CONSERVATION OF IMPERILED CRAYFISH—ORCONECTES (PROCERICAMBARUS) PERUNCUS (CREASER, 1931) (DECAPODA: CAMBARIDAE)

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INTRODUCTION

Common Name.—Big Creek crayfish (Pflieger, 1996).

Conservation Status.—Threatened (Taylor et al., 1996). Imperiled in Missouri and globally (S2, G2; Missouri Natural Heritage Program, 2006). Based on the species’ limited distribution (< 20,000 km²) and its observed decline in significant reaches of several streams reported here, O. peruncus (Creaser, 1931) has been classified as Vulnerable, VU B1b(i, iv), following IUCN (2001).

Identification.—The Big Creek crayfish (Fig. 1), Orconectes peruncus, was first described by Creaser (1931) as Cambarus peruncus from Little Creek, a tributary to Big Creek in the St. Francis River drainage, near the town of Chloride, Iron County, Missouri (Fig. 2). This species is a member of the subgenus Procericambarus as defined by Fitzpatrick (1987). The form I male gonopods are long with slender, tapering central projections slightly curved posteriorly and reaching to the bases of the first pereiopods when the pleon is flexed (Creaser, 1931; Pflieger, 1996). The mesial projection of the gonopod is distinctly shorter and thicker than the central projection, and is grooved along its anterior margin, and the apex is widened and recurved (Creaser, 1931; Pflieger, 1996). Form I males possess hooks on the ischia of the third and fourth pereiopods that are reduced in size in form II males. The female’s annulus ventralis possesses an elevated extension on its posterior margin, an irregularly curved sinus, and a wide, shallow fossa (Creaser, 1931; Pflieger, 1996). The crayfish’s base color is described as olive green to tan or brown with many dark spots on the chelae, cephalothorax and pleon, and a prominent blackish saddle stretching laterally across the dorsal surface of the posterior edge of the cephalothorax and anterior edge of the pleon (Creaser, 1931; Pflieger, 1996).

NATURAL HISTORY

Distribution.—The geographic range of O. peruncus is limited to the upper St. Francis River drainage in St. Francois, Iron, Madison and Wayne counties of southeastern Missouri (Fig. 2; Pflieger, 1996; Riggert et al., 1999). This localized distribution resulted in early conservation classifications of “Threatened” (Taylor et al., 1996) and “Imperiled” (Missouri Natural Heritage Program, 2006). A recent comprehensive survey (Riggert et al., 1999) confirmed not only the narrow range of this species, but also that the range has been reduced in the past 30 years, presumably related to an invasion of Orconectes hylas (Faxon, 1890) from a neighboring drainage.

The first records of O. peruncus were reported by Creaser (1931). He described the species’ distribution as being Little Creek (which he mistakenly described as a tributary to the St. Francis River), a tributary to Big Creek, and Ruble Spring Branch, both in Iron County (Fig. 2). Creaser (1934) also described the historical dispersal and range of O. peruncus (= Faxonius peruncus). The species was considered to have evolved from O. hylas stock from the Black River, and became established in Big Creek on the western side of the St. Francis River drainage, possibly through stream capture. Creaser (1934) hypothesized that O. peruncus spread throughout the headwaters of the entire drainage but that eventually older headwaters were ecologically isolated by habitat changes, and O. peruncus in those streams differentiated into another species of Procericambarus, Orconectes quadruncus (Creaser, 1933). Williams (1954) later reported the known distribution of O. peruncus as being Big Creek and its tributaries, Little Creek, and Ruble Spring Branch in Iron and Madison counties.

Riggert et al. (1999) conducted the first comprehensive survey for O. peruncus and O. quadruncus, when they sampled 57 sites on 30 streams in the St. Francis River drainage and reported on museum specimens from the University of Missouri-Columbia (additional 10 sites on eight streams), the National Museum of Natural History, Smithsonian Institution (five sites on five streams), and the Illinois Natural History Survey Crustacean Collection (three sites on three streams). This study expanded the known range to four counties (listed above) and found O. peruncus to inhabit mainly the Big Creek and Twelvemile Creek subdrainages, as well as the headwaters of the St. Francis River mainstem and a few other tributaries (Fig. 2).

