Nitrate Levels and Potential Downstream Impacts from the Breaching of the Kirkpatrick Dam©*

A Technical Review

By

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For

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INTRODUCTION

A portion of the Cross Florida Barge Canal (CFBC) project was completed in 1968 with the closure of the then named Rodman Dam and the filling of the Rodman Pool. The dam was later renamed the Kirkpatrick Dam. Rodman Pool is often called the Rodman Reservoir. It is not a reservoir as it does not reserve anything. It is not a viable water source as it is too shallow and loses up to 25 million gallons per day just due to evaporation. Rodman Pool was constructed only to float barges during operations of the CFBC. Its construction included the clearing and flooding of approximately 7,500 acres of bottomland hardwood forest upstream (west and south) of the current location of the dam, the disruption of normal seasonal hydrology to about 8,000 acres of similar forest downstream of the dam (east and south). This section of the Ocklawaha River (OR) is now referred to as the "Ocklawaha River Below Kirkpatrick Dam" (see Figure 1 for location map). In addition, the maintenance of excessively high water levels in Rodman Pool only to support boat traffic has damaged another 4,500 acres of shallow wetlands and upland habitat located north of SR 310.

Persuaded the CFBC would have devastating ecological consequences to this "natural treasure . . . uniquely beautiful, semi-tropical stream, one of a very few of its kind in the United States," President Richard M. Nixon put a halt to the CFBC project in 1971 (Statement by President Nixon, January 19, 1971, *Canal Authority of the State of Fla., etc. v. Callaway*, 489 F.2d 567, 570, n.1 (5th Cir. 1974).

These efforts did result in the design of a restoration plan and the submission of a joint federal dredge and fill permit and an Environmental Resources Permit (ERP) application by the Florida Department of Environmental Protection (FDEP) to the U.S. Army Corps of Engineers (COE) and the St. Johns River Water Management District (SJRWMD) on November 24, 1997. The permit application was deemed complete in 1999, but the staff of the SJRWMD would not recommend approval of the application based upon concerns for nitrite-nitrate (NO2-NO3) (hereafter referred to as NOx) levels in the OR, and their opinion that if restoration took place, there was potential for NOx levels in the receiving waters of the St. Johns River (SJR) to increase to levels to produce algae blooms. FDEP requested that the SJRWMD take no action on the permit application pending further negotiations, and that the permit application be held in abeyance indefinitely. Since that time efforts to breach the dam and restore flows to the impounded OR above the dam, and the hydrologically impaired OR below the dam, have languished in a regulatory and political deadlock.

One of the efforts among many that has taken place due to public comment was the hiring of PBSJ (now Atkins) by FDEP to undertake a further review of the issues and make recommendations about how permits could be issued and still protect the SJR. Several draft reports were prepared, none of which were ever finalized due to budget limitations (PBSJ 2008a, b, 2010). Save Our Big Scrub, Inc., (SOBS) and the Putnam County Environmental Coalition (PCEC) formed a team including the author, Karen Ahlers, then president of PCEC, attorney John R. Thomas, Esq., and a consulting hydrologist, Phil Davis of SDI Consulting, to review all of these documents and many others previously prepared, and provide both oral and written review comments to both the FDEP and the SJRWMD. Numerous meetings were also help among all parties. I will refer to this group of commenters as the "OR Restoration Team" or simply ORRT.

