Annual Report

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TITLE: Compilation of America Alligator Data Sets in South Florida for Restoration Needs

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PROJECT ABSTRACT

Alligators have been identified as a key component of the Everglades ecosystem. Long-term changes in alligator numbers, nesting effort, growth, condition, and survival can be used as indicators of the health of the Everglades marsh system. Due to their sensitivity to hydrologic conditions, an alligator population model is underway in the ATLSS program to evaluate restoration alternatives.

Evaluating long-term trends and developing population models require a large amount of data collected over a number of years and a number of locations. Information on alligator densities, nesting and growth have been collected in south Florida since the 1950s by rangers and researchers in Everglades National Park and Big Cypress National Preserve, Florida Fish and Wildlife Conservation Commission personnel, University researchers, and private consultants. Many of the most critical data sets (those having the largest amount of data or those from particular areas or years) are not accessible for use in evaluating restoration alternatives or developing models. The data are not available in a centralized, easily accessible, well-documented database. Further, the size and scope of these data sets are not fully known. Certainly, thousands of individual records need to be evaluated, compiled, and entered into an appropriate database.

It is critical that these data sets are accessible to establish restoration targets for alligator populations, develop models, and design short and long-term monitoring tools for evaluating restoration success.

One particular use of historical data is to make assessments of populations in relation to restoration and water management practices in the Everglades. Most life history characteristics are difficult to use to assess restoration progress because it takes decades of data before it can be used. Condition, on the other hand, can be calculated in a relatively simple manner. Condition can be defined as the "relative fatness of [an animal]. . . . it is a measure of how well that animal is coping with its environment" (Taylor 1979). This definition is the key to using alligators as indicators of the health of their environment. Other parameters can be used to assess the health of a population (nesting effort, growth rate and survival, and density and population), but are much more data intensive.

Objectives:

The main objective of the study is to compile, in a format accessible to all researchers, all data collected on alligator numbers, biology, and ecology in south Florida. The data are required to set restoration success criteria, provide input to models being developed to evaluate effects of Everglades restoration on alligators, and to develop short and long-term monitoring protocols for assessing the success of Restoration efforts.

Specific objectives for the project include:

- Compile a list of studies and data sets relating to alligators in south Florida.
- Obtain and compile at least the highest ranking data sets.
- Develop a standardized format for collecting and managing data on alligators.
- Develop a project plan for obtaining the remaining data sets and producing a digital library of historic reports.
- Use the historical data assembled above to develop a method to compare body condition among alligator populations in south Florida both spatially and temporally.

INFORMATION NEEDS AND USES

- We are developing a database that contains information that will be available for scientific information needs of CERP (CERP Information Need 3070-4).
- We are entering historical scientific data and providing access for CERP information needs (CERP Information Need 3070-1).
- This study was designated a critical project for restoration of crocodilian populations determined by a meeting of over 40 biologists, managers, and administrators held in Homestead in December, 1998.
- Alligators are a key indicator component and are used as ecological attributes and measures in the Everglades Ridge & Slough, Marl Prairie/Rocky Glades, Big Cypress, and Mangrove Transition Zone Conceptual Ecosystem Models.

- This study provides information that directly addresses the critical ecological pathways outlined in the Everglades Ridge & Slough Conceptual Ecosystem Model.

- Specific proposed performance measures relate to the alligator such as reduce frequency of water dry-outs during courtship period and duration of below ground water depths to increase alligator nesting and re-establish hydrological predictability for relationship between peak early wet season water levels and late wet season levels to reduce alligator nest flooding.

- This study allows estimation of parameters necessary for an ATLSS American alligator production index and an ATLSS alligator population model for comparison of restoration alternatives during implementation as outlined in South Florida Ecosystem Restoration: Scientific Information Needs by the Science Subgroup of the South Florida Ecosystem Restoration Task Force.

- Condition is an excellent way to measure the health of an ecosystem. The condition factor analysis designed by this study will allow researchers to quickly assess the progress of restoration in the Everglades.

KEY FINDINGS

- Interviews, questionnaires, and discussions with crocodilian biologists and managers in South Florida have been used to identify, locate, and assess availability of historical data sets.

- The most important datasets have been established. Several have been acquired and assimilated into an ACCESS database. Other databases have been identified and are being acquired.

