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RECENT RECORDS FOR MUDPUPPIES (*NECTURUS MACULOSUS*) IN INDIANA WITH NOTES ON PRESUMED DECLINES THROUGHOUT THE MIDWEST

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ABSTRACT. Mudpuppies (*Necturus maculosus*) have the broadest distribution of any fully aquatic salamander in North America but population trends are poorly understood. There are no demographic data for Mudpuppies in Indiana despite indications of population declines. Considering the dramatic decline of Hellbenders (*Cryptobranchus alleganiensis*) in Indiana, it is important to understand Mudpuppy population trends to ensure that similar declines are not occurring. Thirteen new county records for Mudpuppies are presented and the first published evidence of breeding in the state in almost a century. Salamander Mussel (*Simpsonaias ambigua*) records and the geographic inconsistencies between the known distributions of these two intimately-linked species are also discussed. Mudpuppies should be the subject of more extensive monitoring and conservation efforts to better understand their conservation needs.

Keywords: Mudpuppy, salamander mussel, Indiana

INTRODUCTION

Hellbender (*Cryptobranchus alleganiensis*) populations in the Midwestern United States experienced drastic declines during the mid-1900's (Wheeler et. al 2003). Some biologists (Davis et al. 1998; Minton 1998) have linked this decline with a presumed decline of Mudpuppies (*Necturus maculosus*), and Minton (2001) explicitly mentioned that Mudpuppies and Hellbenders in Indiana have declined for similar reasons. Yet Mudpuppy population dynamics remain understudied and poorly understood (Matson 2005). The most intensive study of an Indiana Mudpuppy population, now almost a century old (Evermann & Clark 1918), comes from Lake Maxinkuckee in Marshall County. This report also detailed the only published account of a Mudpuppy nest in Indiana. Most other Indiana records for Mudpuppies come from scattered museum specimens and anecdotal reports obtained from anglers who occasionally capture the salamanders by accident (Piatt 1931; Allyn & Shockley 1939; Minton 2001).

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Additional insight into Mudpuppy distribution in Indiana comes from a freshwater mussel species that cannot reproduce in their absence. Mudpuppies are the only known host for Salamander Mussel (*Simpsonaias ambigua*) larvae (Howard 1915); thus you will not find *Simpsonaias* unless *Necturus* is present. The Mudpuppy and Salamander Mussel are "Species of Special Concern" in Indiana (IDNR 2013), while the Salamander Mussel is a "Lower Risk, Conservation-dependent Species" globally (IUCN 2013). There is a need for more extensive monitoring of this widespread salamander in order to better understand current population trends and management needs. A compilation of recent survey efforts and historic records is presented to better assess the distribution and current status of Mudpuppies in Indiana.

METHODS

Quantitative sampling.—Searches for Mudpuppies were conducted in streams at Big Oaks National Wildlife Refuge (BONWR) in Jennings County and Ripley County, Indiana. BONWR is a 20,234 ha refuge consisting of varied habitat ranging from grasslands and shrublands to mature forest. Numerous head-

water streams within the upper Muscatatuck River watershed dissect the refuge flowing east to west. These streams are shallow and clear with abundant limestone cliffs, ledges, and flat rocks. Visual encounter searches were conducted for Mudpuppies during June 2012 and May–June 2013 in Otter Creek, Graham Creek, and Little Graham Creek. During these surveys, groups of 3–13 surveyors overturned large, flat, submerged rocks in search of Mudpuppies and nests. Our search method follows Matson (1998) and the timing of our surveys (May and June) corresponds to previous observations of nests (Petranka 1998; Matson 2005). Minnow traps baited with Ol' Roy canned dog food were used from 7 December 2012–12 January 2013 to trap for adult Mudpuppies in Otter Creek. Minnow traps were placed in a paired setup with a Frabill vinyl-coated minnow trap and a Promar medium minnow trap placed at each trapping location. Leaf packs, undercut banks, log jams, and large rocks were targeted when placing traps within streams.

