Landscape-scale conservation planning

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Goal of landscape-scale conservation planning

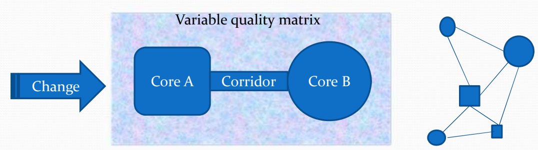
- Represent diversity of species, habitats, ecosystems in a system of reserves that is large and connected enough to support current populations and communities and restore extirpated ones, while providing for ongoing ecological and evolutionary change

Transcending the local

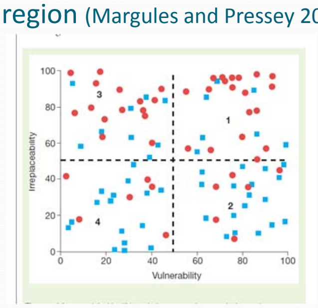
- In many ways, the purpose of landscape-scale conservation is to transcend localized, single species, or purely opportunistic conservation

Recent thinking and methodologies are highly systematic: spatial and temporal models, complex software, and mapped data at multiple scales

- Three primary tasks:
  - **Comprehensive Representation**: *in new core reserves that complement existing reserves*
  - **Connectivity**: *gene flow, migration, and range shifts*
  - **Threat assessment**: *current and forecasted threats*



Goal is to *prioritize* areas for conservation action, relative to other areas in same region (Margules and Pressey 2000)



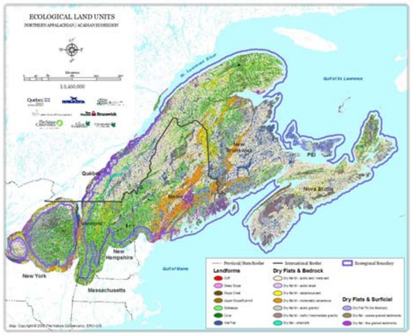
- 100 potential conservation areas in a region
- Red are selected as potential sites that meet some conservation goals
- Blue are potential replacements
- Quadrat location suggests level of threat/urgency/vulnerability and relative value/irreplaceability
- Locations in graph will change through time with added protection status and threat

Coarse filter representation

- Lacking fine-scale data of a suitable extents as well as uncertainty over the future, has lead to *coarse filter planning* (Hunter et al. 1988, Anderson and Ferree 2010)
  - **Biodiversity surrogates**
    - Underlying geophysical diversity = biological diversity
      - Ecological Land Units (ELU) (Anderson et al. 2006)
      - Land Facets (Beier and Brost 2010)

"Preserving the stage, not the actors"

Biodiversity surrogates for representation: ELUs from the Northern Appalachian/Acadian ecoregion (Anderson et al. 2006, TNC Ecoregional Plan)



- Elevation
- Bedrock
- Surficial geology
- Moisture
- Landform

Some modeling tools – representation in core reserves

- MARXAN, MARXAN with Zones, Zonation
- ***Design clumped reserve systems that make sense to the planner*** (Ball et al. 2009)

An attractive feature of these programs is that they have user-driven goals and these are ideal avenues for involving stakeholders from the beginning of a planning process

Example of MARXAN reserve selection outputs for the Northern Appalachian/Acadian Ecoregion (Trombulak et al. 2008, 2C1Forest)

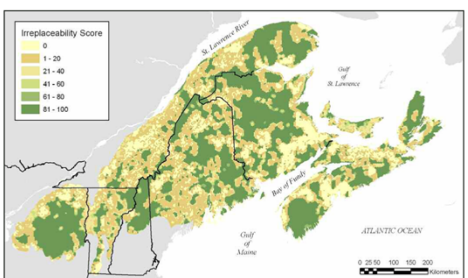
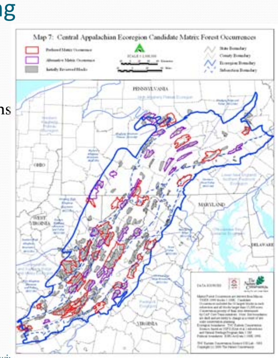


Figure 5.4. Irreplaceability of planning units under the medium target scenario.

Need to understand what other methods important groups are using

- The Nature Conservancy Ecoregional Assessments
  - Northern and Central Appalachians completed
  - Southern Appalachians underway

This approach uses many of the same principles and data, if not the same software and algorithms.



