IMPLEMENTATION OF BIOLOGICAL SEQUESTRATION OFFSETS IN A CARBON REDUCTION POLICY: ANSWERS TO KEY QUESTIONS FOR A SUCCESSFUL DOMESTIC OFFSET PROGRAM

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To ensure a successful atmospheric carbon reduction policy, a domestic offset program that utilizes broad biological sequestration must be implemented in addition to conventional source emission reduction. This type of offset program will not compromise the environmental integrity of a carbon reduction policy if it is conducted under a tight emission cap in which participants must utilize both measures to conform to the cap. A successful offset program will incorporate current conservation programs within a broad sequestration policy to reduce concerns of additionality, provide methods to mitigate the impacts of carbon leakage, and establish means to ensure carbon storage is permanent. To administer such a program, verification and permanence issues should be devolved to the state level, similar to current federal pollution reduction programs, with the federal agency issuing the guidelines under which a program will proceed.

I. INTRODUCTION – EMISSION CUTS ALONE WILL NOT CURB CLIMATE CHANGE: THE VALUE OF BIOLOGICAL SEQUESTRATION FOR CARBON REDUCTION

The domestic debate over policies to reduce the carbon emissions and atmospheric carbon that are causing climate change is rapidly coming to a head.

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Although the debate has shifted from whether or not global climate change is occurring to what strategy should be pursued to reduce or eliminate the threat, this debate is still largely focused on how to reduce greenhouse gas emissions from its sources, not how to reduce these gases, most significantly carbon dioxide, currently in the atmosphere. Further, the switch away from fossil fuels and towards the use of renewable, non-emission energy sources will be gradual, not immediate, thereby allowing atmospheric carbon to continue to build. In terms of the reduction of atmospheric carbon, "[v]ery little carbon is removed from the atmosphere and stored, or sequestered, by deliberate action"[1] and the current policy debate is forgetting, or avoiding, this very important aspect of atmospheric carbon reduction. Colloquially, the domestic reduction policies currently under debate focus on reducing "new" emissions, particularly from large, stationary sources, such as power plants, but ignore the "old" emissions already in the atmosphere that are currently impacting the climate.

Any policy to combat climate change must also focus on the removal of atmospheric carbon, as there are enough greenhouse gases already in the atmosphere for climate change to continue even if zero-generation of emissions was immediately achievable, or achievable at all. Since 1850, approximately 500 gigatons [gT] of carbon have been released into the atmosphere globally, about three-quarters of which are from the burning of fossil fuels, about five percent from cement production, and the remainder from land use changes; of this, an estimated 150 gT is absorbed by the oceans and 120-130 gT by terrestrial ecosystems, leaving 120-130 gT of man-made carbon in the atmosphere.[2] It is this remaining atmospheric carbon that is causing current climate changes and must be addressed. "Even if the concentrations of all [greenhouse gases] and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1 [degrees] C per decade would be expected."[3] Overall, the atmosphere contains 100 parts per million more carbon than before the Industrial Revolution, carbon that must be removed to reduce the effects of climate change.[4] A study by the National Oceanic and Atmospheric Administration (NOAA) concluded that carbon will remain in the atmosphere for perhaps one thousand years, while other gases, even the potent greenhouse gas, methane, will naturally dissipate more quickly.[5] While this does not diminish the need to reduce other gases, it shows the urgency of reducing carbon already in the atmosphere. Many scientists agree that the planet is close to, or has reached, a "tipping point" after which cutting emissions, even to zero, will not slow the effects of climate change. Because of this, the need to quickly and inexpensively reduce atmospheric carbon is that much more urgent. "For global climate change, it does not matter where or from what source the reduction or sequestration occurs:

1. PETER FOLGER, THE CARBON CYCLE: IMPLICATIONS FOR CLIMATE CHANGE AND CONGRESS, at Summary, Cong. Research Serv. (June 25, 2007).

2. KATE TRUMPER ET AL., THE NATURAL FIX? THE ROLE OF ECOSYSTEMS IN CLIMATE MITIGATION 12, United Nations Environment Programme (2009).

3. INTERGOVERNMENTAL PANEL OF CLIMATE CHANGE (IPCC), CLIMATE REPORT 2007: SYNTHESIS REPORT, SUMMARY FOR POLICYMAKERS, Fourth Assessment Report 7 (Nov. 17, 2007).

4. FOLGER, *supra* note 1, at 1.

5. SUSAN SOLOMAN ET AL., IRREVERSIBLE CLIMATE CHANGE DUE TO CARBON DIOXIDE EMISSIONS, 106 Proceedings of the Nat'l Acad. of Scis. of the U.S.A. 1704 (2009).

the effect on the atmospheric concentration of [greenhouse gases] would be the same."[6]

Biological carbon storage, or sequestration, through which atmospheric carbon is absorbed by the natural ecosystem, must be considered as one of the leading atmospheric carbon reduction techniques. "Biological sequestration encompasses various ways of using land to enhance the natural uptake of atmospheric carbon in plants and soil."[7] While biological sequestration certainly cannot store the whole of the industrial carbon in the atmosphere, expanded carbon sequestration programs through the restoration and protection of the natural ecosystem will begin to reduce carbon dioxide immediately at very little public cost. "Although biological sequestration practices have a relatively small technological potential in the United States, they could be put in place by landowners immediately and are fairly inexpensive."[8] Biosequestration alone is certainly not the sole solution to combat climate change, but it must be utilized as part of a broad strategy to combat its potential effects. And, while some carbon reduction technologies are not yet commercially viable, biological sequestration on a large scale could be rapidly put into effect. With this, an expansive carbon sequestration program concentrating on natural vegetation that captures and stores carbon, known as "carbon sinks," must be implemented immediately to reduce atmospheric carbon.

Carbon sinks are an ecosystem's natural absorption and storage of atmospheric carbon, primarily through photosynthesis. In the natural environmental process, large quantities of carbon are transferred between the atmosphere and the world's oceans, vegetation and soils. While current North American carbon sinks are vast, they cannot absorb all of the manmade emissions generated:

> the net balance for all of the [terrestrial and aquatic] ecosystems combined is currently a net sink of 370-505 million tons of carbon (Mt C) per year. This net sink offsets only about 20-30% of the current fossil-fuel emissions from the region (1856 Mt C per year in 2003).[9]

Natural carbon sinks will not sequester all the man-made carbon dioxide in our atmosphere, but rather must be part of a multi-pronged approach that includes emission reduction from stationary and mobile sources, a gradual switch to renewable energy sources, and geological sequestration, when, and if, it becomes technologically and commercially feasible. "[C]arbon sequestration practices . . . need to be considered in the context of a broader range of strategies for mitigating climate change."[10] Natural biological sequestration is an important approach to carbon reduction that cannot be ignored: "[s]tudies estimate that biological sequestration has the technological potential to sequester about 40 billion to 60 billion metric tons of CO_2 in the United States over the

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6. ROSS W. GORTE AND JONATHAN L. RAMSEUR, FOREST CARBON MARKETS: POTENTIAL AND DRAWBACKS 2, Cong. Research Serv. (July 3, 2008).

7. CONG. BUDGET OFFICE, THE POTENTIAL FOR CARBON SEQUESTRATION IN THE UNITED STATES 1 (Sept. 2007) [hereinafter *Carbon Sequestration*].

8. *Id.* at 3.

9. U.S. CLIMATE CHANGE SCIENCE PROGRAM, THE FIRST STATE OF THE CARBON CYCLE REPORT (SOCCR): THE NORTH AMERICAN CARBON BUDGET AND IMPLICATIONS FOR THE GLOBAL CARBON CYCLE 103 (Nov. 2007) [hereinafter *SOCCR*].

10. *Carbon Sequestration*, *supra* note 7, at 3.

course of 50 years and another few tens of billions of tons over the following half-century."[11] Despite this, biological carbon sequestration, even through the forests which make up the bulk of the nation's carbon sinks, and indeed cover the most acreage, is currently given only minor attention in policy discussions while extensive federal funding is spent on researching artificial sequestration techniques.

Further, this utilization of biological sequestration must be part of a strategy of ecological management, in that ecosystems set aside or rehabilitated to store carbon must be maintained to best ensure permanence of this storage, and represents an integral part of any sequestration offset program. "Managing ecosystems for carbon can not only reduce emissions; it can also actively remove carbon dioxide from the atmosphere."[12] Merely capturing the carbon will not be enough; it must also be stored for as long a term as possible:

> [t]he biological management of carbon in tackling climate change has therefore essentially two components: the reduction in emissions from biological systems and the increase in their storage of carbon. These can be achieved in three ways: existing stores could be protected and the current rate of loss reduced; historically depleted stores could be replenished by restoring ecosystems and soils; and, potentially, new stores could be created by encouraging greater carbon storage in areas that currently have little, for example through afforestation.[13]

Management of sequestrating ecosystems is key as "[t]errestrial ecosystems store about 2100 [gigatons of carbon] in living organisms, litter and soil organic matter, which is almost three times that currently present in the atmosphere,"[14] and release of this stored carbon must be prevented. In this, management of ecosystems is an important part of a successful, long-term offset program that relies on biological sequestration.

