Factoring out of indirect and natural effects: challenges and opportunities

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LULUCF in a Post 2012 Climate Agreement

COP-11 Side Event

Montreal, December 5, 2005

Outline

- What is “factoring out”
- Why – Opportunities
- How – Challenges
- Conclusions

Factoring Out

- “Factoring out” is the separation of direct human-induced (DHI) effects on carbon emissions and removals, from natural (N) and indirect human-induced (IHI) effects.
- Separation into only 2 parts: DHI versus (N and IHI)

Factoring out in Marrakesh Accords

- Information should also be provided which indicates whether or not anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities under Article 3 paragraph 3 and elected activities under Article 3 paragraph 4 factor out removals from:

  (a) Elevated CO_2 concentrations above pre-industrial levels;

  (b) Indirect nitrogen deposition; and

  (c) The dynamic effects of age structure resulting from activities prior to 1 January 1990;

Marrakesh Accords: FCCC/CP/2001/13/Add.3, English, Page 23.

Factoring out in Marrkesh Accords

- The MA request only factoring out **REMOVALS** from CO_2 fertilization, N deposition and age-class structure, thus seek to eliminate “undue” credits.
- But natural and indirect human-induced effects can also result in “undue” debits:
  - 2003 drought in Europe caused 0.5 Pg C net source from terrestrial systems (Ciais et al. Nature 2005)
  - Emissions from lightning-cause wildfires in the managed forest
- SBSTA request for IPCC Task 3 was balanced (emissions and removals) but focused on effects due to “past practices”. Excludes age-class effects from changes in disturbance regimes.

Why Factoring Out

- Improves the attribution of emissions and removals to direct human activities (anthropogenic emissions).
- Countries that, due to their current age-class structure will have a sink that exceeds the FM cap have no carbon-related incentive to improve management.
- Large natural disturbances (e.g. fires) and extreme climate events (e.g. drought) may swamp human-induced effects on C balance. This risk decreases incentives to elect or change management.
- As climate change impacts become more severe, relative contribution to carbon emissions and removals of direct human activities diminishes.

Factors affecting stand-level C balance

- Direct human-induced (DHI)
  - tree species selection, site preparation, planting, silviculture, harvest sytems, etc.
- Indirect human-induced (IHI)
  - CO_2 fertilization, indirect nitrogen-enrichment, global climate change
- Natural effects (N)
  - Climate variability

Approaches to Separating DHI versus IHI and Natural Effects

Stand-level

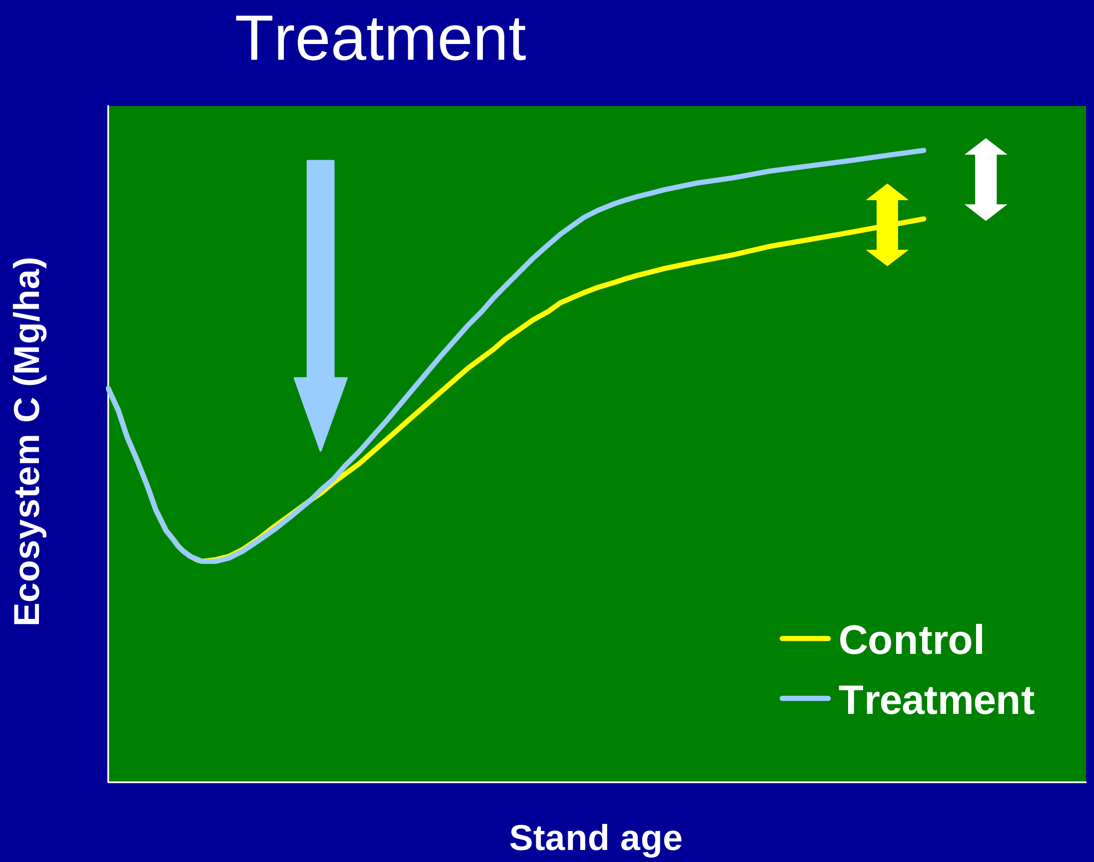
1. Compare against similar stand without direct human-induced effects (e.g. silvicultural treatments)
2. Control does not capture IHI and Nat effects: baseline established through other means (e.g. afforestation)

