Dovetail Partners Consuming Responsibly Report No. 3

Environmental Assessment of Natural vs. Artificial Christmas Trees

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November 19, 2018

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Executive Summary

The question of natural vs. artificial Christmas trees is often a topic of discussion in the popular media as year-end approaches, suggesting more than casual interest in the tradeoffs involved. Among those tradeoffs is environmental impact.

In 2016, 27.4 million natural Christmas trees were sold in the United States, about 9 million more than the number of artificial trees sold (18.6 million). Although more natural trees were sold, the difference in the number of real vs. artificial trees was the smallest ever recorded.[1]

Changing consumer preferences raise a question as to what impact a shift to greater numbers of artificial trees might have on the environment. Which has less impact, natural or artificial trees? The answer is that . . . well, it depends. Which of these choices is environmentally better hinges on such factors as travel distances from local tree retailer to home, the number of years an artificial tree is kept in service, what happens to natural trees at the end of the Christmas season, and what environmental impact measure is judged to be the most important.

In general, production and use of natural trees results in lower environmental impacts than production and use of artificial trees. However, long transportation distances from tree grower to retailer and retailer to home have a significant impact on a range of impact indicators, and can shift the advantage to artificial trees. Minimizing the environmental impacts of artificial trees requires that they be kept in service for a number of years.

Examining the Holiday Tree

Virtually all natural Christmas trees sold in North America are grown within the U.S. or Canada. The vast majority of artificial trees sold are manufactured in China. Transportation distances and modes of transport from point of production to retailer are taken into account when determining life cycle impacts of trees.

The two studies cited in this report – the only two life cycle assessments of natural vs. artificial trees published – both indicate that natural trees result in lower environmental impacts than artificial trees, and most dramatically with respect to global warming potential (GWP). Results also indicate that if artificial trees are selected, they should be kept in service for an extended period. Assuming that the travel distances from retailer

[1] In 2016 27.4 million natural and 18.6 million artificial Christmas trees were sold in the U.S. The difference in numbers – 8.8 million – is far smaller than in 2014, the year previously noted for the least difference in natural vs. artificial tree sales, when 12.4 million more natural trees were sold than artificial ones. (Source: Statista 2017)

to home are the same for both artificial and natural trees, that natural trees are chipped and combusted for energy recovery or taken to landfill at the end of the holiday season, and that GWP is the most important environmental indicator, then an artificial tree must be kept in service for 15-20 years in order to achieve equal environmental impact to an equivalent number of natural trees. When a full range of environmental impact indicators, beyond global warming potential alone, is considered, results indicate that an artificial tree must be kept in service at least 4-6 years in order to achieve comparable environmental impact to a yearly series of natural trees.

> The global warming impact of 18.6 million American consumers choosing artificial trees rather than natural ones in 2017 was equal to about 1.7 *billion* miles (2,736 million km) of driving an 18 mile/gallon (13.1 liters/100 km) vehicle, or 1.2 *billion* miles (1,931 million km) of driving a 25 mile/gallon (9.4 liters/100 km) vehicle.

Two Life Cycle Assessments

This report is informed by two life cycle assessments which were published in 2009 and 2010. Both were conducted in accordance with international protocols for the conduct of LCAs and reviewed by independent third-party experts. In these assessments the full life cycles of unlighted natural and artificial trees 6.5 and 7 feet (about 2 meters) in height were examined. As in all life cycle assessments, inputs of all raw materials (including water) and energy were determined, as were all outputs including emissions to air, water, and ground, and final products and co-products.

Natural trees were evaluated from seed to seedling within a nursery, planting and tree cultivation in the field, final harvest, wrapping for transport, transportation to the distribution site and then to locations where trees are used, and disposal upon end of use. For artificial trees, assessment began with production of PVC resin and steel components, forming of PVC needles and tree branches, assembly and packaging of trees, shipment (from China, and from North American port of entry) to retailer, transportation from retailer to location of use, and finally disposal.

As it was assumed that both natural and artificial trees would be identically decorated, the impacts linked to decorations were not evaluated.

The impacts of harvesting wild trees under permit from state or national forests were not evaluated as part of this report, as such activity accounts for a very small fraction of holiday trees harvested. However, since transportation distance is a major determinant of environmental impact for all options, wild harvesting of trees is associated with low impact only when driving distances from home to forest are short.

