A Case in point: Ecosystem service causal models in SE fire management

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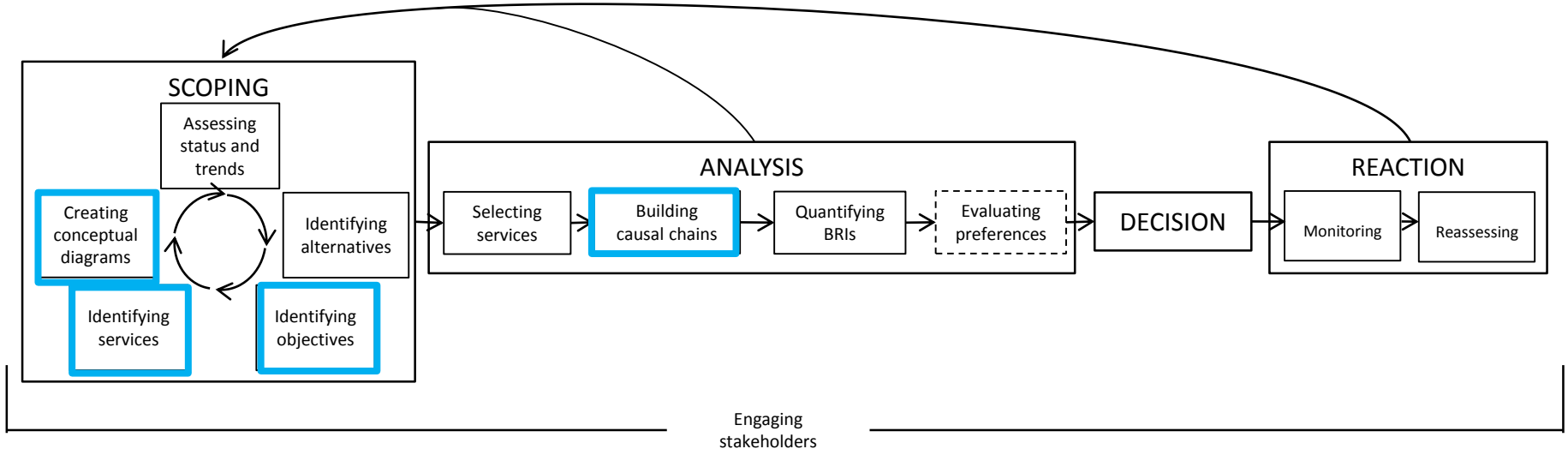
Presented at ACES 2016, Jacksonville FL


SCOPING
Assessing status and trends
Creating conceptual diagrams
Identifying alternatives
Identifying services
Identifying objectives
ANALYSIS
Selecting services
Building causal chains
Quantifying BRIs
Evaluating preferences
DECISION
REACTION
Monitoring
Reassessing
Engaging stakeholders

ES Causal Chain - Ecosystems to people

Ecological Measures

Wetland Impact → Wetland area (acres) → Water storage (volume)

Ecology | **Ecosystem Services** | **Societal Benefit**

Ecosystem Service Measures

Wetland Impact → Wetland area (acres) → Water storage (volume) → Water quantity (average late season water storage volume) → Water quantity available for irrigation (late season water flows to irrigation outtakes) → *valuation* → Marginal crop value attributable to irrigation water

NESP

Figure 7: Results chain for wind energy development in the Central Great Plains whole system

KEY CHALLENGE

Increased wind energy development has the potential to reduce green house gas emissions, climate risk respiratory disease, but lax infrastructure siting drives grassland habitat loss and fragmentation.

Utilities require avoidance of sensitive areas

Well –sited wind projects secure power purchase agreement (utility)

Demand for renewable energy

Improved siting of industrial wind development

Fewer permitting problems further speeds wind development

Much lower Gas and Coal emissions

Much less Particulate Air Pollution

Falling respiratory disease rates

Much Less Climate Change

Fragmentation of grassland halted

Conversion of grassland halted

Grassland extent stable, quality improved

More hiking and hunting

High carbon sequestration

Lower climate risk

DESIRABLE STATE

Wind energy expands significantly to reduce greenhouse gas emissions and climate change risk with no negative impact on grassland habitat extent, connectivity or quality.

More recreational hiking and hunting opportunities and increased respiratory health also result.

Indirect driver or contributing factor

Direct driver

Environmental condition

Human focal area or component

Primary Interest

AN EXAMPLE

EASTERN US FOREST FIRE MANAGEMENT

What kind of model are we building?

