CONSUMPTION OF NATIVE AND NONNATIVE FISHES BY INTRODUCED LARGEMOUTH BASS (*MICROPTERUS SALMOIDES*) IN THE SAN JUAN RIVER, NEW MEXICO

Tyler J. Pilger,* Nathan R. Franssen, and Keith B. Gido

Department of Biological Sciences, Fort Hays State University, Hays, KS 67601 (TJP)
Division of Biology, Kansas State University, Manhattan, KS 66506 (NRF, KBG)
Present address of TJP: Division of Biology, Kansas State University, Manhattan, KS 66506
**Correspondent: tjpilger@ksu.edu*

Abstract—Intense predation on larval and juvenile fishes by introduced piscivores can be detrimental to recruitment of threatened and endangered native fishes. Introduced largemouth bass (*Micropterus salmoides*) in the San Juan River, New Mexico, Colorado, and Utah, rarely are collected as adults; however, juveniles (<200 mm total length) often occur in the same habitats as young-of-the-year native fishes. To evaluate the prevalence of native fishes in the diet of juvenile largemouth bass, stomach samples from juveniles were collected from the San Juan River in New Mexico during July and August 2005, when young-of-the-year native and nonnative fishes were present. Stomach contents of largemouth bass were identified as native catostomids, native cyprinids, or nonnative cyprinids based on pharyngeal teeth. Although nonnative fishes comprised >80% of the potential prey base, significantly more native fishes were identified in stomachs than nonnative fishes. The disproportional abundance of native fishes in the diet of juvenile largemouth bass suggests greater susceptibility of young-of-the-year natives to predation by largemouth bass in the San Juan River.

Resumen—La depredación intensa sobre peces en estadio larval y juvenil por piscívoros introducidos puede ser perjudicial para el reclutamiento de las especies nativas amenazadas o en peligro de extinción. El pez introducido lobina negra (*Micropterus salmoides*) en el río San Juan de los estados de Nuevo México, Colorado y Utah es raramente recolectado como adulto; sin embargo, los juveniles (<200 mm TL) a menudo viven en los mismos hábitats de otros peces nativos jóvenes-del-año. Para evaluar la prevalencia de los peces nativos en la dieta de los juveniles de la lobina negra se colectaron muestras del contenido estomacal de juveniles del río San Juan en Nuevo México durante los meses de julio y agosto del 2005, cuando los jóvenes-del-año de peces nativos y no nativos estuvieron presentes. Basado en la dentadura faringueal, el contenido estomacal del pez lobina negra fue identificado como catostómido nativo, ciprínido nativo y ciprínido no nativo. Aunque los peces no nativos comprendieron >80% de las presas potenciales, significativamente más peces nativos fueron identificados en los estómagos que peces no nativos. La abundancia desproporcionada de los peces nativos en la dieta de los juveniles de la lobina negra sugiere más susceptibilidad de los peces nativos jóvenes-del-año a la depredación de la lobina negra en el río San Juan.

Intense predation on native fishes by nonnative piscivores and alterations to historical flow regimes in the Colorado River Basin have been implicated in the decline of many endemic fishes (Miller, 1961; Tyus et al., 1982; Minckley, 1991). Predators that consume larval and juvenile fishes can directly contribute to poor recruitment of endangered fishes (Ruppert et al., 1993; Scoppettone, 1993; Marsh and Douglas, 1997; Bestgen et al., 2006). Although consumption of adult large-bodied native fishes by introduced piscivores is likely limited by gape size and habitat use of introduced predators, native larval and juvenile fishes are more prone to predation. Juveniles of large-bodied piscivores can occupy the same habitats as native larvae and juveniles, thus increasing the likelihood of negative interspecific interactions (Tyus et al., 1982; Gido and Propst, 1999). Specifically, juvenile largemouth bass (*Micropterus salmoides*) occur in the same slow-velocity habitats as young-of-the-year and juvenile native fishes (Sublette et al., 1990), and efforts to restore or maintain populations of endangered species (e.g., stocking) may be impeded by their presence (Marsh and Langhorst, 1988; Marsh and Brooks, 1989; Marsh and Douglas, 1997).

Of the eight species of fishes that historically occurred in the San Juan River (Tyus et al., 1982), only speckled dace (*Rhinichthys osculus*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*C. latipinnis*) remain relatively common. Federally endangered Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and State-listed roundtail chub (*Gila robusta*) have experienced the largest declines in abundance (Propst and Gido, 2004). Abundant introduced fishes include red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), and largemouth bass (Sublette et al., 1990). Whereas adult largemouth bass are rare in the San Juan River (D. W. Ryden, in litt.), juveniles (<200-mm total length) are common enough to pose a potential predation threat to young-of-the-year native species. The objective of this study was to assess the proportion of native and nonnative prey fishes in the diet of juvenile largemouth bass relative to the proportion of available native and nonnative prey in the San Juan River, New Mexico.

