Assessing Trade-offs between Crop Production and Ecological Services: The Calapooia Basin

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Team Members

- **Co-principal investigators**
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- **Agency Collaborators**
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- **Research Associates**
  - Randall Colvin, Bill Gerth, Nick Baker

Presentation Outline

- Project Goals
- Study Basin Overview
- Aquatic Indicators and Linkages
- Economic Modeling

Project Goals

1. To quantify linkages between conservation practices and biophysical responses
   - Using water quality and biological indicators
2. To develop a model to assess tradeoffs between agricultural practices that maximize economic benefits and conservation actions that sustain or improve ecosystem services.

Examples of Conservation Practices

- Grass covered channels
- Timely fertilizer applications
- No-till seeding of crops
- Maintain existing riparian vegetation
- Forest riparian buffers
- Wildlife buffer plantings

Goal 1) Conservation Practices Effect on:

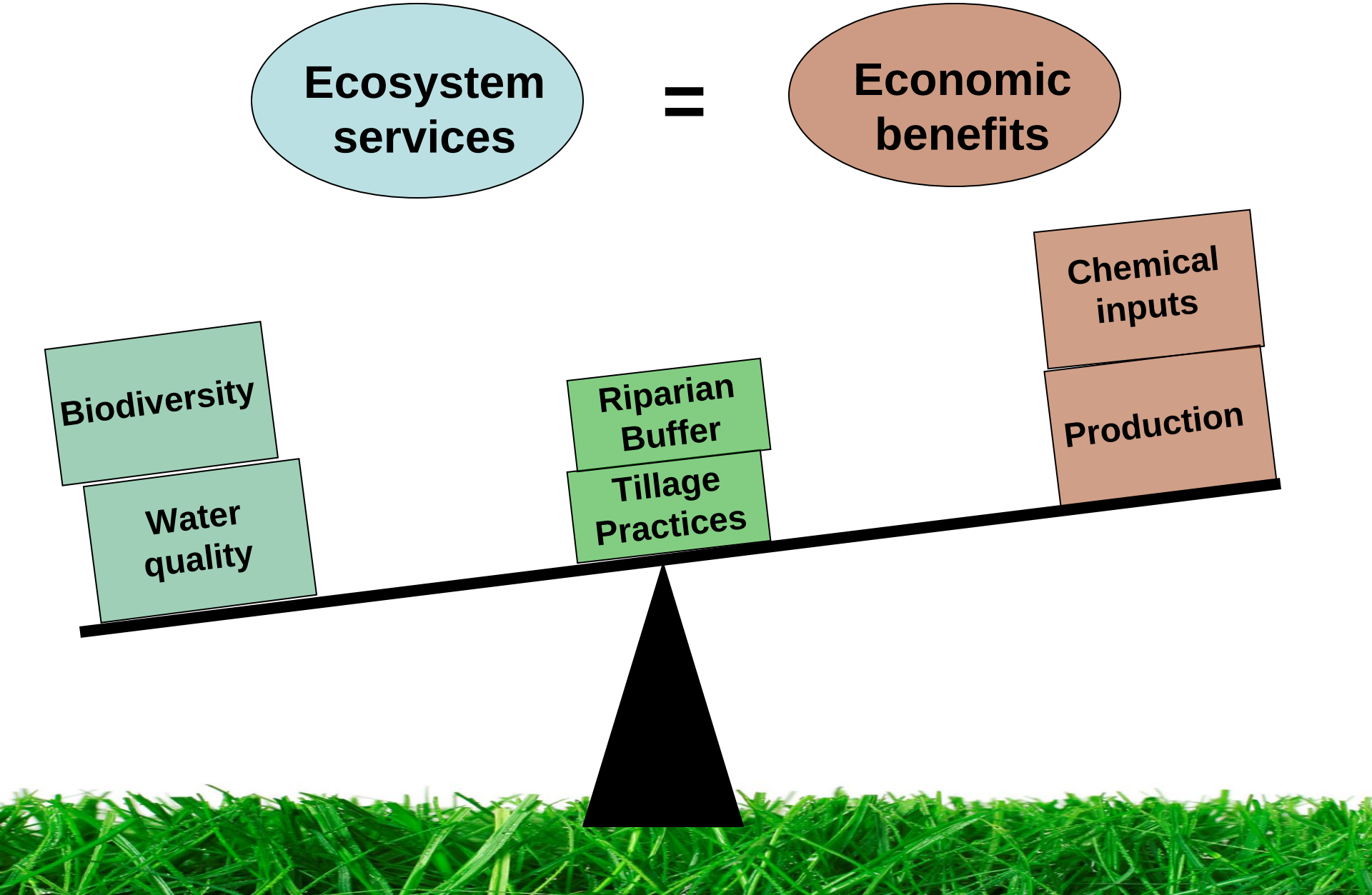
Biological Indicators:

