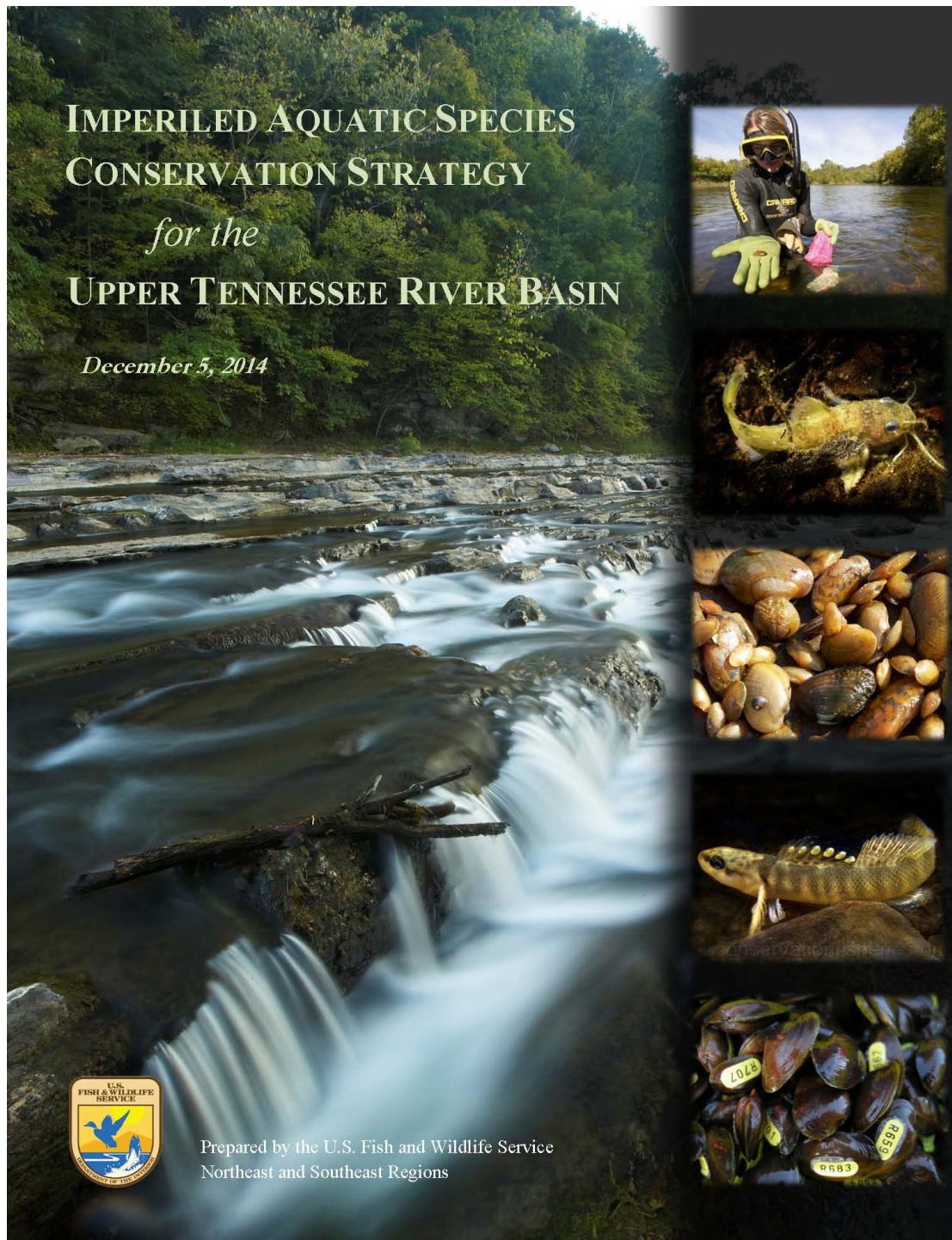
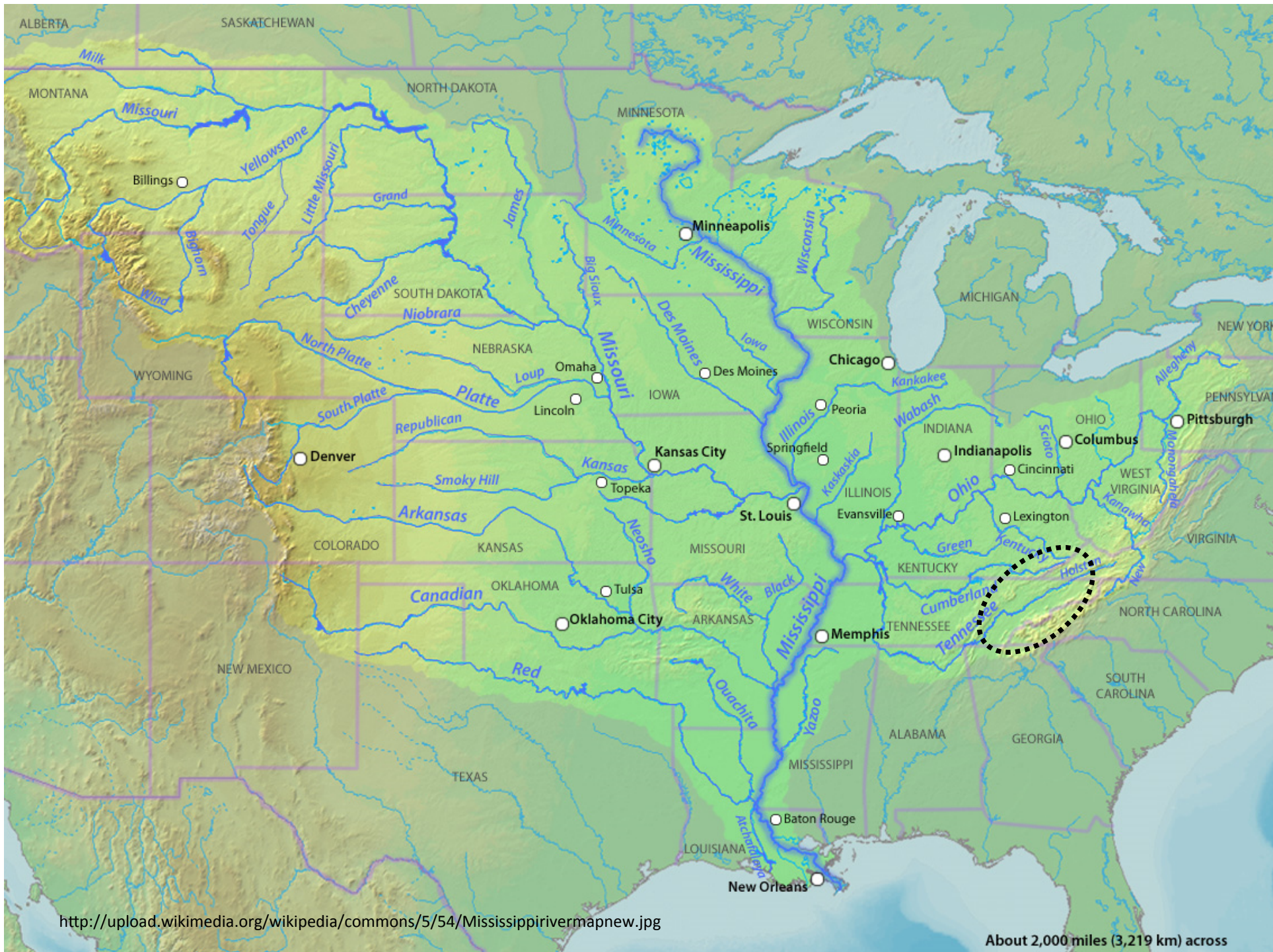


