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# Distribution and Relative Abundance of the Oklahoma Salamander (*Eurycea tynerensis*)

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**The Oklahoma salamander (*Eurycea tynerensis*) occurs in the western Springfield Plateau of the Ozark Mountains of Arkansas, Oklahoma, and Missouri. Our survey of distribution examined 213 sites, 50 of which produced salamanders at the time of sampling, with several new records of distribution documented. Most sites at which salamanders were found were clumped along a few drainages. Potential threats to the species include graveling operations, siltation, and permanent flooding from damming of streams. Notes are provided about the conditions of habitat at new as well as historic sites. ©2001 Oklahoma Academy of Science**

## INTRODUCTION

The Oklahoma salamander, *Eurycea tynerensis*, is a small neotenic salamander endemic to gravel-bottomed streams located along the western slopes of the Ozark Mountains of Oklahoma, Missouri, and Arkansas (1-3). The Springfield Plateau is a unique subregion of the Ozarks due to the presence of deep cherty limestone deposits and to the presence of *E. tynerensis*.

Oklahoma salamanders have been collected from 28 localities in five Oklahoma counties — Adair, Cherokee, Delaware, Mayes, Ottawa — with specimens deposited in the Oklahoma State University Museum of Zoology (OSU) and University of Michigan Museum of Zoology (UMMZ) (2,4-6). In Arkansas, animals were collected at eight sites in Benton County, [Carnegie Museum of Natural History] (7,8); and in Missouri at 40 sites in Barry, McDonald, Newton, Stone, and Taney counties (3,9,10).

Museum records at OSU and UMMZ indicated high population densities at some Oklahoma and Missouri sites. Dundee (2) reported population densities ranging from 2.3-24.2 salamanders per ft<sup>2</sup> (0.09 m<sup>2</sup>) at Pineville, Missouri, yet recent status surveys conducted in Missouri (10) and Arkansas (8) indicated lower densities. Both reports sug-

gested that the species is threatened by habitat loss caused by siltation and graveling operations. Oklahoma salamanders are considered rare or endangered species in all three states (11-13; T. Johnson, personal communication); however, no current data exist concerning the status of the Oklahoma salamander in Oklahoma.

This study was conducted to achieve an extensive survey of the status of the Oklahoma salamander in Oklahoma and a less extensive survey of sites in Missouri and Arkansas. We report relative abundance and conditions supporting populations of Oklahoma salamanders in the areas surveyed.

## METHODS

Potential survey sites were determined from historic records and 7.5 min U.S. Geological Survey quadrangle maps. Details of the 213 specific locations visited are provided in the final report submitted to the U.S. Fish and Wildlife Service (14) and marked on quadrangle maps housed at the Tulsa Field Office. Previous authors (8,10) suggested that the salamanders typically were found in streams bounded by narrow valleys, so we sampled 213 such sites intensively from 1

March through 10 October, but primarily during June and July of 1988. Salamanders were collected by turning submerged stones and catching exposed individuals in aquarium nets. All sites were sampled during daylight for 30 min by two researchers, i.e., 1 work-hour. We surveyed seven microhabitats in each stream: pools, pool edges, riffles, riffle edges, runs, run edges, and isolated pools. Runs were defined as flowing water that was not mixed as violently as riffles. We attempted to invest equal time and intensity while sampling each microhabitat. Three sites in Oklahoma were visited more than once to ascertain within-site variation in density and to gain insight about daytime versus night-time activity. These were: Tyner Creek (the type locality), 4 visits; Peavine Creek, an historic location subject to disturbance by gravel operations (2), 6 visits; and Rock Creek at Camp Egan, a site with historically high population densities based on museum records at OSU, 18 visits. Multiple visits were not included in this analysis, and results of those studies will be reported elsewhere.

Sites were coded for presence/absence and the number of salamanders observed. Relative population density was estimated as the number of salamanders observed per work-hour. Wet channel width (water only; m), dry channel width (total width of the streambed; m), and average water depth (cm) were recorded. Water temperature was measured to 0.2°C with a rapid register thermometer. Flow was measured with a Teledyne Gurley pygmy current meter. Substrate size was coded by use of a modified Wentworth scale (15). Embeddedness is a measure of the accumulation of particles <2 mm diameter that were found filling interstitial spaces under the surface layer of rocks. Aquatic and shoreline vegetation and local landform was recorded for each site. Stream order was determined from 1:500,000 scale water resources maps.

## RESULTS

Two hundred thirteen sites were examined in the three-state area (14; Appendix 1). Voucher specimens of *E. tynerensis* collected from the new locations were deposited in the

Oklahoma State University Museum of Zoology. Two sites in Arkansas, one in Missouri, and 25 in Oklahoma were new records of distribution. Salamanders were present at 50 (23.5%) of the surveyed sites and absent at 82 (38.5%). The remaining 81 (38.0%) sites were dry at the time of survey. Salamanders occupied 37.9% of the sites that had surface flow. Salamanders were found at 43.5% of 92 Oklahoma sites with water at the time of survey, 17.8% of 28 Arkansas sites, and 21.7% of 23 Missouri sites. Missouri and Arkansas sites were examined in early July when water levels were dropping and many streams were dry, thus comparison among states probably is biased.

