THE SOUTHWESTERN NATURALIST 40(3):301–307 SEPTEMBER 1995

SPATIAL HABITAT SELECTION OF ROUNDTAIL CHUB (*GILA ROBUSTA*) IN TWO CENTRAL ARIZONA STREAMS

PAUL J. BARRETT AND O. EUGENE MAUGHAN

National Biological Survey, Arizona Cooperative Fish and Wildlife Research Unit, 210 Biological Sciences East, The University of Arizona, Tucson, Arizona 89721
Present address of PJB: U.S. Fish and Wildlife Service, 2730 Loker Ave. West, Carlsbad, California 92008

ABSTRACT—We developed habitat suitability indices for depth, velocity, substrate, and cover for adult and juvenile roundtail chub (*Gila robusta*) and razorback sucker (*Xyrauchen texanus*) (220–290 mm TL) in Fossil Creek, and adult roundtail chub in Wet Beaver Creek, central Arizona. Adult roundtail chub in Fossil Creek selected wider ranges of velocity (0 to 0.96 mps) and depth (0.9 to 3.1 m) than juveniles (0 to 0.61 mps velocity and 0.9 to 1.5 m depth). Adult roundtail chub in Fossil Creek selected small-boulder and gravel substrates, and large instream objects. Juveniles selected a variety of substrates, particularly sand, but showed little selection for bedrock and large boulders. They did select for other types of cover. Adult roundtail chub in Wet Beaver Creek selected low velocity areas and did not use velocities >0.14 mps. Most adults in Wet Beaver Creek selected depths of about 2.1 m. Few fish selected greater and lesser depths. Adults selected bedrock and large boulder substrates and instream cover.

Razorback sucker in Fossil Creek chose velocities <0.3 mps and showed the highest selection for velocities of 0.15 mps. They selected depths between 1.5 and 2.7 m, most commonly choosing depths of 2.0 m. Most razorback suckers occurred over silt substrates, but small and large boulders and bedrock were also used. Sand and gravel were not utilized. Razorback suckers used large, instream objects and instream overhead cover but also used other types of cover.

Historically, roundtail chub (*Gila robusta*) were abundant in most warmwater streams of the Colorado River basin (Minckley, 1973). Currently, they are found in only a few drainages in Arizona where they are considered a threatened species (Arizona Game and Fish Department, 1988). Despite their declining status, little is known about habitat use by roundtail chub. Information on habitat utilization is necessary for future management of this species. We undertook an evaluation of habitat use and availability on two tributaries of the Verde River in central Arizona that contain roundtail chub, Fossil Creek and Wet Beaver creek (Fig. 1).

Study Overview—Habitat suitability indices (i.e., HSI curves), such as used in the Instream Flow Incremental Methodology (IFIM) and Habitat Evaluation Procedures (HEP), were developed for roundtail chub in Wet Beaver and Fossil creeks as recommended by the U.S. Fish and Wildlife Service. Habitat used by chubs was compared between the two streams to determine the applicability of HSI curves across streams.

Data were also collected on and selection indices produced for razorback sucker (*Xyrauchen texanus*) that had been introduced into Fossil Creek. We estimated that about 16 individuals, all between 220 and 290 mm TL, were in the stream at the time of our study.

The level of "utilization" of a particular habitat parameter (i.e., depth, velocity, substrate, and cover type) was defined as the proportion of all fish sampled that were occupying a given condition. "Availability" was defined as the relative proportion, by surface area, of the combination of parameters of given conditions. Selection was determined by dividing individual utilization : availability ratios by the largest utilization : availability ratio calculated. Utilization implies the application of frequency of use data, and selection implies utilization : availability ratios.

MATERIALS AND METHODS—We selected similar single study sites on each creek characterized by a 150-m riffle, run, and pool complex. Techniques identical to those used to produce HSI curves for small-

