Valuing the Co-Benefits of Source Water Protection

Modeling the Effects of Forest Management on Ecosystem Services

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EARTH ECONOMICS

The client

A **water utility** actively managing forests in its **source watershed**

160K acres, 88% forested
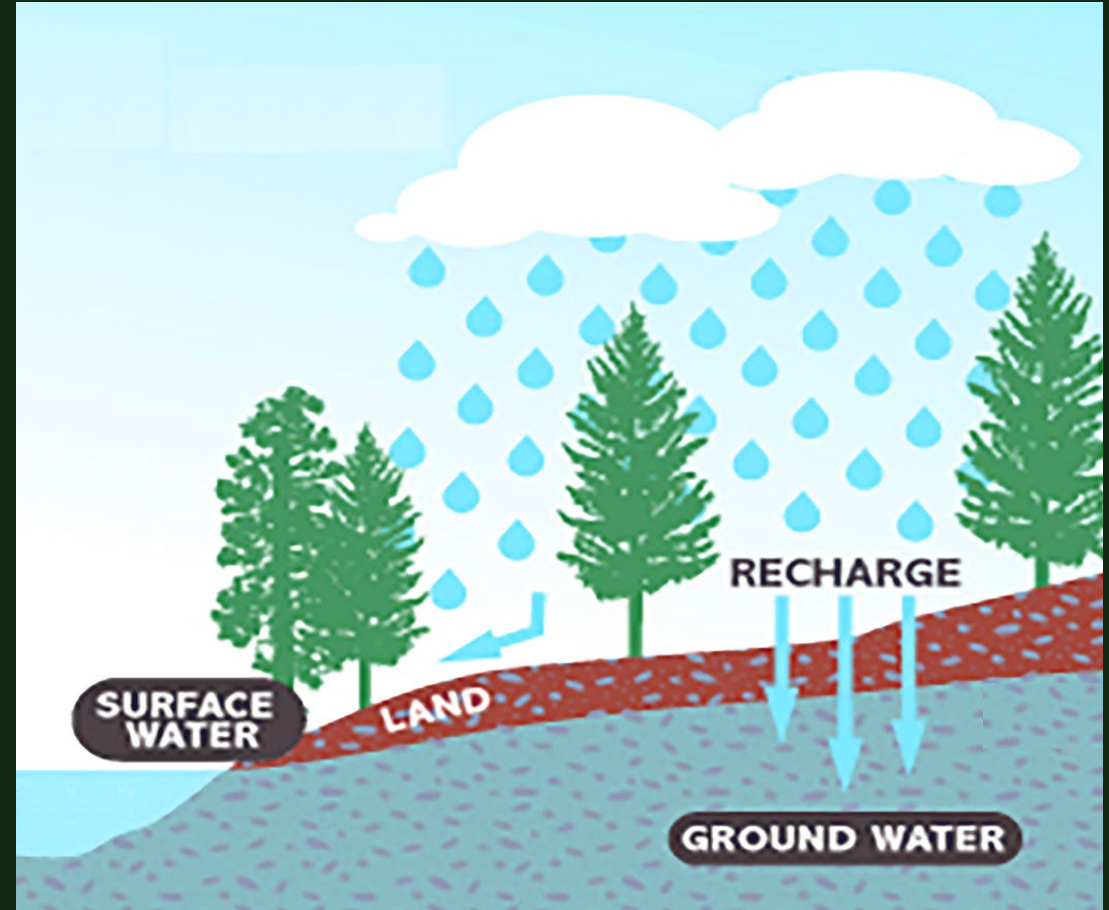
Mid-sized city (~200K residents)

Because this involves an ongoing acquisition effort, we are unable to provide site details

The opportunity

The utility has managed its forests to support **source water protection** for 20+ years

- Commercial activities limited to **25% of forest**
- Thinning to promote **old growth characteristics**
- **70-year** harvest rotations

