1 Fluctuating water depths affect American alligator (*Alligator mississippiensis*) body condition in
2 the Everglades, Florida, USA

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15 Abstract

16 Successful restoration of wetland ecosystems requires knowledge of wetland hydrologic
17 patterns and an understanding of how those patterns affect wetland plant and animal populations.
18 Within the Everglades, Florida, USA restoration, an applied science strategy including
19 conceptual ecological models linking drivers to indicators is being used to organize current
20 scientific understanding to support restoration efforts. A key driver of the ecosystem affecting
21 the distribution and abundance of organisms is the timing, distribution, and volume of water
22 flows that result in water depth patterns across the landscape. American alligators (*Alligator*
23 *mississippiensis*) are one of the ecological indicators being used to assess Everglades restoration

because they are a keystone species and integrate biological impacts of hydrological operations through all life stages. Alligator body condition (the relative fatness of an animal) is one of the metrics being used and targets have been set to allow us to track progress. We examined trends in alligator body condition using Fulton's K over a 15 year period (2000-2014) at seven different wetland areas within the Everglades ecosystem, assessed patterns and trends relative to restoration targets, and related those trends to hydrologic variables. We developed a series of 17 *a priori* hypotheses that we tested with an information theoretic approach to identify which hydrologic factors affect alligator body condition. Alligator body condition was highest throughout the Everglades during the early 2000s and is approximately 5-10% lower now (2014). Values have varied by year, area, and hydrology. Body condition was positively correlated with range in water depth and fall water depth. Our top model was the "Current" model and included variables that describe current year hydrology (spring depth, fall depth, hydroperiod, range, interaction of range and fall depth, interaction of range and hydroperiod). Across all models, interaction between range and fall water depth was the most important variable (relative weight of 1.0) followed by spring and fall water depths (0.99), range (0.96), hydroperiod (0.95) and interaction between range and hydroperiod (0.95). Our work provides additional evidence that restoring a greater range in annual water depths is important for improvement of alligator body condition and ecosystem function. This information can be incorporated into both planning and operations to assist in reaching Everglades restoration goals.

Key words: Ecological indicator, Fulton's K, hydrology, restoration, target

1.0. Introduction

Successful restoration of wetland ecosystems requires knowledge of wetland hydrologic patterns and an understanding of how those patterns affect wetland plant and animal populations. These relationships can be articulated in conceptual ecological models that diagram linkages between drivers, stressors, ecological effects, and attributes that can then be used as indicators of ecosystem state, status, and trends (Gentile, 1996, Rosen et al., 1995). Development and application of conceptual ecological models also can help to guide restoration planning and implementation. Developing stronger and more explicit relationships between drivers and indicators will improve the likelihood of success of restoration efforts (Gentile, 1996, Karr, 2000).

Within Everglades restoration, an applied science strategy including conceptual ecological models (Ogden et al., 2005, Ogden and Davis, 1999) is being used to organize current scientific understanding to support restoration efforts. The applied science strategy includes performance measures and restoration targets, a system-wide monitoring program, and a performance assessment protocol. A key driver of the system is the timing, distribution, and volume of water flows that result in water depth patterns across the landscape. These patterns have been altered from what was experienced prior to 1881 when the extensive water management network of canals and structures was initiated (Light and Dineen, 1994). A goal of the Comprehensive Everglades Restoration Plan (CERP) is to “get the water right” by restoring more natural patterns of timing, distribution, quantity and quality of water to the ecosystem to support native flora and fauna and ecosystem processes (U.S. Army Corps of Engineers, 1999). Defining what that means in terms of restoration plans and water management operations is one of the biggest ecological challenges of CERP. Because the distribution of organisms in wetlands

is greatly impacted by seasonal and long term changes in wetland water depth (Bedford et al., 2012), following trends of, and understanding relationships between, hydrology and ecological indicators described within the Restoration Coordination and Verification (RECOVER) Monitoring and Assessment Plan (MAP; RECOVER, 2001, 2004) is one of the ways ecological information is being brought into restoration planning.

