

Post-Delisting Monitoring Plan
for the
Lake Erie Watersnake (*Nerodia sipedon insularum*)
on the
Offshore Islands of Western Lake Erie



Photo: Melissa Hathaway, Ohio DNR

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I. Introduction

Post-delisting monitoring (PDM) refers to activities undertaken to verify that a species delisted due to recovery remains secure from risk of extinction after the protections of the Endangered Species Act (ESA) no longer apply. One primary goal of PDM is to monitor the species to ensure the status does not deteriorate, and if a substantial decline in the species (numbers of individuals or populations) or an increase in threats is detected, to take measures to halt the decline so that re-listing it as a threatened or endangered species is not needed.

Section 4(g) of the ESA requires the U.S. Fish and Wildlife Service (Service) to implement a system in cooperation with the States to monitor for not less than five years the status of all species that have recovered and been removed from the list of threatened and endangered plants and animals (list). Section 4(g)(2) of the ESA directs the Service to make prompt use of its emergency listing authorities under section 4(b)(7) of the ESA to prevent a significant risk to the well-being of any recovered species. While not specifically mentioned in section 4(g) of the ESA, authorities to list species in accordance with the process prescribed in sections 4(b)(5) and 4(b)(6) may also be used to reinstate species on the list, if warranted.

The Service and States have latitude to determine the extent and intensity of PDM that is needed and appropriate. The ESA does not require the development of a formal PDM “plan.” However, the Service generally desires to follow a written planning document to provide for the effective implementation of section 4(g) by guiding collection and evaluation of pertinent information over the monitoring period and articulating the associated funding needs. Thus this document was prepared to describe the PDM plan for the Lake Erie Watersnake (*Nerodia sipedon insularum*). This PDM plan follows the *Post-Delisting Monitoring Plan Guidance Under the Endangered Species Act* (Services 2008; available on-line at <http://www.fws.gov/endangered>).

II. Background

The Lake Erie Watersnake is a subspecies of the Northern Watersnake (*N. sipedon sipedon*) that occurs primarily on the offshore islands of western Lake Erie in Ohio and Ontario, Canada, but also on a small portion of the U.S. mainland on the Catawba and Marblehead peninsulas of Ottawa County, Ohio (Conant and Clay 1937, p. 2; King 1986, p. 760). Lake Erie Watersnakes are uniformly gray or brown, and have either no banding pattern, or have blotches or banding that are either faded or reduced (Conant and Clay 1937, pp. 2-5; Camin and Ehrlich 1958, p. 504; King 1987, pp. 243-244). Female Lake Erie Watersnakes grow up to 1.1 meters (m) (3.5 feet (ft)), long, and are larger than males (King 1986, p. 762). Newborn Lake Erie Watersnakes are the size of a pencil, and are born during late summer or early fall (King 1986, p. 764).

Lake Erie Watersnake summer habitat is composed of rocky shorelines with limestone or dolomite shelves, ledges, or boulders for sunning and shelter. Shelter occurs in the form

of loose rocks, piled rocks, or shelves and ledges with cracks, crevices, and nearby vegetation. Rip-rap erosion control, armor stone, and docks incorporating a stone crib structure often serve as summer habitat for the snake. Lake Erie Watersnakes typically forage for fish and amphibians in Lake Erie, and recent research indicates that more than 90 percent of their current diet is composed of the nonnative, invasive fish round goby (*Neogobius melanostomus*) (King *et al.* 2006b, p. 110). Jones *et al.* (2009, p. 441) report that the mean foraging distance from shore was 85 m (279 ft), and the average water depth of the foraging locations was 3.32 m (10.9 ft). During the summer, 75 percent of Lake Erie Watersnakes are found within 13 m (42.7 ft) of the water's edge (King 2003, p. 4). King (2003, p. 4) identified that 75 percent of Lake Erie Watersnakes used 437 m (1433 ft) of shoreline or less as a home range. Individual snakes often demonstrate site fidelity, returning to the same shoreline area in successive years (King 2003, pp. 4, 11-17).

In the winter, Lake Erie Watersnakes hibernate below the frost level, in cracks or crevices in the bedrock, interstitial spaces of rocky substrates, tree roots, building foundations, and other similar natural and human-made structures. Seventy-five percent of Lake Erie Watersnakes hibernate within 69 m (226 ft) of the water's edge (King 2003, p. 4). Individual snakes often demonstrate site fidelity, returning to the same or nearby hibernacula in successive years (King 2003, pp. 4, 11-17).

Additional information on the Lake Erie Watersnake's life history and biology can be found in the final listing rule (64 FR 47126, August 30, 1999), Lake Erie Watersnake Recovery Plan (Service 2003, pp. 6-11), and the proposed delisting rule (available at: <http://www.fws.gov/endangered>).

The Service classified the Distinct Population Segment of "Lake Erie water snakes" on the Offshore Islands of Western Lake Erie as a threatened species on August 30, 1999 (64 FR 47126). The subspecies was listed primarily due to the threat of intentional human persecution, but also due to habitat destruction and modification, small population size, and restricted range.

On September 25, 2003, the Service announced the availability of an approved recovery plan for the Lake Erie Watersnake (68 FR 55411). In the recovery plan (Service 2003, p. G-19) we describe a revision to the common name from "Lake Erie water snake" to "Lake Erie Watersnake" per the peer-reviewed naming convention outlined in "Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding" (most recent version Crother 2008, p. 58). Subsequently, we refer to the subspecies as "Lake Erie Watersnake" in this and future documents.

Concurrent with this Post-delisting Monitoring Plan, we are removing the Lake Erie Watersnake from the List of Threatened and Endangered Wildlife due to recovery. The delisting rule is available at <http://www.fws.gov/endangered> or by calling our Ohio Ecological Services Office at 614-416-8993.

III. Brief summary of the roles of all cooperators in the PDM planning effort

This PDM plan was developed in cooperation with the Ohio Department of Natural Resources (ODNR) Division of Wildlife (Division of Wildlife), who has provided funding for much of the Lake Erie Watersnake research, population monitoring, and public outreach since the time of listing. Information on monitoring methods and cost estimates were provided by Lake Erie Watersnake principle investigator Dr. Richard King, Northern Illinois University, who developed the current adult Lake Erie Watersnake census protocol, and has generated annual population estimates and population growth calculations.

A. U.S. Fish and Wildlife Service

The Service has the statutory responsibility to ensure that effective post-delisting monitoring of the Lake Erie Watersnake is accomplished and to cooperate with the State of Ohio in so doing. The Service does not have sufficient resources available to conduct the necessary field work, data analysis, and reporting required for this PDM effort. The Service will work with our partners to seek funding opportunities through existing grant programs, such as, but not limited to, the Section 6 Endangered Species Cooperative Grant Program and the State Wildlife Grant Program. Both of these programs are administered by the Division of Wildlife and require competitive selection. Portions of the PDM work will probably best be accomplished through one or more funding agreements with a third party, for example a university research program or private consulting agency with the appropriate biological expertise. This document uses the term “contractor” to refer to any non-governmental organization that will be involved in PDM work.

Ultimately, the Service has the lead responsibility for this monitoring effort. Service staff will therefore maintain oversight of all activities undertaken as part of PDM. This will include interpreting the intent of the PDM plan, reviewing and commenting on draft reports, distributing final reports and other information to interested parties, approving and documenting any changes to the PDM plan, conducting any necessary future status reviews of the watersnake, and determining when PDM is complete.

B. Ohio Department of Natural Resources, Division of Wildlife

The ESA specifically requires the Service to cooperate with the Division of Wildlife in carrying out PDM. In May 2009, the Service contacted the Division of Wildlife seeking assistance in developing and implementing a PDM plan for the Lake Erie Watersnake. The Division of Wildlife was provided a copy of the Draft PDM plan to review during the public comment period. The Service will work with the Division of Wildlife to obtain adequate funding to support PDM activities.

