Effects of Hurricane Rita on the herpetofauna of Village Creek State Park, Hardin County, Texas.

Print

Author: *Nicoletto, Paul F.*
Article Type: *Report*
Geographic Code: *1USA*
Date: *Mar 1, 2013*
Words: *4821*
Publication: *Southwestern Naturalist*
ISSN: *0038-4909*

In recent years, there has been increasing interest in how stochastic disturbances, such as hurricanes affect herpetofauna (Dodd and Dreslik, 2008). Disturbance of habitats resulting from hurricanes may cause significant effects on surviving herpetofauna, but no clear pattern has emerged (Reagan, 1991; Woolbright, 1991; Greenberg, 2001; Vilella and Fogarty, 2005). The kind and magnitude of effects can depend upon timing, locality, kind and degree of damage, and life history of species (Reagan 1991; Woolbright, 1991; Schoener et al., 2004; Vilella and Fogarty, 2005; Dodd and Dreslik, 2008). In some instances, hurricanes dramatically affected species and assemblages and in others there was no apparent effect (Greenberg, 2001). Disruption caused by hurricanes influences patterns of movement, survivorship, use of habitats, rates of growth, and abundance, diversity, and evenness of species (Reagan, 1991; Woolbright, 1991; Greenberg, 2001; Wunderle et al., 2004; Vilella and Fogarty, 2005; Dodd et al., 2006; Dodd and Dreslik, 2008; Schriever et al., 2009).

Most studies of the impact of hurricanes on herpetofauna have been conducted on Caribbean islands or on the Florida Keys (Reagan, 1991). On the mainland of North America, a few studies have been conducted, e.g., in the southern Appalachian Mountains and in coastal marshes of Louisiana (Greenberg 2001; Schriever et al., 2009). The southeastern United States is home to a diverse herpetofauna (Lewis et al., 2000; Tuberville et al., 2005), but there has been no study that examined effects of hurricanes on herpetofauna in forests of southeastern Texas. Objectives of my study were to compare species, relative abundance, and use of habitats by the herpetofauna at Village Creek State Park, Hardin County, Texas, before and after Hurricane Rita. I compared species and numbers of individuals captured during 2001-2004, which was prior to the hurricane, with those captured in 2007 and 2008, which was 2-3 years after the hurricane.

Materials and Methods--A survey of the herpetofauna was conducted at Village Creek State Park in Lumberton, Hardin County, Texas, before Hurricane Rita in 2001-2004 and after the hurricane in 2007-2008. The park was 441 ha and consisted of six terrestrial habitats as described by Marks and Harcombe (1981) for the Big Thicket: baygall and cypress-tupelo swamp forests, floodplain hardwood forests, low-to-mid-slope oak-pine forests, lower-slope hardwood-pine forests, and upland-sandhill pine forests. Village Creek, a tributary of the Neches River, formed the northern border of the park. The park also contained numerous black-water sloughs. Flooding of low-lying areas was frequent, occurring at least once per year, and massive floods occurred every 3-4 years.

Initial objectives during 2001-2004 were to inventory herpetofauna of the park, investigate use of habitats, and determine relative abundance. To survey, I used box funnel traps with drift fences and visual searches while walking to and from traps. A total of 43 species of amphibians and reptiles was

encountered: 4 salamanders, 11 frogs and toads, 4 turtles, 1 crocodilian, 7 lizards, and 16 snakes.

On 24 September 2005, Hurricane Rita made landfall in southeastern Texas and southwestern Louisiana (www.nhc.noaa.gov/pdf/TCR-AL182005_Rita.pdf). This was a category-lll storm on the Saffir Simpson scale with sustained winds of 188 km/h. The hurricane caused significant damage to coastal and inland areas. The eye of the storm came inland just east of Village Creek State Park, and caused significant damage to the park. The Texas Parks and Wildlife Department estimated that 259 ha (59%) of the park were affected by the hurricane with a loss of 30-80% of the canopy (J. Rashall, pers. comm.). After the hurricane, a timber-salvage operation removed downed and damaged trees from many affected areas. Therefore, as a result of Hurricane Rita, the herpetofauna at Village Creek State Park may have been significantly affected.

