Representing Landowners in a Dynamic Agent-Based Model: A Tool for a Fuzzy World











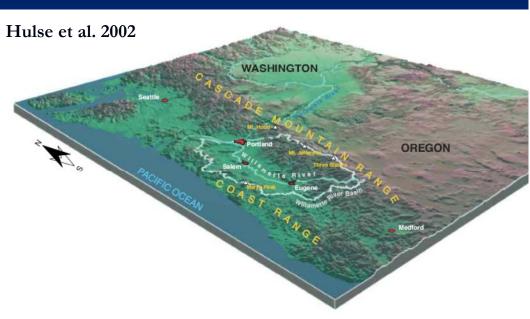
Max Nielsen-Pincus Rob Ribe ISSRM 2011

Climate Change & Land Use

Climate change
Warmer temperature / more fuels ?
Wildland Urban Interface (WUI)
10% of US land area and 40% of US housing

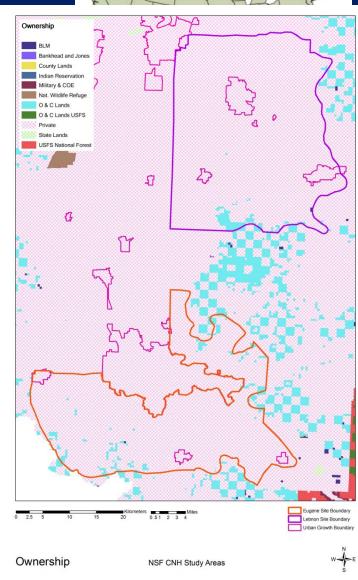
Past fire suppression \rightarrow growing risk of catastrophic wildfire

Oregon's Willamette Valley



Area: **30,000 km²** Oregon's population: **68%** Projections:

- 1.5-4.5°C higher temperatures
- 0-50% more precipitation (winter)
- Longer and deeper summer drought
- More wildfire likely
- Doubling of population



Fire Adapted Oak Savanna Landscape



Oak savanna is a key conservation target Highly vulnerable: 95% loss in 150 years

Low-intensity fires maintained savanna & prevented forest succession. Fire suppression has caused savanna habitat loss



Intense wildfires endanger human and ecological values

How will we respond to wildfire hazard?

How will we choose to develop?

Fire Suppression



Hazard Mitigation

Ecological Restoration





Dispersed development



Compact or clustered development

Multi-Agent Systems (MAS)

MAS Models –

- Useful in the context of simulating landscape change
- Environment is represented spatially
- Agents (actors) are decision making entities
 Actors (e.g., a landowner) are authorized to make decisions influencing their land
- Policies influence or constrain actor decisions
- Actors can respond to change around them

How will climate change, wildfire, and land use interact?

Answer

- Depends on regional land use policy
- Depends on how rural landowners behave, interact, and respond to policy

Objective

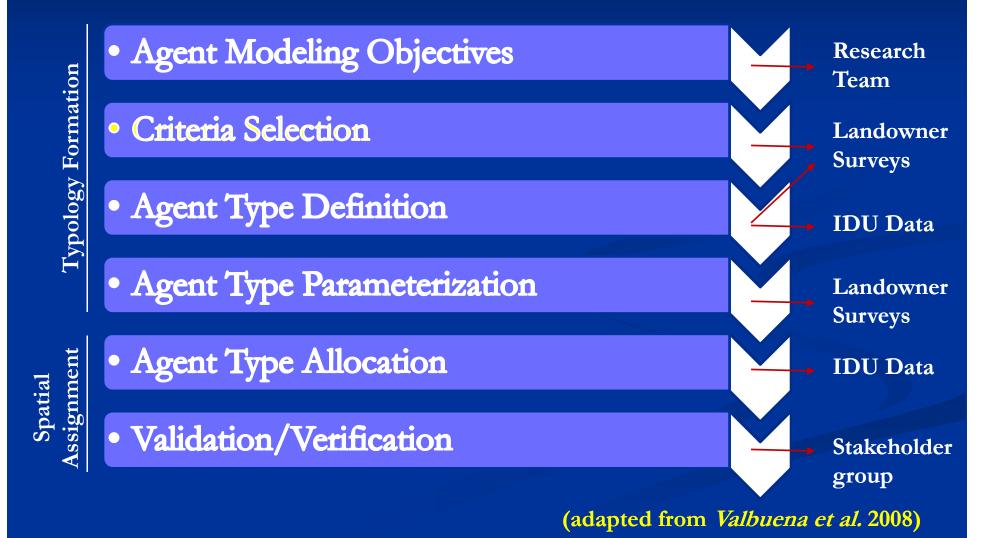
- Identify different types of people on the landscape
- Characterize motivations and land management values
- Assign them to the places in the landscape