IV. Summary of species' status at time of delisting

A. Demographic parameters

The historical range of the Lake Erie Watersnake includes the offshore islands of the western Lake Erie basin in the U.S. and Canada, as well as portions of the Catawba/Marblehead peninsula on the mainland of Ohio, though Federal threatened status applies only to those Lake Erie Watersnakes occurring on U.S. islands more than 1.6 km (1 mi) from the Ohio mainland (64 FR 47126, August 30, 1999). The U.S. islands and rock outcrops within the historical range include, but are not limited to, the islands called Kelleys, South Bass, Middle Bass, North Bass, Sugar, Rattlesnake, Green, Gibraltar, Starve, Gull, Ballast, Lost Ballast, West Sister, Mouse, and Johnson (Figure 1).

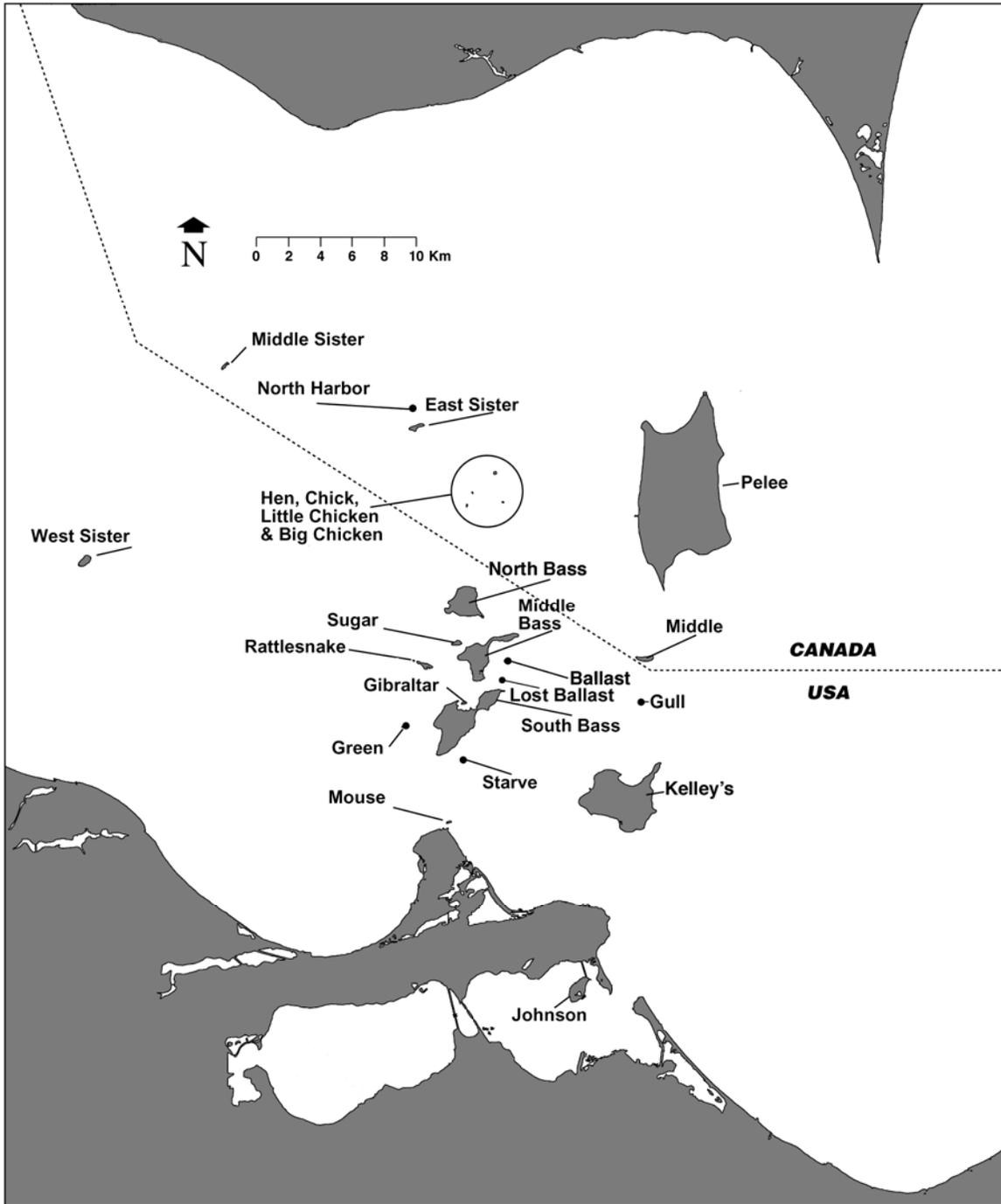


Figure 1. Historical range of Lake Erie Watersnake within the western Lake Erie basin of Ohio and Canada. Map courtesy of Barbara Ball and Department of Biological Sciences, Northern Illinois University.

At the time of listing in 1999, Lake Erie Watersnakes had been extirpated from two U.S. islands within the range, Green and West Sister, and two Canadian islands, Middle Sister and North Harbour. Since the time of listing, Lake Erie Watersnakes have naturally recolonized Green Island, a small island close to South Bass Island, and a viable

population of adult watersnakes has persisted there for nine years after an absence of 10 or more years (King and Stanford 2011, p. 18; King 2002, p. 4).

A main component of the recovery strategy was to ensure the persistence of a viable population of adult Lake Erie Watersnakes as a whole, as well as to ensure the persistence of multiple subpopulations on each of the large islands, and the small islands on which the watersnake was already present. The presence of multiple population centers helps to protect against stochastic events, such as storms, severe winters, or fire. If entire subpopulations are lost from a catastrophic event, the presence of other subpopulations provides the opportunity for individuals to recolonize the disturbed area. The chance that the species will persist over time increases with the presence of additional subpopulations. Further, the maintenance of multiple subpopulations ensures that genetic diversity that may exist across the range is maintained.

Researchers at Northern Illinois University (NIU) have led intensive annual Lake Erie Watersnake censuses since 2001 and have collected data to generate annual adult population estimates as recommended in the Lake Erie Watersnake Recovery Plan (Service 2003a, pp. 39-40). The methodology for conducting censuses and calculating the adult population estimates based on the census data is detailed in King *et al.* (2006a, pp. 88-92). Generally, population estimates are generated using multiple years of mark-recapture data, and applying closed- and open-population methods to analyze the data (King *et al.* 2006a, pp. 88-92). The preferred and most accurate method for calculating population size, the Jolly-Seber method (Jolly 1965, Seber 1965), requires at least three census periods and does not provide an estimate for the first or last period. Thus, the most recent year for which Jolly-Seber population estimates were generated is 2009. To provide population estimates for 2010, the Lincoln-Petersen method (as modified by Bailey in Caughley 1977, p.142) or Schumacher's method (Caughley 1977, p. 145) or a relationship between population density and capture rate was used, depending on the number of within-year census events and captures at a given sampling location (King and Stanford 2011, p.3). As data are collected each year, previous years' estimates are refined and current year estimates are generated using the above methods.

King and Stanford (2011, pp. 17) report the results of these annual adult Lake Erie Watersnake population estimates from the time period encompassing 2001 through 2010. These population estimates indicate that Criterion 1(a) has been fully achieved, and in recent years substantially exceeded, during the period of 2001-2010 (see Table 1 below). Based on the most recent population estimates in King and Stanford (2011), this criterion's population goal of at least 5,555 adults was first achieved in 2002 when there was an estimated 6,180 adult watersnakes on the U.S. islands combined, and has remained well above that level for the last nine years. While the adult population estimate for 2010 seems low compared to other recent years, this is simply a factor associated with the method used to calculate the adult population size for the most recent year's data. As noted above, the Jolly-Seber method cannot be used to generate current year population estimates so a different, though less exact, method is used depending on the number of within-year census events and capture numbers. It is expected that with

another year of census data, the refined population estimates for each island and for the total population for 2010 will be considerably larger and more accurate.

