Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Opportunities for single-use plastic reduction in the food service sector during COVID-19

Shen Molloy, Priyanka Varkey, Tony R. Walker*

School for Resource and Environmental Studies, Dalhousie University, Halifax, Canada

A R T I C L E   I N F O

Article history:
Received 26 October 2021
Revised 21 January 2022
Accepted 27 January 2022
Available online 1 February 2022

Editor: Dr. Wenling Liu

Keywords:
Single-use plastics (SUPs)
Food packaging
COVID-19
Food safety
Reusables
Zero-plastic waste

A B S T R A C T

The COVID-19 pandemic caused a surge in consumption of single-use plastics (SUPs), particularly in the food service sector, due to concerns for public health and safety. To follow public health guidelines, food services have been limited to takeout service and have restricted use of personal reusable items. This study investigated opportunities to reduce increased use of SUPs in Nova Scotia food services sparked by the COVID-19 pandemic using semi-structured interviews and focus groups with stakeholders from the food service sector. Many participants had already implemented SUP reduction strategies prior to COVID-19. However, the COVID-19 pandemic forced businesses to rely on SUPs and to pause SUP reduction strategies. Obstacles to SUP reduction included operational challenges from COVID-19 restrictions, misunderstanding of local waste management systems, costs of transitioning to zero-plastic waste, poorly manufactured alternatives, greenwashing, and ingrained societal convenience culture. Whilst not all SUP consumption patterns were attributed to COVID-19, these barriers prevented food retailers, waste managers and consumers from achieving zero-plastic waste goals. Food services should adopt SUP reduction strategies, including re-introducing reusables, implementing exchange programs for bulk items and takeout, providing education and awareness to staff and consumers, and sourcing sustainable SUP alternatives. SUP reduction strategies can be implemented immediately as public health officials and researchers agree reusable items can be used safely when using basic hygiene measures. Food services across Nova Scotia should adapt their operational procedures and create behaviour change to reduce SUPs.

© 2022 The Author(s). Published by Elsevier Ltd on behalf of Institution of Chemical Engineers. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/)

1. Introduction

Prior to the COVID-19 pandemic, Canadian consumers and retailers began to increase the use of reusables, under the Canada-wide Strategy on Zero Plastic Waste (Schnurr et al., 2018; Walker and Xanthos, 2018). However, given uncertainties surrounding COVID-19 transmission risk, early in the pandemic, some food retailers suspended the use of reusables, such as shopping bags and coffee cups, assuming that disposables could help to reduce spread of the virus through contaminated surfaces (Patricio Silva et al., 2020; Arrandale et al., 2021). Thus, the COVID-19 pandemic presented many challenges for global food services such as restaurants and cafes (Alfonso et al., 2021; Patricio Silva et al., 2020; Patricio Silva et al., 2021; Prata et al., 2020). To reduce the spread of the virus, governments around the world implemented precautionary approaches with COVID-19 restrictions and guidelines that varied during multiple waves of the pandemic. At their peak, COVID-19 restrictions in Nova Scotia, Canada mandated food services to close all in-person services (Restaurants Canada, 2021). However, contactless takeout and delivery was still allowed (Janairo, 2021). Some municipalities in Canada also decided to delay or reverse SUP reduction initiatives, including the new G7 Oceans Plastics Charter, as health and safety concerns were prioritized over environmental initiatives (Walker and Xanthos, 2018; Adyel, 2020).

Initially, knowledge of virus transmission was poorly understood and many food services paused using reusable items for fear of transmission (Arrandale et al., 2021). The plastic industry capitalized on this opportunity by citing studies criticizing reusables (Hale and Song, 2020; Schlegel and Gibson, 2020). Food services were forced to rely on SUPs to remain competitive. Common SUPs used in food services include plastic bags, straws, takeout cutlery, and plastic food packaging (Walker et al., 2021). COVID-19 also increased a less common source of plastic pollution via single-use personal protective equipment (PPE), such as face masks and gloves (Adyel, 2020; Prata et al., 2020; Ammendolia et al., 2021; Patricio Silva et al., 2020, 2021). Consequently, plastic use by Canadians increased 29% throughout the COVID-19 pandemic.

* Corresponding author.
E-mail address: twalker@dal.ca (T.R. Walker).

https://doi.org/10.1016/j.spcc.2022.01.023
2152-5308© 2022 The Author(s). Published by Elsevier Ltd on behalf of Institution of Chemical Engineers. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/)
(Kitz et al., 2021). The Great Canadian Shoreline Clean-up has reported an increase in SUP food and beverage litter from 15% in 2019 to 26% in 2020 (OceanWise, 2019, 2020). Further, plastic waste generation is expected to rise post pandemic due to rebound of economic activity (Vanapalli et al., 2021). Thus, the food service industry faces a packaging dilemma as they adapt to properly manage their post-pandemic plastic waste as consumers and retailers readjust to the new normal (Charlebois et al., 2022).

The increase in use of SUPs highlights the dilemma that exists between the desire to reduce use of SUPs given the effects of plastic pollution on the environment and potential impacts on human health (Patricio Silva et al., 2021; Walker et al., 2021). This dilemma has been further exacerbated with claims made by the plastics industry that SUPs are a safer solution for reducing COVID-19 transmission risks (Plastics Industry Association, 2020). Although there has been some research on the extent of consumer behaviour changes of using SUPs during the pandemic (Kitz et al., 2021), there has been a lack of similar research within the food sector. Specifically, research gaps exist that limit our understanding of the impact of the pandemic on use of SUPs and reusables in the food sector (Arrandale et al., 2021; Kitz et al., 2021). Thus, this research sought to address the increased use of SUPs due to the COVID-19 pandemic, by investigating potential opportunities for SUP reduction in food services across Nova Scotia using semi-structured interviews and focus groups with stakeholders from the food service sector.

