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Downtown Toronto's emergent properties: Exploring new methods for using port records to disaggregate urban metabolism in Toronto, Ontario, 1850-1926

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ABSTRACT

Between 1850 and 1926 Ontario's capital city, Toronto, grew from a small colonial port to one of the largest cities on the Great Lakes. In this article we introduce a rich time series dataset of ships entering the city's port and the commodities they carried, explore its potential for urban metabolism research, and consider some of its limitations. We argue that the detail recorded in the ledgers of the Toronto Harbour Master affords multiple temporal and geospatial scales of analysis to study the city's urban metabolism (e.g. seasonality and consignees of specific commodities), which means historians can use these quantitative sources to move beyond simplistic input-output evaluations and consider the nuance and complexity that characterized the role of the port in the city's social, economic, and environmental history. We demonstrate that the port was vital to the process of assembling the city even as the railways became dominant in Ontario during the second half of the nineteenth century. As the city grew, the data reveal that the port remained an important node within a broader Great Lakes socioecological system at the same time as it served the city's downtown and discrete subsystems of its urban metabolism.

KEYWORDS

urban history; energy history; social metabolism; environmental history; Toronto

Introduction

In his 1911 annual report to Commissioners of the Harbour of Toronto, Harbour Master Colin W. Postlewaith reported that "the quantity of coal brought into the city by vessel is but a tenth of that covered by rail." The decline in coal entering the city via the port, Postlewaith continued, "must be more and more noticeable year by year, for as the city extends towards the north and west the railways can deliver coal almost at the consumers' doors, while the vessel trade is handicapped by the long haul from the water front."[1] This had not always been the case. In the mid-nineteenth century, the material and energy used to assemble the city entered mainly through the port. By the early twentieth century, however, the importance of waterborne shipping was dwarfed by what entered the city by rail. Despite the growing dominance of the railway to Toronto's overall urban metabolism, the port received remarkably consistent volumes of several key commodities, including fresh fruit, bricks, stone, and anthracite coal. As the city grew rapidly during the late nineteenth and early twentieth centuries, the port functioned as a conduit between a large resource hinterland geography of the Great Lakes watershed and a suite of discrete subsystems of the downtown core.

We argue that historians interested in urban history, and especially environmental and economic histories of urban growth, have a great deal to gain by exploring port records to better understand how waterborne shipping shaped particular aspects of the urban metabolism. As a subset of social metabolism research, urban metabolism studies "focus on material and energy flows within urban systems, accumulation of material stocks, and the exchange processes of urban areas with their hinterlands" (Haberl, et al. 2019, 174). In this approach, the city is treated as a system with identifiable boundaries that make it possible to trace the flows that comprise the urban metabolism. We introduce some detailed historic shipping records for the port of Toronto and the fine-grained, relatively long-run dataset we created using these sources, we

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investigate some preliminary findings on Toronto's urban metabolism between 1850 and 1926 to demonstrate the value of these sources and methods, and we conclude with a discussion of potential opportunities and limitations of these types of sources for urban metabolism research. Quantitative methods, such as material and energy flow analysis and Historical Geographic Information Systems (HGIS), present exciting opportunities for urban environmental historians to build on foundational scholarship in the field by asking new questions and revisiting some older ones. The article is organized into three sections, each of which covers a different phase of Toronto's history, and in which we investigate the changing role of the port in shaping particular features of the city's early urban metabolism. Each section presents some preliminary analysis on six key commodities (fruit, stone, bricks, fuelwood, coal, and rail iron) that contributed to the material and energy flows that residents relied on to feed, build, and fuel their city. We use the level of temporal resolution available in these shipping records to posit the benefits of precise interannual (daily, weekly, monthly, seasonal) variability of metabolic flows. In each section, we also adjust the system under investigation to reflect the fact that port activity accounted for a significant proportion of the city's overall urban metabolism in the first phase (1850s and 1860s), a vital proportion of its downtown metabolism in the second phase (1870s and 1880s), and a persistent proportion of specific urban metabolic subsystems, such as resident diets, building stocks, electric utilities, and fuel dealers, in the third phase (1890s–1920s). In this sense, our aim is to present the case for why these types of sources and methods are useful for historical urban metabolism research, rather than demonstrate how they can be used to reconstruct a complete historical urban metabolism.

Historiography and methods

In 1991, William Cronon's *Nature's Metropolis* changed the way historians thought about the relationship between cities and their resource hinterlands. Cronon historicized the work of nineteenth century economist Johann Heinrich von Thünen by demonstrating that "a rural landscape which omits the city and an urban landscape that omits the country are radically incomplete as portraits of their shared world" (Cronon 1991, 51). The book is canonical in environmental history, as well as other disciplines, such as urban ecology and social metabolism. Cronon relied primarily on discourse analysis of qualitative sources, but the book also helped provide the conceptual underpinning of future urban metabolism research, including early HGIS mapping (Clifford, MacFadyen, and Castonguay 2024). The landscape of quantitative historical social metabolism research has changed significantly in the three decades since the book was published. Other urban environmental historians, such as Joel Tarr (1996) and Martin Melosi (2004), engaged with urban metabolism ideas and methods for evaluating urban waste and pollution, but faced significant limits to the quantitative analysis they could make. A great deal of urban environmental history since has been informed by theory and methods that conceptualize the city in organismic or metabolic terms (Clifford 2017; Kiechle 2017; McNeur 2014), but none has deliberately taken a quantitative approach using socioecological methods. How might the topics these historians explore have been shaped by historical datasets and urban metabolism methods?

The subfield of urban metabolism is large, and work has typically fallen into three broad categories: human and Marxist ecology, industrial ecology, and urban political ecology. Human and Marxist ecology research uses metabolism as a metaphor to explain urban inequalities as an outcome of efforts to separate or hybridize society and natural systems. Industrial ecology research pairs the concept of urban metabolism with robust data to trace the stocks and flows of material and energy into, through, and out of cities. And more recently, urban political ecology research has sought nuance and some synthesis of the older approaches by conceptualizing the urban metabolism as a set of complex and diverse socioecological systems (Wachsmuth 2012; Newell and Cousins 2014).

There is analytical value in studying the flow of material and energy into, through, and out of the urban system, because it allows researchers to quantitatively analyze the impacts of urban resource requirements on ecosystems outside the city, and account for the production of sewage, emissions, and garbage (Baccini 1997; Lenzen and Peters 2010). However, positivist claims to a comprehensive view of urban metabolism tend to try to fit all cities into a similar model whereby results are evaluated in aggregate and by comparison. Some ahistorical and largely contemporary-focused research on urban metabolism has characterized cities as "mainly linear reactors," in which "their metabolism consists of consuming materials and goods from elsewhere, transforming them into buildings, technical infrastructures for energy or water supply, communications or mobility, and wastes, which are summarily discarded…" (Ferrão and Fernández 2013, xi). This approach,

characterized by conceptualizing the city as a black box, an organism, or an urban funnel, tends to treat the city in terms of clearly defined system boundaries that rarely reflect the reality of complex urban systems (Newell and Cousins 2014). As Matthew Gandy (2004, 364) argues, this approach "has consistently failed to grasp the way in which urban space is historically produced."

Only a small subset of urban metabolism scholarship is historical. Deliberately historical studies of urban metabolism seek to understand how and why changes to material and energy flows shaped the city's economy, people, and environment over time, and acknowledge that as complex systems, cities did not change linearly (Broto, Allen, and Rapoport 2012). Studies that aim to quantify historical urban metabolisms rely on consistent, long-time series datasets, often compiled from government records created to monitor, control, and tax the import of material and energy entering the city (Barles 2007). Authors establish the system boundaries according to the administrative geography reflected in the sources. The scholarship has also investigated the extent of, and impacts on, resource hinterlands required to supply urban metabolisms in the past (Gingrich, Haidvogl, and Krausmann 2012; Billen et al. 2012; Billen, Garnier and Barles 2012; Kim and Barles 2012).

