BIOLOGICAL ASSESSMENT
MODIFICATIONS TO THE INTERIM OPERATING PLAN FOR JIM WOODRUFF DAM AND THE ASSOCIATED RELEASES TO THE APALACHICOLA RIVER

INTRODUCTION

On 7 March 2006, the U.S. Army Corps of Engineers, Mobile District, submitted a request to initiate formal consultation pursuant to Section 7 of the Endangered Species Act (ESA) regarding the impact of releases from the Jim Woodruff dam to the Apalachicola River, under the existing water control plan operations, on Federally listed endangered or threatened species and critical habitat for those species. Operations regarding releases to the Apalachicola River were described in an Interim Operations Plan (IOP) for Jim Woodruff Dam, since consultation on the overall project operations for the Apalachicola, Chattahoochee,Flint Rivers (ACF) system would be deferred until future efforts to update the water control plans and basin manual for the system. Species of concern include the threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and critical habitat for the Gulf sturgeon; the endangered fat threeridge mussel (*Amblema neislerii*); the threatened purple bankclimber mussel (*Elliptoideus sloatianus*); and the Chipola slabshell mussel (*Eliptio chipolaensis*). During the consultation process, a proposed revision to the IOP plan was developed and submitted for consideration on June 12, 2006. A final Biological Opinion (BO) for the Jim Woodruff Dam IOP (as described in the June 12, 2006 letter) was issued by the U.S. Fish and Wildlife Service, Panama City Field Office on 5 September 2006, and incorporated additional modifications to the IOP in order to avoid or minimize incidental take of listed mussels.

The BO included five reasonable and prudent measures (RPMs) for further limiting the amount of incidental take associated with water management operations at Jim Woodruff Dam. For each of the five RPMs, the BO also included specific terms and conditions which must be met in order to assure compliance with the RPMs. This Biological Assessment has been prepared to address the potential effects of proposed modifications to the IOP as prescribed under RPM3 and the terms and conditions of the BO (described below).

> "**RPM3. Drought provisions**. Develop modifications to the IOP that provide a higher minimum flow to the Apalachicola River when reservoir storage and hydrologic conditions permit.
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> > **Rationale.** Take of listed species due to the IOP may occur when the Corps is using a portion of basin inflow to increase ACF reservoir storage. The Corps can minimize mussel mortality due to low-flow conditions by supporting a higher minimum flow when total reservoir storage and/or hydrologic conditions permit. As proposed, the IOP uses reservoir storage to support a 5,000 cfs minimum flow. The available data indicates that higher minimum flows are supportable during

normal and wet hydrologic periods, and during dry periods when the reservoirs are relatively full. Conversely, during extended drier than normal conditions, it may be prudent to store more water than allowed under the IOP during certain times of the year to insure minimum water availability later. Possible components and triggers of the drought plan could be, but are not limited to: Corps reservoir action zones, cumulative reservoir storage remaining, total basin inflows, indictors of fish spawn, climatic condition indices, and flow levels at gages downstream of the Chattahoochee gage, such as the gage at Wewahitchka.

a. The Corps, with Service concurrence, shall initiate by January 30, 2007, IOP drought provisions that identify the reservoir, climatic, hydrologic, and/or listed species conditions that would allow supporting a higher minimum flow in the Apalachicola River, and that identify recommended water management measures to be implemented when conditions reach the identified drought trigger point(s).

b. If modifications to the IOP parameters for the months of March through May are adopted as part of the drought provisions, the Corps shall assess potential effects to Gulf sturgeon spawning and floodplain inundation. The Corps shall provide the models and a biological assessment of the effects of the drought provisions on listed species at least 135 days in advance of implementing the drought provisions in order to reinitiate this consultation relative to any proposed changes in the IOP" (USFWS 2006).

The Jim Woodruff Dam Interim Operations Plan Biological Opinion Annual Report provided to the USFWS on January 31, 2007 describes in detail the collaborative efforts of the Mobile District, USFWS, and other stakeholders within the basin to develop a plan that meets the intents of RPM3. The following is a brief summary.

During the October 2006 semi-annual/planning meeting, the USFWS and Mobile District discussed possible elements of a drought provision and identified alternative minimum flows of 5,800 cfs, 6,500 cfs and 7,000 cfs to model and evaluate. The higher minimum flows identified were based on the flow conditions necessary to provide "flow-through" conditions at swift Slough and adequate depths at the impacted "hooks and bays" along the main channel of the Apalachicola River; as well as operational constraints relative to making releases through the powerhouse turbines during low flow conditions. Additional storage in the reservoirs would be necessary to maintain the suggested higher flows, and it was agreed to consider increasing storage options during the Gulf sturgeon spring spawning period in order to provide the necessary additional storage. For investigation purposes, it was suggested that an upper basin inflow threshold of 25,000 cfs (below which at least 70 percent of basin inflows would be released and up to 30 percent could be stored); and a lower basin inflow threshold of 16,000 cfs (below which 100 percent of the basin inflows would be released) be modeled to assess the potential for trade-off benefits and/or effects to the species.

The modeling results for the three scenarios indicated that (based on composite storage within the basin), there would be shortages for each of the three scenarios. However, the shortage associated with the 5,800 cfs scenario was relatively small, indicating that a sustained minimum flow close to 5,800 cfs might be sustainable most of the time, but that a drought “trigger” identifying when to revert back to the lower 5,000 cfs minimum flow would be needed during sustained low flow or drought conditions. It was agreed the Mobile District would attempt to define a drought trigger, and that the results of further considerations and modeling would be discussed with USFWS during a meeting on December 6, 2006. During the development of the drought trigger plan the Mobile District and USFWS were presented with suggested concepts for drought provision operations from other stakeholders within the basin. In order to facilitate the development of a drought provision operation pursuant to the requirements of RPM3, share information on concepts being considered by Mobile District and USFWS, and to solicit input from the interested stakeholders, a Drought Provision Workshop was held on 13 December 2006 in Columbus, Georgia. Attendees included Federal, State, and local stakeholders within the ACF Basin. During the workshop, the Mobile District presented several concepts that had been considered in consultation with the USFWS (Concepts 1 through 4), with Concept 3 selected as the drought provision plan to be further analyzed. Concept 3 included a reduction of the upper and lower basin inflow thresholds for the spawning period to 25,000 cfs and 16,000 cfs, respectively, allowing for a higher desired minimum release of 6,500 cfs under normal to wet flow conditions. Concept 3 also included a drought trigger that allowed for a reversion to the lower required minimum release of 5,000 cfs. The drought trigger was based on the Composite Storage remaining within the storage reservoirs within the basin.

Concept 3 was modeled and evaluated using the same statistical and effects analyses as prepared by the USFWS in the BO. In reviewing these results, it was determined that the Concept 3 plan provided the desired beneficial effects to listed mussels when flows were less than 10,000 cfs. However, we determined that the proposed reduction in spring releases may result in adverse effects to the listed mussels by negatively impacting flow regime characteristics relevant to host fish for mussels. The IOP plan described in the BO had resulted in beneficial effects relative to these flow regime characteristics. Based on informal consultation discussions with the USFWS it was determined that an alternative conceptual RPM3 plan could be developed with that could still provide some level of trade offs relative to these beneficial effects, while minimizing or eliminating the identified potentially adverse indirect effects of Concept 3. An alternative conceptual plan (Concept 5) was developed in order to avoid the potentially adverse effects and still meet the intent of RPM3. The Concept 5 plan is similar to Concept 3 with the exception of increasing the spawning season lower threshold flow from 16,000 to 18,000 cfs. Analysis of the effects of the Concept 5 plan was completed and it is now proposed as the drought provision plan to be implemented in accordance with the requirements of RPM3. A detailed description of Concept 5 and the associated effects analysis is provided below.

DESCRIPTION OF PROPOSED ACTION

The proposed action (referred to as “Concept 5” throughout this assessment) is a modification of the IOP as described in the September 7, 2006, letter from the Corps to the USFWS (referred to as “IOPR” throughout this assessment) which incorporated the requirements of RPM2 (requiring a modification of the proposed IOP increasing the lower flow/storage threshold during the June – February period from 8,000 cfs to 10,000 cfs in order to minimize incidental take of mussels) of the BO (Table 1). Concept 5 was developed in accordance with RPM3 of the BO, which requires modifying the IOPR to provide a higher minimum flow to the Apalachicola River when reservoir storage and hydrologic conditions permit.

Concept 5 accomplishes this by maintaining a higher desired minimum release of 6,500 cfs from Jim Woodruff Dam during normal to wet flow conditions. However, during sustained dry or drought conditions, a more conservative drought management operation is "triggered" and the lower required minimum release of 5,000 cfs is maintained consistent with the IOP. The drought trigger is determined by computing the Composite Storage within the three storage reservoirs within the basin. The Composite Storage is calculated by combining the storage of Lake Sidney Lanier, West Point Lake, and Walter F. George. Each of the individual storage reservoirs consists of four Zones. These Zones are determined by the operational guide curve for each project. The Composite Storage utilizes the four Zone concept as well; ie, Zone 1 of the Composite Storage represents the combined storage available in Zone 1 for each of the three storage reservoirs. Figure 1 illustrates the acre-feet of storage available for Composite Zones 1-4 throughout the year. Whenever the Composite Storage falls below the bottom of Zone 2 into Zone 3, the drought trigger dictates a reversion to the required minimum release of 5,000 cfs. The drought management operations maintain a minimum release of 5,000 cfs until conditions improve such that the Composite Storage reaches a level above the top of Zone 2 (i.e., within Zone 1). At that time, the drought management operations are suspended, and the desired higher minimum release of 6,500 cfs is maintained.

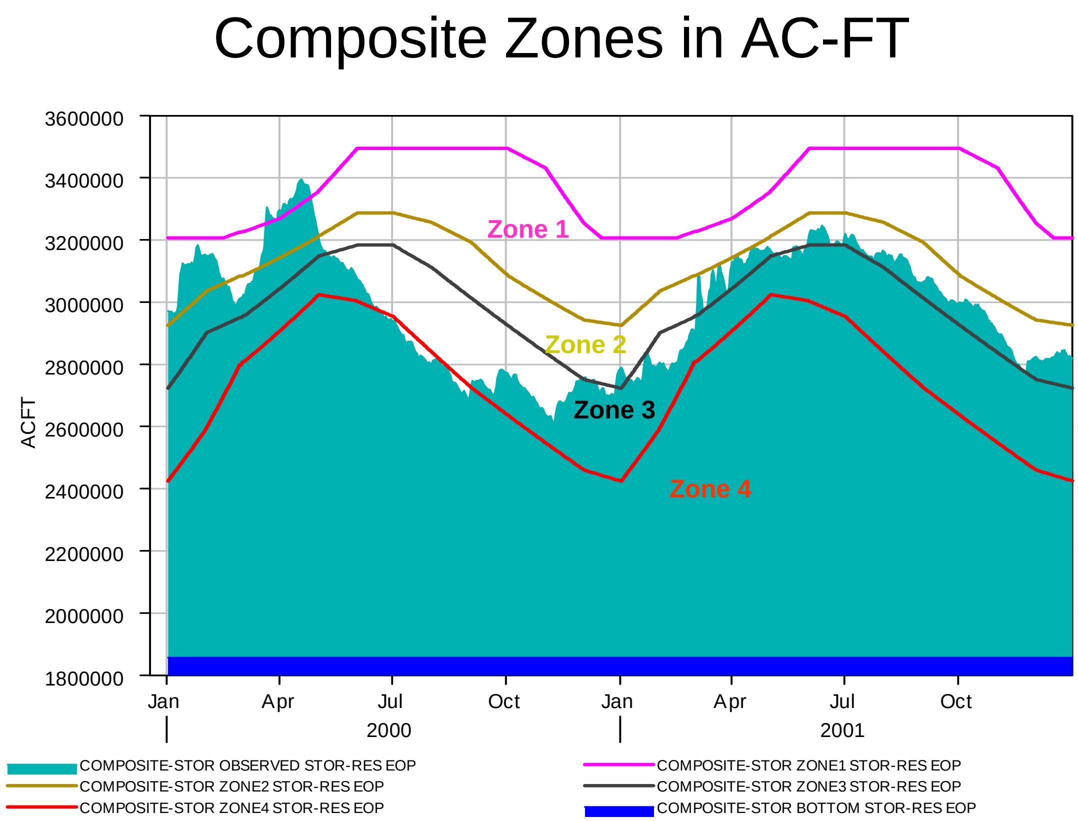


Figure 1. Composite Storage and associated Zones in acre-feet.

