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Spatial Informatics Group, LLC



Optimizing timber and carbon revenue under uncertainty – tool development for large property owners

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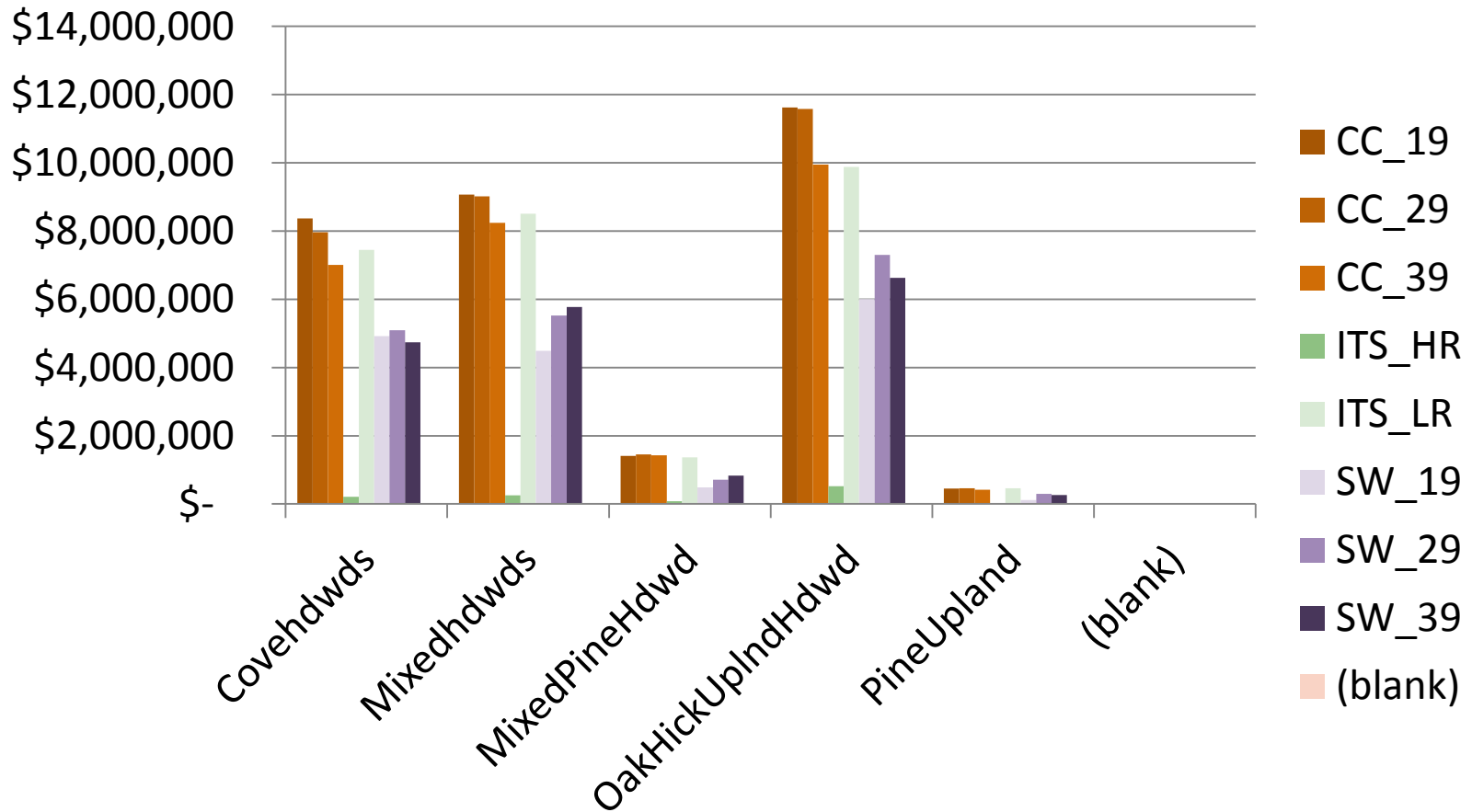
The problem

