SPawning Behavior of Lake Erie Walleye in
The Sandusky River and Bay, Ohio, 2006-09

Project FSDR21, Final Report

Ohio Department of Natural Resources
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*aThis work was completed under Federal Aid in Sport Fish Restoration Project F-69-P, Fish Management in Ohio, Study FSDR21
Abstract. Between 2005 and 2009, we implanted 61 mature walleye from Lake Erie with radio transmitters to examine their spawning movement and behavior in the Sandusky River and Bay, Ohio. Location information was collected through a combination of fixed receiving stations and mobile tracking (by plane, boat, and foot). Additional physical information (water temperature, river discharge, and moon phase) was collected to investigate their affect on walleye location during the spawn. Fifty of the 61 walleye (82%) were located at least once from 2006-2009 in the Sandusky system; a total of 314 locations were recorded during the same period. Only 15% of the walleye tagged in Lake Erie or Sandusky Bay that were located during the study were found to have ascended the Sandusky River to spawn. The majority remained in Sandusky Bay, and presumably spawned there, despite potentially lower quality spawning habitat. Spawning in the Sandusky River appeared to peak during early April in all years. The distance that river-spawning males were located from known spawning habitat was negatively related to river discharge. Bay-spawning females were closer to shore, and potential spawning habitat, during new, waxing, and full-moon periods than during a waning moon. Our research suggests that future examination of the bay-spawning component of the Sandusky spawning stock is necessary, and efforts to evaluate and improve spawning habitat within the bay may prove beneficial to managing this stock.

*This work was completed under Federal Aid in Sport Fish Restoration Project F-69-P, Fish Management in Ohio, Study FSDR21*
INTRODUCTION

Spawning in fish is influenced by a variety of abiotic factors. For walleye (\textit{Sander vitreus}), spawning is driven by the availability of appropriate habitats and environmental conditions, including substrate type (Eschmeyer 1950; Johnson 1961; Colby et al. 1979), proper water temperature (Scott and Crossman 1973; Colby et al. 1979; Pitlo 1989) and current velocity (Houde 1969; Groen and Schroeder 1978; Mion et al. 1998), and distance from spawning areas to nursery areas (Priegel 1970; Jones et al. 2003). Spawning success is often reduced when one or more of these factors are outside of the parameters preferred by the species (McMahon et al. 1984).

Walleye are the dominant piscivore in Lake Erie, and are an important part of Ohio’s recreational fishery, which is valued at over $800 million annually to Ohio’s economy (www.asafishing.org, U.S. Dept. of the Interior 2003). Most Lake Erie walleye originate from three main spawning areas in the western end of Lake Erie: the mid-lake reef complex and islands (Baker 1971), the Maumee River, and the Sandusky River and Bay (Ohio Division of Wildlife 2009; Figure 1). Walleye that spawn in the Sandusky River and Bay are known as the Sandusky stock, and are believed to return to the Sandusky system annually to spawn, while spending the remainder of the year in the main lake. Walleye from the Sandusky stock contribute significantly to angler harvest, particularly in the western and central basins (Ohio Division of Wildlife 2009).

The Sandusky River and its tributaries run over 3,541 river kilometers (rkm), and drain a 4,727 km$^2$ watershed into the 189.9 km$^2$ bay (Ohio Coastal Atlas 2007). Land use within the Sandusky River watershed is dominated by agriculture (83%), and with the

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high clay content of the soils, the Sandusky River delivers 226,796 metric tons of sediment into the Bay annually (Ohio Coastal Atlas 2007). Not surprisingly, the Bay is relatively shallow, less than 3m deep except near the outer portion of the bay and where shipping channels have been dredged for large vessel passage. Bay sediments are dominated by silt and other fine-grained materials.

Creel records from the Sandusky River suggest the Sandusky stock has declined in recent years (Ohio Division of Wildlife unpublished data; Figure 2). Some have hypothesized this decline is due to the lack of quality walleye spawning habitat within the Sandusky system, particularly the river (Cheng 2001; Jones et al. 2003). While the Sandusky River is 210 km long, access to spawning habitat in the Sandusky River is limited by the Ballville Dam, located near the city of Fremont, Ohio, at rkm 29. Constructed in 1911, the Ballville Dam restricts walleye upstream passage and confines spawners to an area downstream that contains approximately one tenth of the suitable spawning habitat in the river (Cheng 2001). It is suspected that this has caused walleye to spawn in less suitable habitat within Sandusky Bay. In addition, channelization in the 1970’s to prevent flooding within Fremont is believed to have altered much of the available spawning habitat remaining. The changes to the flow velocity and resulting increased scouring may be reducing the overall quantity and quality of the accessible spawning habitat in the river.