The opportunity

Acquire additional forests from timber companies

- Limit commercial harvests to **33% of those forests**

- Shift from **40 to 70-year rotations**

- **Conservation management** of other forested areas
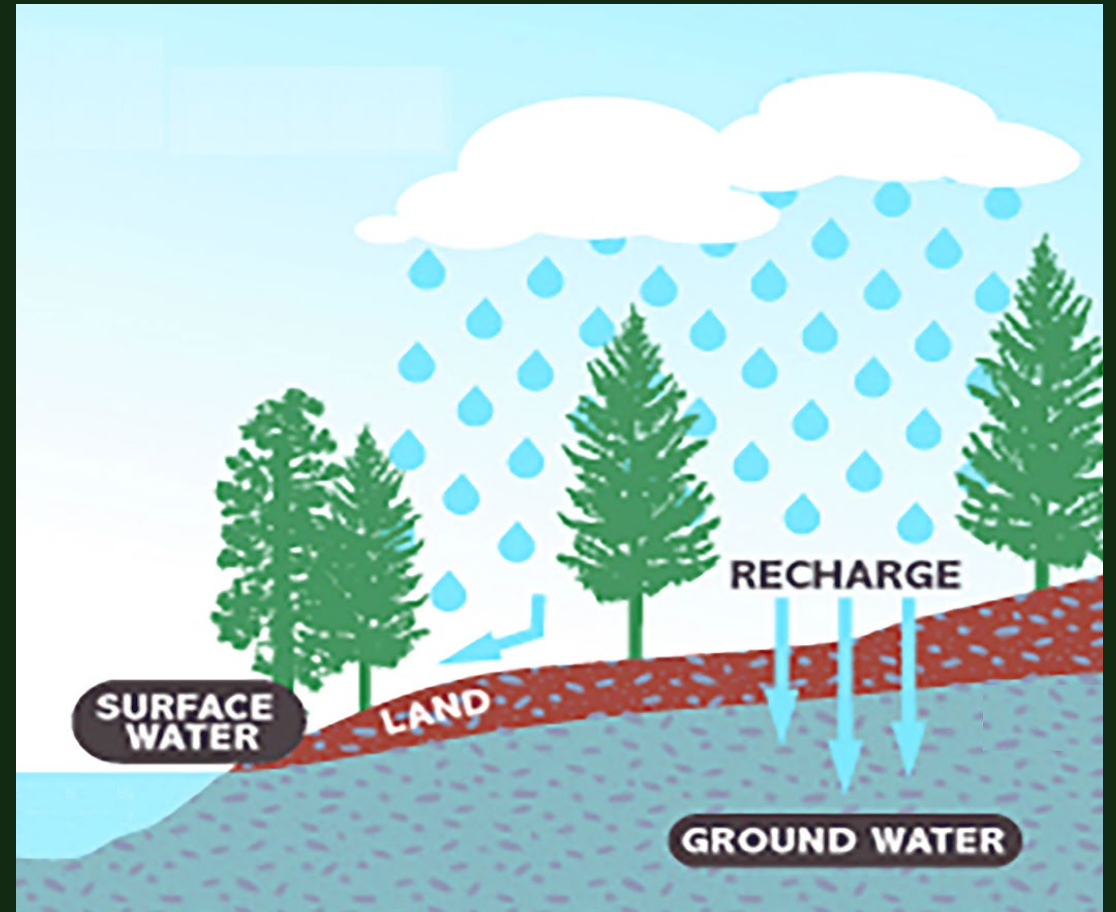
The opportunity

