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Evaluating Alligator Status as a System-wide Ecological Indicator of Restoration Progress Annual Report to the United States Army Corps of Engineers

Nicole D. Jennings¹, Michael R. Rochford¹, Seth C. Farris¹, Caitlin Hackett¹, Laura A. Brandt², and Frank J. Mazzotti¹

¹University of Florida IFAS Fort Lauderdale Research & Education Center ²U.S. Fish and Wildlife Service

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Introduction

The Water Resources Development Act (WRDA) of 2000 authorized the Comprehensive Everglades Restoration Plan (CERP) as a framework for modifications and operational changes to the Central and Southern Florida Project needed to restore the South Florida ecosystem. Provisions within WRDA 2000 provide for specific authorization for an adaptive assessment and monitoring program. A Monitoring and Assessment Plan (MAP) (RECOVER 2004, 2006) has been developed as the primary tool to assess the system- wide performance of the CERP by the REstoration, COordination and VERification (RECOVER) program. The MAP presents the monitoring and supporting research needed to measure responses of the South Florida ecosystem to CERP implementation.

The MAP also presents the system-wide performance measures representative of the natural and human systems found in South Florida, which will be evaluated to help determine CERP progress. These system-wide performance measures address responses of the South Florida ecosystem that the CERP is explicitly designed to improve, correct, or otherwise directly affect.

Generally, our research was intended to support four broad objectives of the American alligator monitoring program:

- Establish pre-CERP reference conditions and variability for each performance measure
- Determine the status and trends of the performance measures over short-(body condition), medium- (distribution, relative density) and long-term (demography) time scales
- Detect unexpected responses of the ecosystem to changes in stressors resulting from CERP activities
- Support scientific investigations designed to increase understanding of cause and effect relationships in ecosystems, and interpret unanticipated results in alligator performance

Specifically, our objective was to monitor changes in alligator populations resulting from restoration over short- (body condition), medium- (distribution, relative density) and long-term (demography) temporal scales.

Methods

In fall (wet season) 2017 and spring (dry season) 2018 (water year 2018; 01 May 2017 – 30 April 2018) we surveyed four marsh routes (WCA3A-N41, WCA3A-Tower, WCA3A-Holiday, WCA3B) for alligators as established in Mazzotti et al. 2010 and updated in Hart et al. 2012. Surveys along these routes were performed by airboat. Alligator locations were recorded using a GPS receiver. Spotlight surveys for relative density in each area were conducted twice each season at least 14 days apart to achieve independent counts (Woodward and Moore 1990, Mazzotti et al. 2010). Capture surveys were conducted in the same general times and locations. Body condition of alligators was determined by conducting a condition factor analysis using Fulton's K (Zweig 2003, Mazzotti et al. 2009). We characterized relative

density and body condition by route for each water year as red, yellow, or green following criteria used for component stoplight values used in the System-wide Ecological Indicators for Everglades Restoration report (Mazzotti et al. 2009, Hart et al. 2014, Brandt et al. 2016a; Tables 1 & 2).

More detailed descriptions of survey routes, methodologies, and analyses can be found in Alligator and Crocodile MAP Annual Assessment Reports (e.g., Mazzotti et al. 2010; Hart et al. 2012).

Results

We observed 102 non-hatchling alligators during surveys in fall 2017 (Appendices A & B). Relative density ranged from 0.33 alligators/km in WCA3B to 1.70 alligators/km in WCA3A-N41 (Table 3). Stoplight colors for fall values of relative density were yellow for WCA3A-HD and WCA3A-N41 and red for WCA3A-TW and WCA3B.

In spring 2018 we observed 222 non-hatchling alligators during surveys (Appendices A & B). Relative density ranged from 0.14 alligators/km in WCA3A-TW to 2.08 alligators/km in WCA3A-N41 (Table 3). Stoplight colors for spring were green in WCA3A-N41, yellow in WCA3A-HD, and red in WCA3A-TW and WCA3B.

Overall in water year 2018, we observed 324 non-hatchling alligators during surveys (Appendices A & B). Average relative density between both surveys ranged from 0.14 alligators/km to 2.08 alligators/km (Table 3). Stoplight colors for average relative density in water year 2018 were yellow for WCA3A-HD, green for WCA3A-N41 and red for WCA3A-TW and WCA3B.

In fall of 2017 we captured 60 alligators (1.39 m to 3.00 m) (39 female, 21 males) in four survey areas. 17 of these animals were recaptures (Figure 1, Appendix C). Average individual body condition (Fulton's K) ranged from 1.96 to 2.15 (Table 4). Stoplight color for body condition for all routes for fall was yellow.

