Tracking Our Footprint

A Greenhouse Gas Assessment for the National Audubon Society

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Executive Summary

Introduction

Over the past several decades, the world has experienced soaring concentrations of greenhouse gases (GHGs), which scientists predict will result in global temperature increases and unpredictable anomalies in climate patterns. The largest anthropogenic source of these emissions is from the combustion of fossil fuels such as oil, coal, and natural gas used in electricity generation, heating, and transportation (United Nations Environment Programme, 2007). Increasing rates of deforestation and other land-use changes diminish the Earth's natural ability to store GHGs and contribute to their rising concentrations. To slow further warming, scientists predict that overall emission levels must be curbed by at least forty percent worldwide (Den Elzen and Höhne, 2008). Today, the United States produces twenty percent of the world's total GHG emissions each year (Baumert, Herzog and Pershing, 2005). The National Audubon Society (Audubon) recognizes that the emissions it creates through its everyday operations are contributing to climate change, ultimately threatening the birds and wildlife it seeks to protect.

Audubon decided to take a proactive approach in quantifying its GHG emissions by enlisting us, graduate students from Columbia University, to conduct a GHG footprint assessment. The GHG footprint was determined by quantifying all GHGs emitted by the organization over the course of one year.

Assessment

The GHG assessment described in this report examines the organization's GHG emissions for 2008, measured in metric tons of carbon dioxide (CO_2) equivalents, in the following four categories: (1) Buildings (2) Transportation (3) Paper and (4) Landholdings. The purpose of this analysis is to establish a baseline so that Audubon can take measurable steps to reduce its emissions in the future and incorporate environmental sustainability more thoroughly into its management decisions and organizational culture.

Because the GHG emissions from each of these categories are unique, calculation methodologies were selected to calculate the emissions from each category. For emissions from buildings and transportation, we selected calculators developed by the World Resources Institute along with the World Business Council for Sustainable Development. For paper use, the Environmental Defense Fund's Paper Calculator was chosen, because it includes the entire lifecycle of paper, from tree harvest to disposal. Operational emissions on landholdings were assessed using the WRI calculator as well. For the carbon sequestration capacities of Audubon's landholdings, "look-up tables" from the US Department of Agriculture were adapted to account for Audubon's diverse landholdings.

Emissions from buildings comprise a significant portion of Audubon's overall GHG footprint. Audubon owns or leases 260 facilities that serve a variety of purposes including office space, nature centers, lodging and storage space.

Based on survey data, we calculated that Audubon consumed 3,334,112 kilowatt hours of electricity in its facilities in 2008, resulting in a total emission of 2,047 metric tons of CO_2 equivalents. On a per square foot basis, Audubon uses less energy than the average office space in the United States. Opportunities to further reduce its emissions include replacing inefficient equipment such as oil heating or HVAC systems with newer models or alternative technologies. Conducting an energy audit would identify and prioritize key areas for reducing energy use, tailored to each specific facility. Additionally, Audubon could increase its use of renewable energy as several locations have already done.

Audubon's transportation footprint encompasses daily commutes to work and business travel. While some employees telecommute or bike to work, the majority drive or take public transit. A total of 1,184,695 miles were traveled by respondents in 2008, and their aggregate GHG emissions for daily commutes totaled 400 metric tons of CO_2 equivalents. Employees also traveled a total of 1,182,085 miles for business travel, mostly in airplanes, resulting in a footprint of 273 metric tons of CO_2 equivalents.

Through extrapolation, the Audubon's total transportation footprint for all 700 employees in the organization was estimated at roughly 1,800 tons of CO_2 equivalents. Although Audubon and its employees are already working towards minimizing their commuting and business travel emissions, Audubon can incentivize zero-emissions commuting, such as biking and walking, and implement organization wide policies for business travel.

Through paper use in its fundraising and promotional mailings as well as its publication of *Audubon* magazine, Audubon emits 4,146 metric tons of CO_2 equivalents. Audubon has already made the decision to switch its magazine paper from 30% recycled content paper to 100% recycled, 90% post-consumer content paper. This will save 608 metric tons of CO_2 equivalents per year.

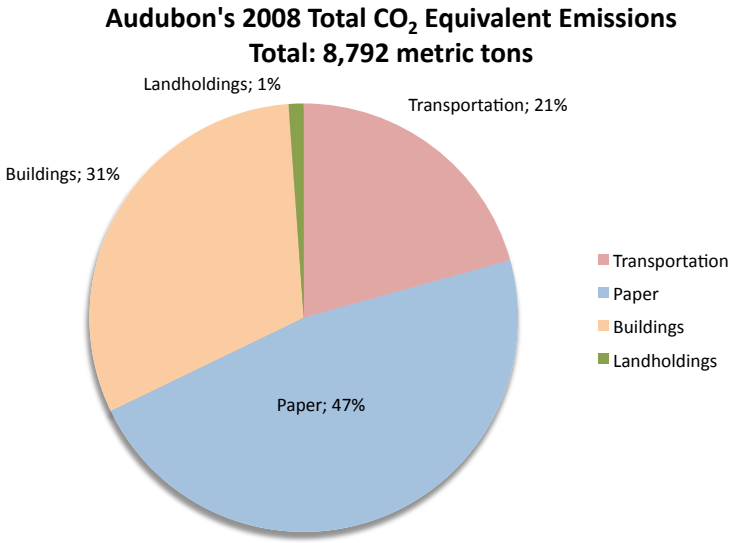
Unlike most organizations that only have GHG emissions associated with buildings, transportation, and paper use, Audubon also owns and manages extensive landholdings. In fact, it is second only to the United States Federal government in total area of conservation lands managed. Vegetation on its landholdings sequester CO_2 through photosynthesis as they grow. For example, one landholding in Mississippi sequesters 2,361 metric tons of CO_2 equivalents annually while only emitting 0.98 metric tons of CO_2 equivalents through vehicle use. The sequestration capacity of this single landholding is greater than emissions from all of Audubon's electricity usage nationwide. Another landholding in New York sequesters 2,001 metric tons of CO_2 equivalents annually and emits only 6.23 metric tons of CO_2 equivalents through vehicle use. This landholding alone more than offsets Audubon's entire transportation footprint.

These are just two of over ninety landholdings under Audubon's influence. This analysis demonstrates that Audubon's natural lands are more than habitats for birds – they are invaluable assets for combatting climate change. This finding can be used to educate Audubon's almost 800,000 annual visitors about the value of forests and the consequences of deforestation.

Conclusion

Overall, the quantitative results from surveys only tell part of Audubon's story (figure below). Interviews with employees nationwide provided examples of their individual environmental efforts. With a demonstrated eco-consciousness and enthusiasm, Audubon can share best practices to inspire and encourage people to positively contribute toward reducing emissions. Audubon and its stakeholders can use this GHG assessment as a tool to establish a baseline of emissions and continuously track the progress of emissions reductions efforts in the future. Easy-to-use calculators have also been developed so that Audubon can continue to count and track its GHG emissions, much like it has counted and tracked bird populations for the last one hundred years.

Audubon should develop educational materials focusing on its efforts to reduce GHG emissions. Informational posters could be displayed at each office and nature center, defining a GHG footprint and listing the GHG emissions for that location. Implementing these ideas institution-wide, in an organization that takes pride in being decentralized, will be no small task. Audubon has clearly demonstrated that it is capable and successful in implementing vast conservation projects. Audubon will need to build on its success at the project level and use this momentum to create institutional change in order to reduce its GHG emissions and truly align its operations with its mission.



INTRODUCTION

In the late nineteenth century, the North American feather trade was in its heyday as fashion trends turned to hats adorned with plumes, and sometimes even whole birds. The plumes, sourced from all over the country, threatened the survival of several bird species, especially the snowy egret. Recognizing this considerable problem, the National Audubon Society (Audubon) spoke out against this practice, and through a widespread letter-writing campaign, helped to pass the New York State Audubon Plumage Law (Graham, 1990). This law eradicated the plume trade and Audubon's efforts became a pioneering example for modern conservation campaigns. In the last half of the twentieth century, fashionable yet unsustainable energy and transportation practices have left the natural world threatened by climate change. Once again, Audubon is determined to create a positive environmental change.

In carrying out its mission, Audubon has recorded information about the migration of birds and other wildlife through yearly bird counts dating back to the late nineteenth century. Since that time, the Christmas Bird Count has been an annual tradition at Audubon and involves tens of thousands of volunteers documenting local bird populations during the months of December and January. Audubon's recent analysis of Christmas Bird Count data from the last forty years "Birds and Climate Change - Ecological Disruption in Motion" indicates that more than half of the 305 bird species in North America have migrated an average of thirty-five miles northward (Niven, Butcher, Bancroft, Monohan, Langham, 2009). During the same four decades, average January temperatures in the continental United States increased more than five degrees Fahrenheit, which has made northern latitudes more desirable to many bird species (National Audubon Society, 2005). These significant alterations in migration patterns not only demonstrate that climate change is a reality, but that birds and other wildlife are a bellwether for our rapidly changing climate.

Over the past twenty years, concentrations of heat-trapping greenhouse gases (GHGs) have rapidly increased, resulting in unforeseeable global temperature rises and anomalies in climate patterns (Kump, Kasting and Crane, 2003). The most prevalent GHGs - carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) - are emitted from both natural and anthropogenic activities. The combustion of fossil fuels such as oil, coal, and natural gas used in electricity generation, heating, and transportation, is the largest anthropogenic source of GHGs (United Nations Environment Programme, 2007). Additionally, deforestation and other land-use changes diminish the Earth's natural ability to store GHGs and contribute to their rising atmospheric concentrations. To prevent further climatic change, scientists warn that developed countries like the United States must reduce their emissions by twenty-five to forty percent (Den Elzen and Höhne, 2008). Today, the United States produces roughly one-fifth of the world's total GHG emissions each year. Individuals and organizations can help mitigate climate change by becoming more efficient and effective in their activities and energy use (United Nations Environment Programme, 2007).

In response to the threat that the effects of climate change pose to both the habitats and wildlife that Audubon seeks to protect, the organization has resolved to both assess and mitigate its own contribution to climate change. Building upon successes, like the construction of a U.S. Green Building Council "Leadership in Energy and Environmental Design (LEED) Platinum" certified headquarters in New York City Audubon is undergoing its first-ever GHG Assessment under the consultation of students from Columbia University's Masters in Public Administration in Environmental Science and Policy program.

A GHG footprint or assessment is a quantification of all GHGs from an organization's operations. We conducted a GHG assessment that evaluated the magnitude of Audubon's GHG emissions and sequestration. The first step towards reducing an organization's emissions is measuring the amount of GHGs emitted or removed from the atmosphere due to its activities during a specified period of time (Rich, 2008). The measurement of GHG emissions is often a difficult process because a large amount of data must be obtained and analyzed in order to develop a baseline. The process is further complicated by the abundance of interrelated methodologies and collection systems designed to record emissions data. Examples include:

- The GHG Protocol Corporate Accounting and Reporting Standard,
- The California Climate Action Registry's General Reporting Protocol,
- The Climate Registry's General Reporting Protocol, and
- The Environmental Protection Agency's (EPA) Climate Leaders Protocol, among others.

We conducted a GHG assessment, using existing protocols and methodologies for GHG accounting, as well as quantitative tools created by our team. The protocols and methodologies were developed by pioneer coalitions of businesses, government agencies and non-profit organizations seeking to document and reduce GHG emissions. As a result of their collaboration, numerous protocols have emerged, yet no official standard has been established (See box insert on page 12). Therefore, our team selected from the best available protocols and tailored the methodology to Audubon's unique organizational structure. In addition to providing a baseline, it could also serve as a benchmark that Audubon can use to measure its performance against similar organizations.

A separate calculator was used for each of four operational categories:

1) Buildings

2) Transportation

3) Paper

4) Landholdings

Since each operational category encompasses different types of activities ranging from fuel use to biological processes, unique methodologies for assessing their individual footprints were required. To perform calculations about the organization's emissions, employees at Audubon facilities across the United States were surveyed. The compiled data was then analyzed using appropriate calculators to determine Audubon's overall GHG footprint.

Based on the results, recommendations for each of these categories were prepared to enable Audubon to appropriately mitigate its GHG emissions. The GHG assessment process and mitigation strategies are critical first steps in Audubon's commitment to fully align its operations with its mission of conserving birds, wildlife, and their natural habitats in the twenty-first century.

It is our hope that these findings could be used to cultivate best practices for GHG assessments and inspire staff, volunteers, and other nonprofit organizations to take action and be accountable for emissions. By engaging in this process, Audubon is taking steps to decrease its emissions. The organization realizes the effects of climate change on the habitat of the birds it seeks to protect and hopes to initiate an organization wide process for continuous improvement.

Assessment Standards

In some cases, the method chosen to measure GHGs will influence the results of the assessment due to differences in underlying assumptions. As a result, there is a movement towards consolidating the various corporate and state coalitions into a single federal repository using a uniform methodology (Rich, 2008). The absence of an official standard, however, does not mean that the various protocols are dissimilar. In fact, many of them are adaptations of the highly regarded GHG Protocol Corporate Accounting and Reporting Standard, created by the World Resources Institute and the World Business Council for Sustainable Development in 2001. In fact, the standard has been widely cited as the basis for subsequent methodologies, including those used by the Environmental Protection Agency, International Standards Organization, and the Climate Registry. Despite its wide application, there is still no clear-cut model for performing a GHG Assessment for a non-profit organization like Audubon, which has a unique mix of facilities and landholdings across the United States...

Buildings

BUILDINGS

Audubon operates in more than 110 locations across the United States, comprising over 260 owned or leased buildings in thirty-one states. Functions range from management offices and nature centers to lodging and storage facilities, and most rely on GHG emitting energy to meet their heating, cooling, and electricity needs. The resulting GHG emissions are attributable to the organization's GHG footprint. Some of Audubon's newer buildings have been built with environmentally sustainable construction practices, while others are historic buildings, adobe brick structures, or even dairy barns. The individual GHG footprint of each facility varies based on the regionally-specific electricity profile. For example, a rural nature center with stand-alone buildings that purchases electricity produced from coal will have a greater GHG footprint than an urban office with LEED certification that purchases electricity produced from nuclear and wind power. By accounting for the diversity of facilities, the GHG footprint calculated for Audubon's buildings established a baseline of organizational energy usage from which reduction recommendations were developed.

To obtain the necessary data, a survey was distributed to building managers. This survey asked a range of questions about energy usage and requested copies of utility bills from 2008 (See Appendix 5 for a complete list of survey questions). Where primary data from utility bills was not available, assumptions were made based on survey responses regarding square footage and EPA region.

As opposed to heating where GHGs are emitted on site from fossil fuel combustion, Audubon's offices are not emitting GHGs on-site from electricity usage. However, these emissions must still be included in the Audubon's footprint as they are attributable to the organization's operations. Each of Audubon's facilities chooses heating fuel and purchases electricity from a local provider. Regional utility companies use a variety of fossil fuel combustion and renewable energy technologies for electricity generation. Sources of electricity generation range from coal and natural gas to nuclear and hydroelectric. States across the country generate electricity in different ways depending on the type of power plants and available resources in the region. Direct emissions from heating and indirect emissions from electricity are the two main categories of energy usage examined in this section.

Direct Emissions: Heating

In the United States, one-third of office buildings' energy usage comes from heating. The major fuel sources are steam, fuel oil, and natural gas (Figure 1). On average, heating costs of offices comprise eleven percent of their total energy bill (Figure 1). Consumers tend to have more control over what type of fuel they use to heat with than they have with what type of energy generates their electricity. This is important to note because the CO_2 emissions vary greatly depending on type of fuel used. The accessibility to types of fuel varies across the United States (Appendix 1, Figures 16-18). Also, in some cases a facility's heating may be included in their electricity usage instead of an outside source.

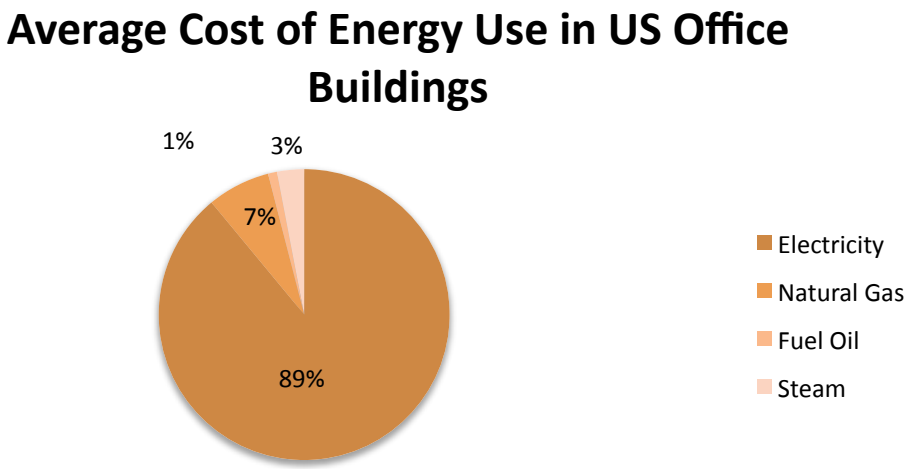


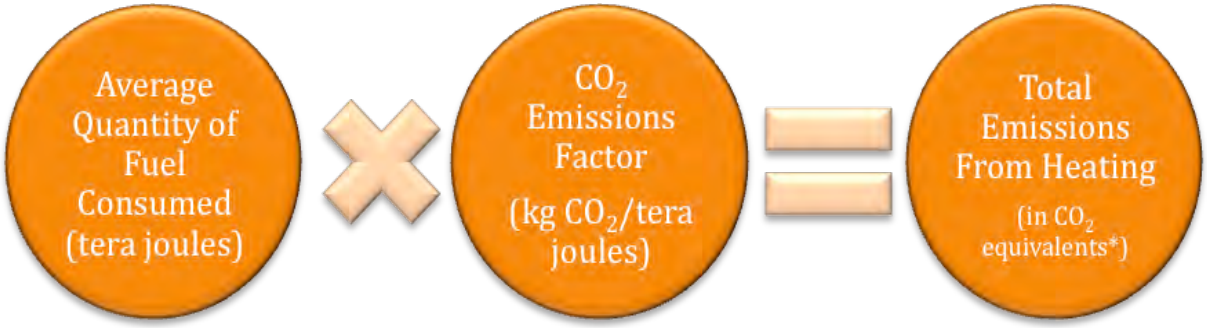
Figure 1. Average cost of energy use in office buildings in the United States (1995) (EIA), 2001b). Electricity comprises the majority of energy costs in office buildings, at about 89% across the US followed by natural gas, steam and fuel oil.

Methodology

Two pieces of information are necessary to calculate the quantity of CO_2 equivalents released through heating emissions: the type and quantity of fuel used. Often, this information can be gathered from utility bills. The most common forms of fuel types used to heat Audubon's offices are natural gas and fuel oil, according to our surveys.

The specific heating fuel type must be known, because emissions from fuel types drastically range in their emissions. For example, natural gas, which is often used to heat buildings, releases 64,200.00 kg GHG/TJ fuel, while residual fuel oil (#2 Fuel Oil) releases more than 77,400.00 kg GHG/TJ fuel. Table 6 (Appendix 1) shows a complete list of the emissions factors for various fuel sources.

Once the type and quantity of fuel consumed were known the number was multiplied by the CO_2 emissions factor specific to the type of fuel consumed. The Energy Information Administration (EIA) and the Department of Energy (DOE) have calculated standard emission factors which can be used to estimate the CO_2 emissions. This simple multiplication produced the CO_2 emissions equivalents from heating office space (Figure 2).



*In order to be consistent with the measures in the rest of the assessment, the result was divided by 1000 so the units would be in metric tons.

Figure 2. Calculation performed to arrive at total emissions from heating in metric tons of CO_2 based on average quantity of fuel consumed.

Results

Natural gas and residual fuel oil (#2 Fuel Oil) were the two types of heating fuel sources reported in the received surveys. Due to the lack of surveys received and the office's specific fuel type and quantity being necessary for calculation, a total CO_2 equivalents emissions amount from heating could not be calculated. Audubon should account for the CO_2 emissions released by the heating fuel it consumes. However, a recent report by the EIA and the DOE shows that heating does not account for a majority of the energy used by office spaces nationwide.

Three heating utility bills detailing the type and quantity of heating fuel consumed annually were received (Table 1). Two of the three locations use residual fuel oil to heat the office spaces and one office uses natural gas. Using the annual quantity of fuel consumed and the emissions factor the total emissions in CO_2 equivalents were calculated.

Audubon Location	Fuel Type	Emissions Factor	Quantity of Fuel Consumed (TJ)	Total Emissions of CO_2 Equivalent
Bent River Audubon Center	#2 Fuel Oil	77400 kg GHG/TJ	0.516	40.11
Constitution Marsh Sanctuary	#2 Fuel Oil	77400 kg GHG/TJ	0.119	9.22
Wyoming Audubon Center	Natural Gas	56100kg GHG/TJ	0.200	6.68

Table 1. List of facilities for which heating information was received, including type of fuel used, emissions factor, quantity of fuel consumed and total emissions of CO_2 equivalents. Of these locations, Bent River Audubon Center emitted the greatest quantity of CO_2 equivalent missions and also consumed the most fuel. Constitution Marsh Sanctuary ranked second in emissions. Though it consumed the least amount of fuel, it had a high emissions factor. Wyoming Audubon Center had the lowest quantity of emissions.

Indirect Emissions: Electricity

Each of Audubon's facilities purchase electricity from a local provider. Every state generates electricity in different ways depending on the resources in its region (Figure 3).