- We have conducted alligator capture and measurements for current alligator condition throughout the Everglades Ecosystem. Animals have been captured from Loxahatchee NWR, WCA 2A, WCA 2B, WCA 3A North, WCA 3A South, Everglades National Park (Shark Slough and estuarine areas), and Big Cypress National Preserve.

- An experiment has been performed using volunteers at Loxahatchee NWR to evaluate the error associated with several morphometric measures for use in condition factor analysis.

PROJECT DESCRIPTION

Purpose and Goals

USGS-BRD and its cooperators are using a system of empirical data collection and simulation modeling to apply information on wildlife community patterns in guiding the restoration process. Through the development of population simulation models based on these empirical data, we can evaluate restoration alternatives and assess restoration performance measures. By applying these models to restoration alternatives and predicting population responses, we can choose the alternatives that result in biotic characteristics that approximate historical conditions and identify future research needs. The benefits to restoration of this project would arise by having more confidence in improved tools, like the ATLSS models, that are used to evaluate alternatives for ecological effects of the Central and Southern Florida Project Restudy, C-111 Project, and Modified Water Deliveries Plan to Shark Slough.

Evaluating long-term trends and developing population models require a large amount of data collected over a number of years and a number of locations. Information on alligator densities, nesting and growth have been collected in south Florida since the 1950s by rangers and researchers in Everglades National Park and Big Cypress National Preserve, Florida Game and Fresh Water Fish Commission personnel, University researchers, and private consultants. Many of the most critical data sets (those having the largest amount of data or those from particular areas or years) are not accessible for use in evaluating restoration alternatives or developing models. The data are not available in a centralized, easily accessible, well-documented database. Further, the size and scope of these data sets are not fully known. Certainly, thousands of individual records need to be evaluated, compiled, and entered into an appropriate database.

It is critical that these data sets are accessible to establish restoration targets for alligator populations, develop models, and design short and long-term monitoring tools for evaluating restoration success.

Historical information provides a suite of useful life history characteristics or population parameters (i.e. health and condition, nesting effort, growth rate and survival, and density and population) that can be used for restoration analysis. However, most life history characteristics are difficult to use to assess restoration progress because it takes decades of data before it can be used. Condition--defined as the “relative fatness of [an animal]. . . . a measure of how well that animal is coping with its environment” (Taylor, 1979), on the other hand, can be calculated in a relatively simple manner. Other parameters can be used to assess the health of a population (nesting effort, growth rate and survival, and density and population), but are much more data intensive.

Objectives:

- Obtain and compile alligator data sets critical for restoration information needs.

- Develop a standardized format for collecting and managing data on alligators.

- Develop a project plan for obtaining the remaining data sets and producing a digital library of historic reports.

- Use the historical data assembled above to develop an index that compares body condition among alligator populations.

Urgency or Timelines

This study provides access to data required for the construction of the ATLSS American alligator population model and other evaluative tools used during adaptive implementation of the Comprehensive Ecosystem Restoration Plan. We also provide other timely investigations involving comparisons of condition of alligator populations in the Everglades. The alligator is both a keystone and indicator species in the Everglades ecosystem. Therefore, it is critical to understand the effects of restoration alternatives on this species and to include the alligator in restoration alternative selection, evaluation, and monitoring.

Effectiveness

- This study allows access to historical data required for ecological modeling and assessment of current and future status of alligator populations that would be otherwise inaccessible.

- This study provides data for parameter estimation in an ongoing ATLSS modeling project.

- We have produced posters and oral presentations to governmental, environmental (both local and international), and educational groups regarding the use of this data in alligator population restoration and management.

- We have used graduate students and university OPS personnel for this study for cost effectiveness and to provide educational opportunities to future researchers and management personnel.

- We provide blood and tissue samples to other ongoing projects on contaminant concentrations, hormonal levels, and blood chemistry of the alligator.

- We have cooperated throughout this project with the Florida Fish and Wildlife Conservation Commission, South Florida Water Management District, the University of Florida, and the National Park Service (both Everglades National Park and Big Cypress National Preserve) to use equipment, personnel, and expertise for alligator capture and data collection especially during peak capture and monitoring periods at no cost to this project.

