

Evaluating landscape connectivity in an eastern US network of parks

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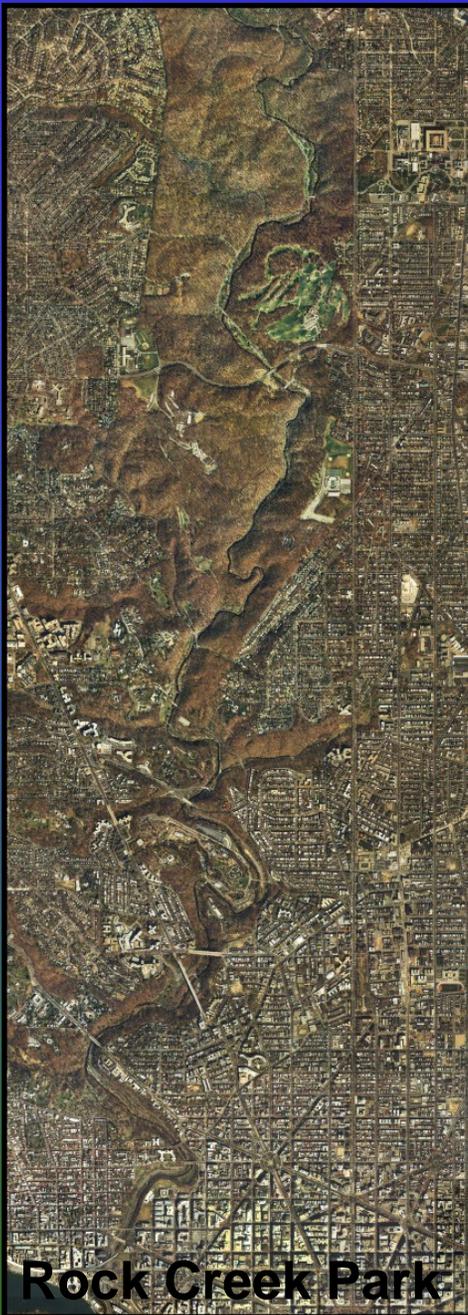


North American Network for Remote
Sensing Park Ecosystem Condition
Santa Fe, New Mexico
March 7, 2007

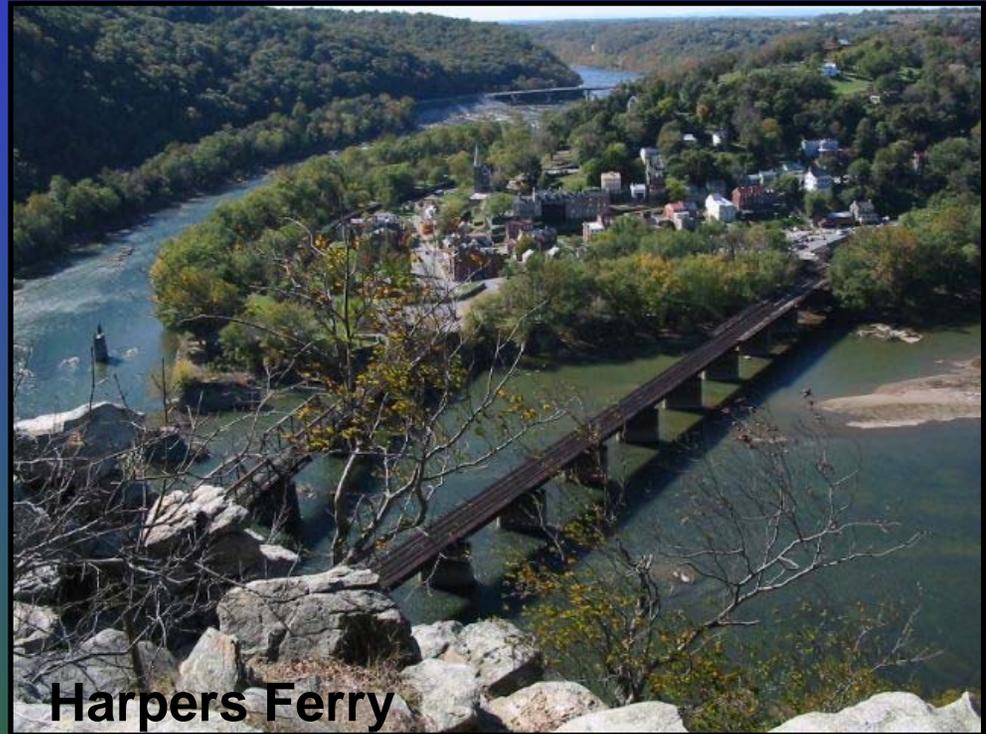


Habitat loss and fragmentation considered
greatest threat to biodiversity
(Fahrig 2003)

Mixed Land Use Setting



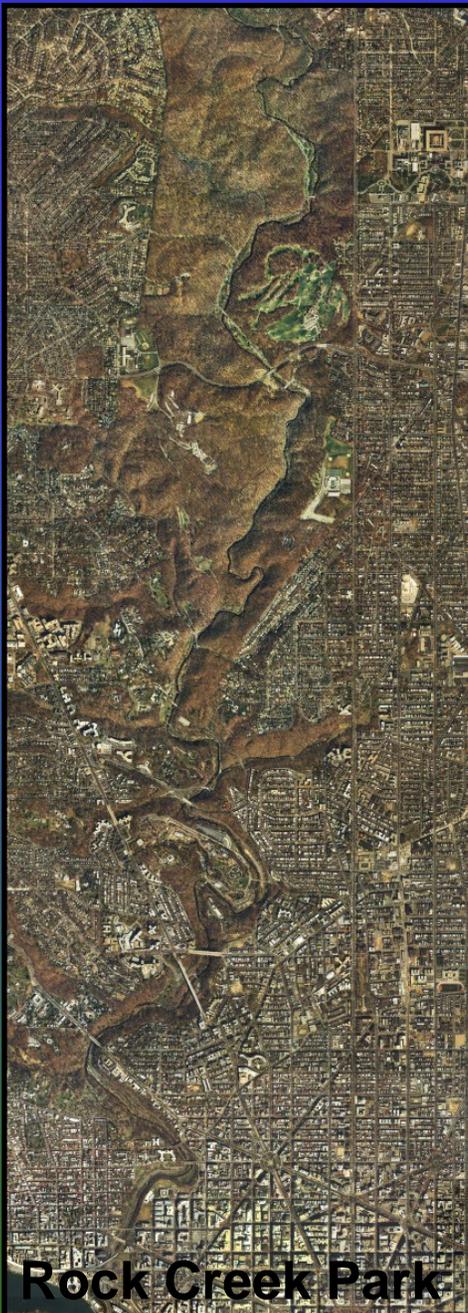
Rock Creek Park



Harpers Ferry

Mixed Land Use Setting

- More people
 - 2000-2003: 30.7% increase in population in Loudoun County
 - 2020: 1.5 million additional people in Potomac Watershed
- Less open space
 - CBW loses ~36,000 ha of open space annually, primarily to urban development
- Parks extremely popular
 - 1% of NPS lands in NCR; 14% of NPS visitations



Rock Creek Park

National Capital Region Network

Small forest patches in fragmented landscapes:

- biological refugia
- migration rest stops
- dispersal corridors
- social, economic, and educational benefits



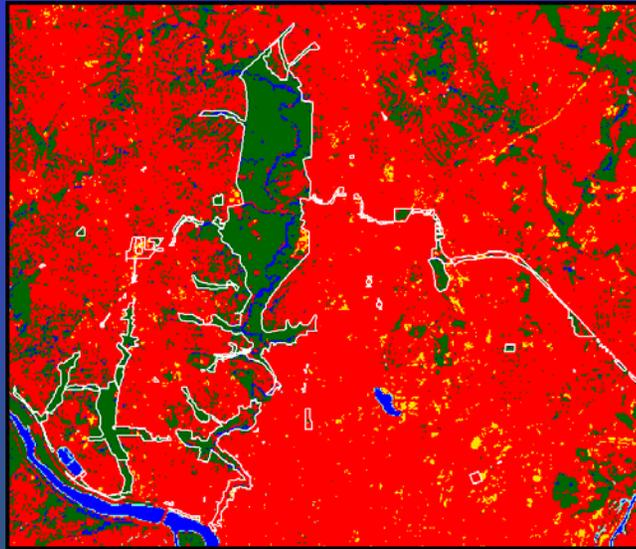
Changes in land cover distribution both within a park and adjacent to that park can dramatically influence a host of park biological, physical and chemical resources. Therefore, maps of land cover distribution and changes in those distributions are often a central component to assessing changes in other resources such as:

- » Water quality
- » Aquatic flora and fauna
- » Terrestrial vertebrates
- » Vegetation communities

- All the king's metrics (background)
- Six-degrees of separation (principles)
- Two stories (performance and evaluation)
- Where do we go from here (further work)



Landscape pattern metrics



- Want to characterize landscape composition and configuration in and around parks.

Landscape pattern metrics

PARK	DATA	p	# Patches	Edge Density	Mean Patch size	Nearest Neighbor
ANTI	Park	35	157	120	229	72

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- Metrics provide information on the parks:
 - In isolation (through time)

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ROCR	Park	71	117	92	435	112

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ANTI	5x boundary	42	589	112	920	77
CATO	5x boundary	...				

