Surface Water Availability & Reliability

USGS Gages

Stream Flow

Over the years, stream flows in the Tar River Basin have been monitored at 55 United States Geological Survey (USGS) gaging stations. As of 2010, there are six active gages with long periods of record on unregulated reaches of the river, where impoundments or other man-made alterations have minimal impacts on stream flows. These six stations provide valuable flow data for drainage areas throughout the basin. Flow, often abbreviated as "Q", is measured in terms of volume of water per unit of time, usually cubic feet per second (cfs). Basic information for these gages is listed in Table 1-1 and their locations are displayed in Figure 1.

Table 1: Unregulated USGS gages in Tar River Basin

USGS Stations	Station Names	Hydrologic Unit	County	Altitude (mean sea level in feet)	Drainage Area (sq-miles)	Years of Record
02081500*	Tar River near Tar River	03020101	Granville	286.34	167	71
02081747	Tar River at Louisburg	03020101	Franklin	175.75	427	47
02082770	Swift Creek at Hillardston	03020101	Nash	129.41	166	47
02082950*	Little Fishing Creek near White Oak	03020102	Halifax	115.44	177	51
02083000*	Fishing Creek near Enfield	03020102	Edgecombe	73.23	526	84
02084557	Van Swamp near Hoke	03020104	Washington	-0.88	23	33

*** USGS stations use for long-term streamflow trend analysis.**

Historic streamflow data are available on the U.S. Geological Survey's website: http://waterdata.usgs.gov/nc/nwis/sw. Other sources of water resources data are available on the N.C. Division of Water Resources' website: http://www.ncwater.org/wrisars/textindex.php, including weekly, monthly and yearly statistical analyses and plots. The monthly average flows are presented for these unregulated gages in Figure 2. Figure 3 shows plots indicating the percentage of time over the historical record that flow at a stream gage equals or exceeds a specific value. The vertical scale shows flow in cfs and the horizontal scale shows percent of time in the flow record for each gage. For example, the plot for the Tar River at Louisburg gage indicates that flow at this location equaled or exceeded 500 cfs for 20 percent of the days in the flow record. Figure 4 characterizes the variability of flows throughout the year at each gage location by showing monthly average streamflow per square mile for the unregulated gages. Figure 5 shows streamflow variability by plotting the seasonal average streamflow for the unregulated gages. The graphs are based on daily flow data through December 2010 and show flow in cubic feet per second.

Figure 1: Map of Six Active USGS Unregulated Streamflow Gages in Tar Pamlico River Basin

