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REPORT ON THE STATUS OF SLOAN'S CRAYFISH (ORCONECTES SLOANII BUNDY) AT THE FRENALD ENVIRONMENTAL PROJECT (P.O. 843147)

11/05/93

LEE ST. JOHN
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REPORT

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Report on the Status of the Sloan's Crayfish (*Orconectes sloanii* Bundy) at the Fernald Environmental Management Project
P.O. 843147

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November 5, 1993

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EXECUTIVE SUMMARY

On September 15, 1993, Dr. F. Lee St. John visited the Fernald Environmental Management Project (FEMP) site to confirm the presence or absence of Sloan's crayfish (*Orconectes sloanii* or *O. sloanii*) in the on-property section of Paddys Run, an intermittent stream which is a tributary of the Great Miami River. This crayfish is a state-listed threatened species in Ohio. Although the stream was dry throughout much of its course, three pooled areas (two on the property and one off property) were found which supported populations of *O. sloanii*. In Paddys Run and other streams which are at the eastern edge of the range of *O. sloanii*, the survival of the species is threatened by habitat destruction and competition with another crayfish species, *Orconectes rusticus* (which was also found in Paddys Run). Because of the intermittent nature of Paddys Run, the upstream portion within the FEMP site is considered only marginal habitat for *O. sloanii*.

INTRODUCTION AND OBJECTIVES

The purpose of the study was to determine if the crayfish, *Orconectes sloanii*, which is a threatened species in Ohio (Ohio Dept. of Natural Resources 1992), is present as part of the natural resources of the FEMP. The presence of other crayfish species was to be noted (per the scope of work), but since collecting specimens for identification in the laboratory was not desired, the identification of species other than *O. sloanii* was not required. The objective then was to determine the presence or absence of *O. sloanii* in the aquatic environment at the FEMP site.

BACKGROUND

DESCRIPTION OF *O. sloanii*:

Figure 1 shows dorsal and ventral views of a typical male crayfish. Females differ in that: 1) the first pair of pleopods (swimmerets) is NOT enlarged and modified for sperm transfer at copulation and 2) between the bases of the third pair of pereiopods (walking legs), there is a dead-end pouch which serves as a sperm receptacle at copulation and stores the sperm until eggs are extruded and fertilized. This structure is called the annulus ventralis. The shape of the annulus varies for different species but is not a definitive characteristic for species identification. The first pair of male pleopods (called gonopods) is a definitive character for species identification in the form I (breeding) males, where it assumes a more rigid and defined shape than in the form II (non-breeding) males. Fortunately, the form I and form II gonopods of *O. sloanii* are distinctive, making field identification relatively easy. Other characteristics used to distinguish one species of crayfish from another are the shape of the chela (pinchers) and the width and length of the areola (Figure 1). Since the survey conducted found only two species of crayfish in Paddys Run, the other being *Orconectes rusticus*, identifying characteristics of both are included in Figures 2a and 2b for future reference.

DISTRIBUTION OF *O. sloanii*:

Bundy (1876) first described *Cambarus sloanii* (now *Orconectes sloanii*) and indicated that its range was southern Indiana and Kentucky. No Kentucky specimens have ever been found, indicating that Dr. Sloan, who reported this to Bundy, was mistaken. St. John (1988) and many others have collected extensively in Kentucky without finding *O. sloanii*. Rhoades (1941) collected the first *Orconectes sloanii* in Ohio from Shakers Creek in Warren County in 1938. Additional Ohio specimens were collected from Butler, Darke, Hamilton, Montgomery, and Preble Counties (Rhoades 1941, 1944). Rhoades (1962) further defined the range of *O. sloanii* in Ohio by listing it as occurring in Butler, Darke, Hamilton, Miami, Montgomery, Preble, Shelby, and Warren Counties. St. John (1988) stated that the species had been extirpated from Miami and Shelby Counties. The range is now known to include parts of Indiana and Ohio (Figure 3). *Orconectes sloanii* is not known to occur anywhere else in the United States beyond the areas of Ohio and Indiana (Figure 3).

NATURAL HISTORY OF *O. sloanii*:

Few crayfish life histories have been documented. This is true for *O. sloanii*; however, the life history may be assumed to be similar to other species of the genus *Orconectes*, such as *O. sanborni*, described by St. John (1976). To summarize, young hatched in the spring of the first year of their life and apparently underwent several closely spaced molts. (Animals with exoskeletons can increase in size only by periodic molting.) The sex of the juveniles was obvious by midsummer because the annulus ventralis, or sperm receptacle, of the female appeared at this time (Figure 1). The first pair of pleopods in males (sperm transfer appendages) became distinctively longer than those of the females. Following the first summer's growth, only two molts occurred in one year, one in the autumn (or late summer) and one in the spring. Both sexes usually reached sexual maturity by the autumn of their second year. At this time, the males molted and became form I (breeding), and the eggs in the females (which also molt at this time) began to increase in size. During the spring molt, the males reverted to form II (non-breeding) until the next autumn molt, when they returned to form I. The maximum life span was found to be 37 months.

