RECOVER Southern Coastal Systems Performance Measure
American Crocodile Growth and Survival

Last Date Revised: October 2015

Acceptance Status: Approved October 2015

1.0 Background and Justification

American crocodiles rely on estuarine environments characterized by appropriate salinity regimes and freshwater inflows (Mazzotti 1999; Mazzotti et al. 2007; Cherkiss et al. 2011); therefore, crocodiles can be used as an indicator to evaluate restoration success in areas affected by the Comprehensive Everglades Restoration Plan (CERP) (Mazzotti et al. 2009) and are expected to benefit from CERP because of substantial enhanced freshwater flows to Florida Bay and decreased salinities in Florida Bay and Shark River Slough estuaries (USCOE 1999). Although adults are tolerant of a wide salinity range because of their ability to osmoregulate, juvenile crocodiles lack this ability (Mazzotti 1989; Mazzotti and Dunson 1989). Several studies report negative effects of salinity on growth rate in American crocodiles, particularly in hatchlings and juveniles (Ellis 1981, Mazzotti and Dunson 1984; Mazzotti et al. 1986, Dunson and Mazzotti 1989, Mazzotti and Brandt 1994, Richards 2003, Richards et al. 2004). Hatchling crocodiles have higher survival and grow more quickly in salinities between 0 and 20 ppt (Moler 1992; Mazzotti 1999; Mazzotti et al. 2007), and in lab-based studies hatchlings grew quickest at 10 ppt and did not grow in salinities >=30 ppt without access to freshwater (Mazzotti 1983; Mazzotti and Dunson 1984).

Regionally, lack of freshwater has been correlated with lower growth and survival of crocodiles (Moler, 1992; Mazzotti and Cherkiss, 2003; Mazzotti et al., 2007), and in fact for every unit increase in salinity, crocodile growth in total length (TL) per day significantly decreased in animals captured in Everglades National Park (ENP) during 1978 to March 2014 (Mazzotti et al. 2014). Within ENP, crocodiles in northeastern Florida Bay demonstrated lower growth rate relative to crocodiles captured at Cape Sable and Flamingo (Mazzotti et al. 2014; Figure 1.) where salinity regimes are being improved by restoration actions of plugging canals. In addition, between 2004 and March 2014 there was higher crocodile survival at Flamingo/Cape Sable than in Northeast Florida Bay (Table 1).

Increased growth rates ought to result in increased survival rates of hatchling crocodiles by reducing their vulnerability to some predators (Thorbjarnarson 1989). This is important since predation is the primary documented cause of mortality in hatchling and juvenile crocodiles in Florida (Kushlan and Mazzotti 1989).

Because the CERP will affect salinity in habitats occupied by crocodiles, reduced salinity is expected to result in increases in crocodile growth and survival through reduced physiological stress resulting from osmotic regulation in a saline environment and increases in productivity of prey. Lorenz (1999) showed that euryhaline fish biomass was influenced by salinity regime with sites with longer freshwater periods having higher fish biomass (more prey for crocodiles and wading birds) than sites with shorter freshwater periods. Increased growth and survival of crocodiles should ultimately result in an increase in nesting.

Crocodiles are known to nest in four major nesting areas: Biscayne Bay (which includes Crocodile Lake National Wildlife Refuge; CRL), the Florida Power & Light Company Turkey Point Power Plant site (Turkey Point), northeast Florida Bay (ENP) and Flamingo/Cape Sable (ENP) (Figure 2). Although crocodiles continue to be sighted in southwestern Florida and crocodiles have deposited clutches of eggs at the Marco Airport in Collier County since the 1990s, there is currently no evidence of current successful nesting in southwest Florida.

Between 1978 and 2014 Crocodile Lake National Wildlife Refuge has ranged between 0 – 10 nests per year, with an average of six. During this same time the number of nests at Turkey Point increased from 2 in 1978 to 25 in 2014, with a maximum of 28 in 2008.

The total number of crocodile nests observed in ENP increased from 11 in 1978 to 112 in 2014, with a maximum of 138 in 2008 (Mazzotti et al. 2014; Figure 3). Most of the crocodile nesting occurred in the relatively new Flamingo/Cape Sable area, improving from 2 in 1986 to a high of 109 nests in 2008, at an annual rate of 2.34 nests/year. We hypothesize that this large increase in nesting in this area is due at least in part to the plugging of canals in this region which reduced salinity to more natural levels allowing for greater survival. In the historical core area of NE Florida Bay nests increased at an annual rate of 0.64 nests/year from 1978 to 2014. Prior to 1995, 14% of crocodile nests in ENP (N = 174) were located in the Flamingo/Cape Sable area. From 1997 to 2014, 66% of crocodile nests (N=771) were located in the Flamingo/Cape Sable nesting area.

Relationship to Conceptual Ecological Models and Adaptive Assessment Hypothesis Clusters

Crocodiles are an attribute in the Everglades Mangrove Estuaries (Davis et al. 2005) Conceptual Ecological Model. They are also an interim goal, part of the crocodilian indicator used by the South Florida Ecosystem Restoration Task Force and within the Ecosystem Characteristics of Everglades Coastal Wetlands in Relation to Freshwater Inflows Hypothesis Cluster of the Monitoring and Assessment Plan (MAP Section 3.3.10, RECOVER 2009). Evaluation and assessment methods described here are consistent with calculations of interim goals and performance expectations from CERP.