Salamanders were observed at 50% of the historic sites in Oklahoma. Three historic sites in Oklahoma (Turkey Ford, Marvin Springs, MacSpadden Falls) were not surveyed because of active gravel operations, denial of access by the landowner, heavy embeddedness, or lack of surface water at the site. Nearby available habitat was sampled in each of these cases, i.e., Council Creek, Tyner Creek, Steeley Springs. Five historic Oklahoma sites could not be located (unnamed creek 9.1 mi W of Colcord, Stansberry-January Cave, Hendron Spring, 0.5 mi E Tahlequah, Moody Township). Three historic sites were dry (Boudinott Springs, Northeastern State University, Turkey Ford), one was heavily embedded (Marvin Springs), and one was flooded (3 mi. S of Salina). *E. tynerensis* historically has not been collected at the spring off Cloud Creek (16), but we collected specimens in Cloud Creek. We were unable to enter Little Spring Creek at the OK Hwy 82 bridge, but we collected salamanders at two other sites on Spring Creek. Museum specimens at OSU and UMMZ collected at Pipe Springs and identified as *E. tynerensis* were actually *Typhlotriton spelaeus*. Historic sites in Missouri were identifiable only by the stream name and the quadrangle map; thus our sample sites were chosen based on easy access.

Salamanders were found in the Baron Fork, Illinois, Spavinaw, Honey, Saline, Spring, Grand, Elk, and White River drainages (Fig. 1). Geologically, their distribution is restricted to the southwestern portion of

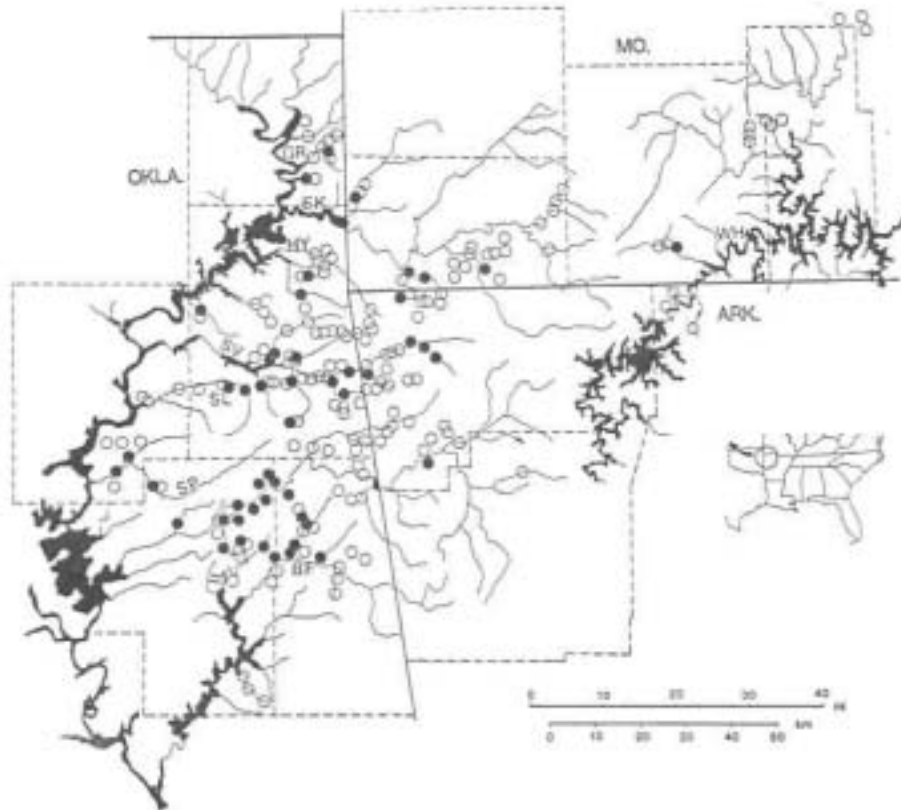


Figure 1. Distribution of *Eurycea tynerensis* in Oklahoma, Missouri, and Arkansas. Open circles indicate sites where salamanders were absent, closed circles indicate sites where salamanders were present.

the Springfield Plateau, bounded on the west by the Grand River and the Osage Plains, and on the south by the Boston Mountains. To the northeast their distribution abuts the western edge of the Salem Plateau, but there was no obvious geological barrier to the north or east.

The stream bed at positive sites had a mean depth of 9.9 cm (range = 1-48 cm). Wet channel width averaged 5.0 m (range = 1-14 m), and dry channel width averaged 11.9 m (range = 1.5-48 m). Average flow rate was 19 cm/s (range = 0.2-75 cm/s). Water temperature averaged 18.9°C (range = 14-23°C). Substrate size was between categories 3 and 4 (particles 16-64 mm and 65-256 mm, respectively). Embeddedness was between categories 3 and 4 (25-50% and 50-75%, respectively). Shorelines comprised riparian forests, fields, and cliffs. Dominant tree spe-

cies in riparian forests included sycamore (*Platanus occidentalis*), willows (*Salix* spp.), American elm (*Ulmus americana*), and oaks (*Quercus* sp.). Water willow (*Justicia americana*) was the most common emergent aquatic macrophyte. A few sites had attached filamentous algae.

Salamanders were found in creeks in broad or narrow valleys. Positive sites often were bordered by cliffs on one side. When cattle pastures bordered creeks, narrow riparian zones usually were present. Salamanders were found in first- (e.g., Rock, Black Fox Hollow, and Dog Hollow creeks), second- (e.g., Tyner, Saline, and Summerfield creeks), and third-order (Spavinaw creek) streams. Extensive field observations indicated that larger streams seldom supported higher densities of salamanders. Salamanders were found in slow moving, shal-

low water along pools, runs, and riffles, and in isolated pools (17). Salamander populations were clumped along major drainages; the greatest concentration of positive sites occurred along the Illinois River northeast of Tahlequah, Oklahoma (Fig. 1).