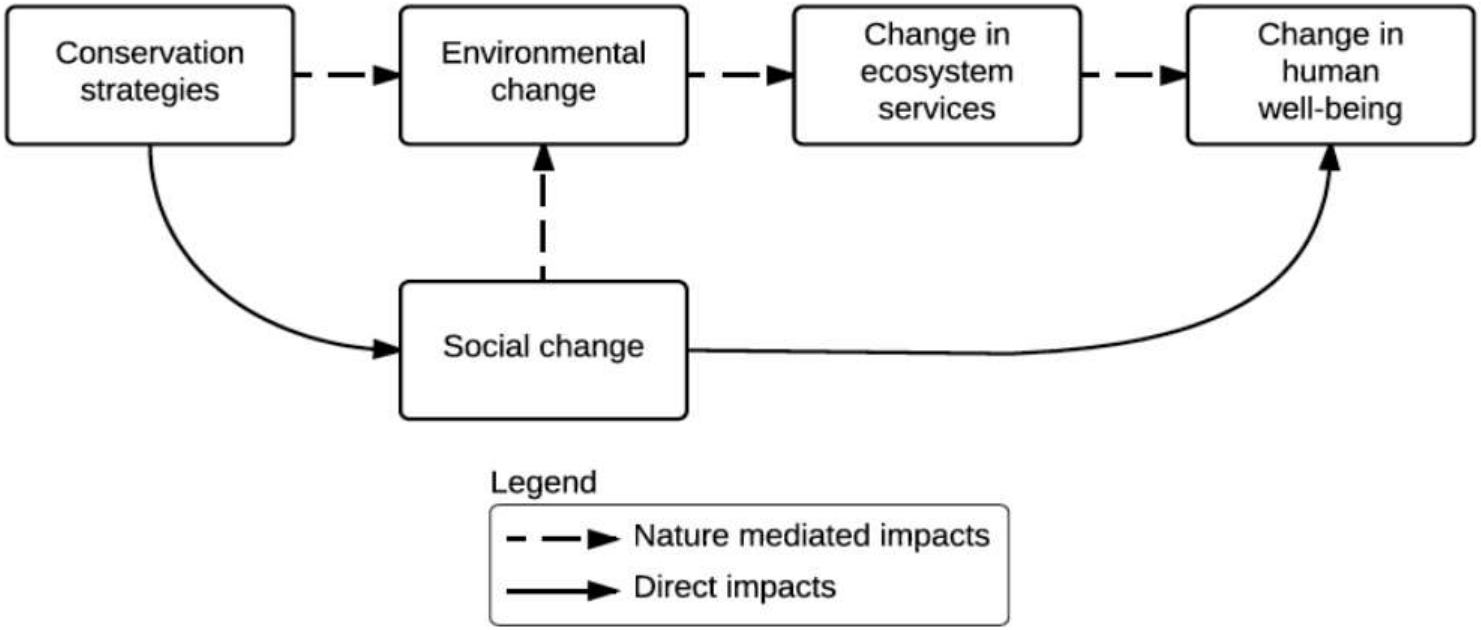
Use

- Develop hypothesis
- Identify data gaps
- Communicate with policy audience
- Scaffold/framework upon which to build evidence
- Framework for computational modeling/options analysis, etc…

Framing

- Short or long term effects, or both
- Local or regional effects, or both
- Expansiveness -- Only those expected to be significant and those identified as important
- Grouping of services?
- Is an expanded front end needed to explore interventions?
- What types of endpoints are appropriate – BRIs, monetary values, wellbeing endpoints

Figure 8: Direct and nature-mediated pathways between conservation and human well-being in simplified results chain



The Nature Conservancy

What kind of model are we building?

Longleaf Pine Forest – fire management

Communications model

Primary Objectives:

1. Reduce risk of catastrophic fire to reduce human fatalities, injuries, health impacts, and loss of property
2. Restore healthy long leaf pine habitat to protect rare and at risk habitat, species, and cultural associations

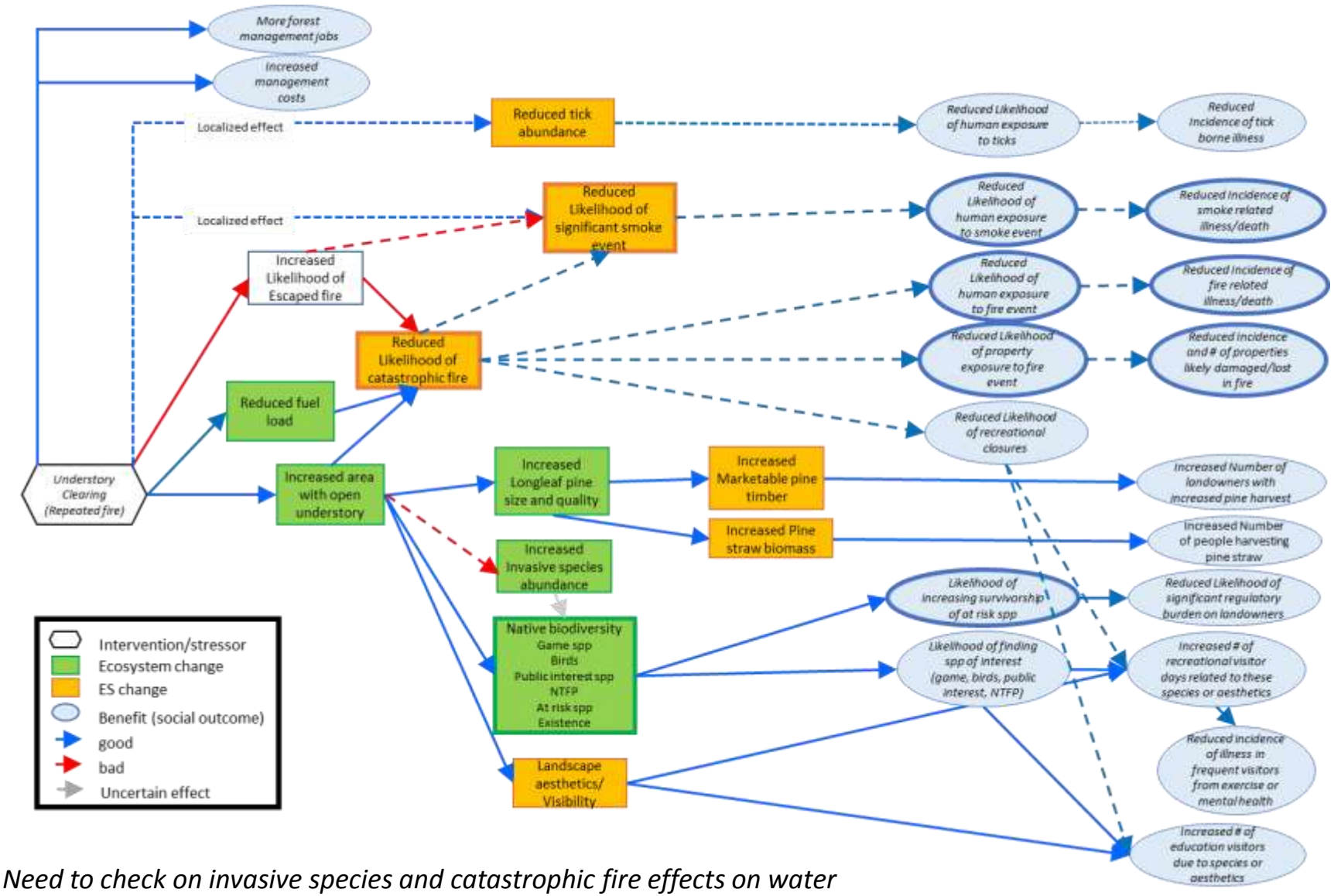
Baseline: long leaf pine that is not being actively managed to maintain long leaf pine
Time span: **long term10+ yr** and short term 3 months or less
Spatial extent: landscape scale (but noting significant localized effects that may affect decisions/ behavior

To keep model simple –

Figure only includes effects most likely to be significant to decision makers – landowners being targeted or larger public welfare effects

Those likely to be important only in special cases (specific areas) or that are more uncertain but probably small (and difficult to determine direction of change) are mentioned in the hypothesis /assumptions but removed from figures.

