Influence of Arctic Terns on Survival of Artificial and Natural Semipalmated Plover Nests

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Abstract.—Survival of Semipalmated Plover (Charadrius semipalmatus) nests was compared in areas with and without nesting Arctic Terns (Sterna paradisaea) to determine whether the protection provided to plovers by association with this colonial species is passive or aggressive. Artificial and natural nests placed ≤100 m from terns had similar rates of survival (<10% of all nests lost to predators), and benefited substantially from protection against predators through aggressive behavior of nesting terns. Natural nests had much higher survival than artificial nests when positioned >100 m from nesting terns, suggesting that the presence of incubating adult plovers reduces the probability of nest predation. Nesting in association with Arctic Terns may represent an alternate form of habitat selection by Semipalmated Plovers and suggests that plovers can employ alternate nest defense strategies when opportunities are present. Received 22 July 2005, accepted 29 November 2005.

Keywords.—Arctic Tern, artificial nests, Charadrius semipalmatus, nest defense behavior, interspecific nest association, nest survival, Semipalmated Plover.

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Nest predation is a major cause of reproductive failure in ground-nesting birds (Alberico et al. 1991; Martin 1993). Shorebirds (Order Charadriiformes) that nest in exposed sites exhibit diverse antipredator tactics, including a variety of aggressive and passive nest defense behaviors, to enhance nest success (Gochfeld 1984; Larsen et al. 1996). Passive defense includes distraction displays and related behavior (e.g., injury-feigning display) intended to lure predators away from nests. Aggressive defense is behavior intended to intimidate or discourage the approach of a potential predator (e.g., mobbing display), and may be costly because shorebirds risk injury or death by predators. Consequently, shorebirds that use passive defense behaviors may opportunistically nest near aggressive colonial species to gain protection against predators to minimize costs and risk (Burger 1987; Powell 2001; Lauro and Tanacredi 2002; Nguyen et al. 2003). Aggressive colonial species provide protection against predators by means of communal defense or information delivered by intraspecific neighbors (Dyrcz et al. 1981; Burger 1987; Powell 2001). The exploitation of such interspecific nest associations appears to be opportunistic because these species may not regularly share similar breeding habitat or period (Burger 1987; Lauro and Tanacredi 2002). Further, individuals that nest near aggressive colonial species do not always have greater nest success than individuals that nest far from colonial species (Alberico et al. 1991; Mayer and Ryan 1991; Kellett et al. 2003).

The benefits of nesting near aggressive colonial species have been inferred from studies of survival of natural nests of shorebirds (Dyrcz et al. 1981; Burger 1987; Alberico et al. 1991; Nguyen et al. 2003). The use of artificial nests may help elucidate the mechanism that shorebirds use to obtain protection against predators in the presence of colonial species (i.e., determine whether the benefit is due to aggressive behavior of colonial species toward predators, passive behavior by providing an early warning system from the colony, or both). Artificial nests do not have incubating adults that could have exploited the early warning system of a colony. If artificial nests without incubating adults have survival rates similar to natural nests when both are near colonial species,
protection is probably through aggressive colony behavior.

In this study, both artificial and natural Semipalmated Plover (Charadrius semipalmatus) nests were used in areas with and without colonial Arctic Terns (Sterna paradisaea) to determine what benefits were derived from association with terns, if any. Artificial and natural plover nests placed in proximity to terns were predicted to experience higher survival than nests placed farther from terns, and natural plover nests were predicted to experience higher nest survival than artificial nests due to the presence of incubating adults that could afford additional nest protection. Additionally, survival of plover nests was examined between years and study areas that varied in the size of the tern colonies.

Study Area

The study was conducted on two areas on Akimiski Island (53°11'N, 81°35'W) in western James Bay, Nunavut, Canada between June and July in 2003 and 2004. Research was conducted on approximately 1102 ha area (hereafter called the main study area) containing a small Arctic Tern colony (<20 pairs) in an area of 17 ha. Another study area containing about 30 pairs of terns in an area of 38 ha, located 10 km from the main study area, was included in the study in 2004. Both study areas had vegetation dominated by creeping goose grass (Puccinellia phryganodes) in the lower intertidal marsh, and red fescue (Festuca rubra), Baltic rush (Juncus balticus), and Hoppner’s sedge (Carex subspathacea) in the upper intertidal marsh and supratidal area (Blaney and Kotanen 2001). Plovers nested in a range of densities on sand beaches and sand-gravel depositional areas surrounded by mudflats. The most common potential predators included Herring Gulls (Larus argentatus), Common Ravens (Corvus corax), American Crows (Corvus brachyrhynchos), and Red Foxes (Vulpes vulpes).

