

# **FINAL PERFORMANCE REPORT**



**Federal Aid Grant No. F13AF01188 (T-73-1)**

**Status, Distribution, and Ecology of the Ozark Emerald  
(*Somatochlora ozarkensis*) and Other Springtime-Emerging  
Dragonflies of Eastern Oklahoma**

**Oklahoma Department of Wildlife Conservation**

**October 1, 2013 through September 30, 2016**

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**State:** Oklahoma

**Grant Number:** F13AF01188 (T-73-1)

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**Grant Period:** 1 October 2013 through 30 September 2016

**Principal Investigators:** Ms. Brenda Smith-Patten and Dr. Michael A. Patten, Oklahoma Biological Survey, University of Oklahoma

### A. ABSTRACT

This project was focused on determining the status and distribution in Oklahoma of three species of dragonflies (Odonata: Anisoptera) that are regional endemics to the south-central United States, the Oklahoma Clubtail (*Gomphus oklahomensis*), Ozark Clubtail (*G. ozarkensis*), and Ozark Emerald (*Somatochlora ozarkensis*), with a special focus on the last of these species. We conducted a thorough review of extant museum specimens, published literature, and archived photographs to establish baseline information on distribution. We used this baseline to design a series of field surveys to a) confirm continued presence at sites where the species was known, b) obtain information on relative abundance, and c) detect species at sites where it had not been found previously. We effectively doubled the number of known records of the three target species, and we added dozens of localities of occurrence. We found the two clubtails in sufficiently large numbers to conclude that neither species is of high conservation concern in the state. The emerald proved to be rare in the state. Its scarcity, along with its regional endemicity and habitat specificity, warrants a high conservation priority. Additional work on this last species, which may be declining rangewide, is needed. We provide information on five other species—the Ouachita Spiketail (*Cordulegaster talaria*), Atlantic Bluet (*Enallagma doubledayi*), Burgundy Bluet (*E. dubium*), Attenuated Bluet (*E. daeckii*), and Westfall's Snaketail (*Ophiogomphus westfalli*)—of conservation interest in the region. We also make recommendations for future research for these and other species of conservation interest.

### B. INTRODUCTION

Over the past dozen years, and prior to the initiation of this grant, we have worked to develop a reasonably clear picture of the status, distribution, and ecology of the Odonata (dragonflies and damselflies) of Oklahoma. We began working with the taxon in 2003, and in 2009 we began intensive statewide surveys. As a means of providing guidance for those surveys we also began in 2009 to compile all known records of Oklahoma Odonata. We first searched the literature - key sources being Ortenburger (1926, 1933), Bird (1932), Pritchard (1935, 1936), Bick and Bick (1957), Beckemeyer (2002), and Abbott (2005) - to compile a preliminary species list for each county. To these lists we added photographic and sighting records and field note data to our database. We consulted 34 museums for specimen data, among them the American Museum of Natural History, New York; California Academy of Sciences, Entomology Collection, San Francisco; Colorado State University, Gillette Museum, Fort Collins, Colorado (CSU); Cornell Insect Collection, Ithaca, New York; Dennis R. Paulson's personal collection (DRP); Essig Museum of Entomology Collection, Berkeley, California (EMEC); International Odonata Research Institute, Gainesville, Florida (IORI); John C. Abbott personal collection (JCAC); Harvard University, Museum of Comparative Zoology, Department of Entomology, Cambridge, Massachusetts; Sam Noble Oklahoma Museum of Natural History, Recent Invertebrates, University of Oklahoma, Norman, Oklahoma; Oklahoma State University, K.C. Emerson Entomology Museum, Stillwater,

Oklahoma; Rosser W. Garrison personal collection; University of Kansas, Snow Entomological Museum, Lawrence, Kansas (SEMC); University of Central Oklahoma, Edmond, Oklahoma; University of Michigan, Museum of Zoology, Ann Arbor, Michigan; National Museum of Natural History/Smithsonian Institution, Washington, DC. Moreover, we have developed a network of citizen scientists who regularly contribute data. Now the Oklahoma Odonata Project (OOP) database contains >48,000 records dating back to 1877. The database accounts for hundreds of thousands of individual odonates, including almost 190,000 from our own surveys alone, and the state species list has grown from 135 known in 2003 to 169 currently, with richness for each and every county now at least 50 species (Smith-Patten and Patten 2016a,b; Fig. 1).

Much of our research on the state's odonates has focused on distribution and relative abundance, although we have begun to address questions of community ecology and biogeography (Bried et al. 2015, 2016; Patten et al. 2015), and we have obtained a much clearer picture of the status and distribution of the state's species of concern, as identified by Patten and Smith-Patten (2013). Yet at the time of this grant's inception, there remained much more to be done to get at basic questions of conservation status, distribution, life history, and ecology of various rare or elusive species.

We requested funding from the Oklahoma Department of Wildlife (ODWC) specifically to study three species classified as Species of Greatest Conservation Need (SGCN) in the Comprehensive Wildlife Conservation Strategy (ODWC 2005): the Ozark Emerald (*Somatochlora ozarkensis*), Ozark Clubtail (*Gomphus ozarkensis*), and Oklahoma Clubtail (*G. oklahomensis*). Each was listed as Tier II species. We identified other species that in our judgment warranted comparable attention: the Ouachita Spiketail (*Cordulegaster talaria*), Atlantic Bluet (*Enallagma doubledayi*), Burgundy Bluet (*E. dubium*), Attenuated Bluet (*E. daeckii*), and Westfall's Snaketail (*Ophiogomphus westfalli*). Additional species within the study area that lacked basic data included the Elegant Spreadwing (*Lestes inaequalis*), Amber-winged Spreadwing (*L. eurinus*; discovered in the state just prior to this grant), Southern Sprite (*Nehalennia integricollis*), Sphagnum Sprite (*N. gracilis*; discovered in the state during the project), Seepage Dancer (*Argia bipunctulata*), Harlequin Darner (*Gomphaeschna furcillata*), Two-striped Forceptail (*Aphylla williamsoni*), Ashy Clubtail (*Gomphus lividus*), Cocoa Clubtail (*G. hybridus*), Banner Clubtail (*G. apomyius*), Twin-spotted Spiketail (*C. maculata*), Swift, Gilded, Royal, and Allegheny River Cruisers (*Macromia illinoiensis*, *M. pacifica*, and *M. taeniolata*, *M. alleghaniensis*), Selys's Sundragon (*Helocordulia selysii*), Clamp-tipped Emerald (*S. tenebrosa*), Painted Skimmer (*Libellula semifasciata*), and Little Blue Dragonlet (*Erythrodiplax minuscula*).

## C. OBJECTIVES

Objective – 1: To conduct intensive surveys to determine status, distribution, and habitat requirements for Odonata species currently considered Tier II SGCN: the Ozark Emerald (*Somatochlora ozarkensis*), Ozark Clubtail (*Gomphus ozarkensis*) and Oklahoma Clubtail (*G. oklahomensis*).

Objective – 2: To conduct surveys to determine the status, distribution and habitat associations of other eastern Oklahoma Odonata species that occur within the general geographic range of the Ozark Emerald and should be evaluated as potential Species of Greatest Conservation Need. These species include the Ouachita Spiketail (*Cordulegaster talaria*), Atlantic Bluet (*Enallagma doubledayi*), Burgundy Bluet (*E. dubium*), Attenuated Bluet (*E. daeckii*) and Westfall's Snaketail (*Ophiogomphus westfalli*).

## D. APPROACH

We started the project by conducting a survey of pertinent literature for the focal species. We conducted literature searches regularly throughout the project to ensure we were up-to-date with published research. Literature records were entered into the OOP database of odonate records from a

variety of sources (e.g., literature, photographic, sightings, field notes, specimens) from across the state. At the start of the project the OOP contained >27,000 records; it now has >48,000 records.

We used data from the OOP along with a suite of environmental data sets for GIS-based analyses to guide where to conduct surveys of target species. We reassessed data routinely whenever we acquired new information - whether from recent surveys, newly located specimens, newly discovered literature, or previously undisclosed photos or sightings. On the basis of these data we were able to examine area maps to pinpoint where surveys could be conducted; i.e., if there was public access or if private landowners were willing to allow access to their property. We were able to perform surveys at or near enough target locations to allow for sufficient data collection. Surveys were primarily conducted within federally or state-owned properties, such as National Wildlife Refuges (NWR), National Forests (NF), and Wildlife Management Areas (WMA), but in some cases privately owned properties were accessed, such as preserves owned by The Nature Conservancy (TNC) or individual landowners.

Surveys were conducted by the PIs (Brenda D. Smith-Patten and Michael A. Patten, hereafter BS-P and MAP) in Adair, Atoka, Bryan, Caddo, Carter, Cherokee, Choctaw, Coal, Comanche, Craig, Creek, Delaware, Garvin, Haskell, Hughes, Johnston, Latimer, Le Flore, Love, Marshall, Mayes, McCurtain, McIntosh, Murray, Muskogee, Nowata, Okmulgee, Osage, Ottawa, Pittsburg, Pontotoc, Pushmataha, Rogers, Seminole, Sequoyah, Stephens, Tulsa, Wagoner, and Washington counties (Fig. 2). During the surveys we walked systematically through appropriate habitat as we looked for all odonate species but with particular attention to focal species. We made note of all species encountered, including counting all individuals, determining age and sex of all individuals, and noting behavior (mating, mate guarding, ovipositing, patrolling, etc.). We also made notes on habitat for focal species. We identified species by sight, capture and release, collection of voucher specimens, photography, or a combination thereof. We used hand-held aerial insect nets for capture. All specimens are archived in the Smith-Patten/Patten Collection (SP), housed at the Oklahoma Biological Survey (OBS), University of Oklahoma. Photographs are archived at OBS and at two off-site locations, to ensure backup recovery, with records of particular note uploaded to an online data repository for odonates (Odonata Central [OC], <http://odonatacentral.org/>).

In addition to our own surveys, we compiled records from reports we received from citizen scientists in that region. The citizen scientists included, but were not limited to, David Arbour (DA), James W. Arterburn (JWA), Bill Carrell (BC), Mike Dillion, Berlin A. Heck (BAH), Cliff Ivy, Jon Ivy, Shawn Johnson, Victor W. Fazio III (VWF), John Fisher, Bryan Reynolds, Jona A. Tucker (JAT), and Ken Williams (KW). Citizen scientist reports were occasionally sightings but most often (>95%) were documented by photographs. We provided regular updates to interested parties (archived updates—[http://www.biosurvey.ou.edu/smith-patten/Oklahoma\\_Odonata\\_progress.html](http://www.biosurvey.ou.edu/smith-patten/Oklahoma_Odonata_progress.html)) and through publications (e.g., Patten and Smith-Patten 2013a, 2014a,b, 2015, 2016; Smith-Patten 2014; Smith-Patten and Hoagland 2015; Smith-Patten and Patten 2016a,b; Smith-Patten and Tucker 2014) and used records for more derived research combined with records from elsewhere in the state (e.g., Patten and Smith-Patten 2013b; Patten et al. 2015).

Habitat assessments were initially done informally by noting where the species was found. In the final year we were able to more formally conduct habitat assessments by using a variety of instruments including a water meter that measured pH, dissolved oxygen (mg/L), conductance ( $\mu\text{S}/\text{cm}$ ), total dissolved solids (mg/L), salinity (PSU), turbidity (FNU), and water temperature ( $^{\circ}\text{C}$ ). We also used a water flow meter to determine flow rate (m/sec) and a densitometer to measure canopy cover. Additional measurements, such as stream width and depth, water odors, water surface oils, level of anthropogenic disturbance, inorganic and organic substrate components and quality, aquatic and terrestrial vegetation assessment, were taken. A sample data sheet is included herein (Appendix A). David C. Hille primarily conducted the habitat assessments with BS-P conducting some end-of-the-season assessments that came after Hille's term of employment expired.

## E. RESULTS AND DISCUSSION

### Results

We conducted surveys for 145 person-days during the project. During those field days we surveyed 281 localities across the counties that comprised our study area (Fig. 2). Approximately 100 additional localities were surveyed by citizen scientists. Our methodology—i.e., recording all species encountered—provided us with a wealth of data, including addition of species to the Oklahoma state list. Indeed, in our proposal for this project we reported that the state list stood at 159 species, but in the few years since it now stands at 169 species. Two of those ten species were added specifically during the field work under this grant (Table 1). Four hundred and eighteen (418) county records were added in the study area since the project began (Table 2).

Species	Date	County	Locality	Collector	Documentation
<i>Nehalennia gracilis</i>	3 June 2014	Atoka	Boehler Seeps	BS-P, JAT	Smith-Patten & Tucker 2014; OC422877; SP1245
<i>Micrathyria hagenii</i>	3 July 2015	Cherokee	Nickel Preserve	BS-P, BWH	Smith-Patten & Hoagland 2015; OC432602; SP1695-1696

BS-P = Brenda D. Smith-Patten, BWH = Bruce W. Hoagland, JAT = Jona A. Tucker, MAP = Michael A. Patten

**Table 1.** Odonate species new to Oklahoma that were found during the project period. Two of those species, the Sphagnum Sprite (*Nehalennia gracilis*) and Thornbush Dasher, (*Micrathyria hagenii*), were found within the study area. Also in the study area was Oklahoma’s first definite record of the nominate subspecies of the Swift River Cruiser (*Macromia illinoiensis illinoiensis*); a ♂ collected at Spavinaw Game Management Area, Delaware Co., 22 June 2016 (MAP, BS-P; SP1971).

County	Before	After	County	Before	After
Adair	51	64	Mayes	43	56
Atoka	75	96	McCurtain	116	118
Bryan	62	72	McIntosh	54	67
Caddo	61	67	Murray	69	71
Carter	56	63	Muskogee	61	76
Cherokee	66	85	Nowata	49	53
Choctaw	69	78	Okmulgee	51	60
Coal	48	60	Osage	69	77
Comanche	98	98	Ottawa	44	56
Craig	44	51	Pawnee	43	53
Creek	55	64	Pittsburg	50	72
Delaware	45	62	Pontotoc	66	68
Garvin	45	55	Pushmataha	79	88
Haskell	50	62	Rogers	44	59
Hughes	50	62	Seminole	51	65
Johnston	74	77	Sequoyah	62	72
Latimer	82	86	Stephens	45	59
Le Flore	83	92	Tulsa	86	90
Love	61	71	Wagoner	56	69
Marshall	80	81	Washington	44	52

**Table 2.** Study area counties along with their species list totals prior to the start of the project and after.

### Ozark Emerald (*Somatochlora ozarkensis*)

The Ozark Emerald is a regional endemic restricted to four states, Arkansas, Kansas, Missouri, and Oklahoma. It is a species that is considered to be globally and nationally at risk, being ranked as “vulnerable” (G3, N3) by NatureServe, <http://explorer.natureserve.org>, and “Near Threatened” by the IUCN, <http://www.iucnredlist.org/details/20345/0>. In Arkansas, Kansas, and Oklahoma it is considered an S1 “critically imperiled” species (Patten and Smith-Patten 2013), whereas in Missouri it has a conservation ranking of S2S3 (imperiled/vulnerable), although in recent years, despite species-specific surveys, the species has been reported only a few times in Missouri (P. McKenzie, U. S. Fish and Wildlife Service, *pers. comm.*; B. Henry, Missouri Department of Conservation, *pers. comm.*), indicating that the conservation rank may need to be upgraded.

