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ARTICLE

Survival of Angled Saugers in the Lower Tennessee River

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Abstract
An intense winter fishery for sauger *Sander canadensis* exists in the lower Tennessee River, and the objective of this study was to estimate the survival of angled saugers. In February 2008 and January–March 2009, 81 angled saugers (72 live plus 9 euthanized) were affixed with ultrasonic tags. The movements (or lack thereof) by saugers released alive were compared with those of euthanized fish to assess survival. Sixty-eight percent of the tagged saugers that were released alive exhibited maximum daily movements exceeding the greatest movement of any euthanized fish (0.5 km/d), and those fish were subsequently classified as survivors. The upstream movements of several euthanized fish indicated that their carcasses were ingested by piscivorous scavengers. In logistic models, the probability of mortality was significantly and inversely related to total length but not to capture depth, water temperature, handling time, or ascent rate. In 2 × 2 contingency tables, the fate of released saugers was not found to be associated with either the presence or absence of bleeding from the hooking wound or whether or not the fish displayed gastric distension. Most released fish survived despite the fact that gastric distension was observed in 72% of the angled saugers.

Sauger *Sander canadensis* populations in Tennessee have historically been an important component of the sport fishery (Hackney and Holbrook 1978). The creation of multiple impoundments along the Tennessee and Cumberland rivers created tailwaters where saugers congregate during winter when they move upstream to spawn (Hackney and Holbrook 1978; Pegg et al. 1997) and become susceptible to high rates of exploitation (Pegg et al. 1996). Declines in sauger populations throughout Tennessee in the late 1980s prompted the Tennessee Wildlife Resources Agency to take measures to improve the sauger fishery (e.g., initiating a stocking program in the 1990s and raising minimum size limits). Despite those measures, angler concerns about the quality of the sauger fishery persisted. In a 2007 survey, 44% of the anglers in Tennessee claimed some level of dissatisfaction with their sauger fishing experience and 32% thought that released saugers would die (Stephens et al. 2008). In particular, anglers voiced concern that undersized saugers they could not retain were often unable to repressurize their air bladders (i.e., they floated upon release and could not sound) and would probably die after they were released.

Saugers are regularly caught by anglers in deep (≥20-m) water in the lower Tennessee River; upon being landed, they often exhibit multiple outward signs that they are suffering from barotrauma. Barotrauma is the physical trauma that results from a rapid reduction in pressure (Nichol and Chilton 2006) and often occurs when fish are caught in deep water and brought to the surface. This phenomenon is common in some orders of physoclistic fish (e.g., Perciformes, which includes sauger and walleye *S. vitreus*) in which air bladders are not connected to the digestive tract by open ducts (Moyle and Cech 2000). Common physical impairments that have been observed in barotrauma-inflicted percids include distended abdomens, exophthalmia,

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hemorrhaging, and everted esophagi (Keniry et al. 1996; Bettoli et al. 2000; Schreer et al. 2009). Rummer and Bennett (2005) identified over 70 different barotrauma-related injuries in a marine study of red snapper *Lutjanus campechanus*. The behavioral impairments of barotrauma-inflicted fish may include abnormal swimming and an inability to return to capture depth (Feathers and Knable 1983). Inflicted fish unable to sound can subsequently be exposed to unsuitable temperatures, avian predation, illegal harvest, or physical injuries from wave action or boat strikes (Lee 1992; Keniry et al. 1996; Gravel and Cooke 2008).

Implicit in the establishment of protective measures such as size limits is the assumption that released fish will survive to contribute to the fishery at a larger size (Gigliotti and Taylor 1990). The survival of released fish has been related to a number of factors, including the frequency and severity of barotrauma, ascent time, water temperature, time spent on the surface, total length, and whether the fish were "vented" or not. Hooking mortality due to gas bladder overinflation and other factors (e.g., hook type and ascent time) was not found to be a serious problem for released saugers in a previous study conducted in the shallower waters of the upper Tennessee River (Bettoli et al. 2000). However, a number of studies have reported a relationship between the survival of angled percids and the frequency of barotrauma or capture depth (Fletcher 1987; Keniry et al. 1996; Cano et al. 2001; Schreer et al. 2009; Schramm et al. 2010), including one on saugers in the Mississippi River (Meerbeek and Hoxmeier 2011). Thus, the objective of this study was to use ultrasonic telemetry to estimate the survival of saugers angled in the lower Tennessee River at depths less than 20 m.

