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NASHVILLE CRAYFISH



RECOVERY PLAN

RECOVERY PLAN

for

Nashville Crayfish (*Orconectes shoupi*)

First Revision

(Original Approved August 12, 1987)

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Date: _____

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ACKNOWLEDGEMENTS SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 1988. Nashville Crayfish Recovery Plan (1st revision). U.S. Fish and Wildlife Service, Atlanta, Georgia. 16 pp.

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PART I

INTRODUCTION

The Nashville crayfish (Orconectes shoupi) was listed as an endangered species without designation of critical habitat on September 26, 1986, (51 FR 34410). It was believed that designating critical habitat in the highly urban area of Nashville, Tennessee, would have substantially increased the threat of take. This species is currently known to exist only in the Mill Creek basin in Davidson and Williamson Counties, Tennessee. The species is threatened by siltation, stream alterations, and general water quality deterioration resulting from urban development pressures. The species' limited distribution also makes it vulnerable to a single catastrophic event such as a toxic chemical spill or other contamination.

Former and Present Distribution

The Nashville crayfish is currently known only from Mill Creek (Davidson and Williamson Counties, Tennessee) from creek mile (CM) 1.0 (1/4 mile north of Lebanon Pike) upstream to CM 22.4 (near Nolensville, Tennessee). The crayfish also continues to exist in six Mill Creek tributaries: Sevenmile Creek, Sims Branch, Whittemore Branch, Indian Creek, Owl Creek, and Edmonson Branch. All tributary populations except Sevenmile Creek are concentrated near the creek mouths (O'Bara et al. 1985, Bouchard 1984). In Sevenmile Creek they have been reported upstream to CM 3.1, but they likely exist somewhat further upstream. All known populations are primarily on privately owned lands. However, due to the urban setting of this habitat and its proximity to roads and bridges, some public lands are involved. A small section of Sevenmile Creek is owned and managed by the State of Tennessee.

Historically, the species has been reported from (1) Big Creek (Elk River system), Giles County, Tennessee; (2) South Harpeth River (Harpeth River system), Davidson County, Tennessee; and (3) Richland Creek (Cumberland River system), Davidson County, Tennessee (O'Bara et al. 1985, Bouchard 1984). All attempts to recollect specimens from these sites have been unsuccessful. The Big Creek and South Harpeth River collections are believed to have been "bait bucket" introductions which did not survive. The Nashville crayfish specimens that have been reported from Richland Creek (O'Bara et al. 1985, Bouchard 1976, 1984) are now known to have been misidentified. According to Dr. Raymond Bouchard of the Philadelphia Academy of Natural Sciences (personal communication, 1988), the Richland Creek specimens are actually a more common species Orconectes placidus.

Description, Ecology, and Life History

Hobbs (1948) described the species as follows:

"Arostrum with lateral spines, thick and concave lateral margins; upper surface with or without a median carina; fingers of chela with

longitudinal ridge much reduced; whole hand resembling that of O. rusticus placidus Hagen; epistome with a median carina; areola approximately 9 to 10 times longer than broad, with two or three punctuations in narrowest part and length 34-36 percent of entire length of carapace; in males, hooks on ischiopodites of the third pereopods only; terminal elements of first pleopod of first-form male short, reaching almost to coxopodite of second pereopod; two terminal elements separated for only a short distance near tip; mesial process recurved caudomesial and shorter than central projection; and annulus ventralis in female immovable."

O'Bara et al. (1985) described the species in more general terms:

"The Nashville crayfish ranges from 1/4 to 7 inches in total length. Pincers are elongate and the tips have a distinctive orange and black coloration. The hard shell of the crayfish terminates in a sharp point between the eyes. The general body coloration of the Nashville crayfish is quite variable. Different individuals may be found with colorations ranging from green to dark brown. There is, however, quite consistently found on the Nashville crayfish an area of lighter coloration on the mid-back region extending down along the sides of the crayfish towards the head."

