Forest Growth: A Missing Component in the BISG/GPI Report on ***Environmental Trends and Climate Impacts, Findings from the U.S. Book Industry***

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In 2007 and early 2008, I served as a member of the Steering Committee that oversaw development of a report put together by the Book Industry Study Group (BISG) and the Green Press Initiative (GPI). The title of the report is: "Environmental Trends and Climate Impacts, Findings from the U.S. Book Industry". In the discussions held by the Steering Committee on the early drafts of the report, we debated at length as to whether to include in our carbon footprint calculation a value for the amount of carbon removed from the air by trees as they grow, and if we were to display a value for growth how we would calculate it. During those discussions, I argued strenuously that such a value must be taken into account in order to provide a realistic picture of the book industry's carbon footprint. For reasons described at the end of this paper, the principle authors of the report, Jim Ford of Borealis Centre and Tyson Miller of the Green Press Initiative, decided that we would not take forest growth into account. Instead, the BISG/GPI report would show a gross amount of "Forest Carbon Loss". As stated on p. 1 of the BISG/GPI report, the carbon footprint model "accounts for forest carbon loss after harvest, a factor that many existing models have yet to attempt." The amount shown in the report for Forest Carbon Loss is simply the total amount of carbon (expressed as CO_2 equivalents) contained in the logs harvested to make book paper, and the calculations for emissions occurring in subsequent steps in the book production cycle are adjusted so that the carbon atoms contained in the logs are not double-counted.

Jim and Tyson have explained their reasoning for the above mentioned decision in the body of the BISG/GPI report. The paper which follows is my attempt to, first, explain why it is necessary to include a value for forest growth, and second, why I believe this value is large. Because the value is large, I feel its omission makes the carbon footprint calculation displayed in the BISG/GPI report quite misleading.

Background

The purpose of a "carbon footprint" is to estimate the amount of greenhouse gases (GHGs) emitted to the atmosphere or removed from the atmosphere by a particular activity. The theory of Global Warming is based on the fact that GHGs in the atmosphere absorb infrared radiation emitted from the surface of the Earth and re-emit some of that heat back toward the surface. Greater concentrations of GHGs in the atmosphere trap more heat near the Earth's surface, thereby causing temperatures on the surface to rise. An explanation of "The Science of Climate Change" is included as an appendix to the BISG/GPI report; therefore, it won't be repeated here. However, for the purposes of the following discussion it is important to emphasize that the critical factor is what effect a particular activity has on the atmosphere. *To put it simply: it's about what happens to the air*. Movements of carbon between one solid form and another which involve no emission to or removal from the air do not affect GHG levels. Movements of carbon (in the form of carbon dioxide or methane) to and from the atmosphere are referred to as fluxes. In calculating a carbon footprint, the emissions and removals we measure should be the actual fluxes that take place to and from the atmosphere, not "potential" fluxes or "avoided" fluxes. In footnote 9, appearing on p. 23 of the BISG/GPI report, Jim Ford emphasizes that the United Nations Framework Convention on Climate Change stipulates that baseline data for the year 1990 be based on actual observed data. He says, "An actual, observed baseline as adopted removes gamesmanship and speculation from the process." Though Jim's comments pertain specifically to the calculation of baseline data from 1990, it is logical to apply the same principle to measurements for subsequent years as well.

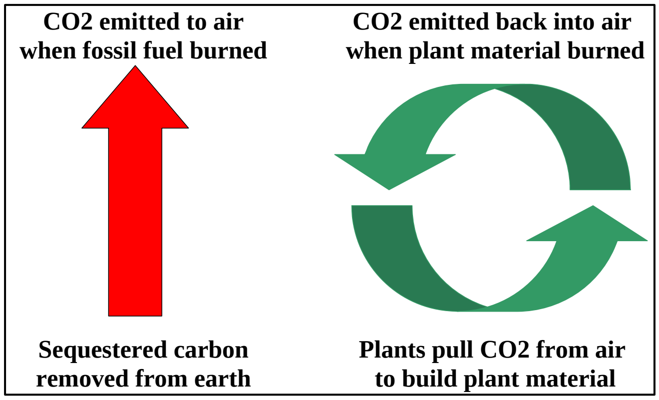
Many human activities require the burning of fossil fuels, which emit carbon to the atmosphere that would otherwise have remained locked in the ground. However, some human activities, such as planting trees, help to remove GHGs from the atmosphere. Trees and other forms of vegetation grow by combining CO_2 with water (H_2O) to form the complex organic molecules of which life is made. In doing this, trees build themselves by removing CO_2 from the air. Under the United Nations Framework Convention on Climate Change, a common method used to "offset" carbon emissions is to plant trees. For an industry such as book publishing, where the principle raw material, paper, is made from trees, this presents a feature in our carbon accounting which most other industries don't face. In addition to calculating the emissions generated in powering the machines used to make books and move them from place to place, we also need to calculate the effect we have on the amount of carbon stored in our forests. If we are depleting carbon stored in forests and allowing it to escape back into the atmosphere, we need to consider that in our calculation. On the other hand, the book industry also has the opportunity to manage its activities so that we grow more wood than we harvest, and thereby routinely remove carbon from the air as part of our process.

Before moving on to look at how we would calculate our effect on carbon stored in forests and seeing what value that calculation might yield, it is important to note that carbon storage is not the only factor we should consider in assessing the book industry's overall impact on forests. Other factors would include protecting endangered species, endangered forests, and high conservation value forests. Much of what follows is concerned with what is taking place in the United States. Most of the forests in the U.S. have, at one time or another over the last 400 years, been harvested for their timber. 50% of U.S. forest stands are less than 60 years old, and 80% are less than 100 years old.[1] Therefore, old growth forests in the U.S., particularly in the eastern part of the country, are rare,[2] and it is important to protect those areas. The fact that this paper deals strictly with carbon stocks and forest growth is not intended to imply that these other aspects of forest stewardship are not important; they are important.