We offer some potential avenues for building on, and contributing to, this approach by exploring the value of narrowing the geographical focus to a relatively consistent urban area (in this case, the portion of Toronto in close proximity to the port). Rather than attempt to offer a totalizing view, we attend to the potential of investigating the emergent properties of discrete subsystems within the urban metabolism that people built and disassembled over time to meet changing opportunities and constraints. The Toronto port records also reveal the value of nuancing the temporal resolution of analysis to add weekly, monthly, and seasonal patterns of change not normally included in historical urban metabolism research. Moreover, we aim to explore not only a methodology for disaggregating the urban metabolism and evaluating the different types of urban metabolism the port shaped over time, but also one that can situate its subsystems into a larger set of nested systems that include the city and various Great Lakes resource hinterlands. As Sherry Olson (2007, 845-46) argues, studies that examine "changes in the metabolism of the city" should consider both "the scale and tempo of urban growth." Over the course of the nineteenth and early twentieth centuries, the function of Toronto's port adjusted to accommodate the needs of different urban metabolic systems, which changed at various rates and scales depending on economic, social, political, and environmental forces.

Historical context

Toronto did not simply grow from a small place to a medium place to a large place. It changed according to both the internal dynamics and feedback loops of its various subsystems and their reliance on shifting relationships with resource hinterlands that became more or less important to the urban metabolism according to geography, technological change, and political-economic forces (competition from other cities, wars and labor strikes, tariffs and trade agreements). During the 1850s and 1860s, the flow of material and energy through the port was central to the process of assembling the nascent city, which featured an economy based primarily on commerce (i.e., very little manufacturing). The concentration of flows through the port attracted railway development in the 1850s and then again in the 1870s, which amplified the movement of the types of material and energy residents relied on to build what became the downtown of the city. During the 1870s and 1880s, the flow of material and energy through the port lent structure to the emergent properties of the downtown urban metabolism, including infrastructure and the built environment (e.g. building foundations and the electric grid), commercial wholesale and retail enterprises (e.g. fresh food grocers and coal and fuelwood dealers), and corporate manufacturing and industry (e.g. iron works and distilleries). Throughout the late nineteenth century, Toronto and its port functioned as a vital node within a series of nested metabolic systems. At the broadest scale, the port transferred material and energy flows between the larger Great Lakes watershed, Toronto, and the region surrounding the city. In addition to channeling the flow of material and energy that helped assemble the city and its emergent properties downtown, the port served merchants and railways as a conduit to funnel resources out of Ontario into the Great Lakes economy. And moving in the other direction, they sent merchandise from other cities, such as Montreal, and resources from the Great Lakes hinterland into the Ontario economy. After 1890, the dominance of the railways and the growth of economic activity outside the downtown core largely decoupled the city's overall urban metabolism from the flow of material and energy via the lake, and the port became reoriented toward mainly specialized industrial metabolisms during and after the First World War, including oil refineries and coal depots.

Sources

The data developed for this study were drawn primarily from the Office of the Harbour Master fonds, held at the Archives of the Toronto Port Authority. During the second half of the nineteenth century, the governments of Canada West (later the province of Ontario) and the City of Toronto entrusted the management of the city's waterfront, including the Harbour and its urban port lands, to the Commissioners of the Harbour of Toronto (Harbour Trust). In 1850, the Board of the Harbour Trust appointed a Harbour master who, in addition to other responsibilities, recorded all shipping activity and dues collected from every ship that unloaded cargo in the port. Starting in 1849, the Harbour master kept a ledger to record the dues paid by each ship delivering cargo to the port.[2] In addition to the dues paid, the ledger recorded the name of every ship that unloaded cargo, the date of its delivery, the amount of each type of cargo it carried, and in some cases the consignee of the cargo. These ledgers cover 87 years, from 1849 to 1937. In 1863, the Harbour master started a separate ledger to track daily activity in the ports, which recorded much of the same information as the dues ledger, as well as details about where each ship originated.[3] The ledger of shipping activity continues until 1977, forty years after the Harbour master stopped recording dues. Taken together these two ledgers provide a detailed accounting of the material and energy delivered to the Toronto port over 128 years.

We focus on the dues ledger, which we have transcribed into a database that breaks down different types of freight delivered by every ship into its own commodity category. The result represents over 64,000 commodity shipments between 1849-1926. Many of these shipments were routine stops. For example, the *Passport* brought an average of 10.3 shipments per year between 1854-1897, mostly fruit, meat, and other merchandise. According to the dues ledger, over 5,000 unique ships entered Toronto's Harbour between 1849 and 1926. The greatest variety of ships were coal haulers; more than 2,600, or almost half of the ships to visit Toronto in this period were coalers. Less than half of the fleet (approximately 1,200) were required to bring fuelwood, and over 1,100 ships supplied stone for the city's booming construction business. Together coal, fuelwood, and stone, accounted for the majority of the ships arriving in Toronto over the late nineteenth and early twentieth centuries. The contributions these ships made to the city's trade accounted for a large share of Toronto's early urban metabolism, a consistent amount of its downtown metabolism over time, and increasingly specialized subsets after the turn of the century.

We focus on the five commodities (fruit, stone, bricks, fuelwood, and coal) that allow us to analyze food, building stocks, and energy components of urban metabolism consistently between the start and end points of the dataset. Over time, the diversity of the types of commodities delivered to Toronto's port declined as the railway became more important and the function of the port adjusted to accommodate increasingly specialized subsystems. Food commodities, such as meats, beer and ale, and potatoes and vegetables disappear from the records in the late 1880s, and grains after 1905. Similarly, building materials, such as lime and plaster drop off in the 1880s, and lumber during WWI. In the conclusions, we discuss the opportunities and limitations of these sources in further detail.

Population numbers are derived from the published *Censuses of Canada* (Canada 1871-1921). The census broke down Toronto's population by ward sub-division, which changed over time. Since our focus is on the area of Toronto that emerged as downtown by the end of the nineteenth century, we have included only the wards that fall within the geography of downtown Toronto to calculate the population, rather than the entirety of Toronto as it expanded north and west over time.[4]

The relationship between the port and downtown Toronto is one example of small subsystems nested within the downtown and the larger urban socioecological system, which was, in turn, nested within a broader Great Lakes system that included other port cities and distant resource hinterlands. As Prudham, Gad, and Anderson (2011, 179) show in their study of Toronto's waterfront and the city's transition from organic to mineral energy, "the development of [the waterfront's] role was never linear," but rather, "occupied a shifting place within the city's evolving energy networks shaped by… dynamic and sometimes contradictory influences." Coal was the most important commodity brought into Toronto through the port between 1850 and 1926. During the early years, however, ships delivered a wide variety of different commodities that residents in Toronto used to assemble the city and what became its downtown core. At the same time as the railway became the dominant mode of material and energy flows for the city, the port became a conduit for several commodities, including fruit, stone, bricks, fuelwood, and coal, which became vital to the downtown metabolism and several subsystems, such as the urban diet, the built environment, steam-powered electric utilities, small manufacturing, and light industry.

Assembling a city: 1850–1869

During the 1850s and 1860s, waterborne shipping delivered a large proportion of the material and energy that residents used to assemble the city. Toronto remained a relatively small port town throughout this period, growing from about 30,000 people in 1851 to 56,000 in 1871, clustered within walking distance of the waterfront (Figure 1). Three companies (the Great Western, the Grand Trunk, and the Northern) built the region's first railways during the 1850s. By the 1870s, tracks from each connected Toronto's waterfront with places throughout Ontario and as far away as Montreal. Despite the new competition from railways, Toronto's mainly commercial economy relied heavily on waterborne shipments to the port, which served as the primary conduit connecting the city to a wider network of resource hinterlands around lower Great Lakes. It is not possible to determine how much of the various commodities unloaded at the Harbour were transshipped elsewhere either by water or land, but we can assume that a majority of it entered Toronto's nascent urban metabolism as stocks of the built environment, food to feed the population, and fuel to cook their food and heat their homes.

