

ENVIRONMENTAL SCIENCES DIVISION

**EVALUATION OF PROTECTED, THREATENED, AND ENDANGERED
FISH SPECIES IN UPPER BEAR CREEK WATERSHED**

M. G. Ryon

Environmental Sciences Division
Publication No. 4799

July 1998

Prepared for
C. W. Hutzler
Bechtel Jacobs LLC

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
managed by
LOCKHEED MARTIN ENERGY RESEARCH CORP.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

ABSTRACT

The East Bear Creek Site for the proposed centralized waste facility on the U.S. Department of Energy's Oak Ridge Reservation was evaluated for potential rare, threatened or endangered (T&E) fish species in the six primary tributaries and the main stem of Bear Creek that are within or adjacent to the facility footprint. These tributaries and portion of Bear Creek comprise the upper Bear Creek watershed. One T&E fish species, the Tennessee dace (*Phoxinus tennesseensis*), was located in these streams. The Tennessee dace is listed by the State of Tennessee as being in need of management, and as such its habitat is afforded some protection. Surveys indicated that Tennessee dace occupy the northern tributaries NT-1, NT-4, and NT-5, as well as Bear Creek. Several specimens of the dace were gravid females, indicating that the streams may function as reproductive habitat for the species. The implications of impacts on the species are discussed and mitigation objectives are included.

INTRODUCTION

Bear Creek is a third-order tributary of the East Fork Poplar Creek (EFPC), which flows westward from spring sources at the west end of the Oak Ridge Y-12 Plant. Bear Creek lies entirely within the Oak Ridge Reservation (ORR), has a watershed area of roughly 19 km², and flows approximately 13 km before joining EFPC (Southworth et al. 1992). There are 27 different tributaries to Bear Creek, as well as a number of adjacent springs, with the majority of tributaries flowing south off Pine Ridge. Previous studies of Bear Creek include assessments of the aquatic ecology (Southworth et al. 1992; Hinzman 1996) and the riparian wetlands (Rosensteel and Trettin 1993). Surveys of rare and endangered species in the watershed include fish surveys conducted in the 1980s (Ryon and Loar 1988).

This assessment requested in response to proposals to create a centralized waste facility on the East Bear Creek site. The site is located in the upper section of the Bear Creek watershed, and the assessment evaluated the presence of protected, threatened, and endangered (T&E) fish species. Field surveys were conducted on six northern tributaries to Bear Creek in March–May 1998, and historic data were summarized from the Biological Monitoring and Abatement Program (BMAP) for Bear Creek. These data were supplemented by literature reviews and personal observations.

METHODS

The target area of the Bear Creek watershed includes six northern tributaries, NT-1 through NT-6, which flow through or adjacent to the proposed waste facility. The proposed facility footprint is also bounded on the southern edge in part by the mainstem of Bear Creek, approximately from stream kilometer 10 to stream kilometer 11 (Fig.1).

