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TORPEDOING KYOTO:
WILL CANADA'S APPROACH
TO FOREST SEQUESTRATION
SINK THE *KYOTO PROTOCOL*?

*The Canadian position on the
treatment of sequestration of carbon
by forests and soils under the Kyoto
Protocol is scientifically unsound and
could lead to massive increases in
atmospheric concentrations of
greenhouse gases*

Chris Rolfe, Staff Counsel
West Coast Environmental Law



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WILL CANADA'S APPROACH TO FOREST SEQUESTRATION SINK THE *KYOTO PROTOCOL?*

This report finds that Canada's position on the treatment of forests could be both detrimental for the Canadian economy and detrimental to the global environment. The Canada position on sinks is also unbalanced – counting credits in the carbon ledger while ignoring debits – reducing Canada's credibility in the international community. It overvalues sequestration relative to reduction of actual emissions. This report recommends a number of changes in Canada's position that will ensure that any inclusion of sinks under the *Kyoto Protocol* is equitable, scientifically sound and does not reduce the environmental effectiveness of the *Protocol*.

EXECUTIVE SUMMARY

BACKGROUND

Carbon dioxide, the primary greenhouse gas, is released into the atmosphere from a variety of processes related to land use and forestry. Land clearing, decay of debris after logging, forest fires, and natural plant respiration all release carbon dioxide. Carbon dioxide is also naturally removed from the atmosphere and stored or sequestered in forests and soils. Growing forests remove carbon dioxide from the atmosphere. Old growth forests both keep this carbon out of the atmosphere and in some cases continue to remove carbon dioxide from the air. Thus, protecting against deforestation and increasing the rate at which greenhouse gases are removed from the atmosphere and sequestered in forest or soil reservoirs is often promoted to mitigate climate change.

The emerging international regime for mitigating climate change provides some recognition of the role for sequestration. Under the *Kyoto Protocol to the United Nations Framework Convention on Climate Change* (the “*Kyoto Protocol*”), developed nations are assigned allowable emission limits for the period 2008 to 2012 (the “First Commitment Period”). These limits require significant reductions from current emission trends. To meet their reduction obligations, nations are able to “credit” certain increases in their carbon sequestration levels and increase their assigned emission limits. Thus, carbon credits for sequestration allow nations to increase greenhouse gas emissions from fuel combustion and industrial processes.

Crediting and debiting for carbon sequestration was extremely contentious during the Kyoto negotiations, and the main provisions that resulted from these negotiations – articles 3.3 and 3.4 – reflect an imperfect but workable compromise. Article 3.3 provides that a nation’s assigned amount of allowable emissions should be credited for any increase in sequestration in the period 2008 to 2012 due to afforestation or reforestation since 1990 and debited for deforestation since 1990. Article 3.4 provides a mechanism for adding other activities into the carbon accounting system.

KEY FINDINGS

- **Reforestation means re-establishment of a forest on lands that had been taken out of forest use.** “Reforestation” as it is used in Article 3.3 was clearly intended to mean planting of forests on lands which have historically contained forests but which have been converted to some other use. It was not intended to include regeneration of trees after harvesting. Deforestation is clearly intended to mean conversion of forests to other land uses. These definitions – while requiring elaboration – are the only interpretations consistent with other provisions in the *Kyoto Protocol*.
- **Canadian government denying intent of the Protocol.** Despite this the Canadian government has taken the position that reforestation in Article 3.3 includes sequestration from regeneration after harvesting, but not the emissions associated with harvesting. This is problematic for a number of reasons:
 - The Canadian interpretation is unbalanced. It is the equivalent of counting only the credit side of an accounting ledger. Although not counting withdrawals may make balancing Canada’s carbon budget easier in the short term, it undermines the *Protocol’s* integrity. Atmospheric emissions will increase by an unknown amount under the Canadian interpretation.

- The Canadian interpretation is contrary to the intent of Kyoto and inconsistent with other provisions of the *Protocol*.
 - The Canadian interpretation potentially creates an incentive to clear-cut forests rather than using potentially less destructive practices such as selection logging.
 - The Canadian interpretation creates an incentive to log old growth, reducing total sequestration.
 - The Canadian interpretation of reforestation will likely lead to one of the following outcomes:
 - Canada receiving a carbon debit for actual losses in sequestration on land logged since 1990;
 - Canada receiving a credit even though sequestration on land logged since 1990 is actually reduced; or
 - Canada receiving a massive carbon debit due to the full inclusion of harvesting emissions but only the partial inclusion of forest regeneration.
 - Canada's current approach to Article 3.3 can only be balanced by the addition of activities under Article 3.4 in a manner that would increase atmospheric emissions of greenhouse gases from industrialized nations by nine percent or 1.4 billion tonnes.
- **Difficulties with the intended meaning of Article 3.3 are less than the difficulties created by Canada's interpretation.** Although there are problems associated with interpreting reforestation as meaning the re-establishment of a forest on lands that had been taken out of forest production, they are far less than the problems inherent in the approach promoted by Canada.
 - **The atmospheric impacts of sequestering a tonne are not equivalent to reducing a tonne of emissions.** Sequestering a tonne of carbon from the atmosphere will only have the same impact on the atmosphere as reducing a tonne of emissions if the sequestration is permanent. Indeed, even if one can be assured that a sequestration project will be maintained in perpetuity, each tonne of carbon sequestered will only completely offset the climate impacts of an extra tonne of emissions if the sequestration project would never occur in the absence of carbon credits.
 - **Tonne for tonne credit shifts responsibility to future generations.** Typically, proponents of sequestration simply assume that if sequestration is reversed in the future, a Party will be responsible for a carbon debit. This means that the costs of permanently reducing atmospheric emissions are placed on future generations. This is especially problematic since climate change will tend to cause forests to become net sources of emissions.
 - **Treating a tonne of sequestration in the same manner as a tonne of emission reductions is inconsistent with the *Kyoto Protocol's* approach to measuring climate impacts of different gases.** Treating a tonne of sequestration as equivalent to a tonne of reduction can overvalue sequestration by several orders of magnitude.