Densities ranged from 1-28 salamanders/work-h. Rock Creek had high densities of salamanders ranging from 15 salamanders/work-h, during one daytime survey, to 92 salamanders/work-h during a night observation, indicating appreciable variation was possible within sites. Twenty salamanders were counted in a 1-m long stretch in 20 min at Camp Egan. Densities appeared to be low at Peavine Creek, an historic site subjected to periodic gravelling operations. Repeated surveys there produced no more than 5 salamanders work-h.

## DISCUSSION

We expanded the known range of *E. tynerensis* approximately 3 km west with the discovery of the Spring Creek site. The population of salamanders at Off Davis Hollow in Barry County, Missouri, represents a 1 km range extension, pending identification of several salamanders collected in Christian County, Missouri (T. Johnson, personal communication).

In general, populations appear to be viable at most locations, with a few notable exceptions. The site 4.8 km south of Salina (5) was flooded sometime after the completion of Lake Hudson Dam in 1964. Although likely extirpated from this site, salamanders may exist further upstream from the site, but this area was not surveyed. Dundee's (2) Turkey Ford site was dry and a major gravel operation was in progress. We collected Oklahoma salamanders under the bridge of OK Hwy 10 approximately 1.3 km downstream from Dundee's site, but our site is threatened by flooding from Grand Lake. Damming of creeks on private land for watering of cattle and recreational use also threatens many sites.

Salamanders were present at Peavine Creek, but the density appeared to be much lower than literature and museum records indicated. Dundee (2) noted that gravel operations began at Peavine Creek in 1954.

Observations made by Cline over the previous 6 y and during this study suggest that this site continues to be disturbed by gravelling. The long-term movement and removal of gravel may have resulted in a negative effect on the salamander population. Salamanders were present at other sites where small gravel operations occurred, so this species apparently can withstand some habitat alteration. However, there appears to be an increase in gravelling throughout the region, and more sites are being modified to provide recreational areas, increasing the threat to salamander populations. Care must be taken when comparing our density results with historic records because equivalent collecting techniques were not used. Long-term monitoring of several sites on relatively undisturbed and heavily impacted streams to determine the effect of gravelling on salamander populations is warranted.

Siltation appears to be a bigger problem in Missouri and Arkansas than in Oklahoma. Streams in those states tended to have smaller riparian zones, were surrounded by fields for cattle grazing, and tended to have deeper soils than comparable Oklahoma sites. Interstitial spaces among gravel particles were filled with silt at many of these sites. Becker (10) and Polechla (8) suggested that increased siltation clogged the gills of salamanders and affected their ability to respire. *E. tynerensis* has reduced gills and probably relies on cutaneous respiration for much of its gaseous exchange, thus siltation may not inhibit branchial respiration for the salamanders. However, siltation fills spaces among stones and inhibits movement of the salamander through the substrate to avoid predation and dessication. Furthermore, it may suffocate eggs, and it may increase the biological oxygen demand, reducing the amount of dissolved oxygen that is available for the animals.

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Appendix 1. Localities visited during the survey of distribution of the Oklahoma salamander (*Eurycea tynerensis*). Comments either describe the site at the time of visit if no *E. tynerensis* was found, or gives the number of individuals found in what appeared to be good habitat (several or many were qualitative assessments of numbers seen). Most sites were roadside locations with sampling at the spring or along the creek above and below the bridge.