MAP Section 3.3.10: American crocodile juvenile growth and survival. *Growth and survival of juvenile American crocodiles increase when salinity fluctuates below 20 ppt in shoreline, pond and creek habitats of Everglades coastal wetlands. Reduced volume and altered timing and distribution of sheet flow to the coastal wetlands have increased salinity in areas where it previously fluctuated below 20 ppt, resulting in reduced growth and survival of juvenile crocodiles. Restoration of the volume, timing and distribution of sheet flow to conditions consistent with Natural System Model (NSM) outputs would decrease salinity to 20 ppt or less, and thereby increase growth and survival of juvenile crocodiles, throughout extensive areas of the coastal wetlands (RECOVER 2009).*

2.0 Restoration Goals Pertaining to American crocodiles

The restoration goals for American crocodiles that are addressed with the performance measures described in this document are to:

1. Increase crocodile growth to >0.15 cm/day average growth rate of animals captured in the reporting year.

2. Increase crocodile survival to >0.85 mean monthly fall survival during the reporting year

3. Increase crocodile relative density (to be evaluated annually and long-term)

4. Increase crocodile body condition (average body condition of sampled crocodiles in a reporting year)

5. Increase crocodile nesting across all nesting colonies with no decrease in success (to be evaluated annually and long-term)

3.0 Metrics and Targets

As for all CERP documents, "evaluation" refers to comparing CERP alternative scenarios against a restoration target; whereas, "assessment" refers to comparing observed data (current real-world condition) against a restoration target.

Evaluation Metric and Target

Crocodile growth & survival salinity index

This index is calculated for August through December, the period following hatching when hatchlings are most vulnerable to high salinities. The index can be calculated for different areas based on availability of salinity data. If hatchlings survive to December they are generally large enough to tolerate higher salinities and other factors such as food become more important. This index can be calculated for an individual gage or for a cell or cells that have a daily salinity value for the period August through December. Each day is coded based on the daily average salinity value with salinity <20 ppt the highest index score of 1. Salinity ≥20 and <30 ppt a score of 0.6, ≥30 and <40 ppt a score of 0.3, and ≥40 ppt a score of 0 (Table 2). The average score is then calculated for the August through December time period to get the yearly index score. Years can be examined individually or in combination by averaging the annual scores. Higher scores indicate better conditions for crocodile growth and survival. Paleo-adjusted NSM salinity (see below) indicates that at six of seven stations analyzed the average over the 35 years 1965-2000 was ≥0.94 and the median index value was 1.0 (Table 3).

Salinity targets (known as "paleo-adjusted NSM salinity targets") are derived using simulated historical hydrologic conditions with the South Florida Water Management District's Natural Systems Model (NSM) Version 4.6.2 (South Florida Water Management District and Interagency Modeling Center, 2005) and multiple linear regression statistical models to estimate salinity response at all Marine

Monitoring Network stations in Florida Bay (Marshall et al. 2011). The NSM salinity time series values at each Marine Monitoring Network station are then adjusted based on paleo-salinity information provided by U.S. Geological Survey studies in Florida Bay (Marshall et al. 2009, Marshall and Wingard 2012, Wingard et al. 2007, Wingard et al. 2010, Wingard and Hudley 2011). These adjustments provide a more accurate prewater management salinity condition than the unadjusted NSM provides. See the Florida Bay salinity performance measure documentation sheet (http://141.232.10.32/pm/recover/perf_se.aspx) for a map of locations of all Marine Monitoring Network stations in Florida Bay for which paleo-adjusted NSM salinity targets are available.

Assessment Metrics and Targets

Crocodile targets have been developed using data collected since 1978. Which time frame was used for development of targets for each metric depends on availability of data. Sections on crocodile growth and survival are modified from Mazzotti et al. 2009. Growth and survival metrics can be combined into one growth and survival index (see section 4.0 Metric Summarization and Reporting)

1. Crocodile Growth

We used data for all crocodiles captured and measured during studies conducted from 1978–2006 (n = 498; Mazzotti et al. 2007) in Everglades National Park and the Biscayne Bay complex (From Matheson Hammock in the north, to Barnes Sound, including Crocodile Lake National Wildlife Refuge) to establish targets for crocodile juvenile growth. Juveniles were defined as animals < 1.5 m total length (TL). Growth rates are based on changes in total length (TL) for crocodiles marked as hatchlings and recaptured as juveniles. Growth was measured in cm/per day over the longest period between captures for animals recaptured at least once between hatching and 1.5 m TL. We examined the data through the use of quartiles and **the target for juvenile growth is the fourth quartile, >0.15 cm/day (average of crocodiles captured during the reporting year). The fourth quartile represents the highest growth rates which we believe is a reasonable and justifiable target (Mazzotti et al. 2009).**

2. Crocodile Survival

Previous targets were developed for crocodile hatchling survival during the critical fall (August–December) post-hatching period (Mazzotti 1983) by two methods. First, we used the Minimum Known Alive analysis of Mazzotti et al. (2007) to develop a range of possible survival probabilities. In that analysis minimum survival was a direct enumeration of crocodiles known to have survived for at least 12 months. Second, we performed multi-state (size class X management unit) capture-recapture survival analyses (Nichols and Kendall 1995) of all captures (n = 3981) from 1978–2004 using Program Mark (White and Burnham 1999). The best model of fall hatchling survival included a management unit effect, a period effect (dry years vs. wet years), and a management unit X period interaction. This model had an Akaike weight of 0.96, indicating very strong support (Burnham and Anderson 2002). Targets were developed by visual inspection of plots of the mean estimates of survival from the above analyses. Best professional judgement was used to identify the divisions between estimates to be used for stoplight scores. **The target for juvenile survival is >0.85 mean monthly fall survival during the reporting year (average for crocodiles captured during the reporting year).** We are in the process of improving on the calculation of the survival target using additional data collected after 2004 and by evaluating effectiveness of using survival for all non-hatchling size classes (total survival) instead of juvenile survival. Total survival more accurately represents the target population and is very dependent on juvenile survival and thus provides the same information. However, the results of this analysis were not available during the creation of this document.

