INSTREAM FLOW GUIDELINES AND PROTECTION OF GEORGIA'S AQUATIC HABITATS

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Abstract. The Georgia Department of Natural Resources protects environmental and economic conditions of river flows with instream flow requirements for surface water withdrawal permits. Instream flow guidelines are to be finalized by 2006. Studies of each major watershed are required for instream flow guidelines to be effective and protective. Declines in low flows in Georgia's rivers indicate that these studies will need to examine effects of climate, current permitted surface water withdrawals, water management, as well as other site-specific conditions. Final instream flow guidelines will need to protect the range of natural water level fluctuations as water supply reservoir operations become more common in managing river flows and take into account effects of groundwater withdrawals.

INTRODUCTION

Instream flow guidelines are the primary mechanism used by the Georgia Department of Natural Resources (DNR) to ensure that adequate water remains in rivers when permitting surface water withdrawals. Adequate water in ecological systems means allowing for a full range of water level fluctuations that resemble natural patterns of flow. This protects against direct impacts of withdrawals to the ecosystem such as extended periods of flow conditions that impair instream hydraulics, sediment movement, water chemistry, and biology. Lateral connections with riparian ecosystems and natural services, such as feeding areas for fish and nitrogen removal, are also maintained with adequate water. Ideally, instream flow guidelines should also protect against indirect impacts of withdrawals such as construction of new reservoirs to provide low-flow augmentation.

The Georgia DNR will finalize instream flow guidelines in 2006. There are, however, few examples nationwide of successful instream flow guidelines that are protective of rivers while providing water for growth and a healthy economy. This paper explores the current state of instream flow guidelines, issues in the assessment of instream flows, and limitations of effectiveness of instream flow guidelines due to Georgia's surface water withdrawal permitting process.

GEORGIA'S INSTREAM FLOW GUIDELINES

Instream flow is the amount of water flowing through a natural stream course that sustains the instream values at a particular level. Instream values and uses include protection of fish and wildlife habitat, migration, and propagation; outdoor recreation; navigation; hydropower generation; waste assimilation; and ecosystem maintenance (Instream Flow Council 2002). Instream flow guidelines are the requirements imposed on a surface water withdrawal permit holder that stipulate when upstream flows drop below the required instream flow at the point of withdrawal, the upstream flow is to be passed (Georgia DNR 2001).

The Environmental Protection Division (EPD) of the Georgia DNR issues surface water withdrawal permits. These permits are required for all users of water with the capacity to pump more than 100,000 gallons per day. Instream flow guidelines are applied to municipalities, industrial users, and non-federal dams. Agricultural users and releases from federal dams are exempt from Georgia instream flow requirements.

Georgia's first established instream flow guidelines in 1977 following passage of the federal Clean Water Act. The guidelines were based on 7Q10 flow (the lowest average stream flow expected to occur for seven consecutive days with an average frequency of once in ten years) and used to determine waste load allocation (Georgia DNR 1993). There was consensus among aquatic biologists, however, that more water needed to be reserved to protect aquatic habitats than was provided by

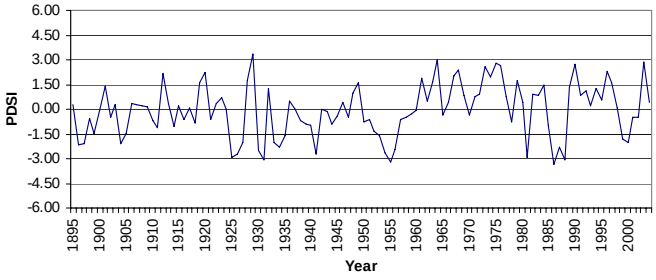

Figure 1. Palmer Drought Severity Index for North Central Georgia (Division 2). See text for index definition.

7Q10 flow. The Georgia DNR Wildlife Resources Division (WRD) and other aquatic resource experts were prompted by the 1989 Water Supply Act, a subsequent plan to construct 12 regional water supply reservoirs, the large number of listed aquatic species of concern, and other events to reevaluate the 7Q10 flow requirements (Evans and England, 1995). A working group was formed in the mid-1990's to develop new instream flow recommendations. In March 2001, these recommendations were presented jointly by the WRD and EPD as an Interim Instream Flow Protection Strategy that was accepted by the Georgia DNR board (Georgia DNR 2001).