Post-hurricane sampling was limited to animals that entered box traps to enable comparisons with pre-hurricane data. Animals that were observed but did not enter traps were not included in analyses. Otherwise, trapping methods before and after the hurricane were the same. The eight box-trap arrays consisted of a central funnel trap constructed of exterior plywood and hardware cloth as described by Lewis et al. (2000). Hardware-cloth funnels were placed at ground level in the center of each side of the trap. Four 15-m, black erosion cloth placed at 90[degree] angles abutted the trap in the center of each funnel. The top of the trap was hinged so that the trap could be opened and animals removed. When traps were opened, a galvanized dish was placed in each trap and filled with water.

Before the hurricane, two trapping arrays were placed in each of four habitats: baygall and cypress-tupelo swamp forest, floodplain hardwood forest, low-to-mid-slope hardwood-pine forest, and upland-sandhill pine forest. This permitted sub-sampling of habitats and enabled statistical comparisons. Sites were selected based on accessibility and where establishing the array would minimize cutting trees for drift fences. Arrays within a habitat were [greater than or equal to] 250 m apart and [greater than or equal to] 250 m from the edge of the habitat. Traps placed in the baygall and cypress-tupelo swamp forest were 15 m from the edge of the baygall, with one drift fence perpendicular to and on the edge of the baygall. The end of the drift fence often was in water. Location of each trapping site was recorded with a GPS unit (Garmin GPS V; Garmin Corp., Olathe, Kansas). Six of the eight traps or drift fences were destroyed by tree-falls during Hurricane Rita and five of these traps were rebuilt and moved after the hurricane. These traps were relocated in the same habitat, as close to the original trapping site as possible.

Amphibians and reptiles were sampled each month during March-October. Traps were set for [greater than or equal to] 1 week and usually checked every other day. Prior to the hurricane, floods occasionally prevented traps from being set during a month. Hurricane Ike, which made landfall in September 2008, prevented access to the park for sampling in September and October. Upon capture, individuals were counted, identified, and released.

The original intent of my study was simply to survey the herpetofauna. Trapping sites were chosen based on type of forest, but no data were collected to characterize vegetation of those forested communities. Lack of quantitative data on vegetation before the hurricane made a quantitative beforeand-after comparison of microhabitats impossible. Therefore, descriptions of changes that occurred in microhabitats are qualitative, based on photographs taken before and after the hurricane.

Percentage canopy cover after the hurricane was estimated at each trapping array from a digital photograph of the canopy. A digital camera (Olympus model SP-56OUZ; Olympus Imaging Corp., Tokyo, Japan) mounted on a tripod was placed atop the traps. The camera was placed 1 m above and oriented 90[degree] perpendicular to the lid of the trap. Photographs were taken at the infinity setting of the zoom and at a resolution of 3,264 by 2,448 pixels. All photographs were taken on a

cloudless day during 1100-1200 h. Photographs were analyzed using Image J (version 1.410, rsb.info.nih.gov/ij) software and converted into binary images; sky was converted to white and canopy to black. This binary image was analyzed using the list-histogram function, which determined the number of white and black pixels. Percentage canopy cover was then calculated by dividing number of black pixels by total number of pixels and multiplying the result by 100.

Only those species that were caught in traps during the 6 years of study were included in analyses. Number of species and differences in sampling effort were analyzed across years using Chi-square tests. Sampling effort differed among the 6 years of the study. Therefore, the analysis for difference in number of individuals captured per year was corrected for differences in number of sampling days. Numbers of individuals of each species caught per day were calculated by dividing total number captured of each species each year by number of sampling days during that year. The pre-hurricane and post-hurricane rates of capture were compared with a paired Wilcoxon rank-sums test using SigmaPlot 11 (Systat Software, Inc., San Jose, California).

Change in use of habitats by species and individuals was analyzed with two-way analysis of variance (ANOVA). Number of species captured in each habitat in each month was divided by number of sampling days for that month. Data for number of species were not distributed normally and were rank transformed to enable use of parametric statistical procedures (Conover and Inman, 1981).