Waterborne shipping was vital not just to the process of assembling the city itself, but also of transshipping commodities to the surrounding region, including many communities that the city absorbed over time. The number of ships delivering commodities to Toronto

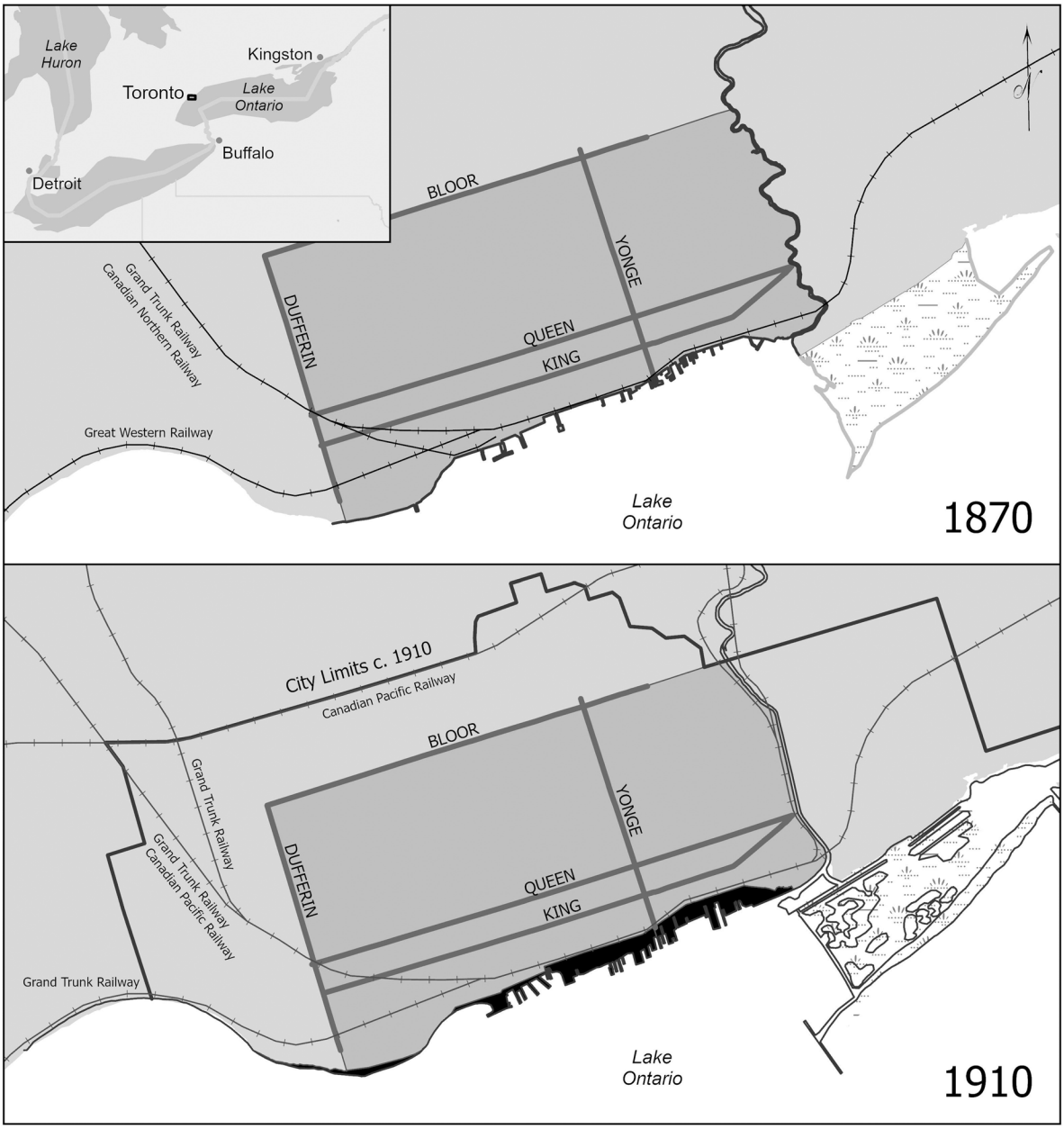

Figure 1. Map of Toronto in 1870 and 1910 (including major roads, railways, and the expanded waterfront).

declined from nearly 1,200 in 1851 to just 334 in 1859, but over the course of two decades generally fluctuated between 400-500 annually. These decades also saw the greatest diversity in the types of commodity delivered to construct the built environment (stone, bricks, lumber), feed inhabitants (meat and fish, beer and cider, potatoes and other vegetables, fresh fruit), and provide fuel for homes and businesses (fuelwood, coal). Deliveries of several commodities dropped off or disappeared suddenly in this period, which partly accounts for the early decline in the number of ships. For instance, the ledgers record 95 shipments of ashes in the 1850s, almost entirely in 1851-2. This industrial commodity was an important by-product of land clearance by settlers (McCalla 1993), but with the decline of pioneering in the region it was no longer shipped by water. Only four more shipments arrived between 1860-75. Other commodities disappeared from the records for unknown reasons, such as oysters and whiskey, but it was likely due to changing consumer demand, suppliers switching to rail or other forms of transportation, or, in the case of whiskey, a burgeoning local supply from distillers like Gooderham and Worts.

Fruit

Ships delivered nearly 7,000 tons of fruit to Toronto in the 1850s and 1860s. In some years, the port received only a few dozen tons, while in others as much as 1,000 arrived. The average was about 350 tons. Generally, there were about 19 deliveries of fruit per year and 19 tons per delivery. Neither the consignee nor the origins of the fruit are listed in the ledgers, but even if some portion of it was sent on to destinations outside the city it is clear that fresh fruit from sites around the lower Great Lakes was an important and relatively consistent part of urban diets during these early years. Remarkably, even if half of the fruit shipped to Toronto carried on to other destinations, this still left about 3.8 kilograms of fresh fruit per inhabitant in 1851, 4.9 kg in 1861, and 2.8 kg in 1871. However, shipments generally followed the seasonality of the fruit-growing season, and environmental factors occasionally shaped its availability, sometimes for long periods of time. As historian Gergely Baics found with the case in New York City in the early nineteenth century, urban residents seldom had access to fruit outside of the half year from May-October. As the century progressed, fruit schooners supplied cities with increasingly global and year-round options (Baics 2016; Lobel 2014). John Soluri (2005, 37) argues that the replacement of schooners with steamships and the expansion of South American markets made bananas "the first seasonless fresh fruit available for mass consumption in the United States." In Toronto, deliveries remained highly seasonal, suggesting that most deliveries consisted of local fruit, such as apples and berries. During the entire two decades between 1850 and 1869, 69% of Toronto's fruit deliveries arrived during the last four months of the year. But there could be significant variability from year to year. In 1855, for example, ships delivered 96% of fruit at the end of the year, while the next year 42% arrived between the start of September and the end of December. In some years, early frosts appear to have devastated fruit crops, seriously limiting the availability of fresh fruit in the city for extended periods. In 1866, 1867, and 1868, the amount of fruit delivered was just 60, 22, and 94 tons, respectively – 17, 6, and 27% of the yearly average for the twenty years between 1850 and 1869.

Stone

During the 1850s and 1860s, nearly 440,000 tons of stone were hauled out of local shallow waters along the north shore of Lake Ontario and delivered to Toronto where they were used to lay the foundations of hundreds of buildings; a smaller portion were used to pave cobblestone streets.[5] The railways transshipped a growing portion of the stone as they connected their tracks between Toronto and outlying towns, but during these early years builders used a majority of it to assemble Toronto's built environment. Crews on relatively small ships known as "stonehookers" removed shale slabs from countless places along the north shore of Lake Ontario, such as Frenchman's Bay at Pickering, Ontario (Brimacombe 2013; Wilkinson 2020; Townsend 1995). Stonehookers were often the first ships to arrive in spring, and winter ice presented the only meaningful disruption to an otherwise consistent flow of stone into Toronto. Each year, an average of 75 stonehookers delivered 373 tons each (see Figure 2). Between 1856 and 1859, ships brought an average of 43,600 tons of stone per year to Toronto, representing a significant building boom. By contrast, in the years 1865 to 1868, an average of only 7,250 tons of stone entered the port each year, reflecting a lull in Toronto's construction.