Conceptual model for understory clearing by prescribe fire for improved health of eastern US long leaf pine forests



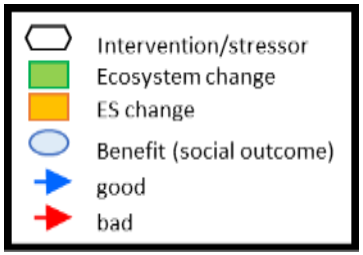
? - Need to check on invasive species and catastrophic fire effects on water

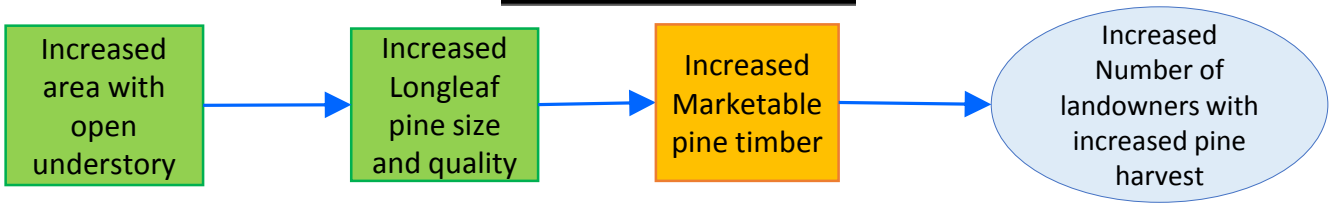
Not fully vetted – workshop version

Decisions Made

RESULTS CHAINS:

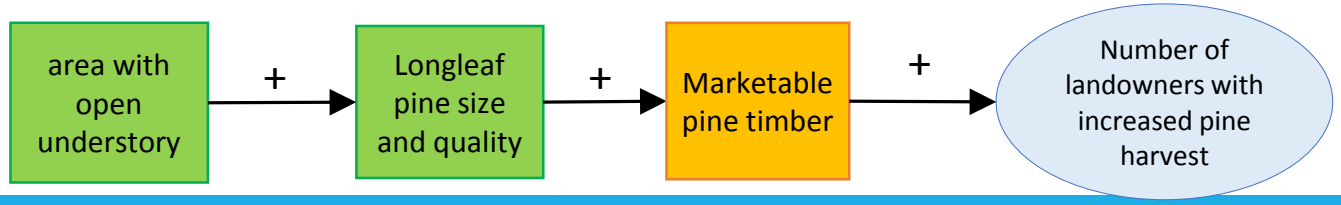
What goes in a box?





What do arrows reflect?

- Is directionality of connections between boxes reflected in the chain? If so, how?
- Is magnitude of strength of connection between boxes reflected in the chain? If so, how?

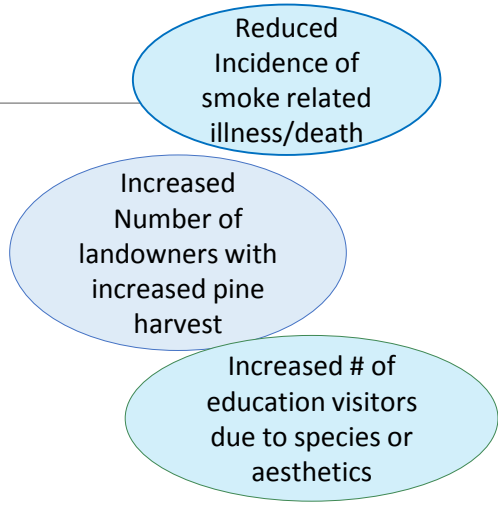


Decisions Made

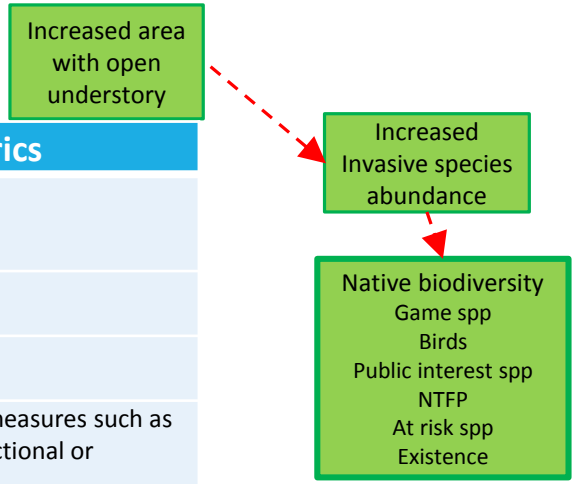
RESULTS CHAINS:

What are the endpoints?

- How far should causal pathways captured in results chains extend?
- How do we get consistent use of endpoints (or other nodes) across sectors?
- How are unintended outcomes (positive and negative) considered?
- Should feedbacks be captured in results chains?



How are assumptions captured and/or expressed?



State 1	state 2	assumption 1	assumption 2	Metrics
Understory clearing fire	**Smoke**	Repeated fire is used to clean understory vegetation	Smoke generation depends on fuels, weather conditions…	Particulates; visibility
	Catastrophic fire risk	Clearing of understory reduce surface fuels		# of large fires
	Tick abundance	Reduce suitable habitats for ticks and also fire kill		Field samples
	Native biodiversity	Effects of fire such as heat or scorch		T & E counts; other measures such as species richness, functional or phylogenic diversity
	Employment	Silvcultural services providers are available		# FTEs in longleaf pine, or wages
	Parklike structure	Understory structure/native elements exisit and will re-establish		Community structure and composition

Did the chain capture everything it needed? - NO

Intervention

- Regulation
- Incentive
- Education
- Etc…

Action

- On the ground actions that affect ecosystems or people

Resulting effects

- Biophysical structure/function
- Ecological structure/function
- Human interaction/action

