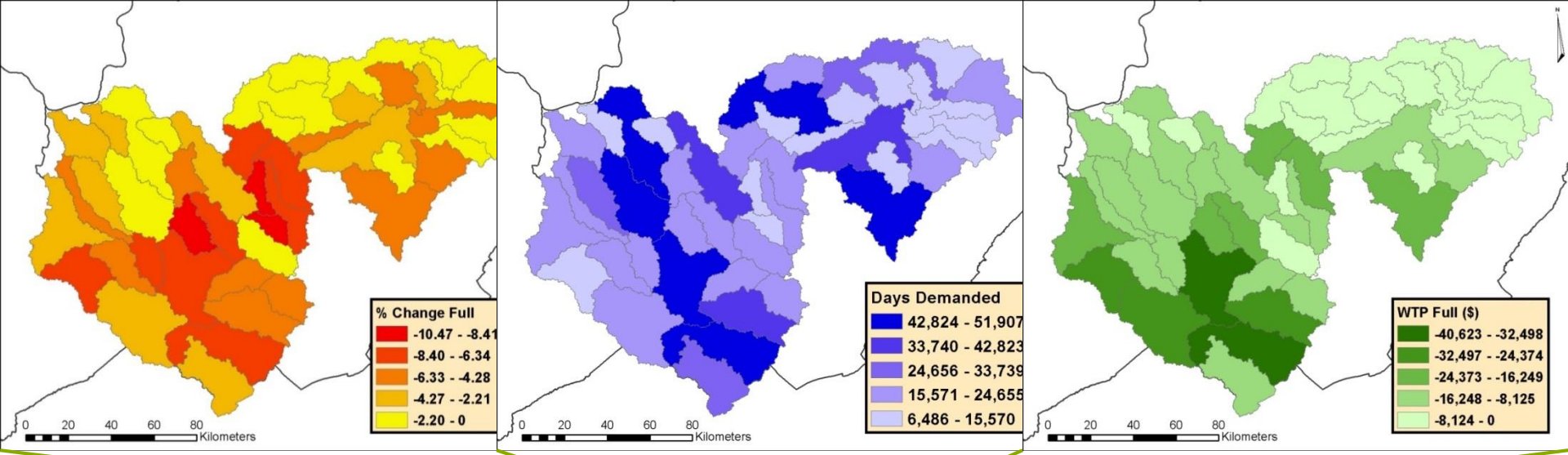

Optimization Modeling to Analyze Multi-Resource Management Goals

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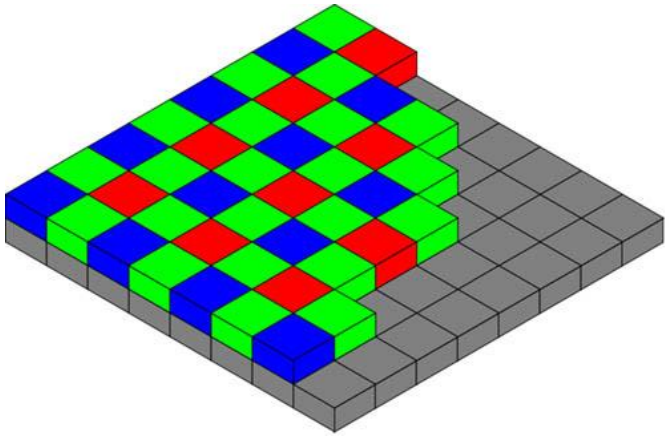
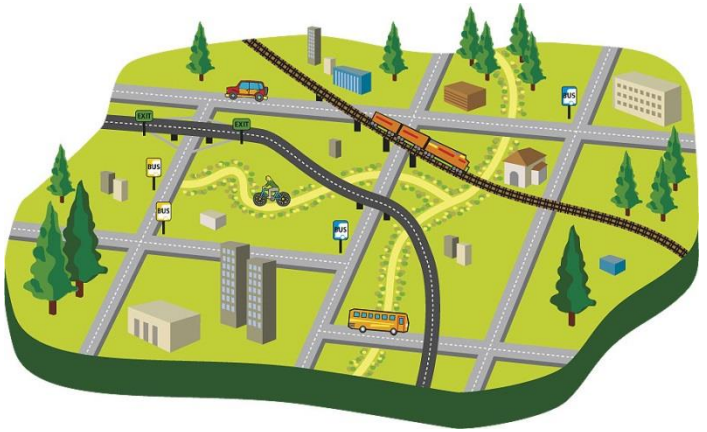
NRC Workshop
June 2, 2015