In order for the system to support this modification, additional reservoir storage during the normal spring filling period is required. It is therefore proposed to lower the basin inflow thresholds and associated releases from Jim Woodruff Dam prescribed by the IOPR during the March – May spawning period (Table 2). Figure 2 provides a graphical representation of the Concept 5 minimum discharge rules from Jim Woodruff Dam during the non-spawning and spawning periods. However, these rules prescribe minimum requirements for releases and generally releases will be higher than those prescribed due to releases made for other project purposes such as hydropower operations, flood control operations, balancing of reservoir levels, etc. During sustained dry periods, releases will more closely conform with the releases shown on the graphs in Figure 2.

Like the IOPR, the releases from Jim Woodruff Dam and maximum fall rate schedule prescribed by Concept 5 are determined based on basin inflow. As described in the BO, basin inflow is the amount of water that would flow by Woodruff Dam during a given time period if all of the Corps' reservoirs maintained a constant water surface elevation during that period. Basin inflow is not the natural flow of the basin at the site of Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal water supply and agricultural irrigation. The consumptive water demands utilized represent an estimate of present levels of the net depletion due to municipal, industrial, and agricultural water uses and evaporative losses from the four largest reservoirs, Lanier, George, West Point, and

Seminole. These depletions vary by month and in the case of agricultural demands and reservoir evaporation, also by year (wet, normal, dry). Concept 5 utilizes the same maximum fall rate schedule described in the IOP and analyzed in the BO.

Consistent with the operational decisions approved in the BO, Concept 5 also includes a volumetric balancing of releases in cases where following the ramping rates specified in the proposed action results in a release greater than that required to meet the calculated 7-day average basin inflow. During rain events, the required ramping rates are often more gradual than the actual decline in basin inflows, and potential over-releases and additional drain on reservoir storage could occur, especially when trying to match releases to the computed 7-day average basin inflow. In order to avoid over-releases and conserve storage during critical periods, the volume of releases can be balanced during and following rain events. Releases after the rainfall events are adjusted to account for any computed under-release or over-release, to assure that net releases are balanced to meet the computed volume of basin inflow over time. The volumetric balancing computations do not include releases for flood control or other special releases not required by Concept 5, but primarily account for possible over-releases that occur due to the ramping rate restrictions.

Minimum Releases

Months	Basin Inflow (BI) (cfs)*	Releases from JWLD (cfs)
March - May	>= 37,400	not less than 37,400
	>= 20,400 and < 37,400	>= 70% BI; not less than 20,400
	< 20,400	>= BI; not less than 5,000
June - February	>= 23,000	not less than 16,000
	>=10,000 and < 23,000	>= 70% BI; not less than 10,000
	< 10,000	>= BI; not less than 5,000

*The running 7-day average daily inflow to the Corps' ACF reservoir projects, excluding releases from project storage.

Down Ramping Rates

Release Range	Maximum Fall Rate (ft/day), measured at Chattahoochee gage
Flows greater than 30,000 cfs*	No ramping restriction**
Flows greater than 20,000 cfs but <= 30,000*	1.0 to 2.0 ft/day
Exceeds Powerhouse Capacity (~16,000 cfs) but <= 20,000 cfs*	0.5 to 1.0 ft/day
Within Powerhouse Capacity and > 8,000 cfs*	0.25 to 0.5 ft/day
Within Powerhouse Capacity and <=8,000 cfs*	0.25 ft/day or less

*Consistent with safety requirements, flood control purposes, equipment cababilities.
**For flows greater than 30,000 cfs, it is not reasonable or prudent to attempt to control down ramping rate, and no ramping rate is required.

Table 1. IOPR minimum discharge rates from Woodruff Dam by month and by basin inflow and maximum fall rate schedule for discharge from Woodruff Dam by release range.

Minimum Releases

Months	Basin Inflow (BI) (cfs)	Releases from JWLD (cfs)
March - May	>= 35,800	not less than 25,000
	>= 18,000 and < 35,800	>= 70% BI; not less than 18,000
	< 18,000	>= BI; not less than 6,500 (Desired Flow)*
		>= BI; not less than 5,000 (Required Flow)
June - February	>= 23,000	not less than 16,000
	>=10,000 and < 23,000	>= 70% BI; not less than 10,000
	< 10,000	>= BI; not less than 6,500 (Desired Flow)*
		>= BI; not less than 5,000 (Required Flow)

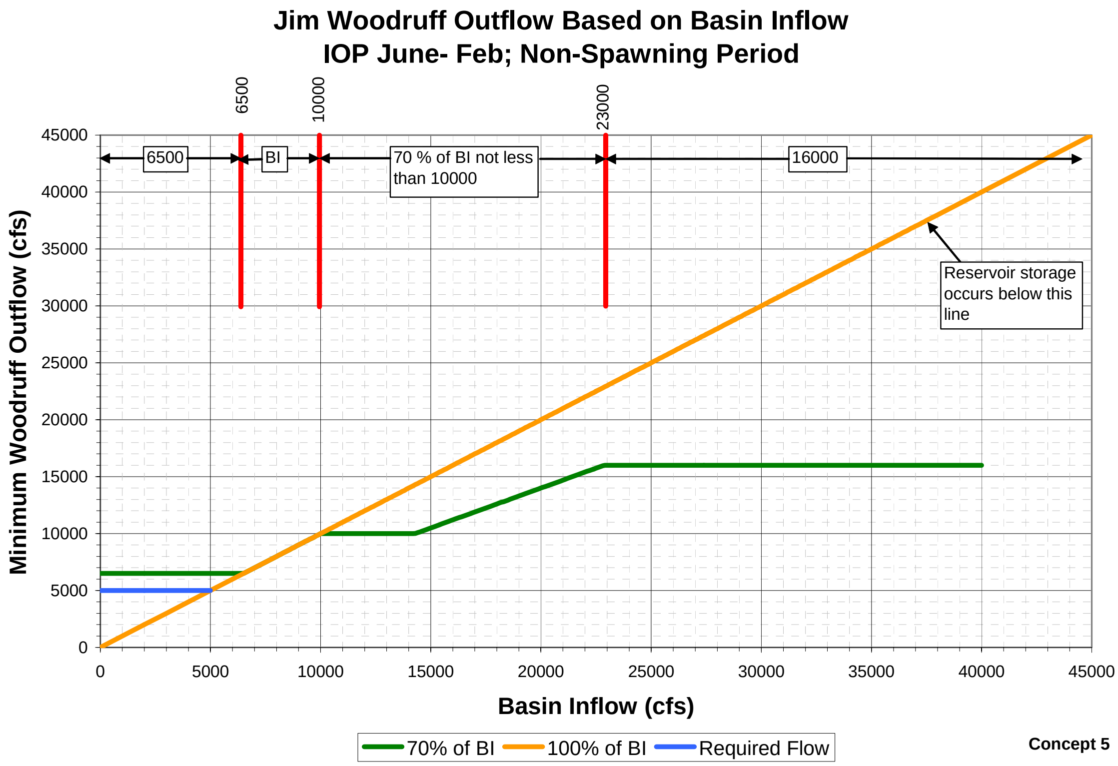
*Drought Provision: When Composite Storage is within Zones 1 and 2, then the higher minimum Release of 6,500 cfs would be maintained. When Composite Storage falls below the top of Zone 3, then Release will be reduced to the 5,000 cfs minimum; when Composite Storage is restored to above the top of Zone 2 (i.e., within Zone 1), then the higher minimum Release of at least 6,500 cfs would again be maintained. Composite Storage is the combined storage of Lake Sidney Lanier, West Point Lake, and Walter F. George.

Down Ramping Rates

Release Range	Maximum Fall Rate (ft/day), measured at Chattahoochee gage
Flows greater than 30,000 cfs*	No ramping restriction**
Flows greater than 20,000 cfs but <= 30,000*	1.0 to 2.0 ft/day
Exceeds Powerhouse Capacity (~16,000 cfs) but <= 20,000 cfs*	0.5 to 1.0 ft/day
Within Powerhouse Capacity and > 8,000 cfs*	0.25 to 0.5 ft/day
Within Powerhouse Capacity and <=8,000 cfs*	0.25 ft/day or less

*Consistent with safety requirements, flood control purposes, equipment cabablities.
**For flows greater than 30,000 cfs, it is not reasonable or prudent to attempt to control down ramping rate, and no ramping rate is required.

Table 2. Concept 5 minimum discharge rates from Woodruff Dam by month and by basin inflow and maximum fall rate schedule for discharge from Woodruff Dam by release range.



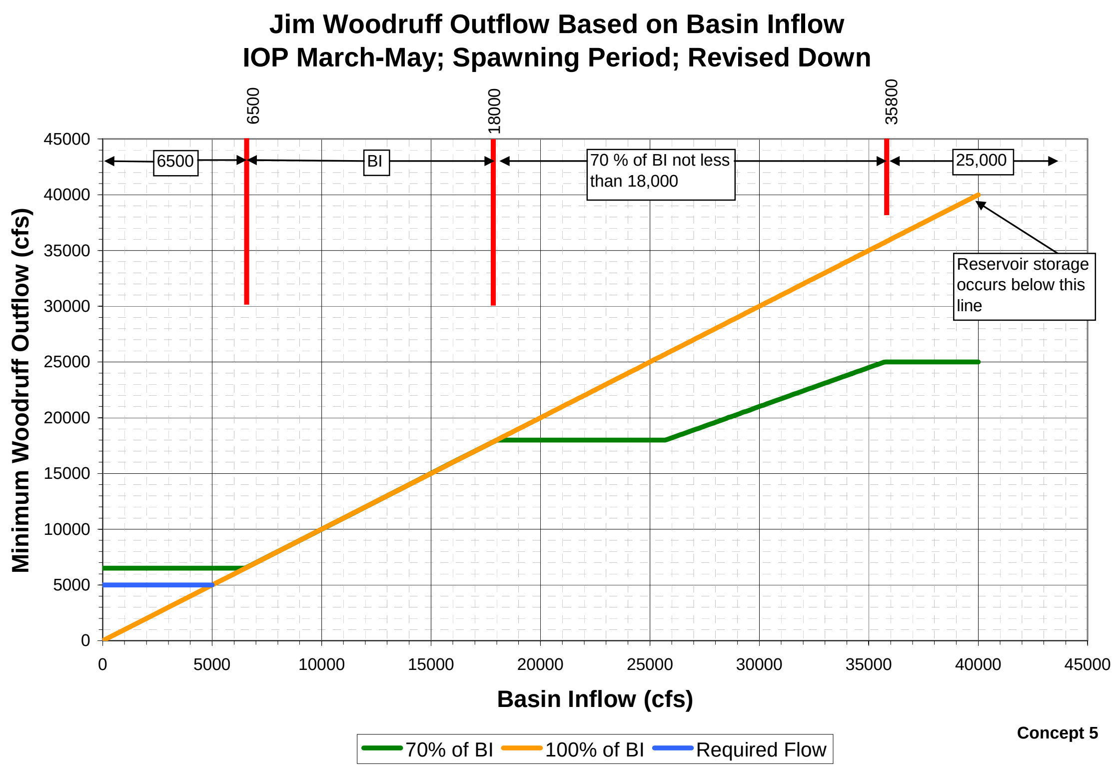


Figure 2. Concept 5 minimum discharge rules from Woodruff Dam during the non-spawning and spawning periods.