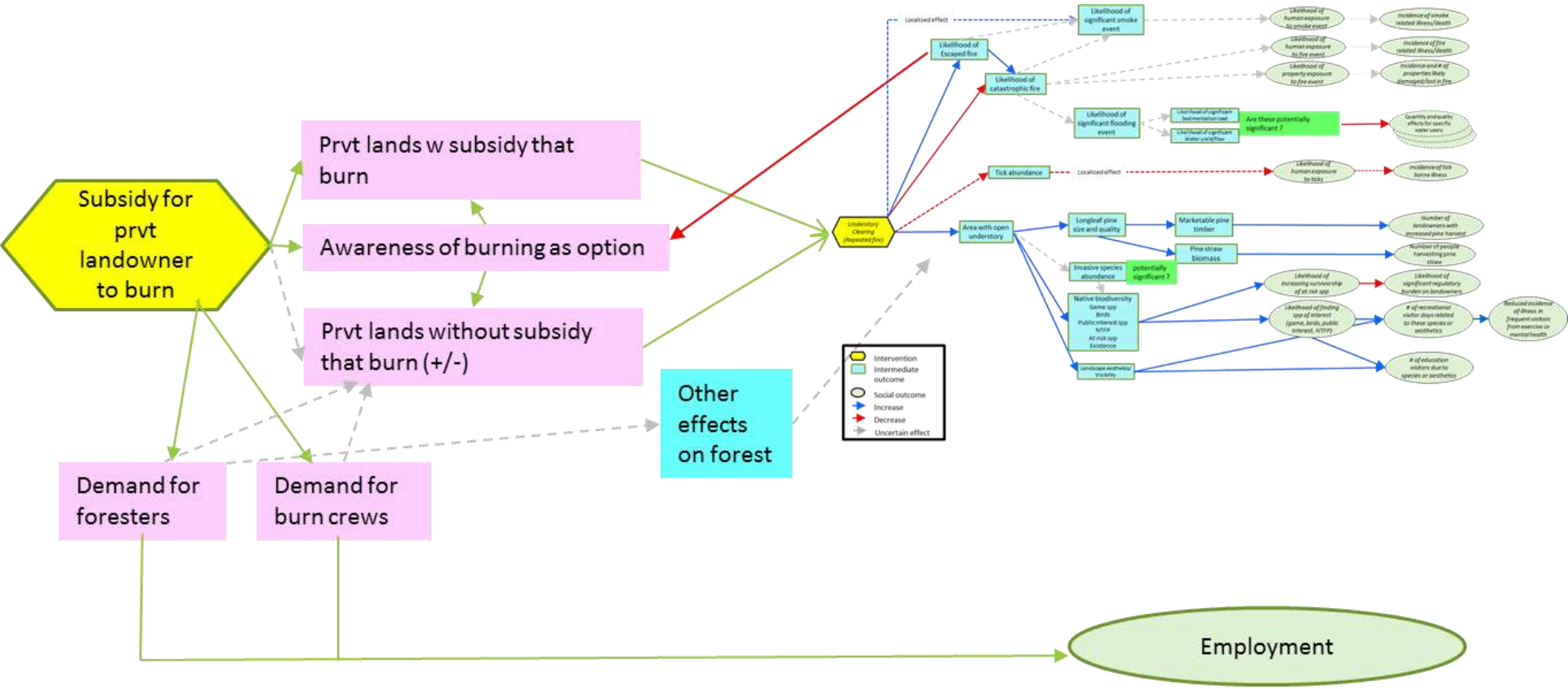
Outcomes

- Direct and environmentally mediated effects of the action (cascade)
- End with benefit relevant indicators; FEGS; things that can be valued

Human Welfare

- Economic implications
- Effects on critical players (e.g., landowners)
- Other well being endpoints
- Equity

Adding programs to encourage prescribed burning on private forest lands will be needed for Eastern Forest Management



What is an appropriate endpoint and should be aiming for consistency?

Intervention

- Regulation
- Incentive
- Education
- Etc…

Action

- On the ground actions that affect ecosystems or people

Resulting effects

- Biophysical structure/function
- Ecological structure/function
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Outcomes