| State    | County  | Section,<br>Township,<br>Range | Comments             |
|----------|---|--------------------------------|----------------------|
| Oklahoma |   |                                |                      |
|          | <b>Adair</b>                                  |                                |                      |
|          | Marvin Springs, 6.3 mi N U.S. Hwy 62          | S23 T18N R24E                  | heavy sediment       |
|          | Tyner Creek, 6.4 mi N U.S. Hwy 62             | S23 T18N R24E                  | 2                    |
|          | Tyner Creek, 6.3 mi N U.S. Hwy 62             | S23 T18N R24E                  | 0                    |
|          | Turkey Hollow Creek, 7 mi N U.S. Hwy 62       | S23 T18N R24E                  | site dry             |
|          | Murrell Hollow 0.75 mi N Clear Fork Church    | S15 T18N R24E                  | site dry             |
|          | Clear Fork Branch of Tyner Creek              | S15 T18N R24E                  | 4                    |
|          | Tate Parris Hollow Creek                      | S28 T19N R25E                  | heavily embedded     |
|          | 5 mi W, 1 mi N Ballard                        |                                |                      |
|          | Fall Branch, Illinois River                   | S29 T19N R24E                  | 2                    |
|          | 6.7 mi N Dog Hollow bridge                    |                                |                      |
|          | Peacheater (=Courthouse) Creek                | S13 T17N R24E                  | 5                    |
|          | U.S. Hwy 62 at Christie                       |                                |                      |
|          | Dennison Hollow Creek, W Christie             | S2 T17N R24E                   | site dry             |
|          | Baron Fork River 0.6 mi S Christie            | S18 T17N R24E                  | 0                    |
|          | Scraper Hollow Rd 2.2mi S Christie            | S24 T17N R24E                  | site dry             |
|          | Scraper Hollow Rd 2.75 mi S Christie          | S25 T17N R24E                  | heavily embedded     |
|          | Tyner Creek 2.5 mi N U.S. Hwy 62              | S33 T18N R24E                  | 12                   |
|          | Wilkerson Hollow Rd 0.6 mi SE U.S. Hwy 62     | S8 T17N R25E                   | site dry             |
|          | Green Creek, Wilkerson Hollow Rd              | S9 T17N R25E                   | heavily embedded     |
|          | 2 mi SE U.S. Hwy 62                           |                                |                      |
|          | Tyner Creek at U.S. Hwy 62 bridge             | S8 T17N R23E                   | 3                    |
|          | unnamed creek off N side Illinois             | S13 T19N R25E                  | site dry             |
|          | River 2 mi W U.S. Hwy 59                      |                                |                      |
|          | Beaver Creek 1.5 mi S OK Hwy 33               | S2 T19N R25E                   | site dry             |
|          | Ballard Creek and 2 springs 0.25-1            | S25 T19N R25E                  | embedded             |
|          | mi W Ballard                                  |                                |                      |
|          | unnamed creek 2 mi W Ballard                  | S26 T19N R25E                  | embedded             |
|          | <b>Cherokee</b>                               |                                |                      |
|          | Pipe Springs Hollow                           | S16 T14N R23E                  | site dry             |
|          | Dog Hollow Creek near Eagle Bluff             | S4 T18N R23E                   | 20                   |
|          | Kirk Springs Hollow                           | S35 T19N R23E                  | 2                    |
|          | Falls Branch, Illinois River                  | S23 T19N R23E                  | 4                    |
|          | 0.9 mi W Round Hollow Access                  |                                |                      |
|          | 2.9 mi N Round Hollow, Illinois R.,           | S13 T19N R23E                  | 28                   |
|          | Winset Hollow                                 |                                |                      |
|          | Black Fox Hollow at OK Hwy 10 bridge          | S13 T19N R23E                  | 15                   |
|          | Pumpkin Hollow Creek 2 mi N                   | S25 T18N R23E                  | 19                   |
|          | Pumpkin Center Cemetary                       |                                |                      |
|          | Elk Creek 2 mi E OK Hwy 82                    | S8 T14N R23E                   | heavily embedded     |
|          | Elk Creek 1.5 mi N Cookson, OK Hwy 82         | S31 T15N R23E                  | exposed bedrock      |
|          | Pumpkin Spring 2.75 mi S Eagle Bluff on       | S26 T18N R22E                  | several              |
|          | OK Hwy 10                                     |                                |                      |
|          | 2.4 mi W OK Hwy 10, rd to Moodys              | S15 T18N R22E                  | heavily embedded     |
|          | creek at Eagle Bluff floats                   | S13 T18N R22E                  | 15                   |
|          | Molly Field Hollow 1 mi S Peavine             | S1 T18N R22E                   | 1 site dry, other    |
|          | Creek on OK Hwy 10 (also S6,7 T18N R23E)      |                                | access denied        |
|          | Peavine Creek, Hanging Rock, OK Hwy 10        | S5 T18N R23E                   | 5, gravel operations |
|          | 3.9 mi S Dog Hollow bridge, Telamay Hollow    | S18 T18N R23E                  | 1                    |
|          | Blackbird Creek OK Hwy 82 bridge              | S22 T18N R21E                  | 2                    |
|          | Spring Creek 1.5 mi NE Peggs                  | S20 T19N R21E                  | 3                    |
|          | Blacksmith Hollow Creek, 1.7 mi NE Peggs      | S20 T19N R21E                  | site dry             |
|          | Camp Egan 3 mi E jct. OK Hwy 51 & U.S. Hwy 62 | S11 T18N R23E                  | 22                   |
|          | 3 tribs to Baron Fork River, 2-2.5 mi N       | S13 T17N R23E                  | site dry             |
|          | OK Hwy 51                                     |                                |                      |
|          | Wall Trip Branch, Baron Fork River            | S26 T17N R23E                  | site dry             |

