Physical Habitat Use by Spikedace in the Upper Verde River, Arizona

Andrea P. Neary,[1] *John N. Rinne*[2] *and Daniel G. Neary*[2]

The spikedace, *Meda fulgida*, is a threatened species of short-lived minnow that persists only in the mid-elevations of the upper Gila River in New Mexico, and Aravaipa Creek and the upper Verde River in Arizona (Rinne 1991). The fish is mottled on the back, silvery on the sides, and whitened ventrally (Minckley 1973). Males become golden on their dorsal and lateral surfaces during breeding. Spawning is in the spring and early summer. One-year-old females produce one batch of 100 to 300 eggs, and two-year-olds may produce two in a single spawning period. Young emerge in April and May and usually grow to lengths of 35-40 mm by November. Individuals seldom exceed four years in age and 65 mm in length. Spikedace feed on aquatic and terrestrial insects as well as the fry of other species.

The upper Verde River is one of the most important habitats for the spikedace. It is a relatively wild, free-flowing stream that has low baseflows (0.57 m^3/sec), no perennial tributaries, and periodic drought and extreme flood events (Stefferud and Rinne 1995). Although adapted to southwestern streams, spikedace populations are affected by natural variations in the Verde River hydrograph (i.e. alternating floods and drought). Habitat degradation produced by impoundment construction, dewatering of streams for irrigation, channel erosion, and sedimentation have contributed to the decline of spikedace populations. In addition, introduction of non-native fishes such as the red shiner has seriously affected the species through competition for food and habitat (Rinne 1991; Douglas et al. 1994). Finally, livestock grazing has been implicated in the decline of spikedace habitats and populations through streambank deterioration and sedimentation. However, the impact of grazing relative to non-native species predation is still unknown.

A major consideration in studying this rare species of native fish is the determination of its preferred habitat. Past surveys may have missed the spikedace because of sampling in the wrong microhabitats. Reconnaissance surveys of the upper Verde River completed in 1993 and 1994 indicated that within stream reaches actually occupied by spikedace, the fish were concentrated in discrete microhabitats.

This preliminary study had two major objectives. First, we planned to examine and define the preferred physical habitat of spikedace relative to water velocity, stream gradient, and stream substrate composition. Second, we wished to make specific sampling recommendations for future studies.

Methods

The site of the fish sampling is in the upper Verde River, Yavapai County, about 6 km downstream of Sullivan Lake. This reach of stream is known as the Burnt Ranch section (see Stefferud and Rinne 1995). It is subject to periodic drought and extreme flood events such as the 70+ year event which occurred in early 1993. Stream types within this reach include rocky, high-gradient riffles; lower gradient riffles consisting mainly of gravel; gentle runs with few large rocks, gravel, and some sand; and wide, gentle glides with mainly sandy bottoms (Rinne and Stefferud 1996).

Fish sampling and physical habitat characterization occurred on 14 different stream microhabitats within several reaches at the Burnt Ranch site. Each distinct microhabitat was classified into one of five types: high-gradient riffle (HGR), low-gradient riffle (LGR), run (RUN), glide (GLD), and pool (POL). Only two runs were found within the sampling areas, and pools were not evaluated based on previous information on the absence of spikedace in this microhabitat. This resulted in evaluation of 14 microhabitats. Each microhabitat was sampled using a 5 x 15 m seine with 3 mm mesh. Fish were collected by dragging the seine

[1]Flagstaff High School, Flagstaff, AZ.

[2]USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Flagstaff AZ.

from up to downstream in microhabitats with pebble to sand bottoms. In microhabitats with extensive cobbles and boulders (i.e. high-gradient and low-gradient riffles), fish were collected by employing direct current, backpack electrofishing gear. In this approach, the seine was used to block the downstream end of a sample microhabitat, and the microhabitat was sampled from upstream to downstream into the net using the electrofishing unit. After either procedure, the seine was brought ashore and captured fish were immediately placed into a water-filled bucket. All the collected fish were identified by species and placed on a measuring board. Total lengths from snout to tail were recorded for use in other studies, and the fish were released back into the Verde at the site of capture.

