

Implementation of the Required Measures to Protect The Lake Erie Watersnake (LEWS)
During the Construction of the Middle Bass Island State Park Marina and Associated Infrastructure

**Ohio Department of Natural Resources,
Division of Wildlife
Lake Erie Watersnake Monitoring;
Use of Artificial Hibernacula**

Final Report

21 September 2009

Kristin Stanford
Department of Biological Sciences
Northern Illinois University
DeKalb, IL 60115

Background

In 2000, the Ohio Department of Natural Resources purchased 124 acres of property on Middle Bass Island with plans to develop a State Park. Beginning in 2003 and continuing through the present, ODNR has made preliminary advancements toward the clean-up and development on portions of this property. In order to minimize any impacts to the Lake Erie watersnake and its habitat, ODNR drafted "The Lake Erie Watersnake Habitat Management Plan for Middle Bass Island State Park (August, 2003)". As part of this agreement with the USFWS, ODNR consulted with Lake Erie watersnake researcher, Kristin Stanford, to ensure that the measures outlined in the plan are followed and that no Lake Erie watersnakes are harmed during the construction activities.

In October of 2007, major development began on the marina basin which spanned the duration of the 2008 season and was completed in early 2009. Significant construction activities included draining the existing marina basin, removal of the center peninsula and excavation and reinforcement of marina walls. In order to minimize the risk to Lake Erie watersnakes, ODNR implemented several preventative measures including construction of a snake barrier around the marina basin, relocation of all snakes found within the work area and on-site monitoring during intensive construction activities.

The following report summarizes the results of the research objectives that were proposed to evaluate the effectiveness of the artificial hibernacula that were constructed as a result of this project and to enhance our existing information regarding current LEWS habitat usage within the Middle Bass Island State Park.

(Objectives 1 & 3) Monitoring the natural and forced usage of artificial hibernacula by the Lake Erie watersnake at Middle Bass Island State Park.

Natural colonization of the Artificial Hibernacula by Lake Erie Watersnakes

Between 14–17 August 2006, two artificial hibernation structures were constructed on the Middle Bass State Park property within parcel F, just south of the existing marina (Figure 1). The MBISP hibernacula were modeled after similar structures built in southern New Jersey by other snake researchers, but with a few modifications (See description in Stanford 2007). The two artificial hibernation structures are approximately 25-30 feet apart at the site and were left open and unfenced during the fall of 2006 so that snakes could safely enter the structures during hibernation. In late October 2006, 3' tall silt fencing was erected around both hibernacula (Figure 2). Past LEWS studies indicate that most snakes reach their over-wintering site by this period of time (King 2003). The structures were left undisturbed until the following spring.

In early April of 2007, the hibernacula were visited to place two newly constructed snake traps along the fence to determine if snakes had utilized the structures. Unfortunately, the fence had been damaged over the winter from a large branch falling on a section. This was repaired without problem, however, the following week when the traps were being installed it was discovered that one entire end of the fence either had not been buried or had been inadvertently pulled up from the wind.

Consequently, one trap was placed, but never set due to the likelihood that any snakes that had been hibernating in the structure had already escaped under the pulled up fence. Temperatures the week before climbed into the 60's and several species of snakes had already been observed to be quite mobile. It was unfortunate that we could not determine if any adult snakes had naturally located and hibernated within the structures that first year, but it was not critical to the rest of the objectives of the research project. Furthermore, semi-natural colonization of the hibernacula was confirmed in early 2009, with the emergence of several translocated individuals that had not been forced (i.e. fenced) into using these structures (see discussion in next section).

Success of Forced Hibernation in Lake Erie Watersnakes

In September of 2007, a portion of fence was removed from one of the structures (Hibernacula 2) to allow snakes searching for over-wintering sites to enter. Additionally, the other hibernacula (Hibernacula 1) was completely enclosed with a snake barrier fence and 21 LEWS were artificially placed inside to test whether they would accept a new hibernation site (Table 1). During the process of enclosing the hibernacula, 2 neonate LEWS were discovered just outside the structure under a portion of the existing fence and were also placed inside the structure (Figure 3). In our previous telemetry study, we hypothesized that female LEWS may give birth some distance from shore as they make a large movement inland to hibernate in the fall (King 2003). Therefore, the finding of neonates was very promising evidence that adult female LEWS may have already naturally located the structures for hibernation.

