What do Wisconsin's Atrazine Prohibition Areas Tell us about Weed Management?

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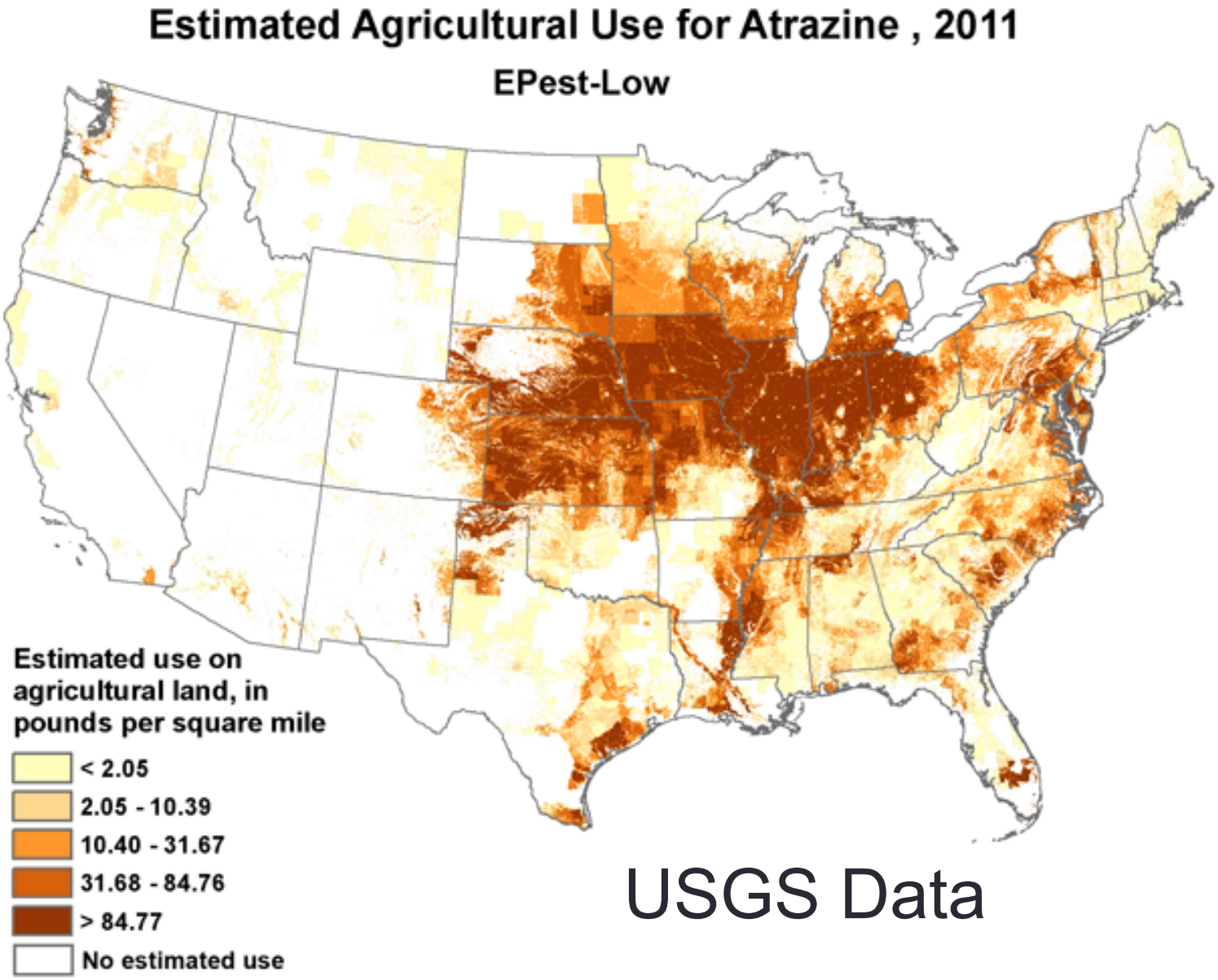
Atrazine

- Registered in 1958/1959
- Primarily used on corn (all types), sorghum, and sugarcane, plus to maintain grass and turf, including in orchards and vineyards

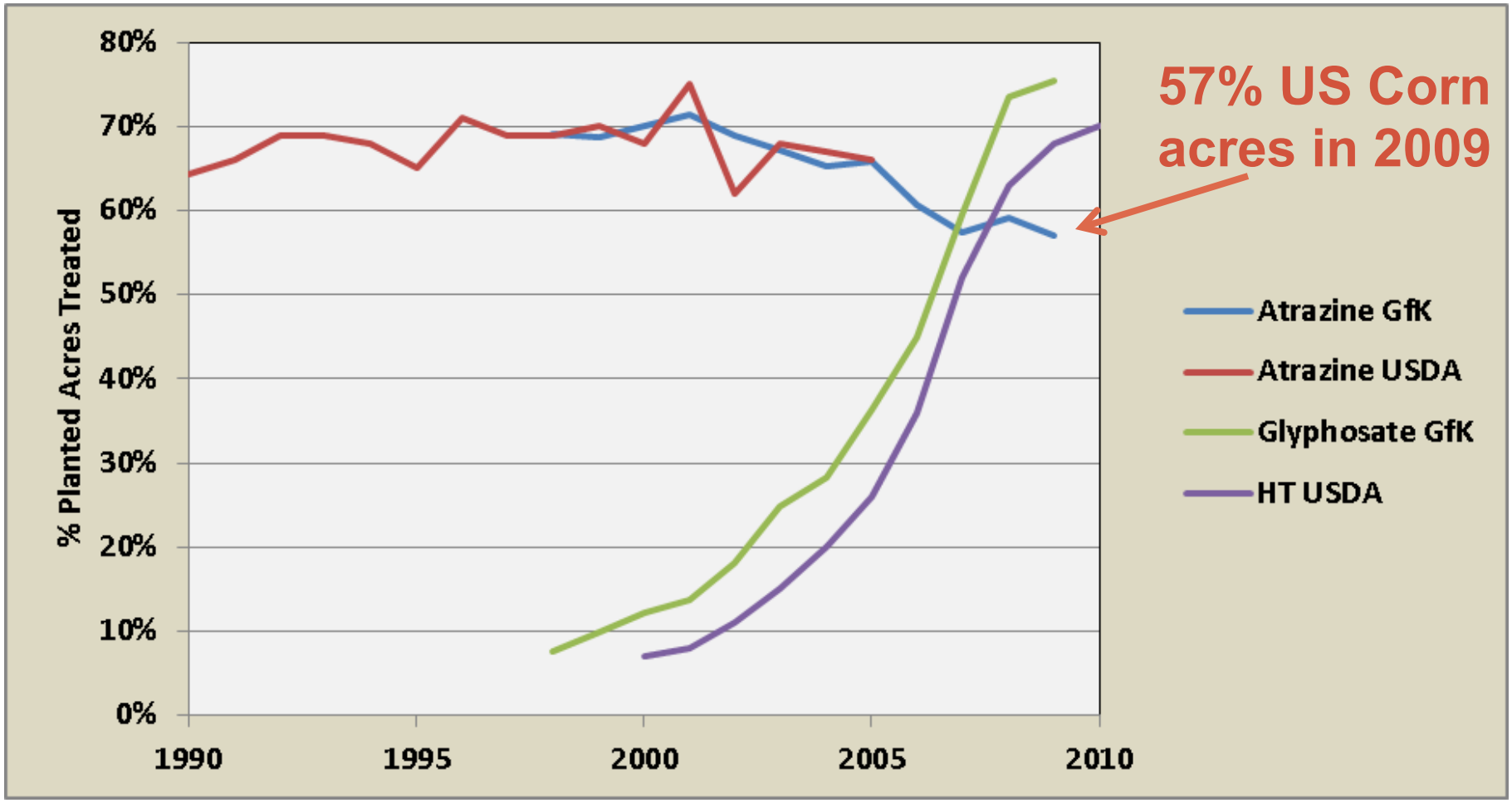
- Probably the most used herbicide in the world
- Probably the most researched herbicide in the world



