Home range analyses of shorebirds wintering along the Gulf of Mexico, Florida, USA

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Gabbard, C., Sprandel, G. & Cobb, D. 2001. Home range analyses of shorebirds wintering along the Gulf of Mexico, Florida, USA. *Wader Study Group Bull.* 96: 79–85.

Radio telemetry was used to document wintering shorebird use at sites centred around Lanark Reef on the north coast of the Gulf of Mexico in Florida, United States. The 50 and 95% convex polygon home range estimates for 10 Willets *Catoptrophorus semipalmatus* averaged 0.52 km^2 and 14.85 km^2, respectively. Fifty and 95% convex polygon home range estimates for two Grey Plovers *Pluvialis squatarola* averaged <0.01 km^2 and 0.10 km^2, respectively. Fifty and 95% convex polygon for one Marbled Godwit *Limosa fedoa* and one Long-billed Curlew *Numenius americanus* were 0.32 km^2 and 6.72 km^2, and 0.36 km^2 and 24.41 km^2, respectively. Shorebirds generally remained on Lanark Reef, or travelled between the reef and the nearby mainland, or at low tide travelled from the reef to mudflats 17 km away. Additionally, some of the shorebirds showed decreased movement as the season progressed. Protection of Lanark Reef, the more productive mudflats, and roosting piers would help provide a sustainable habitat for these species.

INTRODUCTION

Twenty-five of 49 species of shorebirds that regularly breed in North America winter in Florida (Sprandel *et al.* 2000). Because of rapid coastal development in Florida (Kautz 1993), protection of key shorebird sites is a conservation priority (Millsap *et al.* 1990). The tendency of wintering shorebirds to congregate at only a few sites makes them susceptible to disturbance and habitat loss. In addition, there is a paucity of information about site-use and movements of wintering shorebirds in North America. Indeed the only studies of range-size are of wintering Western Sandpipers *Calidris mauri* in San Francisco Bay that showed high site-fidelity with a mean home range of 22 km^2 (Warnock & Takekawa 1995, 1996) and wintering Piping Plovers *Charadrius melodus* in Texas that also showed strong site fidelity, with home-ranges averaging 12.6 km^2 (Drake *et al.* 2001). Previous studies (e.g., Colwell & Cooper 1993, Sprandel *et al.* 2000) have shown high variability in shorebird counts. We hoped that by understanding local movements and site-use we would be able to plan future surveys in a way that would minimize such variability. Therefore this study was carried out both to further knowledge of shorebird movements and to understand the way they use an important Florida wintering site.

Lanark Reef, a small island in the Florida panhandle, is the state's most important wintering shorebird area, with a daily average of 1,872 birds of 15 species (Sprandel *et al.* 2000). The purpose of this study was to examine winter home ranges of selected shorebird species in the vicinity of this site. We used radio telemetry to examine distance between feeding and roosting areas at Lanark Reef during the two winters, 1995–1996 and 1996–1997. We targeted species that were large enough to carry a radio transmitter, could be easily observed, and occurred in concentrations that made trapping possible. These were: Willet *Catoptrophorus semipalmatus*, Grey Plover *Pluvialis squatarola* (also called Black-bellied Plover), Marbled Godwit *Limosa fedoa*, American Oystercatcher *Haematopus palliatus* and Long-billed Curlew *Numenius americanus*.

STUDY AREA

The Lanark Reef shorebird area consists of sites east of the Carrabelle River to Bay North on the northeast shore of the Gulf of Mexico, Florida (Figure 1). This coastline is characterized by medium-energy waves, a small tidal range, sandy beaches, cool winters (7°C average), and light, but increasing, development. The west end of Lanark Reef is located at 84°34.979'W, 29°52.416'N, about 1 km south of the mainland. Dog Island is located 5 km south of Lanark Reef and subdues the erosional effect of storm surges on Lanark Reef (Jim Ladner, FL Geological Survey, pers. comm.). Human activity on the reef during our study period was minimal.

