

**THE CONSERVATION AND STATUS OF *ORCONECTES (FAXONIUS) INDIANENSIS* HAY
(DECAPODA: CAMBARIDAE)**

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ABSTRACT

The Indiana crayfish *Orconectes indianensis* is endemic to southeastern Illinois and southwestern Indiana in the central United States. Previous studies have indicated *O. indianensis* to be rare throughout its range. Page reported nine sites in two Indiana stream basins possessed the species. One hundred twenty-five sites were sampled in the Patoka River basin of Indiana during 2001-2003 in a study designed to assess the status of *Orconectes indianensis* populations. This study found *O. indianensis* in the Patoka basin to be much more common and abundant than previously thought. A total of forty-three new sites (34.4%) yielded the species with most of the sites occurring on public lands. Abundances of *O. indianensis*, where found, ranged from 1—106 individuals, with an average of 32.59 individuals per site and a relative number of 0.004 to 0.76 per square meter. Abundance was found to be most highly correlated with riffle quality, substrate quality, and QHEI habitat score.

The Indiana crayfish *Orconectes indianensis* was first described by Hay (1896) from the Patoka River near the town of Patoka, Gibson County. The species is endemic to southeastern Illinois and southwestern Indiana (Hobbs, 1989), but has been extirpated from a large portion of its historic range in Illinois (Page, 1985; Page, 1994) and has been reported from very few sites in Indiana (Hay, 1896; Eberly, 1955; Page and Mottes, 1995). *Orconectes indianensis* is found in extreme southwestern Indiana in the Patoka River system, a tributary of the Wabash River; in the Black River, a small tributary of the Wabash River in Posey County; and in Ohio River tributaries from Pigeon Creek, Vanderburgh County to Anderson River in Perry County (Page, 1994; Page and Mottes 1995). In Illinois, the species is stable but remains in a precarious state, since the majority of populations are found in the degraded Saline River system (Smith 1971; Page 1994).

Orconectes indianensis has seen significant range reduction as a result of changing land use (Smith 1971; Page 1995). The majority of the changes are a result of oil and gas exploration, coal mining, and acid mine drainage (Simon et al. 1995). Page (1994) indicated that the Patoka River was one of the last remaining watersheds that possessed populations of *O. indianensis*; however, several studies have shown that this watershed is at risk of decimation similar to the Saline River watershed in Illinois (Simon et al. 1995, 2005). Limited life history information has been reported. The species inhabits coarse substrates, primarily large rocks or woody debris, and usually is found in slow to moderate current (Page, 1985; Page, 1994). Limited reproductive data is known with females carrying eggs during March and April (Page, 1985).

During the species review, which was done to determine whether it was necessary to elevate it from Candidate to Federally Endangered, a recommendation was made to further study *Orconectes indianensis* so that changes in status, especially in Indiana, could be observed. Further distribution studies were conducted between 2001-2003 to evaluate the stability and status of the species. Additional life history characters were evaluated to add to known information on the species' life cycle.

MATERIALS AND METHODS

Sampling -- Crayfish were collected with the use of a 120 x 180 cm. minnow seine, a Smith-Root DC generator backpack electrofishing unit, by hand while turning rocks, or extracted from burrows with a

shovel or toilet plunger in small, wadable streams or fields (Simon, 2001). Larger deep river sections were sampled with an electrofishing unit or baited minnow traps. Voucher specimens were preserved in 70% EtOH and are housed in the Crustacean collection of the Indiana Biological Survey. Area sampled was recorded for each site and a Qualitative Habitat Evaluation Index (QHEI) was completed for each stream site following the methodology used by Ohio EPA for stream biological surveys (Rankin, 1995).

Statistics – Correlations between the relative abundance and habitat data was analyzed using Statistica6 (StatSoft, Inc. 2004). All results are reported at a significance level of 0.05.

Conservation status – The IUCN Red List Categories and Criteria Version 3.1 (IUCN 2001) was used to assess the conservation status of *O. indianensis*.

