Mobility of Riverine Smallmouth Bass Related to Tournament Displacement and Seasonal Movements

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Abstract.—Mobility of tournament-caught and released smallmouth bass *Micropterus dolomieu* was monitored in the Grand River, Ontario, between 1995 and 1999 using radiotelemetry and mark–recapture. Smallmouth bass (n = 18, size range 313–486 mm TL) captured and radiotagged following the tournament remained in the immediate release vicinity for extended periods (mean 54 days, median 30 days). Four fish released at the site of original capture generally remained sedentary for the duration of the study (i.e., 11 months). Five of fourteen of displaced smallmouth bass with radio tags returned to their original site of capture and one bass with an external numbered plastic tag returned over a distance of 26 km. Smallmouth bass moved upstream and downstream to overwintering areas, characterized as low velocity pools, where numerous fish aggregated. Anglers recaptured twelve percent, or 13 of 108 externally tagged smallmouth bass. Maximum distance between release and recapture was 84 km for externally tagged fish. Over half of recaptured fish were caught at the release site, and most were recaptured within one week of release. Organizers of competitive angling events in river systems should consider releasing fish near sites of original capture or in areas that are not readily accessible to minimize angling vulnerability immediately after tournaments.

Introduction

Suitable river and stream habitat for adult smallmouth bass *Micropterus dolomieu* consists of pools and riffles, gravel/rock substrate, and logs and boulders as cover (Hallam 1959; Paragamian 1981; Todd and Rabeni 1989). Except for overwintering and spawning movements, smallmouth bass are generally sedentary and rarely exhibit long-range or interpool movements greater than 1 km (Larimore 1952; Forney 1961; Munther 1970; Langhurst and Schoenike 1990). Competitive angling events for smallmouth bass usually coincide with the period when most smallmouth bass are sedentary (i.e., midsummer). Live-release competitive angling events typically result in displacement of fish and relocation to areas with potentially unsuitable habitat.

The Grand River (Ontario, Canada) Bass Derby is a live-release tournament that began in 1988. Like most "road runner" tournaments (Wilde et al. 1998), large fish are collected from a vast area and concentrated at a common weigh-in site. At the end of each day of the tournament, fish are released at various points along the river that have suitable vehicular access. This release strategy differs from that used at many tournaments, where fish are released exclusively at a central weigh-in site (Pflug and Pauley 1983; Stang et al. 1996).

In lakes, dispersal of smallmouth bass and largemouth bass *M. salmoides* away from tournament release areas is usually limited (Blake 1981; Pflug and Pauley 1983), and displacement of fish may have negative biological consequences (Schramm et al. 1991). Release sites chosen by event organizers often have good vehicle access, and may receive greater angling pressure than secluded areas where the majority of tournament fish originate. There are no available data on dispersal of bass from tournament release areas in rivers. In the present study, we explore the possibility that displaced smallmouth bass from the Grand River, Ontario, are no more likely to disperse than smallmouth bass released at original capture locations. Using radiotelemetry and a tagging study we document dispersal and movement patterns of smallmouth bass displaced upstream, downstream, or not displaced from original capture sites. In addition, we use this data to describe timing and movement patterns into and out of overwintering habitat.

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Study Area

The Grand River is a large tributary of Lake Erie that drains a 6734 km^2 watershed in Southwestern Ontario. The primary study area (Figure 1) was a 37 km stretch of the middle Grand River from West Montrose (43°34'N, 80°26'W) downstream to Freeport (43°25'N, 80°25'W). Discharge and temperature data were collected at the Bridgeport monitoring station (Figure 1), located midway along the study section of the river. During the study, mean discharge was 10.3 ± 0.4 m^3/s, and was periodically elevated up to 50 m^3/s between January and April. At the upstream end of the study site, the river runs through agricultural lands, whereas the lower reaches are primarily urban. Noncontiguous riparian buffer strips exist on both sides of the river, and patches of instream cover (i.e., boulders and logs) are common. The study area generally consisted of riffle-run-pool sequences with gravel, pebble and cobble substrate. A low-head weir with two Denil fishways within the study area does not constitute a barrier for upstream migrating smallmouth bass (Bunt et al. 1999). Further details of the downstream end of the study area are available in Bunt et al. (1998).

