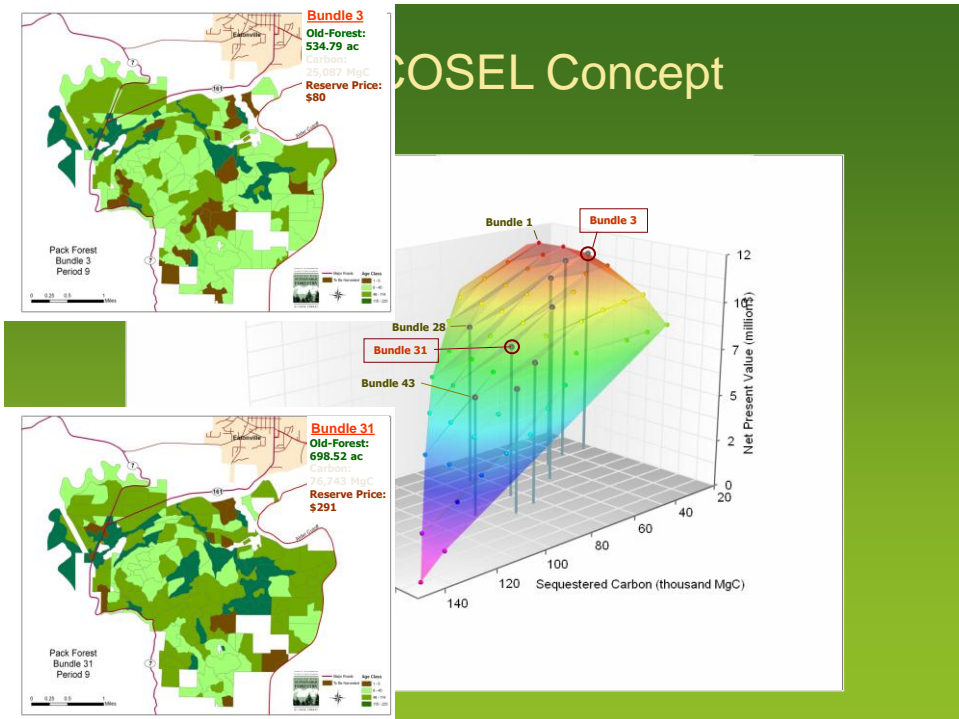




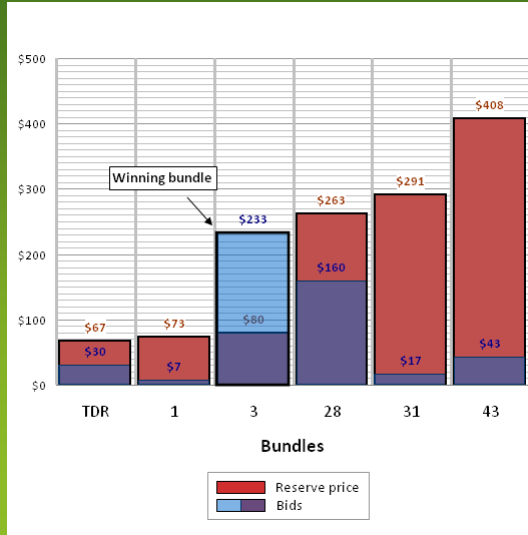
# Linking Biometrics with Economics to Sell Forest Ecosystem Services

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University of Washington

Western Forest Mensurationists and Economists Meeting  
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# The Auction



MEMBER LOGIN

Why Ecosel? Land Campaigns Manage Account

## Ecosel puts forest management in *your* hands.

Here's How It Works:



BIDDERS GO HERE >  
LANDOWNERS GO HERE >

### About ECOSEL

ECOSEL provides a way for the public to join forces and bid collaboratively or competitively to influence forest management on private land. The management alternative that attracts the most bids will be implemented by the landowner through a legally binding conservation easement. [Learn more >](#)

### Current Land Campaigns

**Pack Forest**  
Eatonsville, WA



University of Washington's working forest seeks to continue the tradition of training students. [Learn more >](#)

**Blue Mountain**  
Startup, WA



A landowner seeks to improve water quality and retention in the Sultan Basin. [Learn more >](#)

### Land Management:

*What's Important To You?*

- Habitat Preservation**  
Concerned with the integrity and health of a particular ecosystem? ECOSEL allows you to promote conservation easements. [Learn more >](#)
- Recreation**
- Wood Products**
- Carbon Sequestration**
- Restoration**

Why Ecosel? Campaigns Manage Account Privacy Policy Contact Us



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# How it works

Here's How It Works:

**Step 1**

Select land



Select a land campaign you care about

+

**Step 2**

Bid on a plan



Think about what's important to you

+

**Step 3**

Winning plan implemented



Compare various plans

# How it works

Here's How It Works:

**Step 1**

Select land



Check campaign status

+

**Step 2**

Bid on a plan



Convince others to bid

+

**Step 3**

Winning plan implemented



Strategize. Re-bid.

