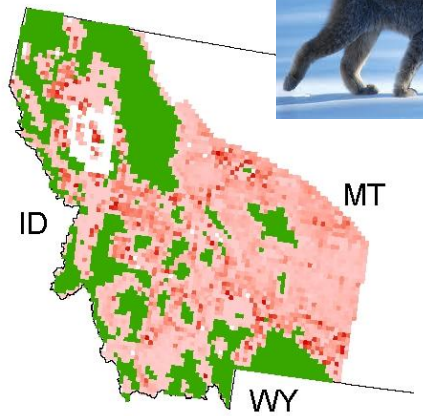
Large Landscape Conservation — Synthetic and Real-world Datasets



Bistra Dilkina	Cornell University
Carla P. Gomes	Cornell University
Katherine Lai	Cornell University
Ronan Le Bras	Cornell University
Kevin S. McKelvey	US Forest Service
Ashish Sabharwal	IBM Research
Michael K. Schwartz	US Forest Service
Jordan Suter	Oberlin College
Yexiang Xue	Cornell University

Motivation: Biodiversity & Conservation

Key causes of biodiversity loss:

Habitat Loss and Fragmentation

urbanization

deforestation

agriculture

Maintaining **landscape connectivity** is critical to reduce inbreeding, increase genetic diversity and provide resilience

Cost-effective Wildlife Conservation

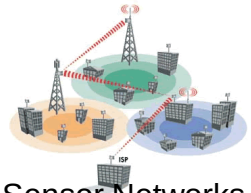
- Conservation targets and priorities set considering only ecological benefits
- Limited economic resources have to be used in the most effective way possible
  - Budget-constrained conservation planning
- Underlying computational challenges:
  - Discrete Optimization
  - Network Design

Wolverines

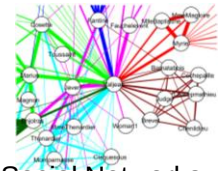
Lynx

Grizzly Bear

Landscape connectivity vs. Network Design


Sensor Networks


Transportation Networks


Social Networks

Steiner tree problem,
Survivable network design,
etc

Network Design

New general models
and methodologies

- Minimum Steiner Multigraph Problem
- Budget-Constrained Steiner Connected Subgraph Problem with Node Profits and Node Costs
- Upgrading Shortest Path
- Minimum Delay Generalized Steiner Network

Landscape Connectivity

How do we choose which habitats to protect so that landscapes will stay robustly well-connected for wild animal species?

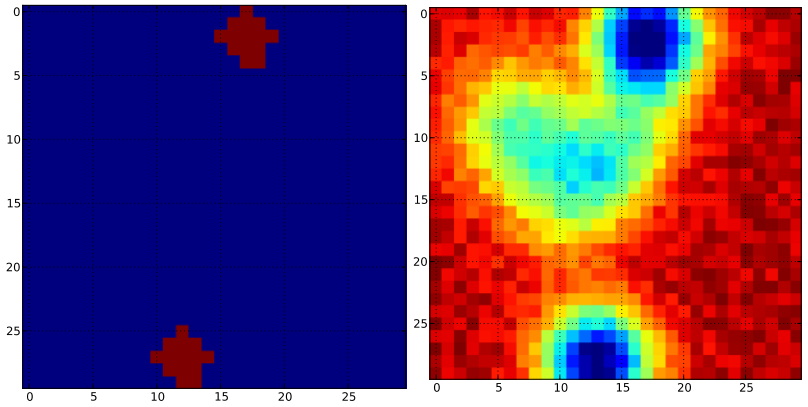
How do factor in specific features of wildlife conservation, e.g., different species requirements, interactions of species, etc?

Research challenges in Landscape Connectivity

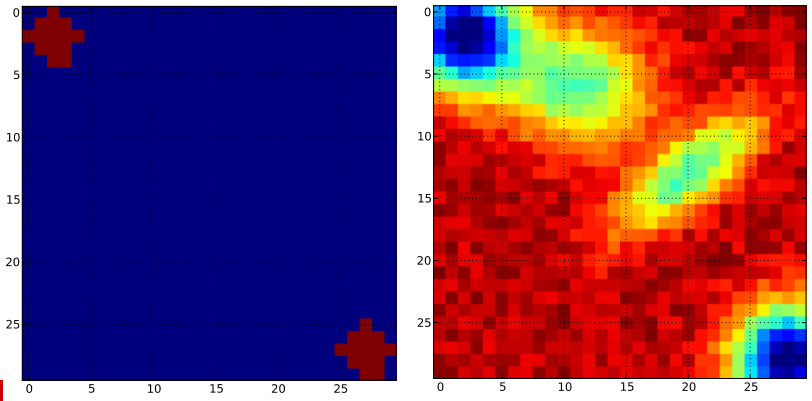
- Better approaches to previously addressed planning setting
- Other planning questions related to landscape connectivity
  - Climate change
  - Adaptive management
  - Multi-period budgets
- Real-world datasets
  - Scale and structure of real problems
- Synthetic generator:
  - Large number of instances
  - Typical-case performance analysis of solution methods