STATUS OF THE SPECIES AND ENVIRONMENTAL BASELINE

Please reference the STATUS OF THE SPECIES/CRITICAL HABITAT and ENVIRONMENTAL BASELINE sections (Sections 2 and 3 respectively) of the September 5, 2006 Biological Opinion and Conference Report on the U.S. Army Corps of Engineers, Mobile District, Interim Operating Plan for Jim Woodruff Dam and the Associated Releases to the Apalachicola River (USFWS 2006). The detailed information provided in these sections represents the best scientific information available on the listed species occurring in the action area and provided the basis for determining the flow regime characteristics identified as relevant to the listed species and their habitats.

EFFECTS ANALYSIS

To determine the future effect of continued project operations as prescribed by the proposed action, we must compare the environmental conditions expected to occur under Concept 5 to the environmental baseline, in a similar manner as was performed in the above-referenced BO. The principal factor examined in determining effects for the alternative operations is the flow regime of the Apalachicola River and how the flow regime affects habitat conditions for the listed species. However, not all of the differences between the Concept 5 flow regime and the Baseline flow regime can be attributed to the proposed action alone. Some of the differences are due to consumptive water uses in the basin rather than Corps reservoir operations.

The level of consumptive water uses supported in the basin upstream of Woodruff Dam, impacts the basin inflow to the Corps' projects. The level of consumptive water uses has increased throughout the post-West Point period (post-1975), which is used to establish the baseline flow regime. Concept 5 dictates minimum releases from Jim Woodruff Dam based on basin inflow available under the present level of consumptive water uses, which is a feature of the most recent years only in the baseline period. Using the inflow based on present consumptive uses means that conditions predicted for Concept 5 are due in part to the proposed action and due in part to an increase in consumptive uses.

In order to differentiate these effects, we examine the environmental conditions that would result if project operations were not continued. This is accomplished by analyzing the conditions predicted for a "run-of-river" operation (RoR), or discontinuing reservoir operations that alter the flow regime of the river. In this effects analyses, RoR is the expected flow regime if the Corps maintained a constant water surface elevation on all of the ACF federal reservoirs, never diminishing basin inflow by raising reservoir levels and never augmenting basin inflow by lowering reservoir levels. RoR is the constant release of basin inflow (as defined above) from Woodruff Dam.

HEC-5 models that represent the expected flow regime under the IOP, IOPR, and Concept 5 operations are utilized for the analysis. Consistent with the analysis conducted in the BO, historically calculated daily basin inflow data is not utilized for these scenarios, since it was influenced by consumptive water uses that increased over time to present levels. Instead, the basin inflow data is calculated using the estimated present (year 2000 data) levels of consumptive water use in the basin.

The effects analysis involves comparing the characteristics of the three flow regimes considered in the BO: Baseline, IOP, and RoR and the characteristics of two additional flow regimes: IOPR (incorporating the requirements of RPM2 of the BO as described in the September 7, 2006, letter from the Corps to the Service), and Concept 5 (incorporating the requirements of RPM3 of the BO). The flow regime characteristics analyzed are consistent with those identified as relevant to the listed species and their habitats in the BO baseline effects evaluation. For each of these flow regime characteristics, we compare the values computed for the Baseline, IOP, RoR, IOPR, and Concept 5. Consistent with the BO evaluation, if the Concept 5 condition does not alter the Baseline, its effect on the species/habitat is considered a continuation of the Baseline effect, if any, and classified as no effect. If the Concept 5 condition represents a beneficial or adverse alteration of the Baseline condition, the effect is accordingly beneficial or adverse; however, whether we attribute the effect to Concept 5 depends on the RoR flow regime, *i.e.*, what would occur with no action on the part of the Corps. In addition, a determination is made whether the effect is biologically significant to the reference species or habitat requirements.

MODEL DESCRIPTION

A simulation of ACF project operations under Concept 5 using the HEC-5 hydrologic simulation software is provided. This version of the HEC-5 model represents the Concept 5 operations as described in the "Description of Proposed Action" section above. The computed RoR flows utilized in this analysis are the same as those utilized in the BO analysis. As defined above, basin inflow is the amount of water that would flow by Woodruff Dam during a given time period if all of the Corps reservoirs maintained a constant water surface elevation during that period. Basin inflow is not the natural flow of the basin at the site of Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal water supply and agricultural irrigation. The RoR, IOP, IOPR, and Concept 5 scenarios include these influences, and all use the same estimates of reservoir evaporation and current water demands; therefore, the difference between these scenarios is the net effect of continued operation under each scenario apart from the effect of influences that are unrelated to project operations.

The consumptive water demands used in the models represent an estimate of present levels of the net depletion due to municipal, industrial, and agricultural water uses and evaporative losses from the four largest reservoirs, Lanier, George, West Point, and Seminole. These depletions vary by month and in the case of agricultural demands and reservoir evaporation, also by year (wet, normal, dry). These consumptive demand estimates and the other model settings and techniques are consistent with those utilized during the development of the BO.

To provide a potential range of flows that might be experienced while Concept 5 is in effect, the HEC-5 model simulates river flow and reservoir levels using a daily time series of unimpaired flow data for a certain period of record. Whereas basin inflow is computed to remove the effects of reservoir operations from observed flow, unimpaired flow is computed to remove the effects of both reservoir operations and consumptive demands from observed flow. The HEC-5 model imposes reservoir operations and consumptive demands onto the unimpaired flow time series to simulate flows and levels under those operations and demands. The unimpaired flow data set is a product of the Tri-State Comprehensive Study, and has been extended to include water years through 2001.

As described in the BO (USFWS 2006), only the output from the models for the period that is also represented in the Baseline (1975 to 2001) is utilized in the effects analysis. Limiting the analysis to this period ensures comparisons that are most likely to reflect anthropogenic differences between the five sets of environmental conditions (Baseline, IOP, RoR, IOPR, and Concept 5) and not hydrologic differences between years. The USFWS concluded that this period provides a sufficient range of flows to represent the anticipated effects during implementation of the various operational scenarios. For simulating the effects of year 2000 estimated depletions, the 1975-2001 period in the model includes 3 years classified as wet (1975, 1991, and 1994), 6 classified as dry (1981, 1986, 1988, 1990, 1999, and 2000), and the rest as normal (USFWS 2006).

GENERAL EFFECTS ON THE FLOW REGIME

Consistent with the analysis conducted in the BO, the effects of the proposed action on the flow regime is evaluated by comparing the Apalachicola River flow frequencies for the various conditions. The Baseline frequencies represent those observed at the Chattahoochee gage during 1975-2001. The IOP, RoR, IOPR, and Concept 5 frequencies are simulated by the HEC-5 model for 1975-2001. RoR is the synthesized unimpaired flow of the river minus the estimated present level of consumptive water use in the basin upstream of Woodruff Dam. The IOP and IOPR flows are included in the analysis to compare the flows of Concept 5 to the flow regimes of operational plans resulting from the previous consultation and the final BO. Concept 5 is the simulated flow of the river under the operational rules of the proposed action (proposed modifications to the IOP required by RPM3 of the BO).

Table 3 compares flow frequency for the Apalachicola River at the Chattahoochee gage observed during 1975-2001 (Baseline), and simulated by the HEC-5 model for 1975-2001 (IOP, RoR, IOPR, and Concept 5). The RoR regime generally has the highest flow associated with the lowest exceedance frequencies, and the lowest flow associated with the highest exceedance frequencies. This discrepancy is a result of reservoir operations under the Baseline, IOP, IOPR, and Concept 5 scenarios that include flood control practices that generally decrease high flows and other practices, such as releases for hydropower that generally increase low flows. The IOP, IOPR, and Concept 5 models also maintain a minimum flow of at least 5,000 cfs, a flow which occurs 3.1, 3.2, and 3.4% of the time respectively. Flows less than or equal to 5,000 cfs occurred for 80 days, or 0.81% of the time, in the Baseline record. The RoR scenario includes 579 days less than or equal to 5,000 cfs (5.9%).

Frequency Exceeded	Baseline	IOP	RoR	IOPR	Concept 5
0%	227,000	248,683	265,832	248,683	248,683
5%	58,300	58,078	59,082	57,962	57,884
10%	45,900	44,327	44,892	44,285	44,227
15%	36,585	37,400	37,656	37,400	36,662
20%	30,600	31,363	31,466	31,355	30,490
25%	26,792	26,277	27,238	26,213	26,339
30%	22,900	22,756	23,810	22,667	23,072
35%	20,000	20,400	21,125	20,400	20,371
40%	18,300	19,257	18,874	19,253	18,219
45%	16,900	17,299	17,011	17,244	17,253
50%	15,500	15,624	15,361	15,623	15,594
55%	14,333	14,103	13,831	14,089	14,032
60%	13,500	12,866	12,450	12,835	12,782
65%	12,600	11,815	11,158	11,778	11,725
70%	11,800	10,894	10,227	10,825	10,785
75%	10,900	10,089	9,223	10,000	10,000
80%	9,870	9,255	8,254	9,586	9,534
85%	9,060	8,396	7,411	8,720	8,693
90%	7,960	7,744	6,170	7,707	7,696
95%	6,250	6,225	4,708	6,226	6,413
100%	3,900	5,000	389	5,000	5,000

Table 3. Observed and simulated flow frequency (% of days flow exceeded) of the Apalachicola River at the Chattahoochee gage for the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

Table 4 compares the average daily discharge (1975-2001) for the 5 flow regimes. The modeled IOP, IOPR, and Concept 5 flow regimes have average daily discharges slightly lower than the Baseline observed average daily discharge (232, 232, and 378 cfs less, respectively). The Concept 5 average daily discharge does not significantly deviate from the Baseline value. The difference between the Concept 5 and Baseline average flows is small (1.7%). The lower flow of these regimes relative to Baseline is most likely due to how the unimpaired flow in the three model runs was calculated from the observed flow by adding to it estimated depletions over time. This technique results in a simulation of depletions that were greater than observed. The RoR average flow is less than the IOP and IOPR averages because reservoir storage augmented flow during the period as a whole, in order to maintain the 5,000 cfs minimum flow requirements. Likewise, the RoR average flow is also less than the Concept 5 average because reservoir storage augmented flow in order to maintain the 6,500 cfs minimum flow requirement during

95% of the period and the 5,000 cfs minimum flow requirement during the remainder of the period.

Flow Regime	Baseline	IOP	RoR	IOPR	Concept 5
Avg Daily Discharge (cfs)	21,884	21,652	21,420	21,652	21,506

Table 4. Observed and simulated average daily discharge of the Apalachicola River at the Chattahoochee gage for the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

Figure 3 displays in greater detail the frequency analysis of Table 3 and further illustrates the low-flow differences between the five regimes by focusing on the lowest flows (flows that are exceeded at least 65% of the time). The Concept 5 flow regime generally results in higher frequencies of lower flows in the range of (5,000 – 12,500 cfs) than the Baseline flow regime. However, the RoR flow regime results in considerably higher frequencies of lower flows in this same range, suggesting that reductions are likely attributable to consumptive uses within the basin rather than operational decisions prescribed by the proposed action. Additionally, the Concept 5 flow regime beneficially alters the Baseline condition by maintaining a minimum flow of 6,500 cfs during 95% of the period and a 5,000 cfs minimum flow requirement during the remainder of the period. The depletion values utilized in the model simulations represent over half of the unimpaired flow during some dry months (USFWS 2006). The potential adverse biological effect of a flow as low as 2,500 cfs versus a flow of 5,000 cfs or greater during those dry months is substantial. Therefore, we have determined that the overall effect of the proposed action is beneficial with respect to the Baseline and RoR conditions for this measure of a flow-dependent habitat feature.