Tagging data from the Ohio Department of Natural Resources (ODNR) suggest that the Sandusky stock stages in the Sandusky sub-basin of Lake Erie, near Huron, Ohio, during the fall (Ohio Division of Wildlife 2009). It is assumed that these walleyes remain near Huron until they migrate to Sandusky Bay and Sandusky River to spawn. A fall and

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early-winter recreational fishery has developed in response to this behavior, and it has been suggested that this fishery may subject this stock to additional exploitation.

Whether this congregation of walleyes is comprised exclusively of the Sandusky stock is unknown. To provide managers with the necessary information to manage the Sandusky stock, the ODNR Division of Wildlife undertook a project that would 1) determine the spawning destination of walleye tagged near Huron, Ohio during the preceding fall staging period; 2) identify spawning locations in Sandusky Bay and Sandusky River using radio telemetry; 3) examine timing of entry, including possible environmental cues (temperature, photo period, and river discharge); 4) determine if river-spawning fish are being impeded by the Ballville Dam or if they are spawning on the first available suitable substrate; and 5) determine the rate of successive spawning for walleye from the Sandusky walleye stock.

METHODS

Radio telemetry has been successfully used to examine movement patterns and identify spawning locations and habitat of many fish, including walleye (Pitlo 1989; Winter 1996). Mature walleye were implanted during 21-30 November 2005 near Huron, Ohio, and during 10-30 March 2006 in Sandusky Bay (n=8 and 42, respectively; Table 1). One mature female walleye and 7 mature walleye of undetermined sex were implanted off of Huron; 34 females and 8 males were implanted in Sandusky Bay. Walleye were captured once weekly in an effort to include fish from throughout the spawning run. Fish were collected using a suite of gears, including gillnets, commercial fishing seines, and electrofishing. Walleye were transported to shore and held in an

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aerated tank prior to surgery. Fish were not anesthetized to reduce handling and recovery time. Total length (mm) and sex (if possible) was recorded prior to transmitter implantation. Fish selected for radio transmitter implantation were placed on their dorsum in a v-shaped holding tray. Gills were hydrated during implantation to reduce damage from cold air temperatures. Lotek coded radio transmitters (Lotek Wireless Inc. model # MCFT-3A) were selected for their small size (16mm diameter, 46mm length, 16g dry weight) and relatively long operational life estimates (641 days with 5s ping rate). Transmitters were implanted using the shielded needle technique (Ross 1981). Stainless steel surgical staples were used to close all incisions to reduce handling time and infection (Swanberg et al. 1999). In addition to the transmitter, each walleye received a PIT tag in the event of transmitter loss. Surgery times were recorded. All surgical equipment was sterilized in a betadine and saline solution between each surgery. Implanted fish were released shortly after implantation, once equilibrium was reached.

On April 8th, 2008, an additional eleven walleye (8 females and 3 males) were collected from the spawning grounds in the Sandusky River in Fremont and implanted with transmitters (Table 1). Six of the transmitters were recovered by DOW staff, sport and commercial fishermen; the remaining five were donated by the USFWS office in Waterford, Michigan. These fish were used to examine river spawning behavior of fish from the Sandusky stock. Fish were collected using electrofishing, and other methods as described above. No PIT tags were placed in these fish.

Fish were located using a combination of mobile and fixed tracking stations. Mobile tracking via boat, airplane, and on foot was used to determine the location of fish within the Sandusky system. Mobile tracking was conducted weekly as weather
permitted, beginning post-ice and continuing until all transmitted walleye returned to Lake Erie. A systematic grid, with transects spaced at equal 1-km intervals, was used to track in Sandusky Bay, while the Sandusky River channel was flown, boated, and walked to collect river positions (Figure 3). Fish locations were recorded on a Global Positioning System (GPS) for later examination. In addition to mobile tracking, fixed station radio receivers were placed at three locations: one at a constriction in Sandusky Bay on the north Bay Bridge fishing access (BBN), one at the mouth of the Sandusky River at the Ottawa Shooting Club (OSC), and one downstream of known spawning grounds in the Sandusky River at the City of Fremont’s Wastewater Treatment Plant (FWW). Fixed station receivers continuously recorded presence/absence of radio tagged fish from February through May. Station data was downloaded every 1-2 weeks during this period.

