APPENDIX 12.D. POTENTIAL WITHDRAWAL EFFECTS ON THE LARGE SUNFISHES ASSEMBLAGE

Members of the Large Sunfishes Assemblage constitute some of the most recreationally valuable freshwater fish in the St. Johns River (Bass and Cox 1985). All are members of the family Centrarchidae (sunfishes) and all build nests and exhibit varying levels of parental care of their eggs and young (Marcy et al. 2005). Juvenile and adult sunfishes are generally both invertivores and piscivores (Appendix 12.A). The sunfishes placed in this assemblage generally occupy open water and littoral habitats. Although some members of this assemblage are commonly the dominant top-level predators in warm water communities, sunfishes also provide forage for many other species and also serve as hosts for sensitive life-stages of many freshwater mussels (Warren Jr. 2009). The presence and density of emergent and submersed aquatic macrophytes (SAV) can greatly influence the abundance, growth, and distribution of members of this assemblage (Bettoli et al. 1993; Hoyer and Canfield 1996; Loftus and Kushlan 1987; Sammons et al. 2005; Spotte 2007; Ware and Gasaway 1976). Abundant SAV can influence population dynamics to such an extent, the effects of relatively modest changes in water level on populations may be undetectable (Bonvechio and Allen 2005).

Members of this assemblage are abundant in the St. Johns River in both lake and riverine habitats (Cox et al. 1981; Cox et al. 1976). Data available for the St. Johns and other areas in Florida suggest that most adult members of this assemblage may exhibit only limited use of the seasonally inundated floodplain. Floodplains provide are important breeding grounds and foraging areas for some riverine fishes (Guillory 1979; Junk et al. 1989; Ross and Baker 1983; Sparks 1995). For many species in tropical systems spawning activity may be triggered by, or strongly related to, the flood pulse (Junk et al. 1989). Peak spawning by the sunfishes in the St. Johns River however, occurs between February and June which is a time of declining water levels associated with the peak of the dry season (Hoyer and Canfield 1994; McLane 1955) and the floodplain is typically dry.

The sunfishes of the St, Johns River are insular populations of wide ranging eastern North American sunfishes that have adapted to temperate climate patterns (Gilbert 1987). In the St. Johns, as throughout North America, most of these sunfish species spawn in response to spring rising temperatures (Carlander 1969b). In temperate climates, spring rainfall also causes rising water levels and the extent of spring and summer flooding has been shown to have important implications toward the formation of subsequent year-class strength (Aggus and Elliott 1975; Martin et al. 1981; Miranda et al. 1984; Rainwater and Houser 1982). In the St. Johns River, however, flooding does not usually occur until late summer or fall and in the Upper Basin, is usually associated with widespread hypoxia (See Chapter 7 Biogeochemistry). Since most members of the Large Sunfishes Assemblage are relatively intolerant of low dissolved oxygen (DO <5 .0 ppm)(Carlander 1969b), the seasonally inundated floodplains of the St. Johns River likely provides suboptimal habitat for either juveniles or adults. Even in the lakes, large areas may become hypoxic in association with the seasonal flooding (See Chapter 7 Biogeochemistry) (Cross et al. 1993). This hypoxia, which is unaffected by water withdrawals (See Chapter 7 Biogeochemistry), may be important in regulating overall population abundances, although the relationship between the extent of hypoxia and sunfish abundance in the St. Johns River, has not been studied.

Quantitative sampling conducted on the floodplain supports limited use of this habitat by most members of the Large Sunfishes Assemblage. Samples taken in floodplain marshes near Lake Washington and Puzzle Lake indicate the fish community is dominated by small live-bearers (Poeciliidae) and top-minnows (Cyprinodontidae). Small sunfishes were relatively absent even though they were abundant in the lakes (Cox et al. 1980; Cox et al. 1977; Cox et al. 1976) . Similar community structure was reported in the marshes adjacent to Lake Blue Cypress (Jordan et al. 1998), in dense marshes around Lake Kissimmee (Allen and Tugend 2002) and in the Everglades (Trexler et al. 2002). In the Everglades, large sunfishes were common in marshes with long hydroperiods, but were generally not abundant (Chick et al. 2004).

