Wheeler
National Wildlife Refuge
Visitor Center
Partners Workshop
Working at a Landscape-level
…
Partnering with LCCs
(Landscape Conservation Cooperatives)
Jean Brennan PhD
Coordinator & Chief Scientist
Appalachian Landscape Conservation Cooperative
March 2, 2017. Wheeler National Wildlife Refuge, Decatur AL

APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Jean Brennan PhD
Coordinator and
Chief Scientist
Gillian Bee
Landscape
Conservation
Fellow, Clemson
Matthew Cimitile
Communications
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Lacey Goldberg
Doctoral
Candidate, PSU
Rose Hessmiller
Ferguson Lynch
Kelly Rene
Outreach &
Communications
Intern,
OH Islands NWR

Prioritize, Plan and Design at a Landscape-level

this morning discussion

Q.#1 Do you see a need to work at a landscape-level?

…Examples (what, where, scope, priorities)?

Why landscape-level conservation approach?

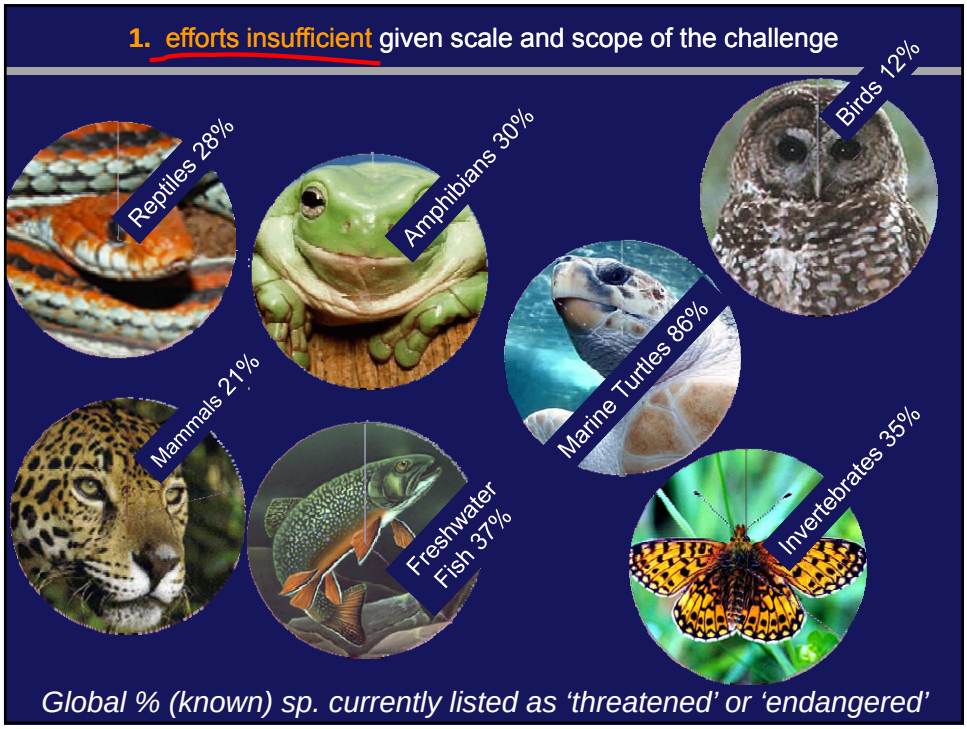
Reflecting on our historic approach to conservation

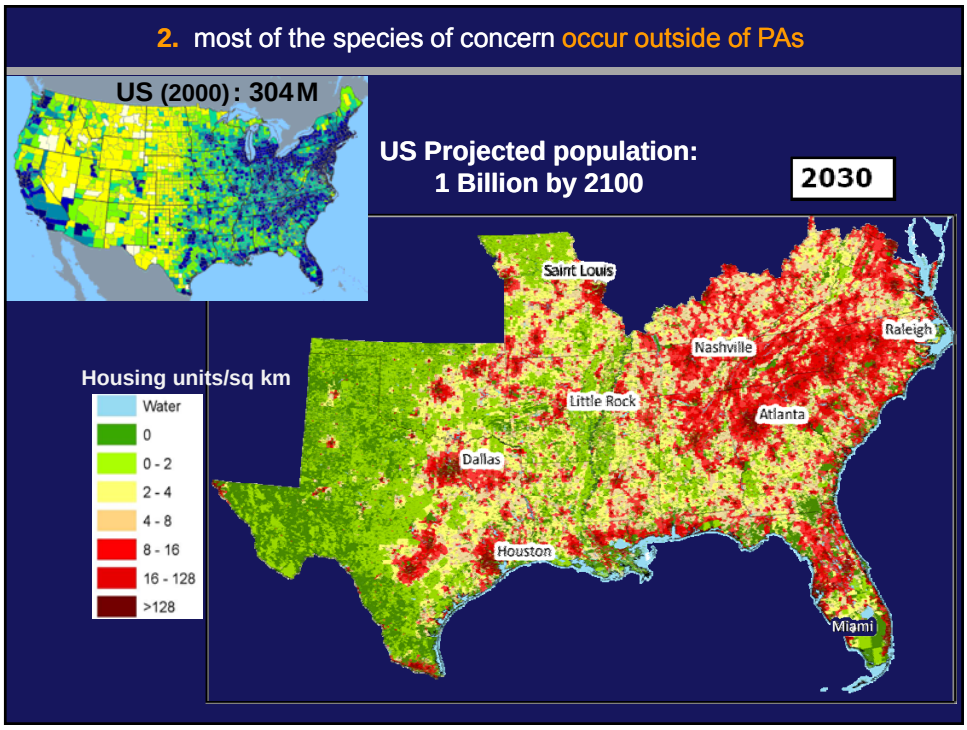
1. efforts insufficient given scale and scope of the challenge
2. most of the species of concern occur outside of PAs
3. reliance on PAs proven insufficient … underlying assumption of stability

Reflecting on management imperative

Reflecting on species' behavioral response to change

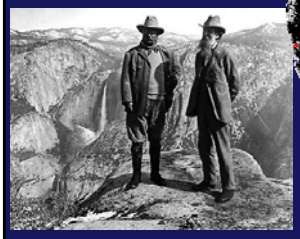
Reflecting on genetic & ability to adapt


1. efforts insufficient given scale and scope of the challenge
Reptiles 28%
Amphibians 30%
Birds 12%
Marine Turtles 86%
Mammals 21%
Freshwater Fish 37%
Invertebrates 35%
Global % (known) sp. currently listed as 'threatened' or 'endangered'

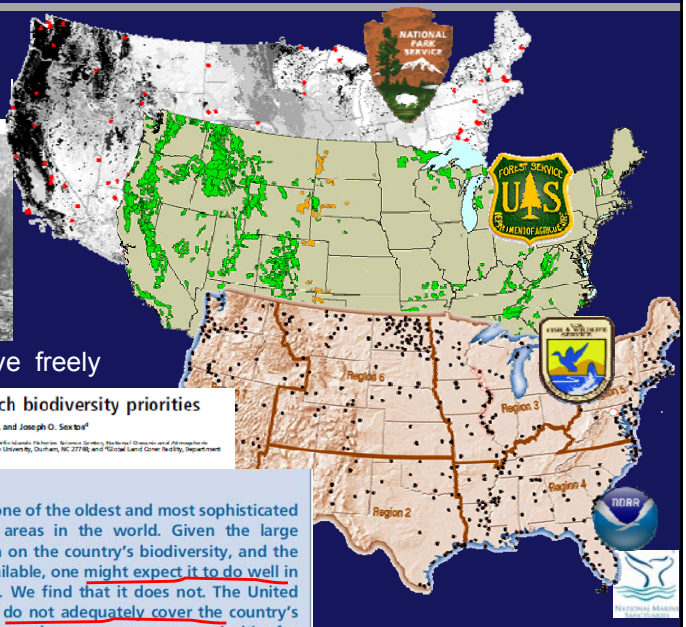

2. most of the species of concern occur outside of PAs
US (2000): 304 M
US Projected population:
1 Billion by 2100
2030
Housing units/sq km
Water
0
0 - 2
2 - 4
4 - 8
8 - 16
16 - 128
>128
Saint Louis
Nashville
Raleigh
Little Rock
Atlanta
Dallas
Houston
Miami

3. reliance on PAs proven insufficient … underlying assumption of stability

Preservation Era John Muir ~1820 – "set aside"



species able to move freely



US protected lands mismatch biodiversity priorities

Clinton N. Jenkins[a,1], Kyle S. Van Houtan[b,c], Stuart L. Pimm[a], and Joseph O. Sexton[d]

PNAS 2014

Significance

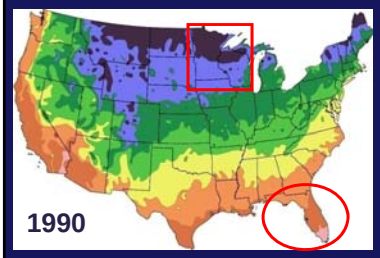
The United States has one of the oldest and most sophisticated systems of protected areas in the world. Given the large amount of information on the country's biodiversity, and the potential resources available, one might expect it to do well in protecting biodiversity. We find that it does not. The United States protected areas do not adequately cover the country's unique species. To improve the coverage, we map priorities for

Why landscape-level conservation approach?

Reflecting on management imperative

4. observed changes, increase in the rate of change
5. manage non-linear response variables… maintain healthy ecosystems
6. other stressors enhance sensitivity to CC impacts ~ "*recalibrate*"

4. observed changes, increase in the rate of change



Source: Arbor Day Foundation

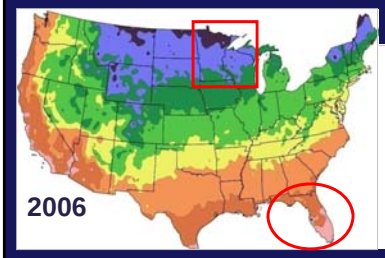
Plant hardiness map

Recorded Shift in Climatic Zones

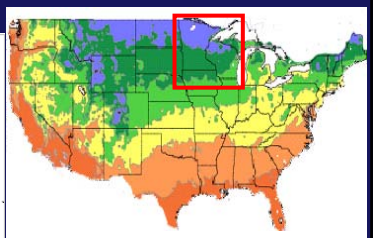
Changes "will affect

- ***structure*** **and** ***function*** **of ecosystems,**
- **species'** ***ecological interactions*****, and**
- **geographic** ***ranges*****, with consequences for biodiversity and ecosystem services"**

Malcom et al.2006



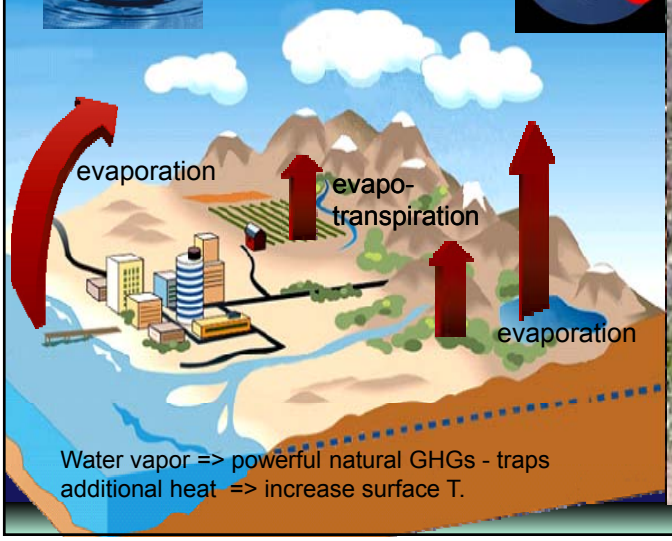
Zone	Avg. Annual Low
3	-30°F through -40°F
4	-20°F through -30°F
5	-10°F through -20°F
6	0°F through -10°F
7	10°F through 0°F
8	20°F through 10°F
9	30°F through 20°F
10	40°F through 30°F



Projection: 2080-2099

Charging the System …and 'Change of State'

water vapor



Water vapor => powerful natural GHGs - traps additional heat => increase surface T.

Drought stress and vegetation die-off
=> decomp./burn
=> increase GHG

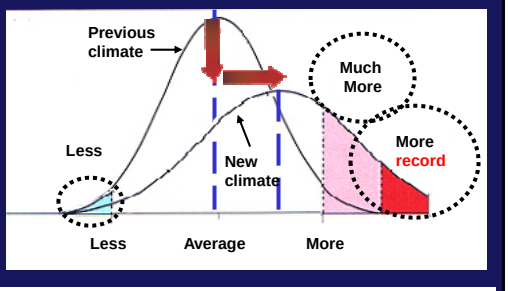
Source: Adams et al. 2009

5. manage non-linear response variables… maintain healthy ecosystems

Observed climatic changes => Change in Variance & Variability

"management...have been designed and operated under the assumption of stationarity.

"implies that any variable has a time-invariant probability density function whose properties can be estimated from the instrument record."



SCIENCE VOL 319 1 FEBRUARY 2008

CLIMATE CHANGE

Stationarity Is Dead: Whither Water Management?

P. C. D. Milly,[1]* Julio Betancourt,[2] Malin Falkenmark,[3] Robert M. Hirsch,[4] Zbigniew W. Kundzewicz,[5] Dennis P. Lettenmaier,[6] Ronald J. Stouffer[7]

"stationarity. ....the idea that natural systems fluctuate within an unchanging envelope of variability

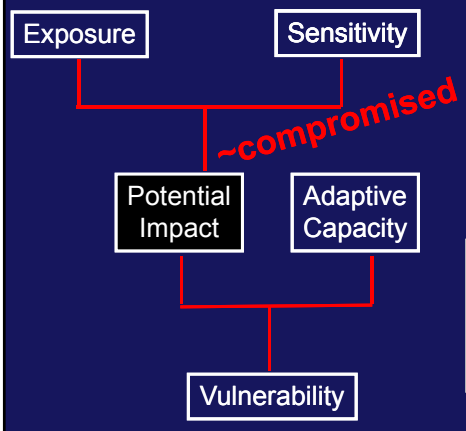
-- fundamental concept that permeates training and practice..."