- How to maximize NPV from both timber and carbon?
- How many acres under carbon?
- Reconciling inventory fluctuations with carbon project reversal risk

Enter example pictures

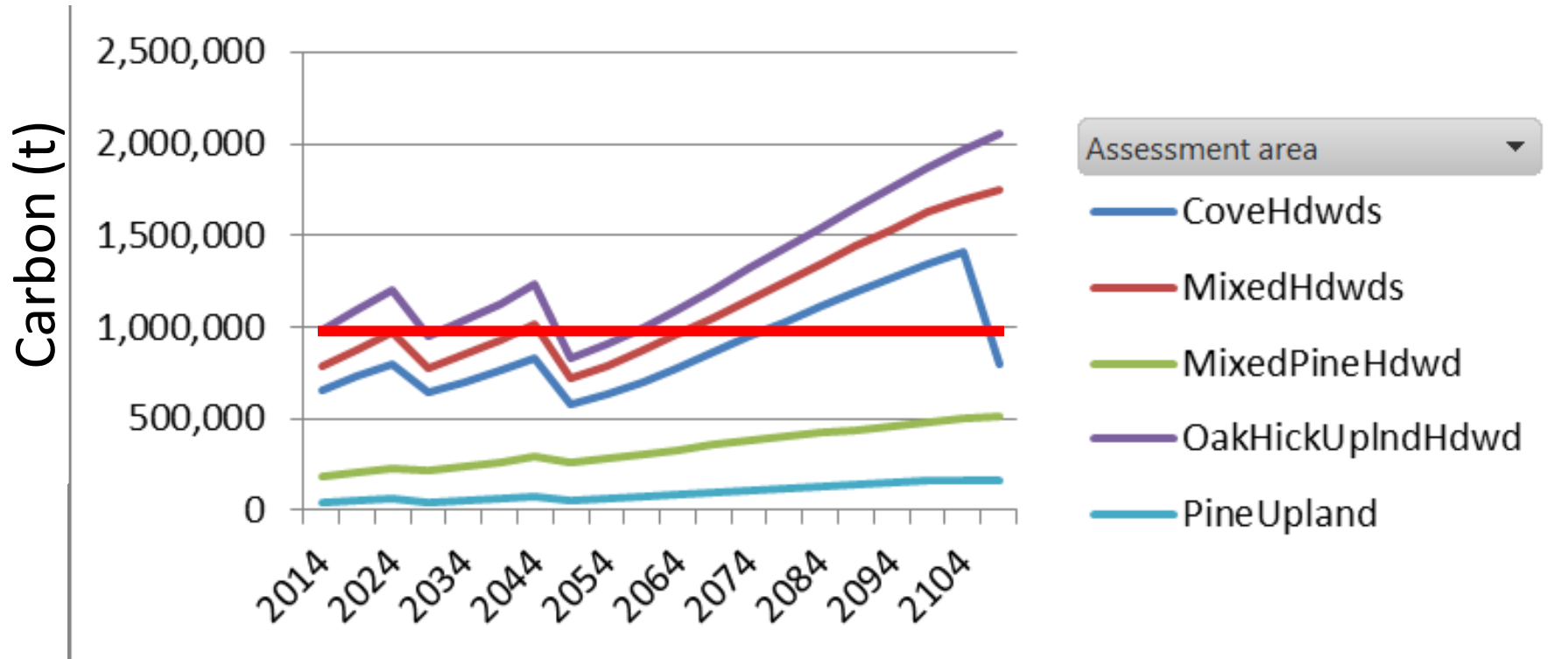


Optimizing NPV for timber



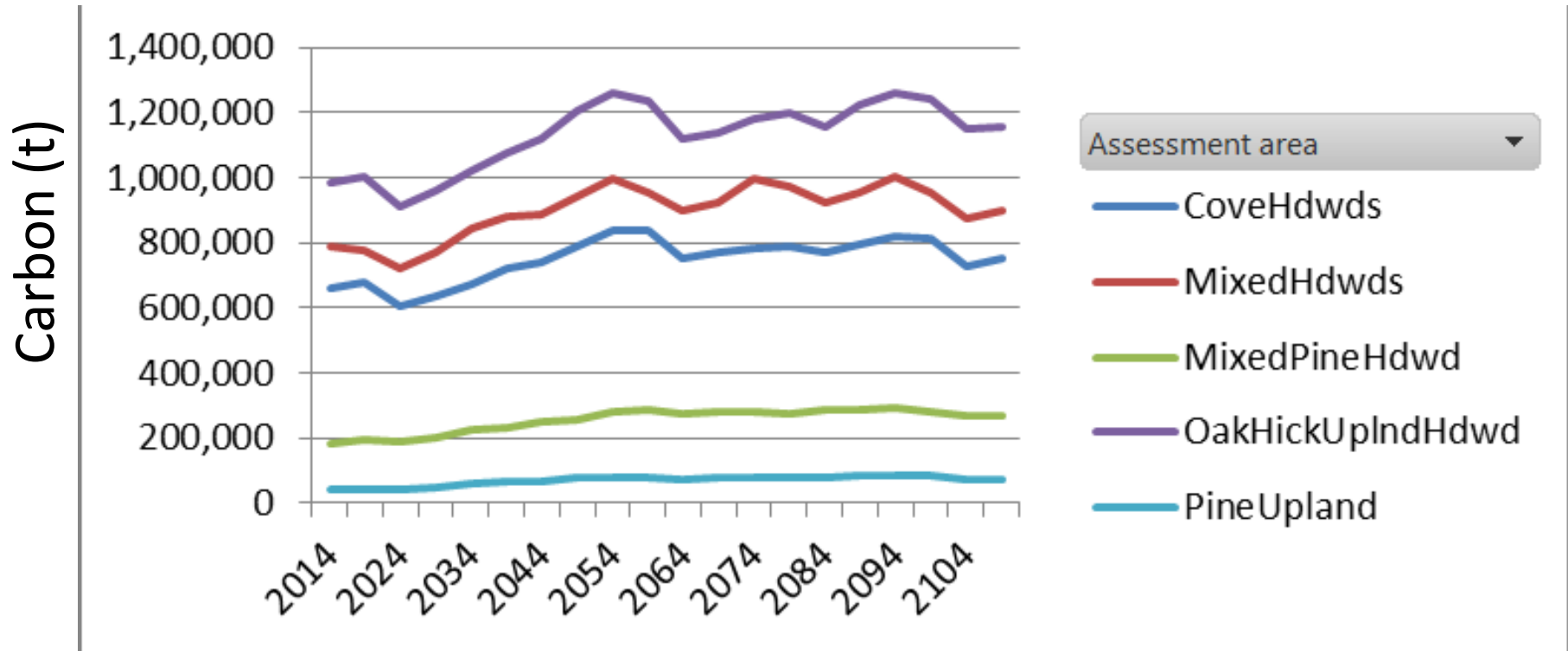
Carbon project reversal risk

Shelterwood prescription



Carbon project reversal risk

Individual Tree Selection – Low Retention



Other constraints

- Sustained yield constraints
 - Minimizing periodic fluctuations in harvests
- Honoring long-term timber contracts
 - Minimum harvest rates by species and period
- Ensuring minimum acreage under defined prescriptions
 - e.g. wildlife management zones, stream management zones



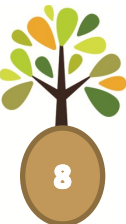
Optimizer Specifications

- Optimization variable
 - Net Present Value (timber and carbon)
- Constraint variables
 - Timber flow fluctuations (e.g. +/-10% per period)
 - Acreage by prescription
 - Harvest volume by species and period
 - Inventory fluctuations (e.g. 'not declining')
- Input variables by stand
 - Harvest volumes (MBF)
 - Carbon inventory by period (tonnes)



Optimizer Specifications

- Up to six forest management prescriptions
- Four species/product groups
- Price appreciation assumptions (carbon credits and stumpage)
- Set up for >2000 stands
- Solve time: ~90 min



Optimizer Dashboard: General

- Timberland values, tax rates
- Individual discount rates for timber and carbon project
- Stumpage and carbon price assumptions, initial costs (e.g. property purchase, carbon project initiation), annual (e.g. forest management, carbon reporting) and periodic (e.g. forest plan) costs.