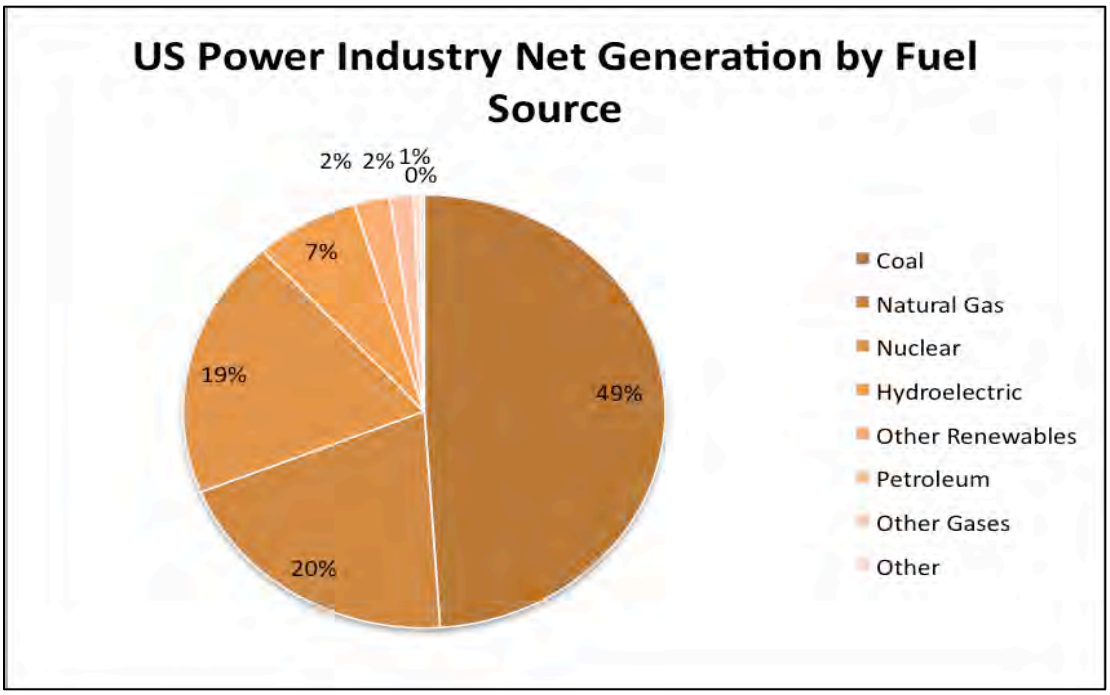


Figure 3: U.S. Electricity Power Industry Net Generation by Fuel Source in 2006. Coal is the major fuel source in the US, comprising 49% of US power industry's generation followed by Natural Gas (20%) Nuclear Power (19%) and Hydroelectric (7%) (EIA, 2009b).

The EIA and DOE have developed standard emissions factors that can be used to estimate the CO_2 emissions equivalents based on the amount of fuel used from electricity generation. A state's emissions factor is defined as the average amount of emissions produced when generating one kWh of electricity in that state and depends on the types of fuel used in that state (Appendix 1, Table 8). The emissions factors are used to convert the kilowatt hours (kWh) of electricity consumed into the amount of CO_2 equivalents released.

Methodology

The information required to calculate a facility's electricity footprint includes: (1) the total area of the building or office space, (2) the total area within that building (the square footage of the office space) used by Audubon, and (3) the total energy use of the building in kilowatt-hours (kWh). In situations where Audubon only takes up part of the entire building, it was critical to only use the square footage of the office space Audubon occupies. However, the square footages may be the same, if Audubon is the only tenant and thus, the only consumer of electricity reflected in the utility bill. The square footage of building and office spaces was collected from the surveys sent to administrators and the information about energy use was gathered from utility bills. If the actual electricity bills from a facility were available, the average annual electricity amount, in kWh, was summed and then multiplied by the appropriate CO_2 emissions factor to determine the total annual emissions from electricity for that specific facility (Figure 4). Ultimately, the data gathered from the surveys was used to determine the total number of CO_2 equivalents emitted based on the regional electricity profile.

In some instances not all twelve months of utility bills were available, so electricity use was averaged using data from the months received.

*In order to be consistent with the measures in the rest of the assessment, the result was divided by 1000 so the units would be in metric tons.

Figure 4. Calculation performed to find a facility's electricity footprint in metric tons of CO_2 equivalents based on square footage.

Calculation Methodology

Increased awareness and demand for sound environmental practices has spurred the development of numerous tools to measure and calculate GHG emissions. While these tools may serve to increase environmental awareness, there is wide variation among their methodologies. Some calculators are geared toward manufacturing organizations, others towards individuals, and a few towards office based organizations. The parameters included in these calculators vary widely. Also, many calculators are region specific and unable to account for electricity profiles that vary by location. All of these factors were considered when choosing the WRI methodology for calculating Audubon's footprint.

The World Resources Institute (WRI), an environmental think-tank, assists organizations and countries around the world in understanding humans' interaction with the environment, and it informs them about ways to make more environmentally conscious decisions. WRI helps companies understand their role in contributing to climate change, and then helps them develop and implement effective climate change mitigation strategies. Along with the World Business Council for Sustainable Development, a global association of over 200 companies, WRI developed the "The GHG Protocol: A Corporate Accounting and Reporting Standard" which provides principles and guidelines for an organization to account for its emissions. This protocol was created with the input of 350 experts from businesses, non-governmental organizations (NGOs), governments and accounting associations (Kirby, 2008). The GHG Protocol has provided or informed the accounting framework for nearly every organization-level GHG standard and program in the world, including the European Union Emissions Trading Scheme and California Climate Action Registry and the footprint reports for over one thousand corporations including Sony, General Electric, DuPont, and IKEA (Kirby, 2008).

The GHG Protocol identifies three principles that must underpin all aspects of GHG accounting and reporting: (1) relevance, (2) completeness, and (3) consistency. Relevance means that a GHG assessment must contain information that "users – both internal and external to the company – need for their decision making" (GHG Protocol Initiative, 2004). Completeness involves accounting for all emissions sources and activities within chosen operational and organizational boundaries. Finally, consistency is defined as "compiling the information in a manner that ensures that the aggregate information is consistent and comparable over time" (GHG Protocol Initiative, 2004). Transparency is an equally important component of a credible GHG calculator (Padgett, Steinmann, Clarke and Vandenbergh, 2008). Many calculators other than WRI were found to lack transparency as their methodologies were not fully explained. A 2008 study comparing ten carbon calculators from different organizations concluded that while many are still being developed to improve accuracy, they have been effective in offering educational opportunities for identifying areas of emissions reductions (Padgett, Steinmann, Clarke and Vandenbergh, 2008). These became the guiding principles in defining the scope and gathering relevant data for Audubon's GHG assessment.

Results

In total, utility bills from fourteen properties and twenty-eight facilities were received and entered into the calculator. This response totaled thirty percent, or 158,92 square feet, of Audubon's total 540,000 square feet of office space. These twenty-eight facilities consumed 1,097,655 kWh of electricity in 2008, which results in 627.94 metric tons of CO_2 equivalent emissions.

To better estimate the electricity consumption of the entire organization, electricity usage for the remaining eighty-two facilities was averaged based on trends from specific geographic locations. The quantity of electricity consumed by offices vary primarily according to location, season, and even throughout the course of a day. The data was broken into regions based on the Environmental Protection Agency's regional operation structure. (Appendix 1, Figure 13).

Based on these assumptions, the 2008 total consumption of electricity for Audubon was 3,334,112 kWh of electricity (277,843 kWh electricity per month). Using the region-specific carbon dioxide emissions factors, Audubon emitted a total of 2,046.81 metric tons of carbon dioxide equivalents in 2008. The standard error for the metric tons of CO_2 equivalents is 0.07 kWh per square foot. To estimate the total emissions for all of Audubon's facilities several assumptions were made. A list of these assumptions can be found in Appendix 1. It is important to note that since there were significant gaps in the data collected, recalculations could alter Audubon's electricity footprint.

Audubon averages 6.08 kWh/square foot electricity consumption across all facilities. This is significantly less than the average kWh per square foot usage for national office spaces, which is 18.9 kWh per square foot (EIA, 2001). The average kWh per square foot for office's nationwide is higher than the national average of all commercial buildings, which is 13.4 kWh per square foot (Figure 5).

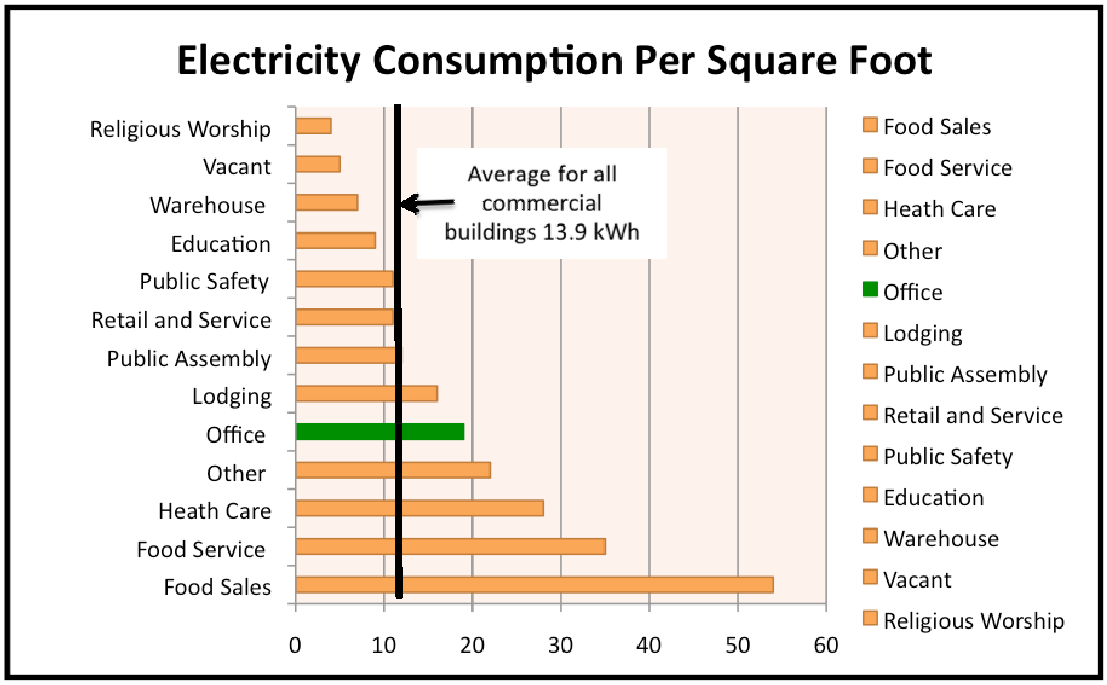


Figure 5: Average Electricity (kWh) Consumption per square foot. The average office space in the US consumes 18.9 kWh per square foot. Audubon's electricity consumption is below the average US office space (EIA, 2001).

Overall, Audubon consumes 12.82 kWh per square foot less than the average office space in the United States, and 7.32 kWh per square foot less than the average commercial building in the United States. It is important to mention that Audubon does have a number of facilities that are not used for an average forty-hour workweek, as were all buildings in the EIS statistics. In fact, some of Audubon's facilities are not even used year round. With this consideration, the average kWh usage for Audubon's office spaces could increase, bringing it closer to the national average.

Recommendations

Reducing GHG emissions from buildings will require direct involvement from all levels of the Audubon organization, ranging from facilities and operations staff to managers and employees. To begin, it is recommended that each office assign a lead staff member to coordinate and implement environmentally friendly procurement and other policies. Enacting conservation and efficiency policies at each facility can be cost-effective and free up funds to be allocated toward other mission related endeavors.

In order to move from project-based initiatives to long-term systemic changes that reduce GHG emissions, Audubon must begin measuring and reporting GHG emissions and develop a strategy to incorporate the reduction of emissions into both everyday and long-term decision making. The recommendations below provide a framework for making strategic decisions related to capital improvements and procurement of equipment. Additional recommendations provide specific examples of best practices.

In general, capital and procurement decisions should be lead by an informed management team in order to align Audubon's operations with its mission. As a practical matter it is recommended to start small and initiate simple actions to create momentum for change. Finally, all actions to reduce GHG emissions should be measured by simple collection of utility bills. Lessons learned from this process should be shared throughout the Audubon organization.

The recommendations are designed to help assist in three categories of decision making:

- general management and operations decisions
- large capital expenditures
- small capital and procurement decisions.

General Management and Operations Decisions

- Conduct an energy audit of all Audubon owned offices and nature centers. Audits should first occur at locations with the largest offices and with the most employees. Energy audits can reveal energy inefficiencies in buildings, information that is not provided by a simple utility bill. Audits can result in reduced energy costs by fifteen to thirty percent (Con Edison, 2009). The National Association of Energy Service Companies or local energy providers can recommend an energy efficiency expert to conduct an audit. The audit will provide managers with information on what activities will generate the greatest savings (The National Association of Energy Service Companies, 2009).

- Develop a maintenance schedule for energy intensive equipment to ensure that it is running efficiently.

- Consider purchasing renewable energy (if available) from a local energy provider. This would allow Audubon to support the expansion of renewable energy services and reduce GHG emissions simultaneously. Further, the use of renewable energy could be used to promote fund raising activities and educate local chapter members.

Large Capital Expenditures

The recommendations listed below have longer payback periods relative to shorter capital expenditures. These considerations are especially relevant when considering whether to purchase or lease new property.

- Replace heating, ventilating and air conditioning systems that are more than ten years old to reduce energy usage. Newer models use twenty percent less energy (The Natural Resources Defense Council (NRDC), 2009b). Installing more efficient HVAC equipment offers one of the greatest opportunities to reduce energy consumption and reduce GHG emissions (Enkvist, Naucier and Rosander, 2007).

- Improve building insulation to reduce heating and cooling loss and improve energy efficiency of heating and cooling equipment. Choose insulation with the highest possible R-value, which indicates the insulation's effectiveness in terms of thickness, material and density (USDOE, 2009b).

- Replace old, inefficient windows/doors to reduce heat and air conditioning leakage in buildings and reduce energy costs. New windows should be double/triple paned with a low-emittance or Low-E coating on the panes to reduce heat loss from within the building through the windows (Efficient Windows Collaborative, 2009).

- Install solar photovoltaics to help offset the electric usage with emissions free power during peak day time hours.

- Replace oil heating systems with natural gas if available. Natural gas produces less CO_2 than oil: 117,000 pounds of CO_2 per billion BTU of energy output versus 164,000 for oil (NaturalGas.org, 2009). Use the Department of Energy's Annual Fuel Utilization Efficiency guidelines to choose an efficient furnace. An efficiency of seventy-five percent is recommended (USDOE, 2009a).

Small Capital and Procurement Decisions

- Replace existing lighting with compact fluorescents for overall roomlighting. Lighting accounts for nineteen percent of the emissions associated with buildings in the US. This is one of the easiest and most cost-effective ways to abate GHG emissions. (Creyts, Derkac, Nyquist, Ostrowski, Stephenson, 2007). They use seventy-five percent less energy than traditional incandescent bulbs and they last about ten times as long (Energy Star, 2009b). Replacement can save seven percent of total energy usage as compared to traditional incandescent lighting (Energy Star, 2009b).

- Replace fluorescent tubes with T8 bulbs which are twenty percent more efficient than the traditional fluorescents. Upgrading the ballast to stabilize a fluorescent lamp's current in a circuit will also improve energy efficiency (U.S. Department of Energy, Federal Energy Management Program, 2009).

- Install motion sensors for hallways, restrooms, kitchens and common areas to remove the risk of forgetting to turn off lights.

- Install programmable thermostats that can be automatically turned off at night after the workday and on in the morning. It is recommended that a model be chosen with a manual override for those late workers or evening office gatherings.

- Lighten the color of the building and roof. Lighter colored roofs reduce roof temperature from 150-190 degrees to 100-120 degrees, reducing interior HVAC needs and therefore saving energy (California Energy Commission, 2009).

- Install ceiling fans for air circulation and reduction of heating/cooling demand. In the summer they should spin to draw hot air out of the room and in the winter should be reversed to move hot air downward (Energy Star, 2009a).

- Choose only Energy Star certified office equipment such as computers, printers, telephones and refrigerators. Energy Star office equipment is twenty-five percent more energy efficient than non-Energy Star office equipment (Energy Star, 2009d).

- Upgrade old water heaters by adding a tankless on demand system if appropriate. These systems remove the need to use electricity or gas to heat water when it is not in use. This is especially in offices where hot water is in low demand (Tankless Water Heaters Direct, 2009; Physorg.com, 2009).

Greenwich, Connecticut
Karen Dixon

When it came time to modernize the buildings at Greenwich Audubon, management decided that using green technology, renewable energy, and a sustainable infrastructure would be both a financially and environmentally sound investment. The Kimberlin Nature Education Center is a state-of-the-art building constructed sustainably on the inside and out. It features a geothermal heating system, is constructed from timber logged locally on the location grounds, and all of the carpets and curtains are made from one-hundred percent recycled materials.

Less than a decade after completion of the Center, Greenwich Audubon has already begun to realize financial savings from its original investment: the geothermal system has begun to pay for itself. Though investments were sourced from a capital campaign and support from the local community, the benefits are enjoyed by all who visit.

A display about the green features of the building educates visitors about the benefits of green technology, including a four-part "Green Home, Green Living" series that increases awareness of climate issues and conservation. Visitors have enthusiastically responded to the many education and outreach programs about green living and climate change.

Greenwich Audubon's success in reducing its GHG footprint and energy bills has inspired staff members and even the local community to understand how they can actually reduce their overall footprint. Audubon staff can often be found working in more dimly lit spaces in order to maximize reductions in electricity usage. Local businesses and homeowners in the region have visited the Center to learn about how they too can create greener buildings and implement better behavioral practices.

The current director, Karen Dixon, does not intend to put an end to the emissions reduction campaign quite yet. Future plans, if the funds can be raised, include implementing a solar power system to offset as much of the current electricity bill as possible. A solar power system would also serve as an excellent educational tool, because unlike the geothermal system, visitors would be able to see the renewable energy system. Other plans include retrofitting other buildings by installing window insulations and expanding green practices throughout the entire compound. Until she finds the capital to execute these projects, Dixon and Greenwich Audubon employees continue to highlight ways to address climate change with behavioral changes and inspire the surrounding community to more positively use nature's resources (K. Dixon, personal communication, April 7, 2009).

Strawberry Plains, Mississippi
Walter Hubbard

Mississippi Audubon received Strawberry Plains as a donation in 1998 and converted it from a cotton plantation into an Audubon compound that focuses on education about operating a natural habitat. The original gift included a herd of cows which Audubon could not tend to and buildings constructed in ways that would not meet Audubon's needs. After addressing these issues, managers began to transform Strawberry Plains into an Audubon landholding.

Strawberry Plains managers have taken climate change issues into account in their management decisions throughout the transformation process. Materials from the original buildings were reused in construction of new buildings, and some of the existing structures were retrofitted to create functional space rather than needlessly constructing new buildings.

Strawberry Plains is a leader in Mississippi in nature educational opportunities for the public. As issues of climate change pervade the national media, the staff is including topics such as the effects of climate change on the natural and native biota in community disucssions. Specifically, rising temperatures due to climate change can further the spread of invasive species that out-compete native species, decreasing the amount of hospitable habitat and food sources for the local bird populations that Audubon strives to protect. To address this issue, the natural development of Strawberry Plains' more than 2,400 acres is overseen by an ecologist.

Some areas are being maintained in a static phase of natural progression where managers are not allowing the natural transition from grasslands to forests to occur. Other areas are being left to their own to succeed naturally. Additionally, Strawberry Plains operates a native-plant nursery and sells non-invasive plants to the local community. They are expanding their influence by encouraging regional nurseries to stop growing and selling non-native species.

In terms of reducing their overall GHG footprint, Strawberry Plains' management team has undertaken direct and indirect measures. The entire location's staff attended a sustainability seminar hosted by the North West Earth Institute and from the knowledge they gained, they are currently devising a landholding-wide sustainability strategy. Although the strategy is still in its early stages, staff and visitors have largely been receptive to the implementation of a recycling program.

Energy-efficiency and GHG emissions reducing projects that the organization would like to undertake include:

- Purchasing a more efficient water heater and Energy Star appliances
- Weather stripping all buildings
- Replacing a gas-guzzling fleet of vehicles with hybrid cars
- Installing solar panels and geothermal heating

In the meantime, while Strawberry Plains seeks the means to implement these capital projects, it will be planting a no-till garden in the 2009 season to increase education about how to reduce the community's overall GHG footprint. The staff is doing whatever they can to do their part in addressing climate change, including bringing their own cloth bags to reuse when running errands at local stores (W. Hubbard, personal communication, April 2, 2009).

Strawberry Plains, Mississippi

Appleton-Whittell Research Ranch, Arizona
Linda Kennedy

Located in the semi-arid climate of Southeast Arizona, the Appleton-Whittell Research Ranch has a two-tier conservation approach, or ethic, that promotes both land stewardship and conservation activities. The Audubon staff takes these conservation ethics to heart, implementing activities to both reduce their GHG footprint and to educate others about ways to make living in their natural resource-sparse climate more sustainable.

The Ranch, unlike many Audubon Centers, does not actively entertain visitors but rather focuses on conducting scientific research. Currently, they are examining the phenology of local flora and fauna, impacts of invasive grassland species, and effective conservation practices for semi-arid regions. The Ranch does reach out to the local community by hosting social events and educational activities.

To create a sense of community and promote awareness of conservation and sustainability issues specific to the region, the staff hosts a monthly "Potluck and Presentation" event. Previous topics have included sustainable building, water harvesting and landscaping, bird and climate study, and local implications of climate change. While the events are popular, the waste is minimal since attendees bring their own china, silverware and food storage containers. Leftovers are composted and the only remaining waste is paper towels. However, this might change if people become receptive to drying their hands with reusable cotton towels.

Employees at the Ranch have taken an active role in educating the community about sustainability practices of living in this arid region. The Ranch's website, "Living Gently on the Land," keeps residents informed about how to effectively live in a natural resource-sparse ecosystem. The Ranch's director, Dr. Linda Kennedy, has authored a booklet for Santa Cruz County outlining valuable information for current and potential residents with information including where their water comes from, information about septic systems and the importance of fire control to the ecosystem.

To encourage the community to harness the rich wind and solar resources, the Ranch will sponsor the Renewable Energy Expo in May 2009 where seventeen vendors and speakers will discuss available technologies in renewable energy and how it could apply to rural homeowners versus homeowner's associations, as well as types of federal aid that might be available to help fund these projects. Audubon and local conservation committees intend to use federal grant money so that a minimum of twenty-five percent of local homes and businesses generate a portion of their own energy. Already, Office Manager Pat Kugler has installed a wind turbine to generate electricity at her own home and hopes to inspire others to do the same.

The Research Ranch hopes to one day become a self-sustaining energy operation. In a solar-rich and wind-intensive area, this is a realistic goal. Already, they have initiated intensive recycling programs, developed practical conservation plans, and employed sustainable living and working practices. The next step in addressing these conservation issues, according to Kennedy, would be to hire a full-time Conservation Coordinator who would devote half his or her time to working on conservation issues on the Ranch and half to developing educational programs on conservation issues, which inevitably include the discussion of human impacts on the climate. As with any well-intentioned project, this will require funding. In the mean time, Kennedy and Appleton-Whittel Research Ranch employees will continue their educational outreach, community involvement, and scientific pursuits to reduce their footprint and educate its community about renewable energy resources and sustainable living practices (L. Kennedy, Personal Communication, April 6, 2009).