Fuelwood

Wood was a vital fuel source in the years before Toronto industrialized and coal became more important. Recognizing that one cord of wood is roughly equal in heat value to one ton of coal, the amount of fuelwood entering the city via the port nearly equaled or surpassed the amount of coal in several years during the 1850s

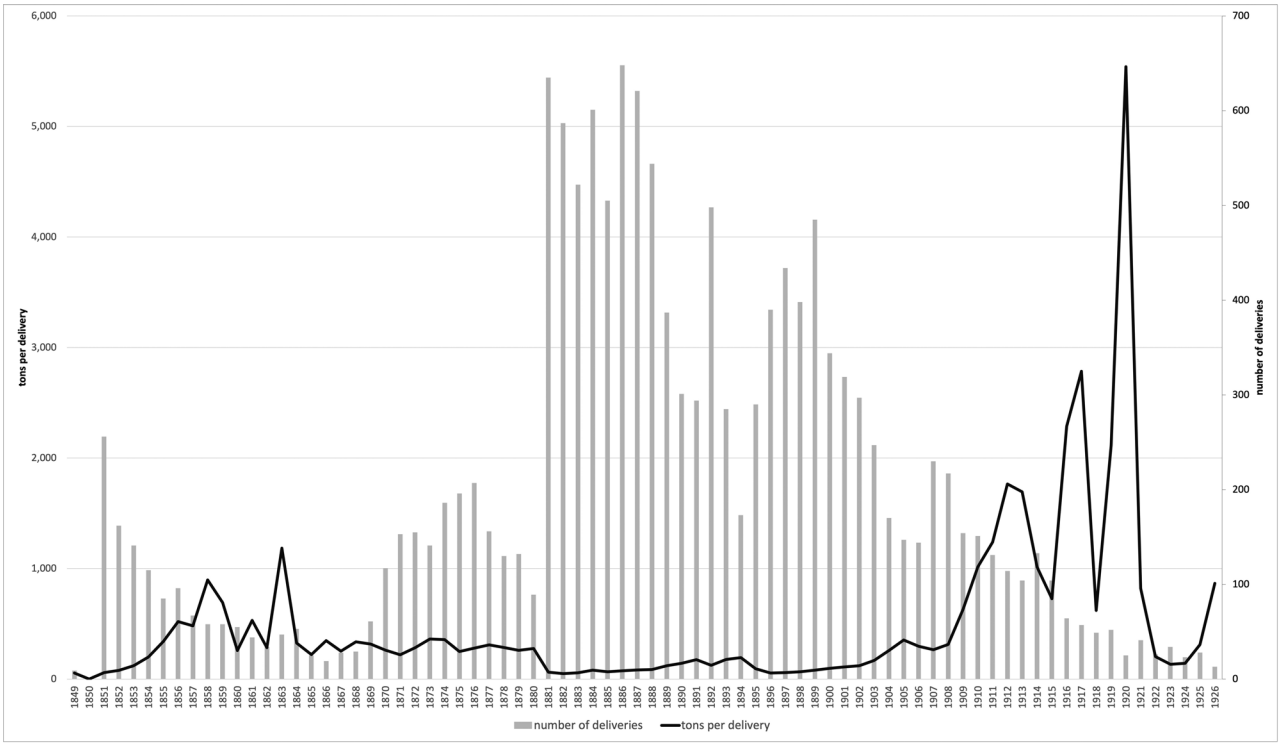

Figure 2. Deliveries of stone (tons) by vessel to Toronto, 1849–1926.

and 1860s. In 1851, fuelwood accounted for fully 88% of fuel delivered to the port by weight.[6] Throughout the next decade, it consistently amounted to more than 50% of fuel imports and in the following decade consistently more than 40%, for an average of 51% throughout that time (see Figure 3). As the city was built and the population grew, residents consumed greater quantities of fuelwood to cook their food and heat their businesses and homes. The port received roughly 10,000 tons each year in the early 1850s, but an average of nearly 49,000 tons during the second half of the 1860s. An average of 181 ships brought fuelwood by water to Toronto each year from more than a dozen locations along the north shore of the Lake Ontario between Kingston and Port Credit. During the 1850s and 1860s, ships delivered an average of 193 tons each trip. Perhaps not surprisingly, deliveries remained steady throughout the ice-free months of the year, with a notable bump at the end of the season as wholesalers brought in a surplus for the winter months. The Harbour master did not record who picked up the fuelwood during the 1850s, but by the end of the 1860s, the ledgers list ten different wholesalers as consignees. In August 1867 alone, coal and fuelwood dealer William Myles received 3,420 tons. While the city's footprint remained modest and located close to the waterfront, fuelwood delivered to the port was an important part of its urban metabolism.

Coal

By the early 1870s, coal surpassed wood as the main fuel in Toronto. Ontario contained no coal deposits, so all waterborne shipments of coal were imported from the United States via ports on Lake Ontario and Lake Erie. Anthracite coal, which people preferred for heating and cooking in their homes, came from mines in Pennsylvania via a handful of ports in New York State, particularly Oswego (Watson 2016). The majority of coal arrived by water until the 1870s, but railways began carrying small amounts as early as the 1860s. In 1851, only eleven boats delivered coal to Toronto. The next year there were 43, and in 1869 there were 201, finally surpassing the number of boats hauling fuelwood. Over these two decades, an average of 77 ships annually delivered hundreds of tons of coal each. Of the total amount delivered each year, ships brought more than half between July and October, and more than a quarter in the weeks before the Harbour froze in early January to stockpile for the winter. The Harbour master recorded careful and consistent details about the consignees of coal deliveries, including several coal and fuelwood merchants, and the Consumer's Gas Company that manufactured coal gas for the city's streetlights.[7] The number of coal and fuelwood dealers grew from 11 in 1856 to 23 ten years later (Mellen 1974, 131). Ships unloaded American coal at various docks along the waterfront where wholesalers coordinated its disbursement to