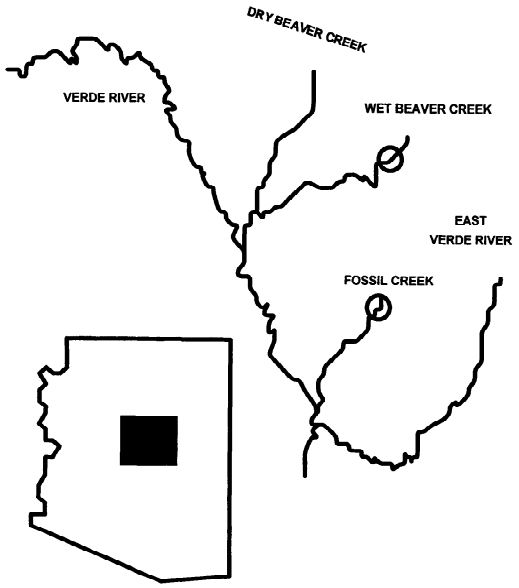

FIG. 1—Stream locations. Circles indicate study sites.

mouth bass (Barrett and Maughan, 1994) were used for adult roundtail chub (TL > 150 mm) in Wet Beaver Creek, and adults and juveniles in Fossil Creek. Habitat factors included depth, velocity, substrate, and cover. Because shadows changed with time of day, and were associated with other physical structures, they were not defined as instream cover. Sampling occurred from June through August in 1989 and 1990. We assumed sampling with replacement at both locations.

Selection curves were produced by grouping preference categories into intervals as recommended by Bovee in a U.S. Fish and Wildlife Service report. Grouping into intervals eliminates information about the variance for each point on a given curve. Using techniques reported by Jakle and Barrett to the U.S. Fish and Wildlife Service, all roundtail chub and smallmouth bass curves, and the razorback sucker velocity curve were produced with sample sizes sufficient to give 95% confidence that the true mean value of the variable was within the interval range used to construct the selection curves. The razorback sucker depth selection curve was produced with a sample size sufficient to give 80% confidence that the true mean value of the variable was within the interval range used to construct the selection curve.

Depth and velocity curves were smoothed by grouping data into intervals using the Sturges method as reported to the U.S. Fish and Wildlife Service by Cheslak and Garcia. The resulting coordinates were subjected to one pass of a three-point running mean, and all plots and histograms were normalized to index values (range 0.0–1.0). The centerpoints of intervals were used to compare curves between locations and species.

Selection curves were not normally distributed and do not represent frequency distributions. Therefore, selection curves were only compared visually.

RESULTS—*Habitat Use in Wet Beaver Creek*—Roundtail chub consistently used the deepest (>1.8 m), lowest velocity (<0.086 meters per second (mps)) portions of the study area. The area most often occupied had a bedrock bottom, adjacent to a large cliff. A deep crevice at the base of the cliff was used as escape cover when disturbed. The fish also congregated near large boulders and entered the shadows surrounding these boulders when disturbed.

Habitat Selection in Wet Beaver Creek—Habitat selections were similar to habitat use in Wet Beaver Creek. Adult roundtail chub selected low velocity areas and did not use velocities >0.14 mps (Fig. 2). Highest selection for depths was at 2.1 m, which declined rapidly at greater and lesser depths. Chub selected bedrock and large boulders with instream cover.

Habitat Use in Fossil Creek—Adult roundtail chub generally used deep (>1.8 m), slow (<0.10 mps) waters, but also occasionally entered shallow (<0.9 m) and swift (>0.46 mps) areas. They congregated near shadows and moved into them when disturbed.

Habitat Selection in Fossil Creek—Adult roundtail chub selected velocities of 0.23 mps with a range of 0–0.96 mps (Fig. 3). Depth selection was bimodal, with a lower selection for 0.9 and 1.2 m and higher selection for 2.1 to 3.1 m. Adult roundtail chub selected small-boulder and gravel substrates, and large instream objects.

Juvenile roundtail chub in Fossil Creek selected velocities of about 0.15 mps and avoided velocities >0.61 mps (Fig. 4). Selection was high for depths between 0.9 and 1.5 m, but low for depths >2.1 m. A variety of substrates was selected, particularly sand, but there was little selection for bedrock and large boulders. All types of cover were selected.