Lanark Reef comprises mostly sand flats (of sand and shell fragments) with mud flats occurring at low tide at the eastern and western ends. Tides are twice-daily with an average difference between mean high tide and mean low tide of 0.85 m (International Marine 1997). At low and high tides, 0.3 and 0.02 km^2 of the reef are exposed, respectively (G. Sprandel, unpubl. data). The middle of the reef is densely vegetated with seagrass *Thalassia* spp., *Halodule wrightii*,

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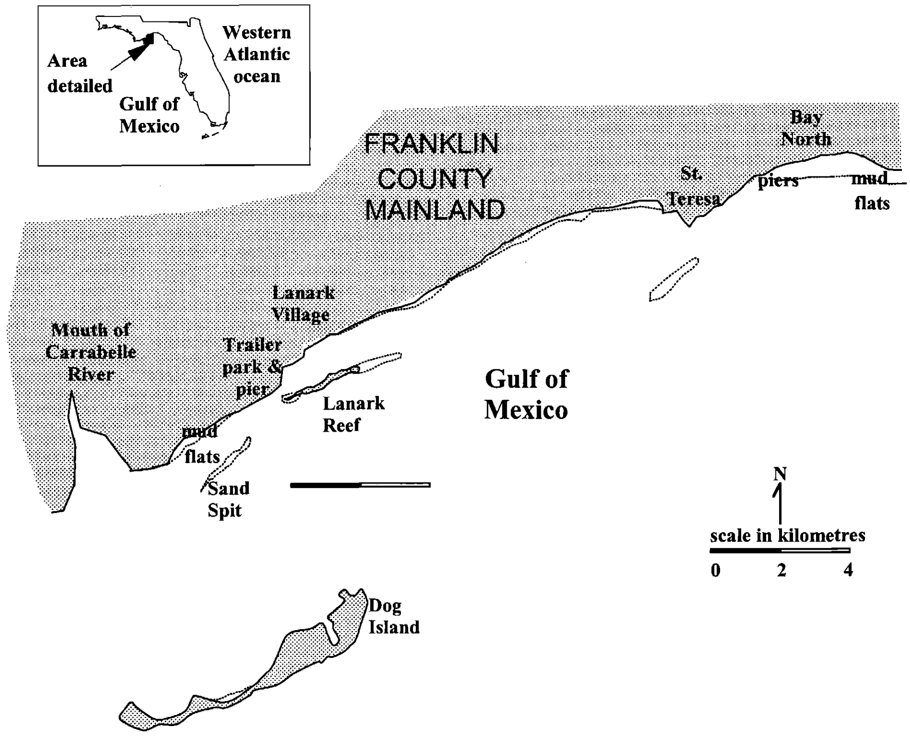

Figure 1. Lanark Reef and vicinity, Franklin County, Florida, United States, 1995–97. The dashed line represents the intertidal area at low tide.

and *Syringodium filliforme* and small succulent bushes *Salicornia* spp. (Wolfe *et al.* 1988), becoming sparse toward the east and west ends.

On the mainland, around Lanark Village and Bay North, are moderate-density single-family residences and trailer parks. Around St Teresa are low-density single-family homes while the coast from St Teresa to Lanark Village is undeveloped. At Bay North, roughly 150 m of mud flats are exposed perpendicular to the shoreline at low tide with the same submergent seagrasses as on Lanark Reef. In the St Teresa and Bay North area are five 70 m long wooden piers, and west of Lanark Village several shorter piers. The area usable for feeding or roosting depends upon the tide level.

METHODS

Shorebirds were trapped at high tide on Lanark Reef when there were roosting congregations of >200 individuals. We trapped from 11 November to 15 December 1995 and from 12 November to 11 December 1996. We initially attempted trapping during the day using mist nets (AFO Mist Nets, PO Box 1770, Manomet Ma, 02345, USA), a Fundy pull trap (Hicklin *et al.* 1989), and a net gun (Coda Enterprises Inc., 1038 E. Norwood, Mesa, AZ, 85203, USA). These attempts were unsuccessful. Subsequently we trapped at night using two-tiered mist nets with a tan colour on the bottom tier and a black net above with a total height of 7 m. High tide limited the availability of exposed land for birds to roost. Therefore nets were placed in close proximity (<50 m) to the roost sites and birds were caught flying to and fro. After the nets were in place, 3–4 observers walked slowly toward the roosting birds and at 20 m made loud noises and flashed lights to flush them toward the nets.