6. other stressors enhance sensitivity to CC impacts ~ *"recalibrate"*

Manage other stressors => CC adds forcing trend

… likely complex, non-linear
/ exceptionally difficult to understand / mitigate

Vulnerability to CC - a function of Exposure, Sensitivity, and Adaptive Capacity

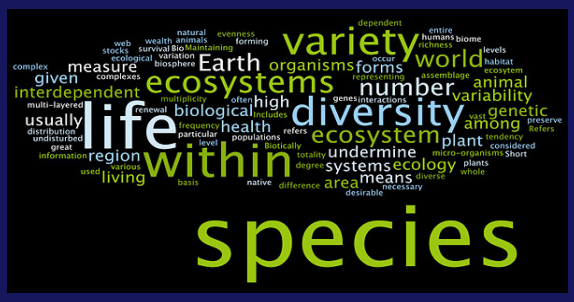


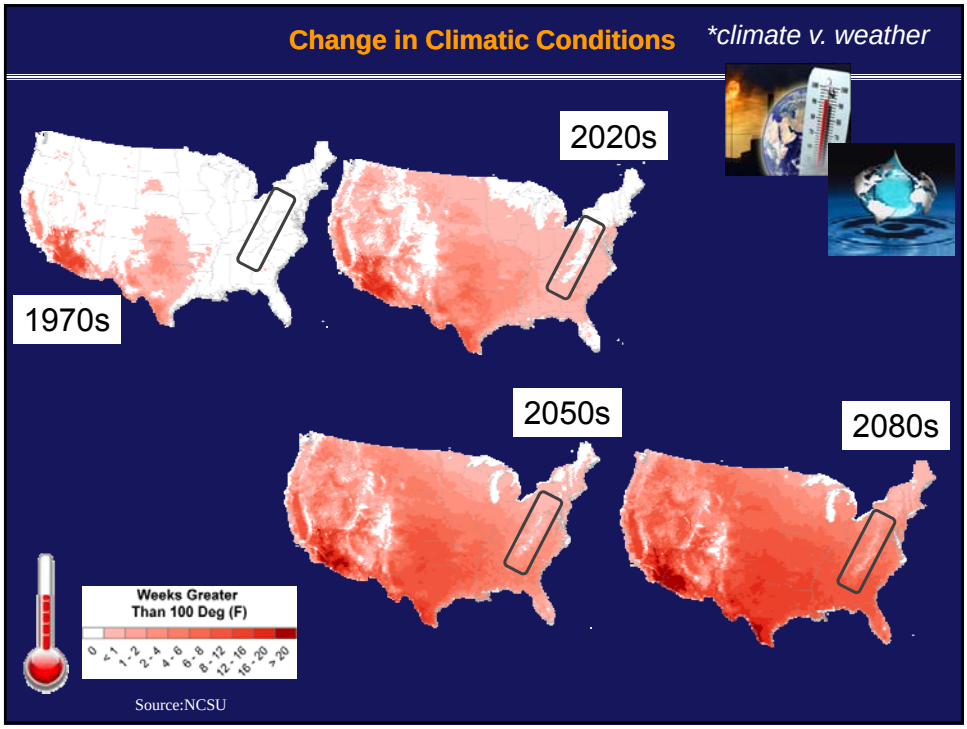
Why landscape-level conservation approach?

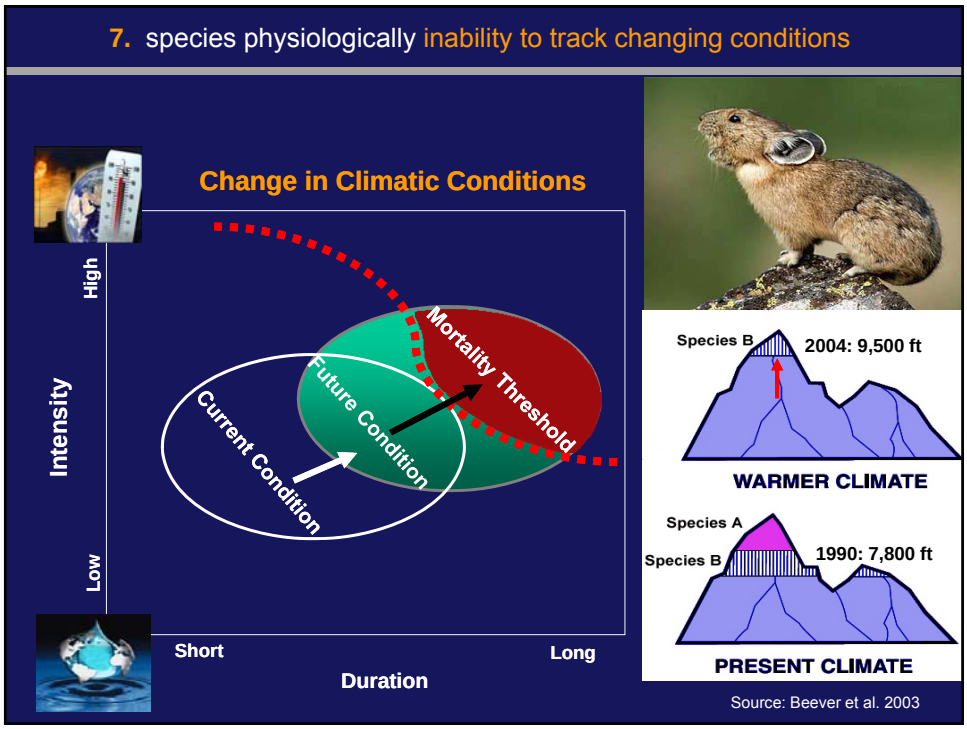
Reflecting on species' behavioral response to change

7. species physiologically inability to track changing conditions
8. increasing human-dominated landscape physical barriers to movement

Q. What is the 'base currency' of Conservation?




Change in Climatic Conditions
*climate v. weather
2020s
1970s
2050s
2080s
Weeks Greater Than 100 Deg (F)
0
< 1
1 - 2
2 - 4
4 - 6
6 - 8
8 - 12
12 - 16
16 - 20
> 20
Source:NCSU


7. species physiologically inability to track changing conditions
Change in Climatic Conditions
High
Intensity
Low
Short
Long
Duration
Mortality Threshold
Future Condition
Current Condition
Species B
2004: 9,500 ft
WARMER CLIMATE
Species A
Species B
1990: 7,800 ft
PRESENT CLIMATE
Source: Beever et al. 2003

8. increasing human-dominated landscape physical barriers to movement

Highly fragmented
…Δ land-use

Why landscape-level conservation approach?

Reflecting on genetic & ability to adapt

9. prevent population isolation and associated loss genetic diversity
10. safeguard adaptive capacity and resilience

Q. What is the 'base currency' of Conservation?

…rarely ever know the genetic status of populations
…. but we do know the effect of isolation (lack of genetic exchange when gene flow (movement) is prevented

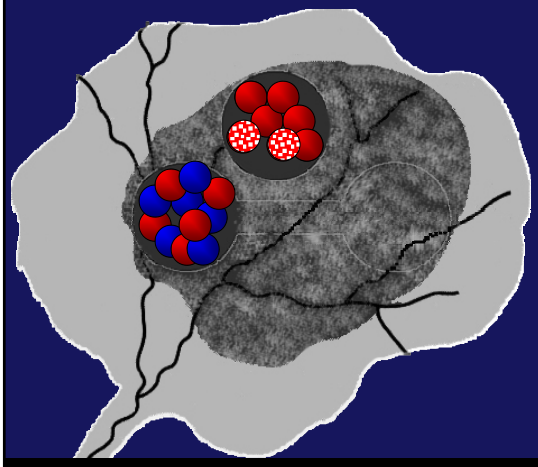
Species will track change, adapt to new conditions, or go extinct

9. prevent population isolation and associated loss genetic diversity

(genetically viable population)
….maintain evolutionary potential / response

• different genotypes

(change in gene frequency)



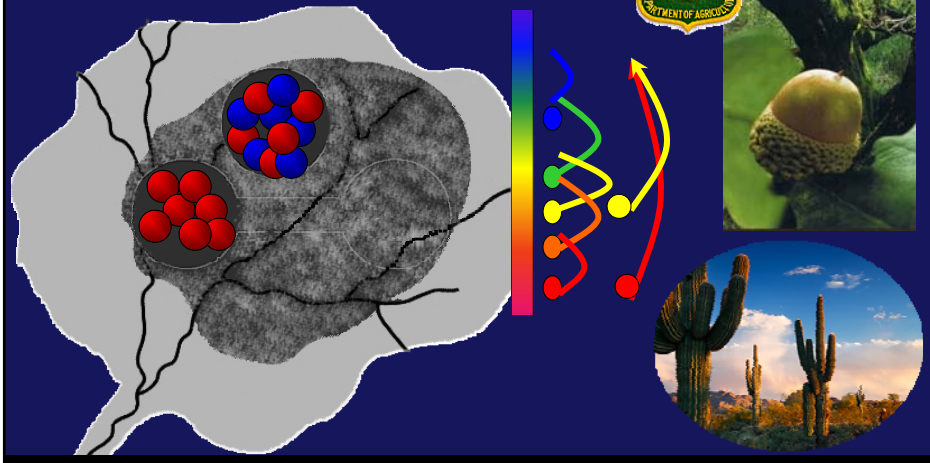
- loss genetic diversity due to bottleneck effect
- founder effect

small populations => forced inbreeding after 1st generation

Genetic diversity…is the 'base currency' of Conservation

10. safeguard adaptive capacity and resilience

to biologists "adaptation" is synonymous with beneficial evolutionary responses



Genetic diversity…is the 'base currency' of Conservation

Prioritize, Plan and Design at a Landscape-level

this morning discussion

Q.#1 Do you see a need to work at a landscape-level?

…Examples (what, where, scope, priorities)?

Take away:

(Given: geographic and temporal scale)

Working at a Landscape-level
…
is a critical component,

that can help frame the overarching planning, design, and actions necessary

to achieve conservation in the 21st Century

Prioritize, Plan and Design at a Landscape-level

this morning discussion

Q.#1

Q.#2 What barriers you experienced or currently exist that influences your ability to work at a larger-scale?

…How have you been able to overcome those?

Source: NRC 2009 **"agencies may soon be unable to fulfill legal and regulatory responsibilities because of climate-related changes"**

Secretarial Order #3289 *(Sept 2009)*

…ordered Department to establish

"a network of Landscape Conservation Cooperatives

(to) engage DOI and federal agencies, states, tribal and *local governments* and the *public,*

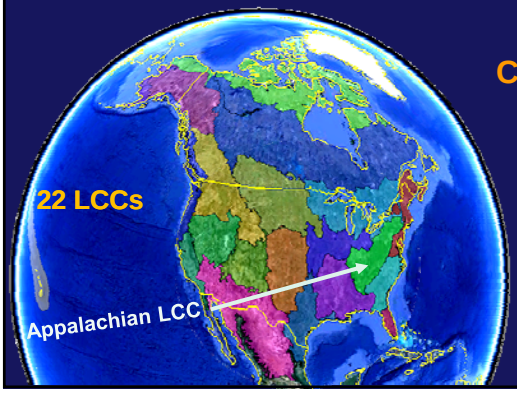
to craft practical, landscape-level strategies for managing climate change impacts."

LANDSCAPE CONSERVATION COOPERATIVES

- **Bird Conservation Regions**
- **Major River Drainage Basins**
- **Ecologically-defined Areas**

A. Landscape: define ecologically-relevant scale to work

B. Conservation: address threats at a scale beyond that of any single entity … *connectivity, resilience, irreplaceability*

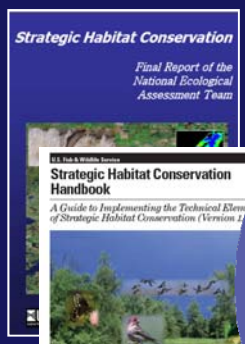


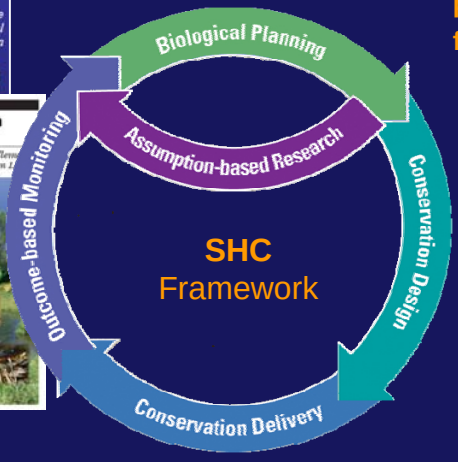
C. Cooperative: work through a collaborative decision-making => ***self-directed partnership***
…all DOI units, federal agencies, state, tribal

DOI has jurisdiction over 1 out of every 5 acres

Organizational Shift

Emphasis on Science





…explicitly linking work of individual programs and field stations

…to sustain species, populations, and natural communities

…as parts of the whole systems -- ecological functions and processes

Working at a Landscape-level …Partnering with the Appalachian LCC

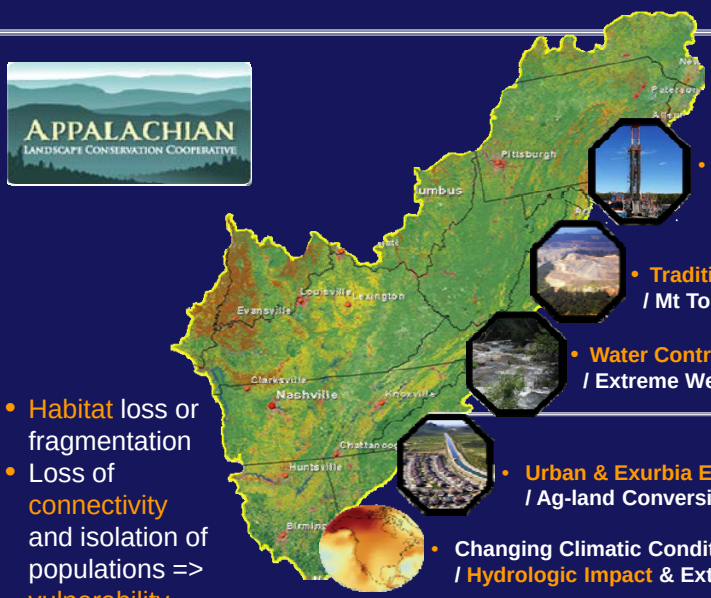
Role of the LCC

Landscape Conservation Cooperative

- **facilitate planning at a scale - typically beyond the reach or resources, of any one entity => to address large-scale stressors, *including* climate change**