Using a structured  
decision making  
process for  
strategic  
conservation of  
imperiled aquatic  
species in the  
Upper Tennessee  
River Basin

David Smith, USGS  
&  
Jess Jones, USFWS

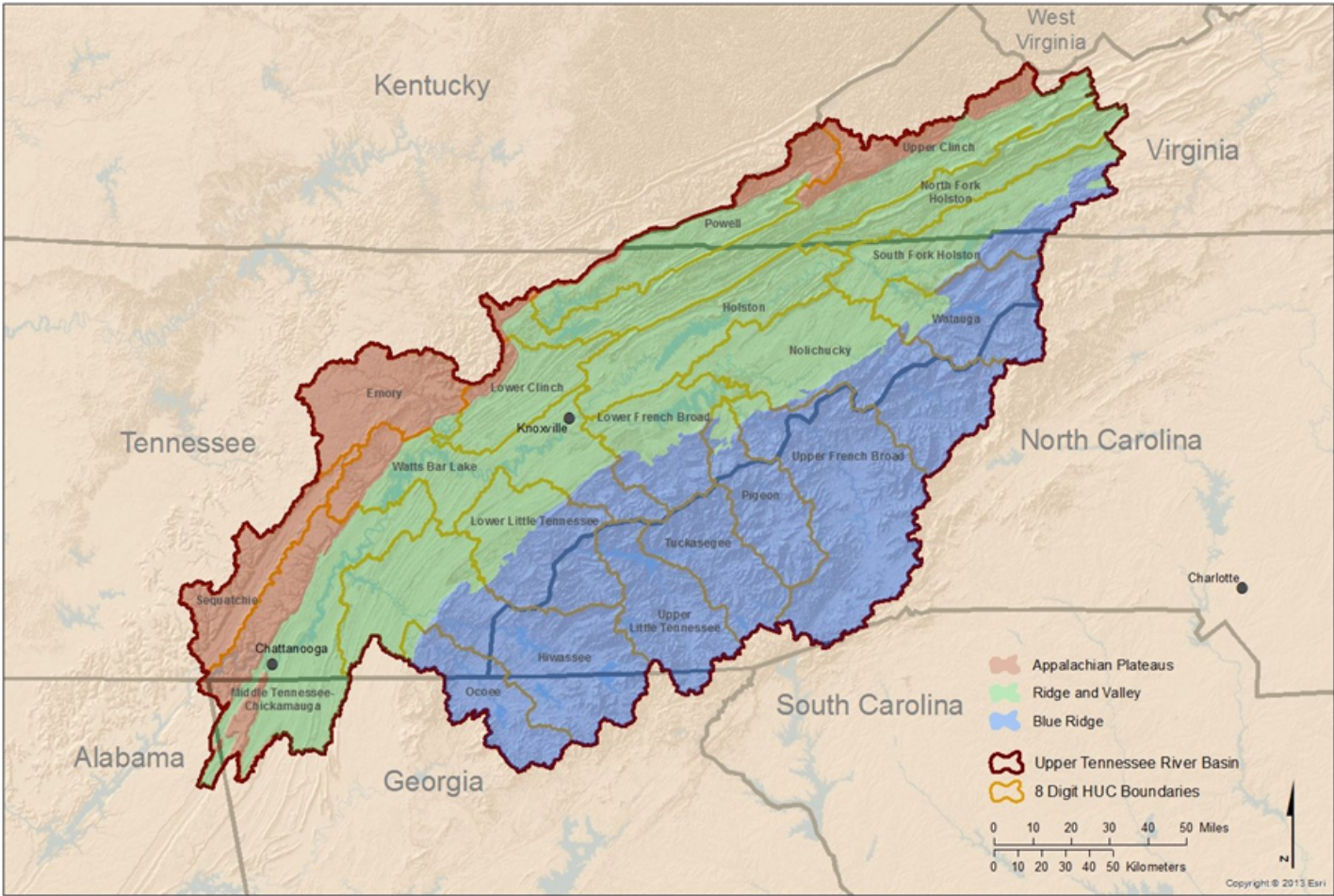
July 16, 2015







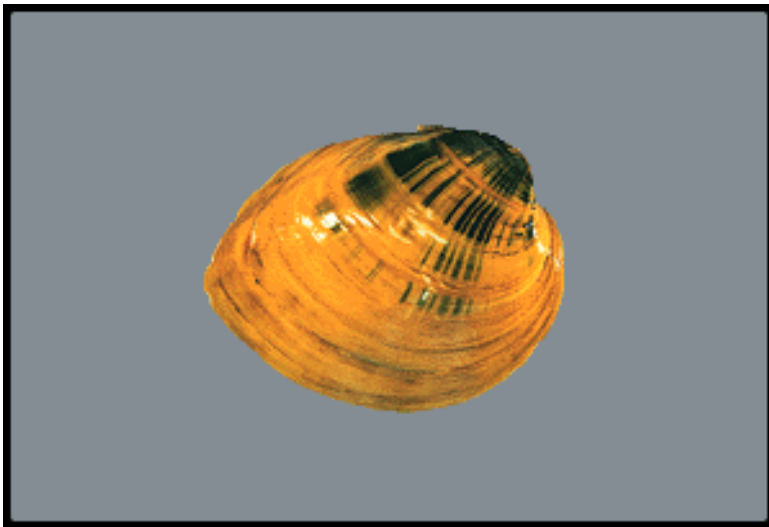
Large geographic area  
(22,360 square miles primarily in VA, NC, and TN)