After sampling the fish in the study area, data were collected to establish the velocities, depths, gradients, and substrates of each sampled micro-habitat. Equipment and established procedures to determine these physical habitat measurements are described in Rinne and Stefferud (1996). Basically, stream velocities and depths were measured at three transects within each sample reach by a direct readout current meter attached to a 2-m rod with centimeter calibrations. When the depth was established and recorded, the bottom of the current meter was then held at 60 percent of the depth from the water surface to obtain mean velocity of the microhabitat. The velocity was recorded when the current meter readout came to a constant reading. Gradients and microhabitat dimensions were determined using a Criterion 400 laser survey instrument. Once into the survey measurements screen, the Criterion was aimed at a target with a reflector that sends back the laser beam. Each target was positioned at the upstream end of the sample site with the Criterion at the downstream end to determine gradient. It was also set up across the stream to determine width. When the Criterion laser fired, information such as distance, azimuth, percent slope, and gradient were automatically computed and presented on the data screen.

To characterize stream substrates, a modified pebble count technique developed by Bevenger and King (1995) was used. Using this method, one sample of the substrate, possibly consisting of sand, gravel, pebbles, cobbles, or boulders, was picked up and measured on the longest dimension with a ruler at the end of every three steps. Thirty measurements were taken throughout the entire sampling site in a random zig-zag pattern. A simple average of the measurements gave the average sediment size for that site.

Results and Discussion

Spikedace microhabitat use was evident in results from stream sampling conducted in 1994 and 1995 (Figure 1). However, microhabitats were visually characterized during the 1994–1995 samplings, and general measurements of depth, velocity, and substrate material were made. No attempts were made in 1994–1995 to systematically classify microhabitats based on physical measurements. Some microhabitats that were identified visually as pools were actually mid-channel pools that were part of other microhabitat types. Since the ability to separate these microhabitats in a reliable manner was uncertain, plans were developed to add measurements of gradient, velocity, depth, and substrate to further refine the definition of the microhabitats.

Physical habitat information gathered during the March, 1996, survey for spikedace was compared to visual estimates of microhabitat type taken at each site. As a result of the laser survey measurements, each habitat was clearly associated with a range of gradients (Figure 2). Glides were less than 0.25 percent, runs were between 0.25 percent and 0.50 percent, low-gradient riffles were between 0.51 percent and 1.00 percent, and high-gradient riffles were greater than 1.00 percent. This gradient separation allows for a more consistent and accurate definition of habitat type than visual determinations.

Spikedace were found in greatest abundance in gradients between 0.4 and 0.6 percent (Figure 3). Accordingly, these gradients fall within runs to low-gradient riffle microhabitat classifications, as we have suggested. These two microhabitats contained almost 60 percent of the spikedace captured in the entire upper Verde River during 1994–1995 (Rinne and Stefferud 1996). Therefore, there is good agreement between the qualitatively defined habitats and those we have defined by laser surveying.

Spikedace were found in habitats with substrates of less than 10 percent sand (Figure 4). According to the greater density of spikedace present in stream reach 3, we determined that spikedace favored habitats with lower sand content. Glides, runs, and low-gradient riffle microhabitats contain increasingly less sand substrate, respectively (Rinne and Stefferud 1996). The data show that spikedace certainly prefer gravel over sand substrate during the spring spawning season. More

