Final Report: Wildlife Preservation Fund

Project Title: Impacts of an introduced crayfish on the state endangered Indiana Crayfish, *Orconectes indianensis*.

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This study will offer insight into the long term survival of the state endangered Indiana Crayfish, *Orconectes indianensis* (Hay), in Illinois as well as other crayfishes with similar ecologies. The impact of the regionally introduced *O. virilis* (Hagen) will be addressed. Findings of this study may be applicable to three other species protected in Illinois, *Orconectes lancifer* (Hagen), *O. kentuckiensis* (Rhoades), and *O. placidus* (Hagen). All of Illinois's protected crayfish species have restricted populations in southern Illinois. *Cambarus robustus* (Girard) has been the only crayfish species extirpated from Illinois (Page, 1985).

The species was thought to be threatened by the regionally introduced *Orconectes virilis*. This species is native to much of Illinois, but is not indigenous to the Saline River, streams of the Shawnee Hills Natural Division, and streams of the eastern Coastal Plain Natural Division (Page, 1985). The most likely method of introduction (possibly into Lake of Egypt) was through the use of the species as a fishing bait. The displacement of native crayfish by introduced species of crayfish has been previously documented. The near extinction of California's shasta crayfish, *Pacifastacus fortis*, may be attributed to displacement by the introduced *P. leniusculus* (Dana) (Light et al, 1995). Bovbjerg (1970) concluded from direct observations that *O. virilis* evicting *O. immunis* (Hagen) from substrate crevices was the force excluding the latter from streams. A study of the impact of the introduced *O. rusticus* (Girard) on the ecology of northern Wisconsin lakes revealed that the displacement of *O. propinquus* (Girard) by *O. rusticus* not only disrupted the native crayfish community but also negatively affected the benthic flora and fauna of the lakes (Olsen et al, 1991). Nonindigenous crayfish are likely to displace native species when the introduced species mature faster, have higher fecundities, possess larger chelipeds, and are ecological equivalents with respect to habitat preferences. In a study of the successful displacement of *O.*

sanborni by the introduced *O. rusticus* , *O. rusticus* grew faster, were larger, produced more young, and reduced the mating success of *O. sanborni* (Butler and Stein, 1985). In addition to *O. indianensis, O. illinoisensis* and the state endangered *O. kentuckiensis* may be required to compete with *O. virilis* if the species becomes established throughout southern Illinois. *O. rusticus* and *O. menae* are other crayfish species introduced into Illinois that may also negatively affect native species.

Methods

Thirty-four locations were surveyed for the composition of the crayfish community. All locations were within the Saline River Watershed and were located in Saline, Williamson, Hamilton, White, Pope, Johnson, and Gallatin counties (Fig. 2). Search methods were the same as those used for life history data collection but were focused on the first five meters upstream and downstream of bridges. Artificial cover in the form of bridge construction materials and rip-rap was often the only visible cover in the lower gradient streams. Crayfish were identified to species in the field or were preserved in 70% alcohol for future identification.

Twenty-two random quantitative sampling units were placed in the visually assessed optimum habitat for each stream section. The first eleven units were located in the South Fork of the Saline River Williamson County, T 10S, R 3E, sections 3, 9, and 17. Units 12 through 14 were located in Wagon Creek, Johnson County, T 11S, R 3E, section 11. Units 15 through 17 were located in Little Saline River, Johnson County, T 11S, R 4E, section 12. Units 18 and 19 were located in Bill Hill Hollow Creek, Saline County, T 11S, R 3E, section 11. Units 20 through 22 were located in Burden Creek, Johnson County, T 11S, R 3E, section 11. Optimum habitat was usually shallow water raceways, gravel and substrate with a swift current but lacking surface turbulence (Carney and Burr, 1989), or shallow portions of pools; both with a high density of large substrate particles. Measurements of crayfish density were taken in the visually assessed optimum habitat area of a stream section, not the entire stream section. Often the optimum habitat was only a few square meters in size.

A thin-edged rectangular metal frame with an area of one square meter was constructed and used to define the sampling units on the stream bottom. The rectangular frame was randomly placed on the stream bottom within the optimum habitat area. Any crayfish in the sampling unit disrupted by the frame placement were collected and measured, after which unimbedded substrate items were slowly lifted and any crayfish revealed were also collected. All crayfish encountered were identified to species, sexed, and measured for carapace length. Cover particle size class (Cummins, 1962) and cover particle depth were also recorded for each capture using the methods employed for the collection of life history data. After the crayfish were removed from within the sampling unit, all substrate particles in the unit belonging to the boulder and cobble size classes were measured to the nearest .5 cm. Four depth readings were also obtained from fixed locations within the sample unit.

Results

22 Quantitative sample units were taken at different locations throughout the Saline system. Mean plot depth was 16.59 cm (sd= 3.75 cm). Mean substrate weighted crayfish densities (the crayfish number per square meter of cover) were then determined for plots in the South Fork of the Saline River and for sample units from streams other than the South Fork (table 1). Substrate weighted crayfish densities were significantly lower for the South Fork as compared to the remaining streams (f=6.19) (fig. 3).

