Precocious reproductive development in a farm-raised and released American alligator, *Alligator mississippiensis*

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ABSTRACT – An alligator trapper from Cameron, Louisiana recently reported harvest of a small "nuisance" alligator (total length = 142.24 cm) which upon internal examination contained 12 hard-shelled eggs within one oviduct. The alligator had been released from a commercial alligator farm as part of Louisiana's alligator egg ranching program 27.75 months prior to being caught. Prior to release, it had been marked with numbered tags attached to the webbing between the toes on the rear feet and by a permanent tail-notch. Based on the size and date of release, the alligator was less than four years old when harvested. To my knowledge this is the smallest female alligator in which reproductive development has been documented..

WILD American alligators (*Alligator mississippiensis*) reach sexual maturity in Louisiana at a minimum estimated total length (TL) of approximately 183 cm (Joanen & McNease, 1980), although a higher percentage of female alligators are reproductively active and nest successfully as TL approaches 213 cm (see review in Elsey *et al.*, 2001a). The age at which wild female alligators reach sexual maturity in Louisiana was estimated to be eight years in estuarine habitats, and thirteen years in paulstrine habitats, where growth rates are slower (Rootes *et al.*, 1991). Wilkinson (1983) reported female alligators in South Carolina do not begin breeding until attaining a TL of 213 cm, at which time they are estimated to be 11.5 years old (Wilkinson & Rhodes, 1997). McIlhenny (1935) reported the smallest female alligator he caught at a nest was 190.5 cm TL, which he estimated to be seven years old. His examination of 175 female alligators killed

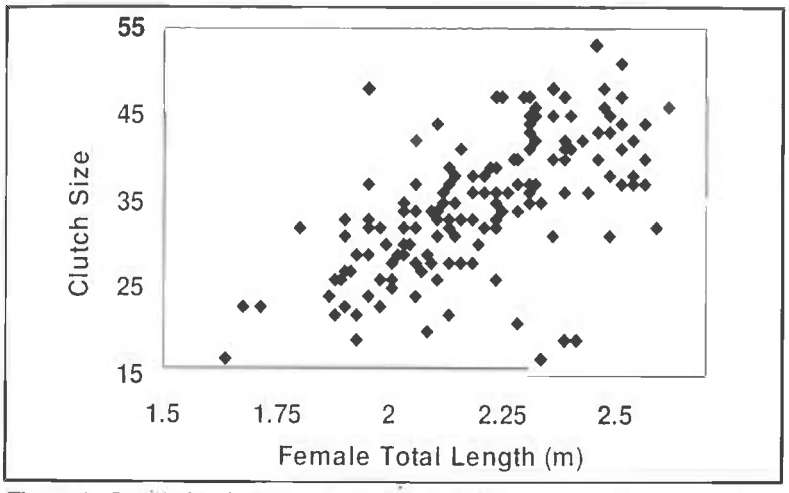

Figure 1. Correlation between clutch size and female total length (m) in *Alligator mississippiensis*.

during the breeding season showed the smallest "with eggs" was 185.42 cm, which led him to conclude female alligators do not breed until they are six or seven years old (McIlhenny, 1935).

In captivity, growth rates of alligators can be markedly accelerated due to animals being fed a high energy diet and maintained in a heated environment, which avoids a winter dormancy seen in wild alligators. These captive-reared alligators grow to a length of approximately 183 cm, and can reach sexual maturity in 5 years, 10 months (70 months total); as compared to wild alligators (from unspecified habitat salinity) that require approximately ten years to attain breeding size (Joanen & McNease, 1987).

In Louisiana, an extensive commercial alligator farming program has been in place since 1986. An alligator egg "ranching" component of this program allows licensed farmers to collect eggs from the wild, and a percentage of the juveniles reared from the hatched eggs are later released back to the wild as part of a "head start" program (Elsey *et al.*, 2001a, 2001b). The superior growth rates of alligators initially raised for one or two years in heated sheds on alligator farms, and subsequently released back to the wild has enabled some farm-released juveniles to reach sexual maturity (based on examination of the reproductive tracts of harvested specimens) and exhibit evidence of nesting in the wild by age 5 years, 10 months (Elsey *et al.*, 2001a).

In many crocodilians, clutch size is strongly correlated with female body size (Thorbjarnarson 1996). Hall (1991) used morphometric models to predict the minimum size (snout-vent length) at reproduction for wild alligators to be 90 cm (approximately 180 cm total length). Joanen (1969) found the smallest female to have nested in his study to be 68.25" TL (173.36 cm) and having a clutch size of 28 eggs; with the average clutch size in that population being 38.9 eggs. A more recent paper (Platt *et al.*, 2004) reviewed the maximum clutch size in American alligators and the relationship between clutch size and female total length, and predicted body length in females based on clutch size (Hall 1991).

OBSERVATIONS

As part of Louisiana's "nuisance" alligator program established to allow for take of alligators causing conflicts or safety concerns for citizens, licensed nuisance trappers are called to relocate or harvest problem alligators. Trappers are mandated to maintain written records of complaints received and the disposition of the alligator in each case for which they are asked to respond.

On approximately 8th August 2006, I received such documents from Mr. Malcolm Savoie from the town of Cameron, Louisiana (Cameron Parish) and upon review noted the written comment "5041170 had 12 eggs hard shell" recorded for an alligator he harvested on 2nd August 2006. I immediately looked at the length of the alligator, which would be of interest as the alligator had been tagged and marked as part of Louisiana's alligator egg ranching program; we have previously documented successful reproduction of farm-released alligators after their release to the wild as part of a "head-start" program (Elsey *et al.*, 2001a). Mr. Savoie listed the alligator's length as 4' 8" (56" TL, or 142.24 cm). As previously mentioned it is generally accepted that female alligators are usually approximately 72" TL (183 cm) when they become sexually mature, although we have documented smaller alligators at successful nests (LDWF unpublished data as detailed below).

