

FEATURE ARTICLES

Status of *Bufo debilis* (Anura: Bufonidae) in Kansas

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Cragin (1894) first reported the Green Toad, *Bufo debilis* Girard, from Kansas, based on specimens he allegedly observed in September 1886 in Morton, Barber, and southern Hamilton counties. Voucher specimens do not exist from that report and Rundquist (1979) has discredited the specimen from Barber County.

Taylor (1929) noted an unspecified number of Morton County specimens he observed and collected from 1926–1928. Hill (1931) and Kellogg (1932) reported on Taylor's Morton County specimens in their respective accounts. Additionally, Kellogg (1932) documented the only known specimen from Grant County (KU 5642, no specific locality), collected in 1911.

Smith (1932) compiled all known literature records and voucher specimens of *Bufo debilis* in Kansas. He added one Greeley County specimen from the University of Kansas Natural History Museum and six Logan County specimens from the Kansas State College (now Kansas State University) vertebrate collection.

Rundquist (1979) discredited Smith's (1932) records for Greeley and Logan counties, as well as Cragin's (1894) Hamilton County observation, because voucher specimens could not be located. Rundquist (1979) confirmed that a single specimen from Logan County (no other data) did exist in the University of Michigan Museum of Zoology (UMMZ 67442).

Platt et al. (1974) listed *Bufo debilis* as rare in Kansas and, subsequently, this anuran received formal protection as a threatened species under the Kansas Nongame and Endangered Species Conservation Act of 1975 (K.S.A. 32-501 to 32-510) and Kansas Department of Wildlife and Parks regulations K.A.R. 23-17-1 and 23-17-2). As defined by Kansas Administrative Regulation 23-17-2, southwest Logan and southeast Wallace counties became designated

critical habitat for *B. debilis* populations in Kansas.

Roth and Collins (1979) reported a single female (KU 182086) at a new locality in Wallace County (see Appendix). Burkhart (1984) contributed information regarding the distribution and status of existing populations, and identified areas of suitable habitat within the remainder of the state. He did not observe *Bufo debilis* in Wallace County, but collected new locality vouchers (KU 192337–38 and KU 193301–03) along the Twin Butte Creek drainage in Logan County (Figure 1, Site C).

The principal objectives of this project were to make observations on *Bufo debilis* populations and update their distribution in Kansas. Observations were made from 1991 to 1994. If enough specimens were collected to support a restocking effort, a repatriation of *B. debilis* into the Cimarron National Grassland was to be attempted.

The collection localities of *Bufo debilis* museum specimens and literature reports were examined and evaluated as to vegetation type, soil composition, geology, hydrology, and topography. Using these assessments as basic habitat requirements, potential localities were sought. When searching for possible sites, areas of relief were determined from USGS 1:100,000-scale metric topographical maps. These areas were then physically examined to assess their similarity to the historical localities.

Once suitable habitat was located, field trips were taken on rainy nights during the late spring and throughout the summer during the course of this study. Roads to pre-selected optimal sites through suitable habitat were driven at night after heavy thunderstorms. Frequent stops were made to listen for choruses in adjacent pasture lands.

Specimens of *Bufo debilis* were observed in Wallace, Logan, Wichita, Greeley, and Hamilton counties. Observations were made on the breeding, habitat, food, and preda-

tors of this secretive amphibian. Voucher specimens and recorded observations (see Appendix) from this study have more accurately detailed the range of *B. debilis* in Kansas.

Bufo debilis seems to prefer areas of native prairie vegetation with considerable topographical relief and presence of an intermittent stream. Following thunderstorms, they congregate at pools of water formed within and below canyon breaks. All localities at which *B. debilis* were observed were grazed by cattle. *B. debilis* was abundant in geologic substrates of conglomerate (Tertiary: Miocene: Ogallala) as well as in association with large limestone and chalk outcrops (Cretaceous: Niobrara). Loamy soils, in particular those soils characterized by slow to moderate permeability, moderate to high water holding capacity and rapid surface runoff, supported the highest concentrations of *B. debilis*. The Colby-Kim-Midway soil association of Wallace and Logan counties is characterized by these properties and supports the greatest concentration of *B. debilis* in Kansas.

