POPULATION DENSITY AND OVER-WINTERING OF AN EXOTIC LIZARD, THE BROWN ANOLE *ANOLIS SAGREI*, AND AN EVALUATION OF ANOLE DISTRIBUTION IN LAFOURCHE AND TERREBONNE PARISHES, LOUISIANA

A Thesis

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Michael P. Wiley
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CERTIFICATE

This is to certify that the thesis entitled "Population Density and Over-wintering of an Exotic Lizard, the Brown Anole *Anolis sagrei*, and an Evaluation of Anole Distribution in Lafourche and Terrebonne Parishes, Louisiana" submitted for the award of Master of Science to Nicholls State University is a record of authentic, original research conducted by Mr. Michael P. Wiley under our supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship, or other similar titles.

APPROVED	SIGNATURE	DATE
Allyse Ferrara, Ph.D. Assistant Professor of Biological Sciences Committee Chair	______________________	___________
Quenton Fontenot, Ph.D. Assistant Professor of Biological Sciences Committee Member	______________________	___________
Gary LaFleur, Ph.D. Associate Professor of Biological Sciences Committee Member	______________________	___________

ABSTRACT

The brown anole *Anolis sagrei*, native to parts of the Caribbean, was introduced into the United States in the Florida Keys in the late 1800's and subsequently became established. Since that time, the lizards have spread to other states via shipments of nursery plants. The brown anole is an aggressive and successful invader organism. In Florida, brown anoles have displaced native green anoles *A. carolinensis* from ground level vegetation to higher-level vegetation. Although brown anoles are currently found in southeastern Louisiana, neither over-wintering nor reproduction has been documented in this area. This study was undertaken with the intention of determining: densities of *A. sagrei* and *A. carolinensis* at a plant distributor in Thibodaux, Louisiana (Hebert's Nursery), the distribution of *A. sagrei* within Lafourche and Terrebonne Parishes, Louisiana, and whether or not *A. sagrei* is over-wintering in southeastern Louisiana. Batch marking of lizards was necessary to achieve these objectives. Rather than using toe-clipping to identify tagged individuals, we evaluated the use of coded wire tags (CWT), a method that does not permanently mutilate the lizards' appendages, for batch marking lizards. We found 95.3 ± 8.1% retention of CWT in *A. carolinensis*, the species chosen for this study because of their local abundance. Based on the high retention rate, CWT were used to document over-wintering of brown anoles in southeastern Louisiana and to estimate population densities of *A. carolinensis* (0.008/m^2) and established *A. sagrei* (0.033/m^2) at Hebert's Nursery (Thibodaux, Louisiana). Over-wintering of *A. sagrei* was also confirmed through a captive study yielding a survival rate of 33.3 ± 0.297% from October 2006 to March 2007. Monthly visual encounter surveys (VES) at one plant distributor (Double Oak Garden Center, Lockport, Louisiana) revealed activity

in both species throughout the winter (October to February) within greenhouses. VES were also used to document *A. sagrei* at eight plant distribution businesses in Lafourche and Terrebonne Parishes, Louisiana, in addition to the nursery where over-wintering and population densities were studied. *A. sagrei* were more abundant than *A. carolinensis* at two of the eight sites. Questioning of nursery staff has identified southern Florida as a possible source for the brown anoles coming into Lafourche and Terrebonne Parishes.

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Most influential to me has been my family who, by guidance, example, and sheer pride, has provided my foundation and my motivation. I have no doubt that helping my children discover the world around them will only feed my love of learning. Thank you all.

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LIST OF ABBREVIATIONS

SVL = snout-vent length
mm = millimeter
cm = centimeter
km = kilometer
CWT = coded wire tags
VES = visual encounter surveys
^{o}C = degrees Centigrade
SD = standard deviation
L = liter
g = gram
N* = estimate of population mean
m^2 = square meter
VIE = visual implant elastomer
PIT = passive integrated transponder
MMWT = mean minimum winter temperature
Ct_{min} = critical thermal minimum
Ct_{max} = critical thermal maximum

INTRODUCTION

The establishment of non-native species is one of the most costly and pressing ecological problems of today (Pimentel 2002). Establishment, however, is not eminent after importation or introduction. The 'tens rule' (Williamson and Fitter 1996) is a statistical model based on studies of British plants that predicts 1 in 10 of those species imported into a country (i.e., taken over international boundaries into an area outside its native range) will become introduced (i.e., released accidentally or purposely into the wild), 1 in 10 of those introduced will become established (i.e., surviving and reproducing; a successful colonizer), and 1 in 10 of those established will become a pest (i.e., invasive, causing economic or environmental harm). According to Williamson (1999), variations and exceptions to the 'tens rule' demonstrate the need for refinement of the model. Variations of the standard 10% relationships range between 5% and 20% (Williamson and Fitter 1996). Among the most notable exceptions to the 'tens rule' are Hawaiian birds and island populations. Agricultural land conversion in Hawaii may decrease habitat suitability for native birds while increasing habitat suitability for introduced species (Williamson and Fitter 1996). Islands such as Hawaii are more vulnerable to introduction because organisms have evolved without the influences of empty niches that may be filled by exotics. For example, no snakes were present on Guam before the brown tree snake *Boiga irregularis* was introduced. Since introduction, the brown tree snake has extirpated 9 of the 12 bird species native to Guam (Rodda et al. 1997).

Alpert et al. (2000) call attention to the fact that, despite the negative connotations associated with the term 'invade' when referring to human warfare and pathogenic microbes, early ecologists attached no implications of harm or encroachment to the term. In doing so, these ecologists synonymized ‘invasion’ with colonization. In contrast, Alpert et al. (2000) suggest that an ‘invasive species’ should be defined as “one that both spreads in space and has negative effects on species already in the space that it enters.” With this definition, the authors stress the point that invasiveness is independent of nativity. This creates four categories in which to place organisms: non-invasive native, invasive native, non-invasive non-native, and invasive non-native. Similarly, Williamson and Fitter (1996) confer the term ‘invasive species’ only upon those non-native populations which have become self-sustaining and have negative biological or economic impacts (i.e., pests). Other terms implying negative impacts and sometimes used to describe invasive non-natives include ‘noxious’, ‘nusiance’, and ‘weed’. Additionally, the terms ‘exotic’ and ‘non-indigenous’ are used interchangeably with ‘non-native’ (King and Krakauer 1966; Colautti et al. 2006). Within this document, ‘invasive’ is meant to convey non-nativity, colonizing abilities, and negative effects upon the invaded ecosystem.

Some non-natives are beneficial as food crops and livestock. Ninety percent of crops in the U.S. are introduced (Pimentel 2003). However, because of the sheer volume of non-native species in the U.S. (>50,000), only a small fraction need become invasive to cause significant ecosystem and public health problems (Pimentel et al. 2000). Approximately 400 of the 958 species on the United States’ threatened and endangered species lists have been placed there because of the risks associated with competition with- and predation by- non-native species. Only habitat destruction poses a greater threat to biodiversity (Wilcove et al. 1998). Approximately $137 billion/year is spent or lost by U.S. federal and state governments as a result of environmental damage from non-native species (Pimentel et al. 2000). On 3 February 1999, President Clinton issued Executive Order 13112 (1999) to coordinate and stimulate research on and management of invasive exotic species. Executive Order 13112 also formed the National Invasive Species Council, an inter-departmental assembly of the U.S. secretaries of the Agriculture, Commerce, Interior, State, Defense, Homeland Security, Treasury, Transportation, Health and Human Services, and administrators of the Environmental Protection Agency, the U.S. Agency for International Development, the Office of the U.S. Trade Representative, and the National Aeronautics and Space Administration. The Council concerns itself with U.S. federal activities regarding invasive species. On 18 January 2001, the National Invasive Species Management Plan was released by the National Invasive Species Council.

Major economic and biologic consequences have arisen from accidental and intentional anthropogenic introductions. Zebra mussels *Dreissena polymorpha* were accidentally introduced into the Great Lakes via ballast water and are clogging electrical plant intake pipes and fouling native mussels (LePage 1993; MacIssac et al. 2002). The cane toad *Bufo marinus* was intentionally introduced to Australia to control the cane beetle *Antitrogus parvulus* and, while the toads have not affected cane beetle populations, the toads have become invasive (Leslie 2004).

Eradication is usually impossible once non-native species are classified as invasive. Arguably, many, if not most, new impacts by invasive species are not predictable (Williamson 1999). Mitigation (reducing the likelihood of invasions) and adaptation (reducing the impacts of introduction, establishment, or spread) are two potential options for dealing with non-natives (Perrings 2005).

There are 137 species of lizards in the continental United States and Canada including 32 introduced species (Powell et al. 1998). The brown anole *A. sagrei* is native to Cuba, Jamaica, the Bahamas, and portions of the West Indies. However its distribution has expanded, predominately by jump dispersal, and there are currently recorded and/or established populations in Florida (Garman 1887; Oliver 1950; Means 1990), Texas (King et al. 1987), Louisiana (Thomas et al. 1990; Platt and Fontenot 1994), Grand Cayman Island (Minton and Minton 1984), Georgia (Campbell and Hammontree 1995), Belize (Rodriguez Schettino 1999), Taiwan (Norval et al. 2002), Grenada (Greene et al. 2002), Hawaii (Goldberg et al. 2002), and South Carolina (Turnbow 2006). *A. sagrei* is the most abundant lizard species in the Caribbean (Schoener and Schoener 1980) and Cuba (Rodriguez Schettino 1999). All of the islands in the Caribbean have native populations of *Anolis* lizards (Schwartz and Henderson 1991). Of the nine species of Caribbean *Anolis* lizards established in the Miami area (Butterfield et al. 1997; Meshaka et al. 1997), *A. sagrei* was the first to show expansion in its range and has spread most rapidly (Godley et al. 1981; Campbell 1996; Christman et al. 2000; Townsend et al. 2002). Although two subspecies were introduced into Florida, *A. s. sagrei* and *A. s. ordinates*, they have melded into a single genetic population distinct from the two colonizers (Conant and Collins 1998). Since their introduction into the U.S. in the late 1800's, brown anoles have become established and are continually introduced into new areas of the country by vehicular rafting (Godley et al. 1981). For example, northern range expansion along Interstates 71 and 95 in Florida and Georgia is evidenced by the presence of *A. sagrei* at rest stops and welcome centers that service northbound vehicles and absence at nearly identical rest stops and welcome centers across the interstate that service southbound vehicles (Campbell 1996). Similarly, the first record of *A. sagrei* in South Carolina came from interstate rest areas (Turnbow 2006). *A. sagrei* is also being spread via shipments of nursery plants (Dixon 1987; Norval et al. 2002). Experimentally introduced brown anoles have been recorded at densities of up to 12,000 individuals per hectare on dredge spoil islands along the east coast of Florida (Campbell and Echternacht 2003). *A. sagrei* is present in Lafourche and Terrebonne Parishes, Louisiana (Wiley et al. *In Press*).

Coloration of *A. sagrei* is variable among individuals and geographically isolated populations (Rodriguez Schettino 1999). Body color ranges from light gray to brown to black. Dewlap, or throat fan, coloration of male *A. sagrei* varies independently of body coloration and ranges from mustard yellow to red-orange to chocolate. Males sometimes possess a crest along the top of the body and the tail. Consequently, they are sometimes referred to as razorbacks in South Louisiana. Other common names are Cuban brown anole, Bahamian brown anole, ground anole, and brown anole (Conant and Collins 1998).

Adult female anoles are generally smaller than similar aged male anoles (Butler et al. 2000). Snout-vent length (SVL) is the distance from the tip of the rostrum to the anterior edge of the cloacal vent. SVL has long been used as the standard method for measuring lizards (e.g., Judd 1975; Tokarz and Beck 1987; Butler and Losos 2002; Gruber and Henle 2004). The tail length is excluded because of the ability of anoles and some other lizard species to detach their tail in avoidance of predators.

Male *A. sagrei* mature at a SVL of 44 mm and can reach weights up to 6-8 g. Females mature at 35 mm SVL and can weigh up to 3-4 g. Campbell (2000) reports a maximum SVL of 67 mm in males and 52 mm in females in Florida. Also in Florida, *A. sagrei* are non-reproductive during the winter (Licht and Gorman 1970). Females lay a single egg about every six days (Tokarz 1998) from mid-March to mid-September. Spermatozoa production begins in January and continues until September when testes begin to regress (Licht and Gorman 1970). However, in Belize, males remain reproductively active year round and females are reproductively active primarily from late May to September (Sexton and Brown 1977). Using *A. sagrei* as a model, Brown and Sexton (1973) demonstrated the positive effect of relative humidity on egg production in *Anolis* lizards. Rainfall is also positively correlated with egg production in *Anolis* lizards (Licht and Gorman 1970; Fitch 1982). Based on nearly complete annual cohort replacement in Florida, both brown and green anoles *Anolis carolinensis* probably live no more than 18 months (Campbell 2000; Lee et al. 1989).

The green anole *A. carolinensis* is the only *Anolis* lizard native to the contiguous U.S. and is found throughout the southeastern U.S. from North Carolina to central Texas (Conant and Collins 1998). An introduced population of *A. carolinensis* resides in Hawaii (McKeown 1996). For camouflage purposes, *A. carolinensis* may change color from bright green to dark brown or vice versa. An irregular brown or white dorsal stripe is sometimes present (Mount 1975). Male green anoles have an extensible pink dewlap used for behavioral displays. Males also have ridges along the dorsal surface of the head and back that may be raised and used for territorial behavior displays. *A. carolinensis* are common members of the backyard fauna of many southern homes and are frequently chased, caught, and played with by children. Due to the lizard's ability to change color and the raised ridges present on displaying males, green anoles are frequently and erroneously called chameleon lizards, although true chameleons are not native to the U.S. (Mount 1975).