RESULTS--Neither Hurricane Rita nor differences in trapping effort had an apparent effect on species of herpetofauna captured at Village Creek State Park. There was no difference among years in numbers of species captured ([chi square] = 1.09, df = 5, P > 0.960) in spite of a significant difference in number of trapping days during some years ([chi square] = 23.35, df = 5, P > 0.001).

A total of 31 species of amphibians and reptiles was captured during the 4-years prior to the hurricane and 28 species were captured after the hurricane (Table 1; Fig. 1a). Five species were captured in the 4 years before the hurricane and not after. Of those five species, three were caught only in 1 year, one in 2 years, and one in 3 years. Of the two species that were caught after the hurricane, but not before the hurricane, one was caught in 1 year and the other was caught in 2 years. Both of these species previously were reported from the park.

There were annual fluctuations in total number of individuals captured for all species before Hurricane Rita (Table 1; Fig. 1b). The largest number of individuals was captured in 2001 (n = 114) and the least in 2002 (n = 71). Numbers of individuals caught in 2003 (n = 86) and 2004 (n = 99) were intermediate. Differences in number of individuals captured among years were not attributable to differences in trapping days as there was no correlation between the two variables ([r.sub.s] = 0.20, df= 3, P = 0.920).

Total number of individuals captured after the hurricane exhibited an overall increase (n = 380 in 2007 and n = 251 in 2008; Table 1; Fig. 1b). There was a significantly larger average number of individuals caught per day after the hurricane than before the hurricane (Wilcoxon signed rank test, Z = 2.957, n = 32, P = 0.003). The dramatic increase in number of bronze frogs (Rana clamitans)in 2007, after the hurricane (Table 1), was not solely responsible for differences in rates of capture (Wilcoxon signed-rank test, Z = 2.786, n = 31, P = 0.005, with R clamitans deleted). However, average increase in number of individuals after the hurricane was not consistent across species. After the hurricane, 24 species increased and 9 decreased in number of individuals. Four of these nine species were rare before the hurricane and not captured after the hurricane. Two species were captured after the hurricane, but not before. All 11 of these species occurred in the park but were sufficiently rare or exhibited behavior that yielded meager trapping success.

There was considerable variation in how the hurricane affected trapping sites among microhabitats. Trapping sites in the upland-sandhill pine forest were unaffected. There were some tree-falls in this habitat, but the canopy in the vicinity of traps remained relatively intact. Canopy cover at trapping sites in the upland-sandhill pine forest was ca. 54 [+ or -] 1.3% and was the highest of the four habitats. The understory and leaf litter in this habitat also was unchanged.

[FIGURE 1 OMITTED]

Few trees fell within baygall and cypress-tupelo swamp forest, so this forest was affected little by the hurricane. However, edges of the habitat where traps were placed were affected significantly. A tornado touched down in the area, which in combination with the subsequent tree-salvage operation, eliminated most of the canopy. Canopy at traps in baygall and cypress-tupelo swamp forest was ca. 35 [+ or -] 12.6% and was the lowest of the four habitats. Understory significantly increased and, in some areas, was nearly impossible for a person to penetrate.

Trapping sites in the floodplain hardwood forest also were affected significantly by the hurricane. Prior to the hurricane, there was a complete canopy and little understory. During the hurricane, a tornado touched down in the area. There were many large tree-falls near traps; some traps had to be relocated after the hurricane. Immediate vicinities of the new trapping sites were covered partially by a canopy, but surrounding forest was patchy. Canopy at trapping sites was ca. 50 [+ or -] 2.9%. There was a significant increase in understory at trapping sites within this habitat.

Trapping sites in the low-to-mid-slope hardwood-pine forest also were affected by the hurricane. There were many tree-falls near trapping sites. Traps were covered partially by a canopy, but the area around traps had scattered trees intermixed with relatively intact forest. Canopy at trapping sites was ca. 50 [+ or -] 9.9%. There also was a significant increase in understory in this habitat.