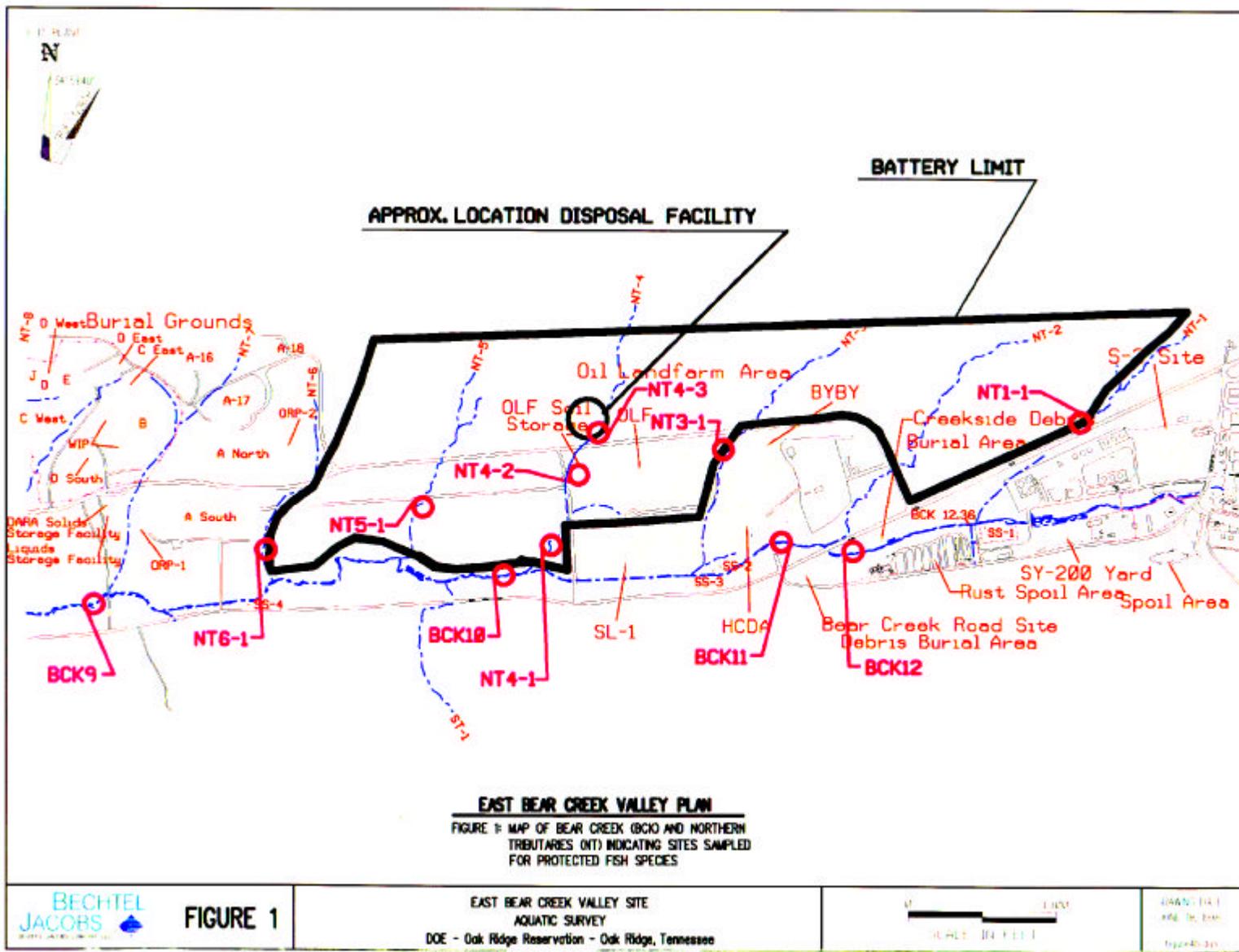


Fig.1. Map of Bear Creek (BCK) and Northern Tributaries (NT), indicating sites sampled for protected fish species

Surveys were made of the tributaries by means of a backpack electrofisher. Approximately 50 to 175 m of stream were sampled in one pass of 10–30 min duration, and all stunned fish and amphibians were collected. Specimens were identified and released back to the sampled stream. Resulting data were used to generate catch per effort (number of fish per minute of sampling effort) in order to provide a relative estimate of fish abundance. These surveys were conducted according to established standard operating procedures (Schilling et al. 1996). Ten locations on the tributaries were examined, and electrofishing samples were collected at seven of these locations (Fig.1). The primary focus of the surveys was to locate specimens of the Tennessee dace (*Phoxinus tennesseensis*), but other fish population data are also provided. The effort focused on the Tennessee dace, a species listed by the State of Tennessee as being in need of management (TWRA 1998), because it is the only known T&E fish species in the Bear Creek watershed.