The SVL of adult male *A. carolinensis* ranges from 48 to 74 mm in southern Louisiana (Lailvaux et al. 2004). For mature females minimum SVL is 41 mm (Fox 1958). For *A. carolinensis*, reproduction occurs during the spring and summer, although males may begin territorial behaviors as early as February (Dundee and Rossman 1989). In New Orleans, female *A. carolinensis* may produce an egg every ten days throughout the reproductive season (Hamlett 1952).

Corn (1971) found that, after an acclimation period of 7 days, critical thermal maximum (Ct_{max}) for *A. carolinensis* ranges from 40.0 to 42.0 ^{o}C when acclimated at 20 ^{o}C and from 41.0 to 43.4 ^{o}C when acclimated at 30 ^{o}C. After an acclimation period of 7 days, Ct_{max} for *A. sagrei* ranges from 38.2 to 41.7 ^{o}C when acclimated at 20 ^{o}C and from 40.0 to 43.0 ^{o}C when acclimated at 30 ^{o}C (Corn 1971). The mean preferred temperature for *A. sagrei* (33.34 ± 2.30 ^{o}C) does not differ significantly from that of *A. carolinensis* (34.00 ± 1.54 ^{o}C; Corn 1971).

A. sagrei has been referred to as "aggressive," "competitive," and "dominant" (Collette 1961; King and Krakauer 1966; Williams 1969) when compared to other *Anolis* species. Tokarz and Beck (1987) report an apparent decline in the Miami area population of *A. carolinensis* since the introduction of *A. sagrei*, but note that quantitative documentation is not available. *A. sagrei* have also vertically displaced *A. carolinensis* in Florida. When the two species occur together *A. carolinensis* tends to be limited to perches higher in the vegetation than those utilized by *A. sagrei* (Oliver 1950; Schoener 1975).

Iguanas, giant anoles, chameleons, lizards, and anoles are members of the class Reptilia, subclass Lepidosauria, order Squamata, suborder Sauria, and infraorder Iguania (Rodriguez Schettino 1999). Phylogenetic and evolutionary relationships within the infraorder Iguania are controversial (Frost and Etheridge 1989; Lazell 1992). Frost and Etheridge (1989) proposed the use of eight families within Iguania and placed anoles into Polychridae, also called Polychrotidae. Iguania may also be thought of as containing only the family Iguanidae (Rodriguez Schettino 1999). Various subfamilies, genera, and subgenera have been proposed. Evolutionary, morphological, and (consequently) taxonomic relationships within the genus *Anolis* are also poorly defined (Irschick et al. 1997; Jackman et al. 1999; Glor et al. 2001; Jackman et al. 2002; Elstrott and Irschick 2004). Nearly 400 species of anoles are recognized and are typically divided into four genera: *Anolis*, *Chamaelolis*, *Chamaelinorops*, and *Phaenacosaurus* (Williams 1976, 1992). Guyer and Savage (1986) proposed five genera: *Anolis*, *Dactyloa*, *Semiurus*, *Ctenotus*, and *Norops*. Under this system, *A. sagrei* is classified as *Norops sagrei* (Guyer and Savage 1986).

Even though the classification of iguanid lizards and particularly anoles is a point of contention among taxonomists, these organisms have been widely studied and an extensive knowledge base exists (reviewed in Rodriguez Schettino 1999). Anoles are often used as “model organisms” for ecological and morphological studies because of their abundance and diversity (e.g., Williams 1969; Losos 1994; Jackman et al. 1999; Butler et al. 2000; Irschick 2000; Butler and Losos 2002; Irschick 2002; Lovern et al.

2004). Dundee and Rossman (1989) state that “biological supply houses sell large numbers of anoles, most of them collected near New Orleans.”

Scientific studies frequently require marking individuals for observation and identification (e.g., batch marking for capture-recapture studies). Within the scientific community, toe clipping is generally accepted as the standard method for marking reptiles and amphibians (Woodbury 1956; Nietfield et al. 1996). Despite its acceptance, toe clipping may reduce recapture rate and survival and/or cause infection (Clarke 1972; Golay and Durrer 1994). Toe clipping involves the removal of at least one toe at the base of the digit. To produce unique patterns for individual recognition, most researchers use a convention of clipping no more than four toes with no more than two toes removed from one foot; adjacent toes are never removed (Tinkle 1967; Nietfield et al. 1996).

Institutional animal care and use committees encourage the use of alternatives to disfiguring procedures such as toe clipping in accordance with the Animal Welfare Act (1996). In addition, ethical questions have arisen concerning toe-clipping (May 2004). In order to eliminate short term stress and discomfort as well as permanent mutilation associated with toe clipping, we explored the use of a novel tagging method for *Anolis* lizards, the coded wire tagging system.

Coded wire tags (CWT) are small pieces of magnetized stainless steel wire usually measuring 1.1 mm x 0.25 mm that are injected into the animal via a hollow needle. Tags are detected with a magnetic wand that sounds when passed over a tag (Niva and Hyvärien 2001) or with x-ray equipment (Jefferts et al. 1963; Uglem and Grimsen 1995; Schaffler and Isely 2001). Coded wire tagging equipment was developed by Northwest Marine Technology, Inc., Shaw Island, Washington, USA. Originally developed for fisheries management applications, CWT have high retention rates not only for fish (Brennan et al. 2005; Dorsey 2004; and Isely and Fontenot 2000), but also for freshwater mussels (Layzer and Heinricher 2004), crustaceans (Davis et al. 2004; Kneib and Huggler 2001; Isely and Eversole 1998; Uglem and Grimsen 1995), sea turtles (Schwartz 1981), yellow meal worms *Tenebrio molitar* (Schaffler and Isely 2001) and common garden skinks *Lampropholis guichenoti* (Downes 2000, 2002). Presently, there are no published studies of CWT use in *Anolis* lizards.

This study was conducted in order to (1) assess the feasibility of using CWT for marking *Anolis* lizards with the intention of providing an alternative to the mutilating practice of toe clipping, (2) determine densities of *A. sagrei* and *A. carolinensis* at Hebert's Nursery, Thibodaux, Louisiana, (3) determine the distribution of *A. sagrei* at introduction sites in Lafourche and Terrebonne Parishes, and (4) determine if there is an over-wintering population of *A. sagrei* in southeastern Louisiana and not merely a transient population supported by immigration.

METHODS

Coded Wire Tagging Feasibility – Short Term

Because of their local abundance, green anoles were selected as a representative *Anolis* species for the studies of short-term coded wire tag retention and effects on growth and survival rates as well as long-term coded wire tag retention. Initially, for the short-term (1 month) study, sixty-three green anoles were obtained from a commercial reptile collector from Chackbay, Louisiana, on 19 July 2005. Lizards were randomly assigned to nine outdoor, sheltered, 38L glass aquaria (seven lizards per aquarium). Aquaria were randomly assigned to one of three treatments (control, toe clip, and CWT). Three replicates of each treatment were used. Each aquarium was furnished with Reptibark^{tm} (commercially available reptile bedding), a live plant, and various perching/shelter materials (twigs, wood scraps, cardboard strips). Each aquarium was covered with a commercially available plastic and wire mesh lid. Lizards were fed daily with commercially available mealworms. The plants and the sides of the aquaria were wetted with a squirt bottle daily to maintain high humidity levels and to provide drinking water.

On 25 July 2005, after six days of acclimation, each lizard was weighed (to the nearest 0.1g) with a suspended spring scale. Lizards were also measured for SVL (to the nearest 0.1 mm) using digital calipers and sex was determined by the presence or absence of a dewlap. For our purposes, toe clipping consisted of removal of the third toe on the left hind leg, at the base of the digit, using nail clippers. A Mark IV coded wire tagger (Northwest Marine Technology, Inc., Shaw Island, Washington, USA) was used to insert tags beneath the skin, below the dorsal base of the skull, perpendicular to the lizard's length. Wounds of both toe clipped and coded wire tagged individuals were swabbed with Betadine® to prevent infection. Mortalities were recorded daily for 30 days. On 25 August 2005, lizards were again weighed, measured, sex determined and checked for tag retention. Changes in weight and SVL were evaluated by analysis of co-variance (ANCOVA; $\alpha = 0.05$; SAS 2003) to account for size variation among individuals and to compare pre-treatment and post-treatment size.

Coded Wire Tagging Feasibility – Long Term

After the comparison of growth and survival rates across treatments, control and toe clipped lizards were released and coded wire tagged lizards were transferred to three 91x61x91 cm wire mesh and wood cages (seven lizards per cage) for monitoring of long-term tag retention. Mortalities were recorded monthly. Care continued as described above. Cages were moved indoors when air temperature dropped below 20 ^{o}C. Indoor temperatures remained between 21 and 31 ^{o}C. Lizards were weighed, measured, and checked for tag retention every 31 days (± 3 days) between 25 October 2005 and 31 May 2006 and on 1 August 2006. No data was collected for September 2005 or June 2006.

Anole Density

A single census mark-recapture study was conducted on 6 and 13 October 2005 to determine the abundance of *A. carolinensis* and *A. sagrei* at Hebert's Nursery, 1500 Saint Mary Street Thibodaux, Louisiana. On 6 October 2005, anoles were captured by hand for 2 hours and were held in 2-20x13x16 cm plastic cages until tagging. All anoles were tagged with a Mark IV coded wire tagger, sex determined, measured for SVL, and weighed. Lizards were held until tagging of all captured lizards was completed. The anoles were then randomly dispersed around the nursery. One week later, we collected anoles again for 1.5 hours and checked for the presence of tags using a magnetic wand tag detector. Abundance was estimated using Chapman's modification of the Peterson Method as follows:

$$N^* = ([M+1][C+1])/(R+1)$$

Where N^* = estimate of population size, M = the number of anoles tagged and released during the first sample, C = the total number captured during the second collection period, and R = the number of tagged individuals collected during the second collection period (Marsh et al. 2003). Anoles collected on 13 October 2005, were tagged before release to assess over-wintering.

Anole Distribution

Originally, 10 plant-distributing businesses within Lafourche and Terrebonne Parishes were surveyed after receiving permission via telephone (Table 1). The nurseries were thoroughly explored during October 2005, during 30 minute visual encounter surveys (VES) and the numbers of *A. carolinensis* and *A. sagrei* were recorded. VES provide no interval with which to determine estimate quality or bias (Schmidt 2004), however our purpose for using this technique was to determine presence or absence of anoles and abundance relative to other sites. VES consisted of a 15 minute period during which the surveyor slowly moved about the nursery and 15 stationary minutes within a randomly chosen quadrant (~1/4 of site area) counting all anoles within view. Surveys were conducted during mid-day hours (1100 – 1400 hours) in order to coincide with maximum anole movement (Collette 1961). Owners/workers were questioned regarding plant supplier locations and their personal observations of anoles. Eight of the businesses were revisited and surveyed for 30 minutes from 1230 to 1300 hours (±10 minutes) between 21 August 2006, and 12 September 2006 (Figure 1).

Table 1. Plant distributors in Lafourche and Terrebonne Parishes surveyed by preliminary 30 minute visual encounter surveys (15 minutes moving, 15 minutes stationary) during mid-day hours (1100-1400 hours), including street addresses, dates, and times of survey.

Plant Distributor	Street Address	Date Visited	Time Visited
Lowe's, Thibodaux	614 North Canal Thibodaux	10 Oct. 05	1300 – 1330
Starke's Garden Center	4836 Hwy. 311 Houma	11 Oct. 05	1310 – 1340
Green Acres Nursery and Gift Shop	731 Cardinal Dr. Thibodaux	17 Oct. 05	1115 – 1145
Home Depot	1717 Martin Luther King Jr. Blvd. Houma	17 Oct. 05	1220 – 1250
Lowe's, Houma	1592 Martin Luther King Jr. Blvd. Houma	17 Oct. 05	1300 – 1330
Chackbay Nursery and Landscaping Inc.	837 Hwy 20 Chackbay	18 Oct. 05	1100 – 1130
Theriot and Brunet Nursery	639 Hwy. 55 Montegut	19 Oct. 05	1230 – 1300
Landscaping by Pam LLC	9672 E. Main St. Houma	19 Oct. 05	1300 – 1330
Garnier's Southdown Gardens	1219 St. Charles St. Houma	21 Oct. 05	1140 – 1210
Double Oak Garden Center	120 Hwy 654 Lockport	22 Oct. 05	1150 – 1220