STUDY AREA

In 2008 and 2009, we collected saugers from Kentucky Lake below Pickwick Dam (river kilometer [rkm] 332.7 of the Tennessee River, measuring from its confluence with the Ohio River), the upper boundary of the lake on the lower Tennessee River. The dam was completed in 1938 and provides hydroelectric power, a navigable channel, and flood control. At full generation, six turbines release approximately 2,265 m^3 of water per second. Saugers were collected from Shiloh Bluff (rkm 320.3) downstream to Cerro Gordo (rkm 289.7), a reach that encompasses the deep (>20-m) water frequented by sauger anglers.

METHODS

Test for tagging effects.—In December 2007, we conducted an experiment to evaluate tag retention and test for the effects of handling and external tag attachment on the survival of saugers. Saugers were collected below Cordell Hull Dam on the Cumberland River using experimental monofilament gill nets and soak times less than 1 h. The captured fish were removed from the nets as quickly as possible, placed in a live well, transported to an aerated hauling tank on a truck, and held overnight. The following morning they were transported to Eagle Bend State Fish Hatchery in Clinton, Tennessee. Some saugers were subjected to a mock tagging procedure, whereby we recorded their total length (TL; mm) and externally attached dummy transmitters made from solid acrylic rods weighing 3.5 g each. A notched, metal pick was used to pass a loop of 36-kg test monofilament (attached to the dummy tag) through the dorsal musculature of the fish. The tag was then passed over the back of the fish and fed through the loop. The tagging procedure (i.e., handling and tagging) required less than 1.5 min. Control fish were measured but not tagged. Fish were held in a raceway for 20 d, after which their fate (dead or alive) and tag insertion injuries were assessed.

We discovered during the first year of field work that the monofilament loops were difficult to work with when ambient temperatures were low. Therefore, we conducted a second tag retention study in late March 2009 to test the effect of another attachment medium (Braided Spiderwire, Stealth, 9.1-kg test) on retention of tags. The dummy transmitters were exact replicates of those used in field studies (see below). Fish were collected and tagged as described above and held in a 0.04-ha hatchery pond from 19 March to 30 April 2009.

Survival of angled saugers.—Saugers ($n = 143$) were caught below Pickwick Dam on 12 occasions using conventional fishing gear (i.e., a bucktail jig with a minnow [1/0-size hook] and trailing size-4 stinger hook) between 14 and 23 February 2008 and between 21 January and 4 March 2009. Ascent time (the elapsed time between hooking and landing), handling time, and water temperature were recorded for each fish. Health assessments of hook wounds (i.e., bleeding at the point of hook penetration) and gastric distension (esophageal eversion) were also made. Gastric distension, a common (Rudershausen et al. 2007) but by no means definitive (Hannah et al. 2008) indicator of barotrauma, was scored as 0 (no expansion visible), 1 (expansion visible at the rear of the buccal cavity), or 2 (stomach or esophagus clearly distended into the buccal cavity; Bettoli et al. 2000). We attempted to capture saugers over a wide range of depths to describe the incidence and severity of gastric distension in this fishery, which (as one outward sign of barotrauma) we hypothesized would influence hooking mortality. Because saugers are demersal, jigging occurred within 1 m of the bottom and it was assumed that bottom depth equaled capture depth. Each fish was then measured for total length before being released or tagged and released.

We externally tagged a subset of the saugers we angled ($n = 81$) to assess postrelease survival; this subsample was overweighted with fish exhibiting moderate or severe gastric distension. We tagged fish with ultrasonic transmitters (IBT-Series Miniature 96-5; 69–79 kHz) manufactured by Sonotronics, Inc., Tuscon, Arizona. The transmitters weighed approximately 10.4 g in air and had a battery life of 5 months. Our external tags weighed 2.1% of the weight of the average sauger we tagged and 6.4% of the smallest tagged sauger. The weight of the shortest sauger that we tagged (264 mm TL), estimated from a logarithmic weight : length regression model for Kentucky Lake saugers collected during 2008–2009 gill-net sampling ($n = 243$; unpublished data), was 162 g. Each transmitter possessed a unique identification code and pulse interval. Transmitters were labeled with contact information and the words "$25 Reward." Tags were tethered to fish using 36-kg test monofilament on the first two tagging dates (14–15 February 2008); all other fish were subsequently tagged using 9.1-kg test braided Spiderwire.