- Want to characterize landscape composition and configuration in and around parks.
- Metrics provide information on the parks:
 - In isolation (through time)
 - Relative to other parks
 - Relative to surrounding lands (different map extents)

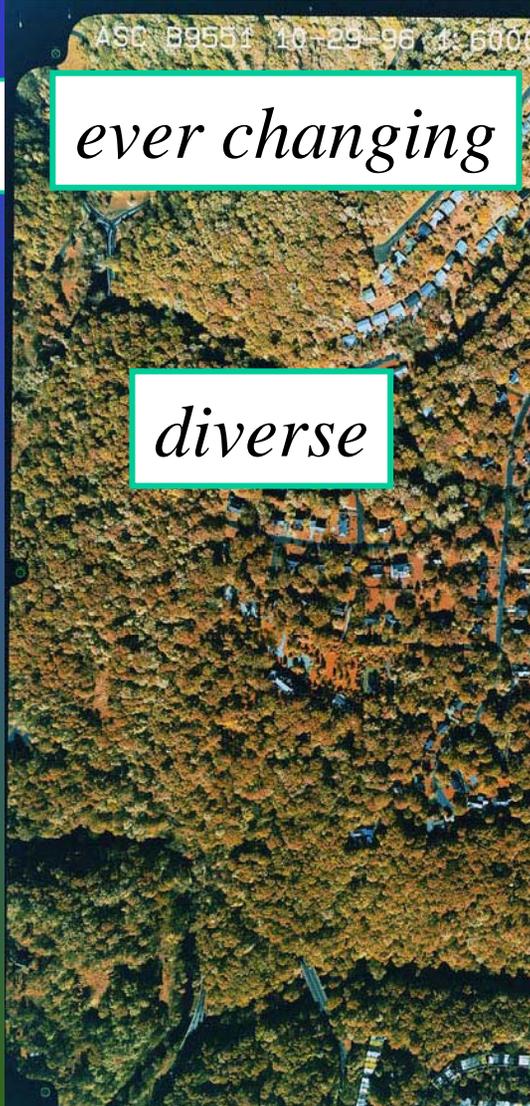
Landscapes are interesting

they are

ever changing

disturbed

diverse



Landscape metrics are uninteresting

unusable

$$P_x = \frac{M_i - \frac{\sum_{k=1}^m n_{ik}^2}{n_i}}{(m-1)} \cdot 100$$

Thresholds?

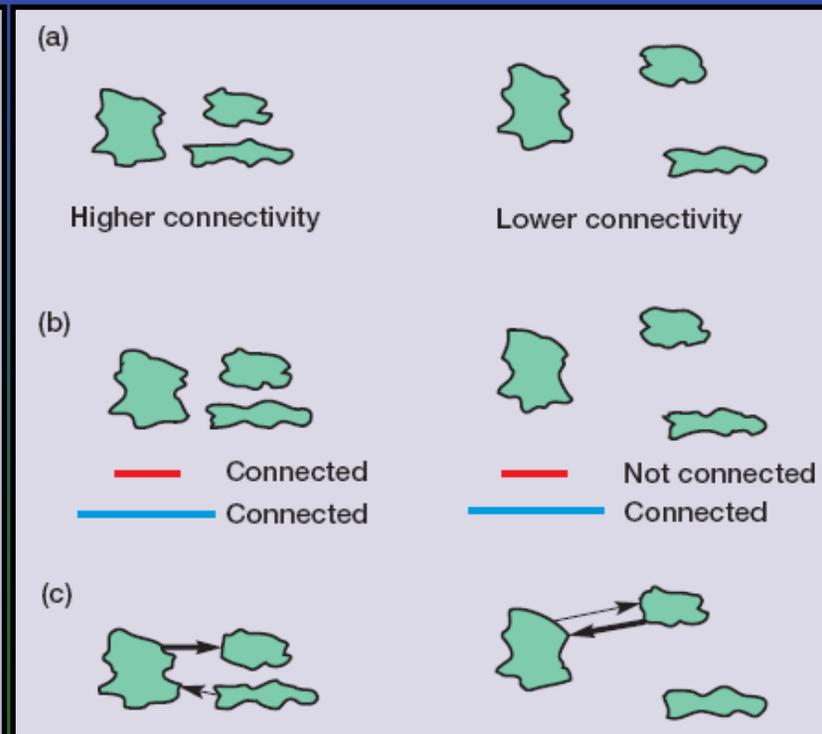
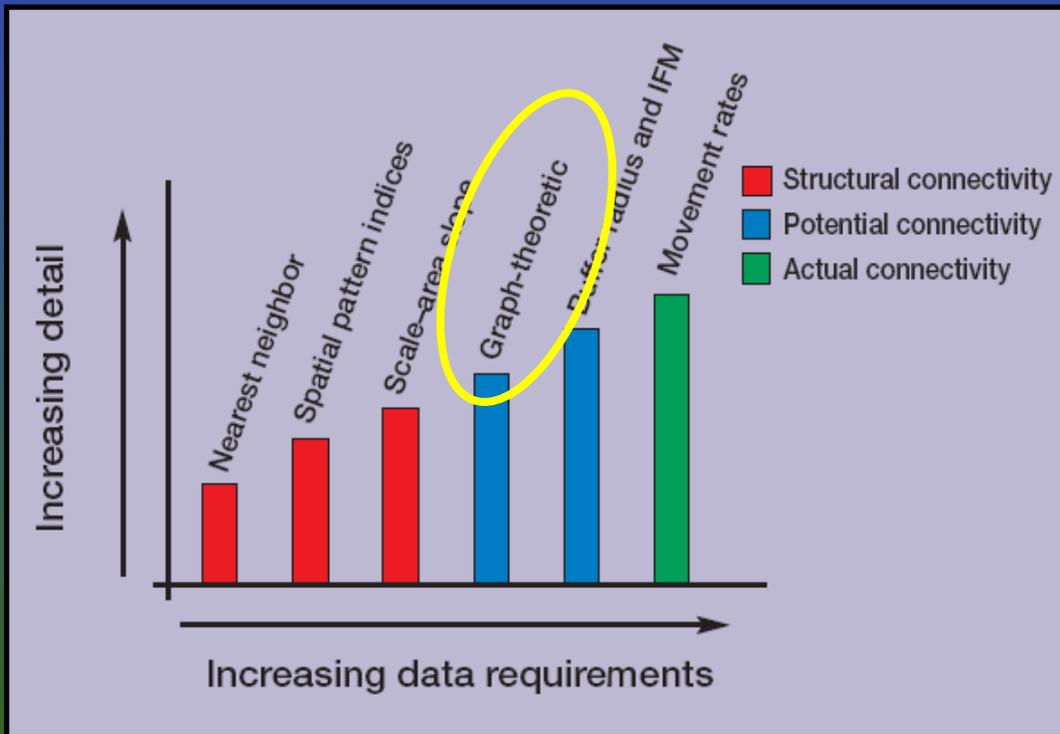
intensity of richness impression

Purpose

- To describe an approach for characterizing ecological process as well as pattern
- To illustrate how assessments of landscape connectivity can inform natural resource management
- To provide examples for a dynamic, urbanizing network of national parks in the greater Washington, D.C. metropolitan area

Connectivity

- Connectivity is an important but inconsistently defined concept in spatial ecology and conservation biology



Graph Theory

Social sciences

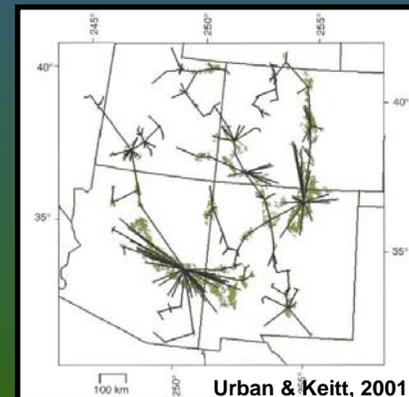
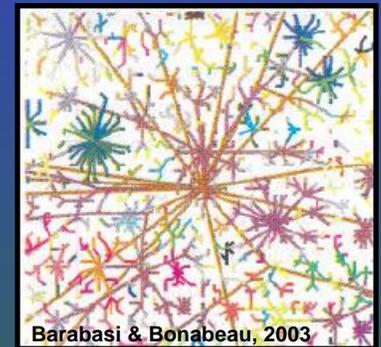
- Small-world phenomenon
- Six-degrees of separation

