



A Defensibility Heuristic for Wildfire Fuel Treatments

Dumb with Intent

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Funding



Natural Resources
Canada

Ressources naturelles
Canada

Canada

The Plan

1. Economics as tools for choosing between alternatives
2. Context and Justification for Heuristic
 - a) Kubernetes (shares Greek root of governance) as metaphor
 - b) OODA loops
 - c) The Laws of Requisite Variety (and multi-scale version) and its implications
3. The Defensibility Heuristic

Economics to me is...

- ~~1. Allocation of scarce resources~~
 - ~~2. A predictive science~~
 - ~~3. Study of production, distribution, and consumption of goods and services~~
 4. About deciding between alternatives— from finance to theory of the firm to mechanism design to welfare theory to institutional economics
-



Kubernetes

- Setting a heading (objective) subject to rain, wind and tides (uncertainty) using sail trim and tiller for control (choice variable)
 - From Norbert Wiener via Stafford Beer



Kubernetes

- Setting a heading (objective) subject to rain, wind and tides (uncertainty) using sail trim and tiller for control (choice variable)
- “The problem lies in the belief that massive data bases are the clue to success. But mere data are useless in themselves. They have the same relationship to information as gossip has to sustained argument.”



Kubernetes

- The key thing to note here is that the Kubernetes does not need to forecast windspeed and direction over the next hour or any of the other uncertainties – the Kubernetes must know where the bow is relative to the heading and how the SHIP is responding to the conditions
- For wildfire – where are the boundaries for the utility of collecting data? Understanding what is the ship and what are the conditions? What is relevant for charting a course?



Colonel John Boyd and the OODA- loop

- Observe, Orient, Decide, Act
 - The team that loops through this fastest wins
- See a lot of observe... observe... observe... orient, tepid decision, pilot project, uh what now...
- Don't over complicate – we get too smart for our own good
 1. What does good look like?
 2. Where are we now?
 3. What path(s) can be taken to get from here to good?
 4. Evaluate alternative paths
 5. Act
 6. Did that get us toward good?



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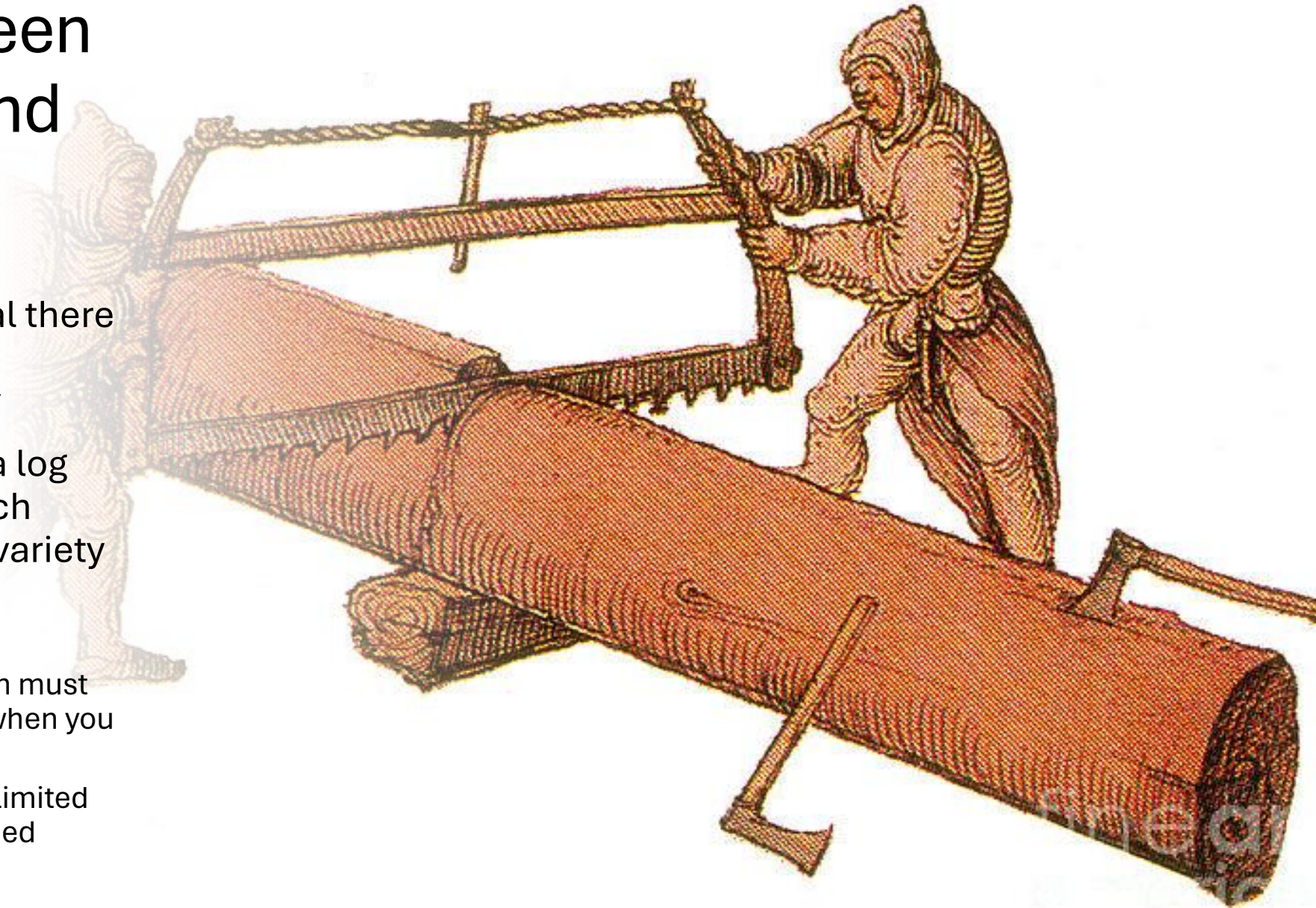