Table 3. Total estimated U.S. adult Lake Erie Watersnake population size, 2001-2010 (King and Stanford 2011, p.17). Estimates that exceed island-specific and overall population size goals specified in the Lake Erie Watersnake Recovery Plan (Service 2003a) are shown in **bold**.

Year	Kelleys	South Bass	Middle Bass	North Bass	Small Islands	Combined U.S. Islands
Recovery Goal	900	850	620	410	Not applicable	5555
2001	1860	1560	770	160	780	5130
2002	2150	1400	1300	550	780	6180
2003	2190	1490	1920	270	780	6650
2004	2750	1590	1460	460	1270	7530
2005	2450	1590	1920	790	920	7670
2006	2800	2670	3710	1380	1430	11990
2007	3930	2110	2480	970	890	10380
2008	3430	2540	3090	760	2060	11880
2009	2850	2630	4370	1170	960	11980
2010	3700	2070	2030	730	1270	9800

Even more enlightening than the adult population estimates is the calculation of realized population growth of adult Lake Erie Watersnakes since intensive monitoring began in 2001. King and Stanford (2009, pp. 6) used the program MARK (White 2004, Cooch and White 2008) to model realized population growth using annual census data from 2001-2008 at eight intensive study sites with the most complete capture histories. This model documented realized population growth of approximately 6 percent per year for the years 2001-2008, with 95 percent confidence limits of 2-10 percent, providing strong evidence of a minimum of 2 percent population growth per year across multiple sites (King and Stanford 2009, pp. 6-7). This indeed demonstrates that the adult Lake Erie Watersnake population has grown measurably since the time of listing, and validates the population estimates that also show increasing trends.

B. Residual threats

As noted above, the most significant listing factor for the Lake Erie Watersnake was the threat of intentional human persecution. While other factors likely contributed to the decline of the subspecies, human persecution was well-documented and occurred on most of the inhabited islands. Public opinion surveys conducted in 2008 indicated that public perception of the Lake Erie Watersnake varies widely between those who are supportive of it, those who are indifferent, and those who dislike or fear the snake. Outreach efforts have reached nearly all island residents, increasing access to information about the Lake

Erie Watersnake including non-lethal ways to address nuisance snakes. Opinion surveys seem to indicate that most people do not now and will not in the future kill Lake Erie Watersnakes, however many people indicate that the sheer number of snakes along the shoreline has become a nuisance, and this may contribute to negative feelings towards the snake. About 4 percent of respondents indicated they had knowingly killed a watersnake since the time of listing, and about 14 percent of respondents said they would knowingly kill a watersnake if it were no longer protected by State or Federal laws (Wilkinson 2008, p. 6). We interpret these responses to indicate that, while the watersnake will still face some human persecution, the vast majority of islanders would not resort to lethal means if they encountered watersnakes on their property. Of note is that, despite the admitted intentional mortality documented by both Wilkinson (2008, p. 6) and Olive (2008, pp. 112-113, 153) adult Lake Erie Watersnake populations have increased substantially since the time of listing, both across the U.S. range and on each large island (King and Stanford 2010, p. 11; King and Stanford 2009, pp. 6-7). This indicates that the adult Lake Erie Watersnake population can tolerate some degree of intentional mortality of individual snakes and still persist at a recovery level, however we intend to continue to monitor both the adult Lake Erie Watersnake population size as well as public opinion and public actions during the post-delisting monitoring period, as described in Section V.

One residual threat to the Lake Erie Watersnake post-delisting is destruction or modification of hibernation habitat during the winter. Destruction or modification of hibernation habitat during the winter when Lake Erie Watersnakes are hibernating will likely result in death of hibernating snakes due to exposure or trauma, as well as the loss of the hibernacula for future generations of snakes. As Lake Erie Watersnakes appear to use a variety of substrates and materials as hibernation habitat, and have been documented to successfully find and use alternate hibernation sites when excluded from historical hibernation sites, it is unlikely that the presence of suitable hibernation habitat is a limiting factor for the snake. A more likely impact is excavation of hibernation habitat during the winter when watersnakes are using it, because mortality from this activity is imminent. During the 12-year period during which Lake Erie Watersnakes have been listed, only five out of approximately 40 projects were anticipated to cause loss of hibernation habitat and take of Lake Erie Watersnakes. While development is fairly evenly spread across three of the large islands (Kelleys, Middle Bass, and South Bass), most projects reviewed during the listing timeframe did not cause loss of hibernation habitat. We anticipate that during the post-delisting monitoring period, loss of Lake Erie Watersnake hibernation habitat will likely proceed at approximately the same rate as within the past 12 years.

The presence of hibernation habitat is not likely a limiting factor for the subspecies; however to limit mortality of watersnakes, it is important that large-scale excavation or filling activities within approximately 69 m (226 ft) of the shoreline do not occur during the winter hibernation season. To minimize impact from this threat, we have updated and will widely distribute “Lake Erie Watersnake Management Guidelines for Construction, Development, and Land Management Activities” (Service 2009). Further, we will recommend to local governments that they adopt these voluntary guidelines on a broad basis. During the post-delisting monitoring period, the Service will coordinate with local

government agencies on Kelleys, Middle Bass, and South Bass Islands, to monitor compliance with these voluntary guidelines.

The Lake Erie Watersnake Recovery Plan (Service 2003, pp. 18, 38, 49, 57) recommended that additional studies be conducted to document the impact that invasive species, including the round goby, may have on the watersnake. King *et al.* (2006b, p. 110) found that since the appearance of round goby in the Great Lakes in the early 1990's, Lake Erie Watersnake diets have shifted from a diet of native fishes and amphibians to a diet composed of more than 90 percent round goby. This dietary shift corresponds to increased watersnake growth rates, increased body size, and increase in fecundity, with female watersnakes producing on average 25 percent more offspring post-invasion (King *et al.* 2008, pp.155, 158; King *et al.* 2006b, pp.111-113). King *et al.* (2008, p. 159) suggest that, "resource availability may have contributed to population declines in Lake Erie Watersnakes during the mid- to late- 1900s... While habitat loss and human-caused mortality are likely contributors to past watersnake population declines, the possibility exists that a reduction in benthic fish biomass, resulting in reduced watersnake fecundity, was also a factor. Unfortunately, quantitative data on long-term temporal trends in benthic fish biomass are lacking." If it is correct that limited foraging opportunities were a cause of the watersnake's population declines, the overabundance of the round goby within the island region of western Lake Erie will likely provide a significant prey source into the foreseeable future, negating any threats from limited prey availability. However, because this nearly complete dietary shift occurred so quickly, and may have contributed to recovery, we will monitor the dietary composition of adult Lake Erie Watersnakes, and local goby abundance during the post-delisting monitoring period, to ensure that this non-native prey base is stable and remains an available food source for Lake Erie Watersnakes, and to assess possible further changes in diet.

Other invasive species, for example Asian carp (*Hypophthalmichthys spp.*), could become established within the western Lake Erie basin and further alter the food web, as round gobies have, both during PDM and beyond the PDM period. Researchers conducting the PDM activities will actively watch for indications of changing predator-prey interactions including potential loss of prey base, communicable diseases, or other indirect factors from invasive species that may lead to watersnake population declines throughout PDM.

C. Legal and management commitments for post-delisting conservation

A number of land parcels distributed across the Lake Erie Watersnake's U.S. range have been voluntarily designated by the landowner as "protected habitat" that will be permanently preserved and managed to benefit the Lake Erie Watersnake. These parcels collectively encompass 318.18 acres (1.287 square kilometers (km²)) of inland hibernation habitat and 11.41 miles (18.25 kilometers (km)) of shoreline summer habitat, and satisfy Criterion 2 of the Lake Erie Watersnake Recovery Plan (Service 2003) (Table 2). These parcels are owned or managed by ODNR, Lake Erie Islands Chapter of the Black Swamp Conservancy (LEIC-BSC), Cleveland Museum of Natural History (CMNH), and Put-in-Bay Township Park District (PIBTPD).