Synopsis of Research Methods

Alligator populations have been studied in the Everglades ecosystem since the 1950s. Many aspects of alligator ecology have been linked to hydrological conditions during certain periods. However, this data is not accessible to present researchers for the comparative research and ecological modeling required during the restoration process. The following discussion is predicated on the need for comparisons to current populations. Water management practices have resulted in a high and unpredictable rate of nest flooding. Historically, maximum summer water levels were positively correlated with water levels during alligator nest construction. This natural predictability has been lost (Kushlan and Jacobsen 1990). Historically, alligators were abundant in prairie habitats of the eastern floodplain, along the edge habitats of the central sloughs. Pre-drainage occupancy of the deep water, central sloughs was relatively low. Marsh alligator densities are now highest in the central sloughs and canals (Kushlan and Jacobsen 1990) and relatively low in the edge habitats. Canal habitats contain high concentrations of adult alligators. Nest densities are also relatively high on levees and associated spoil islands. Less flooding of nests occurs on these higher elevations. However, survival of young may be very low due to a decrease in the number of alligator holes or possible brood habitat proximal to canals. Modified hydrological conditions might be expected to increase nesting effort, nesting success, and abundance of alligators in the aforementioned edge habitats. There may also be a corresponding increase in the number and occupancy of alligator holes to serve as drought refugia.

Everglades alligators weigh less than alligators of similar size from other parts of their range (Jacobson and Kushlan 1989, Barr 1997). Further, maximum length is decreased, and sexual maturity is delayed (Kushlan and Jacobsen 1990, Dalrymple 1996). Jacobsen and Kushlan's (1989) model for growth in the Everglades of Southern Florida predicted alligators reaching a mere 1.26 meters in 10 years and requiring at least 18 years to reach sexual maturity. It is currently suspected that the reason for this poor condition is a combination of low food availability and high temperatures (Jacobson and Kushlan 1989, Dalrymple 1996, Barr 1997).

Historical Data Sets. -- Managers and biologists in the field of alligator research were consulted to determine which datasets were critical, where they were, and the feasibility of obtaining them. Several databases have been collected and incorporated into an ACCESS database. Further, plans for at least three additional databases are in preparation, including one that is in UNIVAC tape format. The tape will be sent to a data retrieval company to recover the alligator measurements. These numbers will have to be interpreted into actual data and entered into the database. Three databases have been obtained as of this report. They are survey and nesting data from A.R.M. Loxahatchee National Wildlife Refuge, nesting data from the Florida Cooperative Fish and Wildlife Research Unit, and Dr. Kenneth Rice's telemetry database which consists of over 50,000 entries.

Database design – The historical data is being entered into a group of MS Access databases that are arranged in a uniform manner (Figure 1).

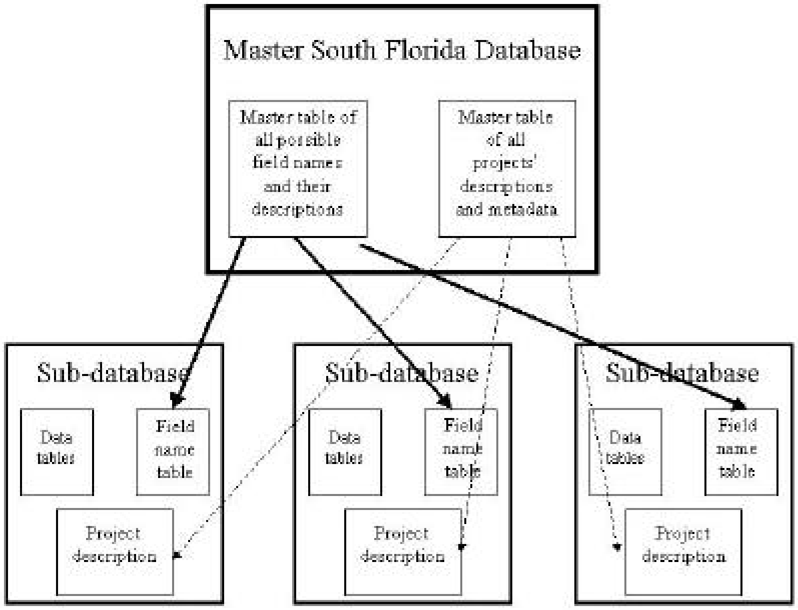

Figure 1: South Florida Alligator database design

Each database consists of a data table, a metadata table, and a field name table. The data table contains only data available from the database. The metadata table provides a description of the project and pertinent collection information such as GPS datum. The field name table includes all field names and their descriptions. One Master database has been created and consists of two tables: a Master metadata table and the Master field name table, which compile all metadata and field name tables into one, easily searchable database. The current Master field name table is available in Appendix I.