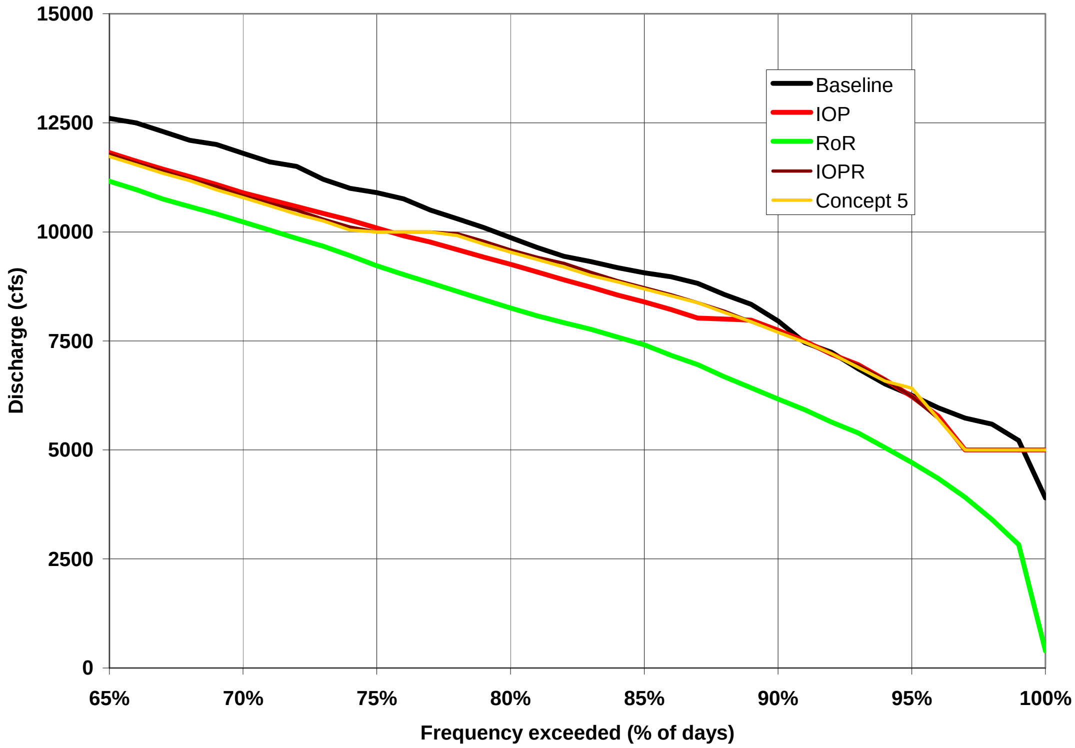


Figure 3. Flow frequency (% of days flow exceeded) of the Apalachicola River at the Chattahoochee gage for the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

SUBMERGED HARD BOTTOM

As described in the BO, the principal analysis for effects of the proposed action on sturgeon consists of comparing the amount of potential spawning habitat available under the various operational scenarios. This is accomplished by combining hard bottom area versus discharge relationship with the time series of daily flow values from the five flow regimes (Baseline, IOP, RoR, IOPR, and Concept 5) to obtain time series of available habitat area. A frequency analysis of these habitat availability time series for the two known Apalachicola River spawning sites, located at RM 105 and RM 99, is shown in Figure 4. This figure represents how much hard-bottom habitat was inundated to depths of 8.5 to 17.8 feet (the range of 80% of sturgeon egg collections in 2005 and 2006) during the months of March, April, and May, under each of the flow time series. Although the five curves cross each other multiple times over the full range of 0 to about 20 acres, habitat availability under all of the flow regimes is generally equivalent (median daily habitat availability of approximately 16 acres). Therefore, we have determined that Concept 5 is not likely to have an appreciable effect on Gulf sturgeon with regards to this flow-dependent habitat feature.

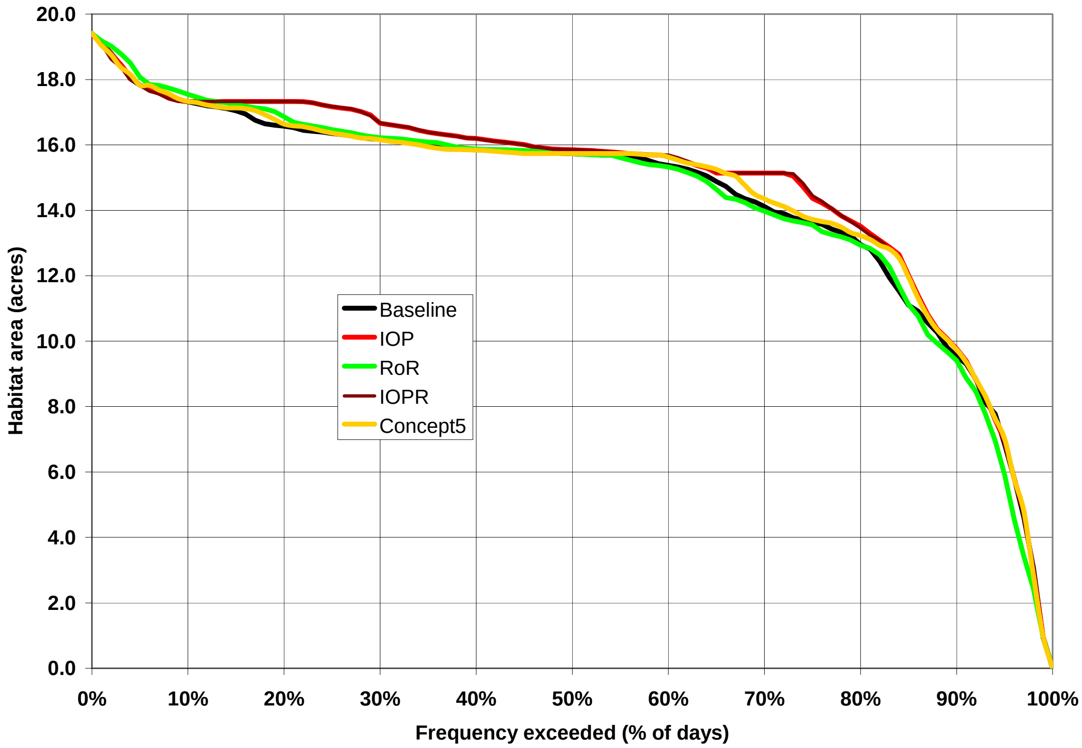


Figure 4. Frequency (% of days) of Gulf sturgeon spawning habitat availability (acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet), on each day March 1 through May 31, at the two sites known to support spawning, under Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

The analysis shown in Figure 4 combines data from all years of each time series into a single pool for frequency computations and does not examine differences between years or the pattern of habitat availability within a year. However, as described in the BO, it is also important to ascertain whether the proposed action would produce exceptionally low and high habitat availability between years or within a year to produce the average conditions that are comparable to the Baseline. Studies indicate that Gulf sturgeon spawning generally begins when water temperature reaches about 17°C and is concluded by the time temperature reaches about 25 °C. Based on available data from the Chattahoochee gage, the mean dates for these events in the Apalachicola River are March 26 and May 23, respectively, a span of 58 days. Sturgeon egg collections during 2005 and 2006 spanned a period of 17 and 27 days, respectively (USFWS 2005 unpublished data; Pine *et al.* 2006). Hatching requires at least 2 days in this temperature range, and several more days are required for larvae to develop a free-swimming ability (USFWS 2006). Based on this phenomenon, we further analyze the effect of the proposed action on Gulf sturgeon spawning success by computing the maximum amount of habitat inundated to the 8.5 to 17.8 ft depth range for at least 30 consecutive days each year, March through May, under the five flow time series (Figure 5). It should be noted that frequency in Figure 5 is percent of years (not percent of days as in the previous figure) that a given area of continuously available habitat is exceeded.

The Concept 5, Baseline, and RoR flow regimes all provide approximately 16 acres of 30-day continuous habitat in the preferred depth range. The median value for Concept 5 (15.6 acres) improves upon those of the Baseline and RoR (14.4 acres (7.6%) and 14.7 acres (5.8%), respectively). It should be noted that the median value for the Concept 5 flow regime is also higher than those of the IOP and IOPR. All of the time series provide a minimum of approximately 13 acres of 30-day continuous habitat in the depth range 8.5 to 17.8 ft in all years, which is the amount that was continuously available at these two sites during the 27-day period of sturgeon egg collections in 2006. However, during approximately 60 percent of the time Concept 5 provides more acres of 30-day continuous habitat in the preferred depth range than either the Baseline or the RoR flow regimes. Despite reducing the March – May minimum discharge thresholds and increasing the associated storage capabilities, the overall effect of the proposed action is beneficial with respect to the Baseline and RoR conditions for this measure of a flow-dependent habitat feature. It should also be noted that for a relatively small percentage of the years, the IOPR provides less spawning habitat than the Baseline and RoR (15.3, 15.6, and 15.5 acres, respectively). Although it is unlikely that a reduction in habitat of this scale is biologically significant, this potentially adverse effect is eliminated in the Concept 5 flow regime.

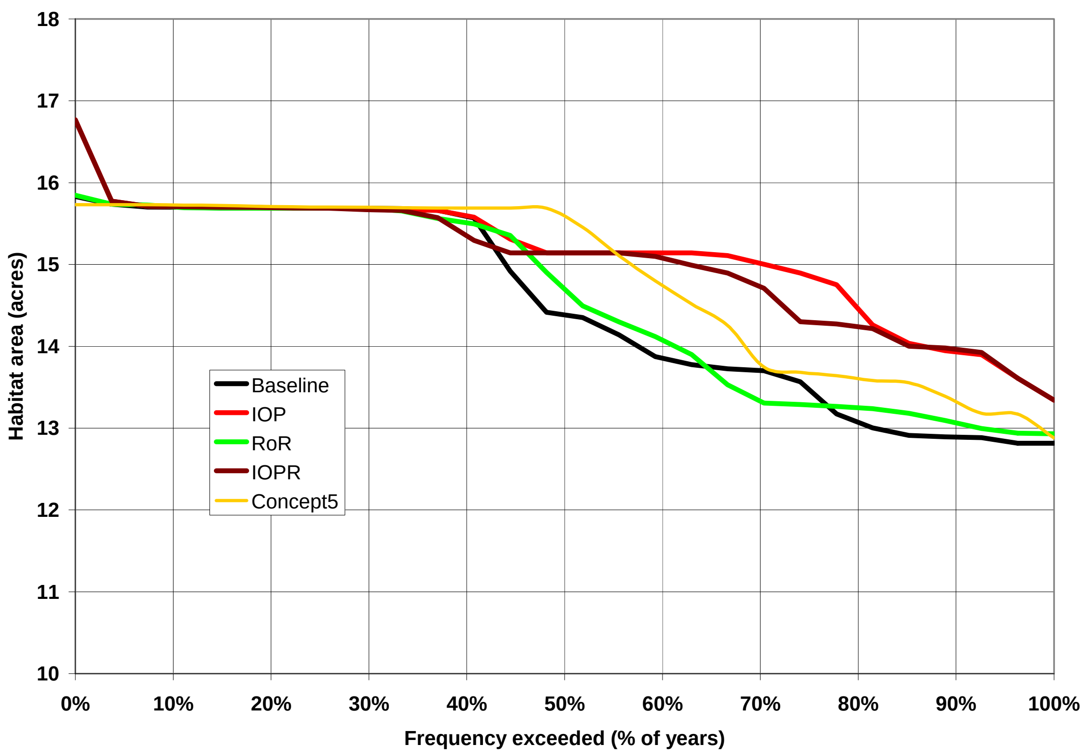


Figure 5. Frequency (% of years) of Gulf sturgeon spawning habitat availability (maximum acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet for at least 30 consecutive days each year), March 1 through May 31, at the two known spawning sites, under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

CHANGES IN SALINITY AND INVERTEBRATE POPULATIONS IN APALACHICOLA BAY

Very little is known about Gulf sturgeon feeding behavior and habitat selection in Apalachicola Bay. However, Gulf sturgeon studies in other systems, known life history patterns, and other studies of the role of freshwater inflow in estuarine ecology can be used to evaluate the possibility of effects of the proposed action on Gulf sturgeon in Apalachicola Bay.