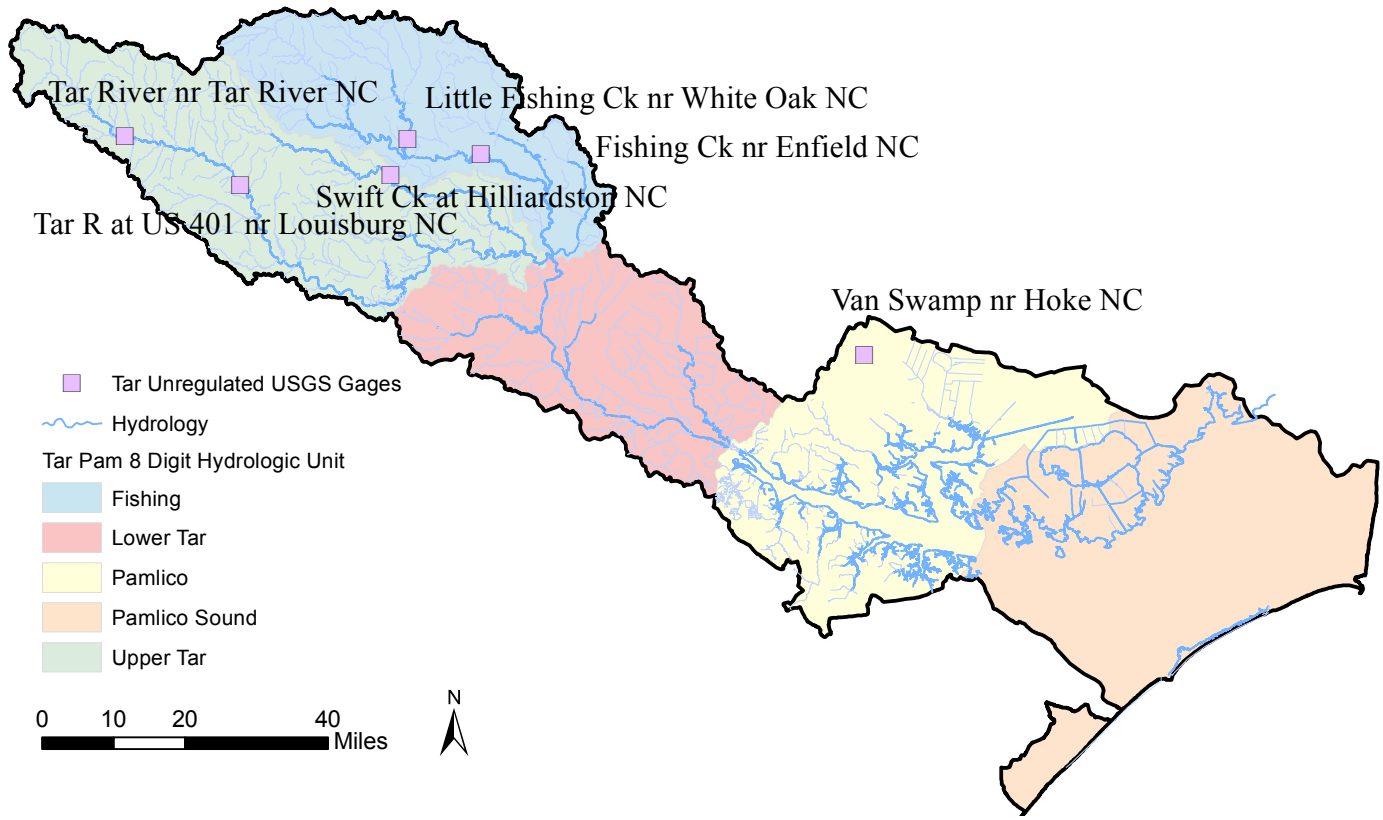


Figure 2: Monthly Average Streamflow Plots for Unregulated USGS sites

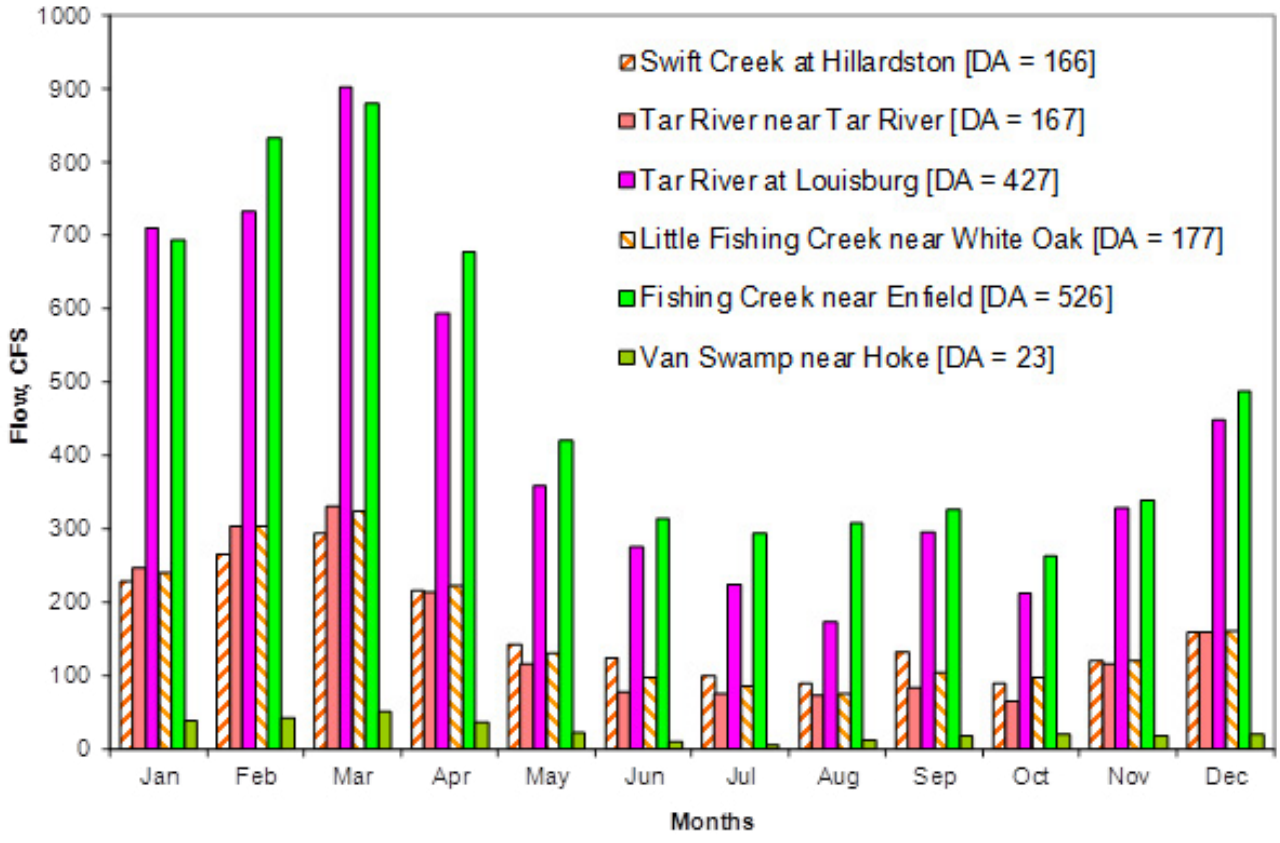


Figure 3: Plots of Flow Duration for Unregulated USGS sites