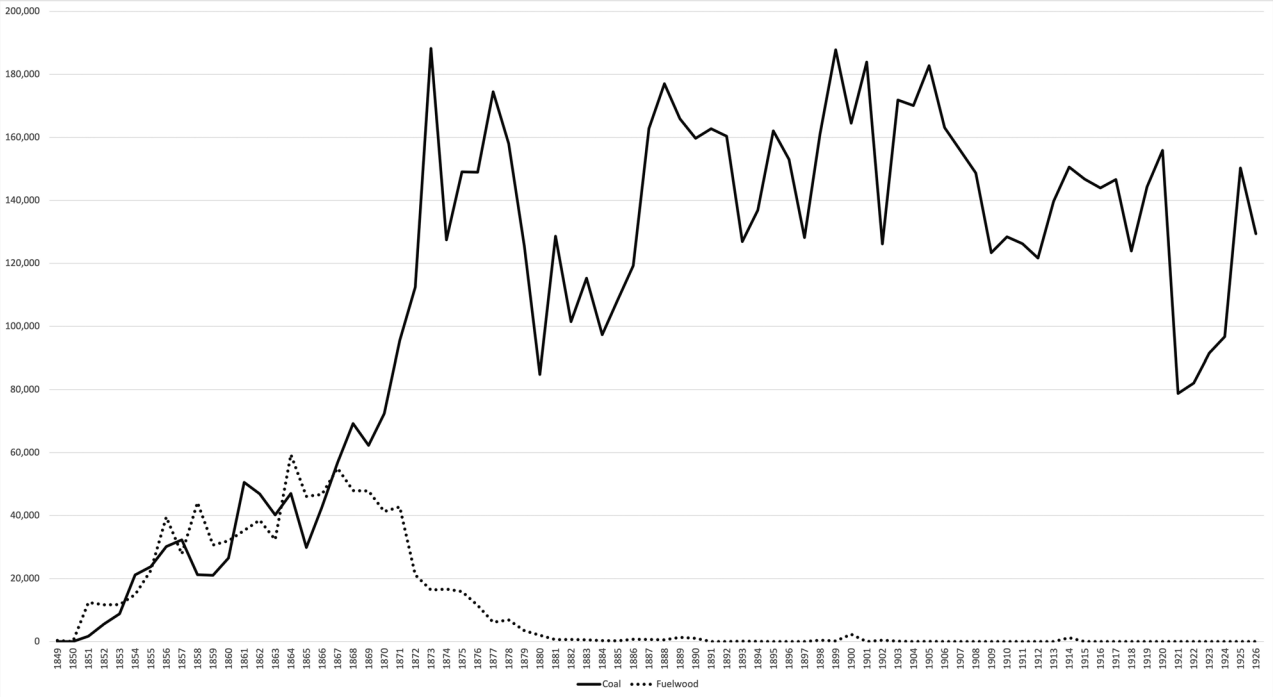

Figure 3. Deliveries of coal and fuelwood (tons) by vessel to Toronto, 1849–1926.

retail sites around the city. During the 1850s and 1860s, the port served as the conduit through which these merchants directed most of the city's energy flows.

Rail iron

Not only was waterborne shipping vital to the processes of assembling the city, it also provided the material and energy used to build large sections of the railways that eventually replaced shipping as the most important conduit for Toronto's overall urban metabolism. Between 1852 and 1860, the three railway companies operating in Toronto laid approximately 1,553 kilometers of track in Canada West (renamed Ontario after Confederation in 1867) (McCalla 1993, 311). During these years, nearly 25,000 tons of the rail iron used to build these lines arrived in the province through the Toronto port (see Figure 4), equal to between 53 and 79% of the total length, depending on the rail profile of the track.[8] C.S. Gzowski, an early Toronto waterfront real estate speculator and contractor for the city's downtown rail corridor, consigned at least 20% of the rail iron to build some of the city's earliest tracks to connect with the Grand Trunk Railway, for which he also served as civil engineer (Mellen 1974, 20). Very small amounts of rail iron arrived in the 1860s, but during another surge in construction between 1871 and 1873, railway companies received more than 10,000 tons of rail iron, enough to build between 330 and 500 kilometers of rail. The city also expanded its horse-drawn commuter railway in this period. The Toronto Street Railway began in 1861 with 70 horses hauling approximately 2,000 daily passengers and some freight wagons over 9.5 kilometers of track. By 1891, when it electrified, 1,372 horses carried 55,000 passengers over 109.5 kilometers of iron rails each day (Toronto Transportation Commission 1942, 7). The materials required to build and maintain this busy system could have been amply supplied by the imported rail iron and stone shipments. Water and rail competed throughout the late nineteenth century, but railways only became the dominant mode of freight transportation by the start of the 1880s. Nevertheless, important material and energy flows continued to enter the city via the port throughout the rest of the century and well into the next.

Emergent properties: 1870–1889

During the 1870s and 1880s, the city's population and geographic area grew considerably, and the material and energy flowing into the overall urban metabolism by rail eclipsed that arriving by waterborne shipping. Despite the increasing dominance of the railway, the port remained a vital node in a network

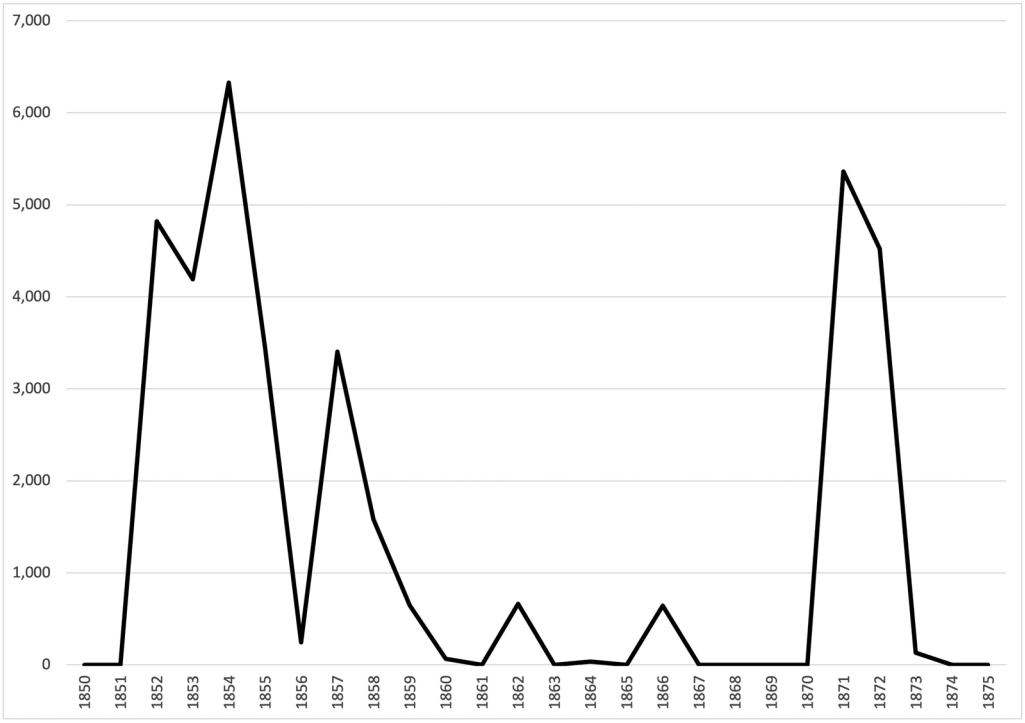

Figure 4. Deliveries of rail iron (tons) by vessel to Toronto, 1850–1875.

of nested systems linking Great Lakes resource hinterlands with the emergent properties of discrete subsystems in downtown Toronto. Over this period, the area of the city spread north and west of the downtown as the railway and streetcars made new areas accessible. Toronto's population more than tripled over the next two decades, from just over 56,000 inhabitants to more than 181,000 in 1891. More than half of the increase occurred downtown where the population grew to 144,000. The number of vessels entering the port reached an all-time high in 1887 with 1,211 ships making deliveries. Between 1869 and 1871, the number of ships entering Toronto's Harbour doubled from 404 to 804. Economic depression during the 1870s cut the number to just 275 in 1880. Throughout the remainder of the 1880s, an average of 1,080 ships made deliveries every year. The Harbour Master records indicate that while ships stopped bringing in some commodities, they also brought in new ones and continued to deliver a steady volume of many others. Even as its traffic increased, the port no longer shaped the entirety of the city's urban metabolism. Downtown, and close to the waterfront, however, it continued to facilitate the flow of some specific commodities, shape changes to the built environment, and meet the rapidly growing energy demands of many residents, manufacturing companies, and light industries.

Fruit

Ships delivered over four and a half times as much fruit during the 1870s and 1880s as they had the previous two decades, more than doubling the amount of fresh fruit available per capita to 9.9 kilograms in 1881 and 8.9 in 1891. After 1870, fresh fruit also began arriving in baskets, boxes, and crates, in addition to barrels.[9] Over these two decades, the port received over 31,000 tons of fruit. Compared with the 1850s and 1860s, the average number of ships delivering fruit each year stayed about the same, but the amount delivered per shipment quadrupled to 76 tons. However, the improved access to fresh fruit for Toronto residents was inconsistent over these two decades, and throughout the course of any given year. The amount delivered to the port rose steadily through the 1870s, but declined dramatically during the early 1880s, from nearly 2,100 tons in 1879 to just 1,100 in 1882. The seasonality of fruit shipments became even more pronounced during the 1870s and 1880s than it had been prior, with over 90% of shipments consistently arriving between August and November. The port remained an important conduit for the flow of an important source of improved diets for urban residents.