To evaluate the status of the Tennessee dace in mainstem Bear Creek (BCK), historic data were compiled from BMAP sampling conducted from 1994 to 1997 (E. M. Schilling, Environmental Sciences Division, Oak Ridge National Laboratory, personal communication) at four locations in Bear Creek (Fig.1). The BMAP sampling provided a quantitative estimate of fish abundance, based on a three-pass removal estimate technique (Carle and Stub 1978). The sample area 45 to 85 m in length was isolated by two blocknets, and three sampling passes were made, covering all habitat within the reach between the nets. The collected fish were processed by pass and returned to the stream, and the data were analyzed by a computer program that used the declining numbers of fish per pass to project a total number of fish that occur in that area (Carle and Strub 1978; Railsback et al. 1989). The estimated numbers were standardized on the basis of the area sampled (m²). These data were also collected, verified, and processed according to established standard operating procedures (Schilling et al. 1996). The four sample locations included one site downstream of the proposed facility footprint (BCK 9), two sites downslope of the proposed facility footprint (BCK 10 and BCK 11), and one site immediately upstream of the proposed facility (BCK 12). Samples were conducted in the spring (S) and fall (F) of each sample year, with sampling suspended at BCK 10 and BCK 11 in fiscal year 1995 because of budget restraints. These four sites provided data to estimate the total fish community over a 2-km stretch of Bear Creek.

RESULTS

The BMAP fish community data indicate that fairly consistent populations of fish occur in Bear Creek above and below the proposed facility (Fig. 2). Total densities generally range from 2–4 fish per square meter below the facility to 3–6 fish per square meter at the most upstream site. Two sample periods, F 95 and S 96, indicated depressed or declining fish communities both above and below the proposed facility. These depressed levels were associated with poor water quality episodes, as indicated by BMAP toxicity tests (Schilling et al. 1997). One site (BCK 10) within the proposed facility

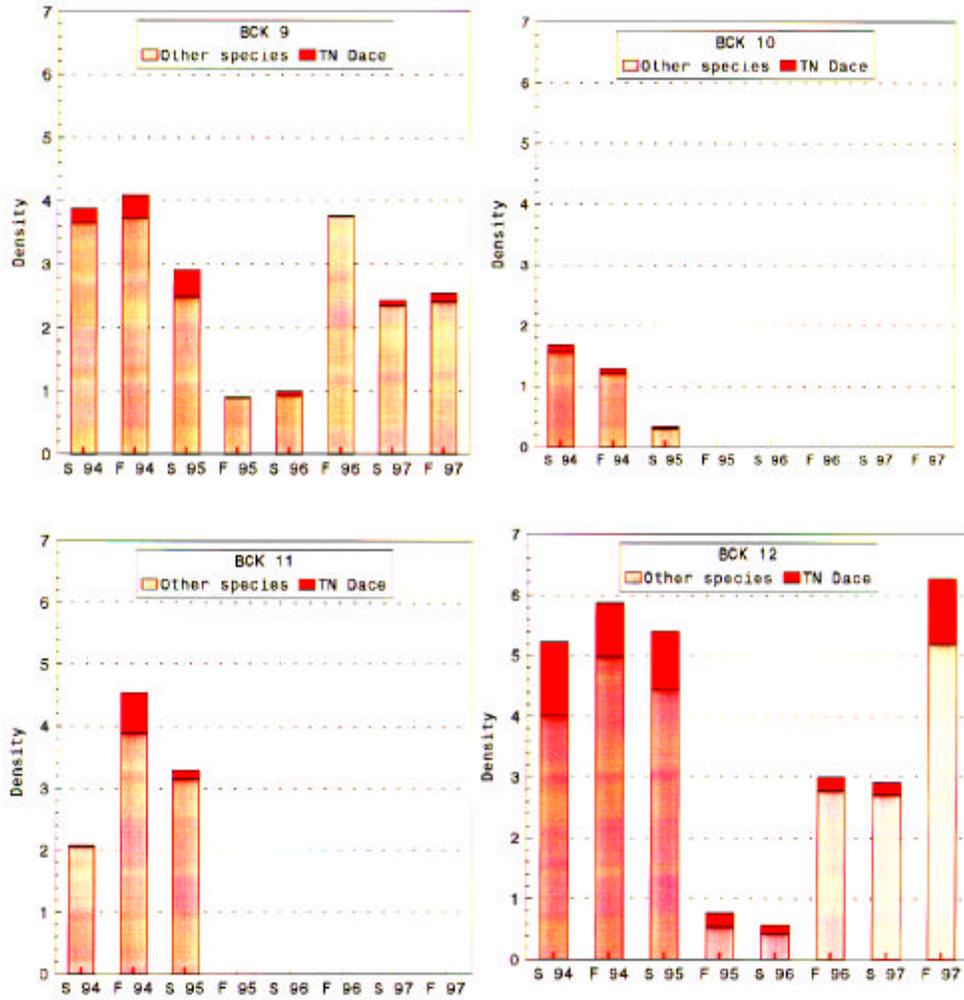


Fig. 2. Density (fish per square meter) of fish community and Tennessee dace populations at Bear Creek sites, 1994–1997.

