



# Outline

## Upcoming Decisions

- Objective Function
- Specification Decisions
  - Revenue
  - Costs
  - Discount Rate

## Objective Function



## Revenue



## Cost



## Discount Rate



# GOAL

- Enable the best decision making
- Inform your decision making
- Equip you with knowledge
  - Decision Context
  - Framework / Evaluation



# Sustainable Harvest Calculation

Choose

Choose  $x$   
(management actions)

Optimize

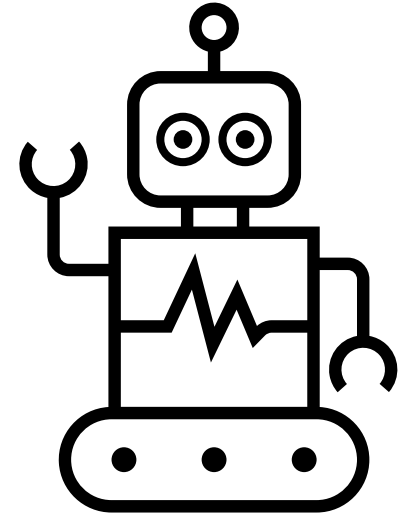
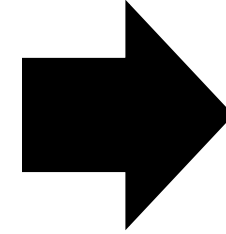
*Maximize*

Objective Function

*Objective(x)*

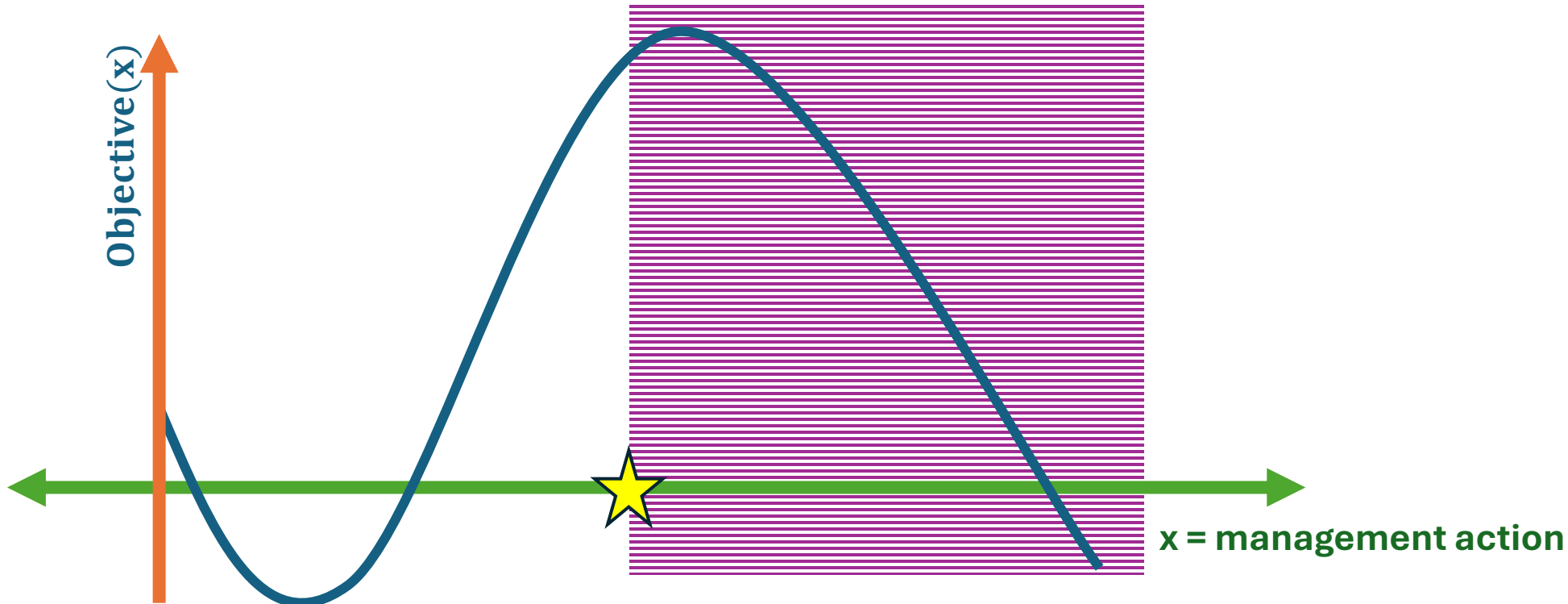
Constraints

s.t. Laws & Regulation



Solve!