In the following paragraphs, I will first explain why our carbon footprint requires us to take forest growth into account. Then I'll present a conceptual model for calculating a value for growth; the arithmetic is fairly simple. Next, I will present some data for the United States, from which we can see roughly what the magnitude of growth is relative to harvest in the U.S.. Then, I will briefly look at the situation in Canada. The reason for focusing on these two countries is obvious; most of the book industry's paper comes from the U.S. and Canada. John Maine, from RISI, gave me a rough estimate for the breakdown of U.S. book papers by country of origin as follows: 60% U.S., 23% Canada, 6% China, and 11% all other.

Finally, I will list the reasons why the principle authors of the BISG/GPI report objected to the rationale used here, and I will try to address those objections.

Why We Need To Consider Growth



To explain why it is necessary to include forest growth in the calculation of the book industry's carbon footprint, it's helpful to look at the example of biofuels. It is thought that making fuel out of crops, such as corn, sugar cane, soybeans, and wood can help stabilize the amount of GHGs in the atmosphere. The diagram at right shows why this is so. When using fossil fuels, such as coal or oil, carbon that had been permanently stored in the earth is removed and emitted to the air, thereby increasing the amount of GHGs in the air. However, when using biofuels, plants remove CO_2 from the air as they are grown. That CO_2 is re-emitted to the air as biofuels are burned, but then it is re-absorbed in an endless cycle as new plants are grown to make more fuel. This endless cycle leads to a stable level of atmospheric GHGs rather than increasing levels, which is why biofuels are considered to be greenhouse gas neutral. It is for this reason that Al Gore advocates increasing our use of biofuels, when he makes the statement below in the section of *An Inconvenient Truth* where he describes steps individuals can take to help fight global warming:

> "The fuel of the future is going to come from fruit like that of the sumac out by the road, or from apples, weeds, sawdust – almost anything. There is fuel in every bit of vegetable matter that can be fermented. There's enough alcohol in one year's yield of an acre of potatoes to drive the machinery necessary to cultivate the fields for a hundred years." Henry Ford spoke these prophetic words in 1925. Some 90 years later we are seeing the application of such innovations, including the use of numerous biofuels derived from renewable plant materials, including corn, wood, and soybeans. The most commonly used renewable fuels today are biodiesel and ethanol. (p. 312)

The very same cycle of growth, harvest, and re-growth applies to making a material such as paper. Paper is made from wood, which is a renewable resource. The carbon footprint depicted in the BISG/GPI report implies that the carbon cycle for making paper is a one-way process, similar to that shown above for fossil fuels. But, in actuality the process for making paper is similar to that shown above for biofuels. Therefore, the carbon footprint of the book industry must take into account how much of the wood we harvest is replaced by new growth.

A Simple Conceptual Model For Incorporating Growth In A Carbon Footprint

Assume that you own a large forest, in which you grow and harvest trees for making paper. At the beginning of the year, your forest contains a certain amount of carbon (denoted by "**C**") which the trees removed from the atmosphere as they grew. During the course of the year several actions take place, and at the end of the year you want to calculate the net impact the activities associated with your forest had on carbon in the atmosphere. The actions are listed below. Those actions resulting in fluxes involving changes in atmospheric carbon are shown in red for emissions to the atmosphere and green for removals from the atmosphere. Actions for which no atmospheric changes take place are shown in black. Again: it's about what happens to the air. Assume that all values are expressed in CO_2 equivalents.

i. You harvest some of the trees. We'll denote the tons of CO_2 equivalents contained in the harvested trees by the letter "**h**", for harvest. Note that carbon is not lost back to the atmosphere at this stage; it is just moved from one solid form (live trees) to another solid form (logs at the mill).

ii. During the course of the year, the remaining trees in your forest continue to grow by pulling in additional CO_2 from the atmosphere. We'll denote the tons of CO_2 removed from the atmosphere by the trees by the letter "**g**", for growth. Note that this is an actual flux of carbon being removed from the atmosphere. (In describing this process, we'll use the term "growth". The term used by the U.S. Forest Service is "net growth", [3] since they measure the net change between the amount of new growth and the amount of tree mortality from fire, wind, insect damage, and other natural causes. It is the concept of "net growth" that is really represented by "**g**" above. However, the term "net gain" will be used below to measure the difference between "net growth" and harvest. Therefore, to avoid confusion, the term "growth" will be used below.)

iii. Not all of the tree material harvested will be usable for making paper. The portion which is unusable will be burned by the paper mill as fuel to power its equipment. This is referred to as burning biomass. When this material is burned, the carbon it contains is emitted back to the atmosphere. We'll denote the tons of CO_2 emitted back to the atmosphere when biomass is burned at the mill by the letter "**b**", for biomass. Note that this is an actual flux back to the atmosphere.

iv. The remaining portion of the wood harvested all goes into finished paper. Note that carbon is not lost to the atmosphere at this stage. It is just moved from one solid material, wood, to another solid material, paper. The carbon will remain in the paper as long as the paper remains intact. It will also remain in the paper if the paper is recycled. We'll denote the tons of CO_2 equivalents remaining in the finished paper as "**s**", for the amount "sequestered" in the finished product.

From the steps described above,[4] what is the change in atmospheric CO_2 resulting from what has happened in your forest during the year? There are two fluxes: a removal (absorption) of **g** tons and an emission of **b** tons. The net result is a change of **g - b** tons.

