OCT 25 1999

Honorable Lindsay Thomas
Federal Commissioner
ACT/ACF River Basins Commissions
233 Peachtree Street NE, Suite 200
Atlanta, GA 30303-1504

Dear Commissioner Thomas:

In response to your memorandum of October 14, 1999, we are providing the enclosed final version of the "Instream Flow Guidelines for the ACT and ACF Basins Interstate Water Allocation Formula." This document describes a set of guidelines for protecting the ACT and ACF Basins' riverine ecosystems under the Compacts. As you are aware, the Fish and Wildlife Service distributed a draft version of the guidelines document, dated August 10, 1999, to each of the negotiating teams. In addition, the draft document has been coordinated with biologists from the U.S. Geological Survey-Biological Resources Division, EPA, the wildlife conservation agencies of Alabama, Florida and Georgia, and The Nature Conservancy.

The document is intended for the evaluation of allocation proposals relative to the Service's authorities under the Endangered Species Act and EPA's authorities under the Clean Water Act. An allocation formula that departs from the environmental baseline developed in the guidelines will require a more detailed review by both of our agencies. We believe that the guidelines may serve purposes beyond an evaluation of allocation proposals because they represent a determination of flow regime features that are necessary for maintaining the present structure and function of the riverine ecosystems.

EPA has determined that the guidelines are an innovative and valuable tool that will, along with other modeling tools, aid in the evaluation under the Clean Water Act of the impacts of Compact allocation proposals on water quality. EPA has concluded that these guidelines can be used to analyze water quality impacts related to the Clean Water Act objective of biological integrity for the Nation's waters.

If you have questions, please do not hesitate to contact us or our agency points of contact: Ms. Gail Carmody of the Service's Panama City Field Office (850/769-0552) and Mr. Tom Welborn of EPA's Atlanta Regional Office (404/562-9354).

Sincerely,

John H. Hankinson, Jr.
Regional Administrator

Sam D. Hamilton
Regional Director

Enclosure

INSTREAM FLOW GUIDELINES FOR THE ACT AND ACF BASINS INTERSTATE WATER ALLOCATION FORMULA -- October 25, 1999

Background and Purpose

This document provides a set of instream flow guidelines for protecting riverine ecosystems under possible interstate water allocation formulas for the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) basins. The U.S. Fish and Wildlife Service (Service) believes that, unless accompanied by further degradation of existing water quality, depletions of surface water and operations of existing reservoirs that are within the limits set by these guidelines are not likely to adversely affect aquatic species protected under the Endangered Species Act of 1973, as amended (Act).

The guidelines are definitions of specific natural flow regime features, i.e., measures of flow magnitude, duration, frequency, seasonality, and rate of change. The riverine ecology literature contains many examples (summarized in Poff et al. 1997) of biologically relevant features of natural flow regimes. The guidelines herein represent the Service's determination of those features that are most relevant and most necessary for maintaining the present structure and function of the riverine ecosystems of the ACT and ACF basins, including, but not limited to, several species protected under the Act. The guidelines are adapted from the flow-regime parameters included in the Indicators of Hydrologic Alteration, developed in recent years by a group of riverine ecologists and hydrologists led by The Nature Conservancy (Richter et al. 1996, 1997).

To estimate natural flow regime features in the basins, we have used the entire hydrologic record. For the reservoir-regulated reaches, we have used the post-dam record to describe a baseline condition, i.e., the present degree of hydrologic alteration relative to the pre-dam record in these reaches. The Service's intent in developing ACT/ACF instream flow guidelines is twofold: 1) to identify the natural regime features that we believe are of greatest importance to the interstate water allocation decisions, and 2) to describe present instream flow conditions relative to these features as an environmental baseline from which to evaluate allocation proposals.

An allocation formula that departs from the environmental baseline defined by the instream flow guidelines would require additional evaluation and consultation with the Service in accordance with the Act. During consultation, the Service would explore reasonable and prudent alternatives and/or measures to minimize harm to listed species and designated critical habitat. We recommend that the states and the Service conduct early consultation before the states release an allocation formula for public review. Formal consultation may be required before the Service can recommend to the Federal Commissioner concurrence or non-concurrence based on compliance with the Act.

The instream flow guidelines are based solely upon an ecological interpretation of hydrological data and do not account for water quality degradation from point or non-point sources of pollution. The guidelines are protective of riverine ecological integrity given relatively unpolluted water. In some reaches, a discharge greater than the natural low-flow levels given in

these guidelines is necessary to maintain specific water quality standards. The instream flow guidelines described herein are an addition to, not a replacement for, these standards.

The guidelines are supported by the best available information on riverine ecology in the two basins. The Service believes that hydrologic alteration within the bounds of these guidelines would not likely impair ecological integrity. However, collecting further data on the effects of hydrologic alteration on ecological integrity should be part of an adaptive approach to handling the interstate water allocation issues under the ACT and ACF compacts. The three States and the Federal government should measure ecological responses to changes in flow patterns through a scientifically rigorous monitoring program. Such monitoring is necessary if we are to improve our understanding of how flow regimes affect biota and make informed water management choices in the future.

Instream Flow Guidelines -- Definitions

The guidelines are based on information, summarized in the following section, gathered from life-history and habitat-use studies of particular species and species-groups native to streams and rivers in the ACF and/or ACT basins, and from data relating biological integrity to hydrologic alteration in specific segments of the basins. We define five instream flow guidelines altogether: two dealing with low-flow conditions; one with average flow conditions, and two with high-flow conditions.

The two low-flow guidelines apply to all mainstem reaches of the basins, but the other three apply only to reaches for which upstream reservoirs have substantially altered the seasonal distribution of flow and/or high-flow regime features. In the ACT and ACF, mid- and high-flow features are noticeably altered when total upstream reservoir capacity exceeds 10 percent of the average annual discharge (AAD). Monthly average flows are widely-recognized general measures of habitat availability, and we have applied a monthly average-flow guideline to all such reaches. We have restricted the application of the two high-flow guidelines, however, to reaches in which high-flow alteration has the greatest potential ecological impact, which are those with large floodplain systems, i.e., the Alabama River downstream of Claiborne Lock and Dam, the lower Tallapoosa River, and the Apalachicola River. Other reaches in the two basins support significant floodplain habitats, but are not regulated, such as the lower Flint River, or are impounded, such as the Alabama River upstream of Claiborne Lock and Dam.

All of the guidelines incorporate an inter-annual frequency component, such as "exceed parameter level A in all years; exceed level B in 3 out of 4 years; and exceed level C in half of the years." The inter-annual frequency component of each guideline is as important as the flow magnitude component. Aquatic populations can survive extremely stressful conditions and persist without essential habitat conditions occasionally, but not for many years in succession. To evaluate the inter-annual frequency component of an allocation proposal, we anticipate applying the guidelines to the results from computer simulations of water demands and reservoir operations under a proposed formula over relatively long time periods on a daily time step. We would calculate both the frequency and the magnitude of a proposal's departures from the

guidelines relative to the baseline. Simulations showing fewer departures than the baseline are not likely to impair riverine ecological integrity. The impacts associated with departures would depend upon their spatial distribution, type, number, and degree.

Table 1 contains definitions of the guidelines, which are labeled according to the type of reach to which they apply: U1 and U2 for unregulated reaches; R1-R3 for all regulated reaches; and F1 and F2 for regulated floodplain reaches. The guidelines are calculated and listed in the Appendix for several river gage locations in both basins

In addition to the guidelines listed in Table 1, we recognize the need for a flow rate-of-change guideline in reaches immediately downstream of hydropeaking dams. Hydropeaking dams are operated to supply power for daily and weekly periods of peak electricity demands. The rapid and extreme changes in river stage resulting from peaking operations is very likely limiting many populations of fish and other aquatic fauna in the mainstem channels for some distance downstream of these dams. However, we believe rate-of-change is more appropriately addressed later as an operational issue in the implementation of an allocation formula, and not as a principle variable in determining an allocation formula.

Instream Flow Guidelines -- Justifications and ACT/ACF Evidence

Monthly 1-Day Minima (guidelines U1 and R1)

Justification - Extreme low-flows are likely among the most stressful natural events faced by river biota. As flow level decreases, available habitat constricts and portions of the channel eventually become dry. Aquatic animals that are unable to move to remaining pools or burrow into the moisture of the stream bed itself perish. Others become concentrated in pools where small-bodied species are more vulnerable to aquatic predators and large-bodied species are more vulnerable to terrestrial predators, particularly birds and raccoons. During warm months, extreme low water levels are accompanied by higher-than-normal water temperatures and low dissolved oxygen levels, further stressing river biota.

Because of the physical and biological harshness of extreme low-flow conditions, decreasing the magnitude of the lowest 1-day minimum flow events at a particular time of year, or increasing the inter-annual frequency of these events is likely to have detrimental effects on native riverine biota. Guidelines U1 and R1 address the magnitude, timing (monthly), and inter-annual frequency of extreme low-flow events. The computations for both are identical, except for the period of record used. U1, applicable to unregulated reaches, is computed from the full gage record. R1, applicable to regulated reaches, is computed from the pre-dam gage record only, because dams and consumptive uses have substantially altered monthly 1-day minima. In some cases, the post-dam minima are greater than the pre-dam minima, and may need to remain so to dilute pollution and comply with water quality standards. Consumptive uses have altered monthly 1-day minima in unregulated reaches. Our use of the full record for computing U1 recognizes that we are

Table 1. Computational definitions of ACT/ACF instream flow guidelines

Unregulated: applicable to reaches not regulated by storage reservoirs

U1. Monthly 1-day minima

Computational definition: using the complete daily discharge record for the reach, compute the 1-day minimum for each month of the year in all years. Compute the minimum, 25th percentile, and median of these values. For each month, the 1-day minimum flow guideline is to:

a. Exceed the minimum in all years.

b. Exceed the 25th percentile in 3 out of 4 years.

c. Exceed the median in half of the years.

U2. Annual low-flow duration

Computational definition: using the complete daily discharge record for the reach, compute the average annual discharge (AAD) for each calendar year, and then the average of these annual values. Compute the number of days per year for all calendar years during which daily discharge is less than 25 percent of the AAD. Compute the maximum, 75th percentile, and median of these values. For each year, the guideline is:

a. Do not exceed the maximum in all years.

b. Do not exceed the 75th percentile in 3 out of 4 years.

c. Do not exceed the median in half of the years.

Regulated: applicable to reaches regulated by storage reservoirs (upstream storage capacity exceeds 10 percent of average annual discharge)

R1. Monthly 1-day minima

Same as U1, except that the guideline values are computed from the pre-dam daily discharge record instead of the full record. The frequency and magnitude of departures from the pre-dam values in the post-dam discharge record forms the baseline for evaluation purposes.

R2. Annual low-flow duration

Same as U2, except that the guideline values are computed from the pre-dam daily discharge record instead of the full record. The frequency and magnitude of departures from the pre-dam values in the post-dam discharge record forms the baseline for evaluation purposes.

R3. Monthly average flow

Computational definition: using the pre-dam daily discharge record for the reach, compute the average flow for each month of the year (sum of daily values divided by number of days per month) in all years. Compute the 25th percentile and 75th percentile of these monthly averages. The guideline is to maintain monthly average flow within the range of the 25th to 75th percentile values in half of the years. The frequency and magnitude of departures from the pre-dam values in the post-dam discharge record forms the baseline for evaluation purposes.

Table 1 (continued).

Regulated Floodplains: Applicable to Reaches with Significant Floodplain Habitats Downstream of Storage Reservoirs	
F1.	**Annual 1-day maximum** Computational definition: using the pre-dam daily discharge record for the reach, compute the 1-day maximum for each year in all years. Compute the minimum, 25th percentile, and median of these values. The 1-day maximum guideline is: a. Exceed the minimum in all years. b. Exceed the 25th percentile in 3 out of 4 years. c. Exceed the median in half of the years. The frequency and magnitude of departures from the pre-dam values in the post-dam discharge record forms the baseline for evaluation purposes.
F2.	**Annual high-flow duration** Computational definition: using the AAD value computed for guideline R2, compute the number of days per year for all calendar years during which daily discharge is greater than 1.25*AAD [where available, substitute field-determined discharge corresponding to inundation of about one third of the potential aquatic floodplain habitat]. Compute the minimum, 25th percentile, and median of these values. For each year, the high-flow duration guideline is: a. Exceed the minimum in all years. b. Exceed the 25th percentile in 3 out of 4 years. c. Exceed the median in half of the years. The frequency and magnitude of departures from the pre-dam values in the post-dam discharge record forms the baseline for evaluation purposes.

unlikely able to reverse these alterations, at least not in the near term, but that it is possible to limit further alterations through water conservation and demand management.

