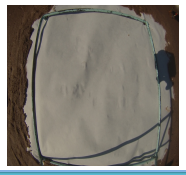
Invertebrate Abundance Near Piping Plover Nests in the Eastern Upper Peninsula of Michigan



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Abstract

Preservation of breeding habitat and careful monitoring of nesting sites has aided in the recovery of the endangered Great Lakes Piping Plover to a record 73 breeding pairs in 2015. While the required physical characteristics of breeding habitats, such as width of shoreline and substrate composition are well understood, the role of food abundance on nest site selection and nest success is poorly understood, partly due to the nature of traditional invertebrate sampling techniques that may pose a danger to the Piping Plovers themselves. We sought to create a passive invertebrate sampling technique to characterize invertebrate communities and determine whether food abundance near Piping Plover nesting sites is greater than the abundance of food in seemingly similar, non-selected nesting sites. BioCams recorded invertebrates within 0.09 m^2 frames every two seconds for four hours at each of the seven nesting locations (Grand Marais (2), Gulliver (2), Vermilion (2), and Port Inland, MI). The BioCams were simultaneously placed near nests at both the shore and dune, and at least 300 m away from active nests. We found BioCams were successful in their ability to identify invertebrates to taxonomic Order and estimate an abundance of available invertebrates without disturbing the Plovers. Dipterans dominated communities near nests and were the most abundant of all identified taxa (p=0.008). There was no variation in invertebrate abundance by proximity (near vs. away from nest) (p=0.436). While overall invertebrate abundance was not a primary factor in nest site selection for Piping Plovers, further study on specific orders and creation of a prey quality index may provide valuable information for future management of Great Lakes Piping Plovers.

Background

Piping Plovers (*Charadrius melodus*) are an endemic species that nest on the shorelines of the Great Lakes (Cairns 1980) and are distinguished into three geographic populations; the Atlantic and Great Plains populations, which are federally threatened, and the Great Lakes population, which are federally endangered (Haffner et al. 2009). Conservation efforts have brought the Piping Plover population from a low of 12 mating pairs to 73 mating pairs in 2015 (Cavalieri 2015). To further aid population recovery, we need to better understand the foraging habits and diet in order to enhance food resource assessments and identification of suitable habitats for the Piping Plover (Cuthbert et al. 1999). Haffner et al. (2009) used Arc GIS technology to determine that Piping Plovers use an average linear distance of 473 ± 53 meters along these wet sandy substrates to forage for invertebrates. Given the relatively small section of beach that is used for nesting, it seems probable that Piping Plovers may select nest sites based on invertebrate abundance. While we know Piping Plovers are visual predators, using site to locate invertebrates along the beach surface (Cuthbert et al. 1999), only Cuthbert et al. (1999) have examined gizzard contents to report actual prey eaten, leaving our best estimate of Plover diet to be a determination of invertebrate abundance along shorelines where Plovers feed. A complicating factor in such assessment is the potential for injury of Plovers by traditional sticky trap type invertebrate assessments. Therefore, the creation of a non-invasive/non-consumptive, or passive, invertebrate sampling technique for use in Piping Plover nest areas is warranted. A simple modification of National Geographic photographer David Littschwager's Biocube would likely allow for estimation of invertebrate abundance with minimal disturbance.

Objectives

The study objectives were (1) develop a non-invasive sampling technique (BioCam) to determine invertebrate abundance near piping plover nests (2) use the BioCam to characterize the invertebrate fauna available to Piping Plovers on the beaches of the Eastern Upper Peninsula of Michigan (3) determine whether or not invertebrate abundance is greater near Piping Plover nests than areas of adjacent beach.

Methods

Study Sites
- Two beaches on Lake Michigan (Gulliver and Port Inland)
- Two beaches on Lake Superior (Grand Marais and Vermilion)

BioCam Construction (Figure 1)
- Constructed using ¼ inch steel rod
- A 20 cm high A-frame was attached to a 0.09 m^2 frame
- A Go Pro camera was attached to a threaded rod that ran through a nut attached to the apex of the A-frame
- The Go Pro was pointed downward and centered above the square

Experimental Design (Figure 1)
- Two BioCams placed near the nest site
  - One BioCam was placed near the nest at the dune line (within 5 m)
  - One BioCam was placed in front of the nest at the high water line
- Two BioCams placed 300 m away from the nest site
  - One BioCam was placed at the dune line
  - One BioCam was placed at the high water line
- Freezer paper placed under the BioCam
- Go Pro cameras (3 - Hero III white, 1 - Hero silver plus) set to take pictures at two second intervals for four hours
- Pictures were viewed and any invertebrate within the 0.09 m^2 area was counted and identified to Order if possible
  - Unidentified invertebrates were placed into two categories
    - Large unknown: any invertebrate larger than a housefly
    - Small unknown: any invertebrate smaller than a housefly

Data Analysis
- Percent similarity (Pielou 1975) - Invertebrate communities within site by proximity (near vs away)
- T-test - Total invertebrate abundances by proximity (near vs away)
- ANOVA (systat) - Invertebrate taxa abundance and abundance by proximity (near vs away)

