

Design, Testing and Implementation of a Large-Scale Urban Dog Waste Composting Program

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In Montreal, Québec, many dogs are exercised in fenced-in runs in parks. Consequently, these dog parks are a high-density source of large amounts of dog waste, which is typically collected by the owner in a plastic bag and deposited in the municipal garbage. In 2004, an experimental large-scale dog waste composting programme was initiated at the Notre-Dame-de-Grâce (NDG) dog run in Montreal, Québec. Dog waste was collected with plastic shovels, deposited into compost bins, and layered with sawdust. In two months, a total of 213kg (470 lbs) of dog waste was collected and composted, along with 33kg (72 lbs) of donated sawdust, in two research compost bins. After a year of incubation, the two bins produced 179kg (394 lbs) of compost. Temperatures in the research bins peaked between 40°C and 55°C but were not maintained long enough for conclusive elimination of pathogens. Participation by dog run users during the trial project was enthusiastic, and full-scale dog waste composting has now been implemented at the dog run, with nine bins being filled over a 12 month period. On an annual basis, this composting programme diverts almost a ton of dog waste (approximately 959kg (2,115 lbs), over 130kg (300 lbs) of sawdust, and at least 7000 plastic bags from Montreal's landfill site, and produces about 770kg (1,700 lbs) of compost annually.

Introduction

Effective waste management is an ever-growing issue in urban environments. Recycling is a sustainable strategy for disposing of waste, and composting can be an important part of a recycling programme. For example, 110 municipalities in Sweden have introduced and strictly enforced a biweekly compost collection for household organic waste. This, combined with material recycling and other forms of waste treatment, has reduced the amount of waste going to landfills in Sweden by 65% from 1994 to 2005 (RVF 2006). Impressively, only 4.8% of their annual quantity of treated household waste actually made it to a landfill in 2005, and it is now illegal to landfill organic waste (*ibid*).

Composting is defined here as a controlled aerobic process by which heterogeneous organic waste is converted into a stabilized, hygienic product, containing high levels of humic substances (Chen *et al.* 1996). Contrary to anaerobic waste disposal systems, properly aerated and controlled composts are a negligible source of CH₄ and are not a net source of CO₂ (Peigné & Girardin 2004). Composting also decreases the amount of waste going to landfill sites and the product can be used as a beneficial soil amendment product for infertile, unstructured soil and nursery crops (Guisquiani *et al.*

1995; Fitzpatrick 2001; Wilson & Mecca 2004).

In the United States alone, it is estimated that dogs and cats produce approximately 10 million tons of waste annually (Brinton and Storms 2004), and the disposal of dog waste can pose a significant problem in areas of high-density dog populations. In 1991, the Fairbanks, Alaska, Soil and Water Conservation District began research on composting dog waste because of the huge amounts of manure being produced by the 20,000 dogs living in the Fairbanks North Star Borough (Freeborne 1994). Pollution from this manure posed threats to water quality, wildlife and public health (Rippy *et al.* 1997). A trial dog waste composting programme was initiated with volunteer mushers and kennel owners and has grown into a successful programme.

Dog waste is also a problem in large Canadian municipalities. In Quebec, 23% of residents own at least one dog (Leger Marketing 2002), resulting in an estimated 1,742,728 dogs in Québec and, conservatively, 432,000 on the Island of Montreal alone (Institut de la statistique Québec 2005a,b). On average, a dog produces 0.34kg (0.75 lbs) of feces per day (Taylor 2004). Consequently, there are approximately 146,860kg (323,770 lbs) of dog waste to be disposed of every day in Montreal. As most dog owners in cities pick up their dog's waste in nonbiodegradable plastic bags, this is

an additional burden on the city's landfills.

In urban Montreal, a large number of domestic dogs exercise and socialize in fenced-in dog runs in city parks, creating areas with high-density dog activity and, consequently, a large volume of dog waste. A city dog run is therefore an ideal area for testing and implementing a large-scale urban dog manure composting program. The Notre-Dame-de-Grâce (NDG) Dog Run, which opened in 1997, was chosen as the test site for this research for a number of reasons. It is a large dog run in a busy urban area, with an estimated 50-75 dogs frequenting the park every day. It is a reputable and trusted dog run due to the presence of the NDG Dog Run Committee, founded in 1999. As well, it was believed that a trial project would be supported because the users of the dog run have a vested interest in their green space, as evidenced by enthusiastic participation in the semi-annual cleanup events. Finally, it is a large dog park (20,000 square feet), which allowed for the placement of multiple compost bins without any adverse effects on the usage pattern in the run.