Evidence from the ACF/ACT basins - The effects of depressed low-flows on river fauna are observable in part by losses of abundance and number of species in river reaches directly below dams that do not provide continuous instream flows at least equal to historic low-flow levels.

The Coosa River downstream from Jordan Dam, where prior to 1990 flow in the channel below the dam was less than 200 cfs during non-generation periods. The dam was variously operated as a peaking hydropower facility or as a bypass channel for Bouldin Dam from 1927 to 1990, during which populations of riverine fishes and the endangered snail *Tulotoma magnifica* were depressed. Provision of continuous minimum flows of 4,475 cfs (March-May) and 2,000 cfs (June-February) increased populations of both fishes and *Tulotoma*. Fishes in samples from shoal habitats more than doubled in abundance and almost doubled in diversity (from 21 to 39

species) over the period 1992-1996 (data from E. R. Irwin, USGS Alabama Cooperative Fish and Wildlife Research Unit).

The Tallapoosa River downstream from Harris Dam, which provides no flow releases between power generation discharges. Fish and invertebrate assemblages in the channel near the dam are seriously depleted (Pierson et al. 1986; M.S. Reed, unpublished reports to USFWS). Fish abundance and number of species increase further downstream from Harris Dam, where tributary inflows and channel storage increase flows and lessen flow fluctuations between power releases (Travnichek and Maceina 1994, Bowen et al. 1998).

The Tallapoosa River downstream from Thurlow Dam, the continuous instream flow was increased from leakage (less than 100 cfs) to 1,200 cfs in 1991. Prior to the increase in continuous flow level, much of the river channel downstream from the dam was de-watered. Supplying the continuous flow has resulted in increased abundance and diversity of fishes. Standardized sampling collected 8 fish species from 1988-1990, compared to 19 species in 1992 (Travnichek et al. 1995). More complete sampling by rotenone showed a similar proportional increase in fish diversity, from 25 species in 1990 to 46 species in 1997 (J. McHugh, ADCNR, unpublished data). Leakage flows that occurred prior to 1991 were insufficient to support the native assemblage of riverine fishes.

Annual Low-Flow Duration (guidelines U2 and R2)

Justification - Low-flows naturally occur in unimpaired rivers during periods of reduced rainfall and runoff. Extreme low-flows are stressful to biota, and the previous guidelines for 1-day minima are intended to address the "acute" effects of extreme lows by limiting their magnitude, timing, and inter-annual frequency to levels that are comparable to natural regimes. This guideline, annual low-flow duration, is intended to address the more "chronic" effects of extended periods of flows greater than 1-day minima but less than average flow. The critical element of this guideline is the definition of the low-flow threshold, which we base upon current velocity in pool habitats and an apparent relationship with average annual discharge.

Current velocity decreases with decreasing discharge. Extreme reduction of current velocity is detrimental to river biota, many or most of which depend on flowing water to deliver food, maintain oxygen/temperature levels, prevent excessive silt deposition on the stream bottom, and allow successful reproduction. Examples of how biota depend on flowing water include:

> Filter-feeding invertebrates, such as net-spinning caddis flies (Trichoptera), feed on particles that they filter from flowing water. Filter-feeders are among the most productive river macrobiota and are a major source of prey for fishes. Loss of flowing water can eliminate populations of many filter-feeding invertebrates.
>
> Drift-feeding fishes, including many minnow species that form food web links between invertebrates and piscivorous fishes, forage on invertebrates carried downstream by

flowing water. Just as for filter-feeding invertebrates, reducing current velocities to low flows also reduces food availability for drift-feeding fishes.

Many riverine fish species spawn in areas with swift current, which may help keep nests and eggs well oxygenated and free of smothering silt.

Riverine fishes that release pelagic (floating) eggs, such as striped bass, require water currents that are sufficient to keep the eggs suspended as they develop while drifting downstream.

Some freshwater mussels reproduce by releasing larvae (glochidia) in a package called a super conglutinate, which resembles a small fish or invertebrate and acts as a lure for the host fish. The reproducing mussel requires sufficient water velocity to suspend the super conglutinate in the water column until a host fish attempts to eat it, which begins the process of incubating the larval mussels. The incubation stage on a host fish, which lasts from days to weeks depending on mussel species, is obligatory in the mussel's life cycle. If current velocities are too low during the reproductive period, the super conglutinate will not be suspended in the current and reproduction would be impaired.

A common observation at low flows is that the velocity in pool habitats becomes very slow and shallow riffles become the only habitats with relatively swift flows. Pools are a critical component in the mix of stream habitats due to their volume and productivity. The Service believes that when pools become stagnant for extended periods, biota begin to suffer from the loss of functions provided by flowing water. This flow guideline is intended to prevent excessive loss of flowing-water conditions in pools. The evidence described in the following section supports limiting the duration of flows less than 25 percent of average annual discharge (AAD), which appears to maintain an average current velocity in pools of greater than 15 centimeters per second (cm/s -- about 0.5 feet per second).

Evidence from the ACF/ACT basins - Data gathered on effects of low-flow levels in the Tallapoosa River downstream from Thurlow Dam provide strong evidence of the biological effects of maintaining sufficient streamflow. Continuous minimum flows at Thurlow Dam were increased from leakage flow (less than 100 cfs) to 1,200 cfs in 1991. Biologists measured the abundance and diversity of fishes in a reach downstream from the dam before (1988-1990) and after (1992, 1997) implementation of the 1,200 cfs minimum flow. The monitoring results show a remarkable change in the fish fauna. Standardized sampling collected 8 fish species from 1988-1990, compared to 19 species in 1992 (Travnichek et al. 1995). More complete sampling by rotenone showed a similar proportional increase in fish diversity, from 25 species in 1990 to 46 species in 1997 (J. McHugh, ADCNR, unpublished data). The low flows that occurred prior to 1991 were insufficient to support the native assemblage of riverine fishes. The data further provide strong evidence that 1,200 cfs, which is approximately 25 percent of the average annual discharge for this section of river, is sufficient to maintain a large portion of the native riverine fish assemblage during the low-flow periods between water releases for power generation. This

does not mean that a constant flow of 1,200 cfs (or 25 percent of AAD) would maintain biological integrity over long periods, but rather that this flow (together with its accompanying conditions, such as reduced fluctuations in daily flows and water temperatures, increased oxygen concentrations, stable low flow) supports at least short-term survival within this river reach. Based on this analysis from the Tallapoosa River below Thurlow Dam, 25 percent of AAD provides a reasonable low-flow threshold until additional data may be collected in other flow-altered reaches.

Consideration of how instream habitat becomes limiting to biota at low flows can provide another approach to setting a low flow below which streams should not be artificially lowered. As discussed above, pool habitats can become extremely slow-flowing at low flow levels, to the point of stagnation. Although comparably low flows occur naturally in many rivers, streamflow to this extreme more often than under natural conditions would compromise habitat quality and continued survival for many river species. To maintain minimal habitat quality in pools, some current velocity must be maintained during low-flows. An average current velocity of at least 15 centimeters per second (cm/s; about 0.5 foot per second) in pools will provide slow but continuous flow through much of the channel. When average stream velocity drops below approximately 10 cm/s, flow will be undetectable through much of the channel. An average channel velocity through pools of at least 15 cm/s provides a reasonable low-flow threshold until additional data on low-flow biological requirements can be gathered.

Flow levels equivalent to 25 percent of AAD appear sufficient to maintain average velocities greater than 15 cm/s through pools at most of the riverine study sites for which instream habitat models were constructed as part of the ACT/ACF Comprehensive Study (Table 2). Table 2 shows that 25 percent of AAD maintains pool average velocities of about 15-20 cm/s at most sites. At some sites (e.g., upper Etowah and upper Tallapoosa) higher flows may be necessary. These preliminary data also show that velocities fall below 15 cm/s at flows lower than 20-30 percent of AAD at almost all sites. Average velocities through riffle (shoal) habitats at flows equivalent to 25 percent of AAD are relatively slow, but are maintained at levels reasonable for short-term survival of species adapted to swifter currents. "Slow riffle" habitat has been defined as having velocities between 30 and 60 cm/s, or about 1.0 to 2.0 ft/s (Aadlund 1993). For the sites listed in Table 2, riffle velocities are greater than 30 cm/s at a flow of 25 percent of AAD.

Monthly Average Flow (guideline R3)

Justification - Many riverine organisms have life history features that are adapted to seasonal patterns of river flow. For example, many fishes spawn at a time of year when flows are most likely to provide the best conditions for their particular spawning habitat type and, subsequently, for juvenile survival and growth. Some species (such as paddlefish) use rising flows in the springtime as cues to migrate to spawning areas or to initiate spawning. Many fishes spawn in swift currents during the spring. Some species, such as striped bass, depend on the current to keep their eggs and larvae suspended while they develop. Others, such as suckers, require adequate flow to clean and aerate gravel nests. Species that spawn in moderate or low velocity

Table 2. Current velocity estimates averaged across pool and riffle/shoal cross-sections for flows of about 25 percent of average annual discharge (AAD) at eight sites for which hydraulic simulation models were developed as part of the ACT/ACF Comprehensive Study (Freeman et al. 1997). The sites listed are those with distinct pool habitats across which cross-sections were measured. Velocity estimates are average water column velocities; the number of cross-sections per site is shown in parentheses.

River Reach / Study Site	Approx. flow (cfs) equal to 25 percent AAD*	Pool velocity (cm/s)**	Riffle/shoal velocity (cm/s)
Lower Flint (ACF 4)	1550	16 (2)	34 (3)
Upper Flint (ACF 6)	375	17 (1)	35 (3)
Upper Tallapoosa (ACT 11)	120	13 (2)	42 (2)
Middle Tallapoosa (ACT 12-13)	850	16 (2)	32 (2)
Lower Tallapoosa (ACT 14)	1200	16 (1)	36 (1)
Lower Tallapoosa (ACT 15)	1560	19 (1)	41 (2)
Upper Etowah (ACT 1)	270	13 (1)	39 (4)
Conasauga (ACT 2)	226	19 (2)	46 (2)

* cfs = cubic feet per second

** cm/s = centimeters per second

areas nearer the stream margins (such as many sunfishes and minnows) often depend on naturally high springtime flows that create the necessary habitat conditions in these shallow-water areas. At lower flows, areas along stream margins may become too slow and shallow to provide good spawning habitat. High springtime flows also can allow juvenile fishes access to productive off-channel habitats such as side channels, floodplain pools, and oxbow lakes. Seasonally high flows are also important for channel maintenance and removing silt and debris deposited during low flow periods from gravel and cobble used by spawning fishes.

We know less about how river organisms may depend upon low flows that naturally occur in late summer and autumn in many river systems. As discussed earlier, extreme low flows are stressful for many riverine species. Nonetheless, the late summer and early fall, which are periods of naturally low and stable flows, are the principle reproductive periods for some animals, as well as periods of juvenile growth for many fishes and invertebrates. During years with frequent spring and summer high flows, stable low flows in late summer may provide the best spawning opportunities for riverine minnows that have long reproductive seasons. Although many floodplain plant species thrive under frequently inundated conditions, most require exposed substrate at some time of year for seed germination. In estuaries, plants and animals also are adapted to seasonally dynamic flows delivered by rivers. High spring flows deliver nutrients and extend the area of freshwater out toward the sea. Low flows in late summer and autumn permit salt water to move inland, sustaining marshland vegetation and allowing saltwater fishes and

invertebrates opportunities to feed in the productive estuarine habitats. The great variety of known biological adaptations to seasonally variable river flows in both the riverine and estuarine environments justifies an instream flow guideline based on a seasonal flow measures, such as monthly averages.