Complex systems

- Communication and transportation
- Neural networks
- World Wide Web

Ecology

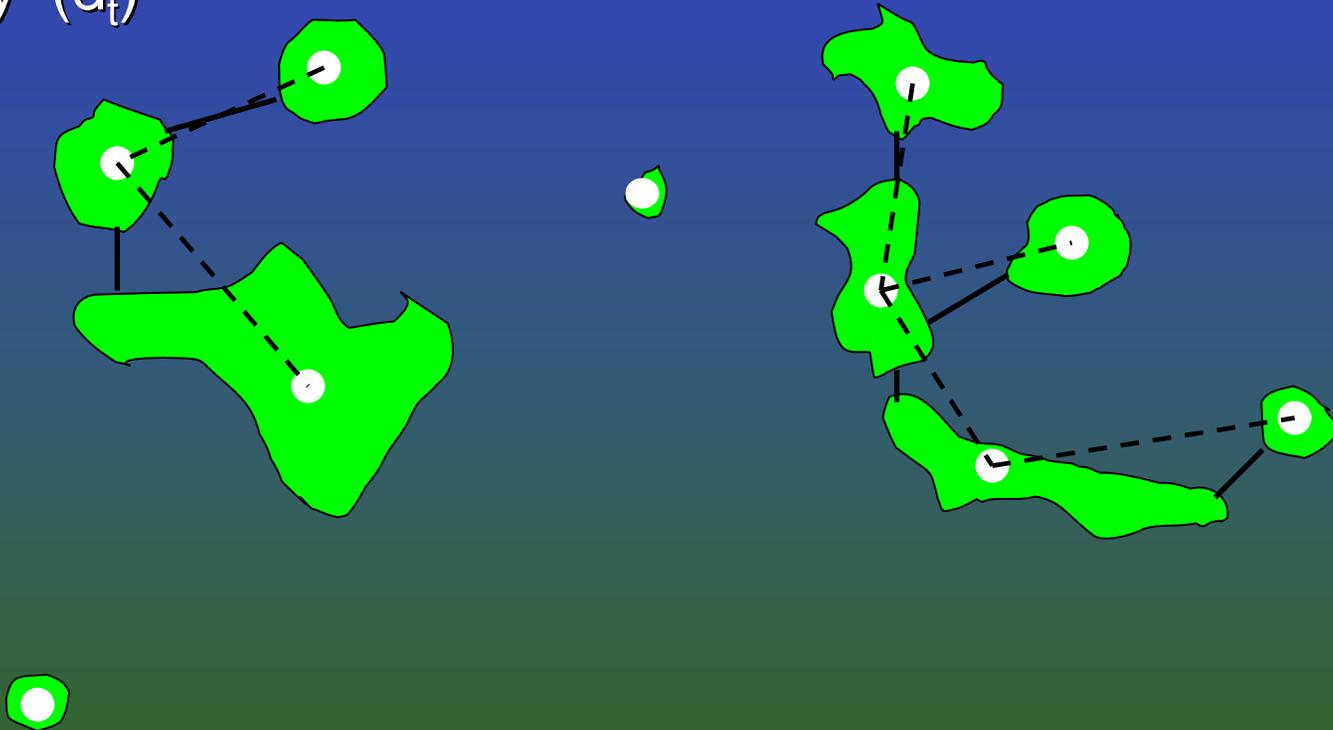
- Flow of energy, water or materials
- Movement of individuals
- Habitat characteristic



Graph representation



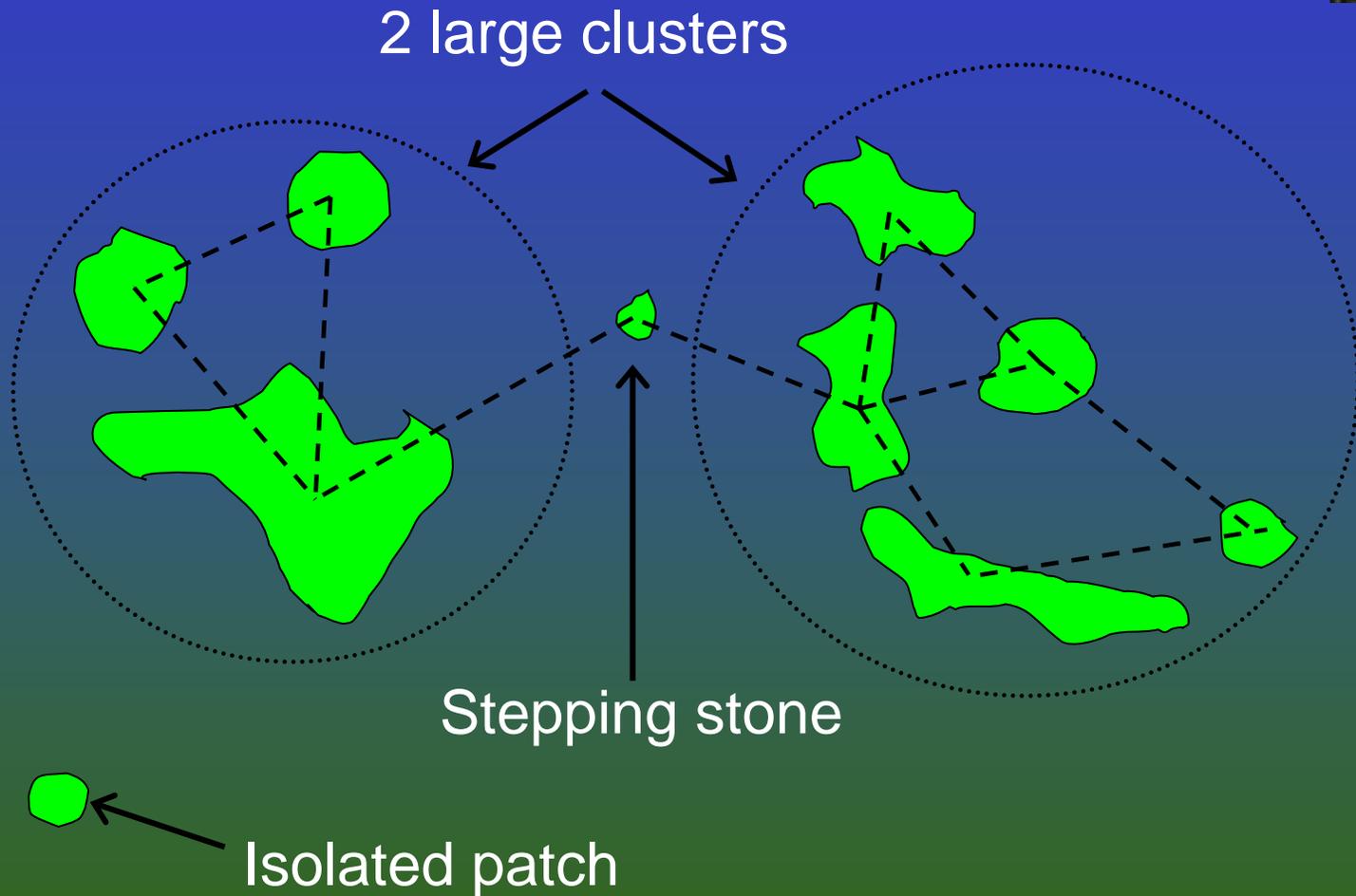
- Patches - features of interest
- Edges or arcs - drawn if the two patches are connected
- Different graphs for organisms with different 'gap crossing ability' (d_t)



Graph representation



- Tripling the threshold distance (d_t)...

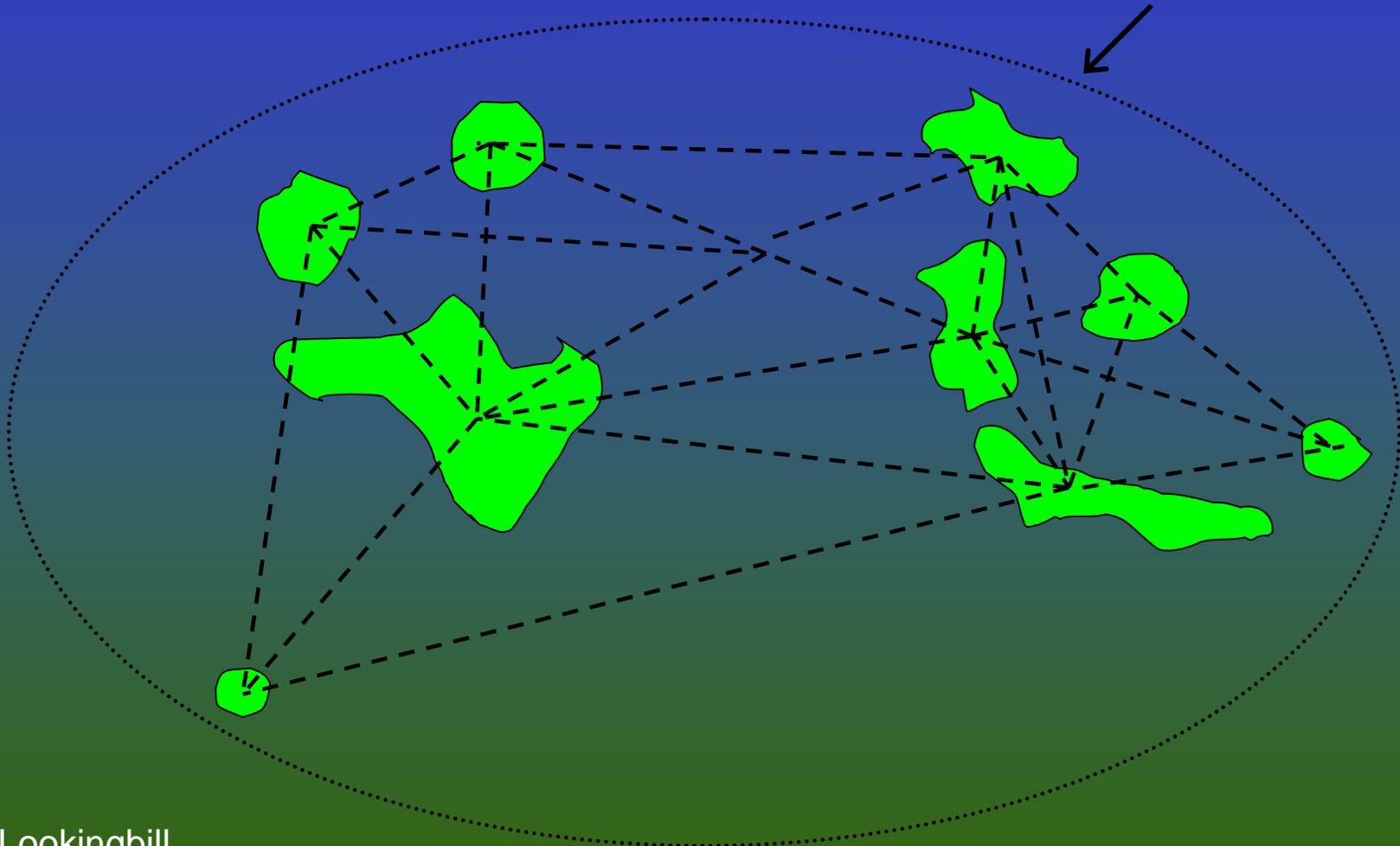


Graph representation



- Increasing d_t by a factor of 10...

