Legacy Sediment Removal Projects

Big Spring Run Project

One of the most comprehensive long-term monitoring studies of a floodplain restoration project is the Big Spring Run project in Pennsylvania, which investigated ecosystem responses to a project that removed legacy sediments from the valley bottom. The initial research findings are described in a series of papers and presentations by Langland et al. (2020), Forshay et al. (2019), Hartranft et al. (2011) and Hartranft (2019), Fleming et al. (2019).

A team of researchers investigated the long-term improvements in ecosystem functions in floodplain restoration projects featuring removal of legacy sediments. The impaired stream reach was about 3,000 feet in length and had a contributing drainage area of about 1,000 acres. Approximately 22,000 tons of legacy sediment were removed from the BSR site. The BSR monitoring program and research findings are described in a series of papers by Langland, (2019), Hartranft et al (2011), Hartranft (2019) and in https://chesapeakestormwater.net/download/9913/

The restoration project was designed in the context of a wider research program on how legacy sediments have influenced stream and floodplain functions in Pennsylvania valley bottoms. Some notable references include Merritts et al (2010, 2011), Walters et al (2007) and Walter and Merritts (2008). Another watershed perspective on floodplain connection research was summarized in a recent Chesapeake Bay Program STAC workshop (Miller et al, 2019). The following section summarizes key research findings on how the BSR restoration project performed in capturing and treating runoff, sediment and nutrients.

> *Flow and groundwater dynamics in the channel and floodplain*. Three years after restoration, surveys confirmed that the wetland-floodplain surface remained stable and there was minimal change in ground elevation (Hartranft, 2019). H&H models showed lower shear stress across the restoration reach during storms and more frequent overtopping of banks by floodwaters, at both lower flow stages and over a greater area than pre-restoration conditions (Parola and Merritts, 2014). The peak discharge rate for storms was extended by 17 minutes following restoration (Walter et al, 2019).
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> Changes in groundwater residence time were highly variable following floodplain restoration, with several wells showing an increase in residence time and others showing a decrease (Audie, 2019). Groundwater monitoring indicated that groundwater nitrate concentrations decreased after the third year following restoration, and in response to increased storage in relation to groundwater nitrogen concentrations (Forshay, 2019).

Summary of nutrient and sediment reductions reported for the Big Spring Run restoration project			
Pollutant	*Reduction*	*Percent Reduction*	*Source*
TSS Load	600 tn/yr	71%	Langland, 2019
TSS Concentration	482 mg/L/yr	87%	Langland, 2019
TP Load	1,380 lb/yr	71%	Walter et al, 2019
TP Concentration	0.15 mg/L	79%	Langland, 2019
Soluble Reactive P Load	--	37%	Forshay et al, 2019
TN Load	1,740 lb/yr	71%	Walter et al, 2019
Nitrate-N Load	--	32%	Forshay et al, 2019

Sediment and nutrient removal efficiency. Monitoring of surface water quality was conducted by USGS and EPA for three years prior to restoration and five years afterward. Prior to restoration, the stream bank erosion rate averaged 875 ton/yr across the BSR reach (Langland, 2019). The BSR project was found to highly effective in reducing both the concentration and mass loads of upstream nutrient and sediments.

Decreases in suspended sediment and dissolved phosphorus were observed the year immediately following restoration (Langland 2019; Forshay, 2019), while surface water nitrate decreased gradually over the five-year monitoring period. Nitrate removal is closely tied to organic carbon availability; the delayed nitrate improvements were attributed to the lag time for floodplain vegetation to develop and mature after restoration (Forshay, 2019).

Local Co-Benefits of Floodplain Reconnection

When done properly, floodplain restoration can create many environmental co-benefits in the riparian corridor beyond pollutant removal, when compared to pre-restoration conditions. Many of these local co-benefits have been documented at Big Spring Run and other PA LSR restoration sites (Hartranft, 2019) and may include:

- Surface water thermal regulation (i.e., cooler summer stream temperatures, Land Studies, 2016)
- Improved stream clarity (i.e., reduced turbidity)
- Detention of extreme flood events (Land Studies, 2017)
- Lower flood peak discharges from floods (Land Studies, 2017).
- Carbon sequestration in the floodplain and particulate carbon retention in stream channel
- Restoration of stream, wetland and riparian aquatic ecosystems
- Restored native plant and animal species diversity and habitat
- Wetland bird, wildlife and pollinator habitat restoration
- Increased groundwater recharge rates
- Increased baseflow in stream and more resilience to drought
- Increased hydrophytic vegetation biomass and species richness

- Restored habitat for threatened and endangered species, such as bog turtles

Other community co-benefits that are often associated with well-designed FR-LSR projects include:

- Reduced damage to public infrastructure, such as roads and sewers
- Reduced flood water surface elevations especially for more frequent storm events
- Creation of an open space amenity and potential greenway/trail corridor
- Can be a cost-effective option in relation to other urban BMPs used to meet MS4 sediment and nutrient pollutant reduction targets (Fleming et al, 2019)

Obviously, the degree of environmental and community benefits created by any floodplain restoration project are strongly influenced by site conditions and how it is assessed, designed, constructed and managed over time.