# How it works

Here's How It Works:

**Step 1**  
Select land

**Step 2**  
Bid on a plan

**Step 3**  
Winning plan implemented



Bidding  
closes

+



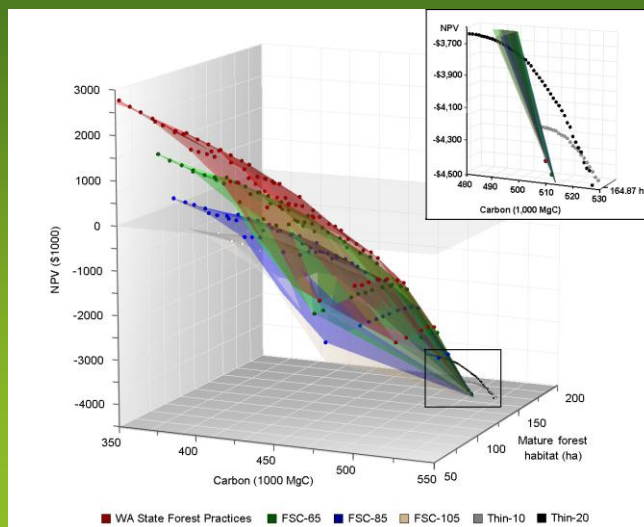
Winning contract  
becomes binding

+



3rd party monitoring  
assures compliance

# Biometrics and Optimization



## Multi-objective Optimization to Identify Efficient Alternatives

$$\max \left( \sum_{i,p} r_{ip} x_{ip}, \sum_{i,p} CO_{ip} x_{ip}, \sum_{i,p} a_i z_{ip} \right)$$

Carbon sequestration

Timber revenues

Mature forest habitat

How do we calculate the coefficients?



## How do we calculate the coefficients (cont.)?

- Revenue coefficients:
  - Continuous inventory plots and FVS for volume projections
  - Internal data for prices, costs and interest rate
- Carbon coefficients
  - Aboveground, belowground and decaying carbon pools
  - Permanent plots for initial stem diameters and heights
  - Allometric equations in FVS (after Shaw 1979, Standish et al. 1987, Jenkins et al. 2003)
  - FVS Fire and Fuel Extension Model (Reinhardt and Crookston 2003) to transform snags to coarse woody debris

## And the question is:

- How much precision (in measurements and projections) do we need?
- Too low levels of precision can lead to lack of credibility and inaccurate threshold costs
- Too high levels of precision can lead to high management and transaction costs

## Economics

Classification: ECOSEL is a multi-unit, multi-dimension, public good subscription game with incomplete information and asymmetric preferences

## Mathematical Characterization

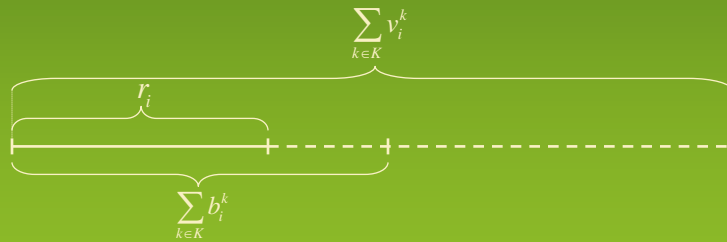
Notation:

- $I$  = the set of bundles available in the auction ( $i$  indexes  $I$ );
- $K$  = the set of players who play the game ( $k$  indexes  $K$ );
- $v_i^k$  = valuation or utility that Player  $k$  assigns to Bundle  $i$ ;
- $b_i^k$  = the final bid that Player  $k$  places on Bundle  $i$ ;  
and
- $r_i$  is the reserve price of Bundle  $i$

## Mathematical Characterization Cont.

Social Surplus:

$$SS_i = \sum_{k \in K} (v_i^k - b_i^k) + \sum_{k \in K} b_i^k - r_i = \sum_{k \in K} v_i^k - r_i$$



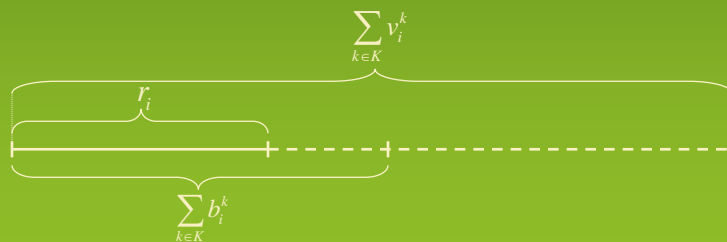
Note: Social surplus does not depend on the value of final bids