In 2008, researchers from the Ohio State University Aquatic Ecology Laboratory collected location information for this project as part of an intensive telemetry project designed to further address walleye spawning habitat use and availability in the Sandusky system. Additional fixed stations were deployed to improve coverage of key areas in the system (Figure 4). Further information regarding the OSU project can be found at Thompson (2009).

ArcGIS (ESRI, Redlands, CA) was used to calculate minimum distance from shore (bay-spawning fish) and minimum distance to known spawning habitat (river-spawning fish). Temperature loggers were placed in the Sandusky River and Bay during 2007 (March 16 – May 1), 2008 (March 27 – May 1), and 2009 (March 1 – May 1; river only) to examine timing of spawning activity. Discharge data from the USGS gauging

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station on the Sandusky River and moon phase data were examined for correlation to spawning activity. River discharge and minimum distance from shore (bay walleye) were log$_{10}$ transformed prior to analysis to normalize the distribution of the data. Distance to known river spawning areas and distance from shore were investigated using mixed model analysis of variance (PROC MIXED in SAS; Littell et al. 1996) and simple linear regression, with sex, river discharge, water temperature, moon phase (Full, Waning, Waxing, and New), year, and week (March-May) as effects.

**RESULTS**

Fifty of sixty one implanted walleye were located a total of 314 times between 2006 and 2009 (82%). Twenty-eight of the fifty were located during multiple years (56%); only four of these were not located in consecutive years (14%). Seventeen of the fifty walleye were located in the Sandusky River at or near the known spawning grounds (34%); however, this includes the eleven walleye implanted in 2008. Only six of the 39 walleye implanted in 2005 and 2006 that were located subsequent to tagging spawned in the river (15%). The majority of walleye located remained in Sandusky Bay and have been identified as bay-spawning walleye. Walleye were first located in the Sandusky system in mid-March during all years but 2008 (OSU collected data, with a late start due to tagging activities associated with their telemetry project), and left the system by early-May every year but 2009 (Table 2). Regardless of year, the number of transmitted walleyes spawning in the bay peaked during the first week of April (31% of total bay locations); river-spawners peaked the second week of April (34% of total river locations).

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Of the eight fish implanted off of Huron, four fish were located within the Sandusky system during the course of the study (Table 3). Only one Huron fish was located in the spawning grounds near Fremont, Ohio, during the study; however, it was the only fish of the 61 tagged to be located during each year of the study. One Huron fish was first located in 2008, then again in 2009, in bay spawning habitat. In addition to the four Huron fish located during the study, two fish were captured outside the study area. One was captured by a commercial fisherman in Ontario waters on 6 November 2006. The other was caught by a sport fisherman on 30 April 2007 from the spawning reef complex near Turtle Creek, Ohio. The remaining two fish, including the one documented female walleye, were never located during the study.

Of the 42 fish implanted in Sandusky Bay during 2006, 33 walleyes were located 202 times during spawning in the Sandusky system from 2006-2009 (Table 4). Fixed receiving stations provided more locations than mobile tracking each year but 2008, when OSU researchers were unable to locate any fish from this study except by mobile tracking. Considering the large area of the bay, it is not surprising that mobile tracking was less effective than fixed station tracking during most years due to the fact that fixed stations were placed at key points where the Sandusky system narrows.

All of the eleven walleye implanted in the Sandusky River on 11 April 2008 were located 25 times before they left the system that year. Fish began to disperse downstream of the spawning grounds shortly after being implanted, suggesting either a tagging effect or that the spawning season was ending. Seven of the eight females tagged were post-spawn when they were captured, suggesting the latter. Seven walleye (2 males, 5

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females) were located 48 times in 2009; only five of the seven returned to Fremont to spawn. The other two walleye were located only in the bay at the BBN and BBS stations.