1 giant cluster



- Highly connected graphs allow inter-patch movement:
 - Genetic “mixing” (increase heterozygosity)
 - “Rescue” effects
 - This leads to the whole concept of “metapopulations” and spatially structured populations.

Three metrics

Dispersal distance = 1500m

Number of connected patches = 47 (0.94)

Connected area = 122 ha (0.90)

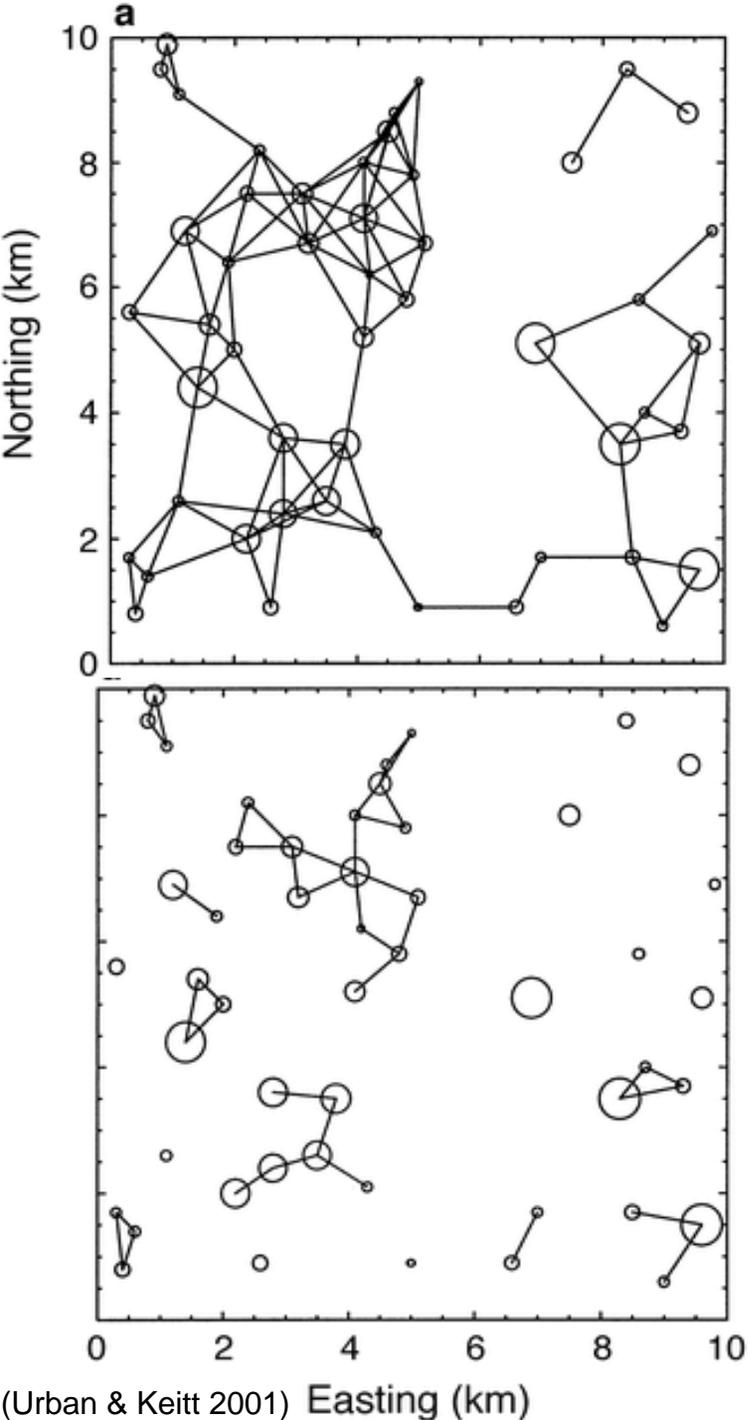
Graph diameter = 15 km

Dispersal distance = 750m

Number of connected patches = 14 (0.28)

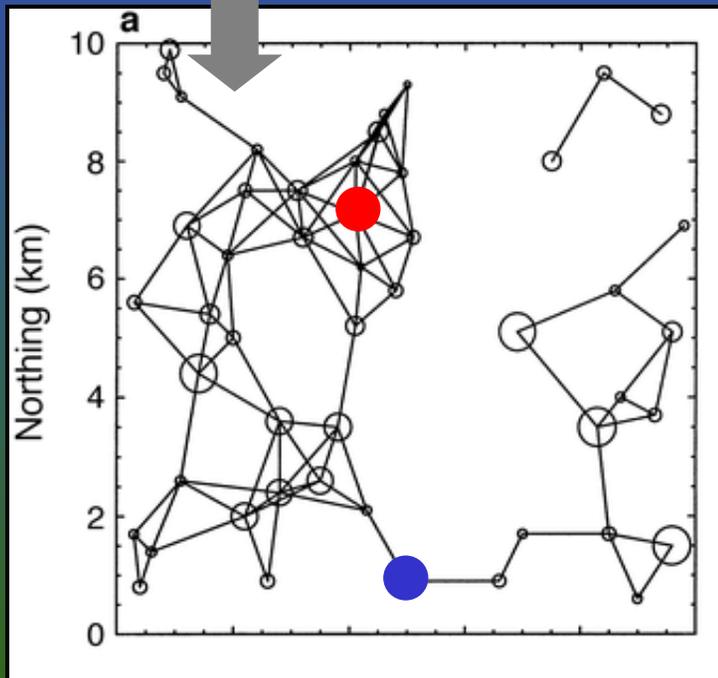
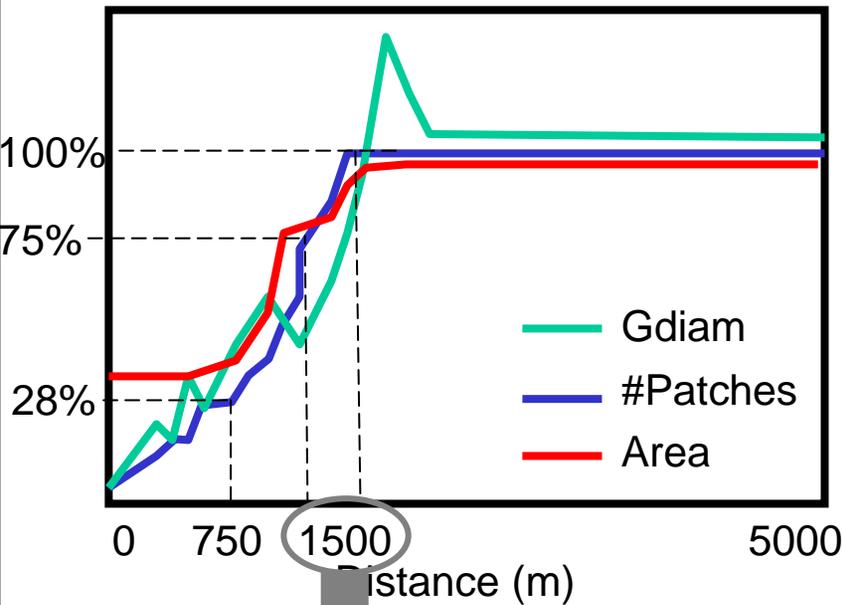
Connected area = 20 (0.15)

