Assessment of Floodplain Reconnection at Geprags Park

Hinesburg, Vermont

Background

Geprags Park is owned by the town of Hinesburg. The lands are comprised of a fallow farm fields, forestlands, re-treed areas, and areas of transitional scrub shrub. The western portion contains an unnamed tributary of the LaPlatte River. As is customary, the stream channel has been straightened and bermed. Prior to 2018, the stream channel has experienced widely varying flow levels across a typical season - from dry stream bed to flood conditions. Prior to 2018, the channel has persisted in a substantially incised condition. Though portions of the floodplain were mapped as wetlands, the adjacent hillsides have played a much greater role than the stream channel in supplying the water that supports wetland hydrology.

In 2018, beavers began colonizing this streamscape. The first pond they created is found roughly midway between the north and south extents of the park. It continues to serve as the primary impoundment today. Since 2018, the beaver complex has expanded. An afterbay was added to the primary dam, 3 additional dams were built to the south, and two additional dams were built to the north. Beaver activity has expanded beyond the park boundaries, both upstream and downstream. Follow the link below to view 'before and after' imagery. Zoom in on the beaver influenced version to see in high resolution the resultant changes.
https://storymaps.arcgis.com/stories/90579f7b158049e4b62a0e4a72f6666a

In retrospect, the park serves as a likely beaver destination, and a fortunate one as well. Low-gradient stream corridors with intact, native plant communities is preferred beaver habitat. Land conversion and infrastructure conflicts have taken much of this habitat out of play within the Champlain Valley. At this site, a potential infrastructure conflict exists at the south end of the park, where the stream flows under Shelburne Falls road. However, beavers have constructed dams immediate upstream and downstream of the box culvert. They have little incentive to block the culvert, and for the time being, pose little risk to Shelburne Falls road. The beaver complex extends the entire length of the park, approximately 2300 ft. It also extends into the parcels north and south of the park, [the north parcel is conserved by Vermont Land Trust.]

Beaver activity has transformed a severely incised stream channel with disconnected floodplains and seasonally dry stream beds into a dynamic and complex aquatic habitat. Zones of inundation, shallow emergent vegetation, and complex flow paths abound. Floodplains have been reconnected, and incision ratios reduced. Per the parameters established by Vermont Functioning

Floodplain Initiative (FFI), these transformations equate to substantial and quantifiable phosphorus flow reductions. ***Calculations indicate a P benefit of 25-30 kilograms per year.***

Quantitative Assessment

On March 4, 2024, a drone survey was conducted to better qualify and quantify the changes to the stream corridor imparted by the beaver complex. Drone mapping was accomplished using a DJI Mavic 3M drone to collect 20MP images along pre-planned transects with 80/80 side/front overlap. The drone is equipped with a high-resolution Real Time Kinematic (RTK) GPS unit with corrections supplied by the VTrans CORS reference network. Additionally, to increase accuracy Ground Control Points (GCPs, visible markers) were placed on the ground and locations collected using an RTK GPS system consisting of base and rover GPS units with sub-centimeter accuracy (corrections for these units were also supplied by the VTrans CORS network).

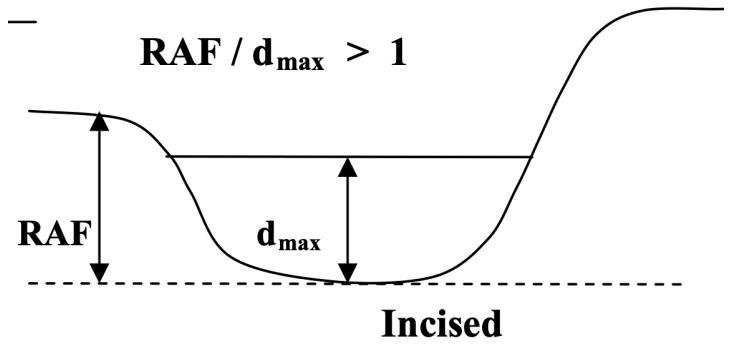
Imagery was stitched together, flattened, and georeferenced to create an orthoimage at a resolution of approximately 0.75" / pixel. The imagery was imported to esri's ArcGIS Pro for further quality control with respect to georeferencing (alignment to durable hardscape easily visible features was used in addition to the GCPs to ensure spatial accuracy for measurements, etc.).

Floodplain Reconnection: In the image, the series of dams are pinned. In addition to the dams, the areas of inundation created by the each dam is apparent. To measure floodplain reconnection, we are using the area of inundation as a proxy, which will give a conservative estimate of floodplain reconnection, by FFI standards. The 1' Lidar contour lines have been superimposed on the image. These serve as reference lines to help identify a contour that aligns with the area inundation. For each dam, a polygon that followed the reference contour lines was established, with the dam setting the elevation and serving as the downstream extent (see table 1.)

