A Brief History of Lake Okeechobee Ecosystem Responses To Water Level Management

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Water management crises in and around Lake Okeechobee in 2016 brought renewed focus to the decisions that guide Lake management. Safety constraints for the Herbert Hoover Dike (HHD) are the priority factor as repairs are underway. But estuary interests, water supply users, and Everglades restoration project managers (e.g., project managers for Lake Okeechobee Watershed Project and Western Everglades Project) are considering future Lake management scenarios. Discussion has focused in part on determining whether the Lake can be kept deeper, and how often and for how long. The Committee on Scientific Review of Everglades Restoration's 2016 Biennial Review on the Progress of Everglades Restoration (NAS 2016) recommended revisiting the Lake's regulation schedule[1], "as soon as possible" but did not suggest a specific increase in the amount of water held in the Lake.

Originally, Lake Okeechobee was larger and deeper than today but this has been forever changed by the modern water management system. Any future Lake management scenarios must consider impacts to the Lake and competing needs outside of the Lake.

Audubon supplies this brief history of Lake Okeechobee ecological responses to different eras of water management in the Lake to inform stakeholders of the likely impact of different regulation schedules in Lake Okeechobee. This document is organized into sequential regulation schedules from 1951 to present. Some final non-sequential scenarios discuss advantages of low water levels and of water quality impacts from higher and lower levels. A summary of conclusions follows.

1951-1978. Beneficial results with water levels maintained below 15.5

The regulation schedule for the Lake from 1951 to 1978 had a high level objective of 15.5 feet NGVD (Trimble and Marban 1988). This level is roughly the same as the highest ground elevations within the HHD and water levels of 15.5 feet flood virtually the entire marsh. During dry seasons, drawdowns occurred regularly in the marsh. This period was considered one of marsh plant diversity and health (Pesnell and Brown 1977, Milleson

[1] A "regulation schedule" is the water management plan developed by the US Army Corps of Engineers that weighs all the needs of the Lake and outlines protocols to meet them. The present regulation schedule is the Lake Okeechobee Regulation Schedule, abbreviated "LORS08" for the year it was adopted.

1987). Everglade Snail Kites and wading birds nested in the Lake in abundance, wintering waterfowl were abundant, and the fishery was productive (Reichert et al. 2015, David 1994a, Johnson and Montalbano 1984, and Fox 1987, for the respective taxa). The lowest level was 10.14 feet in 1956.

1978-1992. Harmful results with water levels maintained above 15.5 feet

In 1978, a new Lake management schedule was adopted with the goal of keeping the Lake between 15.5 and 18.5 feet, essentially never allowing the marsh to dry. Between 1978 and 1988, the Lake was above 15.0 feet 55% of the time.[2] The extended high water created an "ecological emergency" as described by the state-convened Lake Okeechobee Littoral Zone Technical Advisory Group (LOLZTG 1988). Their 1988 report noted problems including, "…loss of wading bird habitat, decline in willow, and loss of moist soil annual plant production." LOLZTG recommended, "lowering the present schedule to improve fish and wildlife habitat in the littoral zone." The lowest level of this period was 9.79 feet in 1981.

1992-2000. More harmful results with water levels maintained above 15.5 feet

Partly in response to the LOLZTG recommendations, the Corps adopted a new schedule in 1992-"Run 25"- designed to manage Lake levels between 15.65 feet to 16.75 feet. This still did not allow drawdowns in the littoral zone except during droughts and by 2000 the result was the almost complete cessation of wading bird nesting (Zaffke 1984, David 1994b, Smith et al. 1995), Everglade Snail Kite nesting (Fletcher at al. 2015), loss of bulrush and other deep-water plant zones, formation of a large organic berm made of dead plants at the outer marsh edges, and a fisheries crash (Havens et al. 2005). The Governing Board of the South Florida Water Management District (SFWMD) declared an emergency and conducted an emergency drawdown to help restore the marsh community (Steinman et al. 2002). Between 1978 and 2000, the Lake had been above 15 feet 53% of the time.[3]

The drought of 2000-01 significantly lowered water levels in the Lake. In order to continue delivering water to permitted users, even after gravity flow from the Lake was no longer possible, portable forward pumps were used for the first time. With the use of these pumps, the Lake dropped to its lowest level ever of 8.97 feet, breaking the previous 88 year record by more than 9 inches.

2000-2008. Harmful impacts from short duration high water events

The Corps adopted a new schedule in 2000 called the "Water Supply and Environment" schedule (WSE) to allow the Lake to drop lower than previous schedules but still allow high Lake levels to prioritize the availability of water for water supply. High water events (>17 feet) in 2003, 2004 and 2005 created serious problems in the Lake, including the loss of about 45,000 acres of plant communities and the loss of water-related bird breeding use. Fisheries crashed (Havens 2005), and the black crappie population did not recover for almost a decade (SFWMD 2015). Hurricanes stirred the mud bottom in the center of

[2] D. Fox, FFWCC pers comm. From DBHydro
[3] D. Fox, FFWCC pers comm. From DBHydro

the Lake, which also greatly increased phosphorus levels and led to water quality problems (James and Havens 2005).