## Mathematical Characterization Cont.

Winning Conditions:

$$(1) \sum_{k \in K} b_i^k - r_i \geq 0$$

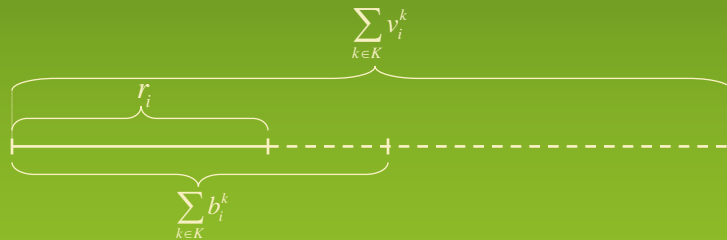
$$(2) \sum_{k \in K} b_i^k - r_i = \text{Max}_{j \in I} \left( \sum_{k \in K} b_j^k - r_j \right)$$



## Mathematical Characterization Cont.

Theoretical Welfare Maximum and Efficiency:

$$\sum_{k \in K} v_i^k - r_i = \text{Max}_{j \in I} \left( \sum_{k \in K} v_j^k - r_j \right)$$



## Mechanism Design

- Design options
  - Maximize social surplus (efficiency)
  - Maximize seller revenue
- Methods
  - Theoretical testing (game theory and simulation)
  - Empirical testing (experimental economics)

## Mechanism Design cont.

- Design variables:
  - Reserve price disclosure
  - Communication policy
  - Bid withdrawal policy
  - Refund policy
  - Number of bundles
  - Auction sequencing
  - And many more....

## Experimental Design

- Auction T1: No communication, 3 projects, threshold costs disclosed
- Auction T2: No communication, 5 projects, No threshold cost disclosure
- Auction T3: Communication, 3 projects, No threshold cost disclosure
- Auction T4: Communication, 5 projects, threshold costs disclosed
- Fractional factorial design

Runs → Rooms ↓	1	2	3	4
R1	T1	T2	T3	T4
R2	T2	T3	T4	T1
R3	T3	T4	T1	T2
R4	T4	T1	T2	T3

## Procedures

- Subjects: UW undergraduates
  - Variety of majors/classes
- 2 rounds of experiments: April and June 2009
  - 54 out of 60 planned participated in April round
  - 71 out of 80 planned participated in June round

## Procedures

- Subjects received either 10 or 20 Experimental Monetary Units (EMUs) for each auction
- EMUs did not carry over between auctions
- 1 EMU = \$0.25
- Each auction had 5 bidding (contribution) rounds, participants were informed that round 5 determined the winning project (if any)

## Subject Utilities and Payoffs

- Induce heterogeneous preferences over ecosystem service X (“tons of carbon sequestered”) and Y (“old-forest habitat”)
- Subject only pays if the project bid on actually wins (full refund) and the seller (experimenter) keeps any excess of subjects’ bids over the threshold cost (no rebates)
- Subject “preferences” determined for them, drawn from 0,1,2 with restriction that no subject would get 0,0 preference (No preference for either X or Y)

$$v_k^i = \begin{cases} \alpha_k X_i + \beta_k Y_i + w_k - b_k^i & \text{if } \sum_{k=1}^K b_k^i - r_i \geq \max_j (\sum_{k=1, j \in I \setminus i}^K b_k^j - r_j) \geq 0 \\ w_k & \text{otherwise} \end{cases}$$

## Summary of results

- Public good provision: 21 out of 32 (65.6%)
- Efficient public good provision:
  - 4 out of 32 auctions (12.5%)
  - Average relative efficiency (Realized net benefit/Max net benefit): 49% across all trials, 80% in auctions ending in public good provision
- Seller revenue:
  - 3.1% average profit margin
  - 5% profit margin in successful auctions
- Mechanism not fully efficient (but we knew that already from theory...)

## Design variables

		Relative efficiency equation [2a]		Seller profit equation [2b]	
		Estimate	P-value	Estimate	P-value
Design variables	Communication allowed:	1.485	0.062	-5.8954	0.295
	Low number of bundles presented:	-0.2404	0.323	4.4158	0.027
	Threshold costs disclosed:	1.3351	0.061	-13.337	0.011
Nuisance variables	Threshold cost of the bundle that maximizes social surplus (% of group endowment):	-4.2499	0.007	---	---
	Max achievable net benefit per person:	0.1537	0.01	0.0365	0.874
	Threshold cost disclosure x Max achievable net benefit per person:	-0.0077	0.08	0.0653	0.043
	Auction run no.:	0.2406	0.068	1.2031	0.124
	Auction run no. x Communication allowed:	-0.2685	0.243	1.7812	0.268
Statistics	Standard deviations ( $\sigma_v / \sigma_\epsilon$ ):	0.4241	< 0.0001	2.7377	< 0.0001
	Correlation coef. ( $\rho$ ):	Estimate = 0.4379; P-value = 0.198			
	Log Likelihood:	-51.915			
	Sample size (N):	24		16	



## Questions?

### ECOSEL TEAM

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