DISTRIBUTION AND MOVEMENT OF WALLEYE (*SANDER VITREUS*) IN MONROE RESERVOIR, INDIANA 2008 AND 2009

Fish Research Final Report

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- Thirty-three walleye were implanted with radio tags in spring 2008. Five more were implanted with recovered tags in the fall 2008. Six walleye went through the dam (5 in 2008 and 1 in 2009), two were harvested (1 in 2008 and 1 in 2009), and seven tags were dropped (either through fish death or ejection) over the course of the two year project.

- Tagged walleye were located weekly during the spring, summer, and fall of 2008 and 2009. Twenty-four hour tracking events were conducted monthly during 2008. Two fish were tracked daily for the period of 5 days during 2008 also.

- Locations were divided into three periods: spawn (March 1 to April 31), summer (May 1 to August 31), and autumn (September 1 to November 30).

- Spawning site fidelity was documented in Saddle Creek and other spawning locations between the two years.

- Site fidelity was documented in summer and autumn locations for individuals.

- Distance moved was significantly greater during the spawn periods, no difference was found between summer and autumn movement distances and tagged walleye moved the least in the winter (last autumn to first spawn location).

- Tagged walleye were found to move extensive distances across the lake and individuals used the entire lake during all periods of the year.

- Posting walleye location updates on a DNR website was very successful with 37 individuals sending over 100 emails. The project website has had over 19,000 views since it was created in May 2008.

- The project has received state and national attention with articles appearing in Indiana Game and Fish and Walleye Insider magazines.

INTRODUCTION

Monroe Reservoir is a 10,750-acre flood control reservoir located in Brown and Monroe Counties southeast of Bloomington, Indiana. It is the largest lake in Indiana, and recreational activities such as boating and fishing are very important. There are nine publicly-owned boat ramps located around the lake. Access is also available at several privately-owned recreational facilities such as boat rentals, sports shops, marinas, and campgrounds. Monroe Reservoir serves as the primary water supply for the city of Bloomington.

Stocked predators, hybrid striped bass and walleye, were introduced in the mid-1980s to utilize the overabundant forage base at Monroe Reservoir (Schoenung 2001). These species are maintaining an angler following. The percent of anglers seeking walleye has stayed consistent from the 2000 to 2007 creel surveys at 3%. Even though the overall angling pressure has decreased from the 2000 to 2007 creel surveys, the catch rate for walleye has remained at 0.01 fish/h between the two surveys. Angler preference for walleye was 5.4% for all tailwater and main lake anglers (Kittaka 2008).

The 2007 creel survey on Monroe Reservoir estimated 1,365 walleye were harvested at the lake and its tailwater (Kittaka 2008). An additional 689 walleye were caught and released. The average length of walleye harvested was 17.4 in TL (total length) and ranged from 14.0 to 27.0 in TL. The combined catch rate for walleye at the tailwater and lake was 0.01 fish/h. Most of the walleye harvested came from the main lake (82%), while an additional 18% were harvested in the tailwater area. The catch rate for walleye for the two months at the tailwater area was 0.05 fish/h. According to the report, anglers seeking bass and walleye were the only ones rating their trip slightly below average satisfaction, each with a score of 3.1. The average score for this question was 2.8 (1 being extremely satisfied, 3 satisfied, and 5 extremely dissatisfied).

Previous telemetry work has been done on hybrid striped bass to evaluate habitat selection and seasonal movements in Monroe Reservoir (Hoffman et al. 2009). That study provided information to biologists about hybrid striped bass habitat requirements and through the creation of a website increased angler awareness and interest in hybrid striped bass fishing opportunities at Monroe Reservoir. The project was found to be successful and was continued in 2008-2009 with walleye being the target species with specific objectives 1) determine seasonal and diel movements, 2) determine habitat preferences, and 3) increase angler awareness and fishing trip success for walleye.

METHODS

Thirty-three walleye were implanted with transmitters during 2008. Additionally, five recovered tags were reimplanted into walleye on October 22nd on the upper end of Monroe Reservoir (Table 1). Walleye were collected using a DC electrofishing boat and large mesh gill nets (300 ft long x 10 ft deep with four successive 75 ft panels including one panel of each 1.5 in, 2 in, 2.5 in, and 3 in mesh) from March 31st through April 16th (Table 1). Walleye were collected from seven separate locations throughout the lake (Figure 1). Walleye of adequate size and condition were immobilized using electrical anesthesia (Sterritt et al. 1994). A patch of scales was removed from the abdomen of the fish and an incision slightly larger than the tag was made. Once the tag was inserted into the incision, a catheter was used to make a small incision ½ in posterior to the first one, and the antenna fed out of the fish through the catheter needle (Figure 2). A minimum of three sutures were tied to close the incision (Figure 3). After surgery, fish were held in tanks with aeration until swimming upright and showing signs of normal activity, and then were released at a site close to capture. Sex was determined when possible by gonadal release.

Walleye were tagged with Advanced Telemetry Systems (ATS) radio tags. Seventeen tags (model F1835) with pulse widths of 17ms, pulse rates of 35 ppm, and a weight of 14 grams were used for fish weighing greater than 680 g (1.5 lb). Sixteen tags (model F1845) with pulse widths of 22ms, pulse rates of 40 ppm, and a weight of 24 grams were used for fish weighing greater than 907 g (2.0 lb). Tag sizes used were less than 2% of the fish's total body weight as recommended by Winter (1996). The battery life of the smaller tag was warranted to 448 days while the larger tag was warranted to 551 days. An ATS R2000 receiver with a directional antenna was used to actively track fish. A test was conducted to find the maximum distance the two tag sizes could be heard to determine an appropriate tracking strategy (Table 2).

Walleye were tracked weekly from April through October 2008 and March through September 2009. Monthly 24 hr tracking was conducted in 2008 on two preselected fish with hourly locations recorded. Daily tracking was also conducted where selected fish were located everyday for about five days with locations taken about the same time each day.

A systematic search pattern was used to find fish. The boat was driven slowly (<10 mph) around the lake about 30 to 40 ft from shore while the radio receiver was set to scan all frequencies, pausing at each frequency for 4 seconds. Once the perimeter of the lake had been searched, focus was placed on wide parts of the lake where tags could not be heard from the shoreline tracking. The boat was driven in parallel transects in these areas with spacing designed to cover wide areas completely.

Upon detecting a signal, the fish was approached. When moving towards the fish the antenna was turned side to side to pinpoint the direction of strongest signal strength. Receiver gain strength was decreased to increase accuracy of locating the fish. Once the peak signal strength was located, the boat was placed at that position and the position recorded on a handheld GPS (either Trimble® GeoExplorer 3 or Nomad). Water temperature and dissolved oxygen profiles were taken at the surface and every 0.5 m to the bottom with an YSI 550A dissolved oxygen meter. Maximum depth was recorded with a boat mounted fish finder. All data was recorded on the GPS. Once a fish was located, its frequency was deleted from the receiver to reduce scan time.

Tracking was also done on Salt Creek downstream of the lake to check for fish that may have gone through the dam. Monthly checks were done at the Monroe Reservoir tailwater to check for fish that had gone through the dam but had not migrated downstream. To check for fish that may have migrated down Salt Creek during the summer in 2008, a small john boat with trolling motor was used to float Salt Creek from the tailwater downstream 5.85 mi to where Judah Logan Road crosses (just upstream of Logan, IN). Additionally, tracking was done on Salt Creek downstream of Bedford, IN to the confluence with the White River (14.7 mi). Periodic checks were also done at the Williams Dam (Williams, IN) on the White River. Data was transferred from the handheld GPS to ArcGIS® using Pathfinder Office® and differentially corrected to improve accuracy. Once transferred to ArcGIS®, tracking event shapefiles were created with all fish locations combined into a single shapefile for the week. Lake maps were then created displaying weekly, 24 h, and daily fish location and were exported in a jpeg format. A DNR web page was created to inform anglers about the project, post tracking maps, and improve interaction between anglers and biologists. The website included tagging information about the fish, tracking maps, maximum depths of located fish, and biologist contact information.

All movement measures represented results from 2008 and 2009 weekly locations. Movement rates (m/day) and core home ranges were calculated for each individual using the Animal Movement extension, Hawths Analysis Tools in ArcGIS (Hooge et al. 1999). Movement was calculated as the distance (m) moved between locations divided by the number of days between locations. Telemetry data was categorized as spawn, which included pre- and postspawning periods (March 1 to April 30), summer (May 1 to August 31), autumn (September 1 to November 30), and winter (the last autumn location to the first spawn location). Local range was defined as sites where walleye were located for at least two consecutive weeks. Telemetry locations were overlaid with bathometric maps to investigate variability in depths used during differing periods (Hoffman et al. 2009).

RESULTS

Reservoir water levels were above summer pool for a large portion of 2008 and 2009 (Figure 4). Due to high water levels, releases from the dam into the tailwater were also greater and unusually large releases lasted well into the summer, especially during 2008 (Figure 4). High water levels flooded a variety of habitats and greatly increased available habitat.

During the spring 2008 implantation, several fish were recaptured after they had been implanted. Six fish were recaptured once, while two fish were recaptured twice. Some recaptured fish were found near where they were released during implantation; one fish was tagged at the dam and recaptured at the causeway eight days later. Several fish were recaptured the day after implantation indicating that the surgery did not inhibit the fish in attempting to spawn. All recaptured fish appeared in good physical health with no inflammation around the incision noted.

