# Farmers' Use of Nutrient Management: Lessons From Watershed Case Studies

Deanna L. Osmond,* Dana L. K. Hoag, Al E. Luloff, Donald W. Meals, and Kathy Neas

MATT LUDINGTON

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# Overview

- 2 Case studies examined regarding nutrient management on agricultural lands
  - (1)Synthesis of National Institute of Food and Agriculture (NIFA) and Conservation Effects Assessment Project (CEAP) joint project
  - (2)Field studies from 2 nutrient-impaired river basins, and 2 nutrient-impaired watersheds in North Carolina
    - Neuse, Tar-Pamlico, Jordan Lake, and Lake Falls Basins
- Both approaches looked into:
  - The need for nutrient management plans
  - Which (if any) were already in use
  - To what extent farmers followed these plans
- Previous studies explored physical attributes of farms as to why nutrient management plans succeeded or failed
  - Osmond et. al. explore farmer decision-making

# Acronyms

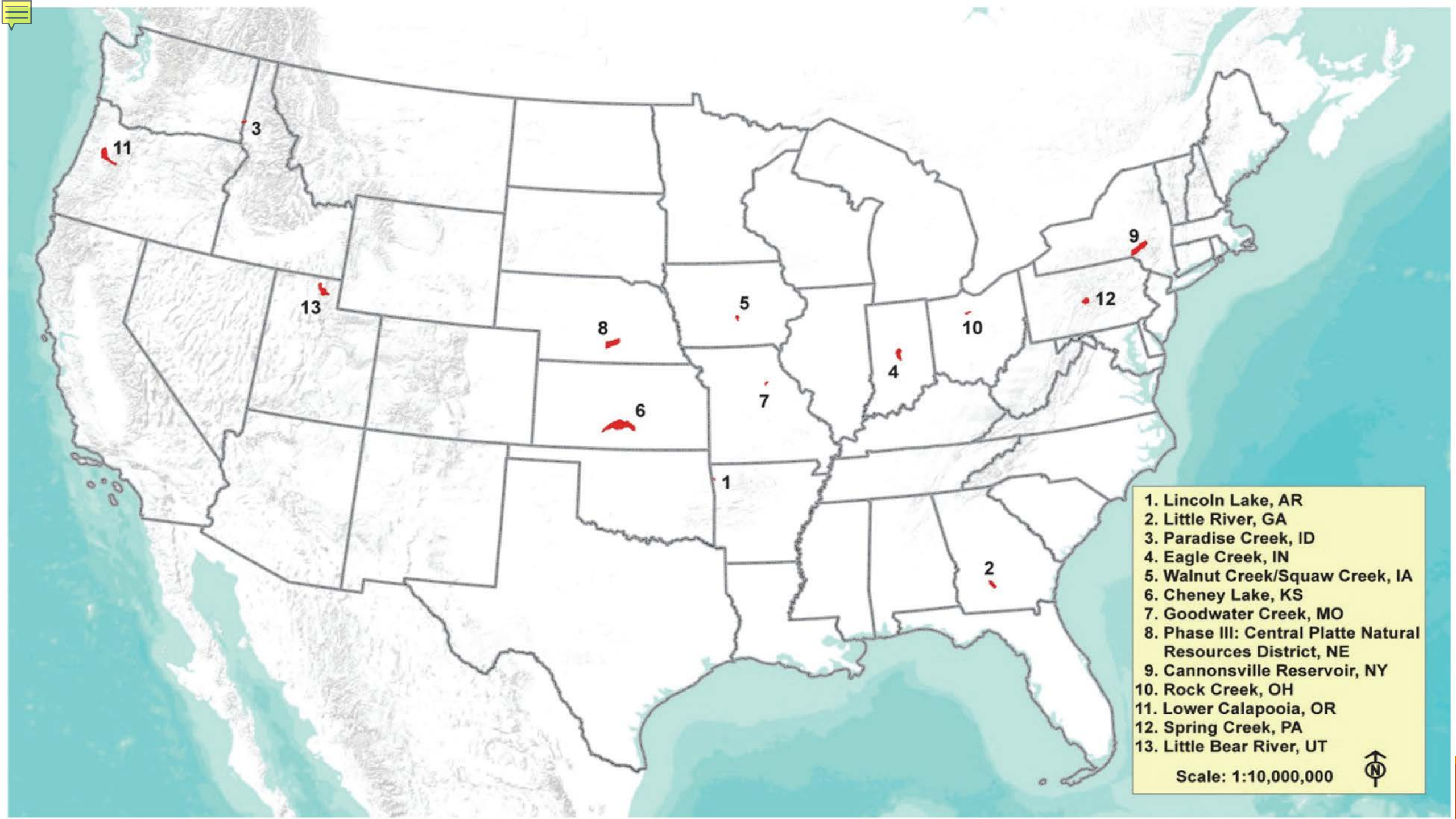
- NIFA - National Institute of Food and Agriculture
- CEAP - Conservation Effects Assessment Project
- NLEW – Nitrogen Loss Estimation Worksheet
- RYE – Realistic Yield Expectations
- STP – Soil Test Phosphorus
- RUSLE - Revised Universal Soil Loss Equation