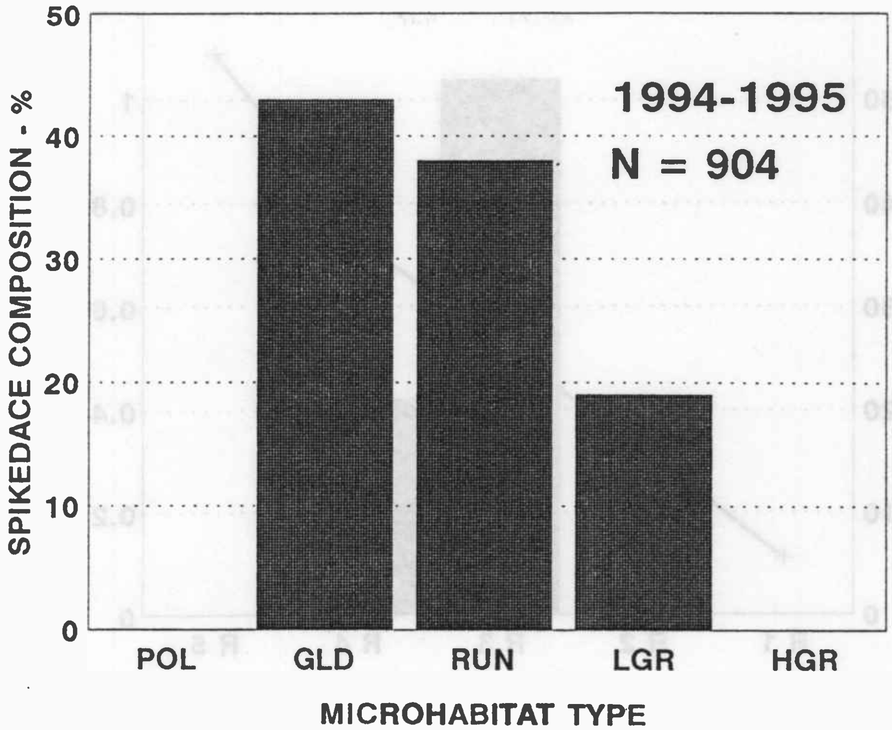

Figure 1. Spikedace distribution by microhabitat type, upper Verde River, Arizona (adapted from Rinne and Stefferud 1996).

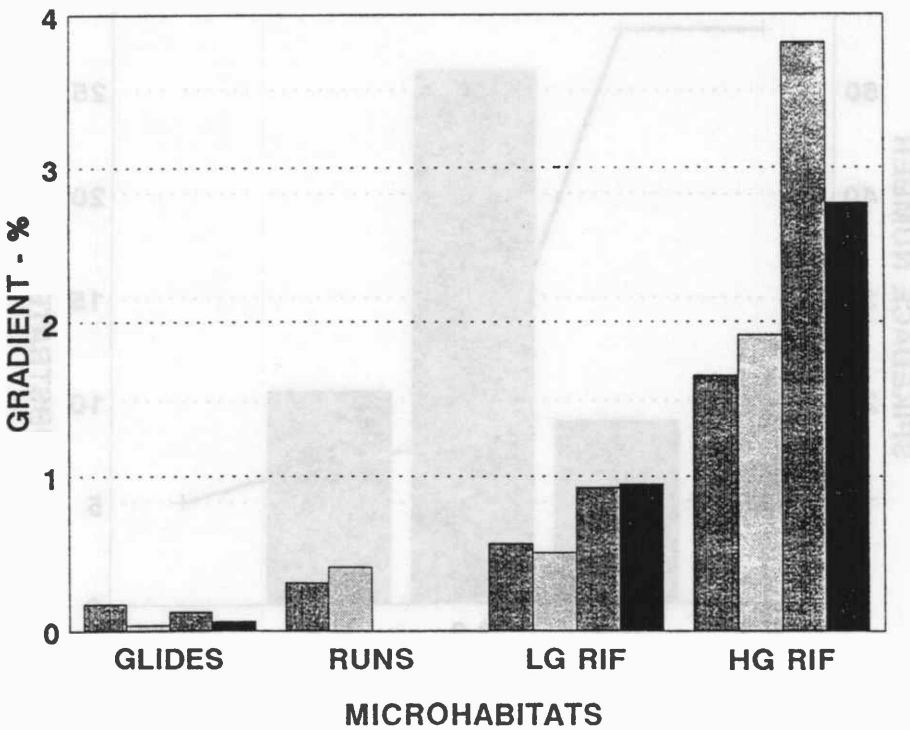

Figure 2. Comparison of gradients of 14 microhabitats, upper Verde River, March 1996.