Crayfish numbers per square meter were corrected for differences in the density of potential cover (unimbedded cobbles and boulders) for each stream section. The area of each particle was estimated by treating the maximum length as the diagonal of a square, and determining the area of that square (Light et al, 1995). The cover indeces were the sum of the total area of each cobble and boulder encountered in the sampling unit. The substrate weighted crayfish density, crayfish per square meter of available cover, was obtained using the appropriate cover index.

A Spearman rank test for correlation indicated there was not a significant correlation between crayfish density and mean plot depth (r_s=.098). There was also no correlation between substrate depth and carapace length (r_s= .028). A positive relationship between cover indeces and substrate weighted crayfish density was significant. (r_s= .4394). A significant relationship between boulder and cobble abundance and substrate weighted crayfish density also existed for each species treated independently. (*O. virilis*, r_s =.9047 ; *O. indianensis*, r_s = .511; *O. immunis*, r_s = .867). The numbers of females and males found under each substrate size particle class were equal (f=.001).

Thirty-four locations distributed in seven counties were surveyed during May, June, and July, 1997 (fig. 2). Only two localities produced the regionally introduced *O. virilis* (fig. 4). During this study, *O. virilis* were collected only from the South Fork of the Saline River. Three individuals were collected and preserved approximately ten stream miles downstream from the Lake of Egypt in Williamson County. The specimens were obtained from two locations less than two stream miles apart and most likely represent a single population. All South Fork populations are considered to be sympatric for *O. indianensis* and *O. virilis*. The other South Fork density sampling location has a historic record for *O. virilis* from the Illinois Natural History Survey crustacean collection records (1997). Page (1985) reported *O. virilis* from Berkel Lake in Saline County, a lentic habitat adjacent to the main stem of the Saline River. The locality was searched in July, 1997 but *Orconectes virilis* was not found. A specimen taken from the Lake of Egypt spillway in 1976 was located in the Southern Illinois University at Carbondale decapod collection and apparently is the earliest record of the species in the Saline system. The distribution of *O. indianensis* did not vary from that proposed by Page (1994) and the species was collected at all South Fork density sampling locations (fig. 1). The only other native congener, *O. immunis*, was found in seventeen locations. Additional species encountered included *Cambarus fodiens* (Cottle) and *Procambarus acutus* (Girard).

A two species test for association with the Yates correction (Ludwig and Reynolds, 1988) was conducted to test for the presence of a positive or negative association between *O. virilis*, and *O. indianensis* in the South Fork of the Saline River. There was no significant association between the two species ($X^2 = .002$). The two were found together in only 9.1 percent of the sample units. A two species test for association and the Yates correction was also conducted for streams containing both *O. immunis* and *O. indianensis* (Wagon and Bill Hill Hollow Creeks in Johnson and Saline Counties). There was no association between these two species either ($X^2 = 1.41$).

Discussion

Since its introduction into the Saline river System over 20 years ago *Orconectes virilis* has yet to colonize most of the apparently suitable habitats in the system (fig. 4). The species also shows no evidence of displacing the native *Orconectes indianensis*. However, this species should be monitored, as other introduced species have become well established in Illinois. The introduced *O. rusticus* has become widespread in northern Illinois possibly at the expense of native species (Taylor and Redmer, 1996) and *Orconectes menae* has recently appeared in a Greene County stream (IDNR, 1994).

O. virilis has been collected from only four locations in the Saline River watershed, two of which are lentic systems. Sympatric populations of *O. indianensis* and *O. virilis* were discovered in the South

Fork of the Saline River. Density data collected at sampling locations along the South Fork indicate *O. virilis* is not displacing and is not associated with the Indiana crayfish. Indiana crayfish densities surpassed *O. virilis* densities for all sampling locations on the South Fork (table 1).

It is unclear why *O. virilis* populations in the Saline System have not reached the high densities reported for the species in its native range (Page 1985, Momot et al, 1978, Mitchel and Smock, 1991). *O. virilis* has also been introduced into the Pit River system of California. Yet in thirty years, the species has not become well established and may be limited by another introduced crayfish species (Light et al, 1995). Due to the uncertainty of the date(s) and location(s) of the introduction, the rate of range expansion for *O. virilis* in the Saline system can not be determined.

Strip mines with acid discharge have had a severe impact on the water quality of the middle and lower reaches of the South Fork (Muir et al, 1996). The poor water quality in a large portion of the South Fork may be limiting the dispersal of *O. virilis*. The pollution that has reduced much of the Indiana crayfish's native range may be protecting the remaining populations from a potentially agressive invader. Crayfish rely on the dispersal of adults for range expansion. Migration of adults upstream and not juvenile postnatal dispersal has been shown to be the method by which crayfish maintain populations in intermittent streams (Momot, 1966). Migration of individuals is likely to be slow and to occur in short increments with respect to stream length. Black (1963) found only 15% of stream-dwelling *Procambarus* species straying outside of a proposed 100 foot home range. Miles of low water quality stream sections could be traversed during flood events if crayfish become drift during such events. However, floods have been shown to have little effect on the dispersal of individual crayfish (Black, 1963). Thus it is highly unlikely that *O. virilis* could disperse through the degraded sections of the South Fork to other higher quality tributaries of the Saline supporting *O. indianensis.*

