

# A Description of Lethal and Nonlethal Predator Management at Two Piping Plover (*Charadrius melodus*) Nesting Colonies in Michigan

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**ABSTRACT:** Predator management in the Great Lakes region of Michigan has played an important role in the recovery program of the federally endangered Great Lakes piping plover (*Charadrius melodus*). We describe 2 long-term piping plover breeding sites located on Lake Michigan with different management strategies. We review data (2003-2014) from Dimmick's Point on North Manitou Island (NMI), part of Sleeping Bear Dunes National Lakeshore, and Ludington State Park (LSP). These sites were chosen because both have had multiple breeding pairs of piping plovers during the entire period we considered, and are in the same region of Michigan, approximately 75 miles apart. The 2 sites are likely impacted by similar environmental conditions and influenced by the same predators. Predator species common to both locations include American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*), ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*) and merlin (*Falco columbarius*). On Dimmick's Point, combinations of lethal and non-lethal predator-management methods were used including shooting with shotgun, suppressed rifle and pyrotechnics. On LSP the only control measures included predator nest enclosures and plover monitoring. Dimmick's Point had a 62% fledge rate of chicks that were hatched after lethal predator management was implemented compared with only 49% of chicks fledged of those hatched at LSP during the same time period. During this time period Dimmick's Point fledged 2.07 chicks per pair compared with 1.77 chicks per pair at LSP, this despite LSP averaging 3.52 chicks hatched per pair compared with 3.28 hatched per pair at Dimmick's. These results suggest that the use of lethal predator management can be useful to increase plover fledging rates at locations where predation continues to be a limiting factor. Without effective predator management, some long-term piping plover nesting sites on the Great Lakes could experience significant losses to predation.

**Key Words:** American crow, common raven, *Charadrius melodus*, endangered species, herring gull, merlin, piping plover, predator management, ring-billed gull.

Proceedings of the 16th Wildlife Damage Management Conference.  
(L.M. Conner, M.D. Smith, Eds). 2016. Pp.65-74.

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## INTRODUCTION

The Great Lakes population of piping plovers (*Charadrius melodus*) was listed as

endangered under provisions of the U.S. Endangered Species Act in 1986. The Great Lakes population had declined from a historic

size of several hundred breeding pairs to 17 at the time of listing. From 1986-2002, the population fluctuated between 12 and 51 breeding pairs, with breeding areas remaining largely confined to Michigan (USFWS 2003).

The plovers are imperiled chiefly by significant loss and degradation to the wide sandy beaches they require for nesting, beaches where they often face a wide range of predators. Predation was identified as the cause of nest failure of approximately 14.5% of clutches in Michigan from 1981 to 1999 (Wemmer 2000), and predators are an important source of mortality for piping plover chicks (Roche et al. 2008). The Recovery Plan for the Great Lakes piping plover identifies predator management as a high priority (USFWS 2003).

In 2003, a pilot project of predator management was initiated by Wildlife Services at the plover nesting colony at Dimmick's Point (Dimmick's) on North Manitou Island (NMI) in Sleeping Bear Dunes National Lakeshore, which appeared to achieve considerable success (Struthers and Ryan 2005). That project has continued at varying levels through 2014.

In this paper, we review the results of 12 years of that effort and compare those results with a similar plover colony 75 miles to the south at Ludington State Park (LSP) in Michigan (Figure 1). Both sites have had multiple breeding pairs during the period of 2003-2014. Additionally, these locations are influenced by similar weather conditions and have similar types of predators including American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*), ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*) and merlin (*Falco columbarius*). During this period a combination of lethal and nonlethal predator management was utilized on Dimmick's, while at LSP only nonlethal management was used. The predator management team responsible for making program decisions included biologists from the National Park Service (NPS), Michigan Department of Natural Resources (DNR), U.S. Fish and Wildlife Service (USFWS), and USDA – Wildlife Services (WS).