# Mussels and Fishes of Upper Tennessee River Basin <sup>INHS</sup>

Mussel Species Known: 83  
Extant Endangered: 24

Fish Species Known: 172  
Extant endangered: 12



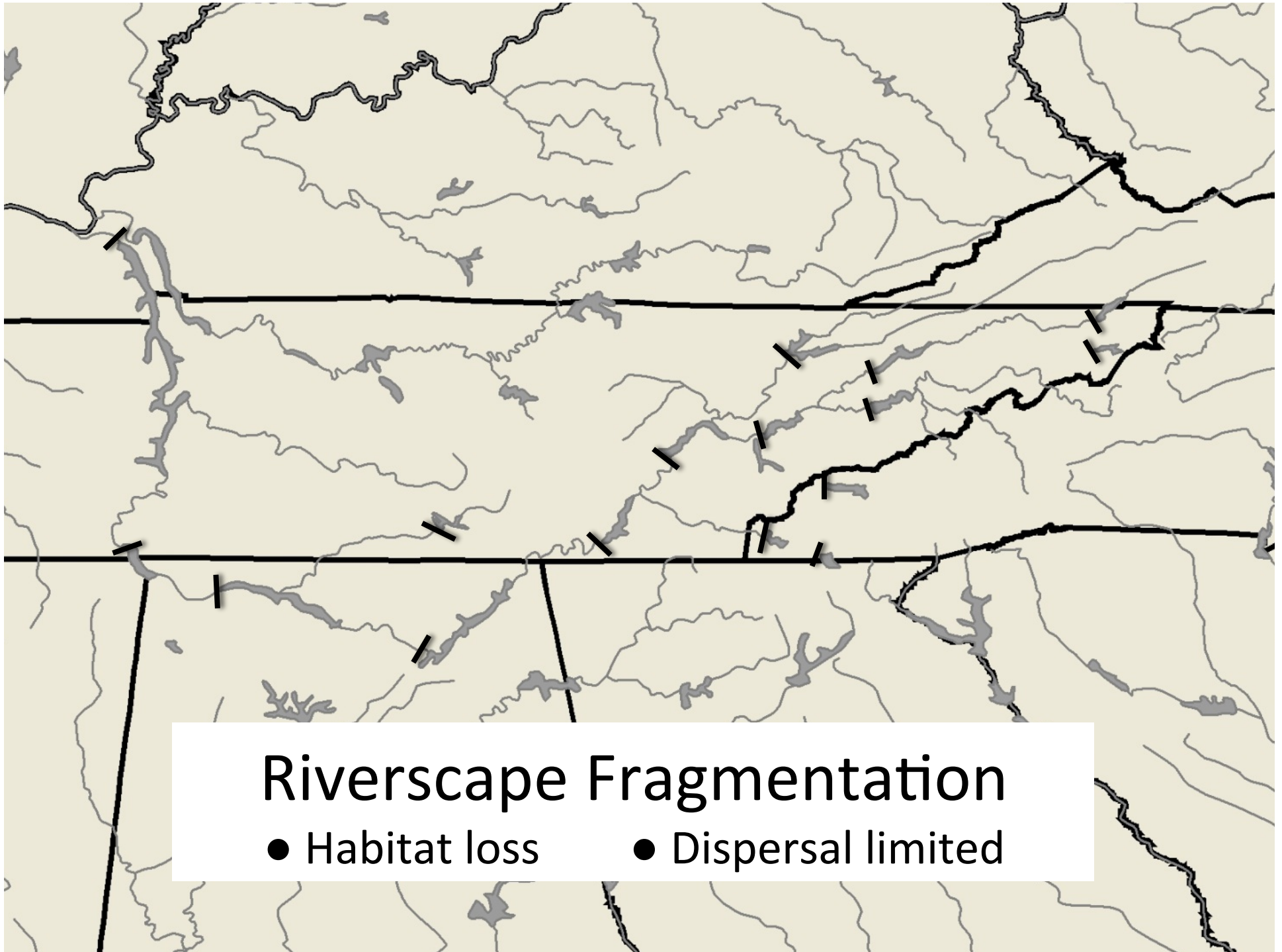
Endangered Slabside Pearlymussel



Endangered Slender Chub

## Current Conditions: Fragmentation and Multiple Stressors.....





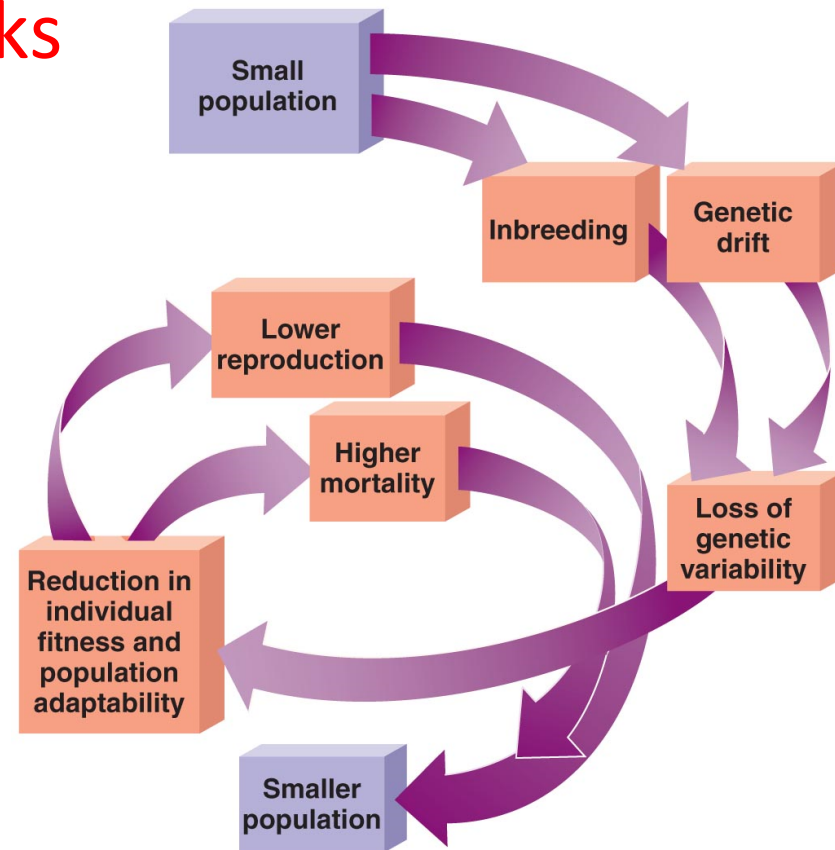
# Small Population Size Risks

## Demographic Risks

- Demographic stochasticity
- Environmental stochasticity
- Extirpation/Extinction