Condition. -- The definition of a reasonable "condition factor" is not trivial. This is true in part because our informal evaluations are often normative. Researchers often note that an alligator is too skinny or a 'healthy' size, but those observations are qualitative. Even when applied to individuals within one population these terms are not objectively informative. In crocodilians we tend to believe that fat is good. Amongst crocodilians it is probably true that fatter females do produce larger clutches in a given year; however we have no strong evidence that their lifetime productivity is higher. Furthermore, even when our condition-assessments have been value-free, they have usually been qualitative rather than quantitative. So long as our definitions of condition remain unquantified, we shall confront serious difficulties when we attempt to compare across populations.

Fisheries biologists routinely face the task of evaluating various populations of a target species. Consequently they have been assiduous in their quest for appropriate measures of condition (Anderson and Gutreuter, 1983; Carlander, 1977; Gabelhouse, 1984; Wege and Anderson, 1978). Clearly this analysis has two components. The preliminary problem is to define the condition of an individual animal. The more complex objective is to establish a protocol for comparison across populations.

A graduate student has been employed to develop a body condition factor analysis. Condition factor can be calculated for any organism that has a length and weight associated with it. However, it is only an index and must be further explained with physiological data. Condition factor in fisheries has been backed up numerous times in the literature by destructive total body fat analyses, so that the index is indicative of actual body fat content. In this analysis, the important thing will be to link alligator condition factor with a physiological factor, such as a population parameter or blood component. The graduate student's objectives are to:

- Determine which standard morphometric measures exhibit the least measurement error.
- Determine which condition factor index best discerns valid differences between populations.
- Determine which condition factor index correlates with alligator population parameters or physiological state.

Current data, as well as historical data, will also be used in the condition factor analysis. Alligators are being captured in the spring and fall by a multi-agency team that consists of members from U.S. Fish and Wildlife Service (USFWS), USGS-BRD, UF, and the FWC. Animals are captured from A.R.M. Loxahatchee National Wildlife Refuge (LOX), Water Conservation Areas 2 (WCA2A) , 3 North (WCA3AN), 3 South (WCA3AS), Everglades National Park (ENP)—Shark Slough, and in the estuaries of Florida Bay—ENP. A size limit of four to six feet was originally placed on the catch because of an aging study that ran concurrently with the catch. However, the size range has been eliminated after a preliminary analysis (C.L. Abercrombie, pers. commun.) showed that a larger range in total length is necessary for further study.

Alligators are captured from airboats in marshes and from motorboats in the estuaries. They are located by spotlighting and captured with a noose or toggle dart. Head length, snout-vent length, total length, right hind foot length, neck girth, tail girth and chest girth are measured to the nearest 0.1 cm. Weight is measured to the nearest 0.1 kg. They are sexed and blood was drawn for a concurrent contaminants study. The alligators are then released, unless they are to be sacrificed for the aging/contaminants study.

To define a preliminary condition factor and determine the health and condition of Everglades alligators, we used least-squares regression (LSR) to create a length-weight curve for five separate areas of south Florida (Loxahatchee National Wildlife Refuge, Water Conservation Area 2A, Water Conservation Area 3A North, Water Conservation Area 3A South, and Everglades National Park). LSR (SAS 1988) was run for each area to obtain the required constants for the following ideal mass equation:

$$\text{Mass} = a(\text{SVL}/100)^b,$$

where ‘a’ and ‘b’ are the constants for each area determined by LSR. Snout-Vent Length (SVL) was divided by 100 to scale down mass to a more friendly number.

We calculated ideal mass using a standard set of SVLs and the unique equation calculated for each area. The resultant curves for all populations (SVL vs. ideal mass) were plotted in one graph for comparison. For the Everglades alligators, there was little difference in condition from area to area.

Because our results were insignificant between alligators, we added a ‘length vs. ideal mass’ curve for the American crocodile to broaden our comparison to crocodilians in the Everglades. The crocodile condition curve was significantly higher than that of the Everglades gators (Figure 2).