In contrast to the current findings, *O. virilis* apparently has the potential of becoming widespread in the Saline system and appears capable of displacing smaller native species. *O. virilis* has a larger body size, chela size (Garvey and Stein, 1993), and expresses a much higher realized fecundity than the Indiana Crayfish. In Virginia, *O. virilis* averaged 102 eggs for first year females (15-25 mm carapace length) and 138 eggs for second year females, with a maximum carapace length of 41.4 mm for females collected (Mitchel & Smock, 1991). *O. virilis* collected in Ontario averaged 214 eggs with maximum female carapace length of 43 mm (Weagle and Ozburn, 1972). Hazlett et al. (1974) reported a maximum carapace length of 69 mm for *O. virilis*. The largest Illinois female collected had a carapace length of

59.5 mm, while a 49.7 mm carapace length female carried an impressive 490 attached eggs (Page, 1985).

Considering the previously mentioned physical advantages of *O. virilis* over *O. indianensis* the former would be expected to dominate the latter. Garvey and Stein (1993) proposed that chela and body size superiority of *O. rusticus* over native congeners were the reasons responsible for the displacement of *O. virilis* and *O. propinquus*. A greater population growth of *O. rusticus* than of *O. sanborni* (Faxon) was attributed to the increased realized fecundity, increased actual fecundity, and faster growth rate of *O. rusticus* (Butler and Stein, 1985). However, behavioral dominance does not guarantee displacement. Capelli and Munjal (1982) found that the more aggressive *O. rusticus* seldom displaced *O. virilis* from preferred substrate in size matched displacement tests.

The few large *O. virilis* discovered occurring sympatrically with *O. indianensis* are likely to displace the Indiana crayfish following one-on-one encounters. As long as other shelter is available, the *O. indianensis* population is unlikely to be affected by the displacement of a few individuals. Resource partitioning will probably occur with the most aggressive and larger crayfish, *O. virilis*, occupying the desired shelter. Following an agressive encounter with *O. virilis*, any displaced *O. indianensis* would likely be able to find suitable shelter. Resource partitioning has been found to be responsible for the habitat associations of two sympatric species of stream dwelling *Orconectes* (Rabeni, 1985). *O. virilis* and *O. propinquus* exhibited a habitat shift in aquaria after encounters with *O. rusticus*. (Hazlett et al, 1992). Only when the *O. virilis* density increases to the point of limiting shelter availability is an associated decrease in *O. indianensis* density likely to occur.

O. virilis should be monitored in the future as the potential for rapid range expansion and population density growth exist. After ten years of stable coexistance a seemingly codominant and stable population of the introduced *Pacifastacus leniusculus* and *Astacus astacus* (Linnaeus) has shown a considerable increase in the population of the introduced species at the expense of the native *A. astacus* (Soderback, 1995).

The ideal habitat for the Indiana crayfish appears to be small to medium sized shallow streams with an abundance of large unimbedded substrate particles and good water quality. The Indiana crayfish extensively uses boulders and cobbles as a primary shelter source (table 2). The majority (93%) of crayfish collected from underneath a shelter were using a boulder or cobble for shelter. *O. illinoisensis* (Brown), a species with similar habitat preferences, was found to be associated with leaf litter (Carmody, 1991). However, the Indiana crayfish was only rarely collected in leaf litter (table 2). The preferred depth observed during life history collections ranged from 10 through 30 centimeters (fig. 5).

A recent survey completed by the Illinois Environmental Protection Agency (Muir et al, 1996) which examined extensive data on the water quality of the Saline River system assigned overall water quality ratings to all major stream segments. The ratings were determined by compiling an Index of Biotic Integrity (IBI), Macroinvertebrate Community Index (MCI), Biological Stream Characterization (BSC), Aquatic life use support, habitat quality, water quality, and sediment quality. The top rating was assigned to tributaries of the Saline River draining the Shawnee Hills and to portions of the North Fork watershed. All Middle Fork and the Saline River Main Stem segments were assigned either a fair or poor rating and neither supports populations of the Indiana crayfish (Page, 1994).

The North Fork watershed contains many oil fields, yet its streams were still assigned the top water quality rating. North Fork stream sections apparently have the water quality to support an *O. indianensis* population, but the species has not been collected there since 1900 (INHS crustacean records, 1997). Smaller order North Fork tributaries may serve as possible introduction localities for the Indiana crayfish, but may be limited by a lack of the preferred substrate. Large substrate particles seem to be restricted to stream sections adjacent to and underneath bridges where they have been deposited during road construction. *Orconectes immunis* and *Cambarus fodiens* were collected in North Fork tributaries during this study.

Streams draining the Shawnee Hills Natural Division have an overall higher water quality than the North and Middle Forks and the Saline River (Muir et al, 1996). Sugar Creek and the Little Saline River were classified as "highly valued aquatic resources" by the Biological Stream Characterization assessment (Hite and Bertrand, 1989). The maximum density for the species, 13 crayfish per square meter, was observed in a portion of the Little Saline River in Johnson County with mean sample unit depth of 16.2 centimeters and an abundance of large unimbedded substrate particles. Barring a significant change in either the surrounding land use patterns or crayfish community composition, these streams should continue to support large populations of *Orconectes indianensis*.