Graph diameter = 3 km



Metrics exhibit thresholds

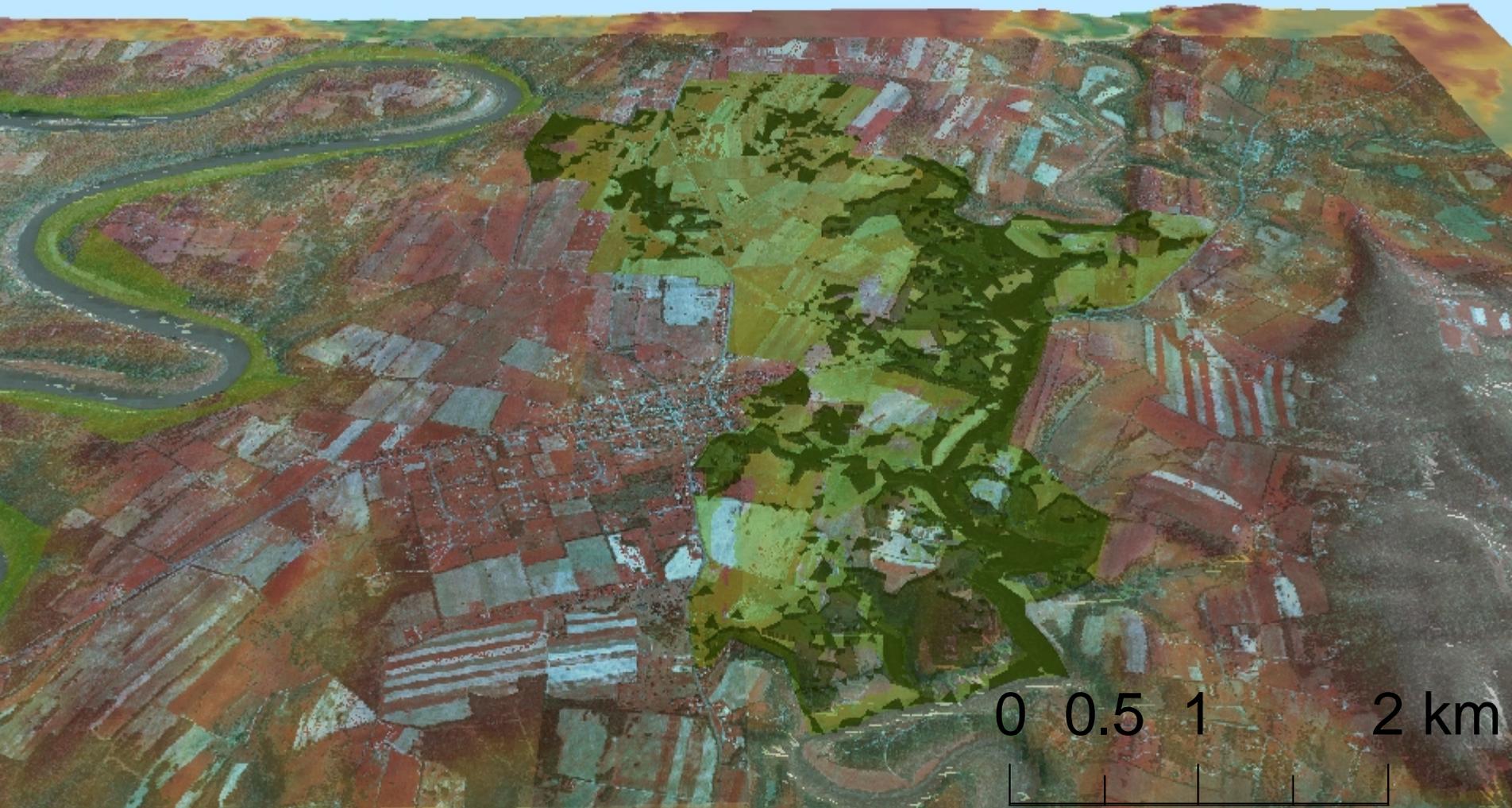
Critical Interpatch Distance (D_t) \cong 1500m
Decrease in connected patches,
connected area and graph diameter



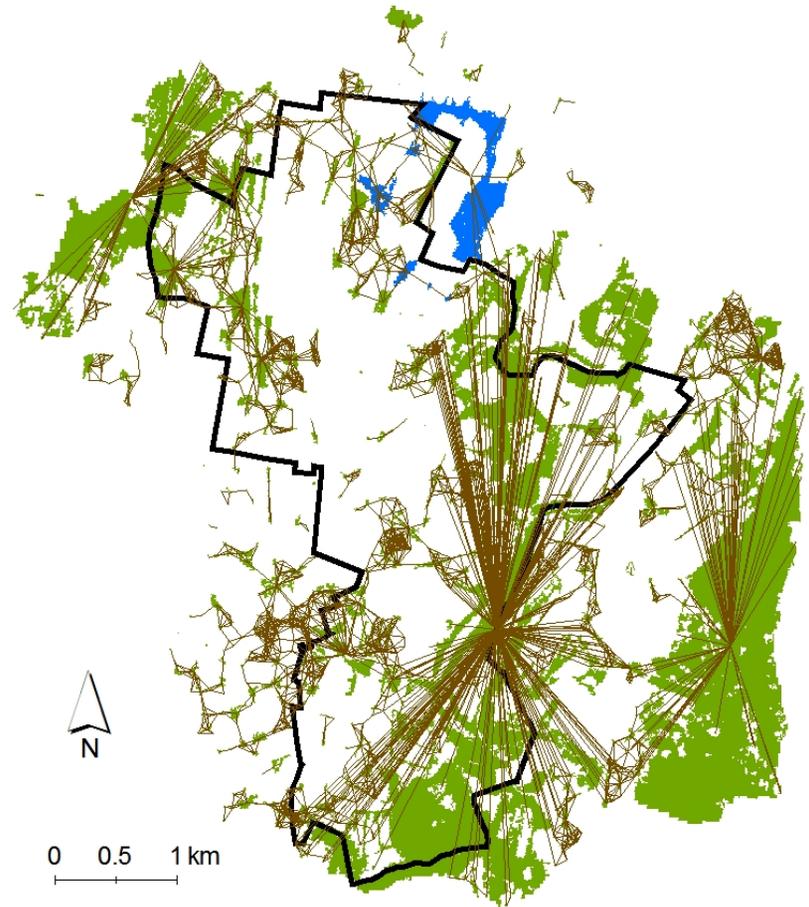
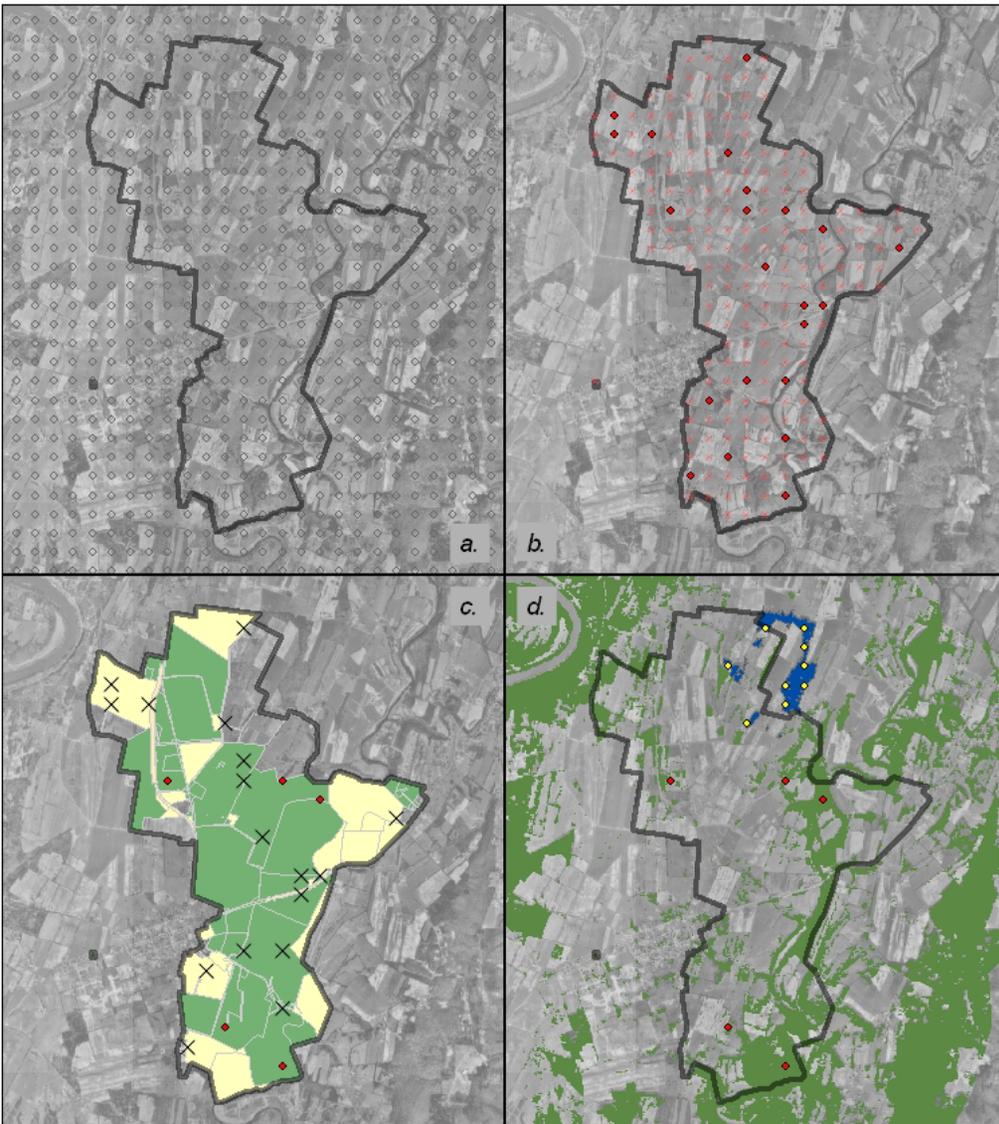
Identification of important patches for landscape connectivity:

- Stepping stones
- Source patches

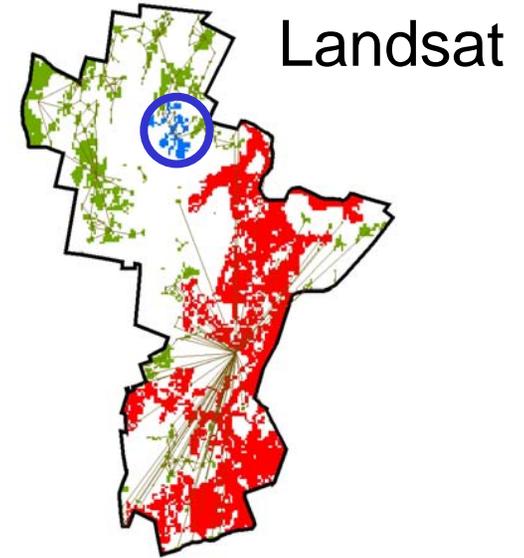
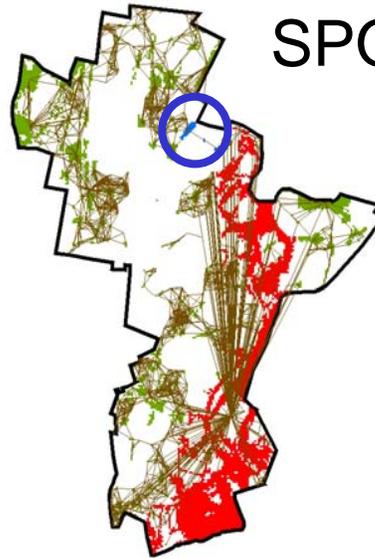
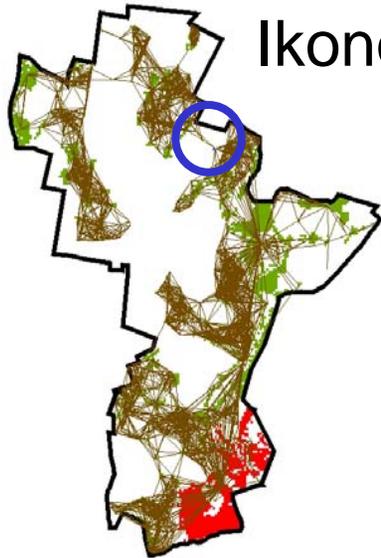
Antietam National Battlefield



Antietam National Battlefield



- Evaluate sensitivity to input data



Manassas National Battlefield



 Manassas Nat'l Battlefield Park

 proposed timber clearing

 incorporated city

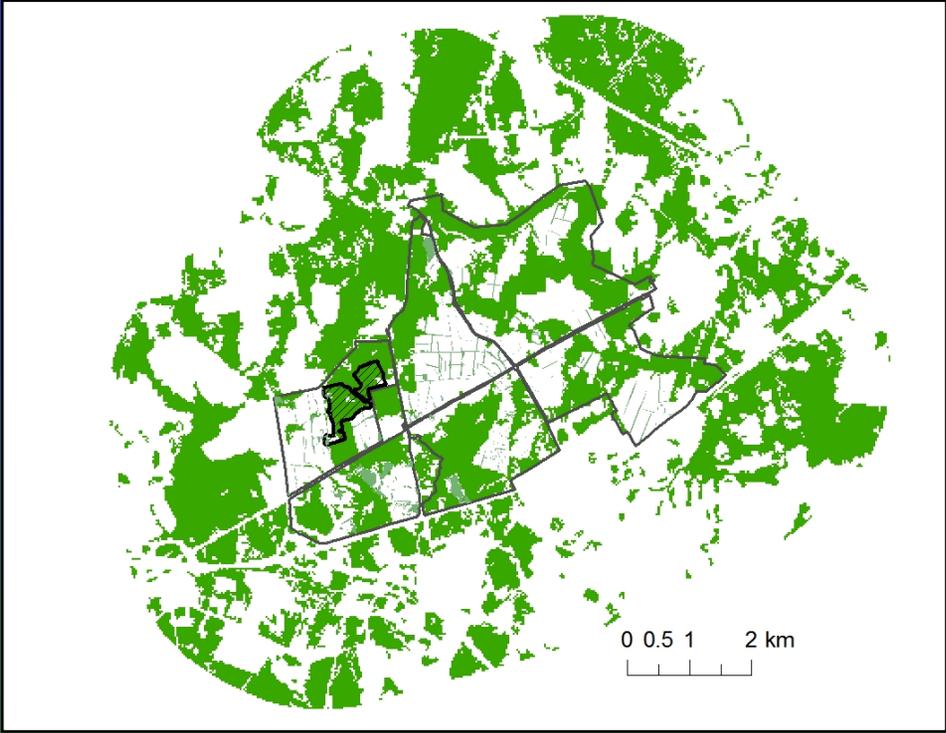
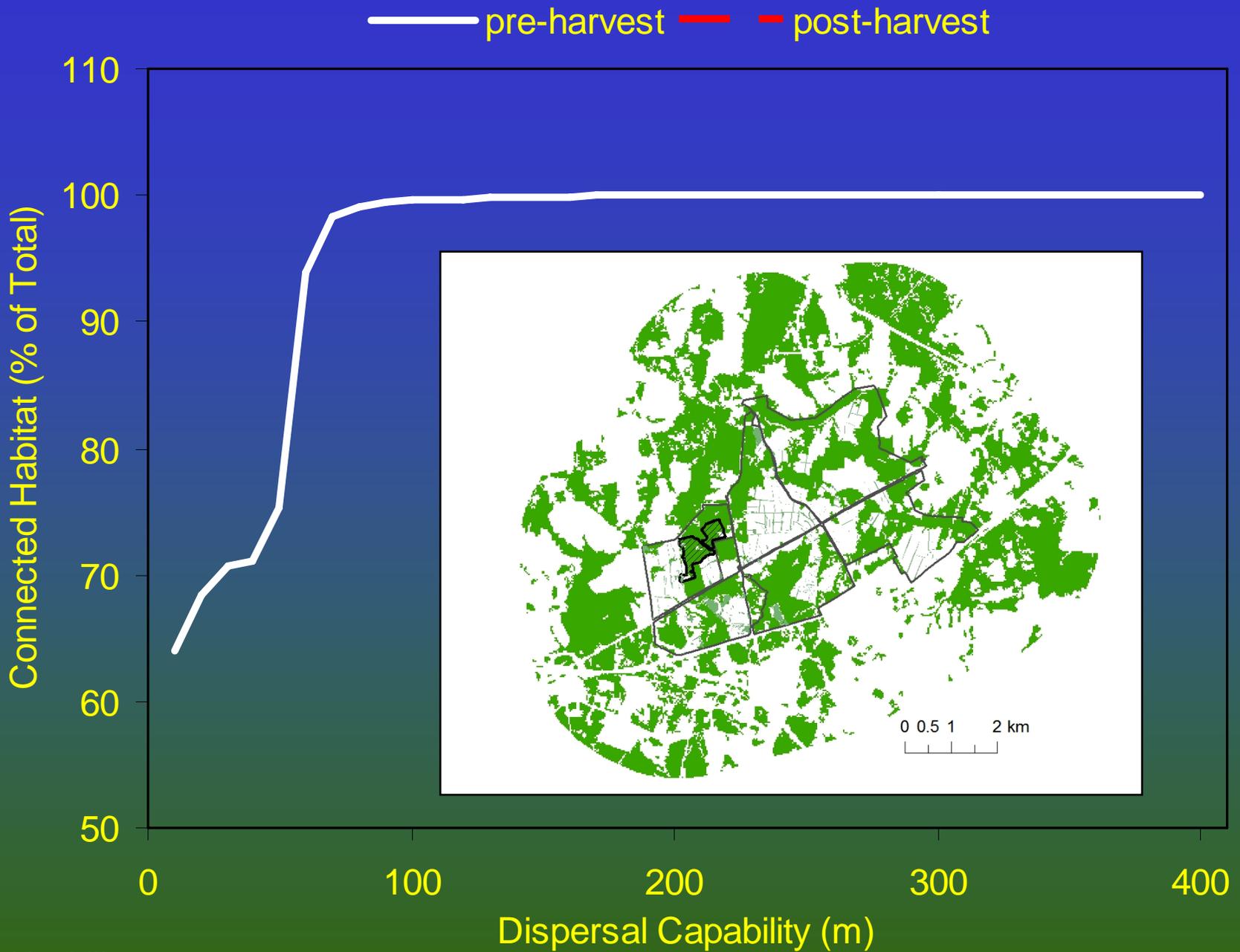
 interstate highway