| State           | County<br>Location                               | Section,<br>Township,<br>Range | Comments           |
|-----------------|--|--------------------------------|--------------------|
|                 | 0.5 mi E OK Hwy 51                               |                                |                    |
|                 | Tahlequah City Park, Tahlequah Creek             | S33 T17N R22E                  | site dry           |
|                 | 0.7 mi W Hwy 10, rd to Steeley                   | S2 T17N R22E                   | 23                 |
|                 | Spring Baptist Church                            |                                |                    |
|                 | Cedar Hollow, E side Illinois                    | S31 T18N R23E                  | several            |
|                 | River 2 mi W section rd to Briggs                |                                |                    |
|                 | Tully Hollow Creek 1 mi W section                | S5 T17N R23E                   | 0                  |
|                 | rd to Briggs                                     |                                |                    |
|                 | 2 unnamed creeks, 1.2 mi E OK Hwy 10             | S17 T17N R23E                  | site dry           |
|                 | Sparrowhawk Mt.                                  |                                |                    |
|                 | unnamed creek near Sparrowhawk                   | S7 T17N R23E                   | site dry           |
|                 | Primitive area                                   |                                |                    |
|                 | Boudinot Springs 0.5 mi S OK Hwy 51              | S25 T17N R22E                  | site dry           |
| <b>Delaware</b> |  |                                |                    |
|                 | Crazy Creek 1 mi S Tonnence, 0.5 mi E            | S26 T21N R25E                  | 0                  |
|                 | OK Hwy 116                                       |                                |                    |
|                 | Spavinaw Creek at gaging station                 | S3 T21N R25E                   | 1                  |
|                 | N prong Summerfield Creek 2.7 mi N Chloeta       | S20 T23N R22E                  | 6                  |
|                 | S prong Summerfield Creek, 2.6 mi N Chloeta      | S20 T23N R22E                  | cattle impact      |
|                 | Cloud Creek 2 mi W Colcord, OK Hwy 116           | S26 T21N R24E                  | 0                  |
|                 | Cloud Creek Spring, OK Hwy 116                   | S26 T21N R24E                  | several            |
|                 | Cherokee Creek 4 mi N, 1 mi E                    | S8 T21N R24E                   | many               |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | unnamed creek 5 mi N OK Hwy 116                  | S33 T22N R25E                  | site dry           |
|                 | Hog Eye Creek 6 mi N OK Hwy 116                  | S28 T22N R25E                  | site dry           |
|                 | unnamed creek 4 mi N, 3.5 mi W                   | S3 T21N R24E                   | site dry           |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | Crazy Nance Hollow 4 mi N, 3 mi W                | S3 T21N R24E                   | site dry           |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | Beartoter Hollow 4 mi N, 2.5 mi W                | S11 T21N R24E                  | site dry           |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | unnamed creek 4 mi N, 2.25 mi W                  | S11 T21N R24E                  | site dry           |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | unnamed creek 4 mi N, 0.5 W                      | S1 T21N R24E                   | site dry           |
|                 | Colcord East Corporate boundary                  |                                |                    |
|                 | Spavinaw Creek 4 mi N Colcord, East Boundary Rd. | S1 T21N R24E                   | exposed bedrock    |
|                 | Beamer Hollow Creek 4 mi N, 0.3 mi E Colcord     | S6 T21N R25E                   | site dry           |
|                 | spring 2.75 mi E, 0.2 mi N Colcord               | S28 T21N R25E                  | heavily embedded   |
|                 | spring 2.75 mi E, 0.4 mi N Colcord               | S28 T21N R25E                  | heavily embedded   |
|                 | trib to Cherokee Creek 2.7 mi E,                 | S28 T21N R25E                  | site dry           |
|                 | 0.5 mi N Colcord                                 |                                |                    |
|                 | 2.75 mi E Colcord, OK Hwy 116, N 0.5             | S28 T21N R25E                  | 0                  |
|                 | mi where stream crosses section road             |                                |                    |
|                 | Cherokee Creek 2.75 mi E Colcord                 | S21 T21N R25E                  | 2                  |
|                 | OK Hwy 116, N 2 mi on section rd                 |                                |                    |
|                 | trib to Cherokee Creek, 1 mi N,                  | S29 T21N R25E                  | heavily embedded   |
|                 | 1.5 mi E Colcord East Corporate boundary         |                                |                    |
|                 | trib to Honey Creek, 0.25 mi E Butler Church     | S26 T24N R24E                  | site dry           |
|                 | trib to Honey Creek, 0.5 mi E Butler Church      | S26 T24N R24E                  | 1                  |
|                 | Honey Creek 3.8 mi S OK Hwy 25                   | S23 T24N R24E                  | heavily graveled   |
|                 | Honey Creek vic Snell Cemetary                   | S24 T24N R24E                  | 0                  |
|                 | Honey Creek trib 3.75 mi S OK Hwy 25             | S24 T24N R24E                  | heavily embedded   |
|                 | Honey Creek 3.2 mi S OK Hwy 25                   | S24 T24N R24E                  | deep, fast water   |
|                 | Honey Creek, 2 tribs 3 mi S OK Hwy 25            | S18 T24N R25E                  | site dry           |
|                 | Honey Creek, Cave Branch 3 mi S OK Hwy 25        | S18 T24N R25E                  | algae, sudsy water |
|                 | unnamed creek 3 mi S, 0.6 mi E                   | S13 T24N R24E                  | site dry           |
|                 | jct OK Hwys 25 and 10                            |                                |                    |
|                 | Elm Creek, 2 branches 1.2 and 1.7                | S11 T24N R24E                  | dry or embedded    |
|                 | mi S OK Hwy 25                                   |                                |                    |
|                 | Elm Creek 1.5 mi S OK Hwy 25                     | S10 T24N R24E                  | site dry           |
|                 | Drowning Creek 3.2 mi NW Jay, OK Hwy 127         | S15 T23N R23E                  | site dry           |
|                 | Muskrat Hollow Creek 1.5 mi NW Jay               | S22 T23N R23E                  | site dry           |
|                 | Rattlesnake Creek 1.2 mi SE OK Hwy 10            | S22 T22N R23E                  | site dry           |
|                 | Rattlesnake Creek N Lake Eucha, W OK Hwy 10      | S28 T22N R23E                  | site dry           |

