

Distribution and Diagnosis of the Copperbelly Watersnake (*Nerodia erythrogaster neglecta*) in Illinois

Michael J. Blanford¹ and Ronald A. Brandon²
P. O. Box 3436 Carbondale, IL 62902-3436¹
Department of Zoology, Southern Illinois University at Carbondale
Carbondale, IL 62901-6501²
Phone:(618)-453-4138

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Introduction

The plainbelly watersnake (*Nerodia erythrogaster*) is a wide ranging species which can be found from the Atlantic coast west to southeastern New Mexico and north to Michigan and includes two isolated Mexican populations (Conant and Collins, 1991). Six subspecies have been described for *N. erythrogaster* with four occurring in the United States, all described largely on geographic variation in the snakes' pigmentation. McCrainie (1990) pointed out that the subspecies of *N. erythrogaster* are not well defined and a taxonomic study of this wide ranging species is sorely needed. Of the four subspecies north of Mexico, the copperbelly watersnake (*N. e. neglecta*) has by far the most restricted range, with fragmented and relictual populations in Michigan, Ohio, Indiana, Kentucky and Illinois.

Because of its highly fragmented range, concern has risen about the continued survival of the copperbelly watersnake and has led to a proposal that it be listed as federally threatened (U. S. Fish and Wildlife Service, 1993). In this case the Endangered Species Act would allow for the copperbelly watersnake subspecies to be treated as a species for the purpose of protection.

In Illinois, the copperbelly watersnake occurs throughout the southeastern corner of the state (Map 2 and 3; Smith, 1961) and intergradates broadly with the yellowbelly variant in central southern Illinois (Smith, 1961; Brandon and Blanford, 1994) and the two subspecies appear to be genetically contiguous along this zone. This broad area of intergradation poses several problems for the protection of the

copperbelly subspecies. First, we have only a limited understanding of the geographic distributions of these two subspecies in Illinois. Extensive intergradation of the copperbelly and yellowbelly watersnake result in snakes with intermediate phenotypes which are often impossible to assign to either subspecies. Additionally animals with phenotypes suggestive of one subspecies or the other are commonly found at the same locality as those of the other subspecies or those with intermediate phenotypes (Brandon and Blanford, 1994). Without a well defined distributional map to the subspecies and the intergradation zone, management on a geographic basis will be problematic. Secondly, the diagnostic characters outlined in the description of the two subspecies (Conant, 1949) are based solely on coloration and are poorly defined. The subtle characteristics used in identification are often a matter of degree and can make identification of animals troublesome for non-specialists. The characters used to identify the two subspecies are summarized in table 1.

Table 1. Color and pattern characteristics of the yellowbelly watersnake (*Nerodia erythrogaster flavigaster*) and the copperbelly watersnake (*N. e. neglecta*).

Subspecies	Venter	Dorsum	Dark ventral pigment	Juvenile
<i>N. e. Flavigaster</i>	Lemon yellow	From green/grey to brown/green	Very little and usually pale grey	Pattern of blotches clean-cut without fusing
<i>N. e. Neglecta</i>	Orange to scarlet red	Black or very dark brown	Profuse dark black blotches encroaching well into the ventrals	Lateral and middorsal blotches fusing irregularly

There are two primary objectives of the current investigation. First, we intend to determine the extent of variation and intergradation between the yellowbelly and copperbelly watersnakes. In doing this we can possibly better identify some of the diagnostic characteristics of these two variants which, if well defined, could be useful tools in establishing a management and enforcement program if the copperbelly is listed federally. Secondly, many gaps occur in the known geographic distribution of the copperbelly watersnake and many of the established localities have only been attributed to the plainbelly watersnake and not to the subspecific level. By establishing a better resolution to the known distribution of true copperbellies and those with intergrade phenotypes, conservation efforts could more effectively concentrate on protecting the subspecies at the geographic level.