footprint supports a much smaller fish community, due in part to the intermittent nature of the stream in this section; in some years water flow in this section goes subsurface, forcing seasonal migration of resident fish depending on water levels (Southworth et al. 1992). The BMAP data document the presence of the Tennessee dace at all four Bear Creek locations, generally at levels comprising less than 20% of the total fish community. Other members of the fish community in Bear Creek include the creek chub (*Semotilus atromaculatus*), the blacknose dace (*Rhinichthys atratulus*), and central stoneroller (*Campostoma anomalum*). Based on BMAP quantitative sampling, the number of Tennessee dace in this section of Bear Creek (stream km 10 through 11) are estimated at approximately 1400 fish.

The spring 1998 sampling of the Bear Creek tributaries indicated that all six streams were very similar in structure and had similar fish communities. The streams appear to be highly seasonal, probably with continuous flow in winter-spring, due to precipitation; some may have additional water input from small springs. Aquatic vegetation was present in some areas of the streams, but other sections obviously supported only subsurface flow most of the year. The streams were generally less than 0.5 m wide and deep, and they had a riffle-pool structure, with undercut banks and woody debris providing sufficient instream fish cover. Substrate was dominated by hard clay bottom, with smaller-sized gravel and sand in the riffles. The headwaters of each stream supported small wetlands, perhaps as a consequence of the haul road crossings. Amphibians that were abundant in all streams included green frog (*Rana clamitans melanota*), northern dusky salamander (*Desmognathus fuscus fuscus*), and southern two-lined salamander (*Eurycea cirrigera*).

NT-1 is located along the eastern edge of the proposed facility footprint. The stream flows parallel to Bear Creek Road for some distance, with mowed grass and second-growth forest comprising the riparian zones. NT-1 was sampled on June 8, covering a 170-m section (designated NT1-1) just north of the Bear Creek Road crossing. Stream flow was moderate on this date, and no aquatic plants were observed. The fish community at NT1-1 was very similar to that in Bear Creek, with four species (Fig. 3) in the sample reach, including the Tennessee dace. Catch per effort was intermediate among the values for the Bear Creek tributaries with a total catch of nearly 2 fish/min.

NT-2 runs southwest to Bear Creek from the Pine Ridge, in the eastern part of the proposed site footprint. To the east of the haul road, it is a small intermittent tributary that consists primarily of a wet weather channel flowing through secondary forest. Downstream of the haul road, NT-2 has a more established stream channel that should be capable of supporting fish populations, at least during part of the year. Given its proximity to Bear Creek, this section of NT-2 is probably utilized by blacknose dace, creek chub, and Tennessee dace.

NT-3, in the middle of the proposed facility footprint, is a small stream (Fig. 4), with a small tree- and shrub-based riparian zone that borders a grassy waste disposal area. The stream includes a large spring-fed pool in the upper section located just below the gravel haul road (Fig. 5). A 75-m stretch (NT3-1) of this creek was sampled on March 31;