Radio-telemetry studies also indicate limited use of the floodplain by the some members of the Large Sunfishes Assemblage. Largemouth bass implanted with radios in the vicinity of Lake Poinsett generally stayed within the main river or lake and only accessed the marsh during more extreme flooding events (Cross et al. 1987). Largemouth bass tagged in Lake Washington exhibited a similar movement response to extreme high water. Movement into the marsh was apparently triggered by hypoxia that forced fish to try to locate more suitable DO and was not associated with spawning (Cross et al. 1987). Largemouth bass in the St. Johns River spawn in the early spring and use protected areas of lakes, canals, and longer hydroperiod marshes adjacent to canals for spawning habitat (Cross et al. 1987). Black crappie implanted with radio tags did not utilize the floodplain (Cross et al. 1987).

The members of the Large Sunfishes Assemblage most likely occurring on the floodplain are bluegill and spotted sunfish. Although McLane (1955) considered the spotted sunfish to be more of a stream dwelling fish, Loftus and Kushlan (1987) reported it to be the most abundant sunfish in the Everglades. The bluegill is reported to be the most ubiquitous species in the St. Johns River (McLane 1955). Both species have a strong association with submersed vegetation and are also abundant in littoral areas throughout the river (Cox et al. 1977).

As mentioned earlier, all members of the Large Sunfishes Assemblage are nest builders. After egg-laying one or both parents may guard the nest and fan the eggs for up to 8 days or more (Carlander 1969b). Sunfishes in this assemblage nest over a wide range of depths but generally in waters between 0.3m (1.0 ft) and 3.0 m (10 ft). Rapid water level recession rates could cause nest abandonment by the adults or, in the worst case, result in exposure and desiccation or stranding of eggs and young fish (Ploskey 1986; Von Geldern Jr. 1971). Water level recession rates can also directly affect community structure by influencing the rate at which individuals abandon and colonize local habitat patches and thus, is a factor that determines local community assembly in a floodplain river littoral zone (Layman et al. 2010).

Average monthly water level recession rates under the Base1995NN Scenario at Lake Poinsett and the H1 MFL Transect (two sites where withdrawals had the biggest effect on water levels) ranged between 0.8 (0.3 in) and 1.7 cm (0.7 in) d^{-1} (Figure 12.D-1). Full withdrawals under the worst-case Full1995NN Scenario did not cause an appreciable increase in average daily recession rates at either site compared to the Base1995NN Scenario (Figure 12.D-1).

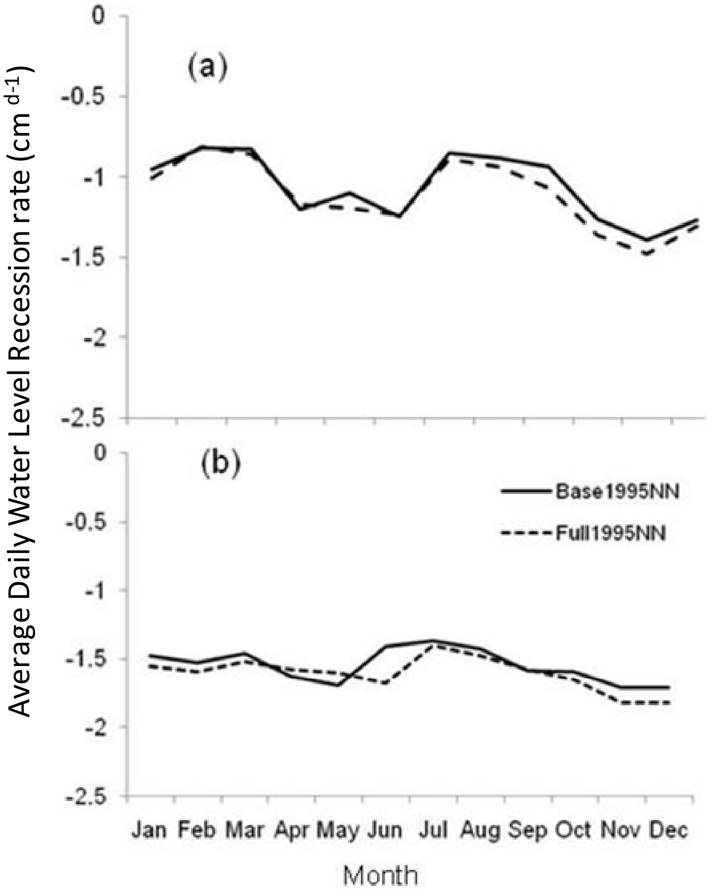

Figure 12.D-1. Average monthly recession rates (cm day $^{-1}$) for the Base1995NN Scenario and worst-case Full1995NN Scenario at (a) Lake Poinsett and (b) MFL Ttransect H1.