RESULTS

Common Name -- Indiana crayfish (Simon 2001)

Conservation status -- Rare (Taylor et al. 1996). Based on the species' limited distribution (< 20,000 km²) and the loss of populations, as reported in this study, *O. indianensis* has been classified as Vulnerable, VU B1b(iv), following IUCN (2001).

Identification -- The Indiana crayfish is a member of the subgenus *Faxonius* and displays the subgenus' characteristic first form male gonopod having both a short mesial process and central projection. The two rami are strongly divergent in both first and second form males, the rostrum is fixed with a median, distal carina, a strongly developed cervical spine is found on each side of the cervical groove, and the annulus ventralis displays bilateral anterior knobs.

Distribution-- The geographic range of *Orconectes indianensis* is restricted to southwest Indiana and southeast Illinois (Fig. 1) and has been considered "Rare" or "Special Concern" (Page, 1985; Page, 1994; Simon, 2001; Taylor et al., 1996). Rhoades (1962) described the historic and current range of *O. indianensis* in relation to glaciation. The species was considered to have been present throughout the entire Wabash River drainage and the dominant crayfish in the White River prior to the Illinoian glacier. The farthest advance of the Illinoian glacier filled the lower White River drainage causing changes at the ice front as it formed three marginal lakes that supported *O. indianensis* populations. Effluents later connected

the three lakes and formed the Patoka River and other Illinoian drainages, the Little Pigeon and Anderson River drainages. The Wisconsin glacier did not have an effect on the distribution of the species (Rhoades, 1962).

The species is currently limited in distribution to the Patoka and Black River systems (Wabash River drainages) and Pigeon Creek and Anderson River (Ohio River drainage) in southwestern Indiana and the Saline River and Honey Creek systems (Ohio River drainage) in southeastern Illinois. These six basins encompass approximately 2,200 km² total drainage area. Hay (1896) first described the species from the Patoka River, Gibson County, Indiana. Rhoades (1962) reported collecting the species in the Patoka River from Gibson, Pike, Dubois, and Orange Counties; the Little Pigeon River, Warrick County; and Anderson River, Perry County, Indiana. Specimens were also found by Page (1994) in the United States National Museum, The Ohio State Museum of Biodiversity, and the Illinois Natural History Survey. These new museum collections validate records for Spencer, Posey, and Vanderburgh Counties. Page (1994) reported that *O. indianensis* was extirpated from Gibson and Dubois Counties; however, our surveys during 2001-2003 found that the species is still extant in these areas. Page (1994) believed that the species was stable in Indiana. Surveys conducted in Indiana during 2001-2003 found additional localities in the upper Patoka River on public lands (Figure 1). A total of forty-two sites (34.4%) yielded the species; however, only two of the historic sites surveyed by Page (1994) retained populations.

The first Illinois records of *O. indianensis* are from Rietz (1912); however some of the localities are believed to be based upon misidentification of two other species, i.e., *Orconectes stannardi* and *O. propinquus* (Page, 1985). Records for the South Fork Saline River in Gallatin County and the North Fork Saline River in Saline County are considered valid; however, additional records for the North Fork Saline River remain unverified. Brown (1955) provided additional records for *O. indianensis* in Cypress Ditch, Gallatin County. Page (1985) found a similar distribution for the species reported by Brown (1955) during a statewide survey in Illinois from 1972 to 1982. Additional records were found for Williamson, Johnson, Saline, Pope, and Gallatin Counties, and Ohio River drainages in Hardin County. Museum collections found additional records for Sugar Creek (Saline River drainage) in Williamson County, and Brushy Slough (Ohio River drainage) in White County. Page (1994) sampled the same sites in Illinois during 1993 where historical collections had been made. The species was found at all but three sites sampled during

1993 as they were during 1972-1982. The species was not collected from Rock Creek (Hardin County), Rock Branch Battle Fork Creek (Saline County), and Brushy Slough (White County). Page (1994) stated that although the Illinois population does not appear to be declining, the reduction of the species' historical range and threats to the main population requires State protection.