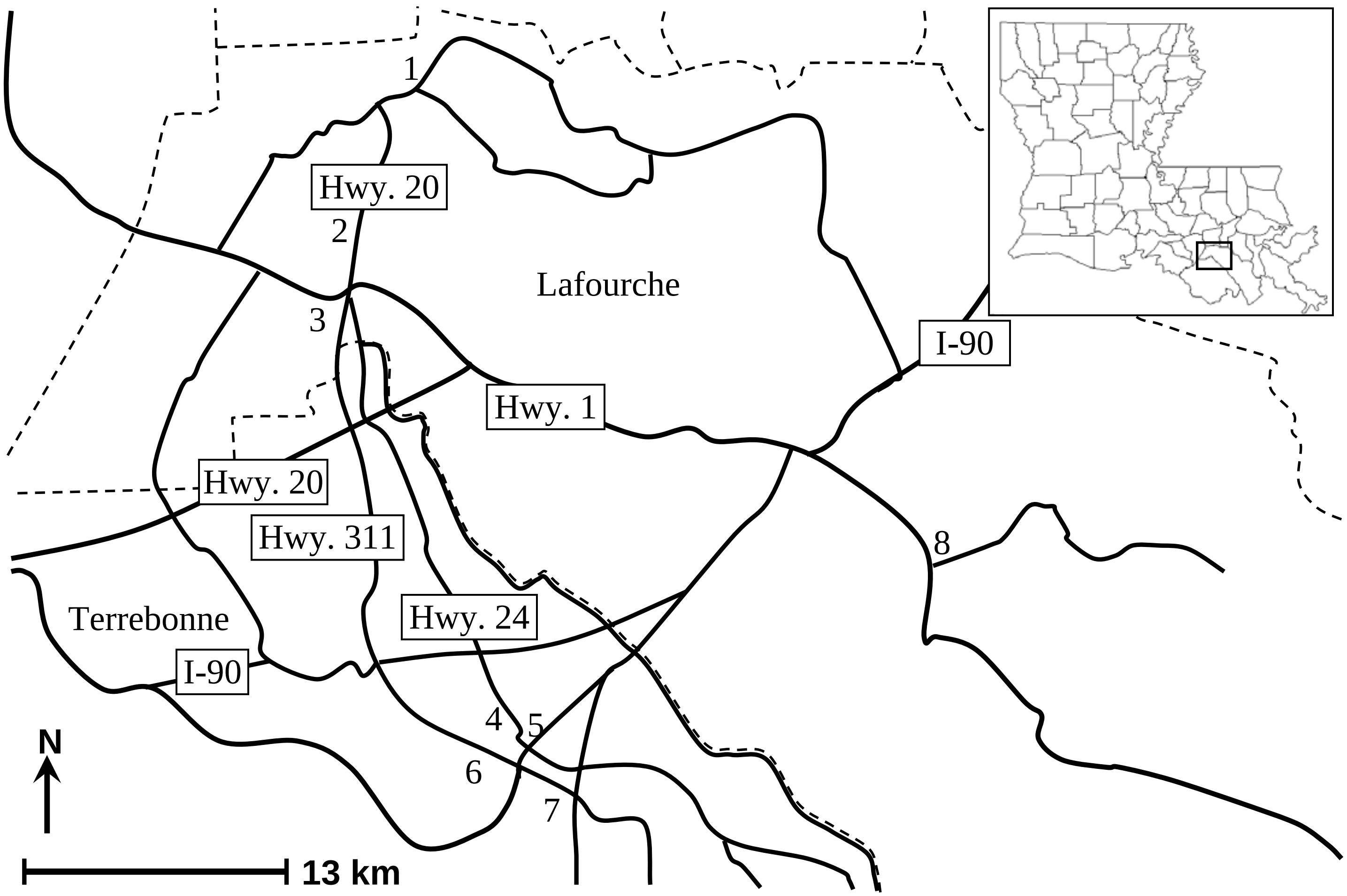

Figure 1. Plant distributors within Lafourche and Terrebonne Parishes surveyed for *Anolis sagrei* and *A. carolinensis* 21 August – 12 October 2006. 1. Chackbay Nursery and Landscaping Inc., 2. Lowe's (Thibodaux), 3. Green Acres Nursery and Gift Shop, 4. Lowe's (Houma), 5. Home Depot, 6. Starke's Garden Center, 7. Garnier's Southdown Gardens, 8. Double Oak Garden Center. Both *A. sagrei* and *A. carolinensis* were present at all sites. Dotted lines represent parish boundaries and solid lines represent major roads.

To obtain mean numbers of *A. sagrei* and *A. carolinensis* per site, two additional surveys were completed at each of the eight sites between 14 September 2006, and 12 October 2006. Air temperature was recorded at each site and remained between 28 and 37 ^{o}C. The Theriot and Brunet Nursery (Montegut, Louisiana) and Landscaping by Pam LLC (Houma, Louisiana) were not revisited because these businesses had closed since the preliminary surveys. Mean numbers of each species were compared at each site using a paired t-test (α = 0.05; SAS 2003).

Evidence of Over-wintering

A highly visible population of *A. sagrei* resides at Hebert's Nursery on Louisiana Hwy. 1 (also known as Saint Mary Street) in Thibodaux, Louisiana. To confirm that this is an established and over-wintering population and not merely the product of immigration on plants, we returned to the nursery on 20 June 2006, to capture and check anoles for tags from the previous year's density study (see previously described method).

Double Oak Garden Center (Lockport, Louisiana) was also host to a visible and abundant population of lizards. Because of the abundance of lizards, the site was re-visited every month from October 2005 to February 2006, in order to determine if the warmth and shelter provided by nine large greenhouses allowed lizards to remain active throughout the winter.

For captive verification of over-wintering, twenty-one *A. sagrei* collected from Hebert's Nursery were maintained outdoors in three 91x61x91 cm wood and mesh cages (seven lizards per cage) from 12 October 2006 to 12 March 2007. Each cage contained perching/shelter material because, in winter, anoles seek shelter from the cold below objects and in crevices (Dundee and Rossman 1989). The cages were placed in a sheltered area, outdoors, in Thibodaux, Louisiana. Cages were monitored daily and mealworms and drinking water were provided when lizards were active.

RESULTS

Coded Wire Tagging Feasibility – Short term

There was no significant change in size (SVL or weight) for any treatment after one month (Figures 2 and 3). Tag retention of CWT was 100% after one month. Four mortalities occurred among the control and toe clipped treatments during the first month. On both 3 and 8 August 2005, one control individual died; however the first of these two mortalities was due to accidental crushing by the aquarium lid. One toe clipped individual died 1 August 2005, and another 6 August 2005. Thus short term mortalities for control, toe clipped, and CWT treatments were 9.5 ± 16.5%, 9.5 ± 8.2%, and 0% respectively.

Coded Wire Tagging Feasibility – Long term

Between August and October 2005, one lizard lost its tag. No other lizards lost tags over the course of the 12 month study. One year CWT retention was 95.3 ± 8.1%. Three mortalities and one escape occurred among the coded wire tagged individuals during March and April 2006. Two more mortalities occurred in July 2006. One year mortality/exclusion from experiment was 28.3 ± 37.6% (Figure 4).

Anole Density

Based on the capture and coded wire tagging of 14 *A. carolinensis* and a second capture a week later of 27 individuals including 3 possessing tags, we estimated the population size of *A. carolinensis* to be 105 individuals at Hebert's Nursery. Using the Poisson method for estimation of 95% confidence intervals we obtained the interval $43<N^*<263$.

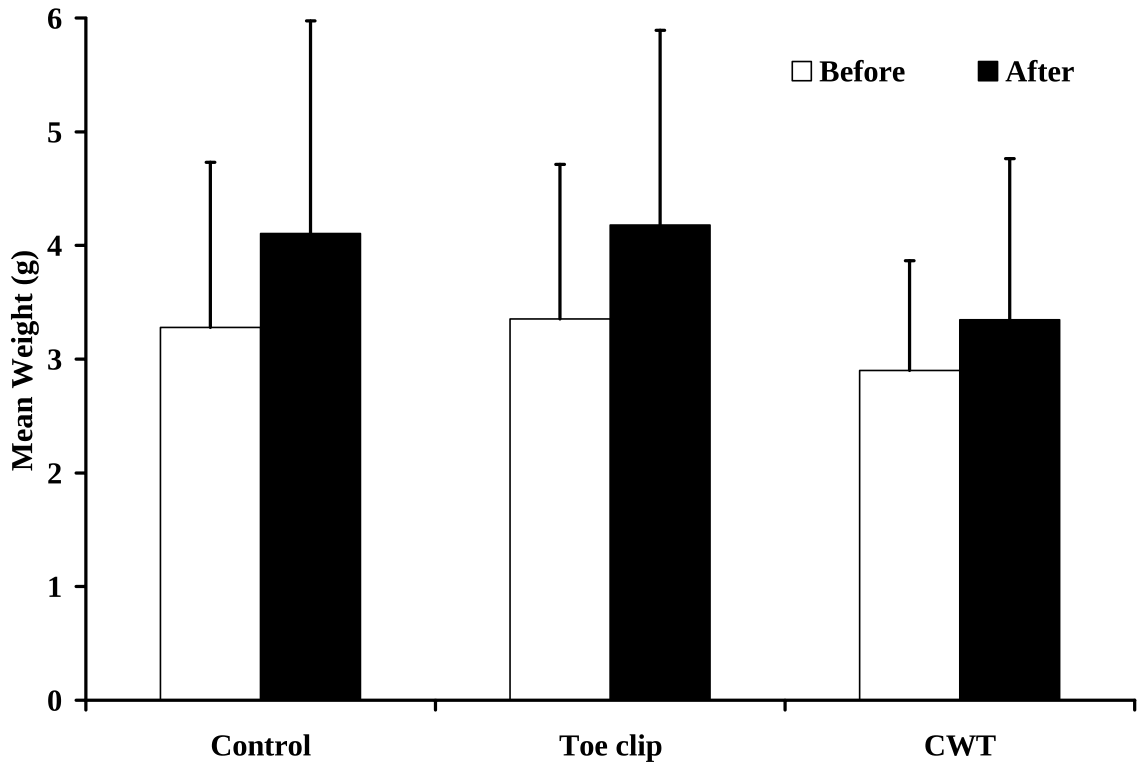

Figure 2. Mean (±SD) weight of 21 control, 21 toe clipped, and 21 coded wire tagged (CWT) *Anolis carolinensis* before treatment (25 July 2005) and one month after (25 August 2005). No means within treatments are significantly different (a = 0.05).

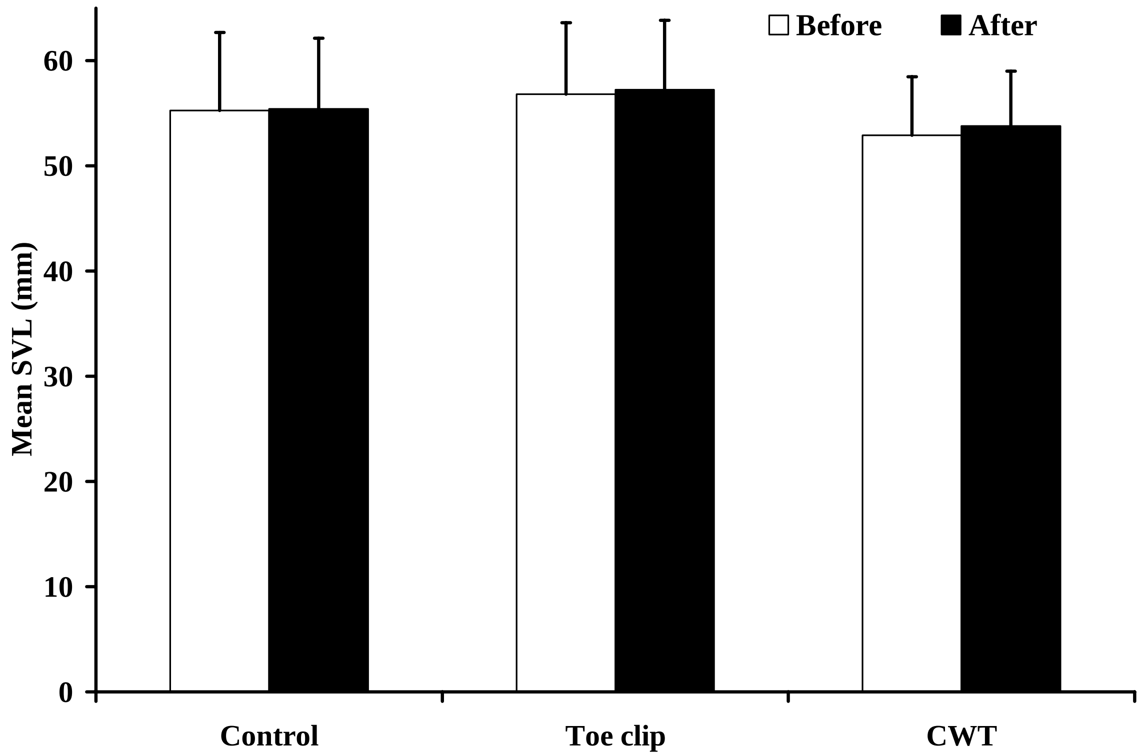

Figure 3. Mean (±SD) snout-vent length of 21 control, 21 toe clipped, and 21 coded wire tagged (CWT) *Anolis carolinensis* before treatment (25 July 2005) and after one month (25 August 2005). No means within treatments are significantly different (a = 0.05).

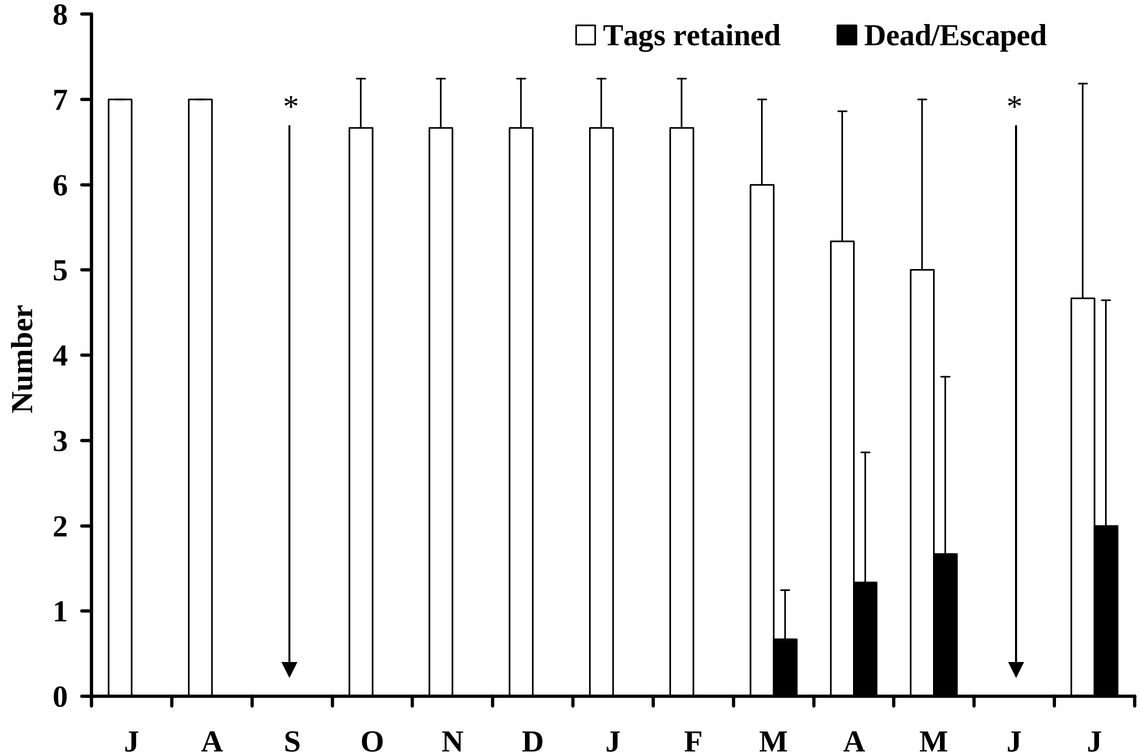

Figure 4. Mean (±SD) number of 21 coded wire tagged *Anolis carolinensis* (3 replicates of 7 lizards each) with tags retained or dead/escaped by monthly checks (25 July 2005 to 1 August 2006). *No data was collected for September 2005 or June 2006.