This is the net change in carbon from the actual activities associated with this forest. The change in carbon (**ΔC**) can be expressed in the following equation:

$$\Delta C = g - b$$

Symbol	Component Represented
C	Captured Carbon Stocks
ΔC	Change in Captured Carbon Stocks
h	Harvest Amount
g	Growth Amount
b	Biomass Burned
s	Carbon Sequestered in Finished Paper
All amounts would be expressed as tons of CO2	

The U.S. Forest Service arrives at the same number, but through a different calculation:

> "Carbon continues to be sequestered in wood after it is harvested…For a complete picture of carbon sequestration by U.S. forests, indicators 27 and 28 [net gain in carbon stored in the forest and carbon sequestered in forest products] must be summed." (This quote appears on page 42 of the *National Report on Sustainable Forests – 2003*, published by the U.S. Department of Agriculture. The full report is available on the U.S. Forest Service website.)

In the above example, the Net Gain/Loss in carbon in the forest is the difference between growth and harvest, or **g - h** tons, and the amount sequestered in the finished paper is **s** tons. Therefore, summing these two amounts, as the Forest Service does, can be expressed in the following equation:

$$\Delta C = (g - h) + s$$

The method used by the Forest Service ignores the actual emissions that occurred from burning biomass at the mill. So, does this method yield the same answer as the equation **$\Delta C = g - b$**? As long as all the material harvested (**h**) was either burned as biomass (**b**) or went into finished paper (**s**), that is **$h = b + s$**, the answer is yes.

$$h = b + s$$

Which means that:

$$h - s = b$$

Substituting for **b** in the equation **$\Delta C = g - b$** yields:

$$\Delta C = g - (h - s)$$

Or

$$\Delta C = g - h + s$$

Or

$$\Delta C = (g - h) + s$$

Where, Net Gain/Loss in the Forest = **(g – h)**

Thus, this last equation for **ΔC** describes the method used by the Forest Service for calculating the change in carbon: Net Gain/Loss in the forest plus the amount sequestered in the final product. It yields the same result as summing the actual fluxes.

Obviously, growth (**g**) is a necessary component of both the above equations for **ΔC**. Without taking growth into account, the correct change in atmospheric carbon from the actual activities in your forest cannot be calculated.

It is possible for Net Gain/Loss **(g – h)** to be either a positive number or a negative number. A positive number would indicate that carbon taken in by the forest during growth exceeds carbon lost from harvest, and therefore, generates a Net Gain. If your forest is of a sufficient size for you to be able to reliably predict how much growth will occur each year, and if you restrict your harvest to an amount less than the expected growth, you can manage your forest in a sustainable manner indefinitely. In fact, this is one of the key objectives of both the Forest Stewardship Council and the Sustainable Forestry Initiative.

In contrast to the above, the BISG/GPI report's carbon footprint calculation for the stages of the book production cycle pertaining to your forest is based on the following equation:

$$\Delta \mathbf{C} = -\mathbf{h} + \mathbf{s}$$

Where, **g** is assumed to be zero. The report's equation could be modified to mirror the equation used by the U.S. Forest Service by changing the number now displayed as harvest (**h**) to a number representing Net Gain/Loss in forest carbon (**g – h**). Now, the question is how to determine how large growth is relative to harvest. In other words, we want to express **g** as a percent of **h**. We need to find data to help us estimate that relative amount.

Estimating Growth in the United States

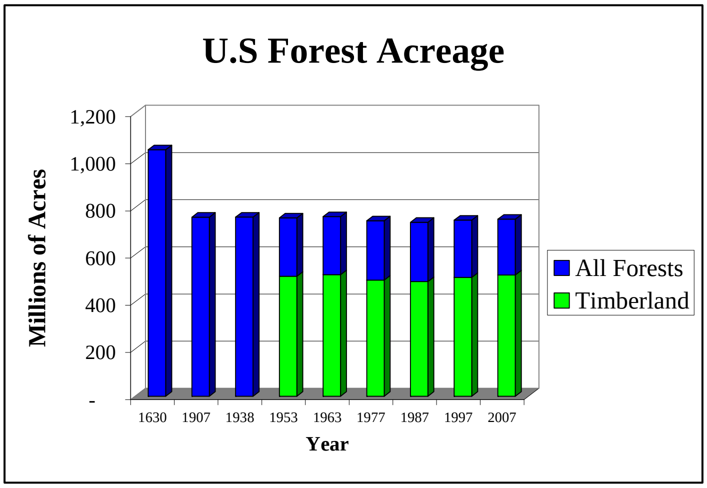
The best estimate we have is that 60% of the paper going into books made for U.S. publishers comes from the United States. In looking at harvests in our forests, it would be impossible to isolate activity specifically related to book papers from the overall forest products industry. There are a number of reasons for this, including the following:

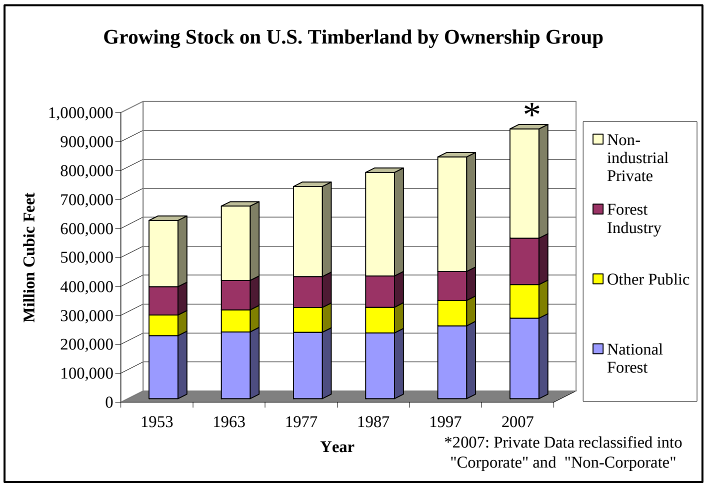
- From a volume standpoint, book papers account for less than 1% of overall timber harvests. [5]
- Many papers which are used in the book market are also used in commercial printing and for office papers.
- Paper mills use sawmill chips as an input in the pulp making process. Therefore, some portions of trees originally harvested for dimensional lumber are used for making book paper.