The Interim Instream Flow Protection Strategy provides several options for a new surface water withdrawal permit new applicant or an existing permit holder seeking to enlarge their withdrawal limits (Georgia DNR 2001). The options are 1) monthly 7Q10 minimum flow, 2) mean annual flow options for regulated and unregulated streams, or 3) a site-specific instream flow study. These options generally result in relatively higher flow requirements during winter and spring months when natural flows are highest. These options are interim with final instream flow guidelines due after watershed specific studies in June 2006.

INSTREAM FLOW ASSESSMENTS

The watershed specific studies required prior to finalization of the instream flow guidelines will consider the hydrologic, physical, chemical, and biological aspects of the river as well as services provided such as municipal and industrial water supply. Study of the hydrologic conditions will be basic, however, to understanding the amount of water available for environmental and human needs. It will be important to establish the current condition of instream flows and assess how protective the 7Q10 instream flow requirements have been. These studies will assess effects of rainfall and current municipal and industrial (M&I) surface water withdrawal permits on flow.

Rainfall

Variations in the seasonality and inter-annual patterns of rainfall largely account for fluctuations in river water levels above the baseflow from groundwater discharge. The magnitude, frequency, and duration of these fluctuations are primary factors in instream values and uses of a river. Periods of low rainfall and flow are when values and uses of a river come into conflict over priority for use of the water.

The Palmer Drought Severity Index (PDSI) can be used as a measure of the amount of available water from rainfall. The PDSI is calculated based on a balance between moisture supply from rain and losses to evaporation, which is related to temperature. The index generally ranges from 6 to –6 with negative values denoting dry periods and positive values indicating wet periods. Values below –0.5 indicate increasing degrees of drought (National Climate Data Center 1994).

The average annual PDSI for north-central Georgia indicates several periods of drought in the last century (Figure 1). Most notable were droughts that extended for several years in the 1950's, 1980's, and late 1990's. These droughts occurred statewide to varying degrees, with the extent and depth of the 1950's drought generally

Table 1. Permitted Surface Water Withdrawals Subject to Instream Flow Requirements in Georgia's 14 River Basins. Rivers were classified as north or south Georgia depending on location of permits. SWP – Surface Water Withdrawal Permit. PMW – Permitted Monthly Average Withdrawal (http://www.state.ga.us/dnr/environ/; accessed 1/5/05). See text for definition of 7Q10 (http://ga2.er.usgs.gov/lowflow/; accessed 1/5/05).

River Basin	# SWP	PMW (cfs)	7Q10 (cfs)	PMW/ 7Q10
North Georgia [1]				
Chattahoochee	58	31870	1400	22.76
Coosa	55	8474	1400	6.05
Flint	31	8290	680	12.19
Ocmulgee	31	2816	410	2.25
Oconee	30	3476	570	6.10
Tallapoosa	7	32	17	1.91
Tennessee [3]	15	2	na	na
South Georgia [2]				
Altamaha [4]	62	131	2250	0.06
Ochlocknee	1	3	5	0.62
Ogeechee	2	5	240	0.02
Satilla	3	334	38	8.79
Savannah [3]	45	1977	6700	0.30
St Marys [3]	1	19	16	1.16
Suwannee	0	0	1	0

[1] North Georgia river USGS Gauge Locations (respectively): Whitesburg, Rome, Montezuma, Macon, Dublin, Tallapoosa, not available for Tennessee.
[2] South Georgia river USGS Gauge Locations (respectively): Doctortown, Thomasville, Eden, Atkinson, Clyo, Maclenny, Fargo
[3] permitted water withdrawal information does not include water use information from adjacent state
[4] including SWP from Oconee and Ocmulgee Rivers

being greater than the subsequent two droughts. These droughts were instrumental in development of the many water supply reservoirs throughout the state (Davis et al. 2001).

It is also worth noting that the periods between droughts in the last half century were extended periods of relatively wet years and water availability. Water during these times was not a limited resource. These periods coincide with development of water intensive irrigation practices in south Georgia, as well as population and economic growth in the northern portion of the state.