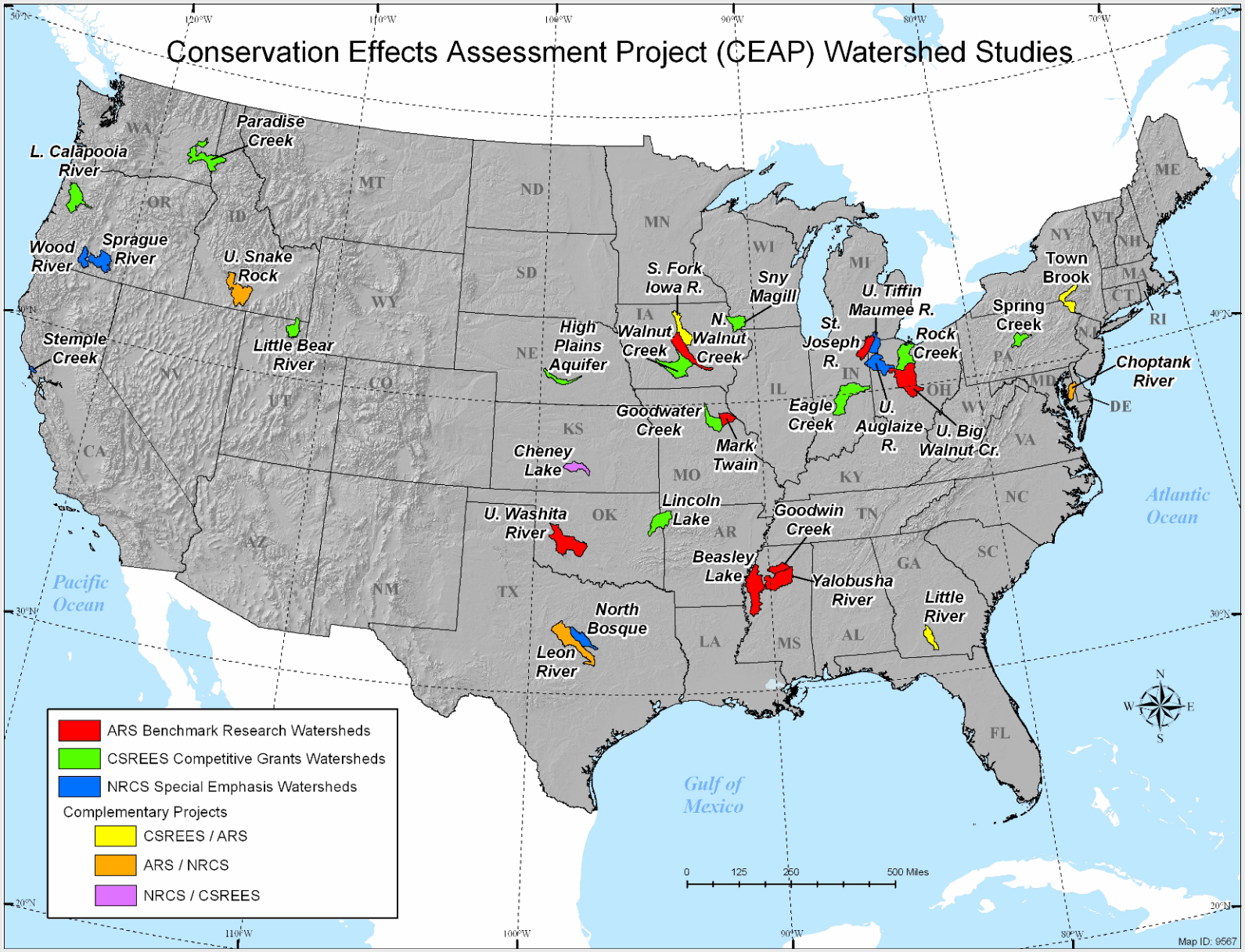
- **Amphibians**
- **Fish**
- **Macroinvertebrates**
- **Birds**

Water Quality:

- **N, P, turbidity, pH, nitrates, temperature, conductivity, TSS**

Goal 2) Model: Economic and Ecological Trade-offs




Conservation Effects Assessment Project (CEAP) Watershed Studies
Paradise Creek
L. Calapooia River
Wood River
Sprague River
U. Snake Rock
Stemple Creek
Little Bear River
S. Fork Iowa R.
Sny Magill
N. Walnut Creek
Walnut Creek
High Plains Aquifer
U. Tiffin
Maumee R.
St. Joseph R.
Rock Creek
Town Brook
Spring Creek
Choptank River
Eagle Creek
U. Auglaize R.
U. Big Walnut Cr.
Goodwater Creek
Mark Twain
Cheney Lake
Lincoln Lake
U. Washita River
Goodwin Creek
Beasley Lake
Yalobusha River
Little River
North Bosque
Leon River
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
WA
OR
ID
MT
ND
MN
WI
MI
NY
VT
NH
ME
MA
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NM
TX
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AR
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SC
GA
AL
MS
LA
FL
0 125 250 500 Miles
ARS Benchmark Research Watersheds
CSREES Competitive Grants Watersheds
NRCS Special Emphasis Watersheds
Complementary Projects
CSREES / ARS
ARS / NRCS
NRCS / CSREES
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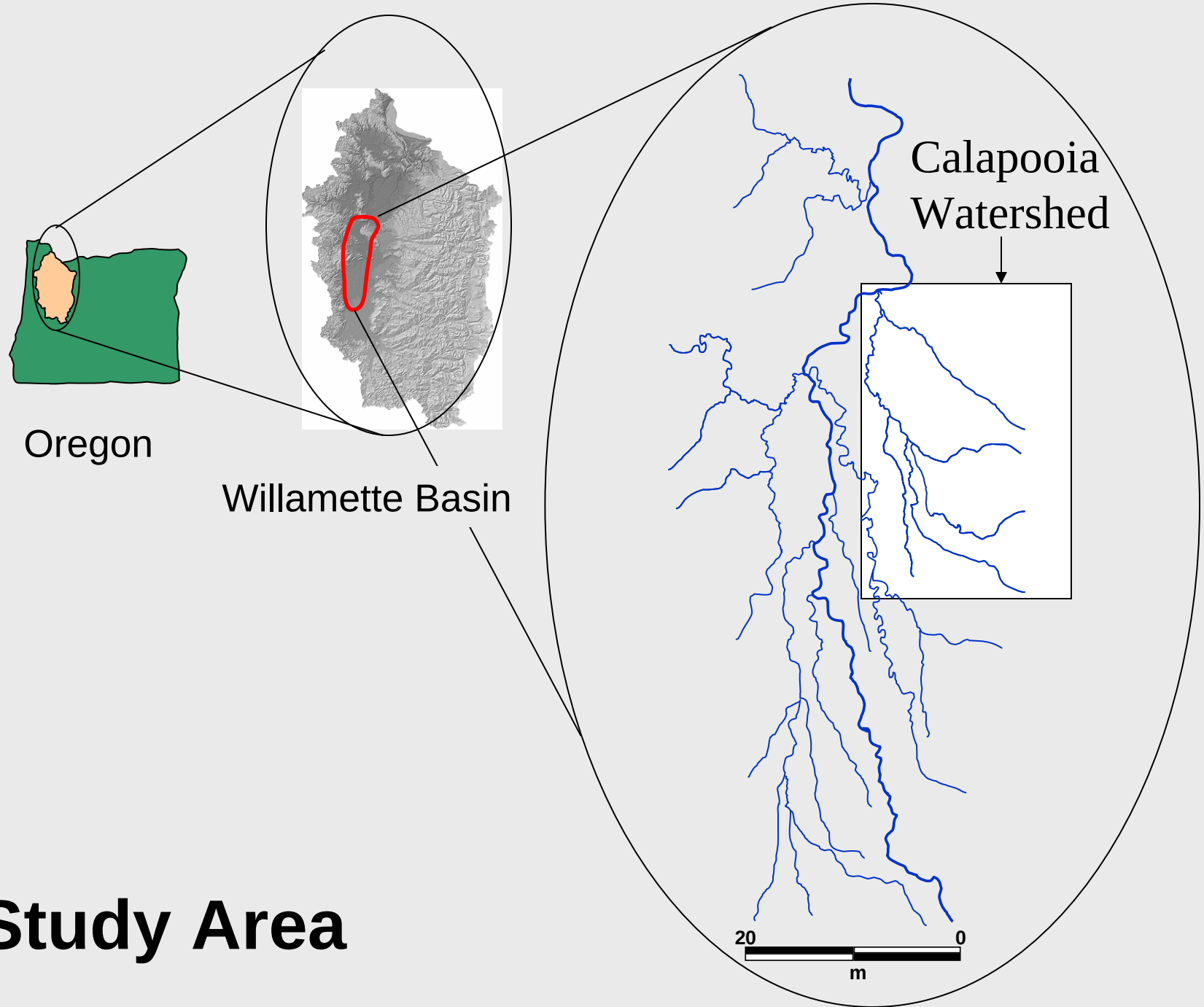
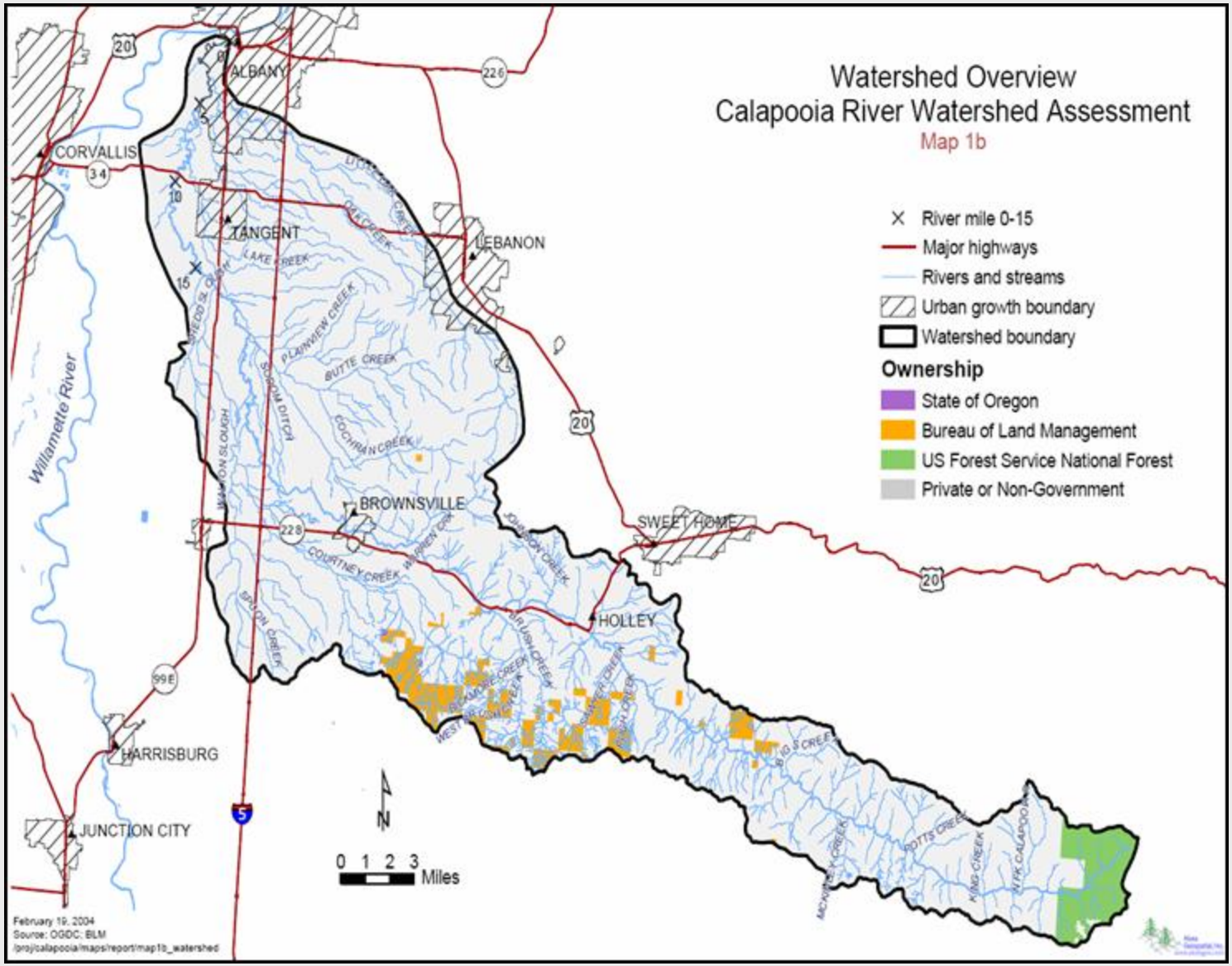
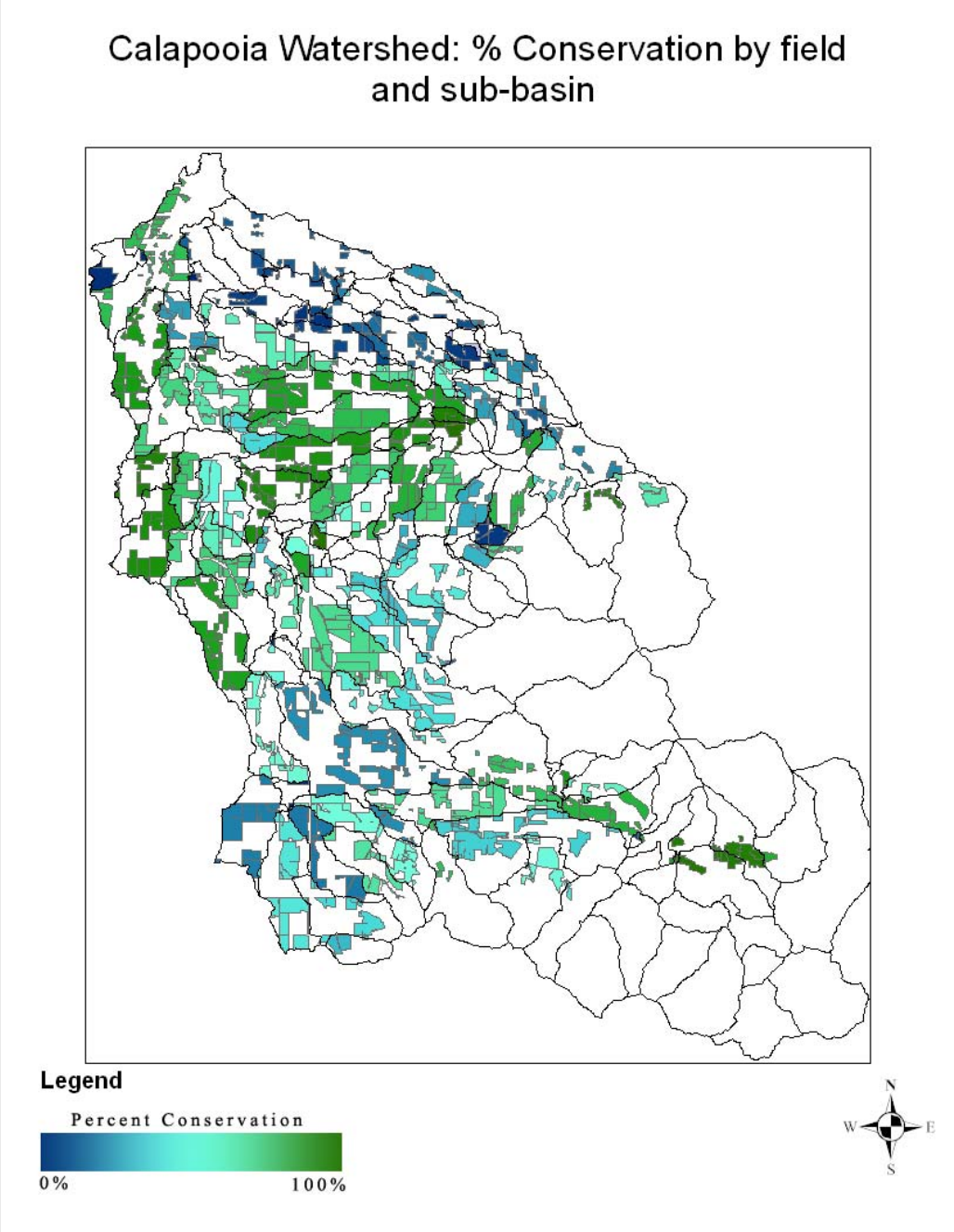