Over the two years of weekly tracking, about 650 walleye locations were mapped. Since tracking began in April 2008, two fish were harvested, seven tags were dropped (i.e., the fish either died or the tag was lost by the live fish), and six fish went through the dam. Four dropped tags and one tag from a harvested walleye were recovered and reimplanted in October 2008. Walleye 444 was harvested in June 2008 near the Salt Creek boat ramp (Figure 5). The angler returned the tag and it was reimplanted in October. One fish of the October implantations was found dead 1½ weeks after implantation, and that tag was recovered. Walleye 724 was harvested on May 2, 2009 near the Highway 446 causeway (Figure 6).

Spawn (March 1 to April 30)

Walleye in spawning condition were found in multiple locations throughout the reservoir, primarily the Fairfax boat ramp, emergency spillway, Hardin Ridge and generally anywhere riprap was available (Figure 7). Spawning site fidelity was documented over the two years. Walleye 523 was tagged in Saddle Creek in 2008 and was found in Saddle Creek again in 2009 (Figure 8). However walleye 403 was tagged in Saddle Creek in 2008 but did not return in 2009 (Figure 9).

Reservoir water levels were well above summer pool during the spawn period in 2008 and slightly above in 2009 (Figure 4). Outflows were high during almost all of the spawn and summer period in 2008 and during the later portion of the spawn period in 2009. When outflows are high during the spawn period the chances of walleye being pulled through the dam is high, as demonstrated by 5 walleye being lost through the dam in 2008 (264, 323, 424, 563, and 623) and 1 in 2009 (204). Tagged walleye were detected below the dam as early as April 6 and as late as June. However, no tagged walleye were located downstream of the tailwater or at Williams Dam. Once fish left the tailwater, they were never located again. After spawning, many walleye were located in flooded timber mainly over the flooded peninsula near Fairfax Beach. Relative frequency distributions of tagged walleye location and distance from shoreline during the spawning period reflected the walleye's use of flooded timber with most walleye located within 50 meters of the shoreline (Figure 10). The greatest relative frequency of locations was found in areas with maximum depths of 0 to 10 ft and 11 to 20 ft (Figure 11). Average meters moved per day during the spawn period were 315 ± 32 m (± standard error), which was significantly greater than the other periods (Figure 12).

Summer (May 1 to August 31)

Locations during the summer period were more concentrated than during the spawning period. Most tagged walleye seemed to prefer certain areas, staying in the same general area for most of the summer; however some walleye continued to move throughout the summer period. Average meters moved per day during the summer period were 103 ± 9 m. Tagged walleye were found to use the secondary channels throughout the lake and were not frequently found in the main Salt Creek channel (Figure 13). Tagged walleye locations were mainly concentrated in bays, with the greatest relative frequency of distance to shore being within 50 meters of the shoreline (Figure 10). Several walleye were found in the Fairfax Marina area. They may be using these areas for cover and for the abundance of small prey fish.

Several walleye tagged on the east idle zone side of the lake surprisingly stayed on that side of the lake for the entire summer period. Initial thoughts were that water temperatures and dissolved oxygen levels would force tagged walleye across the causeway. Walleye stayed in the Saddle Creek cove and above the Pine Grove boat ramp for the entire summer period (Figure 13).

Stratification of the lake occurred during the summer period. Water temperatures near the surface exceeded 25°C and even at 20 ft temperatures were still above 20°C during both years. With very warm water temperatures at the surface and oxygen levels below 20 ft uninhabitable, walleye were restricted to depths from the surface to 20 ft, possibly restricting them to bays. These bays provided shallower water depths (11 to 20 ft) and adequate dissolved oxygen levels to the bottom (Figure 11). Kerr et al. (1997) found that walleye preferred dissolved oxygen levels >3 mgL. Fitz and Holbrook (1978) reported that walleye in Norris Reservoir, Tennessee appeared to avoid temperatures above 24°C when the lake was stratified, even if it required using water with low oxygen concentrations (1 to 2 mg/l) near the thermocline.

Autumn (September 1 to November 30)

Monroe Reservoir destratified during the autumn period (September) and use of open water increased (Figure 14). The majority of locations were still within 50 meters of the shoreline but tagged walleye were also found at higher frequencies at greater than 100 meters from shore (Figure 10). The break up of the stratification allowed walleye access to greater depths as water temperatures decreased and oxygen levels rebounded. Movement was 117 ± 12 m per day. The greatest relative frequency of locations was where depths were 11 to 20 ft (Figure 11).

Individual Fish Movements

Walleye 403 was tagged on April 9, 2008 in Saddle Creek; from there the fish moved under the causeway and spent the spring, summer, and part of fall of 2008 in a cove near Boy Scout Bay (Figure 9). In September 2008, the fish moved across the lake where it stayed for a couple of weeks, then in October it moved up lake before turning and moving down lake. November 2008 found the fish across the lake moving towards the causeway. On March 4, 2009, walleye 403 was located near the causeway which was near its last 2008 location. As March and April 2009 progressed 403 moved towards Fairfax and Hardin Ridge areas. For the rest of 2009, walleye 403 spent its time in a cove near Boy Scout Bay which is where it spent most of the summer and autumn periods in 2008.

Walleye 464 was tagged on April 10, 2008 on the west side of the causeway. From there the fish moved under the causeway and spent the spring, summer, and fall of 2008 in Saddle Creek (Figure 15). On March 9, 2009, walleye 464 was located at the causeway and then proceeded to migrate towards the dam where it was located on March 17, 2009 near Sugar Creek. During the summer and autumn period, walleye 464 moved back to Saddle Creek, which is where the fish spent the summer and autumn period in 2008.

Walleye 523 was tagged on April 9, 2008 in Saddle Creek and spent the summer period of 2008 in the Fairfax area (Figure 8). During the 2008 autumn period, walleye 523 moved up lake towards the causeway. Walleye 523 was found at the mouth of Saddle Creek on April 9, 2009 and was found running up Saddle Creek during the night of April 11, 2009 (Figure 16). In May 2009, walleye 523 was found near the Fairfax Marina where it stayed for the summer and autumn period of 2009 similar to its locations in 2008.

Walleye 764 was captured and tagged near the dam on April 16, 2008 (Figure 17). On May 5, 2008, it was located near the causeway and on May 19 it had moved down lake to near the Fairfax boat ramp, moving approximately 5 mi in 14 days across the lake.

The fish stayed in the Fairfax beach area during the 2008 summer period before moving up lake in the fall to the Boy Scout Bay area. On March 4, 2009, walleye 764 was located near the Fairfax area and then on March 26, 2009 at the dam. After that it spent the summer and autumn periods in the Fairfax and Hardin Ridge areas.

Walleye 783 was captured off Fairfax boat ramp, implanted and released at the Salt Creek boat ramp on April 16, 2008 (Figure 18). The fish moved up lake and spent the summer and early part of autumn periods near the Fairfax beach. Walleye 783 used flooded timber extensively during the spring when lake levels were 15 ft above summer pool during 2008. The fish was located in November moving further up lake towards the causeway. On March 4, 2009, walleye 783 was located in the Fairfax area and then on March 17, 2009 the walleye had moved towards the dam. After that the walleye was located in the Fairfax area for the remainder of the spawn, summer, and autumn periods 2009.

Walleye 805 was captured off Fairfax boat ramp, implanted and released at the Salt Creek boat ramp on April 16, 2008 (Figure 19). This fish was thought lost until it was located near Moore's Creek in March 2009; after that it was located near Hardin Ridge. Walleye 805 disappeared again until it was located above Pine Grove boat ramp in June and again in September 2009. Tracking conditions are difficult in this area with shallow water and tree stumps. Because of that, the area was not included in weekly tracking during 2008 and it is presumed this fish and several others were in this general location during 2008.

In order to see where and how much fish moved between weekly locations, selected walleye were located daily for five consecutive days at approximately 10:00 am (Figure 20 and 21). Selected walleye made small movements daily. However, consecutive daily tracking was only conducted during the summer period. Based on the calculated average distance moved per day, daily movements may have been greater during the spawn period when walleye are moving to spawning locations.

Results from 24-hr tracking were consistent with weekly tracking. Some fish moved extensive distances while others moved little. No seasonal patterns were observed. On June 24 and 25, 2008 two fish in close proximity were located every hour for 24 hr. Walleye 483 moved extensively during the night hours (Figure 22) while walleye 663 moved very little (Figure 23). Most major movement activity was reported after sunset and was probably related to feeding.

Overall Trends

Over the two year study, walleye were found to have site fidelity during the spawn, summer, and autumn period. Spawning site fidelity was demonstrated by walleye 523 that was tagged in Saddle Creek during the spawning period in 2008 and was found back up the creek in 2009 (Figure 8). Summer and autumn site fidelity was demonstrated by several walleye including 403 (Figure 9), 464 (Figure 15), and 783 (Figure 18).

Spring movements significantly differed from the other periods (315 m/d; Figure 12). The summer (103 m/d) and autumn (117 m/d) movements were not significantly different. Winter movements were significantly different from other periods (27 m/d) but locations during this period were limited and movements could be underestimated.

Tagged walleye were not found down lake of the Fairfax boat ramp during the summer and autumn period in either year (Figure 24). This may be due to the lack of shallow substrate (< 20 ft) and habitat in this portion of the lake. Tagged walleye had a strong affinity for the Fairfax point area and were there all year long. This point was under about 10 ft of water during the spawn period in 2008 and was used extensively at that time. However, during the autumn period, walleye used the shallow habitat north and south of the point even after water levels had receded to summer pool.

Tagged walleye used the upper end of the lake in Saddle Creek and North Fork of Salt Creek during the entire year (Figure 24). Previous to this study it was thought that water temperatures and oxygen levels might restrict walleye from using this portion of the lake during the summer and autumn periods. Walleye were found to migrate from the lower end of the lake to these areas and did not seem inhibited by warmer water temperatures and lower oxygen levels during the summer period. Several walleye located above Pine Grove boat ramp were found in the 10 to 15 ft deep North Fork channel in the waterfowl resting area during the summer period.

