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DIET AND GROWTH OF SMALLMOUTH BASS IN THE DEVILS RIVER, TEXAS

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The smallmouth bass, *Micropterus dolomieu*, was first introduced into Amistad Reservoir, at the confluence of the Devils and Rio Grande rivers, in Texas in 1975 (G. Garrett, Texas Parks and Wildlife Department, pers. comm.). This species was introduced into several streams and reservoirs throughout the state to augment recreational fishing opportunities in locations having poor habitat quality for largemouth bass, *Micropterus salmoides*. Following introduction into Amistad, smallmouth bass moved upstream in the Devils River, and have likely been present in the upper portions of the river since the late 1980s. Favorable conditions in the river (i.e., rocky substrate, moderate gradient, and moderate water temperatures) have resulted in a thriving population of smallmouth bass. Little information is available on the biology of smallmouth bass in Texas waters, or the influence of this nonindigenous species on the native fish fauna (but see Garrett, 1985; Gilliland et al., 1991). Here we report on population structure, growth rate, and diet of smallmouth bass from the Devils River near Dolan Falls, Texas.

We captured smallmouth bass from the Devils River using hook and line angling, a Smith Root Model 15-B backpack electrofishing unit, and 2 types of seines—a 3.0 m by 1.8 m straight seine with 6 mm mesh, and a 4.9 m by 1.8 m bag seine with 6 mm mesh. We collected a total of 8 samples, 1 every other month from June 1997 through August 1998. Fish were captured in 3 locations: a deep pool just below Dolan Falls, a shallow reach ca. 100 m upstream from the falls (both within the Texas Nature Conservancy's Dolan Falls Preserve), and a reach ca. 1.5 km upstream from the falls, adjacent to Devils River State Natural Area. A total of 161 smallmouth bass were captured and euthanized for analysis of stomach contents, age, and growth. Fish were measured for standard length (SL), which was later converted to total length (TL) using the formula TL = 1.216*SL (Carlander, 1977) for comparison to similar studies. We captured most of the fish (n = 137) in the shallow reach immediately upstream of the falls. Thirteen individuals were captured in the upstream-most reach (using only seines) and 9 were removed from below the falls (using only hook and line angling). Prey items were recorded by frequency of occurrence, and each item was identified to the lowest practical taxon. The length of each prey item was estimated when possible. We used the cleithrum to determine species for partially digested fish (Hansel et al., 1988). We determined age using otoliths and assessed growth by back-calculation using the Fraser-Lee method (DeVries and Frie, 1996). We also made observations on the presence of parasites.

To estimate relative abundance of prey species for use in calculation of diet electivities, we surveyed fishes within each of the 2 shallow sample reaches during the same sample dates when smallmouth bass were removed. We sampled in 6 meso-scale habitats, which were representative of those commonly used by smallmouth bass (Rankin, 1986) including 2 each of runs, riffles, and channel margins. We sampled fishes during daylight hours using the same 2 seines as for capturing the smallmouth bass. Seining was performed throughout the entire area of each habitat until the total catch per seine haul declined to <5% of the cumulative catch. This generally required a number of seine hauls equivalent to sampling the entire surface area of each habitat 2 times. All captured fishes were identified, counted, and subsequently returned to their habitats.

Most of the smallmouth bass sampled in the 2 stream reaches were young-of-the-year (YOY; 131 of 152). This is not surprising due to the depth of water in these areas (generally <0.5 m) and lack of habitat suitable for larger smallmouth bass (i.e., large rocks capable of providing cover). The only individuals older than age 2 were captured in the deep pool below Dolan Falls (although several apparent age 2+ individuals were observed in a large pool between the 2 areas we sampled). All 9 smallmouth bass captured from this pool were age 1+. The longest smallmouth bass found in the study was 499 mm TL, and the maximum weight (a different individual) was 1,600 g. Parasites (unidentified nematodes) were observed in the intestinal cavity in 27% of the population, often in high concentrations.

Among the fishes captured using seines, *Cyprinella venusta* accounted for approximately one half of all individuals (Table 1). Largemouth bass and federally-listed *Dionda diaboli* were rare in the reaches sampled. *Cyprinella proserpina* and *Etheostoma grahami*, both state-listed as threatened species, were common in these reaches.

