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Novel method for monitoring common terns at a large colony in northern Lake Huron, USA

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ABSTRACT

Novel monitoring and management techniques may be required when working with colonial waterbirds nesting on anthropogenic sites. We tested the utility of fixed sampling frames (quadrats) for estimating number of common tern (*Sterna hirundo*) nests and colony dynamics at a site in northern Lake Huron, U.S.A. We also examined whether within-season herbaceous vegetation management affected number of nests. We were unable to detect any avoidance of fixed quadrats (N = 15) versus staked quadrats (N = 15) over 10 count days in 2015 (Mann-Whitney, $P \geq 0.16$). Both distance from human disturbance (m) and Julian day were significant ($P < 0.01$) predictors of number of nests. Based on these findings and using quadrat data from peak count days each year from 2011 to 2016, we estimated a low of 1100 nests in 2013 and a high of 2000 nests in 2016. We also were unable to detect any differences in the number of nests in quadrats with vegetation treatments (N = 10) versus controls (N = 10) during 11 counts in 2016 (Mann-Whitney, $P \geq 0.18$). For common terns, and potentially other colonial waterbirds breeding on anthropogenic sites in the Great Lakes, we conclude that a fixed quadrat methodology may provide a useful way of estimating colony size and colony dynamics. Future studies should be conducted to compare our novel method with more traditional monitoring techniques.

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Introduction

The common tern (*Sterna hirundo*) is a species of conservation priority in six of the nine states bordering the Great Lakes. As such, the Great Lakes population of common terns is a management priority for the Midwest administrative region of the U.S. Fish and Wildlife Service (USFWS) (Cuthbert et al., 2003). According to Morris et al. (2010), the common tern population in the Great Lakes decreased 19% from 1976 to 2009, with a mean decline of approximately 1% per year. Throughout the late 20th century, common terns were displaced from low lying islands, shoals, and other natural nesting areas due to high water levels (Shugart and Scharf, 1983). Nesting birds often relocated to anthropogenic structures such as piers, jetties, and navigational structures (Courtney and Blokpoel, 1983). Such sites currently contain a significant number of the common tern colonies in the U.S. Great Lakes (Cuthbert et al., 2003; Morris et al., 2010, 2012). However, because many of these sites are attached to the mainland, they allow better access for mammalian predators that are often absent from islands (e.g., domestic dog, *Canis lupus familiaris*, other canids, domestic cat, *Felis catus*). Human disturbance can also be a concern at these sites.

One of the challenges for conservationists is the ability to accurately and/or precisely estimate the size of a population unit within the constraints of resource limitations (e.g., time and money) and disturbance concerns (Bookhout, 1994). For Great Lakes populations of common terns or other colonial waterbirds (e.g., double-crested cormorants, *Phalacrocorax auritus*; ring-billed gulls, *Larus delawarensis*; herring gull, *L. argentatus*; Caspian terns, *Hydroprogne caspia*) that are often monitored by direct nest counts (Cuthbert and Wires, 2011), human disturbance during monitoring may present opportunities for eggs and chick predation by gulls or may induce additional stress in birds already nesting in areas with human activity. Because anthropogenic sites used by colonial waterbirds may be dissimilar to sites that are more natural and may have different conservation issues associated with them, such as predator or vegetation management, more novel monitoring techniques may be required.

Since the late 1990s, a common tern colony has been located on a pier at the U.S. Coast Guard (USCG) facility in northern Lake Huron; monitoring and management of the birds, their breeding habitat, and potential predators are the responsibility of Seney National Wildlife Refuge (NWR). Because this colony is the largest known common tern colony in the upper Great Lakes (Cuthbert and Wires, 2011) and is located on a pier perched 4 m above Lake Huron, monitoring is important, but challenging. Conducting complete ground-based (direct) nest counts among the monoculture of herbaceous vegetation increases the odds

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that chicks and eggs are crushed. Moreover, the time required for such an effort increases stress on adults early in the breeding season (mid-May) and the likelihood of hatch-year birds jumping off the pier and drowning later in the season prior to fledging (early July). Consequently, monitoring the number of nests within the site has been accomplished by using a square sampling frame made of polyvinylchloride (PVC) tubing placed and left on the ground in a manner more commonly done with vegetation sampling (Bookhout, 1994). Because these quadrats are not removed between counts and can be systematically or randomly placed prior to the arrival of nesting birds each spring, this approach ultimately requires less time to sample, reduces the need to walk throughout the site, provides the basis for a statistical extrapolation to estimate the total number of nests in the colony and, when combined with data derived from digital motion cameras, provides the ability to evaluate management concerns that affect productivity (e.g., predation). When combined with vegetation management, the use of quadrats fixed in space and over time may allow for evaluation of vegetation patterns at the same time nest counts are conducted. However, the efficacy of using fixed quadrats for estimating colony size has not been reported in the literature. If effective, this approach may have broad utility for monitoring common terns and other colonial waterbirds nesting on anthropogenic sites elsewhere in the Great Lakes (Cuthbert et al., 2003, Morris et al., 2010, 2012).

Our overarching research question was: do data derived from fixed quadrats provide a useful estimate of the number of breeding common terns within a breeding season? We addressed this question by examining these related questions:

1. Do common terns avoid nesting within fixed quadrats made of PVC tubing?
2. Does a gradient in nesting density exist across the site and how might this affect colony size estimates?
3. What are point estimates for the size of the colony?
4. Does vegetation management used to minimize herbaceous cover within a breeding season affect the number of nests?