Public Interaction

The “Walleye Tracking at Monroe Lake” website (http://www.in.gov/dnr/fishwild/3280.htm) went online towards the end of May 2008. The website has had 10,453 visits and 19,235 views since going online. Since the start of the project, about 100 emails and numerous phone calls have been received about the project. Thirty-seven people sent emails regarding the project with many sending multiple emails. Many emails were general inquires about the project but several emails have been received just showing support and appreciation for the project. Several emails were received summarizing the results from walleye fishing trips and to inform how the website helped anglers catch walleye.

In addition to the website, a press release was issued in the 2008 DNR Spectacular Spring webpage (www.in.gov/dnr/spring), and signs were put up at bait shops and boat ramps. Also, the author contributed to a radio appearance on Outdoors Today on radio WGCL, an article in the Bloomington Herald Times in April 2008, an article in Indiana Game and Fish in January 2009, and an article in Walleye Insider in June 2009.

DISCUSSION

The radio tags used for this project were different from the radio tags used for the hybrid striped bass telemetry project. Both tags used had shorter reception ranges and were not as easily detected. The decreased signal strength made it very difficult to detect fish, especially those with the smaller tags, and probably resulted in missing occasional tagged walleye. The smaller tag was intended for 16.0 to 17.5 in fish, which constitute the largest part of the harvest (Kittaka 2008). However, it was necessary to use them on larger fish as well. In future projects, tag strength should be tested before purchase to ensure the signal strength is adequate.

The angler feedback from this project has been beyond expectation with information gained about reservoir fishing as well as the use of the tailwater for walleye fishing. Anglers documented walleye being caught in the tailwater into November 2008, well after the lake had returned to summer pool and water releases decreased. Walleye anglers have been eager to help and provide information about their catches, including weighing and measuring caught walleye. Biologists may consider walleye tournament monitoring similar to bass tournament monitoring to gain additional information about the walleye fishery in large reservoirs. Walleye tournament participants seem more than willing to take on this responsibility.

The lack of published walleye tracking studies in reservoirs, in addition to the angler participation aspect, make this project unique. Results show that walleye use the entire lake throughout the year with site fidelity in spawning and summer habitats. Walleye were found at various locations across the lake during the spawning period and were found to use several suitable sites during the same spawning period. The Saddle Creek spawning run is of particular interest and the instance of certain walleye having spawning site fidelity in the stream could be a reflection of natural reproduction in the system. Two explanations have been offered on walleye spawning site selection. One is that natal imprinting is a heritable trait (Olson and Scidmore 1962; Crowe 1962; Jennings et al. 1996; Bunt et al. 2000). The other is that site selection is a learned behavior: walleye follow others to spawning sites and repeat these movements in subsequent years (Olson et al. 1978). Natural reproduction has not been investigated and oxytetracycline hydrochloride (OTC) marking should be implemented on stocked walleye to assess whether natural reproduction of walleye is occurring and, if so, to what extent.

The high number of tagged walleye that were flushed through the dam in 2008 may have negative affects on the lake's walleye fishery but is benefiting the tailwater fishery. Water releases during the spawning period drew walleye through the dam and distributed them in the tailwater. Tagged females seemed especially vulnerable to this. Based on communication with anglers, this loss of lake-walleye is benefiting the tailwater fishery and provides an opportunity to shoreline fishers who may not otherwise have the opportunity to fish for walleye.

Based on walleye movement data and personal communication with anglers, walleye seem most susceptible to harvest during the spawn and autumn periods. During the spawn period, walleye are making long migrations and are in areas where both bank fishing (dam) and boat fishing are possible. Generally, walleye seem to be most active at temperatures in the 15 to 18°C range and avoid temperatures exceeding 25° C (Kerr et al. 1997). After the walleye spawn, they move into the backs of coves and into creek channels. Movement was reduced during the summer period. Similar results were found by Eddy and Surber (1947), Holt et al. (1977) and Schupp (1972) and were attributed to high water temperatures. Walleye are considered temperate mesotherms (Hokanson 1977) with optimal temperatures in the 20 to 23°C range and an upper incipient lethal temperature at or near 31°C. Schupp (1972) also suggested that the change in the daily distance moved was influenced by the availability of young-of-the-year yellow perch. Quinn (2008) had similar results with walleye moving into timbered coves after spawning. Twenty-four hour tracking revealed that walleye did move out of the coves into open water around dusk presumably to feed. Holt et al. (1977), Eschmeyer (1950), and Rawson (1956) all found that walleye were most active at night. As the summer progressed and the lake destratified, walleye begin moving into open water.

Results from this telemetry project provide information about walleye use of the east side of the lake. Walleye used this side of the lake during the entire year and can provide a great fishing opportunity during windy and high boat traffic days on the "fast" side of lake. From personal communication with anglers, they find this information very exciting.

Data obtained from this telemetry project have provided insight and national attention about the Monroe Lake walleye fishery. Email inquiries about fishing for walleye at Monroe were received from various counties within Indiana but also from other states. Telemetry projects like this one and the hybrid striped bass project can provide information regarding habitat use, spawning locations, stocking levels, harvest, and anglers, while improving public relations. I would recommend that future telemetry projects with the goal of increasing angler awareness should be done in conjunction with a creel survey to assess whether awareness was increased.

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Table 1. Radio tag number, date of implantation, floy tag number, length, weight, reproductive status, and status of implanted walleye on Monroe Reservoir in 2008.

Radio Tag Number	Implantation Date	Floy Tag Number	Length (mm)	Weight (g)	Reproductive Status	Status
204	03/31/2008	5548	477.5	1020.6	Male	Tailwater
225	03/31/2008	5544	431.8	907.2	Male	Active
243	04/16/2008	5508	459.7	875.4	Male	Dropped
264	04/16/2008	5504	431.8	793.8	Male	Tailwater
283	04/01/2008	5538	477.5	907.2	Male	Dropped
302	04/16/2008	5506	497.8	1016.0	Male	Active
323	04/01/2008	5537	436.9	680.4	Male	Tailwater
343*	04/01/2008	5536	429.3	680.4	Male	Reimplanted
363	04/07/2008	5533	482.6	1256.5	U. Female	Active
384*	04/09/2008	5527	513.1	1360.8	Male	Reimplanted
403	04/09/2008	5528/5529	477.5	1020.6	Male	Active
424	03/31/2008	5543	472.4	1020.6	Male	Tailwater
444*	04/16/2008	5503	439.4	739.4	Male	Harvested/Reimplanted
464	04/10/2008	5530	645.2	2608.1	Male	Active
483	03/31/2008	5541	452.1	1134.0	Male	Active
504	04/16/2008	5502	528.3	1360.8	Male	Active
523	04/09/2008	5531	530.9	1360.0	Male	Active
544	03/31/2008	5550	563.9	1700.0	Male	Active
563	04/07/2008	5532	528.3	1610.3	U. Female	Tailwater
583	03/31/2008	5542	515.6	1587.6	Male	Dropped
603	03/31/2008	5549	548.6	1587.6	Male	Active
623	04/01/2008	5535	604.5	3061.7	Ripe Female	Tailwater
643	03/31/2008	5545	556.3	1701.0	Male	Active
663	04/01/2008	5539	586.7	2268.0	Male	Active
684*	04/01/2008	5540	581.7	1814.4	Male	Reimplanted
704	03/31/2008	5546	551.2	1587.6	Male	Active
724	04/10/2008	5526	655.3	2948.3	Male	Harvested
743	04/02/2008	5534	510.5	1587.6	Ripe Female	Active
764	04/16/2008	5501	528.3	1351.7	Male	Active
783	04/16/2008	5509	510.5	1174.8	Male	Active
805	04/16/2008	5505	642.6	2463.0	Male	Active
823*	04/16/2008	5507	584.2	1868.8	Male	Recovered
843	03/31/2008	5548	566.4	1814.4	Male	Dropped
343	10/22/2008	5337	523.2	1587.6	Unknown	Active
384	10/22/2008	5338	553.7	1701.0	Unknown	Active
444	10/22/2008	5339	431.8	907.2	Unknown	Active
684	10/22/2008	5334	645.2	2834.9	Unknown	Active
823	10/22/2008	5336	614.7	2494.7	Unknown	Dropped

* Denotes tag was dropped, recovered, and reimplanted into a new fish on October 22, 2008.

Table 2. Results from experiment to test detection distance (m) for two tag sizes at various depths.