Jean Brennan PhD
Coordinator and Chief Scientist

Large-scale impacts & accelerating demands

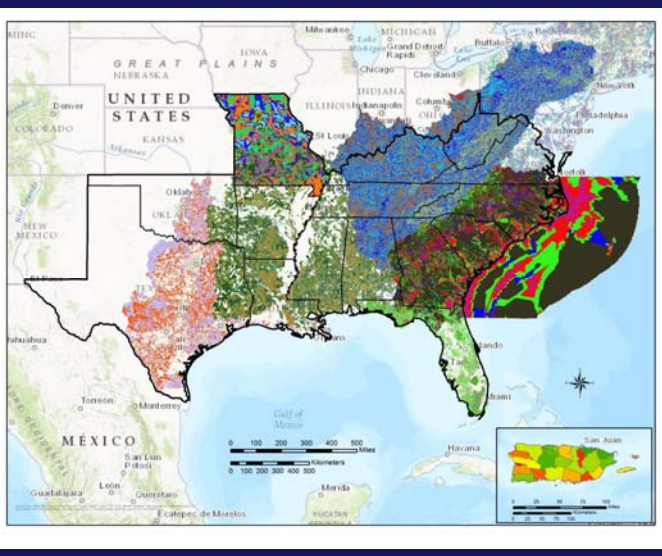


- **Expanding Energy: NG / *hydro-fracking***
- **Traditional Energy / Mt Top Mining**
- **Water Control & Stress / Extreme Weather Events**
- **Urban & Exurbia Expansion / Ag-land Conversion**
- **Changing Climatic Conditions / Hydrologic Impact & Extreme Weather**

- Habitat loss or fragmentation
- Loss of connectivity and isolation of populations => vulnerability

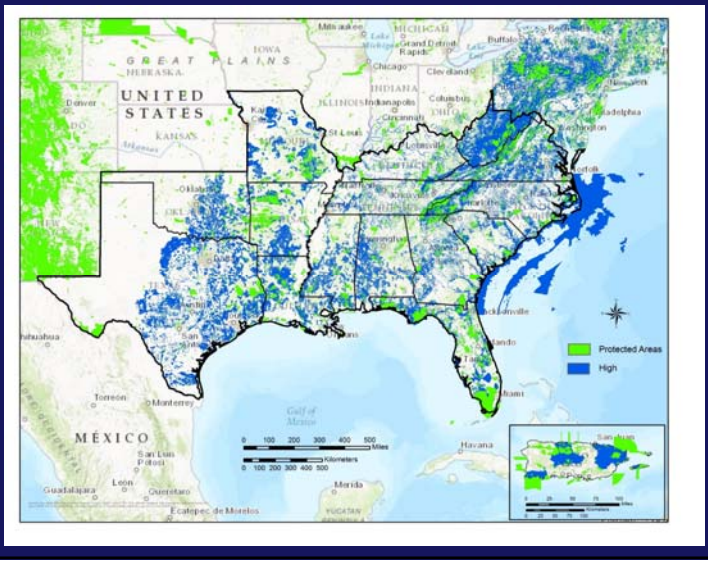
(SE) Regional impacts & conservation planning

SE Regional planning (SECAS) – 6 LCCs (+1Central)



quote from: Mallory Martin, NC WRC

alignment….LCCs moved from edge-mapping (*ex.* SECAS) "to *resolving the fringe*"



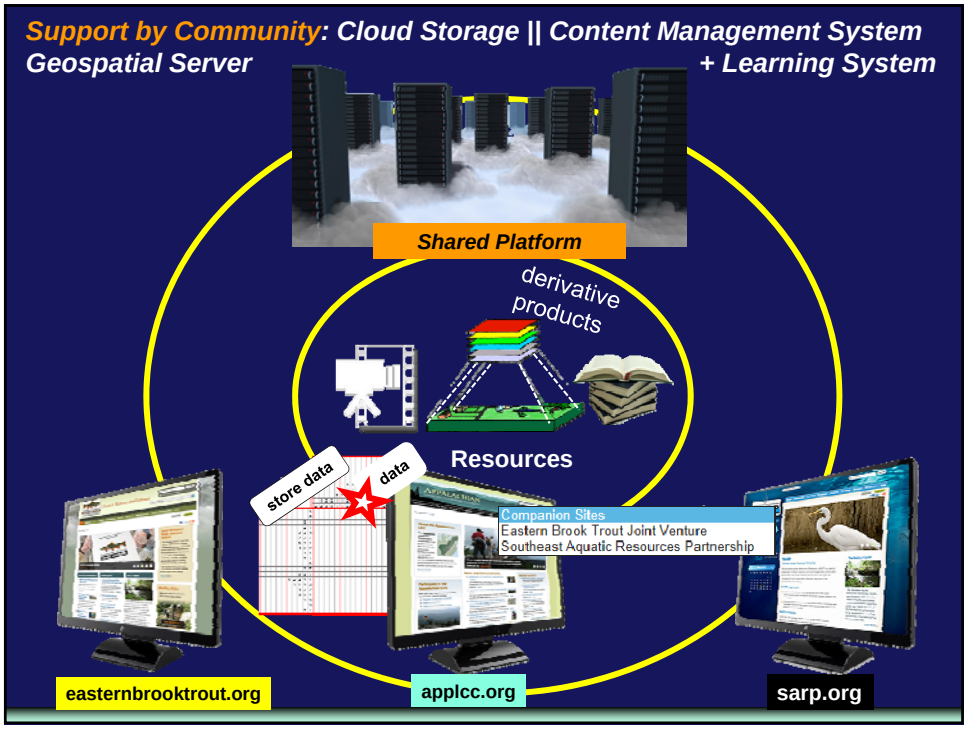
Role of the LCC

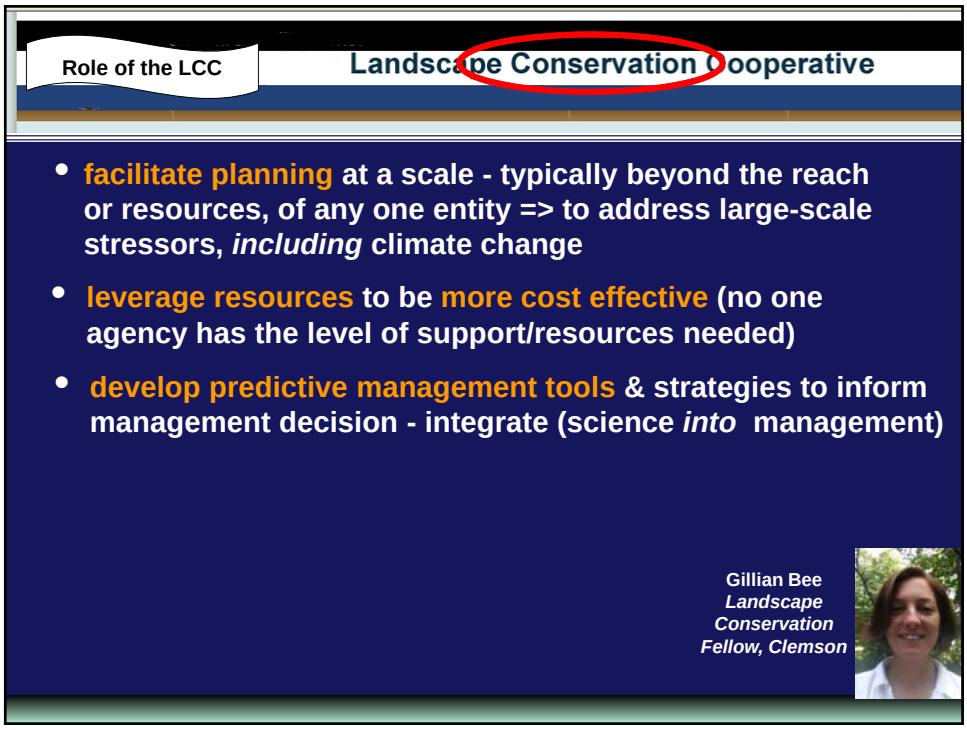
Landscape Conservation Cooperative

- **facilitate planning at a scale - typically beyond the reach or resources, of any one entity => to address large-scale stressors, *including* climate change**
- **leverage resources to be more cost effective (no one agency has the level of support/resources needed)**

Rose Hessmiller

Ferguson Lynch


Support by Community: Cloud Storage || Content Management System
Geospatial Server
+ Learning System
Shared Platform
derivative products
Resources
store data
data
Companion Sites
Eastern Brook Trout Joint Venture
Southeast Aquatic Resources Partnership
easternbrooktrout.org
applcc.org
sarp.org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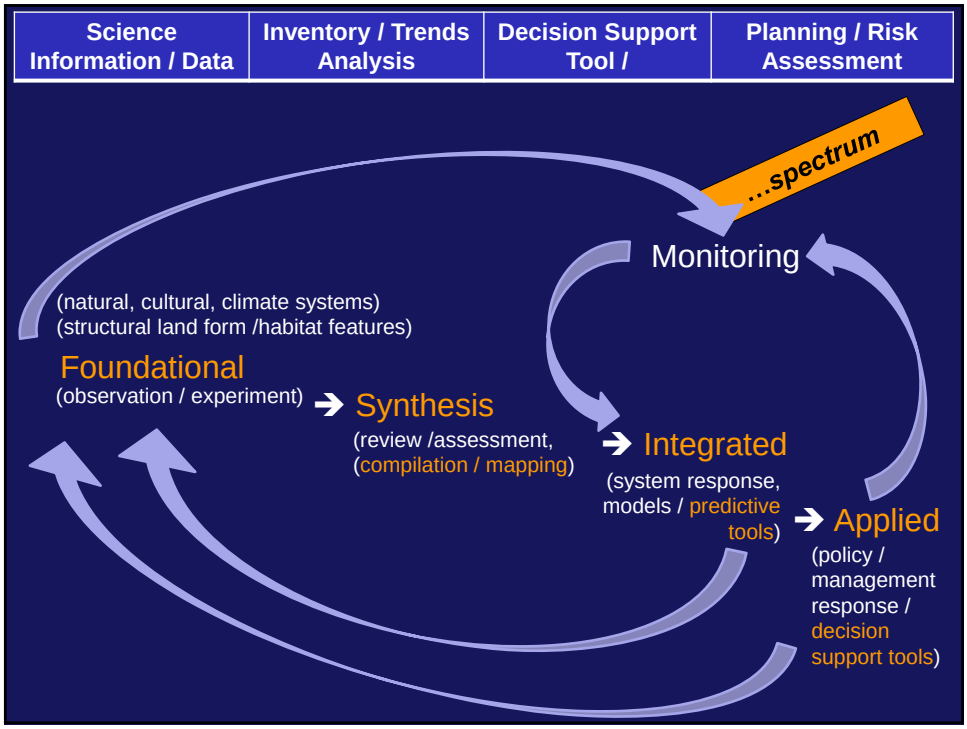
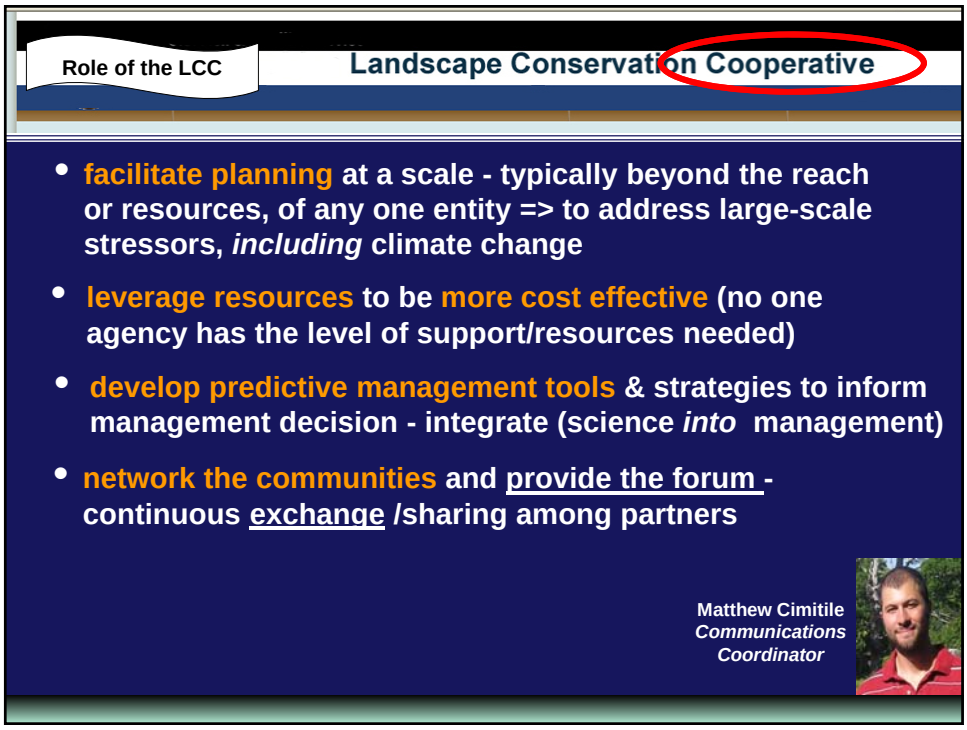
develop predictive management tools & strategies to inform management decision - integrate (science into management)
Gillian Bee
Landscape Conservation Fellow, Clemson


