Webb, G.J.W., Bayliss, P.G. and Manolis, S.C. (1986). Population research on crocodiles in the Northern Territory, 1984-1996. Pp. 22-59 *in* Crocodiles. Proceedings of the 8th Working Meeting of the IUCN/SSC Crocodile Specialist Group, Quito, Ecuador. IUCN: Gland, Switzerland.

Webb, G.J.W., Britton, A.R.C., Manolis, S.C., Ottley, B. and Stirrat, S. (2000). The recovery of *Crocodylus porosus* in the Northern Territory of Australia: 1971-1998. *In* Proceedings of the 15th Meeting of the IUCN/SSC Crocodile Specialist Group, Varadero, Cuba, 15-20 January 2000.

Webb, G.J.W. and Carrillo, E.C. (2000). Risk of extinction and categories of endangerment: perspectives from long-lived reptiles. *Res. Popul. Ecol.* 42 (in press).

Webb, G.J.W. and Cooper-Preston, H. (1989). Effects of incubation temperature on crocodiles and the evolution of reptilian oviparity. *Amer. Zool.* 29: 953-971.

Webb, G.J.W. and Manolis, S.C. (1992). Monitoring saltwater crocodiles (*Crocodylus porosus*) in the Northern Territory of Australia. Pp. 404-418 *in* Wildlife 2001: Populations. McCullough, D.R. and Barrett, R.H. (eds). Elsevier Applied Science: London and New York.

Webb, G.J.W., Manolis, S.C., Whitehead, P.J. and Letts, G.A. (1984). A proposal for the transfer of the Australian population of *Crocodylus porosus* Schneider (1801), from Appendix I to Appendix II of CITES. Report No. 21. Conservation Commission of the Northern Territory: Darwin.

Webb, G.J.W., Manolis, S.C. and Whitehead, P.J. (1987). Preface *in* Wildlife Management: Crocodiles and Alligators. Webb, G.J.W., Manolis, S.C. and Whitehead, P.J. (eds). Surrey Beatty and Sons: Sydney.

Webb, G.J.W., Ottley, B., Britton, A.R.C. and Manolis, S.C. (1999). Recovery of Saltwater Crocodiles (*Crocodylus porosus*) in the Northern Territory: 1971-1998. Unpublished report for the Parks and Wildlife Commission of the Northern Territory.

Webb, G.J.W., Vardon, M.J. and Boeadi (1996). An assessment of the harvest levels and status of three species of reptile (*Varanus salvator*, *Python reticulatus* and *P. curtis*) in Indonesia. Pp. 75-82 *in* Proceedings of the First International Conference on Eastern Indonesia-Australian Vertebrate Fauna, Manado, Indonesia, 22-26 November 1994. Kitchener, D.J. and Suyanto, A. (eds). Western Australian Museum: Perth.

Whitaker, R. and Andrews, H.V. (1996). Snake capture and venom extraction in Tamil Nadu, India. *In* Assessing the Sustainability of Uses of Wild Species. IUCN/SSC Occasional Papers no. 12: 40-46

Woodward, A.R., Schoeb, T., Bermúdez, D., Carbonneau, D., Percival, H.F. and Ross, P. (2000). Unexplained adult mortality and poor egg viability of American alligators on Lake Griffin, Florida: a progress report. *In* Proceedings of the 15th Meeting of the IUCN/SSC Crocodile Specialist Group, Varadero, Cuba, 15-20 January 2000.

Woodward, A.R., Moore, C.T. and Delaney, M.F. (1991). Experimental Alligator Harvest. Final Report, Study Number: 7567. Bureau of Wildlife Research, Florida Game and Freshwater Fish Commission. Gainesville. 118 pp.

SUSTAINABLE USE OF SEA TURTLES

N. Mrosovsky
Department of Zoology,
University of Toronto, Toronto,
Ontario, CANADA M5S 3G5

This note provides a few examples of situations in which use of sea turtles is clearly sustainable. Use may take place at different stages of the life cycle.

Eggs

In the large arribadas (mass nestings) of olive ridleys, few of the many eggs laid survive. In a good-sized arribada at Nancite, Costa Rica, only about 5% of the eggs survive to hatch. About 17% of the eggs laid are destroyed by turtles nesting subsequently; this cause alone may account for a loss of 1.7 million eggs (Cornelius 1986).

In Mexico also, there are some huge arribadas. Egg taking is prohibited. But it still goes on. A recent article by Tennesen (1999), entitled "Mexico's turtle wars: how one country is battling poachers and saving sea turtles", describes with approval how more than 1/2 million confiscated turtle eggs were thrown into the sea to prevent them from being sold. This was just from one truck load; the total destroyed in the season was probably much higher. Surely, with impoverished communities along the west coast of Mexico, and with hundreds of thousands of turtles nesting there, and the associated high natural wastage, there has to be some better way of doing things than dumping protein into the sea.

It may be objected of course that the mass nesting of olive ridleys is unique. But really it is not, it is just an extreme of a continuum. There are other cases where sea turtles nest in sufficiently high densities to destroy eggs laid previously. For instance, on certain beaches in French Guiana, leatherbacks dig up about 10% of eggs laid previously (Fretey and Lescure 1979; see also Girondot and Tucker 1998). Moreover, there are also various causes of egg loss besides destruction by turtles nesting subsequently.

In the Guianas perhaps the main source of egg loss comes not directly from the turtles themselves but from the seas. If one walks along the beaches in the Guianas in the early morning, it is a common sight to see eggs sloshing about in the surf line. In Suriname about 40% of leatherback nests are laid below the high tide line. The figure for green turtles is also high, about 23% (see Mrosovsky 1997). On some of the islands in the Indian Ocean, 3-8% of hatchling green turtles emerge by day when they are decimated by frigate birds (Le Gall et al 1985).

So there are a number of agents of natural mortality. As a general approach, it is a matter of identifying the sources of natural mortality, then saving eggs that would have been lost and allocating some of these for return to the population and others for use. Some of the income derived from the latter can go toward identifying the sources of natural mortality and monitoring the egg harvest. It is really fairly straightforward theoretically.

Adults

Consider the case of green turtles nesting at the protected beach at Tortuguero, Costa Rica. The annual number of emergences of females on an 18 km stretch of beach there is estimated to have increased from something approaching 20,000 in 1971 to close to 60,000 in 1996 (Bjorndal et al 1999). However, the article reporting this almost 3-fold increase warns that this apparently encouraging trend should be viewed with caution. In particular, the worry is that these results concern only the adult female segment of the population; there might not be enough hatchlings and juveniles to sustain this population. On the other hand, without obvious signs of infertile eggs and greater numbers of nesting females, one might reasonably think that more young turtles were being put into the pipeline to adulthood. Without monitoring at earlier stages of the life cycle it is not worth arguing about. But at least the adult females have increased; Bjorndal et al (1999) allow that these results "offer a glimmer of hope". From the point of view of the potential to harvest adults, the situation may be rather more positive. Here are some additional facts, not covered in the article. They concern the estimated take of adults/subadults from the Tortuguero population (see Mrosovsky 2000 for further references and details).

1800/yr Puerto Limon - legal take by fishery
1600/yr Illegal take - conservative estimate

3400 from Costa Rica

plus an unquantified take of thousands from Nicaragua. Lagueux(1998) estimates these as follows:

1991-1996	6000-10,000/yr
1985-1988	1600- 3000/yr
1970's	10,000/yr

Being conservative and taking the lowest of the figures for Nicaragua, that is 1600, and adding this to the figure for Costa Rica, the annual take has been at least 5000/yr for the last few decades. I suspect 10,000 is probably nearer the mark, if one makes more allowance for local use of turtles in Nicaragua and other factors, but 5000 is still an appreciable harvest.

It is not asserted that a take at the level of 10,000 per year is sustainable. That cannot be determined, either way, on the basis of presently available information. And it is not asserted that the protection of nests on the beach at Tortuguero has been unimportant in the increase; it surely has been a major factor. All I am saying is one simple thing: a harvest of adults is not incompatible with an increase in the population. I cannot see how this could be disputed. It does not depend on a population model or any values for growth rates and survival and so on. We need only look at the facts: the nesting population has virtually tripled, *despite* an appreciable harvest at the adult stage. These are facts, not theories.

If Costa Ricans now want total protection, and no harvest, that is their choice. Maybe they have calculated that tourism only will be more economically viable or politically acceptable than continuing the harvest at Puerto Limon. Personally, if I was living in Puerto Limon or Tortuguero, I would prefer the life of a fisherman to that of being in the service industry, making beds and washing dishes for tourists, or being a guide. But if that is what the Costa Ricans want, it is their choice -- and one with which the Nicaraguans should be happy. Likewise, if the Mexicans want to dump protein into the sea, that is their choice.

But I hope the few examples given here are enough to show that, at least in some cases, from a *biological* point of view, some form of harvesting is possible. There are no inherent reasons why some use of sea turtles need drive them to extinction.

Details of harvesting procedures

Of course attention has to be paid to the details. Examples of questions that should be addressed are:

1. Has the harvest of eggs been arranged to avoid sex ratio imbalances? With the laying of several clutches over an extended season, or even all year round in some tropical rookeries, egg harvesting concentrated in months with particular thermal characteristics might introduce demographic biases.

2. What monitoring is in place for an adaptive management approach?

3. If eggs doomed by high tides are to be used, how well can it be predicted on a given beach that particular clutches will be destroyed? In some areas in the Guianas, clutches are often laid in clearly unsuitable places; for these I suspect predictions are fairly accurate, though this needs to be studied systematically. On beaches where it is harder to tell whether a particular clutch is in danger, what would be the consequences of moving all the *potentially* doomed eggs out of reach of the water, thereby increasing the output at this stage for that nesting beach. Then, even without knowing that a given nest will be destroyed or not,

it would still be possible to harvest some turtle eggs without decreasing the total contribution to the population (for further considerations on the use of doomed eggs see Mrosovsky 1997).

4. Have the causes of natural mortality been adequately studied on the particular beach in question? There can be important differences in the ecology of populations of the same species nesting in different parts of the world. For example, in the Indian Ocean as mentioned, frigate birds cause havoc among hatchlings emerging in the daytime. But in the northwestern Hawaiian islands, this does not appear to be a problem: gut contents of frigate birds in this region are devoid of the remains of turtles (Niethammer et al 1992).

5. Is the saving of eggs from one source of destruction going to have substantial effects on the survival of other eggs not originally affected by this source of loss? In some cases this seems unlikely. For instance saving eggs that would have been washed away by the sea, and incubating them in a hatchery would seem unlikely to result in more of the eggs laid on the higher parts of the beach being taken by predators. However, some study might be devoted to these kinds of possibilities.

So I am not advocating some blanket formula or particular numbers and percentages for quotas. Harvesting still needs careful study and adjustment in the light of monitoring.

Conservation philosophy

But -- and here it is impossible to avoid conservation politics -- by and large, the sea turtle conservation community has not devoted much attention to channeling utilization of sea turtles (which has been going on at least since the Greeks and Romans, and still continues), into safe and productive systems. The main emphasis has been on the bad news, and trying to convince the public -- with considerable success too -- that sea turtles are on the brink of extinction. The main thrust has been preservationist, not infrequently featuring the war metaphor, the war on poachers.

The apotheosis of this approach is the burning of hawksbill shell in the Seychelles. At the 1999 Conference on Sea Turtle Biology and Conservation, a resolution was introduced applauding the Government of the Seychelles for their action, and urging every government that harbors populations of hawksbills to take comparable actions (Marine Turtle Newsletter, 1999). This resolution was adopted by a large majority of those present.

The present session is for discussing sustainable use of large reptiles. Burning of natural resources is the antithesis of conservation through use. It is also the antithesis of the World Conservation Strategy, in which the

IUCN has played so large and supportive a role. Given a number of important biological similarities between sea turtles and crocodiles, it is remarkable that the advisory groups to IUCN, the SSC specialist groups for sea turtles (MTSG) and for crocodiles (CSG), have approached the matter of sustainable use so differently (Webb 2000).

In summary, although of course the biology is important, and constrains the details of how utilization could best proceed, it is not the main problem about utilization of sea turtles. Obviously, some use is possible, as it has been in the past. The main matter that needs resolving is the clash of conservation philosophies, and whether one wants to utilize, and is prepared to work constructively on the details, and toward devising simple and conservative procedures, or whether one wants continually to stamp on any promising little shoots of conservation through utilization.

References

Bjorndal K.A., Wetherall, J.A., Bolten, A.B., and Mortimer, J.A. 1999. Twenty-six years of green turtle nesting at Tortuguero, Costa Rica: an encouraging trend. Conserv Biol 13:126-134.

Cornelius, S.E. 1986. The Sea Turtles of Santa Rosa National Park. Fundaçion de Parques Nacionales, Costa Rica.

Fretey, J., and Lescure, J. 1979. Rapport sur l'étude de la protection des tortues marines en Guyane française. Ministère de la Culture de l'Environnement (Paris), 56 pp.

Girondot, M., and Tucker, A. 1998. Density-dependent hatchlings sex-ratio in leatherbacks (*Dermochelys coriacea*) on a French Guiana nesting beach. In: Byles, R., and Fernandez, Y. (compilers), Proc 16th Ann Symp on Sea Turtle Biology and Conservation. NOAA Tech Memorandum NMFS-SEFSC-412:55-57.

Lagueux, C.J. 1998. Marine turtle fishery of Caribbean Nicaragua: human use patterns and harvest trends. PhD thesis, University of Florida, Gainesville.

Le Gall, J-Y., Lebeau, A., and Kopp, J. 1985. Estimation of green turtle *Chelonia mydas* hatchlings on breeding places of Europa and Tromelin (Indian Ocean). Oceanogr Trop 20:117-133.

Marine Turtle Newsletter. 1999. No 85:23-24.

Mrosovsky, N. 1997. A general strategy for conservation through use of sea turtles. In: J Sustainable Use, Vol 1, No 1, Proc Symp on the Sustainable Use of Wildlife Resources, Bali, Indonesia, pp 42-46.

Mrosovsky, N. 2000. Sustainable Use of Hawksbill Turtles: Contemporary Issues in Conservation. Key Centre for Tropical Wildlife Management, Northern Territory University, Darwin, Australia.

Niethammer, K.R., Balazs, G.H., Glynnis, L.N., and McDermond, D.K. 1992. Great frigatebird (*Fregata minor*) predation: not a factor in hatchling green turtle (*Chelonia mydas*) survival at French Frigate Shoals, Hawaii. Colonial Waterbirds 15:128-131.

Tennesen, M. 1999. Mexico's turtle wars. Int Wildlife Nov/Dec.

Webb, G.J.W. 2000. Are all species equal? A comparative assessment. In: Hutton, J. and Dickson, B. (eds), Endangered Species Threatened Convention, Earthscan Publications, London, pp 98-106.

Acknowledgement: Support came from the Natural Sciences and Engineering Research Council of Canada.

Las Técnicas Moleculares en el estudio de las tortugas marinas en Cuba. Resultados y perspectivas

G. Espinosa L[1]., G. Hernández A[1]., R. Díaz F[2]., M. Ramos M[1].

[1]Facultad de Biología, Universidad de La Habana
[2]Centro de Investigaciones Marinas Universidad de La Habana.

Resumen
Se han utilizado varias técnicas moleculares para el estudio de las tortugas marinas, cada una de ellas aplicada a la solución de problemas diferentes. La electroforesis de proteína ha ofrecido poca variación y cuando esta ocurre, la misma está restringida a ligeras diferencias en frecuencias. El polimorfismo de DNA mitocondrial total ha sido también poco informativo, debido a la baja variabilidad genética y poca divergencia entre los linajes de DNA mitocondrial de varias especies de Quelonios. El estudio de la región no codificadora de la molécula de DNA mitocondrial mediante polimorfismo de restricción y secuencia, ha ofrecido información valiosa para la caracterización y conservación de las colonias anidadoras y las áreas de alimentación de estas especies. Se presentan y discuten los resultados de la aplicación de estas técnicas en 2 especies de Tortugas Marinas que anidan y se alimentan en la plataforma cubana *Eretmochelys imbricata* y *Chelonia mydas*.

Introducción
La electroforesis de proteína ha ofrecido poca variación y cuando esta ocurre, la misma está restringida a ligeras diferencias en frecuencias (FitzSimmons, *et al.* 1996) El polimorfismo de DNA mitocondrial total ha sido también poco informativo, debido a la baja variabilidad genética y poca divergencia entre los linajes de DNA mitocondrial de varias especies de Quelonios (Avise *et al*.. 1992). El estudio de la región no codificadora de la molécula de DNA mitocondrial mediante polimorfismo de restricción y secuencia, ha ofrecido información valiosa para la caracterización y conservación de las colonias anidadoras y las áreas de alimentación de estas especies (Bowen *et al.*, 1996; Bass *et al* ., 1996; Diaz-Fernandez *et al*., 1999) .
En el presente trabajo se pretende revisar la utilización de estas herramientas en el estudio de las poblaciones de tortugas marinas que anidan y se alimentan en la plataforma cubana.

Materiales y Métodos.
Para los estudios de DNA nuclear y mitocondrial total se siguió la metodología descrita por Espinosa *et al*. (1999). Se analizó un fragmento de la región de control del DNA mitocondrial mediante PCR y RFLP según la metodología descrita por Espinosa *et al.*, (1998) y PCR y secuenciación según las técnicas descritas por Diaz-Fernandez *et al* . (1999). La secuenciación de la región de control de *Chelonia mydas* se realizó de forma manual según describe Espinosa *et al.*, (1999)

Se analizaron, de la tortuga carey, *Eretmochelys imbricata*, tres poblaciones de alimentación (Isla de Pinos, Nuevitas y Doce Leguas) y el área de anidación de Doce Leguas. De la tortuga verde *Chelonia mydas*, la población anidadora de Playa Antonio de la Región de Guanahacabibes.

Resultados

Se han empleado 4 metodologías diferentes en el estudio de las poblaciones cubanas de *Eretmochelys imbricata*.
En la tabla 1 se muestra, que la variabilidad genética aumenta al utilizar DNA mitocondrial respecto a electroforesis de proteínas y es aun mayor al trabajar con la región de control del DNA mitocondrial. Las tres poblaciones de alimentación, presentan el mismo grado de variabilidad si se comparan cada una de las herramientas moleculares empleadas.
La utilización de la electroforesis de proteínas en los estudios poblacionales de tortugas marinas ha ofrecido poca resolución en comparación con las otras técnicas utilizadas. Sin duda un problema que se presenta, es el bajo número de muestras que se utilizan en la mayoría de los estudios; lo que se debe en esencia a la necesidad del trabajo con muestras frescas.

Tabla 1. Variabilidad genética obtenida empleando electroforesis de proteína, polimorfismo de restricción (RFLP) de DNA mitocondrial total y RFLP y secuencia de un fragmento de la región de control de DNA mitocondrial total.

Area	He*	H (DNA mt.total	Región de Control h	Región de Control Π
	Eretmochelys imbricata			
	Alimentación			
Isla de Pinos	0,109	0,784	0,832	0,038
Nuevitas	0,103	0,657	0,722	0,033
Doce Leguas	0,122	0,639	0,722	0.032
Promedio	0,111	0,693		
	Anidación			
Doce Leguas			0,650	0,024
	Chelonia mydas			
Playa Antonio (Guanahacabibes)			0,649	0,001

*He : heterocigosidad media calculada a partir de 16 loci de proteínas.