Table 2. Lake Erie Watersnake protected habitat

Island	Property	Land within 69 m of shore		Length of shoreline		Partner
		(ac)	(km ²)	(mi)	(km)	
Kelleys	Kelleys Island State Park; North Pond State Nature Preserve; Kelleys Island Alvar	36.90	0.149	1.09	1.74	ODNR
	Long Point Preserve	21.40	0.087	0.36	0.57	CMNH
	Schollenberger Easement	0.14	0.001	0.02	0.03	LEIC-BSC
<i>subtotal</i>		<i>58.44</i>	<i>0.237</i>	<i>1.47</i>	<i>2.34</i>	
South Bass	South Bass Island State Park; Oak Point State Park	12.90	0.052	0.50	0.80	ODNR
	Scheef East Point Nature Preserve	6.4	0.026	0.32	0.52	PIBTPD, LEIC-BSC
<i>subtotal</i>		<i>19.30</i>	<i>0.078</i>	<i>0.82</i>	<i>1.32</i>	
Middle Bass	Middle Bass Island State Park; Kuehnle Wildlife Area	48.70	0.197	1.71	2.74	ODNR
	Petersen Woods	1.55	0.006	0.02	0.03	LEIC-BSC
	Lawrence Evans	0.75	0.003	0	0	LEIC-BSC
	Middle Bass East Point Preserve	4.3	0.017	0.14	0.22	PIBTPD, LEIC-BSC
<i>subtotal</i>		<i>55.30</i>	<i>0.223</i>	<i>1.87</i>	<i>2.99</i>	
North Bass	North Bass Island State Park; Fox's Marsh Wildlife Area	168.80	0.683	6.19	9.90	ODNR
<i>subtotal</i>		<i>168.8</i>	<i>0.683</i>	<i>6.19</i>	<i>9.90</i>	
Green	Green Island Wildlife Area	16.34	0.066	1.06	1.70	ODNR
TOTAL		<i>318.18</i>	<i>1.287</i>	<i>11.41</i>	<i>18.25</i>	

To ensure that these parcels continue to support suitable Lake Erie Watersnake habitat throughout the PDM period, all areas included as protected habitat will be monitored once per year, in collaboration with partners that manage the protected habitat (for example, ODNR, LEIC-BSC). The monitoring will ensure that the management plans, conservation easements, or other agreements are being implemented, and that Lake Erie Watersnakes or suitable habitat persists on the site. Written documentation of the protected habitat monitoring will be filed in the Service's Ohio Field Office.

V. Monitoring methods, including sampling considerations

Post-delisting monitoring of the Lake Erie Watersnake will include continued estimation of population and demographic parameters using methods established prior to and during the recovery period (King *et al.* 2006a). In this way, PDM will build on an established data set that documents conditions prior to delisting, allowing objective assessment of thresholds and triggers for monitoring outcomes and conclusions. Specific elements of the PDM methods are described in detail below.

A. Estimates of adult Lake Erie Watersnake population size

Although population monitoring of the Lake Erie Watersnake using capture-mark-recapture began in 1980, methods to be used in PDM were established in 2001, when a program of intensive annual censuses was initiated (King *et al.* 2006a). These censuses are conducted each spring and span a period of about two weeks (late May to mid-June), during which established study sites are surveyed repeatedly. In addition, a subset of these sites are surveyed outside of this intensive census period, either to provide more accurate population estimates or to meet other research objectives. As of 2008, 14 intensive study sites on the four large U.S. islands (Kelleys Island – five sites, South Bass Island – three sites, Middle Bass Island – three sites, North Bass Island – two sites) and Gibraltar Island were included in intensive annual spring censuses (Table 3). Censuses of intensive study sites consist of area-constrained searches of suitable shoreline habitat. Watersnakes are captured by hand, classified by sex, measured to obtain snout-vent length (SVL), and weighed. Watersnakes are individually marked using passive integrated transponders (PIT tags) and released at their site of capture. Watersnakes are classified as adults if SVL \geq 430 mm (males) or \geq 590 mm (females) (King 1986; King *et al.* 2006a).

Adult Lake Erie Watersnake population sizes at intensive study sites are estimated using standard capture-mark-recapture techniques (Caughley 1977, Krebs 1998). When possible, estimates are generated using the Jolly-Seber model with both death and immigration (Jolly 1965, Seber 1965) via the program JOLLY (<http://www.mbr-pwr.usgs.gov/software.html>) with 95 percent confidence intervals calculated using Manly's method (Manly 1984, Krebs 1998). Capture histories are created for each snake using 0's to denote years in which a given snake was not captured, 1's to denote years in which a snake was captured, and 2's to denote years in which a snake was captured but not released. This latter category included snakes that were found dead, snakes that were subsequently recaptured at a different study site, and snakes that were released without being marked. Because estimates based on small sample size are inherently inaccurate (Greenwood 1996), only estimates based on at least 10 captures in each of three successive years (the year prior to, of, and following the year to which a given estimate applies) are reported here. Furthermore, only estimates with standard deviations less than half the estimate are reported.

The Jolly-Seber method requires at least three census periods and does not provide an estimate for the first or last period. To provide population estimates for the current census

year, the Lincoln-Petersen method (as modified by Bailey in Caughley, 1977, p 142) is used for sites censused twice and Schumacher's method (Caughley, 1977, p 145) is used for sites censused three or more times within the year. The Lincoln-Petersen method is used only when 10 or more adults are captured in both censuses and there is at least one recapture in the second census. Schumacher's method is used only when a total of 30 or more adults are captured and recaptures are present in two or more censuses. For sites not meeting these sample size criteria or for which only a single census was carried out in a given year, population size is estimated based on the relationship between population density, estimated using mark-recapture techniques, and capture rate during intensive spring censuses:

$$\text{Population Density} = 6.32 * \text{Mean Capture Rate}^{0.98} \text{ (King et al. 2006a).}$$

Mean capture rate (adults captured per km) is obtained by dividing the mean number of adult Lake Erie Watersnakes captured per area-constrained search by the extent of shoreline included within each study site. Population densities (adults per km), obtained using the equation above, are converted to population estimates (number of adults) by multiplying by extent of shoreline.

Researchers conducting the annual censuses will actively watch for indications of changing predator-prey interactions (including potential loss of prey base), communicable diseases, or other factors that may lead to watersnake population declines throughout PDM.

Estimates of adult population size will be generated for each year (2011- 2015) of PDM.

Table 3. Numbers of adult Lake Erie Watersnakes captured, checked for marks, marked, and released at 14 intensive study sites, 1996-2010 (King and Stanford 2011, pp. 6-10). Numbers in parentheses denote additional snakes that were captured but not released – see text. Site # corresponds to locations shown in Fig. 2 of King *et al.* (2006a). Length refers to the extent of shoreline (in meters) to which estimates of adult population size estimates apply.