The web tag and tail notch on the alligator revealed it had been marked and released from an alligator farm on 12 April 2004, at which time it was 47" TL (119.38 cm). The tail notch reported by Mr. Savoie was the same ("DG") as per our agency's records for the alligator bearing the web tags he reported. The alligator was noted to be female at the time of release, and the growth interval was appropriate (Elsey *et al.*, 2001b). The land company on which the alligator was released was in close proximity to the residential yard from which the nuisance complaint was filed in a rural area of West Creole, Louisiana. It was not noted to be at or near an alligator nest when caught.

I telephoned the trapper and specifically asked if the alligator had any part of the tail missing; he said it did not. I inquired if the term "eggs" was meant to imply an oval, completely formed egg (because he had supplied the term "hard shell" it seemed likely, however I have heard local trappers use the term "egg" in reference to retained follicles/ova present in an ovary). Mr. Savoie had not personally seen the eggs in question, but referred me to the gentleman who processed the carcass for meat after having removed the hide and had reported the finding. He confirmed what he observed were hard-shelled eggs, and supplied me with four he had saved as he realized it was an unusual finding in such a small alligator. When asked, he stated all twelve eggs were found in one oviduct ("channel") and he had examined the contralateral oviduct, which did not contain further eggs.

The mean length, width, and mass of the four eggs were (mean +/- SEM) 66.57 +/- 1.10 mm; 38.25 +/- 0.53 mm; and 56.52 +/- 2.25 g, respectively; somewhat smaller than normal for alligator eggs. The four eggs examined were infertile and several had mild chalky deposits on the outer surface and two had minor cracks on one pole.

The length of the alligator when initially measured by Louisiana Department of Wildlife and Fisheries staff at a commercial alligator farm immediately prior to release to the wild indicated it had been hatched in late August or early September of 2002. Therefore, this female alligator was less than four years of age when she developed the hard-shelled eggs.

I reviewed data previously collected predominantly on Rockefeller Wildlife Refuge, wherein we captured female alligators at nests (n = 163 nests in ten collecting seasons between 1992 and 2006; although only three nests were from 1992, two from 1995, and one in 1996) and collected the entire clutch of eggs, allowing us to examine the relationship between TL of female alligators and clutch size. There was a strong positive linear correlation between female TL and clutch size ($r^2 = 0.62$; $P < 0.0001$, Fig. 1). In three cases a large female had a relatively small clutch (n = 17, 19, and 19); we speculate that these females had one functioning ovary/oviduct as the clutch sizes of 17, 19, and 19 are about half of a normal clutch quantity. Excluding these three outliers improves the fit of the model ($r^2 = 0.69$, $P < 0.0001$, n = 160). The two smallest clutches in past years were a clutch of 17 eggs from a 163.83 cm female (64.5" TL); and a clutch of 23 eggs from a 171.45 cm female (67.5"); all 23 hatched successfully after incubation in our field laboratory. The eggs from the clutch of 17 were sacrificed intermittently throughout incubation for another study, thus hatch rates are unavailable; but the eggs appeared viable when removed from the incubator.

DISCUSSION

The 142.24 cm (TL) female alligator containing hard-shelled eggs in the oviduct is to my knowledge the smallest and youngest alligator to have demonstrated reproductive activity. I was unable to determine if this female actually constructed a nest in 2006. Nest construction usually occurs in June, and females often (but not always) remain in nest attendance until hatching in late August or early September. The alligator was not reported to be at or near a nest upon capture. It is possible that due to the severe drought conditions in southwest Louisiana in 2006 she did not construct or attempt to construct a nest, or she may have aborted nesting efforts and retained eggs in the oviduct. In addition, she also may have been forced to move away from a nest site to seek a den or source of water, again due to severe drought conditions. Moreover, it is also possible that this alligator did expel eggs from one oviduct, and retained the eggs in the other oviduct. However, it is unlikely such a small female would have produced ~ 24 eggs, if she had approximately the same number of eggs in each oviduct.

The alligator described in this account may have experienced accelerated reproductive development, because it was initially reared in a captive setting on a commercial alligator farm under an aggressive heating and feeding regime, which leads to rapid growth (Elsey *et al.* 2001a, 2001b). Still, this is an unusually small alligator to have exhibited reproductive development. The eggs appeared to be infertile owing to the lack of the opaque band on the eggshell, which can be used to determine fertility and age the developing embryo (Ferguson 1982). It is unknown if female alligators must physically mate with a male alligator in order to initiate the development of fully calcified eggshells, or if infertile eggs can develop in the absence of breeding behavior or copulation. Of note, we have previously observed eggs in alligator nests in which the entire clutch is infertile.

According to the equation of Hall (1991) for predicting female body length from clutch size in alligators [TL = 144.41 + 2.1512CS ($r^2 = 0.64$; SE = $\pm$ 12.8 cm)], a clutch size of 12 eggs would be produced by a female of 170.22 cm; substantially larger than the 142.24 cm measured for the female reported herein.

The philosophy of 'sustained use management' in crocodilian egg ranching has been accepted as a sound wildlife management practice, and the rapid onset of sexual maturity and documentation of successful breeding of 'head start' reintroduced specimens can be helpful to resource managers considering similar programs. The case described in this paper is another example of rapid attainment of reproductive activity in reintroduced alligators, at even a younger age and smaller size than those previously described (Elsey *et al.*, 2001a).

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