A Canadian Assessment

In the 2009 assessment, conducted by the Canadian consulting firm Ellipsos, a life of 6 years was assumed for artificial trees, based on a survey which found this to be the average life of such trees in North America. Natural trees evaluated were assumed to be obtained from a plantation located 93 miles (150 km) from Montreal, Canada for use in that metropolitan area. Artificial trees were assumed to be produced in China and transported via container ship to Vancouver, and then by rail from Vancouver to Montreal. Trees evaluated were 7-feet in height. Comparison of impacts involved examination of seedling production/tree growth/harvest/transport/use/disposal cycles for six natural trees vs. one manufacturing and packaging/ transport/use/disposal cycle for an artificial tree. A distance from tree retailer to home of 3 miles (5 km) was assumed. Also assumed was burning of natural trees for energy recovery upon disposal, reflecting common practice in Montreal. Fifteen different impact categories[2] were assessed and reported.

This study found greater environmental impact of artificial trees in seven of the fifteen impact categories, greater impact of natural trees in seven others, and an essentially equivalent result in one more. A key finding was that climate impacts are over 1 ½ times greater for artificial trees when the useful life of such trees is 6 years. Because climate change potential was judged to be of primary importance for the general population of Québec province, it was concluded that natural were the preferred option. In fact, a life of 20 years would be needed for an artificial tree to yield climate impacts as low as those of a natural tree.

The full range of impact indicators evaluated by Ellipsos was weighted by the authors of this report in accordance with recommendations of the BEES[3] expert panel of the National Institute of Science and Technology (NIST). The weighted outcome also showed natural trees to be environmentally preferable, although by a smaller margin than when considering GWP alone.

The validity of the report's conclusions are strongly influenced by transportation distances. If, for instance, the transport distance from retailer to home is 10 miles (16 km) rather than 3 miles (5 km), then it is environmentally better to purchase an artificial tree, assuming a 6-year or longer useful life of the tree. This result is due to the fact that whereas purchase of an artificial tree would require only one round trip from retailer to home in a 6-year period, purchase of natural trees would require 6 round trips in the same time period.

[2] Impact categories assessed were non-renewable energy demand, terrestrial and aquatic acidification potential, eutrophication potential, global warming potential, ozone depletion potential, aquatic and terrestrial ecotoxicity, mineral extraction, land occupation, ionizing radiation, and four human health impact indicators.

[3] Building for Economic and Environmental Sustainability (BEES) environmental calculator.

A U.S. Assessment

In 2010 an assessment was done by the Boston-based consulting firm PE Americas under contract with the American Christmas Tree Association. In this assessment, the useful life of artificial trees was variously assumed to be 1, 5, or 10 years. Trees were assumed to be 6.5 feet in height. Natural trees evaluated were Fraser fir, the most preferred species in the U.S. Artificial trees were assumed to be produced in Guangdong, China, with the model of tree evaluated the most common sold in the U.S. market at the time of the study. As in the 2009 study, all stages in production of natural and artificial trees were evaluated.

Shipment of artificial trees from China was assumed to be via container ship. Transport within North America was assumed to be on trucks. Based on 2007 data, the average haul distance for miscellaneous durable goods from manufacturer or port of entry to merchant wholesalers was 881 miles (1,418 km); this was the assumed truck transport distance from warehouse to retailer used in this study. The round-trip distance from retailer to end consumer was assumed to be 5 miles (8 km), while transport from end-user to landfill, compost or recycling site, or incinerator was assumed to be 20 miles (32 km). Five different impact categories[4] were assessed and reported.

This study, which did not assume energy recovery from natural trees after disposal, found that when natural trees are landfilled at end of life, thereby sequestering the carbon they contain, and when the one-way distance from retailer to home is 2.5 miles (4 km) or less, natural trees are *always* preferable to artificial trees based on GWP. When the one-way distance from retailer to home is 10 miles (16 km), and natural trees are landfilled at end of life, an artificial tree must be kept in service for at least 9 years to yield the same global warming potential.

For natural trees that are composted or incinerated (no energy recovery) at end of life, the point at which GWP is equal is where artificial trees have been in service for 4 years. Beyond that point, the impact of an artificial tree was found to be lower.

Context of Findings

The Ellipsos study found that CO_2-equivalent[5] emissions resulting from production and use of one artificial tree kept in service for 6 years would be significantly greater than those resulting from production and annual use of six natural trees. The difference was roughly equal to CO_2-equivalent emissions that would result from driving an 18

[4] Impact categories assessed were non-renewable energy demand, acidification potential, eutrophication potential, global warming potential, and smog potential.