Ten of the animals that were artificially placed inside the hibernacula were adults removed from the peninsula on MBI (8 females and 2 males). Ten juvenile snakes (8 females and 2 males) which were removed earlier in the year from inside the ODW aquatic resource center on South Bass Island were also relocated to the hibernacula since they had already been kept in captivity for several months for experimentation (Table 1). These snakes were found as neonates early in the spring (May 5) hibernating in a mass of approximately 30-40 individuals, and were subsequently held and cared for during the summer for digestive rate experimentation.

All of the animals placed in the hibernacula were individually marked with a PIT tag for future identification (except for the 2 neonates naturally found under a portion of the fence). One animal (Female LEWS ID# 3533, Freq. 971 from Gibraltar Island) was also placed within the hibernacula in order to monitor at least one animal within the structure via radio telemetry. Multiple attempts were made to capture and place one of the MBI telemetered animals into the hibernacula, but they were unfortunately not available for capture. Female 971 was being held in the laboratory temporarily to keep her from harms way in another construction project on Gibraltar Island. Since no telemetered animals from MBI were able to be relocated as planned, it was decided that her displacement into the hibernacula would suit the same goals for this objective. She was placed into hibernacula 1 along with the 20 other animals on 12 October 2007.

Visual inspection of the artificial hibernacula occurred on several occasions the week following the initial release and no animals were seen on the surface, despite warm ambient temperatures. This was an initial sign that the LEWS had accepted the new structure for hibernation. A later radio-telemetry check also confirmed that the

telemetered female was inside the hibernacula on November 13, which was the last time she was relocated in 2007.

In early April of 2008, the snake traps were re-installed along the interior of the snake fence to trap animals exiting the hibernacula (Figure 4). Cover objects (extra pieces of black silt fencing) were also placed on the interior of the barrier fence to facilitate additional captures. At this same time, the telemetered female was immediately relocated to confirm that she did indeed hibernate inside the artificial hibernacula. She was relocated on 8 April 2008 and 15 April 2008 and was confirmed to still be within hibernacula 1 which she was released in. On 18 April 2008, she was recorded approximately 20 m adjacent to her last location, within hibernacula 2. On 21 April 2008, she was captured in good health (995 mm SVL, 538 g) as she was exiting one of the entrances in hibernacula 2 (Figure 5). It is unknown whether this female emerged from hibernacula 1 and was able to get over the barrier fence, or whether both structures are connected by a subterranean rock fissure.

Regardless, the capture of this female confirmed that she was able to successfully hibernate within the artificial hibernation structure. On the same day, an additional male (PIT# 494B455769) was found killed inside the enclosed hibernacula (Figure 6). This was determined to be human caused mortality, as the snake's head appeared to be purposely smashed by a rock or foot. The animal was collected and measured and found to be in good condition (730 mm SVL, 221 g). Although this animal's death was unfortunate, the fact that he also successfully hibernated and emerged in the spring was another recorded success for the artificial hibernacula.

Monitoring of the artificial hibernacula continued through July of 2008 and confirmed the additional successful hibernation of several other of the transplanted LEWS as well as two additional unmarked neonate LEWS, an Eastern Gartersnake (*Thamnophis sirtalis*) and a young Eastern Foxsnake (*Pantherophis gloydi*) (Table 2). Although not all individuals were accounted for, the artificial hibernacula were deemed suitable for further use in the marina development project due to all age/size classes of LEWS successfully emerging from hibernation. Of the 21 snakes that were forced to hibernate within the structures, 10 emerged successfully and have been seen again (Table 1). It is also noteworthy to mention that several adult translocated snakes moved from the basin area in late 2008 were captured emerging from the artificial hibernacula in spring of 2009 (Table 2), further confirming the structures' successful usage by Lake Erie watersnakes that may have lost access to their previous hibernation areas. Additionally, several neonates and an unmarked juvenile were also found under the fencing near the hibernacula indicating that natural colonization had also occurred. It may be useful to continue to monitor further colonization over the next few years to document the success of the hibernacula.

(Objective 2) Characterization of habitat usage and hibernation areas of Lake Erie watersnakes residing within the marina area using radio-telemetry and mark-recapture.