USGS Data

Source: http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2011&map=ATRAZINE&hilo=L

Atrazine Still Widely Used on Corn, Even in the "Modern" Era of RR/Bt Corn

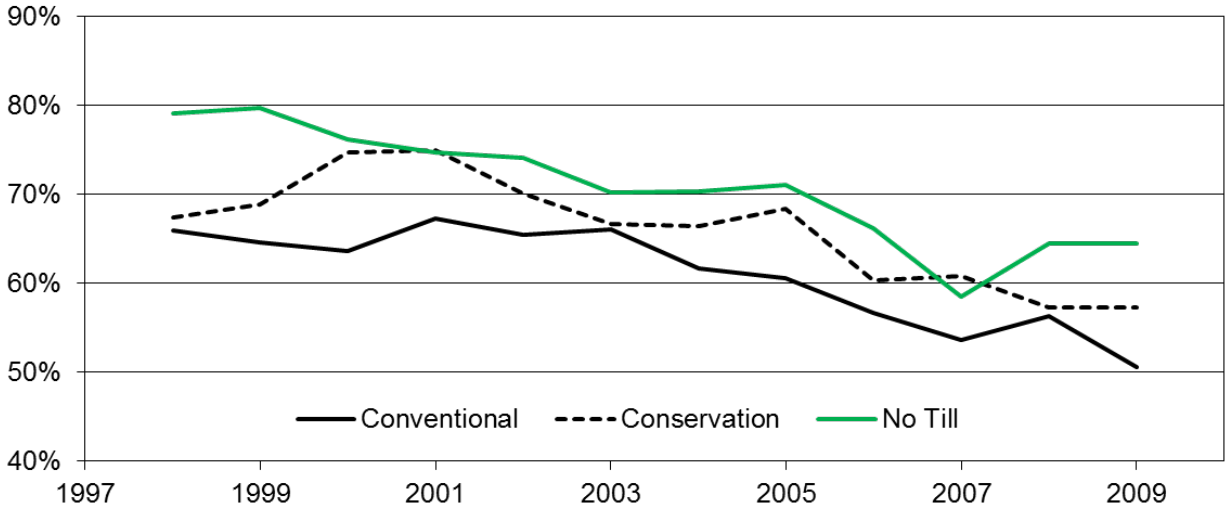


Source: Mitchell (2014)

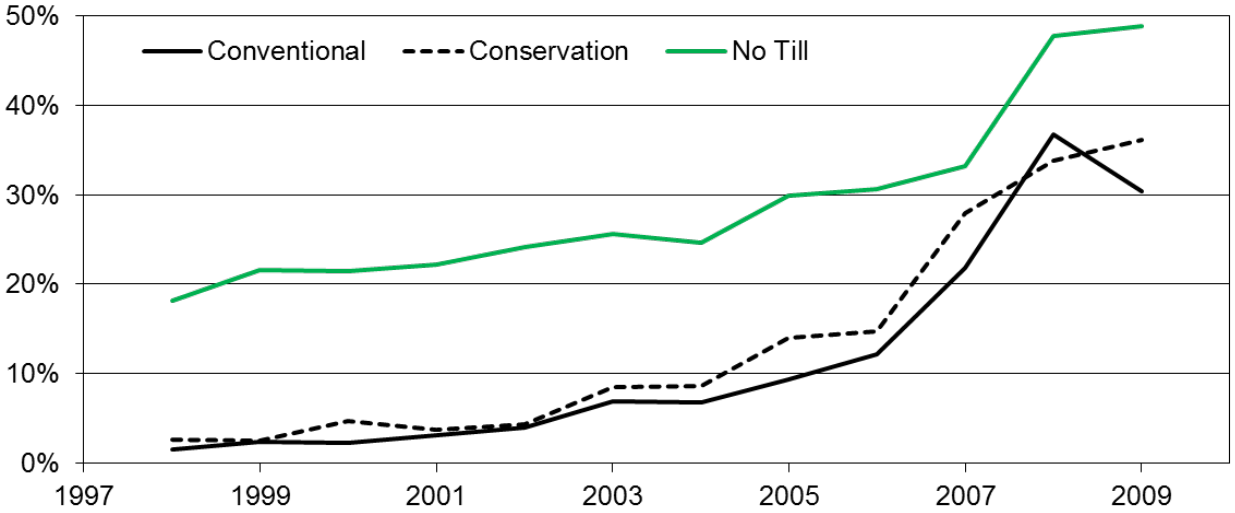
Economic Benefits of Atrazine

- Market-level Assessment of the Economic Benefits of Atrazine in the United States (Mitchell 2014)
- Triazine herbicides: atrazine, simazine & propazine
- Net projected economic benefit for triazine herbicides to the US economy ranges from $2.9 to $3.4 billion annually
  - Small cost increase (± $2.50/A), Yield loss 1.4% - 9.6%.
  - Most of the benefits go to consumers via lower corn prices: big winners are livestock industries and ethanol
- Productivity gains from triazine herbicides maintain an estimated 670,000–960,000 acres in non-crop uses
  - Rural greenspace, habitat, less soil erosion