Water levels recession rates exceeding than 6 cm d^{-1} (2.4 in) or 1.8 m (5.9 ft) month^{-1} have been shown to cause nest abandonment by largemouth bass (Von Geldern Jr. 1971). At MFL Transect H1, the maximum increase in average recession rates at either site due to withdrawals occurred in June, during the largemouth bass spawning season (Figure 12.D-1). If this faster recession occurred for the entire month, the average water level would only drop and additional 7.8 cm (3.0 in) over the Base1995NN scenario. This is well below the recession rate shown to cause largemouth bass nest abandonment.

Results shown in Figure 12.D-1 are for the worst-case scenario. Addition of the Upper Basin Project and 2030 land use changes actually caused average recession rates to decrease slightly from those predicted under Base1995NN because of low-flow augmentation. Because dry season water level recession rates in the areas of the river most influenced by water withdrawals will not increase substantially and, may actually decrease under near-term scenarios, we conclude that full water withdrawals will not likely change water level recession rates to an extent that will adversely effect spawning by members of the Large Sunfishes Assemblage.

Water level fluctuations are a major factor affecting fish recruitment in streams, rivers, natural lakes, and reservoirs (Ploskey 1983; Sammons and Bettoli 2000; Schlosser 1985). Most quantitative relationships between hydrology and fish recruitment use empirical data that encompasses wide interannual variability in water levels and flooding durations. Such data does not necessarily lend itself well for use in quantitatively predicting the effects of the small changes in water levels and flows that occur due to water withdrawals from the St. Johns River.

Bonvechio and Allen (2005) investigated relationships between annual and seasonal hydrologic variables and year-class strength of largemouth bass, bluegill, redear sunfish, redbreast sunfish and black crappie in four rivers and four lakes in Florida. They concluded impacts of hydrology on year-class strength were stronger in the rivers than in the lakes and results varied between species. Redbreast sunfish considered a stream fish by McLane (1955), is most likely to be impacted by changes in river discharge. Redbreast sunfish year-class strength was positively correlated with median discharge rates in the fall prior to spawning (Bonvechio and Allen 2005). Growth of redbreast sunfish in 8 of 9 Georgia rivers was positively related to spring discharge (Sammons and Maceina 2009). Both of these responses likely reflect increased access to the floodplain and enhanced invertebrate food resources which would positively impact both growth and reproductive fitness (Bonvechio and Allen 2005; Sammons and Maceina 2009).

Model output indicates that under the worst-case Full1995NN Scenario, median spring discharges in the river downstream of SR 520 would decrease about 11% (Figure 12.D-2) compared to the Base1995NN Scenario. In the scenarios with the Upper Basin Project completed (Full1995PN) and with 2030 land-use changes (Full2030PN[1]), however, median spring discharges increase 17-27% (Figure 12.D-2). Under such conditions, growth of redbreast sunfish in the river may increase. Increased growth may be offset to a degree by a decline in recruitment. Under the Full1995PN and Full2030PN Scenarios, fall median discharges are 18% and 11% lower than under the Base1995PN Scenario, respectively (Figure 12.D-2). This reduction in fall discharge under these scenarios may have a localized dampening effect on recruitment of redbreast sunfish the following spring in the river between Lakes Poinsett and Harney because of reduced floodplain inundation although we lack empirical data to make any quantitative predictions (Bonvechio and Allen 2005). Regardless, any effects due to water withdrawals on redbreast sunfish would likely be difficult to measure. Although redbreast sunfish are common in the upper sections of the river they are most abundant in the northern half of the drainage and are most abundant in the Ocklawaha River (McLane 1955). Given this distribution, and the fact that withdrawal effects decrease in a downstream fashion, overall impacts of water withdrawals on redbreast sunfish in the entire river drainage are likely small. Potential impacts on redbreast sunfish in the Ocklawaha River however, warrant special consideration in future assessments of potential withdrawal effects on this system.