Methods

Most smallmouth bass entered in the Grand River bass tournament are caught in the middle reaches of the river (Cooke et al. 1998); however contestants may enter fish from the entire length of the river. After arrival at the weigh-in site (Figure 1, location 6), cooperating anglers were interviewed and shown maps to describe where fish originated. We conservatively estimated that determinations of original capture locations were accurate within 1 km. All fish were measured, weighed and externally tagged with a numbered plastic oval tag (14.5 × 8 mm) attached to eight pound test nylon monofilament that was sewn through the dorsal musculature anterior to the base of the spiny dorsal fin. This procedure was followed in 1996, 1997, and 1998, with the addition that in the final year, 22 smallmouth bass (mean size 408 ± 13 mm TL, range 309–486 mm) were randomly selected, surgically implanted with coded radio transmitters, and released on 6 July 1998. Transmitters (Lotek Engineering Ltd., model MCFT-3em, 11 × 49 mm) weighed 8.9 g in air and had an expected battery life of approximately 11 months. To implant transmitters, smallmouth bass were anesthetized in 10 L of river water with a 50-ppm solution of clove oil and ethanol. After anesthesia was induced, fish were placed dorsal side down into foam padding in which a slit had been cut to provide support during surgery. Head and gills were irrigated with aerated river water with a maintenance concentration of 25-ppm anesthetic. A 10 mm incision was made posterior to the right pelvic fin. Using a shielded 18 G hypodermic needle, a small puncture was made, anterior and slightly lateral to the urogenital pore, through the body wall and out of the incision. The 30 cm Teflon-coated transmitter antenna was then inserted into the tip of the needle, which was subsequently withdrawn, leaving the antenna threaded through the puncture near the urogenital pore. The transmitter was inserted into the body cavity and the incision was closed with 1 suture of Ethicon 1–0 nonabsorbable braided silk. Each simple interrupted suture was sealed with Vetbond cyanoacrylate adhesive to reduce suitability of silk as substrate for bacterial and fungal growth. Surgery and recovery required less than five minutes. Fish were then randomly allocated into three groups. One group of fish was released near the capture site (within 1 km), the second group was released upstream from capture site (mean distance = 7.5 km, range 1.9–21 km), and the third group was released downstream from the capture site (mean distance = 10.8 km, range 4.8–22.1 km). Two radiotagged fish were used as controls, and were held in an eight million liter reservoir of Grand River water for up to 21 months. These fish were regularly observed both visually and telemetrically to document postsurgical healing and survival.

Detection of Movement

Movement of radiotagged fish was detected using a Lotek SRX_400 mobile receiver. Tracking exercises using hidden transmitters in the Grand River indicated that locations were accurate to within 5–10 m. The primary study area was scanned at least every two weeks by canoe, or by truck during the winter. To reduce underestimates of fish movement (Gowan et al. 1994), the area upstream from the primary study site was scanned several times during the study by truck, and the river downstream from the primary study area to a distance of approximately 40 km, was scanned in early spring 1999 by canoe. Further movement data were provided by angler recaptures of externally tagged fish over a period of several years.

Positions of fish caught by anglers and radiotagged fish were plotted on enlarged scale maps of the Grand River (1:10000). Distances be-