Razorback sucker in Fossil Creek selected velocities <0.3 mps but 0.15 mps was the most commonly selected velocity (Fig. 5). They selected depths between 1.5 and 2.7 m, preferring depths of 2.0 m. Most razorback suckers occurred over silt substrates, but small and large boulders and bedrock were also used. Sand and gravel were not utilized. Razorback suckers tended to position themselves adjacent to large, instream objects and

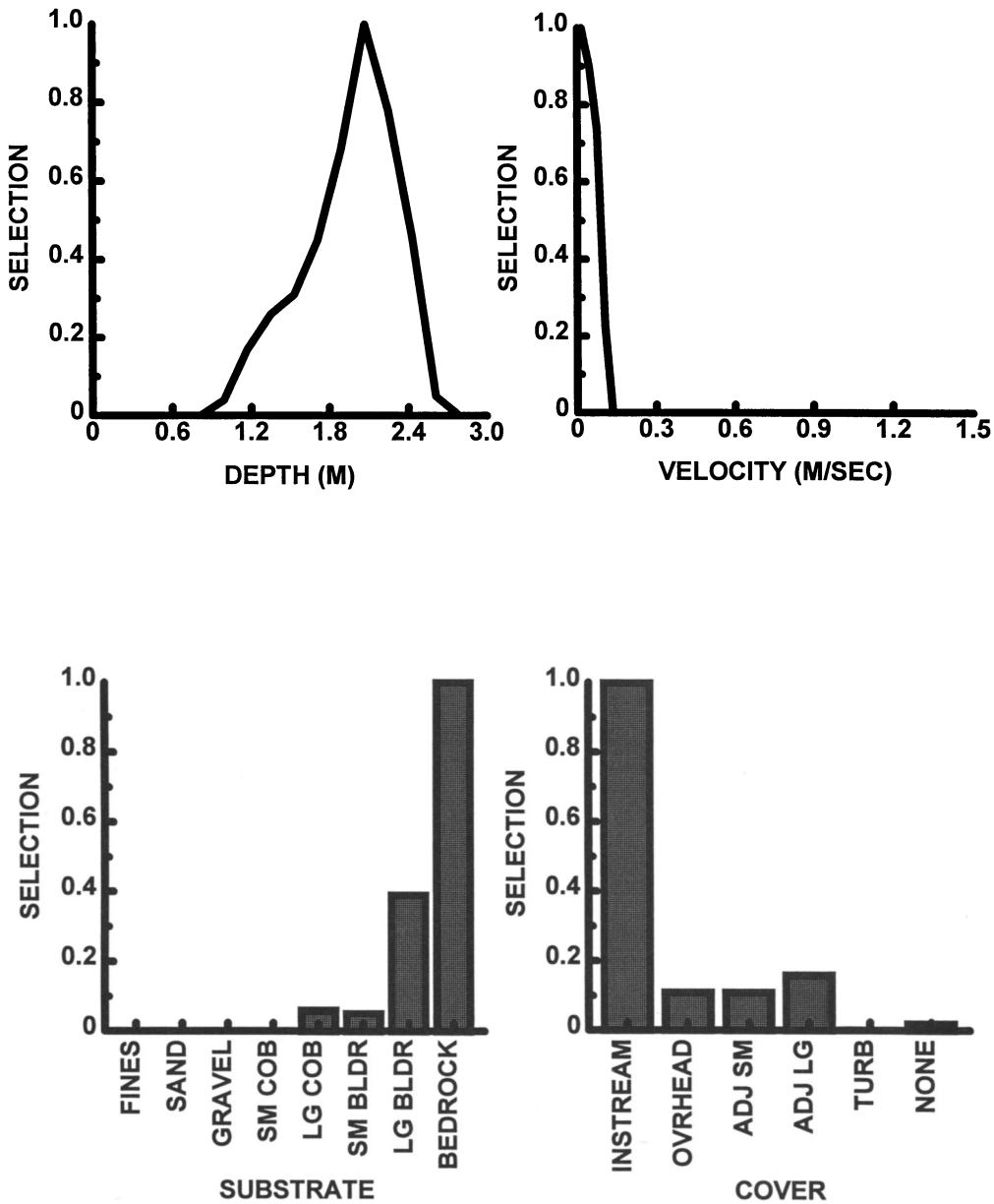

FIG. 2—Habitat selection by adult roundtail chub in Wet Beaver Creek, Arizona, based on 85 snorkel observations of individual fish and 739 habitat availability points. SMCOB = small cobble, LGCOB = large cobble, SMBLDR = small boulder, LGBLDR = large boulder, ADJSM = adjacent to small cover, ADJLG = adjacent to large cover, TURB = turbulence.

overhead objects but also used other types of cover.