Tag Size	Distance tag heard from (m)			
Depth of tag:	2 m	5 m	6 m	8 m
14 g	310	292	200	296
24 g	1109	843	403	452

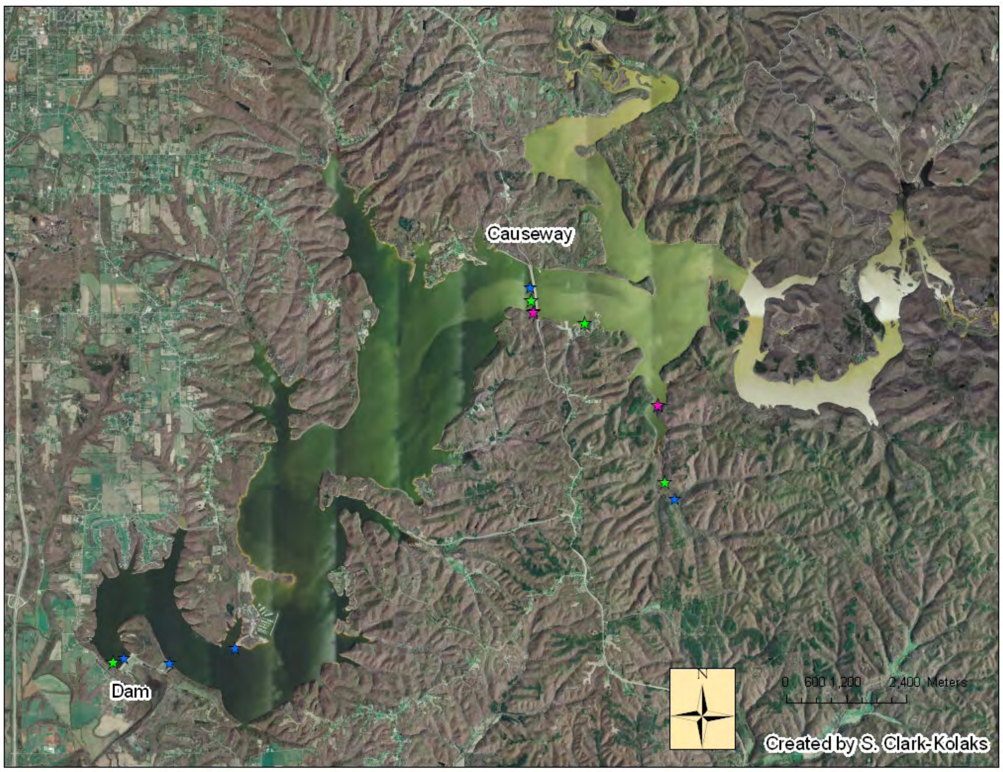

Figure 1. Locations of 2008 walleye implantations on Monroe Reservoir. Blue stars indicate spring capture sites, pink stars indicate fall capture sites, and green stars indicate release site of walleye after implantation.

Figure 2. Picture of incision, catheter hole, and insertion of radio tag.

Figure 3. Picture of inserted radio tag and sutures closing incision.

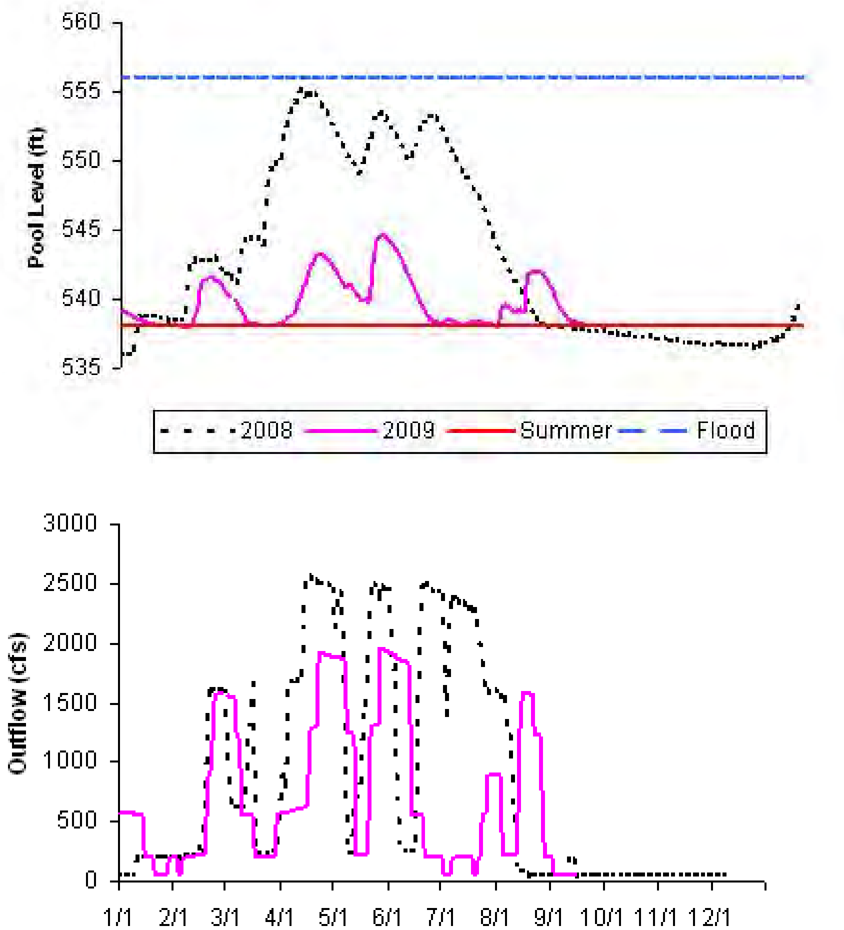

Figure 4. Graph of Monroe Lake 2008 and 2009 pool levels, summer pool level (538 ft), and flood stage (556 ft) depicted. Graph of dam outflow (cfs) released into the tailwater at Monroe Reservoir in 2008 and 2009.

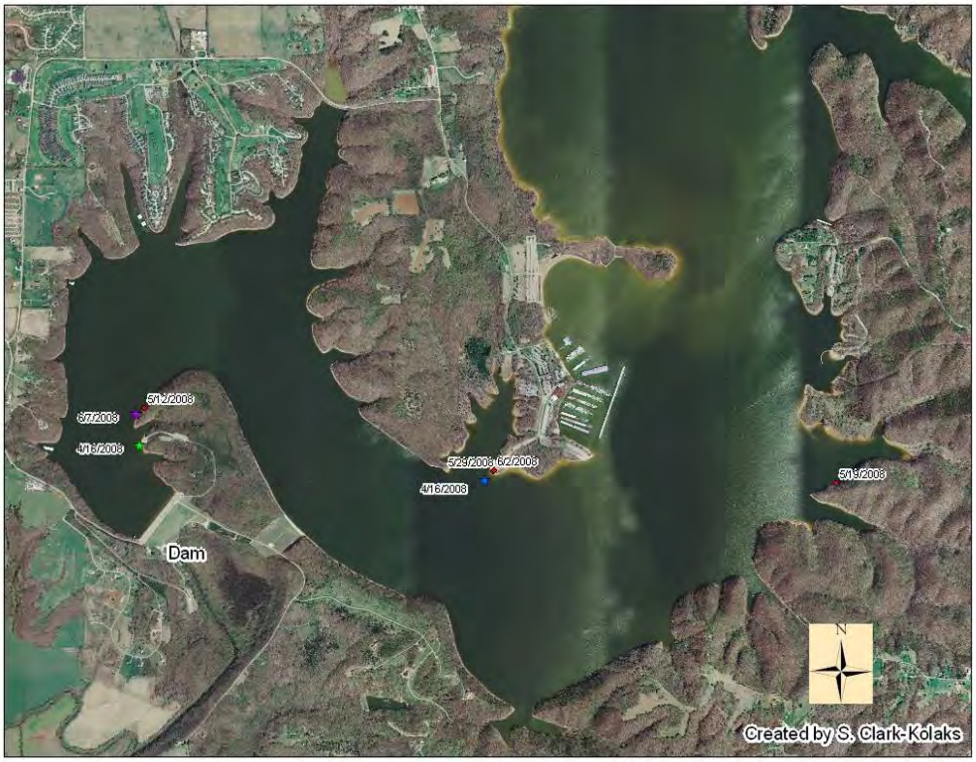

Figure 5. Map of capture site (blue star), release site (green star), telemetry locations (red dots), and angler capture site (purple star) for walleye 444.

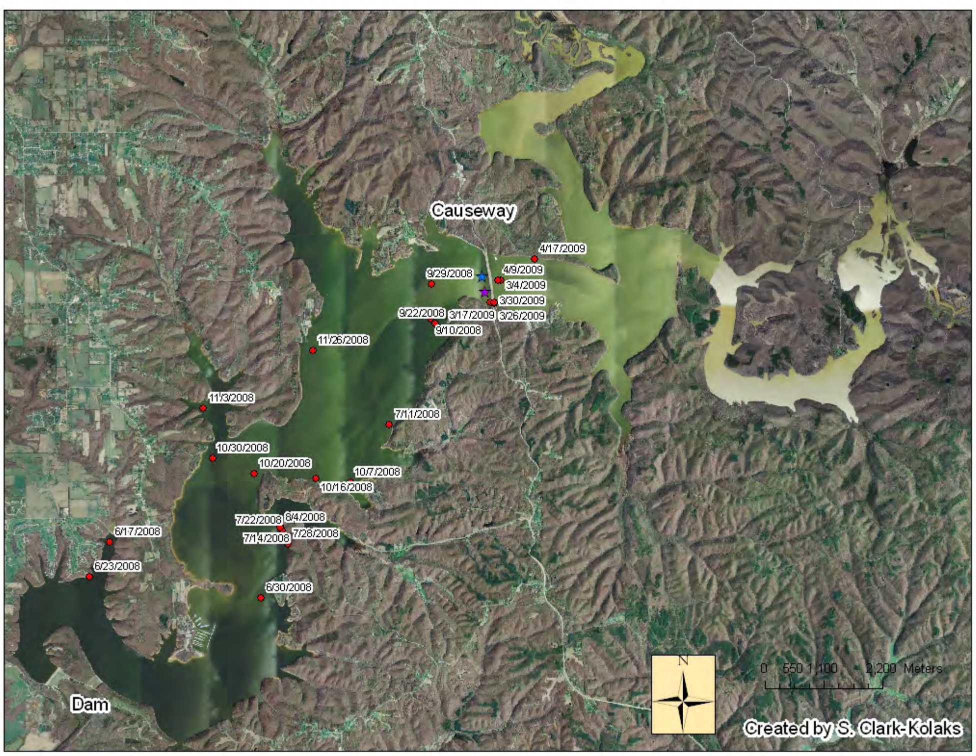

Figure 6. Map of capture and release site (blue star), telemetry locations (red dots), and angler capture site (purple star) for walleye 724.