II. A CAP-AND-TRADE PROGRAM IS THE BEST PLATFORM FOR BIOLOGICAL SEQUESTRATION

A federal policy to mandate reductions in atmospheric carbon is most often considered through two possible policy platforms: cap-and-trade or a carbon tax. Both approaches certainly have merit, but what becomes clear when one studies the issue is that each side staunchly advocates its policy as the best avenue and refuses to yield much ground to those supporting the opposing platform. Although there are certainly exceptions, most economists favor a carbon tax for its simplicity – the theory being, the more something costs, namely energy, the less it will be used – while most environmentalists favor cap-and-trade as it is sets solidly defined goals for emission reduction by establishing a certain percentage reduction of carbon emissions by a set year. And, while an offset program under a carbon tax model is certainly possible, as tax credits could be given for offsets just as easily as allowance credits, the overall goal is the reduction of carbon by a certain amount, not by a certain price, to counter the effects of climate change, making cap-and-trade a more tenable policy domestically and internationally. While cap-and-trade has long been seen as the

11. *Id.* at 2.
12. TRUMPER, *supra* note 2, at 6.
13. *Id.* at 13.
14. *Id.* at 14.

primary policy route for atmospheric carbon reduction, it must be noted that as of the final edit of this article, members of the United States Senate are considering a third option, likely a variety of methods to reduce emissions across various sectors of the economy, in an effort to break the current political impasse. While this author views cap-and-trade as the best avenue to implement a biological sequestration offset program, it is certainly possible that biological sequestration could be implemented within the yet-unveiled U.S. Senate approach.

A carbon tax is a price-based mechanism for reducing carbon; simply, a levy imposed on a ton of carbon emissions. The higher the tax, the higher the cost to emit carbon, thereby reducing carbon emissions as the cost becomes too great and consumers are forced to reduce their energy use. A carbon tax is more direct in passing decision-making on energy use to individuals, letting them determine how much to spend on energy consumption. But, while the cost will be more certain, what is much less certain is exactly by what quantity carbon emissions will be reduced. Some argue that individuals and businesses may simply choose to spend more on energy and less on other goods and services, thereby undermining carbon reduction goals. While on its face this argument seems thin, it could ring true when it comes to items that many consider necessary despite cost, such as gasoline, home heating oil or gas, and food. Further, taxes generally do not spur economic growth, and although there may be a profit incentive to lower costs of energy production under a carbon tax, the emission reduction certainty in cap-and-trade is more likely to spur technological investment and boost a sagging economy. On a practical level, it is politically more difficult to enact a carbon tax, particularly in a depressed economy. This lesson was learned first by the Clinton Administration when it pushed for enactment of the ill-named "BTU tax" during a more prosperous economy and then was experienced more recently by the Liberal Party of Canada. While cap-and-trade may be a political slight-of-hand to some, current political and economic realities render a carbon tax virtually a non-starter.

Climate change has been long considered a scientific matter, and researchers examining climate change and carbon emissions deduced that, while numbers vary, atmospheric carbon must be reduced to between 450 and 350 parts per million to stave off the most catastrophic effects of climate change.[15] Emission reduction goals such as these are more readily achievable through a cap-and-trade mechanism as it will provide environmental certainty, whereas a tax may have to be continually adjusted to reach desired emission reduction levels. Cap-and-trade is a quantity-based mechanism that sets a cap on emissions at a certain level, gives away or auctions off permits, or allowances, to emit pollution and allows emitters to trade these permits if they are below the set cap, thereby "creat[ing] relative certainty about the total quantity of emission reductions each year."[16] Essentially, a market would be established, similar to current financial trading markets, in which these allowances from emission cuts and credits from offset sequestration projects could be bought and sold.

15. Lauren Morello, *Science: Is 350 the new 450?* CLIMATEWIRE (Sept. 28, 2009).

16. Statement of Peter R. Orszag, Director, Issues in Climate Change: Presentation for the CBO Director's Conference on Climate Change, at 8, Cong. Budget Office (Nov. 16, 2007).

> Under such a program, policymakers would set a limit (cap) on total emissions during some period and would require regulated entities to hold rights, or allowances, to the emissions permitted under that cap. After allowances were initially distributed, entities would be free to buy and sell them (the trade part of the program).[17]

These environmental goals will provide more investor certainty than would a carbon tax, encouraging technological development to reach long-term goals on emission reductions. Overall, the emission goal will be set, and emitters will be responsible for reaching that bar through any practicable means, likely pursuing the most cost-effective avenues, technologically or otherwise.

Cap-and-trade has been an effective market-based strategy for sulfur dioxide emission reduction to curb acid rain, but an effective carbon program must continuously reduce atmospheric carbon by tightening the cap over time, and the development of an offset program utilizing carbon sinks will reduce atmospheric carbon as well as lower implementation costs. A major portion of the debate within a cap-and-trade policy is by what percentage current emissions should be reduced by a certain year, or, how tight to set the cap. As there is an economic cost to emission reduction, policy debates incorporate a balance between cost impacts and setting a cap tight enough to have a positive environmental impact. Offsets can be utilized to reduce the implementation costs associated with a tight carbon cap, thereby achieving meaningful atmospheric carbon reductions without unduly burdening the general public. Further, an offset program relying on a broad-based biological sequestration strategy will defray initial costs as a large base of third parties can participate and provide offset credits. Overall, offsets, particularly biological sequestration, will assist emitters in reducing atmospheric carbon and reduce cost.

As the program advances, and the cap tightens, the price of these permits would increase at a rate based on the price of a metric ton of carbon:

> [e]ither a [carbon] tax or a cap would be most efficient (that is, would be best balance expected benefits and costs) if it was designed to gradually become more stringent over time – meaning the tax would gradually rise or the cap would become tighter. Such an approach would best reflect the present value of avoided future damage (the benefit of reducing a ton of emissions), which would take on greater weight as larger potential damage became closer in time.[18]

Under a tight cap, in order to minimize the costs of doing business, emitters will respond two ways – they will install new technology to reduce emissions from the source and will continue to offset their emissions by purchasing credits that restore and protect an ever-increasing acreage of carbon sinks. As the cap becomes more restrictive over time and credits more expensive, emitters will continue to restore and protect an increasing number of carbon sinks, including ones that were previously cost-prohibitive, through a carbon market as a means to balance the cost of installing more expensive emission reduction technology.

> Economic analyses estimate that a CO_2 price of $5 per metric ton would prompt enough changes in forest and crop-soil management to sequester between 0.5 billion and 25 billion metric tons of CO_2 over 100 years . . . A CO_2 price of $50 per metric ton might prompt enough changes to fully exploit the technological potential

17. *Id.* at 1.
18. *Id.* at 8.

> of forest and cropland-soil strategies, sequestering more than 60 billion metric tons of CO_2 over a century.[19]

And, this analysis does not utilize ecosystems that more efficiently sequester carbon, such as terrestrial and coastal wetlands. As the price of carbon becomes more expensive, the environment will benefit as emitters offset their costs by rehabilitating and protecting an increasing amount of ecosystem acreage.

In order to fully utilize our nations' most potent carbon sinks for maximum sequestration in a relatively short period of time, a cap-and-trade system that encourages the reduction of carbon dioxide through biological sequestration must be implemented. This can only be accomplished with a restrictive carbon cap under which companies will not only have to reduce carbon emissions, but also invest in the restoration and protection of the natural ecosystem for biological sequestration in order to reach their target caps. In the longer term, a tighter cap will also spur technological developments that will assist in emission reduction. Since the cap levels will be known, as will target years when caps will become more restrictive, emitters can establish business strategies on these expectations and arrive under those caps in the most cost-effective manner. Unlike current proposals, any and all methods to reduce atmospheric carbon must be utilized, not just a policy that relies heavily on source reductions. Emission reduction is certainly necessary, but current policy approaches must include any method to reduce atmospheric carbon, with a new focus on implementation of a biological sequestration program that can quickly begin to reduce atmospheric CO_2 and potentially store it for long periods of time.