We studied the Ozark Emerald to obtain a clearer picture of its status and distribution in Oklahoma as well as to get a better idea of the species’ ecological needs. We have compiled 48 confirmed records and four probable records of this elusive species in Oklahoma (Appendix B; Fig. 3). These records date from 1931–1934 and 2006–2016 (despite surveys throughout the region by George H. Bick (GHB) and Lothar E. Hornuff (LEH) between 1950 and 1970, the species went unrecorded). Nearly half (44%) of all known records for the Ozark Emerald in Oklahoma were added during this study ( $n = 23$  records, 21 of them confirmed, two probable). Three fourths (17 of 23) of these recent records were added by the PIs.

There are 32 definite and two probable localities in the state where the species has been recorded; all of the definite records are in a mere nine counties: Adair, Atoka, Cherokee, Latimer, Le Flore, McCurtain, Osage, Pushmataha, and Tulsa. Not all of those localities have been re-surveyed, or if they have the Ozark Emerald has been not recorded multiple times. For example, the species’ type locality, on Cunneo Tubby Creek, 2.5 mi NE of Wilburton, Latimer Co. (Bird 1933), is currently inaccessible (i.e., private land), and we resurveyed the Osage Co. locality (see below) on 11 June 2016 without success. We discuss a couple of other examples of negative resurvey results below.

Our work has indicated that the species is rare in Oklahoma, and it appears to be a habitat specialist. It tends to be seen only one or two at a time along creeks, either as single males guarding an ovipositing pool, as mating pairs, or as females ovipositing. On a rare occasion it has been seen up to eight or nine individuals on a given survey, but only when a lengthy reach (e.g.,  $> 1$  km) of a creek was searched. The lower numbers are consistent with sightings in Arkansas and Missouri (G. Harp, Arkansas odonate specialist, *pers. comm.*; B. Henry, Missouri Department of Conservation, *pers. comm.*).

In our experience, Ozark Emeralds are seen in larger numbers only when one happens upon a feeding swarm. We have had two occasions where we estimated  $\geq 25$  emeralds. During these times the emeralds have been in multiple feeding swarms around cleared (often grassy) areas along stretches of dirt or paved roads (1–5 km). Our first large swarm was on 5 July 2014 along Oklahoma Highway 1, the Talimena National Scenic Byway, in Le Flore Co., where we stopped on multiple occasions and managed to capture 1♂ (SP1318) and 8♀, and we saw another 25 small emeralds whose species identification could not be confirmed. A second large swarm was also within the Ouachita NF, this time in McCurtain Co. along a USFS road 10 km NE of Broken Bow, where MAP captured 2♂ and 9♀ (1♀, SP1726) on 24 July 2015. He estimated there were an additional 14 individuals present, and there also were multiple Clamp-tipped Emeralds (*S. tenebrosa*) and Mocha Emeralds (*S. linearis*). DA reported a swarm of 60 emeralds at Pipe Spring, Ouachita NF, on 29 June 2014 that he thought were all, or at least primarily, Ozark Emeralds, but no individuals were captured for confirmation. We visited this site on 5 July 2014, when we had a mere five individuals, and were able to confirm the species in-hand. Lastly, a modest “swarm,” of about five males (one in hand; MAP) and one ovipositing female, was at Robbers Cave WMA, Latimer Co., 3 July 2016.

Aside from the record above, 2015 was not the best year for the species, or at least the best year for us finding the species. We encountered Ozark Emeralds only one other time, on 29 June, when we found a lone ♀ ovipositing on Fourche Maline Creek, Robbers Cave WMA. On 2 July, while on a general survey with ODWC staff at Cookson WMA, Cherokee Co., BS-P saw a lone ♀ emerald ovipositing on Hasting's Hollow Creek. That female appeared to have an ovipositor like that of an Ozark Emerald, but because the individual could not be captured the record was treated as probable rather than confirmed. She was particularly cautious because the record would have been the first in the state for the Ozark Highlands. There was one other record for the year: while on a tour with DA on 10 August, Steven Easley photographed a single ♂ (OC435326) at "The Narrows" on the Mountain Fork River (9 km S of Smithville), McCurtain Co.; there also may have been a mating pair, but the photo was inconclusive.

We were unable to re-find Ozark Emeralds on Crooked Branch Creek in Well Hollow, Ouachita NF, Le Flore Co., where we had it on 5 July 2014 (1 ♀, SP1317) or on Breadtown Creek at Atoka WMA, Atoka Co., where we had found 2 ♂ and 3 ♀ (including one ovipositing) on 13 July 2013 (1 ♀, SP802) prior to the initiation of this survey. Floods scoured the latter creek heavily in 2015, which may account for the species' disappearance. It may also be that the nymphs had yet to mature. Still, we did not find the species at either location in 2016.

In 2015 we received an older report of the species, when on behalf of his daughter, Molly, Mark Ferguson, formally of Oklahoma but now a Natural Heritage Inventory biologist in Vermont, submitted photographs of a ♂ Ozark Emerald (OC435703) they had captured on 2 August 2006 at Torpedo Switch, Osage Co. We consider this record to be the first for the county. For many years we had in the OOP database an unconfirmed literature record of the species from Osage Co. (Donnelly 2004; OC247853), but eventually we tracked down the source of the record, which turned out to be Bick (1983:220; carried forward to Bick 2003), who had cited Houston (1970:72) as the source for a specimen obtained at a stock pond, even though Houston referred specifically to a stock pond in Franklin Co., Arkansas, not Osage Co., Oklahoma. It is unclear why Bick attributed Houston's record to Oklahoma.

With flooding greatly reduced relative to the previous year, 2016 proved to be markedly better for detection of the Ozark Emerald. We added nine new records and five new localities for the species. The season began with a remarkable record for Tulsa Co., where BC found the species at Keystone Dam in the Cross Timbers Ecoregion (1 ♂ adult, OC445702, and 1 ♀ teneral, OC445701) on 5 June. Although not the first record for the ecoregion (see the Osage Co. record, above), it was not expected at the site where it was found. It thus provided further evidence that the species has a population outside of its expected range on the Ozark Highlands and Ouachita Mountains. BC had the species again at that locale on 14 August, when he saw 1 ♂ and photographed an ovipositing ♀ (OC453133), yet BS-P surveyed the site on 12 June (with BC) and 18 August, but she did not find any individuals.

On 19 June and 10 July 2016 MAP surveyed portions of Honobia WMA, Pushmataha Co. (at 8 km SW of Nashoba and 6 km E of Finley, respectively), where he saw 3 ♂ (OC447526, 1 as SP1981) on the first trip and 1 tandem pair on the next. He encountered the species again on 3 July in Latimer Co. (5 ♂ [1 in hand], and 1 ♀ ovipositing on Fourche Maline Creek at Robbers Cave WMA) and McCurtain Co. (1 ♀ ovipositing on Cooper Creek 9 km ENE of Broken Bow).

A few days later, BS-P documented the first record of the Ozark Emerald in the Oklahoma Ozarks. She encountered nine individuals (6 ♂, 3 in hand [2 ♂, SP1998-1999], 3 ♀, 2 in hand [1 ♀, SP2000], OC448780) on Hasting's Hollow Creek in Cookson WMA, Cherokee Co., on 6 July. The next day she saw three individuals (2 ♂, 1 ♀; ♀ photographed as OC448782) on Eagle Pass Hollow Creek, Ozark Plateau WMA, Adair Co. The species was not seen at Ozark Plateau WMA when BS-P revisited the site on 16 August.

The season ended with two additional records for the Ozark region. The first came on 24 September, when Jon Ivy submitted a photo of a single ♂ at TNC's J. T. Nickel Preserve, at Bath tub Rocks (OC456397). This record extended the known flight season for the species by more than a month and a half. Not to be outdone, Cliff Ivy submitted a photo of a single ♀ at the same spot a week later, on 2 October (OC456581). This last record, along with a 2008 record for 28 May (13 km WNW of Hochatown, Cedar Creek, 2♂, both teneral, OC282324), provide the extremes of the known flight season for the Ozark Emerald.

Also in 2016 we received a batch of 2011 and 2012 records for the Ozark Emerald that had not been reported previously to us. The majority of the records were from McCurtain Co. and are JCAC specimens (6♂, 4♀: 8.5 km SSW of Smithville, Ouachita NF, USFS Rd 28000, 2–3 July 2011). On that same trip Greg W. Lasley photographed a ♂ and ♀ (iNaturalist 220655, 9 km E of Bethel, 4 km W of Mountain Fork River). The following year on 4 June, Troy Hibbitts reported one individual at the same location of the JCAC specimens, and the next day he photographed a ♂ on the Talimena Highway, 9 km NNW of Big Cedar, Ouachita NF, Le Flore Co. (OC457345). Lastly, on 5 June 2012, Diana and Terry Hibbitts photographed a ♂ in Le Flore Co., 8 km W of Page (iNaturalist 1393295).

Ozark Emeralds have been found within the ecoregions of the Cross Timbers, Ozark Highlands, Boston Mountains, Arkansas Valley, Ouachita Mountains, and South Central Plains (USEPA 2013). There are also two records reported from the Central Great Plains ecoregion. These records are likely Ozark Emeralds, but they lack voucher specimens, and the photographs cannot without a doubt be attributed to *Somatochlora ozarkensis* (both by VWF in Comanche Co.: OC3134021, 1♂, Fort Sill Military Reserve, West Range, Ketch Canyon, 20 June 2009 and OC328764, 1♂, Wichita Mountains Wildlife Refuge, French Lake, 17 June 2011).

We have not yet analyzed habitat assessment data, but we can offer qualitative impressions of where we have encountered the species. We have found it in deciduous or mixed deciduous-evergreen woodlands at rocky streams, usually those with much bedrock exposure but sometimes also with sand or fine to pebbly gravel. Stream beds tend to be narrow, only 5–8 m wide. During much of the species' flight season the water in these streams flows at least slightly, but towards the end of the season many streams dry, leaving only scattered pools. Stream water is always clear and usually shallow (approx. 2 cm to <1 m). Males tend to guard small pools or riffles in the stream, waiting for females to arrive. When a female arrives she is more-or-less immediately captured to mate. Females have been observed ovipositing most often in trickles of water that flow over gravel or sand, but we have also seen ovipositing in what appear to be non-flowing portions of the stream.

To our knowledge this species is not subject to any serious threats that would cause any immediate concerns for its survival. General threats include forest loss and stream pollution or depletion caused by human activities. Other anthropogenic disturbances come from feral pigs. Although imminent threats are not currently known, we recommend that given this species' rarity, regional endemism, and habitat specificity it continue to be treated as a species of conservation concern and one that warrants high priority. We also recommend, *sensu* USFWS's (2011) request, that further research be conducted for the species including continuing to investigate its status and distribution and its ecology and life history. Intensive surveys and the habitat assessments provided for with this project should be continued, including having intensive surveys conducted at Fort Sill Military Reserve, where we were not able to access during the project's timeframe, and nearby Wichita Mountains Wildlife Refuge. We also recommend that this species be upgraded to Tier I on the ODWC SGCN list.

Future research for this species should include 1) additional surveys of adults to further determine status and distribution of the species, 2) additional habitat assessments for ovipositing and feeding locations, and 3) larval surveys to determine where nymphs are found. If successful, larval surveys will aid in being able to elucidate the physical attributes of the nymphs, including individual and geographic



variation, which will refine taxonomic keys for the genus. Larval surveys also would allow for the first descriptions of the species' life history traits, its habitat and microhabitat, as well as elaborating on the species' general ecology.

#### Oklahoma Clubtail (*Gomphus oklahomensis*)

The Oklahoma Clubtail is a regional endemic that has been recorded in four states: Arkansas, Louisiana, Oklahoma, and Texas. In Oklahoma there are 38 localities known within 19 counties (Adair, Atoka, Choctaw, Creek, Haskell, Hughes, Latimer, Le Flore, Marshall, McCurtain, McIntosh, Muskogee, Okmulgee, Ottawa, Pittsburg, Pushmataha, Seminole, Tulsa, and Wagoner) that fall within five ecoregions (Fig. 4). The OOP has 71 records for the Oklahoma Clubtail (Appendix C). These records span the years of 1931 to 2016, but represent only 17 of those years, including at least one record for each year between 2007 and 2016. During the project years of 2014–2016, 54% of all known records for the species in Oklahoma were added (33 records added by the PIs, five added by others).

We consider this species to be an S4 "apparently secure" species (*sensu* Patten and Smith-Patten 2013), as it appears to be locally fairly common in the eastern third of the state. There are six instances in which numbers >10 individuals have been reported. We have recorded it in numbers as high as 50 (10 unsexed teneral and 25♂ and 15♀ adults, with one pair [SP1511], 11 Apr 2015, BAH's property, 10 km SE of Idabel, McCurtain Co.). Adults are known to fly from 19 March (same location as previous record, by BAH in 2012, 1♂, OC374127) and as late as 14 June (Robber's Cave State Park, Latimer Co., GHB and LEH in 1970, 1♂, IORI).

Our experience with this species indicates that it inhabits areas around small- to medium-sized ponds, or sometimes swampy areas or slow-moving creeks, within evergreen or mixed evergreen-deciduous forest. The species tends to land on the ground near the pond or sometimes on nearby trails or roads. Only on rare occasion is one found on vegetation, particularly if that vegetation is taller than a few centimeters.

We know of no serious threats to this species outside of drainage of ponds and swampy areas. Feral pigs wallowing in these areas would also pose a threat. As long as this sort of habitat is maintained (e.g., at WMAs, NWRs, and in NFs), then we feel populations are likely to be sustainable given how common it appears to be. If threats increase from habitat loss or damage, then the species ought to be re-evaluated. We recommend that this species be removed from the ODWC SGCN list or, at a minimum, downgraded to a Tier III species.

#### Ozark Clubtail (*Gomphus ozarkensis*)

The Ozark Clubtail is a regional endemic that occurs in four states: Arkansas, Kansas, Missouri, and Oklahoma. We know of approximately 45 localities for the species in Oklahoma spread through 11 counties (Atoka, Cherokee, Comanche, Haskell, Latimer, Le Flore, McCurtain, Osage, Pittsburg, Pushmataha, and Sequoyah) and seven ecoregions (Fig. 5).

This species is often encountered 4-6 individuals at a time. We have seen it in numbers as high as 35 (along a dirt road above a dry creek bed within hardwood forest, 14 km W of Hochatown, McCurtain Co., 5 May 2014, 2♂ [1 as SP1170], 2♀, 31 unsexed, with 2 pair). On another occasion we had 19 individuals (Glover River, highway 3, 10 km NE of Wright City, McCurtain Co., 14♂ [1 as SP1168], 5♀). Twenty teneral were reported for the later location (26 March 2012, BAH, JWA, & KW, 2♂, 1♀ [all three as DRP] and 19 unsexed, OC374179), which is also the early flight date for the species in Oklahoma. It is known to fly as late as 9 July (1970 record from LEH, 1♀, IORI, Pushmataha Co., 3 mi W of Honobia).