Bonvechio and Allen (2005) reported largemouth bass year-class strength was generally negatively related to spring (April-June) median discharge rates in rivers. Thus, because of the higher spring median discharges under the Full1995PN and Full2030PN Scenarios as compared to the Base1995NN Scenario (Figure 12.D-2), largemouth bass recruitment in the St. Johns River channel between the lakes could be reduced under these scenarios. However, a reduction in recruitment in riverine habitats under the Full1995PN and Full2030PN Scenarios would be an augmentation, not a withdrawal effect. Given the spatial extent of the lakes in the Upper Basin of the St. Johns River, we propose that spawning in lakes is more important than the spawning in

[1] Full2030PN is synonymous with Full2030PS because sea level rise has no effect on the river upstream of Lake Harney.

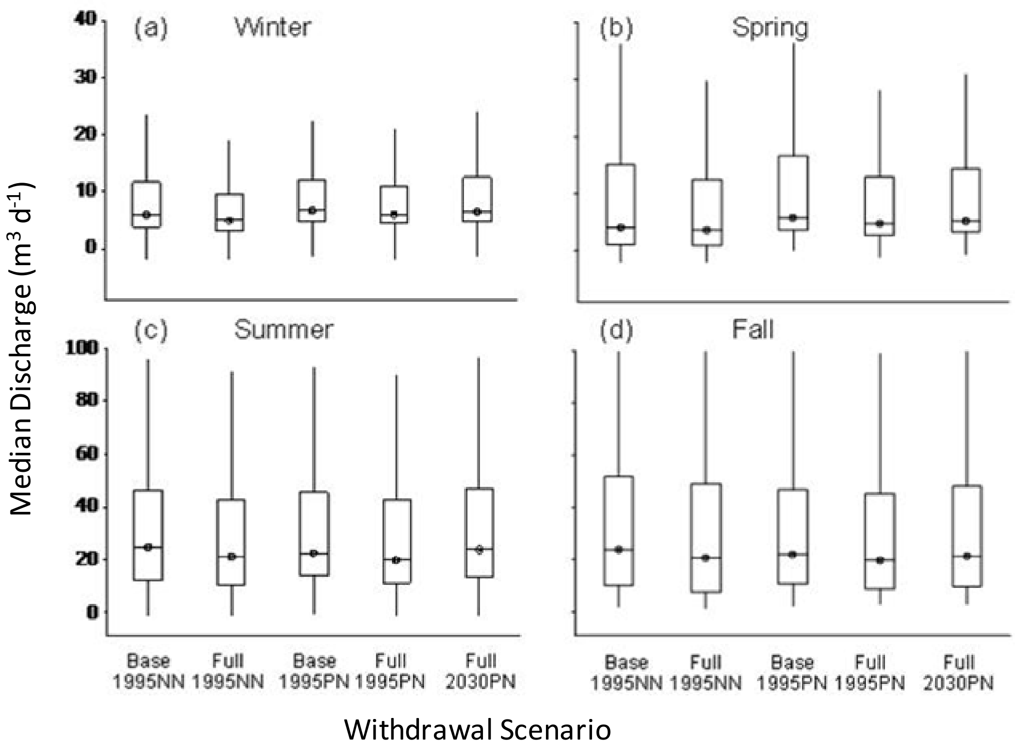

Figure 12.D-2. Median modeled daily discharge (m^3s^{-1}) at SR 520 for the (a) winter (Jan-Mar), (b) spring (Apr-Jun), (c) summer (Jul-Sep), and (d) fall (Oct-Dec) seasons (1975-2008). Boxes represent 25th and 75th quartiles and vertical lines represent minimum and maximum values within respective interquartile extremes.

the river channel in determining overall abundance of largemouth bass in the system. Only two of 26 largemouth bass monitored by radiotelemtery during spawning utilized the river channel (Cross et al. 1987). The rest utilized either lake littoral zones or canal and marsh habitat near the lakes.