Methods and Materials

Preserved material. Preserved materials identified as *Nerodia erythrogaster* were examined from The Field Museum of Natural History (FMNH), the Illinois Natural History Survey (INHS) and the Southern Illinois University at Carbondale Herpetology Collection (SIUC). Specimens were examined for dorsal coloration, and color and encroachment of ventral/lateral pigmentation. Ventral coloration was ignored due to fading resulting from fluid preservation. In most cases preserved specimens were photographed (35mm black and white) for further reference. Dorsal, ventral, and sub-caudal scales were counted on 38 specimens.

Photographs and field notes. When fluid preserved specimens were not available, 35mm photographic slides were reviewed from various sources (Collection of Michael Redmer, Michael Blanford, and SIUC). In addition to those photos in collections, 35mm color transparencies were taken of snake specimens from protected areas (nature preserves and natural areas) where collecting was impossible during this study. These slides will be deposited in the SIUC collection. In some cases the field notes of M. Blanford were examined where appropriate. All specimens examined were then assigned to one of the two subspecies or as an intergrade if the phenotype was intermediate (sharing the characters of both subspecies) and the locality noted.

Results

Diagnosis. Scale counts were discontinued after 38 specimens because variation in these characteristics fell well within the ranges of Smith (1961) and did not appear to be diagnostic of the subspecies. When reviewing the color descriptions in Conant (1949), we found two of the characteristics somewhat problematic in Illinois animals and one to be regularly reliable. The dorsal coloration which is described as darker (even black) in copperbelly watersnakes is highly variable. Specimens coming from what should be well out of the range of the copperbelly often have very dark brown dorsal color, even approaching black while those from the heart of the copperbelly range (although usually dark) can have lighter dorsal colors. The ventral ground color which should be red/orange to scarlet is extremely variable in Illinois

copperbellies as well and can approach yellow/orange making for troublesome identification. Of the three color characters, ventral dark pigment appears to be the most reliable and is very consistent across the presumed ranges of the two subspecies. Although animals with orange bellies can be found throughout the intergradation zone, none have the degree of encroaching black pigment on the venter of snakes collected from the solely copperbelly portion of the specie's range. Figure 1 demonstrates the two extremes in ventral dark pigment characteristic of the two subspecies in Illinois.

Distribution. In total one hundred and twenty three specimens were examined from twenty three Illinois counties (Map 1). Eight counties (Bond, Calhoun, Madison, Monroe, Pike, Randolph, Washington and Williamson) had specimens which were identified as yellowbelly watersnakes (Table 2, Map 2). Six counties (Alexander, Franklin, Jackson, Jefferson, Perry and Union) had specimens which were identified as intergrades or had specimens of both subspecies (Table 2, Map2). Nine counties (Gallatin, Johnson, Massac, Pope, Pulaski, Saline, Wabash, White and Hamilton) had snakes which were identified as copperbelly watersnakes (Table 2, Map 2). In Illinois the copperbelly watersnake appears to occur without intergradation throughout the southeastern corner of the state as far east as Pulaski Co. And as far north as Wabash Co. And perhaps farther (Map 3).

Table 1. Nerodia erythrogaster phenotypes identified from Illinois counties.
Subspecies

County	flavigaster (%)	Intergrade (%)	neglecta (%)	Total
Alexander	14(82)	2(12)	1(6)	17
Bond	3(100)	0(0)	0(0)	3
Calhoun	1(100)	0(0)	0(0)	1
Franklin	0(0)	2(100)	0(0)	2
Gallatin	0(0)	0(0)	2(100)	2
Hamilton	0(0)	0(0)	1(100)	1
Jackson	6(55)	3(27)	2(18)	11
Jefferson	3(75)	1(25)	0(0)	4
Johnson	0(0)	0(0)	16(100)	16
Madison	6(100)	0(0)	0(0)	6
Massac	0(0)	0(0)	2(100)	2
Monroe	6(100)	0(0)	0(0)	6
Perry	2(66)	1(33)	0(0)	3
Pike	1(100)	0(0)	0(0)	1
Pope	0(0)	0(0)	5(100)	5
Pulaski	0(0)	0(0)	2(100)	2
Randolph	5(100)	0(0)	0(0)	5
Saline	0(0)	0(0)	2(100)	2
Union	9(39)	5(22)	9(39)	23
Wabash	0(0)	0(0)	5(100)	5
Washington	1(100)	0(0)	0(0)	1
White	0(0)	0(0)	1(100)	1
Williamson	3(100)	0(0)	0(0)	3