Evidence from the ACF and ACT - Reservoir operations have significantly altered seasonal flow patterns in several reaches of the ACT and ACF basins. For example, median springtime monthly flows have been reduced 42 percent in April in the middle Tallapoosa River since construction of Harris Dam. Median April flows in the lower Alabama River were 38 percent lower during post-dam (1973-1996) as compared to pre-dam period (1931-1962). Flows in October and/or November are significantly higher (compared to pre-dam periods) in the lower Alabama River, Oostanaula River, middle Tallapoosa River below Harris Dam, Etowah River below Allatoona Dam and Chattahoochee River below Buford Dam.

Several changes in ACT/ACF aquatic communities are likely the result of seasonal flow alteration. In the middle Tallapoosa River, suckers (Catostomidae) are disproportionately reduced in numbers downstream from Harris Dam, along with numerous other springtime spawning fishes (such as black basses, Tallapoosa darter, speckled darter and madtom catfishes). Fishes capable of spawning in summer as well as spring numerically dominate fish samples in the middle Tallapoosa River. These data show a disproportionate loss of spring-spawning fishes, suggesting lower spring flows and loss of flow stability in the spring may both be responsible.

Elevated spring flows are important for providing spawning habitat for many ACT and ACF fishes. Examples include: paddlefish, river redhorse, grayfin redhorse (ACF endemic), blue sucker (which may be an ACT endemic and is able to pass locks and dams on the Alabama River at high flows), striped bass, and numerous minnow (Cyprinidae) and darter (Percidae) species. In the Coosa River downstream from Jordan Dam, Dr. Elise Irwin (USGS, Auburn Cooperative Fish and Wildlife Research Unit) observed that fish density in shoals increased in relation to February and March median flows over a 5-year study.

The effects of increased average flows in autumn (resulting from reservoir draw down) may be most evident at the downstream end of the ACT. Higher autumn flows into the Mobile Delta have reportedly shortened the normal occurrence of saltwater invasion in the Delta during late summer and autumn. Possible effects include loss of marsh vegetation and decline in use by estuarine and marine species that, prior to extensive flow alteration, used the Delta to feed, grow and reproduce. Dr. Robert Livingston and colleagues report that species composition and productivity of Apalachicola Bay also depends on natural variations in river inflow. Seasonal dynamics clearly are important to the health of the ACF and ACT estuaries.

Annual 1-Day Maximum (guideline F1)

Justification - High flows perform many functions that are vital to the maintenance of ecological integrity, including:

- the maintenance of channel and floodplain features by transporting sediment;
- the export of organic matter and organisms to the main channel from the floodplain;
- Removing and transporting fine sediments, clearing interstitial spaces in gravel bars used for fish spawning;
- importing woody debris into the channel, creating new high quality habitat for fish and invertebrates;
- scouring floodplain soils, which rejuvenates habitat for early-successional plant species
- connecting the main channel to the floodplain, providing access to spawning habitats, nursery areas, and food sources;
- maintaining flood-resistant, disturbance adapted communities; and
- allowing species with brief life cycles and good colonizing ability to reestablish.

Due to the importance of high-flows to the functioning of the riverine ecosystem, several high-flow magnitude parameters were included in the Indicators of Hydrologic Alterations (Richter et al. 1996, 1997). We have adopted one in these guidelines, the annual 1-day maximum discharge.

Evidence from the ACF and ACT -

The active storage capacity for all mainstem reservoirs in the ACT Basin is currently about 15 percent of the average annual discharge (AAD) measured at Claiborne Lock and Dam. The storage capacity upstream from Jim Woodruff Lock and Dam in the ACF also is about 15 percent of the AAD. This percentage is small enough that reservoir operations collectively cannot prevent nor control annual high flow events in the lower portions of the basin in most years. However, it is large enough to moderately alter the magnitude, timing, and duration of high flows in some years. Therefore, we have constructed this guideline to focus on the lower range of the annual 1-day maximum, (i.e., to exceed the lowest historic annual 1-day maximum discharge in all years), to exceed the 25th percentile in 3 out of 4 years, and to exceed the median in 1 out of 2 years.

<u>ACT- Swift, Oakmulgee, and Mulberry Creeks</u>. Swift and Mulberry Creeks are tributaries to the upper Alabama River. Oakmulgee Creek is a tributary of the Cahaba River. Comparative studies conducted by Auburn University Fish and Wildlife Cooperative Research Unit at these and several out-of-basin creeks suggested that off-channel (floodplain) habitats enhance riverine fish diversity (Knight et al. 1991). Peyton (1994) found that the more diverse floodplain aquatic communities were associated with longer periods of floodplain inundation.

<u>ACF- Apalachicola River</u>. Providing access with periodic high flows to the floodplain and during most years is essential for the survival of many species in the Apalachicola River. Eighty percent of the fish species found in the river, a total of 73 species, are known to inhabit the floodplain at some point in their life cycle (Light et al. 1988). Of these, at least 33 species use floodplain habitats for spawning or rearing. The leaf litter of the floodplain forest forms the basis of a rich food chain for many main-channel fish species, and the complex structure of flooded

snags, roots, and tree trunks provides protection from predators that is important to the survival of larval and juvenile fish.

Annual High-Flow Duration (guideline F2)

Justification - The duration of high-flow conditions largely determines the degree to which many important ecological and geomorphological functions, listed under the previous guideline, are accomplished. For example, sediment transport is a function of both flow magnitude and duration, and species that reproduce in the inundated floodplain must have sufficient time to do so.

Evidence from the ACF and ACT - We sought a discharge threshold that was exceeded for at least 1 week in all years of pre-regulation records in the lower portions of these two basins. Pre-regulation flow records do not exist for the remaining riverine portions of the ACT in the Coastal Plain, since the basins' largest reservoir, Martin Lake, was constructed before discharge records begin on the Tallapoosa and Alabama rivers downstream of Martin Lake. On the Apalachicola River, a discharge of 1.25 times the average annual discharge was exceeded for at least 1 week in all calendar years prior to the construction of Jim Woodruff and Buford Dams. At this discharge, about one third of the potential aquatic habitat of the floodplain is connected to the main channel (Light et al. 1998).

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Appendix A

This appendix includes one example for the ACT and one for the ACF of each of the guidelines. The unregulated reaches represented are the Tallapoosa River at Heflin, Alabama, and the Flint River at Bainbridge, Georgia. The regulated reaches are the Coosa River at Rome, Georgia, and the Chattahoochee River at Whitesburg, Georgia. The regulated reaches with substantial floodplain habitats are the Alabama River at Claiborne Lock and Dam, Alabama, and the Apalachicola River at Chattahoochee, Florida. The Service can provide, upon request, computation of the guidelines for any location in the two basins for which a sufficient gaged period of record is available.

Reach Type	page	Location
Unregulated	1	Tallapoosa River at Heflin, Alabama
	2	Flint River at Bainbridge, Georgia
Regulated	3	Coosa River at Rome, Georgia
	6	Chattahoochee River at Whitesburg, Georgia
Regulated/ Floodplain	9	Alabama River at Claiborne Lock and Dam, Alabama
	13	Apalachicola River at Chattahoochee, Florida

Appendix B

This appendix includes graphics of the flow regime features selected for the instream flow guidelines for one example location: the Apalachicola River at Chattahoochee, Florida. Each graphic is a "box and whiskers" chart showing the full range of variability of one flow regime feature. The values listed in the tables of Appendix A as "Estimates of the natural regime" correspond to elements of the box and whiskers charts labeled as "Natural," and the values listed as "Parameters of the baseline regime" correspond to chart elements labeled as "Baseline."

The first chart is a legend for interpreting the various chart elements, showing how the guidelines are selected points from the full distribution of a particular flow regime feature. For example, the minimum of all the annual January 1-day minima in the period of record is the guideline for "Monthly 1-day minimum exceeded in all years," and is represented as the lowest circle on the chart. The 25th percentile of all the January 1-day minima is the guideline for "Monthly 1-day minimum exceeded in 3 of 4 years," and is represented by the lower line of the box on the chart. Finally, the median of the January 1-day minima is the guideline for "Monthly 1-day minimum exceeded in 1 of 2 years," and is represented by the middle line of the box on the chart.

Instream Flow Guidelines -- Estimates of Natural Flow / Baseline Regime Features

Location: Tallapoosa River at Heflin
Reach type: Unregulated
Period of record used for calculations: 1953 to 1996 44 years page 1 of 1

U1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural / baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	129	272	431
Feb	231	349	502
Mar	254	460	595
Apr	232	451	527
May	126	254	369
Jun	31	179	216
Jul	28	121	158
Aug	26	74	115
Sep	15	59	91
Oct	13	83	127
Nov	16	118	177
Dec	71	165	266

U2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 173 cfs

	Estimates of the natural / baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	171	105	65

Instream Flow Guidelines -- Estimates of Natural Flow / Baseline Regime Features

Location: Flint River at Bainbridge (COE "obs_adj" data)
Reach type: Unregulated
Period of record used for calculations: 1939 to 1993 55 years page 1 of 1

U1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural / baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	2,200	4,477	5,781
Feb	3,100	5,912	6,972
Mar	2,910	6,900	8,740
Apr	3,650	5,880	7,350
May	2,490	3,670	5,016
Jun	2,090	2,898	3,954
Jul	1,905	2,926	3,931
Aug	1,970	2,697	3,450
Sep	1,891	2,237	2,750
Oct	1,476	2,235	2,750
Nov	1,930	2,528	2,924
Dec	1,900	2,980	3,610

U2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 2,109 cfs

	Estimates of the natural / baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	42	1	0

Instream Flow Guidelines -- Estimates of Natural Flow Regime Features

Location: Coosa River at Rome
Reach type: Regulated
Period of record used for calculations: 1897 to 1948 19 years page 1 of 1

R1 **Monthly 1-day minima (1DMin) (cfs)**

	Estimates of the natural regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	1,450	2,340	2,710
Feb	2,110	2,460	4,270
Mar	2,110	4,485	5,100
Apr	2,570	4,035	4,860
May	1,310	2,840	3,340
Jun	1,160	2,085	2,280
Jul	1,640	1,790	2,000
Aug	1,180	1,595	1,880
Sep	900	1,360	1,490
Oct	935	1,220	1,470
Nov	1,180	1,415	1,510
Dec	1,220	1,705	2,140

R2. **Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])**

25 percent AAD = 1,667 cfs

	Estimates of the natural regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	97	65	31

R3. **Monthly average flow (cfs)**

	Estimates of the natural regime	
	25th percentile	75th percentile
Jan	4,699	9,545
Feb	7,774	16,088
Mar	10,157	18,509
Apr	7,233	12,629
May	4,064	5,938
Jun	2,877	5,131
Jul	2,903	5,011
Aug	2,342	4,389
Sep	1,896	2,994
Oct	1,542	2,451
Nov	1,940	4,405
Dec	3,547	7,194

Instream Flow Guidelines -- Calculation of Baseline Conditions

Location: Coosa River at Rome
Reach type: Regulated

Period of record used to estimate natural regime features: 1897 to 1948
n = 19 years

Baseline Conditions: 1949 to 1996
n = 43 years

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years	All years 1DMin	3 of 4 years 1DMin	1 of 2 years 1DMin	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	1,450	2,340	2,710	7	0	0	1,260	2,495	3,520
Feb	2,110	2,460	4,270	7	0	3	1,590	3,210	4,210
Mar	2,110	4,485	5,100	7	28	22	1,820	3,955	4,440
Apr	2,570	4,035	4,860	16	28	22	1,870	3,180	3,950
May	1,310	2,840	3,340	0	17	13	1,320	2,450	3,140
Jun	1,160	2,085	2,280	2	8	3	1,000	2,035	2,260
Jul	1,640	1,790	2,000	35	19	15	937	1,520	1,800
Aug	1,180	1,595	1,880	9	19	17	934	1,385	1,670
Sep	900	1,360	1,490	0	17	3	940	1,185	1,420
Oct	935	1,220	1,470	2	5	3	907	1,185	1,430
Nov	1,180	1,415	1,510	7	1	0	987	1,415	1,890
Dec	1,220	1,705	2,140	2	1	0	1,060	1,735	2,320

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 1,667 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years	All years LFD	1 of 4 years LFD	1 of 2 years LFD	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	97	65	31	5	0	0	120	32	15

R3. Monthly average flow (cfs)

	Estimates of the natural regime		Percentage of years that the baseline regime departs from the guidelines*	Parameters of the baseline regime	
	25th percentile	75th percentile	% outside mid range	25th percentile	75th percentile
Jan	4,699	9,545	8	6,093	12,754
Feb	7,774	16,088	0	7,507	13,172
Mar	10,157	18,509	3	8,529	14,979
Apr	7,233	12,629	8	6,069	13,612
May	4,064	5,938	20	4,775	9,110
Jun	2,877	5,131	0	3,535	5,289
Jul	2,903	5,011	6	2,730	4,576
Aug	2,342	4,389	0	2,435	3,859
Sep	1,896	2,994	1	2,282	3,697
Oct	1,542	2,451	8	2,197	3,989
Nov	1,940	4,405	0	2,905	5,443
Dec	3,547	7,194	1	4,125	7,952

* "Percentage of years" values given are differences between the period of record used to estimate natural regime features and the period of record used to represent baseline conditions. A positive value is the percentage of years that the baseline departs from the natural regime estimate; a zero indicates no departure.