## STUDY AREA

**Dimmick's Point** – This is one of the most important nesting locations for Great Lakes piping plovers. It contains 109 acres (44 hectares) and 2.1 miles (3.3 km) of designated piping plover critical habitat shoreline. Located on the southeastern end of NMI (Fig. 1), it is approximately 9.9 miles (16 km) from the mainland and is managed as a wilderness island, allowing foot travel only.

Conducting predator management on NMI required a considerable logistical effort. Wildlife Services employees were stationed in Gaylord, MI approximately 90 miles (145 km) from the NPS shuttle boat that is used to transport employees and gear to Dimmick's. There are no facilities such as shelter or potable water available at Dimmick's, requiring employees to move food, water, tents and other equipment for periods  $\leq 5$  days (Table 1).

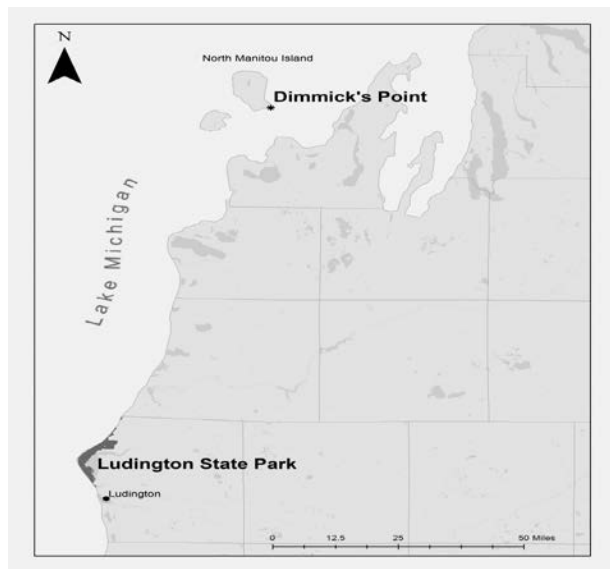
**Ludington State Park** – This site is approximately 5,300 acres (2,144 hectares) in size and consists of a vast dune complex situated between Lake Michigan and the inland Lake Hamlin (Fig. 1). Piping plovers at LSP typically concentrate nests in 2 areas, from near the Big Sable Point Lighthouse north to the northern boundaries of the park, and an area just north and south of the Hamlin Lake outlet. Piping plovers nest near the beaches and fore dunes but also in extensive cobble pans located in the back dunes farther from Lake Michigan.

## METHODS

### Dimmick's Point

Crows, ravens, and merlins were removed using a shotgun or suppressed rifle. In some cases, crows were lured within shooting range with an electronic call. Gulls were dispersed using pyrotechnics reinforced by shotgun shooting. These methods were evaluated and no disruption or disturbance effect on nesting or foraging plovers was observed (Struthers and Ryan 2005). Fenced exclosures were installed around all plover nests shortly after nesting activity began.

Figure 1. Relative locations of Dimmick's Point and Ludington State Park.



Funding limitations did not allow for WS employees to be on-site continuously. The timing and duration of visits was a joint decision between NPS and WS personnel. The first visit was generally scheduled in advance and aimed to coincide with the anticipated peak of hatching. To the degree that funding allowed, additional visits were requested by NPS when predator threats became significant. Typically, 2 or 3 employees were deployed together and worked from dawn to dusk, e.g. 0600 hours to 2100 hours.

*Phases of the management plan.* - As predator abundance and behavior changed,

predator management activities had to adapt to be effective. This was of critical importance. The implementation of predator management was also influenced by the funding provided by either NPS or FWS. The evolution of the management plan as collectively decided by the management team was divided into a succession of 7 phases.

*Phase I: Before lethal predator management (1993 to 2002).* - During this time period the only predator management activities were nest exclosures to protect the nesting plovers and eggs.

*Phase II: Getting started (2003– 2006).* - During this phase, crows and gulls were the primary predators. There was sufficient funding to conduct multiple trips each season. Crows were removed by shooting, but crows became increasingly wary, requiring adaptations such as electronic crow calls, owl effigies, crow decoys, blinds, and various stalking techniques. Once gulls were dispersed, plovers moved into the unoccupied habitat and nested in areas not observed during the previous 10 years.