For these reasons, it is necessary to look at the overall picture of growth and harvest on United States timberlands. The U.S. Forest Service website contains a wealth of data, based on actual observations, for what is happening in U.S. forests.

The U.S. Forest Service defines timberlands as, "Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation." [3] Excluded from timberlands are protected forests, such as many of our National Forests, and forests which can't generate enough trees of sufficient size to justify harvesting activity.

"Growing Stock" is a term the U.S. Forest Service uses to describe the amount of live wood contained in our forests. In the following paragraphs, I will use "volume of growing stock" (or "growing stock") as a proxy for "forest carbon". In its *National Report on Sustainable Forests – 2003*, the U.S. Forest Service estimates that non-soil forest carbon in the U.S. increased by 46% between 1953 and 1997.[6] During that same period, the Forest Service estimates that the volume of growing stock on U.S. timberlands increased by 36%.[7] There is not a one to one correspondence between the two numbers. The 46% forest carbon number is based on all forests, not just timberlands, whereas the 36% growing stock number is just based on timberlands. Also, in addition to live growing stock, there are other components of forest carbon (e.g. dead trees). However, the relationship between the volume of growing stock (live wood) and forest carbon is reasonably close: the more growing stock we have in our forests, the more carbon those forests contain.





Since the early 1900's, the U.S. Forest Service has been collecting data on the health of U.S. forests. These data are presented in periodic Forest Inventory and Analysis (FIA) reports. Following an act of Congress in the 1970's, the Forest Service began publishing FIA reports for the full country on a regular 10 year cycle. The most recent of these was published for 2007. These reports and the Forest Service database can be accessed on the website of the U.S. Forest Service in the "Research and Development" section of the site. Tables containing the data are also referred to as RPA Tables, for the Rangeland Renewable Resources Planning Act, the act passed by Congress in 1974. According to U.S. Forest Service data, the volume of growing stock in U.S. forests has been increasing since at least the 1950's. As the graphs at right show, U.S. forest acreage has been stable for the past 100 years. The two thirds of our forests which are considered timberlands, while remaining stable from an acreage standpoint, have seen a steady increase in growing stock for the past 50 years. (The earliest year for which the Forest Service shows data for growing stock is 1953.)

It is clear from these charts that our actual experience in U.S. forests is that growth is exceeding harvests (i.e. **g** > **h**). This means that, over the past half century, every atom of carbon removed from U.S. forests for the purpose of making paper or wood products has been reabsorbed by new forest growth. Therefore, in the BISG/GPI carbon footprint model, the estimate for carbon removed from the air via forest growth (**g**), for the U.S. portion of papers used by the book industry, should be comparable to or greater than the amount shown as an "emission" due to harvest (**h**).

Based on the table below, taken from the 1997 Forest Inventory Analysis (FIA), the most conservative estimate as to the size of **g** relative to **h** would be based on the growth rate for lands owned by the forest industry. That rate is 92% of the amount harvested, or **g** = 92% **h**. (The 1997 FIA was the last complete inventory in which harvests on land owned by the forest industry were reported separately from harvests on other private land.)

However, it is also appropriate to take into account the data for non-industrial private owners. Forest harvests on non-industrial private lands account for 59% of all harvests; which is an amount more than proportional to their acreage and volume of growing stock. Calculating an overall average for both forest industry lands and non-industrial private lands yields a growth rate equal to 121% of harvest, based on the 1997 data.

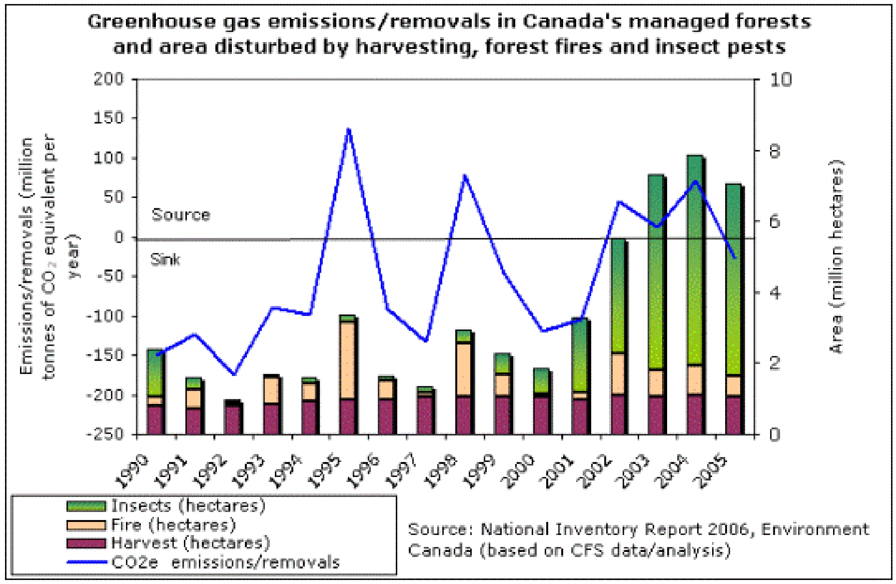
1997 Forest Inventory Analysis Timberland by Ownership Type	**National Forest**	**Other Public**	**Forest Industry**	**Non-industrial Private**	**Total**
Acres (Table 11)	96,435,133	49,531,531	66,857,867	290,839,925	503,664,456
	19.1%	9.8%	13.3%	57.7%	100.0%
Net Volume of Growing Stock (Table 25)*	252,114,960	87,738,050	99,787,030	396,032,360	835,672,400
	30.2%	10.5%	11.9%	47.4%	100.0%
Net Annual Growth of Growing Stock (Table 34)*	4,104,208	2,144,867	4,367,519	12,932,561	23,549,154
	17.4%	9.1%	18.5%	54.9%	100.0%
Annual Removals (Harvest) (Table 35)*	828,197	945,790	4,732,819	9,513,938	16,020,744
	5.2%	5.9%	29.5%	59.4%	100.0%
Net Gain of Growing Stock	3,276,011	1,199,077	(365,300)	3,418,623	7,528,410
Net Annual Growth as Percent of Harvest	495.6%	226.8%	92.3%	135.9%	147.0%
Growth/Harvest for Non-public Land					**121.4%**
*Measures related to growing stock are in thousand cubic feet					

As mentioned above, the 2007 FIA does not break out harvests on industrial land from those on non-industrial private land. In the 2007 FIA, the growth rate for all private owners increased from its 1997 level of 121% to 172% of harvest.