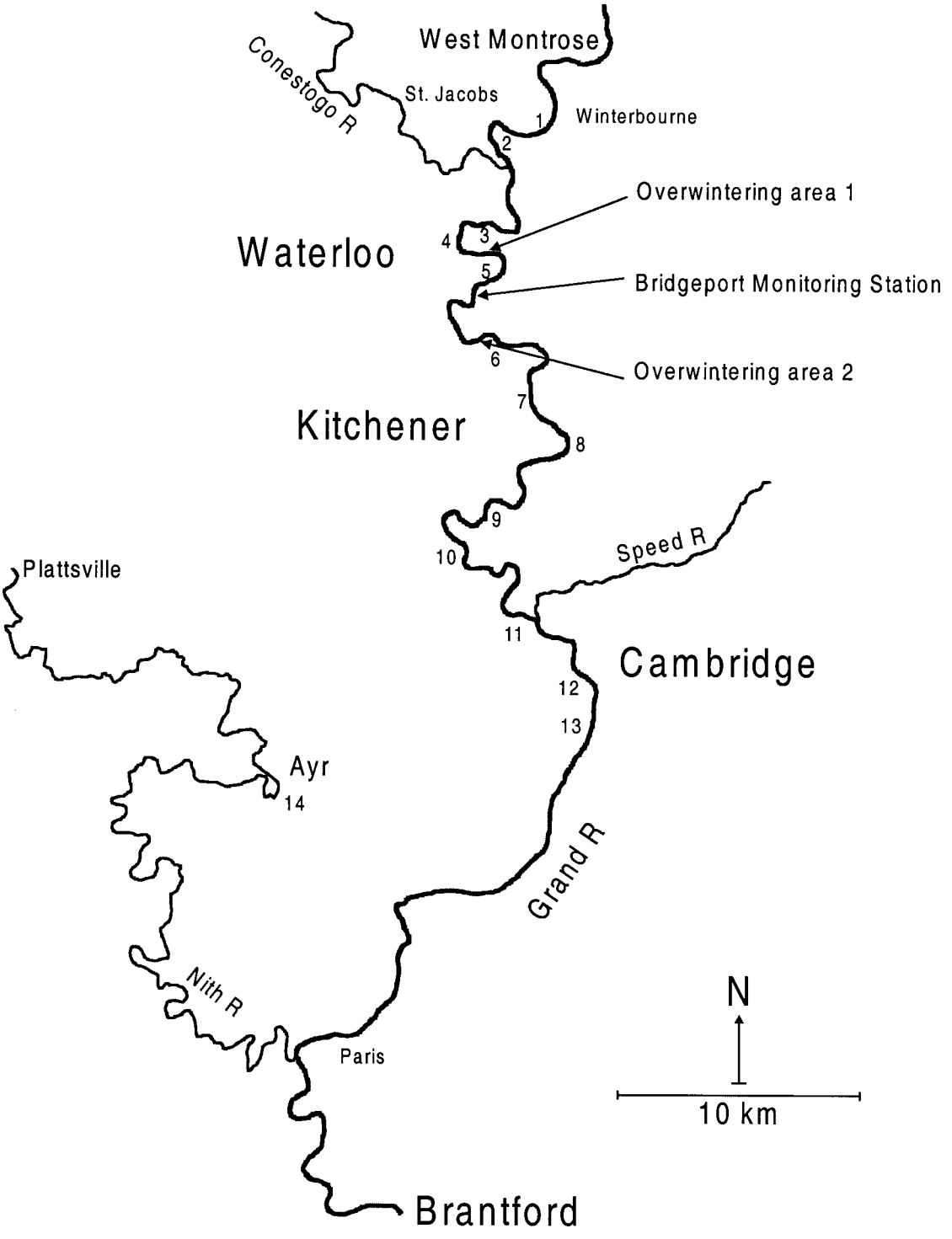

Figure 1: Location of the Bridgeport water monitoring station, overwintering areas, and significant capture and release locations of tagged fish in the Grand River. The tournament weigh-in area was at location 6.

tween consecutive locations of radiotagged fish were measured using a Scalex map measurer to the nearest 50 m. Distances moved by radiotagged fish were compared to water temperature, discharge and fish size using linear regression analysis. For radiotagged fish, movement patterns related to release location, site of original capture, overwintering habitat and spawning habitat are described. Overwintering habitat was examined using underwater videography in March 2000.

Results

Radio-tagged smallmouth bass

Visual observations and telemetry data indicated control smallmouth bass healed extremely well within one month of surgery and showed no negative effects of handling or transmitter implantation. Control fish were recaptured in the reservoir after 15 and 22 months, respectively, during which time they actively foraged. By the end of the study, each fish had grown and eggs were well developed. Postmortem dissections indicated that transmitters were completely encapsulated in approximately 1 mm of fibrous connective tissue and although antenna exit wounds were slightly inflamed, there was no evidence of internal infection. The encapsulated section of antenna that was present within the body cavity was connected to the transmitter capsule so that the entire unit was invaginated from the antenna exit wound. The original incision was completely healed and extremely difficult to detect. One fish retained its external tag, but it was completely overgrown with algae.

Movement patterns of Grand River smallmouth bass were monitored for 11 months over 33 tracking sessions. After tagging, radiotagged smallmouth bass were locally mobile, but remained within 1 km of their release site for a mean duration of 54 days (Figure 2; range 9–300 days, median 30 days, n = 18). Released fish frequently occupied the nearest deep pool (> 1 m) for extended periods before dispersing upstream or downstream.