Law(s) of Requisite Variety and Implications for Decision Making

- Strong-form (Ashby) - “the variety in the control system must be equal to or larger than the variety of the perturbations in order to maintain stability” OR
- “*When the variety or complexity of the environment exceeds the capacity of a system (natural or artificial) the environment will dominate and ultimately destroy that system.*” OR
- *Variety absorbs variety*
- Weak-form (Heylighen) – ““The larger the variety of actions available to a control system, the larger the variety of perturbations it is able to compensate.”
 - The weak-form arose in the examination of bacteria or protozoa– they maintain stability with few options/variety and they do this through ‘randomness’ – they fail quickly and try something different
- Multi-scale law (Bar Yam) ...

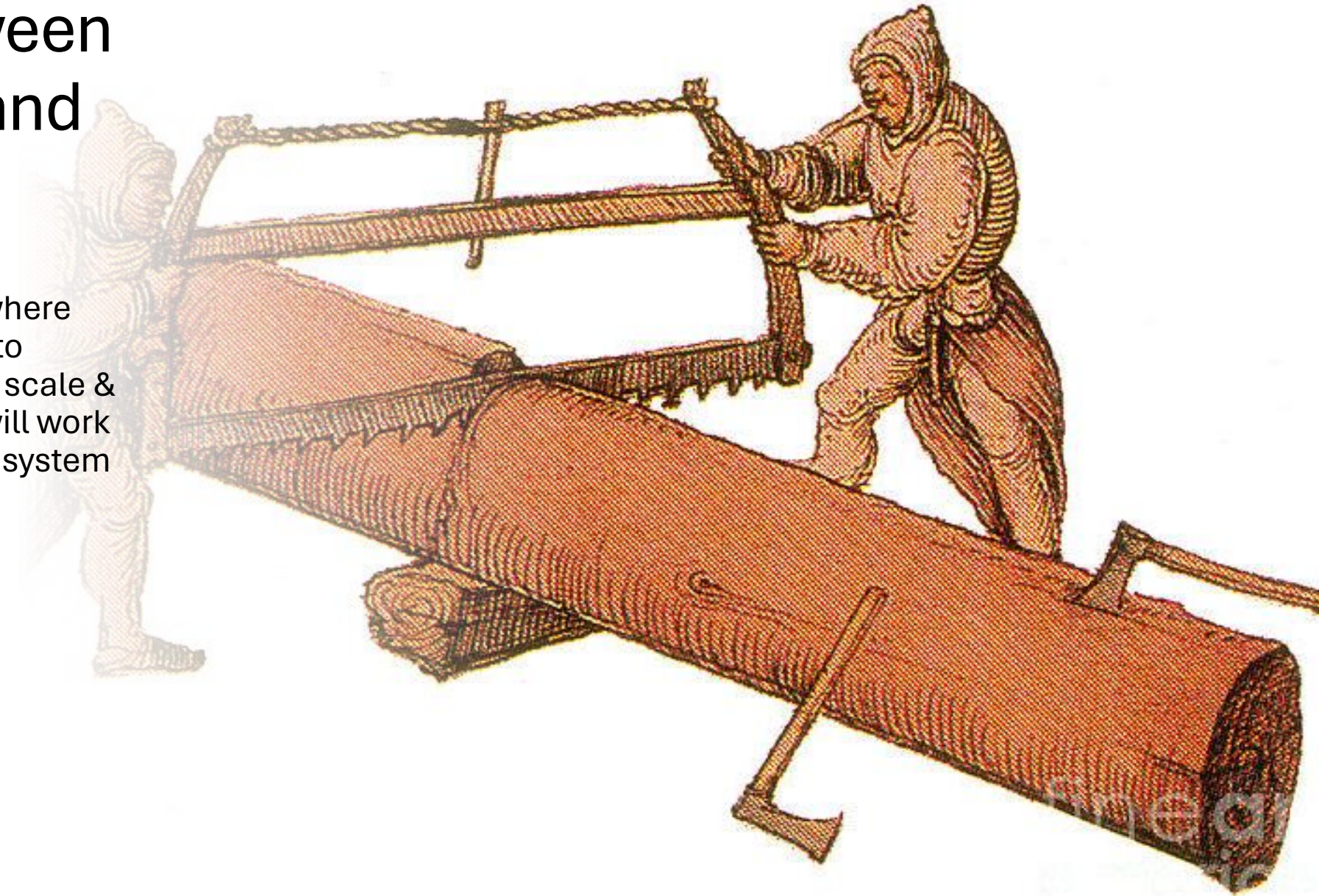
Trade-off between Coordination and Variety

- In trying to achieve a goal there is a trade-off between coordination and variety
- If 2 people want to saw a log with a cross-cut saw each individual has a choice/variety at any given moment – (push,pull)
 - For this to work the action must be coordinated – I push when you pull and vice versa
 - Variety is fundamentally limited for coordination to succeed