Male distance to known river-spawning areas were significantly greater during the final week of March (mean = 34.6 ± 13.3 km) than during the second week of April (mean = 1.4 ± 1.5 km; n = 23, P = 0.0440, F = 2.92, R² = 0.462). Regression analysis of distance to known spawning areas for males was negatively correlated to river discharge (n = 23, P = 0.0186, F=6.51, R² = 0.2366; Figure 5). River water temperature and moon phase had no significant effect on distance to known spawning locations for male river walleyes, and no environmental effects were present for river-spawning females.

Bay-spawning females were located significantly further from shore when the moon was waning (mean = 581.7 ± 316.3 m) than during the full (178.9 ± 127.7 m), new (152.7 ± 129 m), and waxing (93.7 ± 71.1 m) moon phases (n = 160, P < 0.0001, F = 10.91, R² = 0.1734; Figure 6). Female distance from shore differed significantly through the spawn (P = 0.0009, F = 3.73, R² = 0.1466), with locations further offshore during week 9 than during weeks 2, 3, and 7. Based on the number of locations per week, bay spawning appears to peak in week 5 (29 March – 4 April; n = 59); however, number of bay spawning walleye locations remain relatively high through 18 April. Bay water temperature and river discharge had no effect on walleye distance from shore, nor were any effects present for moon phase or week on male distance from shore.

Since 2006, twelve transmitters from implanted walleye have been recovered (Figure 7). Two were recovered from expired fish within Sandusky Bay during mobile tracking activities in May 2006. Six transmitters were returned by sport anglers; one in the Sandusky River during the spawning season (9 April 2006), three in Ohio waters of

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the western and central basins (2006, 2007, and 2009), and two from New York waters of the eastern basin (2006 and 2009). The remaining four transmitters were recovered by commercial fishermen in Ontario waters of Lake Erie (two in 2006; one each in 2008 and 2009). Six of the returned transmitters were re-deployed into new fish in 2008 (see above); the others were either returned damaged or after 11 April 2008.

**DISCUSSION**

Half of the walleye tagged if the fall staging area off of Huron, Ohio (4 of 8), were located in the Sandusky system during the course of the study. Of the four remaining, none were located during the study until two were captured by fishermen and their transmitters returned. Both transmitters were functioning normally after their return (Figure 7), suggesting that these fish never entered the Sandusky system. Although the sample size is very low, it does suggest that the staging area consists of fish from multiple stocks, particularly when one of the returned transmitters came from a flowing male caught by a sport fisherman in the reef complex during peak spawning. In addition, there is evidence to suggest that multiple stocks may be using a portion of Sandusky Bay as a staging area prior to migrating to the western basin reef complex. Seven walleye from our study (17%) and 86 walleye from the Ohio State University project (43%) that were captured from locations at or near the mouth of the bay were never located during tracking (Thompson 2009). During reconnaissance flights in 2008, two fish from the OSU study were located around the islands during peak spawning activity suggesting that other spawning stocks may use the bay environment as a specific resource for pre-spawn

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walleye (i.e. food, temperature), or it may just reflect wandering migratory behavior of walleye.

This study indicates that the river-spawning portion of the Sandusky walleye stock is currently minor compared to the bay-spawning portion of the stock. This result is somewhat surprising; we had anticipated a much larger proportion of the tagged walleye would spawn in the river. However, this did give us an opportunity to identify areas within the bay that may provide some suitable spawning habitat (Figure 8). Bay spawning walleye appear to congregate in areas along the north shore of Sandusky Bay, as well as around the Edison and railroad bridges in the middle of the bay. These areas have higher abundances of available gravel and rocky substrates, both naturally occurring and in the form of shoreline protection structures, such as rip-rap and break waters. This correlates with the findings of Thompson (2009), and will help us direct additional habitat sampling in the future. Walleye spawning in the river were located in or near the historic spawning grounds in Fremont; no new river spawning areas were identified during this study.

Spawning activity in the Sandusky system appears to peak during the first two weeks of April, with the bay peaking the week prior to the river. This is similar to what other researchers have found in the Sandusky River (Van Tassell, pers. comm.; ODNR unpublished data), and this pattern appears to be independent of most environmental cues. Walleye spawning can be influenced by moon phase and river discharge, although neither are universal to all sexes and spawning areas.