Stone

The amount of stone entering the port for use in laying the foundations of new buildings and cobblestone streets nearly doubled during these twenty years compared to the preceding two decades, contributing to new building projects and an increased density of the downtown. Although the depression of the late 1870s affected the building trades, the amount of stone delivered by stonehookers roughly doubled from an average of 22,000 tons each year in the 1850s and 1860s to 42,000 over the next two decades. The seasonal rhythms of shipping stone from the lakeshore remained confined to the ice-free months of the year, and particularly the warmest months. But the general pattern of stone shipments into the port changed dramatically. Between 1870 and 1880, the number of ships delivering stone more than doubled from earlier years while the amount of stone delivered by each ship remained relatively consistent (see Figure 2). In the decade after 1880, however, the number of ships each year rose from an average of about 157 to 514, while the amount of stone they delivered dropped from an average of 287 tons down to just 95. This pattern held for the remainder of the nineteenth century, with hundreds of very small deliveries supplying downtown Toronto with the stone needed to lay the foundations for buildings and cobblestone streets.

Bricks

As building customs, style, and design adopted greater use of bricks during the second half of the century, and later, once the city formalized building codes to protect against fire, the port received modest shipments of bricks. Deliveries quickly increased from nothing during the 1850s to a few hundreds of tons per year in the 1860s. During the 1870s, the amount fluctuated from 97 tons in 1872 to as high as 1,800 tons in 1877.[10] The impact of the depression of the late 1870s does not appear to have had an immediate effect on the shipment of bricks from places like Belleville, Montreal, Osewego, and Cleveland, but in 1880 deliveries declined by 96%. These numbers improved slightly to 1860s levels, but only returned to previous volumes in the 1890s, by which time the brick industry in Toronto began to grow rapidly. As Ontario economic historian Ian Drummond (1987, 124) remarks, bricks were "heavy and expensive [and could not] support the cost of long-distance transportation." Nevertheless, as bricks became an important construction material during the 1870s, the port was an important conduit that supplied a modest volume of these new stocks downtown.

Fuelwood

Toronto transitioned from organic to mineral energy during the second half of the nineteenth century as population growth and industrialization outstripped the capacity of forested regions within a couple of hundred kilometers to meet the growing fuel demands. In their study of the waterfront and changing energy use in downtown Toronto, Scott Prudham, Gunter Gad, and Richard Anderson (2011, 180) insist that the city experienced "increasingly acute fuel-wood shortages between the 1840s and 1860s." This "fuelwood crisis," they argue, was somewhat ameliorated by government mandated rail shipments from as far away as 150-200 kilometers, as well as lake deliveries from Upstate New York. Shipments by rail were important during these years, and as MacFadyen (2021) has shown, large quantities of fuelwood moved by rail during the remainder of the century.[11] It is difficult to be certain how much entered Toronto, but the decline during the 1870s had as much to do with the importance of coal as it did with an actual scarcity of fuelwood. For a few more years, the Harbour master continued to record sizeable volumes of fuelwood entering the city via the port in quantities quite comparable to the amount of coal delivered by vessel (see Figure 3). In 1870, the fuelwood originated from the hinterlands upstream of at least fifteen different Ontario ports mainly east of the city along the north shore of Lake Ontario. After 1867, both the number of shipments and the amount of fuelwood per delivery declined steadily, from an average of 248 tons per delivery and 183 shipments each year in the 1860s to 128 tons per delivery and 145 trips per year in the 1870s. During the 1880s, only a handful of boats unloaded a few hundred tons each year. Railways continued to supply over 250,000 tons of fuelwood to the city's wholesalers in the 1890s (MacFadyen 2021), but the port's energy flows were almost exclusively coal by then.

Coal

During the 1870s and 1880s, coal energy was key to the emergent properties of Toronto's downtown urban

metabolism. As the city grew and industrialized, and the railways assumed a dominant position in the transport of American coal into the province, waterborne shipping accounted for a diminishing portion of energy flows. Yet, the port continued to receive large amounts of waterborne coal. In addition to indoor heating, which was heavily reliant on anthracite coal, and the Consumer's Gas Company that lit the streets at night with coal gas, the city also entered the age of electricity. By 1883, the first year in which the Harbour Commission recorded separate totals for coal entering the city by rail and vessel, over 60% more coal arrived by rail than by water via the port (see Figure 5).[12] And this ratio crept up to roughly double by 1890. Yet, coal deliveries by vessel remained relatively consistent throughout this period, rarely deviating by more than 25% of an average of 135,000 tons per year (see Figure 3). Waterborne transport quickly lost any competitive advantage in bituminous coal, which came mainly from American ports on Lake Erie, particularly Cleveland. Anthracite coal, however, originated from mines in Eastern Pennsylvania and was easily transported to New York State ports, particularly Oswego, almost directly across Lake Ontario from Toronto. In 1891, vessels delivered 18% more anthracite to Toronto than the railways. Coal and fuelwood merchants consigned a significant amount of it, which they distributed to smaller retail locations throughout the downtown to meet the consumer preference demand for anthracite for domestic heating and cooking. Bituminous imports by vessel declined from over 73,000 tons in 1875 to only a few thousand tons in any given year during the 1880s. However, an important consumer of bituminous coal emerged in that decade. In 1882, the Toronto Electric Light Company (TELCo) began burning bituminous coal to operate steam power plants to generate electricity downtown. Ideally located along the waterfront to receive waterborne shipments, TELCo imported very small amounts of coal during its early years, but increased consumption as the company rolled out electricity across downtown during the 1890s. Coal imports by rail and by water increased significantly in the early 1870s, but only modestly over the next two decades. Coal imports through the port remained relatively steady during the late nineteenth century, but this flow of energy no longer fed a pattern of major urban growth. Rather, the port provided coal to fuel energy needs downtown. After the 1890s, these emergent properties formed more coherent, specialized patterns that continued to rely on the port.