Instream Flow Guidelines -- Estimates of Natural Flow Regime Features

Location: Chattahoochee River at Whitesburg
Reach type: Regulated
Period of record used for calculations: 1939 to 1953 15 years

R1 **Monthly 1-day minima (1DMin) (cfs)**

	Estimates of the natural regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	1,170	2,035	2,180
Feb	1,820	2,045	2,800
Mar	1,820	2,965	3,390
Apr	1,920	2,645	3,310
May	970	2,125	2,310
Jun	725	1,605	1,810
Jul	890	1,260	1,400
Aug	660	1,030	1,200
Sep	531	890	1,060
Oct	468	885	1,110
Nov	772	1,045	1,510
Dec	915	1,405	1,600

R2. **Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])**

25 percent AAD = 939 cfs

	Estimates of the natural regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	74	10	0

R3. **Monthly average flow (cfs)**

	Estimates of the natural regime	
	25th percentile	75th percentile
Jan	2,838	7,226
Feb	4,087	7,915
Mar	5,024	8,521
Apr	4,023	6,515
May	3,016	4,145
Jun	2,411	3,289
Jul	2,034	3,816
Aug	1,784	3,397
Sep	1,534	2,252
Oct	1,078	1,919
Nov	1,509	2,159
Dec	2,358	4,638

Instream Flow Guidelines -- Calculation of Baseline Conditions

Location: Chattahoochee River at Whitesburg
Reach type: Regulated

Period of record used to estimate natural regime features: 1939 to 1953
n = 15 years

Baseline Conditions: 1965 to 1996
n = 32 years

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years	All years 1DMin	3 of 4 years 1DMin	1 of 2 years 1DMin	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	1,170	2,035	2,180	0	22	3	1,400	1,808	2,155
Feb	1,820	2,045	2,800	9	6	22	1,400	1,953	2,295
Mar	1,820	2,965	3,390	13	59	47	1,540	2,028	2,510
Apr	1,920	2,645	3,310	22	41	38	1,570	1,973	2,290
May	970	2,125	2,310	0	28	16	1,130	1,740	2,050
Jun	725	1,605	1,810	0	13	16	1,120	1,533	1,650
Jul	890	1,260	1,400	0	0	0	1,130	1,400	1,585
Aug	660	1,030	1,200	0	0	0	1,110	1,428	1,525
Sep	531	890	1,060	0	0	0	1,170	1,378	1,470
Oct	468	885	1,110	0	0	0	1,090	1,368	1,500
Nov	772	1,045	1,510	0	0	0	1,350	1,513	1,630
Dec	915	1,405	1,600	0	0	0	1,330	1,580	1,785

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 939 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years	All years LFD	of 4 years LFD	1 of 2 years LFD	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	74	10	0	0	0	0	0	0	0

R3. Monthly average flow (cfs)

	Estimates of the natural regime		Percentage of years that the baseline regime departs from the guidelines*	Parameters of the baseline regime	
	25th percentile	75th percentile	% outside mid range	25th percentile	75th percentile
Jan	2,838	7,226	0	3,092	6,481
Feb	4,087	7,915	0	3,695	6,851
Mar	5,024	8,521	16	3,929	7,808
Apr	4,023	6,515	31	3,309	7,147
May	3,016	4,145	25	2,851	5,783
Jun	2,411	3,289	13	2,687	4,105
Jul	2,034	3,816	0	2,695	3,778
Aug	1,784	3,397	3	2,973	3,744
Sep	1,534	2,252	44	2,712	3,406
Oct	1,078	1,919	47	2,569	3,667
Nov	1,509	2,159	34	2,398	4,218
Dec	2,358	4,638	0	2,668	4,047

* "Percentage of years" values given are differences between the period of record used to estimate natural regime features and the period of record used to represent baseline conditions. A positive value is the percentage of years that the baseline departs from the natural regime estimate; a zero indicates no departure.

Instream Flow Guidelines -- Estimates of Natural Flow Regime Features

Location: Alabama River at Claiborne (pre-1961, before second half of basin storage built)
Reach type: Regulated/Substantial Floodplain Habitat
Period of record used for calculations: 1931 to 1960 30 years page 1 of 2

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	7,290	13,550	16,850
Feb	8,160	16,900	23,550
Mar	13,400	23,125	26,850
Apr	13,100	20,850	27,050
May	9,590	11,725	15,250
Jun	6,850	11,000	12,300
Jul	6,100	9,295	10,600
Aug	6,240	8,478	10,350
Sep	4,840	7,760	9,500
Oct	4,970	7,710	8,820
Nov	5,530	7,918	9,290
Dec	6,570	10,043	11,050

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 7,772 cfs

	Estimates of the natural regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	129	13	0

R3. Monthly average flow (cfs)

	Estimates of the natural regime	
	25th percentile	75th percentile
Jan	24,443	55,078
Feb	37,750	60,148
Mar	41,323	76,201
Apr	40,216	72,745
May	19,904	34,781
Jun	15,024	19,635
Jul	13,151	22,157
Aug	11,567	20,582
Sep	10,389	14,384
Oct	9,385	13,883
Nov	10,149	17,033
Dec	15,415	29,711

F1 **1-day Maxima (1DMax) (cfs)**

Estimates of the natural regime

	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years
1DMax	71,100	112,500	130,500

F2. **Annual high-flow duration (HFD) (total number days per year greater than 1.25 times average annual discharge)**

1.25 * AAD = 38,862 cfs

Estimates of the natural regime

	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years
HFD	22	64	84

Instream Flow Guidelines -- Calculation of Baseline Conditions

Location: Alabama River at Claiborne (post-Weiss, 1961, as second half of ACT basin storage was built)
Reach type: Regulated/Substantial Floodplain Habitat

Period of record used to estimate natural regime features: 1931 to 1960
n = 30 years

Baseline Conditions: 1961 to 1996
n = 36 years

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years	All years 1DMin	3 of 4 years 1DMin	1 of 2 years 1DMin	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	7,290	13,550	16,850	3	28	11	6,810	10,375	12,600
Feb	8,160	16,900	23,550	3	25	8	7,590	10,300	17,150
Mar	13,400	23,125	26,850	44	42	19	9,930	10,300	15,550
Apr	13,100	20,850	27,050	53	58	42	6,350	10,275	11,600
May	9,590	11,725	15,250	31	44	28	6,370	9,070	10,350
Jun	6,850	11,000	12,300	8	47	33	6,290	7,743	9,750
Jul	6,100	9,295	10,600	11	31	22	2,850	7,483	8,795
Aug	6,240	8,478	10,350	6	17	36	5,470	7,780	8,635
Sep	4,840	7,760	9,500	3	19	31	3,890	6,588	7,920
Oct	4,970	7,710	8,820	3	33	19	4,550	6,278	7,445
Nov	5,530	7,918	9,290	3	8	6	5,130	7,358	8,955
Dec	6,570	10,043	11,050	0	11	3	7,050	9,805	10,800

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 7,772 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years	All years LFD	1 of 4 years LFD	1 of 2 years LFD	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	129	13	0	3	25	22	186	33	11

R3. Monthly average flow (cfs)

	Estimates of the natural regime		Percentage of years that the baseline regime departs from the guidelines*	Parameters of the baseline regime	
	25th percentile	75th percentile	% outside mid range	25th percentile	75th percentile
Jan	24,443	55,078	0	32,360	55,966
Feb	37,750	60,148	8	37,070	62,885
Mar	41,323	76,201	8	35,157	69,271
Apr	40,216	72,745	17	24,924	53,147
May	19,904	34,781	11	17,463	36,650
Jun	15,024	19,635	14	14,439	24,083
Jul	13,151	22,157	14	11,244	21,273
Aug	11,567	20,582	0	10,252	15,091
Sep	10,389	14,384	19	8,654	16,249
Oct	9,385	13,883	8	9,183	17,326
Nov	10,149	17,033	8	11,922	28,580
Dec	15,415	29,711	6	19,948	45,285

F1. 1- day Maxima (1DMax) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines			Parameters of the baseline regime		
	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years	All years 1DMax	3 out of 4 years 1DMax	1 of 2 years 1DMax	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years
DMax	1,100	12,500	130,500	0	44	22	95,300	98,000	99,850

F2. Annual high-flow duration (HFD) (total number days per year greater than 1.25 times average annual discharge [AAD])

1.25 * AAD = 38,862 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years	All years HFD	3 of 4 years HFD	1 of 2 years HFD	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years
HFD	22	64	84	3	0	0	21	67	88

* "Percentage of years" values given are differences between the period of record used to estimate natural regime features and the period of record used to represent baseline conditions. A positive value is the percentage of years that the baseline departs from the natural regime estimate; a zero indicates no departure.

Instream Flow Guidelines -- Estimates of Natural Flow Regime Features

Location: Apalachicola River at Chattahoochee (pre-Woodruff Dam)
Reach type: Regulated/Substantial Floodplain Habitat
Period of record used for calculations: 1929 to 1953 25 years

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	8,620	12,100	14,800
Feb	8,980	13,500	17,900
Mar	11,100	17,100	23,000
Apr	10,800	16,500	19,400
May	6,990	12,400	14,600
Jun	6,200	10,400	12,300
Jul	7,240	8,620	11,100
Aug	6,740	8,440	11,500
Sep	6,080	8,080	9,080
Oct	5,280	7,080	8,620
Nov	5,120	6,990	8,790
Dec	5,760	8,440	10,600

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 5,567 cfs

	Estimates of the natural regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	24	0	0

R3. Monthly average flow (cfs)

	Estimates of the natural regime	
	25th percentile	75th percentile
Jan	16,755	33,065
Feb	19,989	38,375
Mar	27,035	47,613
Apr	21,803	40,923
May	16,603	28,639
Jun	13,057	19,663
Jul	13,984	19,442
Aug	11,786	17,526
Sep	9,827	14,911
Oct	8,111	14,174
Nov	8,788	13,953
Dec	11,600	24,787

F1. **1-day Maxima (1DMax) (cfs)**

	Estimates of the natural regime		
	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years
1DMax	32,600	60,300	74,500

F2. **Annual high-flow duration (HFD) (total number days per year greater than 1.25 times average annual discharge)**

1.25 * AAD = 27,833 cfs

	Estimates of the natural regime		
	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years
HFD	7	38	76

Instream Flow Guidelines -- Calculation of Baseline Conditions

Location: Apalachicola River at Chattahoochee
Reach type: Regulated/Substantial Floodplain Habitat
Period of record used to estimate natural regime features: 1929 to 1953
n = 25 years

Baseline Conditions: 1954 to 1996
n = 43 years

R1. Monthly 1-day minima (1DMin) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years	All years 1DMin	3 of 4 years 1DMin	1 of 2 years 1DMin	1DMin exceeded in all years	1DMin exceeded in 3 of 4 years	1DMin exceeded in 1 of 2 years
Jan	8,620	12,100	14,800	5	8	0	5,980	11,350	16,400
Feb	8,980	13,500	17,900	5	0	0	8,280	16,100	19,000
Mar	11,100	17,100	23,000	0	8	10	11,100	15,650	20,400
Apr	10,800	16,500	19,400	9	19	24	10,400	13,800	17,100
May	6,990	12,400	14,600	0	26	27	7,060	10,500	12,100
Jun	6,200	10,400	12,300	0	5	22	6,440	9,815	11,500
Jul	7,240	8,620	11,100	9	0	1	5,350	9,090	11,000
Aug	6,740	8,440	11,500	16	3	8	4,430	8,015	11,100
Sep	6,080	8,080	9,080	16	0	0	4,530	8,390	9,850
Oct	5,280	7,080	8,620	7	0	0	5,010	7,280	9,120
Nov	5,120	6,990	8,790	7	1	0	3,900	7,195	9,700
Dec	5,760	8,440	10,600	2	0	0	5,150	9,440	11,900