River-spawning walleye do not ascend far enough upstream to be impeded by the Ballville Dam. At no time during our study did we locate a walleye further upstream.
than Rodger Young Park in the City of Fremont, a location 2.5 km downstream from the dam. During 2008 and 2009, a receiving station was placed at the dam by researchers from Ohio State University; no fish from either study were ever recorded at that station (Thompson 2009). Walleye appear to prefer spawning in the lower portions of the Sandusky River’s available habitat. This implies that dam removal alone may not be sufficient to restore spawning activity to the reach above the Ballville Dam and managers may need to facilitate the transport of walleye until they adapt to the improved access to upstream spawning habitat.

Not all walleye appear to spawn in the Sandusky system in successive years. Fourteen percent (4 of 28) of the walleye located in multiple years were not found in successive years, providing some evidence for skip-spawning behavior. However, these results are somewhat inconclusive because 1) those individuals may have spawned elsewhere, either in another ‘stock’ or in the eastern-most portion of the bay where monitoring was less intense, or 2) annual variations in tracking/station efficiency failed to document fish presence. For example, one of the four walleye located in non-consecutive years was located in 2006 and 2007, and then in 2009. In 2008, tracking was compromised by weather and equipment problems.

What is more interesting than the possibility of skip-spawning behavior in the Sandusky walleye stock is the evidence that some walleye switch between spawning in the bay and spawning in the river. In 2006, one walleye was recorded on the OSC station at the mouth of the Sandusky River, but was never located upstream during mobile tracking or at the FWW station. All other locations in 2006 and 2007 were in the bay. The fish was not located in 2008, but was located twice at the Fremont station in the

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River in 2009. Two fish that were implanted in 2008 in the river were only located at the bay stations in 2009. These fish appear to choose between bay and river spawning habitats, possibly influenced by river spawning habitat saturation, river discharge or water temperature, or by other unknown physical or chemical cues. While representing only 6% of the individuals located during this study, this flexibility in spawning behavior is somewhat contrary to that suggested by Jennings et al. (1996), who suggested walleye inherit spawning habitat preferences.

**RECOMMENDATIONS**

Relatively little is known about bay-spawning walleye as opposed to river-spawning walleye in this stock. First, development of a Sandusky stock population assessment tool to include both river and bay spawning walleye should be encouraged; walleye tagging in the bay, which was dropped in 2005, should be reinitiated, particularly from commercial seining operations in the eastern portion of the bay. In addition, technologies such as hydroacoustic and Didson surveys could be deployed in several strategic locations in both the bay and river to estimate fish passage. Second, the relative contribution of river and bay spawning walleye to Sandusky stock recruitment is unknown. Our telemetry data suggest that a higher percentage of the Sandusky walleye stock remain in, and presumably spawn in, the bay itself, as opposed to migrating up the Sandusky River to the historic spawning grounds. However, it is possible that, despite having a lower relative proportion of spawning adults, due to higher quality spawning habitat, the river portion of the stock may produce more viable offspring than the bay portion. Conversely, the relative value of spawning habitat quality in the river versus the

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apparently higher numbers of spawning adults in the bay may serve to equalize contributions from both groups. In addition, annual biotic and abiotic factors that influence recruitment may have differential effects on the offspring of river and bay walleye, allowing recruitment from one source while the other fails to recruit. Larval fish collections from the river and bay could address the question of relative contribution, especially if genetic markers can be found to differentiate between river and bay walleye. Genetic work may also be able to address the amount of spawning site flexibility between bay and river spawning walleye. Third, additional work evaluating the abundance and relative quality of spawning habitat within Sandusky Bay should be undertaken. Thompson (2009) collected side-scan substrate information from the bay, and reported a 92% reduction in spawning habitat from substrate data collected in 1872 and 1905, as mediated by the changes in land use in the watershed and high levels of silt deposition in the bay. Future efforts to conserve the bay-spawning portion of the Sandusky stock should focus on further identification and rehabilitation of historic spawning areas in the bay.

*This work was completed under Federal Aid in Sport Fish Restoration Project F-69-P, Fish Management in Ohio, Study FSDR21*
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Thompson, A. 2009. Walleye habitat use, spawning behavior, and egg deposition in Sandusky Bay, Lake Erie. Master’s thesis. The Ohio State University, Columbus, Ohio, USA.


