Spawning-Season Homing of Common Carp and River Carpsucker

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ABSTRACT -- Spawning-season homing tendencies of common carp (*Cyprinus carpio*) and river carpsucker (*Carpiodes carpio*) were investigated in Bowman-Haley Reservoir, a 712-hectare impoundment in southwestern North Dakota. Adult common carp and river carpsucker, which were captured with trapnets and weirs in three tributaries immediately prior to spawning, were tagged and released in the main reservoir. Fish were recaptured with rotenone three to four weeks following release in two of the tributaries. Of those recaptured, 90% of the common carp and 89% of the river carpsucker returned to the stream of original capture. Observed return rates to streams of origin were significantly different than those predicted by random dispersal, which implied that both species home to their reproduction sites.

Key words: Bowman-Haley Reservoir, *Carpiodes carpio*, common carp, *Cyprinus carpio*, homing, river carpsucker.

Homing is "the return to a place formerly occupied instead of going to other equally probable places" (Gerking 1959). Homing of fishes has been most studied during spawning migrations, although homing need not involve reproduction, and return to a "home range" also has been observed (Parker and Hasler 1959, Gunning 1965, Miller and Menzel 1986, Parker 1995). Homing to specific spawning areas is thought to maximize reproductive success by synchronizing spawning with optimal conditions (Leggett 1977). Homing also can serve to reproductively isolate populations, which leads to specific adaptations to local environments (Taylor 1991, Cury 1994).

Many fishes, including salmonids (Lindsey et al. 1959, Pascual et al. 1995, Dittman and Quinn 1996), walleye (*Stizostedion vitreum*) (Hendrickson 1995), white

sucker (*Catostomus commersoni*) (Werner 1979), white bass (*Morone chrysops*) (Wright and Hasler 1967), and roach (*Rutilus rutilus*) (Goldspink 1977) have been reported to home to specific spawning and rearing areas. O'Connor and Power (1973) reported that in-season and repeated homing of brook trout (*Salvelinus fontinalis*) to spawning areas in tributaries of Matamek Lake, Quebec showed high fidelity, with less than one percent of accounted-for fish found straying to adjacent tributaries. Kristiansen and Doving (1996) found that grayling (*Thymallus thymallus*) from 13 tributaries of Lake Mjosa, Norway fed as a mixed group in the lake, but that 240 of 284 tagged fish recaptured in subsequent spawning seasons were recovered in those streams in which they had been tagged. For non-reproductive homing, Parker (1995) displaced juvenile American eels (*Anguilla rostrata*) upstream and downstream from their capture sites and found that they homed quickly to their point of initial capture. Cury (1994) viewed such homing to specific physical sites as one type of a continuum of reproductive strategies in fish, all relying on imprinting. From his perspective, other situations might involve responding to cues imprinted early in life but not necessarily associated with a particular site. For example, the Pacific lamprey (*Entosphenus tridentata*) was found to not home to specific natal Great Lakes streams, but to rely on other cues besides imprinting to find suitable spawning sites in streams, perhaps cues from larval conspecifics (Bergstedt and Seelye 1995).

In North America, most studies of homing behavior have pertained to anadromous salmonids, and as a result little information exists regarding homing tendencies of most inland fishes. Such knowledge can be valuable in identifying distinct populations of a given species and in providing insight into species ecology and life history. Knowledge of homing not only aids our understanding of stock-specificity, but also can be useful in the control of species such as Pacific lamprey and common carp (*Cyprinus carpio*), which can be nuisances in particular situations.

In Bowman-Haley Reservoir, North Dakota, as in many other Great Plains reservoirs, common carp and river carpsucker (*Carpiodes carpio*) migrate in large numbers each spring from the reservoir into tributaries to spawn. Although some information is available on general movements for both species in other waters, (Sigler 1958, Behmer 1969), we do not known if they home to specific tributaries or what criteria or cues these fishes use to select tributaries for spawning. The objective of our study was to determine if common carp and river carpsucker showed within-year, spawning-season homing tendencies into tributaries of Bowman-Haley Reservoir, North Dakota.