Additional records.—We compiled records for Mudpuppies collected incidentally while sampling fish statewide during other projects of the Wildlife Diversity Program, Indiana Department of Natural Resources, and investigated reports received of Mudpuppies caught by anglers and other biologists. These were verified by photo or specimen when possible. HerpNET and museums were also searched for collection records.

RESULTS

BONWR.—109.5 person hours were spent searching for Mudpuppies during June 2012 and May–June 2013. Eleven adult Mudpuppies and four nests were observed during visual encounter surveys in Otter Creek and Little Graham Creek at BONWR. Individuals were identified based on unique markings and scars noted in photographs. We sampled Otter Creek (88.3 person hours, 1078 cover objects, 4 km covered) more extensively than Graham Creek (21.2 person hours, 370 cover objects, 2 km covered) and Little Graham Creek (5 person hours, 80 cover objects, 100 m covered). During 2012, we found five adult Mudpuppies in Otter Creek, one of which was guarding a clutch of recently hatched larvae. Larvae were dispersed enough to make counting clutch size impossible. These Mudpuppies were observed in three different stretches of Otter Creek (two sites in Jennings County and one in Ripley County) and all were at similar depths (<0.5 m), under large, flat rocks (>80 cm at widest point), and in calm clear portions of the creek.

During 2013, four adult Mudpuppies were found in two stretches of Otter Creek (Jennings County) and a single adult from Little Graham Creek (Jennings County). Two Mudpuppies from Otter Creek and one from Little Graham Creek were females guarding nests. Both Otter Creek nests were located under large, embedded, flat rocks over medium-sized cobble substrate with a single entranceway, and were within 10 m of sites where Mudpuppies were found during 2012. The nests contained 52 and 132 eggs respectively. The eggs were deposited recently as was evident by the lack of development. A live Salamander Mussel was found under both nest rock sites. The nest in Little Graham Creek was also under a large, flat rock over cobble substrate with a single entranceway and contained 63 eggs that were well developed.

Between 7 December 2012 and 12 January 2013, minnow traps were used in the same stretches of Otter Creek in which visual searches were conducted during the previous summer. Traps were placed out for a total of 158 trap nights and the number of traps out at a given time was variable. Day time water temperature (measured daily while traps were out) varied from 0.1° C–10.1° C. During this sampling, only a single Mudpuppy was captured. It was captured beneath an uprooted tree below Northwest Exit Road Bridge (Jennings County) using a Frabill vinyl-coated minnow trap submerged 0.5 m underwater in a leaf pack following a mild, rainy night.

Additional state-wide records.—Twelve additional county records were compiled by the Indiana Department of Natural Resources and are herein reported (Table 1). Most records come from specimens captured during electrofishing surveys or photo documented reports from fishermen. Jagger (2008) reported the only published county record since Minton (2001).

DISCUSSION

Mudpuppy populations have declined in Illinois (Davis et al. 1998; Mierzwa 1998), Indiana (Minton 1998, 2001), and Ohio (Davis et al. 1998), yet detailed population data are unavailable. Population trends are also unknown in Minnesota and Wisconsin where

Table 1.—Additional, unpublished Mudpuppy records collected in Indiana since Minton's 2001 publication. All reported specimens are housed in the collection of the Nongame Aquatic Biologist at the Atterbury Fish and Wildlife Area with the exception of the Steuben County record (housed at the Field Museum of Natural History). Vouched records (either photographs or preserved specimens) are noted when appropriate.