Appleton-Whittell Research Ranch, Arizona

Transportation

TRANSPORTATION

In the twenty-first century, technological innovations make it easier to work from home instead of commuting to an office, or to conduct a conference call rather than scheduling a business trip. However, most job functions still require face-to-face meetings and trips to the office to maintain working relationships. Even though Audubon and some of its employees are making efforts to reduce emissions from transportation, GHG emissions associated with business travel and commuting are a significant component of Audubon's operations and its GHG footprint. Audubon must understand the amount and source of emissions resulting from employee commuting and business travel, in order to make informed decisions on how to decrease its overall transportation footprint.

Methodology

Calculators developed by WRI were selected to determine Audubon's emissions from transportation. A survey was created based on the information required by these calculators and distributed to each Audubon employee. Employees were asked to describe all of the work-related trips they took in 2008, including their daily commute and any business trips, in terms of transportation used and distance traveled (See Appendix 5 for a complete list of survey questions).

Each type of vehicle has a different emissions factor; they vary depending on transportation type (i.e. small car, bus, or train) and fuel type (i.e. natural gas, diesel or electric). Emissions factors were developed by various transportation agencies, including the Bureau of Transportation Statistics and the Department for Environment, Food and Rural Affairs (DEFRA) in the United Kingdom. Information was converted from employee survey responses to GHG emissions in CO_2 equivalents in metric tons, by multiplying specified emissions factors by the quantity of fuel consumed per trip. The total emissions associated with transportation were calculated by multiplying the quantity of fuel consumed by transportation used in commuting and on business trips, by the appropriate emissions factor (Figure 6). The result is Audubon's transportation GHG footprint in metric tons of CO_2 equivalents. Additional detail about these calculations can be found in Appendix 2, as well as details about the assumptions and limitations of these calculations.

*In order to be consistent with the measures in the rest of the assessment, the result was divided by 1000 so the units would be in metric tons.

Figure 6. Calculation to find annual total CO_2 equivalent missions from transportation based on annual quantity of fuel consumed.

Results

Survey responses were received from 256 Audubon employees from forty-two offices, representing forty-seven percent (47%) of Audubon's 685 employees. Combining both commuting and business travel these employees traveled a total of 2,366,780 miles and emitted 673 metric tons of CO_2 equivalents in 2008. Commuting accounts for fifty-nine percent (59%) of the emissions, while business travel accounts for the remaining forty-one percent (41%).

Commuting

Among survey respondents, the average daily commute in 2008 was 23.94 miles round trip as compared to the national average of 24.22 miles (Pisarski, 2006, p. 51). The total distance commuted by survey respondents was 1,184,695 miles.

The most common mode of transportation for Audubon commuters is the standard car accounting for eighty-five percent (85%) of miles commuted. The second most common mode of transportation for survey respondents was transit train representing six percent (6%) of miles commuted (Figure 7).

Jenny Vitale
Audubon Minnesota

Last spring when gas prices started to increase Jenny Vitale was driving a van. She decided it was unnecessary, and traded it in for a scooter for commuting in the warmer months and a car for when it is too cold to commute by scooter. She noticed "a lot of people in the area purchased scooters in the last year; there is an area for scooter parking in the local shopping area."

Vitale also thinks about other ways to reduce her driving time. "I have a family, with two kids, so on weekends it can feel like we are a taxi service. We do try to think about who needs to get where and what's the efficient way to get everyone everywhere they need to go to in the minimum number trips. One of my daughters plays soccer so I coordinated with other parents to set up a carpool." Vitale ensures that when she is driving she is maximizing efficiency by ensuring that she is driving only when it is necessary.

Vitale had a difficult time thinking of downsides but said, "sometimes I come to the office and it starts raining, but I have a short commute. On the upside, in addition to saving money the fun factor is through the roof; it's fun to do something that's not sitting in a car, [scooters are] just fun" (J. Vitale, personal communication, April 3, 2009).

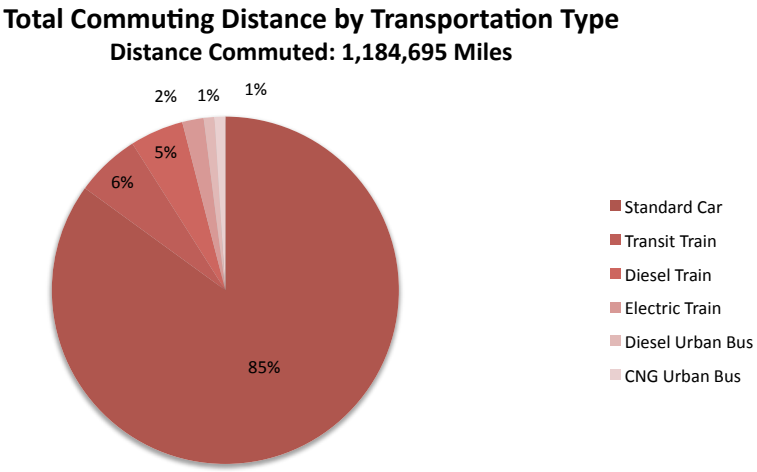


Figure 7. Commuting Distance by Transportation Type. Audubon employees reported that they commuted a total of 1,184,695 miles in the 2008 fiscal year. A majority of these miles (85%) were travelled by standard car. This was followed by Transit Train (6%), Diesel Train (5%) and Electric Train (2%).

The total amount of CO_2 emissions from commuting was 399.5 metric tons of CO_2 equivalents. Distribution of CO_2 emissions from each commuting category closely resembles the distribution for the distance traveled by Audubon employees. The standard car is the largest CO_2 emitter at eighty-six percent (86%) (343 metric tons) of total Audubon vehicle emissions during 2008. Transit train, which includes New York City subway, the Washington DC metro and San Francisco Bay Area Rapid Transit, is the second largest emitter at six percent (6%) (thirty metric tons), followed by diesel trains at four percent (4%) (seventeen metric tons) (Figure 8).

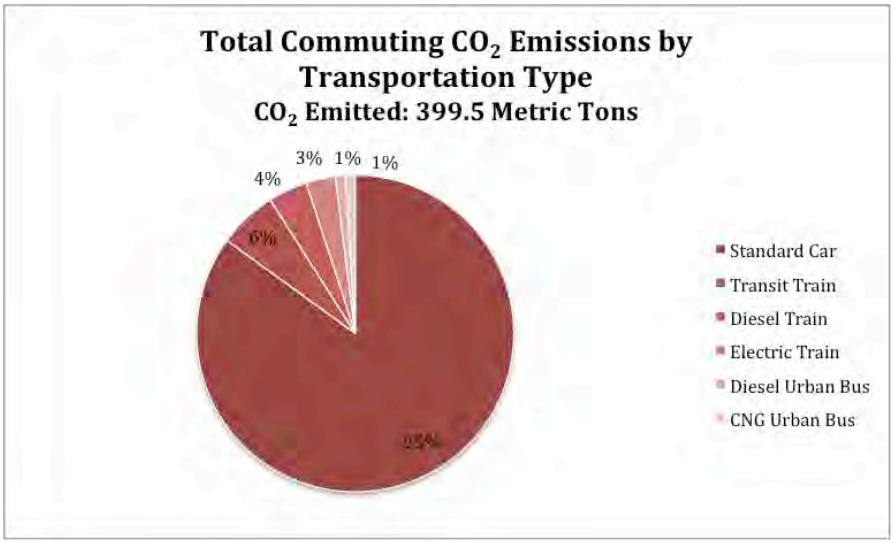


Figure 8. Commuting CO_2 emissions by Transportation Type. Based on the survey data, Audubon employees emitted 399.5 metric tons of CO_2 by commuting to work in the fiscal year 2008. A majority, (85%) were emitted by Standard Car. The remainder were emitted from public transportation.

Audubon survey respondents were less likely to commute alone than the average commuter according to the 2000 US census; sixty-three percent (63%) of Audubon respondents commuted alone as compared to 74.5% of US census respondents. Furthermore, a larger percentage of respondents use public transit: fifteen percent (15%) of Audubon survey respondents as compared to the national average of 4.58%. However, this percentage may be somewhat skewed as a high volume of survey respondents were from the New York City area, where employees have a larger variety of public transit options available to them compared to other areas of the country.

Ten percent (10%) of survey respondents walk to work, as compared to the national average of 2.93% according to the 2000 census. Zero emissions commuting also includes four percent (4%) of survey respondents who bike to work, as compared to .38% nationally, and six percent (6%) that work from home, as compared to 3.26% nationally.

Audubon employees may exceed national averages for zero-emissions commuting, because of greater awareness of about their GHG footprints and a desire to support Audubon's mission. Reasons for choosing zero-emission transportation were not specified in the survey, but may include factors such as proximity to the office, climate and weather variability, health consciousness, cost efficiency and decreasing one's environmental impact.

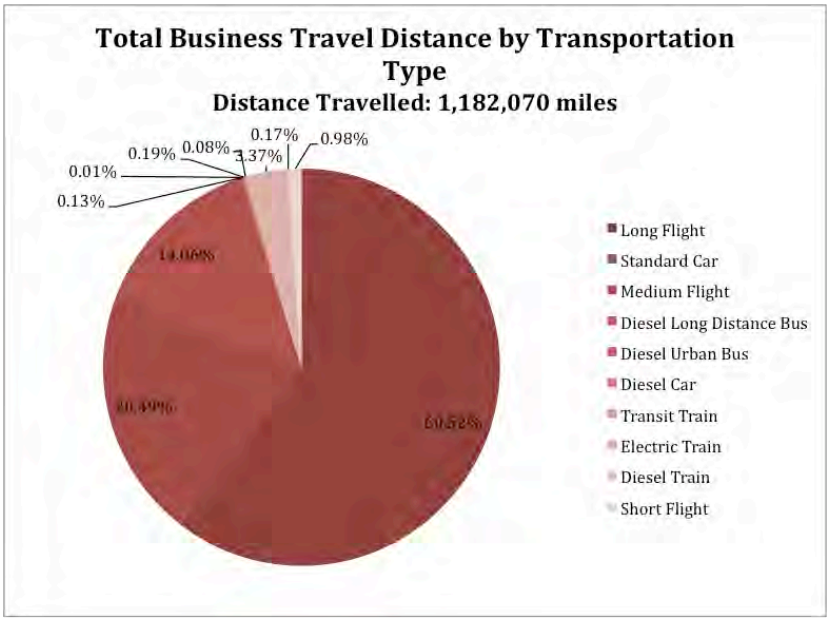


Figure 9. Business Travel Distance by Transportation Type. of the 1,182,070 reported miles travelled for business purposes, the majority were travelled in long flights (60.52%), followed by standard car (20.49%) and medium flights (14.06).

Business Travel

Nearly sixty percent of survey respondents took at least one business trip in 2008. Business travel ranged from a conference in Belize to meetings at neighboring Audubon facilities to trips to perform fieldwork in ecologically sensitive areas. The total number of miles travelled by survey respondents for business in 2008 was 1,182,085 miles. The mode of business travel with the most miles traveled was long-distance flights with sixty-one percent (61%) of the total, followed by standard cars at twenty-one percent and medium flights at fourteen percent (14%) (Figure 9). Business travel from the survey respondents resulted in 273.11 metric tons of CO_2. Long flights accounted for forty-seven percent (47%) of emissions, followed by standard cars at thirty-one percent (31%) and medium flights at twelve percent (12%) (Figure 10).

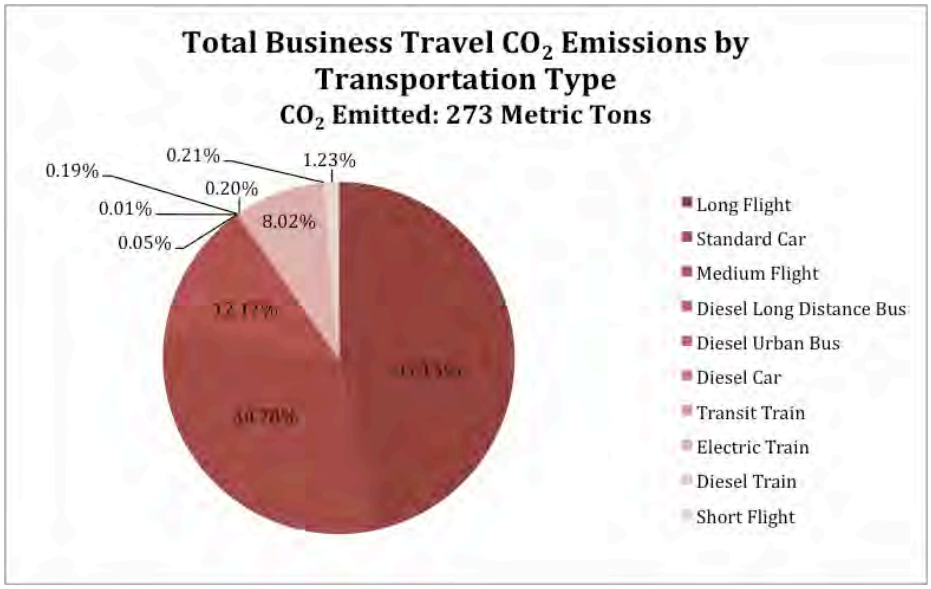


Figure 10. Emissions from Business Travel by Transportation Type. Based on the survey data, Audubon employees emitted a total of 273 metric tons of CO_2 in the fiscal year 2008. Long flights comprised the majority (47.15%) followed by standard car (30.78%) and medium flights (12.17%).

Based on the results from the surveys, we were able to estimate the total commuter and business travel emissions for each of the forty-two offices that responded to the survey. To do this we found the average emissions per employee for each office. This number was then multiplied by the number of employees that work that each office. The totals from each office were then added together to create the estimated total for these forty-two offices. The estimated total emissions were 1,136 metric tons of CO_2 equivalents with 728 from commuting and 408 from business travel. This estimate accounts for approximately sixty-three percent (63%) of Audubon employees.

Bob Perciasepe
New York City Audubon

Bob Perciasepe, COO of Audubon, has one of the largest business travel profiles of all Audubon employees. He does try to replace business trips with phone calls when he can, and he has a web cam for person to person calls so that he can still have face-to-face meetings with individuals even when he is not traveling to their offices. These web calls become difficult with multiple parties however; "The problem is when you have a lot of people in a lot different locations you need to have a lot of different screens, and it can be difficult to see everyone." Perciasepe notes that he is working on trying to improve Audubon teleconferencing capabilities.

Perciasepe also tries to rent hybrid cars, and when they are not available , compact cars. He also tries to stay in designated green hotels.

Audubon also works to select the location of board meetings using criteria including cost, availability of green hotels, and easy access to hub airports. The upcoming board meeting in May is at a green hotel in Charleston, South Carolina while the October meeting is going to be in Columbus at an Audubon center opening in May that is LEED certified. The January meeting will be at Trinity River Center in Dallas Texas, which opened recently, and is LEED certified. It is also fifteen minutes from the Dallas-Fort Worth airport (B. Perciasepe, personal communication, April 6, 2009).

Transportation Recommendations

The transportation sector provides several opportunities for Audubon to reduce its GHG footprint. The recommendations below are categorized into Commuting and Business Travel.

Commuting

- Create a commuting challenge between Audubon offices and reward the office that can reduce its commuting footprint by the highest percentage. A contest between individual employees could also be established.

- Allow employees to telecommute one day per week, where feasible, which can reduce an employee's commuting emissions by twenty percent.

- Establish an interoffice program to encourage carpooling. This could be as simple as posting a rideshare schedule on an office bulletin board, or appointing a carpooling coordinator for the office. For locations that share office space within a building these efforts could be expanded to the entire facility.

- Provide a guaranteed ride home for employees who carpool. This would ensure that even in case of an emergency where the driver must leave early or someone needs to stay late at work, the organization will pay for a bus pass or taxi voucher so the employee can get home.

- Provide transit passes or vouchers as a pretax benefit in urban areas.

- Allow flexible start times for employees to encourage commuting an non-rush hour times. This will reduce the amount of time they sit in traffic, reducing emissions as well as air and noise pollution.

- Provide showers and bicycle storage to encourage biking. This can also be accomplished by providing employees access to a nearby workout facility that has showers available.

Business Travel

- Replace office owned vehicles with hybrids, where feasible.

- Combine business trips by visiting multiple nearby sites at the same time whenever possible.

Sean Mahar
Audubon New York

Like many Audubon employees Sean Mahar considers himself an environmentalist. He uses a self-powered lawn mower, plants a vegetable garden, and shops at the local farmers market. Though he does not consider himself a cycling enthusiast, he tries to bike to work a few days a week to avoid traffic and reduce his environmental footprint.

When he and his wife moved outside of Albany to Troy, New York, his commute got a little longer, but he says that "knowing I was actually increasing my commute I wanted to ride my bike as much as possible." Luckily he is still able to bike to work in spring and summer: "I ride the nine miles into Albany on a bike path, and then take the bus [to the office] to avoid city streets and traffic.

Biking is just one of the ways that Mahar reduces his footprint, "Because I am lobbyist I spend a lot of time in Albany. My wife is also a lobbyist so we try to carpool together as much as possible, which ends up being about one day a week. We are very conscious of combining trips as much as possible."

Mahar also tries to take advantage of the fact that his office has a hybrid car for employee use. When he has to take trips to other parts of New York State, if he cannot use the hybrid he tries to reschedule the meeting or tries to turn the meeting into a conference call. Though not every employee lives close enough to a bike path, or has a short enough commute to bike to work every day, many are in a position to think about combining trips and reducing out of the way errands, all things that can contribute to a lower transportation footprint (S. Mahar, personal communication, April 6, 2009).

Elizabeth Lane
Greenwich Audubon

Like many people Elizabeth Lane bought a Prius last year, but unlike most people she bought it in March before gas prices started to rise. "I bought [the Prius] just before [gas prices] got really high, so there were tons of Priuses."

Lane wanted a Prius for many years; she was tired of driving her old "gas-guzzler," which got about thirteen miles to the gallon. After working at Audubon for a few months she felt she was in the position to buy "the best car, the one that was the most environmentally sustainable."

When asked whether there were any downsides to driving a hybrid, Lane said "I can't think of anything. I love the car. I hardly fill up on gas." She did say that people who like to drive a car for the fun of going fast may not enjoy the Prius as much as she does, "but I have fun looking at the miles per gallon gauge and driving up how many miles I am getting to the gallon."

According to Lane, that miles per gallon gauge makes her think about how she drives. If she guns the engine, and tries to get up to top speed right away from a stop sign she watches as the miles per gallon drop. When she takes her foot off the gas pedal she can see the impact in better mileage. She notes that "it makes you think about how you drive much more." Lane is reducing her footprint by driving her Prius, and learning how to drive in a way that has lower emissions (E. Lane, personal communication April 13, 2009).

- Create an Audubon-wide set of travel guidelines. This set of guidelines could include the following recommendations:
  - Choose hotels within walking distance of conference destinations or airports.
  - Choose compact or hybrid vehicles for all car rentals and do not accept upgrades.
  - Consider the number of employees and distances they will have to travel to reach a destination when choosing meeting locations in order to reduce the total number of miles traveled.
  - Use videoconferencing instead of traveling when possible.
  - Consider train or bus travel instead of flights when planning business trips.
  - Rent a van if many employees will be traveling together to the same conference.
  - Encourage carpooling for group trips, especially if one employee is willing to drive their personal hybrid or fuel-efficient vehicle.

- Use public transportation instead of taxis whenever possible when traveling between the airport and your hotel and within a large city.

- Choose direct flights instead of multiple stopovers; not only are they more convenient, but the takeoffs and landings can increase emissions from a flight by as much as fifty percent (Putt del Pino & Pankaj, 2002).

MOOSE AND WOLVES | WHY WE BIRD | SEEING THROUGH FOG | THE NATURE ISLAND

Audubon

March-April 2008

Birds' Nests
Miniature Marvels of Architecture

Venus Flytrap
A Meat-Eating Plant Holds On

The Everglades
Developers and the Feds Cozy Up

Lost World
Unlocking a 700-Year-Old Mystery

Paper

PAPER

Audubon relies heavily on paper to communicate with stakeholders and promote its mission of conservation. *Audubon* magazine, sent bi-monthly to members, is considered to be the public face of the organization. The magazine is well-respected in the industry, and has earned numerous accolades including the 2007 National Press Club Travel Journalism Award. In addition, promotional mailings, address labels, and other fundraising materials are continuously sent out by Audubon to attract new members and raise money for the organization (National Audubon Society, 2007). Both the magazine and fundraising mailings are part of the effort to further Audubon's message of conservation through individual and collective action.

Audubon recognizes that relying heavily on paper products to convey a message of conservation and bird habitat protection is inconsistent with its mission. This is because of paper manufacturing's contribution to climate change and deforestation. For example, Canada's boreal forest, where some three hundred bird species breed and through which five billion birds migrate each year, is being cut down at a rate of 1.9 million acres or nearly 3,000 square miles per year. The majority of the timber harvested, approximately sixty-five percent, is used for pulp and paper production (Nickens, 2009). Due to the rapid loss of bird and other wildlife habitat from logging and deforestation, Audubon has identified its significant use of paper, especially in fundraising mailings and magazines, as an opportunity for improvement.

Virgin vs Recycled

There are many different types of paper, each with a different use. The types vary from regular copy paper used in most offices to glossy paper used in magazines. Each type of paper is made through a different manufacturing process and has different environmental impacts and GHG emissions associated with the production process. Virgin paper, as it is known, comes strictly from harvested timber that is turned into pulp and then paper. Recycled paper commonly refers to paper that is manufactured with a combination of virgin materials and recycled content. A distinction must be made between post-consumer recycled content and merely recycled content.

Post-consumer recycled content is paper that has been used by a consumer and then recycled. For example, a magazine placed in a recycle bin will be processed and the resulting recycled fiber will be reused. Post-consumer content recycled paper is often described in percentages, usually 10% or 30%, and can be found on the label of paper packages or on the back of magazines and catalogs.

Defining recycled fiber as post consumer content is an important distinction, because paper can be described as recycled without being post-consumer. Virgin paper often contains byproducts from the wood manufacturing processes that can be reused. While reusing this material is technically recycling, it does not reduce the amount of wood needed to manufacture the paper. For the purposes of this assessment, only post-consumer recycled content is considered unless otherwise specified.

