Update on Risk & Uncertainty in Forest Economics

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Trends in Risk & Uncertainty

Purpose: Report on trends risk & uncertainty in the forest economics literature in the past decade

Risk & Uncertainty since 2000

Change in emphasis

- 1990's: Price Fluctuations
- 2000's: Fire, Risk & Uncertainty

Structure

- 1990's
  Price Fluctuations

- 2000's
  - Fire
  - Risk & Uncertainty

- Review of significant fire papers

State of world in late 1990's

- *Forest Decision-Making in an Uncertain World*, Athens Georgia, 1988

- JFE Special Issue

- Review papers
  - Brazee & Newman 1999
  - Newman 2002

State of World in the 2000's

- Risk & Uncertainty still an active area

- Change emphasis
  - Fire
    - Adjacency
    - Value of Information
    - Fuel treatment and reduction
  - Uncertainty
    - Risk aversion
    - Silvicultural treatments

Forestry Risk & Uncertainty

Fire and Catastrophe

Forestry Risk and Uncertainty

Fire Risk: Causes

- Routledge among the first authors to extend Faustmann to include the probability of a catastrophe

- Incorporates salvage value which changes rotation age

- Stochastic models incorporating risk can result in greater profitability and higher land values than deterministic models

The Effect of Potential Catastrophic Mortality and Other Unpredictable Events on Optimal Forest Rotation Policy

Routledge, 1980

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Fire Risk: Causes

- Response Failures
  - 10% of all fires
  - 60% of escaped fires
  - 85% of the area burned

- Containment Failure
  - 7% of all fires
  - 40%of escaped fires
  - 15% of the area burned

- The odds of a response failure for a fire caused by lightning to be more than twice that of human-caused fires

Empirical Models of Forest Fire Initial Attack Success Probabilities: The Effect of Fuels, Anthropogenic Linear Features, Fire Weather, and Management
Arienti, Cumming, Boutin, 2007

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Fire Risk: Adjacency

- Fuel treatment and fire suppression efforts are obvious externalities adjacent stands exhibit on each other

- Typically, landowners do not undertake fuel treatment at the socially optimal levels

- Landowners do not bear the direct costs of government suppression efforts on their land

Adjacency Externalities and Forest Fire Prevention
Crowley, Malik, Amacher, Haight, 2009

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Fire Risk: Adjacency

Average Fuel Treatment Cost: $225/acre
Fuel Suppression Cost: $122/acre to $294/acre

Combined Fire Suppression Costs for Adjacent Stands for Different Landowner Pairs				
Stand A	Government Agency ($)	Informed Landowner ($)	Uninformed Landowner ($)	Harvest Only Landowner ($)
Government Agency	122.88			
Informed Landowner	146.22	167.93		
Uninformed Landowner	146.18	167.38	166.82	
Harvest Landowner	209.16	230.37	230.37	293.91

Adjacency Externalities and Forest Fire Prevention
Crowley, Malik, Amacher, Haight, 2009

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Fire Risk: Adjacency

- If fire mitigation decisions affect neighboring households, then economic efficiency requires collective action.

- Spatially based mitigation strategies perform better than ignition risk-based strategies.

- The buffer strategy outperformed all other spatial or risk-based strategies.

- Spatially concentrating mitigation efforts is better than spreading them out at random.

Protect Thy Neighbor: Investigating the Spatial Externalities of Community Wildfire Hazard Mitigation
Butry, Donovan, 2008

Forestry Risk and Uncertainty

Fire Risk: Adjacency and Fuel Reduction vs. Fire Suppression

•Wind direction and speed along with fire intensity are the primary factors studied in the spread of fire toward adjacent stand