Study Area

Calapooia Watershed: Mostly Privately Owned



Conservation Gradient in the Calapooia



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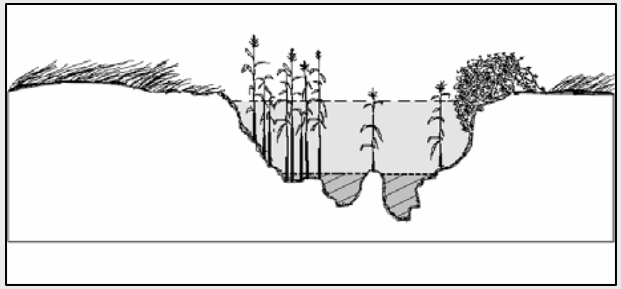
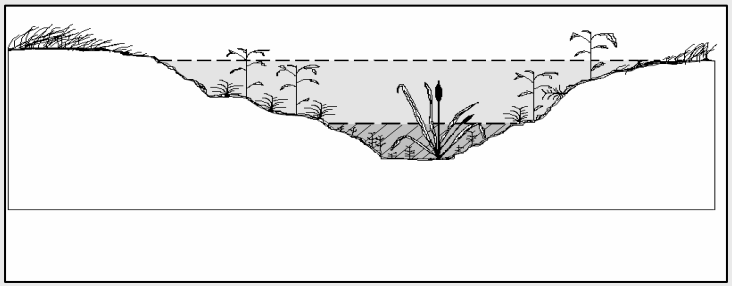
Atypical Intermittent Streams

Flow for 6-8 months

Intermittent ag-watercourses: channel type & discharge





Fish Studys

1. Determine if fish occupy intermittent ag-water-courses **(2002-2004)**

2. Identify fish species in these habitats **(2002-2004)**

3. Examine fish responses to physical habitat variables (local and watershed scale) **(2002-2005)**

4. Identify type and source of fish food resources **(2003-2005)**

5. Assess linkages between ag-conservation practices and invertebrate, fish, amphibian and bird responses**(2006-2009)**

Fish Sampling Gear

Minnowtraps

Hoop-nets

Backpack Electrofisher

Species Found in Intermittent Ag-Watercourses

Native Fish

- Threespine Stickleback
- Redside Shiner
- Reticulate/Riffle Sculpin
- Speckled Dace
- Oregon Chub **
- Northern Pikeminnow
- Largescale Sucker (juv)
- Cutthroat Trout
- Rainbow Trout
- Chinook Salmon (juv) **