Surface Water Withdrawal Permits

Research has shown a clear relationship between the health of riverine biota in Piedmont rivers of Georgia and the amount of water withdrawn relative to the 7Q10 flow of the river (Freeman and Marcinek 2004). This is likely due to several factors, including extended periods of low flow and limited habitat. In addition, EPD has required water supply reservoirs to augment to 7Q10 flows to ensure a continuous water supply during low flow periods. The detrimental environmental impacts of dams could also explain the impairment of downstream riverine biota with increased water withdrawal permits (Freeman and Marcinek 2004, Davis et al. 2001).

Most surface water withdrawal permits that are subject to instream flow requirements are in north Georgia (Table 1). These permits are primarily for municipal and industrial (M&I) use and regulate the majority of water withdrawals, as there are limited agricultural withdrawals in the northern portion of the state. South Georgia has few surface water withdrawal permits for M&I use due to ready access to groundwater from the Floridan Aquifer. About 25% of permitted agricultural irrigation uses surface water in south Georgia and is not subject to instream flow regulations. Although there are direct impacts on surface water flows, groundwater permits do not instream flow or aquifer level limits for withdrawals.

Surface water withdrawals subject to instream flow requirements are the greatest relative to 7Q10 in north Georgia rivers (Table 1). With a median of about 12 times 7Q10 flow permitted for withdrawal in north Georgia rivers, as much as 22 times 7Q10 flow has been permitted for withdrawal in the Chattahoochee River. Permitted surface water withdrawals from south Georgia rivers are generally small relative to 7Q10 flow. The Satilla River is an exception in south Georgia due to large industrial water users in the basin.

Trends in Low Flows

As might be expected from having several droughts in recent years as well as increased water supply demand, flows in Georgia's rivers have declined. The declines are most notable during low flow periods that typically occur in late summer and fall. It is during these hot months with

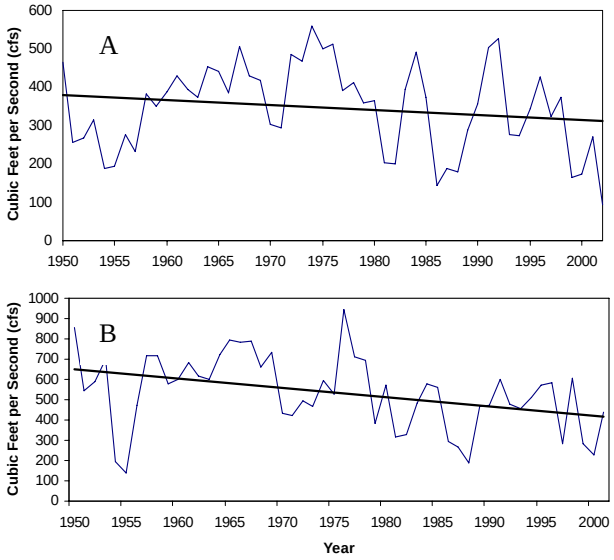

Figure 2. Annual Seven-Day Minimum Flows for two north Georgia Rivers. A. Upper Etowah River at Canton (USGS Gauge 2392000). B. Ocmulgee River at Macon (USGS Gauge 02213000)

low rainfall that water supply demands are greatest, particularly for outdoor watering, and the proportion of flow withdrawn for water supply is greatest. It is not always apparent, however, how much of the decline is due to water withdrawals and how much is due to drought. A comparison of historic flow patterns in two north Georgia rivers illustrates the need for watershed level studies.

The Etowah River at Canton is an unregulated river in north Georgia that has relatively small permitted surface water withdrawals (<1% of 7Q10). Low flows in the last 50 years have declined in the Etowah, with most pronounced declines during the droughts (Figures 1 and 2a). With relatively small permitted surface water withdrawals, it is reasonable to expect that the low flow declines were due to climate. The Etowah River low flows during the 1980's and 1990's droughts, however, were lower than flows during the 1950's drought, which was the most intense drought of the three. Changes in land use may account for decreased low flows as forested area in the region has increased from about 44% in the 1940's to about 67% by 1993 (Stoughton 2000). Decreased runoff with increased soil permeability could help account for this pattern, but requires study.