Se han encontrados nuevos haplotipos en las 2 especies de tortugas estudiadas en la plataforma cubana.
Para la tortuga carey, *E. imbricata*, en el estudio de PCR y RFLP de 14 haplotipos encontrados el 50% de ellos son nuevos (Hernandez, 1999) y en el de PCR y

secuencia de 28 haplotipos encontrados el 53% son nuevos. Para la tortuga verde, *C. mydas*, de 3 haplotipos encontrados el 75% son nuevos. Este hecho de encontrar haplotipos nuevos en las áreas cubanas, sin duda se corresponde con la gran cantidad de muestras analizadas (N= 379). La mayor parte de los haplotipos se encontraron en las áreas de alimentación, lo que indica la necesidad ampliar el estudio en las colonias de anidación con el objetivo de encontrar su procedencia, aspecto que fue sugerido por Bass *et al* ., (1999). En el área de anidación de Doce Leguas para la tortuga carey, E. Imbricata, también se encontraron 2 nuevos haplotipos. En el caso de la tortuga verde (C. Mydas), a pesar de lo cercano que se encuentra el área de anidación cubana a Costa Rica y Florida se encontraron dos haplotipos nuevos, uno de ellos satisface las condiciones del haplotipo hipotético I, sugerido pr Encalada *et al*. (1996).

Las poblaciones anidadoras estudiadas muestran valores de variabilidad genética comparables con otras colonias del Caribe, estudiadas por Bass *et al* ., 1996 y Encalada *et al*. (1996).

La tabla 2 muestra la contribución de las colonias anidadoras a las áreas de alimentación cubanas, obtenidas por los dos métodos de análisis de los productos de PCR. Los resultados nos indican una fuerte concordancia de los resultados obtenidos por ambas metodologías, quiere esto decir que en el análisis de los fragmentos de restricción puede ofrecer resultados de utilidad a más bajo costo. Ejemplos en esta dirección son referidos por Abreu-Grobois *et al*. (1996).

Esta tabla también permite demostrar la utilidad de los haplotipos de DNA mitocondrial como marcador genético, pues permite identificar las poblaciones que contribuyen a una población mezclada, aspectos que pueden aplicar a otras especies en las que su historia natural justifique un comportamiento similar.

Tabla 2. Contribución de las colonias anidadoras de la tortuga carey (*Eremochelys imbricata*) a las áreas de alimentación cubanas. Los valores se presentan en porciento, a corresponde a la metodología de PCR y Restricción y b a PCR secuenciación

Areas de alimentación	Colonias anidadoras: Cuba a	Cuba b	México a	México b	Puerto Rico a	Puerto Rico b	Otras a	Otras b
Sureste (Doce Leguas)	76	70	24	7	0	12	0	11
Suroeste (Isla de Pinos)	40	46	60	10	0	30	0	14
Noroeste (Nuevitas)	44	42	56	14	0	31	0	13

En cuanto a las perspectivas se han caracterizado loci microsatelites en tortugas marinas (FitzSimmons *et al.*,1995) y se ha demostrado su utilidad como marcador genético en tortuga verde (FitzSimmons *et al* ., 1997), por lo que se impone el ensayo de estos marcadores en la tortuga carey. De acuerdo a los resultados obtenidos también es importante aumentar el número de colonias anidadoras en el área del caribe, tratando de localizar el origen de los nuevos haplotipos encontrados en las áreas de alimentación.

Referencias.

Abreu-Grobois, F.A., A.L. Bass, P.H. Dutton y S.E. Encalada (1996) PCR-RFLP analysis of sea turtle populations in the era of DNA sequencing: Is it still useful? Proceedings of the International Symposium on Sea Turtle Conservation Genetics. NOAA Technical Memorandum NMFS-SEFSC'396. P 55-67.

Avise, J.C., B.W. Bowen, T. Lamb, A.B. Meylan y E. Bermingham. (1992). Mitochondrial DNA evolution at a turtle´s pace: evidence for low genetic variability and redued microevlutionary rate in the Testudines. Mol. Biol. Evol. 9:457-473.

Bass, A.L. (1999). Genetic analysis to elucidate the natural history and behavior of Hawksbill turtles (*Eretmochelys imbricata*) in the wider Caribbean: a review and re-analysis. Chelonian Conservation and Biologoy 3: 195-199.

Bass, A.L., D.A. Good, K.A. Bjorndal, J.I.Ricardson, Z-M. Hillis, J.A. Horrocks y B.W. Bowen (1996). Testing models of female reproductive migratory behavior and population structure ein the Caribbean Hawksbill turtle, *Eretmochelys imbricata* with mt DNA sequences. Molecular Ecology 5:321-328.

Bowen, B.W., A.L. Bass, A. García-Rodríguez, C.E. Diez, R. Van Dam, A. Bolten, K.A. Bjorndal, M.M. Miyamoto y R..J. Ferl. (1996). Origin of hawksbill turtles in a Caribbean feeding area as indicated by genetic markers. Ecol. Appl. 6:566-572.

Díaz-Fernández, R., Okayama, T., Uchiyama, T., Carrillo, E., Espinosa, G., Marquez, R., Diez, C. Y Koike, H. (1999). Genetic sourcing for the hawksbill turtle *Eretmochelys imbricata* in the Northern caribbean egion. Chelonian Conservation and Biology. 3 (2): 296-300.

Encalada, S.E., P.N. Lahanas, K.A. Bjorndal, A. B. Bolten, M.M., Miyamoto y B.W. Bowen. (1996). Phylogeography and population structure of the Atlantic and Mediterranean green turtle (*Chelonia mydas*): a mytochondrial DNA control region sequence assessment. Mol. Ecol. 5:473, 484

Espinosa, G., G. Hernández, R. Díaz, H. Sasaki y F. Moncada (1999). Estudio del polimorfismo proteico y del DNA mitocondrial en la tortuga carey *Eretmochelys imbricata*. Rev. Investigaciones Marinas.

Espinosa, G., A. Robainas, G. Bordón, E. García, M. Ramos, G. Hernández y M. Rodríguez.(1998) Contribution of a nesting colony of Hawksbill turtle *Eretmochelys imbricata* to some feeding grounds in the Cuban platform. 18 th International Sea Turtle Symposium, Mazatlán, México.

Espinosa, G. Hernández m. Jager K. Olavarria N. E. Ibarra M. Masselot and J. Deutsch. 1999. Genetic Identification of a nesting colony of green turtle *Chelonia mydas* from

western Cuban shelf. En Proceeding 19vo Simposio Internacional sobre Biología y Conservación de las Tortugas Marinas.

FitzSimmons, N. N., C. Moritz y S.S. Moore (1995). Conservation and dynamics of microsatellite loci over 300 million years of marine turtle evolution. Mol. Biol. Evol. 12: 432-440.

FitzSimmons, N. N., C. Moritz, C.J. Limpus, J.D. Miller, C.J. Parmenter y R. Prince (1996). Comparative genetic structure of green, loggerhead and flatback populations in Australia based on variable mtDNA and nDNA regions. Pp 25-32 En Proceedings of the International Symposium on Sea Turtle Conservation Genetics. NOAA Technical Memorandum NMFS-SEFSC-396.

FitzSimmons, N. N., C. Moritz, C.J. Limpus, L. Pope y R. Prince (1997). Geographic structure of mitochondrial and nuclear gene polymorphisms in Australian green turtle populations and male-biased gene flow. Genetics 147:1843-1854.

Hernández, G. (1999). Caracterización genética de la tortuga carey Eretmochelys imbricata empleando técnicas moleculares. Tesis presentada y aprobada en opción al titulo de Master en Bioquímica, Universidad de La Habana., Cuba.

Agradecimientos:

Este trabajo forma parte de las investigaciones realizadas a través del Proyecto de Investigación sobre la Tortuga Carey en Cuba dirigido por Elvira Carrillo Cardenas del Ministerio de la Industria Pesquera y del Proyecto Universitario para el estudio de las tortugas Marinas dirigido por Maria E. Ibarra Martín del Centro de Investigaciones Marinas de la Universidad de La Habana.

Problems of success: Conservation consequences of crocodilian-human conflict.

James Perran Ross
Florida Museum of Natural History
Box 117800 University of Florida
Gainesville FL 32601 USA

Michael Cherkiss & Frank Mazzotti
Everglades Research and Education Center
Box 8003 University of Florida
Belle Glade FL 33430

In many countries, crocodilian populations have benefited from several decades of reduced commercial hunting as a result of national protection and the strict controls on international trade imposed by CITES. As a result, some crocodilian populations have increased in numbers, expanded their range back into historically occupied areas and the number of larger individuals has increased. At the same time, humans continually expand into crocodilian habitat. This has led to increasing conflicts between crocodilians and people and their livestock. Living with large predators is an issue that developed world conservationists rarely face, although current concerns over re-introduction of wolves in USA and Europe provide similar problems. In tropical wetland areas, crocodilians historically reached high densities and were a major predator in these systems. By returning some crocodilians to their former abundance, we have resurrected an old and dangerous predator of people- an unexpected result of conservation success.

We have recent reports from many countries indicating that crocodilian attacks on people are perceived to be increasing to unacceptable levels. Current reports include Tanzania where several hundred human attacks each year are reported (Anon 2000); new reports of increased human fatalities in Malawi (CSG 2000b), Madagascar (Behra 1996), South Africa (CSG 1999c), Zambia (CSG 1998); a series of fatal attacks by crocodiles in Costa Rica (Jimenez 1998) and Jamaica (CSG 1999a,); attacks in the tourist resort of Cancun, Mexico (Lazcano 1996), attacks in Gudjarat, India (Kumar et al. 1999) and Sri Lanka (CSG 2000c.). The rivers of Sarawak, Malaysia (e.g. Richie & Jong 1993, CSG 1999b.), and Papua New Guinea (Solmu 1996) consistently report attacks on humans by the large saltwater crocodiles there. In parts of USA, and Australia that have large populations of crocodilians and people, human crocodilian conflict is a continuing concern.

In general, only the larger and fiercer species are involved. The Nile crocodile *Crocodylus niloticus* and the saltwater crocodile *C. porosus* are considered most dangerous, but recent attacks, some leading to human deaths, are reported for American alligator (*Alligator mississipiensis*, Conover & Dubow 1997), American crocodiles (*C. acutus,* Jimenez 1998, CSG 1999a.), Morelet's crocodile (*C. moreletii*, Lazcano 1996), Black caiman (*Melanosuchus niger* CSG 1997) and Mugger (*C. palustris*, Kumar et al. 1999). Human fatalities are usually the result of attack by larger crocodilians of 3 m or greater length and, due to the sexual dimorphism of crocodilians, these are usually large males. However, attacks by smaller

individuals and by females are widely reported. Non-fatal interactions can also be serious to local people, particularly predation on pets and livestock. Even indirect effects can be problematic. In Togo, rare narrow snouted crocodiles (*C. cataphractus*) are undermining water retention ponds with their burrows and threatening development of much needed clean water supplies for humans (Boss 1999). Similar burrowing activity by the Chinese alligator is reported to be one reason why local farmers have a low tolerance for this species, contributing to its current decline (Thorbjarnarson et al. 2000).

But it is human death that really raises local people's anger. Crocodilian attacks are human tragedies, particularly when the result is the death of a child, as is often the case. Attacks are also a serious conservation issue. The usual response of people to an attack is to kill the most obvious large crocodilian present. Ecological studies by CSG members confirm that a proportion of large adults can be removed from a crocodilian population without causing population decline. The sustainable level of removal varies with species and situation but falls between 5% and about 15% of adults and so regulated control measures are compatible with the conservation goal of maintaining crocodilian populations. Of more concern is the fear and hatred of crocodilians that can lead to calls for complete extirpation of local crocodilian populations. People's intolerance for a large predator that eats their children and their valuable livestock will override protective legislation or conservation concerns.

The Crocodile Specialist Group is taking a serious approach to this issue. Future crocodilian conservation success may depend on generating solutions to human-crocodile conflicts. The experience of several countries with long term programs to address the problem is instructive. In Florida, nine fatalities are on record since the mid thirties but non-fatal attacks by alligators are an annual occurrence (Conover & Dubow 1997). A statewide program (Woodward & Cook this volume) designates official 'nuisance alligator trappers' for each county and these are often individuals formerly active in alligator hunting. Nuisance trappers remove and kill about 4,500 alligators a year reported to State authorities by the public. Trappers legally sell the skins and meat to repay their costs and support the program. An active public relations program continually advises the public of the need for caution in alligator habitat, feeding alligators is illegal and high-risk locations are prominently sign posted. The combination of these efforts has created an atmosphere of tolerance for alligators and a general understanding that the real risk of alligator attack is much less than many other common activities, such as contact sports, horse riding, boating, driving etc. Nevertheless, the occasional rare fatality still causes hysterical reaction, swift vengeance on the alligator and the need for careful and sensitive statements by conservation authorities.

In northern Australia, the city of Darwin surrounds an extensive estuary, Darwin Harbor, which used to support a substantial population of saltwater crocodiles. Recognizing the incompatibility of having this particularly fierce crocodile within a large urban area, the authorities have quietly declared Darwin Harbor a crocodile free zone and an aggressive trapping program attempts to remove all crocodiles. Early attempts at translocating crocodiles were frustrated by the well developed homing ability of crocodiles which quickly returned to Darwin after discplacements of up to hundreds of km. This program occurs in the context of a territory wide program that has promoted the recovery of the crocodile population to pre-exploitation levels and an estimated more than 50,000 adults and includes an effective egg collection and ranching program and annual population monitoring. In the Cairns region of northeast Queensland a three year trial crocodile removal program has been implemented (CSG 2000). The area is renown for its swimming beaches and problems arise as people expand activities in crocodile habitat, even though crocodiles remain at low density.

Unfortunately these programs are the exception, and in most locations crocodile attacks remain a growing problem that authorities are poorly equipped to deal with. Conflicts between outcries for the removal of crocodiles and calls to protect these 'endangered' species complicate official action. The elements of successful mitigation of crocodile-people conflicts can be discerned among the current programs:

- Accurate monitoring and record keeping to establish the real extent of the problem.
- Crocodile population monitoring and realistic appraisal of the effects of removal of problem animals.
- Sensible decisions about locations where large crocodile populations are and are not appropriate for public safety.
- Effective and prompt nuisance crocodile control.
- Effective public information to explain both the real hazards and the control program.
- Modifying people's behavior to minimize risk (e.g. not swimming or not washing or drinking and at the water side).
- A system to provide financial support for control activities.
- A public relations campaign to reassure the public.

In the special symposium on this topic at its 15th Working Meeting in Varadero, Cuba, in January 2000 the CSG discussed the available information on both the problem and the solutions. A clear conflict was noted between a calm scientific view of the problem and the emotions that can be easily raised (even among experienced crocodilian biologists) when human fatalities are involved. It was generally agreed that the topic required additional discussion and CSG should develop recommendations and guidelines for general use. When crocodiles and people can live together with minimal conflict, crocodile conservation can succeed.

References.

Anon. 2000. Proposal for amendment of CITES Appendices. Maintenance of the Tanzanian population of *Crocodylus niloticus* on Appendix II. Proposal submitted to the 11th Conference of the Parties.

Behra, O. 1996. Reports of crocodile attacks on people in Madagascar. Crocodile Specialist Group Newsletter 15(3):3-4.

Boss, A. S. 1999. Crocodiles threaten development project. Crocodile Specialist Group Newsletter 18(2):4-5.

Conover M. R. & T. J. Dubow. 1997. Alligator attacks on humans in the United States. Herp. Review 28(3):120-124.

CSG. 2000a. Queensland Trial Intensive Management Area. Crocodile Specialist Group Newsletter 19 (1):11-12.

CSG. 2000b. Crocodile magic kills Malawians. Crocodile Specialist Group Newsletter 19(1):3-4.

CSG. 2000c. Crocodile killers use dogs as bait (Sri Lanka). Crocodile Specialist GroupNewsletter 19(1):10-11.

CSG. 1999a. Woman, 70, killed by crocodile in Jamaica. Crocodile Specialist Group Newsletter 18(4):12.

CSG. 1999b. Killer crocodile caught by villagers (Malaysia). Crocodile Specialist Group Newsletter 18(2):6.

CSG. 1999c. New water scheme to protect people from crocs (South Africa). Crocodile Specialist Group Newsletter 18(1):3-4.

CSG. 1998. Zambia to Kill man-eating crocodiles. Crocodile Specialist Group Newsletter 17(1):8.

CSG. 1997. Black Caiman attack. Crocodile Specialist Group Newsletter.16(3):11-12.

CSG.

Jimenez, Y. L. 1998. Crocodile attacks cause conservation crisis. La Nacion, San Jose Costa Rica, translated and reprinted CSG newsletter 17(3):8-9.

Kumar, V. V., R. Vayas & B. C. Choudhury 1999. Status of mugger in Gujarat State (India). Crocodile Specialist Group Newsletter 18(2):7-8.

Lazcano B. M. A. 1996. Crocodile attacks in Cancun (Mexico). Crocodile Specialist Group Newsletter 15(4):18-19.

Richie J. & J. J. Jong. 1993. Bujang Senang, terror of Batang Lupar. Samasa Press Kuching, Sarawak.

Solmu, G. 1996. Another attack in PNG. Crocodile Specialist Group Newsletter. 15 (1):8.

Thorbjarnarson J. Xiaoming Wang & S. T. McMurry. 2000. Conservation status of wild populations of the Chinese alligator. Report to the Anhui Province Forestry Service, Wildlife Conservation Society, NY.

Nuisance-Alligator (*Alligator mississippiensis*) Control in Florida, U.S.A[1]

Allan R. Woodward and Barry L. Cook
Florida Fish and Wildlife Conservation Commission
4005 South Main Street
Gainesville, Florida 32601, U.S.A.

Abstract – Recovery of the American alligator population, following depletion during the 1960s, led to an increase in alligator complaints and attacks on humans in Florida during the 1970s. To reduce the risk of attacks and decrease the costs of handling a burgeoning nuisance alligator, Florida implemented a program in 1978 that used privately contracted trappers to harvest problem alligators. Trappers were compensated for their time and expense through the sale of skins and meat. The frequency of attacks has remained stable since 1977 and the rate of attacks per million Florida residents has shown some evidence of a decline. Costs to the State of Florida of removing alligators are about 25% of the costs of other removal options. Recent modifications in the program are designed to be more pro-active in removing nuisance alligators in areas with high risk of attacks.