County	Waterbody	Date	Voucher	Catalog number
Cass	Deer Creek	07/25/02	Photo	NECTURUS02001
Elkhart	St. Joseph River	06/22/12	Photo	NECTURUS12002
Greene	Richland Creek	09/30/02	Specimen	BEF02253
Greene	Plummer Creek	05/27/03		BEF03015
Greene	Beech Creek	04/25/12	Photo	BEF12024
LaPorte	Little Kankakee River	10/02/13		BEF13163
LaPorte	Lake Michigan	12/15/10		NECTURUS10001
Lawrence	E. Fork White River	12/17/12	Photo	NECTURUS12001
Martin	E. Fork White River	02/11/03		BEF03004
Newton	Kankakee River	10/25/08	Photo	NECTURUS08001
Noble	Crooked Lake	05/04/09		NECTURUS09001
Steuben	Hamilton Lake	Unknown		FMNH 2838
Washington	Delaney Creek	10/07/97	Photo	NECTURUS97001

Mudpuppies are frequently collected in large quantities for biological supply companies (Casper 1998; Moriarty 1998). Mudpuppies have likely declined due to poor water quality and siltation in streams (Casper 1998; Davis et al. 1998; Minton 2001), but overharvesting (Casper 1998; Moriarty 1998) and lampricide application (Matson 1998) potentially threaten local populations. Based on the observations and opinions of numerous biologists, Mudpuppy populations have declined, but the extent of this decline is unknown.

Even with the addition of 13 new county records (Fig. 1), the distribution of Mudpuppies in Indiana has not been described fully. Recent statewide freshwater mussel surveys (Wildlife Diversity Program, Indiana Department of Natural Resources), basin surveys by other researchers (Watters 1988, 1996, 1998; Harmon 1989, 1990, 1992a, b, 1996; Cummings et al. 1991; Lewis 1991; Ecological Specialists, Inc. 1993, 1998; Anderson 1994; Commonwealth Biomonitoring 2004), and a review of museum collections indicate that there are at least 10 counties without Mudpuppy records, where the Salamander Mussel has been found (Fig. 1). Most of these mussel surveys were haphazard (Strayer & Smith 2003), thus the actual distribution of the Salamander Mussel, much like Mudpuppies, could be under-represented. The numerous streams in which Mudpuppies occur where the Salamander Mussel remains undocumented lends further credence to this idea.

Declining Hellbender populations might imply conservation threats to Mudpuppy populations, but the Salamander Mussel is clearly a better indicator of such problems. Unfortunately our understanding of Salamander Mussel distribution in Indiana is only marginally better than that of Mudpuppies. It seems that the Salamander Mussel has declined or is extirpated from numerous streams (personal observation), as evidenced by finding only weathered dead or subfossil shells in many streams (Fig. 1).

Though substantial search effort resulted in relatively few Mudpuppy captures, reproducing populations of Mudpuppies were documented in two streams, Otter and Little Graham Creeks, at BONWR. Harmon (1989) found Salamander Mussels downstream from BONWR in Big Creek and Graham Creek, indicating that Mudpuppies may remain present in these streams.

Visual encounter searches at BONWR, were time consuming and capture rates were low. This method can also disrupt nest rocks and perhaps reduce clutch survivorship. Using nest boxes, similar to those designed for Hellbenders in Missouri (Briggler & Ackerson 2012), would minimize these disturbances and allow researchers to monitor breeding success. Minnow traps are effective tools for sampling Mudpuppies (Chellman & Parish 2010) suggesting that our low capture rates were likely the result of adverse weather. This method should be more effective during milder weather.

The survey of BONWR, along with numerous incidental reports, allow us to fill in some of