LIST OF RECOMMENDATIONS

- The Canadian government should publish a complete and coherent position on sinks with full analysis of the position's impact on Canadian allowable emissions and global emissions.
- Canada should recognize that reforestation in Article 3.3 only refers to planting of forests on lands which have previously contained forests but which have been converted to some other use.
- No credit should be given for areas deforested between 1990 and 2008, or, alternatively credit should only be given to the extent total carbon sequestration in such areas is increased above 1990 levels.
- What constitutes conversion to a non-forest use and the scale at which conversion is determined need to be clearly defined with measurable, objective criteria.
- No additional activities should be added under Article 3.4 during the first commitment period.
- If Canada continues to support the addition of new activities under Article 3.4 in the first commitment period, such activities should only be added where all Parties understand the impacts the addition will have on net emissions entering the atmosphere.
- Canada should reject any methodology for including new activities that would increase net emissions into the atmosphere during the first commitment period.
- Methodologies for measuring sequestration in the second and subsequent commitment periods should be negotiated before the negotiation of emission limits. Expert reviewed projections of the net effect of such methodologies on each nation should be available to Parties during future emission limit negotiations.
- Canada should reject any methodology for including new activities that could lead to credit for natural levels of sequestration.
- In all future commitment periods, credit for sequestration should reflect the lower impacts sequestration has on long term atmospheric concentrations.

BACKGROUND

Carbon dioxide and other greenhouse gases are naturally released into the atmosphere from a variety of processes such as respiration by plants, decay of organic matter and forest fires. These natural releases are normally balanced by natural forest growth and accumulation of carbon in soils. However, since 1850, deforestation and other human activities have reduced the carbon stored or “sequestered” in the world’s vegetation by about 38%. Carbon sequestered by forests, plants and soils continues to be released into the atmosphere by a variety of processes: burning and decay of logging slash; decreases in carbon held in roots and soils following logging and land clearing; incineration of wood-waste; and the decay of wood products in land fills. The carbon removed from the earth’s reservoirs represents a net increase in atmospheric concentrations of greenhouse gases if it is not replaced by growing trees and accumulation of carbon in soils. Thus, both increasing the rate at which greenhouse gases are removed from the atmosphere and stored or sequestered in carbon “sinks” or decreasing the loss of carbon from forest and soil reservoirs are means of mitigating climate change.

THE KYOTO PROTOCOL

In December 1997, negotiators from around the world successfully negotiated the *Kyoto Protocol to the United Nations Framework Convention on Climate Change* (the “*Kyoto Protocol*”). The *Kyoto Protocol* sets binding emission reduction commitments for those Parties – the developed nations – that are listed in Annex B of the *Protocol* (the “Annex B Parties”). Each Annex B Party is assigned an amount of allowable emissions for the period between 2008 and 2012 (the “First Commitment Period”). Canada is required to reduce its emissions of six greenhouse gases by six percent below 1990 levels; the US by seven percent; European Union Parties by eight percent. Developed nations are able to “credit” certain increases in their carbon sequestration levels to meet their emission limits for the First Commitment Period. These credits are added to the nation’s “assigned amounts,” allowing an increase in actual emissions. Conversely, certain losses in carbon sequestration levels lead to carbon debits and will reduce a nation’s allowable emissions.

SINKS AND THE KYOTO NEGOTIATIONS

Prior to the negotiation of the *Kyoto Protocol* in December 1997, Canada was one the most aggressive proponents of the full inclusion of sinks as a means of meeting climate commitments. Canada suggested that national emission limits be set by reference to a nation’s emissions from fossil fuel combustion and industrial processes in 1990 (“gross emissions”). Compliance with limits, on the other hand, would be assessed based on a nation’s gross emissions adjusted by either subtracting net sequestration from land use change and forestry or adding net emissions from land use change and forestry (“net emissions”).¹ This is known as the gross/net approach. Canada rejected the so called net/net

¹ See “Canada’s Response to the FCCC Questions on Sinks” November 10, 1997, in United Nations Framework Convention on Climate Change, Ad Hoc Group on Berlin Mandate, *Response from the Parties on Issues Related to Sinks*, (24 November 1997) FCCC/AGBM/1997/Misc04/Add.1. at page 10.

approach in which emission limits would be set based on net emissions in 1990 and compared to net emissions in the commitment period.²

The treatment of sinks was one of the most contentious items during the Kyoto negotiations. A fundamental difficulty in negotiating sink provisions was the recognition by all parties that the manner in which sinks were included would have dramatic effects on the ease or difficulty of the different Parties meeting their emission limit. Based on data available to the negotiators, it appeared that accounting for all changes in carbon sequestration from land use change and forestry using the gross/net approach would have allowed New Zealand to increase emissions by 27% relative to 1990 levels. This increase would occur without any change in New Zealand's business as usual afforestation programs. On the other hand, the net/net approach would have virtually no impact on New Zealand's targets.³ For Australia the opposite was true: the gross/net approach would make any emission reduction target over twenty percent more difficult; a net/net approach would make an emission reduction target easier to achieve due to projected decreases in deforestation.⁴ Negotiators also recognized that there was a lack of information on how approaches to forestry other than net/net and gross/net would affect nations, and that – even for those approaches – information was tenuous and subject to drastic revisions.⁵

KYOTO SINKS PROVISIONS

The result is two articles in the *Kyoto Protocol* that limit the inclusion of sinks to a narrow sector while at the same time allowing for the possible addition of more sinks. This reduces the possibility that inclusion of sinks will drastically reduce the impacts of climate commitments while at the same time giving sink proponents the possibility of including a broader range of sinks in the future.

Article 3.3 states:

The net changes in greenhouse gas emissions from sources and removals by sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, measured as verifiable changes in stocks in each commitment period shall be used to meet the commitments in this Article [i.e. emission limits for the first commitment period] of each Party included in Annex B.

² Ibid.

³ Based on information available at the Kyoto Conference. See "First Compilation and synthesis of second national communications from Annex 1 Parties." (9 October 1997) FCCC/SBI/1997/19/Add. 1

⁴ Derived from UNFCCC Secretariat, *Summary of the Report of the In-Depth Review of the National Communication of Australia* (Geneva: FCCC Secretariat, 1995). Figures for Australia assume Australia's projected total emissions from land use change and forestry for 2000 will be stable from 2000 to 2010. The emissions for 2000 are positive but seven percent less than 1990 levels.

⁵ The tenuous nature of the information available at Kyoto was borne out by subsequent revisions to Australia's inventory of emissions from land use change and forestry. Australia's First National Communications indicates net emissions of 130, 843 Gg; Australia, *Climate Change, Australia's National Report under the United Nation Framework Convention on Climate Change* (Canberra: Department of Environment, 1994). This was subsequently revised to emissions of only 31,075 Gg; UNFCCC, *Second Compilation and Synthesis of Second National Communications*, 7 October 1998, FCCC/CP/1998/11/Add. 2.

Article 3.4 establishes a process for potentially including emissions and removals from other land and forest categories:

The Conference of the Parties ... shall ... decide upon modalities, rules and guidelines as to how and which additional human-induced activities related to greenhouse gas emissions and removals in the agricultural soil and land use change and forestry categories shall be [included in determining whether a party is in compliance with emission limitations].... Such a decision shall apply in the second and subsequent commitment periods. A Party may choose to apply such a decision on these additional human-induced activities for its first commitment period, provided that these activities have taken place since 1990.

