

# Bound Together or Loose Ends? Foraging Associations in Red Knots



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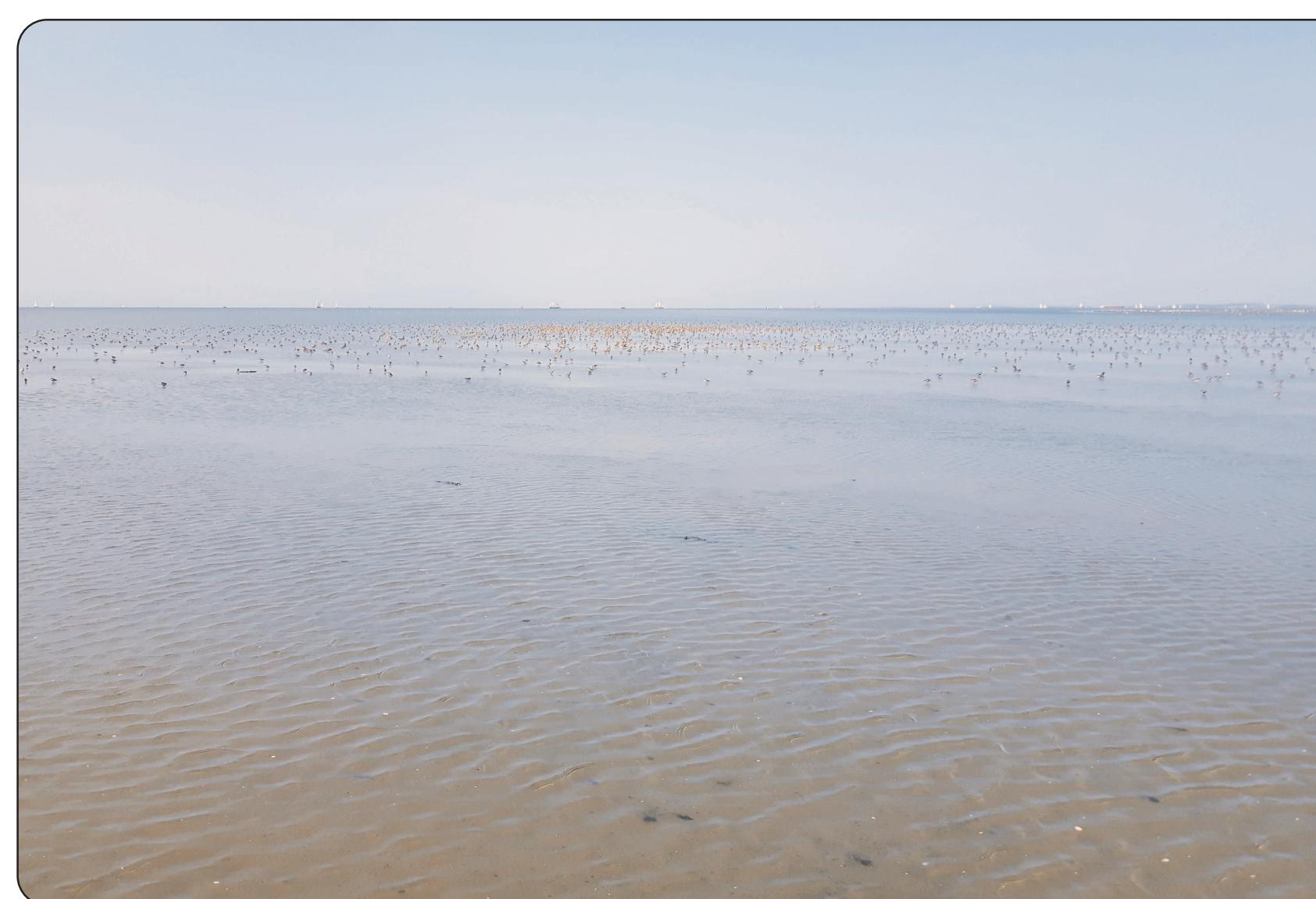
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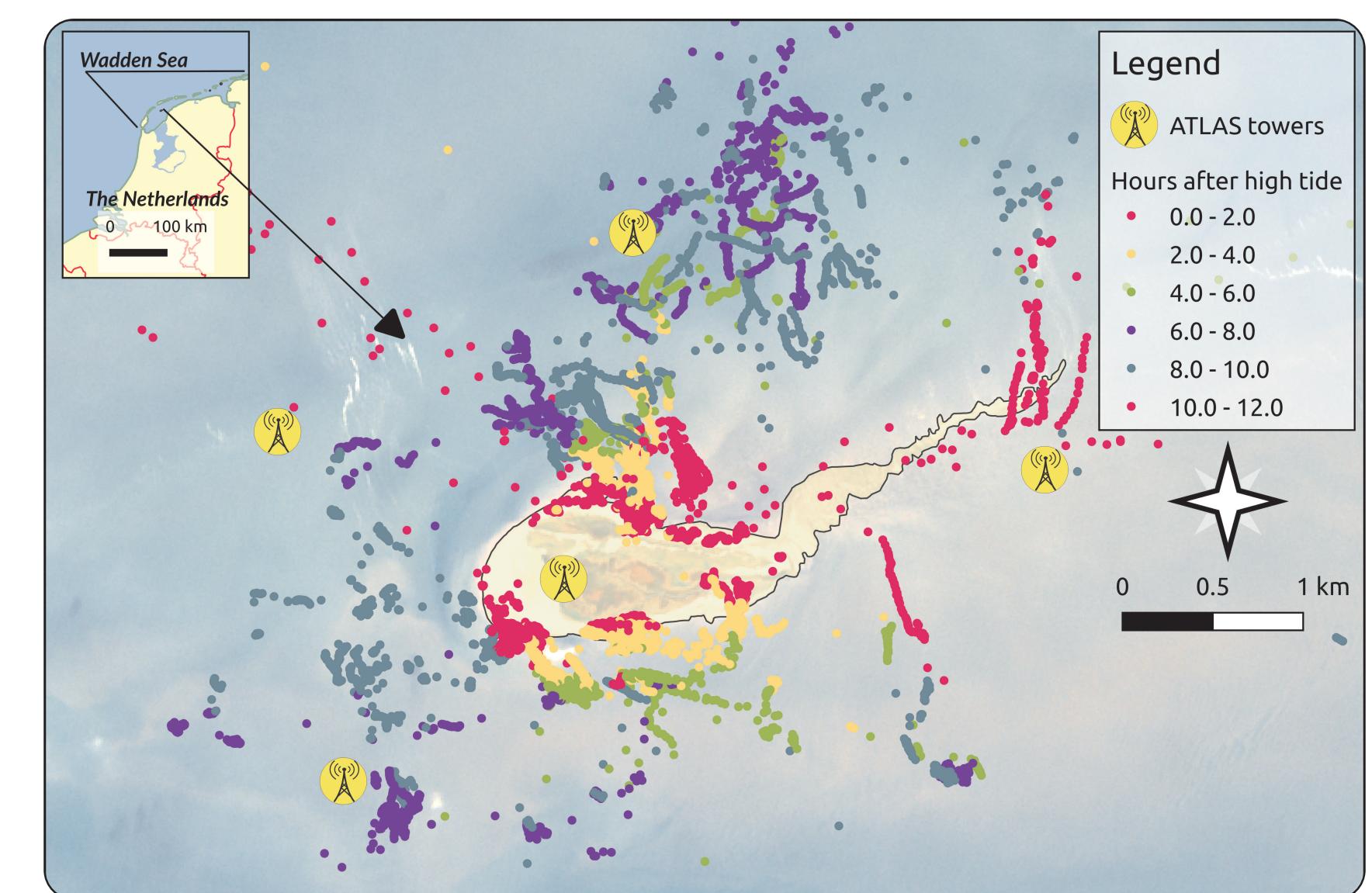
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- Waders such as red knots *Calidris canutus* gather in large flocks in the Wadden Sea, where they forage on the intertidal mudflats;
  - Knots use social information in the lab to find food<sup>1</sup>, and learn the location of foraging patches by observing flock-mates<sup>2</sup>;
  - Knots benefit from associations, but do they have 'friends' – persistent, non-random associations – within & between tidal intervals<sup>3,4</sup>?