• Declining marginal effectiveness exists with additional fuel treatment

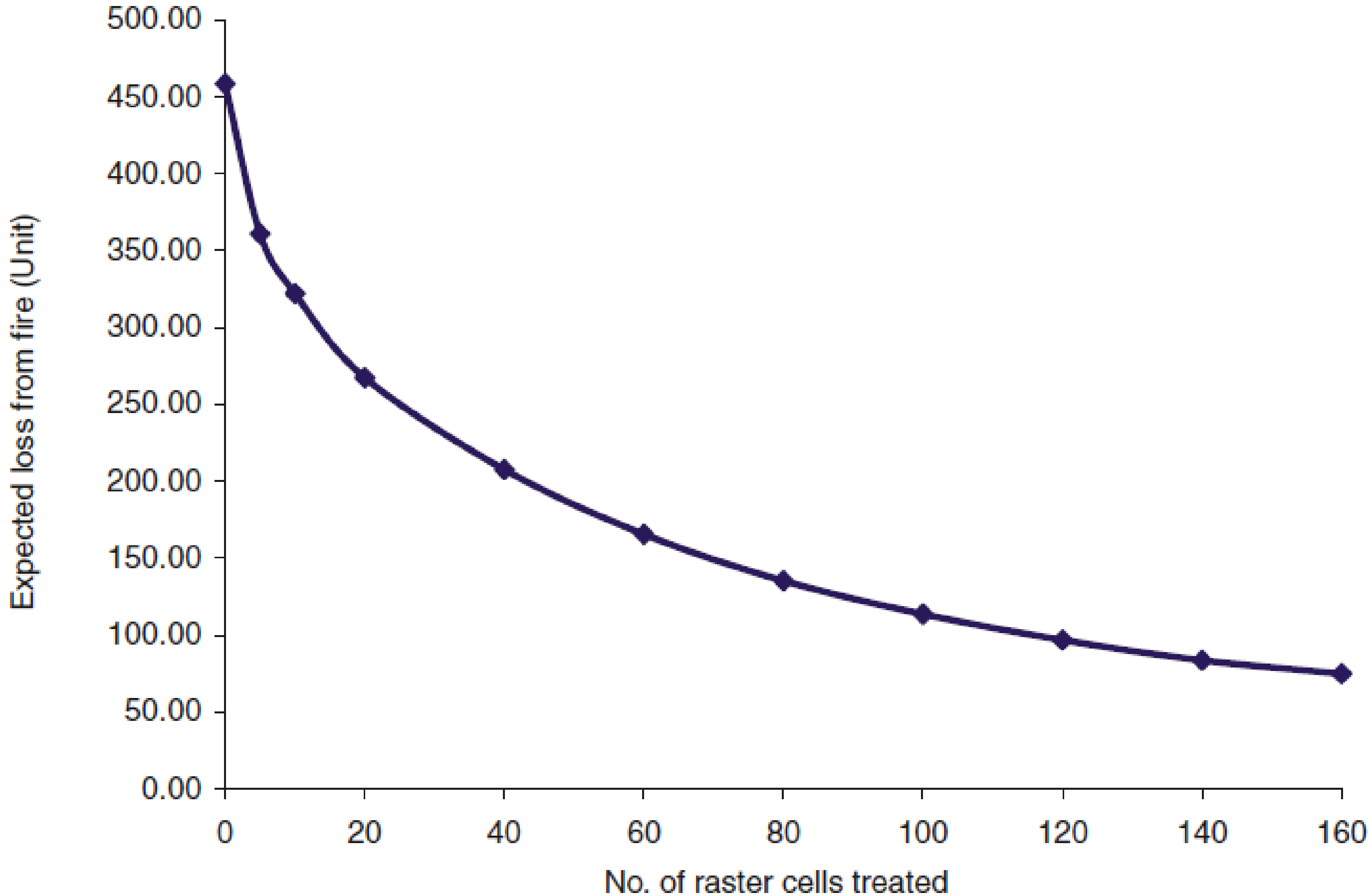
•Cost effective fuel treatment schedules would require strategic and simultaneous consideration of the characteristics of adjacent sections of trees.

An Optimization Model for Locating Fuel Treatment Across Landscape to Reduce Expected Fire Losses
Wei, Rideout, Kirsch, 2008

Forestry Risk and Uncertainty

Fire Risk: Adjacency and Fuel Reduction vs. Fire Suppression

Total expected fire losses after increasing the number of cells to be treated. Marginal productivity decreases when more cells are treated



An Optimization Model for Locating Fuel Treatment Across Landscape to Reduce Expected Fire Losses
Wei, Rideout, Kirsch, 2008

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Fire Risk: Fuel Reduction vs. Fire Suppression

- An optimal balance between fire suppression and fuel reduction must be reached in order to encourage loss reducing incentives.