Native Amphibians

- *Roughskin Newt*
- *Longtoed Salamander*
- *Pacific Treefrog*
- *Redlegged Frog* **

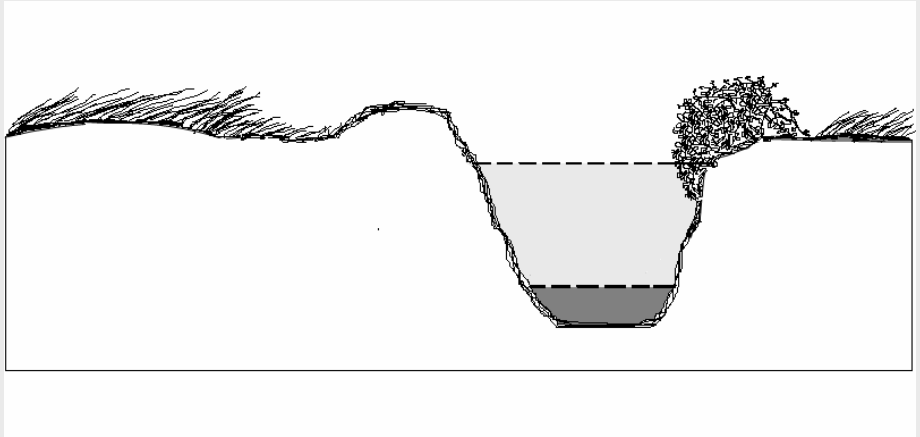
Exotic Species
(<1% catch)

- Gambusia
- Goldfish
- Bluegill
- Yellow Bullhead
- *Bullfrog*

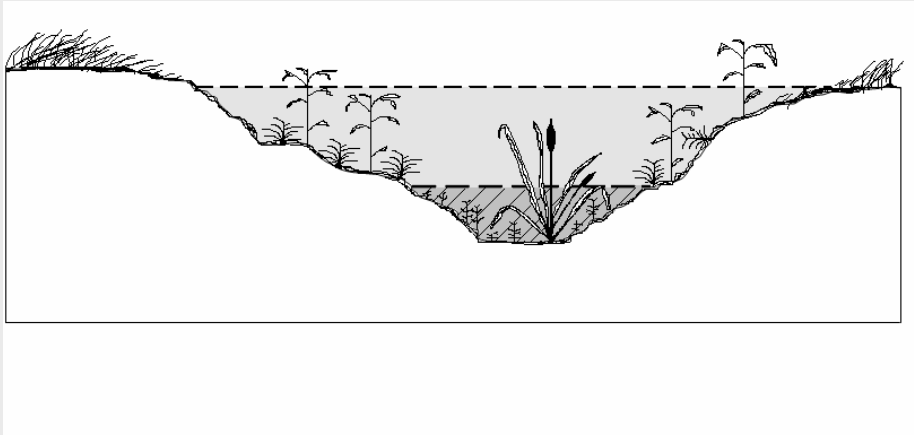
14 Fish Species
(10 Native)