In two of three lakes studied by Bonvechio and Allen (2005), year-class strength of largemouth bass was positively correlated with mean fall water levels. If this relationship was to hold for Upper Basin lakes, largemouth bass recruitment may be slightly lower in the lakes under the Full1995PN Scenario as compared to the Base1995NN Scenario, but remain relatively unchanged under the Full2030PN Scenario (Figure 12.D-3). Under the Full1995PN and Full2030PN Scenarios, some of the reduced fall flooding could be due to the operation of the Upper Basin Project to prevent flooding as well as to withdrawals.

Other studies have shown positive relationships between year-class strength of largemouth bass and water levels in the spring (Aggus and Elliott 1975; Keith 1975; Miranda et al. 1984; Reinert et al. 1995; Sammons and Bettoli 2000). If this relationship holds for lakes in the St. Johns River, higher spring water levels under the Full1995PN and Full2030PN Scenarios (Figure 12.D-3) suggest largemouth bass abundance could increase in the future over the baseline condition. Given the strong effect of SAV (which will not be impacted by water withdrawals—see Chapter 9 Submersed Aquatic Vegetation) on the population dynamics of largemouth bass

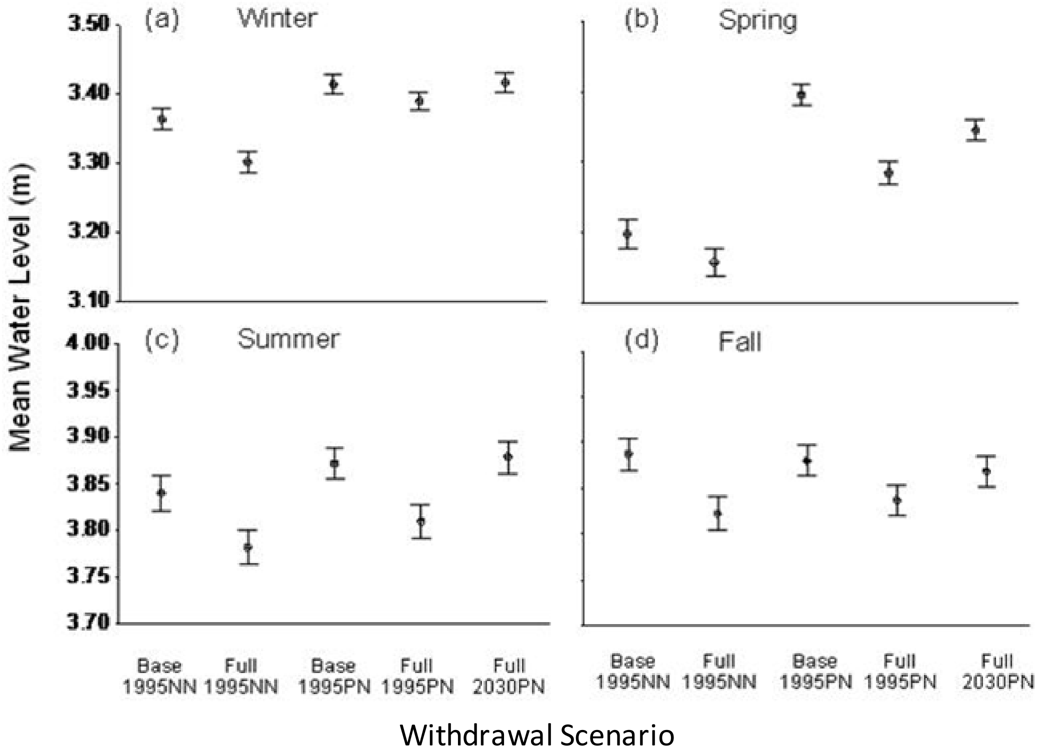

Figure 12.D-3. Mean modeled water levels ±95% CI (m) at SR 520 for the (a) winter (Jan-Mar), (b) spring (Apr-Jun), (c) summer (Jul-Sep), and (d) fall (Oct-Dec) seasons (1975-2008).