DISCUSSION—*Adult*—The two creeks differed in habitats available and the compliment of sympatric fish species. During our study, Wet Beaver Creek had a constant discharge of 0.2 cubic meters per second (cms), whereas discharge in Fossil Creek was a constant 1.2 cms. Fossil Creek, which originated from a large spring less than 1 km

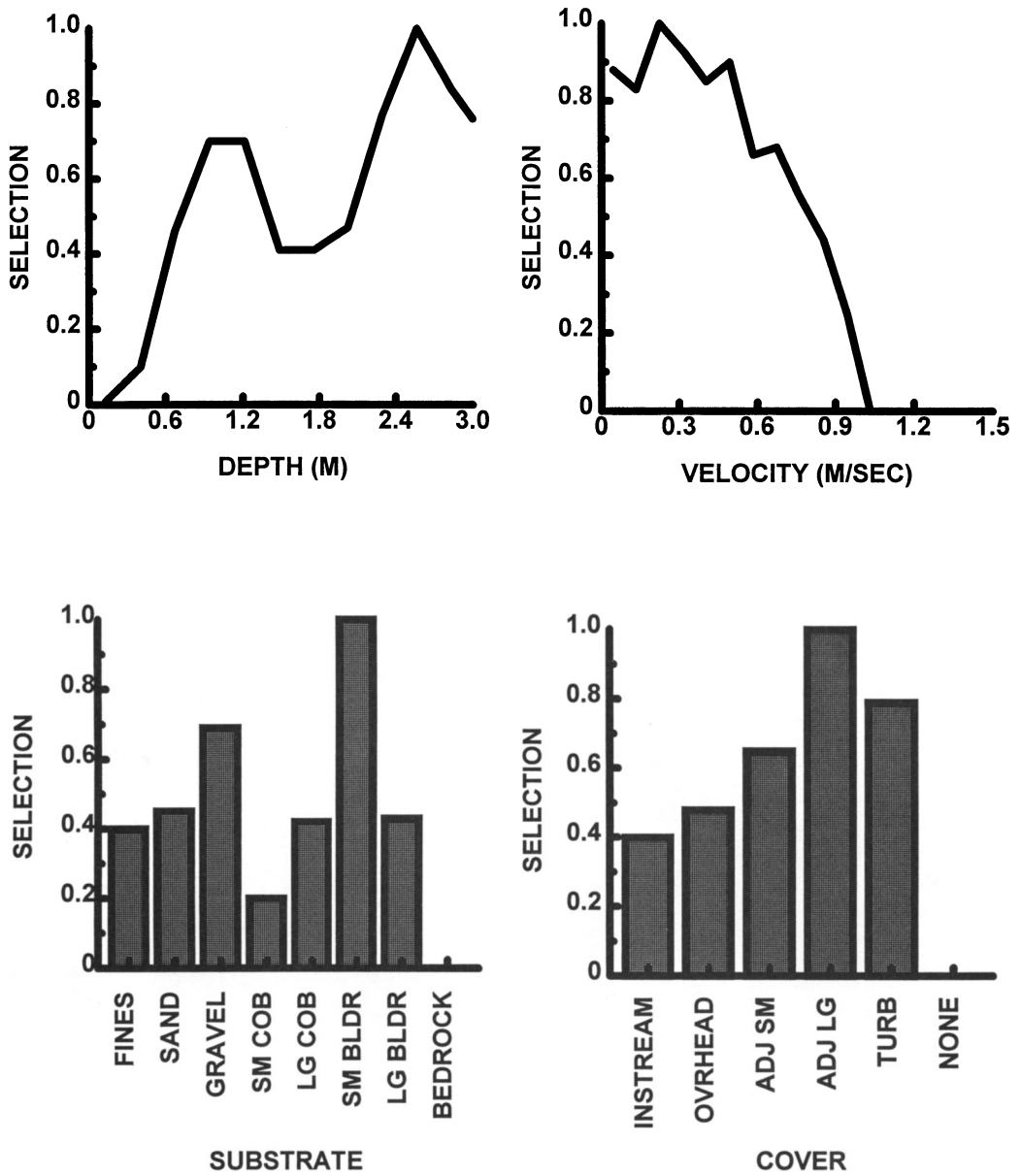

FIG. 3—Habitat selection by adult roundtail chub in Fossil Creek, Arizona, based on 176 snorkel observations of individual fish and 543 habitat availability points. SMCOB = small cobble, LGCOB = large cobble, SMBLDR = small boulder, LGBLDR = large boulder, ADJSM = adjacent to small cover, ADJLG = adjacent to large cover, TURB = turbulence.