[5] The term CO_2 equivalent emissions encompasses a weighted average of the atmospheric warming potential of the full range of heat trapping compounds, including carbon monoxide, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, sulfur hexafluoride, and nitrogen trifluoride. Weighting is necessary since the heating potential of all of these compounds is greater than that of carbon dioxide. Methane, for example, is 25 times more potent than carbon dioxide as a heat trapping compound.

mile/gallon (13.1 liters/100 km) vehicle a distance of 90 miles (145 km). In other words, again assuming a 6-year life for artificial trees, the global warming impact of 18.6 million American consumers choosing artificial trees rather than natural ones in 2017 resulted in an increase in CO_2-equivalent emissions equal to about 1.7 *billion* miles (2,736 million km) of driving an 18 mile/gallon vehicle, or 1.2 *billion* miles (1,931 million km) of driving a 25 mile/gallon (13.1 liters/100 km) vehicle. The PE Americas study led to comparable results. Relatively small impacts at an individual household level can add up to quite substantial impacts for an entire population of a large nation. That said, the carbon emissions resulting from production and use of Christmas trees of all kinds adds up to less than 0.1% of an average person's carbon footprint. This reality doesn't necessarily point to insignificance of impact related to the choice of Christmas tree, but rather to the very large carbon footprint of the U.S.

A factor that has potentially greater impact than production of trees is the type of lights used. As calculated as part of the PE Americas study, lighting a string of 400 incandescent tree lights each season results in 1.5-3.5 times the carbon emissions that the full life cycle of a natural tree does. Use of LED lights results in about one-fifth the carbon emissions as incandescent, reducing considerably the relative impact of lighting.

Self-Harvesting of Natural Trees

For those living near national forests and state forests within some states, cutting of holiday trees is allowed with permit. Removal of small conifers in designated areas can be beneficial to the forest by helping to remove ladder fuels that can allow wildfire to climb to the tops of larger trees. The overall environmental impact of self-harvesting is heavily determined by the driving distance from home to harvest site. Any one-way distance greater than about 6-8 miles is likely to favor other means of obtaining a tree. For those lucky enough to reside on forest land, self-harvesting has essentially zero impact.

In a few locations, innovative options for self-harvesting are available. For example, a unique partnership between the Durango & Silverton narrow gauge railroad, the San Juan National Forest, the San Juan Mountains Association, and Firewise of Southwest Colorado offers families the opportunity to travel by train into the national forest to select and harvest a tree. Harvesting is done under the supervision of professional foresters and harvested trees are loaded onto the train for transport back to the point of departure. In Clark County, Washington, the Chelatchie Prairie Railroad offers families train rides out to a Christmas tree farm where they can harvest a tree of their choosing. And those living near Strasburg, Pennsylvania can ride the rails to a location where they can select a pre-cut tree. All of these potentially reduce individual automobile travel and can reduce the environmental impact of obtaining a tree, provided that the distance from home to the train depot is relatively short.

A New Wrinkle in Christmas-Tree Purchasing

The impacts associated with the availability of real trees via online shopping (e.g., Amazon) have not yet been systematically assessed. On the one hand, packaging is significantly greater than for trees purchased from a Christmas tree lot. On the other hand, transport impacts might be reduced in that individual trips to obtain trees are replaced by consolidated delivery via truck.

Strategies for Reducing Environmental Impacts

There are several things that consumers can do to reduce the environmental impact of a holiday tree. These include:

- If natural trees are available close to home, go natural as real trees generally represent a lower environmental impact option than artificial trees.
- Consider purchasing a living potted tree which can be planted outside following the holiday season.
- If purchasing an artificial tree, select a durable tree and plan to keep it for a number of years.
- Always remove all decorations, lights, and stands from trees, whether natural or artificial, before disposal.
- Check to see if your community recovers energy from natural trees upon disposal, and if not encourage elected officials to adopt this practice; otherwise encourage beneficial reuse or landfilling.
- Check for opportunities in your community for donating natural trees for use in wildlife or fish habitat improvement projects.
- When ready to dispose of an artificial tree, seek opportunities for donating trees for reuse by others. Goodwill is one organization that accepts used artificial trees as long as they are in the original box.

Summary

Based on differences in environmental impact, natural Christmas trees are generally better than artificial trees. With respect to global warming potential, natural trees have a far lower environmental impact than artificial trees, particularly when natural trees are landfilled or chipped for energy recovery upon disposal. Differences are greatest when distances from grower to retailer to home are short.

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