III. OFFSETS WILL NOT HARM THE ENVIRONMENTAL INTEGRITY OF CAP-AND-TRADE: AN OVERVIEW OF OFFSETS

The broadest question concerning an offset program within a cap-and-trade policy is: will offsets compromise the environmental integrity of the cap-and-trade program? Asked another way, will offsets undermine the goal of emission reduction, essentially allowing source emitters to avoid making cuts by investing wholly in offsets, such as biological sequestration? While the issue is complex, the short answer is that these two elements of an overall reduction strategy need not be mutually exclusive, but conversely are both key to a successful atmospheric carbon reduction policy. These two major prongs of a carbon strategy – emission reduction and the capture and storage of atmospheric carbon – must be utilized together to rapidly reduce atmospheric carbon. Biological sequestration is one of the most plausible means to immediately begin the capture of atmospheric carbon. But, this will only be possible under a tight emission cap. If the reduction cap is too loose – said another way, the allowance price is too low – an emitter will indeed be able to avoid emission cuts by focusing exclusively on offsets, even though atmospheric carbon arguably could still be reduced.

Under a tight cap, both emission cuts and sequestration will be utilized to achieve the cap goal in the most economical means possible. And, the most plausible means to implement a cap-and-trade program with a tight cap without

19. *Carbon Sequestration*, *supra* note 7, at 3.

causing undue economic harm is through the utilization of offsets. "[T]he fundamental role of offsets is to provide economic efficiency and cost containment within regulatory cap and trade programs by obtaining emission reductions at a lower cost than would be possible within the capped system."[20]

A tight cap that only allows emission reductions and excludes offsets may indeed cause wide-ranging economic impacts. "Put simply, offsets substitute a lower-cost emission reduction from sources or sinks outside of an emission cap for a higher-cost reduction at sources covered by the cap. The result can be significant cost savings with the same environmental results."[21] It is important to remember that the goal of a cap-and-trade program is to reduce atmospheric carbon, not just cut emissions. The goal is to prevent, as best as possible, climate change from occurring, and this can be more readily achieved with the inclusion of an offset program. "Put another way, offsets make tighter emission caps more affordable and can help win political support for a more stringent policy."[22] With this, the aim of any offset program should be to assist in the removal of atmospheric carbon, not just reduce the cost of implementation of an emission reduction program. Essentially, biological sequestration should be considered a partner with emission cuts in a cap-and-trade program, not a negative foil, and both utilized to reduce atmospheric carbon.

The key to the environmental integrity, and subsequently the success, of any offset program is the allowance price. If an allowance price is low, only a narrow range of potential sequestration offsets will be used, thereby undercutting not only the value of the program, but the environmental integrity of the entire cap-and-trade strategy. The central factors of the allowance price include which sources are utilized and the amount and timing of the reductions. A higher allowance price would enable participants to utilize a much larger pool of potential offsets, especially at the point where emission cuts alone would be cost-prohibitive and offsets can be used to make up the difference and get an emitter under the cap. "If the allowance price is relatively low - ie. $1 to $5 [per metric ton of carbon dioxide - equivalent] - only the 'low-hanging fruit' projects would be financially viable. If the allowance price is higher, more offset projects would become economically competitive."[23]

For example, there could be a shift from less expensive soil practices to more costly wetland restoration. An offset program under a tight cap or a program that tightens the cap more rapidly than current proposals will reduce atmospheric carbon more quickly than emission reductions alone, as it would require the utilization of both emission reduction and ever-broadening sequestration practices to stay under the cap. "The allowance price would determine the supply and type of offsets that would be economically competitive

20. Gary Gero, President, California Climate Action Registry, Testimony before the House Energy and Commerce Comm., Subcomm. on Energy and Env't, 2 (Mar. 5, 2009).

21. NAT'L COMMISSION ON ENERGY POLICY (NCEP) FOR THE BIPARTISAN POLICY CENTER, FORGING THE CLIMATE CONSENSUS: DOMESTIC AND INTERNATIONAL OFFSETS 4 (Sept. 2009).

22. *Id*.

23. JONATHAN L. RAMSEUR, THE ROLE OF OFFSETS IN A GREENHOUSE GAS EMISSIONS CAP-AND-TRADE PROGRAM: POTENTIAL BENEFITS AND CONCERNS 9, Cong. Research Serv. (Apr. 4, 2008) [hereinafter *Role of Offsets*].

in a cap-and-trade system. As price increases, more (and different types of) projects would become cost-effective."[24]

If an emitter is given the option of both cutting emissions and sequestering carbon to get under this tight cap, every method will be used, starting with those most economically feasible. Even if the cap is not overtly restrictive at the onset of the cap-and-trade program, for example, as a means to limit initial costs, a program containing a rapidly tightening cap would allow additional types of offsets to become economically viable as the program progressed, even replacing previous offset methods. "At certain price levels, one mitigation activity may replace another." For example, soil sequestration, the least expensive, might be replaced by afforestation (replanting of trees), which in turn could be shifted to wetland enhancement, considered one of the more expensive sequestration methods.[25] "Offsets increase emission reduction opportunities. When offsets are not allowed, incentives to reduce emissions or sequester carbon are limited to the covered sources and there is little motivation to improve mitigation technologies for non-covered sources."[26] Further, biosequestration has benefits not seen by other offsets or by emission reduction alone: "[t]he multiple benefits of such investments range from improved lives and livelihoods, employment in areas such as conservation, management, monitoring and rehabilitation alongside reversing the rate of loss of biodiversity and improved water supplies up to the stabilization of precious soils."[27] A successful atmospheric carbon program will include an offset program that offers a wide range of biological sequestration options in addition to emission source reduction.[28]

Subsequent to the debate of whether or not any type of offset program should be included in a cap-and-trade strategy, is the question of what, exactly, is considered a viable offset? Although the definitions of offsets vary slightly, the U.S. Government Accountability Office states: "[a] carbon offset can be defined as a measurable reduction of greenhouse gas emissions from an activity or project in one location that is used to compensate for emissions occurring elsewhere."[29] However, many experts have difficulty defining exactly what constitutes an offset in terms of policy usage, as ". . . the concept of a carbon offset is complicated because offsets can involve different activities, definitions, greenhouse gases, and timeframes for measurement."[30] But, an expansive definition is any project or activity that reduces greenhouse gas emissions by a means not covered by a cap-and-trade policy:

> [s]pecifically, carbon offsets can result from three broad types of activities: (1) reductions in greenhouse gases, which may include activities such as the capture of

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24. JONATHAN L. RAMSEUR, POTENTIAL OFFSET SUPPLY IN A CAP-AND-TRADE PROGRAM, at Summary, Cong. Research Serv. (Oct. 14, 2008).

25. *Id.* at 4.

26. *Role of Offsets*, *supra* note 23, at 3.

27. TRUMPER, *supra* note 2, at 4.

28. *Id*. at 13.

29. JOHN B. STEPHENSON ET AL., CARBON OFFSETS: THE U.S. VOLUNTARY MARKET IS GROWING, BUT QUALITY ASSURANCE POSES CHALLENGES FOR MARKET PARTICIPANTS 1 U.S. GOV'T ACCOUNTABILITY OFFICE (2008).

30. Statement of John Stephenson, Director, Gov't Accountability Office, *Climate Change: Observations on the Potential Role of Carbon Offsets in Climate Legislation: Hearing Before the Subcomm. on Energy and Environment of the H. Comm. on Energy and Commerce*, 110th Cong. 3 (2009).

> methane from landfills and coalmines, (2) avoidance of greenhouse gases, which may include activities such as the development of renewable energy infrastructure, and (3) sequestration, which may involve storing carbon dioxide in geologic formations or planting trees that take carbon dioxide out of the atmosphere.[31]

But, of the three methods, biological sequestration can be implemented the most rapidly largely due to its technological simplicity.[32] Further, in many regards, it is the most inexpensive means to reduce carbon already in the atmosphere, if a broad array of biological sequestration offsets, namely protection and rehabilitation of specific acres of ecosystems, are utilized.[33]

By incorporating a large pool of potential biological sequestration offsets, emitters will naturally gravitate towards the least expensive of these three offset methods in an effort to reduce the greatest amount of atmospheric carbon at the lowest cost. "Carbon offsets are a potentially attractive option for those interested in addressing concerns about climate change because they can offer a potentially low-cost and convenient means of reducing, avoiding, or sequestering greenhouse gas emissions relative to other options . . . ."[34] An overall definition of offset by the Congressional Research Service opens other avenues that some critics ignore: "[a]n offset is a measurable reduction, avoidance, or sequestration of [greenhouse gas] emissions from a source not covered by an emission reduction program."[35] In this, a 'source' could be an ecosystem that would be left unprotected if not for an offset program, and 'avoidance' could be adopted as protection of those same ecosystems that would release their carbon stocks (becoming emission sources) if not preserved under a federal program.

