Application of Network Analysis to Fish Movement Data

FISHERIES RESEARCH SERVICES

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Introduction

Fish Farming is the keeping of live fish with a view to their sale or their transfer to other waters. Hatchery sites are used for cultivation of eggs, juvenile fish are moved to other sites for on-growing (Figure 1- Atlantic Salmon Life Cycle). Therefore large numbers of live fish movements occur between fish farms sites (Figure 2- Fish Transportation).

Network analysis is a useful tool to analyse these fish movement data. Contact network models could help define management area boundaries for the reduction of disease risks or rapidly identify high risk farms or areas for spread of infection. In this study analysis of movements on, off and between one Scottish salmon farming business' 68 sites was conducted.

Figure 1 – Atlantic Salmon Life Cycle

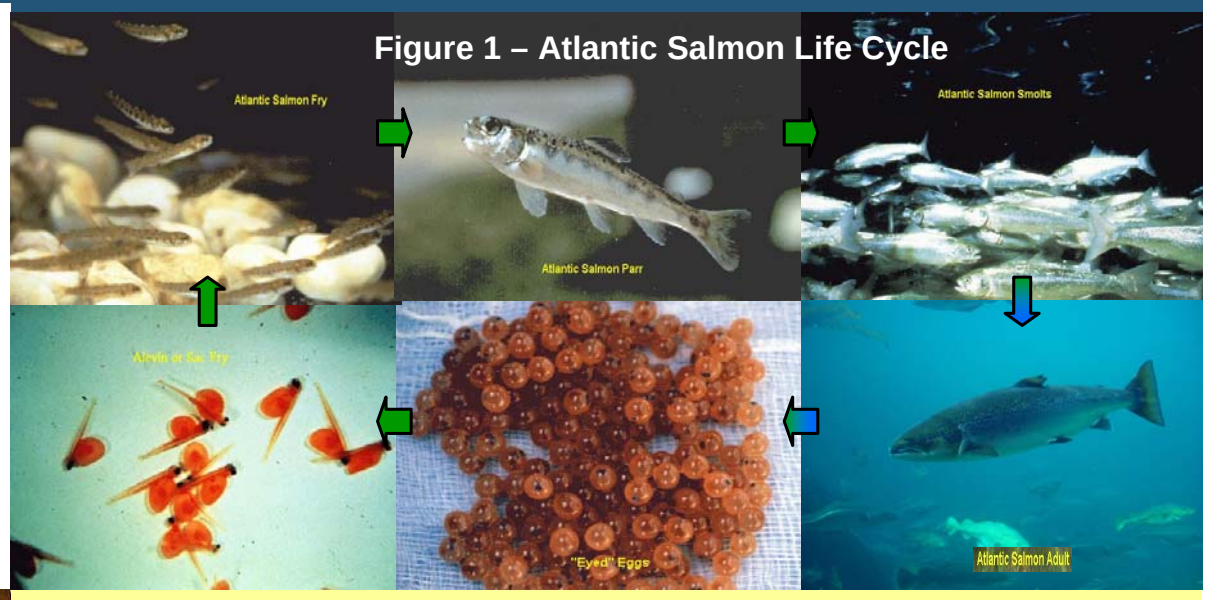

Figure 2 – Fish Transportation: Live fish being moved between a hatchery and a seawater site by either Helicopter, Wellboat or Lorry

Materials & Methods

All Fish Farming businesses in Scotland are required to keep records of all live fish movements on and off their sites.

Data Collection

- Currently movement records held at FRS are paper records.
- Paper records of verified movements from 2003 were transferred to a Database
- Each record in the database holds the following information:

Date of Movement, Species, Number or Weight, Development Stage (Ova, Fry, Parr , Smolt or Post-Smolt), Source/Destination, Supplier, Method of Transportation and Name of Carrier

Data Analysis

Movements between the 68 sites were transferred from the database to Excel® spreadsheets to create a movements matrix. The matrix was then exported into Uncinet (1) and contact network (Figure 3) created in NetDraw 2.24 (Network Visualisation Software). The descriptive degree statistic was then applied to the network (Figure 4). The node degree is the number of other nodes (sites) directly contacted to each node (site) so the bigger the node size the more contacts.

