

Incentive Payments for Forest Carbon Sequestration on Private Land

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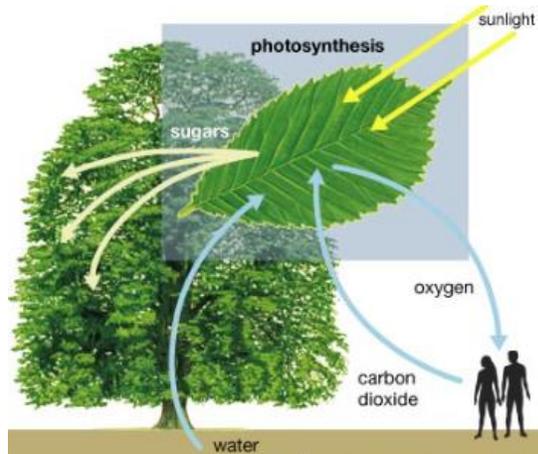
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USDA-NIFA AFRI Project Directors Meeting
Agricultural Economics & Rural Communities Program
Chicago, IL
August 2, 2017



Background

- Focus on forest-based carbon sequestration (as a part of ecosystem services)
 - In relation to climate change: Offset capacity of 905 million metric tons (16.1%) of total US carbon emissions (USEPA 2013)
 - Cost advantage compared to other carbon emission mitigation



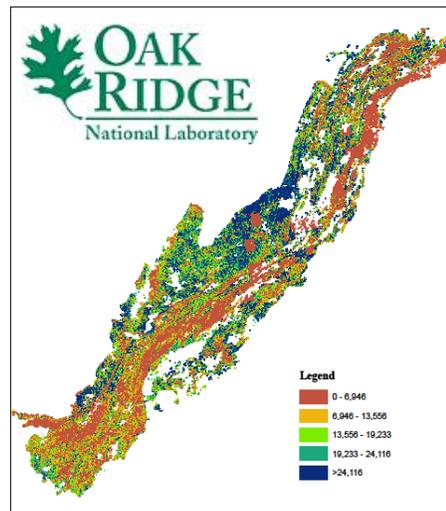
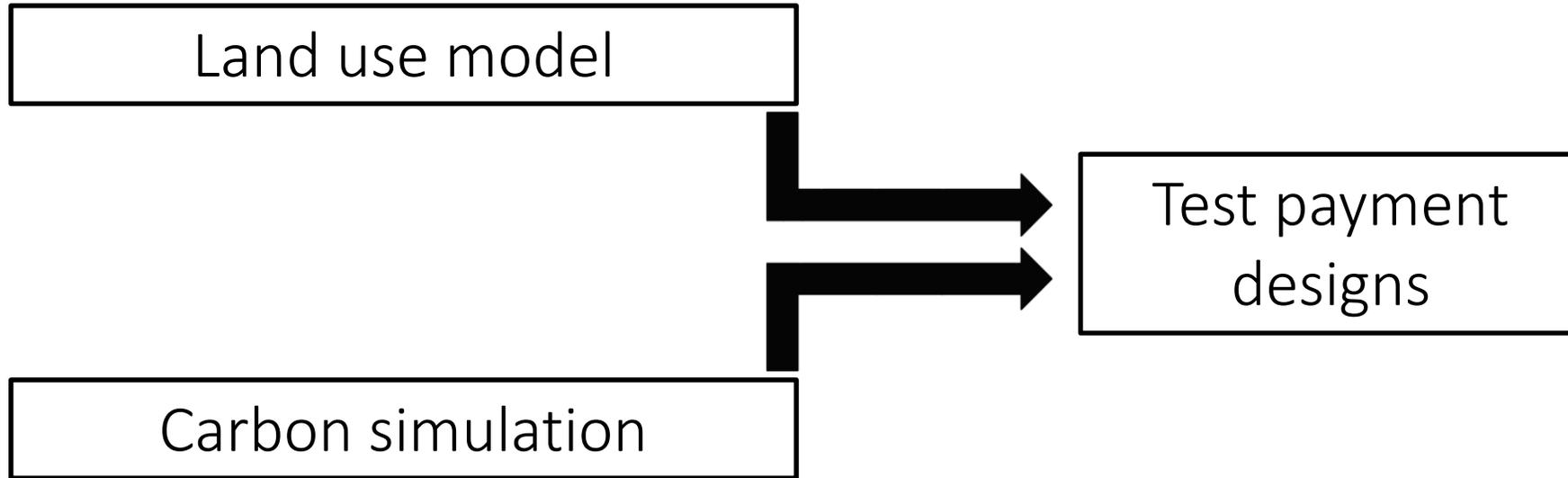
Background – cont.