Alligators (*Alligator mississippiensis*) are an indicator for Everglades restoration because they are a keystone species within the ecosystem and integrate biological impacts of hydrological operations through all life stages (Mazzotti et al., 2009). They are important in food webs as predator, prey (Mazzotti and Brandt, 1994), and protector (Burtner, 2011). They act as ecological engineers by creating areas of high (nest) and low (alligator holes and trails) micro topography that contribute to wetland diversity and productivity (Palmer and Mazzotti 2004). Patterns of water fluctuations are known to affect many aspects of alligator biology including breeding, nest success, growth, survival, and population size class structure (Mazzotti and Brandt, 1994, Rice et al., 2004, Shinde et al., 2014). Changes in patterns of water levels in the Everglades (including increases in frequency and intensity of droughts) have resulted in increased physiological stress for alligators (Jacobsen and Kushlan, 1989), habitat degradation, and reduction in prey base.

Alligator body condition is one metric being used to assess Everglades restoration efforts. Thresholds for desired Everglades restoration targets have been developed for alligator body condition (Mazzotti et al., 2009). Our expectation is that alligator body condition will increase as more natural hydrologic conditions are restored.

Body condition indices, defined by a mass to length relationship, have been used to describe an animal's health, quality, or vigor and could be an important determinant of fitness

(Peig and Green, 2009). Body condition indices describe how well an animal is coping with environmental stressors (Murphy et al., 1990, Taylor, 1979) and reflect energy reserves that can be used for growth or reproduction. They are a non-destructive measure and data are relatively easy to collect. Previous studies have looked at alligator body condition in the Everglades in relation to season (Barr, 1997, Dalrymple, 1996) and water depths (Fujisaki et al., 2009). These studies evaluated one hydrologic factor (water depth) that could affect alligator body condition. Other hydrologic factors such as maximum fall water depth, water recession rate, and frequency and intensity of dry downs known to affect aquatic prey (Loftus and Eklund, 1994, Sargeant et al., 2011) have not been examined. Understanding how these multiple aspects of hydrology affect alligator body condition is an important step in developing and implementing restoration plans that restore ecosystem processes.

In this study we examined trends in alligator body condition over a 15 year period (2000-2014) in seven different wetland areas within the Everglades ecosystem, assessed patterns and trends relative to restoration targets, and related those trends to hydrologic variables. We developed a series of *a priori* hypotheses that we tested with an information theoretic approach to identify which factors affect alligator body condition and discuss our results in the context of overall Everglades restoration.

2.0. Methods

2.1. Study Area

Our study area consisted of freshwater wetlands within the ridge and slough landscape (Ogden 2005) of the Everglades ecosystem including the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX), Water Conservation Area (WCA) 2A, WCA3A, and Everglades National Park (ENP; Figure 1). Vegetation is a mosaic of sloughs, wet prairie,

sawgrass marsh, tree islands, and cattails and varies among areas (Gunderson 1994, Loveless 1959). Hydrology is influenced by rainfall and water management with seventy-five percent of rainfall (approximately 1320 mm/year; Richardson 2010) occurring May-October (wet season) and twenty-five percent November-April (dry season). Water depths vary seasonally with lowest depths generally in mid-May and highest in mid-October. Surface hydrology is managed for flood protection, water supply, and wildlife conservation by the South Florida Water Management District (SFWMD) and U.S. Army Corps of Engineers (USCOE) under various water regulation schedules, operating plans, and input from Florida Fish and Wildlife Conservation Commission, U.S. Fish and Wildlife Service and National Park Service, Everglades National Park.

2.2. *Hydrology*

Average daily stage and ground surface elevation were obtained from seven USGS gauges that are within proximity of alligator capture locations and can act as a reference gauge for that area (Figure 1). Water depth was calculated as stage height minus ground surface elevation. Water year (WY; May 1 of the previous year to April 30 of the reporting year) hydroperiod was calculated as number of days in each water year when the gauge reading was equal to or above 15 cm (6 inches) below which is the depth that makes it harder for alligators to move around the marsh to feed and mate (Rice et al. 2004; Shinde et al. 2014). Three measures of average depth were calculated: the entire water year, depth spanning our spring sampling (January – May), and depth spanning our fall sampling (August – December); however, the entire year average water depth was not used in analysis since it was highly correlated (Pearson's coefficient ≥ 0.7) with both average spring and fall water depths. Water year range was calculated by subtracting minimum depth from maximum depth. Average number of days since

last dry down (DSD) was calculated for each water year as a way to characterize relative timing of dry events. Number of days in that dry event (DIND) also was calculated as a measure of intensity of dry down (Appendix 1).