The population recovery of American alligators (*Alligator mississippiensis*), after being classified as endangered during the 1960s and 1970s, has been hailed as one of the endangered species success stories. However, this recovery has not been without complication. The frequency of attacks increased in Florida during the early years of population recovery (Hines and Keenlyne 1976, Fig. 1), eliciting a considerable amount of negative public opinion. In general, Floridians accept alligators in wild areas, but do not tolerate them in residential areas (Hines and Scheaffer 1977, Responsive Management 1996). Thus, the full restoration of alligator population is difficult to achieve in Florida. The conservation strategy for most crocodilians is to restore populations to natural levels in historic habitats. However, this may not be feasible for large, aggressive crocodilians in areas with heavy human populations (Pooley et al. 1989). Frequently, restoration efforts pit absentee stakeholders (those that do not live in close proximity to crocodilians but desire their protection) against resident stakeholders (those that live in close proximity to crocodilians and have to bear the associated risks and economic damage). In these situations, it may be necessary to strike a balance by reducing crocodilian population densities in high risk areas and removing selected problem animals, while maintaining viable populations. Florida developed a nuisance alligator control program in the late 1970s that was founded on this principle and continues to operate today (Hines and Woodward 1980, 1981). In this paper, we discuss the rationale for the program, summarize some of the operational procedures, evaluate its effectiveness, and discuss some of the more important considerations when developing and running such a program.

[1] Presented at the 15th Working Meeting of the Crocodile Specialist Group in Varadero, Cuba, 17-20 January 2000.

We thank Henry Cabbage for providing summaries of alligator attack data, Linda Harrison for compiling alligator complaint data, and Harry Dutton for providing comments and reviewing the paper.

Rationale for Nuisance Alligator Control

Some early explorers and writers alluded to the ferocity of alligators (Van Dorn 1928, Kellogg 1929) but few substantiated accounts of alligators biting or killing humans can be found prior to the 1970s. Although alligators, are one of the largest crocodilians (large males are typically 3.5-4.0 m and 250-350 kg), naturalists during the early part of the 1900s considered alligators relatively harmless (Audubon 1931, McIlhenny 1935:47, Barbour 1944:178, Neill 1971:251). Only sketchy accounts of attacks can be found prior to 1948, when a woman was severely bitten by an alligator while swimming in the Weeki Wachee River in central Florida (Carle 1948). Although several alligator attacks occurred during the 1950s, the frequency of attacks did not increase markedly until alligators received protection from the Lacey Act in 1970 (Hines and Keenlyne 1976, 1977) and populations began to recover throughout Florida (Hines 1979, Woodward and Moore 1994). Since 1970, 177 unprovoked alligator attacks have been documented in Florida, of which 99 have been severe and 9 have been fatal (Fig. 1). Alligators also attack and eat domestic livestock and pets, cause damage to commercial fishing gear, and create traffic hazards when crossing roads (Woodward and David 1994).

Increasing concern by the public as to the danger of alligators, a 6-7% annual increase in the human population of the state (most of whom migrated from northern states and were unfamiliar with alligators) (Anon. 1998), an increased desire for waterfront living, and a >5% per year increase in the alligator population (Woodward and Moore 1994) combined to create an exponentially increasing probability of human-alligator encounters. Complaints about problem or "nuisance" alligators increased considerably in the early 1970s (Schemnitz 1974) and, by 1975, the Florida Game and Fresh Water Fish Commission (GFC), presently called the Florida Fish and Wildlife Conservation Commission (FWC), was responding to about 5,000 complaints per year and translocating 2,000 alligators (Hines and Woodward 1980). At that time, the Florida population of the American alligator was classified as endangered, and management options were limited to live-capturing and translocation. Most complaints were handled by wildlife officers, who were diverted from more important but less urgent law enforcement activities. The cost of dealing with nuisance alligators in 1975 was estimated to be

$250,000 (equivalent to $800,000 in year-2000). Live capture is not as effective as killing when removing alligators and, therefore, alligators were not always able to be removed expeditiously. Captured alligators were typically moved to more remote areas where it was hoped that they would not cause further problems. However, this created other potential problems by placing tame or potentially aggressive alligators in areas where they would be unexpected by recreationers and sportsmen. In many cases, existing populations in wild areas were nearing carrying capacity and the addition of new, large alligators caused the displacement of existing alligators. Further, translocated alligators have strong homing tendencies (Murphy and Coker 1983) and frequently returned to their original removal sites, causing additional problems on their return journey.

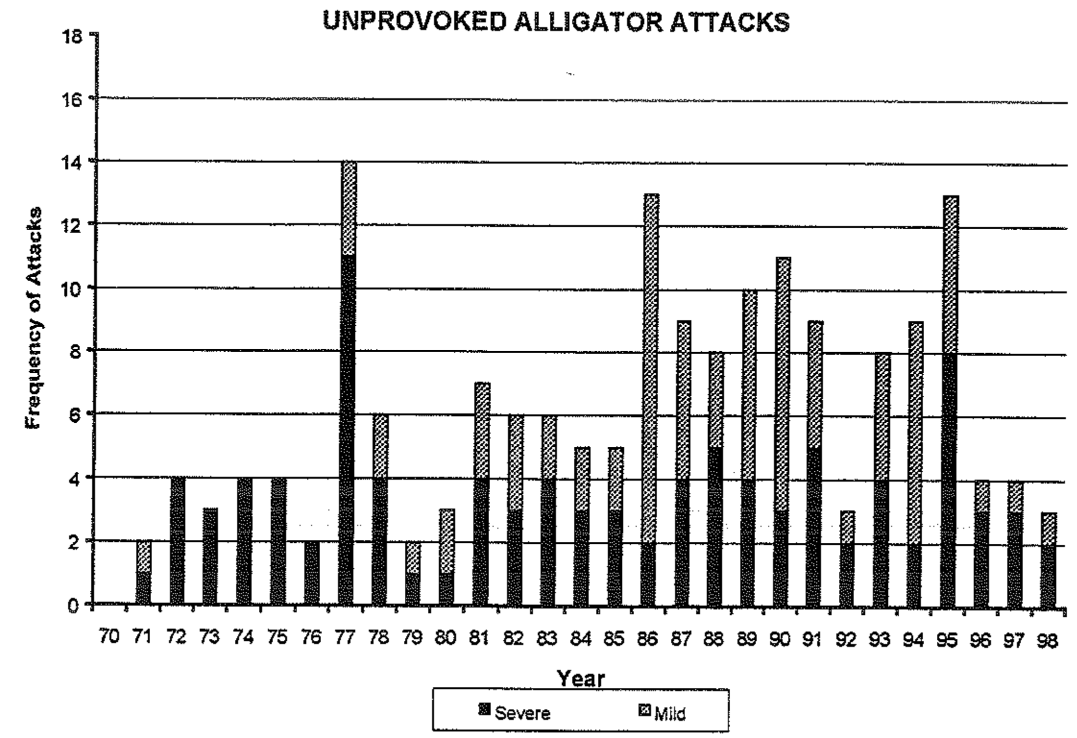

Figure 1: Frequency of severe and mild alligator attacks on humans in Florida during 1970-1998.

The GFC, as Florida's wildlife management agency, found itself in a somewhat paradoxical role of trying to ensure the recovery of Florida's alligator population while providing an acceptable level of public safety. For these reasons, the alligator research project was charged with developing a nuisance alligator control program that would increase the efficiency of removing nuisance alligators, reduce

agency costs, and stabilize or reduce the risk of attacks while maintaining viable alligator populations in all suitable habitats.

Nuisance-Alligator Program

Hines and Woodward (1980) tested several management options for dealing with alligators. Two of the approaches involved killing nuisance alligators and selling their skins. Therefore, to conduct the study, the Florida population of the American alligator had to be reclassified from endangered to threatened. The use of contracted private agents working under the supervision of GFC biologists to remove alligators proved to be the most effective approach (Hines and Woodward 1980, 1981; Woodward et al. 1987). With this approach, agents used their own money and resources to remove nuisance alligators and recouped their costs through the sale of skins. The GFC legally owned the skins and sold them through a sealed-bid auction. Agents were distributed 70% of the proceeds and the state kept 30% to defray administrative costs. This approach was the most cost-effective approach for several reasons: (1) Agents had a financial incentive to remove the problem alligator as soon as possible and take good care of the skin; (2) The costs to the GFC were 25% of what it would have cost to do the task internally; and (3) The 30% retention of proceeds covered a substantial portion of the program's administrative costs.

In Florida, alligators ∃1.2 m total length (TL) that are presenting a danger to humans or their pets, livestock, or property are considered as nuisances. Alligators <1.2 m rarely have been involved in unprovoked attacks. Further, small alligators have relatively little commercial value and harvesting them would not be economically feasible for private trappers. Obviously, alligators that have bitten or attacked humans or domestic animals are considered nuisances. However, this classification extends to alligators that behave in a manner that might lead to attacks. This may include alligators that have shown no wariness of humans or that have frequented areas that placed them in close proximity to humans or domestic animals. Usually, alligator complaints can be effectively evaluated by a trained telephone operator and a decision can be quickly rendered on the validity of the complaint. However, a small percentage of complaints, such as those that occur in wild or protected areas, require more thorough evaluations. In these cases, a nuisance alligator program coordinator questions the complainant and other individuals with a stake in the proposed removal. If the situation is still unclear, the coordinator may request a wildlife officer or wildlife biologist to go on-site and provide an evaluation. In cases where trappers find nuisance alligators to be <1.2 m, alligators are usually live-captured and translocated.

Several important policies formed the basis for the general operation of the program as it was originally set up: (1) Complaints had to originate from the public or from government officials (i.e. park or refuge managers) - trappers were not allowed to generate complaints; (2) Complaints had to be directed to GFC regional offices for evaluation; (3) If a complaint was considered valid, the trapper could not remove an alligator until receiving authorization from GFC staff; (4) Trappers were permitted to take only specific targeted alligators within a specific area; and (5) All alligators taken had to be tagged within a set amount of time with a designated tag.

Since the inception of the nuisance alligator program in 1978, several modifications have been made. Meat sales were allowed in 1980 to help defray removal costs (Hines and Woodward 1981). In 1988, the ownership of skins was transferred to trappers immediately upon taking the alligator (Jennings et al. 1989). Ownership and marketing of skins is risky because they are perishable and markets fluctuate. Therefore, the GFC opted to transfer ownership to trappers at the time of taking and leave the responsibility of skin storage, marketing , and sale to the trappers. To defray administrative costs, the GFC required trappers to purchase an annual alligator trapping license ($250) and pay up to $30 to have each skin validated with a CITES tag. This worked well when skin prices were >$5/cm. However, when skin prices dropped during the early 1990s, trappers had a difficult time achieving adequate compensation, and the GFC subsequently reduced validation fees for alligator skins <2.1 m to $15. Continuing poor skin prices during the mid-late 1990s necessitated the reduction of validation fees for all skins to $5 in 1998. Since 1998, the FWC has identified open permit areas where chronic dangerous situations occur, such as in high-use water recreation areas, fish camps, boat ramps, public parks, and refuges. Nuisance-alligator trappers are allowed to monitor these areas for potential nuisance alligators in a more proactive effort to preclude attacks.

Current Procedures for Dealing with Problem Alligators

Nuisance-alligator complaints are received by radio dispatchers at five FWC regional offices. A toll-free line is provided in each region to facilitate filing of complaints. After complainants are questioned by agency personnel, frivolous and otherwise unwarranted complaints are dismissed. When complaints arise about alligators <1.2 m TL, FWC staff explain to complainants that they are not dangerous to humans. If complainants insist on having small alligators removed and alligators are causing damage (typically eating ducks or fish), wildlife reservists (volunteers) or wildlife officers are assigned to capture and translocate the alligators. When a nuisance alligator is confirmed by FWC staff, a permit is issued to a nuisance-alligator trapper, and the trapper is expected to make a concerted effort to remove the alligator. This may mean making multiple trips and using different methods to capture the alligator. Less than half of permits issued to take nuisance alligators are filled because problem alligators are either too small (<1.2 m), cannot be found, or cannot be trapped. In all, approximately 33% of

complaints result in the taking of an alligator (Fig. 2). The nuisance alligator trapper is expected to operate discreetly and to present a favorable image to the public. Therefore, trappers are required to capture and remove alligators alive to avoid the negative publicity of killing alligators in front of bystanders.

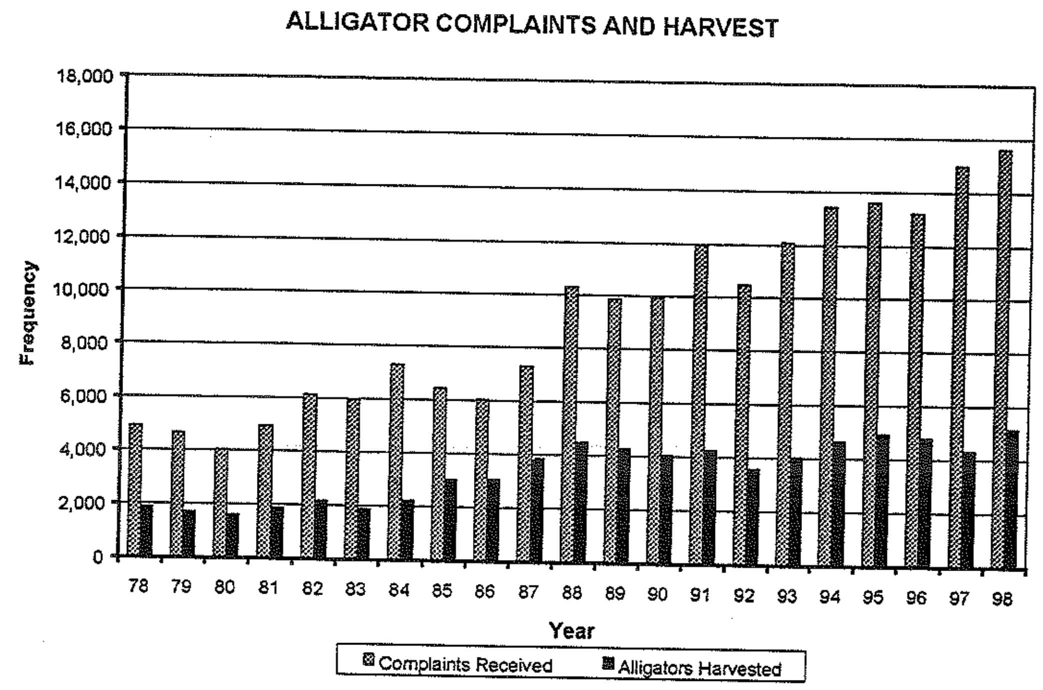

Figure 2: Alligator complaints received and nuisance alliators harvested in Florida during 1978-1998.

Public Education

The FWC tries to educate the general public about the potential danger of alligators through annual news releases to the media. News releases are timed to coincide with the onset of increased alligator activity as temperatures increase in the spring. Messages include warnings that alligator can and do attack, how to avoid attacks, and what one should do if attacked by an alligator. The feeding of alligators conditions them to humans and can create a dangerous situation. Therefore, Florida Statute 372.667 prohibits the feeding or enticement of alligators. The FWC makes "Do Not Feed or Molest Alligators" posters available to businesses and individuals in close association with alligators to alert the public of the potential dangers of alligators. The FWC also makes two brochures, "Living with Alligators" and "American Alligator", available to the pubic that provide information on how to avoid attacks. Recently a non-profit group, the American Alligator Cycle of Protection, in cooperation with the FWC, sponsored a program called "Be Gator Safe" designed to increase public awareness about potential danger of alligators. Also, "Be Gator Safe" brochures stress precautions that should be taken when living or engaging in activities near alligators.

Is the Nuisance Alligator Program Effective?

Over 15 alligator bites per year occur in Florida , but many of these are the result of people intentionally handling alligators such as hunters, exhibitors, farm employees, and people trying to illegally capture alligators. We were primarily concerned with the danger of unexpected attacks by alligators, so our assessment was limited to unprovoked attacks that resulted in bites. We classified alligator attacks into mild (bites resulting in superficial lacerations, abrasions, or minor puncture wounds requiring only first aide) and severe (fatalities or bites resulting in wounds requiring moderate to major medical care). Mild attacks usually occurred when small alligators bit people or when larger alligators bit people in an irresolute encounter. For example, a substantial number of attacks occurred when people bumped into alligators when retrieving golf balls in ponds or water hazards, or when they were wading in water. Typically, mild attack victims received scratches when they were raked by the alligator's teeth or they received superficial puncture wounds.

Florida currently has 15 million residents and over 40 million user-occasions (swimming, wading, etc.) of humans in fresh water. The alligator population has been crudely estimated at approximately 1 million. Alligator complaints have increased ($P < 0.01$) from approximately 5,000 in 1978 to 15,000 in 1998. Yet, during the past 10 years, an average of only 3.6 severe alligator attacks occurred per year. Although the frequency of all (severe and mild) alligator attacks increased ($P = 0.062$) during 1970-1977 (Fig. 1), no trend ($P > 0.55$) has been observed in the frequency of all attacks (mean = 6.9) and severe attacks (mean = 3.3) since the nuisance alligator program was implemented in 1978 (Fig. 1). The rate of severe attacks per million residents has shown some evidence of a decline ($P = 0.104$) since 1977, suggesting that the probability of being the victim of an alligator attack has decreased. Nine fatal attacks occurred during 1970-1998, but no obvious pattern was associated with these incidents. Four of the nine fatal attacks occurred at state or county parks.

We believe that the attack rate has been kept in check because of several factors. First, although not wishing to encourage unwarranted complaints about alligators, the FWC makes the public aware of procedures for taking care of problem alligators through annual news releases and brochures. This helps alert us to potential problems before they happen. Second, toll-free telephone lines are available to facilitate reporting of suspected nuisance alligators. Third, trappers have a financial incentive to remove problem alligators as quickly as possible.

The number of alligators harvested has increased since 1978 along with the number of complaints

(Fig. 2). Because most nuisance alligators occur in widely scattered canals, small ponds, lakes, and streams the FWC has not been able to establish an index of alligator abundance in these areas. However, the number of nuisance-alligator complaints and alligators harvested has steadily increased over the past 21 years, suggesting that populations remain viable (Fig. 2).

Economics

In Florida, 40 nuisance-alligator trappers respond to complaints in 67 counties. Removing nuisance alligators is expensive. Nuisance-alligator trappers are required to respond immediately to a complaint, which usually involves only one alligator, and remove the alligator as soon as possible. This may require several trips to remove a single alligator. Vehicle and labor costs are significant expense components. Trappers must then process the alligator at their own facility or have it contract-processed at a state-licensed processing facility. Trappers must then store, market, and sell their skins and meat. Average operating costs in 1995 were approximately $222/alligator (Woodward 1998). Skin prices were $5.51/cm. and meat prices were $9.26/kg during 1991-1995. This yielded revenue of approximately $362/alligator for a net income of $140/alligator (Woodward 1998). Currently, skin prices are $3.50/cm and net income is considerably less than it was in 1995.

The economic basis of Florida's nuisance-alligator program is being strained by low skin prices. The program was founded upon the concept of an underlying financial incentive providing the impetus for trappers to respond promptly to alligator complaints. Because nuisance alligator trappers provide a valuable service for the state and because of the reduced net income caused by low skin prices, the GFC has reduced tag fees. Start-up costs of purchasing vehicles, boats, and a Florida Health Department-approved processing facility are quite costly. Those trappers that have already purchased and paid for these items, particularly the processing facility, can operate at a lower break-even price. However, new trappers find it difficult to sustain a business on nuisance alligators alone. Many nuisance-alligator trappers participate in other alligator harvest programs offered in Florida including the private lands harvest program, guiding hunters during public waters hunts, collecting eggs for alligator farms, and processing alligators. These alternative harvest programs provide other sources of income and allow more efficient use of capital expense items such as vehicles and processing facilities, thereby lowering the per animal costs of participating in the nuisance-alligator program.