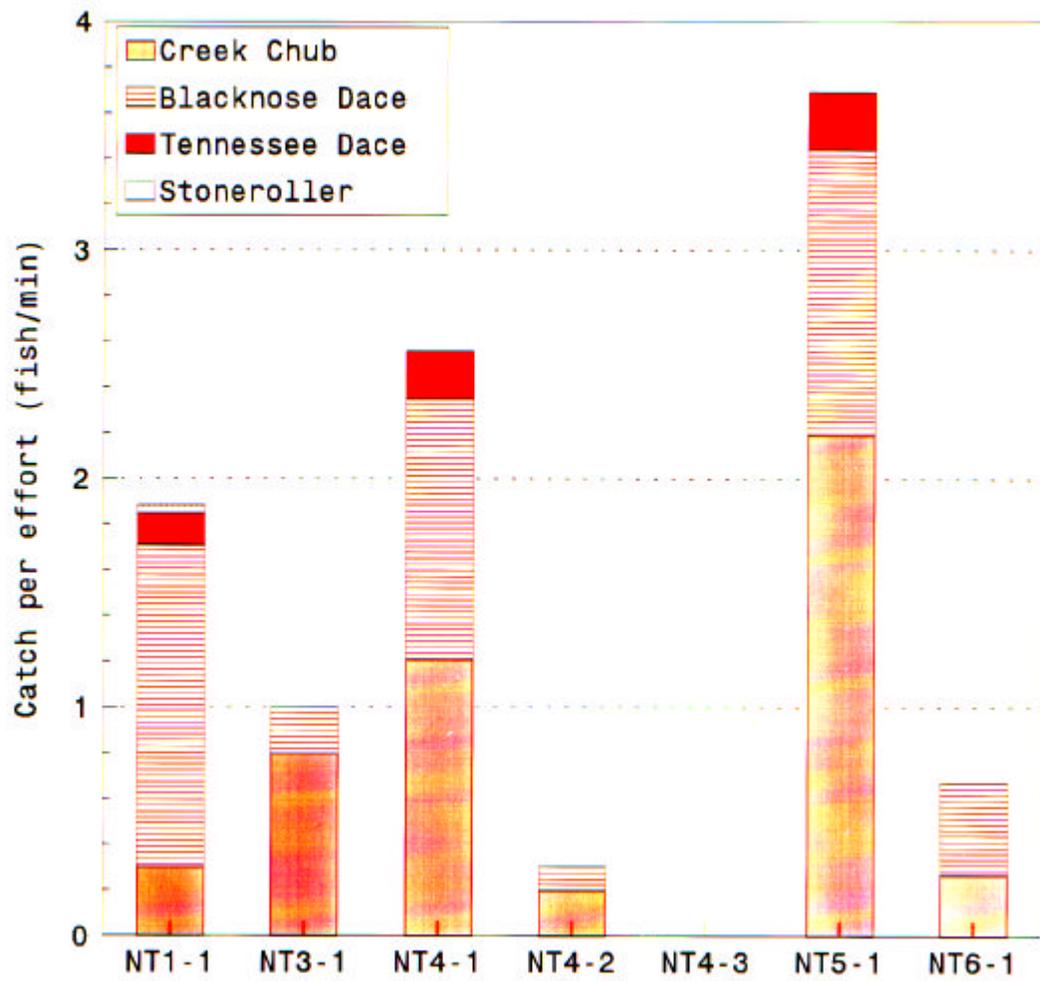


Fig. 3. Catch per unit effort (fish per minute) in Bear Creek's northern tributaries (NT-1, NT-2, NT-3, NT-4, NT-5, and NT-6) in spring 1998.



Fig. 4. Photo of the NT3-1 sampling site on a northern tributary of Bear Creek.



Fig. 5. Photo of large spring-fed pool at the upper section of NT3, a northern tributary of Bear Creek.

sampling proceeded upstream from a small temporary weir located about 150 m upstream of the confluence with Bear Creek. Streamflow was very fast in this section, and aquatic plants were abundant. The fish community included creek chub and blacknose dace, with a total catch per effort of 1 fish/min (Fig. 3).

NT-4 flows through the middle of the proposed facility footprint and was sampled at three locations. Sampling site NT4-1 is located about 90 m above the confluence with Bear Creek (Fig. 6), and a 40-m section was sampled on March 31, starting at a road crossing above a water quality sampler (S9). Three species of fish were also taken at this site, including gravid female Tennessee dace. The catch per effort was intermediate in comparison with samples from some of the other streams (Fig. 3). Site NT4-2 is located another 215 m upstream and is located in wooded and open sections bisected by a gravel access road to TSCA PCB Storage area TS122. A 45-m section of stream was sampled on March 31. The fish community was considerably smaller at this site, with a low catch per effort and only two species. The Tennessee dace was not taken at this location. NT4-3 is the section of stream above the haul road wetland and is more than 400 m from Bear Creek. A survey of a 60-m section was made on April 1, but no fish were found. Prior to the construction of the haul road, this area may have been occupied seasonally by blacknose dace.