Given the nursery area of approximately 13,289 m^2 (0.4047 hectares) this roughly equates to a density of 0.008 *A. carolinensis*/m^2 (80 per hectare) or 1 *A. carolinensis* for every 127 m^2. Thirty-one *A. sagrei* were initially marked and, of the 26 captured a week later, only 1 had been marked. Using the same methods as above, we estimated 432 *A. sagrei* present with a 95% confidence interval of $131<N^*<785$. Density was determined to be approximately 0.033 *A. sagrei*/m^2 (330 per hectare) or 1 *A. sagrei* for every 31 m^2.

<u>Anole Distribution</u>

Of the ten plant distributors visited during the preliminary surveys (Table 1), *A. carolinensis* were seen at 64% (Figure 5). Although no anoles were detected at the Lowe's (Thibodaux, Louisiana) and the Theriot and Brunet Nursery (Montegut, Louisiana), staff had recently seen green anoles. *A. sagrei* were present at 50% of establishments (Figure 5). In addition, staff at Lowe's in Thibodaux had seen brown anoles recently and a staff member at Lowe's in Houma reported seeing brown anoles two years previous. The owner of Starke's Garden Center (Houma, Louisiana) commented that he sees many brown anoles coming in on shipments of *Sable major* (commonly known as cabbage or sable palm) from south Florida. In addition, staff at Lowe's in Thibodaux and Double Oak Garden Center (Lockport, Louisiana) had noticed brown anoles among plants in shipments from Florida. In fact, all businesses at which brown anoles were observed received plants from Florida at least every few months. Staff of Garnier's Southdown Gardens (Houma, Louisiana) stated that brown anoles have been there for at least fifteen years and suggested the anoles may come in on shipments from California (although this may be mistaken because there are no documented populations of any *Anolis* species in California).

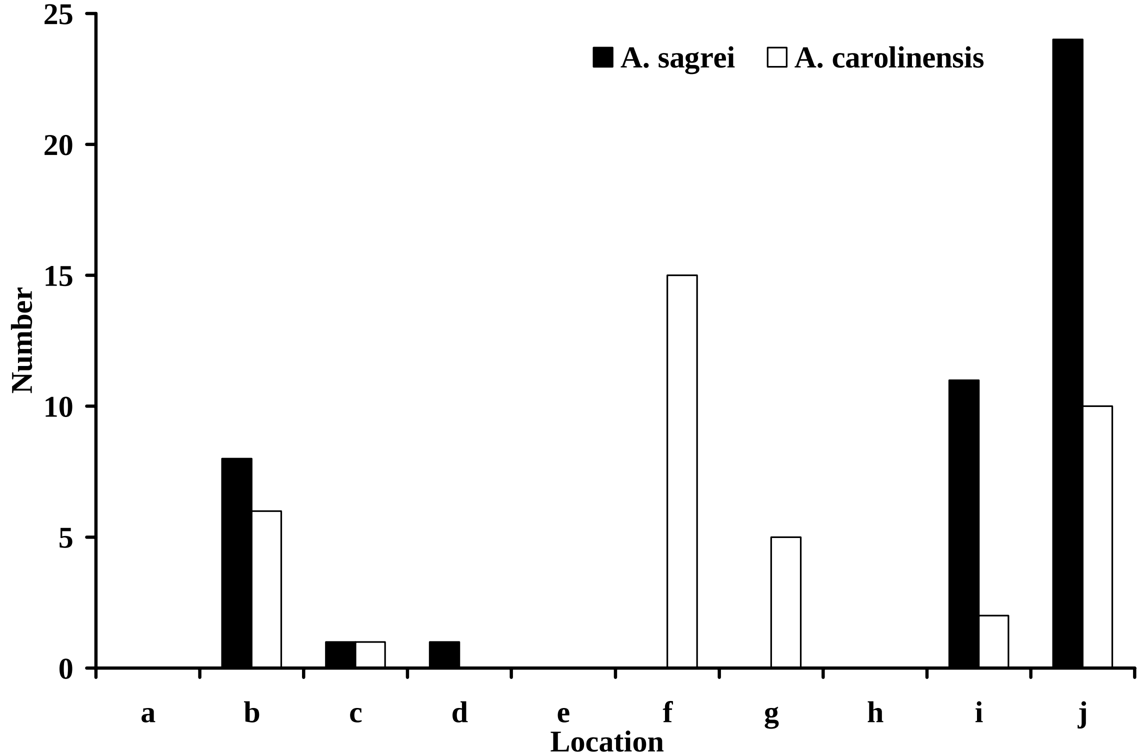

Figure 5. Total number of *Anolis sagrei* and *A. carolinensis* at Lafourche and Terrebonne Parish plant distributors during 30 minute preliminary visual encounter surveys (15 minutes moving, 15 minutes stationary) conducted during mid-day hours (1100-1400 hours) October 2005. a. Lowe's (Thibodaux), b. Starke's Garden Center, c. Green Acres Nursery and Gift Shop, d. Home Depot, e. Lowe's (Houma), f. Chackbay Nursery and Landscaping, Inc., g. Theriot and Brunet Nursery, h. Landscaping by Pam LLC, i. Garnier's Southdown Gardens, j. Double Oak Garden Center.

All owners/workers who commented on brown anole presence were familiar with both species and appeared to be capable of distinguishing between the two.

On subsequent VES (August – October 2006), *A. carolinensis* and *A. sagrei* were found at all eight businesses surveyed (Figure 6). The largest number of *A. carolinensis* was seen at Double Oak Garden Center (9.67 ± 2.52) and the fewest at both the Home Depot (Houma, Louisiana) and the Thibodaux Lowe's (0.33 ± 0.57 at each). The overall mean was 3.5 *A. carolinensis*/30 minutes. The largest number of *A. sagrei* was seen at Green Acres Nursery and Gift Shop (Thibodaux, Louisiana; 16.0 ± 7.94) and fewest at Chackbay Nursery (Chackbay, Louisiana; 2 ± 2.65; Figure 6). The overall mean among businesses was 8.29 *A. sagrei*/30 minutes. *A. sagrei* was more abundant than *A. carolinensis* at two study locations, Starke's Garden Center ($P = 0.022$) and Garnier's Southdown Gardens ($P = 0.004$).

<u>Evidence of Over-wintering</u>

In June 2006, 19 *A. sagrei* and 19 *A. carolinensis* were captured at Hebert's Nursery. Three *A. sagrei* and 4 *A. carolinensis* had retained tags from our mark-recapture in October 2005, and had survived the winter. Also, during collection of *A. sagrei* on 21 September 2006 (eleven months after tagging), 2 of 29 *A. sagrei* captured bore CWT. Sex, number, and size data for each species collected at Hebert's Nursery during mark-recapture and over-wintering studies are summarized in Table 2.

Both green and brown anoles were active at Double Oak Garden Center during all visits from October 2005 - February 2006 (Figure 7). The number of individuals of each species encountered dropped off until December and then rose through February.

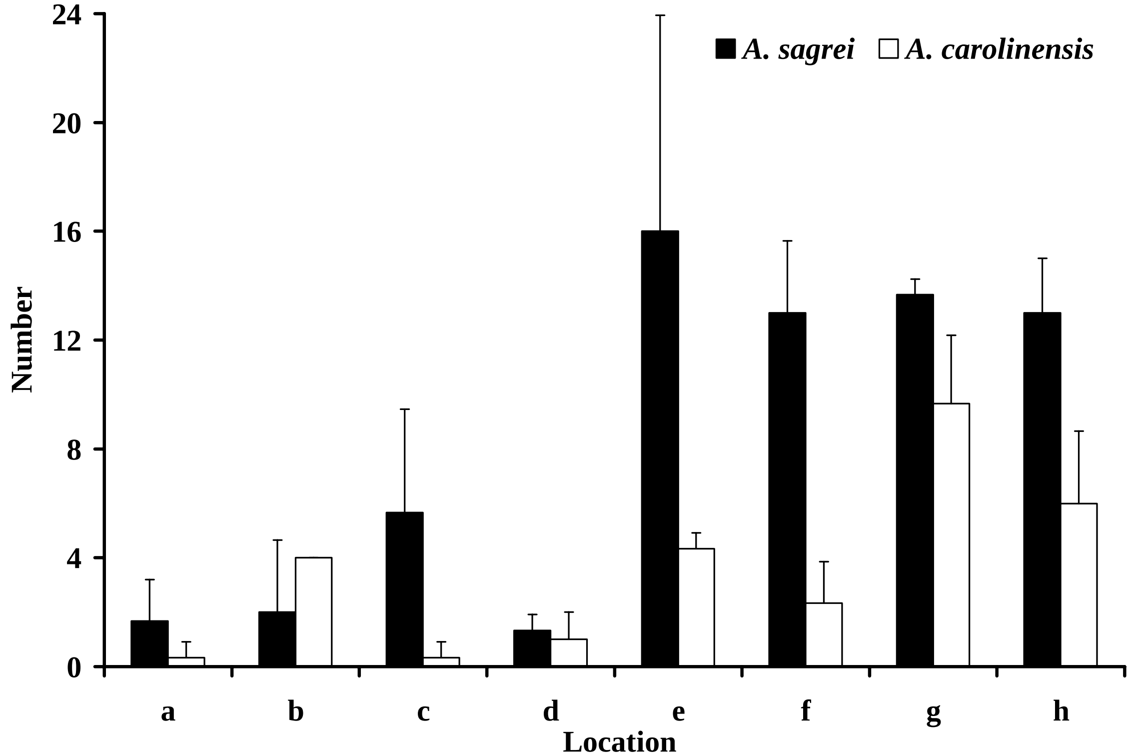

Figure 6. Mean (±SD) *Anolis sagrei* and *A. carolinensis* sighted at Double Oak Garden Center, Lockport, LA, during 30 minute visual encounter surveys (15 minutes moving, 15 minutes stationary) conducted during mid-day hours (1230-1300 hours), October 2005 – February 2006. a. Lowe's (Thibodaux), b. Chackbay Nursery and Landscaping, Inc., c. Home Depot, d. Lowe's (Houma), e. Green Acres Nursery and Gift Shop, f. Garnier's Southdown Gardens, g. Double Oak Garden Center, h. Starke's Garden Center.

Table 2. Sex, number (N), and mean (± SD) and range for snout-vent length (SVL) and weight of *Anolis* lizards collected at Hebert's Nursery (Thibodaux, Louisiana) during mark-recapture (6 and 13 October 2005) and over-wintering (20 June 2006) studies.

Species	Sex	N	Mean (± SD) SVL (mm)	SVL Range (mm)	Mean (± SD) Weight (g)	Weight Range (g)
A. sagrei						
	M	50	44.2 ± 10.3	19.3 - 61.0	2.9 ± 2.0	0.2 - 7.0
	F	17	39.3 ± 4.6	29.1 - 45.9	1.7 ± 0.8	0.5 - 2.9
A. carolinensis						
	M	29	56.4 ± 10.9	36.9 - 70.2	4.1 ± 2.1	0.5 - 6.9
	F	31	44.6 ± 8.8	23.4 - 55.0	2.1 ± 0.9	0.5 - 3.6

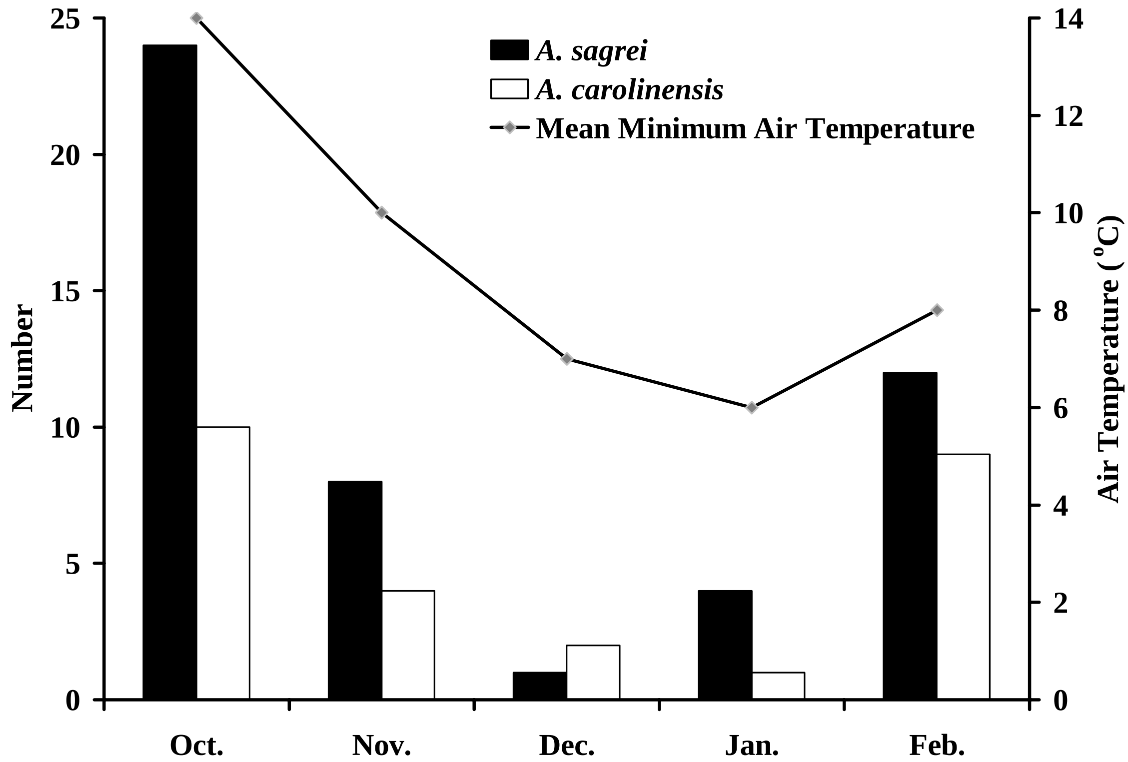

Figure 7. Total number of *Anolis sagrei* and *A. carolinensis* sighted at Double Oak Garden Center, Lockport, LA, during 30 minute visual encounter surveys (15 minutes moving, 15 minutes stationary) conducted during mid-day hours (1230-1300 hours), October 2005 – February 2006 and mean minimum air temperature (°C) for Lockport, Louisiana, by month.