2.3. *Alligator Captures*

Alligators greater than or equal to 1.25 m total length (TL) were captured by hand or noose during spring (January-May) and fall (August-December) from WY 2000-2014 in seven areas within the four wetlands (Figure 1, LOX, WCA2A, WCA3AHD, WCA3ATW, WCA3AN41, ENPFC, ENPSS). Number of captures varied among years and areas because of dry conditions limiting capture opportunities during spring. We measured snout-vent length (SVL) from the tip of the snout to the posterior end of the cloaca, and total length (TL) from the tip of the snout to the end of the tail. Both length measurements were to the nearest 0.1 cm. Mass (M) of each alligator was measured to the nearest 0.1 kg. Sex was determined by cloacal examination. Animals were given an individual mark and released at the sight of capture. Fulton's K body condition was calculated as $K = M / SVL^3 \times 10^5$ (Stevenson and Woods, 2006, Zweig et al., 2014). Animals were classified by body condition as being in poor (≤ 1.95), fair ($> 1.95 - 2.1$), good ($> 2.1 - 2.27$), or excellent (> 2.27) condition following Everglades restoration target calculations described by Mazzotti et al. (2009) and revised with data from 2004-2009.

2.4. *Data Analysis*

We used ANOVA to examine differences in body condition, and percent in good or fair condition by area and water year. Tukey honestly significant difference HSD test was used to identify differences among areas and water years. We used linear regression to examine trends over time for all areas together and for each area separately. Significance was assessed at $p < 0.1$.

Linear mixed effect models with area as a random variable were used to describe the relationship between body condition and hydrologic variables. First, the relationship between each hydrologic variable and body condition was examined through linear regression analysis and inspection of residuals. If there was evidence of a non-linear relationship the hydrologic variable was transformed. This occurred only for body condition and days since dry (DSD). A natural log transformation of DSD resulted in a linear relationship between body condition and LnDSD. Pearson correlations were calculated between body condition and each hydrologic variable to better understand the relationship of body condition to each hydrologic variable. An information-theoretic approach using Akaike information criterion (AIC) was used to select the best models from a suite of 17 candidate models created from combinations of six hydrologic variables (Table 2). The models were developed based on *a priori* hypotheses about how the hydrologic variables interact to affect alligator body condition both through direct effects (stress to alligators from dry conditions for example) and indirect effects (abundance and availability of aquatic prey; Trexler and Goss 2009; RECOVER 2006). In addition to the full model and 11 models of individual variables and single interactions, there were five complex models: Past, Current, Abundance, Availability, Abundance and Availability. In the Past model we hypothesize that past hydrologic conditions drive alligator body condition and included variables that describe hydrologic conditions that may have occurred in previous water years. In the Current model our hypothesis is that the sample water year hydrology drives alligator body condition and included variables that describe current year hydrology. For the Abundance model we focused on variables thought to drive abundance of aquatic prey and in the Availability model we included variables thought to drive how available aquatic prey is. Our Abundance & Availability model combined variables from the previous two models thought to have strongest

influence on either availability or abundance of aquatic prey. We calculated the relative importance of the predictor variables (variable importance) by summing the model probabilities for each of the 17 models (Anderson, 2008) that a variable appeared in. A ΔAIC of <2 was used to select the top models for generating predictions and averaging them across models based on the probability of that model. In addition, we used linear regression to predict body condition using the top model (Current). We conducted all analysis in R (R Core Team, 2014)

3.0. Results

We captured 2097 alligators from water year 2000-2014 in the seven sample areas. Number of animals captured in each area by water year ranged from 10 to 45. Average yearly body condition ranged from 1.88 ± 0.05 (SE) (ENPSS in 2005) to 2.45 ± 0.15 (ENPSS in 2001; Appendix 1). Percent of animals in good or fair condition ranged from 32% (ENPSS in 2005) to 100% (ENPSS in 2000, LOX in 2002, WCA3AN41 in 2007 and WCA3AHD and WCA3ATW in 2008).

Alligator body condition and percent in good or fair condition were significantly different among areas ($p < 0.001$; and $p = 0.0002$). ENPFC, ENPSS, LOX, and WCA2A had significantly lower average body condition than WCA3AN41, WCA3AHD, and WCA3ATW (Figure 2). Average body condition in the lower average body condition group was 4.6 percent lower than in the higher body condition group.