| State | County          | Location   | Section,<br>Township,<br>Range | Comments                    |
|-------|-----------------|--|--------------------------------|-----------------------------|
|       |                 | Brush Creek Spring   | S26 T22N R23E                  | 10                          |
|       |                 | Brush Creek 2 mi NE OK Hwy 10                                      | S24 T22N R23E                  | several                     |
|       |                 | spring trib to Beatty Creek  | S30 T22N R24E                  | 0                           |
|       |                 | Earp Spring off Beatty Creek                                       | S29 T22N R24E                  | 1                           |
|       |                 | Beatty Creek 3.5 mi E OK Hwy 10                                    | S8 T21N R24E                   | water deep                  |
|       |                 | Cloud Creek at Old Cloud Creek<br>Baptist Church Cemetary          | S8 T21N R24E                   | 6                           |
|       |                 | Teesquante Hollow 1 mi SW OK Hwy 10                                | S2 T21N R23E                   | site dry                    |
|       |                 | Dry Creek 3 mi W OK Hwy 10, Kenwood Rd                             | S10 T21N R23E                  | 16                          |
|       |                 | Saline Creek   | S12 T21N R22E                  | 1                           |
|       |                 | Big Acorn Hollow 3.8 mi W Saline Creek                             | S10 T21N R22E                  | 7                           |
|       |                 | unnamed creek 4 mi W OK Hwy 10, Kenwood Rd                         | S11 T21N R22E                  | site dry                    |
|       |                 | Saline Creek 0.2 mi E Kenwood                                      | S8 T21N R22E                   | 0                           |
|       |                 | 4 sites on Sager Creek, 2 mi N OK Hwy 33                           | S19 T20N R26E                  | heavily embedded            |
|       |                 | Dripping Springs park  | S32 T20N R25E                  | heavily embedded            |
|       |                 | Blue Spring Branch, Flint Creek<br>1 mi N OK Hwy 33                | S30 T20N R25E                  | site dry                    |
|       |                 | Flint Creek 0.5 mi N OK Hwy 33                                     | S24 T20N R24E                  | 0                           |
|       |                 | branch, Fivemile Hollow, OK Hwy 33                                 | S21 T20N R24E                  | site dry                    |
|       |                 | Beatty Creek 1.5 mi S OK Hwy 20                                    | S9 T22N R25E                   | heavily embedded            |
|       |                 | Beatty Creek 1.4 mi S OK Hwy 20                                    | S9 T22N R25E                   | water deep, fast            |
|       |                 | 6 tribs to Beatty Creek, 1 mi S OK Hwy 20                          | S7-9T22N R25E                  | all sites dry &<br>embedded |
|       |                 | Brush Creek 1.5 mi N OK Hwy 20                                     | S33 T23N R24E                  | dry and graveled            |
|       |                 | Brush Creek 2 mi N OK Hwy 20                                       | S26 T23N R24E                  | site dry                    |
|       |                 | Yellow Bird Hollow Creek 4 mi N OK Hwy 10                          | S15 T23N R24E                  | site dry                    |
|       |                 | Whitewater Creek 5.5 mi N OK Hwy 10                                | S10 T23N R24E                  | 12                          |
|       | <b>Mayes</b>    | Pipe Springs, Spring River   | S20 T19N R20E                  | site dry                    |
|       |                 | Calvern Hollow Creek   | S21 T19N R20E                  | site dry                    |
|       |                 | Crutchfield Branch 2 mi W Locust<br>Grove, 0.7 mi N OK Hwy 33      | S19 T20N R20E                  | heavily embedded            |
|       |                 | Crutchfield Branch 1 mi W Locust<br>Grove, 0.5 mi N OK Hwy 33      | S19 T20N R20E                  | heavily embedded            |
|       |                 | Pipe Springs, 0.5 mi E jct OK Hwys 33 and 82                       | S23 T20N R20E                  | 0                           |
|       |                 | Snake Creek OK Hwy 82, 2 mi S Locust Grove                         | S34 T20N R20E                  | 8                           |
|       |                 | Spring Creek 2 mi W OK Hwy 82                                      | S16 T19N R20E                  | 14                          |
|       |                 | Saline Creek 2 mi W Kenwood  | S11 T21N R21E                  | 0                           |
|       |                 | Wickliffe Creek 1 mi N Lake Hudson                                 | S19 T21N R21E                  | site dry                    |
|       |                 | unnamed creek 1.5 mi N Lake Hudson                                 | S24 T21N R20E                  | site dry                    |
|       |                 | Chimney Rock Hollow 1 mi S Lake Hudson                             | S36 T21N R20E                  | site dry                    |
|       | <b>Ottawa</b>   | Council Creek at OK Hwy 10   | S21 T26N R24E                  | 5                           |
|       |                 | Council Creek 0.3 mi N OK Hwy 10                                   | S21 T26N R24E                  | site dry                    |
|       |                 | Sycamore Creek OK Hwy 10 bridge                                    | S2 T26N R24E                   | heavy recreation            |
|       |                 | Sycamore Creek 0.1 mi N Sycamore Chapel                            | S35 T27N R24E                  | heavily graveled            |
|       |                 | Sycamore Creek 1.5 mi NE Sycamore Chapel                           | S25 T27N R24E                  | heavily graveled            |
|       |                 | Sycamore Creek 3 mi NE Sycamore Chapel<br>0.3 mi S U.S. Hwy 60     | S19 T27N R24E                  | site dry                    |
|       |                 | jct Brush and Roark Creeks   | S31 T27N R25E                  | embedded                    |
|       |                 | Brush Creek at small trib  | S31 T27N R25E                  | 1                           |
|       |                 | Mason Spring Valley 1 mi S U.S. Hwy 60                             | S20 T27N R25E                  | site dry                    |
|       |                 | Lost Creek on OK Hwy 10, 2 mi E jct<br>OK Hwy 10 and U.S. 60       | S22 T27N R24E                  | site dry                    |
|       |                 | Shawnee Branch Spring River, 2 mi<br>N U.S. Hwy 60, N of Wyandotte | S9 T27N R24E                   | heavily embedded            |
|       | <b>Arkansas</b> |  |                                |                             |
|       | <b>Benton</b>   | Coon Creek at AR Hwy 43 near Spavinaw Creek                        | S10 T19N R34W                  | 18                          |
|       |                 | Cherokee Creek at Cherokee City                                    | S26 T19N R34W                  | embedded                    |
|       |                 | Backer Hollow Creek  | S13 T19N R34W                  | embedded                    |
|       |                 | Spavinaw Creek 2 mi E AR Hwy 43                                    | S31 T20N R33W                  | site dry                    |
|       |                 | Coon Creek, AR Hwy 43 bridge                                       | S13 T19N R34W                  | site dry, graveled          |
|       |                 | Coon Creek 1 mi E Bridge 996                                       | S19 T19N R34W                  | site dry, graveled          |