IV. SPECIFIC CONCERNS REGARDING AN OFFSET PROGRAM

Within the broad question of whether or not an offset program will undermine the environmental integrity of a cap-and-trade program, there are specific concerns about the implementation of an offset program and its effectiveness; principally, will it have an added benefit and can these benefits be confirmed and quantified?[36] "Although definitions differ, our review of literature and discussions with stakeholders identified four general criteria for credible offsets: [t]hey must be additional, quantifiable, real, and permanent."[37] Phrased differently, and more specific to biological sequestration: is the offset additional, permanent, verifiable, and measurable?[38]

The first, and possibly the most contentious, is the concept of 'additionality,' a term that questions whether or not the sequestration would occur in the absence of an offset program, and essentially occur as an indirect benefit of another federal program.[39] However, undercutting this question, while one can certainly argue that protection of an ecosystem from destruction is real,

31. *Id.*

32. *Role of Offsets*, *supra* note 23, at 9-12.

33. *Id.* at 5, 12.

34. STEPHENSON, *supra* note 29, at 1.

35. *Role of Offsets*, *supra* note 23, at Summary.

36. STEPHENSON, *supra* note 29, at Summary.

37. *Id.* at 2.

38. *Id.* at 2-3.

39. ANJA KOLLMUSS ET AL., MAKING SENSE OF THE VOLUNTARY CARBON MARKET: A COMPARISON ON CARBON OFFSET STANDARDS 15 Stockholm Envtl. Inst. – Tricorona (2008).

quantifiable and helps ensure permanence – is protection of that ecosystem 'additional' atmospheric carbon reduction, as it is not now, but could potentially become, a carbon source? A broad sequestration program that encourages protection and restoration of a wide array of ecosystems will limit additionality. Under a broad program, participants will gravitate towards more expensive sequestration projects to earn more credits for their actions.[40] Coupled with this, and arguably a more important issue, is the concern of permanence, or the assurance that the carbon sink will be protected, and store carbon, in the long-term.[41] Permanence can be strengthened through several means, including the establishment of persistent conservation easements for long-term protection, the creation of an insurance 'pool' to reduce integrity impacts, and enrolling current federal conservation programs into an offset program as a means to recognize their carbon storage potential.[42] For biological sequestration, additionality is often the most contentious, and hotly debated, point, but permanence is more important to the overall success of any offset sequestration program.

Interrelated with the above issues, is the concept of 'leakage,' which occurs when a sequestration project causes specific economic activities, such as farming or timber harvest, to shift to another location, thereby undermining the environmental integrity of the offset program.[43] To counter this, while some argue that a carbon cap should simply be tightened to accommodate for leakage, another method to diminish the effects is to award only a percentage of credits per ton of carbon sequestered, thereby incrementally blunting the impact of leakage.[44] The two other issues, measurement and verification, are not as closely related as the previous concerns, but are nonetheless important. Verification involves assurance that the offset is quantifiable and real, or that the offset indeed exists, is storing carbon, and is worthy of tradable credits. Current federal pollution control statutes offer a template for an offset program, in which the federal government would set program guidelines and standards, then delegate authority to the states to verify, implement, and enforce the program. The final concern discussed in this article is measurement, or the specific quantification of how much carbon is sequestered by an acre of a specific ecosystem type, and, therefore, how many credits should be issued per sequestration project. While all of these concerns cannot be completely alleviated, they must be addressed to protect the integrity of the program.

A. Additionality

'Additionality' and its potential impact on the integrity of an offset program is the concern that receives the most attention. Essentially, the notion of additionality in carbon sequestration questions whether or not the carbon

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40. *Role of Offsets*, *supra* note 23, at 18.

41. Greg Marland et al., *Accounting for Sequestered Carbon: The Question of Permanence*, 4 ENVIRON. SCI. POLICY 259, 260-263 (2001).

42. PEW CTR. ON GLOBAL CLIMATE CHANGE, CONGRESSIONAL POLICY BRIEF: GREENHOUSE GAS OFFSETS IN A DOMESTIC CAP-AND TRADE PROGRAM 2-4 (2008); *see also* JUSTIN S. BAKER & CHRISTOPHER S. GALIK, POLICY OPTIONS FOR THE CONSERVATION RESERVE PROGRAMS IN A LOW-CARBON ECONOMY 18-21 Climate Change Policy P'ship, Duke University (Working Paper 2009).

43. *Role of Offsets*, *supra* note 23, at 21.

44. W. AARON JENKINS ET AL., ADDRESSING LEAKAGE IN A GREENHOUSE GAS MITIGATION OFFSETS PROGRAM FOR FORESTRY AND AGRICULTURE 6-8 Duke Univ. (2009).

reductions would have occurred without the influence of, or in absence of, a carbon sequestration program: ". . . a test of additionality would examine whether the offset project would have gone forward in the absence of the program."[45] The issue has slightly different meanings to different critics, thus its subjectivity, but overall, 'additionality' means more than is currently, even if indirectly, accomplished by other conservation programs. Further, experts are divided on how to determine additionality in general: "[t]here is no correct technique for determining additionality because it requires comparison of expected reductions against a projected business-as-usual emissions baseline. Determining additionality is inherently uncertain because it may not be possible to know what would have happened in the future had the projects not been undertaken."[46] For example, is it required under or as a result of another statute? Or, would the project have been profitable if not for the offset program? "There are many ways to estimate whether projects are additional, and many stakeholders said that applying a single test is too simplistic because every project is different from others and operates under different circumstances."[47] While this is difficult to determine, particularly for biological sequestration offsets, overall, the most logical test of additionality would be a determination of whether the project somehow enhances the cap-and-trade program and reduces atmospheric carbon in its own right. Because of this, offsets cannot be retroactive and credit given for past actions, an element that has been introduced in some current Congressional proposals. However, credit should be given for ecosystem protection and ensuring that current sinks do not become future sources due to a change of land use. For example, it would be counterproductive to give credit for a wetland that has been protected in the past without assurances that it would not be farmed under in the future.

As additionality is hard to define, let alone quantify, it is therefore a concept that is much more difficult to include in the debate – how does one exclude a project that cannot be accurately identified as additional? In a similar vein, how can such a project be excluded from an offset program when it is unknown if it will or will not occur in the future? "Ultimately, there is no perfect test for additionality and no perfect compromise between program rigor and environmental certainty on the one hand, and maximum cost-reduction and administrative simplicity on the other hand."[48] In some ways, the debate concerning additionality distracts from the purpose of an offset program, to reduce carbon, and, just as importantly, to prevent more carbon from entering the atmosphere. The benefits of sequestration are oversimplified by arguing whether or not a proposed sequestration project would have 'occurred anyway'. Whether or not the project would have occurred in the future is subjective, and in some cases probably could never be determined, but the benefit of carbon sequestration and storage is more concrete. For example, it could probably never be known whether or not a farmer would engage in soil sequestration techniques without a program, or whether a forest would be replanted, or whether a wetland would be plowed under for a housing development. In these cases, protection of

45. *Role of Offsets*, *supra* note 23, at 18.

46. STEPHENSON, *supra* note 29, at 6-7.

47. *Id.* at 7.

48. NCEP, *supra* note 21, at 6.

an ecosystem is just as important as the establishment of a new acre of ecosystem.

To counter concerns of additionality, a broad offset program under a tight cap that includes the protection and the restoration of natural ecosystems will minimize issues of additionality in that a larger scale program will ensure that more expensive offsets, such as the ecosystem rehabilitation of wetlands and forests from fallow farmland, are utilized. If an offset program is too narrow and limited in scope, it will be much more difficult to determine whether or not a particular project is additional and deserves emission reduction credits or if it would have occurred in the absence of such a program:

> [i]n some cases, numerical limits, because they will tend to favor those projects with the lowest costs, can even make things worse because non-additional projects will by definition have extremely low costs since they would have happened even in the absence of the program. At best, numeric and percentage caps on the use of offsets limit the damage that they can do to an overall climate policy and tend to encourage abatement within capped sectors. However, these limits are extremely problematic if offsets are also relied upon as the major source of cost-control for a cap-and-trade regime.[49]

If the number of biological sequestration offsets allowed in a cap-and-trade program is limited, participants will naturally gravitate to less expensive sequestration practices, such as soil conservation, which have a much higher likelihood of occurring in the absence of such a program.[50] However, a broad program under a tight cap will encourage more expensive sequestration projects, such as wetland restoration, that would have a much less chance of occurring in the absence of an offset program.[51] Overall, the lower the implementation cost of the sequestration project, the higher likelihood of additionality as the project may have occurred anyway in the absence of a credit incentive. Setting a limit on types of sequestration offsets is counterproductive as it increases additionality, while a broad program under a tight cap reduces additionality. While one could never be absolutely sure that a project is additional, the chance is much lower and the integrity of such a program gets a higher degree of protection.