- Incentive payments for forest-based carbon sequestration
 - Internalizing positive externality
 - Controversial due to costs on society
- Focus on spatial dimension of incentive payments
 - Spatial heterogeneity in the opportunity costs of supplying ecosystem services (Armsworth et al., 2012; Lewis et al., 2011; Lubowski et al., 2006; Mason and Plantinga, 2011; Polasky et al., 2014)
 - Cost efficiency depends on how the program can account for payment based on the spatial heterogeneity in the opportunity costs (Antle et al., 2003; Jandl et al., 2007; Gibbons et al. 2011; Hanley et al. 2012).
- Few, if any, studies have explicitly factored in temporal aspects

Objective

- H_0 : Optimal provision of forest-based carbon storage differs across space and time
 - Spatial and temporal heterogeneities in the costs of supplying forest-based carbon storage

Incentive Payments for Carbon on Private Land



Land use model

- Model land use decisions among five types of land use classification (i.e., cropland, pasture, urban, forest, and other) over three periods (i.e., 1992-2001, 2001-2006, and 2006-2011) at 1 km² pixel level
- Hypothesize that shares of the five types of land uses are functions of net returns from the land uses and a variety of other factors
- Estimate probabilities of transitioning from one type of land use to another over each of the three periods
 - Multinomial logistic Markov transition probabilities using maximum likelihood (ML) (MacRae, 1977; Miller and Plantinga, 1999; Ahn et al., 2000; Plantinga and Ahn, 2002; Lambert et al., 2016)