ANALYSIS: IS CANADA SINKING THE KYOTO PROTOCOL?

The remainder of this report examines Canada's position on the treatment of emissions and removals of greenhouse gases from land use change and forestry activities. Canada's current position on sinks is not clearly stated in any single statement. It is not clear whether this is because Canada's position is simply inchoate, whether the framers of Canada's position on sinks have not had an opportunity to publish a defined position, or whether Canada is reluctant to publish a position that would attract derision. Based on the analysis in this report, the latter is a distinct possibility. It is sincerely hoped that the Canadian government will rebutt this possibility by publishing a complete and coherent position on sinks with full analysis of the position's impact on global emissions and Canada's assigned amount.

However, even in the absence of a well-defined position on treatment of sinks, it is possible to glean elements of Canada's position from various publicly available reports and statements. While Canada's overall position on sinks may be ill-defined, the logical result of the published elements of the Canadian position on sinks, if adopted by the international community, would dramatically reduce the effectiveness of the *Kyoto Protocol*. Surprisingly, Canada's position does not appear to be motivated by a parochial desire to increase Canada's assigned amount relative to our trade competitors. While the logical outcome of Canada's position on key elements will clearly benefit a few industries, it is questionable whether it is in Canada's best, parochial interest.

Recommendation:

The Canadian government should publish a complete and coherent position on sinks with full analysis of the position's impact on Canadian allowable emissions and global emissions.

INTERPRETING 3.3

At the Fourth Conference of the Parties to the UN Framework Convention on Climate Change (COP4), the international community confirmed its understanding of Article 3.3:

The adjustment to a Party's assigned amount shall be equal to verifiable changes in carbon stocks during the period 2008 to 2012 resulting from direct human induced activities of afforestation, reforestation and deforestation since 1 January 1990. Where the result of this calculation is a net sink, this value shall be added to the party's assigned amount. Where the



result of this calculation is a net emission, this value shall be subtracted from the party's assigned amount.⁶

Unfortunately, the terms reforestation, afforestation and deforestation are not defined in the actual text of the *Kyoto Protocol*. However, Article 5.2 of the *Kyoto Protocol* adopts the methodologies for estimating emissions and removals by sinks contained in Intergovernmental Panel on Climate Change's *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (the "1996 IPCC Guidelines").⁷ The IPCC — the international climate change scientific advisory panel — defines afforestation as "planting of new forests on lands which, historically, have not contained forests" and reforestation as "planting of forests on lands which have, historically, previously contained forests but which have been converted to some other use."⁸ Deforestation is referred to as conversion of forest to other land uses.

In other words, Article 3.3 is about changes in land use: debits for shifting from forest to pasture or pavement; credits for reforesting land that had been cleared for agriculture. There is no credit for planting trees after harvesting, and there is no debit for trees so long as the land is not taken out of agricultural production.

Crediting post harvest regeneration while not debiting harvesting is the equivalent of counting only one side of an accounting ledger. Although not counting withdrawals may make balancing Canada's carbon budget easier, it undermines the integrity of the carbon accounting system.

This interpretation and the exclusion of regeneration after harvesting is consistent with Article 3.7. Under that Article, those nations for whom land use change and forestry was a net source in 1990 (Australia, the UK and Estonia) can include emissions from land use change (but not forestry) in the 1990 baseline for the purposes of calculating their assigned amount. Australia insisted on this provision to balance out the effects of Article 3.3. In counting only net emissions from land use change (and not forestry) in the 1990 baseline, the clear understanding of all parties was that Article 3.3 only applied to land use change.

As discussed below, Article 3.3 is still problematic and guidance is required on certain issues, but the above interpretation reflects a workable compromise that is environmentally acceptable while having fairly limited impacts on any nation's commitment (see below). To assist the international community in further defining the rules under Article 3.3 and Article 3.4, in June 1998, climate negotiators requested the IPCC to prepare a special report on issues related to land use, land use change and forestry. The final draft of this report will be negotiated in early May 2000. As noted below, much of Canada's position on Articles 3.3 and 3.4 can be gleaned from our criticisms of IPCC drafts.

⁶ FCCC/CP/1998/L.5. Clarification was possible in part because of the last minute addition of a special provision in Article 3.7 of the *Kyoto Protocol* which allowed Australian (and Estonia and the UK) to include its emissions from land use change in its 1990 baseline. This allowed those nations to use a net/net approach and removed any need from Australia's perspective for the reference to "changes in" in Article 3.3.

⁷ See UNFCCC Decision 2/CP.3

⁸ Intergovernmental Panel on Climate Change, Working Group I, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reporting Instructions Glossary* (Geneva: IPCC, 1996).

REINTERPRETING 3.3: CANADA'S EFFORTS FOR AN ASYMMETRIC INTERPRETATION OF 3.3

Less than a month prior to the negotiation of the *Protocol* Canada said that the 1996 *IPCC Guidelines* should be the basis for estimating emissions and removals from the land use change and forestry sector.⁹ Nevertheless, Canada's current interpretation of Article 3.3 is at odds with the definitions contained in the 1996 *IPCC Guidelines*. Canada has taken the position that reforestation be defined as "a land-use practice that through the re-establishment of a stand of trees, forms a forest."¹⁰ In other words, Canada is stating that reforestation includes the regeneration of forests following harvest.

This position was reflected in Canada's comments on the IPCC's draft special report. The Canadian government attacked the report authors for not giving full consideration to definitions of reforestation that include not only land use change, but also planting trees and natural regeneration following harvesting.¹¹ In addition, Canada has critiqued the scientists writing the Special Report for assuming that if credit were given for re-planting after harvesting, that a debit would exist for harvesting.¹²

Thus, the Canadian government position appears to be that Article 3.3 should be interpreted to give credit for planting and re-generation after harvesting and that no debit should be taken for harvesting—the other side of the harvest-regeneration cycle. This is borne out by fierce Canadian government criticisms of the IPCC's recognition of legitimate environmental concerns with regard to such an approach.

The Canadian position on Article 3.3 is problematic for a number of reasons:

- **Canada's position is unbalanced.** Crediting post harvest regeneration while not debiting harvesting is the equivalent of counting only one side of an accounting ledger. Although not counting withdrawals may make balancing Canada's carbon budget easier in the short term, it undermines the integrity of the carbon accounting system.
- **Canada's position is contrary to clear intent of Kyoto.** As discussed above, Canada's position clearly runs contrary to the *Kyoto Protocol*. While Canada has argued that other aspects of the *Protocol* "are not up for re-negotiation" it is attempting to do exactly that in relation to Article 3.3.
- **Canada's position potentially creates an incentive to harvest using clear-cutting rather than potentially less destructive techniques such as selection logging.**

⁹ "Canada's Response to the FCCC Questions on Sinks" November 10, 1997.