1.1. Plastic and plastic pollution

Plastic and plastic products have become integrated into modern society since mass production in the 1950s (Beaumont et al., 2019). The growth in the market can be attributed to the shift from reusable to SUPs (Geyer et al., 2017). Most commercial plastic has a linear lifecycle (Schnurr et al., 2018). Approximately 40–50% of plastic is made for a single-use and consumer convenience (Geyer et al., 2017). Convenience culture promotes unsustainable consumption, particularly with SUPs. Decades of overproduction and inadequate waste disposal practices have caused plastic to become ubiquitous within terrestrial and marine environments (i.e., plastic pollution) (Geyer et al., 2017; Pettipas et al., 2016; Xanthos and Walker, 2017). Plastic pollution can alter species distributions, transport invasive species, and cause mortality through entanglement and ingestion (Gall and Thompson, 2015; Welden, 2020). As plastic degrades into microplastics, it can release methane and ethylene when exposed to solar radiation, and hydrocarbon gas when exposed to water; thus, contributing to greenhouse gas (GHG) emissions (Royer et al., 2018). For example, plastic and microplastics are derived from fossil fuels and plastics account for 6% of global oil consumption (Zhu, 2021). Thus, plastic or microplastics and GHG emissions are synonymous with every step of the plastic life cycle, from production to waste disposal, contributing to climate change (Walker, 2021a). Microplastics can also enter the food chain into human food and drink (Karbalaei et al., 2019).

1.2. Trends in plastic pollution and waste management

In 2019, Canada produced approximately 4.6 million tonnes of plastic, while generating 2.8 million tonnes of plastic waste (Deloitte, 2019). Canadians produce more plastic waste per capita than anywhere else in the world, yet only 9% of our plastic is properly recycled (Environment and Climate Change Canada, 2020a). The Government of Canada has no national framework for recycling of plastics; instead, each province is responsible for their own waste management, and each municipality is responsible for their own waste collection. This fragmented approach to waste management is problematic and difficult to standardise, particularly when Canada strives towards zero-plastic waste (Walker and Xanthos, 2018). Provinces have different criteria for waste diversion, which causes recycling standards to become disjointed across Canada. Further, current waste sorting and processing facilities are ill-equipped to manage the flow of plastics produced from long-established plastic manufacturers (Divert NS, 2021).

Plastics are amongst the most common anthropogenic items found in the environment during clean-up initiatives across Canada (Environment and Climate Change Canada, 2020a). On average, eight out of the top 12 items collected annually are SUPs (OceanWise, 2020). The prevalence of plastic in the environment has created problems for the Canadian economy. Plastic pollution costs up to $8 billion CAD annually via lost economic value and/or environmental damages (Deloitte, 2019; Environment and Climate Change Canada, 2020b). Costs could rise to $11 billion CAD by 2030 if no action is taken to improve Canada’s waste management systems (Deloitte, 2019). Nova Scotia’s disposal rate is almost 50% lower than the Canadian average (Divert NS, 2018). However, plastic accounts for 21% of municipal waste in Nova Scotia landfills (approximately 60,000 tonnes annually) (Ashtab and Whyte, 2019). Prior to implementing the provincial plastic bag ban on October 30, 2020 (Walker, 2021b), 4% of waste comprised plastic bags, equating to 500 million plastic bags annually (Campbell, 2018).

Similar to the rest of Canada, Nova Scotia does not have the capacity to manage large quantities of plastic waste. Instead, several businesses have experimented with different types of plastic processing technologies, such as upcycling plastic to synthetic lumber. Municipalities have also exported plastic waste to be recycled in foreign countries with less rigorous standards (Ashtab and White, 2019). As a coastal province, there is a higher likelihood for plastic waste generated to enter into the marine environment. For example, a recent study found approximately two million debris items on the seafloor in the Bay of Fundy, of which 50% were plastics (Goodman et al., 2020). Despite current plastic management efforts, a more robust strategy to reduce plastic pollution is required.

1.3. Plastic reduction policies

The Canadian government has made progress in addressing plastic management challenges through action plans and legislation. In 2015, Canada adopted the United Nations 2030 Agenda for Sustainable Development (Employment and Social Development Canada [ESDC], 2019). As part of this movement, environmental protection efforts increased across Canada. The same year, microbeads were classified as toxic under the Canadian Environmental Protection Act (CEPA) (Pettipas et al., 2016; Xanthis and Walker, 2017). In 2018, Canada signed onto the G7 Oceans Plastics Charter with the goal of moving towards zero-plastic waste and mitigating marine plastic (Walker and Xanthos, 2018). This gave way to legislation. For example, in 2019, Canada committed to legislatively banning check-out bags, straws, stir sticks, six-pack rings, plastic cutlery, and food containers made from hard to recycle plastic under CEPA by the end of 2021 (Environment and Climate Change Canada, 2020b, 2021; Walker, 2021b, 2021c).

Prior to the COVID-19 pandemic many food services across Nova Scotia adopted sustainable actions and implemented SUP reduction initiatives such as business recognition programs (e.g., Ocean Friendly Nova Scotia [OFNS]) (Varkey et al., 2021). Consumers widely use reusable items, while many restaurants worked toward zero-plastic waste in an attempt to foster a circular economy (Arrandale et al., 2021; Kitz et al., 2021; Walker et al., 2021). In October 2020, Nova Scotia became the third Canadian province to implement a provincial wide plastic bag ban (Government of Nova Scotia, 2019, 2021). Unfortunately, interest in reducing SUPs came to a standstill in many jurisdictions during the COVID-19 pandemic.
(Patricio Silva et al., 2020, A. 2021; Prata et al., 2020; de Oliveira et al., 2021; Kochafańska et al., 2021). Nova Scotia announced its first three cases of COVID-19 on March 15, 2020 and promptly called for the closure of all in-person dining in restaurants. However, take-out and delivery were still permitted (Restaurants Canada, 2021). By July 31, 2020, grocery stores were limited to 25% capacity, and masks were mandatory (Roth et al., 2021). These actions effectively halted the progress of all plastic reduction initiatives.