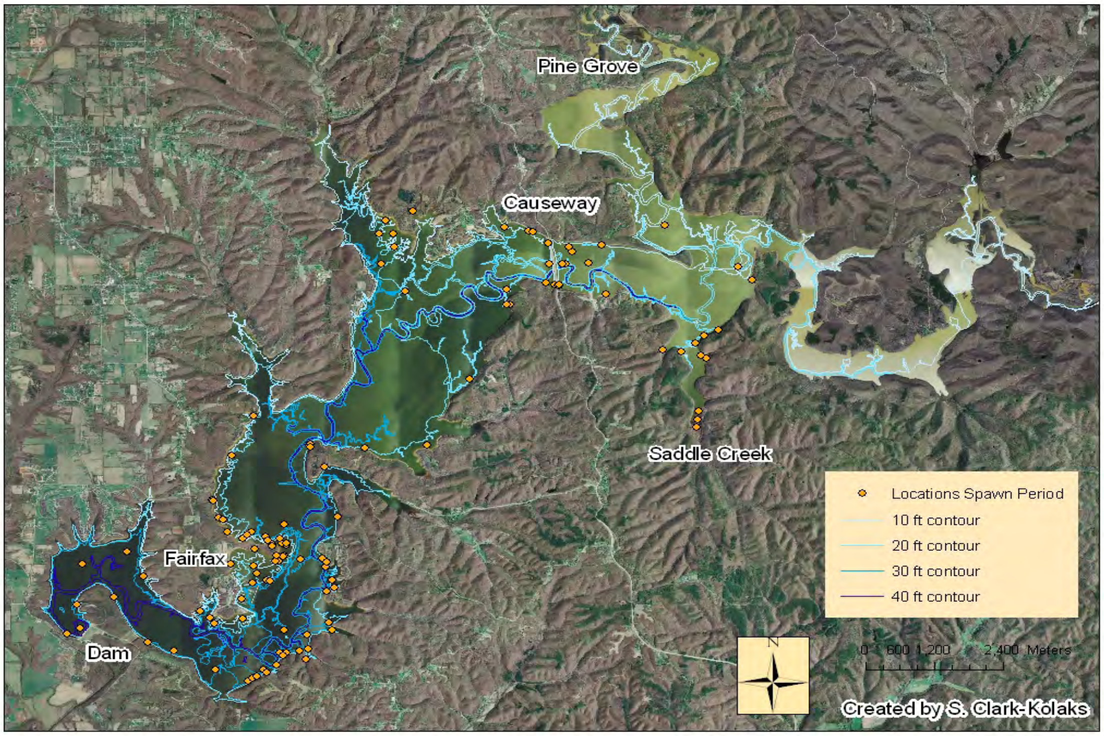

Figure 7. Map of walleye locations (orange dots) found during spawn period (March 1 to April 31) with depth contours.

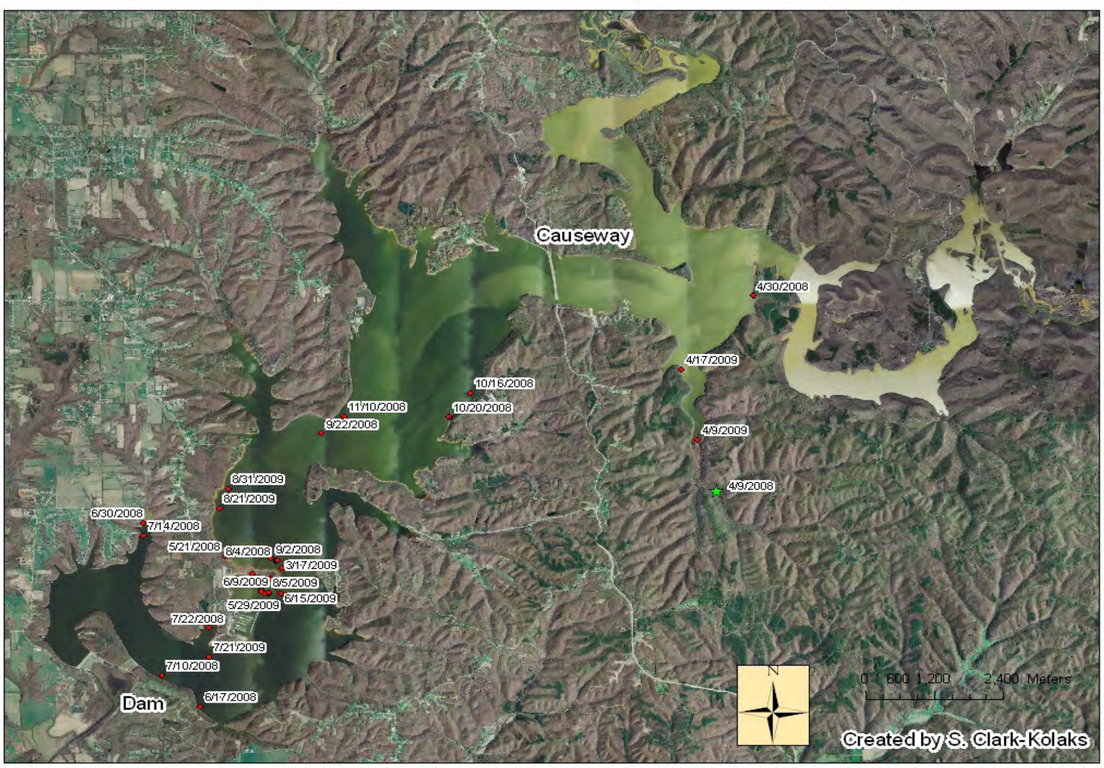

Figure 8. Map of walleye 523 implantation location (green star) and locations (red dots) for tracking period.

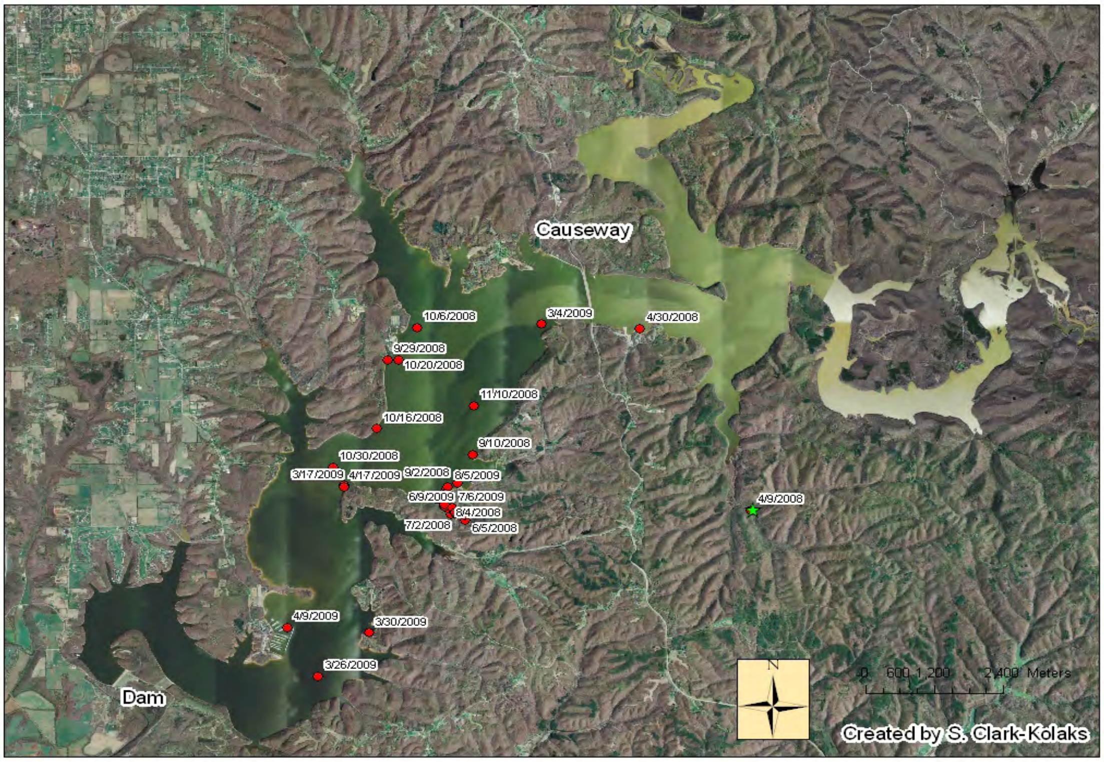

Figure 9. Map of walleye 403 implantation location (green star) and locations (red dots) for tracking period.

