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Barrier crossing and identifiability in an agent-based migration model for avian influenza

Although most transmission models of highly pathogenic avian influenza incorporate wild-bird migration data, few simulate the movement of birds at the individual level. A spatially explicit agent-based model was developed which combines the movement wild birds in North America to an environmental-transmission model. Each simulated bird holds a wintering and a breeding site and, on each day of migration, draws its next landing cell by taking the element-wise product of a flight kernel and that week's eBird relative-abundance map. A calibrated parameter set reproduces the seasonal ranges and arrival timing of blue-winged teals. When the destination lies across water, the product vanishes over the kernel's support. This creates the local-minimum problem encountered in potential-field navigation, requiring an additional rule to guide movement. Four escape mechanisms were implemented, each with a counterpart in robot navigation. A 300-set parameter search and a controlled sweep show that the operating mechanism is set by the heading concentration, κ, through a threshold that follows from the kernel's numerical cut-off. Calibration on arrival within an eBird's season selects κ above that threshold: crossers and detourers both arrive, so routes are not identifiable from endpoints, and the threshold rather than the data chose the route. Consequences for specifying and calibrating movement rules at geographic barriers are discussed, with work in progress on an explicit blocked condition and route-based calibration targets.