The COVID-19 pandemic triggered an increase in the use and disposal of SUPs. Public health guidelines mandating takeout service only, use of PPE, and a fundamental misunderstanding of COVID-19 transmission fuelled unsustainable plastic consumption. There is an urgent need to reverse this trend. To address the rise in SUPs due to COVID-19, this study investigated SUP reduction in the food service sector across Nova Scotia. The primary research objectives for this study were to: identify current challenges of SUP reduction in food services during the COVID-19 pandemic; develop future opportunities for SUP reduction in food services post COVID-19; and, provide resource and recommendation material for food services across Nova Scotia.

2. Methods

A combination of semi-structured interviews and focus group meetings were used to understand concerns surrounding SUP use during COVID-19, and potential opportunities for reduction strategies from stakeholders in the food services, waste management, and public service sectors across Nova Scotia. Semi-structured interviews and focus groups have been widely used in qualitative research as a cost-efficient and timely method of elucidating perceptions and opinions of the participant(s) (Gill et al., 2008; Jamshed, 2014). For this study, sectors were selected to provide a holistic perspective on current challenges facing the food sector during COVID-19 from upstream regulations to downstream waste.

Recruitment of participants included those who hold a position of seniority at restaurants, grocery stores, and waste facilities across Nova Scotia, particularly within the Halifax Regional Municipality (population 431,479 in 2017). This included owners, supervisors, managers, and/or any other position that has knowledge surrounding plastic use, and has authority to enact change, within their respective organization (including academic research, ENGOs, food service, Nova Scotia Environment and Climate Change, Nova Scotia Health and waste management). Grocery store supervisors and/or managers were contacted for participation in this study did not respond.

Targeted participants also included representatives from the Retail Council of Canada, the Nova Scotia Restaurant Association and Public Health officials, as well as relevant internal networks of the research team (Restaurants Canada, 2021). There was no target number of participants. However, the goal was to recruit as many as possible and who were willing to participate in the study. Recruitment was conducted by the lead author through email. Potential participants were invited to participate in a semi-structured interview and/or a focus group. Participants were invited to take part in both data collection methods but had the freedom to choose either or both options. The same invitation script was used for all emails. No screening procedures were used during recruitment; however, participants were at least 18 years old. Other members of the research team were copied on emails. Prior to the start of data collection, all participants were required to sign a form consenting to their involvement in the study. Data collection methods were completed in accordance with the Dalhousie University Research Ethics Board (see supplementary material S1).

2.1. Semi-structured interviews

Semi-structured interviews were conducted one-on-one to attain qualitative information regarding behaviours related to SUP use, waste trends, and waste reduction initiatives in food services before and after the onset of the COVID-19 pandemic. The private and semi-structured nature of interviews allowed participants to freely express their ideas and concerns surrounding a zero-plastic waste future. Interview questions were tailored to each sector (see supplementary material S2). Interviews lasted approximately 30 minutes and were conducted throughout May and June 2021. All interviews were conducted using the video conference platform, Zoom (https://zoom.us/), to maintain COVID-19 safety measures. Interviews were audio recorded, transcribed, and anonymized for secure data analysis.

2.2. Focus groups

Focus groups followed the semi-structured interviews. Focus groups provided a medium for participants to discuss COVID-19 related challenges in SUP reduction, opportunities for SUP reduction during COVID-19, and development of future strategies and resources for long-term SUP reduction post-COVID-19. Participants were divided into two focus groups, to ensure adequate time for all members to convey their thoughts. The online whiteboard application, Mural, was used to generate discussion and organize ideas. It also provided a non-verbal option for members to contribute to the conversation. Both focus groups had the same structure and each took approximately one hour. The first focus group occurred on June 24, 2021, and the second occurred on June 29, 2021. Focus groups were conducted using the video conference platform, Zoom. Focus groups were audio recorded, transcribed, and anonymized for secure data analysis.

2.3. Data analysis

Data gathered from the two collection methods were analysed through a process of coded thematic analysis as described by Bree and Gallagher (2016). The semi-structured interview and focus group transcripts were exported to their own respective Excel spreadsheets. Each spreadsheet was organized by question/discussion point. Interview questions from each sector were consolidated by topic to group similar themes and ideas. The data was conveyed as a single column of all the comments from the participants. Each individual cell was then reviewed and assigned under a theme and sub-theme. There were no pre-determined themes or sub-themes in place prior to the coding. If a comment fit into multiple themes, the cell was duplicated, and each cell was coded respectively to ensure the prevalence of all themes was reflected. The data was then sorted by theme. Themes from the two data collection methods were then compared to develop recommendations for SUPs use, disposal, and reduction strategies during and after COVID-19.

3. Results

3.1. Semi-structured interviews

A total of 14 participants were interviewed representing six sectors (including academic research, ENGO, food service, Nova Scotia Environment And Climate Change, Nova Scotia Health and waste management) (Table 1). Seven key questions asked during each interview. Pie charts illustrate major themes extracted from transcripts. A single set of ordered colors (blue for interviews and green for focus groups) which progress in perceptually equal intervals (i.e., a sequential palette) was used to highlight weight-
ing of participant comments. Darker shades represent the highest proportion of participant comments with comment proportions decreasing towards lighter shades. Sub-themes of interview responses were also determined (see supplementary material S3).

Participants were asked to identify any pre-existing SUP reduction initiatives prior to the onset of COVID-19 with 54 comments extracted from interview transcripts (Fig. 1a). Most comments referenced a variety of operational procedures for plastic reduction in their business before COVID-19. For example one participant said: “We switched to compostable takeaway containers, like cardboard ones instead of Styrofoam. We’ve switched to paper coffee cups instead of Styrofoam. And we’ve switched to compostable straws”. These included internal strategies to reduce SUP use by implementing internal environmental committees, exchange programs, reducing food waste, switching suppliers, financial incentives, and ingraining these reduction strategies into their business models. Using biodegradable alternatives (i.e., compostables and paper options), accepting reusables, and making efforts to reduce unnecessary plastic were all widely used SUP reduction initiatives within the food service sector before COVID-19. One participant commented that there were no plastic reduction initiatives prior to the onset of COVID-19: “Before COVID we were not doing anything down here”.

