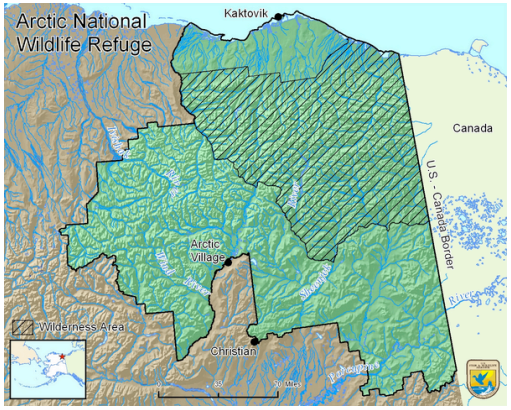
Introduction to Conservation Planning

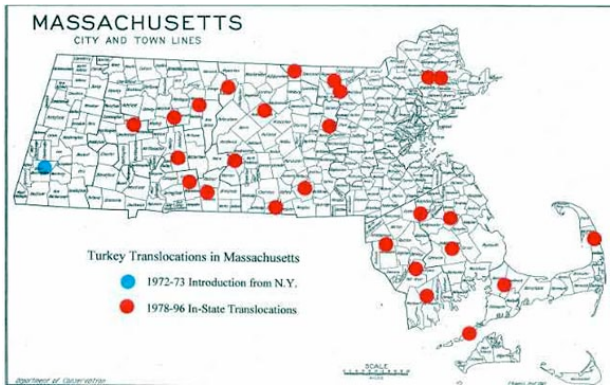
CS 6702: Topics in Computational Sustainability

February 10, 2011

What is conservation planning?

- *Conservation planning* seeks to intervene in ecosystems to support the recovery of species populations.
- Several interventions are available to conservationists and policy-makers.
  - Buying land to maintain as reserves.
  - Transplanting species populations.
  - Installing artificial accommodations for species.
  - Regulating human activity that negatively impacts species.





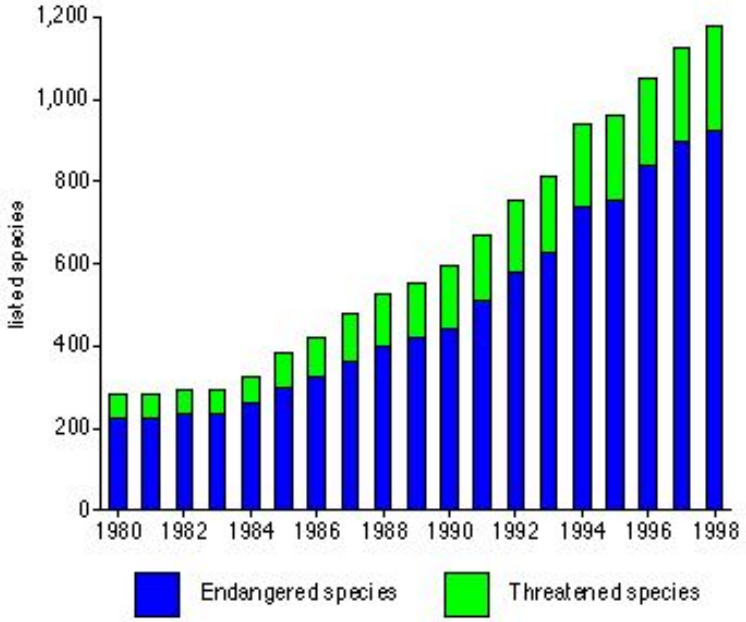
Why conserve species?

- Species provide services to humans.
- Support scientific discoveries beneficial to humans.
- Some species are *keystones* in the ecosystem.
- Species have *economic value*.
  - Research by economists seeks to quantify this value.

The Endangered Species Problem

- International Union for the Conservation of Nature estimates 40% of organisms are endangered (2006).
  - Habitat loss, disease, over-exploitation, climate change.
- The number of endangered species is rising rapidly.

Figure 4.2 Threatened and Endangered U.S. Plant and Animal Species, 1980-1998



Source: U.S. Department of the Interior, Fish and Wildlife Service, Endangered Species Bulletin (DOI, FWS, Washington, DC, bimonthly) and Internet accessible "Box Score" from the Threatened and Endangered Species System (TESS).

Note: Data are year-end cumulative totals. There are 1,821 total U.S. listings. A listing is an E or a T in the status column of 50 CFR 17.11 or 17.12 (The Lists of Endangered and Threatened Wildlife and Plants).