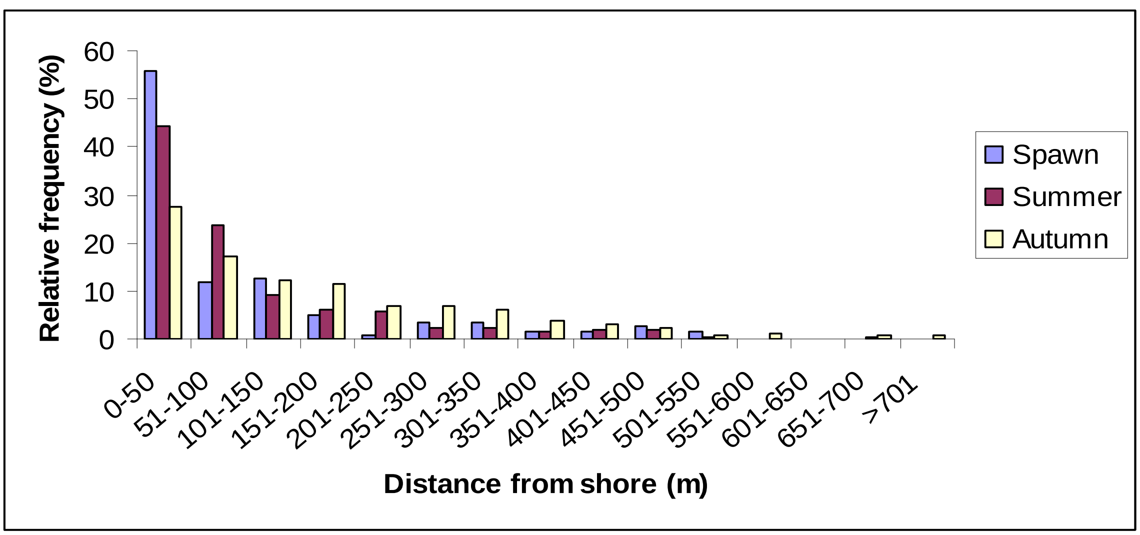

Figure 10. Graph of distance to shoreline relative frequency distribution for locations during the spawning period (March 1 to April 31), summer period (May 1 to August 31), and autumn period (September 1 to November 30).

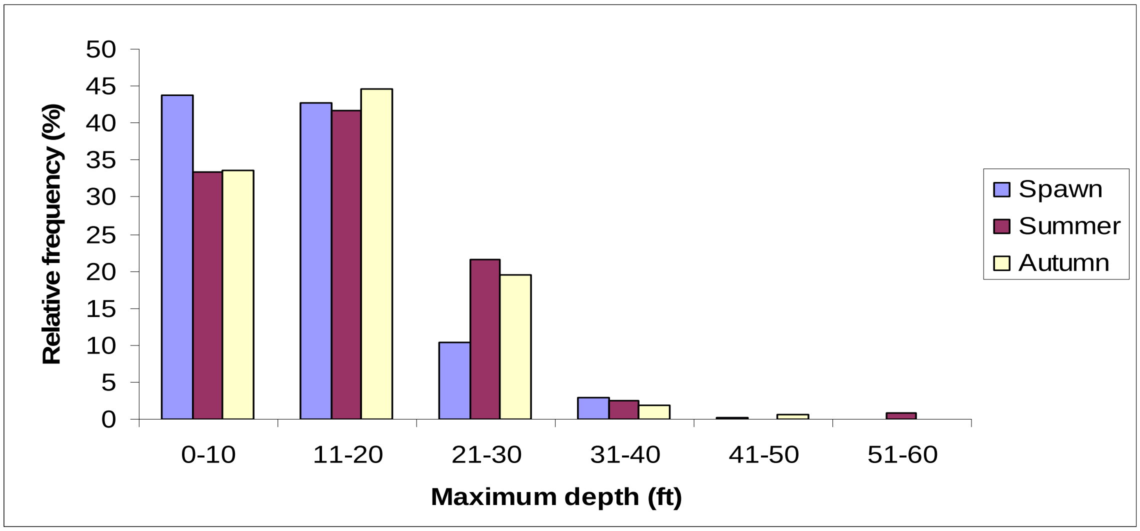

Figure 11. Graph of relative frequency distribution for maximum depth of locations during the spawn (March 1 to April 31), summer (May 1 to August 31), and autumn periods (September 1 to November 30).

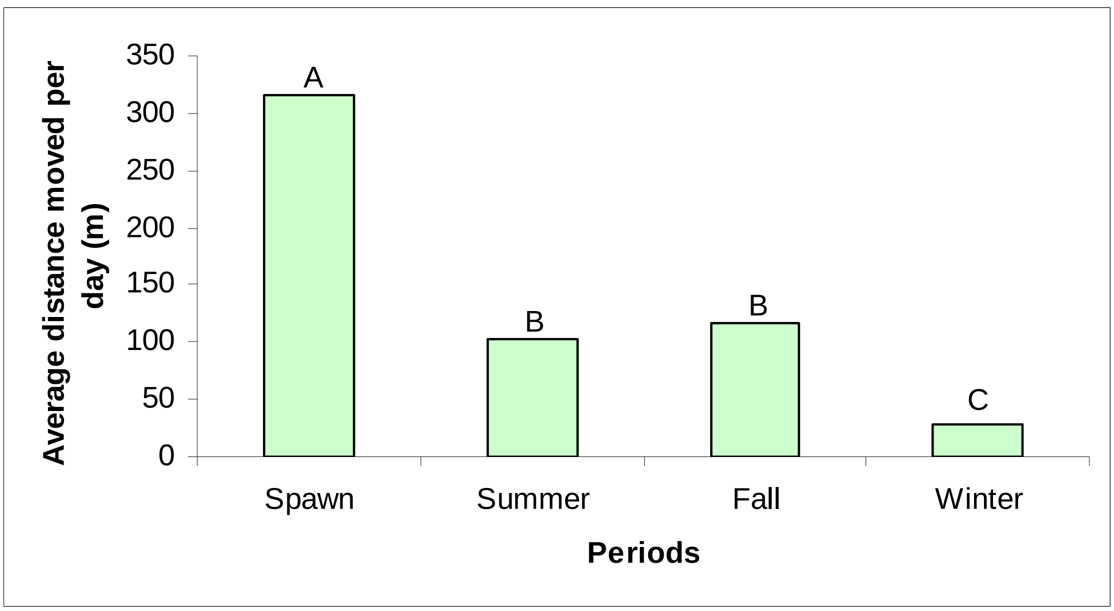

Figure 12. Graph of average distance moved per day (m) during the spawn (March 1 to April 31), summer (May 1 to August 31), and autumn periods (September 1 to November 30). Periods with different letters were significantly different while periods with the same letters were not significantly different ($P < 0.0001$).

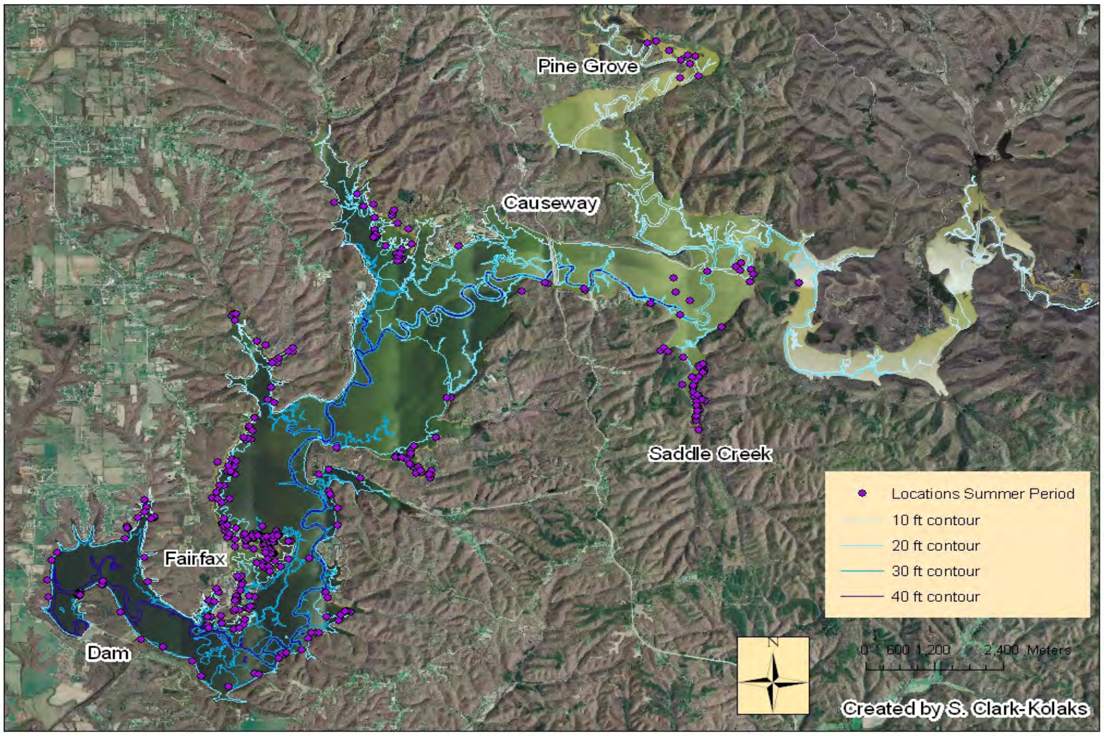

Figure 13. Map of walleye locations (purple dots) found during the summer period (May 1 to August 31) with depth contours.