The target species were fitted with a United States Fish and Wildlife Service leg ring and unique combination of colour-coded UV-resistant plastic leg rings (A.C. Hughes Ltd., 1 High Street, Hampton Hill, Middlesex, TW12 1NA, UK). In 1995, we fitted birds with 6 g radio transmitters with a range of 2 km and a life expectancy of 3 months (American Wildlife Enterprises, 275 West High St., Monticello, FL 32344, USA). These were either glued to the bird's lower back (Warnock & Warnock 1993) using an epoxy adhesive (No. 332, Titan Corporation, 5629 208th St. S.W., Lynwood, WA 98036, USA) or fitted on the birds with a standard backpack harness (Rappole & Tipton 1991) of 36 kg test Dacron cord. During the 1996 trapping season, a smaller (3.5 g), cryptically coloured (grey or black depending on species coloration), and hermetically sealed transmitter (Holohil Systems Ltd., 112 John Cavanagh Rd., Carp, Ontario, Canada K0A 1L0) was glued on target individuals. We targeted species for which the transmitter was <3% of their body mass. Non-target species or individuals <185 g were weighed, ringed and released.

Location of transmittered birds began after a 3-day acclimatization period (White & Garrott 1990) and continued to the end of February. Searches were conducted using a Telonics receiver (Telonics, Inc., 932 E. Impala, Mesa, AZ, 85204, USA) and a 3-element yagi antenna. The study area was searched by boat or car 5 days/week from 10:00 to 17:00. When a signal was heard, the bird was visually located, and coordinates from the bird's exact location were recorded using a Trimble Global Positioning System (GPS) receiver and differentially corrected (Trimble Navigation, Ltd., 645 North Mary Ave, Sunnyvale, CA, 94088, USA). When birds could not be located from the ground, standard aerial location procedures were used (Mech 1983) and the GPS location was recorded where the radio signal was strongest. Wind speed and direction, temperature, and tide height were recorded concomitantly with radio telemetry data. Locations were recorded for an individual bird only if

Table 1. Home range estimates for 14 wintering shorebirds from December–February 1995–96 and 1996–97 near Lanark Reef, Franklin County, Florida, USA.

Species ID	N[a]	Core area[b] (km^2)	50% usage[c] (km^2)	95% usage[c] (km^2)	95% Distance[d] (km)	Max Distance[e] (km)	Pattern[f]
Grey Plover							
109	11	0.35	<0.01	0.04	0.5	0.5	1
032	32	4.21	<0.01	0.15	0.5	4.3	1
Willet							
125	10	0.25	0.34	2.91	2.4	4.0	2
154	38	2.75	0.03	4.21	4.6	5.2	2
210	55	19.97	0.82	4.97	2.8	8.7	2
350	11	8.84	0.18	5.29	5.6	16.5	3
469	22	24.49 [g]	2.59	65.88	25.7	49.9	4
529	25	7.74	0.02	6.32	18.0	18.9	3
550	56	9.01	1.10	11.08	16.8	17.2	4
572	16	0.62 [g]	0.14	10.89	16.8	16.8	3
631	53	24.56 [g]	1.21	34.59	16.9	16.9	3
651	43	5.03	0.08	2.36	3.0	5.2	2
Marbled Godwit							
310	27	11.56	0.32	6.72	7.6	23.8	4
Long-billed Curlew							
189	58	11.57 [g]	0.36	24.41	18.1	18.1	3

[a] N is the number of independent telemetry locations, including the capture location.
[b] Core area was calculated using the harmonic mean method.
[c] The 50% and 95% use areas were computed with the convex polygon method.
[d] The linear distance between furthest points on the 95% convex polygon.
[e] The maximum distance between observed points.
[f] In pattern 1, birds were restricted to Lanark Reef; in pattern 2, birds travelled 1–2 km between the reef and the mainland; in pattern 3 the birds travelled 14 km between the reef and a feeding area; in pattern 4 there was a similar bimodal distribution at the beginning of the winter but the range was reduced later.
[g] This area is the sum of the two bimodal core areas.
[h] Bird moved to Shell Point during mid-season.

they were at least half an hour apart, in order to give the bird ample time to traverse its home range to ensure independent observations (White & Garrott 1990).