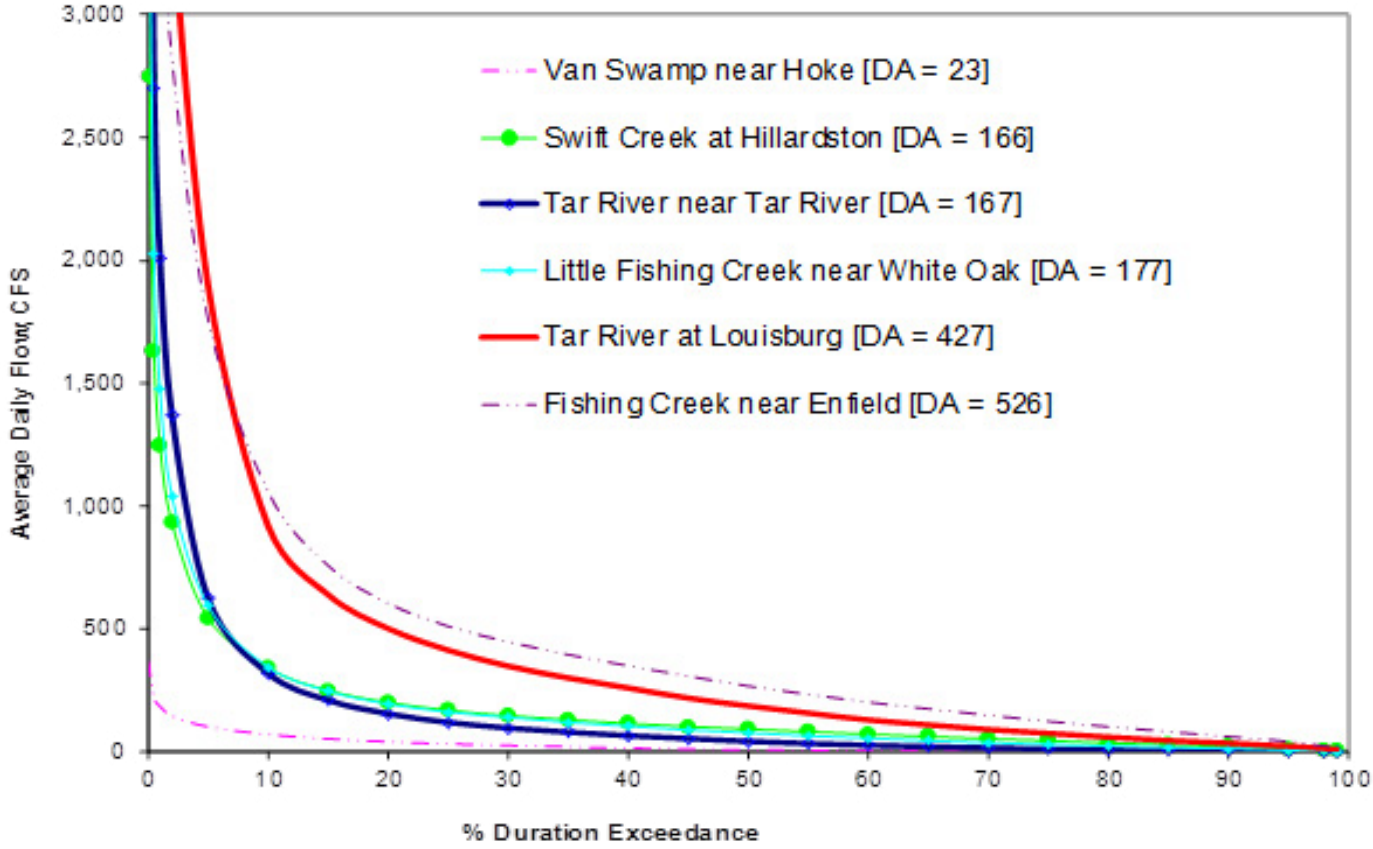


Figure 4: Monthly Average Streamflow per Square Mile for Unregulated USGS sites

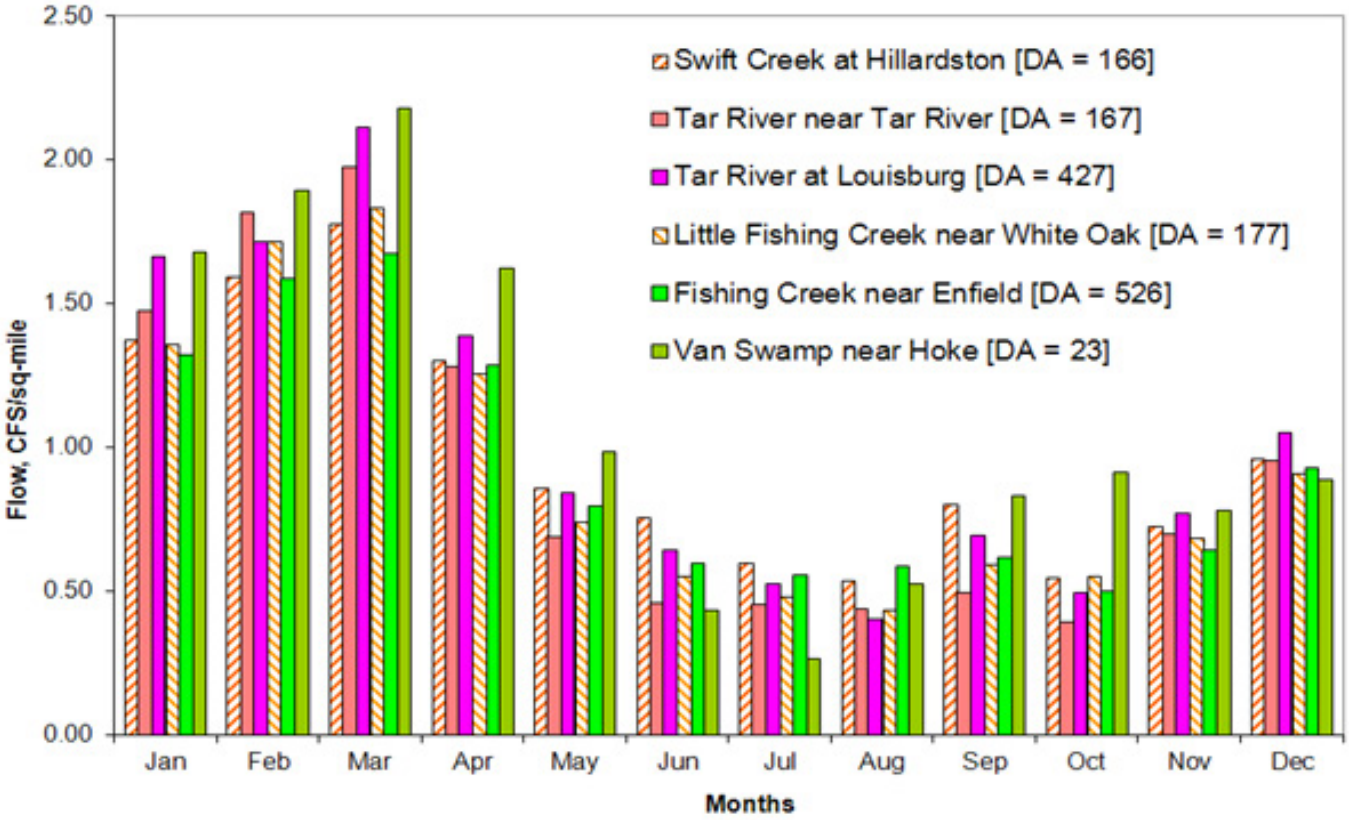
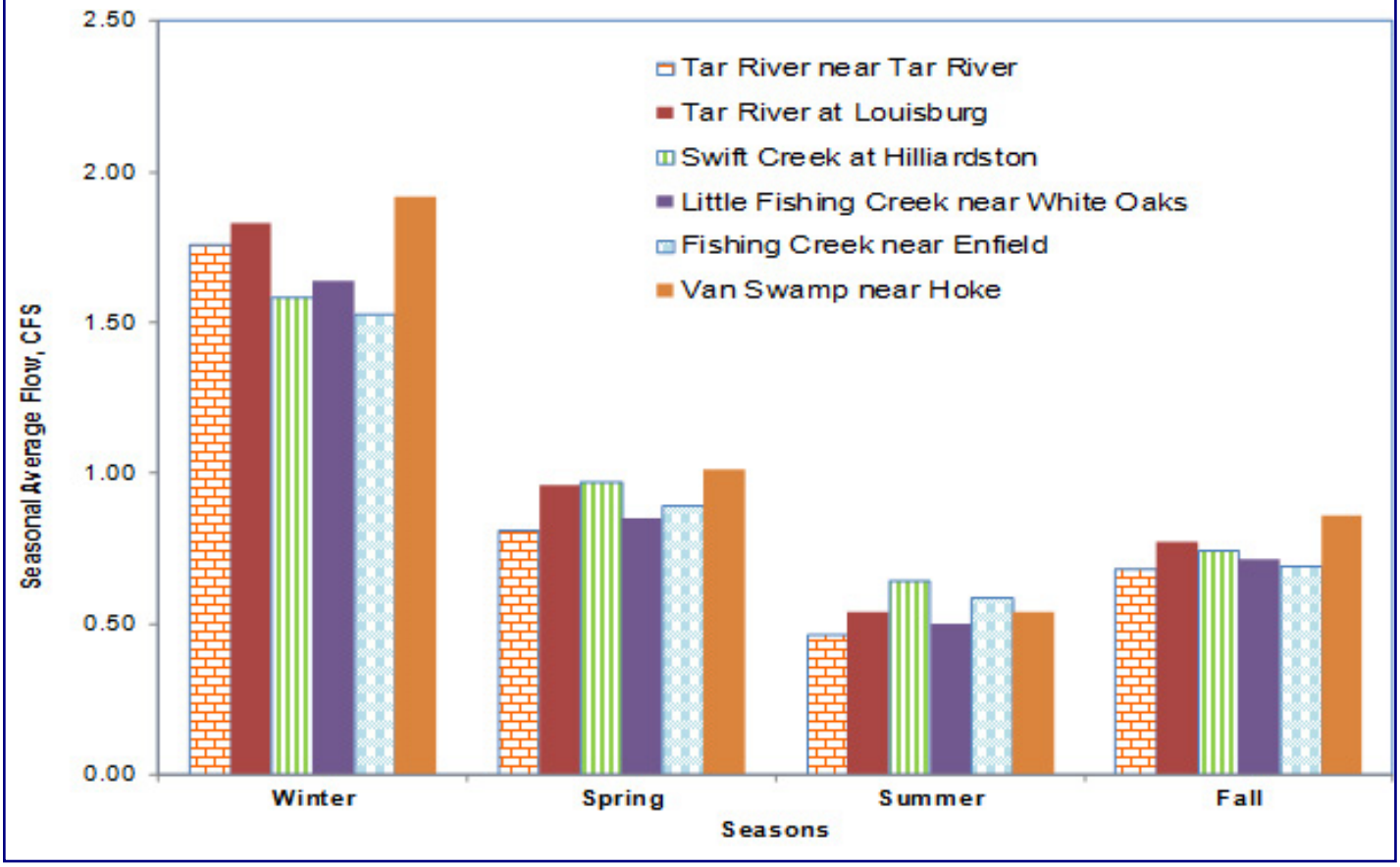