There are roughly the same number of records in the OOP database for the Ozark Clubtail as for the Oklahoma Clubtail (Appendix D), and these two species are encountered in similar numbers, so the former does not appear to face any serious threats. We ranked it as an S4 ("apparently secure") species (Patten and Smith-Patten 2013). Unlike the Oklahoma Clubtail, we hesitate to recommend removing the species from the ODWC SGCN list, principally because populations of the species appear to be disjunct.

One potential population was found at Fort Sill Military Reserve, Comanche Co., where a pair was collected on East Cache Creek on 24 April 2002 (CSU; OC381757, OC381758; Zuelling, et al. 2006). The difficulty with this record is that the area has been surveyed intensively many of the years since that record but no other Ozark Clubtails have been found. If there is an overlooked population there, then it would be important to conserve from a population genetics standpoint.

Similarly, an outlying population in western Osage Co. is of conservation value from a population genetics perspective. In that county there are records only for Salt Creek, 3-4 km NNE of Burbank, but we suspect that there are nearby locations where the species occurs. VWF first found the Ozark Clubtail at this location in 2011, when he saw two males on each visit (31 May, OC328215; 30 June, OC328214). When we began this project we reviewed all Ozark Clubtail records, and these two caught our eye because of odd abdominal patterning. We decided to investigate this population. We were able to survey the site three times (2014: 11 and 29 May, BS-P, MAP; 2016: 11 June, BS-P, BWH). On our first visit we found a ♂ (SP1181) and 3 other individuals. On our second visit we captured two ♂ (SP1210, SP1211) and a ♀ (SP1212) and likely had one other individual. On the third visit BS-P encountered six ♂ (2 as SP1942, SP1943; 4♂ photographed). At this point, and despite the relatively limited sample we have, we are quite confident this population exhibits consistent enough characteristics for a new taxonomic designation—at the least, it is an undescribed subspecies. As such, the Osage population is in need of targeted research to determine its taxonomic status.

It is also recommended that further investigations within Comanche Co. occur. Intensive surveys there would not only determine if a population is resident there (they also may answer the question of whether there is a resident population of the Ozark Emerald; see above). General monitoring of other Ozark Clubtail populations through its Oklahoma range should occur to ensure that this regional endemic retains its current stable conservation status. With all of the considerations presented here in mind, we recommend downgrading the species from Tier II to Tier III on the ODWC SGCN list, although it may be that the Osage population will need to have its own designation.

#### Ouachita Spiketail (*Cordulegaster talaria*)

The single Oklahoma record of the Ouachita Spiketail was of a ♂ photographed near Cedar Creek, 13 km WNW of Hochatown, along USFS road 51000/52400, McCurtain Co., on 18 April 2011 (Heck 2012; OC327732). This individual was at a forest seep that supported blackberry bushes (*Rubus* sp.). The species otherwise is known only from a small area of western Arkansas (Fig. 6).

During the study, we surveyed without success this area and similar habitat in McCurtain and Le Flore Counties. We were thwarted, for logistical reasons, from surveying what appears to be suitable habitat on the eastern side of Broken Bow Lake. It is highly recommended that this area be intensively surveyed in hopes of finding a resident population of the Ouachita Spiketail. Other areas in the Ouachita NF should also be intensively surveyed for this species. Such surveys ought to also result in finding more records for other species of conservation interest, including the Attenuated Bluet (see below), Atlantic Bluet (see below), Burgundy Bluet (see below), Harlequin Darner (*Gomphaeschna furcillata*), Ashy Clubtail (*Gomphus lividus*), Cocoa Clubtail (*G. hybridus*), Banner Clubtail (*G. apomyius*), Allegheny River Cruiser (*Macromia alleghaniensis*), Little Blue Dragonlet (*Erythrodiplax minuscula*), Double-ringed Pennant (*Celithemis verna*), and Painted Skimmer (*Libellula semifasciata*), among others. Surveys would also increase the chances of finding species as yet unrecorded in the state but recorded nearby,

such as the Aurora Damsel (*Chromagrion conditum*), Rapids Clubtail (*Gomphus quadricolor*), and Gulf Coast Clubtail (*G. modestus*).

Surveyors must keep in mind that the Ouachita Spiketail is a low density species and would be found at or very near to forest seeps. Their small numbers and habitat specificity as well as the extreme difficulty of locating the specific habitat will make this species a challenge to research. Given its extremely limited range, intensive surveys would certainly be worthwhile for this regional endemic.

We ranked the Ouachita Spiketail as an S1 critically imperiled species due to its limited numbers and range (Patten and Smith-Patten 2013b). We continue to think that is a warranted ranking for the species. As such, we recommend that the species be included ODWC SGCN as at least a Tier II species, although Tier I would likely be more appropriate given the species' tiny world range.

#### Westfall's Snaketail (*Ophiogomphus westfalli*)

Although expected in Oklahoma, Westfall's Snaketail has not been recorded in the state. This species is a regional endemic, occurring in Arkansas, Kansas, and Missouri, including near the Oklahoma border (Fig. 7). The species occurs in Arkansas and Missouri throughout the Ozark Highlands, so it is surprising that it has not been found in Oklahoma, at least in Ottawa or perhaps Delaware Counties. We surveyed northeastern Oklahoma several times in an attempt to find it, but all surveys were negative. Perhaps the closest we have come to getting an Oklahoma record is when BS-P, during a visit to SEMC, found nymphs collected in Cherokee Co., Kansas, between 1973–1981 (OC 458282), right along the Oklahoma border.

It may be that the species once occurred in Oklahoma, but damming of the Elk River and its tributaries for the Grand Lake O' the Cherokees changed the hydrological landscape sufficiently to have pushed the species out of the state. This scenario may be what transpired at Buffalo Creek, Delaware Co., which has snaketails recorded from it in Missouri only a few tens of kilometers from Oklahoma. We recommend intensive surveys for this species at this location and the Spring River and its tributaries in northern Ottawa Co.

Westfall's Snaketail is considered to be under a high threat level (NatureServe 2016), specifically in regards to pollution, dams, clear-cutting, and development, particularly of retirement housing in that region. Given the threat level and the species' limited range, if it were to be found in Oklahoma, then it would need to be considered for the ODWC SGCN list. Currently Missouri ranks the species as S4 (apparently secure), but it is our impression that the species may not be as common as once thought. In Arkansas the species is ranked as S1S2 (critically imperiled/imperiled). The species is currently on that state's SGCN list and is receiving funding for 2017-2018 surveys, including for limited surveys in Oklahoma. The species has not been ranked in Kansas.

#### Attenuated Bluet (*Enallagma daeckii*)

Throughout the project we monitored a tiny population of the Attenuated Bluet at Crooked Branch Lake, Le Flore Co., where we discovered the species in June 2013 (2♂ [1 as SP669, OC400667], 8 June; 2♂, 1♀, including one pair, 9 June; 2♂, 15 June). We did not find the species there in 2014, but we did find 2♂ there on 6 June 2015 (1 as SP1630). The species was apparently absent again in 2016.

There are only three previous records of the Attenuated Bluet for Oklahoma (Appendix E; Fig. 8). The first was in June 1934, when A. Earl Pritchard added it to the state list (Antlers, Pushmataha Co.; EMEC331092–331094). The second record was not until 13 June 1957, when GHB found 1♂ and 2♀ (IORI) at 1.5 mi N of Antlers (likely the same locale as Pritchard's). It was not seen again for another 35 years, until Sidney W. Dunkle found 2♂ at Bokhoma Camp, McCurtain Co., on 6 June 1992 (IORI).

Despite our surveys across the region, including specifically at these localities, Crooked Branch Lake remains the only locality in the state with a known population.

We continue to regard the Attenuated Bluet as an S1 species (Patten and Smith-Patten 2013b) regardless of its rather large overall range in the southeastern US and along the Atlantic coast. Its single population (concomitant with the possible loss of two historical populations), its apparent low abundance, and its specialized and limited habitat of shaded backwater areas with heavy vegetation, all argue for this species being one of conservation concern in Oklahoma. There is little reason to think that the later two restrictions do not affect the species throughout its range.

We recommend continued monitoring of the Crooked Branch Lake population and intensive surveys in similar habitat in hopes of finding additional populations. We also recommend that the species be added to the ODWC SGCN list as a Tier II species.

#### Atlantic Bluet (*Enallagma doubledayi*)

The Atlantic Bluet, first found in the state in 2012 (Patten and Smith-Patten 2012), has been seen annually since but seemingly is confined to two counties, Atoka and Pushmataha (Appendix E; Fig. 8). In 2014, it was seen twice, both times at McGee Creek WMA, Atoka Co. (30♂ [1 as SP1235] and 1♀, including 1 pair, BS-P, MAP, 2 June; 6♂, 6♀, including 6 pair, and 18 other individuals, JWA, KW, 24 Sept). In 2015, 2♂ were encountered at Pushmataha WMA on 7 June (one as a mixed pair with a ♀ Azure Bluet, *E. aspersum*), and it was seen again on 3 October at McGee Creek WMA (4♂ [1 as SP1805]). The species was only found once in 2016, when 15♂ were present at the same spot at McGee Creek WMA on 17 September (1♂ found dead was retained as SP2203).

As its name suggests, the Atlantic Bluet is a species of the Atlantic coast, although its range extends across the southeastern United States. There are a handful of disjunct inland populations, Oklahoma being one (or, at least, that is the current understanding of this species' range). We suspect that gaps between known populations this far west and north will be filled with increased surveys in the region (for instance, the species was added to the Arkansas state list in 2016; OC445047, 446603). In Oklahoma we expect this species to turn up in the highland conifer belt of McCurtain and Le Flore Counties, at the least, although the species likely will remain locally rare to uncommon, particularly given the species' habitat constraints (Patten and Smith-Patten 2012), appearing to be restricted to small, acidic ponds in evergreen woodlands.

There are no major threats known for this species. General threats include loss of woodland ponds, clear-cutting, and feral pig wallowing. We considered this an S2 species in the state, but we are not inclined to make a pressing argument for its inclusion on the ODWC SGCN list as of yet. We recommend continuing data collection on its status and distribution prior to making a formal recommendation for the SGCN.

#### Burgundy Bluet (*Enallagma dubium*)

Like the Attenuated Bluet, the Burgundy Bluet is an enigmatic species in Oklahoma (Appendix E; Fig. 8). Pritchard (1935) mentioned *E. dubium* in passing as a species he encountered at a pond north of Antlers near the Kiamichi River, which appears to be the same pond that he secured the allotype and many paratypes of the Double-ringed Pennant (*Celithemis verna*). We have not found his voucher specimens, if they ever existed: given his nonchalance in his paper, perhaps he did not actually collect the species, or if he did, he did not retain the specimens.

The next record of the species came from Sidney W. Dunkle, on the day before his Attenuated Bluet record, at Kulli Lake, McCurtain Co. (2♂, IORI). We found none, nor any suitable habitat for it,

when we surveyed that lake on 8 June 2013, but later that day, at a park in the city of Broken Bow, McCurtain Co., we discovered 25♂ and 2♀, including 2 pair (1♂ as SP656; a ♂ was photographed on 10 June by BAH & DA, OC400474). The following year a single ♂ was seen at Broken Bow (14 June 2014, MAP), but the species has not been seen anywhere in the state since.

The Burgundy Bluet has a fairly wide US distribution, although not as extensive as the Atlantic Bluet. Unlike that species, though, Oklahoma is considered to be a "normal" part of the species' range (Paulson 2011). Taking into consideration the casualness of Pritchard's (1935) mention of the species, so casual that it makes us wonder if the species was so common at the time as not to warrant further discussion or preservation of specimens, and that the species appears to wink out where previously found, we have concerns about the conservation status of this species in the state. Speaking more cautiously, it may be that we are essentially working with a false baseline, i.e., that Oklahoma is actually more peripheral to the species' range—although it was just added to the Arkansas state list (Bried et al. 2016)—and that it never occurred here in large numbers. We hence feel this species is essentially data deficient in the state, so we are hesitant to make recommendations as to its true conservation status in Oklahoma.

## General Discussion

Future surveys as recommended for the species above could all continue to be combined within one study that targets multiple species. And those surveys can continue to provide data gathering of non-target odonate species as well as other taxa, for instance, tiger beetle (Coleoptera: Cicindelidae) and robber flies (Diptera: Asilidae). Such multi-taxa surveys are effective at gathering large amounts of data on a suite of organisms with efficient use of person-power while providing tremendous cost savings.

Additional eastern odonate species that ought to be considered for future surveys include: the Amber-winged Spreadwing (*Lestes eurinus*), Southern Sprite (*Nehalennia integricollis*), Seepage Dancer (*Argia bipunctulata*), Ashy Clubtail (*Gomphus lividus*), Cocoa Clubtail (*Gomphus hybridus*), Banner Clubtail (*Gomphus apomyias*), Two-striped Forceptail (*Aphylla williamsoni*), Twin-spotted Spiketail (*Cordulegaster maculata*), Clamp-tipped Emerald (*Somatochlora tenebrosa*), Selys's Sundragon (*Helocordulia selysii*), Smoky Shadowdragon (*Neurocordulia molesta*), Double-ringed Pennant (*Celithemis verna*), and Painted Skimmer (*Libellula semifasciata*). All of these species should be considered for listing on the ODWC SGCN list following Patten and Smith-Patten's (2013b) conservation rankings. In the southwestern portion of the current study area, in addition to determining if the Ozark Emerald and the Ozark Clubtail have established populations, we recommend conducting targeted surveys for Chalky Spreadwing (*Lestes sigma*) and Leonora's Dancer (*Argia leonorae*) to determine if those species have undetected populations.


One final recommendation is that, if at all possible, Berlin Heck's property, located approximately 10 km SE of Idabel, McCurtain Co., should be considered for conservation protection given its high conservation value as the only location in the state harboring the Twin-spotted Spiketail (*Cordulegaster maculata*) and Selys's Sundragon (*Helocordulia selysii*), both of which are S1 species. It is also one of only a handful of sites in the state that have populations of the Ashy Clubtail (*Gomphus lividus*), Painted Skimmer (*Libellula semifasciata*), and Little Blue Dragonlet (*Erythrodiplax minuscula*).


## F. SIGNIFICANT DEVIATIONS:

None.