<u>Goal</u>

Search for policies that are robust at protecting people and biodiversity across a range of plausible scenarios



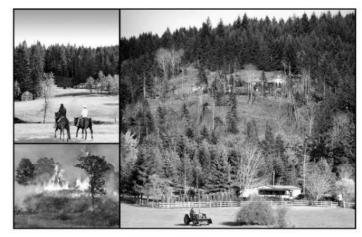
A Method for Creating Agents



Landowner Surveys

- 2 Surveys (Dillman 2000)
- Lane and Linn County
- Non-industrial Private Owners
- Land Mgmt: n=652 (40%)
- Forest Mgmt: n=362 (49%)

WILDFIRE, FOREST MANAGEMENT, AND YOU



A STUDY OF LANDOWNERS IN THE SOUTHERN WILLAMETTE VALLEY FOOTHILLS

WE ONLY ASK YOU TO FILL OUT PARTS OF THIS SURVEY, DEPENDING ON WHAT KIND OF FORESTS YOU OWN.

Your help with this effort is greatly appreciated! Thank You!



Methods for Agent Definition, Allocation, and Parameters

Do groups of respondents exhibit unique characteristics that relate to the landscape?

<u>Criteria</u>

- Motivations \rightarrow
- Land Characteristics $\rightarrow \rightarrow$
- Land Management Values $\rightarrow \rightarrow \rightarrow$ Agent Parameters

Agent Definition Agent Allocation Agent Parameters

Agent Definition

Criteria: 18 goals and objectives for property (factor analysis)
 A set of underlying *motivations*

• *Group* landowners by underlying motivations (cluster analysis)

Agent Type Parameterization: Land Management "Values"

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Agent Spatial Allocation

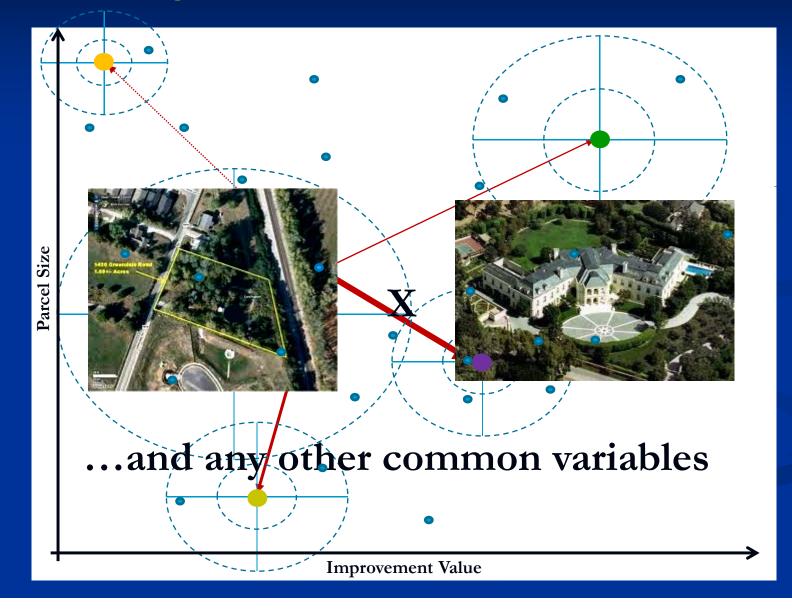
Use common variables to landscape and survey

Compare each parcel's characteristics to the average characteristic for each agent type