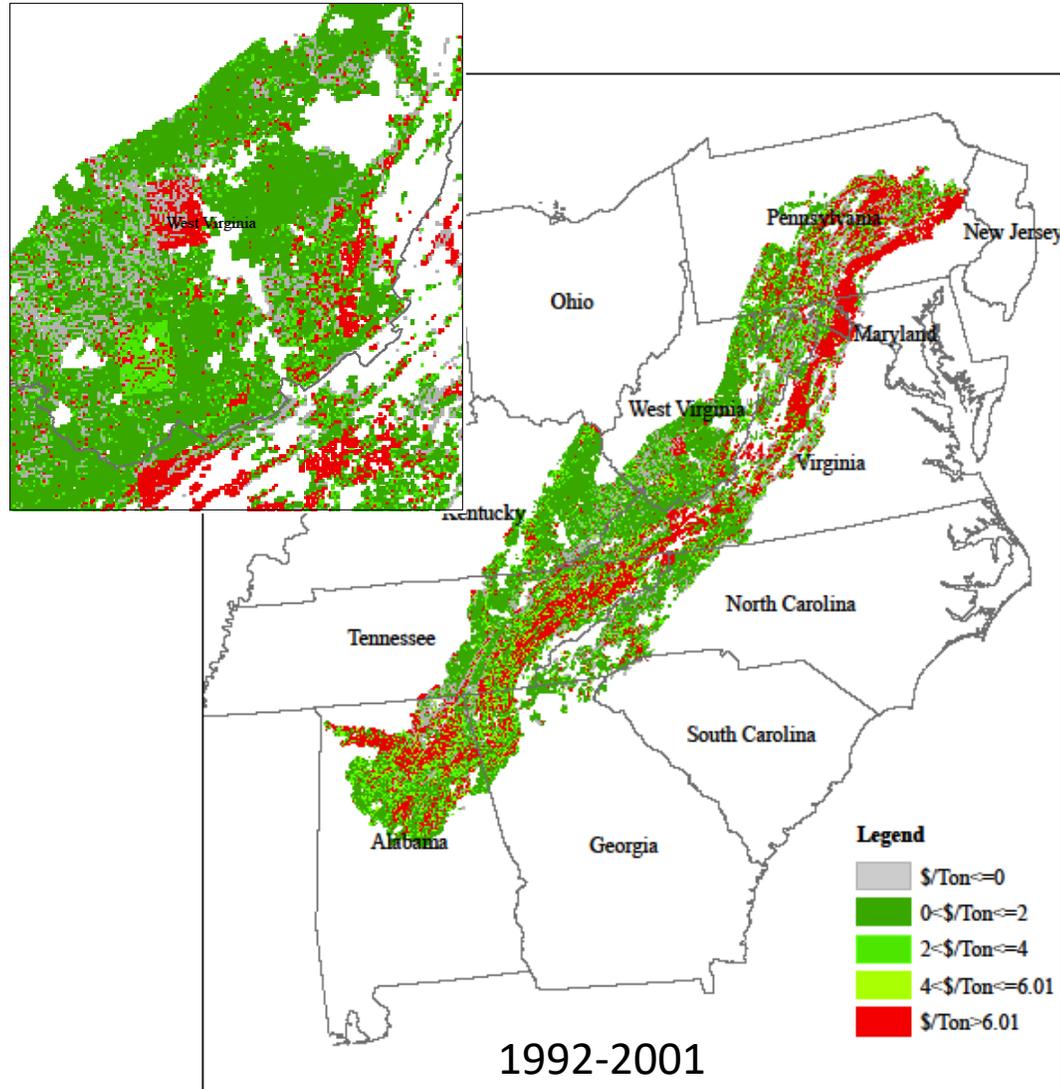
Carbon simulation

- Terrestrial Ecosystem Model at 1 km² pixel level
- Based on climate, forest type, disturbance and management history, and other pixel-level environmental characteristics (Oak Ridge National Laboratory, 2016)
- Net total of carbon uptake through photosynthesis against carbon losses over each of the three periods separately

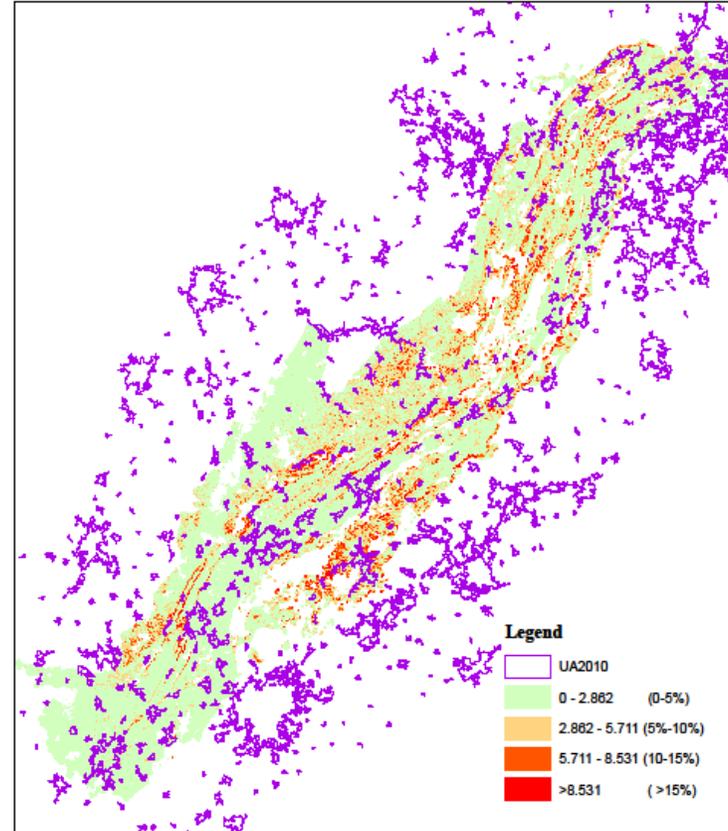
Test payment design

- Create land use transition matrix using Markov transition probability
- Calculate marginal carbon stored per dollar for each \$1 increase in incentive (i.e., increase in return to forest)
- Develop a cost-efficiency map for each of the three periods (\$/ton)