NT-5 is on the western side of the proposed facility footprint and had more moderate flow and more undercut bank structure than NT-3 (Fig. 7). This stream was sampled on April 1, covering a 60-m section (NT5-1) below a cross road near groundwater well GW-904 and about 200 m upstream from the confluence with Bear Creek. This stream had the largest fish community, with a catch per effort greater than 3 fish/min (Fig. 3). Three species of fish were found here, including the Tennessee dace. Two of the specimens of Tennessee dace were gravid females, and this area may be used for spawning in early spring. Several of the creek chubs were gravid females; this also indicates that the stream maintains sufficient flow long enough to be a spawning area for several species.

The last stream, NT-6, lies along the western boundary of the facility site. A 100-m section of the lower reaches of the tributary was sampled on March 31. The stream had several channels, and water flowed between these braided channel structures. Water depth was minimal except near the confluence with Bear Creek and in a few isolated pools. The fish community was limited to blacknose dace and creek chub, with a total catch per effort of less than 1 fish/min (Fig. 3).

DISCUSSION AND RECOMMENDATIONS

The occurrence of the Tennessee dace in the smaller tributaries to Bear Creek is not unusual. The dace has been found at other tributaries downstream and occurs most frequently throughout its range in small first- to third-order streams (Etnier and Starnes 1993). The Tennessee dace is an aggregation spawner: individuals gather in schools



Fig. 6. Photo of the NT4-1 sampling site on a northern tributary of Bear Creek.



Fig. 7. Photo of the NT5-1 sampling site on a northern tributary of Bear Creek.

of up to 100+ individuals, and they spawn en masse over a maintained nest (Schilling and Ryon 1993). The nests (areas of gravel cleaned of overlying silt) are most often those of other cyprinid (minnow) species, such as creek chub. In these species, the male(s) actively clean the gravel and maintain the nest after spawning. This provides the necessary conditions for the eggs and larvae of both species to develop without being smothered by silt. The spawning season in the Bear Creek watershed has been shown to be from mid-March through May, and dace are capable of producing several clutches or batches of eggs (Schilling and Ryon 1993). Despite the capacity for multiple spawns, the total number of eggs produced per female is small (~500 eggs), and the total life span is only 2–3 years. Thus, one or two poor reproductive seasons can imperil a Tennessee dace population.

The capability of the species to utilize seasonal streams such as NT-1, NT-4 and NT-5 for spawning can be important. Fish can move from Bear Creek into these smaller tributaries when high flow in the main stream would impact nest maintenance. At such times, nests in the smaller, less turbulent tributaries could be used. This is significant because at normal densities, it takes a considerable length of stream to provide the number of fish necessary to form a spawning aggregation. In many situations, dace must migrate substantial distances to form the spawning aggregation and locate appropriate gravel areas that contain a cyprinid nest being actively maintained by a male. For example, we have documented a large aggregation of Tennessee dace spawning in upper Pinhook Branch, at approximately 1.6 km from the stream's confluence with EFPC. Because of this reproductive migration, a facet of the critical habitat of the Tennessee dace is the maintenance of open channels between different streams and sections. Any barriers that would prevent access to the reproductive areas could be as damaging as the loss of an entire stream.

Water temperature is another environmental condition that could be impacted by development of the facility. The loss of vegetation and creation of large amounts of paved or hardened surfaces could change both the temperature and pattern of subsequent runoff to the creek. Higher temperatures could reduce the effectiveness of dace reproduction and growth, and faster, more direct runoff could increase water velocities in pulses that could also disrupt spawning or rearing activities. Any of these factors (new barriers, higher temperatures, flashier runoff) could effectively serve to reduce the quality habitat available to the Tennessee dace. The loss of some of this habitat could influence the overall success of the dace population, particularly as additional projects are developed along Bear Creek. There must be some consideration of cumulative impacts on the Tennessee dace when projects are developed in this area. Any single individual project may not have a substantial impact on the viability of the species in Bear Creek, but the cumulative effects of multiple projects could be significant.