ENPSS had the lowest percentage of alligators in good or fair condition (65 ± 0.05) and was significantly different from WCA3AHD, the site with the highest percentage of alligators in good or fair condition (85 ± 0.02 ; Figure 3).

Average body condition was different among water years ($p = 0.0001$) but percent in good or fair condition was not. Average body condition in 2002 was significantly higher than average

body condition in 9 years while average body condition in 2006 was significantly lower than 6 years (Figure 4). Average body condition in 2002 the highest year, was 10% higher than body condition in 2006 the lowest year. Only eight percent of the average body condition values by area and water year fully met the target of 2.27 set for Everglades restoration. Of the remaining values, 14 percent were in the low range (poor condition) of <1.95.

Pooling all study areas there were significant decreases in body condition from 2000-2014 ($F=4.171$, $p=0.0441$; Figure 4), but not in percent of animals in good or fair condition. Two areas (ENPSS and WCA3N41) primarily contributed to this downward trend in body condition ($F=3.784$, $p=0.0737$; $F=4.240$, $p=0.0640$, respectively; Figure 5).

Alligator body condition was positively correlated with water year range and fall water depth ($p<0.0001$ and $p=0.0289$, Pearson correlation 0.18 and 0.05, respectively).

The top model was the Current model (Table 2&3; see Table 1 for descriptions). The next closest model was the Full model, but delta AIC was >2 and the top model was 7.5 times more likely than the second model.

Across all models, the interaction between range and fall water depth was the most important variable (1.0) followed by spring and fall water depths (0.99), range (0.96), hydroperiod (0.95) and the interaction between range and hydroperiod (0.95). All other variable importance was < 0.12.

Predictions of body condition using the top model with average values for each environmental variable was 2.12, similar to the actual average body condition for this data set of 2.10. Regression of observed vs predicted values using the top model (Current) was significant ($p<0.001$) with an adjusted $r^2=0.07$.

4.0. Discussion

Alligator body condition was highest throughout the Everglades during the early 2000s and is 5-10% lower now (2014). Values have varied by year, area, and hydrology. Two areas, ENPSS and WCA3AN41 contributed most to the decline and also had highest body condition in the early 2000s (Figure 5). These declines are similar to declines described by Trexler et al. (2012) for fish and crayfish biomass between 1996 and 2012. Trexler et al. (2012) reported five of six sample sites in Everglades National Park, Shark River Slough showing significant declines (average of 9.5%) and five of eight sites in WCA3A showing declines (13.2%). They attributed these declines to a long-term pattern of decreased water flow into Shark River Slough and resulting increased frequency of marsh drying limiting the ability of aquatic fauna populations to recover. There is concern that this represents a slow, multi-decadal decline in prey biomass. This concurrent decline in prey biomass may be contributing to the observed decline in alligator body condition and declines in prey biomass and alligator body condition may be related to observed declines in relative density of alligators within the same study areas (RECOVER, 2014).

Body condition is a measure of the relative “fatness” of an animal and is a reflection of an animal’s ability to cope with its environment. It is related to overall fitness and may affect reproduction. Thus, the 5-10 percent decline in body condition observed in this study may be contributing to decreases in reproduction (decreased number of nests or decreased clutch size) which then could contribute to declining population trends. Though we don’t know the relationship between body condition and breeding in alligators we have some preliminary information that suggests nesting alligators at the beginning of nesting have greater body condition than non-nesting alligators. Body condition of seven nesting female alligators in the

Arthur R. Marshall Loxahatchee National Wildlife Refuge (LOX) in water year 2000 averaged 2.40 (Brandt, unpublished data), almost 10 percent greater than the average for other animals captured that year at that site and for the alligators captured throughout the Everglades that year (both 2.18). In addition, from 2009-2014 body condition of 321 nesting female alligators in Everglades National Park (ENP) averaged 14 percent greater (2.35; Everglades National Park, unpublished data) than values for alligators captured in this study (2.06)). This suggests that breeding individuals may have higher body condition than non-breeding individuals as has been shown in birds. In the lesser kestrel (*Falco naumanni*) below a minimum body condition threshold females had no chance of breeding (Aparicio and Cordero, 2001) and in the blue petrel (*Halobaena caerulea*) an 11% difference was observed between breeding and non-breeding females (Chastel *et al.* 1995).