HABITAT PREFERENCE OF *O. sloanii*:

Rhoades (1941) described the preferred habitat of *O. sloanii* as being streams with flat bottoms, covered with broken and rounded stones. *Orconectes sloanii* is often found near algal beds and aquatic vegetation. Temperature does not seem to be an important factor in its distribution.

St. John (1991) noted the relative decrease in populations of *O. sloanii* (vis-a-vis populations of another crayfish, *Orconectes rusticus*) in stressed environments such as streams which had been subjected to the effects of urbanization, construction, channelization, and pollution.

In his 1991 study, St. John found that the ratio of *O. sloanii* to *O. rusticus* had actually increased at a site in Hamilton County. This site is in a tributary of the Dry Fork of the Whitewater River, which is adjacent to the entrance of the Miami Whitewater Forest (3.75 km from the FEMP site). He suggested that the relatively protected environment provided by this forest was responsible for the success of the *O. sloanii* population there.

In the author's experience, the best habitat for O. sloanii is a stream with constant (but not necessarily fast) current flowing over a rocky bottom. Algal growth upon and around the rocks is common. Stress to the stream ecosystem (ie., construction projects, siltation and pollution) favors *O. rusticus* to the detriment of *O. sloanii*.

Because crayfish "breathe" via gills located beneath the carapace (Figure 1), any stream siltation may decrease the ability of the animal to survive. Organic pollution, such as sewage, will increase the demand for dissolved oxygen by the decomposing organisms (fungi and bacteria) in the stream, thereby reducing the oxygen available for other stream organisms such as the crayfish populations. Toxic wastes, of course, will also be detrimental to the aquatic organisms, either by killing them directly or by killing other organisms whose decay will deplete the water of dissolved oxygen.

COMPETITION WITH OTHER SPECIES OF CRAYFISH:

Since *O. sloanii* was found only with *O. rusticus* in Paddys Run, this sympatric situation will be addressed. Unfortunately, most studies have shown that ANY species of *Orconectes* crayfish fare poorly in competition with *O. rusticus*. Jezerinac (1982) found that *O. rusticus* was replacing *O. propinquus* in the Chagrin River in northeastern Ohio and suggested that the aggressiveness of *O. rusticus* was a possible cause for this replacement. Butler (1983) discussed the success of *O. rusticus* in competition with *O. sanborni* in Ohio and concluded that *O. rusticus* was more aggressive, grew more rapidly, produced more young, and attained a larger adult size than *O. sanborni*. *Orconectes rusticus* was reported to be replacing *O. propinquus* and *O. virilis* in the Kawartha Lakes region of southern Ontario (Berrill 1978). Capelli (1982) found *O. rusticus* displacing other species of *Orconectes* in northern Wisconsin, but was uncertain of the mechanism responsible for the success of *O. rusticus*. St. John (1991) studied Ohio locations where *O. sloanii* and *O. rusticus* were found together in 1975 through 1977 and showed that, in general, the percentage of *O. sloanii* specimens in recent collections had decreased over the intervening 12 to 14 years. It seems clear that, in an environment subjected to stress (e.g., pollution, siltation and channelization), the *O. sloanii* population will suffer more than the *O. rusticus* population, which may in fact be enhanced.

STATUS OF *O. sloanii*:

Jezerinac (1986) suggested that the crayfish *O. sloanii* be placed on the Ohio list of threatened species. In the absence of *O. rusticus*, greater numbers of *O. sloanii* were found in streams. This suggests that *O. rusticus* competes with and displaces *O. sloanii*.

Additionally, *Orconectes sloanii* is threatened by urban development, stream impoundment, water pollution, and siltation. Combined with competition with the more prevalent *O. rusticus*, *O. sloanii* populations have been declining in Ohio. Because of its limited Ohio distribution, any additional population losses may lead to its elimination in the state.

Paddys Run is at the eastern edge of the range of *O. sloanii*, but at the edge of its range, a species may be either expanding or diminishing in numbers. The *O. sloanii* population appears to be diminishing at the eastern edge of its range in Ohio, as shown by its extirpation from Miami and Shelby Counties in Ohio (St. John, 1988). This seems to be due to habitat destruction and competition from *O. rusticus*. Neighboring populations in Indiana appear to be stable because of minimal habitat alteration. As a result, Ohio has conferred threatened status on *O. sloanii* while Indiana has not (Ohio Dept. of Natural Resources 1992; Indiana Dept. of Natural Resources 1993).

SITE DESCRIPTION AND METHODS

Although the objective of the study was to be qualitative and to determine only the presence or absence of *O. sloanii* at the FEMP site, only two stream species of crayfish were found at the site; since the other species was easily identified in the field as *O. rusticus*, unanticipated quantitative data regarding the ratio of the two species at the sampling sites were obtained. This data may be useful to determine future trends in the survival of these two species in sympatry (species occurring in the same area), especially since *O. rusticus* appears to outcompete *O. sloanii*.