Figure 5: Seasonal Average Streamflow for Unregulated USGS sites



Long-Term Streamflow Assessment

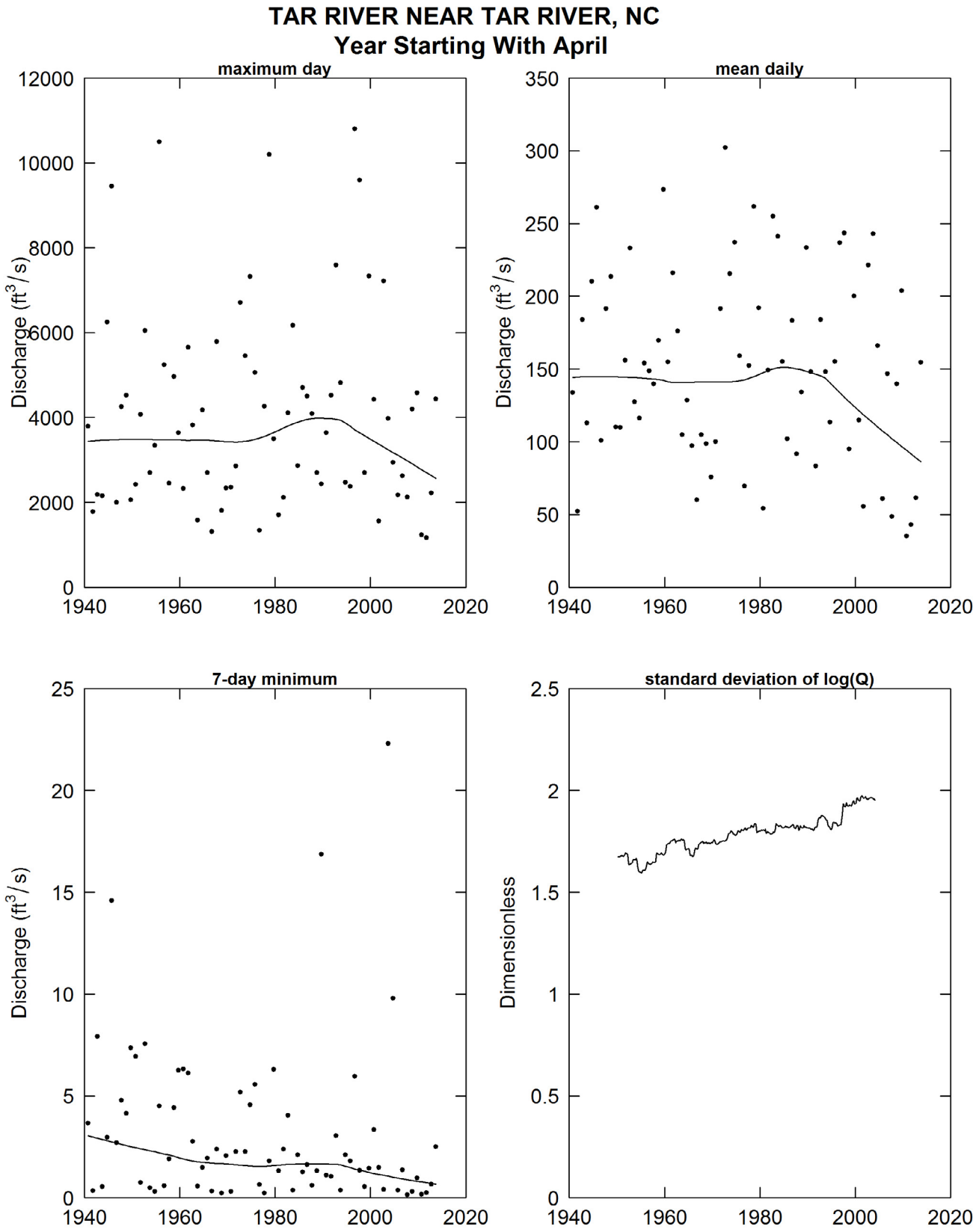
"Historically, the protection of river ecosystems have been limited in scope, emphasizing water quality and only one aspect of water quantity, minimum flow" (Poff et al., 1997). Minimum flow in North Carolina generally refers to 7Q10 and is the lowest average discharge over a period of one week with a recurrence interval of 10 years. North Carolina uses 7Q10's to determine the waste load concentration allowed in a permitted discharge to protect water quality and aquatic life and for "regulated" withdrawals limited to 20 percent of the 7Q10 ("regulated" referring to entities/users required to go through a state or federal certification process).