When fish were released, we noted their swim-down behavior (i.e., whether or not they struggled to descend and repressurize). Fish were assigned swim-down scores of 1 (normal, vigorous swimming), 2 (disoriented, erratic swimming), or 3 (floating), a slight modification of the criteria used by Rudershausen et al. (2007). Unlike in other studies (e.g., Gitschlag and Renaud 1994; Rudershausen et al. 2007; Schreer et al. 2009), a floating, released fish was not presumed to be a mortality in our study.

A DH-4 directional hydrophone in combination with USR-5W and USR-96 scanning receivers (Sonotronics) were used to track tagged fish. We attempted to locate each tagged sauger on three consecutive days postrelease, then again approximately 2, 3, and 4 weeks after tagging. On each tracking day, we tracked the reach that encompassed the last known locations of all tagged saugers. On one occasion (15 March 2009), we conducted a sweep of the river between Pickwick Dam and the Interstate 40 bridge (rkm 143). We listened for tagged fish at 1-km intervals with the boat engine off. When we detected a fish, the identification code, time, and location (using a GPS receiver) were recorded.

The magnitude of movement (or lack thereof) by tagged saugers was used to assess survival. In addition to the saugers exhibiting gastric distension ($n = 65$), "control" fish (those displaying no gastric distension; $n = 7$) and dead fish (i.e., those euthanized with a concussive blow to the head, which included saugers with and without gastric distension; $n = 9$) were tagged; their movements were compared with those of tagged saugers that exhibited gastric distension when released alive. We used the maximum daily movement for each tagged fish after 1 week at large as the primary metric for determining fate. The daily movements of tagged saugers were calculated by dividing the distance traveled between consecutive relocations by the number of days between relocations. For all statistical analyses, we considered saugers to be survivors if they were recaptured alive or their maximum daily movement exceeded that of all euthanized fish. Distances were measured using ArcView 9.3 geographical information systems software (Environmental Systems Research Institute). We censored any fish that were never located following release or that were only located once (Bendock and Alexandersdottir 1993). Bettoli et al. (2000) did not consider missing saugers as mortalities because some censored individuals in that study exhibited similar degrees of gastric distension and hooking wounds as survivors. Additional estimates of survival for tagged saugers were derived by relating the average movement per day (the sum of all observed daily movements divided by the number of days at large) and reach movement per day (the distance between the uppermost and lowermost locations on the river divided by the number of days at large) of fish released alive to the same measurements for euthanized fish.

The possible relationships between fate (alive or dead) and the continuous variables we recorded (depth of capture, water temperature, total length, handling time, and ascent rate) were examined using the LOGISTIC procedure in Statistical Analysis System version 9.1 (SAS Institute 2009) after first testing for correlations among the explanatory variables. When a subset of uncorrelated ($P > 0.05$) variables was identified, we constructed models using all possible combinations of explanatory variables and selected the model with the lowest Akaike information criterion (AIC) score (Burnham and Anderson 2002). The possible associations between fate and categorical variables (presence of gastric distension, bleeding) were separately examined using Fischer's exact test in a 2×2 contingency table.

RESULTS

Test for Tagging Effects

Twenty-two treatment and 22 control fish were used in the December 2007 tag retention study. The mean lengths of tagged fish (378 mm TL; SE = 39.8) and control fish (379 mm TL; SE = 31.2) were similar (t-test; $P = 0.91$). All fish survived the 20-d observation period and no tags were shed. All fish appeared to be healthy, and only minor amounts of inflammation were observed around the insertion and exit points of the monofilament loop.