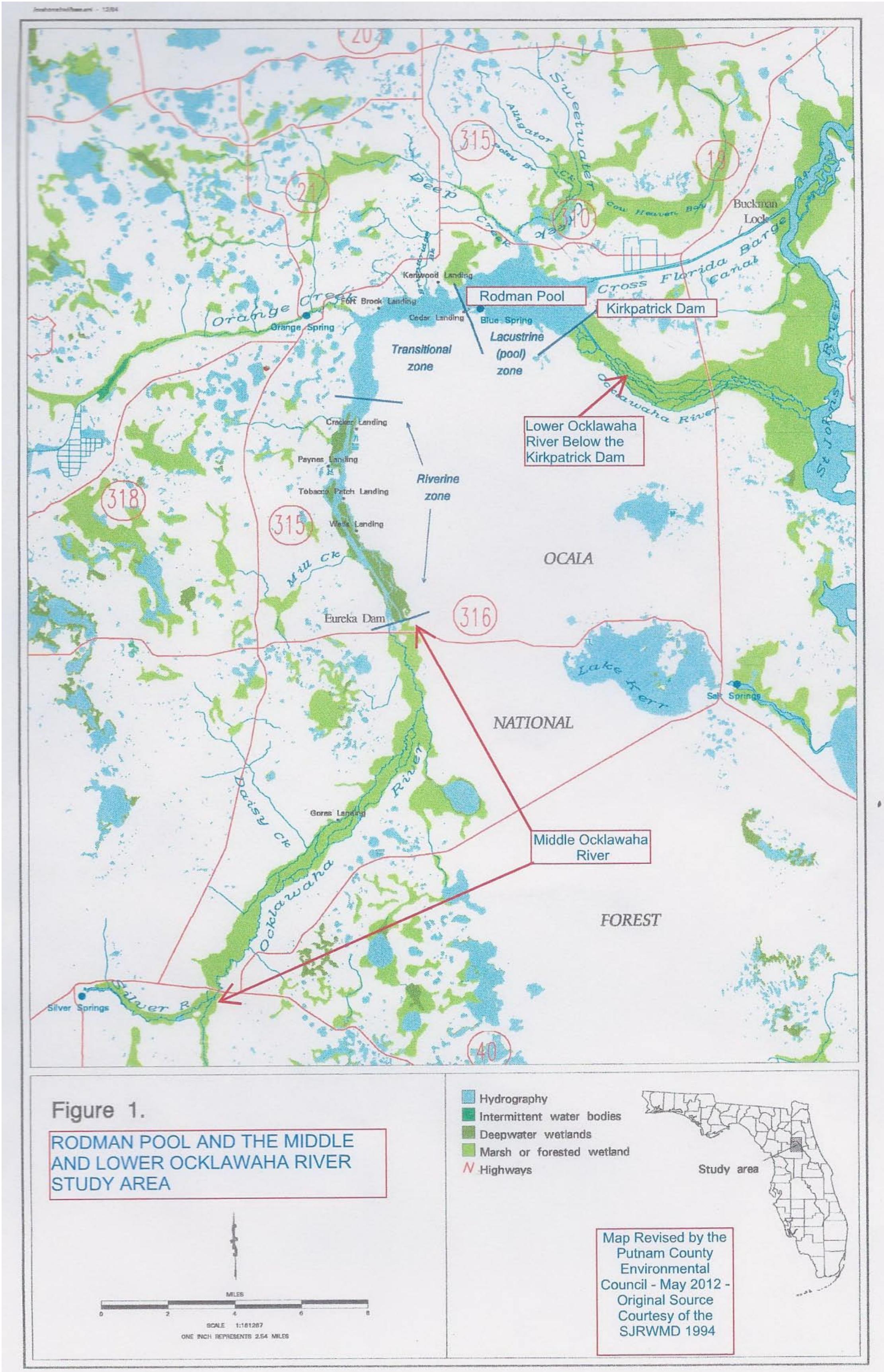


Figure 1.

RODMAN POOL AND THE MIDDLE AND LOWER OCKLAWAHA RIVER STUDY AREA

After a series of studies, aPBSJ (2010) draft report, only long term reduction of of NOx discharges from Silver Springs and the Silver River to the OR could be expected to reduced NOx levels sufficiently to allow SJRWMD to issue permits for restoration. This can be expected to be a multi-decade effort and delay restoration for up to 30-40 years. ORRT strongly disagreed both orally at meetings, and in writing, with both the methodology of the proposed studies, and subsequently with the results and conclusions. As of the date of this technical review no substantive changes have been made to any of the draft PBSJ reports, or draft SJRWMD reports in response to ORRT input, and still another "incomplete draft" report discussing the issues was made available in 2011 (Hendrickson et al. 2011).