Discussion

A taxonomic problem like the one in the current investigation goes far to illustrate some of the fundamental problems which are pervasive in conservation and systematics. Those charged with conserving declining species need to come to terms with what it is they are trying to conserve. Should we manage for a phenotype? Should we manage for genetic units which result in phenotypes? Often considered distant disciplines, conservation and systematic research is intertwined on all levels. We are often asked to make conservation recommendations for species when we still have problems understanding the fundamental unit of organisms, the species, let alone subspecies and variation.

Management recommendations for the copperbelly watersnake in Illinois.

Because of the problems associated with identifying the two subspecies from one another or from those of intergrade populations it is suggested that enforcement, if this species should be listed as federally threatened, should concentrate on geography. Map 2 illustrates the counties for which all examined material was identified as *N. e. neglecta*. This map is consistent with the distribution maps of previous authors (Conant and Collins, 1991; McCrainie, 1990; Smith, 1961). If a management plan was to concentrate on those Illinois counties where we found copperbelly watersnakes to occur, it would include Gallatin, Hamilton, Johnson, Massac, Pope, Pulaski, Saline, Wabash, and White counties. This range should also include Wayne, Edwards, Richland and Lawrence counties for although we collected no specimens, plainbelly

watersnakes from these counties would likely be copperbellies.

Suggestions for further research. The current project concentrated primarily on the taxonomy and distribution of this species in Illinois and only provides part of the information needed for a management plan. Future research should focus on the habitat requirements and the life history of this species including hibernation sites, a little understood area. Although morphology clears up the picture of this taxonomic problem, only a genetic study would provide the lucid high resolution results needed to further understand this species' distribution and systematics across the broad zone of intergradation.