Conclusions

The use of private nuisance-alligator trappers to remove problem alligators in Florida has proven to be a cost effective way of maintaining a low level of risk of alligator attacks. Although serious attacks and occasional fatal attacks occur in Florida, it would be difficult to eliminate these altogether without severely reducing the alligator population, such as occurred in the 1960s. Such a reduction is not consistent with the mission of the FWC. Therefore, the FWC will continue its approach of targeting individual problem alligators for removal and reducing the density of alligators in areas with high-risk of attacks.

Literature Cited

Anon. 1998. 1998 Florida statistical abstracts. Univ. Press Fla., Gainesville. 816pp.

Audubon, J. J. 1931. Observations on the natural history of the alligator. (Reprint) La. Cons. Rev. 2:3-8.

Barbour, T. 1944. That vanishing Eden. Little, Brown and Co., Boston. 250pp.

Carle, W. 1948. Alligators do attack. Fla. Wildl. 2(4):10-11.

Hines, T. C. 1979. The past and present status of the alligator in Florida. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 33:224-232.

____, and K. D. Keenlyne. 1976. Alligator attacks on humans in Florida. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 30:358-361.

____, and ____. 1977. Two incidents of alligator attacks on humans in Florida. Copeia 1977:735-738.

____, and R. Scheaffer. 1977. Public opinion about alligators in Florida. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 31:84-89.

____, and A. R. Woodward. 1980. Nuisance alligator control in Florida. Wildl. Soc. Bull. 8:234-241.

____, and ____. 1981. A report on Florida's nuisance alligator program. Pages 73-76 *in* R. R. Odom and J. W. Guthrie, eds. Proc. Nongame and Endangered Widl. Symp., Ga. Tech. Bull. WL5, Athens.

Jennings, M. L., A. R. Woodward, and D. N. David. 1989. Florida's nuisance alligator control program. Pages 29-36 *in* S. R. Craven, ed. Proc. Fourth Eastern Wildl. Damage Control Conf., Madison, Wisc.

Kellogg, R. 1929. The habits and economic importance of alligators. U. S. Dept. Agric. Tech. Bull. 147pp.

McInhenny, E. A. 1935. The alligator's life history. The Christopher Publ. House, Boston, 117 pp.

Murphy, T. M., and J. W. Coker. 1983. American alligator population studies in South Carolina. Study Compl. Rep., South Carolina Wildl. and Marine Resourc. Dept., Columbia. 120 pp.

Neill, W. T. 1971. Last of the ruling reptiles. Alligators, crocodiles, and their kin. Columbia Univ. Press, New York.

Pooley, A. C., T. Hines, and J. Shield. 1989. Attacks on humans. Pages 172-187 *in* C. A. Ross and S. Garnett, eds., Crocodiles and Alligators. Facts on File, New York.

Responsive Management. 1996. Floridians' opinions on and attitudes toward alligator management in Florida. Rep. to Fla. Game and Fresh Water Fish Comm., Tallahassee, 70pp.

Schemnitz, S. D. 1974. Populations of bear, panther, alligator, and deer in the Florida Everglades. Fla. Sci. 37:157-167.

Van Dorn, M. 1928. Travels of William Bartram. Dover Publ. Co., New York. 414pp.

Woodward, A. R., and D. N. David. 1994. Alligators. Pages F-1 - F-6 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds., Prevention and Control of Wildl. Damage, Univ. of Nebraska.

____, and C. T. Moore. 1994. American alligators in Florida. Pages 11-13 *in* G. S. Farris, ed. Our living resources. U. S. Biological Survey, Lafayette, La.

____, D. N. David, and M. L. Jennings. 1987. American alligator management in Florida. Pags 98-113 *in* R. R. Odom, K. A. Riddleberger, and S. C. Ozier. Proc. 3rd Souteastern Nongame and Endangered Wildl. Symp., Athens, Georgia.

Nuisance-csg2000.doc (3 Feb. 2000)

IMPORTANCIA DE LOS CRIADEROS EN LA EDUCACIÓN AMBIENTAL Y LA PERCEPCIÓN DEL PÚBLICO HACIA LOS COCODRILOS: EXPERIENCIAS DE UN PROGRAMA EDUCATIVO.

BIÓL. FRANCISCO JAVIER LEÓN OJEDA, BIÓL. PATRICIA L. ARREDONDO RAMOS, LIC. MARTHA C. ROBLES MONTIJO. COCODRILOS MEXICANOS, S.A. DE C.V., CULIACÁN, SINALOA, MÉXICO. CORREO ELECTRÓNICO: cocomex@cln.megared.net.mx

ANTECEDENTES:

En los últimos 30 a 40 años la caza ha ejercido una fuerte presión sobre la mayoría de las poblaciones silvestres de cocodrilianos llegando a diezmarlas drásticamente, todos sabemos que esta explotación excesiva se debe principalmente al valor que alcanzan los cueros en el mercado y por otro lado a la idea equivocada de que el cocodrilo es un animal pernicioso y por ende una amenaza para el hombre y los animales domésticos (Bolton, 1994).

La necesidad de los cocodrilos por disponer de espacios grandes y tranquilos en los cuerpos de agua que habitan y donde pueden realizar sus actividades de sobrevivencia como calentamiento corporal, alimentación y reproducción y el hecho de que dichos espacios estén siendo impactados con gran intensidad por la expansión de los asentamientos humanos, megaproyectos turísticos, proyectos de acuicultura y de comunicación, ha generado que la ya de por sí sensible relación que existe entre el hombre y el cocodrilo se vuelva cada vez más conflictiva.

La situación anterior y la demanda de los cueros que ya se había creado en el mercado desde los años setentas y que para atenderlas y al mismo tiempo salvaguardar las reservas de animales salvajes, propició los primeros intentos por criar y manejar en cautiverio distintas especies de cocodrilianos en diferentes países del mundo (Bolton, 1994).

La mayoría de los criaderos más exitosos comercialmente hablando deben su éxito a las buenas prácticas de crianza y comercialización que llevan a cabo y a que una buena parte de sus ingresos son obtenidos vía turismo. En muchas granjas del mundo ya sean turísticas o no el público local o foráneo tiene acceso a visitar dichas instalaciones, pero en la mayoría la información proporcionada sobre la importancia ecológica de los cocodrilianos y su protección es mínima, centrándose la plática durante el recorrido básicamente sobre los aspectos generales de los cocodrilos y de su crianza en cautiverio, algunas tienen guías capacitados otras no.

Los criaderos representan una alternativa tanto comercial como de conservación ya que la crianza de los cocodrilos en cautiverio no perjudica a las poblaciones naturales sino al contrario ayudan a proteger y repoblar la especie en su habitat natural al entregar una parte de su producción para dichos fines. También representan una alternativa económica generando fuentes de empleo y de alimento.

Actualmente los criaderos comerciales pueden no solo limitarse a representar las alternativas anteriores, sino que tienen capacidad para cumplir un papel muy importante

educando al público, transformando y creando una conciencia y percepción positiva hacia los cocodrilos (Burgin, 1993), para ello los criaderos cuentan con todo el conjunto de elementos indispensables, como instalaciones, tecnología y personal capacitado, faltando definir la estrategia.

Así pues con estos antecedentes el director y el personal técnico de la empresa "Cocodrilos Mexicanos, S.A. de C.V." (COCOMEX) ubicado a 20 Km. de la Cd. de Culiacán, en el estado de Sinaloa, México se pusieron en contacto a finales de 1997 con el personal directivo y del área de formación educativa del Centro de Ciencias de Sinaloa (C.C.S.) institución creada por el gobierno del estado de Sinaloa para la divulgación y promoción de la Ciencia. De este y de subsecuentes reuniones se diseñó un programa de educación econológica denominado "Conociendo y Cuidando al Cocodrilo" (CONCUCO).

OBJETIVOS:

El programa surge del interés que tiene el público en conocer las granjas de cocodrilo, pues la mayoría de la gente desconoce la existencia de estas y consideran que los cocodrilos son perjudiciales y que todas las especies están en peligro de extinción. Esa curiosidad o interés bien encaminada es el ingrediente primordial en nuestro programa, el cual está enlazado a otros proyectos que realiza COCOMEX como es el estudio y repoblación del "Cocodrilo de río" o "Caimán" (Crocodylus acutus) en la Laguna de Chiricahueto ubicada a 12 Km. del criadero. (León y Arredondo, 1997).

El programa persigue los siguientes objetivos:

1) Fomentar entre los estudiantes de los niveles de educación básica (preescolar, primaria
y secundaria) y nivel medio (preparatoria o bachillerato) una nueva cultura a favor del cuidado, explotación y conservación del cocodrilo fundamentada bajo el esquema del aprovechamiento sustentable de los recursos naturales.

2) Fomentar prácticas que contribuyan a disminuir las posibilidades de extinción de C.
acutus, especie regional en Sinaloa, mediante acciones que eleven la recuperación de sus poblaciones naturales.

FUNCIONAMIENTO DEL PROGRAMA:

El programa en su etapa actual solo se ha promocionado en la zona escolar de Culiacán. Opera de Enero a Marzo y Septiembre a Diciembre de cada año, esta temporalidad se debe a que el criadero restringe las visitas de Abril a Agosto de cada año época en la que se llevan a cabo las diferentes etapas de la reproducción de los cocodrilos en cautiverio del criadero. El programa consta de 2 etapas: TEÓRICA Y PRÁCTICA.

ETAPA TEÓRICA: Esta etapa se lleva a cabo en las instalaciones del Centro de Ciencias de Sinaloa, el grupo o grupos (solo se reciben un máximo de 2 grupos de 40 alumnos cada uno por visita) son llevados a las aulas del C.C.S. donde se les da una explicación teórica a través de un video "Conociendo y Cuidando al Cocodilo" con imágenes de las principales instalaciones de la granja (acuaterrarios, casetas de ambiente controlado, incubadora, rastro, etc.)., además se desarrollan otras actividades como es el iluminar (colorear) una revista informativa con ilustraciones de "Cuco y su pandilla" que comprende información general sobre: el número de especies de cocodrilianos que hay en el Mundo y las especies que hay en México, habitat y hábitos de los cocodrilos, reproducción, crecimiento y longevidad, distribución geográfica de los cocodrilianos en México, distribución actual y original, factores que afectan su distribución, posibilidades de conservación, importancia económica, leyes que lo protegen, cocodrilos en vida silvestre y cautiverio. También los alumnos de primaria y secundaria tienen oportunidad de aprender utilizando un CD-interactivo diseñado para tal fin y de visitar la pecera-terrario que contiene cocodrilos misma que se encuentra en el Centro de Ciencias de Sinaloa (C.C.S.). La etapa teórica dura 2 días.

ETAPA PRÁCTICA:

Una vez realizada la etapa teórica los alumnos previamente capacitados son llevados el sábado siguiente a la granja donde refuerzan los conocimientos adquiridos. Todos van identificados con su gafete, ahí tienen la oportunidad de tomar un pequeño cocodrilos en sus manos y conocer sus diferentes partes anatómicas. Este contacto acerca e identifica a los niños con los cocodrilos, recalcándoles en todo momento que los cocodrilos no pueden ser mascotas como un perro o un gato, y que es preferible dejarlos ser libres y protegerlos, se les enseña a respetarlos. En la granja se les hace ver a los niños que es posible aprovechar con propósitos comerciales una especie de flora o fauna siempre y cuando existan beneficios para las poblaciones silvestres[1]. La visita a la granja dura de 1 a 1.5 horas. Los alumnos realizan un recorrido por las instalaciones y todas sus dudas son aclaradas, ya sea por el staff técnico o por los guías. Por último en la granja aprecian los productos que se pueden obtener de los cocodrilos, con suerte algunos niños participan en el nacimiento de los primeros cocodrilos de la temporada.

Al terminar la visita en la granja los niños son trasladados a la Laguna de Chiricahueto ubicada a 12 Km. al este de la granja ahí se les explica como se formó la laguna y cuantos cocodrilos acutus habitan en ella y cual es su importancia. Posteriormente se procede a la liberación (previa cuarentena) de 1 cocodrilo de 1 a 2 años de edad por grupo. Cada grupo bautiza con un nombre a su cocodrilo del cual se les indica si es macho o hembra y su número de etiqueta. Los niños despiden con aplausos a su cocodrilo cuando ven que este lentamente deja la orilla y es recibido en su nuevo hogar con decenas de aves playeras que arman una fiesta de recepción en torno al nuevo inquilino.

[1] Se les recalca que los artículos elaborados con piel de cocodrilos provenientes de granjas o de poblaciones silvestres donde está autorizada su captura con una cuota no provocan un deterioro a la especie y su habitat; que no se debe generalizar la prohibición que promocionan algunos grupos ambientalistas para el uso de productos y subproductos provenientes de especies en peligro de extinción, pues en el caso de los cocodrilos existen funcionales esquemas de protección.

Cabe hacer el comentario que los cocodrilos acutus liberados en la Laguna proceden de huevos silvestres ahí colectados, los cuales son incubados en la granja y las crías obtenidas engordadas durante 1 a 2 años.

RESULTADOS:

A la fecha se han llevado a cabo 4 temporadas de visitas. El programa al principio fué difundido, sin embargo, últimamente no ha sido necesario promoverlo pues las escuelas compiten por inscribir a sus alumnos, agotándose en 1999 desde un inicio las reservaciones. Desde que arrancó el programa y hasta Diciembre 11 de 1999 se habían atendido a 1575 alumnos (Cuadro 1) la mayoría de ellos (76.88%) de nivel primaria (37 grupos=1211 alumnos). Durante 1999 se atendieron 921 alumnos, un 40.8 % más con respecto a 1998. Como se puede ver la aceptación del programa va en aumento y podría aumentar significativamente más si tomamos en cuenta que las visitas a la granja están restringidas a los días sábados exclusivamente.

Es importante mencionar que este es un programa institucional para educar a niños y jóvenes pero que en la mayoría de las ocasiones los niños van acompañados de sus padres pues en algunos casos a estos últimos la seguridad de sus hijos les preocupa, con lo que muchas personas adultas acceden a nuestro programa educativo.

De encuestas informales realizadas al finalizar la visita al criadero conocemos que el programa cumple cabalmente con los objetivos propuestos pues los visitantes quedan invadidos por un espíritu de protección y cuidado hacia los cocodrilos y se sorprenden de lo que se realiza en la granja; su perspectiva hacia los cocodrilos cambia radicalmente hacia una apreciación positiva.

CONCLUSIONES:

Desde el punto de vista pedagógico la infancia y la juventud son las etapas de la vida más importantes para inculcar normas y valores.

Nuestro programa educativo se enfoca primordialmente a los niños y jóvenes de nuestra comunidad a quienes se les "siembra" la semilla de la conservación y aprovechamiento sustentable de los recursos naturales. COCOMEX y el Centro de Ciencias de Sinaloa ampliarán y reforzarán este programa para llevarlo a los niños y jóvenes de los poblados aledaños a la laguna de Chiricahueto estando seguros que con esta motivación ellos se convertirán en fieles guardianes de ese recurso. Si la mayoría de los criaderos de cocodrilos adoptan un programa de educación ambiental dirigido a la niñez de las comunidades aledañas, está claro que se estarán dando pasos firmes para cambiar la actitud del público hacia los cocodrilos promoviendo con ello su protección y la conservación de su habitat.

BIBLIOGRAFÍA:

- Bolton M. 1994. La explotación del Cocodrilo en Cautiverio. Cuadernos técnicos de la FAO. No. 22 ONU, Roma, Italia. ISBN 92-5-302875-0.
- Burgin, S. 1993. Captive Breeding. Newsletter Crocodile Specialistic Group. Vol. 12 No. 3 July- September pags. 3-4. IUCN World Conservation Union. SSC.
- León Ojeda, F.J. y Arredondo Ramos, P.L. 1997. Evaluación Poblacional y algunos aspectos Ecológicos de Crocodylus acutus en la Laguna de Chiricahueto, Sinaloa. México. Memorias de la 4ta. Reunión Regional del Grupo de Especialistas en Cocodrilos de América Latina y el Caribe. Centro Regional de Innovación Agroindustrial, S.C. Villahermosa, Tab. Pags. 90-104.
- Martínez Ibarra, J.A. y González, M.P. 1997; Video Educativo "Cocodrilo". Memorias de la 4ta. Reunión Regional del Grupo de Especialistas en Cocodrilos de América Latina y del Caribe. Centro Regional de Innovación Agroindustrial, S.C. Villahermosa, Tab. Pag. 117.

CUADRO 1. RESUMEN DE ESCUELAS, NÚMERO DE GRUPOS, NIVEL Y CANTIDAD DE ALUMNOS PARTICIPANTES EN LOS DOS PERÍODOS DE ACTIVIDADES DE 1998 Y 1999. COCODRILOS MEXICANOS, S.A. DE C.V.

PERÍODO	ESCUELAS	NIVEL				CANTIDAD DE NIÑOS
		Pree.	Prim.	Sec.	Bach.	
Febrero a Abril de 1998	CEDI		1			28
	Esc. Gabriel Leyva		1			26
	María Montessori			1		20
	Esc. Venustiano Carranza		2			47
	Esc. Lázaro Cárdenas		1			18
	Sec. Judith Gaxiola			1		30
	Col. Independencia		1			29
TOTAL	7 ESCUELAS PARTICIPANTES		**6 Grupos**	**2 Grupos**		**198**
Septiembre a Noviembre de 1998	CEDI		1			25
	Instituto México de Culiacán		1			32
	Instituto Nueva Generación		4			128
	Colegio Panamericano		1			29
	Esc. Marcos Mora A.		1			38
	Jardín Carmen Ramos	1				37
	Colegio Imperial		1			27
	Esc. Elodia Zavala		2			52
	Esc. Ramón López Velarde		1			32
	Esc. Adolfo López Mateos		1			30
TOTAL	10 ESCUELAS PARTICIPANTES	**1 Gpo.**	**13 Gpos.**			**456**
Febrero a Marzo	Jardín Hellen Keller	2				59
	Esc. Yoliztli		2			50
	Esc. Enrique Romero		1			48
	Esc. Reynalda López Lachica		1			12

de	Col. Independencia		2			58
1999	CEDI		1			30
	COBAES			3		91
TOTAL	7 ESCUELAS PARTICIPANTES	2 Gpos.	7 Gpos.	3 Gpos.		348
	Almacenes Zaragoza		1			57
	Francisco González Bocanegra		1			40
Septiembre	CEDI		1			29
	CEDI		1			40
	Instituto Nueva Generación		1			62
a	Colegio de Motivación Integral		1			58
	Rodolfo T. Loaiza		1			13
Diciembre	CEDI		1			24
de	COBAES No. 25				1	36
	Héroes de 1864		1			53
1999	Héroes de 1864		1			39
	Secundaria Gral. Culiacancito			1		35
	Instituto Chapultepec		1			57
TOTAL	10 ESCUELAS PARTICIPANTES		11 Gpos	1 Gpo.	1 Gpo.	573

TOTAL 1575

Importancia cultural y uso tradicional de los cocodrilos en Cuba y en diversas partes del mundo

Vilma Rivalta González, Ada Chamizo Lara y Adela Torres Barbosa
Instituto de Ecología y Sistemática, CITMA.
Habana, Cuba
ecologia@unepnet.inf.cu

INTRODUCCION

El cocodrilo representa un recurso natural de gran significación para la mayoría de las comunidades rurales. Los productos del cocodrilo son utilizados para la subsistencia (uso de subsistencia) tales como alimentos, medicina, piel y cuero, adornos, materiales artesanales y arte. Muchos de estos productos han adquirido valor comercial en mercados locales, nacionales e internacionales (uso comercial). El cocodrilo tiene otros valores, como uso cultural: religioso y espiritual.