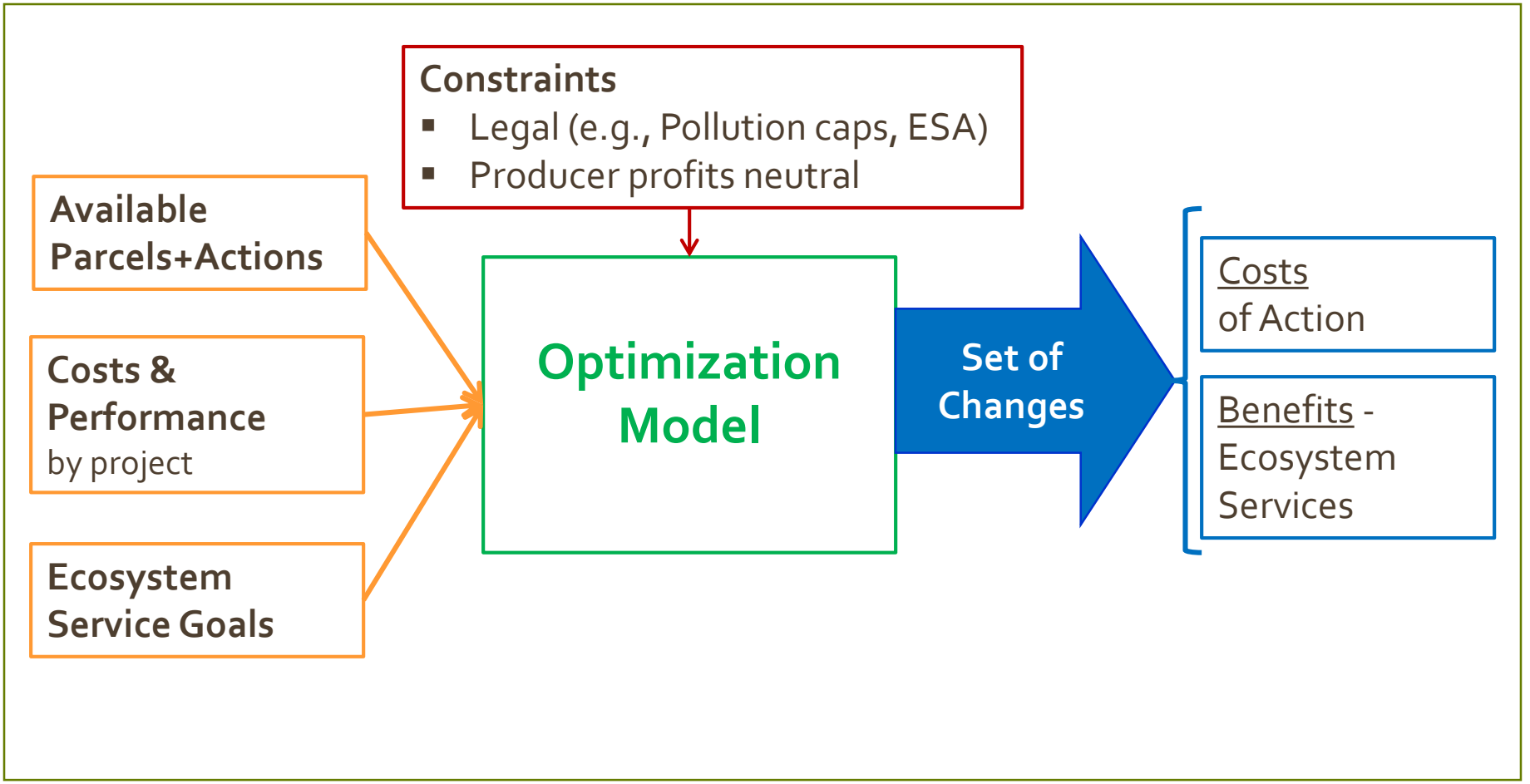
Common criteria for evaluating scenarios / optimizing land use

1. Economic efficiency
   - Parcels in *highest and best use*
   - Cost-efficient landscapes
2. Legal compliance
   - Natural resource condition
   - Human health
   - Limits on incompatible land uses & environmental externalities
3. Social equity
   - Fair distribution of resources