Ten treatment and 10 control fish were used in the March 2009 tag retention study. After 42 d the pond was drained and 6 treatment and 3 control fish remained; predation by river otters *Lutra canadensis* was suspected for the losses. Inflammation around the insertion and exit points of the braided line was more evident on all 6 treatment fish than on fish tagged the previous year with monofilament; however, all 6 fish retained their tags after 42 d.

Survival of Angled Saugers

We experimentally caught 143 saugers at depths ranging from 7 to 19 m (Table 1). Tagged saugers were caught at a mean depth of 10.5 m (range, 7–14 m). Gastric distension was observed in fish caught at all depths (Figure 1), and most saugers exhibited either moderate (39%) or severe gastric distension (33%). Only 6% of released saugers struggled to sound and all were ultimately successful (i.e., none floated upon release).

We tagged 81 saugers, of which 65 were alive and exhibited some gastric distension, 7 were controls, and 9 were euthanized

TABLE 1. Total lengths, water temperatures, depths of capture, ascent times, and ascent rates of 143 saugers experimentally angled in Kentucky Lake, 2008–2009.

Statistic	Total length (mm)	Water temperature (°C)	Depth of capture (m)	Ascent time (s)	Ascent rate (m/s)
Mean	349	7.7	12.4	16.8	0.8
SE	3.6	0.1	0.2	0.5	0.02
Range	264–446	2–9	7–19	8–39	0.25–1.89

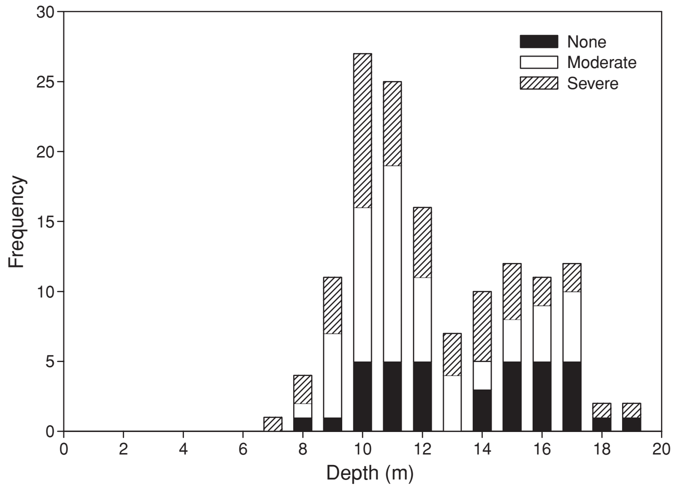

FIGURE 1. Frequency with which saugers angled from Kentucky Lake displayed different degrees of gastric distension, as a function of depth.

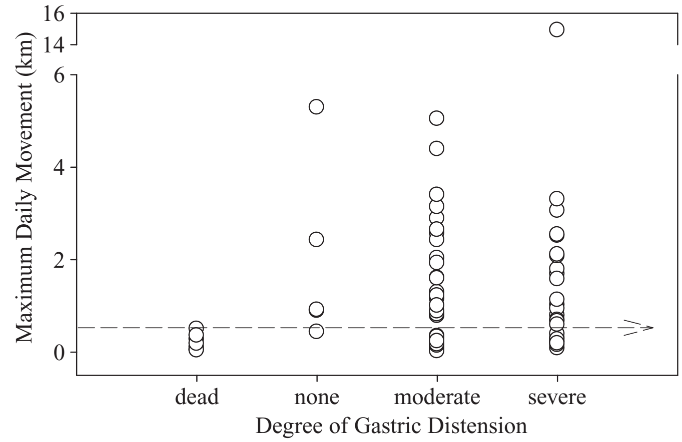

FIGURE 2. Maximum daily movements of tagged saugers by degree of gastric distension. The dashed line (0.5 km/d) indicates the maximum daily movement by any of the seven euthanized fish; all other fish exhibiting movements greater than 0.5 km/d ($n = 43$) were classified as survivors.

