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Movements of Triploid Grass Carp in the Cooper River, South Carolina

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ABSTRACT

The movements of triploid grass carp (*Ctenopharyngodon idella* Valenciennes) were monitored in a coastal river flowing out of the Santee Cooper reservoirs, South Carolina. Twenty-two adult triploid grass carp (90 cm to 110 cm total length) were tagged during 1998 and 1999 with sonic and radio transmitters, released into the Cooper River, South Carolina, and tracked through May 2000. A total of 122 observations were made, of which, approximately 70% were near stands of hydrilla (*Hydrilla verticillata* (L.f.) Royle). Approximately 98% of the fish locations were within 20 river km of the release site. The average maximum movement was 14.4 km while the longest was 44 km. We detected no movement into brackish water nor extensive migrations; however, we urge caution where escapement of grass carp to coastal river is possible, and stocking should be evaluated on a case by case basis.

Key words: Aquatic plants, migration, *Hydrilla verticillata*.

INTRODUCTION

The triploid grass carp has been widely used since the 1980s to control nuisance aquatic vegetation in small impoundments and to a lesser degree in large reservoirs (Sutton 1985, Wattendorf and Anderson 1986, Bain et al. 1990). The utility and limitations of this fish have been described in numerous articles, e.g., Bain (1993). Triploid grass carp can provide inexpensive and long term control (Wattendorf and Anderson 1986, Leslie et al. 1987, Allen and Wattendorf 1987) of preferred species such as hydrilla. However, their tendencies to migrate long distances (Bain et al. 1990, Chilton and Poarch 1997, Maceina et al. 1999), potential impacts to non target vegetation and organisms (Stott and Robson 1970, Fedorenko and Fraser 1978, Shireman and Maceina 1981, Klussman et al. 1988, Bain 1993), and difficulties in matching stocking densities to levels of infestation (Guillory and Gasaway 1978, Noble et al. 1986, Bain et al. 1990, Bain 1993) has prevented widespread use in large systems.

A major challenge for managers has been to avoid over or under stocking. Cassani et al. (1995) developed successful stocking techniques for small impoundments, but managing stocking density is more difficult in open reservoir systems. However during the 1990s, techniques were developed that allowed population assessment in large systems (Morrow and Kirk 1995, Morrow et al. 1997, Kirk et al. 2000). Now, careful population assessment, population modeling, and incremental stocking may allow managers to achieve desired stocking densities (Kirk et al. 2000). However, widespread emigration from areas targeted for control could nullify these efforts.

Hence a major consideration in utilizing this fish for control is the potential of stocked fish to make long movements (Bain et al. 1990). Stocking densities can be affected if fish leave areas targeted for control. However, a more important concern has been that of movement into coastal rivers and eventually into brackish water nursery areas. Such concerns have prevented large stockings in Lake Seminole (Maceina et al. 1999) and several studies have documented populations in coastal rivers emptying into estuaries (Jacobson and Kartalia 1994, Elder and Murphy 1997).

This study was initiated to improve our understanding of triploid grass carp movements in a coastal river flowing out of the Santee Cooper reservoir system. To achieve this objective, we tagged and released adult triploid grass carp into the Cooper River, South Carolina and followed their movement from 1998 through 2000.

METHODS

Triploid grass carp studies began in the Santee Cooper system of South Carolina during the early 1990s (Morrow and Kirk 1995). The system includes Lakes Marion, Moultrie, and a diversion canal that connects the reservoirs. This 70,000 ha system has a history of aquatic vegetation problems, the most recent of which was hydrilla infestations that began in the 1980's (Morrow et al. 1997). A total of 768,500 triploid grass carp were incrementally stocked from 1989 through 1996 for the original purpose of controlling hydrilla. Hydrilla coverage peaked in 1994 at 17,272 ha and rapidly declined afterwards (Kirk et al. 2000). By 1997, essentially no surface mats of hydrilla existed. The South Carolina Department of Natural Resources decided in 1999 to manage for a 10% systemwide coverage of submersed macrophytes by regulating triploid grass carp density.

The Cooper River flows 77 km from the Pinopolis dam at Lake Moultrie to Charleston Harbor (Figure 1). Flows are regulated by hydropower production and diversion of the Santee River. Flows affect the extent of brackish water, which generally extends to or above the I-526 bridge. Dense stands of hydrilla exist in the river proper, abandoned adjacent rice fields, and in Back River reservoir (Steve de Kozlowski, pers. comm.).

