

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



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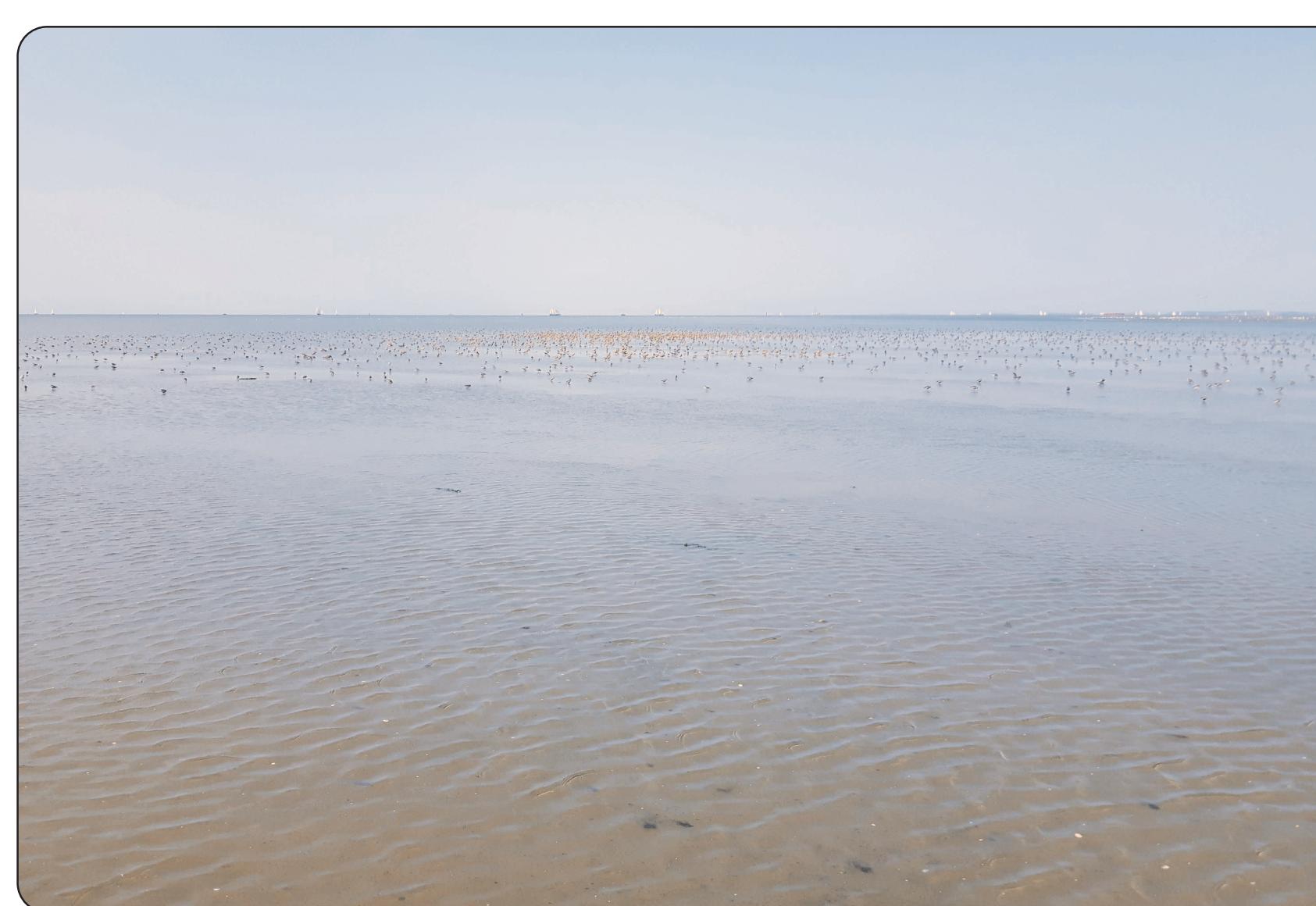
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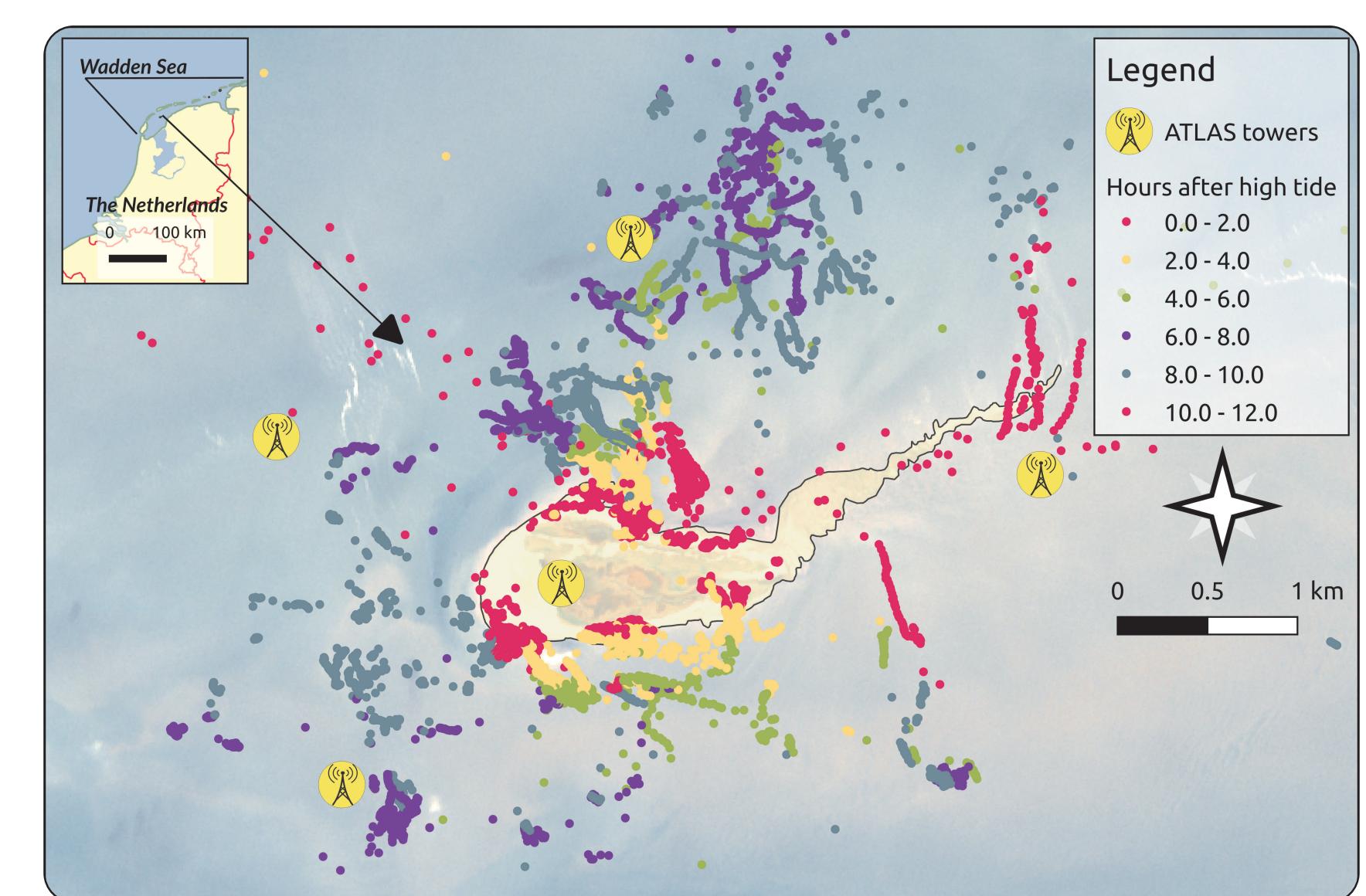
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- 1 Waders such as red knots *Calidris canutus* gather in large flocks in the Wadden Sea, where they forage on the intertidal mudflats
  - 2 Knots use social information in the lab to find food<sup>1</sup>, and learn the location of foraging patches by observing flock-mates<sup>2</sup>
  - 3 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.