Strip mining for coal has had a detrimental impact on the Saline system. Kelley (1984) studied several water quality parameters of Bankston Fork and Brush Creek of the Middle Fork drainage and found high mean turbidities, mean pH values ranging from 2.98 to 8.49, increased acidity, high mean turbidities, mean pH values ranging from 2.98 to 8.49, increased acidity, high concentrations of metals, and elevated sulfate levels characteristic of mine drainage pollution so severe that there was an actual shift from freshwater species of diatoms to brackish species. Kelley's study leaves no doubt of the negative impact of strip mines on the biota of nearby streams. The Middle Fork remains polluted to this day. Sections of the South Fork and Sugar Creek have also been severely affected by strip mining (Muir et al, 1996). Acid mine drainage has been shown to limit the invertebrate diversity of streams severely (Carrithers and Bulow, 1973; Nichols and Bulow, 1973).

Channelization has also disturbed much of the historic range of *O. indianensis*. Channelization alters the natural occurrence of riffle and pool segments. 39.6 % of the North Fork is channelized, 32.2 % of the South Fork is channelized, and 87.6 % of the Middle Fork is channelized (Muir et al, 1996).

The streams draining the Shawnee Hills which support the majority of Illinois's Indiana crayfish populations, typically have small stream orders and many dry out during late summer and early fall. It is unclear what crayfish mortality is during such dry periods. Boyd and Page (1978) found live *O. kentuckiensis* buried under rocks in a dry stream bed. *O. indianensis* is not considered a burrowing species and appears capable of only shallow excavations under the large substrate particles used for cover. After the majority of Wagon Creek in Jefferson County had dried up, an *O. indianensis* was collected from a cavity constructed underneath a large cobble over a sand and gravel substratum. The cavity was several centimeters above the water table, yet remained moist enough to support the aestivating crayfish. The extent to which *O. indianensis* can tolerate stream dessication is not clear. At the same time and location another *O. indianensis* was collected from a shallow burrow in a clay substrate. Adjacent to this burrow a small *Procambarus acutus* female was located in another burrow. It is highly unlikely the *O. indianensis* dug the burrow from which it was collected. The stream has a large population of *O. immunis* and burrows constructed by this and other species are common at the location.

A rare species in Illinois, *Orconectes indianensis* does not appear to have been displaced by the presence of a regionally introduced crayfish species, *Orconectes virilis*. However, the Indiana crayfish remains limited by anthropogenic habitat alterations of streams in the Saline River system.

LITERATURE CITED

Black, J.B. 1963. Observations on the home range of stream-dwelling crawfishes. Ecology 44:592-595.

Bovbjerg, R.V. 1970. Ecological isolation and competitive exclusion in two crayfish (*Orconectes virilis* and *Orconectes immunis*). Ecology 51:225-236.

Boyd, J.A., and L.M. Page. 1978. Life history of the crayfish *Orconectes kentuckiensis* in Big Creek, Illinois. American Midland Naturalist 9:398-414.

Butler, M.J., and R.A. Stein. 1985. An analysis of the mechanisms governing species replacements in crayfish. Oecologia 66:168-177.

Capelli, G.M., and B.L. Munjal. 1982. Aggressive interactions and resource competition in relation to species displacement among crayfish of the genus *Orconectes*. Journal of Crustacean Biology 2:286-492.

Carmody, J.M. 1991. Habitat use by the crayfish (*Orconectes illinoisensis*) and mussels in two Illinois streams. MS Thesis, Southern Illinois University, Carbondale. 54p.

Carney, D.A., and B.M. Burr. 1989. Life histories of the bandfin darter, *Etheostoma zonistium* and the firebelly darter, *Etheostoma pyrrhogaster* in western Kentucky. INHS Biological Notes 134. 16 p.

Carrithers, R.B., and F.J. Bulow. 1973. An ecological survey of the West Fork of the Obey River, Tennessee with emphasis on the effects of acid mine drainage. Journal of the Tennessee Academy of Science 48:65-72.

Cummins, K.W. 1962. An evaluation of some techniques for the collection and analysis of benthic samples with special interest on lotic waters. American Midland Naturalist 67:477-504.

Garvey, J.E., and R.A. Stein. 1993. Evaluating how chela size influences the invasion potential of an introduced crayfish (*Orconectes rusticus*). American Midland Naturalist 129:172-181.

Hazlett, B.A., F.E. Anderson, L. A. Esman, C. Stafford, and E. Munro. 1992. Interspecific behavioral ecology of the crayfish *Orconectes rusticus*. Journal of Freshwater Ecology 7:69-76.

Hazlett, B.A., D. Rittschoff, and D. Rubenstein. 1974. Behavioral Biology of the crayfish *Orconectes virilis* I. home range. American Midland Naturalist 92:301-317.

Hite, R.L., and B.A. Bertrand. 1989. Biological Stream Characterization (BSC): a biological assessment of Illinois stream quality. Illinois Environmental Protection Agency. Springfield, Illinois. Report WPC/89-275.