Landscape-level

1. Sum stand-level contributions of DHI effects, plus
2. Landscape-level emerging properties (e.g. shifts in age-class structure)

Separating DHI versus IHI and Natural Effects

Stand-level: Paired treatment and control plots



DHI Effect

IHI and Nat. Effects

Need not be quantified

Included in control

Separating DHI versus IHI and Natural Effects

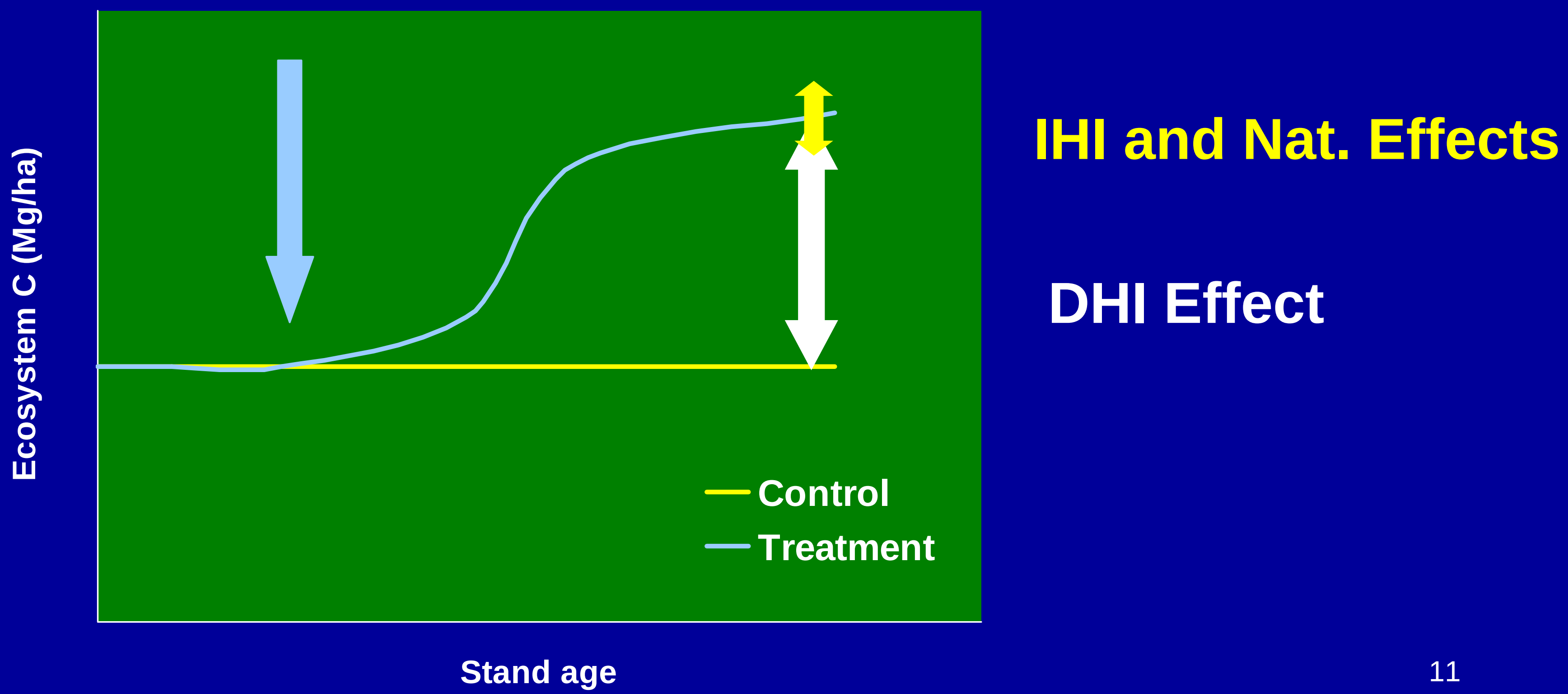
Stand-level

- In some cases, e.g. afforestation, the control plot can not capture the IHI and Nat effects that affect the stand
- Some argue that in the case of A and R the IHI and Nat effects should be separated from the DHI effects.
- This would require alternate means for establishing the IHI and Nat. effects.
  - Could compare to historical growth on similar sites and species combinations but these may not exist in the case of afforestation.