| State           | County            | Location                                       | Section,<br>Township,<br>Range | Comments           |
|-----------------|-------------------|--|--------------------------------|--------------------|
|                 |                   | Columbia Hollow Creek                          | S1 T19N R34W                   | site dry           |
|                 |                   | Town Creek, AR Hwy 72, Maysville               | S21 T22N R34W                  | heavily embedded   |
|                 |                   | Beatty Creek, AR Hwy 72, 0.75 mi N Maysville   | S21 T22N R34W                  | animal farms       |
|                 |                   | Honey Creek 3 mi N AR Hwy 72                   | S25 T21N R34W                  | embedded           |
|                 |                   | Beatty Creek 0.5 mi N AR Hwy 72                | S11 T20N R34W                  | dry and embedded   |
|                 |                   | Flint Creek 1 mi W AR Hwy 59                   | S16 T18N R33W                  | 0                  |
|                 |                   | Chambers Hollow                                | S18 T17N R32W                  | 4                  |
|                 |                   | Flint Creek at AR Hwy 59 bridge                | S15 T18N R33W                  | heavy recreation   |
|                 |                   | unnamed creeks vic Martin Church               | S1 T17N R33W                   | site dry           |
|                 |                   | 0.8 mi N AR Hwy 68                             |                                |                    |
|                 |                   | 0.7 mi SW Gallatin on section rd               | S31 T18N R32W                  | heavily embedded   |
|                 |                   | Palmer Hollow Creek 2 mi NW Logan              | S21 T18N R32W                  | heavily embedded   |
|                 |                   | spring E jct Palmer Hollow and                 | S27 T18N R32W                  | site dry, embedded |
|                 |                   | Galey Hollow Creeks                            |                                |                    |
|                 |                   | Osage Creek 0.75 mi SW Logan                   | S33 T18N R32W                  | 0                  |
|                 |                   | Little Flint Creek at AR Hwy 59, 0.25          | S35 T19N R33W                  | site embedded      |
|                 |                   | mi N jct AR Hwys 12 and 59                     |                                |                    |
|                 |                   | Flint Creek at AR Hwy 12                       | S7 T18N R33W                   | heavily embedded   |
|                 |                   | East Flint Creek 1 mi E Springtown             | S8 T18N R33W                   | site dry           |
|                 |                   | Wolf Creek 1.5 mi E Decatur, AR Hwy 102        | S7 T19N R32W                   | 0                  |
|                 |                   | Decatur Branch 1 mi S High School              | S13 T19N R33W                  | heavily embedded   |
|                 |                   | S prong Spavinaw Creek                         | S4 T19N R32W                   | 4                  |
|                 |                   | S prong Spavinaw Creek near Bethel Cemetary    | S19 T20N R32W                  | 1                  |
|                 |                   | Chalybeate Creek at Butterfield Station        | S21 T21N R33W                  | 1                  |
|                 |                   | Spavinaw Creek at AR Hwy 59                    | S27 T20N R33W                  | 1                  |
|                 |                   | Butler Creek at AR Hwy 59                      | S15 T21N R33W                  | deep, steep banks  |
|                 |                   | Butler Creek vic Sulphur Springs park          | S23 T21N R33W                  | deep, steep banks  |
|                 |                   | Butler Creek 0.25 mi S AR Hwy 59               | S23 T21N R33W                  | site dry           |
|                 |                   | Butler Creek 2-3 mi E Sulphur Springs          | S29-30 T21N R32W               | site dry           |
|                 |                   | Rocky Dell Hollow Creek, bridge 1007           | S36 T21N R33W                  | site dry           |
|                 |                   | Rocky Dell Hollow Creek at AR Hwy 59           | S36 T21N R33W                  | site dry           |
|                 |                   | Deer Creek 2 mi NE Sulphur Springs             | S18 T21N R32W                  | site dry           |
|                 |                   | Mill Creek 4 mi NE Sulphur Springs             | S16 T21N R32W                  | site dry           |
|                 |                   | Sager Creek at AR Hwy 204                      | S32 T18N R33W                  | highly eutrophic   |
|                 | <b>Carroll</b>    |  |                                |                    |
|                 |                   | Leatherwood Creek U.S. Hwy 62 W Eureka Springs | S5 T20N R26W                   | heavily graveled   |
|                 |                   | Butler Creek 2. mi N U.S. Hwy 62               | S14 T21N R27W                  | site dry, graveled |
|                 |                   | Spider Creek at Land of Kong                   | S34 T21N R27W                  | heavy development  |
|                 | <b>Washington</b> |  |                                |                    |
|                 |                   | Greathouse Spring 2.75 mi S AR Hwy 68          | S20 T17N R30W                  | heavily embedded   |
|                 |                   | on AR Hwy 112                                  |                                |                    |
|                 |                   | Clear Creek 2.8 mi S AR Hwy 68 on AR Hwy 112   | S20 T17N R30W                  | heavily embedded   |
| <b>Missouri</b> |                   |  |                                |                    |
|                 | <b>Barry</b>      |  |                                |                    |
|                 |                   | Piebern Hollow, Roaring River SP               | S27 T22N R27W                  | site dry           |
|                 |                   | Dry Hollow, Roaring River SP                   | S34 T22N R27W                  | 0                  |
|                 |                   | Off Davis Hollow at Roaring River              | S36 T22N R27W                  | 11                 |
|                 | <b>Christian</b>  |  |                                |                    |
|                 |                   | Bear Creek 2 mi S U.S. Hwy 65                  | S36 T25N R22W                  | 0                  |
|                 |                   | Reno Spring 2.1 mi S U.S. Hwy 65               | S36 T25N R22W                  | 0                  |
|                 | <b>McDonald</b>   |  |                                |                    |
|                 |                   | Brush Creek S MO Hwy 90                        | S24 T21N R32W                  | heavily embedded   |
|                 |                   | Brush Creek N MO Hwy 90 on section rd          | S13 T21N R32W                  | site dry           |
|                 |                   | Tanner Branch Little Sugar Creek               | S12 T21N R32W                  | site dry           |
|                 |                   | 0.25 mi off U.S. Hwy 71                        |                                |                    |
|                 |                   | Little Sugar Creek on section rd               | S8 T21N R31W                   | no gravel bars     |
|                 |                   | Skagg's Hollow 1 mi upstream off               | S5 T21N R31W                   | site dry           |
|                 |                   | Little Sugar Creek                             |                                |                    |
|                 |                   | Missouri Creek 4 mi S MO Hwy 90                | S22 T21N R31W                  | 2                  |
|                 |                   | Hickory Hollow, MO Hwy 90 0.5 mi W             | S10 T23N R29W                  | site dry           |
|                 |                   | Jct MO Hwys 90 and K                           |                                |                    |
|                 |                   | Mill Creek, MO Hwy 90, 1 mi E Noel             | S23 T21N R33W                  | 1                  |
|                 |                   | Mill Creek, MO Hwy 90, 3 mi E Noel             | S30 T21N R32W                  | 7                  |
|                 |                   | Butler Creek 2 mi S Noel                       | S27 T21N R33W                  | heavy recreation   |