The high clay content in these soils permits greater moisture retention, permitting anuran larvae maximal developmental time. These soils also enhance *chrysothrix* formation in the mud of drying pools, providing microhabitat for recently transformed toadlets. Creusere and Whitford (1976) noted similar affinities of arid-adapted anurans, including *Bufo debilis*, to mud *chrysothrix*s, and noted that of all refugia available to juvenile anurans, the least percentage of mortality was found among the individuals that used the *chrysothrix*s. At every *B. debilis* chorus site, juveniles were ultimately seen in association with the *chrysothrix*s of the dried pool bottom within a few weeks of metamorphosis.

The toadlets voluntarily emerged from mud cracks only at dusk. However, as I walked on the dried pool bottom during the day, toadlets did emerge just ahead of my footsteps. By the end of the summer, juvenile *Bufo debilis* were observed less frequently in association with the pools, but were more commonly found under rocks on the surrounding hillsides.

Breeding activity was observed from 12 June through 2 September after heavy precipitation and daytime air temperatures greater than 29° C. The breeding pools were dry and covered with dense vegetation prior to *oviposition*. The size of the pool utilized varied from 2.9 m² to shallow impounded ponds of up to 3,000 m² and the depth of the pools varied from 33–76 cm. At a site in Logan County, *Bufo debilis* used the pooled runoff from a nearby stock tank for breeding. All the pools used by *B. debilis* had bottoms composed of a high clay content sediment, never limestone or conglomerate. The vegetation was emergent around the pool margin and inundated by water in the deeper sections of the pools.

Flooded vegetation was present at every site *Bufo debilis* were observed. Vegetation in the larger pools consisted primarily of *Xanthium strumarium* (Cocklebur), *Euphor-*

bia marginata (Snow-on-the-mountain), *Polygonum amphibium* (Swamp Smartweed), and *P. persicaria* (Lady's Thumb). The primary vegetation in the smaller pools was composed of *o*-ooded stands of small *X. strumarium*, *Bouteloua gracilis* (Blue Grama), and *Buchloe dactyloides* (Buffalo Grass). Breeding sites did not possess representatives of plant families characteristic of a permanent aquatic environment (e.g. sedges, duckweeds, cattails or the pond weeds). Small *chrysothrix* and blooms of filamentous algae were infrequently observed in the pools.

At the breeding pools, the number of adult male *Bufo debilis* observed varied from a single individual to choruses of approximately 80 specimens. Adult males called with their forelegs propped on the vegetation around the pool margin. When approached they never moved nor quit calling and were therefore easily collected by hand with the aid of a headlamp. Chorusing by individual adult males was witnessed up to *se*ve m from the water's edge on mud banks and rain-moistened grassy slopes.

Pairs of *Bufo debilis* in pectoral amplexus were found inside the ring of emergent vegetation around the inner margin of the pools. When pairs were approached, the female would often dive out of sight, still carrying the male. A single pair in amplexus was discovered on the shore in Wallace County, 1.7 m from the pool.

Other animals occupied these same pools as well. Among other amphibia, *Ambystoma mavortium* (Barred Tiger Salamander), *Spea bombifrons* (Plains Spadefoot), *Rana blairi* (Plains Leopard Frog), *Bufo woodhousii* (Woodhouse's Toad), *Pseudacris maculata/triseriata* complex (Chorus Frog), *Acris crepitans* (Northern Cricket Frog), and *Rana catesbeiana* (Bullfrog) were all observed at the pools in decreasing order of abundance. The most numerous macroscopic invertebrates observed in the pools included members of the Crustacean families Streptocephalidae, Leptestheriidae, and Lepiduridae (Eubranchiopoda) (Pennak 1953). Other Crustaceans identified from the pools were Daphnidae and Bosminidae (Cladocera) and Cyclopidae and Senecellidae (Copepoda).

On 6 July 1992, a pair in amplexus was collected in Logan County and temporarily maintained in a four-quart hard plastic container with cuttings of *Polygonum amphibium* and approximately *se*ve cm of water. A mass of 1,287 eggs was laid by the female shortly after being placed in the container. The eggs were laid singly and no strings were observed in the clutch. The eggs did not adhere to themselves, the container, or *P. amphibium*. The egg mass was deposited at a site at the Cimmaron National Grassland later the same night. Fertilization was not confirmed though it may have occurred.