	Kelleys Island					South Bass Island			Middle Bass Island			North Bass Island		Gibraltar
	Long Point	Southeast Shore	South Shore	Minshall	State Park	East Point	East Shore	State Park	East Point	State Park	West End	NE,E,SE Shore	South Shore	Entire Island
Site #	1	4	7	11	14	21	26	28	34	36	39	44	47	54
Length	3006	1256	936	1506	556	1506	1286	906	1100	1301	1356	2640	2236	900
1996			15	19 (7)	8 (5)	3		21 (1)	12	9	17 (6)	1	15 (2)	5
1997			10 (2)	23 (2)	8 (1)	5		24	40	5	14 (3)	1	7	7
1998			3	9 (1)	22			52 (1)	5	11	13		11	
1999														
2000	16		8	15	11									
2001	30	183	123	36	33	6	4	26	1	5 (1)	13		15	2
2002	32	162	107 (2)	3	41		124	92 (1)		31	138 (3)		48 (1)	
2003	1	118	114	5	73 (2)		103	214 (2)	4	69 (2)	103		58	32
2004	9	161 (3)	72(1)	50	63 (1)		61 (4)	167 (6)	39	78 (1)	139 (2)	37	72 (3)	61 (1)
2005	3	130 (1)	104	26	33	50	115	269 (7)	96 (1)	41 (2)	94 (7)	41 (2)	67 (2)	63
2006	18	138 (1)	136 (1)	35 (1)	104	40	148 (6)	261 (7)	86 (3)	64 (1)	85 (8)	41	36 (2)	33
2007	53 (2)	168 (2)	137 (1)	24 (1)	59 (3)	57	184	319 (6)	138 (4)	162 (5)	144	105	157 (3)	80 (1)
2008	85 (1)	122 (2)	136 (1)	19	56 (1)	51	156 (1)	150 (2)	99 (9)	286 (14)	102 (1)	38	93	23 (15)
2009	77 (1)	134 (1)	149	28	46	81	224 (1)	205 (5)	108 (1)	156 (3)	66 (6)	77 (3)	137	78 (2)
2010	49	199	194	9	50 (1)	154 (2)	173	157 (6)	110 (1)	77 (1)	57	104	140 (1)	58 (5)

B. Status of Lake Erie Watersnakes on small U.S. islands

In addition to Gibraltar Island, which is included among the 14 intensive study sites censused annually, surveys are conducted once every two years to confirm the continued persistence of Lake Erie Watersnakes on four other small U.S. islands (Ballast, Rattlesnake, Green, Sugar). Ballast, Rattlesnake, and Sugar are privately owned. On these three islands, Lake Erie Watersnakes are captured; classified by age (juvenile, adult), sex, and color pattern (unbanded, intermediate, banded); scanned for the presence of PIT tags; and released. Snakes are not routinely measured at these sites, nor are unmarked snakes marked prior to release. Green Island is administered by the Division of Wildlife and on this island, Lake Erie Watersnakes are measured and marked using PIT tags prior to release. Surveys are also conducted on West Sister Island, a part of Ottawa National Wildlife Refuge, once every two years. Historically, Lake Erie Watersnakes were found on this island, but since 1980 only single individuals have been found there (Table 4; King and Stanford 2009).

Presence of Lake Erie Watersnakes on small U.S. islands will be determined during years 2 and 4 (in 2012 and 2014) of PDM.

Table 4. Years in which presence of Lake Erie Watersnakes has been confirmed on five small U.S. islands (King and Stanford 2011, p. 18). Check marks indicate years in which surveys were conducted on small islands. The presence of Lake Erie Watersnakes was confirmed during all surveys of Ballast, Gibraltar, Green, Rattlesnake, and Sugar Island. See text for discussion of the status of Lake Erie Watersnakes on West Sister Island.

Year	Ballast	Gibraltar	Green	Rattlesnake	Sugar	West Sister
1989				✓	✓	
1992				✓	✓	
1996	✓	✓		✓	✓	
1997	✓	✓		✓	✓	
2001		✓				
2002			✓		✓	✓ (1 watersnake)
2003		✓				
2004	✓	✓		✓	✓	
2005		✓				
2006	✓	✓	✓	✓	✓	✓ (absent)
2007		✓				
2008	✓	✓	✓	✓	✓	✓ (1 watersnake)
2009		✓				
2010	✓	✓	✓	✓	✓	

C. Estimates of annual survival of adult Lake Erie Watersnakes

Capture-mark-recapture data are used to estimate annual adult survival using Program MARK (White 2004, Cooch and White 2008). Program MARK utilizes likelihood theory, which assumes that the model structure is already known. In analyzing Lake Erie Watersnake survival during the recovery period, King and Stanford (2009) chose to allow survival to vary between males and females, among study sites, and among years. They created 64 model variations based on the global model $\Phi(\text{sex}*\text{site}*\text{time})p(\text{sex}*\text{site}*\text{time})$. These models examined all possible combinations of 'sex,' 'site,' and 'time' as factors affecting survival and recapture probability. For example, the model $\Phi(\text{sex}*\text{site})p(\text{site}*\text{time})$ specifies that survival differs between males and females and among sites but is constant over time and that recapture probability differs among sites and among years but is the same for males and females. Models were evaluated in MARK using AICc (corrected Akaike Information Criterion), with the best-fit model having the lowest value among the set. A similar approach will be used with PDM data.

Estimates of annual survival of adult Lake Erie Watersnakes will be determined during years 1, 3, and 5 (in 2011, 2013, and 2015) of PDM.

D. Estimates of the realized population growth parameter, λ , for adult Lake Erie Watersnakes

Capture-mark-recapture data are also used to estimate realized population growth ('realized λ '; Pradel 1996; Nichols and Hines 2002; Nichols *et al.* 2005) using the Pradel 'Survival and Lambda' data type extension within Program MARK (White 2004, Cooch and White 2008). In estimating λ during the recovery period (King and Stanford 2009), study sites with shorter capture histories (South Bass Island East Point, Middle Bass Island East Point, North Bass Island NE,E,SE Shore, Gibraltar Island; Table 3) or years with low capture rates (Kelleys Island Long Point, Kelleys Island Minshall; Table 3) were excluded. Consequently, analyses designed to estimate realized λ were restricted to eight study sites with long capture histories and consistently large sample sizes. As recommended by Franklin (2001), a fully parameterized base model, $\Phi(\text{sex}*\text{site}*\text{time})p(\text{sex}*\text{site}*\text{time})\lambda(\text{sex}*\text{site}*\text{time})$, was used and eight model variations with all possible combinations of 'sex,' 'site,' and 'time' as factors affecting realized λ were created. Models utilized logit link functions for estimating survival and capture probability and log link functions for estimating λ . A similar approach will be used with PDM data although we anticipate including additional study sites as data accumulates.

Estimates of the realized population growth parameter, λ , for adult Lake Erie Watersnakes will be determined during years 1, 3, and 5 (in 2011, 2013, and 2015) of PDM.

E. Lake Erie Watersnake diet composition

The diet of the Lake Erie Watersnake underwent a dramatic change following the invasion of the North American Great Lakes by the round goby with round gobies now constituting more than 90 percent of prey consumed, and possibly fueling Lake Erie Watersnake population recovery (King *et al.* 2006b, King *et al.* 2008, Jones *et al.* 2009). To assess possible further changes in the Lake Erie Watersnake's diet, snakes containing recently consumed prey (as detected by palpation) will be manually stimulated to regurgitate. Recovered prey items will be preserved in 70 percent ethanol for identification and measurement. Researchers conducting the diet composition study will actively watch for indications of changing predator-prey interactions including potential loss of prey base that may lead to watersnake population declines throughout PDM.

Lake Erie Watersnake diet composition will be assessed during years 3 and 4 (2013 and 2014) of PDM.

F. Round goby local abundance

To further assess local abundance of round goby as prey for the Lake Erie Watersnake, goby angling and trawl surveys will be conducted at multiple locations near the offshore Lake Erie islands. Thirty-two time-constrained angling surveys will be conducted involving two people angling from a boat continuously with worm-baited hooks. Methods will be similar to those used in the 2007 goby sampling which documented the extent to which gobies were contributing to Lake Erie Watersnake diet (King and Stanford 2008, pp. 3-4). Trawl surveys for goby will be completed at several locations near the Lake Erie islands to gain additional survey information on goby abundance. Information on goby abundance during PCM will be compared with goby abundance data collected in 2007 (King and Stanford 2008, pp. 3-4, 18-19) to assess any local changes in abundance. This information will also be considered in light of Lake Erie Watersnake population size, distribution, annual survival, population growth, and diet composition studies to inform further how the abundance of round goby may influence Lake Erie Watersnake population status.