¹⁰ Canadian National Climate Change Process, Sinks Table, *Sinks Table Option Paper, Land-Use, Land Use Change and Forestry in Canada and the Kyoto Protocol*, (September 23, 1999), p. 58.

¹¹ See for instance, pp. 3 and 26, "Government of Canada Review of IPCC" Draft SR-LULUCF, 3 December 1999.

¹² See for instance p. 27, "Government of Canada Review of IPCC" Draft SR-LULUCF, 3 December 1999.



Depending on how reforestation is defined, an incentive could be created to clear cut rather than selection log.¹³

- **Canada’s position creates an incentive to log old growth.** Maintaining intact old growth forests – especially temperate rain forests, boreal forests and tropical rain forests – is a critical aspect of good climate policy. Indeed, new research suggests that at least some old growth boreal forests are not only major reservoirs of carbon but also significant sinks.¹⁴ Although logging these forests will lead to massive emissions of sequestered carbon into the atmosphere, the Canadian position on Article 3.3 — if adopted — would create an incentive to log old growth because doing so would allow generation of credit on the logged areas. Indeed, shortly after Kyoto was negotiated an Alaskan congressman — interpreting Article 3.3 in the same manner as Canada — called for increased logging of old growth in south-east Alaska.
- **Canada’s position may not be in Canada’s “strategic” interests.** While reducing emissions sooner rather than later may be in a nation’s long term competitive interest,¹⁵ increasing a nation’s assigned amounts is often viewed as being in its “strategic” (albeit parochial) interest, and many nations’ negotiating positions appear to be based in whole or part on these interests. However, counting emissions from post harvest regeneration could lead to a debit on Canada’s assigned amount. For ten to twenty years after harvest carbon is lost from below ground biomass and soils. Unless below ground biomass is excluded, Canada could face an additional debit of two mega-tonnes if its interpretation of reforestation were accepted. (See Table 1.)
- **Counting changes in the carbon sequestered above ground could generate credit even though sequestration is reduced.** The converse of the above is that if only above ground carbon is counted, credit could be generated even though significantly more carbon is being lost from soils and below ground biomass.
- **The Canadian position on reforestation is consistent with an approach that gives Canada an inequitable 200 mega-tonne debit.** The Canadian strategy appears to be to increase assigned amounts by counting above ground regeneration and ignoring both harvesting and below ground carbon stock changes. However, interpretations of Article 3.3 that are consistent with Canada’s suggested definition of reforestation could lead to a large and unfair carbon debit for Canada. First, if reforestation is interpreted as including post harvest regeneration, it is logical that deforestation would include harvesting. Second, Article 3.3 refers to “verifiable changes in carbon stocks during the period 2008 to 2012.” One interpretation of Article 3.3 is that Parties would incur a carbon debit for the carbon released after 2007 on sites that have been reforested since 1990; i.e. if land is reforested after 1990 all changes in carbon stock from that land

¹³ If reforestation is defined by changes in canopy coverage, this would create an incentive to clear cut rather than selection log. Selection logging might not allow generation of credits because the forest would never be depleted below the canopy cover threshold required for reforestation.

¹⁴ Schulze et al, “Productivity of Forests in the Euorsiberian boreal region and their potential to act as a carbon sink – a synthesis of existing knowledge and original data.” 5 *Global Change Biology* 703.

¹⁵ See Chris Rolfe, (January 2000) “Why Act Now” available at West Coast Environmental Law website, www.wcel.org. See also, Doug Russell, “Keeping Canada Competitive” (Vancouver, David Suzuki Foundation, 1998).

between 2008 and 2012 are counted in the *Kyoto Protocol*. Either outcome would mean that most or all of Canada's emissions from logging are counted against Canada. Due to our relatively long rotation periods, the growth on areas replanted since 1990 would not balance out the emissions from areas harvested in the 2008 to 2012 period.¹⁶ The resulting debit would exceed two hundred mega-tonnes even though Canada's managed forests are a net sink.¹⁷

- **Leads to gross-net approach and nine percent increase in global emissions.** Probably the largest concern with Canada's position is that it creates a problem of severely unbalanced reporting that can only be corrected by full carbon accounting using the gross/net approach under through the combination of Articles 3.3 and 3.4. A comprehensive gross/net approach amounts to a re-negotiation of the *Kyoto Protocol* emission limits, allowing an estimated nine percent increase in Annex B Party emissions. Ironically, the gross/net approach may prejudice Canada relative to other Annex B Parties. The gross-net approach is discussed further below.

OTHER PROBLEMS WITH 3.3

Article 3.3 is clearly intended only to credit and debit conversion of land into and out of forest. While advocating that Canada should simply accept the clear intent of Article 3.3, this report recognizes difficulties with Article 3.3. Many of these can be solved by simple rules designed to avoid abuse. For instance, in the absence of specific rules, Article 3.3 could provide credit to a country that logs an area between 1990 and 2007, converts it to another use, and then reforests it prior to 2012. Credit would be given even though carbon sequestration has declined since 1990. To use an extreme example, a nation could log in 2001, graze sheep in a clear-cut for several years (a common silvicultural practice in some areas) and then reforest. Rules need to be developed clarifying that no credit be given for areas deforested after 1990 or credit only be given to the extent sequestration is increased above 1990 levels. Similarly, what constitutes conversion to a non-forest use and the scale at which conversion is determined¹⁸ need to be clearly defined with measurable, objective criteria.

"Since 1990" and the asymmetry of 3.3

The reference to "since 1990" in Article 3.3 creates a discrepancy between the between actual and creditable stock changes caused by conversion of land to or from forest use. For example, a nation might have a balance between carbon stock changes due to deforestation in the 2008 to 2012 period and tree growth on areas of agricultural land converted to forests.¹⁹

¹⁶ This problem – created by the insertion of "since 1990" in Article 3.3 – is discussed further in the section below entitled "'Since 1990" and the asymmetry of 3.3."

¹⁷ Canadian National Climate Change Process, Sinks Table, above at footnote 10, p. 59.

¹⁸ The scale of determination looks at how large a clearing is necessary before it constitutes deforestation; e.g. does creation of a logging road constitute deforestation? does reclamation of an old skidder road constitute reforestation?