Home range is the area traversed by an individual shorebird in its normal activities of feeding, roosting, and flight. Home range analyses were conducted using the program Home Range (Ackerman *et al.* 1990). We analysed data for birds with at least 10 telemetry locations, including the capture location. The area where an animal spends most of its time is known as the core area. Two nonparametric home range estimates, the minimum convex polygon (Mohr 1947) and the harmonic mean (Dixon & Chapman 1980), were used to calculate the core area and the home range within a 95% and 50% use polygon. A 95% convex polygon is the smallest area derived by connecting observation points such that the resultant polygon encloses 95% of all observations and the internal angles do not exceed 180 degrees. Similarly, the 50% convex polygon connects observation points to construct a polygon that is the smallest area containing 50% of the observation points. The harmonic mean method looks at the probability of encountering an animal on a grid by calculating the harmonic mean of the distance from the grid node to the observed location (White & Garrott 1990). In spite of biases introduced by grid-size and inaccuracies due to geographic borders (Worton 1987), the harmonic mean allowed modelling bimodal use within a shorebird's home range. Grid-points for the harmonic mean estimator were set at $x = 35$, $y = 16$; and plot scale 1550 m = 2.54 cm. The convex polygon estimator has a lower variance for home ranges where there are geographic barriers, such as the Gulf of Mexico and the reef orientation (Boulanger & White 1990, White & Garrott 1990). These home range polygons allow us to identify the areas of high use (roost and feeding sites) and to compute distances between roost and feeding sites.

RESULTS

From 11 November to 15 December 1995, we trapped on 8 nights and 5 days, capturing 16 target individuals (3 Grey Plovers, 5 American Oystercatchers, and 8 Willets). No shorebirds were captured during the day using mist-nets, net-gun, or the Fundy pull-trap, probably because the trapping devices were too conspicuous. Transmitters were attached to all 16 birds (eight with harnesses and eight with glue). By the seventh week of the first winter field season, the remains of six birds were located, apparently killed by predators. By the end of the field season nine of the remaining transmittered birds were missing (neither signal heard nor remains found) and only one Grey Plover remained in the study. From 12 November to 11 December 1996, we trapped on 16 nights and captured 31 target shorebirds (3 Grey Plovers, 5 American Oystercatchers, 18 Willets, 3 Marbled Godwits, 1 Long-billed Curlew and 1 Red Knot). By the end of the season, 19 of the transmittered birds were missing. There were no known mortalities in the second field season. Approximately 75% of the catches occurred during high tide and dark skies

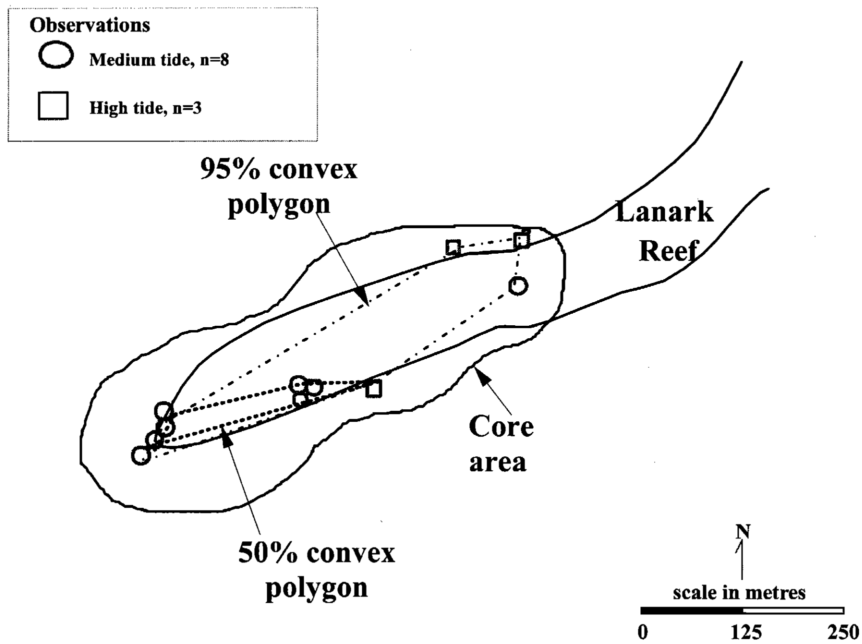

Figure 2. The 50% and 95% convex polygon home ranges and core area for Grey Plover 109 based on 11 telemetry locations in Franklin Co., Florida, United States, 2 December 1995–20 February 1996.

(new moon or heavy cloud cover) with low wind speeds.