Habitat connectivity theories and some software

- Least Cost Path– *CorridorDesigner*
- Circuit Theory– *Circuitscape*
- Centrality – *Connectivity Analysis Toolkit*

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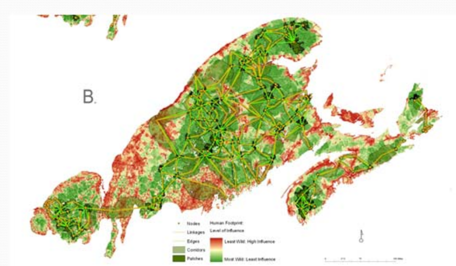
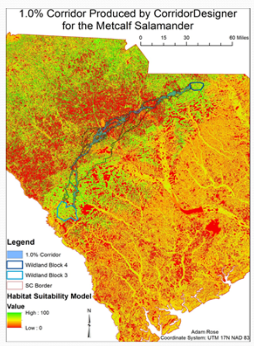
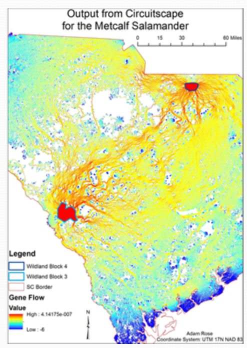
Example of a graph-theoretic, multiple node, LCP approach using the software FunConn (Perkl 2009; Baldwin et al. 2010)



Understand model structure effects: focal species connectivity using two approaches(Adam Rose, MS thesis)





Climate corridors

- Land Facets (from Beier and Brost 2010)

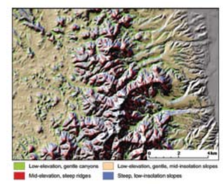


Figure 2. Illustration of the geographic distribution of land facets, defined on the basis of elevation, slope, insolation, and topographic position, draped over a hillshade map. For clarity, not all land facets in the landscape are shown.

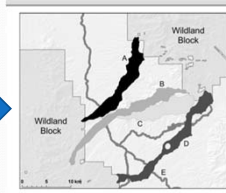


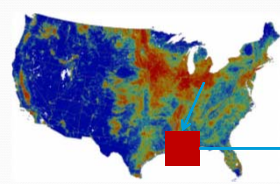
Figure 5. A multistranded linkage of land facets designed to allow species to shift their range in response to climate change and to support movement during periods of quasi equilibrium. Area A optimizes continuity for high local diversity of land facets. Other areas provide the best continuity of high-insolation, steep slopes (area B), low-elevation, gentle canyons (area C), and low-elevation, gentle ridges (area D). Area E encompasses the region's main river and its only perennial tributaries from each wildland block.

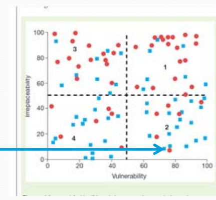
Whatever connectivity modeling approach is adopted, need to validate and improve through on the ground study

Clevenger et al., 2009 Western Transportation Institute

Modeling threats: multiple methodologies to quantify existing and projected land uses

- "Natural landscape metric" (Theobald 2010)
- "Human Footprint" (Sanderson et al. 2002; Woolmer et al. 2008)
- "Future Human Footprint" (Baldwin et al. 2007, 2009)





Example: modeled "Future Human Footprint" scenario; degree of change expected from current

Figure 4.4. *The Future Human Footprint in the Northern Appalachian/Acadian ecoregion in the Rapid Influx B (North Central Lakes region) scenario.*

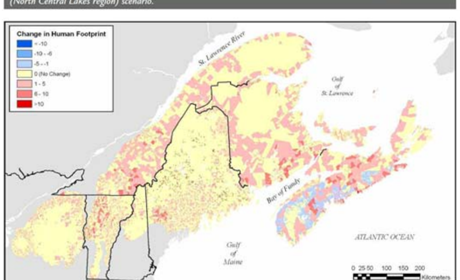
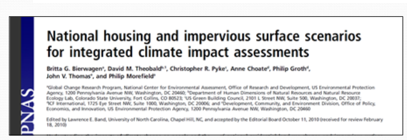