*Phase III: Complications (2007 – 2008).* - During both years funding was limited, which restricted management activities to only 1 trip per year. This resulted in reduced survivorship of adults and chicks. Crow and gull management activities were implemented and merlins started to visit regularly. In 2008, 4 plover nests/adults were lost to suspected merlin predation (SBDNL 2008).

*Phase IV: Restricted merlin management (2009 – 2010).* - Funding was restored to allow multiple trips, providing adequate plover chick protection from crows and gulls. However, 5 plover nests/adults were lost to suspected merlin predation (SBDNL 2009, SBDNL 2010). Because merlins were a state-listed threatened species, the management team limited the lethal take of merlins. For example, there were occasions that the management team would only allow the take of 1 or 2 merlins per trip, even though additional merlins were actively hunting in the plover habitat.

*Phase V: Tipping point (2011).* - Funding was available for multiple trips, providing adequate plover chick protection from crows and gulls. Early in season, before plovers started nesting, NPS monitors found leg bands of an adult plover in a raptor pellet under a popular merlin perch tree. This discovery suggested that merlins might focus on adult plovers and prompted an early emergency trip to conduct merlin management. The perception of a high level of merlin activity put tremendous strain on the decision-making process of how many merlins should be removed. Two plover nests/adults were lost to suspected merlin predation (SBDNL 2011).

*Phase VI: Predators are relentless (2012).* - Funding was available for 5 trips providing adequate chick protection from gulls and crows. This was the first year the predator management team agreed that all merlins using the plover breeding area should be removed. Four of the 5

trips occurred by request in reaction to multiple merlin sightings, requiring constant redeployment. Ten plover chicks were predated during a 5 day period, and multiple crows and merlins were reported using the plover breeding area. One plover nest/adult was lost to suspected merlin predation (SBDNL 2012).

*Phase VII: Intensive program (2013 – 2014).* - This began a new era in proactive predator management. This was the first year the predator management team reorganized the structure of predator management to include 3 planned trips. In the past, one predetermined trip was planned during mean plover hatch dates, and redeployment occurred only after predation occurred. This new strategy, coupled with effectual merlin management, resulted in an increase in plover abundance; 9 pairs in 2013 and 10 pairs in 2014. In both years, no plover adults/nests were lost to suspected merlin predation (SBDNL 2013, SBDNL 2014).