Mark-Recapture Population Monitoring

During 2006, a total of 67 Lake Erie Watersnakes were captured within the Middle Bass State Park Property, 13 of which were recaptures. Attempts to catch LEWS

within the Roesch Marina property were not as successful as planned resulting in no adult LEWS captures. However, in 2007 10 cover objects (large 5' x 5' mats) were placed in select locations in an attempt to increase the number of animals captured (Figure 7). Subsequently, the number of LEWS captured at the MBISP increased from 67 snakes captured in 2006 to 222 total captures, 77 of which were recaptures in 2007. This is a significant increase from the previous year, largely due to the success of the cover mats.

In spring of 2008, the ODNR implemented several preventative measures including the construction of a large-scale exclusion barrier (2875 linear feet (0.88 km)) of silt fencing buried 6 inches and extending 3 vertical feet) around the construction site to minimize potential impacts to the local population of Lake Erie watersnakes residing within the Middle Bass State Park Marina Basin during development (Figure 8). LEWS were captured within the basin area via hand-capture, cover boards, floating minnow traps and funnel traps attached to the silt fence. Animals were measured, weighed and implanted with a PIT tag before being relocated to the old boathouse site approximately 0.5 km from the construction area.

From 5 May through 21 October 2008, a total of 226 individual adult Lake Erie watersnakes were moved from the marina basin to the relocation site (Figure 9, Table 3). A subset of these animals (N=58) required multiple relocations, some as many as 4 times, indicating that site fidelity can be extreme in this species (Table 3). Chi-square showed no differences between the number of males and females initially relocated from the site or the number of males and females that required multiple relocations (Table 3). An additional 13 adult LEWS were unintentionally killed as a result of construction activities (Table 4). The actual number of adult LEWS recorded and removed from within the marina basin area was 239 individuals.

Formal population estimates for the entire Middle Bass State Park property can be found in the 2009 LEWS annual report to the Division of Wildlife (King and Stanford 2009). Between 2006 and 2008, estimates ranged from 410 -590 snakes and include captures from the all locations within State Park property (Marina Basin, Boathouse, Lonz Shoreline and Southeast Shoreline of MBI). Since the basin property is roughly 50% of the total MBISP property surveyed, the removal of 239 adults (or roughly 50% of the adult LEWS population estimate) during 2008 suggests these estimates are fairly accurate.

Characterization of Hibernation Areas Within the Marina Basin

In May of 2006, 10 adult Lake Erie watersnakes (5 males and 5 females) were implanted with Holohill transmitters. In July of 2007, additional snakes were implanted with transmitters, one from Middle Bass State Park (see description below) and two others from Gibraltar Island (to serve as control snakes). Snakes were released a few days following surgery and were subsequently relocated as frequently as possible through 2008. Several undergraduate students assisted in the collection of radio-telemetry data (Table 5) under the supervision of the PI, Kristin Stanford.

Snakes were relocated from April through October and maps of their locations throughout the active season were created. (See Figures 7 - 14 in Stanford 2008). Home range sizes (MCP) were calculated for each year (2006 and 2007) and ranged in size from 0.036 – 23.96 acres (Table 3, Figure 15 in Stanford 2008). Both males and

females were found to have a significant relationship between body size and home range size in 2006, however, reanalysis in 2007 found that only males maintained this significant relationship. Male snakes had a significant negative relationship ($F_{1,4} = 12.64$, $P = 0.038$, $r^2 = 0.81$; Figure 15 bottom graph in Stanford 2008) while females had positive, but non-significant, relationship ($F_{1,7} = 1.92$, $P = 0.215$, $r^2 = 0.24$; Figure 15 top graph in Stanford 2008). Although sample size is still relatively low, this observation is extremely interesting and warrants a more in depth investigation on this relationship, perhaps revisiting the telemetry data from previous years. In 2008, only a few relocations were made on the animals remaining in the study and none of these were outside the already documented home ranges. Therefore, we did not recalculate home range or reanalyze the relationship between body size and home range size in 2008.