# NIFA/CEAP Joint Project

- USDA implemented CEAP in 2002
  - Aimed at determining effectiveness of conservation practices at the watershed level
- Funded 13 watershed scale research sites
- Minimum of 5 years water quality and land use data to be applicable
- 4 research goals
  - Relationship between conservation practices and water quality change
  - Relationship between conservation practices to each other and water quality change
  - Optimal placement of practices in the watershed to achieve water quality goals
  - ***What socioeconomic factors increased/decreased adoption of conservation practices?***
    - Osmond et. al. focused on this question

# NIFA/CEAP Joint Project

- After results of 13 studies, “semi-structured” surveys conducted
  - Participants included farmers, community leaders, agency personnel, citizens, project personnel, others knowledgeable about CEAP projects or water quality in general
  - Questioned on water quality concerns, conservation practices before program, conservation practices added
- Results of interviews used in combination with overall study results to draw links between conservation practices being implemented, and background factors
- Internal validity assessments performed, where disagreements arose reassessments undertaken to eliminate ambiguity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1. Lincoln Lake, AR
2. Little River, GA
3. Paradise Creek, ID
4. Eagle Creek, IN
5. Walnut Creek/Squaw Creek, IA
6. Cheney Lake, KS
7. Goodwater Creek, MO
8. Phase III: Central Platte Natural Resources District, NE
9. Cannonsville Reservoir, NY
10. Rock Creek, OH
11. Lower Calapooia, OR
12. Spring Creek, PA
13. Little Bear River, UT
Scale: 1:10,000,000
N

# NIFA/CEAP Project Results

- Found that farmers understood the water quality problem as well as the federal agency, university, and water conservation district/watershed association personnel
- Decision to implement or disregard nutrient management plans related to other factors
  - Economic factors important, but could be superseded
  - Level of management (additional work)
    - Often mentioned by farmers interviewed
    - Time savings cited as reason *for* conservation tillage
  - Yield expectations
  - Threat of regulation
  - Visibility of problem (Sediment vs. Nutrient)
- List of factors shows priority on efficiency of farm, and relationships

Summary of factors found to increase or decrease adoption of conservation practices

| Category | Increase adoption | Decrease adoption |
|---|---|---|
| Farm business | | |
| Profit | practice also improves profits | reduces profits |
| Yield | practice increases crop yields | practice decreases yields |
| Production cost | lowers cropping costs | increases cropping costs |
| Conservation cost | | practice is expensive to install and maintain |
| Other | government financial incentives, cost share | lost farm land, time, attitude that farming is a business, high commodity prices, lack equipment |
| Conservation efficacy | | |
| On farm | can see the result on-farm (e.g. reduced erosion) | |
| Off farm | can see off-site results | don't see off-farm consequences |
| Other | | difficult to install and maintain |
| Stewardship | belief that conservation is doing the right thing | water quality problems are someone else's fault/problem, lack knowledge/awareness of cons. practices or assistance, concervation not acceptable to farming community |
| Government/NGO‡ | | |
| Relationship | personal attention (time) from experts (e.g., NRCS, Extension); networking and feedback, trust (knowledge, local) | lack of trust |
| Approach | bottom up, not top down, not being told | top down, prescribed, inflexible practice recommendations/ requirements, lost control of property/decisions, paperwork |
| Other | | regulations |