Extending this, as a means to further mute the issue of additionality, current federal conservation programs should be enrolled under one authority, and, in a reversal of current policy, carbon sequestration and storage recognized as the primary purpose of these conservation programs, while habitat protection viewed as a secondary (although important) benefit. There are current federal programs that have the added benefit of carbon reduction and storage, many of them administered by the U.S. Department of Agriculture (USDA),[52] but most have significant shortcomings primarily due to the limited duration of the contract between the landowner and the federal agency and the latter's susceptibility to political pressure. However, as carbon sequestration is not the main purpose of these programs, there are no safeguards to ensure permanence. If these purposes are reversed, with carbon storage becoming the primary goal and habitat

49. MICHAEL W. WARA & DAVID G. VICTOR, A REALISTIC POLICY ON INTERNATIONAL CARBON OFFSETS 20 Stanford Univ. (2008).

50. STEPHENSON, *supra* note 29, at 33-34.

51. NCEP, *supra* note 21, at 6-7.

52. STEPHENSON, *supra* note 29, at 19-20.

conservation as the secondary benefit, issues of additionality from these programs become muted. This role reversal would couple additionality with the more important issue of permanence, which is expanded upon further in this article.

B. Leakage

The concept of 'leakage' is another issue often cited by critics of a biological sequestration offset program for its potential to undermine the environmental integrity of an atmospheric carbon reduction strategy.[53] Leakage is also tied to concerns of permanence, particularly in terms of natural disasters, such as forest fires.[54] It occurs when an activity that releases carbon is halted in one place, but then commences at another location, resulting in the same overall carbon loss. Leakage "[o]ccurs when economic activity is shifted as a result of the emission control regulation and, as a result, emission abatement achieved in one location that is subject to emission control regulation is offset [in this case, diminished] by increased emissions in unregulated locations."[55] For example, in the case of biological sequestration, logging or crop planting ceases for the purpose of carbon sequestration in one location, but then grasslands are disturbed for new crops or a forest is destroyed for harvest in another location to make up for the economic shortfall. "The opportunity for leakage exists when an offset project decreases the supply of a good in one location, leading to greater production of the good somewhere else."[56] While leakage has the ability to diminish the role of biological sequestration as a means to reduce atmospheric carbon, it must be acknowledged that market forces will respond to the limiting of certain goods as a result of increased sequestration, thereby increasing the price of those goods, which cyclically could lead to an increase in leakage due to the loss of more ecosystems.

As with additionality, there is very little way to know for sure that farming or a timber harvest at a certain location is actually due to a lack of those activities for sequestration purposes somewhere else. Further, commodities are needed in a healthy economy – food must be grown and structures must be built. For this reason, one could argue for acceptance of the fact that leakage will occur, that farming, timber harvest, and other activities will, and to a degree, must occur and, therefore, the national cap-and-trade strategy must be adjusted to accommodate this reality. By tightening the cap to adjust for carbon emissions due to leakage, argumentatively, atmospheric carbon reduction goals will be met (i.e. instead of a fifty percent reduction by a certain year, make the goal fifty-one percent by that year to counter inevitable leakage, thereby reaching the original reduction goal). But, this logic is somewhat circular and, instead, more concrete efforts should be made to counter leakage.

A better way to mute, if not completely eliminate, leakage would be through the credit system. While the total amount of leakage will never be

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53. *Id.* at 35.

54. *Id.* at 29.

55. U.S. ENVTL. PROT. AGENCY, TOOLS OF THE TRADE: A GUIDE TO DESIGNING AND OPERATING A CAP AND TRADE PROGRAM FOR POLLUTION CONTROL GLOSSARY-3 Office of Air and Radiation (2003) [hereinafter *Tools of the Trade*].

56. *Role of Offsets*, *supra* note 23, at 21.

completely, accurately, known, it is possible to estimate the amount of leakage within certain types of offsets, such as timber harvest, as the total amount of board feet cut annually could be successfully estimated.[57] With this, the value of a single carbon credit could be adjusted based on this projected leakage. In other words, a ton of atmospheric carbon that has been biologically sequestrated would be worth a percentage of a ton of emissions, instead of a one to one ratio. This would create a public pool to counter leakage. For example, if ten tons of carbon were sequestered annually by a specific project, say, seven credits would be issued, not ten credits. In order to ensure some degree of accuracy over a longer time period, the amount of credits would have to vary, as leakage itself would no doubt vary from year to year, simply, if for no other reason, due to commodity price fluctuations.[58] The exchange rate would have to be adjusted according to the leakage rate not only when credits are initially rewarded, but when they are renewed after a reasonable set time period, be it annually or every five years.[59] To further counter fluctuating commodity prices, this percentage basis for credits could be coupled with the practice of pricing credits for offsets to ensure that sequestration is economically competitive with the production of farm commodities, timber, and other goods.[60] While an approach such as this would not completely eliminate the negative effects of leakage has on overall carbon sequestration rates, it would mitigate the effects. This percentage "pool" also assists in the assurance of permanence of a project, as discussed below.

C. Permanence

Permanence is arguably the most important part of a sequestration offset program, because it where the integrity of the program is the most vulnerable, and the issue is considered the "most pertinent to biological sequestration projects,"[61] more-so than other types of offsets. Sequestered carbon that is naturally stored can be released through both human interference and natural causes: "biological sequestration faces implementation challenges, in part because it can be easily reversed by common natural disturbances, such as fires, or by changes in land use and management."[62] The impact of emission reductions on atmospheric carbon concentrations is indeed permanent, as the carbon was never initially released into the atmosphere. But, with sequestration and storage, the program is a failure if sequestered carbon is released into the atmosphere at a later date.[63] While one can skew the numbers somewhat by arguing that if some carbon is released decades, or even a century, into the life of the cap-and-trade program it will not have as great an impact because atmospheric carbon will have been substantially reduced by that time, this distorted logic misses the point – a biological sequestration program within a cap-and-trade carbon reduction strategy is only as strong as its permanence.

57. *Tools of the Trade*, *supra* note 55, at 2-7, 2-9 - 2-10.

58. *Id.* at 3-6, 3-14 - 3.16.

59. *Id.* at 3-14 - 3-16.

60. *Id.*

61. *Role of Offsets*, *supra* note 23, at 20.

62. *Carbon Sequestration*, *supra* note 7, at 2.

63. *Tools of the Trade*, *supra* note 55, at Glossary-3.

In terms of current conservation programs, the best way to ensure long-term permanence is to enroll current conservation programs into a cap-and-trade program, shifting all or a portion of these federal subsidy payments to credits.[64] In these current federal conservation programs, the initial purpose of habitat conservation will continue essentially as an indirect result of carbon sequestration and storage.[65] This would by no means be an easy bureaucratic transfer, as spending on conservation and land management programs across several federal agencies, including USDA, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service, and others, was $13.87 billion in fiscal year 2007.[66] Among the most prominent current federal programs are the Wetlands Reserve Program (WRP) and the Conservation Reserve Program (CRP), administered by USDA and authorized most recently in the Food, Conservation, and Energy Act of 2008, more commonly known as the "Farm Bill" reauthorization.[67] At issue, these conservation programs must compete for funding with other farm programs, such as commodity subsidies and biofuel incentives, and removal to a separate federal umbrella may abate these regular budgetary battles. Further, many conservation programs, particularly CRP, are vulnerable to simple market fluctuations, when the price of an acre of a certain crop promises more income than the money provided by the conservation program.[68] When crop prices increase, enrollment in these programs decreases as the crops became more profitable than the subsidy payments from the government.[69]

As an example of this, during its initial year in 1985, enrollment in the CRP was 45 million acres, but decreased to 36.4 million acres by 1996.[70] As of January 2010, the enrollment had dropped to 31.19 million acres, down 2.5 million acres from the previous year.[71] The average CRP payment is about $45 an acre for the general CRP program[72] and does not fluctuate to reflect the fair market value as compensation for the opportunity lost to growing and selling crops. The loss of acreage in conservation programs has had an impact on ecosystem protection, and concurrently, on carbon sequestration. In 2008, some conservation groups noted that increased market prices had a devastating effect on preservation programs authorized under the Farm Bill.[73] Due to political

64. BAKER AND GALIK, *supra* note 42, at 19-20.

65. *Id.* at 16.

66. U.S. DEP'T OF AGRIC., *BRIEFING ROOM – CONSERVATION POLICY: BACKGROUND*, http://www.ers.usda.gov/briefing/ConservationPolicy/background.htm (last visited March 11, 2010).

67. *Id.*; Royal C. Gardner, *Rehabilitating Nature: A Comparative Review of Legal Mechanisms That Encourage Wetland Restoration Efforts*, 52 CATH. U. L. REV. 574, 592 (2003).

68. BAKER AND GALIK, *supra* note 42, at 9-10.

69. *Id.*

70. TRISHA MCCLURE ET AL., USDA CONSERVATION PROGRAMS: STAKEHOLDER VIEWS ON PARTICIPATION AND COORDINATION TO BENEFIT THREATENED AND ENDANGERED SPECIES AND THEIR HABITAT 42 U.S. Gov't Accountability Office (2006).