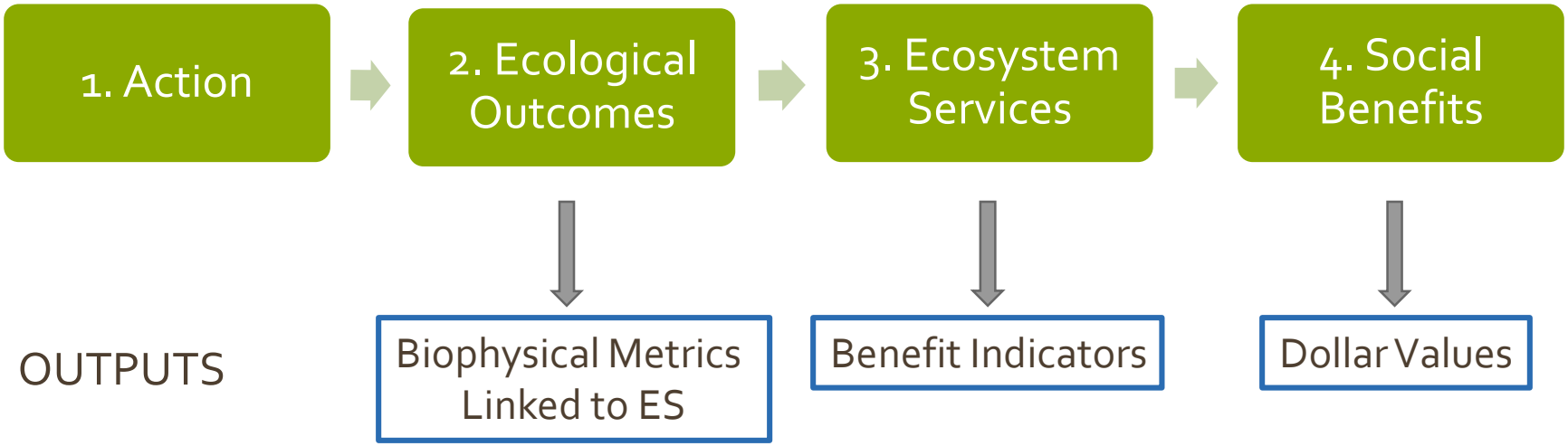


Optimization Modeling to Examine Costs & Benefits of Policy Scenarios



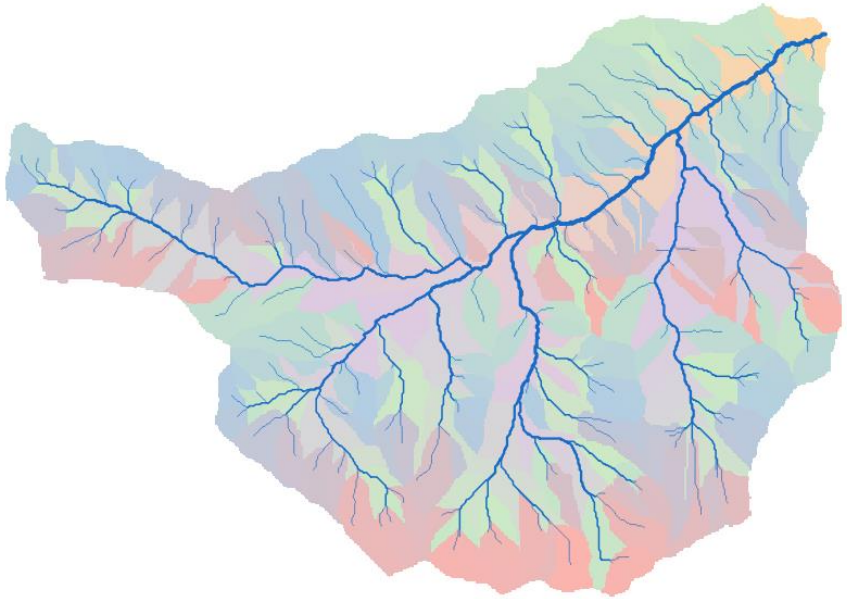
After: Wainger, L.A., et al. 2013. Tradeoffs among Ecosystem Services, Performance Certainty, & Cost-efficiency …. *Agricultural and Resource Economics Review*.

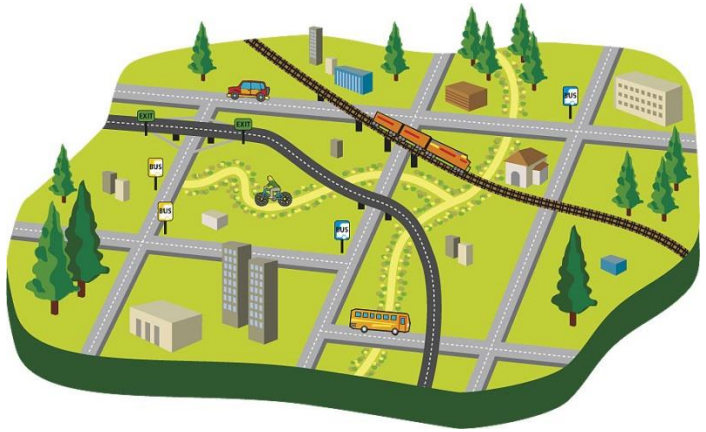
Alternative measures of *highest & best use* for ecosystem service delivery



Beyond the parcel scale - Managing the landscape mosaic

- Adjacency
- Connectivity & networks
- Cumulative impacts (% modified)