Abundance.—Despite its rarity and limited range, O. peruncus appears to be common in streams where it occurs. Riggert et al. (1999) reported relative densities for O. peruncus from three habitat types in its type locality of Little Creek: riffles = 0.9 (± 0.4 SE) individuals/m²; runs = 4.2 (± 1.1)/m²; and pools = 7.0 (± 2.0)/m². DiStefano et al. (2002) reported O. peruncus summer densities of 21/m² at streams identified as “high density sites”. The largest number of O. peruncus collected at a single site was 1384 individuals in about 2 h (C. M. Riggert and R. J. DiStefano, Missouri Department of Conservation, unpublished data).
Habitat and ecology.—Little quantitative habitat data exist for *O. peruncus*. Early reports suggested only that this species was found under small rocks and in shallow burrows of primarily headwater streams (Creaser, 1931; Williams, 1954; Pfieger, 1996). Riggert et al. (1999) noted that *O. peruncus* was most abundant in smaller streams (< 10 m width). They collected it most often from shallow depths (< 0.5 m) and in association with pebble- and cobble-sized rocky substrate (17-250 mm diameter), and in higher densities from habitats with slower current velocities (Riggert et al., 1999).

Reproduction.—Pfieger (1996) noted the presence of mucilaginous sperm plugs indicating successful mating (Fielder, 1972) in March, May, October, and November, and seven ovigerous females carrying 15 to 123 eggs in late March. A life history study of *O. peruncus* (Riggert et al., 1999) reported that female *O. peruncus* began showing initial signs of mating (elevated numbers of active glair glands [Stephens, 1952] and sperm plugs) in late June and early July; they continued to show active glair glands through the following March and sperm plugs through February. Ovigerous females were observed in April and May, but peaked in April when stream temperatures were about 16-17°C (Riggert et al., 1999). Females carrying stage 1 hatchlings, suggesting recent hatching (Muck, 1996), were collected in early May, and many free-living young-of-year were observed in June (Riggert et al., 1999). First form males were collected year-round; their numbers were very low in May and June but increased significantly in July and peaked in November (Riggert et al., 1999).

**CONSERVATION FACTORS**

Threats.—An assessment of the upper St. Francis River watershed in the mid-1980s noted that the basin was largely wooded, with a moderate amount of grassland, cropland and industrial land uses (Missouri Department of Natural Resources, 1984). A more recent study suggested that most stream habitats and water quality were generally in good condition (Boone, 2001). However, the watershed has a history of heavy metal (lead, copper, nickel, cobalt, zinc, cadmium, etc.) mining that has periodically contaminated surface and groundwater and adversely affected stream channel substrates and vegetation (Missouri Department of Natural Resources, 1984). The Missouri Department of Health issued a fish consumption health advisory (lead) for Big Creek in 1999, which remains in effect (Boone, 2001). Runoff from an industrial smelter near the town of Glover into Big Creek has previously violated zinc and cadmium standards and airborne smelter emissions may have negative effects on streams downwind (Missouri Department of Natural Resources, 1984). A recent study in the adjacent Black River drainage indicated that mining-derived metals, e.g., lead, cadmium, zinc, cobalt, and nickel, had severe impacts on crayfish communities for 10 or more kilometers downstream of mine tailings ponds (Allert et al., in press). With these factors in mind, potential threats to *O. peruncus*...
include the lead smelter and chat piles that can leach toxic trace metals into streams. Several streams within the drainage have already suffered from sedimentation from mine tailings.

Approximately 30 years ago, the crayfish *Orconectes hylas* (the woodland crayfish), which is native to the Black River, Meramec River and Big River drainages in Missouri, was introduced into the upper St. Francis River watershed. This invader rapidly expanded its range into portions of streams occupied by *O. peruncus* (Carver Creek, Big Creek, Goose Creek, Crane Pond Creek), and simultaneously the native crayfish was eliminated from several of those locations (Riggert et al., 1999; DiStefano et al., 2002; R. J. DiStefano, Missouri Department of Conservation, unpublished data). *Orconectes hylas* presents a plausible threat to the continued existence of *O. peruncus*.

**Conservation Action.**—The Missouri Department of Conservation (MDC), University of Missouri-Columbia, and Missouri Cooperative Fish and Wildlife Research Unit are researching potential mechanisms causing *O. peruncus* declines, and MDC is engaged in low-level monitoring to estimate the rate at which declines are proceeding. Understanding the mechanisms of replacement should provide information on the potential efficacy of management strategies to control the invader or to allow continued existence of the native crayfish. DiStefano et al. (2002) reported that life history differences between introduced *O. hylas* and native *O. peruncus* may facilitate the apparent displacement of the native species. *Orconectes hylas* was more fecund, its instars grew faster, and the timing of its life cycle showed potential for it to release its young earlier and for them to grow larger than *O. peruncus*. Another study examined direct aggressive interaction as a potential mechanism for displacement, but results did not show *O. hylas* (juveniles or adults) to be behaviorally dominant over *O. peruncus* in the absence of limited resources (Rahm et al., 2005).