Atrazine and Reduced Tillage



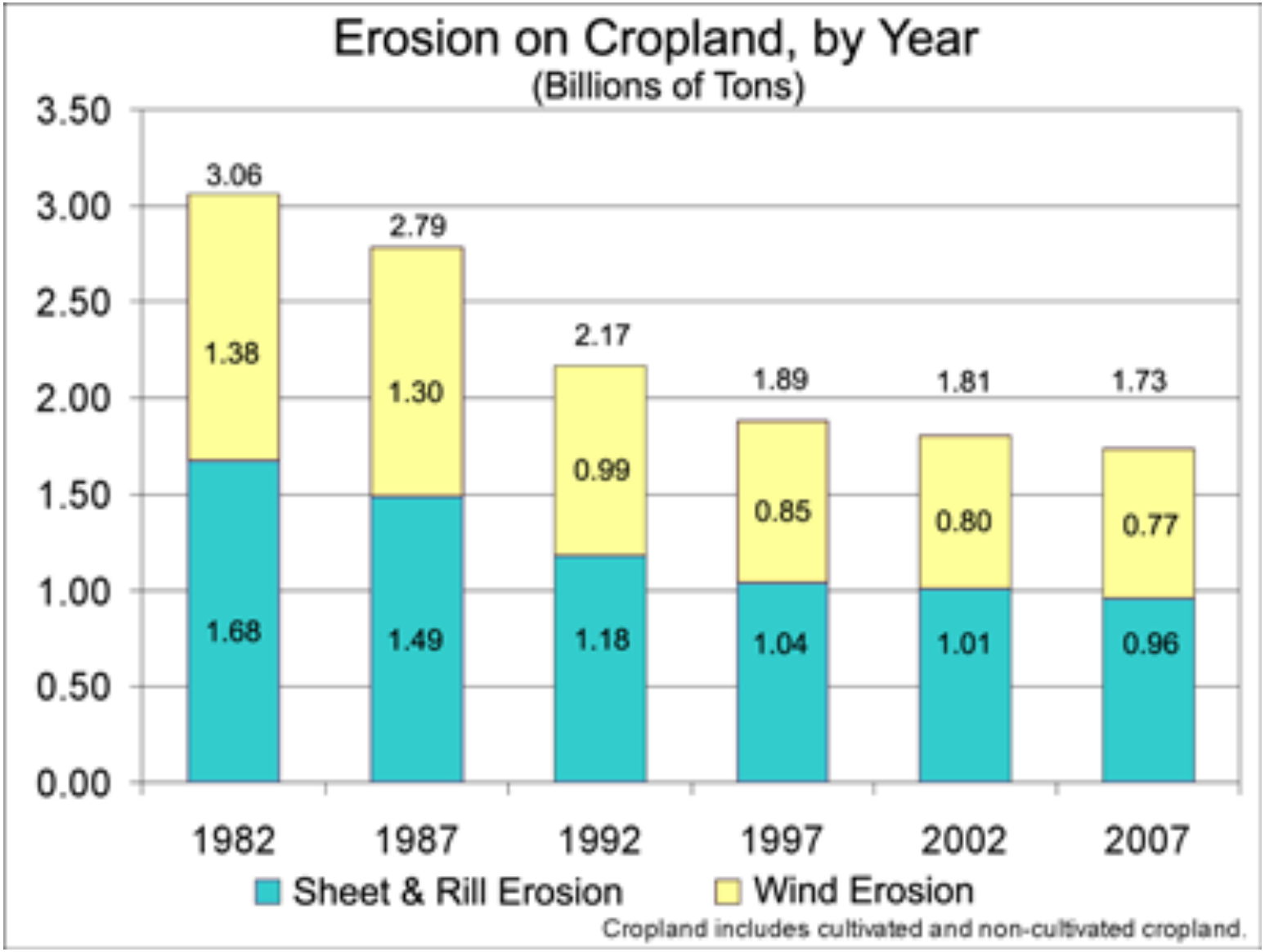
% conventional till, conservation till, no-till corn treated with atrazine:
More atrazine on reduced till acres



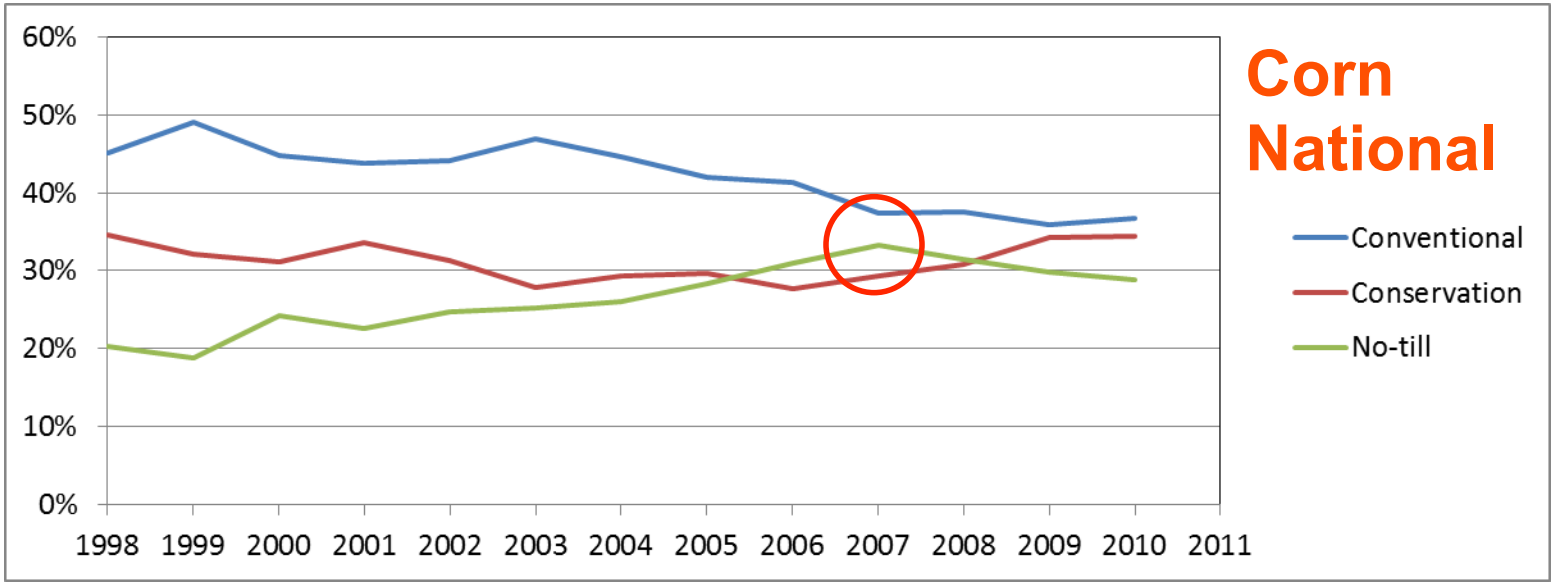
% conventional till, conservation till, no-till corn treated with atrazine + glyphosate:
More atrazine on no till, even if RR corn

Soil Erosion and Atrazine

- Soil Erosion Benefits of Atrazine (Mitchell 2011): http://www.aae.wisc.edu/pubs/sps/pdf/stpap563.pdf
- Triazines estimated to reduce soil erosion by 56 million to 85 million tons annually
  - Allow more reduced/no till
  - Leave more land in non-crop uses for pasture/forage or uncropped
- The value of these soil erosion benefits ranges $210 to $350 million annually