Round goby local abundance surveys will be conducted during years 3 and 4 (2013-2014) of PDM.

G. Public opinion surveys

Public opinion surveys of island residents will be conducted during year 4 of the post-delisting monitoring period to gauge public opinion and actions towards the Lake Erie Watersnake since delisting. Surveys will be sent to a random subset of island addresses available through the U.S. Postal Service. Questions in the survey will be similar to those asked in the 2008 public opinion survey to determine if and how public opinion of Lake Erie Watersnake may be changing. Follow-up surveys will be sent to non-respondents to minimize non-response bias. Public opinion survey results will be correlated with adult Lake Erie Watersnake population trends, if possible.

Public opinion surveys will be conducted during year 4 (2014) of PDM.

H. Protected habitat monitoring

A number of land parcels distributed across the Lake Erie Watersnake's U.S. range have been voluntarily designated by the landowner as "protected habitat" that will be permanently preserved and managed to benefit the Lake Erie Watersnake. These parcels collectively encompass 318.18 acres (1.287 km²) of inland hibernation habitat and 11.41 miles (18.25 km) of shoreline summer habitat, and satisfy Criterion 2 of the Lake Erie Watersnake Recovery Plan (Service 2003) (Table 2). To ensure that these parcels continue to support suitable Lake Erie Watersnake habitat, all areas included as protected habitat will be monitored once per year throughout the PDM period, in collaboration with partners that manage the protected habitat (for example, ODNR, LEIC-BSC). The monitoring will include a site visit to the protected habitat area to ensure that the management plans, conservation easements, or other agreements are being implemented, and that Lake Erie Watersnakes or suitable habitat persists on the site. Written documentation of the protected habitat monitoring for each site will be filed in the Service's Ohio Field Office.

Protected habitat monitoring will be conducted during each year (2011-2015) of PDM.

I. Voluntary guideline implementation monitoring

Destruction or modification of hibernation habitat during the winter when Lake Erie Watersnakes are hibernating will likely result in death of hibernating snakes due to exposure or trauma, as well as the loss of the hibernacula for future generations of snakes. In order to conserve Lake Erie Watersnakes, it is important that large-scale excavation or filling activities within approximately 69 m (226 ft) of the shoreline do not occur during the winter hibernation season. We have updated and distributed "Lake Erie Watersnake Management Guidelines for Construction, Development, and Land Management Activities" (Service 2009). We will recommend that local island governments adopt these voluntary guidelines on a broad basis. During the post-delisting monitoring period, the Service will coordinate with local government agencies on Kelleys, Middle Bass, and South Bass Islands, to monitor compliance with these voluntary guidelines. Documentation of local government responses will be filed in the Service's Ohio Field Office.

Voluntary guideline implementation monitoring will be conducted during each year (2011-2015) of PDM.

VI. Definition of thresholds/triggers for potential monitoring outcomes and conclusions

To effectively implement PDM for the Lake Erie Watersnake, it is essential to identify the circumstances under which the Service would take action (e.g., increase frequency, intensity, or duration of the monitoring; initiate a formal status review; or publish a relisting proposal) Conversely, it is also important to identify the circumstance under

which there is no new concern for the snake's status, the Lake Erie Watersnake population remains secure, and the PDM requirement has been fulfilled. The quantitative triggers described below are based on the information collected under the PDM plan and provide a structured process for evaluating the status of the snake during PDM. Further, we discuss how qualitative monitoring results will be used in assessing the status of the snake during PDM. Finally, other circumstances could arise, such as new threats or increased intensity of existing threats that would warrant additional action to ensure the snake does not become threatened or endangered.

It is important to note that apparent declines in distribution, abundance, reproduction, or persistence of Lake Erie Watersnakes can be confounded by density-dependent population fluctuations or other environmental variables that reduce capture rates (such as poor weather during the annual population census). Realized population growth, λ , has indicated that the adult Lake Erie Watersnake population continued to grow at a rate of approximately 6 percent per year from 2001-2008, with 95 percent confidence limits of 2-10 percent, providing strong evidence of population growth across multiple sites (King and Stanford 2009, pp. 6-7). This indicates that the population may not yet be at carrying capacity. However, it is likely that at some point during PDM, the population may reach carrying capacity and realized population growth may reach a value of 1, indicating no population growth, or realized population growth may reach a value less than 1, indicating population decline. As the population stabilizes around carrying capacity, we anticipate that realized population growth will likely level off, reaching a value of near 1. We have accounted for these possible scenarios in developing the indicators of the Lake Erie Watersnake's population status below. When calculating realized population growth, 95% confidence intervals will also be calculated. Based on past analyses this parameter can be estimated fairly accurately so the confidence intervals will be used to determine if realized population growth is increasing, decreasing, or stable, as follows:

- If 95% confidence interval is fully below 1.0 (e.g., from 0.90-0.97), we would conclude the realized population growth is less than 1.0 (population is declining).
- If 95% confidence interval surrounds 1.0 (e.g., from 0.97-1.02), we would conclude the realized population growth is not different from 1.0 (population is stable).
- If 95% confidence interval is fully above 1.0 (e.g., from 1.02-1.06), we would conclude the realized population growth is greater than 1.0 (population is increasing).

A. PDM indicates that the species remains secure without ESA protections

For PDM to indicate that the Lake Erie Watersnake remains secure without ESA protections, all of the following criteria should be realized by the end of the PDM period:

1. Realized population growth parameter, λ , is greater than or equal to 1.0 for two out of three periods for which it is calculated, including the last period,
2. The adult population estimates are greater than or equal to 5,555 overall, and

3. Each of the four large islands subpopulation estimates are greater than or equal to the goals defined in the recovery plan (Service 2003a, pp. 28-29): Kelleys Island, 900; South Bass Island, 850; Middle Bass, 620; and North Bass 410.

B. PDM indicates that the species may be less secure than anticipated at the time of delisting, but information does not indicate that the species meets the definition of threatened or endangered

For PDM to indicate that the Lake Erie Watersnake may be less secure than anticipated, but that it does not meet the definition of threatened or endangered, the following should be true:

1. Realized population growth parameter, λ , is less than 1.0 for two consecutive periods for which it is calculated.

Should this situation occur, the Service would look closely at the results of the dietary study, round goby local abundance, public opinion survey, and implementation of voluntary guidelines to determine if any residual threats or concerns may be contributing to population declines. Further we will consider if other emerging threats, for example new invasive species or communicable diseases, may be impacting the Lake Erie Watersnake population. Variable courses of action may be considered to address any residual or emerging threats. The Service will also consider whether the population may be reaching carrying capacity and these population declines are a result of normalization around carrying capacity. If the population growth parameter was less than 1 for the first two consecutive periods (Years 1 and 3, 2011 and 2013), PDM would continue as planned, but population growth rates would be calculated in Year 4 as well. If the population growth parameter was less than 1 for the last two consecutive periods (Years 3 and 5, 2013 and 2015) the Service would extend the PDM period for the Lake Erie Watersnake for 2 additional years. All relevant data would be examined to ensure that the population does not meet the definition of threatened or endangered.

C. PDM yields substantial information indicating threats are causing a decline in the species' status since delisting, such that listing the species as threatened or endangered may be warranted

For PDM to indicate that the Lake Erie Watersnake's status is declining and that listing as endangered or threatened may be warranted, the following should be true:

1. Realized population growth parameter, λ , is less than 1.0 for three consecutive periods for which it is calculated.

Should this situation occur, the Service would look closely at the results of the dietary study, round goby local abundance, public opinion survey, and implementation of voluntary guidelines to determine if any residual threats or concerns may be contributing to population declines. Further we will consider if other emerging threats, for example new invasive species or communicable diseases, may be impacting the Lake Erie

Watersnake population. Variable courses of action may be considered to address any residual or emerging threats. The Service will also consider whether the population may be reaching carrying capacity and these population declines are a result of normalization around carrying capacity. Further, the Service would consider whether listing the Lake Erie Watersnake as threatened or endangered is warranted. If listing is not warranted, PDM would be extended for 2 additional years to continue to monitor Lake Erie Watersnake population trends.