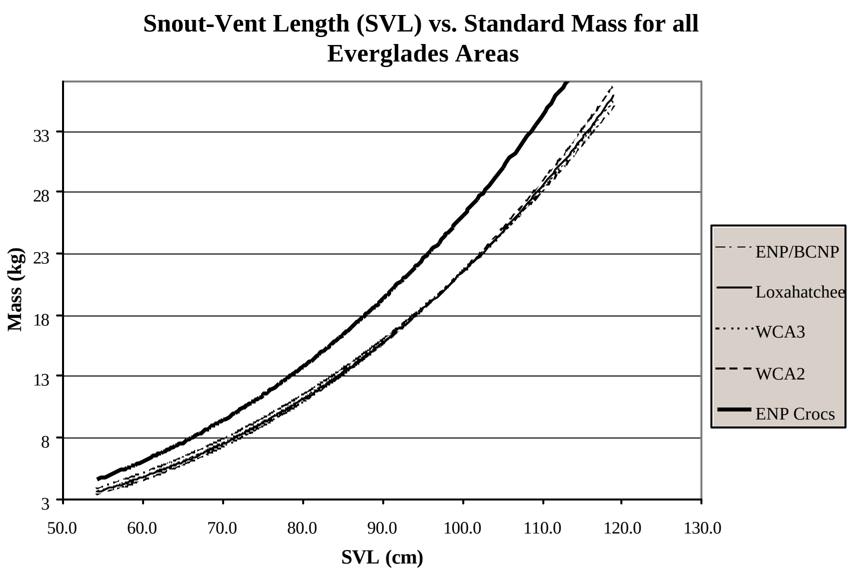

Figure 2: Condition comparison of Everglades alligators and Everglades crocodiles

We also obtained data on several north Florida lakes (Newnan’s, Orange, Woodruff, and Griffin) from FWC (A. Woodward, unpub. data) and one area in South Carolina from the South Carolina Department of Natural Resources (Santee, P. Wilkinson, unpub. data) and calculated SVL vs. ideal mass curves for each data set using the above technique. The Everglades curve was calculated using all data combined from the first analysis. Everglades alligators exhibit reduced body condition in this comparison, as their curve is below all other regions in north Florida and South Carolina (Figure 3)

Snout-Vent Length (SVL) vs. Mass

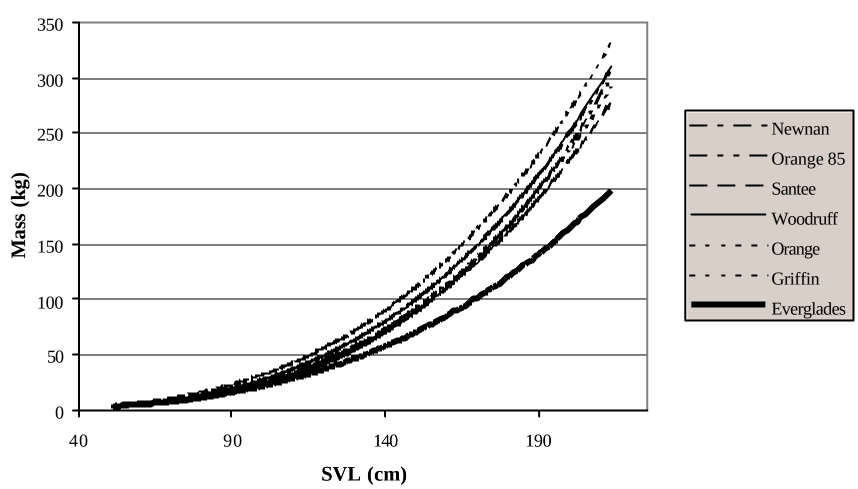

Figure 3: Condition comparison of Everglades alligators to north Florida and South Carolina

One of the most difficult areas of condition-index projects is the accurate determination of mass. This can be especially problematic in remote areas and is particularly difficult for large animals (which must be included in samples if reasonable spectra of "estimated" masses are to be determined). We believe that the condition of a crocodilian can be effectively represented by the animal's length-girth relationship, if error in measurement is minimized. Possible girth measures evaluated include neck, chest, and tail. The LSR analysis from above was run on SVL vs. tail girth and the results are plotted below (Figure 4).