Es decir, que además de su uso como alimento, medicinal y ornamental, el cocodrilo ha tenido gran valor a través de la historia por otras razones importantes como son: las ceremonias religiosas, la mitología y el folklore. Estos valores simbólicos o socioculturales son esenciales y permanecen hoy en día en la mayoría de las comunidades del mundo.

Debido al valor comercial de su piel, han sido extensamente cazados en las regiones tropicales y subtropicales del mundo durante más de un siglo. La sobreexplotación, combinado con problemas más recientes de pérdida de hábitat y la polución de hábitat acuáticos, ha provocado que algunas especies se encuentren al borde de la extinción. La pérdida de cualquier especie de cocodrilo representa una pérdida significativa de biodiversidad, del potencial económico y de la estabilidad de los ecosistemas.

Con respecto a la importancia de los cocodrilos en los ecosistemas se ha señalado su efecto positivo en el ambiente como especie clave en el mantenimiento de su estructura y funcionamiento. Esto incluye la depredación selectiva de peces y cangrejos, que en caso contrario destruyen muchos huevos de peces y alevines, mantener expeditos los canales con su ir y venir, abonar el agua con sus deyecciones, el reciclaje de los nutrientes y el mantenimiento de refugios húmedos durante la sequía.

En Cuba se encuentran tres especies de cocodrilos: *Crocodylus rhombifer,* conocido como "cocodrilo cubano", "cocodrilo criollo" o "cocodrilo perla", que es endémico y se encuentra en hábitat restringidos de agua dulce (Ciénaga de Zapata y una pequeña población en la Ciénaga de Lanier); *Crocodylus acutus,* "cocodrilo americano" o "caimán", ampliamente distribuido en áreas costeras de manglares y en los cayos alrededor de la isla; y *Caimán crocodilus fuscus,* "caimán" o "Babilla de Colombia", introducido en la Isla de la Juventud (Varona, 1966, 1976, 1986a, 1986b, 1987).

En nuestro país los cocodrilos son considerados como un recurso potencial de exportación y es por ésto que *C. rhombifer* y *C. acutus* se crían en cautiverio para su uso comercial ya que están incluídas en el Apéndice I de la Convención Internacional sobre el comercio de especies amenazadas (CITES).

Este estudio se sustenta en un análisis bibliográfico y entre los objetivos de este estudio está el dar a conocer la importancia que reviste el conocimiento del cocodrilo y sus diversos usos en Cuba y en otras partes del mundo, principalmente alimentario, medicinal, mítico y socioeconómico; también se evidencia su carácter como consolidador cultural, al ser objeto de inspiración de leyendas, poesías, dibujos, etc.

USO DE SUBSISTENCIA

Los cocodrilos y sus diversos usos

a utilidad de los cocodrilos en general ha incidido en su disminución, fundamentalmente por consumirse la carne como alimento, por tener piel de gran resistencia (poseen huesos dérmicos u osteodermos) con un diseño atractivo y por su uso medicinal.

En Cuba:

Segun Gundlach (1875) *C. rhombifer* es un remedio antiespasmódico y su manteca se usa en la cura de animales.

Seoane Gallo (1984) refiere que la manteca de cocodrilo y de caimán curan el asma; también, que la flojera (fiebre, catarro o gripe mal cuidados) se quita dándose fricciones fuertes de manteca de caimán en las piernas y en la rabadilla.

El producto de las glándulas mandibulares del cocodrilo se usa como fijador (Nieto, 1997).

El uso más amplio del cocodrilo es el consumo de su carne. Otros dos usos importantes son la taxidermia y el ecoturismo, este último solo practicado en Cuba con los cocodrilos en cautiverio de la Ciénaga de Zapata (Berovides Alvarez, 1998).

En la actualidad, con los cocodrilos en cautiverio de la Ciénaga de Zapata se recaudan mas de 300 mil dólares anuales por concepto de visitas de turistas. Desde 1994 CITES autorizó la comercialización de *C. rhombifer* de este lugar. La piel de *C. rhombifer* está clasificada como competitiva a nivel mundial, pero aun el país no tiene un mercado estable para venderla. En estos momentos se podrían exportar alrededor de 400-500 pieles anuales (González Suárez, 1998).

En otros países:

En el siglo XIII con la grasa de cocodrilo se preparaban ungüentos para eliminar las arrugas faciales. El cuero se usó para protegerse contra el rayo y los dientes para fabricar botones. El almizcle producto de las glándulas odoríferas que poseen los cocodrilos en la mandíbula inferior y en las cercanías de la cloaca se considera un remedio contra las calenturas. En el continente Africano, el almizcle del cocodrilo del Nilo tenía valor comercial pues se empleaba para la fabricación de ungüentos para la piel y los cabellos; también era usado en perfumería. Algunas partes eran usadas en brujería (Gallardo, 1994).

Como remedio indígena se menciona el uso del colmillo de caimán para las mordeduras de culebras, perros rabiosos y otros animales ponzoñosos. Para preservarse de estos animales y de cualquier otro veneno es suficiente llevar el colmillo atado al cuello y a los brazos. La manteca de caimán cura la sordera, el dolor de oídos y desobstruye el bazo. Una gota de la hiel en el lagrimal cura las nubes y cataratas (Pompa, 1988).

La grasa y los huevos del cocodrilo servían para pintar el cuerpo de los indios sudamericanos. El "colmillo de caimán" era usado por los esclavos negros de Colombia como antídoto de las hierbas venenosas que usaban unos contra otros, o contra sus amos (Gallardo, 1994).

Al parecer el primer cocodrilo ampliamente comercializado fue el *Alligator mississippiensis*. Inicialmente la utilización comercial de los alligatóridos se basó en la producción de aceite para engrasar la maquinaria de las máquinas de vapor y las fábricas de algodón.

La grasa del cocodrilo se usa tradicionalmente para el tratamiento de enfermedades respiratorias en regiones de Africa (Nichol, 1987).

Ross (1992) recoge la información de investigadores de diferentes países sobre el uso medicinal de la grasa del cocodrilo para tratar un número de padecimientos que incluyen la cauterización de úlceras en la piel, como tónico para el pulmón, el cáncer y melanomas. Refiere que el uso más importante es para el tratamiento del asma, especialmente si se realiza en unión de antibióticos. Plantea que no está claro si la grasa se debe consumir internamente, externamente o ambas, pero sí se conoce que numerosas culturas rurales creen ampliamente en su eficiencia.

En la República de Santo Domingo muchos cocodrilos machos de *C. acutus* se matan para obtener sus penes, debido a la creencia de que poseen poder afrodisíaco. En el mercado se venden en secreto penes secos de cocodrilo, aunque se matan también por su carne y grasa. La grasa se usa en la industria farmacéutica local para producir medicina antireumática (Schubert y Santana, 1996)

USO CULTURAL

Los cocodrilos en las leyendas y cuentos populares

Desde el punto de vista simbólico, los animales han desempeñado un importante papel en la historia de la cultura de los pueblos por sus cualidades, actividades, formas y colores, pero muy especialmente por sus vínculos con los seres humanos.

Son conocidos los cultos, rituales y ofrendas realizadas por las diversas culturas precolombinas, quienes hacían acompañar a sus muertos con diferentes objetos de la naturaleza, también le ofrecían tributos a la propia naturaleza o a sus dioses para obtener buenas cosechas o cazas.

Cuando los negros africanos fueron traídos como fuerza sustituta de la depauperada esclavitud aborigen, arribaron a nuestras costas con toda una herencia cultural, mística y religiosa que expresaban sus amplios conocimientos de la naturaleza y una cosmovisión muy particular. Estos conocimientos se han trasmitido, conservado y enriquecido a través de muchas generaciones hasta llegar a nuestros días, formando parte esencial de la riqueza cultural de la nación cubana. La relación que se establece entre los creyentes de cultos afrocubanos y la naturaleza permite el análisis de nuestra identidad y una valoración objetiva de nuestros recursos humanos y naturales (Borroto Páez y Aguilar Reyes, en prensa).

En el mapa místico de las influencias continentales heredadas, las dos áreas mas importantes y persistentes en Cuba son la lucumí y la conga (Yorubá y Bantú). Estas dos tendencias se expresan en la Regla de Ocha y en la Regla de Palo Monte con un extenso acerbo cultural y religioso (Cabrera, 1954).

A continuación se exponen dos leyendas de origen africano (yoruba):

> Se dice que los cocodrilos nacen cuando hay tormentas eléctricas pues, Nsasí le da poder a sus huevos. Sus colmillos tienen virtudes insospechadas y en su cabeza hay dibujada una cruz que posee el poder de la protección. Se dice que quien mata a un caimán adquiere sus características (Bolívar Aróstegui y González Díaz de Villegas, 1998).
>
> Se dice que Inosun Meyi fue quien hizo la adivinación al cocodrilo cuando venía a la Tierra. El cocodrilo fue en muchas ocasiones una criatura desamparada, mientras vivía en el cielo solo tenía su boca para comer, hablar y defenderse. Cuando se preparó para venir al mundo, el se dirigió a Oriunmila para consultarse sobre qué hacer para vivir feliz en la Tierra. Le aconsejaron hacer un sacrificio con un serrucho, sierra de hierro y un chivo para Echú. Después que el sacrificio se hizo, se le dió una segunda boca, que era su cola hecha de la sierra o serrucho sacrificatorio. Con la segunda boca, él debió defenderse y luchar por su alimento, pero se le advirtió que no fuera desagradecido con su adivinador. Por consiguiente, al llegar a la Tierra siendo el cocodrilo un anfibio, usaría su cola para batir y debilitar a su víctima, mientras que su boca real la hundiría dentro del agua. El cocodrilo puede tragarse cualquier cosa, pero no las semillas de Orúmila (ikín), el día que las trague, seguramente morirá (Souza Hernández, 1998).

En otros países:

En Papua, Nueva Guinea los jóvenes varones al pasar de la niñez a la vida adulta son sometidos a una ceremonia de iniciación, durante la cual se practican en la piel múltiples heridas cortantes, que cicatrizadas luego, semejan las escamas del cocodrilo y así quedan transformados en "hombres cocodrilos" (Costeau, 1990).

Para los antiguos egipcios los cocodrilos eran motivo de adoración como poseedores de una partícula de divinidad. Se consideraba un honor que algún pariente fuera sacrificado a los cocodrilos. Para ganarse el favor de los cocodrilos lo consideraban como un símbolo del dios Sobek, lo representaban hecho en bronce con corona de Osiris. Otras veces conservaban sus momias. Según un cuento, un cocodrilo de juguete hecho de cera, cobraba vida cuando se le echaba al agua y esto era una forma de aleccionar a los niños frente al peligro de ser devorados por estos reptiles (Gallardo, 1994).

Cada año los antiguos egipcios esperaban con impaciencia la crecida del Nilo. Del desbordamiento del río, del limo que quedaba en sus orillas después de la crecida , dependía la cosecha. Pero a la vez las grandes aguas conducían a la cuenca baja del Nilo a numerosos cocodrilos. Los egipcios pensaban que no era el agua la que llevaba a los cocodrilos, sino que eran estos los que traían el agua. Y como quiera que el agua y todo lo vinculado con ella constituía el fundamento de la vida, se empezó a adorar a los cocodrilos como animales muy provechosos y, por lo tanto, sagrados. Los estanques situados en los parques de los templos se poblaron de cocodrilos sagrados. Prendas de oro y plata adornaban sus patas y cabezas; les servían la comida en vajilla de plata y una vez al año era organizada en El Cairo la Fiesta del Nilo, durante la cual se sacrificaba a una de las doncellas más hermosas, echándola a las fauces de los cocodrilos (Dmitriev, 1992).

Significado simbólico del cocodrilo

Al cocodrilo se le atribuye un significado ambivalente en la que confluyen dos aspectos principales: la agresividad y el poder destructor se asocia con la furia y la maldad; la pertenencia a la tierra y al agua se asocia con la fecundidad y la fuerza. De este modo un reptil tan agresivo como el cocodrilo es representado como símbolo de la sabiduría y la solidaridad (Guanche Pérez y López Díaz, 1997).

Se dice que los cocodrilos son animales muy compasivos o hipócritas. En todo caso, hay testimonios de que el cocodrilo con frecuencia llora después de comerse a algún animal (de esto proviene la expresión "llorar lágrimas de cocodrilo"). Los científicos demostraron que posee un aparato potabilizador. Sus riñones a menudo no pueden segregar todos los excedentes de sales que recibe el organimos y entonces acuden en su ayuda una glándulas que tiene en los ojos. Precisamente a través de ellas expulsa las sales, diluidas en agua (Dmítriev, 1992).

Se le atribuye "insidia" y se le tiene por animal "vengativo" y "traicionero", lo cual deriva seguramente de lo repulsivo que suele causar su fealdad. En sentido figurado se habla de "cocodrilo" para referirse a algo terrible, mientras "caimán" expresa persona muy astuta y taimada. Con un sentido peyorativo se suele hablar de "políticos con piel de cocodrilo", para denotar cierta insensibilidad (Gallardo, 1994).

<u>Los cocodrilos y caimanes: etimologías, toponimias, nombres y fuentes de inspiración</u>

Cocodrilo proviene del griego "krokódeilos", en latín "Crocodilus" y es usado en castellano desde el siglo XIII.

"Yacaré", usado en la familia Alligatoridae, proviene del guaraní castellanizado y tiene como sinónimo el nombre de caimán.

El nombre de "caimán" además del uso en los Alligatóridos sudamericanos se puede dar para *C. intermedius* del Orinoco y para *C. rhombifer* (Gallardo, 1994). Caimán en lengua lucumí (yoruba) es iguele.

Según su toponimia en Cuba existen las localidades de: Cocodrilo (Isla de la Juventud) y Caimanera (Provincia de Guantánamo). La Isla de Cuba se identifica con la forma de un cocodrilo.

En los XIV Juegos Deportivos Centroamericanos y del Caribe celebrados en La Habana en 1982, la mascota fue un cocodrilo (Cuco).

Algunas firmas comerciales usan la figura de un cocodrilo o de un caimán como marca de fábrica, quizás con una reminiscencia totémica por ejemplo, los logotipos de las firmas comerciales Havanatur y Ediciones Cubanas.

El "Caimán Barbudo" es una revista de crítica cultural editada en Cuba.

"De mi cocodrilo verde" es el nombre de un conjunto de música campesina.

Como fuente de inspiración el cocodrilo está representado a través de figuras, las que se plasman en objetos artesanales (dibujos, tallas en madera, mármol, plata, tarro, coco, cobre, cerámica, carey, papier maché, etc.) y en la composición de cantos y poemas.

El pintor cubano Adigio Benítez se ha inspirado en el cocodrilo al realizar sus dibujos.

El grupo musical "Los Compadres" interpreta la canción "Rita la caimana", otros cantos expresan: "Cocodrilo de agua salada", también "caimán no come caimán". Recordemos el popular canto de Colombia: "se va el caimán", aquel que se iba para Barranquilla.

El compositor brasileño Caetano Veloso compuso la canción "Mi cocodrilo verde".

Nicolás Guillén, nuestro Poeta Nacional en su Antología Mayor se refiere al cocodrilo y al caimán en los siguientes términos:

Canción de cuna para despertar a un negrito

Una paloma
cantando pasa.
-Upa, mi negro
que el sol abrasa!

Ya nadie duerme,
ni está en su casa,
ni el **cocodrilo**,
ni la yaguaza,
ni la culebra,
ni la torcaza...
Coco, cacao,
cacho, cachaza,
Upa, mi negro,
que el sol abrasa!

Madrigal
Tu vientre sabe mas que tu cabeza
y tanto como tus muslos.
Esa
es la fuerte gracia negra
de tu cuerpo desnudo.
Signo de selva el tuyo,
con tus collares rojos,
tus brazaletes de oro curvo,
y ese **caimán** oscuro
nadando en el Zambeze de tus ojos.

CONCLUSIONES
Los cocodrilos constituyen un sector de la diversidad animal verdaderamente interesante y dignos de conservación, no sólo en términos de su utilidad, sino como potencial económico y responsable de la estabilidad de los ecosistemas donde viven.

Son conocidos los usos como: comestible, medicinal, ornamental, turístico, cultural y otros. El uso mas común es por su piel ya que su comercio ha incidido en su disminución. El uso en la medicina tradicional de la manteca de cocodrilo en el tratamiento para dolencias respiratorias se practica actualmente y una mayor investigación debe realizarse para explicar y comprobar su efectividad fisiológica. Es interesante notar que muchos usos similares son comunes a grupos étnicos ampliamente separados.

BIBLIOGRAFIA.
Berovides Alvarez, V. 1998. Los reptiles carismáticos de Cuba. Flora y Fauna, Año 2, No. 1: 6-8.

Bolívar Aróstegui, N., y González Díaz de Villegas, C. 1998. *Ta makuende yaya y las Reglas de Palo Monte*. Ediciones Unión.
Borroto Paéz, R. y Aguilar Reyes, A. (en prensa). Estudio preliminar de la utilización de los mamíferos por cultos afrocubanos.
Cabrera, L. 1954. *El Monte. Igbo Finda. Ewe Orisha. Vitilinfinda*. Colección del Chicerecú. Burgay y Cia. La Habana.
Costeau, J. M. 1990. *El espiritu del cocodrilo*. Buenos Aires. Tomado de Gallardo (1994).
Dmitriev, Y. 1992. *El hombre y los animales*. Tomado de *Flora y Fauna*, Año 2, No. 1: 47.
Gallardo, J. M. 1994. *Anfibios y reptiles. Relatos y leyendas, etimología, usos y abusos*. Librería Agropecuaria, S. A. Argentina.
González Suárez, B. G. 1998. Científico o cocodrilero? Flora y Fauna, Año 2, No. 1:16-17.
Guanche Pérez, J. y López Díaz, M. 1997. Serpientes y cocodrilos alados en la herrería colonial del siglo XVIII en Cuba: un saco de transculturación hispanico-africana. *América Negra*, No. 14. Bogotá.
Guillén, N. 1969. *Antología Mayor*. Ediciones Huracán. Instituto del Libro.
Gundlach, J. 1875. *Catálogo de los reptiles cubanos*.
Nichol, J. 1987. *The animal smugglers*. New York.
Nieto, A. 1997. *La fauna silvestre de la Ciénaga de Zapata*. Editorial Científico-Técnica.
Pompa, G. 1988. *Medicamentos indígenas*. Edición 52. Editorial América, S. A. Panamá.
Ross, P. 1992. Crocodile specialist group. *Species*, No. 19. p. 49.
Schubert, A. y Santana, G. 1996. Conservation of the American crocodile (*Crocodylus acutus*) in the Dominican Republic. p. 425-433. En: *Contribution to West Indian Herpetology: A tribute to Albert Schwartz*. R. Powell y R. W. Henderson, (eds.). Society for the Study of Amphibians and Reptiles, Ithaca (New York). Contribution to Herpetology, vol. 12.
Seoane Gallo, J. 1984. *El folclor médico de Cuba*. Editorial de Ciencias Sociales, La Habana.
Souza Hernández, A. de. 1998. *El sacrificio en el culto de los orichas. Ebbó: Animales, materiales y plantas. Religión yoruba*. Ediciones IFATUMO.
Varona, L. S. 1966. Notas sobre crocodílidos de Cuba y descripción de una nueva especie del Pleistoceno. *Poeyana*, Serie A. No. 16: 1-34.
----------. 1976. *Caiman crocodilus* (Reptilia: Alligatoridae) en Cuba. *Miscelánea Zoológica, Acad. Cien. Cuba*. No. 5: 2.
----------.1986a. Implicación taxonómica de algunos caracteres externos de *Crocodylus acutus* (Reptilia:Crocodylidae). *Poeyana*. Serie A. No. 312: 1-6.
----------. 1986b. Algunos datos sobre la etología de *Crocodylus rhombifer* (Reptilia: Crocodylidae). *Poeyana*, Serie A. No. 313: 1-8.
----------. 1987. The state of *Crocodylus acutus* in Cuba. *Carib. J. Sci.* 23 (2): 256-259

Accidentes con *Crocodylus acutus* en Jalisco, México.