The more post-consumer content the paper contains, the lower its impacts and GHG emissions (EDF, 2008). It is important to keep in mind that while using recylced paper reduces GHG emissions, the recycling process itself is a source of GHG emissions. A portion of this decrease is attributable to less intensive manufacturing necessary to make paper from recycled fiber, but the most significant benefits are seen from redirecting paper from the landfill to paper production (EDF, Paper Task Force, 2002). As paper in landfills decomposes, it produces methane, a GHG which is twenty-three times more potent than CO_2 (U.S. Environmental Protection Agency (USEPA), 2006).

In addition to making the distinction between virgin and recycled paper, there are also third parties that certify paper produced with environmentally friendly forestry practices, such as Forest Stewardship Council (FSC). These third party certifications improve forestry practices but do not change environmental impacts associated with paper manufacturing.

Methodology

To calculate the GHG emissions associated with the manufacturing of the paper, we used the Environmental Defense Fund (EDF) Paper Calculator. The EDF paper calculator was created in 2005 and updated in 2008 (R. Beckhardt, Personal communication, Feb 23, 2009). It was a collaborative effort between EDF, Duke University, Time Inc., McDonalds, Johnson & Johnson, and Prudential Insurance Company, known as the Paper Task Force (EDF, Paper Task Force, 2002). The Task Force used existing peer-reviewed research and the calculator's development to author several summary white papers describing their findings. Used by many large corporations, the EDF paper calculator is considered the industry standard for calculating environmental impacts and GHG emissions from paper use. The calculator is highly regarded because it considers the entire lifecycle of paper from tree harvest to landfill or reuse. Wells Fargo, Staples, Starbucks and recently *Discover* Magazine have all used the EDF paper calculator to determine the GHG emissions of its paper use (Wells Fargo, 2008). Further description of the EDF paper calculator can be found in Appendix 3. The calculator itself can be found online at www.papercalculator.org.

In order to collect data on Audubon's paper use, we first had to determine the scope of our analysis. Most decisions on data collection were based on the practicality of retrieving the information in a timely manner and the importance of the information relative to the amount of GHG emissions. To conduct our assessment, we collected information about the types of paper used in each of the three categories (the magazine, the mailings, and office paper), the amount of post consumer recycled content for each paper type, and the total amount of paper used by weight. Emissions from manufacturing, use, and disposal of the paper can be calculated by entering this information into the EDF paper calculator. We were able to obtain the complete information for the magazine and the fundraising mailings, but only partial data for office paper use. Depending on availability and the amount of the data received, supplemental information on the paper's life cycle was included in the calculation. Specifically, GHG emissions from transportation or other manufacturing processes, such as printing, associated with the paper's use were included when data was available (Table 2).

Paper Lifecycle Data	Data Availability		
	Magazine	Mailings	Office Paper
Paper type, percent recycled, totals by weight	X	X	X
Paper transport (Paper Mill to Printer/Manufacturer)	X		X
Printing/Manufacture Energy Use	X		N/A
Production of Ink			N/A
Paper Transport (Printer/Manufacturer to Distribution Center)			

Table 2. Paper Lifecycle Data Availability. Boxes labeled with an 'X' indicate that data was available and included in the analysis. N/A indicates that the item was not applicable to the analysis. Boxes left blank indicate that data was unavailable for analysis or intentionally excluded.

Results

Audubon Magazine

Most of Audubon's paper use can be attributed to the publication of its magazine, *Audubon,* which is published six times a year and has a total readership of over 1.6 million people. Currently, 426,000 copies of each issue are printed, but this will be reduced to 400,000 beginning in July 2009 to reduce costs. Each issue has a different number of pages depending on the stories and number of advertisements, but an average edition has 116 pages. *Audubon* requires an average of 268,964 pounds of paper per issue, of which 245,664 pounds is body stock, 20,750 pounds is cover stock, and 2,550 pounds is for "blow-in" and membership renewal cards. To provide context, a commercial truck can carry approximately 44,000 pounds of paper.

At the end of 2008, Audubon made the decision to switch the body stock from a 30% post-consumer recycled content paper to a 100% recycled, 90% post consumer content paper. The transition is expected to occur in the July/August or September/October 2009 issue; however, the cover stock and membership cards, which both contain 10% recycled content, will not change.

Methodology

In order to calculate the magazine's impact for an entire year, the average length of magazine pages was multiplied by the number of issues per year to determine a full year's emissions. These emissions were compared to the emissions from the future 100% recycled, 90% post consumer content magazine.

Transportation emissions for the trip from the paper mill in Germany to the printer and magazine manufacturer located in Sussex, Wisconsin were also calculated. This includes transportation from the mill to the port by truck. The paper is then shipped via freighter to one of three ports in the US: New York, New York, Philadelphia, Pennsylvania or Charleston, South Carolina and is then shipped via truck or rail to the printer in Wisconsin. Based on six shipments per year, it was assumed that each US port would receive two of the shipments. Further, it was assumed that one of the shipments would be transported to the printer via rail and one by truck. These emissions were calculated based on distance travelled using the previously described WRI transportation calculator for truck, rail, and freight shipping (Appendix 3). Data was also obtained for the emissions associated with the printing and binding of the magazine.

Results

Based on these parameters, the total annual emissions from the magazine, including transport of the paper and the printing is 2,532 metric tons for 30% recycled content and 1,924 metric tons for 100% recycled content paper. Audubon's GHG emissions for the paper used for the magazine, not including printing and transportation, were 1,978 metric tons in 2008, using 30% recycled post-consumer content paper. When Audubon switches to 100% recycled, 90% post-consumer content paper, the total will be 1,370 metric tons per year. This represents a savings of 608 metric tons of CO_2 equivalents per year by switching to the 100% recycled paper (Table 3, Figure 12). Also, there will be an additional savings of eighty-five metric tons of CO_2 equivalents due to the reduction of the magazine distribution from 426,000 to 400,000.

	30% Recycled	90% Recycled
Magazine – Paper Types	CO_2 in Metric Tons	CO_2 in Metric Tons
Body Stock	1,810	1,202
Cover (10%)	149	149
Membership Cards (10%)	19	19
Subtotal for Paper	1,978	1,370
Printing	174	174
Transportation	1031	1031
Total	**3183**	**2575**

Table 3. Comparison of Emissions from 30% recycled paper and 90% recycled paper. Overall emissions from 90% recycled paper are lower than 30% recycled paper.

Fundraising and Membership Mailings

Audubon sends out fundraising and membership mailings six times a year. The fundraising and membership mailings vary in content but may contain mailing labels, brochures, address labels, letters, return envelopes, membership cards, and promotional Audubon fliers. A total of 7,145,485 mailings were distributed in 2008, which required over 1.2 million pounds of paper. Collecting data for the mailings was a challenge due to the multiple paper types used in the letters and the multiple suppliers and printers that are used to procure the papers at the lowest cost. Our calculation is based on the December 2008 mailing, which used seven different paper suppliers and thirty-six different types of paper. The majority of paper used was either gloss or copy paper and was a minimum 10% post-consumer recycled content; however, a limited amount of the paper in the December 2008 order was 30% post-consumer recycled content.

Methodology

Due to the difficulty of obtaining data from multiple printers and suppliers on energy use and transport methods and distances, only the manufacture and disposal of the paper is included in the calculation for this section. After calculating the emissions associated with the December mailing, the number was then used to estimate the total GHG emissions for 2008, by multiplying by six.

Results

The fundraising and membership mailings emit approximately 1,614 metric tons of CO_2 equivalents per year, 269 metric tons of CO_2 equivalents coming from the December mailings.

Office Paper

Office paper is used in various ways at all of the 110 Audubon facilities across the country. The paper is used for day-to-day business and other items such as newsletters or educational materials. The volume of paper used varies greatly among the offices, as does the percentage of recycled content in that paper. Office paper use varies from five reams per year, in the Florida Key's office, to seven hundred reams per year in the New York City office. The recycled content of the office paper used by the individual offices range from 0% to 100%. The majority of offices, however, use at least 30% recycled content or higher.

Methodology

In order to obtain data on the amount of paper used within each office, a survey was developed and then distributed to the offices. We received twenty-two surveys with complete information on the type and quantity of office paper used in the specific office. Based on these surveys, we calculated the total office paper used by the organization. First we found the average paper by weight used per employee and then multiplied this by the total number of employees. This calculation resulted in a total of 32,933 pounds of paper. Since offices use different types of recycled paper, we used a weighted average of the different paper types to determine the percentage of each paper type used. Once the total pounds for each paper type, the amount was plugged into the paper calculator to find the total CO_2 equivalents.

Results

Based on the surveys we received, Audubon's office paper use represents a total of 14.4 metric tons of CO_2 equivalents emitted per year. For the entire organization we estimate office paper emissions of thirty metric tons of CO_2 equivalents per year. As a means of comparison, when WRI calculated its footprint in 2007, paper accounted for seventy-eight metric tons of CO_2 equivalents emitted per year.

Recommendations

As seen with *Audubon* magazine, the decision to switch from 30% recycled content to 100% recycled paper that contains 90% post-consumer recycled content will result in a significant reduction in GHG emissions. Given Audubon's commitment to the switch, the next logical step to further reduce GHG emissions would be to increase the post-consumer recycled content of all paper used by Audubon.

However, there are certain considerations that should be made prior to moving forward with this recommendation. First, increasing the recycled content for the magazine has proven to be a cost saver for Audubon because the recent economic downturn has reduced the demand for recycled fiber, ultimately making it less expensive. The switch from 30% to 100% recycled content paper will significantly reduce GHG emissions and save money. However, some reproduction quality will be sacrificed compared with the previous 30% recycled stock, because the 100% recycled stock has less shine and has tiny specks from the high content of recycled material (H. Devos, Personal communication, March 30, 2009).

Based on the GHG emissions, the type and quantity of paper used, and the importance of the magazine and mailings to Audubon's successful fundraising, we have developed two major recommendations for GHG reduction.

Develop an Audubon Wide Paper Procurement Policy

Fundraising and Membership Mailings – Adopt a procurement policy that increases the recycled content to a minimum 20% by 2010 and a minimum 30% recycled content by 2011. It may be difficult to increase the recycled content of all the paper types used. The current production manager uses a minimum 10% recycled content and seeks obtain the best price available. This often means buying paper directly from a printer, which is cheaper than ordering paper and then sending it to a printer. These printers may not stock higher content recycled paper or Audubon may be required to pay higher prices for the higher recycled content paper (J. Logan Personal communication, April 1, 2009). However, a flexible procurement policy could allow Audubon the opportunity to take advantage of the less expensive prices while gradually increasing the recycled content of its mailings.

The recommended change would provide an estimated savings of 137 metric tons of CO_2 equivalent emissions per year. In order to provide flexibility, the minimum recycled content should be measured as an average of all paper for that distribution. This will allow the production manager to take advantage of discounted paper that may be below the minimum recycled content goal or order a type of paper that is unavailable in the minimum recycled content. Further, this will allow the purchase of certain paper types, envelopes for example, which are easier to find with a higher recycled content to make up the difference.

Office Paper – Adopt a standardized national procurement policy that requires all offices to use 100% recycled content paper. This would reduce Audubon's GHG emission by an estimated 2.9 metric tons per year. Since this number is an estimate based on surveys received, the actual amount would likely be greater. Further, this could also result in a cost savings. For example, a review of Staples.com on April 12, 2009 showed that the price of 100% recycled office paper was $4 less expensive than 30% recycled paper, per case of ten reams, so there is an opportunity to save money as well as reducing emissions. Finally, an policy could be made for letterhead to be a minimum 30% recycled content.

Audubon Magazine – Membership and "blow-in" cards should be a minimum 50% post-consumer recycled content. Other magazines, such as *Discover*, have successfully used this amount in their magazines (Appendix 3) . In addition, once the magazine has successfully transitioned to the 100% paper for the body stock, consideration should be given to increasing the recycled content of the cover (Figure 12).

Increase the Use of Internet-based Fundraising

While direct mail campaigns will remain an important component of Audubon's fundraising strategy in the foreseeable future, one opportunity to decrease the amount of paper consumed by fundraising and membership mailings is to increase the use of internet-based fundraising. This will not only give traditional members an alternative way to donate, but will also create the ability to reach a new audience.

To date, Audubon has not focused its efforts on the promotion of internet-based fundraising despite its potential to reduce paper consumption from direct mailing campaigns and to reach more potential donors. A quick analysis of Audubon's existing internet-based fundraising shows that the ratio of new donors to existing donors was nearly ten to one for the past five years. This ratio demonstrates the potential for recruitment. Additionally, revenue from internet-based fundraising should come at significantly reduced costs compared with direct mail due to the reduced paper use and postage. The use of internet-based fundraising also allows for quicker deployment of fundraising strategies based on current events.

Initiate an internet-based, carbon-free fundraiser challenge. To boost internet-based fundraising Audubon should conduct an internet only "carbon-free" fundraising challenge for individuals with matching funds. Audubon could contact a large donor interested in climate change to put up a large sum money that will act as matching funds for individuals who donate to the challenge. Both the large donor and individuals will be motivated by the opportunity to double their contribution. This is an opportunity to reach out to large donors who are interested in climate change and may be interested in helping to create a larger donor base.

Collect email addresses on new membership and membership renewal forms. By collecting email addresses on new membership and membership renewal forms, Audubon can increase the number of members that it contacts through internet-based communication.

COMPARING AUDUBON & DISCOVER MAGAZINES

Doing the math: GHG emissions per magazine

(CO2 equivalent GHG emissions)

	DISCOVER	AUDUBON
PAPER		
PAPER TYPE	0% Recycled	100% Recycled
TOAL EMISSIONS PER ISSUE*	754.7 metric tons	226.4 metric tons
EMISSIONS PER MAGAZINE	1.66 lbs	1.25 lbs
TRANSPORTATION—PAPER PRODUCER TO PRINTER		
TOTAL EMISSIONS PER ISSUE	36.9 metric tons	63.3 metric tons
EMISSIONS PER MAGAZINE	0.08 lbs	0.35 lbs
PRINTING		
TOTAL EMISSIONS PER ISSUE**	47.2 metric tons	27.2 metric tons
EMISSIONS PER MAGAZINE	0.10 lbs	0.15 lbs
TOTAL MAGAZINES PER ISSUE	1,000,000	400,000
NET GHG EMISSIONS* **	838.8 metric tons	316.9 metric tons
NET GHG EMISSIONS PER MAGAZINE	1.85 lbs	1.75 lbs

*Includes magazine, cover, and inserts paper stocks; also includes disposal and recycling emissions from end of lifecycle

**Does not include ink emissions

***Net GHG emissions does not include indirect employee emissions, distribution after printing, or GHG emissions from ink.

Figure 11. Comparison of Discover and Audubon magazine GHG emissions. Using 0% recycled content paper, almost three times as many metric tons of CO2 equivalents are emitted compared to using 100% recycled content paper. Per issue, transporting 100% recycled content paper emits almost double the quantity of metric tons of CO2 equivalents compared to 0% recycled content paper. In total, Audubon emits less than Discover. This could be due to differences in weight of the magazines and extent of magazine circulation.

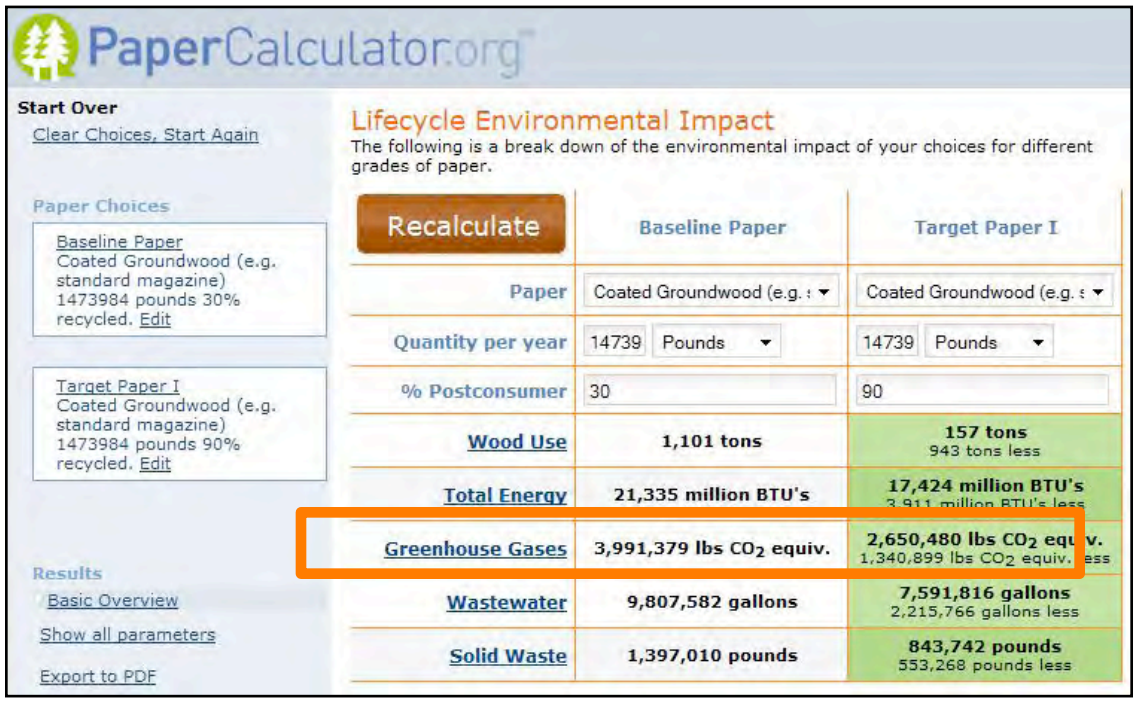


Figure 12: Comparison of Lifecycle Environmental Impact of Audubon's 30% recycled content and Audubon's 90% recycled content. According to PaperCalculator.org, for a typical Audubon Magazine at 14,739 pounds, Audubon will save 1,340,899 pounds of CO2 equivalents by switching from 30% recycled content paper to 90% recycled content paper.

Landholdings

LANDHOLDINGS

To further its mission of protecting birds and their habitats, Audubon owns and manages extensive landholdings throughout the United States. In fact, it manages 150,600 acres of conservation lands, second only to the Federal government. Audubon's lands are located in a wide range of climatic regions, from the Arctic tundra to the Florida Everglades. Ecosystems found on these lands include birch forests and tidal swamps in New York, sage steppe lands in Wyoming, coastal scrub in California, chert glade in Missouri, and post oak forest in Kansas. These diverse landholdings provide habitats for a wide variety of birds, including endangered and migratory species that depend on these landholdings for their survival.

Overall, the GHG footprint of Audubon's landholdings is comprised of both GHG emissions through operations and management activities and opportunities for sequestration in forests.

Maintenance at each landholding location produces varying GHG emission levels. Carbon and other GHGs are emitted primarily through the use of the vehicles and the application of fertilizers and herbicides. For example, facilities workers use trucks to access all parts of the reserves in order to perform routine and necessary habitat upkeep. To combat invasive plants and encourage growth of desired plants, some centers apply herbicides and fertilizers to portions of their landholdings. Each of these activities contributes to the overall footprint of the landholding.

When plants incorporate atmospheric carbon into their own tissues as well as the surrounding soil, the landholdings (forests, grasslands, and wetlands) become carbon sinks since they sequester carbon into the biomass. However, wetlands can sequester carbon through deposition of organic carbon while simultaneously emitting GHGs in the form of methane, which also contributes to Audubon's overall GHG emissions.

Methodology

To determine the GHG footprint of Audubon's landholdings, we used the look-up table methodology developed by the USDA Forest Service (Smith, Heath, Skog, Birdsey, 2006). The USDA look-up tables provide sequestration data for all major forest types throughout the United States, making it possible to accurately assess the GHG footprint for all of Audubon's landholdings using a uniform methodology. With information about the region, tree type, age, and spatial extent of a given forest, one can reference the look-up tables to determine the amount of carbon dioxide sequestered by that forest. The USDA look-up tables are reliable and widely accepted as an accounting device for such calculations. Most notably, they are used by Carbon Trading, an online calculator supported by the National Commission for Science on Sustainable Forestry. (National Commission on Science for Sustainable Forestry, 2008). See Table 16 in Appendix 4 for an illustrated description of a look-up table.

Strawberry Plains Audubon Center

Results

Overall, Audubon's landholdings sequester more GHGs than they emit due to the abundance of forests on its landholdings. This assessment reveals that fertilizers and herbicides have a negligible effect on the overall GHG footprint of Audubon's landholdings, as the majority of emissions on landholdings come from gasoline-powered vehicles. Even so, the sequestration of CO_2 in forests far outweighs all emissions from operations and management on landholdings. Overall, Audubon's forests sequester enough CO_2 to offset emissions from other parts of Audubon's footprint.

These results can be illustrated using data from Rheinstrom Hill Sanctuary and Audubon Center in Craryville, New York and Strawberry Plains Audubon Sanctuary in Mississippi (Figure 13).

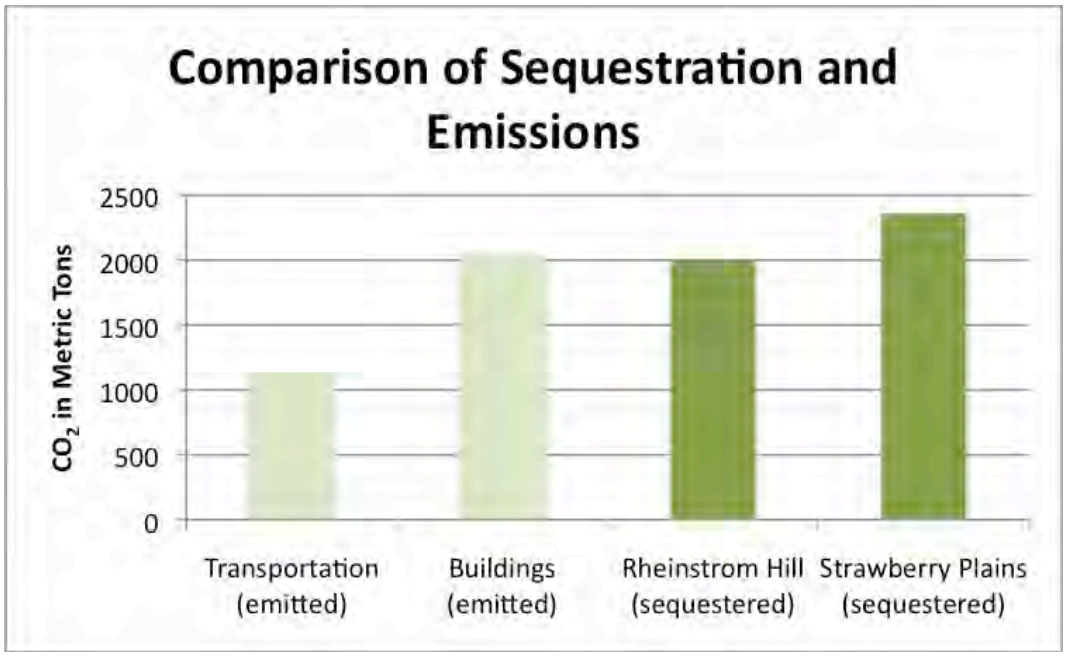


Figure 13. A comparison of the sequestration capacity of Audubon's forests with emissions from Audubon's transportation and buildings. Strawberry Plains sequestered more CO_2 than overall building emissions. Rheinstrom Hill sequestered more CO_2 than overall transportation emissions.