# Management Plan Failures

- Individual Results give better insight
- Most disliked plans
  - Riparian buffers – removed potentially productive land from use
  - Nutrient management – Often quickly abandoned, or farmers simply didn't sign up
    - Lack of trust between farmers and research/universities, "Your location vs. my actual farm"
    - Optimism for upcoming year – desire for N levels to be high enough to support an extraordinary growing season
- Expectation vs. reality – Education and Outreach Programs
  - Agency official reported outreach programs a huge success, with high demand for nutrient management seminars
  - Farmer reported the opposite, saying participants still wary of information even if data is present
- Technological Improvements mistaken for management plan success
  - Nebraska site found lowered ground N levels, later found fertilizer rates steady but new irrigation methods in place

# NIFA/CEAP Project Success

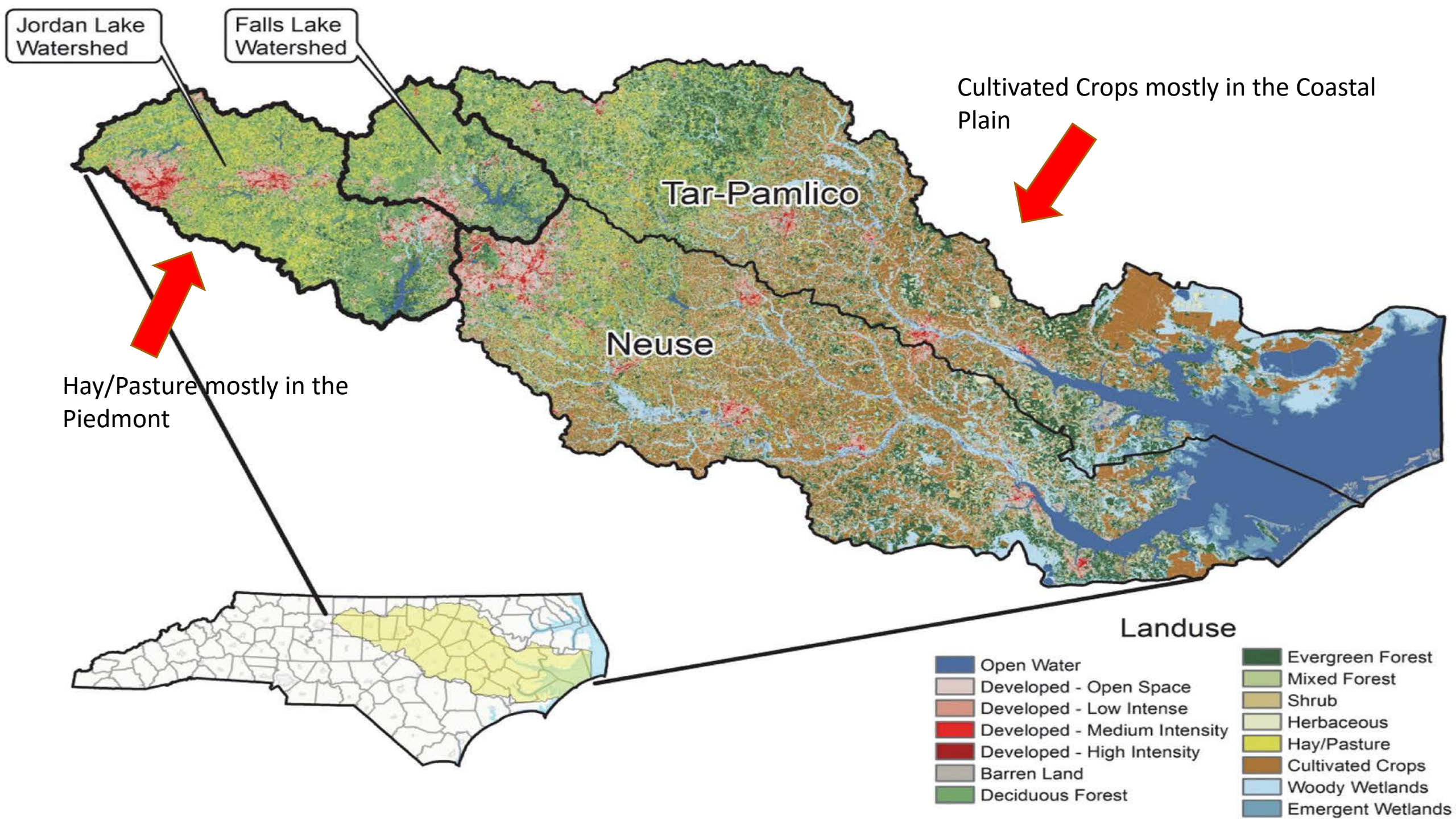
- 2 of the 13 sites showed wide nutrient management plan adoption
- Arkansas
  - Focus on cattle pastures
  - Regulatory pressures brought into play
    - Adoption rates still low
  - Dedicated extension agent hired to meet farmers and gain their trust, adoption rates began climbing
- New York
  - Drinking water comes from upstate NY(Catskills)
    - City pays for conservation management throughout the region, focused on nutrient management
  - Management plans reviewed every 3 years
  - Farmers track nutrient/manure application and yearly apply for reimbursement
  - Successful once nutrient plans were simplified, and financial resources offered as compensation
- Unintentional changes occurred as tilling and technological advances implemented – timing, placement, and rate of nutrient placement alters runoff levels