Separating DHI versus IHI and Natural Effects

Stand-level: Baseline does not capture IHI and Nat effects

Afforestation



Factors affecting landscape-level C balance

Landscape-level

- Direct human-induced (DHI)
  - Protection activities to suppress insects and fire
  - Choice of rotation length and harvest rates
- Indirect human-induced (IHI)
  - CO_2 fertilization, N-enrichment impacts at stand level
  - climate change effects on disturbance regimes
- Natural effects
  - climate variability effects on disturbance regimes

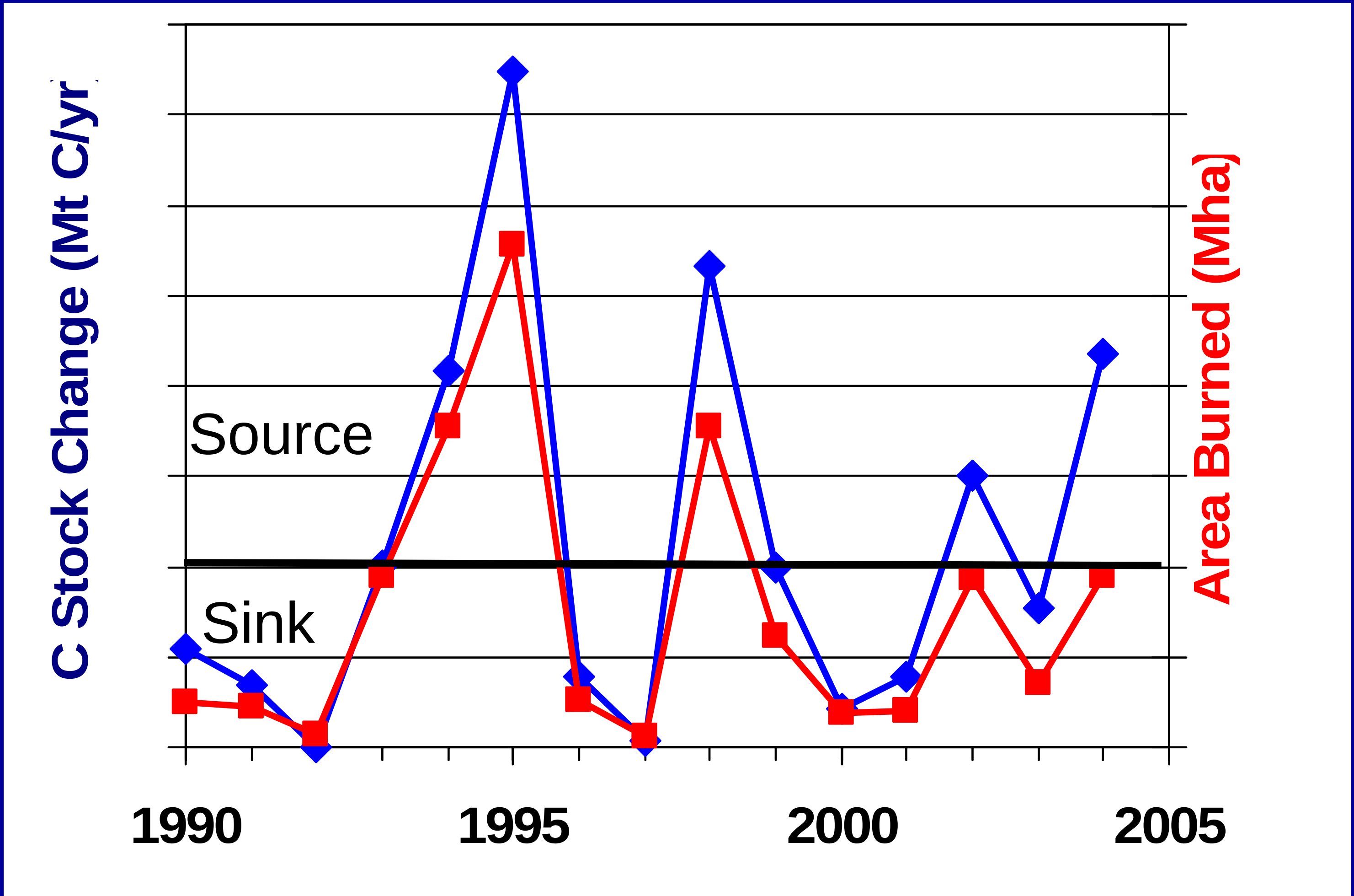
Separating DHI versus IHI and Natural Effects