The original survey planned to include collection and identification of crayfish from several sites along the stream within the FEMP boundaries, as well as from the Storm Sewer Outfall Ditch (SSOD). Because of the unusually dry summer weather in the area, the SSOD and most parts of Paddys Run were dry, making crayfish sampling very difficult. However, three pooled areas were found in the creek, two near the bridge of the railroad siding which enters the FEMP site and one downstream (south) from the FEMP boundary at the New Haven Road bridge (Figure 4). At these three sites, *O. sloanii* was obtained by seining the creek with a minnow seine (1.2 x 1.8 m; 0.64 cm mesh). The pooled areas are not the preferred habitat for *O. sloanii*, but were the only places where crayfish might survive while the stream was so dry.

If a comparison of the dynamics of the crayfish populations in Paddys Run with a reference stream was needed, the tributary of the Dry Fork of the Whitewater River at the bridge on New Haven Road just east of the village of New Haven in Hamilton County might be a good choice. This site is near the entrance to the Miami Whitewater Forest. St. John (1991) found populations of both *O. sloanii* and *O. rusticus* in 1977 and 1989. Data from this stream showed an increase in the ratio of *O. sloanii* to *O. rusticus* over the twelve years. This is a location protected from pollution, siltation, and urbanization, which may explain the unusual success of *O. sloanii* in competition with *O. rusticus* here.

RESULTS

It is not surprising that *O. sloanii* might occur in Paddys Run since it has been collected from nearby tributaries of the Great Miami River including Indian Creek, Four Mile Creek, and the Dry Fork of Whitewater River (St. John 1988).

On September 15, 1993, the author visited the FEMP site to check for the presence of the crayfish *O. sloanii* in Paddys Run and the SSOD. Positive identification of crayfish requires breeding form (form I) males so that the gonopods may be identified. Some form I males were found, making the accurate determination of the species possible.

At Site 1, only *O. sloanii* was found. Two females, one breeding form (form I) male and one non-breeding form (form II) male were found. At Site 2, under the bridge of the FEMP railroad siding, 12 specimens of *O. rusticus* were obtained as well as seven *O. sloanii* [1 male (form I), 3 males (form II) and 3 females]. Three sweeps of the seine were used to collect these 19 specimens. At Site 3, north of the railroad bridge, three sweeps of the seine produced two *O. rusticus* and two *O. sloanii* (both male form I). All specimens were identified and returned to the stream.

CONCLUSIONS AND SUMMARY

Much of Paddys Run was dry during sampling in September 1993; however, this does not mean that *O. sloanii* has been extirpated from these portions of Paddys Run (or the SSOD). In studies of *Orconectes nais* in an intermittent stream in Oklahoma, Momot (1966) determined that crayfish with relatively low reproductive rates can be characterized as organisms which repopulate streams by upstream migration rather than by reproduction in-situ. With ephemeral, intermittent streams, upstream movement is the primary means for stream repopulation. This suggests that, as Paddys Run refills with water in the spring, *O. sloanii* will return from downstream pools. Since spring flooding usually results in stream species being swept downstream, repopulation from the other direction, i.e., from headwater areas toward downstream, is unlikely. However, the size and infrequency of the pools which were remaining in Paddys Run in September 1993 suggest that completely repopulating the stream during the period of spring rains is unlikely. In fact, considering the intermittent nature of Paddys Run (as evidenced by its representation as a dotted line on the USGS topographic map and from information provided by FEMP staff), it appears that this stream should be considered as only marginal habitat for *O. sloanii*.

Maintaining a viable population of *O. sloanii* in the intermittent portion of Paddys Run (which appears to include all of the stream within the boundaries of the FEMP site) would require careful management, including the prevention of: a) siltation from soil erosion accompanying construction, b) the introduction of flyash or other flocculent material which is destructive to gill-breathing animals, c) any damming of the stream, and d) the introduction of polluting chemicals. Constant stream flow is desirable. Any condition which degrades the quality of the stream may lead to the success of the *O. rusticus* population to

the detriment of *O. sloanii*. As noted above, *O. rusticus* appears to be more tolerant and may eventually lead to the extirpation of *O. sloanii*, no matter what precautions are taken. Any extremes of the conditions listed above could, of course, result in the elimination of all crayfish from Paddy Run. It might be possible to relocate the crayfish from the portion of Paddys Run within the FEMP site if it becomes necessary to compromise the integrity of the stream in the future. Seining the pools in the autumn would recover some of the crayfish; some are inevitably missed. Only some of those collected would survive the reintroduction process.

The best sites for possible relocation of *O. sloanii* would be an area of Paddys Run farther south, near its confluence with the Great Miami River. Northern sections of Paddys Run are less optimal because of the ephemeral nature of the water flow in this area. The Dry Fork of Whitewater River in Miami Whitewater Forest, where the species is known to occur (as of June 1989), is an alternative stream for relocation. Conditions for its survival are apt to remain more consistent here, due to the protection of this natural area.

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St. John, F.L. 1991. Changes in mixed populations of *Orconectes* (*R.*) *sloanii* and *O.*(*P.*) *rusticus* (Crustacea: Decapoda: Cambaridae) in southwestern Ohio. Ohio J. Sci. 91: 172-173.