TABLE 1—Abundance of each species captured, using seines, in the Devils River, Texas (1997 to 1998).

Species	Absolute abundance
Cyprinella venusta	1,928
Cyprinella proserpina	629
Notropis amabilis	335
Cichlasoma cyanoguttatum	276
Dionda argentosa	212
Etheostoma grahami	101
Astyanax mexicanus	91
Gambusia speciosa	83
Micropterus dolomieu	45
Ictalurus punctatus	40
Moxostoma congestum	39
Lepomis sp.*	28
Notropis stramineus	18
Pylodictis olivaris	10
Dionda diaboli	3
Micropterus salmoides	2
Total	3,840

* includes *L. megalotis* and *L. auritus* (juveniles were difficult to distinguish in the field).

Insects dominated the diet of smallmouth bass in the Devils River in frequency of occurrence and mean number of prey items recovered. Mayflies were found in 54% of stomachs, and generally consisted of high concentrations of small individuals (<5 mm; Table 2). Small fish species also comprised a large proportion of the diet, with 32% of stomachs containing fish prey. Many YOY smallmouth bass consumed fish; the smallest observed to have fish in its stomach was 52 mm SL, and several 62 mm SL specimens had consumed fish. Over their first summer, 23% of YOY smallmouth bass had fish in their stomachs. Consumption of fish early in life usually results in fast growth during the first year (Livingstone and Rabeni, 1991).

About half of the 75 individuals found in stomachs were impossible to identify, due to missing or damaged cleithra. By examining the cleithrum, most species were distinguishable,

TABLE 2—Prey items found in the stomachs of 161 smallmouth bass in the Devils River, Texas (1997 to 1998). SL = standard length.

Contents	Frequency of occurrence	Mean per stomach	Mean SL (mm)	Range of SL (mm)
Fish	32.5	1.4	28.1	10–95
Crayfish	3.0	1.2	14.4	30–50
Hellgrammite	4.7	1.3	5.8	3–7
Mayfly	54.4	27.4	3.4	2–22
Caddisfly	7.7	1.6	6.4	2–9
Dragonfly/damselfly	5.3	5.3	10.0	6–30
Beetle	1.8	1.0	8.5	5–12
Empty	15.4	—	—	—
Other*	25.4	—	—	—

* Included amphipods, blackflies, caterpillars, hemipterans, isopods, spiders, unidentified insects, and a frog.

but 2 species of the genus *Dionda* were difficult to differentiate. Seven specimens were conclusively identified as *Dionda argentosa,* and 5 other *Dionda* specimens were assumed to be *D. argentosa* because *D. diaboli* was extremely rare in recent collections in this region (Valdes and Winemiller, 1997; G. Garrett, Texas Parks and Wildlife Department, pers. comm.; Robertson and Winemiller, in litt.).

The Strauss electivity index (Strauss, 1979) was used to determine selection by smallmouth bass for each species relative to its abundance in the river. The electivity value for *D. argentosa* was higher than for any other species (Table 3). Despite the apparent preference for *D. argentosa,* smallmouth bass were opportunistic when consuming fish prey in the Devils River, as indicated by the wide range of species found in their stomachs. Although individuals within the genus *Lepomis* also were eaten in relatively high proportions, this number may have been influenced by the close association of these species to rocks and vegetation which may have led to under-sampling and under-representation of their relative abundance, yielding an inflated electivity index value. The most abundant fish in the river, *C. venusta* (Table 1), had a relatively high negative value, which indicates that this species is selected against, or is more effective at avoiding predation by smallmouth bass. The electivity value for all other species was near zero, suggesting they were eaten in proportions nearly equal to those in which they were found in the river.

Although previous studies have shown crayfish to be a large proportion of the diet of

TABLE 3—Fish prey found in 161 smallmouth bass stomachs in the Devils River, Texas (1997 to 1998). Electivity values were calculated using Strauss' (1979) index. SL = standard length.