## Evolutionary Risks

- Loss of genetic variation
- Inbreeding depression
- Loss of adaptive potential

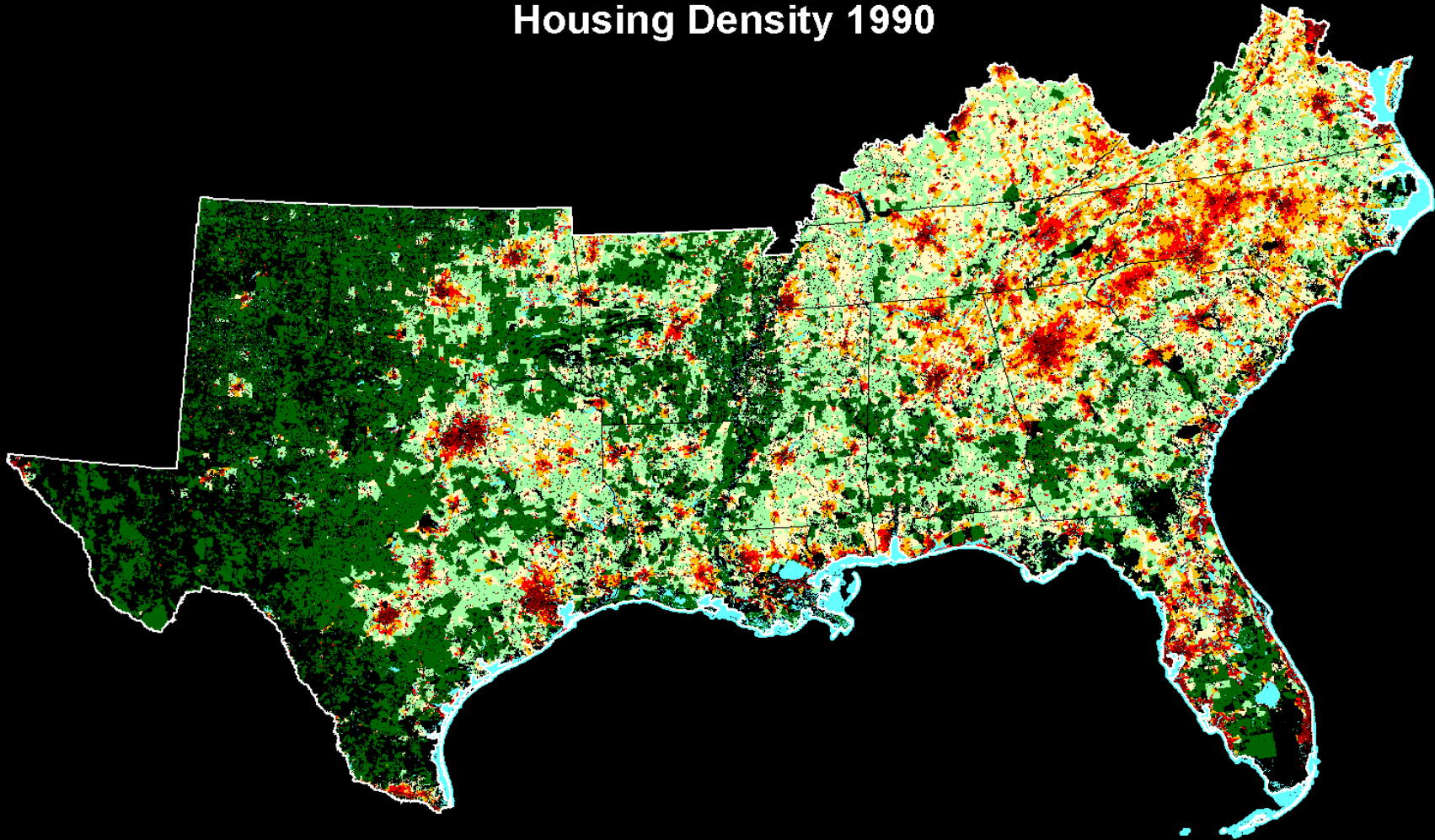


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# Southern Region

## Housing Density 1990

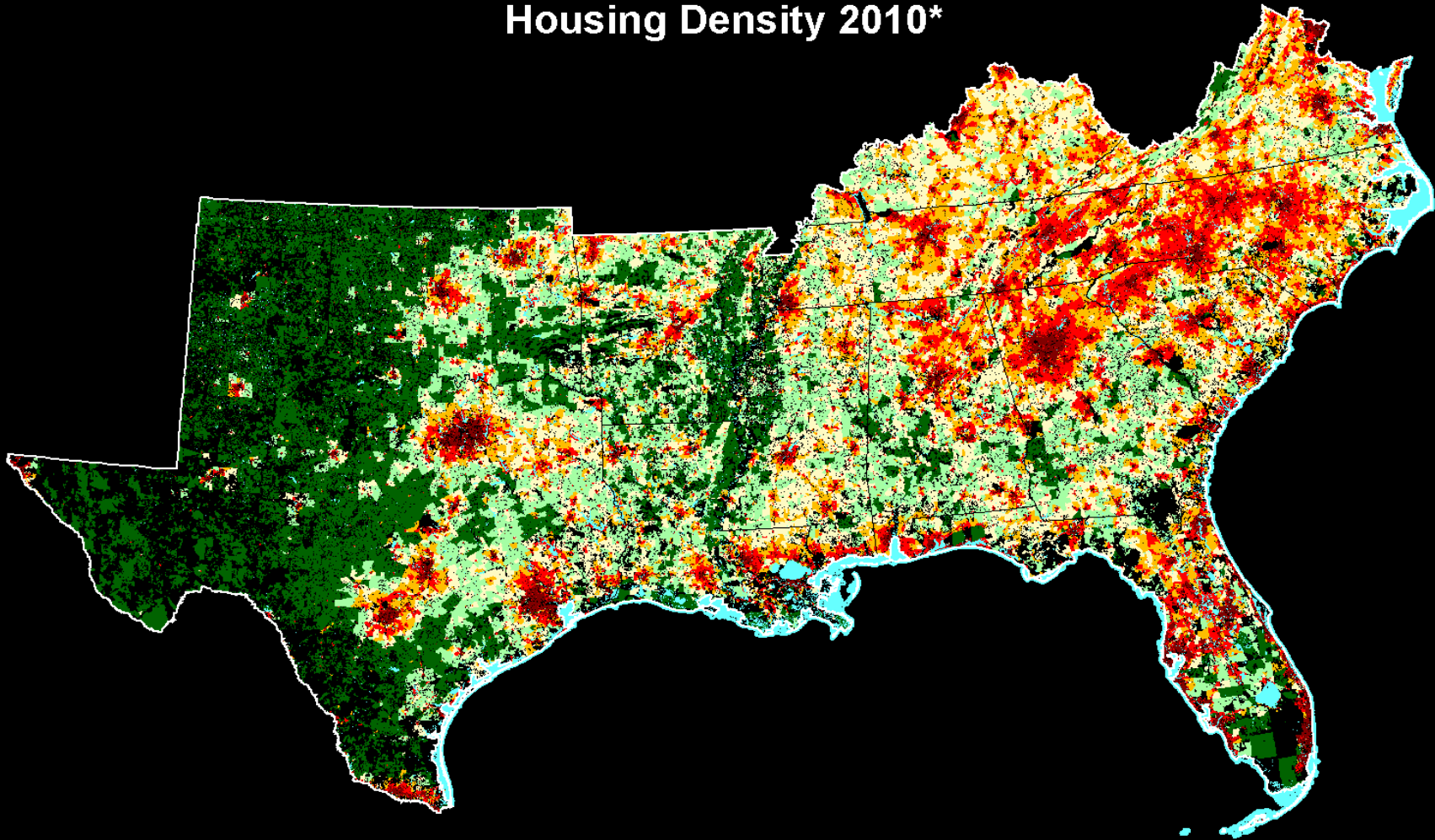


Housing Units per Km<sup>2</sup>



# Southern Region

## Housing Density 2010\*



Housing Units per Km<sup>2</sup>

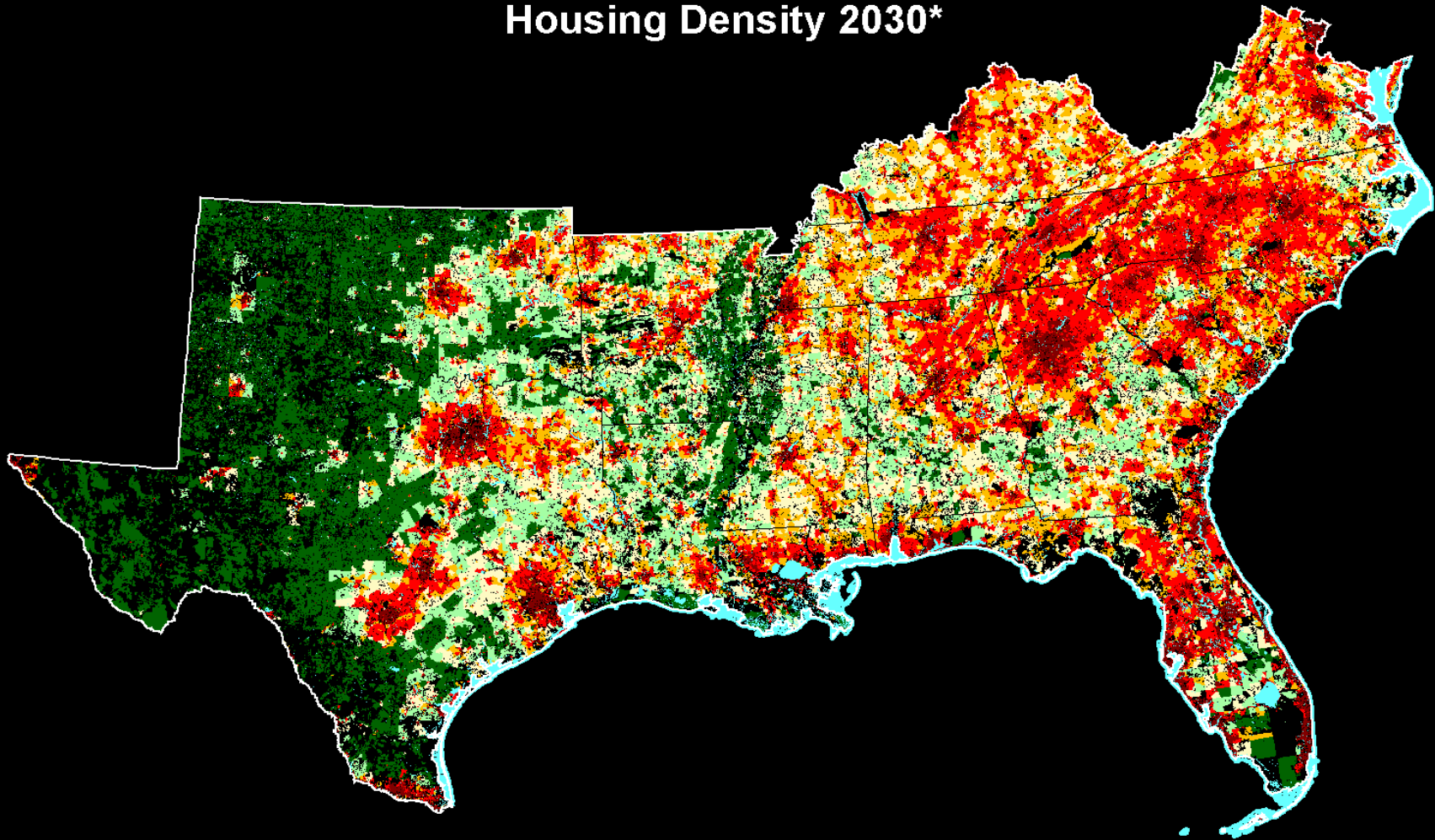
\*Linear projection of 1990s growth



Copyright 2004 R.B. Hammer and V.C. Radeloff  
University of Wisconsin-Madison

# Southern Region

## Housing Density 2030\*

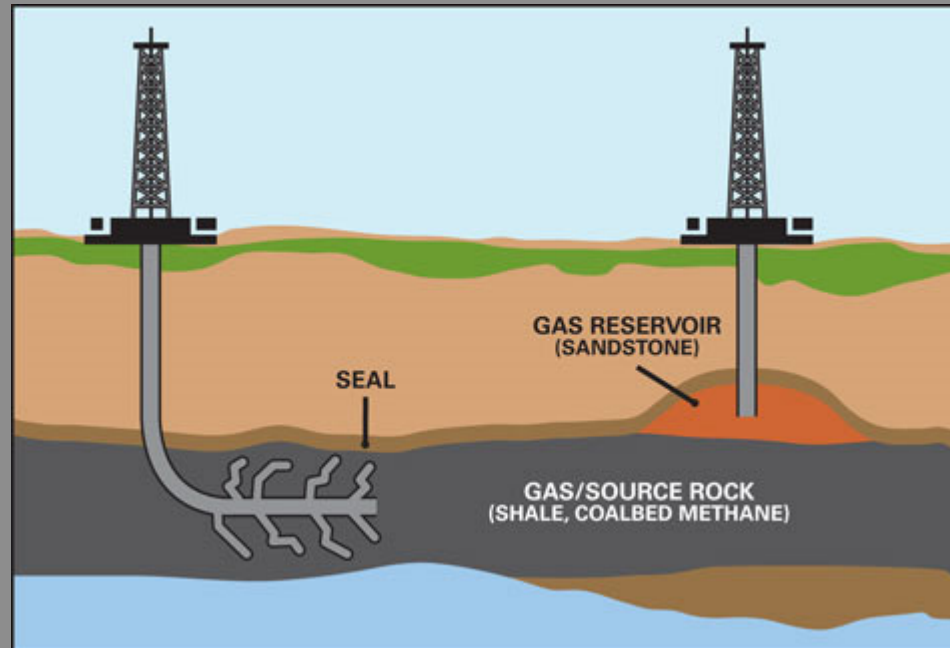


Housing Units per Km<sup>2</sup>



\*Linear projection of 1990s growth

# Emerging Threats – Marcellus Shale Gas Drilling



[http://2.bp.blogspot.com/\\_YN-jSttWaj0/TUnMi3AGI7I/AAAAAAAAAPE/MLVchzC3vZo/s1600/gasdrilling.jpg](http://2.bp.blogspot.com/_YN-jSttWaj0/TUnMi3AGI7I/AAAAAAAAAPE/MLVchzC3vZo/s1600/gasdrilling.jpg)

<http://www.marcellusshales.com/sitebuildercontent/sitebuilderpictures/marcellusshalemap.jpg>



FMCC, Virginia Tech



FMCC, Virginia Tech



# Why Develop the Strategy?

- Complex situation:
  - Limited FWS staff, many partners, limited budgets, extensive coordination, large number of species facing a variety of threats, large geographic area
- Aspire to provide a cost effective approach to guide conservation and management of imperiled freshwater fish and mussel species in the UTRB
- FWS team sought to determine which actions to emphasize to best achieve recovery of these species in the UTRB



