Downstream releases and flow management on the Swift and South Nashua Rivers

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Background

This paper presents current and historical flow regimes on the Swift and South Nashua Rivers as they are affected by releases from the Quabbin and Wachusett Reservoirs, and explores how changes in release management could be used to better replicate natural flow regimes on these two rivers. The paper does not address the question of whether changes in release management should be conditioned in any way on expansion of the Massachusetts Water Resources Authority (MWRA) system, instead taking the position that questions of release management and system expansion should each be informed by science relevant to the particular question. However, release management and system expansion are linked at least physically in the sense that water released to rivers is not currently available for distribution to municipalities. This paper thus explores the question how meaningful improvements in downstream release management might be achieved while still preserving the "capital" of a clean and abundant water supply for potential expansion needs.

Increasing and naturalizing flow in rivers is an important environmental priority in Massachusetts, particularly in the most developed areas of the state. About 160 rivers in Massachusetts are classified as "flow impaired", despite the region receiving about 44 inches of rain a year. Even as water use efficiency increases, development entails increasing use of ground- and surface-water, while sewering and impervious surface area reduce groundwater recharge and expedite flows, creating unnatural peaks in the hydrograph. Reduced river flow not only reduces habitat space, but also allows pollutants introduced by discharges, atmospheric deposition, and runoff to remain inadequately diluted. Climate change is likely to exacerbate these impacts, as increased temperatures, drought and flooding stress riverine ecosystems to an extent not yet seen.

There are many efforts underway in Massachusetts to address the root causes of flow stress on rivers, including state programs to encourage water conservation and development approaches that promote local recharge of stormwater. In a few instances *where reservoir systems are themselves not stressed*, proactive reservoir management can also help restore more natural flows. In the MWRA system, water conservation efforts and leak repair have reduced system water use to historical lows, and water is being released from the Quabbin and Wachusett Reservoirs at commensurately high levels, suggesting it may be possible to adjust reservoir management to better assure minimum flows in the Swift and Nashua Rivers. Restoration of more natural flow regimes could not only help assure minimum flows, but could also enhance seasonal variability to promote high and low flows, riffles and pools, and changes in temperature and substrate that provide dynamic niches for riparian vegetation, and the correct cues and conditions for spawning and hatching of fish, amphibians, and their invertebrate prey.

A combination of reduced public water supply use by the MWRA and high precipitation has meant that Quabbin spillage to the Swift has been high in recent years. While the registered volume for the MWRA system is 312 mgd, and the stated safe yield of the system is 300 mgd, water use in the MWRA system has fallen to 220 mgd in 2007 to 206 mgd in 2008 (although low usage in that year was due in part to precipitation levels that were 41% higher than normal, reducing outdoor water use).[2] As a consequence, Swift River flows in the four years of 2005 to 2008 have been historically high, and the river's hydrograph has been showing a large spring speak (Figure 2) closer to that of an undammed system than previously.

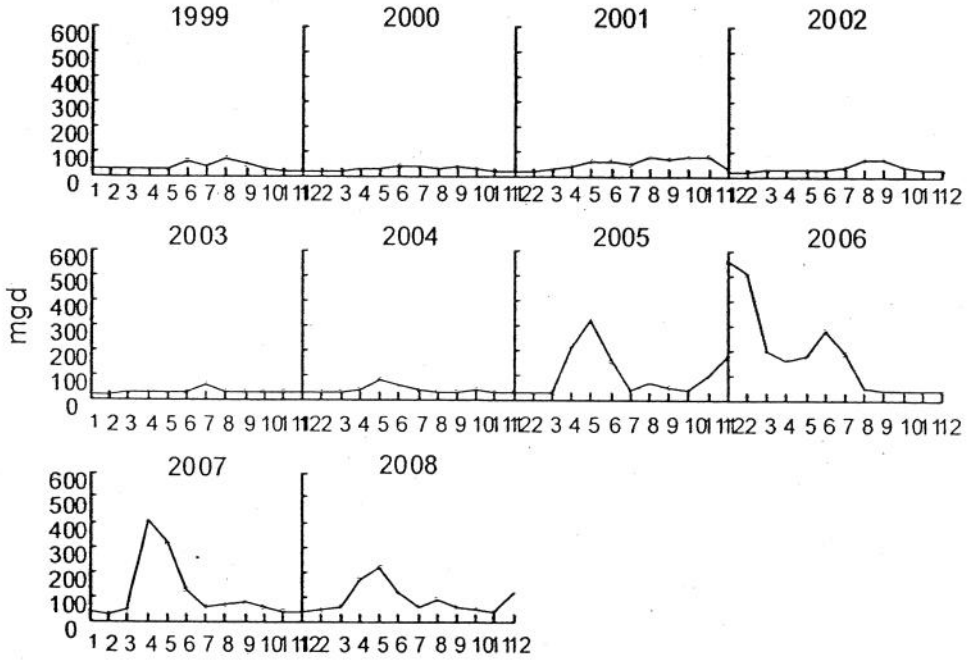

Figure 2. Ten years of monthly average flow on the Swift River (million gallons per day)