In late October 2007, male 097 was located in a crayfish or animal burrow adjacent to the large cottonwood tree at the base of the peninsula (Figures 16 and 17 in Stanford 2008). This site was different than where this male had previously hibernated in 2006, and was also within a previously identified hibernation area for LEWS in an earlier telemetry study (King 2003). In early April of 2008, this male was found basking at the end of the peninsula near his 2006 hibernation site. Therefore, we were unable to confirm that he did hibernate in the crayfish burrow or alternatively moved to the previous 2006 hibernation site late in the season. Additionally in April of 2008, this male was translocated from the peninsula along with male 021 (due to the pending construction activity). They were placed inside the artificial hibernacula to ensure they could escape cold spring temperatures. Male 097 quickly managed to escape and make his way back to the marina basin within a few days. Unfortunately, the transmitters' signal failed later that month and he was never seen or captured again. His last location was on 23 April 2008 behind the sheet steel at the tip of the peninsula. Male 021 also possibly escaped the hibernacula, but was unfortunately found predated five days after being relocated (Figure 10). It is unknown whether this male escaped on his own (as 097 did) or whether he was killed inside the fenced structure and removed by raccoons. Significant raccoon activity and damage within the hibernacula was documented in 2008. In future studies, additional predator trapping may be warranted to ensure the safety of vulnerable emerging snakes.

In July of 2007, an additional female LEWS was implanted with a radio-transmitter to increase the number of female snakes in the study. From the time she was released, this female proved exceedingly difficult to track. After being released at the marina entrance, where she was originally located, she moved North past the Hazards crib dock and break wall area that several of the other female telemetered snakes had utilized in 2006 (See Stanford 2007) and was located several times basking in a brush pile. She never returned to the marina area. Sometime in early to mid September, presumably after she had given birth, her signal was lost. In early October 2007, a faint signal was finally located, but was not possible to pin point due to extremely dense vegetation. We attempted to locate her signal several times in early 2008, but were unsuccessful. We do think that she hibernated well away from the marina basin area and therefore would not have lost her hibernacula (Figure 18 in Stanford 2008). This finding also indicated that there were likely other snakes that used the marina within their home range, but had hibernation sites outside of the basin area that were not disturbed by construction activities.

The final fates of the 11 telemetered snakes monitored at the Middle Bass State Park from 2006 – 2008 are summarized in Table 6. Additionally, documented locations of their hibernation sites are summarized in Figure 11. Unfortunately, all 11 animals within the original study either died, or had transmitter failure by early Spring 2008 and did not allow for follow-up monitoring of displaced resident individuals during construction. Radio-telemetry of 6 additional translocated individuals was conducted during 2008, but also proved difficult. Two of these animals (both large adult females) suffered early predation (Figure 12, Table 6: Female 0C5E carcass and transmitter recovered and Female 1163 transmitter recovered). Other snakes were presumed dead after not moving for more than one month (Table 5, Female 3E39; Male 2175). The last male snake (4E37) emerged in early April 2009 from hibernation with visible damage to the transmitter (antenna pulled out). He was collected and brought into the lab so that a repair surgery could be scheduled. Unfortunately, this male died in captivity one week later presumably from an infection at the damaged surgical site even though, no visible signs were present (no puss, swelling or oozing). The recovery of the bare transmitter and the non-movements of two of the snakes are somewhat inconclusive since some researchers have found that animals can pass transmitters (e.g. Pearson and Shine 2002). However, to date, none of the aforementioned animals have been seen since July of 2008.

Conclusions

The intensive mark-recapture monitoring from 2006 – 2008 at the Middle Bass Island State Park provided more accurate baseline Lake Erie watersnake population size estimates necessary to assess future impacts to the population from construction activities. Since 2006, the numbers of adults marked have steadily increased from 65 in 2006, to 160 in 2007 and finally to 291 individuals in 2008. Population estimates from these captures ranged from 410 – 590 adult animals (See King and Stanford 2009) and were markedly higher than estimates generated in 2005 (see Table 2 and 3 in King and Stanford 2009). The capture and relocation of 226 individual animals from the marina basin in 2008 equates to roughly 50% of the estimate and provides reasonable evidence that they are accurate. Following construction and park development, intensive monitoring of this property should continue to assess long-term population effects.

Radio-telemetry results from the animals monitored from 2006 - 2008 showed that many Lake Erie watersnakes were utilizing the peninsula for both summer active season habitat as well as hibernation (See Figures 12 - 21 in Stanford 2007 and Figures 7-12 in Stanford 2008). This finding confirmed that the loss of the peninsula during marina development would destroy current Lake Erie watersnake hibernacula and justified the construction of the two artificial hibernation structures. Telemetry also showed that several animals which utilized the marina in the Spring also heavily occupied the property adjacent to the North (Hazards) during the summer months (e.g. Figure 10 in Stanford 2008). This finding suggested that some animals excluded from the marina basin area may not have been as adversely impacted as others. It also

provided some evidence that the animals displaced would have additional areas, besides the relocation site, to reside during the construction.