upstream, had a constant temperature of 19°C, while Wet Beaver Creek varied from 19°C in summer to about 7°C in winter. Bedrock substrate was limited in Fossil Creek, but extensive in Wet Beaver Creek. Fossil Creek also contained speckled dace (*Rhinicthys osculus*) and Gila mountain sucker (*Pantosteous clarki*). In our study area, Wet Beaver Creek contained a reproducing population of smallmouth bass and an occasional stocked rainbow trout. The absence of an annual temperature cycle in Fossil Creek allowed roundtail chub to occupy the same habitats year-round.

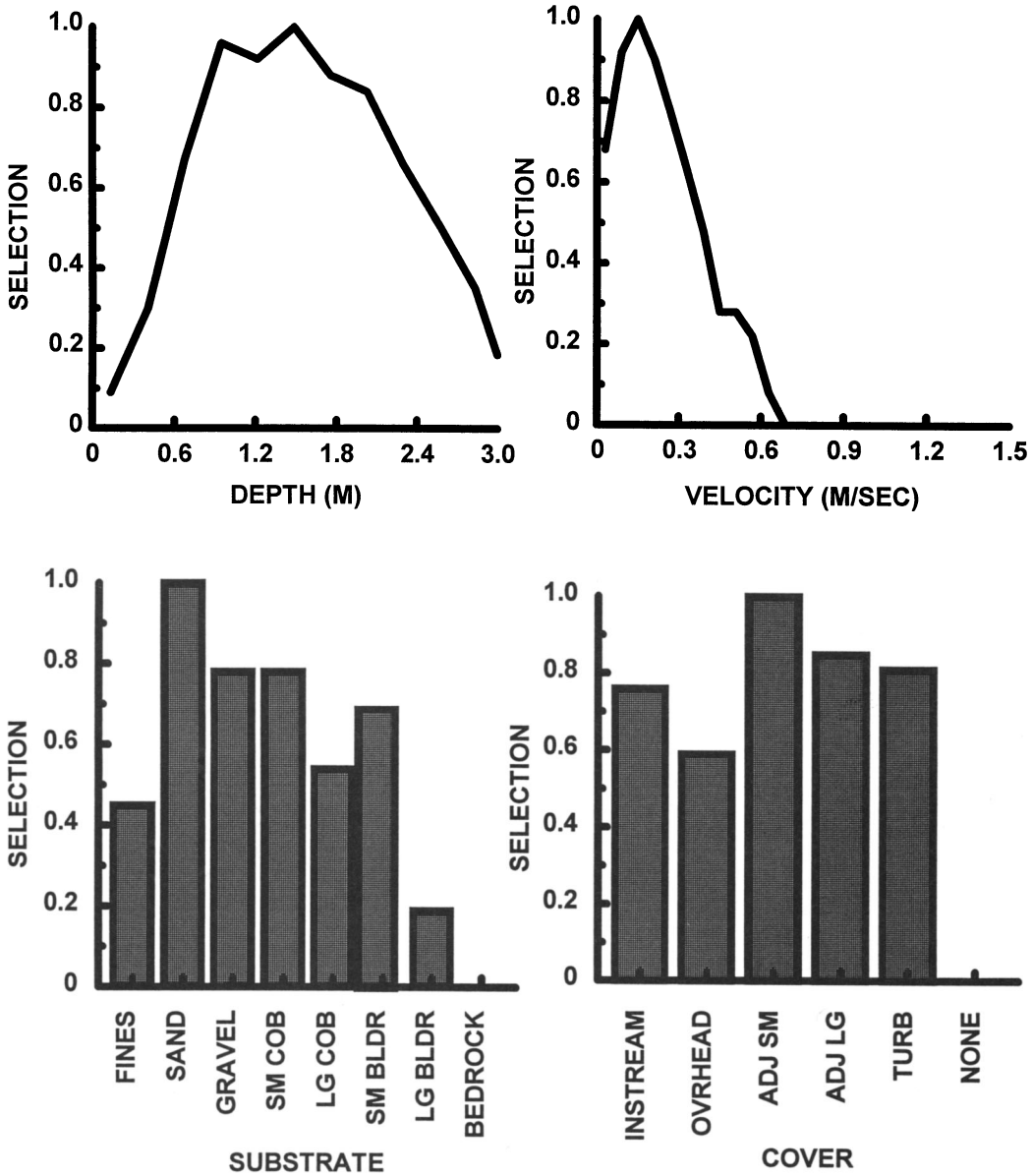

FIG. 4—Habitat by juvenile roundtail chub in Fossil Creek, Arizona, based on 350 snorkel observations of individual fish and 543 habitat availability points. SMCOB = small cobble, LGCOB = large cobble, SMBLDR = small boulder, LGBLDR = large boulder, ADJSM = adjacent to small cover, ADJLG = adjacent to large cover, TURB = turbulence.

Conversely, roundtail chub could not be located in the Wet Beaver Creek study site during winter.

Adult roundtail chub selected a wider range of habitat in Fossil Creek than in Wet Beaver Creek. However, because of great interstream differences, it was impossible to relate differences in temperature, structural, and biological conditions between the two creeks to habitat selection.

Although the species used different habitats, the presence of only adult roundtail chub in Wet Beaver Creek compared to all size classes in Fossil Creek was circumstantial evidence that some-