Figure 2 shows movement patterns of individual radiotagged fish (n = 18) for the duration of the study. For displaced fish (both upstream and downstream), the mean distance between original capture location and release site was 7.0 km (± 2.7 km, 95% CI) and the distance between original capture location and last known radio location was 4.8 km (± 2.5 km, 95% CI). Some radiotagged fish did exhibit homing tendencies (see below), but low sample sizes precluded adequate statistical analyses. One radiotagged fish was recaptured in July 2000 during the Grand River bass tournament at the same capture location in the 1998 tournament.

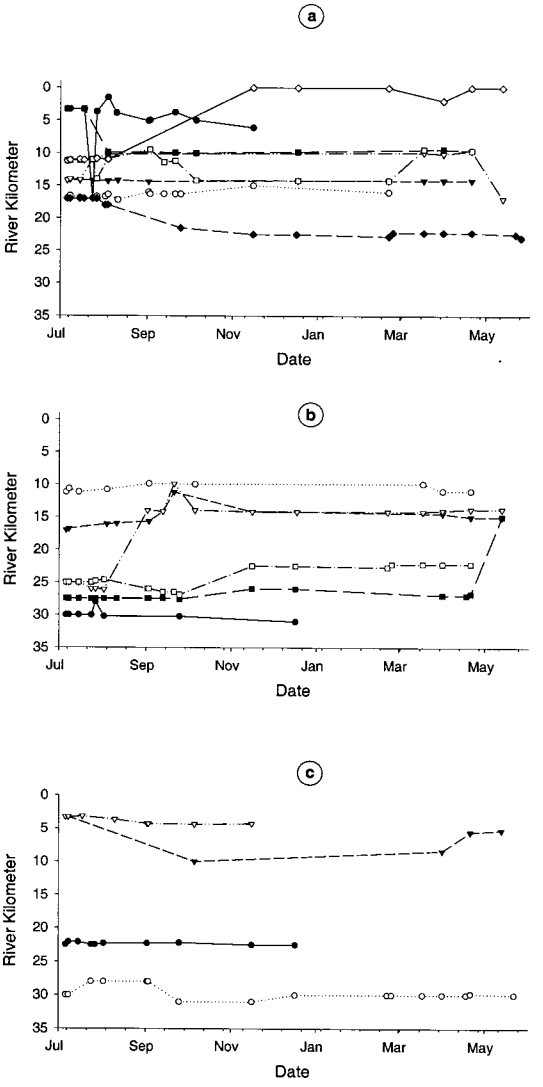

Figure 2: Seasonal movement patterns of radiotagged smallmouth bass (a) displaced upstream from tournament capture locations, (b) displaced downstream from tournament capture locations, and (c), released at tournament capture locations (i.e., not displaced). Symbols represent individual fish in each plot and 0 km on the ordinate axis is the most upstream end of the primary study site.

After tagging, eight smallmouth bass were displaced upstream from their original capture locations (Table 1a, Figure 2a). Although movement patterns were variable, some fish tended to move downstream. Three of these fish remained at the

Table 1. Length, displacement distances, movement and contact periods for radiotagged smallmouth bass released (a) upstream from original capture location (n = 8), (b) downstream from original capture location (n = 6), and (c) at original capture location (n = 4).

	Length (mm TL)	Displacement from original capture location (km)	Distance between original capture location and last radio detection (km)	Total movement (km)	Net movement (km)	Contact period (d)
(a)						
mean	427.9	7.5	7.1	11.8	4.0	278.4
minimum	313.0	1.9	1.0	0.5	0.2	123.0
maximum	486.0	21.0	21.2	29.9	11.5	355.0
(b)						
mean	414.8	10.9	5.2	10.6	5.2	280.5
minimum	366.0	4.8	1.0	3.8	0.2	164.0
maximum	470.0	22.1	11.7	17.9	10.6	319.0
(c)						
mean	398.5	1.0	1.0	4.1	2.3	241.0
minimum	323.0	1.0	1.0	0.7	0.7	133.0
maximum	462.0	1.0	1.0	7.1	4.5	311.0

release area for the duration of the study. Two relocated, one 11 km upstream from the release site after 36 days (location 1, Figure 1) and the second 2 km downstream after 77 days. The three remaining smallmouth bass returned to their original capture locations downstream by 30 days, 90 days, and 300 days, respectively.