Species	*n*	Mean SL (mm)	Range of SL (mm)	Electivity
Cyprinella proserpina	3	28.5	20–43	−0.076
Cyprinella venusta	3	41.2	18–76	−0.414
Dionda argentosa	12	31.3	15–52	0.295
Notropis stramineus	1	—	—	0.025
Notropis amabilis	4	28.5	25–33	0.030
Notropis sp.	4	13.0	13	0.013
Ictaluridae	1	95.0	—	0.016
Gambusia speciosa	1	20.0	—	0.008
Lepomis sp.	6	36.3	30–40	0.169
Etheostoma grahami	3	26.7	20–32	0.062
Unidentified	37	21.9	10–60	—

TABLE 4—Mean back-calculated total lengths (TL) for each year class of smallmouth bass captured from the Devils River, Texas (1997 to 1998). For comparison, mean length at age is also included for other studies in Texas (Garrett, 1985; Gilliland et al., 1991).

Age	*n*	Mean TL at capture (mm)	Mean TL at age (mm)				
			1	2	3	4	5
0	131	100.3					
1	18	204.2	106.9				
2	8	309.7	123.3	291.0			
3	1	498.6	157.4	352.8	462.8		
4	2	472.4	122.7	269.6	342.9	432.7	
5	1	474.2	184.1	331.7	403.0	433.5	458.9
		Mean =	116.6	296.0	387.9	432.9	458.9
Lake Texoma			103	257	341	431	468
Canyon Lake			154.5	227.6	325.7	389.7	410.6

smallmouth bass (Kilambi et al., 1977; Buynak et al., 1982), only 3% of stomachs from the Devils River population contained crayfish (Table 2). Crayfish seemed to be common in the river, although specific sampling was not conducted to verify this observation. Hellgrammites (dobsonfly larvae) were effective as bait for angling; however, they were rare in smallmouth bass stomachs (4.7%).

Smallmouth bass growth was rapid, particularly during the second year (Table 4). Total length during the first year averaged 116 mm, and the mean length increment during the second year was 179 mm. Average first-year growth was 30% higher than the 89 mm TL mean from smallmouth bass populations from southwestern edges of the species' natural range (Arkansas, Missouri, and Oklahoma; Carlander, 1977). Smallmouth bass stocked in Texas were originally taken from stream populations in northern Arkansas (Gilliland et al., 1991), but Texas fish grew larger during their first year than the 87 mm TL attained by first-year smallmouth bass from Arkansas (however, the Arkansas value should be interpreted with caution because of suspected calculation errors; Carlander, 1977). Growth of smallmouth bass in Devils River was also greater during the second year when compared to the increase of 94 mm observed in Arkansas, and the mean of 85 mm for Arkansas, Missouri, and Oklahoma combined. Populations associated with stream systems in these states had first-year growth values ranging from 89 mm TL in Missouri to 99 mm TL in Oklahoma's Illinois River, and second-year growth in the range of 175 mm to 190 mm (Carlander, 1977). Data for ages 3, 4, and 5 also suggested high growth rates in the Devils River, but these estimates are based on only 4 specimens, all of which were obtained from the deep pool below Dolan Falls.

Similar to populations in 2 Texas reservoirs, Canyon (Garrett, 1985) and Texoma (Gilliland et al., 1991), growth estimates in the Devils River were observed to be higher than average for the species. Smallmouth bass generally attain larger sizes in reservoirs, yet the Devils River population had higher growth rates than those in Texas reservoirs. Growth was essentially isometric, with an approximately cubic length-weight relationship ($\text{Log}_{10}\,W = 3.036\,\text{Log}_{10}\,SL - 4.754$), which is similar to findings from other parts of the species' range (Carlander, 1977).

Rapid growth of Devils River smallmouth bass can be attributed, in part, to a longer growing season in this southern extension of the species' range, but high growth rates in smallmouth bass can also be a function of diet. Probst et al. (1984) found that crayfish and fish were the 2 most important prey items (in terms of energy provided) in the diet of smallmouth bass in Jacks Fork River, Missouri. They also noted that crayfish were unimportant in the diet of YOY smallmouth bass. Rankin (1986) found that smallmouth bass <80 mm TL did not feed on crayfish. In both Canyon and Texoma reservoirs in Texas, fish and crayfish were important constituents of stomach contents of smallmouth bass, but each study focused heavily on larger (older) specimens. Because the population of smallmouth bass in the Devils River was dominated by YOY and age 1 fish, rapid growth in this population may have been influenced by the predominance of fishes in the diet. Only 1 species, *D. argentosa,* was consumed in proportions substantially greater than its relative abundance reflected in our seine samples of a variety of habitats. Most fish species were consumed by smallmouth bass in proportions nearly equal to their relative abundances in the river.