(3 with and 6 without gastric distension). Seven fish (5 alive at release and exhibiting some gastric distension; 2 euthanized, 1 without and 1 with gastric distension) were never relocated following release, and 4 fish released alive (2 controls and 2 that exhibited moderate gastric distension) were not located after 4 d at large; therefore, tracking data are presented for 70 fish. The number of days that those 70 fish were detected ranged from 8 to 73. Ten tagged saugers were subsequently caught and their tags returned, 9 in gill nets set by commercial fisherman targeting paddlefish *Polyodon spathula* and 1 by an angler. Movement data based on the date and location of capture for those 10 fish, which were all considered survivors, were included in our analyses.

The maximum daily movements of the 70 (alive and euthanized) tagged saugers that we were able to track for at least 8 d ranged from 0.01 to 14.9 km/d. The maximum daily movement exhibited by any of the 7 euthanized fish was 0.5 km/d. Forty-three of the 63 saugers (68%) released alive and tracked for at least 8 d exhibited maximum daily movements that exceeded 0.5 km/d and were designated survivors (Figure 2). Of those 63 fish, 80% ($n = 4$) of the fish with no gastric distension, 67% ($n = 22$) of the fish with moderate gastric distension, and 68% ($n = 17$) of the fish with severe gastric distension survived. Survival estimates based on whether or not tagged fish exhibited greater average movements per day or reach movements per day than euthanized fish were slightly higher (71% and 78%, respectively; Table 2). All of the fish classified as dead displayed a lack of movement (i.e., sedentary behavior or slow downstream movement) that we equated to mortality within a few days of release; thus, we assumed that all of the mortality we observed was related to being hooked, handled, and released.

The ascent rate (m/s) for tagged fish released alive was correlated with the four other continuous variables we measured ($|r| \geq 0.27$; $P \leq 0.0344$); handling time was also correlated with water temperature ($r = -0.30$; $P = 0.0168$). Therefore, we ran separate logistic models to determine whether any of

TABLE 2. Range of movement for 63 live-released and 7 euthanized saugers according to three criteria used to assign fate (see text); number of live-released, tagged saugers exhibiting three degrees of gastric distension that moved less than (alive, fate = 0) and more than (alive, fate = 1) euthanized saugers; and survival of tagged saugers released alive according to each criterion.

			Degree of gastric distension			
Criterion for assigning fate	Status	Range (km/d)	None	Moderate	Severe	Survival
Maximum daily movement	Euthanized	0.04–0.50				
	Alive, fate = 0	0.01–0.43	1	11	8	
	Alive, fate = 1	0.59–14.9	4	22	17	68%
Average daily movement	Euthanized	0.02–0.21				
	Alive, fate = 0	0.01–0.21	1	10	7	
	Alive, fate = 1	0.22–1.79	4	23	18	71%
Reach daily movement	Euthanized	0.01–0.15				
	Alive, fate = 0	0.01–0.14	1	7	6	
	Alive, fate = 1	0.15–1.76	4	26	19	78%

those five variables influenced mortality. In the first and second single-variable logistic models, the mortality of tagged saugers was not influenced by either handling time or ascent rate ($\chi^2 < 0.59$; $P > 0.4408$). The three uncorrelated variables (total length, water temperature, and depth of capture) were used to construct models ($n = 7$) of all possible combinations of those variables. The best logistic model based on its AIC score was a single-variable model with total length as the predictor variable; the probability of mortality was significantly (and inversely) related to total length ($\chi^2 = 4.65$; $P = 0.0310$). The other two variables (water temperature and depth of capture) were not significant ($\chi^2 \leq 1.71$; $P \geq 0.2329$) in any model. The simple logistic model with total length as the predictor variable provided a good fit to the data (Hosmer–Lemeshow goodness-of-fit test; $\chi^2 = 4.53$, df = 8, $P = 0.8069$). The model was

$$P[\text{mortality}] = \frac{e^{4.2400-0.0147\,(\text{TL})}}{1 + e^{4.2400-0.0147\,(\text{TL})}}.$$

In the 2 × 2 contingency table analyses, fate was not associated with either the presence or absence of bleeding or whether or not the fish displayed gastric distension ($P \geq 0.5177$).