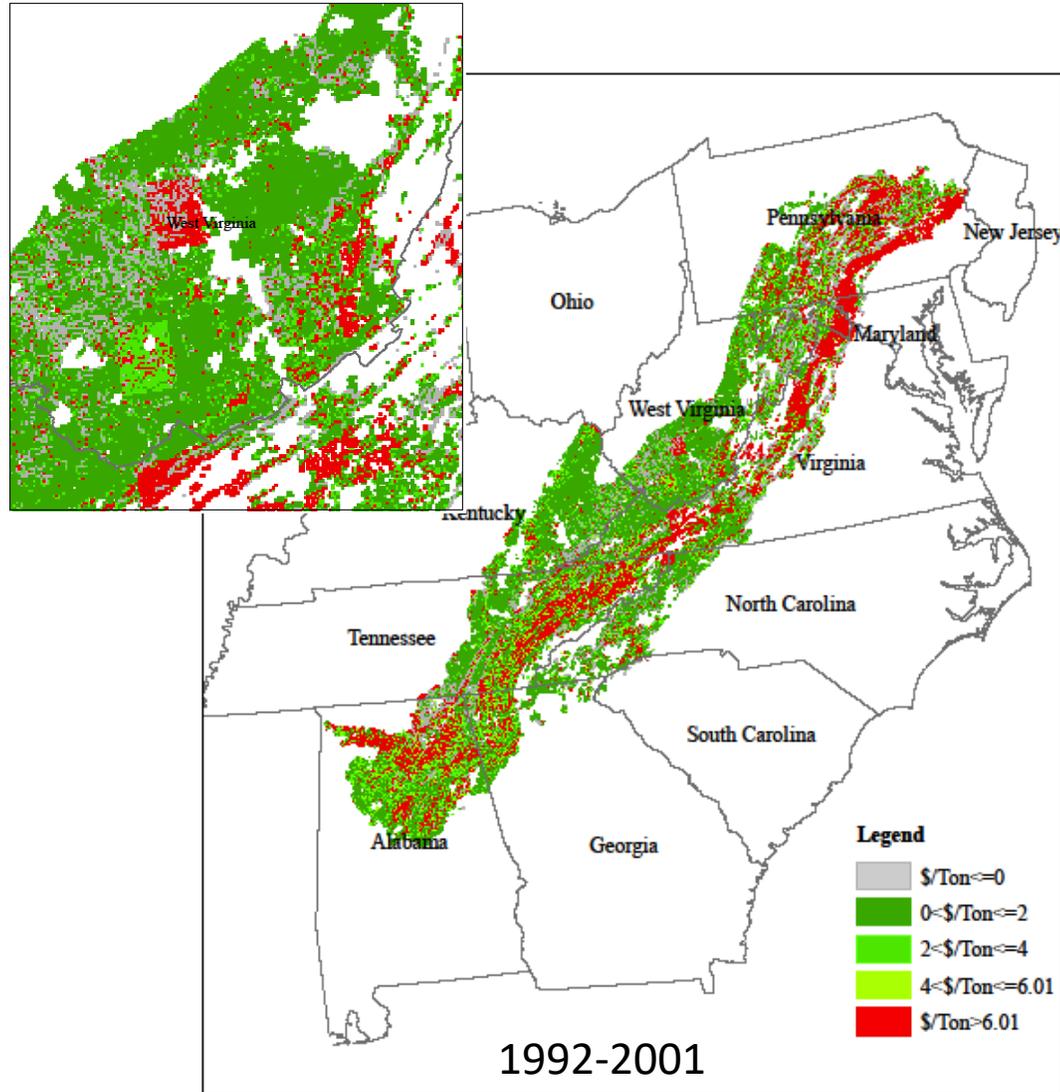
Where & when can you buy carbon cost effectively?



Good places to
buy carbon where...



Where & when can you buy carbon cost effectively?