In spring 2018 we captured 62 alligators (1.32 m to 2.94 m), 29 of which were females and 33 were males. Sixteen alligators were captured in WCA3A-HD, 15 in WCA3A-N41 and WCA3B, and 16 in WCA3A-TW. (Figure 2, Appendix C). Average body condition (Fulton's K) across four routes surveyed in spring ranged from 2.08 to 2.23 (Table 4). Stoplight color was yellow for all four routes. Ten alligators were in poor condition (stoplight value \leq 1.95). One was in WCA3A-N41, four were in WCA3A-HD, two were in WCA3B, and three were in WCA3A-TW.

We captured 123 alligators in water year 2018 (Figures 1-2, Appendix C). Average body condition (Fulton's K) across all routes ranged from 2.16 to 2.23 (Table 4). Stoplight color for average body condition in water year 2018 was yellow for all routes.

Implications

Stoplight color in water years 2008 through 2010 in WCA3A-TW and WCA3B for relative density was always red (Table 3). We do not have stoplight values from 2011 through 2016 due to lack of sampling but red values in 2017 indicate relative density has not increased compared to past data. In WCA3A-N41 stoplight color for density was green from 2008 through 2011 with the exception of 2010 when the color was yellow. We don't have data available for 2012 through 2016 but the yellow stoplight value in this area during 2017 surveys indicates that relative density is not increasing in WCA3A-N41. In WCA3A-HD stoplight colors alternated between yellow and green from 2008 through 2011. We do not know what occurred from 2012 through 2016 due to lack of sampling but the yellow stoplight color in 2017 is consistent with past data.

Stoplight values for body condition of alligators in the four areas sampled were almost always yellow during previous sampling periods (Table 4). We cannot look at recent trends due to a gap in sampling but water year 2017 stoplight colors are yellow in all areas for body condition and are very similar to values prior to the cessation of sampling.

Establishing a consistent sampling regime will allow us to better understand trends in alligator relative density and body condition and to better assess how current conditions are impacting alligators. We can say that current levels of alligator relative density and body condition still fall short of restoration goals. These performance measures may be improved through water management practices. For example, increasing the range in water depth across seasons may improve body condition (Hart et al. 2014, Brandt et al. 2016b). But prolonged increases in water depth with little seasonal variation may decrease condition. Continued monitoring of alligators in these four areas is critical to making evidence-based management decisions to improve performance measures of alligators. We hypothesize that restored hydrological conditions will improve the production and availability of prey for alligators, which in turn will improve alligator body condition and relative density.

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Table 1. Stoplight values and corresponding colors for American alligator relative density (alligators/km).

Relative Density (Alligators/km)	Stoplight Color
0-0.80	Red
>0.80-1.70	Yellow
>1.70	Green

Table 2. Stoplight values and corresponding colors for American alligator body condition (Fulton's K).

Body Condition (Fulton's K)	Stoplight Color
0-1.95	Red
>1.95-2.27	Yellow
>2.27	Green

Table 3. American alligator relative density stoplight values by water year and area.

	WCA3A-HD	WCA3A-N41	WCA3A-TW	WCA3B
2008	0.93	1.88	0.33	0.35
2009	1.73	2.30	0.44	0.38
2010	1.15	1.25	0.18	0.25
2011	2.45	3.63	NA	NA
2012	NA	NA	NA	NA
2013	NA	NA	NA	NA
2014	NA	NA	NA	NA
2015	NA	NA	NA	NA
2016	NA	NA	NA	NA
2017	1.30	1.43	0.33	0.70
2018	1.40	2.08	0.14	0.56

	WCA3A-HD	WCA3A-N41	WCA3A-TW	WCA3B
2000	2.11	2.17	2.18	NA
2001	2.17	2.23	2.11	NA
2002	2.22	2.3	NA	NA
2003	2.14	2.19	NA	NA
2004	2.10	2.15	2.21	1.83
2005	2.28	2.17	2.15	2.03
2006	2.18	2.04	2.19	2.08
2007	2.08	2.25	2.23	2.26
2008	2.21	2.10	2.23	2.1
2009	2.14	2.06	2.19	1.92
2010	2.20	2.11	2.29	NA
2011	2.06	2.05	2.01	NA
2012	2.20	2.11	2.18	NA
2013	2.21	NA	NA	NA
2017	2.15	1.96	2.14	2.15
2018	2.21	2.19	2.15	2.23
Mean	2.17	2.14	2.17	2.08

Table 4. American alligator body condition stoplight values by water year and area.



Figure 1. Location of American alligator spotlight survey routes. Captures of animals from fall 2017 indicated by green dots.



Figure 2. Location of American alligator spotlight survey routes. Captures of animals from spring 2018 indicated by green dots.