Six smallmouth bass were displaced downstream from their original capture locations (Table 1b, Figure 2b). Again, movement patterns were highly variable. For example, two smallmouth bass remained at the release location for the duration of the study. Two fish relocated upstream from the release area after 86 days (early October). The remaining two fish returned and stayed at their original capture locations 3.8 km and 11 km upstream after 60 days and 90 days, respectively.

Four smallmouth bass were not displaced, and were released at their respective capture sites (Table 1c, Figure 2c). There was little variability in observed behavior, as three fish remained near the release area (usually within 1 km) until contact was lost (i.e., for periods ranging from 133 days to 311 days). One fish moved 7 km downstream to overwinter, prior to returning to the release area in April.

Nearly half (i.e., 8) of 18 fish for which movement data were available moved several kilometers upstream and / or downstream during summer months. Five fish moved upstream (mean, 7.8 km; range, 2–12.3 km from release sites) and three fish made similar downstream movements (mean, 7.2 km; range, 3.4–12.8 km from release sites).

In autumn, nine of 18 smallmouth bass moved upstream to overwintering areas. Seven moved in September and two moved in October when mean water temperature was 16.2°C. In addition, five smallmouth bass moved downstream to overwintering areas. One fish moved in September, three moved in October and one moved in November (mean temperature = 12.6°C). Several fish (5 of 18) moved less than 1 km to overwintering sites.

Two major overwintering areas were identified based on where the radiotagged smallmouth bass aggregated. Overwintering area 1 contained four radiotagged smallmouth bass that had moved up to 3.8 km upstream to reach this site (Figure 1, river km 14 in Figure 2). A second overwintering area (Figure 1, river km 22 in Figure 2) supported three radiotagged smallmouth bass. One fish moved 3.5 km upstream, while another fish moved 1 km downstream into the overwintering site. Each area was a deep pool with little current (maximum depth > 3 m, area at least 1.5 m deep > 1000 m^2). Underwater video observations in 2000 revealed aggregations of smallmouth bass over silty or detritus covered substrate. We were not able to quantify abundance because individual fish could not be identified using this technique.

Smallmouth bass movements were detected in the winter when two fish moved up to 2.3 km downstream. As water temperature rose to 15°C (i.e., late April), seven fish moved up to 9.3 km upstream, presumably to spawn. In contrast, three smallmouth bass moved downstream up to 7.5 km. One fish moved 5 km upstream in April (near location 2, Figure 1), only to return 8 km downstream during the first two weeks of May.

Externally tagged smallmouth bass

During the 1996 tournament, 56 smallmouth bass

were externally tagged and released at various locations relative to their sites of original capture. In 1997, 35 smallmouth bass were tagged and released, and in 1998, an additional 17 fish were tagged and released. Of 108 externally tagged smallmouth bass at large, anglers reported 13 recaptures. Of these 13 fish, seven were initially displaced upstream from the original capture site, five were displaced downstream from the capture site and one was released at its capture site.

Three fish swam downstream over one or more weirs. Two of these fish moved more than 25 km from their respective release locations. One fish moved 26.5 km downstream to a deep pool prior to recapture at the original capture location (location 10, Figure 1). The largest detected movement was 40 km downstream over three weirs, to the confluence of the Grand River and the Nith River, where the fish entered the Nith River and swam 44 km upstream. It was recaptured in Ayr, Ontario, after being at large for almost 14 months (location 14, Figure 1).

Seven of the recaptured fish were angled from areas near the posttournament release sites. The majority of these fish (5 of 7) were recaptured within seven days of release. One fish was recaptured approximately three hours after release. The only fish that was released at its original capture location was recaptured at this same location over 12 months later.