Mill Creek's substrate is mainly bedrock which is covered in some areas with gravel and scattered limestone slabs. The pools, backwater areas, and stream margins are covered with silt and sand. Riverweed (Podostemum sp.) occurs on rocks in some swift water areas, and water willow (Justicia sp.) occurs along some shallow gravel shoals. Much of the stream bank is vegetated with trees and shrubs (Bouchard 1976). The Nashville crayfish has been found in a wide range of environments including gravel and cobble runs, pools with up to 10 centimeters (cm) of settled sediment, and under slabrocks and other cover (largest crayfish are usually under cover). The species has also been found in small pools where the flow was intermittent (Stark 1986, Miller and Hartfield 1985). Gravel-cobble substrate provides good cover for juveniles (Stark 1986, Miller and Hartfield 1985). Females seek out large slabrocks when they are carrying eggs and young, and these secluded places are also needed for molting. The species' density over this range of habitats was calculated in 1985 and ranged from 0.6 to 11.9 animals per square meter (Miller and Hartfield 1985). The species is highly photosensitive and is usually found under cover during the day (Bouchard 1976). Canopy cover appears important, as O'Bara et al. (1985) reported that all sites they sampled had canopy cover of 60 to 90 percent.

Very little is known concerning the species' life history, as most studies have concentrated on distributional and status information. However, some life history data does exist, and some speculations can be made based on this species' similarities to other crayfish.

Like many crayfish, this species probably feeds on a variety of organic material, both plant and animal. Reproductive activity begins in late summer and early fall when males change from their non-reproductive form (Form II) to their reproductive form (Form I) (Bouchard 1976). Males are

then ready to breed, and egg-laying probably occurs in late winter and early spring. Females with eggs and young are found in the spring when they are secluded under large objects (rocks, pieces of metal, and other debris) along the stream banks.

This solitary species seeks out cover (large rocks, organic and man-made debris, rubble, etc.) with the largest individuals selecting the largest cover (Stark 1986, Miller and Hartfield 1985, Bouchard 1984). Cover is defended with the largest and most aggressive individuals excluding smaller crayfish (Miller and Hartfield 1985). Cover in some areas may be a limiting factor.

Reasons for Decline and Threats to Its Continued Existence

The Nashville crayfish is endangered by water quality deterioration from development within the watershed. According to a U.S. Army Corps of Engineers' (Corps) report (Corps 1984), about 40 percent of the Mill Creek watershed has been developed. The lower watershed lies within the highly urbanized Nashville, Tennessee, metropolitan area. The Tennessee Department of Public Health (1978) characterized this area of Mill Creek as follows: "The stream's main problem stems from urban commercialization that is gradually overtaking the whole watershed." The Tennessee Department of Public Health also reported that the diversity of organisms in Mill Creek, ". . . does not look good. The number of taxa found was severely limited and decreased as one moved downstream." The upper portion of the Mill Creek watershed has less residential and industrial development, but agricultural activity is extensive. The Corps (1981) concluded that the uppermost segment of Mill Creek was degraded by organic enrichment and had very poor water quality. In that same report, the Corps stated that, "biological communities inhabiting Mill Creek during the 1981 survey indicated water of fair to very poor quality and the influence of moderate to extensive enrichment and disturbance." Threats to the species could also come from other activities in the watershed such as road and bridge construction, stream channel modifications, impoundments, land use changes, and other projects, if such activities are not planned and implemented with the survival of this geographically restricted species in mind. The Nashville crayfish's restricted range makes it very vulnerable to a single catastrophic event such as a chemical spill. The Corps (1984) reported that occasional spills and discharges have occurred along Mill Creek in the past.

Another potential threat to the Nashville crayfish may come from Orconectes placidus (O. placidus). The widespread species is presently not known to inhabit Mill Creek. However, as O. placidus has been able to successfully establish populations in altered riverine habitat (J. Percy Priest Reservoir), further degradation of Mill Creek's habitat and water quality could favor the invasion of O. placidus from adjacent waters.

PART II

RECOVERY

A. RECOVERY OBJECTIVES:

The U.S. Fish and Wildlife Service's goal in developing and implementing recovery plans is to recover a species to the point that Endangered Species Act protection is no longer required. This is often accomplished through the establishment and protection of some specified number of viable populations* throughout a significant portion of the species' range. Based on available information concerning present and historic range and threats to the species, however, the Nashville crayfish's recovery may not be feasible. Historic collection records exist for the Nashville crayfish from three sites outside the Mill Creek drainage (see "Former and Present Distribution" above). According to biologists familiar with the species (Bouchard 1976, 1984; personal communication, 1986; O'Bara et al. 1985), it is believed that two of the collection records represented "bait bucket" introductions that did not establish populations. Thus, they do not represent historic populations and are not appropriate for reintroductions. The third record (Richland Creek) was once thought to have represented a population. However, recent examination of the Richland Creek specimens located in the Philadelphia Academy of Natural Science Museum reveals that the specimens are not Orconectes shoupi but instead O. placidus (Bouchard, personal communication, 1988). Therefore, unless other populations are found or other populations are established in some presently unknown historic habitat, it is unlikely the species can be sufficiently protected from all the threats associated with the rapid development occurring in the Nashville area to allow the species to be delisted.