Participants were asked about future plans for SUP reduction initiatives after COVID-19 with 47 comments extracted from transcripts (Fig. 1b). Most comments referenced plans for implementing SUP reduction initiatives after COVID-19. One participant said: “Yes, we’ve talked about wooden cutlery”. For example, SUP reduction initiatives in Canada already include both provincial and federal bans on plastic grocery bags and harmful or difficult to recycle SUPs. For example, provincial governments in eastern Canada (e.g., Prince Edward Island, Newfoundland and Labrador, and Nova Scotia), have already implemented legislation banning SUP grocery bags (Government of Nova Scotia, 2019, 2021; Government of Prince Edward Island, 2020; Walker et al., 2021). At the federal level, Canada has also committed to banning SUPs such as plastic grocery bags, straws, stir sticks, six-pack rings, cutlery and food containers made from hard-to-recycle plastics by the end of 2021 (Environment and Climate Change Canada, 2020a, A. 2021). Operational procedures and strategies for SUP reduction within food services, such as extended producer responsibility, implementing innovative initiatives, ongoing efforts, and financial incentives were discussed as future options for SUP reduction initiatives after COVID-19 (Diggle and Walker, 2020, 2022). Education and awareness programs were also mentioned. For example, participants showed interest in providing education for staff and consumers, conducting research on best practices, and improving messaging on packaging as education-based strategies. Reducing unnecessary plastic was also mentioned as a future SUP reduction initiative following COVID-19. Reduction-based strategies include

---

**Table 1**

| Number of participants | Sector                                      |
|------------------------|---------------------------------------------|
| 1                      | Academic research                           |
| 2                      | ENGO                                        |
| 6                      | Food service                                |
| 2                      | Nova Scotia Environment and Climate Change  |
| 2                      | Nova Scotia Health                          |
| 1                      | Waste management                            |

**Fig. 1.** Interview response themes to (a) pre-existing SUP reduction initiatives before COVID-19, and (b) plans for SUP reduction initiatives in food services after COVID-19.
use of less plastic based items, limiting plastic available to consumers, and sourcing recyclable material. Although some participant comments did not report any plans for SUP reduction initiatives after COVID-19, other planned SUP reduction initiatives included implementing biodegradable alternatives, relying on current provincial and future federal government legislation, and re-introducing reusables.

Participants were asked which COVID-19 restrictions and guidelines have impacted food services the most with 56 comments extracted from transcripts (Fig. 2a). PPE was the most dominant theme with participants referencing the increased need for sanitization, face coverings, gloves, and plexiglass dividers to reduce the spread of COVID-19. Social distancing was another dominant theme with participants citing limited physical contact, guiding arrows, and reduced staffing capacity. Another common themes included the uncertainty of using reusables. For example, many food service participants are refusing to handle reusable mugs, plates, bags, and other reusables for fear of COVID-19 transmission. Other common themes impacting the food service sector were restrictions limiting to takeout and delivery options only, rather than dining in, reduced occupancy capacities inside businesses, removal of consumer facing products (e.g., self-serve or buffet options), and full business lockdowns. Of less concern was following general public health guidelines and one participant comment did not acknowledge any significant impacts from COVID-19 regulations.

One participant said: "So right now we're limited to take out only. We're not actually currently open right now. But previous times during this pandemic, we have been limited to take only and that has increased our use of single use plastics. Other times during this pandemic we've been allowed 50% capacity. It's reduced our capacity a lot having to have distance and plexiglass dividers between the tables and stuff".

Participants were asked to identify any changes in the type or quantity of SUPs since the start of COVID-19 with 62 comments extracted from transcripts (Fig. 2b). An increase in food containers was the most dominant theme with interview results indicating plastic and Styrofoam for food takeout had increased the most, including catering and condiment containers. The overall increase in plastic packaging was a dominant theme with participants citing that commonly handled products, such as cutlery and food, are now wrapped in plastic to ensure they remain sterile. A general increase in SUPs such as drink containers (bottles and cups) along with increases in cutlery and PPE were identified by interview participants.

Participants were asked what resources food services would require to be better equipped to implement SUP reduction initiatives with 44 comments extracted from transcripts (Fig. 3a). There was a fairly even distribution of ideas from all sectors for how food services can improve plastic management. Education and awareness programs was a dominant theme for this question and was also a common theme discussed across other questions. Participants explained that understanding the packaging supply chain and researching what alternatives are accessible and compatible for their respective local waste diversion programs was critical for reducing...
plastic waste. Financial incentives, available resources and support were common themes. Participants suggested financial encouragement and incentives for businesses to implement sustainable options would support SUP reduction. Additionally, third party assistance in implementing best practices, or a resource guide for SUP reduction initiatives, were mentioned as potentially valuable resources and supports. Collaboration with stakeholders, such as suppliers, ENGOs, or other food services, was considered important.

Sourcing better alternatives, re-modelling business plans to include SUP reduction initiatives, increasing government legislation, and garnering more public support were all identified as potential tools for SUP reduction.

Participants were asked to identify initiatives and strategies food services can implement immediately to reduce SUPs with 87 comments extracted from transcripts (Fig. 3b). Again, operational procedures were the most important strategies identified that could influence SUP reduction initiatives. Simple yet effective operational procedure changes that food services could implement now include only offering plastic items upon request, setting up exchange programs with suppliers and consumers, promoting reduction efforts to consumers, and implementing new innovative initiatives. Switching to biodegradable alternatives, such as compostables, and re-introducing reusable items into food services were suggested.

One participant noted that compostables have their own challenges and unintended environmental consequences; “Compostable plastics or you know, something that looks like it’s a cardboard product but it actually has plastic lining in it. That is, like just not going to really help anything. It’s a waste of their money because they’re paying a premium for that. But it can’t really go in our composting system and it then can’t really be recycled.”

Reducing unnecessary plastic within food services, collaborating with stakeholders, contributing to behaviour change by changing the business-as-usual model (i.e., status quo), improving waste management practices, implementing more education and awareness programs and expanding financial incentives were all identified as other strategies for SUP reduction.