Illinois Department of Energy and Natural Resources, 1994. The changing Illinois environment: critical trends. Summary report and volumes 1-7 technical report. Illinois Department of Energy and Natural Resources, Springfield, IL, ILENR/RE-EA-94/05.

Illinois Natural History Survey. 1997. Crustacean records. Champaign, Illinois.

Kelley, M.H. 1984. Effects of mine drainage on the benthos and periphyton of the Bankston Fork of the Saline River. Doctoral Dissertation, Southern Illinois University, Carbondale. 206p.

Light, T., D.C. Erman, C. Myrisck, and J. Clarke. 1995. Decline of the Shasta crayfish (*Pacifastacus fortis* Faxon) of northeastern California. Conservation Biology 9:1567-1577.

Ludwig, J.A., and J.F. Reynolds. 1988. Statistical Ecology: a primer on methods and computing. John Wiley & Sons. New York, New York. 337 pages.

Mitchel, D.J., and L.A. Smock. 1991. Distribution, life history and production of crayfish in the James River, Virginia. American Midland Naturalist 126:353-363.

Momot, W.T., 1966. Upstream movement of crayfish in an intermittent Oklahoma stream. American Midland Naturalist 75:150-159.

Momot, W.T., H. Gowing, and P.A. Jones. 1978. The dynamics of crayfish and their role in ecosystems. American Midland Naturalist 99:10-31.

Muir, D.B., M.M. King, M.R. Matson, G.L. Minton, S.P. Shasteen, and R.L. Hite 1996. An intensive survey of the Saline river basin: summer 1993. Illinois Environmental Protection Agency. Springfield, Illinois. Report BOW/96-056.

Nichols, L.E., and F.J. Bulow. 1973. Effects of acid mine drainage on the stream ecosystem of the East Fork of the Obey River, Tennessee. Journal of the Tennessee Academy of Science 48:30-38.

Olsen, T.M., D.M. Lodge, G.M. Capelli, and R.J. Houlihan. 1991. Mechanisms of impact of an introduced crayfish (*Orconectes rusticus*) on littoral congeners, snails, and macrophytes. Canandian Journal Fisheries and Aquatic Sciences 48:1853-1861.

Page, L.M. 1985. The crayfishes and shrimps (Decapoda) of Illinois. Illinois Natural History Survey Bulletin.Volume 33. Champaign, Illinois.

Page, L.M. 1994. The distribution and status of the Indiana crayfish, *Orconectes indianensis*. Illinois Natural History Survey; Center for Biodiversity Technical Report 1994 (2). Champaign, Illinois.

Rabeni, C.F. 1985. Resource partitioning by stream-dwelling crayfish: the influence of body size. American Midland Naturalist 113:20-29.

Soderback, B. 1995. Replacement of the native crayfish *Astacus astacus* by the introduced species *Paciastacus leniscul*us in a Swedish lake: possible causes and mechanisms. Freshwater Biology 33:291-304.

Stein, R.A. 1976. Sexual dimorphism in crayfish chelae: functional significance linked to reproductive activities. Canadian Journal of Ecology 54:220-227.

Taylor, C.A., and M. Redmer. 1996. Dispersal of the crayfish *Orconectes rusticus* in Illinois, with notes on species diplacement and habitat preference. Journal of Crustacean Biology 16:547-551.

Weagel, K.V., and G.W. Ozburn. 1972. Observations on the life history of the crayfish, *Orconectes virilis* (Hagen), in northwestern Ontario. 50:366-369.