Construction and monitoring of the artificial hibernacula was fairly successful over the duration of the project. Damages incurred to the snake barrier fence during the first year prevented us from determining whether any snakes had naturally colonized the structures within that first season. However, subsequent monitoring found several small neonates near these structures suggesting that adult females are likely hibernating in the vicinity. Also, the presence of other species that were not directly part of this project suggest that animals have been able to find and utilize the structures on their own (Table 2). Significant raccoon activity and damage was also documented at the hibernacula, suggesting that future studies might also include predator trapping to ensure the safety of vulnerable emerging animals that may be trapped within the structure.

The experiment of forcing LEWS to hibernate within the artificial structure also proved successful. Of the 21 animals placed into the hibernacula, 10 have been seen again (Table 1). These animals range in size from large adults to juvenile snakes, indicating that the structures are useful for all size class and sexes. Most recently, several of the translocated animals from the marina were captured in Spring of 2009 emerging from the hibernacula (Table 2). This finding alone, demonstrates the usefulness and success of these structures in providing over-wintering habitat for animals that may have lost their hibernacula due to the construction activities in the park. In the coming years, it would be useful to further document the usage of these structures by Lake Erie watersnakes and other species within the park. Signage highlighting the construction of these structures and the findings from this study would be an ideal means to educate the public about the intensive efforts put forth by the ODNR toward Lake Erie watersnake conservation.

References

King, R.B. 2003. Hibernation, Seasonal Activity, Movement Patterns and Foraging Behavior of Adult Lake Erie Watersnakes (*Nerodia sipedon insularum*). Annual report to the USFWS and Ohio Division of Wildlife.

King, R.B. and K.M Stanford 2009. Population Persistence of Lake Erie Watersnakes. Annual report to the USFWS and Ohio Division of Wildlife.

Pearson, D.J. and R. Shine. 2002. Expulsion of interperitoneally-implanted radiotransmitters by Australian pythons. *Herpetological Review* 33:261-263.

Stanford, K.M. 2007. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Watersnake Monitoring; Use of Artificial Hibernacula. 2006 Annual Report.

Stanford, K. M. 2008. Ohio Department of Natural Resources, Division of Wildlife Lake Erie Watersnake Monitoring; Use of Artificial Hibernacula. 2007 Annual Report.



Figure 1. Location of the artificial hibernation structures on Middle Bass Island State Park property.



Figure 2. A snake barrier fence was erected around the hibernaculum to aid in the capture of animals emerging from the structures.

Table 1. Lake Erie watersnakes that were used to test whether animals could successfully hibernate in the artificial hibernacula (Objective 3). Age of animals is indicated by '1' for adults and '0' for juveniles. Snakes appearing in bold print were seen again the following spring.

<i>Date</i>	<i>Sex</i>	<i>Age</i>	<i>SVL(mm)</i>	<i>Mass(g)</i>	<i>Comments</i>
14-Sep-07	M	1	677	192.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	1020	596.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	845	378.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	0	563	91.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	1060	648.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	857	447.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	1035	596.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	818	314.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	F	1	860	398.0	MBI snake; held in lab and released into hibernacula on 10/12/07
14-Sep-07	M	1	732	296.0	MBI snake; held in lab and released into hibernacula on 10/12/07
27-Sep-07	F	0	272	10.2	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	263	10.0	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	276	12.9	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	323	17.0	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	277	11.2	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	265	10.9	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	M	0	275	11.3	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	M	0	280	12.8	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	257	8.8	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
27-Sep-07	F	0	220	6.7	Hatchery neonate; re-measured and released into hibernacula on 10/12/07
29-Aug-07	F	1	1015	738.0	Transmitter Female from Gibraltar; Held in lab and released into hibernacula on 10/12/07



Figure 3. The finding of neonate LEWS under the fencing during the fall of 2007 was a good sign that animals would utilize the structures.



Figure 4. Snake traps were installed along the fence to assist in capture animals once they had emerged from hibernation.



Figure 5. Telemetered Female (freq. 971) seen exiting one of the entrances of Hibernacula 2 on 21 April 2008.



Figure 6. Male (PIT# 494B455769) was found killed inside the enclosed hibernacula on 21 April 2008. This was determined to be human caused mortality, as the snake's head appeared to be purposely smashed by a rock or foot.