Benefits of **shifting away from business-as-usual:**

- **Safeguard water quality**

- **Higher timber value** (older trees) *I-O modeling*

- **Carbon credits** for conservation forests
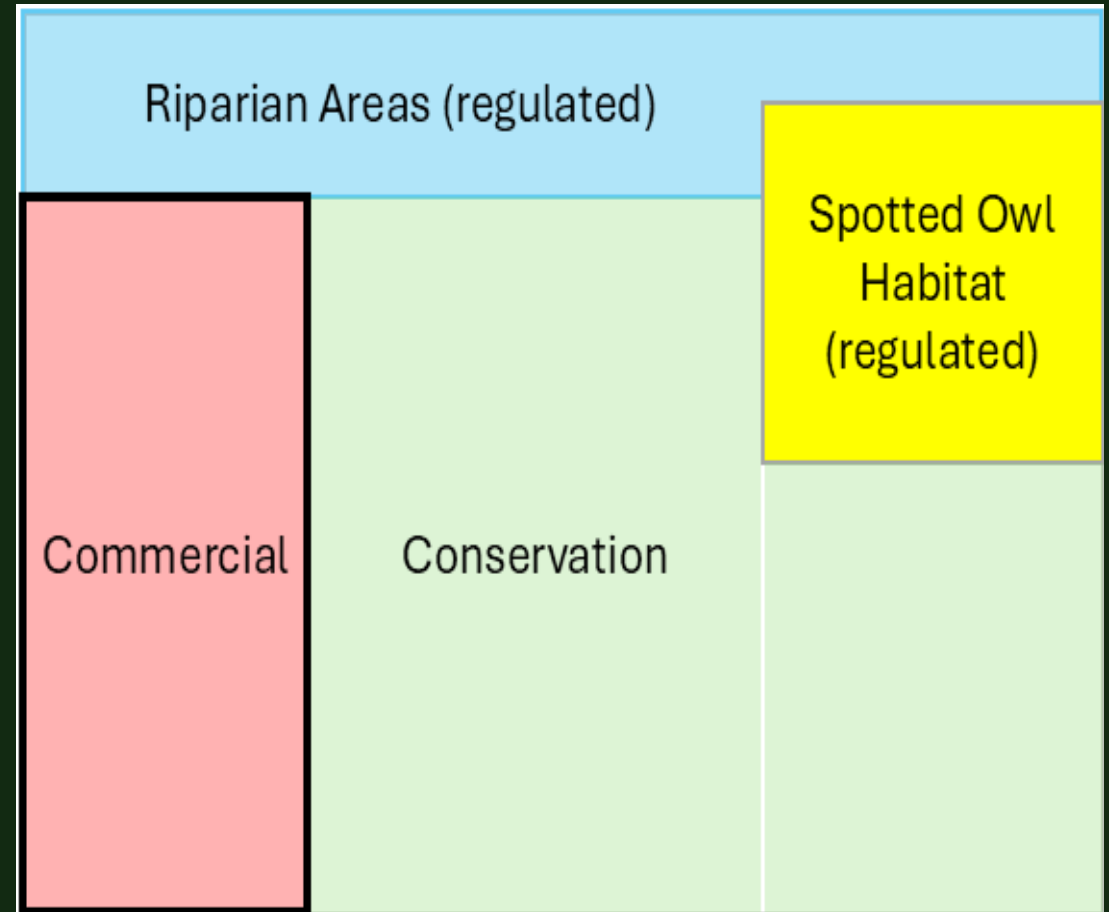
- Other **ecosystem services**

The approach

Modeling impacts of harvest cycles:

- Divide commercial forests into **equal units based on rotation** period

- Avg age of each unit based on year in rotation
(**0-40, 0-70**)

- **Harvest → scrub → forest**

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Hypothetical Model of a 5-year Harvest Rotation with Stand Ages (Years)					
	Stand 1	**Stand 2**	**Stand 3**	**Stand 4**	**Stand 5**
Year 0	4	3	2	1	Replant
Year 1	Harvest	4	3	2	1
Year 2	Fallow	Harvest	4	3	2
Year 3	Replant	Fallow	Harvest	4	3
Year 4	1	Replant	Fallow	Harvest	4
Year 5	2	1	Replant	Fallow	Harvest
Year 6	3	2	1	Replant	Fallow
Year 7	4	3	2	1	Replant
Year 8	Harvest	4	3	2	1
Year 9	Fallow	Harvest	4	3	2
Year 10	Replant	Fallow	Harvest	4	3