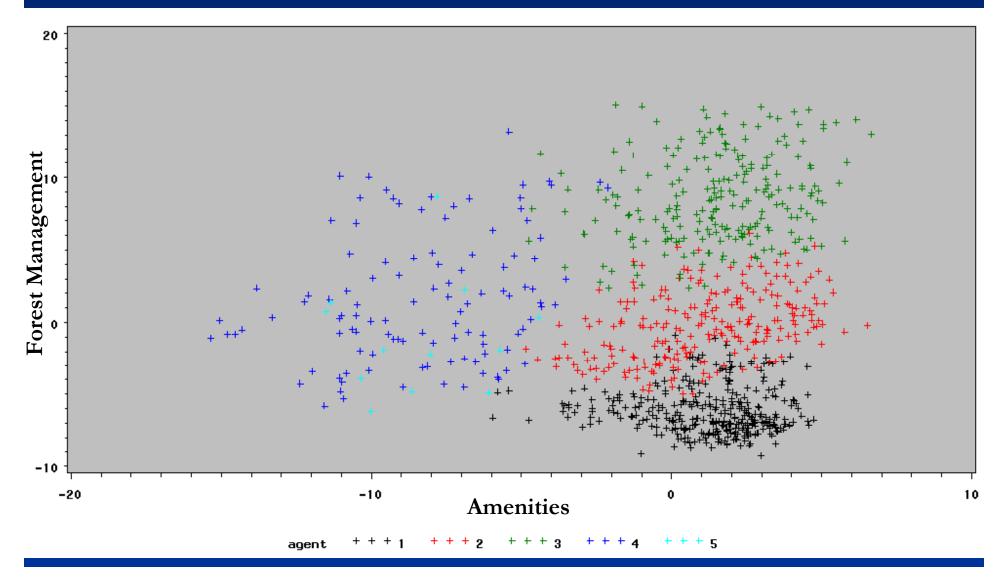
Assign a probability of that each parcel belongs to each agent type

Based on the probability, which agent type does the parcel *most likely* belong to?

Agent Type Allocation



Results – Agent Types Motivation Scores



Results – Agent Types

Type I – Rural Residents (37%) Small Parcels, Moderate Value, Amenity Motivated

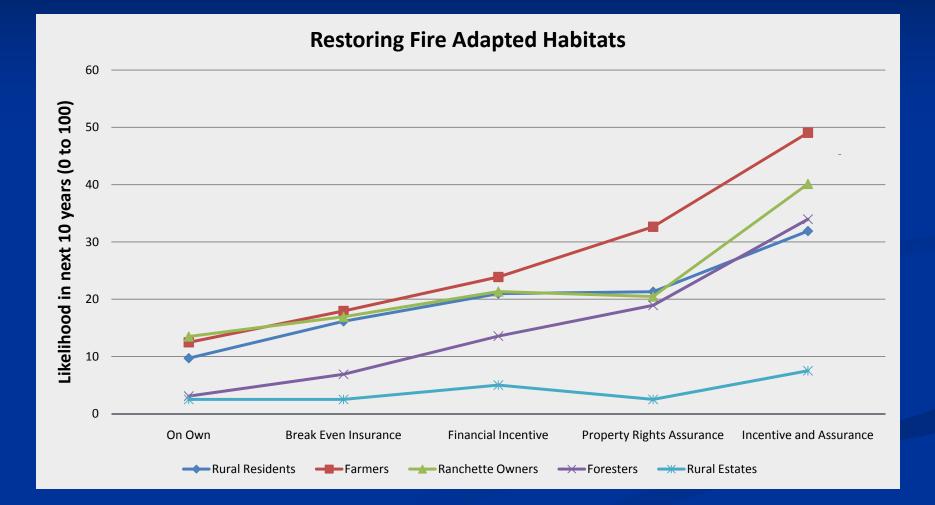
Type II – Ranchette Owners (26%)
 Moderate Parcels, Moderate Value, Diversified Motives