Changes in habitats caused by Hurricane Rita had a significant effect on numbers of species trapped per day in the four habitats within the park. The two-way ANOVA revealed significant main effects for hurricane and habitat, but the significant hurricane-habitat interaction indicated that habitats were affected in different ways by the hurricane ($n = 55$, $P = 0.035$, [F.sub.3, 48] = 3.10). Mean number of species caught per day increased significantly in the floodplain hardwood (2.0 times) and low-to-midslope hardwood-pine forests (2.8 times) after Hurricane Rita (Fig. 1a). Mean number of species per day in the baygall and cypress-tupelo swamp and upland-sandhill pine forests were not significantly different before and after the hurricane, although the trend in the baygall and cypress-tupelo swamp forest approached significance.

After the hurricane, 11 species (43% of species) used more habitats, 2 (7% of species) used fewer, and 14 used the same number of habitats (50% of species). Of species that changed number of habitats used, more tended to expand use of habitats after the hurricane (Fisher distribution-free sign test, $P = 0.057$). Changes in habitats caused by Hurricane Rita had a significant influence on numbers of individuals trapped per day in the four habitats. Average number of individuals caught per day increased significantly in the floodplain hardwood (3.3 times) and low-to-mid-slope hardwood-pine (2.9 times) forests and in the baygall and cypress-tupelo swamp forest (2.4 times) after Hurricane Rita (Fig. 1b). Average number of species captured per day in the upland-sandhill pine forest was not significantly different before and after the hurricane.

Discussion--Results of a 3-year study of the herpetofauna in nearby Big Sandy Creek Unit of Big Thicket National Preserve, Polk County, Texas (Lewis et al., 2000), were similar to mine. The study at Big Sandy Creek was more intensive; Lewis et al. (2000) placed eight trapping arrays with multiple funnel traps in each habitat, while I placed two arrays with one large funnel trap in the center of the

array in each habitat. The study at Big Sandy Creek sampled during spring and autumn, while I sampled April-October. At Big Sandy Creek, 40 species were cataloged compared to 43 in my study. Six species (one salamander, two frogs, and three snakes) that were not detected in my study area were observed at Big Sandy Creek. Nine species (three turtles, one lizard, and four snakes) that were detected in my study area were not noted at Big Sandy Creek. The small difference between sites can be attributed largely to the more upland geography of the Big Sandy Creek Unit and inclusion of the baygall and cypress-tupelo swamp forest at Village Creek State Park. The more-intensive sampling at Big Sandy Creek yielded higher rates of capture than in my study (Big Sandy Creek, n = 1,886; Village Creek State Park, n = 995).

Fallen trees and other debris from the hurricane significantly affected many habitats in Village Creek State Park. The most obvious affect was that tree-fall dramatically increased coarse woody debris, which significantly influences herpetofauna and greatly increases heterogeneity of habitats and surface area available for use by amphibians and reptiles (Whiles and Grubaugh, 1996; Greenberg, 2001). Coarse woody debris is an important structural component of terrestrial habitats that increases diversity of invertebrates and vertebrates (Caldwell, 1996; Hanula 1996; Harmon et al., 1986). This debris provides nesting sites, calling or displaying sites, basking sites, refuge from predators or inclement conditions, and foraging sites (Whiles and Grubaugh, 1996).

Tree-falls result in changes in habitats that are important to reptiles and amphibians. A forest with a newly opened canopy has larger fluctuations in temperature, increased intensity of light, and increased evapotranspiration (Sousa, 1984; Webb et al., 2005). An open canopy results in a significant increase in understory vegetation and ground cover, which leads to increased stratification of habitats (Sousa, 1984). Gaps created by tree-fall lead to an increase in abundance of resources needed by insectivorous amphibians, reptiles, birds, and mammals (Blake and Hoppes, 1986; Loeb 1996; Whiles and Grubaugh, 1996), and their predators (Whiles and Grubaugh, 1996).

Hurricane Rita had a significant quantitative effect, but not a significant qualitative effect on amphibians and reptiles at Village Creek State Park. Quantitatively, 363 individuals were captured in 175 days of sampling before the hurricane and 632 individuals were capture in 126 days after the hurricane. However, composition of the herpetofauna probably did not change. The 28 species captured after the hurricane were all known to be in the park previously. There were five uncommon species not captured in traps after the hurricane. Of these, three species (three-toed box turtle Terrapene carolina, eastern fence lizard Sceloporus undulatus, and western mudsnake Farancia abacura) were observed in the park after the hurricane. The two species not captured or seen after the hurricane were the three-toed amphiuma Amphiuma tridactylum and the northern cricket frog Acris crepitans. Amphiuma tridactylum is an aquatic salamander that was captured in a trap one time after a flood in 2001. Acris crepitans was rare prior to the hurricane and was captured only in 2003 at one trap in floodplain hardwood forest.

