Grass Carp Reproduction in the Lower Trinity River, Texas

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Abstract: Reports of grass carp *(Ctenopharyngodon idella)* from the lower Trinity River and Trinity-Galveston Bay of southeastern Texas prompted concerns that this introduced fish may be successfully spawning and recruiting in local waters. To examine these possibilities, Texas Parks and Wildlife Department (TPWD) personnel conducted icthyoplankton sampling from April through July 1992 and 1993 and electrofished during July and August 1993 in the lower Trinity River. Additionally, fish-kill records from the Trinity-Galveston Bay area were examined. Icthyoplanton samples taken in 1992 and 1993 contained 708 grass carp eggs, including many that were viable and devloping at the time of collection. In 1993, samples also contained 1,500 recently-hatched grass carp larvae. Additionally, 54 juvenile grass carp between 104 and 175 mm total length (TL) were recorded from a section of Bray's Bayou off the Houston Ship Channel in September 1993. These data indicate successful grass carp spawning, egg development, hatching, and possibly recruitment are occurring in the lower Trinity River, Texas.

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Grass carp were first introduced into research facilities in Alabama and Arkansas in 1963 (Stevenson 1965, Sutton 1977). Their presence in North America and subsequent releases or escapements into open waters prompted concern about possible reproduction in the United States. Stanley (1976) predicted grass carp would spawn in the Mississippi River Valley but thought success would be minimal. Stanley et al. (1978) indicated that large, long rivers or canals with high volumes (>400m^3/second and fast flow rates (>0.8 m/second) were needed for successful

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spawning. Pflieger (1978) suggested that the abundance of grass carp in the middle Mississippi River was too great to result solely from escapement. Indeed, only 2 years later, Conner et al. (1980) reported collection of grass carp larvae in the Mississippi River in Arkansas and Louisiana. Shortly thereafter, Leslie et al. (1982) demonstrated egg hatching could occur at flow rates down to 0.23 m/second, thus dramatically expanding the potential locations and occasions where grass carp might successfully spawn.

Collection of grass carp larvae within the Mississippi Basin continued. Zimpfer et al. (1987) found larvae and predicted successful recruitment. Pflieger and Grace (1987) found juvenile grass carp stranded on a desiccated flood plain in Missouri. Brown and Coon (1991) also reported collection of grass carp larvae in the Mississippi River and 4 of its tributaries in Missouri.

In Texas, the first legal stockings of grass carp occurred in 1981 and 1982 when diploid fish were stocked into Lake Conroe located in Montgomery and Walker counties on the San Jacinto River in southeastern Texas (Martyn et al. 1986). By 1983, several large grass carp had been collected in the adjacent Trinity River (Trimm et al. 1989). Over the next few years, other grass carp were collected from the San Jacinto River below Lake Conroe, in and below Lake Houston downstream on the San Jacinto River, in Trinity Bay in the mouth of the San Jacinto River, across Trinity Bay in the mouth of the Trinity River, and up the Trinity River itself (Trimm et al. 1989). Commercial catches of grass carp in the Trinity River (L. Robinson, TPWD, Coastal Fisheries Division [CF], pers. commun.) and complaints from the Galveston Bay Foundation (a local conservation organization) that herbivory by grass carp was a deterrent to establishing smooth cordgrass *(Spartina alterniflora)* in upper Trinity Bay prompted concern that grass carp reproduction may be occurring in the lower Trinity River.

Previous studies have been inconclusive with regard to reproduction and recruitment of grass carp in the Trinity River. Trimm et al. (1989) dismissed the collection of a $<$100-mm juvenile grass carp taken near Baytown, Texas, as probably an illegally stocked escapee. However, most grass carp are stocked at sizes substantially $>$100 mm to avoid predation losses. Trimm et al. (1989) further noted ichthyoplankton collections in the Trinity River during possible spawning periods in 1984 and 1985 by Menn and Pitman (1986) failed to collect either grass carp eggs or larvae. However, their collections were made by surface tows that could have missed grass carp eggs where turbulence was not sufficient to force the eggs to the surface. Additionally, since grass carp have relatively short duration of incubation and yolksac periods at warmer temperatures, prior to active swimming and net avoidance, sampling intervals of more than a few days could fail to detect a significant spawn. The objective of this study was to determine if grass carp reproduce and recruit to juvenile stages in the lower Trinity River, Texas.

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Methods

Ichthyoplankton samples were collected from 3 stations on the lower Trinity River: 135 km, 58 km, and immediately above Trinity Bay. These stations correspond to river crossings at Farm-to-Market Road 787 (FM 787), U.S. Highway 90 (U.S. 90), and Interstate Highway 10 (I-10), respectively (Fig. 1). Collections were conducted during April–July of 1992 and 1993 when surface water temperatures were 18–30 C. A 0.5-m, 560-micron mesh conical plankton net with a flow meter attached was used to take 3 tows at each station once each week. During each tow, the net was allowed to sink to the river bottom then secured approximately 1.0 m above the river bottom for 5 minutes before being retrieved. Samples were taken from the bridge at FM 787 and from a boat approximately 0.8 km upstream from U.S. 90 and I-10. Additional tows were taken during July 1993 in 15 backwater sites off the lower Trinity River throughout the area between FM 787 and I-10 in an effort to collect larvae that may have moved to calmer water to feed. Thirty-four tows of 5 minutes duration each were taken. Typically, surface and bottom tows were taken at each site.