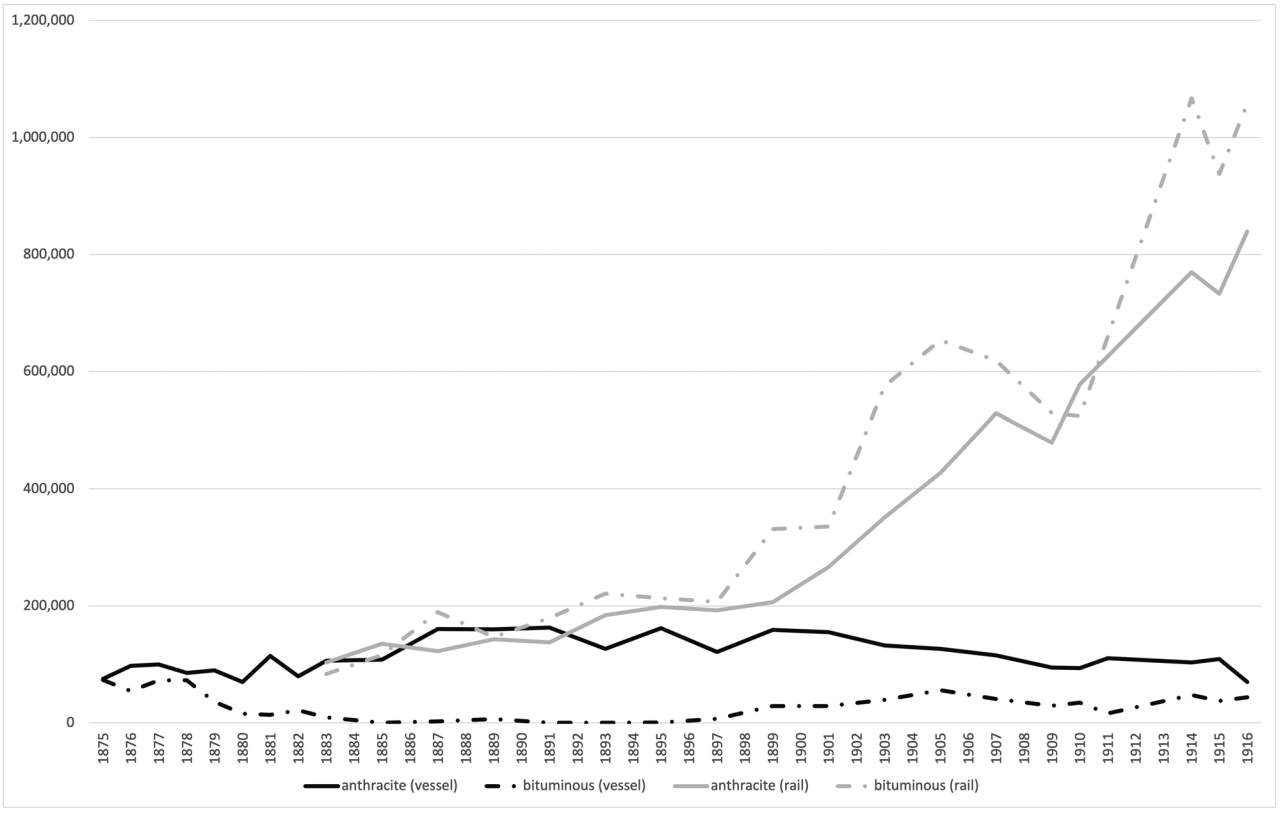

Figure 5. Deliveries of coal (tons) by vessel and rail to Toronto, 1875–1916.

Specialized subsystems: 1890–1926

After 1890, the database of material and energy flows through the port no longer reflected Toronto's overall metabolism, nor likely even that of the city's downtown. Instead, waterborne deliveries increasingly fed a handful of important but discrete subsystems that had developed within a highly industrialized waterfront space. The city's population grew from about 181,000 people in 1891 to 208,000 in 1901. The downtown population remained steady at around 150,000-160,000 during the first decade of the twentieth century. During these years, many of the same types of material and energy flowed into the city through the port, including fresh fruit, stone, and coal. The number of ships entering the port dropped slightly during the 1890s, and then steadily afterwards, from over 1,000 in 1899 to just 348 in 1914. Starting in 1912, the city also dramatically modified and expanded the waterfront to serve industrial purposes (Mellen, 1974; McIlwraith, 1991) (see Figure 1). The war accelerated these changes, so that by the 1920s, the port had become a conduit through which material and energy flowed almost exclusively to industrialized functions within the city. In 1921, when the population of Toronto reached nearly 522,00, the city's overall urban metabolism had almost entirely decoupled from the 103 ships that made deliveries at the port.

Fruit

An extraordinary amount of fresh fruit continued to enter the city via the port during the late nineteenth and early twentieth centuries. The number of tons increased from an average of 4,300 per year in the 1890s to 6,200 per year in the first decade of the century. In 1901, the per capita consumption of fresh fruit by downtown residents doubled during the first two decades of the twentieth century compared to the last two decades of the nineteenth, to an average of 22 kilograms in 1910 and 17 in 1911. Deliveries remained highly seasonal. At least 80% of barreled fruit arrived between September and November, while fruit shipped in boxes generally arrived somewhat earlier in the summer. Shipments of fruit skyrocketed during the war, reaching highs of 10,600 tons in 1915 and 13,700 tons in 1916. During the war, Niagara fruit growers donated large volumes of fruit to volunteer organizations in Hamilton and Toronto, such as the Toronto Liberal Women's Rooms, where women canned and preserved food to send to wounded soldiers in hospital.[13] The vast majority of the fruit entering Toronto during the war likely ended up tinned and sent overseas rather than consumed by downtown residents. After the war, fruit imports by water collapsed almost entirely to an average of just 103 tons per year between 1919 and 1926.

Stone

The flow of stone from the shores of Lake Ontario to the foundations of the city's buildings remained a vital part of the downtown urban metabolism throughout the late nineteenth and early twentieth centuries. Shipments declined slightly during the economic depression of the mid-1890s, from more than 62,000 tons in 1892 to just 21,000 in 1896 – the smallest total since 1869. An average of more than 500 stonehookers per year delivered an average of 95 tons each in the 1880s (see Figure 2). Between 1890 and 1908, about 300 boats brought in 166 tons each on average each year. After 1908, the character of the stonehooking business changed dramatically. Shipments rose quickly to new highs, from 61,000 tons in 1907 to 201,000 in 1912. Stone deliveries fluctuated during the war and immediately afterwards, but remained high at around 113,000 tons each year until 1920. However, between 1909 and 1920, the number of boats shipping stone each year dropped to an average of just 95 and the number of tons each ship carried rose to nearly 1,800. The stonehooking industry shifted from a relatively artisanal occupation to more large-scale operations before rapidly declining after 1920 to annual deliveries of only a few thousand tons. The decline was caused by alternative building materials in the form of concrete blocks and other cement foundations, supplied primarily by rail (Wilkinson 2020; Van Hasselt 2007).

Bricks

After 1890, the number of bricks received at the port fluctuated wildly according to the rhythms of boom and bust experienced in the building trades, from hundreds of thousands in some years to just hundreds in others. In the 1890s, the Ontario brick industry grew quickly, including in Toronto, experiencing an explosion of small brick works, which were then consolidated somewhat over the course of the following decade (Drummond 1987, 124). In 1891, the Ontario Bureau of Mines reported the production of more than 173 million bricks in the province, or 432,500 tons. That number grew over the next two decades so that on the eve of the war the province made more than 490 million bricks, or 1.225 million tons

(Drummond 1987, 400). Compared to this volume of production, the number of bricks entering downtown Toronto via the port was relatively small. In 1892, ships delivered more than 1,000 tons of bricks, reflecting a relatively good year in the building trades. The province entered a depression in the mid-1890s, which hit the building trades hard (Drummond 1987, 109). Between 1894 and 1899, the Harbour master collected dues on an average of just 319 tons of bricks each year. Shipments of bricks recovered after the turn of the century, but the war effectively ended the port's role as a conduit for bricks to the city.

Coal

Fossil fuel imports to Toronto increased roughly 160% faster than its total population, and more than 320% faster than its downtown population, between the 1890s and 1920s. The railways accounted for the increase, while waterborne shipments of American coal, particularly anthracite, remained relatively stable. Until 1911, the Toronto Electric Light Company provided much of the city's electricity from coal-powered steam turbines. Access to hydroelectricity, which in that year the Ontario Hydro-Electric Commission extended to Toronto, does not seem to have reduced coal imports. Urban residents continued to rely on anthracite for heating and cooking, and TELCo coexisted with hydropower well into the interwar years (Drummond 1987, 144). During the 1890s, the number of vessels making coal deliveries remained relatively consistent, but the amount of coal in each delivery crept up from 450 tons in 1890 to 600 in 1902. Over the next two decades, the number of ships making deliveries decreased and the amount of coal in each shipment increased significantly, from 290 ships delivering an average of 630 tons each in 1905 to 20 ships delivering nearly 4,100 tons each in 1922. The cause of this massive shift in the pattern of coal deliveries during the early 1920s was heavily influenced by postwar strikes by coal miners and railway unions in the United States, which effectively closed off the flow of coal to Ontario (Watson 2016, 232). The port received 155,000 tons of coal in 1920, and less than 79,000 tons in 1921 – a reduction of nearly 50%. After the strikes had been resolved and coal began to move across the border, much larger ships did the work of delivering much larger quantities of coal across Lake Ontario. After the city implemented its 1912 Waterfront Plan, several large coal companies used newly-created industrial lands for depots to store coal (Mellen 1974; Prudham, Gad, and Anderson 2011).