Proposals for flow management on the Swift River

Relatively few concrete proposals have been put forward for how flow regimes might be differently managed on the Swift River, although agreement that flow management is a priority has extended to the highest levels, with Secretary of the Environment Robert Golledge stating in a 2007 letter to MWRA that a priority for "surplus" water in the reservoirs should be to ensure the robust health of the riverine systems of the Swift and Nashua rivers. Substantial amounts of water spilling at Quabbin in the last four years have achieved a more natural-looking hydrograph, due both to successful demand management and abundant precipitation, although the latter condition is likely only temporary. One option that has been informally discussed by some environmental groups is abolition of the War Department permit that mandates summer releases in response to

[2] Nvule, Estes-Smargiassi, and Orfeo. Staff summary to the MWRA Board of Directors, January 14, 2009.

River were reduced 24% by the damming of the Swift, decreasing from 1,169 cfs for the 1929 – 1938 period to 890 cfs for the 1940 – 2008 period. However, average yearly flows on the Chicopee River for the 2005 – 2008 period, a period of high spring flows, were 1,251 cfs, higher than historical levels. Even flows during the 15-year 1994 – 2008 period were 1,019 cfs, 87% of pre-Quabbin flows. Water quality impairments from CSO's occur during wet-weather periods when natural streamflow is likely to be highest, and since it is unlikely that Quabbin would be managed to provide even more flow during the spring runoff period when the most spilling is already happening, it is not clear what role additional water from the Swift would play at the present time in reducing pollutant concentrations in the spring. Of course, the spillage of recent history is not guaranteed to continue, so providing for an ongoing peak in spring releases even under drier conditions could potentially support continued water quality improvements on the Chicopee River. Further, there is also currently room for improvement in release management in the autumn, since the Swift River rarely shows the increase in autumn flows typical for river systems in New England. In discussing how flows on the Swift could be further naturalized, it is important to keep in mind that some objectives may conflict with others. For instance, any plan that reduced flows on the Swift River, for instance by eliminating the June 1 – November 30 releases that occur to satisfy the War Department permit, would decrease the amount of fresh water entering the Chicopee and the concomitant dilution of pollutants that currently occurs between June and November.

Wachusett Reservoir and the South Nashua River

Current releases and flows on the South Nashua River

Releases from Wachusett Reservoir to the South Nashua River are mandated under an 1895 act which requires the weekly release of 12 million gallons a week, or 1.71 mgd (2.6 cfs). Approximately another 0.4 mgd is transferred to Lancaster Mills and from there to the river downstream of the dam. Including seepage that occurs under the dam, combined flows at the new USGS gage[5] installed near the Clinton wastewater treatment plant typically range from 4 to over 13 cfs when minimum releases are made. Higher releases from the dam are made according to inflows to the reservoir, and tend to be discharged in 25 million gallon increments, up to about 100 mgd (154.7 cfs). After a request from watershed advocates, releases occurring at the highest levels are now attained gradually, 25 million gallons at a time.

Releases from Wachusett are often made to accommodate large transfers of Quabbin water (Figure 3).

[5] MWRA requested that USGS install this new gage to better understand the role of releases in flows on the Nashua River

Flow patterns on the South Nashua River clearly differ from a typical hydrograph. Comparison with the aquatic base flow standards for New England [6] (at 0.5 cfsm for summer, 1.0 cfsm for fall and winter, and 4.0 cfsm for spring) shows that flows on the South Nashua are relatively low in winter months, and high in summer months. The USGS Streamstats tool estimates August median flows on a hypothetical undammed South Nashua River at 32 cfs, or 0.26 cfsm, considerably lower than the 1.0 – 1.4 cfsm seen in 2007 and 2008.