3. Crocodile Relative Density (Under development)

Currently, the target for relative density of non-hatchling crocodiles is an increase from current rates. Additional analysis is required for this metric and we will explore the use of reference sites or time periods as ways to define more specifically the targets.

4. Crocodile Body Condition (Under development)

We are exploring the best way to set targets for this metric Currently our plan is to use a reference site approach using data from 1978 to 2012 for non-hatchling crocodiles from the Turkey Point Power Plant site, the site that in the past has shown the highest crocodile growth and survival (Mazzotti et al 2007). Additional analysis is required for this metric.

5. Crocodile Nesting (Under development)

The target for crocodile nesting is an overall increase in number of nests (measured annually), with an overall percent success rate (percent of observed nests that produce at least one hatchling) that doesn't decrease. We plan to look at 3, 4 and 5 yr running means using data from 1978 to 2014, to determine the appropriate time period best for assessing changes in nesting. Additional analysis is required for this performance measure.

Restoration of more natural patterns of volume, timing, and distribution of flow should result in an increase in crocodile nesting in areas where it currently and historically occurred along coastal mainland shorelines, islands, and creeks where there is sufficient elevation.

4.0 Metric Summarization and Reporting

Crocodile Growth and Survival Salinity Index (Evaluation)

Yearly index scores are calculated as the average score for the August through December time period. Years can be examined individually (wet and dry years for example) or in combination by averaging the annual scores. Higher scores indicate better conditions for crocodile growth and survival. Values can be plotted and compared by gage or combination of gages for different time periods and different alternatives. Percent change in the index value from base conditions also can be plotted (Figures 4 and 5).

Crocodile Growth and Survival (Assessment)

The two metrics of juvenile growth and survival have been used as part of the overall assessment for crocodilians. That assessment was designed so that in addition to the system-wide crocodilian assessment, crocodiles and alligators could be assessed separately and assessments could be done by geographic area (Mazzotti et al. 2009).

Data for assessments are based on monitoring efforts that allow for capture of hatchlings immediately after hatching (locating and tracking the fate of nests) and capture efforts that occur twice a year (October-December and January-March) in conjunction with surveys for relative density. These capture data also are used to determine body condition.

Surveys for nests are conducted by motorboat, jon boat, canoe, and foot of known and potential nesting habitat during April and May (effort) and June and August (success) for activity (tail drags, digging or scraping) or the presence of eggs or hatchlings. The number and causes of egg failure are noted whenever possible. Hatchlings are captured by hand or tongs and marked by removing tail scutes according to a prescribed sequence (Mazzotti 1983).

Crocodiles also are captured during night-time spotlight surveys of most accessible coastal and estuarine shorelines between East Cape Sable at the western boundary of ENP and the northern boundary of Biscayne National Park (Figure 2). Spotlight surveys follow procedures outlined in Mazzotti et al. (2010). During these surveys crocodiles are captured by hand, tongs or by wire-noose and marked as described in Mazzotti (1983). All crocodiles captured are measured for total length (TL), snout-vent length (SVL) and mass. Additionally, head length (HL) and tail girth (TG) are measured for non-hatchling crocodiles (animals ≥ 65 cm). Crocodile observations and captures are assigned to a size class based on total length (TL): hatchling TL<65cm, juvenile TL 65>150cm, subadult TL 150>225cm, and adult TL>225cm. These data are used for growth, survival, body condition, and relative density metrics.

For annual assessments of growth, scores are assigned to current crocodile juvenile growth (animals captured within the reporting year), mean growth (three-year running average of all captures), and the most recent trend as in Table 4. Assessments are performed by geographic area. In previous implementation of the assessment those geographic areas were ENP Flamingo/Cape Sable and Biscayne Bay Complex-Crocodile Lake NWR. Additional areas such as Biscayne Bay Complex-Biscayne National Park and ENP northeastern Florida Bay can be added as sufficient data are collected. The average of the three scores is the juvenile growth score for each geographic area. This is the growth component score for the geographic area.

For annual assessments of survival, scores are assigned to current crocodile hatchling survival (survival within the reporting year), mean hatchling survival (five-year running average of survival) and the most recent trend as in Table 4. Assessments are performed by geographic area. In previous implementation of the assessment those geographic areas were ENP Flamingo/Cape Sable and Biscayne Bay Complex-Crocodile Lake NWR. Additional areas such as Biscayne Bay Complex-Biscayne National Park and ENP northeastern Florida Bay can be added as sufficient data are collected. The average of the three scores is the juvenile survival score for each geographic area. This is the survival component score for the geographic area.

Each geographic area then receives an overall crocodile score which is the mean of the growth and survival component scores described above (Table 5). Finally, a system-wide crocodile score is calculated as the geometric mean of the geographic area scores.

5.0 Uncertainty

For the evaluation metrics there is uncertainty about how well the individual hydrologic gages from the ENP Marine Monitoring Network represent conditions experienced by crocodiles.

6.0 Sustainability

Yearly monitoring of nests is required to capture hatchlings, as that is the initial capture data needed for the juvenile growth and survival metrics. Seasonal capture efforts (combined with surveys) are needed to obtain subsequent capture data that allows for calculation of juvenile growth and survival metrics as well as relative density and body condition.

7.0 Future Tool Development and Needs

Metrics for growth and survival are established with improvements to calculations of survival underway. Additional analyses are needed to refine metrics for relative density, body condition, and nesting.

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Table 1. Summary of crocodile growth (average for all animals captured) and survival (MKA) among nesting areas (top) and within ENP (below). Data are from 1978 through March 2014. MKA 12 months is minimum known to survive to 12 months. Bolded values are highest values. BBC = Biscayne Bay Complex (which includes Turkey Point), CRL = Crocodile Lake National Wildlife Refuge, ENP = Everglades National Park, NEFL = Northeastern Florida Bay, CAPE = Cape Sable, FLAM = Flamingo.