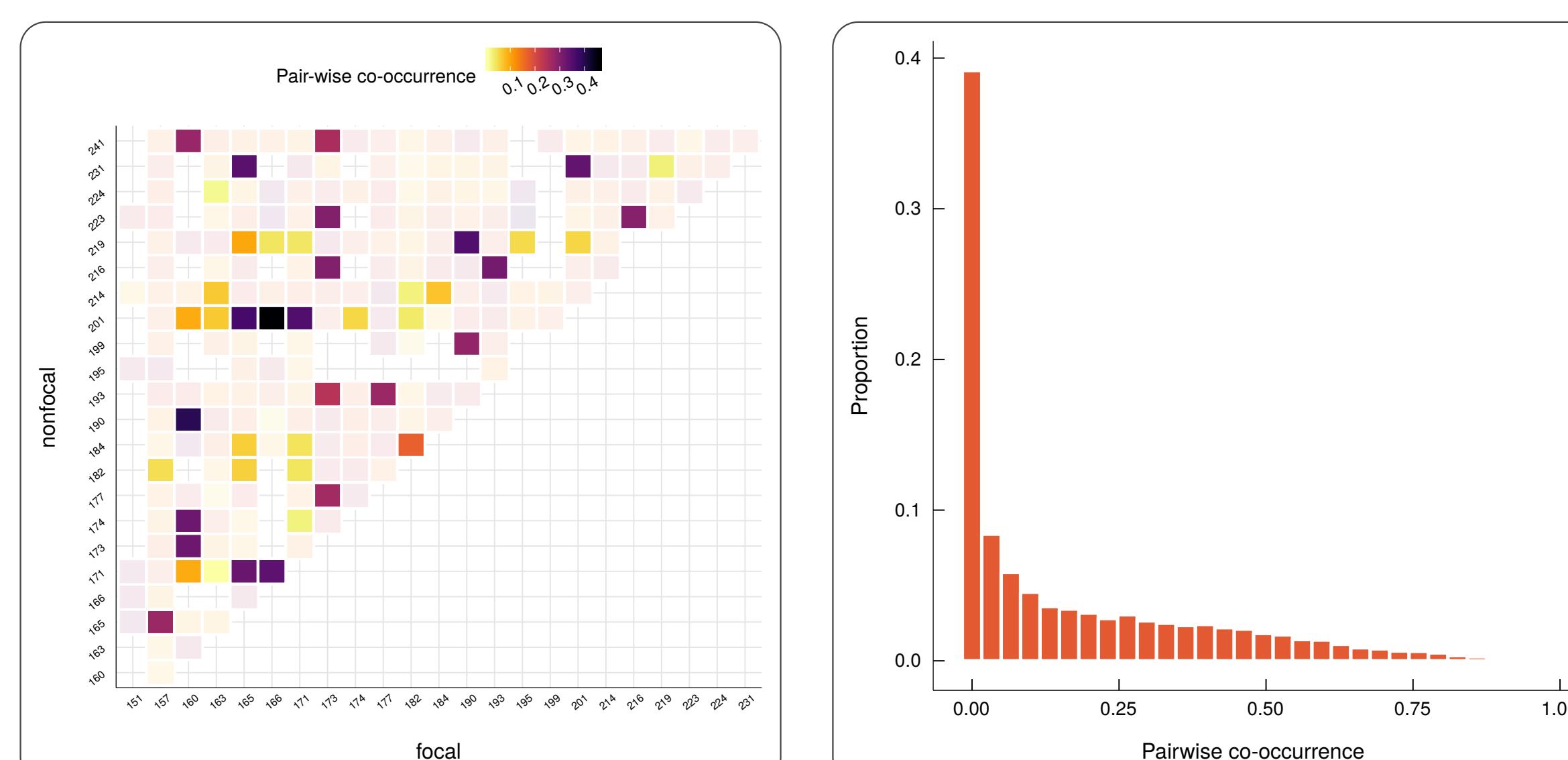
## We ask: Do knots have 'friends'?