Acknowledgments

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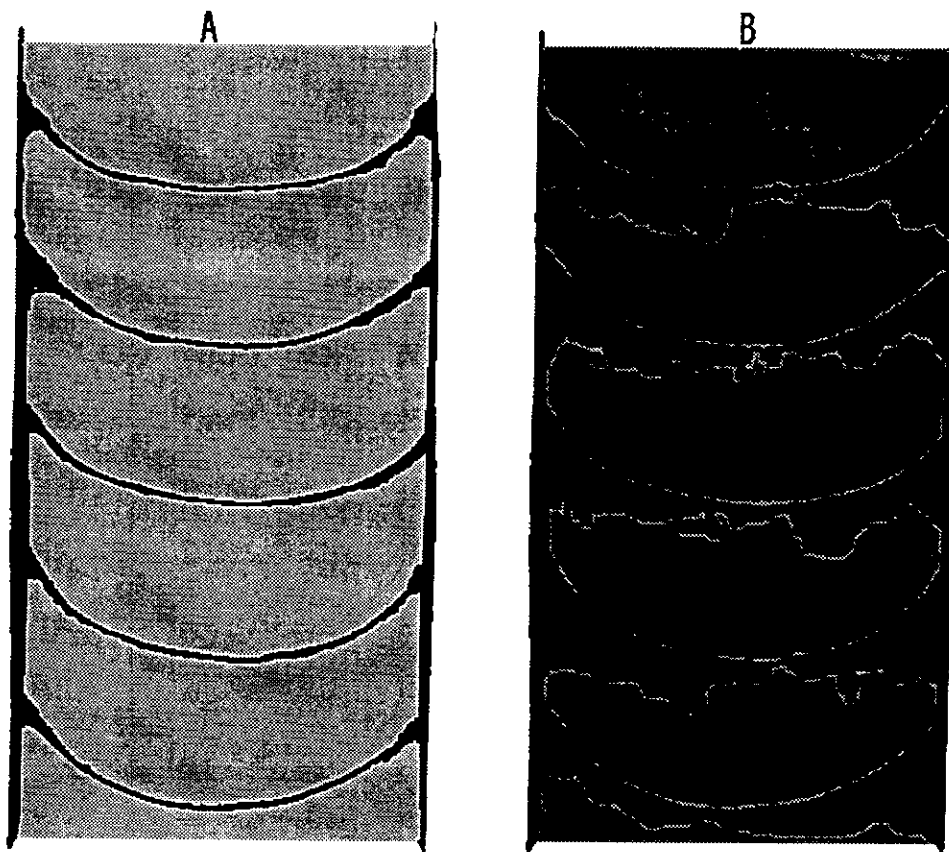