These studies indicate that most adult and sub-adult sturgeon limit feeding almost exclusively to estuarine and marine environments upon departing the river and do not feed much, if at all, during the months of riverine residency. Juvenile Gulf sturgeon studies have also established that direct transition from fresh water into salinities greater than 30 parts per thousand (ppt) is lethal, and gradual acclimation to seawater with higher salinities (34 ppt) is required. Juvenile growth rates are highest at 9 ppt salinity (USFWS 2006).

Since Apalachicola Bay is the first estuarine habitat that both juvenile fish and older fish encounter upon departing the river, substantial alteration of flow regime features that may directly relate to sturgeon and sturgeon critical habitat elements in the bay must be avoided. Based on the analysis in the BO, adverse impacts to ecological processes in the bay critical to sturgeon can be evaluated by comparing the number of consecutive days per year that flows less than 16,000 cfs occurred for the various flow time series. Figure 6 illustrates this comparison and indicates that Concept 5 does not significantly alter the number of consecutive days per year of flows less than 16,000 cfs from that of the Baseline. Therefore, we have determined that the proposed action is not likely to have an appreciable effect on sturgeon estuarine habitat.

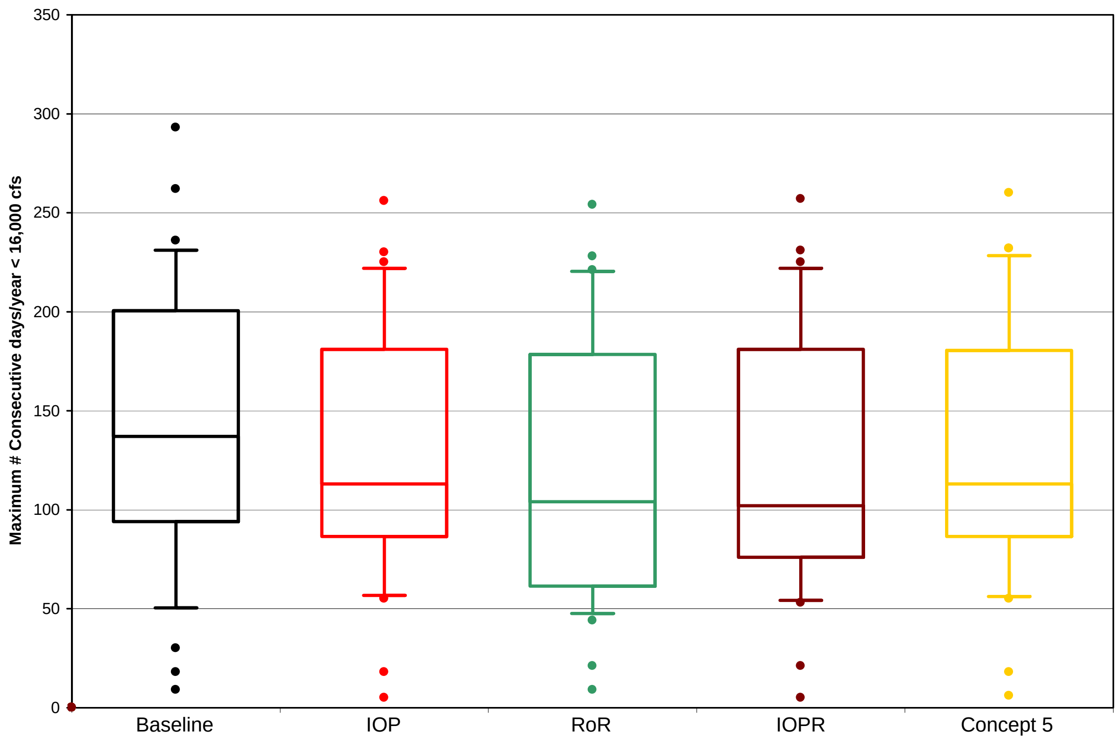


Figure 6. Maximum number of consecutive days/year of flow less than 16,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

SUBMERGED HABITAT BELOW 10,000 CFS

This section focuses on direct effects to listed mussels by exposure during low-flow conditions. During the summer of 2006, listed mussels were found exposed and stranded at elevations up to approximately 10,000 cfs. Therefore, consistent with the BO, impacts to listed mussel species will be evaluated by analyzing the differences between the Baseline, Concept 5, and RoR flow regimes in the range of flow less than 10,000 cfs. As an additional point of comparison, we will also consider the IOP and IOPR flow regimes for this range of flows.

Figure 7 shows the inter-annual frequency of flow rates between 5,000 and 10,000 cfs in the Baseline, IOP, RoR, IOPR, and Concept 5 flow regimes. The inter-annual frequency of flow rates less than 6,500 cfs is reduced in the Concept 5 regime compared to the Baseline and RoR regimes. Concept 5 prevents the occurrence of flows less than 5,000 cfs, which occurred occasionally in the Baseline and maintains a daily discharge of at least 6,500 cfs during the majority (about 95%) of the time series (1975-2001). The inter-annual frequency of flows between 6,500 and 10,000 cfs is considerably higher under Concept 5 than those observed under the Baseline. However, Concept 5 reduces the frequency of flows in this range as compared to the RoR regime. The increased frequency of low flows in the RoR flow regime is attributable to the constant release of only basin inflow from Woodruff Dam without the requirement to augment releases to a minimum of 5,000 cfs. Concept 5 operational decisions are based upon these flows. For basin inflow rates less than 10,000 cfs, Concept 5 prescribes the 7-day average basin inflow, but not less than 6,500 cfs, as the desired minimum release from Woodruff Dam, or in the case of sustained lower flows resulting in significant draws on composite storage in the basin, maintaining at least the required 5,000 cfs minimum release. Furthermore, other project considerations, such as the hydropower schedule, storage limitations, head limits, and occasionally the proposed ramping rate schedule, prompt releases 10 cfs or more greater than the Concept 5 minimum flow schedule most (80.8%) of the time. Indeed, for the entire simulated period of the model 1939 to 2001, releases from Woodruff Dam under Concept 5 exceed the minimum release requirements more than 80% of the time, and half of these additional releases exceed the minimum requirement by more than 4,500 cfs. These additional releases offset to some degree the effect of depletions in the RoR. The use of the 7-day moving average basin inflow also reduces the number of years with releases less than 10,000 cfs, because it eliminates brief periods when basin inflow is less than this amount. Conversely, the 7-day averaging also eliminates brief periods when basin inflow is above this amount, which may extend the duration of days of consecutive low flow.

The IOP addressed in the BO has a slightly higher frequency of flows less than 9,000 cfs than the RoR due to storage of up to 30% when basin inflow is in the range of 8,000 to 10,000 cfs. This potentially adverse effect is eliminated in the IOPR and Concept 5 plans by restricting storage to basin inflows greater than 10,000 cfs. Additionally, Concept 5 provides lower inter-annual frequencies of flows between 5,000 and 7,000 cfs than those observed in the IOPR flow regime. Therefore, we determined that the proposed action provides a beneficial effect to listed mussels based on reductions to the inter-annual frequencies when flow rates are less than 6,500 cfs relative to the Baseline and RoR. Furthermore, potentially adverse effects related to higher inter-annual frequencies of flow rates between 6,500 and 10,000 cfs are likely the result of consumptive uses within the basin and not operational decisions prescribed by Concept 5.

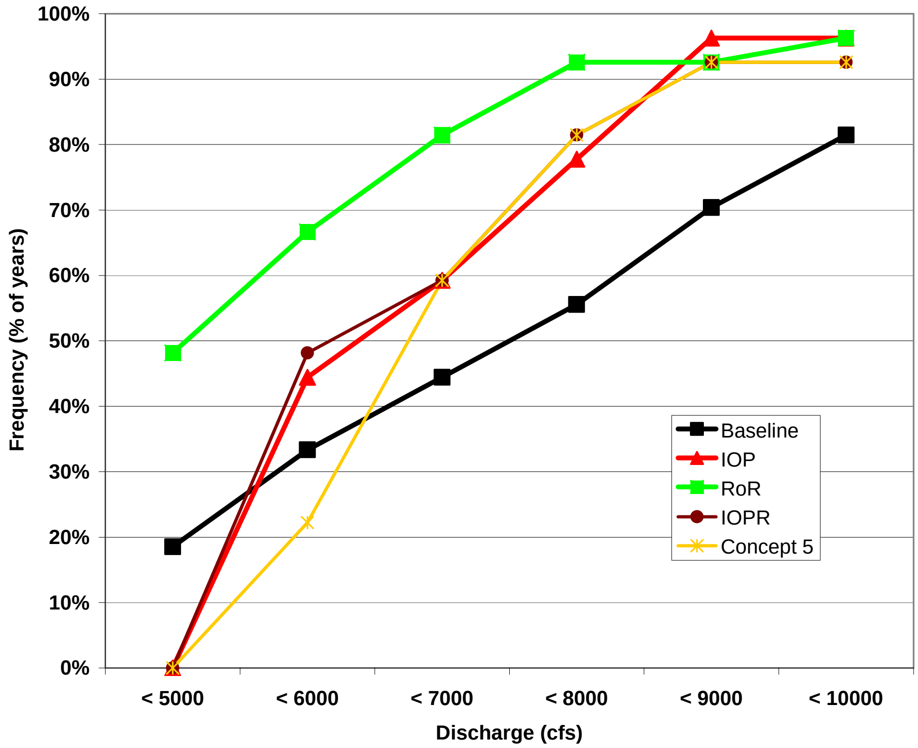


Figure 7. Inter-annual frequency (percent of years) of discharge events less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

We use the maximum number of days per year with flows less than 5,000 to 10,000 cfs as a measure of the most severe year for aquatic biota under each flow scenario (Figure 8). The Concept 5 plan reduces the maximum number of days per year with flows less than 5,000 to 10,000 cfs compared to the Baseline and RoR flow regimes. In this respect, Concept 5 has a lesser effect than the Baseline and RoR flow regimes. The IOP flow regime resulted in a higher maximum number of days per year with flows around 9,000 cfs as compared to the Baseline and RoR. This is likely a result of operations that allowed for storage of up to 30% when basin inflow is in the range of 8,000 to 10,000 cfs under the IOP. This potentially adverse effect is eliminated in the IOPR and Concept 5 plans by restricting storage to basin inflows greater than 10,000 cfs. For this parameter, the overall effect of the proposed action is beneficial with respect to the Baseline and RoR conditions.