Adult *Bufo debilis* were found by day at the pools, and on the surrounding hillsides under rocks and human refuse, and once at the entrance to a *Cynomys ludovicianus* (Black-Tailed Prairie Dog) burrow in Logan County. The *chrysothrix* of

these hillsides was comprised primarily of *Agropyron smithii* (Western Wheatgrass), *Sporobolus giganteus* (Tall Dropseed), *Andropogon provincialis* (Big Bluestem), *A. scoparius* (Little Bluestem), *Bouteloua curtipendula* (Sideoats Grama), *B. gracilis*, and *B. dactyloides*. Soapweed (*Yucca glauca*) was liberally distributed across the upland landscape.

Bufo debilis was occasionally observed in the open on the steep slopes and grassy plains during the day. An adult male from Logan County was collected on a talus slope at an air temperature of 35° C at 1321 hours, and a sub-adult individual was found along a cattle trail in Wallace County at 1516 hours and an ambient air temperature of 24° C. Seymour (1973) reported *B. debilis* active by day at 15° C. He observed them basking on wet mud banks in direct sunlight and increasing their body temperatures up to 30.9° C.

In the field, Green Toads were observed consuming various small insects, principally ants (Hymenoptera) and small Lepidopterans, Coleopterans, and Orthopterans. Harvester ants (*Pogonomyrmex occidentalis*), which were common in areas of suitable habitat, were typically ignored. Three times a single *Bufo debilis* toadlet was placed near a harvester ant mound in Wichita County. Three to seven ants attacked the toadlet each time, and within fifteen seconds the toadlet appeared wet and the ants immediately left it. The toadlet was recovered and maintained for two weeks in captivity with no apparent ill effects resulting from the confrontation.

Thamnophis radix (Plains Garter Snake) was the most commonly observed predator on the adults, toadlets, and tadpoles of *Bufo debilis*. A larval *Ambystoma mavortium* was observed consuming a young *B. debilis* near metamorphosis at night on 13 August 1993 in Wallace County. Creusere and Whitford (1976) observed predation on *B. debilis* by *Heterodon nasicus* (Western Hognose Snake), *Masticophis flagellum* (Coachwhip), and *Pituophis catenifer* (Gopher Snake) in the Chihuahuan Desert. All three of these serpents are common throughout western Kansas (Collins, 1993).

Time to metamorphosis in *Bufo debilis* is uncertain. Zweifel (1968) studied the eggs from specimens collected in Cochise County, Arizona, and found that at an optimal water temperature of 33.1° C the embryos hatched within 24 hours. At 18.2° C, hatching required 140 hours. Strecker (1926) suggested that metamorphosis of *B. debilis* in Texas took less than three weeks. Burkhart (1984) estimated the larval life to exceed 25 days in Kansas.

Based on one observation at a pool in Wallace County, development from zygote to toadlet was placed at eight days. On 29 June 1991, the pool was seined and contained no amphibian larvae. The area received heavy rain that night and a few small choruses of *Bufo debilis*, 5–7 males each, were heard along the system of pools in the canyon, along with smaller choruses of *Rana blairi*, *Spea*

bombifrons, and *Bufo woodhousii*. On 7 July 1991, most of the water in the pool had evaporated, fissures had developed in the mud, and toadlets were abundant on the dried pool bottom. Near the center of the dried pool were approximately 500 dead anuran larvae. *S. bombifrons* tadpoles were the only species of larvae identified (Altig 1970). The precise time from zygote to metamorphosis is probably dependent on a number of environmental variables, e.g. soil permeability, evaporation rate, water temperature (Zweifel 1968), dissolved oxygen content, and competition between *B. debilis* larvae and that of sympatric anurans, as well as constraints of phylogeny.

Green Toads appear to avoid the large sandy alluvial floodplains of the major river valleys, as they were only found in more rugged habitat adjacent to smaller tributaries. However, during heavy rains, tadpoles or eggs are surely swept into the larger rivers. This mechanism may serve as a primary means of dispersal down the watershed and allow for gene exchange across otherwise isolated populations. The small individual size and currently disjunct populations of *Bufo debilis* make terrestrial dispersal far from these valleys virtually impossible. In northwestern Kansas localities, *B. debilis* is abundant and often conspicuous. Historic populations farther south are extirpated or scarce at best. The historic distribution may have once been continuous across these two areas until agricultural practices and simultaneous drought modified the habitat.