¹⁹ P. Collas et. al. *Canada's Greenhouse Gas Inventory, 1997 Emissions and Removals with Trends* (Ottawa: Environment Canada, 1999) Table 6.1 shows 2.8 Mt emissions from conversion of land from forest to other uses and 3.2 tonnes of removals from conversion of forests to forest. (Actual categories reported include conversion of grass lands; this is assumed to be minimal).



However, unless the nation has a very rapid rotation period it would still receive a net debit because the sudden emission from deforestation is not cancelled out by growth on the fraction of afforested or reforested land that has been afforested or reforested since 1990.

While Article 3.3 is asymmetric, the impact of the asymmetry is less than the range of uncertainty. As shown in Table 1, the impact of including all removals due to conversion of land to forest uses (regardless of the timing of the conversion) provides Canada with an credit of 3 to 6.5 Mt., compared to a credit of zero to two megatonnes if only removals due to conversions since 1990 are counted. In contrast, deforestation could lead to a debit of anywhere between one and nineteen megatonnes.

Trying to balance the asymmetry of Article 3.3 by interpreting post harvest re-generation in the definition of reforestation either exacerbates the asymmetry of Article 3.3 – giving Canada a larger debit – or creates a larger asymmetry. If Canada's definition of reforestation were adopted it would lead to an additional two megatonne debit unless below ground carbon stocks are ignored. If below ground stocks are ignored the result would be to correct a relatively minor problem (3.0 Mt.) that prejudices Canada, with an asymmetry that prejudices the environment by 13 Mt.

Recommendations:

- **Canada should recognize that reforestation in Article 3.3 only refers to planting of forests on lands which previously contained forests but which have been converted to some other use.**
- **No credit should be given for areas deforested between 1990 and 2008, or, alternatively credit should only be given to the extent sequestration of such areas is increased above 1990 levels.**
- **What constitutes conversion to a non-forest use, and the scale at which conversion is determined, need to be clearly defined with measurable, objective criteria.**

Table 1 — Estimated Annual Net Emissions from Reforestation, Afforestation and Deforestation

Megatonnes; negatives are removals or credits	Deforestation	Reforestation	Afforestation	Total
Article 3.3 (IPCC definitions; since 1990)				
Above ground only	1.0 to 14 ²⁰	0 to -2 ²¹		-1.0 to 14
All carbon stocks	3 to 19 ²²	0 to -2 ²¹		3-19 (debit)
Symmetric Reforestation, Afforestation and deforestation (IPCC definitions; no since 1990)				
Above ground only	1.0 to 14 ²⁰	-3 ²³		-2.0 to 11
All carbon stocks	3 to 19 ²²	-6.6 ²³		-3.5 to 12.4
Canadian Position (reforestation includes post harvest regen; since 1990)				
Above ground	1.0 to 14 ²⁰	-13 ²⁴	0 ²¹	-12 to 1
All carbon stocks	3 to 19 ²²	2 ²⁴	0 ²¹	-5 to -21

EXPANDING INCLUSION OF SINKS UNDER 3.4

While expanding the inclusion of sinks under Article 3.4 can encourage various activities that are positive from a climate perspective, methodologies for including sinks under Article 3.4 are likely to be either impractical or lead to an increase in atmospheric emissions.

EXPANDING THE GROSS/NET APPROACH

As noted above, Canada's approach going into Kyoto was to support the adoption of a gross/net approach. It is possible that the Canadian position on the definition of reforestation, is simply a strategy for adoption of a comprehensive gross/net approach through the combined effect of Article 3.3 and 3.4.

²⁰ Canadian National Climate Change Process, Sinks Table, above at footnote 10, estimates 9-14 mt. for emissions from above ground deforestation. Amounts depend on assumptions. P. Collas, above at footnote 19, estimates only 1.23 Mt. emissions from above ground conversion of forests to agriculture or urban use.

²¹ Canadian National Climate Change Process, Sinks Table, above at footnote 10, p. 26

²² From personal communication with Art Jaques, Environment Canada, March 30, 2000; Amounts depend on assumptions. P. Collas, above at footnote 19, Table 6.4-1 indicates 6.2 Mt emissions from soils in 1996 due to land use change and Table 6.2.2-1 indicates an additional 2.47 emissions from above ground biomass due to conversion of forest to farm or urban land.

²³ P. Collas, above at footnote 19, Tables 6.3.2-1 and 6.4-1 indicates removals to soils and removals to above ground biomass due to conversions to forest in 1996 totalling 6.6 Mt..

²⁴ From personal communication with Art Jaques, Environment Canada, March 30, 2000.



The obvious imbalance in the Canada's suggested approach to Article 3.3 could be addressed by including a broader range of sinks in Article 3.4. However, as noted above, one cannot balance the inclusion of removals due to post harvest regeneration since 1990 by including emissions from harvesting since 1990. If post harvest regeneration is included in Article 3.3 the only means by which it could be balanced would be to include all emissions and removals from managed forest lands in Article 3.4. Although there are many different ways of approaching baselines for crediting carbon sequestration (e.g. net/net, gross/net, changes in sequestration from business as usual), a balanced carbon equation is only possible if a consistent approach is taken to baselines. Since post harvest regeneration is included in Article 3.3 on a gross/net approach, a balanced approach would require inclusion of other forest related emissions and removals on a gross/net approach. In other words, Canada's imbalanced approach to Article 3.3 can only be balanced by the full inclusion of land use change and forestry on a gross/net approach.

The severe imbalance in Canada's position can only be corrected by adopting an approach that would allow an estimated nine percent increase in Annex B emissions.

While supporting a gross/net approach was a reasonable approach prior to Kyoto²⁵, adopting the gross/net approach after the negotiation of emission limits would severely reduce the environmental effectiveness of those limitations. As indicated in Table 2, with only three exceptions, all of the industrialized nations that negotiated emission limits in the *Kyoto Protocol* have net emissions that are lower than gross emissions. Measuring compliance by reference to net emissions while setting emission limits by reference to gross emissions means that each country can, without any changes to forest practices, increase emissions by the difference between gross and net emissions.

Actual or projected net removals from land use change in forestry from Annex B Parties are nine percent of 1990 Annex B emissions. If all of this were credited it would amount to a nine percent increase in Annex B emissions over what is allowed in the absence of credit for sinks.²⁶

In addition there is a risk that credit could be given for changes in carbon stock that are far greater than the nine percent figure. For decades, scientists have been unable to account for between 1,100 to 2,200 mega-tonnes of carbon being removed from the atmosphere yearly, an amount equivalent to 28 to 56 percent of Annex B 1990 emissions.²⁷ Scientists are increasingly suggesting that the missing sink is located in northern (Annex B) forests and wetlands. There is a risk that countries will take credit for this natural sequestration and use this credit to increase net emissions. It is currently impossible to separate natural sequestration from sequestration due to human management of forests. Thus, under the gross/net approach countries may be able to take credit for this natural sequestration even if logging has reduced the rate of natural sequestration. Any significant crediting of this natural sequestration would defeat the effectiveness of the *Protocol*.