Flow rates and variability are well understood to be key factors in determining the health of most watersheds and the main driver of watershed ecology. According to Poff et al., (1997), the hydrology of a system can be described by five ecologically important characteristics of flow regime: magnitude of discharge, frequency of occurrence of discharge above a given level, duration of discharge of a specific flow event, predictability of a defined flow and the rate of change of flow or flashiness.

Historical streamflow records at three unregulated USGS stream gages were used to evaluate long-term streamflow changes in the Tar-Pamlico River basin (Tar River near Tar River, Little Fishing Creek near White Oak, and Fishing Creek near Enfield; see Table 1 for gage specific information and Figure 1 for station locations). The DWR Modeling and Assessment Branch used the USGS Exploration and Graphics for RivEr Trends (EGRET) tool to assess long-term changes in streamflow statistics (high flow/annual 1-day maximum, average flow/annual mean, and low flow/annual 7-day minimum)(Hirsch and De Cicco, 2015). The assessment is based on time-series smoothing methods and works best for complete daily discharge data sets of 50 years or longer.

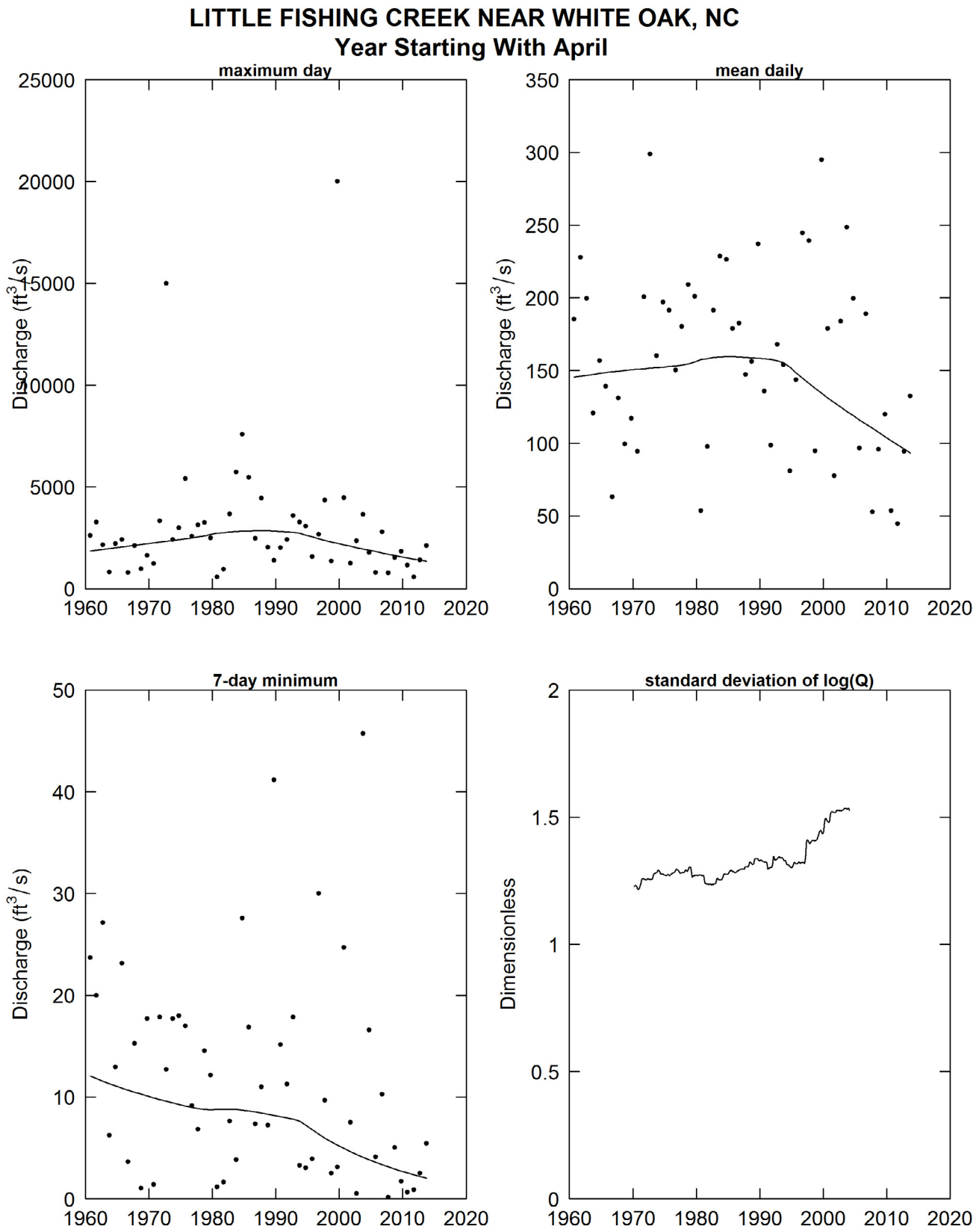
USGS developed EGRET to run using R, an open source computer language and developed a user guide which is available at http://pubs.usgs.gov/tm/04/a10/pdf/tm4A10.pdf (Hirsch and De Cicco, 2015).