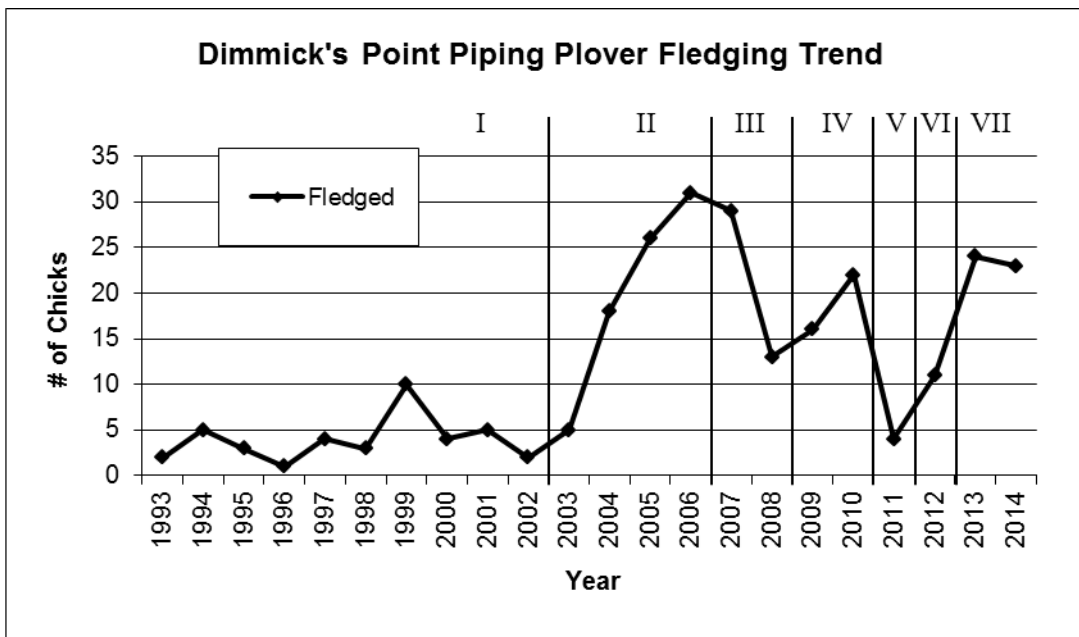


Figure 2. Piping plover chick fledging success at Dimmick’s Point, Sleeping Bear Dunes National Lakeshore. Periods marked I through VII refer to different phases of predator management (see main text).

## **Ludington State Park**

The only predator management activities implemented were nest exclosures. A nest exclosure is a welded wire fence that completely encloses the nesting plovers. It is buried 4 to 6 inches into the beach-sand to prevent access to egg predators, and has netting over the top to prevent predation from avian predators. The adult plovers gain access by walking through the spaces between the welded wires. The exclosure is very effective at protecting the nesting plovers and eggs (Larson et al, 2002, Stringham and Robinson 2015). However, piping plover chicks are precocial and leave the nest 4 hours after hatching. They remain flightless for approximately 27 days, which makes them very vulnerable to predation (Roche et al. 2008).

At LSP, plover monitors are responsible for locating individual plovers along a 6-mile section of Lake Michigan shoreline. Plover monitors were also responsible for documenting predators and predator tracks observed during their daily duties. Each location was only observed a few hours a day, making the task of witnessing a predation event very difficult.

Predators observed at LSP worth noting were crow, raven, ring-billed gull, herring gull and merlin. These are the same species found at Dimmick's Point.

## **RESULTS**

### **Dimmick's Point**

Predator abundance and behavior varied somewhat over the years and, consequently, so have predator management and results (Tables 1,

2). In the early years, crow and gull numbers were noticeably higher and required the majority of the management activities. Eventually, the crow and gull numbers were reduced, requiring less management effort. Conversely, the merlin numbers rose steadily and became the primary management concern.

Between 2003 through 2006, gull harassment played an important role in protecting plover chicks. At that time, it was common to see approximately 2,000 gulls using the plover habitat. Once the gulls were dispersed, the plovers nested in areas not observed by NSP monitors in the previous 10 years before management. Between 2007 through 2014 gull numbers declined and the harassment efforts were conducted with less frequency.

During the first 3 years of the project, crows were abundant, vocal, and predictable. Early on, the local crow population was high with multiple nesting pairs within a mile of the plover colony. Each crow nest had multiple subadults assisting with chick rearing duties. However, by the end of the 2005 season we noticed a significant change in crow behavior. The local surviving crow population was reduced, more wary, less vocal, and non-responsive to the electronic call.

Before predator management (1993-2002) the percentage of hatched plovers that fledged averaged 45%. When active predator management was applied from 2003-2014, the average number of hatched plovers that fledged rose to 62%.

Table 1. Summary of predator management effort (# of trips, # of days) by USDA-WS and predator management results to protect piping plovers at Dimmick's Point, Sleeping Bear Dunes National Lakeshore, MI. (AMCR = American crow, CORA= common raven, RBGU = ring-billed gull, HEGU= herring gull, MERL= merlin)

Year	Trips	Days	AMCR removed	CORA removed	MERL removed	RBGL removed	HEGU removed	Gulls dispersed
2003	2	13	23	0	0	50	6	750
2004	3	14	23	7	0	60	15	1200
2005	2	10	26	0	3	75	12	900
2006	3	10	14	0	0	200	0	3650
2007	1	6	17	0	0	15	0	400
2008	1	4	0	0	1	0	0	0
2009	2	6	6	0	1	57	0	400
2010	5	8	5	3	4	0	0	0
2011	2	8	2	0	1	8	0	700
2012	5	12	8	0	9	0	0	0
2013	4	13	7	0	10	6	0	800
2014	3	9	3	2	4	0	0	0
<b>TOTALS</b>	<b>33</b>	<b>113</b>	<b>134</b>	<b>12</b>	<b>33</b>	<b>471</b>	<b>33</b>	<b>8800</b>

Table 2. Piping plover nesting results at North Manitou Island, Sleeping Bear Dunes National Lakeshore, MI.