D. PDM documents a decline in the species' probability of persistence, such that the species once again meets the definition of a threatened or endangered species under the ESA

For PDM to indicate that the Lake Erie Watersnake's probability of persistence is declining such that the species once again meets the definition of an endangered or threatened species under the ESA, all of the following should be true:

1. Realized population growth parameter, λ , is less than 1.0 for two consecutive periods for which it is calculated, and
2. One of the following two situations occurs:
 - a. Range-wide adult Lake Erie Watersnake population estimate is less than the recovery goal of 5,555 during the most recent census, or
 - b. One or more of the large island subpopulation estimates is less than the population recovery goal specified in the recovery plan (Service 2003a pp. 28-29), when using the Jolly-Seber method of population estimation (Jolly 1965, Seber 1965).

Should this situation occur, the Service would look closely at the results of the dietary study, public opinion survey, and implementation of voluntary guidelines to determine which residual threats or concerns may be contributing to population declines. Further we will consider if other emerging threats, for example new invasive species or communicable diseases, may be impacting the Lake Erie Watersnake population. Variable courses of action may be considered to address residual or emerging threats. Further, the Service would likely initiate the process to list the Lake Erie Watersnake as a threatened or endangered species under the ESA. If the species was listed, the PDM plan would be discontinued.

VII. Data compilation and reporting procedures and responsibilities

As described in Section V, Monitoring Methods Including Sampling Considerations, a multi-faceted approach to monitoring several aspects of Lake Erie Watersnake demography, as well as residual threats and concerns, will be undertaken for PDM. Various aspects of monitoring will require reporting at specific intervals. These are described below.

A. Annual reports

The annual census of adult Lake Erie Watersnakes will generate the data to provide estimates of population size, annual survival, and realized population growth, and will provide the prey items for the diet composition study. Therefore, a single annual report will be required from the contractor completing this work for each year of PDM.

Estimates of adult Lake Erie Watersnake population size, based on the annual census of the four large islands and Gibraltar, will be submitted by the contractor completing the work each year of PDM. Any observations of changing predator-prey interactions, communicable diseases, or other factors observed during the census that may lead to declining populations of Lake Erie Watersnakes should be included in the annual report. The census typically occurs in late May and early June, and data entry and analysis is completed within the following six months. An annual report summarizing the findings of the census and including the adult population estimate will be provided by the contractor to the Service and ODNR in January of the year following the census event.

In PDM years 2 and 4 (2012 and 2014), the annual report will also document the presence or absence of Lake Erie Watersnakes on the small islands, and any associated discussion of the status of Lake Erie Watersnakes on the small islands, specifically West Sister Island.

In PDM years 1, 3, and 5 (2011, 2013, and 2015), the annual report will include the results of the estimates of annual survival and realized population growth.

In PDM years 3 and 4 (2013 and 2014), the annual report will include the results of the diet composition study.

B. Round goby local abundance

Round goby local abundance sampling will be conducted by a contractor, and will occur over PDM Years 3-4 (2013-2014). The results of the sampling will be submitted to the Service and ODNR in a single summary report. A completed report will be due by January 2015.

C. Public opinion survey

The public opinion survey will be conducted by a contractor, with input provided from the Service and ODNR during year 4 (2014) of PDM. The survey will be conducted during the summer of 2014, when island residents are present on the islands and easily contacted. The survey questions will be developed using similar questions as the 2008 public opinion survey (Wilkinson 2008), so as to compare changes over time. The results of the public opinion survey will be submitted to the Service and ODNR in a summary report. A completed report will be due by December 2014.

D. Protected habitat and voluntary guideline implementation monitoring

Monitoring of protected habitat will be conducted by staff of the Service and/or ODNR on an annual basis. Service staff will contact all owners or managers of protected habitat

to confirm that habitat is being appropriately managed, in accordance with existing agreements, conservation easements, or other documentation. Site visits to protected habitat will also be conducted to observe protected habitat. Written documentation of the status of each protected habitat area will be filed in the Service's Ohio Ecological Services Field Office during each year of PDM (2011-2015).

Service staff will monitor implementation of voluntary guidelines on an annual basis. Service staff will contact local government officials on Kelleys, Middle Bass, and South Bass Islands during each year of PDM to document the extent to which the voluntary guidelines are implemented. Site visits to the islands may be conducted to observe development areas and trends on these islands. Written documentation of these findings will be filed in the Service's Ohio Ecological Services Field Office during each year of PDM (2011-2015).

VIII. Funding

A. Estimated funding requirements

Table 5 itemizes the estimated cost of \$289,000 for completing PDM for the Lake Erie Watersnake, at a cost of approximately \$58,000 per year for five years. These estimates are not adjusted for inflation and assume that the monitoring schedule is consistent with the methodology and schedule contained in this PDM plan. The actual costs of completing PDM could be more or less than this estimate. These cost estimates include some staff time for Service employees to conduct site visits and complete reporting requirements associated with monitoring protected habitat and voluntary guideline implementation. Additional costs not included in these estimates are those of staff time that would accrue by personnel of the Service, ODNR and other partners in coordinating PDM activities and reviewing draft reports. These costs will likely be born as in-kind services provided by the cooperating agencies and partners.

B. Potential funding sources

Funding of PDM presents a challenge for all partners following removal of ESA protections. While the ESA authorizes expenditure of both recovery funds and section 6 grants to the States to plan and implement PDM, to date Congress has not allocated any funds expressly for this purpose. Funding of PDM activities, therefore, will require trade-offs with other competing endangered species' conservation needs. The Service and ODNR will continue to work together to secure funding to implement this PDM plan.

C. Anti-Deficiency Act disclaimer

Post-delisting monitoring is a cooperative effort between the Service, State, other Federal agencies, and nongovernmental partners. Funding of PDM presents a challenge for all partners committed to ensuring the continued viability of the Lake Erie Watersnake following removal of ESA protections. To the extent feasible, the Service intends to provide funding for post-delisting monitoring efforts through the annual appropriations

process. Nonetheless, nothing in this PDM Plan should be construed as a commitment or requirement that any Federal agency, including the Service, obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation.

Table 5. Estimated funding requirements for completing PDM for the Lake Erie Watersnake. Funding estimates for most tasks were based on actual costs of conducting these same tasks during the listing period, and were provided by Northern Illinois University. Indirect costs of 6% were factored into all work to be conducted by contractors, to account for overhead costs.

	2011	2012	2013	2014	2015	Total
<i>Task: Census of islands, estimate of adult Lake Erie Watersnake Population Size</i>						
Direct Costs	\$42,455	\$44,153	\$45,919	\$47,756	\$49,666	\$229,951
Indirect Costs (6%)	\$2,547	\$2,649	\$2,755	\$2,865	\$2,980	\$13,797
Subtotal	\$45,002	\$46,803	\$48,675	\$50,622	\$52,646	\$243,748
<i>Task: Survivorship and Population Growth Estimation</i>						
Direct Costs	\$6,199		\$6,705		\$7,252	\$20,156
Indirect Costs (6%)	\$372		\$402		\$435	\$1,209
Subtotal	\$6,571		\$7,107		\$7,687	\$21,365
<i>Task: Diet Composition</i>						
Direct Costs			\$1,000	\$1,040		\$2,040
Indirect Costs (6%)			\$60	\$62		\$122
Subtotal			\$1,060	\$1,102		\$2,162
<i>Task: Round Goby Local Abundance</i>						
Direct Costs			\$4,000	\$4,000		\$8,000
Indirect Costs (6%)			\$240	\$240		\$480
Subtotal			\$4,240	\$4,240		\$8,480
<i>Task: Public Opinion Surveys</i>						
Direct Costs				\$4,000		\$4,000
Indirect Costs (6%)				\$240		\$240
Subtotal				\$4,240		\$4,240
<i>Task: Protected Habitat and Voluntary Guideline Implementation Monitoring</i>						
Subtotal	\$1,800	\$1,800	\$1,800	\$1,800	\$1,800	\$9,000
Total of All PDM	\$53,373	\$48,603	\$62,882	\$62,004	\$62,133	\$288,995

IX. PDM implementation schedule

Table 6. General schedule for post-delisting monitoring of the Lake Erie Watersnake. If the watersnake were delisted in early 2011, the “Year 1” would be calendar year 2011, etc. The schedule is subject to change if monitoring results in a need for more intensive sampling as described in Section VI above.