Although removal from the Act's protection is unlikely, reclassification to threatened status may be feasible. The following are criteria that must be met before reclassification can be considered. The potential for developing recovery goals will be reevaluated as data on the species is gathered.

1. Through protection of the existing Mill Creek basin population and by reintroduction of the species into some as yet unknown historic habitat or by discovery of an additional distinct population, there exist two distinct viable populations.

*Viable population: A reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes. The number of individuals needed will be determined as a recovery task.

2. A newly discovered or reintroduced population must (a) have been established or be self-sustaining for a minimum of 10 years without augmentation from an outside source, (b) represent a significant component of the crayfish fauna throughout most of that creek, and (c) be stable or increasing in numbers and range.
3. The species and its habitat in the Mill Creek system and one other system are protected from human-related and natural threats that would be likely to cause the species' extinction in the foreseeable future.

B. Step-down Outline

1. Preserve Mill Creek population and presently occupied habitat of the Nashville crayfish.
 - 1.1. Monitor local, state, and Federal regulatory agencies' enforcement of existing legislation and regulations (Federal Endangered Species Act, state endangered species laws, water quality regulations, stream alteration regulations, etc.) to protect the species and its habitat and take appropriate measures, where indicated, to ensure adequate enforcement.
 - 1.2. Conduct research necessary for the management and, where possible and required, the improvement of the species' status.
 - 1.2.1. Conduct life history research to include such factors as reproduction, food habits, age and growth, and mortality.
 - 1.2.2. Characterize the species' habitat (relevant physical, chemical, and biological components) for all life history stages.
 - 1.2.3. Identify the present and foreseeable perturbations in Mill Creek, assess their potential impact on the Nashville crayfish and its habitat, and, where necessary and feasible, implement preventive and/or protective measures.
 - 1.2.4. Evaluate potential threats to the Nashville Crayfish from Orconectes placidus.
 - 1.2.5. Investigate the need and value of habitat improvement. Implement improvements if needed to secure viable populations.
 - 1.2.6. Determine the number of individuals required to maintain a viable population.
 - 1.3. Solicit help in protecting the species and its habitat.

- 1.3.1. Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support to protect the species.
- 1.3.2. Meet with local business and/or industry interests and try to elicit their support in implementing protective actions.
- 1.3.3. Meet with landowners adjacent to the species' population centers, inform them of the project, and try to get their support in habitat protection measures.
- 1.4. Develop an educational program using such items as slide/tape shows, and brochures. Present this material to business groups, civic groups, youth groups, and church organizations.
2. Search for additional populations and/or historic habitat suitable for reintroduction efforts.
3. Develop a reintroduction plan and reintroduce the Nashville crayfish into suitable stream reaches that are determined to have been historic habitat.
 - 3.1. Develop a stocking technique and reintroduce the species into historic habitat.
 - 3.2. Implement the same protective measures for any introduced populations as outlined for established populations.
4. Develop and implement a program to monitor population levels and habitat conditions of the presently established population as well as any introduced or newly discovered populations.
5. Annually assess overall success of the recovery program and recommend such actions as changing recovery objectives, delisting, continuing to protect, implementing new measures, and initiating other studies.

C. Narrative Outline

1. Preserve Mill Creek population and presently occupied habitat of the Nashville crayfish. The protection of the one existing population and its habitat in the Mill Creek basin is essential to the species' survival.
 - 1.1. Monitor local, state, and Federal regulatory agencies' enforcement of existing legislation and regulations (Federal Endangered Species Act, state endangered species laws, water

quality regulations, stream alteration regulations, etc.) to protect the species and its habitat and take appropriate measures, where indicated, to ensure adequate enforcement. Prior to and during implementation of this recovery plan, the species and its habitat can be protected by the full enforcement of existing laws and regulations.