Source: USDA-NRCS (2010):
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/?&cid=stelprdb1041887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Corn National
Conventional
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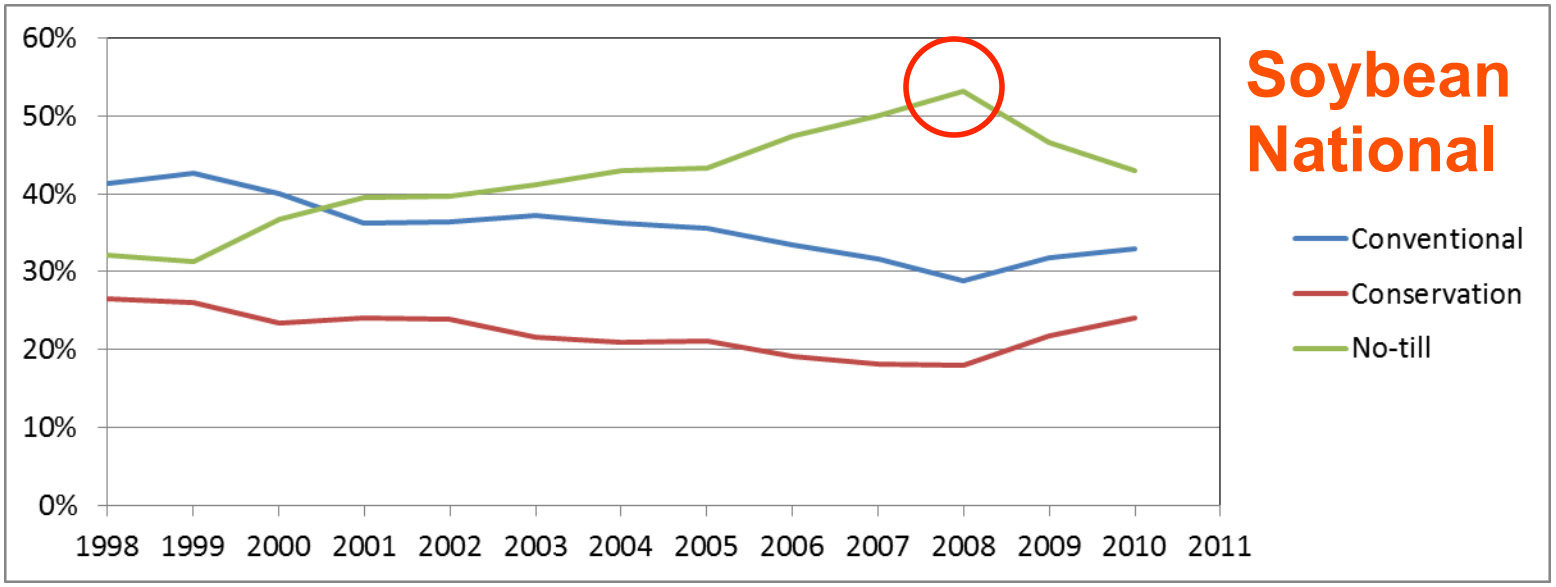