Monthly mean minimum air temperatures in Lockport, Louisiana, as reported by The Weather Channel (www.weather.com), fall through January before beginning to rise (Figure 7). Of the original 21 *A. sagrei* caged and held outdoors, 7 (33.3 ± 0.297%) survived through the winter of 2006-2007 despite 11 freeze events (Southern Regional Climate Center, Houma station, http://www.srcc.lsu.edu/southernClimate).

DISCUSSION

Colonization/Invasion

Although intentionally introduced crops and livestock have generally proven beneficial for food production, other (accidental or intentional) anthropogenically introduced species such as the brown tree snake and cane toad have caused biologic and economic damage to the locations at which they have been introduced. Callaway and Aschenhoug (2000) support the theory that invaders are freed from their natural controlling factors and may, therefore, out-compete natives. Certainly, there is reason for concern over the establishment of any non-native species in Louisiana.

The brown tree snake is believed to have been introduced to Guam through the post World War II salvage of vehicles and equipment from New Guinea (Rodda et al. 1992). Since then, 6 of 12 native lizard species and 9 of 12 native forest bird species have disappeared from the previously snake-free island (Rodda et al. 1997). Pimentel et al. (2000) reviews the invasions of several organisms into the U.S. Concerning the brown tree snake, the authors estimate the annual associated costs to be >$5.6 million. This includes economic losses (Teodosio 1987), healthcare costs resulting from snake bites (Fritz et al. 1994), recovery efforts and research on Guam, and control on Hawaii (Holt 1998).

Cane toads were intentionally introduced into northern Queensland, Australia, in 1935 via a shipment of 100 toads from Hawaii in an effort to control cane beetles that were destroying sugarcane *Saccharum* spp. crops. The toads did not affect beetle populations and became invasive (Leslie 2004). The cane toad is poisonous at all stages in its life and mammalian predators poisoned by the toad experience rapid heart failure.

The toads eat food left out for pets creating a situation where pets may 'mouth' a toad and be poisoned (Reeves 2004). Cane toads both consume and compete with native animals in Australia (Greenlees et al. 2006). Because cane toads eat feces, they may transmit pathogenic bacteria such as *Salmonella* spp. when human hygiene is lacking (O'shea 1990).

There are roughly 53 non-native amphibian and reptile species in the warmer regions of the U.S, 32 of which are lizards (Pimentel et al. 2000; Powell et al. 1998). *Anolis* lizards have successfully expanded their ranges within the Carribean region and into Florida (Roughgarden et al. 1984; Wingate 1965; Ober 1973; Losos 1996). In a literature review of the outcomes of several anole introductions, Losos et al. (1993) found that only two of 23 introductions examined failed. Failed introductions occurred when invader and resident species were ecologically similar; however, invaders became established in ten instances of invader and resident similarity.

Several characteristics (reviewed in Campbell and Echternacht 2003) make *A. sagrei* the epitome of a successful invader including: an extensive native range, generalized diet and habitat use (Schoener 1968), adaptation to open, disturbed, and urban areas (Williams 1969; Wilson and Porras 1983), the ability to store sperm (Tokarz 1998), and the ability to disperse directly across water (Schoener and Schoener 1984). Also, Campbell (2000) found evidence suggesting that *A. sagrei* hatchlings could reach reproductive maturity before the end of their first summer providing for quick establishment.

The Mediterranean gecko *Hemidactylus turcicus* is another successfully colonizing lizard species (Barbour 1936; Byers et al. 2007). *H. turcicus* was first introduced to the U.S. at Key West, Florida (Fowler 1915; Stejneger 1922). *H. turcicus* was first reported in Louisiana by Etheridge (1952) based on sightings in New Orleans in 1949. Viosca (1957) claims the introduction into New Orleans occurred as early as 1945. Etheridge (1952) proposed accidental introduction of *H. turcicus* by cargo shipping into the port of New Orleans. The success of *H. turcicus* as an invader in Louisiana is partially due to the absence of native vertebrate species with the same ecological niche (i.e., nocturnal insect-feeder; Dundee and Rossman 1989).

Anole Interactions/Density

Williams (1969) refers to *A. sagrei* as a "dominant" species. *A. sagrei* has not only affected the vertical distribution of *A. carolinensis* in Florida, Losos et al. (1993) found that *A. sagrei* also causes *A. conspersus*, another invasive species in Florida, to desert lower perches and to adopt higher perches than would be utilized in the absence of *A. sagrei* on Grand Cayman. Conversely, Salzburg (1984) reported that co-habitation of *A. sagrei* and *A. cristatellus* in Florida resulted in the exclusion of *A. sagrei* from tree trunks, elevated perches, and shaded perches.

Collette (1961) realized the importance of examining the interactions between *A. sagrei* and *A. carolinensis* because the two species were coming into contact as *A. sagrei* expanded its range. He noted that male *A. sagrei* were always found facing downward on fence posts no more than a few feet from the ground indicating that their food is terrestrial. In the same manner, *A. sagrei* has both fewer lamellae per toe and a shorter tail than *A. carolinensis* (with respect to body size). Both of these features indicate a preference for near ground-level habitats since an arboreal life-style requires more lamellae for grasping and a longer tail for balancing. Hence, *A. carolinensis* yields lower perches to *A. sagrei* (Collette 1961).

Unlike *H. turcicus*, *A. sagrei* may be experiencing slight competition with a native counter-part in Louisiana, *A. carolinensis*. Tokarz and Beck (1987) used *A. carolinensis* from Louisiana to study behavioral interferences with *A. sagrei* in Florida and found that behavioral competition (i.e., courtship behavior and territorial aggression) between the species is less pronounced than that between individuals of the same species. Evidence exists supporting competition between *A. sagrei* and *A. carolinensis* due to dietary overlap although *A. carolinensis* may experience dietary shifts (i.e., consumption of more arboreal insects) due to *A. sagrei* induced habitat shift (Campbell 2000). Both *A. sagrei* and *A. carolinensis* practice intraguild predation; however, adult *A. sagrei* eat more juveniles than do adult *A. carolinensis*. Furthermore, *A. sagrei* adults preferred juveniles of other species over their own (Gerber and Echternacht 2000). The presence of *A. carolinensis*, though not preventing establishment or spread of *A. sagrei*, could be slowing these processes.

A. sagrei can introduce blood parasites into new areas where they can infect *A. carolinensis* (Wozniak et al. 1996; Goldberg and Bursey 2000). Also, potential negative effects of *A. sagrei* presence on egg production in female *A. carolinensis* have been suggested (Vincent 1999).

Losos and Spiller (1999) staged island introductions of *A. sagrei* and *A. carolinensis* in order to examine the effects of each species upon the population of the other. *Anolis* species were introduced in seclusion and in sympatry and population sizes were estimated yearly for three years. The authors stress that not all island habitats contained vegetation high enough to be suitable for *A. carolinensis*, but maintain that *A. carolinensis* population densities were lower in the presence of *A. sagrei* when compared to densities of *A. carolinensis* introduced alone (Losos and Spiller 1999). Campbell (2000), also using islands, demonstrated that increased densities of *A. sagrei* can rapidly and significantly exert negative influences on population size and density of *A. carolinensis*.

Our estimate of 0.033 *A. sagrei*/m^2 at Hebert's Nursery is low in comparison to other reported densities of *A. sagrei*. For example, Spiller and Schoener (1994) reported ~0.1 individuals/m^2 in Exumas, Bahamas, a site within the native range of *A. sagrei*, *A. carolinensis*, and other *Anolis* species. Other reported density estimates for *A. sagrei* include 0.17 per m^2 on Bimini (Oliver 1948), >0.20 per m^2 on Cuba (Lister 1976), 0.97 per m^2 on Bahamian islands (Schoener and Schoener 1980), and 1.20 per m^2 on dredge spoil islands in Florida (Campbell 2000). Schoener and Schoener (1980) found *A. carolinensis* at a density of 0.069 per m^2 on Bimini, 16% of the density of *A. sagrei* in the same study.

Predator-prey relationships of *A. sagrei* and web building spiders and the resulting food web effects have been studied extensively in the Bahamas (Spiller and Schoener 1990; Schoener and Spiller 1999; Schoener et al. 2002). *A. sagrei* presence negatively affects web building spider density because of competition and predation (Spiller and Schoener 1990). This creates a cascading effect on the food chain and results in increased numbers of small aerial arthropods (Schoener and Spiller 1999). *A. sagrei* also reduces scar and leaf mine damage to plants because the lizards consume the herbivorous arthropods that cause such damage (Schoener et al. 2002; Schoener and Spiller 1999).

Tagging

Despite general acceptance as the standard method for marking reptiles and amphibians, toe clipping reduces survival in Fowler's toad *Bufo woodhousei* (Clarke 1972). Also, infections at the tag injection site have occurred in natterjack toads *Bufo clamitia* (Golay and Durrer 1994).

No detrimental effects of CWT were found regarding the growth or survival of *A. carolinensis*. Individuals within all treatments were observed molting; shedding did not appear to be affected by the tags nor did shedding affect the tag retention. Lizards were also observed mating within all treatments. Lizard eggs were found in the potted plants and/or Reptibark^{tm} of aquaria housing all three treatment groups; no treatment appeared to inhibit egg deposition.

The 95% one year coded wire tag retention rate for *A. carolinensis* is similar to the 94-99% 12-week coded wire tag retention rate of juvenile lobsters *Homarus gammarus* (Uglem and Grimsen 1995). Also, green sea turtles *Chelonia mydas* and Atlantic loggerhead turtles *Caretta caretta* exhibited high coded wire tag retention rates over two years, 80% and 85% respectively (Schwartz 1981). Other CWT retention rates range from 100% in red swamp crayfish *Procambarus clarkii* over 200 days (Isely and Eversole 1998) to 35% for CWT inserted at the base of the uropod of white shrimp *Litopenaeus setiferus* over 28 days (Kneib and Huggler 2001).

Downes (2000) determined that CWT were suitable for use in another lizard species, the common garden skink *Lampropholis guichenoti* (size range 20-40 mm SVL) when injected under the skin of the lizard's ventral surface, near each limb. The skinks exhibited 100% retention of CWT over 12 months and 10% mortality over six weeks.

Also, no apparent morphological or behavioral effects were seen in a comparison of running speeds and activity levels pre-tagging and six weeks post-tagging.

The cost of coded wire tagging equipment may prevent this method from becoming widely used, especially when viewed in light of the low cost of toe-clipping. Coded wire tagging was designed for large-scale studies of fish that may involve the tagging of many thousands of individuals. A less costly alternative to the full compliment of coded wire tagging gear (automatic tagger and/or handheld tagger, wand detector, and tags), for studies involving fewer than 1000 individuals, is manual injection of pre-cut tags via a syringe. Use of manual injection would only incur the costs of a single shot injector, a wand detector, and tags. If it is necessary to identify individuals, a tag reading jig (grooved brass base to restrain organisms against while viewing under a microscope) is also recommended. Sharing equipment among universities or agencies helps to defray tagging costs.

Other identification techniques that have been used for lizards include: photography (Carlstrom and Edelstam 1946), cloth tape marking (Minnich and Shoemaker 1970), paint markings (Jenssen 1970; Medica et al. 1971; Vinegar 1975), branding (Clark 1971), aluminum rings (Rao and Rajabai 1972), foil pieces attached to string or thread and tied around the abdomen (Deavers 1972; Judd 1975), pattern/tail regeneration recognition (Stamps 1973), indelible pencil marks (Stebbins and Cohen 1973), numbering using felt tip pen (Henderson 1974), “jingle bells” tied around the neck with fishing line (Henderson 1974), and visual implant elastomer tags (Losos et al. 2004). External paint/pencil/ink markings are impermanent due to shedding. For full descriptions of these techniques see Ferner (1979).