5 Amphibian Species
(4 Native)

Non-Grass Covered

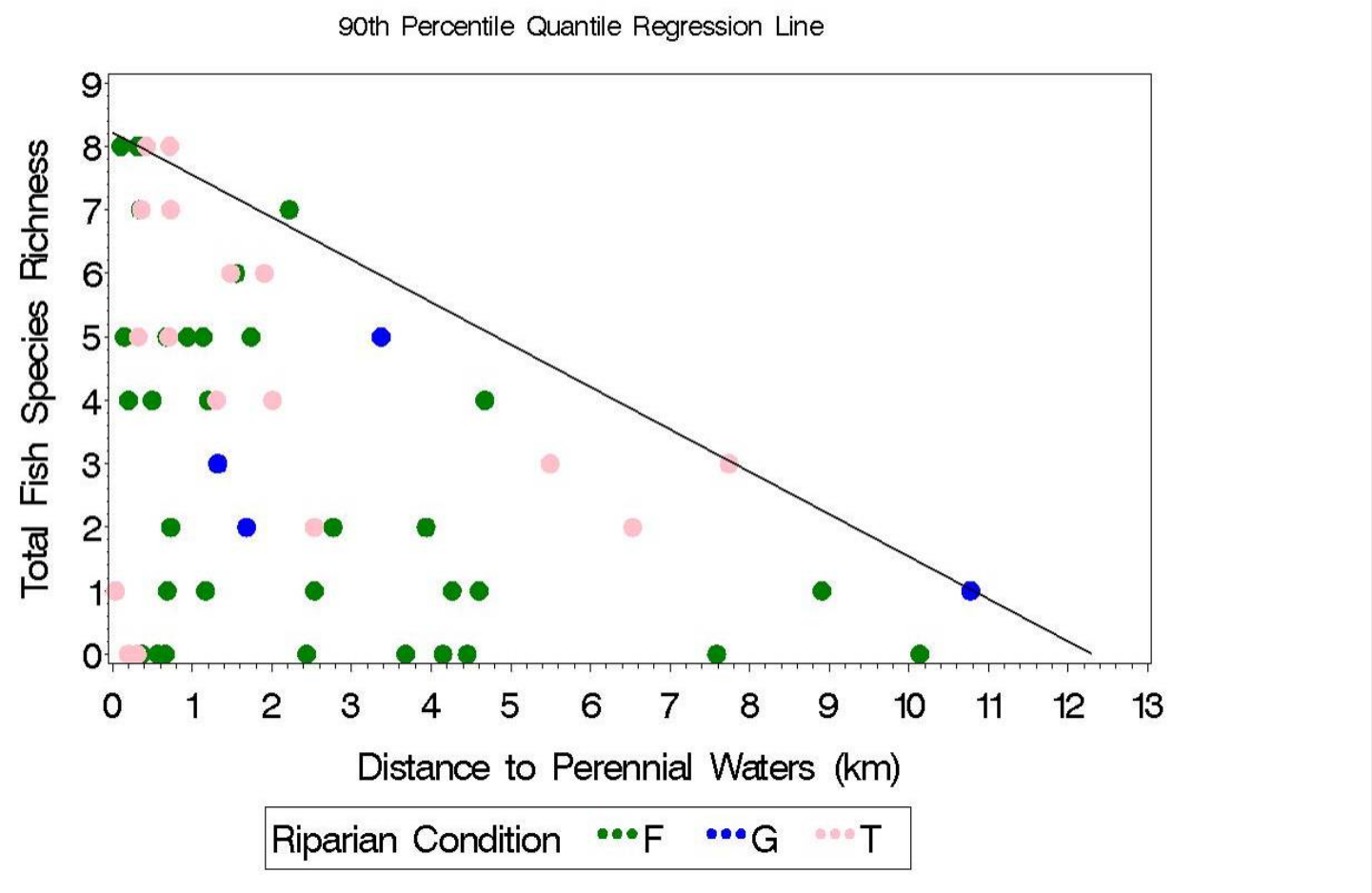


Grass Covered



Distance to Perennial Water

Fish species declined as distance to perennial water increased



Adjustment for Natural Gradients

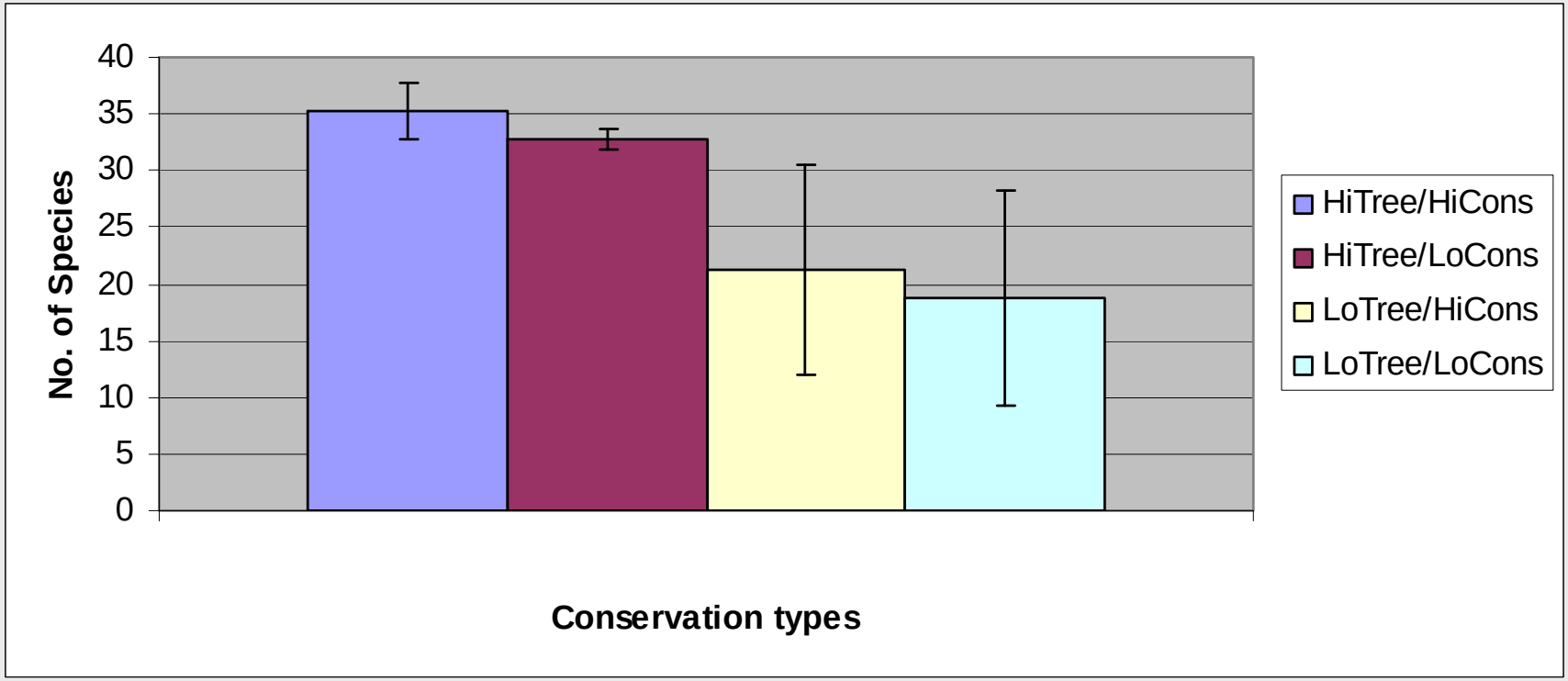
- **We used quantile regression to fit upper quantile regressions to the metric-distance to perennial water plot**
- **For each site, calculate the metric residual from the quantile regression line**
- **Residuals are distance-corrected metric scores representing site biological condition after adjusting for the distance to perennial water natural gradient**

Biological Condition Metrics to be Used

Metric	Correction
<u>Fish Metrics</u> **Native species richness**	**90th percentile quantile regression (QR)**
Shannon Diversity	**90th percentile QR**
CPUE-electrofish+seine	**Negative exponential, 80th percentile QR**
CPUE-minnow trap	**Negative exponential, 90th percentile QR**
<u>Macroinvertebrates</u> **Total Richness**	**90th percentile quantile regression**
Hilsenhoff Biotic Index	**No correction needed**
% Non-insects	**2/π*arcsine(square root) transform**
Total Density	**No correction needed**

Bird Assemblage Results

Preliminary patterns of bird species richness among four categories of conservation practice representation on square kilometer areas in the lower Calapooia Basin, Oregon.



