Variation in Irish cattle movement data of relevance to the identification of high risk herds

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Background

We examined Irish cattle movements in 2016. We hypothesised that risk factors for disease spread would include not only the number of movements between herds, but also the distances travelled and the length of time animals were held in the herd between moves. The spatial distribution of these factors is also likely to be important and should be taken account of in surveillance activities and epidemiological investigations.

Methods

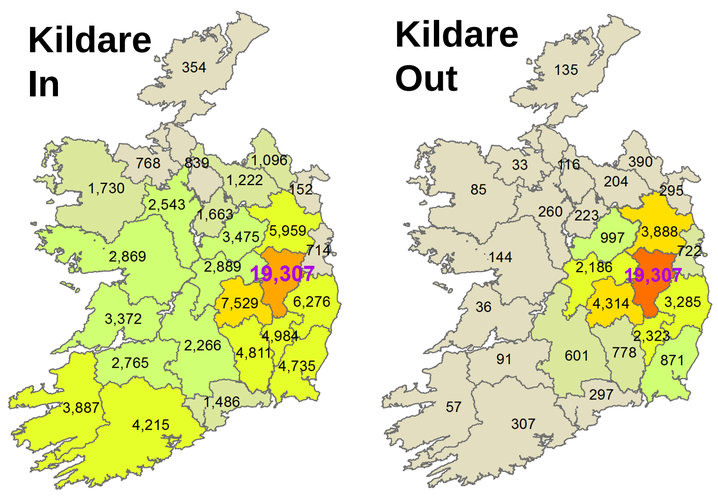
Four measures of network flow were calculated: *Degree* (distinct source and target), *contacts* (distinct source, target, date), *bovines* (distinct source, target, date, animal), and *betweenness* (how often a herd constitutes the shortest path between other herds). Straight-line distance between source and target herd were calculated for each contact, and the mean time spent in the herd between moves was calculated for all herds.

Findings

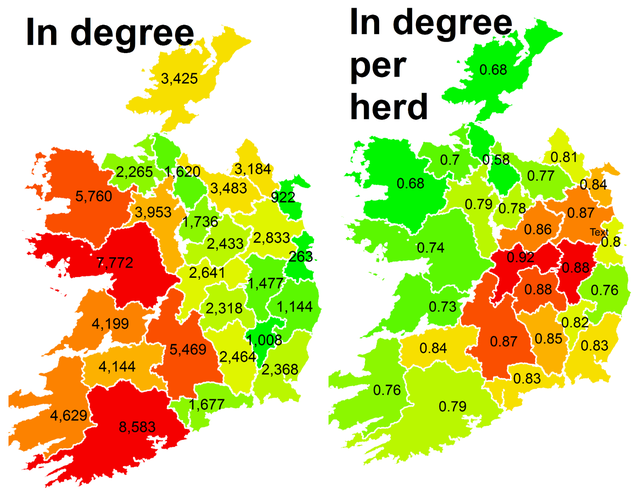
Measures of inward movement (in-degree, in-contacts, in-bovines) were closely correlated, as were the equivalent measures of outward movement. However, inward measures were not closely correlated with outward. Correlations of betweenness with these other measures lay between these extremes. The Pearson correlations are shown below.

	Between-ness	In Bovines	In Contacts	In Degree	Out Bovines	Out Contacts
In Bovines	0.54					
In Contacts	0.61	0.92				
In Degree	0.6	0.86	0.98			
Out Bovines	0.73	0.56	0.59	0.58		
Out Contacts	0.68	0.35	0.4	0.39	0.8	
Out Degree	0.59	0.26	0.31	0.3	0.66	0.95

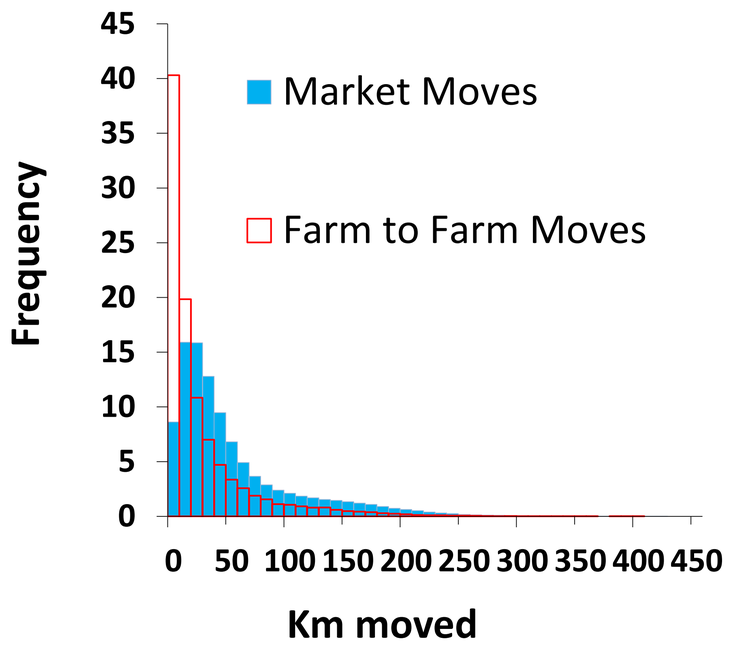
A large proportion of moves were within the same county and this was strongly positively correlated with the size of the county (R = 0.8). The maps below show bovines into (left) and out of (right) County Kildare by source (left) and target (right) county.