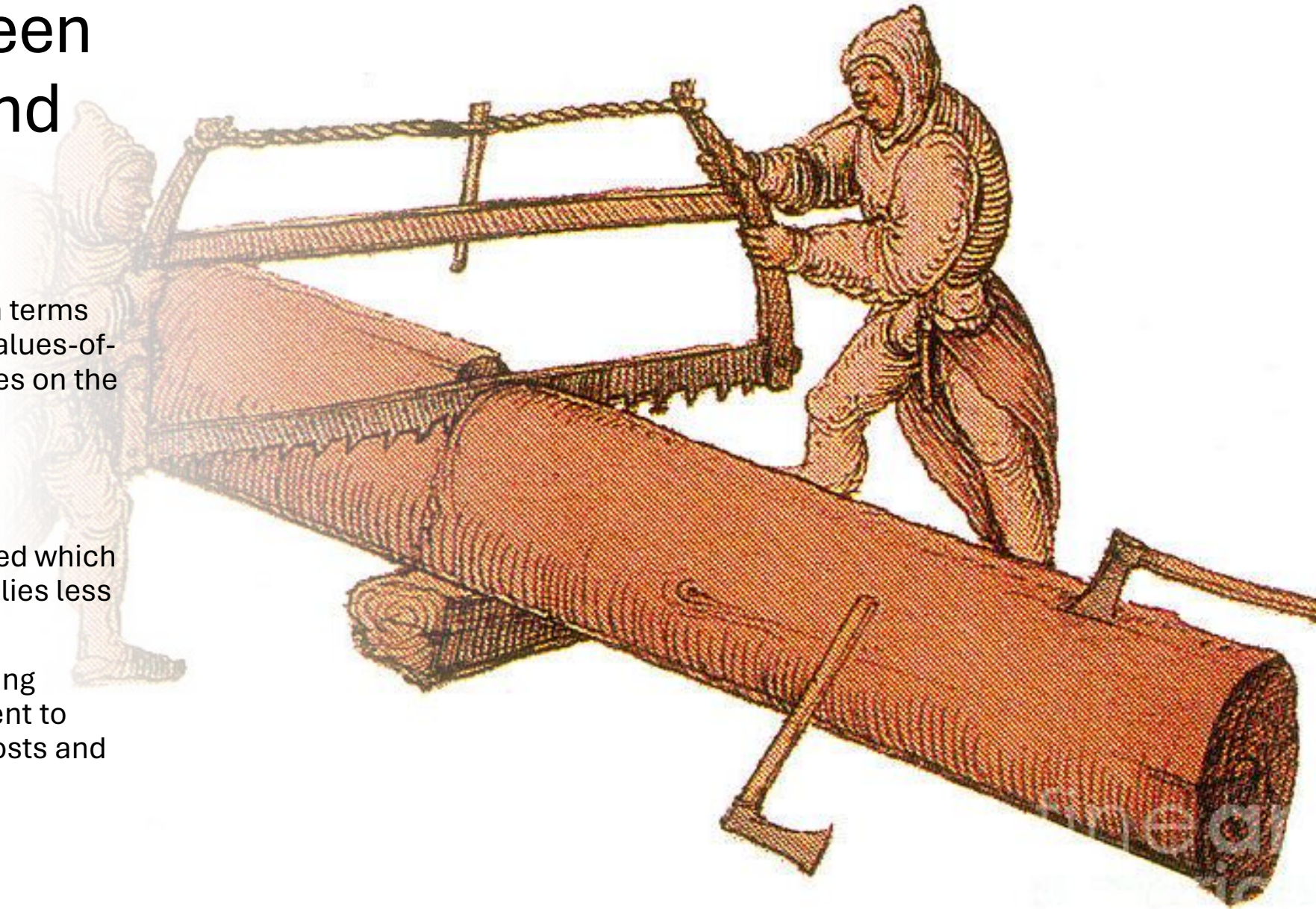
Trade-off between Coordination and Variety

In a complex environment where
variety in action is required to
respond to variety in stimuli scale &
the requisite coordination will work
against sustainability of the system



Trade-off between Coordination and Variety

- Wildfire is a very high variety in terms of the unique features of the values-of-risk and the operational realities on the ground
- Has to be met with variety OR randomness (i.e. failure)
- Failure is not generally accepted which means need variety which implies less coordination and less scale.
- How to build a tool for evaluating choice paths in this environment to reduce wildfire suppression costs and damages?



Characteristics of a Useful Tool in a High Variety Context

01

Need/want a large quantity & variety of fuel mitigation proposals – need a tool that can process all of the proposals