$x =$  ★



Optimize

Objective Function

# Operating Environment - PSF

Maximize

Objective(x)

**ECONOMIC PERFORMANCE**  
The Economic Performance category contains policies that, consistent with the other policies in this document, provide the broad context for DNR's economic management of forested state trust lands and the production of perpetual revenue for each trust beneficiary. These policies relate to revenue production and financial performance, including activities and commodities to be considered in producing revenue from forested state trust lands; sustainable harvest; and lands that are available for timber management activities:

- Financial Drivers
- Financial Assumptions
- Definition of Sustainable Harvest
- Recalculation of Sustainable Harvest
- Harvest Deferral

**Intended Outcome**  
The Economic Performance policies are intended to ensure perpetual revenue for the trusts by:

- Using aggressive marketing and market timing of forest products and

Page 5

**POLICY ON DEFINITION OF SUSTAINABILITY FOR THE SUSTAINABLE HARVEST CALCULATION**

- The department will calculate, and the Board of Natural Resources will adopt, a separate long-term desired sustainable harvest level for each of several distinct sustainable harvest units. The department will express the sustainable harvest level for a given unit as mean annual timber volume for a planning decade.
- In Western Washington, the sustainable harvest units (a total of 20) are as follows:
  - The Olympic Experimental State Forest, regardless of trust.
  - The Capital State Forest, regardless of trust.
  - Each of the 17 county beneficiaries of State Forest Transfer lands (separately including those lands in the Olympic Experimental State Forest or Capital State Forest).
- All of the federally granted trust and State Forest purchase lands in Western Washington, together, with the exception of the Olympic Experimental State Forest and Capital State Forest.

For Eastern Washington, sustainable harvest units will be determined as follows:

- The department will, within an estimated or volume forest from the Trustee lands, a forest shall be established with:
- market opportunities, the harvest level for any year within the planning decade may fluctuate up to 25 percent plus or minus from the mean annual harvest level adopted by the Board of Natural Resources, as long as the decision does not violate over the decade.

The department will analyze the financial characteristics of forest stands in order to optimize the economic value of forest stands and timber production over time, in calculating the sustainable harvest level, in planning and calculating timber harvests, in making investments in forest growth, and in searching for the least-cost methods of achieving other forest management objectives.

related to economic and financial trends may identify partnerships or additional opportunities to improve financial performance through diversification.

**POLICY ON FINANCIAL DIVERSIFICATION**

- The department will identify and offer a mix of forest products to take advantage of existing markets and market value fluctuations.
- The department will evaluate and capture financial opportunities through production, marketing and sales of both timber and non-timber related commodities and uses.
- The department will actively expand its efforts to identify, develop and target new national and international markets for forest products and seek opportunities to creatively market and sell forest products to improve overall financial performance.
- Anticipating future demand, the department will prudently pursue economic opportunities related to ecological and social benefits that flow from forested state trust lands, to improve the net revenue from harvests.
- To guide decisions about trust asset management and allocation and to

Page 27

DNR makes certain assumptions as it uses various investment models to guide decisions related to silvicultural investments, capital investments (such as roads), forestland investments, and others.

DNR relies primarily on net present value as the most comprehensive and direct way to measure financial returns to the trusts and evaluate investments. However, measures such as internal rate of return and cost-benefit ratio may be best suited for some specific situations.

The nature and timeliness of reviews and updates of financial assumptions are critical to making sound investment decisions on behalf of each trust. In addition, all DNR updated programs benefit from a periodic department review and, where appropriate, adjustment of basic financial assumptions. Such an approach provides better consistency between the various update programs and financial decision-making on behalf of each trust.

NATURAL RESOURCES



## POLICY FOR SUSTAINABLE FORESTS



DECEMBER 2006



WASHINGTON STATE DEPARTMENT OF Natural Resources  
Doug Schellard, Commissioner of Forest Lands



WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

Q: What should the SHC optimize?

A: Economic Value

Optimizing the economic value of forest stands;

Pursuing both existing and future economic opportunities related to non-

Q: How do we determine economic value?

A: Analysis of financial characteristics

The department will analyze the financial characteristics of forest stands in order to optimize the economic value of forest stands and timber production over time, in calculating the sustainable harvest level, in

Q: What financial analysis should be done?  
A: NPV (maybe IRR or C-B Ratio)

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The nature and timeliness of reviews and updates of financial assumptions are critical to making sound investment decisions on behalf of each trust. In addition,

Choose

Choose  $x$   
(management actions)

Optimize

*Maximize*

Objective Function

*Objective(x)*

Constraints

s.t. Laws & Regulation

Economic Value(x)

**Q: What should the SHC optimize?**  
**A: Economic Value**

Financial Analysis(x)

**Q: How do we determine economic value?**  
**A: Analysis of financial characteristics**

Net Present Value(x)

**Q: What financial analysis should be done?**  
**A: NPV (maybe IRR or C-B Ratio)**



Choose

Choose x  
(management actions)