Participants were asked to discuss any concerns surrounding SUPs and plastic waste with 256 comments extracted from transcripts (Fig. 4). Confusion surrounding waste management programs and facilities was the most dominant concern. Specifically, participants referenced inadequate waste processing facilities for biodegradable alternatives, contamination in the compost, low recycling rates, pre-existing plastic pollution, and inconsistency in waste management practices across jurisdictions. The financial cost of switching to zero-plastic waste was also identified as a major concern. Participants expressed concern over the high price of sourcing proper alternatives, and prices have further increased during COVID-19. COVID-19 restrictions were also identified as a concern. Interviewees noted that food services faced many restrictions related to the pandemic and many struggled to survive. They were limited to takeout/delivery only and so paused SUP reduction initiatives. Other barriers to SUP reduction included lack of alternative standards, convenience culture, the large scale and size of the issue, poor waste management, market issues, health and safety requirements, lack of education, insufficient government action, and negative public perceptions.
3.2. Focus groups

A total of 10 participants participated in two focus groups representing five sectors (including ENGO, food service, Nova Scotia Environment And Climate Change, Nova Scotia Health and waste management). (Table 2). Other than lacking representation from the academic sector (which as only represented by a single participant), the recruitment and composition of the focus groups was comparable to the semi-structured interviews. Four key research questions were discussed based on the primary research objectives. Pie charts illustrate major themes extracted from four discussion questions. Sub-themes of focus group responses were also determined (see supplementary material S3).

The first focus group topic asked participants to discuss challenges and barriers for SUP reduction in food services with 143 comments extracted from transcripts (Fig. 5a). Challenges triggered by COVID-19 restrictions, improper alternatives, and convenience culture were the most important and equally common themes to SUP and/or plastic waste concerns in food services.

Fig. 4. Interview response themes to SUP and/or plastic waste concerns in food services.

Fig. 5. Focus group themes on (a) challenges for SUP reduction, and (b) existing opportunities for SUP reduction in food services across Nova Scotia.
Table 2

Focus group participants (n=10).

| Number of participants | Sector                                      |
|------------------------|---------------------------------------------|
| Focus Group 1          |                                             |
| 1                      | ENGO                                        |
| 4                      | Food service                                |
| Focus Group 2          |                                             |
| 1                      | ENGO                                        |
| 1                      | Food service                                |
| 1                      | Nova Scotia Environment and Climate Change   |
| 1                      | Nova Scotia Health                          |
| 1                      | Waste management                            |

barriers. COVID-19 restrictions discussed included restrictions on reusables, limiting services to takeout/delivery, and social distancing measures. These barriers caused many food services to pause SUP reduction initiatives as businesses were focused on remaining in operation throughout the pandemic. Many food services had limited plastic alternative options and many stakeholders expressed that some alternatives have a higher carbon impact than plastic. However, a recent life cycle assessment study by Cabernard et al. (2021) indicated the environmental footprint of plastics is higher than previously thought, and driven mainly by coal combustion during production. Often food services had invested in alternatives that were not truly biodegrable, or were not accepted in local waste management facilities. The lack of regulated standards for plastic alternatives creates confusion for food services, which gives rise to the threat of greenwashing. Convenience culture has created a barrier for SUP reduction. Many food services automatically include plastic items (e.g., cutlery) for consumers. Other barriers mentioned include waste management confusion, negative public perceptions, financial barriers, the daunting scale of the SUP reduction problem, lack of education and awareness, lack of government action, poor waste management, and health and safety requirements.

The second focus group discussion topic explored existing opportunities for SUP reduction in food services with 105 participant comments extracted from transcripts (Fig. 5b). Existing opportunities were defined as initiatives and/or activities that could be implemented within one year if public health guidelines allowed. Operational procedures, and education and awareness programs were considered the most important by participants. Small, easy to implement changes in operational procedures in food services can help provide strategies for SUP reduction such as only offering plastic items at consumer’s request, promoting SUP reduction initiatives via social media or directly to consumers, and implementing financial incentives for SUP reduction. Using biodegradable alternatives, compostables, and/or paper options were considered important opportunities for SUP reduction. Other existing opportunities for SUP reduction included creating behaviour change, re-introducing reusables into food services and reducing unnecessary plastic. Additionally, collaborating with other businesses, suppliers, and consumers, government action and improving waste collection practices were also considered important.

The third focus group discussion topic explored the potential for future SUP reduction strategies in food services with 65 participant comments extracted from transcripts (Fig. 6a). Future opportunities were defined as projects requiring more than one year to implement. The most common strategy suggested by participants was implementing exchange programs in which food services may swap reusable containers with other organizations, consumers, suppliers, and within the business. Remodelling operational procedures was also considered important by participants. Creating new SUP reduction initiatives and engraining them into business models was recommended to create behaviour change among consumers. Another operational procedure suggested was development of internal environmental committees to improve business accountability. Better access to SUP reduction resources and supports was also suggested. Creation of SUP reduction guides for businesses could help reduce confusion amongst managers and assist them in implementation waste reduction strategies. Improving financial incentives within food services was also suggested. To a lesser extent, supporting government actions, education and awareness programs, sourcing better alternatives, and increasing public support were considered important future strategies for SUP reduction by participants.

The final focus group discussion topic highlighted resources and tools required to achieve zero-plastic waste in food services with 43 participant comments extracted from the transcripts (Fig. 6b). The need for public support was considered most important. Food services require buy-in, and consumer power to sustain and maintain SUP reduction initiatives. Without buy-in, many initiatives may not prioritized, and can be costly to implement. Consumer behaviour can also direct businesses priorities and can be used to influence SUP reduction. Collaboration with stakeholders was proposed by participants as a potential way to influence plastic waste reduction in food services. Participants discussed the need for all points of the plastic supply chain, from manufacturing to waste management, to collaborate SUP reduction efforts. Further, participants mentioned that future strategies need to be examined using a top-down holistic approach. Food services need to revamp their business models, operational procedures and build infrastructure to support SUP reduction initiatives. Receiving some form of financial assistance from the government or a third party was considered important by participants. Participants also believed that creating behaviour change, sourcing better alternatives, and implementing education and awareness programs were required to achieve zero-plastic waste.