The approach

Modeling **impacts of conservation forestry:**

- Divide **transition forests** into equal units based on age class

- Assume **minimum age for noncommercial stands**

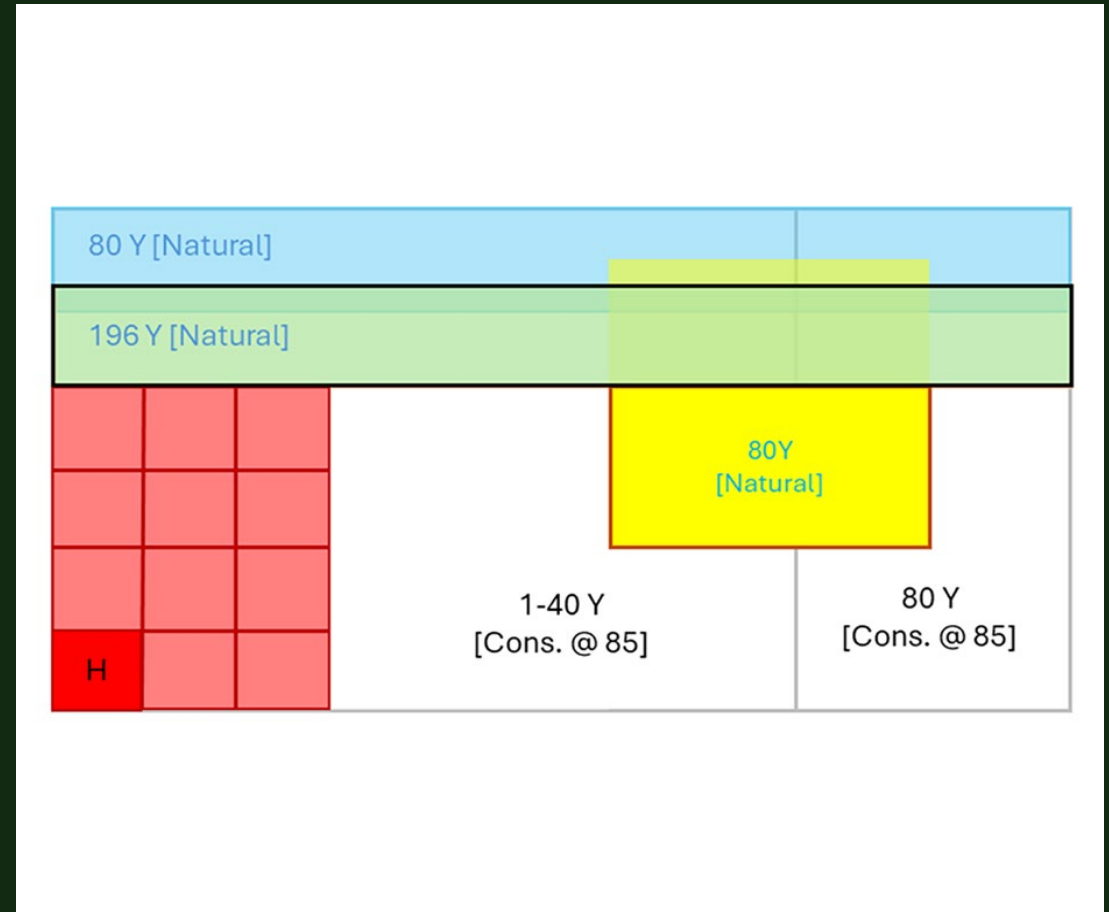- **Thinning** was assumed to have **neutral** effects on ES
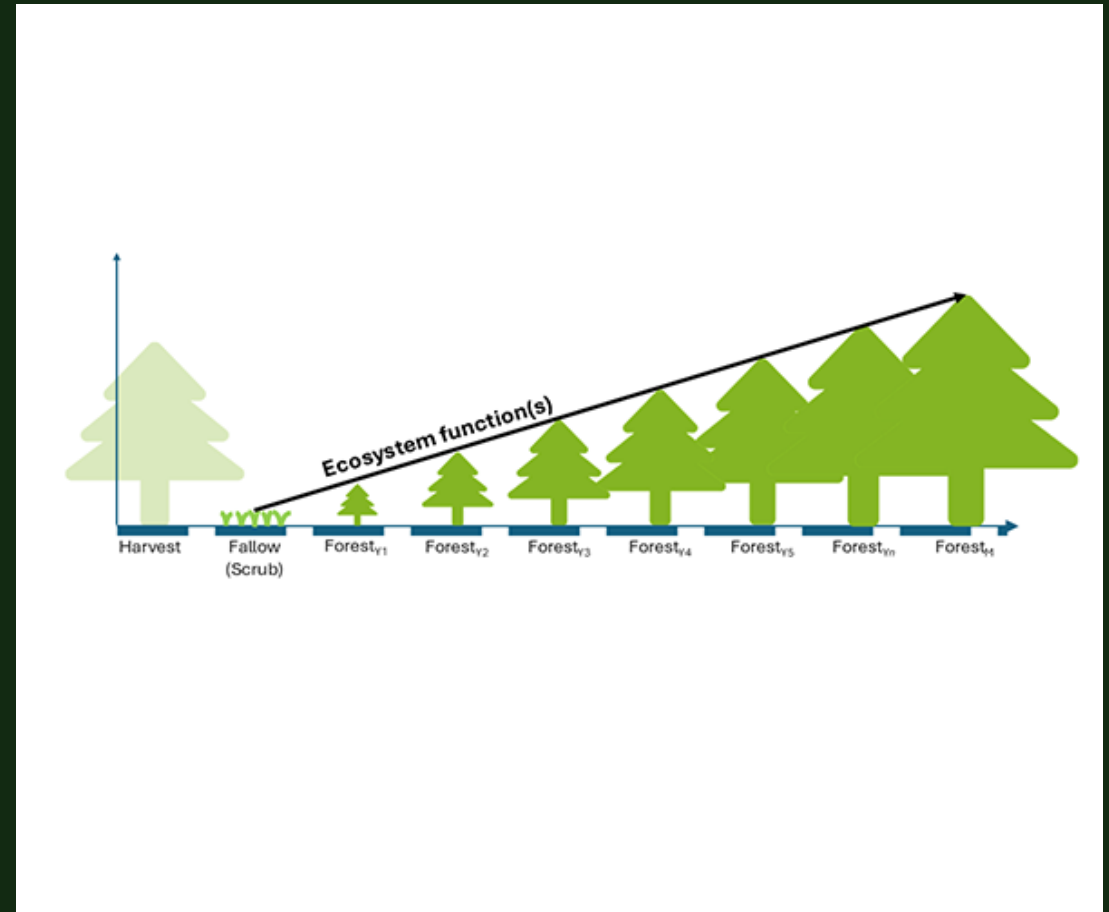
The approach