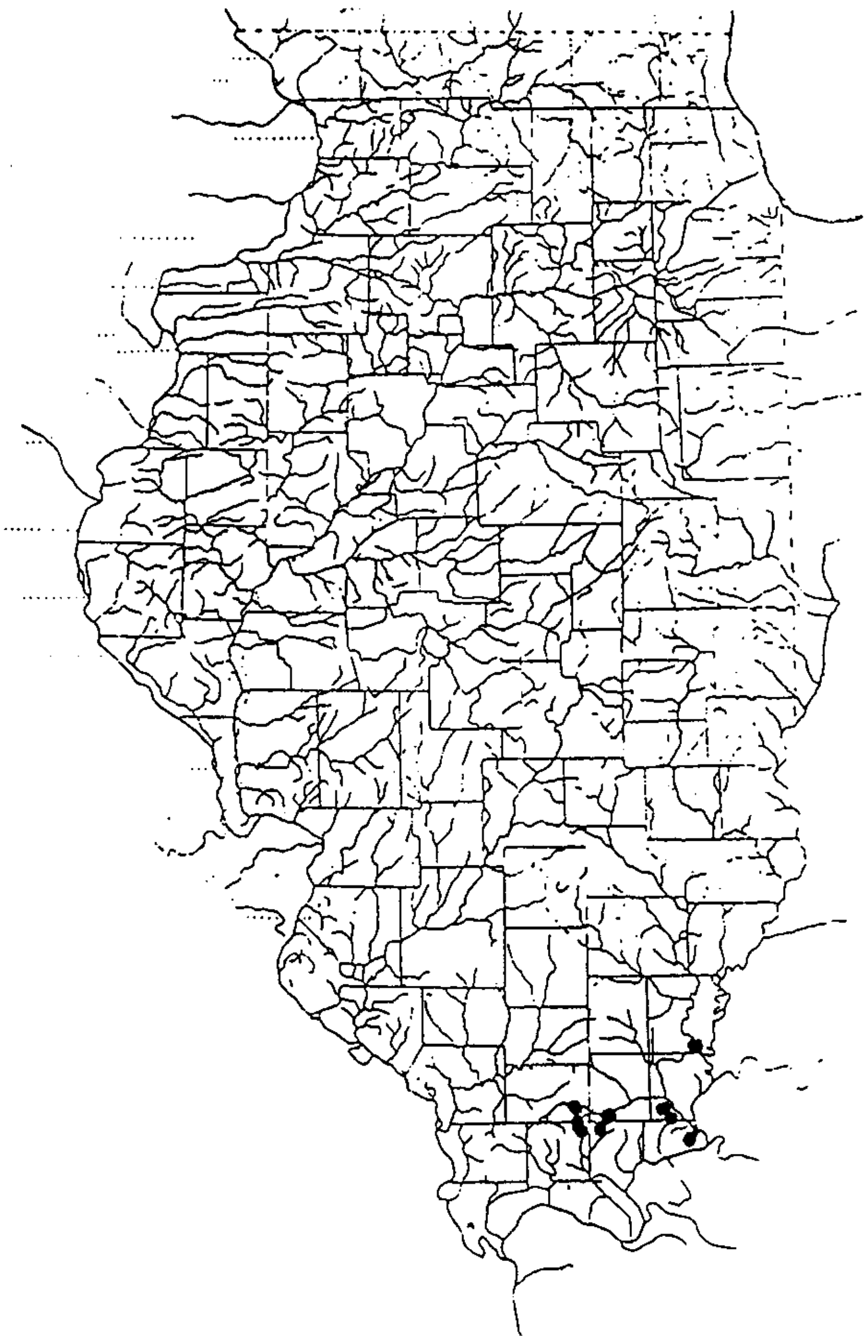

Figure 1. Current distribution of the Indiana crayfish, *Orconectes indianensis*, in Illlinois (modified from Page, 1994).

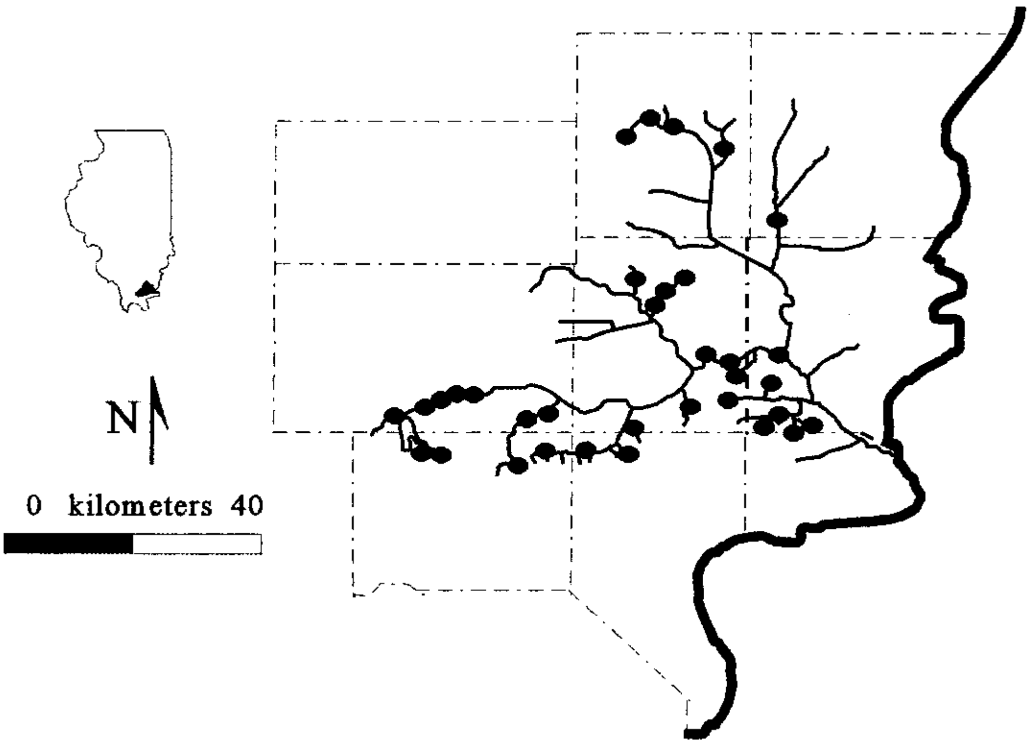

Figure 2. The Saline River system of southeastern Illinois and localities inventoried for the presence of *Orconectes virilis*.