This technical review is necessarily a work in progress and is intended to provide a summary of some of, but not all, the important issues related to nutrients and restoration in order to facilitate quicker restoration through breaching of the Kirkpatrick Dam. Further revisions will be made over time. Questions and comments to the author are welcomed (lesrrl3@aol.com, lesrrl3@gmail.com).

DISCUSSION

Current NOx Levels and Changes

Figure 2 indentifies more clearly the three zones of the Rodman Pool as denoted by the SJRWMD. The same zones are also shown on Figure 1. The three zones are the riverine zone, the transition zone and the lacustrine zone. Figure 3 shows river station water quality sampling points as described in PBSJ (2010) that include these zones. Figure 4 shows the data presented in PBSJ regarding NOx concentration declines from water quality sampling along the OR between Silver River (station SSR) and eight (8) other stations. Some of these are not shown in Figure 3.

In general there is a decline in NOx as the water flows from Silver Springs to its discharge over the Kirkpatrick Dam (station RR1). This decrease is about 90% (from about 1.1 mg/l to 0.1 mg/l). It is important to note these are concentrations and not total load of NOx at any given point. This general phenomenon, known to be occurring for many years, has been assumed to be due to some undescribed "pollutant removal by the Rodman Pool" and has led to many erroneous conclusions about the fate of NOx with river restoration.

The first common error is to assume that all the NOx is removed by Rodman Pool, presumably by uptake or assimilation of NOx by floating leaved and submerged aquatic plants. None of the reports to date actually developed a nitrogen budget for this system, and even if all the NOx was going into floating or submerged aquatic plants, it was not actually leaving the system. It would be incorporated into plant tissue, then end up as a mud deposit when the plants died and their parts sank to the bottom of the Pool. NOx would then be regenerated by anaerobic and aerobic decomposition and placed back into the water column over time, and certainly with disturbance such as winds and periodic drawdowns.

