Can we have our forest carbon and use it too?

Tom Gower
Professor of Forest Ecosystem Ecology
Department of Forest and Wildlife Ecology
University of Wisconsin
Madison, WI
Outline

- Systems Ecology & C Management
- Biological Ecosystems C Dynamics
- Industrial Ecosystem Dynamics
- Concluding thoughts
Biological and Industrial Ecosystem C Budgets

Forest System Production

Adapted from Gower 2003

NEP = NPP - RH
Conceptual model of “strategy of ecosystem development” and C dynamics

Adapted from Odum 1969 & Sprugel 1985

Luyssaert et al. 2008 claims old-growth forest are C sink

Adapted from Odum 1969 & Sprugel 1985
Net ecosystem production during stand development of five forest ecosystems. Gower et al. 2012

NEP (tC/ha/yr) vs Stand age (years)
Not all North American old-growth forests are a C sink!
Forest ecosystem process models allow scientists to examine the effects of past and future harvest “scenarios” on carbon dynamics.

Primary forests in northern Wisconsin (and other Great Lake Regions forests) were clear-cut, resulting in a largely even-aged forests.
Chequemegon-Nicolet National Forest (CNNF)

0.65 million ha., 94% forested
1.4 billion board feet (1986-1995)

Derived from 6 dates of MODIS 250m imagery
Simulated net biome production (NBP) for the Chequamegon-Nicolet National Forest

Peckham, Gower, Buongiorno 2012
Biome-BGC stand simulations for hypothetical northern hardwood stand

No harvest yields greatest vegetation C content

Infrequent selective harvest has greatest NEP. Note infrequent selective harvest avoids the large C loss observed for stand-killing disturbances
Optimizing harvest regime to maximize NBP for Chequamegon-Nicolet Nat’l Forest

Current CNNF harvest regime only 50% of allowable harvest.

Optimization analysis suggests NBP for the CNNF could be increased by 30% by increasing harvest to 2.5% area/yr.

Peckham, Gower, Buongiorno 2012
Industrial Ecosystem
Greenhouse Gas LCI for a Magazine & Lumber Chain

Gower et al. 2006
Percent greenhouse gas emission (tCO2-eq/t product) for Time and InStyle magazine (black bar) and CanFor lumber (red bar).

Magazine: 1.2 tCO2-eq, Lumber: 0.8 tCO2-eq

Legend Key:
H = harvest
TM = transport to mill
ME = mill emissions
TP = transport to printer
PE = printer emissions
TC = transport to consumer
FF = final fate

Gower et al. 2006
Lumber: long transportation = GHG emissions
Value of LCA: Fate of Time Magazines

(t/yr)

Gower et al. 2006
General Conclusions:

BIOLOGICAL ECOSYSTEMS
1. Not all old-growth forests are C sinks.
2. C management opportunities depend on
   (a) stage of stand development
   (b) objective?: C storage vs C sequestration
   (c) appropriate silviculture and risks for each
      biome.

INDUSTRIAL ECOSYSTEMS
1. Wood and paper products contain C, but they
   are not net C sinks.
2. Many opportunities to reduce decrease C
   emissions.

WHOLE SYSTEM
General Conclusions:

INDUSTRIAL ECOSYSTEMS

1. Wood and paper products contain C, but they are not net C sinks.
2. Many opportunities to reduce decrease C emissions.

WHOLE SYSTEM

1. Optimization analysis for multiple forest ecosystem services and goods