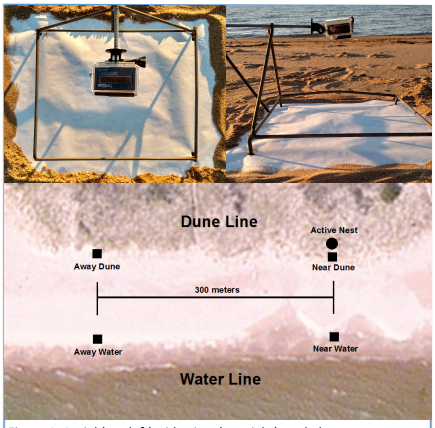

Figure 1. Aerial (top left), side view (top right), and placement (bottom) of the BioCam setups near and away from nests.

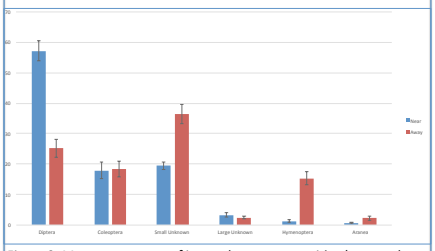

Figure 2. Mean percentage of invertebrate communities (near and away from Piping Plover nest) represented by identified taxa.

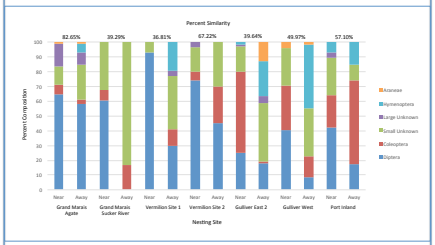

Figure 3. Invertebrate community composition (%) near and away with percent similarity values from Piping Plover nests at seven locations in Michigan's Eastern Upper Peninsula.

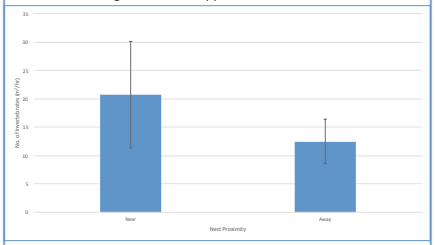

Figure 4. Total abundance of invertebrates near and away from Piping Plover nests at seven locations in Michigan's Eastern Upper Peninsula.

Results

BioCams
- Successfully surveyed invertebrates
- Can be used for a wide range of studies
- Resolution dependent on Go Pro model

Invertebrate Community Characterization
- Overall community by proximity (near, away) (Figure 2)
  - Near nests dominated by Diptera
  - Hymenoptera most represented in samples away from nests
- Within site invertebrate communities (% similarity) (Figure 3)
  - Mean value = 52.24%
  - Most similar – Grand Marais Agate: 82.65%
  - Least similar – Vermilion Site 1: 36.81%

Invertebrate Abundances
- Overall invertebrate abundance similar by proximity (p=0.436) (Figure 4)
- Dipterans most abundant overall (p=0.008) but not by proximity (p=0.142)
  - Diptera (21.34 ± 4.70 m^2/h)
  - Coleoptera (10.76 ± 4.61 m^2/h)
  - Hymenoptera (3.94 ± 1.29 m^2/h)

Discussion

Biocams were successful in documenting invertebrates to Order and estimating invertebrate abundance. However, they only allow us to see Piping Plover habitats in 2-dimensions. Piping Plover chicks have been observed gleaning insects from beach vegetation (Cuthbert et al. 1999), so a 2-dimensional view may not allow us to collect all abundance data, but simple modifications could be added to incorporate this data. Resolution of smaller invertebrates could be improved with higher quality camera.

Three taxa dominated the invertebrate communities (Diptera, Hymenoptera, and Coleoptera) and were also the three most abundant of the 6 represented orders present in gizzard contents of juvenile Piping Plovers necropsied from Grand Marais, MI in 1996 and 1997 (Cuthbert et al. 1999). Since the Orders identified by the BioCams in this study correlate to the Orders of the Grand Marais study, this suggests that Diptera, Hymenoptera, and Coleoptera are indeed a main diet source for Piping Plovers in the Great Lakes region. Invertebrate community structure near nest sites appeared different than that away from the nest as evident by the percent of community composition represented by Dipterans and Hymenopterans, respectively. Although invertebrate abundance did not differ by nest proximity, the observed difference in community composition may be an indication of quality in nest site selection. Given the limited sampling replicates in this study data, collection in subsequent years should be conducted to further explore this hypothesis.

While overall invertebrate abundance was not a primary factor in nest site selection, it may have influenced fledging success and chick survival as starvation-induced weakness can lead to lower Piping Plover chick survival (Loegering and Fraser 1995). Chick mortality may be related to three factors-quality of foraging habitat, predation rates, and human disturbance (Patterson et. al. 1991). Future research should examine the importance of invertebrate abundance and community structure in relation to nest site selection and chick survival with special attention to determining an index of quality in invertebrate prey sources.

Acknowledgements

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