Biotelemetry studies began in the Cooper River during April 1998. At that time, 12 triploid grass carp, between 90 to

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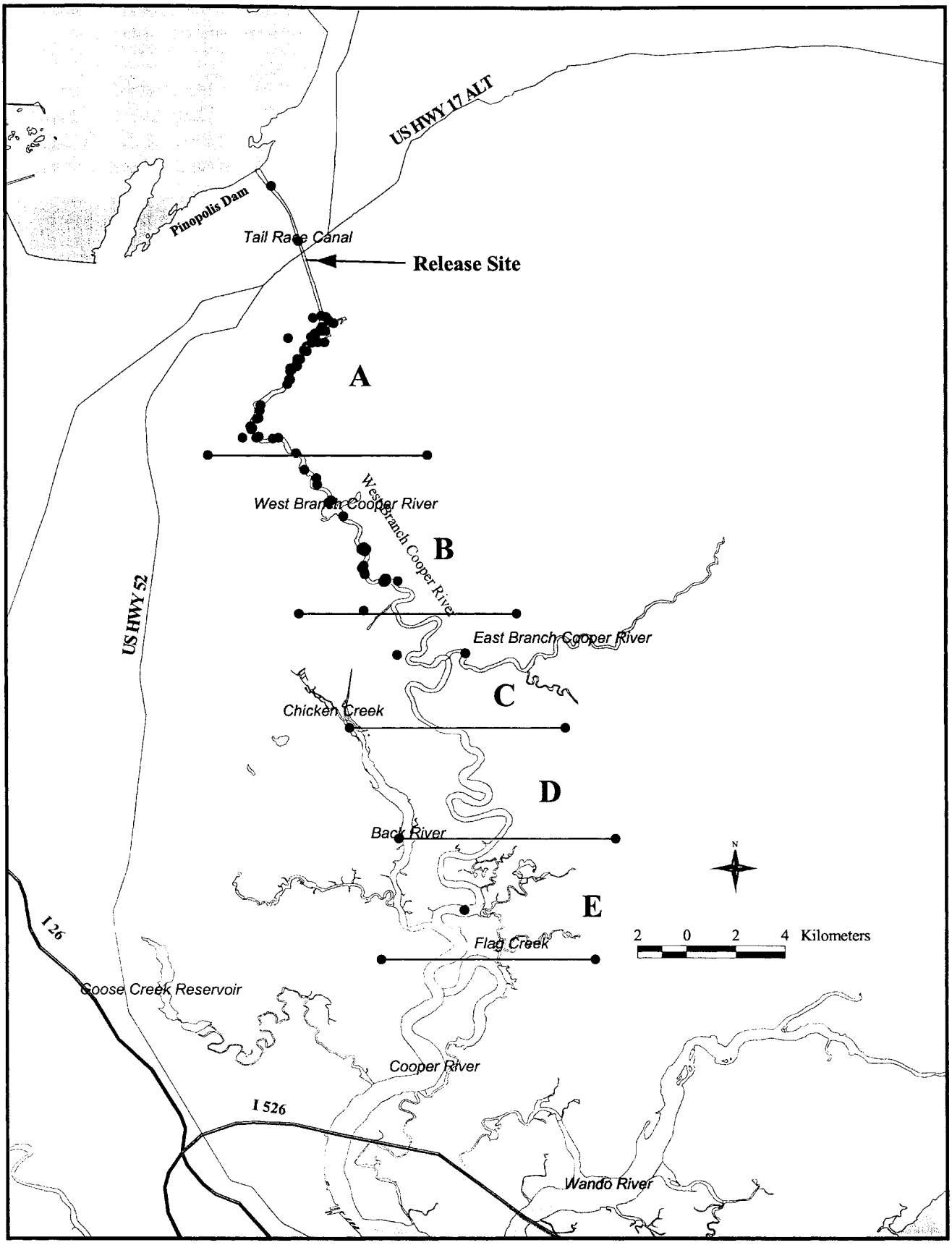

Figure 1. Location of tagged triploid grass carp in the Cooper River, South Carolina during 1998 through 2000.

110 cm total length, captured by electrofishing from fish stocked into the Santee Cooper reservoirs, were surgically implanted with sonic tags (Schramm and Black 1984) in the 73 to 76 kHz range and released at a landing near the Highway 52 bypass (Figure 1). In May 1999, another 10 similar sized fish were tagged, (seven of the ten were dual tagged with sonic, described above, and radio tags in the 49 MgHz range) and released at same location. Tracking by boat from the Pinopolis dam to Charleston harbor was performed at least monthly through May 2000. When a tagged fish was located, GPS coordinates were taken and the location was plotted and placed into one of five zones (a through e) that each spanned approximately 10 river km. Depth, salinity, dissolved oxygen, and water temperature were measured at each location. Aquatic vegetation coverage was estimated by visual observation and plants were collected for identification using a rake attached to a line.

RESULTS AND DISCUSSION

A total of 21 out of 22 tagged triploid grass carp was located at least once during the study period, but little data was collected during 1998 due to faulty hydrophones. However, three of the twelve triploid grass carp were subsequently located and tracked during 1999 or 2000. Tracking during 1999 and 2000 was more successful and observations were made for an entire year (May 1999 through May 2000). Fish tagged in 1999 were all tracked for some period of time but we speculate that two or three may have died or shed transmitters.