Discussion

Smallmouth bass remained within 1 km of the release area for one to eleven months. Return to original sites of capture was observed in some fish pointing to a homing ability among these fish for certain river sections. Limited postrelease dispersal of smallmouth bass has been reported in other studies (Blake 1981; Pflug and Pauley 1983; Ridgway and Shuter 1996; Stang et al. 1996). Blake (1981) noted that tournament-caught displaced smallmouth bass moved more than smallmouth bass that had been released at original capture locations. In a study of smallmouth bass movement and homing, Pflug and Pauley (1983) showed that 80% of smallmouth bass that were released at original capture locations moved very little, indicating an affinity for home range areas. During a similar investigation of tournament-caught smallmouth bass in the autumn, dispersal from the release area was uncommon (Stang et al. 1996). Although these results were based on observations of only five radiotagged smallmouth bass, Stang et al.'s (1996) conclusions were consistent with those derived from the present study. After displacement and release into the St. Lawrence River, four of the five smallmouth bass exhibited little movement for approximately three weeks, and one fish returned to its original capture location 3.7 km downstream after four days (Stang et al. 1996).

Smallmouth bass movements in rivers and streams appear to be spatially limited within seasons (Larimore 1952; Gerking 1953; Fajen 1962; Todd and Rabeni 1989). Movements between seasons (i.e., summer and winter locations) as well as spatial changes associated with life history stages (Funk 1955) probably account for larger scale movements for nondisplaced fish. Most wild smallmouth bass tend to move very little, but some individuals have been reported to move 31 km (Brown 1961), 64 km (Behmer 1964), 7.5 km (Todd and Rabeni 1989), 84 km (this study), and 109 km (Langhurst and Schoenike 1990). These large-scale movements typically occur during spring and autumn when fish appear to be moving to spawning and overwintering habitat, respectively. Smallmouth bass may also move between different rivers within a watershed, as observed in this study, and by Langhurst and Schoenike (1990).

The ability to return to the original site of capture after a long distance displacement (26 km) was observed in one externally tagged smallmouth bass in this study. This also occurred among five (28%) of eighteen radiotagged smallmouth bass. Returns over shorter distances for displaced adult smallmouth bass has also been observed in other studies (e.g., Forney 1961; Fajen 1962; Larimore 1952; Beam 1990; Langhurst and Schoenike 1990; Ridgway and Shuter 1996). Pflug and Pauley (1983) found that 98 (41%) of 240 displaced smallmouth bass (range, 0.8–11.3 km) returned to the site of capture in Lake Sammamish, Washington. Ridgway and Shuter (1996) found that 15 (83%) of 18 ultrasonically tagged smallmouth bass returned to home range areas from a mean displacement distance of 6.7 km (range, 0.8–14.0 km) in Lake Opeongo, Ontario. Stang et al. (1996) reported that four of five smallmouth bass released at a central weigh-in area in September remained within a few kilometers of the release site nine months after release. Displaced fish in this study appeared to move more than nondisplaced fish. For some smallmouth bass, these movements resulted in a return to original capture locations. Despite these larger scale movements and apparent homing ability in some fish, movements among other bass did not appear to lead to widespread dispersal away from central release sites over the first days and

weeks after release.

To the best of our knowledge, anglers captured no radiotagged fish during the study; however, one radiotagged fish was recaptured and re-entered in the tournament in 2000. Thirteen of 108 externally tagged fish were recaptured, with seven of these recaptured at the release site. The majority of these fish were recaptured within one week of release, with one being recaptured within hours of release. It is likely that anglers caught and released some radiotagged fish without reporting this information. We also had evidence that retention of external tags was extremely poor (although maximum retention time was 14 months) and algae may have made tags difficult to detect. This resulted in relatively frequent reports of recaptured fish early in the study, with a precipitous decline in the number of externally tagged fish at large as the study progressed.

This study has clear implications for operators of competitive angling events. By concentrating large smallmouth bass in areas with easy access (e.g., central weigh-in areas), the availability of these fish to anglers is increased. Behavior of riverine smallmouth bass following release may leave fish vulnerable to posttournament angling. In contrast, Healey (1990) showed that externally tagged bass in Shasta Lake dispersed and were not vulnerable to angling near the release site within 10 days of release. However, Van Woert (1980) and Healey (1990) also report that smallmouth bass survival in Shasta Lake is low and is related to high angler exploitation.

Angling vulnerability at the release site may persist until smallmouth bass disperse (at least 1 month). Furthermore, smallmouth bass are not difficult to catch in the early summer when most tournaments are held. Therefore, appropriate post- tournament release areas should be considered. Smallmouth bass should not be released at weigh-in stations or other easy access areas that receive disproportionately high amounts of angling pressure.

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