Table 2. All snakes that were recorded emerging from the artificial hibernacula between Spring of 2008 and Spring of 2009. Future monitoring of these structures is recommended to further document the extent of use by Lake Erie watersnakes as well as other species.

<i>Date</i>	<i>ID</i>	<i>PIT</i>	<i>Sex</i>	<i>SVL</i>	<i>Mass</i>	<i>Morph</i>	<i>Comment</i>
4/21/2008	R	494B455769	1	730	221	1	FOUND KILLED INSIDE; HEAD SMASHED
4/21/2008	R	452A463533	2	995	538	3	HIB 2; CAPTURED EMERGING FROM ENTRANCE; PHOTOS
4/23/2008	N	GARTER	2	501	63		IN TRAP - HIB 2
5/5/2008	R	494B18681D	2	270	9	3	HIB 1
5/5/2008	R	CLIP1	2	210	6.1	3	HIB 1
5/16/2008	N		1	190	4	2	UNDER BLACK FENCE HIB 1; CAUTERY MARK PLACED MID-BODY
5/27/2008	N		1	205	4	2	UNDER BLACK FENCE HIB 1; CAUTERY MARK PLACED MID-BODY
6/2/2008	R	474F762137	2	855	306	1	HIB 1
6/2/2008	R	494F294645	2	1070	542	1	HIB 1
6/2/2008	R	494A7E151F	1	288	9	2	HIB 1
6/2/2008	R	494C220728	2	281	9	2	HIB 1
7/2/2008	N	49662C5B41	2	425	29		HIB 1- FOX SNAKE
04/02/09	R	494F255O4E	1			3	NO MEASURE
05/05/09	R	4750000960	1	930	543	2	
05/05/09	R	494F013601	1	890	358	3	
05/05/09	R	494B0F1033	1	855	375	1	
05/05/09	R	494D275F15	1	915	392	1	
05/05/09	N	NEONATE	2	200	4.6	3	
5/28/2009	N	4B1E32361B	2	320	15.3	1	JUV
5/28/2009	N	NEONATE	2	197	5.2	3	
5/28/2009	N	NEONATE	1	200	4.8	2	
06/06/09	R		1				ADULT? Not sure which one on sheet.



Figure 7. Black pieces of conveyor belt placed along the shoreline were very productive for capturing animals at MBISP.



Figure 8. Aerial view of the Middle Bass State Park Marina Basin area during construction in 2008. The dotted yellow line highlights the area that was enclosed with a 3' tall snake barrier fence to exclude all snakes from the construction zone.