Task	Responsible Party	Year 1	Year 2	Year 3	Year 4	Year 5
Census of islands, estimate of adult Lake Erie Watersnake Population Size	Contractor	X	X	X	X	X
Annual Report	Contractor	X	X	X	X	X
Survivorship and Population Growth Estimation	Contractor	X		X		X
Diet Composition	Contractor			X	X	
Round Goby Local Abundance Survey	Contractor			X	X	
Round Goby Local Abundance Report	Contractor				X	
Public Opinion Survey Design and Implementation	Contractor, Service, ODNR				X	
Public Opinion Survey Report	Contractor				X	
Protected Habitat and Voluntary Guideline Implementation Monitoring and Reporting	Service, ODNR	X	X	X	X	X
Final Report	Service					X

X. Conclusion of PDM

At the end of the planned PDM period the Service will conduct a final review following submission of the fifth annual report in PDM Year 5. The final review will be concluded with a final report on the status of the Lake Erie Watersnake. At the conclusion of PDM, one of the four conclusions outlined in Section VI will be assigned to the status of the Lake Erie Watersnake, based on the outcomes of PDM, as defined in Section VI. Any relisting decision by the Service will require evaluating the status of the Lake Erie Watersnake relative to the ESA’s five listing factors (section 4(a)(1)). The Service

intends to work with all of our partners toward maintaining recovery of the Lake Erie Watersnake so as not to require relisting the species.

XI. Review and adaptation of PDM plan

Once finalized and approved by the Service's Region 3 Regional Director, this PDM plan may be updated as needed to account for and respond to new information discovered as part of the ongoing data collection and analysis. If substantial changes are made to the PDM plans set forth in this document, this PDM plan will be revised to document the changes. Recognizing the need for potential future changes to the PDM plans will provide the necessary flexibility to ensure effective PDM for the Lake Erie Watersnake. The final PDM plan for the Lake Erie Watersnake and any future revisions to the PDM plan will be made available on the Service's web site at <http://www.fws.gov/endangered> or by calling our Ohio Ecological Services Office at 614-416-8993.

XII. Literature cited

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Appendix A: Responses to Public Comments on “Draft Post-Delisting Monitoring Plan for the Lake Erie Watersnake (*Nerodia sipedon insularum*) on the Offshore Islands of Western Lake Erie, May 18, 2010.”

Introduction

On June 1, 2010 the U.S. Fish and Wildlife Service (Service) announced the availability of its proposed rule to remove the Lake Erie Watersnake (*Nerodia sipedon insularum*) from the List of Threatened and Endangered Wildlife (List) due to recovery, and concurrently released the “Draft Post-Delisting Monitoring Plan for the Lake Erie Watersnake (*Nerodia sipedon insularum*) on the Offshore Islands of Western Lake Erie” (PDMP) for public and peer review and comment. The comment period closed on August 2, 2010. The Plan is intended to fulfill the Service’s responsibility under the Endangered Species Act of 1973, as amended, to monitor the status of the Lake Erie Watersnake for five years after its removal from the List.

The Service received four (4) substantive comments on the Draft PDMP. After the comment period closed, the Service reviewed each comment received and prepared comments in response to any substantive comments. Those comments and the Service’s responses are summarized below.

Comments and Responses

Comment: One peer reviewer commented that the PDMP should include some form of goby monitoring, since this is such a substantial portion of the watersnake diet and goby populations will likely not remain static. He states: "If gobies were to decline in abundance, levels of mortality that have been insufficient to cause population declines could become unsupportable. To some extent, such a situation could be detected through examination of population growth and diet data, but given the apparent importance of the goby to watersnake population growth, a direct measure of prey availability could be critical to interpreting the future prospects for the subspecies."

Response: The Service has incorporated an additional monitoring component into the PDMP, entitled “round goby local abundance” to document the status of the local goby population. Both angling and trawl surveys will be completed in Years 3-4 of post-delisting monitoring (PDM) to document the abundance of round goby locally, and compared to similar data collected by Lake Erie Watersnake researchers in 2007. The results of this monitoring will be considered with other monitoring results to interpret changes in Watersnake annual population estimates, survival, and realized population growth estimates.

Comment: One peer reviewer commented on the concept of confidence intervals around the calculated value for lambda (realized population growth): "The PDM Plan outlines several thresholds for interpreting outcomes of delisting and evaluation future actions for

the subspecies. Several of these thresholds are explicit and quantitative, however each of these values is an estimate with an associated confidence interval and it is unclear to me how the thresholds will be interpreted in light of uncertainty in parameter estimates. eg) what will be the conclusion in a situation where the point estimate for lambda exceeds 1, but the confidence interval overlaps 1? Will this be interpreted as being greater than or equal to 1 or less than 1?"

Response: The Service has clarified the interpretation of confidence intervals around lambda in the text of the PDMP.

Comment: One peer reviewer requested that the Service indicate a "stronger commitment to extending monitoring initiatives under scenarios B, C, and D, but especially B."

Response: The Service has revised and clarified our commitments to extending the PDM period under Scenarios B, C, and D. This is reflected in the text of the PDMP. In Scenario B (*PDM indicates that the species may be less secure than anticipated at the time of delisting, but information does not indicate that the species meets the definition of threatened or endangered*) the Service will conduct an additional 2 years of PDM if realized population growth is less than 1 in the last two consecutive monitoring periods (Years 2013 and 2015). In Scenario C (*PDM yields substantial information indicating threats are causing a decline in the species' status since delisting, such that listing the species as threatened or endangered may be warranted*) the Service will conduct an additional 2 years of PDM if it is determined that listing is not warranted. In Scenario D (*PDM documents a decline in the species' probability of persistence, such that the species once again meets the definition of a threatened or endangered species under the ESA*), additional PDM would be precluded by the listing of the subspecies, and the PDMP would no longer be implemented.

Comment: One peer reviewer suggested the PDMP address the potential establishment of Asian carp (*Hypophthalmichthys spp.*) in western Lake Erie, as introduction of these species might be expected to impact populations of Lake Erie Watersnakes by further modifying the food web. Specifically, it was suggested that the Service conduct the dietary study earlier in PDM if Asian carp are detected in western Lake Erie. Further, it was suggested that the Service commit to supporting research on the interactions of Asian carp and Lake Erie Watersnakes even if carp are not detected until after the 5 year PDM period.

Response: The Service agrees that during PDM any newly identified emerging threats, for example, the establishment of Asian carp within Western Lake Erie, should be identified and monitored. We have indicated this in the text of the PDMP. Specifically, we have identified that researchers conducting the annual census and the dietary studies should actively look for signs of changing predator-prey relationships, communicable

diseases, or other issues that may result in a decline in the Lake Erie Watersnake population, and report their findings in the annual report. We have also added language regarding these potential emerging threats in the “Triggers for potential monitoring outcomes and conclusions” section of the PDMP. If, at the end of PDM, it is documented that the Lake Erie Watersnake remains secure without ESA protections, it would not be appropriate to monitor interactions between the Lake Erie Watersnake and Asian carp under the context of the Endangered Species Act.