Science Information / Data
Inventory / Trends Analysis
Decision Support Tool /
Planning / Risk Assessment
…spectrum
Monitoring
(natural, cultural, climate systems)
(structural land form /habitat features)
Foundational
(observation / experiment)
Synthesis
(review /assessment,
(compilation / mapping)
Integrated
(system response,
models / predictive tools)
Applied
(policy / management response / decision support tools)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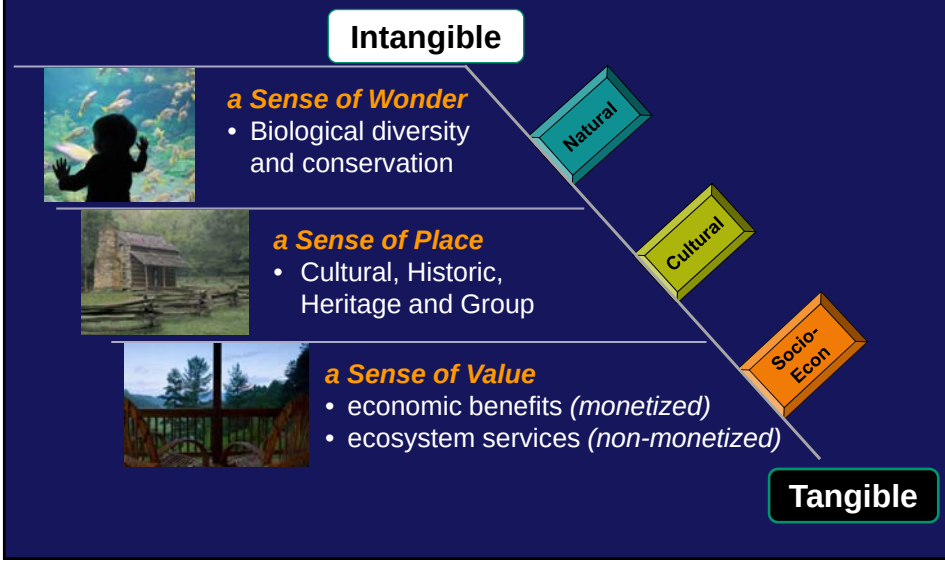
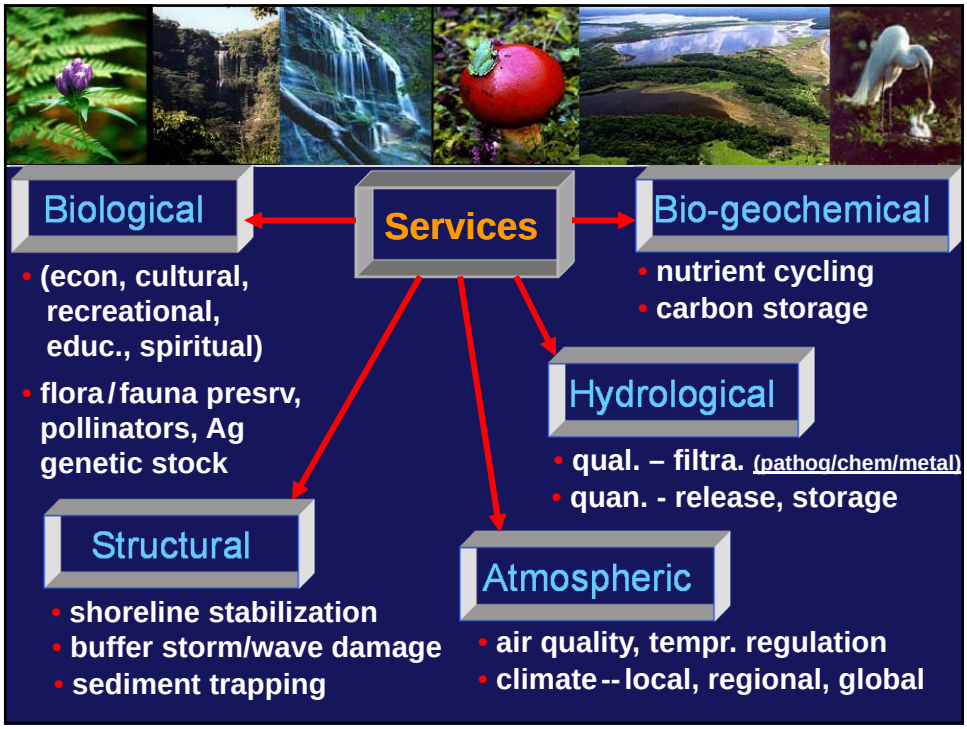
develop predictive management tools & strategies to inform management decision - integrate (science *into* management)
network the communities and provide the forum - continuous exchange /sharing among partners
Matthew Cimitile
Communications Coordinator

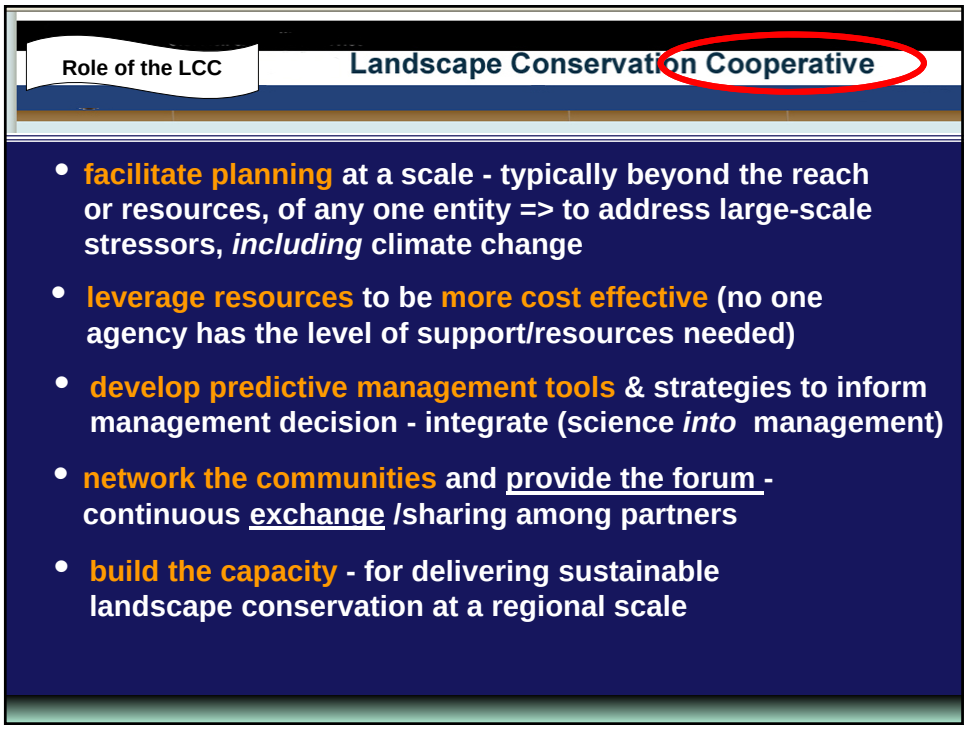
DOI Secretarial Order: …encourage the Department to actively seek to engage both traditional & non-traditional partners

(such as local governments, industry, and private land-owners)

"How do we communicate the relevancy of conservation to the broader society?"




Biological
• (econ, cultural, recreational, educ., spiritual)
• flora / fauna presrv, pollinators, Ag genetic stock
Services
Bio-geochemical
• nutrient cycling
• carbon storage
Hydrological
• qual. – filtra. (pathog/chem/metal)
• quan. - release, storage
Structural
• shoreline stabilization
• buffer storm/wave damage
• sediment trapping
Atmospheric
• air quality, tempr. regulation
• climate -- local, regional, global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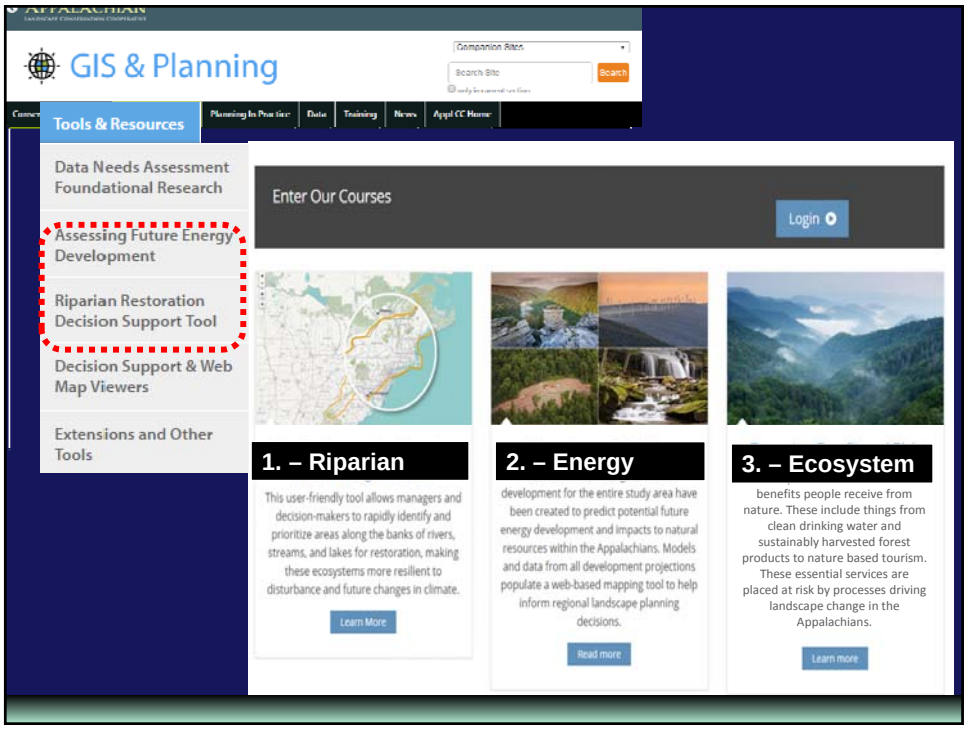
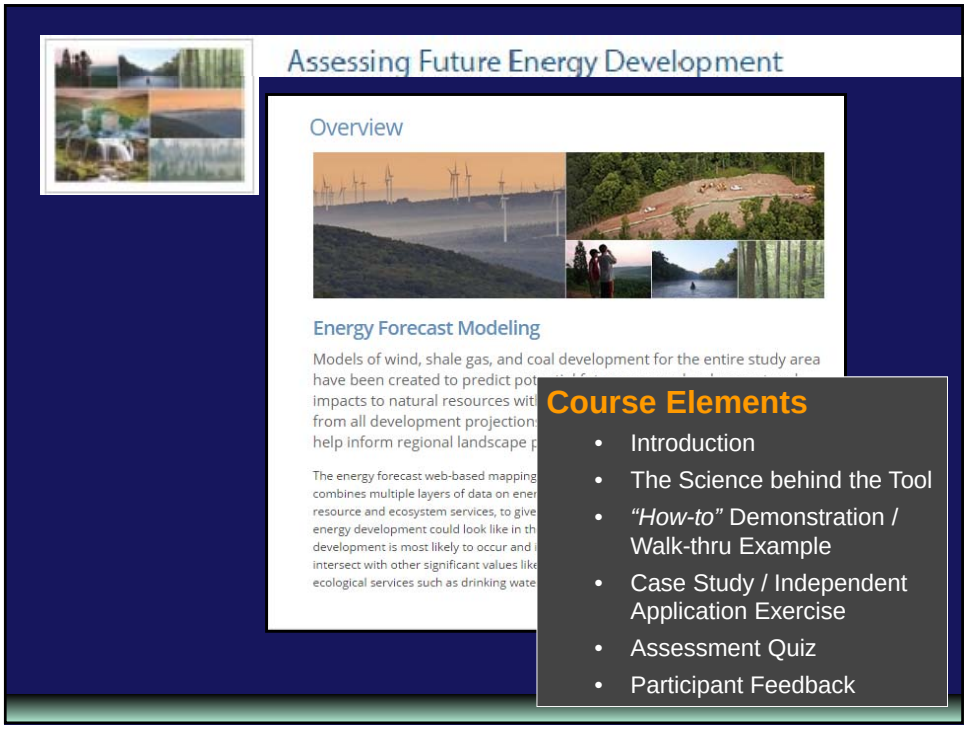
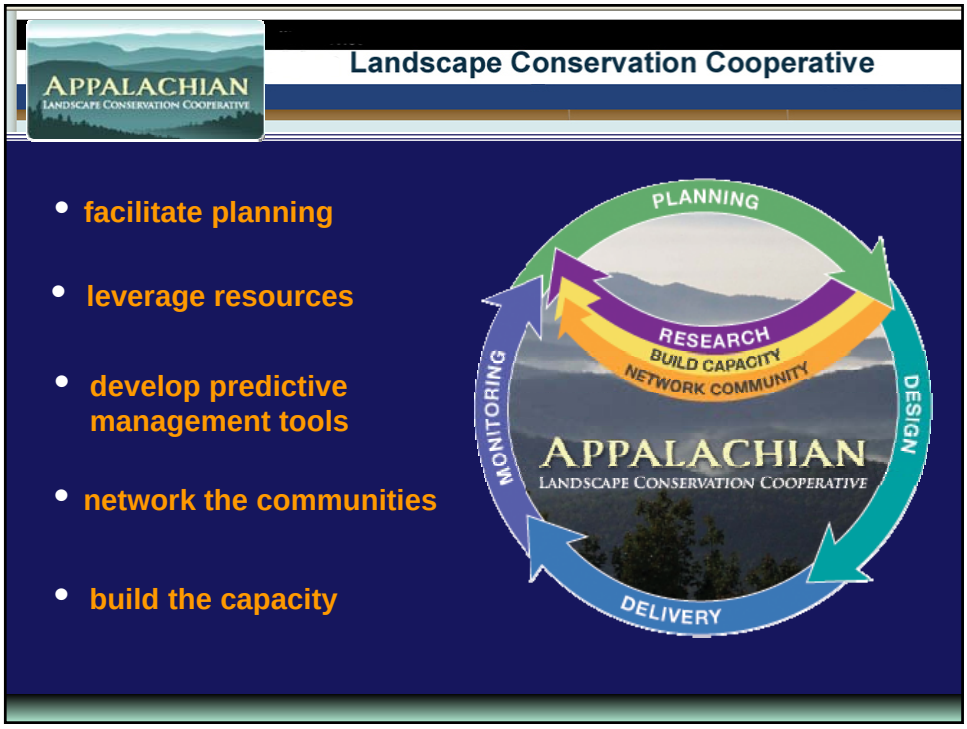
• leverage resources to be more cost effective (no one agency has the level of support/resources needed)
• develop predictive management tools & strategies to inform management decision - integrate (science *into* management)
• network the communities and provide the forum - continuous exchange /sharing among partners
• build the capacity - for delivering sustainable landscape conservation at a regional scale

Quick Links
On-line Training Courses
Navigate
APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Plan & Design
Focal Areas
Issues
Partner Projects
Training and Online Learning
Tools & Resources
1 – Riparian Tool
2 – Energy Tool
3 – Ecosystem Services
4 – Climate Change Vulnerability
5 – Conservation Planning Atlas
Training and Online Learning
Lacey Goldberg
Doctoral Candidate, PSU


GIS & Planning
Tools & Resources
Data Needs Assessment Foundational Research
Assessing Future Energy Development
Riparian Restoration Decision Support Tool
Decision Support & Web Map Viewers
Extensions and Other Tools
Enter Our Courses
Login
1. – Riparian
This user-friendly tool allows managers and decision-makers to rapidly identify and prioritize areas along the banks of rivers, streams, and lakes for restoration, making these ecosystems more resilient to disturbance and future changes in climate.
Learn More
2. – Energy
development for the entire study area have been created to predict potential future energy development and impacts to natural resources within the Appalachians. Models and data from all development projections populate a web-based mapping tool to help inform regional landscape planning decisions.
Read more
3. – Ecosystem
benefits people receive from nature. These include things from clean drinking water and sustainably harvested forest products to nature based tourism. These essential services are placed at risk by processes driving landscape change in the Appalachians.
Learn more