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**H. DATE:** 7 December 2016

**I. APPROVED BY:**   
Wildlife Division Administration  
Oklahoma Department of Wildlife Conservation

  
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Oklahoma Department of Wildlife Conservation

**J. LITERATURE CITED:**

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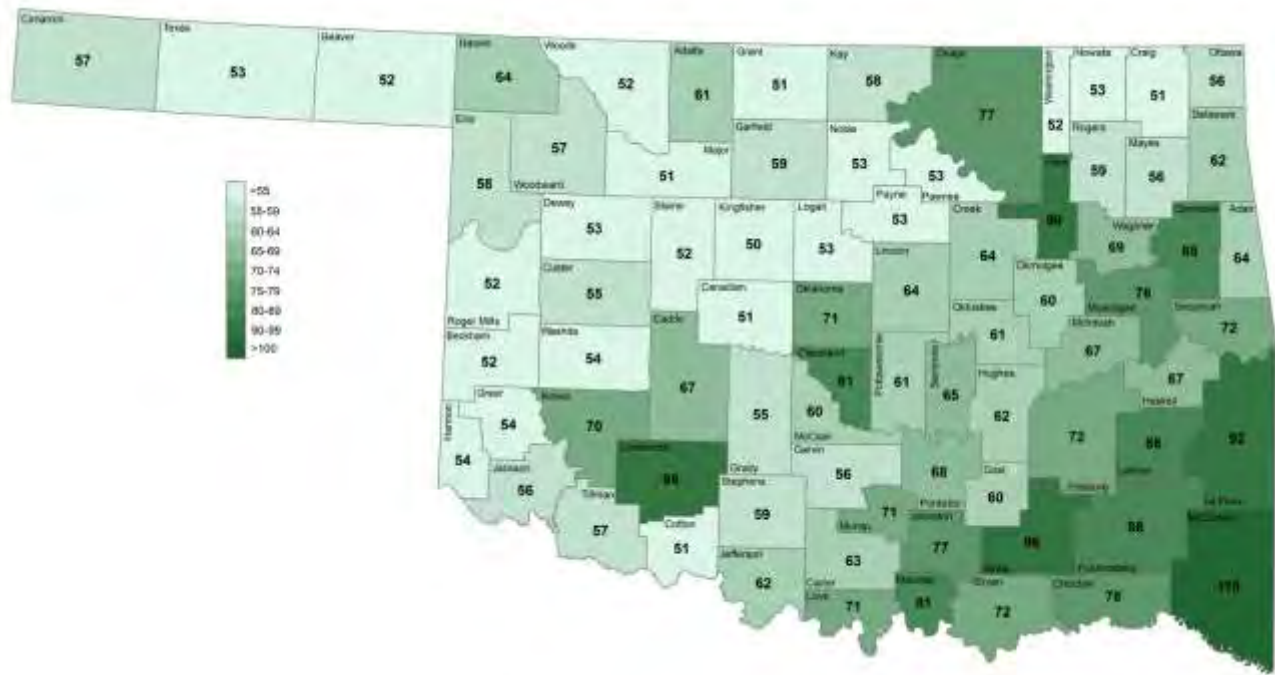
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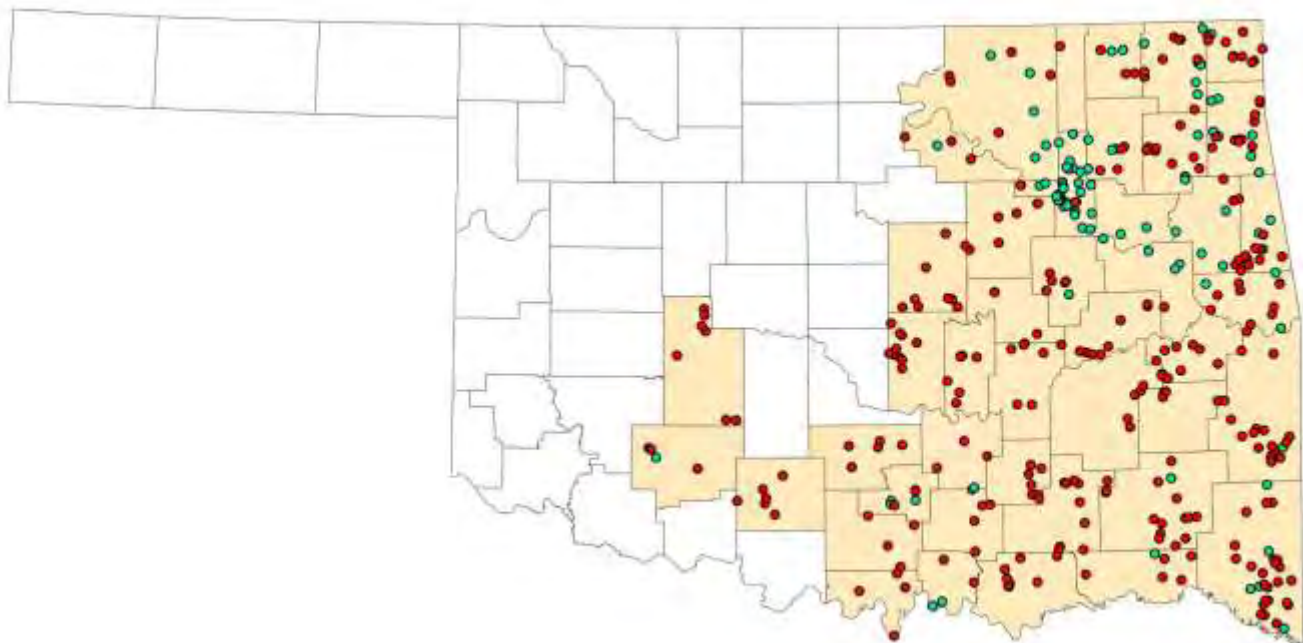
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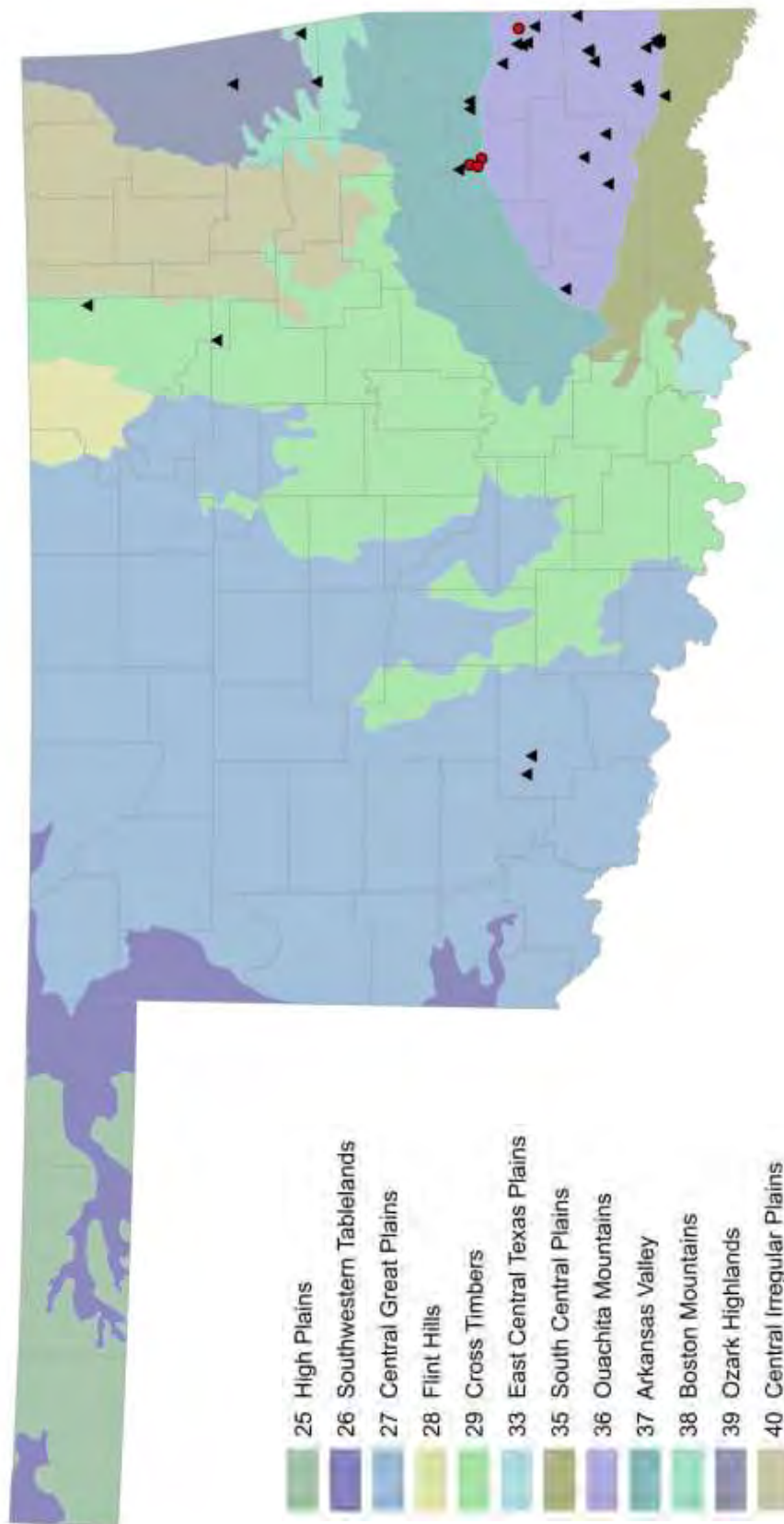


**Figure 1.** Map of Oklahoma depicting species totals for each county, and color coded by diversity. Shades of green vary with species richness, from palest (50–54 species) to darkest (>100 species).

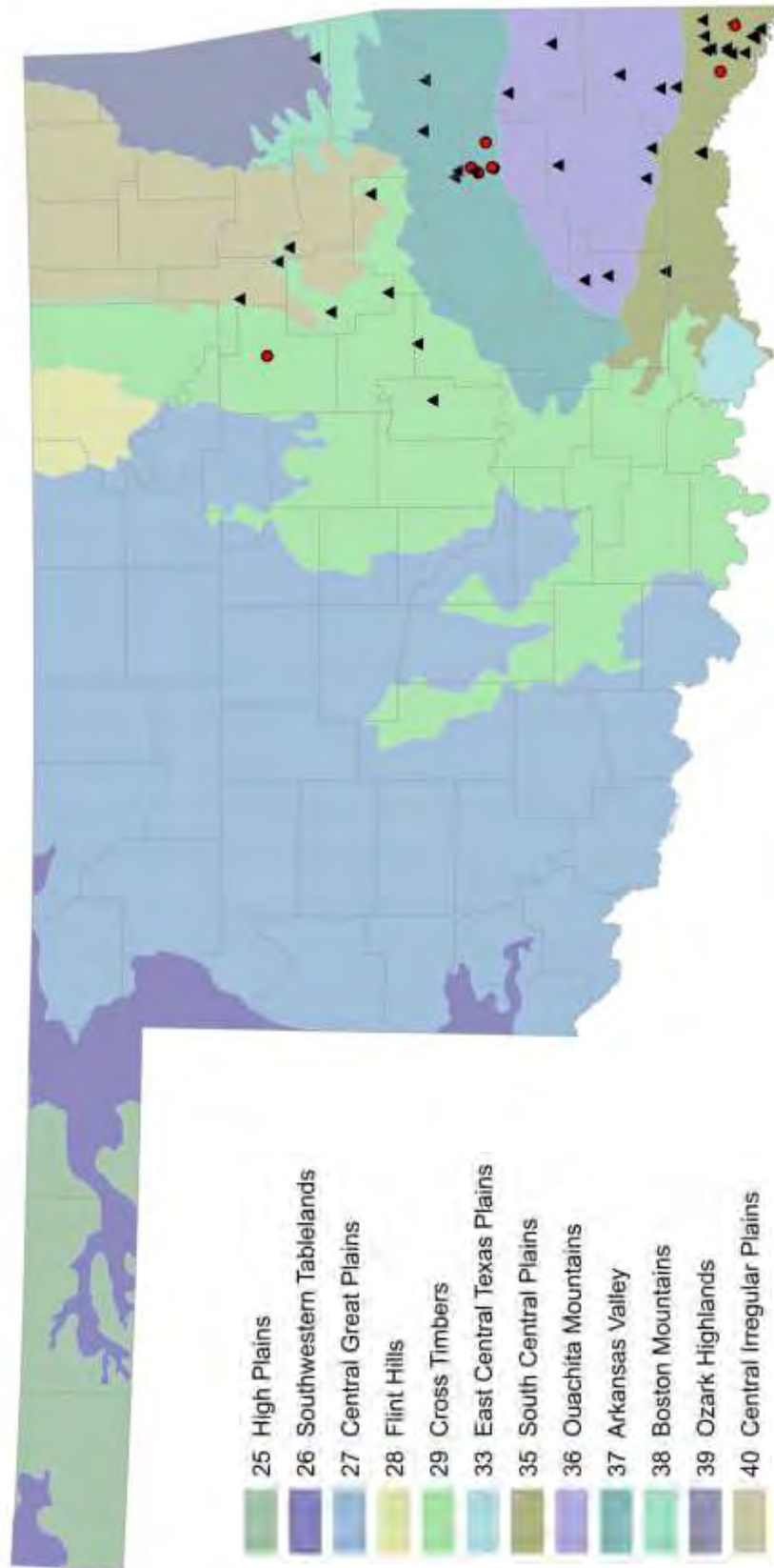


**Figure 2.** Study area (shaded counties) and surveys conducted during the project in Oklahoma. Surveys conducted by the PIs are in red; surveys by citizen scientists in green.