No-till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Soybean National
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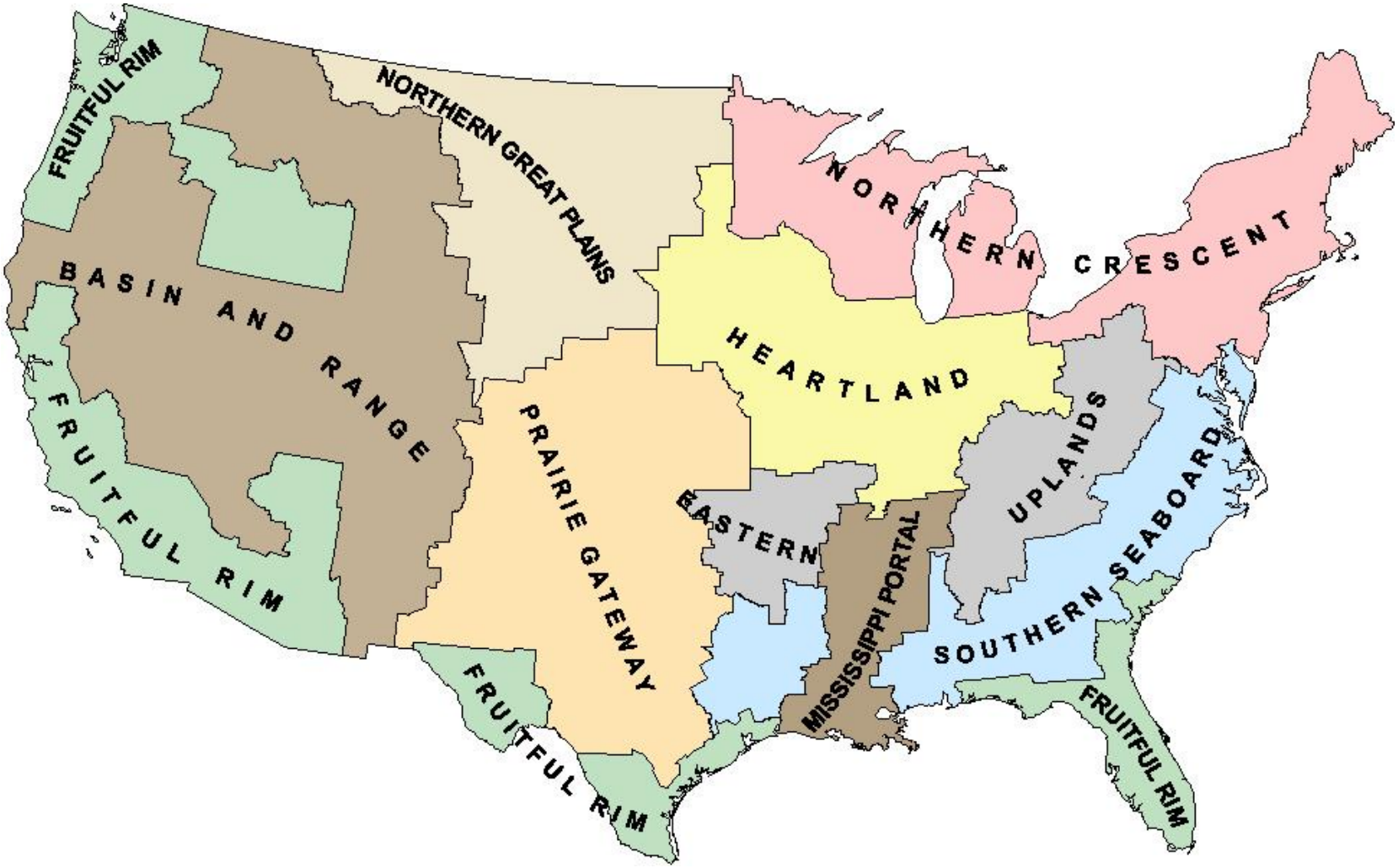
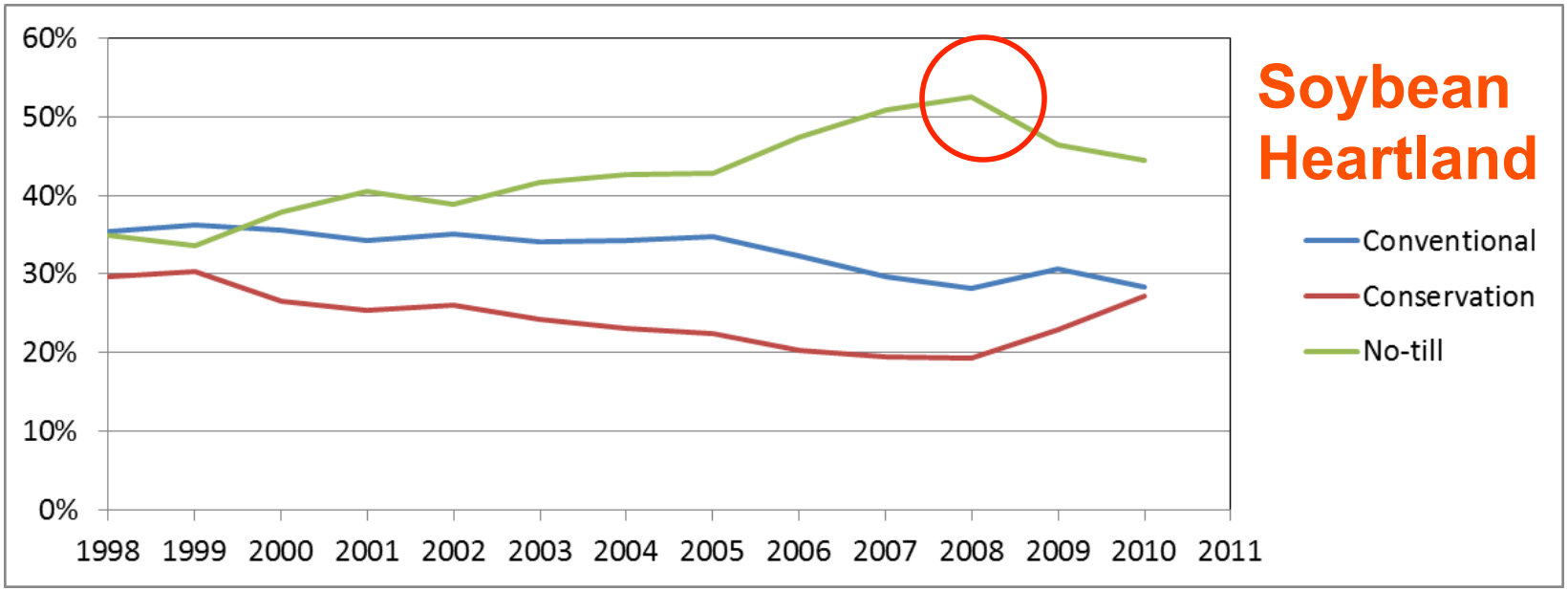
No-till