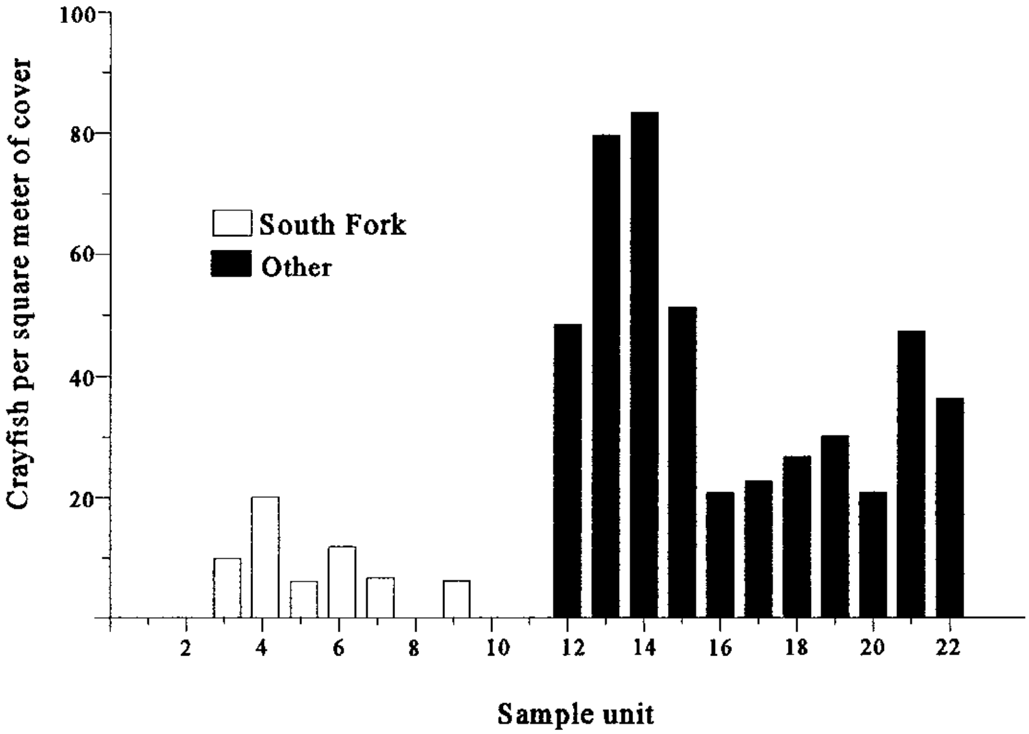

Figure 3. Overall substrate weighted crayfish densities for the South Fork of the Saline River (sample units 1-11) and other streams (sample units 12-22).