Portable forward pumps were used again during the 2007-08 drought and the Lake reached 8.82 feet- another record low.

2008 to ~2014. Beneficial results from LORS 2008 keeping levels below 16 feet

A new Lake Okeechobee Regulation Schedule (LORS08) was adopted in 2008, keeping the Lake below 16 feet most of the time. Lower levels were adopted partly to ensure the safety of the HHD, but also in recognition of the repetitive harmful impacts that had occurred from higher Lake levels. The 2015 South Florida Ecosystem Report (Chapter 8) details that in the 6 years since the adoption of LORS, there had been substantial recovery of submerged aquatic vegetation, bass and crappie fisheries, wading bird and Everglade Snail Kite breeding and feeding and other biological improvements in the Lake. The famous FLW Bass Tournament[4] on Lake Okeechobee in 2011 saw the three heaviest stringers of bass ever caught in the history of the tournament (C:\Users\pgray\Documents\My Documents\Lake Okeechobee\data sets\Fishing News Lake Okeechobee rebound - FLW Outdoors.mht).

2015-2017. Plant and animal losses during LORS with only moderately high levels

From August 2015 to August 2016, record high rainfall occurred in Lake Okeechobee and its watershed. This period was marked by water levels above 16 feet (with a high of 16.4 feet NVGD) for about one month during February, and a brief excursion above 16 feet in September. This period demonstrated the impacts that occur with even modest excursions above 16 feet. Submerged Aquatic Vegetation (SAV) acreage in Okeechobee declined 45%, from 33,345 acres to 18,525 acres. This represents a loss of 23 square miles of plant communities (SFWMD 2016). Wading bird nesting in Lake Okeechobee in 2016 was 49% below the 10-year average (Gawlik et al. 2016).

Summary

The case studies above review about 65 years of water level management on Lake Okeechobee. The trends are clear. When the management goal is to keep the Lake below 16 feet, Lake biota, from the marsh, to birds, to fisheries, tend to be robust. When Okeechobee levels rise above 16 feet, even for short periods of time, environmental degradation results. When Lake management schedules persistently hold water levels higher than 16 feet, the damages are compounded.

A deeper lake is a dirtier lake

Havens (1997) noted a correlation between deeper water levels and poorer water quality. The deepest water levels often occur after tropical or heavy rain storms that carry heavy nutrient loads into the Lake. And they often are associated with wind events that stir up bottom sediments. Deep dirty water can drown SAVs, depleting their ability to absorb nutrients and perform local water quality functions. Once lost, SAVs cannot recover until

[4] Named for Forest L. Wood, founder of Ranger Boats, and considered the developer of modern bass boats.

drought conditions lower the Lake enough for reestablishment (Havens 2003). And the high nutrient inflows associated with deep water events set the stage for cyanobacteria blooms (Havens 1997, Hanlon 1999, Havens et al. 2016).

Deep dirty water impacts marsh health. At levels above about 15.5 feet, nutrient rich water from the middle of the Lake flows into the marsh, degrades water quality, shades out desirable plant communities and encourages noxious plants such as cattails to expand (Havens and Gawlik 2005, Graham et al. 2015 (see page 115)).

Conversely, low phosphorus levels in the Lake occurred after a multi-year period of relatively low water conditions. Phosphorus levels in 2012 in the middle of the Lake dropped to 92 ppb total phosphorus and near-shore levels dropped to 41 ppb total phosphorus, the lowest values in a decade (SFWMD 2014, see Table 8-15). This low phosphorus period followed low inflow years of 2007, 2008 and 2011. When Lake inflows and levels subsequently increased, phosphorus levels increased again (SFWMD 2015).

The essential need for natural water level fluctuation

Wetlands are habitats that alternate between flooding and drying, with both phases indispensable to proper function (Weller 1987). Florida's distinct wet and dry seasons allow for natural drawdowns virtually ever year. Direct harm to Lake Okeechobee's marshes from excessively deep water was emphasized in the above scenarios. But holding Lake levels higher also prevented this natural fluctuation of water levels.

Varying the water levels on the Lake is essential to rejuvenate its marshes (Havens and Gawlik 2005, Johnson et al. 2007). Lowering the Lake during the dry season facilitates decomposition of dead plants, wading bird feeding, and seed germination (some seeds germinate only on mudflats while others need light penetration to the bottom to germinate). Prey fish are concentrated during the dry season, allowing other fish and wildlife access to an abundant food source.Beneficial prescribed or natural burns can occur.