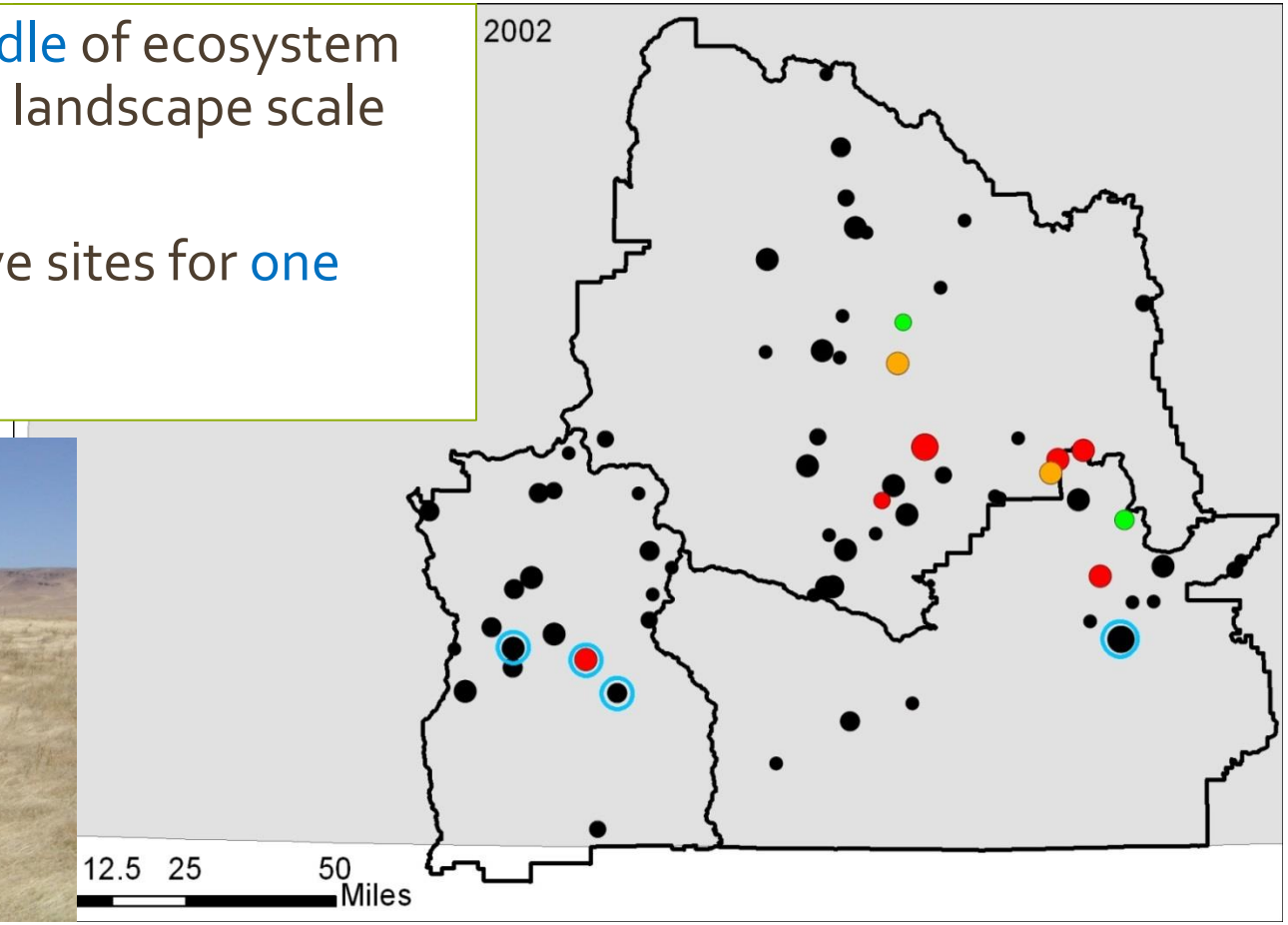
Decision rules that generate alternative scenarios