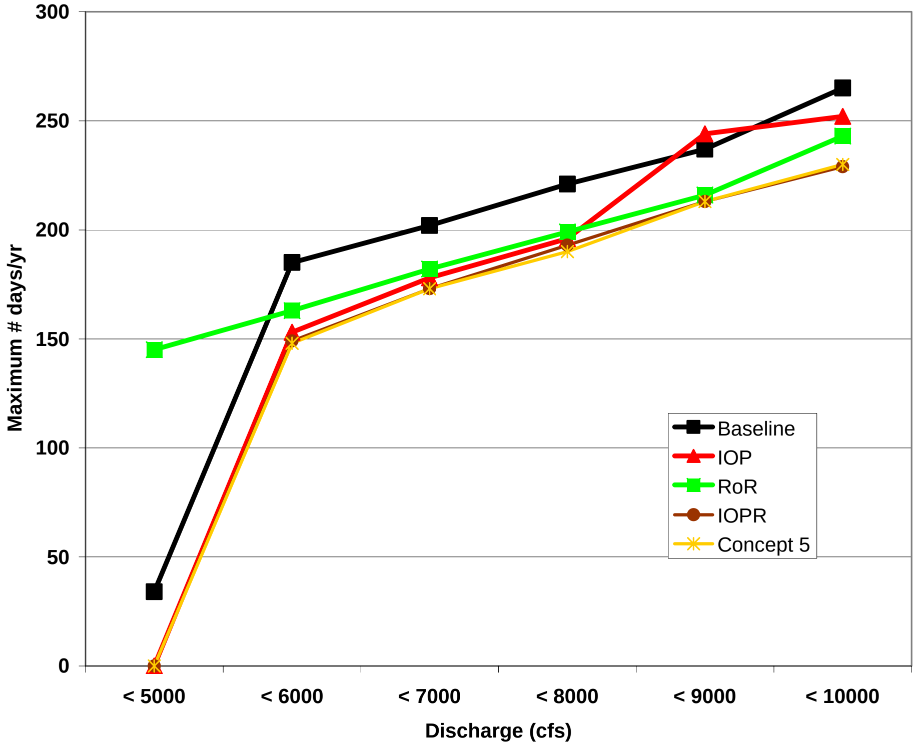


Figure 8. Maximum number of days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

As observed in 2006, some mussels may survive brief periods of exposure by closing their shells tightly or burrowing into the substrate. Therefore, unless water temperature is extreme, the stress of exposure is most likely a function of exposure duration (USFWS 2006). Figure 9 illustrates a most-severe event analysis by computing the maximum number of consecutive days of flow less than the 5,000 to 10,000 cfs thresholds. With respect to this parameter, Concept 5 considerably improves upon the Baseline flow regime and is slightly better than the RoR. For example, when flows are between 7,000 and 10,000 cfs Concept 5 reduces the duration of the most-severe event observed in the Baseline by an average of 68 days. Concept 5 also considerably improves upon the IOP flow regime regarding the maximum number of consecutive days per year of flows between 8,500 and 10,000 cfs. Within this range, the IOP flow regime resulted in an adverse effect to listed mussels. As described above, this is likely the result of restricting storage to basin inflows greater than 10,000 cfs. The IOPR and Concept 5 flow regimes eliminate this effect by meeting at least basin inflows when inflows are at 10,000 cfs or less. The overall effect of the proposed action is beneficial with respect to the Baseline and RoR conditions for this measure of a flow-dependent habitat feature.

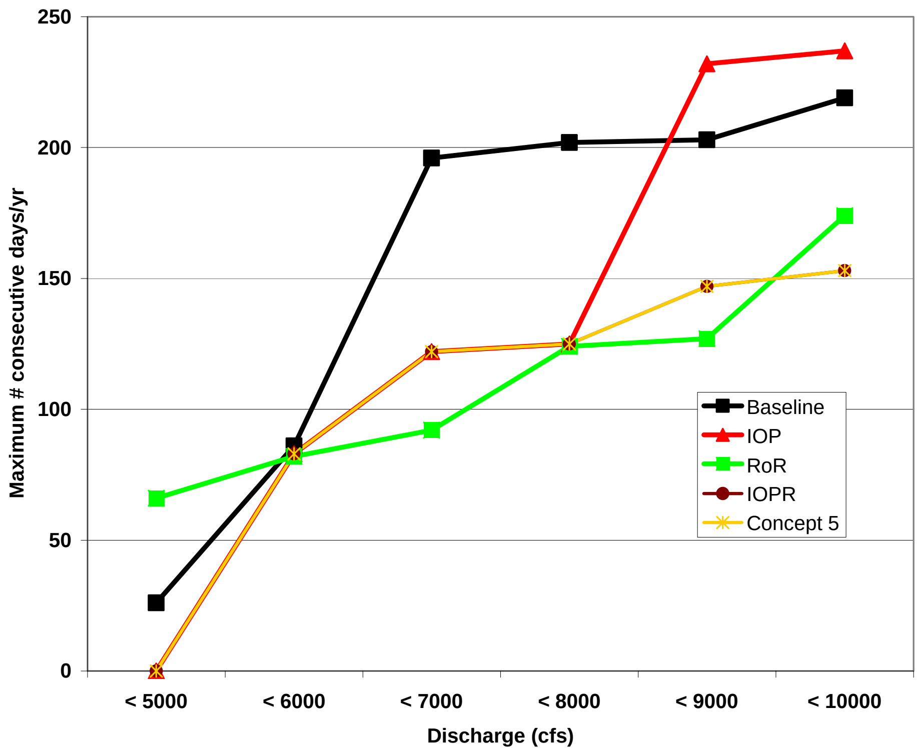


Figure 9. Maximum number of consecutive days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

"Because moderately low flows, not just the most extreme events, constrict aquatic habitat availability and are generally stressful to mussels and other aquatic biota, it is appropriate to also consider the more common low-flow condition, *i.e.*, the magnitude and duration of low flows that occur in half the years of the flow regime. If the common low-flow conditions become even more common or more severe, it would reduce the amount of habitat available to mussels and would increase their vulnerability to exposure-related mortality, including increased predation by terrestrial predators" (USFWS 2006). Figure 10 displays the median number of days per year less than the thresholds of 5,000 to 10,000 cfs. Half of the years in Concept 5 and the Baseline have no days less than 6,000 cfs, but the median number days less than the 7,000 through 9,000-cfs thresholds in Concept 5 exceeds the Baseline. Concept 5 has slightly fewer median number of days less than the 10,000 cfs threshold as compared to the Baseline (62 and 69 days respectively). The median number of days at all 6 thresholds is greater in the RoR than both the proposed action and Baseline, so the differences between Concept 5 and the Baseline are most likely attributable to increased consumptive demands.

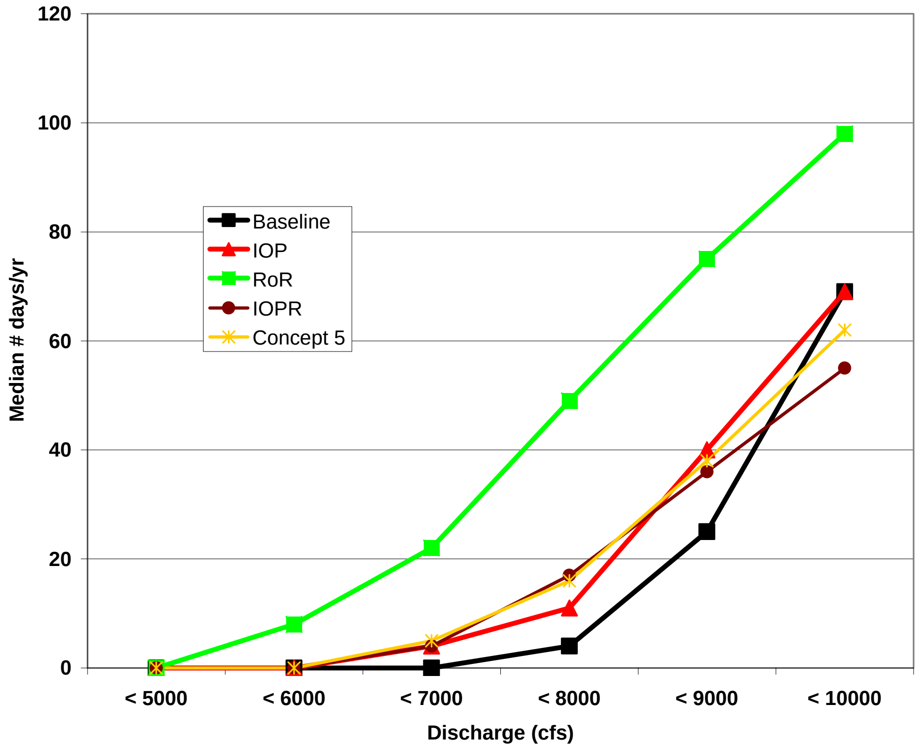


Figure 10. Median number of days per year of discharge less than 5,000 to 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

As described in the "Description of Proposed Action" section Concept 5 utilizes the same maximum fall rate schedule as the IOP and IOPR plans. The schedule limits operations to more gradual fall rates as flow declines to the river stages where listed mussels may occur. At the time of development of the schedule, and subsequent informal consultation with USFWS, the majority of listed mussels were believed to occur at stages at or below approximately 8,000 cfs (Miller and Payne 2005). Therefore, based on the vulnerability of some fraction of the listed mussels to exposure during declining flow in the range of 8,000 to 5,000 cfs, the maximum fall rate schedule was formulated to provide for more gradual fall rates within this range of flows in order to facilitate, as much as possible, the movement of mussels and other aquatic biota from higher to lower elevation habitats. The general intent of the schedule is to avoid extreme daily declines in river stage and thereby lessen the potential for exposing or stranding listed mussels, their host fish, and other aquatic biota.

To analyze effects due to altered fall rates, we computed daily rates of stage change of the Baseline period directly from the daily average gage height values recorded for the Chattahoochee gage as the difference between each pair of consecutive daily values (previous day gage height minus current day gage height = change rate associated with current day). For the modeled flow regimes, we used the Chattahoochee gage rating curve that characterizes the stage/discharge relationship during recent years (Light *et al.*

2006) to compute the gage heights associated with simulated daily flows, and then computed change rates in the same fashion as for the observed gage heights.

Figure 11 is a frequency histogram of the rate of change results, which lumps all stable or rising days into one category and uses the ranges that correspond to the maximum fall rate schedule as categories for the falling days (<=0.25 ft/day, > 0.25 to <= 0.50 ft/day, > 0.50 to <= 1.00 ft/day, > 1.00 to <= 2.00 ft/day, and > 2.00 ft day). Among the falling days, rates less than 0.25 ft day are the most common occurrence in the Baseline and RoR flow regimes. The IOP, IOPR, and Concept 5 flow regimes have a higher percentage of days in the 0.25 to 0.50 ft/day range. Collectively, Concept 5 has a higher percentage of days in the fall rate categories of greater than 0.25 ft/day than either the Baseline or RoR (37.4% versus 24.9% in the Baseline, and 32.8% in the RoR), but a lower percentage than the IOP addressed in the BO. This shift increases the relative risk of stranding and exposure of aquatic organisms over Baseline or RoR; however, most of the shift is confined to the 0.25 to 0.50 ft/day category and not the more extreme categories. Therefore we have determined that Concept 5 could potentially have a small but measurable adverse effect on listed mussels with regards to this flow-dependent habitat parameter. However, this potential adverse effect is less than that addressed in the BO for the IOP.