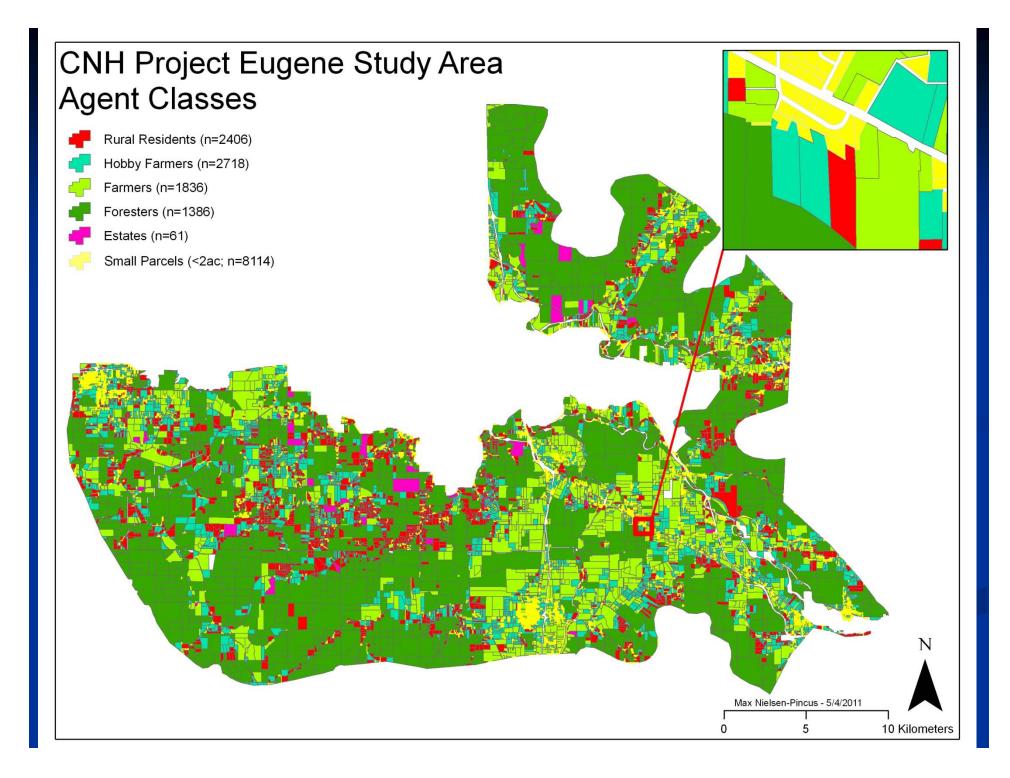
Type III – Farmers (24%) Large Parcels, Low Value, Agricultural Motives

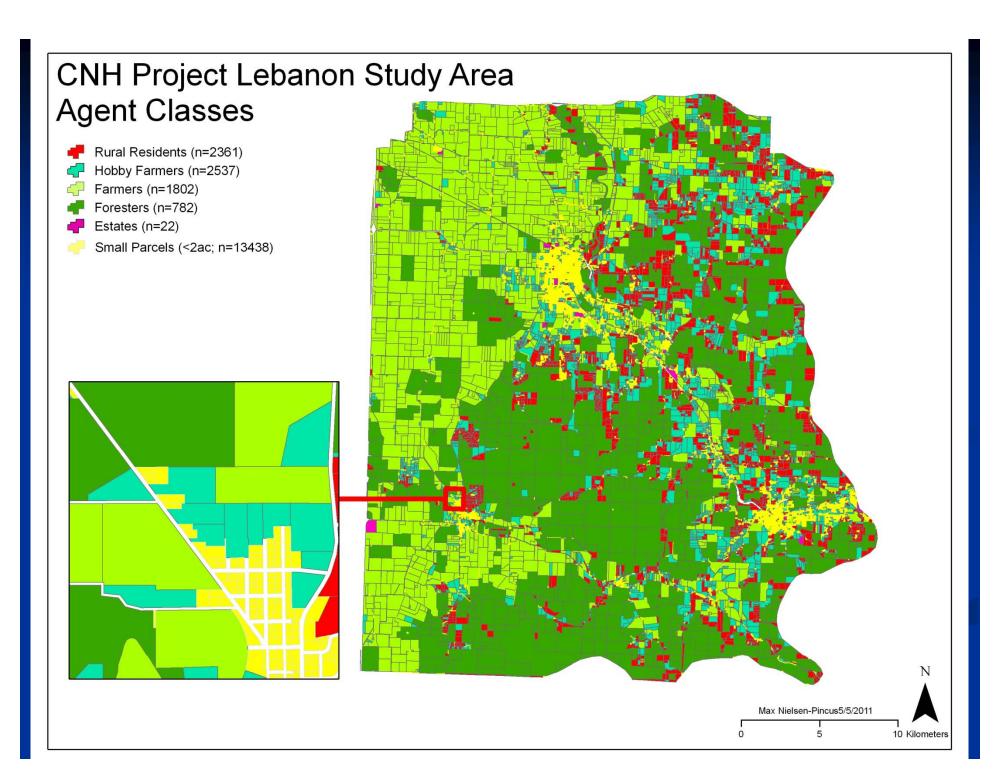
Type IV – Foresters (12%)
 Large Parcels, Low Value, New, Forestry & Development Motives

Type V – Rural Estates (1%) Moderate Parcels, High Value, New, Educated, Development Motives