Landscape-level

- Sum of quantifiable stand-level effects, e.g. silvicultural treatments that alter carbon density per ha,
  PLUS
- Landscape-level effects, such as changed harvest rotation and altered disturbance regimes that affect age-class structures.
- Treatment and control approach not possible because
  - Large scale (regional differences prevent comparable pairs), and
  - no human activities may not be acceptable in the “control” landscape (e.g. let forests burn?)

Factoring Out Challenges

- Forest Carbon Stock changes are highly correlated with area burned by wildfire (example for 100 Mha region).



Factoring Out Challenges

- Could calculate, at year end, the “expected” area burned based on observed fire season weather.
- Then give credit (or debit) based on deviation of actual from expected area burned.
- Quantifying the effect of fire (or insect) suppression efforts at the landscape-scale remains difficult
  - Models that relate area burned to environmental variables (e.g. fire weather index) have moderate explanatory power
  - Several factors interact: e.g. Mountain Pine Beetle outbreak in British Columbia is attributed to changes in vegetation (natural aging, succession), management (fire suppression) and climate conditions (no minus 40ºC winter).

The age-class legacy

The future net C balance is affected by the current forest age-class structure which results from stand-replacing disturbances over the past decades.

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

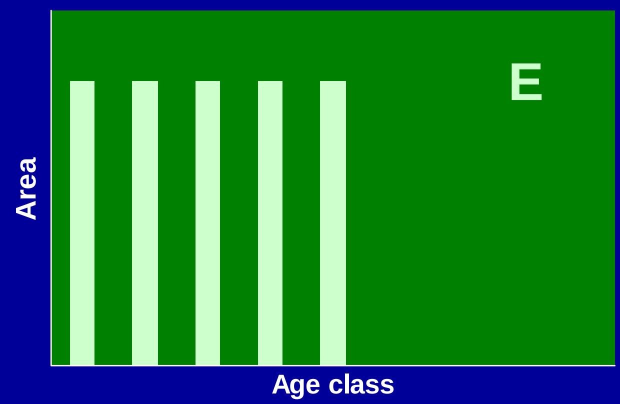
- An operational-scale model of forest C dynamics.

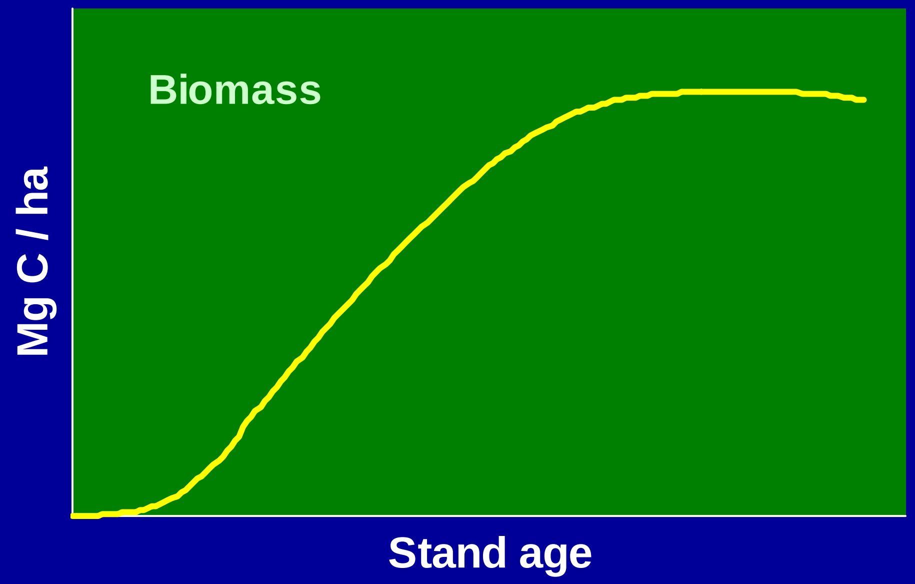
- Freely available at carbon.cfs.nrcan.gc.ca