²⁵ The gross/net approach has the advantage of being comprehensive and less subjective. Approaches which provide credit based on distinct activities (e.g. credit for different silvicultural activities such as planting, spacing and fertilizing) could lead to double counting and exaggeration of credit because the impacts of these specific activities are difficult to separate. In comparison, a comprehensive approach (including gross/net) could be considerably less subjective, simply measuring all changes in carbon stock on managed forest lands.

²⁶ See Table 2.

²⁷ Jocelyn Kaiser, "Possibly Vast Greenhouse Gas Sponge Ignites Controversy" (16 October 1998) v. 282 *Science* p. 386.

Finally, it is not clear that full inclusion of sinks on a gross net approach is in Canada's parochial or strategic interest. Assuming that an increase in assigned amounts is in Canada's narrow best interest, Canada receives less of a "benefit" from the gross/net approach than our competitors. Although Canada would, with no change in forest practices, receive credits equivalent to three percent of 1990 emissions, the gross/net approach benefits Canada far less than its Annex B competitors. Canada's main competitor, the United States receives a nine percent increase in allowable emissions.

BASELINE FOR ADDITIONAL ACTIVITIES:

Even if full carbon accounting using the gross/net approach is not adopted, there are a number of difficulties in adding additional activities under Article 3.4. First and foremost, it will be difficult to develop baselines that are not highly subjective, do not reduce the effectiveness of a given climate commitment, or do not significantly change nation's climate commitments (making them politically problematic). For this reason, any methodology for adding sinks may not be appropriate for the first commitment period.

A number of potential approaches to setting baselines are possible:

- **Gross/net.** The problems inherent in application of the gross/net approach to the first commitment period are discussed above.
- **Net/net.** Credit or debits are only given for improvements in sequestration rates relative to 1990. Provided methodologies for measuring sequestration are dramatically improved, this provides a relatively objective way of measuring carbon removals. Because business as usual projections show that most nations' level of sequestration will increase from 1990 to 2010, a broad inclusion of sinks using a net/net approach is projected to reduce the effectiveness of current commitments by 1.2 percent.²⁸ The potential for crediting the missing sink is reduced.

This approach has been criticised because it could theoretically lead to a nation that is making best efforts to improve sequestration receiving a debit (Sequestration levels in forests will plateau as forests reach maturity). While subsequent commitment periods could factor this into the levels of commitments undertaken by nations, the net/net approach is unlikely to be acceptable for the first commitment period because it has significant impacts on the ease or difficulty of Parties achieving their target. Sweden, for instance, would receive a debit equivalent to 18% of its 1990 emissions.²⁹ Russia, on the other hand, with large areas of recent afforestation, would receive a credit of five percent of 1990 emissions. Finally, it is not clear that reliable estimates can feasibly be made of net sequestration in 1990 (although a later baseline year could be used).

²⁸ Derived from United Nations Framework Convention on Climate Change, Conference of the Parties, *Second Compilation and Synthesis of Second National Communications*. (7 October, 1998) FCCC/CP/1998/11/Add.2, Tables C.1 and C-2 using projected sequestration levels for 2010 and baseline year, and projected emission levels for baseline year. Nations with no projected 2010 sequestration levels excluded from calculation.

²⁹ Derived from UNFCCC, Conference of the Parties, above at footnote 28, Tables C.2 and B.16 using projected sequestration levels for 2010 and baseline year.



TABLE 2

Party	Gross Emissions 1990 gigagrams	LUCF Removals 1990 or 1997 gigagrams	Notes: Data from 2010 projected, 1997 actual or 1990 actual. NE = LUCF sector net emitter NA = data not available
Australia			NE
Austria	73,727	13,753	1997
Belgium	139,276	2,057	2010
Bulgaria	136,093	7,807	2010
Canada	599,450	19,000	1997
Czech	189,837	5,000	2010
Denmark	71,658	2,063	2010
Estonia		11,546	2010
Finland			NA
France	561,330	64,906	2010
Germany	1,210,047	33,493	1997
Greece			NA
Hungary	101,634	3,097	1990
Iceland			NA
Ireland	56,861	9,690	2010
Italy	533,762	24,507	2010
Japan	1,213,262	55,811	2010
Latvia	35,669	13,752	2010
Liech	260	22	1990
Lithuania	51,548	7,667	2010
Luxembourg	13,448	295	2010
Monaco			NA
Netherlands	217,052	1,700	2010
NZ	72,516	21,208	2010
Norway	51,874	14,800	2010
Poland	564,286	40,521	
Portugal	68,442	1,152	1990
Romania	264,879	2,925	1990
Russia	3,040,062	550,000	2010
Slovakia	72,496	7,957	2010
Slovenia	19,212	2,293	1990
Spain			NA
Sweden	69,467	22,000	2010
Switzerland	53,749	5,100	2010
Ukraine	919,220	70,702	2010
UK			NE
USA	5,983,570	400,030	2010
Totals:	16,384,687	1,414,854	

Estimated increase in GHG emissions relative to 1990 levels that occurs if there is full inclusion of land use change and forestry activities and a gross/net approach is used: 8.6%

Notes on Table 2:

Based on United Nations Framework Convention on Climate Change, Conference of the Parties, *Second Compilation and Synthesis of Second National Communications*. (7 October, 1998) FCCC/CP/1998/11/Add.2, Table C.2; and United Nations Framework Convention on Climate Change, Subsidiary Body for Implementation, *National Communications from Parties Included in Annex 1 to the Convention, Greenhouse Gas Inventory Data, 1990-1997*. (29 September, 1999) FCCC/SBI/1999/12, Tables A1 and A2.

Projections for 2010 removals have been used where available. Where not available, data for 1997 net removals have been used in preference to 1990 data. Total removals using 1990 and 1997 data only are 1,637,004.

The estimates of LUCF removals used in this document are based on IPCC methodologies that were not intended for determination of compliance with a legal limit. Data using more rigorous methodologies is not available.

If more rigorous IPCC methodologies are developed and include all emissions and removals in the Land Use, Land Use Change and Forestry sectors, the result could be an increase in the significance of the Gross Net Approach. This is due to the fact that certain IPCC assumptions clearly underestimate net removals (and thus the environmental significance of sinks). For instance, the IPCC assumes that all carbon sequestered in a tree is released on logging; in fact a significant portion of the sequestered carbon continues to be sequestered in forest products.