Sara M. Huerta Ortega y Paulino Ponce Campos. Bosque Tropical A. C. A. P. 5-515. Guadalajara, Jalisco, México. C.P. 45042. e-mail: smhuerta@jal1.telmex.net.mx

RESUMEN

Uno de los principales problemas para conservar el "caimán" *C. acutus* en la costa de Jalisco, se debe a los accidentes ocurridos. Debido a esto es importante estudiar la problemática hombre-cocodrilos para encontrar acciones por medio de programas productivos en donde los cocodrilianos aporten recursos para la gente local, así como programas educativos.

Para llevar a cabo este estudio se visitaron la mayoría de los cuerpos de agua costeros, donde se hicieron entrevistas a la gente local. Una vez detectado el accidente se buscó al implicado o algún testigo ocular. Hasta el momento se han registrado 11 accidentes en los cinco municipios de la costa del Estado desde 1958 a la fecha. Entre 1960-62 se registró la única pérdida humana hasta el momento. Se investigaron tres casos a parte de los anteriores y fueron descartados. Diez de los accidentes ocurridos fueron con gente local, y se involucran en total ocho animales adultos, un juvenil y un subadulto. La mayoría de los accidentes se relacionan con actividades de pesca y cuatro de estos coinciden con la temporada reproductiva.

A partir de 1993 se han incrementado los accidentes, lo cual se asocia con el aumento de la actividad humana en los esteros, principalmente la pesca. Por lo tanto es necesario informar a la gente sobre los riesgos que existen y como evitarlos.

Palabras clave: Accidentes, Crocodylus acutus, Costa de Jalisco, México.

SESSION: 2. Dealing with success: managing human-crocodile interactions.
Presentation and poster

BODY TEMPERATURE PATTERNS OF AMERICAN ALLIGATORS IN THE EVERGLADES

Stanley R. Howarter[1], Kenneth G. Rice[2], H. Franklin Percival[1], Kenneth M. Portier[3], and Cory R. Morea[4]

The Everglades of South Florida have been greatly altered within the last 100 years. Efforts currently are underway to restore the historic hydropattern of the Everglades. The American alligator (Alligator mississippiensis) is a primarily temperate species whose range extends into the subtropical Everglades. In South Florida, alligators face ambient temperature patterns unlike elsewhere in their range. The consistently high temperatures lead to increased metabolic cost (Coulson and Hernandez, 1983; Lewis and Gatten, 1985). Examination of annual body temperature patterns of Everglades alligators across seasonal hydropatterns may reveal information about their physiology and ecology. By understanding the physiology and ecology of alligators and how changes in their environment may affect them, we are better able to manage the species and its habitat.

The Everglades is believed to be a harsh environment for alligators. Whereas the largest known alligators come from central Florida (Woodward et al., 1995), alligators from subtropical south Florida are much smaller and in poorer body condition indicating that they are from marginal habitat (Jacobsen and Kushlan, 1989; Dalrymple, 1996; Barr, 1997). Alligators in the Shark Slough region of the Everglades have reduced length to weight ratio (Jacobsen and Kushlan, 1989; Barr, 1997), reduced total length, and delayed onset of sexual maturity (Kushlan and Jacobsen, 1990; Dalrymple, 1996) compared with other parts of their range. It is currently suspected that the reason for this poor condition is a combination of low food availability and very high temperatures (Jacobsen and Kushlan, 1989; Dalrymple, 1996; Barr, 1997).

When food is available, alligators seek high temperatures and may increase their metabolic rate three fold (Coulson and Hernandez, 1979; Lang, 1987). The result is a doubling of the rate of food absorption from a body temperature of 20° C to 28° C with no appreciable change in digestive efficiency (Coulson and Hernandez, 1983). Higher temperatures also promote faster protein assimilation and synthesis. By attaining higher temperatures after feeding, alligators can process their prey quickly, enabling them to

[1]Florida Cooperative Fish and Wildlife Research Unit, USGS, Biological Resources Division, University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, Florida.

[2] Florida Caribbean Science Center, USGS, Biological Resources Division, Everglades National Park Field Station, Homestead, Florida

[3] University of Florida, Statistics, Gainesville, Florida.

[4]Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida

acquire more food or devote attention to other behaviors (Lang, 1987). However, when food availability is low, high body temperatures must be avoided in order to avoid the associated high metabolic costs that would deplete resources and lower body condition.

Until the 1970's, data on body temperatures of wild crocodilians consisted of individual measurements of captured or killed animals (Brattstrom, 1965). With the development of radio transmitters, crocodilians could be studied unrestrained under natural conditions in captive enclosures (Smith, 1975; Lang, 1977; Asa et al., 1998; Grigg et al., 1998) or in the wild (Smith, 1975; Brisbin et al., 1982; Seebacher and Grigg, 1997). However, data collection was limited to times when researchers could access implanted animals or when remote recording stations could receive signals from transmitters. Technological advances have allowed miniaturization of temperature data logging devices so that continuous data collection is now possible.

In this study, 10 adult American alligators free ranging in the Everglades were implanted with temperature recording data loggers. This allowed thorough examination of their body temperature patterns. By examining these patterns we hope to better understand the ecology of these animals and help guide management of their unique habitat.

Study Area

The Everglades is dominated by a large expanse of seasonally flooded sawgrass (Cladium jamaicense). Historically, a continuous sheet of water flowed from Lake Okeechobee south to Florida Bay (Light and Dineen, 1994; McIvor et al., 1994). The vegetation changes from stands of tall sawgrass in the north to a mosaic of sawgrass, spike rush (Eleocharis cellulosa) and waterlilies (Nuphar luteum, Nymphaea odorata, and Nymphoides aquatica) in the southern, deeper waters of the drainage (Gunderson, 1994).

The Everglades, in most years, has distinct wet (May - September) and dry (October - April) seasons. Alligators compensate for the lack of water by maintaining "gator holes," depressions in the marsh that retain water in times of drought (McIlhenny, 1935; Craighead, 1968; Mazzotti and Brandt, 1994). The recent creation of canals and airboat trails has added low maintenance deepwater refuges for alligators in the Everglades. Animals in this study were located in Water Conservation Area 3A North.

Methods

Animals were captured using snares and toggle darts from airboats (Howarter, 1999) Alligators were then taken to the University of Florida Fort Lauderdale Research and Education Center in Davie, Florida. The total length, snout-vent length (to the end of the vent), head length, hind foot length, tail girth, mass, and sex were recorded. Each alligator was then permanently marked with two individually numbered Monel tags, a size 6 tag on the first sagittal scute on the tail and a size 3 tag in the webbing of the right hind foot.

Data loggers

The disk shaped data loggers (Tidbit Stowaway Temperature Loggers manufactured by Onset Computer Corporation) had a diameter of 3.0 cm and a thickness of 1.5 cm. Each data logger was capable of recording 7944 temperature readings from a range of -5 to 37 °C with an accuracy of +/- 0.2 C. Data loggers were programmed to record temperature every 72 minutes, allowing 396 days of continuous data collection. Data collection times were programmed using Logbook software (Onset Computer Corporation) and a PC computer. All data loggers were synchronized so that they recorded temperature simultaneously. Once recovered, datalogger's thermistors were tested to ensure that they had not drifted.

Data loggers were also used to record environmental temperatures. Air and deep water temperatures were recorded in the marsh near the home ranges of implanted alligators. The air temperature data logger was shielded from direct solar radiation by a glossy white 14 l plastic bucket with slotted vents for ventilation. The bucket was attached upside down to a post and the data logger was suspended in the middle of the bucket. The deep water temperature data logger was attached to a concrete block that anchored it at the bottom of the water column. The average of air and deep water temperature from each 72 minute interval was then used to create a time series of ambient temperature.

Surgery

Alligators were anesthetized using a combination of medetomidine and isoflurine (T. S. Gross, United States Geological Survey, unpublished data). Data loggers were cold sterilized and surgically implanted intraperitoneally on the left flank between the last rib and the hind limb. This technique allowed low impact access to the center of the body, which provided accurate core body temperature readings. Two sterilized radio transmitters were then implanted between the peritoneum and the muscle layer on each side of the alligator, one accessed via the incision used to implant the data logger, and the other through an additional incision on the right flank. After incisions were sutured, the medetomidine was reversed using atipamezole hydrochloride and the alligators were monitored for signs of ill health. The alligators were then released within 24 hours at the exact capture location.

After one year of temperature recording, alligators were recaptured, dataloggers were removed using the same surgical techniques, and the animals were released at the recapture site.

Data Analysis

Body temperatures over the course of the year were subdivided among seasons to examine differences in means and variances among summer, fall, winter, and spring

seasons. The data were placed into biologically meaningful categories to determine the composition of the temperature profile. Temperatures below 16 C° were considered metabolically inactive. Temperatures from16 C° to 22 C° were considered metabolically restrained since alligators typically do not feed if body temperature falls below this point (Coulson and Hernandez, 1983). Temperatures from 22 to 28 C° were considered intermediate since the lower end of activity temperature has been described as 28 C° (Coulson and Hernandez, 1983; Lang, 1987). Temperatures from 28 to 31 C° were considered metabolically active. Because of their high metabolic cost, temperatures above 31 C° were considered metabolically expensive. The composition of temperatures was examined for the entire year and within seasons.

To analyze patterns, each data set was smoothed to quantify and remove seasonal, weekly, and daily components. A moving average was used to extract the temperature components. The number of data points averaged (the averaging window size) determined the pattern being quantified. For example, to determine the seasonal component, an averaging window of 1680 (84 days) data points, 839 before and 840 after a specific time point was used. The resulting time series represented the general pattern in temperature of an alligator over the year. This general pattern, or seasonal component, was then subtracted from the original data time series with the result representing the pattern of body temperatures as deviations from the seasonal pattern. This technique was then used to remove the weekly component (140 data points), which represents the fluctuation in body temperature as affected by weekly weather events such as cold fronts and other weather systems. The technique was then used to remove the daily component (20 data points), which represented day to day variability in T_b. Subtracting this third smoothed time series from the deviations from the weekly time series revealed the within-day variability of T_b.

The smoothing process reduced the size of the data set by the number of data points being smoothed. Since only the averaged data were used, data points at the beginning and end of the data set that were used to create the average were not part of the smoothed data set. Thus seasonal, weekly and daily smoothes reduced the data set by a total of 1840 observations. This limited comparison of smoothed temperatures to fall, winter, and spring seasons since data for summer were not available.

Seasonally smoothed body temperatures represented the seasonal pattern of T_b and thus were used to describe the seasonal pattern of T_b over the course of the year. The variances of the seasonal, weekly, daily, and within-day components were used to indicate the variability within each component's portion of the pattern in T_b. Means were not used to describe weekly, daily, and within-day components because they fluctuated around a baseline of zero.

The proportion of the total variability in T_b was determined for seasonal, weekly, daily, and within-day components by dividing the variance of each component by the total variance. The proportions of total variability from seasonal, weekly, daily, and within-day components were then determined for fall, winter, and spring seasons. The proportions of the components were compared among seasons using a two sample T-test assuming unequal variances. To avoid possibility of type I errors due to multiple comparisons, only P values < 0.01 were considered significant.

For the analysis, the traditional seasons were changed to16 September 1997 to 15 December 1997 for fall, 16 December 1997 to 16 March 1998 for winter, and 17 March 1998 to 16 June 1998 for spring. While these are eight days earlier than the traditional seasonal delineation, advancing the dates assured that equal numbers of temperature observations would be used for each season, and that all the data could be used in the analysis. This also permitted seasonal temperature patterns to represent wet (summer and fall) and dry (winter and spring) seasons. Adjusting the seasonal delineation allowed consistency in seasonal time frames when describing smoothed and non-smoothed data. Because data collection began midsummer, data from two years was combined to create the non-smoothed summer data set, which consisted of data collected from 1 August to 14 September 1997 and from 17 June to 31 July 1998.

To establish if alligator T_b corresponded to changes in fall and spring ambient temperatures, the correlation between T_b and ambient temperature was determined for all 10 alligators. Each time series was smoothed using a window of 20 data points (one day) in order to identify the pattern in temperature across the season. The time series from each alligator was then paired with the corresponding ambient temperatures and analyzed using SAS (SAS Institute). Because some ambient temperature data were missing, fall analysis was limited to 10 October 1997 to 16 December 1997.

Results

Ten functional dataloggers were recovered from alligators in WCA, seven females from the marsh habitat, one female and two males from the canal habitat. The ten recovered animals ranged in weight from 20 to 49 kg. Marsh animals weighed less ($\bar{x} = 25.5$ kg, $n = 7$) than canal animals ($\bar{x} = 45.3$ kg, $n = 3$; $P = 0.006$).

All alligators followed a similar pattern of annual body temperature (Fig. 1). Summer temperatures were high and stable ($\bar{x} = 29.0 \pm 1.7°$ C; Fig. 2). Fall temperatures ($\bar{x} = 24.0 \pm 3.3°$ C; Fig. 2) declined corresponding to a decline in ambient temperature ($P < 0.0001$, $R^2 = 0.6397$, $n = 13910$; Fig. 3). Winter temperatures remained low ($\bar{x} = 20.8 \pm 3.2$°C; Fig. 2), fluctuating with environmental temperatures (Fig. 3), with only occasional periods where body temperatures were raised above 28° C. During spring minimum body temperatures ($\bar{x} = 26.3 \pm 3.4°$ C; Fig. 2) increased with increasing environmental temperatures ($P < 0.0001$, $R^2 = 6895$, $n = 18400$; Fig. 3).

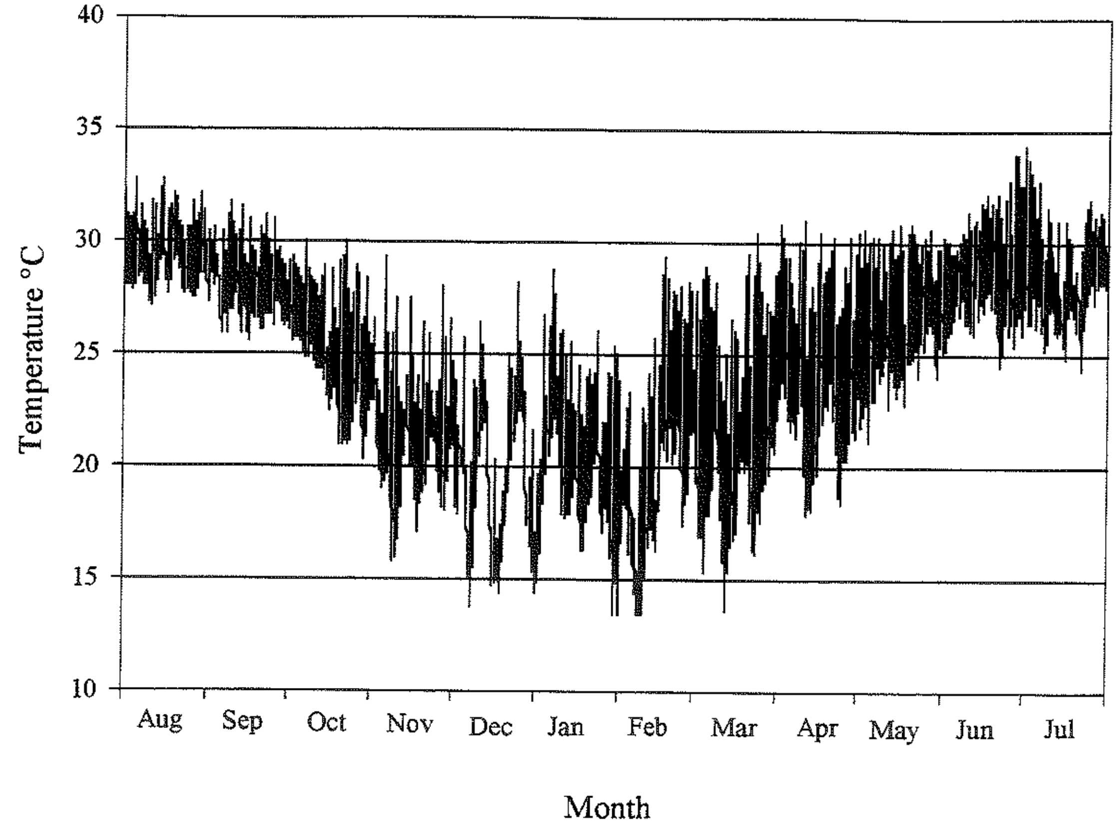

Figure 1. The typical pattern of body temperature of an alligator from Water Conservation Area 3A North (from alligator # 878, a 30 Kg female). Temperature was recorded at 72 minute intervals from 1 August 1997 to 31 July 1998.

The distribution of the 7296 consecutive temperature observations recorded over a one-year period for each alligator in the WCA fit a bell shaped curve within the five metabolically based temperature categories (Fig. 4). The distribution pattern of temperatures varied greatly between seasons. In the fall the bell shaped curve narrowed with most temperatures in the intermediate category (Fig. 4). Four alligators had no body temperatures below 16° C. Three of the four were the largest alligators in the study and inhabited a canal. In winter the majority of observations were in the colder categories (Fig. 4). Winter body temperatures were rarely in the warmest categories. Spring body temperatures skewed towards the warmer categories (Fig. 4). No alligators had body temperatures in the inactive range. Metabolically expensive temperatures were nearly 10 times as frequent in spring as in fall. Metabolically active temperatures were more than twice as frequent in spring than in fall. In summer warm temperatures dominated the distribution (Fig. 4). Metabolically expensive temperatures averaged 13.8% with one individual having 27.8% of observations in this category. The lowest temperature of any alligators during summer was 23.8° C.