Flows in the Ocmulgee River at Macon have been primarily regulated by Lloyd Shoals Dam at Lake Jackson for hydropower generation since 1911. As a non-federal industrial use, these flows have been subject to instream flow requirements since the late 1970's. A Federal Energy Regulatory Commission relicensing in the early 1900's raised the minimum flows from 100 to 300 cfs (Evans 1991; USGS reports the 7Q10 at Macon as 410 cfs). Most surface water withdrawal permits in the Upper Ocmulgee River are upstream of Lake Jackson.

Low flows in the Ocmulgee River have generally declined over the past 50 years. In contrast to the Etowah River example and with 2.25 times 7Q10 flows permitted

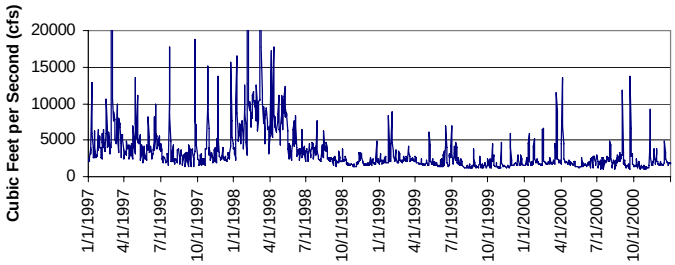

Figure 3. Daily Flows of Chattahoochee River at Whitesburg (USGS Gauge 2338000) from 1997 to 2000.

for surface water withdrawals (Table 1), low flows during the two most recent droughts were slightly higher than during the 1950's drought (Figures 1 and 2b). While instream flow requirements were apparently protective of flows in the Ocmulgee River during droughts, active management of Lake Jackson water levels was likely required to provide adequate water for augmentation to minimum flows.

As larger proportions of 7Q10 are permitted for surface water withdrawals, more augmentation of low flows from water supply reservoirs will become necessary to meet permit requirements and maintain water supplies. A major concern about the 7Q10 instream flow guideline is the potential for water to remain in storage with only minimum flows being released, particularly during low flow periods. The potential results are reduced high flows and a "flat line" hydrograph, in which there is little of the water level variation that sustains many environmental values and uses. With 22 times 7Q10 flow permitted for surface water withdrawal above Whitesburg, water levels in the Chattahoochee River at Whitesburg approached this condition during the 1990's drought (Figure 4). For example, water levels were much more constant in 1999 and 2000 than in the previous two years.

APPLICATION OF INSTREAM FLOW GUIDELINES

In order to fully understand river flow conditions around the state and develop effective instream flow guidelines, other influences on river flows must be considered. Permitted surface water withdrawals represent a significant portion of water use in north Georgia, but relatively little water use in the southern portion of the state. Effects of surface water withdrawals for agricultural uses in the upper Suwannee (including the Withlacoochee, Alapaha, and Little Rivers) and lower Flint River basins are large, but not subject to instream flows.

Discharges to surface water contribute significantly to surface water flows where wastewater treatment plants do not use land applications. This is a significant source of flow in north Georgia, particularly in the metro Atlanta area. River flows may actually increase in south Georgia as M&I discharges that were obtained from groundwater are added to flow.

Operations of federal reservoirs affect only two rivers in Georgia, the Savannah and Chattahoochee Rivers. Both of these rivers provide significant surface water supply, but are not subject to instream flows. Both rivers support significant assemblages of aquatic biota and economic development. Instream flows in these rivers are dependent on flood control, navigation, hydropower generation, and other interests.

CONCLUSION

This preliminary examination of conditions affecting flows in Georgia rivers indicates a clear need for study at the individual watershed level. Determination of instream flow requirements will have to take into account many conflicting conditions. As water supply demand and low flow conditions come into conflict more often and for longer durations, a primary consideration for instream flow guidelines will need to be protection of flows from effects of water supply reservoirs. Furthermore, under current withdrawal permit requirements, instream flows can only be protected in north Georgia where most permitted M&I surface water withdrawals occur. Effects of groundwater withdrawals on south Georgia rivers is significant and requires study as well.

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