### METHODS

#### ATLAS Tracking

1 Tags on knots (*C. canutus islandica*, n = 35, tag mass = 4.2 g, 1 Hz) transmit radio signals – tracking tower array triangulates position using signal Time of Arrival (ToA);

2 We aggregated position data at 1 minute intervals for Aug. 23 – Sep. 11 2017.



#### Tidal Intervals

3 We determined tidal intervals (high tide to high tide) – 44 tidal intervals over 19 calendar days;

4 We analysed each knot's positions and association with other knots between and within tidal intervals

#### Knot Association

5 We calculated association between two individuals i and j as  $c_{ij}$

$$c_{ij} = n_{250}/N$$

Where

$n_{250}$  = number of positions where i and j were  $\leq 250$  m apart

N = number of positions where i and j positions are both known;

6 Association was between 0 and 1, where 0 = no positional association, and 1 = complete association per tide.



Courtesy Benjamin Gnepp COS-NIOZ

### RESULTS

#### Association is low but 10% pairs are 'friends'

- 1 Association is mostly low (mean  $\pm$  SD =  $0.14 \pm 0.3$ )
- 2 ~80% pairwise association distributions are not different from the overall distribution of association (Kolmogorov-Smirnov test)
- 3 10.5% of pairwise associations are higher than expected by chance; 10% are lower than expected by chance

#### Knot associations are tidally forced

- 4 Mean population co-occurrence is highest during the receding tide (0 – 3 hours post high tide, mean  $\pm$  95% CI =  $0.22 \pm 0.008$ ) and the advancing tide (10 – 12 hours post high tide, mean  $\pm$  95% CI =  $0.12 \pm 0.007$ ) and lowest around low tide (4 – 9 hours post high tide, mean  $\pm$  95% CI =  $0.11 \pm 0.005$ )

### DISCUSSION

1 Most knots, like other waders<sup>3,4</sup>, have no 'friends'

2 However, 20% of associations are different from chance – consistent behavioural differences may play a role

3 Of these, 10% are lower than expected – do knots have 'enemies'?

4 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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