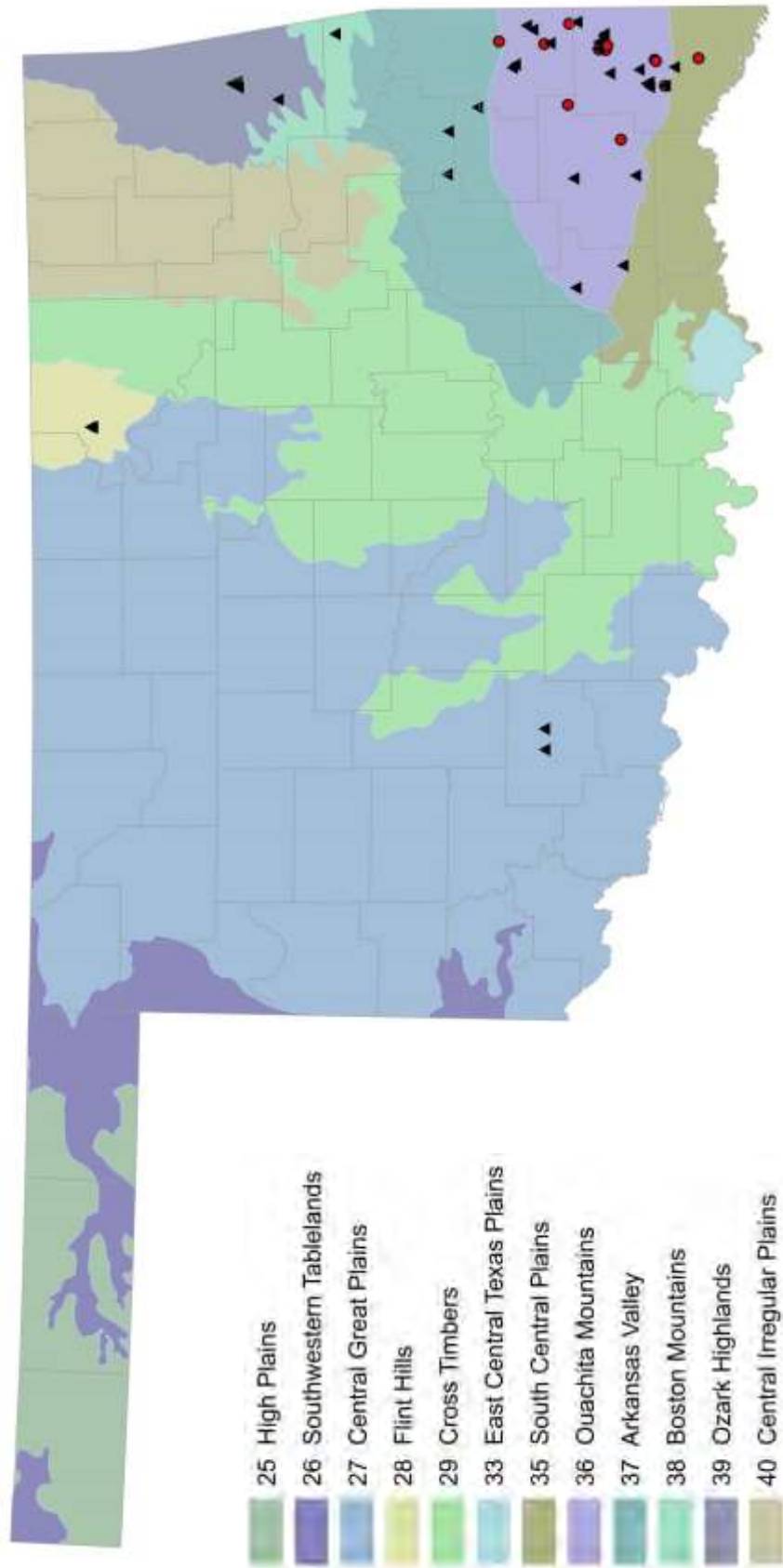
**Figure 3.** Known locations for the Ozark Emerald (*Somatochlora ozarkensis*) in Oklahoma. Historical localities (1931-1934) are red circles; more recent records (2006-2016) are black triangles. The species was not reported between 1934 and 2006. The Comanche County records are likely Ozark Emeralds, but they lack voucher specimens, and the photographs cannot without a doubt be attributed to *S. ozarkensis*.

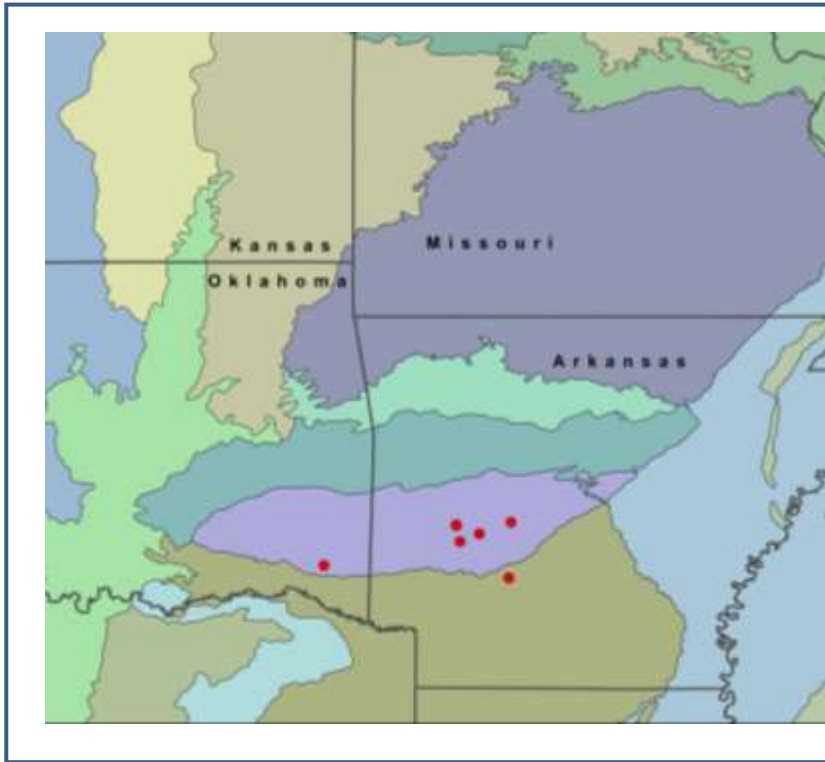


**Figure 4.** Known locations for the Oklahoma Clubtail (*Gomphus oklahomensis*) in Oklahoma. Historical localities (1931-1992) are red circles; more recent records (2007-2016) are black triangles. The species was not reported between 1992 and 2007.

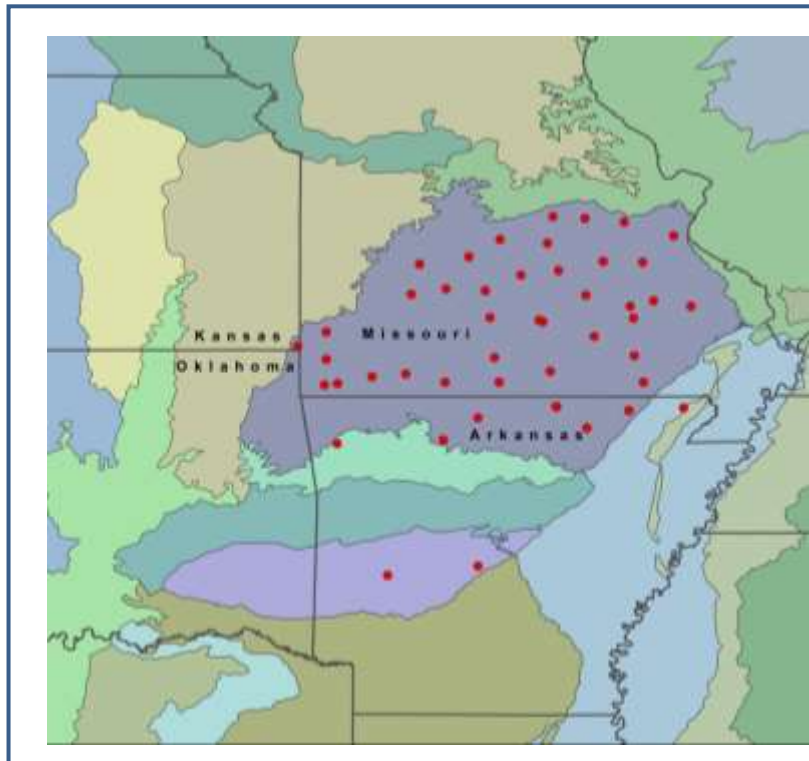


**Figure 5.** Known locations for the Ozark Clubtail (*Gomphus ozarkensis*) in Oklahoma. Historical localities (1956-1999) are red circles; more recent records (2000-2016) are black triangles.



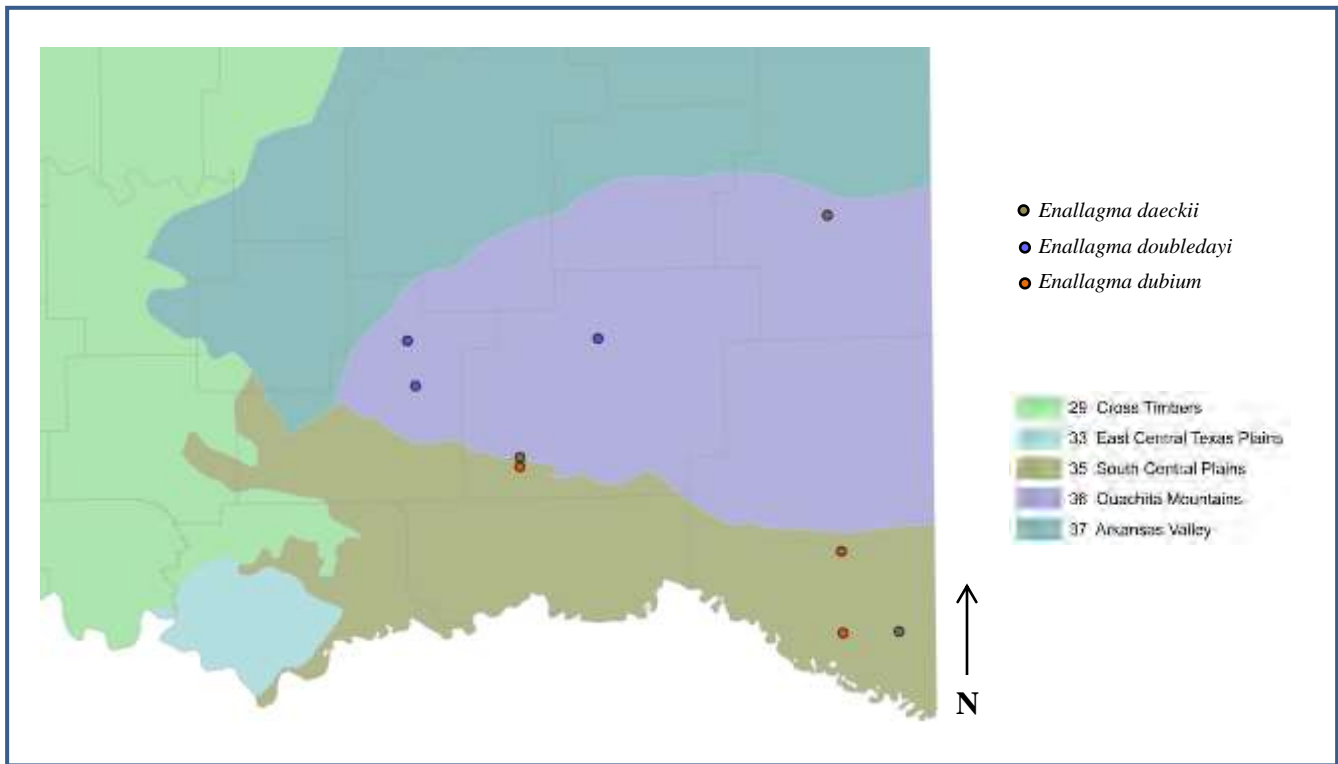


**Figure 6.** Known locations for the Ouachita Spiketail (*Cordulegaster* species endemic to Arkansas and Oklahoma.



**Figure 7.** Known locations for Westfall's Snaketail (*Ophiogomphus* species endemic to Arkansas, Kansas, Missouri, and probably Oklahoma.

- 812 001 Coastal Plains
- 812 002 Coastal Plains
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- 812 004 Coastal Plains
- 812 005 Coastal Plains
- 812 006 Coastal Plains
- 812 007 Coastal Plains
- 812 008 Coastal Plains
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- 812 100 Coastal Plains



**Figure 8.** Known locations for the Attenuated Bluet (*Enallagma daeckii*), Atlantic Bluet (*E. doubledayi*), and Burgundy Bluet (*E. dubium*) in southeastern Oklahoma.

## **Appendices (as pdf)**

Appendix A. Habitat assessment data sheet sample.

Appendix B. Ozark Emerald (*Somatochlora ozarkensis*) records from the OOP database.

Appendix C. Oklahoma Clubtail (*Gomphus oklahomensis*) records from the OOP database.

Appendix D. Ozark Clubtail (*Gomphus ozarkensis*) records from the OOP database.

Appendix E. Attenuated Bluet (*Enallagma daeckii*), Atlantic Bluet (*E. doubledayi*), Burgundy Bluet (*E. dubium*) records from the OOP database.

# Appendix A

## OKLAHOMA ODONATA LOTIC HABITAT ASSESSMENT DATA SHEET

<b>POINT DATA</b>	Site _____
Point Data (within 5 m on either side of point):	
Point Name: _____	
Size: Stream width (m)    ___ min    ___ max	
Depth: _____ cm <input type="checkbox"/> <10 cm <input type="checkbox"/> 11-25 cm <input type="checkbox"/> 26-50 cm <input type="checkbox"/> 51-100 cm <input type="checkbox"/> >1 m <input type="checkbox"/> unable to determine	
Stream bank slope 1: <input type="checkbox"/> level <input type="checkbox"/> gentle <input type="checkbox"/> moderate <input type="checkbox"/> steep <input type="checkbox"/> vertical    comments _____	
Stream bank slope 2: <input type="checkbox"/> level <input type="checkbox"/> gentle <input type="checkbox"/> moderate <input type="checkbox"/> steep <input type="checkbox"/> vertical    comments _____	
Water odors: <input type="checkbox"/> none <input type="checkbox"/> sewage <input type="checkbox"/> petroleum <input type="checkbox"/> chemical <input type="checkbox"/> fishy <input type="checkbox"/> other _____	
Water surface oils: <input type="checkbox"/> none <input type="checkbox"/> slick <input type="checkbox"/> sheen <input type="checkbox"/> globs <input type="checkbox"/> flecks <input type="checkbox"/> other _____	
Anthropogenic disturbance (within 18 m from shoreline): <input type="checkbox"/> sludge <input type="checkbox"/> trash <input type="checkbox"/> sand <input type="checkbox"/> atv <input type="checkbox"/> logging <input type="checkbox"/> cows <input type="checkbox"/> feral pigs <input type="checkbox"/> anglers <input type="checkbox"/> paved road <input type="checkbox"/> building infrastructure    comments _____	
Flow rate: _____ m/sec <input type="checkbox"/> none <input type="checkbox"/> low <input type="checkbox"/> moderate <input type="checkbox"/> high	
Water temperature: _____ °C    pH: _____	
Dissolved Oxygen: _____ mg/L    Conductance _____ µS/cm	
TDS _____ mg/L    Turbidity: _____ FNU    Salinity _____ PSU	
Aquatic Sediment/Substrate:	
Odors: <input type="checkbox"/> none <input type="checkbox"/> anaerobic <input type="checkbox"/> other _____	
Stones not deeply embedded, are the undersides black in color? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> No stones	
Canopy cover: _____ = _____ %	
Riparian vegetation (2x2 quadrant; should add to 100%):	
Bank 1:    ___ bare ground ( <i>sand, silt, clay</i> )    ___ rock ( <i>bedrock, cobble, gravel</i> )    ___ leaf litter ___ large woody debris    ___ trees    ___ shrubs    ___ herbaceous    ___ vines	
Bank 2:    ___ bare ground ( <i>sand, silt, clay</i> )    ___ rock ( <i>bedrock, cobble, gravel</i> )    ___ leaf litter ___ large woody debris    ___ trees    ___ shrubs    ___ herbaceous    ___ vines	
Aquatic vegetation:	
<input type="checkbox"/> rooted emergents <input type="checkbox"/> rooted submergents <input type="checkbox"/> rooted floating (e.g., <i>water lilies</i> ) <input type="checkbox"/> free floating	
<input type="checkbox"/> floating algae <input type="checkbox"/> attached algae	
portion with aquatic vegetation _____ %	

*adapted from Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition, Appendix A, form 1, pages 5-6*