Climate, environmental stability, historical factors, size of area, heterogeneity of habitats, and availability of energy are primary factors that may influence diversity of species and density of populations (Kerr and Packer, 1997). Heterogeneity of habitats and availability of energy have changed at Village Creek State Park as a result of Hurricane Rita. Coarse woody debris from tree-fall and root-ball holes has significantly increased heterogeneity of habitats. Significant reduction of canopy in many areas increased the amount of solar radiation reaching the understory and resulted in significant growth of under-story. Both of these factors probably have favored increase in size of populations after the hurricane.

An increase in number of species may also occur in the park if a pool of nonresident species existed and corridors link those species to the park. Historically, 72 species of herpetofauna are known in

Hardin County (University of Texas at Austin, Texas Memorial Museum, www.herpsoftexas.org). Of these species, 43 occur at Village Creek State Park and 3 of them are listed as threatened by the Texas Department of Parks and Wildlife.

In general, response of herpetofauna to disturbance caused by a hurricane depends upon type and magnitude of the disturbance and species examined (Greenberg, 2002; Schriever etal., 2009; Waide, 1991). Loss of aboreal habitat caused by hurricane-induced tree-falls affects density of populations, use of habitats, and mobility in some species. Puerto Rican boas (Epicrates inornatus) switched from arboreal to terrestrial habitats because damage caused by Hurricane Georges reduced access to trees. Movement also increased with males moving more often and farther than females (Wunderle et al., 2004). Significant loss of canopy resulting from Hurricane Hugo shifted Anolis from canopy to ground and near ground levels. The barred anole (Anolis stratulus), a canopy-dwelling species, responded to changes in structure of habitat, while Gundlach's anole (A. gundlachi), a forest-interior species, responded to changes in microclimate (Reagan, 1991). At Village Creek State Park, Hurricane Rita led to a significant overall increase in number of individuals captured and in number of habitats used by some species. There was an increase in daily rate of capture for 22 of the 26 species caught before and after the hurricane. Rates of capture of the other four species were reduced. Of these four species, one was the Woodhouse's toad Bufo woodhousii, and the others were lizards. Two of the lizards, the green anole Anolis carolinensis and eastern fence lizard tended to be arboreal species and the other, the little brown skink Scincella lateralis, was terrestrial.

The hurricane affected the number of habitats used by amphibians and reptiles in different ways. Three species of amphibians did not expand their use of habitats, while two increased and two decreased use of habitats. Eleven species of reptiles did not change use of habitats and, while no reptile exhibited a decrease in habitat, eight species expanded use of habitats. The most expanded use of habitats was by the coachwhip Masticophis flagellum. The coachwhip, like Puerto Rican boas (Wunderle et al., 2004), is a species with strong arboreal tendencies (Tennant et al., 1998). Prior to Hurricane Rita, a total of seven coachwhips was captured in 4 years in two habitats. After the hurricane, a total of64 coachwhips was captured in 2 years and in all four habitats.

In summary, Hurricane Rita had a positive effect on the herpetofauna at Village Creek State Park. It is doubtful that any species was lost and numbers of some species greatly increased. Tree-fall and coarse woody debris from the hurricane and increased sunlight reaching the forest floor appeared to increase heterogeneity of habitats, which has lead to an increase in resources and living space for amphibians and reptiles.

I thank personnel of the Texas Department of Parks and Wildlife and the Department of Biology at Lamar University for funding this project. I thank M. Haiduk, A. Posey, G. Carpenter, and two anonymous reviewers for comments. I also thank J. Rashall and the numerous people that helped construct and check traps, in particular the staff and volunteers at Village Creek State Park.

Submitted 26 September 2011. Accepted 28 November 2012. Associate Editor was Geoffrey C. Carpenter.