Alligator body condition is used as a performance measure for Everglades restoration with a full restoration target of an average alligator body condition of 2.27 for each area each year. Of the 90 average body condition values calculated by area and water year in this study, only eight percent fully met the target of 2.27 set for Everglades restoration. Of the remaining values 14 percent were in the low range (<1.95) indicating significant need for restoration. Not only are the values in this study (1.88 to 2.45, average of 2.10, Appendix 1) low for the Everglades, they are generally lower than reported for alligators in northcentral Florida (2.48 to 2.99; Rice 2004) and crocodilians in other areas (For example, averages of 2.16 to 2.39 for *Caiman crocodilus* and 2.30 for *Melanosuchus niger* in Piagaçu-Purus Self Development Reserve, Brazil (Nóbrega, 2013) and 2.30 to 2.70 for adult *Crocodylus moreletti* in Belize (Mazzotti *et al.* 2012).

Our work suggests that the interaction of range in annual water depths and fall and spring water depths as well as hydroperiod are all factors influencing alligator body condition. Range in water depth was included in three of the six most important variables across all of our models (range, interaction of range and fall water depth, interaction of range and hydroperiod) and as an individual variable was one of two correlated with body condition (the other was fall water depth). The Everglades is a harsh environment for alligators because of year round high temperatures and fluctuating food resources. Alligators in the Everglades exhibit slower growth rates, smaller size at maturity, take longer to reach maturity (Dalrymple, 1996, Mazzotti and Brandt 1994), have reduced nesting effort, and lower clutch sizes (Kushlan and Jacobsen, 1990) compared to alligators in other parts of their range. Altered hydrologic patterns that homogenize or exacerbate high or low water conditions make conditions even harsher. Restoration seeks to improve these suboptimal conditions by restoring more natural hydrologic patterns and wetland functions. Fluctuations in water depth are known to affect wetland plant communities and productivity is generally higher in wetlands with fluctuating water levels (Sharitz and Pennings, 2014) while reductions in fluctuations result in more homogenous ecosystems (Bedford et al., 2012). Bedford et al. (2012) state that within wetlands, it is seasonal and long term changes in the depth of water that typically have the greatest impact on the distribution of organisms. While there is considerable evidence for how range in water depth affects plants (Leira and Cantonati, 2008) there are fewer studies that have addressed this for animals. In Everglades National Park, wood stork nest failure was more likely to occur in years with lower hydroperiod amplitude because of less effective concentration of prey fish (Nuttall, 1997). This was also supported by more recent work showing nesting effort for wood storks, white ibises, and great egrets in years when amplitude was high and days of rising water levels were low (Botson and Gawlik,

unpublished data). This relationship supported Botson and Gawlik's landscape availability hypotheses where high wet season (fall) water depths increase inundated marsh area providing more places for aquatic fauna to grow and reproduce (Loftus and Eklund, 1994) followed by low dry season water depths that provide a broad drying front with a continuous supply of shallow water and concentrated prey. Our study suggests that higher range in water depths and higher fall water depths result in higher alligator body condition, possibly via similar mechanisms as described by Botson and Gawlik (unpublished data), though we did not see a correlation of body condition with lower spring water depths. It was somewhat surprising that spring water depth was not correlated with alligator body condition and that the model indicated a positive relationship between spring water depth and body condition. This is counter to our hypothesis that lower spring water depths would lead to higher body condition because prey is concentrated allowing for easier foraging. However, it is important to consider the range of spring water depths that occurred in this study (Appendix 1) and what they represent across the landscape. Gauges are generally in the deepest part of the wetland so values are at the high end of actual conditions experienced by alligators. Actual conditions would include a mosaic of wetter and drier areas providing a range of foraging sites including sloughs, which have average dry season water depths of approximately 0.30 m (McVoy et al., 2011), and wet prairies that are slightly shallower. We defined dry for an alligator as 0.15 m as this is a depth when it becomes harder for animals to move around. It may be that the actual depth at which alligators benefit from prey concentration is greater than what is being reflected in our models. This difference in the scale at which the hydrology was characterized and what is actually experienced by an individual alligator may also help to explain the low amount of variability (less than 10%) explained by our top model. The low amount of variability explain also indicates there are other important factors