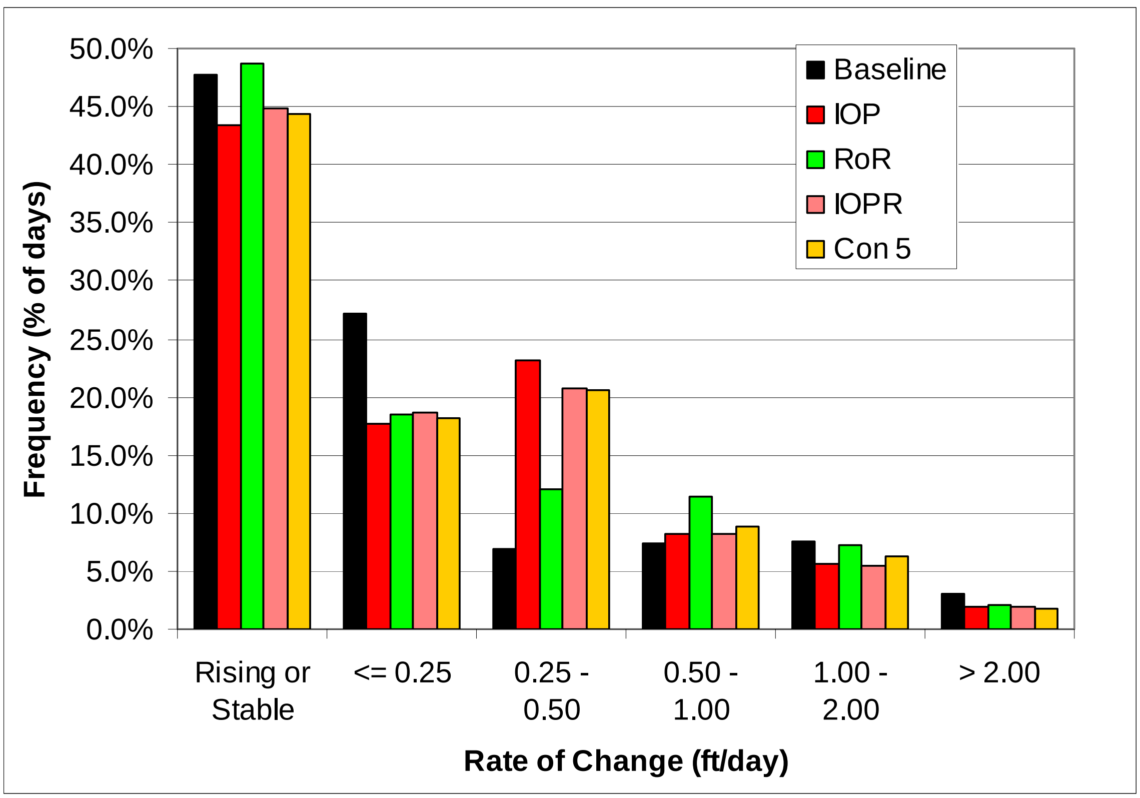


Figure 11. Frequency (percent of days) of daily stage changes (ft/day) under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

As noted earlier, the USFWS observed mussels exposed at stages as high as about 10,000 cfs during the summer of 2006. Therefore, listed mussels could potentially be directly impacted by increases in the percentage of days that fall rates greater than 0.25 ft/day occur and flows are less than 10,000 cfs. Figure 12 shows a count of days in the various rate-of-change categories when flow was less than 10,000 cfs. For this analysis, the flow associated with the rate of change on a given day is the flow of the previous day. A count of days is utilized here for the vertical scale of this figure instead of a percentage of days as in Figure 11, because each flow regime has a different number of days less than 10,000 cfs, and this difference is relevant to the effects analysis (Baseline 2,025, Concept 5 2,211, and RoR 2,839 days). The number of days in the greater than 0.25 ft/day categories for Concept 5 is 375, more than double the number in the Baseline (124), but considerably less than in the RoR (523). Therefore, it appears that this effect is a result of consumptive water uses in the basin and would not be attributable to the operational decisions prescribed under Concept 5 since the RoR flow regime results in more days in the greater than 0.25 ft/day fall rate categories when flows are less than 10,000 cfs. With respect to this parameter, Concept 5 actually improves upon the values calculated for the IOP and IOPR which were more closely correlated to the RoR (534 and 448 days respectively).

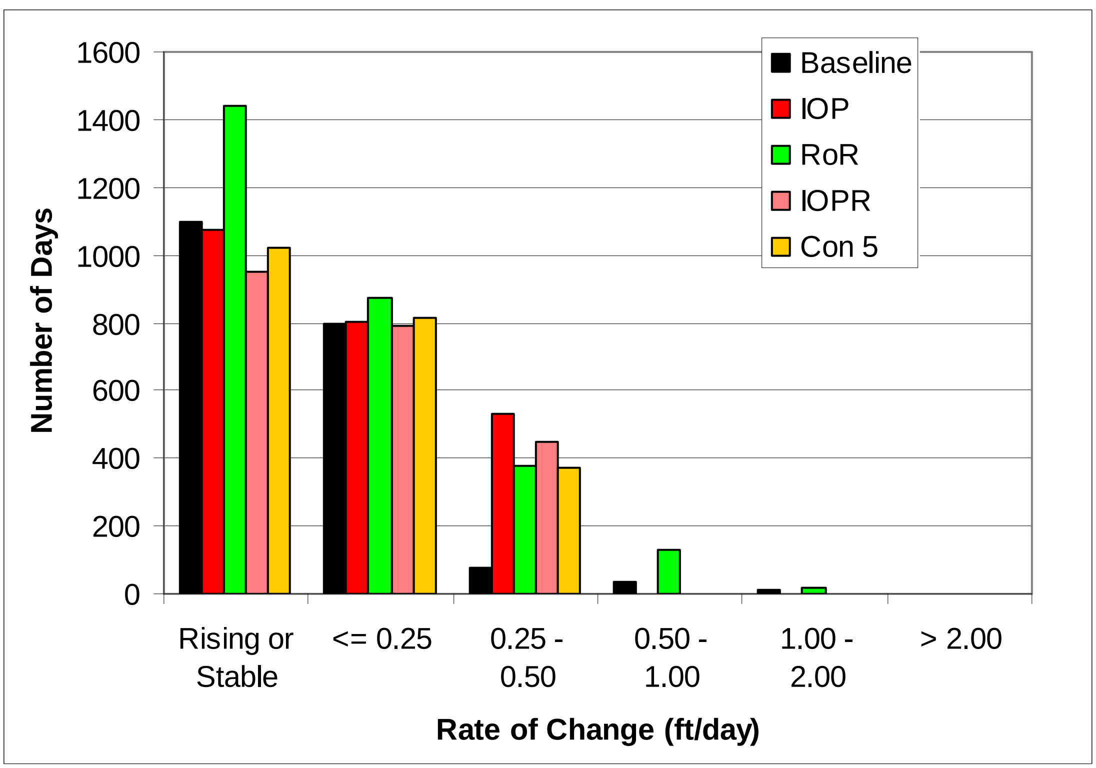


Figure 12. Frequency (number of days) of daily stage changes (ft/day) when releases from Woodruff Dam are less than 10,000 cfs under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

In the 2006 BO, the USFWS determined that the 0.25 ft/day maximum fall rate for flows less than 8,000 cfs provided sufficient protection of listed mussels situated in locations with access to flowing water during declining flow. This determination was based on the 2006 mussel exposure observations which occurred almost entirely in areas where mussels did not have such access to flowing water during declining flow. It is likely that even a more gradual down-ramping rate would not have prevented exposure of these mussels because they were located in the broad, irregular stream bed of Swift Slough or in side-channel swales along the main river where flowing water could not be accessed by moving laterally downward on the channel cross section.

Most, but not all, of the effects of increased duration and inter-annual frequency of low flows under Concept 5 relative to the baseline appear to be a function of low basin inflow; *i.e.*, the RoR scenario would have greater adverse effects. The Concept 5 plan eliminates the most severe effects of flow less than 5,000 cfs by supporting this level as a minimum flow with releases from reservoir storage when basin inflow is less than 5,000 cfs. Additionally, by maintaining a flow of at least 6,500 cfs during 95% of the simulated period, Concept 5 further benefits listed mussels by maintaining "flow-through" conditions at Swift Slough and adequate depths within the "hooks and bays" located along the main channel of the Apalachicola River. Although we attribute most of the adverse differences between Concept 5 and the Baseline to increased depletions from non-project related water uses and not to the proposed action itself, the reality for mussels and other aquatic biota is increased stress and potential mortality in the future as the river will experience low-flow conditions more often under Concept 5 than under the Baseline condition. However, as noted above, Concept 5 generally provides for equivalent or less adverse effect than the IOP conditions that were addressed in the BO.

FLOODPLAIN CONNECTIVITY AND SYSTEM PRODUCTIVITY

Listed mussels and sturgeon can be indirectly affected by changes to the frequency, timing, and duration of floodplain habitat connectivity/inundation. The Apalachicola River floodplain is a highly productive area that likely provides spawning and rearing habitats for one or more of the host fishes of the purple bankclimber and fat threeridge. Floodplain inundation is also critical to the movement of organic matter and nutrients into the riverine feeding habitats of both the mussels and juvenile sturgeon, and into the estuarine feeding habitats of juvenile and adult sturgeon (USFWS 2006).

Therefore, we must analyze the impact of the proposed action on the timing, and duration of floodplain habitat connectivity and inundation. As described in the BO, this is accomplished by utilizing the relationship documented by Light *et al.* (1998) between total area of nontidal floodplain area inundated and discharge at the Chattahoochee gage (USFWS 2006). Figure 13 displays a frequency analysis of the results of transforming the five daily discharge time series during the growing season months (April – October) to connected floodplain area. The overall area/frequency pattern of Concept 5 is comparable to the Baseline and RoR. Although it improves slightly upon the Baseline maximum and minimum acreages, Concept 5 generally provides less connected floodplain area than the Baseline (approximately 28% less habitat is available during half of the days simulated). Therefore we compared the RoR frequencies to Concept 5 in order to determine if this is a reflection of operational decisions or non-project related consumptive demands. Concept 5 generally provides more connected floodplain area than the RoR (median values: 1,960 and 1,747 acres, respectivley). However, during approximately 30% of the days simulated, the RoR provided an average of 8% more acres of connected floodplain than Concept 5. This slight discrepancy between the Concept 5 and RoR flow regimes is likely due to operational transitions allowing for storage of a portion of the basin inflow when basin inflow is greater than 18,000 cfs during the months of April and May. It appears that consumptive uses within the basin are largely responsible for the reduction in acres of connected floodplain (during the growing season) for Concept 5 relative to the Baseline. Regardless, it appears that the proposed action could potentially have a small but measurable adverse effect on Gulf sturgeon and listed mussels with regards to this flow-dependent habitat parameter. Therefore, we analyzed the 30-day continuous floodplain habitat inundation during the growing-season to further interpret the biological effects of any deviations from Baseline due to the proposed action.

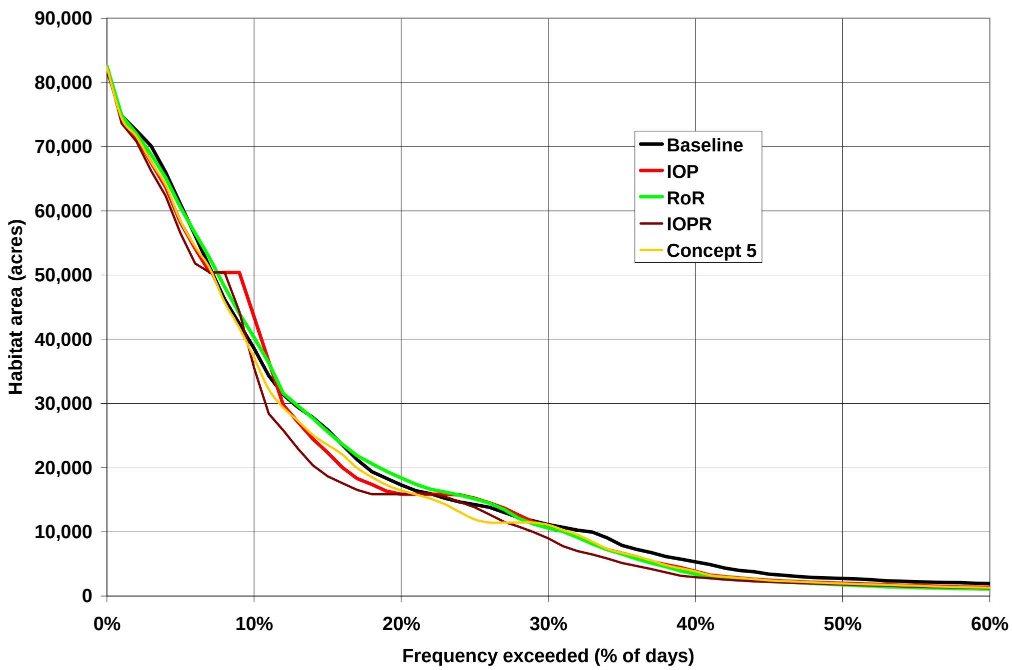


Figure 13. Frequency (percent of days) of growing-season (April-October) floodplain connectivity (acres) to the main channel under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

A period of continual inundation is required for successful spawning and rearing of host fishes of the listed mussel species. Therefore, we used a 30-day moving minimum to represent this aspect of habitat availability, identifying the maximum acreage inundated during the growing-season for at least 30 consecutive days each year. Figure 14 illustrates this analysis by comparing the frequency (percent of years) of the maximum amount of growing season 30 day continuous connected floodplain habitat per year for the five flow regimes.