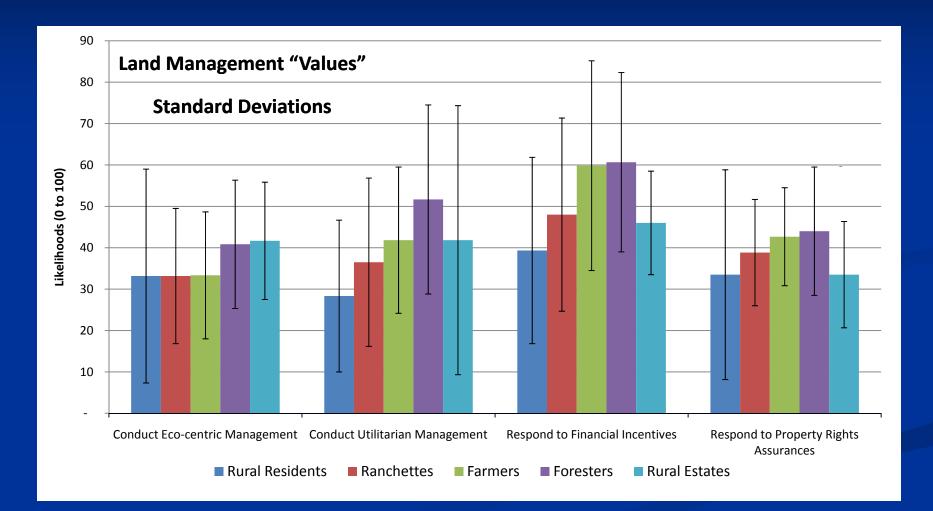
Results – Agent "Values"



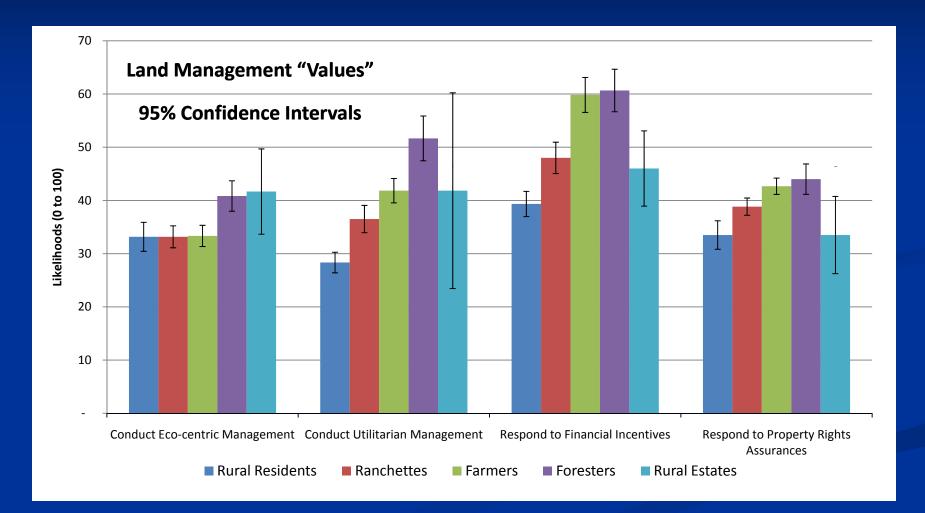




Why Fuzzy?



Why Fuzzy?



Next Steps

- Stakeholder group developing policy scenarios (Summer and Fall 2010)
- Couple models of agents, policies, vegetation, climate, and wildfire, and run fully coupled landscape simulations (Summer 2011)
- Identify scenarios that best protect people and ecosystems across the uncertainties of climate, wildfire, and land use

Refine –

- How do agents learn (neighbors, adaptive mgmt)
- Allow agents to change as landscape changes around them
- New agent types (climate migrants?)

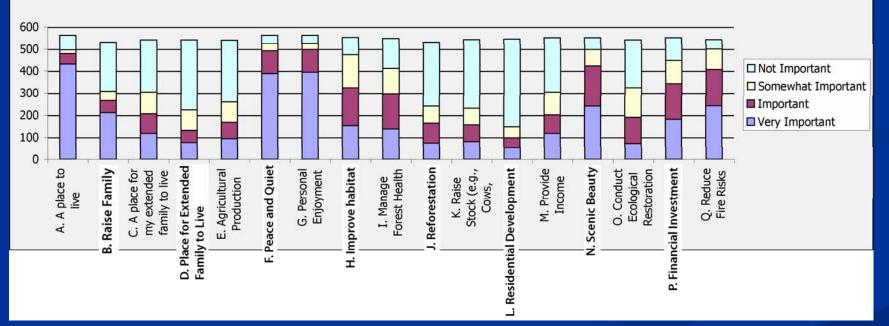
Acknowledgements

Bart Johnson, David Hulse, John Bolte, Landowners

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Agent Type Definition: Goals for Managing Land