## Appendix B

*Somatochlora ozarkensis*  
Oklahoma Odonata Project records

record_type_id	total_indiv	males	females	unsexed	pair	age	county	locality	coll_by_date
specimen - OMNH1612 (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Bird, RD, 9 June 1931
specimen - UMMZ (Allotype)	1		1			adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Bird, RD, 9 June 1931
specimen - UMMZ (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Bird, RD, 9 June 1931
specimen - OMNH1613 (Paratype)	1		1			adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Bird, RD, 14 June 1931
specimen - OMNH1614 (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Bird, RD, 14 June 1931
specimen note (Bick)	1	1				adult	Latimer		coll: 22 June 1931
specimen - UMMZ (Holotype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Fisher, WM, 14 July 1931
specimen - OMNH1615 (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Fisher, WM, 21 July 1931
specimen - OMNH1616 (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Fisher, WM, 21 July 1932
specimen - UMMZ (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Fisher, WM, 26 July 1932
specimen - CUIC3020.1 (Paratype)	1	1				adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Pritchard, AE, 10 June 1934
specimen - EMEC81607	1	1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - EMEC81610	1	1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - IORI	1	1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - OSU	1	1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - USNM336146	1	1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - CUIC3020.2 (Paratype)	1		1			adult	Latimer	2.5 mi NE of Wilburton; Cunneo Tubby Creek	coll by: Pritchard, AE, 14 June 1934
specimen - EMEC81613	1		1			adult	Latimer	Wilburton	coll by: Pritchard, AE, 14 June 1934
literature (Pritchard 1936)						adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
specimen - EMEC81608	1	1				adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
specimen - EMEC81609	1		1			adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
specimen - EMEC81611	1		1			adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
specimen - EMEC81612	1		1			adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
specimen - IORI	1		1			adult	Le Flore	Page	coll by: Pritchard, AE, 23 June 1934
photograph, archived - OC435703	1	1				adult	Osage	Torpedo Switch	coll by: Ferguson, MR, 2 August 2006
specimen - JCAC16501; 23653 [UTIC]	1	1				adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River [presumed]	coll by: Arbour, D & Heck, BA, 8 August 2007
specimen - JCAC16501; 39886 [UTIC]	1		1			adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River [presumed]	coll by: Arbour, D & Heck, BA, 8 August 2007
photograph, archived - OC262977	2	1	1			adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Arbour, D, 8 August 2007
photograph, archived - OC282324	2	2				general	McCurtain	13 km WNW of Hochatown; Cedar Creek, along FS 53000 Rd	coll by: Heck, BA, 28 May 2008
specimen - JCAC16782; 41009 [UTIC]	1			1		adult	McCurtain	3 mi SE of Wright City	coll by: Heck, BA & Heck, BA, III, 9 July 2008
specimen - JCAC16782; 41674 [UTIC]	1			1		adult	McCurtain	3 mi SE of Wright City	coll by: Heck, BA & Heck, BA, III, 9 July 2008
photograph, archived - OC283171	8				8	adult	McCurtain	3 mi SE of Wright City	coll by: Heck, BA, 9 July 2008
specimen - DRP28	3	1	2			adult	McCurtain	NE of Wright City; FR 53000 near Cedar Creek	coll by: Heck, BA, 26 July 2008
specimen - DRP28	1	1				adult	McCurtain	NE of Wright City; FR 53000 near Cedar Creek	coll by: Heck, BA, 27 July 2008
specimen - JCAC16985; 41023 [UTIC]	1		1			adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Heck, BA, 27 July 2008
specimen - JCAC16985; 41688 [UTIC]	1		1			adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Heck, BA, 27 July 2008
photograph, archived - OC283514	8	1		7		adult	McCurtain	13 km WNW of Hochatown; Cedar Creek, along FS 53000 Rd	coll by: Heck, BA, 14 August 2008
photograph, archived - OC313402	1	1				adult	Comanche	Fort Sill Military Reserve; West Range; Ketch Canyon	coll by: Fazio, VW, III, 20 June 2009
photograph, archived - OC313462	1			1		adult	McCurtain	11 km NE of Broken Bow; Mountain Fork Park	coll by: Heck, BA, 26 June 2009
photograph, archived - OC328764	1	1				adult	Comanche	Wichita Mountains Wildlife Refuge; French Lake	coll by: Fazio, VW, III, 17 June 2011
specimen - JCAC48944 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC & Heck, BA, 2 July 2011
specimen - JCAC48945 [UTIC]	1		1			adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC & Heck, BA, 2 July 2011
photograph, archived - iNaturalist220655	2	1	1			adult	McCurtain	9 km E of Bethel; 4 km W of Mountain Fork River	coll by: Lasley, GW, 3 July 2011
specimen - JCAC48961 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48962 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48963 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48964 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48965 [UTIC]	1	1				adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48966 [UTIC]	1		1			adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48967 [UTIC]	1		1			adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
specimen - JCAC48968 [UTIC]	1		1			adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Lasley, GE, Abbott, JC, & Abbott, KK, 3 July 2011
photograph, archived - OC329494	1			1		adult	McCurtain	Beavers Bend State Park	coll by: Heck, BA, 7 July 2011
photograph, archived - OC329867	1		1			adult	McCurtain	4 mi ENE of Watson; Dry Creek	coll by: Heck, BA, 10 July 2011
photograph, archived - OC330254	1		1			adult	Le Flore	5 km NNE of Lynn Mountain	coll by: Arterburn, JW & Williams, K, 11 July 2011
photograph, archived - OC332308	4		1	3		adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Kompier, T, 19 July 2011
photograph, archived - OC333281	3	1		2		adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Kompier, T, 29 July 2011
sight	1			1		adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Hibbits, Troy, 4 June 2012
photograph, archived - iNaturalist1393295	1	1				adult	Le Flore	8 km W of Page	coll by: Hibbits, D & Hibbits, Terry, 5 June 2012
field notes	1		1			general	Latimer	3 km E of Hughes; Cedar Creek	coll by: Smith-Patten, BD & Patten, MA, 16 June 2013
specimen - SP700	1		1			general	Latimer	3 km E of Hughes; Cedar Creek	coll by: Smith-Patten, BD & Patten, MA, 16 June 2013
field notes	5	2	3			adult	Atoka	Atoka Wildlife Management Area; Breadtown Creek	coll by: Smith-Patten, BD & Patten, MA, 13 July 2013
specimen - SP802	1		1			adult	Atoka	Atoka Wildlife Management Area; Breadtown Creek	coll by: Smith-Patten, BD & Patten, MA, 13 July 2013
sight	60			60		adult	Le Flore	Ouachita National Forest; Pipe Spring	coll by: Arbour, D, 29 June 2014
field notes	1		1			adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
specimen - SP1317	1		1			adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
photograph, archived - OC424100	1		1			adult	Le Flore	Ouachita National Forest; creek near Crooked Branch Lake	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
field notes	1		1			adult	Le Flore	Ouachita National Forest; Pipe Spring	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014

## Appendix B

*Somatochlora ozarkensis*  
Oklahoma Odonata Project records

field notes	4	1	3	adult	Le Flore	Ouachita National Forest; Pipe Spring	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
field notes	9	1	8	adult	Le Flore	Talimena National Scenic Byway (Highway 1)	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
field notes	22		22	adult	Le Flore	Talimena National Scenic Byway (Highway 1)	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
specimen - SP1318	1	1		adult	Le Flore	Talimena National Scenic Byway (Highway 1) and Forest Service Road 6068	coll by: Smith-Patten, BD & Patten, MA, 5 July 2014
field notes	1	1		adult	Latimer	3 km E of Hughes; Cedar Creek	coll by: Smith-Patten, BD & Patten, MA, 6 July 2014
photograph, archived - OC424121	1		1	adult	Latimer	8 km E of Red Oak; Turkey Creek	coll by: Smith-Patten, BD & Patten, MA, 6 July 2014
field notes	2	1	1	adult	Latimer	Robbers Cave Wildlife Management Area; Fourche Maline, highway 2	coll by: Smith-Patten, BD & Patten, MA, 6 July 2014
photograph, archived - OC424122	1		1	adult	Latimer	Robbers Cave Wildlife Management Area; Fourche Maline, highway 2	coll by: Smith-Patten, BD & Patten, MA, 6 July 2014
field notes	1		1	adult	McCurtain	10 km NE of Broken Bow; Ouachita National Forest, pond	coll by: Smith-Patten, BD & Patten, MA, 23 August 2014
field notes	1		1	adult	Latimer	Robbers Cave Wildlife Management Area; Fourche Maline, highway 2	coll by: Smith-Patten, BD & Patten, MA, 29 June 2015
field notes	1		1	adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, et al., 2 July 2015
field notes	25	5	20	adult	McCurtain	10 km NE of Broken Bow; Ouachita National Forest	coll by: Patten, MA, 24 July 2015
specimen - SP1726	1		1	adult	McCurtain	10 km NE of Broken Bow; Ouachita National Forest	coll by: Patten, MA, 24 July 2015
photograph, archived	3	2	1	adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Easley, S & Arbour, D, 10 August 2015
photograph, archived - OC435326	1		1	adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Easley, S, 10 August 2015
photograph, archived - OC445701	1		1	general	Tulsa	Keystone Dam, SE side of dam, US Army Corp hiking trails	coll by: Carrell, B, 5 June 2016
photograph, archived - OC445702	1	1		adult	Tulsa	Keystone Dam, SE side of dam, US Army Corp hiking trails	coll by: Carrell, B, 5 June 2016
field notes	3	3		adult	Pushmataha	Honobia Creek Wildlife Management Area; 8 km SW of Nashoba	coll by: Patten, MA, 19 June 2016
photograph, archived - OC447526	1	1		adult	Pushmataha	Honobia Creek Wildlife Management Area; 8 km SW of Nashoba	coll by: Patten, MA, 19 June 2016
specimen - SP1981	1	1		adult	Pushmataha	Honobia Creek Wildlife Management Area; 8 km SW of Nashoba	coll by: Patten, MA, 19 June 2016
field notes	6	5	1	adult	Latimer	Robbers Cave Wildlife Management Area; Fourche Maline, highway 2	coll by: Patten, MA, 3 July 2016
field notes	1		1	adult	McCurtain	9 km ENE of Broken Bow; Cooper Creek	coll by: Patten, MA, 3 July 2016
field notes	9	6	3	adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, 6 July 2016
photograph, archived - OC448780	9	6	3	adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, 6 July 2016
specimen - SP1998	1	1		adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, 6 July 2016
specimen - SP1999	1	1		adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, 6 July 2016
specimen - SP2000	1		1	adult	Cherokee	Cookson Wildlife Management Area; Hastings Hollow Creek	coll by: Smith-Patten, BD, 6 July 2016
field notes	3	2	1	adult	Adair	Ozark Plateau Wildlife Management Area; Eagle Pass Hollow Creek	coll by: Smith-Patten, BD, 7 July 2016
photograph, archived - OC448782	3	2	1	adult	Adair	Ozark Plateau Wildlife Management Area; Eagle Pass Hollow Creek	coll by: Smith-Patten, BD, 7 July 2016
field notes	2	1	1	adult	Pushmataha	Honobia Creek Wildlife Management Area; 6 km E of Finley	coll by: Patten, MA, 10 July 2016
photograph, archived - OC453133	2	1	1	adult	Tulsa	Keystone Dam, SE side of dam, US Army Corp hiking trails	coll by: Carrell, B, 14 August 2016
photograph, archived - OC456397	1	1		adult	Cherokee	TNC JT Nickel Preserve; Bathtub Rocks	coll by: Ivy, J, 24 September 2016
photograph, archived - OC456581	1		1	adult	Cherokee	TNC JT Nickel Preserve; Bathtub Rocks	coll by: Ivy, C, 2 October 2016
specimen - MCZ	1		1	adult	Latimer	Wilburton	coll by: Pritchard, AE, 14 June 1934[?]
literature (Pritchard 1936)				adult	Latimer	Wilburton; Fourche Maline Creek	coll by: Pritchard, AE, 1934 [?]
literature (Pritchard 1936)				adult	Pushmataha	Nashoba	coll by: Pritchard, AE, 1934 [?]
literature (Dot Map Project) - OC247851				adult	Latimer		
literature (Dot Map Project) - OC247852				Le Flore			
literature (Dot Map Project) - OC247853	1		1	Osage		Erroneous record	