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Human Welfare

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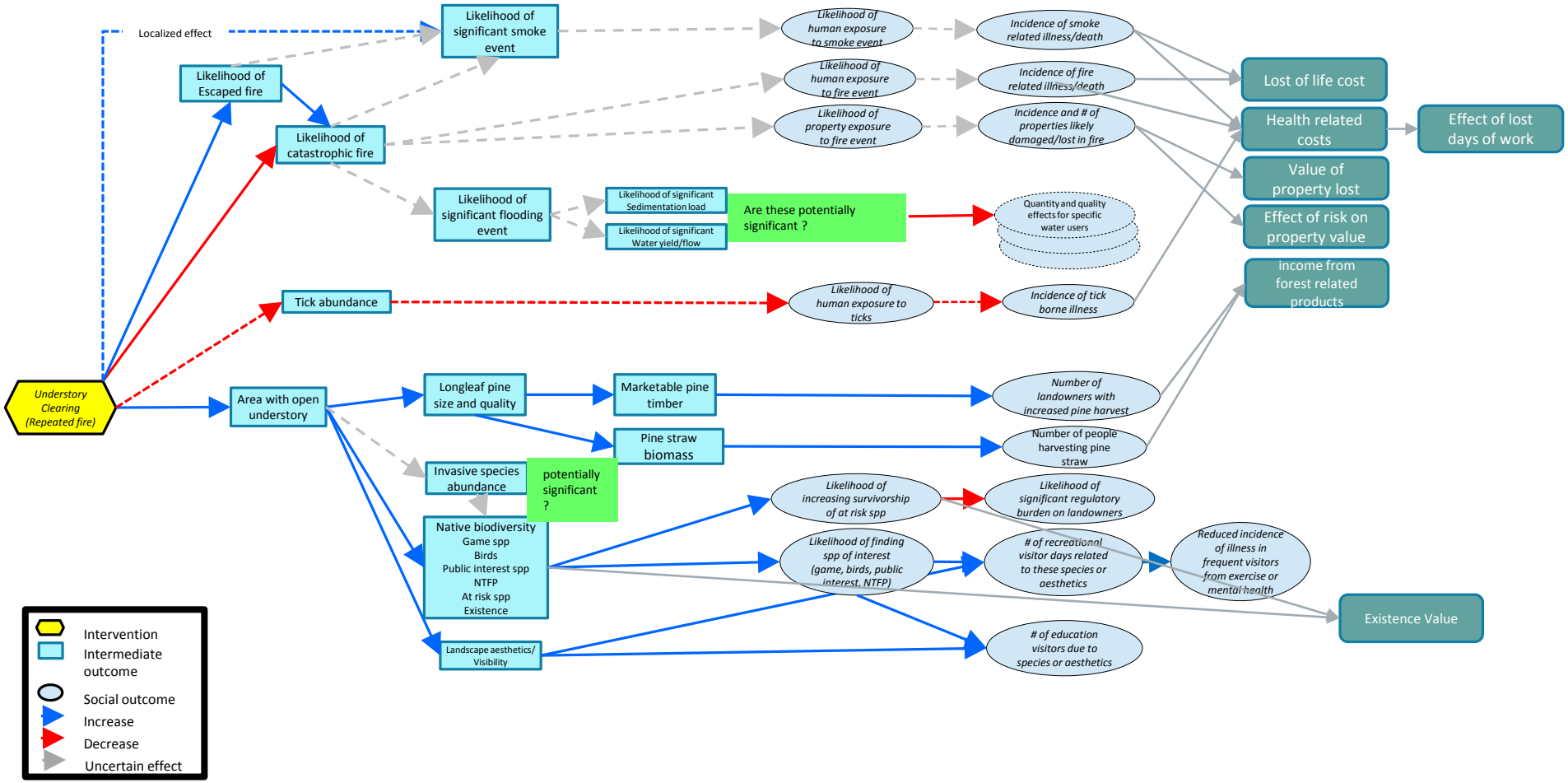
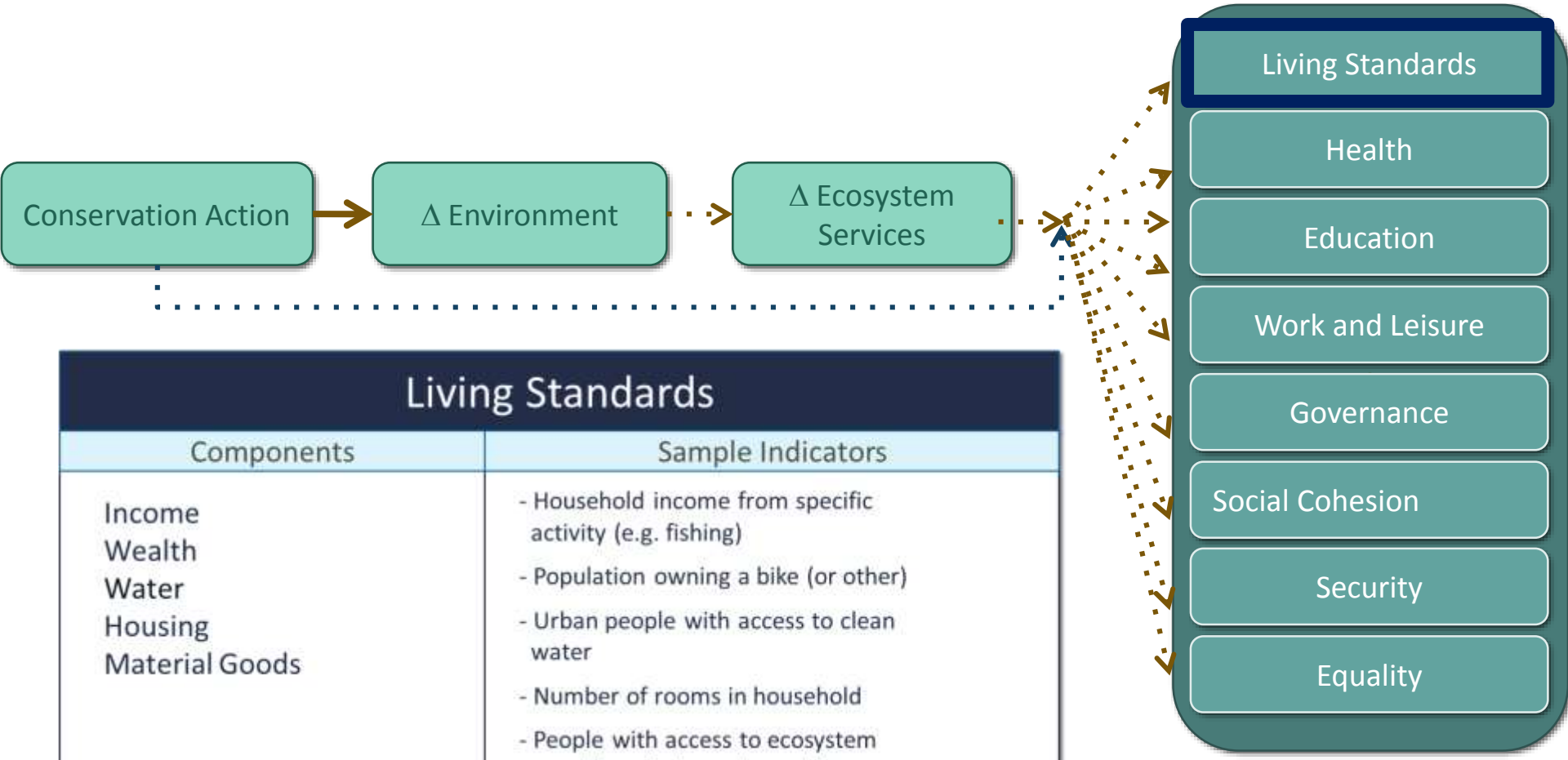
- Equity

Modified by Lydia, August 31 2016
Analytical version – long term
Linked to values