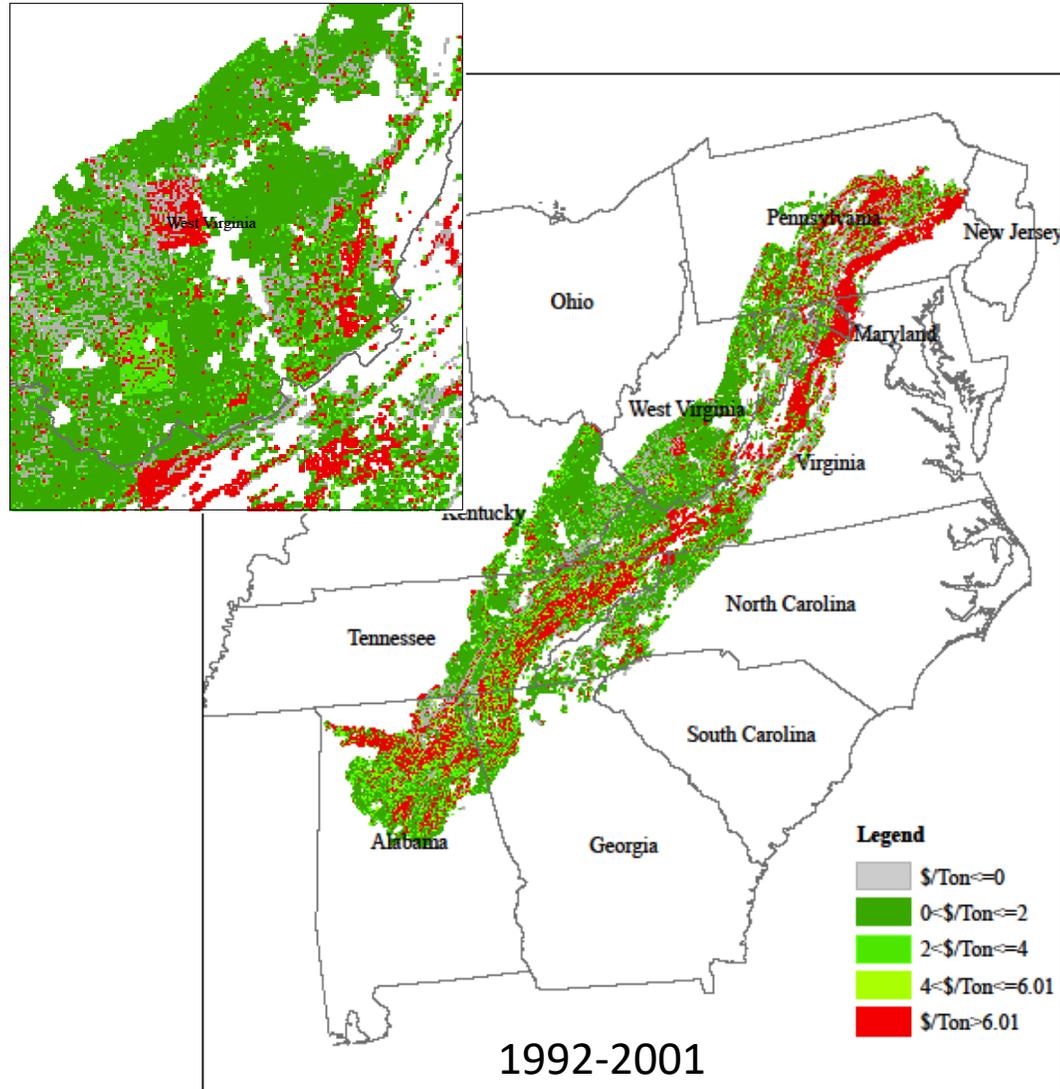


Good places to buy carbon where...

