of area labeled

Straightened channel



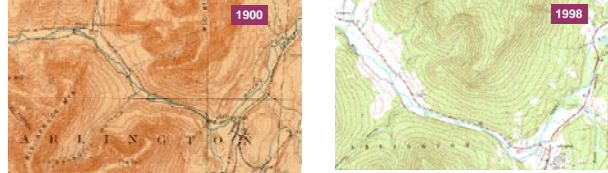
Note: Looking downstream from Rt 313 bridge

Original channel



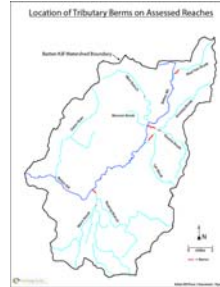
Note: Looking upstream from Rt 313

Similarities between the 1900 topographic map with recent maps indicate that the straightening occurred prior to 1894 (the survey date). Continued channel maintenance activities such as dredging have maintained this condition until the present day:



Tributaries

The mouths of all major tributaries draining the Green Mountains were extensively bermed during flood control efforts in 1973 and earlier. The berms contain large floods within the channel as a result of the artificially heightened banks:



Bourn Brook berm



Lye Brook berm



Much of the berming occurred after major flooding June 30 - July 1, 1973 as documented by historical photographs from Roaring Branch and patterns of vegetation growth on Bourn Brook. The presence of double berms on Lye Brook (see cross section above) indicate that some berming also occurred prior to 1973:

Headline from Bennington Banner on July 6, 1973



Photo of Roaring Branch from Russell Collection. Note berm on right



Photo of dying tree buried in Bourn Brook berm

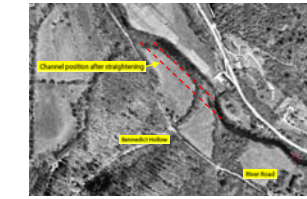


Channel Adjustments to Human Alterations

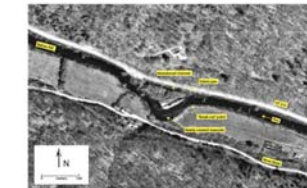
Mainstem

While the position of the straightened channel segments has remained relatively unchanged in over 100 years, subtle adjustments have occurred that demonstrate the river's sensitivity to channel adjustments as the river's meanders are reformed:

Sediment inputs from Benedict Hollow have nudged the channel towards the opposite bank (west of Arlington):



Woody debris jams in the channel have caused the channel to "break out" across the floodplain and form new meanders (west of Arlington):



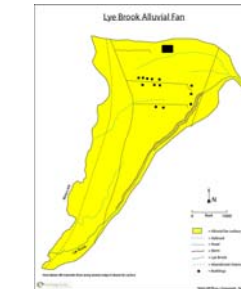
Bridges trap sediment upstream and resulting bars divert flow into opposite bank and cause erosion as demonstrated with paired photos looking upstream from Rochester bridge west of Arlington:

Site 6 - Rochester Bridge, Arlington looking southeast



Tributaries

Tributary berms have cut off access to side channels on alluvial fans. This increases flow velocities within the channel, which, in turn, keeps bars from revegetating and prevents the channel from becoming deeper and narrower:



Note side channels blocked by long berm on west bank

Flow confinement on Roaring Branch scours bar frequently enough to prevent revegetation and channel narrowing (looking downstream from Rt 7A bridge):



Channel confinement by berms also increases sediment delivery downstream on the mainstem where additional problems are encountered such as this erosion bank at the mouth of Roaring Branch

Restoration Opportunities to Reduce Hazards and Improve Habitat

Mainstem

Recognizing the channel's tendency to reform meanders and opportunities to allow the channel to "break out" across the floodplain in uninhabited areas would reduce the hazard of unplanned "break outs" occurring near homes, roads, or other infrastructure. Physical habitat within the newly formed meanders would also be improved over the existing straightened channels. Habitat improvements include:

- deeper pools
- better particle segregation
- improved overhanging bank cover
- greater complexity in velocity/depth patterns



Tributaries

Alluvial fan side channels are reforming on Lye Brook where the berm has been breached. Removing berms near uninhabited areas would reduce flow velocities and depths and, therefore, decrease the likelihood of sudden berm breaches near human developments. Returning natural flow conditions to the alluvial fans would have multiple habitat benefits including:

- access to side channels
- reduced sediment delivery to the mainstem
- revegetation of gravel bars
- channel narrowing