A total of 122 observations of tagged triploid grass carp were made over the period of the study (Table 1). Water temperatures ranged from 9 to 30C and depths from less than a meter to 7 meters (mean 3.4 m). Dissolved oxygen ranged from 1.5 to 11.5 ppm (mean DO was 7.0).

Approximately 70% of the observations were made in or near submersed aquatic vegetation which, for one exception, was hydrilla. Figure 1 shows locations of tagged fish but many locations overlap on the map. Table 1 summarizes the maximum total distances traveled among all recorded locations; the average was 14.4 km (range 2.7 to 44.8 km; standard deviation 8.9 km). A total of 76 and 43 locations were in zones a and b, respectively (Table 1). Hence, approximately 98% of the observations were within 20 river km of the release site. No fish were located in brackish water and most movements appeared to be very short. Examination of individual fish locations suggested fish moved to areas with hydrilla and generally remained in the vicinity for extended periods.

Although grass carp are known to make long-distance movements (Bain et al. 1990, Chilton and Poarch 1997, Maceina et al. 1999) movements in the Cooper River were short. Foltz et al. (1994) found similar results in studies conducted in the Santee Cooper reservoirs, namely that fish tended to remain near stands of hydrilla. In addition, tagged fish were not found in brackish water, despite the fact they have been found in the lower Trinity River, Texas, the Houston shipping channel (Webb et al. 1994), and rivers flowing into the Chesapeake Bay (Jacobson and Kartalia 1994). One explanation for short movements and no occurrences in brackish water might be that adult triploid grass carp readily sought preferred food sources, such as hydrilla, and remained there after a period of acclimation (Foltz et al. 1994, Chilton and Poarch 1997).

TABLE 1. MOVEMENT SUMMARY OF TRIPLOID GRASS CARP RELEASED INTO THE COOPER RIVER, SOUTH CAROLINA BETWEEN 1998 AND 2000. SEE FIGURE 1 FOR LOCATION OF ZONES ON THE COOPER RIVER.

Fish number	Frequency	Maximum distance moved (km)	Number of observations in zones					
			Total	A	B	C	D	E
1	49.32	2.7	1	1				
2	49.35	17.6	9		9			
3	49.42	15.2	5		5			
4	2237	15.3	9	3	6			
5	2246	7.6	11	11				
6	246	17.6	2	1	1			
7	249	10	5		5			
8	258	20.9	7	1	6			
9	267	7.6	15	15				
10	285	8	3	3				
11	294	4.9	1	1				
12	339	7	11	11				
13	348	5.5	3	3				
14	366	25.4	3	3				
15	375	44.8	6	5				1
16	384	13.7	3	1	2			
17	445	12.5	7	6	1			
18	447	17.1	2	1	1			
19	456	11.3	1		1			
20	465	16.4	11	5	5	1		
21	555	21	7	5	1	1		
Summary		average = 14.4	122	76	43	2		1

A relatively low number of observations (122 locations) were made to evaluate triploid grass carp movements. Relatively high mortality for adult fish used in this study may be one possible explanation. Kirk et al. (2000) estimated total annual mortality ranging from 32% to 39% in the population from which tagged fish were collected. Consequently, from April 1998 through May 2000, some of the tagged fish may have died. Another possibility is that tagged triploid grass carp may have dispersed into Charleston harbor, or other downstream reaches of high salinity, and hence were not located. This seems unlikely since Maceina and Shireman (1980) demonstrated that growth and reproduction are suppressed at salinities above 9 ppt and that death occurs at salinities over 17 ppt (Kilambi and Zdinak 1980). Therefore, triploid grass carp were unlikely to move out of the study area into the full salinity of Charleston harbor.

We did not observe triploid grass carp in brackish water. Tagged fish generally remained in the same locations during late winter and early spring, when hydrilla coverage is lower. However, we are uncertain if tagged fish would have moved into brackish water if hydrilla had not been abundant. While we found no evidence of large movements downstream (119 out of 122 observations were made within 20 river km of the release site), South Carolina Department of Natural Resource biologists frequently collect triploid grass carp that have moved from the Santee Cooper reservoirs up the Congaree River (James Bulak, pers. comm.).

The literature concerning grass carp movements into brackish water areas is contradictory with a preponderance suggesting reasons for concern (Bain et al. 1990; Jacobsen and Kartalia 1994, Elder and Murphy 1997, Chilton and Poarch 1997). In this study and Foltz et al. (1994), large movements were not documented but this may be due to an abundance of preferred forage. Concerns about migration into sensitive brackish water plant communities should always be considered, but may represent an acceptable risk in the Cooper River. However, the potential for unwanted grass carp movements should be evaluated on a case by case basis. Risk assessment considerations should include distances from release site to brackish water, the ability of stocked fish to move through dams or locks, food availability in both fresh and brackish water, and the potential life span of the grass carp population.

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