4. Discussion

4.1. Misperceptions of COVID-19 transmission concerning reusables

Participants in this study confirmed there were many opportunities for SUP reduction in food services prior to COVID-19. However, they highlighted that many challenges remain for food services operating during the pandemic (Figs. 1, 5a, 5b). This study reafirms that COVID-19 halted, and in some cases reversed, progress made to reduce SUPs in the food service sector in Nova Scotia reported in previous studies (e.g., Kitz et al., 2021; Varkey et al., 2021) (Figs. 2a and 4). This has been a pattern observed in many jurisdictions around the world, with reversal of SUP reduction policies and increased use of SUPs for food takeout (e.g., plastics containers, plastic utensils and plastic bags) (Patricio Silva et al., 2020, A. 2021; Prata et al., 2020; de Oliveira et al., 2021; Kochańska et al., 2021) (Fig. 2b). Much of this increased SUP use was due to safety concerns over COVID-19 (Hale and Song, 2020; Kitz et al., 2021).

Given the unprecedented nature of the pandemic, there was much public uncertainty and confusion surrounding transmission of the virus, particularly with surfaces (Hale and Song, 2020). During the first wave of the pandemic, studies confirmed the COVID-19 virus can survive on surfaces for days, and guidance issued by the World Health Organization (WHO) at the time, stated COVID-19 can spread through contaminated surfaces (van Doremalen et al., 2020; World Health Organization, 2020). However, as research and evidence accumulated throughout the pandemic, understandings of transmission changed (Hale and Song, 2020). Instead, COVID-19 spreads primarily via aerosol droplets when infected people cough, sneeze, or speak (Siorria, 2020; Hatmi, 2021; Lewis, 2021). If preventive measures and sanitizing routines are maintained, the risk of COVID-19 infection from contact with a contaminated surface is
less than 5 in 10,000, which is lower than the surface transmission risk for the common flu (Lewis, 2021; Singh et al., 2021). Therefore, this science-based evidence undermines the argument to use SUPs as a health measure to prevent COVID-19 transmission. The Government of Nova Scotia in collaboration with Restaurants Canada provided a re-opening guidance document to prevent the spread of COVID-19 for food service operators. The re-opening plan requires mandatory masks for servers, use of approved cleaning and products and procedures, and maintenance of 2 m physical distancing whenever possible (Restaurants Canada, 2021). The re-opening plan also recommends third-party support and resources for best practices to assist food services in operating a safe and sustainable business.

Public health guidance and current understanding of transmission may not be the only driver for increase SUP use (Figs. 2a and 4). Early in the pandemic some food retail businesses took action to suspend accepting reusable products even before public health guidance about reusables became available, citing the need for caution and health and safety concerns for employees, customers and store owners (Arrandale et al., 2021). In a Greenpeace USA statement released in June 2020, a group of over 125 virologists, epidemiologists and health experts from 19 countries agreed that the risk of transmitting COVID-19 via surface contact was slim, and reusables were safe and should be encouraged (Greenpeace USA, 2020). Unfortunately, despite reassurances from experts that the risk of transmission of the virus through contact with contaminated surfaces is low (Centers for Disease Control and Prevention [CDC], 2021; Greenpease USA, 2020; Arrandale et al., 2021), there is still some uncertainty surrounding use of personal reusable containers, such as coffee mugs, within food services (Harris, 2021). Participant comments indicate that accepting reusables inside a business depends on the individual perspective of the staff member, and their assessment that the item is clean. For example, a coffee shop in Nova Scotia wrote a notice to communicate to customers that reusables may or may not be accepted based on comfort levels of the staff due to safety concerns (Fig. S5). It is critical that these misperceptions surrounding COVID-19 transmission be corrected. The re-introduction of reusables is an immediate opportunity for SUP reduction in food services.

Unfortunately, this study did not include interviews with consumers. This study focused on SUP use and opportunities to increase reusables within the food sector during the pandemic. To date, there has been little research on the extent of consumer behaviour changes related to SUP use or reusables during the pandemic (Kitz et al., 2021). Thus, several research gaps exist that limit our understanding of the impact of the pandemic on use of SUPs and reusables (Arrandale et al., 2021; Kitz et al., 2021). Gaps include how the COVID-19 pandemic has affected consumer use of reusables items, or what concerns prompted changes in use. Several recent studies have investigated how the pandemic has affected food waste-related behaviour. For example, the pandemic has led to reduced household food waste and to changes in food consumption habits (Principato et al., 2020; Qian et al., 2020). Similar research on the use of SUPs vs. use of reusables may offer in-
sight into how pro-environmental consumer behaviour can be promoted after the pandemic (Arrandale et al., 2021).

4.2. Convenience culture and behaviour change

Before the pandemic, previous studies reported strong consumer awareness about the negative environmental impacts of SUPs with many consumers adopting pro-environmental behaviours (Borg et al., 2020; Adam et al., 2021; Adeyanju et al., 2021; Walker et al., 2021). However, the COVID-19 pandemic has since reversed many of these pro-environmental behaviours and consumer attitudes toward SUP food packaging (Kitz et al., 2021). Results suggest SUP convenience culture made a resurgence within the food services sector, fuelled by challenges brought on by COVID-19 restrictions. Businesses were forced to change operational procedures to follow social distancing guidelines and service limitations (Restaurants Canada, 2021). Pro-environmental behaviour and sustainability initiatives took a backburner during COVID-19 as businesses struggled to remain open (University of Guelph, 2021). Pausing SUP reduction initiatives skewed perceptions of zero-plastic waste and slowed progress towards a circular economy (Vanapalli et al., 2021). Consumers were restricted to only takeout and delivery food and drink options for months at a time during the pandemic. Participant comments indicated that during these times, food services maintained standard to-go practices as convenience culture continued to persist in society. Businesses provided socially-expected SUPs, such as cutlery and straws; however this practice became increasingly wasteful as many consumers were eating to-go food at home which did not require SUPs.

