Management Application of an Agent-Based Model: Control of Cowbirds at the Landscape Level

Harper, Westervelt, and Shapiro (2002)

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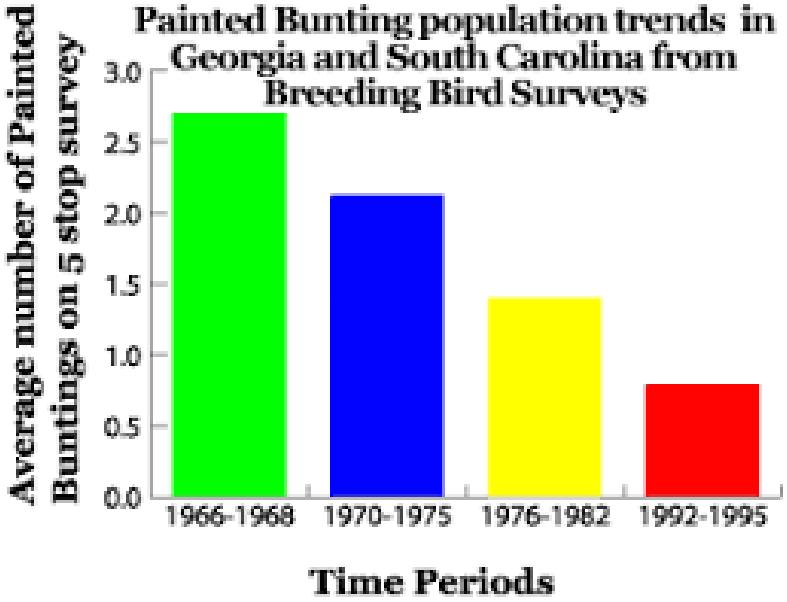
The greatest threats to the United States?

The hidden menace

A bloody campaign of deception and sabotage



Taking aim at the heart of American military power

Only the A(BM)-Team can stop this reign of terror

Authors

- Steven Harper, University of Georgia
- James Westervelt, U.S. Army Corps of Engineers
- Ann-Marie Shapiro, University of Illinois

Other research

- Desert tortoises at Fort Irwin
- Endangered birds at Fort Hood

Goals

- Build model to predict feeding locations of cowbirds
- Extend model to simulate trapping of cowbirds
- Use this capability to develop optimal trapping strategy
- Terminate with extreme prejudice

Overview

GIS (GRASS) and ABM (SWARM)

58 km x 58 km (335,000 ha) area

1 day time step, 100 steps

Three agent types

- Feeding area (fixed)
- Cattle herd (mobile)
- Cowbird (mobile)

Feeding area $\rightarrow$ cattle movement $\rightarrow$ bird movement $\rightarrow$ trap placement

Feeding areas

56 ha square

Main attribute of interest: **grazing suitability**

(Partially) determines propensity of cow herd to move to that square

Determined by four sub-attributes

- Amount of grassland
- Patchiness of grassland
- Distance from corral
- Distance from permanent water

Cattle herds

30 head per herd, 464 herds, initialized at 116 corrals

Move around environment grazing according to "win-switch" strategy

Movement logic: pick cell with highest **grazing quality**

- Grazing suitability (per previous slide)
- Time since previous occupation
- Distance from current location

Move after 8 days

Cowbirds

Randomly initialized in breeding-area squares

Cognition for moving from breeding area to feeding area

Four possible movement rules

- Next-nearest: move randomly to nearest feeding area until cows found
- Memory: try places have been before
- Memory-with-perception: add ability to assess feeding areas en-route
- Omniscient: benchmark

Trapping

Two new agent types

Traps

- Can be mobile or fixed
- Occupy cell
- Have some probability of capturing a bird that visits cell

Trap managers

- Goal: place traps where most cowbirds are
- Places traps and moves mobile ones
- Cognition for doing so is under-described

V&V and results

Parameter values well-justified and subjected to sensitivity analyses

- Field studies, literature review, etc.
- Many different runs with different settings (e.g. cowbird cognition)

Simulation appears to qualitatively match real life

Fixed traps more effective (entirely based on parameter $p(\mathrm{catch})$)

Model-based trapping strategy caught 42% more than real life

Model effectiveness and course themes

In our taxonomy: analyzed-analyzed

In my opinion, one of the best models this semester

- Clear, scoped purpose (no *exploration of potential* here!)
- Logical and well-justified modeling choices
- Solves real-world problem

Somewhat depressing that best models (e.g. this and Yellowstone elk) are of animals with much more limited behavior space than humans

Course themes:

- ABM-GIS integration: serves as a great example of a problem that is nearly-intractable unless you include both elements and integrate