Optimizer Dashboard: Carbon

| Flow Constraints | |
|---------------------------------------|--------|
| Constraint | Toggle |
| Nondeclining stocks on carbon project | Yes |
| 20% Leakage Limit | No |
| Nondeclining Stocks | No |
| | |
| Carbon Constraints | |
| Constraint | Input |
| Turn Off Carbon Revenue After Year: | 100 |
| Turn Off Carbon Project | No |



Optimizer Dashboard: timber

| Harvest flow | | | |
|-------------------------------------|-----|------------|-----------------|
| Harvest Flow | 10% | +/- Decade | |
| Low-impact prescription Constraints | | | |
| Tract | | Acres (>=) | Acres Available |
| Tract 1 | | 4,180 | 19,951 |
| Tract 2 | | 428 | 9,297 |
| Tract 3 | | 2,400 | 19,654 |
| Tract 4 | | 501 | 3,847 |
| Tract 5 | | 300 | 12,994 |
| Total | | 7,809 | 65,744 |



Optimizer Dashboard: timber

| Offtake Constraints | | | |
|---------------------|--|-----------------------|------------------------|
| Species Group | | MBF/Decade (\geq) | Avg. MBF/Decade Avail. |
| Species 1 | | 75,000 | 264,184 |
| Species 2 | | 75,000 | 242,759 |
| Species 3 | | 150,000 | 157,396 |



Optimizer Dashboard

| Silviculture Table | | | |
|-------------------------------|---------|------------|----------|
| Prescription | Acres | Percentage | Min acre |
| Grow | 8,830 | 6.4% | 5,000 |
| Clearcut (Start in Decade 1) | 50,648 | 36.7% | 40,000 |
| Clearcut (Start in Decade 2) | 21,656 | 15.7% | 20,000 |
| Selection (Start in Decade 1) | 31,146 | 22.6% | 15,000 |
| Selection (Start in Decade 2) | 23,944 | 17.3% | 10,000 |
| Sanitation/Salvage | 1,824 | 1.3% | 0 |
| Total | 138,048 | 100.0% | |