Assessing Future Energy Development
Overview
Energy Forecast Modeling
Models of wind, shale gas, and coal development for the entire study area
Course Elements
Introduction
The Science behind the Tool
"How-to" Demonstration / Walk-thru Example
Case Study / Independent Application Exercise
Assessment Quiz
Participant Feedback


APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Landscape Conservation Cooperative
facilitate planning
leverage resources
develop predictive management tools
network the communities
build the capacity
PLANNING
DESIGN
DELIVERY
MONITORING
RESEARCH
BUILD CAPACITY
NETWORK COMMUNITY
APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE

Take away:

Working at a Landscape-level

…

LCCs offer a 'conservation engine'

(forum) (framework) (mechanism) (institutional partnership)

to achieve a connected landscape and help maintain genetic diversity and resilience,

to facilitate management-relevant research, and the development of predictive models and tools, inform decision-making,

to help build the core competencies and organizational capacity, and

to catalyze conservation delivery and outreach as a system of conservation networks

http://www.applcc.org

Research – Management Questions

Data and Conservation Planning Atlas

On-line Training Courses

Networking People, Expertise, Projects

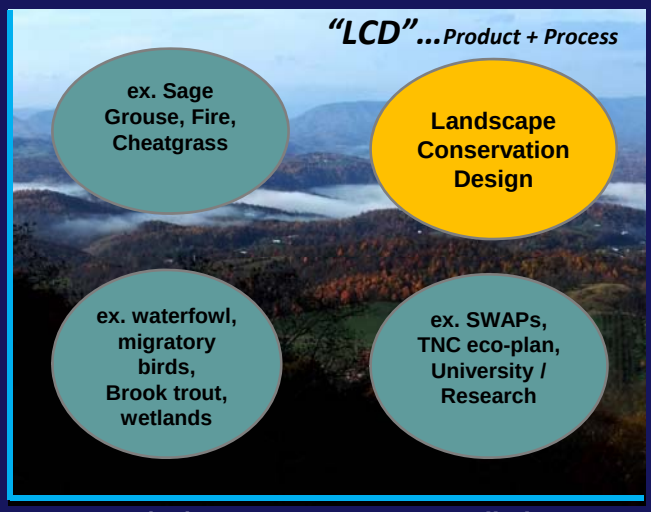
The Big Questions

I. ***Why landscape planning & design approach?***

II. ***What are Landscape Conservation Designs (LCDs)?***

III. ***How can the LCD inform Conservation Planning?***

What are Landscape Conservation Designs (LCDs)?



Stakeholders / Audience

Limited / Internal

All Stakeholders

Single

Holistic

Targets (species, issue, habitats, etc.)

…to address *"Wicked Problems"*

Image Source: Tom Miewald

What are Landscape Conservation Designs (LCDs)?

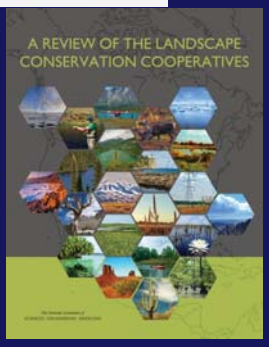
Secretarial Order #3289 *(Sept 2009)*

…ordered Department to establish

"a network of Landscape Conservation Cooperatives

(to) engage DOI and federal agencies, states, tribal and *local governments* and the *public*,

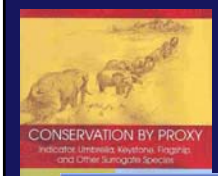
to craft practical, landscape-level strategies for managing climate change impacts."

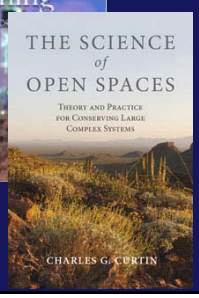


2016 NAS: "landscape conservation designs…signature product"

What are Landscape Conservation Designs (LCDs)?

LCDs – evolution / understanding, guidance





Source: Rob Campellone, Policy NWR System

LCD evolution / understanding, guidance, framing

Reference: (http://www.journals.elsevier.com/landscapeandurbanplanning)

iCASS
- **i** innovation
- **C** Convene
- **A** Assessment
- **S** Spatial
- **S** Strategy

iCASS

innovation

…to address ***"Wicked Problems"***

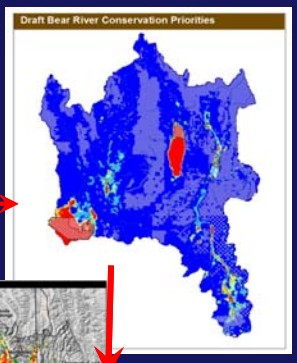
How much?
How much more?
Where?

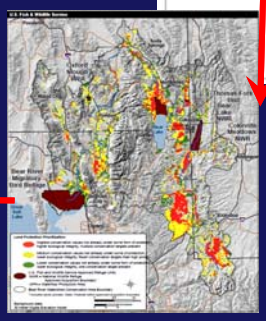
Convene

Outreach
- Conversations with agencies, NGOs, landowners
- Invitations to 14 tribes
- 12 public meetings

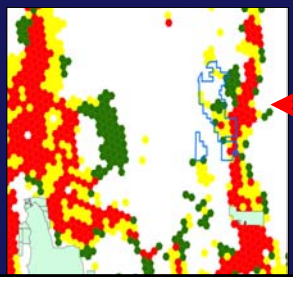
Source: Tom Miewald

Assessment

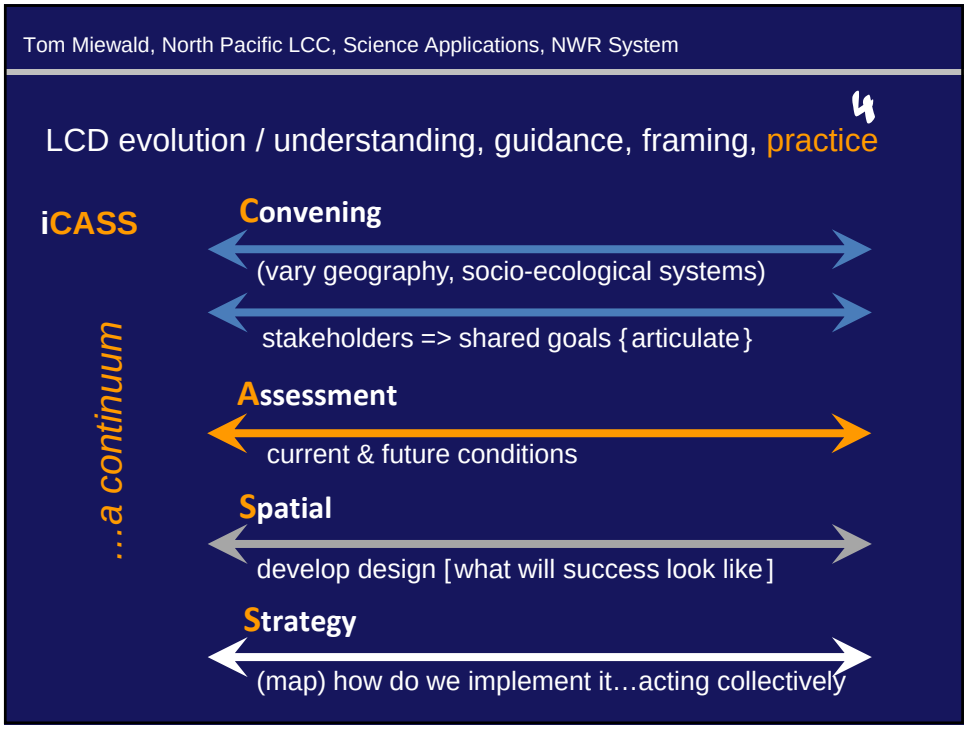


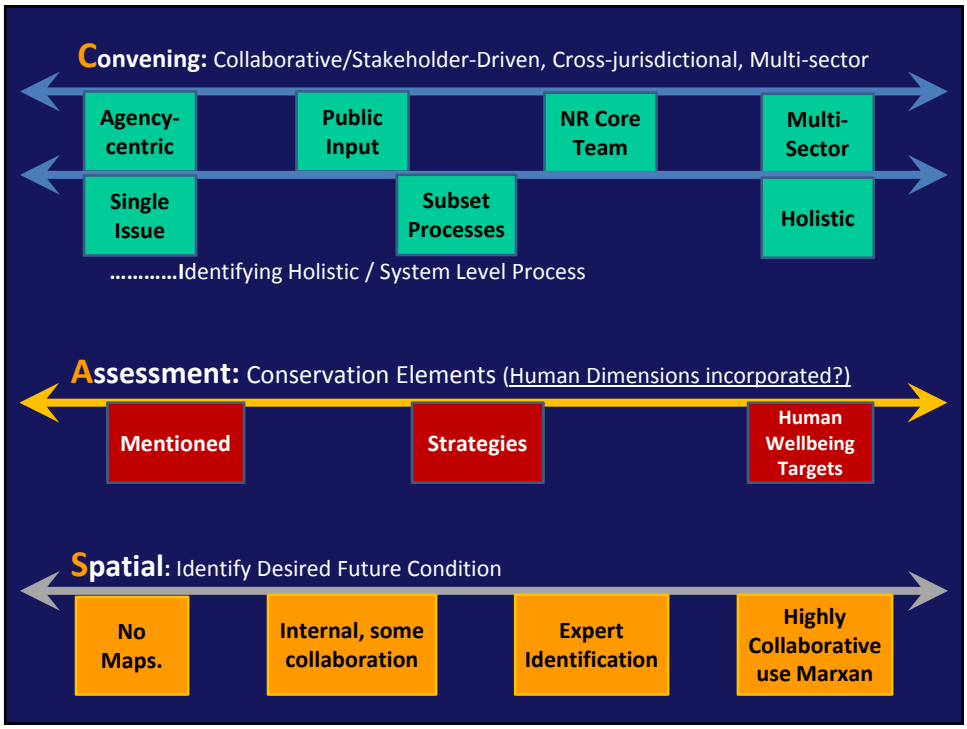


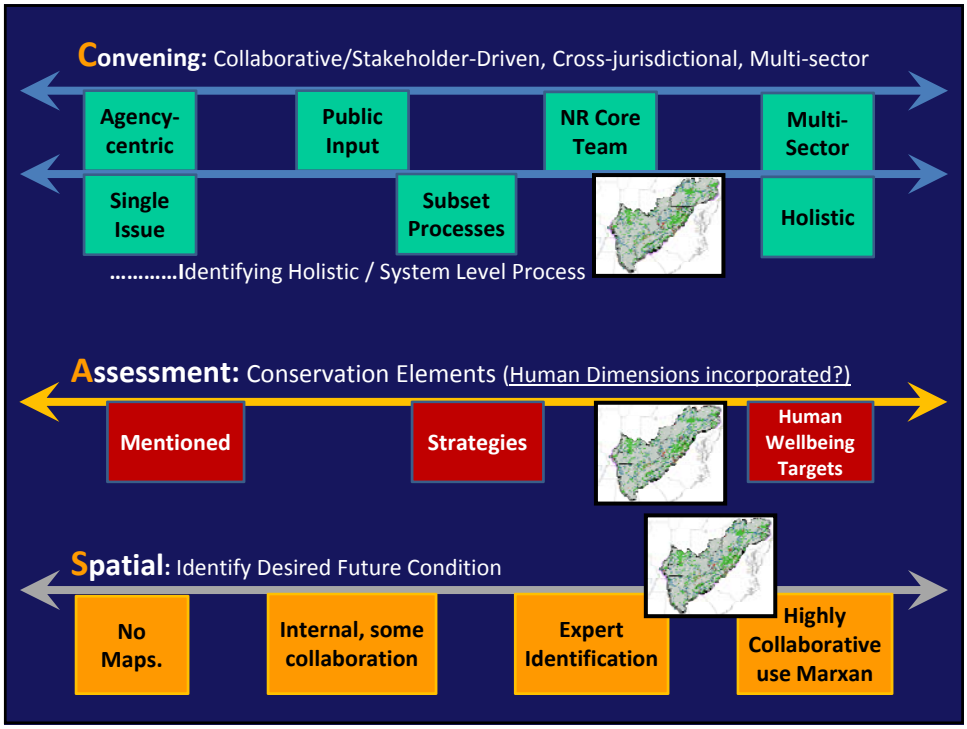
Spatial
Design



Strategy
Design


Tom Miewald, North Pacific LCC, Science Applications, NWR System
LCD evolution / understanding, guidance, framing, practice
4
iCASS
…a continuum
Convening
(vary geography, socio-ecological systems)
stakeholders => shared goals {articulate}
Assessment
current & future conditions
Spatial
develop design [what will success look like]
Strategy
(map) how do we implement it…acting collectively