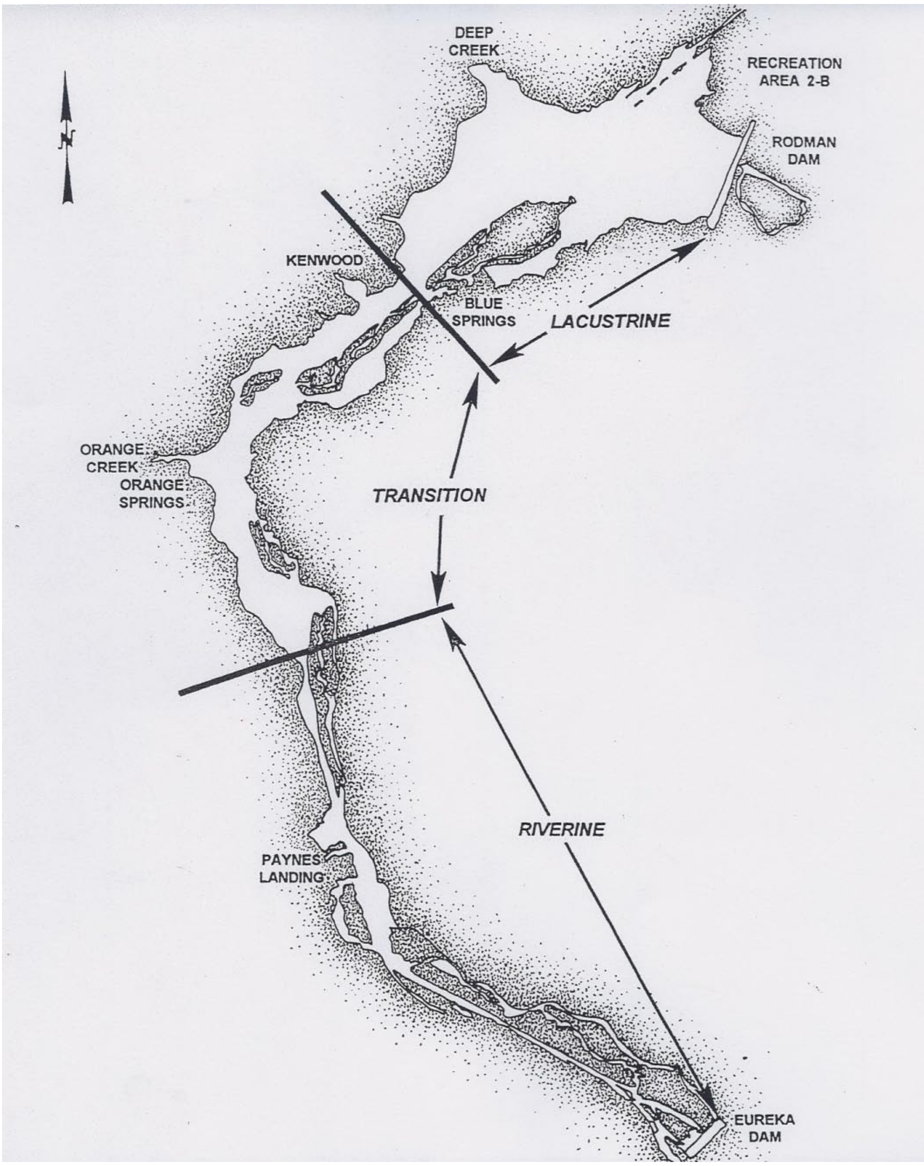
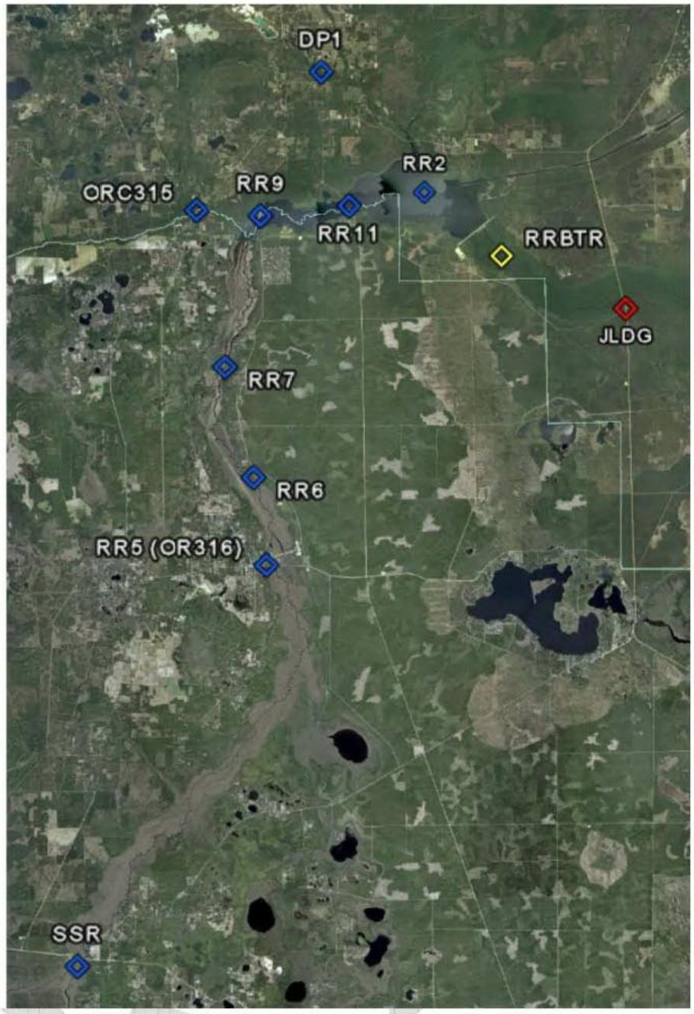


Figure 2. The designated ecological zones of Rodman Pool.