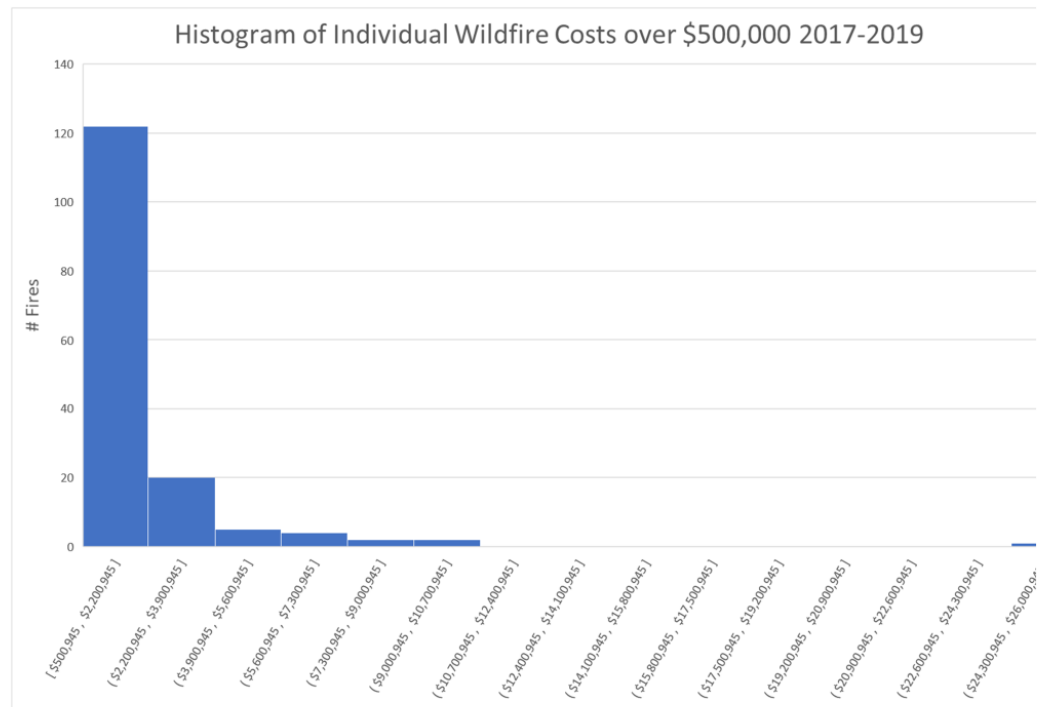
02

Want to close that OODA-loop and go fast

03

Minimize the amount of data needed to make a decision to bare minimum – faster and lower cost

The Constraint of a Fat Tail



1.8% (78 of 4287) of fires in this period resulted in 60% of Suppression Costs

2000-2019 Wildfire
Suppression Data
Cariboo &
Kamloops Fire
Centres

**0.8% (99 of 12,080) of fires resulted in 60% of
Suppression Costs**

~\$364 million over 20 years in 99 fires

Average fire cost is ~\$50,000 – not informative

**If the defensibility of these fires is not improved
by fuel treatment efforts, then what is the point?**

- Have to focus on the right category of risk/magnitude of event.

The Defensibility Heuristic

$$\text{Adjusted Avoided Costs} = PR(1\% \text{ Fire Over Life of Project}) \\ * \text{Sum(Avoided Costs)}$$

$$d = \frac{\text{Fuel Treatment Cost}}{\text{Adjusted Avoided Costs}}$$

Think of d as how much more defensible the assets at risk are

“What percentage of the time are we going to be able to protect this asset when we couldn’t before under the worst fire conditions?”