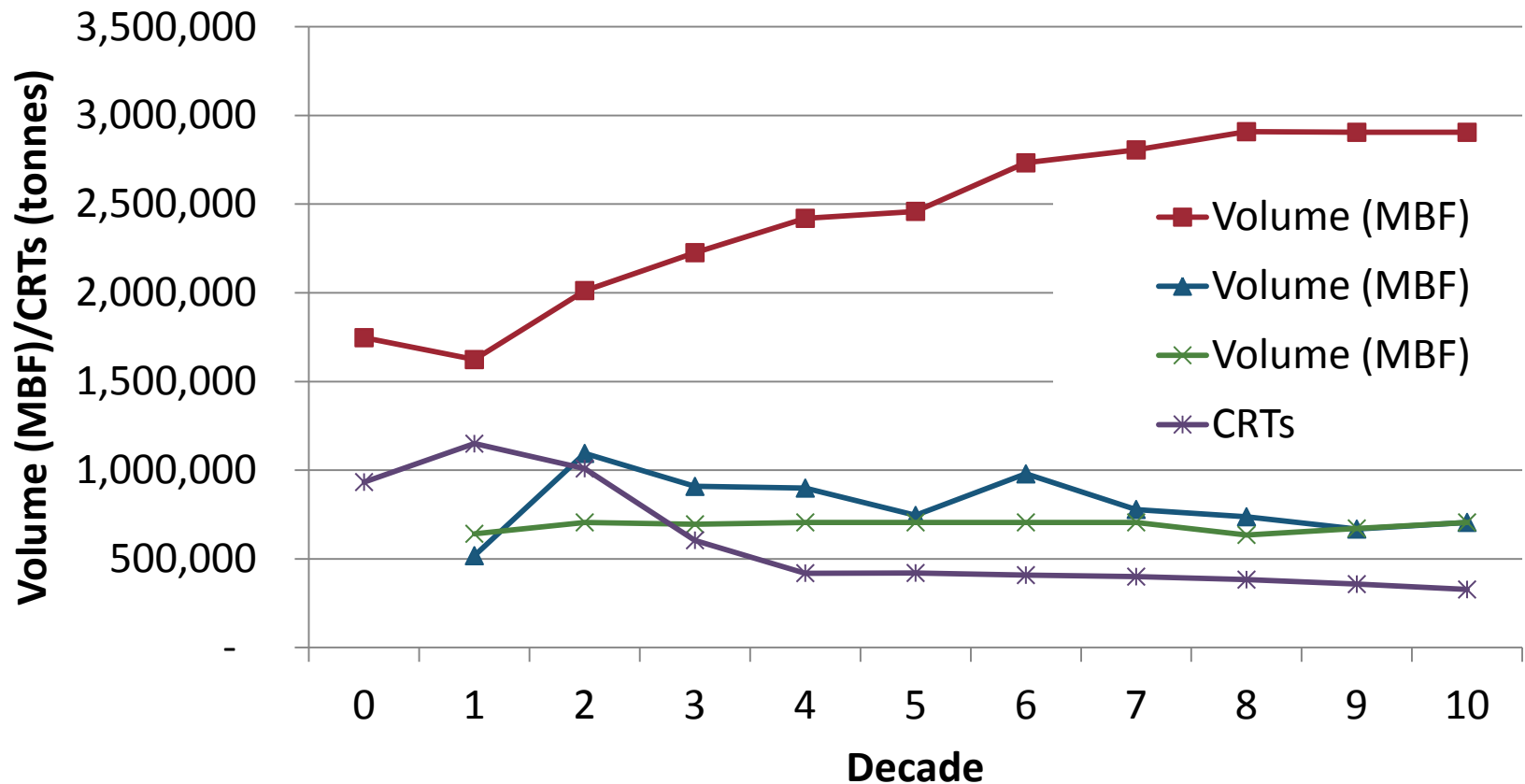


Optimizer dashboard: Outputs

| | | | |
|-------------------------------|-------------------|---------------------------|-----------------|
| Total Acres: | 138,047.6 | Carb. Proj. Acres: | 63,950.6 |
| Total Harvested (MBF): | 6,876,959.0 | CRTs (tonnes): | 6,413,133 |
| Species 1 Harvested (MBF): | 2,641,841.5 | | |
| Species 2 Harvested (MBF): | 2,427,591.2 | | |
| Species 3 Harvested (MBF): | 1,573,962.5 | | |
| Misc. Harvested (MBF): | 233,517.9 | Timber | Carbon |
| NPV: | \$ 254,133,294.11 | \$ 230,431,050 | \$ 23,702,244 |
| NPV per Net Acre: | \$ 1,841 | \$ 1,669 | \$ 172 |
| NPV per Total Acre: | \$ 1,475 | \$ 1,337 | \$ 138 |
| NPV per Acre (Low Timber): | \$ 1,250 | | |
| NPV per Acre (High Timber): | \$ 3,135 | | |