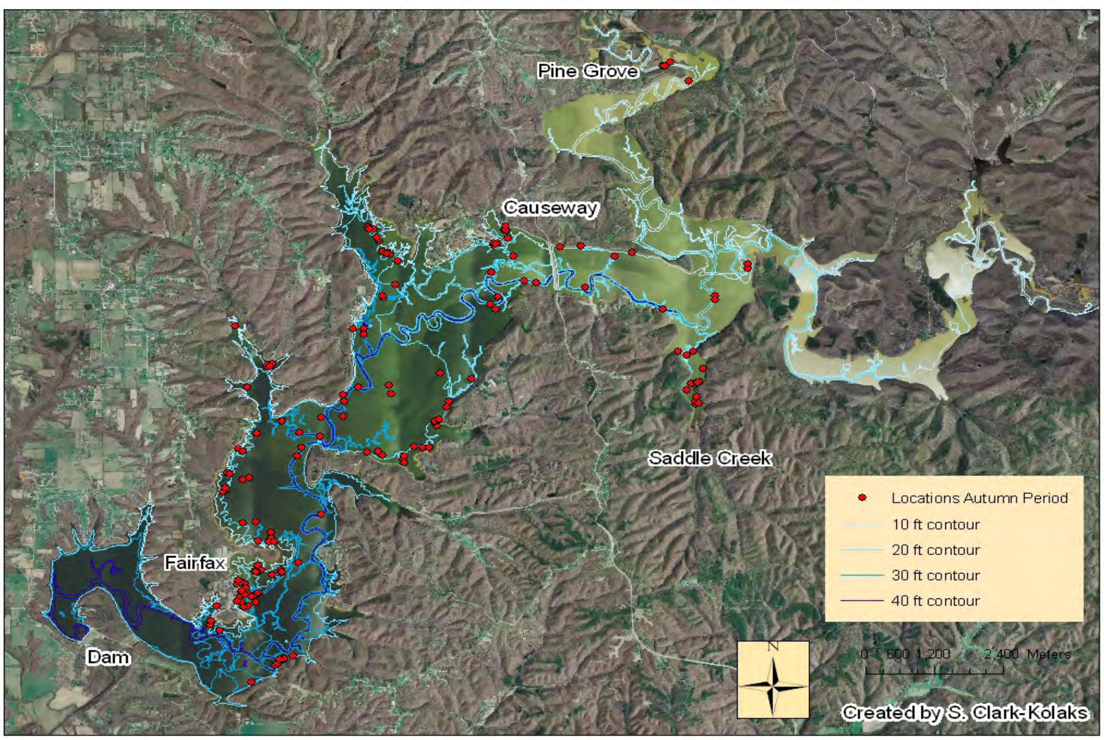

Figure 14. Map of walleye locations (red dots) found during the autumn period (September 1 to November 30) with depth contours.

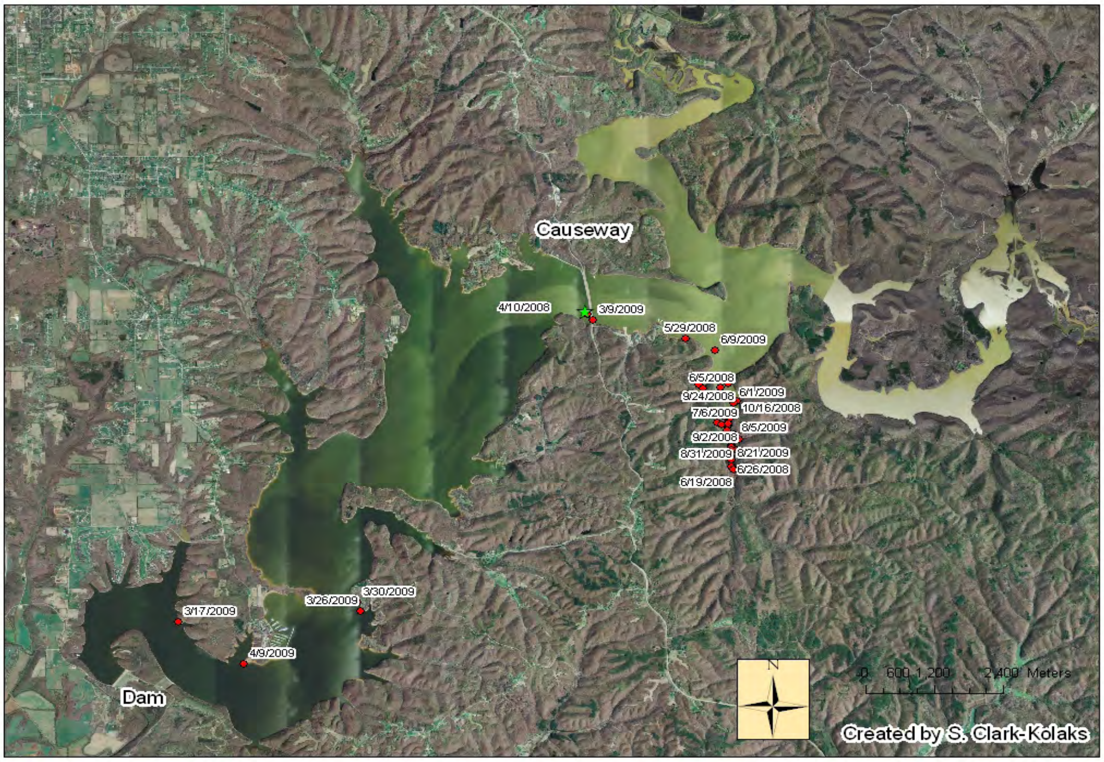

Figure 15. Map of walleye 464 implantation location (green star) and locations (red dots) for tracking period.

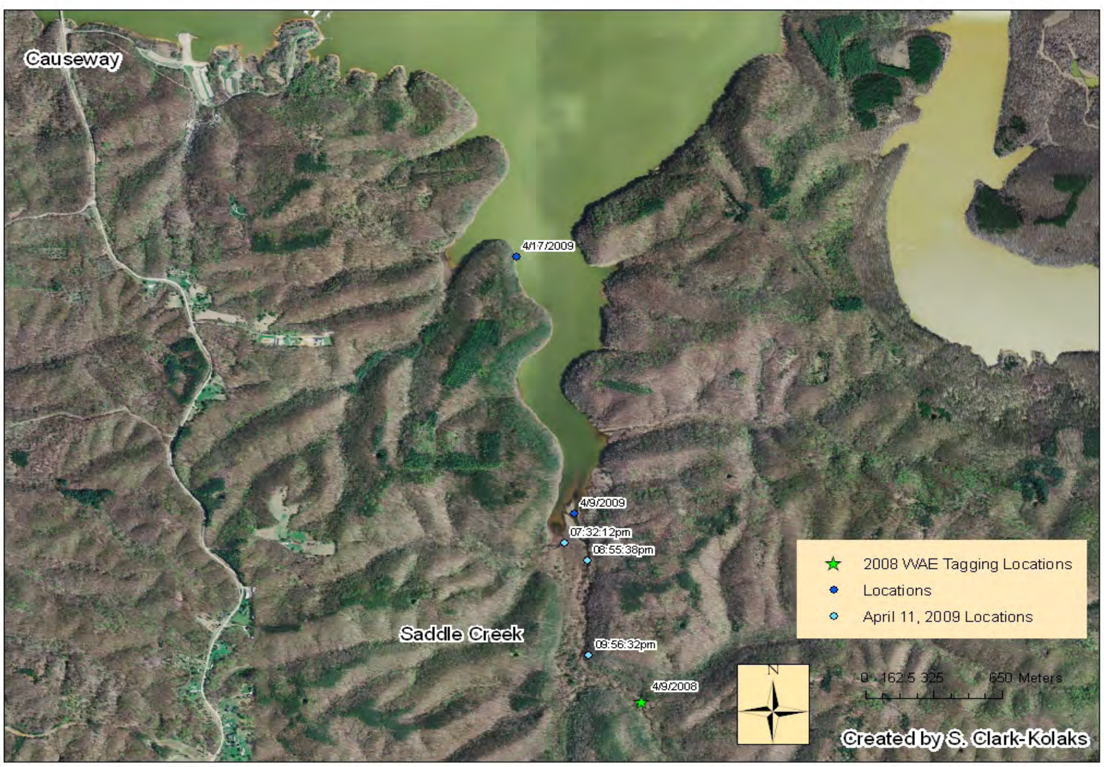

Figure 16. Map of walleye 523 implantation (green star), daily locations (blue dots), and hourly locations for April 11, 2009 (light blue dots).

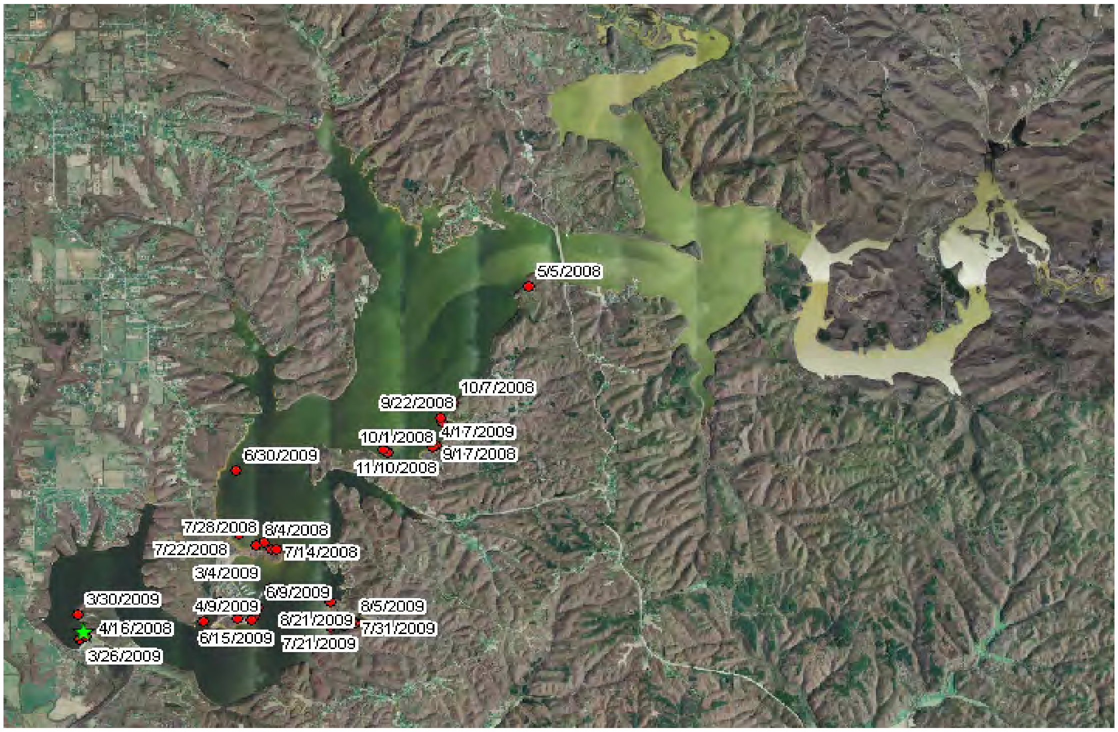

Figure 17. Map of walleye 764 implantation location (green star) and locations (red dots) for tracking period.