Year	PIPL Pairs	Eggs Hatched	PIPL chicks fledged	PIPL chicks/pair
2003	2	7	5	2.5
2004	7	26	18	2.57
2005	10	39	26	2.6
2006	12	40	31	2.58
2007	13	47	29	2.23
2008	12	32	13	1.08
2009	10	25	17	1.7
2010	10	27	22	2.2
2011	3	8	3	1
2012	8	28	11	1.375
2013	9	34	23	2.56
2014	10	35	25	2.5
<b>TOTALS</b>	<b>106</b>	<b>348</b>	<b>223</b>	<b>2.07</b>

### Ludington State Park

From 2003 to 2009 nesting success varied with several years of relatively good productivity followed by unproductive years, much like results at Dimmick's prior to predator

management (1993-2002) (Figure 3; Table 3). In 2013 and 2014 Ludington had extremely low productivity, possibly due to increased merlin predation.

Figure 3. Piping plover fledging success at Ludington State Park - without lethal predator management

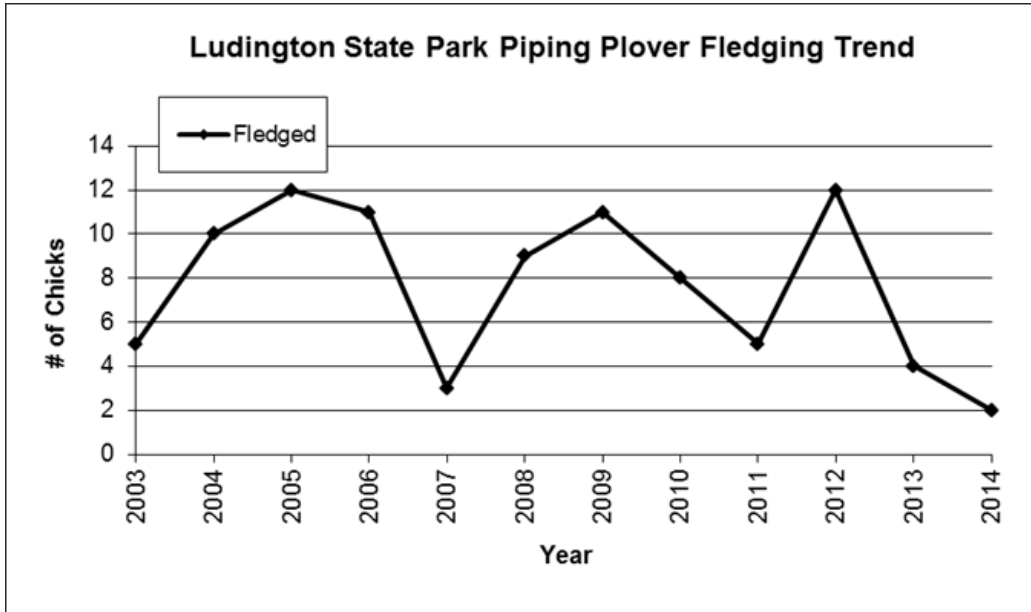


Table 3. Piping plover nesting success at Ludington State Park, MI from 2003 to 2014.