Visual implant elasomer (VIE) tags have been used in reptiles and amphibians as an alternative to toe clipping (Jung et al. 2000; Kondo and Downes 2004; Losos et al. 2004). This two-part silicone-based material is mixed immediately before use and injected as a liquid polymer of biocompatible materials that cures into a pliable solid (Guy et al. 1996). Jung et al. (2000) created 255 individual codes using three colors and four injection locations in salamanders. Davis et al. (2004) found CWT to be superior to VIE tags in tagging juvenile blue crabs in part because of the speed of tagging although this was dependant on operator skill/experience.

Passive integrated transponder (PIT) tags are used to identify individual organisms, but have not been used in *Anolis* lizards. PIT tags are glass-encased electromagnetic coils and microchips with unique alphanumeric codes. Unlike CWT, these codes provide for individual identification without x-ray or sacrifice. Temperature sensitive PIT tags are also available (Implantable Programmable Temperature Transponders, Biomedic Data Systems, Seaford, DE). PIT tags transmit information to a reader after activation by the reader via a low-frequency electromagnetic signal (Camper and Dixon 1988). PIT tags have successfully been used in fish (Das Mahapatra et al. 2001), sea urchins (Hagen 1996; Woods and James 2005), crayfish (Bubb et al. 2006), small mammals (Rehmeier et al. 2006), birds (Carver et al. 1999; Jamison et al. 2000), freshwater turtles (Camper and Dixon 1988; Buhlmann and Tuberville 1998), sea turtles (Fontaine et al. 1987), snakes (Elbin and Burger 1994; Keck 1994; Roark and Dorcas 2000), crocodilians (Dixon and Yanosky 1993), and some lizard species (Camper and Dixon 1988; Germano and Williams 1993). Because of their capacity for identification of individuals, PIT tags can be used to track movement patterns and to compare these patterns between sexes and/or age classes (Bubb et al. 2007; Rehmeier et al. 2006).

The size of PIT tags (12.45 mm x 2.02 mm) has largely prevented their use in lizards (Ferner 1979). Germano and Willimas (1993) reported intra-abdominal injection of PIT tags into blunt-nosed leopard lizards *Gambelia sila*, as small as 50 mm SVL. The authors note that intra-abdominal injection could damage internal organs.

In July 2006, Biomark Inc., Boise, Idaho, USA began marketing the smallest available PIT tags. These tags (Model TXP1485B) are 8.5 mm x 2.12 mm and weigh 0.067 g. The advent of this new technology may allow for successful PIT tagging of *Anolis* lizards.

<u>Distribution/Over-wintering</u>

The landscaping industry is directly responsible for 85% of the woody invasive species in North America (Reichard and Hamilton 1997). The unintentional utility of plant shipping as an importation vector for *A. sagrei* is not unprecedented. The first recorded *A. sagrei* in Taiwan were collected near a plant nursery (Norval et al. 2002). *A. sagrei* was first found in Texas at a plant nursery in Houston, Texas, and a subsequent search of nurseries in southern Texas found *A. sagrei* populations at one nursery in each of the cities of Brownsville, Harlingen, and San Antonio (Dixon 1987; King et al. 1987). King et al. (1987) suggested two possible means by which *A. sagrei* adults or eggs may have been introduced into Texas: (1) transport on tropical plants from Florida when Texas nurseries replenished their stocks following a harsh freeze that devastated citrus and tropical plants in 1983 and/or (2) transport on ships visiting the ports of Brownsville or Harlingen. Wingate (1965) reported that dispersal of *A. grahami* in Bermuda was anthropogenically hastened because *A. grahami* was a novelty and people would catch lizards for release at their homes. This is also likely to occur at plant nurseries with introduced populations of *A. sagrei*. Although lizards are likely to abandon plants sold at nurseries during loading, unintentional translocation of eggs remains feasible (Losos 1996).

Unadjusted counts such as our VES make the untested assumption that detection probabilities are equal. Unlike mark-recapture estimates, VES do not allow for determination of the magnitude or direction of bias (Schmidt 2004). Hairston and Wiley (1993) encountered fluctuations in apparent abundance of salamanders due to variation in surveyor motivation. I avoided this potential source of bias by conducting all surveys myself.

As temperatures increase globally (Dickinson and Cicerone 1986) and changes in rainfall patterns ensue (Hartshorn 1992), the inhabitable ranges of many species may expand or retreat along a latitudinal gradient (Westbrooks 2001; Stohlgren et al. 2005; Taulman and Robbins 1996). Models exist for the projected, climate related, range changes of loblolly pine *Pinus taeda* (Miller et al. 1987), Japanese knotweed *Fallopia japonica* (Beerling et al. 1995), and fire ants *Solenopsis invicta* (Korzukhin et al. 2001; Kriticos et al. 2003; Morrison et al. 2005). The U.S. range of *A. sagrei* is probably limited by diffusion dispersal rates from introduction sites in coastal states receiving plants from the Caribbean. As the lizards disperse they should eventually encounter a barrier beyond which over-wintering is impossible. As of 2002, the northernmost record of *A. sagrei* was from Houston County, Georgia (Parmley 2002). However, *A. sagrei* has recently expanded into Orangeburg, Colleton, and Jasper Counties, South Carolina (Turnbow 2006).

Mean minimum winter temperature (MMWT) in Thibodaux, Louisiana (Latitude 29.79 ^{o}N) for the period 1971-2000 was 5.7 ^{o}C. In comparison, MMWT in St. Petersburg, Florida (Latitude 27.46 ^{o}N), a site where Fitch (1982) reported no hibernation for *A. sagrei*, was 12.2 ^{o}C over the same period. Houston County, Georgia (Latitude 32.40 ^{o}N), the site of the northernmost reported *A. sagrei* as of 2002 (Parmley 2002) had a MMWT of 0.2 ^{o}C, also over the same period (National Climatic Data Center, stations Thibodaux 3 ESE, St. Petersburg, and Byron Experiment Station, http://www5.ncd.cnoaa.cov/climatenormals).

As the range of *A. sagrei* expands, it is probable that it will continually reduce abundance and trigger habitat shifts in *A. carolinensis*. In addition, trophic consequences such as those related to web building spiders are likely to follow.

Evidence of an established population of *A. sagrei* in Florida comes from the presence of eggshell fragments and individuals of varying sizes (Cochran 1990). Although some nursery owners had seen lizard eggs, the eggs could have come from *A. carolinensis* or *A. sagrei*. Differences in egg shell morphology are distinguishable between the two species with reasonable accuracy with the use of a dissecting microscope (Vincent 1999); however no eggs were seen at or collected from plant distributors during this study. Although reproductively immature *A. sagrei* were consistently found, the possibility that either the immature lizards or lizard eggs were imported (and no reproduction occurred on site) cannot be ruled out.

The presence of coded wire tagged anoles at Hebert's Nursery following the winter of 2005 – 2006, confirms the ability of *A. sagrei* to over-winter in southeastern Louisiana. The activity seen in *A. sagrei* throughout the winter within the greenhouses of Double Oak Garden Center and the outdoor, over-winter survival of captive individuals both support the coded wire tagging evidence. Mean minimum air temperature in Lockport, Louisiana does not necessarily reflect the trends that were occurring during the study period.

<u>Summary</u>

Coded wire tagging is a valid method for marking *Anolis* lizards. One hundred percent of coded wire tags were retained after one month. One individual lost its tag before three months resulting in a 12 month 95% retention rate. Using mark-recapture techniques we estimated the population densities of 0.033 *A. sagrei*/m^2 and 0.008 *A.carolinensis*/m^2 at Hebert's Nursery (Thibodaux, Louisiana). *A. sagrei* was present at eight plant distributors in Lafourche and Terrebonne Parishes and was more abundant than *A. carolinensis* at all locations except Starke's Garden Center and Garnier's Southdown Gardens. *A. sagrei* can over-winter in South Louisiana and remain active under greenhouse conditions throughout the winter.

RECOMENDATIONS

The feasibility of using PIT tags in *Anolis* lizards as a method of individual identification without sacrifice should be considered. If feasible for use in anoles, temperature sensitive PIT tags would provide an efficient means for determining critical thermal minimum (Ct_{min}) under varying circumstances.

Five factors concerning the invasion of *A. sagrei* that were not addressed by this study are verification of reproduction and reproductive rate within southeastern Louisiana, the rate and extent of spread from each introduction site, and the Ct_{min}/freeze-tolerance of *A. sagrei*. Elucidation of these ecological facets will allow for more accurate modeling of boundaries that limit the distribution of *A. sagrei*. Reproduction of introduced populations of *A. sagrei* could be confirmed by egg collection and examination at our study sites during spring and summer. In order to confirm egg identification abilities of the researchers, a sub-sample could be taken off-site and hatched out. Determination of the reproductive rate (i.e., frequency of egg deposition and survival of hatchlings) of *A. sagrei* in southeastern Louisiana could help explain the apparent competitive advantage over *A. carolinensis*. Rate and extent of spread could potentially be determined by annual summer surveys along transects radiating out from plant distributors into surrounding vegetation/fields. This technique may or may not be effective based on transect lengths required to include un-invaded area. Extensive variation regarding periods and temperatures of acclimation and exposure would be required to determine Ct_{min} under varying circumstances.

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APPENDIX I:

SHORT TERM TAG RETENTION DATA

Appendix I. Snout-vent length (SVL; mm), weight (g), and sex of control, coded wire tagged (CWT), and toe clipped green anoles *A. carolinensis* maintained outdoors from 25 July 2005 to 25 August 2005.

Treatment	Repetition	SVL	Weight	Sex	Date
Control	1	50.4	2.4	F	25-Jul-05
Control	1	69.9	6.1	M	25-Jul-05
Control	1	52.5	2.3	F	25-Jul-05
Control	1	54.1	3.3	M	25-Jul-05
Control	1	49.1	2.3	M	25-Jul-05
Control	1	64.7	5.75	M	25-Jul-05
Control	1	63.1	4.3	M	25-Jul-05
Control	2	49.8	2.5	M	25-Jul-05
Control	2	51	2.8	M	25-Jul-05
Control	2	48.7	1.75	M	25-Jul-05
Control	2	63.8	5	M	25-Jul-05
Control	2	69.5	5.7	M	25-Jul-05
Control	2	48.3	2	F	25-Jul-05
Control	2	50.2	2	F	25-Jul-05
Control	3	55	3.2	M	25-Jul-05
Control	3	56.2	3	F	25-Jul-05
Control	3	48.6	2.3	M	25-Jul-05
Control	3	65.1	5.45	M	25-Jul-05
Control	3	49.8	2.4	F	25-Jul-05
Control	3	49	2.2	F	25-Jul-05
Control	3	51.6	2.1	M	25-Jul-05
CWT	1	50.1	2.6	F	25-Jul-05
CWT	1	52.4	2.4	F	25-Jul-05
CWT	1	48.6	2	F	25-Jul-05
CWT	1	53.2	3.1	M	25-Jul-05
CWT	1	52.9	2.2	F	25-Jul-05
CWT	1	63.6	4.4	M	25-Jul-05
CWT	1	49.3	2.7	F	25-Jul-05
CWT	2	47.3	2.4	M	25-Jul-05
CWT	2	55	3.1	M	25-Jul-05
CWT	2	51.5	2.5	F	25-Jul-05
CWT	2	62.5	4	M	25-Jul-05
CWT	2	46.6	2	F	25-Jul-05
CWT	2	48.9	2.3	F	25-Jul-05
CWT	2	51.1	2.2	F	25-Jul-05
CWT	3	64.8	5.7	M	25-Jul-05
CWT	3	49.8	2.5	M	25-Jul-05
CWT	3	48.6	3.1	M	25-Jul-05
CWT	3	51.9	2.3	M	25-Jul-05

Treatment	Repetition	SVL	Weight	Sex	Date
CWT	3	50.1	2.3	M	25-Jul-05
CWT	3	62.5	4.5	M	25-Jul-05
Toe clip	1	52.0	2.9	F	25-Jul-05
Toe clip	1	58.7	3.9	M	25-Jul-05
Toe clip	1	62.8	5.0	M	25-Jul-05
Toe clip	1	61.8	4.2	M	25-Jul-05
Toe clip	1	66.4	4.8	M	25-Jul-05
Toe clip	1	45.7	1.5	F	25-Jul-05
Toe clip	1	54.0	2.7	M	25-Jul-05
Toe clip	2	52.5	2.3	M	25-Jul-05
Toe clip	2	51.2	2.3	F	25-Jul-05
Toe clip	2	66.7	5.1	M	25-Jul-05
Toe clip	2	49.8	1.7	M	25-Jul-05
Toe clip	2	51.9	2.4	M	25-Jul-05
Toe clip	2	52.7	2.3	F	25-Jul-05
Toe clip	2	54.8	3.3	M	25-Jul-05
Toe clip	3	64.2	4.4	M	25-Jul-05
Toe clip	3	54.4	2.3	M	25-Jul-05
Toe clip	3	49.0	1.9	F	25-Jul-05
Toe clip	3	67.1	6.1	M	25-Jul-05
Toe clip	3	67.0	5.5	M	25-Jul-05
Toe clip	3	59.4	3.5	F	25-Jul-05
Toe clip	3	51.3	2.5	F	25-Jul-05
Control	1	53.3	3.8	M	25-Aug-05
Control	1	51.4	2.9	M	25-Aug-05
Control	1	66.0	7.0	M	25-Aug-05
Control	1	63.3	6.5	M	25-Aug-05
Control	1	63.4	5.4	M	25-Aug-05
Control	1	49.4	2.8	F	25-Aug-05
Control	1	53.7	3	F	25-Aug-05
Control	2	63.0	5.9	M	25-Aug-05
Control	2	66.7	7.5	M	25-Aug-05
Control	2	51.7	2.7	F	25-Aug-05
Control	2	45.9	2.5	M	25-Aug-05
Control	2	52.8	3.1	M	25-Aug-05
Control	3	62.9	7.0	M	25-Aug-05
Control	3	52.7	2.8	F	25-Aug-05
Control	3	51.3	2.6	M	25-Aug-05
Control	3	48.4	2.9	F	25-Aug-05
Control	3	52.0	3.6	M	25-Aug-05
Control	3	50.0	1.9	F	25-Aug-05
Control	3	49.9	2.3	M	25-Aug-05
CWT	1	52.7	2.8	F	25-Aug-05
CWT	1	50.2	2.0	F	25-Aug-05