Tackling the Problem

- In 2007, the United States federal and state governments spent over $1.6 billion on habitat and species conservation.
- Organizations like The Conservation Fund spend millions annually on conservation efforts.
- *Computational Sustainability* can guide policy-makers by finding optimal intervention strategies under limited budgets.

Example Species: The Red-Cockaded Woodpecker (RCW)

- Originally distributed throughout the southeast United States, population has severely declined.
- Classified by federal government as an endangered species.
- Population estimates (1999)
  - Circa 30 isolated populations
  - Circa 11,000 individuals total.
- The RCW is a keystone species.
- The Conservation Fund seeks to increase the population that exists in the P3 Reserve on the coast of North Carolina.

Conservation Planning: The Red-Cockaded Woodpecker

- Collaborative project to develop optimal conservation strategies for Red-Cockaded Woodpecker (RCW)
  - Institute for Computational Sustainability (Cornell and OSU):
    Daniel Sheldon, Bistra Dilkina, Adam Elmachtoub, Ryan Finseth, Kiyan Ahmadizadeh, Ashish Sabharwal, Jon Conrad, Carla P. Gomes, David Shmoys
  - The Conservation Fund:
    Will Allen, Ole Amundsen, Buck Vaughan

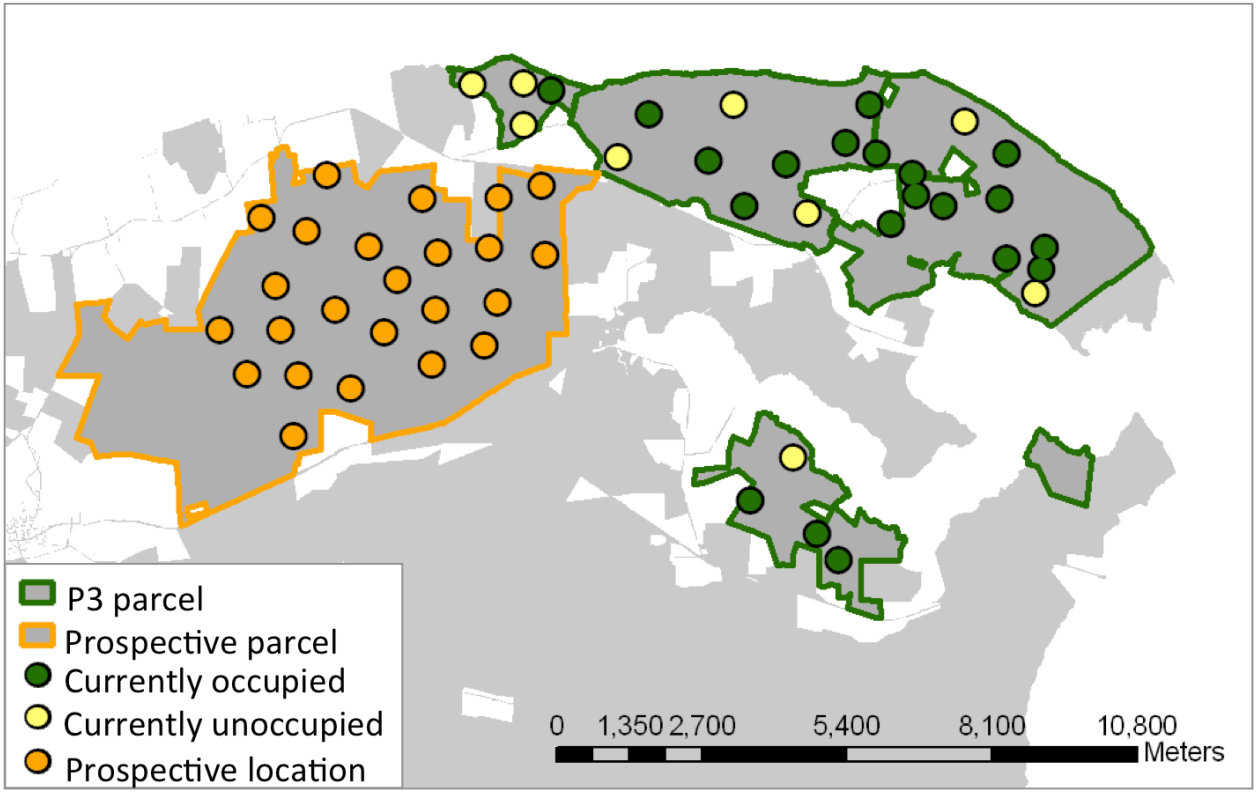
RCW: Conservation Planning

- Cooperative breeders: live in small family groups in well-defined *territories* centered around cluster of cavity trees
- Cavities!
  - One for each family group.
  - Live, old-growth pine (80+ years old)
  - 2-10 years to excavate
  - Extensively reused
- → Habitat requirements in conflict with modern land-use
- Management tools
  - Translocation
  - Buy land for conservation + install artificial cavities
- http://bna.birds.cornell.edu/bna