## Appendix C

*Gomphus oklahomensis*  
Oklahoma Odonata Project records

record_type_id	total_indiv	larvae	males	females	unsexed	pair	age	county	locality	coll_by_date
literature (Pritchard 1935) - Paratype specimen - EMEC81402 (Paratype)	1		1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 25 April 1931
specimen - EMEC310258 (Paratype)	1		1				adult	McCurtain	Idabel	coll by: Sooter, CA, 28 April 1934
specimen - UMMZ (Allotype)	1			1			adult	Latimer	Wilburton	coll by: Pritchard, AE, 28 April 1934
specimen - UMMZ (Holotype)	1		1				adult	Latimer	Wilburton; Fourche Maline Creek	coll by: Pritchard, AE, 28 April 1934
literature (Pritchard 1935)	2		1	1		1	adult	Latimer	8 mi N of Wilburton; Fourche Maline Creek	coll by: Pritchard, AE, 28 April 1934
literature (Pritchard 1935)	26		24	2			adult	Latimer	8 mi N of Wilburton; Fourche Maline Creek	coll by: Pritchard, AE & Sooter, CA, 28 April 1934
literature (Pritchard 1935) - Paratype specimen - EMEC81373 (Paratype)	6		3	3			adult	Latimer	Idabel	coll by: Sooter, CA, 28 April 1934
literature (Pritchard 1935) - Paratype specimen - EMEC81401 (Paratype)	1			1			adult	Latimer	Wilburton	coll by: Pritchard, AE, 12 May 1934
literature (Pritchard 1935) - Paratype specimen - EMEC81372	3			3			adult	Latimer	Wilburton	coll by: Pritchard, AE, 9 June 1934
specimen - IORI	1		1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - IORI	1			1			adult	Latimer	Wilburton	coll by: Pritchard, AE, 10 June 1934
specimen - IORI	1		1				adult	Latimer	Wilburton	coll by: Pritchard, AE, 12 June 1934
specimen - IORI	1		1				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen - IORI	1		1				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen - IORI	2		2				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen - IORI	2		1	1			adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen - JCAC22688	1		1				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen note (Bick)	8		7	1			adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen note (Bick)	1	1					nymph	Latimer	Robbers Cave State Park	coll by: Bick, GH, 18 April 1959
specimen - IORI	1		1				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH & Hornuff, LE, 14 June 1970
specimen note (Bick)	1		1				adult	Latimer	Robbers Cave State Park	coll by: Bick, GH, 14 June 1970
specimen - IORI	1		1				adult	Creek	Heyburn Lake	coll by: Harwood, PD, 25 May 1971
specimen - IORI	1			1			adult	Latimer	5 mi W of Red Oak	coll by: Stephan, K, 7 May 1977
specimen - JCAC22692	1				1		adult	McCurtain	vic. Bokhoma [presumed]	coll by: Dunkle, SW, 6 June 1992
sight	1			1			adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D, Nelson, J, & Fisher, J, 19 April 2007
photograph, archived - OC282048	1			1			adult	McCurtain	Little River National Wildlife Refuge	coll by: Heck, BA, 20 April 2008
photograph, archived - OC282047	1			1			adult	McCurtain	Red Slough Wildlife Management Area	coll by: Heck, BA, 22 April 2008
photograph, archived - OC312424	1			1			adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D, 30 March 2009
sight	1			1			adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D & Heck, BA, 14 April 2009
photograph, archived - OC318424	1			1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Heck, BA, 14 April 2010
photograph, archived - OC318687	1			1			adult	Choctaw	Raymond Gary State Park	coll by: Heck, BA, 5 May 2010
photograph, archived - OC327585	1			1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Heck, BA, 1 April 2011
photograph, archived - OC374127	1		1				adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Heck, BA, 19 March 2012
photograph, archived - OC374621	2			1			adult	Wagoner	Bixhoma Lake	coll by: Arterburn, JW & Williams, K, 4 April 2012
specimen - DRP24	1			1			adult	McCurtain	10 km NE of Wright City; Glover River	coll by: Heck, BA, 16 April 2012
photograph, archived - OC399296	1		1				adult	Seminole	10 km E of Seminole; Sportsman Lake	coll by: Smith-Patten, BD & Patten, MA, 22 April 2012
photograph, archived - OC399297	1		1				adult	Seminole	10 km E of Seminole; Sportsman Lake	coll by: Smith-Patten, BD & Patten, MA, 22 April 2012
specimen - SP151	1		1				adult	Seminole	10 km E of Seminole; Sportsman Lake	coll by: Smith-Patten, BD & Patten, MA, 22 April 2012
specimen - SP152	1		1				adult	Seminole	10 km E of Seminole; Sportsman Lake	coll by: Smith-Patten, BD & Patten, MA, 22 April 2012
field notes	4		3	1			adult	Seminole	10 km E of Seminole; Sportsman Lake	coll by: Patten, MA & Smith-Patten, BD, 22 April 2012
field notes	2		1	1			adult	Adair	4.3 km NNE of Greasy; Greasy Creek	coll by: Patten, MA & Smith-Patten, BD, 28 April 2012
photograph, archived - OC399407	1			1			adult	Hughes	5 km N of Wetumka; Lake Wetumka	coll by: Smith-Patten, BD & Patten, MA, 26 May 2012
specimen - SP251	1			1			adult	Hughes	5 km N of Wetumka; Lake Wetumka	coll by: Smith-Patten, BD & Patten, MA, 26 May 2012
field notes	1			1			adult	Hughes	Lake Wetumka	coll by: Smith-Patten, BD & Patten, MA, 26 May 2012
field notes	1		1				adult	Okmulgee	Henryetta; Nichols Park	coll by: Smith-Patten, BD & Patten, MA, 27 May 2012
specimen - SP525	1		1				adult	Choctaw	Raymond Gary State Park	coll by: Smith-Patten, BD & Patten, MA, 27 April 2013
specimen - SP526	1			1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA, 27 April 2013
field notes	24		2	10	12	1	adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA, 27 April 2013
field notes	6				6		teneral	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA, 27 April 2013
specimen - SP543	1		1				adult	Pushmataha	3 km NW of Tuskahoma; Lake Nanih Waiya	coll by: Smith-Patten, BD & Patten, MA, 29 April 2013
specimen - SP550	1		1				adult	Atoka	Atoka Public Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 29 April 2013
field notes	5		4	1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA; Heck, BA, 11 April 2014
field notes	1		1				adult	McCurtain	Grassy Slough Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 11 April 2014
field notes	1			1			teneral	McCurtain	Grassy Slough Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 11 April 2014
field notes	10				10		teneral	McCurtain	Grassy Slough Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 11 April 2014
field notes	1		1				adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 12 April 2014
field notes	6		2	4			teneral	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 12 April 2014
field notes	1						adult	McCurtain	Little River National Wildlife Refuge	coll by: Smith-Patten, BD & Patten, MA; Heck, BA, 12 April 2014
photograph, archived - OC421932	1		1				adult	Tulsa	Tulsa; Turkey Mountain Urban Wilderness Area	coll by: Arterburn, JW, 22 April 2014
photograph, archived - OC422085	1		1				adult	Haskell	10 km SE of Keota; Coal Creek	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
specimen - SP1126	1			1			teneral	McIntosh	3 km SW of Shady Grove; Shady Grove Creek	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
specimen - SP1137	1		1				adult	Haskell	3 km SE of Stigler; Lake John Wells	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
field notes	1		1				adult	Haskell	10 km SE of Keota; Coal Creek	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
field notes	7		5	2		1	adult	Haskell	3 km SE of Stigler; Lake John Wells	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
field notes	2		1	1			adult	McIntosh	3 km SW of Shady Grove; Shady Grove Creek	coll by: Smith-Patten, BD & Patten, MA, 25 April 2014
photograph, archived - OC422073	2		2				adult	Okmulgee	Okmulgee Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 26 April 2014
field notes	2		2				adult	Okmulgee	Okmulgee Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 26 April 2014
photograph, archived - OC422079	4		4				adult	Le Flore	9 km SE of Le Flore; Boney Ridge Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014
photograph, archived - OC422082	1				1		adult	Pittsburg	3 km SSE of Quinton; Mill Creek	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014

## Appendix C

*Gomphus oklahomensis*  
Oklahoma Odonata Project records

specimen - SP1163	1	1			adult	Le Flore	9 km SE of Le Flore; Boney Ridge Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014	
field notes	2	2			adult	Haskell	9 km SW of Kinta	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014	
field notes	1	1			adult	Latimer	Robbers Cave Wildlife Management Area; Fourche Maline, highway 2	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014	
field notes	4	4			adult	Le Flore	9 km SE of Le Flore; Boney Ridge Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014	
field notes	1	1			adult	Pittsburg	3 km SSE of Quinton; Mill Creek	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014	
sight	1	1			adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D, 5 May 2014	
field notes	1	1			adult	Choctaw	Raymond Gary State Park	coll by: Smith-Patten, BD & Patten, MA, 5 May 2014	
field notes	2	2			adult	McCurtain	14 km W of Hochatown	coll by: Smith-Patten, BD & Patten, MA, 5 May 2014	
photograph, archived - OC422137	1		1		adult	Muskogee	Haskell Lake	coll by: Arterburn, JW, 15 May 2014	
specimen - SP1238	1	1			adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
specimen - SP1239	1		1		adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
field notes	5	3	2		adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
specimen - SP1511	2	1	1		1	adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Patten, MA, 11 April 2015
field notes	40	25	15		2	adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA, 11 April 2015
field notes	10			10	teneral	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Patten, MA, 11 April 2015	
field notes	2	2			adult	McCurtain	Grassy Slough Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 11 April 2015	
sight	1			1	adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D, 21 April 2015	
field notes	10	10			adult	Atoka	TNC Boehler Seeps Preserve	coll by: Patten, MA, 25 April 2015	
field notes	6	5	1		adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Patten, MA, 26 April 2015	
field notes	1	1			adult	Pushmataha	Lake Ozzie Cobb	coll by: Patten, MA, 26 April 2015	
photograph, archived - OC430737	1			1	adult	Atoka	TNC Boehler Seeps Preserve; Boehler Lake	coll by: Smith-Patten, BD & Patten, MA, 1 May 2015	
specimen - SP1534	1	1			adult	Atoka	TNC Boehler Seeps Preserve; Boehler Lake	coll by: Smith-Patten, BD & Patten, MA, 1 May 2015	
specimen - SP1535	1	1			adult	Atoka	TNC Boehler Seeps Preserve; Boehler Lake	coll by: Smith-Patten, BD & Patten, MA, 1 May 2015	
field notes	4	4			adult	Atoka	TNC Boehler Seeps Preserve; Boehler Lake	coll by: Smith-Patten, BD & Patten, MA, 1 May 2015	
field notes	1	1			adult	Pushmataha	Honobia Creek Wildlife Management Area; North Turkey Creek; 7 km NE of Corinne	coll by: Smith-Patten, BD & Patten, MA, 2 May 2015	
field notes	4	4			adult	Pushmataha	Lake Ozzie Cobb	coll by: Smith-Patten, BD & Patten, MA, 2 May 2015	
specimen - SP1542	1	1			adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
field notes	5	5			adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
specimen - SP1639	1	1			adult	Le Flore	Big Cedar	coll by: Smith-Patten, BD & Patten, MA, 7 June 2015	
field notes	1	1			adult	Le Flore	Big Cedar	coll by: Smith-Patten, BD & Patten, MA, 7 June 2015	
specimen - SP1833	1	1			adult	McCurtain	2 km NNE of Bokhoma	coll by: Patten, MA, 26 March 2016	
field notes	1	1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Patten, MA, 26 March 2016	
field notes	2	1	1		teneral	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Patten, MA, 26 March 2016	
field notes	2	1	1		adult	McCurtain	2 km NNE of Bokhoma	coll by: Patten, MA, 26 March 2016	
specimen - SP1845	1	1			adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Patten, MA, 26 March 2016	
field notes	9	6	3		adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	1		1		adult	McCurtain	5 km NE of Haworth	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	1		1		teneral	McCurtain	7 km NW of Haworth; Mud Creek	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	6		6		adult	McCurtain	10 km SE of Idabel; Berlin Heck's property	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	5		5		teneral	McCurtain	7 km NW of Haworth; Mud Creek	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	2	1	1		adult	McCurtain	Little River National Wildlife Refuge; Buzzards Roost	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	4	2	2		adult	McCurtain	Little River National Wildlife Refuge; Forked Lake	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
field notes	2			2	adult	McCurtain	Little River National Wildlife Refuge; Forked Lake	coll by: Smith-Patten, BD & Hoagland, BW, 2 April 2016	
sight	2	1	1		1	adult	McCurtain	Red Slough Wildlife Management Area	coll by: Arbour, D, 5 April 2016
field notes	13	8	5		adult	McCurtain	Little River National Wildlife Refuge; Forked Lake	coll by: Patten, MA, 8 May 2016	
specimen - JCAC18630	1			1	adult	Marshall		coll by: unknown	
literature (Dot Map Project) - OC199274						Creek			
literature (Dot Map Project) - OC199275						Latimer			
literature (Dot Map Project) - OC199276						Marshall			
literature (Dot Map Project) - OC199277						McCurtain			
specimen - USNM338751	1	1			adult	Ottawa	Commerce	coll by: Harwell	
literature (Bick & Bick 1957)						Latimer			
literature (Bick & Bick 1957)						McCurtain			

## Appendix D

*Gomphus ozarkensis*  
Oklahoma Odonata Project records

record_type_id	total_indiv	males	females	unsexed	pair	age	county	locality	coll_by_date
specimen - IORI	1		1			adult	McCurtain	1 mi SW of Hochatown	coll by: Hornuff, LE, 12 April 1956
specimen - IORI	1		1			adult	McCurtain	1.5 mi SW of Hochatown	coll by: Hornuff, LE, 26 April 1956
specimen - IORI	1		1			adult	McCurtain	Little River, at highway 7 [70?]	coll by: Bick, GH, 13 June 1957
specimen - IORI	1	1				adult	McCurtain	8 mi E of Bethel	coll by: Bick, GH, 29 June 1970
specimen - IORI	1		1			adult	Pushmataha	3 mi W of Honobia	coll by: Hornuff, LE, 9 July 1970
specimen - KJT	2	1	1			adult	Pushmataha	Honobia Creek WMA; Little River; 5.5 mi E of Cloudy	coll by: Louton, JA, 27 May 1977
specimen - IORI	1	1				adult	Le Flore	Hodgen	coll by: Cuyler, RD, 3 May 1988
specimen - JCAC39394	1			1		adult	Le Flore	Beach Creek [Beech Creek], highway 260	coll by: Dunkle, SW, 8 June 1992
specimen - IORI	2	1	1			adult	McCurtain	N of Broken Bow Lake; Mountain Fork River; Weyerhauser low water crossing	coll by: Dunkle, SW, 12 June 1996
specimen - IORI	2	1	1			adult	McCurtain	N of Broken Bow Lake; Mountain Fork River; Weyerhauser low water crossing	coll by: Dunkle, SW, 12 June 1996
specimen - JCAC22774	1			1		adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Dunkle, SW, 12 June 1996
specimen - JCAC22775	1			1		adult	Le Flore	Kiamichi River, highway 259	coll by: Dunkle, SW, 9 June 1999
specimen - JCAC29353	1			1		adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Dunkle, SW, 9 June 1999
specimen - JCAC30031	1			1		adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Dunkle, SW, 9 June 1999
specimen - JCAC30709	1			1		adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Dunkle, SW, 9 June 1999
specimen - JCAC39376	1			1		adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Dunkle, SW, 9 June 1999
specimen - CSU	2	1	1		1	adult	Comanche	Fort Sill Military Reserve; East Cache Creek; South Boundary Rd.	coll by: Kondratieff, BC, 24 April 2002
photograph, archived - OC3	1	1				adult	Comanche	Fort Sill Military Reserve	coll by: Kondratieff, BC, 24 April 2002
photograph, archived - OC3	1		1			adult	Comanche	Fort Sill Military Reserve	coll by: Kondratieff, BC, 24 April 2002
literature (Kondratieff, et al	2			2		adult	Comanche	Fort Sill Military Reserve; East Range, East Cache Creek, South Boundary Road	coll by: Kondratieff, BC; et al., 24 April 2002
photograph, archived - OC3	7	1		6		adult	McCurtain	9 km NE of Hochatown	coll by: Heck, BA, 22 April 2009
photograph, archived - OC3	12			12		adult	McCurtain	11 km SSW of Smithville; Buffalo Creek	coll by: Heck, BA, 25 April 2009
photograph, archived - OC3	1	1				adult	McCurtain	12 km SSE of Smithville; Big Hudson Creek	coll by: Heck, BA, 27 April 2010
photograph, archived - OC3	1	1				adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Heck, BA, 27 April 2010
photograph, archived - OC3	1	1				adult	McCurtain	13 km WNW of Hochatown; Cedar Creek, along FS 53000 Rd	coll by: Heck, BA, 27 April 2010
photograph, archived - OC3	1		1			adult	McCurtain	13 km WNW of Hochatown; Cedar Creek, along FS 53000 Rd	coll by: Heck, BA, 12 May 2010
photograph, archived - OC3	1			1		adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Heck, BA, 15 May 2010
photograph, archived - OC3	1		1			adult	McCurtain	13 km WNW of Hochatown, along FS 52420 Rd	coll by: Heck, BA, 20 May 2010
photograph, archived - OC3	1			1		adult	McCurtain	10 km NE of Wright City; Glover River	coll by: Heck, BA, 25 May 2010
photograph, archived - OC3	2	1	1		1	adult	McCurtain	8.5 km SSW of Smithville; Ouachita National Forest 28000 Road	coll by: Heck, BA, 29 May 2010
photograph, archived - OC3	1			1		adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Heck, BA, 2 April 2011
photograph, archived - OC3	2	2				adult	Osage	3 km NNE of Burbank	coll by: Fazio, VW, III, 31 May 2011
photograph, archived - OC3	2	2				adult	Osage	3 km NNE of Burbank	coll by: Fazio, VW, III, 31 May 2011
photograph, archived - OC3	1			1		adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Heck, BA, 10 June 2011
photograph, archived - OC3	1			1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Fazio, VW, III, 30 June 2011
specimen - DRP24	3	2	1			teneral	McCurtain	10 mi NW of Broken Bow; Glover River, off highway 3	coll by: Heck, BA, 26 March 2012
photograph, archived - OC3	20	2	1	17		teneral	McCurtain	10 km NE of Wright City; Glover River	coll by: Heck, BA, Arterburn, JW, & Williams, K, 26 March 2012
photograph, archived - OC3	12		1	11		adult	McCurtain	8 km S of Smithville; Ouachita National Forest 28000 Road	coll by: Heck, BA, 1 April 2012
photograph, archived - OC3	1	1				adult	McCurtain	13 km WNW of Hochatown; Cedar Creek, vic. FS 52420 Rd	coll by: Heck, BA, 5 April 2012
specimen - DRP24	1	1				adult	McCurtain	10 mi NW of Broken Bow; Glover River, off highway 3	coll by: Heck, BA, 9 April 2012
photograph, archived - OC3	1			1		adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Heck, BA, 9 April 2012
photograph, archived - OC3	2		2			adult	Cherokee	4 km ESE of Park Hill; confluence of Baron Fork and Illinois River	coll by: Arterburn, JW, 24 April 2012
photograph, archived - OC3	1	1				adult	McCurtain	10 km ENE of Smithville; Beech Creek	coll by: Heck, BA, 26 April 2012
photograph, archived - OC3	1			1		adult	McCurtain	vic. Little River Wildlife Management Area	coll by: Arbour, D, 27 April 2013
specimen - SP531	1	1				adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Smith-Patten, BD & Patten, MA, 28 April 2013
specimen - SP532	1		1			teneral	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Smith-Patten, BD & Patten, MA, 28 April 2013
specimen - SP535	1		1			adult	McCurtain	8 km S of Smithville; Ouachita National Forest 28000 Road	coll by: Smith-Patten, BD & Patten, MA, 28 April 2013
field notes	3	2	1			adult	McCurtain	8 km S of Smithville; Ouachita National Forest 28000 Road	coll by: Smith-Patten, BD & Patten, MA, 28 April 2013
field notes	3	2	1			adult	McCurtain	9 km SW of Smithville; The Narrows; Mountain Fork of the Little River	coll by: Smith-Patten, BD & Patten, MA, 28 April 2013
field notes	2	2				adult	Le Flore	Ouachita National Forest; Well Hollow Walk-in Turkey Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 29 April 2013
photograph, archived - OC4	1			1		adult	Sequoyah	Nicut; Little Lee Creek (coordinates are for Nicut, as exact location on creek is unknown to sut	coll by: Ivy, C, 18 May 2013
photograph, archived	1					adult	Sequoyah	Nicut; Little Lee Creek	coll by: Ivy, C, 18 May 2013
specimen - SP693	1	1				adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 10 June 2013
field notes	1	1				adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 10 June 2013
specimen - SP698	1		1			adult	Haskell	2 mi SW of Lequire; Eaton Creek	coll by: Smith-Patten, BD & Patten, MA, 15 June 2013
field notes	1		1			adult	Haskell	2 mi SW of Lequire; Eaton Creek	coll by: Smith-Patten, BD & Patten, MA, 15 June 2013
field notes	4	4				adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 12 April 2014
field notes	6	2	4			teneral	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 12 April 2014
photograph, archived - OC4	1			1		adult	Pittsburg	3 km SSE of Quinton; Mill Creek	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014
field notes	1		1			adult	Le Flore	Ouachita National Forest; Well Hollow Walk-in Turkey Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014
field notes	1	1				adult	Pittsburg	3 km SSE of Quinton; Mill Creek	coll by: Smith-Patten, BD & Patten, MA, 3 May 2014
specimen - SP1168	1	1				adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 4 May 2014
field notes	1	1				adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 4 May 2014
field notes	2		2			immature	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 4 May 2014
field notes	16	13	3			adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Smith-Patten, BD & Patten, MA, 4 May 2014
field notes	5	5				adult	McCurtain	6 km NW of Broken Bow; Lukfata Creek	coll by: Smith-Patten, BD & Patten, MA, 4 May 2014