APPENDIX A
FIGURES

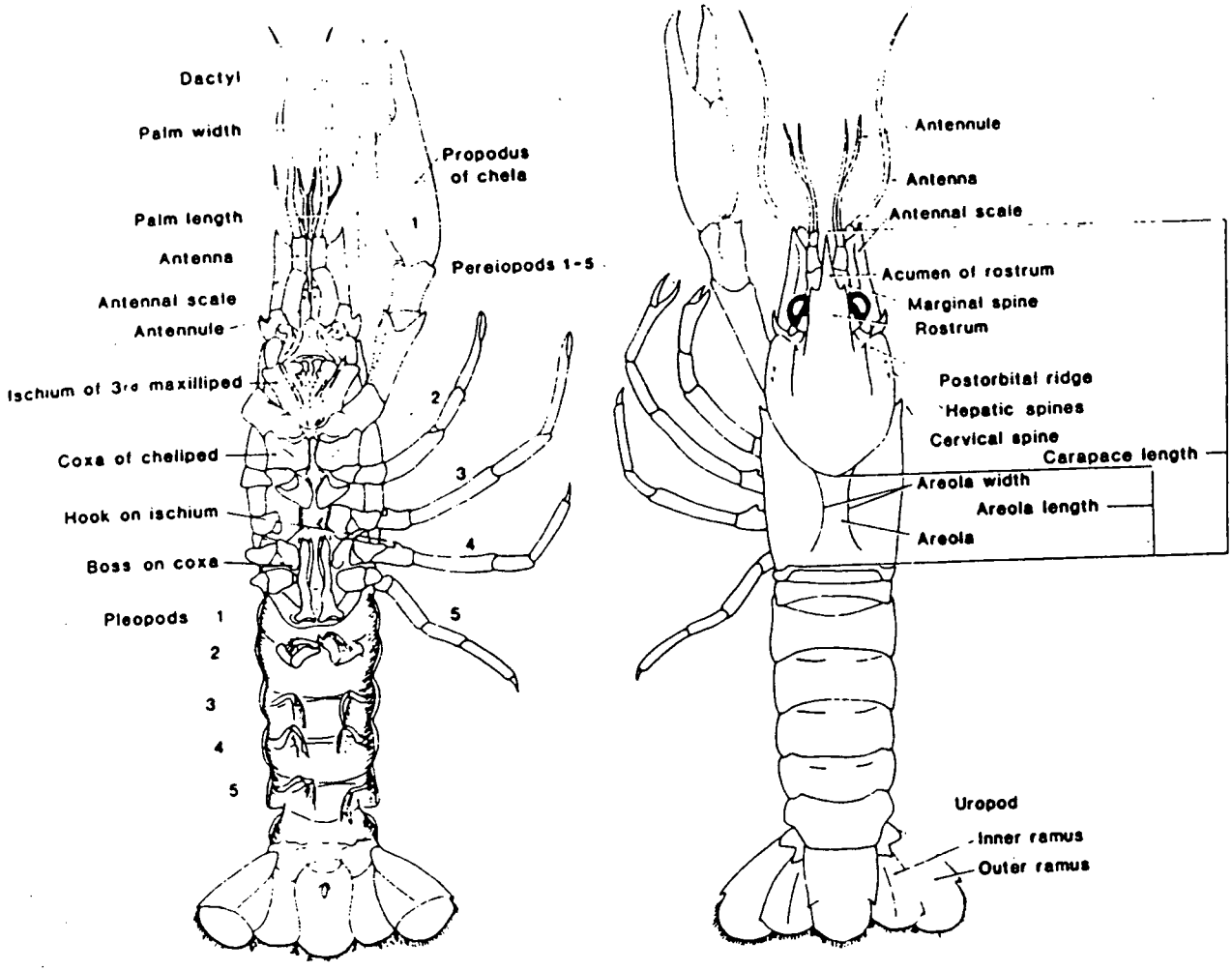
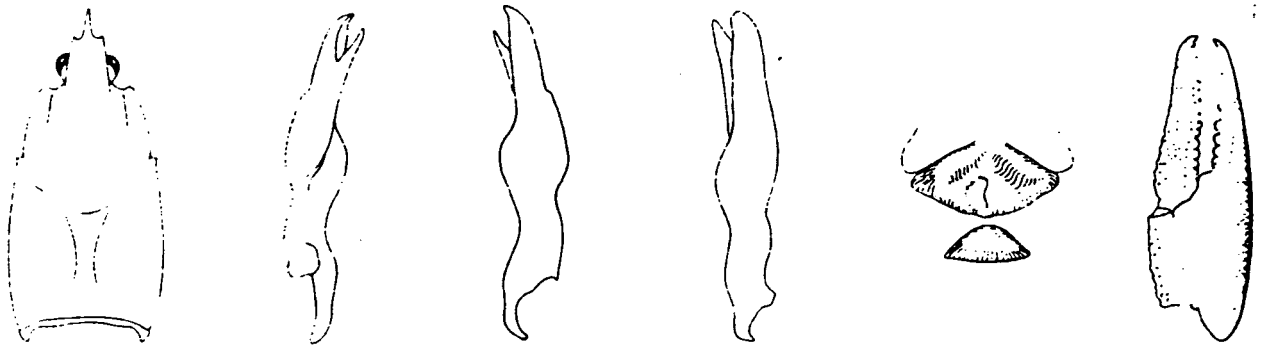
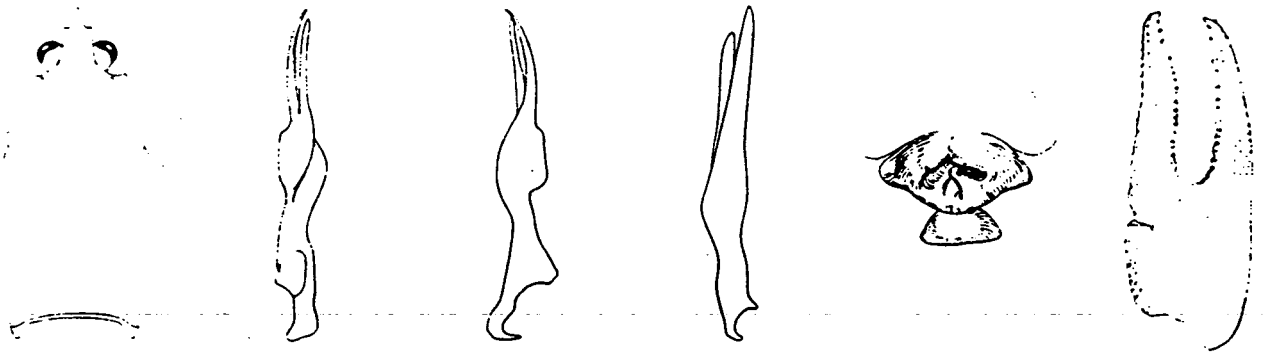