Figure 6: Long-Term Streamflow Trends at USGS Station 02081500 Tar River near Tar River



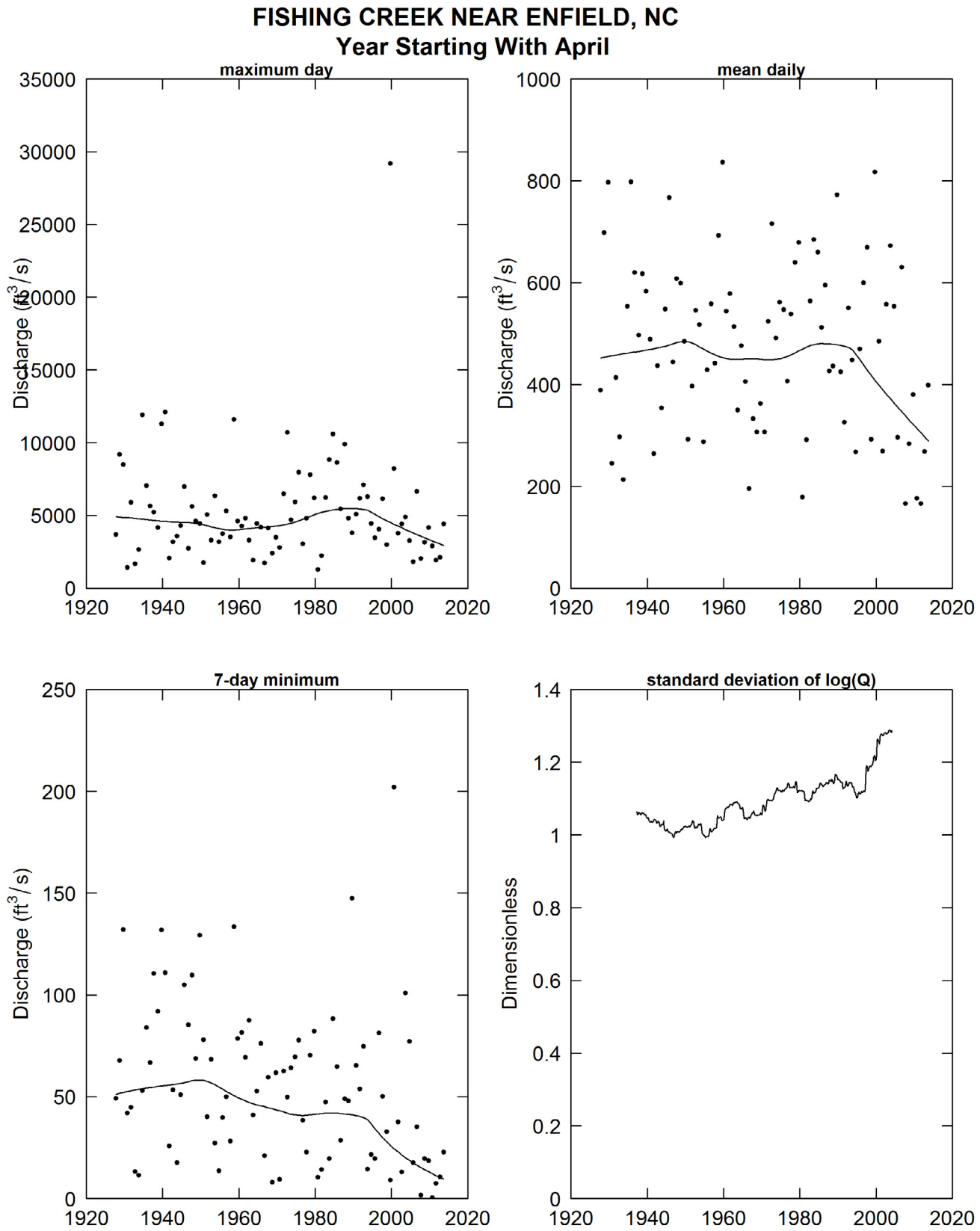
The results from the three longest term unregulated stream gaging stations were very similar. All three stations showed a declining flow trend in the annual mean, annual 7-day minimum, and annual maximum flows starting around 1990 (Figure 6, Figure 7 and Figure 8).

Figure 7: Long-Term Streamflow Trends at USGS Station 02082950 Little Fishing Creek near White Oak



The variability as seen by the increasing standard deviation overtime at all three stations indicating a larger flow difference between low flows and storm event high flows occurring in all three watersheds assessed. As climate becomes more variable, an increase in variability is expected to occur as has been demonstrated in the Tar-Pamlico River basin gage stations.

Figure 8: Long-Term Streamflow Trends at USGS Station 02083000 Fishing Creek near Enfield



The long-term streamflow trend analysis was also assessed to see if there was a seasonal variability component. The overall seasonal trends were similar to the annual average trends. The seasonal trends were more pronounced during the higher flow periods of winter and spring. It is important to note the axis scales change between seasons and flow evaluation type. All seasonal graphs are available in Appendix I(Figure 9, Figure 10, and Figure 11).

The unregulated streamflow in the Tar-Pamlico River basin are experiencing more variability with a downward trend in streamflow. These trends could due to such causes as climate variability, water management changes, land-use changes and groundwater level changes. Poff et al., (1997) describes land use activities, including timber harvesting, livestock grazing, agriculture and urbanization as often the primary causes of altered flow regimes. Additional research will be need in order to better understand the causes of the declining stream flows and increase in stream variability in the Tar-Pamlico River basin.

