An Assessment of Habitat Quality Using Dissolved Oxygen Concentrations in Floodplain Water Bodies in Relation to River Flow and Mainstream Connectivity

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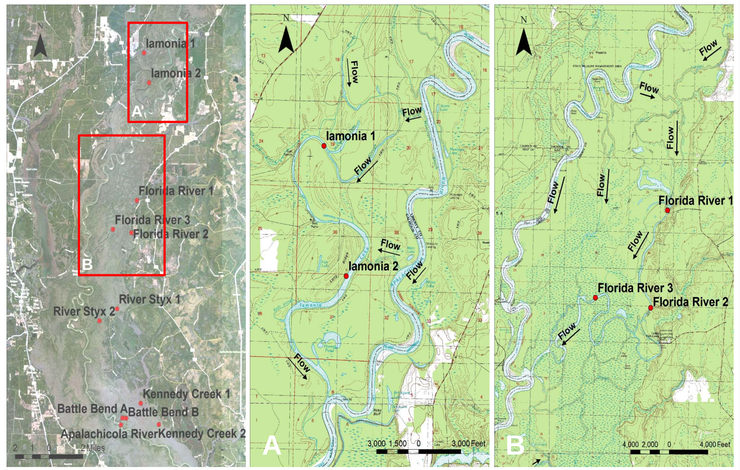
Introduction

The aquatic habitats that exist within the Apalachicola River floodplain serve a critical role to the overall health of the river ecosystem by providing essential spawning and nursery areas for a diverse array of aquatic organisms. Dissolved oxygen (DO) levels are a critical aspect of aquatic habitat quality, and DO levels are affected by river-floodplain connectivity.

Objective

To characterize the relationship between dissolved oxygen (DO) and the hydraulic connectivity of the ecologically-important large slough systems within the Apalachicola River floodplain over a range of flow conditions.

Study Sites



Methods

Water level, DO, and temperature data were continuously monitored within four (4) major floodplain sloughs, one (1) oxbow lake, and mainstem (control) from August 2009 to January 2011. A comparison was made between statistically-representative DO concentrations (daily mean, diurnal range, daily minimum and maximum) for each site and in the river. River discharge was estimated at each site from nearby gages. By examining distinct changes in DO signatures with increasing flow, it was possible to determine the approximate flow at which the sloughs and oxbow lakes begin to become activated, or hydraulically-connected (flowing water connection), to the mainstem of the Apalachicola River. The flow rates at which these floodplain water bodies become fully-connected is referred to as the "controlling flow." The Florida River and Iamonia monitoring sites are the focus of the results presented herein.

Results

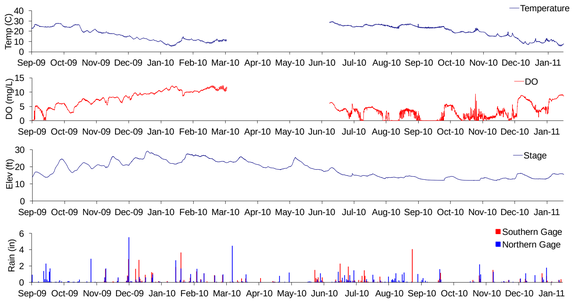


Figure 1. Water quality and stage data collected at the Florida River 1 monitoring station

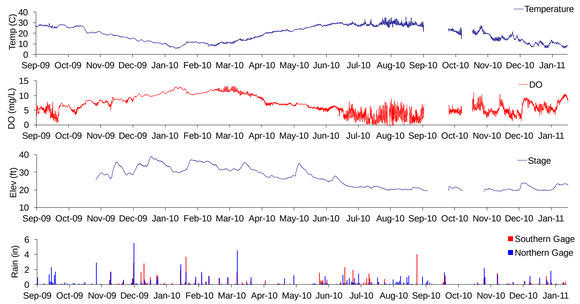


Figure 2. Water quality and stage data collected at the Iamonia 1 monitoring station

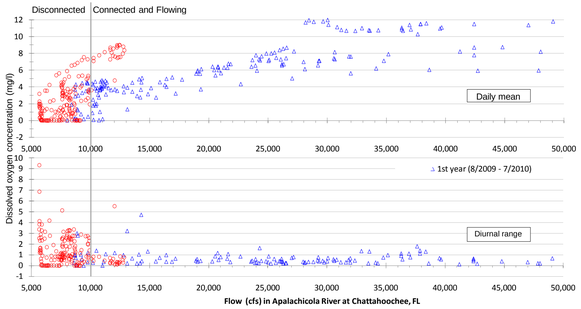


Figure 3. Florida River 1: Dissolved oxygen concentration expressed in daily mean / diurnal range versus discharge on the mainstem of the Apalachicola River at Chattaoochee, FL. The vertical grey line represents the beginning of a transition toward a flowing condition within the slough.