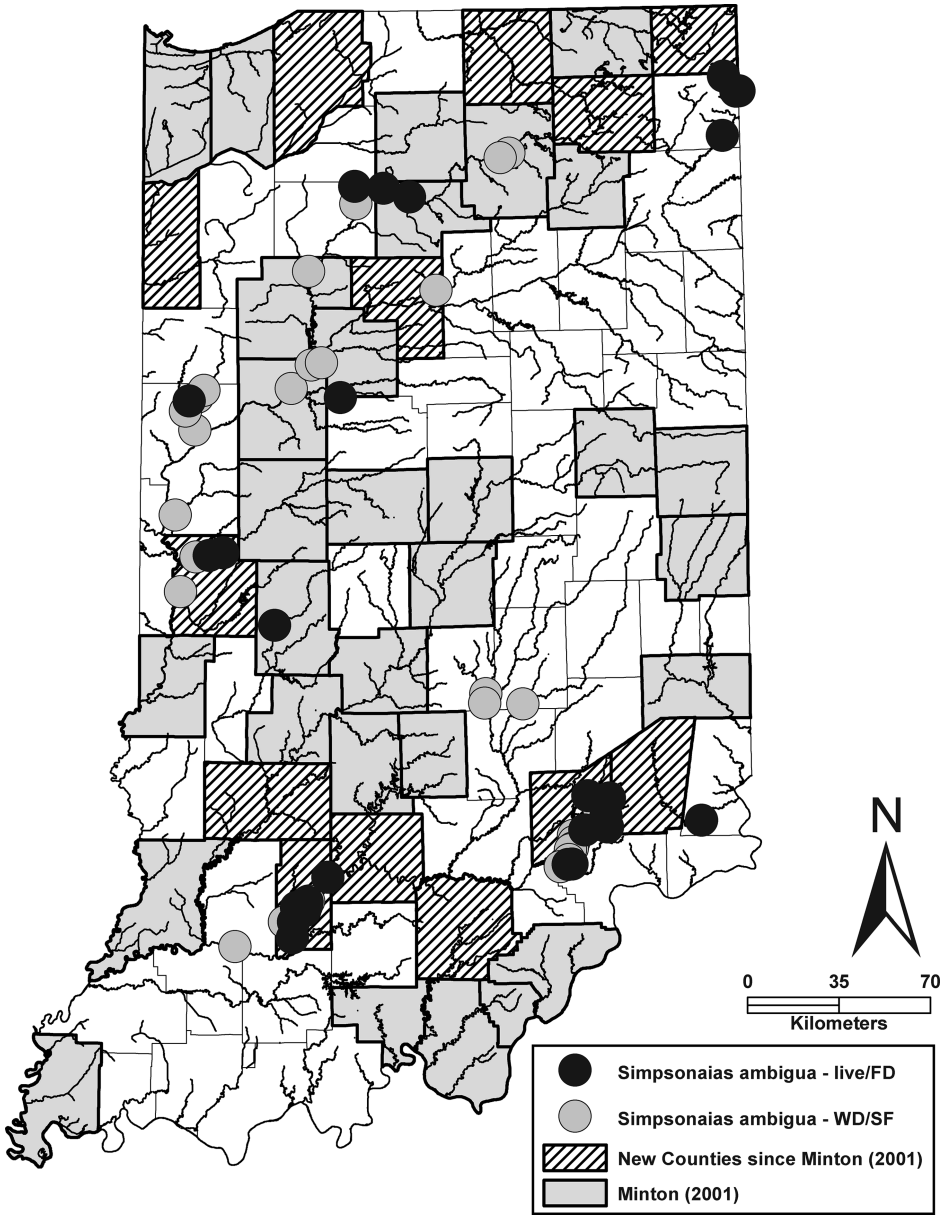

Figure 1.—The collective known distribution for the Salamander Mussel and Mudpuppy in Indiana. Circles represent point localities where Salamander Mussel was found live or as fresh dead (FD) shell material (black circles) or recorded as weathered dead (WD) or subfossil shell (SF) material (gray circles). Gray shaded counties represent Mudpuppy records reported by Minton (2001) and cross-hatched counties represent new records since 2001. A recently published Parke County record (Jagger 2008) was also included in the latter category.

the gaps in our knowledge of Mudpuppy distribution in Indiana. Furthermore, we identify the Upper Muscatatuck River watershed as a potentially important conservation area for both the Mudpuppy and Salamander Mussel.

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