# North Carolina Impaired Basin Study

- 18 year study aimed at nutrient-impaired river or lake basins to better determine agricultural activities within these basins
  - Focused on whether farmers were following recommendations of management plans or research, or applying based on outside advice/no additional input
- Models used to select for heavy agricultural regions, and exclude urban areas
- Farmers in selected regions (each contained between 1- >30 fields) interviewed, and farms surveyed for physical aspects, conservation practices, and/or water control
  - Specific attention paid to nutrient levels in soil testing, and fertilizer/nutrient application practices

# RUSLE/NLEW

- Revised Universal Soil Loss Equation
  - Allows for calculation of soil erosion as well as appropriate N rates for various crop types
- Nitrogen Loss Estimation Worksheet
  - Used to compare farmer-applied N rates with state agency recommendations
  - Determines farmer use of Nitrogen
    - Accounted poorly to some extent for non-homogeneous locations and crop ratios, but gave an overall understanding of results
- Note: Osmond et. al. recognized the difficulty for predicting N requirements with differing crop and yearly specifics, but submit that it is necessary for reducing N losses
  - North Carolina uses a Realistic Yield Expectation (RYE) to determine levels, based on a best 3 out of 5 years approach, for each crop by soil series. Crop N rates determined by the Interagency Nutrient Management committee.


Jordan Lake Watershed
Falls Lake Watershed
Cultivated Crops mostly in the Coastal Plain
Tar-Pamlico
Neuse
Hay/Pasture mostly in the Piedmont
Landuse
Open Water
Developed - Open Space
Developed - Low Intense
Developed - Medium Intensity
Developed - High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub
Herbaceous
Hay/Pasture
Cultivated Crops
Woody Wetlands
Emergent Wetlands