An argument can be made for excluding growth rates from harvests on public lands on the basis of several facts. First, harvests on public lands are a small and declining portion of our overall harvests (11.1% of harvests in 1997 and 8.4% in 2007). Second, public land harvests are also small in proportion to their share of acreage and growing stock. Finally, a greater share of harvests on public lands may go toward the dimensional lumber industry as opposed to the paper industry.

In attempting to arrive at a single value for growth as a percent of harvest, the 1997 rate for the forest industry alone, of 92%, and the 2007 rate for all private lands, of 172%, present reasonable upper and lower limits. A reasonable point estimate would be somewhere in the middle of this range, or comfortably above 100%.

Canada



The ownership structure for forests in Canada is quite different from that of the U.S. In the U.S. most of the forest land is privately owned; whereas, in Canada, the vast majority of forest land is owned by the Canadian provinces.[8] Despite the higher proportion of public ownership, the Canadian Forest Service doesn't provide information as extensive as that published by the U.S. Forest Service. Nevertheless, the Canadian Forest Service has recently begun publishing data pertaining to carbon stocks in Canadian forests. The graph above is taken from the Canadian Forest Service website, and it shows a history of net carbon emissions and removals for the forest areas from which trees are harvested in Canada over the past 16 years. The heading in the chart indicates that this is for "Canada's managed forests and area disturbed by harvesting, forest fires and insect pests." Though these forests experienced a loss of carbon in five of the years shown, the overall average for the 16 year period was an annual absorption (removal) of 50 million metric tonnes of CO_2. The most recent year, 2005, showed a removal of about 35 million metric tonnes from the air. This suggests that the value for forest growth for the Canadian portion of U.S. book papers would also be at least 100% of the harvest level. 35 to 50 million metric tonnes is roughly one quarter to one third the annual amount sequestered by U.S. forests. Canadian harvests are a bit less than half the size to U.S. harvests.[9] This implies that the growth rate relative to harvest for Canadian forests, while exceeding 100%, is somewhat less than the level in the U.S.

Other Countries of Origin

China accounts for about 6% of U.S. book paper, and all other countries account for roughly 11%. It is estimated that Chinese forest carbon stocks have been increasing at a rate of 21 million metric tons per year since the late 1970's.[10] This is about half the annual increase shown in Canada, and about one seventh the U.S. level. However, some pulp used by Chinese paper makers may come from trees grown in countries such as

Indonesia, where forest carbon levels have declined. Therefore, it is difficult to say with certainty that the “fiber basket” supplying Chinese paper mills is experiencing increasing carbon levels. Lacking data for China and especially for “All Other”, it isn’t possible to estimate an exact amount of growth to assign to this 17% of U.S. book papers. It is possible that forest harvests exceed forest growth in these other countries as a group. However, forest harvests in these countries would have to exceed growth by a very substantial amount to overcome the Net Gain accumulated between the U.S. and Canada. For this reason, I recommended to the Steering Committee for the BISG/GPI report that a conservative estimate of growth to display in our carbon footprint would be 100% of harvest. This recommendation was rejected for a number of reasons which I will address below; however, a common thread in the reasons for rejecting my recommendation was that we lacked data to arrive at a precise enough estimate. It was, therefore, decided that we would display no amount for growth. We would, however, display an amount for harvest, since that was a number we could be reasonably certain about. It was my opinion that displaying an “emission” amount for harvest without displaying a removal amount for growth was far more misleading than trying to arrive at a reasonable estimate for growth. (The word “emission” is shown in quotation marks because, as mentioned above, an actual flux between the atmosphere and forest carbon does not take place at the time trees are harvested.)

Opposing Arguments

Uncertainty Regarding the Value: Uncertainty was a specific reason for not assigning a value to growth and, as mentioned above, it was a common thread among all the reasons. As the foregoing paragraphs demonstrate there is a broad range within which to find a reasonable estimate. Nevertheless, it is in the very nature of a report such as the one prepared by BISG and GPI to estimate values that are difficult to determine. The important task is to develop a methodology for estimating such values and clearly communicate the methodology, along with its associated assumptions. In that way, the methodology can be improved in the future, or the same methodology can be followed in a more rigorous manner to arrive at a more precise estimate in future studies.

I can cite several examples of other values which lack certainty, and yet are still displayed in the BISG/GPI report. The most significant of these would be the estimate that we will save 1 billion pounds of GHG emissions by increasing our use of PCW fiber from 5% to 30% (see p. 45 of the BISG/GPI report). The figure of 1 billion pounds comes from Environmental Defense’s *Paper Calculator*. The *Paper Calculator* assumes that 100% of paper made from PCW fiber is recycled at the end of its life. In comparison, the *Paper Calculator* assumes that 80% of paper made from virgin fiber goes into a landfill at the end of its life, while the other 20% is incinerated. To put it more succinctly: all paper made from PCW will be recycled at the end of its life, whereas all paper made from virgin fiber will be landfilled or incinerated. Nearly half the GHG emissions attributed to virgin fiber are landfill emissions; none are attributed to PCW.[11] Clearly, in reality consumers are equally likely to discard in landfills products made from PCW or virgin fiber. Therefore, there is considerable uncertainty in the estimate that greater use of PCW fiber will actually save 1 billion pounds of emissions.