Methods

Study area

The study site was located within a 0.097 ha area at the east end of the active USCG pier in northern Lake Huron, St. Ignace, Michigan (N45°51′19″, W84°42′5″). An electrified, chain-link fence (~2.5 m in height with 6.25 cm mesh) was constructed to separate birds from USCG personnel and exclude mammalian predators: striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), domestic dog, domestic cat, red fox (*Vulpes vulpes*), and mink (*Mustela vison*). The pier extended east approximately 125 m into Lake Huron. The most western 74 m of the pier is where the USCG vessel *BISCAYNE BAY* and visiting vessels moored; this area also has an associated parking lot where most human activity occurred. The remaining 51 m at the eastern end of the pier was composed of a uniform rocky substrate on which herbaceous vegetation grew. This area of the pier was the location where navigational structures were stored during winter months, where common terns nested, and where vegetation management occurred.

Nest count and vegetation treatment protocol

Since 2011, multiple nest counts were conducted across multiple days each year using fixed quadrats in a frame constructed of 1.25 cm diameter polyvinylchloride (PVC) tubing glued together using PVC elbows (hereafter, fixed PVC quadrat). Because in some years there was a considerable amount of debris (e.g., building material, navigational devices) on the site, we systematically or randomly placed these quadrats on the ground. The weight and low profile of these fixed PVC quadrats precluded high winds from moving them. Based on the number of nests recorded in these fixed PVC quadrats during the maximum nest count day each year, we then extrapolated these density values (i.e., 1.47 nests m^{-2}, 1.41 nests m^{-2}, 1.10 nests m^{-2}, 1.53 nests m^{-2}, 2011–2014) over the entire area to estimate the size of the colony (unpub. data). However, by the end of the 2014 field season we realized there were two potential flaws in our approach: 1) we did not know whether birds avoided nesting in fixed PVC quadrats and 2) we did not know if a nesting gradient existed along the pier. Therefore, in 2015 we tested whether birds avoided nesting in fixed PVC quadrats and examined to what extent a nest gradient existed over the breeding season.

We established and maintained 30 1 m × 1 m sampling areas in three columns (east-west) throughout the site. Sampling areas were equally spaced 3.5 m apart. Of the overall 30 sampling areas, 15 consisted of fixed PVC quadrats while the other 15 were each marked by a 2 cm dowel (hereafter, staked quadrat) placed at quadrat center (a movable frame would later be used to sample staked quadrats, see below). Both fixed PVC and staked quadrats were arranged in an alternating pattern (Fig. 1). This systematic sampling was chosen over sampling at random to increase efficiency and reduce the likelihood of stepping on eggs and young. As such, and due to the uniformity of the site in terms of vegetation and other features, our methods follow the general guidelines of Anderson et al. (1979) for the use of transects in wildlife studies.

In 2016, we tested whether the management of herbaceous vegetation within a breeding season affected the density (number) of nests. In a review of management actions taken at tern colonies, Lamb (2015) indicated that vegetation is commonly managed at many sites to prevent secondary succession; but that the efficacy of these management

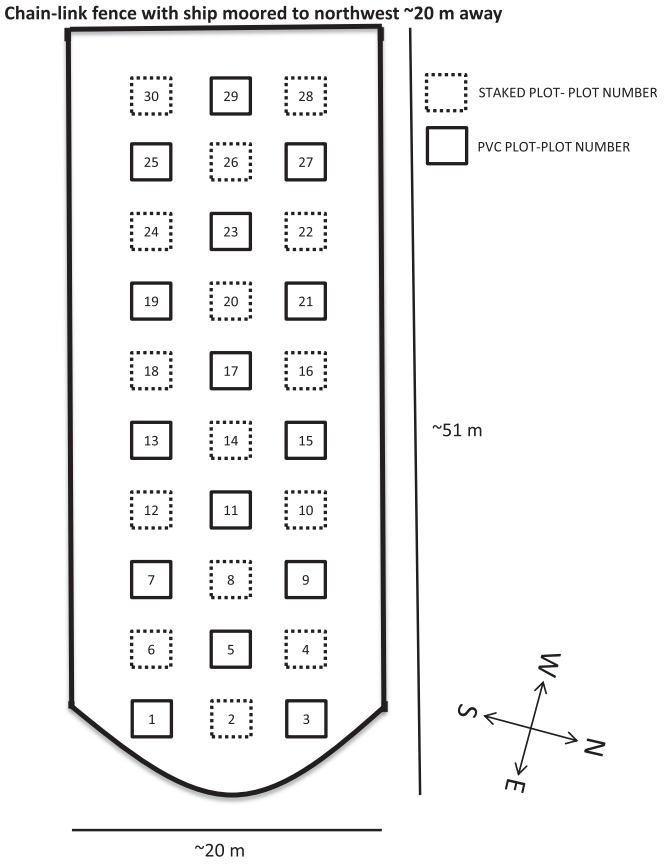

Fig. 1. Layout of U.S. Coast Guard pier St. Ignace, MI with locations of 30 1-m^2 common tern monitoring quadrats (2015). Map is not to scale as only ~3% of the site was sampled by quadrats.

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