The main objective of this research was to develop and determine the feasibility and efficiency of an on-site dog waste composting programme in an urban park, using a passively aerated composting system with dog waste and wood chips as organic matter. If this could be established, both in terms of actual composting and public participation, the second objective was to implement the composting system on a permanent basis. The programme has been a success, and the results are presented below.

Animal Waste Composting

Composting has been successfully completed using garden waste, solid refuse, and the agricultural waste of pigs, cattle, rabbits, poultry, horses, ducks, sheep and goats (Soliva & Giro 1992; Rynk 1992; Liao *et al.* 1993; Lafond *et al.* 2002). It has even been successfully used to decompose slaughterhouse waste and dead chickens, as well as salmon-farm mortalities (Sims *et al.* 1992; Liao *et al.* 1994).

Composting requires suitable temperatures, nutrient availability, oxygen input, moisture content and a 25:1 carbon to nitrogen ratio in order to reach and maintain maximal microbial activity, thereby resulting in increased efficiency and speed of decomposition (Beffa *et al.* 1996; Stentiford 1996; Rynk 1992). The microorganisms involved oxidize carbon as an energy source for growth and ingest nitrogen for protein synthesis (Taylor 2004). Consequently, the right carbon to nitrogen ratio in composting systems is required for efficient decomposition. On average, wet dog manure contains 0.7% nitrogen (N),

0.25% phosphate (P_2O_5) and 0.02% potash (K_2O). Compared to wet cattle manure, dog waste contains 40% more nitrogen, the same amount of phosphate, and 1/20 the amount of potash (Hall & Schulte 1979). Due to the high nitrogen content of dog manure, a source high in carbon, such as wood chips, shavings or sawdust (C:N ratio of 560-641:1) is needed for efficient decomposition (Rynk 1992). Heat evolution occurs in proportion to metabolic activity and is an efficient method of observing the rate of composting microbial activity (Miller 1996).

Methodology

Set-up and Education

The project began in June 2004, with a 10 week trial period. For the purposes of the research it was necessary to collect and weigh the dog manure before putting it into the compost bin. Therefore, four plastic kitchen garbage pails, each with a 0.4 cubic meter (1.3 ft³) capacity, were placed, chained and locked throughout the dog run in high traffic areas to act as collection bins. Each collection bin had a secure lid and was lined with a large garbage bag. Collection equipment, consisting of garden trowels and plastic dust pans, was hung nearby. Bilingual (French/English) flyers were made and distributed by the NDG Dog Run Committee during an intensive two week education period, and bilingual signs of explanation were laminated and posted around the dog run in high traffic areas, as well as beside every collection bin. Participants were instructed to pick up dog waste using the collection equipment provided and to deposit it only in the collection bins.

Two round commercial compost bins made of recycled plastic were set up in the dog run in a bright, sunny area a significant distance away from the park benches. Each compost bin has a total capacity of 4 cubic meters (13 ft³), with a lightweight, locking lid, and holes along all sides for aeration (Table 1). Plastic was

TABLE 1.
Compost bin specifications for dog waste composting at a dog park in Notre-Dame-de-Grâce, Québec

	Specifications
Shape	Round
Body dimensions	81cm x 81cm x 76cm (32" x 32" x 30")
Top opening dimensions	67cm x 71cm (26.5" x 28")
Total capacity	4 cubic meters (13 cubic feet)
Composition	Recycled plastic (60% post-consumer, 40% post-industrial)
Features	Locking lid, two 33cm x 33cm (13" x 13") sliding doors on either side of the base, aeration vents
Brand	Smith & Hawken: The Home Composter

taped across the bottom of each compost bin to retain all material, and a 5cm (2") layer of weighed household waste compost and commercial potting soil (mixed at a ratio of 3:1) was added to the bottom of each bin to separate the fresh feces and wood chips from the plastic and to help activate decomposition. Both bins were chained and locked to the surrounding fence to ensure that they would not be moved. Bilingual "Controlled Research, Do Not Touch" signs were put up on the compost bins to prevent people from adding un-weighed material directly to the research compost bins. Dry wood chips and shavings were donated by a local construction company (D & G) as the carbon source for composting. The wood material had a mixed provenance, with a range of composition and moisture content. The particle size ranged from 1-2 cm² flat shavings to dust.