Convening: Collaborative/Stakeholder-Driven, Cross-jurisdictional, Multi-sector
Agency-centric
Public Input
NR Core Team
Multi-Sector
Single Issue
Subset Processes
Holistic
…….Identifying Holistic / System Level Process
Assessment: Conservation Elements (Human Dimensions incorporated?)
Mentioned
Strategies
Human Wellbeing Targets
Spatial: Identify Desired Future Condition
No Maps.
Internal, some collaboration
Expert Identification
Highly Collaborative use Marxan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Public Input
NR Core Team
Multi-Sector
Single Issue
Subset Processes
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……Identifying Holistic / System Level Process
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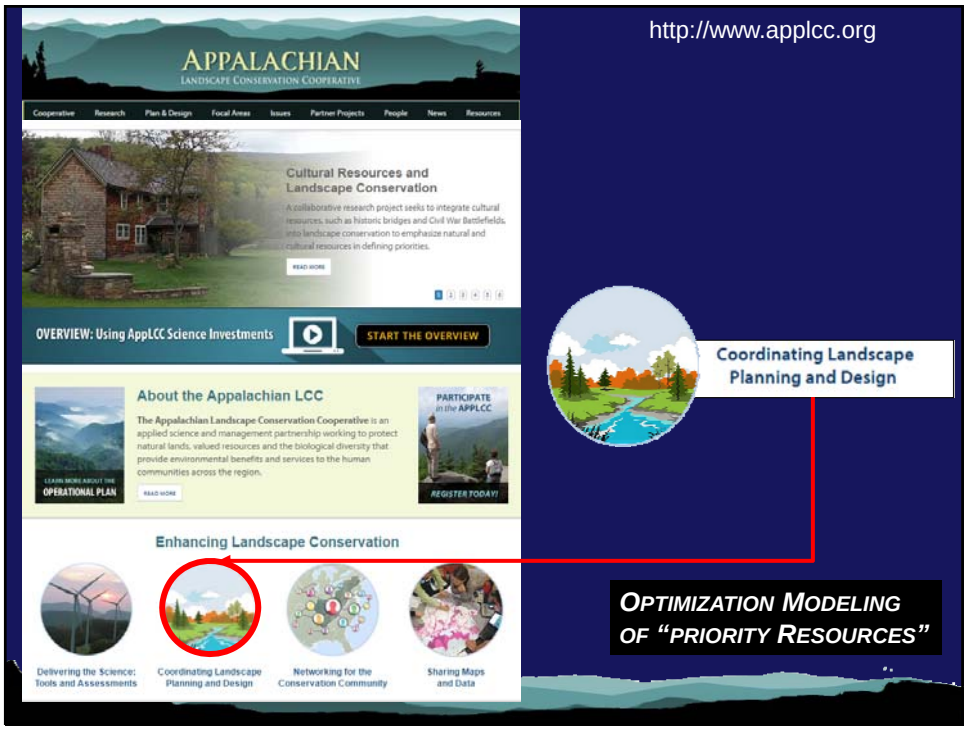
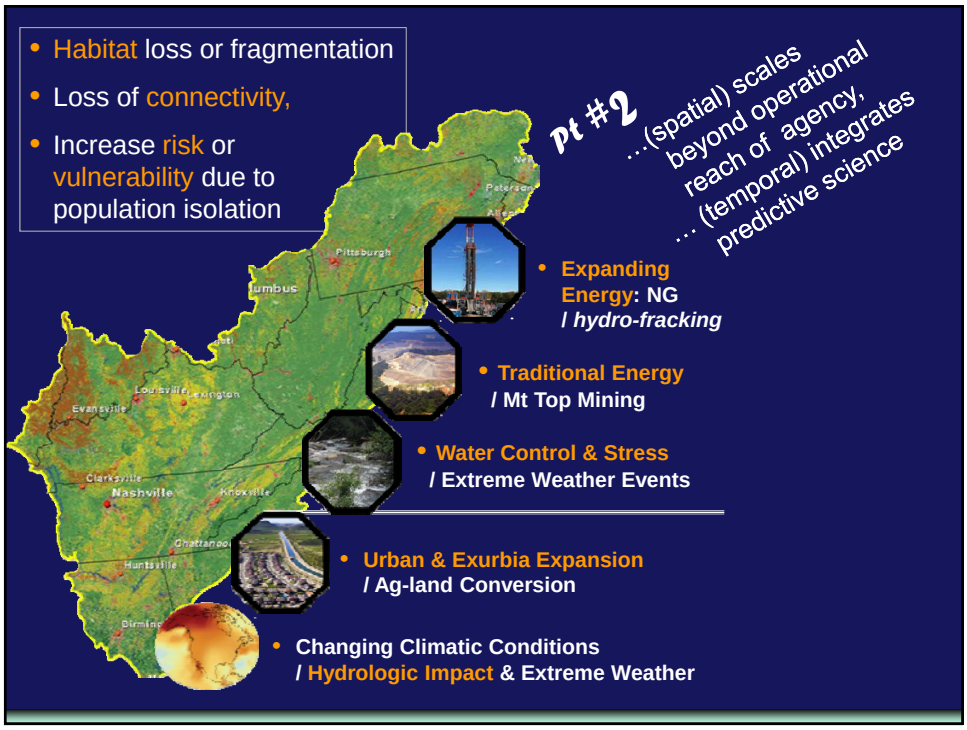

http://www.applcc.org
APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Cultural Resources and Landscape Conservation
OVERVIEW: Using AppLCC Science Investments
START THE OVERVIEW
About the Appalachian LCC
Enhancing Landscape Conservation
Delivering the Science: Tools and Assessments
Coordinating Landscape Planning and Design
Networking for the Conservation Community
Sharing Maps and Data
Coordinating Landscape Planning and Design
OPTIMIZATION MODELING OF "PRIORITY RESOURCES"

APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Steering Comm. (30)
7 States …
15 Fed (10 Votes) …
1 Tribal (EBC)
2 NGO …
5 regional Partner-ships
Vision
Ecological Integrity.
Environmental Benefits.
Sustainable Fish and Wildlife Populations.
Pt #1
…self-directed partnership
MD DNR
NRCS
USGS
TVA
SARP
The Nature Conservancy
Central Hardwoods Joint Venture
Ohio River Basin


Habitat loss or fragmentation
Loss of connectivity,
Increase risk or vulnerability due to population isolation
Pt #2
…(spatial) scales beyond operational reach of agency,
… (temporal) integrates predictive science
Pittsburgh
Louisville
Evansville
Nashville
Knoxville
Chattanooga
Huntsville
Expanding Energy: NG / hydro-fracking
Traditional Energy / Mt Top Mining
Water Control & Stress / Extreme Weather Events
Urban & Exurbia Expansion / Ag-land Conversion
Changing Climatic Conditions / Hydrologic Impact & Extreme Weather

Partner Prioritization (…desired outcome) (…science-driven)

What will success look like?

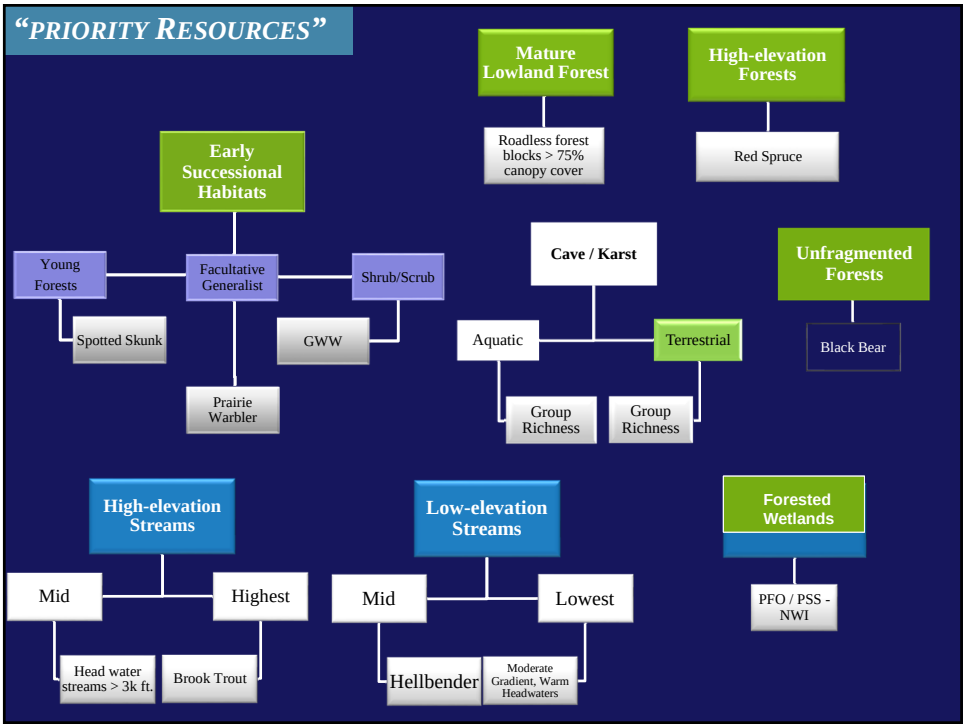
Engage Technical Teams

Priority Resources / Ecosystems+

1. Unfragmented forest
2. High-elevation forest
3. Mature lowland forest
4. Early successional habitats
5. High-elevation streams [mid- high]
6. Low-elevation streams [mid-low]
7. Cave/Karst Systems
8. Forested Wetlands

(LCD1-modeling scenarios: 500 million iterations)

"PRIORITY RESOURCES"



(20) Model 'seeds' => Targets (to capture PR)

Species Distribution Model (SDM)

Black bear distribution
(used to create "cost" surface = connectivity)

1. Hellbender
2. Brook Trout
3. Spotted Skunk
4. Golden-winged warbler
5. Prairie Warbler
6. Red Spruce

7. Cave Obligate Aquatic Sp. Richness
8. Cave Obligate Terrestrial Sp. Richness

Special Places

9. Typic Foothills Cove Forest
10. Typic Montane Cove Forest
11. Rich Montane Cove Forest
12. Shale Barrens
13. Rock Outcrops
14. *Acidic Fens *later removed from model (under revision)*

Key Features

15. Moderate gradient, warm headwaters
16. Headwaters > 3k feet in elevation
17. Top (10%) resilient sites (TNC)
18. Lowland Mature Forest (= Roadless forest blocks > 75% canopy cover)
19. Forested Wetlands
20. Least likely to depart from historical climate regimes

Landscape Modeling - Optimization

- Climate T Projections (PRISM)
- Energy Forecast Model (TNC-LCC)
- Urbanization Model Results (UWI)

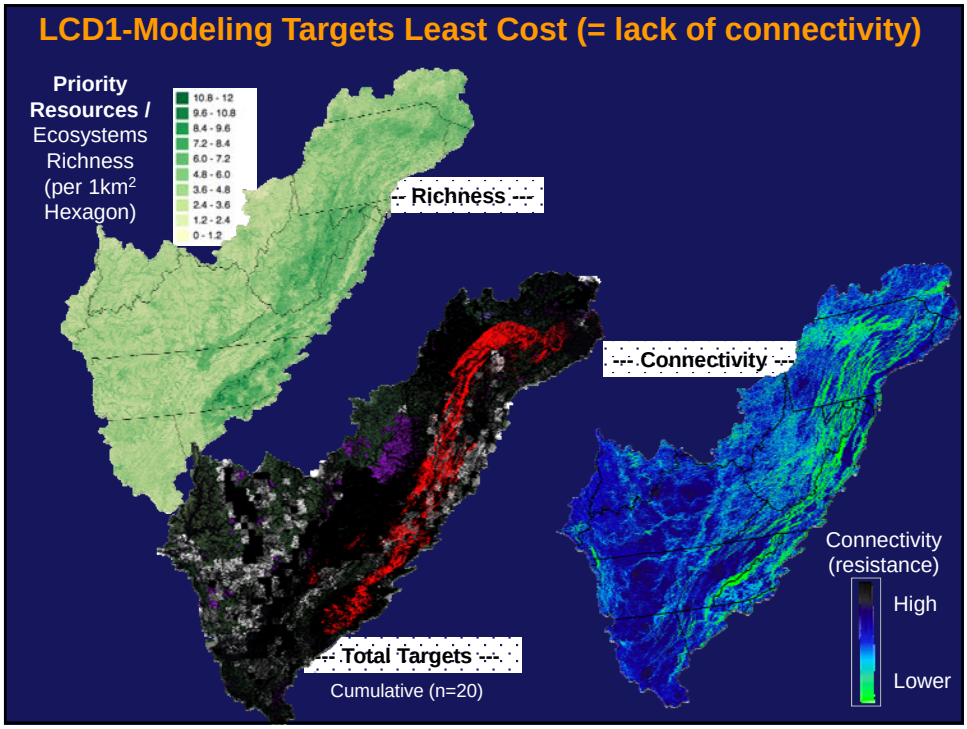
"PRIORITY RESOURCES"

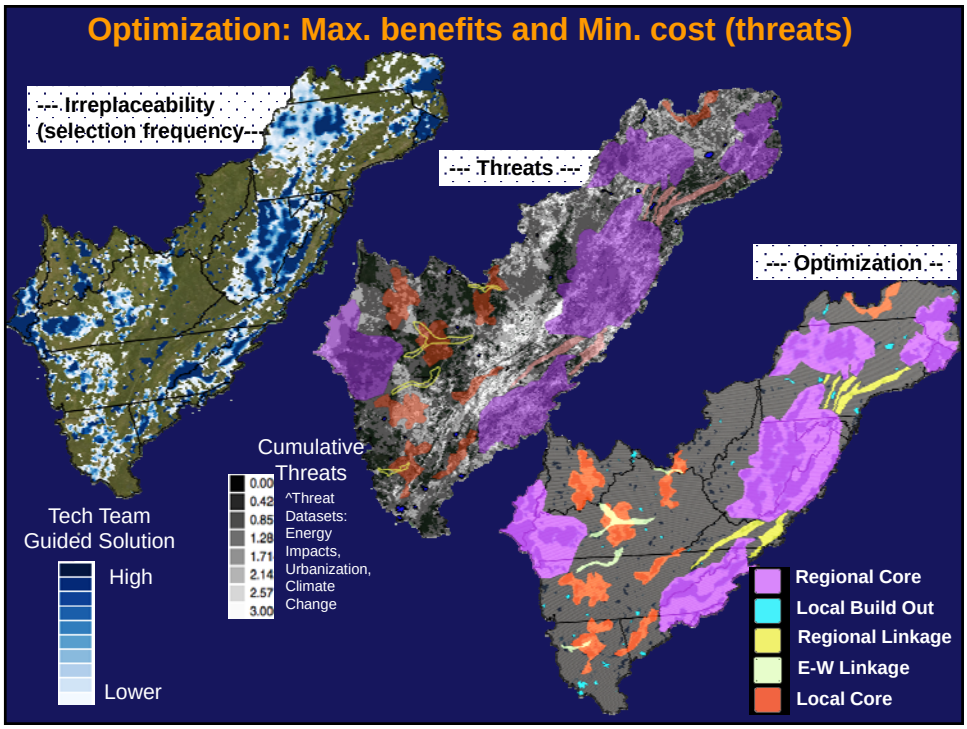
- Target Species
- Special Places
- Key Features

1. Un-fragmented forest
2. High-elevation forest
3. Mature lowland forest
4. Early successional habitats
5. High-elevation streams [mid- high]
6. Low-elevation streams [mid-low]
7. Cave/Karst Systems
8. Forested Wetlands

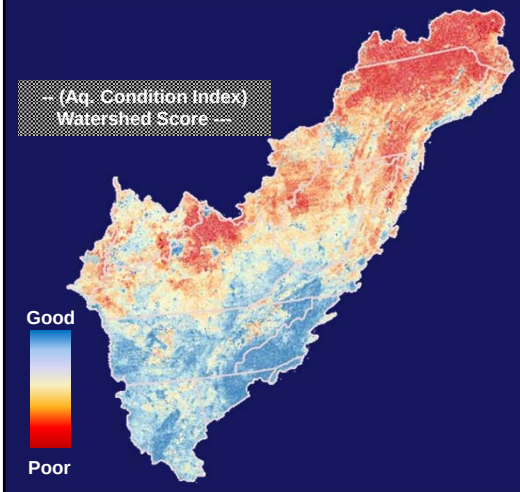
- Special Places
- Key Features

- **Resilient sites - TNC Top 10%**
- **Soil deficit: least likely to depart historical climate regime**