Treatment	Repetition	SVL	Weight	Sex	Date
CWT	1	55.0	3.2	M	25-Aug-05
CWT	1	52.1	2.7	F	25-Aug-05
CWT	1	62.3	6.0	M	25-Aug-05
CWT	1	51.1	2.8	F	25-Aug-05
CWT	1	53.0	3.0	F	25-Aug-05
CWT	2	49.9	2.7	F	25-Aug-05
CWT	2	54.3	3.1	F	25-Aug-05
CWT	2	50.8	3.0	M	25-Aug-05
CWT	2	62.7	5.2	M	25-Aug-05
CWT	2	52.4	2.7	M	25-Aug-05
CWT	2	48.0	2.1	F	25-Aug-05
CWT	2	50.5	2.5	F	25-Aug-05
CWT	3	63.0	4.6	M	25-Aug-05
CWT	3	50.1	2.8	M	25-Aug-05
CWT	3	49.6	2.7	M	25-Aug-05
CWT	3	67.4	8.0	M	25-Aug-05
CWT	3	53.7	3.6	M	25-Aug-05
CWT	3	51.0	3.0	M	25-Aug-05
CWT	3	53.7	2.8	M	25-Aug-05
Toe clip	1	62.3	4.2	M	25-Aug-05
Toe clip	1	65.7	5.1	M	25-Aug-05
Toe clip	1	52.7	3.2	F	25-Aug-05
Toe clip	1	60.3	6.0	M	25-Aug-05
Toe clip	1	62.5	4.9	M	25-Aug-05
Toe clip	1	52.7	3.1	F	25-Aug-05
Toe clip	2	50.9	2.9	F	25-Aug-05
Toe clip	2	63.1	7.0	M	25-Aug-05
Toe clip	2	51.4	2.3	M	25-Aug-05
Toe clip	2	53.1	3.1	F	25-Aug-05
Toe clip	2	54.7	3.3	F	25-Aug-05
Toe clip	2	51.9	2.8	M	25-Aug-05
Toe clip	2	45.6	1.5	F	25-Aug-05
Toe clip	3	59.6	5.3	M	25-Aug-05
Toe clip	3	51.3	3.1	M	25-Aug-05
Toe clip	3	66.1	6.5	M	25-Aug-05
Toe clip	3	65.8	5.8	M	25-Aug-05
Toe clip	3	51.5	2.3	M	25-Aug-05
Toe clip	3	66.4	7.0	M	25-Aug-05

APPENDIX II:

LONG TERM TAG RETENTION DATA

Appendix II. Monthly snout-vent length (SVL; mm), weight (g), and tag retention status (Y or N) of coded wire tagged *A. carolinensis* from 25 October 2005 to 1 August 2006. Cages were initially outdoors, but were moved indoors when air temperatures dropped below 20°C.

Cage	SVL	Weight	Tag Retained	Date
1	61.6	6.0	Y	25-Oct-05
1	53.2	2.5	Y	25-Oct-05
1	51.8	2.0	Y	25-Oct-05
1	49.5	2.8	Y	25-Oct-05
1	51.5	2.3	Y	25-Oct-05
1	56.2	3.0	N	25-Oct-05
1	54.9	3.8	Y	25-Oct-05
2	50.3	3.0	Y	25-Oct-05
2	55.9	3.5	Y	25-Oct-05
2	62.2	5.5	Y	25-Oct-05
2	53.1	2.8	Y	25-Oct-05
2	53.1	2.5	Y	25-Oct-05
2	50.1	2.8	Y	25-Oct-05
2	50.9	2.3	Y	25-Oct-05
3	69.1	6.5	Y	25-Oct-05
3	63.1	5.0	Y	25-Oct-05
3	51.4	2.5	Y	25-Oct-05
3	51.8	2.5	Y	25-Oct-05
3	51.4	2.8	Y	25-Oct-05
3	54.8	2.8	Y	25-Oct-05
3	51.2	2.8	Y	25-Oct-05
1	51.5	2.0	Y	26-Nov-05
1	47.8	2.5	Y	26-Nov-05
1	61.8	5.0	Y	26-Nov-05
1	52.4	2.3	N	26-Nov-05
1	55.5	3.5	Y	26-Nov-05
1	50.6	2.0	Y	26-Nov-05
1	48.0	2.0	Y	26-Nov-05
2	47.1	1.8	Y	26-Nov-05
2	48.2	1.8	Y	26-Nov-05
2	62.6	4.0	Y	26-Nov-05
2	54.1	2.8	Y	26-Nov-05
2	51.3	2.8	Y	26-Nov-05
2	50.3	2.0	Y	26-Nov-05
2	49.5	2.0	Y	26-Nov-05
3	66.9	6.0	Y	26-Nov-05
3	51.0	2.8	Y	26-Nov-05
3	52.6	1.8	Y	26-Nov-05
3	62.5	4.8	Y	26-Nov-05

Cage	SVL	Weight	Tag Retained	Date
3	48.8	2.5	Y	26-Nov-05
3	50.2	2.3	Y	26-Nov-05
3	47.4	2.3	Y	26-Nov-05
1	55.3	3.0	Y	30-Dec-05
1	53.0	2.3	N	30-Dec-05
1	62.1	5.4	Y	30-Dec-05
1	47.7	2.2	Y	30-Dec-05
1	45.1	1.8	Y	30-Dec-05
1	51.9	2.2	Y	30-Dec-05
1	52.1	2.7	Y	30-Dec-05
2	50.3	2.2	Y	30-Dec-05
2	62.7	5.3	Y	30-Dec-05
2	48.0	1.8	Y	30-Dec-05
2	49.4	2.0	Y	30-Dec-05
2	48.9	2.0	Y	30-Dec-05
2	54.6	2.5	Y	30-Dec-05
2	54.9	3.0	Y	30-Dec-05
3	66.0	6.3	Y	30-Dec-05
3	61.2	5.3	Y	30-Dec-05
3	49.0	2.1	Y	30-Dec-05
3	50.3	2.4	Y	30-Dec-05
3	48.4	2.5	Y	30-Dec-05
3	49.5	2.4	Y	30-Dec-05
3	50.5	2.5	Y	30-Dec-05
1	60.0	5.6	Y	29-Jan-06
1	49.8	1.8	Y	29-Jan-06
1	46.7	2.1	Y	29-Jan-06
1	50.1	2.1	Y	29-Jan-06
1	51.4	2.3	Y	29-Jan-06
1	54.3	2.6	Y	29-Jan-06
1	52.4	2.7	N	29-Jan-06
2	47.6	2.3	Y	29-Jan-06
2	49.3	2.0	Y	29-Jan-06
2	63.4	5.8	Y	29-Jan-06
2	47.7	1.7	Y	29-Jan-06
2	54.6	2.7	Y	29-Jan-06
2	52.6	2.2	Y	29-Jan-06
2	48.4	1.7	Y	29-Jan-06
3	62.7	4.8	Y	29-Jan-06
3	66.1	6.6	Y	29-Jan-06
3	52.0	2.3	Y	29-Jan-06
3	48.4	2.0	Y	29-Jan-06
3	54.2	2.5	Y	29-Jan-06
3	48.1	2.5	Y	29-Jan-06

Cage	SVL	Weight	Tag Retained	Date
3	50.2	2.8	Y	29-Jan-06
1	47.6	2.0	Y	3-Mar-06
1	51.1	2.3	Y	3-Mar-06
1	64.0	6.0	Y	3-Mar-06
1	48.5	2.3	Y	3-Mar-06
1	50.2	2.2	Y	3-Mar-06
1	56.8	2.9	Y	3-Mar-06
1	50.9	2.1	N	3-Mar-06
2	51.3	2.0	Y	3-Mar-06
2	49.1	2.3	Y	3-Mar-06
2	63.7	5.2	Y	3-Mar-06
2	55.1	2.4	Y	3-Mar-06
2	50.1	1.8	Y	3-Mar-06
2	54.1	3.0	Y	3-Mar-06
2	51.4	2.6	Y	3-Mar-06
3	62.3	4.8	Y	3-Mar-06
3	67.7	7.6	Y	3-Mar-06
3	50.5	2.5	Y	3-Mar-06
3	51.6	2.5	Y	3-Mar-06
3	54.7	3.3	Y	3-Mar-06
3	49.7	2.8	Y	3-Mar-06
3	51.6	3.0	Y	3-Mar-06
1	54.8	3.2	Y	2-Apr-06
1	48.9	1.7	Y	2-Apr-06
1	49.5	2.0	Y	2-Apr-06
1	61.1	4.6	Y	2-Apr-06
1	49.7	2.0	Y	2-Apr-06
1	52.5	2.4	N	2-Apr-06
2	61.5	5.0	Y	2-Apr-06
2	51.5	1.6	Y	2-Apr-06
2	50.4	1.5	Y	2-Apr-06
2	50.8	2.5	Y	2-Apr-06
2	50.8	2.1	Y	2-Apr-06
2	54.7	3.4	Y	2-Apr-06
3	65.1	4.5	Y	2-Apr-06
3	54.4	2.8	Y	2-Apr-06
3	51.3	2.3	Y	2-Apr-06
3	49.7	1.7	Y	2-Apr-06
3	50.0	3.3	Y	2-Apr-06
3	68.1	7.3	Y	2-Apr-06
3	47.9	2.6	Y	2-Apr-06
1	51.6	2.4	Y	1-May-06
1	53.3	3.0	Y	1-May-06
1	61.5	5.8	Y	1-May-06

Cage	SVL	Weight	Tag Retained	Date
1	57.8	3.8	Y	1-May-06
1	56.2	2.7	N	1-May-06
1	46.1	2.0	Y	1-May-06
2	50.2	2.7	Y	1-May-06
2	52.4	2.5	Y	1-May-06
2	56.2	4.4	Y	1-May-06
2	63.9	5.4	Y	1-May-06
3	58.0	5.3	Y	1-May-06
3	69.0	7.5	Y	1-May-06
3	53.5	2.9	Y	1-May-06
3	45.5	2.4	Y	1-May-06
3	54.6	2.6	Y	1-May-06
3	52.5	2.8	Y	1-May-06
3	52.1	3.1	Y	1-May-06
1	50.1	1.9	Y	31-May-06
1	53.5	2.5	N	31-May-06
1	59.6	6.5	Y	31-May-06
1	54.0	2.5	Y	31-May-06
1	56.5	4.1	Y	31-May-06
1	52.7	3.0	Y	31-May-06
2	61.9	5.2	Y	31-May-06
2	50.1	2.7	Y	31-May-06
2	56.3	4.1	Y	31-May-06
2	48.8	2.4	Y	31-May-06
3	63.4	5.3	Y	31-May-06
3	68.2	7.1	Y	31-May-06
3	52.6	2.9	Y	31-May-06
3	52.5	2.8	Y	31-May-06
3	49.5	2.5	Y	31-May-06
3	51.2	2.7	Y	31-May-06
3	50.6	2.5	Y	31-May-06
1	49.6	2.2	N	1-Aug-06
1	57.5	4.1	Y	1-Aug-06
1	48.1	1.6	Y	1-Aug-06
1	52.2	2.2	Y	1-Aug-06
1	52.2	2.6	Y	1-Aug-06
1	60.4	5.0	Y	1-Aug-06
2	63.9	5.3	Y	1-Aug-06
2	47.4	2.1	Y	1-Aug-06
2	54.6	3.6	Y	1-Aug-06
3	64.5	5.5	Y	1-Aug-06
3	67.8	7.4	Y	1-Aug-06
3	51.9	2.5	Y	1-Aug-06
3	48.1	2.7	Y	1-Aug-06

Cage	SVL	Weight	Tag Retained	Date
3	49.1	2.6	Y	1-Aug-06
3	52.7	2.5	Y	1-Aug-06
3	50.2	2.5	Y	1-Aug-06

APPENDIX III:

MARK-RECAPTURE

AND

OVER-WINTERING DATA

Appendix III. Date, species, sex, snout vent length (SVL; mm), weight (g), and tag retention status: not applicable (N/A), Yes (Y), and No (N) of anoles tagged at Hebert's Nursery (Thibodaux, Louisiana) on 6 and 13 October 2005 and 20 June 2006. Dots indicate data that could not be determined due to the small size of the individual.