References

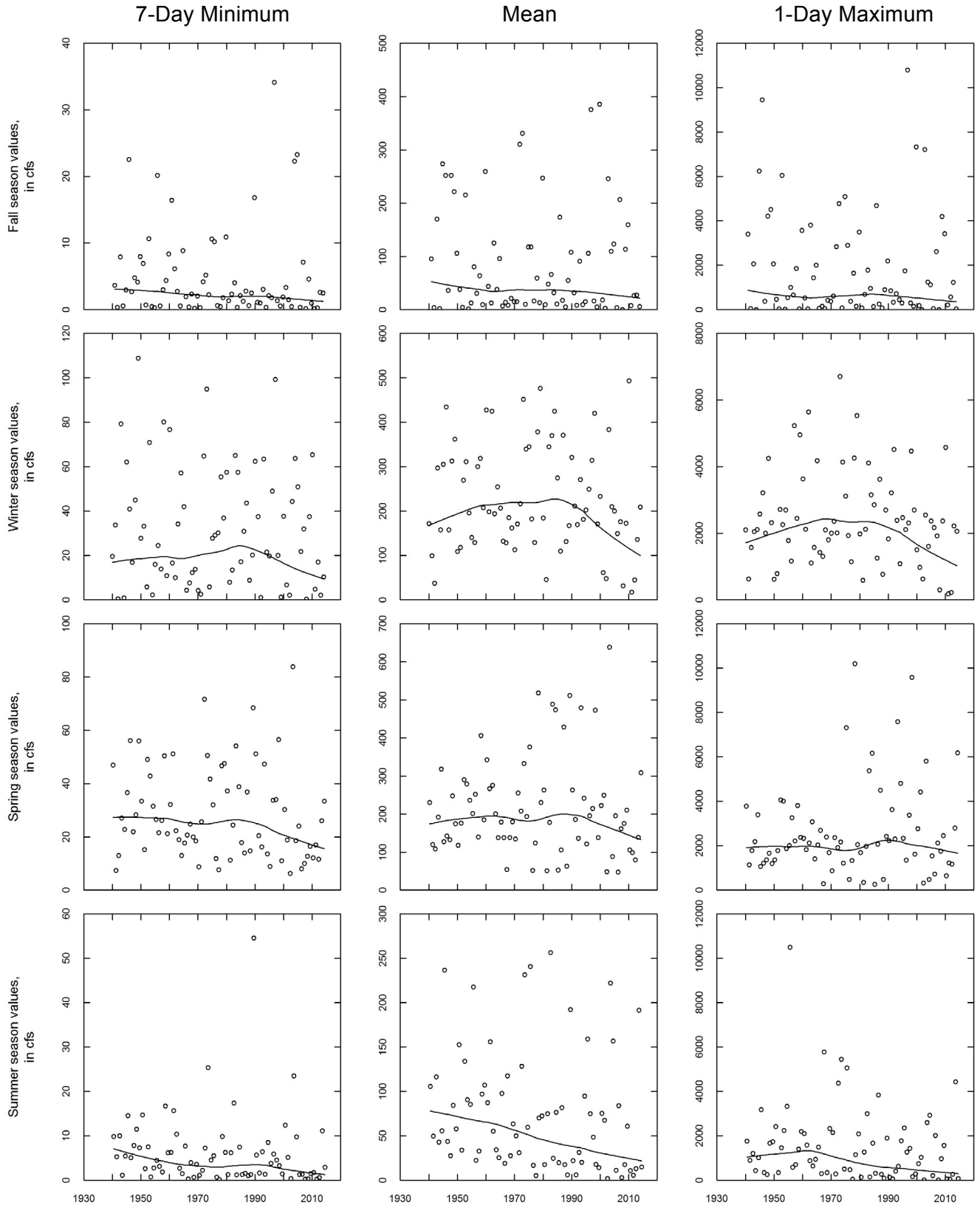
Hirsch, Robert M. and Laura De Cicco 2015. User Guide to Exploration and Graphics for RivEr Trends (EGRET) and dataRetrieval: R Packages for Hydrologic Data. U.S. Geological Survey Techniques and Methods 4-A10, Version 2.0, February 2015. http://pubs.usgs.gov/tm/04/a10/pdf/tm4A10.pdf

Poff, LeRoy N., David J. Allen, Mark B. Bain, James R. Karr, Karen L. Prestegaard, Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg 1997. The Natural Flow Regime. A Paradigm for River Conservation and Restoration. BioScience Vol. 47 (11), 769-784