Figure 1: Generalized diagram of crayfish: ventral view on left, dorsal view on right (Hobbs, et al., 1977).



a b c d e f

Figure 2a: Identifying characteristics of *Orconectes sloanii* - a. dorsal view of carapace of male, form I; b. mesial view of first pleopod of male, form I; c. lateral view of same; d. lateral view of first pleopod of male, form II; e. annulus ventralis of female; f. dorsal view of chela of male, form I.



a b c d e f

Figure 2b: Identifying characteristics of *Orconectes rusticus*, a, b, c, d, e and f the same as Figure 2a, above.

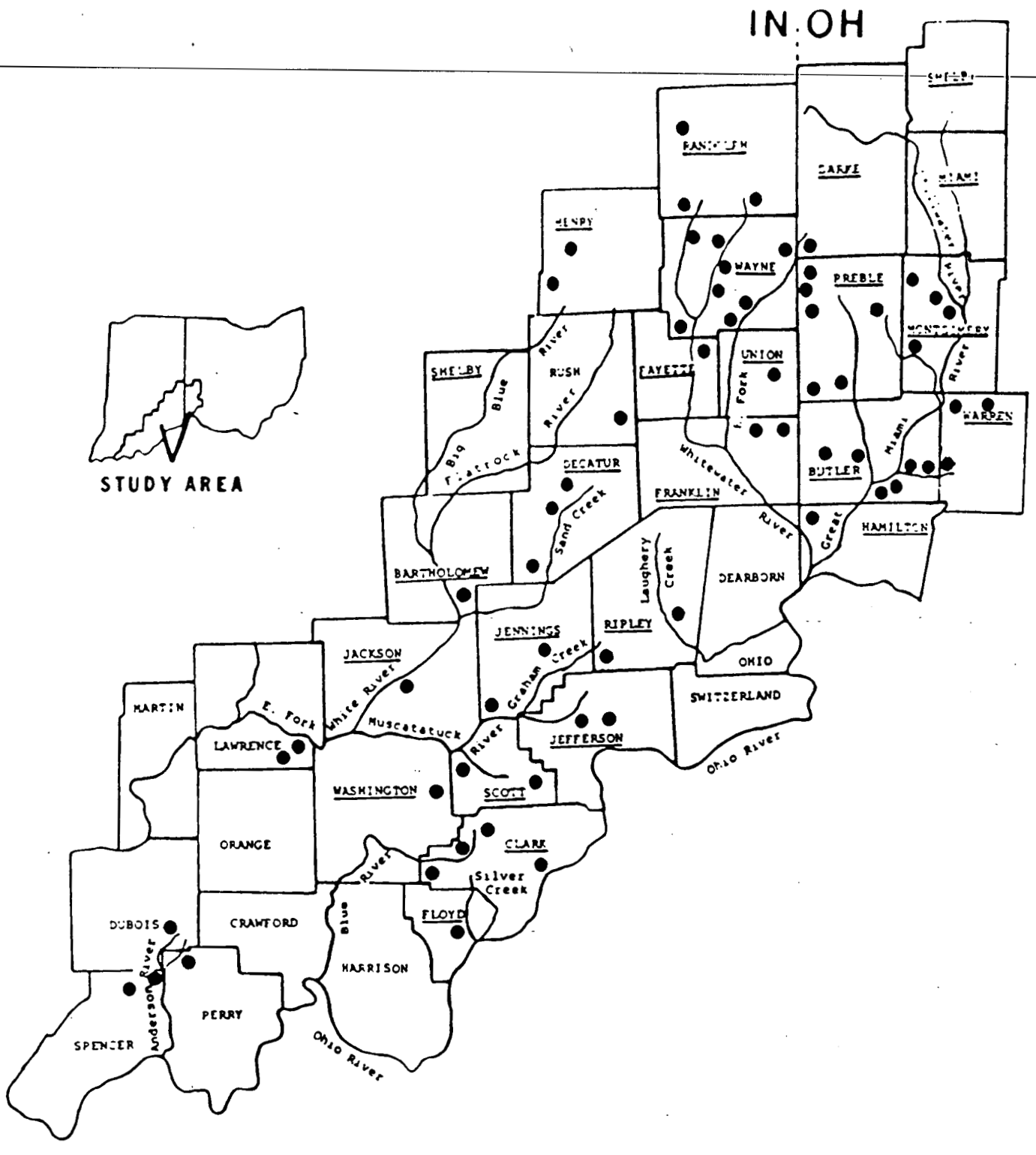


Figure 3: Distribution of the crayfish species *Orconectes sloanii* throughout its entire range (Indiana and Ohio). Each dot represents a collection of crayfish containing specimens of *O. sloanii*, collected by the author from 1975 through 1989 (St. John 1988).

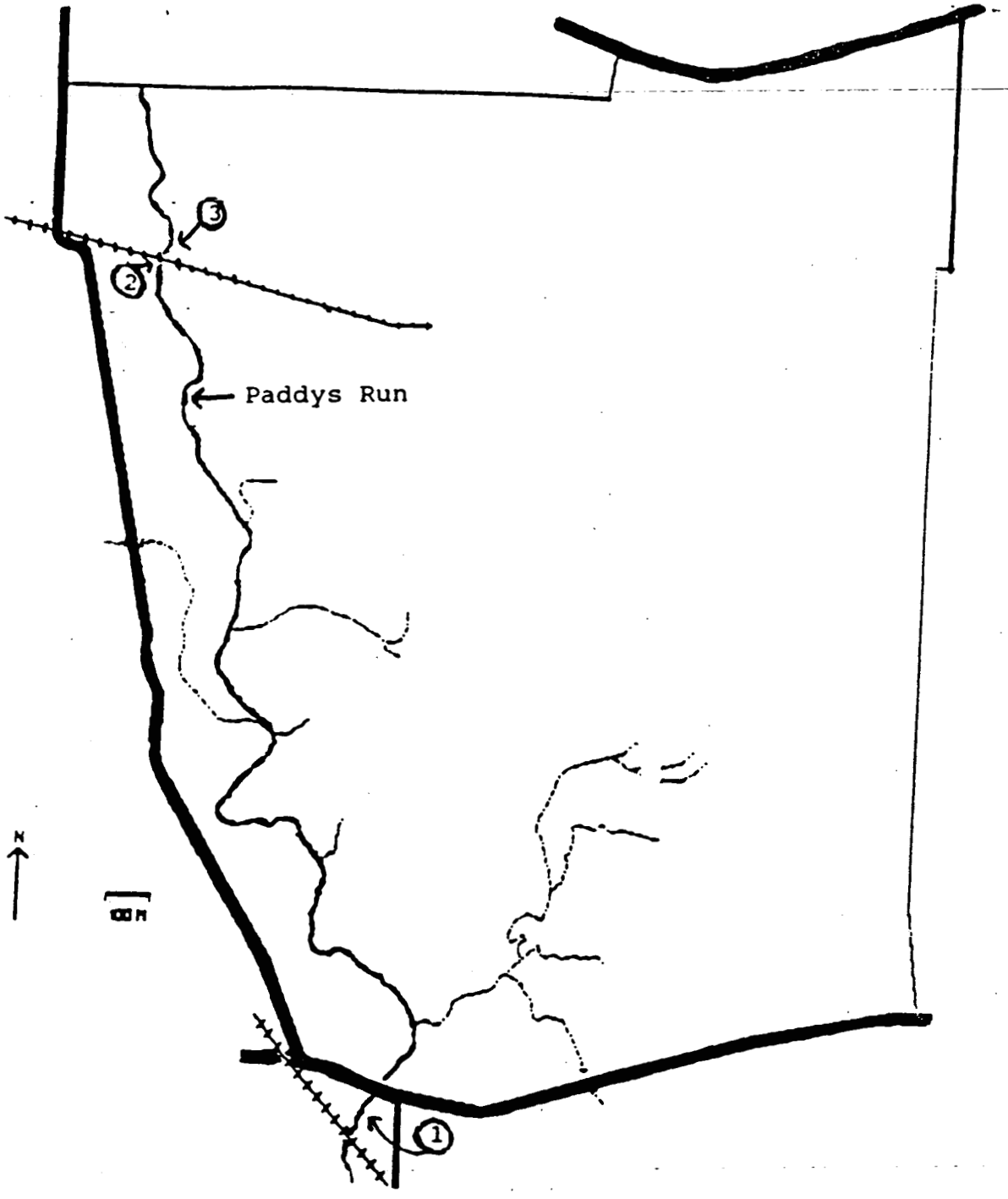


Figure 4: Map of the FEMP site showing the three crayfish collection sites, with numbers in circles (modified from Facemire, et al., 1990.)