The largest populations of *Bufo debilis* were found in the Smoky Hill River drainage of southeast Wallace County, southwest Logan County, and areas immediately adjacent to the south, along Ladder Creek in Greeley and Wichita counties (Fig. 1). Suitable habitat exists in vast contiguous tracts in this area. Habitat to the south, in the Arkansas River drainage, is isolated due to large-scale agricultural activity.

Hammerson (1991) reported a single specimen of *Bufo debilis* from Picture Canyon in Baca County, Colorado, collected on 12 June 1988 (Sec. 7, T35S, R47W). This locality is 62.8 km west of Morton County, Kansas on the Colorado and New Mexico border at the western edge of what were the most extreme dust bowl conditions (Fig. 2). Picture Canyon is part of the deeply dissected and rugged Black Mesa system, and has not been cultivated within historical times.

Only seven juvenile *Bufo debilis* (KU 218838–844) were collected in Hamilton County in 1991. Since then no specimens have been observed there, despite repeated collecting trips the subsequent three summers. However, rainfall conditions in southwest Kansas appeared suboptimal during this study.

Bufo debilis has not been observed in Grant and Morton counties since 1911 and 1928 respectively. Collins and Collins (1991) thoroughly studied the herpetofauna of the

Cimarron National Grassland and indicated that the severe change in habitat conditions due to the drought of the 1930's, combined with the prevailing farming and ranching practices at that time, resulted in the extirpation of *Bufo debilis* from Morton County and adjacent areas. Morton County was one of the most devastated areas during the Dust Bowl (Figure 2). Today 43,777 ha of Morton County has been incorporated into the Cimarron National Grass-

land (Fig. 1) and reseeded to native grasses and forbs, thereby restoring suitable habitat and offering protection under the auspices of the United States Forest Service.

I toe-clipped and released 422 *Bufo debilis* (see Appendix) at 8 sites in the Cimarron National Grassland in 1992 and 1993. In addition, a mass of 1,287 eggs were placed in a windmill runoff pool in 1992 at the Grassland site considered the most suitable for *B. debilis* based on