Nesting Areas

	BBC	CRL	ENP
Mean Growth (cm/day TL) ± SD	**0.110±0.06**	0.105±0.10	0.100±0.10
N	**1091**	800	545
Survival (MKA 12 months)	2.9%	**10.8%**	1.4%
Number of hatchings marked	7083	991	**7560**

Everglades National Park

	NEFL	CAPE	FLAM
Mean Growth (cm/day TL) ± SD	0.084±0.06	0.090±0.03	**0.108±0.04**
N	82	76	**368**
Survival (MKA 12 months)	0.25%		**0.65% (CAPE and FLAM)**
Number of hatchings marked	2445		**5115**

Table 2. Example of spreadsheet calculations used to determine crocodile growth and salinity index values for evaluation of restoration alternative plans. Salinity is from gage data describing the existing conditions base (ECB) model run. Example is from 1965.

				Salinity ppt				Crocodile growth and salinity index (0-1)			
Date	Numeric al Month	Month	Year	Joe Bay	Maderia Bay	Long Sound	Trout Cove	Joe BayCrocIndex2012 ECB	Little Maderia BayCrocIndex2012 ECB	Long SoundCrocIndex2012ECB	Trout CoveCrocIndex2012ECB
8/1/1965	8	8	1965	39.49699	28.64511	30.81166	46.41754	0.3	0.6	0.3	0
8/2/1965	8	8	1965	40.10362	28.11159	31.02775	46.75646	0	0.6	0.3	0
8/3/1965	8	8	1965	37.15006	27.46449	30.78032	47.49497	0.3	0.6	0.3	0
8/4/1965	8	8	1965	35.76708	27.18457	31.01035	45.50388	0.3	0.6	0.3	0
8/5/1965	8	8	1965	35.57756	27.83966	30.98907	44.8871	0.3	0.6	0.3	0
8/6/1965	8	8	1965	35.4203	27.24089	31.1495	46.47947	0.3	0.6	0.3	0
8/7/1965	8	8	1965	35.06145	27.73236	31.16889	47.76197	0.3	0.6	0.3	0
8/8/1965	8	8	1965	34.70768	28.29412	31.97561	47.91975	0.3	0.6	0.3	0
8/9/1965	8	8	1965	36.38584	28.59463	32.21369	49.93529	0.3	0.6	0.3	0
8/10/1965	8	8	1965	37.46262	29.04863	32.91241	50.12758	0.3	0.6	0.3	0
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12/20/1965	12	12	1965	9.650533	18.83401	15.87865	16.07912	1	1	1	1
12/21/1965	12	12	1965	10.75732	20.11543	16.21328	14.47882	1	0.6	1	1
12/22/1965	12	12	1965	8.303665	20.98909	16.21418	12.51566	1	0.6	1	1
12/23/1965	12	12	1965	7.65484	19.87906	16.35708	10.46233	1	1	1	1
12/24/1965	12	12	1965	7.706985	18.16331	16.04606	13.02176	1	1	1	1
12/25/1965	12	12	1965	8.363732	18.36004	16.2142	15.42397	1	1	1	1
12/26/1965	12	12	1965	8.879417	19.36881	17.12753	12.63198	1	1	1	1
12/27/1965	12	12	1965	9.65102	20.0934	17.53645	12.13943	1	0.6	1	1
12/28/1965	12	12	1965	7.653523	19.1302	17.58582	10.14118	1	1	1	1
12/29/1965	12	12	1965	7.280297	18.38955	17.53312	11.14245	1	1	1	1
12/30/1965	12	12	1965	7.569091	17.75489	17.72923	13.05136	1	1	1	1
12/31/1965	12	12	1965	7.935829	17.54594	17.7872	14.24072	1	1	1	1
							Average	0.8	0.9	0.8	0.8
formula for cells using 8/1/1965 Joe Bay as an example- =IF(E2<20,1,IF(E2<30,0.6,IF(E2<40,0.3, IF(E2 >=40, 0))))											

Table 3. Crocodile growth and survival index calculated using paleo-adjusted NSM salinity for 1965-2000 (average, minimum, and maximum index values provided). Joe Bay, Trout Cove, and Little Madeira Bay (green highlight) are the gages closest to current significant crocodile nesting areas. Averages for Existing Conditions Base (ECB) and Future With Out (FWO) are provided for comparison, as well as differences and percent differences between ECB and Paleo-adjusted NSM.

Gage	Average Paleo Corrected Salinity Croc Index	Min Paleo Corrected Salinity Croc Index	Max Paleo Corrected Salinity Croc Index	Median Paleo Corrected Salinity Croc Index	Average all years ECB Croc Index	Average all years FWO Croc Index	Difference between ECB and PaleoCorrected	%Difference bewteen ECB and PaleoCorrected
Little Blackwater	0.94	0.60	1.00	1.00	0.79	0.79	-0.15	-21%
Long Sound	0.99	0.88	1.00	1.00	0.93	0.93	-0.06	-7%
Joe Bay	1.00	0.90	1.00	1.00	0.97	0.97	-0.03	-3%
Trout Cove	0.99	0.90	1.00	1.00	0.90	0.89	-0.10	-10%
Little Madeira Bay	0.96	0.60	1.00	1.00	0.81	0.82	-0.15	-19%
Terrapin Bay	0.80	0.34	1.00	0.80	0.50	0.64	-0.30	-50%
Garfield Bight	0.94	0.57	1.00	1.00	0.65	0.50	-0.29	-35%

Table 4. Criteria used for assessment of crocodile growth and survival (adapted from Mazzotti et al. 2007). The following are the decision rules used to assess status of crocodiles by geographic area and system-wide. Each component is assigned a score and a color based on the criteria below.

