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Temporal and spatial characterization of the network of live Atlantic salmon movements in Ireland: implications for disease prevention and control

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Live fish movement has been deemed as having an important role in the transmission of infectious diseases both locally and globally. For that reason, the characterization of the patterns and dynamics of live fish movements in a region or country provides not only a better understanding of how fish diseases can spread but also how to allocate interventions for more cost effective disease prevention and control programs.

Here we analyzed the structure and dynamics of live Atlantic salmon movement network (ASN) in Ireland from 2009 to 2013, using social network analysis and spatial epidemiology methods.

During the study period there were 81 nodes and 494 shipments, corresponding to 71.6 mill fish moved. The number of nodes of the ASN decreased from 59 to 48 while the number of edges and fish moved per year increased from 79 to 104 edges and 11.5 mill to 15.2 mill fish moved. The ASN was disconnected exhibiting a marked seasonality associated to the salmon production cycle.

For every year the ASN exhibited both small-world and scale-free topologies. There was an increase in average path length and clustering coefficient during the study period. Only few sites were highly connected (hubs). Community detection algorithms found a relatively stable community structure over the years, indicating that ASN form a single country-wide compartment. Significant spatial clusters were found for different centrality measures, indicating that hubs tend to aggregate in specific regions of the country. Finally, we have characterized the biosecurity of these hubs in an attempt to further estimate their potential for disease introduction and spread to the rest of the ASN.

The results of these analyses will be used by local stakeholders as an input for risk assessments and for the design and implementation of risk based disease surveillance and control strategies.