Optimize

*Maximize*

Objective Function

**Net Present Value(x)**

Constraints

s.t. Laws & Regulation

**Q: What is Net Present Value?**

$$A: \sum_t \frac{Revenue_t - Cost_t}{(1+r)^t} \quad \begin{array}{l} r = \text{discount rate} \\ t = \text{year} \end{array}$$

← Standard

**Q: What is Benefit-Cost Ratio?**

$$A: \frac{\sum_t \frac{Revenue_t}{(1+r)^t}}{\sum_t \frac{Cost_t}{(1+r)^t}}$$

← Ratio instead of difference

**Q: What is Internal Rate of Return**

$$A: \text{Choose } r \text{ such that } \sum_t \frac{Revenue_t - Cost_t}{(1+r)^t} = 0$$

← Not defined for DNR

Can't calculate if always cash-flow positive



Choose

Choose  $x$   
(management actions)

Optimize

*Maximize*

Objective Function

**Net Present Value( $x$ )**

Constraints

s.t. Laws & Regulation


# Q: What is Net Present Value?

A: 
$$\sum_t \frac{\text{Revenue}_t - \text{Cost}_t}{(1+r)^t}$$



# Revenue

$$\text{Revenue} = \text{Price} * \text{Volume}$$

  
Parameter

  
Biophysical Model Output

**Price should be:**

- **By Species**
- **Real market prices**



# Revenue

$$\text{Revenue} = \text{Price} * \text{Volume}$$

Parameter

Biophysical Model Output

	Douglas Fir	Ponderosa Pine
Appraisal Price	\$250	\$100
Volume	1	1

$$\text{Appraisal} = \$250 \times 1 + \$100 \times 1 = \$350$$

	Douglas Fir	Ponderosa Pine
Auction Price	\$260	\$110
Volume	1	1

$$\text{Auction} = \$370$$



Choose

Choose  $x$   
(management actions)