... profit from urban is lower

...large share of forest

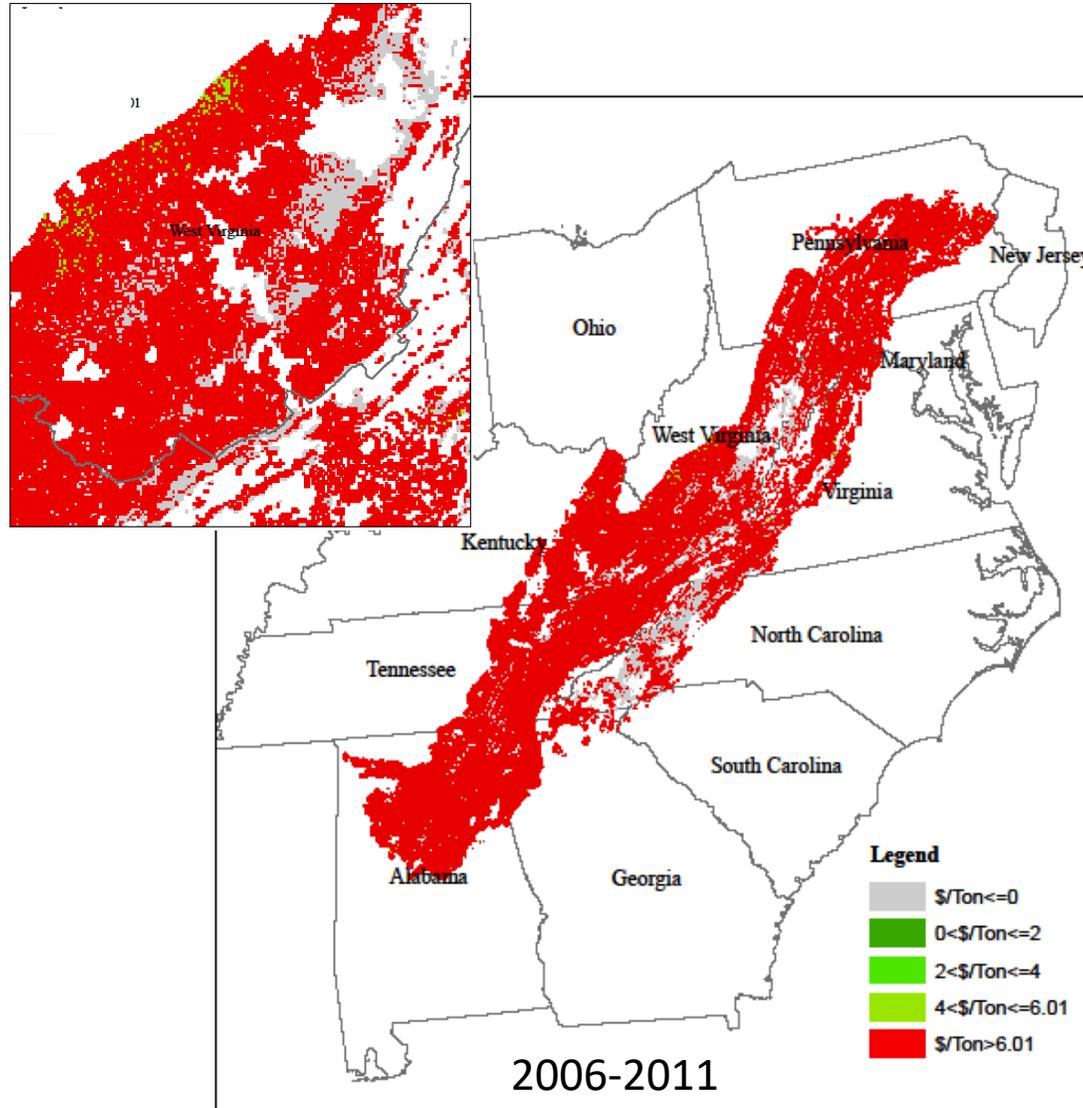
Where & when can you buy carbon cost effectively?



1992-2001

Payments to landowners supply carbon on 64% of area for less than EPA's social cost of carbon

Where & when can you buy carbon cost effectively?



2006-2011

Payments to landowners supply carbon on <1% of area for less than EPA's social cost of carbon

Where & when can you buy carbon cost effectively?

For the average property:

	92-01	01-06	06-11
Forest \$/acre	133	691	1650
Carbon \$/ton	1.84	12.1	28.7
EPA's social cost of carbon			6.01

Payments most cost effective in moderate economic conditions. Boom expensive. Recession v. expensive.

Testing alternative policy designs

Tax relief versus incentive payment (published, Environmental Conservation)

Market impact on cost efficiency (revised & resubmitted, Journal of Environmental Planning & Management)

Per acre versus per ton (revising, Ecological Economics)

Uniform payments vs. more targeted

Auctions vs. fixed rate payments

Mitigating deforestation vs. encouraging afforestation

Implications for rural economies – inc. employment

Improving Terrestrial Ecosystem modeling

Incentive Payment for Carbon on Private Land

Payments to private landowners offer cost effective carbon

in some places

(= spatial targeting important in policy)

&

at some times

(= choice of conservation action depends on market conditions)



Questions?

**Thanks for
your
attention!**

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