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Low Flow Monitoring Pilot Study

An Assessment of Habitat, Water Quality, and Biological Responses to Low Flow Conditions in the Juniata River Subbasin in 2010 and 2011

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INTRODUCTION

Stream flow affects the physical structure of river ecosystems at every level, from the hydraulic conditions on the surface of an individual cobble, to the distribution of riffles and pools within a stretch of stream, to channel dimensions at the watershed scale (Hart and Finelli, 1999). Instream habitat is heavily influenced by flow-mediated physical processes, especially the movement of water and sediment within the stream channel and between the channel and floodplain (Poff and others, 1997). The natural flow regime of a stream varies in response to climate, topography, geology, land cover, soils, and geographic position within the stream network (Poff and Zimmerman, 2010). The magnitude, frequency, duration, seasonal timing, and predictability of major flow events, both low and high, are unique to individual river systems. Stream-dwelling organisms have developed adaptive strategies and behavioral mechanisms in direct response to the natural flow regimes of their native rivers (Lytle and Poff, 2004). Important life cycle events such as reproduction and migration are often closely tied to seasonal low or high flows. Maintaining natural flow regimes is therefore critical to conserving the native biodiversity of freshwater systems.

Floods and droughts are natural features of river ecosystems that occur on a relatively predictable basis throughout much of the world (Lake, 2003). Naturally occurring seasonal low flows are common in areas where precipitation varies throughout the year and are generally benign in terms of ecological impacts (Boulton, 2003). On the other hand, artificial flow reductions resulting from human activities such as groundwater abstraction, water diversion, and surface water withdrawals can create low flow conditions out of season or extend the duration and severity of natural low flow events (Dewson and others, 2007a). Extended periods of drought, whether natural or human-influenced, that significantly reduce or completely eliminate instream habitat have the potential to negatively impact the distribution and abundance of fish, macroinvertebrates, and other organisms (Humphries and Baldwin, 2003).

Both flood damage reduction and low flow mitigation planning are ongoing priorities of the Susquehanna River Basin Commission (SRBC). In recent years, SRBC has been actively involved in a number of projects that explore the ecological implications of natural and human-influenced flow alterations. In 2010, The Nature Conservancy (TNC), in partnership with SRBC and the U.S. Army Corps of Engineers (USACE), published a report identifying seasonal ecosystem flow needs for the streams and rivers of the Susquehanna River Basin (DePhilip and Moberg, 2010). The outcome of this project was a set of flow recommendations intended to protect the biological communities and key ecological processes of the Susquehanna River Basin (i.e., ecological flows) throughout the year. In addition to ecosystem flow recommendations, the study partners also proposed a number of hypotheses regarding anticipated responses of species, groups of species, or physical habitat to changing conditions during high and low flows.

As the first step towards developing and implementing a basin-wide low flow monitoring plan, SRBC staff conducted a pilot study in the Juniata River Subbasin in 2010 and 2011. The purpose of this Low Flow Monitoring (LFM) Pilot Study was to provide preliminary data to guide development of a basin-wide low flow monitoring network and to begin testing some of the hypotheses outlined in TNC's ecosystem flows report. Much of the existing knowledge regarding the effects of reduced flows in unregulated, free-flowing systems has been gathered opportunistically or anecdotally (Boulton, 2003; Lake, 2003). Observational and experimental studies to investigate the ecological effects of water extraction and diversion are even more limited, although the body of literature on the definition and potential impacts of drought is large. Managing for ecological flows is still a relatively new concept in environmental science; therefore, the results of this pilot study can potentially provide valuable information not only to SRBC, but also to state and local environmental agencies and the scientific community as a whole.

Great Trough Creek, Huntingdon Co., Pa., during baseline flow (left) and low flow (right) in 2010.