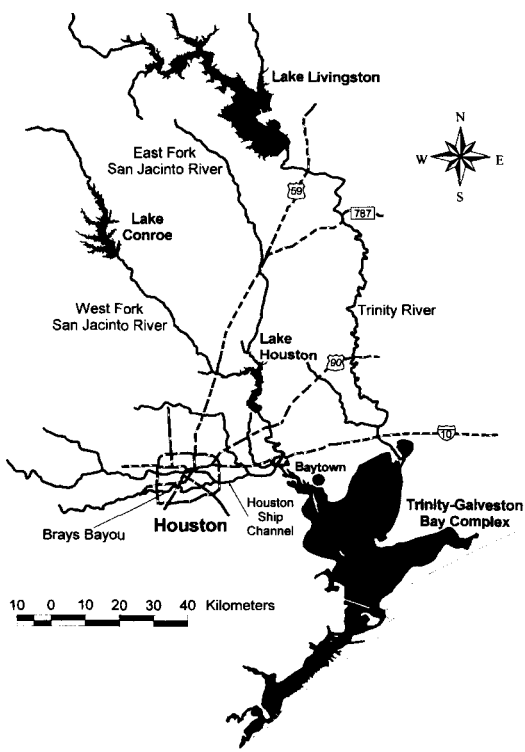

Figure 1. Map of upper Trinity-Galveston Bay complex including lower Trinity and San Jacinto Rivers, Texas.

All samples were preserved using a 10% formalin solution and stained with rose bengal to facilitate subsequent specimen removal. Grass carp eggs and larvae were identified according to methods described by Soin and Sukhanova (1972), Conner et al. (1980), Kilambi and Zdinak (1981), and Howells (1985). Identifications of a subsample of 5 larval fish were confirmed by Dr. Darrel Snyder, University of Colorado Larval Fish Laboratory, Fort Collins.

A 5-kw boat-mounted electrofisher was used to sample for juvenile grass carp in both the main river channel and backwater sites during July and August 1993. Forty-one sites were sampled from FM 787 to the mouth of Trinity Bay. Sample duration varied from 5.0 minutes to 91.4 minutes depending on size of area covered (total electrofishing effort = 12.1 hours). Also, fish kill investigation records from TPWD, Resource Protection Division (TPWD-RP) were examined for juvenile grass carp in the Trinity/Galveston Bay area.

Results

During May and June 1992, 691 grass carp eggs were collected at FM 787 and U.S. 90. No other grass carp eggs and no grass carp larvae were collected during 1992. Sampling in June 1993 yielded 17 grass carp eggs and 1,500 grass carp larvae. All grass carp eggs and larvae collected in 1993 were taken on the same day, with eggs collected at FM 787 and U.S. 90 and larvae collected at I-10. Progressive development was seen in eggs taken from the upper and middle stations both years. No eggs or larvae were taken from backwater samples.

Although adult grass carp were seen and collected during electrofishing, no juvenile grass carp were collected. However, fish kill records from TPWD-RP show 54 juvenile grass carp between 104 and 175 mm total length (TL) were recorded from a 18.3-m section of Bray's Bayou off the Houston Ship Channel in September 1993.

Discussion

Collection of grass carp eggs and larvae from the lower Trinity River and small juvenile grass carp from the Trinity/Galveston Bay complex indicates that successful grass carp spawning, egg development, hatching, and recruitment occurred in the Trinity River and Trinity/Galveston Bay complex, Texas. High flow conditions accompanied the June 1993 samples that yielded grass carp eggs and larvae. Velocity recorded during the day's sampling ranged from 0.4 to 8.6 m/second with the upper value recorded at FM 787. Similarly, Zimpfer et al. (1987) reported peak abundance in their samples at 0.4 to 2.2 m/second.

Stocking of triploid grass carp is allowed under permit in Texas (as of January 1992). Legally stocked triploid and illegally stocked diploid grass carp are generally 200 mm TL or larger at the time of stocking. Commercial harvest of grass carp from the lower Trinity River from 1991–1999 totaling 28,662 kg (L. Robinson, TPWD-CF, pers. commun.) indicates the grass carp population in the Trinity River is well

established. Elder and Murphy (1997) reported that 85% of 153 grass carp they collected from the lower Trinity River and tested for ploidy were diploid. These fish (captured in April 1993 through May 1994) ranged from 4 to 9 years old indicating that the majority of the adult population being utilized by commercial fisherman may be the product of natural reproduction. M. Kelly (Univ. Houston, Clear Lake, pers. commun.) reported substantial non-triploid grass carp populations throughout the Houston Ship Channel system; however, whether these fish are a result of spawning in the lower Trinity River or are a product of spawning in some other area of the Trinity-Galveston Bay complex is currently unknown.

Representatives of the Galveston Bay Foundation have reported that smooth cordgrass planted as part of their restoration efforts as well as naturally occurring vegetation has been severely impacted by herbivory (J. Johnson, unpubl. rep., TPWD, 1992). Although it is unlikely that the reproducing grass carp population in the Trinity River can ever be eradicated, more research to determine the habits of grass carp in Trinity-Galveston Bay is warranted so that methods may be established for minimizing the potential impact of grass carp on bay restoration projects. Cross (1970) found that grass carp $\geq$2 year old can survive in salinities up to 17.5 ppt but stop feeding at salinities of 6–9 ppt. The salinity range in the upper Trinity Bay portion of the Trinity-Galveston Bay complex varies seasonally but typically averages 5–10 ppt with a range of 0–20 ppt (L. Robinson, TPWD-CF, pers. commun.). Grass carp movements and feeding habits in relation to changes in Trinity-Galveston Bay salinity remain unknown. Determination of grass carp behavior in the Trinity-Galveston Bay complex could lead to the identification of low impact zones with conditions suitable for establishment of estuarine vegetation but not for grass carp feeding.

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