STUDY AREA

Bowman-Haley Reservoir is a 712 ha impoundment in southwestern North

Dakota (Fig. 1). Three tributaries, Spring Creek, Alkali Creek, and the North Fork of the Grand River (hereafter Grand River) drain approximately 123,000 ha. The mouth of the Grand River is approximately 6 km (through reservoir) from the mouths of Spring Creek and Alkali Creek, which are 1 km apart.

METHODS

From May 15 to May 25, 1995, adult common carp (50 to 80 cm total length, TL) and river carpsucker (50 to 66 cm TL) were captured with fyke-nets (1.8 x 2.4 m frame with 2 cm mesh) in Spring Creek, Alkali Creek, and the Grand River. This period coincided with peak spawning migrations for both species. Fish were tagged with numbered anchor tags. River carpsucker were tagged at the base of the dorsal fin and common carp at the base of the anal fin. To evaluate tag loss, the left pelvic fin was clipped at its base. Fish in poor condition or which freely released eggs or milt were not tagged. We assumed these fish would be less likely to return if they were in poor condition or if they had already spawned. Tagged fish were towed across the reservoir in a floating net-pen and released near the dam, a distance of 4 to 5 km from capture sites.

Near the mouths of the Grand River and Spring Creek, nylon block nets were stretched upstream at an angle from each bank to the middle of the stream creating a v-shaped funnel, which allowed upstream migrating fish to enter, but prevented downstream migrating fish from returning to the reservoir (Fig. 1). At approximately 4 km upstream of block nets on the Grand River we placed a barrier fence across the stream, which blocked fish from continuing upstream. In Spring Creek, a low-head dam located 3 km upstream from the mouth prevented fish from continuing upstream.

On June 4 and 5, as part of a common carp control program, North Dakota Department of Game and Fish personnel applied powdered rotenone by boat to the Grand River and to Spring Creek between block nets and upstream migration barriers. Liquid rotenone was dripped from sites at the upstream migration barriers. Following surfacing of dead fish, we inspected each adult common carp and river carpsucker for fin-clips and tags. Alkali Creek was not treated with rotenone due to low densities of common carp between the block nets. Too few common carp or river carpsucker were recaptured in Alkali Creek with trapnets and seines to evaluate homing to this tributary. From July 1 to August 5, 1995, fish were sampled throughout the reservoir with fyke-nets. All common carp and river carpsucker were inspected for tags.

Statistical significance of recapture rates for common carp and river carpsucker returning to a particular tributary was assessed with Chi-square tests. Expected numbers of fish returning to a given tributary from each of three tagging