Optimize

*Maximize*

Objective Function

**Net Present Value( $x$ )**

Constraints

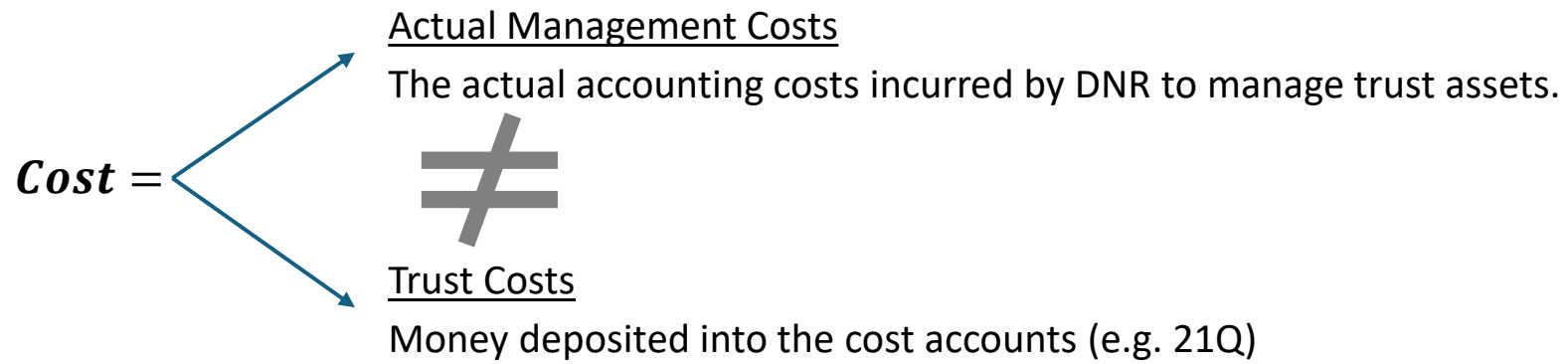
s.t. Laws & Regulation

# Q: What is Net Present Value?

A: 
$$\sum_t \frac{\text{Revenue}_t - \text{Cost}_t}{(1+r)^t}$$



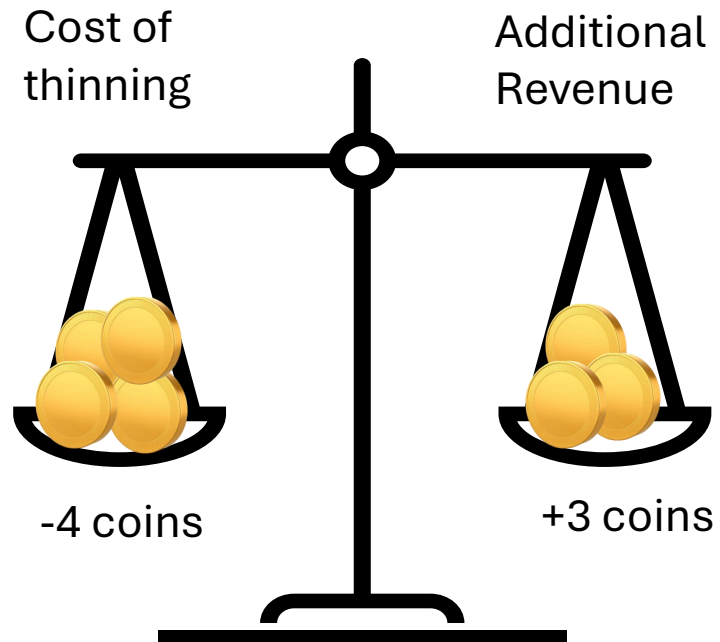
# ***Cost***



# *Cost*

## To thin or not to thin?

... depends on how we account costs



### Thinning

- +3 Coin - reduces competition for light, water, and nutrients, allowing the remaining trees to grow faster and stronger
- -4 Coin – cost to pay for labor & resources required to carry out thinning

# Cost

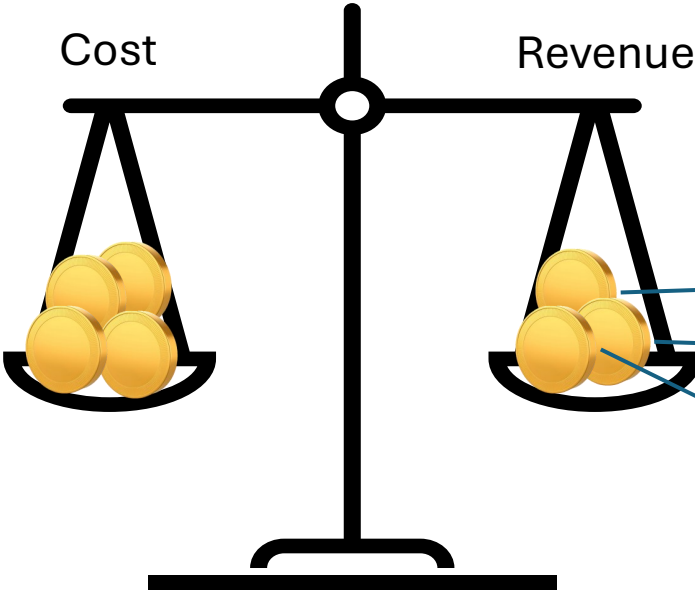
# To thin or not to thin?