But just as holding the Lake too high can have devastating impacts, drawdowns or Lake schedules that drop water levels too low, for too long, or too often are harmful. To identify and prevent damaging low water events, the SFWMD established a Minimum Flow and Level (MFL) that identifies the minimum level of water that is needed to protect the health of Lake Okeechobee. The Lake's MFL states that if it drops below 11 feet for more than 80 days, more often than once every six years, then "significant harm" occurs (SFWMD 2007). Significant harm is defined as "harm that requires multiple years for the water resource to recover."

Significant harm can typically be seen in four ways: First, marsh-wide population crashes occur in wetland-dependent species such as Florida apple snails, frogs, aquatic snakes, turtles, round-tailed muskrats and similar species. Second, massive evacuations of wildlife can take place. Many species leave but may not find suitable habitat elsewhere. This was demonstrated by the Everglade Snail Kite, which suffered 50% population losses during

the droughts of 2001 and 2007-08 when the Lake habitat was too dry to be suitable for Kites (Fletcher et al. 2014). Third, permanent subsidence and loss of organic soils occurs on the south end of the Lake. Finally, fish, alligator, and aquatic invertebrate lose reproductive capacity when marsh breeding areas are completely dry. As the MFL designation recognizes, it can take years to recover from these types of harm.

Performance Measures for Lake Okeechobee

SFWMD's Adaptive Protocols for Lake Okeechobee Operations (SFWMD 2010) includes "Performance Measures" for the Lake. These measures were developed by analyzing the historical data and experiences of past Lake management schedules. Fig. 1 shows the "Extreme High Stage" performance measure and notes that "impacts can occur rapidly" when levels are above 16 feet; that is, harm accelerates in magnitude and severity as levels increase above 16 feet.

Table A-1. Performance measure categories for Lake Okeechobee

Performance Measure	Criteria	Categories*
Extreme High Stage	>17 feet	
Impacts can occur rapidly	16 to 17 feet	

Fig. 1. Extreme High Stage performance measure for Lake Okeechobee from SFWMD's Adaptive Protocols.

Similarly, the "Stage Envelope" performance measure reflects the levels considered "ideal" for Lake health (see Havens et al. 1999). This measure ranges from a maximum high of about 16 feet at the end of the wet season to a minimum low of about 12 feet at the end of the dry season (Fig. 2).

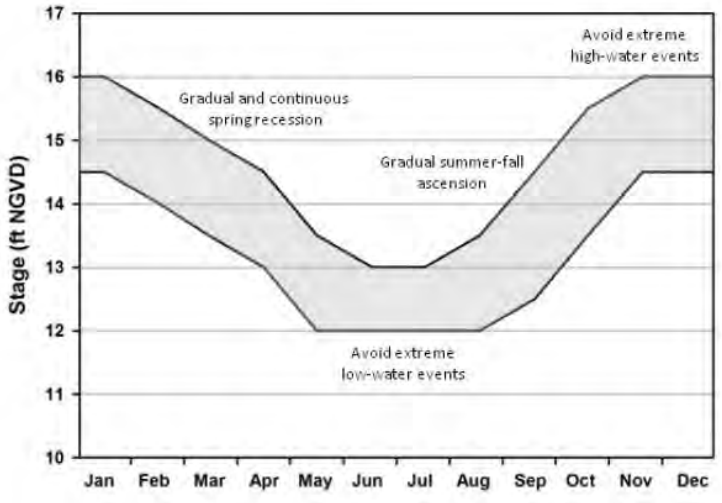

Figure A-1. Lake Okeechobee stage envelope

Fig. 2. "Stage Envelope" performance measure from the SFWMD's Adaptive Protocols showing "ideal" annual water level changes for Lake Okeechobee from dry season to wet season. Levels above or below this range create negative impacts.

Performance measures do not dictate the only way to manage a water body, but rather reflect the best recommendations for ecological function. These measure should therefore be the guiding tool behind decisions related to Lake Okeechobee's water levels.

Conclusion

Since 1951, Lake Okeechobee water levels have been managed with a variety of approaches and goals. Extensive data has been collected that documents how the Lake's biota respond to different water management schedules. Lake levels in the 12.5-15.5 foot range produce thriving plant and wildlife communities. When the Lake rises above 16 feet, harm begins, and accelerates if levels continue to rise.

Lake Okeechobee is one of the great natural resources of our nation. Its bass fishery is world famous, its black crappie fishery can yield more fish than the rest of Florida combined. It is critical for the endangered Everglade Snail Kite, is a migratory stopover for millions of birds, and hosts a significant percent of wading bird nesting in the state. Any future decisions about Lake Okeechobee's water levels must carefully consider the impacts of holding too much or too little water in the Lake.

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