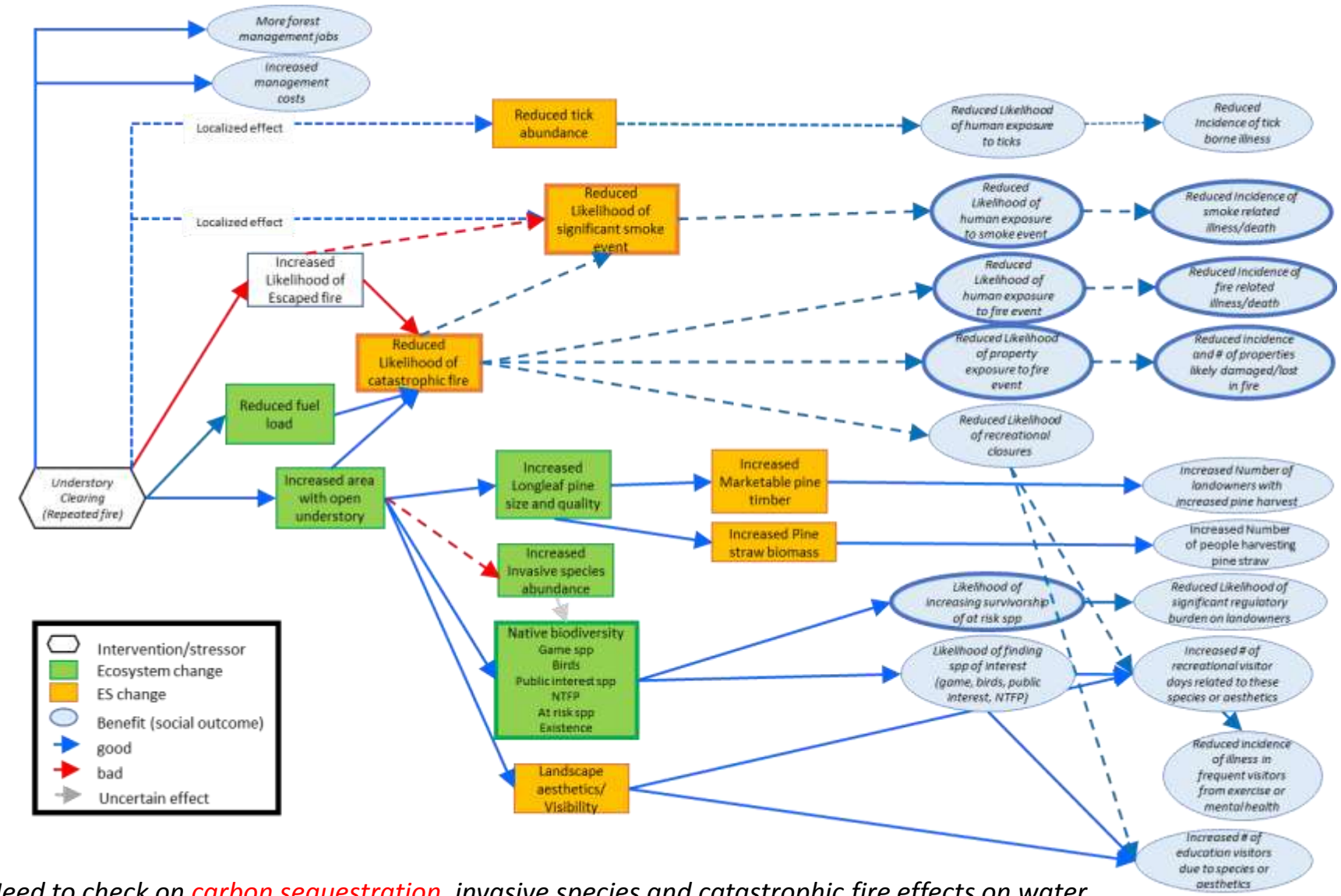
Human Well Being – What ENDPOINTS



Living Standards

Components	Sample Indicators
Income Wealth Water Housing Material Goods	- Household income from specific activity (e.g. fishing) - Population owning a bike (or other) - Urban people with access to clean water - Number of rooms in household - People with access to ecosystem good (e.g. timber, charcoal) - People below poverty line

NEXT STEP- Incorporating evidence



? - Need to check on carbon sequestration, invasive species and catastrophic fire effects on water

Not fully vetted – workshop version

Literature review:
Is the change in carbon sequestration or storage important?