Collection and Maintenance

The contents of the plastic bag-lined collection bins were a mix of dog feces and gravel, unavoidably picked up during collection of the manure. The material in the collection bins was weighed with a 0.2 kg/lb graduation electronic scale (EK5) every 48 hours, and then emptied into the first of the two research compost bins. New plastic bags were then placed in the collection bins to avoid odour build-up. Wood shavings were added to the compost bin at a 10:1 feces to wood mass ratio, calculated according to the procedure outlined in Rynk (1992) and resulting in an estimated C:N ratio of 22.3. The materials were mixed using a metal shovel. Water was added to the compost bin to keep moisture levels at approximately 60-70%, which was verified using a scaled moisture meter (0/dry-10/wet, MoistureMeter©). Rubber gloves were used during every step to prevent parasite transmission.

The first research bin was filled and closed in late July 2004 and allowed to incubate. The second compost bin was filled and closed by early September 2004. The peripheral (approximately 10cm (4") from the bin wall) and central temperatures of each closed compost bin were taken every 48 hours with a lab thermometer. The compost was turned in the compost bins with a metal spade when the temperatures were observed to be decreasing.

Final Measurements

The research bins were opened and emptied in August 2005. Moisture readings were taken every 10cm on a wet basis using the scaled moisture meter (0/dry-10/wet). The mass of the final products (a mix of compost and gravel) was measured using the elec-

tronic scale. The gravel was then sifted out of the compost using a 1/4 inch wire screen, and pressure-washed, dried, and weighed. The mass of feces collected and compost produced was determined by subtracting the weight of the gravel from the input and output measurements. A paired t-test was performed on the central and peripheral temperature readings to determine if temperatures between the two compost bins were significantly different from each other. Standard error of input and output weights due to scale inconsistencies was calculated based on 20 repeated measurements of a bucket of soil before experimentation began. All statistical analyses were performed using SYSTAT software, version 11.

Other sources of error were restricted to minor loss of material from shovels used for turning the compost, the sides of the compost bins when dismantled, gloves and other tools used for transferring the compost from the bin to the garbage bags, minor loss of compost due to accidental spillage during weighing of the unsifted compost, and minor loss of gravel due to accidental spillage while cleaning, drying and weighing the gravel.

Implementation of a Permanent System

Due to the success of the trial research phase, the NDG Dog Run Committee permanently implemented the dog waste composting programme at the NDG dog run. The four collection bins were removed and seven new compost bins were added. A new education programme was launched by the committee in September 2004, instructing dog owners to now directly deposit dog waste into the compost bins. Currently, there are three compost bins open and being filled, and six closed and reserved for incubating compost.

In the original research bins, the bottom was sealed and starter compost and soil was included. Water was added as needed during the composting process. However, when working with compost bins that are open at the bottom, it is simply necessary to layer the ground with sawdust when starting a new bin. Manure is collected year round and layered daily with sawdust by volunteers. Frozen and layered manure and sawdust needs to be vigorously turned when it thaws in the spring. Also, snow collected along with the feces during the winter melts in the spring and supplies adequate moisture to the compost.

Results

The two research compost bins in this study showed major decreases in mass, produced no offensive odours, and underwent extensive changes in col-

or and texture of the materials. The final, mature compost was homogenous in both texture and color after sifting through a 1/4 inch mesh screen. Both bins underwent thermophilic stages, with central temperatures reaching as high as 42°C in compost bin 1, and 55°C in compost bin 2 (Figure 1). Compost bin 1 maintained a temperature of 39°C and higher for three consecutive days, while compost bin 2 was more successful at reaching high temperatures and maintained a central temperature of 50°C and higher for three consecutive days. However, a paired t-test indicated that the central temperatures of both bins were not significantly different from each other ($t = 1.468$, $df = 29$, $p = 0.153$). Peripheral temperatures were different between the two compost bins ($t = 3.348$, $df = 29$, $p = 0.002$), possibly due to differences in turning effort of the compost during incubation.