we did not consider. In this analysis, we only included food availability implicitly through the construction of models that have hydrologic variables shown to affect aquatic fauna biomass (Loftus and Eklund, 1994, Turner et al., 1999, Trexler et al., 2005). Those relationships are primarily for small fish and may not account for patterns of other potential alligator prey items including larger fish, amphiumas, sirens, turtles, mammalian, or avian prey. In addition, our analysis did not take into account seasonal effects associated with sequences of above or below average wet or dry seasons. It may be that patterns such as dry wet seasons followed by wet dry seasons explain more of the variation. For example in studies by Dalrymple (1996) and Fujisaki (2009), alligator body condition was higher in spring (lower water) than fall, whereas Barr (1997) found body condition highest in fall. Barr (1997) suggested that at least during one of his spring samples (March 1995) water level was as high as it was in the fall sample, so there was no seasonal concentration of prey that year. In addition, differences in temperature may influence patterns of body condition since temperature influences metabolic rate in crocodilians. In Brazil, body condition of small *Caiman latirostris* was positively related to cloacal temperature (Passos et al. 2010). In the Everglades, temperature exceeds the minimum for growth all year (Lang, 1987) which could allow for greater body condition; however, limited food availability may offset any benefit of a year round growing season (Jacobson and Kushlan, 1989).

This study provides additional evidence on the importance of considering fluctuations in water depths when developing restoration plans for the Everglades. The highest correlation between alligator body condition and a hydrologic variable was with range in water depth. In addition, range in water depth was an important component of our top model. The depth over which this range occurs is also important, illustrated by the importance of interaction between range and fall depth. Fluctuations do not need to include complete dry-downs every year. In

fact our data indicate that within the range of spring water depths higher depths were positively related to alligator body condition. Our hypothesis is that dry-downs no more than once every three to five years combined with yearly fluctuations in water depth will provide better conditions for alligators (and aquatic fauna) which will result in increases in alligator body condition, reproduction, and relative density. By gaining a better understanding of how hydrologic patterns such as these affect alligator body condition we are better able to make recommendations on the type of hydrologic conditions that represent a more functioning Everglades ecosystem.

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365 Crespo, Jr.
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555 Table Captions

556 Table 1. Seventeen models used to examine relationship between alligator body condition and
557 hydrologic variables.

558 Table 2. AIC results for seventeen candidate models describing the relationship between
559 alligator body condition and hydrologic variables.

560 Table 3. Parameter estimates and standard errors for the top model (Current) describing the
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562

563 Figure Captions

564 Figure 1. Location of alligator captures 2000-2014 and water level gauge used to represent
565 hydrology for that wetland.

566 Figure 2. Average alligator body condition (Fulton's K using SVL and mass) with standard
567 errors by area across all years (2000-2014) ordered north to south. Areas with different symbols
568 are significantly different.

569 Figure 3. Percent of alligators in fair or good body condition (Fulton's K using SVL and mass)
570 and standard errors by area (ordered north to south) across all years (2000-2014). Alligators are
571 in fair or good condition if body condition is >1.95 . Areas with different letters are significantly
572 different.

573 Figure 4. Average alligator body condition (Fulton's K using SVL and mass) and standard errors
574 across all areas by water year. Years with different letters are significantly different. In
575 addition, there is a significant negative trend across the entire period ($F=4.171$, $p=0.0441$).
576 Water year runs from May 1 of the preceding year to April 30 of the reporting year.

577 Figure 5. Alligator body condition (Fulton's K using SVL and mass) in Everglades National Park
578 Shark Slough (2000-2014) and Water Conservation Area 3A N41 (2000-2012). Both areas
579 showed negative trends ($F=3.784$, $p=0.0737$; $F=4.240$, $p=0.0640$, respectively). Water year runs
580 from May 1 of the preceding year to April 30 of the reporting year.

Table 1. Seventeen models used to examine relationship between alligator body condition and hydrologic variables.