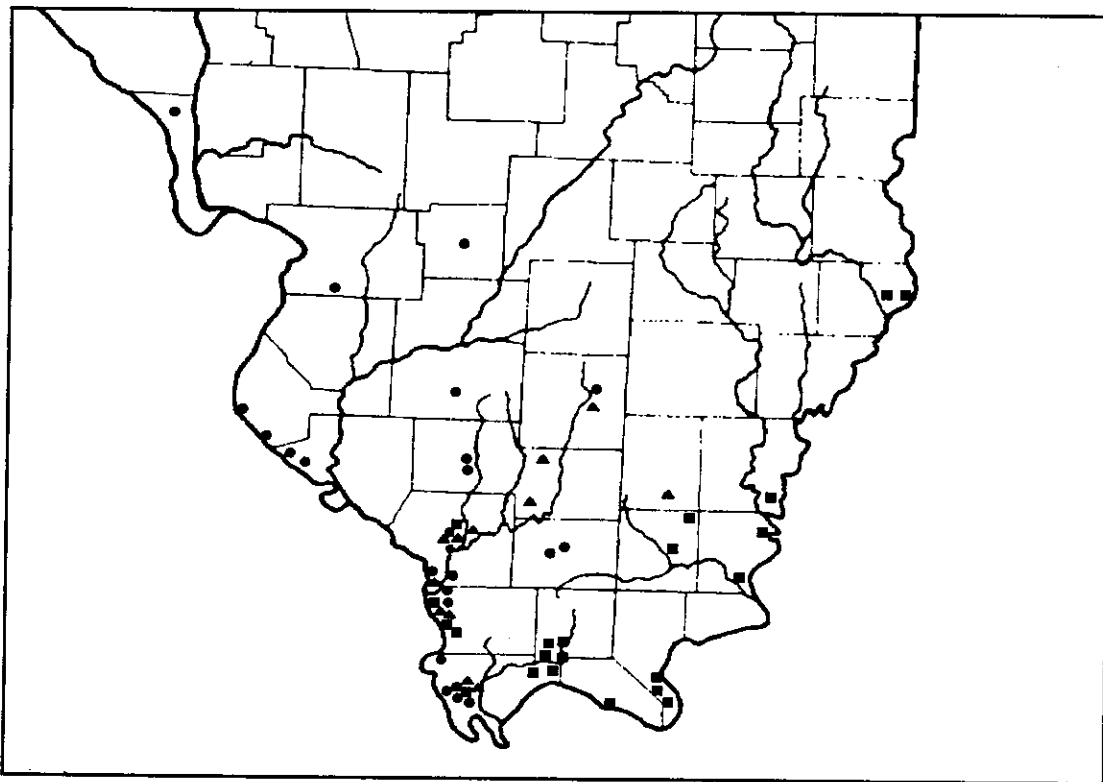
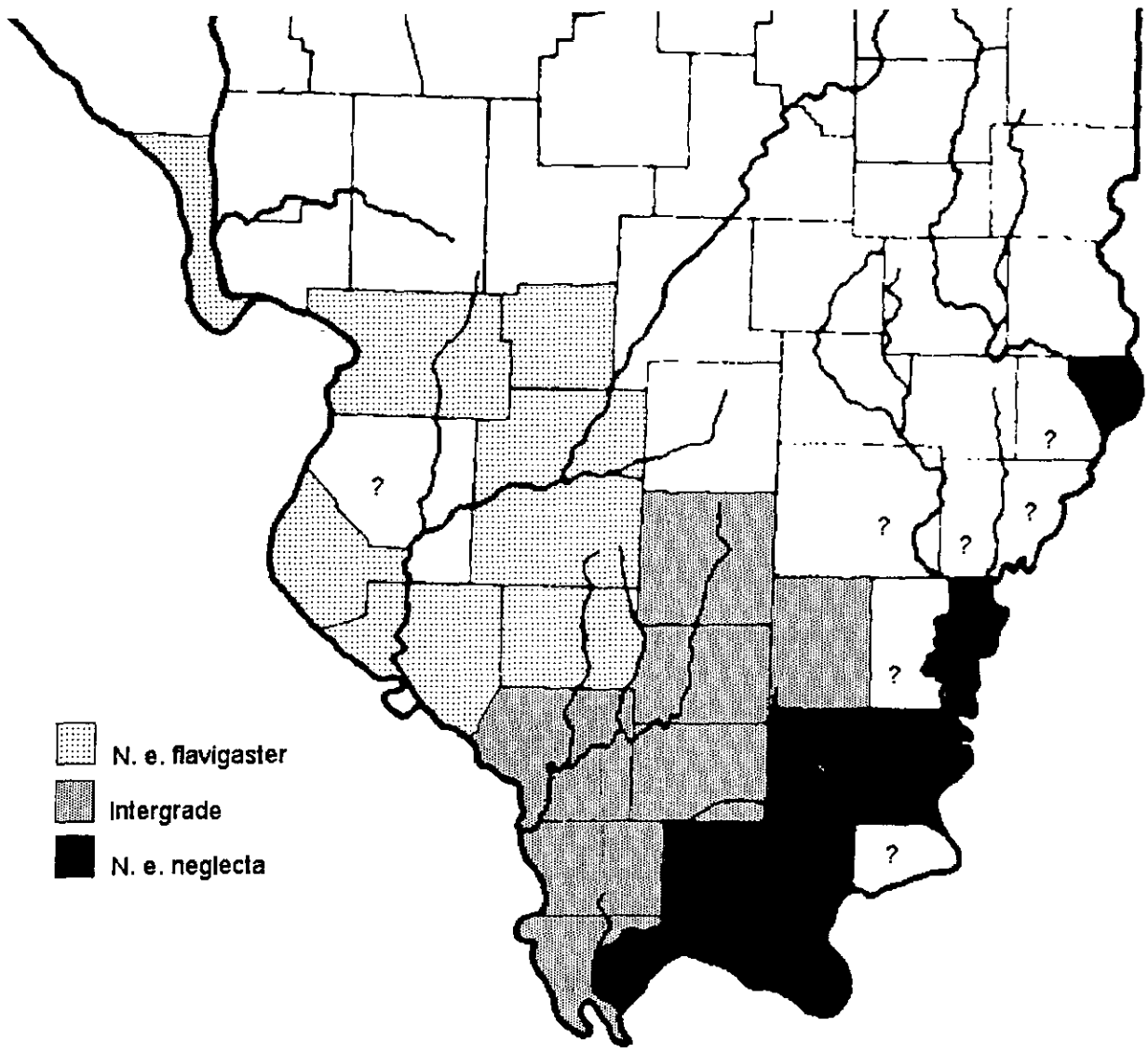