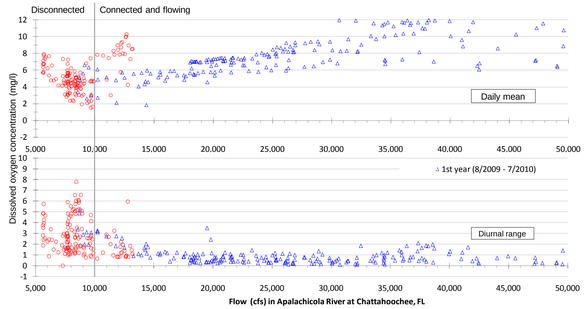
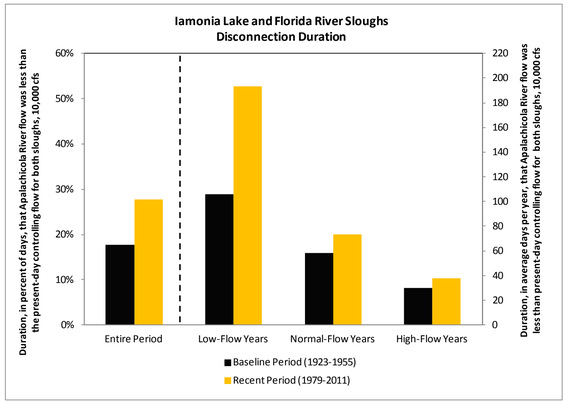


Figure 4. Iamonia 1: Dissolved oxygen concentration expressed in daily mean / diurnal range versus discharge on the mainstem of the Apalachicola River at Chattaoochee, FL. The vertical grey line represents the beginning of a transition toward a flowing condition within the slough.

Table 1. Summary of average dissolved oxygen concentration and diurnal ranges (mg/l) under backwater and flowing-water conditions for floodplain sloughs, oxbow lakes and mainstem of the Apalachicola River. Note that DO values less than 2 mg/l are considered uninhabitable for most fish species.

Monitoring Site	Activation Discharge (cfs)	Backwater connection (no flow)						Flowing-water connection					
		Average Daily				Avg diurnal range	*n*	Average Daily				Avg diurnal range	*n*
		Mean	Min	-	Max			Mean	Min	-	Max		
Iamonia Lake 1	10,000	4.6	3.2	-	6.3	3.1	133	8.0	7.5	-	8.5	1.0	340
Iamonia Lake 2	17,000	5.8	4.7	-	7.1	2.4	189	8.1	7.6	-	8.5	0.9	252
Florida River 1	10,000	2.1	*1.5*	-	2.9	1.4	168	7.4	7.1	-	7.7	0.6	244
Florida River 2	10,000	3.3	2.4	-	4.4	1.9	138	7.2	7.0	-	7.5	0.6	284
Florida River 3	10,000	3.9	3.0	-	5.1	2.1	117	5.4	4.8	-	6.1	1.3	341
Apalachicola River	Apalachicola River	*NA*						7.8	7.6	-	8.0	0.4	407

Figure 5. Floodplain sloughs become disconnected when flows in the Apalachicola mainstem drops below the controlling flow for a given slough. Durations were calculated for this figure by comparing the occurrence of the present-day controlling flow during historic and recent periods. The geometry of the river and floodplain channels has changed over time; therefore, durations based on present-day controlling flows do not represent actual connectivity conditions throughout both time periods. This figure nonetheless provides a vivid depiction of trends in duration of slough disconnections caused by long-term changes in river flow. Note: the sample of years is divided into thirds based on annual discharge.



Conclusions

(1) The discharge of Apalachicola River directly affects the connectivity between the river's mainstem and the sloughs and lakes on the floodplain and the overall quality of habitat (relative to DO) that exists within these areas.

(2) Apalachicola River flows within the 10,000-12,000 cfs flow range provide a direct hydraulic connection to portions of Iamonia Lake, River Styx, Kennedy Creek and the entire Florida River slough complex. At flows less than 10,000 cfs, there is a substantial loss of suitable habitat for most fish species.

(3) Results of this study indicate that a 'flowing-water' connection to the mainstem of the Apalachicola River is essential for the several of the large slough systems to consistently maintain dissolved oxygen at levels that provide suitable habitat for most fish species.

(4) The duration of hydraulic connectivity between the mainstem and the floodplain water bodies within the Apalachicola River system has decreased in recent decades due to changes in the watershed hydrologic regime.