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

Harper, Westervelt, and Shapiro (2002)

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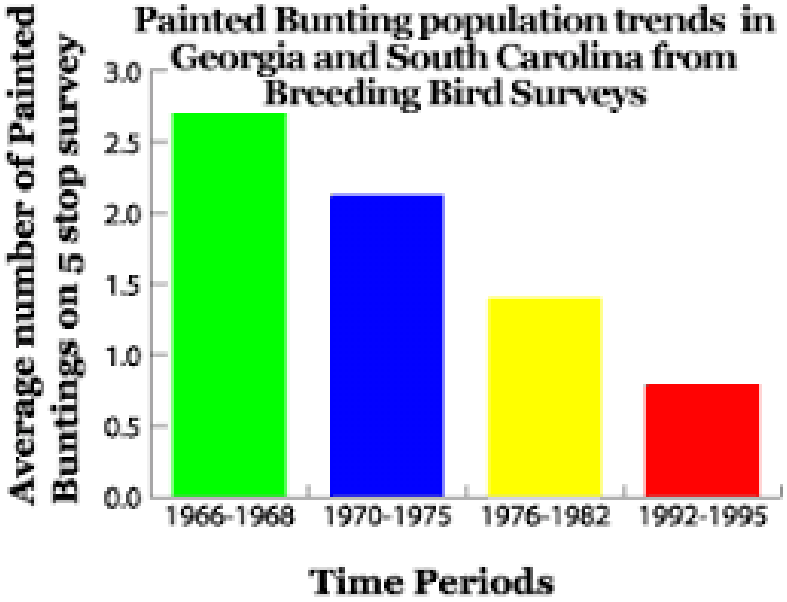
Spring 2018

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 strategy

Sensitivity analyses

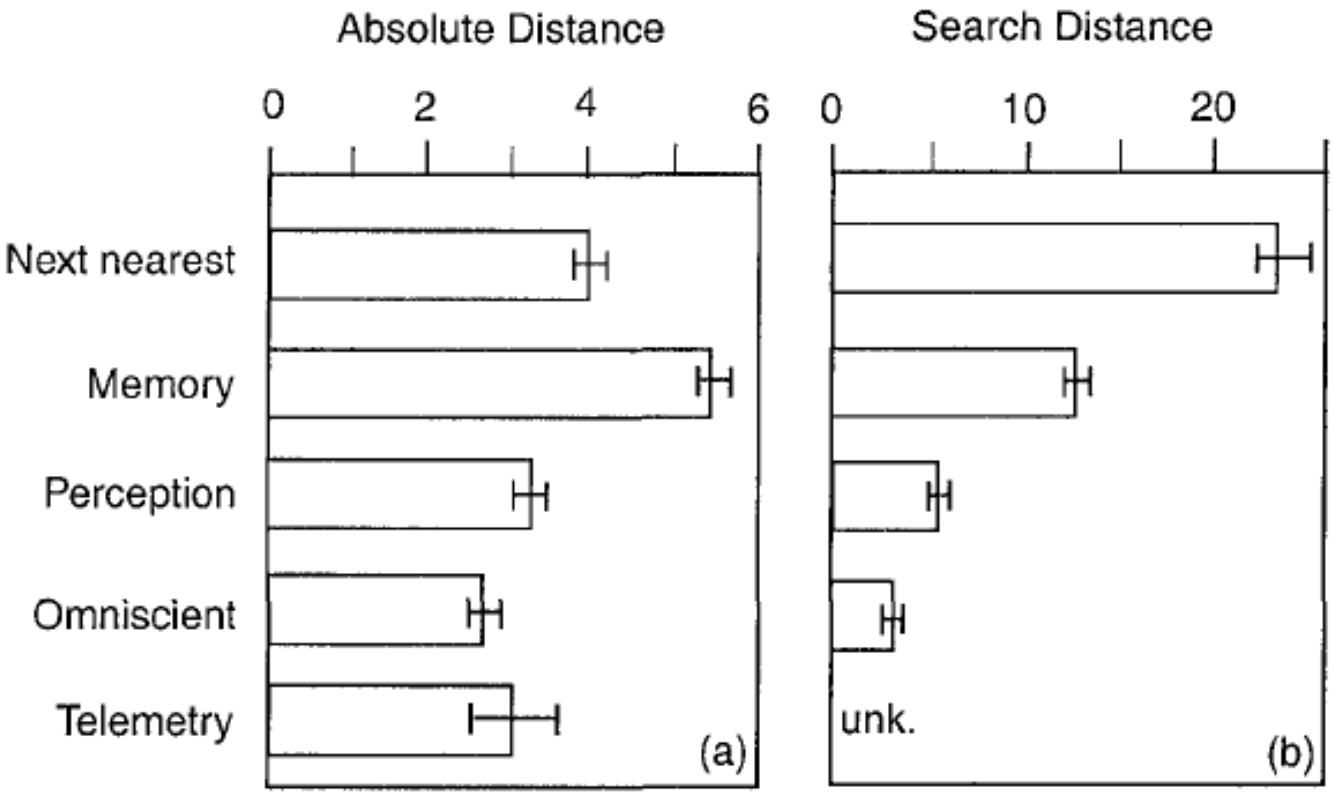


FIGURE 2 Results of simulations using four different cowbird movement rules with regard to (a) the absolute distance between breeding and feeding locations, and (b) the total search distance traveled to locate a suitable feeding area. Values are means (± 1 SD) of the daily movements of 312 cowbirds averaged over a 100 d simulation. Absolute distance data are also plotted for seven telemetered cowbirds studied at Fort Hood [7].