R2. Annual low-flow duration (LFD) (total number days per year less than 25 percent of average annual discharge [AAD])

25 percent AAD = 5,567 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years	All years LFD	of 4 years LFD	1 of 2 years LFD	Maximum LFD	LFD exceeded in 1 of 4 years	LFD exceeded in 1 of 2 years
LFD	24	0	0	9	0	0	41	0	0

R3. Monthly average flow (cfs)

	Estimates of the natural regime		Percentage of years that the baseline regime departs from the guidelines*	Parameters of the baseline regime	
	25th percentile	75th percentile	% outside mid range	25th percentile	75th percentile
Jan	16,755	33,065	6	18,040	38,318
Feb	19,989	38,375	1	27,247	48,567
Mar	27,035	47,613	6	25,108	50,932
Apr	21,803	40,923	0	22,710	39,815
May	16,603	28,639	10	14,540	26,561
Jun	13,057	19,663	0	13,034	18,396
Jul	13,984	19,442	29	11,384	19,461
Aug	11,786	17,526	1	10,986	16,319
Sep	9,827	14,911	0	9,617	13,860
Oct	8,111	14,174	0	9,377	13,426
Nov	8,788	13,953	1	9,140	16,611
Dec	11,600	24,787	0	12,708	26,620

F1. 1-day Maxima (1DMax) (cfs)

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines			Parameters of the baseline regime		
	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years	All years 1DMax	3 out of 4 years 1DMax	1 of 2 years 1DMax	1DMax exceeded in all years	1DMax exceeded in 3 of 4 years	1DMax exceeded in 1 of 2 years
1DMax	32,600	60,300	74,500	0	0	0	43,100	72,400	85,900

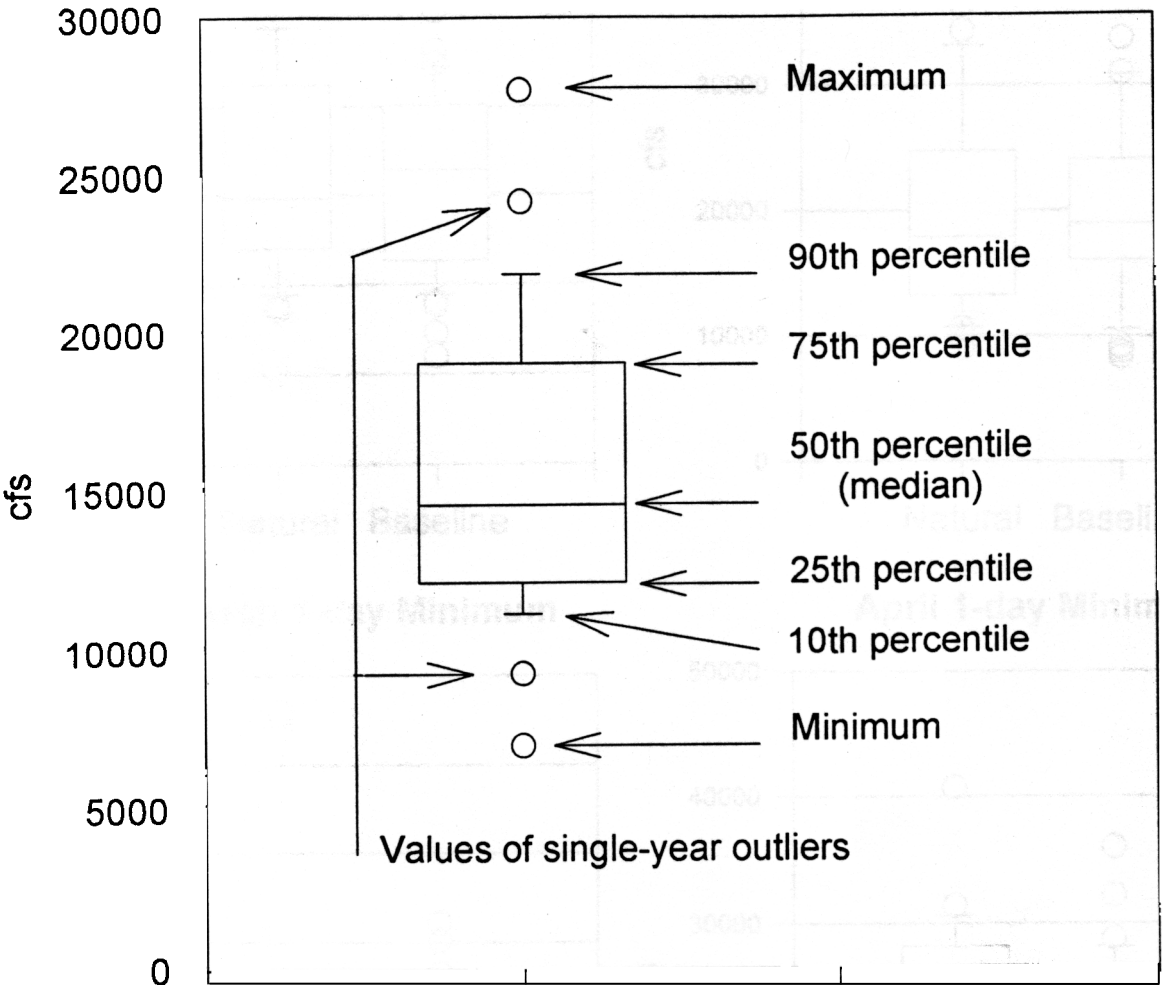
F2. Annual high-flow duration (HFD) (total number days per year greater than 1.25 times average annual discharge [AAD])

1.25 * AAD = 27833 cfs

	Estimates of the natural regime			Percentage of years that the baseline regime departs from the guidelines*			Parameters of the baseline regime		
	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years	All years HFD	3 of 4 years HFD	1 of 2 years HFD	Minimum HFD	HFD exceeded in 3 of 4 years	HFD exceeded in 1 of 2 years
HFD	7	38	76	0	0	0	11	53	91

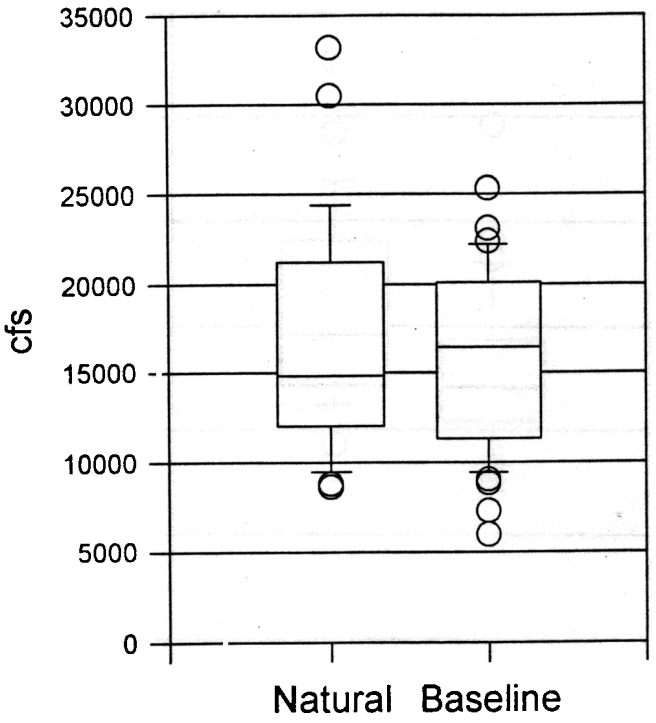
* "Percentage of years" values given are differences between the period of record used to estimate natural regime features and the period of record used to represent baseline conditions. A positive value is the percentage of years that the baseline departs from the natural regime estimate; a zero indicates no departure.

Elements of box plots showing the inter-annual distribution of flow regime features