1. What is the current growth of juvenile crocodiles (≤ 150 cm) in cm/day for each geographic area in south Florida during reporting year (average of crocodiles captured in the reporting year)?

	Value	Score	Color
a.	0 – 0.068	Score: 0	Red
b.	>0.068-0.15	Score: 0.50	Yellow
c.	> 0.15	Score: 1.0	Green

2. What is the mean growth of juvenile crocodiles (≤ 150 cm) in cm/day by geographic area in south Florida (3-yr running mean of average of crocodiles captured in the reporting years)?

a.	0 – 0.068	Score: 0	Red
b.	>0.068-0.15	Score: 0.50	Yellow
c.	> 0.15	Score: 1.0	Green

3. What is the most recent trend in growth of juvenile crocodiles (≤150 cm) in cm/day by geographic area in south Florida?

a.	- slope	Score: 0	Red
b.	stable	Score: 0.5	Yellow
c.	+ slope	Score: 1.0	Green

The average of the scores for 1-3 is the crocodile growth component score for each geographic area.

4. What is the current survival of hatchling crocodiles (mean monthly fall survival of crocodiles captured during reporting year) by geographic area in south Florida during reporting year?

a.	0 – 0.64	Score: 0	Red
b.	>0.64-0.85	Score: 0.50	Yellow
c.	> 0.85	Score: 1.0	Green

5. What is the mean survival of hatchling crocodiles by geographic area in south Florida (5-yr running mean of monthly survival of crocodiles captured during fall of hatch year)?

a.	0 – 0.64	Score: 0	Red
b.	>0.64-0.85	Score: 0.50	Yellow
c.	> 0.85	Score: 1.0	Green

6. What is the most recent trend in survival of hatchling crocodiles by geographic area in south Florida?

a.	- slope	Score: 0	Red
b.	stable	Score: 0.5	Yellow
c.	+ slope	Score: 1.0	Green

The average of 4-6 is the crocodile survival component score for each geographic area.

Translation table for converting component scores and geographic area scores to stoplight colors.

	Component Score	**Index Value**	**Stoplight Color**
a.	0.0-0.4	Score: 0	Red
b.	>0.4-0.8	Score: 0.5	Yellow
c.	>0.8-1.0	Score: 1.0	Green

The crocodile growth component score and the crocodile survival component score are averaged to get an overall crocodile growth and survival score for each geographic area.

A system-wide crocodile score is obtained by taking the geometric mean of the geographic area scores.

Table 5. Example of scoring for assessment of crocodile growth and survival in one geographic area. See Table 4 for criteria for scores.

Component	Current Value of Metric	Index Score	Metric Value Stoplight Color	Mean Metric Value	Index Score	Metric Value Stoplight Color	Trend	Trend score	Trend Stoplight	Average Component Score	Component Stoplight
Juvenile Growth (cm/day)	0.078	0.5	🟡	0.1	0.5	🟡	-	0	🔴	(0.5+0.5+0)/3=0.33	🔴
Fall Monthly Hatchling Survival (%)	0.787	0.5	🟡	0.766	0.5	🟡	±	0.5	🟡	(0.5+0.5+0.5)/3=0.5	🟡
Mean of crocodile growth and survival component scores (0.5 + 0.33)/2 = 0.41											
Final geographic area Crocodile Index score = 0.41											🟡

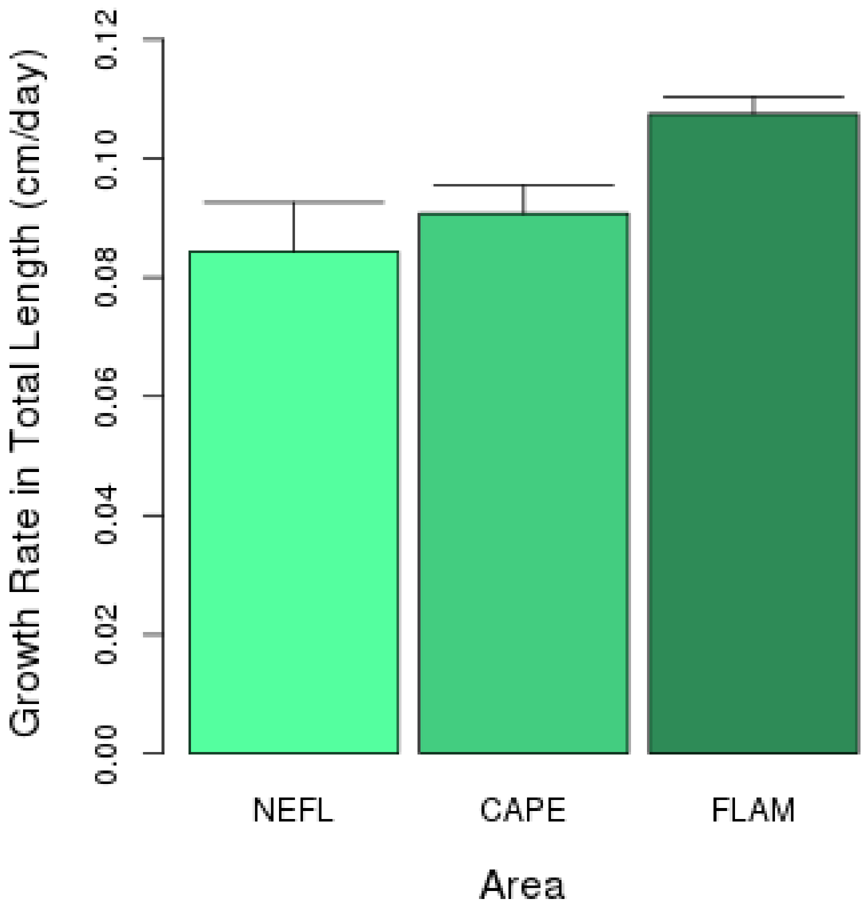

Figure 1. Growth rate in total length of crocodiles caught at major areas within ENP from 1978- March 2014, which are northeastern Florida Bay (NEFL), Cape Sable (CAPE) and Flamingo (FLAM). FLAM had the highest growth rate in total length, and NEFL had the lowest $F_{2,297} = 6.86$, $p < 0.001$ (Mazzotti et al. 2014).