Conclusion

Like any set of sources that provide a glimpse into the past, the Harbour Master ledgers do not offer a complete picture of Toronto's historical urban metabolism. Rather than account for a comprehensive urban metabolic analysis, which is the approach taken by most historical urban metabolism research, we propose an investigation that reflects how port records might be used to study different types of systems within the context of urban changes over several decades or longer. Indeed, the fine-grained, long-time series detail of the ledgers provoke new questions about urban ports, including the changing intensity, seasonality, and nature of waterborne trade, and the changing relationship between cities and their resource hinterlands in the past. Toronto's port records provide insight into how and why port activity remained important to the urban metabolism long after railways became the dominant mode of transportation, and the database of over 64,000 shipments introduces new ways to understand and evaluate the social metabolism of nested subsystems in a growing and changing city.

As we have outlined, the data can be used to recreate the functions of, and linkages between, various components of the urban metabolism. During the early years, the data contributes to a rather comprehensive processes of assembling the nascent city, while in the 1870s and 1880s it accounts for only various emergent properties of the downtown metabolism, and after 1890 mainly to just discrete subsystems, such as the Toronto Electric Light Company or the distribution networks of coal dealers. The level of detail contained in the ledgers also allow for several scales of temporal and spatial analysis. As the discussion above on our preliminary work reveals, three major periods of the port's influence on the downtown urban metabolism emerge from the aggregated data, but within each framing it is possible to decipher subtle changes with daily, weekly, and seasonal resolution. Important changes in the history of the city are apparent in the shifts from one period to the next, but the level of detail in the data also illustrate the impacts of important historical moments, such as depression during the late 1870s or coal miner and railroad worker strikes in the early postwar years, as well as seasonal fluctuations in deliveries caused by the growing season and the Harbour freezing. The ledgers include incredibly precise information about which ships carried specific commodities according to what rhythms over days, weeks, months, years, and decades.

For some commodities, the data provides details to reconstruct the flow of material and energy from particular Great Lakes resource hinterlands through the port and into specific components of the urban metabolism. For example, the ledgers list the port of origin for ships carrying coal as well as the consignee of each shipment, which makes it possible to track coal from mines in Pennsylvania to ports in New York, across Lake Ontario by ship to Toronto where it was received by merchants and distributed to individual businesses and households through retail locations around the downtown. Future research can trace the flow of coal between nodes linking these nested systems by joining the ledger data with geospatial information from city directories and fire insurance maps using Historical GIS. The quality and quantity of the data available supports numerous scales of historical analysis that is simply impossible with most types of sources.

There are some important limitations of the ledgers. The ledgers record very inconsistent data regarding commodities leaving Toronto's port, so there is no way of estimating how much of what entered the port was transshipped by boat or overland. In other words, it is impossible to know for certain how much of what entered the port stayed in the city. Detailed railway records do not exist, so a complete picture of the material and energy flowing into the city is impossible from the available sources. The ledgers record a consistent volume of diverse commodities during the 1850s and 1860s, but afterwards several types of commodity decline or disappear from the records altogether. Finally, the ledgers do not list the origins of most commodities, nor the consignees of their shipments in Toronto, making it difficult to trace the flow of material and energy from hinterland environments and analyze its distribution to final consumers in the city. The data compiled by the Harbour Master over more than 80 years must be combined with other sources to investigate some aspects of what we outline here, let alone contribute to reconstructing and analyzing a complete historical urban metabolism for Toronto.

Toronto was a small port town in 1850 and one of the largest cities on the Great Lakes in 1926. The Harbour Master ledgers offer an extraordinarily valuable account of the flow of material and energy into the port, which fed various aspects of the urban metabolism during that time. Historians have not spent enough time exploring this type of source to investigate patterns of environmental and economic change in urban places, and social metabolism methods present a highly-suited approach to integrating robust quantitative sources into standard historical inquiry. By historicizing quantitative sources and combining the data with a variety of other sources that help fill in or complement missing information, social metabolism methods present exciting opportunities and potentially rich avenues for future research with detailed, long-time series data to raise important new questions, insights, and approaches to the history of cities.

Notes

1. Canada, "Annual Report of the Toronto Harbour Commissioners," Report of the Department of Marine and Fisheries, *Sessional Papers of the Dominion of Canada,* Volume 15 (Ottawa: King's Printer, 1913): 315.
2. Manifest books, account of harbour dues collected at the Port of Toronto, 1849–1937," RG 2/5, Office of the Harbour Master fonds, PortsToronto Archives.
3. Vessel arrivals and tonnage, 1863–1977," RG 2/6, Office of the Harbour Master fonds, PortsToronto Archives.
4. We define the boundaries of downtown Toronto as the area west of the Don River, east of Dufferin Street, and south of Bloor Street. The ward sub-divisions were redrawn periodically, so these estimates include some people that lived outside of the boundaries we have defined for our analysis. The total population of the city recorded in the list of cities and towns with more than 5,000 inhabitants is larger than the combined population of the census subdivisions that correlate with the portions of the city's wards included in the boundaries we define as downtown. Canada, *Fourth Census of Canada, Volume 1: Population* (Ottawa: S.E. Dawson, 1902): 22; Canada, "Electoral Atlas of the Dominion of Canada as divided for the tenth general election held in the year 1904," Department of Public Printing and Stationary (Ottawa: Government Printing Bureau, 1906): 109–113; https://recherche-collection-search.bac-lac.gc.ca/eng/home/record?app=fonandcol&IdNumber=196055.
5. The port ledgers recorded stone deliveries in toise, a unit of volume. This required estimating the dimensions of one toise and the average cubic weight of stone. Canada, "Inland Revenue: Reports, Returns and Statistics of the Inland Revenues of the Dominion of Canada, Supplement No.2: Weights and Measures, 1879," *Sessional Papers of the Dominion of Canada, Volume 3* (Ottawa: MacLean, Roger & Co., 1880): 181; William A. Parks, Report on the Building and Ornamental Stones of Canada, Volume 1," Department of Mines, Mines Branch (Ottawa: Government Printing Bureau, 1912): 150.
6. The weight per volume of fuelwood (1.8 tons per cord) was calculated based on the reported weight (tons) and volume (cords) for select railways in the *Sessional Papers* of Canada. Canada, Parliament, *Sessional Papers* 1876, paper no. 51, pp. 24–25.
7. *Brown's Toronto General Directory* (Toronto: Maclear and Co., 1856): xli, 271.

8. For details about the weight per length of rail profile, see William G. Raymond, *The Elements of Railroad Engineering* (New York: John Wiley & Sons, 1911): 27.
9. Standardizing these several categories of fruit shipments required estimating the weight of baskets, boxes, barrels, and bushels of fresh fruit. In some cases, these conversion factors were very straightforward, but in others, one unit needed to be converted into another unit for which a weight estimate exists in the historical records. Canada, "Weights and Measures," (1879): 181; Canada, "Report of the Minister of Agriculture," *Sessional Papers of the Dominion of Canada, Volume 5* (Ottawa: S.E. Dawson, 1895): xxiv; Paul N. Hasluck, *Basket Work of All Kinds* (Philadelphia: David McKay, 1903): 64.
10. When the port ledger distinguished between bricks it listed either common or fire varieties. We added together the numbers of both varieties and converted them into estimated weights. Canada, "Weights and Measures," (1879): 181.
11. See for example Canada, Parliament, *Sessional Papers*., 7th Parl., 4th sess., vol.8 (1894), Paper no. 10., pp. 458–463; Statistics Canada, *Canada Year Book 1903*, p.453, Statement of the Principal Articles of Freight Carried in 1903 by the Railways Mentioned, 1904.
12. Canada, "Annual Report of the Toronto Harbour Commissioners," Annual Report of the Department of Marine and Fisheries, *Sessional Papers of the Dominion of Canada, 18*75–1916.
13. "Preserving Fruit for Sick Soldiers," *The Globe* (August 4, 1915): 6; "Liberal Rooms Canning Centre," *The Globe* (September 10, 1917): 4; "Canning Peaches for the Soldiers," *The Globe* (September 28, 1917): 4.

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