Addendum to the Report on the Status of the Sloan's Crayfish, *Orconectes sloanii* (Bundy, 1876), at the Fernald Environmental Management Project (FEMP) (P.O. JM-69471)

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June 24, 1994

Proposal No. JM-69471, dated Nov. 5, 1993, reported on the status of Sloan's crayfish, *Orconectes sloanii* (Bundy, 1876), at the Fernald Environmental Management Project (FEMP) site. This crayfish is a threatened species in Ohio. During the survey (September 15, 1993), specimens of Sloan's crayfish were found at three localities within Paddys Run. One of these sites was located off property south of the FEMP boundary. All three localities were pooled areas while the remainder of the creek bed was dry.

It was predicted in the report that the crayfish would repopulate the run and riffle portions of the stream when water returned to the creek bed following spring rains. It was further suggested that (1) this would occur by upstream migration from the pools which had served as refugia during the summer (and, of course, winter) and (2) that, due to the intermittent nature of Paddys Run, completely repopulating the stream following spring rains, but before summer drying, would be unlikely.

On May 21, 1994, the author examined 25 sites along Paddys Run (three of these were off-property), which was flowing throughout the entire section along the FEMP property. The Storm Sewer Outfall Ditch was also surveyed. Crayfish, where present, were collected by using a minnow seine (1.2 m x 1.8 m; 0.64 cm mesh). They were identified in the field and then returned live to the stream. Seven of the 24 sites yielded crayfish and six of these seven sites yielded specimens of *O. sloanii*. The other crayfish species found in Paddys Run, either alone or in sympatry with *O. sloanii*, was *Orconectes rusticus*, which was also true in the 1993 sampling (Table 1 and Figure 1).

Reference to the 1993 report will show that the two on-property locations where *O. sloanii* was found were two pooled areas, one immediately north and one immediately south of the railroad trestle, in the northwest section of the FEMP property. These correspond to sites 4 and 5 in Figure 1 of this report. The fact that *O. sloanii* was not found at these sites during this survey is not surprising since *O. sloanii* prefers riffles and runs with rocky bottoms. The dry conditions found in September had forced the "survivors" into the less desirable pool habitat where they remained during the summer as well as the winter. Following the spring rains, the species has migrated from the pool refugia to repopulate the runs.

It should be noted that off-property sites in Figure 1 (numbers 23, 24 and 25) are at the same location as site C sampled in 1993, where New Haven Road crosses Paddys Run. The 1993 report map is in error; site 1 should be farther south, beyond the limits of the map.

From the brush and debris caught in vegetation along the banks of Paddys Run, it was obvious that the spring flood(s) preceding the May 21 survey had raised the water level three to four feet above normal and had subjected the stream to a swift current. While crayfish could be dislodged from an upstream pool and redistributed downstream, such a flood current would probably sweep them far downstream. A more likely mode of repopulation would be the slow downstream movement following the cessation of the spring

flooding. The 1993 report, however, cited Momot (1966): "Crayfish, which have a relatively low reproductive rate, should definitely be added to the list of organisms that repopulate streams by upstream migration rather than by reproduction in situ." It is obvious that in Paddys Run, *O. sloanii* is repopulating by migration, but by downstream migration rather than upstream. This is evident by the specimens collected from sites 6 through 10, just downstream from the pools at the railroad bridge. However, this slow downstream repopulation of the stream has currently extended only about 1000 feet from the pool areas. Further downstream movement may well be limited by the annual summer drying of most of the streambed.

The population of *O. sloanii* appears to be localized near the railroad bridge over Paddys Run in the northwest portion of the FEMP site. The crayfish are confined to the permanent pools at this location when the remainder of the stream is dry and they repopulate the stream in the spring (after the floods) by downstream migration. This is a slow process, proceeding this spring only about 1000 feet by May 21. It is anticipated that further downstream migration may well be hindered by the summer drying of the streambed. Although periodic summer rains may temporarily restore water to intermittent portions of Paddy Run, the discontinuous nature of the habitable parts of the stream will preclude any further significant repopulation. To reiterate the 1993 report, Paddys Run is only marginal habitat for *O. sloanii* for the reasons just cited.

Collecting site 21 (Figure 1) is the Storm Sewer Outfall Ditch. Inasmuch as it was dry at the time of the 1993 report, sampling was again attempted for the current report. The Storm Sewer Outfall Ditch was dry again in May 1994, leading to the conclusion that its extreme intermittent nature makes it an unlikely habitat for any species of stream crayfish.