USDA-ERS Farm Resource Regions



Source: USDA-ERS (2000). http://maps.ers.usda.gov/mapimages/ers_reg_color.jpg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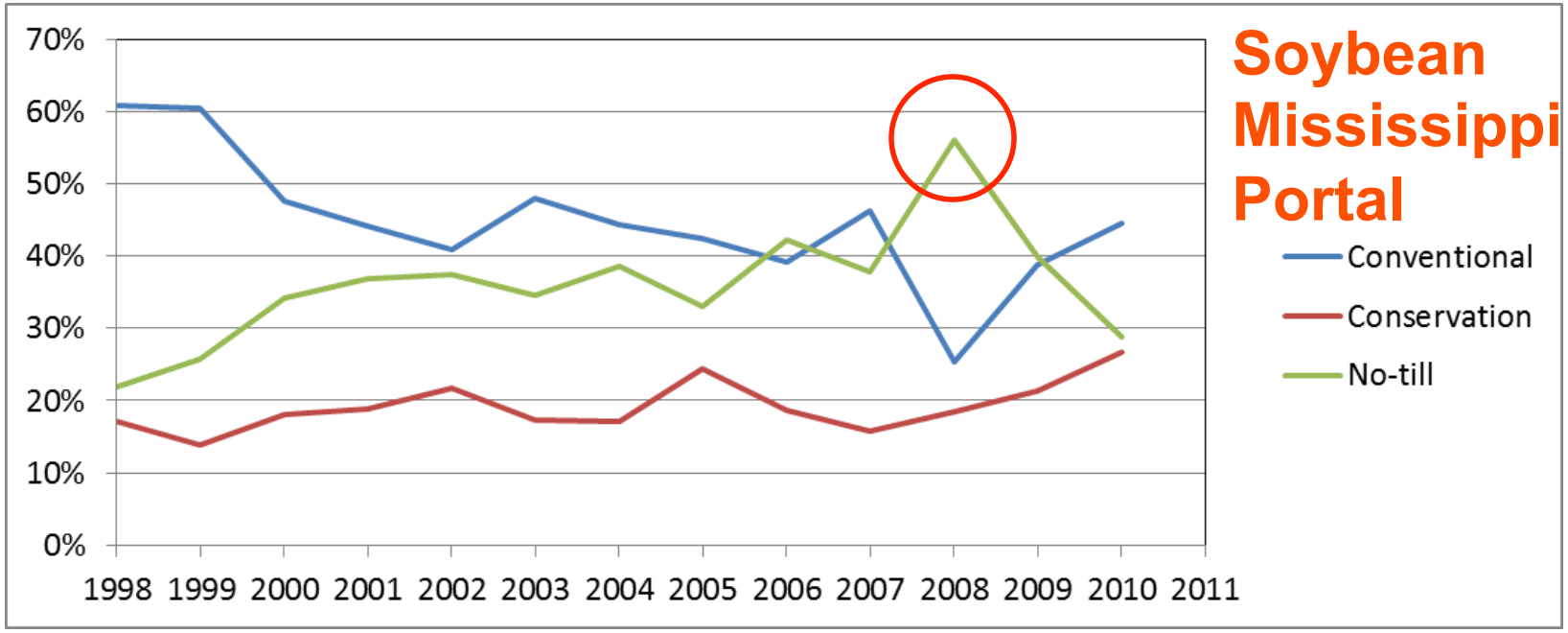
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Soybean Mississippi Portal
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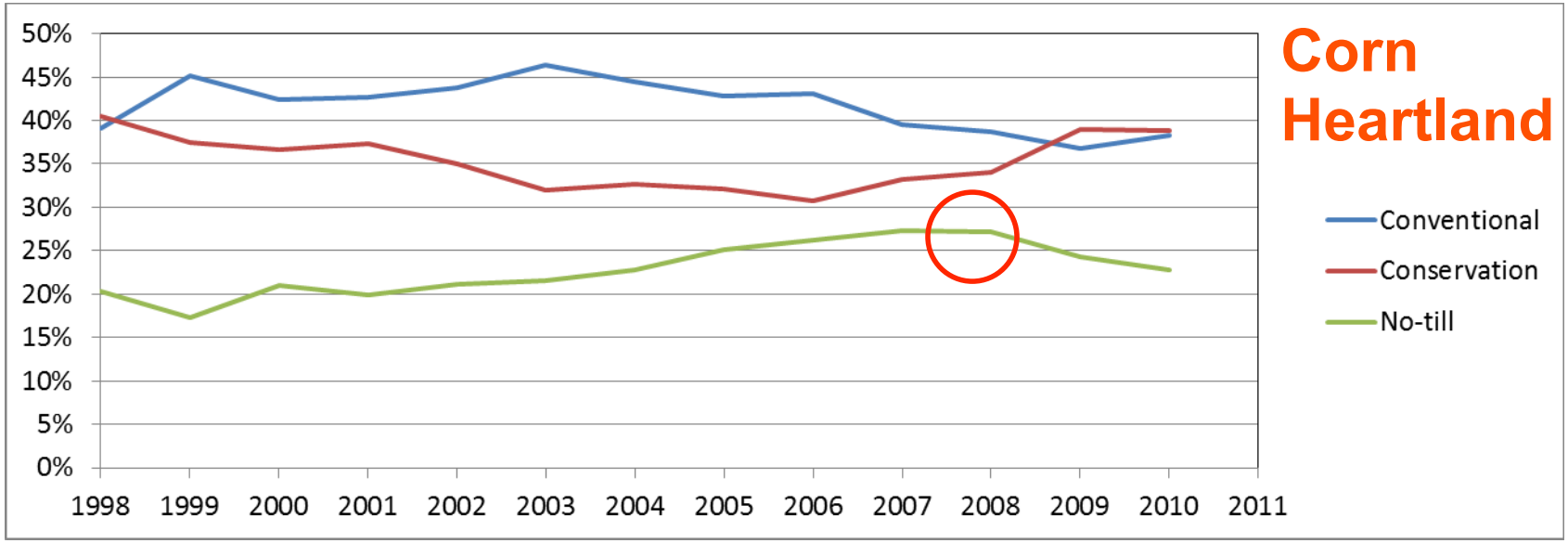
No-till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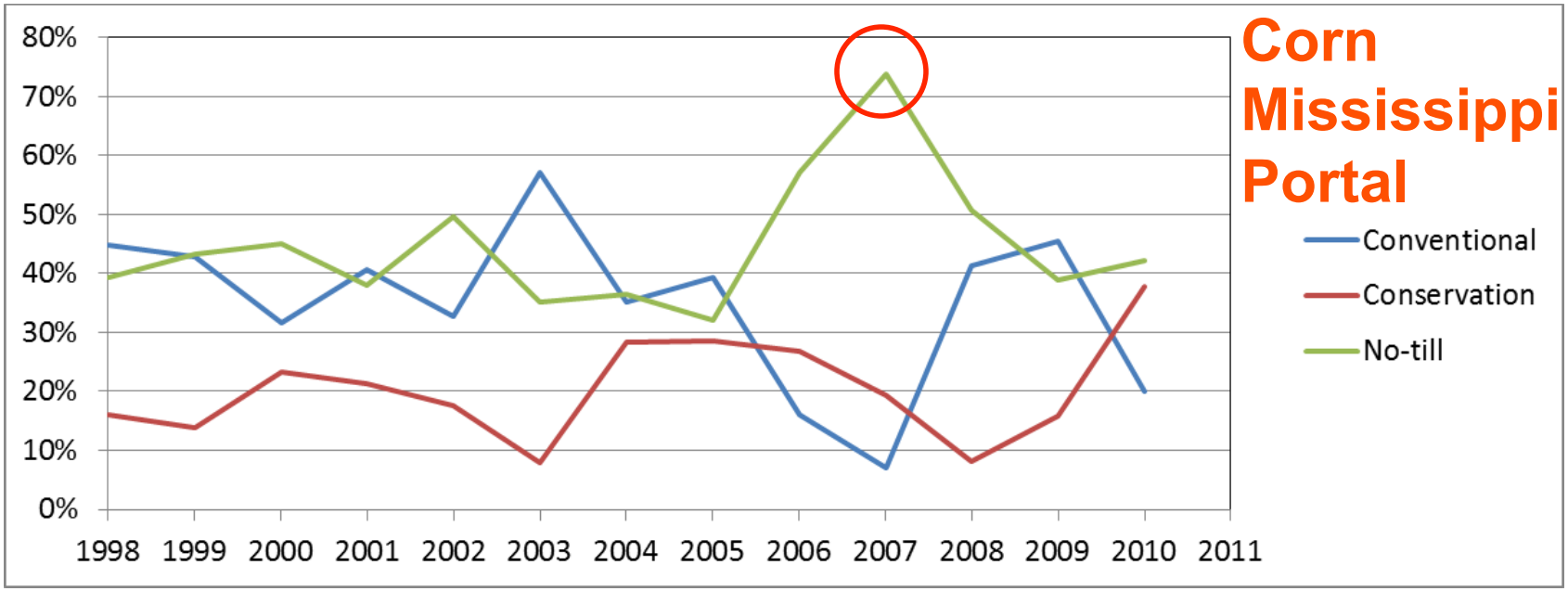
Corn Mississippi Portal
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1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Conventional
Conservation
No-till