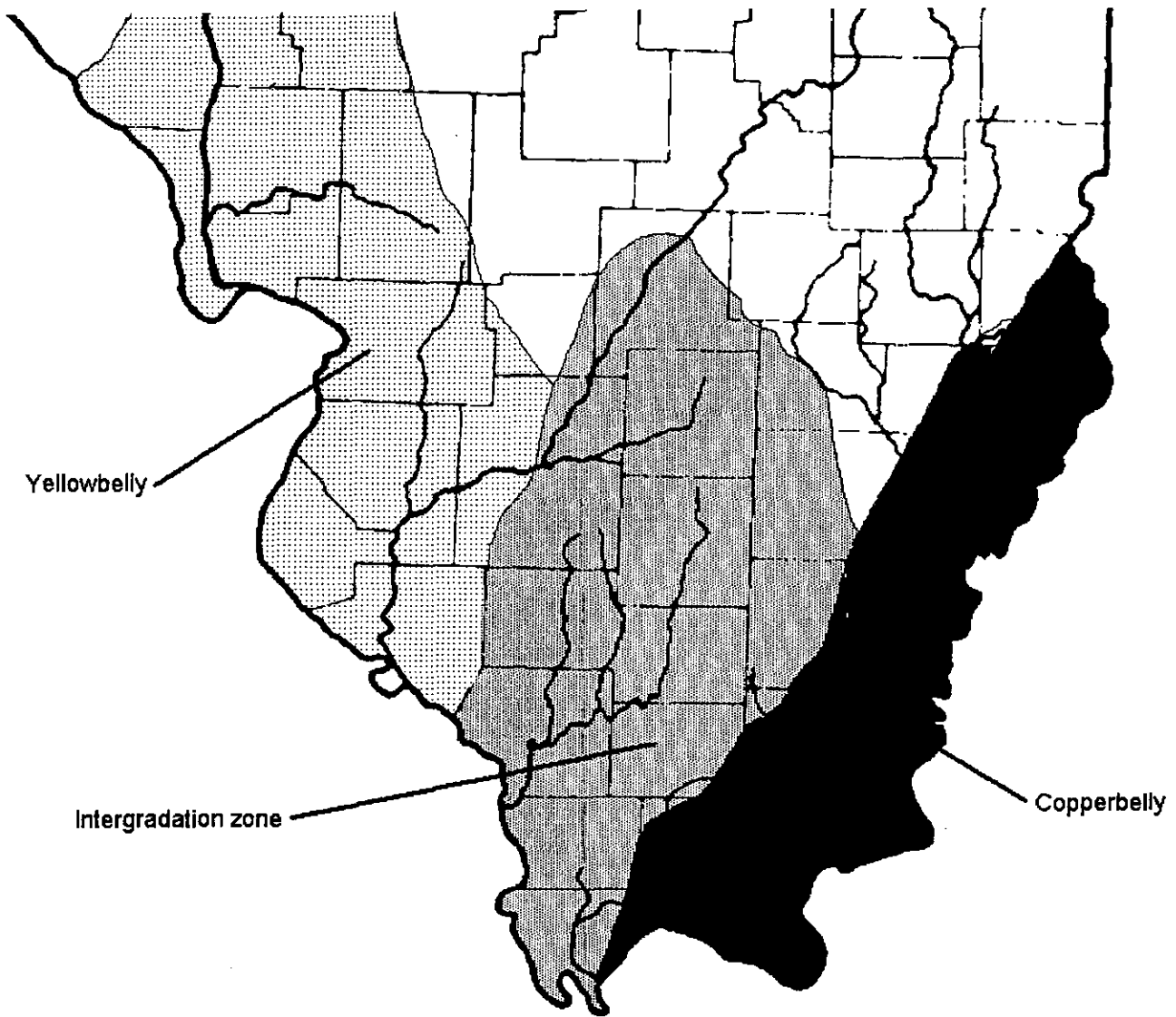
Figure 1. Generalized ventral pattern and coloration for *Nerodia erythrogaster flavigaster* (A) and *N. e. neglecta* (B).