- **Changes in sequestration from Business as Usual.** Potentially, business as usual sequestration levels could be used as a baseline, and parties could be credited with increases in sequestration from business as usual. Theoretically, this would ensure that the addition of sequestration activities under Article 3.4 would not reduce the short term environmental effectiveness of the *Protocol*. However, it is not clear whether it is feasible to develop business as usual baselines that have any integrity for an entire sector.
- **Adding activities at a project level.** Potentially, credit could only be given at a project by project level; however, this introduces many of the same problems as crediting emission reduction project in developing countries. In particular, there is a risk that business as usual sequestration projects would be credited. For instance, Canada might claim credit for good but standard silvicultural practices while ignoring our high rate of forest conversion to logging roads, pipeline rights of way, etc. This will reduce the environmental effectiveness of the *Protocol*.

Key Recommendations:

- **No additional activities should be added under Article 3.4 during the first commitment period.**
- **If Canada continues to support the addition of new activities in the first commitment period,**
 - **such activities should only be added with a clear understanding of the addition's impacts on net emissions entering the atmosphere; and**



- methodologies which increase net emissions should be rejected. In particular, Canada should reject use of the gross/net approach.
- For second and subsequent commitment periods:
 - Methodologies for counting sequestration should be determined prior to negotiation of emission limits;
 - Expert reviewed projections of the net effect of agreed methodologies on each Annex B Party should be available to all Parties in advance of emission limit negotiations.
 - Canada should reject any methodology for including new activities that could lead to credit for natural levels of sequestration. In particular Canada should reject the gross/net approach for second and subsequent commitment periods.

PERMANENCE AND THE TIME VALUE OF REDUCTIONS

Allowing an extra tonne of emissions because a party has sequestered a tonne of carbon is often justified on the assumption that the impacts on the atmosphere are the same. While the immediate impacts on the atmosphere may be equal (provided the tonne of sequestration would not have occurred anyway) the long term atmospheric impacts of a tonne of sequestration are unlikely to ever be as significant as a tonne of emission reductions.

IS A TONNE A TONNE?

Sequestering a tonne of carbon will only have the same impact on the atmosphere as reducing a tonne of emissions if the sequestration is permanent. Indeed, even if one can be assured that a sequestration project will be maintained in perpetuity, each tonne of carbon sequestered will only completely offset the climate impacts of an extra tonne of emissions if the sequestration project would never occur in the absence of carbon credits. For instance, compare the effect of offsetting emissions with, on the one hand, an additional emission reduction project, and on the other hand, with an additional sequestration project. (Additional means that projects require the incentive of carbon credits to proceed.) If the emission reduction project is only additional for ten years (i.e. it would have happened ten years later in the absence of credits), it will have succeeded in reducing carbon emissions to the atmosphere for ten years, and this will have a permanent impact on global carbon dioxide concentrations. In the case of a sequestration project, if credit only causes the sequestration to occur ten years earlier, there is only a ten year impact on global concentrations. A tonne of sequestration is only equivalent to a tonne of reductions if it is maintained in perpetuity (or for a geologic timeframe) and if it would never have occurred in the absence of carbon credits.

BUILDING A FIREWALL WITH PAPER: THE CARBON TIME-BOMB

Typically, proponents of sequestration simply assume that if sequestration is reversed in the future, a Party will be responsible for offsetting a carbon debit. This approach is implicit in

the gross/net approach advocated by Canada in past statements on sinks.³⁰ Under this approach, the costs of permanently reducing atmospheric emissions are placed on future generations. Because human institutions outside of government cannot meaningfully guarantee liabilities that might arise one-hundred years from now,³¹ costs will be shifted to society at large, rather than being borne by the parties that relied on sequestration.

This is problematic, since there is a potential for massive reversals of carbon sequestration due to climate change. Future generations simply may not be able to cope with the need to reduce emissions from current levels while at the same time being responsible for offsetting the effects of sequestration reversals. Reliability of sequestration is thrown into doubt by the possible impacts of climate change itself and other environmental stresses. According to the IPCC,

... [c]limate-induced vegetation changes could release CO₂ into the atmosphere, counteracting the biosphere's capacity to take up CO₂. The magnitude of this feedback is highly uncertain; it could be near zero, or with low probability, as much as 200 GtC [36 times average annual emissions from fossil fuels] over the next one to two centuries. The more rapid climate change, the greater probability of a large transient carbon release.³²

Indeed, since the above passage was written, scientists are increasingly warning that sequestration is a high-risk strategy. First, additional terrestrial uptake of atmospheric carbon dioxide is projected to diminish and reverse in several decades as plant respiration (emissions of CO₂ from living plants) increases with increased temperatures while photosynthesis (sequestration of CO₂ by plants) levels off.³³ Second, there are increasing warnings of sequestration reversals due to climate change. The Hadley Centre for Climate Prediction has predicted massive die back of tropical rain forests – especially in the Amazon -- due to climate change.³⁴

Canadian forests are not immune to reversals in sequestration. Best estimates indicate that from 1970 to 1990, Canada's forests shifted from removing over 200 million tonnes of carbon dioxide per year, to emitting about 60 million tonnes of carbon dioxide per year.³⁵ (Managed forests are still a sink.³⁶) Boreal forests are projected to continue being a source for

³⁰ See Canada, above at footnote 1.

³¹ According to a representative of Jardine Insurance Services, one of Canada's largest insurance and bond brokers, insurers will not issue performance bonds (e.g. insure performance of a contract) that extend beyond a five year period: personal communication with Amanda Caverly.

³² J.M. Melillo *et al.*, "Terrestrial Biotic Responses to Environmental Change and Feedback to Climate" in J.T. Houghton *et al.*, eds, *Climate Change 1995: The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change* (Melbourne, Australia: University of Cambridge, 1996) at 449.

³³ R.J. Scholes *et al.* "Biogeochemistry of terrestrial ecosystems" in *Implications of Global Change for Natural and Managed Ecosystems* (Cambridge: Cambridge University Press, 1998)

³⁴ Hadley Center for Climate Prediction and Research, *Climate Change and Its Impacts* (London: the Meteorological Office, October 1999).

³⁵ Julia Martinez *et al.*, *Report on the in-depth review of the national communication of Canada* (Geneva: UNFCCC Secretariat, February 1996) at 10.