Rheinstrom Hill Sanctuary and Audubon Center in Craryville, NY is composed of roughly 1037 acres of hardwood forests. Land managers at the site do not use fertilizers or chemicals, and total gasoline usage at the site was estimated at 700 gallons per year. Overall, forests at the Craryville site sequester 2,001 metric tons of CO_2 per year, while 6.23 metric tons of CO_2 equivalents are emitted annually from gasoline use at this site. Thus, the magnitude of sequestration is more than 300 times as large as on-site emissions. The net GHG balance for the Rheinstrom Hill Property is -1995 metric tons of CO_2 equivalents, meaning that it sequesters 1995 metric tons of CO_2 equivalents more than it emits. In the context of Audubon's overall GHG footprint, the scale of sequestration on landholdings is immense. The GHG emissions of all of Audubon's transportation total 1,818 metric tons of CO_2 equivalents. Therefore, the forests at Audubon's Craryville, NY site alone neutralize emissions from all of Audubon's business and commuting travel.

Strawberry Plains Audubon Sanctuary in northern Mississippi also has a large sequestration capacity. This sanctuary has roughly 780 acres of mixed hardwood forests. Land managers at the site only use fertilizers or chemicals sparingly around the landholding, and in total, they use about 110 gallons of gasoline per year for motor vehicles. This relatively small amount of gasoline used emits 0.98 metric tons of CO_2 equivalents. The mixed hardwood forests at Strawberry Plains sequester 2,361.10 metric tons of CO_2 per year. In this case, the magnitude of sequestration is more than 2,400 times as large as the emissions from on-site gasoline use. The net GHG balance for the Strawberry Plains is -2,360 metric tons of CO_2 equivalents. In the context of Audubon's overall GHG footprint, the sequestration capability of this landholding is enough to offset emissions from all of Audubon's buildings nationwide.

Rheinstrom Hill and Strawberry Plains are just two of over ninety landholdings under Audubon's control, yet its forests alone sequester enough CO_2 to offset a large portion of Audubon's overall GHG footprint. Thus, Audubon's natural lands are clearly much more than habitats for birds.

The sequestration capacity of landholdings should not be used by Audubon as a reason to ignore emissions but instead should be a leader in the fight against climate change by continuing to decrease emissions throughout the organization. Also, Audubon can use the sequestration capacity of its forests as a teaching opportunity. By doing so, Audubon can educate employees and visitors about the immense value of forests and stress the importance of halting deforestation.

Recommendations

Vehicles

- Purchase alternative fuel, hybrid, or fuel-efficient vehicles. Replace vehicles in the fleet which have reached the end of their useful lives with ones that are more fuel efficient. Prioritize sites with the most vehicle miles traveled to maximize GHG savings.

- Reduce the use of vehicles through planning. Assess the current use of vehicles and curb unnecessary or redundant use.

Fertilizers

- Compost waste from food, gardening, and forest maintenance (i.e. cutting of limbs, clearing detritus for trails, etc) for natural fertilizers. The production of fertilizers, pesticides, and herbicides results in the emission of GHGes.

Pesticides and Herbicides

- Use Integrated Pest Management strategies, such as allelopathic remedies, to reduce use of pesticides and herbicides. Allelopathy is a process where chemicals released by one plant can inhibit the growth of other plant species nearby (Weston and Duke, 2003). This practice must be site specific to ensure that undesirable plants are not introduced. Examples of allelopathic plants include the Black Walnut, which inhibits respiration of certain other plants and sorghum, which inhibits photosynthesis and is used as a weed suppressant. Similar to the composting, this organic activity will eliminate the GHG emissions caused by pesticide and herbicide production.

Education

- Provide outreach materials to visitors at nature centers on landholdings and on the website to educate visitors about the sequestration capabilities of natural lands and their own carbon footprints.

Carbon Offsets and Carbon Credits

Carbon offsets are purchased to reduce metric tons of CO_2 equivalents and financially support the creation of renewable energy, energy efficiency and reforestation projects globally (Carbonfund.org, 2009). They are financial tools that can be bought and sold as a strategy to further reduce one's GHG footprint after all emissions reductions opportunities have been exhausted. Some Audubon chapters, such as Audubon New York, and individual employees have contracted with Carbonfund.org to offset some emissions from operational activities.

According to the *Sustainability Best Practices Memo* distributed to Audubon employees in 2008, Carbonfund.org was selected because "it mirrored [Audubon's] own organizational goals with regards to global warming and has a proven track record of promoting new, additive renewable energy projects that will contribute to an overall lessening of global warming emissions worldwide" (Sustainability Best Practices Memo 2008). The validity of carbon offsets is currently a contentious subject; actual emissions reductions from projects are difficult to measure and track and the ease of purchasing credits can give a false impression of mitigation.

Currently, the purchase of carbon offsets by organizations such as Audubon is voluntary, although future legislation may require companies and organizations to purchase carbon offsets in order to comply with caps on the total amount of GHGs they are allowed to emit. In recognition of a future market for carbon offsets, Audubon might wish to consider the monetary value of the sequestration of its landholdings. By calculating its annual carbon sequestration and selling the equivalent carbon credits, Audubon will generate revenue to further protect these natural areas. Alternatively, Audubon could use the carbon credits from its landholdings to offset its own operational emissions, thereby eliminating the need to purchase carbon offsets from other organizations. While there are still many unknowns about carbon offsets and carbon credit trading schemes, Audubon should maintain an awareness and appreciation about the inherent value of its landholdings, not just for their ability to conserve wildlife but also to sequester GHGs.

CONCLUSION

Audubon's February 2009 report, "Birds and Climate Change – Ecological Disruption in Motion," indicates that climate change is one of the biggest threats to birds and their ecosystems. The report states,

> "Failure to prevent the worst impact of global warming would undermine the conservation work that Audubon has accomplished over more than a century. Tackling this critically important challenge is one of Audubon's top priorities (Niven, Butcher, Bancroft, Monohan, Langham, 2009)."

In addition to being a priority, this challenge is directly in line with Audubon's mission "to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity."

Even before this report was released, Audubon expressed its concern about the potential impacts of climate change through articles in its magazine and educational materials available on its website. The assessment and calculation of Audubon's GHG footprint is a first step towards ensuring that, as an organization, Audubon is not contributing to the degradation of the species and habitats that it is trying to protect. This GHG assessment is merely a first step toward bringing its operations in line with its mission.

Results

Though preliminary, the results of this assessment estimated the proportional contribution of each emissions source that comprises Audubon's overall footprint. We were able to approximate the relative share of GHG emissions resulting from buildings, transportation, paper, and landholdings (Figure 14, Table 4).

The net sequestration capabilities of the eleven landholdings for which we received data clearly exceeds CO_2 equivalents emitted from operations. Though their sequestration capacities are immense, Audubon could enhance its leadership potential by focusing its emissions reduction efforts on buildings, transportation, and paper rather than on landholdings.

In a 1978 report to members, Elvis Stahl the President of Audubon wrote,

> "National Audubon owns many millions of dollars' worth of real estate, but because Audubon sanctuaries and centers are not for sale, we carry them on our books at a combined value of exactly one dollar. They are, nonetheless tremendous assets for our missions of conservation, action, wildlife and ecosystem research, and environmental education."

Audubon's landholdings can be viewed from the same perspective in terms of the role they play in Audubon's overall GHG footprint. Understanding their sequestration capabilities allows Audubon to appreciate another facet of the landholdings inherent value, but should not replace efforts to more thoroughly align its operations with its mission.

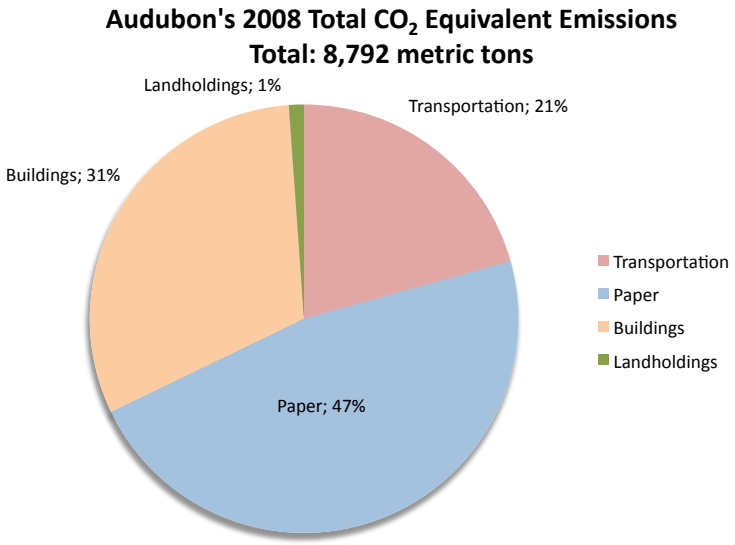


Figure 14. Audubon's 2008 Total CO2 Equivalent Emissions. Paper comprises the majority of Audubon's emissions (47%), followed by Buildings (31%), Transportation (21%) and Landholdings (1%).

Emissions Sources	2008 Emissions
Heating	56.01
Electricity	627.94
Commuting	400
Business Travel	273
Magazine Paper (30% Recycled Content)	2,352
Fundraising Mailings	1,614
Office Paper	14.4
Landholdings	100
Total	**5,437.35**

Table 4. List of Audubon's emissions based on returned surveys. Audubon's reported metric tons of CO_2 emissions were greatest for Magazine Paper followed by Fundrasing Mailings, Commuting, Business Travel and Heating.

Recommendations

Operating a non-profit with offices throughout the country and the associated travel it requires contributes to climate change through GHG emissions. There is currently no way to completely eliminate the emissions cost of doing business, but Audubon is striving to reduce its emissions in the same way that it is advocating that its members work to cut their emissions. It is clear that Audubon, as an organization, is committed to the issue of protecting birds and their environment. However, the goal of adopting more environmentally sustainable and efficient methods of operations can never be fully reached.

By undertaking this project, Audubon, an organization where employees tend to choose hybrids over SUVs and prefer to work in the dark rather than waste energy, acknowledges that it can always improve. In the same way that Audubon asks its members to constantly re-evaluate the choices they make and think about the impact they might have, Audubon should institutionalize a method for continuous improvement.

Ultimately, this project will aid Audubon in accomplishing this goal in two ways: first, by assisting Audubon in calculating a baseline GHG footprint from which to benchmark its improvements, and second we have developed a methodology for them to easily complete the 2008 footprint, and begin the process of calculating its footprint annually. Easy to use calculators were also created and given to Audubon so that they can continue to update and refine GHG emissions totals. Much like counting birds during the Christmas Bird Count, Audubon can also count its GHG emissions.

Providing recommendations to a conservation organization on ways to reduce GHG emissions is similar to explaining the difference between a turkey and bald eagle to David Attenborough. There is no shortage of knowledge within Audubon's ranks for how to reduce emissions. However, implementing these ideas institution-wide, in an organization that takes pride in being decentralized is no small task.

Audubon has demonstrated that it is capable and successful in conducting conservation projects. Audubon now needs to build from its success at the project level and use this momentum to create institutional change in order to reduce its GHG emissions and holistically align its operations with its mission. The following Audubon-wide recommendations, based on the results of this assessment, should be implemented to begin this process.

What Gets Measured Gets Done

Recommendation: Measure Audubon's activities that significantly contribute to its GHG emissions.
Action: Develop procedures that will require and encourage offices to track and report on the energy use, employee commuting, business travel and paper use.

Recommendation: Include GHG emissions in financial accounting and decision making.
Action: Consider GHG emissions associated with proposed projects and capital expenditures. Weigh the costs and benefits of both emissions and finances during decision making.

Recommendation**:** Use local pride to achieve national emission reduction goals.
Action: Create GHG reduction challenges that encourage local offices to compete with each other to reduce their emissions.

Recommendation: Encourage local chapters to share their success stories.
Action**:** Develop an information network for local chapters to exchange information and ideas on reducing emissions.

Procurement

Recommendation: Consider the environmental impacts of alternative products when making expenditures.
Action: Develop a procurement policy that requires local managers to compare the existing purchases and an environmentally superior alternative.

Education

Recommendation: Enhance education materials to match Audubon's focus on GHG emissions reductions to inspire its visitors.
Action: Produce posters, tri-folds, and leaflets to be displayed at nature centers, highlighting the efforts Audubon has undertaken to reduce its own GHG footprint and the actual GHG emissions emitted by the facility.

Recommendation: Take advantage of the internet to increase the reach of education materials.
Action: Include links on Audubon's website so individuals can calculate their own GHG footprint and find ways to reduce their emissions.

Outreach/Benchmarking

Recommendation: Share Audubon's experience of creating a GHG assessment with other organizations.
Action: Publish Audubon's complete GHG footprint, as well as the appropriate surveys and calculators, on its website and encourage comparable nonprofit organizations to undertake similar GHG assessments of their own operations.

The Big Idea

Recommendation: Once the 2008 GHG baseline is finalized, place an organizational "cap" on Audubon's GHG emissions.
Action: Develop an internal Audubon "cap and trade" system that would establish GHG reductions for each Audubon office and allow local offices to trade reductions credits from office to office.

Audubon is already a standard bearer among non-profit organizations, and is proactive in ensuring its operations are consistent with its conservation goals. Local chapters are making great strides in terms of ensuring a reduced footprint, but Audubon as an organization is challenging them to go even further. This assessment, including recommendations, should be used as a tool to reduce Audubon's future GHG emissions.

Glossary of Key Terms

Allelopathy – The chemical inhibition of one plant (or other organism) by another, due to the release of substances into the environment acting as germination or growth inhibitors (Oxford American Dictionary, 2009).

Baseline – A calculation of GHG emissions for a reference year, to be used as a standard for comparison with emissions in future years.

Carbon Sequestration – The biochemical process in which carbon from the atmosphere is absorbed by terrestrial and aquatic organisms. Plants, for example, absorb carbon dioxide, release the oxygen and use the carbon to build cells. This also refers to the physical process of storing carbon in soil (USEPA, 2009).

Carbon Dioxide (CO_2) Equivalent – The standard unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6). It is determined by multiplying the metric tons of a gas by its GWP, for example one metric ton of methane has the same GWP as 25 metric tons of CO_2 equivalents (GHG Protocol Initiative, 2004).

Carbon Sink - A natural or manmade reservoir that accumulates and stores carbon-containing chemical compounds for an indefinite period following their removal from the atmosphere. This usually refers to forests and underground/deep sea reservoirs of CO_2 (GHG Protocol Initiative, 2004) (USEPA, 2009).

Completeness – The necessity to account for all emissions sources and activities within chosen organizational and operational boundaries. This relates to the idea of materiality, commonly used in general accounting principles, which requires that important and relevant information be provided, and is a core guiding principle of the GHG Protocol (Putt del Pino & Pankaj, 2002).

Consistency – The necessity to allow for meaningful comparison of emissions performance over time. This requires organizations to clearly state any changes to the basis of reporting to enable continued valid comparison, and is a core guiding principle of the GHG protocol (Putt del Pino & Pankaj, 2002).

Direct GHG Emissions – Emissions from sources that are owned or controlled by the reporting organization. This includes emissions from the combustion of fuel in boilers or furnaces owned by the organization, generating electricity, steam or heat in equipment owned by the reporting organization, and business travel and employee commuting owned by the reporting organization (GHG Protocol Initiative, 2004).

Emissions Factor – A conversion multiplier allowing GHG emissions to be estimated from a unit of activity based on available data. This can be used to calculate the GHG emissions from a specific activity, based on the greenhouse gas intensity of its fuel source, and a larger number indicates more GHGs emitted (USEPA, 2009).

Greenhouse Gas (GHG) – Any gas in the atmosphere that traps infrared radiation emitted by the Earth and reemits it back to the surface. These are essential to maintain the temperature of the earth's surface, but increased concentrations due to anthropogenic activities have begun to create excessive warming and the other affects associated with climate change (USEPA, 2009).

The six GHGs highlighted by the Kyoto Protocol include:

Carbon dioxide	(CO_2)
Methane	(CH_4)
Nitrous oxide	(N_2O)
Hydro fluorocarbons	(HFCs)
Perfluorocarbons	(PFCs)
Sulphur hexafluoride	(SF_6)

GHG source – Any physical unit or process that releases GHG into the atmosphere. This includes emissions from both natural and anthropogenic activities (USEPA, 2009).

Greenhouse Gas (GHG) Protocol – The most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. A decade-long partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), the GHG Protocol has worked with businesses, governments, and environmental groups around the world to build a new generation of credible and effective programs for tackling climate change. It serves as the foundation for nearly every GHG standard and program in the world - from the International Standards Organization to The Climate Registry - as well as hundreds of GHG inventories prepared by individual companies (GHG Protocol Initiative, 2004).

Indirect Emissions – Emissions from sources that are not owned or controlled by the reporting organization, but for which they are responsible. This includes emissions from the generation of purchased electricity, steam or heat as well as employee commuting and business travel in vehicles not owned by the organization (GHG Protocol Initiative, 2004).

Leadership in Energy and Environmental Design (LEED) Certification – A green building rating system developed by the US Green Business Council that provides a point system to evaluate environmentally sustainable construction (NRDC, 2009a).

Materiality Threshold – A concept employed in the process of verification, often used to determine whether an error or omission is a material discrepancy or not. It should not be viewed as a de minimus for defining a complete inventory (GHG Protocol Initiative, 2004).

Metric Ton of Carbon Dioxide (CO_2) – A common standard measurement for a quantity of greenhouse gas emissions. One metric ton is equal to 1.102 short tons and 2205 pounds (USEPA, 2009).

Regional Electricity Profile – A combination of coal, natural gas, nuclear, hydroelectric and other renewable electricity sources specific to a state or region.

Relevance – The necessity to define the boundaries that appropriately reflect the GHG emissions of an organization and the decision-making needs of inventory users. This is a core guiding principle of the GHG Protocol (Putt del Pino & Pankaj, 2002).

Significance Threshold – A qualitative or quantitative criteria used to define a significant structural change. It is the responsibility of the organization to determine this when considering recalculations of emissions from a baseline and usually depends on the use of the information, the characteristics of the company, and the features of structural changes (GHG Protocol Initiative, 2004).

Silviculture – The art of growing and cultivating trees, including the establishment, growth, composition, health, and quality of forests (Oxford American Dictionary, 2009).

Transparency – The necessity to address all relevant issues in a factual and coherent manner based on a clear audit trail. This includes disclosing any important assumptions and citing the calculation methodologies used and is a guiding principle of GHG Protocol (Putt del Pino & Pankaj, 2002).

Therm – The equivalent of one hundred thousand (100,000) British Thermal Units (BTUs). A BTU is the amount of heat energy needed to raise the temperature of one pound of water by one degree Fahrenheit (°F). This is the standard measurement used to express the amount of energy that a fuel has as well as the amount of output of any heat generating device (Oxford American Dictionary, 2009).

United Nations Framework Convention on Climate Change (UNFCCC) – An international treaty signed in 1992 at the Rio Earth Summit whose signatories aim to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. In addition to the treaty, most countries have signed onto its principle update, the Kyoto Protocol, which has more powerful (and legally binding) measures (United Nations Framework Convention on Climate Change, 2009).

World Business Council for Sustainable Development (WBCSD) – A CEO-led, global association of approximately 200 companies dealing exclusively with business and sustainable development. It provides a platform for companies to share knowledge and advocate business positions, working with governments, non-governmental and intergovernmental organizations, including the World Resources Institute (WRI), World Economic Forum, International Institute for Sustainable Development and United Nations Framework Convention on Climate Change (UNFCCC) (World Business Council for Sustainable Development, 2009).

World Economic Forum – A global community of business, political, intellectual and other leaders of society who are committed to improving the state of the world. It establishes networks, publishes reports, and arranges regional as well as global meetings under the supervision of the Swiss Federal Government. Together with the World Business Council on Sustainable Development (WBCSD) in July 2008, its Climate Change Initiative published detailed policy recommendations on climate change backed by more than 100 CEOs from many of the world's largest companies and presented to the world's political leaders (World Economic Forum, 2009).

World Resources Institute (WRI) – An environmental think tank that focuses on "finding practical ways to protect the earth and improve people's lives," with a mission to "move human society to live in ways that protect Earth's environment and its capacity to provide for the needs and aspirations of current and future generations" (WRI, 2009).


Appendix 1: Buildings

Calculation Methodology: World Resources Institute Calculator

There are currently wide variations in methodology among available buildings GHG emissions calculators. Some calculators are geared toward manufacturing organizations, others towards individuals, and a few towards office based organizations. As such, the parameters included in these calculators vary widely. Many calculators are region specific and do not account for electricity profiles that vary by location.

Because it best accounted for the emissions of a nationwide office based organization, the WRI calculator was chosen to complete this assessment. WRI, an environmental think-tank, assists organizations and countries around the world in understanding humans' interaction with the environment, and informs them about ways to make more environmentally conscious decisions. Along with the World Business Council for Sustainable Development, a global association of over 200 companies, WRI developed the "The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard which provides principles and guidelines for organizations to account for their emissions (Table 5). This protocol was created with the input of 350 experts from businesses, non-governmental organizations (NGOs), governments and accounting associations (Kirby 2009). The GHG Protocol has provided or informed the accounting framework for nearly every organization-level GHG standard and program in the world, including the European Union Emissions Trading Scheme and California Climate Action Registry and the footprint reports for over one thousand corporations including Sony, General Electric, DuPont, and IKEA (Kirby, 2008).