Model	Rationale
Range	Fluctuations in water level are known to affect wetland productivity (Bedford et al. 2012). Higher fluctuations should result in higher productivity and higher alligator body condition. Nuttle (1997) and Botson and Gawlik (In Review) found positive relationships between wading bird nesting success and harmonic amplitude.
Fall water depth	Fall is the wet season and water depths are generally higher. Higher water depths may make it harder for alligators to catch prey because it is more dispersed. Higher fall depths should result in lower alligator body condition.
Spring water depth	Spring is the dry season and wetland water depths recede concentrating aquatic prey which makes it easier for alligators to feed resulting in higher body condition. However, extreme low spring water depths that result in marsh dry out will make it harder for alligators to feed and increase physiological stress resulting in lower alligator body condition.
Hydroperiod (HP)	The number of days that the wetland is wet during the year may affect the amount of time that alligators can forage without expending excess energy. When it is dry alligators have to expend more energy to move around. Shorter hydroperiods should result in lower alligator body condition.
Days since the last dry down (DSD)	The number of days since the last dry event has been shown to affect small fish biomass (Loftus and Eklund 1994, Turner et al. 1999, Trexler et al. 2005) and may help to explain food availability. It takes 3-8 years for fish populations to stabilize after droughts. More frequent dry downs (lower DSD) results in lower fish biomass which should result in lower food abundance and lower alligator body condition.
Days in the last dry down (DIND)	Days in the last dry down is a measure of intensity of the last dry event. Longer dry events have a greater effect on aquatic prey resulting in lower abundance and lower alligator body condition.

Range*HP	Interaction between range and hydroperiod. Areas with shorter hydroperiod but high range may be more stressful for alligators resulting in lower body condition. In addition, they may have lower fish biomass.
Range*Fall water depth	Interaction between range and fall depth. Low fall depths with high range may indicate a more intense dry down resulting in decreased fish biomass, more stressful conditions and lower alligator body condition.
Range and Range*Fall water depth	Years with higher fluctuations should result in higher body condition; however, this may be influenced by fall water depths because higher water depths may make it harder for alligators to catch prey because it is more dispersed.
Range and Spring water depth	Years with higher fluctuations should result in higher body condition; however, this may be influenced by spring water depths because higher spring water depths may make it harder for alligators to catch prey because it is more dispersed.
DSD*DIND	Interaction between intensity and timing of last dry down. Longer more intense dry downs are expected to have a greater effect on body condition because of more stress to alligators and their prey.
Full model	All hydrologic variables are important.
Past	Variables that describe hydrologic conditions that may have occurred in previous water years (DSD, DSIND, DSD*DIND). Previous hydrologic conditions are important in determining alligator body condition.
Current	Variables that describe current year hydrology (Spring depth, Fall depth, Hydroperiod, Range, Range*fall depth, Range*hydroperiod). Current year hydrologic conditions are important for determining alligator body condition.
Abundance	Variables thought to drive abundance of aquatic prey (Hydroperiod, Range, DSD, DIND, DSD*DIND, Range*hydroperiod).
Availability	Variables thought to drive how available aquatic prey is (Spring depth, Fall depth, Range*fall depth).

Abundance& Availability

Variables thought to have strongest influence on availability and abundance of aquatic prey together (Spring depth, Range, DSD).

Table 2. AIC results for seventeen candidate models describing the relationship between alligator body condition and hydrologic variables.

Model	Df	AIC	DeltaAIC	AIC Weight
Current	9	376.11	0	0.84
Full	12	380.15	4.04	0.11
Availability	7	382.38	6.27	0.04
Range*Fall	6	386.68	10.57	0.00
Range and Range*Fall depth	6	386.68	10.57	0.00
Abundance	9	394.09	17.98	0.00
Range	4	399.5	23.39	0.00
Range*HP	6	399.79	23.68	0.00
Abundance and Availability	6	400.94	24.83	0.00
Range and Spring depth	5	401.45	25.34	0.00
Past	6	423.78	47.67	0.00
DSD:DIND	6	423.78	47.67	0.00
Days since Dry	4	425.27	49.16	0.00
Days in Dry	4	427.24	51.13	0.00
HP	4	435.07	58.96	0.00
Spring depth	4	435.24	59.13	0.00
Fall depth	4	436.26	60.15	0.00

Table 3. Parameter estimates and standard errors for the top model (Current) describing the relationship between alligator body condition and hydrologic variables.

	Estimate	Std. Error
Current		
(Intercept)	2.187	0.188
Range	-0.077	0.232
Sph20	0.223	0.111
Fallh20	0.172	0.181
HP	0.001	0.001
Range:Fallh20	-0.588	0.191
Range:HP	0.002	0.001

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.