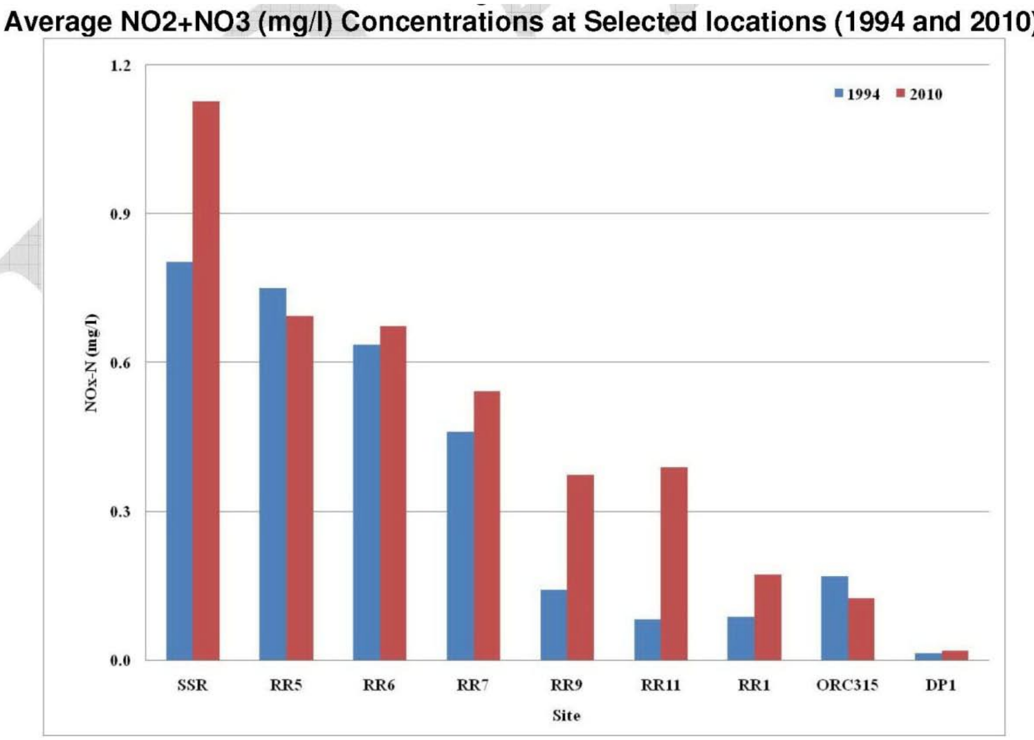
Figure 3 (from PBSJ 2010)

Sampling Location in the Designated Ecological Zones (blue-sampled in both 1994 and 2010, red- sampled in 1994, yellow- sampled in 2010.



A careful examination of Figure 4, however, shows that approximately 1/3 of the decline in NOx concentration occurs PRIOR to any contact with the Rodman Pool, and over half of the decline (55%) actually takes place in the Middle Ocklawaha River between the Silver River and station RR7, in the riverine zone of the Pool.

Figure 4 (from PBSJ 2010)