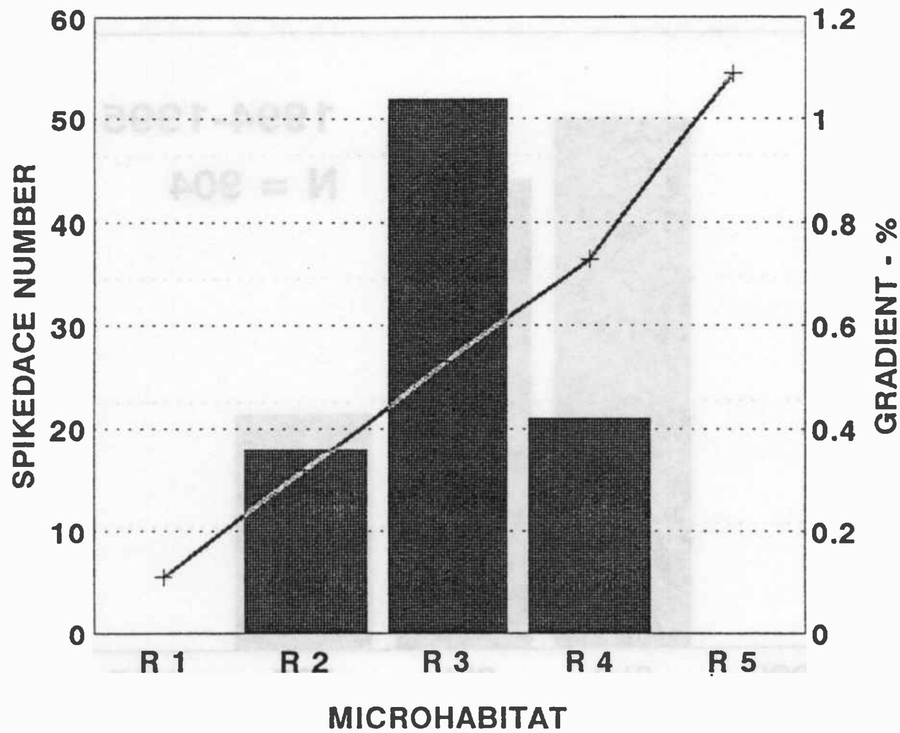

Figure 3. Spikedace numbers and stream gradient, Burnt Ranch section, upper Verde River, March 1996.

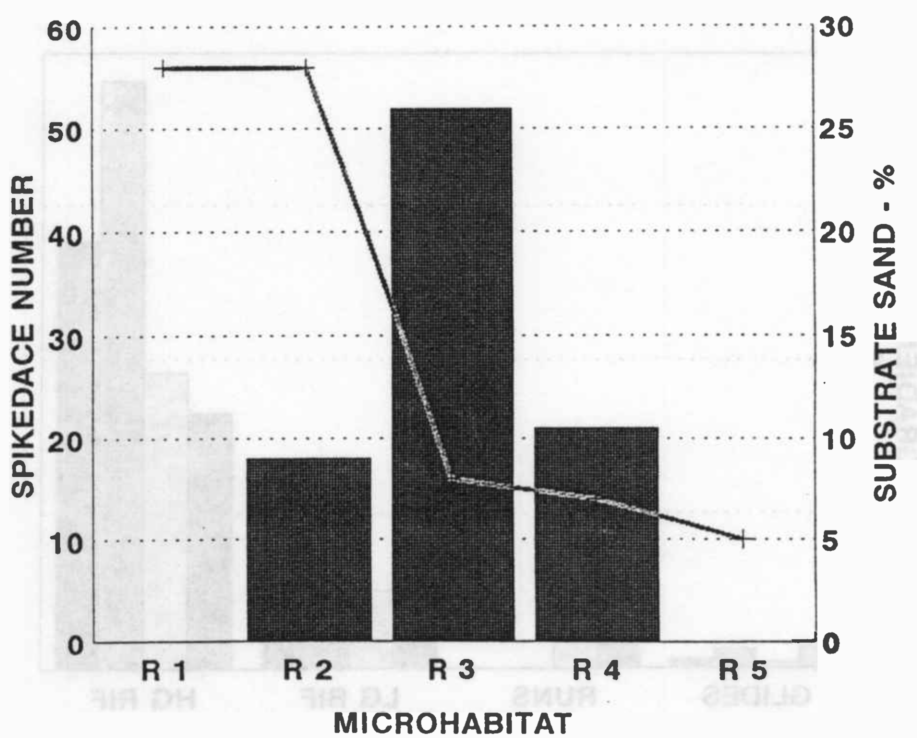

Figure 4. Spikedace numbers and percent sand in streambed substrate, Burnt Ranch study section, upper Verde River, March 1996.