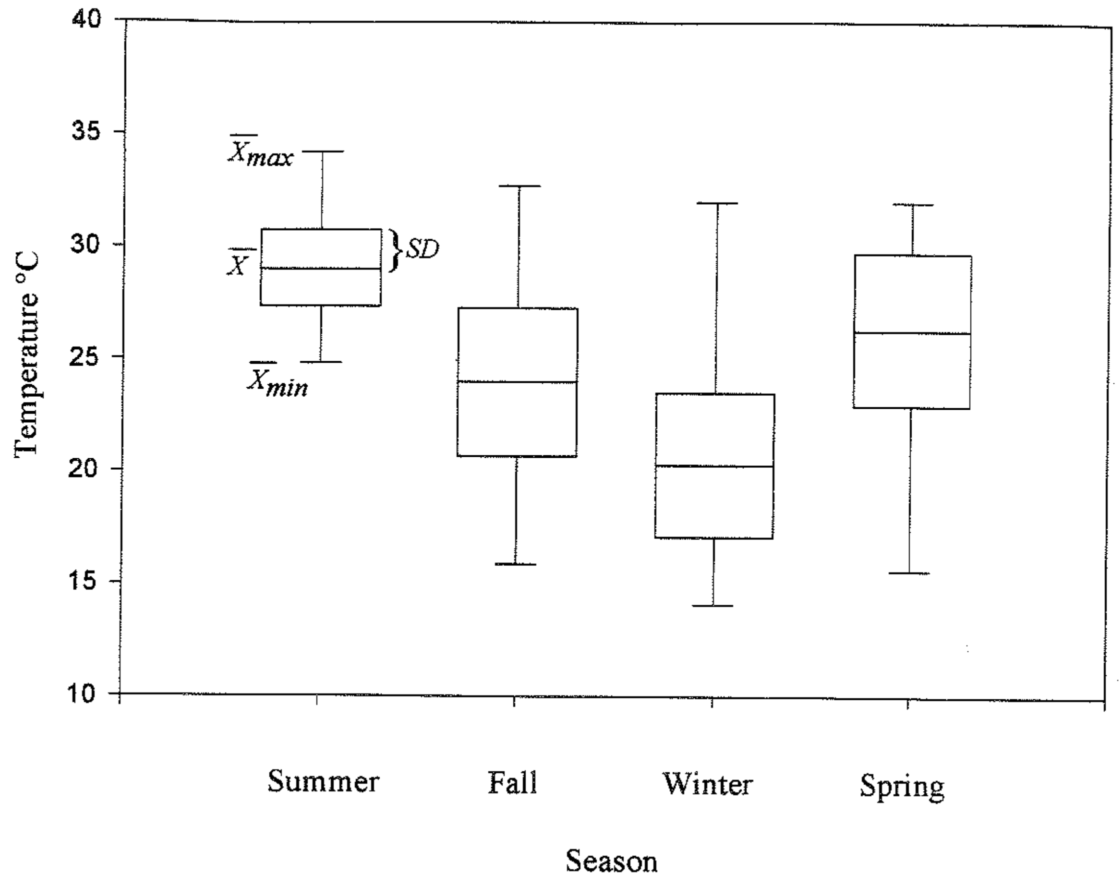

Figure 2. Mean of ten alligator's mean seasonal body temperatures ($\bar{x}$), +/- one mean standard deviation (SD), mean maximum body temperature ($\bar{x}_{max}$), and mean minimum body temperature ($\bar{x}_{min}$) were recorded from free ranging adult alligators in Water Conservation Area 3A North for summer (1 August to 14 September 1997 and 17 June to 31 July 1998), fall (16 September to 15 December 1997), winter (16 December 1997 to 16 March 1998), and spring (17 March to 16 June 1998).

In fall, mean seasonally smoothed T_b steadily decreased from 27.7° C to 20.9° C with an overall mean of 24.0° C (Fig. 5). In winter the seasonal body temperatures decreased to a mean of 20.0° C (Fig. 5), then steadily increased in the second half of the season (Fig. 5). All but one alligator reached its lowest seasonal smoothed body temperature on 5 or 6 January; the exception was a canal male who reached his lowest seasonal smoothed body temperature on 9 February. The ninth of February coincided with a cold front that reduced ambient temperature to 9.4° C. This was also the coldest day (± one day) for body temperatures for all alligators. After reaching this low, seasonal smoothed body temperatures steadily increased. Overall mean winter seasonal smoothed body temperatures were 20.8° C (Fig. 5). In spring the mean seasonal smoothed body temperatures steadily increased from 22.4° C to 28.7° C with an overall mean of 26.1° C (Fig. 5).

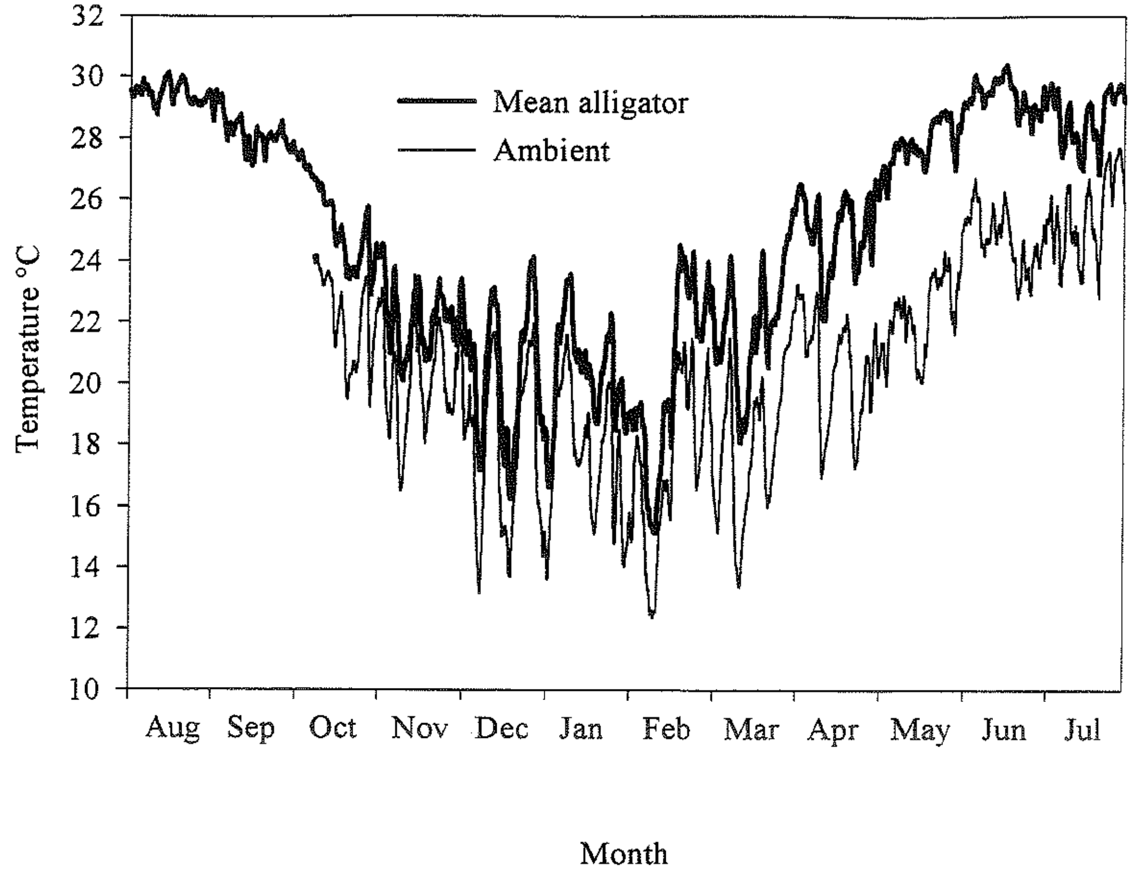

Figure 3. Mean smoothed body temperatures of ten alligators from WCA 3A North (1 August 1997 to 31 July 1998) plotted with ambient temperatures (7 October 1997 to 31 July 1998). All temperatures were recorded simultaneously at 72 minute intervals and then smoothed using a moving average of 20 observations (one day). Ambient temperature was the average of air and marsh water temperatures.

The variance of T_b differed among temporal components and between seasons (Fig. 6). When the variances from the seasonal, weekly, daily, and within-day components were combined for each alligator, the average of the total variances was 14.6° C. The average percent of total variance that was accounted for by each component was 54%, 12%, 6%, and 28% respectively (Fig. 7).

When the components were subdivided by season, the fall percentages were similar to the overall patterns with seasonal, weekly, daily, and within-day components accounting for 51, 9, 9, and 31 percent of the average total variance, respectively (Fig. 7). In winter there is a drastic shift in the composition of the total variance from fall (Fig. 7). The seasonal component is reduced to 5% of the total variance ($P < 0.001$), while the weekly component increased to 34% ($P < 0.001$). The daily component increased to an average of 14% ($P < 0.001$) and the within-day component increased to an average of 46% ($P = 0.014$). In spring the composition again changes with the within-day component becoming the predominant component (Fig. 7). The seasonal component averaged 36% of the total variance, an increase over winter

($P < 0.001$) and a decrease from fall ($P < 0.001$). The weekly component averaged 9%, a decrease from winter ($P < 0.001$) but not significantly different from fall ($P = 0.07$). The daily component averaged 6%, a decrease from winter ($P < 0.001$) and a smaller but significant decrease from fall ($P = 0.002$). The within-day component was the dominant variance in spring. It encompassed 50% of the variance, an increase from both winter ($P = 0.004$) and fall ($P < 0.001$).

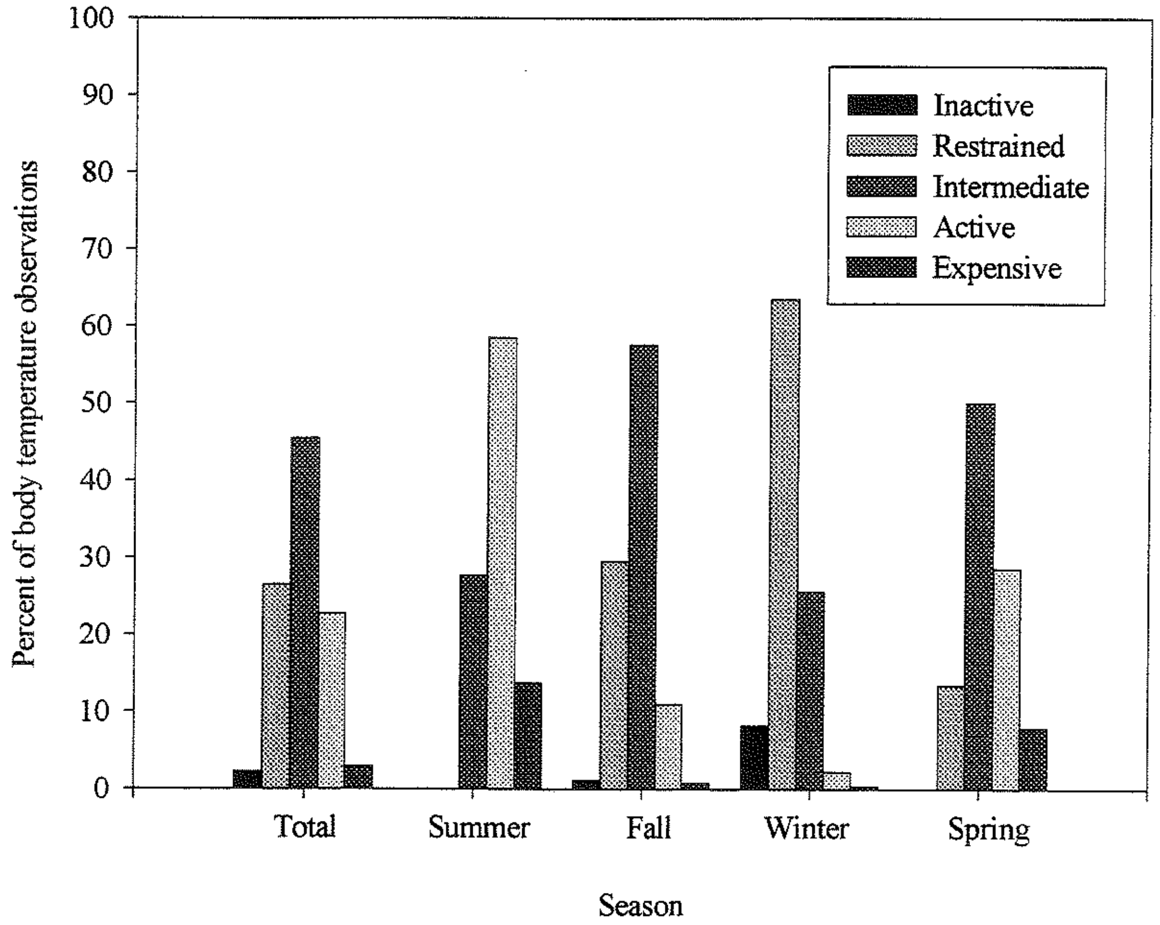

Figure 4. Percent of body temperature observations distributed within inactive (11.01 - 16.00° C), restrained (16.01 - 22.00° C), intermediate (22.01 - 28.00° C), active (28.01 - 31.00° C), and expensive (>31.01° C) metabolic temperature categories. A total of 7296 observations were recorded for each of ten alligators in Water Conservation Area 3A North. Temperatures were recorded simultaneously at 72 minute intervals from 1 August 1997 to 31 July 1998. Seasons consisted of 1820 observations each for summer (1 August to 14 September 1997 and 17 June to 31 July 1998), fall (16 September to 15 December 1997), winter (16 December 1998 to 16 March 1998), and spring (17 March to 16 June 1998).

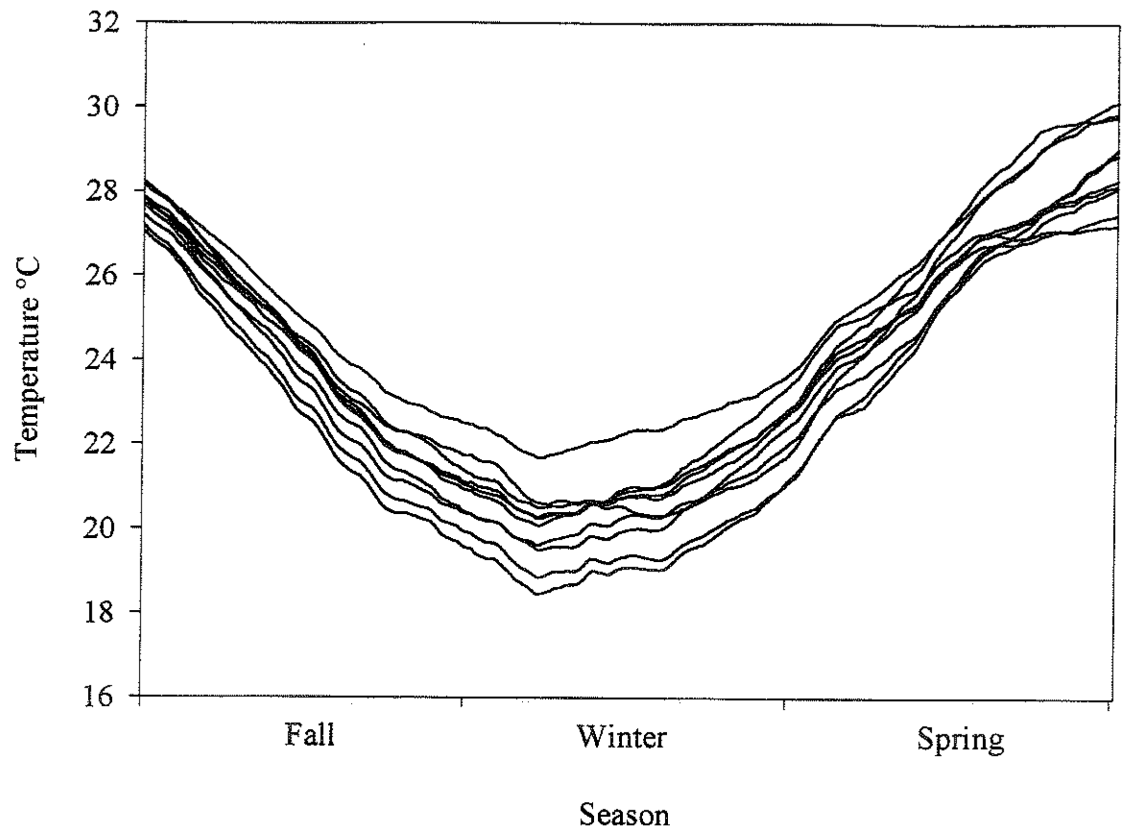

Figure 5. Seasonally smoothed body temperatures of ten alligators from Water Conservation Area 3A North. Body temperatures were recorded simultaneously at 72 minute intervals from 1 August 1997 to 31 July 1998 and then smoothed using a moving average of 1680 data points (84 days).

Discussion

In spring, alligators raised their body temperature well above the average ambient temperatures on a nearly daily basis. While this pattern is observed occasionally in winter and to a lesser degree in fall, it was most frequent in spring. Since spring ambient temperatures are similar to those of fall and even winter, biological factors, rather than passive fluctuations in body temperature must be driving this difference.

Elevation of T_b in spring may be a consequence of alligator's reproductive strategy. Alligators have a compressed breeding season. Females lay their eggs within a four week period beginning in mid June. To accomplish this task, they must be physiologically prepared to breed. Hormone production and efficiency are temperature dependent. Warm temperatures are necessary for proper hormone levels to induce sperm and egg production (Lance, 1987).