Incidentally, a number of components for the calculation of the carbon footprint contained in the BISG/GPI report are based on values derived from the *Paper Calculator* found on the website of Environmental Defense. One of those components is emissions at the paper mill. In the making of uncoated free sheet (UFS), the *Paper Calculator* assumes that mills derive about half of their energy by burning biomass, and the *Paper Calculator* considers that a "carbon neutral" form of energy generation. [12] Therefore, the *Paper Calculator* incorporates an implicit assumption of forest growth in its calculations. The *Paper Calculator* is one of the "existing models which have yet to attempt" to include forest carbon loss in its emissions calculations. (See quote cited above on p. 1 of the BISG/GPI report.)

Tree Growth Occurs Naturally: The argument here is that, because trees grow on their own, it is not appropriate to give the paper industry credit for growth. Whether or not tree growth is induced by humans, it still takes place and is a part of the carbon cycle that must be taken into account. What's more, the fact that trees grow without human intervention gives many types of wood tremendous environmental advantages in comparison to other materials. The wood fiber content of the uncoated freesheets used to make book papers consists of roughly two thirds hardwood fiber (oak and hickory are examples of hardwood species) and one third softwood fiber (pines are examples of softwood species). [13] In many places the most efficient and environmentally friendly cultivation method for growing hardwoods is simply to let the forest grow back by itself after a section of it is cut. No fertilizers, pesticides, or irrigation are required. Where human intervention more often takes place is in the growing of softwoods, as they need to be protected from the hardwoods that would otherwise crowd them out. This protection comes in the form of a couple of applications of herbicide over the twenty to thirty year lifecycle of the softwood trees. Therefore, even with softwoods, the use of fertilizers, pesticides, and irrigation is far less intensive than that which occurs in the typical corn field. In February 2008, my company went through our first audit for FSC and SFI chain of custody certification. The lead auditor was Craig Howard, from Bureau Veritas. During the audit, he told me that, for the reasons just stated, his opinion is that there is no more environmentally friendly form of economic activity than making wood products out of trees grown under FSC or SFI standards. How can it be appropriate to consider the re-growth of corn when looking at the carbon footprint of the biofuels industry, and it isn't appropriate to look at the re-growth of trees in the wood products industry?

We Should Compare Results From Harvesting to What Would Be Achieved Without Harvesting: The argument here is that, while we might see positive Net Gain if we harvest in a sustainable manner, we would see even greater Net Gain if we didn't harvest at all. It's probably safe to say that we would accumulate more carbon in our forests if we didn't harvest at all, provided we can assume that forest owners won't be induced to develop their land or convert it to growing other crops if they couldn't harvest trees.[14] Yet, the fact that we would see greater gain under that scenario doesn't invalidate the actual numbers that we do see. Since we're dealing with carbon accounting it is appropriate to use a financial accounting analogy for the reasoning in this objection: a publishing company sums up its revenues and costs at the end of a year and determines that it made a profit of $1 million; however, it finds that a competitor of equal size made a profit of $5 million. Therefore, the first publisher should record a loss for the year of $4 million, since it didn't make as much as it could have. This reasoning is not appropriate for financial accounting purposes, nor is it appropriate for carbon accounting.

We Need to Consider the Reduced Potential of the Forest to Store Carbon After Harvest: Using another financial analogy, forests are somewhat similar to certificates of deposit – they both exhibit compound annual growth. However, the growth curves for the two differ in that CDs grow at a constant compound rate, whereas forest carbon grows at a slow rate early in a forest's life, then the growth rate accelerates, and then it tapers off as the forest matures. There are a number of sub-points to this objection, and these are covered in pp. 33 – 36 of the BISG/GPI report. First, trees grown for paper are harvested earlier in their lives than trees harvested for dimensional lumber. Therefore, forests harvested for paper are always younger, on average, and contain less carbon than either forests harvested for lumber or forests which aren't harvested at all. A second sub-point to the objection is that, by harvesting trees before their growth rate tapers off, we don't take full advantage of the amount of carbon they might store. A third sub-point is that, when we harvest trees we send the forest back to a point at which it is once again accumulating carbon in very small annual amounts, as the trees that are growing in the forest are mere seedlings. (The forest may even be losing carbon annually for a couple of years after harvest.) Based on all these points, the principle authors felt that forest growth in harvested areas could be well less than the 92% lower limit mentioned above. In fact, growth (not just Net Gain) in harvested areas could actually be less than zero.

An argument I have with all the sub-points to this objection is that they focus very narrowly on the area of the forest that has just been cut. Unlike corn, where the grower harvests the entire crop every year, the nature of growing trees for harvest is that only a small percentage of the total amount being grown is harvested each year. Therefore, it is incorrect to focus strictly on the area that has just been cut. A broader, more system-wide view is required. The overall view looks at the portions of the forest that were just cut, along with the portions that were cut a year ago, and two years ago, etc., on up to the portions that will be harvested next year. The U.S. Forest Service data supports this broader view. From 1953 to 2007, the volume of growing stock on our timberlands (the forests from which we can harvest trees) increased by more than 50%, and during all that time we were harvesting vast amounts of wood every year. This fact is highly compelling. Clearly, growth in the overall areas from which we harvest wood in the U.S. is at least as great as harvest.

Regarding the other sub-points that we would store more carbon in our forests if we cut the trees later in their lives, and that the forest reverts back to very small accumulation levels after harvest, these are variations of the objection that we should compare our actual results with those we would achieve without harvest. While it is true that we would store more carbon with either longer rotations or no harvesting at all, that doesn't invalidate the results we are actually achieving. The idea that we should somehow account for the fact that the compounding of carbon is less in a young forest than in a middle aged forest brings to mind another financial analogy: if a company pays its expenses by writing checks on an interest bearing account, the amount of the expense recognized on the company's financial statement should be increased by the future interest which is foregone as the account balance is drawn down. Again, financial accounting doesn't work that way, and neither should carbon accounting. The actual results are what they are, and that they might be better under a different scenario doesn't make them invalid.