In secondary and primary channels of the San Juan River between Shiprock, New Mexico, and the confluence with the Mancos River, 138 mesohabitats were sampled. A detailed description of this area is given in Propst and Gido (2004). We collected largemouth bass and potential prey fishes during July and August 2005, when young-of-the-year native fishes were in highest absolute abundance (Gido et al., 1997). Fishes were collected during daylight hours with a 1.8 by 4.6-m seine, 4.5-mm mesh. Habitats sampled averaged 17 m^2 in area and 0.27 m in depth (range 0.07–0.84 m), with an average velocity of 0.13 m/s (range 0–0.52 m/s). Substrates consisted of silt, gravel, cobbles, and bedrock (modified Wentworth scale; Cummins, 1962). All fishes were identified, enumerated, and released on site, except largemouth bass, which were preserved in 10% formalin and returned to the laboratory for analysis. No regurgitated prey items were observed as a result of preservation. Stomachs were removed and contents were observed with the aid of a stereomicroscope and identified to the lowest possible taxonomic classification; order and family for invertebrates, and family for fishes. Fish prey items were further classified as native catostomid, native cyprinid, or nonnative cyprinid through identification of pharyngeal teeth as reported by Sublette et al. (1990).

The proportion of available native and nonnative prey was calculated from individuals collected in the same habitats where largemouth bass were collected (i.e., range of depth and velocity where largemouth bass were seined). A Chi-square goodness of fit with a Yate's correction was used to test if the proportion of consumed native and nonnative prey differed from available native and nonnative prey. Stomachs of largemouth bass that were empty, contained only invertebrates, or undetermined items were not included in statistical analysis.

Largemouth bass were collected in about 10% of mesohabitats sampled. Overall, largemouth bass were collected from shallow (range 0.16–0.41 m; mean = 0.28 m), low-velocity habitats (range 0.00–0.23 m/s; mean = 0.14 m/s). Sixty juvenile largemouth bass were collected (range 39–169-mm total length; mean = 63.4 mm), of which 13 had empty stomachs, 12 contained only invertebrates, 16 contained only fish, 18 contained invertebrates and fish, and 1 stomach contained undetermined items. The most frequent invertebrate prey included the orders Hemiptera, Trichoptera, Ephemeroptera, and Diptera (Chironomidae). Thirty-four stomachs had fish prey items (n = 45 fish items; mean = 1.3 fish/stomach). The fish prey items identified belonged to two families; Catostomidae (many, long, slender pharyngeal teeth) and Cyprinidae (8–12, short, thick pharyngeal teeth). Of the 45 fish prey items, 26 were classified as native prey and 4 were classified as nonnative prey (Table 1).

Juvenile largemouth bass collected from the San Juan River consumed a significantly higher proportion of native fishes (0.87) than nonnative fishes (0.13; $\chi^2 = 69.4$; $df = 1$; $P < 0.001$). Of the 4,201 available prey individuals collected from seineable habitats, the proportion of native and nonnative fishes (0.22 and 0.78, respectively) was similar to the proportion of larval native and nonnative fishes collected during a more extensive survey conducted at the same period by Brandenburg and Farrington (0.14 and 0.86, respectively; W. H. Brandenburg and M. A. Farrington, in litt.). Because the available prey base was overwhelmingly nonnative fishes (Gido

Table 1—Fish prey items observed in 34 stomachs of largemouth bass (*Micropterus salmoides*). Prey items were identified using arrangements of pharyngeal teeth and classified as native or nonnative prey species.

Arrangement of pharyngeal teeth	Prey item	Number observed
Many, long, slender teeth	Native catostomid	11
1, 4–4, 1 hooked	Native cyprinid	10
2, 4–4, 2 hooked	Native cyprinid	5
0, 4–4, 0 hooked	Nonnative cyprinid	3
0, 4–4, 0 not hooked	Nonnative cyprinid	1
Absent or broken	Unknown fish	15
	Total	45

et al., 1997; Franssen et al., 2007; W. H. Brandenburg and M. A. Farrington, in litt.), the greater occurrence of native prey fishes in the diet of largemouth bass may be attributed either to largemouth bass having a stronger preference for native prey species or native species being more vulnerable to predation.

Similar to Brandenburg and Gido (1999), predation by largemouth bass on larval fishes may be underestimated due to rapid digestion. Because identification of stomach contents was at times limited to observing bony structures, smaller larval fishes lacking ossified structures may have been overlooked. This could bias our estimates of the ratio of native to nonnative fishes in the diet because nonnative young-of-the-year were on average smaller than native young-of-the-year (Franssen et al., 2007). Nevertheless, if we consider the unidentified fishes to be nonnative, the ratio of native to nonnative fishes in diet of largemouth bass (0.58 and 0.42, respectively) is still greater than what was available in the river.

In addition to largemouth bass, other piscivores, such as green sunfish (*Lepomis cyanellus*) and channel catfish are present in this reach of the San Juan River (Gido et al., 1997) and presumably are preying on native species (Marsh and Douglas, 1997). Channel catfish occur frequently and are currently the subject of intense nonnative removal efforts. Ruppert et al. (1993) and Brandenburg and Gido (1999) indicated that omnivorous species, such as the highly competitive red shiner and fathead minnow, can prey on larvae of native fishes. Based on the numerical abundance, and similar resource and habitat use, these nonnative cyprinids could have severe negative effects on native fishes as well (Gido et al., 2006). The scarcity of adult size classes of largemouth bass and other nonnative piscivores in the San Juan River (D. W. Ryden, in litt.) suggests an external source of juveniles, such as off-channel ponds stocked with game species (Martinez et al., 2001). Addressing such issues as the intentional release or escape of nonnative fishes into the San Juan River may alleviate the deleterious impact nonnative fishes have on native fishes. This study and similar studies indicate that negative interactions caused by introduced fishes may have deleterious impacts on recruitment of species of fishes endemic to the Colorado River Basin.

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