Hypothetical Landscape Example

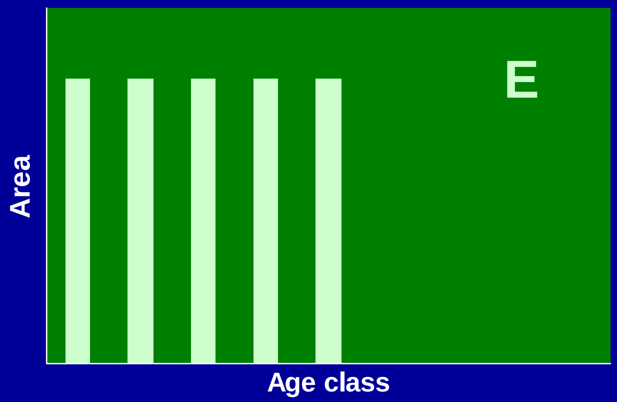
- 100,000 ha landscape
- Single site type described by one growth curve
- Three initial age-class structures:
  - Even (1% of area in each 1 to 100 year)
  - Left shifted (e.g. created from increased disturbances)
  - Right shifted (e.g. created from decreased disturbances)
- Management regime: clearcut harvest 1 % of area / yr

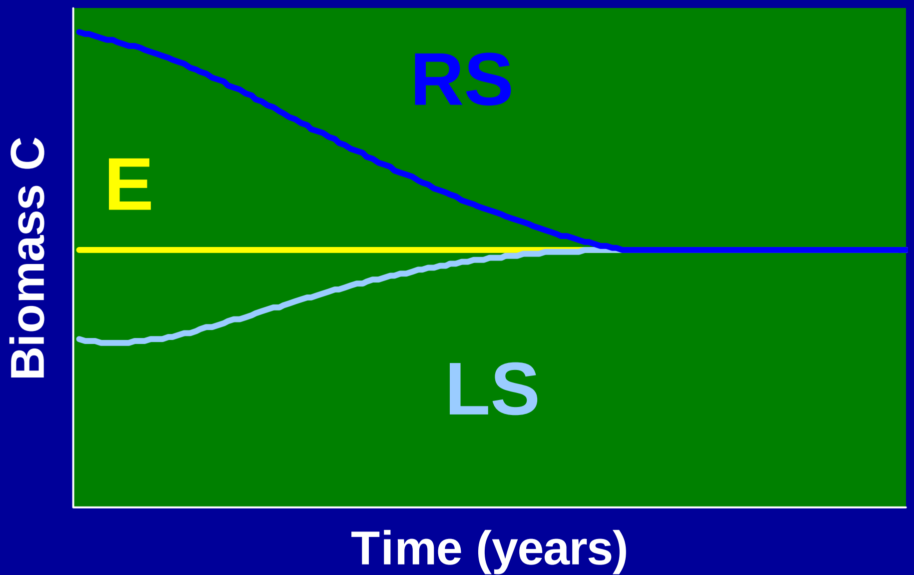
The age-class legacy





The age-class legacy





Lessons Learned

- Age-class structure affects the amount of C stored:

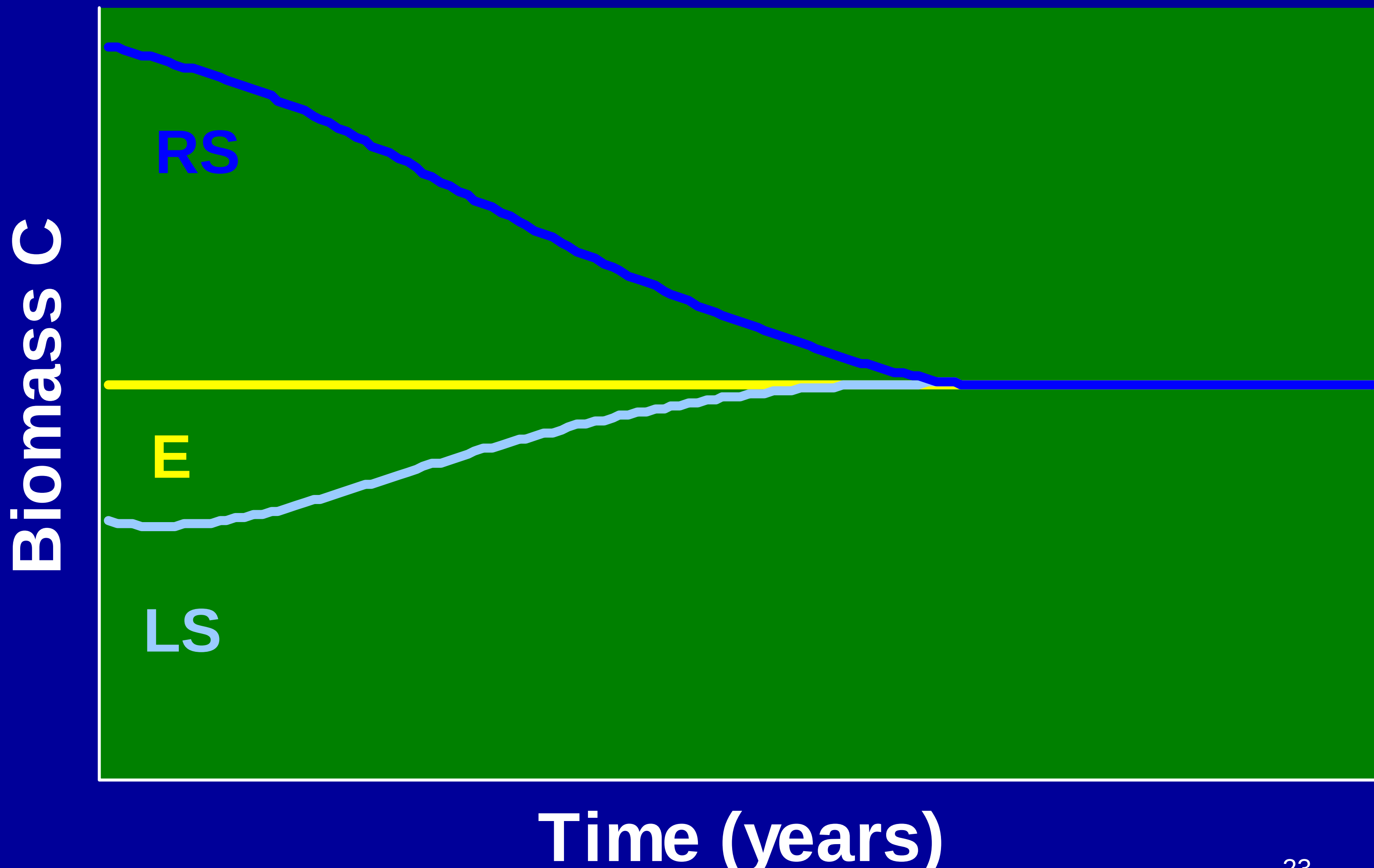
  In this example, the RS age-class structure contains 2.8 times the biomass of the LA age-class structure.
- Age-class structure also affects future C dynamics:

  With same management regime (harvest 1 % of area / yr):
  - the RS landscape loses biomass C (debit),
  - the E landscape is “neutral” and
  - the LS landscape gains biomass C (credit).

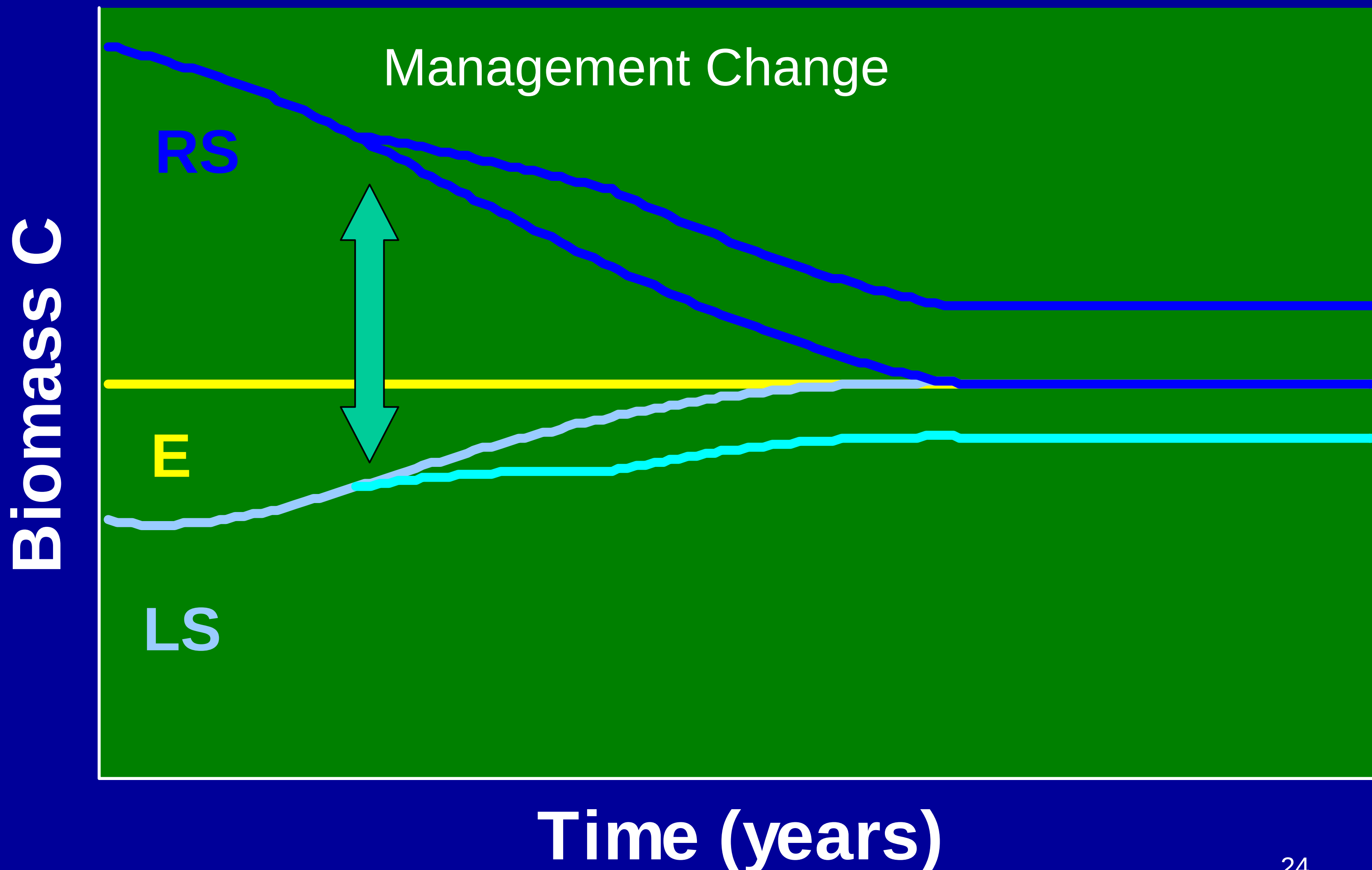
Factoring Out Challenge

- How to establish the reference age-class structure from which the baseline carbon dynamics are calculated?