SVL vs. Tail Girth

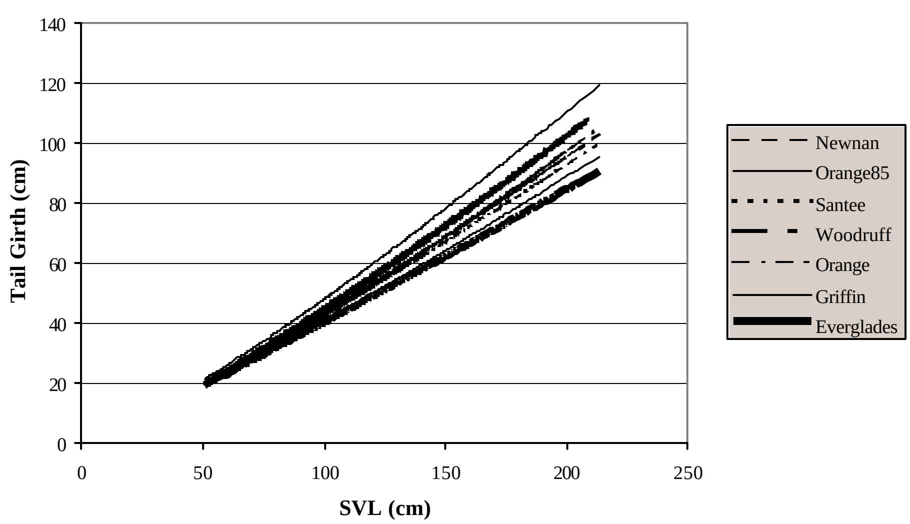

Figure 4: SVL vs. Tail Girth regression to define condition for Florida and South Carolina populations

To determine which body measurement has the least error and would be most appropriate for a condition factor analysis, an experiment was performed using ten alligators captured at A.R.M. Loxahatchee National Wildlife Refuge (LOX) and six groups of volunteers. The volunteers consisted of LOX staff, UF employees, U.S. Geological Survey employees, and students from Palm Beach Atlantic Community College.

Each group was given both verbal and written instructions on how to take correct measurements. All groups measured every gator (head length, snout-vent length, total length, neck girth, tail girth, chest girth, and weight) and the data was entered into a database. It was analyzed using standard deviation to determine which measurement displayed less error from group to group. The experiment will be replicated in October with alligator biologists to confirm the preliminary results and make sure that the associated error was not from inexperience. The biologists will be given the same set of instructions and the data will be treated to the same standard deviation analysis. Preliminary results are available in Appendix II.

Key Results

- A list of historic and current alligator projects and data sets has been compiled by sending a questionnaire to FFWCC, NPS, USFWS, University researchers, and private consultants who are currently or who have conducted research on alligators in south Florida. These are:
  - Dr. James Kushlan's Everglades data.
  - Dr. Brady Barr's food habits data.
  - Dr. Paul Cardeilhac's blood analysis data.
  - Everglades National Park SRF data.
  - Dr. George Dalrymple's capture data.
  - Dr. Franklin Percival's nesting data.
  - Dr. Ken Rice's telemetry data.
  - FWC's survey data.
  - A.R.M. Loxahatchee National Wildlife Refuge's survey and nesting data.
  - Dr. Frank Mazzotti and Dr. Ken Rice's current south Florida catch data.

- Four of these databases have been collected and standardized for storage in MS Access: Dr. Rice's telemetry, Dr. Percival's nesting data, Loxahatchee's survey and nesting, and the south Florida catch data.

- We have conducted alligator capture and measurements for current alligator condition throughout the Everglades Ecosystem. Animals have been captured from Loxahatchee NWR, WCA 2A, WCA 2B, WCA 3A North, WCA 3A South, Everglades National Park (Shark Slough and estuarine areas), and Big Cypress National Preserve.

- A graduate assistant has been hired to perform the condition factor analysis for Everglades alligators.

- An experiment has been performed using volunteers at Loxahatchee NWR to determine the measurement to use in the condition factor analysis that involves the least error.

INFORMATION PRODUCTS

Technical Reports

See www.fcsc.usgs.gov.

Data & Models

All data will be maintained at the USGS-BRD, Florida Caribbean Science Center, Restoration Ecology Branch, University of Florida Field Station, Davie, Florida and the University of Florida's Ft. Lauderdale Research and Education Center in Ft. Lauderdale, Florida. All data requests should be forwarded to Kenneth G. Rice (954-577-6305 or ken_g_rice@usgs.gov).