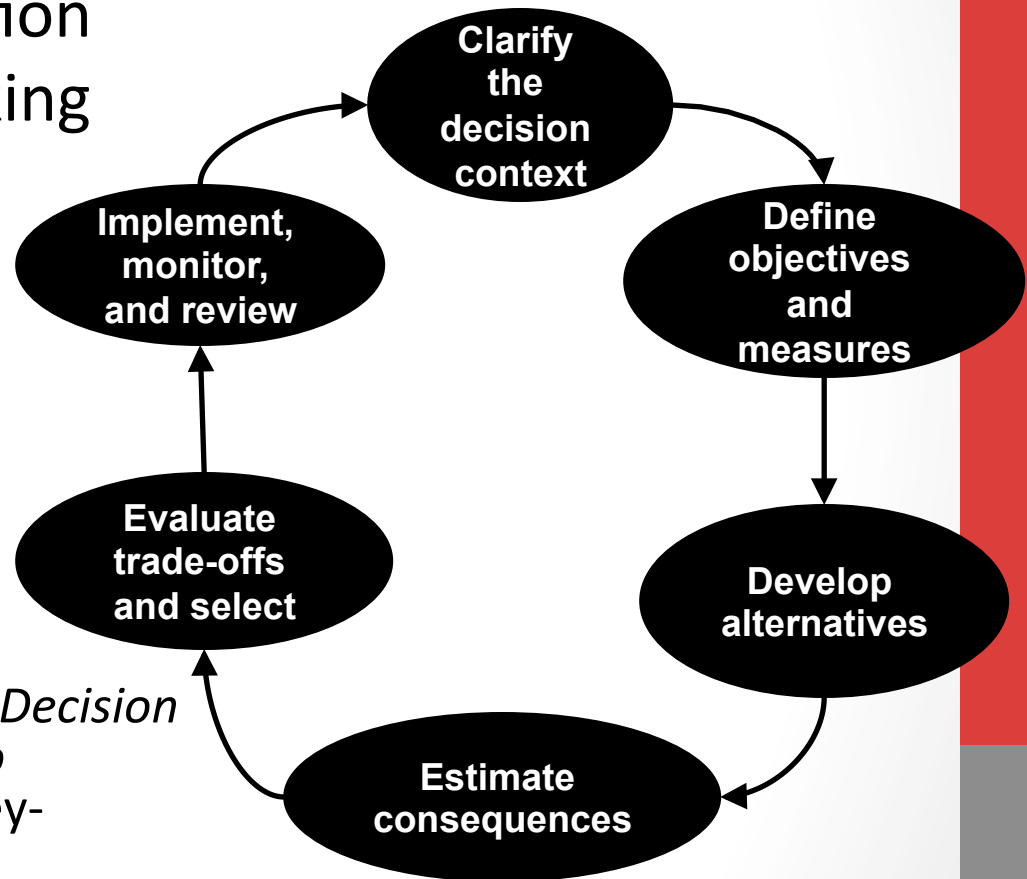


# Decision context

- Challenges to strategy development
  - Uncertainty in species response to management actions
  - Budgetary constraints
  - Scaling expected conservation benefits from local to landscape and from single species to multiple species
  - Paucity of data available to evaluate potential consequences
- Seek a strategy that
  - Has greatest chance to achieve conservation objectives
  - Robust to uncertainties in conservation outcomes

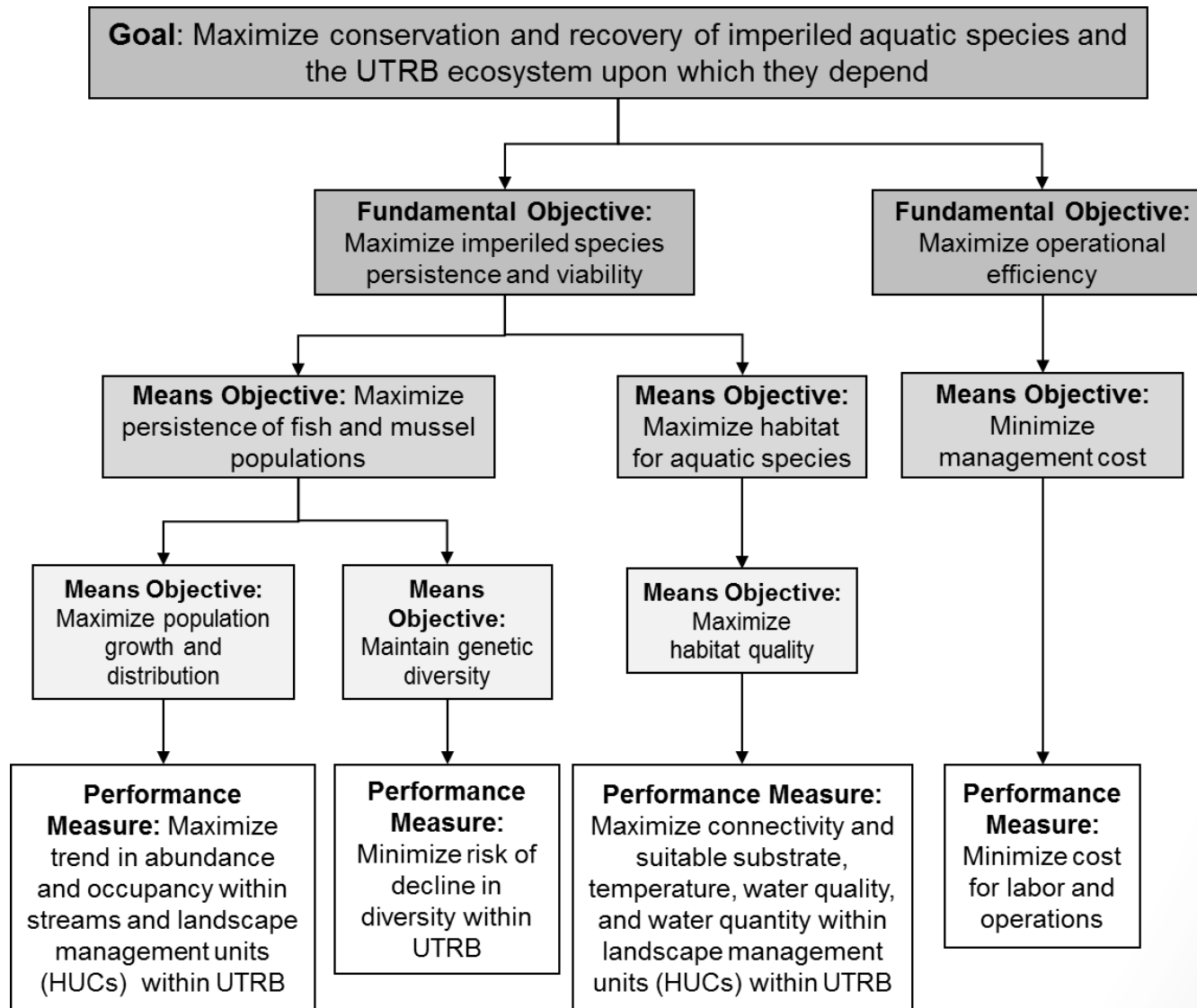
# Structured Decision Making

- Problem decomposition
- Values-focused thinking



Gregory et al. 2012. *Structured Decision Making: A Practical Guide to Environmental Choices*. Wiley-Blackwell

# Objectives and measures



# Alternative approaches

Management Actions		Alternative Approaches		
Type	Task	Status Quo	Habitat Emphasis	Population Emphasis
Population Management	<ul style="list-style-type: none"> <li>• Implement ESA Section 7 &amp; 10</li> <li>• Protect or establish populations</li> <li>• Conduct status assessment</li> <li>• Increase extant populations</li> <li>• Establish new populations</li> <li>• Manage captive populations</li> </ul>	0 (100)	— (85)	+ (159)
Habitat Management	<ul style="list-style-type: none"> <li>• BMPs for habitat mgmt</li> <li>• Land acquisition and easements</li> <li>• Restoration of habitat</li> </ul>	0 (100)	+ (136)	— (82)
Monitoring & Research	<ul style="list-style-type: none"> <li>• Life history</li> <li>• Popn and habitat monitoring</li> <li>• Evaluate and monitor threats</li> <li>• Genetics monitoring &amp; research</li> <li>• Population viability analyses</li> <li>• Evaluate habitat for reintroductions</li> <li>• Propagation and captive management research</li> <li>• Evaluate ecosystem services</li> </ul>	0 (100)	0 (109)	+ (191)
Communication & Partnerships	<ul style="list-style-type: none"> <li>• Outreach</li> <li>• Work with partners and industry</li> <li>• Intra-agency</li> </ul>	0 (100)	+ (169)	+ (131)