The GHG Protocol identifies three principles that must underpin all aspects of GHG accounting and reporting: (1) relevance, (2) completeness, and (3) consistency. Relevance means that a GHG assessment must contain information that "users – both internal and external to the company – need for their decision making" (GHG Protocol Initiative, 2004). Completeness involves accounting for all emissions sources and activities within chosen operational and organizational boundaries. Finally, consistency is defined as "compiling the information in a matter that ensures that the aggregate information is consistent and comparable over time" (GHG Protocol Initiative, 2004). These became the guiding principles in defining the scope and gathering relevant data for Audubon's GHG assessment. Transparency is an equally important component of a credible GHG calculator (Padgett, Steinmann, Clarke and Vandenbergh, 2008).

Many calculators were found to lack transparency because their methodologies were not fully explained. A 2008 study comparing ten carbon calculators from different organizations concluded that while many are still being developed to improve accuracy, the WRI calculators ranked high for transparency (Padgett, Steinmann, Clarke and Vandenbergh, 2008).

Examples of Office of Emission Sources	
Direct Emissions	- Combustion of fuel in boilers or furnaces that are owned by the reporting organization - Generation of electricity, steam, or heat in equipment that is owned by the reporting organization - Business travel in vehicles that are owned by the reporting company, such as corporate jets - Employees commuting in company-owned vehicles, such as a van pool or company car
Indirect emissions	- Generation of purchased electricity, steam, or heat - Business travel in non-company-owned vehicles such as rental cars, employee cars, trains, and commercial planes - Combustion of fuel in boilers or furnaces not owned by the reporting organization - Employee commuting in vehicles not owned by the reporting organization, such as light rail, train, buses and employee cars - Production or manufacture of materials and resources used by an office organization, such as furniture, paper, equipment, toner cartridges, etc. - Incineration of office waste or decomposition in a landfill where the facilities are not owned by the reporting organization (GHG emissions that result from the manufacture and disposal of paper include CO_2 and methane CH_4) - Outsourced activities such as shipping, courier services, and printing services

Table 5: WRI Emissions Sources (Putt del Pino & Pankaj, 2002).

Direct Emissions: Heating

WRI defines direct emissions as "emissions from sources that you own or control" (Putt del Pino & Pankaj, 2002). This includes production of heat (and sometimes hot water and air conditioning) in buildings owned or leased by the organization. Based on this definition, Audubon's direct emissions include the emissions associated with the combustion of heating oil or natural gas delivered to some buildings. This combustion emits CO_2 and other GHGs. A comprehensive list of fuel types and their related conversion factors can be found in Table 6. These conversion factors represent the CO_2 equivalents emitted from combusting the fuel (USDOE, 2009c). Although direct emissions also include fuel combustion at Audubon's leased facilities, collecting data from these facilities is challenging because the organization does not directly purchase fuel but instead pays an all-inclusive rental fee that includes these fuel charges.

		Lower Heating Value/Net Calorific Value Basis kg GHG / TJ fuel		
Fuel		**CO_2**	**CH_4**	**N_2O**
Crude oil and derived substances	Crude oil	73300.0	10.0	0.6
	Orimulsion	77000.0	10.0	0.6
	Natural Gas Liquids	64200.0	10.0	0.6
	Motor Gasoline	69300.0	10.0	0.6
	Aviation Gasoline	70000.0	10.0	0.6
	Jet Gasoline	70000.0	10.0	0.6
	Jet Kerosene	71500.0	10.0	0.6
	Other Kerosene	71900.0	10.0	0.6
	Shale oil	73300.0	10.0	0.6
	Gas/Diesel oil	74100.0	10.0	0.6
	Residual Fuel oil	77400.0	10.0	0.6
	Liquified Petroleum Gases	63100.0	5.0	0.1
	Ethane	61600.0	5.0	0.1
	Naphtha	73300.0	10.0	0.6
	Bitumen	80700.0	10.0	0.6
	Lubricants	73300.0	10.0	0.6
	Petroleum coke	97500.0	10.0	0.6
	Refinery feedstocks	73300.0	10.0	0.6
	Refinery Gas	57600.0	5.0	0.1
	Paraffin waxes	73300.0	10.0	0.6
	White Spirit & SBP	73300.0	10.0	0.6
	Other petroleum products	73300.0	10.0	0.6

		Lower Heating Value/Net Calorific Value Basis kg GHG / TJ fuel		
Fuel		**CO_2**	**CH_4**	**N_2O**
Coal and derived products	Anthracite	98300.0	10.0	1.5
	Coking coal	94600.0	10.0	1.5
	Other bituminous coal	94600.0	10.0	1.5
	Sub-bituminous coal	96100.0	10.0	1.5
	Lignite	101000.0	10.0	1.5
	Oil shale and tar sands	107000.0	10.0	1.5
	Brown coal briquettes	97500.0	10.0	1.5
	Patent fuel	97500.0	10.0	1.5
	Coke oven coke & lignite coke	107000.0	10.0	1.5
	Gas coke	107000.0	5.0	0.1
	Coal tar	80700.0	10.0	1.5
	Gas works gas	44400.0	5.0	0.1
	Coke oven gas	44400.0	5.0	0.1
	Blast furnace gas	260000.0	5.0	0.1
	Oxygen steel furnace gas	182000.0	5.0	0.1
Natural Gas	Natural Gas	56100.0	5.0	0.1
Non-biomass waste	Municipal wastes (non-biomass fraction)	91700.0	300.0	4.0
	Industrial wastes	143000.0	300.0	4.0
	Waste oils	73300.0	300.0	4.0
Peat	Peat	106000.0	10.0	1.4
Biomass waste	Wood/Wood waste	112000.0	300.0	4.0
	Sulphite lyes (Black liquor)	95300.0	3.0	2.0
	Other primary solid biomass fuels	100000.0	300.0	4.0
	Charcoal	112000.0	200.0	1.0
	Biogasoline	70800.0	10.0	0.6
	Biodiesels	70800.0	10.0	0.6
	Other liquid biofuels	79600.0	10.0	0.6
	Landfill gas	54600.0	5.0	0.1
	Sludge gas	54600.0	5.0	0.1
	Other biogas	54600.0	5.0	0.1
	Municipal wastes (biomass fraction)	100000.0	300.0	4.0

Table 6: Emissions Factors for Specific Fuel Types, from the World Resources Institute Heating Calculator. The emission factors, published by WRI, are from the Revised 1996 IPCC Guidelines, Table 1-3, Volume II and from the U.S. Department of Energy/Energy Information Administration (DOE/EIA) from the EIA-1605 Instructions published in 1996. Both of the main sources provided information on the carbon emission factors.
Key: [kg GHG/ TJ = kilograms of Greenhouse Gases per tera joule. GEG Emissions from fuel use in facilities. Version 3.0. December 2007. Developed by the World Resources Institute (GHG Protocol Initiative, 2004).

To calculate the quantity of CO_2 released from the generation of heat, the specific type and quantity of fuel must be known. Once the quantity of fuel (A) has been identified it can be matched to the specific emissions factor (B) (Table 6). The quantity of fuel consumed may need to be converted to tera joules. These factors are given in kg GHG/ tera joule. The GHG emissions from heating a given building will be (A) * (B). This procedure must be completed separately for each of Audubon's buildings, due to the variation in fuel types and quantities. The sum from all buildings will be Audubon's total CO_2 equivalent emissions from heating.

Indirect Emissions: Electricity

WRI defines indirect emissions as emissions "from the generation of purchased electricity, steam, or heat" (Putt del Pino & Pankaj, 2002). The main component of an organization's indirect emissions are GHGs emitted from off-site production of energy (Putt del Pino & Pankaj, 2002). Depending on the local electricity production profile, a kWh of electricity can have a vastly different GHG emissions factor, so the WRI calculator accounts for this regional variation (Table 7). As depicted in Figure 3, forty-eight percent of electricity production in the United States comes from coal (EIA, 2007). Of the remaining fifty-two percent of electricity generation, twenty-two percent is produced from natural gas and petroleum, 19% percent from nuclear power and eight percent from renewable technologies including hydroelectric, solar, wind, and geothermal (EIA, 2007). Therefore, both the quantity of electricity consumed and the location of purchase were necessary to calculate emissions. Although Audubon's leased facilities are also accountable for the GHG emissions from purchased electricity it is much more difficult to make an accurate assessment of consumption for these locations, since this usage is not directly billed to Audubon.

US Electric Power Industry Net Generation, 2007 (Kilowatt hours)		
Coal	48.5%	2016456 kWh
Petroleum	1.6%	65739
Natural Gas	21.6%	896590
Nuclear	19.4%	806425
Hydroelectric Conventional	5.8%	240614
Other Renewables	2.5%	105238
Other	0.6%	25684

Table 7: US Electric Power Industry Net Generation, 2007 (EIA, 2009a) Source: Energy Information Administration, Form EIA-923, "Power Plant Operations Report" and predecessor form(s) including Energy Information Administration, Form EIA-906, "Power Plant Report;" and Form EIA-920, "Combined Heat and Power Plant Report."

The emission factors, published by WRI, were obtained from DOE's Revised State-Level GHG Emissions Factors for Electricity Generation, completed in April 2002 (Putt del Pino & Pankaj, 2002). If the utility bill reflects the kWh consumption for an entire building, the following steps should be taken. Divide the square footage of Audubon's office space by the square footage of the entire building. This number will then be multiplied by the kWh used and the appropriate state emissions factor. If Audubon owns the entire building or office space, then the square footage can be directly multiplied by the kWh and the emissions factor (Table 8).

For the buildings where specific electricity usage was not obtained, averages of electricity usage per square foot from other Audubon buildings in the same EPA Region were used to extrapolate a national total (Figure 15). Using the average electricity per square foot of Audubon buildings in the same region allows for a closer estimation of electricity used in the unknown locations.

Assumptions

For the greenhouse gas footprint from electricity, the following assumptions were made to complete the calculations:

- Using the utility bills received from twenty-eight facilities, the remaining kWh were estimated. In order to find the regional average kWh use, each Audubon facility was assigned to its corresponding EPA region (Figure 15 and Table 10). Then the kWh usage from each of the twenty-eight Audubon facilities from which information was received was averaged (Table 9). None of the Audubon facilities that are located in EPA Regions 3, 6, or 10 reported their kWh usages. For all facilities located in these EPA Regions, the average of all twenty-eight offices was used.

- When electricity bills were received, they were averaged over the twelve-month span of 2008 to obtain monthly average electricity consumption for each facility.

- Six of the twenty-eight facilities who submitted electricity bills provided only partial data; therefore only twenty-two facilities had truly annual averages.

- The number of Audubon's offices that pay their utilities with their rent is unknown, so it was impossible to determine the specific kWh usage for these facilities. These facilities were assigned the appropriate EPA regional approximation.

- An exhaustive list of Audubon's facilities was unavailable, since many office locations have multiple buildings on each property. An organization-wide total square footage was also unavailable. As a result, the estimated GHG footprint from electricity may be an underestimate if Audubon has additional locations that were not on the list of facilities and also did not send in surveys.

Not in Scope

Several sources of emissions from Audubon's operations were omitted from these calculations. The decision to exclude activities can be attributed to excessive difficulty in acquiring data, difficulty in calculating GHG emissions, or attributing specific aspects of the activities to the organization. However, these activities still offer opportunities for emissions mitigation recommendations.

Based on this definition emissions out of the scope of this project include home office activities, waste disposal, and water usage. The GHG emissions associated with home offices contribute to Audubon's footprint but are excessively difficult to quantify. Waste disposal by the organization was also excluded because of the difficulty in identifying the amounts and types of waste. Behavioral changes can be encouraged to limit the amount of waste and increase recycling programs. While water usage indirectly emits GHGs (for the pumping of fresh water to the facility, purification process, and eventual disposal of waste water), this is also difficult to quantify and beyond the scope of this assessment.

Also included in this category are Audubon's promotional items; while they are responsible for purchasing and shipping these items, the supply chain of these items is beyond the scope of Audubon's GHG reduction goals at this time.

Additional Recommendations

Incentives and Tax Credits

Heating

Installation costs of combined heat and power systems are eligible for a 10% investment tax credit with a maximum of fifteen MegaWatts of power per property. 50MW and smaller systems are eligible if installed between October 3, 2008 and January 1, 2017. To qualify, the systems must be 60% efficient, as minimum of 20% of its useful energy must be produced as electricity, and another 20% produced as thermal energy (EnergyTaxIncentives.org, 2009). For further information, please visit: http://www.energytaxincentives.org/business/chp.php and http://www.epa.gov/chp/index.html.

Energy Efficiency

- Energy Star: Energy Star provides tax deductions for commercial buildings (Federal Tax Credits for Energy Efficiency). For the owners of new and existing buildings that meet the American Society of Heating Refrigeration and Air Conditioning Engineers Standard 90.1-2001 and save at least fifty percent of their heating and cooling, there is a tax deduction of $1.80 per square foot . Efficiency measures that include the building envelope, lighting or heating and cooling, there is a partial tax deduction off $.60 per square foot (Energy Star, 2009c). For further information, please visit: http://www.ahrae.org/technology/page/548.

- The Department of Energy provides tax breaks and incentives for business in the areas of:
    - Renewable Energy tax credits: wind, refined coal, geothermal, biomass, solar, and combined heat and power systems (USDOE, 2009d).
    - Transportation and domestic fuel security tax credits: alternative fueling stations, cellulosic biofuel facilities, and alternative fuel production: including biofuels, biomass gas versions of liquefied petroleum gas, liquefied or compressed natural gas (USDOE, 2009d).
    - Energy conservation and efficiency through the reduction of GHGs (USDOE, 2009d). For further information, please visit: http://www.energy.gov/additionaltaxbreaks.htm

- The Database of State Incentives for Renewable Energy (DSIRE) can assist with finding state, local, utility, and federal incentives for energy efficiency incentives and measures.
    - DSIRE lists Federal, state and utility energy efficiency incentives by state and including rebates, grants, loans, and bonds. For further information, please visit http://www.dsireusa.org/.

- *Solar and Photovoltaic:* Businesses are eligible for tax credits for the installation of solar and photovoltaic systems for heating water and cooling and electricity, as well as some solar lighting systems. Systems installed between January 1, 2006 and December 31, 2016 are eligible for the tax credit, which will cover thirty percent of the cost of the system (EnergyTaxIncentives.org, 2009). For further information please visit: Solar Energy Industries Association: http://www.seia.org/ and http://www.seia.org/cs/state_issues.

- *Wind Turbines*: Eligible businesses can receive a Federal level tax credit that will cover thirty percent of the installation cost of a 100kW or less wind turbine. The credit will be available for systems installed through December 31, 2016 (EnergyTaxIncentives.org, 2009). For further information, please visit: http://www.energytaxincentives.org/business/renewables.php and The American Wind Energy Association: http://www.awea.org.

- *Geothermal Heat Pumps:* An investment tax credit of ten percent of the installation cost of a geothermal heat pump available through April 2016. The American Recover and Reinvestment Tax Act of 2009 (ARRA), offers grants to businesses as an alternative to the credit which is worth ten percent of the cost of installation if the equipment is installed between 2009 and 2010 (EnergyTaxIncentives.org, 2009). For further information, please visit: http://www.energytaxincentives.org/business/renewables.php and http://www.geoexchange.org/.

- *Fuel Cells:* Tax credits are also available for businesses who use fuel cells (electricity generation through a chemical process) to produce energy. The tax credit for thirty percent of the cost of installation, with a maximum of $3000 per Kw of power. Eligible systems are required to have at least thirty percent efficiency and 0.5kW of capacity (EnergyTaxIncentives.org, 2009). For further information, please visit: http://www.energytaxincentives.org/business/fuel_cells.php and http://www.usfcc.com/.

State	lbs. CO_2/kWh
Alabama AL	1.31
Alaska AK	1.38
Arizona AZ	1.05
Arkansas AR	1.29
California CA	0.61
Colorado CO	1.93
Connecticut CT	0.94
Delaware DE	1.83
Florida FL	1.39

Table 8. These U.S. average electricity emission factors by state were used in the calculation for GHG emissions from electricity usage and are listed alphabetically by state.

State	lbs. CO_2/kWh
Georgia GA	1.37
Hawaii HI	1.66
Idaho ID	0.03
Illinois IL	1.16
Indiana IN	2.08
Iowa IA	1.88
Kansas KS	1.68
Kentucky KY	2.01
Louisiana LA	1.18
Maine ME	0.85
Maryland (inc. DC) MD	1.37
Massachusetts MA	1.28
Michigan MI	1.58
Minnesota MN	1.52
Mississippi MS	1.29
Missouri MO	1.84
Montana MT	1.43
Nebraska NE	1.4
Nevada NV	1.52
New Hampshire NH	0.68
New Jersey NJ	0.71
New Mexico NM	2.02
New York NY	0.86
North Carolina NC	1.24
North Dakota ND	2.24
Ohio OH	1.8
Oklahoma OK	1.72
Oregon OR	0.28
Pennsylvania PA	1.26
Rhode Island RD	1.05
South Carolina SC	0.83
South Dakota SD	0.8
Tennessee TN	1.3
Texas TX	1.46
Utah UT	1.93
Vermont VT	0.03
Virginia VA	1.16
Washinton WA	0.25
West Virginia WV	1.98
Wisconsin WI	1.64
Wyoming WY	2.15

Table 8 (continued)

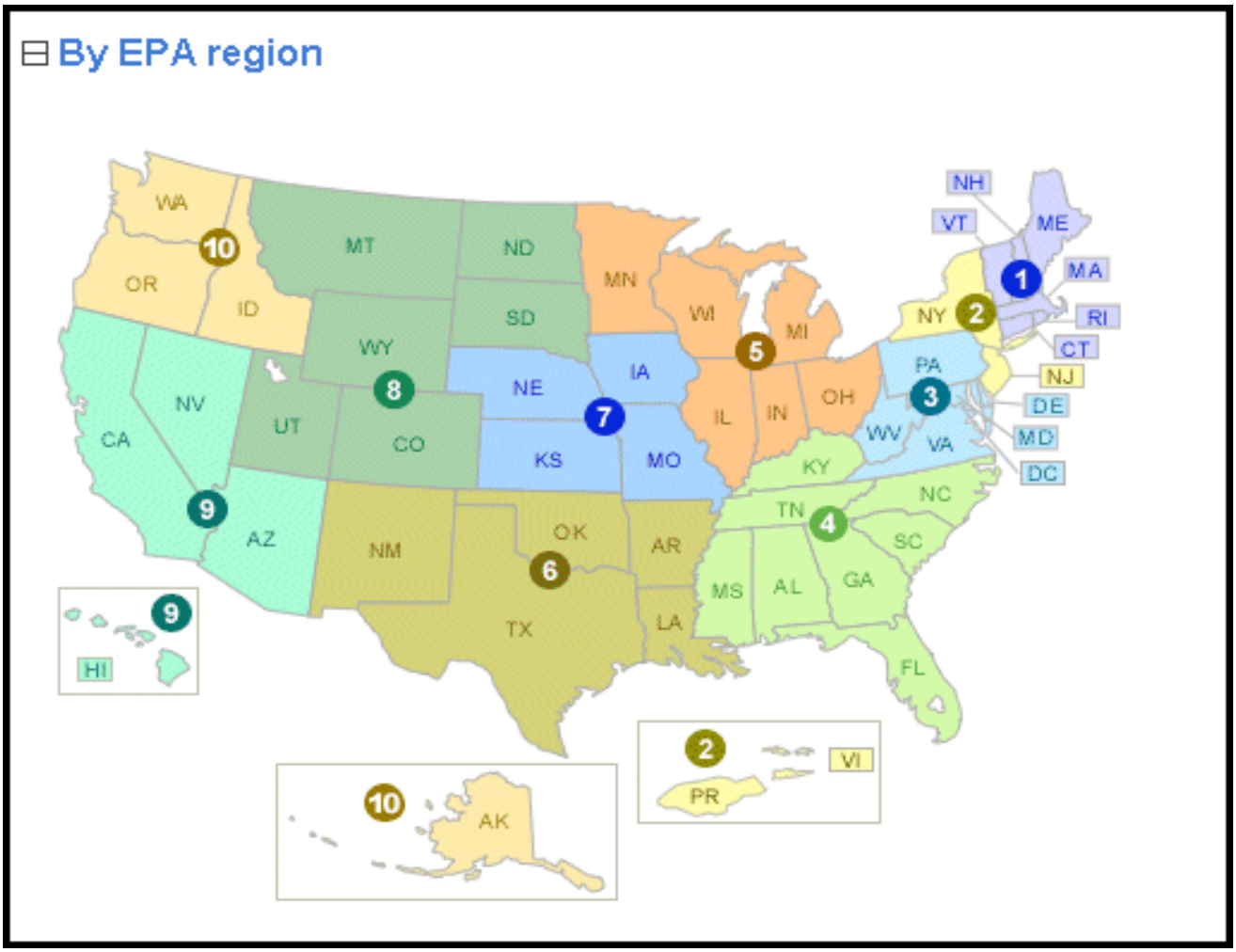


Figure 15: This figure depicts EPA Region Codes. It corresponds to Table 9 which lists each region's annual kWh usage per square foot.

EPA Region	Average Annual kWh Usage per Square Foot
1	1.138594276
2	10.68283309
3	6.905576023
4	7.500430234
5	12.58013663
6	6.905576023
7	15.22090261
8	5.598218182
9	0.719373984
10	6.905576023

Table 9: This table lists the average annual kWh usage per square foot according to EPA Region code.