## Appendix D

*Gomphus ozarkensis*  
Oklahoma Odonata Project records

specimen - SP1170	1	1		adult	McCurtain	14 km W of Hochatown	coll by: Smith-Patten, BD & Patten, MA, 5 May 2014	
field notes	35		35	2	adult	McCurtain	14 km W of Hochatown	coll by: Smith-Patten, BD & Patten, MA, 5 May 2014
specimen - SP1181	1	1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 11 May 2014	
field notes	4	1	3	teneral	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 11 May 2014	
sight	1	1		adult	Le Flore	Rich Mountain	coll by: Arbour, D, 18 May 2014	
photograph, archived - OC4	1		1	adult	Cherokee	TNC JT Nickel Preserve; Pumpkin Flats	coll by: Carrell, B, 25 May 2014	
specimen - SP1210	1	1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 29 May 2014	
specimen - SP1211	1	1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 29 May 2014	
specimen - SP1212	1		1	adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 29 May 2014	
field notes	3	2	1	adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD & Patten, MA, 29 May 2014	
specimen - SP1232	1		1	adult	Latimer	8 km E of Red Oak; Turkey Creek	coll by: Smith-Patten, BD & Patten, MA, 1 June 2014	
field notes	3	1	2	adult	Latimer	8 km E of Red Oak; Turkey Creek	coll by: Smith-Patten, BD & Patten, MA, 1 June 2014	
photograph, archived - OC4	1		1	adult	Atoka	Atoka Wildlife Management Area; Breatdown Creek	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
specimen - SP1242	1		1	adult	Atoka	Atoka Wildlife Management Area; Breatdown Creek	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
field notes	1		1	adult	Atoka	Atoka Wildlife Management Area; Breatdown Creek	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014	
field notes	1		1	adult	Atoka	McGee Creek State Park, dam spillway	coll by: Smith-Patten, BD, 3 June 2014	
specimen - SP1261	1	1		adult	Atoka	McGee Creek State Park, dam spillway	coll by: Smith-Patten, BD & Patten, MA, 6 June 2014	
field notes	2	1	1	adult	Atoka	McGee Creek State Park, dam spillway	coll by: Smith-Patten, BD & Patten, MA, 6 June 2014	
field notes	6	4	2	adult	Atoka	McGee Creek State Park, dam spillway	coll by: Patten, MA, 25 April 2015	
specimen - SP1565	1	1		adult	Pushmataha	Lake Ozzie Cobb	coll by: Patten, MA, 26 April 2015	
field notes	2	1	1	adult	McCurtain	10 km NE of Wright City; Glover River, at highway 3 bridge	coll by: Patten, MA, 26 April 2015	
field notes	1	1		adult	Pushmataha	Lake Ozzie Cobb	coll by: Patten, MA, 26 April 2015	
field notes	7	4	3	adult	Atoka	McGee Creek State Park, dam spillway	coll by: Smith-Patten, BD & Patten, MA, 1 May 2015	
field notes	6	2	4	adult	Atoka	McGee Creek State Park, dam spillway	coll by: Smith-Patten, BD & Patten, MA, 2 May 2015	
photograph, archived - OC4	2	2		adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
specimen - SP1543	1	1		adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
specimen - SP1548	1	1		adult	Le Flore	vic. Lynn Mountain	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
field notes	6	6		adult	Le Flore	vic. Lynn Mountain	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
field notes	2	2		adult	McCurtain	Three Rivers Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 3 May 2015	
photograph, archived	1	1		adult	Cherokee	TNC JT Nickel Preserve	coll by: Reynolds, BE, 12 May 2015	
photograph, archived	1		1	adult	Cherokee	TNC JT Nickel Preserve	coll by: Carrell, B, 24 April 2016	
specimen - SP1942	1	1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD, 11 June 2016	
specimen - SP1943	1	1		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD, 11 June 2016	
field notes	6	6		adult	Osage	4 km NNE of Burbank; Salt Creek	coll by: Smith-Patten, BD, 11 June 2016	
specimen - SP1979	1		1	adult	Le Flore	Page; Big Creek, Haw Creek Road	coll by: Patten, MA, 19 June 2016	
field notes	1		1	adult	Le Flore	Page; Big Creek, Haw Creek Road	coll by: Patten, MA, 19 June 2016	
literature - OC196275					Le Flore			
literature - OC196276					McCurtain			
literature - OC196277					Pushmataha			
literature (Zuellig, et al. 2006)					Comanche	Fort Sill Military Reserve		

## Appendix E

*Enallagma daeckii, doubledayi, dubium*  
Oklahoma Odonata Project records

record_type_id	species	total_indiv	total_imm/ad	males	females	unsexed	pair	age	county	locality	coll_by_date
specimen - EMEC331092	<i>Enallagma daeckii</i>	1	1		1			adult	Pushmataha	Antlers	coll by: Pritchard, AE, 16 June 1934
specimen - EMEC331093	<i>Enallagma daeckii</i>	2	2	2				adult	Pushmataha	Antlers	coll by: Pritchard, AE, 16 June 1934
specimen - EMEC331094	<i>Enallagma daeckii</i>	1	1	1				adult	Pushmataha	Antlers	coll by: Pritchard, AE, 26 June 1934
specimen - IORI	<i>Enallagma daeckii</i>	1	1	1				adult	Pushmataha	1.5 mi N of Antlers	coll by: Bick, GH, 13 June 1957
specimen - IORI	<i>Enallagma daeckii</i>	2	2		2			adult	Pushmataha	1.5 mi N of Antlers	coll by: Bick, GH, 13 June 1957
specimen - IORI	<i>Enallagma daeckii</i>	2	2	2				adult	McCurtain	Bokhoma Camp pond	coll by: Dunkle, SW, 6 June 1992
field notes	<i>Enallagma daeckii</i>	2	2	2				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 8 June 2013
photograph, archived - OC400667	<i>Enallagma daeckii</i>	2	2	2				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 8 June 2013
specimen - SP669	<i>Enallagma daeckii</i>	1	1	1				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 8 June 2013
field notes	<i>Enallagma daeckii</i>	4	4	3	1		1	adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 9 June 2013
field notes	<i>Enallagma daeckii</i>	2	2	2				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 15 June 2013
field notes	<i>Enallagma daeckii</i>	2	2	2				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 6 June 2015
specimen - SP1630	<i>Enallagma daeckii</i>	1	1	1				adult	Le Flore	Crooked Branch Lake; Ouachita National Forest	coll by: Smith-Patten, BD & Patten, MA, 6 June 2015
specimen - MCZ	<i>Enallagma daeckii</i>	2	2	2				adult	Pushmataha	Antlers	coll by: Pritchard, AE, 26 June [1934?]
literature (Bick & Bick 1957)	<i>Enallagma daeckii</i>								Pushmataha		
literature (Pritchard 1935)	<i>Enallagma daeckii</i>								Pushmataha	Antlers	coll by: Pritchard, AE
literature (Dot Map Project) - OC177575	<i>Enallagma daeckii</i>								McCurtain		
literature (Dot Map Project) - OC177576	<i>Enallagma daeckii</i>								Pushmataha		
field notes	<i>Enallagma doubledayi</i>	32	32	30	2			adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
photograph, archived - OC381566	<i>Enallagma doubledayi</i>	1	1			1		adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
photograph, archived - OC399550	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
photograph, archived - OC399551	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
photograph, archived - OC399552	<i>Enallagma doubledayi</i>	1	1		1			adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
specimen - SP390	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
specimen - SP391	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
specimen - SP392	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
specimen - SP393	<i>Enallagma doubledayi</i>	1	1		1			adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 September 2012
field notes	<i>Enallagma doubledayi</i>	60	60	60				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 8 September 2012
photograph, archived - OC399553	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 8 September 2012
photograph, archived - OC399554	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 8 September 2012
specimen - SP394	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 8 September 2012
specimen - SP395	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 8 September 2012
field notes	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	Atoka Public Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 29 April 2013
specimen - SP544	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	Atoka Public Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 29 April 2013
field notes	<i>Enallagma doubledayi</i>	1	1	1				adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 10 June 2013
specimen - SP690	<i>Enallagma doubledayi</i>	1	1	1				adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 10 June 2013
field notes	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	Atoka Public Hunting Area	coll by: Smith-Patten, BD & Patten, MA, 13 July 2013
field notes	<i>Enallagma doubledayi</i>	75	75	7	6	62	6	adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 13 July 2013
specimen - SP807	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 13 July 2013
field notes	<i>Enallagma doubledayi</i>	31	31	30	1		1	adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014
specimen - SP1235	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 2 June 2014
sight	<i>Enallagma doubledayi</i>	30	30	6	6	18	6	adult	Atoka	McGee Creek Wildlife Management Area	coll by: Arterburn, JW & Williams, K, 24 September 2014
field notes	<i>Enallagma doubledayi</i>	2	2	2				adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 7 June 2015
field notes	<i>Enallagma doubledayi</i>	4	4	4				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Patten, MA, 3 October 2015
specimen - SP1805	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Patten, MA, 3 October 2015
field notes	<i>Enallagma doubledayi</i>	15	15	15				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Patten, MA, 17 September 2016
specimen - SP2203	<i>Enallagma doubledayi</i>	1	1	1				adult	Atoka	McGee Creek Wildlife Management Area	coll by: Patten, MA, 17 September 2016
specimen - SP1644	<i>Enallagma doubledayi</i> & <i>aspersum</i>	2	2	1	1		1	adult	Pushmataha	Pushmataha Wildlife Management Area	coll by: Smith-Patten, BD & Patten, MA, 7 June 2015
specimen - IORI	<i>Enallagma dubium</i>	2	2	2				adult	McCurtain	Kulli Lake	coll by: Dunkle, SW, 5 June 1992
field notes	<i>Enallagma dubium</i>	27	27	25	2		2	adult	McCurtain	Broken Bow; Broken Bow City Park	coll by: Smith-Patten, BD & Patten, MA, 8 June 2013
specimen - SP656	<i>Enallagma dubium</i>	1	1	1				adult	McCurtain	Broken Bow; Broken Bow City Park	coll by: Smith-Patten, BD & Patten, MA, 8 June 2013
photograph, archived - OC400474	<i>Enallagma dubium</i>	1	1			1		adult	McCurtain	Broken Bow; Broken Bow City Park	coll by: Arbour, D & Heck, BA, 10 June 2013
field notes	<i>Enallagma dubium</i>	1	1	1				adult	McCurtain	Broken Bow; Broken Bow City Park	coll by: Patten, MA, 14 June 2014
literature (Bick & Bick 1957)	<i>Enallagma dubium</i>								Pushmataha		
literature (Pritchard 1935)	<i>Enallagma dubium</i>								Pushmataha	Antlers	coll by: Pritchard, AE
literature (Dot Map Project) - OC178282	<i>Enallagma dubium</i>								McCurtain		
literature (Dot Map Project) - OC178283	<i>Enallagma dubium</i>								Pushmataha		