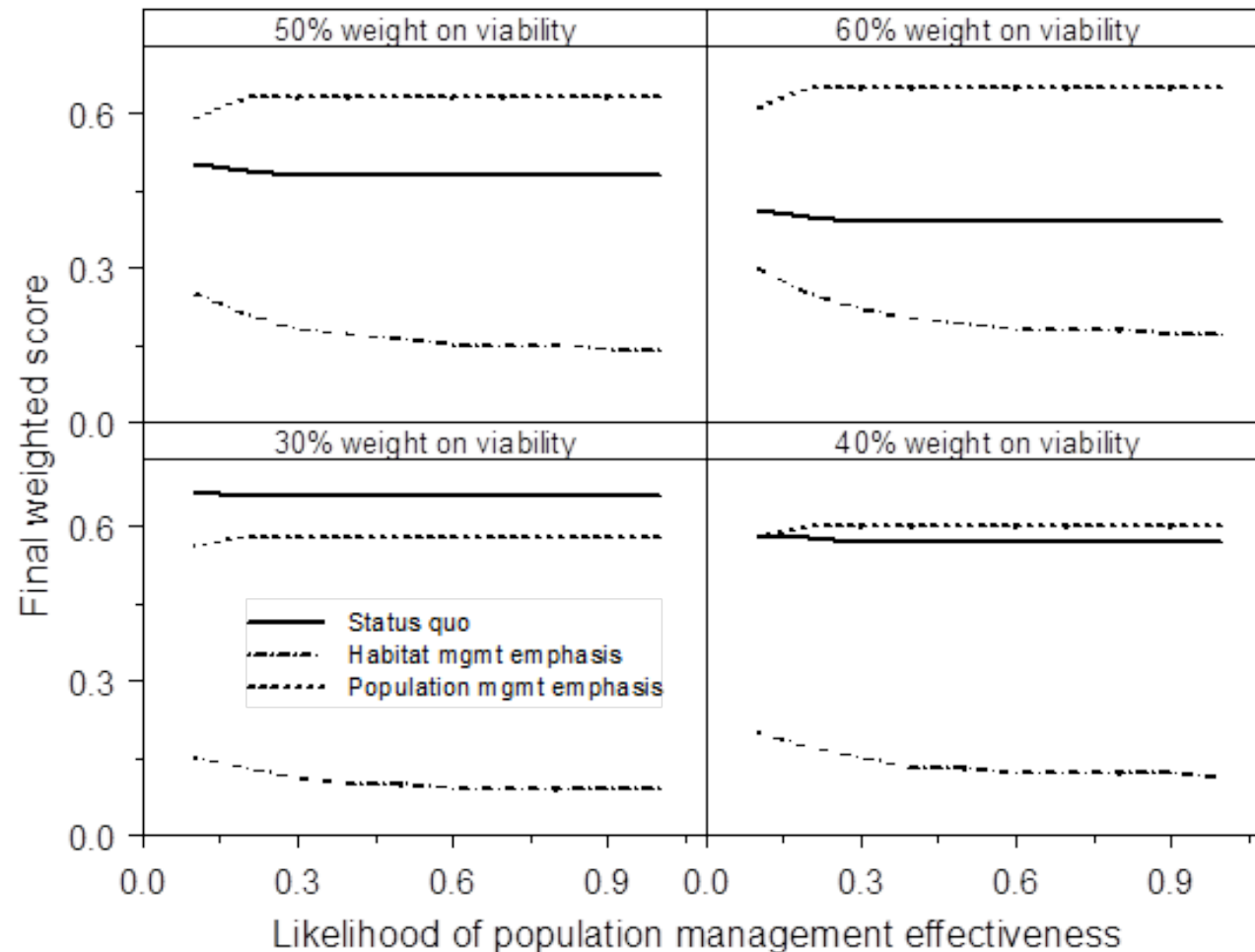
# Estimate consequences

- Existing data provided the species current condition
- Elicited knowledge and judgment from experts in imperiled fish and mussel to project consequences over 20 years
- Species-specific abundance trend and distribution
  - 12-digit HUC for fishes
  - Important stream reaches for mussels
- Habitat quality at 8-digit HUC
- Genetic diversity
- Operational costs
- Scaled up to basin scale for fishes and mussels

# Evaluate trade-offs

Objective	Sub-objective	Direction	Alternative Approaches		
			Status Quo	Habitat Emphasis	Popn Emphasis
Species persistence and viability	Fish abundance trend	Maximize	0.04	0	0.46
	Fish distribution	Maximize	7.83	8	8.92
	Mussel abundance trend	Maximize	-0.13	-0.04	0.58
	Mussel distribution	Maximize	4.09	4.09	7.83
	Genetic diversity	Maximize	-0.17	-0.17	0.52
	Habitat quality	Maximize	2.73	3.34	2.68
Operating costs	Staff	Minimize	9.5	11.5	11.5
	Management costs	Minimize	4.8	5.4	4.7

# Sensitivity analysis



# Population Management Emphasis

Emphasize:

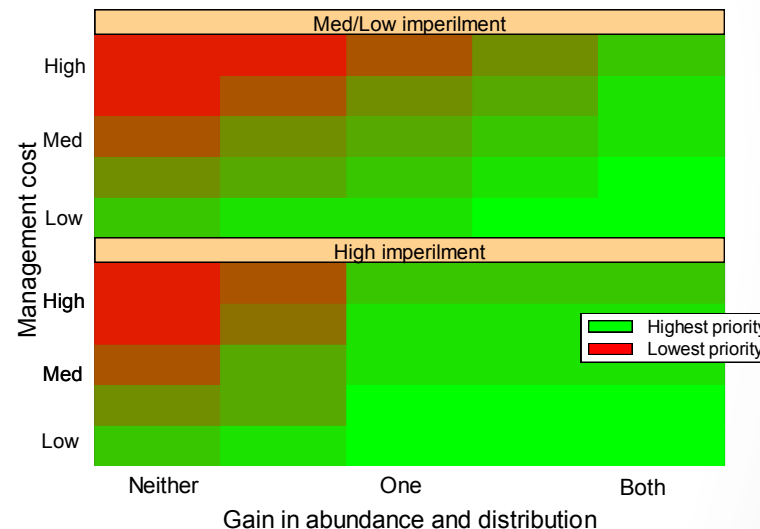
- Implementing ESA Section 7 and 10 regulations
- Using available means to protect or establish populations
- Increasing extant populations
- Establishing new populations
- Developing best management practices for managing stream and riparian habitat
- Evaluating and monitoring threats
- Analyzing population viability
- Evaluating habitat for reintroductions
- Working with partners and industry





# Prioritization: species and watersheds

- Conservation benefits are not likely to be achieved equally among all species and watersheds.
- Prioritize imperiled fish and mussels based on degree of imperilment, expected gain in abundance trend and distribution, and management costs.
- Prioritize watersheds at HUC8 level based on richness of imperiled species and feasibility of implementing habitat management



# Species Prioritization – Imperiled Fishes

Prioritization variables included degree of imperilment, expected conservation benefit from management actions, and management cost accrued over the next 20 years.