Year	PIPL Pairs	Eggs Hatched	PIPL chicks fledged	PIPL # chicks/ pair
2003	3	12	5	1.67
2004	3	11	10	3.33
2005	4	15	12	3
2006	7	25	11	1.57
2007	3	10	3	1
2008	4	15	9	2.25
2009	4	12	11	2.75
2010	5	20	8	1.6
2011	4	13	5	1.25
2012	7	26	12	1.71
2013	5	19	4	0.8
2014	6	15	2	0.33
TOTALS	55	193	92	1.77

**DISCUSSION**

Predators have been implicated in the decline of piping plovers and other similar beach nesting shorebirds (Ivan and Murphy 2005, Dinsmore et al. 2014). Efforts to increase plover survival have included the use of predator

exlosures and lethal predator control. A modeling study by Stringham and Robinson (2015) found that a combination of using both predator exlosures and lethal predator control was the best option for increasing piping plover abundance on the Atlantic Coast. While our

sample size is small, we have some evidence that this may be the case for Great Lakes piping plovers as well. Before predator management at Dimmick's (1993-2002), only 45% of chicks hatched survived to fledge. When active predator management was applied from 2003-2014, 62% of hatched chicks survived until fledging.

Although each site has somewhat different conditions and there is still a limited sample size to compare these locations, there is suggestive evidence that a combination of predator exclosures and lethal predator management at Dimmick's has been more successful than using predator exclosures alone at LSP. During this time period Dimmick's fledged 2.07 chicks per pair compared with 1.77 chicks per pair at LSP, this despite LSP averaging 3.6 chicks hatched per pair compared with 3.2 hatched per pair at Dimmick's. While monitoring and nest exclosures are key to hatching success, it may be that lethal predator management is one of the few ways to protect chicks during the vulnerable period between hatching and fledging. Dimmick's had a 62% fledge rate of chicks that were hatched after lethal predator control was instituted compared with only 49% of chicks fledged of those hatched at LSP during the same time period.

Merlins are very serious threats because they will take adult plovers and adults, especially experienced breeders that are critical to the long-term rebuilding of this population (LeDee et al. 2010). Merlins have been implicated in loss of many adult Great Lakes piping plovers (Roche et al. 2010). Lethal predator management is one of the few ways to reduce the presence of Merlins at Piping Plover breeding sites. This could lead to a long-term increase in plover abundance if this helps increase survival of breeding adult plovers.

Predators remain an important source of mortality in the Great Lakes piping plover population and present a barrier to recovery of this federally endangered population. A combination of predator exclosures and lethal predator management may be an important strategy to increase long-term plover survival and lead to population recovery.

## Lessons Learned

It was valuable that experienced employees were available for predator management. Experience paid off in not only in skill with management techniques but also in understanding predator behavior and patterns. Often the predators used the same habitats and were found at the same locations. These locations often took years to identify.

The NPS stationed plover monitors at Dimmick's and their astute observations of predators were extremely useful since Wildlife Services could not be on Dimmick's continuously.

Crows/ravens become wary and elusive when exposed to management and thus required elaborate measures to be successful. The following are our observations and recommendations for a successful crow/raven management program for the long term.

1. Initially crows/ravens were easy to call and would immediately start flying towards the sounds of the electronic call.
2. Eventually crows/ravens become call-shy and had to be coaxed in by diversifying calls.
3. Do not remove the crow/raven nest or chicks until all the adults have been collected.
4. Often crows/ravens can be found in the same locations year after year.
5. It may take several days to remove the last few educated crows/ravens from the targeted group.
6. Crows/ravens begin foraging at daybreak in the plover nesting area.

Gulls can be incredibly difficult to disperse because they seem to be slow to associate danger with humans, shooting and pyrotechnics. It may require several days of repetitive harassment to alter their habits. Initial harassment efforts may take all of the daylight hours and hundreds of pyrotechnics.

Merlins may be difficult to observe and thus require diligent surveillance. Most encounters with merlins in the plover nesting area occurred at dawn or dusk but can occur at any time. Merlins have a unique call which can be useful for locating a nest.