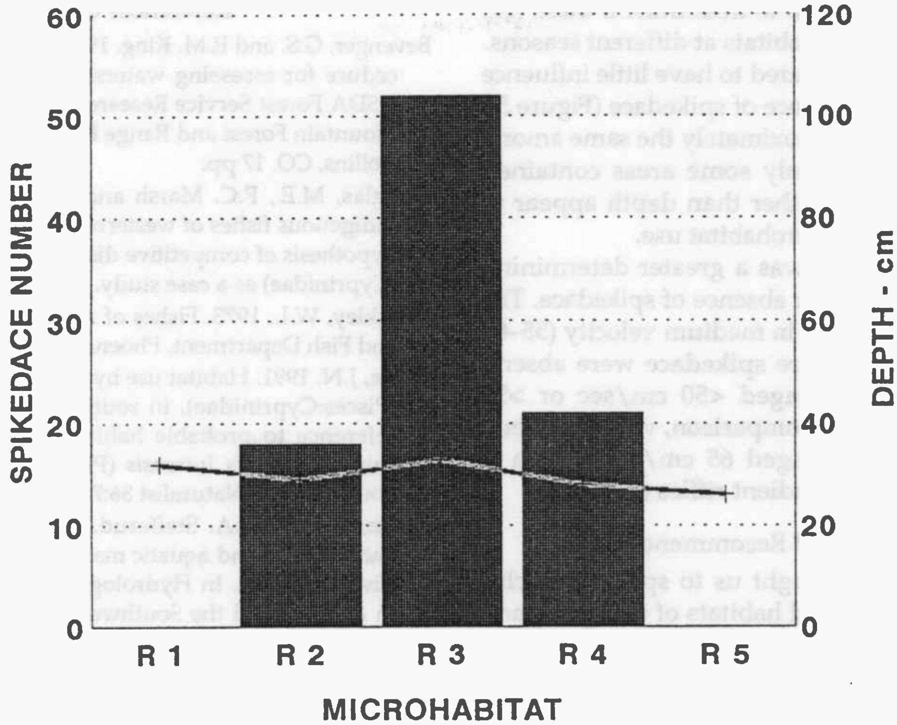

Figure 5. Spikedace numbers and stream depth, Burnt Ranch section, upper Verde River, March 1996.

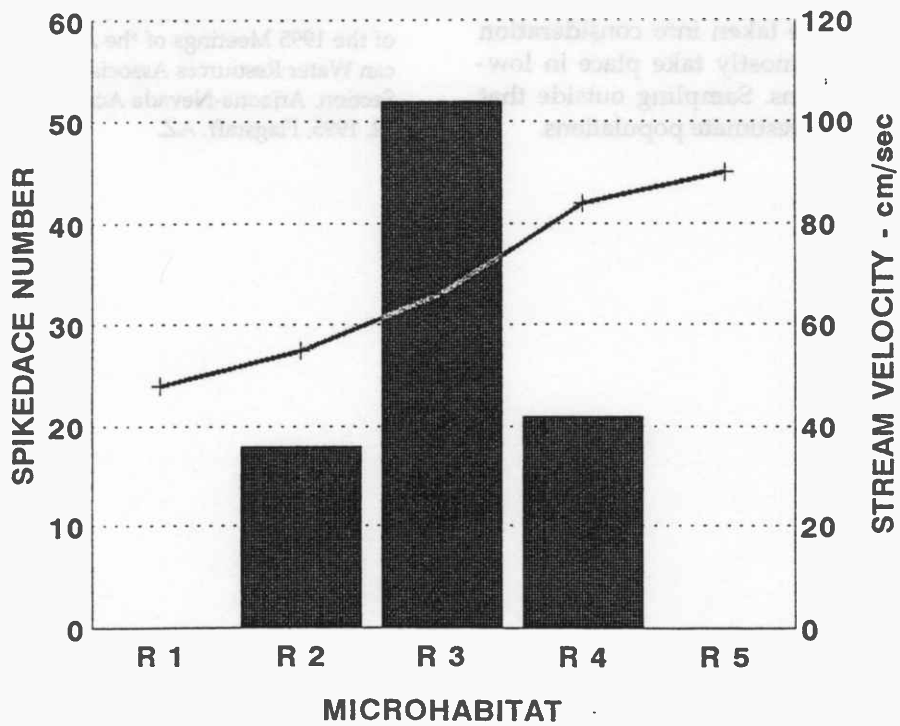

Figure 6. Spikedace numbers and stream average velocity, Burnt Ranch study section, upper Verde River, March 1996.

field sampling is needed to determine if these fish move into other microhabitats at different seasons.

Depth of water appeared to have little influence on the presence or absence of spikedace (Figure 5). That is, depth was approximately the same among all sample sites, yet only some areas contained spikedace. So factors other than depth appear to influence spikedace microhabitat use.

Velocity, however, was a greater determining factor in the presence or absence of spikedace. The species was found only in medium velocity (55–85 cm/sec) habitats. Where spikedace were absent, stream velocities averaged <50 cm/sec or >90 cm/sec (Figure 6). By comparison, where present, stream velocities averaged 65 cm/sec, which is characteristic of low-gradient riffles (Figure 2).

Conclusions and Recommendations

Briefly, our study brought us to specific conclusions as to the preferred habitats of the spikedace. Spikedace were found only in habitats with a specific range of velocity, substrate, and gradient characteristics. They were found in areas with velocities ranging from 55 to 85 cm/sec (mean 65), gradients of 0.4 to 0.6 percent (mean 0.5%) substrates of less than 10 percent sand, and in narrower channel sections.

For help in future sampling of the spikedace, all these factors should be taken into consideration and sampling should mostly take place in low-gradient riffles and runs. Sampling outside that range will greatly underestimate populations.

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