A non-profit research group associated with the forest products industry commissioned a study to calculate a carbon footprint for that industry on a global basis. In the study, it used the concept of "avoided emissions" in the overall calculations.[15] An example of an avoided emission is as follows: paper mills use combined systems to generate both heat and power used at the mill. These combined heat and power systems use far less energy than the mills would use if they generated heat and power from separate systems. Therefore, the industry should be credited for the emissions they would have had, but avoided by use of the more efficient system. Avoided emissions are considered the same as removals. The principle authors of the BISG/GPI report argue, I feel justifiably, that this example of avoided emissions is not valid. However, I also feel that "foregone growth" and "lost potential to store carbon" are also invalid concepts for the same reason: they don't measure actual fluxes; rather, they are "what if" scenarios. This violates the principle expressed in footnote 9 on p. 23 of the BISG/GPI report that our measurements be based on actual observed emissions and removals.

Conclusion

Paper is made from a renewable resource – wood. Conceptually, it makes sense to consider that renewal process in calculating a carbon footprint, and to do that means growth must be taken into account. The arithmetic clearly shows that an estimate for forest growth is a necessary component of the carbon footprint for the book industry. Omitting this component is far more misleading than displaying a reasonable estimate, even though that estimate carries with it some uncertainty. Other figures displayed in the BISG/GPI report also carry uncertainty.

The estimate used for forest growth should be based on actual data. Data from both the U.S. and Canada are available from the Forest Services of both countries. These two countries account for 83% of the paper used by the U.S. book industry. The data for the U.S. and Canada show that their volumes of growing stock and forest carbon are increasing. Though we lack definitive data for China and other suppliers, the fact that the U.S. and Canada account for such a large proportion of the industry's paper makes it reasonable to assume that forest growth for our products is at least 100% of (equal to) harvest. If we incorporate a figure for growth equal to harvest (**g = h**) the overall carbon footprint of the U.S. book industry would be an annual emission of 4.8 million metric tons of CO_2, rather than the 12.4 million tons shown in the BISG/GPI report. Failing to incorporate growth into the calculation obviously results in a dramatic overstatement of book industry emissions. Many of the conclusions and recommendations contained in the BISG/GPI report are based on the notion that growth is zero.[16]

The above are the empirical reasons for including this component and using this estimate; however, there is a practical reason for including the component as well. Several sections of the BISG/GPI report stress the importance of employing sustainable forestry practices in procuring the fiber needed for our paper. I fully support that assertion. However, with growth missing as a component of the carbon footprint, we have no way to measure the impact of our forestry practices. As the carbon footprint is now displayed in the BISG/GPI report, it wouldn't matter if we used world class forestry practices or left a barren landscape in our wake, the calculation of the carbon footprint wouldn't change. It is sometimes said that, if you want results you need to measure. Including forest growth in the carbon footprint is not only conceptually correct, but would yield practical benefits in spurring future improvement as well.

Notes

[1] *National Report on Sustainable Forests – 2003*, published by the United States Department of Agriculture, p. 40. Available on the U.S. Forest Service website.

[2] *Final Appalachia (USA) Regional Forest Stewardship Standard, Version 4.2*, as displayed on the Forest Stewardship Council website. See comment on p. 51, regarding Intact Old-growth Forest. Similar comments are made regarding old-growth forests in the standards of other FSC regions in the U.S. east of the Mississippi.

[3] The U.S. Forest Service provides the following definitions in the glossary accompanying the 2002 FIA (*Forest Resources of the United States – 2002*):

Forest land—Land at least 10 percent stocked by forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Forest land includes transition zones, such as areas between heavily forested and nonforested lands that are at least 10 percent stocked with forest trees and forest areas adjacent to urban and built-up lands. Also included are pinyon-juniper and chaparral areas in the West and afforested areas. The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if less than 120 feet wide.

Timberland—Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Growing stock—A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Cull trees are excluded. When associated with volume, includes only trees 5.0 inches d.b.h. [diameter at breast height] and larger.

Net annual growth—The average annual net increase in the volume of trees during the period between inventories. Components include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year.

Net volume in cubic feet—The gross volume in cubic feet less deductions for rot, roughness, and poor form. Volume is computed for the central stem from a 1-foot stump to a minimum 4.0-inch top diameter outside bark, or to the point where the central stem breaks into limbs.

Annual removals—The net volume of growingstock trees removed from the inventory during a specified year by harvesting, cultural operations such as timber stand improvement, or land clearing. (Though it is not entirely appropriate, I have used the word "harvest" synonymously with annual removals.)

[4] There are other steps in the book industry's overall process which involve the emission of GHGs from the paper itself. These are the steps involved in the disposal stages of a book's lifecycle. In calculating

the book industry's overall carbon footprint, it is necessary to include the disposal steps, and the calculation in the BISG/GPI report does take those steps into account. However, emissions at the disposal stages are divorced from the activities associated with the forest by decisions made by consumers and municipal waste managers; disposal emissions depend on what proportions of material consumers archive, recycle, landfill, or incinerate. Because the disposal steps are separated from the calculations shown in this paper they are not discussed above. I support the methodology and calculations used in the revised edition of the BISG/GPI report released on March 13, 2008.