Of the 47 transmittered birds, 10 Willets, 2 Grey Plovers, a Marbled Godwit, and a Long-billed Curlew had at least 10 locations for calculating home ranges (Table 1). Primary roosting areas used by the shorebirds in 1995–1997 were Lanark Reef, the shore by the trailer park, and the piers (Figure 1). The main feeding areas were Lanark Reef, the sand spit, the mud-flats east of Bay North and near St Teresa (Figure 1).

DISCUSSION

The transmittered shorebirds tended to use a single feeding and roosting area within their home range. For the 14 birds with at least 10 locations (Table 1), just 7% of the telemetry locations were found outside these feeding and roosting areas. When comparing movement among the shorebirds, four patterns become apparent. Because of small sample sizes for Grey Plover, Marbled Godwit and Long-billed Cur-

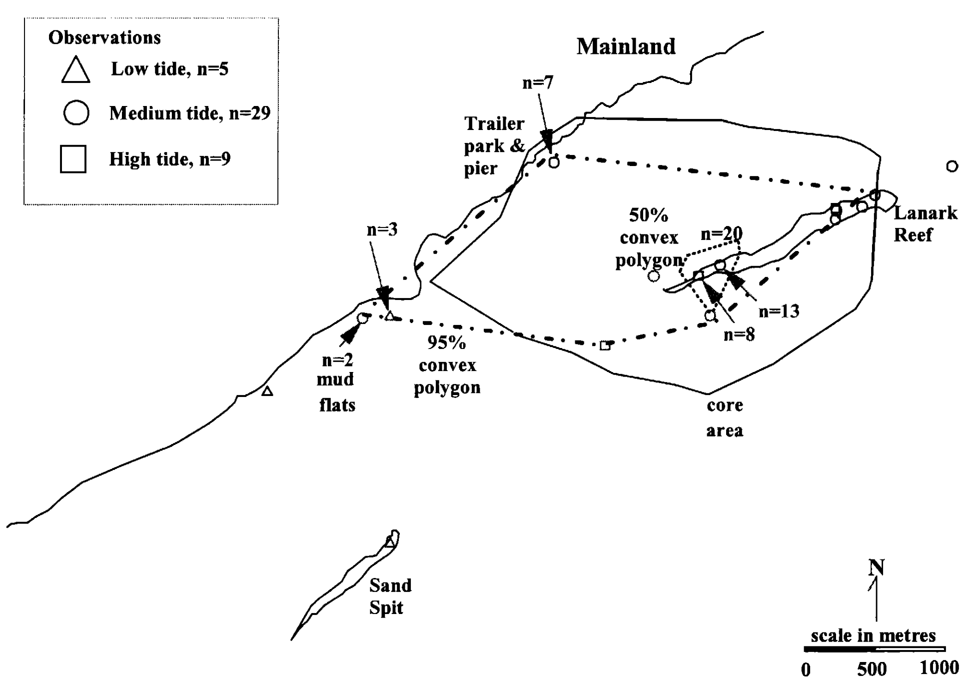

Figure 3. The 50% and 95% convex polygon home range and core area for Willet 651 based on 43 telemetry locations in Franklin Co , Florida, United States, 6 December 1996–19 February 1997.