The rate of replacement of *O. peruncus* by *O. hylas* in streams of the St. Francis River drainage is an important consideration in the planning for conservation strategies, since it provides a time frame for action, as well as indications of the mechanisms of replacement. MDC researchers have collected data on the diminishing distribution of *O. peruncus* and expanding distribution of *O. hylas* in Carver Creek (Fig. 2) for the past seven years (2001-2007; R. J. DiStefano, MDC, unpublished data). The entire length of Carver Creek was intensively sampled in 2001, and in each successive year the leading edge of the *O. hylas* invasion has been identified with repeated sampling. Results of this annual effort may provide managers with some indication of the rate at which *O. hylas* might spread and *O. peruncus* might decline throughout other streams in the drainage.

Decline of the native *O. peruncus* in the presence of an invading species might be a purely biological phenomenon occurring in an unperturbed habitat, but may also be accelerated or facilitated by human-induced stressors. A new cooperative study between MDC and the Missouri Cooperative Fish and Wildlife Research Unit started in 2007, with three objectives designed to address potential causal mechanisms and rate of decline of *O. peruncus*. This project will produce: 1) a spatially-explicit, reach-specific watershed characterization that documents human stressors that might impact

**O. peruncus** distribution and abundance, 2) a long term monitoring program to determine range and population changes over time for *O. peruncus* and *O. hylas*, and 3) an assessment of multi-scale habitat requirements for both the native and invading crayfishes with the aim of predicting future distribution patterns and potential refugia for the endemic.

One possible mechanism for the initial introduction and/or spread of *O. hylas* in the St. Francis River drainage is bait bucket introduction (Eng and Daniels, 1982; Ludwig and Leitch, 1996; Lodge et al., 2000). In response to bait bucket and similar intentional introductions MDC has launched several campaigns to educate the public about the dangers of introducing non-native aquatic fauna to Missouri waters. This includes distribution of posters and bumper stickers about bait bucket introductions to all Missouri bait shops, articles about the topic in the state conservation magazine (Canady et al., in press), an episode of MDC’s television
program Missouri Outdoors about O. peruncus, and pertinent information in a brochure that accompanies all issued state wildlife collecting permits.

Conservation Recommendations.—MDC recently completed A Program Plan for Conservation and Management of Missouri’s Non-cave Dwelling Crayfish Resources (DiStefano, 2005) that identifies specific strategies for addressing the plight of imperiled crayfishes, including O. peruncus. A biologist has been assigned full time (nearly 100%) to execute strategies identified in the plan. “Sub-strategy 4.c.” of that plan specifies that MDC “immediately design and implement a multi-scale monitoring program and related important research for the imperiled, endemic O. peruncus” that includes monitoring on watershed and stream scales to detect significant population changes over time, e.g., 10 years, in a series of stream sampling sites throughout the watershed, and associated research to determine habitat requirements. “Strategy 5” of the plan mandates that MDC “anticipate, investigate and identify potential causes of decline or ‘human stressors’ to species of concern (including O. peruncus), including conducting watershed characterizations to identify those potential causes, initiate research and monitoring activities to confirm and document those threats and/or their affects.”

CONCLUSIONS

The status of Orconectes peruncus is of serious concern to Missouri biologists. It is currently listed as “Imperiled” (Missouri Natural Heritage Program, 2006) and “Threatened” (Taylor et al., 1996), and meets the criteria for “Vulnerable” (IUCN, 2001) based on its limited distribution and an overall decline that was observed in the late 1980s (Pflieger, 1996) and validated during the late 1990’s (Riggert et al., 1999). However, O. peruncus’ status has not been examined since the comprehensive survey, nearly ten years ago. Based upon continuing distribution declines for this crayfish observed in Carver Creek during the past seven years (R. J. DiStefano, MDC, unpublished data), it seems likely that O. peruncus might be experiencing continued declines in distribution in other streams such as Big Creek (Fig. 2) where the previous survey (Riggert et al., 1999) documented the presence of O. hylas and declines of O. peruncus. Removal of the invading O. hylas is improbable, but it is hoped that a newly initiated cooperative study will reveal habitat differences between the two species that may allow researchers and managers to identify refugia for O. peruncus, and that continuing public education efforts will prevent further introductions in this drainage.

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REFERENCES


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