Date	Species	Sex	SVL	Weight	Tag Retained
6-Oct-05	*A. sagrei*	M	40.2	1.5	N/A
6-Oct-05	*A. sagrei*	M	19.3	0.2	N/A
6-Oct-05	*A. sagrei*	M	47.4	2.5	N/A
6-Oct-05	*A. sagrei*	M	50.9	3.5	N/A
6-Oct-05	*A. sagrei*	M	50.7	3.0	N/A
6-Oct-05	*A. sagrei*	M	47.8	2.5	N/A
6-Oct-05	*A. sagrei*	M	41.6	1.8	N/A
6-Oct-05	*A. sagrei*	M	46.8	2.3	N/A
6-Oct-05	*A. sagrei*	M	38.3	1.8	N/A
6-Oct-05	*A. sagrei*	M	32.9	1.0	N/A
6-Oct-05	*A. sagrei*	M	33.8	0.8	N/A
6-Oct-05	*A. sagrei*	M	45.8	2.5	N/A
6-Oct-05	*A. sagrei*	M	58.6	5.5	N/A
6-Oct-05	*A. sagrei*	M	43.2	2.0	N/A
6-Oct-05	*A. sagrei*	M	36.8	1.5	N/A
6-Oct-05	*A. sagrei*	M	40.9	1.5	N/A
6-Oct-05	*A. sagrei*	M	29.6	0.5	N/A
6-Oct-05	*A. sagrei*	F	34.8	1.3	N/A
6-Oct-05	*A. sagrei*	F	42.0	1.8	N/A
6-Oct-05	*A. sagrei*	F	31.6	0.8	N/A
6-Oct-05	*A. sagrei*	F	38.5	1.3	N/A
6-Oct-05	*A. sagrei*	F	35.8	1.0	N/A
6-Oct-05	*A. sagrei*	F	37.3	1.5	N/A
6-Oct-05	*A. sagrei*	F	36.2	1.0	N/A
6-Oct-05	*A. sagrei*	F	40.3	1.8	N/A
6-Oct-05	*A. sagrei*	F	38.9	1.3	N/A
6-Oct-05	*A. sagrei*	F	29.1	0.5	N/A
6-Oct-05	*A. sagrei*	·	19.9	0.3	N/A
6-Oct-05	*A. sagrei*	·	24.1	0.3	N/A
6-Oct-05	*A. sagrei*	·	19.2	0.3	N/A
6-Oct-05	*A. sagrei*	·	31.3	0.5	N/A
6-Oct-05	*A. carolinensis*	M	62.7	5.3	N/A
6-Oct-05	*A. carolinensis*	M	67.4	5.8	N/A
6-Oct-05	*A. carolinensis*	M	50.5	2.0	N/A
6-Oct-05	*A. carolinensis*	M	43.3	2.3	N/A
6-Oct-05	*A. carolinensis*	M	39.1	1.0	N/A
6-Oct-05	*A. carolinensis*	F	49.6	2.0	N/A
6-Oct-05	*A. carolinensis*	F	36.5	1.0	N/A
6-Oct-05	*A. carolinensis*	F	40.1	1.3	N/A

Date	Species	Sex	SVL	Weight	Tag Retained
6-Oct-05	*A. carolinensis*	F	40.0	1.0	N/A
6-Oct-05	*A. carolinensis*	F	51.9	2.3	N/A
6-Oct-05	*A. carolinensis*	F	53.4	2.5	N/A
6-Oct-05	*A. carolinensis*	F	52.9	2.3	N/A
6-Oct-05	*A. carolinensis*	F	39.1	1.0	N/A
6-Oct-05	*A. carolinensis*	F	39.1	1.0	N/A
13-Oct-05	*A. sagrei*	M	46.7	3.3	N
13-Oct-05	*A. sagrei*	M	51.1	4.5	N
13-Oct-05	*A. sagrei*	M	31.2	1.0	N
13-Oct-05	*A. sagrei*	M	39.4	1.5	N
13-Oct-05	*A. sagrei*	M	42.0	6.8	N
13-Oct-05	*A. sagrei*	M	44.7	2.5	N
13-Oct-05	*A. sagrei*	M	36.8	1.5	N
13-Oct-05	*A. sagrei*	M	32.8	0.8	N
13-Oct-05	*A. sagrei*	M	40.0	2.0	N
13-Oct-05	*A. sagrei*	M	41.9	2.0	N
13-Oct-05	*A. sagrei*	M	52.1	4.0	N
13-Oct-05	*A. sagrei*	M	37.2	1.3	N
13-Oct-05	*A. sagrei*	M	41.0	1.8	N
13-Oct-05	*A. sagrei*	M	47.2	3.3	Y
13-Oct-05	*A. sagrei*	M	44.4	2.3	N
13-Oct-05	*A. sagrei*	M	49.0	3.5	N
13-Oct-05	*A. sagrei*	M	45.9	2.5	N
13-Oct-05	*A. sagrei*	M	43.6	2.0	N
13-Oct-05	*A. sagrei*	M	47.5	3.0	N
13-Oct-05	*A. sagrei*	M	27.8	0.8	N
13-Oct-05	*A. sagrei*	M	29.1	0.8	N
13-Oct-05	*A. sagrei*	M	29.3	0.5	N
13-Oct-05	*A. sagrei*	M	25.1	0.3	N
13-Oct-05	*A. sagrei*	F	43.1	1.3	N
13-Oct-05	*A. sagrei*	·	20.5	0.3	N
13-Oct-05	*A. sagrei*	·	20.8	0.3	N
13-Oct-05	*A. carolinensis*	M	66.7	6.0	N
13-Oct-05	*A. carolinensis*	M	66.9	6.0	N
13-Oct-05	*A. carolinensis*	M	63.6	5.3	N
13-Oct-05	*A. carolinensis*	M	36.9	1.3	N
13-Oct-05	*A. carolinensis*	M	53.6	3.0	N
13-Oct-05	*A. carolinensis*	M	66.5	5.5	N
13-Oct-05	*A. carolinensis*	M	39.9	1.5	Y
13-Oct-05	*A. carolinensis*	M	44.6	2.0	N
13-Oct-05	*A. carolinensis*	M	63.6	5.0	N
13-Oct-05	*A. carolinensis*	M	41.5	1.3	N
13-Oct-05	*A. carolinensis*	M	66.1	5.5	N
13-Oct-05	*A. carolinensis*	M	45.6	0.5	N

Date	Species	Sex	SVL	Weight	Tag Retained
13-Oct-05	*A. carolinensis*	M	66.2	6.3	Y
13-Oct-05	*A. carolinensis*	M	53.0	3.0	N
13-Oct-05	*A. carolinensis*	M	46.2	2.0	N
13-Oct-05	*A. carolinensis*	F	32.0	0.8	N
13-Oct-05	*A. carolinensis*	F	37.6	1.0	N
13-Oct-05	*A. carolinensis*	F	24.2	2.5	N
13-Oct-05	*A. carolinensis*	F	39.8	1.5	N
13-Oct-05	*A. carolinensis*	F	37.8	1.5	N
13-Oct-05	*A. carolinensis*	F	34.9	0.5	N
13-Oct-05	*A. carolinensis*	F	55.0	3.5	N
13-Oct-05	*A. carolinensis*	F	51.9	2.3	Y
13-Oct-05	*A. carolinensis*	F	52.0	3.0	N
13-Oct-05	*A. carolinensis*	F	49.8	2.3	N
13-Oct-05	*A. carolinensis*	F	23.4	1.3	N
13-Oct-05	*A. carolinensis*	F	53.6	2.5	N
20-Jun-06	*A. sagrei*	M	57.8	6.0	N
20-Jun-06	*A. sagrei*	M	59.7	6.5	N
20-Jun-06	*A. sagrei*	M	50.9	3.9	Y
20-Jun-06	*A. sagrei*	M	60.0	7.0	N
20-Jun-06	*A. sagrei*	M	57.6	5.9	N
20-Jun-06	*A. sagrei*	M	58.3	6.4	Y
20-Jun-06	*A. sagrei*	M	57.8	5.4	Y
20-Jun-06	*A. sagrei*	M	61.0	5.5	N
20-Jun-06	*A. sagrei*	M	58.1	5.9	N
20-Jun-06	*A. sagrei*	M	59.1	6.1	N
20-Jun-06	*A. sagrei*	F	43.7	2.7	N
20-Jun-06	*A. sagrei*	F	45.9	2.9	N
20-Jun-06	*A. sagrei*	F	43.3	2.8	N
20-Jun-06	*A. sagrei*	F	41.7	2.7	N
20-Jun-06	*A. sagrei*	F	43.9	2.7	N
20-Jun-06	*A. sagrei*	F	41.6	2.3	N
20-Jun-06	*A. sagrei*	·	·	·	N
20-Jun-06	*A. sagrei*	·	·	·	N
20-Jun-06	*A. sagrei*	·	18.7	·	N
20-Jun-06	*A. carolinensis*	M	70.2	6.2	N
20-Jun-06	*A. carolinensis*	M	66.4	6.1	N
20-Jun-06	*A. carolinensis*	M	66.9	6.2	Y
20-Jun-06	*A. carolinensis*	M	61.3	6.9	N
20-Jun-06	*A. carolinensis*	M	63.5	5.2	N
20-Jun-06	*A. carolinensis*	M	63.9	6.7	Y
20-Jun-06	*A. carolinensis*	M	48.4	3.0	N
20-Jun-06	*A. carolinensis*	M	65.8	6.1	N
20-Jun-06	*A. carolinensis*	M	46.0	2.0	N
20-Jun-06	*A. carolinensis*	F	50.2	2.4	N

Date	Species	Sex	SVL	Weight	Tag Retained
20-Jun-06	*A. carolinensis*	F	54,7	3.6	Y
20-Jun-06	*A. carolinensis*	F	47.9	2.5	N
20-Jun-06	*A. carolinensis*	F	54.0	3.3	N
20-Jun-06	*A. carolinensis*	F	47.8	2.4	N
20-Jun-06	*A. carolinensis*	F	53.6	3.5	Y
20-Jun-06	*A. carolinensis*	F	51.2	2.7	N
20-Jun-06	*A. carolinensis*	F	45.8	2.5	N
20-Jun-06	*A. carolinensis*	F	47.0	2.0	N
20-Jun-06	*A. carolinensis*	F	47.2	2.5	N

BIOGRAPHICAL SKETCH

Michael Wiley was born on August 26, 1983, in Alexandria, Louisiana. After graduating from Buckeye High School in Deville, Louisiana in 2001, Michael attended Nicholls State University. Michael earned a B.S. degree in Biology with a concentration in Marine Biology from Nicholls State University in May 2005. The following Fall, Michael enrolled in the graduate program in Marine and Environmental Biology at Nicholls State University where he worked under the supervision of Drs. Allyse Ferrara and Quenton Fontenot of the Bayousphere Research Lab. Michael's research interests centered around the dynamics of the biological invasion of the brown anole *Anolis sagrei* into South Louisiana. Michael plans to seek employment as a high school biology or physics teacher and obtain to teaching certification after graduation in the Spring of 2007.

CURRICULUM VITAE

Michael Paul Wiley

Graduate Student
Nicholls State University

102 Thoroughbred Park Dr.
Thibodaux, Louisiana, 70301
(985) 446-7517
michaelpwiley@hotmail.com

EDUCATION

M.S. Marine and Environmental Biology, Spring 2007, Nicholls State University, Thibodaux, Louisiana, 70310. Thesis title: Estimation of Over-wintering, Population Density, and Distribution of an Exotic Lizard, the Brown Anole *Anolis sagrei,* in Southeastern Louisiana, Using a Novel Tagging Method.

B.S. Biology with a concentration in Marine Biology, Spring 2005, Nicholls State University, Thibodaux, Louisiana, 70310.

TEACHING EXPERIENCE

Fall 2005-Spring 2007: Teaching Assistant, Nicholls State University, Department of Biological Sciences. Duties included preparing and teaching introductory freshman biology labs that surveyed the plant and animal kingdoms as well as conducting study sessions and grading assignments.

Summer 2003: Marine Education Intern, Louisiana Universities Marine Consortium. Duties included observation, field guidance, and classroom instruction of various summer camp participants ranging elementary school children through high school science teachers.

RESEARCH EXPERIENCE

Fall 2005-Spring 2007: Estimation of Over-wintering, Population Density, and Distribution of an Exotic Lizard, the Brown Anole *Anolis sagrei*, in Southeastern Louisiana, Using a Novel Tagging Method.

Fall 2004: A search for the Crustacean Hypoglycemic Hormone

SKILLS

ATV operation, water quality monitoring, restorative coastal vegetation grow out/planting, data management

LABORATORY EXPERIENCE

Care and maintenance of live lizards, spectrophotometry

MEMBERSHIP AND SERVICES

American Society of Icthyologists and Herpetologists

Phi Kappa Phi

HONORS AND AWARDS

2006 Chancellors List, Nicholls State University

2006 Nicholls State University Research Council Student Research Competition. 3rd Place Abstract.

2006 Nicholls State University Research Council Student Research Competition. 3rd Place Poster Presentation.

PUBLICATIONS

Wiley, M.P., A.M. Ferrara, and Q.C. Fontenot. (*In Press*) Geographic distribution. *Anolis sagrei*. Herpetological Review.

SCIENTIFIC PRESENTATIONS

2006 **Wiley, M.P**., D. Romano, J. Reulet, C. Bonvillian, Q.C. Fontentot, A.M. Ferrara. Retention of Coded Wire Tags in the Green Anole *Anolis carolinensis*. July 2006. Annual Meeting of the American Society of Icthyologists and Herpetologists, New Orleans, Louisiana.

2006 **Wiley, M.P.**, D. Romano, J. Reulet, C. Bonvillian, Q.C. Fontentot, A.M. Ferrara. Retention of Coded Wire Tags in the Green Anole *Anolis carolinensis*. March 2006. Nicholls State University Research Week Competition, Thibodaux, Louisiana (poster presentation).

2006 **Wiley, M.P.**, D. Romano, J. Reulet, C. Bonvillian, Q.C. Fontentot, A.M. Ferrara. Retention of Coded Wire Tags in the Green Anole *Anolis carolinensis*. November 2006. Annual Meeting of the Louisiana Herpetological Research Group.

EMPLOYMENT

August 2005 – Present. Graduate Teaching Assistant, Nicholls State University, Department of Biological Sciences. Assisted in teaching introductory biology courses.

June 2005 – August 2005. Student Worker, Barataria Terrebonne National Estuary Program. Performed office duties and prepared educational materials for distribution.

June 2006 – August 2006. Graduate Research Assistant, Nicholls State University Department of Biological Sciences. Assisted in transplanting, care, and planting of plants for coastal restoration.