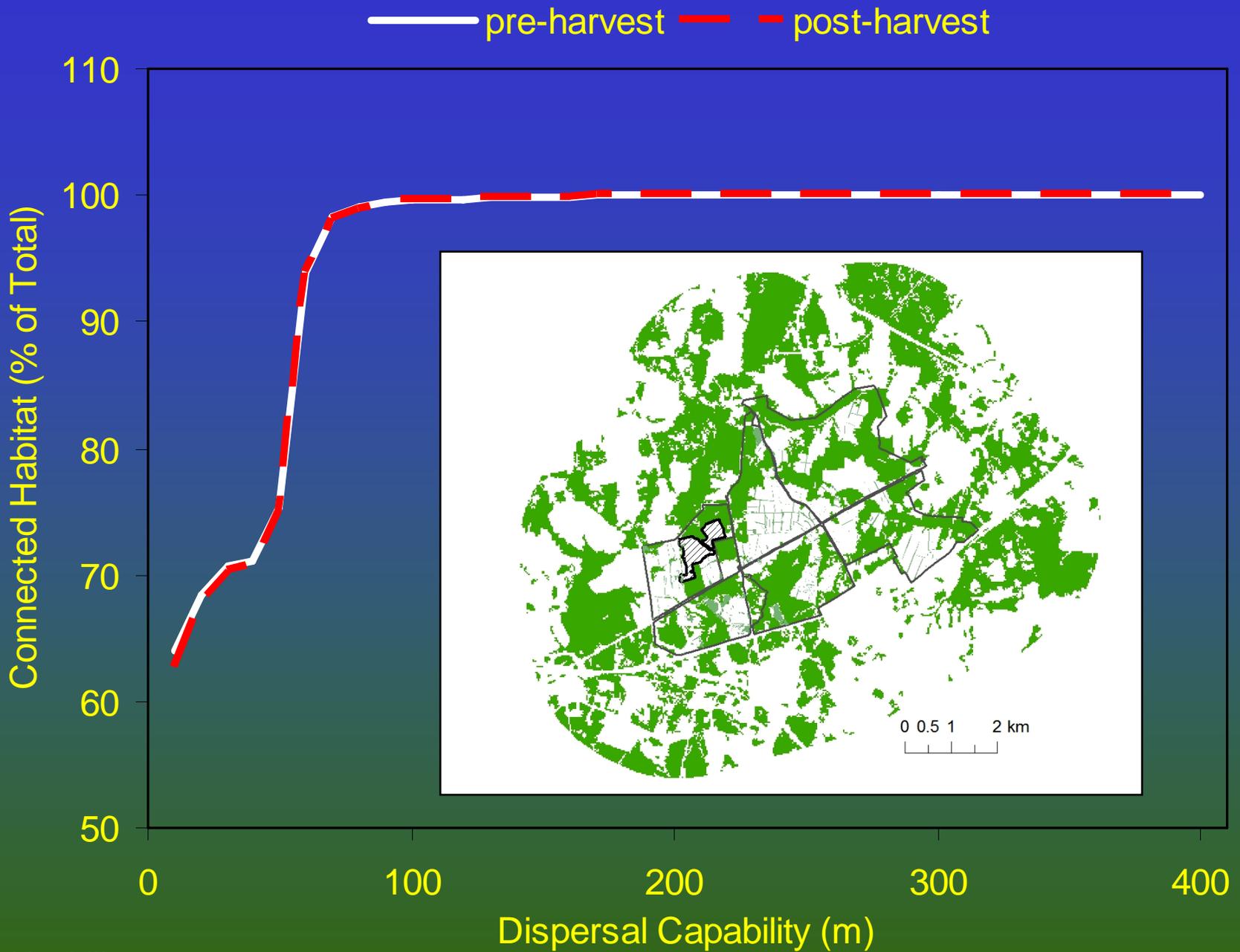
0 2.5 5
Kilometers

Amphibian dispersal

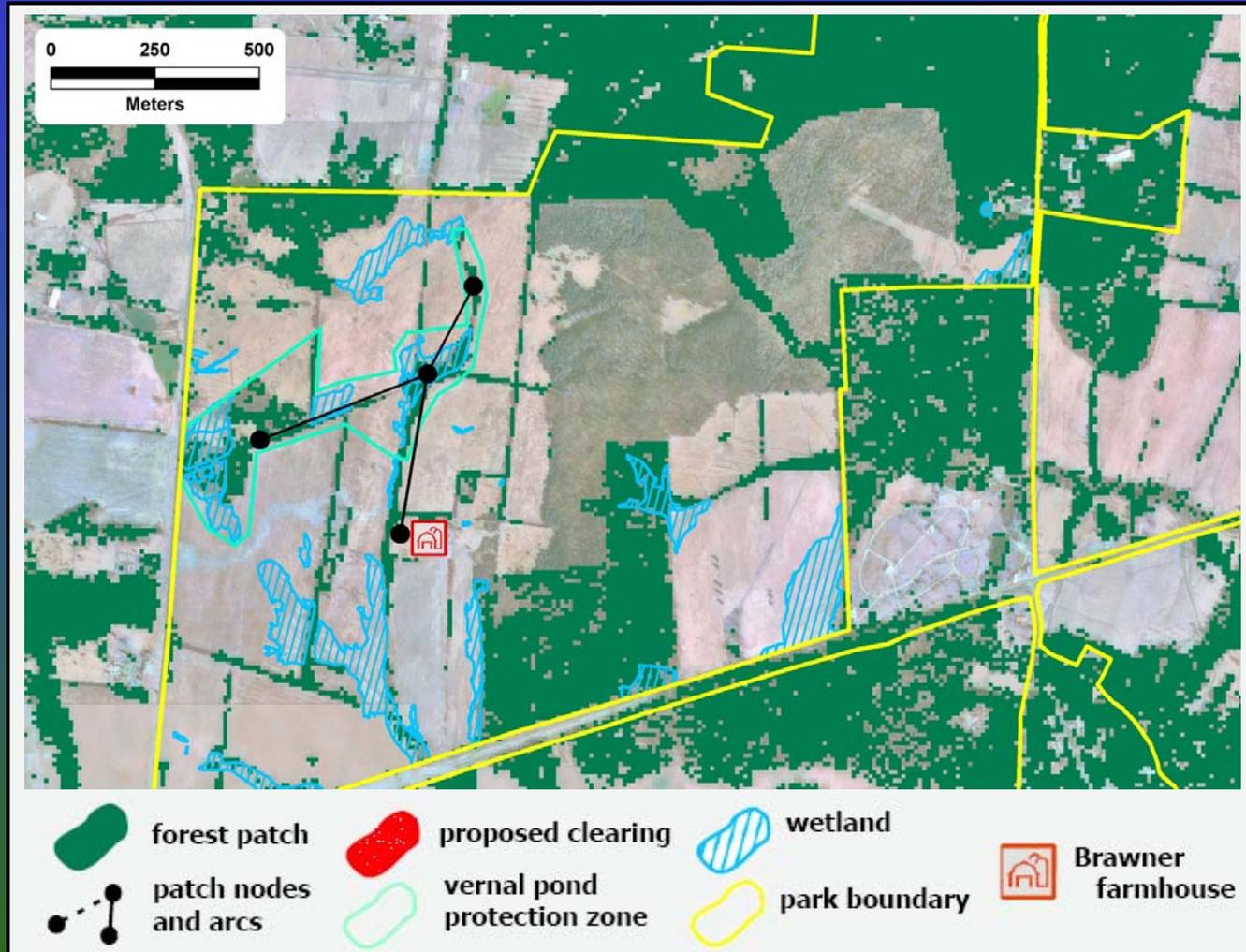
- Isolation of ephemeral ponds a concern
- Marsh et al. (2004)
10's of m
- Smith & Green (2005)
400m



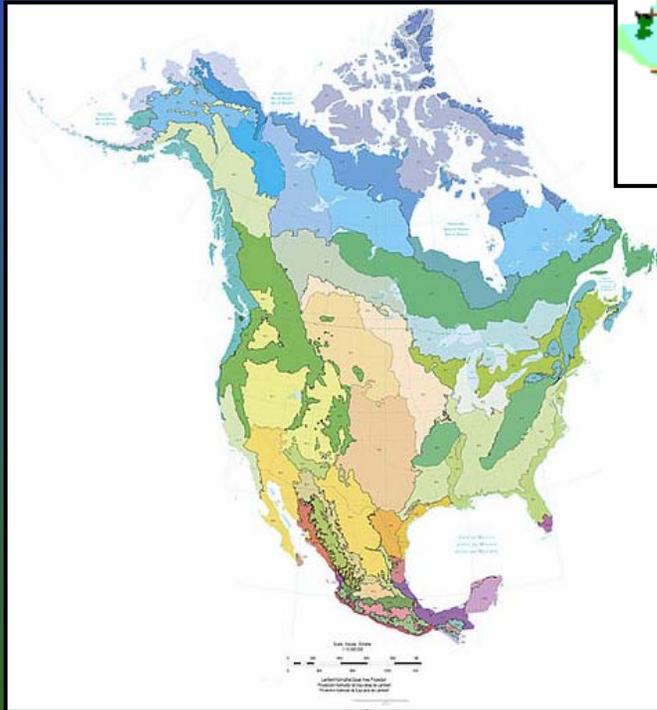




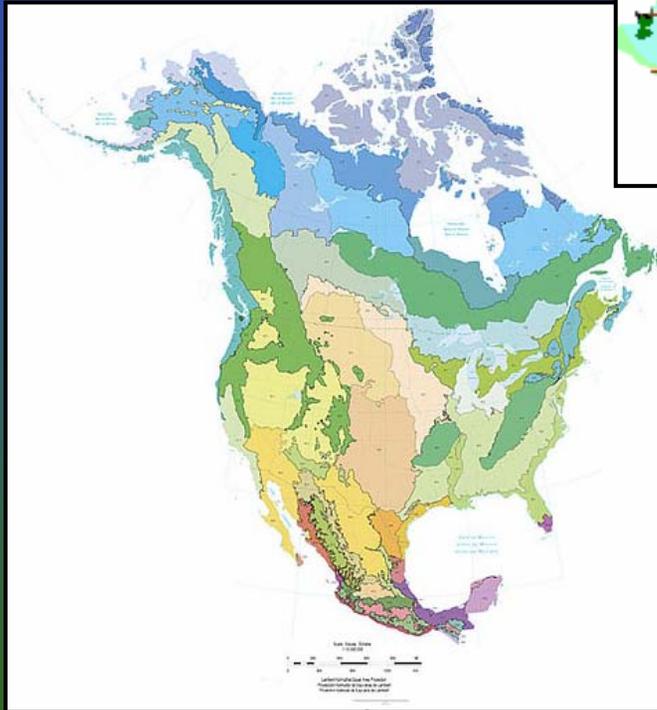
Local resources may be at risk



Next steps and expected applicability



Next steps and expected applicability



	<u>Dt (75%)</u>	<u>Dt (100%)</u>	<u>100m</u>
Antietam	180	250	31%
Catoctin	30	40	100%
Prince William	30	80	100%
Rock Creek	270	2610	10%
Manassas	60	230	94%