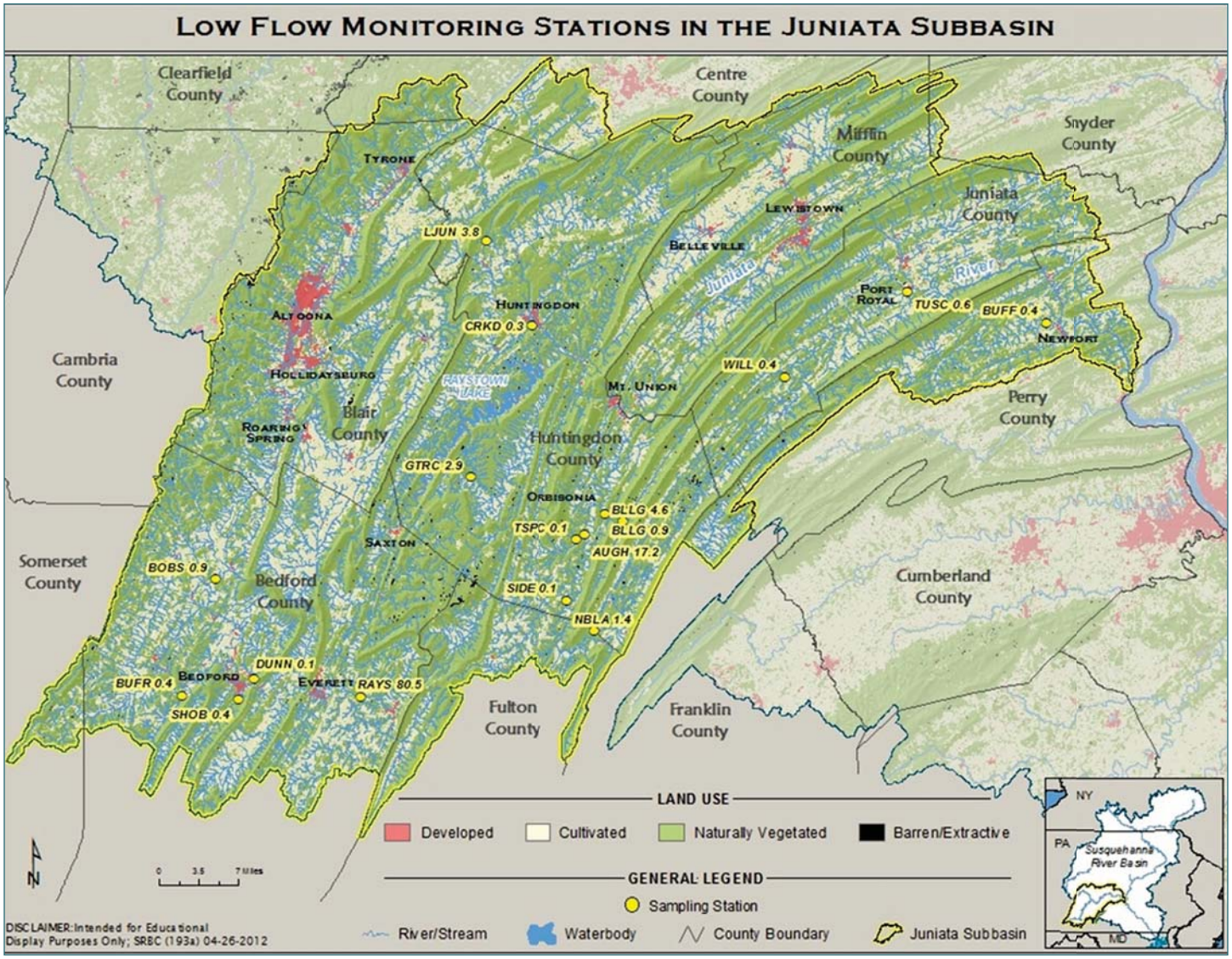

Figure 1. Location of the Low Flow Monitoring Pilot Study Stations in the Juniata River Subbasin

STUDY AREA AND MONITORING NETWORK

The Juniata River Subbasin drains an area of approximately 3,400 square miles from west of Bedford to Duncannon, Pennsylvania, which includes portions of Bedford, Blair, Fulton, Huntingdon, Perry, Juniata, and Mifflin Counties (Figure 1). Two ecoregions are found within this area: Central Appalachian Ridges and Valleys (Ecoregion 67) and Central Appalachians (Ecoregion 69) (Omernik, 1987). Ecoregion 67 is characterized by almost parallel ridges and valleys formed by folding and faulting events. The dominant geologic materials include sandstone, shale, limestone, dolomite, siltstone, chert, mudstone, and marble. The carbonate terrain characterizing this ecoregion commonly features subterranean springs and caves. Ecoregion 69 is a plateau formation typified by sandstone, shale, conglomerate, and coal geologic materials. Mining for bituminous coal has also occurred in this ecoregion, and there are some lands and streams affected by abandoned mine drainage.

Land use in the Juniata River Subbasin is mixed and includes forested areas concentrated in the ridges with agricultural and urban areas in the valleys. Many of the forested areas are managed as state forest or game lands. The largest urban center in the subbasin is Altoona; other notable developed areas include Bedford, Everett, Tyrone, Huntingdon, Mount Union, Lewistown, and Newport.

The streams of the Juniata River Subbasin are largely unregulated except for a handful of small water supply reservoirs and Raystown Lake on the Raystown Branch Juniata River, which was dammed in 1968 for flood control, hydropower, and recreational purposes. This subbasin also has the fewest number of permitted withdrawals in the Susquehanna River Basin, making it an ideal location for the LFM Pilot Study. Because there are relatively few human impacts to flow regime in the Juniata River Subbasin, differences in abiotic and biotic factors observed between summer baseline flow and low flow conditions are likely natural rather than resulting from anthropogenic inputs.