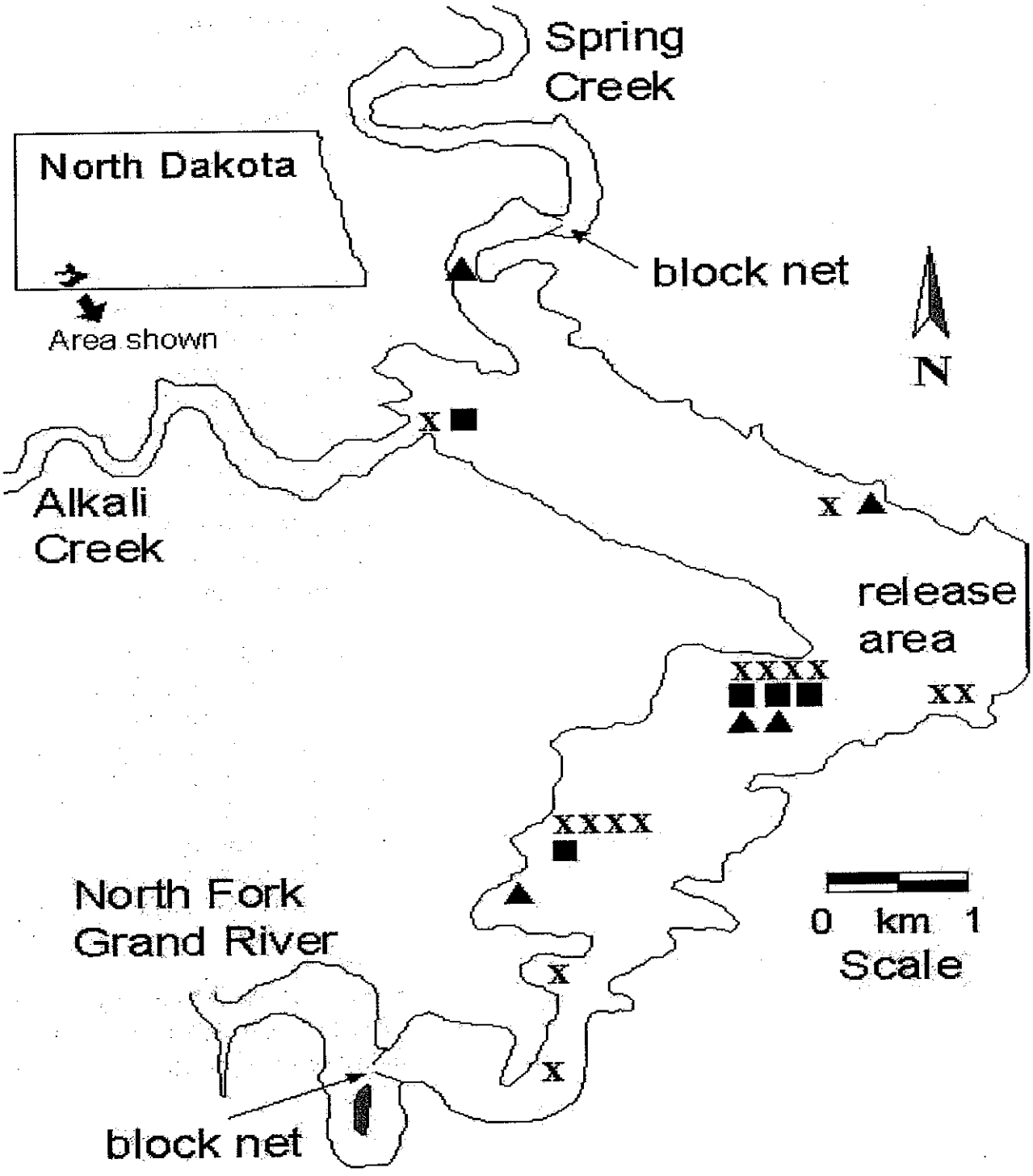

Figure 1. Map of Bowman-Haley Reservoir and three tributaries. Also included are recapture locations of river carpsucker originally tagged in Spring Creek (▲), Alkali Creek (▲), and the North Fork Grand River (X).

locations were calculated by multiplying the total number of fish recaptured in the tributary by the proportion of fish tagged at each location. The null hypothesis was that the number of recaptures of common carp and river carpsucker in each tributary did not differ from those predicted by random dispersal of fish.

RESULTS

A total of 423 common carp was captured (181 in the Grand River, 102 in Spring Creek, and 140 in Alkali Creek), tagged, and released in the main reservoir (Table 1). Following rotenone treatments, we inspected 47,003 adult common carp for tags (31,431 in the Grand River and 15,572 in Spring Creek) and found 34 tagged fish in the Grand River and 14 tagged fish in Spring Creek (a total of 11% of the fish originally tagged). Of the fish recaptured in the Grand River, 33 of 34 (97%) had been tagged in the Grand River. Of those recaptured in Spring Creek, 10 of 14 (71%) had been tagged in Spring Creek. The observed numbers of common carp recaptured from the three tagging locations differed significantly from expected in both Spring Creek ($X^2 = 21.0$, $P < 0.001$, $n = 14$) and the Grand River ($X^2 = 38.7$, $P < 0.001$, $n = 34$). Tag loss was less than 5%. Too few common carp were recaptured in the reservoir to evaluate dispersal.