Financial Accounting



Trust Accounting

Cost > Revenue

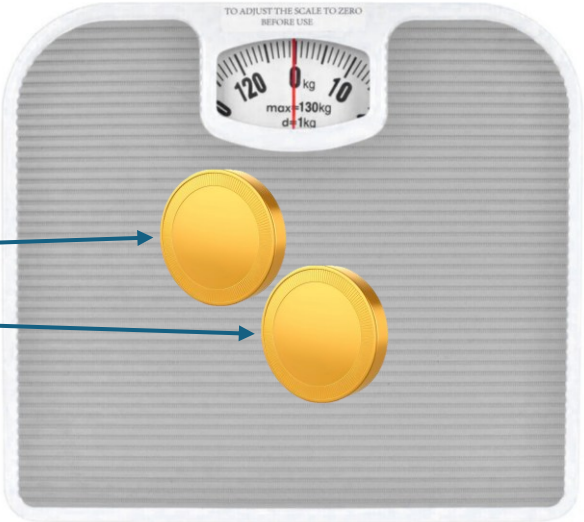


RMCA Example

69% of Revenue > 0



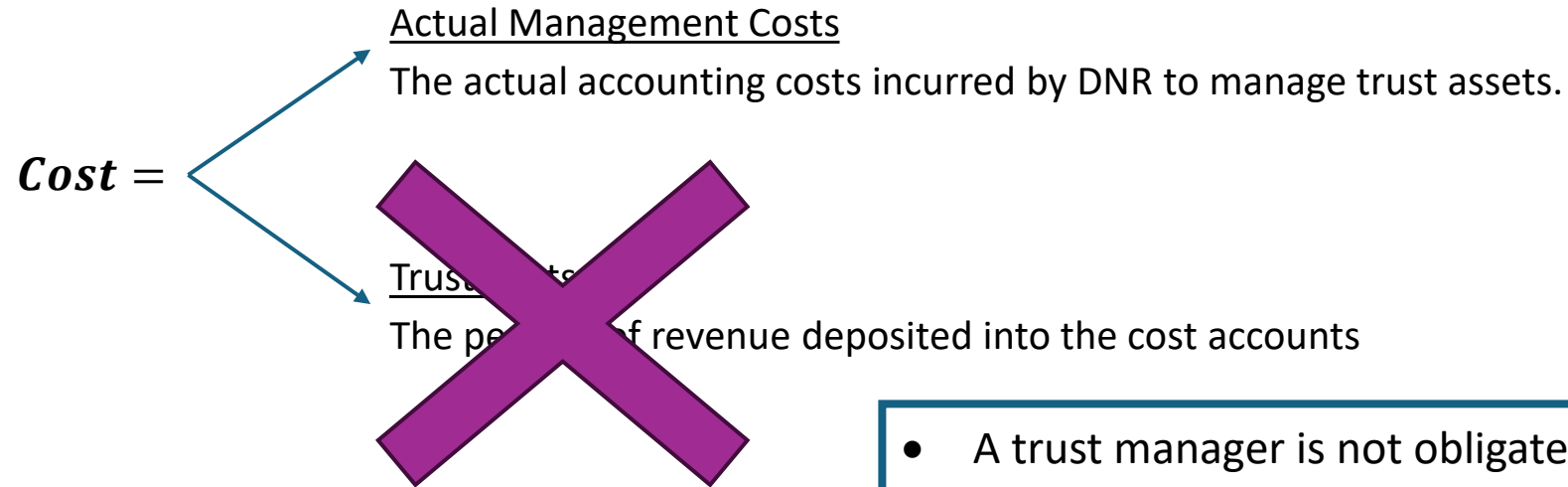
2 coins to the trust



31% to RMCA

1 coin to Cost Account

# *Cost*

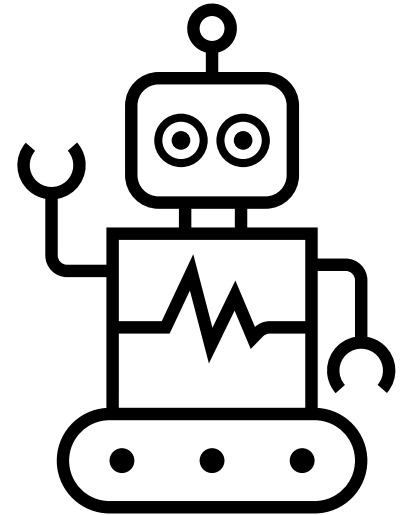
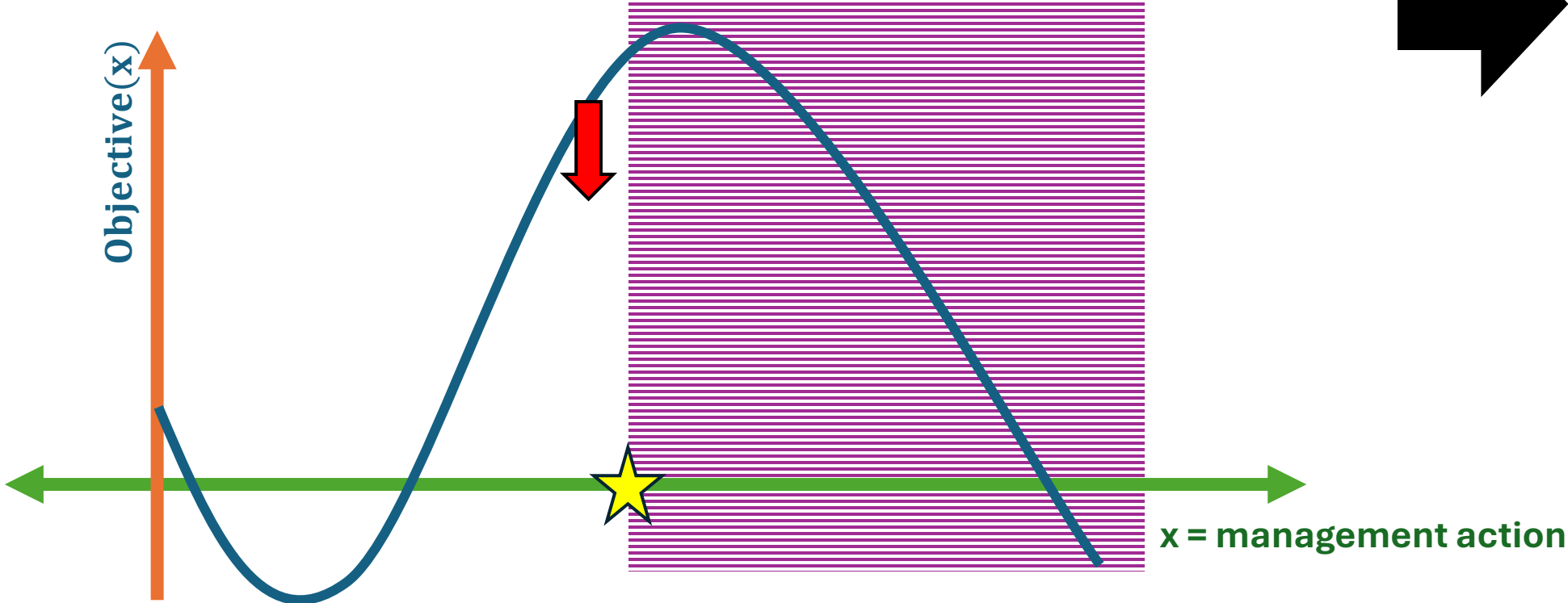