- 1.2. Conduct research necessary for the management and, where possible and required, the improvement of the species' status.
 - 1.2.1. Conduct life history research to include such factors as reproduction, food habits, age and growth, and mortality. Some work has been done by Stark (1986) on the Nashville crayfish's micro-habitat and interspecific relationship with an undescribed *Orconectes* in Mill Creek and its tributaries. However, much is still unknown concerning the species' life history. Unless the species' life cycle and environmental requirements are understood, recovery efforts may be inconsequential or misdirected. As the Mill Creek basin population is very vulnerable, care must be taken to ensure research does not further threaten the species.
 - 1.2.2. Characterize the species' habitat (relevant physical, chemical, and biological components) for all life history stages. Before the species' habitat can be adequately protected, it must be completely characterized. Some of the generalized physical habitat requirements are understood (Stark 1986); but more needs to be learned, especially concerning the needs of ovigerous females and specific water quality and biological factors. Knowledge of the species' habitat will enable the recovery effort to focus management and protection attempts on the habitat and ecological associations required for the survival of the species.
 - 1.2.3. Identify the present and foreseeable perturbations in Mill Creek, assess their potential impact on the Nashville crayfish and its habitat, and, where necessary and feasible, implement preventive and/or protective measures. The Mill Creek watershed is extensively developed, and the area is under constant assault from land use changes, stream bank and channel disturbances, pollution events, and other factors impacting the stream habitat. To minimize and/or eliminate these threats where needed to meet recovery, the threats must be identified and correlated with the species' specific life history and habitat requirements gathered under 1.2.1 and

1.2.2, and measures must be taken to minimize or alleviate the sources of the problem.

- 1.2.4. Evaluate the potential threat to the Nashville crayfish from *Orconectes placidus*. *Orconectes placidus* is a related crayfish that has been able to adapt to altered riverine habitat. This species which inhabits other streams in the Nashville basin does not presently exist in Mill Creek. If Mill Creek habitat deteriorates further, this species might be able to invade Mill Creek and outcompete *O. shoupi*. Laboratory studies on competitive interactions between these species would help evaluate the degree of this threat.
- 1.2.5. Investigate the need and value of habitat improvement. Implement improvements if needed to secure viable populations. Specific components of the species' habitat may be missing or, because of some environmental degradation, the habitat may have been rendered unsuitable or marginal. These may be limiting the species' potential expansion. Habitat improvement programs may be needed to alleviate or minimize these limiting factors.
- 1.2.6. Determine the number of individuals required to maintain a viable population. Theoretical considerations by Franklin (1980) and Soul (1980) indicate that 500 individuals represent a minimum population level (effective population size) which would contain sufficient genetic variation to enable that population to evolve and respond to natural habitat changes. The actual population size in a natural ecosystem can be expected to be larger, possibly by as much as 10 times. The factors which will influence actual population size include sex ratio, length of species' reproductive life, fecundity, and extent of exchange of genetic material within the population, plus other life history aspects of these species. Some of these factors can be addressed under Task 1.2.1, while others will need to be addressed as part of this task on a need-to-know basis.
- 1.3. Solicit help in protecting the species and its habitat. Section 7 consultation under the Endangered Species Act and Fish and Wildlife Coordination Act activities can assist in protection of the species, but these programs alone cannot recover the Nashville crayfish. The assistance of Federal and state agencies as well as local governments will be essential. Also, support of the local industrial and business community as well as local people will be needed to

meet the goal of recovering the species. Without a commitment from the people in the Mill Creek basin who have an influence on habitat quality, recovery efforts will be doomed.

- 1.3.1. Meet with local government officials and regional and local planners to inform them of our plans to attempt recovery and request their support to protect the species.
- 1.3.2. Meet with local business and/or industry interests and try to elicit their support in implementing protective actions.
- 1.3.3. Meet with landowners adjacent to the species' population centers, inform them of the project, and try to get their support in habitat protection measures.
- 1.4. Develop an educational program using such items as slide/tape shows, and brochures. Present this material to business groups, civic groups, youth groups, and church organizations. Educational material outlining the recovery goals with emphasis on the other benefits of maintaining and upgrading habitat quality will be extremely useful in informing the public of our actions. However, care must be taken in the presentation of the educational material so that the species does not become more vulnerable to vandalism.
2. Search for additional populations and/or historic habitat suitable for reintroduction efforts. Studies of the species' distribution have been completed (Bouchard 1976, 1984; O'Bara et al. 1985). These studies involved extensive sampling of reported historic collection sites, areas adjacent to these sites, and numerous other streams in the Nashville basin. Although no other populations were encountered, further surveys may be warranted after studies under Tasks 1.2.1 and 1.2.2 better define the species' specific habitat requirements.
3. Develop a reintroduction plan and reintroduce the Nashville crayfish back into suitable stream reaches that are determined to have been historic habitat. Although no other historic populations are presently known, historic habitat may be found and may still be suitable for reintroductions. If another population can be established, it would help prevent extinction of the species.
 - 3.1. Develop a stocking technique and reintroduce the species into historic habitat. Because of the extent of the Nashville crayfish population in Mill Creek, it is likely that sufficient animals would be available for stocking. However, procedures for stocking (number of animals, size and sex, time of year, method of release, removal of competing species

from release sites, etc.) would need to be developed before the release.