The mass of manure collected and mature compost produced was calculated by subtracting the weight of the gravel from the input and output measurements (Table 2). Standard error due to scale inconsistencies (based on 20 repeated measurements) was found to be 0.026. Averaged between the two trial compost bins, 106.6kg (235.0 lbs) of feces and 16.2kg (35.8 lbs) of saw-

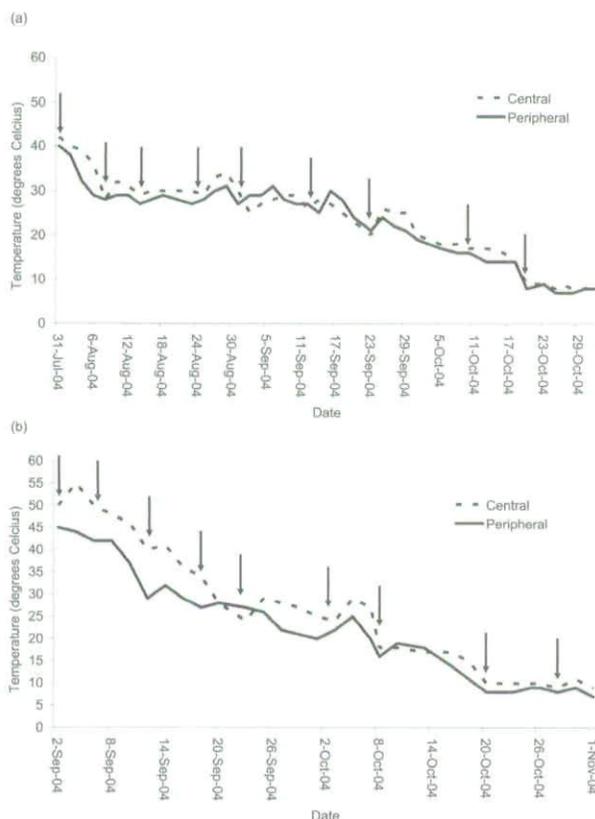


FIGURE 1: The central and peripheral temperature readings for two dog waste compost bins at a dog park in Montreal, Québec. (a) Compost bin 1, (b) Compost bin 2. Turning events are indicated by arrows.

TABLE 2:

Mass (in kilograms) of inputs and outputs for two trial dog waste compost bins

Inputs & Outputs	Bin # 1 (kg) (\pm 1SE)	Bin # 2 (kg) (\pm 1SE)
Feces + gravel	165.8 (4.3)	167.4 (4.4)
Clean gravel	58.5 (1.5)	61.5 (1.6)
Mass of feces*	107.3 (2.8)	105.9 (2.8)
Sawdust	14.6 (0.4)	17.9 (0.5)
Starter compost, soil, water	41.7 (1.1)	40.3 (1.0)
Total starting mass	163.6 (4.3)	164.1 (4.3)
Compost + gravel	150.1 (3.9)	148.9 (3.9)
Clean gravel	58.5 (1.5)	61.5 (1.6)
Total compost mass**	91.6 (2.4)	87.4 (2.3)

* mass of feces = (feces + gravel) - clean gravel.

** mass of compost = (compost + gravel) - clean gravel.

dust produced 89.6kg (197.2 lbs) of compost after one incubation cycle. Moisture readings of the final compost ranged from 55% in the top layer to 85% at the bottom of the compost pile.

In September 2005, one of the new, nonresearch compost bins was emptied, and the compost was screened and weighed, although the gravel was not washed. The weight of the mature compost from this bin was 79.0kg (174.0 lbs), a number consistent with the amount produced from the two research bins, considering the loss of compost that adhered to the gravel from this bin. When these results are prorated over nine bins filled during 12 months, an estimated 960kg (2115 lbs) of feces are collected, 147kg (325 lbs) of sawdust are used, and 805kg (1775 lbs) of compost are produced annually. Additionally, an estimated 7000 plastic bags containing dog feces are diverted from the landfill site annually.