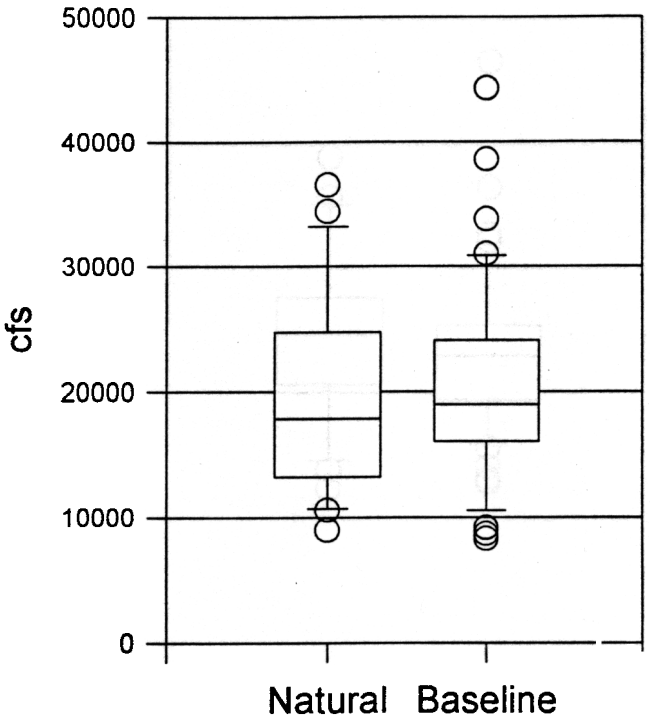


Apalachicola River at Chattahoochee, Florida

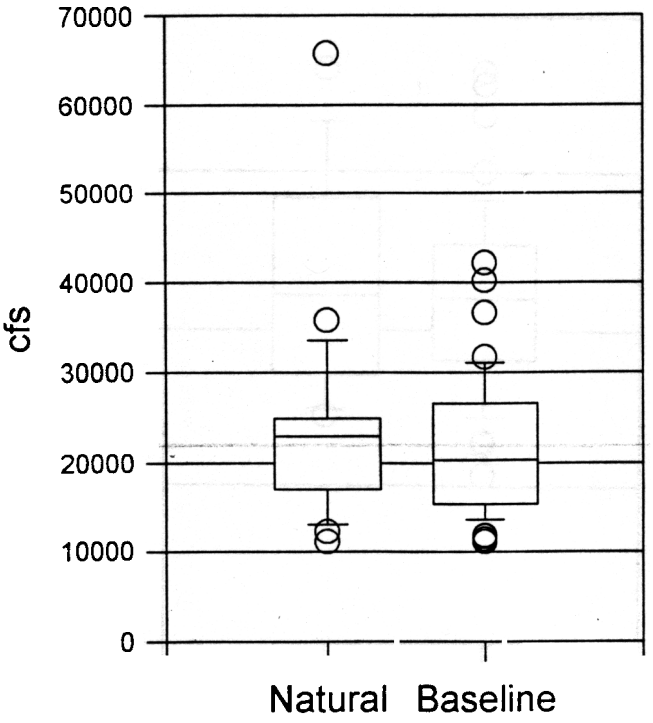
January 1-day Minimum



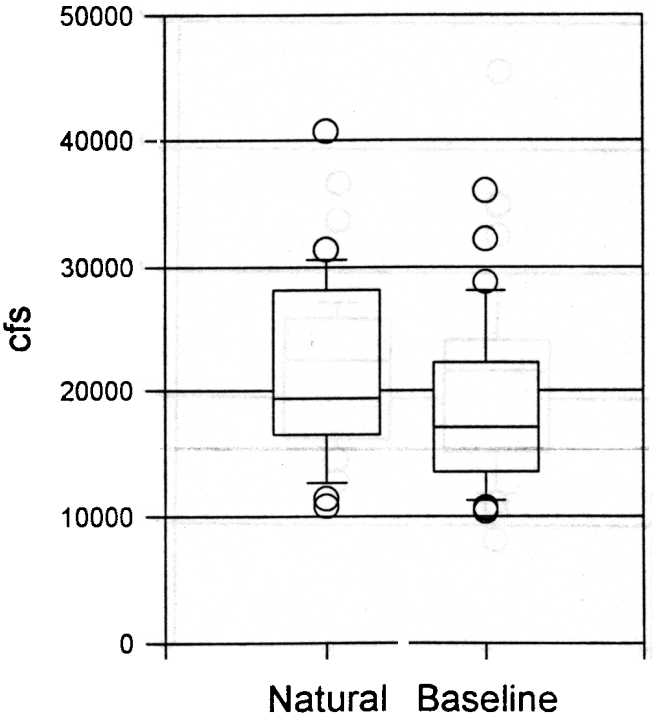
February 1-day Minimum



March 1-day Minimum

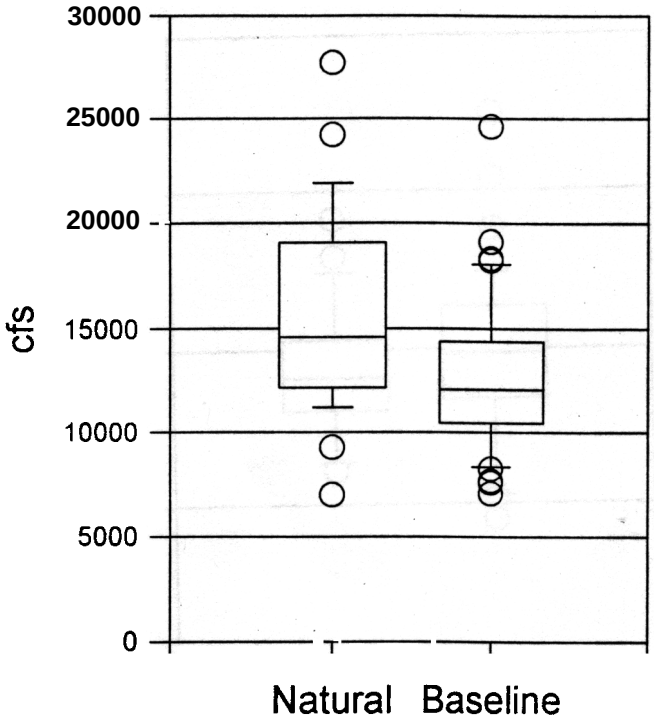


April 1-day Minimum

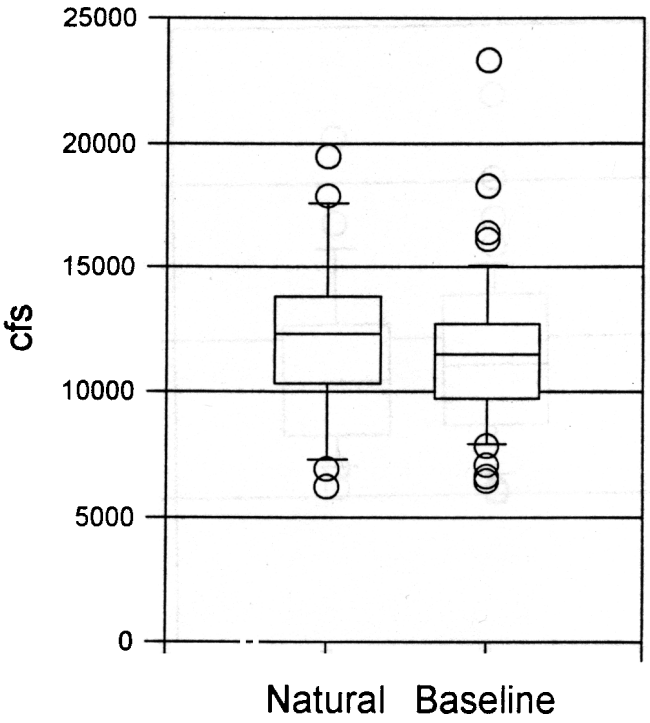


Apalachicola River at Chattahoochee, Florida

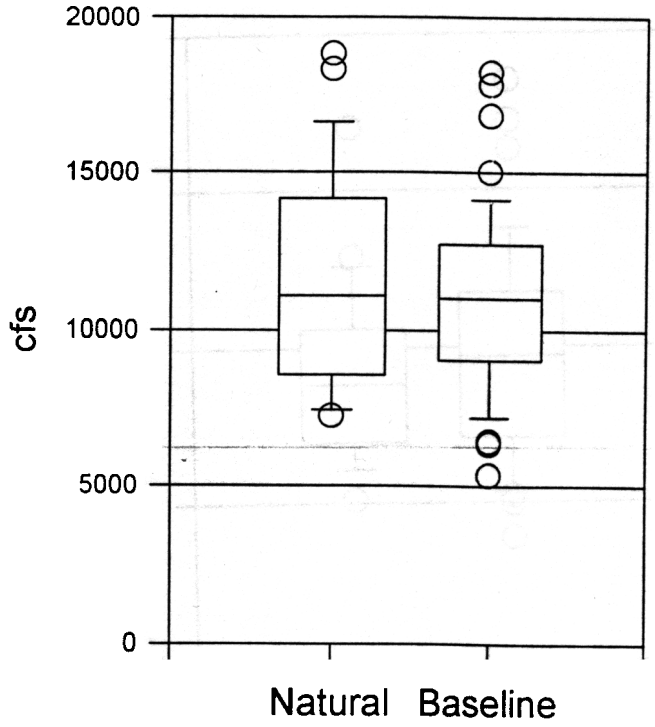
May 1-day Minimum



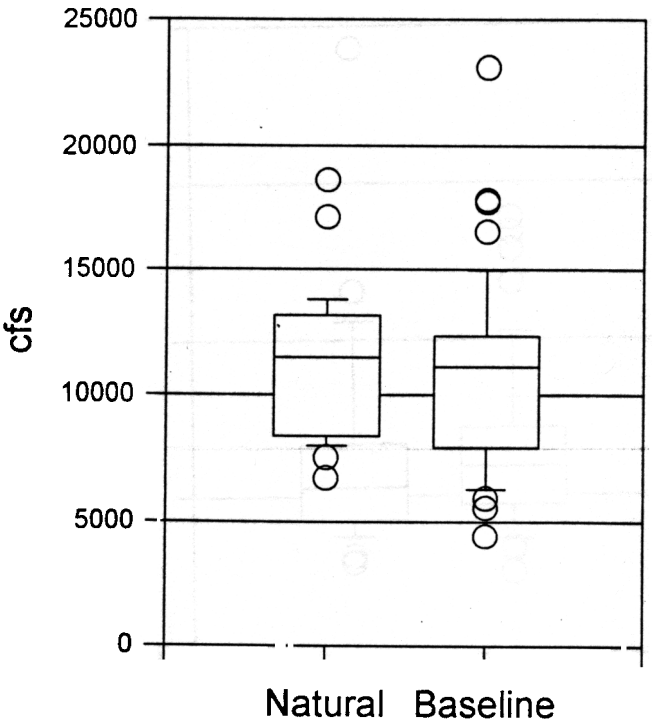
June 1-day Minimum



July 1-day Minimum

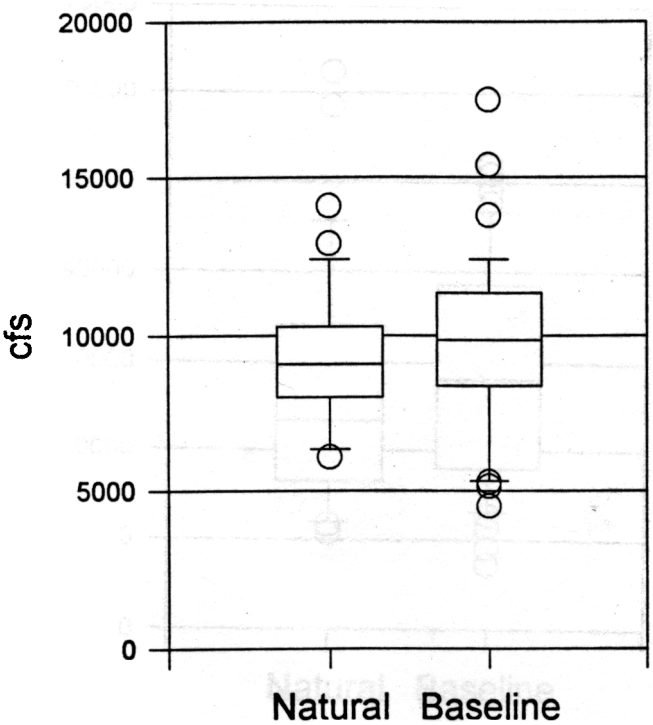


August 1-day Minimum

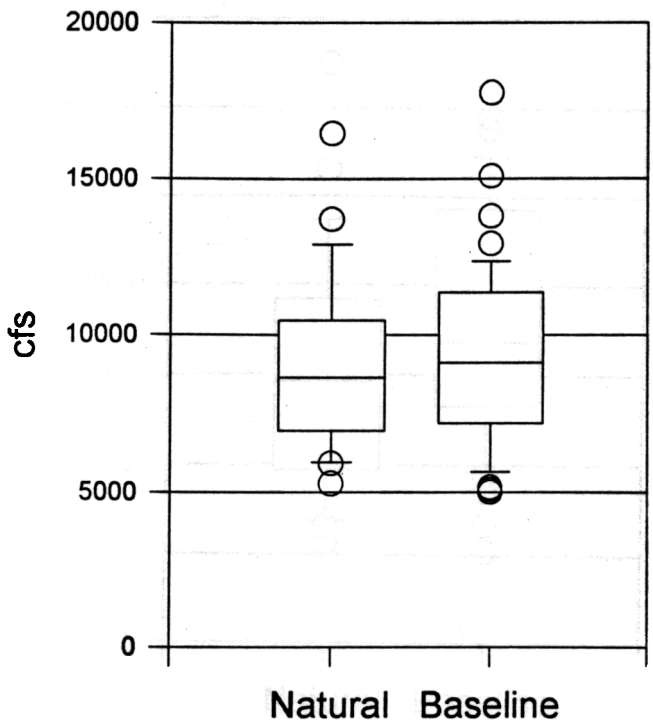


Apalachicola River at Chattahoochee, Florida