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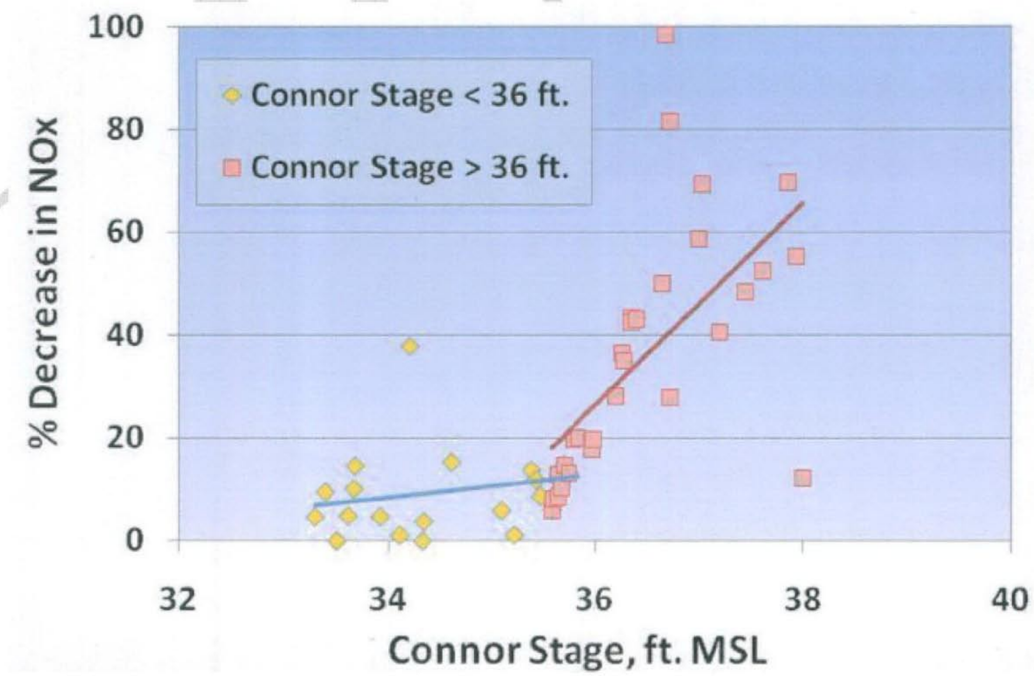
June 2010

Figure 5 (originally from Hendrickson (2007)

Relationship between the Percent Change in NO2+NO (Conner to Eureka) with Stage at Conner (Figure from SJRWMD Presentation)



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June 2010

A substantial portion of this reach of the river is predominantly forested floodplain. This removal of NOx in the riverine portion of Rodman Pool has been erroneously attributed ONLY to floating leaved and submerged aquatic vegetation by PBSJ (2010). The extensive floodplain forests in this reach of the Pool, and the extensive contact with that forest and its floodplain surface during typical high water conditions in the Pool, have been discounted as playing any role in removal of nitrogen from the system.

Craig, et al. 2008 documented that contact with riverine floodplains provides opportunity for "the biologically mediated reduction of nitrate to gaseous forms (N2 and N20) under anaerobic conditions."This biochemical process, called denitrification, converts the NOx dissolved in riverine waters to gaseous forms that exits the river ecosystem to the atmosphere and is true "removal" of NOx, and protects downstream receiving waters from excess NOx loading. While Hendrickson (2007) has acknowledged the role of flooding in the floodplains of the OR in inducing denitrification (see also Figure 5) and NOx removal, and stated "[T]he strong relationship between stage and NOx loss rate [see Figure 5] suggests riparian areas contact leading to increased assimilation and denitrification may be important in controlling mechanisms for eventual NOx export from the Ocklawaha River," PBSJ (2010) has largely discounted the potential role of floodplain denitrification in controlling NOx downstream transport. They have also failed to discuss the possibility of managing water flows and stages within the entire middle and lower OR ecosystem (including both above and below the dam) to increase NOx removal as part of a plan to prevent any long term impacts to the SJR. The ORRT has been strongly critical of this narrow viewpoint.