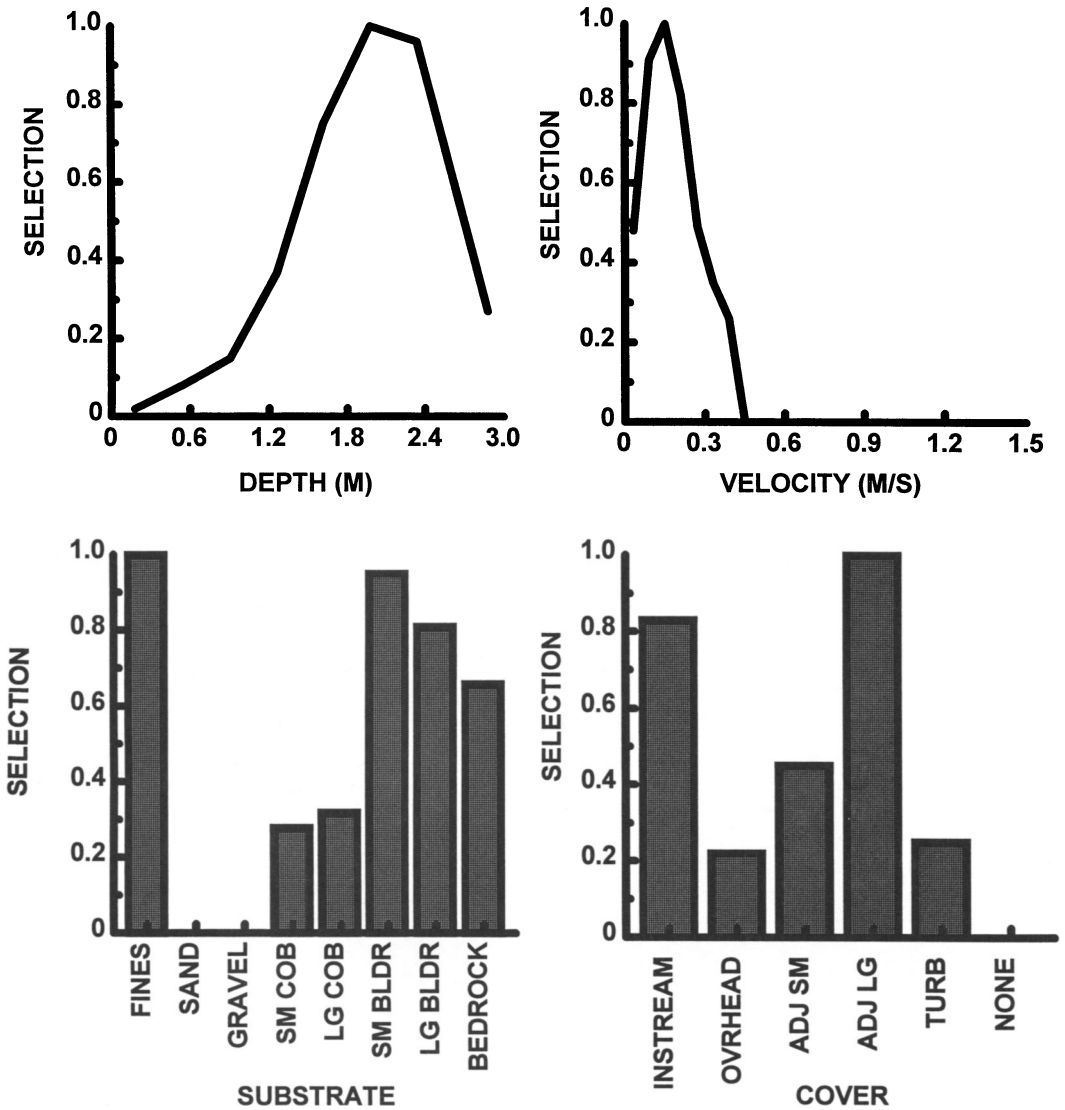

FIG. 5—Habitat by razorback sucker in Fossil Creek, Arizona, based on 31 snorkel observations of individual fish and 543 habitat availability points. SMCOB = small cobble, LGCOB = large cobble, SMBLDR = small boulder, LGBLDR = large boulder, ADJSM = adjacent to small cover, ADJLG = adjacent to large cover, TURB = turbulence.

thing, perhaps the presence of smallmouth bass made the Wet Beaver Creek habitat less suitable. The Fossil Creek population of roundtail chub was large and contained multiple lifestages. The presence of multiple life stages indicates that habitat requirements are being met. In contrast, the Wet Beaver Creek population was small and only adults were seen. The absence of juvenile chub in Wet Beaver Creek and the presence of smallmouth bass may indicate that habitats selected by adults in this stream do not represent "typical" habitats and possibly fail to meet the needs of the species.

Juveniles—There were differences between juvenile and adult selection relative to depth, velocity and substrate in Fossil Creek. Juveniles used riffles, and shallower, lower velocity water than adults in Fossil Creek, but higher velocity

water than adults in Wet Beaver Creek. The tendency for juveniles to occupy lower velocity water than conspecific adults has been reported in other species. In a report to the U.S. Fish and Wildlife Service in 1984, Raleigh et al. reported similar findings for rainbow trout. Ontogenetic shifts in habitat use may indicate differences in foraging strategies between lifestages of a single species. Different habitats may provide different prey bases, and both intraspecific and interspecific predation may force smaller fishes to occupy less optimal foraging areas (Werner and Hall, 1988).