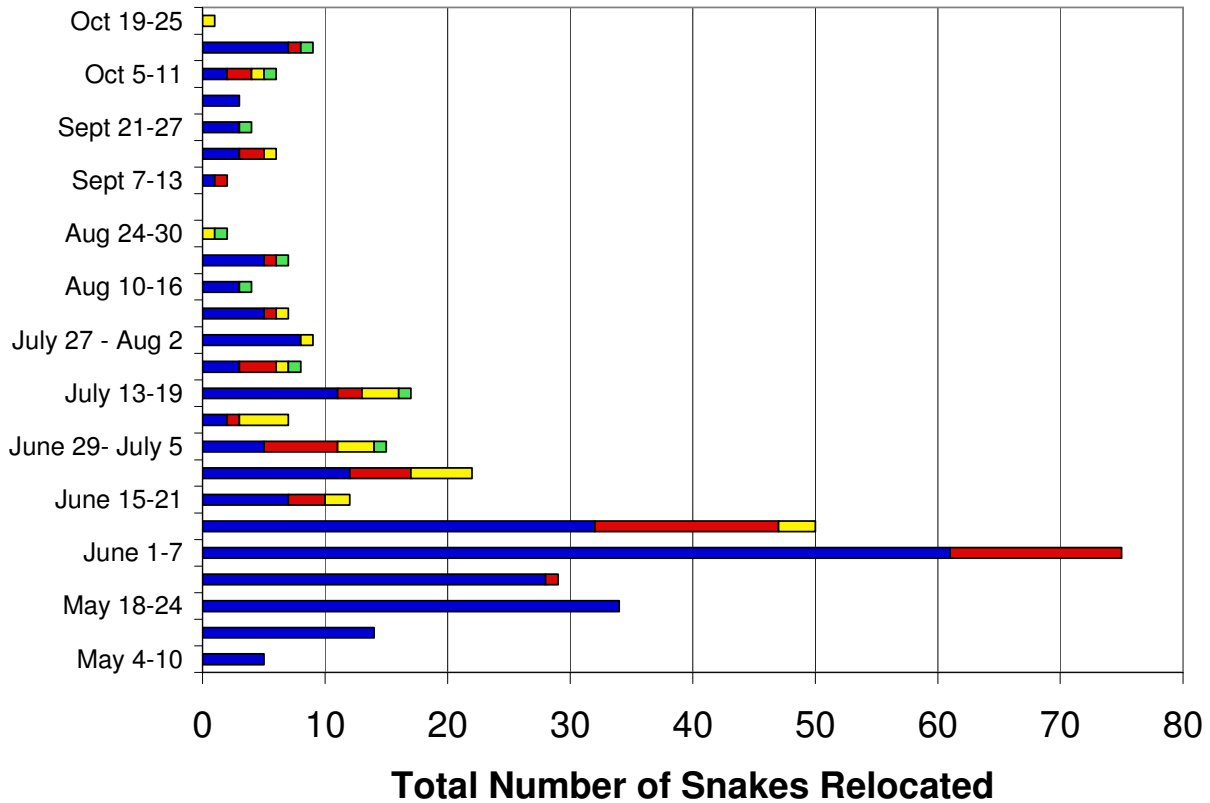


Figure 9. The total number of snakes relocated weekly from the site from May-October in 2008 shown as a function of the number of relocation attempts for each individual. Blue portions of the graph correspond to snakes being relocated for the first time, red corresponds to those being relocated twice, yellow a third time and green the fourth time. A total of 347 relocations were made during the 25 week period.

Table 3. The total number of snakes relocated from the MBISP marina site shown as function of the number of relocations required. Color coding corresponds with the above graph. Chi-square tests showed that there were no differences in the number of males and females requiring multiple relocations, indicating that site fidelity is equal between the sexes.

Number of Relocations	Males	Females	Total	Chi Square (X^2 (0.5, 1) = 3.841)
1	87	81	168	0.21
2	16	14	30	0.13
3	6	12	18	2.00
4	4	6	10	0.40
Total Number of Snakes Relocated	113	113	226	0.00

Table 4. Lake Erie watersnakes that were unintentionally killed during renovation of the Middle Bass Island State Park Marina.

<i>Date</i>	<i>ID</i>	<i>Age</i>	<i>Sex</i>	<i>SVL</i>	<i>Mass</i>	<i>Morph</i>	<i>Comments</i>
10/11/2007		1	1	640	136	2	killed during rock removal on east side south of entrance; consultant not present when activity occurred; Specimen #100
10/11/2007		0	2	374	34.6	1	killed during rock removal on east side south of entrance; consultant not present when activity occurred; Specimen #101
10/11/2007		0	?	Inc.	Inc.	3	1/2 neonate LEWS killed during rock removal on east side south of entrance; consultant not present when activity occurred; Specimen #102
5/23/2008		0	2	221	5	2	neonate killed during steel sheet removal at base of peninsula; consultant present; Specimen #103
6/6/2008		0	1	395	22.7	2	Raccoon death? Found half eaten along fence at NE corner of marina. Specimen #104
7/22/2008		1	1	605	133.4	2	killed during hibernacula excavation and rock removal at end of peninsula; consultants present. Specimen #105
7/7/2008	494C080C5E	1	2			1	transmitted female snake found predated at end of peninsula; Specimen #107
8/6/2008		1	2	1000	722	3	killed during brush pile removal outside snake fence on east side; consultant present. Specimen #108
8/6/2008		1	1	Inc.	Inc.	2	killed during brush pile removal outside snake fence on east side; consultant present. Specimen #109
8/6/2008		1	2?	Inc.	Inc.	1	killed during brush pile removal outside snake fence on east side; consultant present. Specimen #110
8/17/2008		1	1	630	126.6	1	killed during peninsula stone removal; consultant present. Specimen #111
8/17/2008		1	?	Inc.	Inc.	1	killed during peninsula stone removal; consultant present. Specimen #112
8/7/2008	466311151C	1	2	Inc.	Inc.	3	killed during peninsula stone removal; consultant present. Specimen #113
8/19/2008	474C685053	1	2	865	358	1	killed during peninsula removal; snake was found dead on the top of the peninsula and appeared to be run over by a truck; consultant on site, but not present at time of death. Specimen #115
7/22/2008		1	2	920	464	2	found dead on site, Possibly runover?; consultant on site, but not present at time of death. Specimen #116
5/24/2008		1	2	Inc.	Inc.		killed during bulldozing of peninsula; consultant on site, but not present at time of death. Specimen #117
5/28/2008		1	2	Inc.	Inc.		found dead (in pieces) in burn pit; consultant on site, but not present at time of death. Specimen #118
8/16/2008		1	1?	Inc.	Inc.	1	killed during peninsula stone removal; consultant present. Specimen #119