National Audubon Society Facilities	EPA Region Codes
EDITH L. LEOPOLD PROPERTY	1
AUDUBON MILES WILDLIFE SANCTUARY	1
AUDUBON CENTER AT BENT OF RIVER	**1**
SHARON AUDUBON CENTER	1
GREENWICH AUDUBON CENTER	**1**
SEABIRD RESTORATION PROGRAM SUMMER CABIN	1
SEABIRD RESTORATION PROGRAM WINTER CABIN	1
SCIENCE OFFICE IN MAINE	1
TODD WILDLIFE SANCTUARY / AUDUBON ECOLOGY CAMP OF MAINE	1
VERMONT NATURE CENTER (GREEN MOUNTAIN)	1
IS DEPARTMENT	**2**
AUDUBON HOUSE : New York City Office	**2**
NEW YORK STATE OFFICE	**2**
IMPORTANT BIRD AREAS PROGRAM	2
AUDUBON NEW YORK SCIENCE STAFF OFFICE (MIKE BURGER)	2
CONSTITUTION ISLAND MARSH SANCTUARY & AUDUBON CENTER	2
THEODORE ROOSEVELT SANCTUARY & AUDUBON CENTER - Cottage	2
THEODORE ROOSEVELT SANCTUARY & AUDUBON CENTER - Gatehouse	2
THEODORE ROOSEVELT SANCTUARY & AUDUBON CENTER - Trailside Museum	2
RHEINSTROM HILL SANCTUARY & AUDUBON CENTER - Cambridge Rd Copake, NY	**2**
RHEINSTROM HILL SANCTUARY & AUDUBON CENTER - Crarysville, NY	**2**
PUBLIC POLICY DIVISION	3
AUDUBON PATTERSON PARK OUTREACH CENTER	3
PICKERING CREEK AUDUBON CENTER	3
PENNSYLVANIA STATE OFFICE	3
PENNSYLVANIA SCIENCE CENTER	3
MILL GROVE AUDUBON CENTER	3
EVERGLADES CAMPAIGN - FLORIDA STATE OFFICE	4
FLORIDA COASTAL ISLANDS SANCTUARY	4
TALLAHASSEE OFFICE	4
TAVERNIER SCIENCE CENTER	4
MARINA FOR TAVERNIER CENTER	4
OKEECHOBEE/KISSIMMEE OFFICE	4
FLORDIA KEYS ENVIRONMENTAL	**4**
BLAIR AUDUBON CENTER AT CORKSCREW SWAMP SANCTUARY	4
Birds of Prey - Maitland, FL (Service Building)	**4**
Birds of Prey - Maitland, FL (House)	**4**
Birds of Prey - Maitland, FL (Clinic Building)	**4**
CLYDE E. BUCKLEY WILDLIFE SANCTUARY & AUDUBON CENTER	4
AUDUBON MISSISSIPPI – VICKSBURG	4
AUDUBON MISSISSIPPI COASTAL PROJECT OFFICE	4
STRAWBERRY PLAINS AUDUBON CENTER - lights in the field	**4**
Strawberry Plains Audubon Center - Visitor Center	**4**

National Audubon Society Facilities	EPA Region Codes
Strawberry Plains Audubon Center - Antebellum House	**4**
Strawberry Plains Audubon Center - Hunters Cabin	**4**
STRAWBERRY PLAINS AUDUBON CENTER - office	**4**
WILMINGTON COASTAL PROJECT OFFICE	4
NORTH CAROLINA STATE OFFICE	4
PINE ISLAND SANCTUARY	4
AUDUBON CENTER & SANCTUARY AT FRANCIS BEIDLER FOREST	4
SILVER BLUFF AUDUBON CENTER & SANCTUARY - Manger's Residence	**4**
SILVER BLUFF AUDUBON CENTER & SANCTUARY - Visitor Cente	**4**
SILVER BLUFF AUDUBON CENTER & SANCTUARY - Kathwood Office/ Work Shop	**4**
SILVER BLUFF AUDUBON CENTER & SANCTUARY - Cabin	**4**
SILVER BLUFF AUDUBON CENTER & SANCTUARY - Classroom Trailer	**4**
SILVER BLUFF AUDUBON CENTER & SANCTUARY	4
CHICAGO WILDERNESS PROGRAM	5
CHICAGO REGION	5
UPPER MISSISSIPPI RIVER CAMPAIGN / MINNESOTA STATE OFFICE	5
AUDUBON MINNESOTA	5
OHIO STATE OFFICE	5
Aullwood Audubon - Maintinance Shed	**5**
Aullwood Audubon - Intern Residence	**5**
AULLWOOD AUDUBON CENTER	**5**
AULLWOOD AUDUBON -Pump house	**5**
SCHLITZ AUDUBON NATURE CENTER	5
ARKANSAS STATE OFFICE	6
AUDUBON ARKANSAS - FAYETTEVILLE LOCATION	6
GULF COAST INITIATIVE	6
PAUL J. RAINEY WILDLIFE SANCTUARY	6
RANDALL DAVEY AUDUBON CENTER	6
AUDUBON TEXAS- AUSTIN OFFICE	6
MITCHELL LAKE AUDUBON CENTER	6
DALLAS OFFICE	6
SABAL PALM GROVE SANCTUARY & AUDUBON CENTER	6
MS RIVER INITIATIVE -ROGER STILL	7
WILDCATS GLADES CONSERVATION & AUDUBON CENTER	7
HORNADY PROPERTY - PART OF ROWE SANCTUARY	7
SPRING CREEK PRAIRIE AUDUBON CENTER	**7**
IAIN NICOLSON AUDUBON CENTER AT LILLIAN ANNETTE ROWE SANCTUARY	7
COLORADO STATE OFFICE	8
CHAPTER SERVICES OFFICE	8
AUDUBON DAKOTA	8

National Audubon Society Facilities	EPA Region Codes
EDWARD M. BRIGHAM III ALKALI LAKE SANCTUARY	8
WYOMING AUDUBON / AUDUBON CENTER AT GARDEN CREEK	8
WYOMING STATE OFFICE	**8**
LES COREY'S OFFICE - FIELD OFFICE	9
ARIZONA STATE OFFICE - RIO SALADO AUDUBON CENTER	9
APPLETON -WHITTELL RESEARCH RANCH	**9**
TUCSON AUDUBON SOCIETY	9
AUDUBON CALIFORNIA - SAN FRANCISCO AREA	9
CA STATE OFFICE/ FIELD OPERATIONS -WEST	9
BOBELAINE AUDUBON SANCTUARY	9
AUDUBON CALIFORNIA - DEVELOPMENT OFFICE	9
LANDOWNER STEWARDSHIP OFFICE (VANCE RUSSELL OFFICE)	9
AUDUBON CA IBA PROGRAM	9
SPRAGUE RANCH HOUSE / ALEXANDER RANCH (part of Kern River Preserve)	9
AUDUBON CENTER AT DEBS PARK	9
BOBCAT RANCH	9
RICHARDSON BAY AUDUBON CENTER & SANCTUARY	9
KERN RIVER PRESERVE	9
STARR RANCH SANCTUARY	9
WILLIAMS SISTERS RANCH SANCTUARY	9
ALASKA STATE OFFICE	10

Table 10: List of National Audubon Society Facilities and corresponding EPA Region. The bolded locations are those from which electricity use was calculated directly from utility bills and the un-bolded facilities are those buildings for which electricity was estimated.

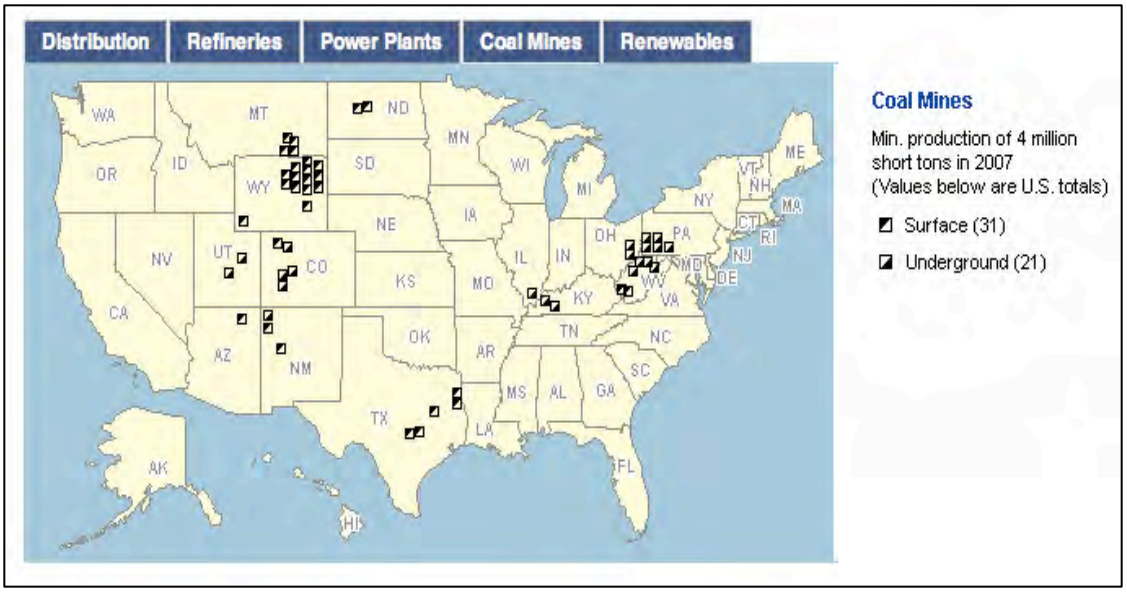


Figure 16: Location of the 31 surface and 21 underground coal mines in the United States, from the Energy Information Administration (EIA, 2009).

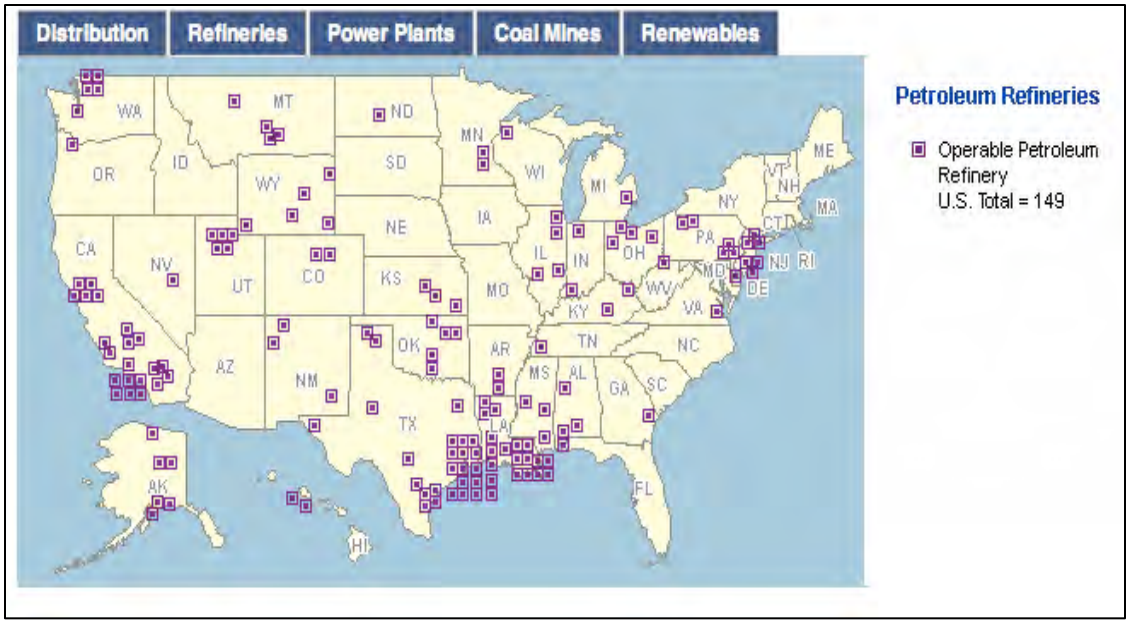


Figure 17: Location of the 149 Petroleum Refineries Operating in the United States, from the Energy Information Administration (EIA, 2009).

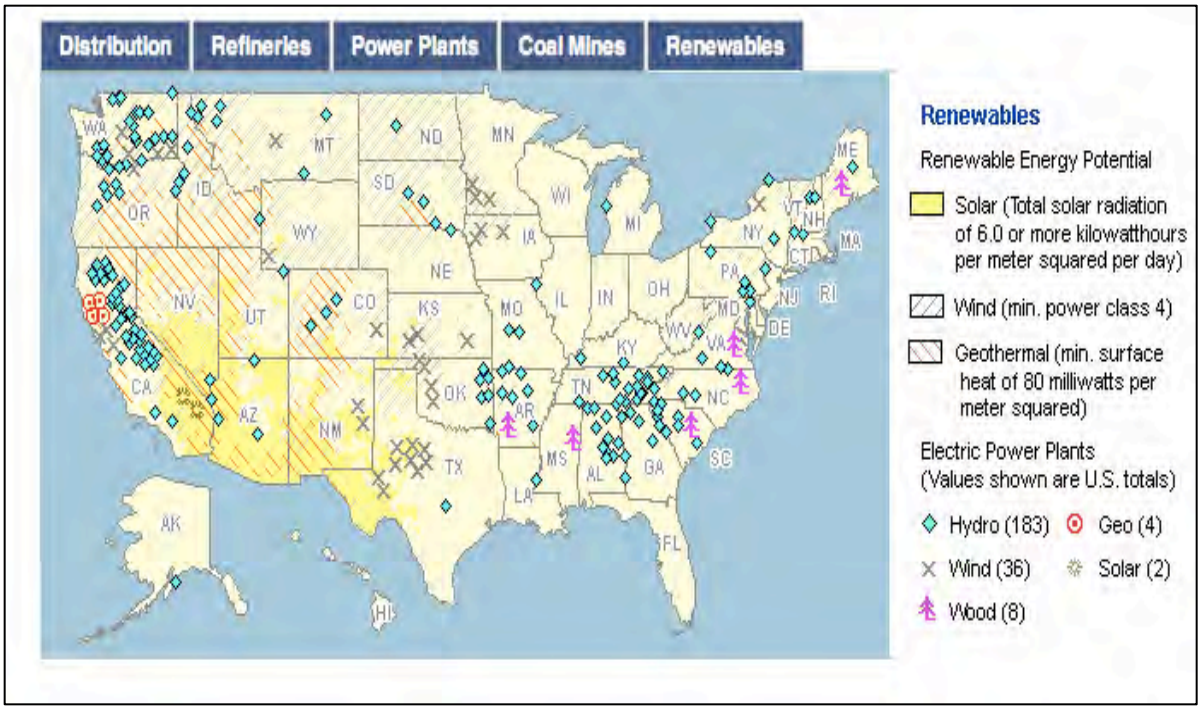


Figure 18: Location of Potential Renewable Energy Sources in the United States, from the Energy Information Administration (EIA, 2009).

Appendix 2: Transportation

Employee commuting in cars, buses, and trains, as well as business travel in airplanes, rental cars, buses, and trains are included in the transportation category. The differences between the emissions levels from various types of transportation for a standard trip between New York City and Washington DC (Figure 19).

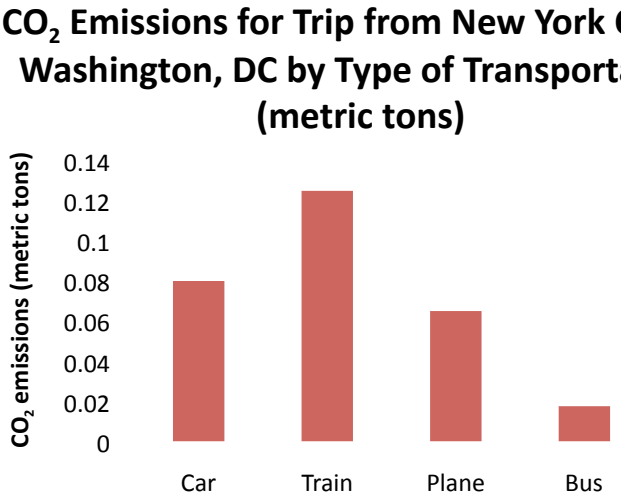


Figure 19. This figure shows the emissions based on transportation for the 238 mile trip between New York City and Washington DC, the route most frequently traveled by Audubon employees.

Methodology

Using the World Resources Institute Carbon Calculator questionnaire as a template, a survey was developed and distributed to each employee with questions about personal commuting and business travel during 2008. This survey can be found in Appendix 5. Of Audubon's 700 employees 256 returned surveys. Calculating an accurate transportation footprint required making many assumptions. The assumptions associated with each calculation are detailed below.

Calculations

To calculate the emissions associated with each type of commuting, emissions factors from the mode of transportation and the distance traveled annually were multiplied by a standard emissions factor for each type of transportation. The emissions factor allowed for conversion of distance travelled into emissions in kilograms of CO_2 equivalents. This value was then converted to metric tons. A description of each of the emissions factors follows.

Car Travel. Since the fuel efficiency of each employee's vehicles was not available, the emissions factors used were based on a default fuel efficiency associated with the size of the car (Table 11).

Size of Car, Fuel efficiency: MPG (Highway, City)	**Kg CO_2 per mile**
Small Car (greater than 32, greater than 26)	0.28
Medium Car (greater than 30, greater than 22)	0.36
Large Car (greater than 25, greater than 18)	0.44

Table 11. This table shows the emissions factors for small cars, medium cars, and large cars. Source: Environmental Reporting – Guidelines for Company Reporting on GHG Emissions, UK DEFRA: http://www.defra.gov.uk/environment/envrp/gas/10.htm (Putt del Pino & Pankaj, 2002).

Assumptions

The following assumptions were made when calculating the emissions associated with travel by car:

- When a car type was not specified, a medium car was assumed.
- If employees shared a ride somewhere for business travel or commuting, the trip was counted as part of each of their transportation GHG footprints. Due to the difficulty in determining when rides were shared, business travel may have been overestimated.
- When an origin and destination were indicated on an employee's questionnaire but the distance traveled was not, mapquest.com was used to calculate the miles from the origin to the destination.
- When an employee reported commuting a range of days per week, the higher number of the range was assumed, or the number of days commuted was averaged (for example when an employee reported commuting two to three days a week, in some instances the number of days commuted was assumed to be three, in other instances it was assumed to be 2.5).
- When ground transportation was indicated for business trips but distance traveled was not, the ground transportation was not included.
- There is no emissions factor for motorcycles, so for employees using a motorcycle to commute, a small car emissions factor was used.
- There was no way to accurately measure whether travel was through high traffic (which would indicate higher emissions), or lower traffic (which would account for this).

Air travel. Most emissions in air travel occur during takeoff and landing, which means that the emissions per mile for short flights are usually larger than for medium or long flights (Putt del Pino & Pankaj, 2002). The emissions factors used to determine air travel GHG emissions are based on default values for short, medium and long flights. These emission factors assume an average level of occupancy on each airplane to determine the emissions measured in CO_2 per passenger per mile (Table 12)(Putt del Pino & Pankaj, 2002).

Length of Trip	kg CO_2 per passenger mile
Short (trips less than 281 miles)	0.29
Medium (trips between 281 and 994 miles)	0.20
Long (trips more than 994 miles)	0.18

Table 12. This table shows the kg CO_2 per passenger mile, for short flights, medium flights, and long flights. Source: Air travel definitions and factors are from the GHG Protocol Mobile Combustion Tool. The emissions factors for short and long haul flights are originally from UK DEFRA. The emissions factor for medium flights was derived, using an assumed distance of 1600 km and the following formulas.

X+452y =.18*452 for short flights

X+6342y=.11*6342 for long flights

Based on Emission Factors provided by DEFRA (Table 9, Environmental Reporting - Guidelines for Company Reporting on GHG Emissions) for short haul and long haul flights http://www.defra.gov.uk/environment/envrp/gas/10.htm (Putt del Pino & Pankaj, 2002).

The following assumptions have been made when calculating emissions associated with air travel:

- Distances traveled by airplane were measured using http://webflyer.com/travel/milemarker/index.php, however airports were rarely indicated. The largest regional airport was assumed and, thus flight distances may be inaccurate.
- Most employees indicated air travel by origin and destination, and did not indicate whether or not there were multiple flights. This may cause emissions to be under-estimated as rates of emissions are higher for shorter flights.
- Some employees indicated air travel that did not occur in 2008; this air travel was not included. However, when a date was not indicated air travel was included, so it is possible that some trips not taken in 2008 were included in the transportation GHG footprint.

Train Travel. Rail travel emissions factors are based on the type of fuel used and distance travelled. Emissions factors for different types of trains are based on the type of fuel used. For example, Amtrak trains use diesel fuel and are thus defined as diesel rail, whereas urban rail systems such as the New York City subway or the Washington D.C. Metro have different emissions profiles based on using electricity and typically having more frequent and shorter trips so a different transit emissions factor is used (Table 13) (Amtrak Representative, Personal Communication, April 1, 2009).

Type of Train	kg CO_2 per passenger mile
US Diesel Train[1]	0.28
US Coal Train[2]	0.37
US Electric Train[3]	0.55
US Transit Rail[4]	0.55

Table 13. This table shows the kg of CO_2 per passenger mile for the types of trains used by Audubon employees for commuting and business travel.

1. Source: Bureau of Transportation Statistics, 2000 (table 4.20/energy intensity for Amtrak 1997)

2. Multiplies diesel emissions per unit by 26.8/20.2, the ratio of Carbon emissions per gigajoule, coal to diesel.

3. Multiplies diesel locomotive numbers times two, assuming generation fuel mix is slightly less carbon intensive than diesel, but generation and transmission are about 40% efficient. This will vary considerably depending upon the carbon intensity of fuel mix.

4. To obtain this number, the following were multiplied: 3105Btu/psgr-mile(TEDB) * 1.055kJ/Btu (conversion) * 1kwh/3600 kJ (conversion) * 1.34 lbsCO2/kwh (EIA) * 0.4536 kgCO2/lbsCO2 (conversion)
   Sources:
   TEDB = Transportation Energy Data Book, Edition 22- 2002, Table 2.11. Available at http://www-cta.ornl.gov/data.
   EIA = ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/e-supdoc.pdf, page
   Note: transit rail is defined as light and heavy rail. For definitions, please see http://www.apta.com/info/define/mode.htm (Putt del Pino & Pankaj, 2002).

Bus Travel. Emission factors for bus travel were determined by fuel type and length of trip. Since most emissions are released during starting or accelerating the engine, larger emissions factors are found in urban bus travel than in long distance bus travel (Table 14) (Putt del Pino & Pankaj, 2002).

Type of Bus	kg CO_2 per passenger mile
Diesel, urban	0.30
Diesel, long distance	0.08

Table 14. This table shows the kg CO_2 per passenger mile for bus types used by Audubon employees in commuting and business travel. Source for diesel: Bureau of Transportation, National Transportation Statistics for 2000.
Source for CNG: Multiplies diesel (urban) emissions per unit by 56/73.9, the ratio of CO2 emissions per terajoule, natural gas to diesel. Emission factors are based on lower heating values. They are sourced from Revised IPCC, 1996, Vol. 2, Table 1-2 (Putt del Pino & Pankaj, 2002).

In general, the transportation calculations were based on the following key assumptions:

- It was assumed that employees worked fifty-two weeks a year, which does not account for sick days or vacation days. This assumption likely led to an overestimation of the emissions from commuting.
- There is no standard emissions factor for marine transport included in the calculator, so when employees indicated travel by ferry or cruise ship these trips were not included.