Results

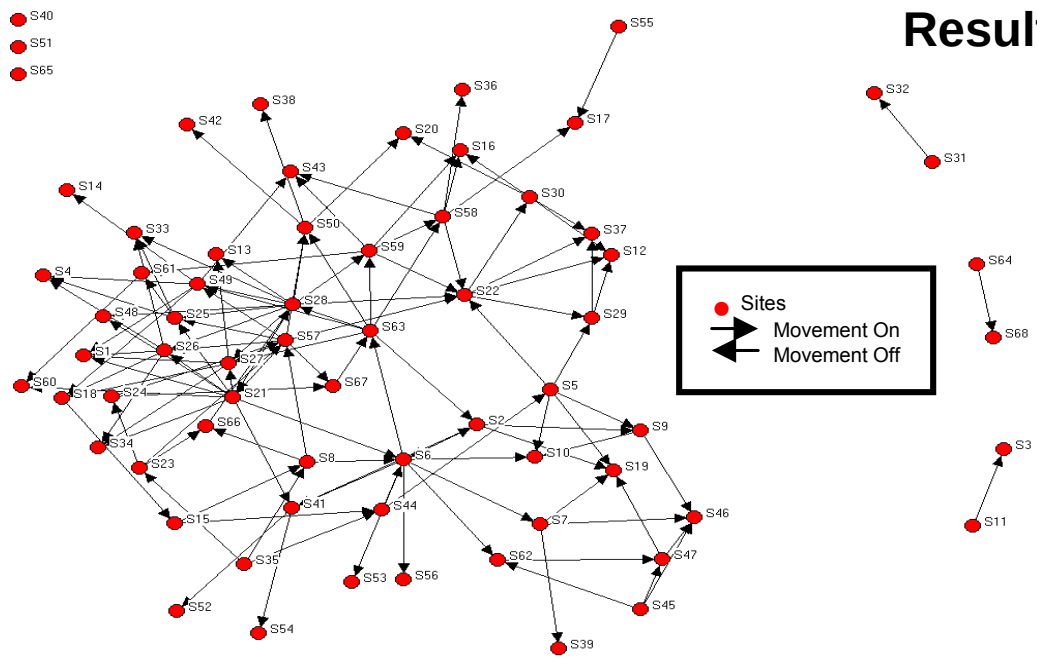

Figure 3: Basic Contact Network

- Demonstrates the visual aspects of Network Analysis
- Shows sites with high number of contacts on and off site
- 3 sites have no contacts with other sites. In these cases the 3 sites did have live fish movements in 2003 but they took place with external businesses. No contacts could also be explained by the fact that sites work a 2 year production cycle and we have only analysed 1 years data
- 3 pairs of sites only have contact with each other

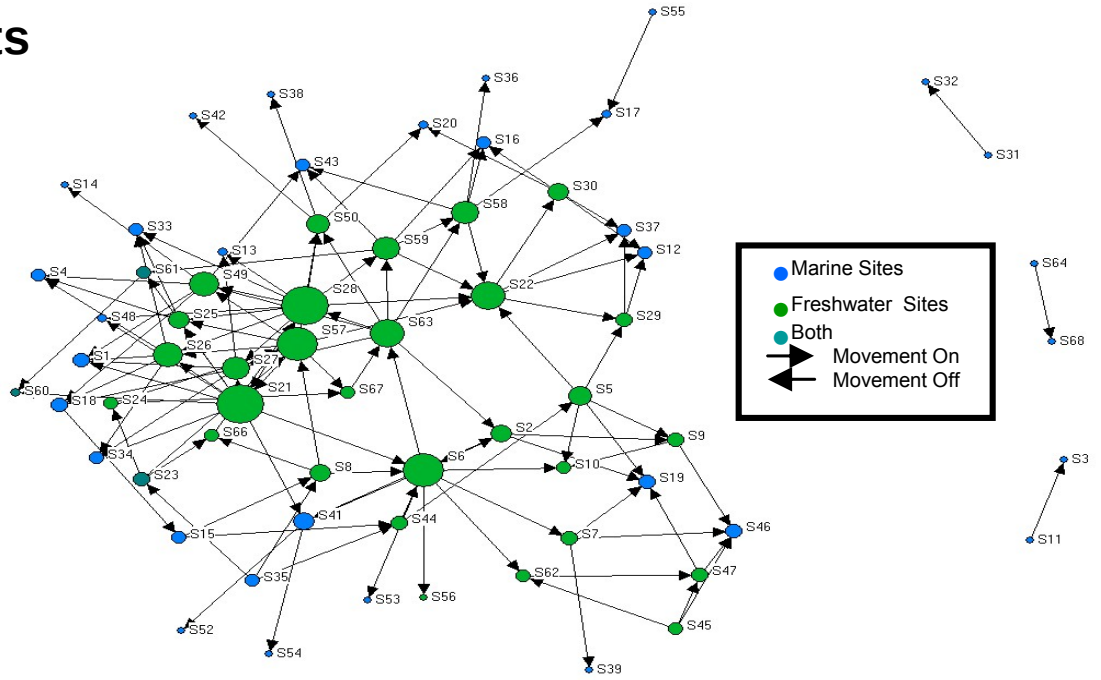

Figure 4: Degree Statistic Contact Network

- Large node size indicates a high number of contacts
- S21 and S28 have the highest number (13) of contacts
- Sites with high numbers of contacts were smolt producing units
- The smallest nodes S41, S51 and S65 are the sites with no contacts
- From the different coloured nodes it can be seen that marine sites have few or no movements off site while freshwater sites are extensively connected with movements on and off site

Discussion

This poster demonstrates the usefulness of Network Analysis for visualisation of live fish movements and identification of problem areas. The network provides us with a relatively quick method to identify potentially high risk sites for spread and transmission of diseases. Currently we have investigated the contacts between 68 sites from one fish farming business in Scotland but we will be looking to increase the network to include all Scottish Fish Farming Sites.

References

Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard,MA: Analytic Technologies.

Acknowledgements

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