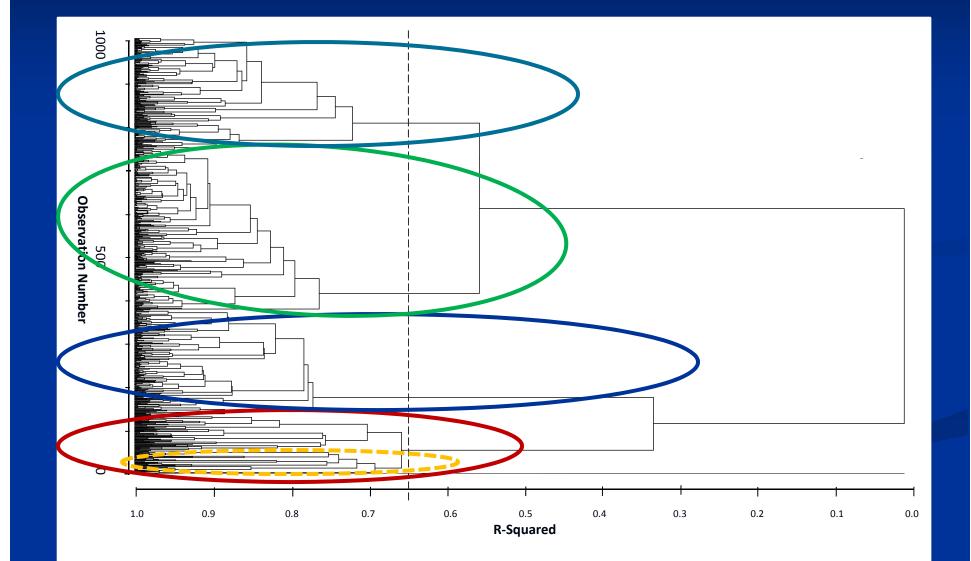


9. Which of the following are important goals for your property in the coming ten years? For each option please check one answer.

Factor Analysis – Landowner Goals

	Amenity	Forest	Home &	Farming	Development
Ownership Goals	Engagement	Management	Family		
Peace and quiet	.76 .76				
Personal enjoyment	.78 .78				
Improve wildlife habitat	.62 .62				
Maintain or improve scenic beauty	.77 .77				
Conduct ecological restoration	.57 .57				-
Reduce fire risks	.49 .50				
A place to live	.60 .58		.58 .59		
A place to raise my family			.75 .75		
A place for my extended family to live			.73 .74		
Timber production		.79 .79			
Manage forest health		.78 .77			
Reforestation of cleared land		.81 .81			
Agricultural production				.88 .87	
Raise stock				.74 .74	
Provide income				.60 .60	
Residential development					.72 .72
Land as a financial investment					.77 .78
Raw Results (n=847) Imputed Results (n=943); Eigenv	alues > 1.0; Five fact	ors account for 65% o	of variance		

Cluster Tree – 5 Underlying Motivations



Agent Type Allocation

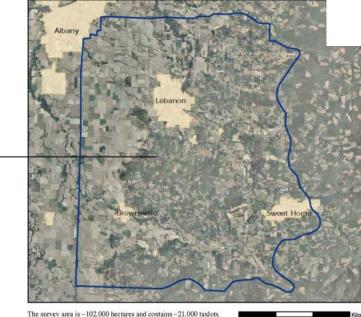
Proposed survey area in Lane County



The survey area is \sim 81,500 hectares and contains \sim 16,500 taxlots. \sim 8,000 of the taxlots (\sim 2,000 hectares) are < 2 acres. \sim 3,700 of the taxlots (\sim 1,200 hectares) are within UGBs.

July 18, 2008

Proposed survey area in Linn County



The survey area is ~102,000 nectares and contains ~21,000 taxios. ~13,000 of the taxiots (2,300 hectares) are < 2 areas. ~11,000 of the taxiots (~4,000 hectares) are within UGBs.

Two contrasting 1000-km² study areas

Agent Type Allocation

- Use variables common to survey respondents and all parcels:
 - Parcel Size
 - Improvement Value
 - Average acres of Oak
 - Percent of parcel classed as Agriculture
 - Percent of parcel classed as Forest
 - Percent of parcel not classed as Other LULC