DISCUSSION

The saugers in the present study experienced a much higher rate of gastric distension (72%) than the 113 saugers captured (38%) for the study by Bettoli et al. (2000). The saugers in the present study were also captured at greater depth (12.4 ± 0.24 m [mean ± SE]) than in the earlier study (9.0 ± 0.60 m; $P = 0.0001$), but over the same (narrower) range in capture depths (8–12 m) we still observed more gastric distension in the present study (76%) than in the previous one (35%). One environmental variable that differed between the two studies was water temperature: it was significantly lower in the present study (mean water temperature, 7.7°C; range, 2–9°C) than in the previous study (10.0°C; range, 7–13°C) ($z = 7.4305$; $P = 0.0001$). However, we are unaware of any relationship between temperature and the ability of fish to cope with rapid depressurization that might explain why the fish in the present study (in colder water) suffered more gastric distension than those in the earlier study (in warmer water).

In some demersal species (e.g., quillback rockfish *Sebastes maliger*), swim bladder gases may escape during ascent when swim bladders rupture, and esophageal eversion (i.e., gastric distension) will be uncommon (Hannah et al. 2008). Our designations of fish suffering from barotrauma based on gastric distension—and subsequent analyses of the role of barotrauma in the fishery we studied—would have been confounded if a similar phenomenon existed among the saugers in the lower Tennessee River.

Swim-down behavior would have provided a much different estimate of survival in our study. According to the criteria used by other studies (i.e., that fish struggled to descend or were unable to sound; Gitschlag and Renaud 1994; Wilson and Burns 1996; Hannah and Matteson 2007; Rudershausen et al. 2007), most of the fish in the present study (94%) would have been classified as survivors because few of them struggled to descend when released and all were able to sound. None of the few fish in the present study that struggled to sound were subsequently classified as dead according to their movements; conversely, some of the fish that we classified as dead based on their movements readily sounded when released. Struggling to descend may be an appropriate criterion for other species, but we consider it to be of limited use for studying sauger survival in the Tennessee River.

In this study, we detected a direct relationship between total length and survival. However, the relationship between fish size and survival appears to vary by taxon. Although Patterson et al. (2000) and Stewart (2007) reported that large red snappers and silver seabreams *Pagrus auratus* were more likely to survive than small ones, length was not a significant predictor of hooking mortality for West Australian dhufish *Glaucosoma hebraicu* (Gitschlag and Renaud 1994). Similarly, Meerbeek and Hoxmeier (2011) detected no relationship between sauger lengths and survival, and Schreer et al. (2009) found no relationship between the sizes of walleye and yellow perch *Perca flavescens* and the incidence of barotrauma or survival.

Bettoli et al. (2000) suspected that ascent rate is an important factor in determining the incidence of barotrauma (and possibly survival) in saugers; however, ascent rate was not statistically related to survival in the present study. In contrast, several studies have suggested a relationship between ascent rate and the survival of several other species (Rogers et al. 1986; Starr et al. 2000; Stewart 2007), including percids (Keniry et al. 1996).

As in the present study, Bettoli et al. (2000) did not detect a relationship between mortality (12-d) and incidence of gastric distension in saugers. However, the saugers in the present study had a higher mortality rate (22–32%, depending on the criterion used) than those caught, radio-tagged and released by Bettoli et al. (2000; 12%). The literature would suggest that the greater depths of capture and higher rates of external signs of barotrauma in the present study contributed to the higher mortality we observed. Two studies that assessed the short-term (≤12-d) hooking mortality of walleyes attributed high survival rates (>90%) to shallow capture depths (less than 10 m) and cautioned that catching walleyes at greater depths might increase mortality (e.g., Fletcher 1987; Cano et al. 2001). Schreer et al. (2009) reported that walleyes and yellow perch caught at greater depths were more likely to have barotrauma and die as a result of it. Meerbeek and Hoxmeier (2011), who observed a hooking mortality rate (26%) similar to our estimates (22–32%), also reported a direct relationship between mortality and capture depth for the saugers they angled in the upper Mississippi River at depths down to 24 m. Finally, Schramm et al. (2010) also concluded that capture depth in tournaments inversely affected the survival of walleyes and saugers (although warm temperatures were considered to be the primary determinant of mortality in released fish). However, no such statistical relationships between fate and the incidence of gastric distension or depth of capture revealed themselves to us in the results presented herein.