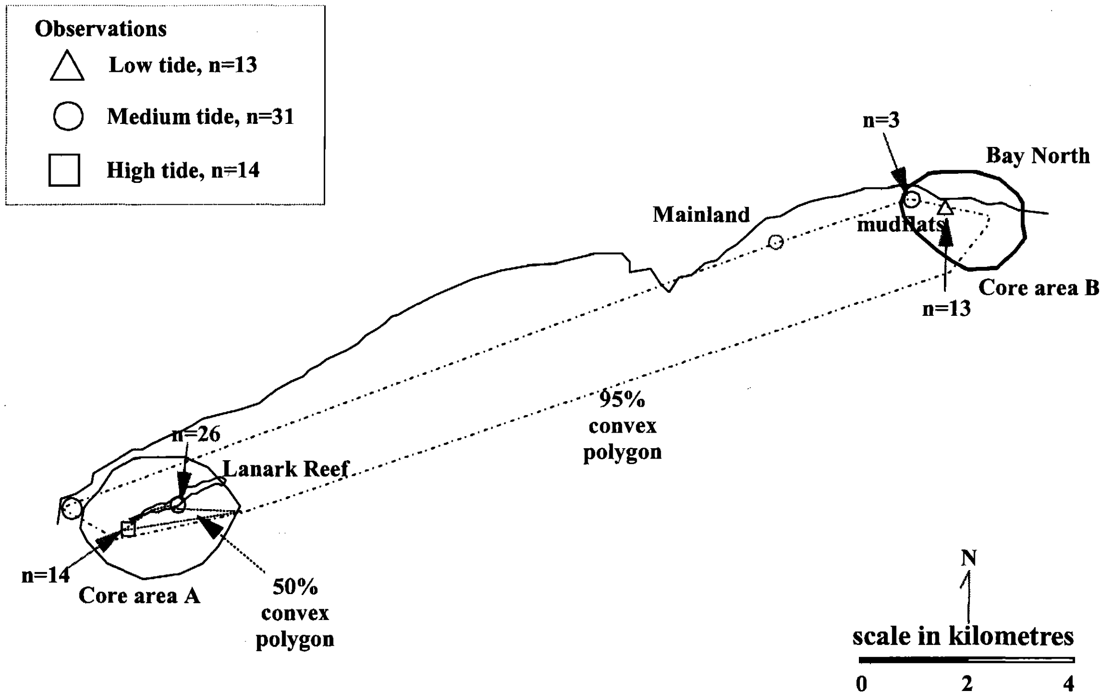

Figure 4. The 50% and 95% convex polygon home range and core areas for Long-billed Curlew 189, based on 58 telemetry locations in Franklin Co., Florida, United States, 11 December 1996–27 February 1997.

lew generalizations cannot be made from these data. Also, although five American Oystercatchers were caught each year none were located at least 10 times.

Pattern 1 was shown by the two Grey Plovers that used Lanark Reef for both feeding and roosting at both low and high tide (Figure 2) and that ranged just 0.5 km (Table 1). For this pattern, most of the area of the home range polygons was usable for both feeding and roosting. Other studies have reported similar distances for Grey Plover: Symonds & Langslow (1984) reported movements within the same 3-km-wide Scottish bay; Wood (1986) reported movements of 2–3 km at Teesmouth, England; and Turpie (1995) reported nonbreeding territories in South Africa ranging from 0.0005 to 0.003 km^2. Dugan (1981) reported 2–3 km movement between day and night areas

Pattern 2 consisted of movement between Lanark Reef and the nearby mainland (e.g., Figure 3). This pattern was exhibited by four Willets (identification numbers 125, 154, 210 and 651). The two farthest points on the 95% convex polygon for each of these birds were <4.6 km apart and contained one core area. Most of the 50% convex polygon included habitat that appeared suitable for feeding or roosting at some point in the tidal cycle, while for the 95% and core area polygons about 20% appeared suitable for feeding or roosting. Generally, these birds roosted during mid-to-high tides (0.3 m to 0.7 m) on Lanark Reef, the shore and pier by the trailer parks and wood pier to the northwest of Lanark, and fed during low-to-mid tides (–0.2 m to 0.3 m) on the sand spit and the mudflats to the north of Lanark Reef on the mainland. Similarly, Kelly & Cogswell (1979) found that Willets wintering in San Francisco Bay primarily used two high tide roosts with feeding areas within 1 km.

In pattern 3, the birds travelled an average of 14 km between the reef and a feeding area depending on the tide height (Figure 4). Of the five shorebirds displaying this pattern (Willets 350, 529, 572, and 631, and the Long-billed Curlew) three had two core areas (Table 1). For the 50% convex polygon and for the core area(s), roughly 25% of the area was suitable feeding or roosting habitat, but for the 95% polygon perhaps less than 5% of the area was suitable for these purposes. Most of these birds fed during the lower tides at the mudflats on the mainland, east of Bay North, and north of the sandspit, and areas northeast of St Teresa. Occasionally, birds were also seen feeding on Lanark Reef. Common roost sites included Lanark Reef, three piers along the mainland, and the trailer parks to the north. The piers in particular provided roost areas near feeding areas (Figure 1.). Local movements between feeding and roosting areas have been documented for many shorebird species such as Dunlin *Calidris alpina* (Warnock *et al.* 1995, Warnock 1996).