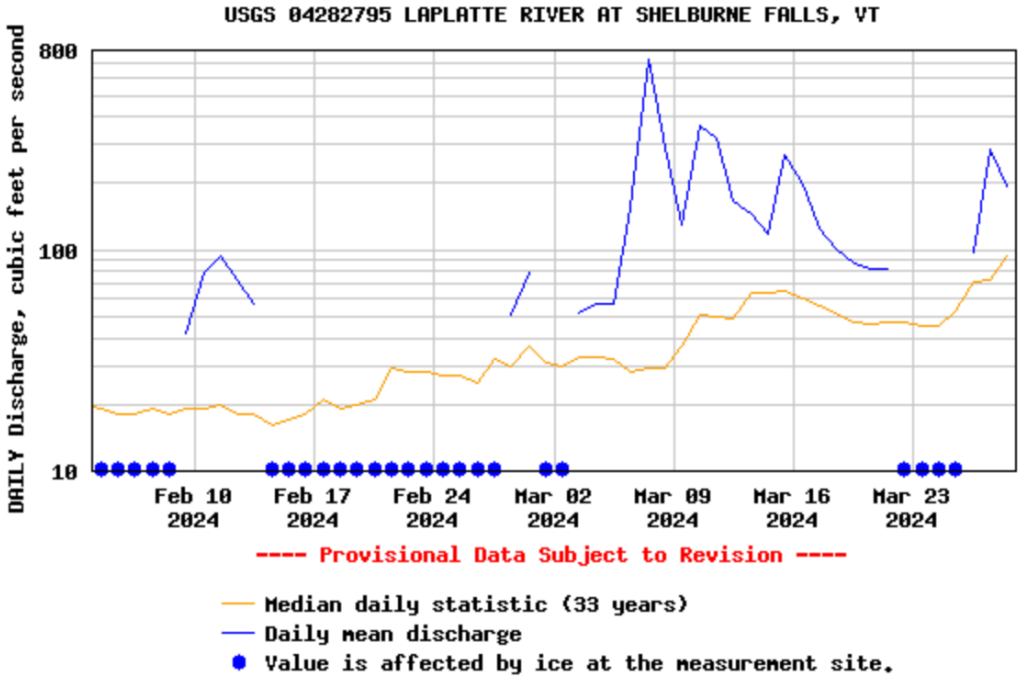
	elevation	inundation area (ft2)
dam 1 (south)	331	15,600
dam 2	333	76,700
dam 3 afterbay	334	9200
dam 4 main pond	337	149,800
dam 5 (north)	338	15,800
TOTAL		267,100
Acres of inundation		6.1

Incision Ratio: Per the Vermont Geomorphic Stream Assessment Phase 2 Handbook, incision ratio is calculated by dividing the elevation of the recently abandoned floodplain (RAF) by the bankful depth (dmax). The handbook states that a ratio greater than 1 indicates an incised stream. Few if any streams in the Champlain Valley can meet this standard.

Pre-beaver, the incision ratio of the Geprags stream was > 3. This can be determined by measuring the channel geometry and calculating the flows that would be generated by the watershed (there may be geomorphic assessments with the Vermont Gas Pipeline project.) While much of the stream channel geometry is intact, the bankful conditions have drastically increased, driving the incision ratio back to 1. This is pretty typical for an active beaver complex, particularly in a low gradient system.



Monitored Flows: the drone imagery was obtained on March 4. Typically, March 4 could yield high flows due to spring runoff. The closest and likely most relevant stream gauge is the Shelburne Falls gauge on the LaPlatte River, approximately 7.5 stream miles (downstream) from the park. Referring to the flow graph below, it looks as though the flows on March 4 were in the 50-60 cubic feet per second. Flow readings two days before were impeded by ice, and flows approximately 2 days after spiked at 790 ft3/s.