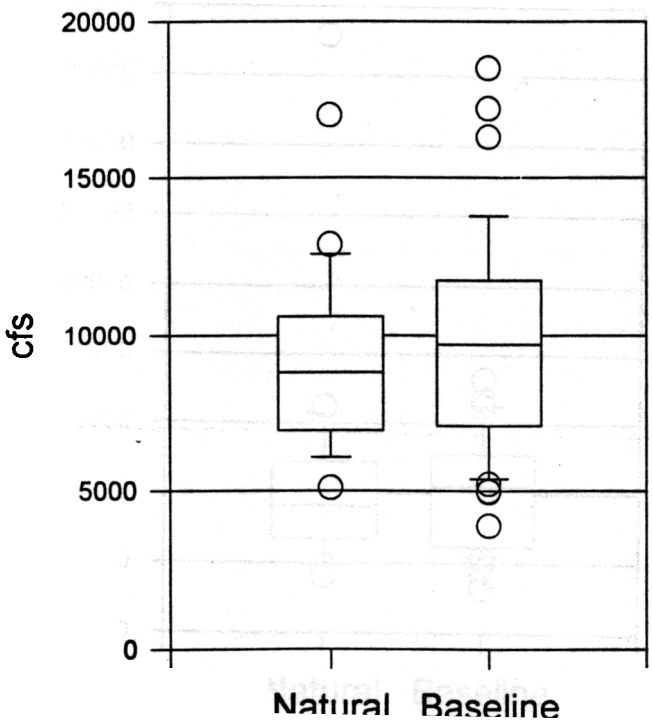
September 1-day Minimum



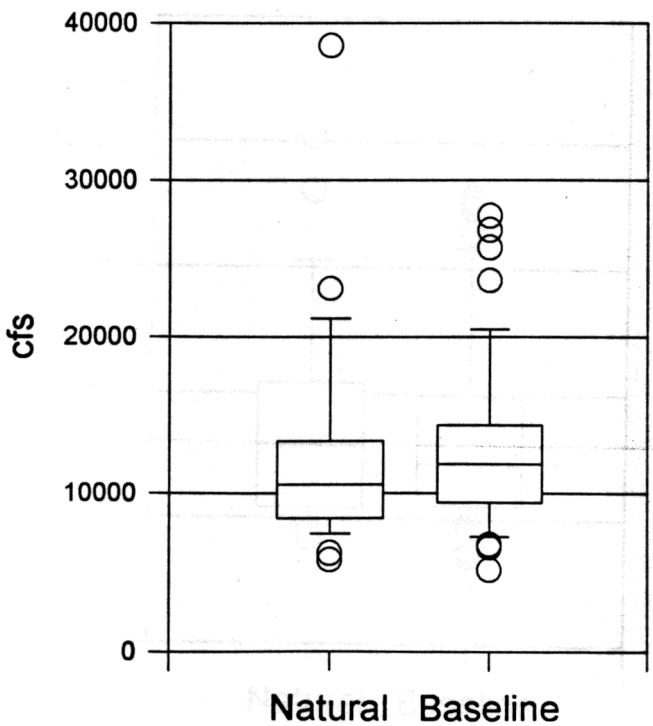
October 1-day Minimum



November 1-day Minimum

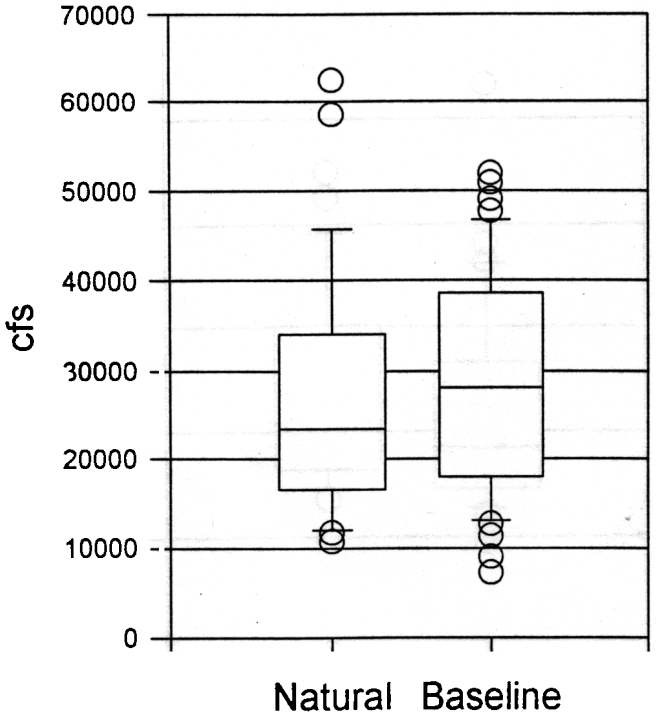


December 1-day Minimum

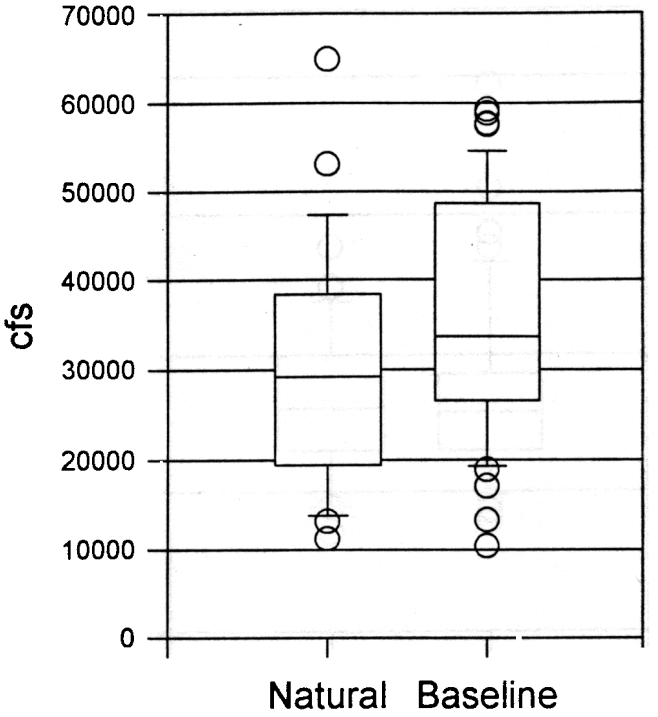


Apalachicola River at Chattahoochee, Florida

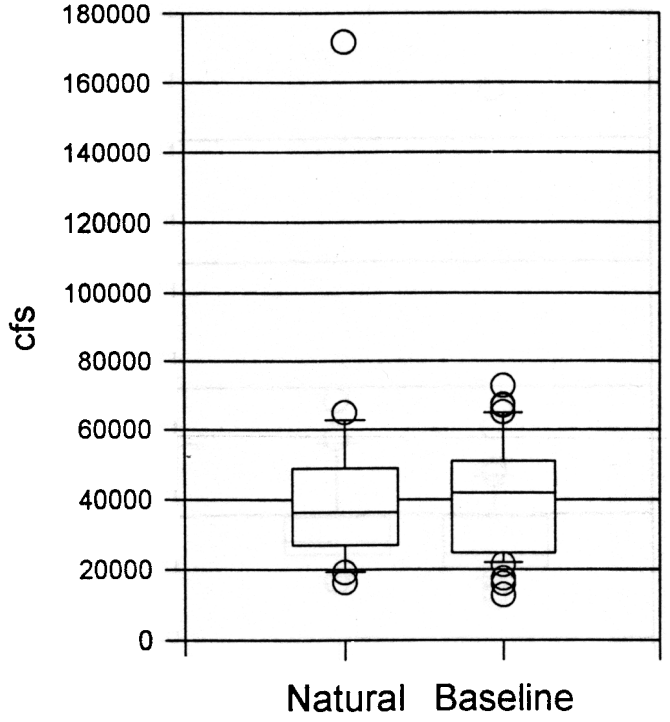
January Average Flow



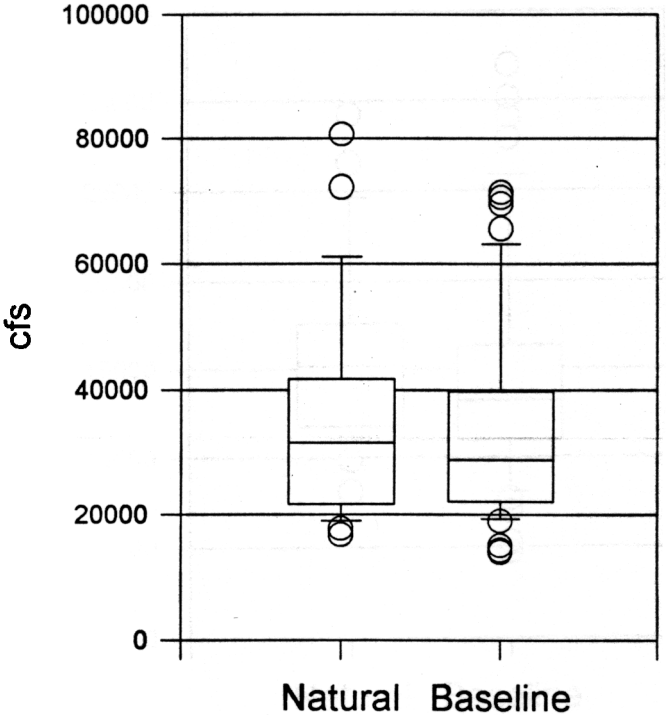
February Average Flow



March Average Flow

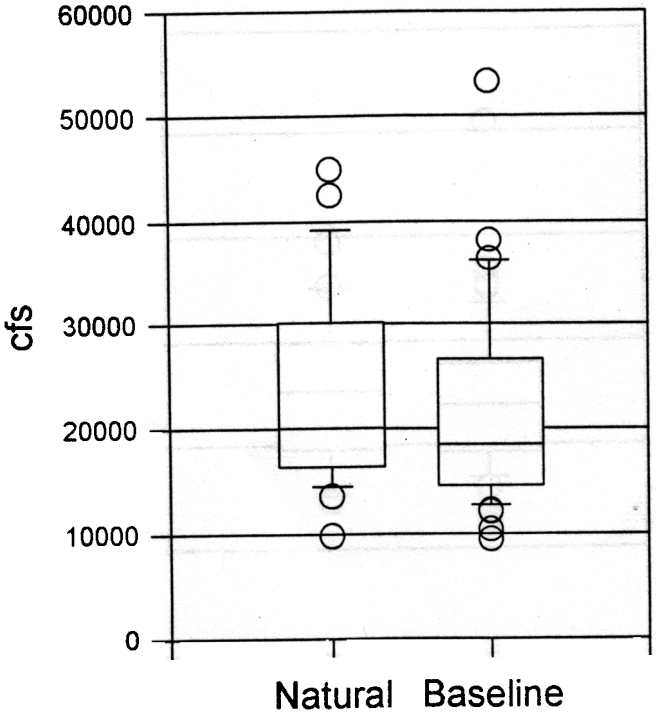


April Average Flow

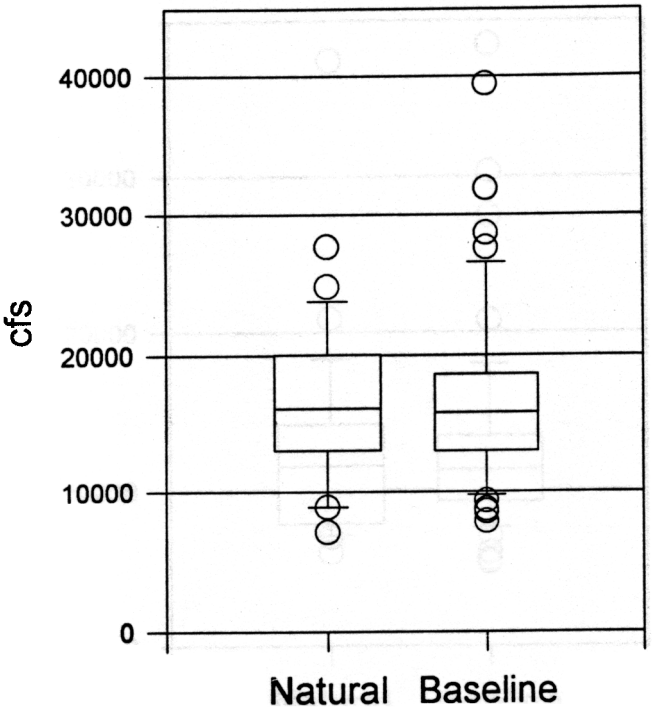


Apalachicola River at Chattahoochee, Florida

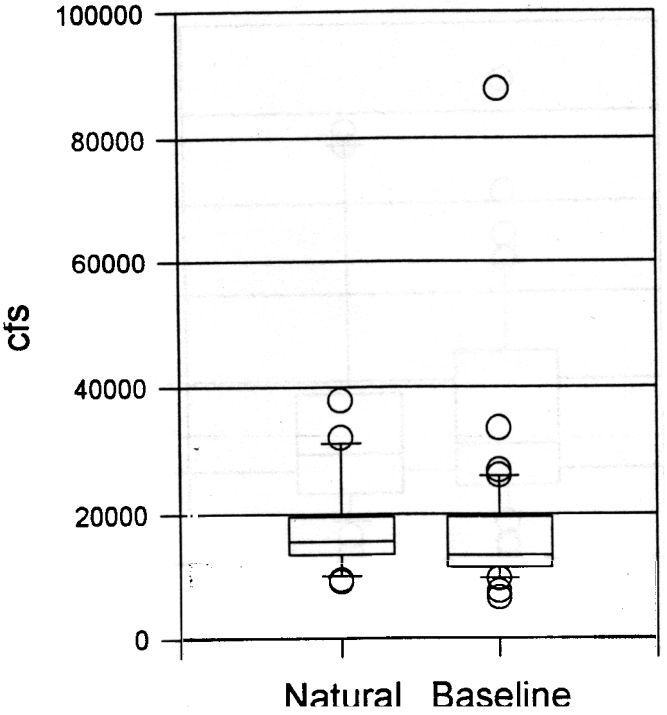