71. U.S. Department of Agriculture, Farm Service Agency, Conservation Reserve Program, Status-January 31, 2010, http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rns-css (last visited March 11, 2010).

72. McClure, *supra* note 70, at 45.

73. Ducks Unlimited, *DU Says CRP Losses Astounding: National Trend for Habitat Loss Concerning* (Jan. 4, 2008), *available at* http://www.ducks.org/news/1456/ DUsaysCRPlossesastou.html.

pressure, the 2008 reauthorization of the bill cut key conservation programs.[74] "The conservation [group] Ducks Unlimited says it's as if someone plowed up a three-mile swath of wildlife habitat across North Dakota, from the its southern border to Canada."[75] In 2007, approximately 420,000 acres of the CRP were lost to cropland as landowners failed to renew their ten to fifteen year contracts with the program, instead plowing the land and planting more profitable crops due to a higher market price.[76] In terms of the overall future of USDA conservation programs, many have been cut. The 2002 Farm Bill authorized 250,000 acres annually in the WRP, but was cut to 153,000 acres in the 2008 reauthorization.[77] The CRP program was reduced by 7 million acres, with 31 million acres currently enrolled.[78] More importantly, the contracts on approximately 15 million acres are due to expire by 2011, almost half the program.[79] With so much research funding being authorized for climate change research, renewable energy projects, and geographic sequestration, it would seem illogical not to redirect some of this funding for long-term biological sequestration programs that ensure a reasonable rate of return per acre of land in a carbon market.

To further overcome political and market hurdles, these programs should be altered into a federal conservation easement policy, similar to those used at the local level to protect farmland from development, in order to ensure permanence. Essentially, easements are contractual obligations to abstain from private land use in specified ways in exchange for payment, often tax deductions. The land use restrictions can vary from contract to contract, even including a restrictive covenant that could limit any type of use of the property. With conservation easements, also known as perpetual conservation restrictions, the land protections run with the title of the land thereby passing the conservation obligation to successive owners. In terms of applying this to a sequestration program, instead of the short-term contracts that are the norm of current federal conservation programs, the sequestration projects, such as those enrolled in CRP or WRP, would run with the title of the land, even if ownership changes hands, ensuring that carbon storage will occur long-term. For example, the CRP, which pays farmers to idle acres as habitat for an average ten-year to fifteen-year contract, is popular when commodity prices are low. However, in 2007, farmers pressured the USDA and elected officials to break these contracts and put the acres back in production when corn prices were at a high. But, by late 2009, when prices settled, the USDA received a record number of applicants for the program. A program similar to conservation easements could potentially eliminate these commodity-influenced conservation fluctuations, but the allowance price per acre may have to be substantial to offset the fact that the land would be perpetually off-limits for any other use.

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74. Steve Adair & Neil Shader, *America's New Farm Bill: Changes to Farm Bill Programs Mean your Support for DU's Habitat Conservation Work is More Vital Than Ever* DUCKS UNLIMITED (2008), *available at* http://www.ducks.org/DU_Magazine/DUMagazineJulyAugust2008/3863/AmericasNewFarmBill.html.

75. DU – Losses Astounding, *supra* note 77, at 1.

76. *Id.*

77. DU – New Farm Bill, *supra* note 74, at 2.

78. *Id.*

79. *Id.*; Mike Checkett, Ducks Unlimited, *Blog: CRP Continues to Slip Away…* (Nov. 17, 2009), *available at* http://www.ducks.org/blogs/1/325/index.html.

Other conservation initiatives could also be folded into a biological sequestration program. As just one example of many potential such programs, the North American Wetlands Conservation Act of 1989 established public-private partnerships with over 4,000 participants and has protected 24.4 million acres of wetlands through the disbursement of $918.6 million in grants.[80] But, even this program does not ensure permanent protection. To ensure a greater degree of permanence, this program could be shifted to a biological sequestration program within a cap-and-trade strategy to ensure long-term protection of these wetlands, and the grants altered to allowance credits that could be sold.

In this vein, permanence is closely tied to, and must heavily rely upon, sound ecosystem management. While fraud or deliberate destruction of a sink enrolled in an offset program should be a punishable offense, it is safe to say that some natural disturbances, such forest fires, will never be completely abated. But the environment, natural, enhanced or rehabilitated, must be protected as a carbon sink. Such natural disturbances will occur, and certainly do today, but they must be minimized to ensure success of the program. "Although natural events (fires or pests) are hard to control, human activity can be constrained through legal documents, such as land easements."[81] Disturbances ranging from catastrophic wildfires that cause massive carbon loss to changes in land use through agriculture that cause much smaller releases all have varying impacts on a sequestration program and can be minimized through better management. The possibility of other disturbances can be diminished by program changes or contracts. Certain measures can be taken to insure carbon losses, and their impact on the integrity of the program, are minimized in the case of unintended events.

The Forest Project Protocol (FPP), implemented by the California Climate Action Reserve, offers a template for many aspects of a sequestration offset program, particularly in matters of permanence. Overall, the program

> provides project eligibility rules; methods to calculate a project's net effects on greenhouse gas (GHG) emissions and removals of CO_2 from the atmosphere ("removals"); procedures for assessing the risk that carbon sequestered by a project may be reversed . . .; and approaches for long term project monitoring and reporting.[82]

The FPP not only relies on perpetual conservation easements to ensure permanence, but establishes a "Buffer Pool" as a "Reserve" to insure against "unavoidable" carbon losses, namely natural disasters, such as forest fires, that are beyond the control of the program participant. Similar to the suggestions made to counter man-made leakage, sequestration participants must contribute a percentage of credits to the Buffer Pool to counter potential reversals, creating a system that essentially circulates fewer credits than are actually issued. The number of credits that must be contributed to the Pool is based on a formula that includes the risk of unavoidable reversal – the higher the risks, the more credits must be contributed to the Pool, thereby protecting the integrity of the system.

80. *Id*.

81. Scientists and Engineers for America, *Voluntary Carbon Offsets*, http://sharp.sefora.org/issues/voluntary-carbon-offsets/2/ (last visited Feb. 1, 2010).

82. CLIMATE ACTION RESERVE, FOREST PROJECT PROTOCOL, VERSION 3.0 (Sept. 1, 2009), *available at* http://www.climateactionreserve.org/wp-content/uploads/2009/03/Forest-Project-Protocol-Version-3.0.pdf.

"The Buffer Pool therefore acts as a general insurance mechanism against unavoidable reversals for all Forest Projects registered with the Reserve."[83] The Pool provides insurance of program integrity, as well as a more accurate accounting method: "[i]f a Forest Project experiences an unavoidable reversal of GHG [greenhouse gas] reductions and removals . . . the Reserve will retire a number of CRTs [Credit Reserve Tonne] from the Buffer Pool equal to the total amount of carbon that was reversed."[84] For a national sequestration program, such a Buffer Pool could be implemented at the federal level or by state agencies with similar results.

It cannot be overstated that in order to have a successful offset program, sinks need to be protected long-term so carbon is not gradually released into the atmosphere through man-made disturbances. If, for some reason, these sinks are destroyed and altered for another use, the entire cap-and-trade program would be compromised. With this, carbon sinks would have to be protected in the long-term to ensure a participant does not violate the program, thereby protecting the valuable wildlife habitat and the environment, as well. It must be noted that this type of cap-and-trade would require verification of carbon sinks and monitoring to ensure that the program is being followed and the benefits are actually being realized.

D. Measurement

A more subtle concern of any biological sequestration program is how to measure the amount of carbon sequestered by a specific ecosystem. "Providing this assurance is inherently challenging because it involves measuring the reductions achieved through an offset project against a projected baseline of what would have occurred in its absence."[85] If this sequestered amount is unknown, it is difficult to accurately determine how much credit should be given for the specific sequestration activity without affecting the integrity of the offset program. If measurement is overly general, then the program is at risk of being compromised because it would never be known with any degree of certainty that reduction goals are actually being met. However, enough is known about the sequestration abilities of certain types of ecosystems to include biological sequestration offsets in a cap-and-trade program.

While some data on carbon sequestration amounts and rates by specific ecosystems is lacking, the generalities are known and the lack of specific data for some categories should not be a reason to dismiss biological sequestration offsets as a whole. Some specific sequestration rates by, for example, certain species of marsh grasses may be unknown, but information exists on the sequestration abilities of overall ecosystem types. Further, some sequestration rates by specific vegetative species are well known as more research has been conducted on these types, while more accurate study needs to be conducted on others.

> Carbon sequestration rates vary by tree species, soil type, regional climate, topography and management practice. In the U.S., fairly well-established values for carbon sequestration rates are available for most tree species. Soil carbon

83. *Id.* at 55.

84. *Id*.