NOTE THAT THE ANALYST CANNOT MAKE THIS CALL – THIS IS TACIT KNOWLEDGE THAT ONLY EXPERIENCED WILDFIRE FIGHTERS HAVE

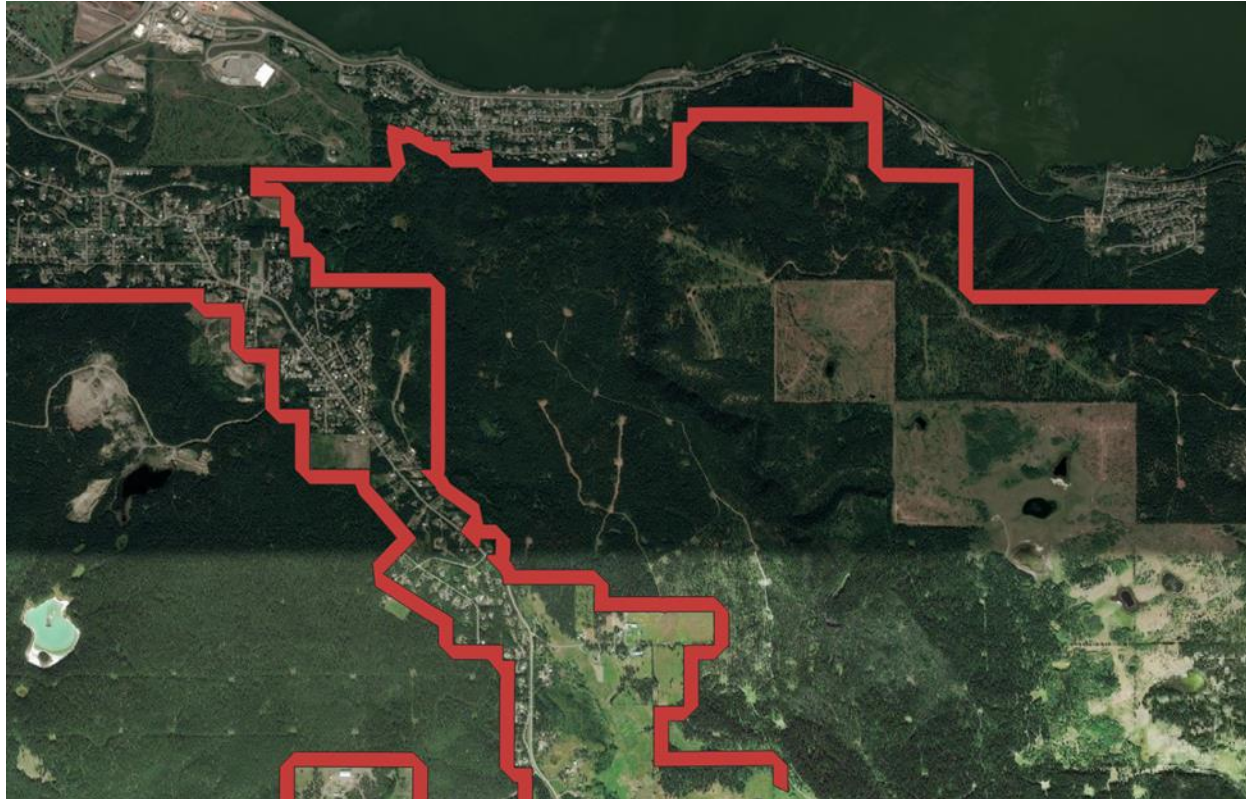
150 Mile House



Housing
Gas Compressor Station - \$125 million
(minimum value – true likely in
\$billions)
1577 ha @ \$2000/ha ~ \$3 million

		Probability of Treatment Being Tested		
Homes at Risk	d	0.05	0.1	0.2
	50	47.1%	23.6%	11.8%
	100	44.2%	22.1%	11.0%
	200	39.3%	19.6%	9.8%

South Lakeside – Williams Lake



Housing Values

315ha @ \$2000ha = \$630,000

		Probability of Treatment Being Tested		
	d	0.05	0.1	0.2
Homes at Risk	50	145%	73%	36%
	100	73%	36%	18%
	200	36%	18%	9%

What do I take to treasury?

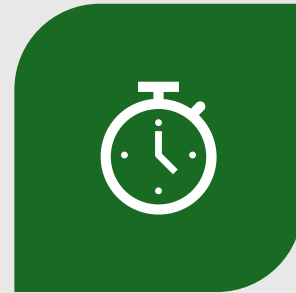
- Traditional Cost-Benefit Analysis is often used to make an ask to treasury – not immediately obvious how to do that with this.
- BC Wildfire Service has RSWAP – set of priorities for taking action