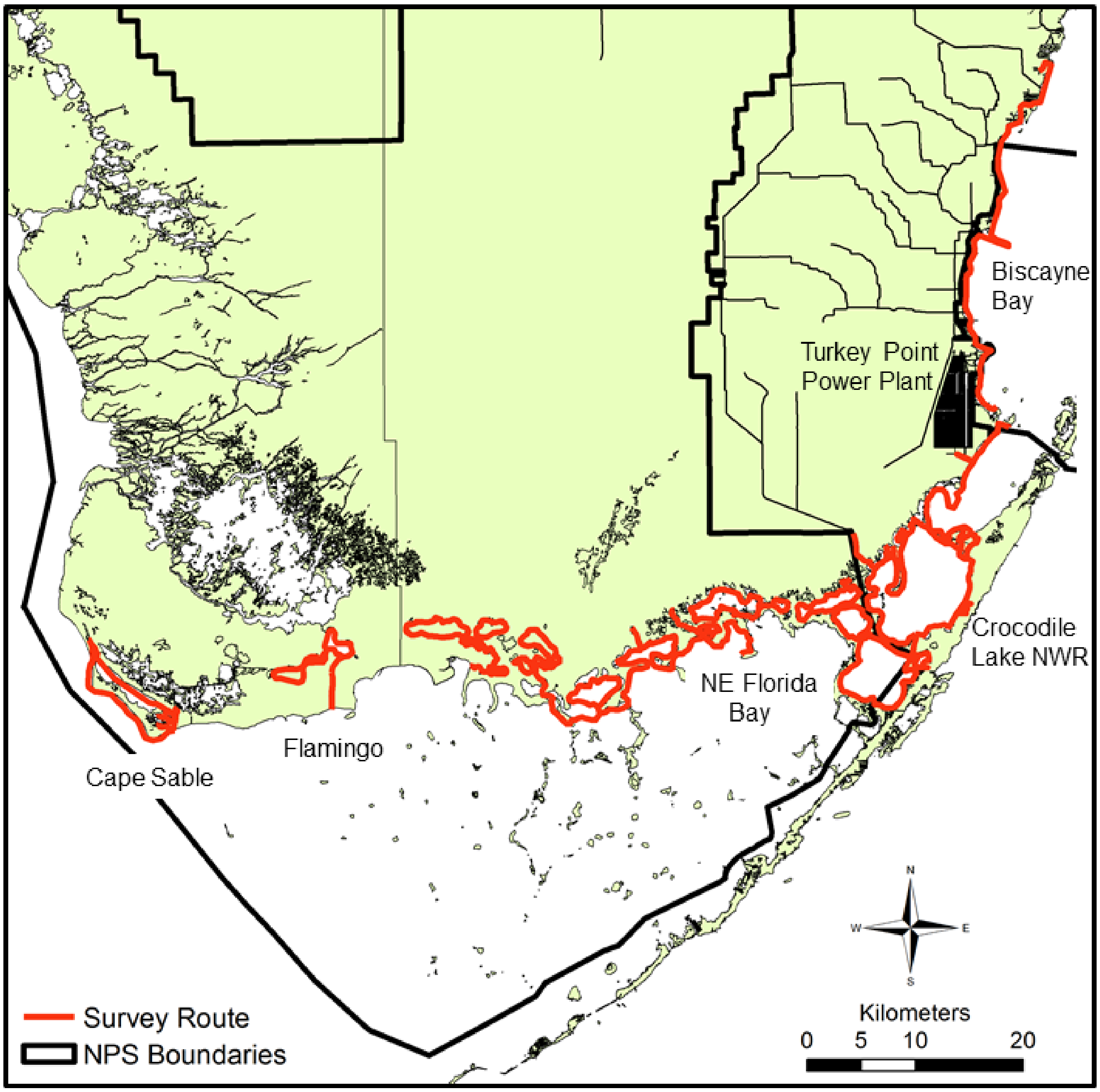

Figure 2. Locations of the four major crocodile nesting colonies and routes for spotlight surveys. Nesting colonies are Biscayne Bay which includes Crocodile Lake National Wildlife Refuge, Turkey Point, Northeastern Florida Bay and Flamingo/Cape Sable.