Although we captured saugers over a wide range of depths (7–19 m), all of those we tagged were caught at depths less than 15 m. Thus, we might have been able to detect a relationship between mortality and depth if we had tagged some of the saugers we captured at depths of 15 m or more. Additionally, we may have been able to detect the expected relationships between depth, gastric distension, and fate if we had assigned barotrauma status based on multiple signs of barotrauma and not merely on the presence or absence of gastric distension. Schreer et al. (2009) reported that it is not uncommon for walleyes and yellow perch to display multiple outward signs of barotrauma (e.g., loss of equilibrium, bloating, and stomach eversion), and Hannah et al. (2008) observed that fish can suffer from barotrauma in the absence of gastric distension. Thus, our use of a single objective measure of barotrauma (gastric distension) may have underestimated its incidence, especially in fish caught in deep water. For instance, we observed abdominal bloating in at least 8 saugers caught in water 16–18 m deep, but those fish did not exhibit any gastric distension. The phenomenon of ruptured gas bladders, especially in fish caught at the greatest depths (Hannah et al. 2008), might explain why the incidence of gastric distension actually declined for saugers caught at such depths in our study. Therefore, even in the absence of gastric distension, it is possible that some saugers were suffering from internal injuries attributable to barotrauma that ultimately affected their survival (i.e., control fish may have been suffering from barotrauma).

Saugers are a mobile species, especially during the spawning run (Pegg et al. 1997; Jaeger et al. 2005; Kuhn et al. 2008). Pegg et al. (1997) observed that the average daily movement of 37 saugers (collected in gill nets) in the Tennessee River was 1.1 km per day (range, 0.3–3.5 km). The observed movements over several months of those same 37 saugers averaged 66.8 km (range, 1.0–276.3 km). Lack of movement may not be a good indicator of mortality for many species, and possibly for saugers at other times of the year, but we feel that sedentary behavior during the spawning run is an excellent indicator of their fate after being caught and released.

Tracking euthanized saugers proved useful in discerning which fish lived and which died based on their movements. This method, in combination with telemetry of live-released individuals, is one way to reduce the uncertainty associated with estimating the mortality rates of free-ranging fish (Donaldson et al. 2008). Most of the movements exhibited by our euthanized fish were consistent with those of dead fish in other studies (i.e., remaining immobile over consecutive fixes or moving downstream slowly over several kilometers; Bendock and Alexandersdottir 1993; Nelson et al. 2005). However, three euthanized fish in our study moved upstream at some point, making upstream movement alone a faulty criterion for determining the fate of individuals. This phenomenon deserves further consideration in future studies of fish movements in lotic waters; tracking the movements of a larger sample of euthanized (and control) fish would also provide additional insight into the best metric to use to subsequently designate fish released alive as "dead or alive." The means by which those three euthanized fish moved upstream are unknown, but the most plausible explanation is that the carcasses were ingested by the large piscivores common to the Tennessee River (e.g., blue catfish *Ictalurus furcatus* or flathead catfish *Pylodictis olivaris*). The observed upstream and downstream movements of less than 5 km by euthanized fish, and by fish subsequently classified as mortalities according to their movements, were well within the ranges exhibited by catfish in other studies (Daugherty and Sutton 2005; Vokoun and Rabeni 2006). Furthermore, catfish predation on saugers in our study area has been observed (D. Blackwelder, commercial fisher, personal communication). No studies have looked at predation on live, adult saugers; thus, we cannot speculate on what role predation may have played in the mortality of the live saugers we released that did not survive.

There is considerable inconsistency among U.S. state fisheries agencies regarding the preferred manner by which fish should be brought to the surface and handled (i.e., fast versus slow ascent speeds; vented versus unvented air bladders; Pelletier et al. 2007). In their annual fishing guidebook, the Tennessee Wildlife Resources Agency dissuades anglers from venting barotrauma-inflicted fish and promotes the quick release of fish. Although Tennessee sauger anglers are often concerned about the welfare of fish angled in deep water and subsequently released, our results should help alleviate some of those concerns because most (68–78%) angled saugers, even those displaying external signs of barotrauma, survived when released.

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