Publications and Presentations

Abercrombie, C., K. Rice, L.A. Brandt, P. Wilkinson, K.A. Hite, and F.J. Mazzotti. 2000. Claryfing the conundrum of crocodilian condition: telling thick from thin. 15th Working Meeting of the Crocodile Specialist Group, IUCN, Varadero, Cuba. *Poster*.

Mazzotti, F.J., C. Zweig, M. Moller, K.G. Rice, L.A. Brandt, and C.L. Abercrombie. 2000. Historical ecology of the American alligator in Greater Everglades Ecosystem. Greater Everglades Ecosystem Restoration Conference. *Poster*.

Literature Cited and Related References

Anderson, R.O., and S.J. Gutreuter. 1983. Length, weight, and associated structural indices. Pages 283-300 *in* L.A. Nielsen and D. L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Barr, B. 1997. Food Habits of the American alligator, Alligator mississippiensis, in the southern Everglades. Unpublished Ph.D. Thesis, Univ. Miami, Florida.

Carlander, K.D. 1977. Handbook of freshwater fishery biology, volume 2. Iowa State University Press, Ames.

Dalrymple, G. H. 1996. Growth of American Alligators in the Shark Valley Region of Everglades National Park. Copeia. 1996(1): 212-216.

Gablehouse, D.W. 1984. A length-categorization system to assess fish stocks. North American Jorunal of Fisheries Management 4:273-285.

Jacobsen, T. and J. A. Kushlan. 1989. Growth dynamics in the American alligator (Alligator mississippiensis). J. Zool., Lond. 219(2): 309-328.

Kushlan, J. A. and T. Jacobsen. 1990. Environmental variability and the reproductive success of Everglades alligators. J. Herpetol. 24(2):176-184.

SAS Institute Inc. 1988. SAS/STAT user's guide, release 6.03 edition. SAS Institute Inc., Cary, NC. 1028 pp.

Taylor, J.A. 1979. The foods and feeding habits of subadult *Crocodylus porosus* Schneider in Northern Australia. Australian Wildlife Research. 5:385-399.

Wege, J.R. and R.O. Anderson. 1978. Relative weight (Wr): a new index of condition for largemouth bass. Pages 79-91 *in* G.D. Novi9nger and J.G. Dillard, editors. New approaches to the management of small impoundments. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.

Appendix I

tblMasterFieldList

Field	**Description**
Air Temp	Air temperature in C
Area	Area research was done in--LOX,WCA2A,WCA3AN,WCA3AS,ENP-SS,EN
Area Scute Clip	Area designated by a scute cut on the single row--11=LOX 12=WCA2A 13=WCA3AN 14=WCA3AS 15=ENP
Banded	Number of banded eggs
Blastodi	Number of unbanded eggs with blastodisc
Capture Date	Date alligator was captured
Capture Method	Method of capture--either hand, toggle dart, snare, or tongs
Capture Status	Alligator's status at capture--vigorous, etc.
Capture Time	Time alligator was captured in military time
CavDepth	Distance measured from top of nest to top of egg cavity (cm)
Chest Girth	Measured circumfrence of chest just posterior to front legs in cm
ClutchWt	Weight of clutch (g). Badly damaged eggs were not weighed
CollDate	Date of egg collections--mm/dd/yy
CollTime	Time (24 hour) of egg collection
Conditn	Handling and transport conditions (see condition table)
Crew	Names of boat crew-First initials and full last names
Damaged	Number of eggs damaged to the extent that eggs shell membrane has been opened
Deformed	Number of deformed hatchlings or late-term deaths produced by clutch (includes "Pelican Pouch", curved bodies and tails, etc.)
Deformities	Any physical deformities or prominent scars
EarlMort	Number of alligators that died when 1-20 days old
EmbAge4	Age of embryo upon inspection (days)
Embstat	Embryo status upon initial inspection (see Embstat table)
FemBeh	Female behavior (see FemBeh table)
FemSize	Estimated size of nesting female (ft)
FertDead	Number of banded eggs with dead embryo on initial check
Fertile	Number of eggs with band or blastodisc
FertLive	Number of banded eggs with live embryo including killed embryos
Flooded	Number of eggs totally (>half) flooded
Habitat Type	Specific habitat type. 1=Open Water 2=Forested Wetlands 3=Shrubs/Shrub Islands 4=Mixed Emergents 5= Sawgrass Marsh 6=Spikerush Marsh 7=Cattail Marsh 8=Water Lily/Floating Leaved Veg 9=Canal 10=Alligator Hole 11=Levee Break 12=Mangrove Pond 13=Open Slough
HachDate	Date majority of eggs hatched--mm/dd/yy
Head Length	Measure dorsally from tip of snout to center of posterior end of skull in cm