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BERLYN REVIEW

A meta-analysis of management effects on forest carbon storage

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ABSTRACT

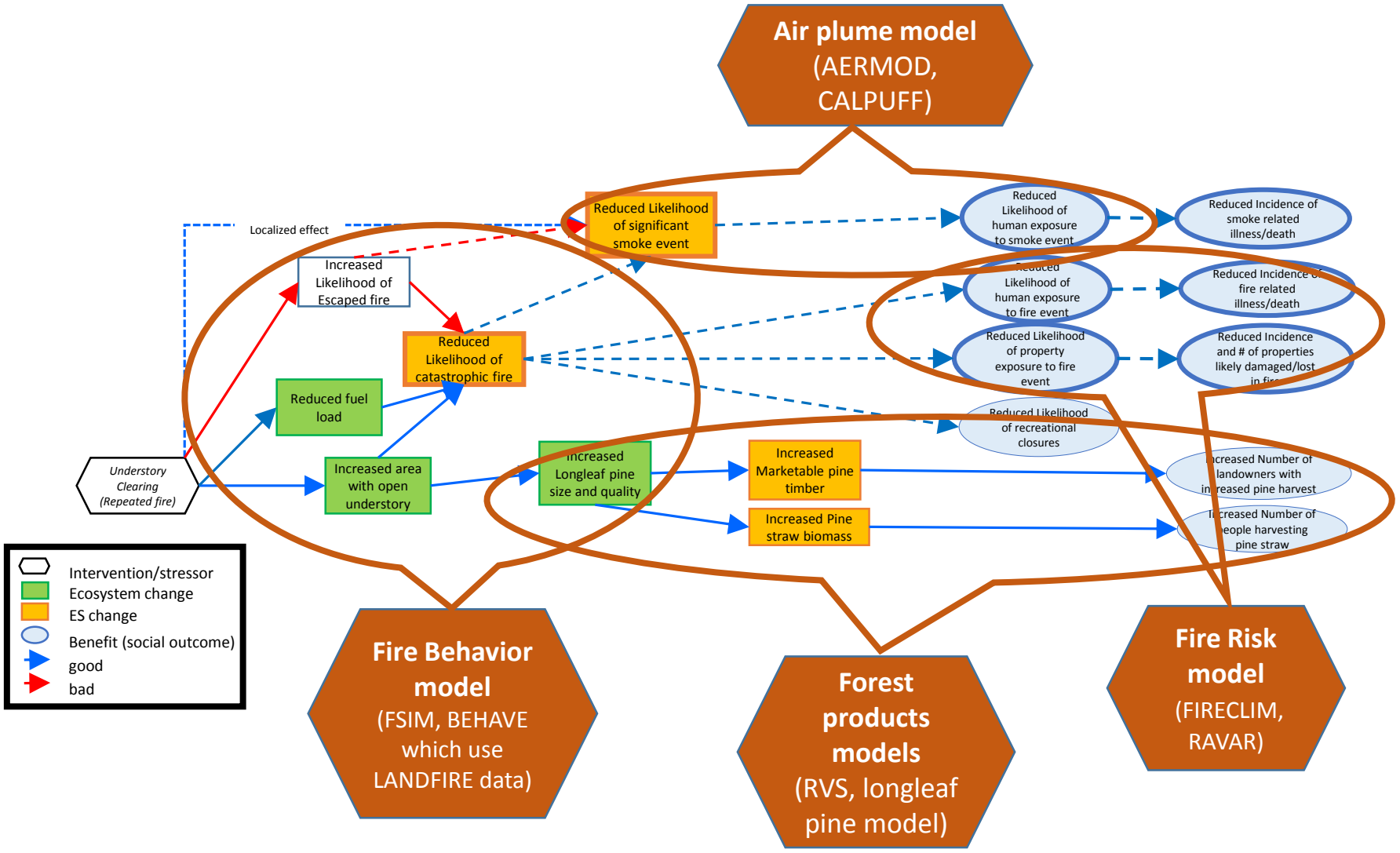
Forest management can have substantial impacts on ecosystem carbon storage, but those effects can vary significantly with management type and species composition. We used systematic review methodology to identify and synthesize effects of thinning and/or burning, timber harvesting, clear-cut, and wildfire on four components of ecosystem carbon: aboveground vegetation, soil, litter, and deadwood. We performed a meta-analysis on studies from the United States and Canada because those represented 85% of the studies conducted worldwide. We found that the most important variables in predicting effect sizes (ratio of carbon stored in treated stands versus controls) were, in decreasing order of importance, ecosystem carbon component, time since treatment, and age of control. Management treatment was the least important of all the variables we examined, but the trends we found suggest that thinning and/or burning treatments resulted in less carbon loss than wildfire or clear-cut. This finding is consistent with recent modeling studies indicating that forest management is unimportant to long-term carbon dynamics relative to the effects of large-scale natural disturbances (e.g., drought, fire, pest outbreak). However, many data gaps still exist on total ecosystem carbon, particularly in regions other than North America, and in timber production forests and plantations.

KEYWORDS

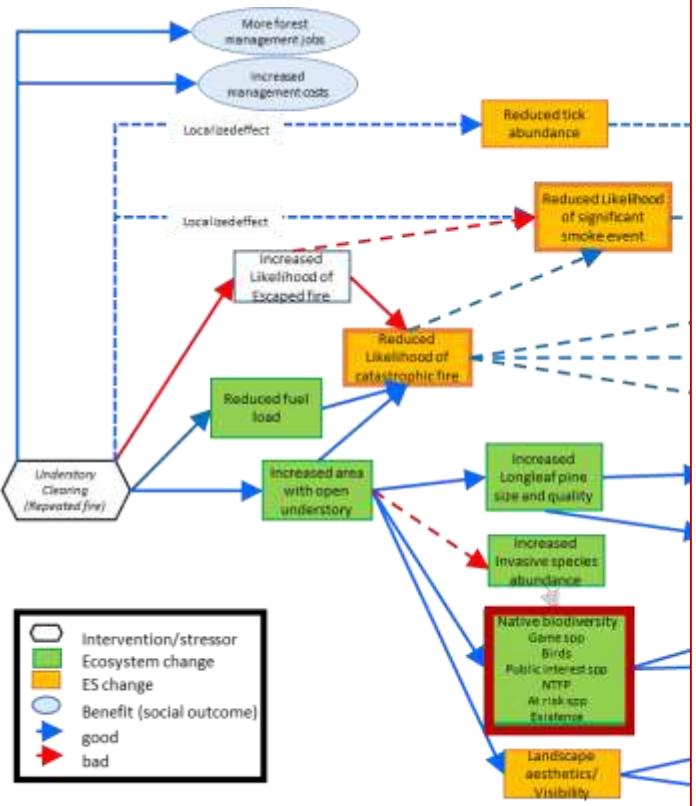
Ecosystem carbon; fuel reduction treatment; harvest; plantation; prescribed fire; wildfire

"Forest management is unimportant to long-term C dynamics relative to … large scale natural disturbances"

Using existing models..



In some cases there will be only “generic” information



Meta-analysis of avian and small-mammal response to fire severity and fire surrogate treatments in U.S. fire-prone forests

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Abstract. Management in fire-prone ecosystems relies widely upon application of prescribed fire and/or fire surrogate (e.g., forest thinning) treatments to maintain biodiversity and ecosystem function. Recently, published literature examining wildlife response to fire and fire management has increased rapidly. However, none of this literature has been synthesized quantitatively, precluding assessment of consistent patterns of wildlife response among treatment types. Using meta-analysis, we examined the scientific literature on vertebrate demographic responses to burn severity (low/moderate, high), fire surrogates (forest thinning), and fire and fire surrogate combined treatments in the most extensively studied fire-prone, forested biome (forests of the United States). Effect sizes (magnitude of response) and their 95% confidence limits (response consistency) were estimated for each species-by-treatment combination with two or more observations. We found 41 studies of 119 bird and 17 small-mammal species that examined short-term responses ($\leq$4 years) to thinning, low/moderate- and high-severity fire, and thinning plus prescribed fire; data on other taxa and at longer time scales were too sparse to permit quantitative assessment. At the stand scale ($<$50 ha), thinning and low/moderate-severity fire demonstrated similar response patterns in these forests. Combined thinning plus prescribed fire produced a higher percentage of positive responses. High-severity fire provoked stronger responses, with a majority of species possessing higher or lower effect sizes relative to fires of lower severity. In the short term and at fine spatial scales, fire surrogate forest-thinning treatments appear to effectively mimic low/moderate-severity fire, whereas low/moderate-severity fire is not a substitute for high-severity fire. The varied response of taxa to each of the four conditions considered makes it clear that the full range of fire-based disturbances (or their surrogates) is necessary to maintain a full complement of vertebrate species, including fire-sensitive taxa. This is especially true for high-severity fire, where positive responses from many avian taxa suggest that this disturbance (either as wildfire or prescribed fire) should be included in management plans where it is consistent with historic fire regimes and where maintenance of regional vertebrate biodiversity is a goal.