An off-property population of *O. sloanii* seems to be similarly established near where New Haven Road crosses Paddys Run. However, this population does not appear to migrate significantly upstream to include any part of Paddys Run within the FEMP boundaries. For the study of the FEMP property, this population may be disregarded except (1) as it might be influenced by siltation and/or pollution travelling downstream, or (2) as a possible site for relocation of on-property *O. sloanii*, if needed (however, a more suitable relocation site was suggested in the Nov. 5, 1993, report by this author.). Unfortunately, no studies of crayfish relocation projects are known to the author and the success of such an endeavor is uncertain.

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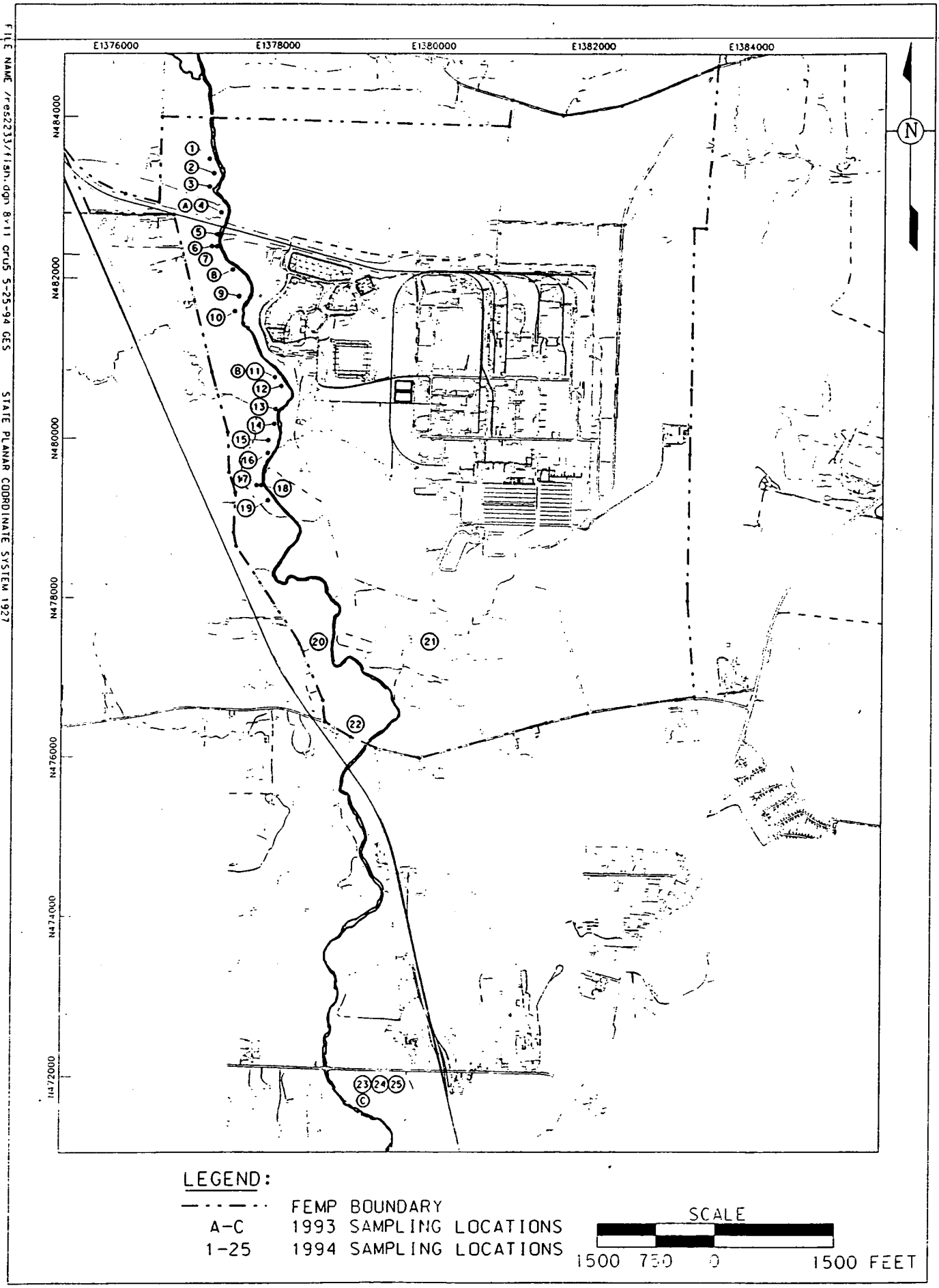
TABLE 1

Collecting Sites	Results
1	no specimens
2	no specimens
3	no specimens
4	no specimens
5	no specimens
6	1 *O. sloanii*
7	3 *O. sloanii*, 3 *O. rusticus*
8	3 *O. sloanii*, 3 *O. rusticus*
9	1 *O. sloanii*, 2 *O. rusticus*
10	1 *O. sloanii*, 2 *O. rusticus*
11	no specimens
12	no specimens
13	no specimens
14	no specimens
15	no specimens
16	no specimens
17	2 *O. rusticus*, 1 unidentified juvenile
18	no specimens
19	no specimens
20	no specimens
21	no specimens
22	no specimens
23	2 *O. sloanii*, 1 *O. rusticus*
24	no specimens
25	no specimens



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