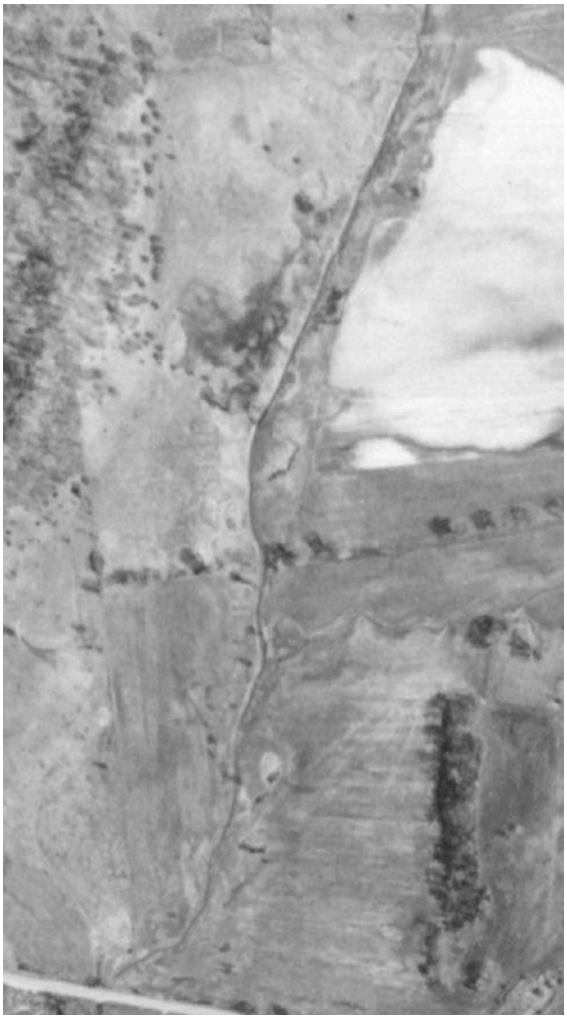


Discussion

This method of analysis is extremely conservative in estimating area of floodplain connection. The beaver colony is active, and the area of inundation has likely expanded since March 4. Incision ratios have been drastically reduced, by any measure. By standards established within FFI, this is a wildly successful stream restoration project. Floodplain reconnection is the accepted proxy for phosphorus reduction - and based on quantifiable floodplain reconnection, this site should absolutely be evaluated and credited for phosphorus reduction within the Lake Champlain Watershed.

Beaver colonies are not forever, and the tenure can be unpredictable. Decisions to maintain or abandon rests with the beavers, as colony success is based on successful reproduction, food availability, ability to fend off predation. That said, humans often have the final say, particularly in areas of higher population density like the Champlain Valley.

Beavers clearly have done the heavy lifting in restoring this streamscape. They have seemingly restored these ecosystem services, and provided a multitude of co-benefits at no cost. However, beavers did not magically appear in Geprags Park, nor was it an arbitrary decision on the part of beavers to colonize Geprags Park. The stream channel has persisted for years in a degraded condition, the legacy of the ill-informed landuse practices.



1962 aerial survey

The channel has maintained the pre-beaver incised condition since 1962, at least. Left to geomorphic processes alone, this degraded condition could easily persist for another 63 years. While the stream channel languished, the riparian plant community and the adjoining woods were allowed to regenerate. This regeneration resulted in a largely native plant community (a rarity for the Champlain Valley). This native plant community is key to the riverscape restoration, as non-native woody vegetation does not serve as a food source for beavers. This plant community was nearly lost 8 years ago, when Vermont Gas attempted to lay a pipeline through the stream corridor. This operation would have removed, at minimum, a 60' wide swath of vegetation, and would have created additional zones of disturbance and soil compaction as well. The capacity for this site to support beavers would have been severely compromised.

Compensatory Costs

While this project does not conform to standard project models, there are a range of costs associated with it that warrant compensation.

1. Direct costs associated with survey, documentation, and spatial analysis; this is fairly straight forward, and mirrors expenses incurred in a standard restoration project.
2. Anticipated expenses associated with installation of beaver coexistence strategies. Beaver complexes of scale will likely raise concerns about infrastructure conflicts, particularly in the Champlain Valley. These conflicts often can be anticipated and mitigated. There are

practitioners in Vermont whom are knowledgable and skilled in installing devices to resolve conflicts.

3. Opportunity cost incurred by landowners. Much of the highest value beaver habitat in the Champlain Valley has been converted to uses incompatible with beaver. In Hinesburg, much of this habitat has been converted to agriculture, transportation infrastructure, and housing. Even in cases when these practices have been abandoned (agriculture), the beaver incompatibility persist.
4. Landowners whom, either by choice or chance, avoided these practices, also missed out on the economic benefits that these practices typically render. In the case of Geprags Park, it was the foresight of the Geprags sisters who conserved the land, and of the Hinesburg Conservation Commission that pushed for protections of these lands under threat of pipeline construction.

	Channel and Floodplain Dynamics	**Property Considerations**	**Costs...**
Floodplain/Stream Restoration - Initial Survey and Preliminary Design	- Determine physical extent of beaver complex - Evaluate channel for expansion potential - Evaluate site for carrying capacity - Survey exposed channel for incision ratios - Check FFI data for phase 2 info	- establish legal property lines - Evaluate for existing and/or potential infrastructure conflicts - Execute title earch - Contact adjoining land owners	TBD
Floodplain/Stream Restoration - Current floodplain reconnection and Final Design	- Conduct remote sensing - Calculate current floodplain reconnection - Establish management plan for floodplain plant community; NNIP control, legacy tree protection - Establish beaver coexistence strategy (BCS) plan; flow control, infrastructure protection	- Draft O&M plan - Develop signage - Resolve any title issues/ easement issues	TBD
Floodplain/Stream Restoration - Implementation	- Conduct annual remote sensing to establish changes in floodplain reconnection - Execute plant community management plan - Execute BCS plan as needed	- Post management area - Monitor for violations	TBD