All local businesses have the ability to not cater to convenience culture by modifying operational procedures and implementing SUP reduction initiatives back into daily activities and functions (Figs. 3a, 3b, 6a, 6b). In this case of convenience culture, providing SUPs to the consumer should be the exception, as opposed to the default. Overtime, consumers will become familiarized with the new standard and our dependence on SUPs can be successfully phased out by creating social norms of “green” behaviours and eliminating convenience culture (Borg et al., 2020). Influencing behaviour change within food services can help reduce consumption of plastics (Huang, 2016). Results indicate SUP reduction initiatives are most effective in the food services sector when ingrained within business models from the start. However, changes to business operational procedures can and should be implemented at any point. Making an active effort to alter and adapt operational changes gradually over time to support environmental goals and sustainability initiatives is a continuous opportunity for SUP reduction in food services.

4.3. Lack of standards for alternatives and waste management

Results suggest there is a great deal of confusion and concern in food services surrounding proper alternatives to SUPs and their associated waste management, since standards are inconsistent across Nova Scotia (Fig. 2b). Biodegradable plastics, or “bioplastics”, are commonly marketed as sustainable alternatives (Charlebois et al., 2022). However, the recyclability of any bioplastic depends on design and raw materials used (Jia, 2020). Although most bioplastics claim to be bioderadable, the degradability of bioplastics in the natural environment leads to increased plastic pollution (Vanapalli et al., 2021). Further, local waste facilities may lack capacity to process bioplastics, and instead they end up contaminating the recycling and/or composting stream (Perennia, 2021).

An issue that was perhaps amplified by increased takeout and delivery in food services was the responsibility of consumers to properly sort waste. Participant comments indicate bioplastics are especially problematic in waste sorting. Municipal composting facilities are often unable to distinguish between normal and bioplastics, resulting in “compostable plastics” being banned in many Nova Scotian communities (Divert NS, 2021). However, some jurisdiction like Shelburne Municipality and the Valley Waste Resource Management will accept compostable plastic bags that have a specific logo indicating compliance with Biodegradable Products Institute standards (supplementary material S4). The mismanagement of plastic waste and differences in waste management between jurisdictions results in plastic contamination at processing facilities, especially when people travel between regions (Prata et al., 2020). The development of diversified waste management strategies would improve recycling capabilities.

Understandably, participant comments indicate businesses are also concerned about the financial cost of switching to SUP alternatives (Figs. 3a and 4). Bioplastics are expensive to purchase and integrate, and can only compete on price with SUP if oil prices are high (Golberry, 2020). COVID-19 has led to a crash in global oil prices, which also decreased the price of creating SUPs (Ebner and Iacovidou, 2021). With SUPs being the most inexpensive available material for takeout containers, many food services fall back to using them. Losing customers to a less expensive competitor is a real threat for restaurants, many of whom have small profit margins. Businesses might be more likely to switch to environmentally friendly alternatives if the government is able to subsidize the additional costs as an incentive. Perception and behaviour change toward sustainability and climate-friendly behaviour can be significantly influenced by government policy or regulations. (Adeyanju et al., 2021).

4.4. Limitations and considerations

This research was conducting during the COVID-19 pandemic. Therefore, it is likely that COVID-19 may have dissuaded additional participants from participating in the data collection process as many food services were closed or had competing priorities. As such, participants (n=14) in this study represent only a small fraction of the sectors to which they belong and those who participated were likely already concerned about excessive SUP use which could have introduced bias in the data. Similarly, due to scheduling and availability, participants in the two focus groups did not represent a strong distribution of all food retail sectors. Rather, participants ended up being grouped together by sector, resulting in similarly participants people in the same focus group. This, unfortunately, reduced the potential for debate and discussion between sectors. One major contributor to SUP use during the COVID-19 pandemic in the food services sector were grocery stores (Helmer, 2021a). However, all grocery store supervisors and/or managers contacted for participation in this study did not respond. This is a knowledge gap and an opportunity for future research.

4.5. Recommendations

Based on responses from semi-structured interviews and focus groups, the following strategies are recommended for food service SUP reduction in Nova Scotia:

1. **Adopt operational procedures that reduce business reliance on plastic products**: Operational procedures that promote use of plastic for convenience should be phased out. These were re-occurring themes through many of the interview question responses. This includes automatically giving out SUPs to consumers, using plastic-based materials inside businesses, and excessive plastic packaging. Altering business operations to eliminate unnecessary consumer-facing plastic will help to reduce
public demand, and thus create behaviour change. Businesses can utilize external resources to assist in reducing SUPs. Costal Action's Ocean Friendly Nova Scotia Initiative is a business recognition program that offers consultation and provides resources to assist businesses transition away from SUPs and develop a plan for achieving sustainability goals (Varkey et al., 2021). To some extent, this will become a federally legislated requirement once certain harmful or difficult to recyle SUPs are banned (Walker, 2021b,c).

2. Promote education and awareness to staff and consumers: Education on plastic issues can support food services in making informed decisions and create accountability for plastics used. These were reoccurring themes through many interview and focus group responses (e.g., Figs. 1a, 3a, 3b, 5b, 6a and 6b). Ensuring food services understand best practices for environmental sustainability, such as becoming familiar with local alternative options and waste processing standards, can assist in reducing SUPs within their businesses. In Nova Scotia there are a number of ENGOs that provide training materials in SUP reduction for food services. Divert NS offers a free education session with a local waste educator so business can learn about best waste management practices within their municipality (Divert NS, 2021).

3. Re-introduce reusables: Food services are encouraged to return to serving customers with reusable items, such as mugs, containers, and water bottles. Again, these were reoccurring themes through many interview and focus group responses (e.g., Figs. 1a, 1b, 2a, 3b, and 5b). Health officials and researchers have confirmed that reusables are safe to use in food services with proper sanitary precautions in place. Notable businesses including Starbucks and Target have already returned to using reusables in stores (Harris, 2021; Helmer, 2020b). Businesses should advocate for reusables as new scientific evidence becomes available, thereby emphasizing that SUPs are not inherently safer than reusables. Accepting reusables can eliminate the need for disposable takeout items, particularly coffee cups.