A total of 267 river carpsucker were captured (122 in the Grand River, 60 in Spring Creek, and 85 in Alkali Creek), tagged, and released in the main reservoir (Table 1). Following rotenone treatments, we inspected 2703 adult river carpsucker for tags (2002 in the Grand River and 701 in Spring Creek) and found 36 tagged fish in the Grand River and 18 tagged fish in Spring Creek (a total of 20% of fish originally tagged). Of those recaptured in the Grand River, 36 of 36 (100%) had been tagged in the Grand River and of those recaptured in Spring Creek, 12 of 18 (67%) had been tagged in Spring Creek. The observed numbers of river carpsuckers recaptured from the three tagging locations differed significantly from expected in both Spring Creek ($X^2 = 20.7$, $P < 0.001$, $n = 18$) and the Grand River ($X^2 = 40.2$, $P < 0.001$, $n = 36$). Tag loss was less than 5%.

During summer (July 1 - August 5), 24 tagged river carpsucker were recaptured at sites located throughout the reservoir (Fig. 1). Fish from each of the tributaries appeared to intermingle in the reservoir after spawning. Tag loss as of August 10 was less than 10%.

DISCUSSION

Our results indicated that common carp and river carpsucker displaced from a tributary in spring prior to spawning were more likely to return to that tributary than to other tributaries. Precision of returns to tributary spawning areas for

Table 1. Numbers of common carp and river carpsucker tagged, monitored, and recaptured from each location. Numbers in parentheses indicate expected number of returning fish.

Location	Number tagged		Number monitored		Number recaptured		
	Carp	Carpsucker	Carp	Carpsucker	Carp	Carpsucker	Tag origin
Grand	181	122	31,431	2002	33 (15)	36 (17)	Grand
					0 (8)	0 (8)	Spring
					1 (11)	0 (11)	Alkali
					X^2=38.7 (P<0.001)	X^2=40.2 (P<0.001)	
Spring	102	60	15,572	701	3 (6)	4 (8)	Grand
					10 (3)	12 (4)	Spring
					1 (5)	2 (6)	Alkali
					X^2=21.0 (P<0.001)	X^2=20.7 (P<0.001)	
Alkali	140	85					
Total	423	267	47,003	2703	48 (48)	54 (54)	

common carp (71 and 97%) and river carpsucker (67 and 100%) was similar to homing precision reported for other species. For example, Lindsey et al. (1959) reported homing precision of rainbow trout (*Oncorhynchus mykiss*) to be 94%, Werner (1979) reported homing precision of white sucker to be 85%, and L'Abee-Lund and Vollestad (1985) reported homing precision of roach to be 83 to 92%. Similarly high degrees of spawning site fidelity, both within and between years, were reported for grayling (Kristiansen and Doving 1996) and brook trout (O'Connor and Power 1973).

Although recaptured fish displayed high precision in returning to the stream of original capture, rates of recapture were low. Many tagged fish did not return to the tributaries but remained in the reservoir. Some homing studies have reported low recapture rates (e.g., Bergstedt and Seelye 1995), but most studies have reported somewhat higher rates of recapture than the 11% and 20% rates in our study (e.g., Helle 1966, O'Connor and Power 1973, Kristiansen and Doving 1996). We assumed that one reason for the low return rates was that some tagged fish, especially fish tagged at the end of the tagging period, had already spawned, had little or no inclination to return to spawning tributaries, and remained in the reservoir. For those common carp and river carpsucker tagged from May 15 to

May 20, recapture rates were 24%, but for those tagged later, from May 21 to May 25, recapture rates were only 6%. In addition, some fish might not have returned to tributaries quickly enough to be recaptured at the time of the rotenone application.

In our study, adult common carp and river carpsucker, transplanted during the spawning season, clearly demonstrated a tendency to return to the stream of original capture during that season. Results of our study, obtained within one spawning season, can not prove that common carp and river carpsucker demonstrate inter-annual homing to natal streams for spawning. The observed ability of these species to return within season to known spawning sites, however, is strong evidence for spawning stream fidelity. Further studies are necessary to elucidate if these species display inter-annual homing to natal streams characteristic of salmonids (Pascual et al. 1995) and many other fish species.

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