LITERATURE CITED

BLAKE, J. G., AND W. G. HOPPES. 1986. Influence of resource abundance on use of tree-fall gaps by birds in an isolated woodlot. Auk 103:328-340.

CALDWELL, R. S. 1996. Earthworms, biodiversity, and coarse woody debris in forest ecosystems of the southeastern U.S.A. Pages 49-54 in Biodiversity and coarse woody debris in southern forests (J. W. McMinn and D. A. Crossley, Jr., editors). United States Department of Agriculture Forest Service,

Southern Research Station, Asheville, North Carolina GTR-SE-94:1-146

CONOVER, W. J., AND R. L. INMAN. 1981. Rank transformations as a bridge between parametric and nonparametric statistics. American Statistics 35:124-129.

DODD, C. K., JR., AND M. J. DRESLIK. 2008. Habitat disturbances differentially affect individual growth rates in a long-lived turtle. Journal of Zoology (London) 275:18-25.

DODD, C. K., JR., A. OZGUL, AND M. K. OLI. 2006. The influence of disturbance events on survival and dispersal rates of Florida box turtles. Ecological Applications 16:1936-1944.

GREENBERG, C. H. 2001. Response of reptile and amphibian communities to canopy gaps created by wind disturbance in the southern Appalachians. Forest Ecology and Management 148:135-144.

GREENBERG, C. H. 2002. Fire, habitat structure, and herpertofauna in the Southeast. Pages 231-236 in The role of fire in nongame wildlife management and community restoration: traditional issues and new directions (W. M. Ford, K. R. Russell, and C. E. Morrman, editors). United States Department of Agriculture Forest Service, General Technical Report NE-288:1-145.

HANULA, J. L. 1996. Relationship of wood-feeding insects and coarse woody debris. Pages 55-81 in Biodiversity and coarse woody debris in southern forests (J. W. McMinn and D. A. Crossley, Jr., editors). United States Department of Agriculture Forest Service, Southern Research Station, Asheville, North Carolina GTR-SE-94:1-146.

HARMON, M. E., J. F. FRANKLIN, F. J. SWANSON, P. SOLLINS, S. V. GREGORY, J. D. LATTIN, N. H. ANDERSON, S. P. CLINE, N. G. AUMEN, J. R. SEDELL, G.W. LIENKAEMPER, K. CROMACK, JR., AND K. W. CUMMINS. 1986. Ecology of coarse woody debris in temperate ecosystems. Pages 133-302 in Advances in ecological research, volume 15 (A. MacFadyen and E. D. Ford, editors). Academic Press, London, United Kingdom.

KERR, J. T., AND L. PACKER. 1997. Habitat heterogeneity as a determinate of mammalian species richness in high-energy regions. Nature 385:252-254.

LEWIS, S. D., R. R. FLEET, AND F. L. RAINWATER. 2000. Herpetofaunal assemblages of four forest types in the Big Sandy Creek unit of the Big Thicket National Preserve. Texas Journal of Science 52:139-150.

LOEB, S. C. 1996. The role of coarse woody debris in the ecology of southeastern mammals. Pages 106-118 in Biodiversity and coarse woody debris in southern forests (J. W. McMinn and D. A. Crossley, Jr., editors). United States Department of Agriculture Forest Service, Southern Research Station, Asheville, North Carolina GTR-SE-94:1-146.

MARKS, P. L., AND P. A. HARCOMBE. 1981. Forest vegetation of the Big Thicket, Southeast Texas. Ecological Monographs 51:287-305.

REAGAN, D. P. 1991. The response of Anolis lizards to hurricaneinduced habitat changes in a Puerto Rican rain forest. Biotropica 23:468-474.

SCHOENER, T. W., D. A. SPILLER, AND J. B. LOSOS. 2004. Variable ecological effects of hurricanes: the importance of seasonal timing for survival of lizards on Bahamian islands. Proceedings of the National Academy of Sciences 101:177-181.

SCHRIEVER, T. A., J. RAMSPOTT, B. I. CROTHER, AND C. L. FONTENOT, JR. 2009. Effects of hurricanes Ivan, Katrina, and Rita on a southeastern Louisiana herpetofauna. Wetlands 29:112-122.
SOUSA, W. P. 1984. The role of disturbance in natural communities. Annual Review of Ecology and Systematics 15:353-391.