Concept 5 appears to generally provide more 30 day continuous connected floodplain per year during the growing season than the Baseline. However, since the Baseline, RoR, and Concept 5 curves cross each other multiple times over the range of about 1,000 to 55,000 acres of 30 day continuous connected floodplain habitat, we compare the median value habitat availability to assess effects, if any, of the proposed action. During half of the years observed or simulated, these three flow regimes provided at least 11,000 acres of 30 day continuous connected floodplain: 11,128 acres (Baseline), 12,485 acres (RoR), and 11,425 acres (Concept 5). The proposed action provides slightly more (297) acres of 30 day continuous connected habitat than the Baseline flow regime. However, this relatively small increase in acreage is not likely to result in any significant biological benefits for the listed species. Therefore, we have determined that Concept 5 is not likely to have an appreciable beneficial or adverse effect on Gulf sturgeon and host fish for listed mussels with regards to this flow-dependent habitat feature.

It should be noted that the median value for the IOP and IOPR flow regimes (15,117 and 15,113 acres, respectively) is much higher than the other three flow regimes. The loss of this beneficial effect is primarily due to reductions in the flow/storage thresholds during the spring spawning period in order to allow storage in support of augmentation flows during low flow periods for mussels. This tradeoff in benefits was provided by the provisions of RPM3 in the BO. As previously described, during coordination and development of the proposed action, the USFWS recognized that trade offs of these indirect beneficial effects were required in order to facilitate the intent of RPM3, which is to maintain a higher minimum flow on the Apalachicola River during most, but not all low flow periods for the direct benefit of the listed mussels. As described above and illustrated in the graph below, this tradeoff can be accomplished without any appreciable adverse effect on the listed species.

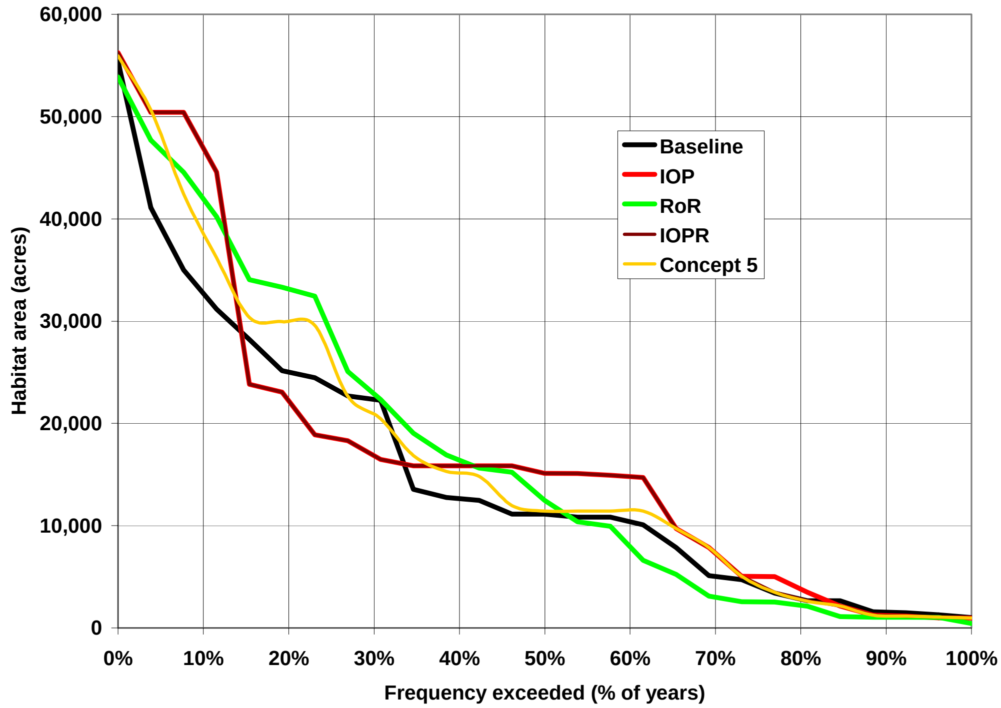


Figure 14. Frequency (percent of years) of growing-season (April-October) floodplain connectivity (maximum 30-day continuous connectivity, acres, per year) to the main channel under the Baseline (observed flow 1975-2001), IOP (HEC-5 simulated flow 1975-2001), RoR (Computed basin inflow 1975-2001), IOPR (HEC-5 simulated flow 1975-2001), and Concept 5 (HEC-5 simulated flow 1975-2001).

CONCLUSIONS

The following documents our determinations regarding impacts to the listed species through implementation of the proposed action.

Gulf Sturgeon

The analyses presented in Figures 4 and 6 indicate that the proposed action generally does not result in any appreciable effect to Gulf sturgeon. Therefore, we have determined that the proposed action does not result in adverse effects to Gulf sturgeon with respect to this measure of spawning habitat availability and conditions in Apalachicola Bay that may directly relate to sturgeon and sturgeon critical habitat elements.

The analyses presented in Figure 5 indicates that Concept 5 provides a direct beneficial effect to Gulf sturgeon by providing more acres of 30-day continuous habitat (March 1 – May 31) in the preferred depth range than either the Baseline or the RoR flow regimes during approximately 60 percent of the time. It should also be noted that for a relatively small percentage of the years, the IOPR provides less spawning habitat than the Baseline and RoR (15.3, 15.6, and 15.5 acres, respectively). Although it is unlikely that a reduction in habitat of this scale is biologically significant, this potentially adverse effect is eliminated in the Concept 5 flow regime. Therefore, we have determined that despite reducing the March – May minimum discharge thresholds and increasing the associated storage capabilities, the overall effect of the proposed action is beneficial with respect to the Baseline and RoR conditions for this measure of spawning habitat availability.

Listed Mussels

The analyses presented in Figures 7, 8, and 9 indicate that Concept 5 generally improves upon these Baseline and RoR flow regime characteristics identified as relevant to the listed mussels and their habitats. Therefore, we have determined that the proposed action results in a beneficial effect to listed mussels with respect to these flow-dependent habitat features.

The analyses presented in Figures 10 and 12 indicate that although Concept 5 negatively impacts habitat conditions compared to the Baseline flow regime, the impacts are most likely a result of consumptive water uses in the basin and would not be attributable to the operational decisions prescribed under Concept 5. Therefore, we have determined that implementation of Concept 5 may result in an adverse effect to listed mussels, but the effect is not directly attributable to the proposed action.

The analyses presented in Figure 11 indicates that Concept 5 results in a higher percentage of days in the fall rate categories of greater than 0.25 ft/day than either the Baseline or RoR. This shift increases the relative risk of stranding and exposure of aquatic organisms; however, most of the shift is confined to the 0.25 to 0.50 ft/day category and not the more extreme categories. Therefore we have determined that the proposed action could potentially have a small but measurable adverse effect on listed mussels with regards to this flow-dependent habitat parameter. However, the Concept 5 percentage is less than the IOP percentage addressed in the BO and therefore does not significantly deviate from the effects of the IOP.

The analysis presented in Figure 13 indicates that Concept 5 negatively impacts spawning habitat for host fish of the listed mussels compared to the Baseline flow regime. However, this impact is most likely a result of consumptive water uses in the basin and would not be attributable to the operational decisions prescribed under Concept 5. Therefore, we have determined that implementation of Concept 5 may result in an adverse effect to listed mussels, but the effect is not directly attributable to the proposed action.

The analysis presented in Figure 14 indicates that Concept 5 generally does not result in any appreciable effect to listed mussels. Therefore, we have determined that the proposed action does not result in adverse effects to listed mussels with respect to this measure of host fish spawning habitat availability.

Appendix A provides a matrix comparing the effects of the Concept 5 and IOPR plans. The matrix demonstrates that the proposed action does not result in additional adverse effects to listed species from those addressed in the BO for the IOP and illustrates where tradeoffs occur in order to meet the intent of RPM3. As previously described, RPM3 is intended to minimize mussel mortality due to low-flow conditions by supporting a higher minimum flow when total reservoir storage and/or hydrologic conditions permit. We believe the tradeoff between lower thresholds for restrictions on storage during the sturgeon spawning season and providing higher minimum flows later in the year was achieved without producing appreciable adverse effects to the listed species or their critical habitat.

It is our determination that the proposed action fulfills the requirements of RPM3.

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APPENDIX A

EFFECTS MATRIX

FLOW REGIME CHARACTERISTICS	BENEFICIAL, NOT DUE TO CORPS	BENEFICIAL	NO EFFECT	ADVERSE	ADVERSE, NOT DUE TO CORPS
Flow frequency (%days flow exceeded) of the Apalachicola River at the Chattahoochee gage		X X			
Frequency (%days) of Gulf sturgeon spawning habitat availability (acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet), on each day March 1 through May 31, at the two known spawning sites			X X[1]		
Frequency (%years) of Gulf sturgeon spawning habitat availability (maximum acres of potentially suitable spawning substrate inundated to depths of 8.5 to 17.8 feet for at least 30 consecutive days each year), March 1 through May 31, at the two known spawning sites		X		X[2]	
Maximum number of consecutive days/year of flow less than 16,000 cfs			X X[3]		
Inter-annual frequency (%years) of discharge events less than 5,000 to 10,000 cfs		X[1] X			
Maximum number of days per year of discharge less than 5,000 to 10,000 cfs		X X			
Maximum number of consecutive days per year of discharge less than 5,000 to 10,000 cfs		X X			
Median number of days per year of discharge less than 5,000 to 10,000 cfs					X X[4]
Frequency (% days) of daily stage changes (ft/day)				X X[5]	
Frequency (# days) of daily stage changes (ft/day) when releases from Woodruff Dam are less than 10,000 cfs					X[2] X

FLOW REGIME CHARACTERISTICS	BENEFICIAL, NOT DUE TO CORPS	BENEFICIAL	NO EFFECT	ADVERSE	ADVERSE, NOT DUE TO CORPS
Frequency (% days) of growing-season (April-October) floodplain connectivity (acres) to the main channel			**X**[6]		**X**
Frequency (% years) of growing-season (April-October) floodplain connectivity (maximum 30-day continuous connectivity, acres, per year) to the main channel		**X**[7]	**X**		

X = Concept 5
X = IOPR

X[1] = IOPR generally provides slightly more habitat than Concept 5.
X[2] = Majority of the time, IOPR provides more habitat than Concept 5. However, small portion of the time IOPR provides less habitat than the Baseline and RoR.
X[3] = IOPR includes slightly less Maximum number of consecutive days/year of flow less than 16,000 cfs than Concept 5.
X[1] = Concept 5 provides lower inter-annual frequencies of flows between 5,000 and 7,000 cfs than IOPR.
X[4] = IOPR provides slightly lower values for median number of days per year of discharge less than 9,000 to 10,000 cfs than Concept5.
X[5] = IOPR has a slightly lower percentage of days in the fall rate categories of greater than 0.25 ft/day than Concept 5.
X[2] = Concept 5 provides less days in the greater than 0.25 ft/day fall categories than the IOPR at flows less than 10,000 cfs.
X[6] = IOPR provides more habitat than Baseline and RoR small percentage of time which offsets days with less habitat than Baseline and RoR.
X[7] = IOPR provides more 30-day continuous floodplain connectivity in half the years than Concept 5.