- 3.2. Implement the same protective measures for any introduced populations as outlined for established populations.
4. Develop and implement a program to monitor population levels and habitat conditions of the presently established population as well as any introduced or newly discovered populations. This could be developed as separate tasks for introduced populations and the Mill Creek population. Once recovery actions are implemented, the response of the species and its habitat must be monitored to assess any progress toward recovery. This will likely require a biennial census schedule.
5. Annually assess overall success of the recovery program and recommend such actions as changing recovery objectives, delisting, continuing to protect the species, implementing new measures, and initiating other studies. The recovery plan must be evaluated periodically to determine if it is on track and to recommend future actions. As more is learned about the species, the recovery objectives may need to be modified.

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KEY TO IMPLEMENTATION SCHEDULE COLUMNS 1 & 4

General Category (Column 1):

Information Gathering - I or R (Research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - 0

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Priorities within this section (Column 4) have been assigned according to the following:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

IMPLEMENTATION SCHEDULE

#1 GENERAL CATEGORY	PLAN TASK	TASK NUMBER	PRIORITY	TASK DURATION	RESPONSIBLE AGENCIES #2			ESTIMATED FISCAL YEAR COSTS #4			COMMENTS/NOTES
					FWS		OTHERS #3	FY 1	FY 2	FY 3	
					REGION	DIVISION					
01-4	Continue to utilize existing legislation and regulations to protect species and its habitat.	1.1	1	Continuous	4	FWE	TWRA and THP	.5	.5	.5	
R3-10	Conduct research into life history and habitat requirements.	1.2.1 and 1.2.2	2	3 years	4	FWE/ Research	TWRA and THP	6	6	6	
R1,2, and 12	Determine present and foreseeable threats.	1.2.3 1.2.4	1	3 years	4	FWE/ Research	TWRA and THP	10	10	10	
M3	Investigate the need and value of habitat improvements and implement if needed.	1.2.5	3	1 year	4	FWE/ Research	TWRA and THP	---	---	2	
R14	Determine the number of individuals needed to maintain a viable population.	1.2.6	3	1 year	4	FWE/ Research	TWRA and THP	---	---	???	
01 and 04	Solicit help in protecting species and essential habitat.	1.3	2	Continuous	4	FWE	TWRA and THP	1	1	1	
01	Develop and utilize information and education programs (slide/tape shows, brochures, etc.) for local distribution.	1.4	1	1 year for develop- ing; continuous implemen- tation	4	FWE	TWRA and THP	2	2	2	
I1	Search for additional populations and/or historic habitat.	2.	3	1 year	4	FWE/ Research	TWRA and THP	---	---	6	

IMPLEMENTATION SCHEDULE

#1 GENERAL CATEGORY	PLAN TASK	TASK NUMBER	PRIORITY	TASK DURATION	RESPONSIBLE AGENCIES #2			ESTIMATED FISCAL YEAR COSTS #4			COMMENTS/NOTES
					FWS		OTHERS #3	FY 1	FY 2	FY 3	
					REGION	DIVISION					
I7, I4, and M2	Determine the feasibility of reestablishing historic populations and reintroduce.	3.	3	1 year	4	FWE/ Research	TWRA and THP	---	---	3	
I1-2	Develop and implement a monitoring program.	4.	2	Continuous (every two years)	4	FWE/ Research	TWRA and THP	1.5	---	1.5	
04	Annual assessment of recovery program and modify where needed.	5.	3	Continuous	4	FWE/ Research	TWRA and THP	.5	.5	.5	
*1. See page entitled "Key to Implementation Schedules."											
*2. TWRA - Tennessee Wildlife Resources Agency THP - Tennessee Heritage Program											
*3. Other agencies' responsibility would be of a cooperative nature or projects funded under a contract or grant program. In some cases contracts could be let to universities or private enterprises.											
*4. All estimates are for FWS funds only (in thousands).											

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