Please note that surveys were received from individuals who were not on the original employee list, which may have lead to an underestimated final number for emissions.


Appendix 3: Paper

The methodology chosen to calculate the lifecycle GHG emissions for Audubon's paper consumption is EDF's Paper Calculator. The EDF paper calculator has been used by advocacy organizations such as The Environmental Paper Network, Conservatree, and the Green Press Initiative (EDF, 2009)

The paper calculator was chosen because it incorporates a complete life cycle assessment of paper use, following both virgin and recycled paper from harvest to processing, manufacturing, and decomposition and/or reuse. The paper calculator calculates emissions in several units including: wood consumption, total energy used, amount of energy purchased, and GHG emissions (EDF, 2009).

The paper calculator compares three different possible scenarios that might occur in a paper's lifecycle:

1. Acquisition of virgin fiber, processing of virgin paper, paper use, followed by disposal in a landfill;

2. Acquisition of virgin fiber, processing of virgin paper, paper use, followed by paper being incinerated;

3. Manufacture of recycled paper, paper use, followed by recycling collection, processing and transport to a site of remanufacture (EDF, Paper Task Force, 2002).

GHG emissions from tree harvesting, transporting of logs or chips from the forest to the mill, and debarking and chipping of logs are also included in these scenarios as industry averages (EDF, Paper Task Force, 2002, 5). The EDF paper calculator requires the user to input the quantity of paper used by weight and type of paper (i.e. copy paper or newsprint). It then calculates GHG emissions from the use of that paper by comparing data from the three scenarios listed above and proportionally distributes the GHG emissions depending on the paper's ratio of virgin to recycled content. The first and

second scenario calculations are included based on an average of how much paper goes to the landfill (80%) or incinerator (20%). These values are United States averages, as determined by the EPA (EDF, Paper Task Force, 2002, 4). For example, an analysis of a ton of 30% post-consumer recycled content paper would proportionally allocate emissions as follows: 70% of the paper's emissions number would come from the allocated combination of scenario 1 and 2, the virgin fiber paper, and 30% of the emissions' number would come from scenario 3, recycled paper (EDF, Paper Task Force, 2002, 3). This weighted average will determine the GHG emissions of the paper.

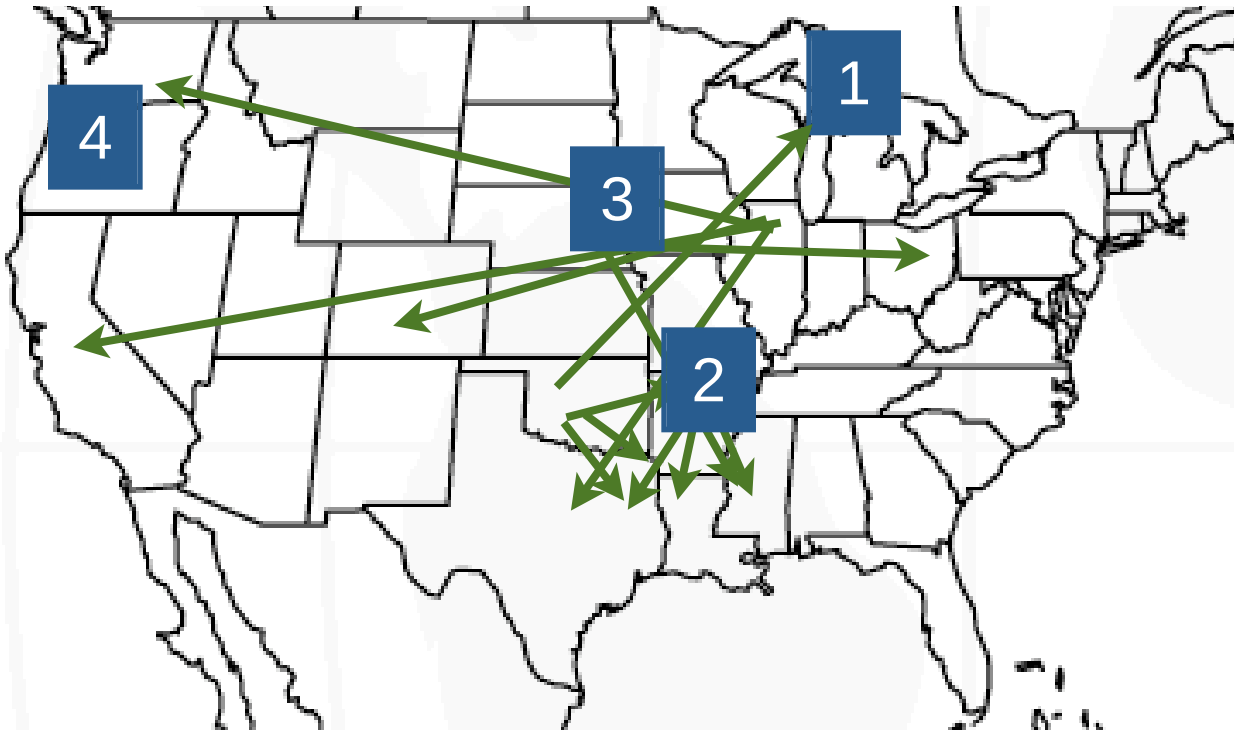
To fully assess the impacts of the paper, we also considered the transportation and shipping impacts of the paper from supplier to the printer. Transportation emissions were calculated using the WRI calculator as specified in the transportation section.

Certain portions of the paper life cycle were intentionally left out of the calculation. There are two primary reasons for these omissions. The first is that the data on certain portions of the life cycle would be prohibitively difficult to obtain and present with accuracy. For example, GHGs associated with chemical fertilizers or pesticides used in silviculture activities are hard to quantify and assign to a specific amount of wood. The second reason is that certain activities are beyond Audubon's control. For example, delivery service by the United States Postal Service will continue whether or not Audubon Magazine uses this service. While in many cases Audubon may not have direct control over a segment of the lifecycle, in some instances it can influence that segment either through contracting or procurement choices. These are the elements of the lifecycle that we focused on when determining which activities to include in Audubon's paper emissions footprint (Table 15).

Lifecycle – Stage	Calculation Methodology
Tree to Pulp Paper	EDF Paper Calculator
Recycled Fiber Processing	EDF Paper Calculator
Paper Delivery to Printer	WRI Transportation Calculator
Printer Impact	Printer Supplied Emission Data
Disposal/Recycle	EDF Paper Calculator

Table 15. Paper lifecycle and the methodology used to account for these emissions.

Discover Magazine Case Study



Key

1. Quebec, Canada paper mill
2. Jonesboro, Arkansas printer
3. Chicago, Illinois main distribution facility; trucked to 6 regional distribution facilities
4. 213 wholesalers across the nation

Staff / Office

4.9 metric tons CO_2 / month

35 staff members

DISCOVER HEADQUARTERS (NY, NY)

7.9 metric tons CO_2 / month

9,091 kilowatt-hours

Sources: EPA (regional emissions rates for electricity generation), Dept. of Energy (natural gas emission figures)

Paper Production & Transport

38.1 metric tons CO_2

TRUCK

PAPER MILL (QUEBEC)

557 metric tons CO_2

(Magazine & Inserts)

12.4 metric tons CO_2

TRUCK

(348,000 lbs. of paper)

TRAIN

PRINTING FACILITY (JONESBORO, ARKANSAS)

Sources: Paper Task Force
Greenhouse Gas Protocol

Printing

4.3 metric tons CO_2

MAIN DISTRIBUTION CENTER (CHICAGO)

600,000 issues

TRUCK

47.2 metric tons CO_2

PRINTING FACILITY (JONESBORO, AR)

8.7 metric tons CO_2

INK PRODUCTION

TRUCK

5.3 metric tons CO_2

213 WHOLESALERS (ACROSS US & CANADA)

300,000 issues

Subscription

6.6 metric tons CO_2 | 3.0 metric tons CO_2 | 14.5 metric tons CO_2

MAIN DISTRIBUTION CENTER (CHICAGO) → TRUCK → 6 REGIONAL DISTRIBUTION CENTERS → TRUCK → UNITED STATES POSTAL SERVICE → TRUCK → YOUR HOME

Sources: USPS Footprint

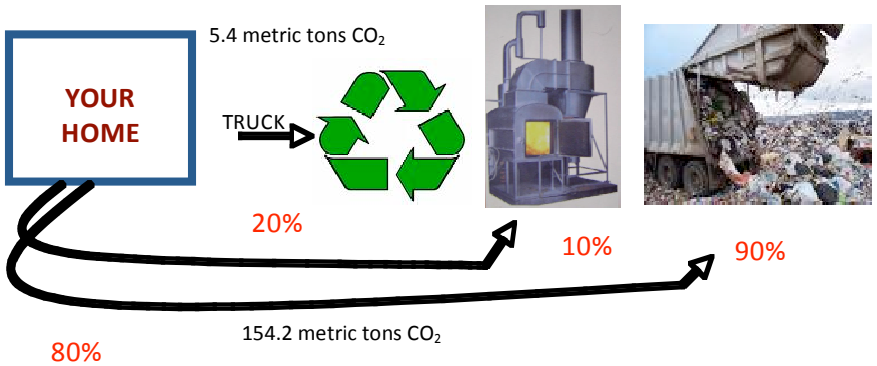
Wholesale

2.1 metric tons CO_2

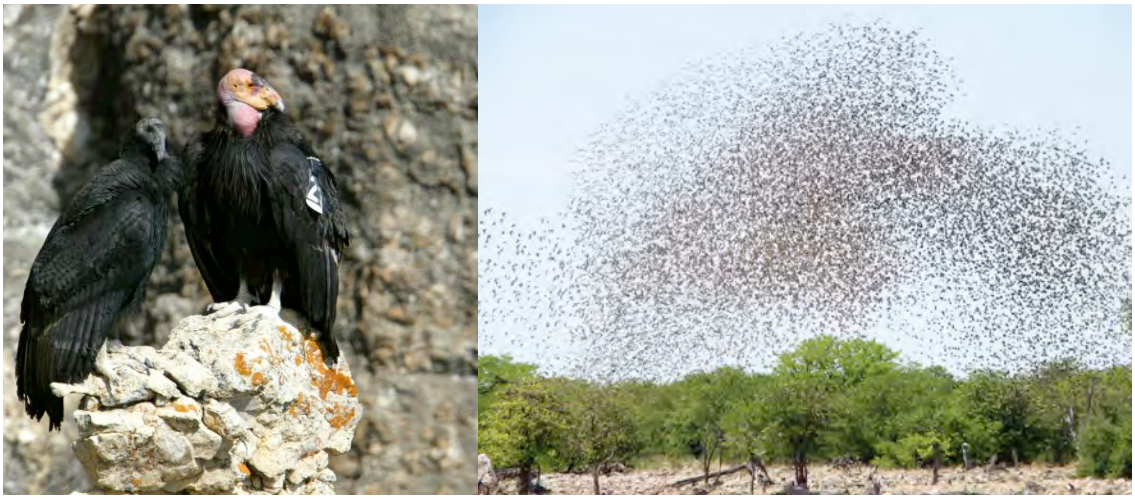
213 WHOLESALE DISTRIBUTORS (ACROSS US & CANADA) → TRUCK → 41,500 LOCAL RETAILERS

(Each local retailer is within a 100-mile radius of their wholesaler)

End of Lifecycle



Source: Magazine Publishers Association



Appendix 4: Landholdings

To assess the GHG sources and sinks for the Audubon Society's landholdings, a method of calculation based on the US Forest Service General Technical Report NE-343 (Smith, Heath, Skog, Birdsey, 2006) was developed. There are three possible methods for calculating the GHG footprint of forests: direct measurements, mathematical models, and look-up tables (National Commission on Science for Sustainable Forestry, 2008). GHG calculators provide a secondary method for determining a GHG footprint, as they combine data from these primary methods with simplifying assumptions to estimate the magnitude of GHG sources and sinks.

Industry leaders, government agencies, and non-profit organizations have developed a number of GHG calculators for forestland. Many, like the Climate Action Registry's calculator, provide only region-specific data. Therefore, the assumptions that are built into the calculator only apply to those specific regions. Because Audubon owns lands throughout the United States, these calculators are inadequate for analyzing the sequestration of its landholdings. Other calculators make overly simplistic assumptions (e.g., assuming that all trees have equal carbon storage capacity) or have undefined methodologies. Due to the limitations of available calculators, we designed a calculator based on primary data from look-up tables to determine the GHG footprint of Audubon's landholdings.

Methodology

Report NE-343 describes a look-up table methodology that can be used to quantify the carbon storage of forests based on a number of variables (For an example of a look-up table see Table 16). Ideally, direct measurements and mathematical models provide the most precise estimates for forest sequestration, but this would require a large investment in both time and money, and would offer only region-specific data (Smith, Heath, Skog, Birdsey, 2006).

Age (years)	Mean Volume of Wood (m3/ha)	Mean Carbon Density in Soil (metric tons C/ha)	Mean Carbon Density in Biomass (metric tons C/ha)
0	0.0	69.6	61.8
5	0.0	69.6	52.2
15	28.0	69.6	64.7
25	58.1	69.6	85.7
35	89.6	69.6	107.8
45	119.1	69.6	126.0
55	146.6	69.6	142.7
65	172.1	69.6	157.7
75	195.6	69.6	171.2
85	217.1	69.6	183.2
95	236.6	69.6	193.9
105	254.1	69.6	203.4
115	269.7	69.6	211.7
125	283.2	69.6	218.8

Table 16. A reproduction of a look-up table for maple-beech-birch stands in the NE. By using the age of a maple-beech-birch stand in the NE, one can determine the total carbon stored by summing the values for carbon in soil and carbon in biomass. For example, a maple-beech-birch stand in the NE that is 35 years old will store 69.6 metric tons of carbon per hectare in soil and 107.8 metric tons of carbon per hectare in biomass. Thus, this forest sequesters a total of 177.4 metric tons of carbon per hectare (Table adapted from Smith, Heath, Skog, Birdsey, 2006).

Wetlands

In addition to forests, Audubon's landholdings also include wetlands, which are not covered by the look-up tables. The contribution of wetlands to the GHG footprint of landholdings is still a source of uncertainty within the scientific community, but research generally suggests that wetlands can be both sources and sinks of carbon (Environment Canada, 1998; Bernal, B. and W. J. Mitsch, 2008). Though wetlands produce methane from biological activity, they also capture carbon through carbon fixation and deposition of organic matter. Studies suggest that wetlands capture 0.63 to 0.98 tons CO_2 equivalents per acre annually (McCarty and Ritchie, 2002; Mitsch, 2000). At the same time, they release a similar quantity of carbon equivalents in the form of methane (Matthews and Fung, 1987; Agarwal and Garg, 2009; Cao et al, 1998). Some wetlands emit more greenhouse gases than they sequester, while others sequester more than they emit. Because of the uncertainty in the exact greenhouse gas balance of wetlands, this GHG Assessment does not report on wetland emissions.

In addition to natural land characteristics, operations and management also factor into the GHG footprint of Audubon's landholdings. In particular, fuel and chemicals are used on landholdings, which are sources of GHG emissions. In order to quantify the GHG emissions from fuel used by vehicles on landholdings, the emissions factor was multiplied by the total volume of fuel used by each landholding. The emissions factor for gasoline is 8.9 kg CO_2/gallon while diesel emits 10.2 kg CO_2/gallon (USEPA, 2008).

Furthermore, some of Audubon's land managers use chemicals such as fertilizers to maintain plant life. According to a calculator published by Carbon Independent, six tons of CO_2 equivalents are emitted for every seven tons of fertilizer used. This figure includes emissions due to production and caused by chemical changes in soil (Carbon Independent, 2008). However, given that chemical use is minimal in Audubon's landholdings, the contribution of fertilizers to the Audubon's overall GHG footprint is negligible.

The emissions of GHGs from fuel and chemical use are relatively small when compared to the large sequestration capacity of biomass on landholdings. Thus, given the many components of the Audubon Society's GHG footprint on landholdings, anthropogenic factors like chemical and fuel use have a relatively insignificant impact on the overall footprint, while the sequestration on landholdings is the most dominant feature.

Appendix 5: Survey

Survey Questionnaire: For Facility Managers
General Questions:

1. How many employees work in your facility?
2. What is the total square footage of your office space?
3. Do you receive a utility bill or are utilities included in the rent? If possible, please attach copies of all electricity and heating bills from January 2008 – December 2008.
4. Do you receive a water bill? If possible, please attach copies of all water bills from January 2008 – December 2008.
5. If you are not directly billed, can you provide us with the contact information for your leasing agent so we might retrieve the information?
6. Is your office in a stand-alone or multi-tenant building?
7. Do you have a green roof (ie a roof covered in vegetation)?
8. If not, what color is your roof and building exterior color and material type?

Heating

1. What type of heating does your office use (ie, oil, gas, electric, steam)?
2. Do you have adjustable thermostats?
3. If so, is there one for the office or multiple throughout the office (describe locations)?
4. How many days per week and hours per day is the office in use?
5. Is the building insulated?
6. How old is the building?
7. Is it a landmarked building?

Electricity

1. Does your office have energy efficient lighting (including fluorescent)?
2. Does your office have motion sensor lighting? If so, where (ie, in the bathrooms, in individual offices, etc)?
3. Does your office have any Energy Star appliances and electronics (please list)?
4. Do you encourage any energy conservation behaviors?

Water

1. Does your office monitor water use?
2. Do you have landscaping?
3. If so, how is it watered?
4. Do you have a sprinkler system?
5. Does your office have a stand-alone water cooler for employee/visitor use?
6. If so, is it connected to the plumbing system?
7. Do you have low flow toilets and sink faucet aerators?
8. Do you encourage any water conservation behaviors?

Waste

1. Does your office space have a common kitchen?
2. Does it have tableware and silverware for common use? Is it disposable or reusable?
3. Do you provide coffee?
4. Do you provide food for the office? Is the food organic, fair trade certified or locally produced (within 100 miles)?
5. Do you compost?
6. On average, do more people bring in their own lunch or take-in?
7. Do you encourage employees to use reusable containers, mugs and bottles?

Recycling

1. Does your office have a waste reduction/ recycling program?
2. If so, who is in charge of monitoring it?
3. What do you recycle? Please indicate all those that apply:
    1. Paper
    2. Plastic
    3. Glass
    4. Aluminum
    5. Electronic equipment (Please indicate: computers, monitors, printers, other _____)
    6. Ink cartridges
    7. Batteries
    8. Office materials (Please indicate: carpets, desks, chairs, other _____)
4. Is the garbage and recycling collected by the city or a private carter for the building?

Survey Questionnaire: For landholdings managers

In order to effectively measure the impact of your land holdings on the National Audubon's carbon footprint, please answer the following questions about your property.

General Questions

1. What is the name of the property and where is it located (*state, location within state, and if possible the longitudinal and latitudinal coordinates*)?
2. How large is your land holding? *(Please specify units, e.g. acres or hectares)*

Questions about vegetation

3. What is/are the dominant vegetation types in your land holding (*e.g., maple forest, prairie grass, pine forest*). If more than one, what is the percent coverage of each type?
4. What is the average age of trees in your forest? If you don't know the exact age, is the forest a transitional forest or an old growth forest?
5. Besides the vegetative cover, are there any other geologic formations (e.g., bodies of water, wetlands, mineral deposits that are being extracted) on your land holding?

Questions about non-vegetative properties

6. What is the soil composition of your land holding (e.g., clay, silt, loam, and/or sandy)? If more than one, what is the percentage coverage of each type?
7. Do you have any data sets, GIS maps, or aerial photographs of your land holdings? If so, can you please provide us with this data.

Questions about operation and maintenance procedures

8. Do you use chemicals such as fertilizers or pesticides on your property? If so,
    a. What types do you use (please give the chemical composition of the substance)?
    b. How much do you use (please give weight)?
9. What modes of transportation are used on your land and for what purpose (e.g., do you use four by fours to patrol forests, are visitors transported around by vehicle)?
    a. If yes, what vehicle type(s) do you have?
    b. How many vehicles do you have?
    c. What is the gas mileage of each vehicle?
    d. How many miles does each vehicle travel per month or year?

Survey Questionnaire: For Employees

Building Location: _____

Transportation

Commuting

1. How many days of the week do you work?
2. Of the days you work, how many do you commute to the office?
3. How many miles per day do you commute?
4. What is your habitual mode of transportation?
5. If you commute by car:
    1. How many other people ride in the car other than you?
    2. Please indicate car type that applies: Large; Medium; Small; Diesel; Hybrid?
    3. What is the Fuel Economy of your car (MPG)?
    4. How many miles do you drive to and from the office?
6. If you commute by train:
    1. Do you drive to the train station? (If so please answer the car commuting questions)
    2. How many miles is your train ride to and from the office?
7. If you commute by bus:
    1. Do you drive to the bus? (If so please answer the car commuting questions)
    2. How many miles is your bus ride to and from the office?
8. If you commute by subway (BART or other similar city train transit):
    1. Do you drive to the train stop? (If so please answer the car commuting questions)
    2. How many miles is your subway commute to and from the office?
9. If you bike to the office, how many days per month?
10. If you walk to the office, how many days per month?

Business Travel

1. Did you take any business trips in Fiscal Year 08? (ie for national meetings, conventions, conferences, events, etc.)
    1. If so, How many? If possible, please attach records of the flights and transportation for each trip (ie Frequent Flier or Travel Agent account log)
    2. Alternatively, please list:
        1. Departure and arrival city for each trip
        2. How you got there (ie, plane, car, train, bus, ferry, etc.)
        3. How you traveled when you arrived (rental car type, miles driven, taxi trip distances)
        4. How many days you stayed

Appendix 6: Acronyms

AFUE	Annual Fuel Utilization Efficiency
ARRA	American Recovery and Reinvestment Act
CH_4	Methane
CO_2	Carbon Dioxide
DEFRA	Department for Environment, Food and Rural Affairs
DOE	Department of Energy
DSIRE	Database of State Incentives for Renewable Energy
EDF	Environmental Defense Fund
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FSC	Forest Stewardship Council
GHG	Greenhouse Gas Assessment
GHGP	Greenhouse Gas Protocol
HVAC	Heating, Ventilating, and Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
Kg	Kilogram
kWh	Kilowatt Hour
LEED	Leadership in Energy and Environmental Design
MW	MegaWatt
NRDC	Natural Resources Defense Council
NGO	Non-Governmental Organization
N_2O	Nitrous Oxide
TJ	Tera Joule
U.S.	United States of America
USPS	United States Postal Service
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

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