- Fuel reduction efforts can result in salvage rates between 70% and 94% depending on fire arrival rates

- The combined fuel treatment and suppression costs of $12.8 to $53 per acre compared to $144 per acre on suppression costs alone

Reducing Social Losses from Forest Fires
Amacher, Malik and Haight, 2006

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Fire Risk: Value of Information

•Partial prevention landowner stands to gain between $14 and $28 in net rents per acre with an increase in information accuracy,

- •Full prevention landowner gains between $4 to $12 per acre, and
- •Full prevention with non-timber benefits gains between $3 and $14 per acre.

•Managers stand to gain even greater potential profitability when considering the risk of fire over a long enough time line.

Forest landowner decisions and the value of information under fire risk
Amacher, Malik, Haight, 2006

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Fire Risk: Profitability

- Finds the net present value of the site under a variety of scenarios and risk levels.
- Classic risk and return results

Estimating Harvesting Scheduling and Profitability Under Risk of Fire
Peter & Nelson 2005

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Strategy

Forestry Risk and Uncertainty

Strategy: Uncertainty versus Risk

Uncertainty	Risk
• Develops certain criteria to assess information under uncertainty to determine risk	•Known trends and probabilities are variables optimal thinning and growth functions
• When the growth function is initially unavailable, adaptive optimization is used to transform uncertainty to risk	•Concentrating on thinning and growth prediction, a solution method based on probabilistic dynamic programming is derived to solve the problem.
•After the first stage, the growth function and thinning regimes approaches the true growth function and thinning regimes	• For stand level questions, dynamic programming is a powerful solution technique.

Optimal Stocking Levels and Rotation under Uncertainty and Optimal Stocking Levels and Rotation under Risk

Kao, 1982

Forestry Risk and Uncertainty

Strategy: Uncertainty versus Risk

•Measuring the difference between Uncertainty and Risk means to assess the amount of information and probabilities known about particular issue before making a management decision.

- •Uncertain managers are ignorant to the probabilities of an occurrence
- •Risky managers know the probabilities of an occurrence and act based on that information.

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Strategy: Uncertainty versus Risk

- With small interest rates (0-3.5%) the risk of volatile prices gets smaller using transformation techniques

- Very high stumpage prices may compensate for very low stumpage prices.

- 88% of the revenue is earned all at once under even-aged treatment versus a streams of revenue which reduces the risk in stand management.

On the effect of volatile stumpage prices on the economic attractiveness of a silvicultural transformation strategy

Knoke, Moog & Plusczyk, 2001

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Strategy: Risk Averse Silvicultural Strategies

- Intensive silvicultural practices (e.g., herbicide use and fertilization) can reduce the reservation price and the variance of the financial return, but push up the mean return of a plantation project.

- Intensive management regime increases the timber stock and thus the opportunity cost of delaying harvest at each stand age, depressing the reservation price

- An intensive regime increases the growth of timber and thus the expected benefits of delaying harvesting at each stand age, increasing the reservation price.

- the study showed that intensive practices reduced the expected rotation age by 5 years and the variability of harvest age by 30%.

Optimal Harvest Strategy for Slash Pine Plantations: The Impact of Auto correlated Prices for Multiple Products

Gong & Yin.

Forestry Risk and Uncertainty

Strategy: Risk Averse Silvicultural Strategies

- Risk-neutral forester will likely choose a harvest investment schedule maximizing expected future wealth

- Risk-averse forester will always choose the schedule with the greatest average expected future along with the lowest variance

- Forest investment attractiveness would increase for risk-averse owners under increasingly fluctuating stumpage prices due to potential benefits from risk diversification by investing in forestry

- Risk averter may find it optimal to hoard wealth in the forest.

Risk-Aversion and the Short-Run Supply of Timber
Gong & Lofgren 2003

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Catastrophe: Government Intervention Strategies

- Under existing government program forest managers are less likely to purchase insurance programs
    - Results in a divergence from the socially optimal level of government costs and insurance purchased

- Socially optimal expenditure can be reached through risk-reducing activities (i.e. fuel reduction, thinning) in conjunction with a government programs compensating for losses

Public compensation for windstorm damage reduces incentives for risk management investments

Brunette & Couture 2008

Summary

- Read a few dozen papers
- Report a sampling
- Did not integrate themes