Preliminary Conclusions for Biological Indicators

- Strong relationships found with invertebrate density & tolerant taxa richness with vegetated substrate

- Fish abundance and richness were highly correlated with distance to perennial water.

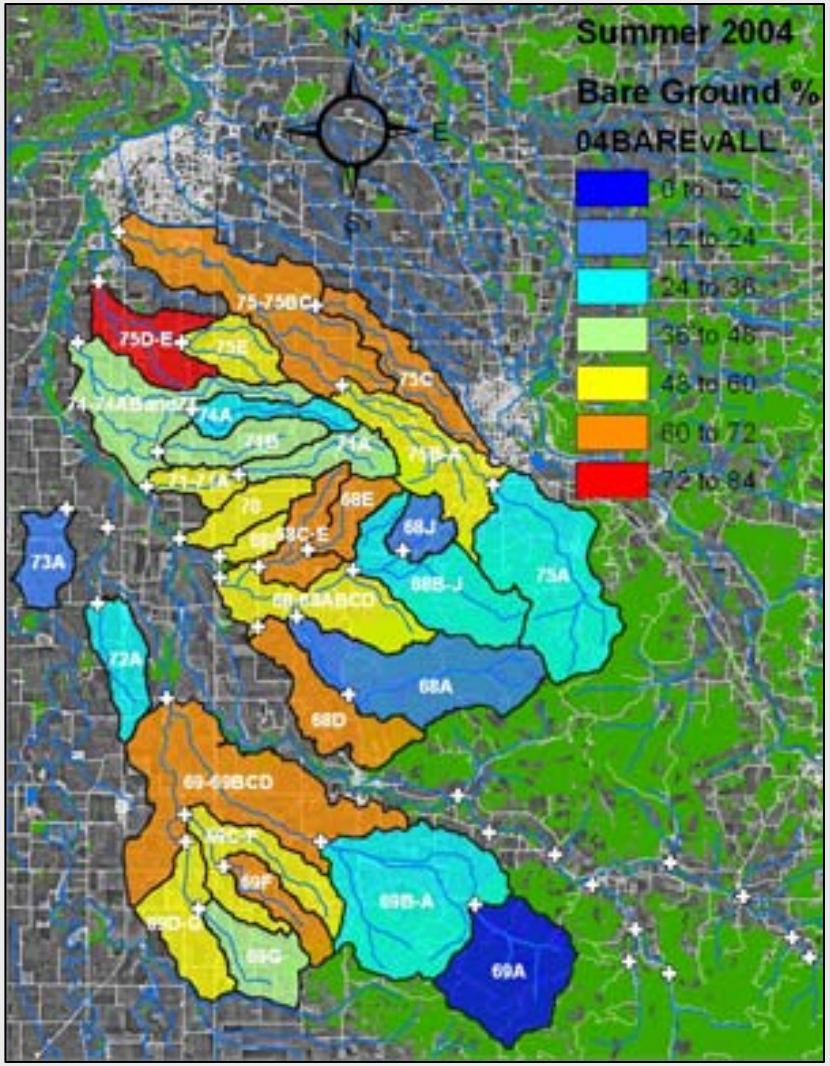
- Bird density and richness are strongly related to wooded areas

Economic Modeling

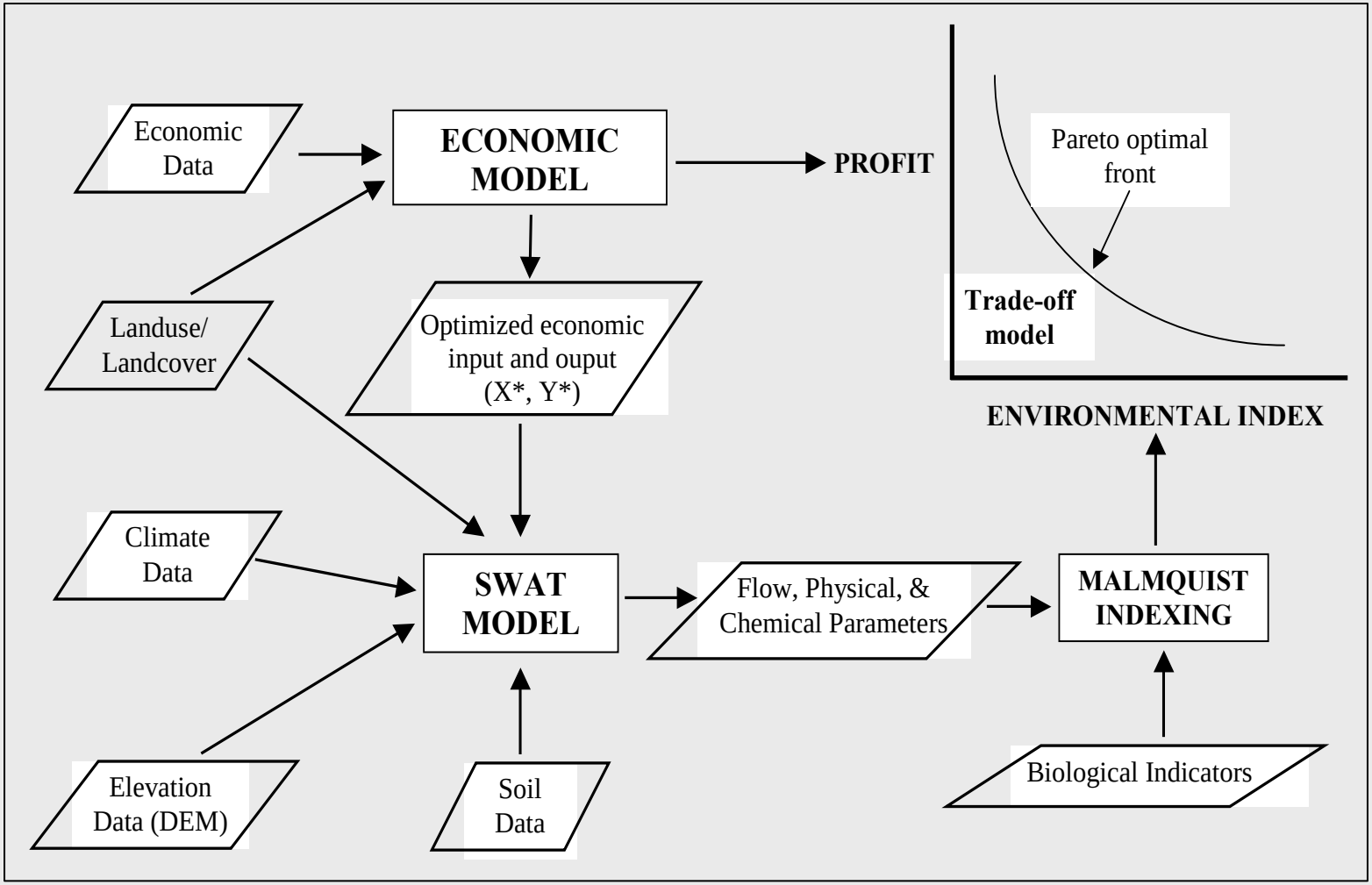
- Develop models to evaluate tradeoffs between agricultural practices and conservation actions
- Optimize economics of conservation practices with environmental indicators