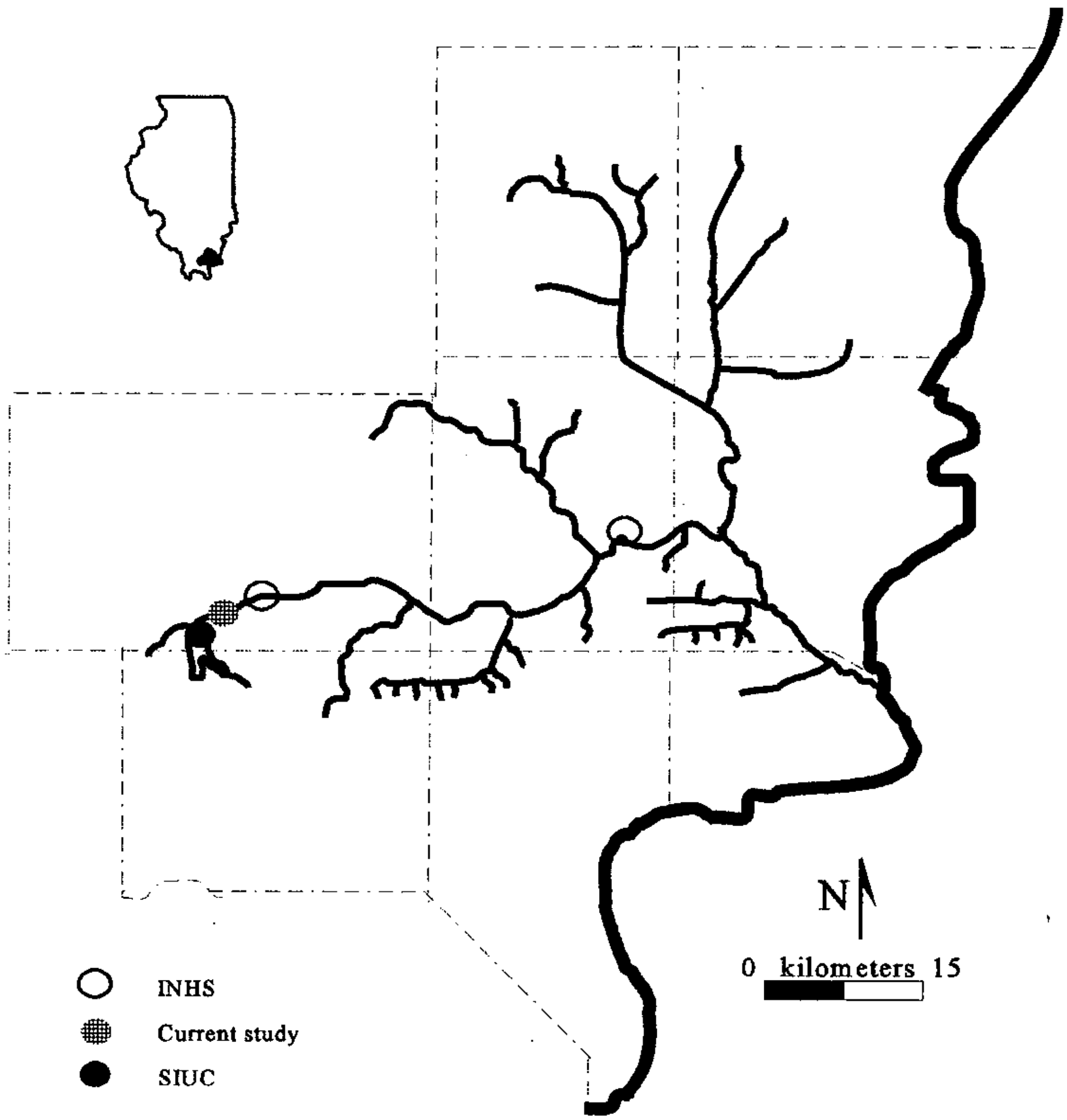

Figure 4. Distribution of the regionally introduced *Orconectes virilis* in the Saline River system (INHS = Illinois Natural History Survey crustacean collection records, 1997; SIUC = Southern Illinois University at Carbondale, decapod collection).

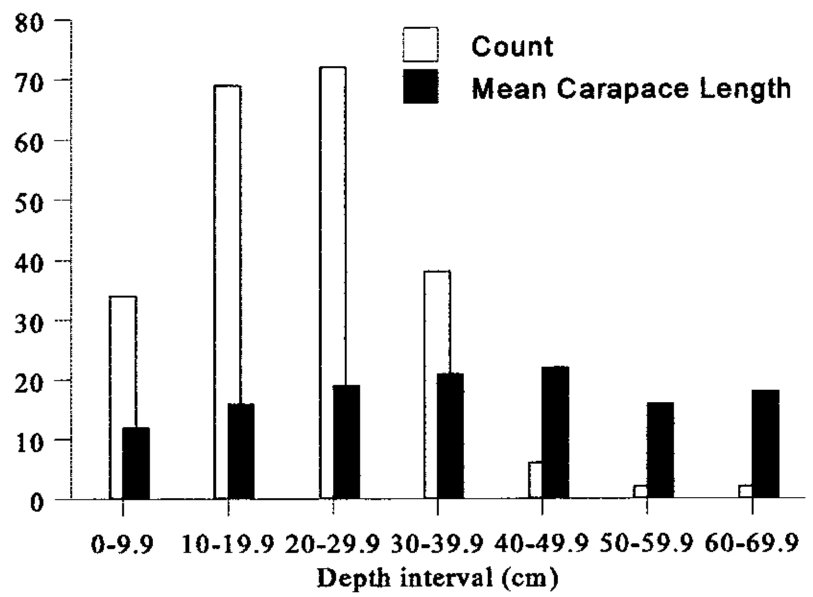

Figure 5. Observed frequency and mean carapace lengths of *Orconectes indianensis* for 7 depth intervals.

Table 1. Uncorrected densities of *Orconectes* species in the South Fork of the Saline River (units 1-11) and other stream systems (units 12-22), substrate composition, and the substrate weighted crayfish density.

Sample unit	Density		% Boulder & cobble	Substrate weighted density	
South Fork Saline River	*O. indianensis*	*O. virilis*		*O. indianensis*	*O. virilis*
1	0	0	19.2	0	0
2	0	0	18.4	0	0
3	1	1	17.6	5.7	5.7
4	3	0	23.9	12.5	0
5	2	0	30.6	6.5	0
6	3	0	28.1	10.7	0
7	1	0	11.1	9.0	0
8	0	0	11.6	0	0
9	1	0	12.8	7.8	0
10	0	0	13.7	0	0
11	0	0	12.0	0	0
Mean	**.82**	**.09**	**18.09**	**4.95**	**.52**
Other streams	*O. indianensis*	*O. immunis*		*O. indianensis*	*O. immunis*
12	0	3	21.0	0	14.3
13	7	4	28.9	24.2	13.8
14	5	0	15.7	31.8	0
15	15	0	27.1	55.4	0
16	18	0	28.4	63.4	0
17	6	0	8.0	74.9	0
18	1	3	4.3	23.3	69.8
19	0	2	7.6	0	26.3
20	5	0	19.7	25.4	0
12	7	0	32.3	21.7	0
22	7	0	15.9	43.9	0
Mean	**6.5**	**1.1**	**18.99**	**33.1**	**11.3**

Table 2. Realized fecundity of *Orconectes indianensis*.

Month	*# individuals*	$\overline{X}$ *eggs*	*SD*	*Range*
March	1	60	-	-
April	4	71.8	34.3	31-115
May	2	37.5	3.5	35-40
Total This Study	7	60.3	29.2	31-115
Page (1985)	3	149	28.5	121-178
Overall	10	86.9	50.8	31-178