# North Carolina Results

- N application often found to be lower than recommended
  - Tar-Pimlico and Jordan Lake Basins, when compared RYE rates and NLEW results
  - Where over-application existed, it was generally small
- Even where nutrient management plans existed, N application often did not match needs for recommended levels
  - Most did not have plans
- Phosphorus application shown to be unrelated to previous existing levels in soil
  - Majority of counties found to be above levels that required additional P (60 mg/kg)
    - Neuse River Basin had high testing levels, Jordan Lake ~1/3 prior testing
  - In the Jordan Lake Basin, 2/3 of the fields had unneeded application
    - High starting levels associated with high application, and vice versa
    - Largely associated with crop type, pasture vs. crop land

| County | N applied by farmers | N needed per North Carolina nutrient recommendations |
|---|---|---|
| | kg | |
| | **Tar-Pamlico River Basin** | |
| Beaufort | 3,925 | 3,990 |
| Edgecombe | 5,875 | 7,808 |
| Franklin | 5,334 | 5,985 |
| Granville | 1,687 | 2,752 |
| Halifax | 3,723 | 4,598 |
| Hyde | 20,448 | 7,789 |
| Martin | 4,406 | 3,599 |
| Nash | 4,217 | 4,928 |
| Pamlico | 493 | 240 |
| Pitt | 6,183 | 6,690 |
| Washington | 3,004 | 2,902 |
| Wilson | 2,091 | 3,705 |
| | **Jordan Lake watershed** | |
| Alamance | 14,614 | 39,303 |
| Caswell | 1,871 | 1,659 |
| Chatham | 44,286 | 30,260 |
| Forsyth | 1,519 | 4,786 |
| Guilford | 50,730 | 125,504 |
| Orange | 49,191 | 48,524 |
| Randolph | 10,325 | 7,656 |
| Rockingham | 16,192 | 36,849 |
| Wake | 161 | 103 |

# North Carolina
# Use of Nutrient Management Plans

- Fertilizer/Nutrient application rarely found to follow nutrient management plans
  - One county hired an extension agent to work with farmers
  - Enabled farmers to write their own plans, and held a mandatory one day workshop
  - Agent reported that 2 years in, no farmers were still using the plans

| Organization or individual | Neuse River | | Jordan Lake | |
|---|---|---|---|---|
| | No.of people | % | No. of people | % |
| Fertilizer dealer | 391 | 19.7 | 15 | 8.5 |
| Paid consultant | 51 | 2.6 | 0 | 0 |
| NRCS | 5 | 0.3 | 5 | 2.9 |
| Extension | 10 | 0.5 | 2 | 1.1 |
| Friend/other farmer | 15 | 0.8 | 5 | 2.9 |
| Self | 1192 | 60.0 | 123 | 70.3 |
| Other | 239 | 12.3 | 7 | 4.0 |
| No commercial fertilizer applied | 81 | 4.1 | 18 | 10.3 |

- Majority of farmers used the same fertilizer levels throughout a crop, even across multiple fields
  - Lowest found with “Miscellaneous” and wheat crops, with no variation between fields at 81% of farmers
  - No accounting for existing levels, or soil/geographical conditions
- In many cases (especially coastal regions) P application was entirely unnecessary, but still undertaken

# Conclusion

- In general, nutrient management plans either did not exist, or were not being followed
- Study suggests 3 likely reasons
  - Farmers hesitant to follow suggested levels due to lack of trust in research and findings
  - Abundant nutrients viewed as insurance for higher yield
  - Used recommendations from other sources – fertilizer dealers
- Successful nutrient management plans had common factors
  - Efforts eased management time
  - Worked directly and consistently with a small group of farmers
  - Substantial monetary (or other) resources were allocated
- A disconnect exists between front-line farmer needs, and need for nutrient management
  - Efforts to reduce nutrient pollution must take into account farmer needs, and must address social and cultural forces behind farmer decision making

# Discussion Questions?

- Should farmers have to absorb some, if any, of the costs to reduce nutrient pollution? (Including testing costs)

- Can strategies be marketed as increasing yield, not just reducing pollution?
  - 4 R's – Right rate, time, source, place