Pattern 4 was a bimodal distribution, but the area contracted as the winter season progressed. Although Willet 469 began the season exhibiting bimodal habitat use around Bay North and Lanark Reef, after 17 January 1997 it was found exclusively at Shell Point (a 1-km stretch of shore) 17 km to the northeast, outside the main study area. Willet 550 had a bimodal distribution using Lanark Reef and common roosting and feeding sites around Bay North. However, after 23 January 1997, Willet 550 was found primarily within a few kilometres of Bay North. Similarly, Rompré & McNeil (1996) observed changes in the local movements of Willets within a winter. Competition among individuals may cause shifts in habitat use within a season (Duffy *et al.* 1981). In addition, because Willets breed in the area (G. Sprandel, unpubl. data), they might exhibit reduced movement if they start pairing and territory selection at an early date. Marbled Godwit 310 started out with a bimodal distribution including Lanark and the Bay North mud flats, but was not found on the eastern half of the study area after 17 January 1997, and had a 95% use area of 7.6 km. Luther (1968) reported that roost and feeding sites averaged 6.1 km apart for the Marbled Godwit.

Movements of shorebirds within the Lanark Reef complex may be the result of trade-offs between expending energy in travel and arriving at better feeding areas (Evans 1976, Connors *et al.* 1981) and may also be influenced by severe weather (Smith *et al.* 1999). Many factors affect prey availability in an area (Goss-Custard 1984) and additional studies looking at how shorebirds respond to invertebrate densities (e.g. Kalejta & Hockey 1994) in this area of Florida are needed. Additionally we cannot say if nocturnal patterns would be similar (Dugan 1981, Smith *et al.* 1999). Why individuals of the same species showed different activity patterns is unclear, perhaps the pattern is determined during their first winter (Townshend 1985). The observed patterns did not appear to be dependant upon either the number of locations or the range of dates the birds were observed.

The high mortality (6 individuals) during the first year cannot be completely explained. The transmitters used were heavier in first year than in the second year (6 g vs. 3.5 g), and had a shiny black reflective surface that might have attracted the attention of predators. Three of the depredated Willet remains were found with an owl pellet. Both Barred Owl *Strix varia* and Great Horned Owl *Bubo virginianus* occur in the area. However the only owl observed on Lanark Reef was Short-eared Owl *Asio flammeus*, a rare visitor to Florida that only occurred in the first year and may have affected shorebird patterns that season (Hilton *et al.* 1999) or caused age-dependent segregation (Cresswell 1994). Predation occurred on birds fitted with a backpack and also on those with glued transmitters. Warnock & Warnock (1993) state that feather clipping would result in heat loss in cold weather, but the first winter temperatures on average were not colder than the second.

Identification of shorebird feeding and roosting sites is most useful for conservation if there is consistency in annual use and site fidelity (Kelly & Cogswell 1979). One Willet ringed on Lanark Reef in a 1994 pilot study was observed in the winter of 1996–1997 on the mainland and in winter 1997–1998 on Lanark Reef. The Long-billed Curlew was observed in the winter of 1997–1998 feeding near Bay North. Additionally, the Marbled Godwit ringed in this study was observed again in the area in the autumn of 1999. Concentrated use by shorebirds of the reef and nearby mainland feeding areas has been observed for nine winters (G. Sprandel, unpubl. data.).

CONCLUSION

Although predicting the impact of the loss of a single wintering site may be difficult (Goss-Custard *et al.* 1995), we believe that observed areas of high use such as Lanark Reef and Bay North mudflats should be the highest priority for protection. We also suggest maintaining or rebuilding wood piers as roost sites near key feeding areas. Owing to its stability, high use by shorebirds, and minimal disturbance, Lanark Reef is an optimal area for preservation and for the continued monitoring of these wintering species.

ACKNOWLEDGEMENTS

Heather Bolte, Barbara Cerauskis, Stuart Cumberbatch, Kevin Enge, Jeff Gore, Alex Kropp, and Karen Lamonte assisted in trapping. Bob and Grace Evans provided a safe harbour for boat launching. Michael Vaughan provided great advice for problems encountered while completing this paper. Jeff Gore, Karen Lamonte, Doug McNair, Glenn Reynolds, Humphrey Sitters, and Nils Warnock provided helpful comments on this manuscript.

REFERENCES

Ackerman, B.B., Leban, F.B., Samuel, M.D. & Garton, E.O. 1990 *User's manual for program home range.* College of Forestry, Wildl. Range Exp. Stn., Univ. Idaho, Moscow.