Table 5. Field workers who participated in data collection on Middle Bass Island and the dates they were involved with the project.

<i>Field Worker</i>	<i>Dates of Service</i>
Kristin Stanford, Research Supervisor	April 1 2006 - Present
April Sidoti, Research Assistant	June 19 2006 – August 19 2006
Brian Speer and Meg Crary, REU Students	June 19 2006 - July 20 2006
Amy Barrett, REU Student	July 21 2006 – August 19 2006
Tyler Lawson, Research Assistant	May 15 2007 – August 10 2007
Nikki Hoffsteter, Stone Lab Assistant	June 19 2007 – July 17 2007
Keith Hanson, Research Assistant	May 15 2008 – October 1 2008
Stephanie Bohlen, REU Student	June 20 2008 – August 20 2008
Melissa Cheung, REU Student	July 20 2008 – August 20 2008



Figure 10. Male 021 was found predated in the woods adjacent to the hibernacula. It is unknown whether he was killed while inside the fenced structure and removed by raccoons, or whether he escaped on his own and was subsequently killed.



Figure 11. Final hibernation locations within the Middle Bass Island State Park property documented in the 2006-2008 telemetry study.



Figure 12. Female 0C5E was found predated within the construction site only two weeks after being released.

Table 6. Lake Erie watersnakes that were monitored via radio-telemetry between 2006 – 2008 at the Middle Bass Island State Park. Shaded individuals were added to the study in 2008 and represent translocated individuals monitored during the construction.

Snake ID	Sex	Dates Monitored	Number of Relocations	Home Range (ha)	Fate
1A5F (151)	Female	5/17/2006 - 9/5/06	38	7.2	Presumed Dead; transmitter recovered 8/11/08
5336 (121)	Female	5/17/2006 - 4/15/08	56	1.3	Dead; overwinter mortality winter 2007; transmitter not recovered
7349 (201)	Female	5/17/2006 - 9/20/06	41	0.56	Presumed Dead; transmitter not recovered
5A33 (239)	Female	5/17/2006 - 9/12/06	25	2.7	Unknown; Transmitter Failed
4613 (169)	Female	5/17/2006 - 7/7/06	11	0.91	Dead; Euthanized 7/10/06
312D (062)	Male	5/17/2006 - 6/28/07	53	0.21	Dead; skeleton and transmitter recovered 7/22/08
2F21 (081)	Male	5/17/2006 - 8/29/08	37	0.38	Presumed Dead; transmitter not recovered
2E7B (097)	Male	5/17/2006 - 4/28/08	60	9.7	Unknown; transmitter failure on 4/28/08
5420 (021)	Male	5/30/2006 - 4/15/08	55	0.4	Predation; carcass and transmitter recovered
0B01 (042)	Male	5/30/2006 - 6/20/08	53	1.41	Dead; overwinter mortality in 2007; transmitter recovered 8/11/08
4731 (948)	Female	7/6/2007 - 4/23/08	4	None	Unknown; signal lost in fall 07
2175 (308)	Male	6/23/08 - 06/21/09	40	0.5	Dead?; Failed to emerge from hibernation; transmitter not recovered
2C1C (352)	Female	6/23/08 - 9/10/08	21	1.6	Unknown; Transmitter Failed
3E39 (371)	Female	6/23/08 - 10/20/08	35	6.2	Dead?; position same since August; transmitter not recovered
0C5E (388)	Female	6/23/08 - 7/7/08	7	None	Predation; transmitter and carcass recovered
4E37 (909)	Male	6/23/08 – 04/02/09	38	0.4	Dead; Emerged from hibernation in early April with noted damage to transmitter (antenna pulled out) and died in captivity one week later.
1163 (388)	Female	7/26/08 - 7/29/08	1	None	Predation?; Transmitter found on trail, but no carcass