Discussion

The design and implementation of a dog waste composting program at an urban dog park was successful. Dog owners participated in the research eagerly. Despite the concerns of many participants, in the summer months there was no discernable bad odour once the dog waste was covered with sawdust in the compost bins, and no odour in the spring when the bins thawed. Over a two month research trial period, 213kg (470.0 lbs) of dog feces were collected and 179kg (394 lbs) of compost were produced. Additionally, 33kg (72 lbs) of sawdust and an estimated 1250 plastic bags were diverted from Montreal's landfill site.

The optimal moisture content for organic waste at the start of composting is between 40-65%, with more successful results at the higher extreme (Agnew & Leonard 2003, Stentiford 1996). At 70%, the average

moisture reading from this compost, while at the higher extreme, was within the bounds of efficiency.

Dog waste may contain potentially harmful pathogens that can be transmitted to people (USDA 2005). Verocytotoxicogenic *Escherichia coli* (*E. coli*), roundworm eggs, tapeworms, and hookworms are some of the pathogens and parasites easily transmitted to humans from contaminated dog feces (Duffy 2003; Rippey *et al.* 1997). In the Alaska study, sample compost bins were tested for parasites, and the results indicated that parasites were not found in the finished compost from dog waste known to be contaminated with parasites (Rippey *et al.* 1997). To ensure complete pathogen elimination, the Ontario Ministry of the Environment requires manure to be composted at 55°C for a minimum of five days to meet the standard for unrestricted use compost (A. Wheatley, p. comm. 2005; CCME 2006). In properly controlled large batch compost systems, temperatures can reach between 55°C to 65°C for three consecutive days or longer, the necessary heat and duration to inactivate pathogens (Duffy 2003; Stentiford 1996; USDA 2005). Unfortunately, in this study, while the temperatures of the trial compost bins reached between 40-55°C and were more than high enough for efficient composting of dog waste, the above standards were not met. Consequently, the resulting compost should only be used for flower beds and houseplants, grass on which no children play, or at dog park sites. Care should be taken when handling all dog waste and dog waste compost, and the use of rubber gloves is highly recommended.

Nutrient analysis from previous studies in Alaska indicate that compost from dog manure is high in nitrogen, phosphorus and potassium, and contains high levels of salt, common in compost made from a variety of materials (Rippey *et al.* 1997). The pH of the compost was close to neutral (*ibid.*). Due to the high salinity and nutrient content, it is suggested that the compost be mixed at a one to four ratio with commercial potting soil before application (Freeborne 1994).

To date, this programme is the only known large-scale urban dog waste composting system. In Toronto, residents can put organic material, including pet waste and used diapers, out for curbside collection (Toronto 2005), but this is on an individual residential basis and does not apply to off-leash dog areas where large numbers of dogs congregate. In Vancouver, a newly amended bylaw required dog owners to take home their dog's waste from public parks and dispose of it themselves. Many people refuse to go to these lengths and, consequently, the amount of dog waste being left on the ground has grown drastically (LEES 2004). In 2004, The National Capital Coalition for People and Dogs proposed to solve the problem by setting up an on-site

composting system at Everett Crowley Park (Taylor 2004). As of this writing, the research for this project has not yet begun (C. O'Connell, p. comm. 2006).

Conclusions

Dog waste composting appears to be a feasible and highly functional method of managing large amounts of dog waste in an environmentally-friendly way. Dog waste composting reduces the amount of waste being sent to landfills (Sequi 1996), reduces the amount of methane being released into the atmosphere (Peigné & Girardin 2004), and can provide poor soil quality areas with an efficient soil amendment product (Albaladejo *et al.* 2000). It is estimated that from just this one dog run alone, over a ton of dog manure, over 136kg (300 lbs) of sawdust, and approximately 7000 plastic bags are diverted annually from the Montreal landfill site.

The composting program designed and tested during this study has now been fully implemented at the NDG dog park, and a total of nine compost bins are currently being used and maintained by the dog run committee. The resulting compost is sifted and distributed to members of the dog run, and used in flowerpots in the dog run itself. This sustainable composting program allows individuals to benefit directly from their environmentally positive actions, and provides the park with an environmentally-friendly method for effective waste management. This pilot project has demonstrated that large-scale dog waste composting programs can be successfully implemented in urban settings and provide a means of partially reducing solid waste going to municipal landfill sites.

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