- A trust manager is not obligated to incur financial losses in order to increase revenue for trust beneficiaries. Doing so is going beyond the trust mandate and is not required.
- It is not prudent to incur financial losses. Carrying out activities where the actual costs of carrying out the action are greater than the revenues generated from the action would not be prudent management.



# Cost

Fixed Cost – Shifts Objective Function Down  
Doesn't change the solution



Solve!

$x =$  ★



# Recommendation

- **Continue to maximize NPV as the objective for the SHC**
- **NPV Specification**
  - **Use Adjusted Appraisal Prices as the SHC prices**
  - **Cost**
    - Use Actual Management Costs
    - Fixed costs are not required to calculate optimal volumes



Choose

Choose  $x$   
(management actions)

Optimize

*Maximize*

Objective Function

**Net Present Value( $x$ )**

Constraints

s.t. Laws & Regulation

# Q: What is Net Present Value?

A: 
$$\sum_t \frac{\text{Revenue}_t - \text{Cost}_t}{(1+r)^t}$$



# *Discount Rate*





# Discount Rate in the Sustainable Harvest Calculation for Eastern Washington

*"Every graduate student should spend a fair amount of time immersed in the discount rate literature, if for no other reason than to feel decidedly uncomfortable the rest of their professional career when using any particular discount rate"*

*- R.G Cummings in Just et. al., p 586*

# What should the discount rate be?

## Outline

What is discounting?

What discount rates are used elsewhere?