Population Models (Overview)

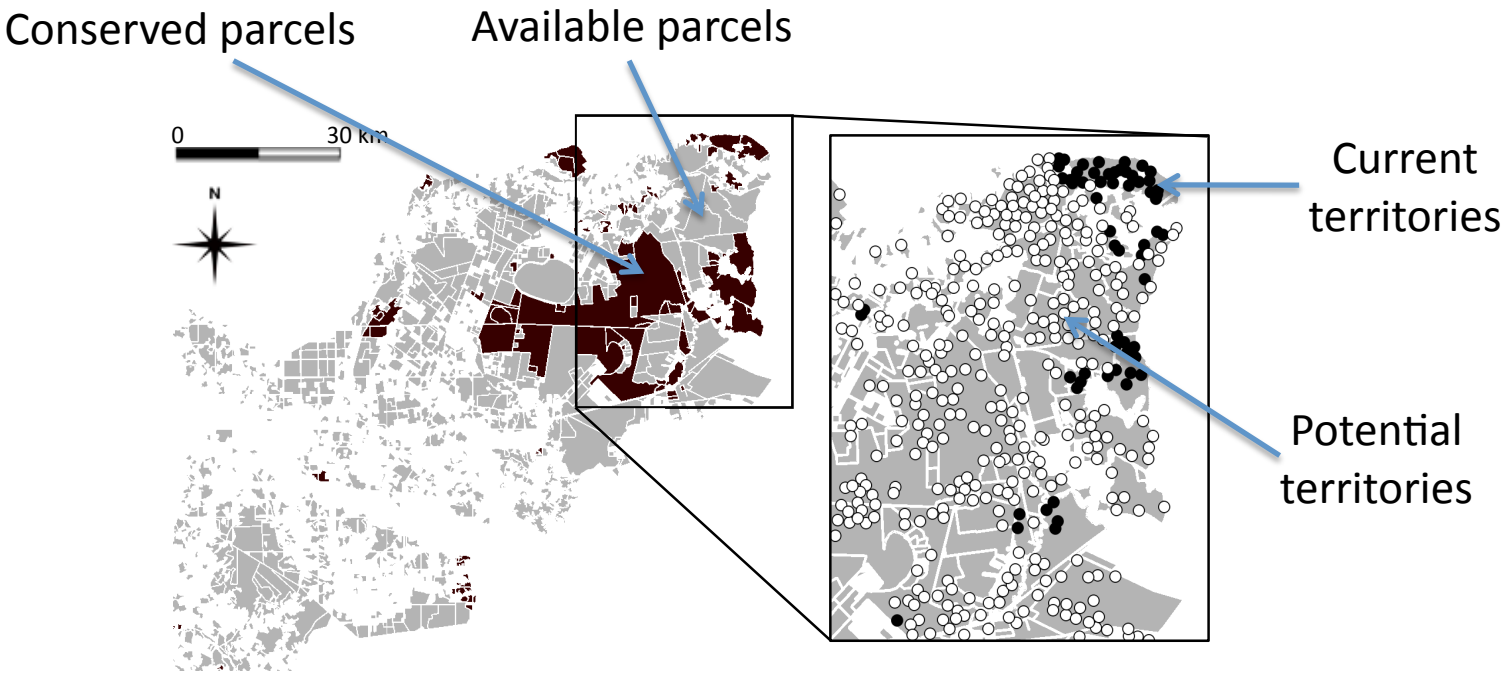
- A model of RCW population growth and dispersion is needed to optimize intervention strategies.
  - **Agent-Based**: Models RCW reproduction, movement, etc. on an individual level.
  - **Metapopulation**: Models RCW occupation of territories in a network stochastically.
  - **Logistic**: Mathematically models RCW population growth.

Problem Setup (Talk 1): Cost Effective Recovery using a Logistic Model



How can we achieve a specified population target at the end of a finite time horizon at a minimum cost?

Problem Setup (Talk 2): Site Selection using a Metapopulation Model



Given limited budget, what parcels should I conserve to maximize the expected number of occupied territories in 50 years?

Future Work: Agent-based Models

- An agent-based model exists to predict RCW growth and dispersion in a region.
  - Create our own implementation.
  - Incorporate management actions into model.
  - Use agent-based model to support optimization.
  - More general agent-based model for bird conservation?
    - Embedded model?