1. Maximize bundle of ecosystem services at the landscape scale

   vs

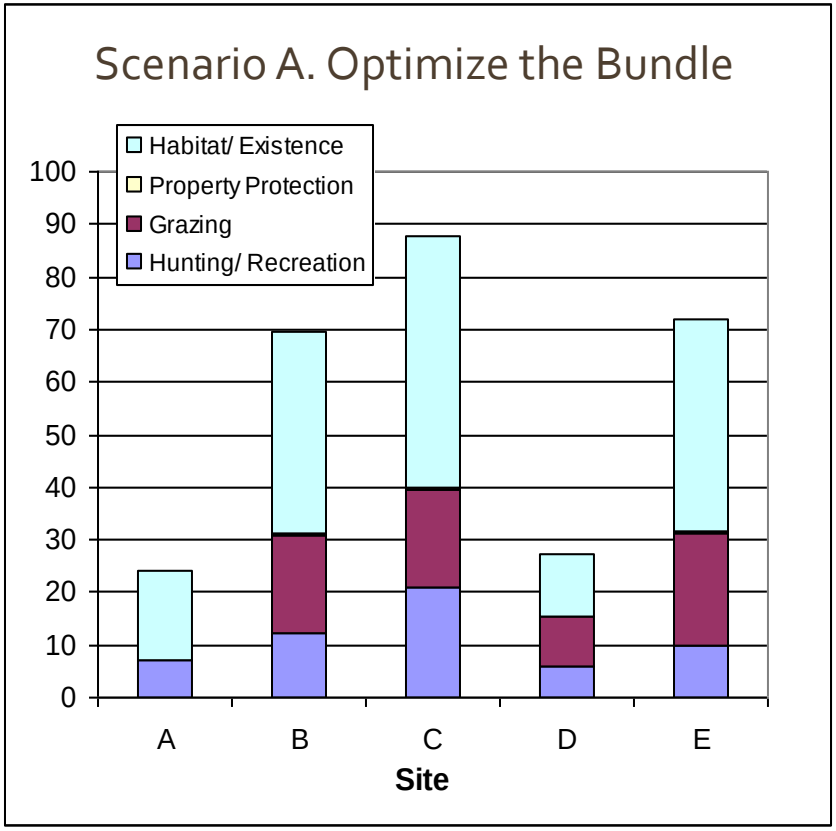
2. Pick superlative sites for one service

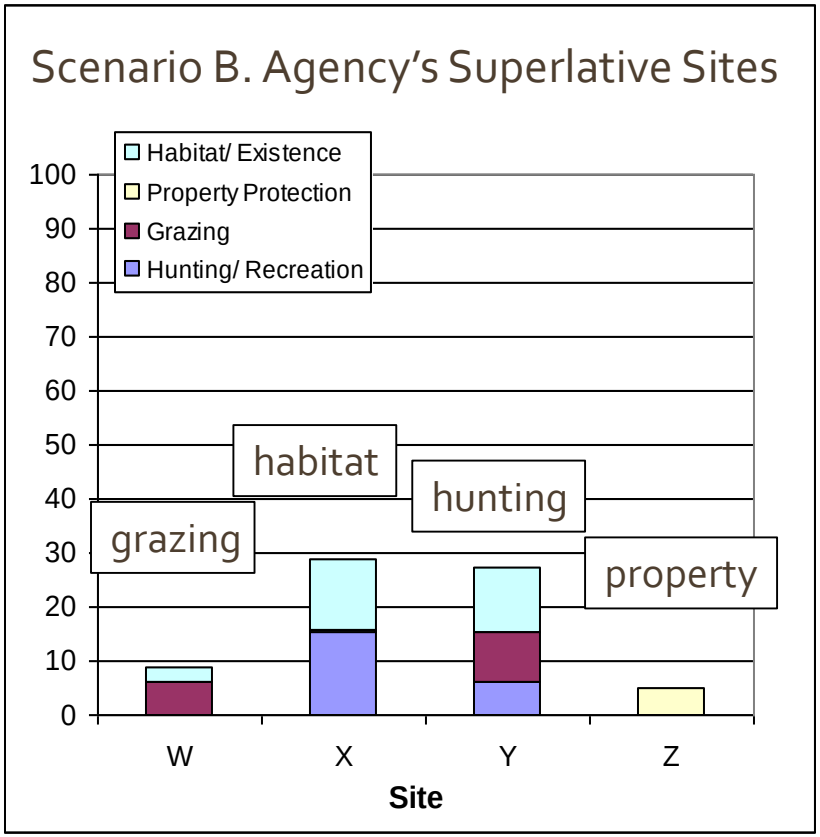
Burned areas needing restoration to avoid invasive infestation



Scenario Results – Benefits of bundles

Considering multiple benefits at once = more cost-effective
More acreage & higher benefits for lower cost