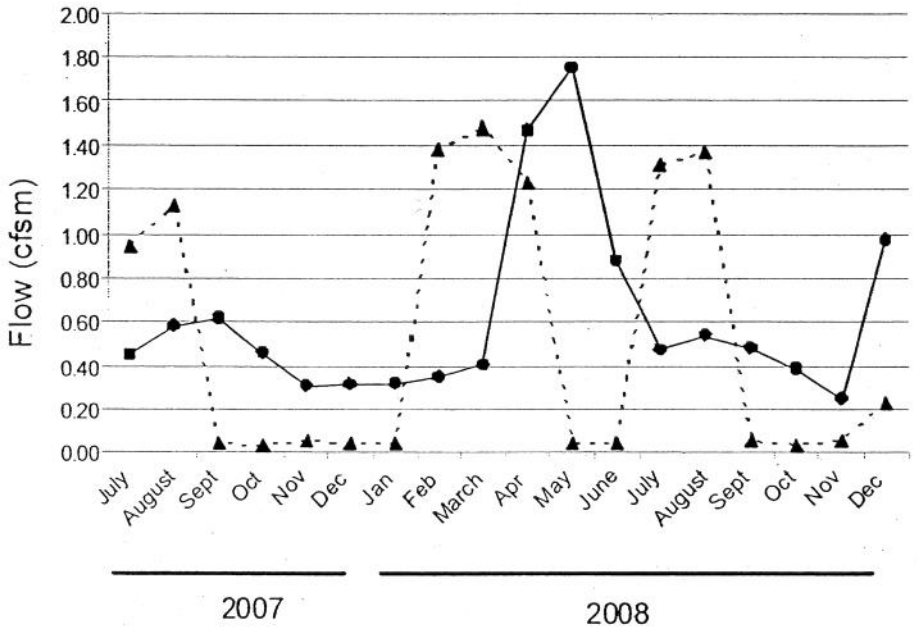

Figure 4. Median monthly flows in the South Nashua River (dotted line, triangles) and Swift River (solid line, circles) in cubic feet per second, divided by watershed area (in square miles).

The 7Q10 flow (i.e. the consecutive seven-day low flow with a ten year return frequency) on an undammed South Nashua would be 8.1 cfs (5.2 mgd), slightly higher than the average flow of 6 cfs (3.9 mgd) measured at the USGS gage when the dam is making the minimum release of 1.7 to 1.8 mgd.

Proposals for flow management on the South Nashua River

Although flows on the South Nashua are clearly low for the size of the basin, few specific proposals for release management have been put forward, in part due to a need for more information. The 2003 Water Quality Assessment Report for the Nashua River

[6] Armstrong, D.S. et al. 2004. Evaluation of streamflow requirement for habitat protection by comparison to streamflow characteristics at index streamflow-gaging stations in Southern New England. USGS Water-Resources Investigations Report 03-4332. Aquatic baseflow standards are simply guidelines; for instance, some rivers in Massachusetts naturally show flows lower than the summer standard.

How much water is required?

It is probably premature to estimate of the amount of water needed to achieve meaningful ecological restoration on either the Swift or South Nashua rivers, since several factors must be weighed including MWRA's operational capabilities. Given that large releases will continue to be made from Wachusett Reservoir during any season in the foreseeable future, an important question is what the goals should be for restoration on the South Nashua, if true flow naturalization is not possible. Re-convening the stakeholders task force for the South Nashua River is one way this issue could be again brought to the fore. Further, the proposal to install hydropower at the Wachusett dam will likely entail some scrutiny of downstream conditions. Further study of the Swift River would also help to determine how downstream releases should be managed in a changing environment where possibly more water is moved to the Wachusett Reservoir to support releases there. The most balanced outcome will likely result if the MWRA water system is considered as a whole by those interested in increased downstream releases, just as it is by MWRA itself, to avoid the "interests" of one downstream community outweighing those of another.

Finally, with talk of the need for increased downstream releases it is sometimes possible to forget that all water in excess of reservoir capacity is now currently released at both MWRA reservoirs. Thus, discussion of meeting ecosystem goals is mostly a discussion of how current releases can be reallocated. It is a real concern on the part of MWRA that any agreement to changes in release management will limit the Authority's flexibility in the future and prevent resources from being reallocated. Such concerns can stand in the way of achieving an agreement about reservoir and river management. In the past, however, incremental changes in reservoir management have produced real improvements in flow regimes on the rivers, for instance when MWRA agreed to gradual ramping up and down of releases to the South Nashua. The proposal by MWRA to install hydropower at the Wachusett Dam may itself increase minimum flows, so serious and timely consideration should now be given to whether there are additional management changes that can improve the downstream ecosystems on the South Nashua and Swift rivers.

Abbreviations

7Q10	consecutive seven-day low flow with a ten-year return frequency
cfs	cubic feet per second
cfsm	cubic feet (per second) per square mile (of watershed area)
gpd	gallons per day
mgd	million gallons per day