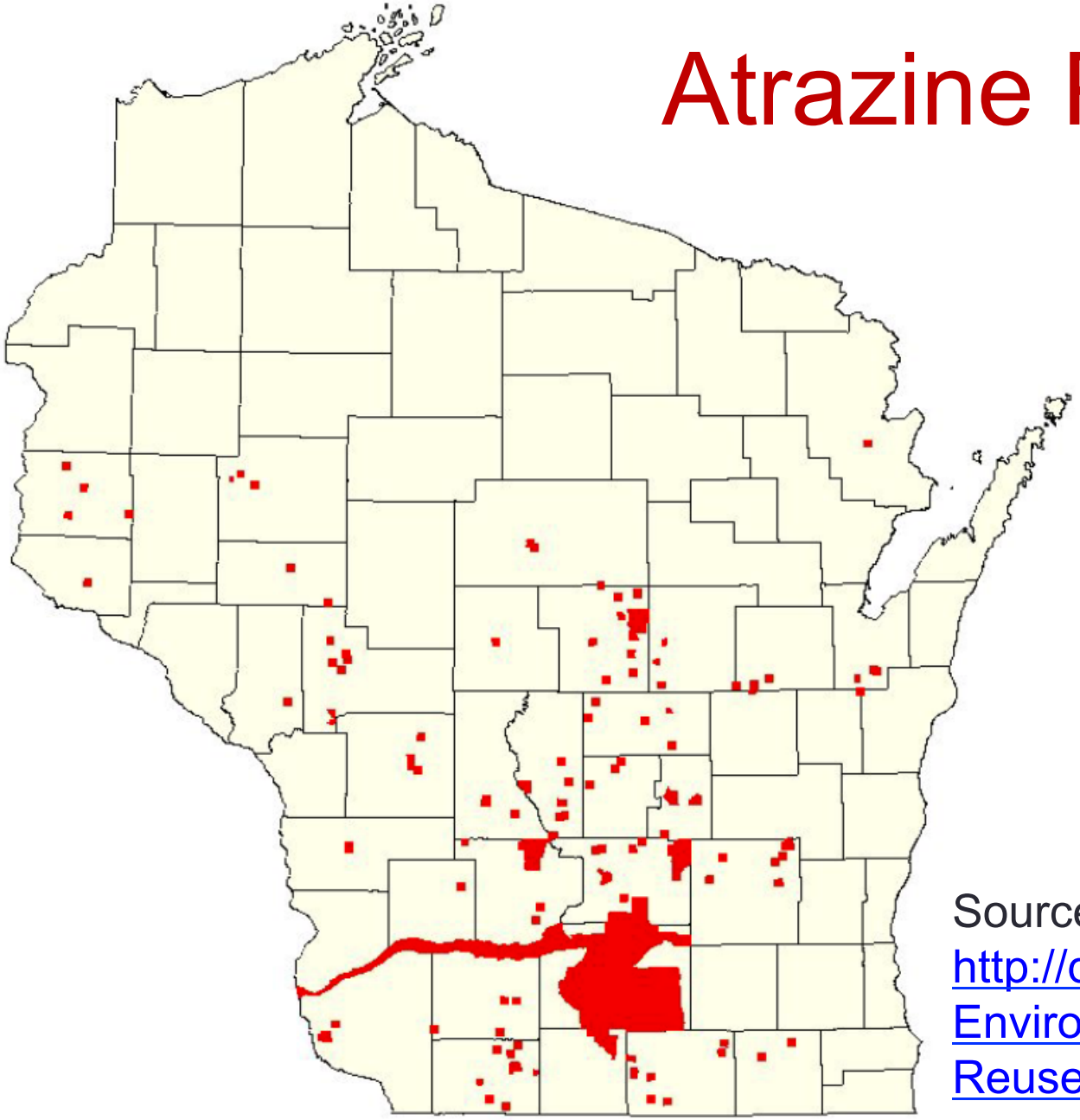
Goal Today

- Atrazine is still important
- Soil Erosion a continuing problem
- Atrazine a key part of tillage choices
- Present preliminary results from on-going research:
- How does atrazine fit into farmer weed and soil management program?
  - Explore the interactions between Atrazine, Tillage, RR Seed and Glyphosate
- Use unique data collected by USDA-NASS

Wisconsin Atrazine Prohibition Areas

- Atrazine first detected in Wisconsin groundwater in mid-1980's
- 10% to 16% of surveyed wells contaminated with detectable levels of atrazine
- Atrazine Rule (1991) created atrazine prohibition areas (PA's) in the state
- Atrazine use prohibited in each PA where concentrations in private wells exceed 3 ppb groundwater standard
- First atrazine PA's declared and defined in 1993
- Currently 102 PA's in WI, covering over 1.2 million acres

Atrazine PA's in WI



Source:
http://datcp.wi.gov/uploads/Environment/pdf/ReuseStudyFinalReport.pdf

Wisconsin Atrazine Prohibition Areas

- Nothing like WI's atrazine PA's exist elsewhere in US at this scale
- A problem for atrazine benefits study is developing counterfactual scenarios
  - What would U.S. famers do without atrazine?
- WI atrazine PA's provide a unique case to see what farmers have done without atrazine
- This presentation focuses on the Management Impacts
- Specifically: Examine the relation between atrazine ban, tillage, RR seed, and glyphosate

DATCP Survey

- WI DATCP conducted a small survey “piggy-backed” on USDA-NASS 2010 ARMS survey of corn growers
- 102 farmers inside atrazine PAs
- Final Report on the 2010 Survey of Weed Management Practices in Wisconsin’s Atrazine Prohibition Areas
- http://datcp.wi.gov/uploads/Environment/pdf/WeedMgtAtrazinePAs.pdf
- Briefly summarize some results here

DATCP Survey

"Does it cost more to control weeds on your corn acres inside a PA than on your corn acres outside a PA?"

Response	Number of respondents (%)
Yes	15 (39%)
No	15 (39%)
Don't know	8 (21%)

DATCP Survey

"During the past three years, has the prohibition of atrazine in the PA caused a reduction of your corn yield when compared to your fields outside the PA?"

Response	Number of respondents (%)
Yes	2 (5%)
No	32 (84%)
Don't know	4 (11%)

DATCP Survey

"In terms of the number of corn acres applied to in the PA, what are the top three herbicides you used in the past three years as alternatives to atrazine?"

Herbicide Active Ingredients	Number of Responses
Glyphosate	92
s-Metolachlor	22
Mesotrione	21
Acetochlor	19
Dicamba	10
Clopyralid	10
Flumetsulam	10

DATCP Survey

"Have you changed or added any of the following field practices on your corn acres inside a PA to control weeds"

Practice	Number of Yes Responses
Tillage	37
Cultivation	16
Scouting	48
Crop Rotation	47
Increased number of trips	25

DATCP Survey

Comparison of selected herbicide use inside and outside of PAs in 2010

Herbicide	Area applied inside PAs (%)	Area applied outside PAs (%)	Rate per crop year inside PAs (lbs/A)	Rate per crop year outside PAs (lbs/A)
Glyphosate	48	51	1.08	0.97
S-Metolachlor	24	26	1.34	1.39
Clopyralid	23	25	0.14	0.12
Acetochlor	19	26	1.49	1.78
Mesotrione	20	27	0.12	0.13
Flumetsulam	23	25	0.053	0.043

Main Point

- Summary of Findings: "… *although many corn growers would like the option to use atrazine in PAs, they have adapted well to growing corn without it."* [p. 7]
- Not more difficult to control weeds, cost and yield impacts minor to moderate, most switch to glyphosate, minor differences for herbicide use inside and outside of PAs
- My concerns
  - Small sample size (38 observations)
  - What about tillage and soil erosion?

Data

- USDA-NASS 2010 Agricultural Resource Management Survey (ARMS) Corn Production Practices & Costs Report
- Major national USDA survey (the survey that DATCP "piggy-backed" on)
- Wisconsin Supplement to this survey
- 805 Wisconsin farms
  - 468 in an atrazine PA
  - 337 not in an atrazine PA

Our Analysis of NASS Data

- Focus on use of no till/minimum till
- How does being inside/outside an atrazine PA affect use of no till?