LCD1-Modeling Targets Least Cost (= lack of connectivity)
Priority Resources / Ecosystems Richness (per 1km2 Hexagon)
10.8 - 12
9.6 - 10.8
8.4 - 9.6
7.2 - 8.4
6.0 - 7.2
4.8 - 6.0
3.6 - 4.8
2.4 - 3.6
1.2 - 2.4
0 - 1.2
-- Richness ---
--- Connectivity ---
-- Total Targets ---
Cumulative (n=20)
Connectivity (resistance)
High
Lower


Optimization: Max. benefits and Min. cost (threats)
--- Irreplaceability (selection frequency---
--- Threats ---
--- Optimization --
Cumulative Threats
0.00
0.42
0.85
1.28
1.71
2.14
2.57
3.00
^Threat Datasets: Energy Impacts, Urbanization, Climate Change
Tech Team Guided Solution
High
Lower
Regional Core
Local Build Out
Regional Linkage
E-W Linkage
Local Core

Optimization: (Integrated = LCD2) …Aquatic Condition



NHD Plus ver.2

Catchment Scale

Within (Local)

Network (Cumulative)

Pt #1 Allows condition of upstream drainage area to influence scores

4 Spatial Scales for Predictors

Final Responses

Fish

Attribute	Biological metric
Shannon Diversity	Diversity
Functional Group	Invertivore Taxa
	Piscivore Taxa
	Herbivore Taxa
Taxa Quality	Lithophilic Spawners
	Taxa Preferring Coarse Sediment
	Intolerant Taxa
	Tolerant Taxa

Aquatic Macroinvertebrates

Attribute	Biological metric
Taxa Quality	EPT Taxa
	5 Dominant Taxa
	Intolerant Taxa
	Tolerant Taxa

Average Fish Score + Av. Aquatic Macroinvertebrate Score

Pt #2

Average Aquatic Response Score

Landscape Modeling – LCD2

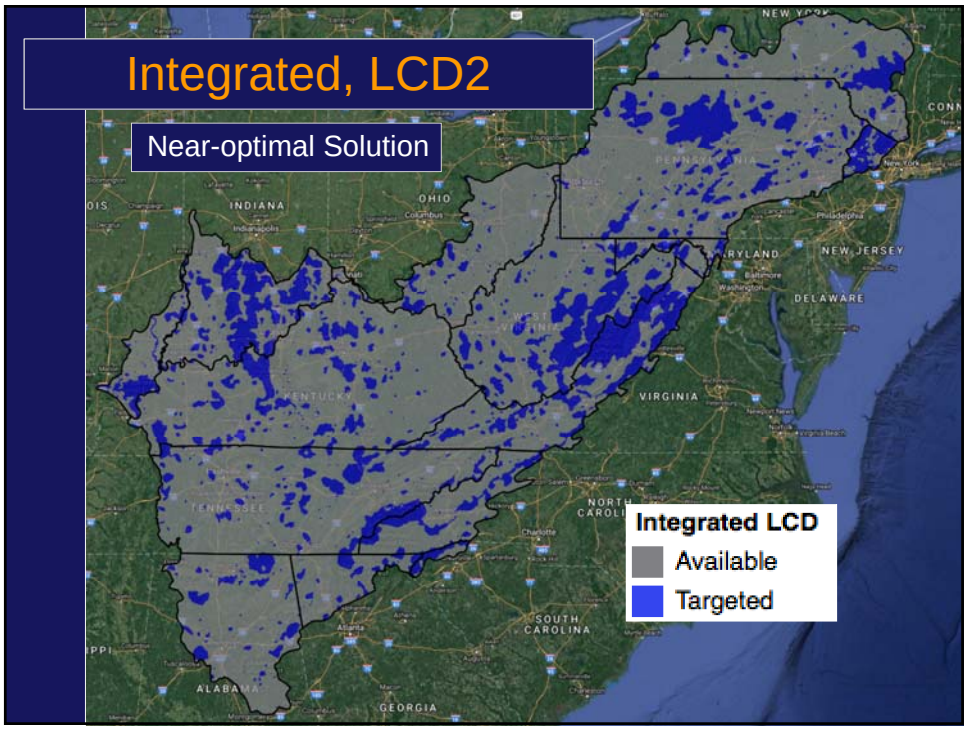
- Climate T Projections (PRISM)
- Energy Forecast Model (TNC-LCC)
- Urbanization Model Results (UWI)
- (Risk) Environmental Services

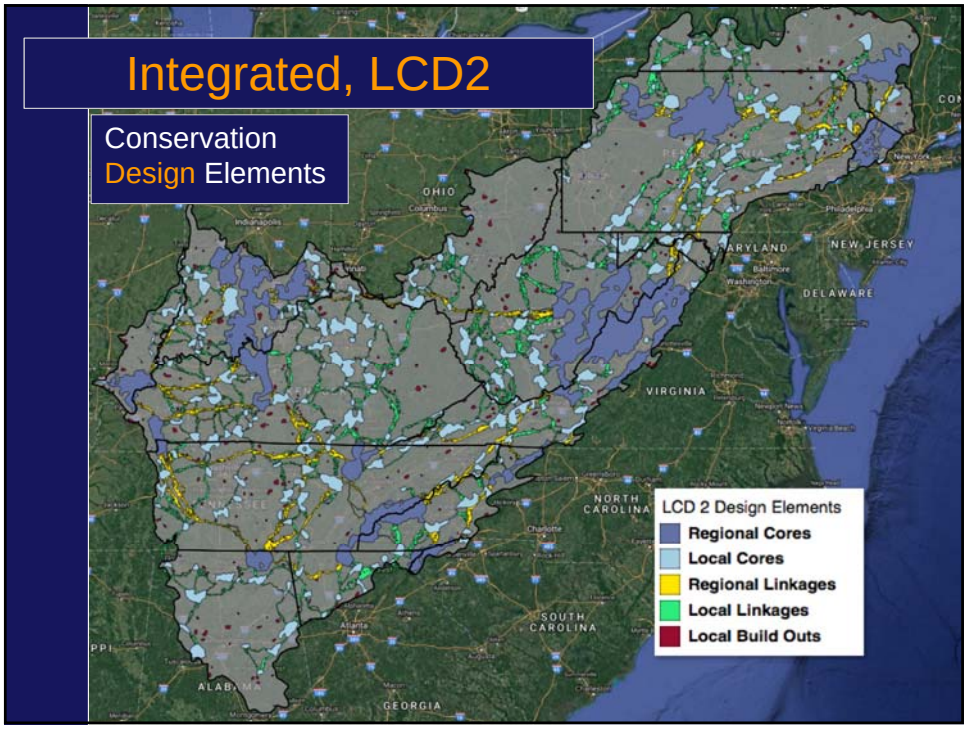
"PRIORITY RESOURCES"

- **Target Species**
- Special Places
- Key Features
- Aquatic Integrity
- (Benefits) Env. Services

1. Un-fragmented forest
2. High-elevation forest
3. Mature lowland forest
4. Early successional habitats
5. High-elevation streams [mid- high]
6. Low-elevation streams [mid-low]
7. Cave/Karst Systems
8. Forested Wetlands

- Special Places
- Key Features
- Aquatic Integrity
- (Benefits) Env. Services




Integrated, LCD2
Conservation
Design Elements
OHIO
MARYLAND
NEW JERSEY
DELAWARE
VIRGINIA
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
LCD 2 Design Elements
Regional Cores
Local Cores
Regional Linkages
Local Linkages
Local Build Outs

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GET STARTED
http://www.applcc.org
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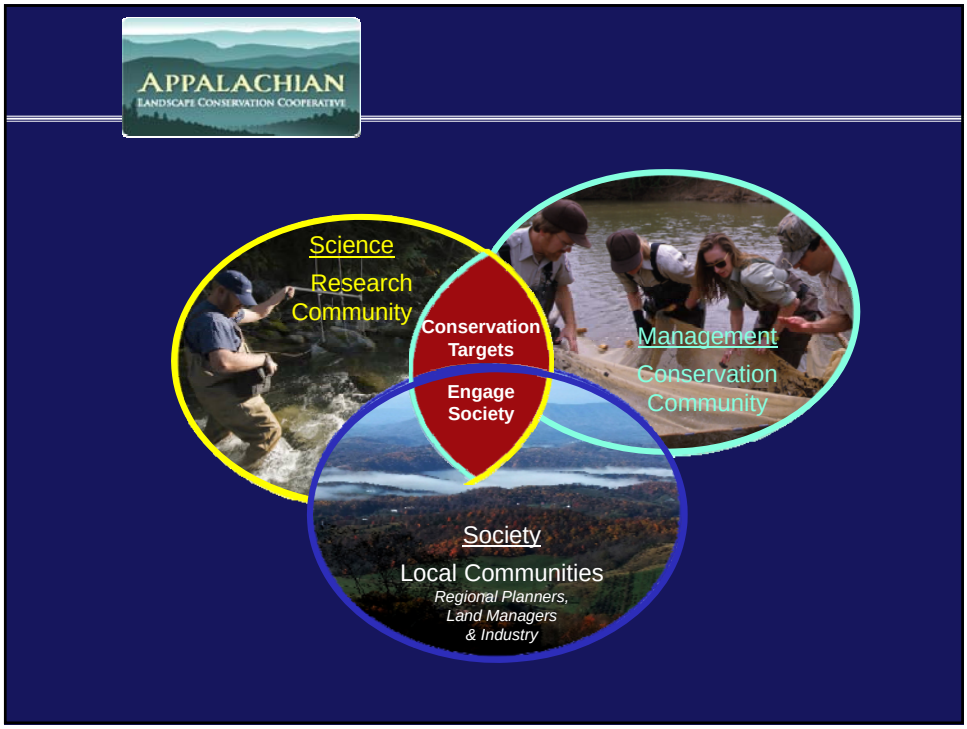
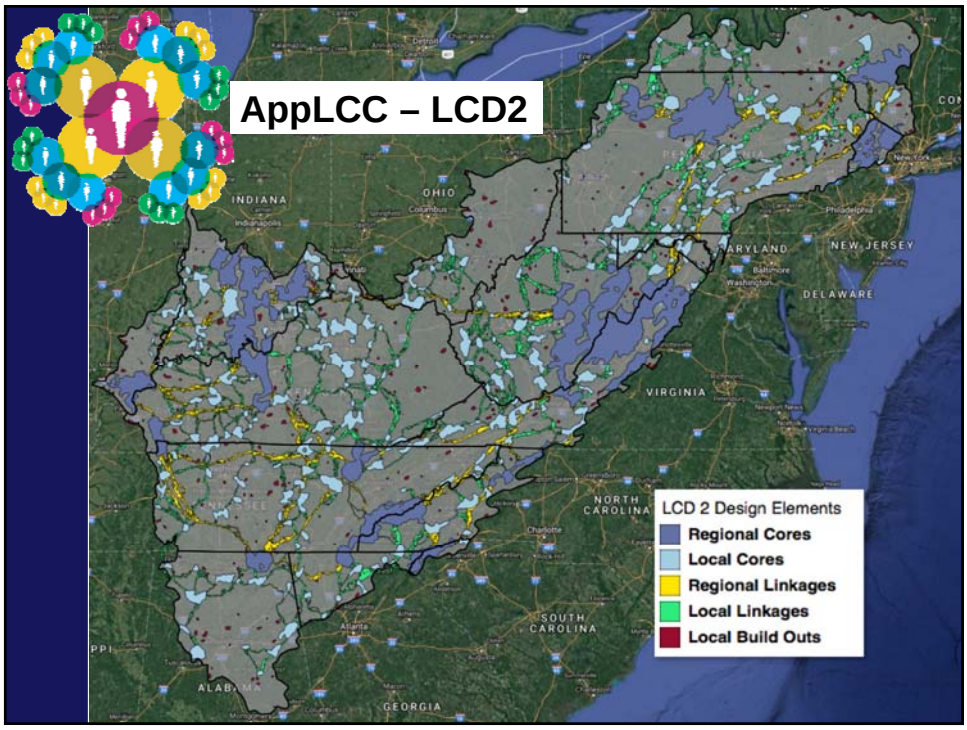
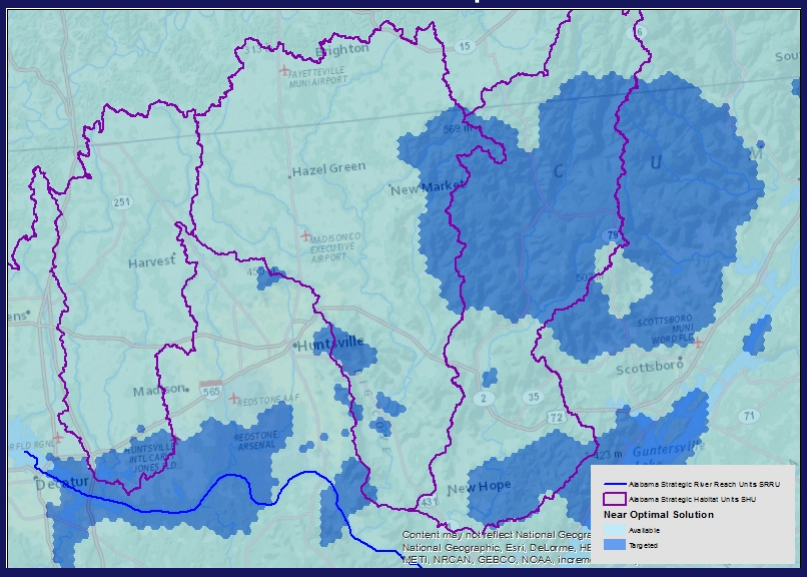
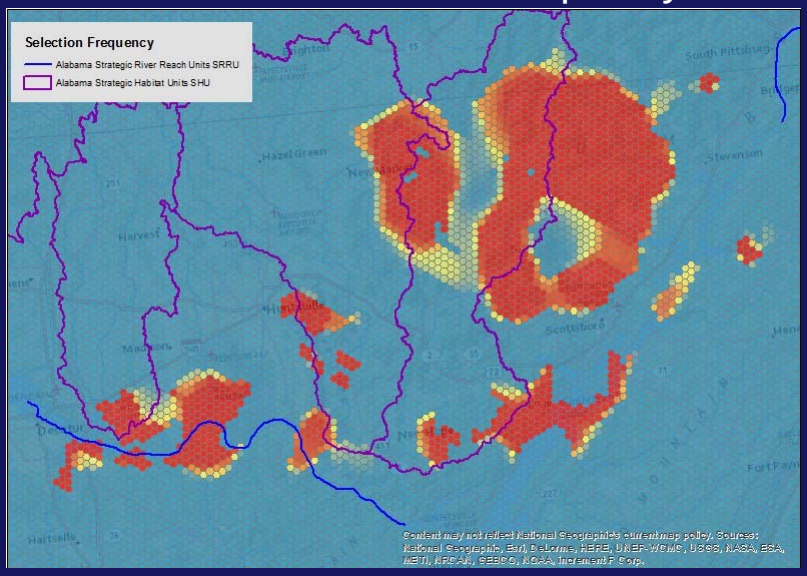