Abundance-- The relative abundance of *O. indianensis* is very high (0.76 individuals/sq.m.) in streams with cobble, rubble bottoms ($R = 0.259$) and low sediment loads, and absent or low abundance having only 1--2 individuals in heavily sedimented streams (Figure 2). Smaller headwater and intermittent streams produced the largest numbers of crayfish. The largest number of *O. indianensis* collected at a single site was 106 individuals (0.707 crayfish/m²).

Habitat and ecology—*Orconectes indianensis* prefers high gradient streams having riffles, runs, and pools with clear water of moderate nutrient levels. Habitat preferences show that *O. indianensis* presence is strongly correlated with the presence of rock cobble or boulder habitat (Table 1). The preferred stream size includes perennial headwater and intermittent streams; however, the species has also been collected from the main channel of the Patoka River at the type locality and further downstream near the mouth of the Patoka River near the confluence with the Wabash River. This site possesses riffle habitat, which is uncharacteristic of the lower Patoka River, which is extensively channelized. The species has not been collected from areas that are heavily silted. Heavy siltation was especially common in channelized stream reaches. *Orconectes indianensis* is a tertiary burrower and does not excavate complex burrows, preferring to construct simple chambers under rocks during the warmer, dry months of the year.

Reproduction -- Page (1985) reported that females were found carrying eggs during April and May. Both first form males and ovigerous females were observed during this study. Two ovigerous females carried 81 and 9 eggs total and five females with attached instars carried 16 to 108 individuals ($\bar{x} = 36.8$). First form males and females were observed from only a short reproductive season in late fall and early spring (Table 2). NO TABLE 2 PRESENT

Threats -- Stream modifications, especially channelization; high nutrient and sediment loads; strip mining and consequent pH changes threaten this species. The North and Middle Forks of the Saline River are extremely polluted as a result of water quality degradation from strip-mining, oil-field pollution, siltation, and desiccation (Smith 1971). Rhoades (1962) suggested that the Patoka River was the stronghold for the species. Currently, coal mining, stream channel clearing, channelization, and poor water quality threaten the watershed. Eight of the eleven sites sampled by Page (1994) within the Patoka River watershed failed to provide any evidence of *O. indianensis* and two of the eight sites were badly polluted. Efforts by the Patoka National Wildlife Refuge to reduce water quality impacts of acid mine drainage and oil brine along the perimeter of the Refuge will increase available habitat.

Another imminent threat is the potential introduction of the rusty crayfish (*Orconectes rusticus*). It is likely that the establishment of *Orconectes rusticus* in streams occupied by *O. indianensis* will result in drastic reductions of *O. indianensis* and confinement of populations to a few small, low nutrient headwater streams in the basin.

Conservation action-- *Orconectes indianensis* is presently not considered Federal Endangered and not listed by Indiana (Simon, 2001). Simon (2001) recommended *O. indianensis* be considered for State listing as Special Concern. Page (1994) reported that a total of 18 historic localities were sampled in both Indiana and Illinois in 1993. Six of the sites no longer have documented populations, three have declining populations, and 9 have stable populations. Sites sampled during 2001-2003 showed that only two of the nine sites previously possessing Indiana crayfish remained stable in Indiana. The remaining sites no longer support populations (Simon and Thoma, 2003). This loss of historic populations is a troubling trend for the future of the species.

Orconectes indianensis has a narrow distribution and large areas of its range have been impacted in ways that have greatly reduced its abundance. Further non-point impacts and habitat modifications will further reduce the abundance of *O. indianensis* and the establishment of the rusty crayfish (*O. rusticus*) could cause the species to slip into the endangered range. Continued monitoring of the species is required to maintain knowledge of its status.