**Fig. 1** Wadden Sea mudflats at low tide, with foraging waders



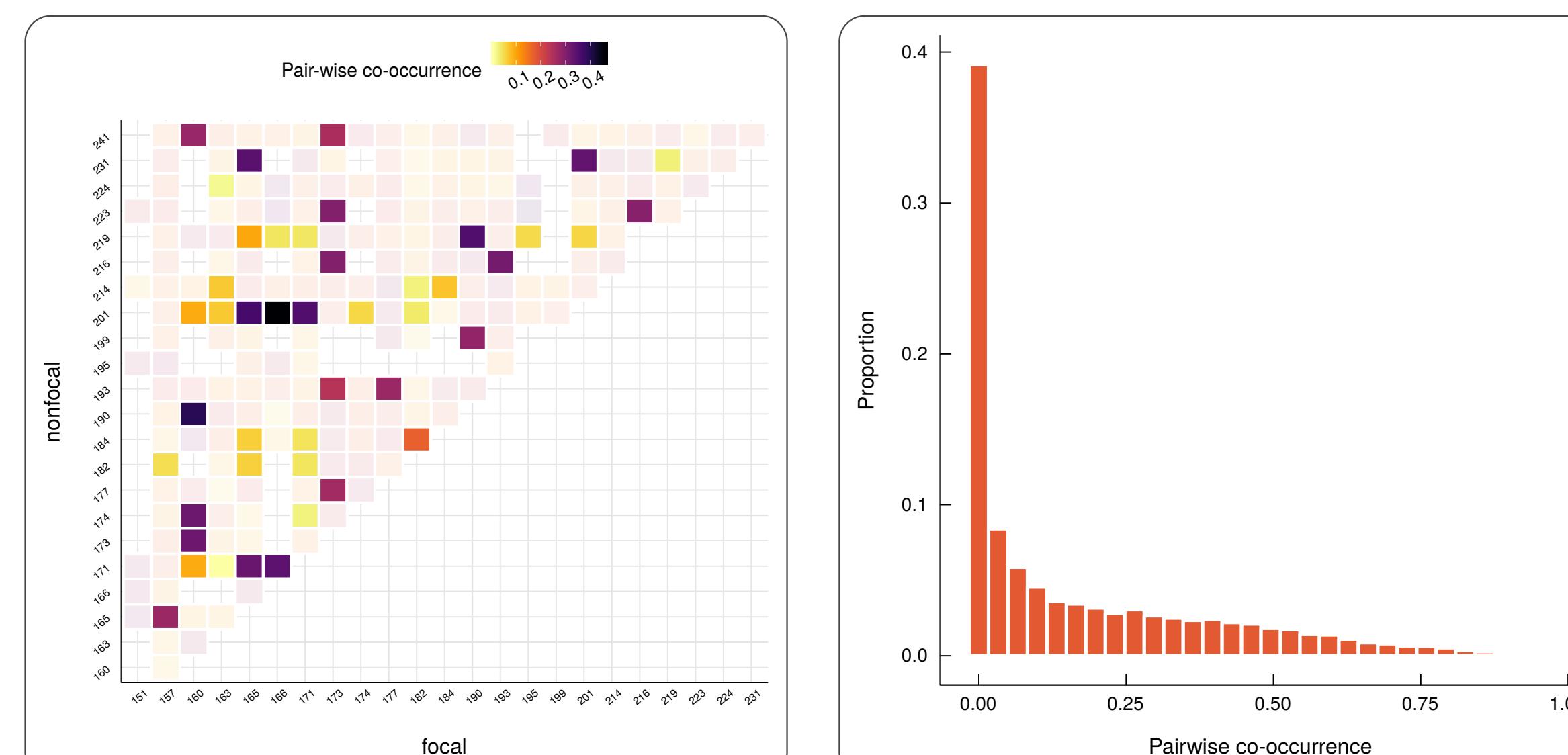
**Fig. 2** Study area; ATLAS tower locations; knot positions coloured by hours after high tide.

## We ask: Do knots have 'friends'?

### METHODS

#### ATLAS tracking

Over a 19-day tracking period (23 Aug – 11 Sep 2017), we collected position data from 35 tagged knots. Tags (4.2 g, 1 Hz, aggregated over 1 minute) emit radio signals allowing the triangulation of position by an array of five ATLAS towers.



**Fig. 3** Red knot pairwise association over all tides

**Fig. 4** Overall association distribution over all tides



Courtesy Benjamin Gnepp COS-NIOZ

#### Tidal intervals

We determined tidal intervals (high tide to high tide) – 44 tidal intervals over 19 calendar days, and analysed each knot's positions and association with other knots between and within tidal intervals.

#### Knot association

We calculated the number of times that the positions of two individuals *i* and *j* were both known as  $n_{ij}$  and association between them as  $c_{ij}$ , the proportion of  $n_{ij}$  when the distance between *i* and *j* was  $\leq 250$  m;  $c_{ij}$  varies from 0 (= the distance between the birds was always  $> 250$  m) to 1 (= the distance was always  $\leq 250$  m); We obtained one  $c_{ij}$  value per pair per tidal interval, for a maximum of 44 values per pair.

### RESULTS

#### Association is skewed, 10% pairs are 'friends'

- $c_{ij}$  was strongly skewed (mean  $\pm$  SD =  $0.14 \pm 0.3$ );
- ~80% pairwise  $c_{ij}$  distributions were not different from the overall  $c_{ij}$  distribution (Kolmogorov-Smirnov test);
- 10.5% of pairwise  $c_{ij}$  were higher than expected by chance; 10% were lower than expected by chance.

#### Knot associations are tidally forced

$c_{ij}$  was highest during the receding tide (0 – 3 hours post high tide, 95% CI =  $0.22 \pm 0.008$ ) and substantially lower in the advancing tide (10 – 12 hours post high tide, 95% CI =  $0.12 \pm 0.007$ ) and around low tide (4 – 9 hours post high tide, 95% CI =  $0.11 \pm 0.005$ ).

### CONCLUSIONS

- Most knots, like other waders<sup>3,4</sup>, have no 'friends';
- However, 20% of pairwise associations are different from random expectation – consistent behavioural differences may play a role;
- Association tracks tidal water level, suggesting that wader density and association is largely a result of environmental, and not social, drivers.

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**References** 1. Bijleveld et al. 2015. Benefits of foraging in small groups: An experimental study on public information use in red knots *Calidris canutus*. *Behav. Processes.* 2. Bijleveld et al. 2010. Beyond the information centre hypothesis: communal roosting for information on food, predators, travel companions and mates? *Oikos.* 3. Myers 1983. Space, time, and the pattern of individual associations in a group-living species: sanderlings have no friends. *Behav. Ecol. Sociobiol.* 4. Conklin & Colwell 2008. Individual associations in a wintering shorebird population: do dunlin have friends? *J. Field. Ornith.* 5. Harrington and Leddy 1982. Are wader flocks random grouping? A knotty problem. *Wader Study Group Bull.*