| State | County   | Section,<br>Township,<br>Range | Comments         |
|-------|--|--------------------------------|------------------|
|       | Location   |                                |                  |
|       | Missouri Creek 2 mi S MO Hwy 90  | S23 T21N R31W                  | dry and embedded |
|       | Bear Hollow 3 mi S jct MO Hwys 90<br>and E, and 0.5 mi W MO Hwy E      | S21 T21N R30W                  | site dry         |
|       | Bentonville Hollow, MO Hwy E 0.9 mi<br>N jct MO Hwys E and 90          | S9 T21N R30W                   | site dry         |
|       | Bentonville and Rose Spring Hollows<br>1.5 mi N MO Hwys E and 90, on E | S4 T21N R30W                   | muddy water      |
|       | Bentonville Hollow 2.1 mi N jct<br>MO Hwys E and 90, on E              | S33 T22N R30W                  | site dry         |
|       | Trent Creek at MO Hwy 90   | S36 T22N R30W                  | heavily graveled |
|       | Mike's Creek 4 mi S jct MO Hwys 76 and U, on U                         | S20 T23N R29W                  | site dry         |
|       | Mike's Creek on MO Hwy U, 4.5 mi S<br>jct MO Hwys 76 and U             | S29 T23N R29W                  | 0                |
|       | Star Hollow off MO Hwy U, 6.5 mi S<br>jct MO Hwys 76 and U             | S6 T22N R29W                   | site dry         |
|       | Sugar Camp Hollow off MO Hwy U, 7.5<br>mi S jct MO Hwys 76 and U       | S12 T22N R30W                  | site dry         |
|       | Buffalo Creek at MO Hwy 43   | S4 T22N R34W                   | 0                |
|       | Buffalo Creek 2 mi upstream of MO Hwy 43                               | S26 T26N R34W                  | 4                |
|       | trib to Buffalo Creek 3 mi upstream MO Hwy 43                          | S23 T26N R34W                  | heavily embedded |
|       | Buffalo Creek 4 mi upstream of MO Hwy 43                               | S14 T26N R34W                  | heavily embedded |
|       | <b>Stone</b>   |                                |                  |
|       | Carney Spring 1.5 mi S MO Hwy 248                                      | S3 T24N R25W                   | 0                |
|       | Carney Creek 3.5 mi S MO Hwy 248                                       | S15 T24N R25W                  | deep, fast water |
|       | Carney Creek 4.25 mi S MO Hwy 248                                      | S27 T24N R25W                  | heavily embedded |
|       | Horse Creek 1.5 mi N MO Hwy 44   | S27 T25N R23W                  | site dry         |
|       | Horse Creek 1.75 mi N MO Hwy 44  | S28 T25N R23W                  | site dry         |
|       | Pine Run 1 mi W Galena on MO Hwy 13                                    | S1 T24N R24W                   | heavily embedded |
|       | Pine Run N of Galena on MO Hwy 44                                      | S31 T25N R23W                  | site dry         |
|       | Pine Run 1.5 mi W Galena on MO Hwy 13<br>near jct MO Hwy AA            | S31 T25N R24W                  | heavily embedded |
|       | <b>Taney</b>   |                                |                  |
|       | Hurricane Creek 3.25 mi S U.S. Hwy 65                                  | S2 T24N R22W                   | heavily embedded |
|       | West Fork Bear Creek, 5.25 mi S U.S. Hwy 65                            | S14 T24N R22W                  | site dry         |
|       | Dry Branch Bear Creek, 5.75 mi S U.S. Hwy 65                           | S13 T24N R22W                  | site dry         |