SWAT Model

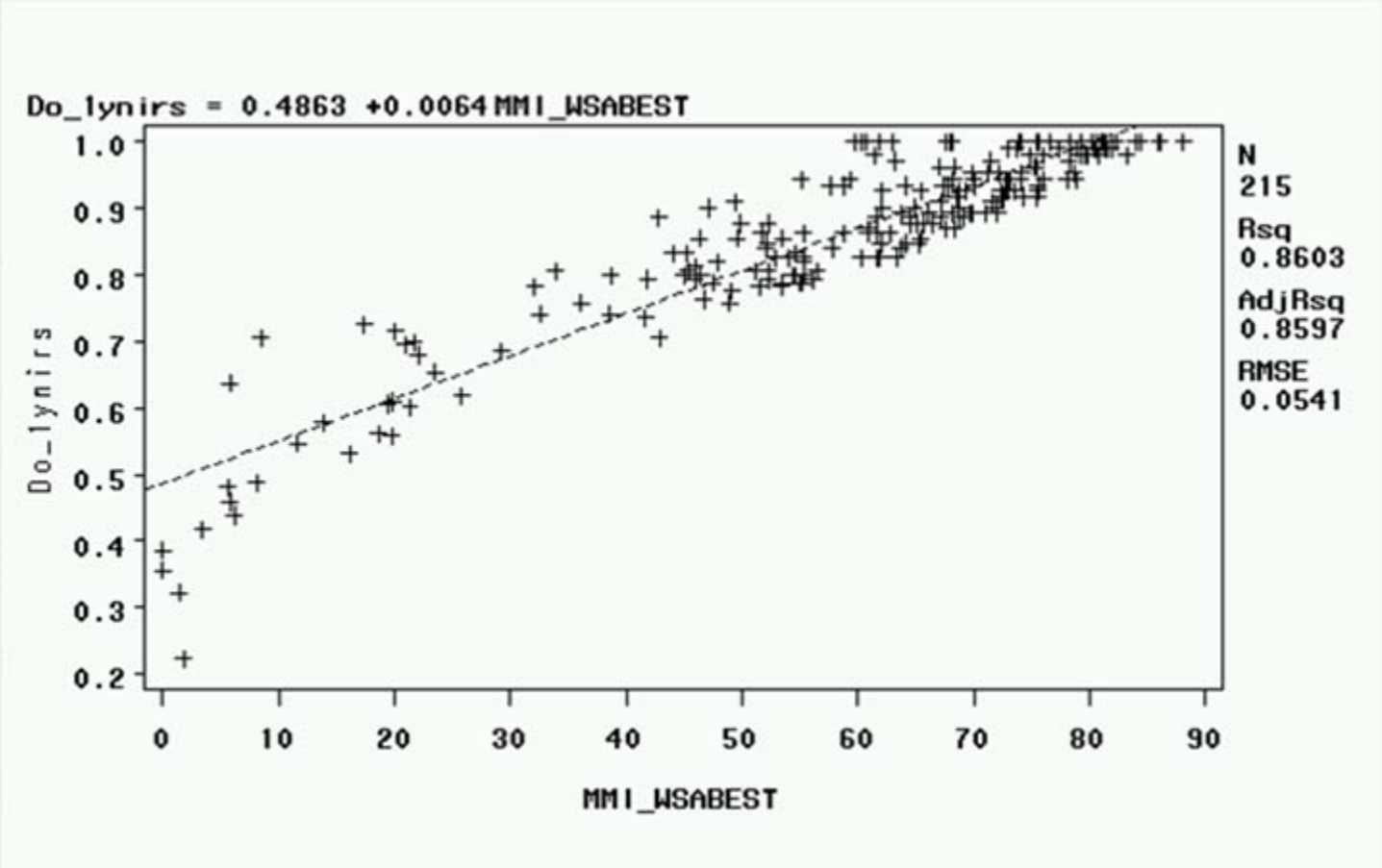
- Use of SWAT model (Soil and Water Assessment Tool) to predict long-term impacts of land use on water, sediment and agro-chemical yields for sub-watersheds with different proportions of land under conservation practices



The integrated economic-biophysical watershed model



Comparison of Benthic Multimetric Index of Biotic Integrity to Data Envelopment Analysis (DEA) Index



From EPA EMAP Data in Northern Appalachians

What’s Done

- Aquatic Data Collected
  - Validated databases
  - Indicators selected
  - Adjusted for natural gradients
  - First year of amphibian data collected
- SWAT Model Ready
- Economic model, DEA Ready

Plans for Year 2

- Amphibian data collection and analysis
- Reference site sampling
- Quantify SWAT-biota linkages for economic modeling
- Get all models working together
- Turn crank and optimize economics with conservation practices