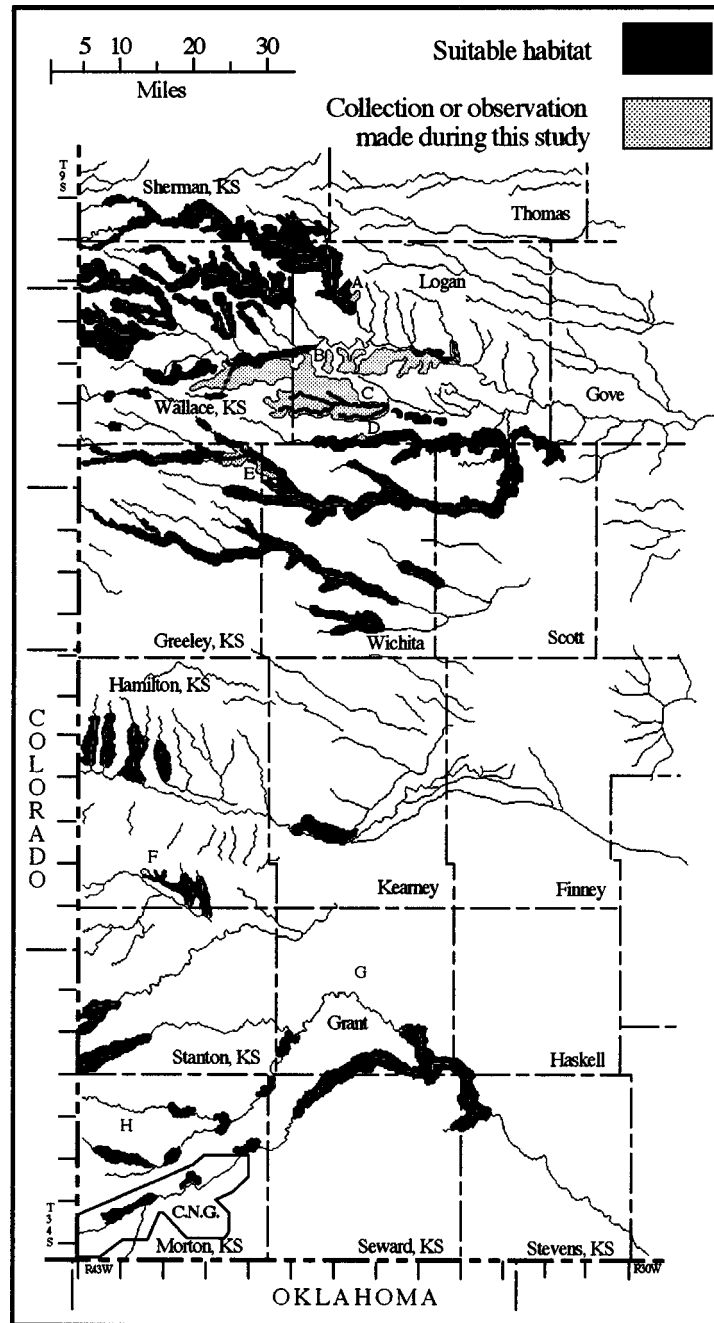


Figure 1. General localities where Green Toads (*Bufo debilis*) were observed or collected during this study and areas of their possible occurrence within Kansas. C.N.G. = Cimarron National Grassland, the site of an attempted repatriation. Letters A-H correspond to localities listed in the Appendix.

geological, hydrological, and vegetative similarities to the northwestern Kansas sites with extant populations. No specimens have been observed on the Grassland since the repatriations and future work is needed to determine the present status of the reintroductions and the assess the feasibility for further reintroductions.

I recommend that future studies examine the genetic relationships of *Bufo debilis* throughout Kansas and adjacent states using a marker based on nuclear DNA (*i.e.* allozymes). How long the Smoky Hill River populations have existed in allopatry and the degree of divergence they have reached in isolation cannot be assessed without these data. This information is important from a biodiversity and conservation point of view; it will allow us to determine if this population is simply disjunct or a new taxon endemic

to Kansas. Determining genetic diversity in these populations will also be very useful in future repatriation attempts.

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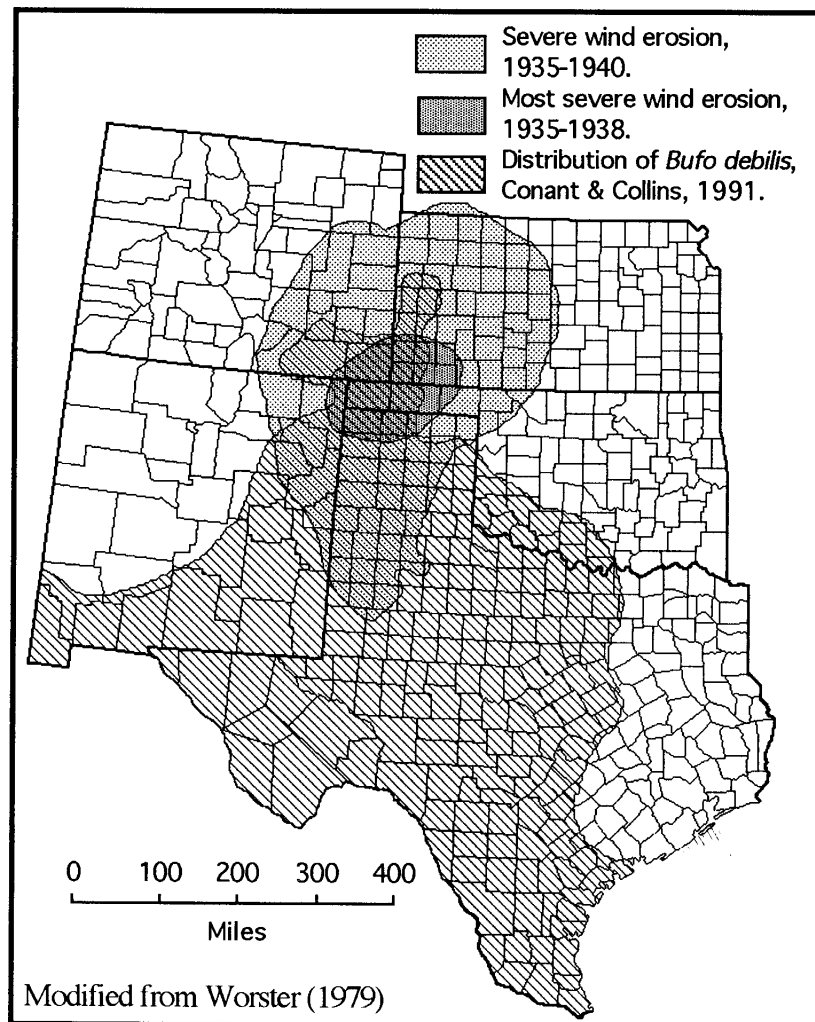