Conservation recommendations -- Streams with suitable water quality would benefit from the placement of rock-rubble substrates in the stream. The addition of rock-rubble substrates will greatly enhance the potential for establishment and expansion of *O. indianensis* populations. Prevention of non-point run off by employing wooded and grassed buffer strips on stream and ditch edges will also enhance *O. indianensis* habitat. Further efforts to secure additional public lands along the edges of Hoosier National Forest, The U.S. Fish and Wildlife Service Patoka River National Wildlife Refuge, and land owned by the Army Corps of Engineers would benefit the long-term stability of this species.

Remarks -- *Orconectes indianensis* was found to be more widely distributed and more abundant than initially considered prior to conducting this survey. New populations found during surveys conducted during 2001-2003 in the headwaters of the Patoka River drainage include numerous sites in Hoosier National Forest, Patoka National Wildlife Refuge, and on public land owned by the Army Corps of Engineers. It does not meet the criteria to be designated Federally Endangered. Threats posed by potential introduction of rusty crayfish to streams inhabited by *O. indianensis* are considered to be extreme. Similar to populations of *Orconectes propinquus* or *Orconectes sanbornii* observed in Ohio (Thoma and Jezerinac, 2000), *O. indianensis* shows a propensity to prosper in small first order streams with low nutrient levels. Such areas in Ohio have proven to be important refuges for the two species as *O. rusticus* does not prosper in waters low in nutrient that lack aquatic plant growth such as filamentous algae (Thoma and Jezerinac, 2000).

CONCLUSIONS

The status of *Orconectes indianensis* has been shown to be more secure than previously thought in Indiana and has remained stable in Illinois (Page 1994; Page and Mottes 1995; Simon and Thoma 2003). Despite widespread degradation in the Saline and Patoka River drainages, the species has remained stable in Illinois and although significant loss has occurred in known historic locations, this study has found them at an additional 27 sites in the headwaters of the Patoka River. Habitat enhancement for *O. indianensis* can be achieved by increasing rock-rubble coverage of stream bottoms and reducing the extent of silt and sand coverage. Establishment of wooded riparian cover would prove to be beneficial to this species. Any

establishment of *O. rusticus* populations in any stream basin with *O. indianensis* should be immediately and completely eliminated.

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Table 1. Correlations of environmental variables with *Orconectes indianensis* abundance. All variables are significant at $p < 0.05$, $N=133$.

Positively correlated Variables	Correlation
Riffle Score	0.315
Substrate score	0.304
QHEI	0.300
Cover score	0.285
Overhanging vegetation	0.269
Number of substrate types	0.264
% Boulder/cobble	0.259
Gravel	0.253
Limestone	0.252
No embeddedness	0.243
Moderate sinuosity	0.225
No channelization	0.224
Riffle depth 10-50 cm.	0.223
Riffle embeddedness	0.222
Gradient	0.221
Pool score	0.219
pH	0.215
Stream development good	0.214
Channel score	0.212
Riffles stable	0.211
Cobble	0.206
Pool depth > 100 cm.	0.197
Temperature	0.197
Boulder cobble cover	0.184
Narrow riparian	0.179
Negatively correlated variables	
Specific conductivity	-0.172
Salinity	-0.174
Recent channelization	-0.180
Poor stream development	-0.199
Sparse cover	-0.200
Silt abundance	-0.205
Cover lacking	-0.206
Bank erosion heavy	-0.207
No riffles	-0.217
Silt heavy	-0.220
Extensive embeddedness	-0.227
Low streambed stability	-0.230
No sinuosity	-0.237
Riffles unstable	-0.245

Table 2. Reproductive

Figure Captions

Fig. 1. Present and historical distribution of *Orconectes indianensis* Hay in Illinois and Indiana. Large open circles = 1950 and earlier; medium open circles = 1951-1980; solid circles = 1981-2004.

Fig. 2. Abundance of *Orconectes indianensis* Hay in Illinois and Indiana. Increasing dot size represents increasing numbers observed at collection sites. Small solid dots = 1 – 25 crayfish; medium hollow dots = 26 - 50 crayfish; medium solid dots = 51 - 75 crayfish; large hollow dots = 76 – 100 crayfish; and large solid dots = 101 -106 crayfish.