Methods

Nest Searching and Monitoring

The study areas were searched for plover nests by walking systematically through intertidal and supratidal habitats, flushing adults from nests, or using parental behavior as cues to nest presence (Nol and Blanken 1999). Nests were rechecked at 3-day intervals using a Global Positioning System (GARMIN International, 1999) and nest searching was directed by searching for plovers nesting in the same area. Logistic constraints (i.e., need for helicopter access to the remote second study area) limited monitoring of these artificial nests to 7 days. Care was taken to approach the nests from different directions to avoid creating obvious paths for potential predators. If a potential predator was detected, the nest was not approached until the predator moved away.

Statistical Analysis

Daily survival rates of natural nests in the main study area were estimated using a linear logistic exposure model (Rotella et al. 2004; Shaffer 2004) in PROC GENMOD (SAS Institute 2000). This statistical approach is similar to logistic regression, where the regression coefficients describe the effects of the explanatory variable(s) on daily nest survival rate (Shaffer 2004). Year (2003 or 2004), distance to Arctic Terns (≤100 or >100 m), and the interaction term between year × distance to Arctic Terns were considered potential candidate models in explaining variation in nest survival. Although the causes of year effects are often unknown, year was modeled because annual variation in nest success is common (Nol et al. 1997). The strength of each model was interpreted from 95% confidence intervals based on unconditional standard errors (Burnham and Anderson 2002).

The effects of study area did not influence nest success of natural plover nests ≤100 m of Arctic Terns in 2004 (Fisher’s exact test, n.s.), so nest survival results of artificial and natural nests in both study areas were pooled in subsequent analysis. Daily nest survival was calculated to fit a logistic-exposure model to nest type (natural or artificial), distance to Arctic Terns (≤100 or >100 m), and nest type × distance to Arctic Terns interaction (Rotella et al. 2004; Shaffer 2004). Values are presented as means ±SE.

The corrected Akaike’s Information Criterion (AICc) was used to identify the model that best explained variability in survival (Burnham and Anderson 2002). This information-theoretic approach evaluates the relative strength of multiple models of the relationships between daily nest survival and explanatory vari-
ables by ranking those models according to the fit of the
data relative to the number of parameters in the model
(i.e., principle of parsimony). The best model has the
lowest AICc value, and differences in AICc values be-
tween the best overall model and candidate models can
be used to assess the likelihood of those models. Differ-
ences in AICc values <2 indicate substantial support for
candidate models, differences between 4 and 7 indicate
candidate models have considerably less support, and
differences >10 indicate candidate models are very un-
likely (Burnham and Anderson 2002).

RESULTS

Patterns of Nest Survival

Fifty-eight Semipalmated Plover nests were
found in 2003, of which 30 (52%) hatched, 13
(22%) failed due to predation, 5 (9%) were
abandoned, and 10 (17%) had uncertain
fates. Seven of these plover nests were located
≤100 m from Arctic Terns, of which 5 (71%)
hatched. Forty-eight plover nests were found
in the main study area in 2004, of which 10
(21%) hatched, 30 (63%) failed due to preda-
tion, 2 (4%) were abandoned, 4 (8%) had un-
certain fates, and 2 (4%) still had incubating
plovers in late July when we left the study area.
Ten of these plover nests were located ≤100 m
from terns, of which 8 (80%) hatched. All 26
artificial nests (100%) in the main study area
>100 m from terns failed within 14 days.

In the second study area in 2004, all 9
plover nests (100%) were found ≤100 m
from terns and still had incubating adults in
late June. Only one of 16 artificial nests (6%) posi-
tioned ≤100 m from terns in the second
study area failed within 7 days.

Nest Association with Arctic Terns

The linear logistic-exposure model of
natural nests in the main study area showed
that year was important for variation in nest
survival (intercept: 2.672 ± 0.193; 2003 year:
1.271 ± 0.340). Daily nest survival of natural
plover nests was significantly higher in 2003
than in 2004 (0.981 ± 0.005, N = 43 and 0.935
± 0.011, N = 44, respectively). Distance to
Arctic Tern was also important for variation
in nest survival (intercept: 4.920 ± 0.710;
>100 m from Arctic Terns: -1.903 ± 0.728).
Survival of plover nests was significantly
higher when placed ≤100 m from terns than
when placed >100 m from terns (0.993 ±
0.004, N = 15 and 0.953 ± 0.024, N = 72,
respectively). No regression coefficients for
the effects of the year × distance to Arctic
Terns interaction were different from zero,
suggesting that the effect of distance to terns
was similar in both years.