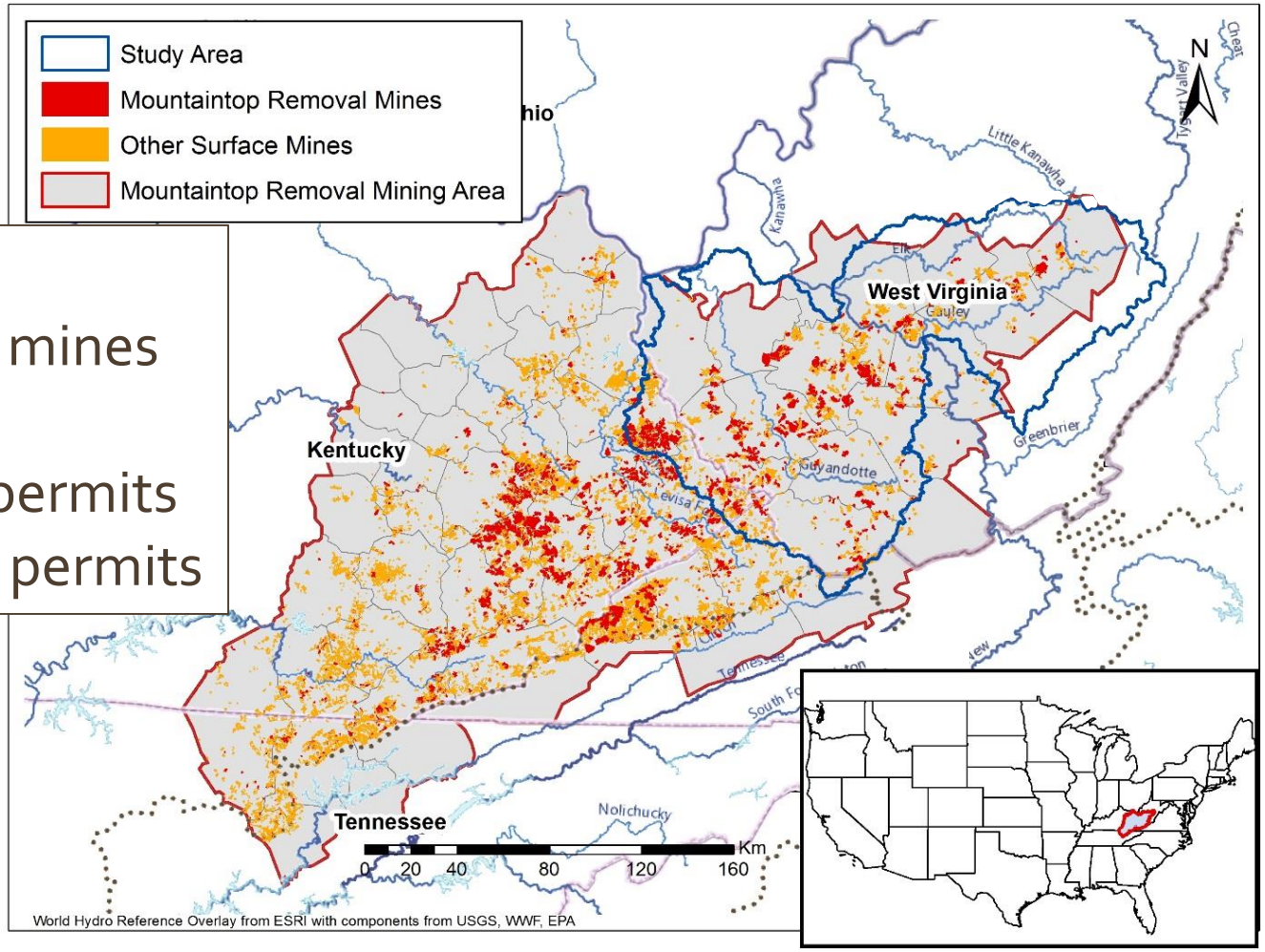


From: Wainger et al. 2010. Can the concept of ecosystem services be practically applied to improve natural resource management decisions? *Ecological Economics* 69:978–987.