Appendix I continued

Field	Description
Hind Foot Length	Measured ventrally from the first single extended scute posterior to heel to the anterior end of middle toe, not including nail, in cm
Incubat	Inucbation Facility (see IncubFacility table)
Infert	Number of unbanded eggs (not including unbanded eggs with blastodiscs)
InspDate	Date of staging of embryo
Killed	Number of live embryos killed during first inspection
LateMort	Number of alligators that died at 41 days
LiveHach	Number of live hatchlings produced by clutch including weak and deformed hatchlings that lived
Location and habitat description	Describes capture site and dominant vegetation
Maston Age left (yrs)	Age determined by skeletochronology of left front femur
Maston Age Right (yrs)	Age determined by skeletochronography from front right femur
MidMort	Number of alligators that died when 21-40 days old
Moisture	Moistness of nest material--1=Dry, 2=Moist,3=Wet
Muck Depth	Depth of muck in cm
Neck Girth	Measured circumfrence of neck between head and shoulders in cm
Nest	Nest Number
NestDia1	Greatest nest diameter (cm)
NestDia2	Least nest diameter (cm)
NestHT	Straight line distance from bottom to top of nest (cm)
NestMat	Predominant type of nesting material (see NestMaterials table)
NestTemp	Temperature of nest cavity (degrees C)
NonBand	Number of eggs with no band
Notes	Any additional information important to project
NumSet	Number of eggs set after first inspection
OthTurt	Number of clutches of other species of turtle eggs in nest
ParFlood	Number of eggs partially (<half) flooded
Recapture Tag #	Tag number of recaptured animal
Recapture?	A Yes/No field. Has gator been caught previous to this capture?
RedBelly	Number of clutches of redbelly turtle eggs in nest (assume one clutch unless otherwise indicated)
Release Status	Alligator status at release
Sex	Male (M), Female (F), or No Data (N)
Shade	Surface area of nest shaded by overhead vegetation (%)
Status	Nest status at time of collection (see nest status table)
SV Length	Measured ventrally from tip of snout to posterior end of vent in cm
Tag Type	Agency or person who issues tag
Tail Girth	Measured circumfrence of tail at third scute row posterior of rear legs in cm
Tail Scute Clip #	Number designated by scute removal on tail fork, right fork being the hundreds digit, left is the tens, and the singles are the scutes running down the tail
Tclutch	Total number of eggs in clutch

Appendix I continued

Field	Description
Time of Bleeding	Time blood was drawn from alligator
Total Length	Measured ventrally from tip of snout to tip of tail in cm
TurtCK	Check for turtle eggs note on field sheet (yes/no)
UnkFert	Number of eggs with unknown fertility
UnkMort	Date of death of embryo or neonate upon death
UTM Easting	UTM easting coordinates in NAD83, prefaced by 17R
UTM Northing	UTM northing coordinates in NAD83
Water Depth	Depth of water in cm
Water Temp	Water temperature in C
WeakHach	Number of weak or sick hatchlings produced by clutch
Web Tag #	Number on tag placed on web of right hind leg
Weight	Total weight of animal in kg
Year	Nesting Year

Appendix II

Preliminary Results

In all alligators, head length varied less than any other measurement among measuring groups, straight or circumferential. However, within the circumferential measurements, tail girth showed less measurement error than neck or chest girth. Head length, the shortest straight length to measure, showed less variation than other straight measurements (Table 1).

Table 1: Standard Deviation in Alligator Measurements

HL	SVL	TL	HFL	TG	NG	CG	Weight
0.445	1.03	0.986	1.62	1.82	2.21	4.01	4.56

HL = Head Length
SVL = Snout-Vent Length
TL = Total Length
HFL = Hind Foot Length
TG = Tail Girth
NG = Neck Girth
CG = Chest Girth