Map 1. Collection localities and phenotypes for *N. e. flavigaster* (circle), *N. e. neglecta* (square) and intermediate phenotypes (triangle) in Illinois.



Map 2. Phenotypic composition of Illinois Counties based on examined material.



Map 3. Estimated range of the two plainbelly watersnake subspecies and the intergradation zone in Illinois.

Appendix A

Materials examined. Specimens of *Nerodia erythrogaster* examined for locality and phenotype. Key: MJB= Michael Blanford field notes or photo collection; SIUC photo=Southern Illinois University herpetology photo collection; SIUC=Southern Illinois University at Carbondale Herpetology Collection; FMNH=Field Museum of Natural History; INHS=Illinois Natural History Survey; MAM=Michael A. Morris Collection.

Specimen	County	Locality	Subspecies Phenotype
SIUC 2355	Alexander	3/4 mi. NW Fayette	flavigaster
SIUC 2486	Alexander	Horseshoe Lake C.A.	Intergrade
SIUC 2640	Alexander	Horseshoe Lake C.A.	flavigaster
SIUC 2641	Alexander	Horseshoe Lake C.A.	flavigaster
SIUC 2723	Alexander	nr. McClure	flavigaster
INHS 5458	Alexander	Horseshoe Lake	flavigaster
INHS 5737	Alexander	Horseshoe Lake	flavigaster
INHS 6004	Alexander	Horseshoe Lake	flavigaster
INHS 6431	Alexander	Horseshoe Lake	intergrade
FMNH 2229	Alexander	Olive Branch	flavigaster
FMNH 2234	Alexander	Olive Branch	flavigaster
FMNH 2240	Alexander	Olive Branch	flavigaster
FMNH 2241	Alexander	Olive Branch	flavigaster
MJB	Alexander	Horseshoe Lake	flavigaster
MJB	Alexander	Horseshoe Lake	flavigaster

Uncataloged	Alexander	Horseshoe Lake	flavigaster
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Specimen	County	Locality	Subspecies Phenotype
Uncataloged	Alexander	Big Cypress	neglecta
INHS 8269	Bond	Greenville	flavigaster
INHS 8270	Bond	Greenville	flavigaster
INHS 8271	Bond	Greenville	flavigaster
INHS 5819	Calhoun	Kampsville	flavigaster
SIUC 1610	Franklin	Royaltin	intergrade
MJB	Franklin	near Sesser	intergrade
INHS 1472	Gallatin	Saline Mines	neglecta
Uncataloged	Gallatin	Cow Pond	neglecta
Uncataloged	Hamilton	S McLeansboro	intergrade
SIUC 126	Jackson	Lake Murphysboro	intergrade
SIUC 174	Jackson	Rattlesnake Ferry rd..	Intergrade
SIUC 321	Jackson	Carbondale	flavigaster
SIUC 2099	Jackson	Indian Hills, Boskydell Rd..	neglecta
SIUC 2350	Jackson	Sand Ridge Road	flavigaster
SIUC 2351	Jackson	Sand Ridge Road	intergrade
SIUC 2705	Jackson	Gorham	flavigaster
INHS 2093	Jackson	Murphysboro	flavigaster
MJB	Jackson	Gorham Fish Farm	neglecta
MJB	Jackson	Gorham Fish Farm	flavigaster
MJB	Jackson	Otter Pond	flavigaster
SIUC 284	Jefferson	Waltenville	flavigaster
SIUC 327	Jefferson	Mt. Vernon	flavigaster
SIUC 328	Jefferson	Mt. Vernon	intergrade
INHS 9289	Jefferson	Mt. Vernon	flavigaster

Specimen	County	Locality	Subspecies Phenotype
SIUC 542	Johnson	Belknap	neglecta
SIUC 2249	Johnson	1 mi. W Grantsburg	neglecta
SIUC 2314	Johnson	1 mi. E Grantsburg	neglecta
SIUC 2352	Johnson	Vienna	neglecta
SIUC 2881	Johnson	Grantsburg	neglecta
SIUC 2720	Johnson	nr. Heron Pond	neglecta
MAM	Johnson	Heron Pond	neglecta
INHS 2456	Johnson	Forman	neglecta
INHS 3329	Johnson	Forman	neglecta
INHS 3361	Johnson	Belknap	neglecta
INHS 3362	Johnson	Belknap	neglecta
MJB	Johnson	Bell Pond	neglecta
MJB	Johnson	Thorn Pond	neglecta
MJB	Johnson	Lower Cache River Access	neglecta
MJB	Johnson	Heron Pond	neglecta
MJB	Johnson	Heron Pond	neglecta
INHS 11103	Madison	Clifton Terrace Rd..	flavigaster
INHS 11104	Madison	Clifton Terrace Rd..	flavigaster
INHS 11100	Madison	Clifton Terrace Rd..	flavigaster
INHS 11099	Madison	Clifton Terrace Rd..	flavigaster
INHS 11098	Madison	Clifton Terrace Rd..	flavigaster
INHS 11108	Madison	Clifton Terrace Rd..	flavigaster
MJB	Massac	Ft. Massac St. Park	neglecta
MJB	Massac	Ft. Massac St. Park	neglecta
SIUC 2722	Monroe	Kidd Lake Marsh	flavigaster
INHS 5761	Monroe	Fults	flavigaster