The interaction between nest type × dis-
tance to Arctic Terns best explained the vari-
ation in daily survival of all nests, and was ≥30
AICc units better than all other models. The
model predicted that daily nest survival de-
creases when natural or artificial nests are
>100 m from terns (Table 1). These daily nest
survival rates also reflected that all artificial
nests placed >100 m from terns were lost pri-
or to 24 days, the length of the incubation pe-
riod for plovers (Nol and Blanken 1999).
Natural and artificial nests placed ≤100 m
from terns had similar rates of survival.

DISCUSSION

Semipalmated Plover nest survival dur-
ing 2003 was similar to those of populations
in Churchill, Manitoba (Nol et al. 1997), and
other members of the same genus, including
Piping Plovers (C. melodus, Burger 1987; Lau-
ro and Tanacredi 2002) and Snowy Plovers
(C. alexandrinus, Powell 2001). However, nest
survival during 2004 was the lowest reported

Table 1. Mean ± SE (N) daily survival rates of natural and artificial Semipalmated Plover (Charadrius semipalmatus)
nests located ≤100 and >100 m from Arctic Terns (Sterna paradisaea) on Akimiski Island, Nunavut, Canada, 2004.
The model including the interaction term of nest type × distance to Arctic Tern was best supported using the cor-
corrected Akaike’s Information Criteria (AICc; Burnham and Anderson 2002).

<table>
<thead>
<tr>
<th>Nest Type</th>
<th>Distance to Arctic Tern</th>
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<tbody>
<tr>
<td></td>
<td>≤100 m</td>
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<tr>
<td>Natural Nest</td>
<td>0.996 ± 0.004 (16)</td>
</tr>
<tr>
<td>Artificial Nest</td>
<td>0.977 ± 0.016 (16)</td>
</tr>
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cies may be an alternate form of habitat se-
est predation in areas far from Arctic Terns. 

Survival of artificial Piping Plover nests was similar 
ner colonial and semi-colonial American 
and active defence by incubating adult plovers 
and the presence of 

survival than artificial nests when positioned 
higher level of protection because they are 
are rarely left unattended during incubation 
Additionally, many plover species have elaborate 
function as antipredator 

tactic is a trade-off between advertising nest 
parent risk injury or death. In 
this study, artificial nests positioned >100 m 
from terns suffered much higher mortality 
from plover nests, indicating that nest 
displays that function as antipredator 
In this study, artificial nests positioned >100 m 
from terns benefited substantially from pro-
tection against predators and had similar rates 
of survival (<10% of all nests lost to predators). 
Conversely, natural nests had much higher 
survival than artificial nests when positioned 
>100 m from nesting terns. We conclude that 
protection from predators for plovers nesting 
are often placed near terns as Arctic Terns 
and those who do not is warranted. 
There may be post-hatch costs associated 
with nesting near a colony as Arctic Terns 
were observed being physically aggressive 
towards Semipalmated Plover chicks in one 
case, and deserves further study.

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Literature Cited

Nesting near a Common Tern colony increases and 
decreases Spotted Sandpiper nest predation. Auk 
108: 904-910.

Blaney, C. S. and P. M. Kotanen. 2001. The vascular flora 
of Akimiski Island, Nunavut Territory, Canada. Ca-
nadian Field-Naturalist 115: 88-98.

Burger, J. 1987. Physical and social determinants of nest-
site selection in Piping Plover in New Jersey. Condor 
89: 811-818.

Burnham, K. P. and D. R. Anderson. 2002. Model selec-
tion and multi-model inference: A practical informa-
thetoric approach. 2nd ed. Springer-Verlag, New York, NY.

Cresswell, W. 1997. Nest predation: The relative effects of 
egg characteristics, clutch size and parental be-

Dyrcz, A., J. Witkowski and J. Okulewicz. 1981. Nesting of 'timid' waders in the vicinity of 'bold' ones as an 
antipredator adaptation. Ibis 123: 542-545.

and distraction displays of shorebirds. In J. Burger 
and B. L. Olla (Eds.), Behavior of marine animals: 
Current perspectives in research, Vol. 5; Shorebirds: 
Breeding behavior and populations. Plenum Press, 
New York, NY.

Nest-site selection, interspecific associations, and 

Larsen, T., T. A. Sordahl and I. Byrkjedal. 1996. Factors 
related to aggressive nest protection behaviour: A