Synthetic Instance Generator

- Fully Random and Structured Instances
- **Parameters:** size of grid, number of core areas and pairs, size of core areas, resistance structure as Mixture of Gaussian Functions, multiple species

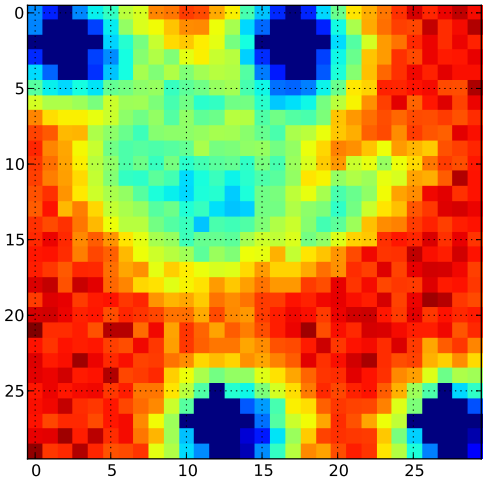


Species 1



Species 2

cost



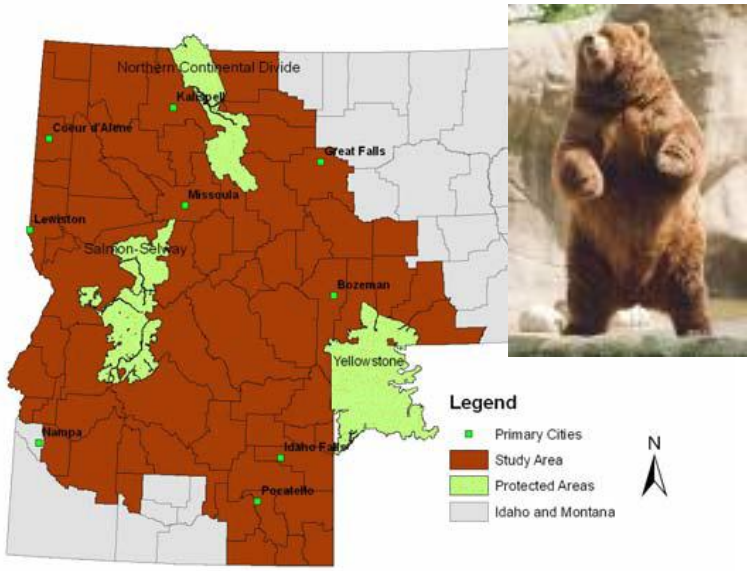
Grizzly Bears in the US Northern Rockies

connecting 3 reserves:

Yellowstone National Park

Glacier Park / Northern Continental Divide

Salmon-Selway Ecosystem



Different resolutions:

40x40km grid cells

10x10km grid cells

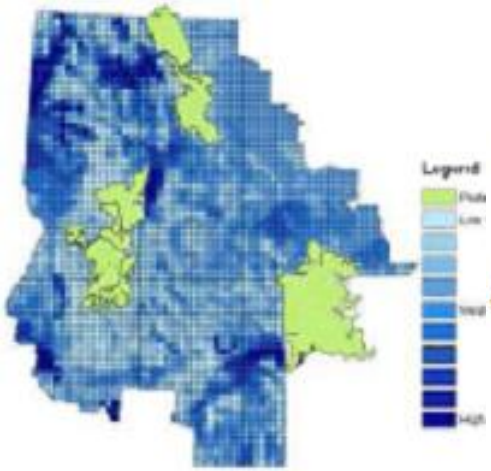
5x5km grid cells

25 sq. km hexagonal cells

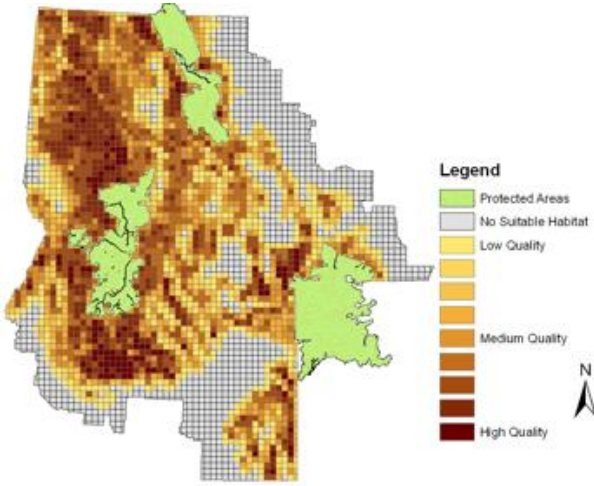
1) Problem instances in graph format

2) GIS layers to visualize data and proposed solutions

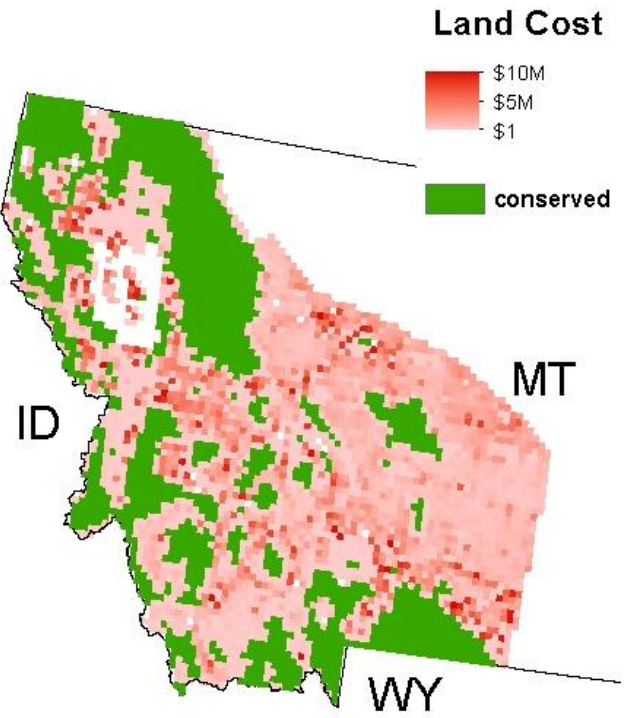
Economic costs

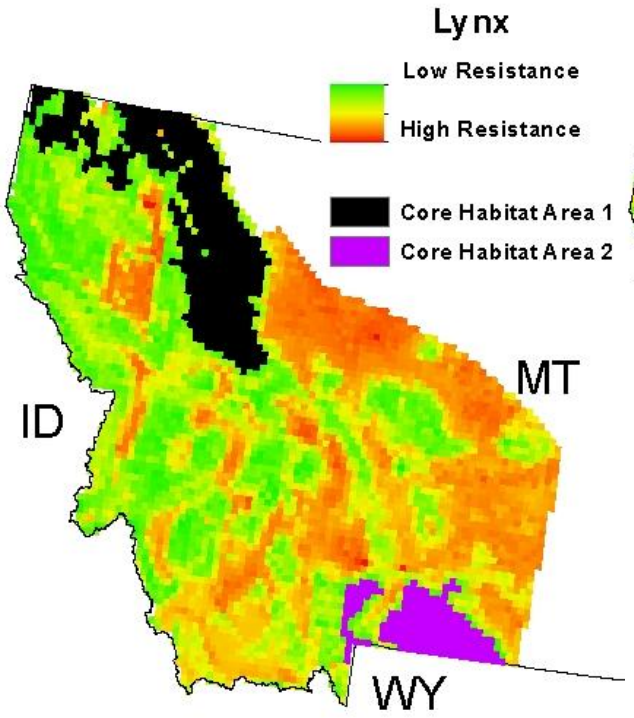


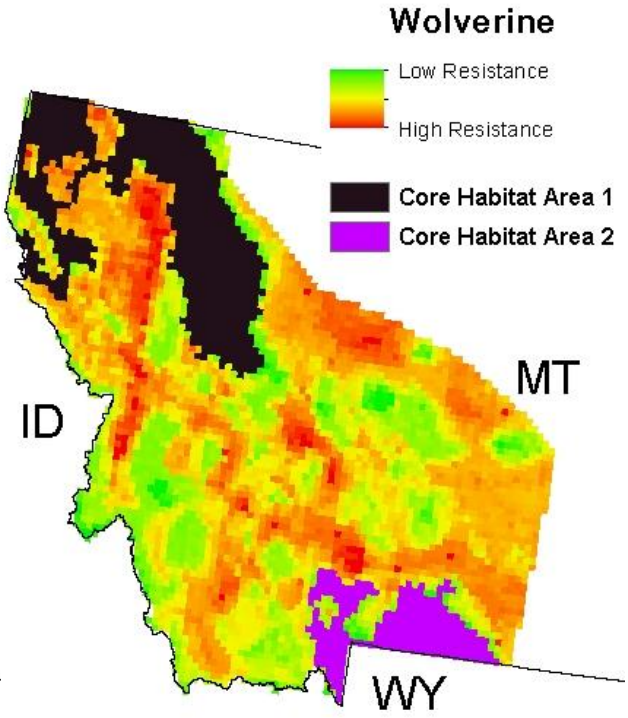
Suitability/resistance



West Montana: Wolverine and Lynx

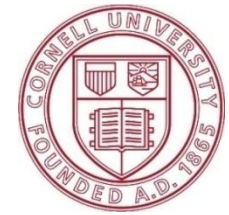






6x6km grid cells

GIS ascii data



CORNELL
UNIVERSITY

Please follow up with research:
http://www.cis.cornell.edu/ics/Datasets

Thank you!

Wolverines in West Montana