Specimen	County	Locality	Subspecies Phenotype
INHS 4403	Monroe	3 mi. N Maeyes	flavigaster
INHS 4327	Monroe	Valmeyer	flavigaster
MJB	Monroe	Kidd Lake Marsh	flavigaster
MJB	Monroe	Kidd Lake Marsh	flavigaster
SIUC 307	Perry	3 mi. S DuBois	Intergrade
INHS 9923	Perry	Pickneyville	flavigaster
MJB	Perry	Near Pickneyville	flavigaster
INHS 10230	Pike	Pleasant Hill	flavigaster
SIUC 271	Pope	3 mi. N, 1 mi. Hwys 146, 147	neglecta
SIUC 2021	Pope	Bay City	neglecta
SIUC 2312	Pope	New Liberty	neglecta
SIUC 2719	Pope	New Liberty	neglecta
MAM	Pope	0.5 mi W Brownfield	neglecta
SIUC 2313	Pulaski	1.5 mi. N Ullin	neglecta
MJB	Pulaski	Limekiln Slough	neglecta
Uncataloged	Pulaski	Limekiln Slough	neglecta
SIUC 2353	Randolph	Modoc	flavigaster
INHS 5820	Randolph	Modoc	flavigaster
INHS 6691	Randolph	Modoc	flavigaster
INHS 4326	Randolph	Prairie du Rocher	flavigaster
INHS 6430	Randolph	Rockwood	flavigaster
SIUC 2878	Saline	2.8 mi. N 13 in Harrisburg	neglecta
MAM	Saline	0.5 mi N Texas City	neglecta
SIUC 151	Union	Pine Hills	flavigaster
SIUC 164	Union	Union Co. Refuge	flavigaster

Specimen	County	Locality	Subspecies Phenotype
SIUC 275	Union	1.5 mi. E Aldridge	flavigaster
SIUC 711	Union	Pine Hills	intergrade
SIUC 1447	Union	Pine Hills	neglecta
SIUC 1615	Union	Wolf Lake	neglecta
SIUC 1618	Union	Clear Creek	neglecta
SIUC 1615	Union	Wolf Lake	neglecta
SIUC 1618	Union	Clear Creek	neglecta
SIUC 2354	Union	NE 1/4, SEC 4, T15S R3W	neglecta
SIUC 2663	Union	Bluff Lake	Intergrade
INHS 6017	Union	Pine Hills	Intergrade
INHS 6018	Union	Pine Hills	Intergrade
INHS 6019	Union	Pine Hills	neglecta
INHS 6017	Union	3 mi. N. McClure	neglecta
INHS 3120	Union	Pine Hills	flavigaster
INHS 1397	Union	CCC Camp Huthchins	flavigaster
INHS 1398	Union	CCC Camp Huthchins	flavigaster
INHS 1399	Union	CCC Camp Huthchins	flavigaster
INHS 6016	Union	Fountain Bluff	Intergrade
INHS 10278	Union	Ware	flavigaster
INHS 3917	Union	Ware	flavigaster
INHS 5023	Union	Ware	flavigaster
SIUC 2095	Wabash	Rd.. Crossing Bompas Cr.	neglecta
MAM	Wabash	3 mi. E Bone Gap	neglecta
MAM	Wabash	3 mi. E Bone Gap	neglecta
MAM	Wabash	3 mi. E Bone Gap	neglecta

Specimen	County	Locality	Subspecies Phenotype
INHS 1471	Wabash	Mt. Carmel	neglecta
INHS 9922	Washington	Washington Co. Conservation Area	flavigaster
MAM	White	3 mi. S Norris City	neglecta
SIUC 290	Williamson	Little Grassy Lake	flavigaster
SIUC 1611	Williamson	Herrin	flavigaster
SIUC 1613	Williamson	Herrin	flavigaster