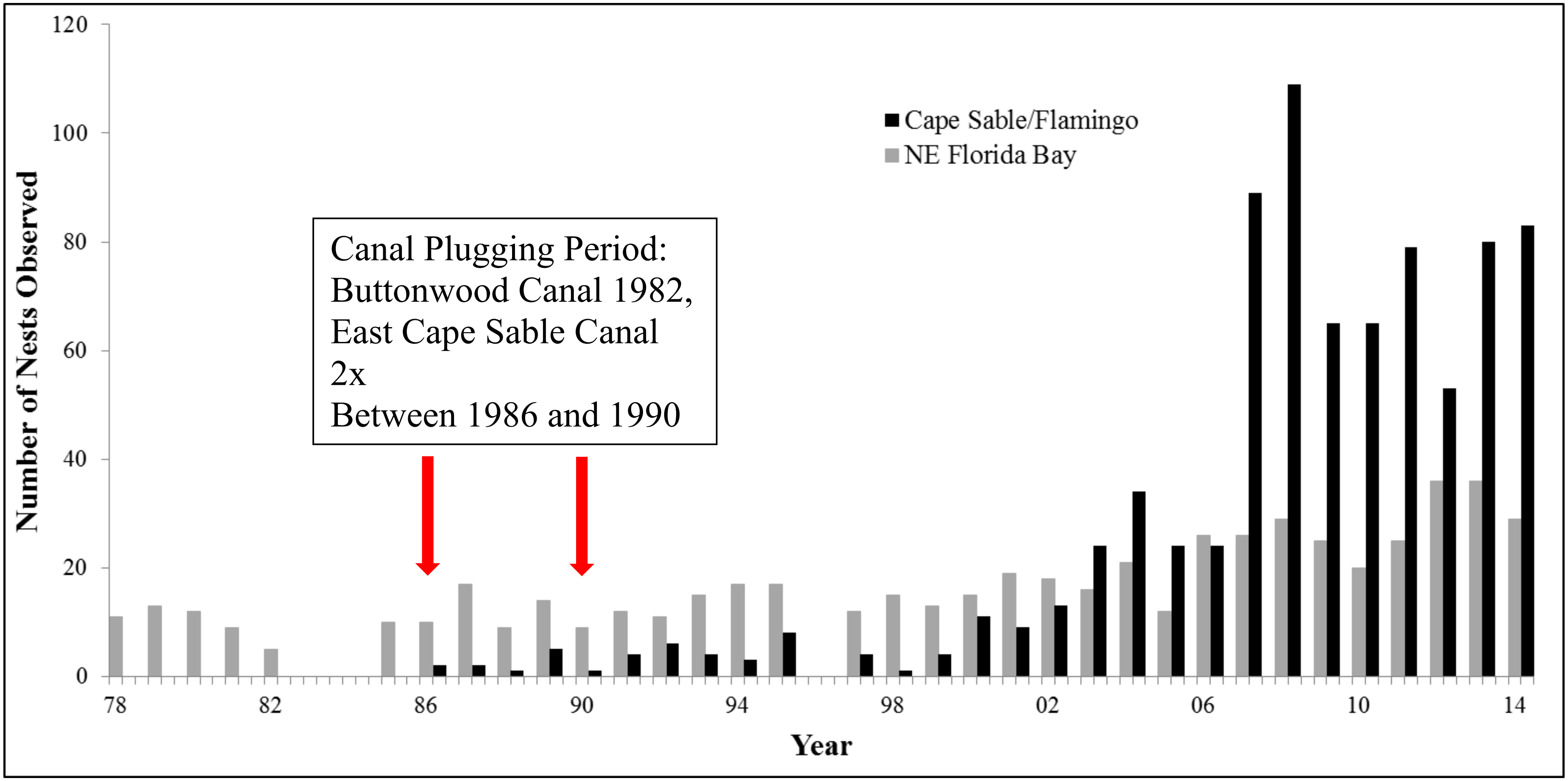

Figure 3. Distribution and abundance of crocodile nesting between NE Florida Bay and the Flamingo/Cape Sable area between 1978 and 2014.