Figure 4.5. *The difference between the Current Human Footprint and the Future Human Footprint (Rapid Influx B scenario) for the Northern Appalachian/Acadian ecoregion. Areas colored pink and red are projected to experience increased transformation—or threat—in future years. Areas in blue are projected to experience reduced threat.*

Climate change

- ***Need to consider climate-land use interactions!***

Accessible climate and land use change tools and datasets are coming online, for conservation planning
(Girvetz et al. 2009 PloS One; Bierwagen et al. 2011)



PNAS

National housing and impervious surface scenarios for integrated climate impact assessments

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Organized stakeholder involvement

- Nested groups of stakeholders involved in range of activities from parameterizing models (e.g., setting targets) to identifying conservation opportunities and drawing reserve/corridor boundaries

"California Essential Habitat Connectivity project (Spencer et al. 2010) was guided by 3 nested groups of stakeholders. There were 200 anticipated map users from 62 federal, state, tribal, regional, and local agencies. A subgroup of 44 technical advisors participated in workshops that made decisions on data sources, models, and mapping criteria. Finally, a steering committee representing 4 agencies conferred with the analysts to make project management decisions." (Beier et al. 2010 Cons Bio)

Stakeholders examining MARXAN outputs in Northern Appalachian/Acadian Ecoregion 2007: iterative meetings at localities throughout region

Need to have transparency and documentation when gathering expert opinion (Beazley et al., 2010)

Challenges for the Appalachian LCC

- Large-landscape scale conservation planning is limited by 3 things
  - *Data* available at a sufficient grain size and extent to be meaningful at ecoregional scales
  - *Software* capable of integrating data in models sophisticated enough to recognize variability (individual, population, landscape) and environmental change, and *modelers* who are *biologists*
  - *Organized participation* by stakeholders who know about "the local" and envision the "big picture"

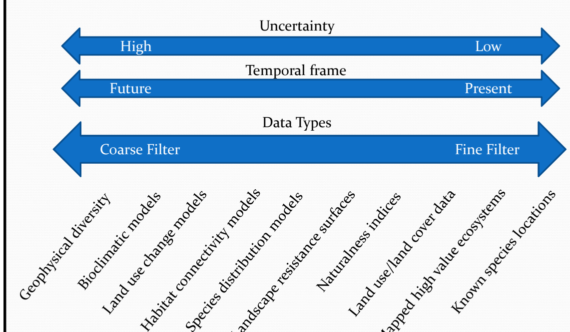
Selected Resources

- Books
  - Moilanen, A., K.A. Wilson, H.P. Possingham, eds 2009. Spatial Conservation Priorization: Quantitative Methods and Computational Tools. Oxford.
  - Trombulak, S. and R. Baldwin, eds. 2010. Landscape-scale Conservation Planning. Springer.
- Foundational articles
  - Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405:243-253
  - Groves C et al. (2002) Planning for biodiversity conservation: putting conservation science into practice. Bioscience 52:499-512
  - Carroll C, Noss RF, Paquet PC, Schumaker NH (2003) Use of population viability analysis and reserve selection algorithms in regional conservation plans. Ecological Applications 13:1771-1789
  - Beier P, Majka DR, Spencer WD (2008) Forks in the road: choices in procedures for designing wildland linkages. Conservation Biology 22:836-851
  - McRae BH, Dickson BG, Keitt TH, Shah VB (2008) Using circuit theory to model connectivity in ecology, evolution, and conservation. Ecology 89:2712-2724
  - Beier P, Brost B (2010) Use of land facets to plan for climate change: conserving the arenas, not the actors. Conservation Biology 24:701-710
  - Anderson MG, Ferree CE (2010) Conserving the stage: climate change and the geophysical underpinnings of species diversity. PloS One 5:e11554
  - Beier P, Spencer WD, Baldwin RF, McRae BH (2011) Toward best practices for developing regional connectivity maps. Conservation Biology 25:879-892

Selected Resources

- Websites
  - http://corridordesign.org/
  - http://www.uq.edu.au/marxan/
  - http://www.circuitscape.org/Circuitscape/Welcome.html
  - http://www.natureserve.org/prodServices/vista/overview.jsp
  - http://conserveonline.org/workspaces/ecs/napai/nap

Data context in conservation planning



Need to bridge the coarse filter-fine filter gap

- Better spatial data at finer grains and greater extents
- Access to that data
- More integrated models
- Computing power to run fine-grain models at large extents