May Average Flow



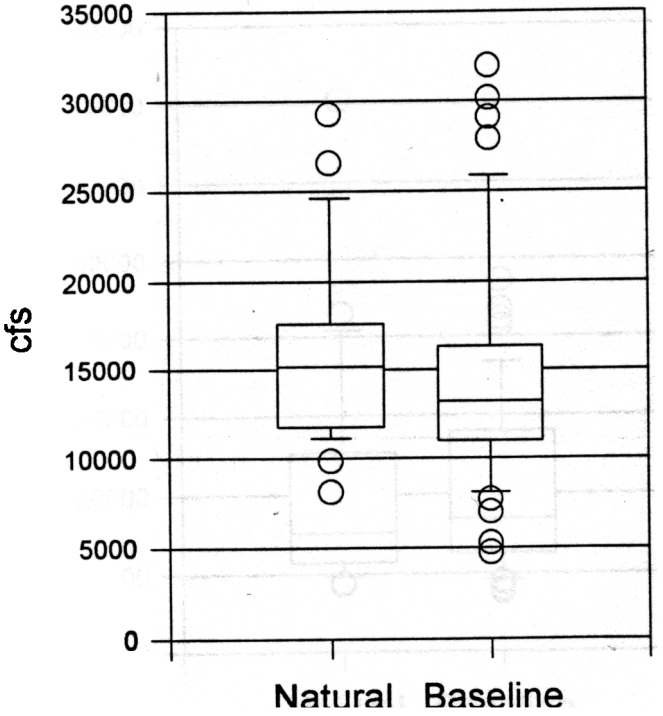
June Average Flow



July Average Flow

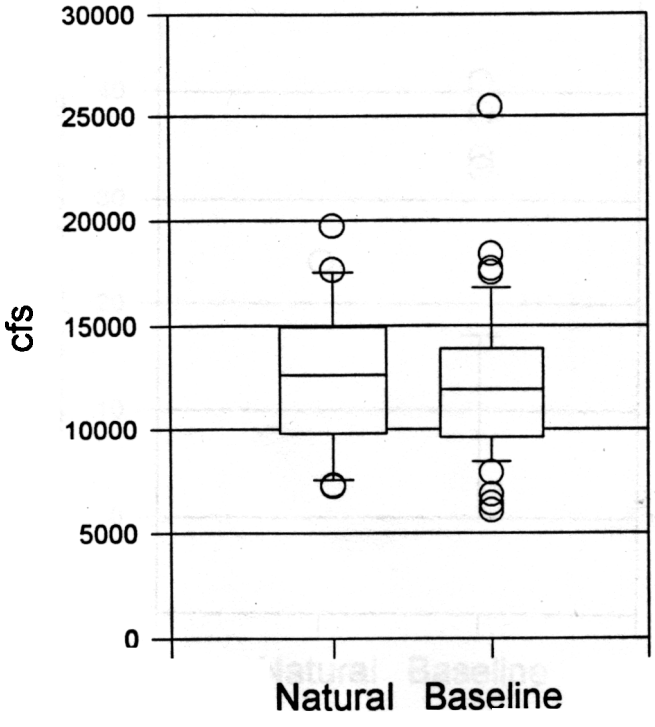


August Average Flow

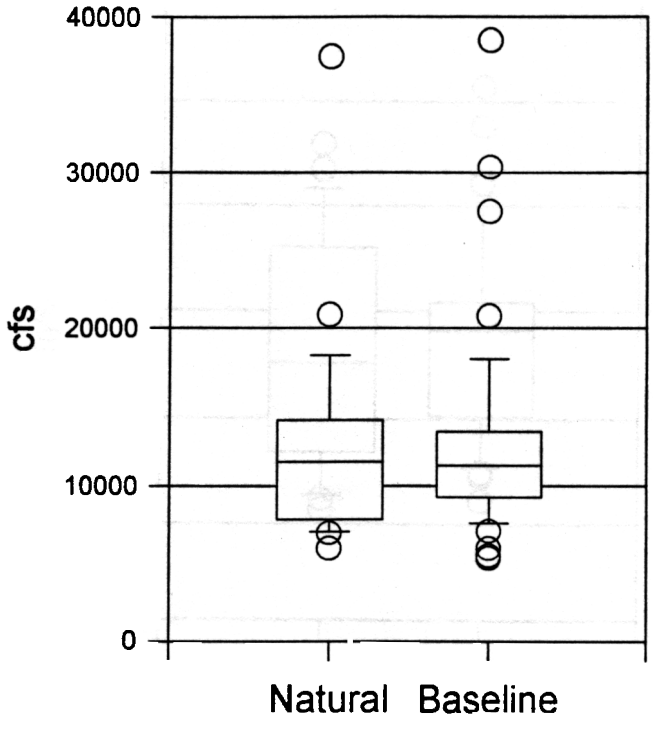


Apalachicola River at Chattahoochee, Florida

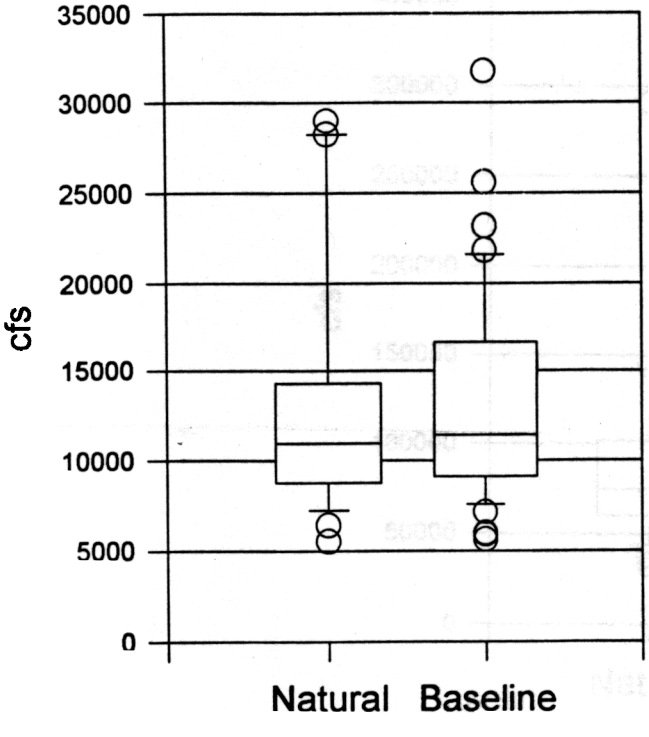
September Average Flow



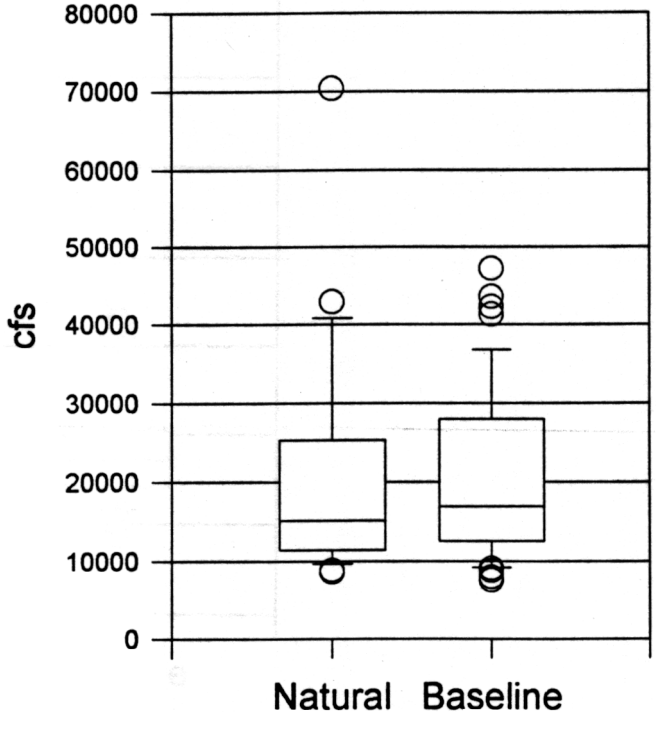
October Average Flow



November Average Flow

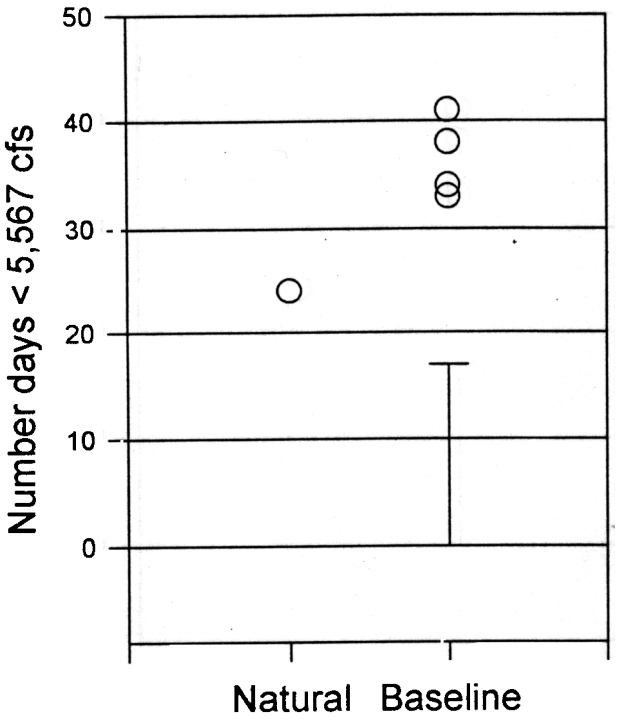


December Average Flow

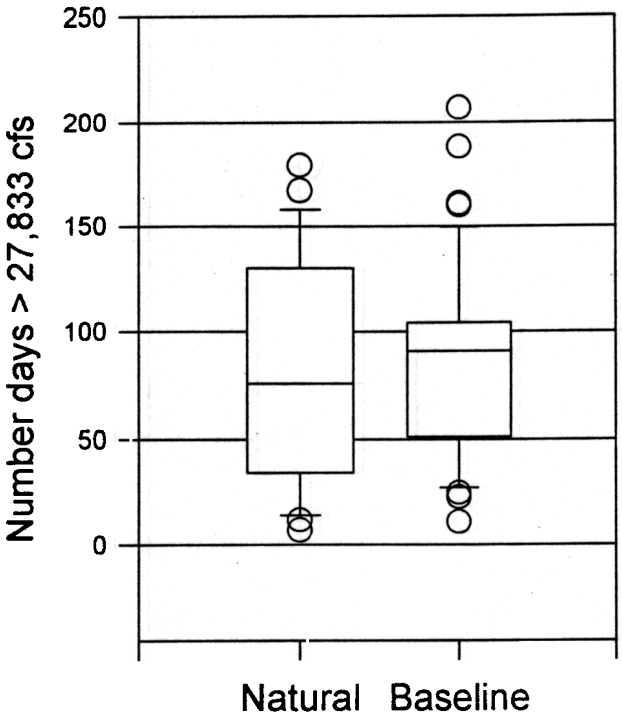
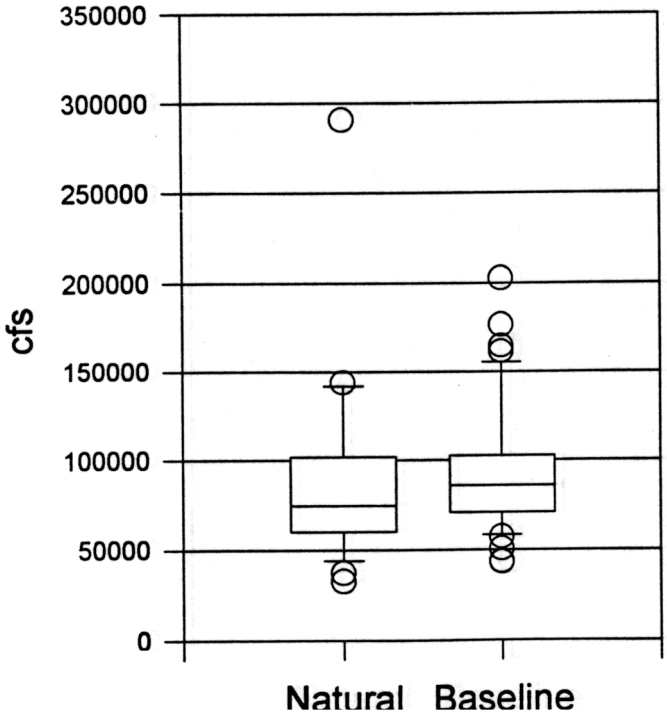


Apalachicola River at Chattahoochee, Florida

Annual Low Flow Duration



Annual High-Flow Duration



Annual 1-day Maximum Flow