³⁶ P. Collas, above at footnote 19.



the near future.³⁷ Analyses suggest that forest fires could double by 2050 in the McKenzie Basin because of climate change.³⁸ In addition, under warmer conditions forest pests are expected to increase in numbers and range.³⁹ Die back of boreal forests due to drought, fire, disease and pests will likely reverse sequestration.⁴⁰

Credit for sequestration may also place shift costs onto future generations in other ways. For instance, increased sequestration in wood products may lead to increased landfill gas emissions in the future. Canada has promoted credit for increases in the stock of carbon contained in wood products. While increasing carbon stored in wood products can reduce the carbon in the atmosphere, it can also lead to the introduction of carbon into the atmosphere in a form – CH₄ – which is twenty one times as powerful as CO₂. A portion of wood products are eventually land-filled. Typically decomposition of the products occurs in anaerobic conditions and creates landfill gas.

TONNE FOR TONNE CREDIT: OVERVALUES SEQUESTRATION, INCONSISTENT WITH 100 YEAR GLOBAL WARMING POTENTIALS

Giving a tonne of emission reductions and tonne of sequestered carbon equal credit overvalues sequestration and is inconsistent with other aspects of the *United Nations Framework Convention on Climate Change* and *Kyoto Protocol*. It overvalues sequestration because its impacts on atmospheric concentrations are only equal if the sequestration is maintained in perpetuity and additional in perpetuity.

It is inconsistent with the UNFCCC and *Kyoto Protocol* because those agreements take a relatively long-term approach to comparing the impacts of emissions of different gases and their different impacts on short and long-term climate change. Both agreements adopt 100 year Global Warming Potentials (GWPs) to compare the climate impact of different greenhouse gases. GWPs are based on the cumulative warming impact of a gas over a one hundred-year time frame. Although methane is over 100 times as powerful a greenhouse gas as carbon dioxide in the instant it is released, is only valued as 21 times as powerful as carbon dioxide because it is short lived in the atmosphere. Essentially GWPs apply no discount for any climate impact caused by a gas over the next one hundred years. Any climate impacts after one hundred years are discounted to zero.

Treating a tonne of sequestration in the same manner as a tonne of emission reductions is inconsistent with this approach. If a tonne of carbon is only sequestered for 46 years its cumulative impact on warming over one hundred years is only 17 years. Sequestration for forty-six years can be analysed as a removal of one tonne of CO₂ in year zero followed by an emission in year 46. The impacts of this over a one hundred-year time frame are indicated in

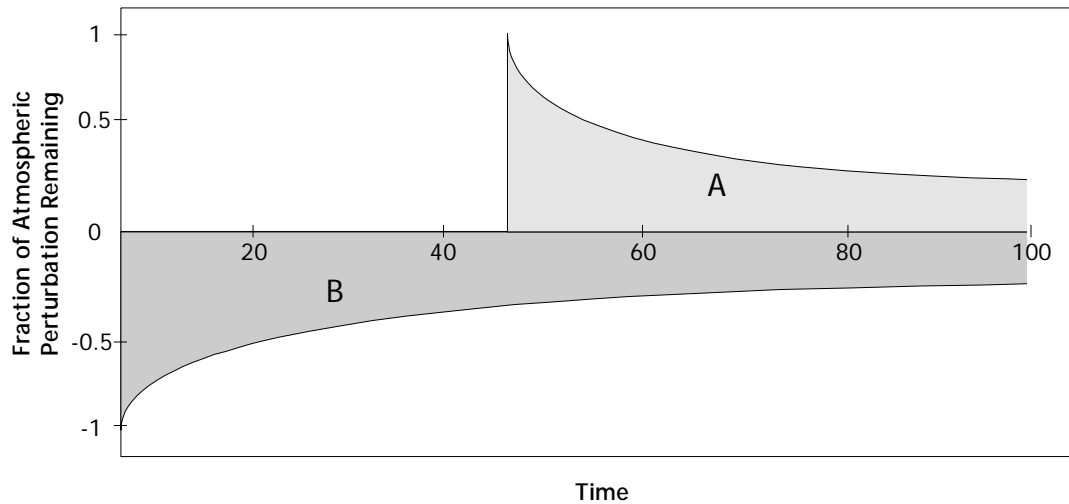
³⁷ Werner A. Kurz *et al.*, "Retrospective Assessment of carbon flows in Canadian boreal forests." In *Forest Ecosystems, Forest Management and the Global Carbon Cycle* (Heidelberg: Springer-Verlag, 1996).

³⁸ Climate models forecast that a doubling in the forest fire index will occur. This will mean a doubling in forest fires given current management practices: Personal communication with Stewart Cohen, UBC, Sustainable Development Research Institute.

³⁹ Environment Canada, *The Canada Country Study: Climate Impacts and Adaptation, British Columbia and Yukon Summary* (Ottawa: Environment Canada, 1997).

⁴⁰ See Environment Canada, *The Canada Country Study: Climate Impacts and Adaptation, Canadian Prairies Summary* (Ottawa: Environment Canada, 1997).

Figure 1. Area B represents the impacts of an actual reduction over a one hundred-year time frame. Area A represents the impact of an emission in 46 years. The difference between areas B and A represents the net impact of a 46-year sequestration project.⁴¹



Even though sequestration for 46 years only has 17% of the impact on atmospheric burden, an investor weighing the value of sequestration against actual reductions will treat the two as being virtually equal if one tonne of credit is given immediately and a one tonne debit imposed in 46 years. Assuming a real discount rate of 5% and no change in the real value of an emission reduction, an investor would value a sequestration project with a lifetime of 46 years as having 89% of the value of an emission reduction. This is despite the fact that its atmospheric impact over a one hundred-year time period is only 17% of the impact from an emission reduction. Sequestration is overvalued by a factor of five over emission reductions.

Since it is impossible to guarantee that sequestration projects will be permanent over a one-hundred year time frame, it is essential to create a mechanism which ensures that sequestration is not over valued by either parties or the market. One solution to this problem is to value carbon using a tonne year approach. To be consistent with the approach above, in the each year that a tonne of carbon remains sequestered, the Party would receive a credit equal to the impact of that year's sequestration compared to an emission reduction in year one of the project. Over one hundred years, the Party would receive one tonne of credit. In the first years the credit would be relatively small, while it would increase towards the end of the one hundred years.

Alternatively, the proponent might receive credit for 1/100th of a tonne of reductions in each year of the project. Although this would tend to overvalue very short-lived projects, discounting of the future stream of payments would counteract the initial overvaluation.

As a final alternative, sequestration projects could be discounted by a very significant factor (e.g. from 50 to 80 percent).

⁴¹ See D.A. Lashof and B Hare, "The role of biotic carbon stocks in stabilising greenhouse gas concentrations at safe levels" (1999) 2:2 *Environmental Science and Policy* 101 [check w. Dan].



Key Recommendation:

- **In all future commitment periods, credit for sequestration should reflect the lower impacts sequestration has on long term atmospheric concentrations. Credit for carbon sequestration should either be based on tonne-years or credit should be discounted by fifty percent or more.**