Appendix I

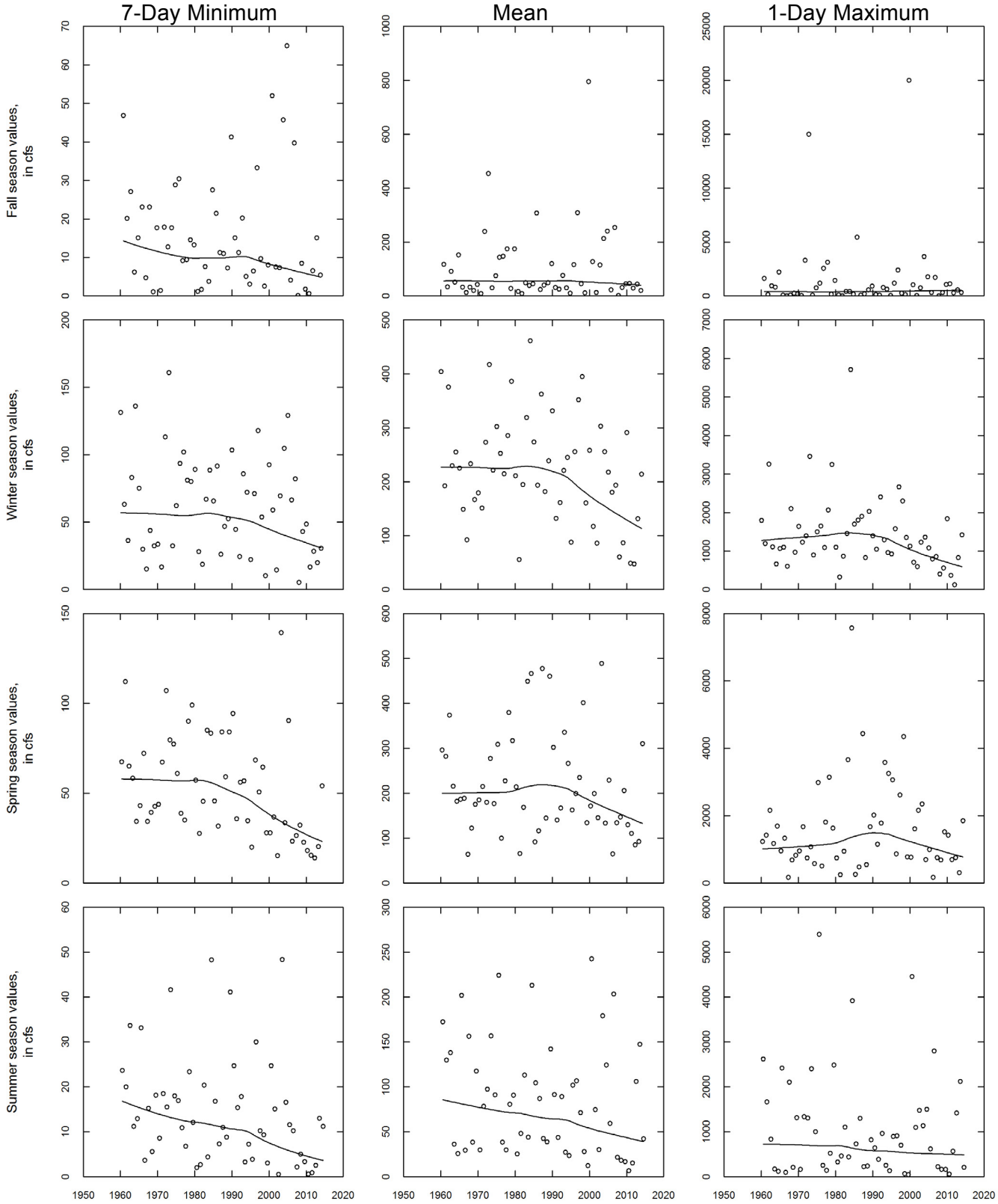
Long-Term Streamflow Seasonal Result

Figure 9: Long-Term Streamflow Seasonal Trends at USGS Station 02081500 Tar River near Tar River



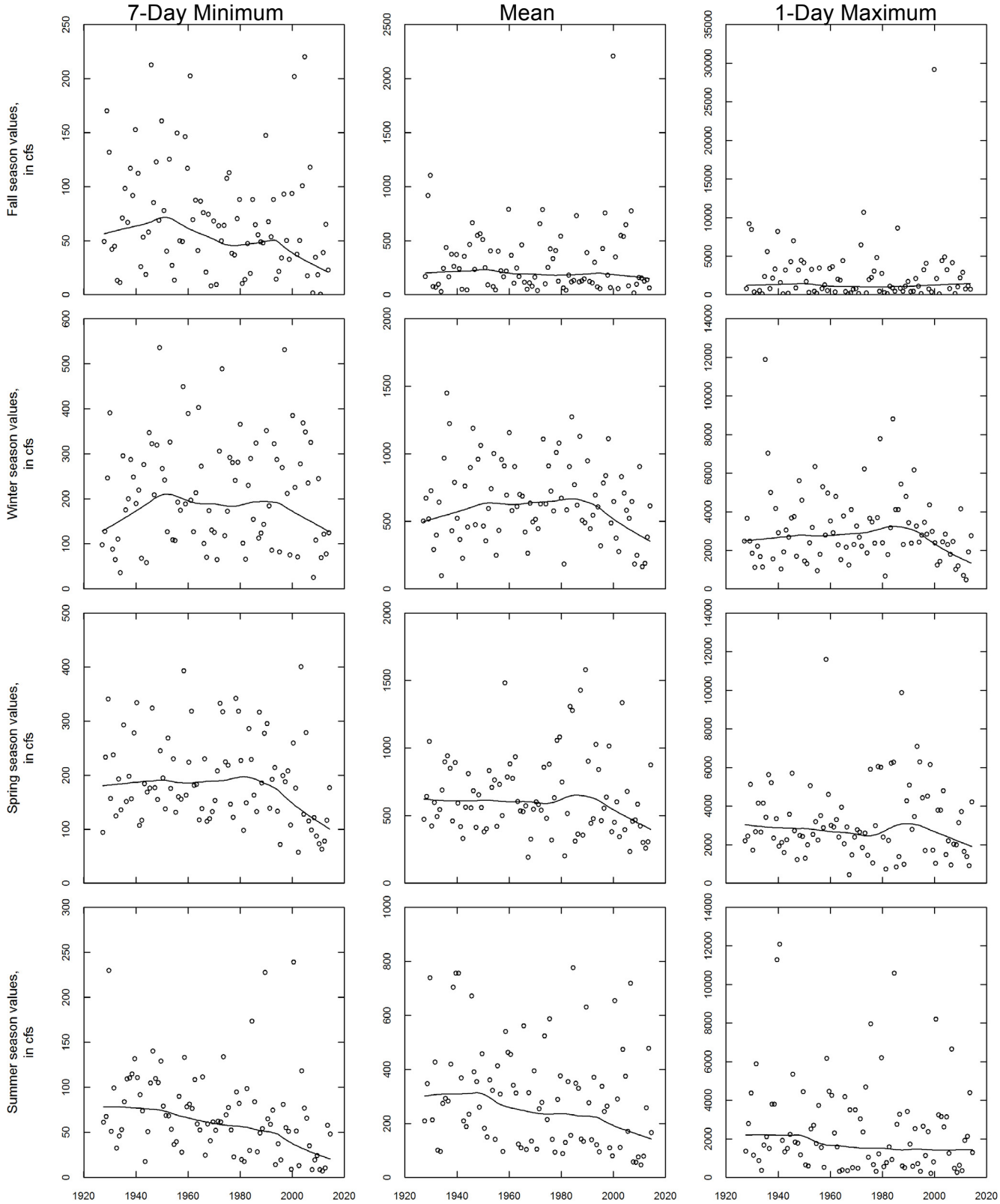
Streamflow statistics (circles) in units of cfs, annual values and seasonal values
Fall (Sept., Oct., and Nov.), Winter (Dec., Jan., and Feb.), Spring (Mar., Apr., and May), and Summer (June, July, and Aug.) and locally weighted scatterplot smooth (solid curve) for TAR RIVER NEAR TAR RIVER, NC for 1939 - 2014.

Figure 10: Long-Term Streamflow Seasonal Trends at USGS Station 02082950 Little Fishing Creek near White Oak



Streamflow statistics (circles) in units of cfs, annual values and seasonal values
Fall (Sept., Oct., and Nov.), Winter (Dec., Jan., and Feb.), Spring (Mar., Apr., and May), and Summer (June, July, and Aug.)
and locally weighted scatterplot smooth (solid curve) for LITTLE FISHING CREEK NEAR WHITE OAK, NC for 1959 - 2014.

Figure 11: Long-Term Streamflow Seasonal Trends at USGS Station 02083000 Fishing Creek near Enfield



Streamflow statistics (circles) in units of cfs, annual values and seasonal values
Fall (Sept., Oct., and Nov.), Winter (Dec., Jan., and Feb.), Spring (Mar., Apr., and May), and Summer (June, July, and Aug.)
and locally weighted scatterplot smooth (solid curve) for FISHING CREEK NEAR ENFIELD, NC for 1926 - 2014.