Towards A Science Based Approach To NOx Management for Restoration

The ORRT has repeatedly suggested that following restoration and the return of normal flooding frequencies in all reaches of the Middle and Lower OR, multiple opportunities exist to manage NOx removal to prevent any long term problems in the SJR. One of these opportunities is simply to stage the restoration over time and carefully measure, report and manage NOx levels as needed. This in fact is the proposed plan as outline by FDEP in their 1997 ERP submittal. It is not the current plan to simply breach the dirt portion of the Kirkpatrick Dam (not the dam's gate structure) all at once. Instead, through a careful series of declining stages in the Pool over a three year period, flows would be tested and monitored for NOx concentrations, loading and removal. From these quantitative data, and a joint group effort on the part of an OR Restoration Team, further refinements to the final breaching timing and scale could be made. This staging would also provide substantial environmental benefits through hydrologic restoration of the wetlands below Kirkpatrick Dam (see Figure 1 and Figure 6).

Careful monitoring and restoration of historical flows as needed in this twelve mile stretch of bottomland hardwood forest stretching from the Kirkpatrick Dam to the SJR would allow for fine tuning flows and reopening closed streams to facilitate NOx assimilation and denitrification.

Figure 6. The Ocklawaha River Below Kirkpatrick Dam.

This section of the OR contains approximately 50 miles of interconnected streamways, and 8,000 acres of stressed bottomland hardwood forest (Figure 6). For over 40 years, flows to this portion of the OR and its adjacent floodplain have been both reduced due to declines in flows from upstream (PCEC 2010), but also reduced due to declines in flows from springs flooded by the backwaters of Rodman Pool. Mark Stewart, Ph.D, P.G., of the University of South Florida first commented on this in 1992 (Stewart 1992), "[S]pring discharge from the Floridan Aquifer into the Ocklawaha will increase as the head (water level) over the spring vents decreases. The increased discharge from the Floridan Aquifer will have negligible effect on local or regional water levels in the aquifer , but will contribute more low dissolved solids, low nutrient level waters to the flow of the river…Springs that existed prior to the construction of Rodman Dam and the flooding of the pool will be rejuvenated. There were approximately 20 small-medium size springs flooded by the pool" (emphasis added). More recently, Hendrickson (2011) noted that "[D]uring the drawdown phase…Rodman discharge is elevated approximately 500 cfs [approximately 300 mgd] above that expected to occur under the reservoir condition for the same Eureka discharge occurrence frequency."

What this means is that the stage (water level) in the floodplain below the dam could be expected to be higher after restoration, and certainly flood surges, now blocked by the Kirkpatrick Dam, would resume their normal pattern and assist with rejuvenating the now hydrologically stressed floodplain below the dam (Figure 7). We would also expect that this restored hydrology would provide greatly increased opportunities for denitrification and removal of NOx before it reaches the SJR.

We would note that none of the above observations nor opportunities to increase denitrification after restoration have been noted in any previous publication by FDEP, PBSJ nor the SJRWMD.

Figure 7. Typical floodplain view showing hydrologic stress and organic soils loss (subsidence) in the Ocklawaha River Below Kirkpatrick Dam (photo by Robin Lewis, July 21, 2007).

SUMMARY

In closing, the ORRT would like to state that there may be difficulties in accomplishing restoration of the Ocklawaha River, but using what we consider to be poor science and false paradigms to justify leaving the Kirkpatrick Dam in place has stalled restoration much too long. Restoration will rejuvenate 8,000 acres of floodplain forest and wildlife and fisheries habitat below the dam, allow for natural revegetation and/or planting of 7,500 acres of similar habitat above the dam and currently submerged under the Rodman Pool, and relieve hydrologic stress (excess flooding) within the Deep Creek ecosystem north of SR 310 (approximately 4,500 acres), for a total minimum riverine floodplain habitat restoration of approximately 15,500 acres, and prevention of further damage to approximately 4,500 acres of publically owned and currently mismanaged habitats. Fisheries restoration is expected to be very successful, particularly given the 92% decline in fish biomass over the last 50 years in Silver Springs, and the complete loss of such fisheries as that for the native striped bass, (*Morone saxitilis*) in the Silver River, and Middle and Lower OR (Lewis 2012).

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