85. STEPHENSON, *supra* note 29, at 2.

> sequestration rates vary by soil type and cropping practice and are less well documented but information and research in this area is growing rapidly.[86]

Currently, enough is known about the general rates of sequestration of ecosystem types for a broad biological sequestration program to be viably measured. As research advances and the data becomes more specific, the credit system could be refined to include rate of sequestration, as well as overall carbon tonnage.

Overall, more is known about the sequestration rates of forests and tree species than other types of ecosystems, one of the reasons they are advanced for sequestration potential in policy discussions. For example, in 2007, the net sequestration of the nation's forests was 809.6 million metric tons of atmospheric carbon annually.[87] Through methods such as the Forest and Agriculture Sector Optimization Model with Greenhouse Gases (FASOMGHG), it is known that afforestation alone accounts for 2.2 – 9.5 tons of CO_2 storage per acre per year.[88] Similarly, it is known that the conversion of cropland to grassland sequesters 0.9 – 1.9 tons of CO_2 per acre per year.[89] The variations in these rates are due to specific species, regions, management practices and other factors that can be applied to narrow the uncertainty of rate. Separate studies have concluded that the nation's 312,193 square kilometers of freshwater mineral wetlands sequester 9.4 million tons of carbon annually, a rate (through conversion by this author) of approximately 8.2 tons of carbon an acre.[90] As sequestration rates become more specifically known, credits awarded for a specific biological sequestration project can be adjusted as well.

Under a broad sequestration program, participants will have more choices as to which types of ecosystems to protect and restore. In order to maximize the amount of credits received per sequestration project, participants will revitalize and protect ecosystems that will offer the most credits per acre, namely the ecosystems that sequester carbon at the highest annual rate. Essentially, as carbon credits are issued for the total amount of carbon sequestered annually per project, in this case, by ecosystem acre, participants in a sequestration offset program will seek the highest rate of return on their ecosystem investment. More inexpensive sequestration practices, such as soil management, will have a smaller annual rate of return on credits than more expensive practices, such as wetland restoration, which will offer a vastly larger rate of return for credits. To maximize sequestration within a shorter time frame, instead of viewing natural carbon sinks as static acreage that stores carbon at the same rate regardless of ecosystem type, be they forests, oceans, grasslands, or wetlands, the rate of sequestration by a specific ecosystem type will be taken into account by offset participants. Under a broad sequestration program, participants will gravitate

86. U.S. Envt'l Prot. Agency, *Carbon Sequestration in Agriculture and Forestry*, http://www.epa.gov/sequestration/faq.html (last visited Feb. 1, 2010).

87. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, 7-14 Fed. Reg. 10,249 (March 10, 2009).

88. BRIAN C. MURRAY ET AL., GREENHOUSE GAS MITIGATION POTENTIAL IN U.S. FORESTRY AND AGRICULTURE, U.S. Envt'l Prot. Agency, Office of Atmospheric Programs 2-2 (November 2005), *available at* http://www.epa.gov/sequestration/pdf/ghg_part1.pdf.

89. *Id* at 2-3.

90. *SOCCR*, *supra* note 9, at 141.

towards ecosystem restoration and protection for those systems that sequester carbon more rapidly, as they will earn more credits annually.

Concentrating on this notion, wetlands as an ecosystem have a particularly high rate of carbon sequestration that cannot be ignored and must be utilized. If emitters can be induced to gravitate towards protection of ecosystems that store carbon at a higher rate, such as wetlands, sequestration will occur more promptly. As an example of the potential of this approach, consider the argument for including wetlands as carbon sinks when compared to more traditional carbon sinks, such as forests:

Currently, both international and U.S domestic policy discussions concerning the restoration of ecosystems as carbon sinks concentrate on forest ecosystems. Forest carbon management is the practice of specifically growing stands of trees, not just for harvest, but rather to trap and store carbon.[91] As the trees grow, they capture and store carbon, but upon maturity, the process slows and sequestration is diminished, thereby reducing their value as a dynamic sink as they age. Nevertheless, the forests of the United States absorb 269 Mt C annually, making them the largest terrestrial sink, even if they are not the most efficient sink in terms of carbon absorption rate.[92] In comparison, estuarine wetlands can sequester and store atmospheric carbon at a higher and more constant rate. In terms of sequestration, wetlands absorb carbon at nearly six times the rate per hectare than forests,[93] therefore

> [s]ome ecologists believe that wetlands can be managed as carbon sinks as part of a mitigative approach to climate change. Should this prove to be correct, then the argument for conserving wetlands and enhancing and sustaining their wide diversity of benefits can be bolstered by an entirely new set of ecological functions and values.[94]

While the specific sequestration ability of wetlands is still the subject of debate, the fact that they can store carbon more rapidly and to a greater degree than other ecosystems has been established. "The extent . . . to which a wetland contributes to carbon sequestration is the subject of ongoing research and depends on the type and characteristics of the wetland. Nevertheless, the carbon sequestration potential of wetlands offers an additional reason for their restoration."[95]

Wetlands, particularly estuarine wetlands, are valuable sinks because marsh grasses grow much more rapidly than trees, thus capturing more carbon at a faster rate than other sinks.

> Wetlands have the highest carbon density of all terrestrial ecosystems. . . . [Wetlands] are among the most productive ecosystems in the world, and have properties that reduce the rate of organic matter turnover. Hence, wetland ecosystems are characterized by the two primary factors controlling carbon

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91. Andrew Aulisi et al., *Trees in the Greenhouse: Why Climate Change is Transforming the Forest Products Business*, WORLD RESOURCES INSTITUTE, June 2008, at 43, *available at* http://pdf.wri.org/trees_in_the_greenhouse.pdf.

92. *SOCCR*, *supra* note 9, at 32.

93. *Id.* at 105.

94. WETLANDS INTERNATIONAL – AMERICAS, ET AL., WETLANDS AND CLIMATE CHANGE PHASE I: FEASIBILITY INVESTIGATION ON THE POTENTIAL FOR CREDITING WETLAND CONSERVATION AS CARBON SINKS 3 (March 31, 1999), *available at* http://www.iisd.org/wetlands/wtlnds_cc.pdf.

95. Gardner, *supra* note 67, at 586.

sequestration, high rates of organic matter input and reduced rates of decomposition.[96]

The water and sedimentation that characterize wetlands allow for this increased storage of carbon, trapping the carbon-rich grasses instead of releasing it back into the atmosphere through decomposition.

Wetlands, consisting of freshwater mineral-soil wetlands, peatlands, and estuarine wetlands (i.e. salt marshes), comprise the second largest natural carbon sink in North America and about forty percent of wetlands globally, currently storing 223 billion tons of carbon, which must be protected as a carbon reservoir.[97] Overall, wetlands only absorb 23 Mt C annually, or about one-tenth the amount that forests absorb, but three times as much as agricultural soils.[98] Despite this relatively small amount, one must consider that wetlands only make up 5.5% of the total landmass of the U.S., which is only forty-eight percent of the historic wetland total due to their destruction for other land uses, such as agriculture.[99] Domestically, wetlands hold thirty-five percent of the nation's total terrestrial carbon and their loss would significantly add to the amount of carbon currently in the atmosphere.[100] As a testament to the sequestration value of wetlands, despite covering only 5.5% of the nation, the total carbon stock, or amount of carbon stored, in wetlands is 64 billion tons, while forests store 67 billion tons.[101] All of these numbers aside, one simply has to consider the amount of coal resources in the nation to understand the implications of wetland protection to contain sequestered carbon.

Of all wetlands types, coastal marshes are the most valuable for carbon sequestration due to their high absorption rate. "Estuarine wetlands sequester carbon at a rate about ten times higher on an area basis than other wetland ecosystems due to high sedimentation rates, high soil carbon content and constant burial due to sea level rise."[102] In this, wetlands make a much more potent carbon sink than forests and must be utilized to the greatest extent possible. It is estimated "that estuarine wetlands currently sequester -10.2 Mt C per year" and, overall, wetlands have the potential to reduce atmospheric carbon by 49 Mt C per year.[103] This rate will increase if coastal and inland wetlands can be restored closer to their original numbers.

Further, while wetlands represent a smaller sink per acreage than other ecosystems, one must take into account the historic destruction of wetlands for other purposes, such as development and agriculture: "[h]istorically, the destruction of North American wetlands through land-use changes has reduced carbon storage in wetlands by 15 million tons of carbon per year, primarily

96. *Sinks Table Options Paper: Land-Use, Land-Use Change and Forestry in Canada and the Kyoto Protocol, National Climate Change Process*, ENVIRONMENT CANADA, Sept. 23, 1999, at 127.

97. *SOCCR*, *supra* note 9, at 139.

98. *Id.* at 32.

99. *Id.* at 140.