Visualizations could use some work

FIGURE 3 Map of the cumulative number of visits to feeding areas across the simulated landscape made by all breeding cowbirds. Values are means generated from 100 simulations in which 312 cowbirds were instantiated and moved using the memory-with-perception rule. Darker shades of grey represent larger numbers, within the range of values indicated. The Fort Hood installation boundary is plotted for reference.

Improved in subsequent publications

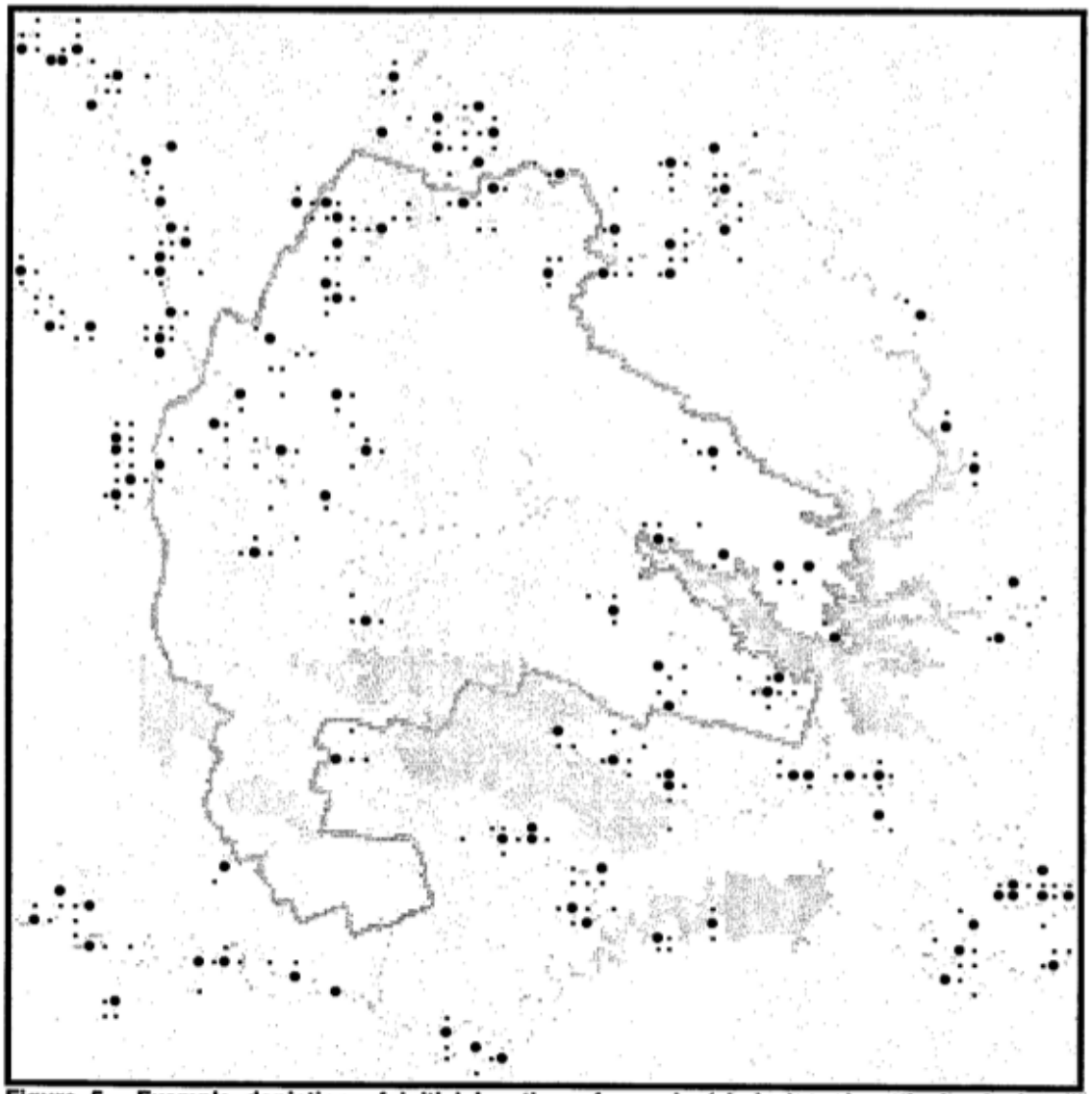


Figure 5. Example depiction of initial location of corrals (circles) and cattle herds (small squares).

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