4. Build infrastructure around exchange programs: Exchange programs for takeout containers as well as coffee mugs are becoming increasingly common in larger Canadian cities like Toronto. Food services can create exchange programs in which the business swaps takeout containers with consumers, or bulk food containers with suppliers. Businesses can also reach out to third party organizations, such as Suppli and Muuse, that manage exchange programs for them (Muuse, 2021; MySuppli, 2021). Common formats involve businesses partnering with third parties to obtain access to their reusable containers. After consumer use, containers can be dropped off at designated locations to be cleaned and sanitized by the third party and returned to the restaurant for reuse. Exchange programs can largely eliminate the need for single-use containers within food services. Exchange programs provide a solution for eliminating plastic takeout containers.

5. Source SUP alternatives in consultation with waste facilities: Use of 100% plant based biodegradable alternatives in food services is preferred over SUPs. This can include bamboo cutlery, mushroom packaging, or other alternatives manufactured with paper-based material, sugarcane, and/or wheat grains (Mushroom packaging, 2021). Plant based biodegradable alternatives without plastic liners alleviate pressure on local waste management systems by diverting material to the compost and reducing the flow of plastic. Use of sustainable products should be encouraged in food services. It is essential that businesses collaborate with local waste managers to find alternatives acceptable within their facilities, otherwise businesses run the risk of investing in the wrong alternative. A province-wide waste sorting and management guide may help reduce confusion and contamination.

5. Conclusions

Government restrictions and public health guidelines triggered a reversal of societal consumption of SUPs. Initial uncertainties and excessive misinformation on virus transmission caused many food services to rely on SUPs to operate. Ongoing research contributes to improved understanding of the pandemic. As food services adapt to COVID-19, businesses are encouraged to return to pre-pandemic SUP reduction efforts such as accepting reusables, using biodegradable alternatives, and phasing out SUPs. However, businesses often require external nudges to implement action.

Results highlight the need for all food sector stakeholders to cooperate at all levels of the plastic supply chain from manufacturers to businesses to processing and disposal facilities to reduce the flow of SUPs. Creating behaviour change and combatting convenience culture comes from implementing a variety of SUP reduction initiatives. It is recommended that food services update their business models to better support operational programs and initiatives that re-introduce SUP reduction for both suppliers and consumers. Future studies should investigate the use of SUPs vs. use of reusables to understand how pro-environmental consumer behaviour can be promoted after the pandemic. Food services have a responsibility to address their plastic use, and make adjustments to reduce their plastic waste.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

Funding was provided by Divert NS.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.spc.2022.01.023.

References

Adam, I., Walker, T.R., Clayton, A., Bezerra, J.C., 2021. Attitudinal and behavioural segments on single-use plastics in Ghana: Implications for reducing marine plastic pollution. Environ. Challenges 4, 100185.

Adeyoooju, G.C., Augustine, T.M., Volkman, S., Oyebamuj, A.O., Ran, S., Osohnoj, O.A., Oitoj, A., 2021. Effectiveness of intervention on behaviour change against use of non-biodegradable plastic bags: a systematic review. Discover Sustain. 2 (14), 2876.

Adel, T., 2020. Accumulation of plastic waste during COVID-19. Science 396 (6509), 1314–1315.

Alfonso, M., Arias, A., Menendez, M., Ronda, A., Harte, A., Piccolo, P., Marcovitcho, J., 2021. Assessing threats, regulations, and strategies to abate plastic pollution in LAC beaches during COVID-19 pandemic. Ocean Coast. Manage. 208 (105613), 1–8.

Ammodounda, J., Saturno, J., Brooks, A.L., Jacobs, S., Jambeck, J.R., 2021. An emerging source of plastic pollution: environmental presence of plastic personal protective equipment (PPE) debris related to COVID-19 in a metropolitan city. Environ. Pollut. 269, 116360.

Arrandale, V.H., Ikiz, E., Lee, C., Maclaren, V.W., Bondy, S.J., Sander- son, R.A., Miller, F.A., 2021. Opportunities For Reusables in Retail Setting During the COVID-19 Pandemic in Canada: A review of Guidance and Evidence. University of Toronto. Sponsored by the Dalla Lana School of Public Health, Toronto (ON) http://www.nwzc.ca/Document/ NZWC_OpportunitiesforReusablesinRetailReport.pdf.

Ashr, S., Whyte, G., 2019. Circular Economy of Nova Scotia. Workplace Rev. 17 (24), 1–9.

Beaumont, N., Aanesen, M., Asten, M., Boger, T., Clark, J., Cole, M., Hooper, T., Lind- eque, P., Pasco, C., Wyles, K., 2019. Global ecological, social and economic impacts of marine plastic. Mar. Pollut. Bull. 142, 189–195.
Walker, T.R., 2021c. Canada is right to classify single-use plastics as toxic. Nature 594 (7864), 496.
Walker, T.R., Xanthos, D., 2018. A call for Canada to move toward zero plastic waste by reducing and recycling single-use plastics. Resour. Conserv. Recycl. 133, 99–100.
Walker, T.R., McGuinty, E., Charlebois, S., Music, J., 2021. Single-use plastic packaging in the Canadian food industry: consumer behavior and perceptions. Humanities Social Sci. Commun. 8 (1), 80.
Welden, N., 2020. Chapter 8—The environmental impacts of plastic pollution. Plastic Waste Recycl. 195–222.

World Health Organization. (2020). Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf.
Xanthos, D., Walker, T.R., 2017. International policies to reduce plastic marine pollution from single-use plastics (plastics bags and microbeads): A review. Mar. Pollut. Bull. 118, 17–26.
Zhu, X., 2021. The Plastic Cycle–An Unknown Branch of the Carbon Cycle. Front. Marine Sci. 7, 1227.