Conclusion

### Destination Brief

Policy & Data Supported Range

Sensitivity Analysis

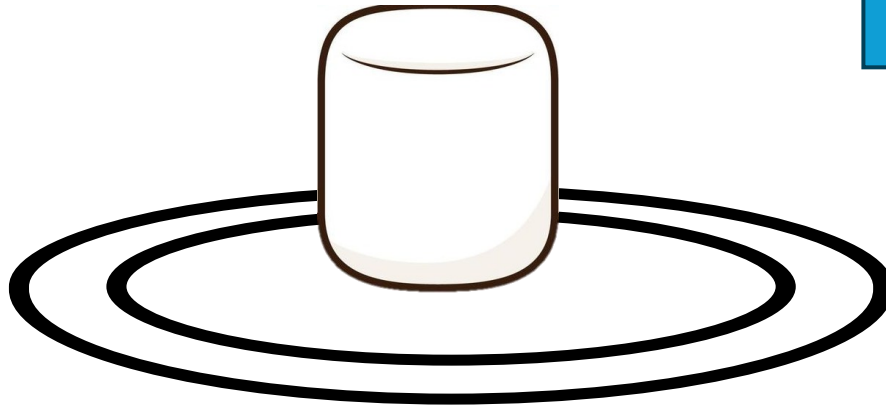


# Tradeoff over time

# Marshmallow Experiment

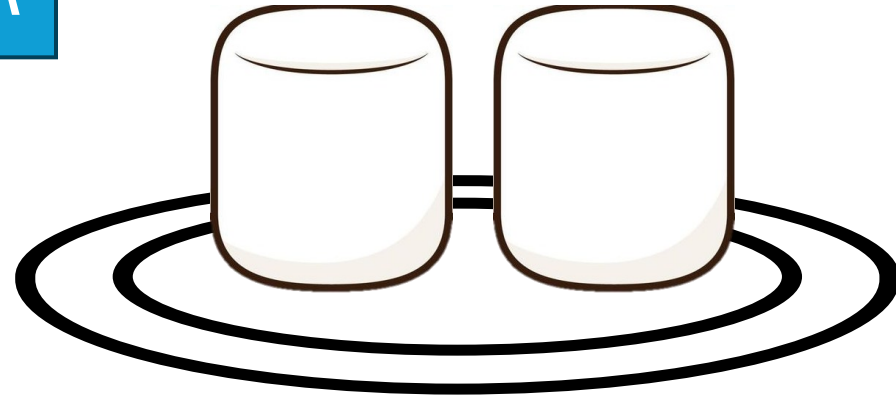


Now



OR

+15 Min



# Tradeoff over time



# Harvest Calculation

Now



\$1 Million

OR

+10 Years

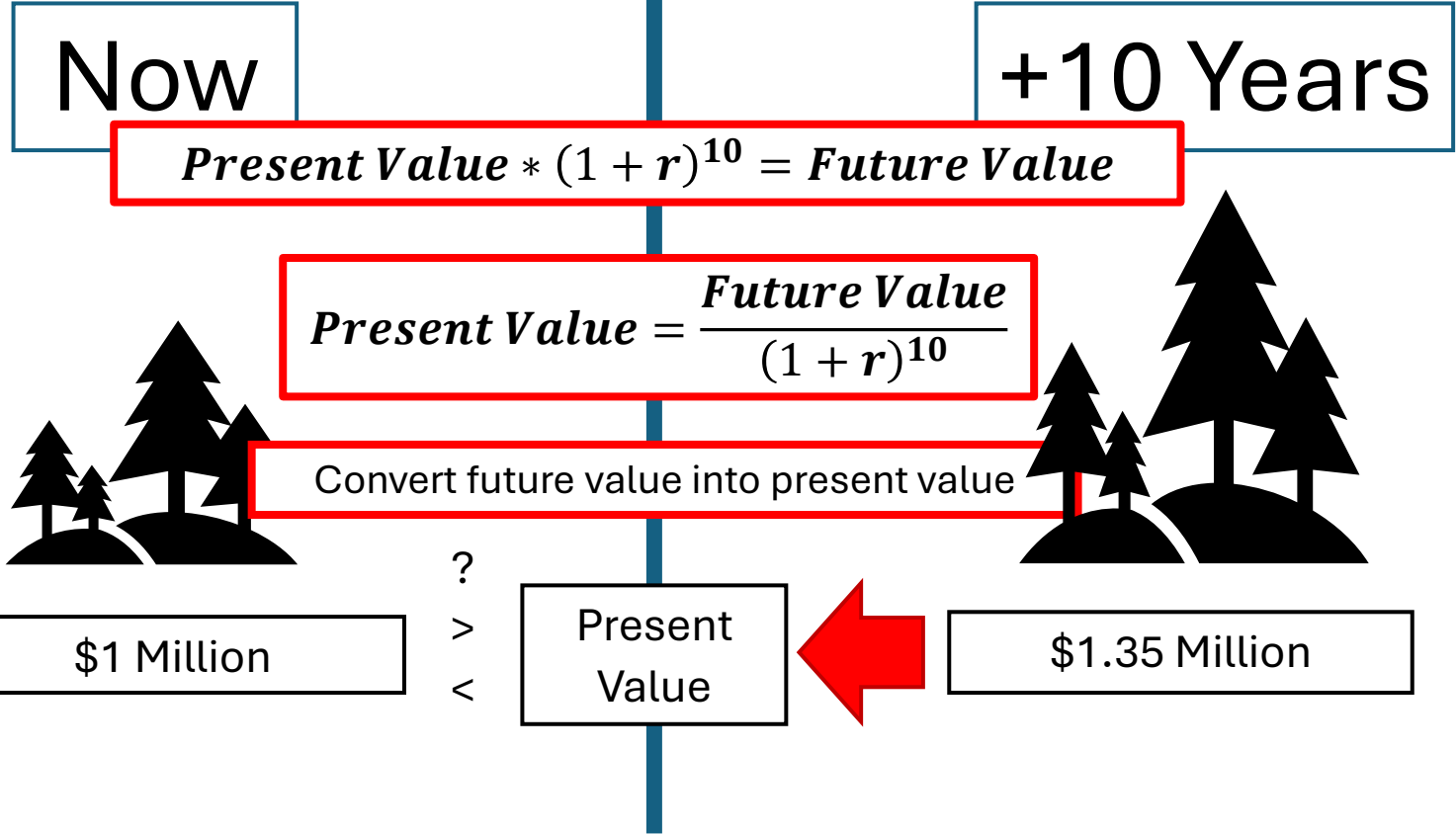


\$1.35 Million



# What is discounting?

# Harvest Calculation



Discount Rate (r)	PV Now	PV +10 Yrs	Optimal
2.0%	\$1,000,000	\$1,107,000	Wait 10
2.5%	\$1,000,000	\$1,1055,000	Wait 10
3.0%	\$1,000,000	\$1,000,000	Tie
3.5%	\$1,000,000	\$957,000	Harvest Now
4.0%	\$1,000,000	\$912,000	Harvest Now



# Relative Rates

Return Rate  
 $r = 4\%$

Borrowing Rate  
 $r = 2\%$

Now  
\$0

Now  
\$1.11 million



+10 Year  
\$1.48 million

+10 Year  
\$0

Discount Rate depends

- Are we borrowing from the future?
- Are we saving for the future?