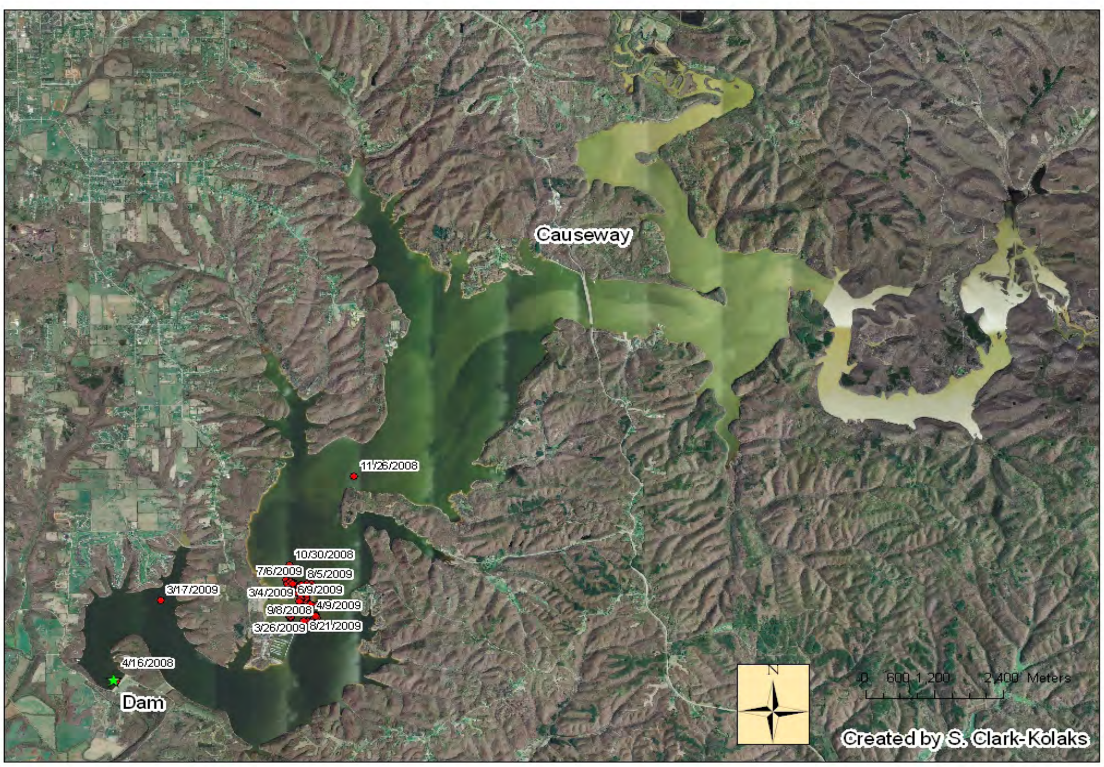

Figure 18. Map of walleye 783 implantation location (green star) and locations (red dots) for tracking period.

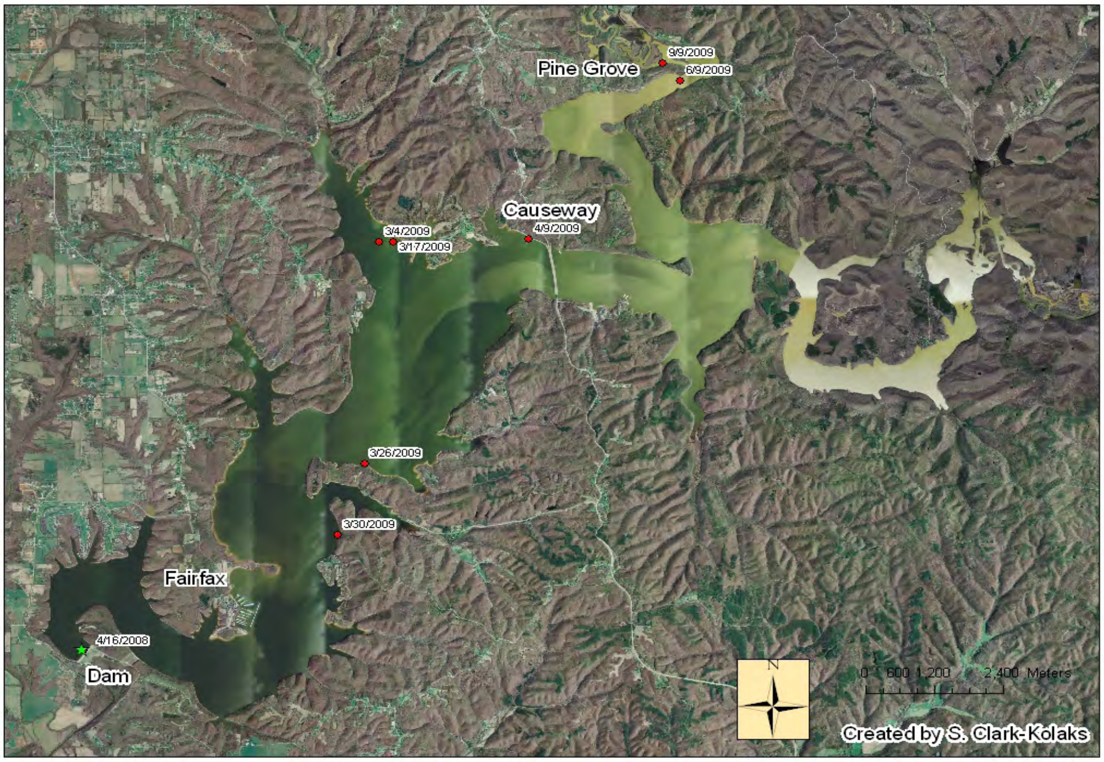

Figure 19. Map of walleye 805 implantation location (green star) and locations (red dots) for tracking period.

Figure 20. Map of weekly tracking locations (red dots) for walleye 764 and depth contours.

Figure 21. Map of weekly tracking locations (red dots) for walleye 523 and depth contours.

Figure 22. Map of 24 hr tracking locations (red dots) for walleye 483 conducted in June 2008.

Figure 23. Map of 24 hr tracking locations (red dots) for walleye 663 conducted in June 2008.

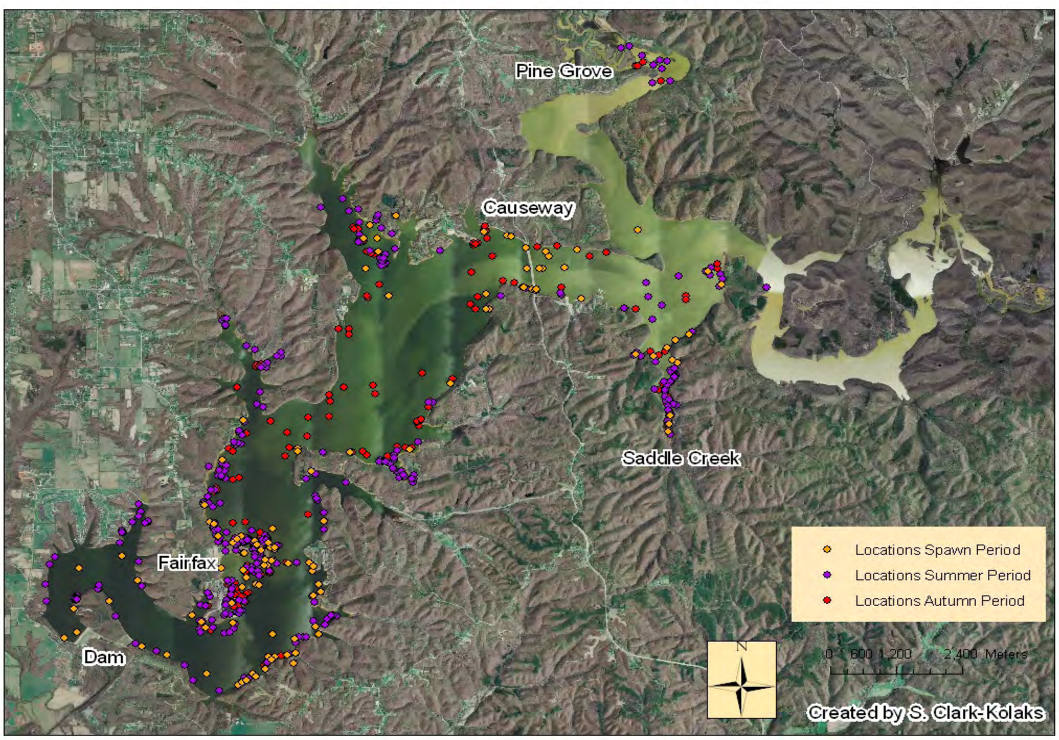

Figure 24. Map of walleye locations found during the spawn (March 1 to April 31), summer (May 1 to August 31), and autumn (September 1 to November 30) periods.