[5] The assertion that book papers account for less than 1% of timber harvests is based on the following:

- In the comments attached to the 2002 FIA, the U.S. Forest Service estimates that 35% of timber harvests are used for paper and "composite products". Therefore, after factoring out the "composite products" component of this, the paper portion is something less than 35%.
- According to the American Forest & Paper Association (AF&PA), Printing & Writing papers account for 32% of the total paper market.
- According to AF&PA, book papers account for about 5.7% of the Printing & Writing paper market.
- Multiplying the above values through, book papers would account for 5.7% of 32% of 35% of timber harvests, or 0.64% of timber harvests. Given some uncertainties regarding the relative yields, from harvest to finished product, for various paper types and the portion of timber harvested for "composite products" the assertion is relaxed to being less than 1%.

[6] *National Report on Sustainable Forests – 2003,* p. 40.

[7] *1997 Forest Inventory and Analysis,* available on the U.S. Forest Service website. See Table 32 – Net Volume of Growing Stock, compare the amounts for total U.S. timberlands for 1953 and 1997.

[8] U.S. data is available in the 2007 FIA, Table 2, which indicates that 56% of all U.S. forest land is privately owned. In the General Information section of the Canadian Forest Service website, data is shown for Canadian forest ownership as follows: 93% is publicly owned, of which 77% is owned by the provinces and 16% is owned by the federal government.

[9] An earlier version of this report incorrectly stated that Canadian harvests were comparable in size to U.S. harvests. According to United Nations Food and Agriculture Organization data for 2004, the U.S. harvested 1,454 million cubic meters of wood and Canadian harvests were 670 million cubic meters.

[10] Jingyun Fang, Anping Chen, Changhui Peng, Shuqing Zhao, Longjun Ci, "Changes in Forest Biomass Carbon Storage in China Between 1949 and 1998." *Science* 22 June 2001: Vol. 292, no 5525, pp. 2320 – 2322.

[11] The calculations of the values displayed in the *Paper Calculator* are explained in *White Paper No. 3* prepared by the Paper Task Force. Both the *Paper Calculator* and *White Paper No. 3* are available on the website of Environmental Defense. *White Paper No. 3* was written for the purpose of comparing environmental outcomes from recycling waste paper products vs. disposing of them in landfills and incinerators. Its focus is on the disposal stage. In comparing these disposal methods, the *White Paper's* authors were faced with the problem that when products go into landfills or incinerators their lives end, whereas when products are recycled their lives begin again, and the environmental impacts resulting from making paper products from recycled fiber and virgin fiber differ. Thus, in determining the overall difference in environmental impact, it is necessary to look at the complete life cycles of virgin and recycled products, from beginning to end. To establish bounds for their comparison the Paper Task Force assumed that paper recycled at the end of its life began its life as recycled fiber, whereas paper disposed of in landfills or incinerators began its life as virgin fiber. In the real world this assumption is obviously false: paper products made from virgin fiber do get recycled, and paper products made from PCW fiber do get discarded in landfills or incinerators. Nevertheless, in order to make a full life cycle comparison, the assumption was necessary. Based on this assumption, the authors calculated GHG and other emissions for a full cycle of each product's life: virgin fiber to landfill, virgin fiber to incinerator, and recycled fiber to recycled fiber. At the time *White Paper No. 3* was written, 80% of U.S. municipal waste which was not recycled went into landfills and 20% went into incinerators. To come up with an average set of values for all non-recycled waste, the authors blended the landfill and incinerator numbers into a "waste management" category using an 80/20 ratio. A summary of their findings with respect to GHG and other air emissions is displayed in Table C-3 on page 132 of *White Paper No. 3*. To see that the numbers displayed by the *Paper Calculator* are derived from the assumptions of *White Paper No. 3,* use the *Paper Calculator* to compute emissions for one ton of office paper made from 0% PCW and one

ton of office paper made from 100% PCW. (Office paper is equivalent to uncoated free sheet book paper). The total amount for GHG emissions displayed on the *Paper Calculator* for the 100% PCW sheet (3,582 pounds) matches exactly the total GHG emissions value shown in Table C-3 of *White Paper No. 3* for the recycled-to-recycled life cycle of office paper. The value shown for the 0% PCW sheet is only slightly less than the total GHG emissions shown in Table C-3 for the virgin-to-waste management life cycle (5,690 pounds and 5,803 pounds respectively). This very slight difference of 113 pounds appears to be due to the *Paper Calculator* using more up-to-date values in its calculation. The values in *White Paper No. 3* were last updated in 2002. Of the 5,803 pounds of GHG emissions which *White Paper No. 3* attributes to paper made from virgin fiber, 2,608 are methane emissions from landfills. Of the 3,582 pounds of GHG emissions attributable to paper made from PCW fiber, zero come from landfill emissions.

[12] Values for energy consumption and GHG emissions are displayed in Tables C-2 and C-3 on pages 131 and 132 respectively of *White Paper No. 3*. For Office Paper (UFS), compare values for Total Energy, Purchased Energy, Fossil Fuel consumption and net GHG emissions for virgin pulp vs. PCW pulp in the Paper Manufacturing stage of the life cycle. Fossil fuel consumption for virgin paper is 14% lower than the amount for PCW paper. GHG emissions for virgin paper are 11% lower than those of PCW paper. If the GHG emissions were not calculated based on the assumption that burning biomass is "carbon neutral", the relationship would be closer to that of Total Energy consumption, and virgin emissions would be nearly twice those of PCW.

[13] Information provided by Glatfelter Corporation.

[14] In "The Paper Consumer's Guide to Climate Change", published by Metafore and The Gagliardi Group, the following quote appears on p. 3: "Far from reducing forest cover…the forest products industry, which manufactures paper, has provided an irresistible economic incentive to keep land forested."

[15] Miner, Reid; "The Greenhouse Gas and Carbon Profile of the Global Forest Products Industry", prepared for the National Council for Air and Stream Improvement.

[16] The first such conclusion appears on p. 1 of the BISG/GPI report: "The majority of the climate impacts are connected to loss of carbon storage capacity from heavy reliance on wood fiber for paper…"