100. Jon Kusler, *Climate Change in Wetland Areas Part II: Carbon Cycle Implications*, ACCLIMATIONS - Newsletter of the U.S. National Assessment of the Potential Consequences of Climate Variability and Change July-August 1999 at 2, *available at* http://www.usgcrp.gov/usgcrp/Library/nationalassessment/newsletter/1999.08/Wet.html.

101. *SOCCR*, *supra* note 9, at 35.

102. *Id.* at 143.

103. *Id*.

through the oxidation of carbon in peatland soils as they are drained and a more general reduction in carbon uptake and storage capacity of wetlands converted to other land uses."[104] If restored on an appropriate scale, wetlands could be a potential large-scale sink due to a greater sequestration rate than other terrestrial sinks.

If one considers the breadth of this argument for a broad sequestration program as a means to encourage the protection and restoration of ecosystems that absorb carbon more rapidly to earn more annual credits, it could be a means for utilizing the rehabilitation of the natural environment to reduce atmospheric carbon at a faster rate.

E. Verification

Any sequestration offset program will be ineffective, and subject to massive fraud, unless an implementing federal agency can verify in a timely manner that the sequestration projects actually exist and are storing carbon. Indeed, a concern over international carbon sequestration is the lag time between application, verification, and issuance of credits due, in part, to a lack of credible verifying parties. Domestically, this can be corrected with the inclusion of state agencies. As with other successful environmental statutes, the implementing federal agency would set the parameters of an offset program, including the verification process, and require the states to manage the local aspects of the program. The federal agency would review scientific data, establish the guidelines and parameters of the program, namely what constitutes viable offsets and how much credit the sequestration by a specific ecosystem would receive, and then mandate that state agencies implement the program. Of course, as with similar environmental programs, adequate federal funding would be necessary. Like other federal pollution abatement programs, a sequestration offset program within a cap-and-trade strategy will not succeed without strong partnerships with state agencies. The Clean Air Act (CAA) and the Clean Water Act (CWA) are successful due to state participation and certain sections of the former provide a template for an offset program.

Elements of the CAA provide a guide for verification of offsets within a federal cap-and-trade program.[105] Overall, the CAA requires the federal government to set minimum national standards for air quality based on a scientifically established baseline to protect human health, but the Act defers compliance and enforcement authority to the states.[106] If a region, particularly more heavily populated areas, cannot comply with the national standards, or are in nonattainment, then the state must establish a specific pollution control program for the region so it may come into compliance with CAA standards.[107] Similarly, a national cap-and-trade program for atmospheric carbon reduction would require the federal government to designate the cap for carbon levels, and then enlist the states for verification, and if necessary, enforcement. In this case, nonattainment would translate into exceeding the set carbon emission cap, a status that could be confirmed through the use of the proposed national

104. *SOCCR*, *supra* note 9, at 139.

105. Clean Air Act, 42 U.S.C. § 85 (2006).

106. 42 U.S.C. § 7401 (2006); CAA § 101 and 42 U.S.C. § 7409 (2006); CAA § 109.

107. 42 U.S.C. §§ 7502 - 7503 (2006); CAA §§ 172 – 173.

greenhouse gas registry. Conversely, not only would state authorities verify emission reductions, but would also implement the biological sequestration offset program within the cap-and-trade policy to verify that the sequestration projects are real and qualify for credits to be traded in a carbon market.

A national cap-and-trade program to reduce atmospheric carbon would require carbon reductions to parallel with prior pollution abatement programs. In a similar vein, a state would implement a permit program to ensure its region, or state, is within the carbon cap. After the implementing federal agency sets the guidelines for a sequestration program, the states would become responsible for verification and enforcement. This would include a permit system that would provide for certification of sequestration projects as a condition before credits could be sold or traded to emitters. More specifically, the Nonattainment Area Permit Program contained in CAA §172 and its requirements under §173, offers an outline for a sequestration offset program.[108] Overall, the CAA requires the federal government to set limits on a pollutant and requires the states to ensure that these limits are reached within a certain region, part of which is accomplished through a permit program for potential, future stationary source polluters.[109] While this permit program within the CAA is a means by which to reduce urban pollution specifically when a pollution emitter wants to build a new emission facility, particularly a power plant to meet the energy needs of a growing urban community, portions of the permit process are relevant to a sequestration program. Elements of CAA §172 and §173 are applicable to a modern cap-and-trade program, including the so-called "growth allowance provision" under §173(a)(1), in which a state can require current pollution sources to reduce their emissions by a certain, but attainable, amount to allow for the construction of a new source.[110] To better ensure that pollution is reduced from within a nonattainment area, §173(c)(1) specifies that the offsets must come from within the region, and not, say, from another part of the state.[111] Further, in a requirement that hints at the concept of additionality, §173(c)(2) of the CAA prohibits the use of emission reductions that are already required by statute or regulation to satisfy the offset requirements.[112] With these measures, theoretically, even though there are now more emitters in one region, the area stays under its pollution "cap."

A problem with the initial permit program was that many areas didn't reach (and in some cases still have not reached, partly due to lengthy implementation extensions) their air pollution abatement goals. In an effort to remedy this, the permit system was strengthened by Title V of the 1990 Clean Air Act Amendments.[113] In enacting the measure, the United States Senate gave sound reasoning for Title V that has parallels for the implementation of a sequestration permit system, stating the measure would "(1) better enforce the requirements of the law by applying them more clearly to individual sources and allowing better tracking of compliance, and (2) provide an expedited process for implementing

108. *Id.*
109. *Id.*
110. *Id.*
111. *Id.*
112. *Id.*
113. 24 U.S.C. §§ 7661 – 1661f (2006); CAA §§ 501 – 507.

new control requirements. . ."[114] The major difference, of course, between a Title V permit and a proposed permit system for a sequestration program is that a Title V permit is required for "major stationary source[s]" of air pollution, while an offset permit would allow a carbon sequestration project credit to be sold in a carbon market. Yet, the Senate's intentions for Title V are analogous to the implementation of a biological sequestration program:

> "[f]inally, the permit program provides a ready vehicle for the states to assume responsibility for administration of significant parts of the air toxics program and the acid deposition program. States that are delegated responsibility for these programs will use the permit systems to administer them, with the resulting advantages of better enforcement and a means for EPA oversight."[115]

One could apply aspects of the compliance plans of Title V to a sequestration program, as well. Per CAA §503(1) and (2), an applicant submits a compliance plan ". . .describing how the source will comply with all applicable requirements" prior to permit approval.[116] If the permit is approved, periodic certification is required to ensure that the facility remains in compliance. These steps would prove useful to an implementing state agency to ensure that the sequestration projects are real and qualify for credits. Overall, the federal agency would set the parameters and guidelines for a sequestration program, and the states would be empowered to oversee daily management of verification and certification of individual offset projects. Those that wish to participate in the offset program and biologically sequester carbon would apply for permits with the state agency, which would then approve or reject the application based upon the criteria set by the EPA. If the application is approved, the party would then be able to receive a certain amount of credits for the verified offset and be qualified to sell those credits to a carbon emitter through an established market.

V. CONCLUSION

In conclusion, a multi-pronged strategy to reduce the effects and overall impact of climate change must be implemented – incorporating source reduction, as well as long-term and short-term biological and technological sequestration. It is unlikely that the effects of climate change can be completely avoided or reversed, but immediate steps must be taken to mitigate its effects. While cutting emissions is certainly important, immediate steps must be taken to reduce atmospheric carbon and back the planet away from a "tipping point" from which the worst effects of climate change may well be unstoppable. Biological sequestration through carbon sinks is one of the quickest and most inexpensive ways to accomplish this.

As with any aspect of an atmospheric carbon reduction strategy, a biological sequestration offset program does have some potential drawbacks, most prominently additionality and permanence. But, while the agency implementing such a program may not be able to eliminate these drawbacks, they can be muted and the program ensured a success. A broad program will help alleviate environmental integrity concerns by spreading sequestration to many participants and many types of ecosystems. Specifically, the incorporation

114. S. REP. NO. 101-228, at 3729 (1989).

115. *Id.* at 3731.

116. 42 U.S.C. § 7661b (2006).

of current conservation programs into a sequestration strategy, thereby making carbon reduction the primary purpose and habitat protection an indirect benefit, will reduce concerns of additionality as the programs will transparently be used to sequester carbon, as opposed to an incidental benefit. Further, the incorporation of the cornerstones of successful local conservation easement programs into a biological sequestration policy will assure a greater level of permanence. While it is true that more research is needed to more accurately quantify sequestration rates and assist in verification that reductions are occurring, enough generalities are known to launch a sequestration program and inclusion of the rate of sequestration by specific ecosystems should be acknowledged in credit allocation to ensure rapid atmospheric carbon removal. Overall, a biological sequestration program, similar to an overall cap-and-trade strategy, will never be perfect, nor all things to all people, but this is no reason not to use every available policy tool to reduce atmospheric carbon and mitigate the effects of climate change.