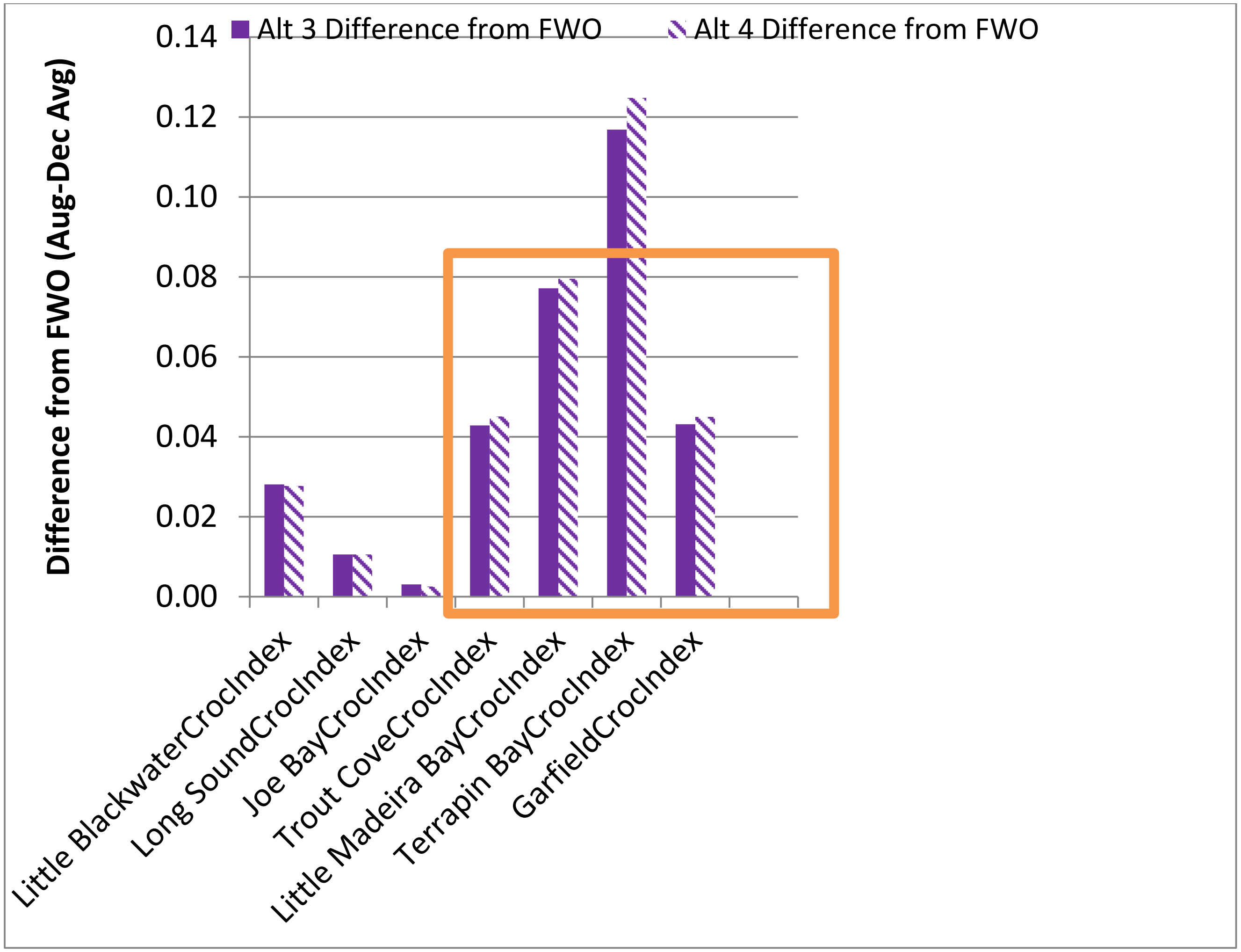

Figure 4. Example of graphics that can be produced using the crocodile growth and survival index for evaluation purposes. This shows the difference from modeled future without (FWO) conditions and average index value across all years used for two Central Everglades Planning Project (CEPP) alternatives. Box indicates sites that currently have higher density of nest sites compared to other sites shown in this graph.

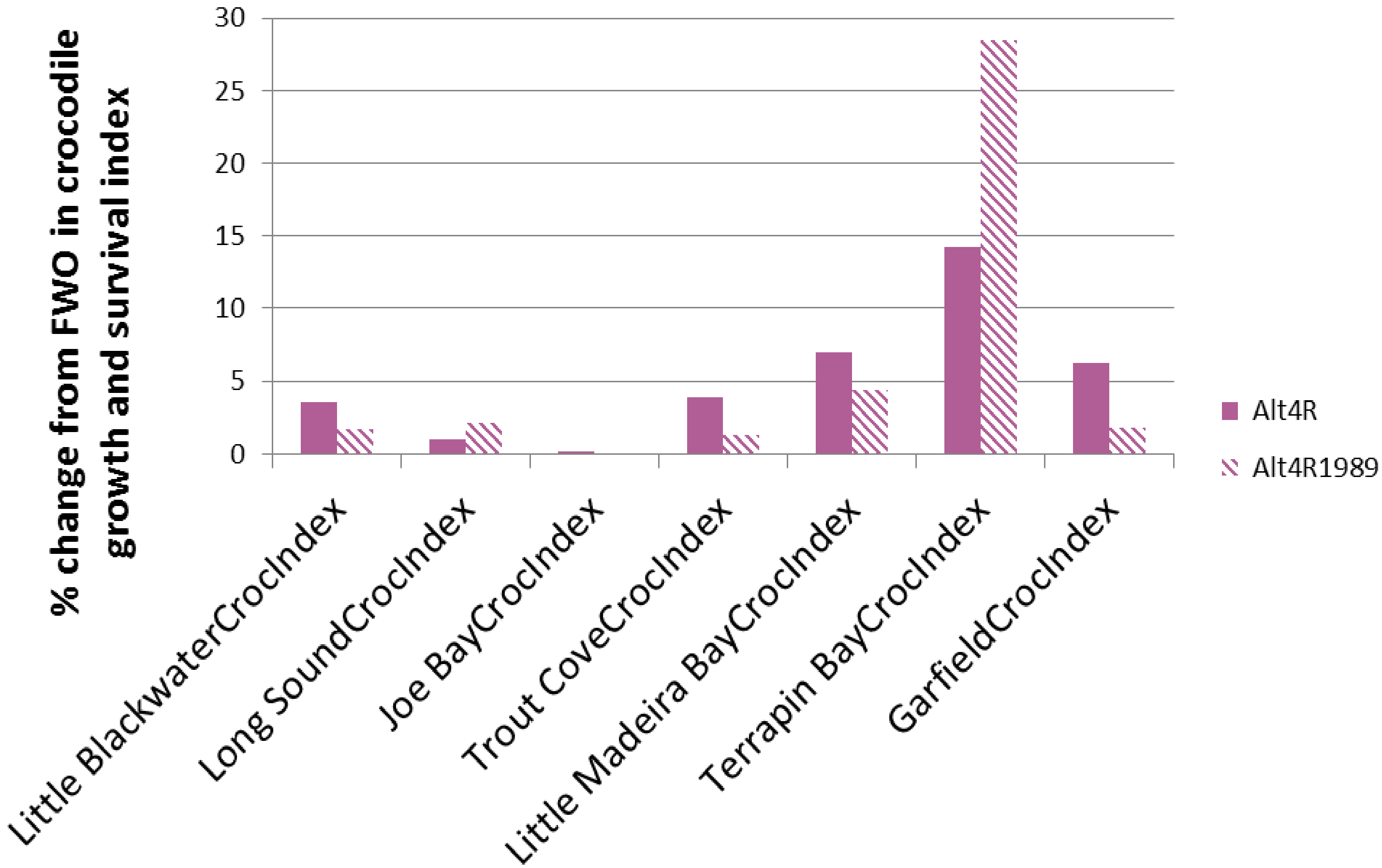

Figure 5. Example of graphics that can be produced using the crocodile growth and survival index for evaluation purposes. This shows the percentage change from modeled future without (FWO) conditions and average index value across all years in the model period of record used for one alternative and a dry year for that same alternative (CEPP Alt4R1989).