(Bettoli et al. 1993; Hoyer and Canfield 1996), any water levels effects on recruitment due to withdrawals in the lakes could also be difficult to detect (Bonvechio and Allen 2005). Because of higher spring water levels and the association between largemouth bass abundance and SAV, we conclude that water withdrawal effects on largemouth bass in the St. Johns River will likely be minimal under both potential near- and long-term withdrawal scenarios.

In rivers, bluegill and redear sunfish year-class strength in rivers was positively related to median discharge rates in the fall prior to spawning (Bonvechio and Allen 2005). No general trends for these three species were evident across lakes, although in Lake Disston, bluegill year-class strength was negatively correlated with mean fall water levels prior to spawning (Bonvechio and Allen 2005). If this relationship were to hold for St. Johns River lakes, bluegill recruitment would be enhanced under the Full1995PN and Full2030PN Scenarios (Figure 12.D-3). In the river channel however, recruitment under the scenarios may be slightly depressed. As with largemouth bass, we believe that spawning in lakes is more important than the spawning in the river channel in determining overall abundance of bluegill and redear sunfish in the St. Johns River. Both species are gregarious and nest in colonies with the largest colonies generally being located in the littoral zones of lakes (McLane 1955; Spotte 2007). Both species will often utilize the same spawning sites (McLane 1955). Further, McLane (1955) reported bluegill and redear sunfish were more abundant in the lakes of the St. Johns River than in the swifter flowing currents of the main river although they were common in all habitats. The abundance and population dynamics of both species are strongly affected by the occurrence of SAV (Carlander 1969b; Cox et al. 1977; Spotte 2007). For the same reasons listed for largemouth bass, we conclude that water withdrawal effects on bluegill and redear sunfish will also likely be undetectable or minimal under both potential near- and long-term withdrawal scenarios as compared to base conditions.

Black crappie occur primarily in the lakes and deeper river channels of the St. Johns River (McLane 1955). Black crappies spawn in the spring in littoral areas generally in association with SAV. In lakes, year-class strength of black crappie has been reported to be negatively correlated with maximum water levels during the fall (Bonvechio and Allen 2005; Maceina 2003) and positively correlated with water levels during the winter-spring spawning season (Miller et al. 1990; Sammons et al. 2002). Lower fall water levels along with higher water levels in the winter and spring under the Full1995PN and Full2030PN scenarios (Figure 12.D-3) suggest black crappie recruitment may be enhanced over the base condition in the future, even with full withdrawals from the river. Given these results and the association black crappie have with SAV for spawning (SAV will not be affected by withdrawals—see Chapter 9 Submersed Aquatic Vegetation), we conclude that water withdrawals will not likely adversely affect black crappie.

According to McLane (1955), spotted sunfish are found throughout the St. Johns River system but it is typically a stream dwelling species found where there is an abundance of SAV. Their association with SAV has also been noted in other Florida systems (Hoyer and Canfield 1994; Loftus and Kushlan 1987). In the St. Johns River, spotted sunfish are common but not abundant, rarely comprising > 3% of either number or biomass of block net samples (Cox et al. 1980; Cox et al. 1977; Eisenhauer et al. 1993). They are generally most abundant in Lower Basin (McLane 1955).

Spotted sunfish have been proposed as a potential indicator of fish community responses to water level fluctuations (Rogers et al. 2005). Regression models developed for the Ocklawaha River indicated spotted sunfish abundance relates positively to minimum river water levels during the year prior to sampling (Rogers et al. 2005). Under the Full1995PN and Full2030PN Scenarios, dry season and yearly mean water levels will increase in the Upper Basin as compared to the Base1995NN Scenario. Under the Full1995PN Scenario, water levels from Lake Monroe downstream will decrease. Under this scenario water, withdrawals may enhance spotted sunfish populations in the Upper Basin and depress them in the Lower Basin. With 2030 land use changes and sea-level rise however, mean water levels will remain unchanged or increase and consequently, spotted sunfish populations may be unimpacted or enhanced along the entire river. Given these results along with its close association with SAV (which will be unaffected by withdrawals), we conclude withdrawals under the potential near- and long-term scenarios will likely have a minimal impact on spotted sunfish in the entire river drainage. Potential withdrawal effects on spotted sunfish in the Ocklawaha River warrant more detailed consideration however, in future assessments of withdrawal impacts on this system.

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