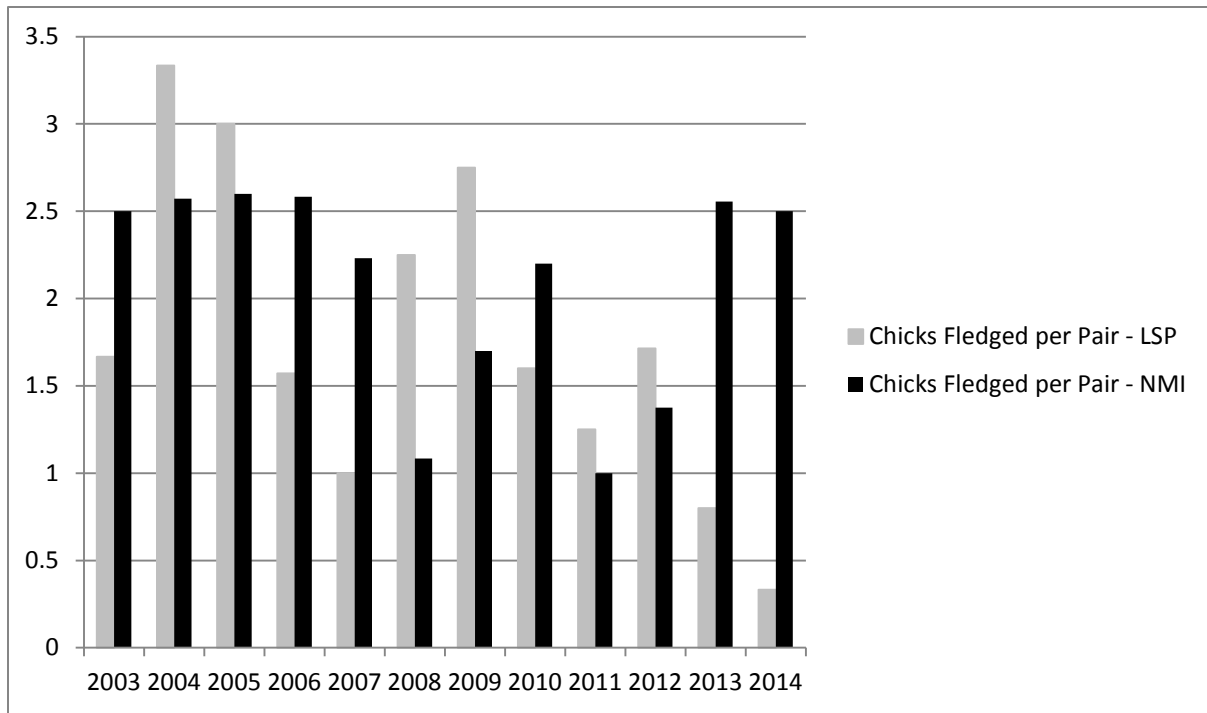


Figure 4. A comparison of piping plover chicks fledged per pair at Dimmick’s and LSP. The Recovery Goal is to maintain 1.5 chicks fledged per pair each season.

**MANAGEMENT IMPLICATIONS**

Predation can be a serious obstacle to the recovery of piping plovers. An effort to intervene on behalf of plovers needs to take into account the sudden and relentless nature of predation. Twelve years of experience at Dimmick’s which combined non-lethal measures with lethal removal appears to provide benefits for plovers. Keys to a successful strategy include the timely and prompt application of a full range of methods by skillful and experienced personnel.

**ACKNOWLEDGEMENTS**

Funding for plover protection at Dimmick’s was provided by both USFWS and Sleeping Bear Dunes National Lakeshore. We are very appreciative for the considerable support and guidance of the personnel of Michigan Department of Natural Resources and Sleeping Bear Dunes National Lakeshore. We would like

to thank Dr. Francie Cuthbert and her many graduate students for their work monitoring the Great Lakes piping plover each season and for compiling years of plover demographic information. We would also like to thank the many dedicated piping plover monitors who spend the summers watching over these rare and imperiled shorebirds of the Great Lakes. We credit Dave Marks and Brandi Saidy for their assistance with graphics in this paper. We extend our sincere gratitude to the Wildlife Services employees Dane Williams, Greg Rigney, Anthony Wilson, and Tony Aderman who worked with such determination and effectiveness in protecting piping plovers at Dimmick’s Point.

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