- Two Methods
- 1) Method of Matching
- 2) Classification and Regression Tree (CART)

Method of Matching

- Compare treatment group individuals to similar individuals in control group in order to attribute the differences in outcomes between groups to the effects of the treatment
- Simple Example: Does Madison's excellent cross country ski trial maintenance increase cross country skiing?
- Compare % of Madison residents that cross country ski to national average: Not surprisingly, it's higher
- Can't use this fact to argue that that Madison's excellent maintenance increases skiing
- Need to compare Madison to a similar city

Method of Matching

- We use bias-corrected nearest-neighbor matching algorithm to estimate average treatment effects
- Estimate the effect of being inside an atrazine PA on
  - Proportion that use no-till/minimum till
  - Proportion that use RR seed
- Estimate the effect of RR seed use on
  - Proportion that use no-till/minimum till

Average Treatment Effects

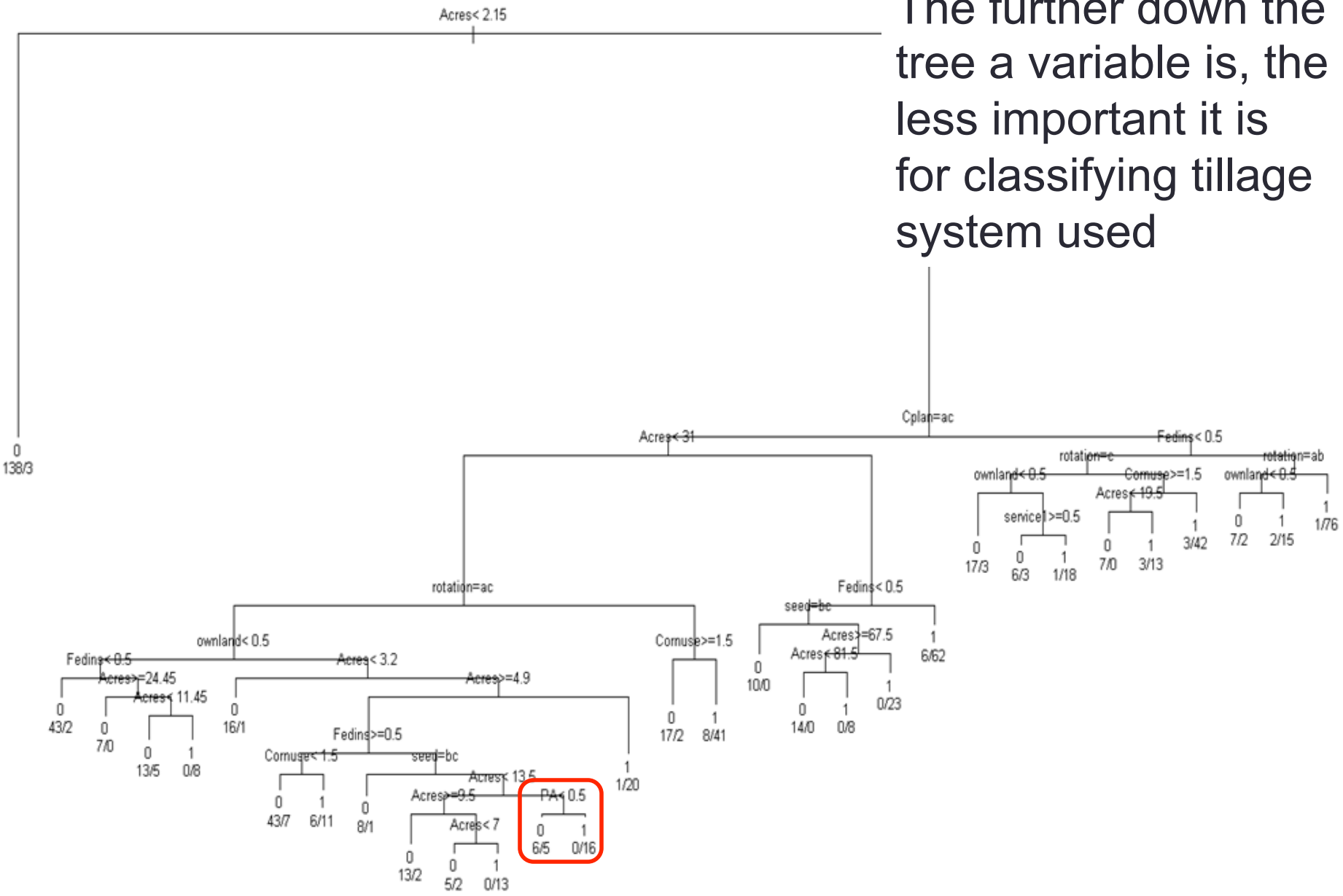
Treatment	Estimate	St Err	P Value	95% Confidence Interval
Atrazine PA on no/ min till use	0.166	0.044	0.000	(0.079, 0.253)
Atrazine PA on RR seed use	-0.004	0.040	0.914	(-0.082, 0.074)
RR seed use on no/ min till use	0.176	0.062	0.004	(0.055, 0.297)

- Being inside an Atrazine PA
  - Increases proportion of farmers using no till/minimum till
  - Has no significant effect on use of RR corn
- Using RR seed
  - Increases proportion of farmers using no till/minimum till

Classification and Regression Tree Analysis (CART)

- Statistical method based on a “recursive binary splitting” of data into mutually exclusive subgroups
- Output: Identifies key variables that categorize the data and gives them an Importance Weight
- Analysis goal: Identify key variables explaining use of no till/minimum till and see how being in an atrazine PA fits in

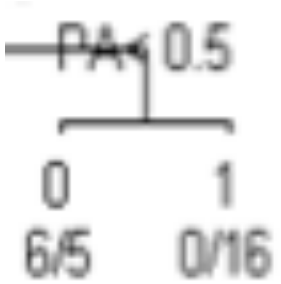
Graphical Output



The further down the tree a variable is, the less important it is for classifying tillage system used

Zoom in on the PA Node

- Left 0: means not in a PA
  - 6/5: 6 use conventional, 5 use no till
- Right 1: means in a PA
  - 0/16: 0 use conventional, 16 use no till
- Main Point: After controlling for lots of other factors, farmers inside atrazine PA's more likely to use no till/minimum till
- Being in an atrazine PA's matters for use of no till, but it is just one of many factors and not among the most important



Variable	Importance	Variable	Importance
Field Size	31	Inside PA	4
Use RR Seed	13	Conservation Plan	3
Corn Use (Grain, Silage, Seed)	12	Highly Erodible Land	2
Atrazine Used	10	Field has Crop Insurance	1
Have Nutrient Mgmnt Plan	5	Have Pest Mgmnt Training	1
Crop Rotation	5	Have Roundup Resistant Weeds	1
Own the Land	5	Plant Early	1
Pre-emergent Herbicide App	5		

Atrazine and Tillage

- Matching and CART both agree RR corn increases adoption of no till
- Both agree that fields in atrazine PAs are more likely to use no till
- Does this mean atrazine ban increases no till?
- What's going on with Atrazine and Tillage?
- Seems RR corn and other factors are more important than Atrazine for driving tillage system use
  - Difficult to find the atrazine "signal" amidst the RR "noise" even though atrazine is 2nd most common corn herbicide

Conclusion

- This is all work in progress, results may change
- We have been thinking about tillage, herbicides, soil erosion, biotech seeds, and herbicide resistant weeds
- They all interact in complex ways so that even simple generalizations are hard to find
- Policies to reduce/control soil erosion and herbicide resistant weeds need to be simple
- What's needed? New Ideas, Passion, Commitment, Hard Work, Practical Answers: Agriculture excels at these!
- Farmers and ag professionals need to start thinking about weed management and soil erosion again and UW/UWEX needs to help farmers and ag professionals do it

Thanks for Your Attention!

Questions?

The authors gratefully acknowledges the support of Syngenta Crop Protection and the Wisconsin Corn Promotion Board