TENNANT, A., J. E. FORKS, AND G. T. SALMON. 1998. A field guide to Texas snakes. Second edition. Gulf Publishing, Houston, Texas.

TUBERVILLE, T. D., J. D. WILLSON, M. E. DORCAS, AND J. W. GIBBONS. 2005. Herpetofaunal species richness of southeastern national parks. Southeastern Naturalist 4:537-569.

VILELLA, F. J., AND J. H. FOGARTY. 2005. Diversity and abundance of forest frogs (Anura: Leptodactylidae) before and after Hurricane Georges in the Cordillera Central of Puerto Rico. Caribbean Journal of Science 41:157-162.

WAIDE, R. B. 1991. Summary of the response of animal populations to hurricanes in the Caribbean. Biotropica 23:508-512.

WEBB, J. K., R. SHINE, AND R. M. PRINGLE. 2005. Canopy removal restores habitat quality for an endangered snake in a fire suppressed landscape. Copeia 2005:894-900.

WHILES, M. R., AND J. W. GRUBAUGH. 1996. Importance of coarse woody debris to southern forest herpetofauna. Pages 94-100 in Biodiversity and coarse woody debris in southern forests (J. W. McMinn and D. A. Crossley, Jr., editors). United States Department of Agriculture Forest Service, Southern Research Station, Asheville, North Carolina GTR-SE-94:1-146.

WOOLBRIGHT, L. L. 1991. The Impact of Hurricane Hugo on forest frogs in Puerto Rico. Biotropica 23:462-467.

WUNDERLE, J. M., JR., J. E. MERCADO, B. PARRESOL, AND E. TERRANOVA. 2004. Spatial ecology of Puerto Rican boas (Epicrates inornatus) in a hurricane impacted forest. Biotropica 36:555-571.

Paul F. Nicoletto

Department of Biology, P.O. Box 10037, Lamar University, Beaumont, TX 77710 Correspondent: pfnicoletto@my.lamar. edu

TABLE 1-Numbers of reptiles and amphibians captured during 4 years before (2001-2004) and 2 years after (2007-2008) Hurricane Rita at Village Creek State Park, Hardin County, Texas.

Taxon	2001	2002	2003	2004	2007	2008
Ambystoma opacum	0	1	0	0	0	1
Amphiuma tridactylum	1	0	0	0	0	0
Incilius valliceps	3	2	1	1	5	10
Bufo woodhousii	2	3	9	9	7	2
Scaphiopus hurterii	14	0	1	1	0	0
Acris crepitans	0	0	6	0	0	0
Hyla squirella	0	0	0	0	0	3
Hyla versicolor	0	2	0	1	2	2
Rana catesbeiana	0	2	2	0	13	0
Rana clamitans	7	5	14	8	143	23

Rana sphenocephala	20	10	6	13	31	24
Kinosternon subrubrum	1	0	0	0	1	0
Terrapene carolina	1	0	0	0	0	0
Anolis carolinensis	0	12	15	28	19	27
Aspidoscelis sexlineatus	0	2	1	1	4	4
Plestiodon fasciatus	11	6	5	3	10	11
Plestiodon laticeps	4	4	0	1	4	5
Sceloporus undulatus	0	2	0	1	0	1
Scincella lateralis	3	4	3	8	2	12
Agkistrodon contortrix	3	2	1	0	5	11
Agkistrodon piscivorus	8	1	5	7	19	15
Coluber constrictor	1	0	2	0	0	7
Elaphe obsoleta	12	1	4	5	10	16
Farancia abacura	1	0	0	1	0	0
Heterodon platirhinos	2	0	1	2	9	5
Lampropeltis getula	1	1	2	0	4	9
Lampropeltis triangulum	2	0	0	0	1	3
Masticophis flagellum	0	3	2	2	34	30
Micrurus tener	2	0	1	1	2	1
Nerodia erythrogaster	8	3	1	6	25	15
Nerodia fasciata	0	0	0	0	3	2
Thamnophis proximus	0	5	4	0	27	13
Total	107	71	86	99	380	252