Although this study was descriptive and cannot directly assess the influence of smallmouth bass predation on the population dynamics of rare and endemic fishes of the Devils River, it has established that this nonindigenous predator consumes at least 66% (8 of 12) of the small fish species in the assemblage. In addition, the smallmouth bass population is thriving, as indicated by rapid individual growth, high abundance relative to native predators (i.e., Ictaluridae and *Micropterus salmoides*), and abundance of YOY relative to other age classes.

Resumen—Luego de su introducción en la represa Amistad durante la década de 1970, la lobina de boca pequeña, *Micropterus dolomieu,* se ha multiplicado abundantemente en el Río Devils, Texas. Esta situación ha generado preocupación debido al impacto que esta especie pudiera tener sobre la fauna nativa, especialmente a peces endémicos raros. Examinamos la dieta y el crecimiento somático de *M. dolomieu* introducido en el Río Devils y encontramos que, aunque los insectos conforman una proporción sustancial de su dieta, el 32% de los estómagos examinados contenían peces. *Micropterus dolomieu* fue piscívoro aún en estadios juveniles de talla pequeña. La mayoría de las especies de pequeños peces fueron consumidas en proporciones cercanas a su abundancia relativa en el río, y dos especies amenazadas fueron identificadas en los estómagos. Altos valores de selectividad por *Dionda argentosa* indican una preferencia por esta especie. Las tasas de crecimiento somático, especialmente durante el segundo año, fueron mayores en el Río Devils al compararlas con la tasa promedio en Norteamérica y en otras represas de Texas.

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Literature Cited

Buynak, G. L., A. J. Gurzynski, and H. W. Mohr, Jr. 1982. Comparison of the food habits of smallmouth bass (*Micropterus dolomieui*) at two stations on the Susquehanna River. Proceedings of the Pennsylvania Academy of Science 56:127–132.

Carlander, K. D. 1977. Handbook of freshwater biology. Iowa State University Press, Ames.

DeVries, D. R., and R. V. Frie. 1996. Determination of age and growth. In: Murphy, B. R., and D. W. Willis, editors. Fisheries techniques, Second ed. American Fisheries Society, Bethesda, Maryland. Pp. 483–512.

Garrett, G. P. 1985. Aspects of the life history of smallmouth bass in a Texas reservoir. Annual Proceedings of the Texas Chapter of the American Fisheries Society 8:46–61.

Gilliland, E., R. Horton, B. Hysmith, and J. Moczygemba. 1991. Smallmouth bass in Lake Texoma, a case history. In: Jackson, D., editor. First international smallmouth bass symposium. Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, Meridian. Pp. 104–109.

Hansel, H. C., S. D. Duke, P. T. Lofy, and G. A. Gray. 1988. Use of diagnostic bones to identify and estimate original lengths of ingested prey fishes. Transactions of the American Fisheries Society 117:55–62.

Kilambi, R. V., W. R. Robison, and J. C. Adams. 1977. Growth, mortality, food habits, and fecundity of the Buffalo River smallmouth bass. Proceedings of the Arkansas Academy of Science 31:62–65.

Livingstone, A. C., and C. F. Rabeni. 1991. Food-habitat relationships of underyearling smallmouth bass in an Ozark stream. In: Jackson, D., editor. First international smallmouth bass symposium. Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, Meridian. Pp. 76–83.

Probst, W. E., C. F. Rabeni, W. G. Covington, and R. E. Marteney. 1984. Resource use by stream-dwelling rock bass and smallmouth bass. Transactions of the American Fisheries Society 113: 283–294.

RANKIN, E. T. 1986. Habitat selection by smallmouth bass in response to physical characteristics in a natural stream. Transactions of the American Fisheries Society 115:322–334.

STRAUSS, R. E. 1979. Reliability estimate for Ivlev's electivity index, the forage ratio, and a proposed linear index of food selection. Transactions of the American Fisheries Society 108:344–352.

VALDES, N. E., AND K. O. WINEMILLER. 1997. Structure and habitat associations of Devils River fish assemblages. Southwestern Naturalist 42:265–278.

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