Common Name	Degree of Imperilment	Expected Conservation Benefit Relative to Current Status		Management Cost		Priority
		Net Gain in Abundance	Net Gain in Distribution	Cost of Propagation	Cost of Reintroduction	
		Trend				
Marbled darter	High	1.5	0.3	Low	Low	1
Citico darter	High	1.0	0.5	Low	Low	1
Duskytail darter	High	1.0	0.5	Low	Medium	2
Laurel dace	High	1.0	0.0	Medium	Low	2
Pygmy madtom	High	0.5	2.0	Medium	Medium	3
Smoky madtom	High	0.0	1.0	Medium	Medium	3
Spotfin chub	Low	1.0	0.1	Medium	High	4
Yellowfin madtom	Medium	0.0	0.1	Low	Medium	4
Sicklefin redhorse	Low	0.5	0.0	High	High	10
Chucky madtom	High	0.0	0.0	High	Medium	12
Slender chub	High	0.0	0.0	High	High	15
Snail darter	Low	0.0	0.0	High	Medium to High	15

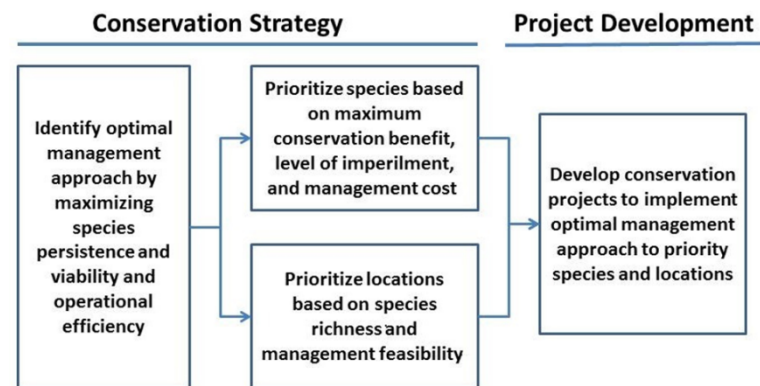
# Watershed Prioritization

Species richness and management feasibility values were standardized and weighted to provide weighted average scores for prioritization.

8-digit HUC	Species Richness	Standardized Richness	Feasibility	Standardized Feasibility	Weighted Average
Upper Clinch	24	1.00	2.50	0.7	0.90
Powell	16	0.65	2.33	0.6	0.65
Nolichucky	7	0.26	2.67	0.8	0.47
Upper Little Tennessee	4	0.13	3.00	1.0	0.45
Hiwassee	7	0.26	2.40	0.7	0.41
Tuckasegee	2	0.04	3.00	1.0	0.40
North Fork Holston	6	0.22	2.33	0.6	0.37
Lower Little Tennessee	6	0.22	2.33	0.6	0.37
Emory	3	0.09	2.60	0.8	0.35
Squatchie	3	0.09	2.40	0.7	0.31
Upper French Broad	1	0.00	2.50	0.7	0.27
Pigeon	1	0.00	2.50	0.7	0.27
South Fork Holston	4	0.13	2.00	0.5	0.25
Lower French Broad	4	0.13	2.00	0.5	0.25
Holston	5	0.17	1.67	0.3	0.21
Watts Bar Lake	6	0.22	1.40	0.1	0.18
Middle Tennessee-Chickamauga	6	0.22	1.25	0.0	0.15
Ocoee	1	0.00	1.80	0.3	0.13
Lower Clinch	1	0.00	1.17	0.0	0.00

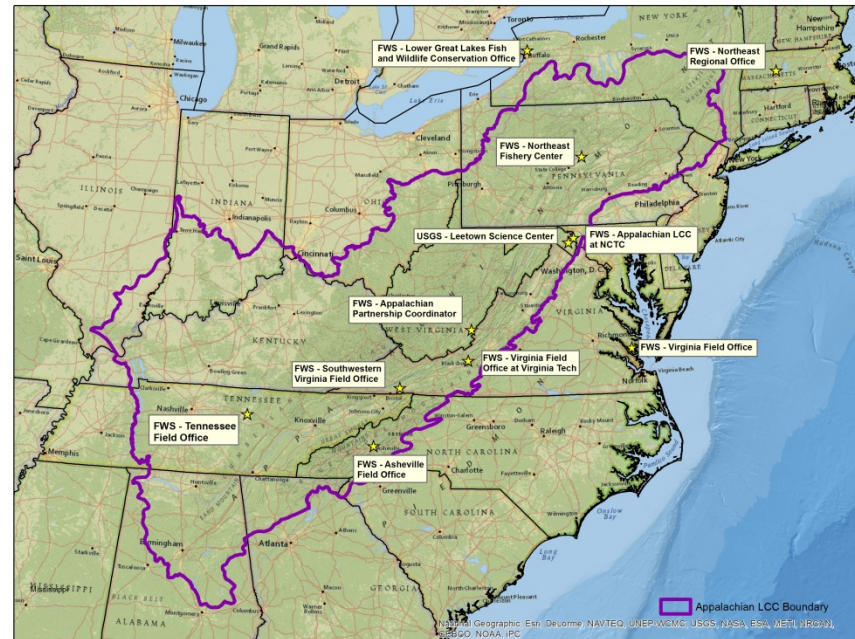
# Overview

- Conservation Strategy
  - Emphasize population management,
  - Prioritize imperiled fish and mussel species for focused population management, and
  - Prioritize watersheds for focused habitat management.
- Guides project development. Not a rigid management prescription.
- Flexibility will help FWS better integrate its efforts internally and with those of partners.
- Monitor effectiveness, periodic review, and adapt.



# Strategy Team Members

- Meredith Bartron, FWS, Northeast Fishery Center
- Rick Bennett, FWS, Northeast Regional Office
- Jean Brennan, FWS, Appalachian Landscape Conservation Cooperative
- Bob Butler, FWS, Asheville Field Office
- Stephanie Chance, FWS, Tennessee Field Office
- Brian Evans, FWS, Southwestern Virginia Field Office
- Catherine Gatenby, FWS, Lower Great Lakes Fish and Wildlife Conservation Office
- Shane Hanlon, FWS, Southwestern Virginia Field Office
- Roberta Hylton, FWS, Southwestern Virginia
- Mary Jennings, FWS, Tennessee Field Office
- Jess Jones, FWS, Virginia Field Office
- Callie McMunigal, FWS, Appalachian Partnership Coordinator
- Martin Miller, FWS, Northeast Regional Office
- Mary Parkin, FWS, Northeast Regional Office
- Cindy Schulz, FWS, Virginia Ecological Services
- Peggy Shute, FWS, Tennessee Field Office
- Dave Smith, USGS, Leetown Science Center
- Kurt Snider, FWS, Tennessee Field Office



# Conservation Partner Review of Draft Strategy

- Conservation Fisheries, Incorporated
- Land Trust of the Little Tennessee
- North Carolina Department of Environment and Natural Resources
- North Carolina Wildlife Resources Commission
- Tennessee Department of Environment and Conservation
- Tennessee Valley Authority
- Tennessee Wildlife Resources Agency
- The Nature Conservancy – NC
- The Nature Conservancy – TN
- The Nature Conservancy – VA
- Virginia Department of Game and Inland Fisheries
- Virginia Natural Heritage Program



# Thank You. Questions.



Photo credit: Conservation Fisheries, Inc., Knoxville, TN

“There can be no purpose more inspiring than to begin the age of restoration,  
re-weaving the wondrous diversity of life that still surrounds us”

Edward O. Wilson  
The Diversity of Life

**A pdf copy of the plan “Imperiled Aquatic Species Conservation Strategy for the Upper Tennessee River Basin” can be obtained from the Virginia Field Office website homepage: <http://www.fws.gov/northeast/virginiafield/>**