APPALACHIAN
LANDSCAPE CONSERVATION COOPERATIVE
Science
Research
Community
Conservation
Targets
Engage
Society
Management
Conservation
Community
Society
Local Communities
Regional Planners,
Land Managers
& Industry


AppLCC – LCD2
INDIANA
OHIO
NEW JERSEY
DELAWARE
VIRGINIA
NORTH
CAROLINA
SOUTH
CAROLINA
GEORGIA
LCD 2 Design Elements
Regional Cores
Local Cores
Regional Linkages
Local Linkages
Local Build Outs

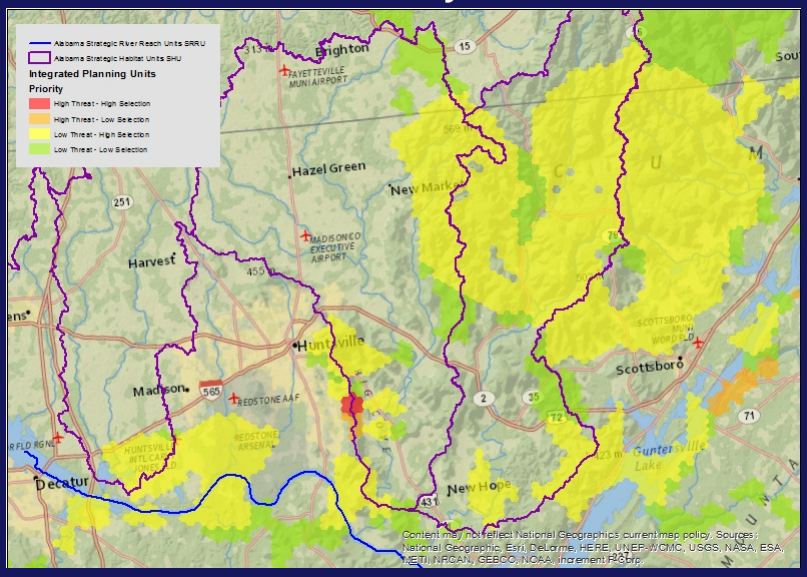
Zoomed SHUs – near Optimal

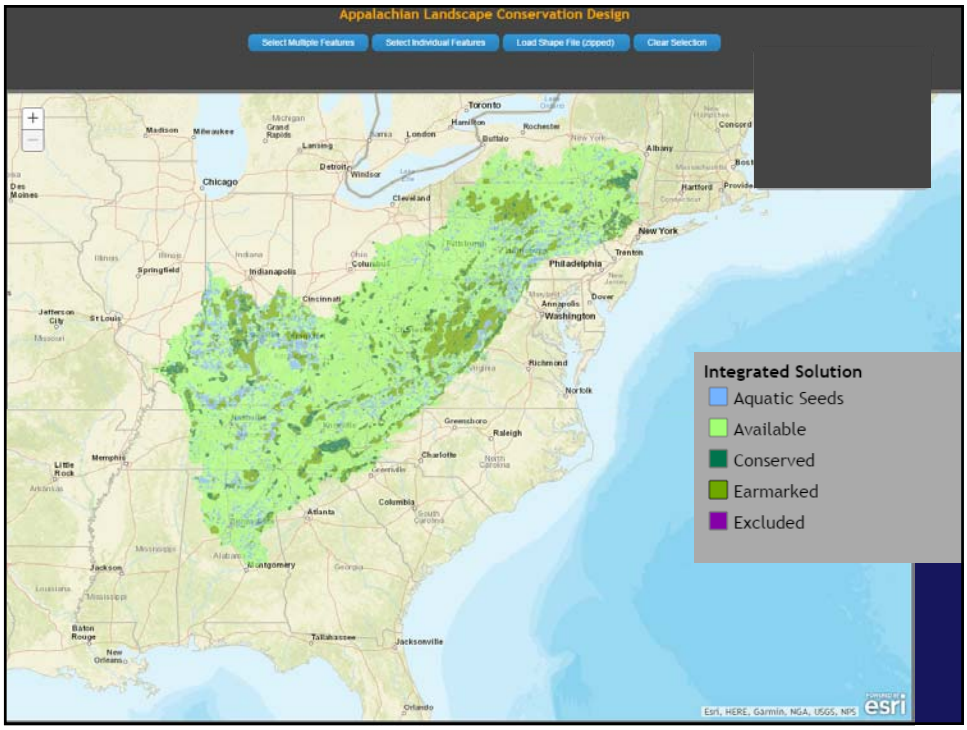


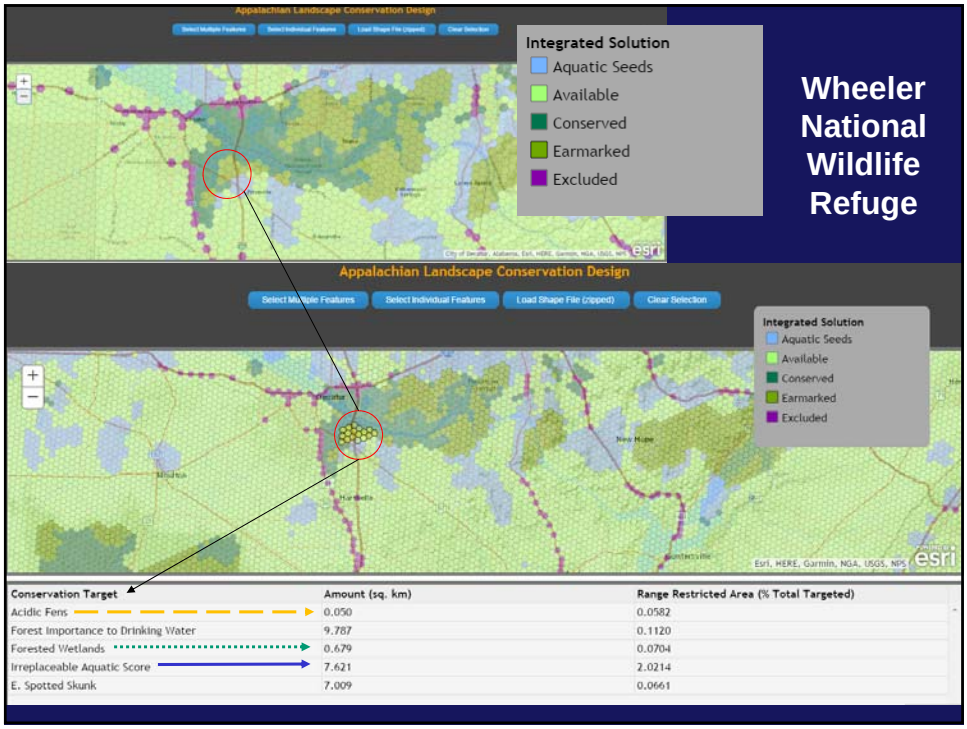
Zoom SHUs – Selection Frequency

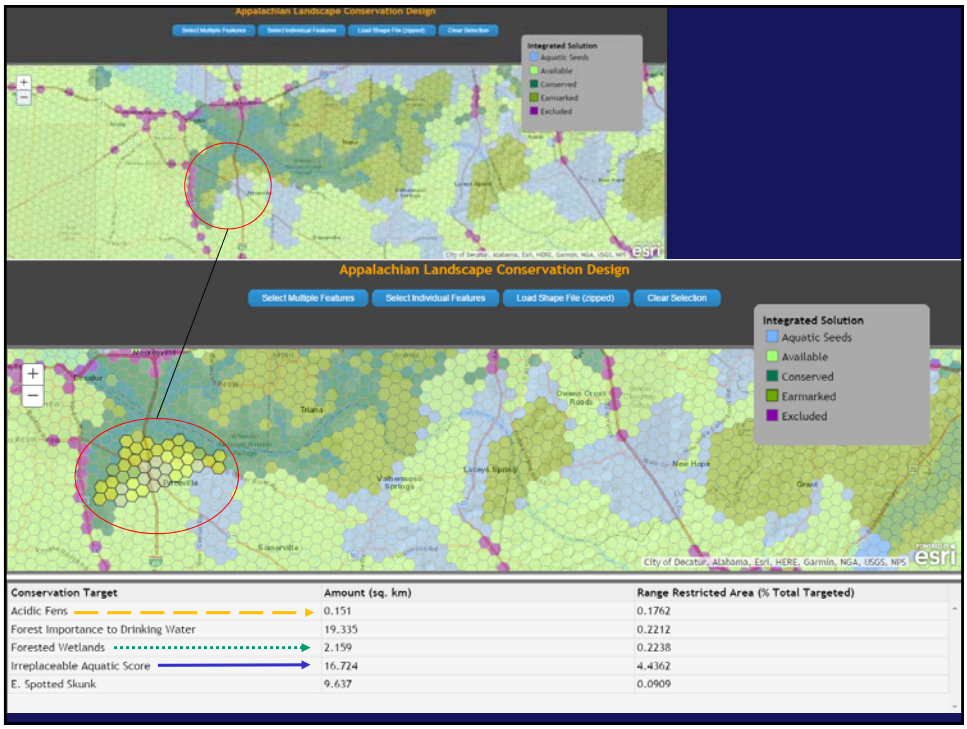


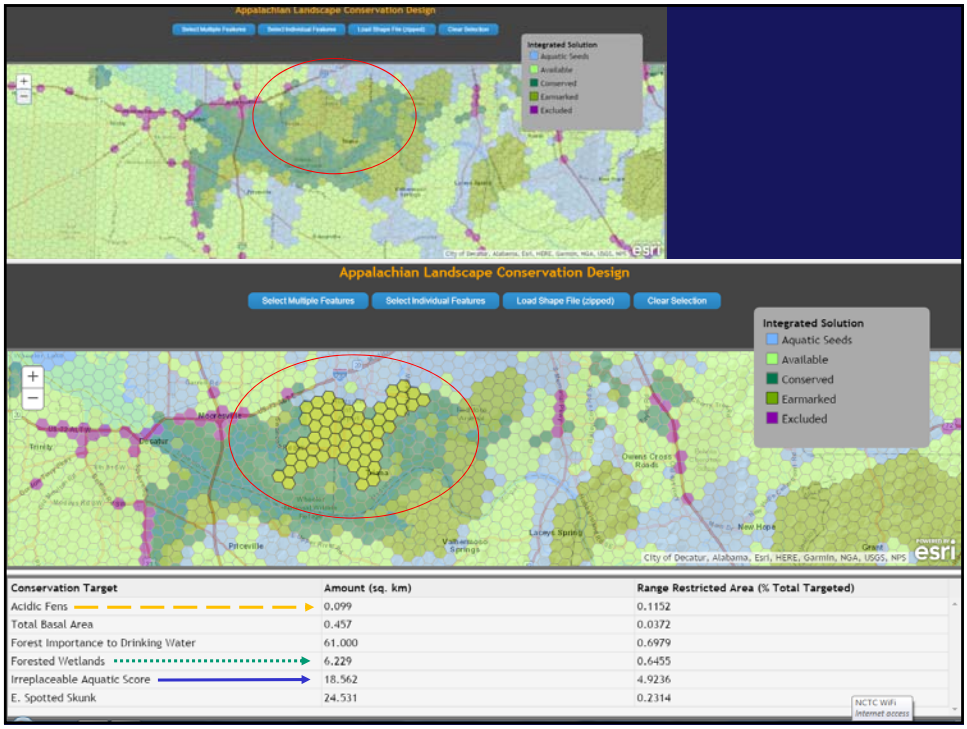
Zoomed SHUs - Priority






Appalachian Landscape Conservation Design
Integrated Solution
Aquatic Seeds
Available
Conserved
Earmarked
Excluded
Wheeler National Wildlife Refuge
Select Multiple Features
Select Individual Features
Load Shape File (zipped)
Clear Selection
Conservation Target
Amount (sq. km)
Range Restricted Area (% Total Targeted)
Acidic Fens
0.050
0.0582
Forest Importance to Drinking Water
9.787
0.1120
Forested Wetlands
0.679
0.0704
Irreplaceable Aquatic Score
7.621
2.0214
E. Spotted Skunk
7.009
0.0661


Appalachian Landscape Conservation Design
Integrated Solution
Aquatic Seeds
Available
Conserved
Earmarked
Excluded
Select Multiple Features
Select Individual Features
Load Shape File (zipped)
Clear Selection
Conservation Target
Amount (sq. km)
Range Restricted Area (% Total Targeted)
Acidic Fens
0.151
0.1762
Forest Importance to Drinking Water
19.335
0.2212
Forested Wetlands
2.159
0.2238
Irreplaceable Aquatic Score
16.724
4.4362
E. Spotted Skunk
9.637
0.0909



Conservation Target	Amount (sq. km)	Range Restricted Area (% Total Targeted)
Acidic Fens	0.099	0.1152
Total Basal Area	0.457	0.0372
Forest Importance to Drinking Water	61.000	0.6979
Forested Wetlands	6.229	0.6455
Irreplaceable Aquatic Score	18.562	4.9236
E. Spotted Skunk	24.531	0.2314

Problems and Solutions of *21st Century Conservation:*

barriers...

transcend the boundaries of individual agencies, programs, and organizations…
exceed their operational reach …

ability....

- Capacity to characterize, assess, and predict population and habitat sustainability at landscape scales.
- New core competencies in landscape assessment.
- Partnering region's conservation infrastructure *(private, state, federal)* to operate as a networked, leveraged system.

Working at a Landscape-level …Partnering with LCCs
(Landscape Conservation Cooperatives)

conservation
... in a changing climate
...given the scale and rate of land-use changes,
means
we can't do it alone
Photo Source: B. Smith