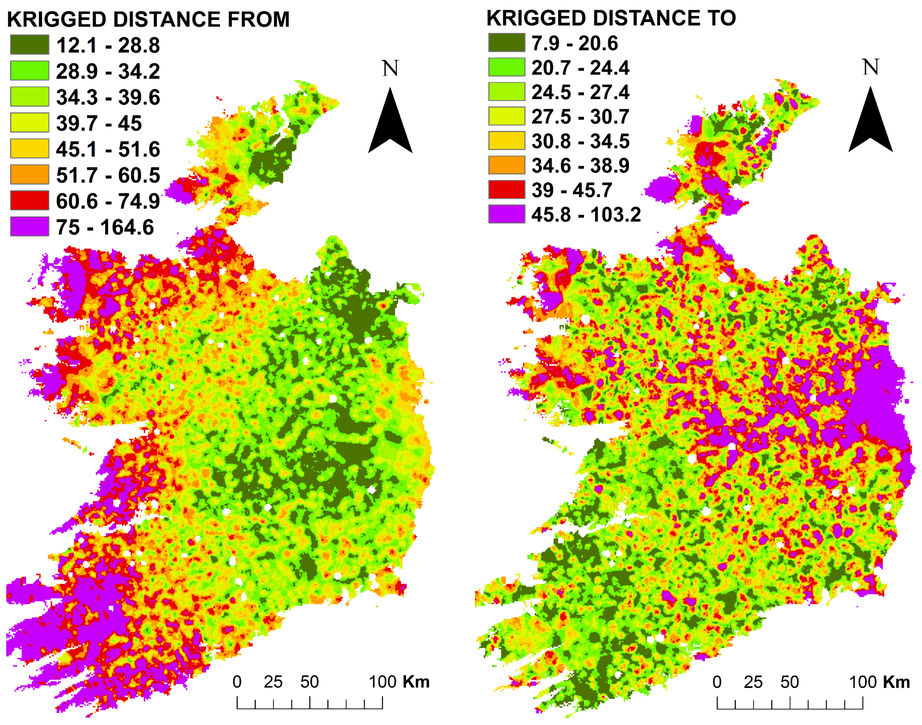
Distinct regional patterns were observed in all the measures examined but normalising by county size, herd size and bovine population often changed these.



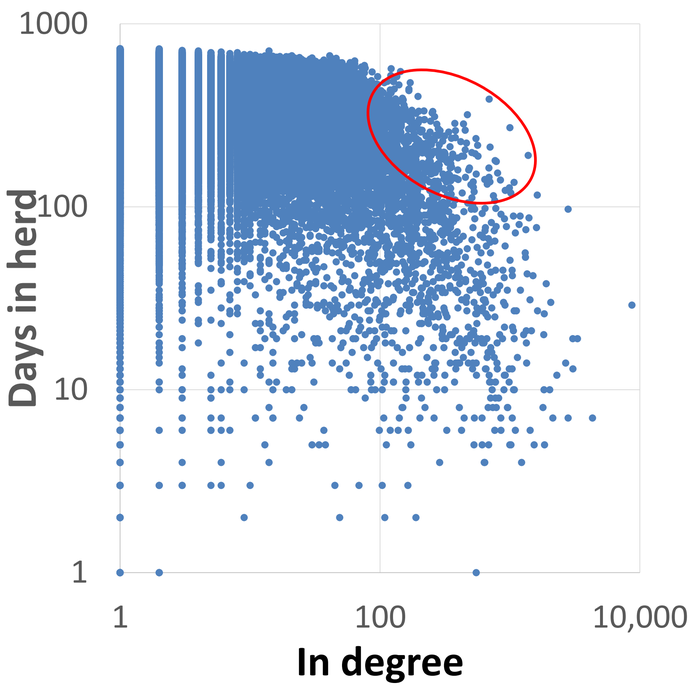
Farm to farm contacts were generally of shorter distance than contacts via a market (Median: 29.4 < 37.2 km), although both categories contained at least 1 % of moves > 192 km.



Outward movement tended to be farthest for Western herds, inward for Eastern herds, although there was a great deal of local variability in the mean distances travelled.



A small number of herds participated in a very large number of movements combined with long durations of residency in the herd, suggesting higher risk.



Conclusions

Using a single measure to characterise movement is unlikely to capture all pertinent variability.

Most movement occurs at relatively close distances but there are a small proportion of very long distance transports which may facilitate disease spread.

Additionally, some herds with both a large number of animal transports into or out of the herd and long residency of animals in the herd may be particularly important.