Other landcovers:

- Protected forests (**80+ yrs**)
- Old growth forests (**196+ yrs**)
- ES of other ecosystems assumed to be static

Modeled for **140 years** (2 long rotations) at 0%, 3%, and 7% discount rates

The approach

| Ecosystem Services	Scrubland	Transition forests	Mature forests (80 yrs)	Old-growth forests (196 yrs)	Riparian forests	Grasses	Wetlands
Aesthetic Information		○	●	●	●		●
Cultural Value		○	●	●	●		●
Recreation and Tourism (general)			●	●	●		●
Air Quality	●	●	●	●	●	●	
Climate Stability (Sequestration)	△	△	△	△	△	●	●
Disaster Risk Reduction		○	●	●	●		●
Water Capture, Conveyance, and Supply		○	●	●	●		●
Water Quality							●
Water Quality (Nitrogen Removal)		○	●	●	●		
Water Quality (Phosphorus removal)		○	●	●	●		
Water Quality (Sediment)		○	●	●	●		
Habitat		●	●	●	●		●
Habitat (northern spotted owl)				●			
Habitat (salmon)					●		
	$0.21	$0.67	$4,155	$4,592	$4,331	$15.02	$3,272

● included in age-class value estimate ○ included in age-class, but begins at 0 value △ modeled independently