We recommend caution in applying HSI curves for roundtail chub beyond the drainage in which they were developed. If such application is necessary, we recommend using HSI curves from Fossil Creek and then only for summer habitat use. We do not recommend using HSI curves from Wet Beaver Creek.

To our knowledge, our observations from Fossil Creek constitute the only available information on habitat use by razorback suckers introduced into streams in the lower Colorado River basin. Nonetheless, we recommend caution in the application of these curves because 1) they were developed with data from a small number of similar-sized and introduced fish, 2) there is no evidence of reproduction and hence long term persistence, and 3) they do not show patterns of use that are compatible with those of fish in other more commonly occupied habitats (e.g., backwaters along the Colorado River).

Funding for this research was provided by The Arizona Cooperative Fish and Wildlife Research Unit, which is jointly sponsored by the National Biological Survey, the U.S. Fish and Wildlife Service, Arizona Game and Fish Department, and the University of Arizona. The U.S. Forest Service, Beaver Creek Ranger Station allowed access to restricted areas on Wet Beaver Creek. Personnel from Arizona Public Service's Irving Power Plant in general, and S. Bowmar and G. Went in particular, provided access to Fossil Creek. The following individuals helped with data collection; S. Barrett, S. Villegas, J. Seals, P. Smith, G. Antonio, T. Ashbeck, and Z. Zdinak.

Literature Cited

Arizona Game and Fish Department. 1988. Threatened native wildlife in Arizona. Arizona Game Fish Dept. Publ., Phoenix.

Barrett, P. J., and O. E. Maughan. 1994. Habitat preferences of introduced smallmouth bass in a central Arizona stream. N. Amer. J. Fish. Mgmt., 14: 112–118.

Minckley, W. L. 1973. The fishes of Arizona. Arizona Game Fish Dept. Phoenix.

Werner, E. E., and D. J. Hall. 1988. Ontogenetic habitat shifts in bluegill: the foraging rate-predation risk tradeoff. Ecology, 69:1352–1366.