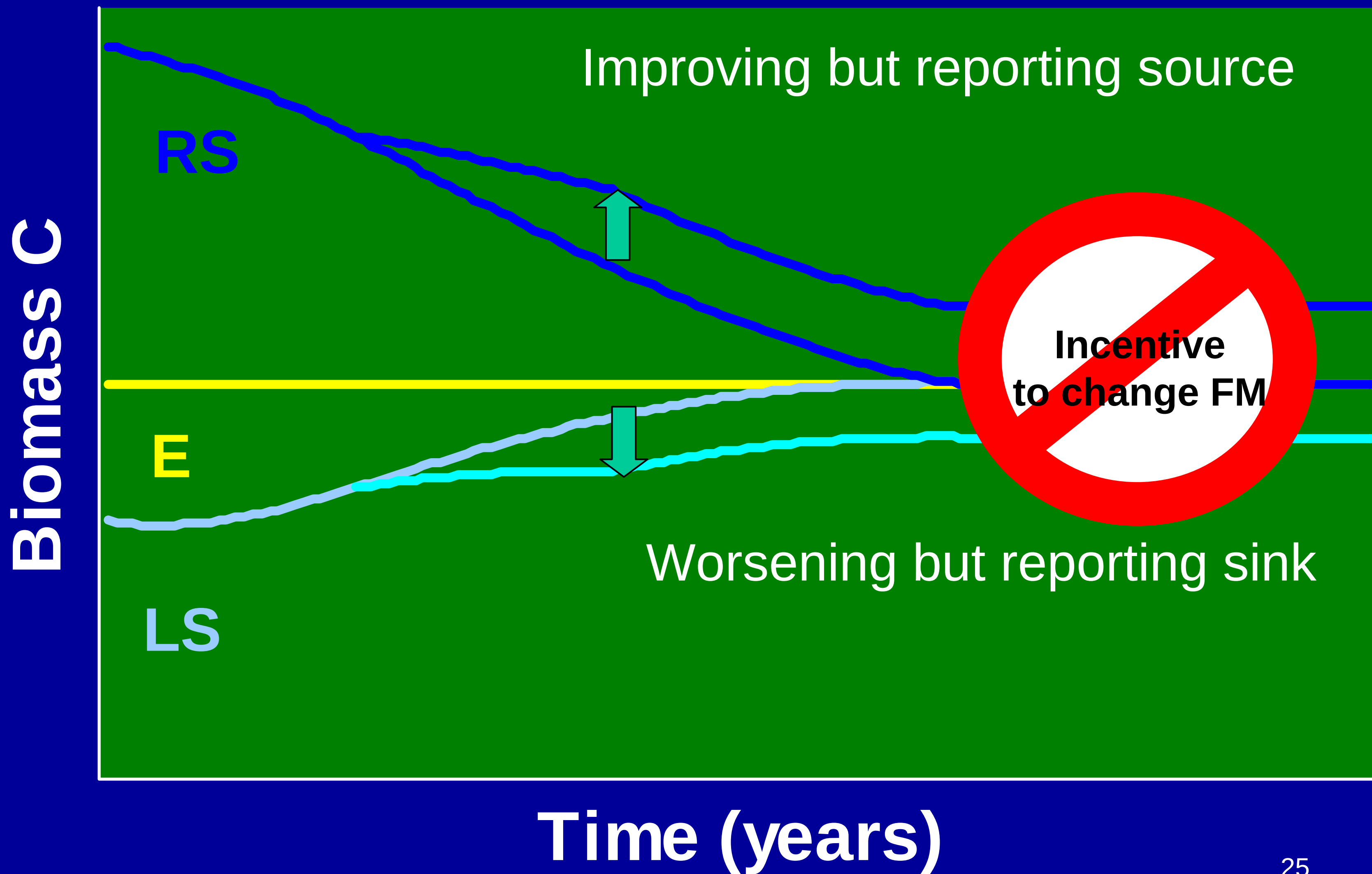
Management Effects



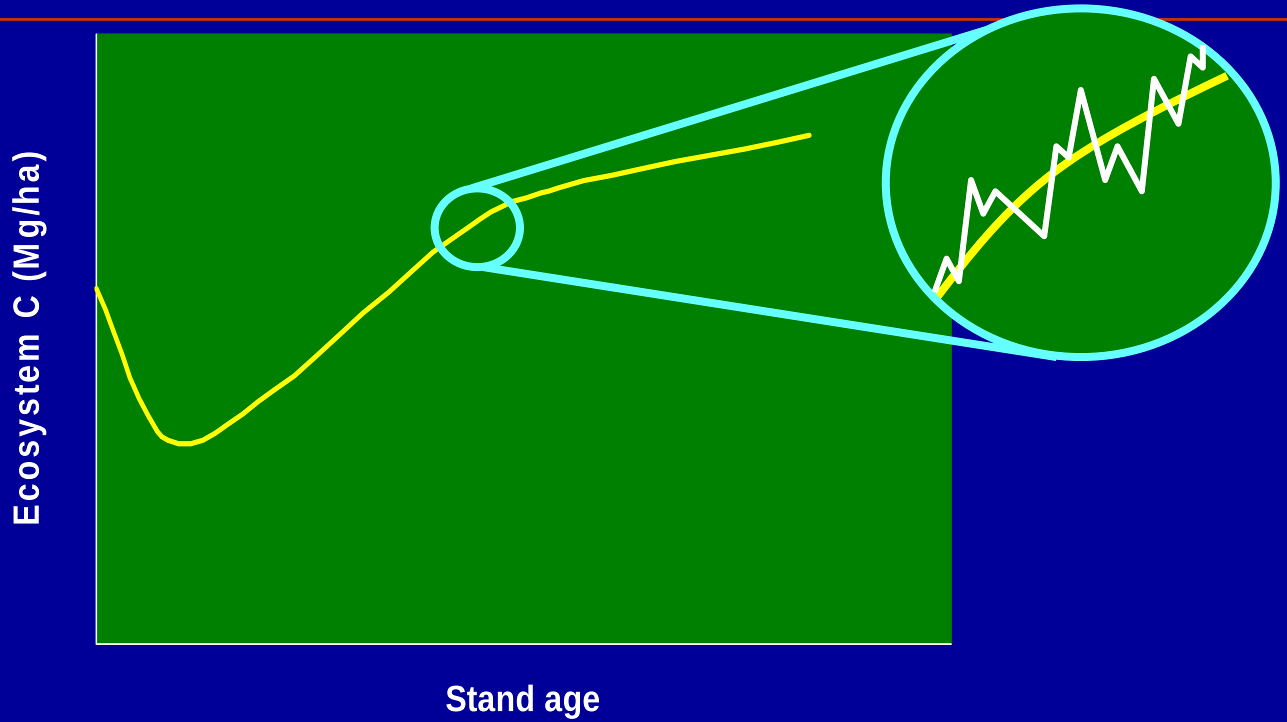
Management Effects



Management Effects



Factoring Out Challenges



- Use models to calculate carbon budget using average climate and factor out effects of climate variation.
- But what is the “normal climate” with which a baseline can be established?

Factoring Out Challenges

- Factoring out may result in “accounted” carbon stock changes that differ in magnitude and sign from actual impact on the atmosphere.
- This can be addressed through two estimates:
  – The estimate of forest contribution to atmosphere (full carbon cycle estimate)
  – The attribution of emissions and removals to direct human activities.
- We need to understand the impacts on the atmosphere and limit the credits/debits to the direct human-induced component.

Conclusions

"Factoring out", or subtracting natural and indirect human effects from carbon budgets:

- helps attribute debits and credits for C emissions and removals to human activities in LULUCF
- provides opportunity for improve incentives to increase sinks and decrease sources through change in activities
- should be accompanied by complete estimate of carbon balance, to quantify the impacts on the atmosphere
- will complicate accounting and reporting methods
- remains scientifically challenging, but good progress is being made

Questions?
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