Although the Tennessee dace is listed as a species in need of management and has not been impacted to a such a degree as to warrant listing as threatened or endangered, the current status of the species is not being enhanced statewide. Previous surveys have indicated that many of the locations elsewhere in the state where the dace had been found can no longer support viable populations (Schilling and Ryon 1993). Thus, the occurrence

of the dace on the ORR represents a valuable resource. The numbers of dace represented by the populations in the Bear Creek watershed have been identified as a significant stronghold, statewide, for the species (Ryon and Loar 1988; Etnier and Starnes 1993).

State guidance on species in need of management indicates that it is unlawful to knowingly destroy the habitat (TWRA 1998) of such species without a permit. Thus, the proposed facility should obtain proper permitting and devise a mitigation plan to offset the planned loss of or impact on Tennessee dace habitat. Necessary objectives of this plan should include the following:

1. Effective design and implementation of sediment control procedures (to minimize siltation impacts on Tennessee dace reproduction).
2. Effective design of replacement channels for any loss of stream (i.e., NT-4). This design should include undercut banks, riffle:pool stream structure, presence of gravel areas, and vegetated riparian zones. These channels should remain sized appropriately for the stream to be replaced, and not be simultaneously utilized as runoff channels designed to handle high flows (as for example, how the replacement channel for NT-7 was designed).
3. Effective design to protect vegetated buffer zones along the streams that border (NT-1, NT-6, and Bear Creek) the facility footprint. Such buffer zones should be a minimum of 25 m in width; greater if slope or aspect favors increased impacts.
4. Implementation of monitoring studies to verify the effectiveness of all protection measures and to evaluate any long-term impacts on the associated Tennessee dace populations in the Bear Creek watershed.

REFERENCES

- Carle, F. L., and M. R. Strub. 1978. A new method for estimating population size from removal data. *Biometrics* 34:621-630.
- Etnier, D. A., and W. C. Starnes. 1993. *The Fishes of Tennessee*. The University of Tennessee Press, Knoxville, Tennessee.
- Hinzman, R. L. (ed.) 1996. Report on the Biological Monitoring Program for Bear Creek at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee. ORNL/TM-12884. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Railsback, S. F., B. D. Holcomb, and M. G. Ryon. 1989. A Computer Program for Estimating Fish Population Sizes and Annual Productions Rates. ORNL/TM-11061. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Rosensteel, B. A., and C. C. Trettin. 1993. Identification and Characterization of Wetlands in the Bear Creek Watershed. Y/TS-1016. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Ryon, M. G., and J. M. Loar. 1988. A Checklist of Fishes on the Department of Energy Oak Ridge Reservation. *J. Tenn. Acad. Sci.* 63:98–102.
- Schilling, E. M., and M. G. Ryon. 1993. Reproductive biology of the Tennessee dace (*Phoxinus tennesseensis*) on the DOE Oak Ridge Reservation. Abstract. American Society of Ichthyologists and Herpetologists, Austin, Texas, 27 May–2 June 1993. p. 274.
- Schilling, E. M., B. A. Carrico, R. P. Hoffmeister, W. K. Roy, and M. G. Ryon. 1996. Biological Monitoring and Abatement Program (BMAP) Fish Community Studies, Standard Operating Procedures. QAP-X-90-ES-067. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Schilling, E. M., M. G. Ryon, and L. A. Kszos. 1997. Fish community in a disturbed stream is recovering following remedial actions but toxic episodes continue to have an effect. Abstract. American Society of Ichthyologists and Herpetologists, Seattle, Washington, 26 June–2 July 1997. p. 262.
- Southworth, G. R., J. M. Loar, M. G. Ryon, J. G. Smith, A. J. Stewart, and J. A. Burris. 1992. Ecological effects of contaminants and remedial actions in Bear Creek. ORNL/TM-11977. Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- TWRA (Tennessee Wildlife Resources Agency). 1998. List of Species in Need of Management. Tennessee Wildlife Resources Commission Proclamation: Wildlife in Need of Management. (List generated under authority granted by Tennessee Code Annotated, Sections 70-8-104 and 70-8-107). 3 pp.

To Obtain an Electronic Copy of This Report

An electronic copy of this report in PDF format is available to the public and can be obtained via the World Wide Web through Oak Ridge National Laboratory's Publications Database (<http://128.219.84.235:8083/BASIS/tidd/fqma/tpsext/SF>).