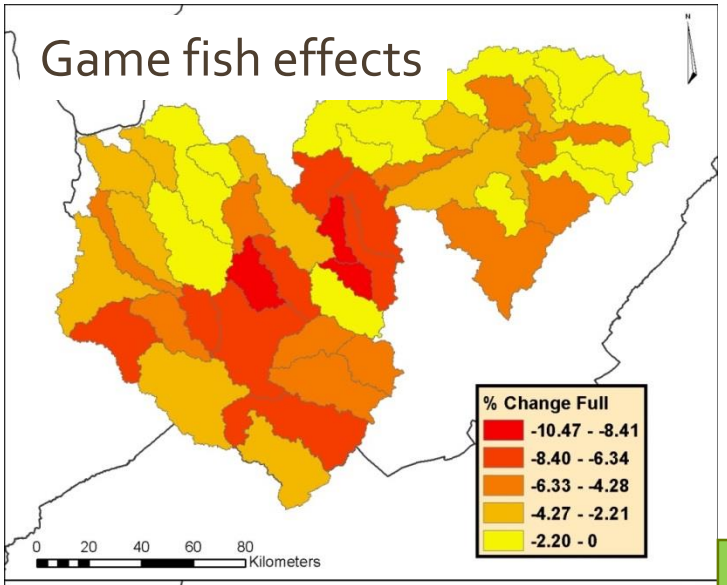
Mining permit decisions

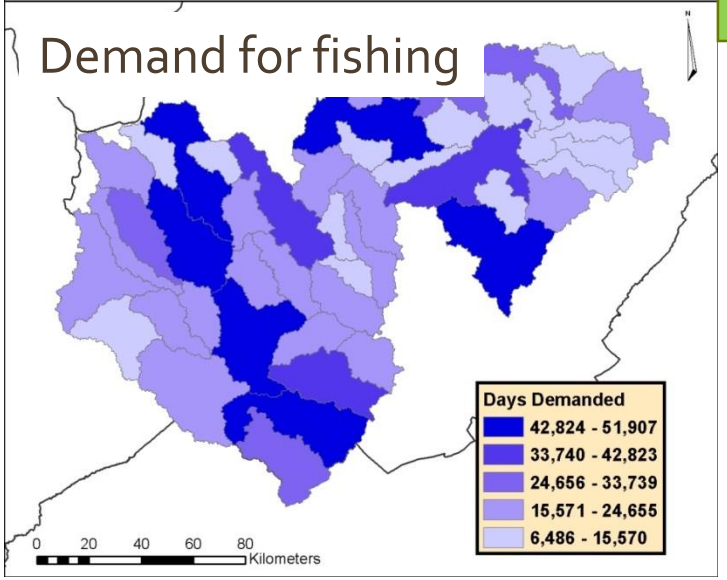
Scenarios

1. No additional mines Scenario
2. 20% of mine permits
3. 100% of mine permits

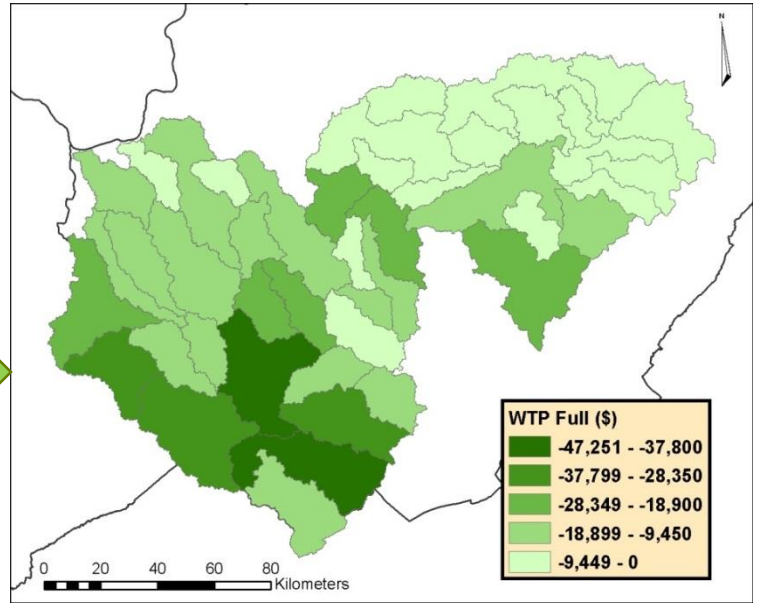


Effect of Mining on Freshwater Angling Benefits



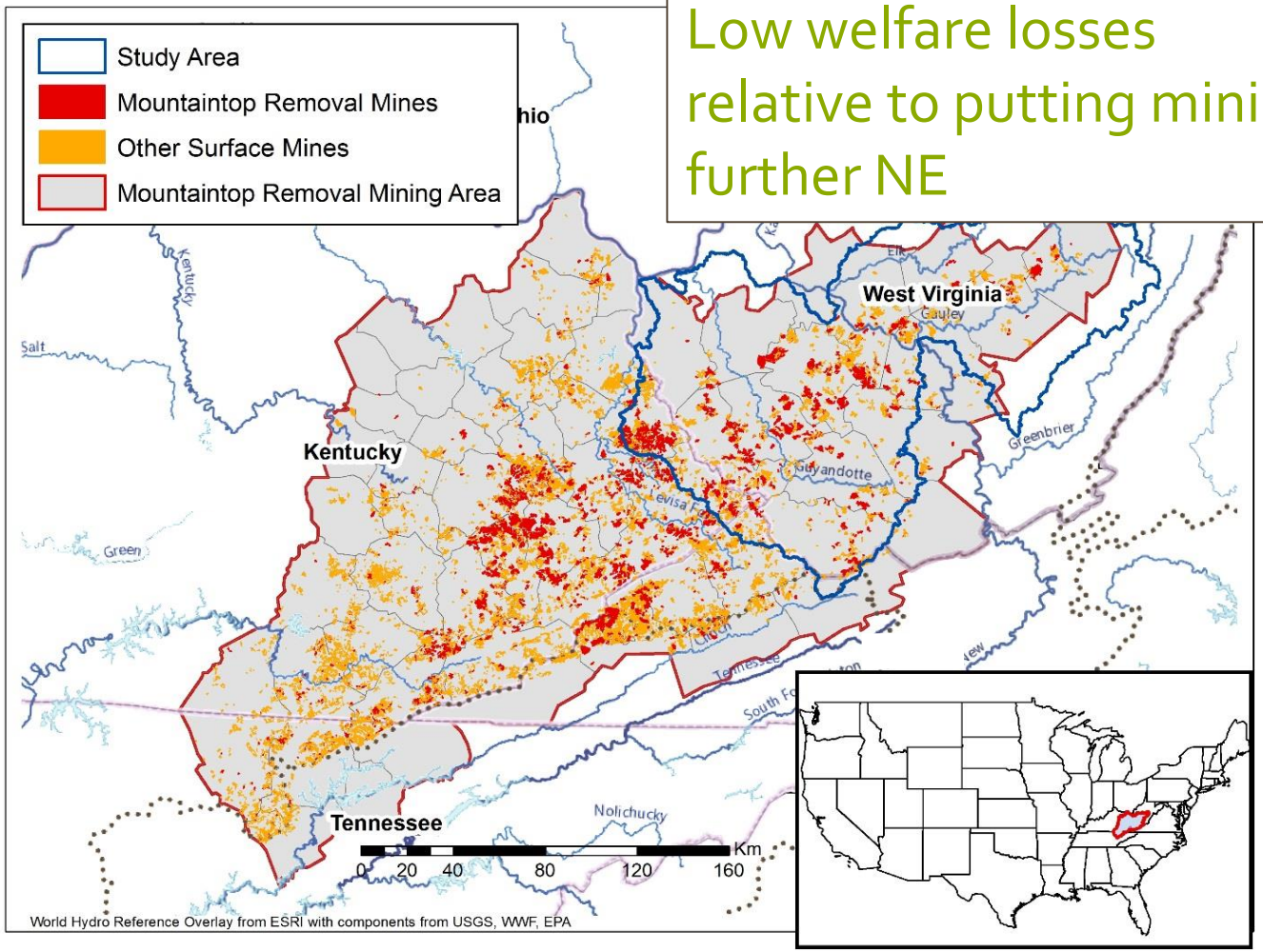


Welfare impacts



If mining decisions were based on this one benefit – We might reduce the future permits associated with the greatest welfare losses

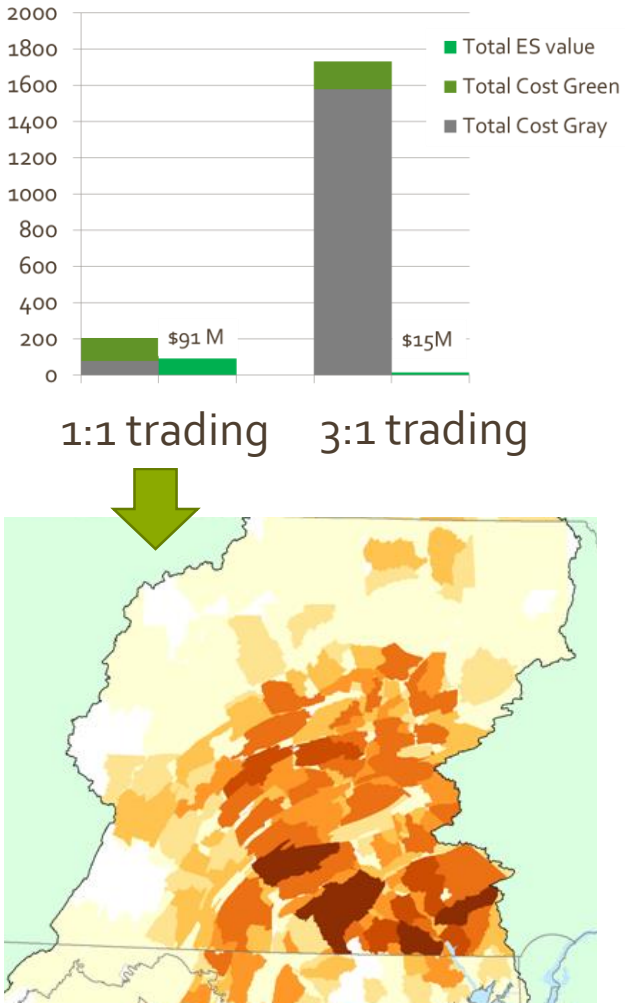
Spatial separation of incompatible uses



Low welfare losses relative to putting mining further NE

What scenario analysis can and cannot tell us

- Preferred scenarios given pre-defined goals & constraints
- Changes in co-benefits & costs with policy choices
- Sensitivity to market fluctuations (crop & land values)
- Provides a vision;
  if human behavior not modeled – does not say how to get there



Conclusions

1. What to optimize is determined by economic, legal & social conditions
2. Scenario analysis reveals costs, benefits and sensitivities of policy specifics
3. Applying "highest & best use" principle can clarify what to put where on the landscape
   - Site and landscape conditions affect benefits by location
   - Benefit indicators and monetary values both useful
4. Optimize the landscape not the pixel
   - All needs cannot be simultaneously met at each site
   - Why zoning was invented
5. Ideal scenarios are visions to be achieved through economic incentives, laws & policies, or social pressure