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Table 1. Location, year, sex, mean total length (TL), and number of walleye implanted with radio transmitters from December 2005 through April 2008.

<table>
<thead>
<tr>
<th>Tagging Location</th>
<th>Year</th>
<th>Sex</th>
<th>TL (mm)</th>
<th>Number Tagged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Woman Creek</td>
<td>2005</td>
<td>F</td>
<td>721</td>
<td>1</td>
</tr>
<tr>
<td>Old Woman Creek</td>
<td>2005</td>
<td>U</td>
<td>571.8</td>
<td>7</td>
</tr>
<tr>
<td>Sandusky Bay</td>
<td>2006</td>
<td>F</td>
<td>684.9</td>
<td>34</td>
</tr>
<tr>
<td>Sandusky Bay</td>
<td>2006</td>
<td>M</td>
<td>590.1</td>
<td>8</td>
</tr>
<tr>
<td>Sandusky River</td>
<td>2008</td>
<td>F</td>
<td>621.5</td>
<td>8</td>
</tr>
<tr>
<td>Sandusky River</td>
<td>2008</td>
<td>M</td>
<td>566.7</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2. Date of first and last locations of transmitter-bearing walleye from 2006-2009.

<table>
<thead>
<tr>
<th>Year</th>
<th>1(^{st}) Location</th>
<th>Last Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>March 9th</td>
<td>April 17th</td>
</tr>
<tr>
<td>2007</td>
<td>March 14th</td>
<td>April 22nd</td>
</tr>
<tr>
<td>2008</td>
<td>March 31st</td>
<td>May 1st</td>
</tr>
<tr>
<td>2009</td>
<td>March 11th</td>
<td>May 20th</td>
</tr>
</tbody>
</table>

Table 3. Annual number of individual Huron-tagged walleye located in the Sandusky system 2006-2009, including total locations by source. All located fish were of undetermined sex.

<table>
<thead>
<tr>
<th>Year</th>
<th># of Walleye</th>
<th>Bay : River Spawning</th>
<th>Number of Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mobile Tracking</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>2:1</td>
<td>4</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
<td>1:1</td>
<td>2</td>
</tr>
<tr>
<td>2008</td>
<td>2</td>
<td>1:1</td>
<td>3</td>
</tr>
<tr>
<td>2009</td>
<td>2</td>
<td>1:1</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^{a}\)This work was completed under Federal Aid in Sport Fish Restoration Project F-69-P, Fish Management in Ohio, Study FSDR21
Table 4. Distribution of male (M) and female (F) bay-tagged walleye in the Sandusky system and total annual locations.

<table>
<thead>
<tr>
<th>Year</th>
<th># Bay Spawning</th>
<th># River Spawning</th>
<th>Total Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M F</td>
<td>M F</td>
<td>Mobile Tracking</td>
</tr>
<tr>
<td>2006</td>
<td>3 24</td>
<td>1 2</td>
<td>41</td>
</tr>
<tr>
<td>2007</td>
<td>2 13</td>
<td>0 0</td>
<td>11</td>
</tr>
<tr>
<td>2008</td>
<td>0 9</td>
<td>0 2</td>
<td>18</td>
</tr>
<tr>
<td>2009</td>
<td>0 3</td>
<td>0 1</td>
<td>0</td>
</tr>
</tbody>
</table>

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Figure 1. Map of western Lake Erie showing spring spawning locations of walleye. Managers use spawning locations to discriminate between major walleye stocks.
Figure 2. Estimated spring walleye harvest and targeted effort from the Sandusky River, 1975-2007.

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Figure 3. Mobile tracking transects and fixed receiving station locations, 2006-2007.

Figure 4. Locations of fixed receiving stations, 2008-2009.
Figure 5. Distance to spawning area for river-spawning male walleye as influenced by river discharge (c.f.s.).

Figure 6. Distance to shore for bay-spawning female walleye as influenced by moon phase.

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Figure 7. Re-capture location and source of returned radio transmitters, 2006-2009. The two Huron-tagged fish are noteworthy as they were never located within the Sandusky system during any tracking activities.

Figure 8. Potential walleye spawning locations in Sandusky Bay, Ohio, identified using radio telemetry, 2006-2009.

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