# Harvest Calculation

Now



\$1 Million

OR

+10 Years



\$1.35 Million



# What should the discount rate be?



What is relevant for the SHC?

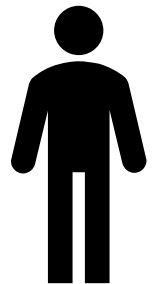
- Borrowing Rate
  - Is there “borrowing”?
  - Relevance unclear
- Return Rate
  - Can there be “investing”?
  - Relevance unclear
- Performance of asset
  - Return rate on EWA forests
  - ~ forest growth rate
  - Relevant

2025  
Beneficiary



VS

2075  
Beneficiary



# What should the discount rate be?

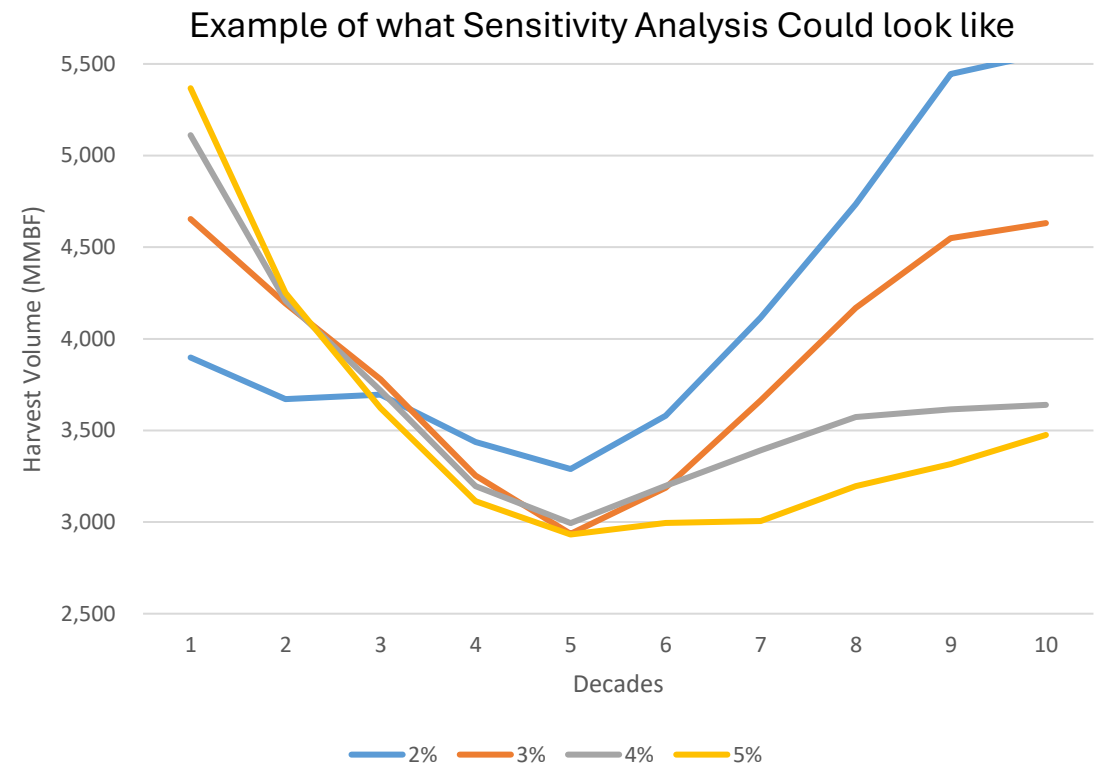
Real Rates		
Performance of asset	Forest Growth Rate	1.7%
	EWA Forest Rate of Return	2.7%
Borrowing Rate	Municipal Bond Index	2.6% (nominal)
	WA State Treasury Bonds	1.9% (4.45 nominal)
Rate of Return	NCREIF (timberlands)	3%
	Permanent Funds	3.4%
Rates Used by Peers	Oregon Dept. of Forestry	3% - 4%
	Idaho Dept. of Lands	3.4%
	WA DNR	3% (past)
	WA State Inst. Public Policy	2-5%
	US OMB (intergenerational)	1%-3%

- Policy Data supported range
  - 1% - 2.7% (Eastern WA)
- Choice within the range
  - Err on the low side
    - Growth is ~ 1.7%
    - Intergenerational
- Sensitivity analysis
  - See how  $r$  impacts outcomes over time



# Sensitivity Analysis

- Board should see the impact
  - Discount rate is a blunt instrument
  - It impacts harvest volumes over time





DNR staff gave this presentation to the Board of Natural Resources at a virtual study session on February 20, 2026, 2-4 pm PDT. A full recording of this study session is available on the [Board of Natural Resources Webpage](#). This presentation starts at 18.25 minutes into the recording.