 1. Life and property
 2. Critical infrastructure
 3. High environmental and cultural values
 4. Other resources

The risk has already been mapped. Fuels mitigation for the top 50 assets in categories 1+2 are likely to exceed budget for any possible ask.

Advantages of this Approach



BETTER USE OF TACIT KNOWLEDGE
OF FIELD STAFF FOR RISK
MANAGEMENT PROBLEMS –
FORCES BACK AND FORTH
BETWEEN MODELERS/MANAGERS
AND DOMAIN EXPERTS

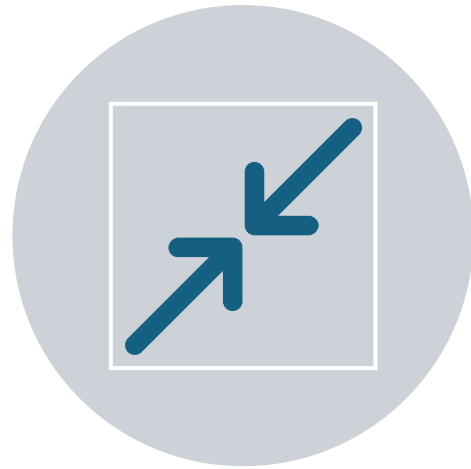


QUICK HEURISTIC THAT IS TIME AND
EXPERTISE EFFICIENT



REDUCES RISK THAT MONEY IS
SPENT ON PROJECTS THAT DON'T
WORK FOR THE EVENTS THAT
REALLY HURT.

Advantages of this Approach



SHORTENS THE OODA-LOOP



PUSHES DECISION MAKING OUT TO OPERATIONS
– THE PEOPLE WITH THE EXPERIENCE AND TACIT
KNOWLEDGE TO MEET VARIETY WITH VARIETY

Questions?

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