The results

| Scenario	Owner	Landcover	Rotation Years	NPV 140 years ($M)	NPV at 140 years, per forest acre	NPV at 140 years, all acres	Ratio: Scenario/BAU
BAU	Company 1	Commercial forests	40	$850–$1,345	$69,852–$110,586	$56,033–$88,709	
		Natural and commercial forests, other		$1,639–$2,599	$134,719–$213,603	$108,068–$171,347	
		Subtotal		**$2,489–$3,944**	**$204,571–$324,189**	**$164,102–$260,056**	
	Company 2	Commercial forests	40	$987–$1,561	$48,560–$76,878	$41,642–$65,926	
		Natural and commercial forests, other		$2,952–$4,737	$145,312–$233,175	$124,611–$199,958	
		Subtotal		**$3,939–$6,299**	**$193,872–$310,053**	**$166,254–$265,884**	
	Utility	Commercial forests	70	$575–$911	$45,147–$71,485	$37,077–$58,707	
		Natural and commercial forests, other		$3,886–$6,082	$305,007–$477,282	$250,489–$391,970	
		Subtotal		**$4,462–$6,992**	**$350,154–$548,766**	**$287,566–$450,677**	
		Total across all ownership		**$10,889–$17,235**	**$748,597–$1,183,008**	**$617,921–$976,617**	
2	Company 1	Commercial forests	40→70	$528–$836	$43,406–$68,728	$34,819–$55,132	0.62
		Natural and commercial forests, other		$4,202–$6,610	$345,417–$543,332	$277,085–$435,848	2.54–2.56
		Subtotal		**$4,730–$7,446**	**$388,823–$612,060**	**$311,905–$490,980**	**1.89–1.90**
		Total across all ownership		**$13,130.5–$20,737.2**	**$932,849–$1,470,879**	**$765,724–$1,207,540**	**1.24**
3	Company 2	Commercial forests	40→70	$1,562–$970	$47,778–$76,878	$40,972–$65,926	0.62–1.58
		Natural and commercial forests, other		$5,647–$8,953	$277,963–$440,719	$238,365–$377,935	1.89–1.91
		Subtotal		**$7,209–$9,924**	**$354,841–$488,497**	**$304,291–$418,907**	**1.58–1.83**
		Total across all ownership		**$14,159–$20,860**	**$909,565–$1,361,451**	**$755,958–$1,129,640**	**1.16–1.22**

Limitations

- Assumed **linear growth** of all ecosystem functions, ecosystem service value

- Can be adjusted to account for variations in **recovery curves**

- Effects of this assumption vary

2% discount rate

FULL — LINEAR — EXPONENTIAL — HYPERBOLIC — LOGISTIC
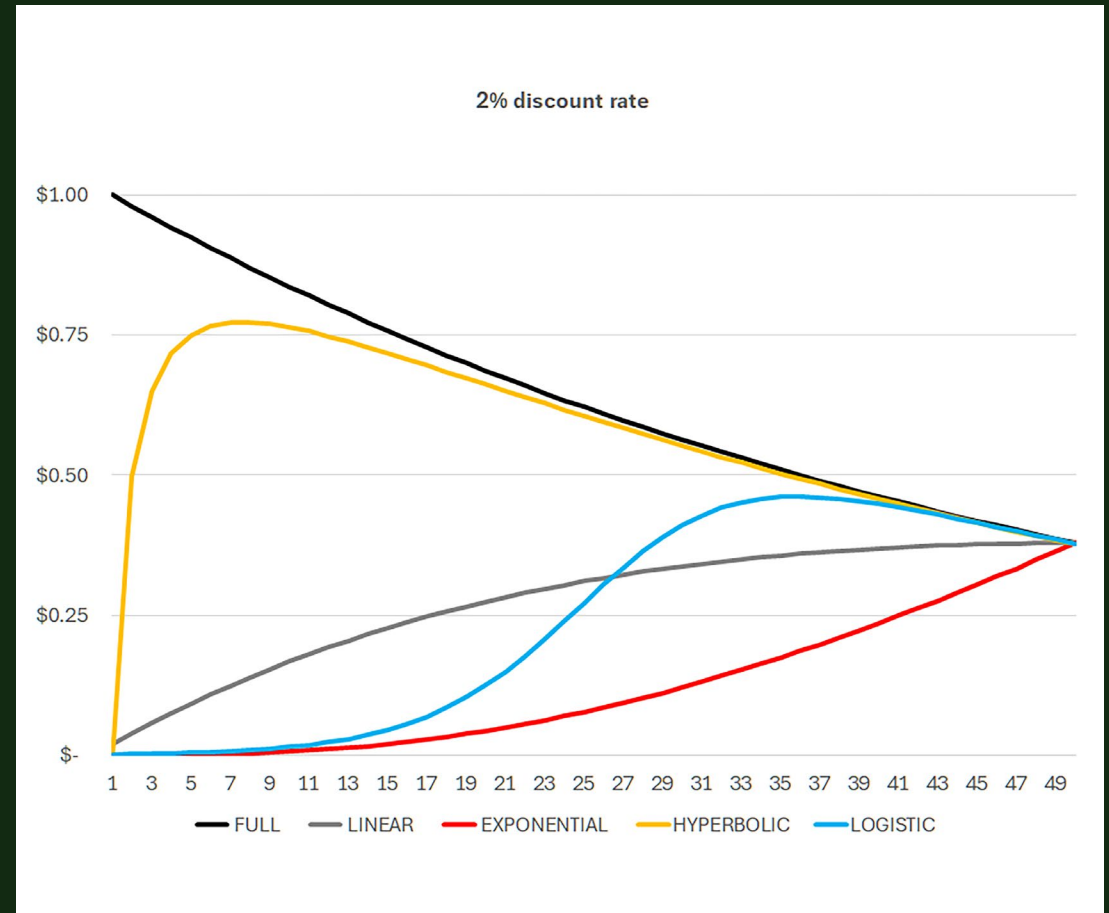
Future research