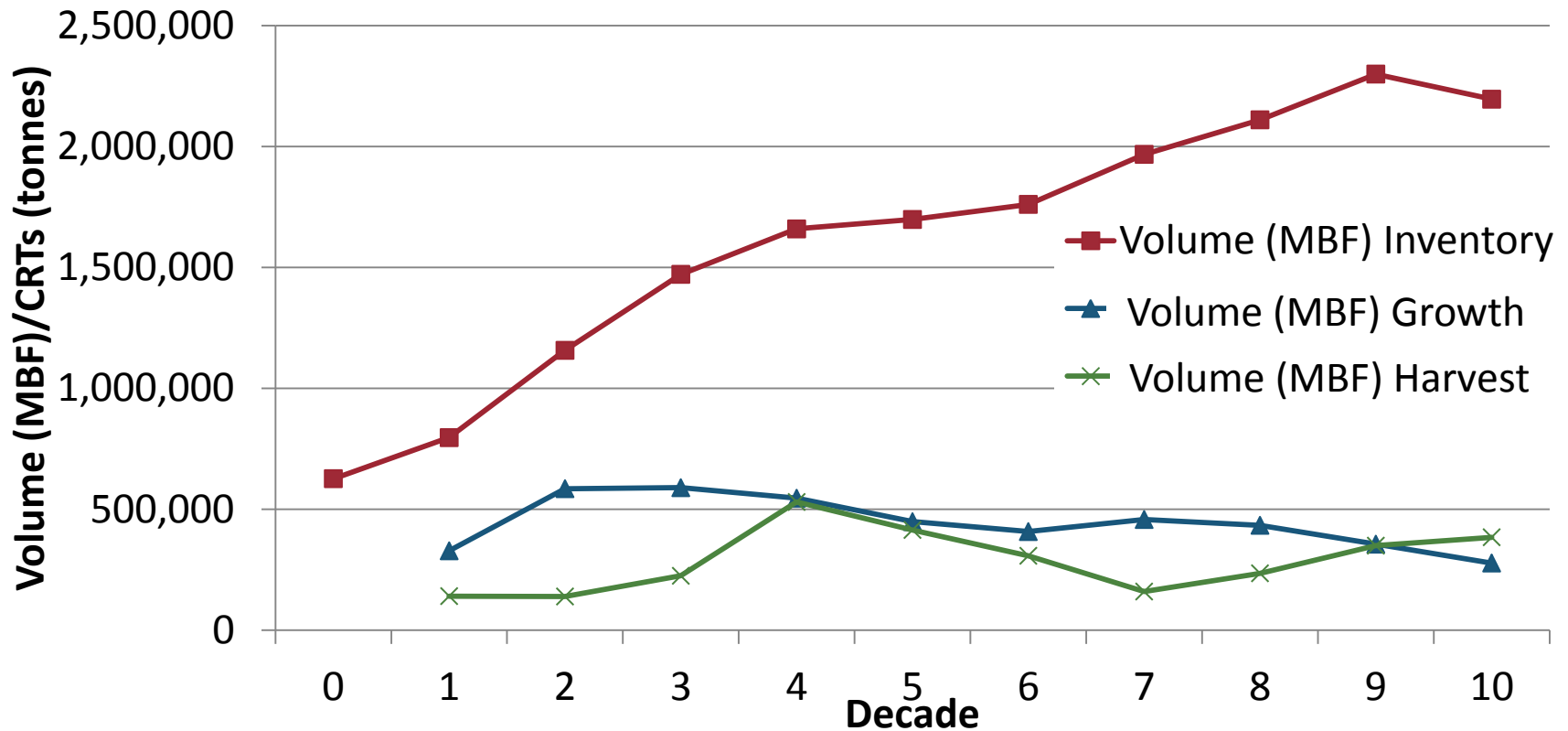


Optimizer dashboard: Outputs



Optimizer dashboard: Outputs

Carbon Project Area Only



Findings

- At current offset prices, the model optimizes for timber only
- Fits well for Ongoing management:
 - Advanced purchase negotiations, Planning for existing properties
- Challenges in application:
 - Early purchase /feasibility study
- High-impact variables: Inventory, Timber quality, Silvicultural prescription definitions
- Low impact variables (with current market conditions):
Carbon price, Stumpage, discount rates



Questions



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