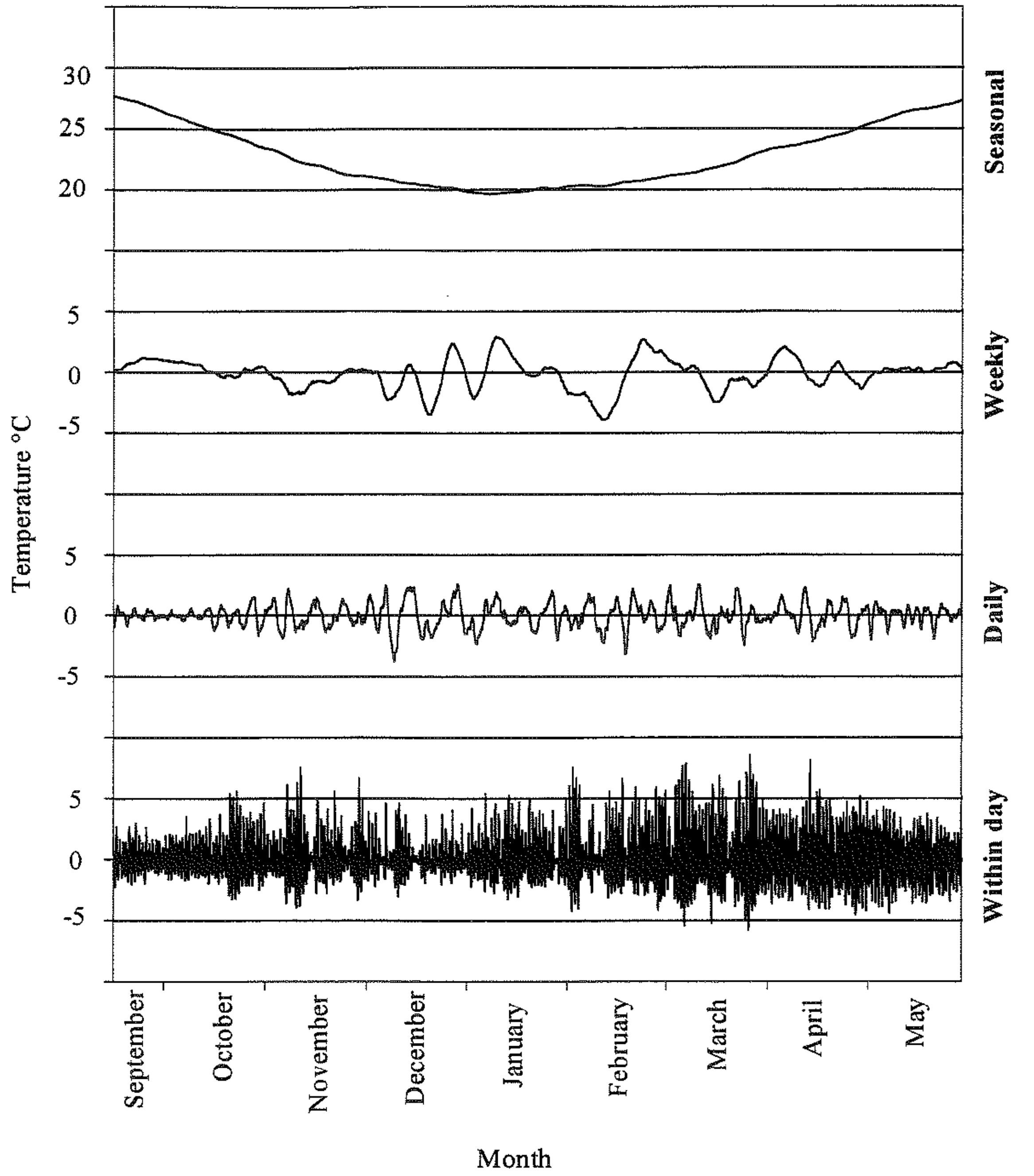

Figure 6. Seasonal, weekly, daily, and within-day components of body temperature of a typical alligator (alligator# 878, a 30 Kg female) from Water Conservation Area 3A North.

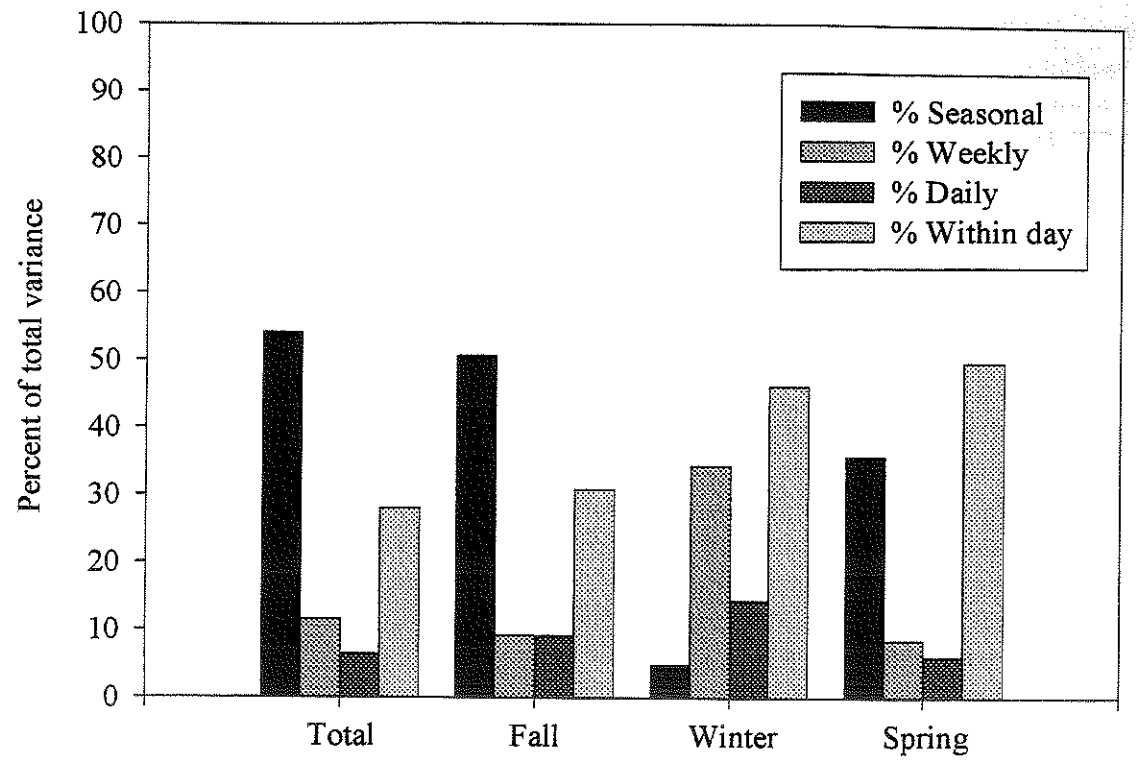

Figure 7. Percent of total variance accounted by seasonal, weekly, daily, and within-day components in body temperature from 10 alligators from Water Conservation Area 3A North. The total smoothed time series consisted of observations from 16 September 1997 to 16 June 1998. The time series was then subdivided into fall (16 September to 15 December 1997), winter (16 December 1998 to 16 March 1998), and spring (17 March to 16 June 1998) seasons for inter-seasonal comparisons.

Spring is also the peak of the dry season in the Everglades. The Southern Everglades is a nutrient poor system and food for alligators is relatively scarce (Barr, 1997). When water levels are high, prey species are widely dispersed across the landscape. However, in the dry season the lower water levels concentrate prey in the few remaining areas of deeper water, such as gator holes (Kushlan, 1976). These areas provide an abundant food source for alligators. To take full advantage of this feeding opportunity, alligators must be able to process as much food as possible during this time period.

Because temperatures during the dry season are relatively cool, body temperatures must be elevated to facilitate maximal assimilation of nutrients. By raising body temperatures, metabolic rate and enzymatic activity is greatly increased, allowing alligators to quickly process prey (Coulson and Hernandez, 1983). They are thus able to consume and assimilate larger amounts of nutrients in a shorter period of time.

The decrease in water level also reduces the thermal buffer that alligators use to moderate temperature fluctuations. This may account for some of the increased variability in spring T_bs, but it is unlikely that it can account for all of it. When alligator temperatures are compared with environmental temperatures, the difference between alligator and environmental patterns is distinctly greater in spring than any other season. In addition, alligators from canals, which have abundant water year round, show the same pattern of elevated spring temperatures as marsh alligators.

During the summer wet season in the Everglades, prey items are dispersed and difficult to acquire (Kushlan, 1976). Because summer is also a time of consistently high temperatures, metabolic rates are very high, increasing the demand for food resources. Since energy resources are most difficult to acquire when they are needed most, summer is likely a time of negative energy balance for Everglades alligators.

In summer T_b frequently rises above the normal activity temperature of 31° C and may attain temperatures as high as 36° C. While gator holes and caves provide some refuge from the heat, alligators that are attending nests or otherwise exposed must endure temperatures above the normal activity level. While alligators will raise their body temperature above 31° C at other times of the year, this usually occurs during periods when nighttime ambient temperatures are low. At such times, raising daytime body temperature above 31° C may well be an attempt to use thermal inertia to maintain an overall higher temperature into the cool night. In contrast, high summer temperatures represent an increased metabolic burden resulting from high ambient temperatures.

In the fall T_b follows a pattern of thermoconformity similar to summer in that temperatures fluctuate little around the daily mean. However, unlike summer, when ambient temperatures are stable around an alligator's activity temperature, fall ambient temperatures decline steadily. Fall T_bs decline along with declining ambient temperatures. Only occasionally are T_bs raised to activity temperatures in the cooler portions of fall. Because water levels are very high this time of year, the limited availability of food probably drives alligators to minimize T_b in order to minimize metabolic costs.

Although Everglades alligators maintain low T_bs during the winter months, T_bs are occasionally raised to activity levels. These heating events are not synchronized as would be expected if environmental factors alone were inducing basking behavior. Rarely did more than one alligator elevate T_b on the same day. While high T_bs are associated with feeding, winter T_bs are elevated only for short periods, usually one day. Digestion of prey could not be accomplished in such a short time (Barr, 1997). Perhaps elevated T_bs in winter are necessary for excretion of metabolic wastes (Coulson and Hernandez, 1983).

No alligators had T_bs below 11° C and rarely were they below 15° C. Since alligators are adapted to temperate climates, they have evolved an annual cycle that includes winter hibernation. While throughout most of the alligator's range cold winter temperatures promote a deep hibernation in which metabolism is greatly reduced, winter

temperatures in the Everglades are not low enough for effective hibernation. Thus, while winter temperatures average 22° C, the approximate temperature at which alligators refrain from eating (Coulson and Hernandez, 1983), their metabolic rates are sufficiently high to create waste that must be excreted. Occasional high body temperatures may be necessary to accomplish this task. A more thorough study of the physiological ecology of these animals is necessary in order to understand the biological forces driving these temperature patterns.

Conclusion

Summer represents a difficult period in the annual cycle of the Everglades alligator. To acquire sufficient resources to survive this metabolically expensive time of year, alligators rely on the spring reduction of free standing water in the marsh to concentrate prey. Without natural fluctuation of hydropattern to concentrate food, alligator populations would be negatively impacted. Since many species in the Everglades depend on the maintenance of gator holes for refugia during time of drought, factors negatively affecting alligator populations would impact the entire ecosystem.

While a complete drawdown would make the majority of the prey items in the marsh available for consumption, this would increase the recovery period needed for prey to repopulate the marsh. A more natural balance must be struck where prey becomes available to alligators but enough standing water remains so that breeding sized adult prey survive. By restoring the historic hydrologic patterns of the Everglades, fringe marshes could dry out while the deeper sloughs and drainages would retain water. This would insure that food would become available in the short term yet not be eliminated in the long term.

Literature cited

Asa, C. S., G. D. London, R. R. Goellner, N. Haskell, G. Roberts, and C. Wilson. 1998. Thermoregulatory behavior of captive American alligators (Alligator mississippiensis). J. Herpetol. 32:191-197.

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

Brattstrom, B. H. 1965. Body temperatures of reptiles. Am. Midl. Nat. 73:376-422.

Brisbin, I. L., E. A. Standora, and M. J. Vargo. 1982. Body temperature and behavior of American alligators during cold winter weather. Am. Midl. Nat. 107:209-218.

Coulson, R. A., and T. Hernandez. 1979. Increase in metabolic rate of the alligator fed protiens or amino acids. J. Nutr. 109:538-550.

Coulson R. A., and T. Hernandez. 1983. Alligator metabolism, studies on chemical reactions in vivo. Comp. Biochem. Physiol. 74B:1-182.

Craighead, F. C. 1968. The role of the alligator in shaping plant communities and maintaining wildlife in the southern everglades. Fla. Nat. 41:2-7, 69-74, 94.

Dalrymple, G. H. 1996. Growth of the American alligator in the Shark Valley region of Everglades National Park. Copeia. 1:212-216.

Grigg, G. C., F. Seebacher, L. A. Beard, and D. Morris. 1998. Thermal relations of large crocodiles, Crocodylus porosus, free-ranging in a naturalistic situation. Proc. R. Soc. Lond. B 265:1-7.

Gunderson, L. H. 1994. Vegetation of the Everglades: determinants of community composition in S. Davis and J. Ogden (eds.), Everglades: The Ecosystem and its Restoration, pp. 848, St. Lucie Press, Delray Beach, FL.

Howarter, S. R. 1999. Thermal Ecology of the American Alligator in the Everglades. MS Thesis, Univ. Florida, Gainesville, Florida.

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

Kushlan, J. A. 1976. Wading bird predation in a seasonally fluctuating pond. Auk. 93:464-476.

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

Lance, V. A. 1987. Hormonal control of reproduction in crocodilians. in G. J. W. Webb, S. C. Manolis, and P. J. Whitehead (eds.), Wildlife Management: Crocodiles and Alligators, pp. 301-317. Surrey Beatty and Sons, Ltd., New South Wales, Australia.

Lang, J. W. 1977. Studies of the thermal behavior and body temperature of crocodilians. Ph.D. Thesis Dissertation, Univ. Minnesota, Minneapolis, Minnesota.

Lang, J. W. 1987. Crocodilian thermal selection. in G. J. W. Webb, S. C. Manolis, and P. J. Whitehead (eds.), Wildlife Management: Crocodiles and Alligators, pp. 301-317. Surrey Beatty and Sons, Ltd., New South Wales, Australia.

Lewis, L.Y., and R. E. Gatten Jr.. 1985. Aerobic metabolism of American alligators, Alligator mississippiensis, under standard conditions and during voluntary activity. Comp. Biochem. Physiol. 80A:442-7.

Light, S. S., and J. W. Dineen. 1994. Water control in the Everglades: a historical perspective in S. Davis and J. Ogden (eds.), Everglades: The Ecosystem and its Restoration, pp.47-84. St. Lucie Press, Delray Beach, FL

Lodge, T.E. 1994. The Everglades Handbook: Understanding the Ecosystem. St. Lucie Press, Delray Beach, Florida.

Mazzotii, F. J., and L. A. Brandt. 1994. Ecology of the American alligator in a seasonally fluctuating environment in S. Davis and J. Ogden (eds.), Everglades: The Ecosystem and its Restoration, pp. 485-506. St. Lucie Press, Delray Beach, FL.

McIlhenny, E. A. 1935. The alligator's life history. Christopher Publ. House, Boston. 117pp.

McIvor, C. C., J. A. Ley, and R. D. Bjork. 1994. Changes in freshwater inflow from the Everglades to Florida Bay including effects on biota and biotic processes: a review. in S. Davis and J. Ogden (eds.), Everglades: The Ecosystem and its Restoration, pp. 149-198. St. Lucie Press, Delray Beach, FL

Morea, C. R. 1999. Home range, movement, and the habitat use of the American alligator in the Everglades. MS Thesis, Univ. Florida, Gainesville, Florida.

Seebacher, F., and G. C. Grigg. 1997. Patterns of body temperature in wild freshwater crocodiles, Crocodylus johnstoni: thermoregulation versus thermoconformity, seasonal acclimatization, and the effect of social interactions. Copeia. 3:549-557

Smith, E. N. 1975. Thermoregulation of the American alligator, Alligator mississippiensis. Physiol. Zool. 48:177-194.

Woodward, A.R., J.H. White, and S.B. Linda. 1995. Maximum size of the alligator (Alligator mississippiensis). J. Herpetol. 29(4): 507-513.

Home Range and Daily Movement of the American Alligator in the Everglades

Cory R. Morea, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida 32399-1600

Kenneth G. Rice USGS, Biological Resources Division, Florida Caribbean Science Center, 40001 SR 9336, Homestead, Florida 33034

H. Franklin Percival, Florida Cooperative Fish and Wildlife Research Unit, USGS, Biological Resources Division, University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, Florida 32611

Stanley R. Howarter, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Department of Wildlife Ecology and Conservation, Gainesville, Florida 32611

Abstract

The American alligator (*Alligator mississippiensis*) characterizes the Everglades of South Florida and is considered a keystone species within the system. Everglades restoration efforts have begun and are intended to improve the system and mimic a more natural hydrology. A multi-component modeling effort, Across Trophic Level System Simulation (ATLSS), was undertaken to help determine restoration alternatives for the Everglades that were beneficial to the flora and fauna endemic to the region. A radio-telemetry project was initiated to quantify ATLSS modeling parameters for the alligator.

Home range size and daily movement were determined for 16 radio-tagged alligators in Water Conservation Area 3A North (WCA) and 15 radio-tagged alligators in Everglades National Park (ENP). Alligators were captured and surgically implanted with radio-transmitters. Weekly aerial locations collected from 1 July 1997 to 21 September 1998 were used to estimate home range size. Weeklong intensive field missions conducted in each fall, winter, spring, and summer from 7 November 1997 to 31 July 1998 were used to estimate daily movement.

Alligator home range size and daily movement were most affected by gender, temperature, reproductive efforts, habitat, and water level. Mean seasonal alligator home ranges successively decreased from spring (39 ha) to summer (32 ha) to fall (28 ha) to winter (14 ha). Mean annual home range size for male alligators (122 ha) was significantly greater than for females (36 ha). Mean seasonal daily movements successively decreased from spring (406 m/24-hr) to summer (261 m/24-hr) to fall (154 m/24-hr) to winter (100 m/24-hr). Male alligators (167 m/24-hr) moved significantly more than female alligators (70 m/24-hr).

Introduction

Radio-telemetry studies of the American alligator (*Alligator mississippiensis*) have been conducted in Louisiana (Joanen and McNease, 1970; Joanen and McNease, 1972; McNease and Joanen, 1974; Taylor, 1984; Rootes and Chabreck, 1993), South Carolina (Murphy, 1977), and Florida (Goodwin and Marion, 1979). Hines et al. (1968) studied alligator movement in the Everglades using mark and recapture techniques on juveniles. These studies have provided valuable data on the temporal and spatial variability of alligator home range size and daily movement attributable to differences in gender, habitat, season, reproductive class, and size. Information regarding home range size and daily movement of alligators are lacking for the Everglades region of South Florida.

Factors affecting the natural movement of alligators include gender, age, temperature, breeding season, water level, food supply, and water salinity (Chabreck, 1965; Fogarty, 1984). Temperature, water level, food supply, and water salinity can vary temporally and spatially within a wetland and weakens any inferences based upon movement data collected in other wetland systems or geographic regions. Thus, in order to adequately draw in-depth conclusions concerning a species home range and daily movement, the population in question must be studied.

Prior to the late 1800s, the Everglades of South Florida remained in a natural state (Lodge, 1994). Human influences during this time were limited to minor manipulations of the environment by the Indian population in the area. Indian subsistence hunting, burning, and the cutting of trails were of such a small scale that they would probably be unnoticed by comparison with modern human influences. Beginning in 1882, the Caloosahatchee River was canalized and canals (the Miami, North New River, Hillsborough, and West Palm Beach canals) were cut through the central portions of the Everglades (Douglas, 1994). A final canal, the St. Lucie, was constructed in 1916, and the southern rim of Lake Okeechobee was diked to reclaim lands south of the lake for agricultural purposes (Douglas, 1994). These alterations dramatically changed the natural hydrology of the Everglades and in 1948; Congress authorized the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project; Lodge, 1994). With implementation beginning in the mid-1950s and the main features completed by the mid-1960s, the subsequent water management regime has been highly beneficial to many of man's interests (i.e., agriculture, water supply, and flood control), but not to wildlife (Lodge, 1994).

The C&SF Project Comprehensive Review Study, known as the Restudy, was authorized by Congress in 1992, to determine "the feasibility of modifying the project to restore the South Florida ecosystem and to provide for the other-related needs of the region" (USACE, 1999). Based on this initiative, Everglades restoration has begun and comprehensive modeling of biotic and abiotic attributes have been undertaken to determine suitable restoration alternatives (USACE, 1999). A multi-component