Figure 2. The Dust Bowl of the 1930's. Extent of erosional damage attributed to the wind during the drought and subsequent Dust Bowl in the lower Great Plains from 1935 through 1940. Drought conditions extended far beyond the boundaries shown here, but this area was particularly hard hit by drought and wind erosion. The range of the Green Toad (*Bufo debilis*) has been superimposed. Modified from Worster (1979).

Bufo debilis back into the Cimarron National Grassland. Eugene D. Fleharty (FHSU), Kelly J. Irwin (Texas A&M University), Jay Taggart, R. Bruce Taggart, and Karen Toepfer also rendered assistance.

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APPENDIX

Sites where *Bufo debilis* were observed and/or specimens were or have been collected. Lettered headings correspond to the letters in Figure 1.

- A. North Fork Smoky Hill River. Logan Co: T13S, R36W, Sec. 2. B. Smoky Hill River's Southern tributaries. Logan Co: T13S, R34W, N Sec. 23 (KU 220752–53); Sec. 32, 33: T13S, R35W, Sec. 29, 32, 35; NE Sec. 27 (KU 211368, KU 212582): T13S, R36W, Sec. 27, 28: T13S, R37W, E Sec. 35; SE Sec. 26, 32: T14S, R34W, Sec. 4, 6, 8; NW Sec. 7; NE Sec. 17: T14S, R35W, Sec. 3, 6: T14S, R36W, SE Sec. 5; Sec. 6: T14S, R37W, W Sec. 4. Wallace Co: T14S, R38W, N Sec. 17; Sec. 4, 5, 6, 8, 9, 16; Sec. 7 (KU 186731–36, KU 153046); 6.4 km S Wallace (KU 182086): T14S, R39W, Sec. 9, 12, 13, 14, 15, 16, 21; S Sec. 11; NE Sec. 8, 11; NW Sec. 29; NE Sec. 30; SW Sec. 10; Sec. 12 (KU 220754–55). C. Twin Butte Creek drainage. Logan Co: T13S, R37W, Sec. 35 (KU 193303): T14S, R37W, S Sec. 29; NE Sec. 20; SE Sec. 28; N Sec. 23; NW Sec. 21: T15S, R37W, S Sec. 4, 5; 24 km S & 6.4 km W McAllaster (KU 192337–38); 19.6 km S & 4.8 km W McAllaster (KU 193301–02). D. Chalk Creek drainage. Logan Co: T15S, R36W, Sec. 32, 36. E. Ladder Creek Drainage. Greeley Co: T16S, R39W, Sec. 8, 11 (KU 218823–27). Wallace County, T15S, R40W, Sec. 35. Wichita Co: T16S, R38W, Sec. 19 (KU 218845). F. Bear Creek drainage. Hamilton Co: T26S, R42W, SE Sec. 12 (KU 218838–44). G. Cimarron River drainage. Grant Co: No specific locality (KU 5642); No specific locality (UMMZ 67442). H. North Fork Cimarron River drainage. Morton Co: no specific locality (KU 564345), 18 mi N Elkhart (KU 5646–5654).

Release sites and number of *Bufo debilis* released (males:females:juveniles:embryos).

- T33S, R42W, SE/NE Sec. 33, (57:25:81:1287); E/SW Sec. 32, (0:0:65:0); T34S, R43W, SE/SW 4 Sec. 2, (0:0:65:0); NE Sec. 10, (0:0:65:0); W Sec. 20, (0:0:65:0).

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