Key words: birds; Fire and Fire Surrogate study; fire management; fuels reduction; prescribed fire; thinning; wildfire; wildlife.

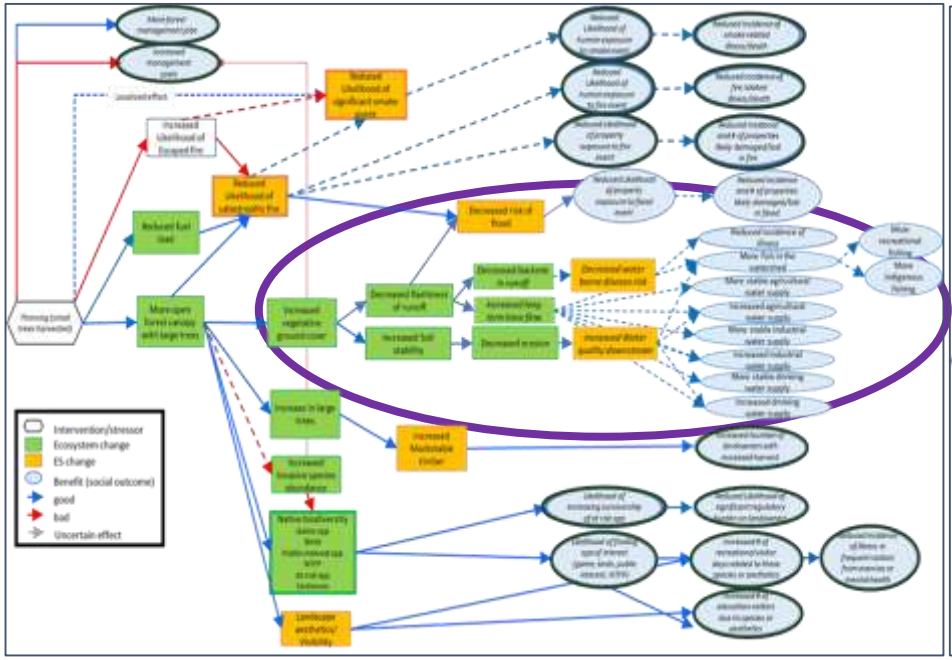
What do the principles affect?

EVIDENCE:

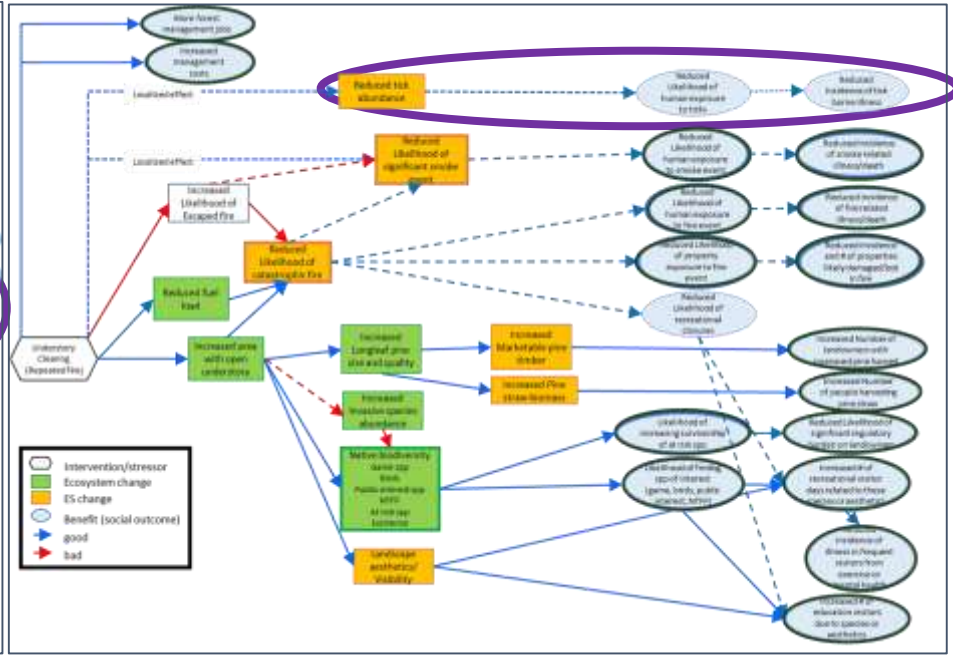
- How is confidence in the quality (efficacy, precision, accuracy) of evidence determined?
  - Is it the same for a single piece of evidence and for bodies of evidence?
- Do we need different considerations for assessing quality of evidence for a single link in a chain versus for an entire chain from intervention to outcome?
- How can different types of evidence be incorporated and considered consistently (e.g., observations, models, local knowledge, qualitative information, non-peer review literature)?

Transferability: Common elements across conceptual models

Western US



Southeastern US



Is a whole chain or parts of a results chain common or transferable across similar decision contexts?

Transferability of the model and evidence

- What pathways or sub models within the larger conceptual model stay the same across geographies or contexts?
- How do we determine and represent transferability of evidence from studies to a new case (i.e. external validity, transferability or generalizability of the evidence in a results chain)?
  - Can the same analytical models be used or are they site specific? Can we just change the initializing parameters?
  - Do the meta-analyses or studies available in the literature suggest similar or different outcomes/values in different contexts and do we have information to adapt our models already gathered or do we need to find more?

What we learned

CHAINS

- Important to know the purpose
- Important to consider temporal and spatial scale needed
- Need to know baseline (and alternatives if needed)
- Important to consider the whole chain (front and back ends) and different types of endpoints

EVIDENCE

- Need evidence that the model has the right linkages and boxes
- Need evidence about direction and magnitude for links or paths
- Need some approach to evaluate confidence in the evidence

TRANSFERABILITY

- Parts of models rather than have commonality
- Will need to assess applicability of evidence to new contexts