- Ecosystem status **baselines**

- **Recovery curves**

- **Relationships** between ecosystem **function**, **provisioning** levels, and **value** of benefits

- Identify and assess **proxies** (esp. remote sensing data) **for function and/or value** (e.g. NPP, NDVI)

Response curves
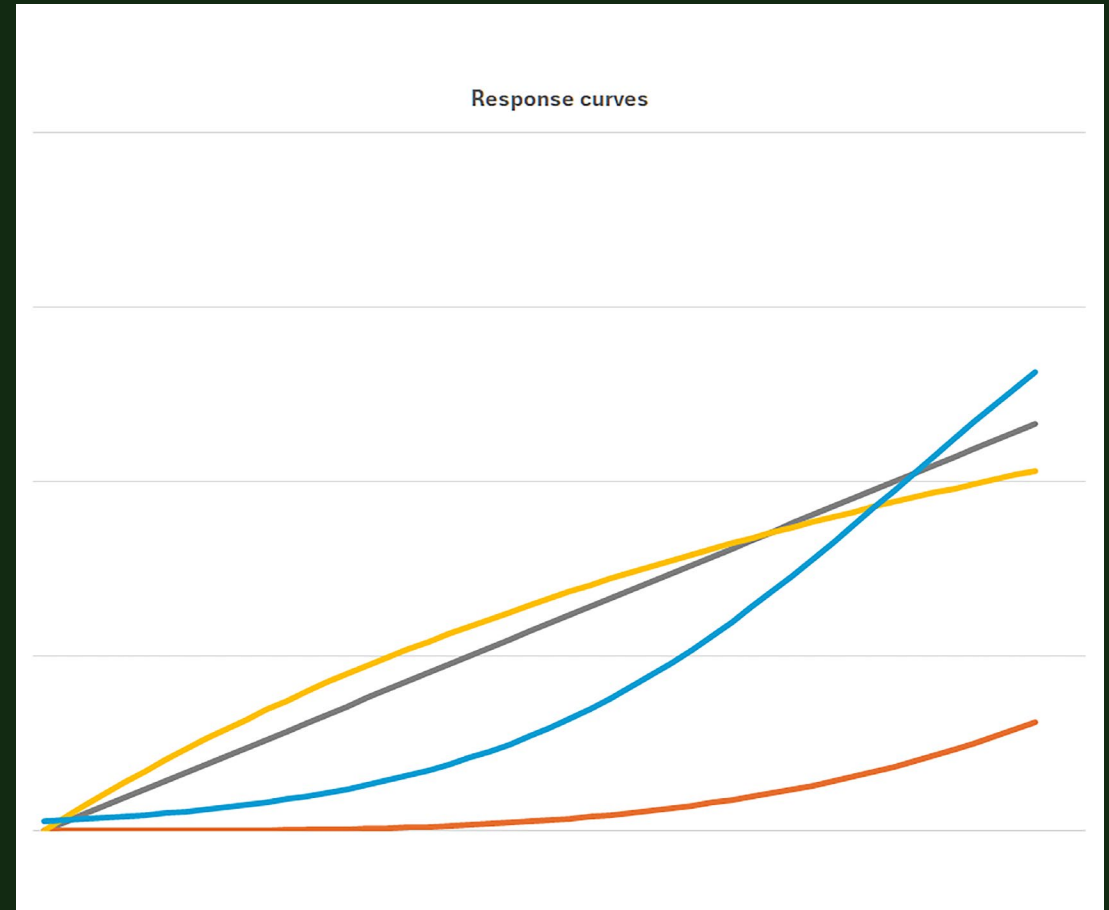
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Thank you for your time.

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