Boulanger, J.G., & White, G.C. 1990. A comparison of home-range estimators using Monte Carlo simulation. *J. Wildl. Manage.* 54: 310–315.

Colwell, M.A, & Cooper, R.J. 1993. Estimates of coastal shorebird abundance: the importance of multiple counts. *J. Field Ornith.* 64: 293–301.

Connors, P.G., Myers, J. P., Connors, C.W.W. & Pitelka, F.A. 1981 Interhabitat movements by Sanderlings in relation to foraging profitability and the tidal cycle. *Auk* 98: 49–64.

Cresswell, W. 1994. Age-dependent choice of redshank (*Tringa totanus*) feeding location: profitability or risk? *J. Anim. Ecol.* 63: 589–600

Dixon, K.R., & Chapman, J.A. 1980. Harmonic mean measure of animal activity areas. *Ecology* 61: 1040–1044.

Drake, K.R., Thompson, J.E., Drake, K. L. & Zonick, C. 2001. Movements, habitat use, and survival of nonbreeding Piping Plovers. *Condor* 103: 259–267.

Duffy, D.C., Atkins, N. & Schneider, D.C. 1981. Do shorebirds compete on their wintering grounds? *Auk* 98: 215–229.

Dugan, P.J. 1981. The importance of nocturnal foraging in shorebirds: a consequence of incresed invertebrate prey activity. In N.V. Jones & W. J. Wolff (eds.). *Feeding and survival strategies of estuarine organisms.* Plenum Press, New York.

Evans, P.R. 1976. Energy balance and optimal foraging strategies in shorebirds: some implications for their distributions and movements in the non-breeding season. *Ardea* 64: 117–139.

Goss-Custard, J.D. 1984. Intake rates and food supply in migrating and wintering shorebirds. Pages 233–270 *in* J. Burger & B.L. Olla, eds *Shorebirds: migration and foraging behaviour. Behavior of marine animals.* Vol. 6. Plenum Press, New York, N.Y.

Goss-Custard, J.D., Caldow, R.W.G., Clarke, R.T., Durrel, S.E.A. le V. dit., Urfi, J. & West, A. D. 1995. Consequences of habitat loss and change to populations of wintering migratory birds: predicting the local and global effects from studies of individuals. *Ibis* 137: 56–66.

Hicklin, P.W., Hounsell, R.G. & Finney, G.H. 1989. Fundy pull trap a new method of capturing shorebirds. *J. Field Ornith.* 60: 94–101

Hilton, G.M., Ruxton, G.D. & Cresswell, W. 1999. Choice of foraging area with respect to predation risk in redshanks: the effects of weather and predator activity. *Oikos* 87: 295–302.

International Marine. 1997. *Tide tables 1997, high and low water predictions, east coast of North and South America.* International Marine, Camden, Maine.

Kalejta, B., & P.A.R. Hockey. 1994. Distribution of shorebirds at the Berg River Estuary, South Africa, in relation to foraging mode, food supply and environmental features. *Ibis* 136: 33–239.

Kautz, R. S. 1993. Trends in Florida wildlife habitat 1936–1987. Fla. Sci 56: 7–24.

Kelly P.R., & Cogswell, H. L. 1979. Movements and habitat use by wintering populations of Willets and Marbled Godwits. *Stud. Avian Biol* 2: 69–82.

Luther, J.S. 1968. *Populations and behavior of wintering Marbled Godwits in relation to tide cycles on Hayward Shore of San Francisco Bay.* M.S. Thesis, California State College at Hayward.

Mech, D.L. 1983. *Handbook of animal radio-tracking.* Univ. Minnesota Press, Minneapolis.

Millsap, B.A., J. Gore, D.E. Runde, & S. Cerulean. 1990. *Setting priorities for the conservation of wildlife species in Florida.* Wildl Monogr. No. 111.

Mohr, C.O. 1947. Table of equivalent populations of North American small mammals. *Am. Midl. Nat.* 37: 223–249.

Rappole, J.H., & Tipton, A.R. 1991. New harness design for attachment of radio transmitters to small passerines. *J. Field Ornith.* 62: 335–337

Rompré, G. & McNeil, R. 1996. Variability in day and night feeding habitat use in the Willet *Catoptrophorus semipalmatus* during the non-breeding season in northeastern Venezuela. *Wader Study Group Bull* 81: 82–87.