Regional Connectivity



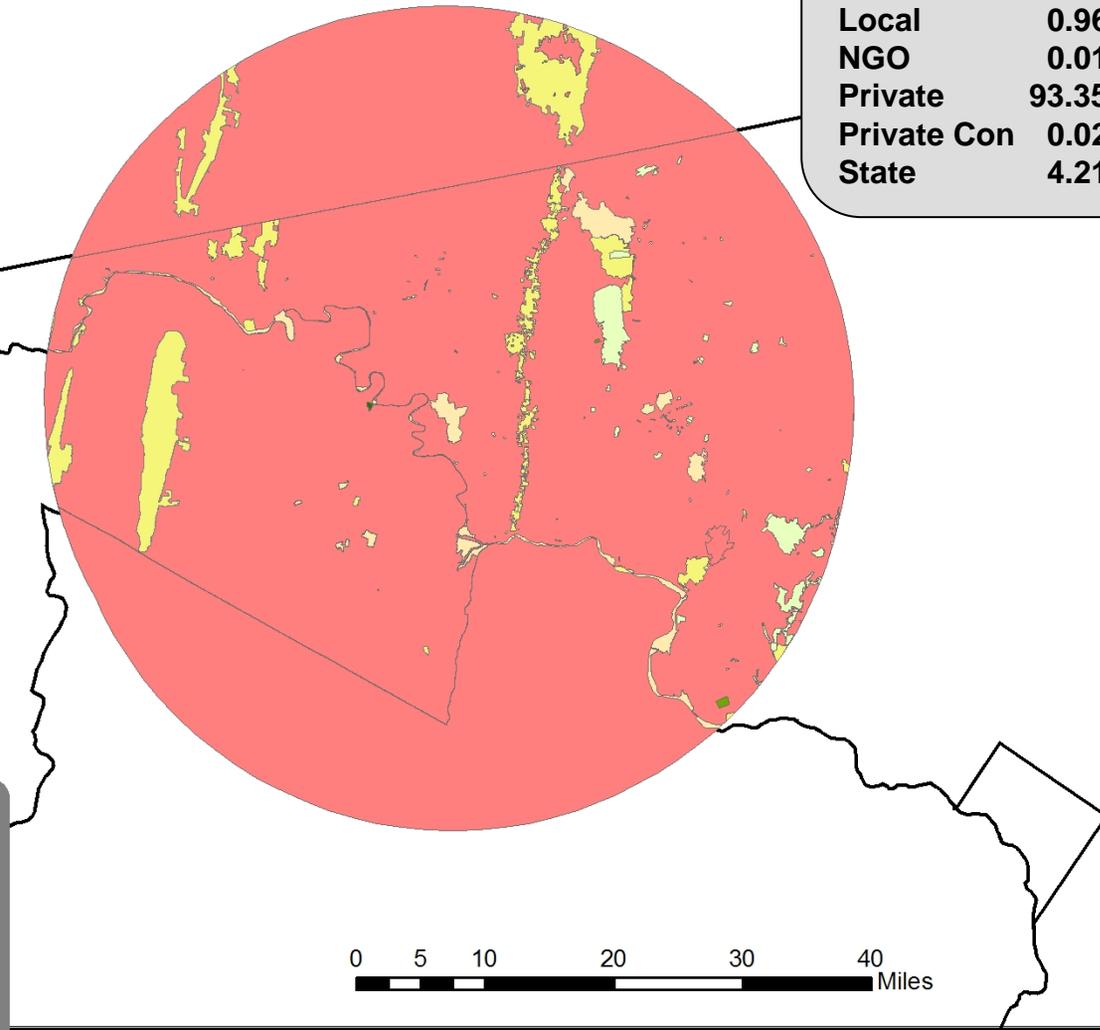
	Percent Area
Antietam	0.16%
Federal	1.31%
Local	0.96%
NGO	0.01%
Private	93.35%
Private Con	0.02%
State	4.21%

Stewardship in 30 mile Buffer

Protected Areas

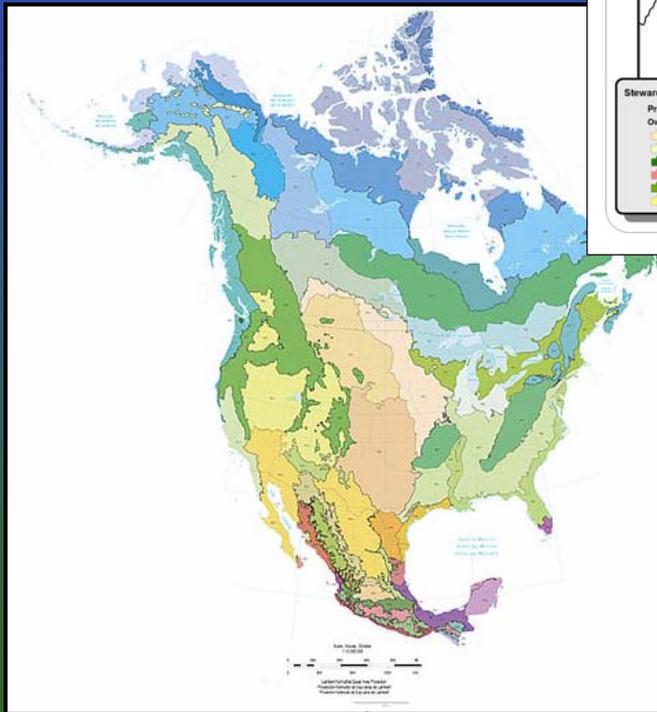
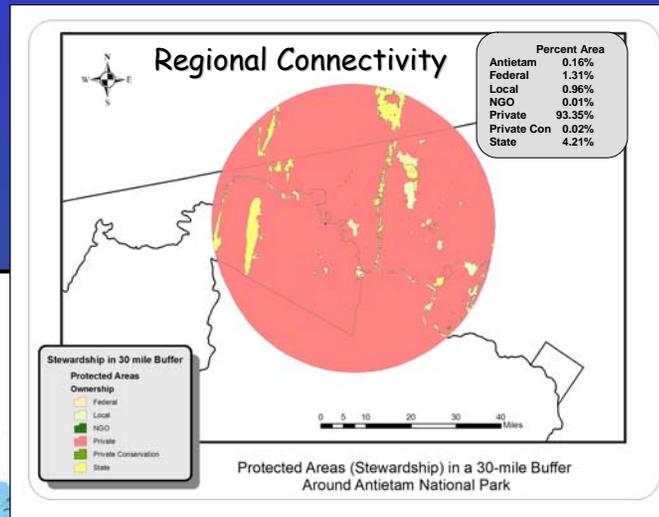
Ownership

- Federal
- Local
- NGO
- Private
- Private Conservation
- State



Protected Areas (Stewardship) in a 30-mile Buffer Around Antietam National Park

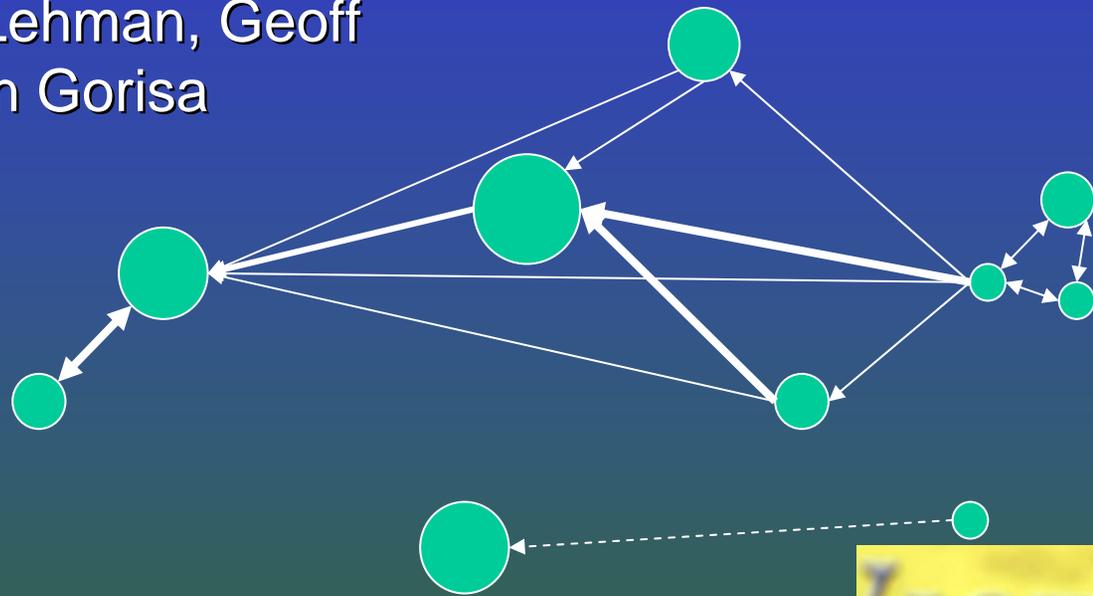
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Acknowledgements

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Dean Urban, Mark Lehman, Geoff
Sanders, Brian Gorisa



Questions?

